

## Geologic Scene Investigators: Part 1 – Scratching the Surface Setting the Scene

### Image Information

Please look carefully at the images and select those appropriate to the age of the children in your program. The images with the lower numbers should be the most easy for the children to identify. Mix and match to your audience needs!

Ways to identify features

- Flowing water erodes – or carves – ribbon-like channels across the surface. The flow pattern may be “dendritic,” looking like a tree that branches out into progressively finer limbs. The term comes from the Greek, *dendrites*: tree-like.
- Very rapidly flowing water carves wider, deeper channels, often made of several channels "braided" together. Tear-drop shaped islands and large scattered blocks of material are sometimes present.
- Volcanos create "cones" or "domes" on the surface. These rise above the surface, and often have a circular bowl at the peak. Note that the sides may be steep, like Mount Rainier or Mount St. Helens, found in the Northwest of the United States. Other volcanos are more gentle, made from runny lava, like the volcanos of Hawaii or many of the volcanos on Mars. The base of a volcano forms a rough circle, but often it's edges are scallop-shaped because volcanos form from many lava flows over a long time. Depending on the angle of the Sun, volcanos will cast a shadow on the surface of the planet beyond the volcano.
- Craters are holes, or depressions, in the surface. They often have a very sharp, circular rim. The rim may be raised a little above the surface, and it is surrounded by material that was thrown out of the crater when the impactor hit. Depending on the angle of the Sun, craters will have shadows predominantly inside of the bowl.

# Setting the Scene

## Earth Images

### 1. Earth – Volcano

Photograph of the eruption of Pu`u `O`o in September of 1983. This is a small volcano, now not more 180 meters (600 feet) high on the much larger Kilauea Volcano of Hawaii.

*Photograph by J.D. Griggs, courtesy of the United States Geological Survey  
[http://hvo.wr.usgs.gov/gallery/kilauea/erupt/24ds064\\_caption.html](http://hvo.wr.usgs.gov/gallery/kilauea/erupt/24ds064_caption.html)*

### 2. Earth – Crater

Image from an airplane looking across at Barringer Crater, created by the impact of a meteorite that struck Arizona about 50,000 years ago. This is a small crater, 1.2 kilometers across (0.75 miles) and 419 m deep (1300 feet). The crater has a circular outline with a raised rim, and a deep, bowl-shaped shape.

*Photograph by D. Roddy, courtesy of the Lunar and Planetary Institute [http://www.lpi.usra.edu/publications/slidesets/craters/slide\\_10.html](http://www.lpi.usra.edu/publications/slidesets/craters/slide_10.html)*

### 3. Earth – Channels

Satellite image of the San Juan River channel in southeastern Utah. The river cuts a ribbon-like pattern in the landscape, where it has eroded down through the layers of rock. The river water looks black in this image.

*Image courtesy of NASA's Visible Earth, from Space Imaging [http://visibleearth.nasa.gov/view\\_rec.php?id=17180](http://visibleearth.nasa.gov/view_rec.php?id=17180)*

### 4. Earth – Channels

Image of the Republic of South Yemen taken from the Space Shuttle. While no rivers are flowing now, except for occasional flash floods, the branching pattern – dendritic - was produced by running water. Finding patterns like this on other planets suggests that water flowed across their surfaces.

*Space Shuttle Image STS-41G Picture #17-36-036 courtesy of the Lunar and Planetary Institute  
[http://www.lpi.usra.edu/publications/slidesets/geology/sgeo/slide\\_21.html](http://www.lpi.usra.edu/publications/slidesets/geology/sgeo/slide_21.html)*

### 5. Earth – Volcano

Image of a plume of brown ash spewing from the Cleveland Volcano, one of several volcanos in the Aleutian Islands off Alaska. The picture was taken by astronauts aboard the International Space Station. The volcano rises out of the dark blue to black ocean. Its outline is roughly – though not perfectly – circular. The circular opening at the top of the volcano, where the ash is pouring out, is not visible.

*Image ISS013-E-24184 courtesy of NASA. [http://visibleearth.nasa.gov/view\\_rec.php?id=20701](http://visibleearth.nasa.gov/view_rec.php?id=20701)*

### 6. Earth – Channels

Image taken of the Mississippi River from above in a plane. The river has carved a ribbon-like channel in the landscape. The water in the river is white because it is reflecting the sunlight. The river lies between hills to the left of the photograph and farm fields to the right.

*<http://www.ecology.info/river-that-meanders.htm>*

### 7. Earth – Crater

Aerial image of Wolf Creek crater in Australia taken from a plane. The crater formed about 300,000 years ago when a meteorite hit the Earth. The crater is about 0.85 kilometers (about half a mile) across and about 50 meters (150 feet) deep. It has a circular shape and a sharp rim that rises a little above the surrounding land.

*Photograph by V.L. Sharpton, courtesy of the Lunar and Planetary Institute [http://www.lpi.usra.edu/publications/slidesets/craters/slide\\_12.html](http://www.lpi.usra.edu/publications/slidesets/craters/slide_12.html)*

## 8. Earth – Volcano

Photograph of Mount Rainier and the city of Tacoma, Washington taken from across the bay. Mount Rainier is a steep-sided volcano that last erupted in the 1800's. Such steep sided volcanos are found most commonly on Earth. They form from flows of thick lava and volcanic ash. Mount Rainier is over 4,392 meters tall (14,000 feet).

*Photograph by Lyn Topinka, courtesy of the United States Geological Survey*  
[http://vulcan.wr.usgs.gov/Volcanoes/Rainier/description\\_rainier.html](http://vulcan.wr.usgs.gov/Volcanoes/Rainier/description_rainier.html)

## 9. Earth – Channels

A false-color satellite image of the Dnieper River and the rivers that feed into it in the region of the Ukraine. The edge of the Black Sea can be seen in the lower part of the image. In the image, vegetation is green, bare ground is tan and pink, and clouds are light blue. Water is black and dark blue. There are several streams that flow into the larger river, but the water flowing through them is not seen in this image.

*Image by Jacques Descloitres, MODIS Rapid Response Team, courtesy of NASA and the Goddard Space Flight Center*  
[http://visibleearth.nasa.gov/view\\_rec.php?id=6879](http://visibleearth.nasa.gov/view_rec.php?id=6879)

## 10. Earth – Volcano

Photograph from the ground of ash rise into the air above Mayon Volcano in the Philippines. Ash flows also can be seen moving down the volcano flanks. This feature has a steep-sided cone shape typical of some of Earth's volcanos.

*Image by C.G. Newhall courtesy of the United States Geological Survey* [http://volcanoes.usgs.gov/Images/Jpg/Mayon/32923351-020\\_caption.html](http://volcanoes.usgs.gov/Images/Jpg/Mayon/32923351-020_caption.html)

## 11. Earth – Craters

Space Shuttle image taken above Clearwater Lakes in Quebec, Canada showing two roughly circular lakes. These lakes fill in the depressions – "holes" – of two impact craters that formed simultaneously when two separate, but probably related, meteorites impacted Earth about 300 million years ago. The lake to the left is about 20 kilometers (12 miles) across.

*Space shuttle image STS61A-35-86 courtesy of the Lunar and Planetary Institute*  
[http://www.lpi.usra.edu/publications/slidesets/craters/slide\\_29.html](http://www.lpi.usra.edu/publications/slidesets/craters/slide_29.html)

## 12. Earth – Channels

Satellite image of the Mississippi River and delta from above. A delta forms where a river makes its way to a lake or ocean and drops – or deposits – all of the sand and silt and clay that it is carrying. In the image, the land is green. The river flows in a ribbon-like channel across the land, and enters the blue-green Gulf of Mexico. The brighter to white regions along the river edge are where cities and fields exist. The water in the river and along the coast is brown because of all of the sediment the river is carrying. The part of the delta that the river is building is the piece that is sticking out in the lower right of the photograph.

*Image courtesy of NASA* <http://rapidfire.sci.gsfc.nasa.gov/gallery/?search=mississippi>

## 13. Earth – Volcano

Photograph of the northwest flank of Mauna Loa Volcano, Hawaii. This large, gently sloping "cone" is a shield volcano. Its slopes are so gentle because it is made out of numerous flows of runny basaltic lava. The lava spreads out rather than stacks up. This type of volcano shape – and composition – is found on Mars. Mauna Loa is the largest volcano on Earth. From its base at the bottom of the Pacific Ocean to its tip, it measures 17 kilometers (10.5 miles). It makes up about half of the island of Hawaii.

*Photograph by D. Little, courtesy of the United States Geological Survey* <http://volcanoes.usgs.gov/Products/Pglossary/ShieldVolcano.html>

## 14. Earth - Craters

Space shuttle image of Manicouagan crater in Canada. The crater formed when a large impactor struck Earth about 215 million years ago, creating a large circular depression. The central portion of the crater was uplifted. The crater has been worn down through time by glaciers and water erosion. A lake now occupies the crater, filling in the low areas around the central portion.

*Space shuttle image STS42-207-14 courtesy of the Lunar and Planetary Institute*  
[http://www.lpi.usra.edu/publications/slidesets/craters/slide\\_28.html](http://www.lpi.usra.edu/publications/slidesets/craters/slide_28.html)

# Setting the Scene

## Mars Images

### 1. Mars – Volcano

A three-dimensional view of Olympus Mons, the tallest volcano on Mars, created by using elevational data and planetary imagery. The volcano forms a gently sloped "cone" on the surface of Mars. Olympus Mons rises 22 kilometers (13 miles) above the surface of Mars and is 500 kilometers (310 miles) wide at its base.

*Image courtesy of NASA [http://www.esa.int/SPECIALS/Mars\\_Express/SEM2K1W4QWD\\_0.html](http://www.esa.int/SPECIALS/Mars_Express/SEM2K1W4QWD_0.html)*

### 2. Mars – Channels

Satellite image of river channels on Mars. The branching – dendritic - pattern was produced by flowing water carving ribbon-like channels into the land. No liquid water is present on the surface of Mars today, so these channels were formed by flowing water in the past. The image is about 200 kilometers (124 miles) across.

*Image courtesy of the Lunar and Planetary Institute [http://www.lpi.usra.edu/publications/slidesets/redplanet2/slide\\_26.html](http://www.lpi.usra.edu/publications/slidesets/redplanet2/slide_26.html)*

### 3. Mars – Craters

Spacecraft image of two circular depressions – craters - created when impactors struck the surface of Mars. The crater on the bottom of the image is about 8 kilometers (5 miles) across, and has a blanket of ejecta surrounding it – material that was thrown out of the crater or disturbed when the impactor struck. The crater floors appear to be modified only by deposits of fine materials. A smaller crater can be seen on the edge of the crater in the upper portion of the image. The sunlight is coming from the left side of the image; shining on the right side of the crater and leaving the left portion of the crater in shadow.

*THEMIS image courtesy of NASA/Jet Propulsion Laboratory/Arizona State University. <http://themis.asu.edu/zoom-20061025a>*

### 4. Mars – Volcano

Infra-red spacecraft image over the small-dome shaped Hecate Tholus volcano on Mars. The sunlight is coming from the left side of the image; shining on the left side of the volcano and leaving the right side in shadow.

*THEMIS image courtesy of NASA/Jet Propulsion Laboratory/Arizona State University <http://themis.asu.edu/zoom-20040820A>*

### 5. Mars - Channels

Spacecraft image of channels carved into the surface of Mars. The channels merge together toward the bottom right of the image. No liquid water is present today, so these ribbon-like channels were cut by flowing water in the past. The sunlight is coming from the upper right side of the image.

*Image courtesy of the European Space Agency / DLR / FU Berlin (G. Neukum)  
<http://www.esa.int/esa-mm/mmg.pl?b=b&type=l&mission=Mars%20Express&single=y&start=91&size=b>*

### 6. Mars – Craters

Spacecraft image of a circular depression on the surface of Mars created by an impactor striking the planet. The material thrown from the crater (ejecta) forms a rough, irregular surface around the crater. The crater is approximately 6 kilometers (3.7 miles) across. The sunlight is coming from the left side of the image; shining on the right side of the crater and leaving the left portion of the crater in shadow.

*THEMIS image courtesy of NASA/Jet Propulsion Laboratory/Arizona State University <http://themis.asu.edu/zoom-20060818a>*

## **7. Mars – Volcanos**

Two small volcanos rise above the surface of Mars, Uranius Tholus and Ceraunius Tholus in this spacecraft image. Ceraunius Tholus, the larger volcano on the bottom of the image, is about 110 kilometers (68 miles) across. Smaller impact craters dot the surface around the volcanos, and on the volcanos, too! The large, flat bottomed, circular depressions on the tops of the volcanos are calderas, the location from which lava flows. A wiggly lava channel has flowed from the top of Ceraunius Tholus to its base. The sunlight is coming from the left side of the image; shining on the left side of the volcano and leaving the right side in shadow.

*Image courtesy of NASA. <http://erc.arc.nasa.gov/MarsVolc/TharsisTholi.htm>*

## **8. Mars – Channels (Delta)**

Spacecraft image above the surface of Mars showing a fan-shaped landform made up of many ribbon-like channel features. This is interpreted to be a delta, a feature that forms when a river deposits the sediment it is carrying in a lake or river. This is very similar in shape to the Mississippi River delta. The fan is 13 kilometers (8 miles) high by 11 kilometers (7 miles) wide.

*Mars Global Surveyor Image courtesy of NASA/JPL/Malin Space Science Systems  
[http://www.msss.com/mars\\_images/moc/2005/09/20/eberswalde/](http://www.msss.com/mars_images/moc/2005/09/20/eberswalde/)*

## **9. Mars – Craters**

Spacecraft image of a circular depression on the surface of Mars created by a an impactor striking the planet. The material thrown from the crater (ejecta) forms a rough, irregular surface around the crater. The crater is approximately 5 kilometers (3.1 miles) across. The sunlight is coming from the left side of the image; shining on the right side of the crater and leaving the left portion of the crater in shadow.

*THEMIS image courtesy of NASA/Jet Propulsion Laboratory/Arizona State University <http://themis.asu.edu/zoom-20060406a>*

## **10. Mars – Channels**

Spacecraft image above ribbon-like channels cut into the surface of Mars. Unlike the dendritic patterns observed on other images, these channels are wider and have many branches braided together, with tear-drop islands separating the channels. These are interpreted to have been carved by fast flowing water flooding across the surface.

*Image courtesy of NASA [http://www.msss.com/moc\\_gallery/m19\\_m23/images/M21/M2101914.html](http://www.msss.com/moc_gallery/m19_m23/images/M21/M2101914.html) MOC narrow-angle image M21-01914*

## **11. Mars – Channels**

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*Image courtesy of NASA. [http://jules.unavco.org/Voyager/Docs/ImageGallery/mars\\_channels](http://jules.unavco.org/Voyager/Docs/ImageGallery/mars_channels)*

## **12. Mars – Channels**

Spacecraft image above Mars showing ribbon-like channels joining to form a larger channel.

*THEMIS image courtesy of NASA/Jet Propulsion Laboratory/Arizona State University  
<http://themis.asu.edu/zoom-20060111a>*