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Wind, Water, Impact Craters?

Overview

Children model the effects of wind, water, and impacts on a planetary surface using sand. They will compare the surface features they modeled with images of planetary surfaces to see if they can determine which process caused the features in the images.

What's the point?

Models are used to test ideas about how the Universe works. Modeling something on a small scale can give clues to how processes work on a large scale. Since people haven't visited other worlds aside from the Moon, modeling is a way of testing what another world might be like.

By looking at surface features of another planet, we can often compare these features to ones we see on Earth. This gives us clues to what might have happened on that planet.

Learning goals

After doing this activity, students will be able to:

- Demonstrate how a simple model can be used to explain some features commonly found in planetary images.
- Recognize whether wind, water, or impacts were among the geologic processes that helped create or shape surface features visible in images of planetary surfaces.

Time

45 minutes to an hour

Materials

- Six lightweight plastic trays about 1m (3 feet) long and 10cm (4 inches) wide (wall paper trays from a paint store or similar)
- Four Aluminum deep steam table pans (1/2 size)
- Sandbox "play" sand to cover each tray to a depth of 5cm (~2 inches)
- Two colors of colored craft sand, recommended in contrasting natural shades to the play sand (black, white, red, or dark brown)
- One set of Feature Cards Earth images per group of three students
- One set of Feature Cards Earth Volcano images

- Two sets of Feature Cards Mars images
- Two sets of Feature Cards Venus images
- Two sets of Feature Cards Mercury images
- Two sets of Feature Cards Moon images
- Copies of student sheets
- Copy of Quick Reference

Materials for Wind Station

- Clear plastic wrap to cover trays
- Tape
- Drinking straws (one per student)
- Copy of Wind Station Directions

Materials for Water Station

- Three Pitchers of water
- Blocks or bricks to raise one end of each tray
- Nine large paper cups
- Nine small paper cups
- Three buckets for collecting excess sandy water
- Newspapers to place under trays (optional)
- Clean up supplies (sponges, rags, access to a sink)
- Copy of Water Station Directions

Materials for Impacts Station

- Objects in a variety of sizes to use as impactors, such as marbles, golf balls, bouncy balls, tennis balls, rocks, coins, blocks, ball bearings etc.
- Copy of Impacts Station Directions

Preparation

- Cut Feature Cards into sets of Earth, Earth's Volcanoes, Mars, Moon, Mercury and Venus.

- While keeping cards in their respective sets, be sure to shuffle the cards.
- Print one copy of the Quick Reference.

Prepare Wind Station

- Fill the four Aluminum steam table trays with about 4cm of play sand, a thin coat of a contrasting color of craft sand (less than 1cm), and an additional covering (about 1cm) of play sand over the colored sand.
- Place trays in station.
- Cover each tray with plastic wrap.
- Tape the plastic wrap all along the sides of the tray so it won't come off.
- Poke one hole in the plastic wrap near one end of each tray large enough to fit a straw into.

Prepare Water Station

- Fill 3 wallpaper (or similar) trays with 5cm of slightly moistened play sand and place in station.
- (Optional) Place newspapers beneath each tray.
- Dampen the sand in each tray.
- Place blocks at one end of each tray to raise them at an angle (so water runs down)
- Have additional blocks available for students to change the angle of the trays.
- Place buckets, jugs of water, cups and clean up supplies at each tray.

Prepare Impacts Station

- Fill 3 wallpaper trays (or similar) with 4cm of play sand, a thin covering of colored craft sand, and an additional covering of play sand (about 1cm) of and place in station.
- Place an assortment of impactors at each tray.

Procedure

Procedure Wind Station

1. Ensure students keep plastic wrap attached at all times.
2. Have students stick straws into the hole in the plastic wrap and blow gently across the surface.
3. Let them explore on their own, but encourage them to use different angles (vertically and horizontally) to blow across the sand and observe the features they create.

Procedure Water Station

1. Have students slowly and carefully pour a cup of water onto the higher end of the tray.
2. Students should observe the features they create carefully
3. Encourage students to repeat the experiment by lowering or raising the angle of the tray, using additional blocks as necessary
4. Show students how to scoop the excess water into a cup and pour the sandy water into the buckets.
5. Dispose of bucket water outside (sandy water will clog drains)

Procedure Impacts Station

1. Have students drop objects of various sizes at various heights into the sand
2. Students should observe the features they create carefully

- After students rotate through the stations, hand out sets of the Earth Feature cards.
- Without turning over the cards, students work in pairs to determine whether wind, water, or impacts created the features they see, or if a combination of these things created the features.
- Students should discuss why they decided on wind, water, or impacts as the primary cause of the features (based upon their station work).
- For older students, discuss the terminology of the geology (Wind=Aeolian, Water=Fluvial) using the backs of the cards and the Quick Reference as a guide.

- Introduce the Earth Volcano cards and discuss identification of volcanoes, something that was not modeled during the sand station activity, using the Quick Reference as a guide.
- Explain that these same *geologic forces* also affect other planets and objects in our Solar System.
- In groups of three, have each group select one image set of Mars, Venus, Mercury or the Moon.
- Have students sort the cards by the geologic process they think is occurring in the photo (Wind, Water, Impacts, and also Volcanoes). Students may look at shape, color, texture, position, etc.
- When students are finished, have each group explain why they sorted the cards as they did; have them observe the work of other groups, make comparisons, and ask questions. It is more important that students defend and revisit their ideas rather than confirming a right and wrong answer. Make sure students know that scientists don't always agree with one another.
- Explain that scientists use all kinds of evidence. Images are one kind of evidence that we can use to support ideas. Ask students how we could confirm whether our matches were correct on the other planets (we could visit and make observations, we could send a robot with instruments, we could look at pictures using better instruments on spacecraft).

Alternate ideas

- If you are only using sand, students can drop impactors into the wet sand from the water station after everyone has gone through each station. See if students can recreate *ejecta*, the material around a crater that is thrown up during the impact and deposits radially all around it.
- For very young students, the text on the back of the Earth cards may be left off.
- All students could use one set of planetary cards instead of allowing them to choose which body to sort. This may lead to interesting discussions when differences of opinion arise.
- Students can illustrate and create their own text about impacts, water, volcanoes, and wind to create a book to explain the differences to others.
- For more advanced classes, make sets of the Optional Jovian Moons cards and repeat the sorting activity.
- The letter-number codes on each card correspond with the image set and mission. A web-search of the code will uncover more information about

each specific image and mission. Students can investigate one or more images from a set to discover more, and share findings with the group or class.

- If the Optional Jovian Moons cards are used, students may visit the following for more information: http://lasp.colorado.edu/education/outerplanets/moons_galilean.php

Credits and Inspiration:

Paige Graff provided permission to modify the Blue Marble Matches lesson and use the image sets, created by the Astromaterials Research and Exploration Science (ARES) Education Program. http://ares.jsc.nasa.gov/education/eeab/BMM.cfm

Station activities are from the Mars and Earth Science Learning Activities for Afterschool Resource Guide, a NASA product created by the American Museum of Natural History. https://www.nasa.gov/pdf/145913main_Mars.and.Earth.Guide.pdf

Wind station directions

1. **Poke the straw into the plastic wrap and blow across the sand.**
2. **Observe the features you create.**
3. **Angle the straw at different angles and repeat the experiment.**

Things to think about

How does the angle of the wind change the features?

How does the force you use to blow across the sand change the features?

What shapes does the wind make in the sand?

Water Station Directions

1. **Using a cup, pour water onto the sand near the top of the container.**
2. **Observe the shapes the water makes in the sand.**
3. **Change the angle of the container and repeat the experiment.**
4. **Carefully dump water into the bucket provided.**
5. **Level the sand using your hand or a block so the next group can experiment.**

Things to think about

How does the angle of the container change the features?

What shapes does the water make in the sand?

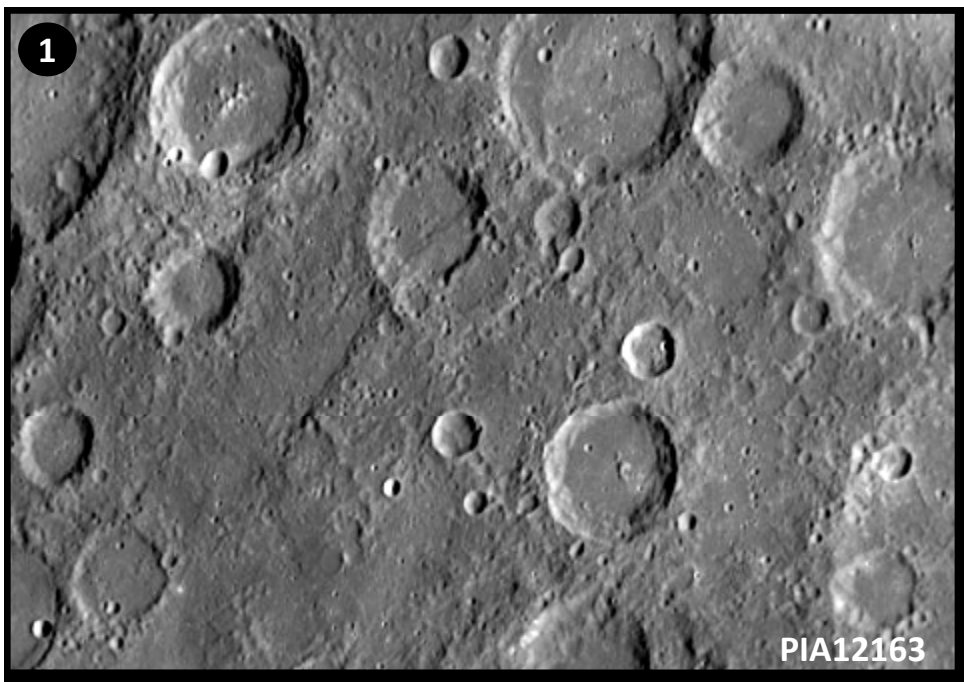
Impact Craters Station Directions

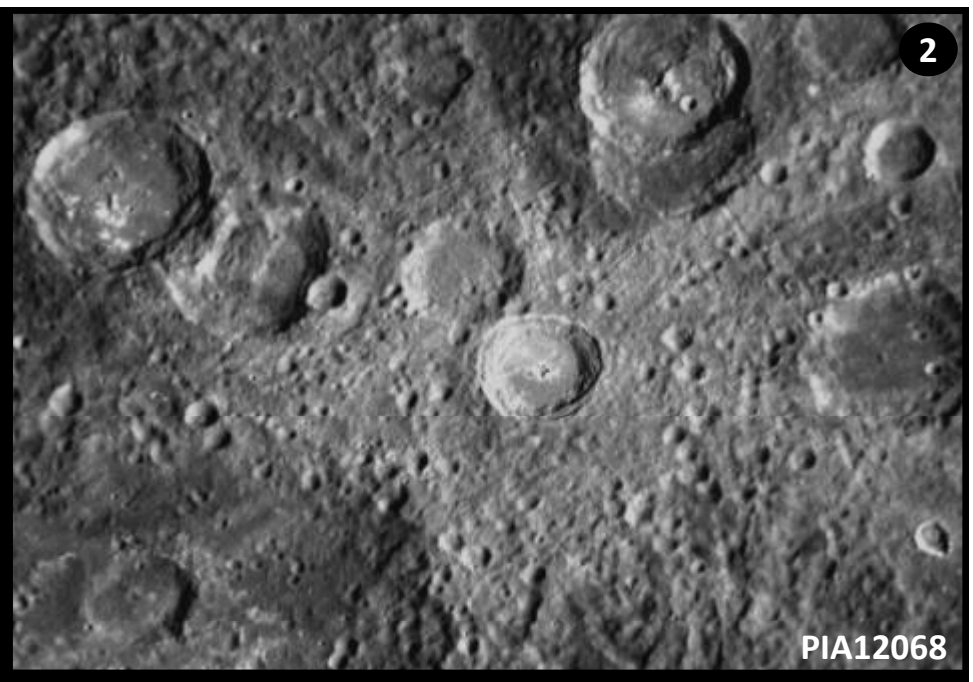
1. **Drop objects into the sand.**
2. **Observe the shapes made by the objects in the sand.**
3. **Try dropping objects at an angle.**
4. **Try dropping objects with a little more force.**
5. **Level the sand using your hand or a block so the next group can experiment. You may need to add a thin layer of play sand (ask instructor for assistance).**

Things to think about

How does changing the angle of the impactor affect the shape or size of the crater?

How does the size of the impactor affect the size and shape of the crater?





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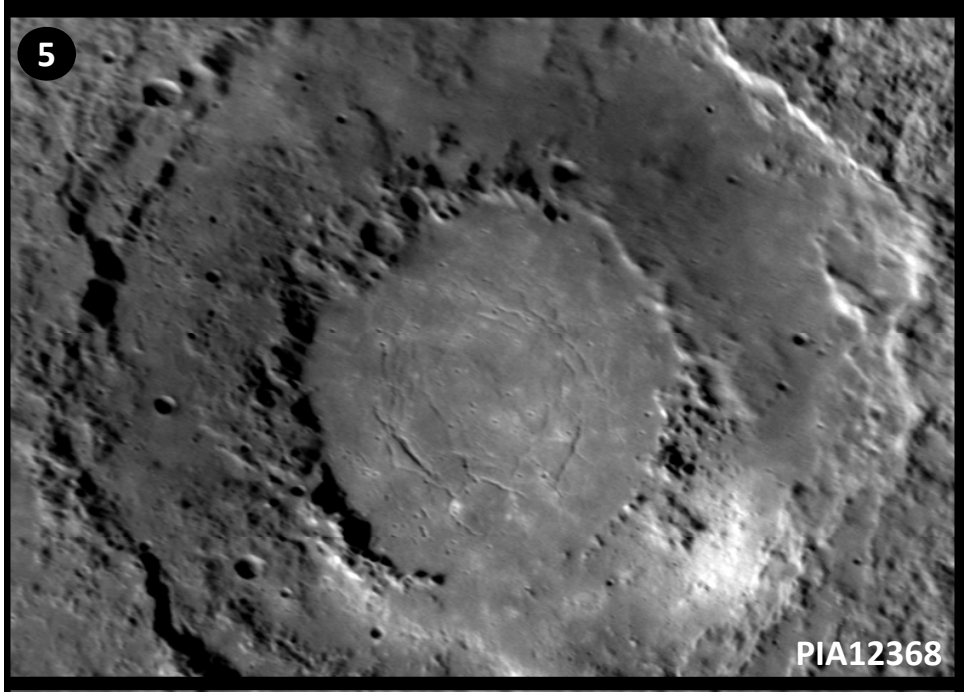

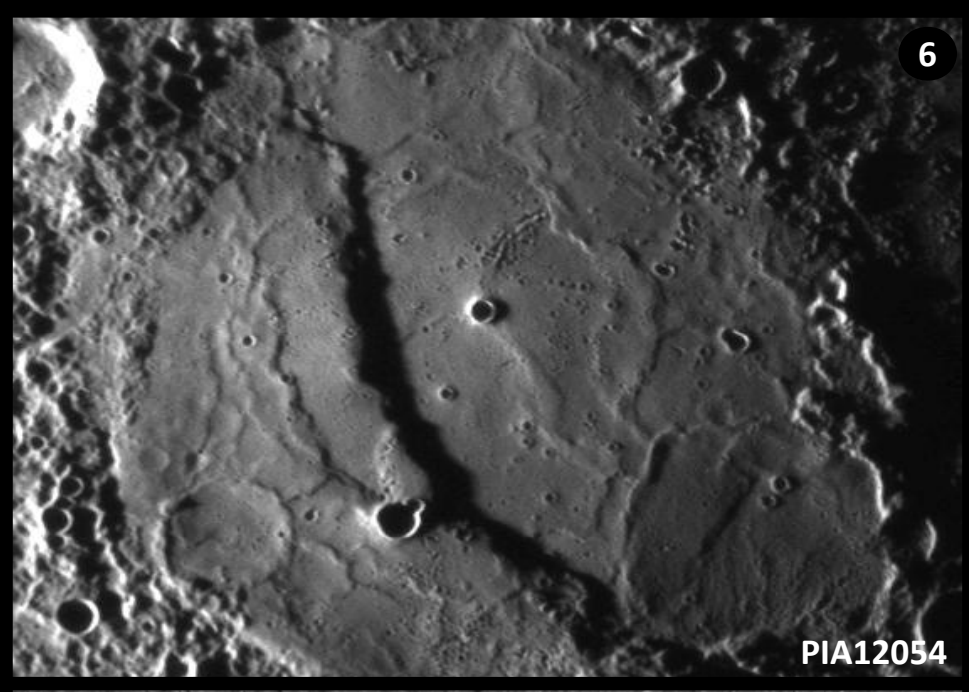

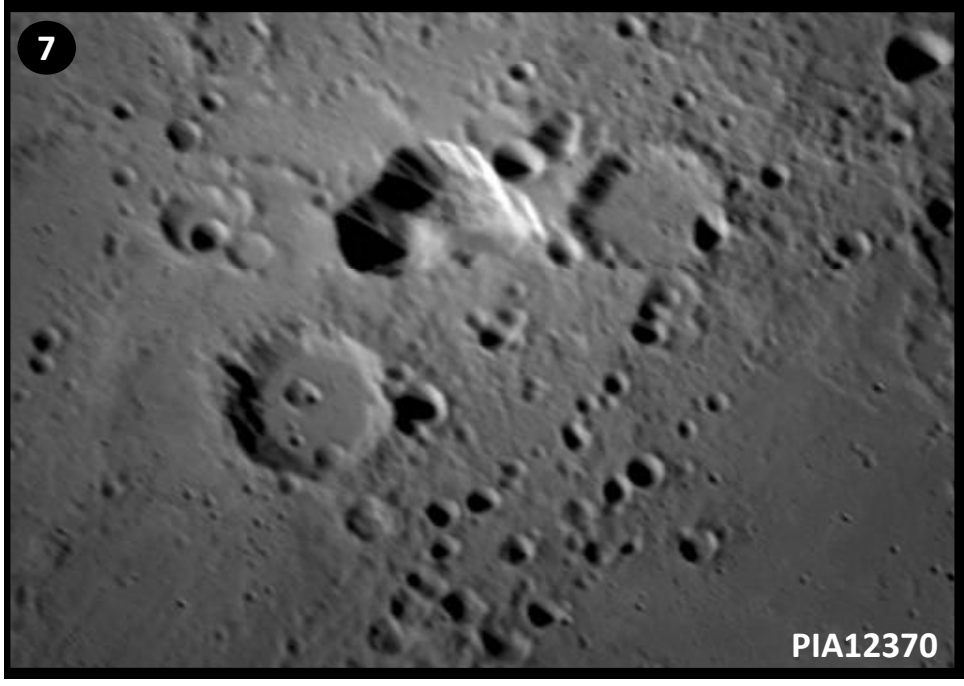

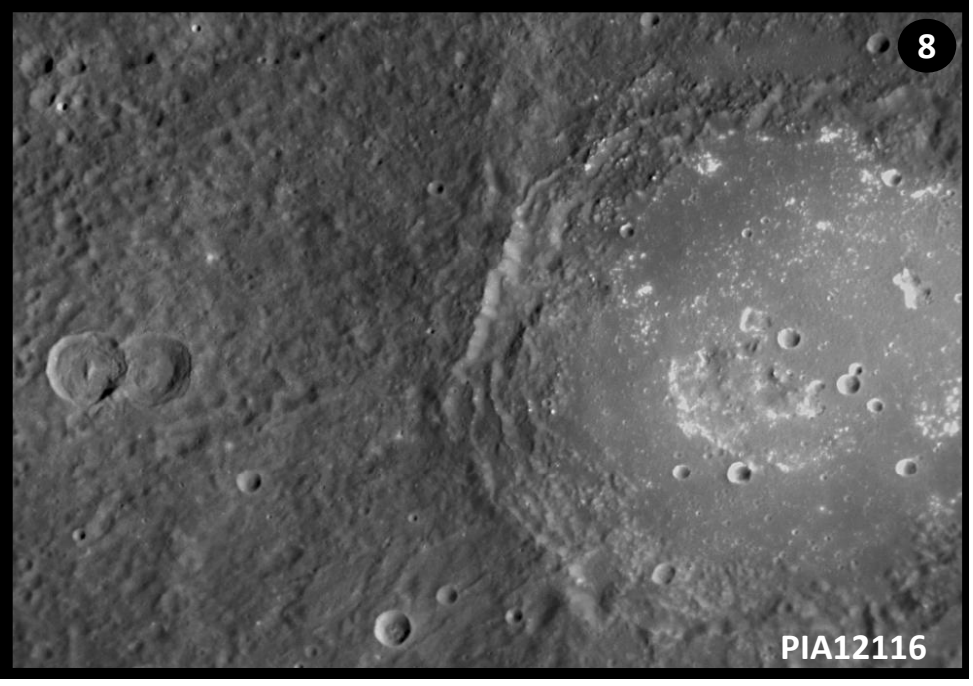

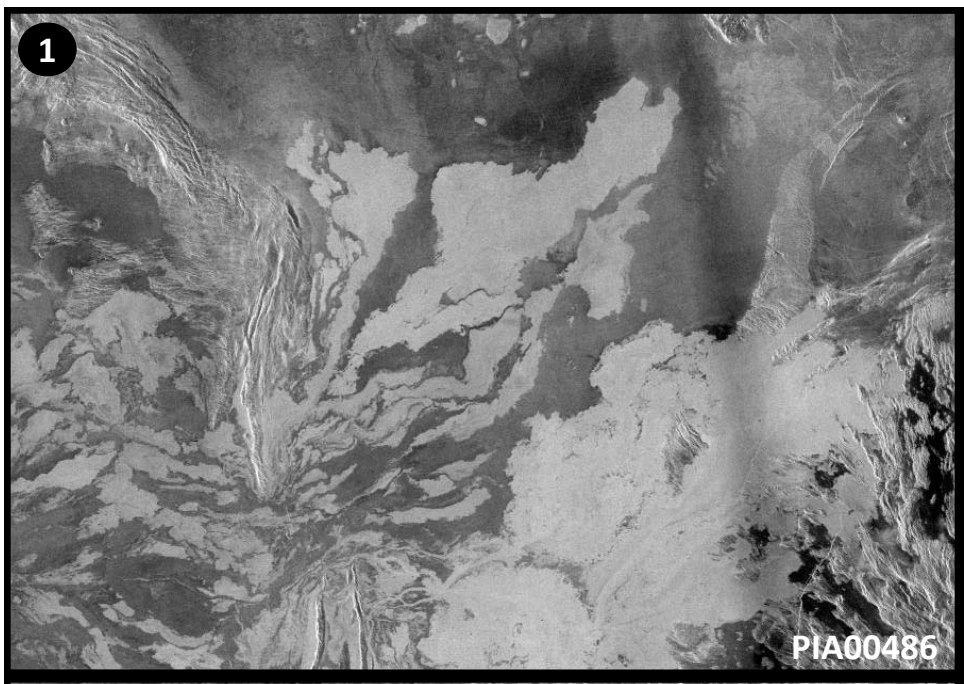

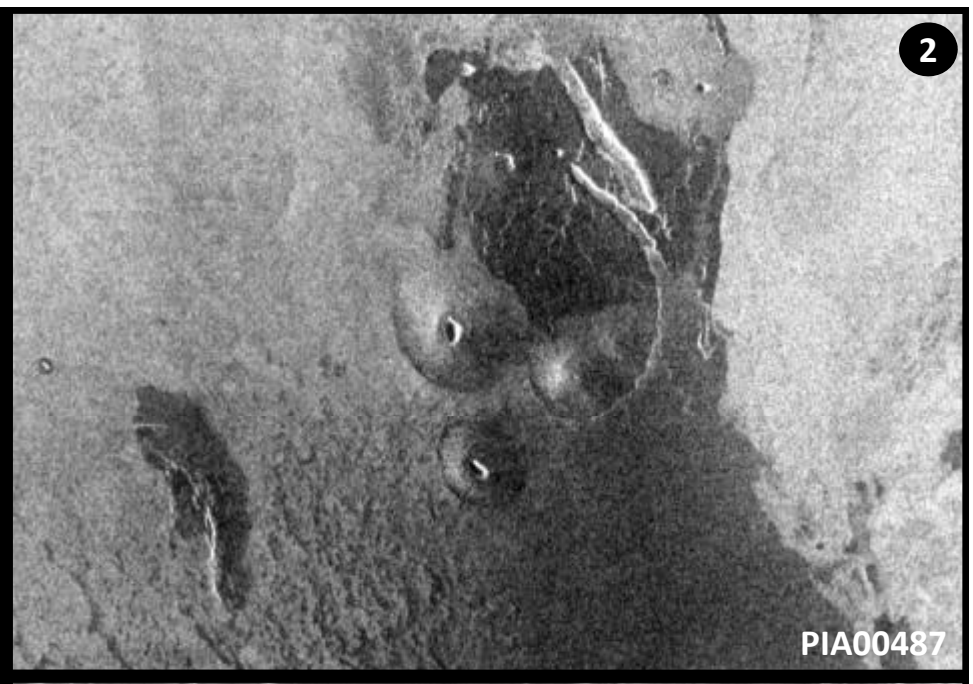

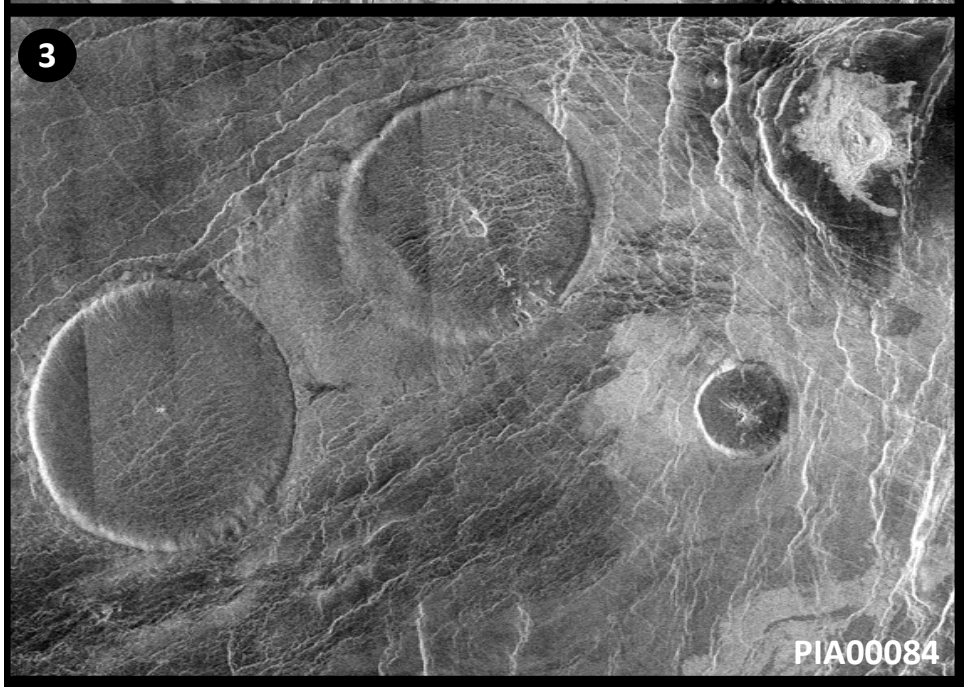

VENUS

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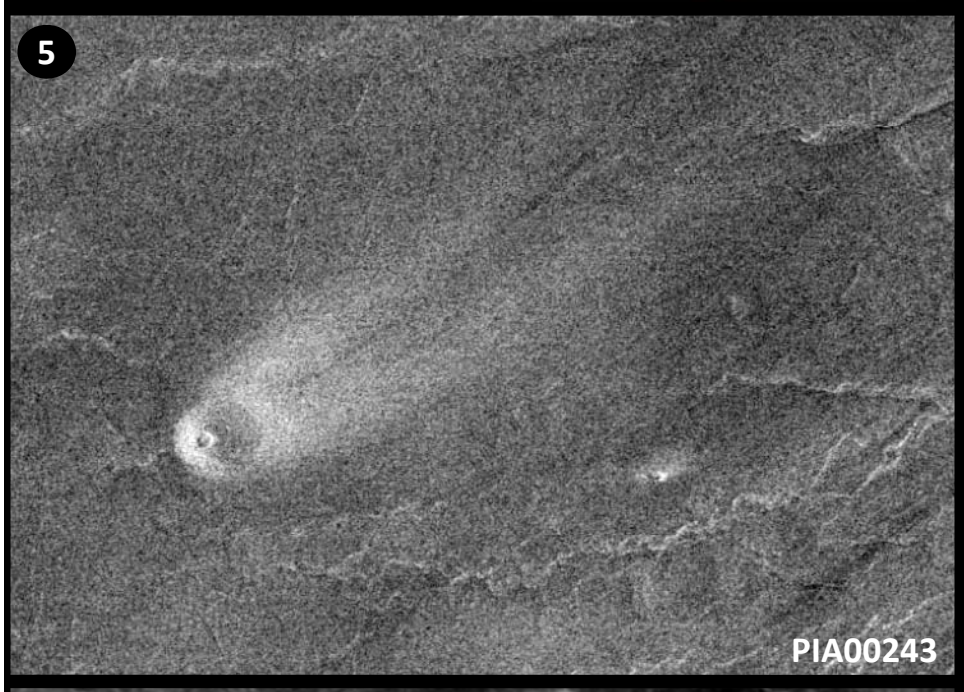

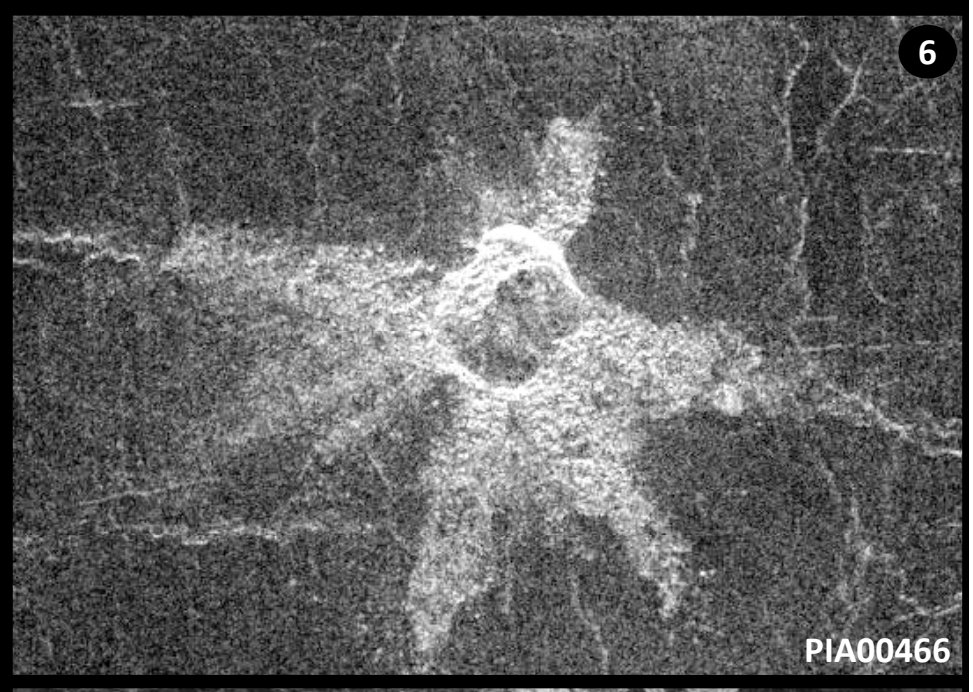

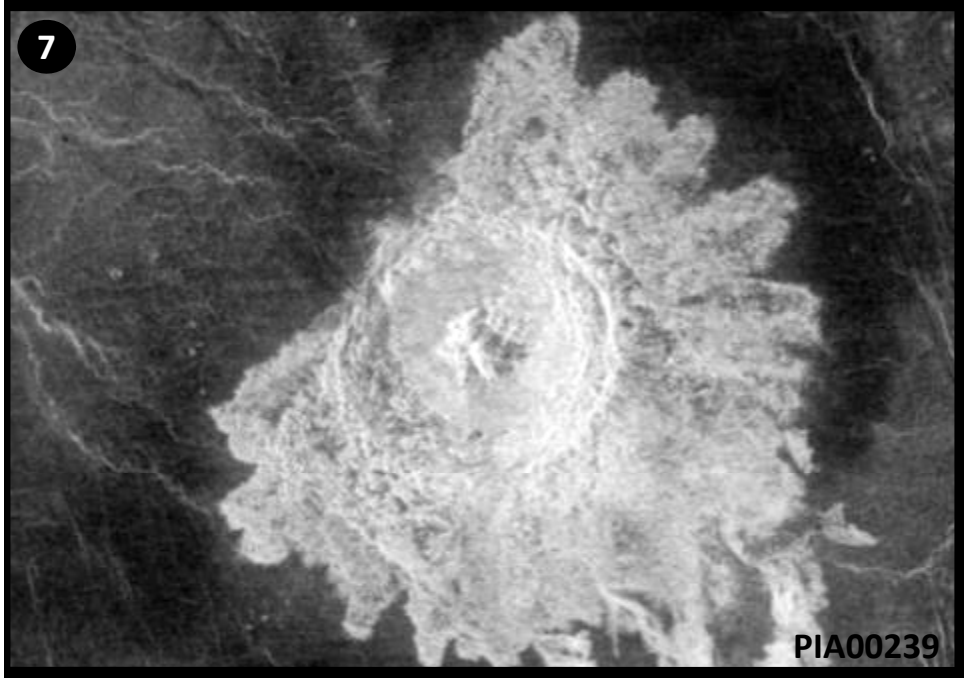

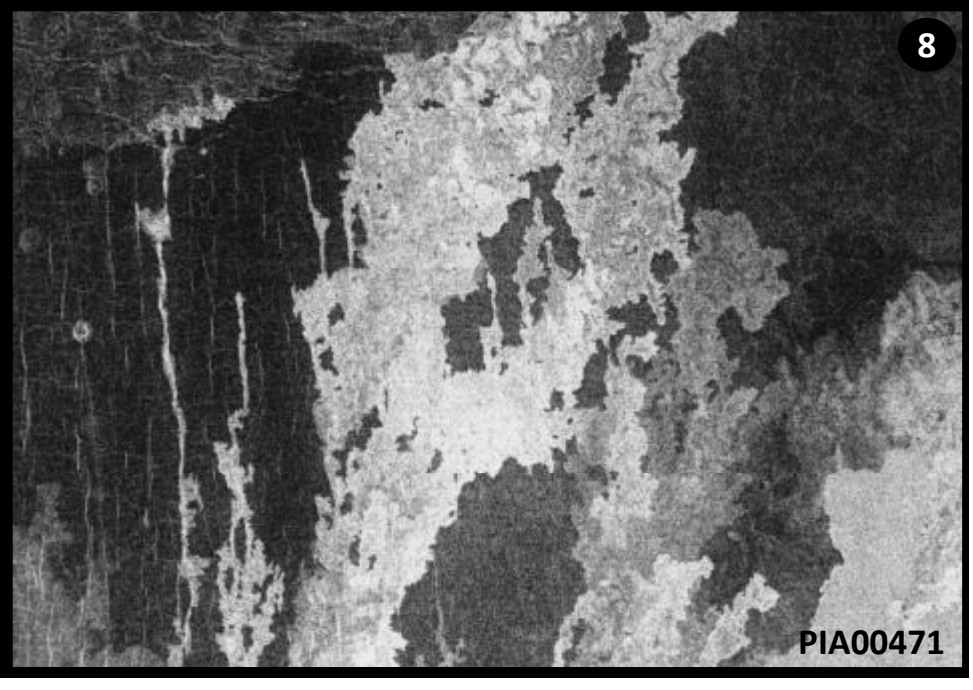

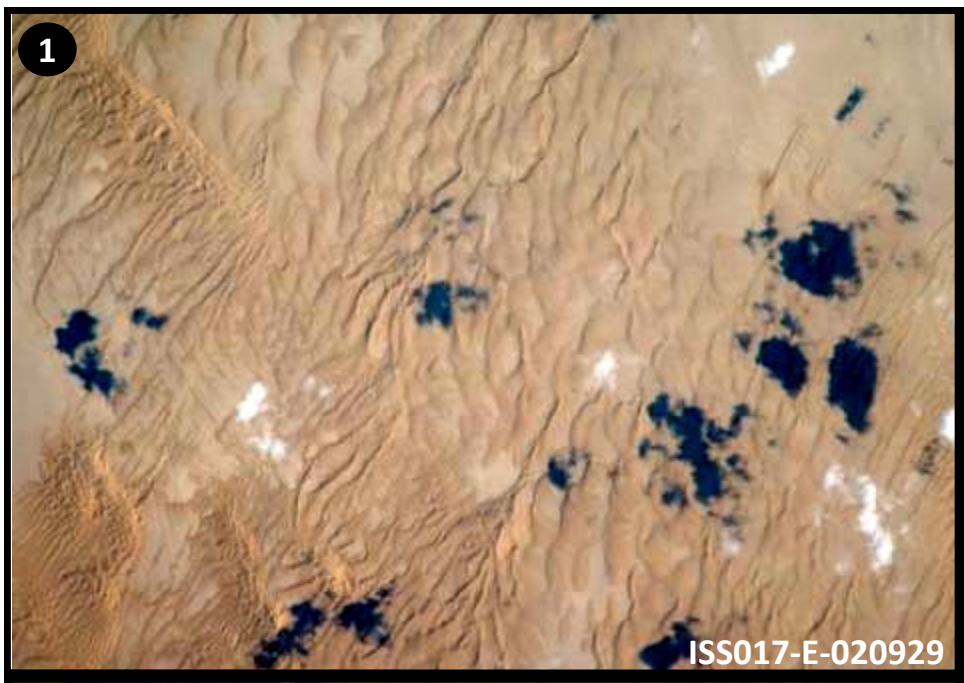

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AEOLIAN FEATURES

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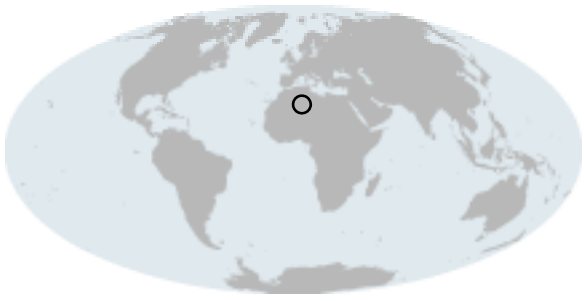
2

AEOLIAN FEATURE: SAND DUNES

Geographic Location: ALGERIA
Image ID#: STS070-705-94



- This astronaut image is showing a large area of orange colored sand dunes in Algeria called the Tifernine Dunes. This area is part of the Sahara desert. Drainage channels show where water once flowed through the area when the climate was wetter.
- **OTHER VISIBLE FEATURE(S): Drainage channels**

AEOLIAN FEATURE: SAND DUNES

1

Geographic Location: EGYPT
Image ID#: ISS017-E-020929

- This astronaut image is taken of an area in northern Egypt almost completely covered in sand dunes. This area, west of Cairo, is part of the Sahara Desert.
- **OTHER VISIBLE FEATURE(S): Clouds, cloud shadows**

4

AEOLIAN FEATURE: YARDANGS

Geographic Location: NAMIBIA
Image ID#: STS040-17-26

- This astronaut image is taken of yardangs in an area along the northern coast of Namibia called the Skeleton Coast.
- **OTHER VISIBLE FEATURE(S): Coastline**

AEOLIAN FEATURE: SAND DUNES

3

Geographic Location: UNITED STATES
Image ID#: ISS016-E-6986

- This astronaut image is taken of the Sangre de Cristo Mountains and sand dunes located in Great Sand Dunes National Park in Colorado.
- The mountains are outlined by dark green forests at lower elevations and white, snow-capped peaks at the highest elevations.
- **OTHER VISIBLE FEATURE(S): Mountains, forests, snow**

EARTH

AEOLIAN FEATURES

6

AEOLIAN FEATURE: YARDANGS

Geographic Location: NIGER
Image ID#: STS052-73-12

- This astronaut image is taken of yardangs in the Djado plateau of Niger. This area is located in the Sahara and is heavily eroded by wind.
- **OTHER VISIBLE FEATURE(S): n/a**

AEOLIAN FEATURE: YARDANGS

5

Geographic Location: CHAD
Image ID#: ISS012-E-09638

- This astronaut image is taken of wind eroded ridges (yardangs) that have modified a multi-ringed impact crater called Aorounga. The Aorounga crater is located to the southeast of Emi Koussi (a volcano not seen in this image) on the Tibesti mountains in Chad.
- **OTHER VISIBLE FEATURE(S): Impact crater**

8

AEOLIAN FEATURE: WIND STREAKS

Geographic Location: SUDAN
Image ID#: ISS013-E-18533

- This astronaut image showing numerous wind streaks is taken of an area affected by strong winds in the northern part of Sudan.
- **OTHER VISIBLE FEATURE(S): Escarpments**

AEOLIAN FEATURE: WIND STREAKS

7

Geographic Location: CHAD
Image ID#: ISS016-E-16058

- This astronaut image is taken of an area where a channel once flowed that is now affected by strong winds on the Tibesti mountains in Chad. This image is dominated by features created by effects of wind erosion.
- **OTHER VISIBLE FEATURE(S): Channel (visible in the center of image)**

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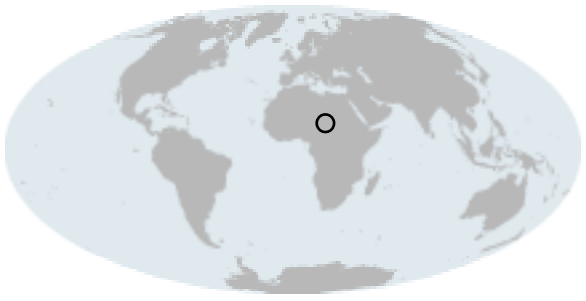
FLUVIAL FEATURES

2 FLUVIAL FEATURE: DRAINAGE NETWORK

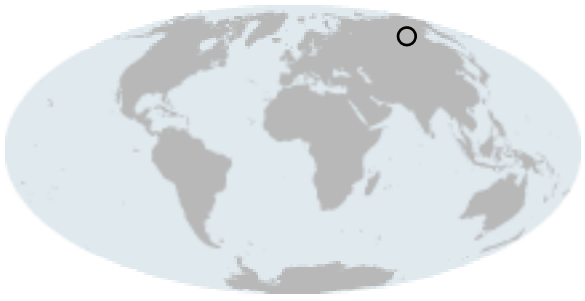
Geographic Location: CHAD
Image ID#: ISS018-E-7208



- This astronaut image is centered on a set of valley or drainage networks in Chad, Africa. In arid regions these drainage networks consist of a network of wadis. Wadis are channel-like features that are dry but have intermittent streamflow during periods of rain.
- **OTHER VISIBLE FEATURE(S): n/a**

FLUVIAL FEATURE: DRAINAGE NETWORK 1

Geographic Location: CHINA
Image ID#: ISS014-E-20488



- This astronaut image is centered on valley or drainage networks located in China. The dendritic pattern as seen in this image is common for these networks.
- **OTHER VISIBLE FEATURE(S): Snow**

4 FLUVIAL FEATURE: CHANNEL

Geographic Location: ARGENTINA
Image ID#: ISS010-E-5070

- This astronaut image is centered on the Parana River in northern Argentina just to the south of Paraguay. The Parana River is the third largest river in South America. Sun glint on the river gives it a silvery glow and allows varying currents to be visible.
- **OTHER VISIBLE FEATURE(S): Urban area, channel islands, meander scars**

FLUVIAL FEATURE: CHANNEL 3

Geographic Location: ARGENTINA
Image ID#: ISS012-E-13327

- This astronaut image is centered on the Bermejo River in northern Argentina. This river meanders along the dark green dense forests visible on both sides of its banks. The lighter green squares are agricultural areas.
- **OTHER VISIBLE FEATURE(S): Forests, agricultural areas**

6 FLUVIAL FEATURE: DELTA

Geographic Location: INDIA
Image ID#: STS032-72-61

- This astronaut image highlights a portion of the Krishna River Delta that flows into the Bay of Bengal in India. Sediment deposits are tan to brownish in color.
- **OTHER VISIBLE FEATURE(S): River channel, sediment deposits, bay**

FLUVIAL FEATURE: CHANNEL 5

Geographic Location: PERU
Image ID#: ISS007-E-14816

- This astronaut image is centered on the Ucayali River east of the Andes Mountains in Peru. This river is one of four rivers considered as the main headwater of the Amazon River.
- **OTHER VISIBLE FEATURE(S): Oxbow lakes, meander scars**

8 FLUVIAL FEATURE: DELTA

Geographic Location: EGYPT
Image ID#: STS077-718-56

- This astronaut image is centered on the Nile River Delta in Egypt. This area is where the Nile River spreads out and drains into the Mediterranean Sea.
- **OTHER VISIBLE FEATURE(S): River channel, sea, clouds**

FLUVIAL FEATURE: DELTA 7

Geographic Location: RUSSIA
Image ID#: STS059-213-65

- This astronaut image is centered on the Selenga River Delta flowing into Lake Baikal in Russia. Sunglint gives a silver-white sheen to the water surface of Lake Baikal. The Selenga River is the main river that stretches between Mongolia and Russia.
- **OTHER VISIBLE FEATURE(S): Lake, river channels, clouds**

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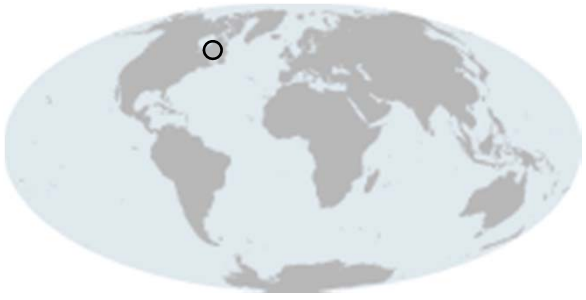
IMPACT FEATURES

2

IMPACT FEATURE: CRATER

Geographic Location: CANADA
Image ID#: ISS012-E-15881

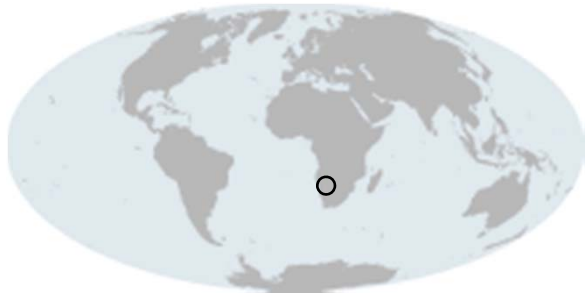


- This astronaut image is centered on the Manicouagan Impact Crater located in Quebec, Canada. The rim of the crater is now filled with water and referred to as the Manicouagan reservoir. Part of the central mound of the crater is still visible.
- **OTHER VISIBLE FEATURE(S): Reservoir or lakes**

IMPACT FEATURE: CRATER

1

Geographic Location: NAMIBIA
Image ID#: ISS006-E-16068



- This astronaut image is taken of the Roter Kamm Impact Crater, found in the Namib Desert in Namibia.
- **OTHER VISIBLE FEATURE(S): Sand dunes, mountains**

4

IMPACT FEATURE: CRATER

Geographic Location: UNITED STATES
Image ID#: ISS014-E-15775

- This astronaut image is centered on Barringer Crater (also know as Meteor Crater) located in northern Arizona. It is one of the best-known impact craters in the world.
- **OTHER VISIBLE FEATURE(S): River channel, wind streak**

IMPACT FEATURE: CRATER

3

Geographic Location: LIBYA
Image ID#: ISS014-E-11841

- This astronaut image is centered on the Oasis Impact Crater found in the Sahara Desert in Libya.
- **OTHER VISIBLE FEATURE(S): n/a**

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IMPACT FEATURES

6

IMPACT FEATURE: CRATER

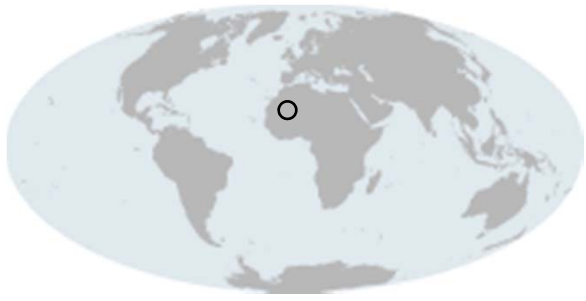
Geographic Location: AUSTRALIA
Image ID#: ISS015-E-17360

- This astronaut image is centered on Gosses Bluff, an impact crater located in Australia's Northern Territory.
- **OTHER VISIBLE FEATURE(S): River channel**

IMPACT FEATURE: CRATER

5

Geographic Location: ALGERIA
Image ID#: ISS014-E-19496

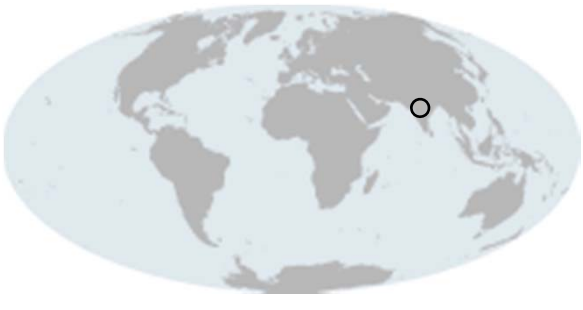


- This astronaut image shows the Ouarkziz Impact Crater and sedimentary layers located in western Algeria close to the border of Morocco.
- **OTHER VISIBLE FEATURE(S): Sedimentary rocks & layers, small circular hills**

8

IMPACT FEATURE: CRATER

Geographic Location: INDIA
Image ID#: ISS018-E-23713

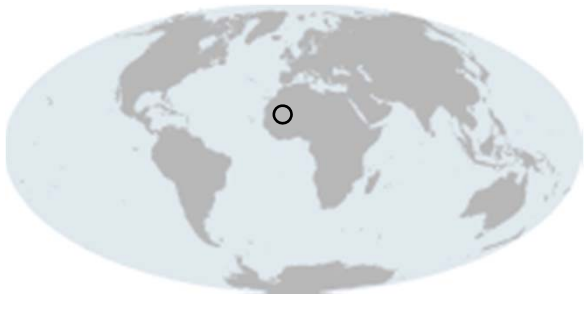


- This astronaut image is centered on the Lonar Impact Crater located in Central India. The central portion of this crater is now filled with water.
- **OTHER VISIBLE FEATURE(S): Lake, agricultural fields, urban area**

IMPACT FEATURE: CRATER

7

Geographic Location: MAURITANIA
Image ID#: ISS018-E-14908



- This astronaut image is centered on the Tenoumer Impact Crater located in the Sahara Desert in Mauritania.
- **OTHER VISIBLE FEATURE(S): n/a**

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VOLCANIC FEATURES

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2

VOLCANIC FEATURE: VOLCANOES

Geographic Location: RUSSIA
Image ID#: STS61A-45-98

- This astronaut image includes two of more than 100 volcanoes that exist in this region. These snow covered volcanoes are located in the Kamchatka Penninsula in Russia. This area is part of the "Ring of Fire" and has many active volcanoes.
- **OTHER VISIBLE FEATURE(S): Caldera, lava drainage channels, snow, lake**

VOLCANIC FEATURE: VOLCANOES

1

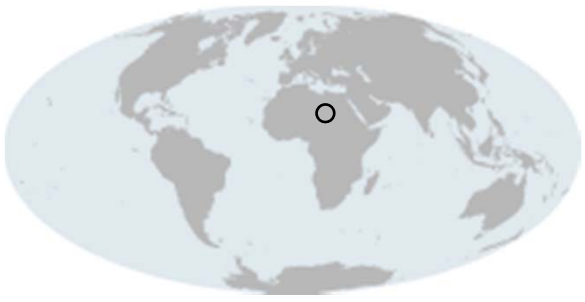
Geographic Location: UNITED STATES
Image ID#: ISS013-E-24184

- This astronaut image captured the beginning of an eruption of a stratovolcano in Alaska called the Cleveland Volcano. Carlisle Island, another volcano, is visible in the upper left hand portion of the image.
- **OTHER VISIBLE FEATURE(S): Ash plume, central vent, ocean, snow**

4

VOLCANIC FEATURES: VOLCANO, CALDERA, LAVA FLOWS

Geographic Location: CHAD
Image ID#: ISS016-E-8402

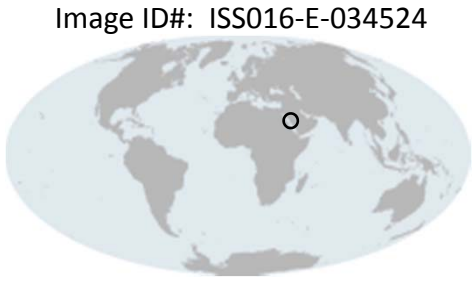


- This astronaut image shows the Emi Koussi Volcano located at the south end of the Tibesti Mountains in Chad. Extensive lava flows are visible all around the volcano.
- **OTHER VISIBLE FEATURE(S): n/a**

VOLCANIC FEATURES: VOLCANOES, CALDERAS, LAVA FLOWS

3

Geographic Location: SAUDI ARABIA
Image ID#: ISS016-E-034524



- This astronaut image is taken of a volcanic field in Saudi Arabia. There are volcanoes of different sizes, shapes, and chemical compositions. Lava flows vary in color. Features that look like impact craters were actually caused by volcanic eruptions in the presence of water (some of which are now filled with light-colored sand and silt).
- **OTHER VISIBLE FEATURE(S): n/a**

EARTH

VOLCANIC FEATURES

6

VOLCANIC FEATURES: LAVA FLOWS, CALDERA

Geographic Location: UNITED STATES
Image ID#: ISS017-E-013065

- This astronaut image shows lava flows on either side of the summit caldera of the tallest volcano on Earth. Mauna Loa, located on the Big Island of Hawaii rises ~9 km (~5.6 mi) above the sea floor.
- **OTHER VISIBLE FEATURE(S): Clouds**

VOLCANIC FEATURE: CALDERA

5

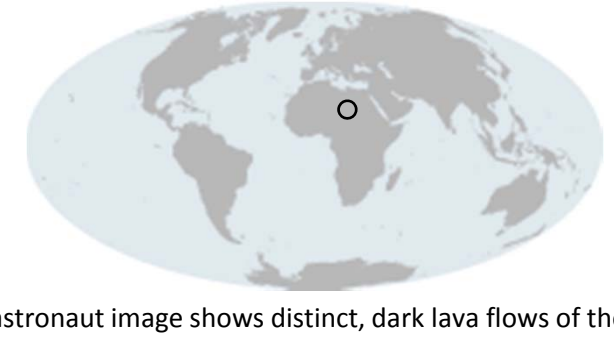
Geographic Location: SUDAN
Image ID#: ISS018-E-6051

- This astronaut images is taken of the Deriba Caldera, a dormant volcanic structure located at the top of the Marra Mountains in western Sudan. Numerous drainage networks are visible around the caldera. Within the caldera are two inner volcanic depressions called craters.
- **OTHER VISIBLE FEATURE(S): Drainage networks, inner crater lakes**

8

VOLCANIC FEATURE: LAVA FLOWS

Geographic Location: CHAD
Image ID#: ISS016-E-035095

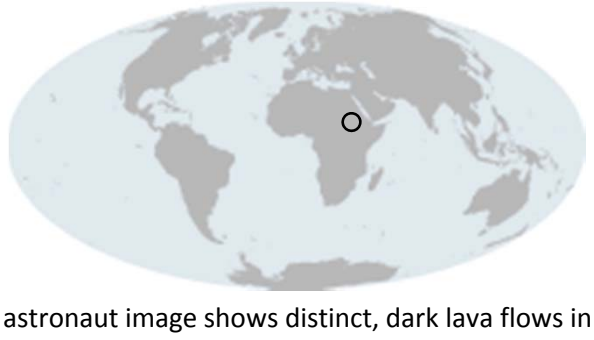


- This astronaut image shows distinct, dark lava flows of the Tousside Peak Volcano in Chad. The Tousside Peak Volcano (not shown in this image) is the westernmost volcano of the Tibesti Mountains in northwestern Chad.
- **OTHER VISIBLE FEATURE(S): n/a**

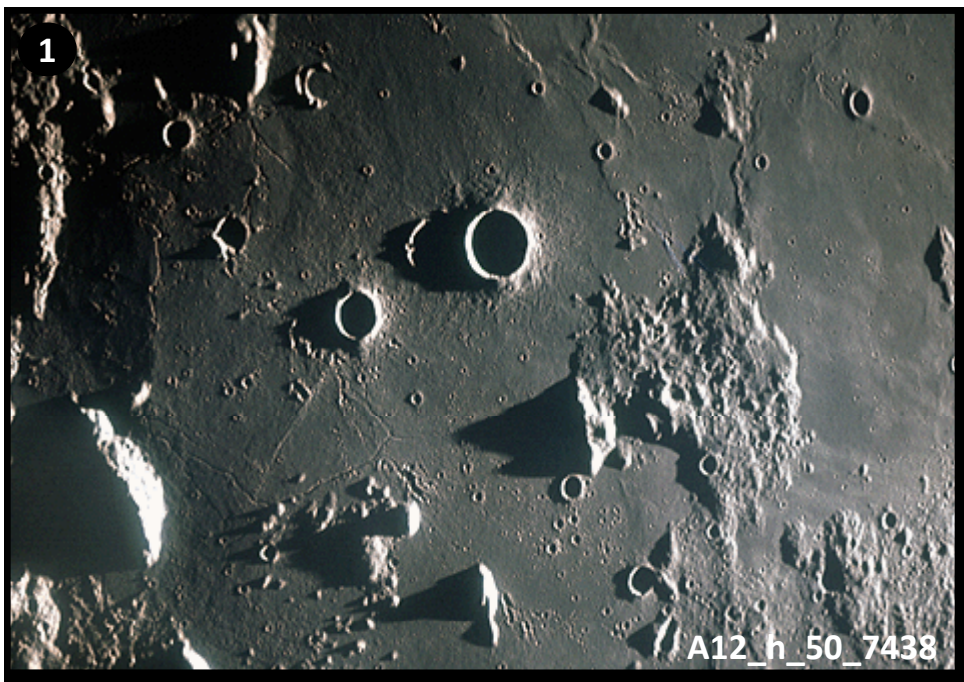
VOLCANIC FEATURE: LAVA FLOWS

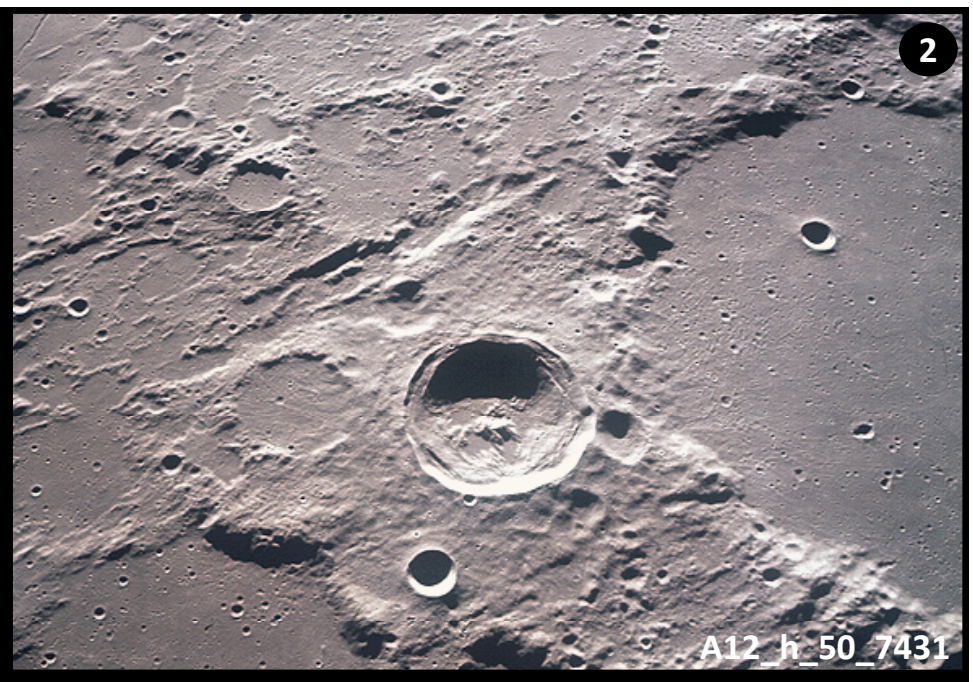
7

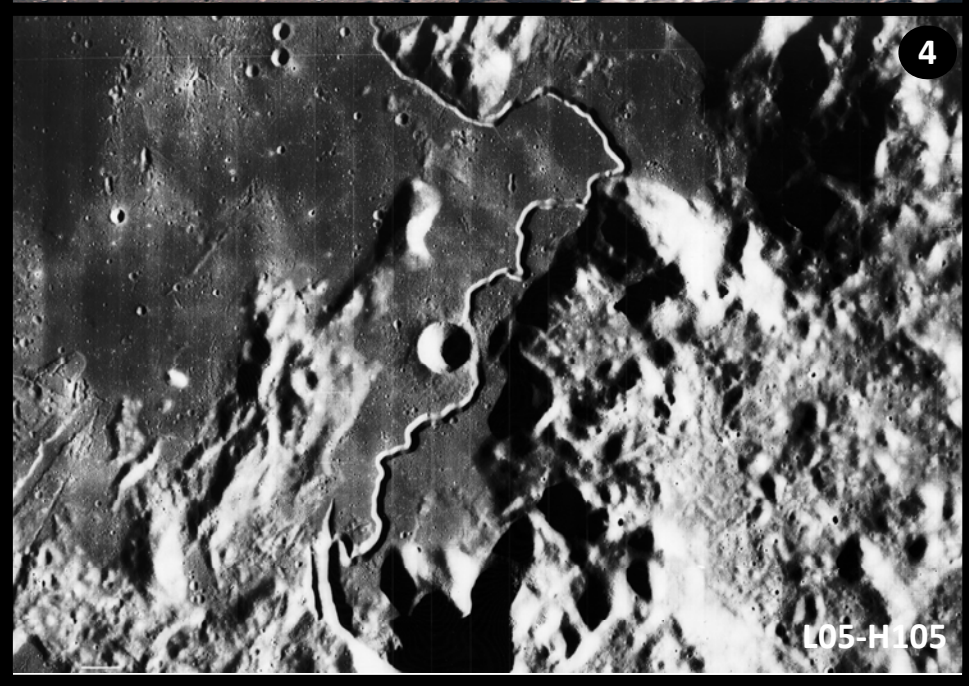
Geographic Location: ETHIOPIA
Image ID#: ISS017-E-5656



- This astronaut image shows distinct, dark lava flows in the Afar volcanic region of Ethiopia. Although not visible in this image, three large volcanoes are located to the north of these lava flows.
- **OTHER VISIBLE FEATURE(S): n/a**







EARTH'S MOON

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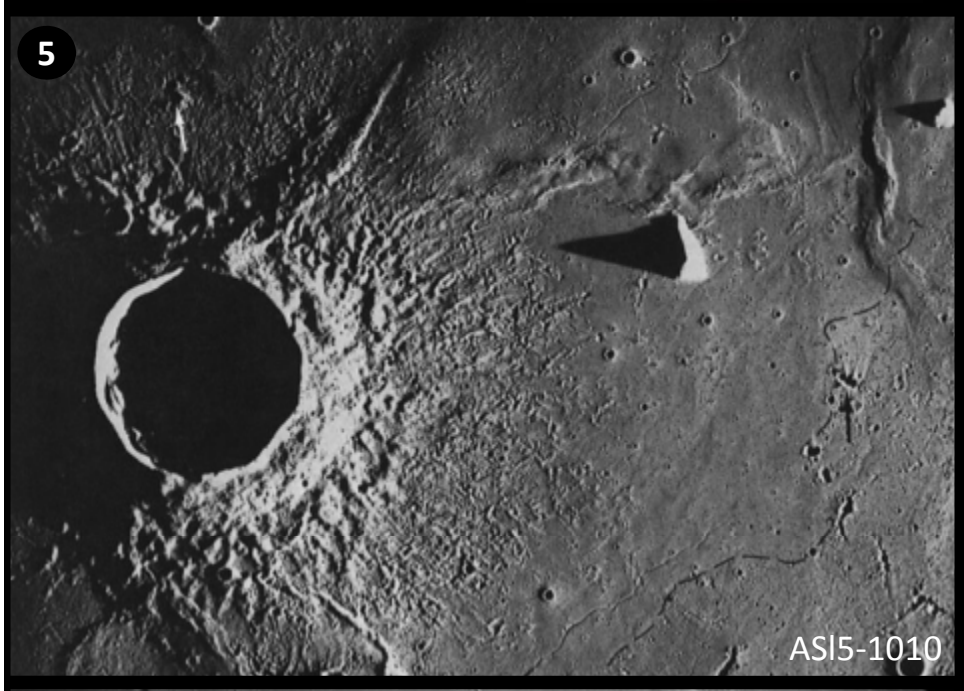

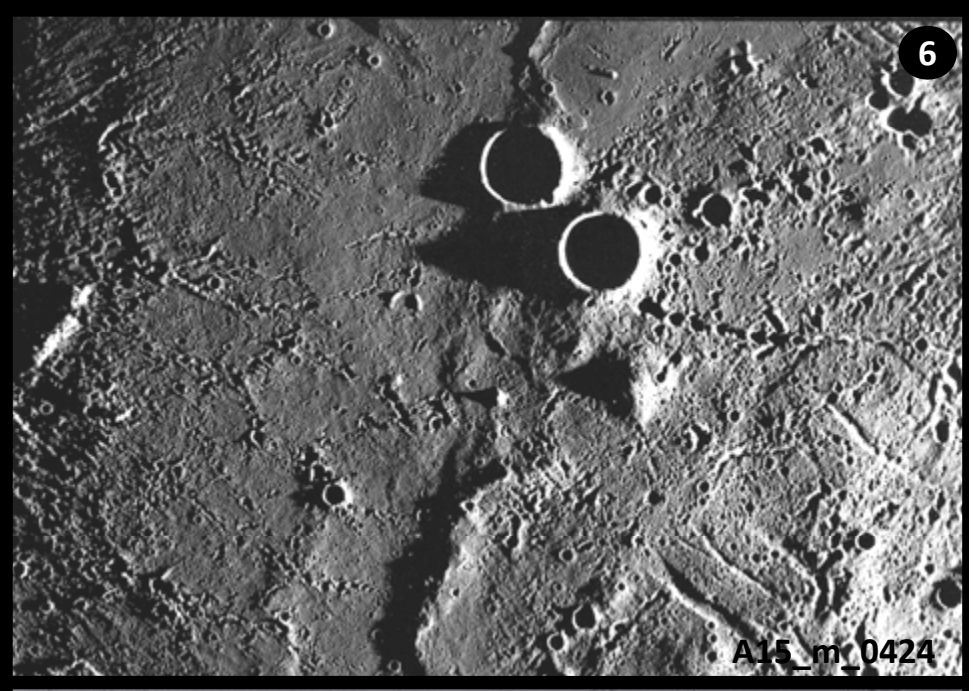

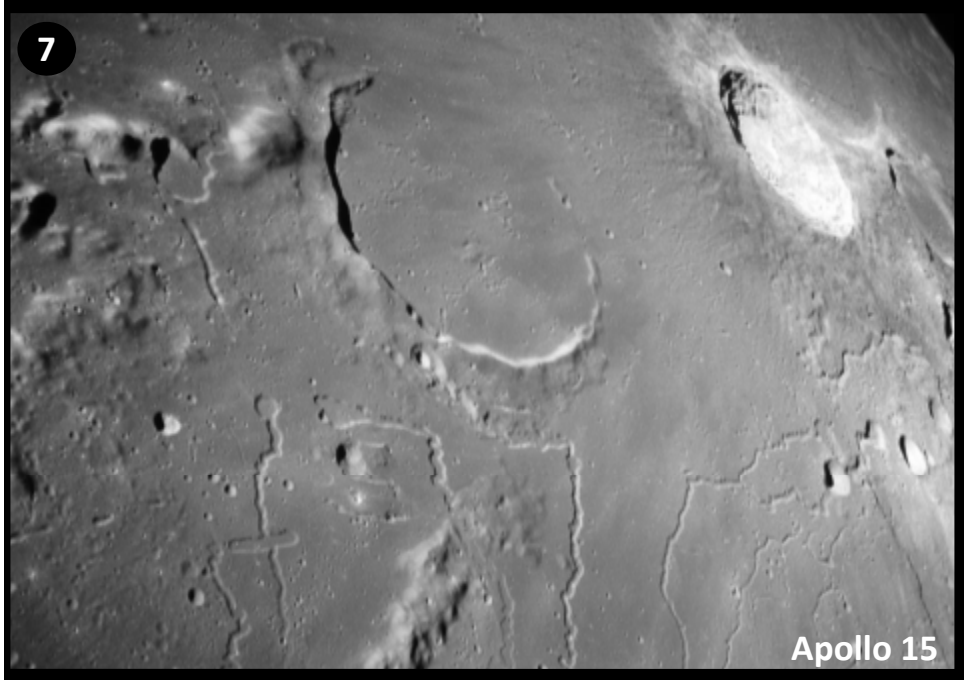

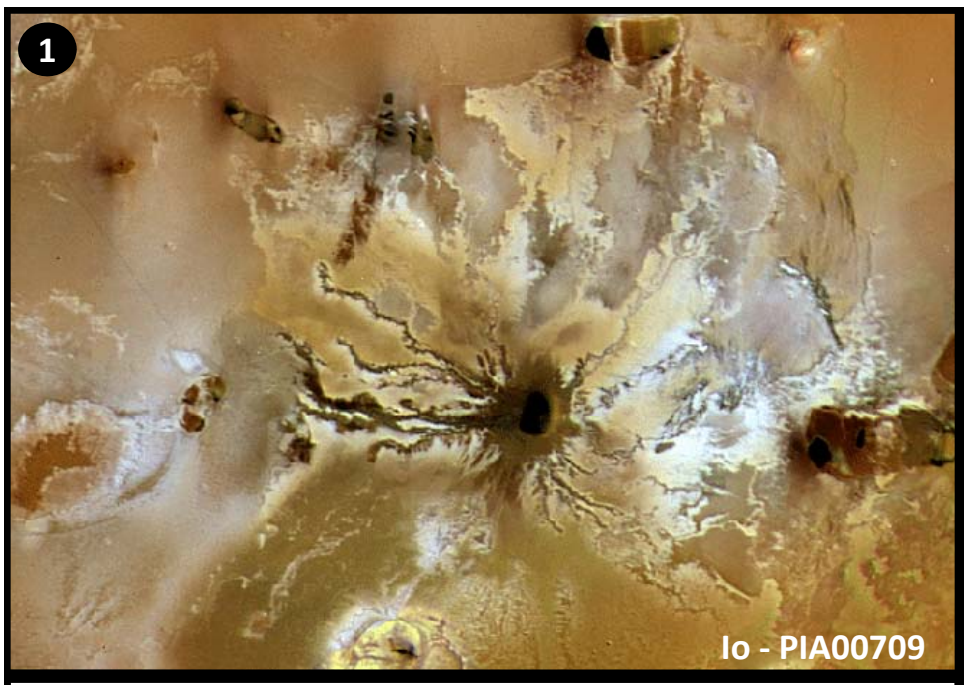

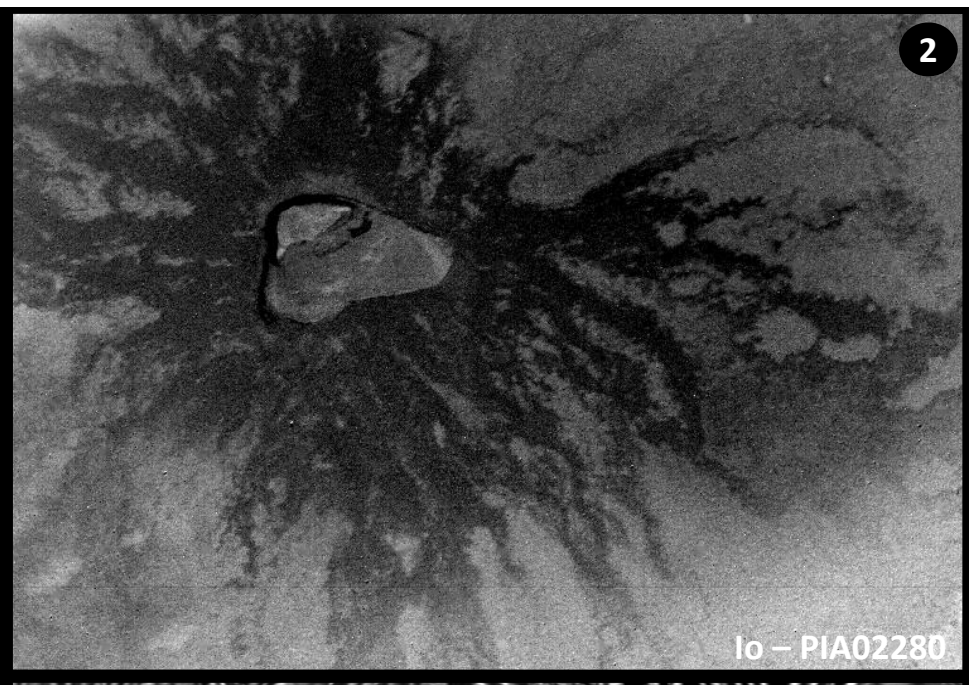

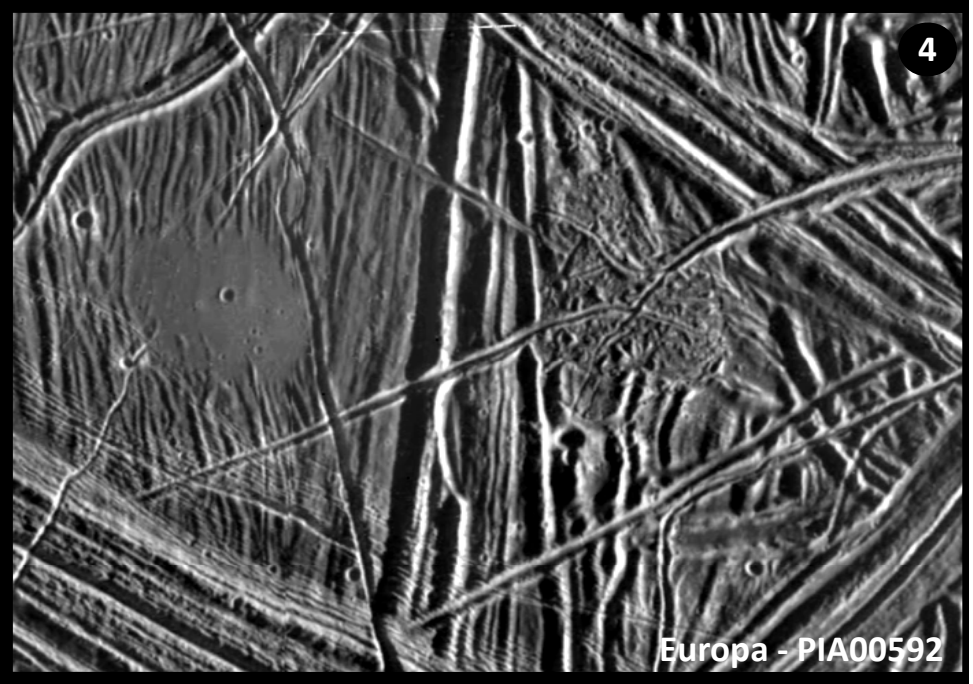

JOVIAN MOONS

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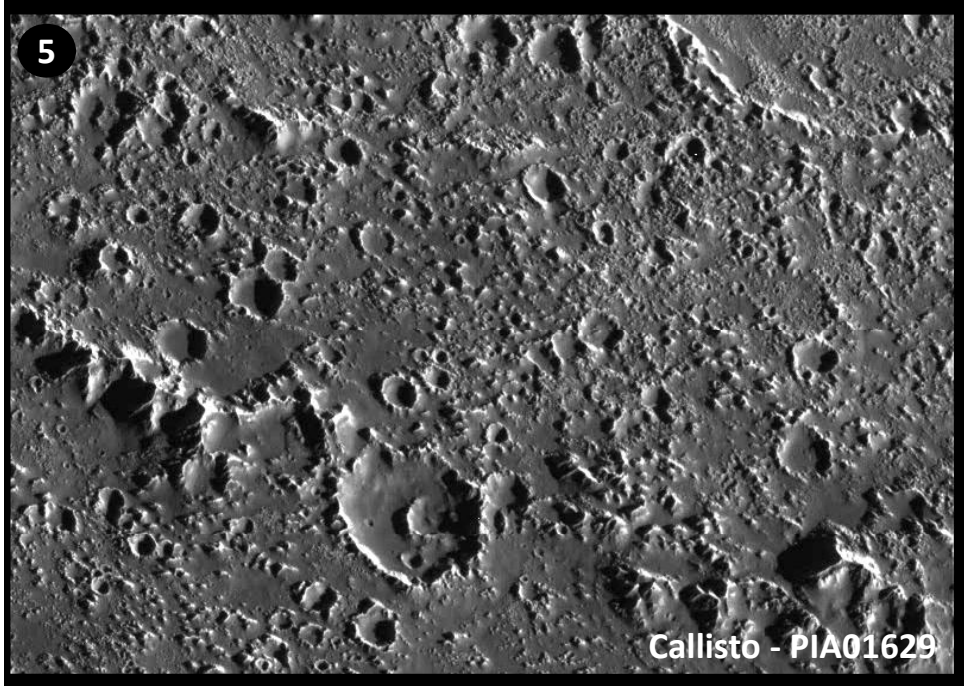

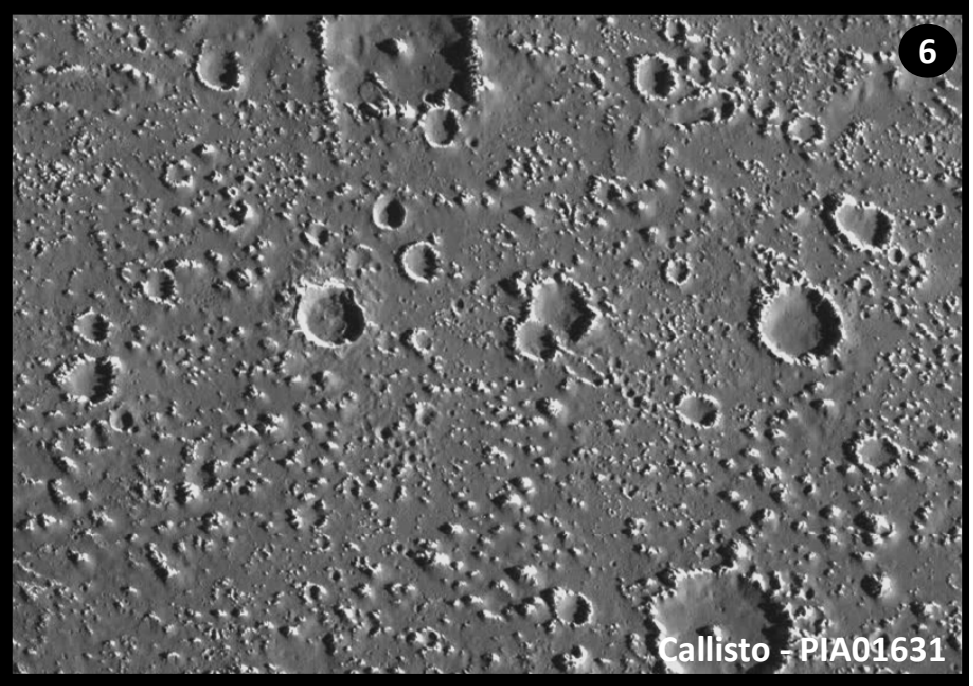

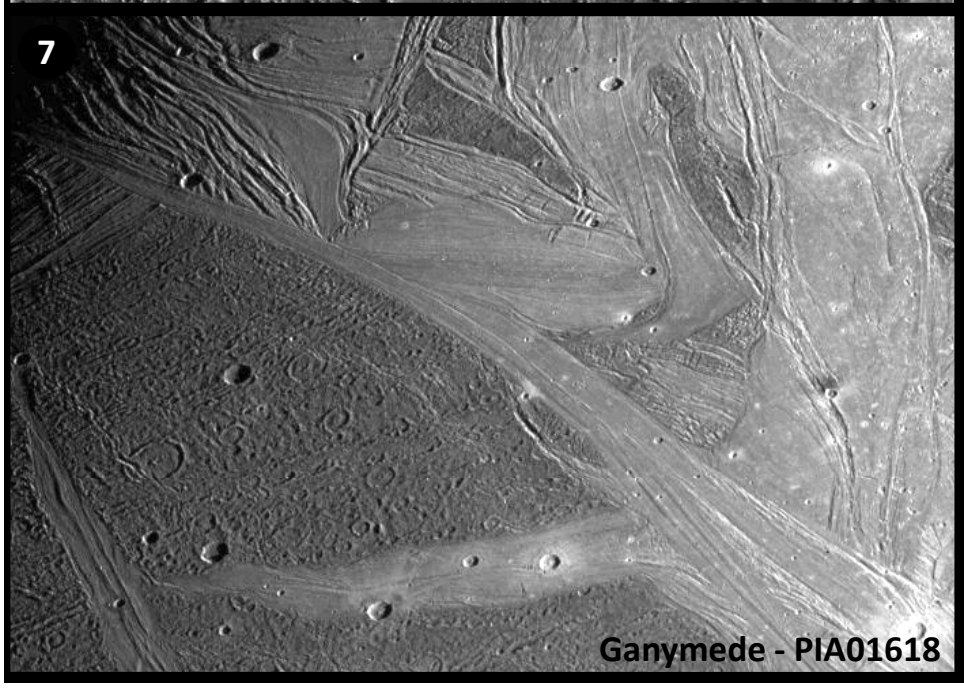

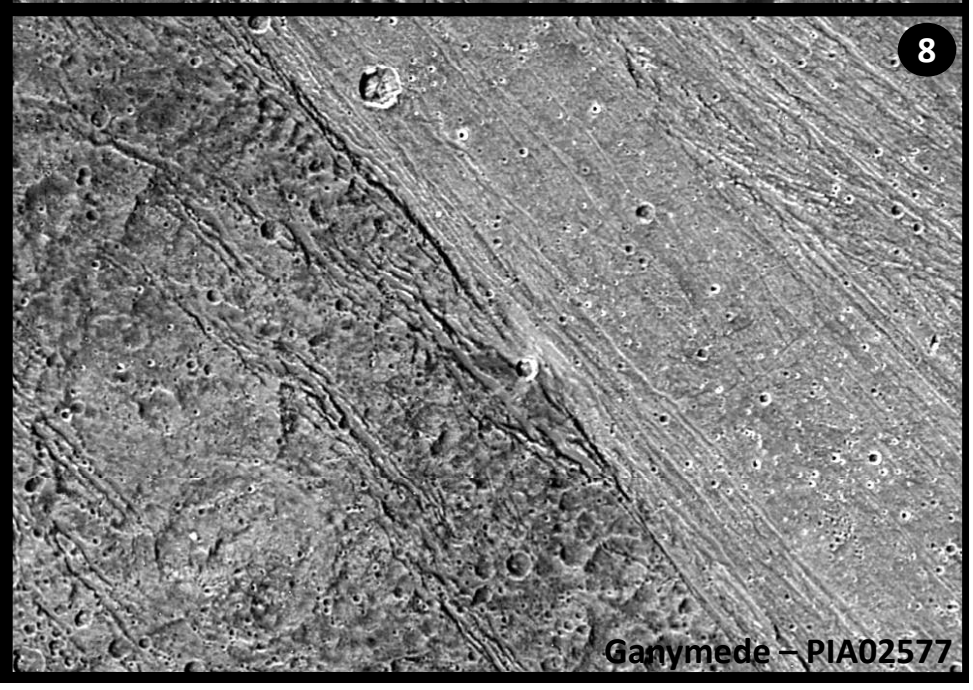

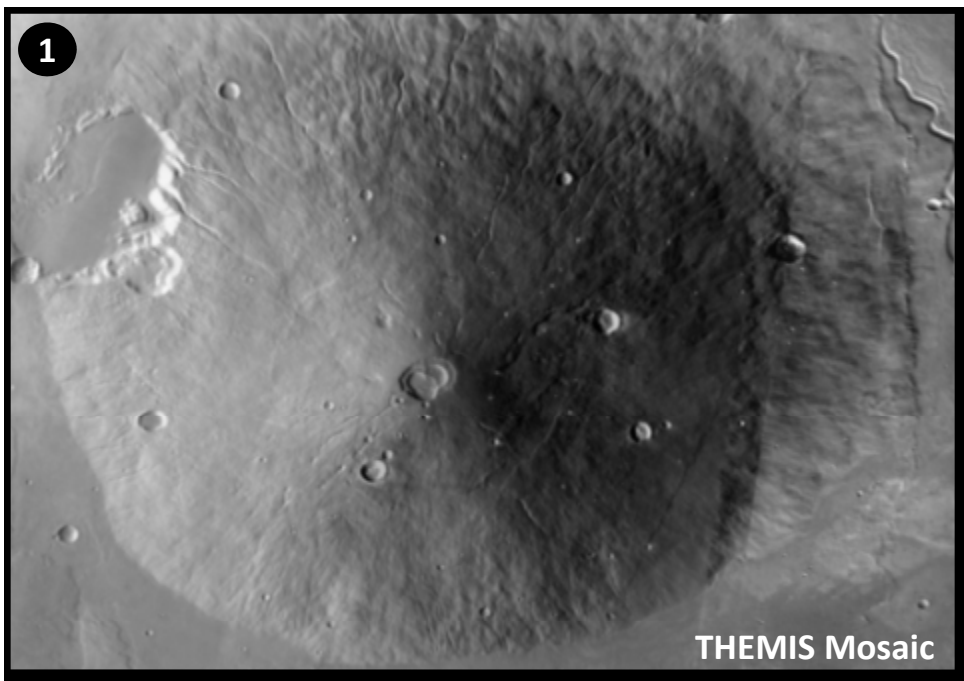

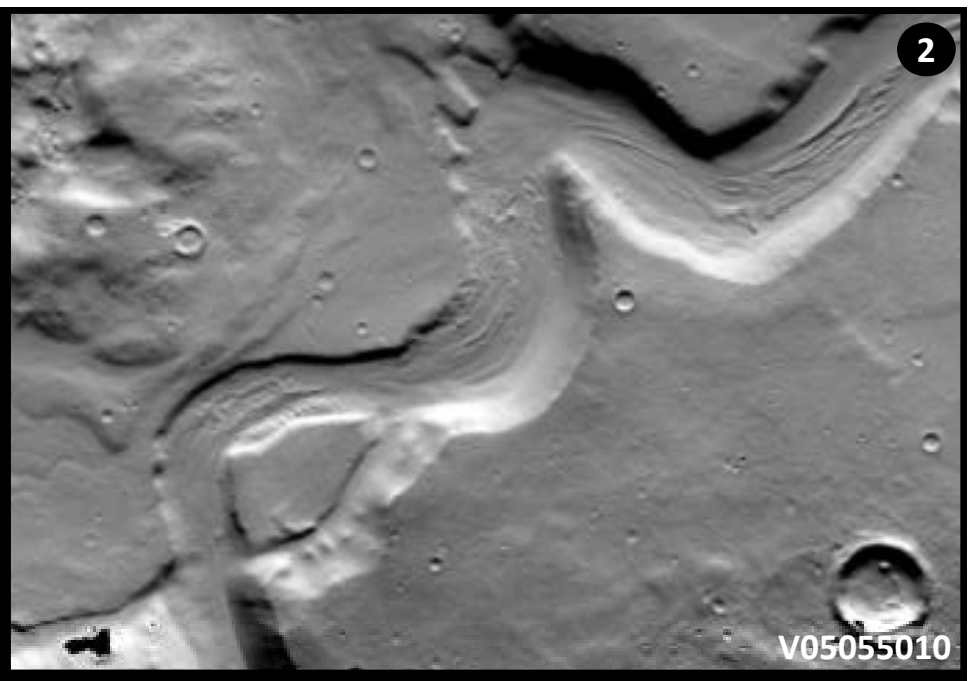

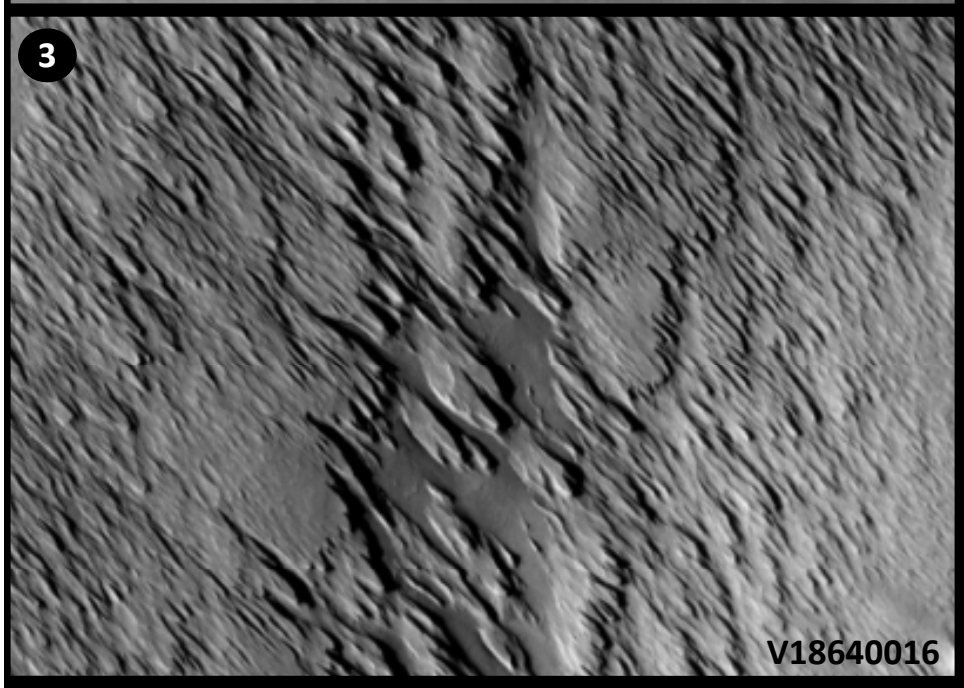

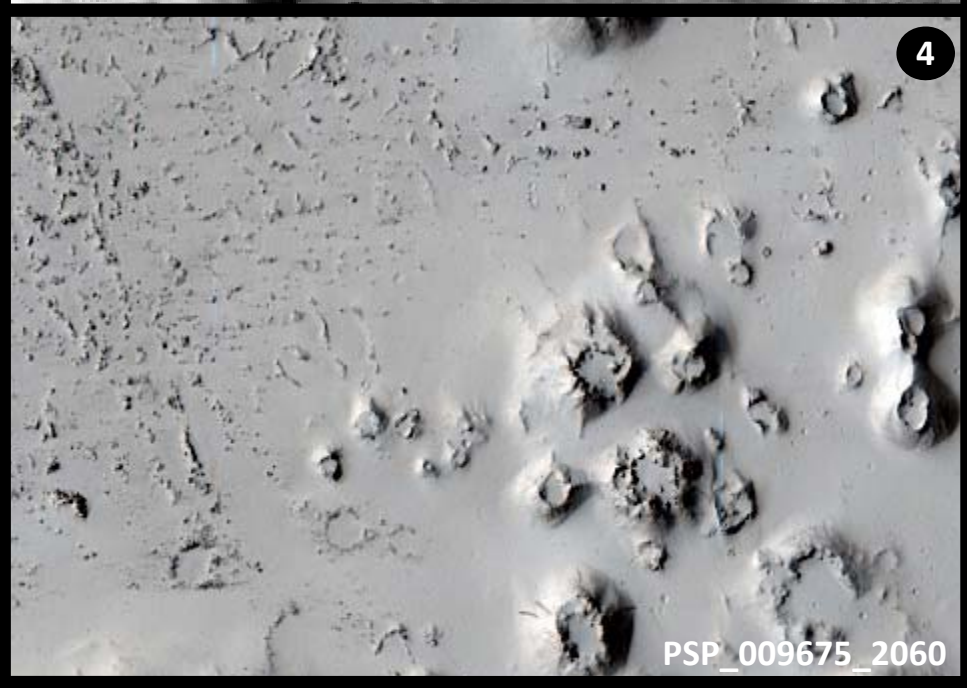

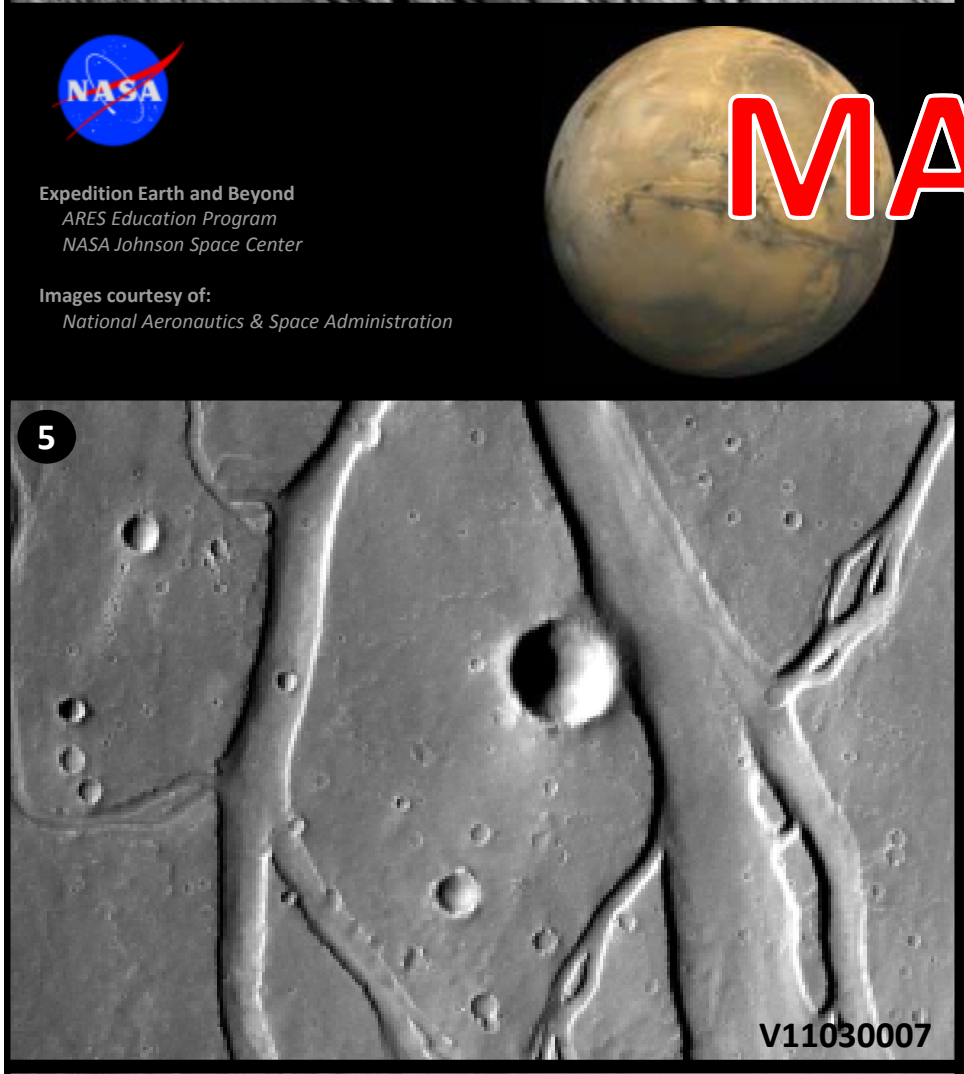

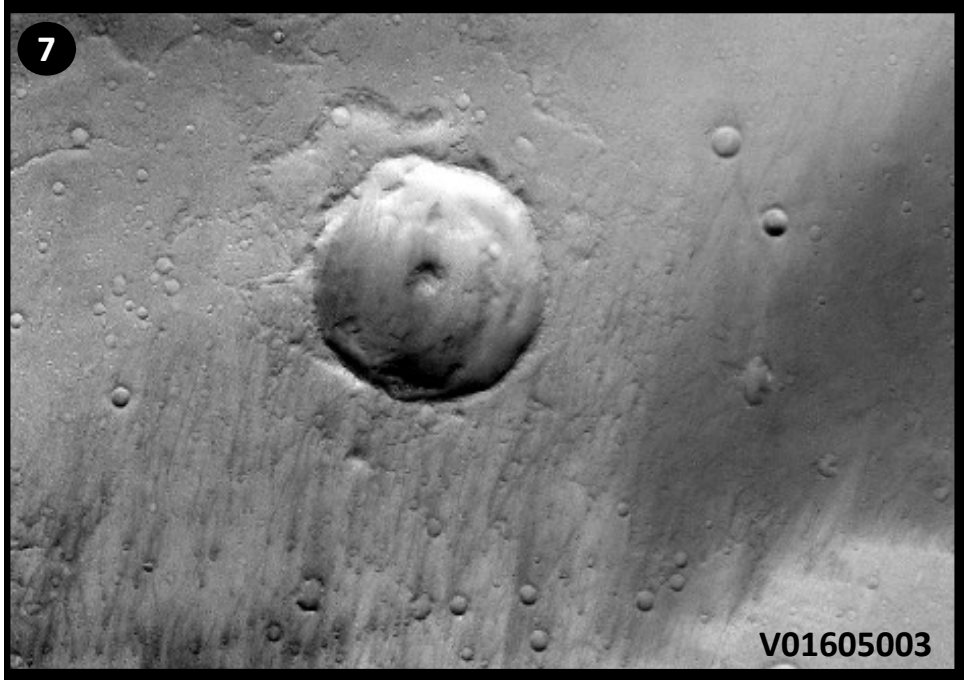

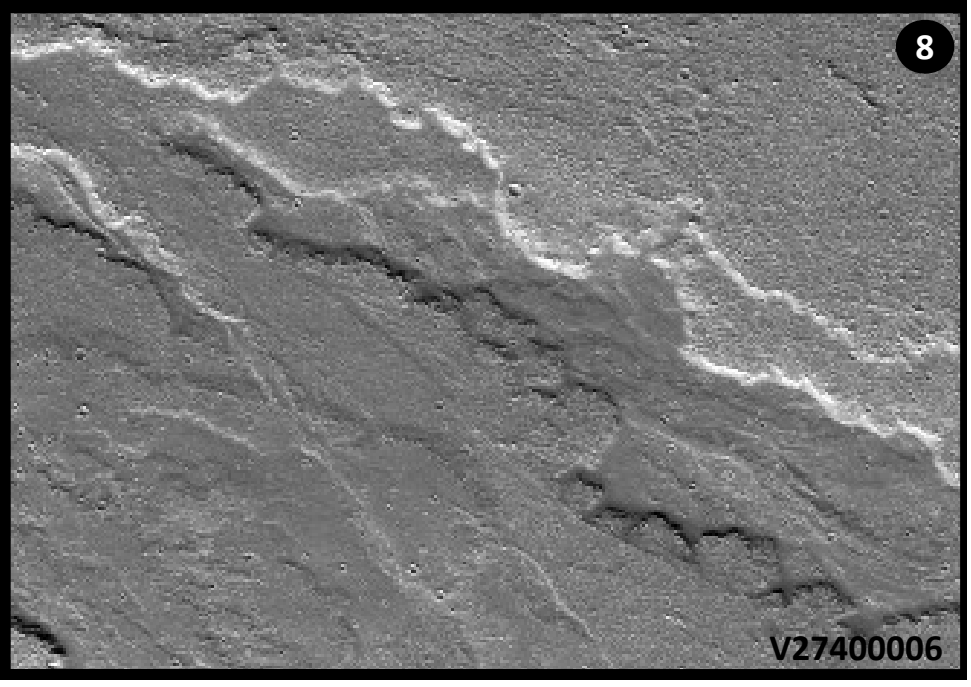

MARS

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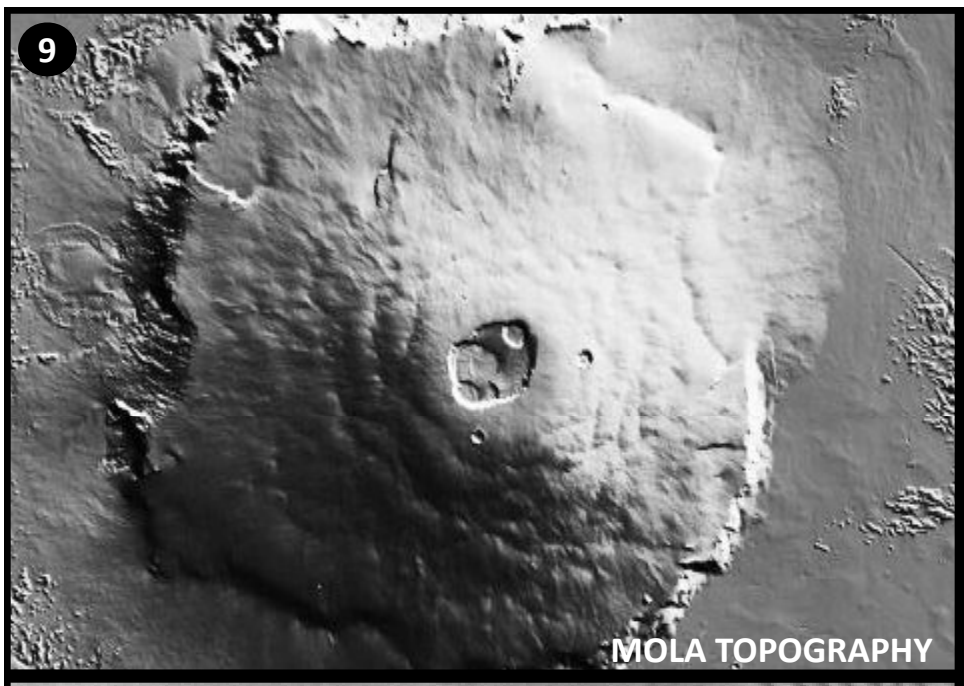

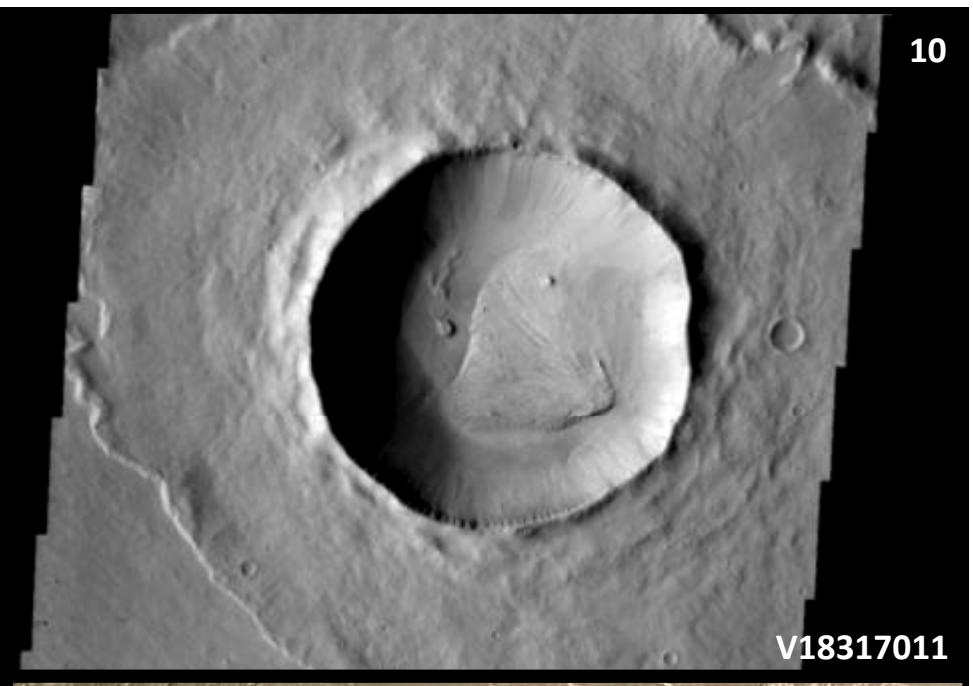

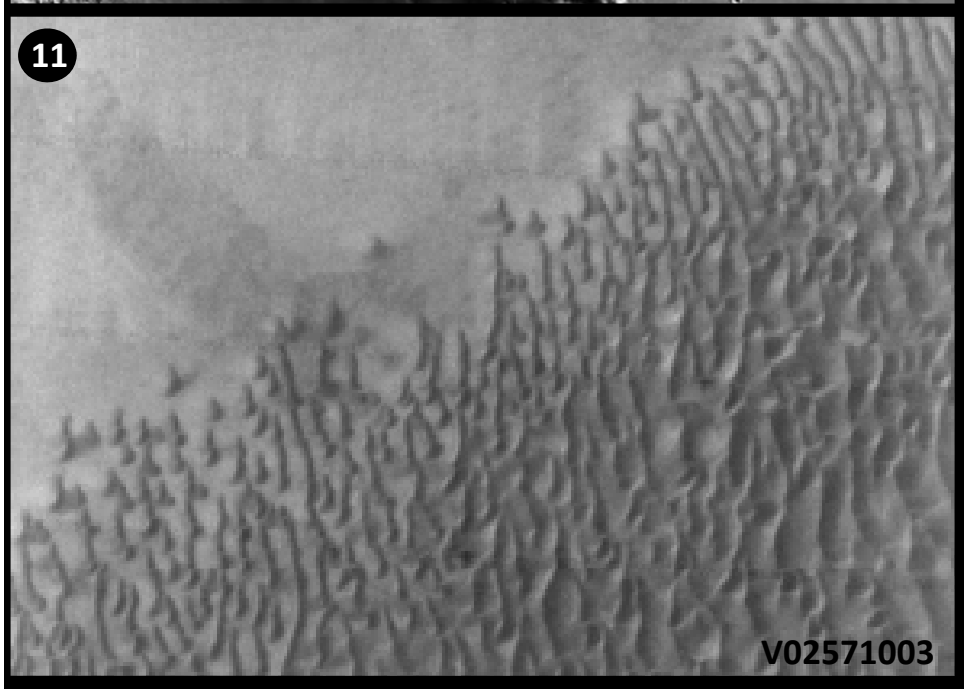

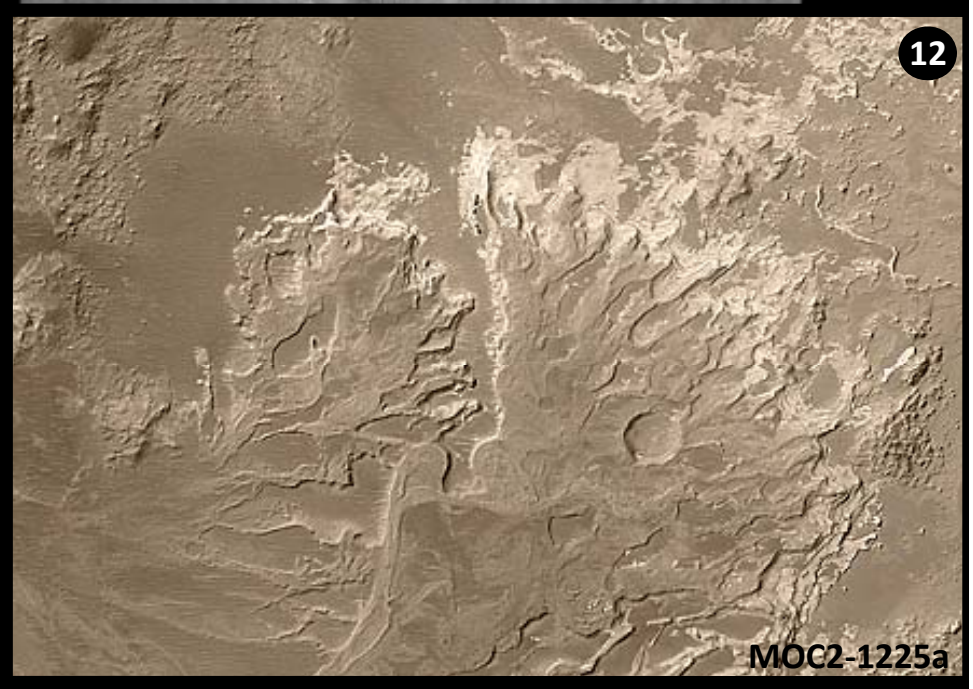

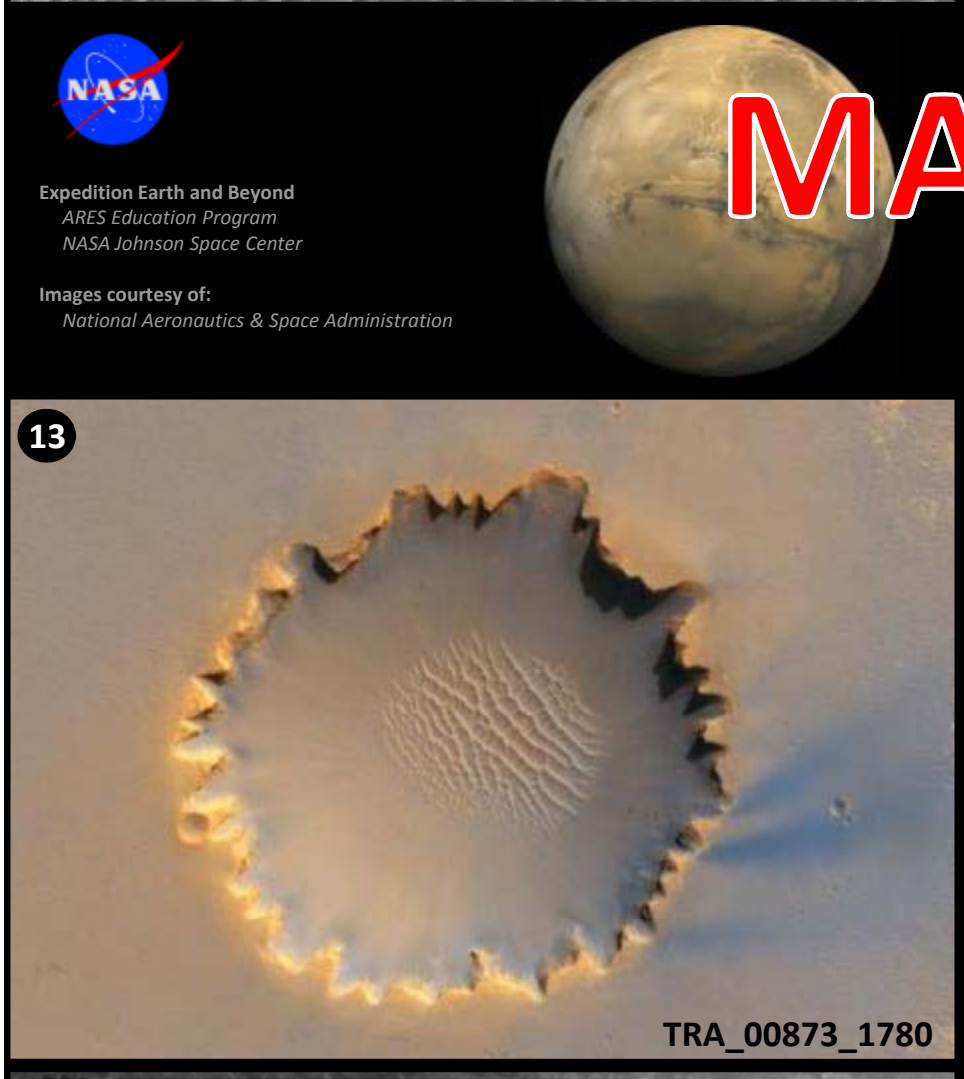

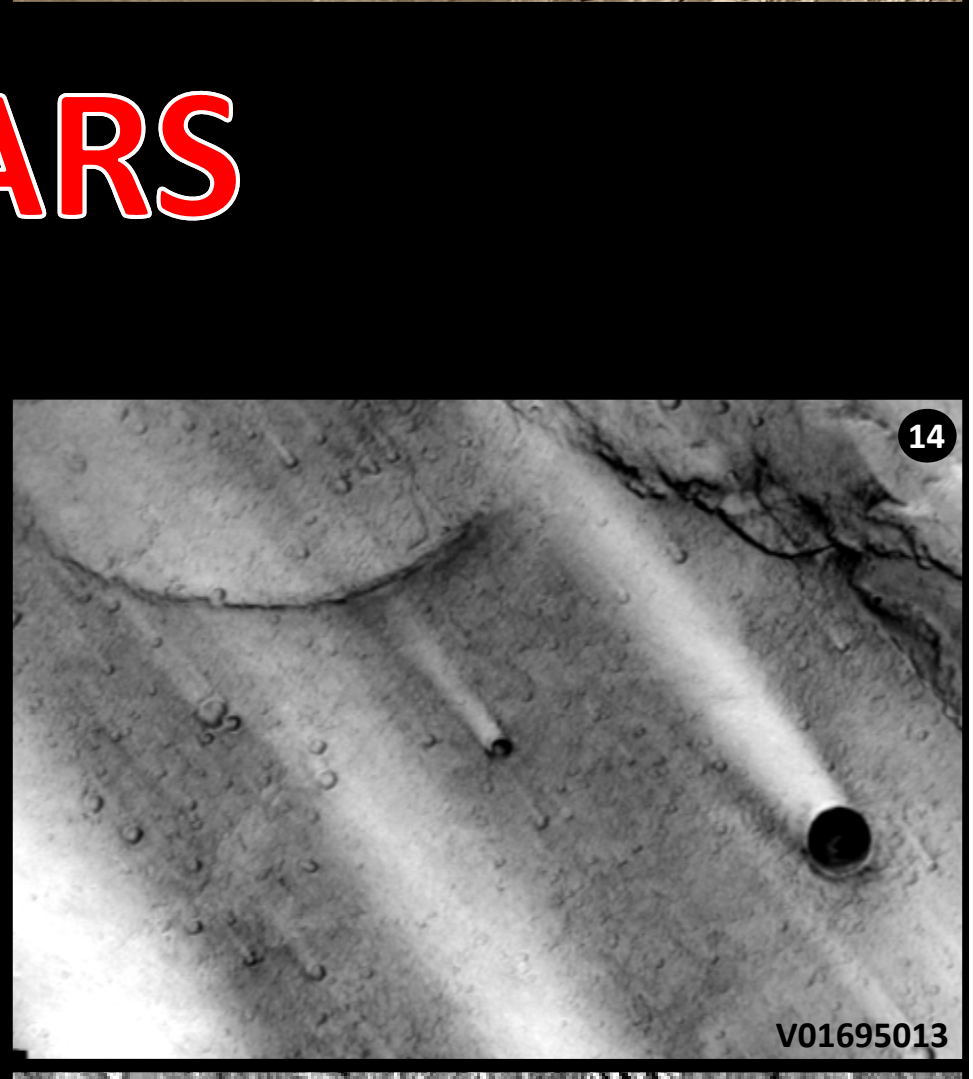

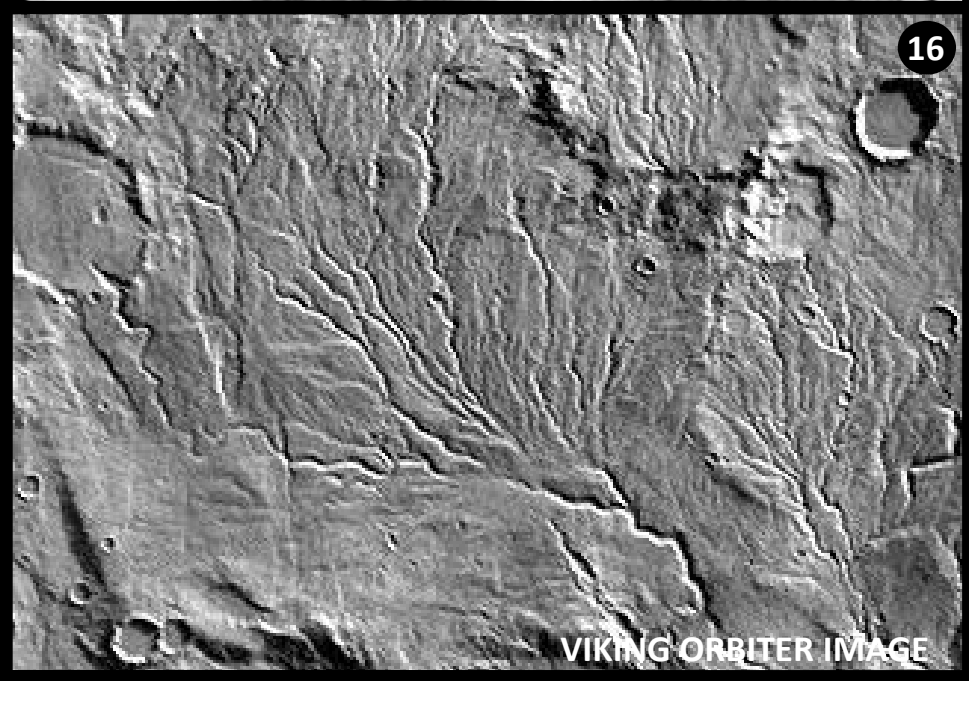

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