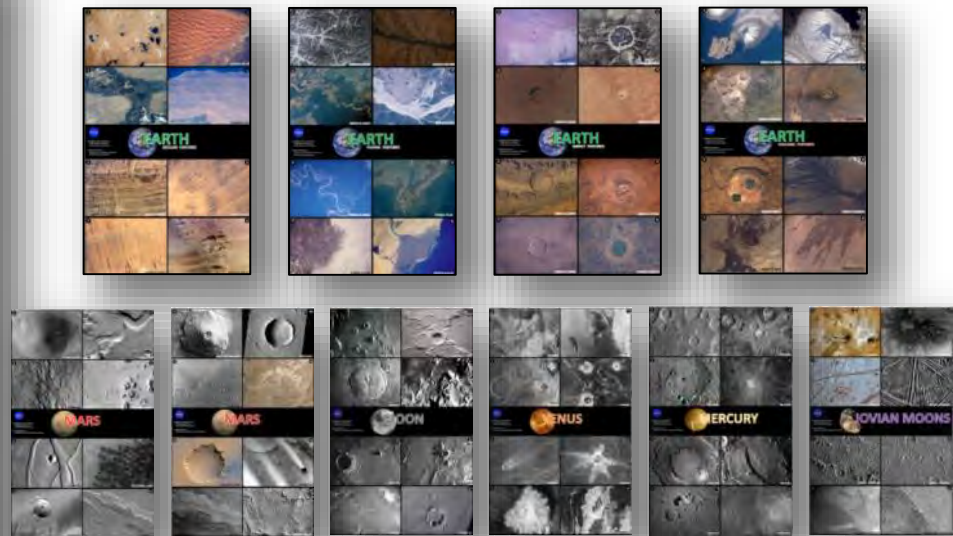
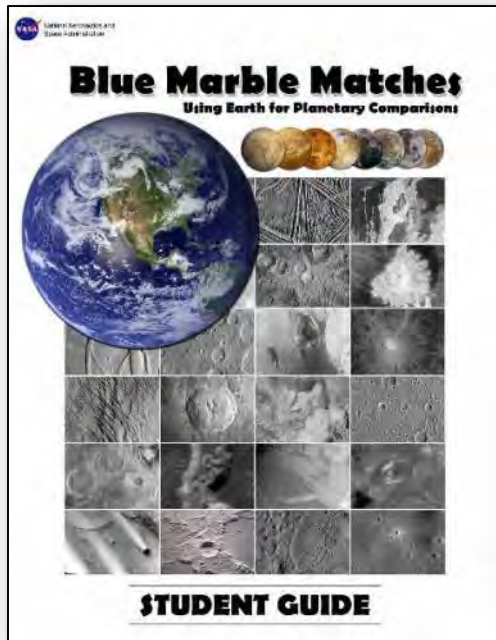


Blue Marble Matches: Using Earth for Planetary Comparisons



PRESENTER:

Paige Valderrama Graff (paige.v.graff@nasa.gov)
Jacobs @ NASA Johnson Space Center



Overview of Presentation

- Brief Introduction
- Hands-on Activity:
 - Blue Marble Matches: Using Earth For Planetary Comparisons
- Student Research in the Classroom

Astromaterials Research & Exploration Science (ARES)



- Acquisition & Curation
- Astromaterials Research
- Exploration Science



Images courtesy of NASA and ARES



Crew Earth Observations (CEO)





**Getting students actively involved
with NASA exploration and discovery.**
<http://ares.jsc.nasa.gov/ares/eeab/>

Getting Started

Launchpad Activities



Standards-aligned, inquiry-based,
hands-on activities.

Modeling the Process of Science

Student Investigation Resources



Resources that help facilitate student-led investigations
about Earth and/or planetary comparisons.

Enrichment Components



**Team Wiki
Pages**



**Interacting w/
Scientists**

Educator Trainings



**Data
Requests**



**Team
Presentations**



ISS023E058455





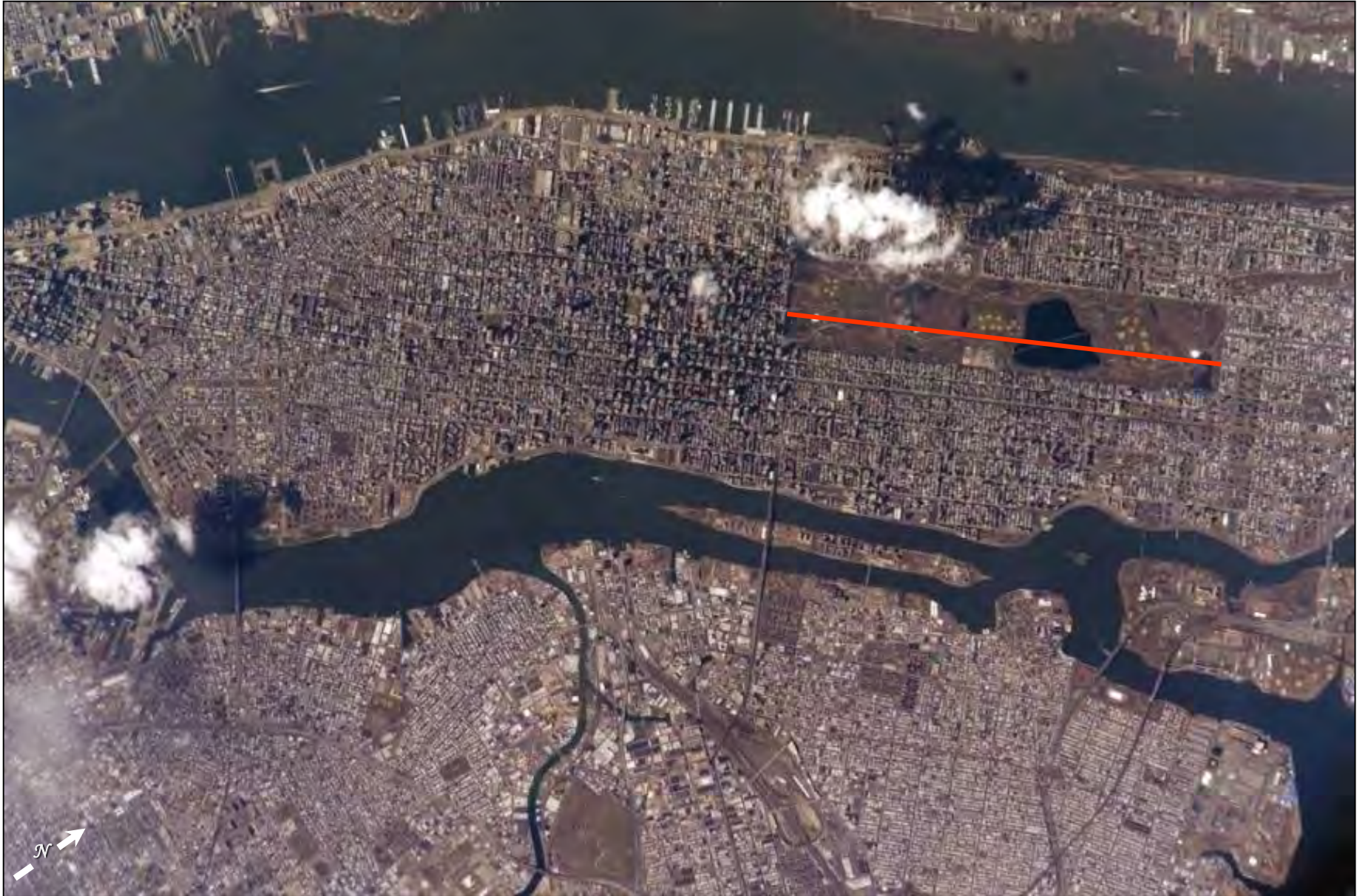
ISS013-E-6947

The red line drawn in the image above represents ≈ 4.1 km.



ISS014E15767

The red line drawn in the image above represents ≈ 6.3 km.



ISS010-E-21487

The red line drawn in the image above represents ≈ 4.1 km.



ISS007-E-5697

The red line drawn in the image above represents ≈ 4.5 km.

Carlisle Island

2



**Getting students actively involved
with NASA exploration and discovery.**
<http://ares.jsc.nasa.gov/ares/eeab/>

Getting Started

Launchpad Activities



Standards-aligned, inquiry-based,
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Modeling the Process of Science

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Resources that help facilitate student-led investigations
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Team Wiki
Pages



Interacting w/
Scientists

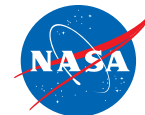
Educator Trainings



Data
Requests

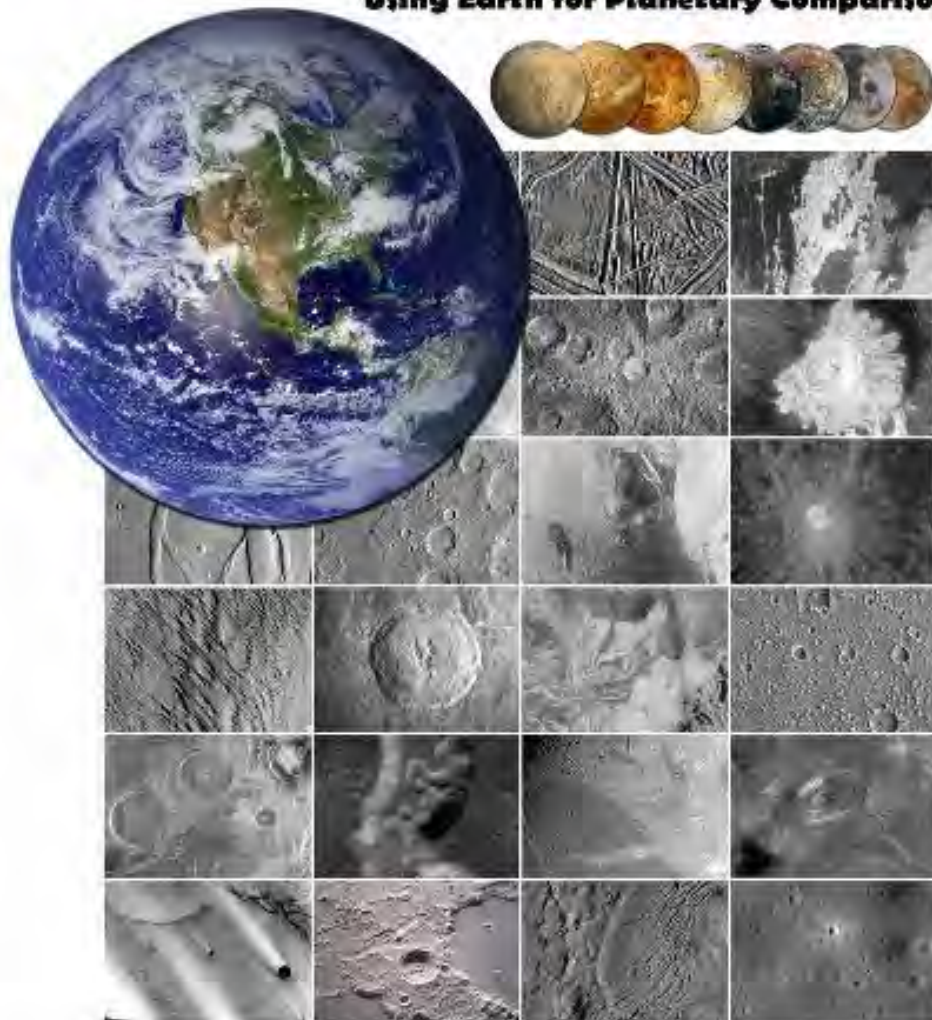


Team
Presentations



Blue Marble Matches

Using Earth for Planetary Comparisons



STUDENT GUIDE

Today we will:

- Identify common **characteristics** to describe features in images.
- Identify **geologic processes** and **features** and how they form on Earth.
- Create a list of **criteria** to identify geologic features.
- Use **criteria** to identify features on other planetary bodies.
- Discuss “building” a **planetary comparison** feature wall.

Designed using the
5-E MODEL OF INQUIRY



BLUE MARBLE MATCHES

CONTEXT FOR ACTIVITY:

- NASA explores planetary bodies, including Earth, to better understand our Solar System.
- How do scientists determine what geologic features exist on other planets? This activity will help you understand part of that process.
- It starts with making good observations, being descriptive, and using what we know about Earth.

BLUE MARBLE MATCHES




Part 1: Be Descriptive!

- **OPTION 1:** Students could write their own descriptions of a given image in the space provided.
- **OPTION 2:** Listen to a given **DESCRIPTION** and **IDENTIFY** which image is being described.



Option 1

**Write
descriptions here**

 National Aeronautics and Space Administration

BLUE MARBLE MATCHES

Using Earth for Planetary Comparisons

Part 1: Observations and Descriptions

NASA explores planetary bodies, including Earth, to better understand the Solar System in which we live. Various types of spacecraft and scientific instruments are used to explore and gather data. Scientists use the data returned from these spacecraft to make observations which they record, analyze, and interpret. One technique or process of gathering data from a distance using spacecraft or even aircraft is called remote sensing. This technique allows you to gather data of a location you might not be able to visit in person.

One application of remote sensing is using images to identify geologic features on different planets. How do scientists determine what geologic features exist on other planets? This activity will help you understand part of that process. It starts with making good observations, being descriptive, and using what we know about Earth. For the first part of this activity, we will test your skills in how observant and descriptive you can be.

The remote sensing images of Earth you will observe in this activity were taken by astronauts from the International Space Station or Space Shuttle using hand held cameras. You will be given one image to observe and describe in the space provided below. As you write your descriptions, do not name features you are observing. Instead, use descriptive words to describe what you see. Someone will attempt to identify the image you describe.

IMAGE DESCRIPTION
Use descriptive words to describe your image. Do not name features.

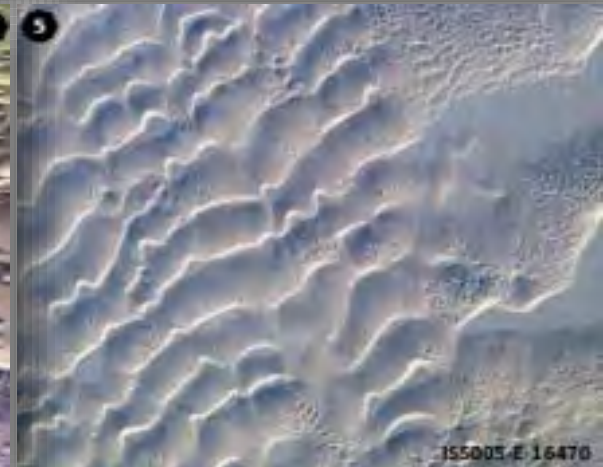
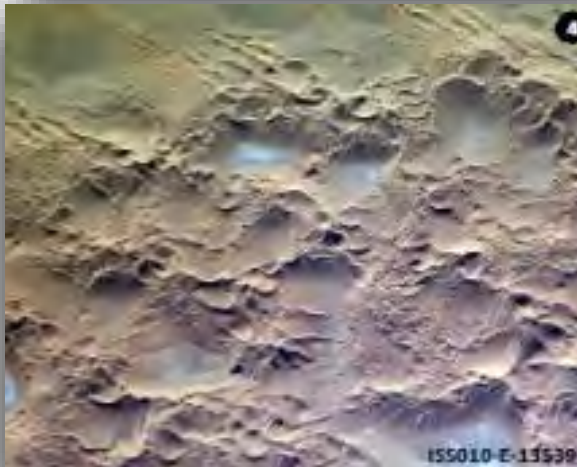
**Write
descriptions here**

Now we will see how descriptive you were! Read your description to other students in the class to see if they can correctly identify your image. Discuss how you could improve image descriptions as you go through this process.

Examine Earth and Beyond: Astronomical Background and Cooperative Science (NASA/JPL/University of Arizona)

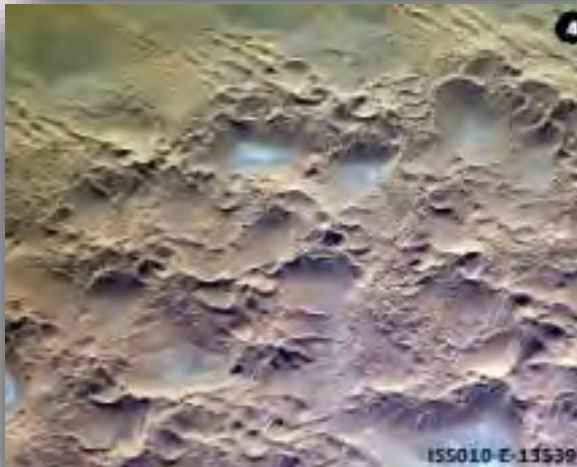
BEING DESCRIPTIVE

- Listen to the image description and try to identify the image being described.



BEING DESCRIPTIVE

- What were good descriptive characteristics (descriptors) or good ways to describe the features in these images.



Based on your discussion with other students, list 3-5 useful characteristics or descriptive ways to describe features in images:

- a.
- b.
- c.
- d.
- e.

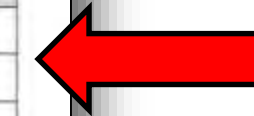
So, what are these images all about? They are remote sensing images of Earth that focus on features related to four different geologic processes that help shape the surface of our planet. These processes are related to wind, water, volcanoes, and impacts (meteors striking the surface). Based on what you may know, do the following:

1. Discuss how you would group the images in pairs that relate to the same geologic process.
2. List which of the four given geologic processes you think created those features. Choose from wind, water, volcanic, or impact.
3. If you think you know the names of any features in these images, feel free to list your best guesses!

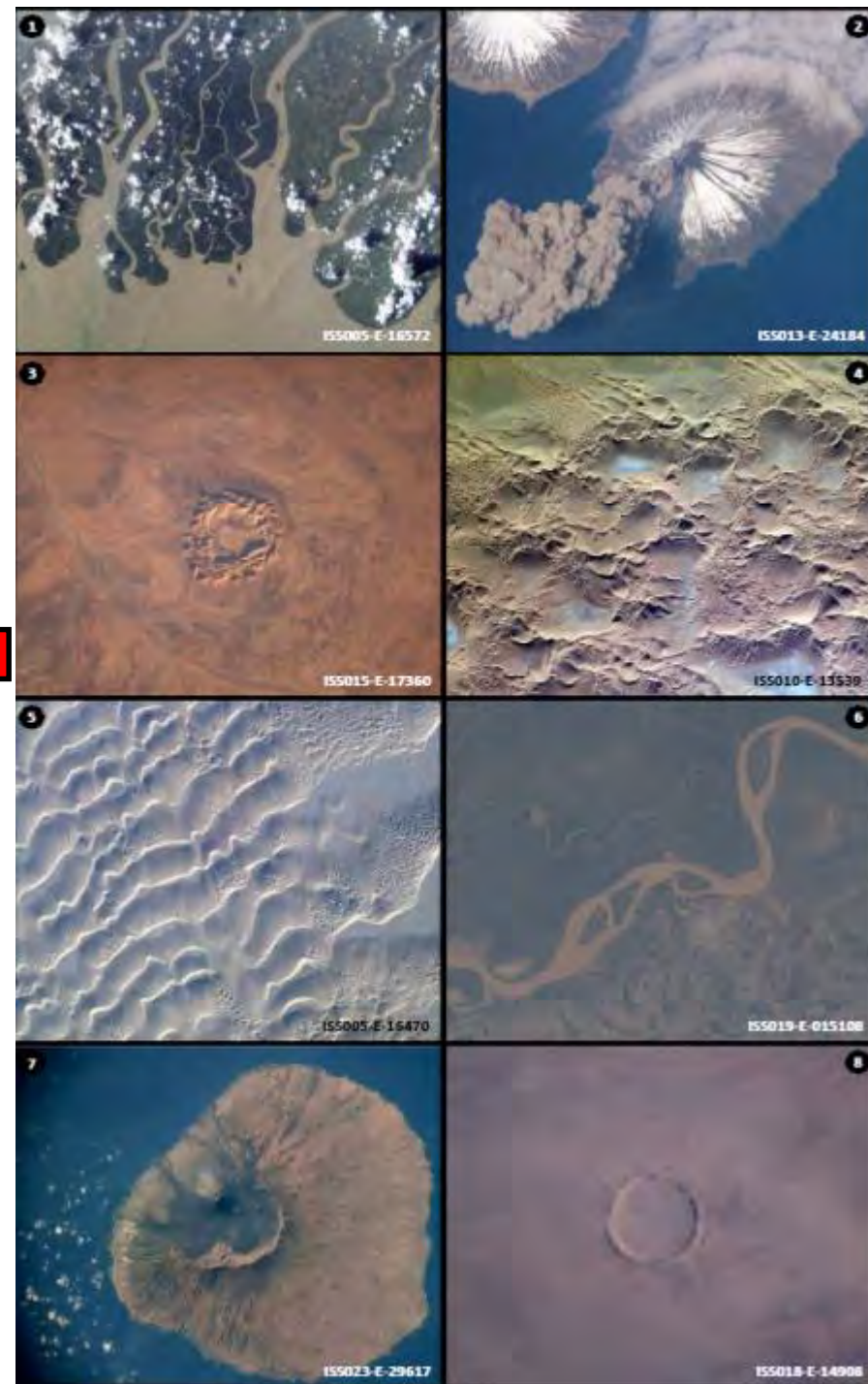
As you make your observations and discuss as a group, fill out the table below.

	IMAGES (use numbers 1-8)	GEOLOGIC PROCESS (Wind, Water, Volcanic, or Impact)	FEATURE NAMES (optional)
Group 1			
Group 2			
Group 3			
Group 4			

Now that you have an idea of how you can be descriptive and have some thoughts about the geologic processes related to the images you observed, let's investigate further. Did you know the names of these geologic features? Do you know how they form? Are these same features found on other planets in our solar system? How do scientists use what they know about Earth to explore other planets? This activity will help you understand and answer these questions. Let's explore!



So what are these
images all about?



➤ Which images would you pair together that represent the same geologic process.

Based on your discussion with other students, list 3-5 useful characteristics or descriptive ways to describe features in images:

-
-
-
-
-

EXAMPLE

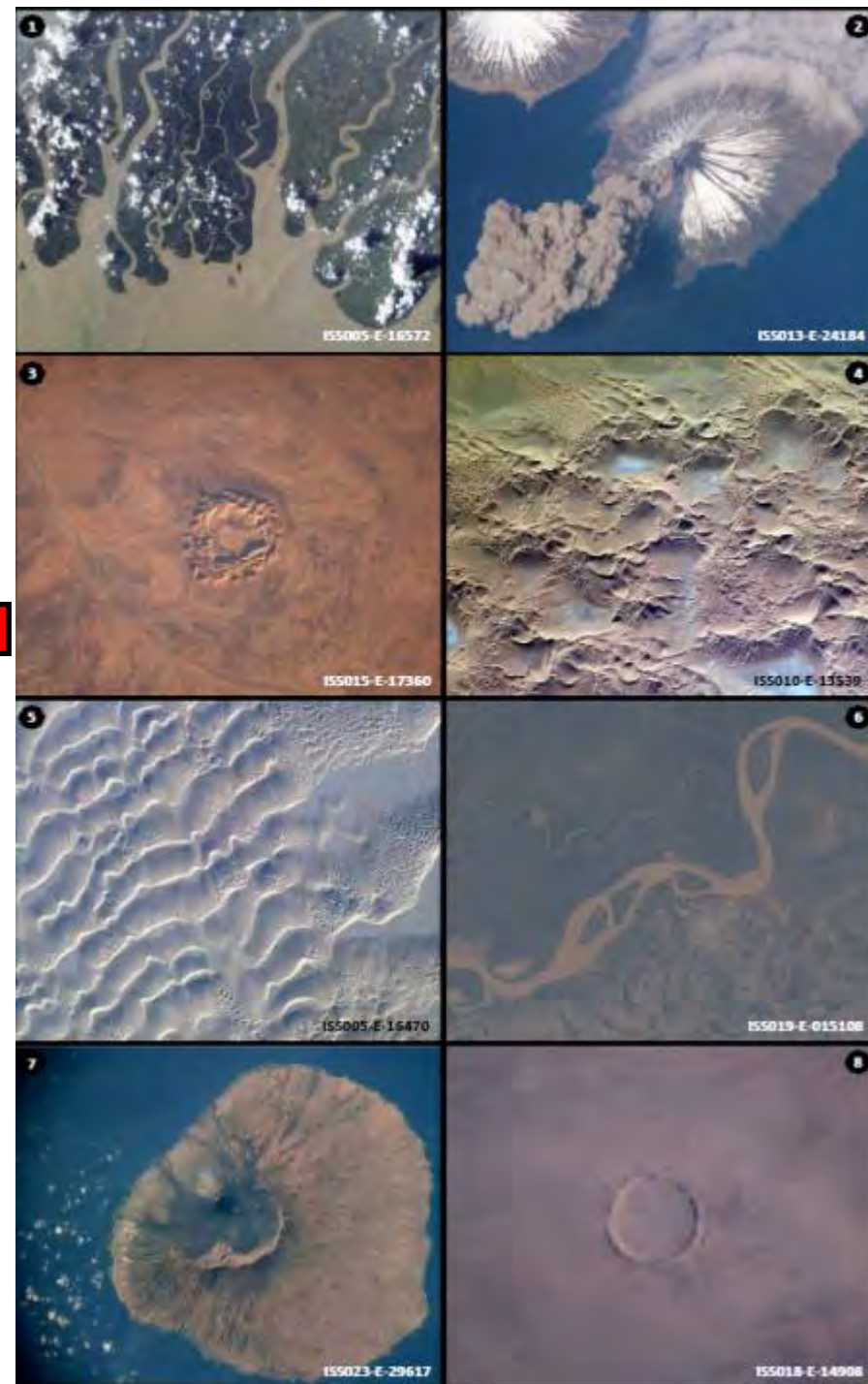
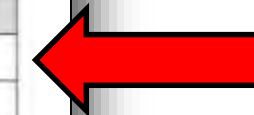
So, what are these images all about? They are remote sensing images of Earth that focus on features related to four different geologic processes that help shape the surface of our planet. These processes are related to wind, water, volcanoes, and impacts (meteors striking the surface). Based on what you may know, do the following:

1. Discuss how you would group the images in pairs that relate to the same geologic process.
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3. If you think you know the names of any features in these images, feel free to list your best guesses!

As you make your observations and discuss as a group, fill out the table below.

	IMAGES (use numbers 1-8)	GEOLOGIC PROCESS (Wind, Water, Volcano, or Impact)	FEATURE NAMES (optional)
Group 1	3 & 8	Impact	
Group 2			
Group 3			
Group 4			

Now that you have an idea of how you can be descriptive and have some thoughts about the geologic processes related to the images you observed, let's investigate further. Did you know the names of these geologic features? Do you know how they form? Are these same features found on other planets in our solar system? How do scientists use what they know about Earth to explore other planets? This activity will help you understand and answer these questions. Let's explore!



➤ Which images would you pair together that represent the same geologic process.

Based on your discussion with other students, list 3-5 useful characteristics or descriptive ways to describe features in images:

-
-
-
-
-

EXAMPLE

So, what are these images all about? They are remote sensing images of Earth that focus on features related to four different geologic processes that help shape the surface of our planet. These processes are related to wind, water, volcanoes, and impacts (meteors striking the surface). Based on what you may know, do the following:

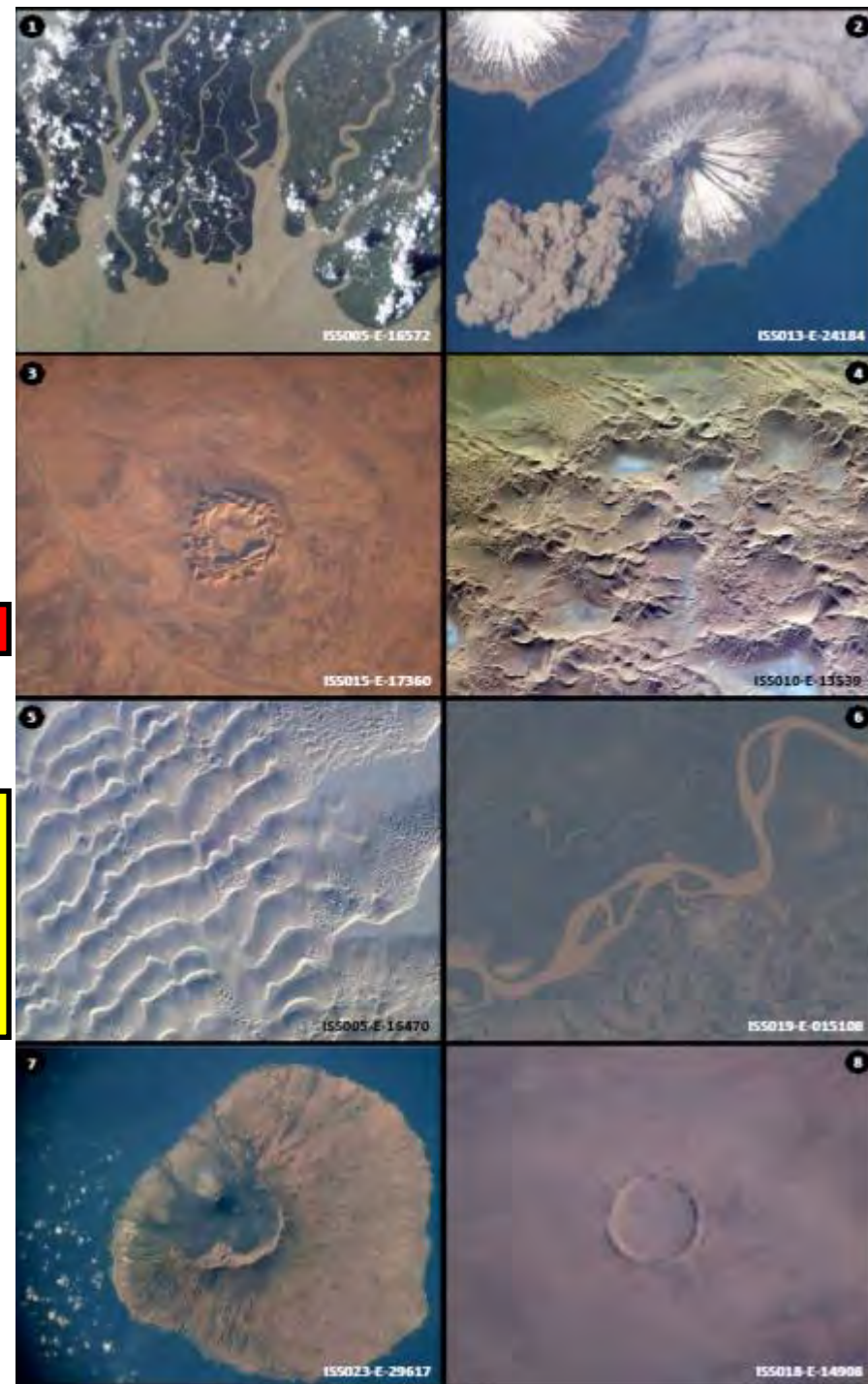
1. Discuss how you would group the images in pairs that relate to the same geologic process.
2. List which of the four given geologic processes you think created those features. Choose from wind, water, volcanic, or impact.
3. If you think you know the names of any features in these images, feel free to list your best guesses!

As you make your observations and discuss as a group, fill out the table below:

	IMAGES (use numbers 1-8)	GEOLOGIC PROCESS (Wind, Water, Volcanic, or Impact)	FEATURE NAMES (optional)
Group 1	3 & 8	Impact	
Group 2			
Group 3			
Group 4			

On your handout, list the pairs of images that represent the other processes (*water, volcanic, wind*).

➤ Which images would you pair together that represent the same geologic process.

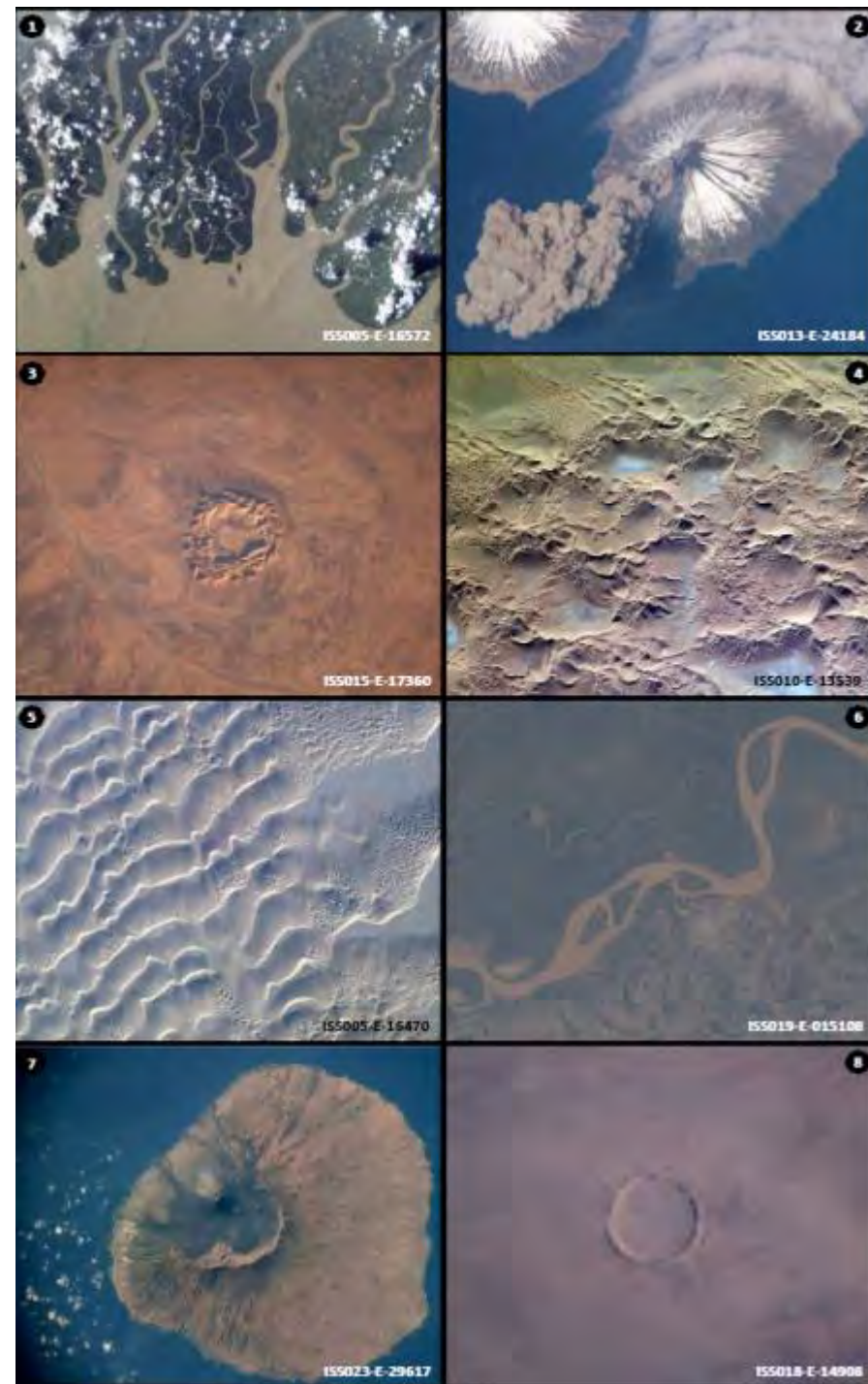


EXAMPLE

- Which images would you pair together that represent the same geologic process:
 - Impact
 - Water
 - Volcanic
 - Wind

ANSWERS:

- **IMPACT:** Images # 3 & 8

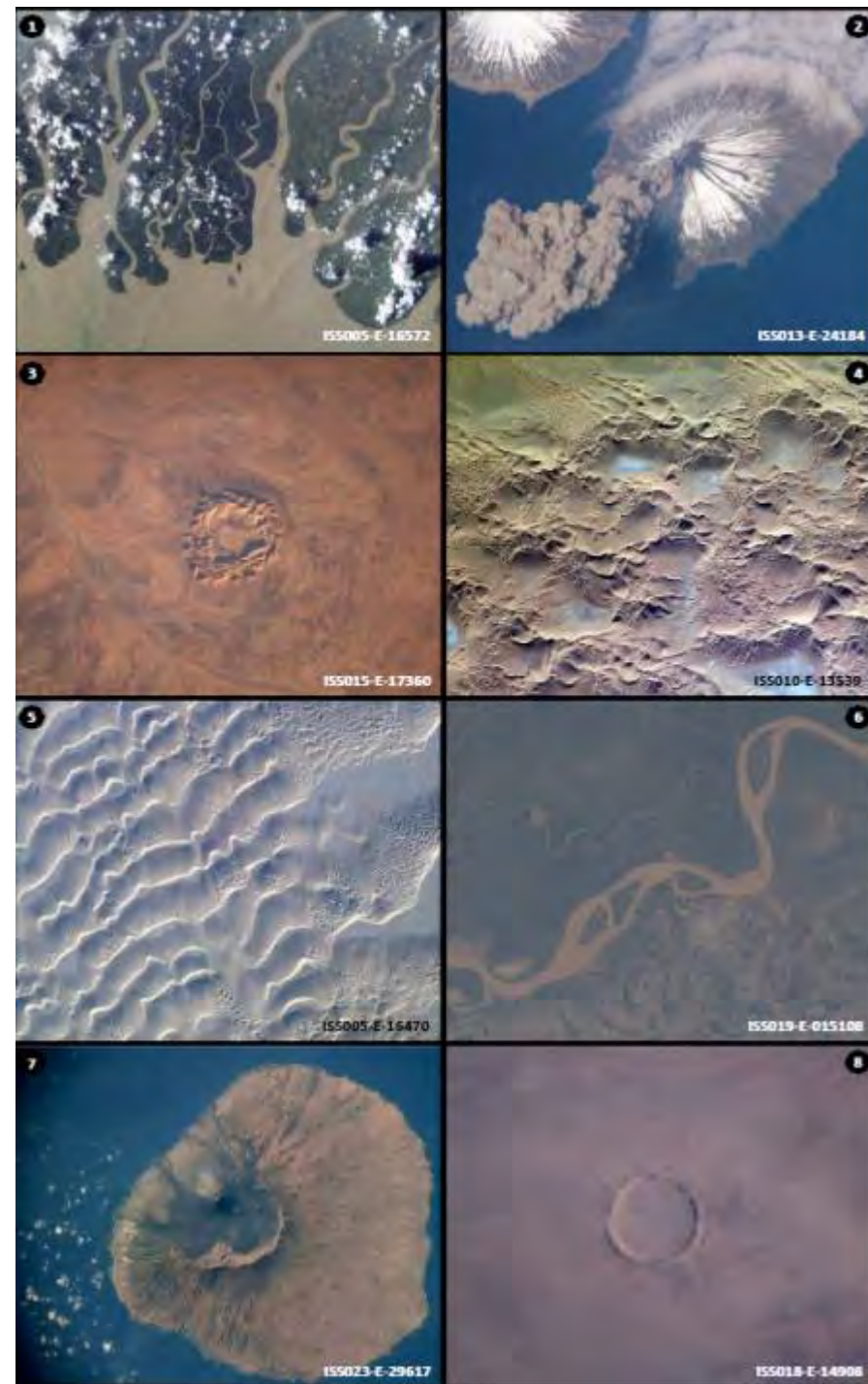


EXAMPLE

- Which images would you pair together that represent the same geologic process:
 - Impact
 - Water
 - Volcanic
 - Wind

ANSWERS:

- **IMPACT:** Images # 3 & 8
- **WATER:** 1 & 6

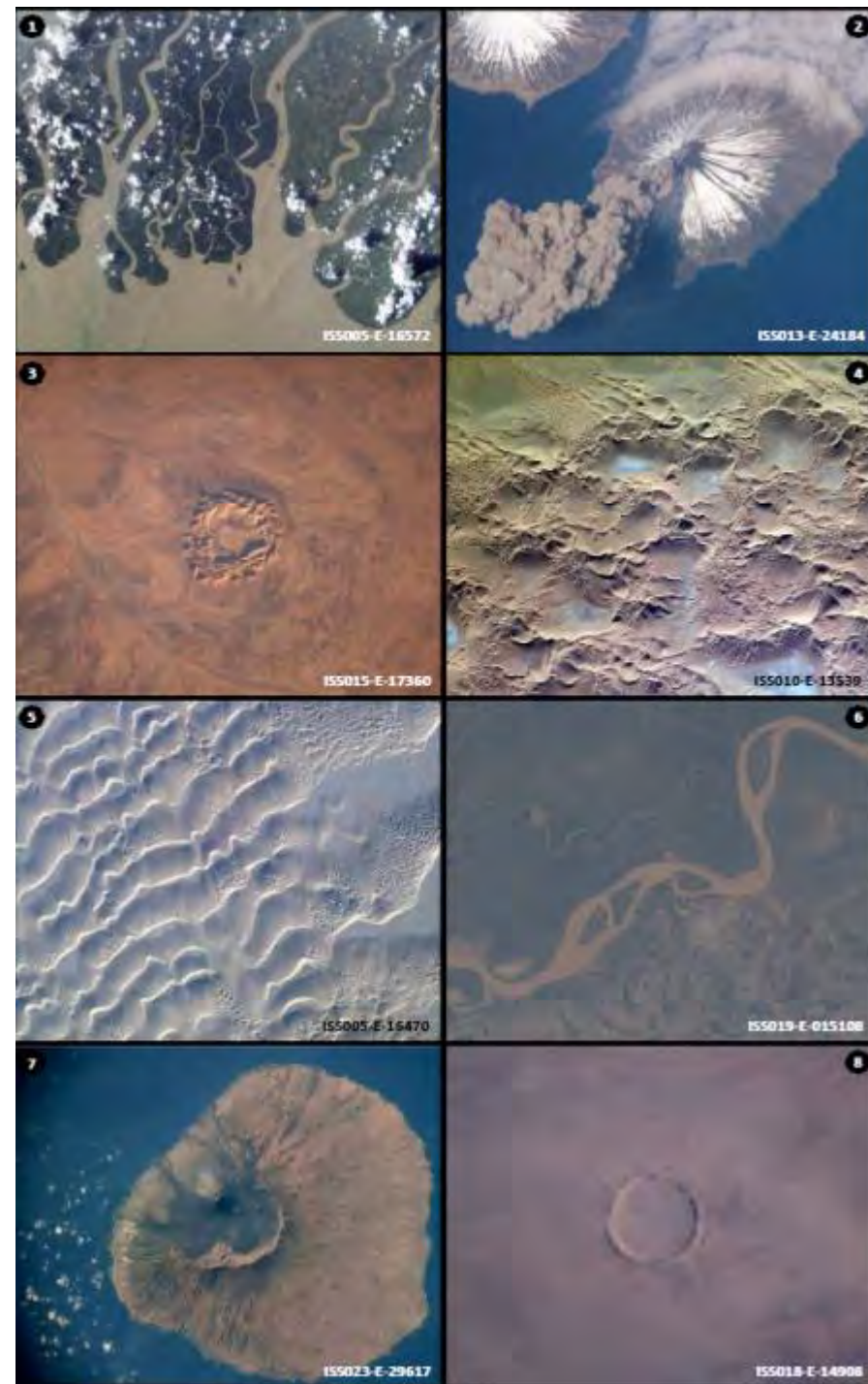


EXAMPLE

- Which images would you pair together that represent the same geologic process:
 - Impact
 - Water
 - Volcanic
 - Wind

ANSWERS:

- **IMPACT:** Images # 3 & 8
- **WATER:** 1 & 6
- **VOLCANIC:** 2 & 7

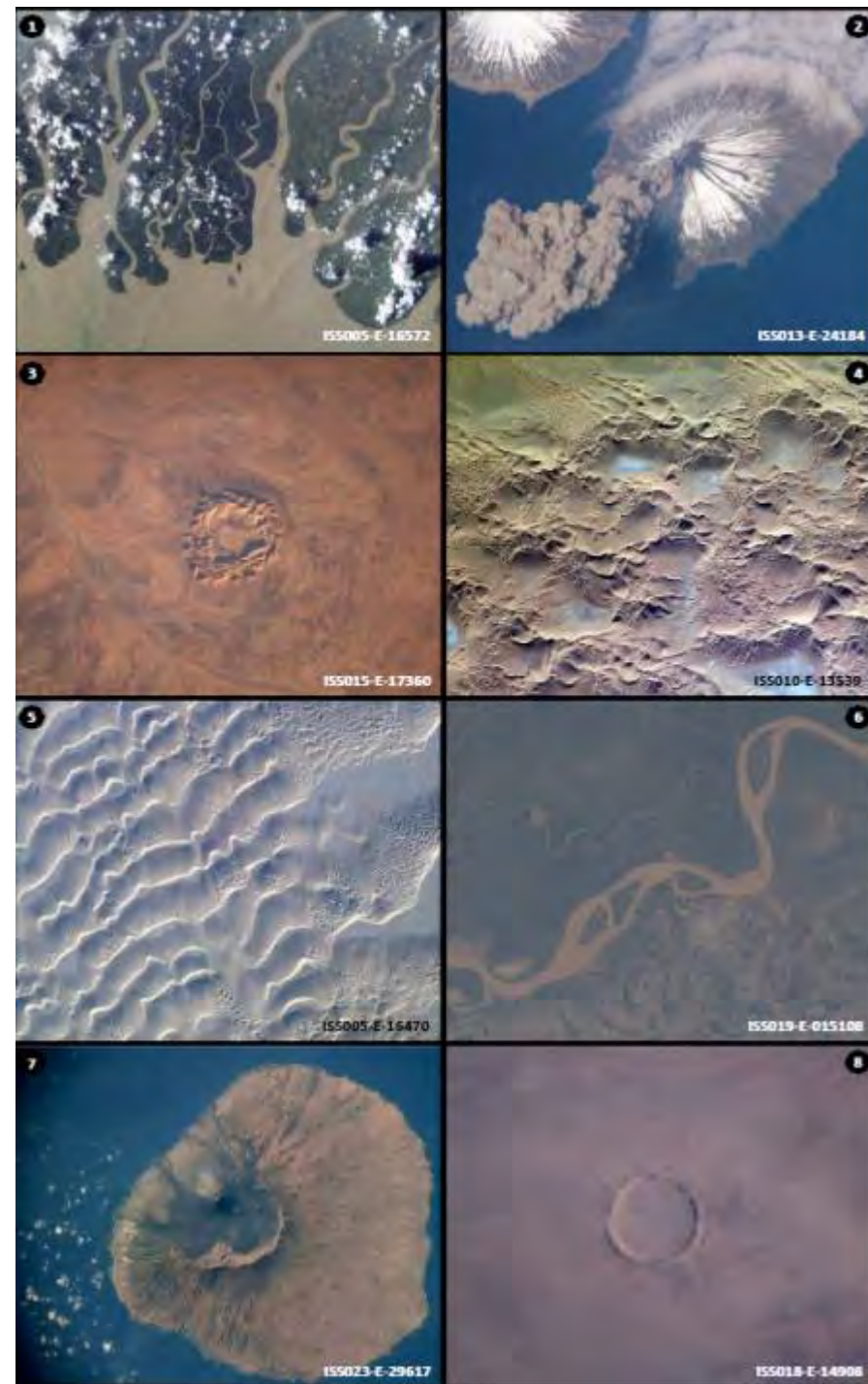


EXAMPLE

- Which images would you pair together that represent the same geologic process:
 - Impact
 - Water
 - Volcanic
 - Wind

ANSWERS:

- **IMPACT:** Images # 3 & 8
- **WATER:** 1 & 6
- **VOLCANIC:** 2 & 7
- **WIND:** 4 & 5



BLUE MARBLE MATCHES

Part 2: Developing Identification Criteria

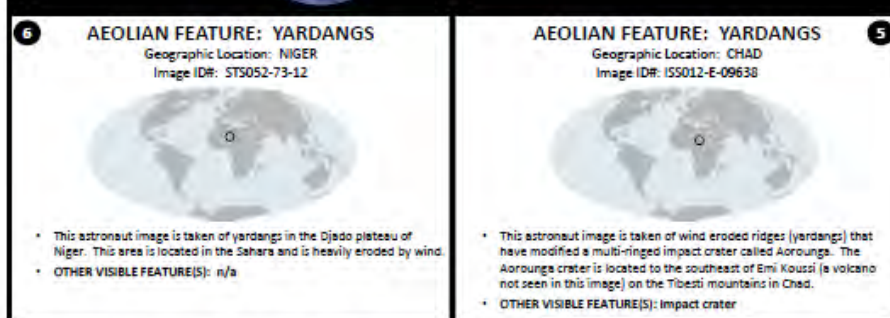
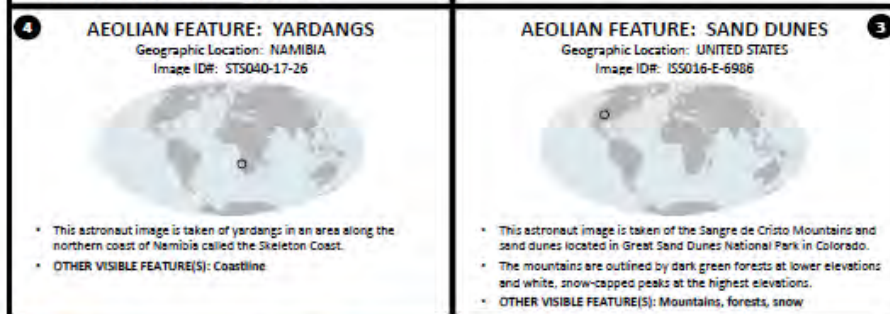
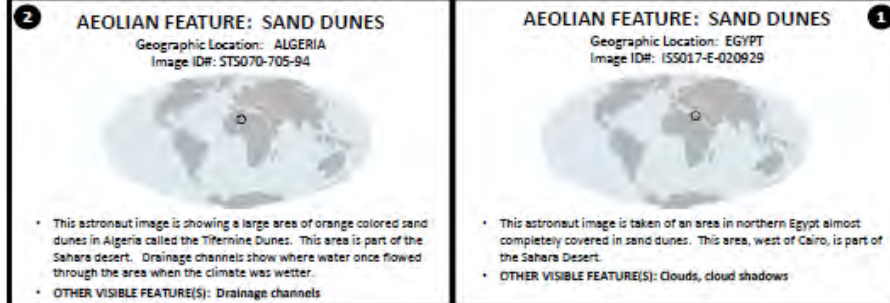
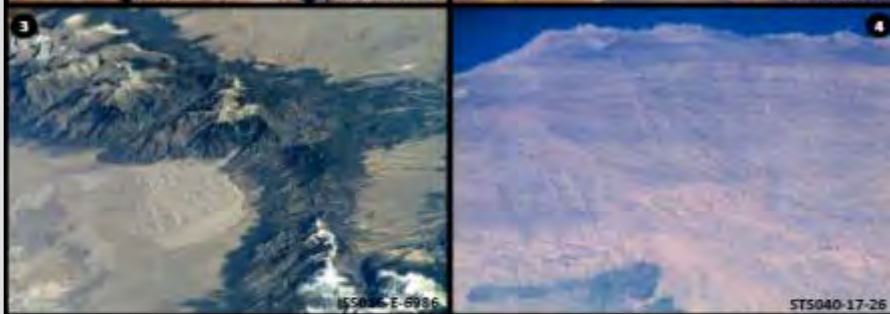
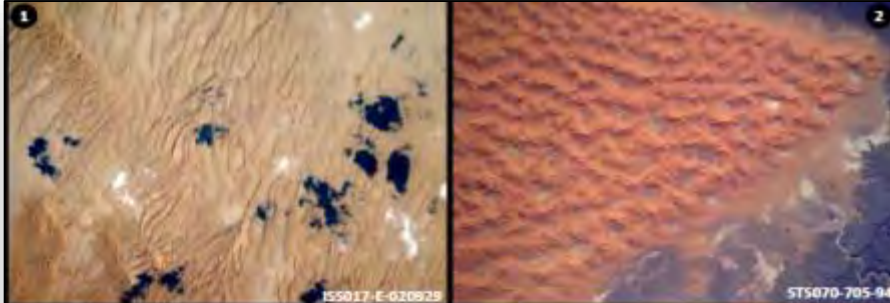


Aeolian
(Wind)

Fluvial
(Water)

Impact

Volcanic



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 Tifemine 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

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

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

Geographic Location: UNITED STATES
Image ID#: ISS016-E-6906



- 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

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

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

AEOLIAN FEATURE: WIND STREAKS

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



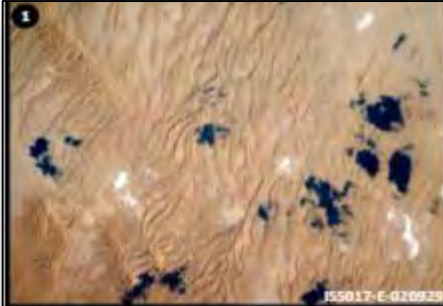
- This astronaut image showing numerous wind streaks is taken of an area affected by strong winds in the northern part of Sudan.
- OTHER VISIBLE FEATURE(S): Escarpments

AEOLIAN FEATURE: WIND STREAKS

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)



AEOLIAN FEATURE: SAND DUNES
 Geographic Location: ALGERIA
 Image ID#: ISS017-005-94

- This astronaut image is showing a large area of orange colored sand dunes in Algeria called the Tifemine Dunes. This area is part of the Sahara desert. Drainage channels show where water once flowed through the area when the climate was wetter.

AEOLIAN FEATURE: SAND DUNES
 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



AEOLIAN FEATURE: SAND DUNES

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

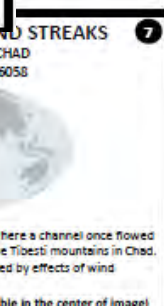
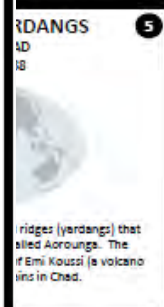
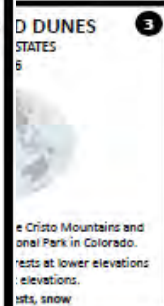


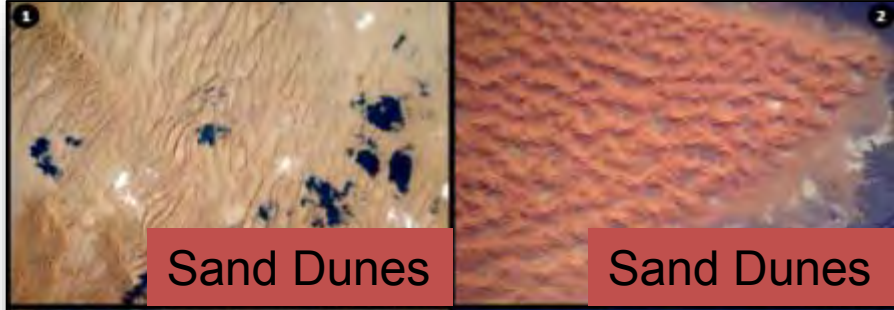
AEOLIAN FEATURE: WIND STREAKS
 Geographic Location: SUDAN
 Image ID#: ISS013-E-18533

- 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
 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)





Sand Dunes

Sand Dunes



Sand Dunes

Yardangs



Yardangs

Yardangs



Wind Streaks

Wind Streaks

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 Tifemine 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

1

AEOLIAN FEATURE: SAND DUNES
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

3

AEOLIAN FEATURE: SAND DUNES
Geographic Location: UNITED STATES
Image ID#: ISS016-E-6906

- 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



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

5

AEOLIAN FEATURE: YARDANGS
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

7

AEOLIAN FEATURE: WIND STREAKS
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)

WHAT YOU WILL DO:

-

EXAMPLE

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make observations, think about how each feature is formed and be prepared to select and create identification criteria for each feature in the tables below.

Once you have a feature chart, you will:

1. Make observations of the different geologic features visible in the images on the feature chart.
2. Use check marks on each table below to indicate which 2 criteria best describe each feature. Make changes or adjustments to listed criteria if you wish.
3. Create your own descriptions that can be used as other identification criteria for each feature.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

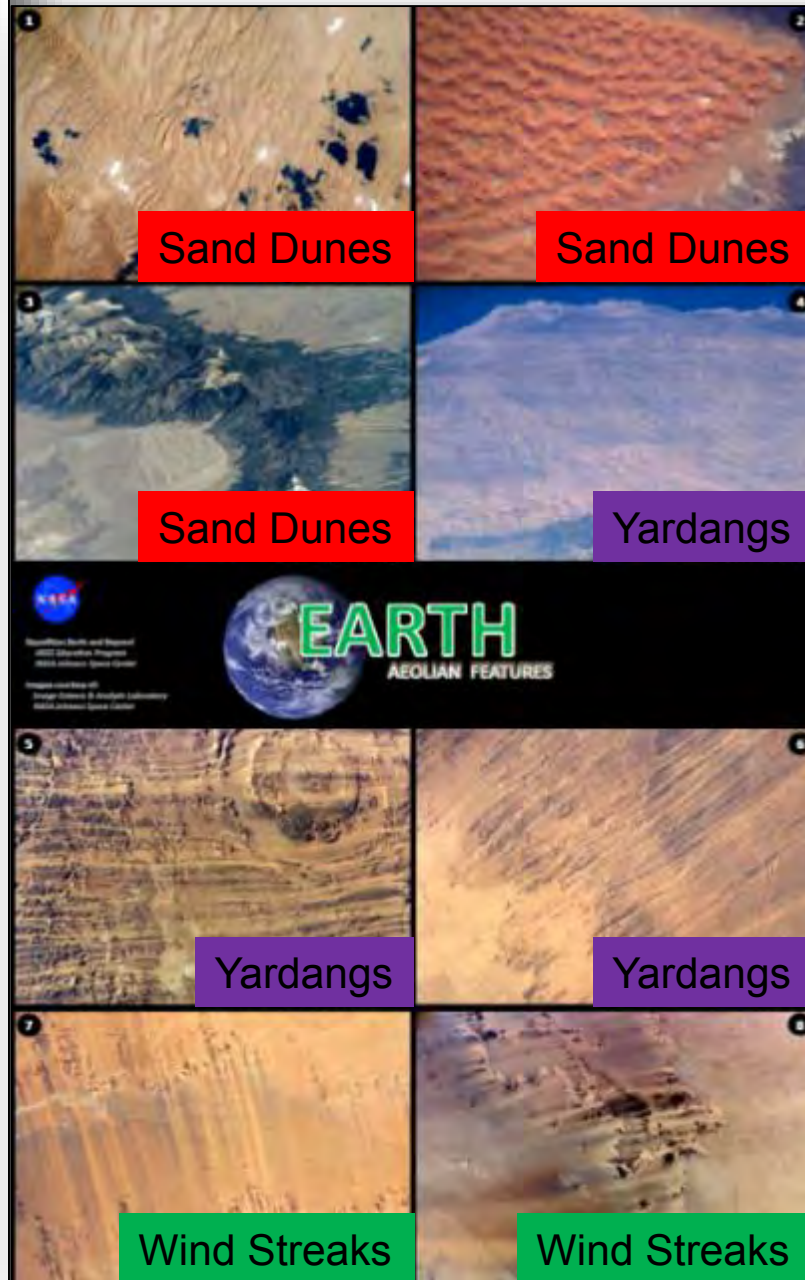
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

Part 2: Identification Criteria

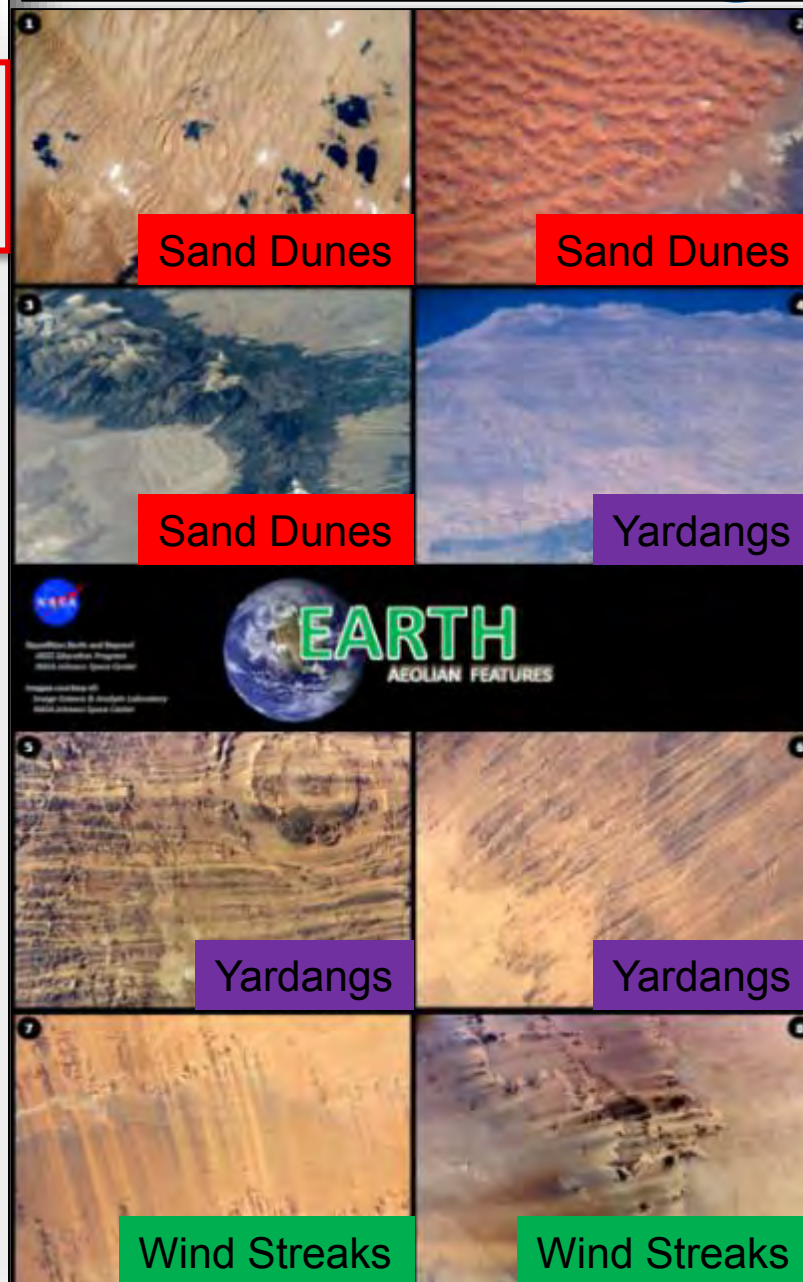
Select/revise **2 CRITERIA** that best describe **each feature**.

1. Make observations of the different geologic features visible in the photos on the feature chart.
2. Use check marks on each table below to indicate which **2 criteria** best describe **each feature**. Make changes or adjustments to listed criteria if you wish.
3. Create your own descriptions that can be used as other identification criteria for each feature.

AEOLIAN PROCESSES Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

Part 2: Identification Criteria

Select/revise **2 CRITERIA** that best describe **each feature**.

1. Make observations of the different geologic features visible in the photos on the feature chart.
2. Use check marks on each table below to indicate which **2 criteria** best describe **each feature**. Make changes or adjustments to listed criteria if you wish.
3. Create your own descriptions that can be used as other identification criteria for each feature.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

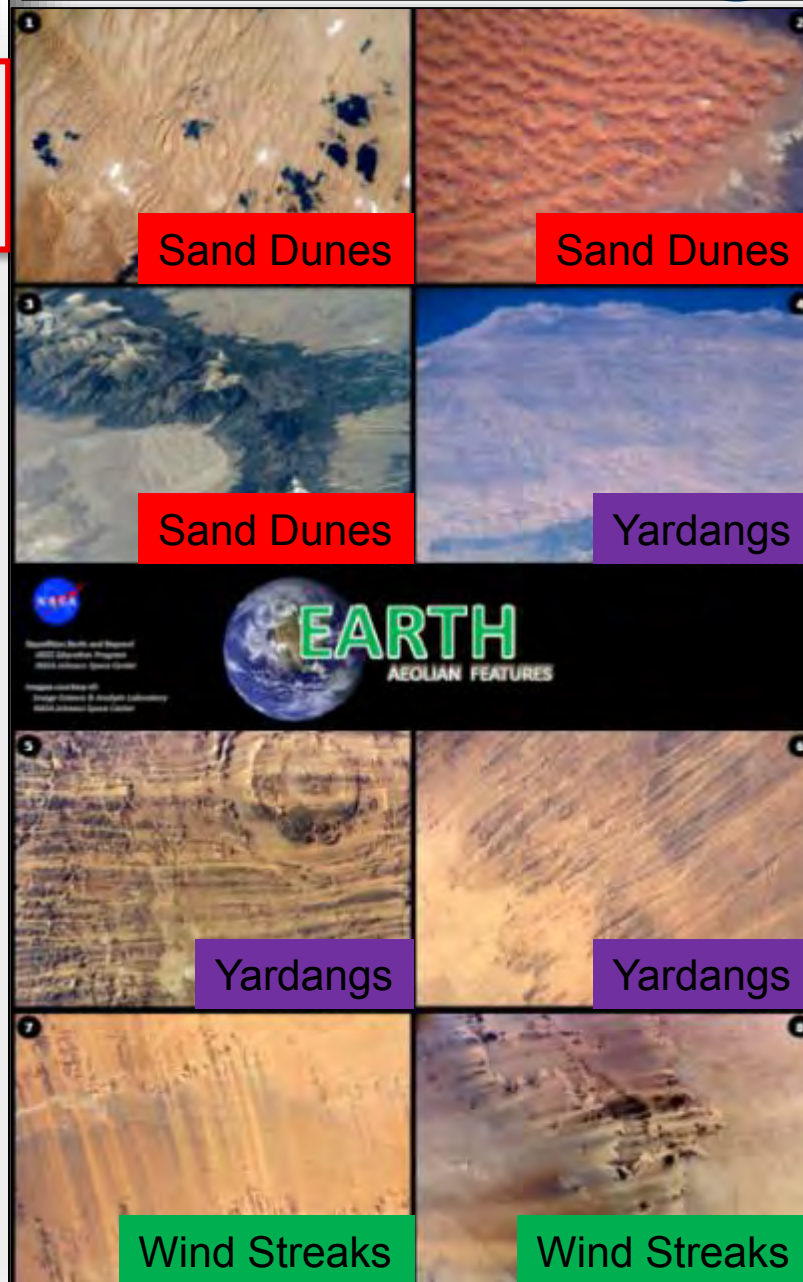
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

Part 2: Identification Criteria

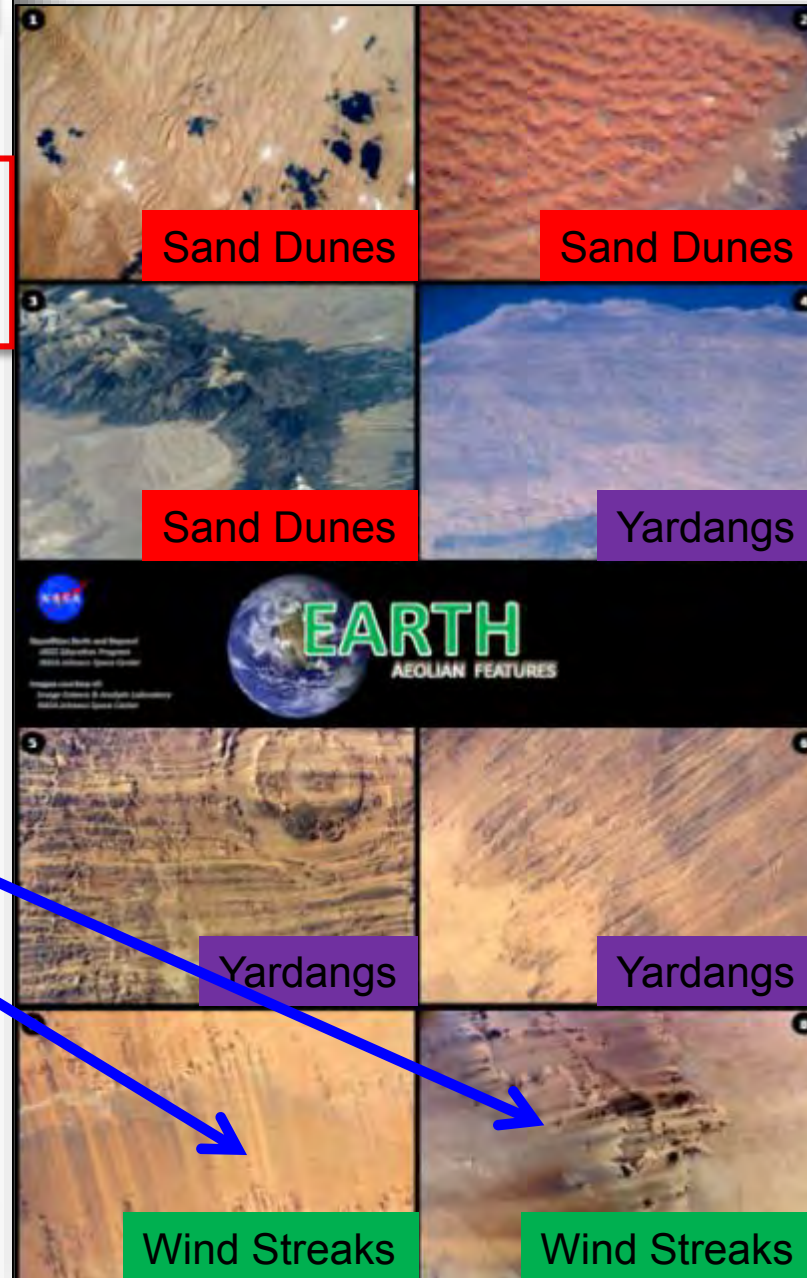
You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

Part 2: Identification Criteria

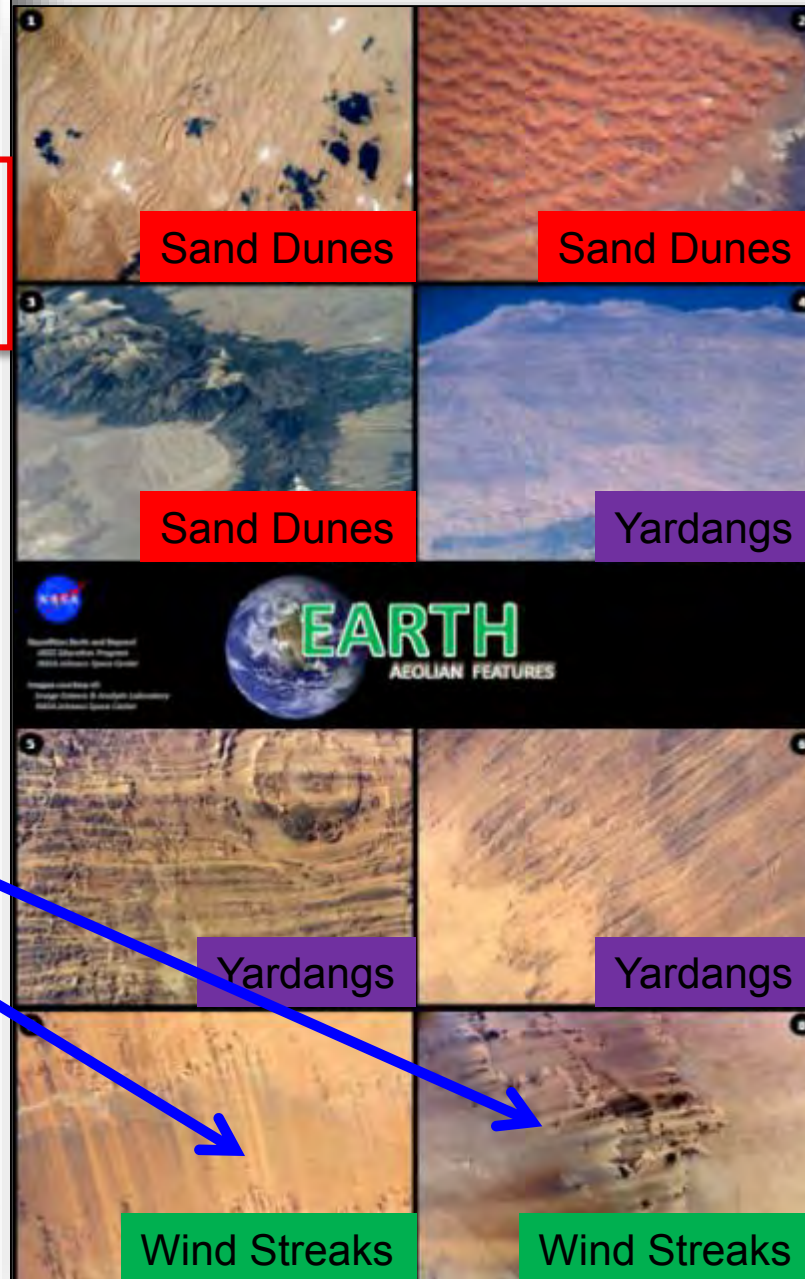
You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface		X	
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

Part 2: Identification Criteria

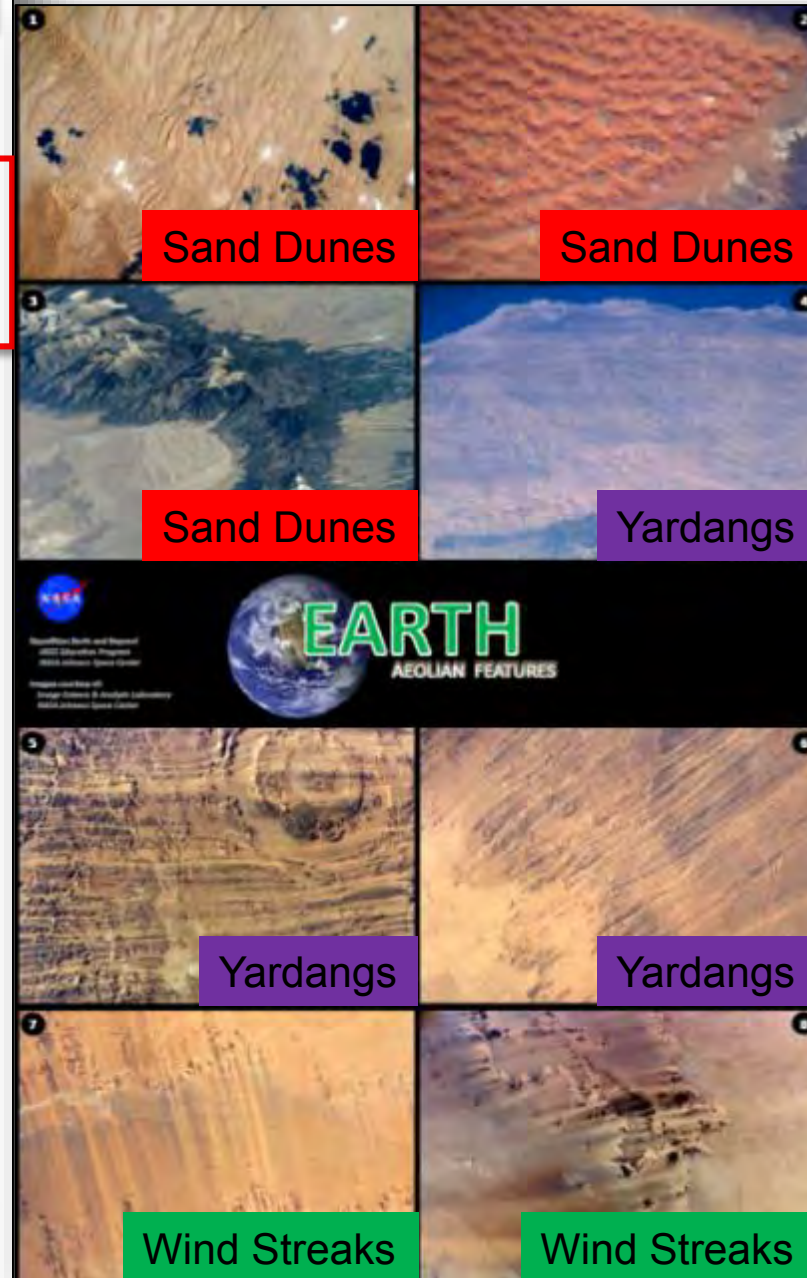
You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface		✗	
Has a ripple-like appearance			
Has a ripple like appearance			
surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

AEOLIAN FEATURES



EXAMPLE

AEOLIAN FEATURES

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface		✗	
Has a ripple-like appearance			
Has a ripple like appearance			

Look for the images that include a feature that best fits this (each) identification criteria.

CONTINUE THIS PROCESS UNTIL YOU HAVE....



Other:

EXAMPLE

AEOLIAN FEATURES

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

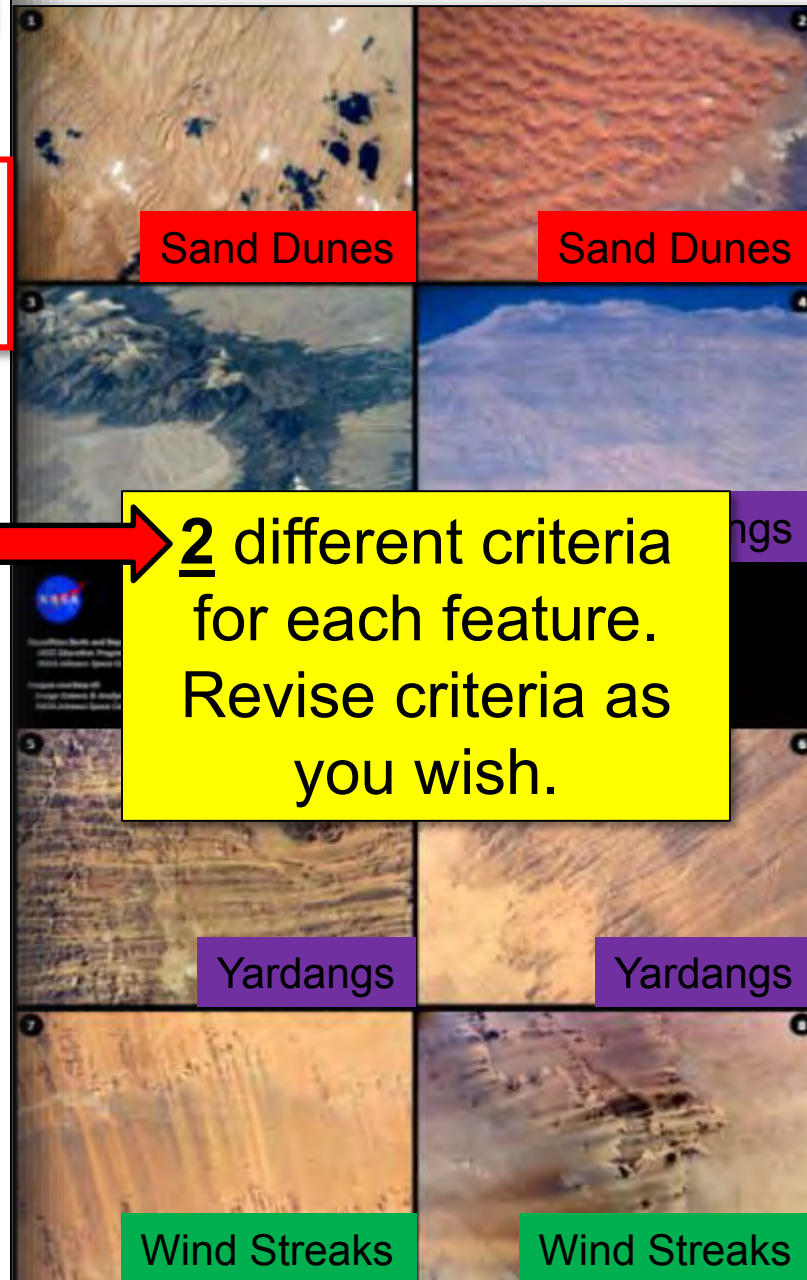
Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface		×	
Has a ripple-like appearance	×		
Look "cut into" the surface forming criss-crossing or parallel lines			×
Sand-sized particles closely grouped together on the surface	×		
Look like a series of grooves scratched into the surface			×
Look like a faint mixture of light or dark smudges on the surface		×	
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	



2 different criteria for each feature. Revise criteria as you wish.



EXAMPLE

AEOLIAN FEATURES

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like <u>smear</u> across the surface		×	
Has <u>ripple-like</u> appearance	×		
Look "cut into" the surface forming criss-crossing or parallel lines			×
Sand-sized particles closely grouped together on the surface	×		
Look like a series of grooves scratched into the surface			×
Look like a faint mixture of light or dark smudges on the surface		×	
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	



2 different criteria for each feature. Revise criteria as you wish.

****Circle, underline, or highlight KEY WORDS.****



EXAMPLE

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

IMPACT FEATURES



EXAMPLE

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

IMPACT FEATURES



EXAMPLE

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
1 Circular feature that sometimes has a raised rim and a smooth, flat floor	
2 Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

IMPACT FEATURES



There is only 1 feature shown – they are all IMPACT CRATERS.

EXAMPLE

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESS			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESS	
Features created by or associated with objects striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
1 Circular feature that sometimes has a raised rim and a smooth, flat floor	
2 Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	

IMPACT FEATURES



There is only 1 feature shown – they are all IMPACT CRATERS.

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

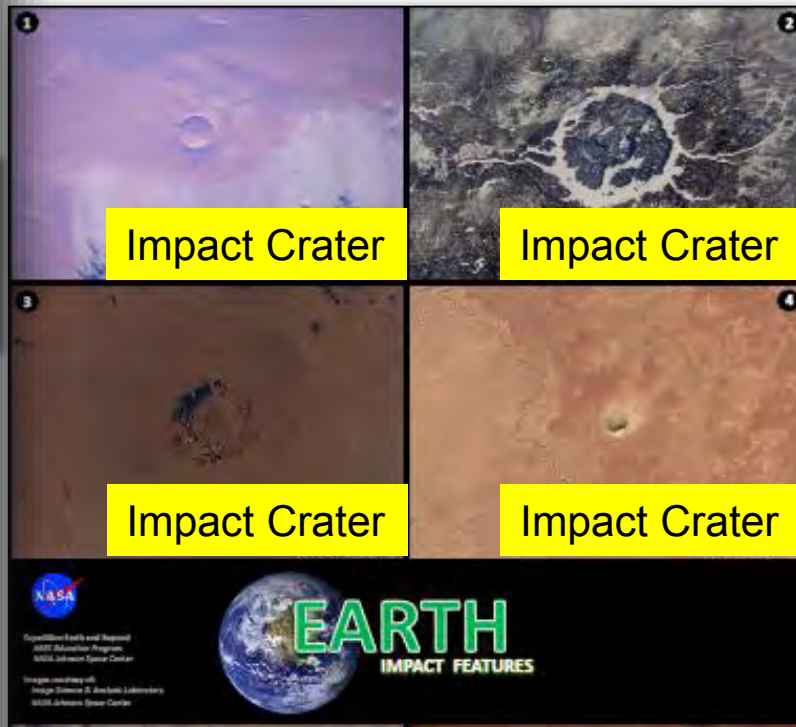
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
1 <u>Circular feature</u> that sometimes has <u>raised rim</u> and <u>smooth, flat</u> floor	✗
2 <u>Flat, roundish feature</u> that looks eroded and is sometimes filled in or outlined by water	✗
Other:	
Other:	

IMPACT FEATURES



There is only 1 feature shown – they are all IMPACT CRATERS. Simply put an "x" for the 2 criteria and focus on identifying KEY WORDS.

EXAMPLE

AEOLIAN FEATURES

Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make

Select/revise **2 CRITERIA** that best describe **each feature**.

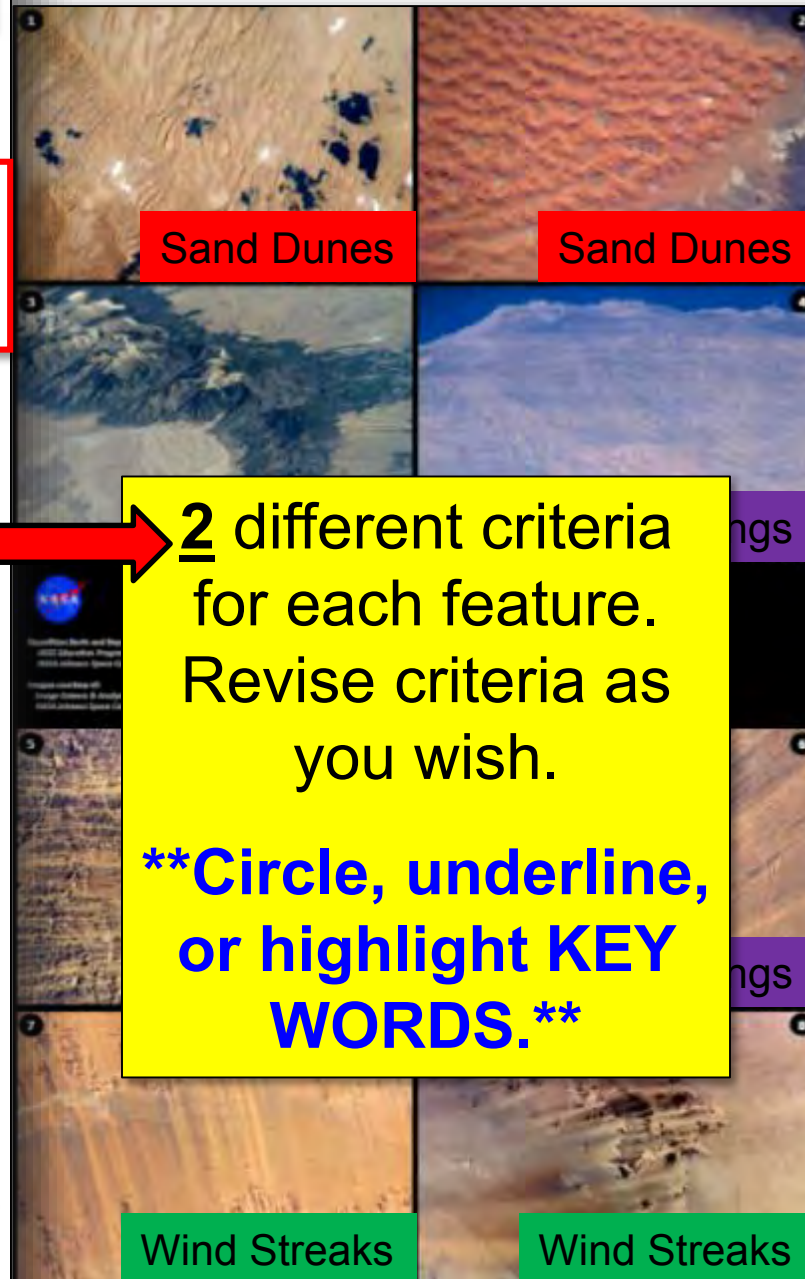
AEOLIAN PROCESSES			
Features created by or associated with the effects of WIND			
IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like <u>smear</u> across the surface		×	
Has <u>ripple-like</u> appearance	×		
Look "cut into" the surface forming criss-crossing or parallel lines			×
Sand-sized particles closely grouped together on the surface	×		
Look like a series of grooves scratched into the surface			×
Look like a faint mixture of light or dark smudges on the surface		×	
Other:			
Other:			
Other:			

IMPACT PROCESSES	
Features created by or associated with a meteor striking the surface	
IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	



2 different criteria for each feature. Revise criteria as you wish.

****Circle, underline, or highlight KEY WORDS.****





Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make observations, think about how each feature is formed and be prepared to select and create identification criteria for each feature in the tables below.

Once you have a feature chart, you will:

1. Make observations of the different geologic features visible in the images on the feature chart.
2. Use check marks on each table below to indicate which **2 criteria** best describe **each** feature. Make changes or adjustments to listed criteria if you wish.
3. Create your own descriptions that can be used as other identification criteria for each feature.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	



Part 2: Identification Criteria

You will now make observations of other astronaut photographs of Earth. Your logged observations of these images will help you learn to identify specific features associated with different geologic processes (aeolian, impact, fluvial, and volcanic). The feature charts you will examine include images grouped by process. Information is included on the back of each image to help you. As you make observations, think about how each feature is formed and be prepared to select and create identification criteria for each feature in the tables below.

Once you have a feature chart, you will:

1. Make observations of the different geologic features visible in the images on the feature chart.
2. Use check marks on each table below to indicate which 2 criteria best describe each feature. Make changes or adjustments to listed criteria if you wish.
3. Create your own descriptions that can be used as other identification criteria for each feature.

AEOLIAN PROCESSES

Features created by or associated with the effects of WIND

IDENTIFICATION CRITERIA	SAND DUNES	WIND STREAKS	YARDANGS
Look like a smear across the surface			
Has a ripple-like appearance			
Look "cut into" the surface forming criss-crossing or parallel lines			
Sand-sized particles closely grouped together on the surface			
Look like a series of grooves scratched into the surface			
Look like a faint mixture of light or dark smudges on the surface			
Other:			
Other:			
Other:			

IMPACT PROCESSES

Features created by or associated with a meteor striking the surface

IDENTIFICATION CRITERIA	IMPACT CRATER
Circular feature that sometimes has a raised rim and a smooth, flat floor	
Flat, roundish feature that looks eroded and is sometimes filled in or outlined by water	
Other:	
Other:	





FLUVIAL PROCESSES

Features created by or associated with the effects of WATER

IDENTIFICATION CRITERIA	CHANNEL	DRAINAGE NETWORK	DELTA
Feature has a very dendritic-like pattern; similar to the vein-like pattern within a leaf			
Long extended feature that curves or meanders through an area; sometimes has two or three smaller channels connected to it			
Long windy feature that sometimes contains features such as U-shaped oxbow lakes, meander scars or tear-drop shaped island(s)			
Has a fan-like or triangular shape			
Sometimes looks like a triangle or birds foot where sediment is built up and deposited			
Numerous small channels or tributaries that feed into larger channels or valleys			
Other:			
Other:			
Other:			

VOLCANIC PROCESSES

Features created by or associated with volcanic activity

IDENTIFICATION CRITERIA	VOLCANO	CENTRAL VENT/CALDERA	LAVA FLOWS
Looks similar to an impact crater and is circular in shape			
An entire structure that includes a circular opening at the top and has flanks or sides			
An entire structure that may look raised and have a cone or dome or steeple-like shape			
Channel-like flow or fingery appearance with uneven edges			
Single or multiple circular depressions, at the center or top of volcano			
Flow-like material that appears to be darker than the surrounding surface			
Other:			
Other:			
Other:			



ISS014-E-20488



ISS018-E-007208



ISS012-E-13327



ISS010-E-5070



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ARES Education Program
NASA Johnson Space Center

Images courtesy of:
Angie Sanner & Annette Labaree
NASA Johnson Space Center



EARTH

FLUVIAL FEATURES



ISS007-E-14816



STS082-72-61



STS059-213-65



STS077-718-56



FLUVIAL PROCESSES

Features created by or associated with the effects of WATER

IDENTIFICATION CRITERIA	CHANNEL	DRAINAGE NETWORK	DELTA
Feature has a very dendritic-like pattern; similar to the vein-like pattern within a leaf			
Long extended feature that curves or meanders through an area; sometimes has two or three smaller channels connected to it			
Long windy feature that sometimes contains features such as U-shaped oxbow lakes, meander scars or tear-drop shaped island(s)			
Has a fan-like or triangular shape			
Sometimes looks like a triangle or birds foot where sediment is built up and deposited			
Numerous small channels or tributaries that feed into larger channels or valleys			
Other:			
Other:			
Other:			

VOLCANIC PROCESSES

Features created by or associated with volcanic activity

IDENTIFICATION CRITERIA	VOLCANO	CENTRAL VENT/CALDERA	LAVA FLOWS
Looks similar to an impact crater and is circular in shape			
An entire structure that includes a circular opening at the top and has flanks or sides			
An entire structure that may look raised and have a cone or dome or steeply-like shape			
Channel-like flow or fingery appearance with uneven edges			
Single or multiple circular depressions, at the center or top of volcano			
Flow-like material that appears to be darker than the surrounding surface			
Other:			
Other:			
Other:			



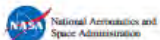
BLUE MARBLE MATCHES

Part 3: Feature Recognition and Review

WHAT YOU WILL DO:

1

Complete *Feature Recognition and Review* handout.



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different geologic features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

In order to help reinforce and review your feature recognition skills you will receive a new set of images to observe. In the table below you will:

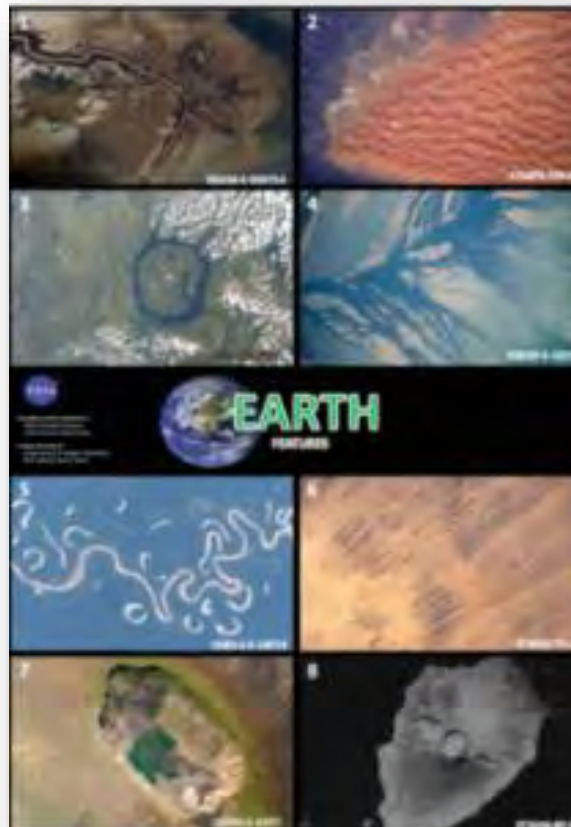
1. List identification criteria for the main feature shown in the image.
2. Based on your listed criteria, name the main geologic feature that best matches.
3. Name the main geologic process that helped form that feature.

As you discuss your answers, you may experience how scientists (both professionals and students) do not always agree! Scientific debate and using evidence to back up interpretations are key elements of science. Be open to changing your original identification of a feature if you can be convinced. It is not all about what answer is right or wrong. More importantly, it is about evidence that support your interpretation. Not all scientists agree, which is an important aspect of how science progresses.

Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (List new PC criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (weather, fluvial, volcanic, tectonic)
1			
2			
3			
4			
5			
6			
7			
8			

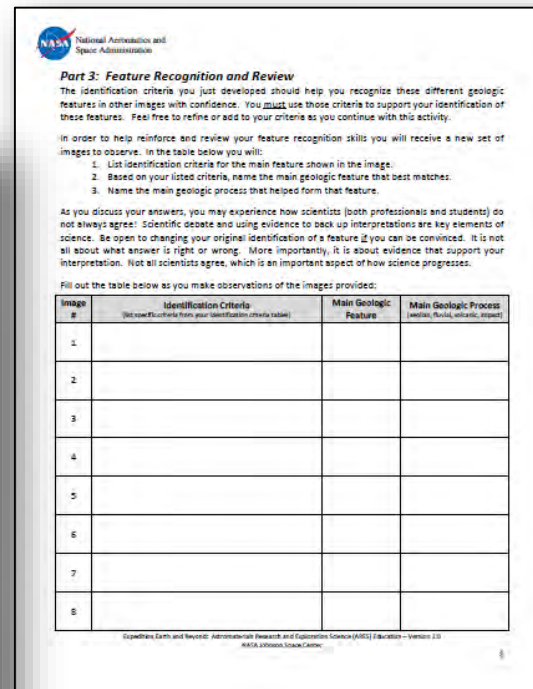
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NASA Johnson Space Center



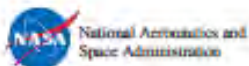
Feature Recognition & Review Handout

For each image think about and decide:

1. Which *geologic PROCESS* is represented.
2. List *identification criteria KEY WORDS* that best describe feature.
3. Identify the *geologic FEATURE*.



EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different geologic features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

In order to help reinforce and review your feature recognition skills you will receive a new set of images to observe. In the table below you will:

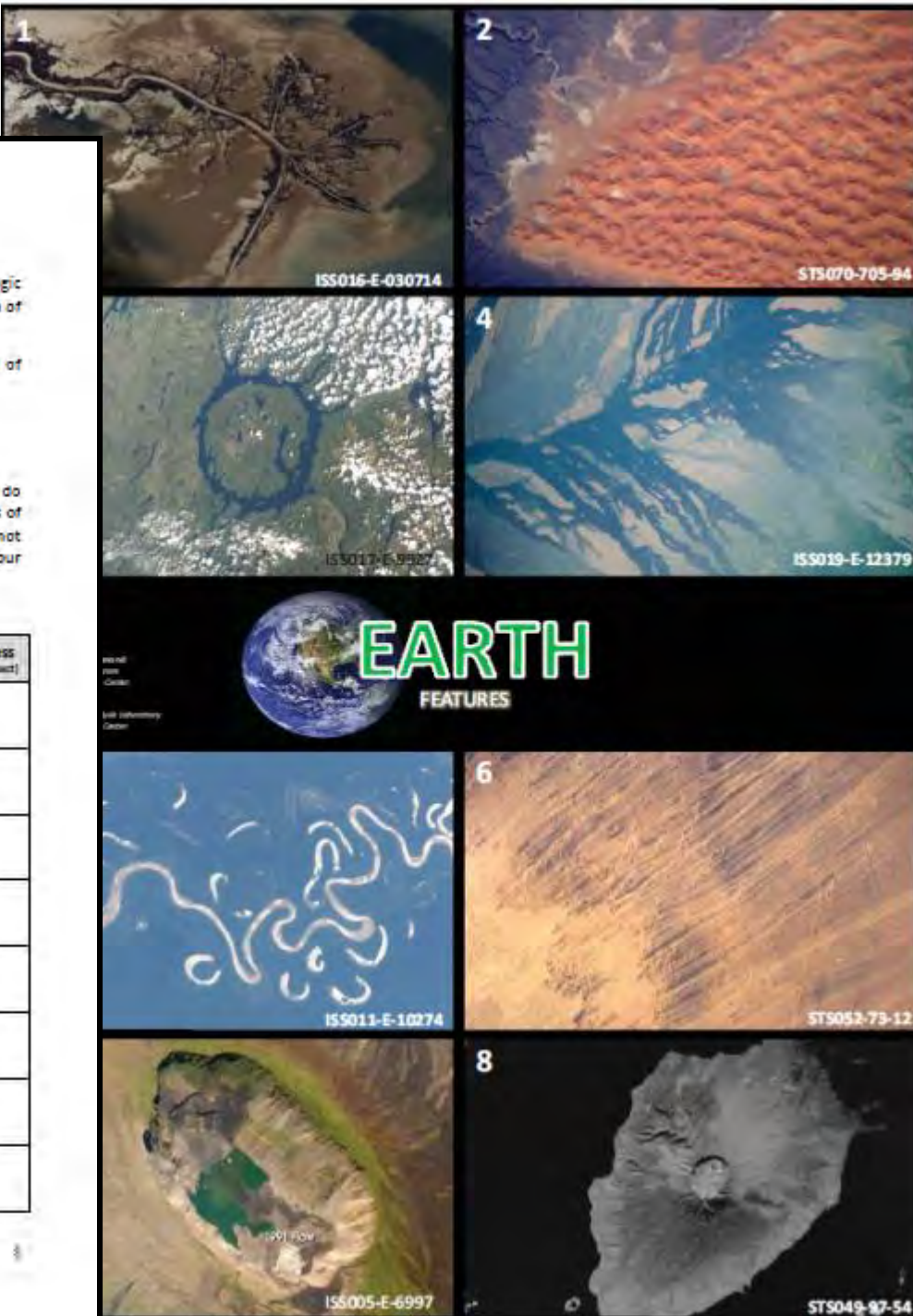
1. List identification criteria for the main feature shown in the image.
2. Based on your listed criteria, name the main geologic feature that best matches.
3. Name the main geologic process that helped form that feature.

As you discuss your answers, you may experience how scientists (both professionals and students) do not always agree! Scientific debate and using evidence to back up interpretations are key elements of science. Be open to changing your original identification of a feature if you can be convinced. It is not all about what answer is right or wrong. More importantly, it is about evidence that support your interpretation. Not all scientists agree, which is an important aspect of how science progresses.

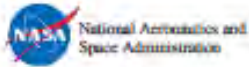
Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (list specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1			
2			
3			
4			
5			
6			
7			
8			

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EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these features in other images with confidence. You must use those criteria to support your answers to these features. Feel free to refine or add to your criteria as you continue with this activity.

In order to help reinforce and review your feature recognition skills you will receive a series of images to observe. In the table below you will:

1. List identification criteria for the main feature shown in the image.
2. Based on your listed criteria, name the main geologic feature that best matches the image.
3. Name the main geologic process that helped form that feature.

As you discuss your answers, you may experience how scientists (both professionals and students) do not always agree! Scientific debate and using evidence to back up interpretations are part of science. Be open to changing your original identification of a feature if you can be convinced by evidence that your original answer is right or wrong. More importantly, it is about evidence that supports your interpretation. Not all scientists agree, which is an important aspect of how science progresses.

Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1			
2			
3			
4			
5			
6			
7			
8			

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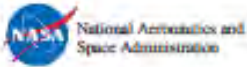


1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these features in other images with confidence. You must use those criteria to support your answers to these features. Feel free to refine or add to your criteria as you continue with this activity.

In order to help reinforce and review your feature recognition skills you will receive a series of images to observe. In the table below you will:

1. List identification criteria for the main feature shown in the image.
2. Based on your listed criteria, name the main geologic feature that best matches the image.
3. Name the main geologic process that helped form that feature.

As you discuss your answers, you may experience how scientists (both professionals and students) do not always agree! Scientific debate and using evidence to back up interpretations are part of science. Be open to changing your original identification of a feature if you can be convinced by evidence that your original answer is wrong. More importantly, it is about evidence that supports your interpretation. Not all scientists agree, which is an important aspect of how science progresses.

Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1			Fluvial
2			
3			
4			
5			
6			
7			
8			

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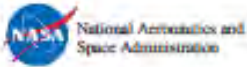


1. Main geologic
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2. Identification
Criteria KEY
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3. FEATURE?

EXAMPLE



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Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (Aeolian, fluvial, volcanic, impact)
1	birds foot; fan-like triangular shape		Fluvial
2			
3			
4			
5			
6			
7			
8			

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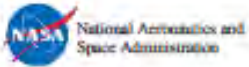


1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

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Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (Aeolian, fluvial, volcanic, impact)
1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6			
7			
8			

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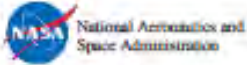


1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

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Fill out the table below as you make observations of the images provided:

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1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6			
7			
8			

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6



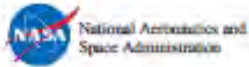
STS052 73 12

1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

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1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6			Aeolian
7			
8			

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6

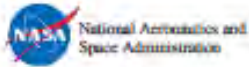


1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

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Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (list specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6	"cut into" surface; grooves scratched into surface		Aeolian
7			
8			

6



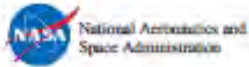
STS052 73 12

1. Main geologic
PROCESS?

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Criteria KEY
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EXAMPLE



Part 3: Feature Recognition and Review

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Image #	Identification Criteria (list specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6	"cut into" surface; grooves scratched into surface	Yardangs	Aeolian
7			
8			

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6

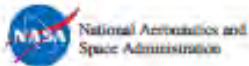


1. Main geologic
PROCESS?

2. Identification
Criteria KEY
WORDS?

3. FEATURE?

EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different geologic features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

In order to help reinforce and review your feature recognition skills you will receive a new set of images to observe. In the table below you will:

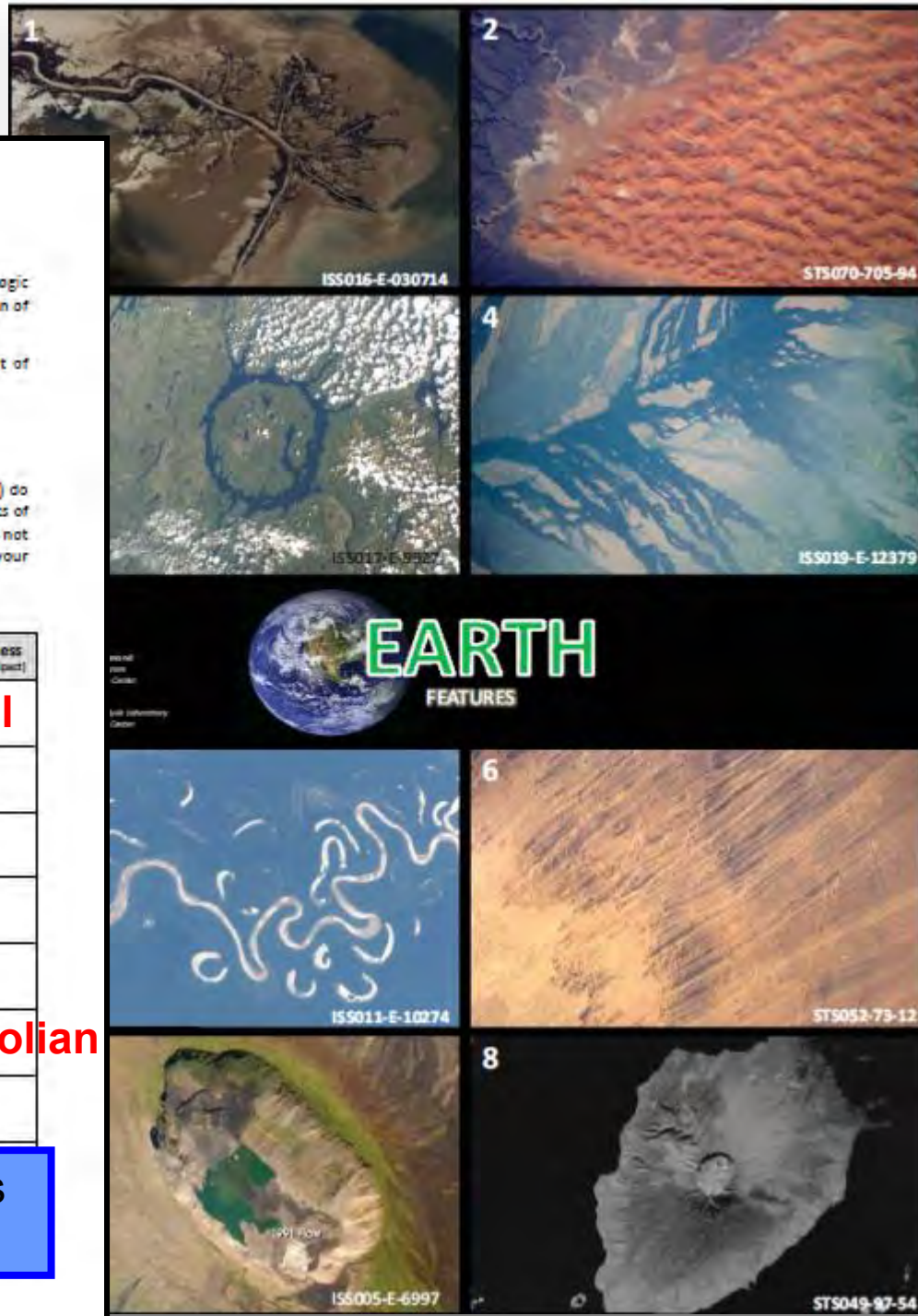
1. List identification criteria for the main feature shown in the image.
2. Based on your listed criteria, name the main geologic feature that best matches.
3. Name the main geologic process that helped form that feature.

As you discuss your answers, you may experience how scientists (both professionals and students) do not always agree! Scientific debate and using evidence to back up interpretations are key elements of science. Be open to changing your original identification of a feature if you can be convinced. It is not all about what answer is right or wrong. More importantly, it is about evidence that support your interpretation. Not all scientists agree, which is an important aspect of how science progresses.

Fill out the table below as you make observations of the images provided:

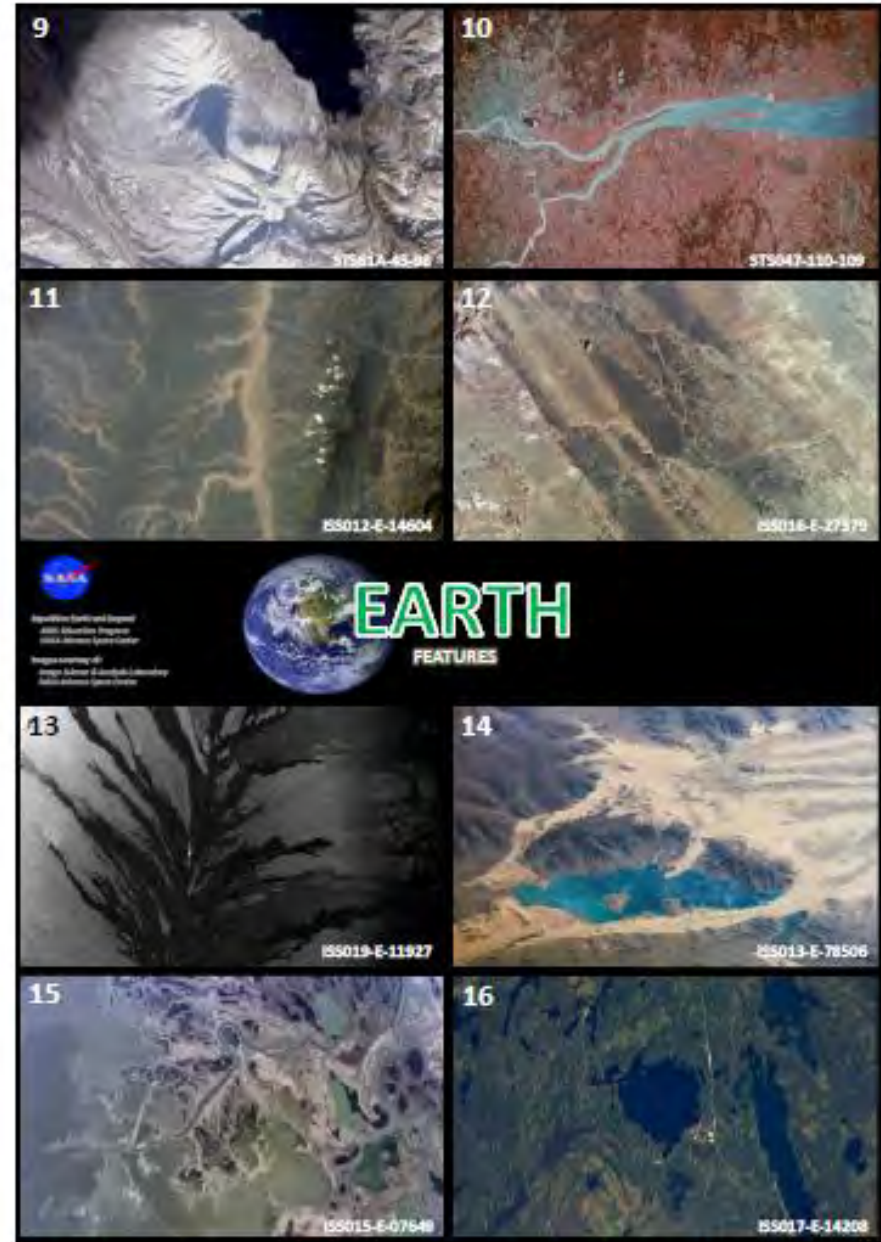
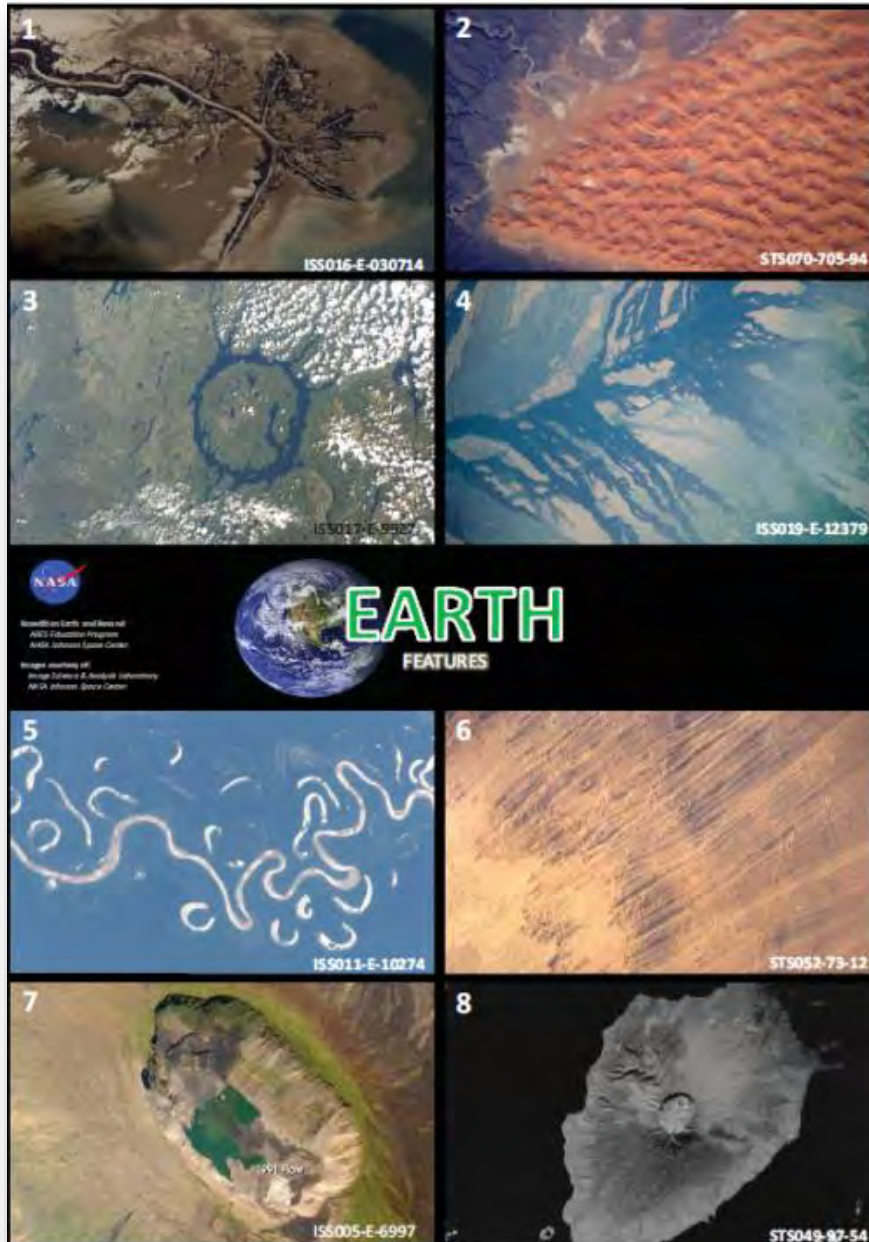
Image #	Identification Criteria (list specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6	"cut into" surface; grooves scratched into surface	Yardangs	Aeolian
7			
8			

Complete this for as many images as you can during time allotted.

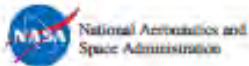


Suggestion: Give your students choices....

Example: Complete this exercise for any 8 images of your choice.



EXAMPLE



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different geologic features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

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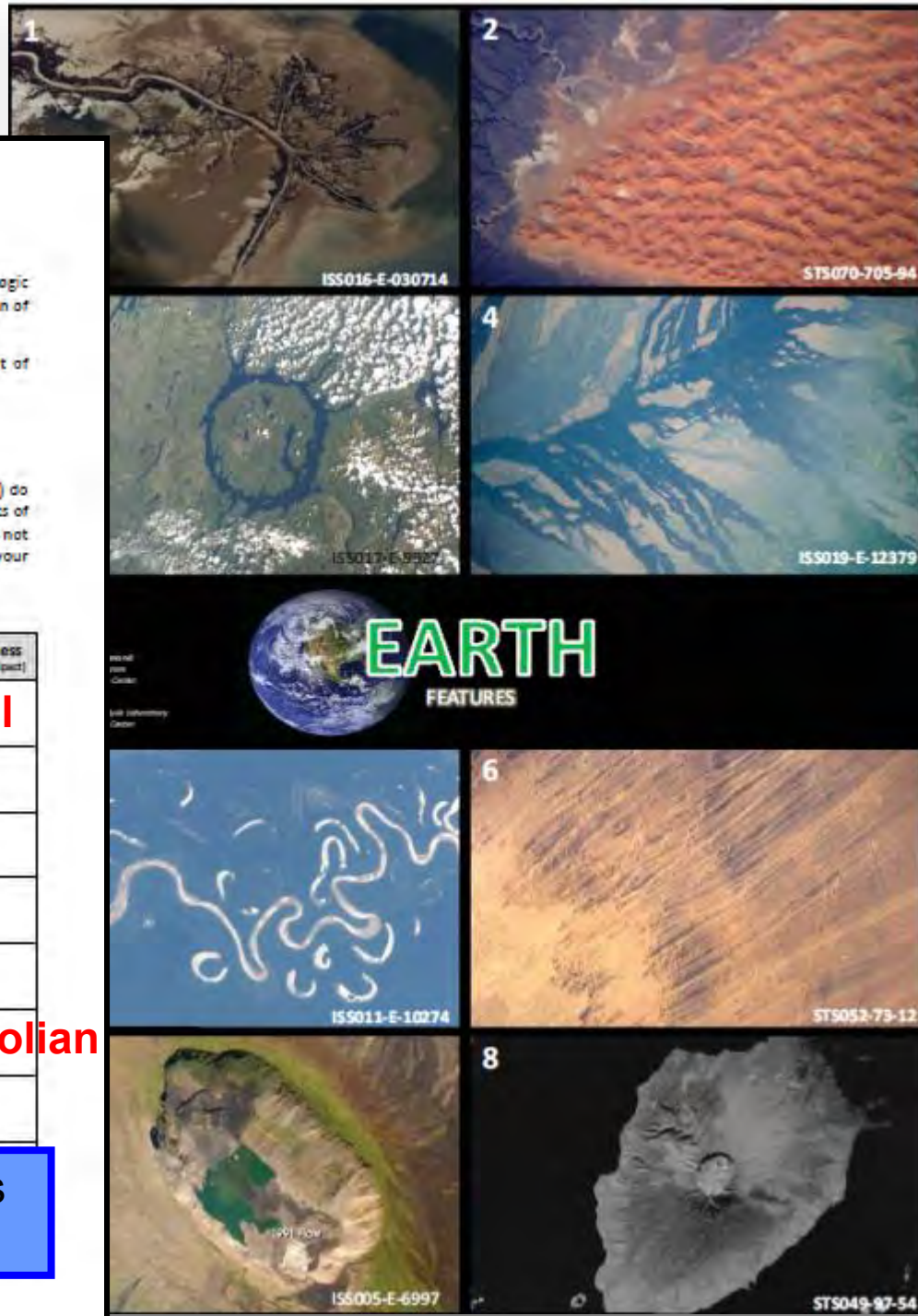
1. List identification criteria for the main feature shown in the image.
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1	birds foot; fan-like triangular shape	Delta	Fluvial
2			
3			
4			
5			
6	"cut into" surface; grooves scratched into surface	Yardangs	Aeolian
7			
8			

Complete this for as many images as you can during time allotted.



Feature Recognition & Review

- A. Process
- B. Criteria
- C. Feature



Feature Recognition & Review

- A. Process
- B. Criteria
- C. Feature



Feature Recognition & Review

- A. Process
- B. Criteria
- C. Feature



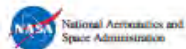
Feature Recognition & Review

- A. Process
- B. Criteria
- C. Feature



Name the following for each image:

1. Geologic Process
2. Criteria/KEY WORDS
3. Geologic Feature



Part 3: Feature Recognition and Review

The identification criteria you just developed should help you recognize these different geologic features in other images with confidence. You must use those criteria to support your identification of these features. Feel free to refine or add to your criteria as you continue with this activity.

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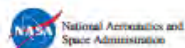
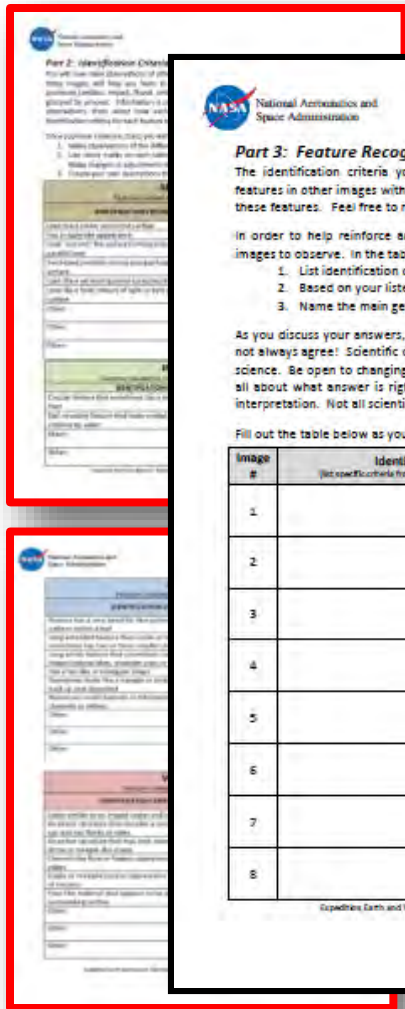
Fill out the table below as you make observations of the images provided:

Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (erosion, faulting, volcanic, impact)
1			
2			
3			
4			
5			
6			
7			
8			

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Name the following for each image:

1. Geologic Process
2. Criteria/KEY WORDS
3. Geologic Feature



Part 3: Feature Recognition and Review

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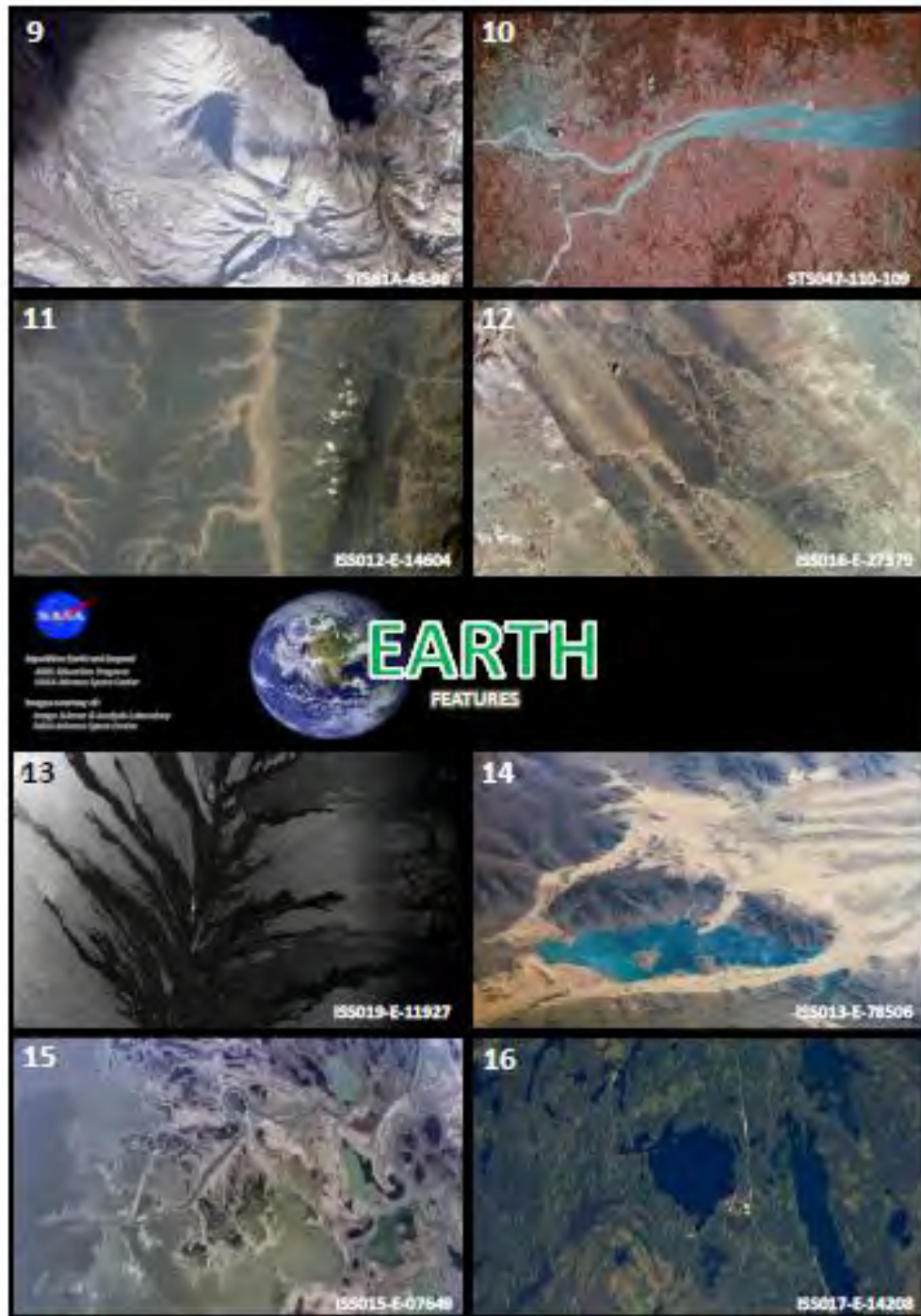
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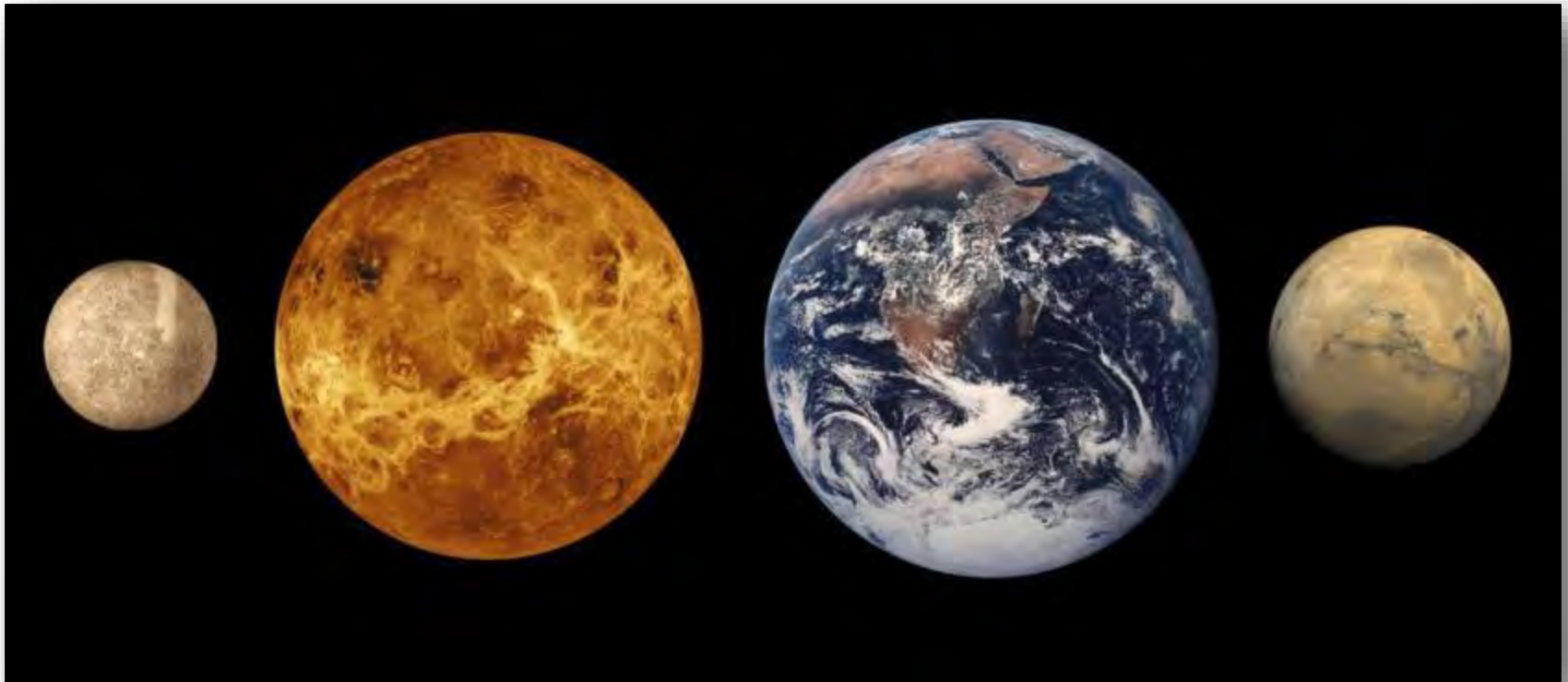
Image #	Identification Criteria (List specific criteria from your identification criteria table)	Main Geologic Feature	Main Geologic Process (weather, fluid, volcanic, impact)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

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BLUE MARBLE MATCHES

PLANETARY BODY COMPARISONS:
Use Earth as your home laboratory!



Planetary scientists must have an understanding of how processes on Earth work in order to make comparisons to other bodies in the Solar System.

BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons



BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons



BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons

Use **Identification Criteria/KEY WORDS** to identify features on Mars.



Part 2: Identification Criteria

You will now make observations of other antonova photographs of Earth. Your logged observations done images will help you learn to identify specific features associated with different gas giants, planets, moons, rings, and comets. The feature charts you will receive include a grouped by process. Information is included on the back of each image to help you. As you observations, think about how each feature is formed and be prepared to select and identify it and then to the feature chart in the next table below.

Check your home's features chart, you will:

1. Make observations of the different geologic features visible in the image on the features of
2. Use check marks on each table below to indicate which **features** and describe **what** the
3. Make changes or adjustments to listed criteria if you wish.
4. Create your own questions that can be used as pretest questions for students in the next class.

AQUAN PROCESSES

cellular, revealed by an association with the effects of NMDA.

DEFINITION (TEXT)	CLASS DEFINITION	WORD DEFINITION	EXAMPLE
Look like a surface across the surface that a right-angle appearance			
Look "flat like" the surface forming into a line as possible line			
Look about parallel closely connected together as the surface			
Look like a series of grooves connected over the surface			
Look like a line, instead of light or dark shadows on the surface			
Class:			
Other:			
Other:			

IMPACT PROCESSORS

Les tubes illustrés ici ou associés avec le modèle à l'annexe 10, page 10.

IDENTIFICATION CRITERIA	APPLY CRITERIA
Circular Breach: Each locomotive has a circular cut area in the nose of the bogie	
Flat, reported to be a low rail, heavy ground and in succession filled from bottom by water	
Other:	
Other:	

© 2004 Blackwell Publishing Ltd, *Journal of Internal Medicine* 255: 103–110



FILIPINO PHILISTINES

© 2000 Blackwell Science Ltd *Journal of Internal Medicine* 247: 399–405

[illegible]

WITH CANINE PHOTOGRAPHS

1. *Frequency of use* (in 12 months):

[illegible]

Copyright © 2009 John Wiley & Sons, Ltd.



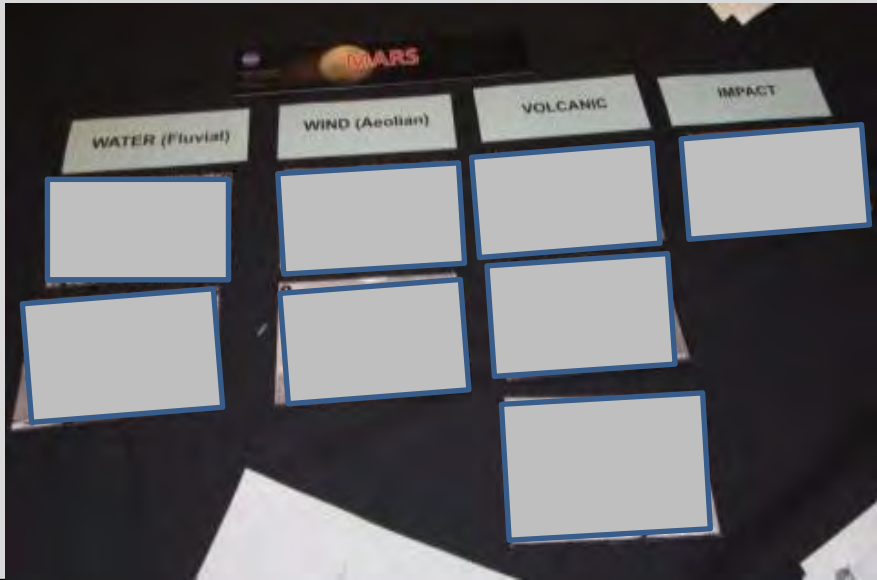
BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons:

WHAT TO DO: 3 total tasks

1

Arrange planetary cards by geologic **PROCESS**.



NOTES:

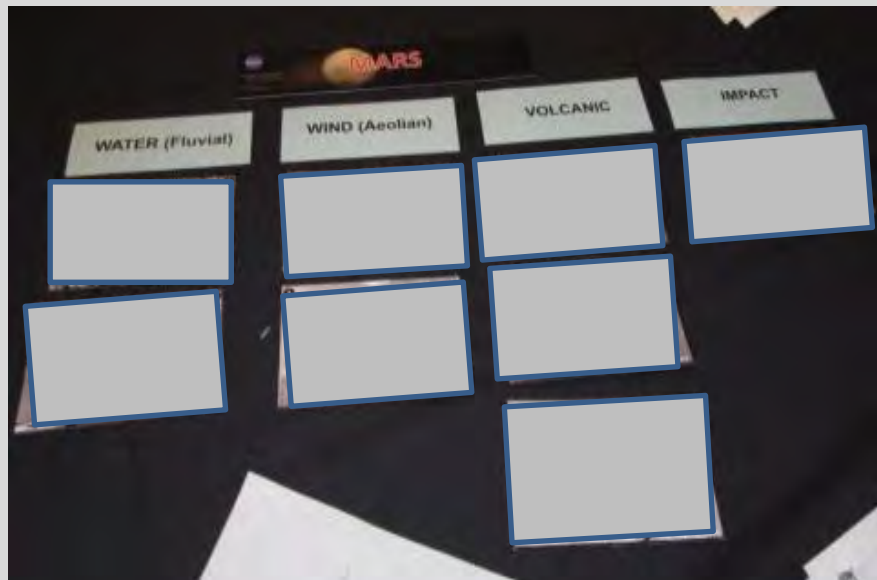
- A. There is **not** an “even” # of images or features per category.
- B. Focus in on what you feel is the “main” feature in each image.
- C. Think about what you may be unsure about.

BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons:

WHAT TO DO: 3 total tasks

1 Arrange planetary cards by geologic **PROCESS**.



2 On a post-it, list 2 criteria **KEY WORDS**, the **name of feature**, & **level of confidence**.



❖ Criteria:

- 1) Entire Structure
- 2) Cone shaped, looks raised

❖ Feature: **Volcano**

❖ Confidence: **3**
(3= very confident)

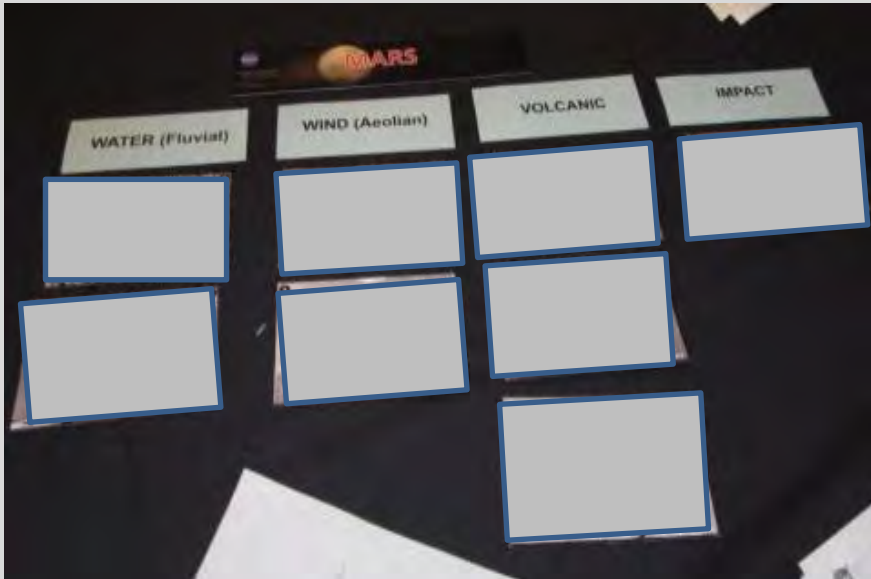
BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons:

WHAT TO DO: 3 total tasks

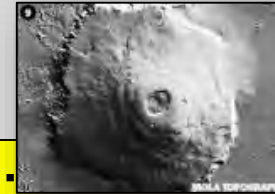
1

Arrange planetary cards by geologic **PROCESS**.



2

On a post-it, list 2 criteria **KEY WORDS**, the **name of feature**, & **level of confidence**.



3

Discuss & compare w/ another group.

❖ Criteria:

- 1) Entire Structure
- 2) Cone shaped, look

❖ Feature: **Volcano**

❖ Confidence: **3**

(3= very confident)

FILL OUT PLANETARY COMPARISON TABLE

Part 4: Using Earth For Planetary Comparisons

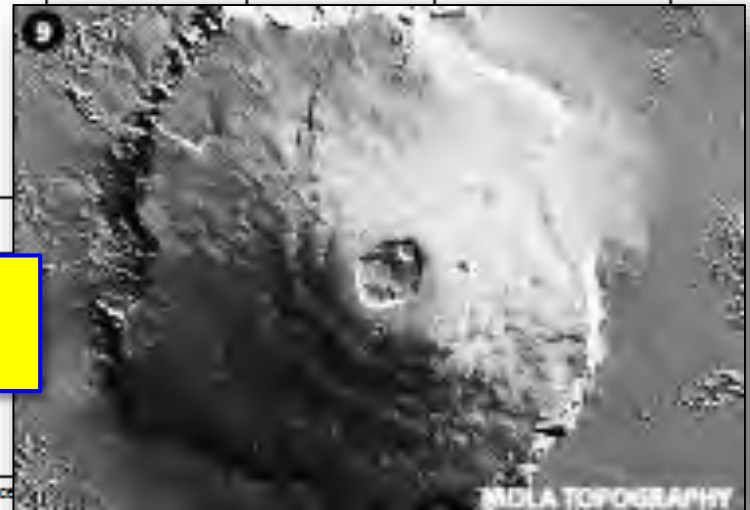
EXAMPLE

What	Which geologic	Level of
------	----------------	----------

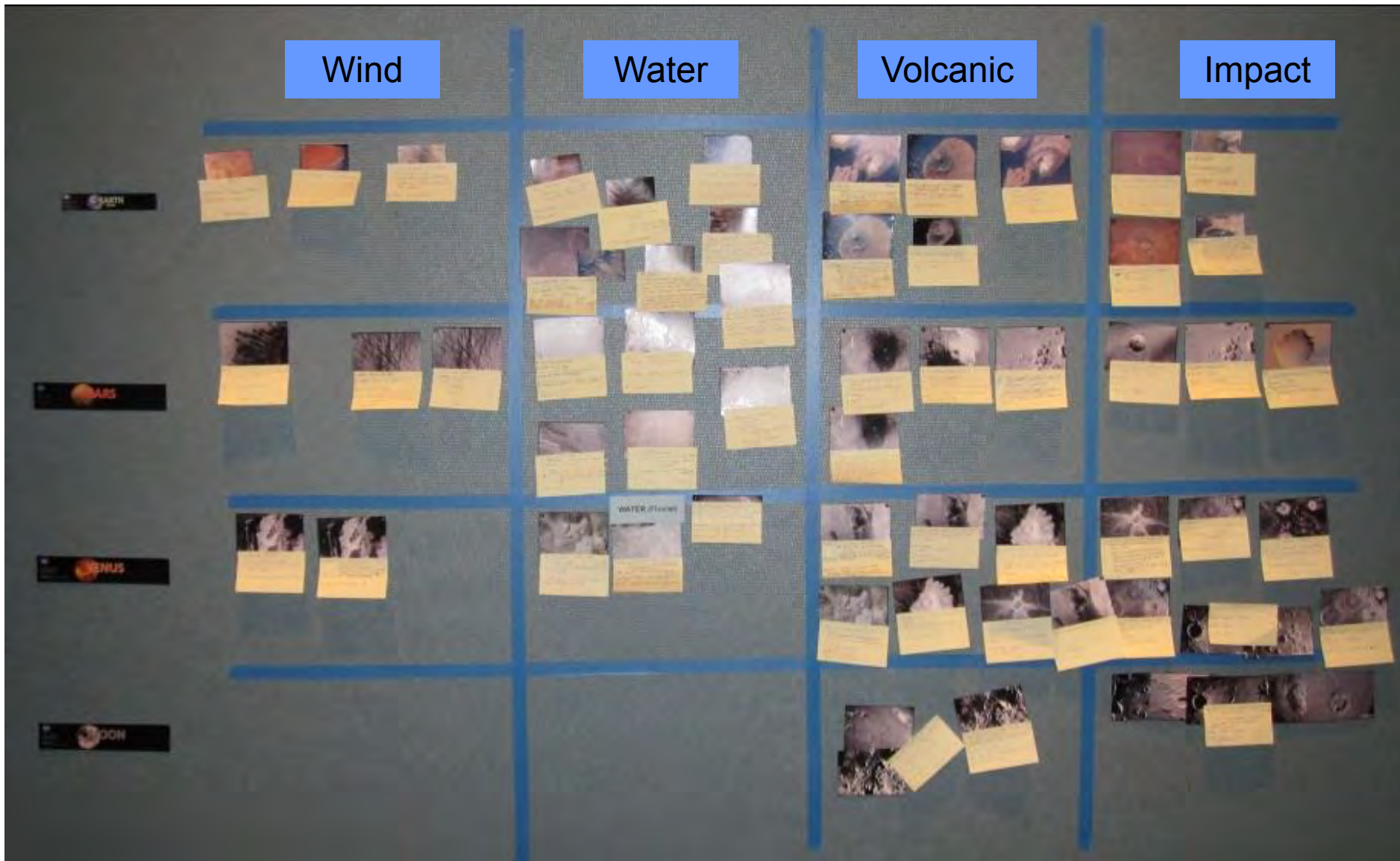
As you discuss your answers, you will likely experience again how science is a process. The evidence to back up your interpretations are key elements of science. It is about evidence and criteria that support your interpretation!

PLANETARY BODY NAME:	Mars
----------------------	------

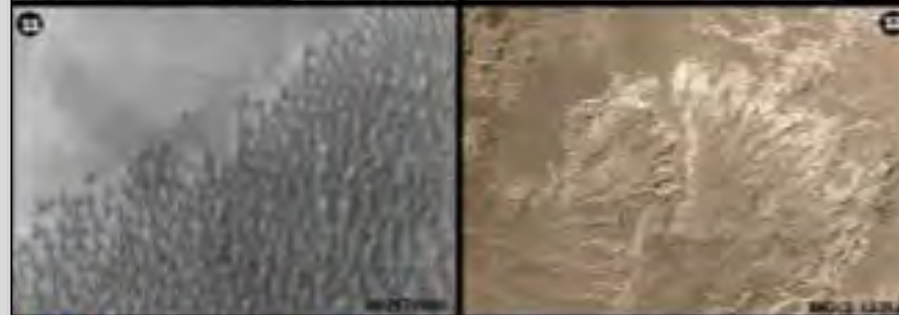
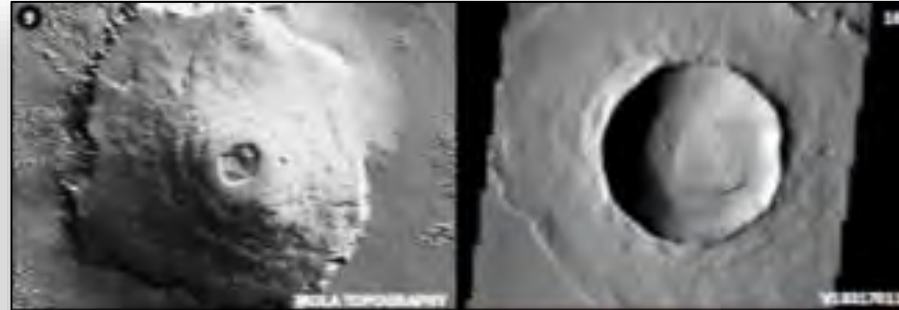
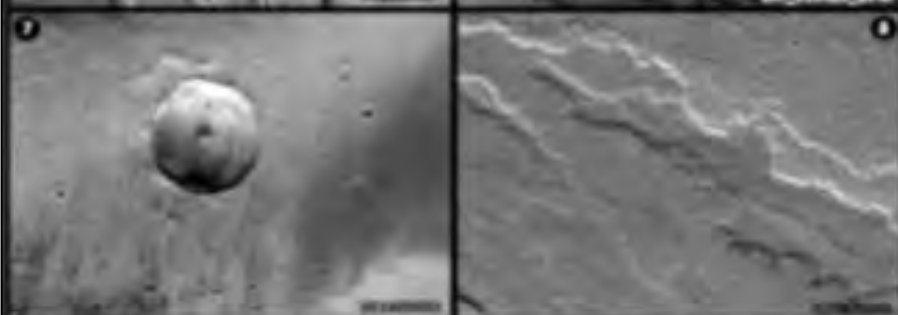
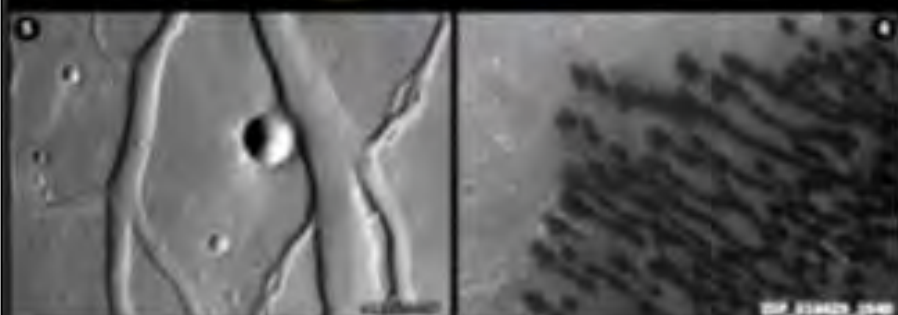
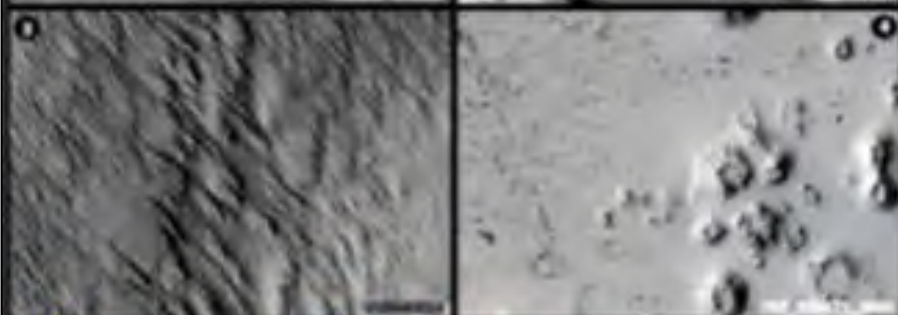
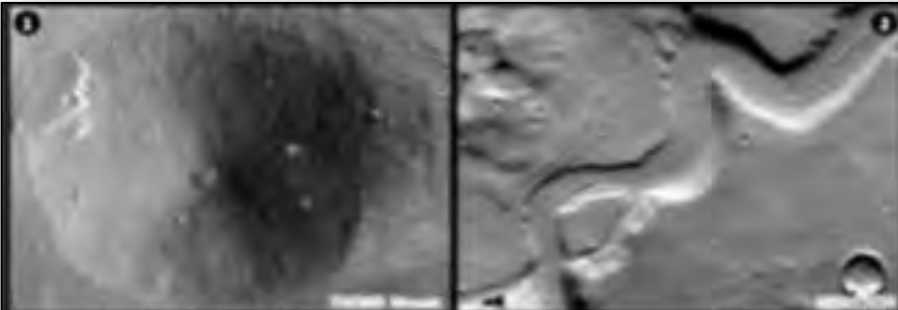
Image # (use #'s 1 - 8 or 9 - 16)	Identification Criteria (list specific criteria from your identification criteria tables)	Characteristics that DO NOT match Identification Criteria or Observations that Decrease Level of Confidence (if any)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)	Level of Confidence of Identified Feature 1 = Not Confident 2 = Somewhat Confident 3 = Totally Confident
9	Entire structure with circular opening, entire structure with cone shape.	Not 100% sure if feature is raised, but our group thinks it is.	Volcano	Volcanic	3
ADDITIONAL OBSERVATIONS, COMMENTS, OR QUESTIONS					



Planetary Comparison Feature Wall

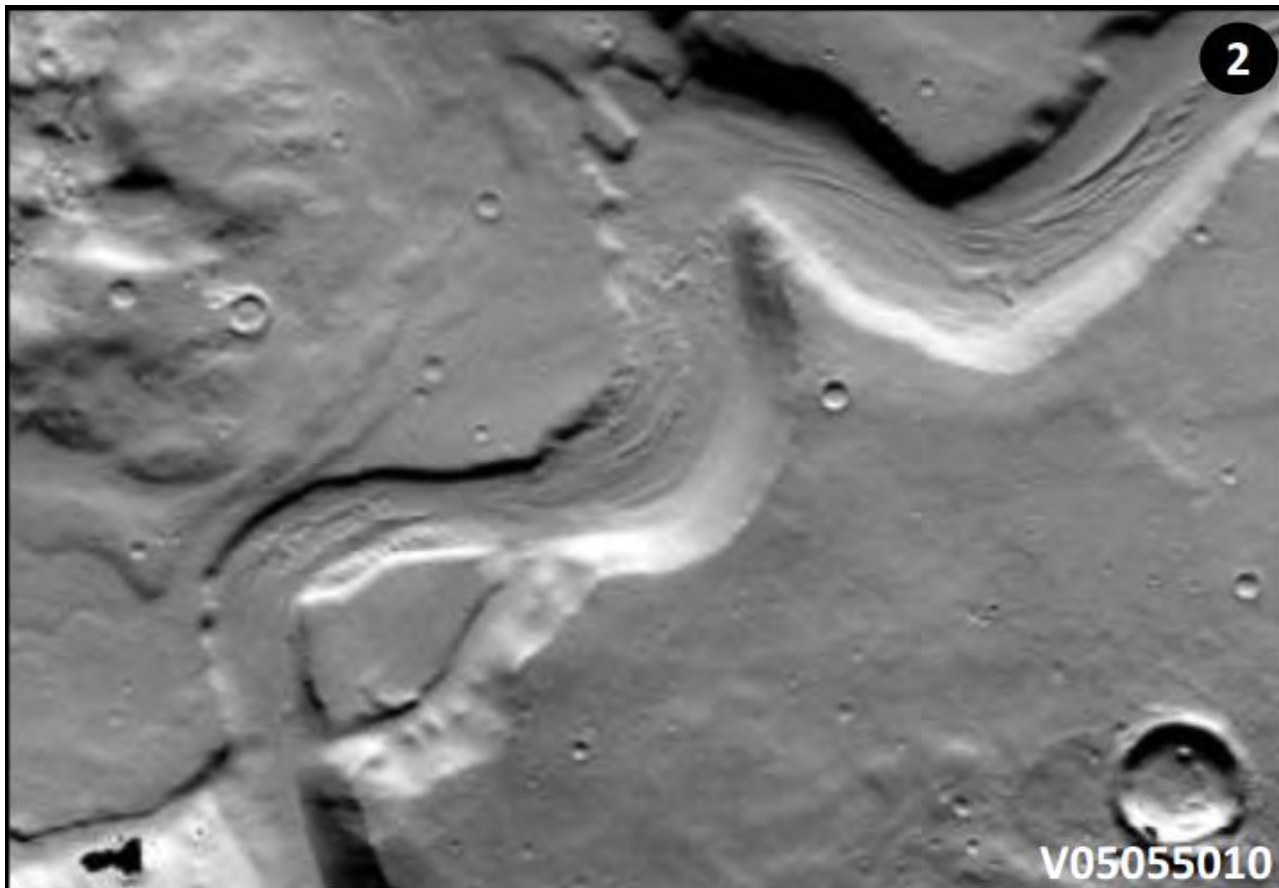


Features shown here are not necessarily in their correct category.



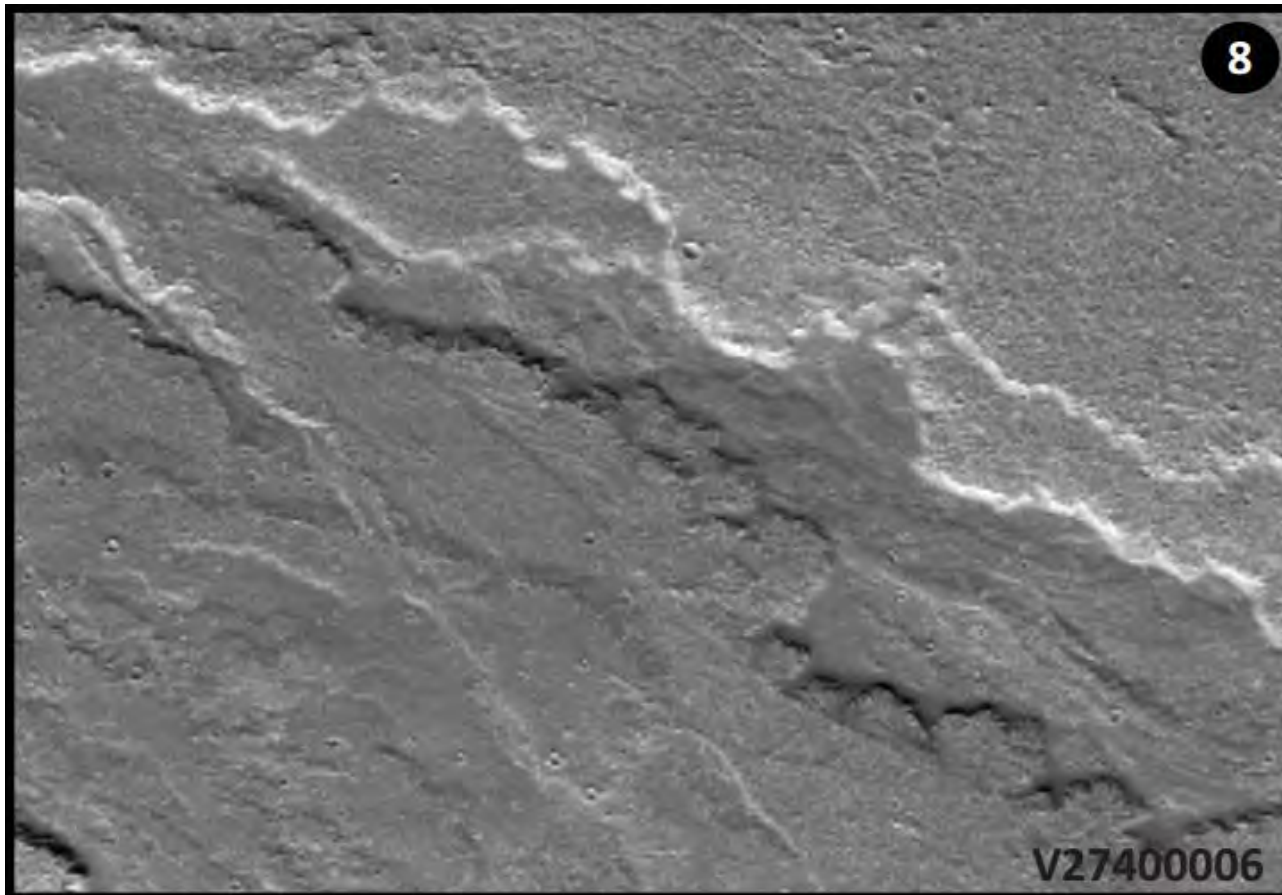
Feature Identification on Mars

- A. Process: *Fluvial*
- B. Criteria: *Long & windy; meandering*
- C. Feature: *Channel*



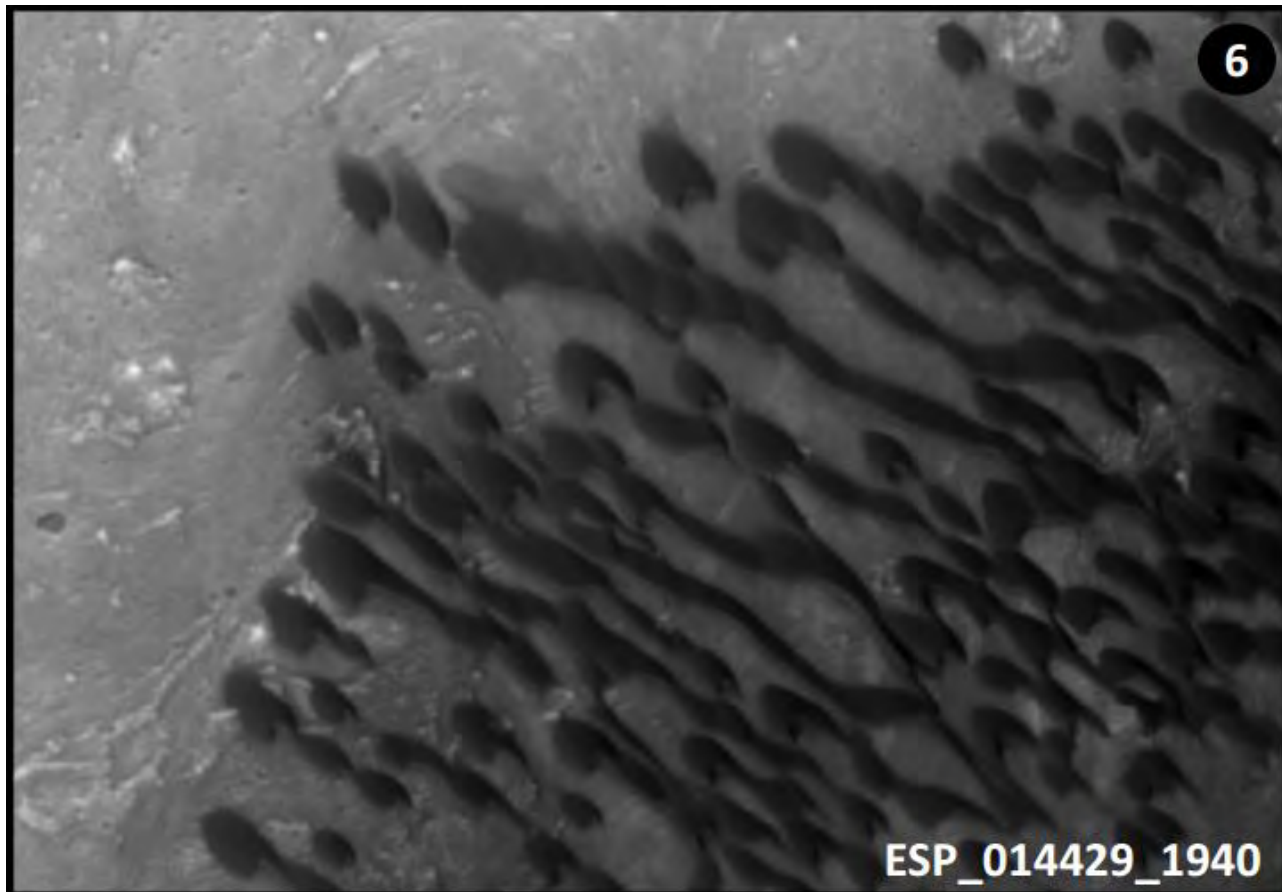
Feature Identification on Mars

- A. Process: *Volcanic*
- B. Criteria: *Uneven edges, flow-like material*
- C. Feature: *Channel*



Feature Identification on Mars

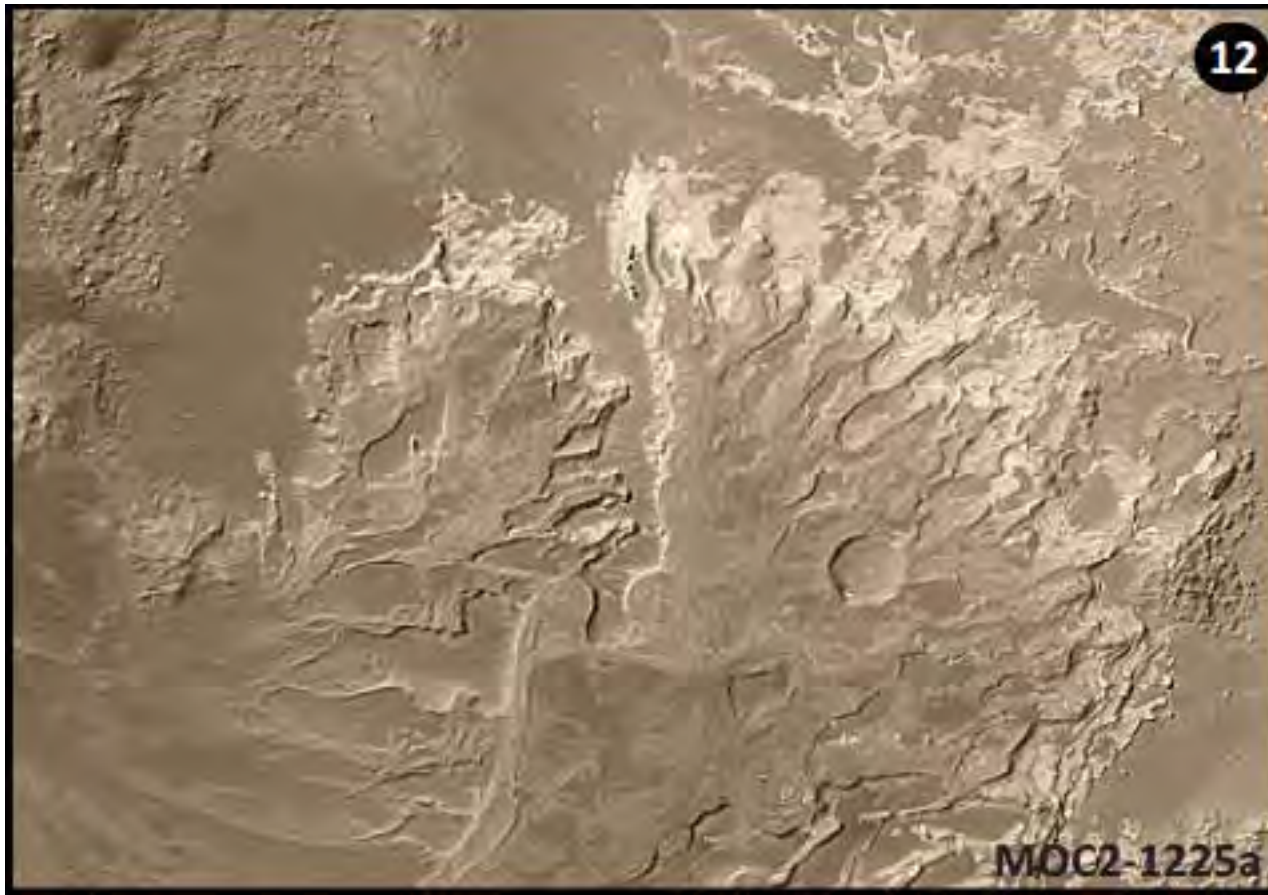
- A. Process: *Aeolian*
- B. Criteria: *Ripple-like, particles grouped together*
- C. Feature: *Sand dunes*



Feature Identification on Mars

A. Process: *Fluvial*
B. Criteria: *Triangular, fan-like*
C. Feature: *Delta*

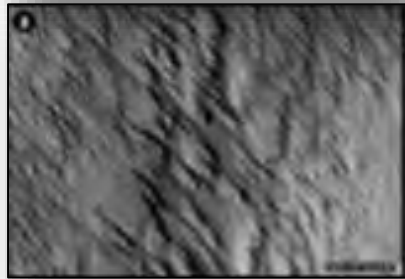
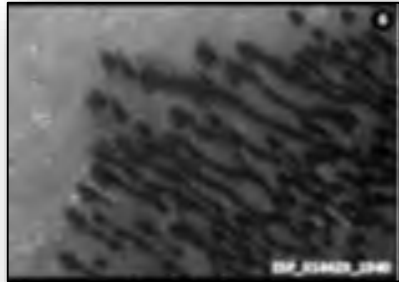
A. Process: *Volcanic*
B. Criteria: *Uneven edges, flow-like material*
C. Feature: *Lava flows*



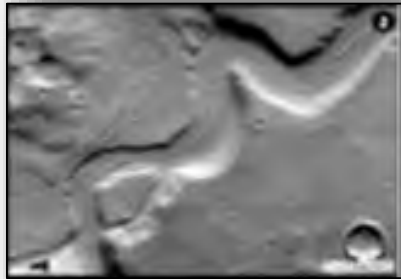
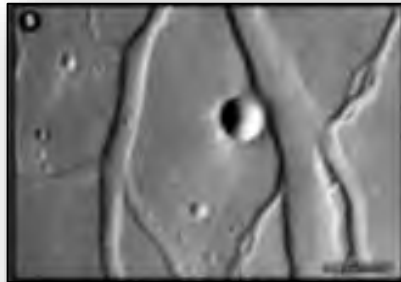
ARRANGE IMAGES BY GEOLOGIC PROCESS



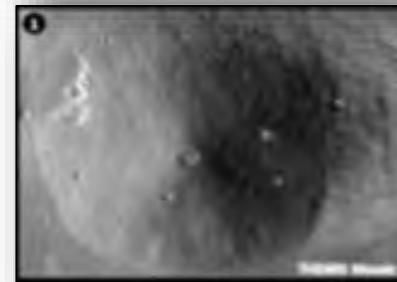
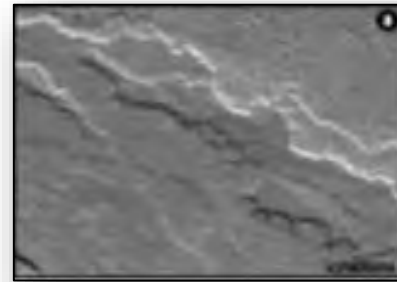
WIND (Aeolian)



WATER (Fluvial)



VOLCANICS



IMPACT

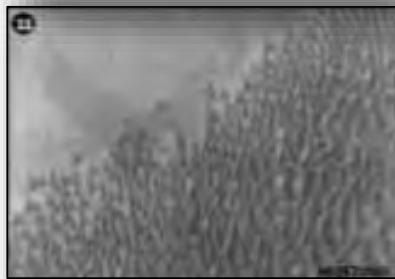
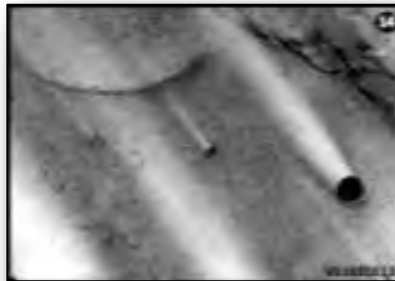


Be sure to **apply** identification criteria **key words** to justify your identification of each **feature**.

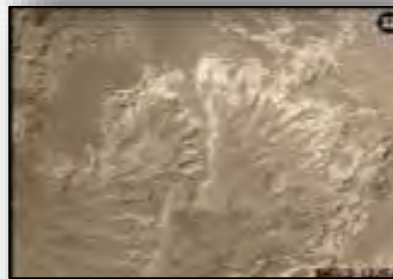
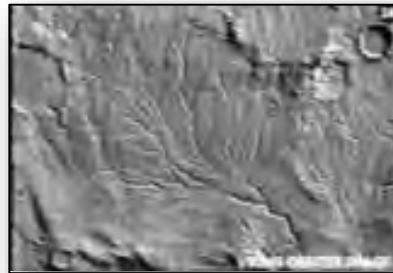
ARRANGE IMAGES BY GEOLOGIC PROCESS



WIND (Aeolian)



WATER (Fluvial)



VOLCANICS



IMPACT

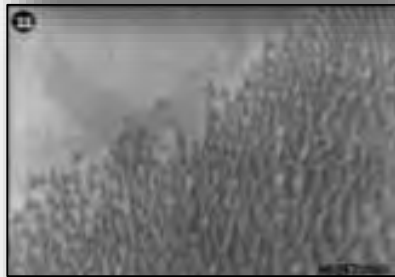
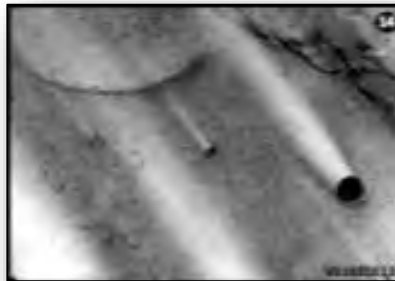


Be sure to **apply** identification criteria **key words** to justify your identification of each **feature**.

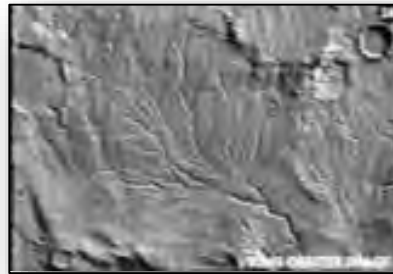
ARRANGE IMAGES BY GEOLOGIC PROCESS



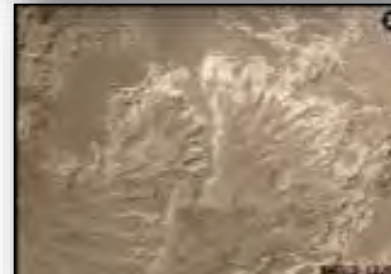
WIND (Aeolian)



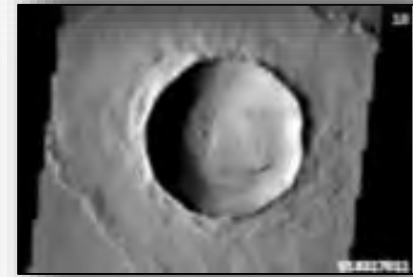
WATER (Fluvial)



VOLCANICS



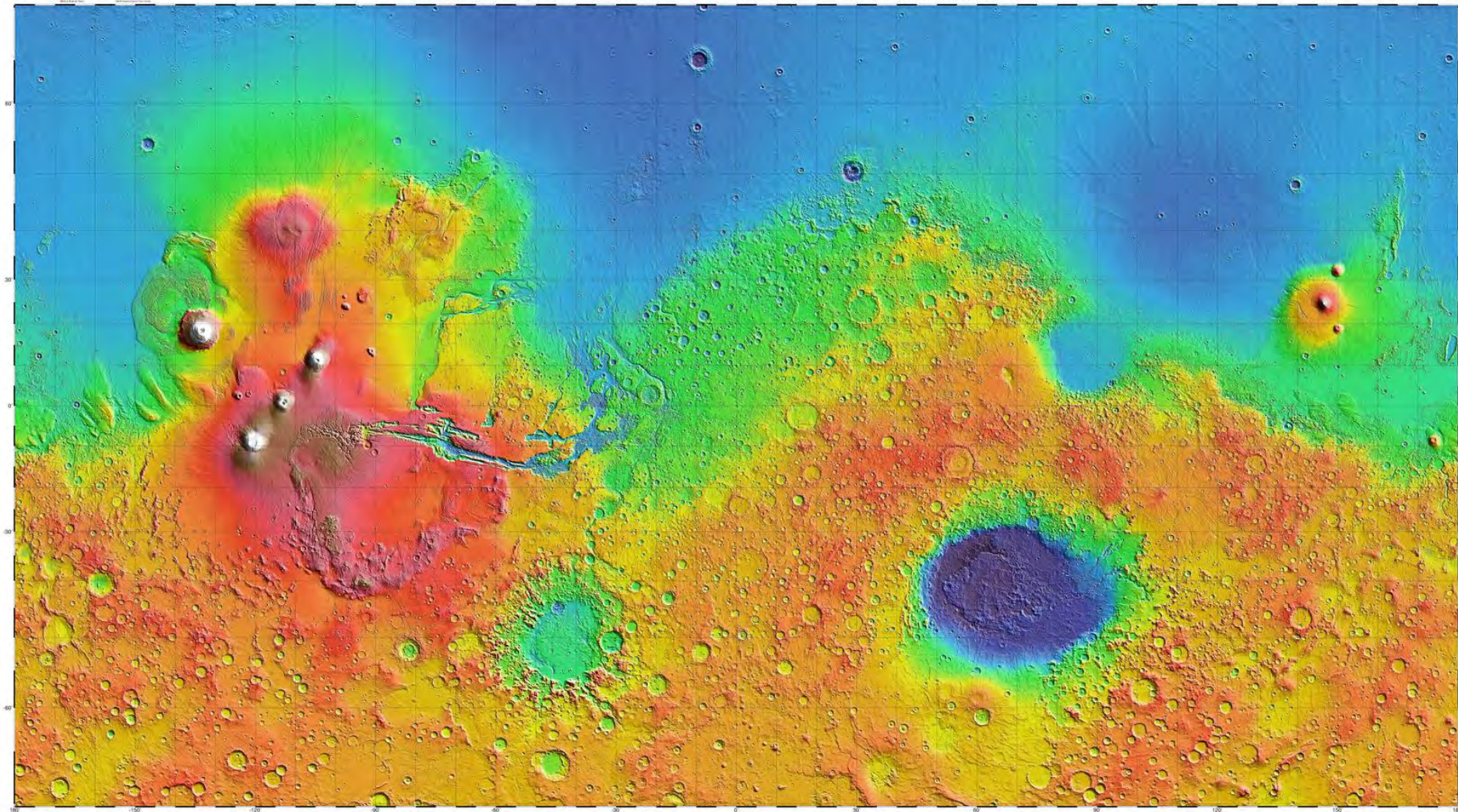
IMPACT



Be sure to **apply** identification criteria **key words** to justify your identification of each **feature**.



THE TOPOGRAPHY OF MARS BY THE MARS ORBITER LASER ALTIMETER (MOLA)



BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons

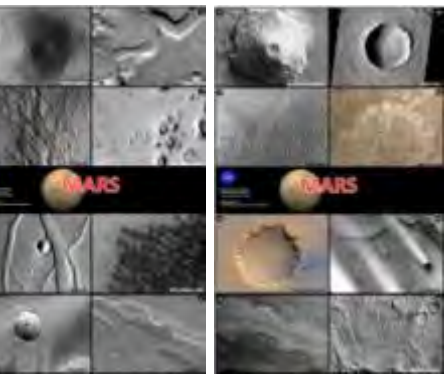
You may decide to focus on 1 planetary comparison at a time....



BLUE MARBLE MATCHES

Part 4: Using Earth for Planetary Comparisons

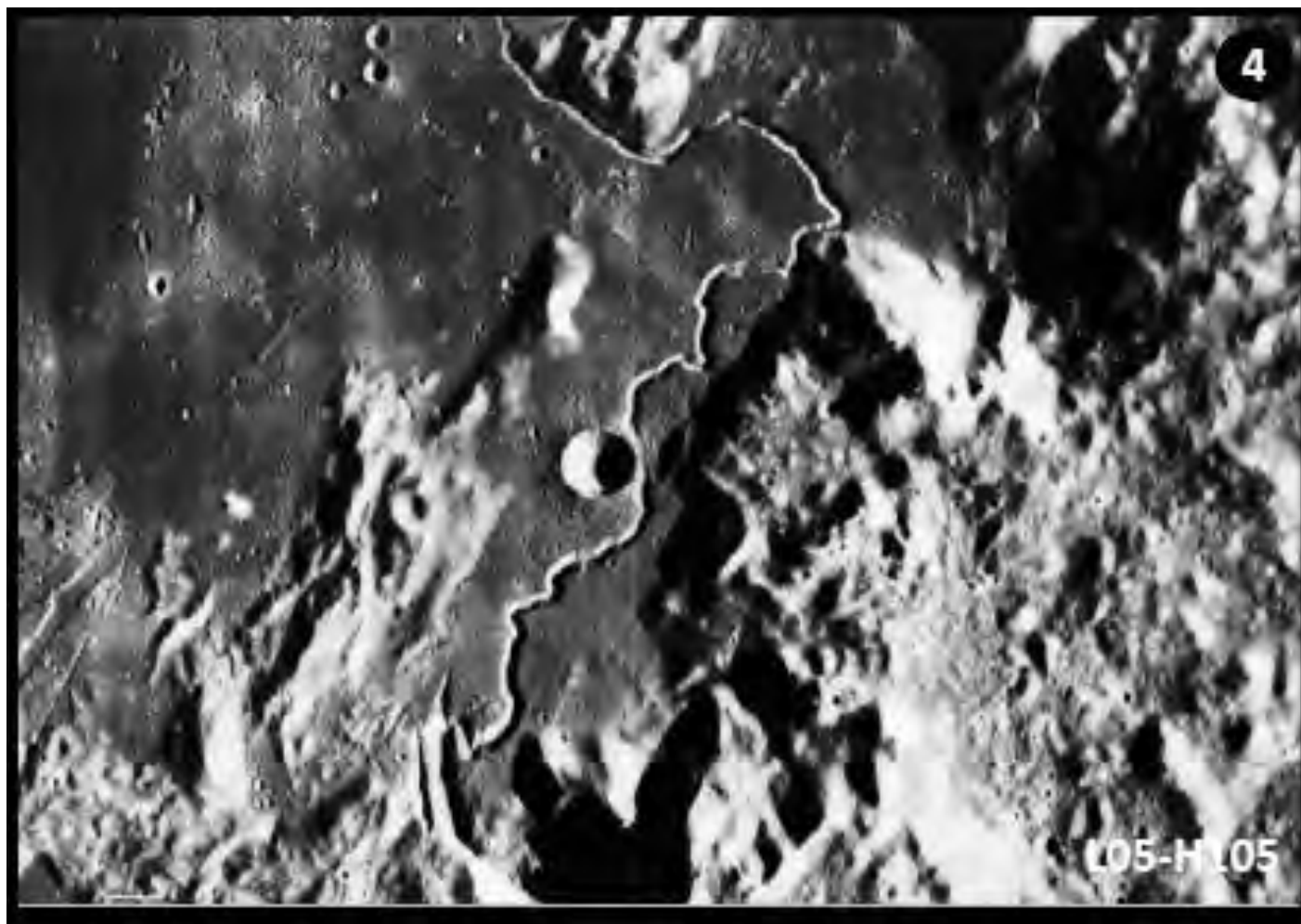
Or a few choice planetary worlds...or.... all worlds included in activity.





Expedition Earth and Beyond
ARES Education Program
NASA Johnson Space Center

Images courtesy of:
National Aeronautics & Space Administration





**Getting students actively involved
with NASA exploration and discovery.**
<http://ares.jsc.nasa.gov/ares/eeab/>

Getting Started

Launchpad Activities



Standards-aligned, inquiry-based,
hands-on activities.

Modeling the Process of Science

Student Investigation Resources



Resources that help facilitate student-led investigations
about Earth and/or planetary comparisons.

Enrichment Components



Team Wiki
Pages



Interacting w/
Scientists

Educator Trainings



Data
Requests



Team
Presentations



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CRATER COMPARISONS

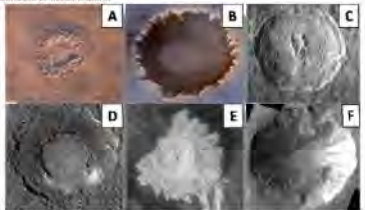


Investigating Impact Craters on Earth and Other Planetary Worlds

An “all-inclusive” activity designed to help introduce and guide you/your students through each step of the process of science.

CRATER COMPARISONS
Investigating Impact Craters on Earth and Other Planetary Worlds

PART 1: COMPARING CRATER CHARACTERISTICS
The images below are of impact craters from different planetary worlds in our Solar System. In the table below, list your observations of similarities and differences of the visible characteristics of these craters.





SIMILARITIES	DIFFERENCES

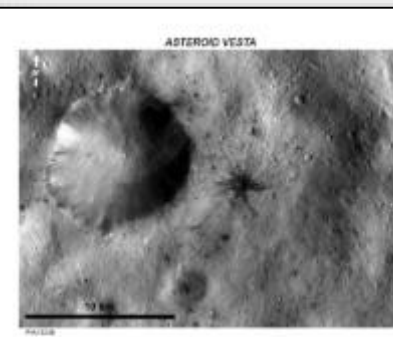
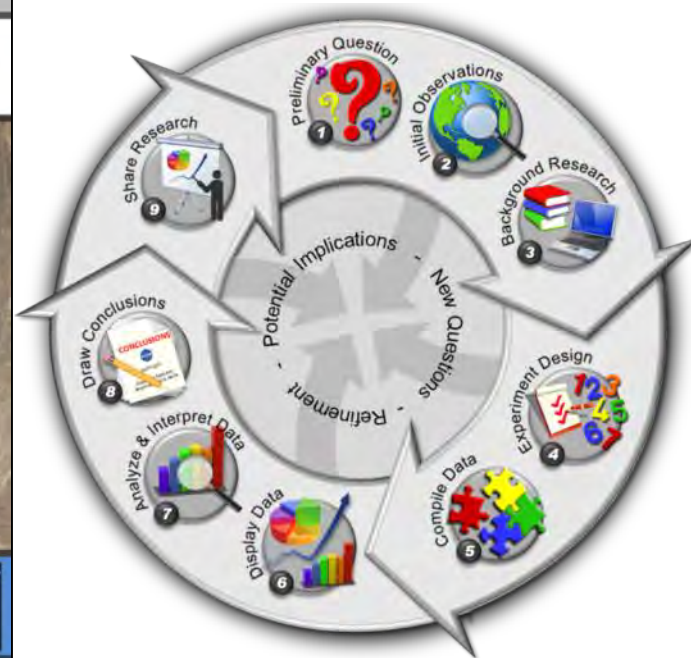
Based on your observations of the above images, list at least 1 question you have about impact craters in the space below?

Images Credit: NASA
Question Earth and Beyond: Acceleration Research and Exploration Science (ARES) Education – CRAPT Version 2.2
NASA Johnson Space Center

CRATER COMPARISONS
Investigating Impact Craters on Earth and Other Planetary Worlds

STUDENT GUIDE





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with NASA exploration and discovery.**
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Enrichment Components



Team Wiki
Pages



Interacting w/
Scientists

Educator Trainings



Data
Requests



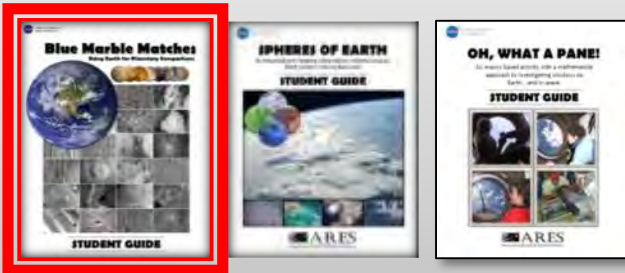
Team
Presentations



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Scientists

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Data
Requests



Team
Presentations



ARES | Expedition Earth and Beyond

Home → Education → EEAB → Home

Project Overview

Get Involved


DL Events & Workshops

Quick List of Images

Feature Charts

Event Calendar

Student Team Images

Request Astronaut Imagery 

External Links

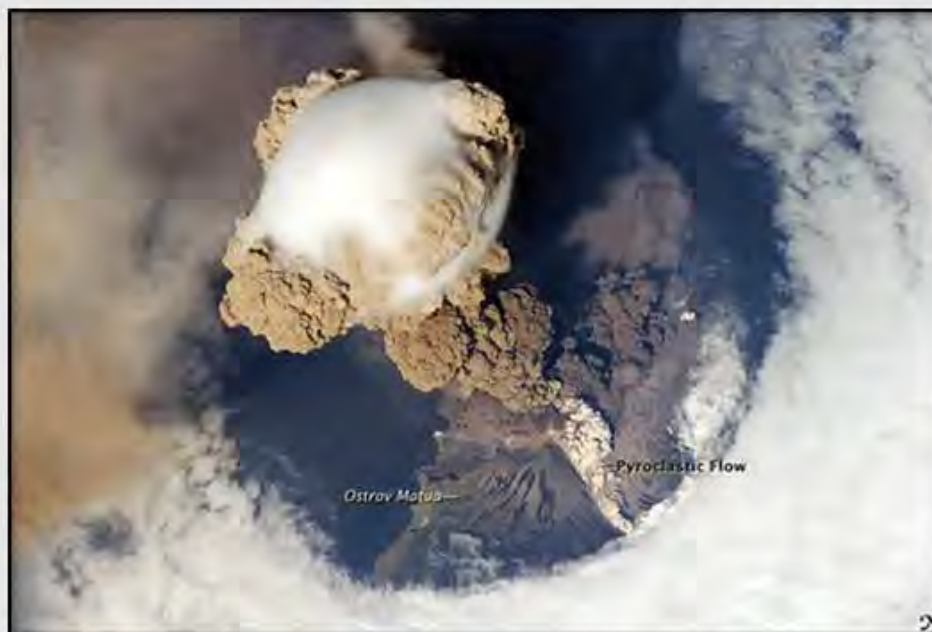
- ▶ Gateway to Astronaut Photography
- ▶ Earth from Space



WELCOME TO EXPEDITION EARTH AND BEYOND

This program is designed to motivate students to gain an interest in Science Math, Engineering, and Technology (STEM) related subjects. Stunning images, like those being shown below, are the hook to help students not only want to learn about Earth processes but to provide them with the opportunity to get involved with NASA in the process of exploration, discovery, and science.

Bring rigor and relevance to your classroom and have your students be transformed into scientists as they explore Earth and other planetary bodies in our solar system.



ISS020-E-9048: Sarychev Peak Eruption, Kuril Islands: A fortuitous orbit of the International Space Station allowed the astronauts this striking view of Sarychev Volcano (Kuril Islands, northeast of Japan) in an early stage of eruption on June 12, 2009.



Online DATA REQUEST FORM

Includes three sections: 1) Team info, 2) Project info, 3) Image Requests

The Gateway to Astronaut Photography of Earth

(NASA Crew Earth Observations)

EXPEDITION EARTH AND BEYOND

DATA REQUEST FORM

This Data Request Form is for student teams who want to request new imagery for a class project/research investigation. Imagery would be acquired by an astronaut from the International Space Station (ISS). Submissions will be reviewed and accepted based on justification. Data requests are not guaranteed.

Please fill out the information requested in the drop down boxes below. Required information is indicated by an asterisk (*).

- Student Research Team Information
- Your Project
- Image Requests

Student Research Team Information

School Name:
School Address:
Address Line 1:
Address Line 2:
City:
State/Province:
Country:
Zip Code:
Teacher Name:
Teacher Email:
Phone:
Student Team Grade Level:
Number of Student Team Members:

Your Project

1. Please indicate what stage of research you are in:
☐ Currently Collecting Data ☐ Finishing Research ☐ Other: (Describe below)

2. What is your team research question?

3. Explain the importance of your research:

4. Depending on the stage of your research, please provide information about your: a) conclusions:
a. Hypothesis: (State your hypothesis and what has led your team to formulate it)
b. Conclusions: (State your conclusions and explain what led your team to draw them)

5. List the Image Identification numbers of at least 3 astronaut photos that provide evidence for your hypothesis or conclusions:

6. How would this new data aid or support your team's research?

Image Requests

Include at least one site (two maximum) you would like to have acquired to help support your research and draw your conclusions. Provide detailed information to help ensure that your request can be considered and accepted in the Crew Earth Observation target list sent to astronauts onboard the ISS. If two sites are requested, please indicate which is the higher priority by checking the appropriate box.

Higher Priority Request: ☒ Request 1 ☐ Request 2

Request 1

A. Description **and** name of specific feature you are trying to obtain in the image:

B. Center latitude and longitude of feature or location of interest:
Latitude (Use degrees only and a negative number for south):
Longitude (Use degrees only and a negative number for west):

C. Lens preference or approximate area of feature:

D. Description of geographic location:

E. List at least 1 website that provides an image and/or reference information about this feature:

F. OPTIONAL (BUT HIGHLY ENCOURAGED): To help ensure we appropriately identify your image request, please provide up to two screen shots showing the area you would like imaged. Suggested screen shots include: 1) a context view with appropriate geographic reference information visible and 2) a zoomed in screen shot that clearly identifies the area of interest. Make sure you clearly indicate the areas within each screen shot you would like imaged.

No file selected. No file selected.



PLANNING A POTENTIAL INVESTIGATION

INVESTIGATION PLANNING

1. Choose a feature from the list below (or another feature of your choosing) that interests you.

List that feature here: ***Sand Dunes***

Glaciers	Lakes	Hurricanes	Mountains	Volcanoes	Coral Reefs		
Plankton	Dust Storms	Oceans	Clouds	Impact Craters	Forests		
Sand Dunes	Wind Streaks	Yardangs	Caldera	Lava Flows	Delta	Drainage Network	Channel

2. Come up with a question you could ask AND answer about that feature using additional astronaut photos?
3. Discuss and describe how you would go about answering that question.



PLANNING A POTENTIAL INVESTIGATION

INVESTIGATION PLANNING

1. Choose a feature from the list below (or another feature of your choosing) that interests you.

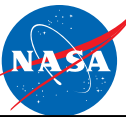
List that feature here: ***Sand Dunes***

Glaciers	Lakes	Hurricanes	Mountains	Volcanoes	Coral Reefs		
Plankton	Dust Storms	Oceans	Clouds	Impact Craters	Forests		
Sand Dunes	Wind Streaks	Yardangs	Caldera	Lava Flows	Delta	Drainage Network	Channel

2. Come up with a question you could ask AND answer about that feature using additional astronaut photos?

How do sand dunes form?

3. Discuss and describe how you would go about answering that question.



INVESTIGATION PLANNING

1. Choose a feature from the list below (or another feature of your choosing) that interests you.

List that feature here: **Sand dunes**

Glaciers	Lakes	Hurricanes	Mountains	Volcanoes	Coral Reefs		
Plankton	Dust Storms	Oceans	Clouds	Impact Craters	Forests		
Sand Dunes	Wind Streaks	Yardangs	Caldera	Lava Flows	Delta	Drainage Network	Channel

2. Come up with a question you could ask AND answer about that feature using additional astronaut photos?

What criteria can we use to identify the different types of sand dunes on Earth? Describe how effectively we can apply that criteria to imagery from space to identify different types of sand dunes on Earth and/or Mars?

3. Discuss and describe how you would go about answering that question.

INVESTIGATION PLANNING

1. Choose a feature from the list below (or another feature of your choosing) that interests you.

List that feature here: ***Sand dunes***

Glaciers	Lakes	Hurricanes	Mountains	Volcanoes	Coral Reefs		
Plankton	Dust Storms	Oceans	Clouds	Impact Craters	Forests		
Sand Dunes	Wind Streaks	Yardangs	Caldera	Lava Flows	Delta	Drainage Network	Channel

2. Come up with a question you could ask AND answer about that feature using additional astronaut photos?

What criteria can we use to identify the different types of sand dunes on Earth? Describe how effectively we can apply that criteria to imagery from space to identify different types of sand dunes on Earth and/or Mars?

3. Discuss and describe how you would go about answering that question.

A. Define identification criteria for different types of sand dunes on Earth.

B. Search for imagery of sand dunes on Earth.

C. Log observations:

- ***Image ID***
- ***Location***
- ***Identification criteria***
- ***Type of sand dune***
- ***Criteria effectiveness*** [1 = very effective; 2 = somewhat effective; 3 = not very effective]

D. Search for imagery of sand dunes on Mars

E. Log same observations as you did for Earth



CHARLESTON MIDDLE SCHOOL TEAM IMAGE

Dead Sea and Evaporation Ponds, Jordan

Image ID: ISS027-E-20337 Acquired 3/30/11

Image courtesy of Crew Earth Observations and Image Science & Analysis Laboratory,
NASA Johnson Space Center





PEORIA HIGH SCHOOL MESA TEAM IMAGE

Mississippi River Flooding

Image ID: ISS027-E-33193 Acquired 5/17/11

*Image courtesy of Crew Earth Observations and Image Science & Analysis Laboratory,
NASA Johnson Space Center*





EVERGREEN MIDDLE SCHOOL 2013/2014 TEAM IMAGE

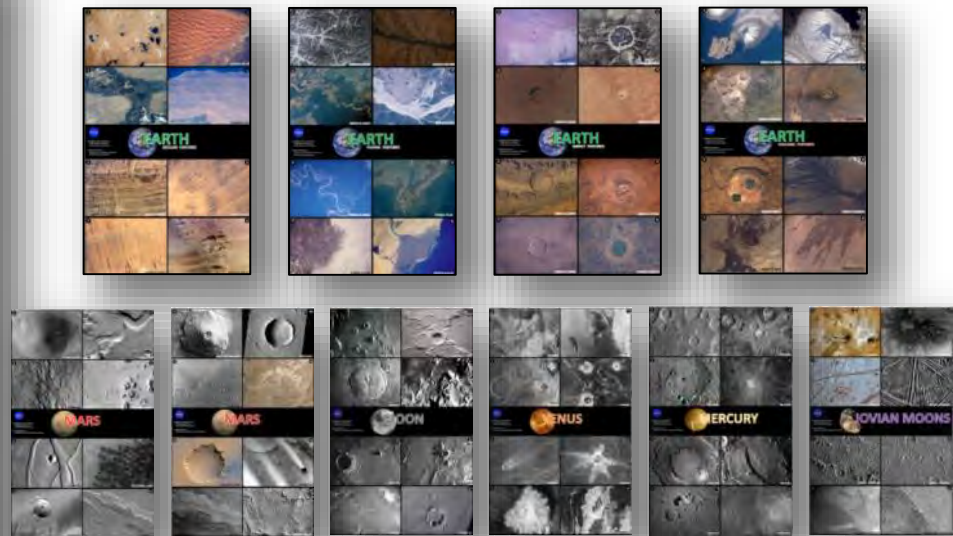
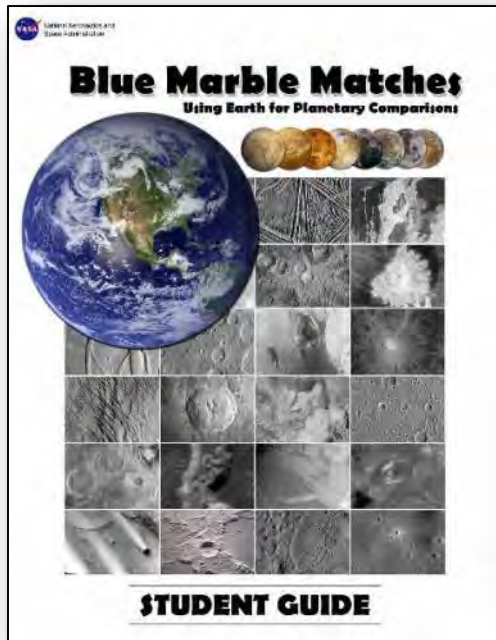
Research Topic: Glaciers **Target Glacier:** Viedma Glacier

Image ID: ISS038-E-34980 Acquired 1/19/14

*Image courtesy of Crew Earth Observations and Image Science & Analysis Laboratory,
NASA Johnson Space Center*



Blue Marble Matches: Using Earth for Planetary Comparisons



PRESENTER:

Paige Valderrama Graff (paige.v.graff@nasa.gov)
Jacobs @ NASA Johnson Space Center