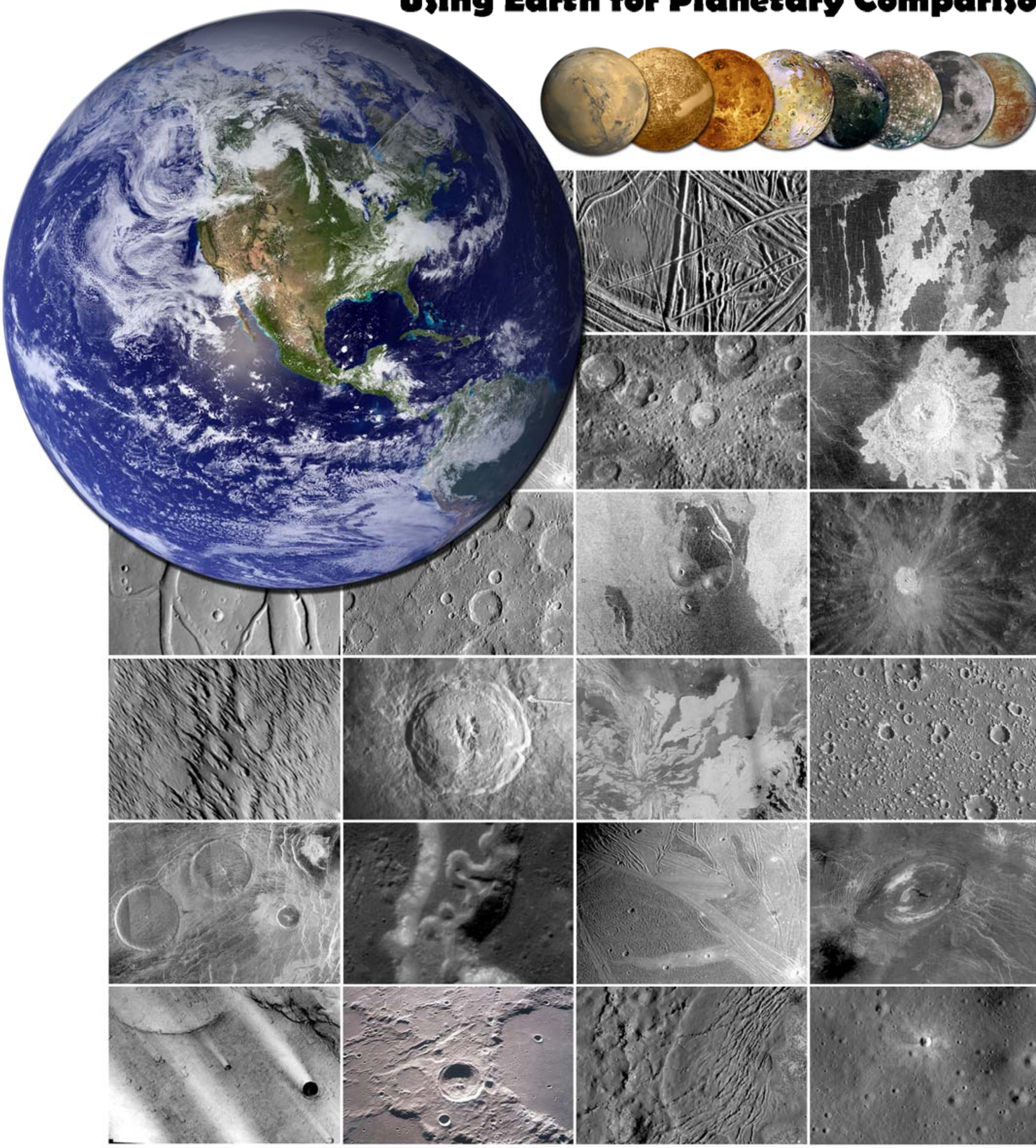
National Aeronautics and
Space Administration

Blue Marble Matches

Using Earth for Planetary Comparisons



STUDENT GUIDE

National Aeronautics and
Space Administration

Blue Marble Matches

Using Earth For Planetary Comparisons

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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. Remote sensing 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. To begin, you will be given one image to observe and describe in the space below. As you write your description, do not name features or objects in the image. 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 or objects.**

Now we will see how descriptive you were! A set of images will be shown to the class. You will read your description to other students to see if they can correctly identify your image. Discuss how you could improve image descriptions as you go through this process.

Based on your discussion with other students, list 3-5 useful characteristics or 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!

BACKGROUND INFORMATION

Defining Characteristics of Geologic Features

Just as you experienced in the beginning of this lesson, planetary scientists who make observations of geologic features on Earth need to have useful ways to describe those features. This becomes especially important as they compare geologic features on Earth to features being observed on other planets. When using images to identify and compare features, scientists must create identification criteria. These criteria are common characteristics that can be used to identify a feature. What types of useful ways did you come up with to describe features? Below is a list of characteristics scientists often use to describe geologic features in images based on their observations.

DESCRIPTOR CHARACTERISTICS:

1. **Size:** Features can be described in terms of actual or relative size. For a detailed planetary comparison study, image scales and actual sizes of features becomes necessary. If the exact size of a feature is not known, relative or comparative sizes of features within the same image can be described. In this lesson we will focus on relative sizes.
   Useful Descriptors: Larger than, longer than, smaller than, shorter than, narrow, wide, thick, thin, tall, short, etc.
2. **Shape:** Features can be described in terms of geometric shape.
   Useful Descriptors: Roundish, oblong, square, etc.
3. **Texture:** Features can be described as having a certain texture.
   Useful Descriptors: Smooth, rough, jagged, scalloped, smeared, etc.
4. **Position/Orientation:** Features can be described in terms of their location relative to other features in an image.
   Useful Descriptors: On top of, next to, below, under, slanted, parallel, perpendicular, etc.
5. **Color/Tone:** Features can be described in terms of their actual color or shade variations/tone.
   Useful Descriptors: Darker, lighter, bright, dull, bluish, reddish, grayish, etc.

Keep in mind that the same geologic feature does not always look *exactly* the same, even on Earth. Most features, however, will have common characteristics. As you create a list of identification criteria for each geologic feature later in this activity, use as many of the above descriptor characteristics that apply.

Systems Science

Scientists who study Earth oftentimes study it using an Earth Systems Science approach. This approach looks at Earth being made up of different parts, or systems, that work together to make up the planet as a whole. The following 4 "spheres" is one way to break down Earth's systems: 1) **Atmosphere**: mixture of gases and small particles above the surface and surrounding the planet; 2) **Biosphere:** related to living systems (life); 3) **Hydrosphere:** water in solid and liquid states; and 4) **Lithosphere** (sometimes referred to as the **Geosphere):** rocks, soils, and sediment. These different Earth systems are all connected, and combined make up our unique planet (see Figure 1). The past, present, and future of our planet is based on a constant interaction among these systems.

Other terrestrial (rocky) bodies in our solar system (the Moon, Mars, Venus, etc.), all have a lithosphere -- they have rocks -- but they may not have the other systems that make up Earth. For example, some also have atmospheres, others do not. No other planetary body in our solar system has a biosphere that we know of…yet. In this activity we will focus on geologic features that are part of the litho/geosphere.

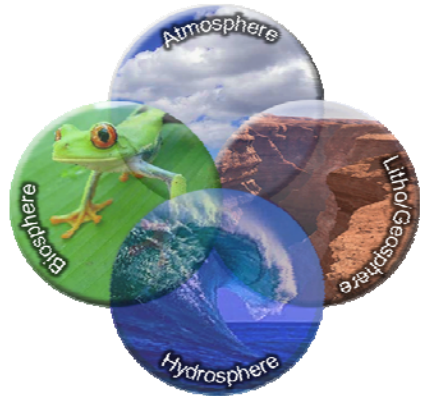

Figure 1: Earth's linked systems

Earth is used as our home laboratory and helps scientists learn how systems and processes work. There is still a lot to learn and scientists continue to conduct research about Earth to better understand our home planet. Let's take a closer look at geologic processes and features on Earth.

Earth Processes and Geologic Features

The information below is listed to help you understand four different types of geologic processes on Earth (aeolian, impact, fluvial, and volcanic) and features associated with them. The features listed are not the only features associated with each process. They will, however, give you a starting point to learn about the different processes. You will want to keep this information in mind later as you look for these features in images. Knowing how a feature forms can help you better understand the processes that shape the surface of a planet.

AEOLIAN PROCESSES: Features created by or associated with the effects of wind. A planetary body needs to have an atmosphere in order to have aeolian processes.

- Sand Dune: A mound of sand formed by windblown sand-sized particles. There are different sand dune types or shapes such as crescent, barchan, longitudinal, and star.
- Wind Streak: A feature formed when wind blows sand or dust-sized particles off the surface (erosional) or onto the surface (depositional).
- Yardang: A sharp ridge or multiple ridges oriented in the same direction formed by sand-sized particles eroding exposed rock.

IMPACT PROCESSES: Features created by or associated with a meteor striking the surface. The thickness of an atmosphere plays a role in the size and number of impactors that strike the surface. Planetary bodies with active geologic processes can cause impact craters to erode or get filled in.

- Impact Crater: A circular hole (depression) in the surface formed by the result of a meteor striking the surface at a high velocity.
  Note: Sometimes a central peak or uplift is visible in the center of an impact crater. This feature is an exposed set of uplifted rocks that show evidence of fracturing and shock that occurs during impact. Not all craters have this feature.

FLUVIAL PROCESSES: Features created by or associated with flowing water. A planetary body needs to have a certain balance between atmospheric pressure and temperature in order to have water flow on the surface.

- Channel: A feature often created by the flow of water. Can vary in size and shape depending on local geology and steepness of topography. In flatter areas they meander into a snake-like shape. Can include the following features: meanders, oxbow lakes (created when a meander is cut off and forms a U-shaped body of water), streamlined islands, levees, bars, and banks.
- Valley/Drainage Network: A set of channels formed by water draining downslope creating a network of small channels or tributaries that merge to form progressively larger channels. These features most often have a branch like appearance.
- Delta: A feature formed by the deposition of sediment that builds up where the mouth of a river flows into another body of water.

VOLCANIC PROCESSES: Features created by or associated with volcanic activity. A planetary body needs to have a hot interior in order to have active volcanic processes.

- Volcano: A raised structure that includes an opening in the crust of a planet where hot molten rock (magma) and gases escape from below the surface.
- Central Vent or Caldera: A circular depression generally at the top of a volcano where magma and gas escape to the surface. These terms are closely related. When a magma chamber is empty enough for the central vent to collapse it is referred to as a caldera.
- Volcanic deposits (lava flows, ash flows): As hot magma reaches the surface and flows out onto the surface it is called a lava flow. Ash flows or plumes come from more explosive eruptions and include tephra (ash, cinders, or volcanic bombs) and gas released into the atmosphere and/or on the surface.

Planetary Comparisons

Scientists use what they know about the formation of features on Earth to develop and test hypotheses, make inferences, and draw conclusions about what may be happening on other planetary bodies. This type of science is called comparative planetology. As scientists make planetary comparisons, they base their conclusions on their observations and interpretations, as well as what information is already known about the planet(s) they are studying. This information includes factors such as the composition of the planet, temperatures, the atmosphere (if one exists), the interior, the surface features, etc. The more knowledge scientists have about the planet as a whole, the better they can draw conclusions with supporting evidence. Scientists cannot assume a certain process has occurred on another planet just because of the identification of a feature that looks like one on Earth. They sometimes consider alternate hypotheses. By conducting planetary comparisons, scientists are able to better understand the history of other planets and the processes that shape their surfaces.

As you complete this activity and use Earth for planetary comparisons, keep in mind that you should consider what you know, but also acknowledge there may be a lot you do not know. Science involves building knowledge to deepen your understanding of how something may work based on new research. What you learn today may be refined tomorrow based on new information gained.

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. In the tables below, use 2 check marks for each column 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:			

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 tables)	**Main Geologic Feature**	**Main Geologic Process** (aeolian, fluvial, volcanic, impact)
1			
2			
3			
4			
5			
6			
7			
8			

Image #	Identification Criteria (list specific criteria from your identification criteria tables)	Main Geologic Feature	Main Geologic Process (aeolian, fluvial, volcanic, impact)
9			
10			
11			
12			
13			
14			
15			
16			

Part 4: Using Earth For Planetary Comparisons

You have reviewed, reinforced, and refined your identification criteria for geologic features found on Earth. It is essential to use those criteria as you observe other images of Earth but also as you observe images from other planetary bodies.

For this part of the activity, you will, just as planetary scientists do, use Earth for planetary comparisons. As you make observations of images from other planetary bodies, think about which worlds are most or least like Earth. By identifying geologic features you will better understand the processes that may have helped shape the surface of these worlds. It will also help you better understand their geologic history. **Use your identification criteria** as you identify features, but as available, you are encouraged to also use other resources such as books, or the internet. These resources can increase your knowledge and help support the identification of features and processes.

The image charts you will use are grouped by planetary body and include Earth's Moon, Mars, Venus, Mercury, and Jovian Moons (the 4 largest moons of Jupiter discovered by Galileo which are Io, Europa, Callisto, and Ganymede). The images were taken by remote sensing instruments on different spacecraft sent to study these terrestrial worlds. As you make observations of these images you will notice that some features may match your identification criteria perfectly! Others may not. This may cause the level of confidence of the feature you identified to be high or low. The higher the level of confidence, the more strongly you, or any scientist, can debate and defend your interpretation. Being able to defend your identification or discuss your uncertainty are both extremely valuable skills.

Use the table below as an example as you make observations of each image:

1. List identification criteria for the main feature shown in the image. There may be multiple features in a given image. You can list other features at the bottom of the table.
2. List characteristics that do not match your identification criteria or observations that may cause your level of confidence of the identified feature to be lowered.
3. Based on your listed criteria, name the main geologic feature that best matches.
4. Name the main geologic process that helped form that feature.
5. List your level of confidence of the identified feature (and process).

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
1	Entire structure with circular opening; entire structure that looks raised and has cone shape	none	Volcano	Volcanic	3
2	Long, windy feature that looks to meander; feature contains u-shaped oxbow shape	Not sure if feature is raised or carved into surface	Channel	Fluvial	2 or 2.5 (pretty sure this is a channel)
3					
4					
5					
6					
7					
8					
ADDITIONAL OBSERVATIONS, COMMENTS, OR QUESTIONS: Image #1 seems to have a chunk missing from the side of this "volcano" on the upper left. Other visible features include a caldera and impact craters; Image #2 has interesting layers in the channel. Other features include impact craters; Image #3…					

Part 4: Using Earth For Planetary Comparisons

Fill out the table below for the planetary body image chart you are given. Use the identification criteria you developed and refined for features on Earth. You must use those criteria as evidence to support your identification of these features. If there are characteristics that do not match your criteria for the feature on Earth or if you are making observations that cause you to be unsure about the identification of the feature, be sure to list those in the table. Based on your observations and how well your criteria match a given feature, list your level of confidence in the last column. Be ready to defend your identification or discuss your uncertainty.

As you discuss your answers, you will likely experience again how scientists do not always agree! Remember, scientific debate and using evidence to back up your interpretations are key elements of science. It is not all about what answer is right or wrong. More importantly, it is about evidence and criteria that support your interpretation!

PLANETARY BODY NAME:

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

ADDITIONAL OBSERVATIONS, COMMENTS, OR QUESTIONS:

Part 4: Using Earth For Planetary Comparisons

Fill out the table below for the planetary body image chart you are given. Use the identification criteria you developed and refined for features on Earth. You must use those criteria as evidence to support your identification of these features. If there are characteristics that do not match your criteria for the feature on Earth or if you are making observations that cause you to be unsure about the identification of the feature, be sure to list those in the table. Based on your observations and how well your criteria match a given feature, list your level of confidence in the last column. Be ready to defend your identification or discuss your uncertainty.

As you discuss your answers, you will likely experience again how scientists do not always agree! Remember, scientific debate and using evidence to back up your interpretations are key elements of science. It is not all about what answer is right or wrong. More importantly, it is about evidence and criteria that support your interpretation!

PLANETARY BODY NAME:

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

ADDITIONAL OBSERVATIONS, COMMENTS, OR QUESTIONS:

Part 5: Observations, Interpretations, and Drawing Conclusions

As you can probably tell, planetary bodies are affected by similar processes that help shape the surface of Earth. Some processes, however, seem to be more (or less) dominant than others. Some planetary bodies have tons of impact craters, others have few. Some have evidence of wind, water, or volcanic features, others do not. Which planetary body is most like Earth? Which is least like Earth? If you only made observations of one planetary body, how is it similar or different from Earth? What do these similarities and differences mean? Based on your observations, what can you infer about these planetary bodies? These are important questions that are an important part of the process of science.

As part of that process, all scientists make observations and interpret those observations to gain a better understanding and draw conclusions about what they are researching. Observations are general trends, patterns, or descriptions that almost everyone can agree upon. Interpretations are what you think those observations may mean. Interpretations, as you should already know, can vary from scientist to scientist, but are based on supporting evidence. Throughout this activity you have already been making observations and interpretations. Your observations were the identification criteria you used to describe features in images. Your interpretations included naming the geologic feature you felt best matched your criteria.

Similar to what professional scientists do, you will now take this idea of observations and interpretations to the next level. Scientists use initial observations and interpretations to help raise their level of understanding. As they make additional observations and learn more, they can use this new knowledge to make more advanced interpretations and draw conclusions or make inferences.

EXAMPLE SCENARIO

Here is an example/scenario related to a school situation that may help you understand how observations and interpretations can help you draw conclusions or make inferences:

It is Tuesday morning and you walk into your classroom. As you enter the room, you make some observations. One of your observations is as follows: *Your teacher is not sitting at his/her desk.* No one would argue with this observation. As you think about your observation, you immediately interpret or think about what this could mean. Based on what you know, your interpretation might be: *The teacher is sick -OR- the teacher has a meeting with the principal -OR- the teacher is running late.* You make note of some additional observations. This includes your observations that the teacher was coughing and sneezing yesterday and that lots of people at school have been out sick with the flu. These additional observations help you advance your interpretation. Your new interpretation is that your teacher is likely home sick for the day. This advanced interpretation also helps you draw conclusions and make inferences about your teacher. You may conclude that you will have a substitute for the day and that the teacher may be absent for a few days. You may infer that *if* you have a substitute *than* you will likely have no homework. This conclusion and your inference may or may not be completely accurate, but they are based on your overall observations, your current knowledge, previous experiences, and your interpretations.

Let's take this idea of observations, interpretations and making inferences/drawing conclusions and apply it to the planetary comparisons you have made throughout this activity. To do this, you need to bring together what you have learned through this activity. Some of what you have learned includes:

- Information about 4 different geologic processes and the formation of features associated with these processes. These geologic processes and associated features include:
  - Aeolian Processes: Sand dunes, wind streaks, yardangs
  - Impact Processes: Impact craters
  - Fluvial Processes: Channels, valley/drainage networks, deltas
  - Volcanic Processes: Volcanoes, central vents/calderas, volcanic deposits

- Details about what a planetary body needs in order to have each of these processes:
  - Example: Aeolian Processes: A planetary body needs to have an atmosphere in order to have aeolian processes.

This information, along with additional information you have obtained from other resources can help you piece together your observations and interpretations and try to make sense of what it all means.

For this part of the activity you will revisit and review observations and interpretations you have already made. You will then extend that information using the knowledge you have gained and additional observations you have made. This will allow you to advance your interpretations and draw conclusions or make inferences about what you have learned. As you fill out information in the table on the next page, consider the following:

- **OBSERVATION:** List a specific planetary body and include one observation you made. Your observation should be the specific identification criteria used to identify a specific feature.
- **FEATURE INTERPRETATION**: Based on the identification criteria, name the feature that best matches. If there can be a potential misinterpretation or confusion between what the feature may be, include information to help you interpret the feature consistently.
- **ADDITIONAL OBSERVATIONS**: Log additional observations you made of images in Part 4. If you found additional information about the planetary body from other sources (books, the internet), it's a good idea to get into the habit of referencing those sources.
- **ADVANCED INTERPRETATIONS**: Your additional observations and background knowledge gained from this activity and other sources of information should allow you to list advanced interpretations. These advanced interpretations allow you to make deeper connections that will help you make inferences or draw conclusions. As with all parts of the process of science, you must have evidence to support your interpretations and conclusions. Interpretations can change as you gain more knowledge.
- **CONCLUSIONS/INFERENCES ABOUT PROCESSES THAT SHAPE THE SURFACE**: The information you include here are your conclusions or inferences about processes that shape the surface of the particular planetary body.

Use the first example on the table as a guide as you list your own observations, interpretations and conclusions.

Part 5: Observations, Interpretations, and Drawing Conclusions

Log at least 3 observations, interpretations and conclusions. Your logged information should support the conclusions and inferences you make about processes that shape the surface of the planetary body/bodies you have observed. You should be able to support and defend all logged information.

OBSERVATION (list specific planetary body and identification criteria)	**FEATURE INTERPRETATION**	**ADDITIONAL OBSERVATIONS** (list additional observations)	**ADVANCED INTERPRETATION**	**CONCLUSIONS/INFERENCES ABOUT PROCESSES THAT SHAPE THE SURFACE**
Planetary Body: ***MARS*** **Observation:** ***There are circular depressions on the surface.***	***These circular depressions could be volcanic craters or impact craters. When they are not part of a raised structure, they are most likely impact craters.***	• ***Impact crater rims appear to be worn down.*** • ***Rims do not always appear as perfect circles.*** • ***There appears to be evidence of wind related features (wind streaks and sand dunes) in and around impact craters.*** • ***Mars is a dusty planet. (http://science.nasa.gov/science-news/science-at-nasa/2003/09jul_marsdust/)***	• ***Dust and sand are likely carried by the wind and can either erode the surface or be deposited on the surface.*** • ***Impact craters have likely been affected by these processes.***	• ***Mars must have an atmosphere since there is evidence of aeolian processes.*** • ***Wind has eroded the surface of Mars in its past and may still be changing the surface today.*** • ***Dust and sand likely erode the surface.*** • ***The atmosphere is thick enough to have wind but not thick enough to prevent meteors from striking the surface.***
Planetary Body: ________________ **Observation:**				
Planetary Body: ________________ **Observation:**				

Part 5: Observations, Interpretations, and Drawing Conclusions (continued)

OBSERVATION (list specific planetary body and identification criteria)	**FEATURE INTERPRETATION**	**ADDITIONAL OBSERVATIONS** (list additional observations)	**ADVANCED INTERPRETATION**	**CONCLUSIONS/INFERENCES ABOUT PROCESSES THAT SHAPE THE SURFACE**
Planetary Body: ________________ **Observation:**				

You have made observations and interpretations that have allowed you to draw conclusions and make inferences about the planetary bodies you investigated. These terrestrial worlds or rocky planets all have a lithosphere/geosphere – they have rocks. Did any other planetary body you observed also have an atmosphere? Do any of them have a hydrosphere? How do we go about detecting if any of them have a biosphere? If you remember, the different Earth systems (litho/geosphere, atmosphere, hydrosphere, and biosphere) are all connected and combined make up our unique planet. The interaction of different systems on other planetary bodies likely play a role in the past, present, and future of these bodies, just as they do on Earth. There is so much yet to be discovered!

As the exploration of Earth and other planetary bodies in our solar system continues and new discoveries are made, scientific progress and our understanding of our solar system deepens. What we learn today may be refined tomorrow. This makes science an ever-changing and dynamic discipline. You are encouraged to follow along with NASA's journey of exploration or even better yet, become a part of it. NASA needs the next generation of scientists and engineers to help continue the exploration of Earth and beyond. That next generation of explorers includes you!