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!