Finding Mars on Earth Student Worksheet

by David V. Black

Student Names: ____
Date: ________________ Period: ________

Instructions: Your job is to compare and contrast landforms on Earth with those on Mars to see if similar processes are at work on both planets. Print out this worksheet, and for each landform your group is assigned, compare the photos of the Mars terrain with its Earth analog. Use Google Earth to look at both features in three dimensions from different angles. As a team, decide which processes described below are at work, list them, and write a sentence description of how that process contributed to the formation of each terrain, then compare and contrast the similarities and differences of the two landforms, and write a conclusion statement regarding how long water must have existed at this site. Once you have competed all the terrains, share your answers with the rest of the class, then answer the questions at the bottom.

Process Definitions:

Frost Heaving: Water is more dense as a liquid than as a solid (ice). When liquid water gets into cracks in rocks and freezes, it expands and breaks the rocks apart.

Gravity: This is a force that pulls objects downhill. The larger and rounder a rock, and the steeper a slope, the further the rock will travel. If a slope is gentle and the rock pieces are small, they won't travel very far; if the slope is steep and the rock pieces large, they will travel quite a long distance before coming to rest.

Water Erosion: Running water carries small grains of rock and other materials that gradually dissolve and pluck out grains and small pieces from the rocks that the water runs over. The faster the water runs, such as on steep slopes, the more power it has to erode the rocks. Rocks that have been eroded by water tend to become smooth and rounded as their corners are knocked off and they are polished by the water. Around lakes and oceans, waves tend to cut terraces and beaches.

Water Transportation: Running water also transports materials that have been eroded. The larger the piece of material, the harder it is to move with water. Fine grains, like silt, can be transported long distances and will only settle out if the water is calm. Medium-sized grains, such as sand, can be carried far if the water is running swiftly, but tend to deposit in slow water. Large pieces, such as gravel, can only be moved short distances in swift water.

Headward Erosion: When there is a steep slope, such as a cliff caused by a fault or a crater wall, water will tend to cut deep, V-shaped gullies into the cliff face where gravity is strongest and the water has the most power to erode. The gullies gradually erode farther into the cliff, fanning out to form tributaries that then develop their own tributaries, like the branches on a tree. The mouth of the gully at the edge of the cliff stays V-shaped, steep, and deep.

Wind Erosion: Sand particles and finer grains can be carried along by the wind or hop along the ground. If they hit into other rocks, they will gradually smooth and erode the exposed surfaces like a sandblaster. Such rocks tend to become wedge-shaped as winds come from only certain prevailing directions.

Water Deposition: When water flows slowly or is calm, and particles it contains will settle out and get deposited in sand bars, mud flats, and river deltas. In wet climates, these particles can be carries a long way. In arid climates, they tend to pile up right at the mouth of canyons as soon as the occasional water slows down as it exits the canyon.

Talus Slope: On steep slopes, frost weathering and gravity will cause avalanches of rock that then pile up at the base of the cliff. The larger rocks have more momentum and travel to the bottom of the slope; the small rocks (pebbles) pile up at the top of the slope. These piles are not caused by running water, so there are no V-shaped canyons or tributaries above them.

Mass Wasting: A steep cliff can become gradually weakened at its base by erosion. or water saturation. Eventually, the entire cliff may collapse and slump off into the canyon below. If the mountains' material is saturated with water, the slump will liquify and turn into a mud slide or mud avalanche (lahar). Such collapses happen suddenly and the pile of rocks and mud at the bottom will not be well-sorted like in a talus slope or in long lasting water deposition.

Sand Deposition: When wind blown sand hits an obstruction, like a sagebrush, a hill, or a large rock, it will pile up on the windward side of the obstruction. On the lee side of the pile, the sand grains blow over the top and fall onto the face, creating the characteristic crescent shape of a barchan sand dune. Barchan dunes migrate slowly as the wind picks up grains on the windward side and deposits them on the lee side. Where wind comes from several prevailing directions during different seasons, it will form transverse dunes (long ridges) that often form a checkerboard pattern.

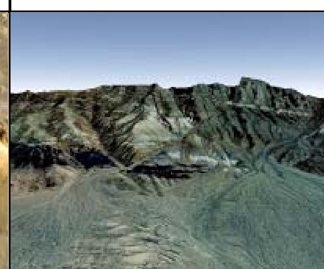
River Meander: Rivers form channels as the water erodes into the rocks. In areas of gentle slope, the channels will begin to form long curves. Water coming around the outside of a curve is moving faster and tends to erode into the bank, making the curve even more pronounced. On the inside of the curve, the water moves slowly and sand grains become deposited as sand bars. Eventually, the curves meander loop becomes so long that the neck of the loop gets eroded through and the loop is stranded as an oxbow lake. Such features are only seen in a mature, long lasting river system.

Inner and Outer River Valleys: Some river valleys show a broad outer valley that fills up with water during peak runoff (springtime) or during catastrophic floods, such as flash floods. They will also have an inner valley where the stream runs during most of the year.

Playa Lake: In a desert region, especially one without integrated drainage through to the ocean, water may run into a valley but then not go any further. Gradually, the valley floors become filled with mud, which dries up each summer to form cracked mud flats or hard pans. If the playa lake is large, it can gradually build up salt flats. Minerals that erode out of the mountains are trapped in the lakebed and are not washed to the sea. As the water evaporates each summer, it leaves salt crystals (such as sodium chloride [table salt] or magnesium sulfate [gypsum]) behind.

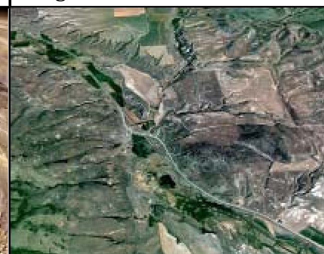
Impact Crater: Unlike a volcanic crater which has lava flows and igneous rocks that have erupted from it, an impact crater can be found in any type of rock. Its walls are lifted up from the surrounding area as the force of impact explodes outward and rebounds the crust. Impact craters also can have central peaks and will have a debris apron around them.

Student Data Table

Feature Name and Description:	Mars Terrain:	Earth Analog:	Processes:	Comparison:	Conclusions About Mars Terrain:
Erosion Amphitheater: A depression shaped like an amphitheater found at the edge of a steep slope (a crater wall or mountain range). It has a deep, narrow opening at the edge of the slope, but fans out into a bowl shape as it goes deeper in.	 ***Holden Crater North Rim:*** Latitude: 24° 51’ 07.46” S Longitude: 34° 07’ 54.25” W	 ***Willow Creek Canyon, Utah:*** Latitude: 39° 44’ 25.67” N Longitude: 111° 48’ 45.06” W	***Frost heaving:*** Rocks at the top edge of the bowl are broken off by snow and frost. ***Gravity:*** Broken rocks fall down the slope into the gullies. ***Water transportation:*** Water transports the broken rocks downhill. ***Headward erosion:*** Gullies gradually expand deeper into the slope, fanning out as they go. The mouth is left as a narrow opening.	The features on Earth and in Holden Crater on Mars are identical, except the ones on Earth are better developed. The only difference is that the slope on Mars is a crater wall whereas the slope on Earth is caused by normal faulting.	Because of the fan shape of tributaries and the length of time it would take for this to form, there had to be many cycles of frost heaving, water transportation, and headward erosion. Water must have persisted here for a long time.
Alluvial Fan:	 ***Holden Crater North Rim:*** Latitude: 24° 51’ 07.46” S Longitude: 34° 07’ 54.25” W	 ***West of Notch Peak, Utah:*** Latitude: 39° 08’ 05.04” N Longitude: 113° 27’ 18.6			

Feature Name and Description:	Mars Terrain:	Earth Analog:	Processes:	Comparison:	Conclusions About Mars Terrain:
Landslide:	 ***Coprates Chasma:*** Latitude: 13° 21’ 25.32” S Longitude: 57° 49’ 59.36” W	 ***Wheeler Peak, Nevada:*** Latitude: 38° 59’ 18.75” N Longitude: 114° 18’ 32.14” W			
Arroyo (Gully):	 ***Ares Vallis (Pathfinder Site):*** Latitude: 19° 02’ 50.48” N Longitude: 33° 17’ 38.70” W	 ***Little Wild Horse Canyon, Utah:*** Latitude: 38° 35’ 06.39” N Longitude: 110° 41’ 32.93” W			
Mesas:	 ***Deuteronilus Mensae:*** Latitude: 44° 27’ 30.34” N Longitude: 28° 09’ 34.88” E	 ***Monument Valley, Arizona:*** Latitude: 36° 54’ 52.92” N Longitude: 110° 05’ 59.38” W			
River Valley:	 ***Uzboi Vallis:*** Latitude: 24° 03’ 21.93” S Longitude: 34° 00’ 37.05” W	 ***Goosenecks of the San Juan, UT:*** Latitude: 37° 11’ 21.44” N Longitude: 109° 49’ 41.41” W			

Feature Name and Description:	Mars Terrain:	Earth Analog:	Processes:	Comparison:	Conclusions About Mars Terrain:
River Delta:	 ***Eberswalde Crater:*** Latitude: 23° 50’ 32.02” S Longitude: 33° 36’ 26.54” W	 ***Sevier River Delta, Utah:*** Latitude: 39° 21’ 17.08” N Longitude: 112° 34’ 40.44” W			
Playa Lake:	 ***Miyamoto Crater:*** Latitude: 3° 12’ 10.55” S Longitude: 7° 19’ 59.71” W	 ***Tule Valley, Utah:*** Latitude: 39° 34’ 57.84” N Longitude: 113° 07’ 23.66” W			
Land-Locked Lake:	 ***Aram Chaos:*** Latitude: 2° 08’ 16.76” N Longitude: 18° 26’ 45.60” W	 ***Great Salt Lake, Utah:*** Latitude: 41° 18’ 30.41” N Longitude: 112° 44’ 21.59” W			
Salt Flat:	 ***Mawrth Vallis:*** Latitude: 24° 03’ 31.77” N Longitude: 18° 45’ 24.00” W	 ***Sevier Lake, Utah:*** Latitude: 39° 06’ 37.86” N Longitude: 112° 49’ 22.87” W			

Feature Name and Description:	Mars Terrain:	Earth Analog:	Processes:	Comparison:	Conclusions About Mars Terrain:
Wave-Cut Terrace:	 ***Crommelin Crater:*** Latitude: 4° 53’ 51.78” N Longitude: 10° 09’ 55.46” W	 ***Great Stone Face, Utah:*** Latitude: 39° 14’ 00.14” N Longitude: 112° 44’ 55.33” W			
Outflow Channel:	 ***Aram Chaos Outflow:*** Latitude: 2° 49’ 06.77” N Longitude: 18° 27’ 53.01” W	 ***Red Rock Pass, Idaho:*** Latitude: 42° 21’ 02.82” N Longitude: 112° 02’ 36.53” W			
Sand Dunes:	 ***Victoria Crater Dunes:*** Latitude: 2° 03’ 01.59” S Longitude: 5° 29’ 44.75” W	 ***Little Sahara Dunes, Utah:*** Latitude: 39° 37’ 06.85” N Longitude: 112° 23’ 11.95” W			
Impact Crater:	 ***Victoria Crater:*** Latitude: 2° 03’ 01.59” S Longitude: 5° 29’ 44.75” W	 ***Meteor Crater, Arizona:*** Latitude: 35° 01’ 27.49” N Longitude: 111° 00’ 47.25” W			

Deeper Questions:

1. What pieces of evidence from your above analysis support the conclusion that liquid water existed on the surface of Mars at some time in the past?

2. What terrains show evidence that liquid water persisted there for long periods of time?

3. What patterns have you discovered from this analysis that show liquid water still plays a role in geology on Mars?

4. What are the major processes that actively shape the features of Mars today?

5. How do you explain the similarities between Earth and Mars?

6. On the large scale, what types of features are common on Mars but not common on Earth?

7. What features are common or prominent on Earth but missing on Mars?

8. How do you explain the differences between Earth and Mars?

9. What have you learned about Mars by comparing it with Earth analogs?

10. If you were a scientist studying Mars, what places would you recommend as landing sites for the Mars Science Laboratory (Curiosity) rover? Why?