Searching for Gullies on Mars
MSIP Proposal

February 2013

Washington Academy
Accelerated Learner Program
Belvidere, Illinois

About Our Team

- Washington Academy is a K-7 STEM magnet school.
- The ALP program provides STEM enrichment to students who qualify for services.
- We are a PBL school!

Our Guiding Questions:

- What role will space exploration play in our future?
- Could and should human habitation of Mars be a possibility?

Introduction

As young explorers, we are excited to look at Mars as a future place for humans to live and explore.

We've spent a lot of our class time discussing the basic survival needs of humans and how those needs could be met on Mars when its environment is so different from Earth.

We've developed a criteria list that we feel any area being evaluated as a living site should meet to make sure human survival is possible.

Our Criteria for Site Consideration

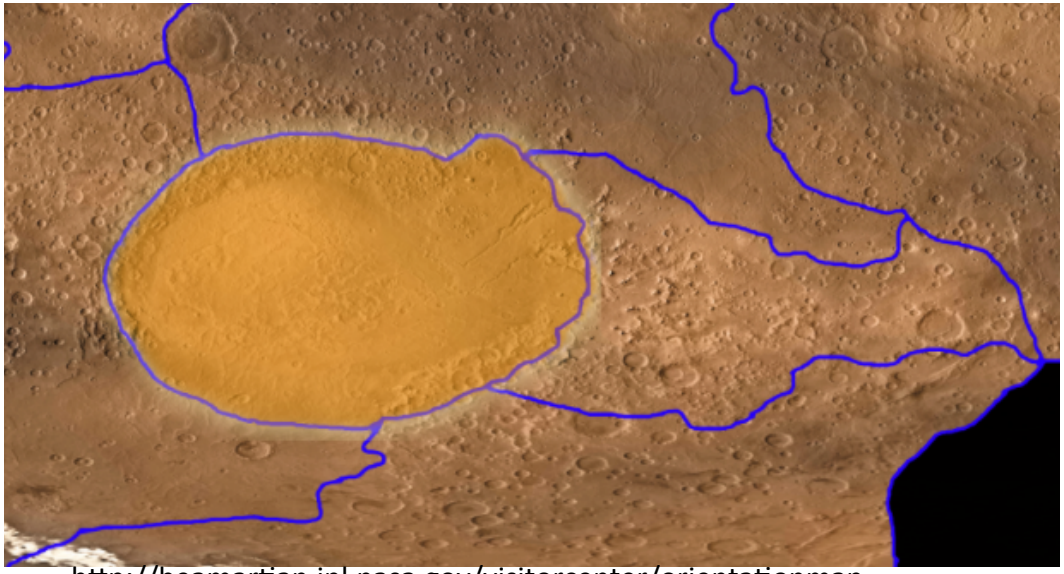
An area must have:

- a temperature range that is tolerable by humans
- a terrain that allows for safe landings & rover travel
- a potential water source (Our focus will be gullied craters for this research.)

Selecting & Evaluating an Area

- Early discussion of near-Equator location
- Interest in Dr. Christensen's research (Christensen, 2003)
- Southern hemisphere selected based on MOLA map (MSIP Website)
- HEND map→ presence of H_2O (JMARS)
- Mid Latitude Temps: average= -50 degrees C (-58F) range= -60 to 0 degrees C (-76F to 32F) (NASA Quest Website (http://quest.nasa.gov/aero/planetary/mars.html), retrieved 1/17/13)

Border between Hellas Planitia & Eridania Regions



http://beamartian.jpl.nasa.gov/visitorcenter/orientationmap

Research Question

Is there evidence of gullies in craters found at the border between the Hellas Planitia and Eridania regions?

Why is this Important?

- Gullies provide evidence of recent liquid water or snow covered areas. (Feature ID Chart, pg. 2) They can point to where to look!
- Water is vital to human existence, and success of humans living on another planet depends on meeting their survival needs.
- We were surprised to learn through Dr. Christensen's paper that water in the form of melting snow & ice could be happening right now rather than in the past! (Christensen, 2003)

Our Hypotheses

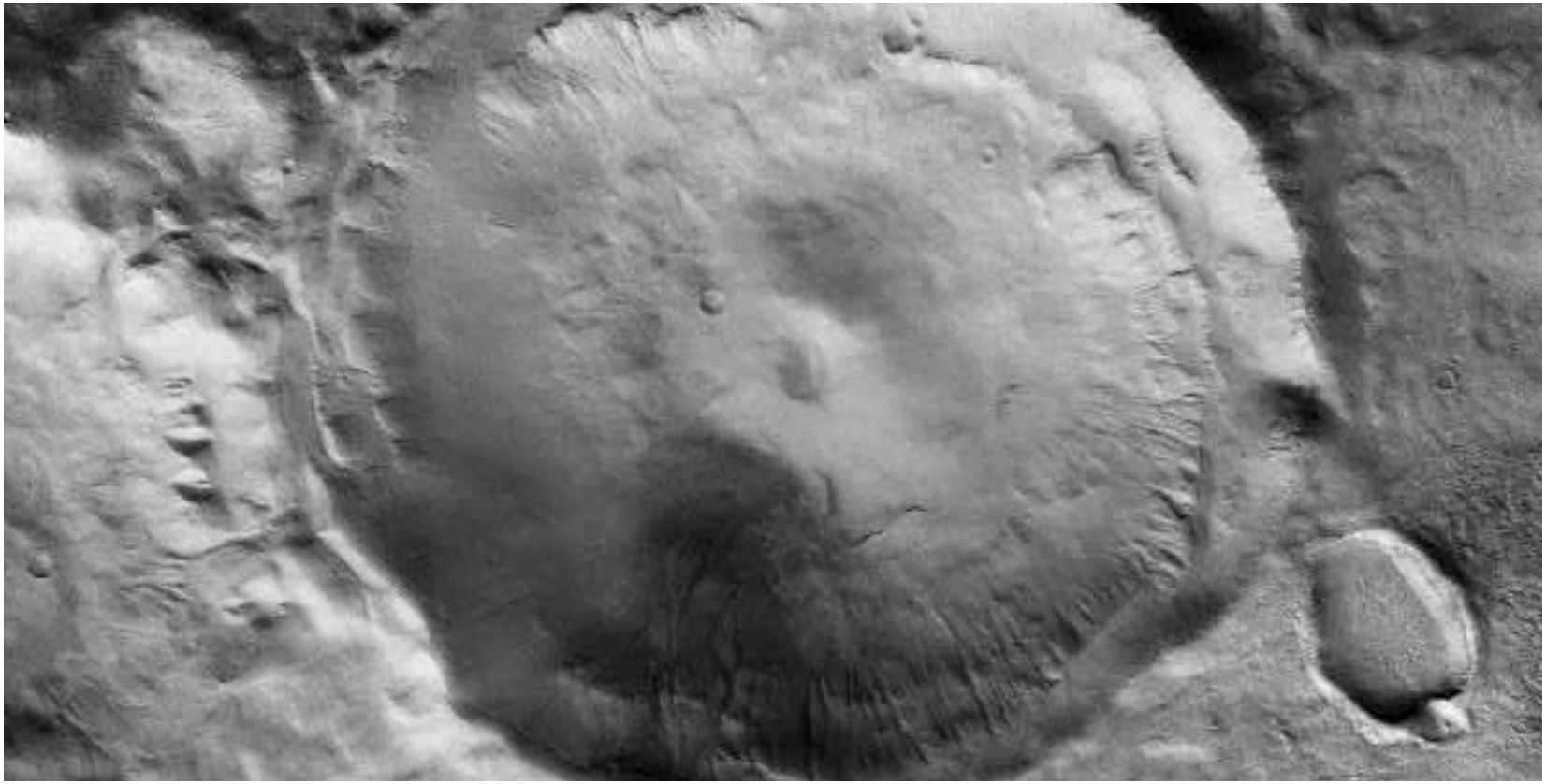
If this region is south of the 30 degree latitude and in an area containing craters & similar steep slope terrain, then we will observe evidence of gully formation.

If we do not observe the presence of gullied craters, then the landforms are not structured to develop gullies or that snow/ice melt is not occurring.

Background

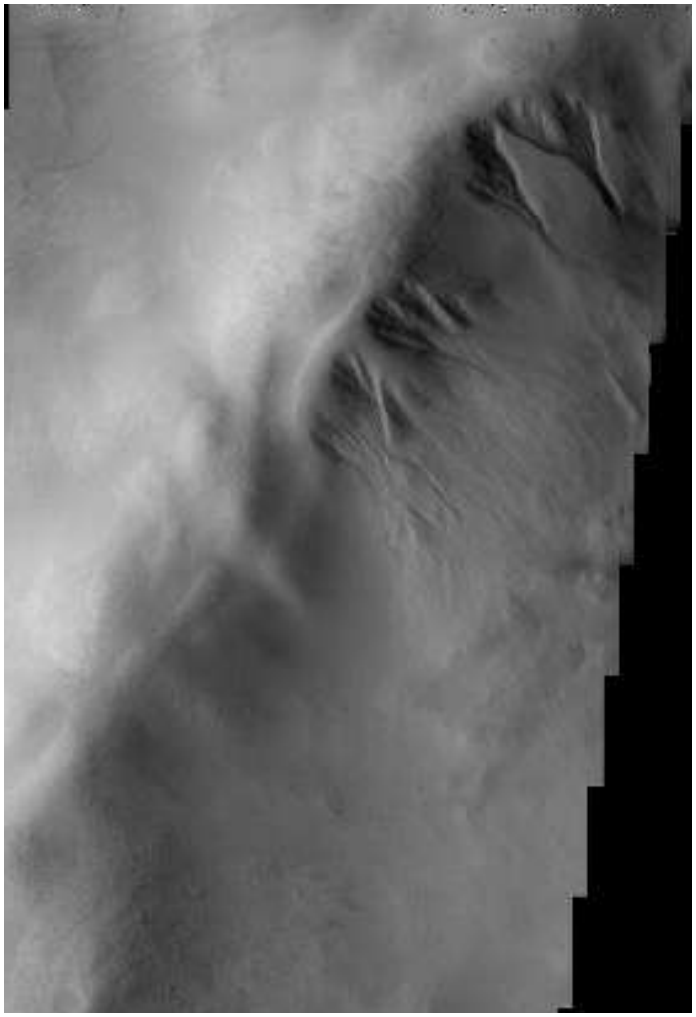
- Craters happen when meteorites hit the surface and leave a circular indentation.
- A crater can be identified by its shape and its features: a rim, floor and walls. Sometimes at the center there remains a mountain peak.
- The age of a crater can be determined based on the preserved or changed shape of the rim as well as its depth (Feature Identification Chart, pg. 2).
- Gullies on Mars are most often found inside craters near the rim or along sloped landforms.
- They are believed to be a sign of past liquid water or that an area was once snow-covered (Feature Identification Chart, pg. 2).
- To answer our research question, we will be looking at craters to determine if gullies are present. We will also note any instances of observing gullies on other sloped land forms in our chosen area.

Example of Gullies Inside a Crater



THEMIS Website: http://themis.asu.edu
Image ID # V01131003
Latitude: -41.2517, Longitude: 161.115

Example of a Gully on a Slope



THEMIS Website: http://themis.asu.edu
Image ID # V16503003
Latitude: -52.3557, Longitude: 304.535

How We Will Utilize These Examples

- Comparison to what we see in JMARS
- Ensure we do not mistake canyon walls and layers as gullies
- Examples show how a gully forms near the rim and lengthens down the slope in a funnel shape as it grows

Theories about Gullies

2 Groups of Theories:

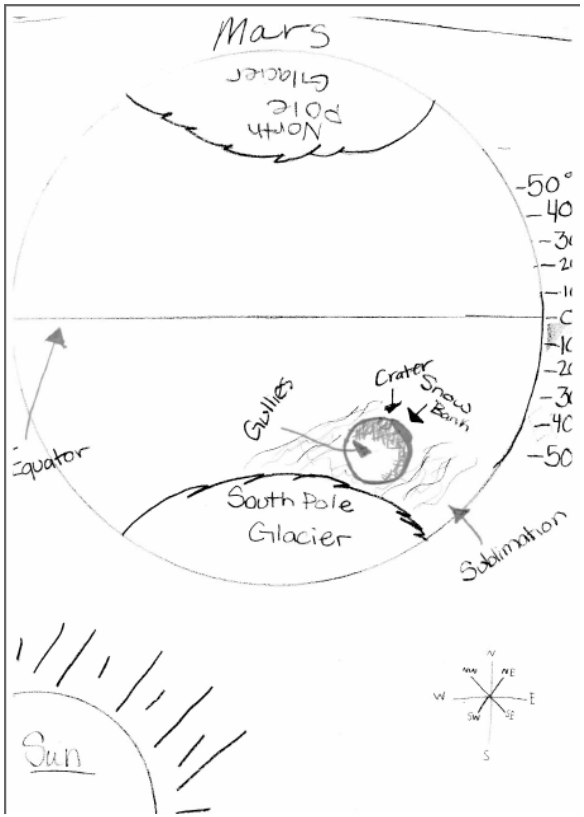
1. Water or some other fluid like liquid carbon dioxide created gullies just like flowing water does here on Earth.
2. Dry materials of some kind cause the erosion of gullies like you would see in an avalanche. This dry material could be moved by gasses.

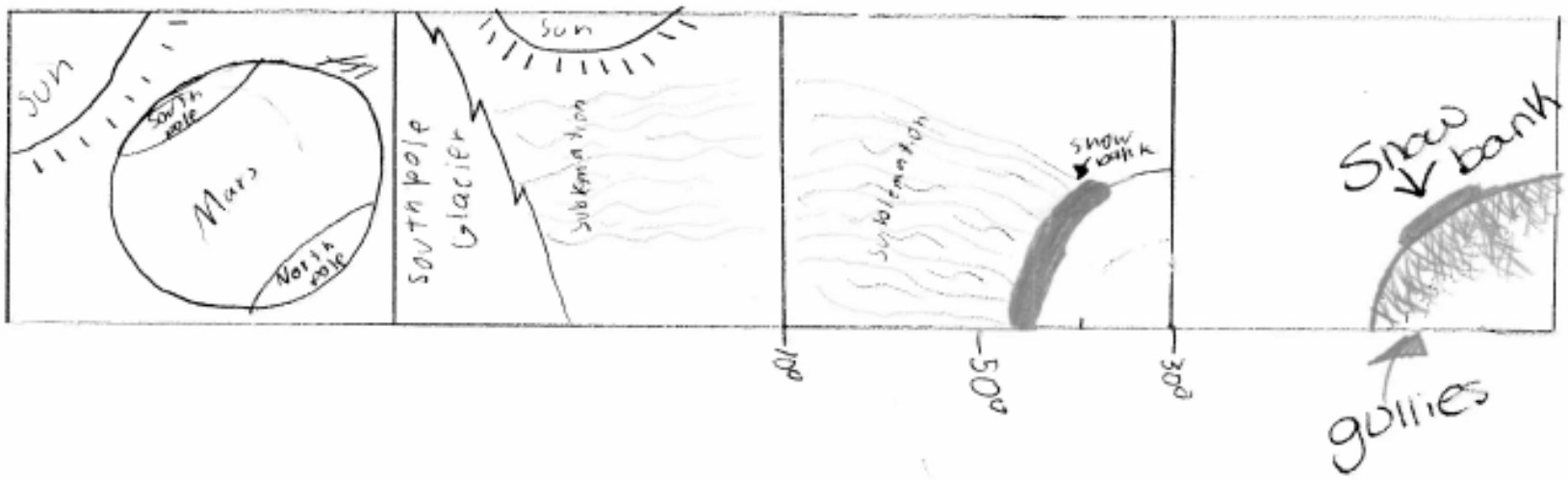
(Cedillo-Flores and Durand-Manterola, 2010)

Understanding Dr. C's Research

- Sublimation is a process where solid material transfers directly to a gas state without passing through a liquid state first.
- Sublimation moves moisture from the poles to the mid latitudes where it deposits as snow & ice.
- Fine layer of dust helps to protect this snow and ice from melting quickly.
- Snow-melt and ice is observed on the pole-facing side of craters. (Christensen, 2003)

The Sublimation Process





What Do We See on Earth?

Both gullies and craters can be found on Earth.

- Gullies on Earth are formed when the movement of flowing water, sand or dust erodes the side of a steep hillside. As this material is worn away, cuts are made forming a network of channels leading down the hillside.
- When first formed, they are narrow with vertical sidewalls. Once the gully is fully formed, it begins to get wider and longer as water continues to flow along these cuts.

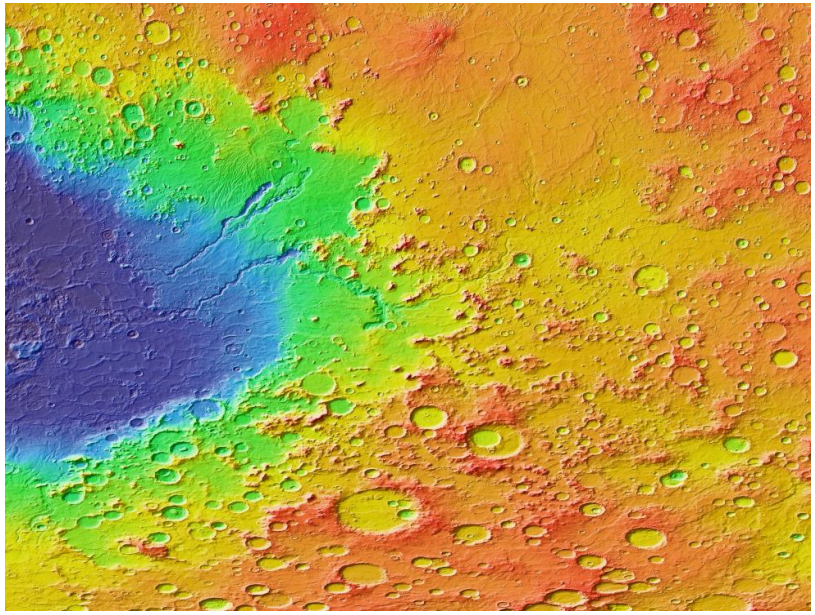
(Iowa Geological & Water Survey by the Iowa Dept. of Natural Resources, http://www.igsb.uiowa.edu/browse/gullyero/gullyero.htm, retrieved on 1/29/13)

- Craters can also be found on the Earth's surface. Craters can be formed when objects from space connect with the Earth.
- There are also craters formed by volcanic explosions from our own surface.
- Intact craters can be hard to find because they are old, and our Earth is constantly changing. The movement of tectonic plates can bury existing craters making them hard to study.

(NASA Lunar Science Institute, http://lunarscience.nasa.gov/articles/how-are craters-formed/, retrieved 1/31/13)

Experiment Design

- Mars Odyssey orbiter
- THEMIS camera
- We will document information about the craters found in this area. Gullies are known to form inside craters on the walls and rim. We will look here for evidence of features that point to a history of water.
- We are choosing to focus on a region in the southern hemisphere south of thirty degrees latitude. Specifically, we will look at the bordering area between the Hellas Planitia and Eridania regions as indicated on this section of the MOLA colorized elevation map in green and yellow.



Approximate Latitude Range: -20 degrees to -60 degrees
Approximate Longitude Range: 75 degrees to 115 degrees

Websites for our Research

To gather our data we will use several websites:

Website	Reason for Use
THEMIS Website http://themis.asu.edu	As we look at THEMIS images in JMARS, we will also use this site to read descriptions about some of these images. We will also use this site to reference other examples of gullies in craters either from this region or from others on Mars.
JMARS GIS Program	We will use this GIS tool to access THEMIS images from this area as well as to document and measure specific features such as crater diameter, gully length, latitude and longitude and elevation.
MSIP Website http:// marsed.mars.asu.edu/ msip	We will use this site to access specific resources needed to complete our assessment of this region: Feature ID Charts, MOLA map, and an outline for reporting our findings.

Image Data

To answer our research question, we will aim to gather at least 100 images. As part of our experiment design, we will record the following information from each image in a table:

- **Image identification # (V#)**: This will allow us and other scientists to reexamine the images we observed to check our data.
- **Latitude and longitude:** This will allow us to map where each image we examine is located
- **Specific feature(s) (***Craters and Gullies)*: We will look for craters and gullies as those directly relate to our science question.
- **Gully Present**: Answering yes or no will help us to assess the percentage of all craters observed that showed a gully presence.
- **Gully Location**: Noting if the gully is forming on the pole-facing side will help us to understand and compare our findings to what Dr. Christensen has written about.
- **Measurements**: Here we will list crater diameter and gully length measurements. Knowing these pieces of information will allow us to look for patterns later and draw conclusions about whether gullies are found more commonly in one type of setting.

Measurement Plan

- Use of JMARS measuring tools
- Specific measurements of all craters and gullies we see:
  - diameter of the crater
  - length of the head to the foot of the gully

- These measurements are important:
  - Is there a relationship between these two measurements?
  - Can we make any inferences about the age of the gully because its length?

- We will also use the latitude/longitude layer to determine the coordinates of interesting features.

Analysis Plan

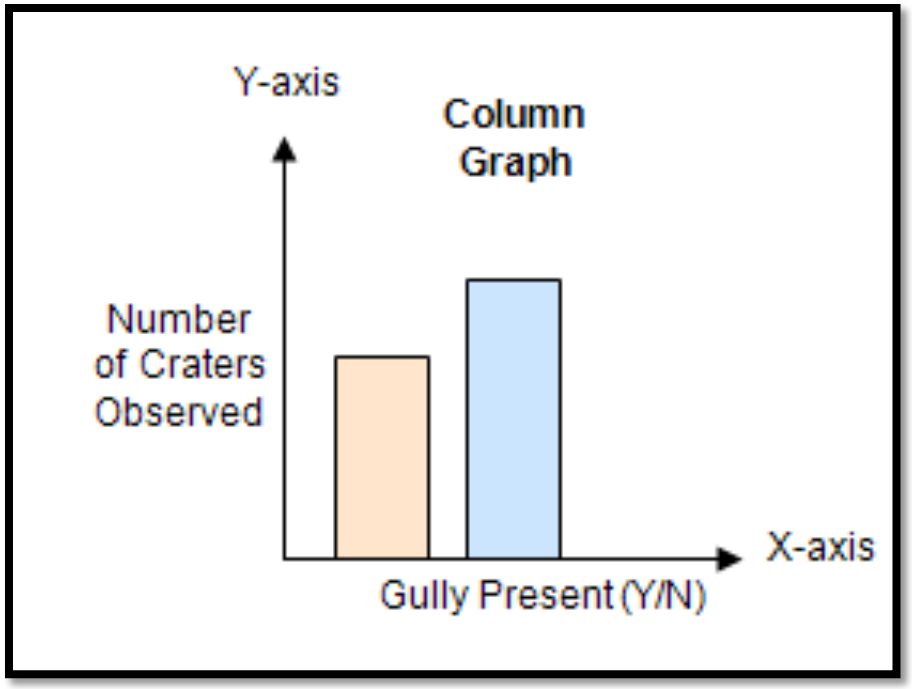
As we examine THEMIS images, we will record our scientific observations and measurement data in the chart below.

Image ID#	Lat/ Long	Sketch or jpg	Specific Features (Craters & Gullies)	Gully observed? (Y/N)	Gully Location (pole facing/ equator facing)	Measurements: Crater Diameter, Gully Length

Graphing the Data

We plan to compare and graph the following three data pairs.

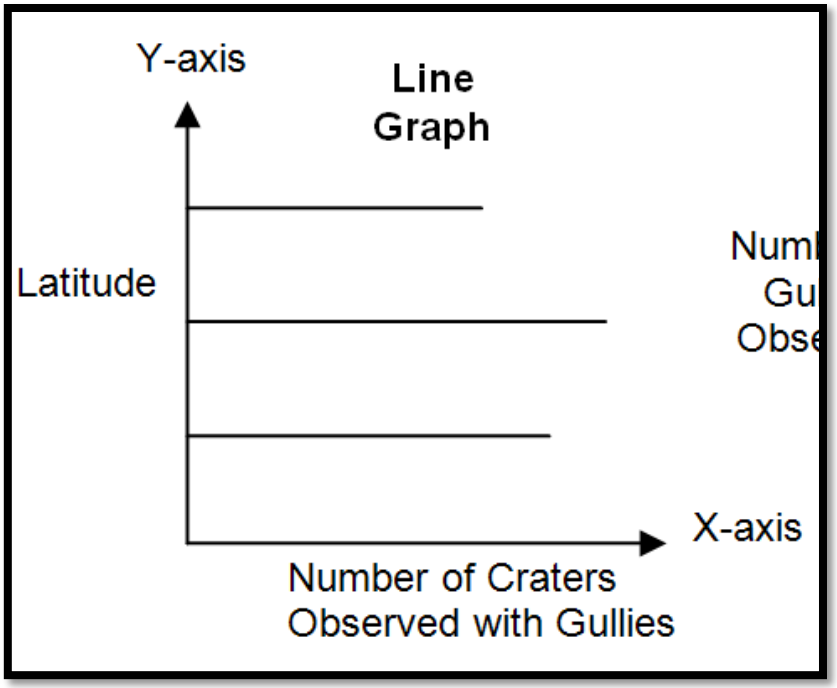
1. Number of craters observed versus gully presence



- This will let us compare the yes and no amounts with an easy to see visual.
- We will be able to tell right away how the two classifications compare with each other.
- Very quickly, we'll be able to tell if there is a balance or more of one kind of crater finding, with gully or without gully.

Graphing the Data

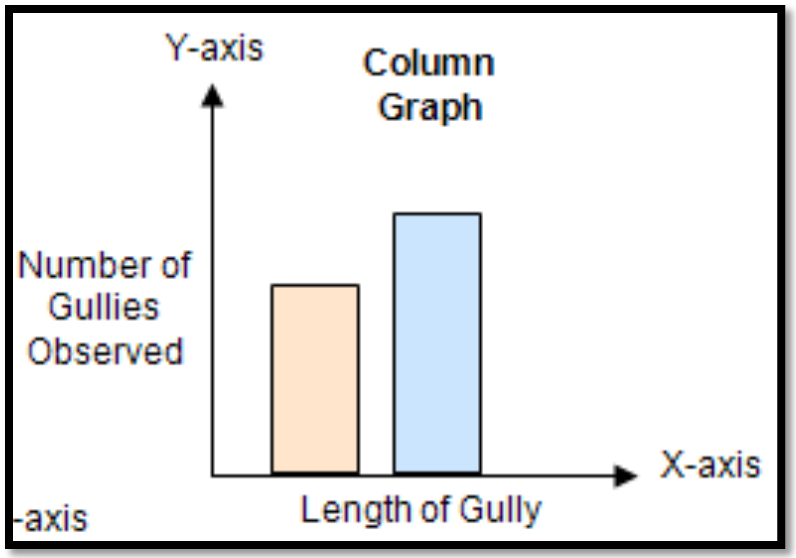
2. Latitude verses number of craters observed with gullies



- We can see how total amounts of craters with gullies changes as the latitude moves higher or lower.
- We want to know if there are specific latitudes where we find more gullies than other latitude areas.

Graphing the Data

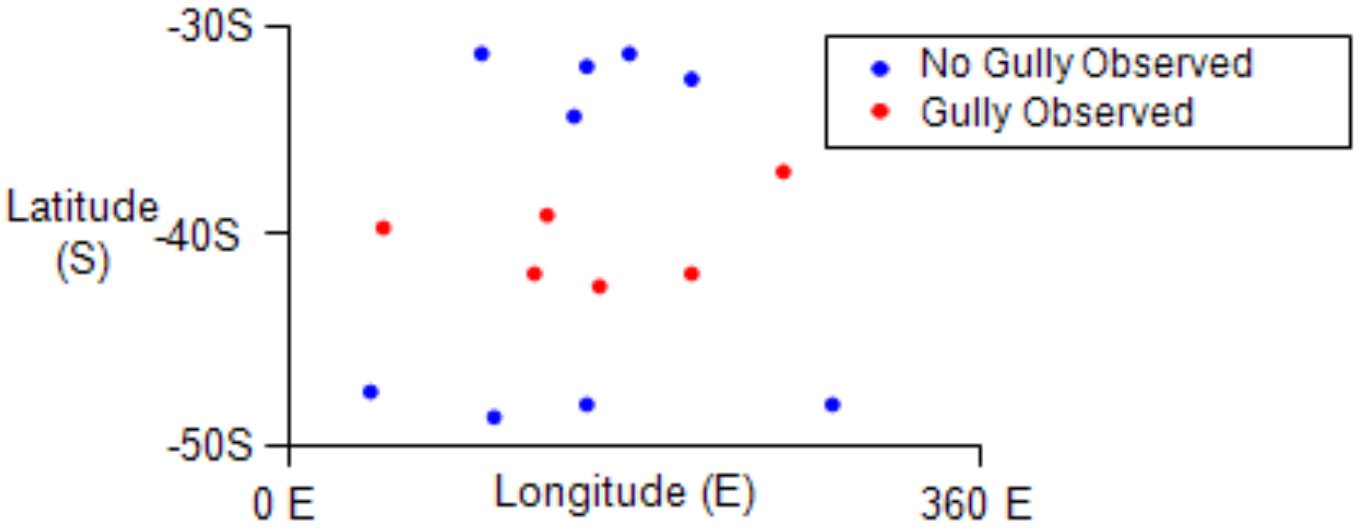
3. Number of gullies observed versus length of gully



- We want to know what the average gully length is in this area.
- Knowing more information about the gully lengths helps us to make generalizations about how old or how young the gullies are.

Analyzing the Data

We will also plot the specific crater sites observed on a latitude/ longitude map to see overall where crater gullies have the largest presence within our chosen area.



Conclusion

We have selected a specific area of the border between the Hellas Planitia and Eridania regions to evaluate against our criteria for human survival. To test our final criteria, we must evaluate if this region has a gully presence.

To see if this area meets our gully criteria, we will focus on a specific research question about this region's craters. We will try to answer the question of whether gullies are present in the craters we observe. This will allow us to confirm and support our criteria for choosing this location.

Is there evidence of gullies in craters found at the border between the Hellas Planitia and Eridania regions?

Conclusion

We hypothesize that:

- **If this region is south of the 30 degree latitude line and in an area that contains craters and similar steep sloped terrain, then we will observe evidence of gully formation.**

- **If we do not observe the presence of gullied craters, then this may indicate that the craters and landforms in this region do not have enough depth to develop gullies or that snow melt is not occurring.**

Conclusion

Completing this research is important because it will help us to decide if our chosen region on Mars meets our criteria for human survival.

We believe that human beings should have the goal of trying to go to Mars to live and explore. We need to make sure it will be safe before sending humans that far from home.

If un-melted snow and ice found near gullied craters can help us to supply astronauts with an accessible water source, then it is important that we find these areas. **This is why we are asking for permission to use the THEMIS camera.**

References

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