Westhill Mars Mission WM^2 Proposal

Introduction

Throughout the ages, man has looked to the skies for answers, and over time this fascination has developed to become a more practical notion of finding clues that might explain the Earth's past. With the dawn of the space age and the success of the Apollo missions, Mars has become the new target for exploration as the next step for man into the solar system. Through the study of Mars, it has been found that many of the features and geologic processes that take place on the surface of the planet share common aspects with those that occur on the surface of the Earth. Many of these features and processes have been well documented by the Rover Missions and the Martian Exploration Satellites that have been placed into orbit around the planet. One set of features that remain without much known about them are glacial features.

Glacial features dominate the surface of Earth, especially here in New York State. A number of glacial activities have given the planets crust its present appearance. Glaciers prominent on Earth form by the combination of water and climate, on Mars glaciers form from the presence of dry ice, water and climate. Since scientists believe both Mars and Earth are extremely similar, observing similarities will help to uncover how closely the planets are related. In our project we hope to study the relationship of glacial features on Mars to their locations (latitude and altitude). Through this we hope to gain a better idea of the conditions needed on Mars for glaciers to form and possibly how the climate has changed in the past. Our hypothesis is that we will see glacial features at high latitude and altitude, like on Earth.

Background

A glacier is a large body of ice, which persists over the face of a planet in an ice age climate where the average temperature of the Earth dramatically decreases. In Mars's case the ice does not consist of water, but instead solid

Carbon Dioxide. On Mars these vast ice caps tend to stay close to the planet's north and south poles similarly to the planet Earth. Although made of a different material, they also grow and recede regularly like those on Earth due to sight changes in the climate. Glacial formations like the Arabia Terra are found in northern terrain on Mars's surface. This surface is covered in massive ice caps containing glacial formations. Topographical features and computer models of Mars illustrate the presence of glaciers in the past.

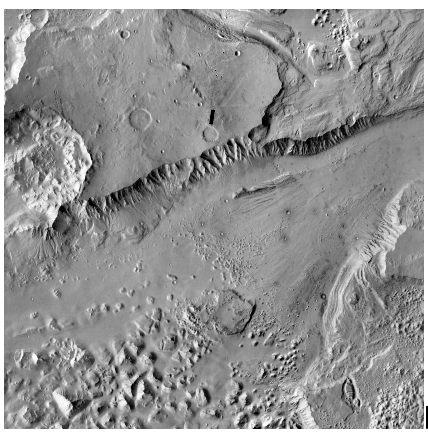
A piedmont glacier is a lobe of ice that forms from a valley glacier that extends and spreads out over adjacent lowlands. These glaciers form on Earth at the foot range of mountains at or near a valley. Piedmont glaciers are observed as generally rounded, flat glaciers. Alaska contains probably the greatest number of piedmont glaciers on Earth. Various Martian glaciers are created due to ice sheets forming from Mars's high tilting axis. Buried glaciers may have preserved fragments from a previous ice age. Debris covered piedmont glaciers exist at lower latitudes on the surface of Mars and on Olympus Mons. Scientists have discovered very few of these glaciers on Mars and research appears to have taken on a high priority. Further study would increase the scientific community's knowledge on glaciers and their effect on a planet's climate, topography or geological composition.

Glaciers produce two main types of features: erosional, and depositional. One erosional feature we see with glaciers is called a horn. A horn is a peak created by three or more cirques or arêtes. The shape looks like three walls coming together from different angles. The point where these walls meet is elevated and is known as a horn. The discovery of these features indicates that glaciers had or have been involved with eroding the planet's surfaces and glacial involvement in generating a new topography, therefore influencing the crust of the planet. So far we have not found evidence of horns on Mars.

Glacial striations are ridges and lines that were cut into rock during the movement of ice from a glacier. This process is called glacial abrasion. Sediments and rocks being carried by the moving ice cause these grooves to form in the bedrock. These marks can show in the form of channels and linear marks that are multiple, straight and/or parallel, and they also show which direction a glacier moved.   On Earth, the majority of the striations were revealed after the Little Ice Age.

A hanging valley is fabricated when the main valley erodes at a different rate than the valleys that enter along its sides. The main valley erodes more slowly than the tributary valley. The depth difference between the two valleys increases over time. The tributaries hang on the edges, far above the main valley. On Earth, streams and rivers enter by means of waterfalls.

Eos, on Mars, may be a hanging valley, but no one knows for sure. It may even have been caused by floodwater that gushed across the surface of Mars, eroding areas unequally. Eos is a mesa, giant-sized and olivine-rich, with sections eroded away. A wide river is cut into the top. It is similar to Niagara River above Niagara Falls. Eos is 2, 500 meters tall compared to Niagara Falls, which is only 50 meters. Unlike most waterfalls on Earth, Eos has no plunge pools, undercut cap rock, or debris piles. However, it does have an alluvial fan on the west side, making it more likely that water was the cause of the formation of Eos.

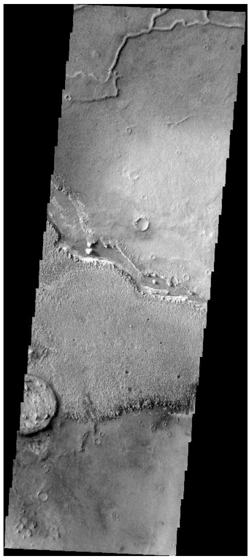

Hanging Valley

http://themis.asu.edu/files/features/054_eos_chasma/054eoschasma.png

Eskers are glacial deposits found where a glacier once existed on Earth It comes from the Irish Gaelic word eiscir meaning ridge of gravel. The glacier receded when the temperature of the Earth increased. They are encountered in the regions where these glaciers once existed thousands of years ago. The glacial features appear like winding hills over the surface of the Earth. Eskers were created when melt water flowed though cracks in the glacier like small streams. These streams often occur underneath the glacier. As the melt water flows it deposits sediments along the way, which were captured inside the frozen glacier. The melt water moves from areas of high pressure to those of low pressure. These sediments build up over time as the glacier recedes due to the increase of temperature. Small winding ridges of sediments are left leaving a unique topography; with steep sides ranging from 25 to 30 degrees. Eskers are often very strong due to the sorting of their sediments as deposited. The gaps in the eskers are most likely from modern stream erosion; however, some could have developed while the Esker was being created. In these instances the water flowed at a faster velocity, causing less sediments to be deposited. The sediments are a mix of silt and clay, usually fine sediments all mixed together. Prominent eskers can be found in North Dakota and New York State. Most of the time eskers are found to flow perpendicular to the glacier. The direction in which the melt water ran can be determined by the topography around the esker, which can suggest the probable glacial margin.

Temperature and water on Mars has been key to helping NASA scientists understand the truth about Mar’s current and past climate. Many experiments are currently being run on Earth in order to gain more knowledge about eskers in order to compare it to these glacial features on Mars. Their sediment deposits are unique and their freshwater flows are similar to Mars's topography in the past and can help uncover how water could have once functioned on the surface of the planet. Some scientists are looking at microbes encountered in the eskers on Earth in hopes that Mars's eskers will have similar characteristics, which could lead to the discovery of microbes. However, the esker structure on Earth must be understood first.

Specific studies on the sorted layers can relate to the past and present topography on Mars and since the water cannot last today on Mars' surface, the past will hold the answers to the water on Mars. If eskers can provide information on Mars's water and glacial past, then they could answer the question about life on the planet. Eskers on Mars were discovered at the Waterville Plateau and on the floor of Argyre Basin.



V12569008 Eskers

Drumlins are deposited when ice sheet glaciers glide across rock debris or till and ground moraine, which generally is encountered in lowland regions. These drumlins are roughly parallel to the path in which the glacier is flowing. The side in which the glacier is moving away from is always high and steep. Here in New York State the side of the drumlin generally faces north. The lee side tends to be smooth and have a gradual decrease in elevation.

The size of drumlins can vary dramatically in size, from only 1 to 2 km and heights of 15 to 30 meters. Widths can also vary between different drumlins, due to their uniqueness, from 400 to 600 meters. Interestingly, they are commonly found in clusters in the thousands in a belt shaped arrangement. They often cause difficulty in drainage in the surroundings causing small lakes and swamps to form between them.

Moraines are often described as unconsolidated sediments, which were deposited by moving glaciers. They have a distinct difference from tills, which form at the melting end of a glacier known as terminal moraines.

Each moraine marks the former position of an ice margin, where it could be located for a few decades. In some instances, the moraines can mark the end of a major glacial re-advance, where the retreating ice advanced farther ahead, pushing material in front of the glacier and forming the moraine. At times it may also symbolize the location in which the advance of a glacier paused for an extended amount of time. The most probable explanation for this is the rate of advance of the ice internally equaled the rate at which melting occurred. Many time the sediments are unsorted and often angular, they may however, contain rock picked up from moving glaciers.

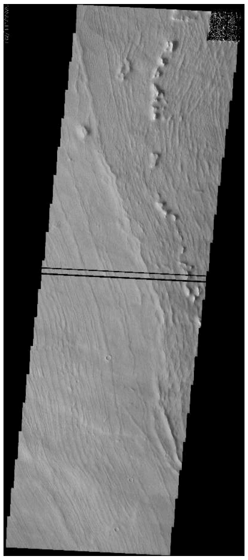
As a glacier moves over a river valley, the depression will immediately become a collection point for gravel and some boulders, which have traveled hundreds of miles. It is this process, which gives the Earth the underground gravel beds which it has today. Interestingly, they can become valuable aquifers.

Annual ice advances create push moraines in a similar manner as terminal moraines. They can be encountered on top of older moraines especially in cases when the summer retreat is small and the winter advance is larger than it usually is annually.

Lateral moraines are frequently associated with mountain glaciers due to the fact that they are formed along the edge or side of a glacier as it progresses down a mountain valley. Erosion debris along the valley walls is carried along with the ice. When the glacier begins to melt, the debris is deposited part of the way up the valley's slope.

Terminal moraines are prominent in the arctic. One famous terminal moraine is the Giant's Wall in Norway. It is known in today's society that terminal moraines are created during a glacier's greatest advance forward. The debris that has been pushed by the front edge of the ice can be driven no farther and is left in a pile. Because the glacier acts very much like a conveyer belt, the longer it stays in one place, the larger the amount of material deposited. The moraine is left as the marking point of the terminal extent of the ice.

Drop moraines are found on the Arsia Mons tropical mountain glacier on Mars. Superposed drop moraines formed due to a cold-based glacier receding and dropping sediments or soil that were on top of it at about 70 degrees north latitude.



V07258002 Moraines

When a glacier moves across the ground, it acts as a huge bulldozer pushing massive amounts of dirt with it. When the glacier melts, it may leave behind a depression in the land. On Earth, it is possible for these depressions to fill with water and form a lake. The Great Lakes are a result of glaciations. One type of common glacial depression found on Earth is a kettle. A glacial kettle is formed when a large chunk of ice breaks off of the main glacier and is buried in a layer of till. When the climate warms the ice chunk will melt and leave behind a “kettle” shaped depression. On Earth, kettles are found throughout Canada, Minnesota, and the Tully region of New York State. On Mars, these depressions are hard to recognize due to layers of dust that cover these glacial features. These features on Mars are also difficult to identify because they are easily confused with the dunes found on the surface of the planet. One possible site of kettle depressions on Mars is Moreux Crater (44°E, 42°N), which is found in the mid-latitudes. These ice chunks are the basin for a small body of water. Water has the unbelievable ability to alter geology, especially with sedimentary rocks, deposition and erosion as occurring on Earth. Water features on Mar’s planet could have formed when these ice masses changed states from solids to liquids.

Experiment Design

For our research, we will be using pictures taken by the THEMIS (Thermal Emission Imaging System) camera aboard the Mars Odyssey satellite. We will be focusing on glacier features that have occurred on Mars. We will be focusing on the mid-altitude region of Mars to complete our research and analysis. We will be using the Mars Odyssey THEMIS photo database located at: http://themis.asu.edu/ to retrieve photos and thus complete our research. It is unknown as of right now as to how many pictures we require to answer this question; however, we do know that we need multiple pictures with select glacial features in order to achieve a solution.

In order for us to make the measurements that are included in the data table located below, we will use a program known as Gimp (http://www.gimp.org/) to measure select regions. Also, we will use Google Docs (http://docs.google.com/) to record our data (see data table below) and we will be using Google Earth (http://www.google.com/earth/) to “pinpoint” exact coordinates of features located on Mars to correlate with each other’s observations.

MARS DATA	v.0.2 2/28/11						
DATE	PHOTO ID	DATE TAKEN	TYPE OF FEATURE	LATITUDE	LONGITUDE	ALTITUDE	KEY INFORMATION

Figure 1

Description of how you plan to analyze and present your results

Once data has been collected from the images, we will plot the location of the glacial features on a MOLA map of Mars to see if there is a relationship between the latitude and altitude of the features. In addition we will plot a line graph showing the number of glacial features vs. the latitude and the number of glacial features vs. the altitude. Patterns of glaciers on Mars will be noted for elevation and more importantly latitude and how they affect the topography of the regions in which these glacial features exist. These will then be compared to the same feature on Earth.

The Westhill Mars Student Imaging Project plans on presenting the results through a combination of data tables, graphs, maps, and annotated images. Our data tables will go into detailed analysis of images studied due to their relation to glacial features; in short it will contain information ranging from the date of the photos to the latitude and longitudes of the images. At Arizona State University the team will put together graphs that will summarize our collected data showing general trends between latitude, number of features, and the general effects the features have had on the topography. Through further analysis and study the results will be presented to Arizona State University using a combination of maps and annotated images of the Mars features chosen to assist in the glacial features studies

Conclusion

In deciding on a project we chose to look at glacial features because in New York State we are surrounded by a landscape that has been heavily influenced by glaciation. Our goal, throughout this assignment, is to discover and learn more about a little understood process of glaciation on Mars. Using THEMIS images we hope to show that there is a pattern of glacial distribution on Mars similar to that on Earth.

We believe that we can eliminate the unknown details of Mars one step at a time and hopefully, discover something that no one has discovered before. Westhill Mars Mission strives to use the resources allotted to us by the MSIP program to determine whether patterns of glaciers on Earth occur on Mars as well.

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