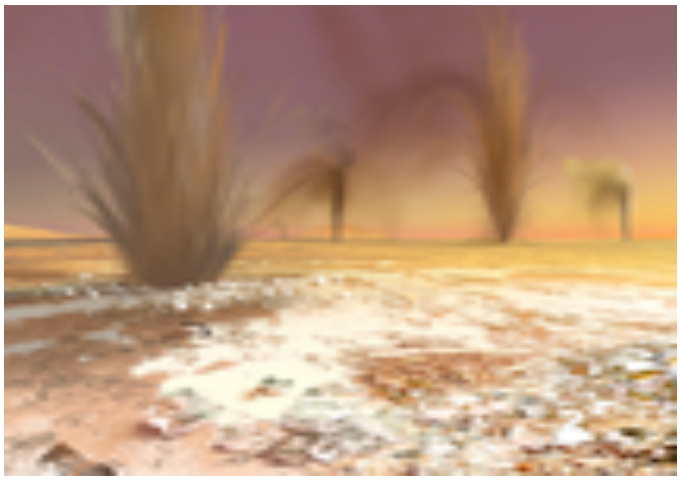
MSIP Final Report



Chabad Hebrew Academy Science Seminar Class

Introduction:

1. Updated scientific question:
   Will Sand Geysers erupt in the same region and same time in different years?

2. Why is this important?
   Sand Geysers do not occur on Earth, and knowing more about them will help to determine more about conditions on Mars.

3. What is your hypothesis?
   Our hypothesis is that the sand geysers erupt in the same general area over the same period of time.

II. Background:

What research has been done related to this question?

We found that frozen carbon dioxide begins to warm in the spring which causes it to sublimate at the surface after the frost goes away. The temperature at the surface of the dark spots is as cold as the rest of the surface of dry ice, therefore scientists think that the spots could not be exposed bare sand. Instead, they think that the frozen dry ice is clear, like glass, and the sun's energy heats the dark sand beneath the ice. This causes the dry ice to sublimate which creates a layer of gas underneath the ice. As more gas is produced, pressure builds up and eventually the gas pushes its way through weak spots causing huge eruptions of the gas. The gas carries the dark sand and dust with it as it erupts, which covers the surface of the dry ice with the ejected material. This material makes the dark spots and dust trails visible from space. When this happens, they think that the warmer gas moves under the ice, making visible spidery channels. This might allow for eruptions to occur in the same place more than once.

- Not all scientists agree with this theory. French scientists from the Institut d'Astrophysique Spatiale in Orsay, France do not think that the right conditions needed for the geysers to form

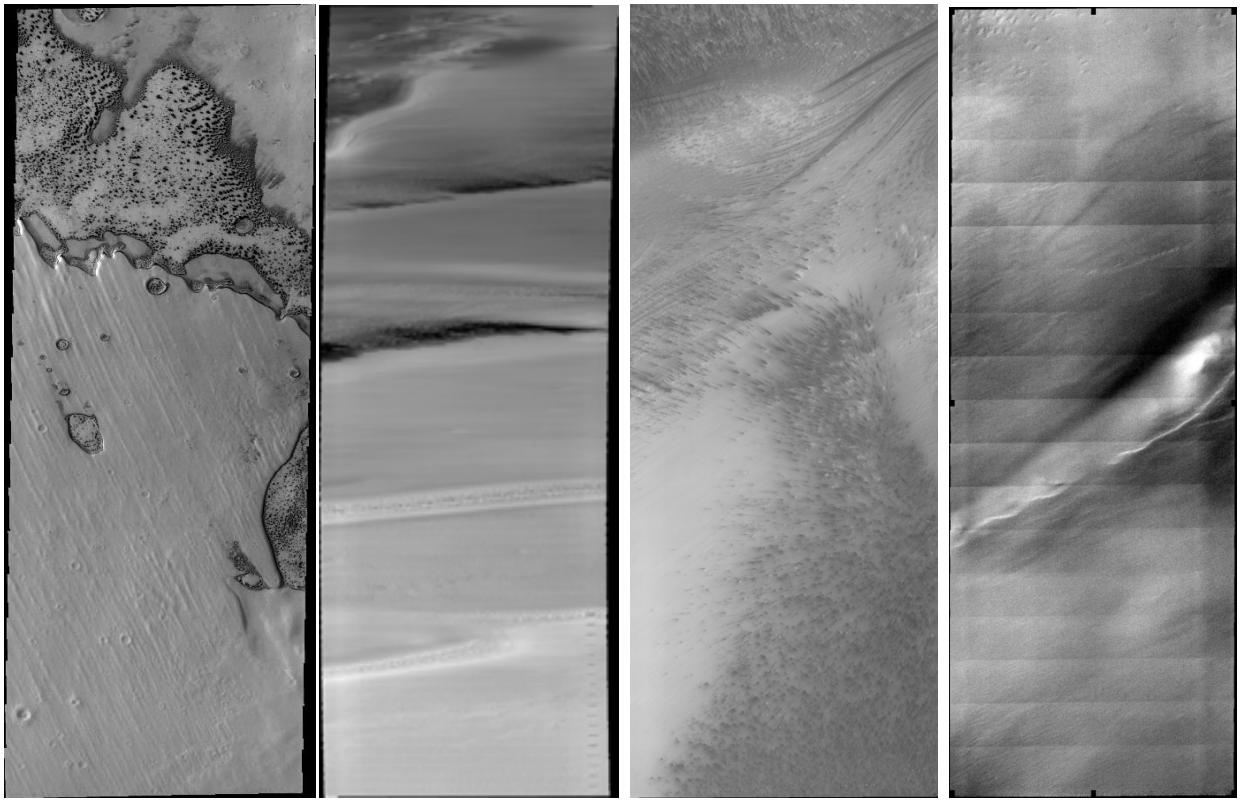
are where the black spots are located. They say that where the dark spots occur, the instruments that measure the ice indicate that it is weak. Thick, clear slabs of frozen $Co_{2,}$ however, do not give off weak ice readings. ASU scientists argue that the collected dust and debris on top of the ice could be the reason for the weak CO_2 ice signal.

These geysers appear to occur with more frequency as spring advances, but visibility gets more difficult as global sand storms cover the area.

Definitions:

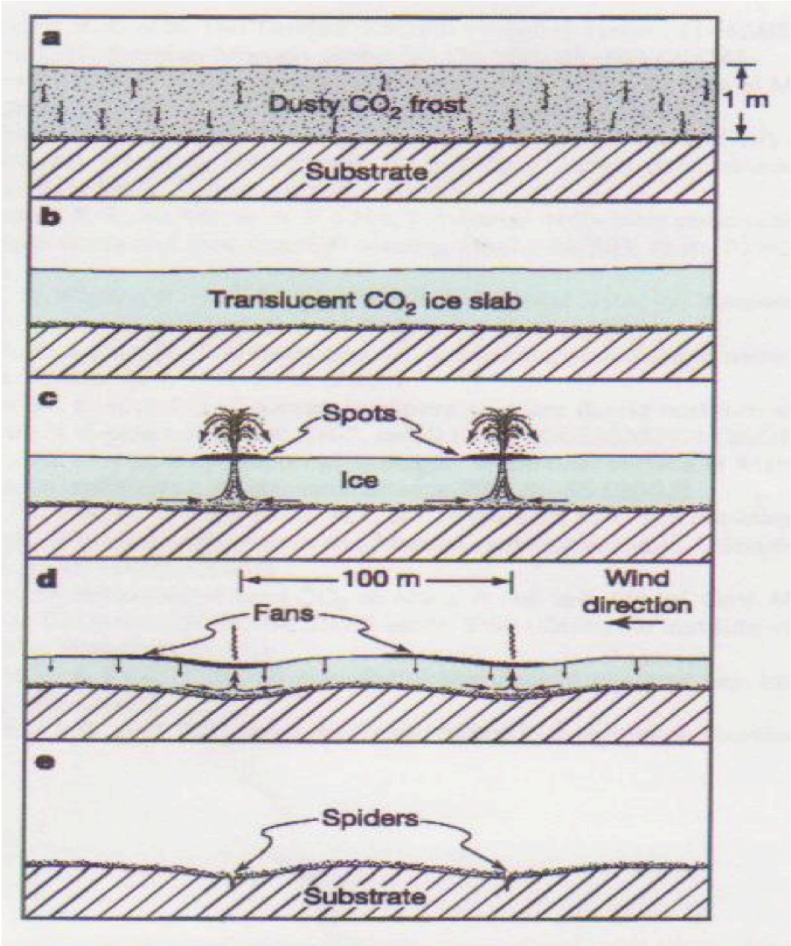
- Sand Geyser- A geyser made of sand and gas that is caused by pressure build-up on the South Pole of Mars. The gas as it pushes up carries the sand or dust making it look like a visible geyser. Without the dust the geyser would be invisible.
- Gas- The gas in the eruption is carbon dioxide.
- Polar Ice (on Mars)- The southern pole of Mars has ice composed mainly of frozen carbon dioxide
- Sublimate- To skip a level in form. Dry ice turns from solid to gas, not solid to liquid and then to gas.

Background Features:



The three forms of eruption we identified are pre-eruption (pictures 1 & 2); eruption (picture 3); and erosion; picture 4. We decided that a pre-eruption image could have no visible streaks. An eruption image must have black streaks streaming from the dark spots. The erosion images should have blurry or fuzzy gray areas with no well defined streaks.

Formation of the Geysers:



On Mars the geysers form by CO_2 ice clearing because the frost is evaporating, sunlight reaching the dark dirt below, and carbon dioxide gas forming beneath the ice layer, finally bursting through the surface along with the dirt. This kind of geysers is not found on Earth. By learning more about these geysers we can learn more about Mars.

What questions remained unanswered by previous studies?

The actual cause of the geysers is still being debated. More importantly, we don't know if there is a pattern to the eruptions, or if they erupt in the same place more than once.

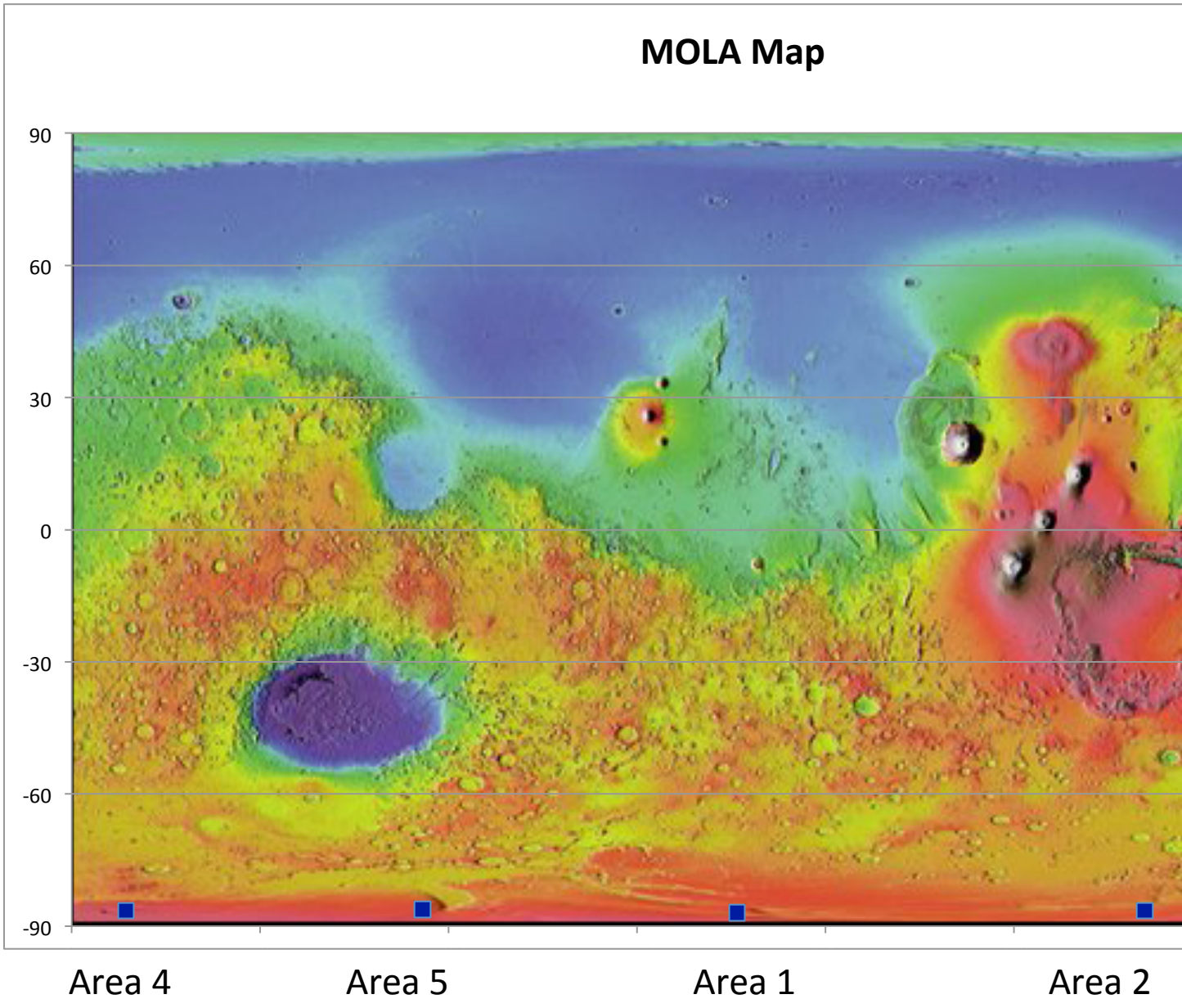
How does your project relate to or build upon these past studies?

Targeting several areas with known geysers would allow for analyzing forms eruptions and their solar longitude. This could help us to determine if there are patterns to the times of the eruptions.

Experiment Description / Methods and Materials

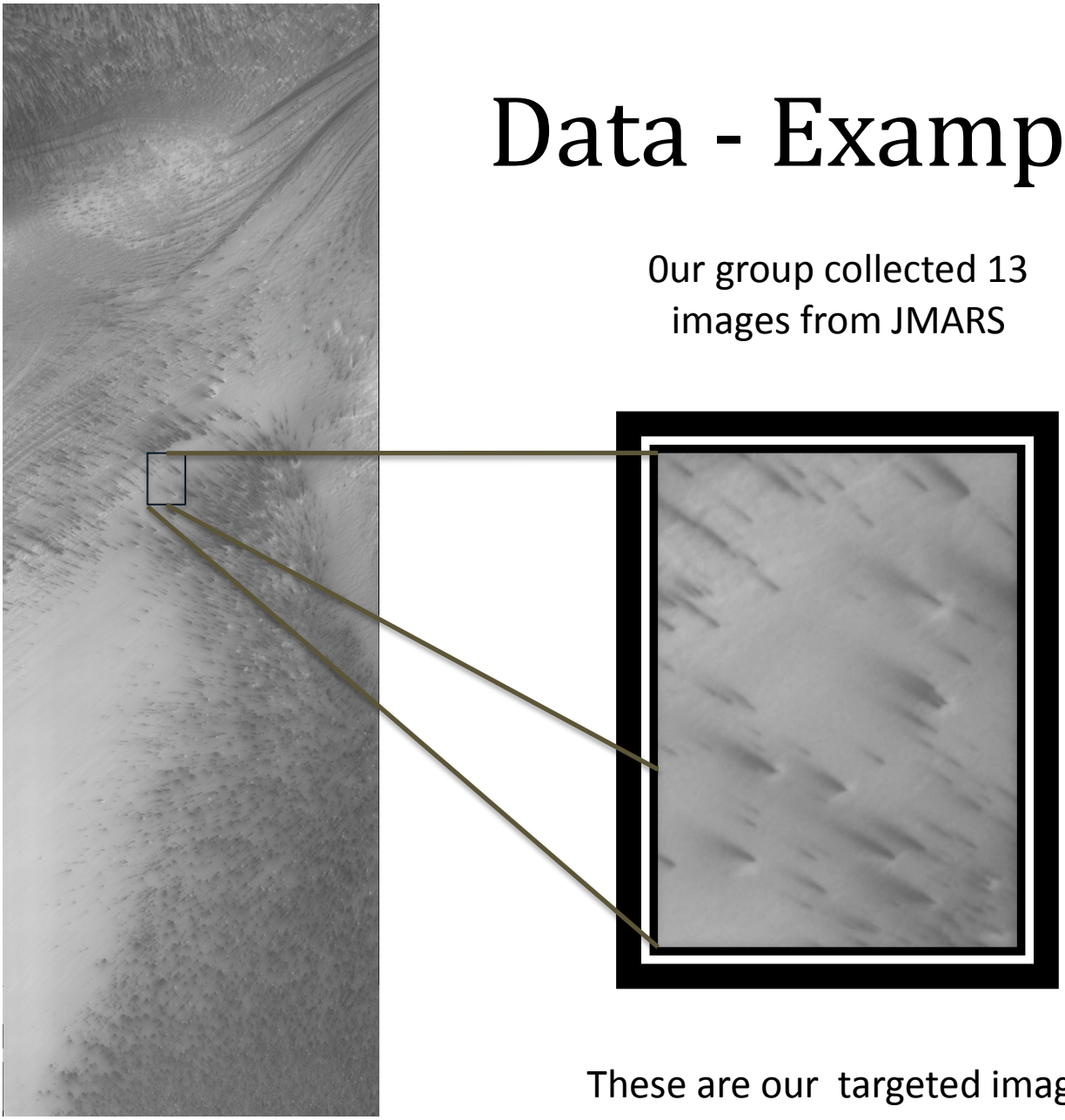
- We used the THEMIS camera aboard the Mars Oddysey to take the images. We used the program JMARS to download and view the images and collect data. We looked specifically for images that had been taken from 5 regions in the south polar region that have similar latitudes and longitudes. Using the internet, we accessed JMARS images from these regions that were dated between Mars 211 and 240 solar latitude over the period of Mars years 25-30. We then analyzed those images to determine the state of eruption - Pre-eruption[1] , Eruption[2], Erosion[3]

Below is the MOLA map indicating the 5 regions we studied.



What is the latitude and longitude of your image?

Data - Examples



0ur group collected 13 images from JMARS

These are our targeted images

Lat: -86.25763

Lon: 92.99186

Why did you choose this particular site?

It is an area known to have many geysers in the past. We also chose to use this site because 2 images can be taken in a close proximity of time to each other on a north-south, and then on a south-north approach. This will allow us to compare changes in the same area over a short period of time.

How did you use this image to answer your question? These images added to our data and gave evidence of erupting geysers. We compared these images to others of the same area in similar solar longitude over 5 Mars years.

What did you use as your control, and how did you use it?

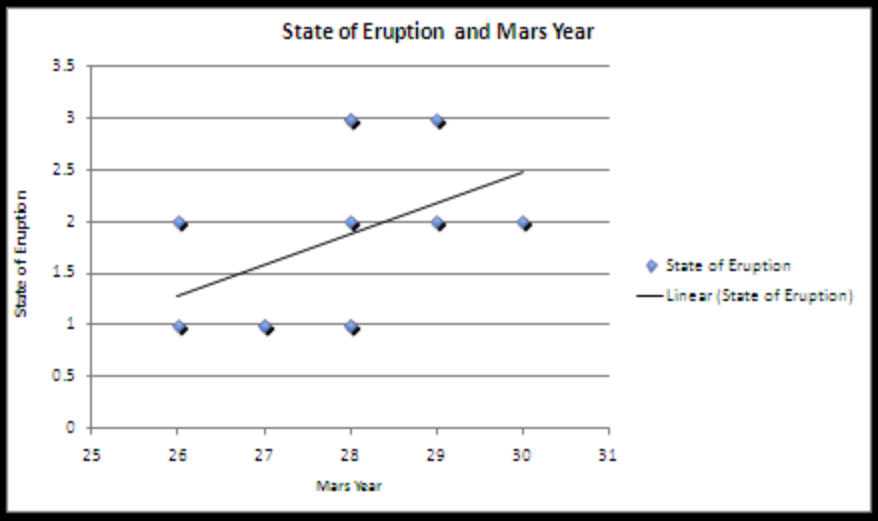
Previous images in the same area in a similar solar longitude will be the control, the new images will be compared them for states of eruption.

Data:

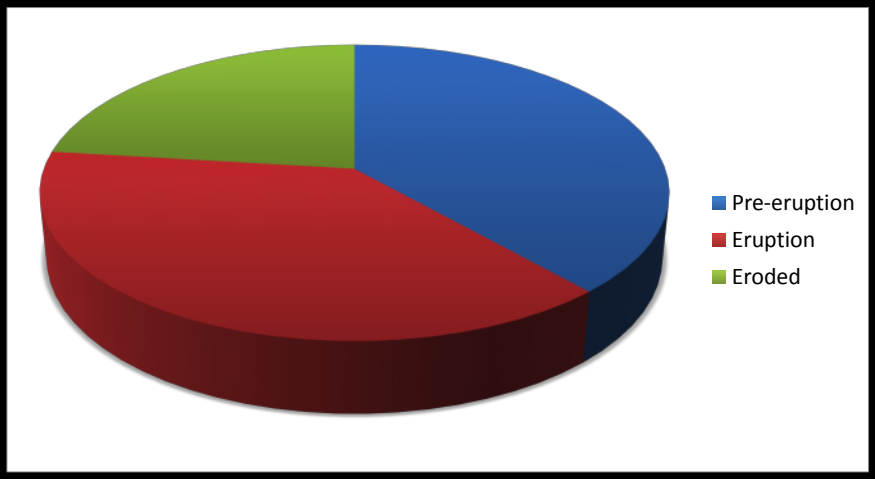
Area 5 Data Table

Image ID #	Longitude (E)	Latitude (N)	Solar Longitude	Mars Year	Pre-eruption	Eruption	Er Eru
V23304017	93E	-86	201.69589	28	No	No	Yes
V31689007	93E	-86	203.12244	29	No	No	Yes

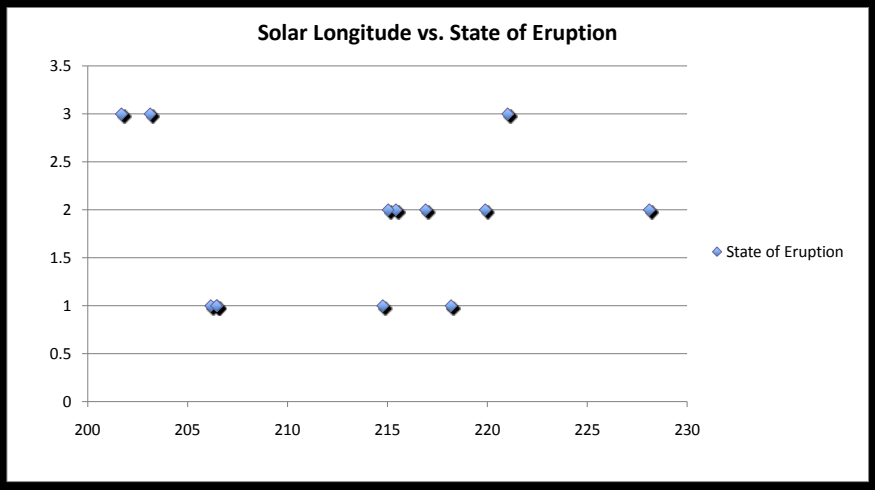
State of Eruption and Mars Year



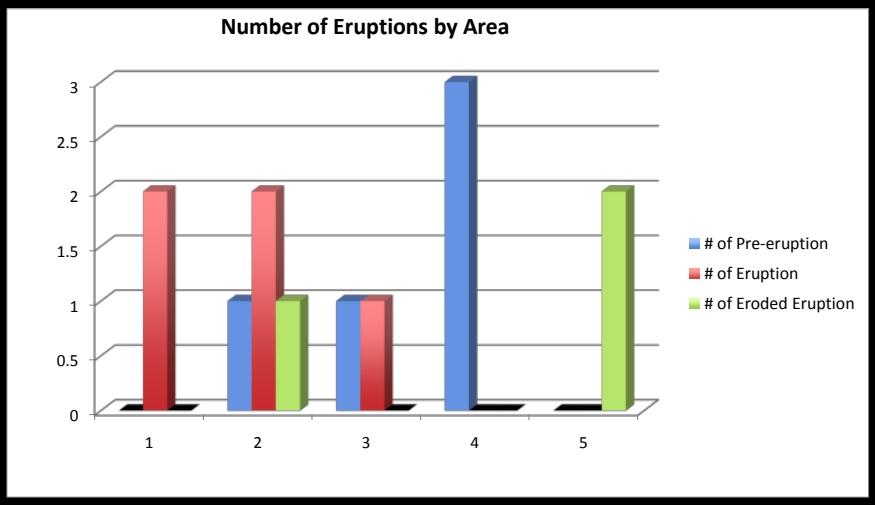
Pie Chart of Pre-eruption, Eruption & Eroded Eruption



Solar Longitude vs. State of Eruption



Number of Eruptions by Area



Results

- The JMARS filter was not working well, and solar longitude seemed to be popping up with different dates than the ones we selected. We ended up with a few images with incorrect solar longitude
- Lack of time kept us from finding more images that would help answer our question.
- Many of the images were close, but not the same exact location as previous ones, so it was difficult to analyze accurately.
- More data would have helped to formulate a better picture of the eruptions over time.

Conclusion

Our hypothesis was that the sand geysers would erupt in the same regions and at the same time in different years? We determined from our data that the geysers don't always erupt at the same time in the same location each year. With the data we were able to collect, it appeared that there might be a slight trend showing that the geysers are erupting a little bit earlier each Mars year. This does not support our hypothesis. It also leads to asking more questions. We would like to examine more images to determine if there is more evidence to show a trend toward earlier eruptions. We then discussed that if the geysers are, in fact, erupting earlier each year, this might mean that Mars is warming, or that Mars atmosphere is thinning because it is being stripped away by solar wind. It might mean that Mars elliptical orbit causes temperatures to vary from season to season throughout the Martian year. It might indicate a slight variation in Mars orbit. A trend toward earlier eruptions could mean that either the CO_2 ice or the dark sand layer is thinning out and therefore heating differently. We hypothesized that perhaps the light and dark substances are due to varying thicknesses of the ice and therefore appear to be different substances.

We asked new questions for future research about how the identification of both the white and dark substances is determined. More research and equipment would help to better determine the composition of the substances. It still needs to be determined whether the spidery tunnels are weak areas that reoccur in the same places each year. Also, it appears that the sand is being more and more spread out with each eruption, and if the ice does not sublimate completely, would this thin out the dark spots? This led to asking if the CO_2 ice actually does sublimate completely each season, thus allowing the spewed sand to fall back into the original dark area. Finally we wondered if any of these things could cause the geysers to eventually stop erupting. With more time more data, and more resources, we might be better able to determine the answers to these questions as well as our original question.

Acknowledgements:

We appreciate the generous help from Jonathan Hill, Jessica Swann, Mike Vito, Mrs. Sniffen, Mr. Schuyler, and all the parents who took their time and money to be here today.

References

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