A Study of the Relative Ages of Olympus Mons, Uranius Tholus, Euripus Mons, and Hecates Tholus

Supai Middle School

7th Grade Science Investigations Class

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Introduction & Hypotheses

Science Question: What is the difference in the relative ages of Olympus Mons, Uranius Tholus, Euripus Mons, and Hecates Tholus and their respective cones, calderas, and flanks?

Our science question is important because, by finding an answer, we will be able to piece together some of the history of the formation of Martian landscape, which could help us understand if there is a cycle in the formation of volcanoes over time, and if this would also apply to Earth, as well as Mars.

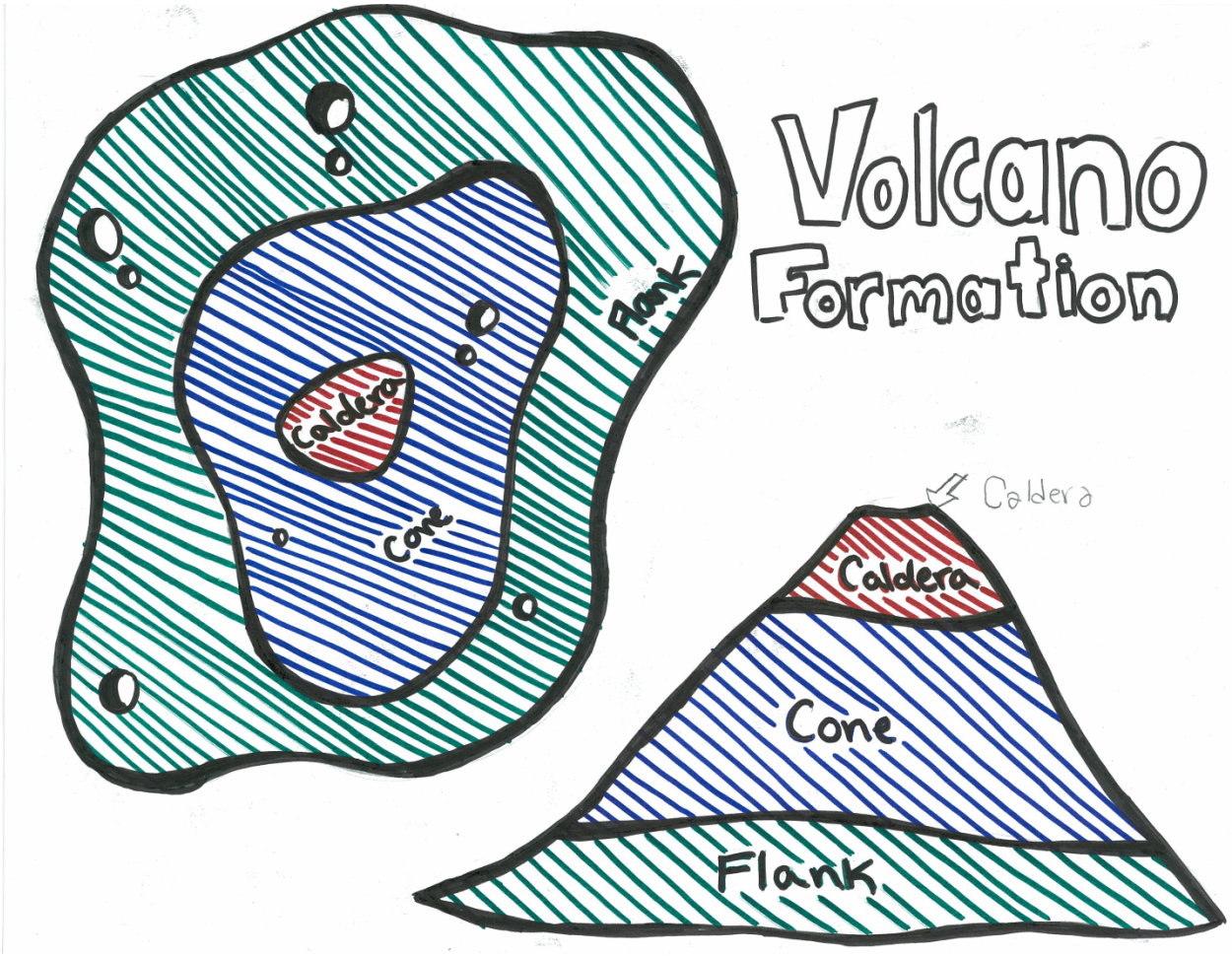
This query intrigues us, because its answer will allow us to gain further knowledge of Mars and its geological properties, which will possibly aid further studies into this topic, or pertaining to, these four volcanoes.

From previous research, we hypothesize that Uranius Tholus is the oldest volcano. Also, based on the amount of craters that we have found on its surface, we believe that Olympus Mons is the youngest.

Background

First, we will state all what we learned while we were collecting data for our experimental design.

We learned that a volcano is a formation made of the planet's crust which contains lava and releases out of a caldera (the top part of the volcano). The lava then flows down the cone, or the rising part between the caldera and flank. The flank would be the outer most rim where lava stopped flowing. Magma is lava that has yet to reach a planets surface and is in the mantle.



All around the volcanoes are impact craters. They are all holes in the ground created when a meteor or flying debris impacts the planet's crust.

All our information was gathered around Olympus Mons, Euripus Mons, Hecates Tholus, and Uranius Tholus. All these volcanoes were found on high elevations on the MOLA map. Three volcanoes were found in the Northern Hemisphere, while the only volcano in the Southern Hemisphere was Euripus Mons.

Scientists believe that Mons volcanoes, such as Olympus Mons and Euripus Mons, are shield volcanoes because of their broad, flat, gentle slope. Most of the slope is formed when the lava runs down over it and withers away part of the surface. Many scientific studies show that Mons are believed to have a low silica percentage indicating that the flow of the lava is smooth. Scientists also believe that Mons are the youngest, most active volcanoes on the planet when compared to other volcanoes on the planet.

Scientists can concur that Tholus volcanoes, such as Uranius Tholus and Hecates Tholus, are composite volcanoes because of their cone-shaped mountains. The volcano is built up by

the accumulation of material erupted through the conduit and increases in size as lava is added to its slopes. Tholus volcanoes are believed to have a high silica percentage that indicates that there are many violent eruptions.

Feature Formation on Earth and Mars

We believe that volcanoes on Earth and Mars were formed very similarly, by gas, magma, and lava that rises to the planets' crust in a specific area. A Tholus volcano on Earth forms around plate boundaries, but since Mars has no plates they form in random locations. A Mons volcano on Earth and Mars form in the same way, which is through weak spots in the crust. The Hawaiian Islands are examples of Mons volcanoes on Earth, and Mt. St. Helens, Mt. Shasta, and Crater Lake on Earth are examples of Tholus volcanoe.

Methods

The main features of our project were volcanoes and impact craters. We studied the flanks, cones, and calderas of Olympus Mons, Euripus Mons, Uranius Tholus, and Hecates Tholus. We defined the edge of the flank being the area where the lava flowed farthest away from the volcano. The cone was the actual volcano itself between the flank and the caldera. The caldera was the part of the volcano where eruptions occur. We also examined the impact craters on the surface of each volcano and their parts. We didn't classify any of the craters we found (preserved, modified, or destroyed) because we figured that the information was irrelevant for our project.

We collected data on the location of impact craters on each volcano using data collected with a computer program designed by Jonathan Hill. Other tools that we used involved the use of J-Mars, Day over Night IR images, and using the shape layer tool of J-Mars.

We used these tools to define the shapes of each volcano and the cone, caldera, and flanks of each volcano. To define the impact craters we used a 512 zoom level. We used these tools to determine the number of impact craters on each volcano.

From our data we then calculated the number of impact craters on each volcano, the flank, cone, and caldera. This data was then put in tables and graphs. In addition, we created maps of each volcano showing the impact craters in the caldera, cone, and flank.

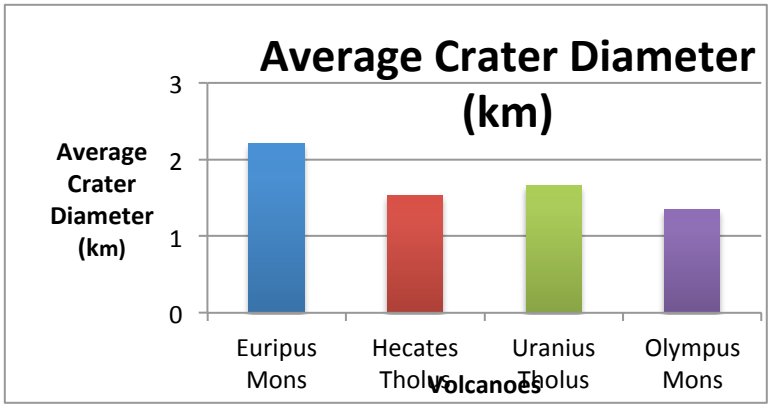
Data

Areas of Calderas, Flanks and Cones

Volcano	Caldera (km^2)	Cone (km^2)	Flank (km^2)
Uranius Tholus	347.673	2418.99	6488.7
Hecates Tholus	71.58	24586.22	2095.05
Olympus Mons	4095.44	227953.88	1749513.95
Euripus Mons	0	1556.46	3187.62

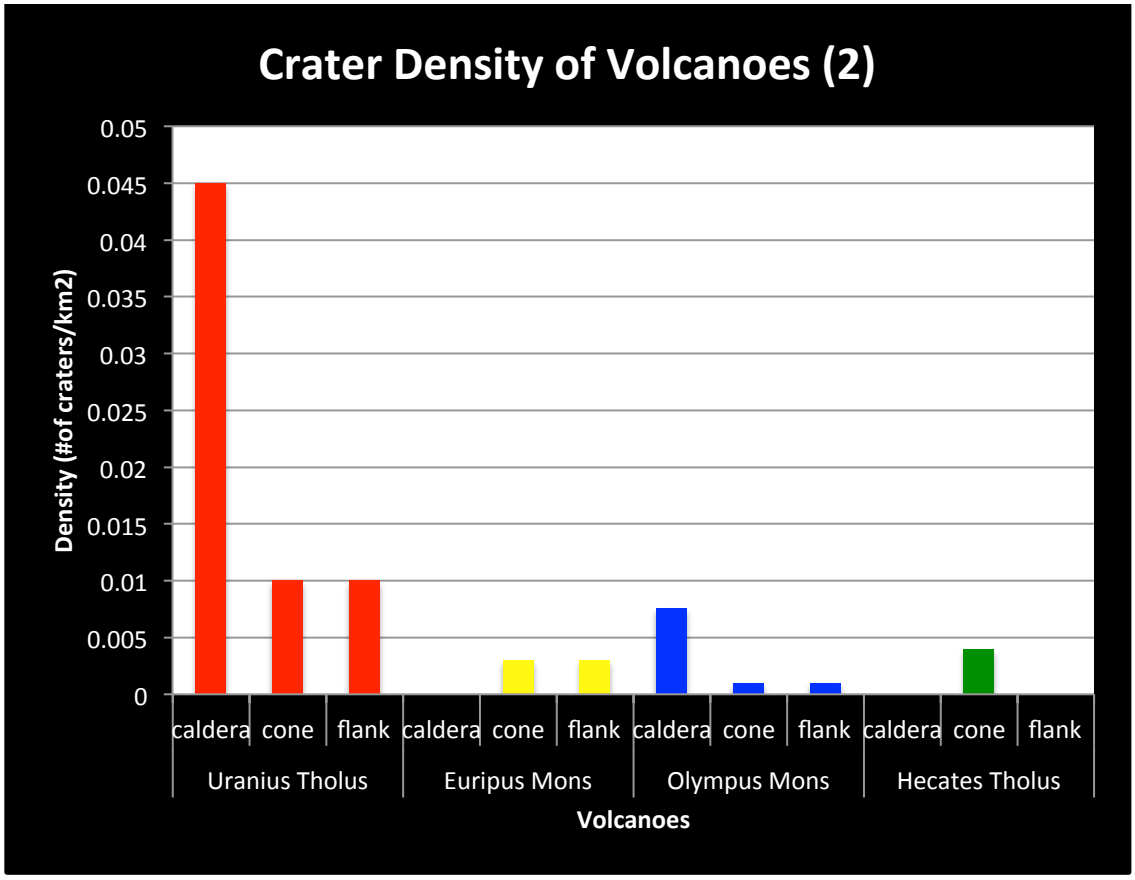
Average Crater Diameter

Volcano	Average Crater Diameter (km)
Euripus Mons	2.21
Hecates Tholus	1.53
Uranius Tholus	1.66
Olympus Mons	1.35

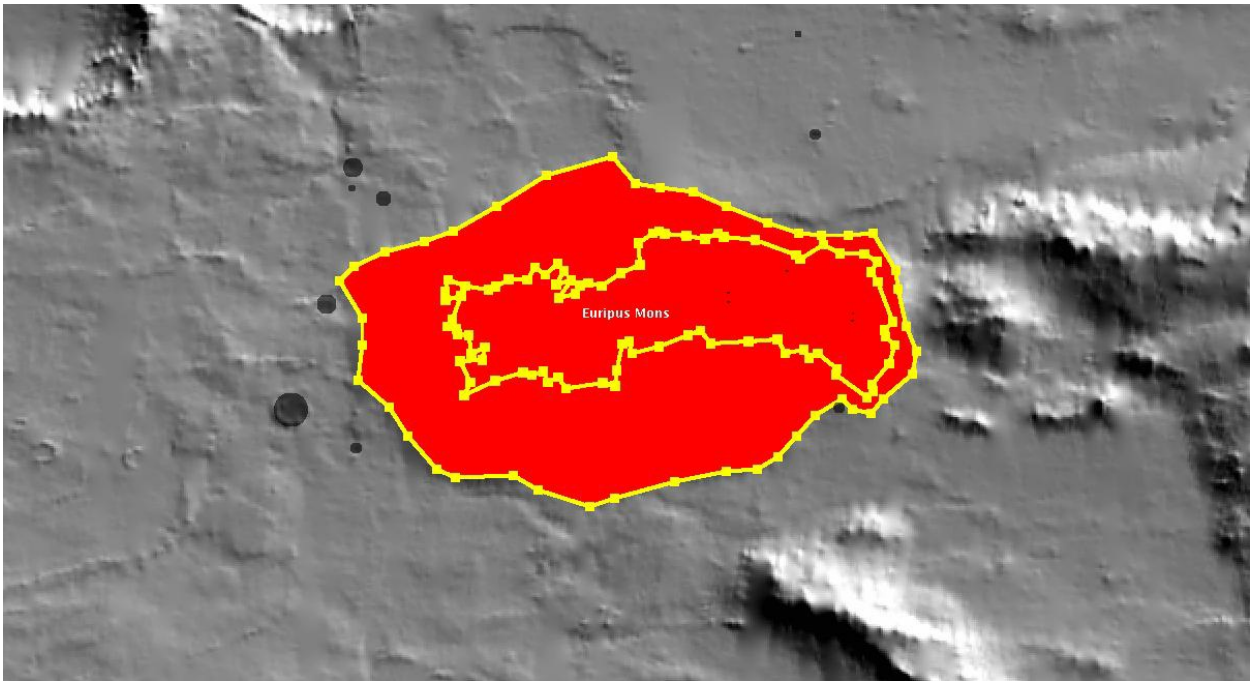


Density of Impact Craters

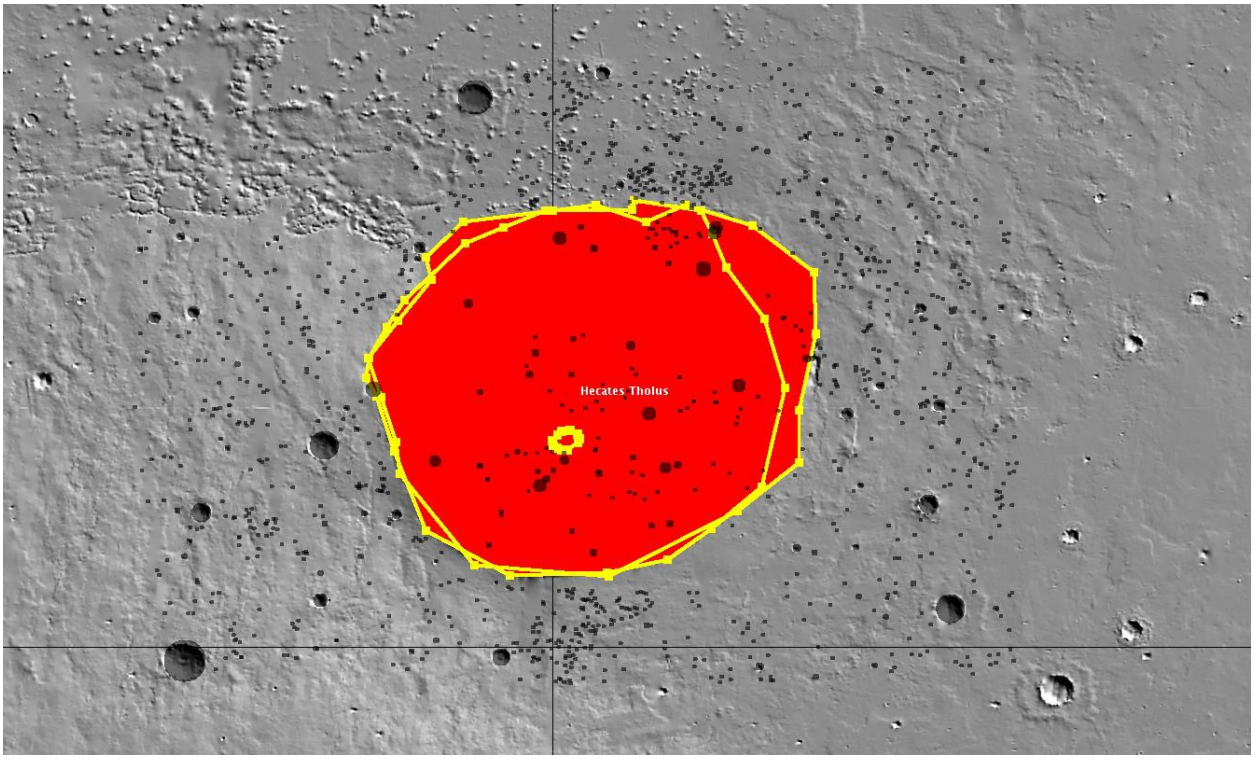
Volcano	Region	Density (#of craters/km2)
Uranius Tholus	caldera	0.045
	cone	0.01
	flank	0.01
Euripus Mons	caldera	0
	cone	0.003
	flank	0.003
Olympus Mons	caldera	0.0076
	cone	0.001
	flank	0.001
Hecates Tholus	caldera	0
	cone	0.004
	flank	0



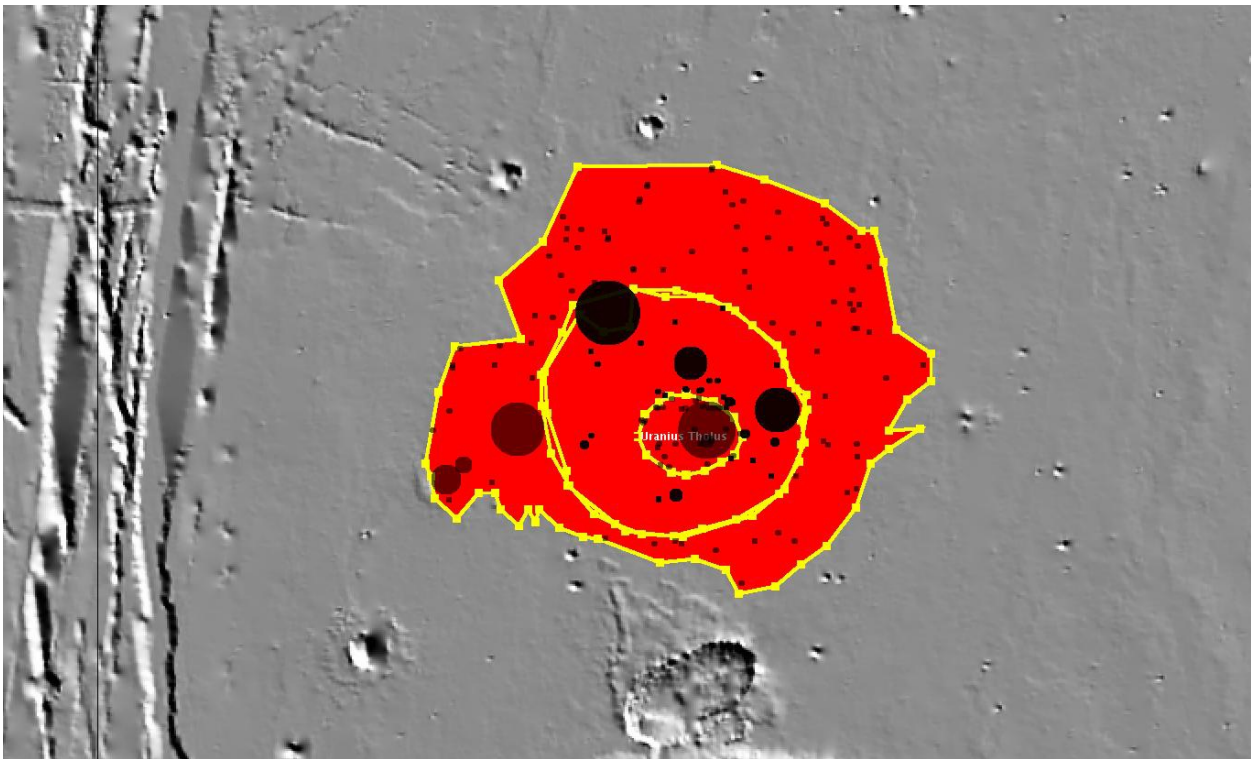
Euripus Mons Impact Craters



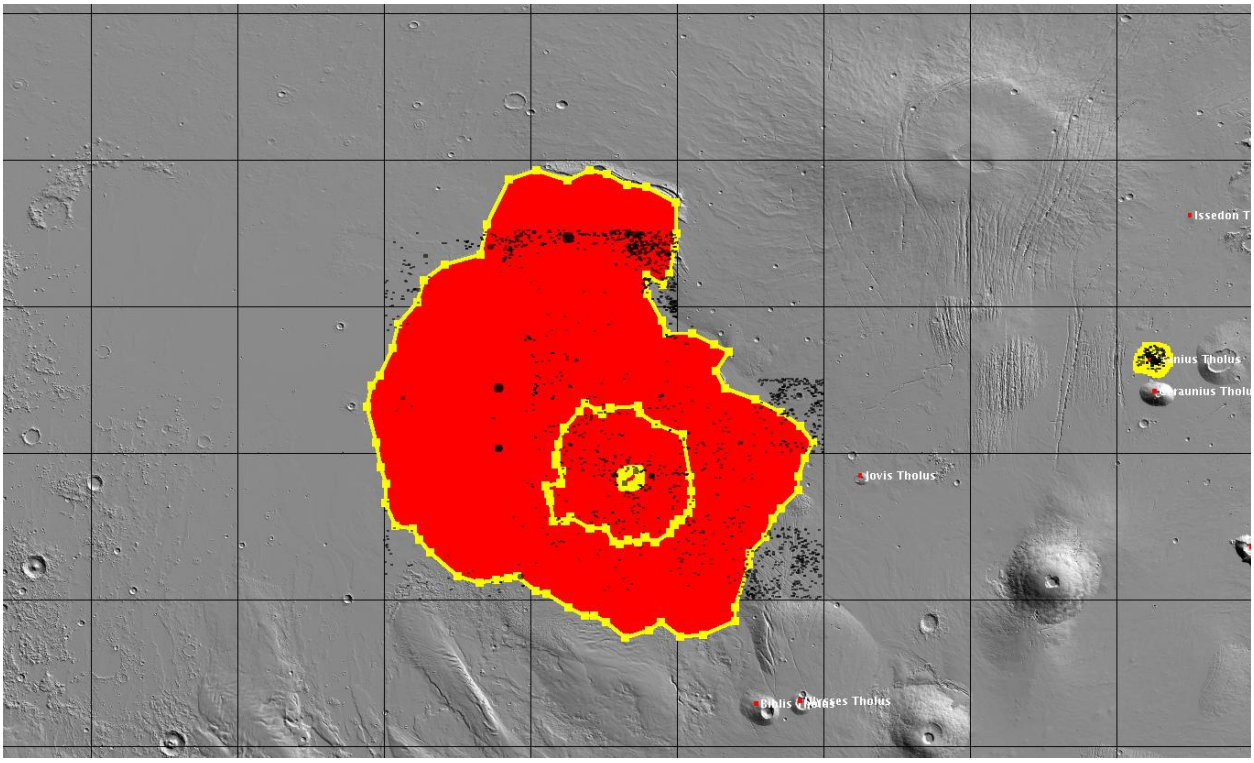
Hecates Tholus Impact Craters



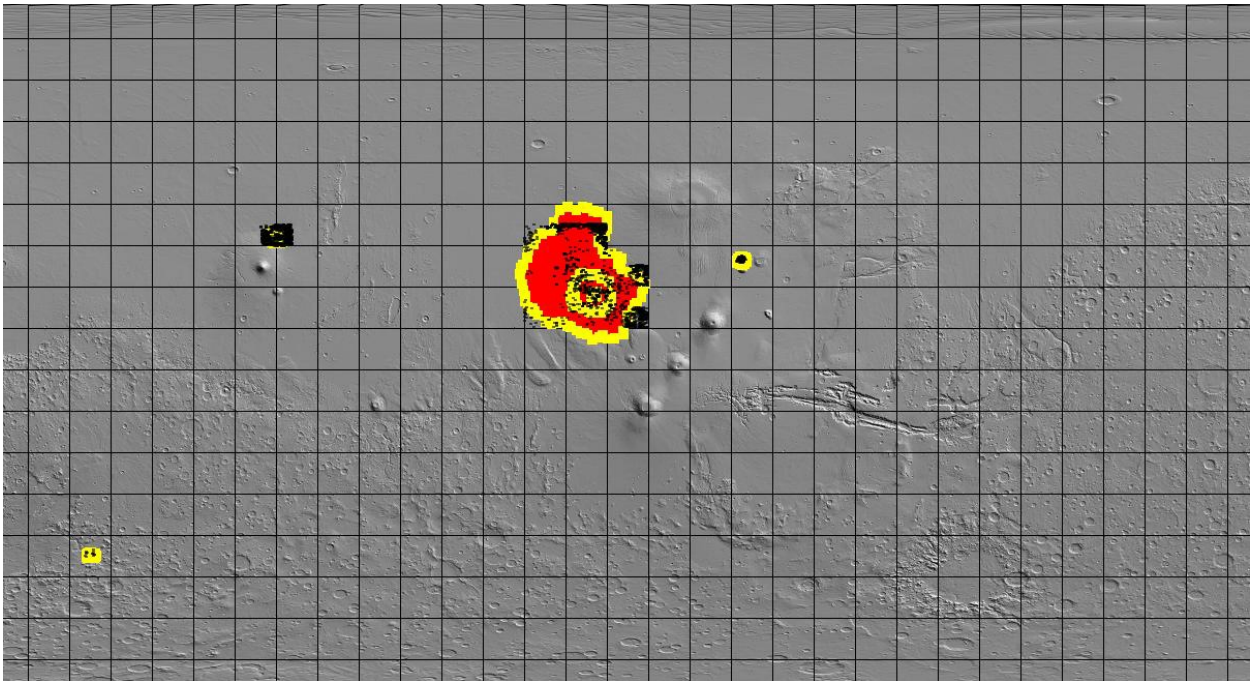
Uranius Tholus Impact Craters



Olympus Mons Impact Craters

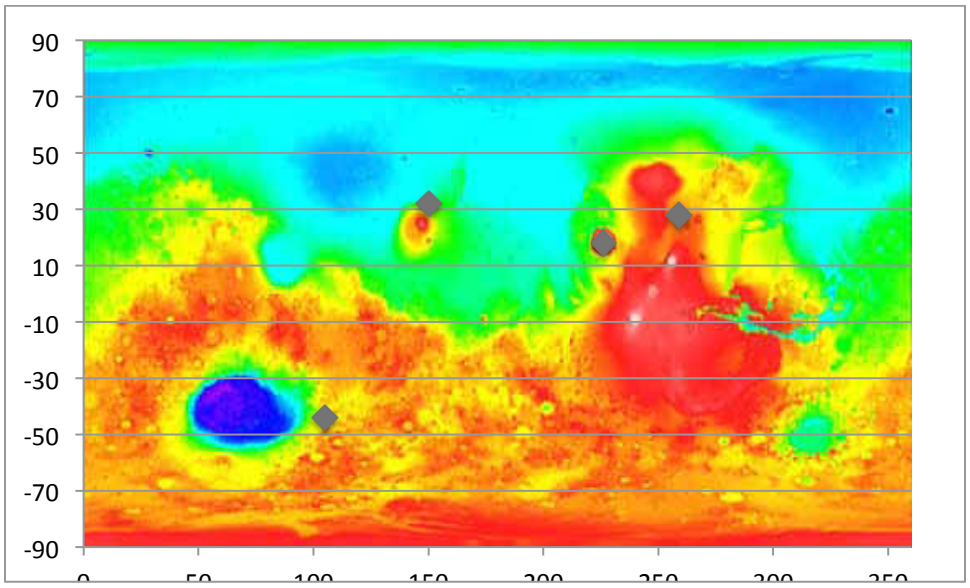


Location of the Volcanoes We Studied



Mola Map Locations of Volcanoes Studied

Name	Lat	Long
Euripus Mons	-44	105
Uranius Tholus	28	259
Hecates Tholus	32	150
Olympus Mons	18	226



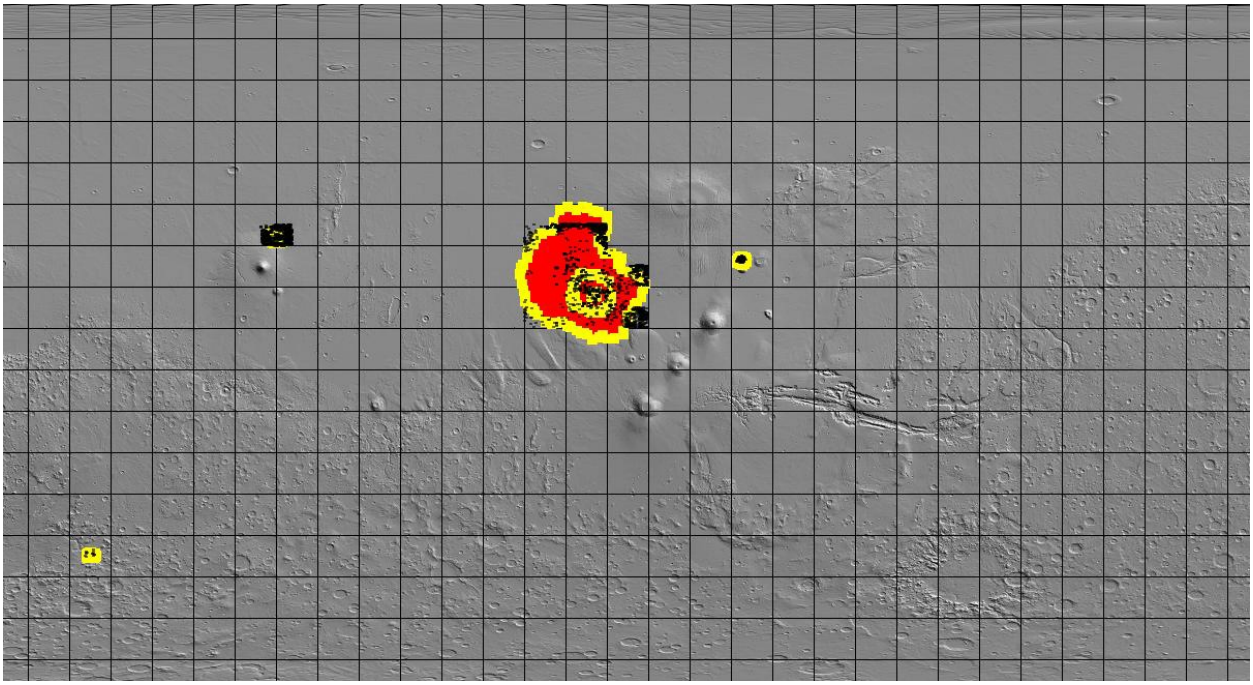
Discussion

The data we collected showed us that Uranius Tholus is the oldest of our four volcanoes. Our first graph displayed the flank and cones were equal in crater density. Using this information we figured that the same would go for Hecates Tholus even though our data was defective.

We, as a class, noticed that the calderas were less likely to have craters than the other areas. One theory of ours was because the caldera was much smaller than the area of the cone or flank it had less craters. It is harder to hit the desired point when the area is smaller. We also wondered if some of the craters on Uranius Tholus' caldera are volcanic craters. Even with this being one piece of the scientific puzzle, we inferred that Uranius Tholus is most likely the oldest, Hecates Tholus is the second oldest most likely Eurpuis Mons is the third eldest and Olympus Mons is the youngest. After collecting and analyzing this information, we figured out

that the Tholi are older than the Mons. With this discovery, we were wondering if there was a change in the tectonic plate in Mars history.

In our maps of the areas for our volcanoes we found that even though Olympus Mons is the youngest it also has the largest areas.



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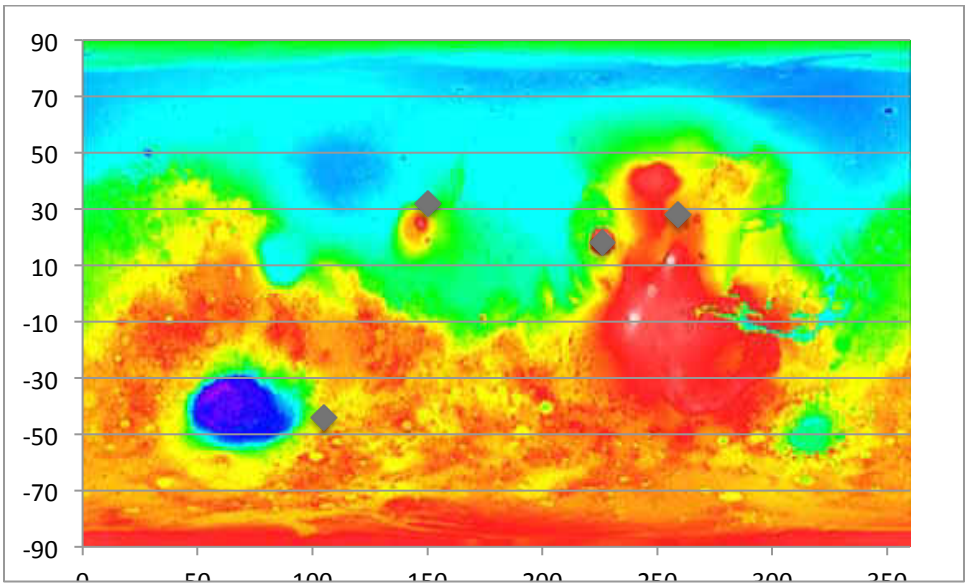
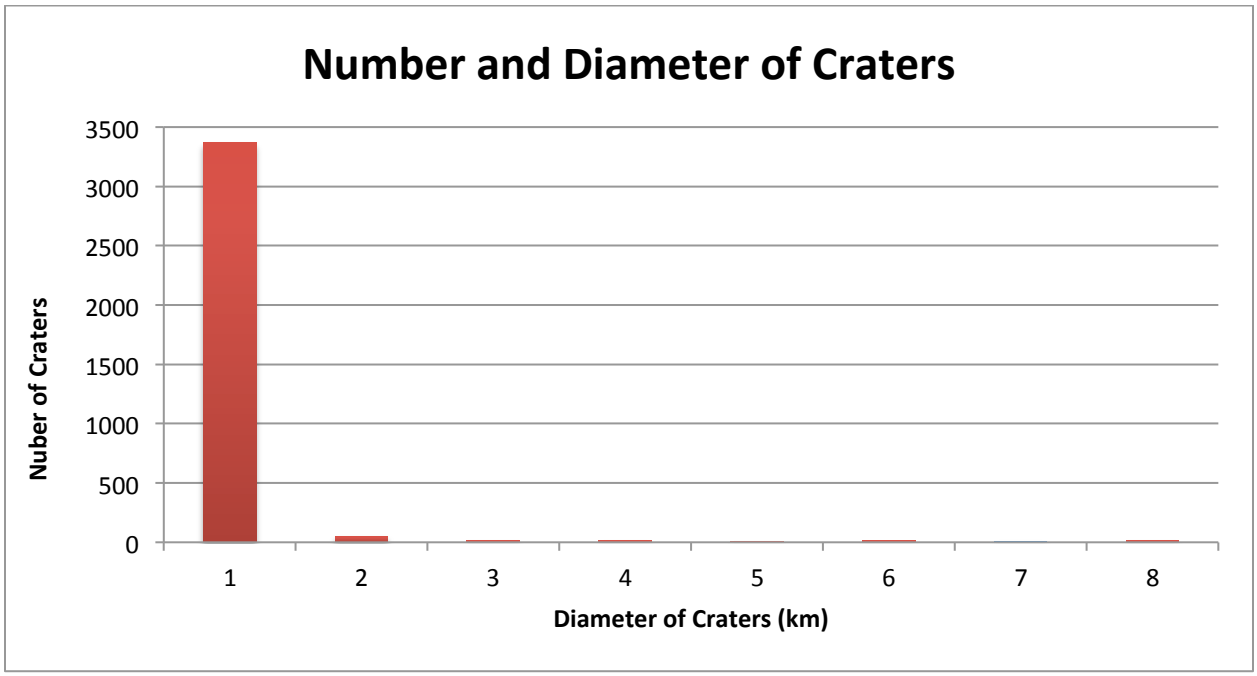
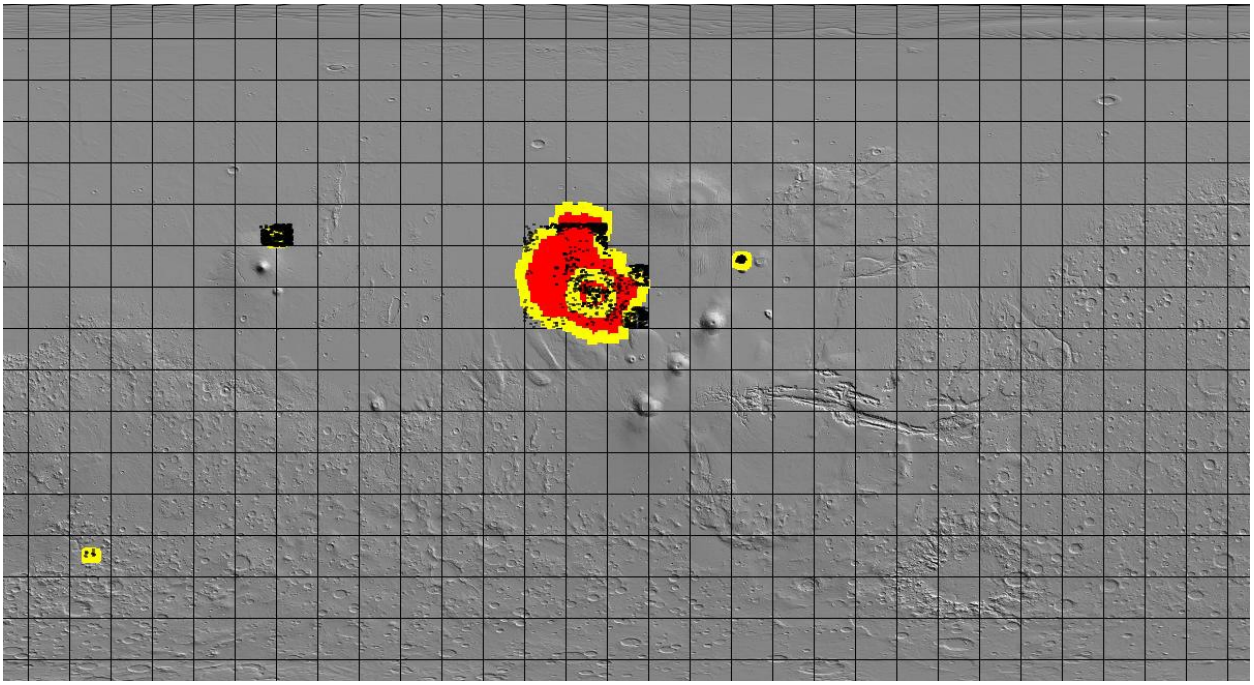


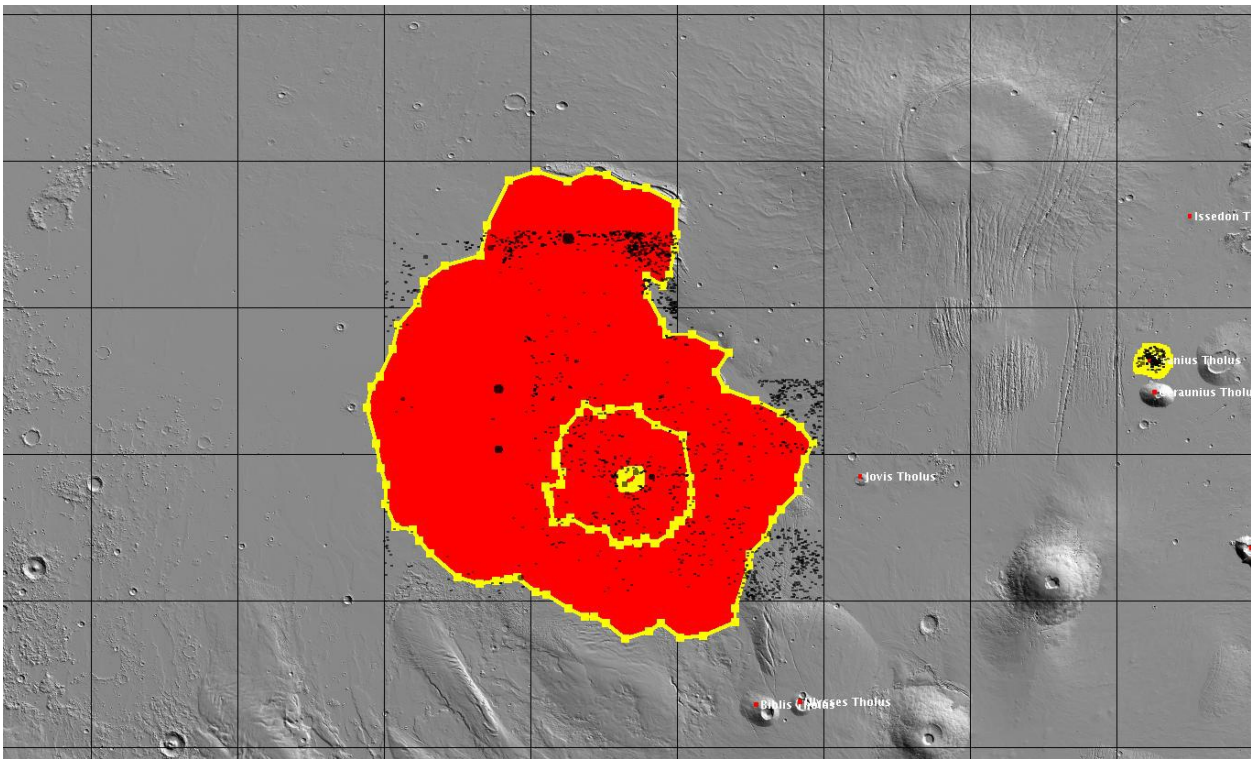
With the research we collected we saw that we could form another graph listing the number of craters with a certain diameter. Using this information we saw that most of the craters were about one kilometer in diameter. This shows that the volcanoes are still relatively young, because there are few large impact craters.



Using the global map we see the placement of the four volcanoes. This also allows us to see the amount of craters and the shape of the volcanoes for us to compare.



One volcano we used in our experiment was Olympus Mons. Olympus Mons has a scarce amount of craters for its size, and that confirms that it has a relatively young age.



Errors and Bias

During our studies we came upon several errors in progress. These errors made some of our data invalid. These errors included miscounted craters, extensive boundaries along the volcanoes and craters that were counted more than once. Also, there were other problems that we couldn't control such as secondary craters caused by other large meteorites crashing on Mars and sending debris up which later crashed back on the surface. We also could have counted volcanic craters caused by violent eruptions, and some volcanoes' calderas could have been too small to correctly gather crater counting data for them. Lastly, one thing that we didn't necessarily have to do to get an answer for our science question was to separate the volcanoes' cone, caldera, and flanks and crater count them separately.

Conclusion

Our science question was, "What are the relative ages of Olympus Mons, Uranius Tholus, Hecates Tholus, and Euripus Mons using impact craters on their calderas, flanks, and cones?" From the data we have collected we have concluded that the two Tholi; Uranius Tholus and Hecates Tholus, are the oldest, while the Mons; Euripus Mons and Olympus Mons, are the youngest. We believe that Uranius Tholus is the oldest based on our research, because it had the most impact craters per square kilometer. Olympus Mons is the youngest due to fewer impact craters per square kilometer. Our data supports our hypotheses by stating that Uranius Tholus is the oldest, and Olympus Mons would be the youngest. Our data and project are important, because this information will help future investigations by allowing scientists to determine how far apart Uranius Tholus and Olympus Mons are in age. Our data also suggests that Mars might have had two periods of volcanic building activity.

We would like to acknowledge Jessica Swann, Jon Hill, Mr. Gardner, the Odyssey Mars orbiter, the THEMIS camera, all the chaperones, NASA, and ASU for helping us throughout the course of our project and giving us this once in a lifetime opportunity.

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Equipment:

THEMIS Camera
Odyssey Orbiter
Mars Reconnaissance Orbiter