How Do Rootless Cones on Mars Compare to Those on Earth?

Xavier College Preparatory Astronomy I Class
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Introduction

The purpose of this experiment is to determine if there is a relationship between the height and diameter of rootless cones on Mars and rootless cones on Earth. If the rootless cones on Mars have similar heights and diameters and are formed the same way as rootless cones on Earth, the cones on Mars will mark a place where ground ice may have existed up to ten million years ago. This evidence that there was once water on Mars will lead to a higher chance of discovering the possibility of life on Mars. Also, rootless cones can lead to a better understanding of the evolution of geologic changes, the previous and current climate, surface evolution, and volcanic processes on Mars.

Background

On Earth, when lava flows react with surface water, ice, permafrost, or wet ground, it forms a rootless cone. Rootless cones, also known as pseudocraters, lack primary vents connected by vertical conduits to a subsurface magma source, which is why they are considered “rootless”. They are present in Iceland and have a similar structure to those on Mars, which allows a unique insight into their type and effect on Mars (Matthew 831).

The Viking landers sent by NASA in the 1970s provided some of the first images and concrete evidence of rootless cones on Mars. Several rootless cones have been found in regions such as Chryse Planitia, Euteronlius Mensae, Acidalia Planitia, Isidis Planitia, and Elysium Planitia. (PSR Discoveries) Due to the continuous use of satellites and other research methods over the past forty years, there has been more evidence of the presence of rootless cones in the Cerberus plains, Marte Valles, and Amazonis Planitia. Their diameters range from 20 to 300 meters, and several features have been analyzed by MOC (Mars Orbiter Camera) images taken (PSR Discoveries). Rootless cones on Mars look as shown below:
On Earth, Iceland is heavily populated by rootless cones; several of them are located at Rauðhólar. Rauðhólar is a cluster of rootless cones formed when Leitahraun lava flowed over a wetland 5,200 years ago. In the mid-twentieth century, a large part of the craters were mined for scoria (volcanic rock), leaving behind a number of carved-out craters and relics. As a result, the interior of pseudocraters can be examined more closely and scientists will be able to make more discoveries about rootless cones (Rauðhólar).

The image shown above is of a set of visible rootless cones located in Myrdalsjökull, Iceland. The cones are spaced around 100 meters apart and are 20 meters in height. Some rootless cones are covered in scoria. These volcanoes represent the interaction between erupting lava and ground water on earth, similar to those on Mars which interact with subsurface ice.
The image above shows rootless cones on Mars. They are located near the bottom of small impact craters. Rootless cones are formed when volcanic heat and subsurface water meet; this creates steam that breaks through the crater’s surface.

**Experimental Design**

We will be measuring the number, frequency, elevation, location, height, and diameter of rootless cones on both Earth and Mars. Rootless cones are usually found where ice is present because they form when volcanic activity interacts with water and ice. We will mostly be looking for rootless cones in Iceland because it is where they are most likely to be located and seen on Earth due to the amount of ice and volcanic activity. On Mars, we will be looking for rootless cones near known volcanoes located at mid-northern latitudes. We will be using THEMIS images provided by Arizona State University’s website to view rootless cones on Mars (Christensen). We will also be searching for images using Google Maps for rootless cones on Earth to compare and contrast the height and diameter with those we observe on Mars (Google Maps).
The following are images of previously studied rootless cones present on Earth in various regions of Iceland:

1.

**Fig. 2.** (a) Aerial photograph and (b) high resolution image showing well-formed cones in the Landbrot rootless cone field, southern Iceland. Illumination is from the upper right. Cone alignments are discussed by Bruno et al. (2004).

(Burr)
Data Analysis

We will measure the number, frequency, location, elevation, diameter, and the height of rootless cones on both Mars and Earth. We will use pictures of rootless cones from both of these planets in order to compare and contrast them.

Frequency of rootless cones may vary on Earth and Mars. To analyze the frequency, a bar graph will be used. We think Mars will have more rootless cones because it has more lava and ice to form them.

The diameters of rootless cones on Mars and Earth can be measured using THEMIS images of Mars and maps of Earth that show the sizes of rootless cones in Iceland. To compare the size difference of the rootless cones, a bar graph will be produced. A bar graph will allow us to compare the size differences of rootless cones in the different locations. We will most likely find that rootless cones on Mars are larger than those on Earth due to the lack of plate tectonics and a weaker gravitational pull.

The height of the rootless cones will be studied comparatively within the location they are found. Then we will measure and compare the height of the rootless cones on Mars with the ones found on Earth. After finding this data, we will make another bar graph depicting this information. We hope to find very similar data of rootless cones on Mars to those that are here on Earth.

In order to analyze the location and elevation of a rootless cone, one may observe a MOLA map. MOLA (Mars Orbiter Laser Alimeter) measures elevations on planets by sending out laser pulses toward a planet’s surface. A bar graph can again be used to record this data. We believe that we will find rootless cones on Mars to be very similar to the ones on Earth, but the cones on Mars could have a higher elevation due to more subsurface ice reacting with molten
lava.

**Regions with rootless cones on Mars**

<table>
<thead>
<tr>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chryse Planitia</td>
<td>26.7° N</td>
<td>40° W</td>
</tr>
<tr>
<td>Deuteronomus Mensae</td>
<td>47.5° N</td>
<td>28.4° E</td>
</tr>
<tr>
<td>Acidalia Planitia</td>
<td>23° N</td>
<td>35° W</td>
</tr>
<tr>
<td>Isidis Planitia</td>
<td>12.9° N</td>
<td>87° E</td>
</tr>
<tr>
<td>Elysium Planitia</td>
<td>0.1° S</td>
<td>172.1° E</td>
</tr>
<tr>
<td>Cerebrus Plains</td>
<td>14.8° N</td>
<td>155° E</td>
</tr>
<tr>
<td>Marte Valles</td>
<td>14.8° N</td>
<td>176.5° W</td>
</tr>
<tr>
<td>Amazonis Planitia</td>
<td>24.8° N</td>
<td>164° W</td>
</tr>
<tr>
<td>Valles Marineris</td>
<td>24.8° N</td>
<td>196° E</td>
</tr>
<tr>
<td>Cydonia Mensae</td>
<td>40.2° N</td>
<td>350.2° E</td>
</tr>
</tbody>
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**Images of Rootless Cones on Mars**

<table>
<thead>
<tr>
<th>Image #</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>V13973007</td>
<td>8.6 °N</td>
<td>187.5 °E</td>
</tr>
<tr>
<td>I07884020</td>
<td>7.9° N</td>
<td>150.6° E</td>
</tr>
<tr>
<td>V10140020</td>
<td>9.3° N</td>
<td>85.6° E</td>
</tr>
<tr>
<td>V28225029</td>
<td>16.7° N</td>
<td>176.0 °E</td>
</tr>
<tr>
<td>V31107007</td>
<td>17.0° N</td>
<td>177.3° E</td>
</tr>
<tr>
<td>V10380012</td>
<td>14.5° N</td>
<td>20.5° E</td>
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<tr>
<td>V27451020</td>
<td>23.9693 °N</td>
<td>186.758 °E</td>
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<tr>
<td>V11493006</td>
<td>9.3° N</td>
<td>88.2° E</td>
</tr>
<tr>
<td>V130050010</td>
<td>0.092786 °N</td>
<td>172.08957 °E</td>
</tr>
<tr>
<td></td>
<td>Latitude</td>
<td>Longitude</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Iceland</td>
<td>29.3° N</td>
<td>170° E</td>
</tr>
<tr>
<td>V21267010</td>
<td>15.5° N</td>
<td>20.1 E</td>
</tr>
</tbody>
</table>

Coordinates of Rootless Cones on Earth

<table>
<thead>
<tr>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>63 degrees 55'51.35&quot;N</td>
<td>22 degrees 37'24.94&quot;W</td>
</tr>
<tr>
<td>Reykjavik, Iceland</td>
<td>64.8 N</td>
<td>21.56 E 1.5 km east of town</td>
</tr>
<tr>
<td>Myvatn Lake, Iceland</td>
<td>65°42'53&quot;N</td>
<td>16°43'40&quot;W</td>
</tr>
<tr>
<td>Kirkjubaejarklauster, Iceland</td>
<td>63.47 N</td>
<td>18.04 W</td>
</tr>
<tr>
<td>Laki Iceland</td>
<td>64.4 N</td>
<td>18.13 W</td>
</tr>
</tbody>
</table>

Images of Rootless Cones on Earth

Raudholar Cone Group, Reykjavik, Iceland

(Courtesy of Thorvaldur Thordarson, Univ. of Hawai‘i.)

Raudholar Rootless Cone Group at Reykjavik, Iceland. This group is located about 1.5 kilometers from the eastern edge of town (see apartment buildings on the horizon for scale.) The cone group is in the Leitin lava flow, which covered a small shallow lake here. The cluster is located about 27 kilometers from the source vents of the lava.
Landbrot pseudocraters in Kirkjubaejarklauster, Iceland.

Image comparison of rootless cones in Laki Iceland to those on Mars.

**Conclusion**

The purpose of this experiment is to find a relationship between the height and diameter of rootless cones on Mars and rootless cones on Earth. It is important to answer this question so we can move closer toward being able to determine whether or not ground ice exists or existed up to ten million years ago on Mars, which could lead to a higher probability of life. This question will be interesting to answer because by determining the height and diameter of rootless
cones on Mars and comparing their size to those on Earth, we will be able to take a closer look
at climate, geologic changes, and the evolution of the surface of Mars. The reactions that cause
rootless cones involve both lava and water, two elements that, on Earth, combine under the
sea to create life; perhaps something similar may have happened on Mars at an earlier age. By
comparing rootless cones in these different environments, perhaps we can determine if life was
ever a possibility on Mars.

References

Burr, Devon M., Barbara C. Bruno, Peter D. Lanagan, Lori S. Glaze, Windy L. Jaeger,
Richard J. Soare, Jean-Michael Wan Bun Tseung, James A. Skinner Jr., and Stephen
M. Baloga. "Mesoscale Raised Rim Depressions (MRRDs) on Earth: A Review of the
Characteristics, Processes, and Spatial Distributions of Analogs for Mars." Planetary

Christensen, P.R., B.M. Jakosky, H.H. Kieffer, M.C. Malin, H.Y. McSween, Jr., K. Nealson,
G.L. Mehall, S.H. Silverman, S. Ferry, M. Caplinger, and M. Ravine, The Thermal
Emission Imaging System (THEMIS) for the Mars 2001 Odyssey Mission, Space Science


Martel, Linda M.V. "PSR Discoveries: Rootless Cones on Mars." Planetary Science Research
June01/lavaIceMars.html>.

Mathew, George, Kanchan Pande, Soumen Mallick, and Balaram Jena. Journal of Earth
831-38.SpringerLink.

"Mars Odyssey Mission THEMIS". ASU School of Earth and Space Exploration. 31 August

18r56250745272w2/>.

<http://www.nasaimages.org/luna/servlet/detail/nasaNAS~4~4~24790~128537:Possibl
e-Rootless-Cones-or-Pseudo-c>.

Roark, Jim. "Rootless Volcanic Cones South of The Mydralsjokull Ice Cap Crater."

Rauðhólar - Rootless Cones. Iceland Geosurvey. 31 August 2010.

<http://www.psrd.hawaii.edu/June01/lavaIceMars.html>.