An Analysis of Sediment Samples and Boulder Sizes from a Volcanic Crater

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INTRODUCTION

We investigated a maar in Central Oregon called Hole In The Ground (HITG), shown in **Fig. 1** (a maar is a type of volcanic crater that forms from a steam eruption, as shown in **Fig. 2**) to use it as a model that can help identify such craters—which are potential water sources—on Mars. We looked at soil composition and boulder sizes relative to their locations to get an idea of what happened right after the crater's multiple explosions. How maars form is the same regardless of which planet you look at, and thus, they could be potential water sources on Earth as well as on Mars.

We drove out to the HITG site in La Pine, Oregon where we were able to take tephra (particles ejected by the eruption) samples to a depth of 1 meter. One thing to note is that this crater and the surrounding region was covered with 1-2 meters of ash from the Mount Mazama volcanic eruption—the eruption that formed Crater Lake as we know it today. This made it challenging to reach the tephra layer produced by the HITG eruptions when collecting samples. The soil makeup was also important when determining which layer we were looking at and what it was comprised of; a representation is shown in **Fig. 3**.

Research Objective:
Since this formation process is the same on Earth as it is on other planetary bodies, the objective of the study was to create a data model of an Earth maar, specifically Hole in the Ground, to become more familiar with the fine details of maars and to show them as potential water sources on Mars and other planetary bodies.

We specifically looked at:
- Landscape morphology
- Tephra form, sphericity, and size/volume
- Distribution of boulders from the center of HITG Maar

Fig. 1 Hole In The Ground

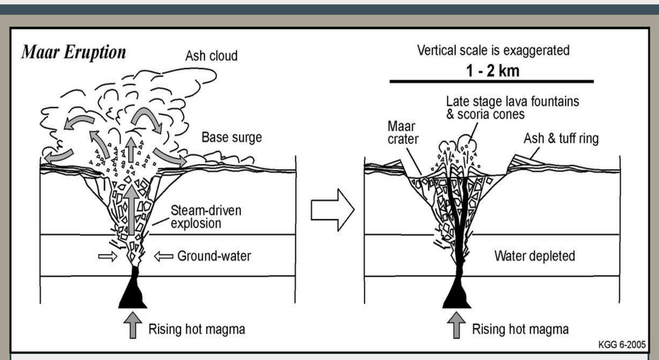

Fig. 2 Maars are craters that form when magma heats up underground water, making it boil and disrupt the ground above.

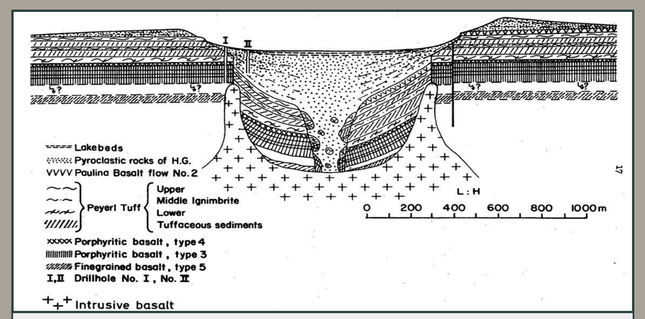

Fig. 3 This is a diagram of the soil makeup of Hole In The Ground as predicted by Volker Lorenz.

METHODOLOGY

Field Work:
While in the field we:
- Took core soil samples,
- Located dig site and boulder coordinates using GPS technology,
- Documented approximate boulder measurements,
- Took infrared photographs of said boulders as well as the crater itself in hopes of locating cracks where water would most likely be.

Lab Work:
While in the lab we:
- Analyzed sediment size using a sieve shaker machine for each core sample we took and sorted the 3 biggest sediment size sieves into the types of material it was:
  - Mazama Ash, Peyerl Tuff, and Basalt,
- Turned the sieve analysis data into graphs,
- Edited and began to analyze the infrared images taken at the crater.

RESULTS

We measured the size of the boulders surrounding the crater's rim and recorded their altitudes and approximate visible volumes. **Fig. 4** shows one main trend: the Western rim had the lowest elevation and the boulders with the largest volume while the Eastern rim had the highest elevation and the smallest boulder volume.

We also measured average sediment size based on what the type of material was for each core sample we took. **Fig. 5**. Shows the average of all of these. Roughly 75% of our soil samples were smaller than 1mm.

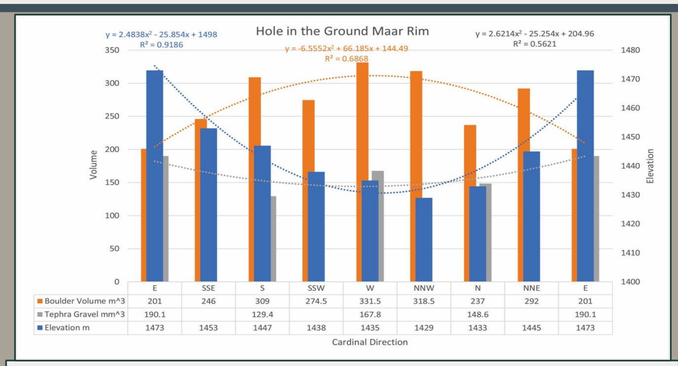

Fig. 4 A graph of boulder volume mapped against elevation along crater rim. Average tephra gravel size (gray) was not affected the same way.

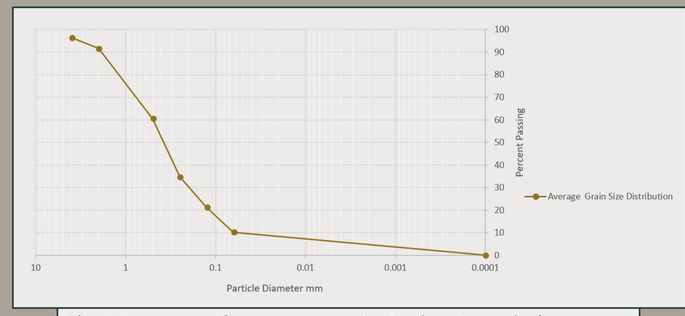

Fig. 5 A measure of the average grain size (X-axis, mm) of all the different soils we measured vs. how much of it there was (Y-axis, %). On the x-scale, each line is a tenth of the number marked to the left.

CONCLUSION

After gathering and organizing our data, we made an inference about the boulders: the reason the largest boulders stayed on the smallest side of the rim might be that heavy wind going in a SE direction interfered during one of the crater's explosions and helped smaller boulders move to the Eastern and Southern areas. **Fig. 4** concluded that given the height of the crater walls and the force of the eruptions, larger boulders were not able to make it over the higher side of the crater wall. The most we could do was document details such as this, but doing so can help us compare data with Martian maars, which will in turn help verify whether a crater is indeed a maar. In addition, since maars on Earth and Mars are both created with water, Mars' maars must have sources of water underneath or must have had a them at some point. Therefore, maars on Mars may be of much importance in the future.

ACKNOWLEDGEMENTS

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Fig. 4 and 5: Bernhardt, G. (2021)