Geomorphic Comparison of Volcanoes on Earth and Mars: Implications for Plate Tectonics

By: Liz Roberts, University of Hawaii`i at Mānoa Mentor: Pamela E. Jansma, University of Arkansas

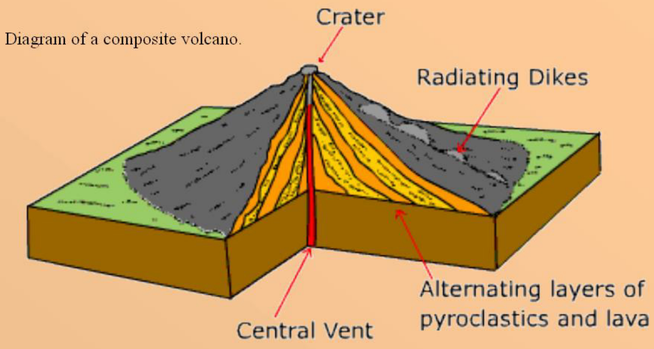
Introduction

Many volcanoes on Earth are asymmetric in shape. By measuring the volcanic asymmetry the geomorphology of a volcano can be assessed. This research focuses on the tectonic settings that influence the asymmetric shape of volcanoes on Earth. The volcanic regions studied in this research are in South America, the Caribbean, the Philippines, and Hawaii. These volcanic regions will then be compared to the volcanic regions on Mars by comparing the asymmetries and geomorphology.

Background

Radially symmetric volcanoes are your typical textbook volcanoes. They have circular symmetry, are conical in shape, and have few factors working against them. What we know as composite volcanoes or stratovolcanoes represent the best examples of radially symmetric volcanoes. These volcanoes are mainly found at convergent plate boundaries but can also be found in other volcanic regions. Not all volcanoes around the world are symmetric in shape. Volcanic asymmetry can be caused by tectonic movement, sector collapse, regional extension, volcanic ejection, erosion, and many other factors.

Diagram of a composite volcano.

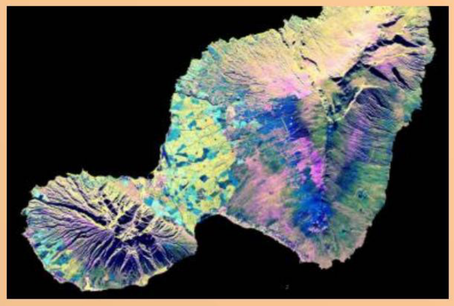


This image of St. Augustine volcano, in Alaska, is an example of a radially symmetric composite volcano.

By comparing this model of a radially symmetric volcano to real life volcanoes in different regions of the world, the influences and causes of asymmetry can be examined. Asymmetry caused by plate tectonics could include preferential extension in one direction, sector collapse, and faulting.

Mt. Pelee (north left end of the island), Martinique, in the West Indies, is formed from an ocean-ocean convergent margin where the North American plate is being subducted beneath the Caribbean plate. The growth of the Mt. Pelee edifice was limited by the movement of the two plates.

Photograph of Mt. St. Helens after its last eruption, which caused a large sector collapse in it's northern flank.



False color satellite image of Maui, Hawaii. The Western volcano and Eastern volcano, better known as Haleakala, both show deformation caused by plate movement. Volcanic fault scarps can be seen on the 3 main ridges of Haleakala.

Methodology

The geomorphology of volcanoes will be examined through remote sensing. Volcanic asymmetry, for this research, is measured by using the satellite imagery produced from Seasat. Seasat is a satellite that was launched in the summer of 1978. One of the instruments on board the satellite was a synthetic aperture imaging radar (SAR). Seasat operated for only 3 ½ months when it short-circuited and was no longer able to image the earth. SAR images of volcanoes in the areas of interest will be examined for this research.

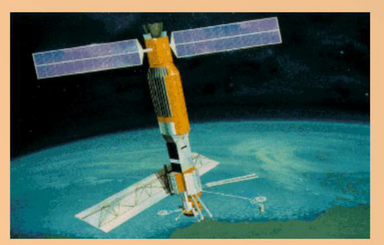


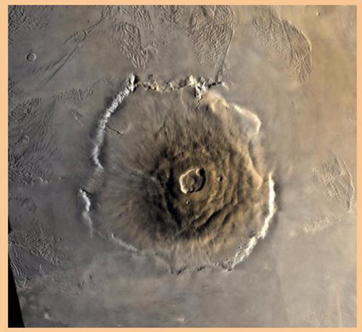
Image of the Seasat satellite in orbit above the Earth.

Volcanic asymmetry will be examined by measuring the size of the volcanic edifice. The long axis and a perpendicular axis to that will be measured and then compared to known tectonic movement in the region of the volcano.

Discussion and Future Research

Once a database is compiled of the volcanoes researched, the information found will be compared to those volcanoes examined on the surface of Mars. Martian and terrestrial volcanoes will be compared to see if there are similar plate tectonic influences that effect volcanic morphologies.

Apollinaris Patera, Mars. The edifice of this volcano has an elongated shape that may have been caused by tectonic processes



Olympus Mons, Mars.

More information is still needed in this ongoing research in order to make any conclusions at this time. This research only focuses on a few selected regions on Earth and Mars where volcanic activity occurs. Ideally a global database of the volcanoes on Earth would be needed to make more accurate conclusions when comparing to Martian volcanism.

Acknowledgements

I would like to acknowledge Pamela E. Jansma and Dr. Derek Sears for their guidance, the Center for Space and Planetary Sciences and the National Science Foundation for this research opportunity and funding.