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Global Martian volcanism as a new interpretation of geological past of terrestrial bodies and moons in the Solar System

N. Zalewska (1,2)
(1) The Institute of Aviation, Warsaw, Poland (2) Space Research Center PAS, Poland (natalia.zalewska@ilot.edu.pl).

1. Introduction

Many papers and articles have been telling us for years about the (Late) Heavy Bombardment of Earth-type planets including our Moon. Numerous craters on these planets are considered traces of collisions with smaller celestial bodies. This theory has been around for years, since the exploration of space began. Besides, Jupiter's moons have such traces and even characteristic crater chains interpreted exclusively as traces of serial impacts of asteroids after fragmentation above the surface. But when we look at the volcanic cones and the various other volcanic forms on Earth, we also notice that craters, especially those that are inactive for millions of years, are strikingly similar to the conically formed domes and caldera craters on Mars [1] and terrestrial planets, additionally including moons of Jupiter and moons of other large planets as well as our Moon.

2. Comparison, analogues

The primary basaltic volcanism of hundreds of millions of years ago could produce very broad calderas because of very low viscosity (low Si content of ultramafic rocks: <5% assuming ~ 100 μm grains) [2], which bottom part collapsed in time after cooling, creating something that resembles a crater. Also, the center of volcanic crater, which stagnated last and after solidification formed a cone, which could have been interpreted as the central peak of the impact crater. Ring material from the caldera, instead of being interpreted as the edges of lava flows, is interpreted as ejecta-material thrown during the impact. Forms that we can compare them to on Earth are, for example: Lake Myvatn with its pseudo-craters located in volcanic active part of Iceland, underwater volcanoes in Hudson Bay, Pinacate Peaks in Mexico (Fig.1,3), Atlantic volcanism, Aleutian maars (large calderas), Hawaiian volcanoes, Pacific plate volcanoes in San Francisco and Crater Lake in Oregon. Volcanic forms we can observe are: pseudo-craters, scoria cones, maars, tuyas, guyots and lava domes. Many of these form under ice cover or at the bottom of the ocean. Similar forms are recognizable on Mars especially on its northern hemisphere. Isidis Planitia (Fig.2), Acidalia Planitia, Utopia Planitia and Amazonis Planitia (Fig.4) are densely dotted with cones and calderas. Latest study of LCP/HCP (low and high calcium pyroxene) from dust-free Mars sites show a relatively recent volcanism on Mars [3], [4].

3. Conclusions

The difference between the impact crater and the volcanic crater on terrestrial bodies can be very difficult to recognize because of close similarity between them, especially in morphology as well as the geometric distortion of images made by spectrometers in the nadir. In this case, the geochemistry and the degree of melting or lack there at the moment of impact must be taken into account. Whether krystobalite, trydymite, stiszovite, shocked varieties of quartz are found in the crater or not, will tell us which phenomenon occurred. This would require precise on site research using rovers.

References

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[3] Mangold N. et al. : Mineralogy of recent volcanic plains in the Tharsis region, Mars, and implications for platy-ridged flow composition, Earth and Planetary Science Letters Vol. 294, pp. 440-450, 2010.

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Figure 1: Pinacate Mexico, image 2x2 km. The beginning of eruption 4 million years ago. Characteristic double caldera is in the center of the image. 31.756338 N, 113.496827 W

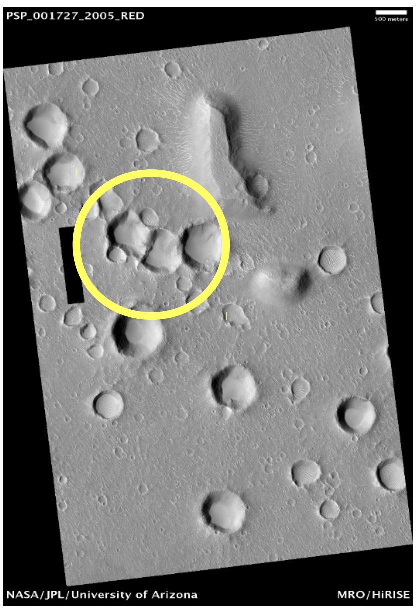

Figure 2: HiRISE PSP 001727_2005, Lat: 20.5° Long: 94.8°. Northern part of Isidis. Characteristic double calderas are in the center of the image. Calderas in the form of a maars on Isidis are probably not the result of an impact but of extensive volcanism.

Figure 3: Cerro Colorado volcano Pinacate Crater in Mexico-irregular caldera, diameter 975 m, 31.916360 N, 113.299865 W

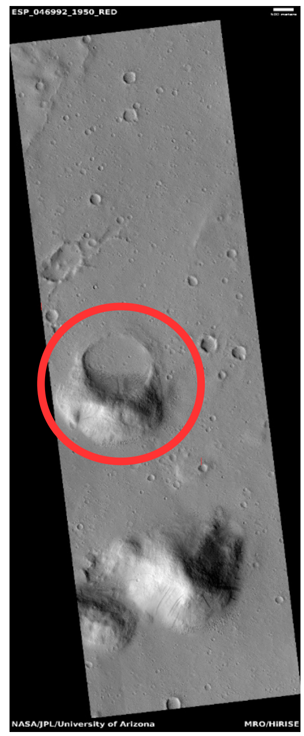

Figure 4: HiRISE ESP 046992_1950, Lat: 15° Long: 192.1°, Amazonis Planitia. In the middle of the image an irregular caldera is visible. The calderas are covered with dust. Forms are probably of volcanic origin.