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Small-scale volcanoes on Mars: distribution and types

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Volcanoes differ in sizes, as does the amount of magma which ascends to a planetary surface. On Earth, the size of volcanoes is anti-correlated with their frequency, i.e. small volcanoes are much more numerous than large ones. The most common terrestrial volcanoes are scoria cones (<few km in diameter) followed by tuff cones and tuff rings. As Mars is a planet which was volcanically active over most (if not all) of its history, a similar distribution of volcano size might be expected. Martian small-scale volcanoes were not intensely studied for a long time due to a lack of high-resolution data enabling their proper identification; however their existence and basic characteristics were predicted on theoretical grounds. Streams of new high-resolution images now enable discovering and studying kilometer-size volcanoes with various shapes in unprecedented detail.

Several types of small-scale volcanoes in various regions on Mars were recently described. Scoria cones provide a record of magmatic volatile content and have been identified in Tharsis (Ulysses Colles), on flanks of large volcanoes (e.g., Pavonis Mons), in the caldera of Ulysses Patera, in chaotic terrains or other large depressions (Hydraotes Colles, Coprates Chasma) and in the northern lowlands. Tuff rings and tuff cones, formed as a result of water-magma interaction, seem to be relatively rare on Mars and were only tentatively identified in three locations (Nepenthes/Amenthes region, Arena Colles and inside Lederberg crater), and alternative interpretations (mud volcanoes) seem possible. Other relatively rare volcanoes seem to be lava domes, reported only from two regions (Acracida Planitia and Terra Sirenum). On the other hand, small shields and rootless cones (which are not primary volcanic landforms) represent widely spread phenomena recognized in Tharsis and Elysium. Based on these new observations, the distribution of small volcanoes on Mars seems to be much more widespread than anticipated a decade ago.

There are sometimes significant differences in the final morphologies between Martian hypothesized and possible terrestrial analogs, despite fact that the physical processes behind volcano formation should be similar on both planets. For example, Martian scoria cones are $\sim$2.6 times wider than terrestrial analogues, as lower gravity and atmospheric pressure enable wider dispersion of pyroclasts from the vent. In addition, exit velocities of ejected particles should be increased on Mars because the lower atmospheric pressure favors more rapid exsolution of dissolved gases from the magma, which also favors a wider dispersion of ejected particles. Therefore, care must be taken when applying terrestrial morphometric relationships to the interpretation of hypothesized volcanic features on Mars and other terrestrial bodies.

As on Earth, small-scale volcanoes on Mars display diverse shapes and hence provide insight into diverse volcanic processes responsible for such variations. Those diverse processes may point to various mechanisms of magma ascent and eruption styles in dependency on magma properties (e.g., amount of volatiles) and the paleo-environment at the time of formation. Hence the investigation of small-scale volcanoes provides useful tool enabling us to deepen our knowledge about the variety and richness of volcanism on Mars.