



Small shields swarms on Mars and Venus: Surface manifestation of deep mantle plume

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In spite of large shield volcanoes on terrestrial planets are most remarkable volcanic edifices and have been extensively studied, small shields, especially small shields swarms are also important surface manifestation of deep interior thermal anomalies and indicative of planetary thermal history. In this study, we identified and mapped two shield swarms on Mars based on MOLA, THEMIS and HRSC data and compared their features with shield fields on Venus. It is suggested that these terrestrial small shields swarms are surface manifestation of hot spots or mantle plumes.

There are small shield swarms in Syria Planum and Thaumasia Highland on Mars. More than seventy small shield volcanoes can be identified in the Syria Planum with an area of $24 \times 10^4 \text{ km}^2$. These small shield volcanoes are Hesperian in age and are typically 10-30 km in diameter and 100-250 m high. Volcanoes to the north are symmetric and have steeper slope than those volcanoes to the southeast. Generally, there are few volcanoes beyond the north-western Syria plateau. Eleven small volcanoes in the Noachian Coprates Rise and Thaumasia Highlands have been identified and more than thirty similar small volcanoes were mapped in Thaumasia Fossae and to the southwest on the southern cratered highlands. They cover an area about $33 \times 10^4 \text{ km}^2$. All of these Noachian shields have diameters ranging from 50 to 80 km, and 1.5-2.0 km high. They are randomly distributed in the heavily cratered highlands. These edifices are heavily cut by radial channels, suggesting the edifices are original shields or cones.

There are tens thousands of small shields (mostly less than 20 km in diameter) on Venus. They are randomly distributed on the Venusian surface. We classify those regions with high concentration of small shields (more than 5 shields within an area of 1000 km^2) as small shield swarms. This density is much higher than that on Mars. They are occurring primarily in the lowlands. Of total 556 shield swarms, mostly are 100-200 km in diameter. Some are big as 1000 km in diameter. Two major shield swarms are in Beta-Phoebe-Atla regions and in Akkriva Colles. Small shields in these regions are 2 to 5 km in diameter.

By comparing the morphology and space distribution of small shield swarms on Mars and Venus, it is suggested that they have some similarity and also many significant differences. However, it is possibly the early Noachian volcanism of Mars is similar with what we see on Venus. All these small shield swarms are extrusive volcanism from deep mantle plume sources. Extensive resurfacing processes have destroyed most small shields formed in the early Noachian time, and only some big shields are remained.