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Title of the doctoral dissertation:

Reconstruction of magmatic plumbing systems of the Tharsis Volcanic Province in the context of future research on the distribution of ore mineralization on Mars

Summary:

Understanding the igneous and volcanic processes will be crucial in searching for ore mineralization on Mars. In my Ph.D. thesis, I investigated the most extensive magmatic system on Mars, Tharsis, to understand the evolution of volcanic activity, which probably controlled the post-magmatic hydrothermal activity and associated ore mineralization. The doctoral dissertation comprises three peer-reviewed and published scientific articles in journals from the JCR list, which are devoted to 1) regional reconstruction of the Tharsis magmatic plumbing system based on distributed volcanism, 2) documenting the explosive-origin volcanic field of pyroclastic scoria cones in the Noctis Fossae region (southern part of Tharsis), and 3) developing the concept of the MIRORES spectrometer devoted for the identifying ore minerals on the Martian surface. The results presented in the first two articles were obtained using public-domain satellite images of the surface and digital elevation models of Mars. These data were used to map volcanic landforms, determine the ages of the latest volcanic activity using the crater counting method, calculate morphometric parameters, and create three-dimensional terrain models of the studied volcanic landforms. In designing the MIRORES spectrometer, the available published spectral data have been used to determine and calibrate the detectors' positions. In addition, the pyrite emissivity measurements were conducted to model the sulfide detection accuracy of the designed spectrometer. An integrated optical, electronic, and mechanical systems of the instrument was also designed by the MIRORES team for the purposes of this project.

The obtained results proved that the distributed volcanism is most likely geologically associated (temporally and spatially) with the activity of the central volcanoes and that the magma feeding the distributed volcanism has migrated in the Martian crust using radial and circumferential dikes. The conducted reconstruction of the volcanic activity allowed us to distinguish six separate magmatic plumbing systems that may have remained active after the volcanic activity had been stopped within the adjacent central volcano. The obtained ages suggest that the volcanism remains inactive. However, in the past, it was probably interrupted by periods of dormancy that indicate the repeated pulses of increased magmatic activity. Continuing the mapping of Tharsis, a local volcanic field comprising small scoria cones (<4 km in diameter) indicates the occurrence of putative explosive volcanism. Detailed morphometrical studies and age determinations confirmed that the Noctis Fossae volcanic field hosts volcanic edifices that reveal a varied age of their last activity, indicating long-term magmatic evolution. Local explosive eruptions on Mars may be associated with post-magmatic hydrothermal activity and associated ore mineralization. The presented results are not only of regional but also global importance. Conducting detailed research on ore mineralization on the surface of Mars will be possible thanks to the development of the MIRORES spectrometer operating in the far infrared. The designed spectrometer will be able to identify commonly occurring on Mars sulfides, including pyrite, chalcopyrite, and marcasite, especially within the studied volcanic regions. The published articles might constitute an introduction to the more in-depth research that can be continued thanks to the obtained in this dissertation results.