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Analysis of lava flow features on Venus for radar sounder simulations

New missions towards Venus are planned for the near future with the aim of unveiling why and how the evolution of Venus diverged from that of Earth, considered its twin planet. One of these missions is ESA's EnVision, to be launched in 2031, focused on the study of Venus geological and geodynamical evolution and its relationship with the atmosphere. The study of the geological features is performed by various instruments, among these by the subsurface radar sounder (SRS). The analysis of the performance of the radar sounder can be enhanced with simulations of the radargrams based on geological analogues of the targets of interest. This approach exploits existing radargrams in geologically analogous terrains to produce realistic simulations of the investigated target, using parameters related to the composition and morphometry of the target. Since the Venusian surface is dominated by volcanic morphology, SRS targets are focused on some volcanic morphologies, such as lava flow features. This research work aims at providing the morphological and compositional properties to be employed in the simulations of lava flow features. They compose one of the youngest geologic features and provide important insights into the stratigraphic history and current geologic activity on Venus. They have been classified based on their morphology
or based on appearance in the Magellan SAR data.
Estimates of flow thicknesses on Venus from Magellan altimeter data and
stratigraphic relationships with other features pointed out a lower limit of 10-30 m of
thickness for individual lobes, and a maximum thickness in the
order of 400 m. The extension of flows ranges from tens up to thousands of kilometres. Observations of Magellan radar backscatter of Venus flows and comparison with similar measurements on Earth indicate that they are mostly consistent with a smooth, pahoehoe-like surface roughness with limited occurrences of a'a. Roughness values of rms slopes (at Magellan resolution, 75 m) are around 2.50°-8°. The composition of lava flows has been inferred by measurements at Venera and VEGA landing sites and from morphological observations. Analyses from some of the Venera and Vega missions yield a predominantly mafic composition. The pahoehoe-like behaviour also supports a basaltic composition as on Earth. More exotic compositions for the longest flows are considered, such as carbonatite or sulphur and more evolved compositions are possible. Emissivity measurements of Venus flows range from 0.7 to 0.9, consistent with basaltic samples. Through emissivity data it is also possible to discriminate between fresh basaltic lava flows and weathered ones, providing relative dating of these features with respect to the surrounding basaltic plains. The multiplicity of eruptive environments suggests different sources and mechanism of emplacement, probably indicative of different periods of activity across Venus history. This analysis is useful in determining what could be the expected performance of SRS. The ability of the instrument to penetrate up to several hundred meters allows the discrimination between individual lobes or sequences of lava flows based on composition, porosity, surface roughness and temperature, and could provide a new stratigraphic perspective of Venus history.

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