

Venusian plains: Similarities with Mid-Ocean Ridge Basalts. Tracy K.P. Gregg (Department of Geology, 126 Cooke Hall, University at Buffalo, Buffalo NY 14260; tgregg@buffalo.edu).

Introduction: Plains comprise the majority of the Venusian surface [1], and “regional plains” have been proposed as a potential landing site for the planned Roscosmos Venera-D mission [e.g., 2]. Based on morphologic similarities with similar plains materials on the Moon and Venus, the general consensus is that the plains are composed of fluid (flood-like) lavas, although morphologic similarities to compacted sediments has been noted [3, 4]. Understanding the timing and style of plains-forming eruptions on Venus is essential to unraveling its thermal and chemical evolution.

Arcuate and sinuous troughs as long as thousands of kilometers are found within Venus’ regional plains. These are morphologically similar to lunar sinuous rilles, which are interpreted to be lava distributary systems (either lava channels or collapsed lava tubes) [e.g., 5]. On Earth and the Moon, lava channels and tubes are commonly the same composition as the lava flow fields in which they are found. In contrast, the extremely long Venusian sinuous rilles (called canali) has led to the hypotheses that they are generated by “exotic” (i.e., non-basaltic) lavas such as carbonatites, komatiites, or sulfur [6].

The simplest explanation for Venusian canali is that they are lava distribution systems, and that the surrounding plains are composed of fluid lavas that were emplaced through these canali.

Plains Morphologies: At the scale of Pioneer Venus and Magellan radars (both S-band), the Venusian plains are smooth and flat-lying. Although the landing ellipses for the Venera and Vega landers are about 300 km across [7], all but Venera 8 most likely landed on plains [8].

Images collected from Veneras 9, 10, 13 and 14 (see <https://www.planetary.org/articles/every-picture-from-venus-surface-ever> for clear renderings of these photos) reveal generally flat-lying, platy surfaces with intervening regolith deposits. Compositional analyses from all sites except Venera 8 are consistent with basalt. Venera 8 may show a slightly more evolved composition [7, 8].

The morphologies revealed by the Venusian landers are remarkably similar to the fluid basaltic lava flows erupted at Earth’s mid-ocean ridges (MORs) (Fig. 1). The high ambient pressures (250 MPa) at Earth’s MORs keep volatiles dissolved within the lavas, keeping the lavas a vesicular. Cold seawater rapidly quenches the surface of molten basalt flows, generating smooth glassy flow tops that insulate the molten flow core from

further rapid heat loss [9]. Repeated high-temperature, rapidly cooled basaltic eruptions at MORs result in thinly layered, flat-lying lava flows. The high cooling rate of submarine lava flows, combined with lava drainback or drainout and subsequent collapse can also reveal “bathtub rings” (formed during cooling and drainback) [10] that can be misinterpreted at lava layers.



Figure 1. Lava flow ledges at the Endeavor Ridge, formed during cooling and drainback of basaltic lavas. (Image courtesy of Monterey Bay Aquarium Research Institute; <https://www.mbari.org/science/seafloor-processes/volcanoes/mid-ocean-ridges/>.)

Plains Compositions: The most probable explanation for the morphologies revealed by the Venera landers is that the Venusian plains are basaltic (or broadly mafic, in the sense of low silica content). Venus’ high surface temperatures and pressures contribute to smooth, planar lavas. Canali and channels found within the plains likely fed the plains, and were therefore generated by basaltic (mafic) lavas [6].

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