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Radiating Mafic Dyke Swarms, How Far Can They Go? Insights From Venus.

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Radiating dyke swarms provide key constraints on mantle plume dynamics, magma transport, and lithospheric stress states on terrestrial planets. On Venus, they are identified by preserved surface expressions—grabens, fissures, and fractures—owing to minimal erosion. Radial swarms are widespread and range from <50 km to >2000 km in radius.

Atla Regio, part of the BAT (Beta, Atla, Themis) Region and the proposed Atla "superplume" , is exceptional for three reasons: (1) it forms the locus of four rift arms in a triple-junction configuration, including the ~10,000 km-long Parga Chasmata, likely the longest rift system on Venus; (2) it hosts four major volcanic edifices—Ongwuti, Unnamed, Ozza, and Maat Montes—among the planet's largest edifices; and (3) it contains some of the most extensive spectacular radiating dyke systems, with the Ozza Mons swarm the most prominent. Magellan SAR mapping showed the Ozza swarm extending >2000 km, and the Great Dyke of Atla Regio traceable for ≥3700 km.

In the present work, we expand previous mapping with >80,000 extensional lineaments identified to date, grouped into radial, circumferential, and linear swarms. Our new mapping indicates that Atla Regio radial swarms extend much farther than previously recognized—potentially >8000 km southeastward along Parga Chasmata. This would make Atla Regio the largest known giant radiating dyke swarm on Venus, Earth, or elsewhere in the Solar System, far exceeding the typical 100–1000 km scale of venusian swarms. These structures likely belong to the Ozza Mons swarm, though links to Maat Mons, Ongwuti Mons, or the Unnamed center remain under investigation.

A >8000 km swarm radius exceeds the ~6000 km extent proposed for Artemis Corona, suggesting additional giant swarms may remain undiscovered. Plume heads on Earth or Venus are expected to be ~2000–2400 km across; beyond this boundary, dyke emplacement must be laterally buffered. Thus, extreme dyke lengths imply large, sustained magma reservoirs. On Earth, giant swarms (>300 km radius) are common but fragmented by plate tectonics. Even the largest, associated with CAMP (~2800 km radius), is smaller than 8000 km, implying terrestrial analogs may be underestimated.