

Hotspot Variability: Perspectives From a Planet with no Plate Motion

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The heat loss budget, mantle properties, and convection pattern on Venus are believed to be generally similar to those of Earth. In the absence of plate motion, hotspot on Venus can provide some insight into the nature of mantle plumes. There are approximately 9 Hawaiian-scale hotspots on Venus. Although these features are not perfectly symmetric, they show no evidence of migration. Based on their gravity/topography signature, many of these regions are believed to be active. Their age and duration is unknown. The buoyancy flux required to generate the topographic swells is less than that of most terrestrial plumes, assuming comparable plume durations of up to ~150 m.y. In addition to these large-scale features that resemble terrestrial hotspots, there are approximately 700 widely distributed smaller scale features that are also believed to be mantle upwellings. These features are called coronae, and range in size from 100 to 1000 km, with an average diameter of 300 km. They occur most commonly along fracture or rift zones with little associated strain, but are also found in clusters and as individual features. Several of the coronae clusters occur on broad topographic swells, leading to the suggestion that they resulted from plume head break-up. However, mapping studies in these regions show a long, complex geologic history that is inconsistent with roughly synchronous coronae formation. Due to the small scale of coronae, they may originate at depths considerably shallower than the core-mantle boundary, perhaps at the upper-lower mantle boundary. Coronae in general, and coronae clusters in particular, may represent a good analogy to some terrestrial hotspots that are now recognized to be inconsistent with the fixed hotspot model, such as the Cook-Austral islands (McNutt et al. 1997). Coronae on Venus are the result of deformation of the lithosphere by small-scale upwellings. On Earth, the presence of a low viscosity zone under the oceanic lithosphere may cause extensive spreading of small plumes heads and diffusion of the heating over a broad zone. Thus the deformation and associated volcanism is more broadly distributed and weaker, consistent with the interpretation of McNutt et al. (1997) that tectonic weaknesses are necessary to permit magma to rise to the surface.

McNutt, M.K. et al., *Nature*, 389, 479, 1997.