VENUS CORONAE: FORMATION BY MANTLE PLUMES; G. Schubert[1], D. Bercovici[1], P. J. Thomas[2] and D. B. Campbell[3]; [1]Dept. of Earth and Space Sciences, UCLA, Los Angeles, CA 90024; [2]Center for Radiophysics and Space Research, Cornell University, Ithaca, NY 14853; [3]National Astronomy and Ionosphere Center, Cornell University, Ithaca, NY 14853.

Coronae on Venus are ovoidal features, 150-600 km in diameter, characterized by encircling discontinuous ridges and grooves (1,2), an uplifted region of height 100-800 m above the surrounding terrain (3), and interior lava flows and domes, indicative of volcanic activity (4). Nineteen features satisfying these criteria appear in the high-resolution (1-2 km) radar maps of the northern hemisphere of Venus (90° - 30°N) produced by the Venera 15/16 spacecraft. Their distribution is apparently not random. The majority of identified coronae appear to be clustered around the margin of Lakshmi Planum, possibly a region of volcanic activity (5).

We present data indicating the presence of coronae at high southern latitudes. In the 1983 close approach of Venus to the Earth, the Arecibo observatory radar was used to image a section of the southern hemisphere of the planet (to 68°S). At a resolution of 3 km at least one feature similar in morphology to the coronae observed in the northern hemisphere is apparent. The identified feature is 300 km in diameter and is located at 63°S. The southern hemisphere feature implies that coronae are globally distributed, although a comprehensive map of their distribution must wait for Magellan.

We investigate the possibility that mantle convection processes, in particular, the ascent of mantle plumes and their impingement on the base of the lithosphere, are responsible for forming the coronae. Hot spot volcanism has been suggested as an important mechanism of lithospheric heat transfer for Venus (6) and a possible formation mechanism for coronae (4,7). In this model, uplift of the surface occurs as a result of both buoyant and dynamic support by the plume. Recent numerical simulations of fully three-dimensional convection in a spherical shell mantle indicate that the prominent form of upwelling is the cylindrical plume (8). The number of plumes depends on the amount of internal radiogenic heating relative to the heat flow from the core. Several to tens of plumes are possible; fewer and stronger plumes occur with increased proportion of bottom heating. The dynamic uplift provided by plumes is about a kilometer.

We are currently constructing detailed models of the thermal and mechanical interaction of mantle plumes with a thin, weak lithosphere to determine whether production of topographic and tectonic features similar to coronae is plausible. The detailed behavior of mantle plumes is mainly determined by the strongly temperature-dependent rheology of mantle material. This concentrates ascending plumes into narrow, low-viscosity conduits (9,10). This tendency would be even more marked were the rheological law to exhibit a power-law dependence upon stress. Numerical simulations of plume-lithosphere interactions reveal that significant penetration of the lithosphere by ascending plumes is considerably enhanced both by a "soft" (low activation energy) rheology or a strong pressure dependence of viscosity (11). In any event, surface expression of plume impingement on the base of the lithosphere will be aided by the probably thinner Venusian lithosphere (12).

If coronae do form as a result of mantle plume activity, several important conclusions follow. The plumes are indirect evidence of the existence of Venus' core, because the source of the plumes is instability of a lower thermal boundary layer which is most likely located at a core-mantle interface (13) - (15). The number of coronae, their diameters and surface expressions may allow an estimate of the heat flow from Venus' core and the relative distribution of internal and bottom heating (8). The spatial distribution of coronae provides a map of at least some of the upwelling centers in Venus' mantle. Numerical models of plume-lithosphere interaction in Venus and comparison with surface signatures of coronae can constrain the thickness and rheology of the lithosphere.

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