Surface Processes: Surface processes include eolian, mass wasting, and other processes [16]. Examples where measurements of relief will be useful include (1) analyses of erosion-deposition patterns behind obstacles [16], (2) slopes of erosion-deposition environments, (3) slope stability analyses, and (4) estimates of landslide volumes.

Rheological Analyses: There is a host of applications of relief measurements to the analyses of the rheological properties of venusian flow associated with volcanism [8], impact cratering [7], and debris flows [17]. These applications include flow thicknesses and relations between the flows and the adjacent topography. Lava flow thickness as large as 100 to 700 m have already been measured using parallax [18]. According to Magellan altimetry, bright outflows from impact craters flow up slopes, and flow margins may be 100 m or so above the centers of the outflows. If true, these relations have important implications about the kinematics and rheology of the outflows. Relations between the relief and runout may reveal the rheological properties of venusian landslides [17,19].

Backscatter Functions: A better understanding of the relations between backscatter cross sections and incidence angles can be gained by analyses of given classes of landforms and terrains with variable slopes and sufficient relief for stereometric analyses. Multiple viewing conditions are essential in understanding (1) the forms of the scattering laws, (2) the dielectric properties, (3) the contributions of conducting materials to scattering behaviors, (4) the fine-scale roughnesses, and (5) the contributions of quasispecular and diffuse echoes to average backscatter cross sections of tesserae, impact craters, and volcanic edifices, craters, and flows [20]. An understanding of the above will assist in geologic interpretations of tesserae, impact cratering, and volcanism.

Radarclinometry and Shape from Shading: Once the backscatter functions of the various classes of landforms are established, shape from shading can be used to refine the topography of landforms with stereo-relief data [21], and radarclinometry can be used to estimate the relief and shapes of landforms of the same class where there is no stereoscopic coverage and where the landforms are too small for stereo-parallax measurements.

Topographic Analyses: Radargrammetric reduction of stereoscopic models and radarclinometry (shape from shading) [21] may provide information on the topography of venusian surfaces at slope lengths smaller than those achievable with Magellan altimetry and larger than those obtained by analyses of quasispecular echoes from level surfaces with surface tilts smaller than the image resolution [22]. Derived topographic information includes slope probabilities, power spectral densities, and fractal dimensions.

Altimetry: Radargrammetric reduction of stereoscopic models can confirm, refute, or supplement Magellan altimetry where problems with the altimetry exist. The current problem of the steep slopes of Maxwell Montes is an example, but there are others.

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FLEXURAL MODELS OF TRENCH/OUTER RISE TOPOGRAPHY OF CORONAE ON VENUS WITH AXISYMMETRIC SPHERICAL SHELL ELASTIC PLATES. W. Moore[1], G. Schubert[1], and D. T. Sandwell[2], [1]University of California, Los Angeles CA, USA, [2]Scripps Institution of Oceanography, University of California–San Diego, La Jolla CA, USA.

Magellan altimetry has revealed that many coronae on Venus have trenches or moats around their peripheries and rises outboard of the trenches [1,2]. This trench/outer rise topographic signature is generally associated with the tectonic annulus of the corona. Sandwell and Schubert [3,4] have interpreted the trench/outer rise topography and the associated tectonic annulus around coronae to be the result of elastic bending of the Venus lithosphere (though the tectonic structures are consequences of inelastic deformation of the lithosphere). They used two-dimensional elastic plate flexure theory to fit topographic profiles across a number of large coronae and inferred elastic lithosphere thicknesses between about 15 and 40 km, similar to inferred values of elastic thickness for the Earth's lithosphere at subduction zones around the Pacific Ocean. Here, we report the results of using axisymmetric elastic flexure theory for the deformation of thin spherical shell plates [5] to interpret the trench/outer rise topography of the large coronae modeled by Sandwell and Schubert [3,4] and of coronae as small as 250 km in diameter. In the case of a corona only a few hundred kilometers in diameter, the model accounts for the small planform radius of the moat and the nonradial orientation of altimetric traces across the corona. By fitting the flexural topography of coronae we determine the elastic thickness and loading necessary to account for the observed flexure. We calculate the associated bending moment and determine whether the corona interior topographic load can provide the required moment. We also calculate surface stresses and compare the stress distribution with the location of annular tectonic features.

The model lithosphere is a spherical elastic shell buoyantly supported by a dense internal fluid. Although the model includes membrane stresses, for a planet the size of Venus the buoyant support provides the dominant reaction to the load. The load is modeled as either an axisymmetric disk (uniform loading) or a ring (peripheral loading). Other load geometries may be achieved by superposition. The wavelength of the flexural feature depends only on the thickness of the plate and not on the details of the loading, allowing a unique determination of the elastic thickness from the best-fitting model. Vertical strains are not included so that the vertical displacement at the top of the lithosphere is the same as that at the bottom where the buoyancy forces are acting. This model includes the effects of a distributed load and a continuous lithosphere that are absent in two-dimensional models and that become important when the radius of the load is reduced to a few flexural wavelengths.

The models are fit to the topography using least squares fitting and the relevant parameters are determined from the best-fitting model. For the corona Latona (diameter = 800 km) we reproduce Sandwell and Schubert's [3] value of approximately 30 km for the elastic thickness, demonstrating the agreement of the axisymmetric and two-dimensional models in the case of a large corona. For smaller coronae, we find that elastic lithosphere thicknesses between 10 km and 15 km provide the best fits to the flexural topography (Table 1).

TABLE 1.

Corona Name	Location	Diameter (km)	Elastic Thickness (km)
Fatua	17°S, 17°E	310	15
Selu	43°S, 6°E	300	10
Aramaiti	26°S, 82°E	350	10
Boann	27°N, 136°E	300	5
Latona	20°S, 171°E	800	30

The disk loading model can be used to deduce the gravity signature of a corona. We will report calculations of gravity using the disk loads inferred for the larger coronae and compare with recent gravity data, e.g., over Artemis [6].

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RADAR-ANOMALOUS, HIGH-ALTITUDE FEATURES ON VENUS. Duane O. Muhleman and Bryan J. Butler, Division of Geological and Planetary Science, California Institute of Technology, Pasadena CA 91125, USA.

Over nearly all of the surface of Venus the reflectivity and emissivity at centimeter wavelengths are about 0.15 and 0.85 respectively. These values are consistent with moderately dense soils and rock populations, but the mean reflectivity is about a factor of 2 greater than that for the Moon and other terrestrial planets (in the case of the Earth, regions free of moisture). Pettingill and Ford [1], using Pioneer Venus reflectivities and emissivities, found a number of anomalous features on Venus that showed much higher reflectivities and much lower emissivities with both values approaching 0.5. These include Maxwell Montes, a number of high regions in Aphrodite Terra and Beta Regio, and several isolated mountain peaks. Most of the features are at altitudes above the the mean radius by 2 to 3 km or more. However, such features have been found in the Magellan data at low altitudes and the anomalies do not exist on all high structures, Maat Mons being the most outstanding example. A number of papers have been written that attempt to explain the phenomena in terms of the geochemistry balance of weathering effects on likely surface minerals; see reference [2] and papers cited therein. The geochemists have shown that the fundamentally basaltic surface would be stable at the temperatures and pressures of the mean radius in the form of magnetite,but would evolve to pyrite (FeS_2) and/or pyrrhotite ($Fe_{0.877}S$) in the presence of sulfur-bearing compounds such as SO_2. Pyrite will be stable at altitudes above 4 or 5 km on Venus. The details of the stability of these rather good electrical conductors depends on the availability of O in excess over that tied up in equilibrium with the parent constituent of the atmosphere, CO_2. This is clearly explained in [2]. However, the abundance of the sulfur compound SO_2 is very uncertain and arguments are made that it is actually varying with time on a scale of 10 yr.

Although the geochemical arguments are rather compelling, it is vitally important to rationally look at other explanations for the radar and radio emission measurements such as that presented by Tryka and Muhleman [3]. The radar reflectivity values are retrieved from the raw Magellan backscatter measurements by fitting the Hagfors' radar scattering model in which a surface roughness parameter and a normal incidence electrical reflectivity are estimated. The assumptions of the theory behind the model must be considered carefully before the results can be believed. These include that the surface roughness exists only at horizontal scales large compared to the wavelength, the vertical deviations are gaussianly distributed, there is no shadowing, and that the reflection occurs at the interface of two homogeneous dielectric half-spaces. Probably all these conditions are violated at the anomalous features under discussion! The most important of these is the homogeneity of the near surface of Venus, particularly in highlands. Under the assumptions of the theory, all of the radio energy is reflected by the impedance jump at the very boundary. However, in heterogeneous soil some fraction of the illuminating energy is propagated into the soil and then scattered back out by impedance discontinuities such as rocks, voids, and cracks. In light soils, the latter effect can overwhelm the scattering effects of the true surface and greatly enhance the backscatter power, suggesting a much higher value of an effective dielectric constant that would be estimated from Hagfors' model.

The phenomenon of emission is similar but has several important different characteristics. In the case of thermal emission from a smooth, homogeneous dielectric into vacuum, some of the radiation generated in the effective black body passes through the interface to the observer and a fraction is reflected back downward into the material where it is reabsorbed. In the simple case of an isothermal layer (such as the near surface of Venus), radiating from a homogeneous layer, the emissivity is determined by the Fresnel reflection coefficients at the observing angle to the normal. However, if the layer contains multiple scatterers in a light soil, radiation generated even at small depths cannot reach the surface since the tendency is to scatter the energy backward, similar to the strong backscattering reflection from above such a surface. Thus, the emissivity can be greatly depressed and the observed brightness temperature will be low. This phenomenon for Venus was discussed in 1979 [4] as an explanation for the decrease in the average disk temperature of Venus at wavelengths longward of 10–20 cm.

The most outstanding and relevant example of the importance of multiple scattering or volume scattering in radar and microwave emission are the icy satellites of Jupiter [5]. The radar reflectivity of the full disk of Europa at 13-cm wavelength is 0.65 and the emissivity is about 0.42! Certainly, the surface of Europa is almost pure water ice that, if it existed in the form of dense ice, would have a reflectivity of 0.07 and an emissivity of 0.93. If the Europa ice was in the form of a homogeneous layer, under dense frost the reflectivity would be even lower. It is obvious that the reflection and emission phenomena on Europa are independent of the Fresnel surface reflection coefficients and dependent entirely on the physical structure of the near surface, i.e, the existence of lumps, voids, cracks, etc. It is also very important that ice as cold as 130 K is highly transparent at centimeter wavelengths and very little of the energy is ohmically absorbed in the near surface. If that were not the case, the surface would be a good emitter and a rather poor reflector.

The radiative transfer calculations for the emission and reflection from a layer with volume scattering are very complex, with the