We have explored behavior of this model for a range of the parameters. The time-averaged thickness of the depleted layer is controlled in part by T_{flow}: decreasing T_{flow} to 1000°C reduces this thickness by about 50%. Decreasing T_{ge} to 700°C reduces the time-average thickness of the crust by about 20 km. However, the cyclical variation in depleted layer thickness, along with the accompanying fluctuation in crustal thickness, is a robust feature of the models. Varying the initial temperature by ±200°C and radioactive heating, expressed as a fraction of that required to explain all the Earth's present-day heatflow by radioactivity, by a factor of 2 influences the onset time of this behavior, but the period of the variation remains on the order of 300–500 m.y. for the complete range of conditions considered.

The parameterized convection model assumes that instabilities are globally synchronous. If the instability described by this model is global in scale, it may take the form of episodic plate spreading and subduction. But studies of impact crater densities on Venus [6] and the distribution of volcanic features [4] suggest that resurfacing may occur in patches rather than globally. Localized volcanic resurfacing on Venus may be a consequence of local instability of the lithosphere or alternatively may mean that large, exceptionally hot plumes penetrate even thick, buoyant lithosphere. The Archean greenstone belts on Earth, which are flooded by high MgO volcanics, require similar mechanisms of formation. Komatiites, for example, require potential temperatures of at least 1800°C [9,10] and mean depths of melt segregation of 160–330 km [11], yet average mantle temperatures in the Archean are thought to be only 100°–150°C higher than present [12]. These contradictions are best explained by a model in which komatiites form only in plumes, whereas more typical terrestrial basalts form at spreading centers. The chemical differentiation of Venus described in this study almost demands that komatiite-to-picrite volcanics form the dominant portion of the venusian crust.

References: [1] Dupeyrat L. et al. (1992) *LPSC XXIII*, 319. [2] Parmentier E. M. and Hess P. C. (1992) *LPSC XXIII*, 1037. [3] Smrekar S. E. and Phillips R.J. (1991) *EPSL*, *107*, 582. [4] Head J. W. et al. (1992) *LPSC XXIII*, 517. [5] Solomon S. C. et al. (1992) *LPSC XXIII*, 1333. [6] Phillips R. J. et al. (1992) *LPSC XXIII*, 1065. [7] Turcotte D. L. et al. (1979) *Proc. LPSC 10th*, 2375. [8] Olson P. and Kincaid C. (1991) *JGR*, *96*, 4347. [9] Hess P.C. (1990) *LPSC XXI*, 501. [10] Miller G. H. et al. (1991) *JGR*, *96*, 11849. [11] Herzberg C. (1992) *JGR*, *97*, 4521. [12] Turcotte D.L. (1980) *EPSL*, *48*, 53.

N93-14359

VENUS STEEP-SIDED DOMES: RELATIONSHIPS BETWEEN GEOLOGICAL ASSOCIATIONS AND POSSIBLE PETROGENETIC MODELS. B. Pavri and J. W. Head III, Department of Geological Sciences, Brown University, Providence RI 02912, USA.

Introduction: Venus domes are characterized by steep sides, a circular shape, and a relatively flat summit area. In addition, they are orders of magnitude larger in volume and have a lower height/diameter ratio than terrestrial silicic lava domes [1]. The morphology of the domes is consistent with formation by lava with a high apparent viscosity [2]. Twenty percent of the domes are located in or near tessera (highly deformed highlands), while most others (62%) are located in and near coronae (circular deformational features thought to represent local mantle upwelling). These geological associations provide evidence for mechanisms of petrogenesis and several of these models are found to be plausible: remelting of basaltic or evolved crust, differentiation of basaltic melts, and volatile enhancement and eruption of basaltic foams.

Development of Models: Hess and Head have shown that the full range of magma compositions existing on the Earth is plausible under various environmental conditions on Venus [11]. Most of the Venera and Vega lander compositional data are consistent with tholeiitic basalt [3–6]; however, evidence for evolved magmas was provided by Venera 8 data consistent with a quartz monzonite composition [7]. Pieters et al. have examined the color of the Venus surface from Venera lander images and interpret the surface there to be oxidized [8].

Preliminary modeling of dome growth has provided some interpretations of lava rheology. Viscosity values obtained from these models range from 10^{14}–10^{17} Pa•s [9], and the yield strength has been calculated to be between 10^4 and 10^6 Pa [1], consistent with terrestrial silicic rocks. The apparent high viscosity of the dome lavas suggests that the domes have a silicic composition or must augment their viscosity with increased visicularity or crystal content.

Petrogenetic Models: Sixty-two percent of the Venus domes are associated with coronae, circular features that have been proposed as sites of mantle upwelling, and 20% of the domes are located near tessera, relatively high areas of complex deformed terrain. We have investigated several models that are consistent with these geologic associations. The first case involves the differentiation of basalt in a magma reservoir in the crust, perhaps produced by partial melting within a mantle plume. The second case is melting at the base of thickened basaltic crust, and the final case is volatile exsolution and enhancement within a basaltic magma reservoir. The association of domes with tessera might be explained by crustal remelting, while the association with coronae may be consistent with chemical differentiation of a magma reservoir or the exsolution and concentration of volatiles in the reservoir before eruption.

Chemical Differentiation: High-silica magmas can be produced under reducing or oxidizing conditions, and regardless of whether the crust is wet or dry. If water is present, crystal fractionation of a basaltic magma will produce intermediate to silicic magmas. Differentiation of dry oxidized basalt in a magma reservoir can also produce silica-rich magma, as well as a suite of intermediate composition magmas [10]. The production of immiscible silica-rich melts and ferrobasalts occurs under reducing conditions, but no intermediate magma is produced [10].

Crustal Remelting: The melting of dry tholeiite basalt at pressures of 15–25 kbar or above will result in SiO_2-rich magmas for <20% partial melting [11]. Depths of 53–88 km are necessary so that melting occurs in the eclogite facies where garnet is present as a low-silica phase in the residue. For higher degrees of melting, andesites or basaltic andesites will form. The presence of water would allow the formation of high silica melts at shallower depths since amphibole could replace garnet as a low silica residue. An excess of water would also reduce the viscosity of a high silica melt, making it easier to transport. The volume of crustal melting required to produce one dome would be reduced considerably if tessera represents evolved crust, as proposed by Nikolayeva [7].

Volatile Exsolution/Basalt Foam: Volatile enhancement represents an alternative mechanism for increasing magma viscosity. In this model, magma viscosity is increased by two mechanisms. First, as more vesicles form in the magma, the bubbles have difficulty moving past one another and second, the liquid has difficulty moving along the thin interbubble walls as the vesicles become close-packed. The maximum vesicle content that a lava can sustain without disruption is 75% vesicles; this represents the maximum viscosity increase achievable with this mechanism.

Model Comparisons: One difficulty with the chemical differentiation model involves trying to concentrate large volumes of silicic melt so that the eruption can occur as a single, steady effusion of lava before the magma freezes or is trapped in the crystal mush. It is uncertain whether the low melt fractions will be able to move through the crust to collect in a reservoir. Work by Wickham indicates a threshold of >30% melt for the efficient escape of silica-rich magmas from a crystal mush [12]. If this mechanism is active in forming dome lavas, then this is probably an indication that the dome lavas are of an intermediate composition.

The crustal remelting model has its difficulties, as well. First, the strong correlation of gravity with topography at the scale investigated by Pioneer Venus [13] argues against deep isostatic compensation for many features on the planet. If this is true for tessera blocks, then eclogite would not be expected at the depths necessary for the formation of high silica melts. It is possible that subduction could transport basaltic or eclogite crust to the depths necessary for garnet to be present in the residue [14,15], but it is difficult to invoke this mechanism to explain the global dome distribution. However, if amphibolite is present as the low-silica melt residue, deep crustal melting is not necessary to generate high-silica melts. An additional problem with this model is its inability to explain the presence of domes on the periphery of the tessera, but not in the tessera itself. It seems most likely that the domes would be emplaced directly above the melting region, not hundreds of kilometers laterally displaced from it. It is necessary to develop a mechanism that will transport high-viscosity, silicic magma to the plains surrounding tessera, while simultaneously discouraging the eruption of this same magma in the tessera. An alternative explanation might be that domes are formed in the tessera, but that subsequent tectonic strain has destroyed them, and the domes on the plains survive because they are emplaced in a less tectonically active environment.

The volatile enhancement mechanism will need to be examined more closely to resolve some of the difficulties inherent in the model. First, the exsolution of volatiles should increase pressure in the chamber and prevent further exsolution unless the excess pressure is released. At present, it is difficult to envision a mechanism that allows the concentration of the volatiles into a "foam layer" at the top of the chamber without allowing the volatiles to escape before eruption. Perhaps an uneven chamber roof could trap pockets of volatile-rich foam that are not drawn off by earlier eruptions that release pressure from the chamber. An additional problem is the altitude distribution of the domes. Modeling by Head and Wilson indicates that the necessary shallow magma chambers in which this volatile exsolution could occur are not likely to form at altitudes at or below the mean planetary radius [16].

We have also examined the case of partial melts from the mantle. If the mantle of Venus is similar to Earth's (of a peridotitic composition), it is impossible to generate a silica-rich melt from the direct partial melting of the mantle without some secondary differentiation process occurring. If a buoyant, depleted mantle layer forms under the crust, it will be even more refractory than pristine mantle and will tend to trap rising plumes. This will encourage melting of plumes at the base of the depleted layer, resulting in the production of MgO-rich low-viscosity melts [17].

Conclusions: We have shown that there are at least three plausible models for the petrogenesis of high effective viscosity magmas on Venus, and we have suggested geologic environments in which these different mechanisms might be active. Chemical differentiation and crustal remelting are common mechanisms for generating silicic, high-viscosity magmas on the Earth, and are consistent with dome associations with coronae and tessera respectively. In both cases, further research will be necessary to understand how the magma is able to escape the crystal mush and migrate to the surface. The crustal remelting model has the additional difficulty of the lack of domes in tessera, above the supposed melting region. The volatile exsolution model will require future research in order to determine if a layer enhanced in volatiles can form at the top of a magma reservoir, and if the shallow reservoirs necessary for volatile exsolution can form at the low altitudes at which the domes are found. Further research will focus on refining the models, examining their implications for crustal evolution, and developing tests to determine which are active in different environments on Venus.

References: [1] Pavri B. et al. (1992) *JGR*, special Magellan issue, in press. [2] Head J. et al. (1991) *Science, 252,* 276–288. [3] Surkov Yu. A. et al. (1977) *Space Research, 17,* 659. [4] Surkov Yu. A. et al. (1983) *Proc. LPSC 13th,* in *JGR, 88,* A481–A494. [5] Surkov Yu. A. et al. (1984) *Proc. LPSC 14th,* in *JGR, 89,* B393–B402. [6] Surkov Yu. A. et al. (1987) *Proc. LPSC 17th,* in *JGR, 92,* E537–E540. [7] Nikolayeva O. V. (1990) *Earth Moon Planets, 50/51,* 329–341. [8] Pieters C. M. et al. (1986) *Science, 234,* 1379–1383. [9] McKenzie D. et al. (1992) *JGR*, special Magellan issue. [10] Hess P. C. (1989) *The Origins of Igneous Rocks,* Harvard Univ., Cambridge. [11] Hess P. C. and Head J. W. (1990) *Earth Moon Planets, 50/51,* 57–80. [12] Wickham S. M. (1987) *J. Geol. Soc., London, 144,* 281–297. [13] Anada M. P. et al. (1980) *JGR, 85,* 8308–8318. [14] Head J. W. (1990) *Earth Moon Planets, 50/51,* 25–56. [15] Burt J. D. and Head J. W. (1992) *GRL,* submitted. [16] Head J. W. and Wilson L. (1992) *JGR, 97,* 3877–3903. [17] Parmentier E. M. and Hess P. C. (1992) *LPSC XXIII,* 1037–1038.

N93-14360

DIELECTRIC SURFACE PROPERTIES OF VENUS.

G. H. Pettengill, R. J. Wilt, and P. G. Ford, Center for Space Research, Massachusetts Institute of Technology, Cambridge MA 02139, USA.

It has been known for over a decade [1] that certain high-altitude regions on Venus exhibit bizarre radar-scattering and radiothermal-emission behavior. For example, observed values for normal-incidence power reflection coefficients in these areas can exceed 0.5; enhanced backscatter in some mountainous areas in the Magellan SAR images creates a bright surface with the appearance of snow; and reduced thermal emission in the anomalous areas makes the surface there appear hundreds of degrees cooler than the corresponding physical surface temperatures. The inferred radio emmissivity in several of these regions falls to 0.3 for horizontal linear polarization at viewing angles in the range 20°–40°.

Several explanations have been offered for these linked phenomena:

1. Single-surface reflection from a sharp discontinuity separating two media that have extremely disparate values of electromagnetic propagation. The mismatch may occur in either or both the real (associated with propagation velocity) or imaginary (associated with absorption) components of the relevant indices of refraction, and the discontinuity must take place over a distance appreciably shorter than a wavelength. An example of such an interaction on Earth would occur at the surface of a body of water. At radio wavelengths, water has an index of refraction of 9 (dielectric permittivity of about 80), and an associated loss factor that varies