entirely by lithospheric conduction, then the conductive geotherm may be estimated from the average surface heat flow of 74 mW/m^2 derived earlier. This heat flow is very close to twice the heat flux in old oceanic lithosphere near thermal equilibrium, given as 38 ± 4 mW/m^2 by *Sclater et al.* [1980]. Thus if the Venus lithosphere has a thermal conductivity similar to the average value of 3.1 W/m K adopted for the terrestrial oceanic lithosphere [*Parsons and Sclater*, 1977], then the thermal gradient in the Venus lithosphere is 24 K/km, or approximately twice that in old ocean basins. Geotherms for oceanic lithosphere at equilibrium [*Sclater et al.*, 1980] and for average lithosphere on Venus, assuming that heat transfer occurs solely by lithospheric conduction, are shown in Figure 3.

A consequence of the Venus geotherms shown in Figure 3 is that the lithosphere would be substantially thinner than on earth for comparable material properties of the mantle. The base of the thermal lithosphere in ocean basins is 1350 ± 275°C [*Parsons and Sclater*, 1977]. A temperature of 1350°C would be reached at a depth of about 40 km on Venus according to the geotherms shown in Figure 3. The base of the elastic lithosphere in oceanic regions is well approximated by the position of the 500 ± 150°C isotherm [*Watts et al.*, 1980]. An elastic lithosphere on Venus limited by this same temperature, a value governed by the ductile flow law for dry olivine [*Goetze and Evans*, 1979], would be at most 10 km in average thickness for a purely conductive Venus.

On both of these grounds, it is difficult to envision mechanisms for supporting the 13 km of relief on Venus [*Pettengill et al.*, 1980] for geologically long periods of time except perhaps through shear tractions associated with mantle convective flow. A likely implication, therefore, of the hypothesis that conduction dominates heat transfer on Venus is that all surface topographic relief on scales smaller than the characteristic horizontal scales of mantle convection is geologically young. Preservation of topographic relief for extended periods of time might occur more readily if elevated regions on Venus are

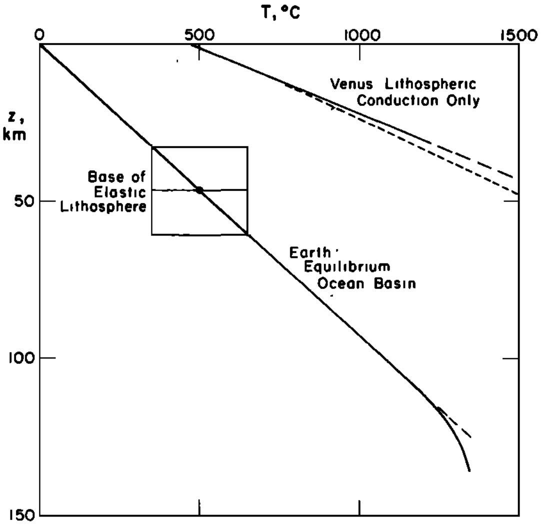

Fig. 3. Average lithospheric geotherms on Venus assuming that conduction is the only mode of lithospheric heat transfer. The solid line shows the case when all of the heat loss from Venus is generated below the lithosphere; the short-dashed curve indicates the case when 15% of the Venus heat loss is generated by radioactivity distributed uniformly in a crust 30 km thick. Also shown are the terrestrial geotherm for an old ocean basin in thermal equilibrium [*Parsons and Sclater*, 1977; *Sclater et al.*, 1980] and the range of isotherms inferred to define the base of the elastic lithosphere in ocean basins [*Watts et al.*, 1980].

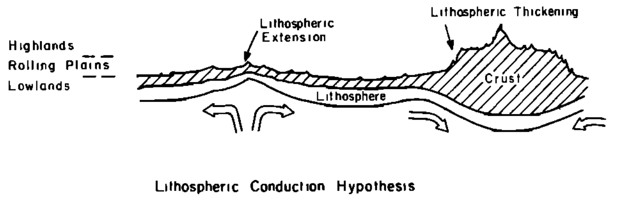

Fig. 4. A schematic illustration of the conduction hypothesis for lithospheric heat transport on Venus. On average, the lithosphere is only about 40 km thick and may be readily deformed by tractions associated with convection in the underlying asthenosphere. Modestly elevated regions in the rolling plains may be areas of recently extended and thinned crust and lithosphere, areas which will subside to lowland elevations during lithospheric cooling and thickening [e.g., *McKenzie*, 1978]. The more elevated highlands may be areas of thickened crust and lithosphere resulting from lithospheric compression.

characterized by a mantle heat flux that is lower than average. That such regionally low values of mantle heat flux could persist for hundreds of millions to billions of years for a planet with lithospheric heat transfer dominated by conduction, however, is unlikely. Alternatively, since the history of the surface temperature is uncertain [*Pollack*, 1971, 1979], topographic relief may have persisted for geologically long periods if the characteristic time for viscous relaxation is comparable to or less than the time since formation of the present atmospheric 'greenhouse.' The viscous relaxation time is unlikely to exceed a few hundred million years [*Solomon et al.*, 1982], however, so this possibility would require a geologically recent greenhouse.

The Venus geotherm shown as a solid line in Figure 3 is based on the simplification that all of the heat lost by the planet is generated beneath the lithosphere. The lithospheric thermal gradient would be lessened if concentration of radioactive heat sources in the Venus crust has occurred, thereby reducing the heat flux from the mantle [e.g., *Phillips and Malin*, 1982]. Since, by the conduction hypothesis, plate recycling and attendant remelting of basaltic crust at subduction zones would not have progressed on Venus to the current stage of concentration of heat sources in continental crust on the earth, a reasonable upper bound to the fraction of Venus heat flux contributed by crustal radioactivity is the terrestrial value of about 15% [*Sclater et al.*, 1980]. A greater concentration of radioactive heat sources into the crust on Venus than on the earth would also be difficult to reconcile with the lower ^{40}Ar abundance in the Venus atmosphere [*Hoffman et al.*, 1980]. With the 15% value assumed for the fraction of global heat loss generated in the crust, the mantle heat flux on a Venus with the same heat loss per mass as the earth would be 29×10^{12} W, and the temperature gradient in the Venus lithosphere would, as shown by the dashed curve in Figure 3, be only slightly modified from that discussed above.

The hypothesis that lithospheric heat flux on Venus occurs principally by conduction cannot be rejected on the basis of presently available information. A schematic illustration of this hypothesis is given in Figure 4, and a summary of the implications for the surface geology of Venus is given in Table 1. The average lithospheric thermal gradients are predicted to be substantially greater, and the lithospheric thickness correspondingly less, than for volcanic mechanisms of heat transport, including both plate recycling and hot spot volcanism. The lithospheric strength and resistance to deformation should generally be less for this hypothesis than for the hypothesis that either plate recycling or hot spot volcanism dominates lithospheric heat transport on Venus. As a result, lithospheric and