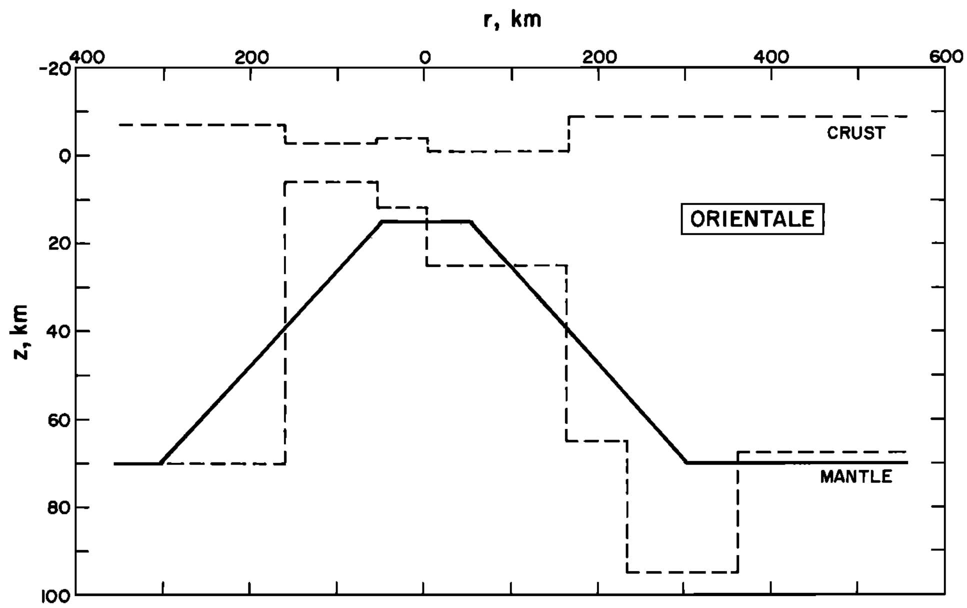

Fig. 8. Structure of the crust and upper mantle beneath Orientale determined from an inversion of gravity and topographic data over the lunar nearside [*Bratt et al.*, 1985*a*]. The dashed line at the base of the crust delineates the Moho as computed in the inversion along a profile from 30°S, 100°W to 5°S, 85°W. The solid line represents an azimuthally averaged Moho profile used in the estimate of isotherm uplift in this paper.

Isotherm Uplift

The shape of the Moho beneath Orientale (Figure 8) provides a measure of the extent of uplift of lower crust and upper mantle during basin formation. This measure is strictly only a lower bound, since the newly formed basin may have been modified by such processes as long-term viscous relaxation. Because Orientale is the youngest lunar basin and preserves a large amount of topographic relief, however, the effects of long-term modification processes are thought to be minor. The uplifted mantle (Figure 8) may be approximated by a truncated cone with an upper radius of 50 km, a lower radius of 310 km, and a height of 55 km. From the estimated age of the basin ($\sim$3.8 b.y.), the ambient temperature profile taken from a global thermal history model [*Solomon and Head*, 1979], and the Moho relief shown in Figure 8, the anomalous temperature field resulting solely from isotherm uplift can be estimated. Figure 9 shows the pre-impact and post-uplift temperature profiles beneath the center of Orientale as well as the anomalous temperature distribution, equal to the difference ΔT between these two curves. At the lunar surface ΔT is nearly 600°C. The initial anomalous temperature field produced by isotherm uplift is shown as a function of r and z in Figure 10. The total anomalous heat contributed by isotherm uplift beneath Orientale is 1.4×10^{32} erg.

A thermal history model for the basin (model A) in which uplift heating is the sole contribution to the anomalous temperature field is illustrated in Figure 10. By $t = 10$ m.y. (Figure 10*b*), much of the heat in the upper 20 km of model A has left the basin region. By 100 m.y. (Figure 10*c*) only about 30% of the initial heat remains. By 500 m.y. (Figure 10*d*) less than 1% of the heat is left. Thus most of the thermal contraction and stress contributed by isotherm uplift will take place within 100 m.y. of basin formation for this model.

The major uncertainties in the contribution of isotherm uplift to basin thermal evolution are the adopted pre-impact temperature profile and the extent and distribution of uplift. It is difficult to assess error in the adopted global temperature profile, but an estimate for the error in the amount of uplift beneath Orientale follows from the uncertainty of about ± 10 km in the crustal thickness beneath the basin center [*Bratt et al.*, 1985*a*]. We have computed the basin thermal histories subsequent to isotherm uplift by amounts 10 km greater and less than for model A; temperatures differ by less than 10% from those shown in Figure 10.

The surface displacements and thermal stresses predicted by model A at several times after basin formation are shown in Figure 11. The center of the basin subsides (Figure 11*a*) about

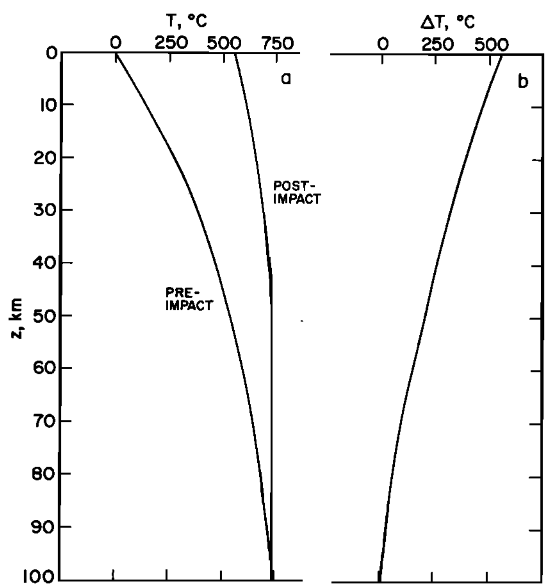

Fig. 9. (*a*) Pre-impact thermal profile 3.8 b.y. ago [*Solomon and Head*, 1979] and temperature distribution beneath the center of the newly formed Orientale basin due only to isotherm uplift. (*b*) Anomalous temperature profile contributed by isotherm uplift beneath the basin center.