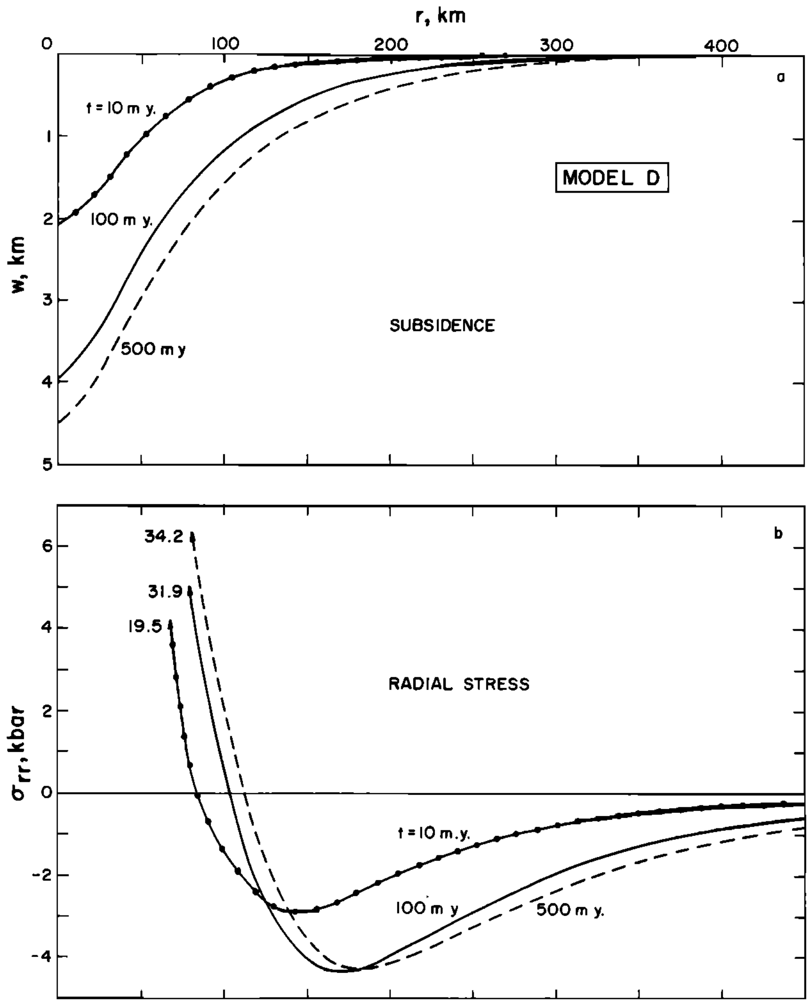

Fig. 17. Surface subsidence w and radial stress σ_{rr} for model D (Figure 16).

uplift (model A). The sum of the subsidence from models A and D accounts for essentially all of the present relief from the base of the central mare to the foot of the inner Rook Mountains. Also, that most of the subsidence occurs at radial distances less than 200 km is in agreement with the observed topographic profile (Figure 2). Since some of the relief of the Orientale central depression may not be the result of thermal contraction, the amounts of cooling and of subsidence in model D should be regarded as upper bounds.

By 100 m.y. after basin formation in model D, accumulated values of σ_{rr} reach nearly final values (Figure 17). This is in agreement with the inferred timing of fissuring in the corrugated and plains facies of Orientale. Near the center of the basin, σ_{rr} and $\sigma_{\theta\theta}$ are compressional and exceed the compressive strength even of unfractured igneous rock at low confining pressure, typically 2–5 kbar [*Brace*, 1964]. Radial stress is most extensional between about 100 and 250 km radial distance. Between 10 and 100 m.y. after basin formation, the predicted location of maximum accumulated extensional stress moves from $r = 140$ to $r = 180$ km. The greatest extensional stress reaches -2 kbar by 10 m.y. and -3 kbar by 100 m.y. Thus even by 10 m.y., σ_{rr} exceeds the extensional strength of unfractured rock at low confining pressure [*Brace*, 1964]. Fissuring is likely within 10 m.y. of basin formation and would be predicted to occur earlier if convective heat transport were included in the thermal model. The location of maximum extensional σ_{rr} in Figure 17 is consistent with the location of the band of fissures (150–230 km radial distance) within Orientale.

Effect of an Elastic Blocking Temperature

As discussed above, material at sufficiently elevated temperatures will not likely contribute significantly to the thermal stress field. This effect has been parameterized with an elastic blocking temperature [*Turcotte*, 1974, 1983] in thermal stress model E depicted in Figure 18. In model E, the anomalous temperature field contains contributions from both isotherm uplift (model A) and impact heating. To determine whether a parcel of material is above or below the elastic blocking temperature T_e, the ambient thermal gradient (Figure 9) must be added to the anomalous temperature. We use a blocking temperature of 800°C, corresponding to the temperature at the greatest depth of earthquakes in terrestrial intraplate settings [*Chen and Molnar*, 1983]. The use of a blocking temperature does not affect the calculated subsidence, which should reflect the combined solutions to the full thermal contraction problem for the isotherm uplift and impact heating cases.

Model E (Figure 18) combines isotherm uplift from model A and impact heating from model D. Immediately following basin formation, temperatures beneath the center of the basin exceed T_e at all depths. During early cooling, thermal stress thus accumulates only in the shallow crust exterior to the regions most extensively heated by the basin formation pro-