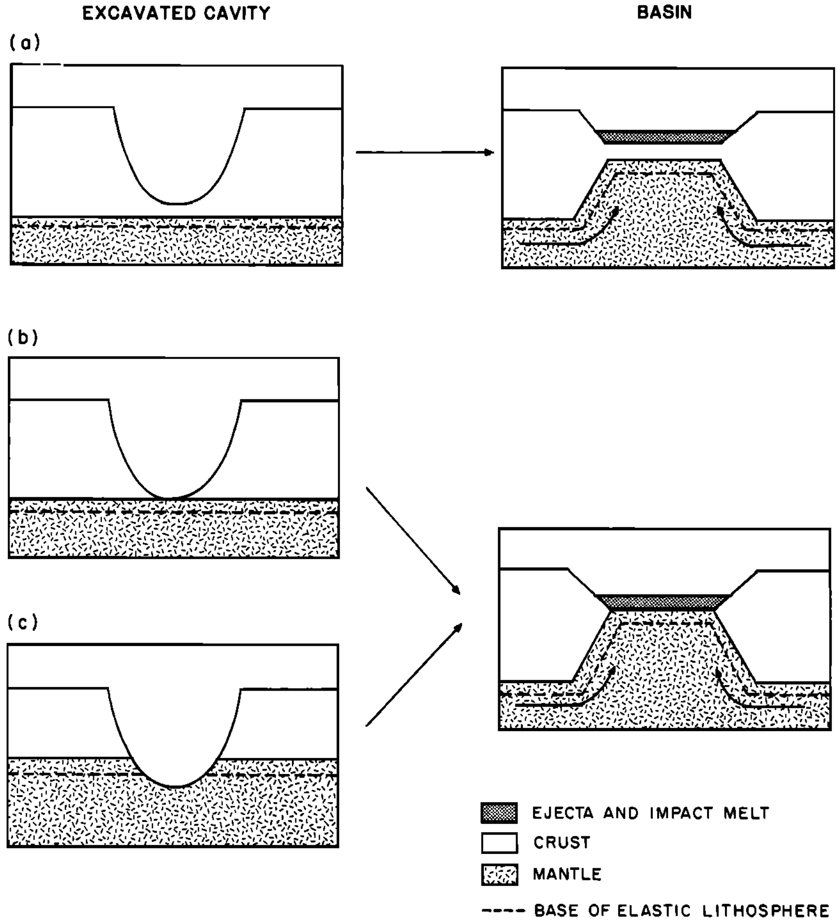

Fig. 11. Three scenarios for the formation of young impact basins formed when the elastic lithosphere is comparable or greater in thickness than the crust. In all cases, uplift of the sublithospheric mantle dominates the late-stage collapse of the transient cavity. (*a*) The excavated cavity is confined to the crust. (*b*) With a larger ratio of crater diameter to crustal thickness the excavated cavity is prevented from extending significantly deeper than the Moho by the relatively greater strength of mantle material. (*c*) With a still larger ratio of crater diameter to crustal thickness the transient cavity may extend into the uppermost mantle. If the preserved nonmare crust beneath the basin center is dominated by fallback of ejected crustal material in the scenarios depicted in Figures 11*b* and 11*c*, it may be similar in thickness for the two cases. Discovery of mantle material among the returned lunar samples would strengthen the possibility of the scenario in Figure 11*c*.

if excavation of the transient cavity for basins 400–600 km in diameter extended to the base of the crust or to the uppermost mantle. If the excavated volumes did not extend at least to near the base of the crust for these basins (Figure 11*a*), then the value of t_c for a basin of a given diameter should be greater for a thicker preimpact crust. The quantity t_c should also decrease with increasing diameter for basins formed in crust of similar thickness. Neither relation is indicated by the values in Table 1. Of course, the youngest six basins in Table 1 may have been affected to varying degrees by long-term viscous relaxation and other modification processes, but it is hard to imagine how such processes would have led coincidentally to the similar present values of t_c. As noted above, the conclusion that excavation of the youngest nearside basins extended to the lower crust has been suggested on independent geochemical and photogeological grounds by *Spudis* [1982, 1983] and *Spudis et al.* [1984].

If we accept that the excavated volumes for the basins in Table 1 extended in depth at least to the lowermost crust, we still must seek a mechanism for the near constancy of t_c. One explanation is motivated by the observation that mantle material is significantly stronger than crustal material at laboratory strain rates [e.g., *Brace and Kohlstedt*, 1980]. If this difference in strength can be extrapolated to the high strain rates thought to accompany cavity formation [e.g., *O'Keefe and Ahrens*, 1977], the Moho may have acted more or less as a barrier to the deepening of cavity excavation (Figure 11*b*). The 20- to 30-km thickness of nonmare crust beneath the central regions of large young impact basins, by this hypothesis, would be a combination of ejecta fallback and crustal material transported laterally during cavity collapse. These two components would be difficult to distinguish.

An alternative explanation for the uniformity of t_c is that the transient cavity for the largest basins excavated through the crust and into the mantle (Figure 11*c*). If the equivalent thickness of preimpact crustal material that fell back into the central basin region was only weakly dependent on basin diameter, then the indicated value of t_c would be similar for basins that had excavated to different mantle depths. Of course, the actual ejecta would have consisted of a mixture of crustal and mantle material, but the inversion procedure we have followed cannot distinguish a thin nonmare crust from a thicker layer with the same volume of low-density crustal rock admixed with mantle material. The paucity of candidates in the Apollo sample collection for material from the lunar mantle [see *Head et al.*, 1975], however, suggests that exca-