100-year 24-hour 25.9 km^2 precipitation frequency values from NOAA Atlas 2 (Miller and others, 1973). A 100-year 24-hour rainfall of 102 mm over the nearly flat area of south-western Arizona and south-eastern California was assumed to be entirely convergence rainfall. Comparable convergence values over minimally orographic portions of the study region were estimated by first applying reductions for effective barrier and elevation. The total 100-year 24-hour rainfall was then expressed as a percentage of this convergence component. This percentage was then applied to the convergence component of PMP to obtain a first approximation to the orographic effects. Implicit in this procedure is the assumption that the orographic and convergence components of PMP have the same relation to each other as the relation between the orographic and convergence components of the 100-year 24-hour rainfall, each appropriately adjusted for elevation and barrier.

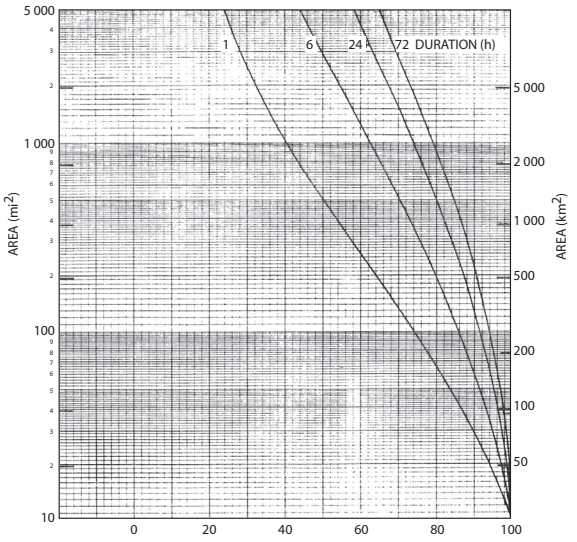

Figure 5.38. Depth–area–duration relaton for orographic region of Missouri and Yellowstone River basins (Miller and others, 1984*b*)

5.3.5.1.1 *Modifications of the first approximation to the orographic precipitation index*

Several factors were used to provide guidance in modifying the first approximation to the orographic PMP index. The first of these were rain ratios for line segments across ridges in the region. The rain ratio is the rate of change in rainfall per 305 m divided by the base elevation rainfall. This rain ratio is one index to the variation of rainfall with elevation and is related to the low-elevation amounts. Various rain ratios were computed based on the 100-year 24-hour rainfall, mean annual precipitation, mean seasonal precipitation, and maximum observed values. A modification of this rain ratio was based upon mean monthly rainfalls adjusted by a frequency of rain versus elevation relation. This ratio was not greatly different from, but generally slightly smaller than, rain ratios not adjusted by the frequency of rainfall relations. Rain ratio profiles were also computed for several major storms in the region. As a basis for a comparison, all ratios were plotted on graphs, using distance from the ridge for the *x*-coordinate Also plotted on the graphs were the terrain profiles. Similar ratios were also computed for the region beyond the ridge to the valley on the lee side. Using this information, the region was divided into three separate terrain categories: (a) most orographic; (b) least orographic; and (c) intermediate orographic.

In the areas of most orographic effects, the gradient of PMP was maintained at about twice the gradient in the rain ratios of 100-year 24-hour rainfall and mean annual precipitation. In the least orographic regions, orographic PMP had a lower limit of 25.4 mm. Orographic rainfall in these regions is attributed to either spillover from upwind regions or the generalized influence of smaller hills that make up a part of most areas classified as least orographic. In intermediate orographic areas, isoline gradient was maintained at about the same as for the rainfall ratios. Figure 5.39 shows a portion of the orographic index PMP map for southern Arizona, south-western New Mexico and south-eastern California.

5.3.5.2 Variation with basin size

In a previous study (United States Weather Bureau, 1961*a*) using the orographic separation method, variation with basin size was related to steepness, height, length, orientation and exposure of each slope to moisture bearing winds. The assumption is that there is a limit to the lateral extent over which moisture can be transported over mountain slopes without a decrease in intensity. This decrease was assessed by a study of the variation of pressure gradients with distance between stations that take pressure observations. In the inter-mountain portion of the western United States, inflow from several directions must be considered in determining the magnitude and gradient of orographic PMP for the entire storm period. For any particular 6-hour period of the PMP storm over a given drainage, however, the winds would generally be from one direction. Thus, they would have their maximum orographic influence on slopes normal to that direction only. An approximate method was determined to take into account both the reduction due to a lateral