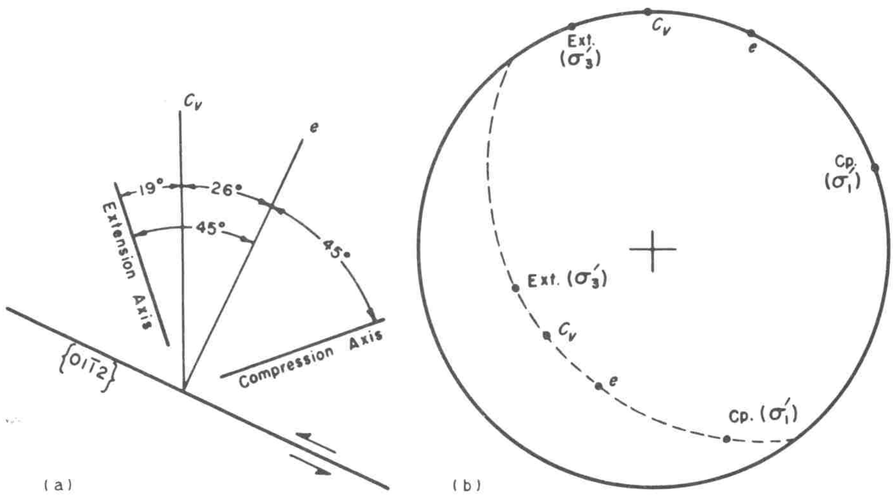

Fig. 25—Diagrams illustrating the orientation of the axes of compression (σ_1') and extension (σ_3') that would be most effective in causing twin gliding on e{01$\bar{1}$2} in calcite. (a) The plane of the diagram is perpendicular to the gliding plane and contains the gliding direction, the c_v, and the normal to the gliding plane (e). (b) Lower hemisphere, equal-area projection of the relationships in (a) are shown for two differently oriented cases.

therefore, the positions of σ_1' and σ_3' for $S_o = 0.5$ can be determined (Fig. 25(b)) by measuring and plotting e_1 and c_v.

Twinning can, of course, be initiated for S_o values less than 0.5 as long as τ_c is exceeded and the correct sense is maintained. For example, the average S_o value is 0.27 for the twinned calcite cement of an experimentally deformed sandstone.(59) Turner's technique utilizes $S_o = 0.5$, however, because this value allows unique location of the principal stresses. (There are an infinite number of possible orientations for the stress axes for $S_o < 0.5$.) Moreover, there is a good empirical relationship between the amount of twinning and S_o values. In experimentally deformed Yule marble and Hasmark dolomite, the greatest amount of twinning occurs on that set of twin gliding planes for which the resolved shear-stress coefficient was highest (Fig. 26).(52,106)

The technique using calcite twin lamellae to derive the orientations of the principal stresses in a rock consists of the following steps. (1) The orientation of the best developed set of twin lamellae and the host c_v in each grain are determined by universal-stage

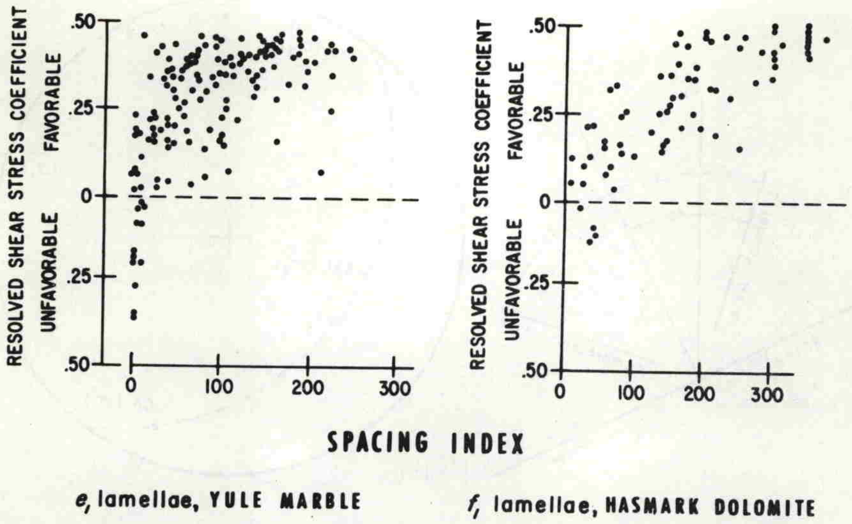

Fig. 26—Plots illustrating the relationship between e_1 and f_1 twin-lamellae spacing indices and S_o values for these planes as calculated from the known stress orientations in experimentally deformed Yule marble and Hasmark dolomite, respectively (from Turner and Ch'ih, Ref. 106, Fig. 6; and Handin and Fairbairn, Ref. 52, Fig. 6, respectively). Twin-lamellae spacing index is defined as the number of lamellae per millimeter when viewed on edge.

measurements. (2) These data are plotted in equal-area projection, and the compression and extension axes are located for each grain as outlined above. (3) The data measured in two or more mutually perpendicular thin sections are combined into a composite diagram, and the resulting orientation pattern is interpreted as reflecting the average orientation of σ_1 and σ_3 in the rock at the time twinning took place. Friedman[59] has found good agreement between the derived position of σ_1 and the known orientation of σ_1 in experimentally deformed calcite-cemented sandstones (Fig. 27).

A readily visible example of this technique is described by Friedman and Conger.[112] Calcite crystals within the walls of a naturally deformed fossil shell (Fig. 28) exhibit in thin section a systematic development of e twin lamellae. In transverse section the walls are elliptical and the crystals along two opposite sides of the ellipse (each encompassing 120 degrees of arc) are profusely twinned, whereas those along the two remaining 60-degree arcs are sparsely twinned. Calcite c_v are oriented radially. Fig. 29(a) shows that the preferential development of twin lamellae probably depends on favorable