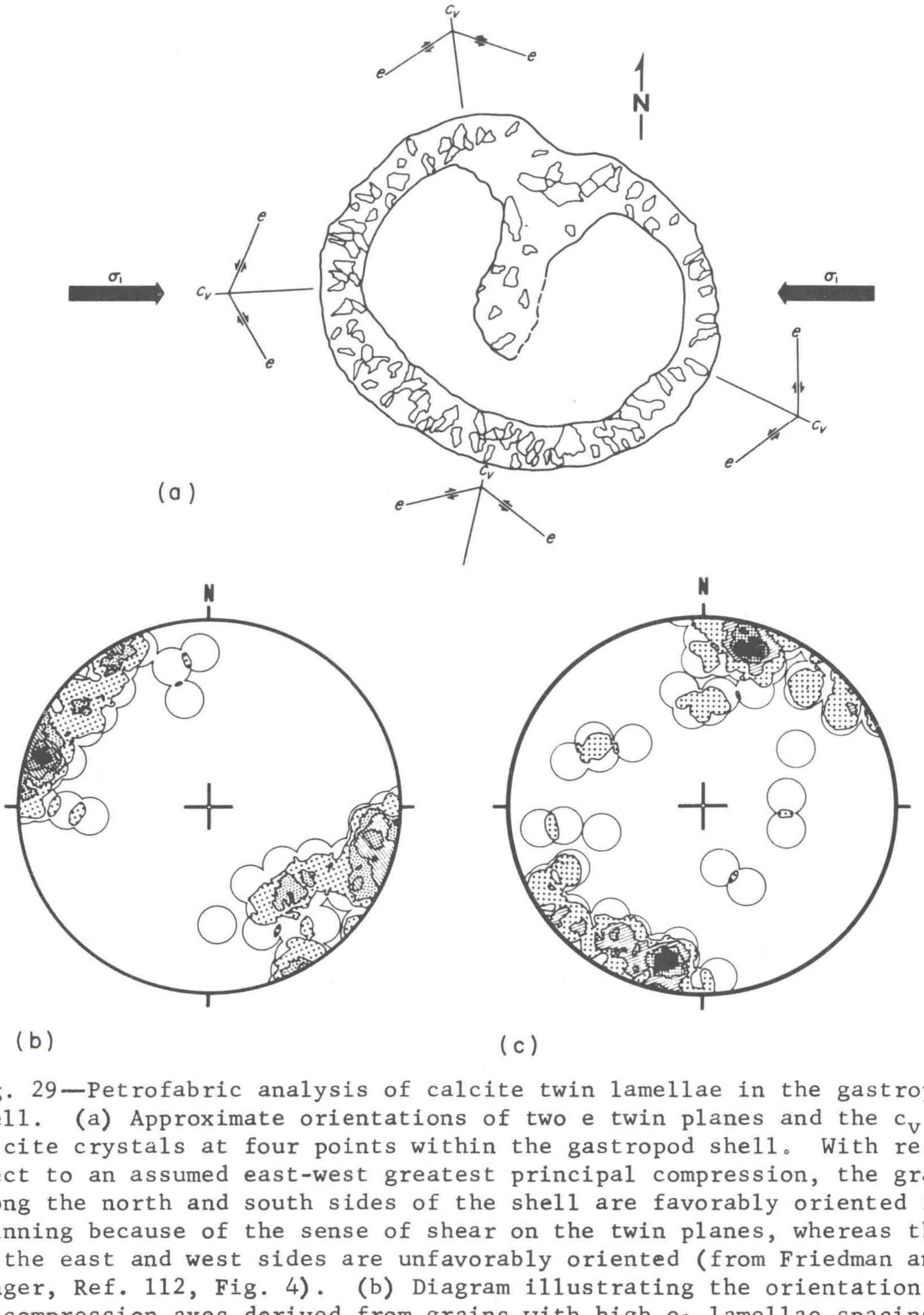

Fig. 29—Petrofabric analysis of calcite twin lamellae in the gastropod shell. (a) Approximate orientations of two e twin planes and the c_v in calcite crystals at four points within the gastropod shell. With respect to an assumed east-west greatest principal compression, the grains along the north and south sides of the shell are favorably oriented for twinning because of the sense of shear on the twin planes, whereas those on the east and west sides are unfavorably oriented (from Friedman and Conger, Ref. 112, Fig. 4). (b) Diagram illustrating the orientation of 70 compression axes derived from grains with high e_1 lamellae spacing index. Plane of the diagram is parallel to bedding with north as indicated for bedding unfolded. Contours are at 1.4, 2.9, 5.7, 8.6, 11.4, and 14.3 per cent per 1 per cent area, 15.7 per cent maximum (from Friedman and Conger, Ref. 112, Fig. 8b). (c) Diagram illustrating the orientations of 70 extension axes derived from same grains as in (b). Diagram oriented same as in (b). Contours are at 1.4, 2.9, 5.7, 8.6, and 11.4 per cent per 1 per cent area, 14.3 per cent maximum (from Friedman and Conger, Ref. 112, Fig. 9b).

those twin lamellae formed during the last stages of deformation yielded consistent results, and that the lamellae formed earlier were disturbed by later differential movement of the grains and so gave inconclusive, nearly random stress patterns.

This brief review emphasizes at least two difficulties encountered in applying this technique to metamorphic rocks. (1) The rocks have probably undergone recrystallization during deformation such that the observed twin lamellae relate only to the latest phase in the deformation history. Clearly, this limits the usefulness of highly deformed calcite. (2) In marbles the c_v of the grains are typically strongly oriented at high angles to the foliation. As a result the orientations of the derived compression and extension axes are restricted by the c_v subfabric. Only when the grains in a rock are randomly or diffusely oriented can one equate the derived compression and extension axes to the principal stresses σ_1 and σ_3.[117]

The study of calcite twin lamellae in slightly and moderately deformed rocks (which are relatively free of the recrystallization and the strong c_v orientation effects) has only recently been initiated. Nickelsen and Gross[118] extended the technique to study two low-grade metamorphic, sandy textured, carbonate rocks from the Ordovician Conestoga formation in Pennsylvania. They found concentrations of compression axes in a broad zone whose center was approximately normal to a slaty cleavage. According to the authors this agreed very well with the observation that grains, pebbles, and boulders were flattened parallel to the cleavage. In addition, the authors positioned the axes that corresponded to the bisectors of the acute angles between the two gliding lines for grains in which two sets of lamellae were developed. This gave a similar compression axis orientation pattern.

Conel[119] determined compression and extension axes in two specimens within a single bed of folded limestone (Fig. 30). His specimens were collected from the trough portion of a syncline--one near the top of the bed and the other near the bottom. In the former, compression axes are strongly grouped normal to the fold axis, whereas in the latter, the compression axes are strongly grouped normal to bedding. Conel concluded that these orientations were analogous to those expected from elastic analyses of bent plates.