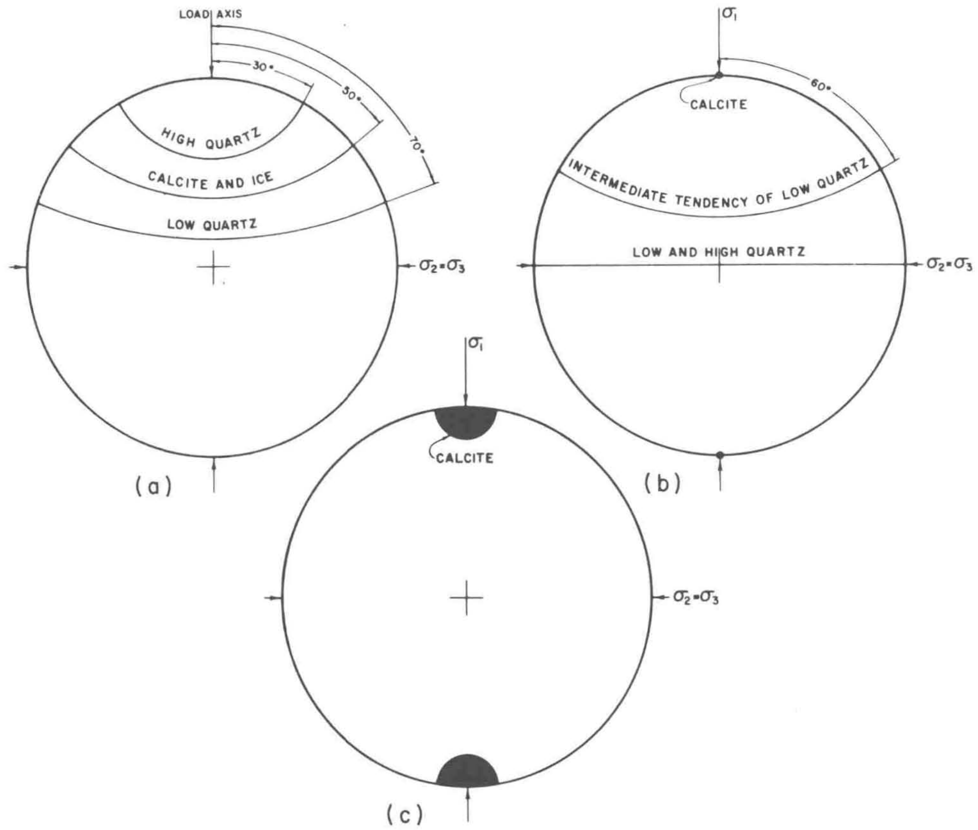

Fig. 47—Stereograms showing the predicted (a and b) and the experimentally determined (c) orientations of c_V in minerals recrystallized under a uniaxial state of stress (stereographic projection). (a) Orientations of c_V predicted by MacDonald[165] and calculated by Brace (Ref. 169, Fig. 4) for calcite, ice, high and low quartz. (b) Orientations of quartz and calcite c_V predicted by Kamb[167] for recrystallization in the presence of a fluid phase. (c) Orientation of calcite c_V produced in experiments as a result of syntectonic, dry recrystallization.

normal to σ_1 (Fig. 47(b)). Moreover, low quartz is considered by Kamb to be unique among the common hexagonal and rhombohedral minerals in that the theory predicts "intermediate" orientation positions. For the case $\sigma_1 > \sigma_2 = \sigma_3$, the c_v will tend to lie along a small girdle at about 60 degrees to σ_1; and for $\sigma_1 = \sigma_2 > \sigma_3$, the c_v will tend to develop a small girdle at about 29 degrees to σ_3. Kamb also extends Gibbs' theory to predict orientations under conditions of dry recrystallization. He finds that if the initial grain shapes are equant, the most stable orientation for most hexagonal or rhombohedral crystals is such that their axes of least elastic modulus tend to lie normal to the unique stress axis (whether tensional or compressional). This orientation is directly opposite to that predicted for recrystallization by solution and redeposition. On the other hand, if the dry grains are initially much flattened normal to the load axis, the orientations would be reversed, and therefore identical wet or dry. If Kamb's view is correct, one must know the mechanism of recrystallization before applying his theory.

Although the thermodynamic approach holds great promise, the predictions of MacDonald and Kamb differ widely. Furthermore, they are based on infinitesimal strain. At present, they cannot be applied to geologic problems.

Experimental Approach. A most important experimental result has been the dry recrystallization of calcite and quartz under simulated geological conditions, since previously most geologists had seemed to regard the agency of solutions as necessary for metamorphic recrystallization.* Syntectonic recrystallization occurs during the course of triaxial compression or extension tests, i.e., during deformation. Annealing recrystallization (familiar in metallurgy) occurs when an aggregate is first deformed at low temperature (cold-worked) and then held at an elevated temperature to accelerate the process. Presumably there is a critical temperature below which annealing recrystallization does not take place regardless of the duration of heating.[171] This temperature decreases as the initial strain is increased. Syntectonic recrystallization appears to occur not only above some critical temperature, but also below some temperature above which strain energy is annealed out faster than it can be stored.

Syntectonic recrystallization of calcite was first observed in specimens of Yule marble deformed at 300°C and at 5-kb confining pressure.[108] The evidence is intergranular flow and development of textures closely resembling those of naturally deformed marble. In specimens deformed at 400° and 500°C[110] the evidence is augmented by the development of small lobes and lensoid streaks in which new optic axes, differing from those of the host grains, tend to parallel the

*See Refs. 43, 108, 110, 143, and 170.