Preferred Orientation of Constituent Crystals or Grains

In the section on crystal orientation it was noted that the physical and mechanical properties for the individual crystal varied with crystallographic direction. It follows that the behavior of a rock is strongly dependent upon any preferred (nonrandom) crystallographic orientation of the constituent crystals or grains. The orientational anisotropy in Yule marble is an excellent example. This marble is characterized by a strong concentration of calcite c axes oriented at high angles to a weakly developed macroscopic foliation. Accordingly, compression parallel to or extension normal to the foliation tends to promote e twin gliding (the "easy" gliding system) in the individual crystals. For opposite loading orientations r translation is favored. As the critical resolved shear stress τ_c for e twin gliding is much less than that for r translation at low and moderate temperatures, the yield stresses for the crystals are correspondingly affected, and the Yule marble shows the qualitatively predictable strength anisotropy (Figure 4). This anisotropy tends to diminish with increased temperature as τ_c for r translation decreases toward that for e twin gliding (Figure 2).

Brace (1965) has shown quantitatively that the variation in measured values of linear compressibility in ten rocks are in close agreement with the variation calculated from preferred orientation, modal analyses, and crystal properties. Moreover, measured values of thermal expansion and conductivity for Yule marble are in close agreement with those predicted from the fabric. In these studies Brace applied a weighting factor to calculate the contribution of each crystal to the bulk anisotropy of the rock. Further, Christensen (1965) demonstrated that velocity anisotropy in metamorphic rocks is related to mineral orientation.