This orientation pattern can be used to position the principal stresses if it is characterized by groups or concentrations of normals which define planes that can be related to patterns expected from previous experience.

For example, if θ is 30 degrees, the geometric relationships between shear and extension fractures for the general state of stress are shown in Fig. 8(a). By comparison to this configuration all three principal stresses can be located from the observed subfabric orientation pattern (a) if it exhibits three planar sets intersecting in a nearly common line and inclined at 30 and/or 60 degrees to each other, or (b) if it shows two sets of features intersecting at about 60 degrees (two conjugate faults). Frequently, partial geometries are encountered, perhaps in part because all elements of the basic geometry (Fig. 8(a)) do not always form. Accordingly, the pattern observed at any one locality may consist of any or all parts of the basic configuration. Indeterminate cases occur if the pattern consists of two elements intersecting at about 30 degrees or if a single concentration results. In the former case, it is not clear whether one is dealing with two conjugate shear fractures of small dihedral angle[69] or a set of extension fractures and a set of one of the potentially conjugate faults. At best, one can state only the orientation of σ_2 (parallel to the line of intersection) and, therefore, define the plane containing σ_1 and σ_3. In the case of a single concentration, one can not determine whether the concentration is related to a set of shear fractures or to a set of extension fractures. Ambiguities in the subfabric for a single locality can frequently be resolved by comparison with fabric data from other neighboring localities in similar structural positions where the pattern is unambiguous. Similar comparisons of observed fracture orientation patterns with expected patterns for the states of stress $\sigma_1 > \sigma_2 = \sigma_3$ and $\sigma_1 = \sigma_2 > \sigma_3$ lead to determinations of the unique principal stress only.

Along with the orientation data, information is sometimes available on the sense of shear along faults or shear fractures. Shear criteria permit reliable determination of principal stress directions provided the observed offset occurred at the time of faulting, the slip direction of the movement is known,* and the value of θ is known or can be determined experimentally. Given these facts one can determine (1) that σ_2 lies in the plane of the fault at right angles to the slip direction, (2) that σ_1 is inclined at θ degrees to the fault in the direction appropriate for the observed sense of shear and lies in the plane that is normal to the fault surface and contains the slip direction, and (3) that σ_3 lies in this same plane at 90 degrees to σ_1. Valid sense of shear criteria also permit resolution of the pattern consisting of two elements intersecting at a small dihedral angle. Observations of a consistent sense of shear displacement along one of the features and none along the other implies that the former is a fault and the latter an extension fracture set, provided the extension fracture set is disposed appropriately with respect to the observed sense of shear on the fault. Similarly, if consistent and opposite senses of shear are observed on each of two sets of features they can be recognized as two conjugate faults of low dihedral angle. Once the fractures and faults have been recognized, the derivation of the principal stresses follows from the basic relationship in Fig. 8(a).

Certain morphological features on the surfaces of macrofractures and faults have been investigated by a number of workers as possible criteria for the distinction between extension and shear failure. Three types of features have been recognized: slickensides, plumose structure, and conchoidal structure.[70-78] Unfortunately the genetic implications of these features are not well understood.

Clearly, slickensides (polished and striated surfaces) indicate offset parallel to the walls of the fracture or fault. They can not, however, be regarded as generally reliable criteria because they record only the last movement along the surface. Conceivably the surface of an extension fracture (initial movement normal to the fracture walls) may be slickensided as a result of later movements parallel to the walls. Plumose structure consists of grooves and ridges on a rock surface. There is a central axis into which barbs or plumes converge

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*Direction of slip along a fault is needed only if one fault or one set of faults is present. For those cases involving intersecting conjugate elements, the line of intersection is parallel to σ_2 and normal to the slip direction.