PETROFABRIC TECHNIQUES FOR THE DETERMINATION OF PRINCIPAL STRESS DIRECTIONS IN ROCKS

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Introduction to Petrofabrics

PETROFABRICS (from Gefügekunde der Gesteine[1]) is an important geological discipline which can provide knowledge on the state of stress associated with naturally deformed rocks. According to Turner's interpretation (Ref. 2, p. 149) of "Gefüge" (fabric), petrofabrics is the study of all structural and textural features of a rock as manifested in every recognizable rock element from the configuration of the crystal lattices of the individual mineral grains up to and including large-scale features which require field investigation. The fabric of a rock, therefore, is extremely complex, is seldom completely specified, and is developed throughout the entire history of the rock. An undeformed sedimentary rock, for example, has a fabric which relates to its depositional and diagenetic histories. For instance, the long axes of detrital grains, flute casts on bedding planes, and cross beds are fabric elements related to current directions during sedimentation. Permanent deformation of this rock (Ref. 3, p. 3) modifies the initial fabric and introduces many new fabric elements. These may range in size over at least 15 orders of magnitude from changes in the crystal lattices (10^{-9} m = 10 Å) to deformation of the rock into great folds and faults of mountain ranges and basins (10^{6} m). Although many kinds of elements can be distinguished, in practice a few easily measured ones are chosen which are thought or are known to be critical to the problem at hand. Those recognized as criteria of deformation include a variety of crystallographic parameters, deformation lamellae, kink

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bands, lineations, fold axes, fractures, faults, and other planes of mechanical discontinuity. The spatial array of any one of these elements is called a "subfabric" (Ref. 4, p. 863), and the measurements that specify their orientation and distribution are termed "fabric data." Petrofabrics consists, therefore, of a descriptive phase in which the fabric elements are recognized, measured, and illustrated, and an interpretive phase in which the rock fabric serves as a basis for explaining the deformation history either kinematically or dynamically (Fig. 1).

Tectonically significant fabric elements have been recognized and the techniques for their study perfected primarily through the efforts of Professors Sander and Schmidt, their co-workers, and students in Germany and Austria, and Professors Knopf, Turner, Ingerson, Phillips, and Weiss, their co-workers, and students in the United States and England. The subject has evolved from the study of complexly deformed terrains for which normal field mapping methods did not provide structural resolution. In recent years several commonly occurring fabric

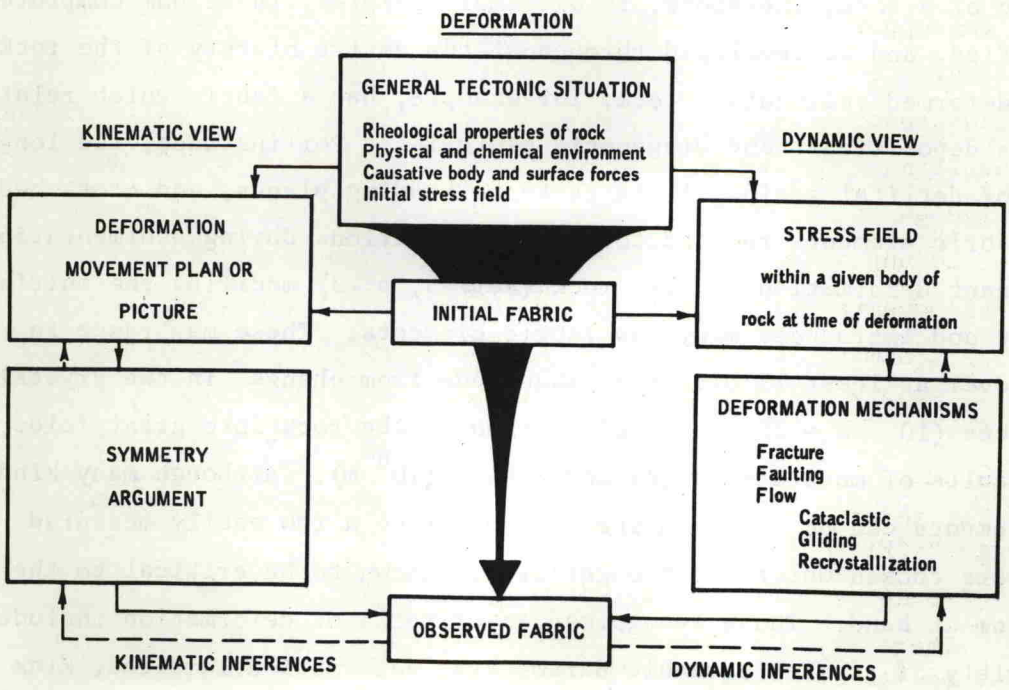

Fig. 1—Geologic deformation from the viewpoints of kinematic and dynamic petrofabrics.