

INTEGRATING A COMPLETE MECHANICS INTO THE STRUCTURAL GEOLOGY CURRICULUM

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We recommend that undergraduate and graduate-level courses in structural geology be based on the interplay of field and laboratory observations and the conceptual framework for understanding the process and products of rock deformation provided by a complete mechanics. The latter replaces the traditional and incomplete presentation of stress, strain, and rheology that leaves out their quantitative linkages.

The continuum version of Newton's 3rd Law (stress at a point) is followed up with the continuum version of Newton's 2nd Law (the stress equilibrium equations). The role of stress in Newton's 3rd Law permits a clear understanding of traction boundary conditions. Armed with these conceptual tools, one may discuss continuous stress distributions or stress fields and these replace the commonly used "regional stress." The arena for classroom discussions is concrete physical space rather than abstract stress space, as represented in Mohr's circle.

Infinitesimal strain plays a central role in the important topics of elastic deformation and the inception of brittle failure. However, strain is absent from the formulation and analysis of a process of rock deformation by flow, although an observed distribution of strain affords a key constraint on mechanical models. Both velocity and strain are essential parts of kinematics, and the origin of strain as an integral over the history of the velocity field, through the velocity gradient tensor, should be made clear. In the current teaching literature, strain is elevated to a causative principle – an *élan vital* – through the use of phrases such as "the strain was partitioned," which evokes the image of a river separating into two distributaries of 'Trans' and 'Pression'; such a river does not exist.

The rate of deformation (not strain rate) plays the central role in constitutive relations for flow, such as that for the Newtonian viscous fluid. A complete mechanics, consisting of Newton's 3rd and 2nd laws, kinematics, and constitutive relations is used to model the evolution of low-amplitude folds in transpression or transtension. The causative agents of the folding process, as in laboratory-generated or natural fold arrays, may then be appreciated. The methodology is illustrated by discussing the formulation and analysis of the model and application of its results to natural folds.