2006 Philadelphia Annual Meeting (22–25 October 2006)

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WHAT SHOULD BE BALANCED IN THE CONSTRUCTION AND RESTORATION OF CROSS SECTIONS?

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Advances in 3D seismic reflection surveying, in the power of desktop computers, and in the availability of computationally-robust software support the development of the next generation of cross section construction and restoration tools. While the challenge of quantifying magnitudes of deformation in diverse tectonic settings could be attributed to inadequate data, hardware, and software in the past, the challenge today is to integrate a complete mechanics into the methodology.

As an example we review the classic reconstruction of the Sprüsel fold from the Jura Mountains of Switzerland by Laubscher based upon conservation of line length and area. This methodology is compared to a geomechanical reconstruction using the finite element method (FEM) and based upon conservation of mass in which the material time derivative of density balances the product of mass density and the divergence of the velocity field. In Laubscher's reconstruction the Mesozoic strata are kinematically constrained to form two complementary kink bands terminating downward at a mobile layer resting on a detachment at the top of a rigid basement. The FEM analysis is based upon conservation of linear and angular momentum in which the product of density and the material time derivative of velocity balances the resultant surface and body forces. The kinematics of folding and deformation of the mobile layer and basement follow from these laws of nature rather than being pre-supposed. The equations of motion, derived by combining the conservation laws with appropriate constitutive laws, can be solved to extract deformational histories from diverse tectonic environments so one can compare model rates and geologic rates of deformation.

We offer three examples to illustrate the power of the geomechanical methodology: 1) restoration of detached sedimentary strata over salt from the North Sea extensional province to evaluate the evolution of the salt body and associated structures through time; 2) restoration of normal faults of the Rhine graben to mechanically validate the structural interpretation and relationships between intersecting normal faults; and 3) restoration of contractional structures in the deep-water fold and thrust belts of the Niger Delta, to elucidate thrust fault propagation and quantify the magnitude of shortening.

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