Predicting folding by optimization

Leroy (1) Y. M. and B. Maillot (2)

(1) Laboratoire de Géologie, CNRS UMR 8538, Ecole Normale Supérieure, France
(2) Département GÃl'osciences et Environnement, Université de Cergy-Pontoise, France

The objective of this seminar is to present a simple procedure, compared to the finite-element method, to select and optimize the dominant mode of folding and to construct thrusting sequences in fold-and-thrust belts and accretionary wedges. Mechanical equilibrium as well as the rock limited strength are accounted for.
The *first* part of the procedure consists in estimating the upper bound on the tectonic force with the application of the maximum strength theorem (Maillot and Leroy, 2006), which is at the core of the external approach of limit analysis. The structure geometrical features are optimized to obtain the least upper bound on the tectonic force. The optimization is conducted at the onset of folding but also during the development of the geological structure. For example, it is shown how the normal sequence of thrusts in an accretionary prism is interrupted by an out-of-sequence thrust (Cubas et al., 2008).
The *second* part of the procedure is based on the application of the Equilibrium Element Method (Krabbenhøft et al., 2005), which is a numerical solution to the internal approach of limit analysis. The optimum stress field provides the lower bound on the tectonic force. The example discussed is the fault-bend fold composed of a block gliding over a flat dÃl'collement and with a single pre-defined ramp. Activation of the whole décollement and the ramp requires localized failure in the bulk, typical of a back-thrust rooted at the base of the ramp (Souloumiac et al., 2009).
The experimental validation in the laboratory of the *first* part of the procedure is conducted with sand, the ideal analogue material for frictional, upper-crustal rocks. Theoretical predictions and observed thrusting sequences are compared with an inverse problem formalism to provide probability distributions of mechanical parameters. The small computer-time cost of the direct approach renders possible the exploration of the complete material parameter space with the help of a computer grid.