Geophysical Research Abstracts, Vol. 8, 04508, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04508

Kink-fold kinematics constrained by rheology and mechanical equilibrium

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

(1) Département des Sciences de la Terre et de l'Environnement, CNRS UMR 7072, Université de Cergy-Pontoise, France, (2) Laboratoire de Géologie, CNRS UMR 8538, Ecole Normale Supérieure, Paris, France (leroyy@geologie.ens.fr)

This work is part of a research effort to account for rock rheology and mechanical equilibrium in geometrical models of folds. The main idea is to apply the maximum strength theorem [1] to optimize the geometry. It is considered here for the case of a kink-fold [2]. The structure of interest occupies initially a rectangular shaped domain and is composed of many horizontal thin beds of equal thickness with low friction interfaces. It is subjected to a horizontal compressive force. The postulated fold kinematics relies on the existence of two conjugate kink bands, each with two parallel hinges, separating the structure in three rigid blocks. The central block moves upwards, the two side blocks move sideways, by distances defining the fold amplitude and the horizontal shortening, respectively. Inside the kink bands, the beds undergo rigid body rotations and translations. Internal work is assumed to be performed only by bedding slip within the kink bands, and by opening, shear, or compaction, along the hinges. Slip along bedding is controled by the Coulomb criterion. The hinges crossing the bedding have also a strength domain of a Coulomb type with the addition of a closure in in compression to account for compaction deformation mechanisms. The dips of the hinges (hinge dip) and of the beds within the kink band (kink dip) are optimized for every fold amplitude to provide the least upper bound in the compressive force in terms of the maximum strength theorem.

The kink band initiates as a sub-vertical compaction band of finite thickness (proportional to the bed thickness times the sine of the friction angle over the beddings). It rotates rapidly, decreasing the hinge dip and increasing the kink dip such that their sum is always complementary to the friction angle over the bedding. The pin point, separating opening from compacting regions along the hinge crossing each bed, migrates

from the bottom of the bed – pure compaction at the onset – towards a position at 80 % of the bed thickness – development dominantly controled by opening. This shift between these two mechanisms is accompanied by a sharp drop of the compressive force, thus illustrating the strong imperfection sensitivity of the onset of kink folding. After the onset, development is marked by a thickening of the kink band by outward migration of the hinges, with an approximately constant dip.

Limb rotation (i.e., increasing kink dip around fixed hinges) and kink band migration (i.e., migrating hinges at constant kink dip) are the two end-member models of the geometry of natural kink folds. Limb rotation and hinge migration are predicted to be equally combined at the early stages of the folding (for amplitudes up to 20% of the total unfolded thickness), and the latter is taking on most of the shortening when folding is well developped. These findings should help to interpret the detailed evolution of the geometry of kink folds. For example, the two geometrical interpretations provided in [3,4] of the Sant Llorenç de Morunys fold (Eastern Pyrenees, France), recorded by growth strata, could be compared in terms of mechanical efficiency (i.e., the intrepretation leading to the least upper bound in tectonic load is the most plausible). These field studies highlight in turn the need to incorporate erosion/sedimentation in our theory to provide predictions of growth strata geometries that account for changes in the mass balance.

In conclusion, it is noted that such combination of postulated fold kinematics and the application of the maximum strength theorem to optimize the structure can be generalized to folding in the presence of ramps, providing valuable insight into the mechanics of fold-and-thrust belts and of accretionary wedges.

[1] Salençon, J., Théorie de la plasticité pour les applications à la mécanique des sols, Editions Eyrolles-Paris, 1974, (English translation: Applications of the theory of plasticity in soil mechanics, John Willey & Sons, 1977).

[2] Maillot, B. and Leroy, Y.M., Kink-fold onset and development based on the maximum strength theorem, submitted for publication.

[3] Ford, M., Williams, E.A., Artoni, A. and Vergés, J., Progressive evolution of a fault-related fold pair from growth strata geometries, Sant Llorenç de Morunys, eastern Pyrenees, J. of Structural Geology, 413-441, 1997.

[4] Suppe, J., Sabàt, F., Muñoz, J.A., Poblet, J., Roca, E. and Vergés, J., Bed-by-bed fold growth by kink-band migration: Sant Llorenç de Morunys, eastern Pyrenees, J. of Structural Geology, 443-461, 1997.