Plio-Quaternary kinematics of fault-tip folding from modeling the structural and geomorphic record of deformation

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Introduction

It is rarely straightforward to interpret uplift rates recorded by geomorphic and structural markers in terms of horizontal shortening, e.g. in the context of piedmont folds, where thrust faults are often blind. Usually, this requires a spatially continuous record of the uplift, such as well-preserved alluvial or fluvial surfaces, as well as assumptions on the underlying pattern of deformation.

Here, using a simple kinematic model derived from analogical experiments (Bennett et al., submitted) and applied first to the analysis of Pakasahua antiform in Taiwan (Bennett et al., submitted), we are able to constrain the horizontal shortening history of a young fault-tip fold, as recorded by pre-growth and growth strata, deformed geomorphic markers and topography.

Modeling Approach

In a fault-tip fold model (e.g. Daëron, 1996; Mitra, 2003), noses are deformed above the tip or tip-areas of a sub-horizontal detachment fault that more aptly refers to "young" folds, since after a certain amount of shortening has been accommodated in this pattern, strain tends to localize, evolving toward a more complex "folded" style (Daëron, 1996).

Anjihai

The Anjihai antiform is located in a series of folds dipping N at the range front. The surface antiform is cut by westward-dipping, E-W-trending reflectors. Some of these reflectors show a sudden change in their dip around the center of the fold, suggesting that growth strata become pre-tectonic in the center of the fold (Charreau et al., 2005, in prep.).

Conclusions

• Using a reasonably small number of hinges, it is possible to reproduce the finite deformation of a fault-tip fold using the modeling approach proposed by Bennett et al.
• Given such a model, any uplifted and tilted geomorphic marker can be interpreted in terms of the amount of deformation it went through, providing constraints on the history of shortening as a function of stratigraphic depth.
• Even in a "simple" fold like Anjihai, this modeling documents a shortening history somewhat more complex than expected.
• These results are not model-dependent and could be attempted using other descriptions of the velocity field as a function of incremental shortening.

Two main data sets were analyzed: the finite amount of shortening measured by 1.55 km of shortening, tilted too far back, implying that the finite amount of shortening is significantly smaller than the initial one (1.8 km).

A unified kinematic model for the evolution of detachment folds investigating kinematics of folding from sandbox experiments.

A more likely scenario should then include a first continuous tilting of the growth strata, followed by more continuous tilting of the growth strata, then more amounts of shortening necessary to tilt each hinge. A more likely scenario should then include a first continuous tilting of the growth strata, followed by more increments of the fold started somewhere between 0.3 and 1 km.

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