Surface Effects Of Active Folding, Illustrated With Examples From The Tianshan

Aurélia Hubert-Ferrari

Institut de Géologie, Université de Neuchâtel, rue Emile Argand 11, Neuchâtel, Switzerland

Department of Geosciences, Princeton University, Princeton, USA

John Suppe, Ramon Gonzalez-Mieres

Department of Geosciences, Princeton University, Princeton, USA

Wang Xin

Geosciences Department, Zhejiang University, Hangzhou, China

The combination of good surface exposure and subsurface imaging allow us to directly relate the anticlinal morphology to its deep active structure. The two studied Yakeng and Quilitak folds are located at the front of the Kuche-fold –and-thrust belt of the Southern Tianshan. The folds have fundamentally different folding mechanisms, which is reflected in their contrasting geomorphology.

Seismic reflection profiles show that the Yakeng anticline is gentle detachment fold with limb dip generally less than 5-6 degrees. By measuring area of structural relief as a function of elevation we constrain its magnitude and the history of growth. The analysis yields a total shortening of 1200 m with the beginning of growth at horizon 14 time and an approximately linear upward decrease in shortening through the 2.4 km thick growth sequence. Furthermore during most of its growth Yakeng was completely buried with a constant ratio between shortening and cumulated sediment height of 0.2. A recent growth acceleration probably triggered by diapiric flow, leading to its topographic emergence. At the surface the low ridge formed by Yakeng anticline is similar to the deep structure. Its two-stage growth is also visible in the morphology. Yakeng emergence has been completely disrupted the river network and changed the sedimentation pattern. Before that time, wide alluvial fans were covering the northern part of the present Yakeng structural high. Finally a quantitative comparison between the warped surface of Yakeng and its deep shape shows that Yakeng topography is a direct image at reduced amplitude of its deep structure. Yakeng is thus a self-similar fold where the instantaneous uplift rate varies smoothly across the structure and is collocated to the finite uplift.

In contrast, the Quilitak anticline does not directly reflect its deep structure. Quilitak is a complex fault-bend-fold having a deep width of 10 to 20 km and forming at the surface a 5 to 7 km wide mountainous ridge with a cumulated relief of ~1000 m. The edges of the Quilitak relief forms continuous linear front characterized by steep triangular facets. We demonstrate that this striking morphology corresponds to an active axial surface- or hinge- along which an abrupt change in bedding dip occurs. The Quilitak front is this a cumulative fold scarp resulting for the folding of an erosional surface south of Quilitak high across an active axial surface pinned to the underlying fault bend and thus fixed relative to the rocks. Fold scarp formation occurs because active axial surface are fixed locus of instantaneous uplift. Quilitak morphology thus directly reflects the deep kink-band folding mechanism which implies that active axial surface is a fixed locus of instantaneous uplift.