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Kinematics of the arcuate periclinal termination of a basement-cored anticline: Structural and microstructural studies at Rattlesnake Mountain Anticline (Wyoming, USA)

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The kinematics of fold, especially basement-cored folds, is usually studied and discussed in the light of conceptual, physical, or numerical models. The understanding of their kinematics may however greatly benefit from microstructural data collected in the field. Especially, small-scale fractures and faults are the only record (beyond growth strata) of the evolution of the fold shape. Moreover, fold models are often 2D and, consequently, the problem of their lateral tip is not considered.

Several hypotheses about the kinematics of the lateral termination of a fold may a priori be encountered: (1) the fold propagates laterally while it grows; (2) the fold does not propagate during the first steps of shortening, either because the underlying fault is inherited and reactivated (and must accommodate a significant amount of displacement before propagating laterally), or because the lateral tip connects to another (transverse) structure.

To address those questions, we studied a basement-cored anticline in the Laramide foreland in Wyoming, Rattlesnake Mountain Anticline (RMA). RMA is an asymmetrical anticline where Precambrian granitic rocks have been thrusted onto Paleozoic sedimentary rocks thanks to a SW verging high angle basement thrust striking NW-SE. To the SE, its lateral termination, called Cedar Mountain (CM), displays an arcuate shape in map view: it strikes nearly E-W, i.e. strongly oblique to the main fold trend, and connects further SE to the Horse center Anticline. The Horse center Anticline strikes NW-SE and is also usually interpreted as being underlain by a basement thrust.

Different geometries of basement faults have been proposed to account for this oblique lateral tip: (1) the basement thrust underlying RMA is itself curved (the oblique fault segment would thus result from the propagation of the main thrust); (2) there is a preexisting fault striking E-W below Cedar Mountain, which connects to the NW-SE thrust underlying RMA. The E-W fault has therefore the geological meaning of a relay zone (or transfer fault) between two major basement faults striking NW-SE. These two different hypotheses raise the question about the timing of the fold development along its strike: did the E-W trending Cedar Mountain fold develop coevally with the NW-SE trending RMA ?

In order to test these hypotheses and to better constrain the geometry and the kinematics of the fold and its termination, we have built serial geological cross-sections and we performed a detailed study of fracture pattern in both the cylindrical part of the fold and in its oblique SE termination.

The Laramide compressional trend as revealed by microfault analysis is NE-SW, i.e. perpendicular to the NW-SE segment of the fold. Interestingly, there is no evidence of strike-slip tectonics within the oblique E-W termination of the fold as would have been expected for an oblique ramp. Fracture patterns and 3D structural considerations suggest that the oblique termination is a rather late feature.