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The Velma and Milroy Structures, Ardmore Basin, Southern Oklahoma: A New Look

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Detailed work at Milroy and Velma illustrate that the structures are disharmonic with three scales of structuring. First order morphology is related to faulting in the basement and Arbuckle. Basement features verge northeasterly ahead of the Wichita Front. Second order morphology is caused by backthrusting in the Arbuckle Formation and rabbit ears in the Simpson. Third order morphology is caused by detachments in the Caney-Goddard section, which thrust material up both flanks of the structures. Arbuckle orogenic reactivation further deformed the structures, and produced fault breakthrough of faulting in the Arbuckle Formation at Velma.

Throughout the structures, shales do not appear to have acted in a ductile fashion. Thickness changes are rare on crests and limbs, and the character of the Sylvan on SCAT plots does not imply flow. However, mechanical stratigraphy did influence fold morphology: thick shales focused fault-fold initiation in the Simpson and Goddard, and the thick competent Viola-to-Sycamore section constrained faulting below the Viola. Simpson rabbit ears form map-scale substructures within the main structure causing the structures to commonly have 2 Simpson closures.

Velma and Milroy formed without significant strike-slip. The fold morphology of both structures is inconsistent with a strike-slip origin. The forming fault and the resulting fold are coincident, rather than oblique. Divergent & convergent bend related features are missing. The only observed translation feature in the system is at Velma and is ~ 2500 ft at translation in a localized tear zone. Finally, applying dip-slip compression produces reasonable interpretations.

Milroy and Velma are representative of the Cruce-to-Graham system. Individual structures within the system are separate culminations of a continuous line of folding in the footwall of the Wichita Uplift. Structures in the system are detached in the basement and verge to the NE at depth. Folds in the Cruce-to-Graham system progressively tighten to the NW as slip on these deep faults decreases along strike from SE to NW. However, progressive tightening of the folds above the Arbuckle resulted in backthrusts, which are locally vergent to the SW. The entire system progressively plunges to the NW. Consequently, the deeper fault-propagation folds are progressively overthrust by Springer with successive position to the NW until cross-crestal thrusts at last completely override the system at Cruce.