Multi-stage Laramide Deformation in the Colorado Headwaters Basin (North Park-Middle Park), Colorado

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Dickinson and others (1988; also Chapin and Cather, 1983) described three types of Laramide sedimentary basins in the Southern Rocky Mountains: 1) Ponded basins, adjacent to the Overthrust Belt that are characterized by thick, lacustrine strata and modest deformation; 2) Perimeter basins, flanking the eastern margin of the Laramide foreland that are characterized by thinner, largely fluvial strata and one-sided deformation; and 3) Axial basins, centrally located between the first two types, that are characterized by thick, highly variable, conglomeratic strata and complex deformation. The Colorado Headwaters Basin (CHB; Cole and others, 2010) is the early Cenozoic structural trough that underlies the modern physiographic areas of North Park and Middle Park in northern Colorado and is a well-exposed example of the axial-basin type.

Late Cretaceous withdrawal of the interior seaway and initiation of syndeformational sedimentation are recorded nearby in the (perimeter-type) Denver Basin by strata that span the K-T boundary. In contrast, the CHB records contemporaneous broad uplift and erosion of the upper >4,500 ft of Pierre Shale prior to onset of subsidence and sedimentation in late early Paleocene. Gravelly fluvial and lacustrine strata of the Middle Park Formation and the broadly coeval Coalmont Formation in CHB generally overlie the Hygiene Sandstone Member of the Pierre Shale over a wide area, consistent with vertical (non-tilted) basement uplift. Locally within CHB, basal Middle Park-Coalmont rests on eroded Lower Cretaceous or older strata adjacent to internal faults, indicating some differential structural tilting prior to deposition. Sedimentary architecture within CHB suggests little tilting during deposition through middle Eocene time. Total preserved thickness exceeds 8,000 ft., indicating the minimum accommodation due to basement subsidence.

Laramide structures that deform CHB chiefly include north-northwest, short-wavelength, large amplitude asymmetric fold belts and steep reverse faults that locally place Proterozoic basement over Paleogene CHB sediments (locally >12,000 ft. stratigraphic displacement). Those structures within CHB generally verge away from the basin center, suggesting they might be retro-activated normal faults that accommodated subsidence during deposition. The margins of the flanking Proterozoic basement uplifts are locally reverse-faulted (short, en echelon structures that verge toward CHB), but are more typically tilted intact (draped) sections, which must overlie (blind) faulted basement at depth.

The anomalous east-west trace of the Independence Mountain fault (IMF) at the northern end of CHB truncates the NNW-trending structures. The IMF was previously interpreted to be a low-angle, south-verging thrust that places Proterozoic basement over the Coalmont Formation, even though expected folding is not displayed in the presumed footwall block. We show that field and drillhole data are more consistent with a network of steep, en echelon, WNW-trending faults (probably with sinistral slip) that are linked by short, bridging reverse faults. The evidence suggests a distinct, younger event with transpressional geometry.