

# **A new look at the Laramide orogeny in the Seminoe and Shirley Mountains, Freezeout Hills, and Hanna Basin, south-central Wyoming**

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## **ABSTRACT**

The trip focuses on the Laramide orogeny in the heart of the Rocky Mountain foreland. We present new information on depositional and tectonic histories of the southeastern flank of the Sweetwater arch (involving parts of the Seminoe and Shirley mountains, Freezeout Hills, and Flat Top anticline and adjacent northern margin of the Hanna Basin. The relatively miniscule Hanna Basin exhibits a fossil-rich sequence of upper Cretaceous to Lower Eocene marine and nonmarine strata that probably is the thickest syn-Laramide section in the Rockies. New paleontological and structural data allow documentation of a multi-phasic local deformational history, and provide insight to the sequence and nature of tectonic interactions between the basin and its adjacent uplifts. We provide evidence in support of prolonged, sequential, and exquisitely complex Laramide tectonism in south-central Wyoming. The local base of the Hanna Formation in the northeastern basin was deposited late in the early Paleocene, upon deeply eroded flanks of newly formed, enormous, basin-margin anticlines. Final deformation of the radiating, fan-like arrangement of anticlinal/synclinal axes that constitutes the southern Shirley Mountains, Freezeout Hills, and Flat Top anticline occurred early in Eocene time, following deposition of most of the Hanna Formation. At that time, the southern or western ends of the anticlinal axes existing at the structural margin of the Hanna Basin steepened their plunges nearly to vertical, or even beyond. Strata of the basin-margin commonly became overturned, and a vast, complex series of out-of-the-basin thrusts developed within the extraordinarily thick Upper Cretaceous and Paleogene section of the northern basin. Although the northern Hanna Basin itself represents the hanging wall for this late deformation, the tectonically more active component of the system was the footwall (i.e., the southern Shirley Mountains and Freezeout Hills). Associated with closing phases of local Laramide deformation along the northeastern basinal margin was extensive development of faults having components of oblique-slip separations

that cumulatively totalled several kilometers. Our new geologic mapping requires major revision of the standard interpretation of the “Shirley thrust”. This fault, as exposed at the surface, is a basement-involved, high-angle reverse fault that terminates in a tight fold in Upper Cretaceous strata immediately east of the southeastern corner of the Shirley Mountains. More easterly parts of what has been mapped previously as “Shirley thrust” are in reality out-of-the-basin thrust faults, directed northward rather than southward (as required under standard interpretation of the “Shirley thrust”). We are evaluating two main hypotheses in explanation of uplift of the Seminoe-Shirley mountains and Freezeout Hills. One hypothesis is based upon postulated existence of a blind, deep Shirley thrust (i.e., a new sense of a Shirley thrust) that served as a controlling, master fault for the high-angle Shirley fault (in the sense of this paper, and seen to be of limited extent). Other locally important, relatively high angle faults that reach the surface may represent additional splays off of a deep, shallowly dipping, presently hypothetical, master fault. An alternative interpretation explains much of the uplift of these ranges, including Flat Top anticline, through contractional strain related to development of the fan-like array of west or northwest-vergent, faulted, asymmetric anticlines that constitute the southeastern margin of the Sweetwater arch. Axial ribs of the anticlinal fan converge geometrically to roughly a common point within the northeastern corner of the Hanna Basin. This scenario requires significant left-lateral transfer of the Shirley Mountains-Freezeout Hills terrane relative to the northern margin of the Hanna Basin, possibly along traces of the out-of-the-basin thrusts. These two main hypotheses are not mutually exclusive. Indeed, evidence exists to support the concept that both scenarios played important roles in structural development of the Seminoe-Shirley mountains, Freezeout Hills, and Flat Top anticline in relation to the northern Hanna Basin

