

U-Pb dating of calcite veins reveals complex stress evolution and thrust sequence in the Bighorn Basin, Wyoming, USA

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Beaudoin et al. (2018) report precise U-Pb dates on calcite vein sets from the Bighorn arch and three anticlines in Bighorn basin (BHB). This direct dating of deformation provides an exciting avenue to unravel strain histories in intracratonic orogens. However, we summarize previously published data that conflict with the local and regional interpretations presented in their paper.

Published onset estimates for major Laramide arches in the northern foreland show an eastward sweep (Fig. 1): Blacktail-Snowcrest: 90–85 Ma (Nichols et al., 1985); Madison-Gravelly: ca. 79 Ma (Kellogg and Harlan, 2007); Beartooth: 73–68 Ma (Cerveny, 1990; Peyton et al., 2012); and Black Hills: 65–60 Ma (Lisenbee and DeWitt, 1993). Basin sedimentary records support this sequence: Crazy Mountains basin 77–69 Ma (Dickinson et al., 1988), BHB 71–66 Ma (Finn, 2010), and Powder River basin 70–63 Ma (Dickinson et al., 1988). This is interpreted to represent Farallon shallowing and lithospheric hydration (Humphreys et al., 2003), and is at odds with a singular westward sequence. Furthermore, shortening along the Oregon thrust (Fig. 1) occurred during Lance Formation deposition (ca. 71–66 Ma; Finn, 2010), and stratigraphic cross sections (A-A' and B-B' of Finn [2010]; Fig. 1) show the Lance/Hell Creek Formation thickening toward the Beartooth front, which we interpret as flexure related to thrusting. This is 11–6 m.y. earlier than western BHB L-I vein ages (ca. 60 Ma; Beaudoin et al.'s figures 3 and 4) Recent thermochronology supports earlier exhumation for this area as well (Carrapa et al., 2019).

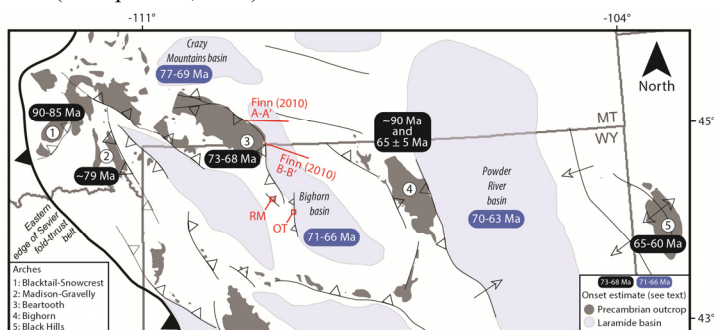


Figure 1. Map showing structural arches and basins discussed herein. RM—Rattlesnake Mountain anticline; OT—Oregon thrust.

Early cooling took place on the Bighorn arch at ca. 90 Ma (Peyton et al., 2012). A second phase at 65 ± 5 Ma (Crowley et al., 2002) is concordant with Powder River basin subsidence and the eastward sweep. Early ca. 90–70 Ma cooling ages are also reported in the Medicine Bow and Laramie arches of southeast Wyoming (Kelley, 2005). Speculatively, these signals may reflect a structurally enhanced Sevier forebulge coincident with proposed Santonian uplifts (Merewether and Cobban, 1986) and weaknesses imparted by Ancestral Rocky Mountains deformation (Maughan, 1990). This combined evidence suggests spatiotemporal overlap of Sevier and Laramide tectonism within the Montana-Wyoming foreland.

A westward sweep of rapid exhumation is shown by Fan and Carrapa (2014). Beartooth arch onset at ca. 71–66 Ma shows the presence of Laramide-style strain in the western BHB prior to rapid exhumation at ca. 57 Ma. This is consistent with a preceding eastward sweep due to slab shallowing, followed by later westward rapid exhumation due to slab delamination (Fan and Carrapa, 2014).

We view both Sevier and Laramide “stresses” to be the products of evolving convergent tectonism in the foreland. L-I vein ages of ca. 60 Ma presented by Beaudoin et al. do not record the first presence of Laramide-style strain in the western BHB. Rather, these dates may record a secondary westward sweep and/or protracted strain, either of which post-dated an initial eastward sweep that is not recorded by the U-Pb ages.

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