Collisional orogeny for the Late Cretaceous–Paleogene Laramide event

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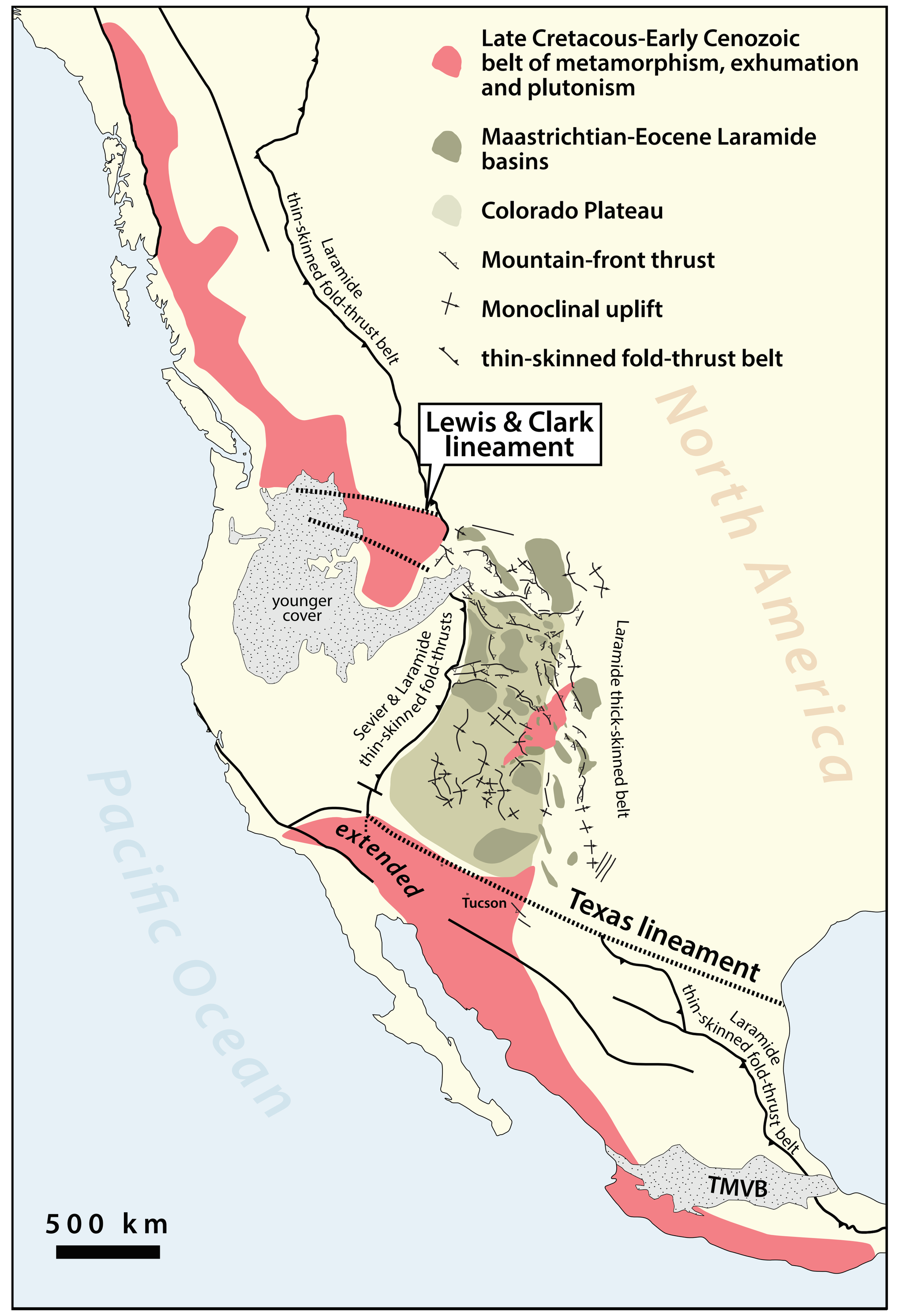
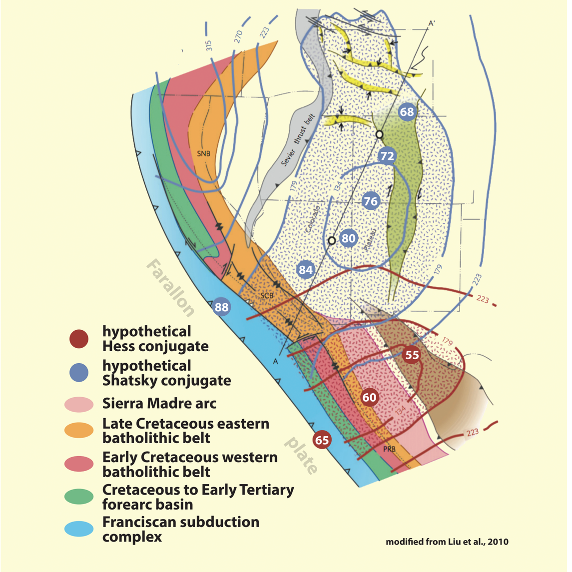
Introduction



The Laramide event is a Late Cretaceous-early Cenozoic deformational event that appears to have affected rocks from Tierra del Fuego to Alaska (Hildebrand and Whalen, 2014a). Deformation was both thin- and thick-skinned, and thrust faults are dominantly easterly vergent. Here, we focus on the North American sector, which not only includes thrust and strike-slip faults within both the Cordilleran fold-and-thrust belt and Rocky Mountain foreland, but also an exhumed metamorphic hinterland riddled with largely postdeformational plutons. We first address the traditional Laramide thick-skinned deformation within the Rocky Mountain foreland, as most geologists consider this the essence of the Laramide event, or orogeny.

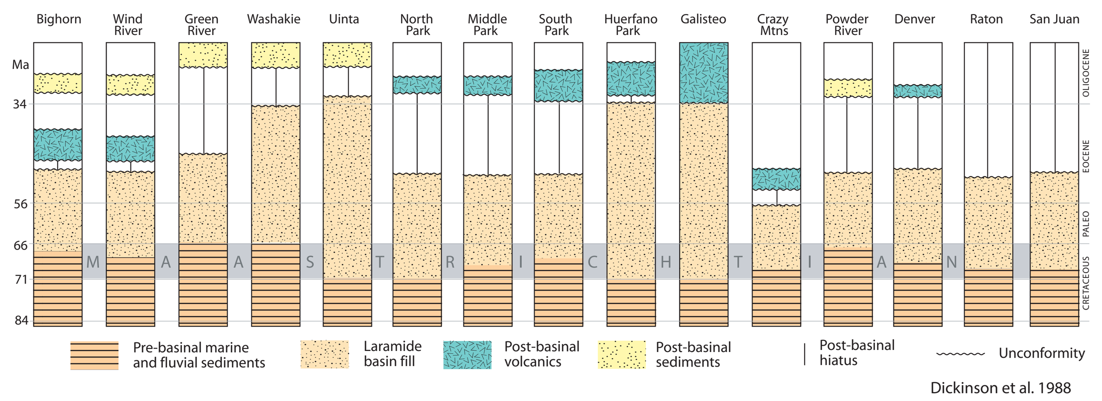
Laramide thick-skin deformation

The Rocky Mountain foreland of west-central North America contains a number of spectacular mountain ranges and adjacent syntectonic basins filled by alluvial and lacustrine deposits. The structure is variable, ranging from huge crystalline massifs hundreds of kilometers long in the Rocky Mountains to enormous monoclinal flexures on the Colorado Plateau. The uplifts trend north-south, northwest-southeast, or east-west. The deformation is thick-skinned, as it involved cratonic basement and commonly referred to as "Laramide style".

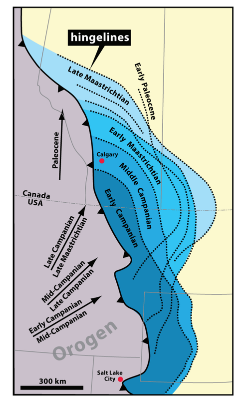


The standard model today attempts to explain the lack of arc magmatism in the region by eastward flat-slab subduction with or without subduction of the hypothetical Shatsky & Hess rise conjugates.

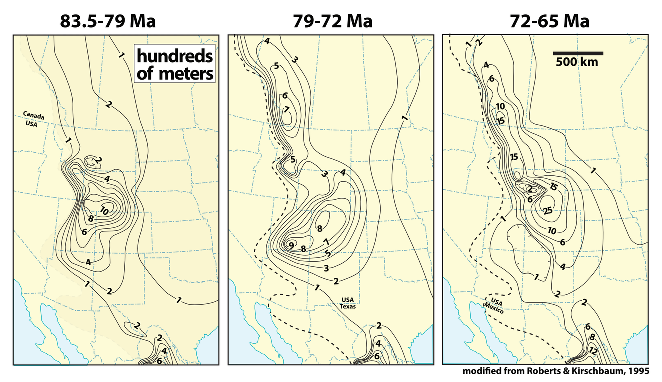
These models fail because they ignore many factors and much contrary data, some of which are described in the next column.

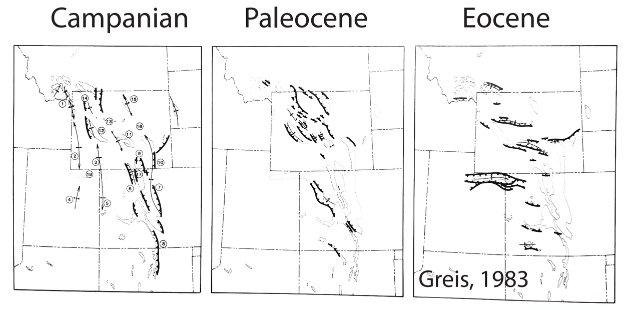


The age of the thick-skin Rocky Mountain uplifts and their adjacent basins is Maastrichtian to Eocene

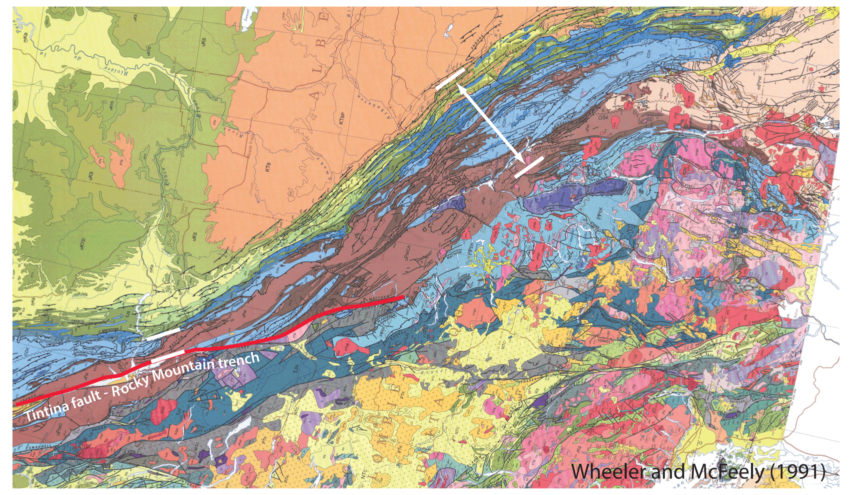


The Laramide foredeep migrated northward from the Campanian to Paleocene (Catuneanu et al., 2000; Roberts and Kirschbaum, 1995);





Laramide thick-skinned deformation evolved with time from E-W compression to N-S transpression.



Thick-skinned deformation of the Rocky Mountain foreland was approximately coeval with the thin-skinned deformation north of the Lewis and Clark lineament within the Canadian Cordillera, and south of the Texas lineament within the Mexican sector of the orogen (Armstrong, 1974). Note how the thin-skin thrusts of the same age as the Laramide thick-skin thrusts of the western US feed progressively into the Tintina fault suggesting that they have a considerable right-lateral strike-slip component.

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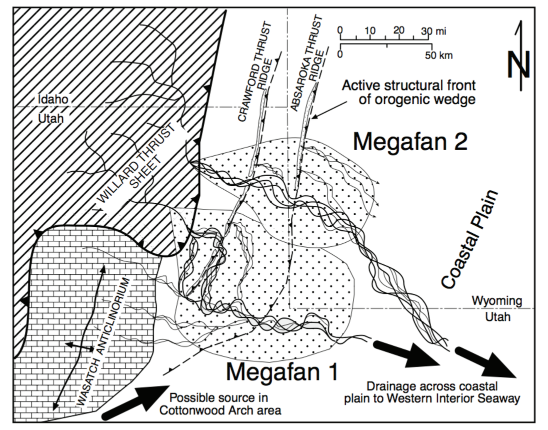
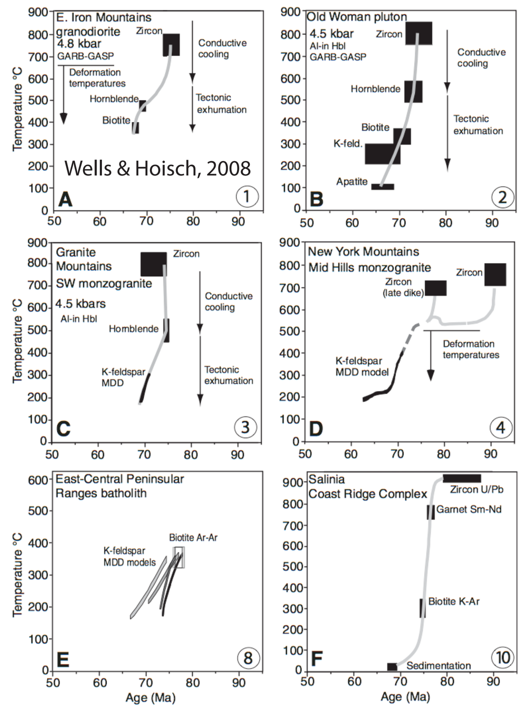
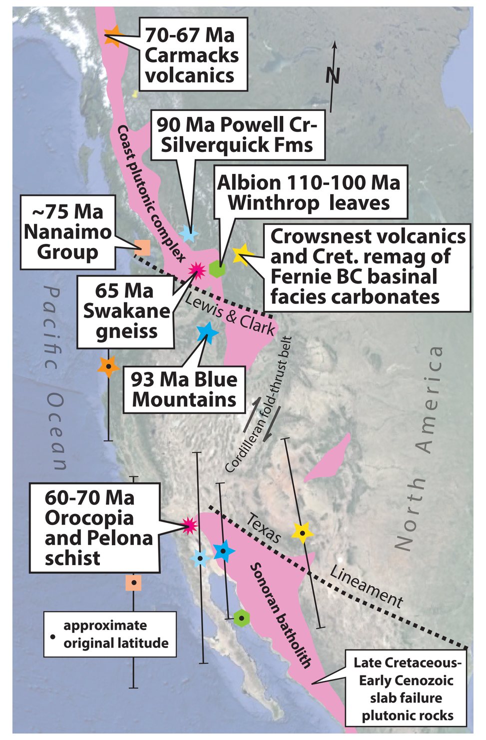
Thin-skin thrusting, exhumation and post-collisional slab failure magmatism

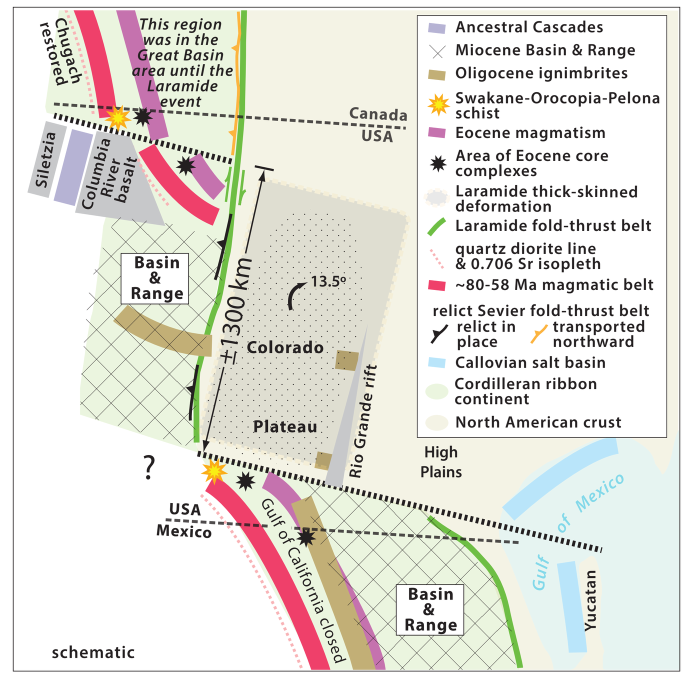


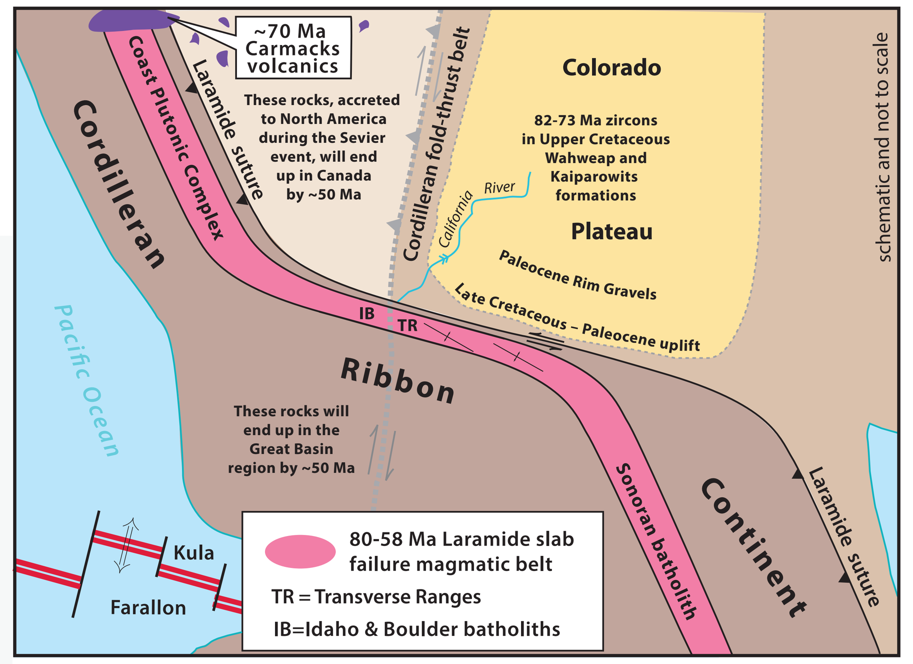
The thrusting in the US thin-skinned fold-thrust belt was more or less coeval with deformation and metamorphism within the orogenic hinterland, and stopped by the mid-Campanian, when the leading edge of the thrust belt was eroded and, along with rocks of the adjacent foredeep, buried by conglomerate and gravels of fluvial megafans derived from the more interior portions of the thrust wedge (DeCelles and Cavazza, 1999; DeCelles, 2004; Liu et al., 2005).



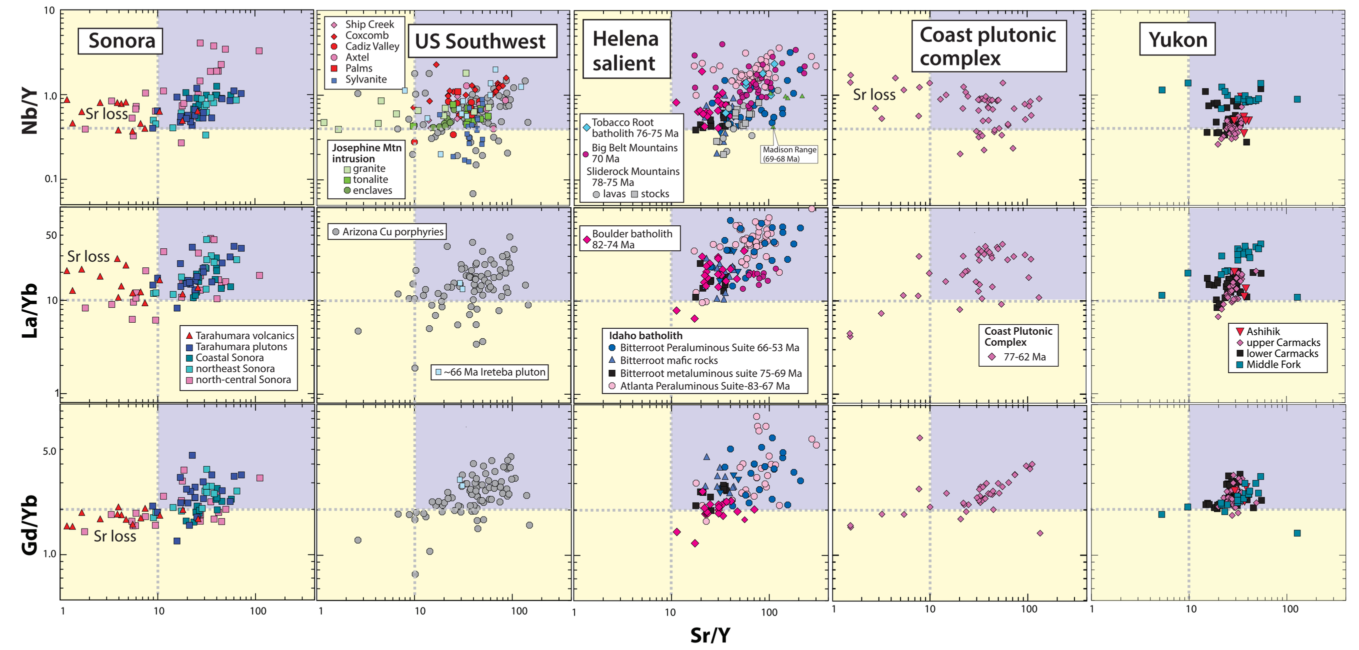
Exhumation in the hinterland started during the Late Campanian when thin-skin thrusting stopped

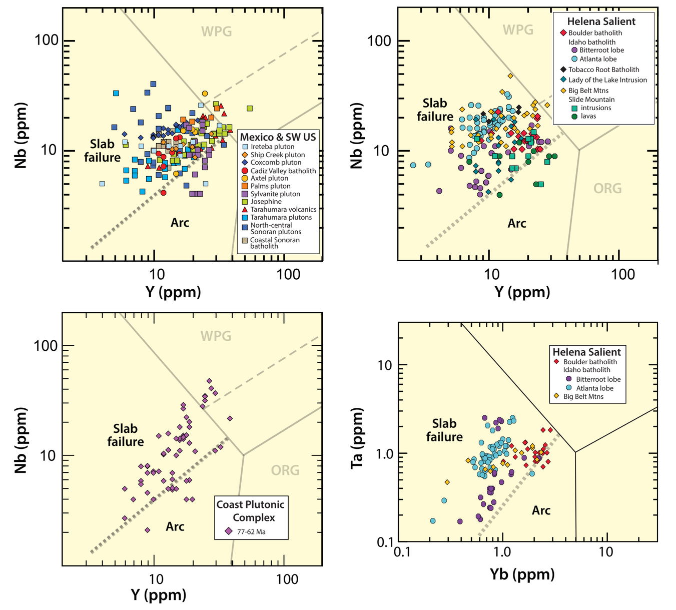






A long-standing problem in Cordilleran geology is the far-sided paleopoles for most regions west of cratonic North America. Hildebrand (2015) used the Lewis & Clark and Texas lineaments as piercing points to restore the inboard paleopoles. This reconstruction, which implies considerable strike-slip movement on faults of the fold-thrust belt, also re-unites the orogenic hinterland and its swarm of post-collisional slab failure plutons into a continuous band.





Uppermost Cretaceous to Paleocene plutons have slab failure, not arc, geochemistry consistent with their emplacement during regional exhumation.

Closure of a poorly known basin, which must have been wide enough to have had oceanic lithosphere, led to a thin-skinned fold-thrust belt. Once the slab failed, thrusting ceased, slab melts formed, and the pluton-riddled hinterland was exhumed. Northward migration, likely driven by the Kula-Farallon ridge, generated the thick-skin Laramide-type structures and drove the Cordillera northward about 1300 km. Eocene-Miocene arc magmatism formed from N-NE subduction as indicated by the volcanic isochrons across the Great Basin.