I70 west of Vail
Where is evidence for Ancestral Rockies
Where ARE the Ancestral Rockies?

Might note that the timescale on right shown here is out of date (it was one Kluth used). Penn–Perm now put at 299 Ma, Mis–Penn 323 Ma by GSA, 318 by stratigraphy.org
Where is evidence for Ancestral Rockies?

Where ARE the Ancestral Rockies?
Where is evidence for Ancestral Rockies?

Where ARE the Ancestral Rockies?

New Age Dates

<table>
<thead>
<tr>
<th>Epoch</th>
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<tr>
<td>Paleozoic</td>
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<td>Neogene</td>
<td>6 Ma</td>
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West of Green River, UT
Canyonlands NP, UT
Eckes, CO
Dobeske, CO
Colorado Med
Parachute, CO
Gypsum, CO
Vail, CO
New Age Dates

Ma
280
299
299
306.5
308
311.7
318
333
340
348

- Wolfcampian
- Virgilian
- Missourian
- Des Moinesian
- Atokan
- Morrowan
- Chesterian
- Meramecian
- Osagean

- Wyoming, UT
- Carpathians, MF, UT
- Diloma, CO
- Colorado, NM
- Parachute, CO
- Gypsum, CO
New Age Dates
320-313 Ma

Ye et al., AAPG Bull, 1996
313-308 Ma

Ye et al., AAPG Bull, 1996
308-305 Ma
305-303 Ma

MISSOURIAN

Ye et al., AAPG Bull, 1996
296-280 Ma (Permian)

Ye et al., AAPG Bull, 1996
280-273 Ma

Ye et al., AAPG Bull, 1996
273-261 Ma

Ye et al., AAPG Bull, 1996
What were Ancestral Rockies Uplifts?
What were Ancestral Rockies Uplifts?

Obvious Basin (Accumulated sediment)
What were Ancestral Rockies Uplifts?

Obvious Basin (Accumulated sediment)

Less Obvious Basin (Lower Pz preserved)
What were Ancestral Rockies Uplifts?

Obvious Basin (Accumulated sediment)

Less Obvious Basin (Lower Pz preserved)

No Pz under Mz-likely uplift
What were Ancestral Rockies Uplifts?

Obvious Basin (Accumulated sediment)

Less Obvious Basin (Lower Pz preserved)

Gore Fault Zone a likely Ancestral Rockies structure

No Pz under Mz-likely uplift
Obvious Basin
(Accumulated sediment)
Gore Fault Zone a likely Ancstral Rockies structure

...except it cuts Mesozoic strata too
No Pz under Mz-likely uplift
So maybe can look at strat record more closely
So maybe can look at strat record more closely
So maybe can look at strat record more closely
Inferred lots of normal faults and strike-slip faults
Northwest end of Uncompahgre Plateau

Figure 5. Seismic line B-B' showing deformed bedding in the Paradox Formation and the position of the Uncornpahgre fault zone. Location of line shown in figure 6.

Areas of maximum salt deformation are also evident on seismic. The top of the Paradox salt is characterized by a high amplitude reflection and is easily followed throughout most of the area. Areas of maximum salt thickness are shown in Figure 7 together with areas where the salt section has flowed into neighboring anticlines.

Seismic Stratigraphy

Seismic data are of sufficient quality to allow us to infer various stratigraphic relationships in the Pennsylvanian section. An approximate age for movement of the Paradox salt was determined from horizons within the Honaker Trail Formation (Fig. 4). The lower 750-1,250 ft of the Honaker Trail is conformable with the underlying Paradox Formation, whereas the younger beds progressively downlap to the southwest. Consequently, flowage of the massive salt unit in this area can be dated as coincident with lower to middle Honaker Trail deposition.

The seismic character of the Paradox salt member appears to grade laterally from southwest to northeast into a pattern that more closely resembles the arkosic facies of the Honaker Trail. This can be seen in Figure 4 from 1.7-2.2 seconds as a change from fairly continuous, bright reflectors into more low amplitude, discontinuous events. Depth to the first salt horizon in the Elba Flats well was accurately predicted by character of the seismic alone. The arkosic facies of the Paradox is shown in Figure 7.

Seismic stratigraphic relationships in the Lower Paradox were used to date the age of the structure. Figure 8 shows the Mississippian horizon in concordance with underlying Devonian and Cambrian reflectors. Above the Mississippian are lower Paradox beds that truncate against the Mississippian reflector. This onlapping indicates the structure at Elba Flats to be Late Mississippian to Early Pennsylvanian in age.

Uncompahgre Fault

The fault plane of the Uncompahgre thrust cannot be pinpointed on seismic. There appears to be a dilatant zone along the fault, but it lacks the associated high reflectivity and low velocity character that is present in other foreland margin thrusts (Zawislak and Smithson, 1981). Indeed, sonic velocities...
Figure 9. Generalized cross-section model of the northern Uncompahgre front. Frahm and Vaughn, RMAG 1983
Figure 9. Photographs of angular unconformity in Hermosa beds exposed along U.S. Highway 550 south of the Snowdon fault. Orientations of the views are shown in Figure 2, and the location is shown in Figure 5. (A) Steep south limb of anticline at west end of the Snowdon fault; the angular unconformity is exposed beneath more gently dipping beds south (left in view) of the abrupt hinge on the south limb of the anticline (view to west). The crest of the anticline and the trace of the Snowdon fault are out of the view to the north (right in view). (B) Angular unconformity exposed in highway cut (view to north). The hinge and steep up-turn of the south limb of the anticline are hidden behind the shoulder of the highway cut. The Snowdon fault crosses the highway approximately at the position of the most distant car on the highway. The north-dipping beds in the distance are in the north limb of the anticline on the north side of the Snowdon fault.
Figure 10. Geologic map of the Gibson Peak growth syncline in the footwall of the Crestone thrust fault. See Figure 3B for map location.

Note angular unconformities (labeled U1 and U2) located in alluvial-fan deposits of the Crestone Conglomerate Member that indicate intraformational structural rotation. Note the progressive eastward decrease in dip of bedding in the Crestone Conglomerate Member away from the Crestone thrust fault.

Cristo Mountains, which offsets the Sangre de Cristo Formation, may be a footwall splay off the Huckleberry Mountain thrust fault and is likewise interpreted to have accommodated Laramide deformation.

The Gibson Peak syncline that we previously discussed is also present in the footwall of the Sand Creek thrust fault (Fig. 13). The syncline is bounded by the Pennsylvanian–Permian Sand Creek fault on the west and by the potentially Late Cretaceous–Eocene Huckleberry Mountain fault on the east. This age relationship of an older fault bounding the syncline on the west and a younger fault bounding the syncline on the east is identical.

These deposits have been called the "undifferentiated" Sangre de Cristo Formation (Lindsey et al., 1983, 1986a) because here the formation cannot be divided into the lower member of the Sangre de Cristo Formation and Crestone Conglomerate Member (Fig. 3B) as is done in the hanging walls of the thrust sheets in the western Sangre de Cristo Mountains (Fig. 2A). Additionally, two major basement-involved thrust faults, the Sand Creek thrust fault and the Crestone thrust fault, are present along the western side of the Sangre de Cristo Mountains (Fig. 3B; Lindsey et al., 1985).

Paleontologic data indicate that the Minturn Formation is of Late Paleocene age and the Sangre de Cristo Formation is of Early Eocene age.
**TIME SCALE**

<table>
<thead>
<tr>
<th>International</th>
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</table>

---Figure 17. Inferred timing and kinematics of faults with a documented ancestral Rocky Mountains history. Light gray represents predominantly strike-slip motion, whereas dark gray indicates predominantly reverse motion. Dashed bars indicate range of time faulting is thought to have initiated (bottom of figure) or ceased (top of figure). Abbreviations: ut—Uncompahgre thrust (slip-sense from Frahme and Vaughan, 1983); rf—Ridgeway fault (slip-sense from Stevenson and Baars, 1986; Thomas, 2007); pp—Picuris-Pecos fault (slip-sense from Cather et al., 2006; Wawrzyniec et al., 2007); ct—Crestone thrust (slip-sense from Hoy and Ridgway, 2002); aup—ancestral Ute Pass fault (slip-sense data herein); fc—Freezeout Creek fault (slip-sense from Maher, 1953; McKee, 1975); at—Anadarko thrust (slip-sense from Brewer et al., 1983); wv—Washita Valley fault (slip-sense from Tanner, 1967). Time scale is from Gradstein et al. (2004).

Sweet and Soreghan, GSA Bull 2009