

The Idaho connection: Drainage capture origin of the Mahogany Zone, Green River Formation

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The Mahogany Zone of the Green River Formation represents the maximum expansion of Lake Uinta across the Piceance Creek and Uinta basins. It has long been famous as the type example of an organic-rich lacustrine mudstone. The lake expansion it records has generally been assumed climatic in origin, but recent isotopic and geochronology studies in Wyoming and Montana link it instead to a major drainage capture event that occurred hundreds of km upstream, in central Idaho. Precipitation from the Sevier orogenic plateau and adjacent areas drained through the Sage Creek Basin in southwest Montana, and then southeast toward the Green River Formation lake system. The oxygen isotopic composition of these waters is recorded by calcite cement in volcanoclastic sandstone of the Sage Creek Formation. In sandstone deposited at ~49 Ma, cement $\delta^{18}\text{O}$ shifts dramatically from ~20 to ~12 per mil (VSMOW). Sedimentary facies do not exhibit a major change, but do suggest slightly wetter conditions. A simultaneous and rapid shift in $\delta^{18}\text{O}$ occurred within the LaCledde Bed of the Green River formation in Wyoming. Balanced fill lacustrine facies of the lower LaCledde bed average 26 per mil, whereas overfilled facies in the Upper LaCledde bed dropped to 20 per mil over a period of 100-200 ka. We interpret these changes to record drainage reorganization in central Idaho, resulting in the capture of a high-altitude precipitation with relatively low $\delta^{18}\text{O}$. The higher $\delta^{18}\text{O}$ values and a narrower range of change in Wyoming are consistent with progressive downstream addition of lower altitude rivers and with lake surface evaporation. The resultant increased inflow of surface water caused Lake Gosiute to spill over the Uinta arch, resulting in flooding of the Piceance Creek and Uinta basins. This and other recent work shows clearly that the evolution of Green River Formation oil shale was intimately tied to the larger geomorphic evolution of the surrounding landscape in ways not previously suspected.

