

Dating Cenozoic Erosional Events in the Powder River Basin Using Evidence from Natural Coal Fires

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It has been fairly easy to determine the timing of depositional events because we can use fossils and volcanic ash in sediments to determine their age. It is much more difficult to determine the age of erosional events. In the Powder River Basin (PRB) of northeast Wyoming and southeast Montana, there are large data gaps, especially since the Oligocene, where Cenozoic sediments were never deposited or have since been eroded away. When did this erosion occur and how quickly did it happen? The vast coal reserves in the Fort Union and Wasatch Formations of the PRB, when brought near the surface by erosion, have burned naturally and baked and melted the overburden to produce 3700 square kilometers of reddish clinker. Sandstones that overlie coal beds contain a small proportion of zircon grains, whose U-Th/He (ZHe) ratios record the time of cooling. When a sandstone is baked by an underlying coal fire and transformed into clinker, the ZHe clock in the zircon grains is reset. As a result, the only He present is that produced after the coal fire, thus dating the age of the fire and formation of the clinker. Analysis of 86 in-situ clinker samples from different parts of the Powder River Basin reveals that sampled clinker outcrops range from 1.1 Ma to less than 0.01 Ma, and that more clinker forms in periods of high orbital eccentricity and interglacial times. This corroborates and adds more accurate dates to earlier zircon fission-track (ZFT) dating of zircons in PRB clinker. ZHe dating of six detrital clinker clasts in a gravel terrace west of Colstrip, Montana, 360 m above the present Yellowstone River, indicates that the terrace formed 2.4-2.8 Ma, near the onset of Pleistocene glaciation, and that coal beds have burned to produce clinker as early as 5 Ma. These limited tests have proven that ZHe dating of clinker can be a useful tool to help define the timing and rates of erosional events in the PRB and other Rocky Mountain coal basins.