Field Trip Guide to the Geology of Paint Mines Interpretative Park
FCDCC - Landscape SIG Outing - April, 23-24, 2016
Prepared by Frank G. Ethridge

Overview: Paint Mines Interpretive Park, located about 36 road miles east of exit 158 on I-25 in east-central Colorado. Paint Mines is home to towering hoodoos, colorful rock formations (some interpreted as ancient soils), a complex ecosystem of plants and wildlife and a rich archaeological history. Evidence of human civilization dates back almost 9,000 years when native American peoples used the colorful clay to make pottery and for ceremonial purposes. Mother Nature's Network ranks Paint Mines Park as one of twelve of Earth's most colorful natural wonders. The best discussion of the geology of Paint Mines Park is Abbott and Cook (2012, Ch. 17, Hallmarks of a Hothouse World).

Directions: Paint Mines Park is located at 29950 Paint Mines Road, about 1 mi. southeast of Calhan in northeastern El Paso County, CO. From Fort Collins we follow I-25 south to Exit 163 from I-25 S. Continue east on S County Line Rd/Palmer Divide Rd. Take CO-83 S, Hodgen Rd, Murphy Rd and US-24 E to Paint Mine Rd in El Paso County. Total distance from Exit 158 to Paint Mines is 40.3 mi.

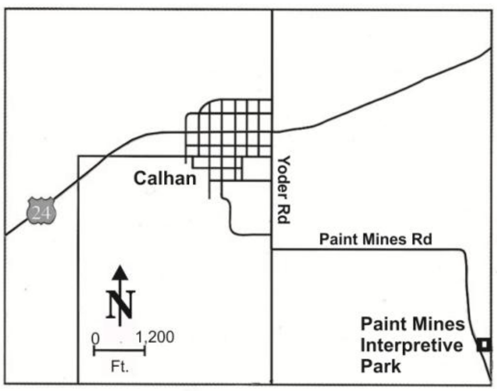

Figure 1. Local highway map of Calhan and Paint Mines Interpretative Park.

For those of us spending the night at the Ramada Monument return to I-25 S and take Exit 161. The Ramada Monument is a just north of 2nd St. (Hwy 105) on the east side of I-25 S at 1865 Woodmoor Dr.

Ancient Climate: About 55.5 Myrs ago Earth's climate abruptly warmed as much as 5-8ºC during the Paleocene-Eocene Thermal Maximum (PETM). The Paleocene and Eocene are the earliest two epochs of the Cenozoic (most recent geologic era). The Paleocene epoch began after the dinosaur extinction at the end of the Cretaceous, 65.5 Myrs ago, and ended with the beginning of the Eocene epoch some 55.8 Myrs ago. This warming is related to massive release of methane (CH_4) into Earth's ocean-atmospheric system, suggested by a decrease in carbon-13 (Figure 2B) and an increase in carbon-12 isotopes. New data from terrestrial deposits in the Bighorn Basin, WY suggest two distinct pulses of carbon with the first lasting fewer than 2,000 Yrs. These data suggest a greater similarity between the PETM and modern anthropogenic emissions than previously thought (Bowen, et al., 2014).

Earth's surface temperature can be discerned from stable isotopes of oxygen, specifically the $^{18}O/^{16}O$ ratio in formanifera (single celled amoeboid protists with an external shell commonly made of calcium carbonate ($CaCO_3$)). When temperatures were warmer than average there is less Oxygen-18 and when colder than average there is more oxygen-18. Figure 2A&B shows an abrupt decrease in Oxygen-18 during the PETM. Other evidence for paleoclimate includes

Mg/Ca ratio of calcite in foraminifera, pollen, tree growth (dendrochronology), biomarkers (alkenones), and leaf-margin analysis.

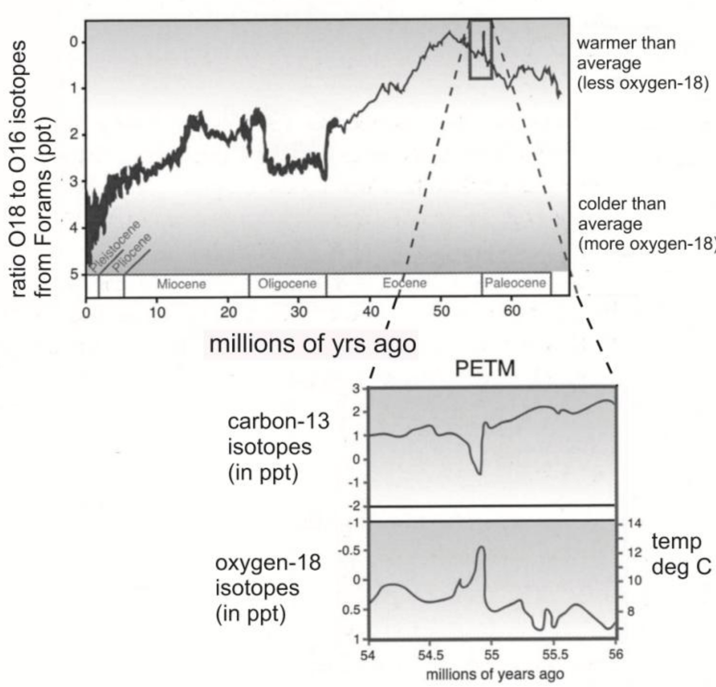

Figure 2. (A) Oxygen-18 isotope curve for the last 65 million years showing the spike that coincides with the PETM. (B) Details of the carbon-13 and oxygen-18 curves for the PETM (Based on Zachos, et al., 2008; modified after Abbott & Cook, 2012, p. 251).

The Geologic Section at Paint Mines Interpretive Park: The sedimentary rock section at Paint Mines consists of consists of a 30-foot-thick deposit of colorful mudstones in between white sandstones (Fig. 3). The D1 sandstone is part of the D1 sequence of rocks that dates to the Cretaceous-Cenozoic boundary and the D2 sandstone is part of the D2 sequence of rocks that was deposited in the latest Paleocene and earliest Eocene. Between these two sandstones there is a gap or unconformity of about 8 Myrs that reflects a depositional hiatus or an episode of erosion (Raynolds, 2007), but where is this unconformity located and how do the colorful mudstones fit into the succession. Evidence suggests that the primary unconformity is located below the mudstone interval and that this interval is part of the overlying succession of D2 rock unit (Fig. 3). The mudstone interval thus dates to the PETM (discussed above).

Along the trail from the main parking lot you will see several thin dark grey layers interbedded with the thicker sandstones. These layers are composed of lignite, that are preserved layers of ancient swamps. Leaves are often preserved in these lignite deposits. The thick D1 sandstone is deposits of ancient rivers that flowed off the Front Range uplift during the Laramide mountain-building event. These river deposits consist of the weathered debris from the Pikes Peak granite. The mudstone layers above the D1 sandstone are ancient soils (paleosols; not one but multiple paleosols). Evidence for this interpretation includes intense mottling, limonite nodules, burrows and root casts. These ancient soils are various described as oxisols or laterites, that are common today in tropical rain forests and are the product of intense weathering the enriches them in iron and aluminum that produces a rusty red color. Interbedded with these ancient soil deposits are lenses of sandstone that are also the deposits of ancient streams (Fig. 3). The Paint Mines mudstones form a badlands topography and are characterized by hoodoos. Badlands describes a terrain of soft rocks that are gullied and lack vegetation. Hoodoos are thin spires of rock that protrude from the bottom of an arid drainage basin. They are commonly, temporarily preserved in the process of erosion by a harder cap rock, in this case the D2 sandstone.

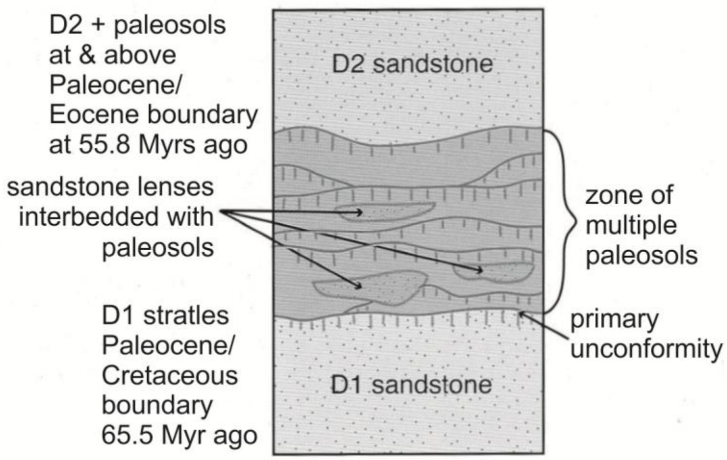

Figure 3. Generalized stratigraphic section at Paint Mines Interpretative Park (not to scale), showing general ages and rock characteristics. D1 and D2 are sandstones that fall within the D1 and D2 rock sequences (Raynolds, et al., 2007). Diagram is modified from Abbott and Cook, 2012 , p. 248).

References Cited:

Abbott, L. and Cook, T., 2012, Geology Underfoot Along Colorado's Front Range, Chapter 17, Hallmarks of a Hothouse World, Paint Mines Interpretive Park, p. 243-253 (Excellent general geologic guide to the geology and geologic history of the Colorado Front Range)

Bowen, J.B., et al., 2015, Two massive, rapid releases of carbon during the onset of the Paleocene–Eocene thermal maximum, Nature Geoscience, v. 8, p.44-47.

Raynolds, R.G., et al., 2007, Earth history along Colorado’s Front Range: Salvaging geologic data in the suburbs and sharing it with the citizens, GSA Today, v. 17, no. 12, p. 4-10.

Zachos, et al., 2008, An early Cenozoic perspective on greenhouse warming and carbon-cycle dynamics, Nature v 451, p. 279-283.