Clues on how soils may respond to climate change found

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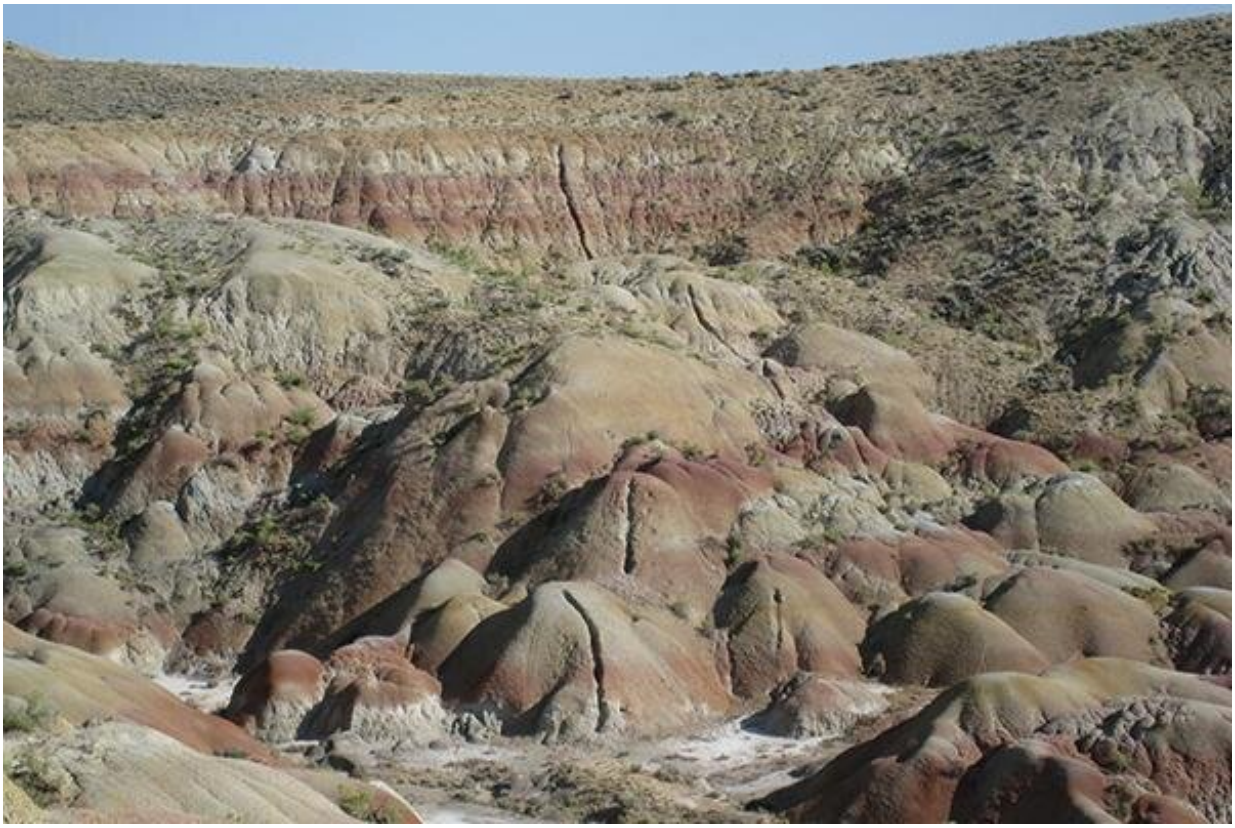

Scientists collected rock samples from red, purple and orange Paleocene-Eocene Thermal Maximum soil horizons in Wyoming. Credit: Allison Baczynski, Penn State

Rock core samples from a period of warming millions of years ago

indicate soils contributed to a rapid rise in atmospheric greenhouse gas and suggest modern climate models may overestimate Earth's ability to mitigate future warming, according to an international team of scientists.

Researchers discovered a drastic drop in organic material preserved in sections of core samples from the Paleocene-Eocene Thermal Maximum (PETM), a global warming event 55.5 million years ago that's considered the best analogue for modern climate change.

The findings, according to the researchers, suggest ancient soils from a site in modern day Wyoming acted as a source of atmospheric carbon dioxide, emitting the greenhouse gas into the atmosphere, and not a sink, trapping and storing carbon underground.

The researchers said this could mean global climate models, which expect soils to be a sink, may overstate the ability of terrestrial ecosystems to lessen the impacts of climate change. However, additional studies are needed to see how soils reacted to the PETM in other parts of the world, they said.

"We see the amount of carbon drops drastically, by orders of magnitude, during this PETM event," said Allison Baczynski, a postdoctoral scholar in geosciences at Penn State and lead author on the study. "So at least in Wyoming, my data suggests soils acted as a source, not a sink, for carbon dioxide, which could provide new information as we try to figure out where our climate is heading."

The team reported their findings in the journal *Paleoceanography and Paleoclimatology*. Katherine Freeman, Evan Pugh University Professor of Geosciences, and Baczynski's adviser, is co-author.

The cores, drilled in 2011 at the Bighorn Basin in Wyoming, are the first terrestrial core samples of the PETM. The scientists found the samples

contained less organic matter than expected, but, at the time, the team lacked tools with enough sensitivity to measure specific biomarkers.

Baczynski spent parts of four years improving the sensitivity of the equipment by two orders of magnitude, and using that tool, the team collected the first biomarker record of the PETM from terrestrial core samples.

"Prior to improving the sensitivity, we had carbon isotope values from before and after the PETM, but nothing during," Baczynski said. "We were able to fill in that gap in this study."

The researchers found the 130-foot section they believe to represent the PETM had the lowest weight of total carbon and biomarkers of any part of the core.

"At least in the Bighorn Basin, it appears that high PETM temperature, seasonally intense precipitation, or a combination, accelerated organic matter decay rates such that they outpaced plant productivity and ultimately resulted in reduced soil organic carbon during the PETM," Baczynski said.

The PETM is marked by global rise in temperatures, from about 9 to 15 degrees Fahrenheit, and a rapid increase in atmospheric carbon dioxide. The carbon dioxide from this time has a unique isotopic signature, and scientists can identify it in tree and plant fossils that absorbed the carbon.

The scientists found the PETM section of the core lacked evidence of this process. Using the new tool, and comparing samples with nearby outcrops, scientists believe up to 40 percent of the core may be composed of older fossil carbon that predates the PETM. The area was once a floodplain, and rivers may have carried and deposited the older

carbon, scientists said.

Baczynski said the instrument she developed will help with similar fossil research and has boarder applications to study materials with low carbon levels, like extraterrestrial samples that could someday come from Mars.

More information: Allison A. Baczynski et al, Carbon Isotope Record of Trace n -alkanes in a Continental PETM Section Recovered by the Bighorn Basin Coring Project (BBCP), *Paleoceanography and Paleoclimatology* (2019). DOI: 10.1029/2019PA003579

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