Investigating fire during the PETM using polycyclic aromatic hydrocarbons (PAHs)

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The Paleocene-Eocene Thermal Maximum (PETM) was a geologically abrupt global warming event that occurred 56 million years ago. The PETM coincided with a negative carbon isotope excursion, suggesting a large release of ^{13}C-depleted carbon to the atmosphere. In the modern, increased atmospheric CO_2 concentrations and corresponding temperature and moisture changes are associated with increases in wildfire activity.

In this study, a diverse suite of polycyclic aromatic hydrocarbons (PAHs), organic compounds produced as aerosols during combustion, were characterized and quantified in order to investigate evidence for fire during the PETM. We sampled intervals of cores from two sites in the Bighorn Basin, WY (Basin Substation and Polecat Bench), collected as part of the Bighorn Basin Coring Project (BBCP), and an outcrop section from the Piceance Creek Basin, CO. PAHs were evaluated using gas chromatography-mass spectrometry (GC-MS) in selective ion monitoring (SIM) mode. We found a range of three- to seven-ring PAHs from phenanthrene to coronene. Total PAH concentrations normalized to total organic carbon (TOC) were comparable at all three sites, ranging from ~1 to 1000 μg/g TOC, but did not show a marked increase in PAHs during the PETM. At Basin Substation, PAH concentrations actually decreased by an order of magnitude in PETM samples, concurrent with a sharp decline in TOC. In addition, a greater proportion of high molecular weight (MW) PAHs relative to low MW PAHs were associated with low TOC samples, suggesting loss of low MW PAHs. Since low MW PAHs can be more susceptible to post-depositional processes, we attempt to use the relative proportion of high MW PAHs, TOC, and lithology to discern the signals of fire and signals of preservation.