Paleoclimate Proxies Also Record Human Impact Signals

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Human impacts on the environment affect the flux and isotopic signature of elements in the Earth's Critical Zone. The impacts on chemistry can persist and become recorded in environments traditionally used as paleoclimate proxies. Here we present two examples of paleoclimate proxy archives that also register a human impact signal. Thin-section microscopy of a speleothem from Crystal Cave, USA shows evidence of sooty particulate material in plane-polarized light and ultra-violet fluorescence (UVF) imaging shows brighter areas correspond to increased concentrations of sooty organic matter and inclusions filled with hydrocarbons, likely kerosene. This soot coincides with a zone of calcite sector zonation likely related to addition of impurities during calcite growth. Using historical documentation, we infer that the soot microlaminations reflect an era of cave illumination using kerosene in the late 19th – early 20th century. It is plausible that the positive carbon flux introduced into speleothems by humans masked the paleoclimate signature during the Industrial Era. The $\delta^{13}C_{som}$ from alluvial soils along the Delaware River valley record above average $\%C_4$ for the past 1,000 years that coincides with the first documented occurrence of maize in the northeastern USA and a substantial increase in human population during the Late Woodland. These associations suggest that humans influenced $\delta^{13}C_{som}$ during the late Holocene through land-use change and farming. The two case studies show common types of paleoclimate proxies that record evidence of human impact in addition to past climate. The implications are that many of Earth's paleoclimate records document a human impact signal that may be misinterpreted as climate change.