Assessing Replication of Pyrogenic Organic Compounds in Coeval Tropical Stalagmites

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Polycyclic aromatic hydrocarbons (PAHs) are produced by the burning of biomass, with molecular weights reflecting combustion conditions. After being formed, PAHs are transported downward through soil and bedrock by infiltrating rainwater (Perrette et al., 2013), and in karst areas can become incorporated into stalagmites as they crystallize from dripwater in underlying caves (Perrette et al., 2008; Denniston et al., 2018). Thus, when stalagmite growth is high, infiltration times short, and fluid mixing minimized, there exists the potential for PAHs in stalagmites to preserve evidence of the presence and intensity of fire through time.

We have previously reported a high-resolution analysis of PAH distributions in two non-overlapping aragonite stalagmites from cave KNI-51, tropical Western Australia, that together span the majority of the last 900 years. The geologic conditions of this site make it well suited for the transmission of discrete pulses of fire-derived compounds from the land surface to the stalagmite. Soils are thin to absent above the stalagmite chamber and the cave is shallow. As a result, homogenization of infiltrated water (and thus PAHs) is expected to be small on interannual time scales. In addition, intense summer monsoon rains flush fire debris from the hillsides over the cave. These characteristics, coupled with the fast growth rates (1-2 mm/yr) and precise radiometric dates (±1-30 years 2 s.d. over the last millennium) of KNI-51 stalagmites suggest that they hold the potential for extremely high resolution paleofire reconstruction. Here we provide the first test of replication of PAH abundances, ratios, and trends in coeval stalagmites. Samples were analyzed at Ca' Foscari University using methods of Argiriadis et al. (2019) and the results validated by comparing them with fire activity detected through satellite images. Stalagmites KNI-51-F and -G overlap in age from CE 1310-1630, allowing an examination of the consistency of the PAH signal along different infiltration pathways.

References

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