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Hydrothermal hydrocarbon generation in 3.5 Ga basalt-hosted seafloor vent systems, North Pole Dome, Pilbara Craton, Australia

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The origin of carbon in ancient sedimentary rocks is key to questions about the emergence and antiquity of life. Some of the oldest well-preserved carbon occurs in vertical black chert veins that transect Paleoarchean basalt-dominated successions in the Pilbara Craton, Australia, and the Kaapvaal Craton, South Africa. In the north Pilbara region west of Marble Bar, they famously host carbonaceous filaments in the Apex chert, which were interpreted to represent the fossilized remains of microbes resembling cyanobacteria (Schopf 1993). These findings were subsequently challenged by Brasier et al. (2002), who argued that the black chert is not sedimentary but occurs in veins that crosscut bedding and formed by precipitation from hydrothermal fluids. New *in situ* transmission electron microscopy and microanalysis of ~3.5 Ga black chert veins from the North Pole Dome area (Rasmussen & Muhling 2023) show that they contain abundant carbonaceous structures, including coalesced droplets, that resemble thermally altered relicts of migrated oil. Other textures, including characteristic black clots, resemble those preserved in bituminous chert from the 340 Ma Red Dog hydrothermal Zn-Pb-barite deposit, Alaska, suggesting that much of the carbon in the 3.5 Ga veins was originally an organic-rich liquid that co-precipitated with silica. These results suggest that carbonaceous matter in the 3.5 Ga black cherts is not exclusively indigenous cellular carbon (i.e. kerogen), but includes migrated carbon with implications for assessing the biogenicity of simple fossil-like microstructures. The lack of organic-rich source rocks in the volcanic-dominated succession points to a contribution from abiotic organic synthesis either during hydrothermal fluid-rock reactions in the mafic-ultramafic lavas and/or polymerization of methane from mantle outgassing.

References

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