The origin of abiotic low-molecular weight hydrocarbons in seafloor serpentinization systems

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The chemical and isotopic composition of CH_4 and other low-molecular weight hydrocarbons in hot-spring fluids from serpentinizing hydrothermal systems support an abiotic origin. Recent analyses of vent fluids from the ultramafic-influenced Von Damm hydrothermal field, however, demonstrate that CH_4 is not formed from the reduction of CO_2 during active circulation of seawater-derived hydrothermal fluids [1]. An alternative source of CH_4 and potentially other low-molecular weight hydrocarbons involves leaching from fluid inclusions hosted in plutonic rocks [1,2].

To better constrain the origin of abiotic hydrocarbons in seafloor serpentinization systems, we examined the chemical and isotopic composition of fluid inclusions in mafic and ultramafic rocks from the Mount Dent oceanic core complex hosting the Von Damm hydrothermal field. Peridotite, troctolite, and gabbro contain olivine with abundant secondary fluid inclusions. Raman spectroscopy reveals that these inclusions are chiefly composed of CH_4, with minor H_2, H_2O vapor, and secondary minerals including serpentine, brucite, and magnetite. Partial pressures of CH_4 in fluid inclusions exceed 20 MPa in Von Damm host rocks. To determine the abundances and stable isotopic compositions of CH_4 and C_2H_6, we crushed bulk rock samples and analyzed the released volatiles by gas chromatography (GC) and gas chromatography-isotope ratio mass spectroscopy (GC-IRMS). Isotopic analyses of CH_4 in bulk samples yielded $\delta^{13}C$ values of -4‰ to -17‰. Comparisons of isotopic compositions and relative abundances of CH_4 and C_2H_6 with values from Von Damm vent fluids suggest that leaching of fluid inclusions may provide a significant contribution of hydrocarbons to actively circulating fluids at the Von Damm site. Similarity in the abundances and isotopic compositions of CH_4 and C_2H_6 from a variety of hydrothermal fields hosted in olivine-rich rocks lends further credence to the idea that a significant portion of abiotic hydrocarbons in their vent fluids is derived from fluid inclusions.

[1] McDermott et al. (2015) *PNAS* **112**, 7668-7672.

[2] Kelley and Früh-Green (1999) *JGR* **104**, 10,439-10,460.