Abiotic synthesis of zerovalent carbon in hydrothermal vents

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Using electron microscopy techniques and selected area electron diffraction (SAED), we demonstrate the presence of (sub)micron-sized graphitic carbon in fluids emanating from both focused, high temperature, and low temperature venting sites at the 9° 50' N East Pacific Rise vent field. Settling velocity calculations indicate the potential for the particles to become entrained in the buoyant plume and distributed far from the vent fields. These data corroborate previous observations of graphite particles in sediment traps adjacent to vent fields and provide direct evidence for vents acting as a source of black carbon to the deep-ocean and sediment as previously hypothesized. Commonly applied analytical techniques for DOC and POC may misclassify this fraction of carbon as either dissolved or particulate organic carbon limiting a broader understanding of its flux and impact. Observed particles vary in size, morphology, and crystallinity, but were consistently composed of pure carbon. Metals and sulfide have elevated concentrations in hydrothermal fluids and likely act as catalysts for the abiotic reduction of CO and CO_2 to form this graphitic material. Nevertheless, SAED data show that (nano)particles have turbostratic disorder and rough edges indicating that alteration / dissolution may occur as they emanate from hot vent waters and mix with cold oxic waters. Thus, graphite may act as a source for aromatic compound formation in vent fluids.