Generation of condensed carbon from serpentinization fluids

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Carbonaceous materials were identified in serpentinites bodies from the subseafloor and attributed either to an abiotic [1] or a biologic origin [2]. We carried out experimental dissolution of siderite to investigate the reduction of CO_2 in hydrothermal fluids [3]. The produced magnetite was found to be coated by carbonaceous material precipitated from the fluid. Additional experiments with carbon-labeled siderite showed the production of carboxylic acid and methanol at isotopic equilibrium with the siderite.

Compositional paths of serpentinization fluids were calculated and compared to natural and experimental fluid compositions. Considering kinetic limitations in the formation of alkanes, calculations showed fluid compositions equilibrating with a carbonaceous material, which buffers the H_2 and CO_2 activities. Fluids from serpentinization experiments [4] and from the Lost City [5] and the Rainbow [6] hydrothermal fields are shown to be consistent with this model. Missing amounts of carbon in mass balance extracted from experimental studies are in agreement with the predicted amounts of carbonaceous material, showing that it is the dominant carbon product of CO_2 reduction in these hydrothermal settings.

Formation of carbonaceous material in serpentinization fluids would have large implications for the deep Earth carbon cycle by creating an important pool of reduced carbon, and for H_2 production in ultrabasic environments through the intrinsic consumption of H_2.

[1] Shilobreva et al., 2011; [2] Menez et al., 2012; [3] Milesi et al., 2015; [4] e.g., McCollom and Seewald, 2001, McCollom et al. (in prep.); [5] Proskurowski et al., 2008; [6] Charlou et al., 2002