Experimental study of the role of komatiite alteration on methane in Earth's early atmosphere

Codi Lazar, Thomas M. McCollom, and Craig E. Manning

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ABSTRACT

Methane-bearing fluids are a natural consequence of the interaction of water with ultramafic rocks at low metamorphic grades (see figure 1). This implies that komatiite-hosted abiotic methanogenesis, if volumetrically significant on the early Earth, could have influenced the bulk composition of the early terrestrial atmosphere. To test this hypothesis, we conducted an experimental study of komatiite alteration at 300°C and 350 bars. Using a ~60 mL flexible gold-cell hydrothermal apparatus (after McCollom and Seewald, 2001), we reacted a carbon-bearing fluid with natural and synthetic komatiite powders. To distinguish between reduced carbon present as organic contaminants and that generated during the experiments, we introduced isotopically labeled formic acid, H13COOH, which decomposes readily into 13CO2 and H2 at hydrothermal conditions. Assuming that the rate of methanogenesis is limited by the supply of rock, we estimate a production rate of 1 micromole of CH4 per gram of komatiite per year. Using modern slow spreading MORB extrusion rates, we calculate that komatiitic alteration contributed 1013 moles of CH4 per year to the atmosphere. This production rate would have generated a methane mixing ratio on par with Earth’s present biological flux (Kasting, 2005).