Changes in geochemistry and proteins across the transition to photosynthesis in hydrothermal ecosystems

A. COX[1,2,*], S. L. LAW[1], G. R. DAHLQUIST[3], J. FOSTER[1]

[1]Montana Tech of the University of Montana, Butte, MT, 59701, USA (*correspondence: acox@mtech.edu)
[2]Yachay Tech University, Urcuqui, Ecuador
[3]University of South Carolina, Columbia, SC, 29208, USA

The transition to photosynthesis in hydrothermal ecosystems is determined by many factors, including temperature, pH, total dissolved sulfide concentrations, and others, yet it remains poorly understood [1,2,3,4]. The upper temperature limit is 73–75°C and decreases with decreasing pH [1,2,4]. Here we combine aqueous geochemistry with protein analysis across the photosynthetic fringe in the outflow channel of two alkaline hot springs in the same area but with different source waters to constrain the occurrence of photosynthesis. Combining these analyses provides insight into the geochemical restrictions limiting photosynthesis at temperatures where it might otherwise exist.

Conductivity, dissolved ions, and δD and $\delta^{18}O$ of water demonstrated that the Rabbit Creek Source (T 83.5 ± 0.1°C, pH 8.83 ± 0.02, cond 4055 ± 6 µS/cm) has undergone hydrothermal water-rock reaction at depth and a nearby unnamed spring (T 88.6 ± 0.3°C, pH 8.00 ± 0.03, cond 588 ± 10 µS/cm) is shallow, heated meteroic water with minimal water-rock reaction. Both of these low sulfide springs have outflow channels that contain a clear onset of photosynthetic life (fringe: 69.9 ± 0.1°C and 72.4 ± 0.0°C, respectively). Samples for geochemical and protein analysis were collected across the photosynthetic fringe.

Major cations and anions, and many trace elements, showed no observable change due to the transition to photosynthesis in either outflow. Increases in total dissolved Be, Mn, Sb, and Ba across the fringe may be related to the onset of photosynthesis in one outflow. Total dissolved Li also decreased across the photosynthetic fringe. Extracted protein yields across the fringe ranged from 2-338 µg/g (µg protein per g wet sediment or mat), with higher yields from mats than sediment. Further proteomic identification of the trypsin digested protein extracts will detail biomolecular changes permitted by the prevailing geochemical conditions.

[1] Cox and Shock (2003) *Eos Trans. AGU* **84**, B41D-0927. [2] Cox (2004) *ASU Honors Thesis*. [3] Boyd *et al.* (2010) *ISME J.* **4**, 1485-1495. [4] Cox *et al.* (2011) *Chem. Geol.* **280**, 344-351.