RADIOACTIVITY AND TEMPERATURE VARIATIONS AT WORSWICK HOT SPRINGS.

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Introduction: We report on a systematic characterization of the environmental conditions at Worswick Hot Springs, a biosignature-rich hydrothermal system in Idaho, USA (Figure 1). Our investigations support companion microbiology studies that have revealed a biogeochemistry indicating microbial metabolisms linked to carbon, iron and sulfur. We have discovered localized areas of elevated radiation that are approximately 4 to 5 times greater than background radiation, and we have observed that both radioactivity and temperature of the spring waters vary over time. Preliminary X-ray diffraction analyses have revealed Opal-A silica minerals to be common on the surfaces of rocks found at the field site, and aqueous geochemistry are correlated with elevated radioactivity.

Figure 1. Biosignatures in rocks from Worswick Hot Springs.

Methods: Our approach has been to perform repeated measurements at the same locations to observe the changes in the system over time. *Radiation Measurements:* A Bicron Micro Analyst micro-r-meter (Bicron NE, Saint-Gobain Industrial Ceramics, Inc.) capable of sensing x-rays and gamma-rays (0-5000 μR/hr), was used to gather radiation data at twenty-four locations around and above the region of the two main stream channels (Stream A and Stream B). *Temperature measurements:* A digital hand-held infrared thermometer (Oakton WD-39642-00 Mini-Temp Tester) was used to measure water temperatures (˚C) at all radioactivity measurement locations. Figure two contains the radiation and temperature data gathered from each field visit to Worswick since 2011.

Results: We have consistently observed higher levels of radioactivity along Stream A as compared to Stream B. Significant increases in both radioactivity and water temperature occurred between May 2015 and September 2015, and to date, have remained or trended higher than the May 2015 observations. Several elevated point sources of radioactivity have been identified in both Stream A and Stream B.

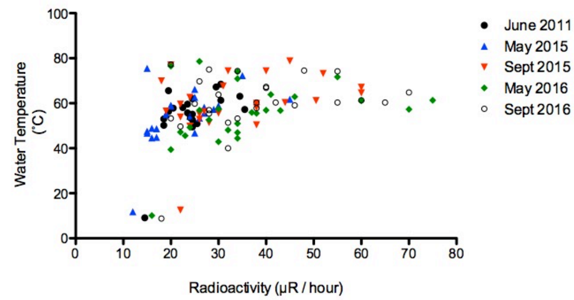

Figure 2. Radioactivity and water temperature data from Worswick. Background radiation and upstream cold stream temperature measurements appearing in the lower left serve as a baseline.

Summary: While it is clear that some hot springs around the world are radioactive in nature, we have been unable to find a record that documents the presence of elevated radioactivity around Worswick Hot Springs, despite detailed characterization of its waters and local hydrothermal systems [1]. We believe our work represents the discovery of radioactivity at Worswick Hot Springs. Our work also suggests that a correlation between temperature and radioactivity may exist at Worswick, and the ICP-MS aqueous geochemistry results indicate that Thorium and Uranium are possible sources of the radioactivity.

With regard to radioactive hot springs as a model geomicrobiological system for exobiology studies, we assert that elevated radioactivity in a hot spring on Earth serves as a useful analog environment for hot springs on other planetary bodies with thinner atmospheres and elevated levels of radiation on their surfaces [2][3]. We recommend that a search for the signatures of radioactive hot springs on Mars should also be performed.

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References: [1] Mariner, R.H., et. al. (2006) *Geoth*. 35(1):3-25. [2] Rask, J.C., Bywaters, K.F., Magnuson, T. S., (2016) Proceedings of the Sixth Mars Polar Science Conference, abstract 6110. [3] Ruff, S. W., Farmer, J., (2016) Ncomms, 7:13554.