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LABORATORY ANALOGUES OF BLACK SMOKER HYDROTHERMAL VENT MINERAL FACIES RELEVANT TO PLANETARY SCIENCE

Abstract

Hydrothermal systems form when mineral rich vent fluid is released through cracks in the ocean crust, causing a precipitation reaction. These systems are currently, or were previously, present on a variety of planetary bodies in this solar system, including Earth, Mars and possibly Europa and Enceladus. Hydrothermal systems support diverse ecosystems and provide insight into the origins of life. They contain a number of gradients (temperature, pH, pressure, mineralogy), making the environment a complex system to untangle. Deep ocean hydrothermal vents are difficult to access, requiring ocean cruises, and limited monitoring opportunities. For these reasons, laboratory analogue studies can provide unique ways to test the primary controls on hydrothermal vent formation, by controlling variables. Past and future planetary missions, like Cassini and Europa Clipper, contain instrument suites capable of detecting organic materials and other environmental data to better determine the ability of a planetary environment to contain life. Due to the importance of hydrothermal environments for future space-flight missions, it is important to consider geochemical conditions in how reactions would proceed, particularly regarding hydrothermal chimney growth. This presentation explores the growth of laboratory analogues of hydrothermal chimneys, focusing on the mineralogical gradient from interior to exterior and how chemical composition affects the morphology of the chimney. In these experiments, chimneys with different elemental compositions (namely, sulfide rich and sulfide poor iron chimneys) were grown via an injection method to explore how chimneys grow in an environment devoid of life. This can provide a good analogue environment for investigating planetary conditions, and can also simulate conditions where life is not as dominant as on Earth. The experiments found that laboratory chimneys grown with realistic ratios comparatively to the Roane chimney from the Mothra Hydrothermal Field on the Juan de Fuca Ridge did not form vertical structures as expected, but instead would form precipitate which would collect at the bottom of the vessel. This work was conducted as part of a 2023 National Indigenous Space Academy internship at the NASA Jet Propulsion Laboratory.