**AN EXCEPTIONAL ACTIVE ICELANDIC ANALOG FOR RECENT HABITABLE ENVIRONMENTS ON MARS CREATED BY LAVA–WATER INTERACTION.**

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**Introduction:** Effusive volcanic eruptions on Mars should have created ephemeral habitable environments where the heat of the lava interacted with water or ice in the shallow subsurface [e.g., 1,2]. There are numerous examples of lava following water-carved flood channels [e.g., 3–6]; and in some cases, there are indications of lava–water interaction preserved on the surface of the lava flows [e.g., 3,7]. One of the likely sources of water in these cases is a deep aquifer that was ruptured by ascending magma [e.g., 8,9]. In this scenario, organisms that might be living in the deep aquifer would not only be brought to the surface, but they would be temporarily in a warm and wet near-surface environment. Such organisms could thrive for several years and then perish in the shallow subsurface, under and around the lava flow. Given that the most recent example of this kind of activity (in Athabasca Valles) may be just a few million years old [e.g., 10,11], the preservation potential for the remains of such organisms is quite high.

While this scenario is very intriguing, the current tools to investigate this habitable environment on Mars are limited. For example, to understand the size of the habitable environment, how long it lasts, and how quickly it moves spatially, we need to rely on numerical models. However, models based on thermal conduction [e.g., 6,12] fail to reproduce even basic parameters such as the maximum heating as a function of distance from a shallow intrusion into wet sediments [13]. Simple advective models fair only slightly better, indicating that at least one key physical process is missing from the models [13], but the geometry and mobility of water around the base of a lava flow is different from this sill in significant ways. A closer terrestrial analog, where the key parameters can be directly measured, is critically needed to allow the development of more reliable numerical models.

**Terrestrial Analogs:** Situations where a lava flow interacts with a river or groundwater in a setting where the air temperature is often below freezing is a geologically common event in high latitude areas on Earth, but has not been witnessed in our lifetime—until the 2014–2015 eruption at Holuhraun, Iceland.

This 1.45 $km^3$ (1.2–1.3 $km^3$ DRE [15]) lava flow, the largest eruption in Iceland in 230 years, is interacting with both groundwater and river water [14–16]. Surface water and shallow groundwater reach the lava from several directions and go beneath it. The lava–water interactions manifest in several ways: steam plumes rising from fractures in the lava; warm springs emerging from under the lava flow; and deflection of a cold glacial stream (part of the braided river system Jökulsá á Fjöllum) along the southern edge of the lava flow field. The warm springs at the front of the lava flow had flourishing green algae in an otherwise amazingly barren and Mars-like setting.

As part of a larger multi-institutional collaborative field endeavor led by the University of Arizona, the USGS has deployed a rudimentary network of temperature and flow meters to monitor the evolving hydrothermal system around this lava flow. Our expectation is that hydrothermal waters will maintain a hospitable year-round environment in this area for several years. Measurements of the temporal and spatial evolution of this analog system will provide the missing parameters that are the key to understanding this intriguing habitable environment on Mars.

**Acknowledgments:** CMD and TT were funded by NNH15AB16I and Vinir Vatnajökuls, respectively.

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