Hunting for hydrothermal vents at the local-scale using AUV's and machine-learning classification in the Earth's oceans. S. M. White[1], [1]School of the Earth, Ocean, Environment; University of South Carolina, Columbia, SC 29208 (smw@sc.edu).

Introduction: Knowing where and why deep-sea hydrothermal vents exist is important in understanding an environment that shows strong possibilities as the crucible of life [1]. Our understanding of what factors control hydrothermal chimneys in Earth's oceans is incomplete. It is well established on a theoretical foundation that the two drivers for hydrothermal circulation are permeability, which describes how easily water can flow within the crust, and heat, which derives from magma or exothermic chemical reactions such as serpentinization. On a global to regional scale, heat supply seems to exert the dominant control on hydrothermal vent occurrence [2]. However, at the local scale this relationship remains unclear. Locating individual hydrothermal vents or specific vent fields proves much more difficult. Also, the style of hydrothermal venting can differ quite significantly across very short spatial scales, depending on their geologic environment which ultimately controls the relative balance of heat and permeability in regulating hydrothermal flow [3]. For these reasons, zooming in to find and categorize as many different individual vent fields as possible is critical to understanding the nature and diversity of seafloor habitats.

New autonomous underwater vehicle (AUV) technology has enabled deep-seafloor mapping at scales unprecedented prior to the past decade. While it is difficult to measure heat or permeability directly, on the mid-ocean ridge previously studies successfully used features such as lava flows, cracks, and faults to qualitatively explain the relationship of hydrothermal venting to ridge segmentation [4]. We now have the ability to map these features at the relevant scales [5].

Some Preliminary Correlations: Comparing the 23 individual hydrothermal chimneys found by Alvin with the AUV Sentry bathymetry establish criteria that allow many other chimneys to be located with only bathymetric data [5]. Thus, we derived the first nearly complete catalog of active and inactive chimneys over a full ridge segment to correlate with other seafloor features. We use lava morphology, extent of mapped lava flow units, and volcanic features such as tumuli as proxies for heat sources. For permeability sources, over 350 fault and fissures have been cataloged on this segment. By analyzing the locations of all these features it was possible to empirically constrain which types of seafloor terrain were more conducive to hosting hydrothermal vents in this ridge setting.

For ~150 individual hydrothermal chimneys on the Galapagos Spreading Center, volcanic mounds were found to host fewer than 50% of hydrothermal vent sites, but >75% of were found within 60m of a major fault, and were typically aligned parallel to the regional fissure trend [5]. This weakens the argument for heat-flow as a main controlling factor at the local scale and implies that we need to reconsider how and where we hunt for hydrothermal venting.

The Way Forward: Water depth, geology of the seafloor, temperature and chemistry of the vent fluids, all play key roles in determining the type of venting, thus habitat structure and the resulting biota [3]. Work in the next year by myself and my students will focus on two fronts. First, detecting individual hydrothermal spires and mounds using AI-based methods, such as random decision forests and object based image analysis, of AUV-derived bathymetry that already exists. Second, better understanding the geologic controls on hydrothermal venting by developing proxies for heat supply and permeability to investigate correlations with hydrothermal vent types.

References:

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