High precision hydrothermal plume survey based on multi-sensor data processing

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To date, multi-beam echo sounder (MBES) equipped on Research vessels and AUVs has been widely accepted as a powerful tool for detecting interception of any rising, buoyant hydrothermal plumes, without water sampling (Nakamura et al., 2015). Although utilization of water column sonar data enabled us to achieve certain results, to find new vents, this approach is not sufficient to distinguish gas seeps and hydrothermal vents, and moreover, it is inadequate to determine hydrothermal plumes with a low gas content. To improve efficiency and accuracy of exploring hydrothermal plumes and to understand their properties, we use multi-sensor data such as temperature, turbidity, redox potential, and methane concentration. These sensors were equipped on AUV Urashima, which was programmed to fly at an altitude of ~200 m above the seabed, at an average speed across the seafloor of ~1.3 m/s. An area of 2000 m x 5000 m on the seafloor can routinely be surveyed, at 400 m line spacing, during a single AUV Urashima dive. In this presentation, we will overview oceanographic, chemical and acoustic sonar data obtained during AUV Urashima Dives 217, 250, 251, and 252 in the Okinawa Trough, and will introduce data-driven analytical techniques to determine chemical properties of the water masses, and make a comparative review of 3 discrete hydrothermal fields. Each hydrothermal field has different features: i) Yokosuka Field, the highest temperature vent-site on record in the Okinawa Trough (364.1˚C at 2183 m depth), shows strong water column acoustic reflections and consistently detectable sharp peaks in turbidity, redox potential, and methane concentration. ii) Futagoyama Field is characterized by its gas seeps, strong water column acoustic reflections, and little change in turbidity and redox potential. iii) hydrothermal field off-Kume Island, which includes at least 9 active hydrothermal vents, is characterized by its acoustically invisible plumes, low H_2S content, as well as sharp peaks in turbidity, redox potential, and methane concentration. These case studies will provide an insight into the feature of each hydrothermal activity, and ensure much more efficient use of deep-submergence assets such as human occupied vehicles and remotely operated vehicles during follow-on studies.

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