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An interpretation of periodicity of an underwater geyser varying with tide

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The periodicity of an under water geyser in the Taketomi submarine hot spring in Yaeyama archipelago, Japan, has been investigated for the first time by Furushima et al. (Marine Technology Society Journal, 43(3), 13-22, 2009). After conducting a periodic analysis of the upward velocity, taken by an acoustic current meter, they concluded that the time cycle of the geyser responded to the tide. The time cycles of the geyser at high and low tide were 66 s and 41 s, respectively. They also considered the relationship between the temperatures of the heat source and the recharge water. In doing so, they assumed that the vertical tube model, a physics model of an onshore geyser, is also applicable to their underwater geyser. In accordance with the vertical tube theory an elevated boiling-point will be caused at high tide due to the increased hydrostatic pressure and the heated domain is underground just below the sea bottom if the temperature of the heat source is over 200 deg C and the recharge water temperature is 117.96 deg C, if so the observed time cycles at high and low tides can be sustained. However, the relationship between the temperatures of the heat source and the recharge water can vary according to the underground depth of the heated domain. In this study we obtained a time series of the underground heated domain depths from the averaged integration of upward flux per each eruption, after assuming that the cross-sectional area of the vertical tube had a constant value throughout the vertical direction. Results showed that the underground depth varied from 6.6 m to 14.9 m and averaged 9.9 m. With some exceptions, we can regard the underground depth as a constant value of 10 m, as the tide changed from high to low. And, if the underground depth of the heated domain was 10 m, again according to the vertical tube model the temperature of the heat source was over 200 deg C and the recharge water temperature was 130.57 deg C the observed time cycles at high and low tide could be sustained. Additionally, our estimation of the heat source temperature to be over 200 deg C was consistent with the estimation of the "deep underground water temperature" at Taketomi Submarine Hot Spring, which was reported to range from 160 to 200 deg C in previous studies.

Keywords: Taketomi Submarine Hot Spring, undersea geyser, periodic analysis, tide, boiling-point elevation, acoustic current meter