New type of self-potential anomaly observed near a hydrothermal site of Oomuro-dashi volcano, Izu-Ogasawara arc

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Using a deep-towed electrode array, we identified a pair of positive and negative self-potential anomalies observed near an active hydrothermal field associated with a quarterly rhyolitic volcano, Oomuro-dashi, Izu-Ogasawara arc. Results with different rowed directions, the magnitude of both anomalies is of the order of millivolt. The negative anomaly is located immediately above the most active area; the positive self-potential anomaly is located a few hundreds of meters away from the most active hydrothermal area, where no apparent hydrothermal activity has been detected. The discovery of the positive self-potential anomaly in marine environments is probably the first time.

The origin of the negative self-potential anomalies may be explained by the geo-battery mechanism (Sato and Mooney, 1960), in which the presence of a conductive ore body crossing the redox gradient results in the upward electron transfer to give a negative self-potential anomaly above the body. Oxidized materials near the seafloor are reduced. In other words, an ore body near the seafloor behaves as a cathode. We have reported negative self-potential anomalies many times above hydrothermal areas of other sites (e.g., Sato et al., 2017; Kawada and Kasaya, 2017, 2018).

The origin of this newly founded positive self-potential anomaly is problematic. One possibility is that an anode of the geo-battery, where reduced materials are oxidized, is exhumed near to the seafloor. If this is true, shallow drilling or piston coring may confirm signals from oxidized chemical reactions around an anode. This is important for the understanding of the geo-battery because its anode is usually located far below the seafloor and cannot be accessed easily. Another possibility is the streaming potential, which is caused by a local charge imbalance due to the flow of electrolytes in the pore space. Although this mechanism is estimated to be minor in marine environments, a positive self-potential anomaly of the order of one millivolt may not be immediately rejected above an area of upward fluid flow. However, the area of this positive self-potential anomaly is away from the active hydrothermal site, where upward fluid discharge is expected.

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