Morphology of hydrothermal deposits and its implication for evolution in the Longqi-1 hydrothermal field, Southwest Indian Ridge

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Abstract

The Longqi-1 hydrothermal field is the first confirmed high-temperature venting area along the ultraslow-spreading Southwest Indian Ridge (SWIR). It hosts two main zones, S and M, at which high-temperature (max 381°C) chimneys co-occur with a greater number of hydrothermal edifices. In this study, we carried out detailed geological mapping of the area using HOV (human-occupied vehicle) dives and determined the distribution and types of diffuse and focused discharge throughout the field. We suggest that at least four main evolutionary stages of hydrothermal activities based on the spatial clustering of areas with different levels of activity. The first is represented by large sulfide deposits with vigorously venting chimneys that would have been the earliest places where sulfide accumulation occurred. The second one is given by large-scale inactive structures, sites of discharge activity stopped when changes occurred in the fluid flow. Third, are new chimneys that have not yet formed a large sulfide accumulation structure represent a renewal of activity with a rise in fluid temperature. Finally, large beehive diffuser and low-temperature structures represent the early stage of renewed vent chimney development. Chimney growth and the scale of hydrothermal accumulation in the Longqi-1 vent field are likely controlled by fluid mixing, sub-seafloor permeability, regional tectonic activity, the bottom current, and, to a smaller extent, human activity. The features of the hydrothermal activity, including the number and maximum temperature of high-temperature venting structures and distribution of sulfide breccias and low-temperature precipitates, shows that the field may be in a rejuvenated state. This study provides key information for understanding the metallogeny in this particular hydrothermal field and for developing tools for exploration in the contract area licensed by the International Seabed Authority.