

Hydrothermal Mineralization and Source Origin in the Mirae-2 Vent Field, Central Indian Ridge

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We recently discovered the Mirae-2 vent field (MVF-2; 14°18'S, 66°08'E; at a water depth of ~3300m) in the middle part of the Central Indian Ridge. Basement rocks collected from the MVF-2 consist of basalt, gabbro, and serpentinized harzburgite. The MVF-2 is dominated by inactive vents, but a cluster of black smokers (~100 m in diameter) is also located north of the vent site, from which we recovered chimney and mound samples by a remotely operated vehicle. Bulk chemical compositions of the samples are characterized by high concentrations of Pb (up to 8.91 wt.%), Ba (>10 wt.%), Au (13.5 ppm), Ag (955 ppm), Co (4310 ppm), and Sn (1000 ppm). In particular, large enrichments of Pb and Ba are not typical of MOR-hosted systems. Mineralizing conditions of the chimneys show abrupt changes in redox state and temperature of the hydrothermal fluid as mineralization progressed; (1) early stage (barite + pyrite + sphalerite ± isocubanite), (2) main stage (isocubanite + pyrrhotite + Fe-rich sphalerite ± chalcopyrite ± electrum), and (3) late stage (barite + sphalerite + galena). The mound sample consists of chimney fragments, but is accompanied by later overprinting mineralization (sphalerite + pyrite + barite). The LA-ICP-MS analysis shows that most trace elements occur in the sulfid minerals in solid solution form, mainly controlled by ore-forming processes and physicochemical conditions of the hydrothermal fluids. The in-situ $\delta^{34}\text{S}$ values of pyrite and pyrrhotite range from +5.46‰ to +17.2‰, whereas the $^{208}\text{Pb}/^{204}\text{Pb}$ (37.850–38.781), $^{207}\text{Pb}/^{204}\text{Pb}$ (15.252–15.594), and $^{206}\text{Pb}/^{204}\text{Pb}$ (18.184–18.592) ratios of sphalerite all fall within the domain of basalt (enriched MORB composition) from the MVF-2. Our results indicate that sulfur and metals of the MVF-2 were predominantly leached from the associated host rocks with little magmatic contribution. This was most likely controlled by hydrothermal fluids circulating through both mafic and ultramafic substrates. However, hidden sedimentary contribution may have played an additional role in determining the enrichments of Pb and Ba in the MVF-2.