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Electromagnetic imaging of seafloor massive sulfide deposits at the Central Indian Ridge

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Electromagnetics is considered to become a key method to evaluate the spatial extent, composition, and inner structure of Seafloor Massive Sulfide (SMS) deposits that contain potentially high grades of polymetallic minerals - essential ingredients for the growing high-tech industry. On land, airborne or ground electromagnetic methods are established as standard geophysical tools for locating and mapping massive sulfide deposits. In contrast to terrestrial systems, marine EM instrumentation to locate the heterogeneous and often sediment covered ore deposits are still in their infancy.

To accomplish EM imaging of such complex deep sea environments, the GOLDEN EYE deep sea profiler has been developed at the University of Bremen by contract of the BGR, based on experiences with the MARUM NERIDIS benthic EM Profiler. GOLDEN EYE lands on the seafloor or glides with well constrained ground distance and is entirely controlled from the vessel. The rigid, circular fiberglass platform of 3.5 m in diameter hosts a frequency domain EM inloop sensor with horizontal transmitter of 3.34 m diameter and coaxial receiver and bucking coils. Operation frequencies between 10 and 20,000 Hz can be combined and jointly inverted to resolve the resistivity structure of the topmost 10 to 15 meters below seafloor with high lateral and near-surface resolution.

We will present the concept and development state of this deep sea electromagnetic profiler, and first results from a recent cruise to the Edmond hydrothermal vent field in 3 km water depth. Preliminary analysis of the new data reveal electric conductivity values of more than 10 S/m associated with active and inactive SMS deposits. Simultaneously collected DC magnetic data indicate a local positive magnetic anomaly associated with the active Edmond hydrothermal vent field while nearby fossil deposits are characterized by negative magnetic anomalies. First 1D inversion results provide insights into the vertical extend and overburden thickness of the SMS deposits.