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Quantitative Estimation of Magnetite in Serpentinite as a Key Tracer of Natural H_2 Formation: a Case Study in the Central Indian Ridge

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As interest in natural hydrogen has recently been raised, Ocean Core Complex (OCC) in the Central Indian Ridge are also recognized as significant natural hydrogen generating areas. It is known that olivine and pyroxene in ultramafic rocks, exposed by OCC, form serpentine minerals through the reaction with seawater and/or hydrothermal fluids. During the process, magnetite and hydrogen are generated as by-products. Hence, quantitative estimation of magnetite after the reaction can be used as a tracer of hydrogen production by applying a related mineral chemical equation. The present study collected serpentinized rock samples showing different alteration degrees using the ROV from the Cheoeum Vent Field and Onnuri Vent Field areas developed on the OCCs in the Central Indian Ridge. To identify the magnetic properties of magnetite in serpentinite, various rock magnetic measurements were subjected to the prepared samples. Of them, saturation magnetization (M_s) is proportional to the magnetic mineralogy and concentration. As the M_s of stoichiometric magnetite is 92.36 Am^2kg^{-1}, the weight concentration of magnetite in a sample can be estimated by normalizing the sample M_s with M_s of magnetite. Ferrous oxide (FeO) in olivine has no magnetic remanence; thus, the M_s of serpentinite reflects the newly generated magnetite contribution. The calculated magnetite concentration ranges from 0.76 to 3.74 wt.%. Moreover, M_s values correlate well ($r^2 = 0.87$) with easily measurable magnetic susceptibility. Magnetic hysteresis and first-order reverse curve reveal the presence of single-domain magnetite. Under the microscope, they occur along micro-fractures of serpentinite as aggregates showing a new euhedral individual shape.