

Prediction on composition of primitive seawater in the Hadean Earth

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Geological evidence in the Hadean has hardly been left. However, it is a particularly important period in the history of the earth where various events such as magma ocean, giant impact, formation of the ocean, the birth of life occurred.

Particularly with regard to the ocean in the Hadean, previous research suggested that seawater was weak acidity (pH 4-6) because carbon dioxide concentration was very high compared to that at present (e.g, Walker, 1983), and/or it was strongly acidic (pH 1-2) because large amount of halogen substance dissolved to seawater (Maruyama, 2013), but specific value of the seawater composition have not reported. In order to discuss and understand the birth of life and the evolution of seawater composition, we need to know more about primitive seawater composition, because chemical exchange reactions would strongly depend on the composition of rock and seawater.

In this study, we focus on the formation process of ocean from water vapor and assume the following condition. Immediately after the formation of the earth, it was possibly covered with high temperature atmosphere containing such as HCl and CO₂. In the atmosphere, when the upper atmosphere layer fell below the critical point, it began to rain at about 400 °C. After that, hydrothermal alteration of strongly acidic subcritical fluid and crust (komatiite or basalt) started. This high temperature ocean continues to react with crustal rock until it cooled to 100 °C or less, and dramatically changed the chemical composition. After that, it was cooled down to 100 °C or lower, forming a stable primitive ocean.

To understand the chemical nature of primitive seawater in the Hadean, I conducted two batch experiments involving primordial crust and strongly acidic subcritical fluid (pH < 0.1 at 25 °C) with decreasing temperature from 350 °C to 25 °C, at 500 bars. The results suggested that the composition is different from present seawater composition (e.g., CO₂-rich fluid, low pH, Fe and Mg-rich fluid). We will compare our results with results of thermodynamic calculation and geological evidence.

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