

Analytical and experimental study on sulfates precipitating from seawater

Naotatsu Shikazono

Faculty of Science and Technology, Keio University

Summary

1. Introduction

Sulfates (Ca, Mg, Sr, Ba) which form from seawater are genetically divided into low-temperature and high-temperature types. Low-temperature sulfates are evaporite and sedimentary ones. High-temperature type is hydrothermally formed. In order to elucidate the mechanism of formation of the sulfates of seawater origin, analytical and experimental investigations were done.

Particularly, partitioning of trace elements (Mg, Ba, Sr) between gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and salt solutions was studied in detail.

2. Analytical study

Trace elements of low-temperature and high-temperature type gypsum were analyzed. The chemical analyses indicate (1) strontium content of high-temperature massive gypsum from Kuroko deposits is higher than that of crystalline gypsum from Kuroko deposits. Large crystal of low-temperature sedimentary gypsum contains low strontium content, (2) Magnesium content of gypsum from Kuroko deposits is higher than that of low-temperature sedimentary and evaporitic gypsum. Analytical data suggest that trace elements contents of gypsum are strongly controlled by rate of formation and recrystallization.

3. Experimental study

Partitioning of magnesium and strontium between gypsum and aqueous solutions was experimentally investigated. The concentrations of calcium, magnesium, strontium and sulfate of starting solution are 5, 10, 20, 30, 50 times of seawater and the ratios of Sr/Ca and Mg/Ca are same to those of seawater. Experimental results show that (1) partition coefficient (Kd) obtained by evaporation experiments does not change with time except Kd (Mg) which decreases with time, (2) Kd(Sr) increases with increase in the concentrations but Kd (Mg) decreases, and (3) ionic radii are also important factor.

Experimental study suggests that trace elements were partitioned into gypsum crystal under nearly equilibrium condition and activity of water is important factor under the high concentrated condition,

4. Genetical consideration on sulfates formation

Above-mentioned analytical, experimental and theoretical studies indicate that (1) high-temperature sulfates formed under the non-equilibrium condition due to the rapid mixing of hydrothermal solution and ambient cold seawater on the seafloor and/or subseafloor environment. (2) Important factors for the formation of high-temperature sulfates are degree of supersaturation, rate of precipitation, and fluid flow. (3) Low-temperature sulfates formed by slow evaporation of seawater and modified seawater under the nearly equilibrium condition. (4) Important factors for the formation of low-temperature sulfates are partitioning, ionic radii, physical properties of crystal, salt concentration and activity of water.