

The stable region of sibirskite and parasibirskite

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1. Introduction

Many type of novel minerals from high temperature type of gehlenite-spurrite skarns were found in the Fuka area, Okayama prefecture, Japan. At the last stage of the formation of the skarn, many borate minerals were also formed. The minerals at the first stage of the borate minerals was takedite ($\text{Ca}_3\text{B}_2\text{O}_6$) (Kusachi et al., 1995), and various secondary hydroborate minerals were formed after that. Sibirskite (CaHBO_3) (Kusachi et al., 1997) and parasibirskite (Kusachi et al., 1998) was formed at this stage. These hydroborate minerals were considered as a polymorph each other. The synthesis of sibirskite was reported by the Sun et al. (2011), and parasibirskite was reported by the Schafer (1968a) etc. In this study, we attempted to define the stable region of the sibirskite and parasibirskite by the synthetic experiments.

2. Sibirskite and parasibirskite

Sibirskite is hydroborate CaHBO_3 . It occurs in many places of Russia, and Fuka is the third place of occurrence. It is white with vitreous luster in hand specimen, and colorless in thin section. In Fuka mine, It occurs as aggregates of prismatic crystals up to 0.1 mm long and 0.02 mm wide, in association with takedaite, frolovite and calcite. The cell dimensions and the space group determined are $P2_1/a$, $a=8.643(6)$, $b=9.523(2)$, $c=3.567(3)$ Å, $s=119.23(3)^\circ$ and $Z=4$ (Kusachi et al., 1997).

Parasibirskite is a polymorph of sibirskite, and it is a new mineral found at Fuka mine. It is white with weak pearly luster in hand specimen, and colorless in thin section. In Fuka, it occurs subparallel aggregates of tabular crystals up to $40 \times 20 \times 3$ μm in size, in association with takedaite, olshanskyite, sibirskite, frolovite and calcite. The cell dimensions and the space group are $P2_1/a$, $a=6.722(4)$, $b=5.437(2)$, $c=3.555(2)$ Å, $s=93.00(5)^\circ$ (Kusachi et al., 1998).

3. Result

3-1 Synthesis from takedite

In Fuka mine, the sibirskite and parasibirskite were formed by hydrothermal alteration of takedite. So, these minerals were synthesized from natural takedite by boric acidic water alteration and changing the quantity, temperature, pressure and synthesis period. The reaction formula is $\text{Ca}_3\text{B}_2\text{O}_6 + \text{H}_3\text{BO}_3 \rightarrow 3\text{CaHBO}_3$

At 350°C and 400°C condition, calcibolite (CaB_2O_4) was synthesized or not identified because the XRD peak so low. Sibirskite and parasibirskite were formed when synthesizing it for 7 days at 1000 kg/cm³ and 300°C, and only sibirskite was formed for 14 days.

3-2 Stable temperature and pressure region for sibirskite and parasibirskite

To examine the stable region of sibirskite and parasibirskite, the mixing samples of these minerals with water were synthesized under the hydrothermal condition. The temperature were changed from 200°C to 450°C by the step of 50°C, and the pressure were changed from 500 kg/cm³ to 1500 kg/cm³ every 500 kg/cm³.

Parasibirskite was decomposed to form the sibirskite by 14 days duration time with over 250°C of synthetic temperature. At 1500 kg/cm³ and 400°C, and 450°C, sibirskite and parasibirskite were decomposed to form the Shimazakiite ($\text{Ca}_2\text{B}_2\text{O}_5$) (Masubara et al., 2011). Moreover, at below the 200°C of synthetic temperature, the XRD peaks of sibirskite and parasibirskite were nearly not changed.

4. Discussion

The sibirskite and parasibirskite that occurred in Fuka mine were considered as formed by the hydrothermal alteration of takedite. In this study, those minerals were also synthesized from takedite by the 500, 1000 and 1500 kg/cm³ with 300°C. However, the parasibirskite were decomposed by 14 days of synthesis time. So, those were considered as the minerals of first stage and partially unstable one. From the result of 3-2 experiments, the stable region of sibirskite were limited with 350°C to 400°C with 1500 kg/cm³, with 400°C to 450°C with 500 kg/cm³. At the outer of stable region, the mineral is changed to the Shimazakiite. The lower limit of sibirskite and upper limit of parasibirskite were considered as 200°C.

Keywords: sibirskite, parasibirskite, synthesis