

New occurrence and mineralogical properties of rhabdophane group minerals from Higashimatsuura basalt, Kyushu, Japan

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1. Introduction

Higashimatsuura basalt is the alkali olivine basalt distributed in the northwest of Saga Prefecture, Japan. Many rare earth minerals including five new rare earth minerals, kimuraite-(Y) (Nagashima et al., 1986), kozoite-(Nd) (Miyawaki et al., 2000), kozoite-(La) (Miyawaki et al., 2003), hizenite-(Y) (Takai and Uehara, 2013) rhabdophane-(Y) (Takai and Uehara, 2012), were found in the basalts. It is very rare locality that rare earth minerals are found in basalts.

Rhabdophane, (REE) PO₄ • H₂O (REE = La, Ce, Nd, Y), is a hydrous rare earth phosphate mineral. Rhabdophane commonly occurs as a secondary mineral replacing monazite in syenite, alkali syenite pegmatite and sedimentary rock. Recently, many synthetic studies of rhabdophane group minerals are reported for industrial application (e.g., Mesbah et al., 2014). Some rhabdophane which do not found in nature are also synthesized; rhabdophane-(REE) (REE = La, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Y, Er, Yb, Lu) are made (Hikichi et al., 1989; Min et al., 2000). However, detailed occurrence studies of rhabdophane in the nature have not been well investigated.

Takai and Uehara (2012) reported rhabdophane-(Y) as a new mineral from Hinodematsu located in the center of Higashimatsuura peninsula. However, its detailed occurrence of rhabdophane species and their chemical variations were not reported. This paper reports the occurrence, distribution and mineralogical features of rhabdophane group minerals from Hinodematsu and their distribution in Higashimatsuura peninsula.

2. Analysis method

Nineteen samples (H01-H19) were collected from the Higashimatsuura basalt in Hinodematsu. All samples were prepared as several thin sections, and the existence of rare earth minerals were investigated and carried out chemical analyses by scanning electron microscope with EDS (JEOL JSM-5800LV SEM-EDS and JEOL JEM7001F FE-SEM). In some samples, mineralogical features of rare earth phosphates were investigated by SEM (JEOL JSM7001F and Carl Zeiss GEMINI URTRA55 FE-SEM), X-ray diffraction (Rigaku RINT RAPIDII) and scanning/transmission electron microscope (JEM-ARM 200F TEM/STEM).

3. Result and Discussion

(1) Rare earth phosphates from Hinodematsu

Rhabdophane group minerals are found in cavities of the basalts as two types of occurrence at Hinodematsu (Fig.). One is spherical type which is an isolated relatively large spherical (or radiated) crystal with more than 50 μm in diameter composed of very small rhabdophane hexagonal prismatic crystals of few hundreds nm in width. The other is coating type which is aggregated spherical crystals, the size of each spherical crystal is relatively small with one to 10 μm in diameter. Five rare earth phosphates were observed in these two types of spherulites; rhabdophane-(La), rhabdophane-(Nd), rhabdophane-(Ce), rhabdophane-(Y) and xenotime-(Y) like mineral. Chemical compositions of rhabdophane vary widely in one sample. The Nd/La ratios of rhabdophane were constant in one sample and the amount of Y was different. The Nd/La ratios in all samples were divisible into two types, which is Nd-rich type and La-rich type. Rare earth phosphates from Hinodematsu often occur with chemical zoning as coating type and spherical type. In zoning structure, Nd-rich type occurs as spherical type and La-rich type occurs as coating type. Hinodemastu was unique area where many species of rhabdophane group minerals with chemical zoning are found in the alkali olivine basalts.

(2) Rhabdophane group minerals from Higashimatsuura peninsula

Rhabdophanes from Higashimatsuura peninsula are found in several localities and have wide chemical composition as same as the variation found in the Hinodematu rhabdophane group minerals. Rhabdophane-(Ce) is also found. Therefore, rhabdophane group minerals from Hinodematsu and Higashimatsuura peninsula should be primary minerals formed by late stage, low temperature hydrothermal mineral in REE rich alkali basalts.

Keywords: rhabdophane group minerals, rhabdophane-(Y), hydrous rare earth phosphate mineral, Higashimatsuura basalt, Hinodematu

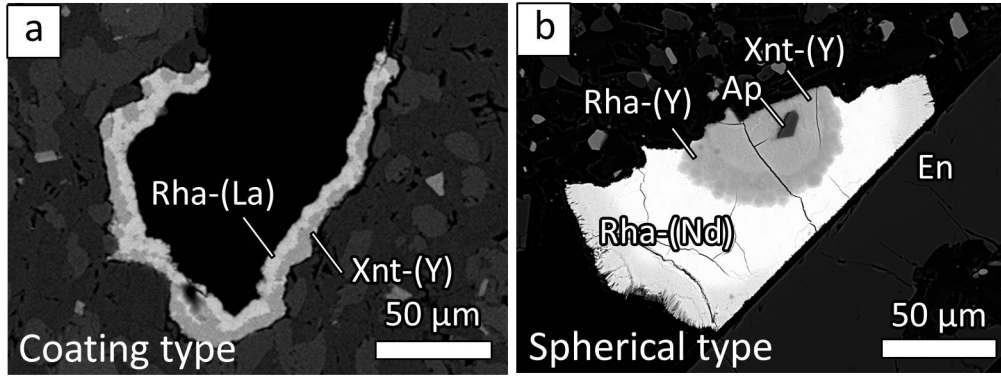


Fig. BSE images of REE phosphates with chemical zoning structure. (a) Cavity coated with rhabdophane-(La) and xenotime-(Y) like minerals (sample H06). (b) Sphere of REE phosphates with zoning structure consisted of rhabdophane-(Nd), rhabdophane-(Y) and xenotime-(Y) like mineral (sample H07).