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# Carbon dioxide into beryl: an experimental study

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Beryl is an accessory mineral typical of pegmatitic rocks, with the ideal formula $Al_2Be_3Si_6O_{18}$ (space group $P6/mcc$). Its honeycomb structure is characterized by open channels parallel to the $c$ axis. Chemical compositions of natural beryl substantially deviate from the ideal formula owing to complex cationic substitutions. Although beryl is a nominally anhydrous mineral, channels also typically contain $H_2O$ and $CO_2$ molecules. $H_2O$ within the structure occurs in two distinct orientations, named type I or II, depending on the orientation of the twofold axis of the molecule relative to the $c$ axis of beryl (Wood and Nassau 1968). Because of its size, the linear $CO_2$ molecule is normal to the $c$ axis and parallel to the larger dimension of the channel (Wood and Nassau, 1968; Charoy et al., 1996). Due to its bearing in petrology, the solubility of water and $CO_2$ in the structurally related cordierite has been studied extensively while there are no data for beryl. We report here the preliminary results of an experimental study aimed at defining the solubility mechanisms of carbon dioxide into the beryl channels. Single-crystals of Cr-doped beryl (emerald) synthesized using the flux method by Hautefeuille and Perrey (1888) obtained from the Natural History Museum of Paris were used as starting materials. These crystals show a perfect hexagonal prismatic morphology and a size not exceeding 1 mm in length and 0.5 mm across; due to the synthesis procedures they are $CO_2$-free and contain only few ppm water (Bellatreccia et al., 2008). Experiments were done using a non end-loaded piston cylinder at P in the range 200-500 MPa and T in the range 700-900°C. Samples were prepared as Pt tubes charged with emerald grains mixed with $AgCO_3$ as a source for $CO_2$. The run products were studied by optical methods using a spindle stage and by FTIR microspectroscopy. The results show that P has a strong effect on the solubility of carbon dioxide and that at least 24 hrs are needed to significantly diffuse $CO_2$ into the beryl channels. Measurement of the refraction indexes show that after the treatment with $CO_2$, the $\varepsilon$ index remains virtually constant while there is a strong increase of $\omega$. This is in agreement with the alignment of the linear $CO_2$ molecule perpendicular to the $c$ axis as also confirmed by polarized FTIR micro-spectroscopy. FTIR images obtained using an FPA detector show that carbon dioxide diffuses along the channel direction.

References

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