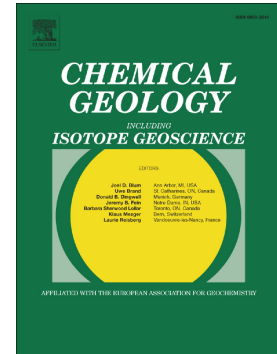


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The limitations of hibonite as a single-mineral oxybarometer for early solar system processes

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Abstract

The relationships between the composition of hibonite with the general formula $\text{CaAl}_{12-2x-y}\text{Mg}_x\text{Ti}^{4+}_x\text{Ti}^{3+}_y\text{O}_{19}$, the oxidation state of Ti ($\text{Ti}^{3+}/\Sigma\text{Ti}$, where $\Sigma\text{Ti} = \text{Ti}^{3+} + \text{Ti}^{4+}$), and oxygen fugacity ($f\text{O}_2$) were investigated experimentally. It was found that hibonite can be synthesised with a range of $\text{Ti}^{3+}/\Sigma\text{Ti}$ values at constant $f\text{O}_2$ and with a constant $\text{Ti}^{3+}/\Sigma\text{Ti}$ value for a range of $f\text{O}_2$ s. It was also found that if hibonite with the formula $\text{CaAl}_{12-y}\text{Ti}^{3+}_y\text{O}_{19}$ ($\text{Ti}^{3+}/\Sigma\text{Ti} = 1$) is equilibrated with a melt of CAI composition at $f\text{O}_2$ s below the iron-wüstite buffer then the resulting hibonite contained Mg, with Mg per formula unit (pfu) ~ 0.8 Ti pfu, and $\text{Ti}^{3+}/\Sigma\text{Ti} \sim 0.2$, irrespective of the $f\text{O}_2$. These results suggest that the availability of Mg, rather than $f\text{O}_2$, is the key factor that determines $\text{Ti}^{3+}/\Sigma\text{Ti}$ of hibonite. The structures of synthetic samples of hibonite with the general formula $\text{CaAl}_{12-2x}\text{Mg}_x\text{Ti}^{4+}_x\text{O}_{19}$, where $0 \leq X < 1$, were determined by Rietveld refinement of X-ray powder diffraction data. The predominant site occupied by Ti^{4+}

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