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# Uses of near-infrared transmission spectra for the identification of hydrothermal kaolinite, dickite and kaolinite-dickite

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**Abstract:** X-ray diffraction (XRD) patterns and near-infrared (NIR) spectra have been evaluated and compared to differentiate hydrothermal kaolinite, dickite and kaolinite-dickite. The spectral bands were fitted for the first overtone and combination area of the infrared spectra of kaolinite, dickite and kaolinite-dickite, and the characteristic bands of kaolinite, dickite and kaolinite-dickite were obtained. The infrared spectra of kaolinite and dickite have obvious differences in the first overtone and combination area of OH bands. When kaolinite and dickite need to be distinguished from kaolinite-dickite, the first overtone and the combination region need to be analysed together. 7237 $cm^{-1}$ is a characteristic band of dickite, and 7170 $cm^{-1}$ is a characteristic band of kaolinite. The ratio of intensity at 7170 $cm^{-1}$ and 7237 $cm^{-1}$ can help distinguish kaolinite, dickite, and kaolinite-dickite.

**Key words:** kaolinite; dickite; X-ray diffraction analysis; Near-infrared spectra analysis

## 1. Introduction:

As an important mineral material, kaolin is widely used in many fields in society and the economy (Murray, 2000), such as ceramics (Efavi, Damoah, Yaw Bensah, Dodoo Arhin, & Tetteh, 2012), cement industry (Aras, Albayrak, Arikan, & Sobolev, 2007), refractory (Adeosun, Akpan, Gbenebor, Taiwo, & Eke, 2016), paper (Wang, Gu, & Ma, 2007), medicine (Tan et al., 2014), and nanocomposites (Zhang, Tang, Yang, & Ouyang, 2016). Hydrothermal kaolin deposits are widely distributed in China, and many of the high-quality materials produced are used as seal stones. Seal stones are highly desired in China, and the identification of their constituent minerals is of great significance. Kaolinite and dickite are major constituent minerals of many types of seal stones.

Kaolinite and dickite belong to the kaolinite family, and their structures are only slightly different. In the early days, many scientists distinguished kaolinite and dickite by the 3500-3700 $cm^{-1}$ section in infrared spectroscopy (Brindley, Kao, Harrison, Lipsicas, & Raythatha, 1986; Prost et al., 1989; Shoval et al., 1999). However, when kaolinite is disordered, the doublet at 3669 $cm^{-1}$ and 3652 $cm^{-1}$ is replaced by a single broad band at 3653 $cm^{-1}$, and the difference between disordered kaolinite and dickite is not obvious (Wilson & M., 1987).

Near-infrared (NIR) spectroscopy can be used to identify mineral species based on the differences in overtone and combinations of OH bands in different minerals (Post & Crawford,

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