**Exsolution and Al-Si disorder in alkali feldspars: Their analysis by infrared spectroscopy**

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**ABSTRACT**

An experimental method for the determination of Ab-Or exsolution and Al-Si ordering in alkali feldspar is described. Powder infrared spectroscopy was used to measure spectra in the spectral range between 50 and 1500 cm⁻¹ using about 5 mg of sample material. The spectra were analyzed using reference spectra of uniform samples with various Ab-Or compositions and several degrees of Al-Si order. The application of this method is demonstrated for two examples of exsolved feldspar minerals, and it is shown that detailed characterization of alkali feldspars using IR spectroscopy leads to new insight into their structural details.

**INTRODUCTION**

Infrared spectroscopy is a sensitive tool for the determination of both the chemical composition of a sample and its structural state (Salje 1992, 1994). Previous work concentrated on the determination of the local degree of Al-Si order in sodium feldspar by using line shifts and intensity changes in the spectral region between 500 and 700 cm⁻¹ (Salje et al. 1989; Zhang et al. 1996), the separation of T₁-T₂ ordering from T₁o-T₁m ordering in potassium feldspar (Harris et al. 1989), study of the structural phase transition I₁-I₃ in calcium feldspar (Redfern and Salje 1992), investigation of the kinetics of the monoclinic to monoclinic phase transition in BaAl₂Ge₂O₈ feldspar (Malcherek et al. 1995), and of Al-Si ordering in strontium feldspar (Benna et al. 1995). This paper presents an easy-to-handle experimental method for the quantitative characterization of alkali feldspars. Systematic applications of this approach will be published in a separate paper.

**EXPERIMENTAL METHOD**

**Infrared technique**

Infrared spectroscopy was performed using a standard Bruker 113 V Fourier-transform infrared spectrometer. The conventional IR pellet technique with about 5 mg of sample material was used. The sample preparation and experimental details were reported previously (e.g., Zhang et al. 1996). Each spectrum was calculated by Fourier transformation of 512 scans. All spectra were then recorded as absorbance A, with 

\[ A = -\log_{10}(S_{\text{sample}}/S_{\text{reference}}), \]

where S is the single-beam transmission intensity.

In general, a typical procedure for the quantitative analysis of an unknown alkali feldspar sample involves the following basic steps: (1) preparation of standard samples, including the acquisition of reference spectra and analysis of reference spectra to determine the spectral bands suitable for better quantitative analysis; (2) calculation of a calibration curve using the reference spectra; and (3) acquisition of spectra of the unknown sample, followed by an analysis of its chemical composition and degree of Al-Si order. These steps will now be described in some detail.

**Standard samples for calibration**

Synthetic alkali feldspars with various Ab-Or compositions were prepared as reported in Zhang et al. (1996). Lattice parameters were determined by X-ray Guinier powder diffraction. The chemical compositions of the products were confirmed using the lattice parameters published by Kroll et al. (1986). In addition, a fully disordered synthetic Or₉₀ sample (Kroll et al. 1986) was used as a standard.

To obtain standard spectra for different degrees of Al-Si order, Amelia albite was annealed at 1353 K for annealing times between 0.5 h and 9 d. Similar samples were studied previously (Salje et al. 1989) by IR spectroscopy in the region between 450 and 1500 cm⁻¹. The spectral range has now been extended to 50–1500 cm⁻¹.

**Analyzed samples**

Two natural samples were chosen to demonstrate the application of the analytical method. One sample, a microperthite, GGU140021, originated from the Klokken syenite intrusion, southern Greenland. It contains ordered albite-microcline intergrowths with an average composition of Or₄₇. Details of the bulk composition, lamellar exsolution, and microstructures were reported by Brown et al. (1983). The second sample is a feldspar from Sri Lanka, VSL510, which was previously described by Voll et al. (1994). Further details of the two samples and some samples used for calibration are given in Table 1.