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HIGH-TEMPERATURE ALKALI FELDSPARS: A COMPOSITIONAL GAP

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ABSTRACT

Compositional data based on refined unit-cell parameters for alkali feldspars from hypabyssal intrusive and volcanic igneous rocks indicate a statistically significant compositional gap from Or_{49} to Or_{59}.

Keywords: disordered alkali feldspars, miscibility gap, exsolution, coherent spinodal.

SOMMAIRE

Les données sur la composition des feldspaths alcalins de roches ignées hypabyssales, intrusives et extrusives, établies à partir de paramètres réticulaires affinés, révèlent une lacune statistiquement valide entre Or_{49} et Or_{59}.

(Traduit par la Rédaction)

Mots-clés: feldspaths alcalins désordonnés, lacune de miscibilité, démixtion, spinode cohérent.

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Data on composition and unit-cell dimensions for fifty-seven homogeneous alkali feldspars from hypabyssal intrusive and volcanic igneous rocks were compiled from the literature and measured for ten selected samples in order to determine the compositional distribution of the natural sanidine–anorthoclase series. The data are plotted in Figures 1 and 2; the actual values and references may be obtained from the senior author.

Although the number of samples fitting the criteria of homogeneity and proper structural state is limited, the data indicate that two distinct compositional groups exist. These groups are an anotrthoclase–sodic sanidine series (Or_{10}–Or_{49}) and a potassic sanidine series (Or_{59}–Or_{86}). These groupings are not obvious if the data are plotted on the conventional *b–c* plot (Fig. 1); a frequency distribution of compositional data

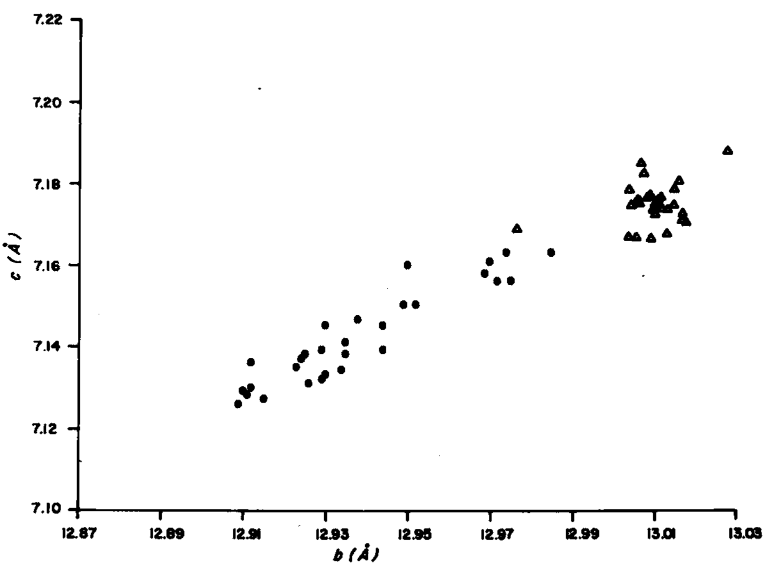

FIG. 1. A plot of *b versus c* for natural alkali feldspars from hypabyssal intrusive and volcanic igneous rocks. Solid circles are sodic feldspars and open triangles are potassic feldspars.

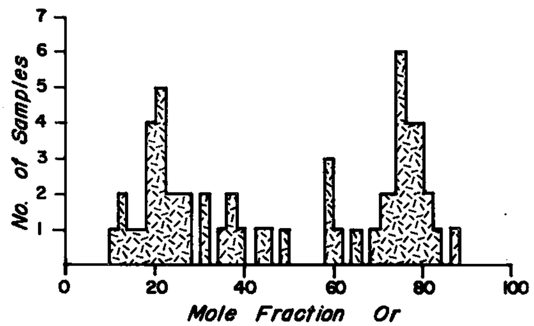

FIG. 2. Histogram showing compositional distribution of high-temperature alkali feldspars. Compositions calculated using polynomial expressions of Luth & Querol-Suñé (1970) for data on sanidine–high albite series of Orville (1967).

(Fig. 2) reveals a ten-mole-percent gap between Or_{49} and Or_{59}.

To determine whether this compositional gap is the result of bias in sampling or whether it represents a true lack of homogeneous feldspars within this compositional range, a statistical comparison of the means of the two groups was made. A t-test of the equality of the means (Guenther 1965) for samples of unequal variances has a critical value $t = 3.515$ for rejection of the hypothesis of equality of means at the 99.9% confidence level. The value of t obtained for the two feldspar-groups is 20.74; therefore, the two groups are distinct, and it is unlikely that they represent a single homogeneous population.

The existence of two compositionally different groups of alkali feldspars is expected from patterns of crystallization in the system $CaAl_2Si_2O_8$–$NaAlSi_3O_8$–$KAlSi_3O_8$ (Carmichael 1963). The anorthoclase–sodic sanidine series represents alkali feldspars that crystallize from melts with compositions on the sodic side of the thermal valley and the ternary minimum. The potassic sanidine series corresponds to alkali feldspars that crystallize on the potassic side of the thermal valley and ternary minimum.

Smith (1974) noted that members of the sanidine–anorthoclase series tend to be perthitic if their bulk Or composition lies between Or_{20} and Or_{60}. The composition range Or_{20}–Or_{60} corresponds approximately to the miscibility gap of the coherent spinodal (Yund 1975). No homogeneous feldspars are reported for the compositional range $Or_{49.4}$–$Or_{59.2}$. This gap is significant and suggests that anorthoclases and sodic sanidines with compositions within the coherent spinodal may be quenched but that potassic sanidines exsolve too rapidly to be quenched. The process of exsolution is in part diffusion-controlled; exsolution in sanidines depends on the diffusion rates of potassium and sodium in the particular feldspar (Yund 1974). Data on diffusion in feldspars indicate that both potassium and sodium would diffuse more rapidly in potassic sanidines, as their unit-cell volumes are greater (Smith 1974).

The compositional distribution of natural, homogeneous alkali feldspars of the sanidine–anorthoclase series is consistent with what would be predicted from experimental studies of the alkali feldspars. Such a pattern of distribution may provide evidence of differential exsolution rates dependent on bulk composition of the feldspar. The latter hypothesis may be tested experimentally, The experimental data of Sipling & Yund (1976) on the coherent solvus in the sanidine–high albite series provide an excellent beginning for determining diffusion rates during exsolution.

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