

*The Hydrothermal Chemistry of Silicates. Part VI.**
A Lamellar Habit in Synthetic Felspar.

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Very thin lamellar crystals of synthetic potash felspar have been found associated in some preparations with major yields of synthetic leucite and in others with major yields of synthetic felspar of normal prismatic habit. 010 surfaces of the lamellæ were highly developed, while $1k0$, $0kl$, and $1k\bar{l}$ were also common. The 010 surfaces of a small number of the lamellar crystals had straight shallow steps parallel to the c -axis and no more than a very small number of unit cells high. These appear to be growth steps.

STUDIES from these laboratories have been concerned with syntheses and properties of crystalline aluminosilicates of Li (Barrer and White, *J.*, 1951, 1167), Na (*idem, ibid.*, 1952, 1561; Barrer and Bultitude, in preparation), Rb (Barrer and McCallum, *J.*, 1953, 1466, 4029), Cs (*ibid.*, p. 1466), and Tl (*ibid.*, p. 4029; Taylor, *J.*, 1949, 1253). In a corresponding study (Barrer and Baynham, unpublished work) of the crystallisation field of potassium aluminosilicates, lamellar crystals were observed with some interesting features now to be described.

The techniques used by us in hydrothermal crystallisation have been discussed in earlier papers of this series, reactions being carried out in steel autoclaves. Reaction products were examined optically, by X-ray powder photography, and, particularly in this paper, with a Metropolitan Vickers M-V EM3 electron microscope in which electron-diffraction patterns of small areas of the specimens can be recorded.

By means of the electron microscope, lamellar crystals, such as those shown in Figs. 1 and 2, were discovered in minor yields. They were associated in certain preparations with major yields of synthetic leucite; in others, with major yields of synthetic potash felspar of normal prismatic habit. The leucite and associated lamellar crystals were grown from 0.5 g. of an aluminosilicate gel of molar composition $K_2O : Al_2O_3 : SiO_2 = 1 : 1 : 3$ with 0.3 g. of potassium hydroxide and 10 ml. of water. The mixture was heated in a 15-ml. steel autoclave at 300° for 3 days. The prismatic potash felspar crystals and associated lamellar crystals were grown from more siliceous gels of several compositions. For example, 0.5 g. of an aluminosilicate gel of composition $K_2O : Al_2O_3 : SiO_2 = 1 : 1 : 5$ was heated with 51% molar excess of potassium hydroxide in water for 4 days at 250° .

Identification of Lamellar Crystals.—Unit-cell determinations of the lamellar crystals were made by electron diffraction. The diffraction pattern (*e.g.*, Fig. 3) is a projection of the reciprocal lattice of a number of atom planes perpendicular to the electron beam, divided into approximately circular Laue zones, due to scattering from the row of lattice points most nearly parallel to the electron beam. Unit-cell dimensions can be determined from the distances between rows of spots and the radii of the circular Laue zones. The Table summarises unit-cell dimensions of several potash felspars and of two

Unit cells of lamellar crystals and of potash felspars.

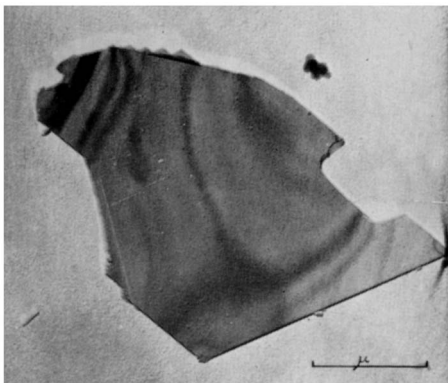
Unit-cell dimension	Lamellar crystals (1)	Lamellar crystals (2)	Orthoclase	Sanidine	Microcline
a	8.49 (± 0.15)	8.43 (± 0.09)	8.45	8.40	8.44
c	7.08 (± 0.07)	7.05 (± 0.11)	7.15	7.10	7.21
β	116—117°	115—117°	116° 3'	115° 35'	155° 50'
b	12.8 (± 0.33)	12.7 (± 0.22)	12.90	12.90	13.00

of the lamellar crystals, one associated with leucite and one with prismatic potash felspar. The lamellar crystals clearly have a unit cell very close to those of the potash felspars. The ' b '-dimension, being determined from the radii of the Laue zones, is the least accurate.

Further to confirm the identity of the lamellæ with felspar, natural orthoclase was

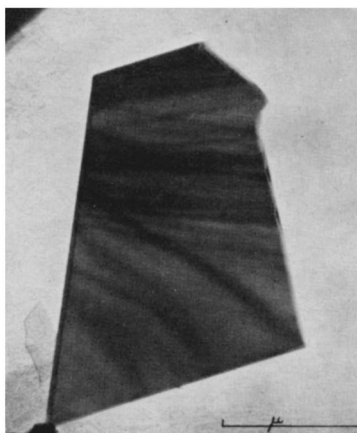
* Part V, *J.*, 1953, 4035.

FIG. 1. *Laminar crystal of potash felspar.*



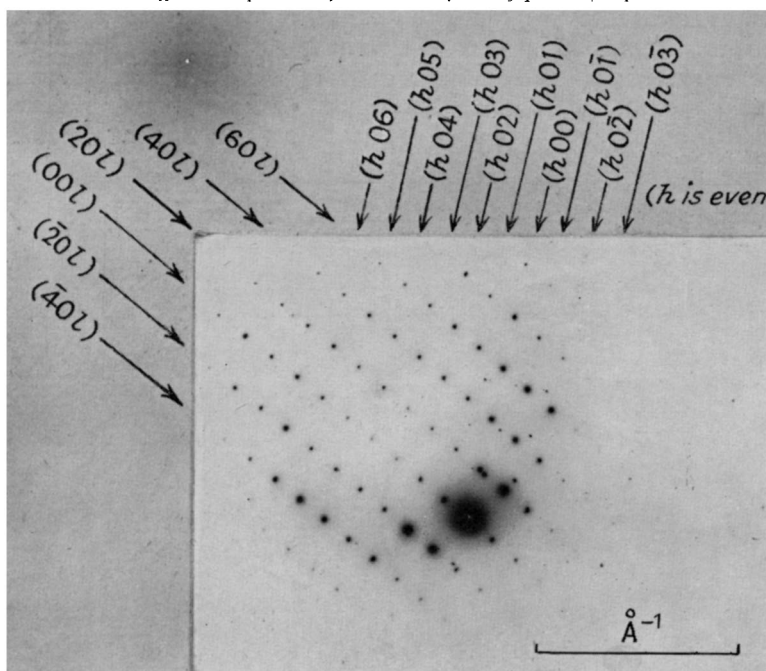
The continuous step along one edge resembles those of layer lattice minerals.

FIG. 2. *Crystals of potash felspar.*



The larger crystal has six steps parallel to its long edge. The smaller is ca. 70 Å thick (5–6 unit cells).

FIG. 3. *Electron-diffraction pattern of lamellar crystal of potash felspar, 2000 Å thick.*



The 010 planes are perpendicular to, and the *b*-axis parallel to, the electron beam.

FIG. 4. Pairs of similarly oriented and shaped lamellar potash felspar crystals.

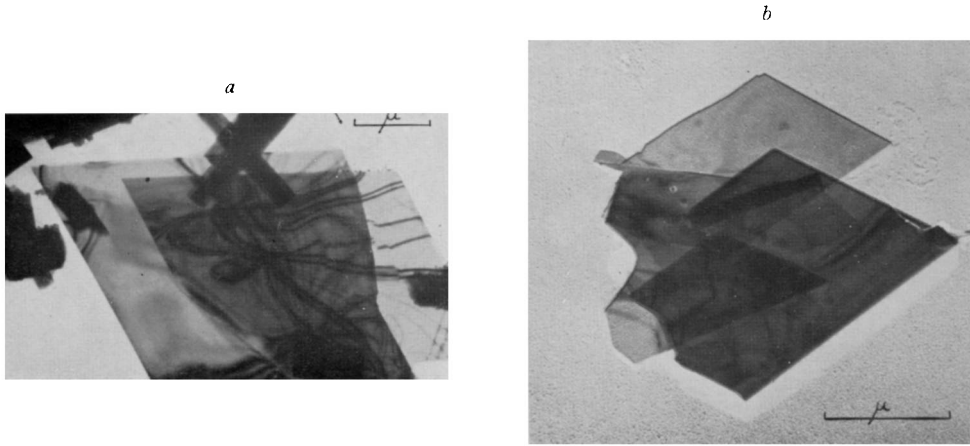
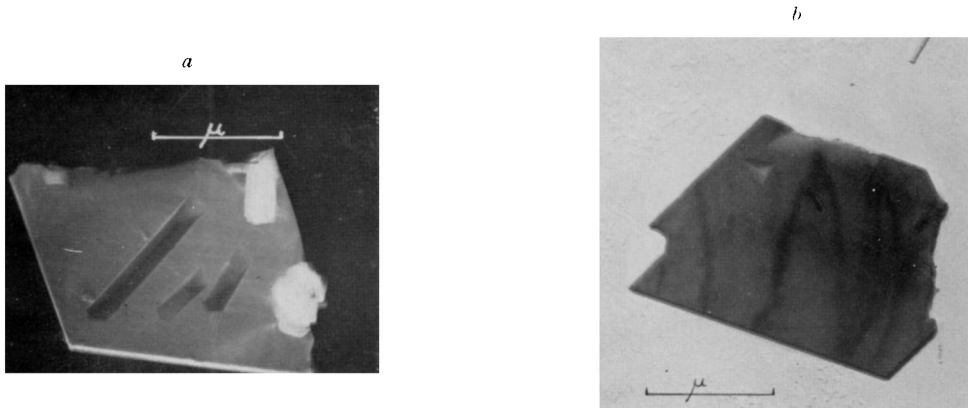
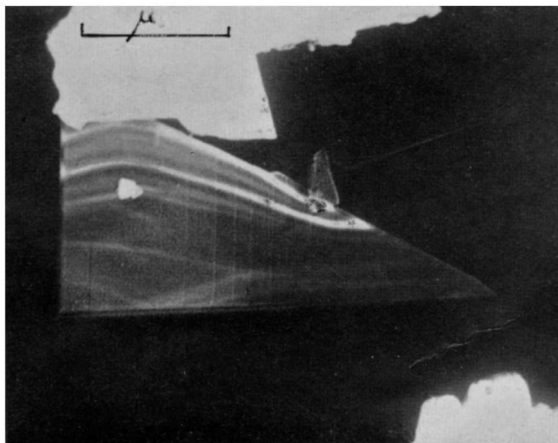


FIG. 5. Crystals of potash felspar with regular depressions on the surfaces.



The crystal (a) has V-shaped grooves, and parallel growth steps which are not continuous across the grooves. This suggests that growth has been initially around an obstruction which has later been displaced. The crystal (b) has a triangular notch and a flat depression at the upper edge.

FIG. 6. Crystal of potash felspar, showing a shallow platform, with one growth step towards the edge on the left, and several parallel steps towards the point on the right.



finely ground and individual crystal pieces were examined by electron diffraction. Only a few patterns similar to those given by the lamellæ were observed, since the number of pieces with orientation in the electron beam the same as the lamellæ (*i.e.*, *b*-axis parallel to the beam) was very limited. However, this experiment supports the identification of the lamellæ as potash felspar. Mineralogical works record such a habit, although the extreme thinness of the present crystal flakes is quite unusual.

Topography and Growth Layers.—The lamellæ were small compared with the normal prismatic felspar crystals among which they were found. The finest specimen was only about 70 Å in thickness. The 010 surfaces (the faces of the lamellæ) were normally perfectly plane, and of variable shape. Most crystals showed two or more other faces, one of which always corresponded to $1k0$, while $0kl$ and $1kl$ were also common. Pairs of similarly shaped crystals are seen in Fig. 4. Several crystals (*e.g.*, Fig. 5) showed V-shaped grooves in the 010 surface. Probably the crystals grew round prismatic crystals which became dislodged later.

Among the lamellar crystals associated with leucite was a small proportion in which the 010 surfaces were traversed from edge to edge by a number of parallel straight marks, which were shown by shadow casting to be shallow steps (Figs. 2, 5*a*, 6). Fig. 6 shows a crystal with a shallow platform with steps leading from it to both extremities of the flake. The parallel steps were invariably in the direction of the *c*-axis. No accurate estimate of the height of each step was possible but this height was probably less than 25 Å. The steps almost certainly represent the terminations of successive growth layers. In Fig. 5*a*, where the 010 surface was broken by the regular depressions already described, the steps did not usually correspond on opposite sides of a depression, indicating different rates of advance of the growth layers on the two sides. These growth layers are not compatible with crystal growth from screw dislocations (*e.g.*, Frank, *Discuss. Faraday Soc.*, 1949, 5, 48), but represent an alternative mode of growth likely to be important at higher degrees of supersaturation.

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