and it is possible then that at some stage late in the crystallization of the rock, an analcime residuum develops.

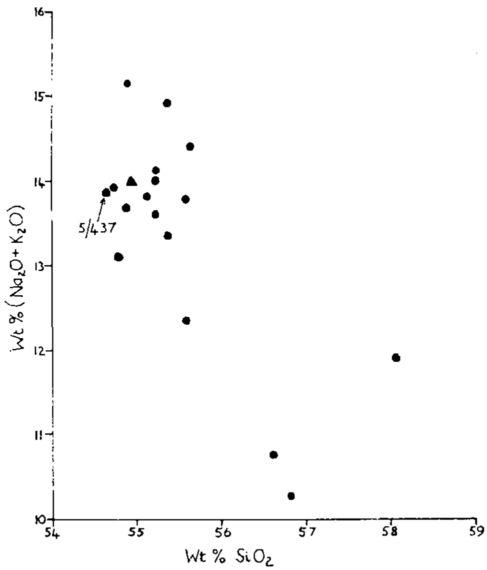

FIG. 1

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REFERENCES

PRIOR (G. T.), 1903. *Min. Mag.* **13**, 228–63.
WEBB (P. K.), 1971. Unpub. Ph.D. thesis, University of London.

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Classification of K-feldspar polymorphs by X-ray means

RECENTLY, Parsons and Boyd (1971) have discussed a relationship between K-feldspar order and igneous rock composition. Like many earlier workers they used the 131 reflections of the K-feldspars to estimate structural state. Feldspars were crudely classified on the basis of the appearance and relative intensities of the 131 reflections at positions indicating monoclinic or triclinic symmetry; many natural perthitic alkali feldspars from plutonic rocks contain a K-phase consisting of monoclinic material and material with obliquity extending to that of maximum microcline. The seven '131 reflection types' figured by Parsons and Boyd are described in outline on fig. 1.

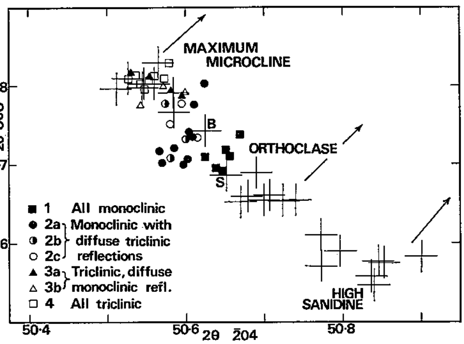

FIG. 1. Plot of 2θ 060 and 2θ $\bar{2}04$ (Cu-$K\alpha_1$) for K-phases of microperthites classified by 131 reflection type (Parsons and Boyd, 1971). The differences between the seven reflection types are summarized in the key. Large crosses are K-feldspars with $> Or_{85}$ given by Wright (1968); the size of these crosses exceeds the range observed in measurements of more than one X-ray pattern of the same sample. The points for the present study should be drawn as large. B = Spencer B, S = SH 1070. Arrows indicate the trend of ion-exchange series with albites and maximum microcline, 'orthoclase', and high sanidine as end members.

Wright and Stewart (1968) have shown that the degree of Al–Si order in alkali feldspars can be estimated from the *b* and *c* cell dimensions, and Wright (1968) has suggested that measurement of 2θ 060 and $\bar{2}04$ is a simple, related way of indicating degree of order. Wright and Stewart point out that reflections must be sharp for meaningful measurements by their technique and point out that the 131 reflection should be inspected for sharpness before using their methods. The Parsons and Boyd reflection types 1 and 4, and to a lesser extent 2a and 3b are measurably sharp. Wright's method therefore offered a check on the ranking used by us, and to this end a selection of samples giving each of the 131 reflection types have been X-rayed using Wright's method. Some intermediate types with diffuse 131 reflections were included to see how these would be ranked by his method. All the samples were feldspars from hypersolvus rocks so that we are here concerned with the K-phases of sodic microperthites.

The 060 and $\bar{2}04$ reflections were measured at their tops using $KBrO_3$ as an internal standard (Morse, 1970). Fig. 1 shows excellent agreement between the ranking obtained by the 131 method and by Wright's method. Sharp 060 and $\bar{2}04$ reflections plotting close to Wright's group of maximum microclines were obtained for all type 4 traces. Very sharp reflections were obtained for all but one of the type 1 traces and many 2a traces. The most diffuse 060–$\bar{2}04$ reflections in the present study were obtained from finely microperthitic crystals irrespective of the diffuseness of 131. Even though the samples show a variable degree of order on the 131 criterion, this may not be clear from the 060–$\bar{2}04$ reflections because the 2θ difference between reflection positions for the least well ordered and most highly ordered material in these feldspars is only about 0·1° (as against 0·4° between the orthoclase 131 and maximum microcline 131 positions) and resolution of the $K\alpha_1$–α_2 reflections is effective at higher angles. Type 3 reflections plot near maximum microcline even though some subsidiary monoclinic material is present.

The ranking used by Parsons and Boyd may be criticized on the grounds of crudity and the fact that diffuseness of reflections in perthitic crystals could be caused by compositional variation in the K-phases or lattice distortion at interfaces between K and Na-phases, rather than by variation in degree of order. However, the specimens do not give significantly anomalous 060–$\bar{2}04$ 2θ values, $\bar{2}01$ reflections are sharp, and the ranking by Wright's method seems to confirm the assumption that the 131 reflection types show the relative proportion of highly ordered K-feldspar, close to maximum microcline, and less well ordered material, 'orthoclase', in the samples. Fig. 1 should not, of course, be interpreted in a strictly quantitative fashion. Whether the distinct separate grouping of the types 1 and 2a reflections is due to differing degrees of order in the monoclinic feldspar or skewing of $\bar{2}04$ and 060 by the small amount of more ordered triclinic material present in type 2a is not clear although it does appear to support the correctness of the distinction drawn by Parsons and Boyd.

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REFERENCES

MORSE (S. A.), 1970. *Journ. Petrology*, **11**, 221.
PARSONS (I.) and BOYD (R.), 1971. *Min. Mag.* **38**, 295.
WRIGHT (T. L.) and STEWART (D. B.), 1968. *Amer. Min.* **53**, 38.
—— (T. L.), 1968. Ibid. 88.

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Carbon-dioxide metasomatism in the Campsie Lavas

IN the Campsie Fells, north of Glasgow, basalts and related volcanic rocks of the Clyde Plateau Lavas (Lower Carboniferous) exhibit varying degrees of alteration, there being few flows that can be described as completely fresh. Alteration usually takes the form of a break-down of ferro-magnesium minerals, which in many cases are replaced by calcite. This calcitization is commonly accompanied by oxidation, which in extreme cases converts nearly all the iron to the ferric state.

The above features are characteristic throughout the Campsie Fells except in an area about 1½ miles across lying between the Meikle Bin volcanic vent and the plug, Dungoil (Geological Survey Scotland, 1″ sheet 31). Within this area calcitization is more intense than usual; there are areas of near-complete alteration where the lavas have been transformed to a cream-coloured rock, which often contains small amounts