AN OCCURRENCE OF AUTHIGENIC FELSPAR AND QUARTZ IN YOREDALE LIMESTONES

SIR,—The insoluble residues from the Simonstone, and Middle Limestones of Darnbrook Fell, and from the same limestones on the ridge between Littondale and Wharfedale contain authigenic quartz and felspar crystals.

The authigenic quartz calls for little comment. The crystals range in size from $\cdot 03 \times \cdot 01$ to $\cdot 27 \times \cdot 05$ mm., and are prismatic in habit with pyramidal terminations. They contain abundant inclusions which are highly birefringent.

The felspars range in size from $\cdot 05 \times \cdot 025$ mm. to $\cdot 175 \times \cdot 06$ mm. The crystals are triclinic and elongated along the *a* axis. The faces commonly present are (001), (010), (101), (110), but the last of these may not be developed. Usually the crystals come to rest on (001) and show clean sharp outlines. When turned on to (010), however, the (101) faces are seen to be irregular and the junctions between these and the (001) faces are not sharp. In extreme cases these junctions are so rounded that the crystal is barrel-shaped. Since the other faces are clean and have sharp junctions, these irregular features are hardly likely to be due to fracture or erosion, and it is assumed that they are original characteristics.

Average measurements for some of the interfacial angles are :—

$$(110) : (1\bar{1}0) \quad 56° \quad \text{(32 measurements)}$$
$$(001) : (101) \quad 43° \quad \text{(10 measurements)}$$

Other angles (not averages) are :—

$$(001) : (110) \quad 72°$$
$$(101) : (110) \quad 64°$$

On (001), the extinction angles measured from the edge of the pinacoid range from 1°–6°. All (001) sections show twinning and the two sets may both extinguish in $+$ direction. These sections are length fast (elongation along the a axis) and give refractive indices of $1 \cdot 529$ and $1 \cdot 537$ ($\pm$ $\cdot 001$). The variation in thickness due to the presence of the (101) faces produces a gradation in the interference colour from light grey at the apices to yellow or orange at the centre.

(010) sections show no twinning and give extinction angles of about 15° measured from the edge of the pinacoid. The extinction angles may be positive or negative. Extinction is sometimes undulose. The refractive indices on this section are $1 \cdot 529$ and $1 \cdot 531$ ($\pm$ $\cdot 001$). The section is length fast (elongation along the a axis).

Approximate values for the refractive index are therefore $\alpha = 1 \cdot 529$; $\gamma = 1 \cdot 537$; birefringence $= \cdot 008$. These values and the optical characters in general, approximate to Albite.

Twinning of an unusual character is seen on all (001) faces. It consists of twins on the Carlsbad law combined with wedge-shaped Albite lamellae, together with rotation twinning about the a axis. Considerable variety is to be found—ranging from almost simple Carlsbad to almost pure Albite in character, but the second rotational element is always present. Occasionally, re-entrant angles may be seen on the crystal faces.

Inclusions are invariably present and consist of granular black material, partly concentrated near the centre of the crystal and partly disseminated throughout it.

So far as the writer is aware, the only previously recorded examples of authigenic felspars in Britain are those described by D. L. Reynolds,[1] and there are no previous records of the occurrence in Britain of authigenic quartz and felspar together.

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[1] Reynolds, D. L., 1929. Some new occurrences of authigenic Potash Felspar. *Geol. Mag.,* lx, p. 390.