Non-coaxial quartz- and mica-girdles in lineated quartzites from the Broken Hill District, New South Wales

With Plate XII

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Summary. Non-coaxial quartz- and mica-girdles in lineated quartzites from the Broken Hill District, New South Wales, are described and discussed.

A RECENT account of the geology of the Broken Hill District has been given by King and Thomson (1953). The intensely deformed Willyama Series (Archaean), a metamorphosed sedimentary succession which is the country rock of the lead-zinc lodes, has been folded about axes trending approximately north-east south-west into a number of tight anticlines and more open synclines with general southerly plunge. Subsequently, but probably soon after the folding, a number of major faults developed. These are grouped into three types:

1. *The Mundi-Mundi type,* strike 20° to 40° true, dip unknown but probably steep, direction of offset obscure.
2. *The Thackaringa type,* strike 90° to 100° true, dip vertical, horizontal offset, S.-block W., vertical movement unknown.
3. *The DeBavay type,* strike 320° to 350° true, dip steeply NE., horizontal offset E.-block N., vertical movement E.-block up.

These major faults are essentially crush zones, wide belts of schist up to some thousands of feet in width, occurring 'mainly as a series of rock flowage phenomena, rather than as examples of clean sharp fractures' (Andrews, 1948). In places, however, one or another of the individual fractures within the zones may be marked by persistent bands of laminated quartz, which in some places weather into grooved pencils or rods (King and Thomson, *ibid.*, p. 553).

The specimens to be described were collected from the East–West Fault (Thackaringa type) and from the British Fault (DeBavay type). These two types together form a set of complementary shear-planes which are 'sympathetic with the Willyama folding' (King and Thomson, *ibid.*, p. 554; see also den Tex, 1958, p. 80). At the locality in the East–

West Fault it was possible to confirm in the field that the relative displacement corresponded to S.-block W. A detailed description of the British Fault is given by Gustafson, Burrell, and Garretty (1950, p. 1417).

The strictly rectilinear character of the lineation (plate XII, fig. 2) enables sections to be cut at right angles to this direction with great accuracy. The quartz, in sections in this direction, shows scarcely any preferred elongation, being developed in grains of about 0·3 mm average diameter which meet each other along rather smooth boundaries showing a strong tendency to triple junctions. A very small amount of colourless mica is present in the form of flakes of average length about 0·075 mm, mostly scattered through the quartz grains but occasionally aggregated into nests and only very rarely tending to a distribution along a plane.

Both quartz [0001]-axes and mica {001}-poles show strong preferred orientation in sharply defined girdles (fig. 1). The planes of the mica girdles are strictly at right angles to the macroscopic lineation, but those of the quartz are oblique to it. From contoured diagrams (as in fig. 2) the dihedral angle between the two girdles in a given specimen can be determined as about 25°. The mica fabrics show a close approach to orthorhombic symmetry. The quartz fabrics are themselves triclinic in view of the obliquity of the axis of the girdle to the macroscopic lineation (which, it is to be noted, is expressed entirely by the quartz—the mica flakes are too minute and too sparse to contribute to a visible lineation). The combination of these two component fabrics yields a clearly triclinic total fabric, a feature which has been noted in other specimens and at other localities and thus appears to be a rather general characteristic of this kind of lineated quartzite in the Broken Hill District.

The problem of the origin and significance of such a fabric is, of course, one of long standing in structural petrology. It has been considered, for example, by Weiss (1955) in relation to a particular example of a triclinic tectonite from Anglesey. He came to the conclusion that many such triclinic fabrics may be products of monoclinic deformations acting upon initially layered fabrics whose symmetry did not conform with that of the deforming movements. The quartz and mica girdles, though not coaxial, are considered to have been produced during a single phase of movement. Such layering might be primary sedimentary banding or a product of metamorphism. It seems unlikely, however, that such an explanation can apply to the Broken Hill fabrics. The minute mica flakes, sparsely and irregularly distributed, can have had little geometrical

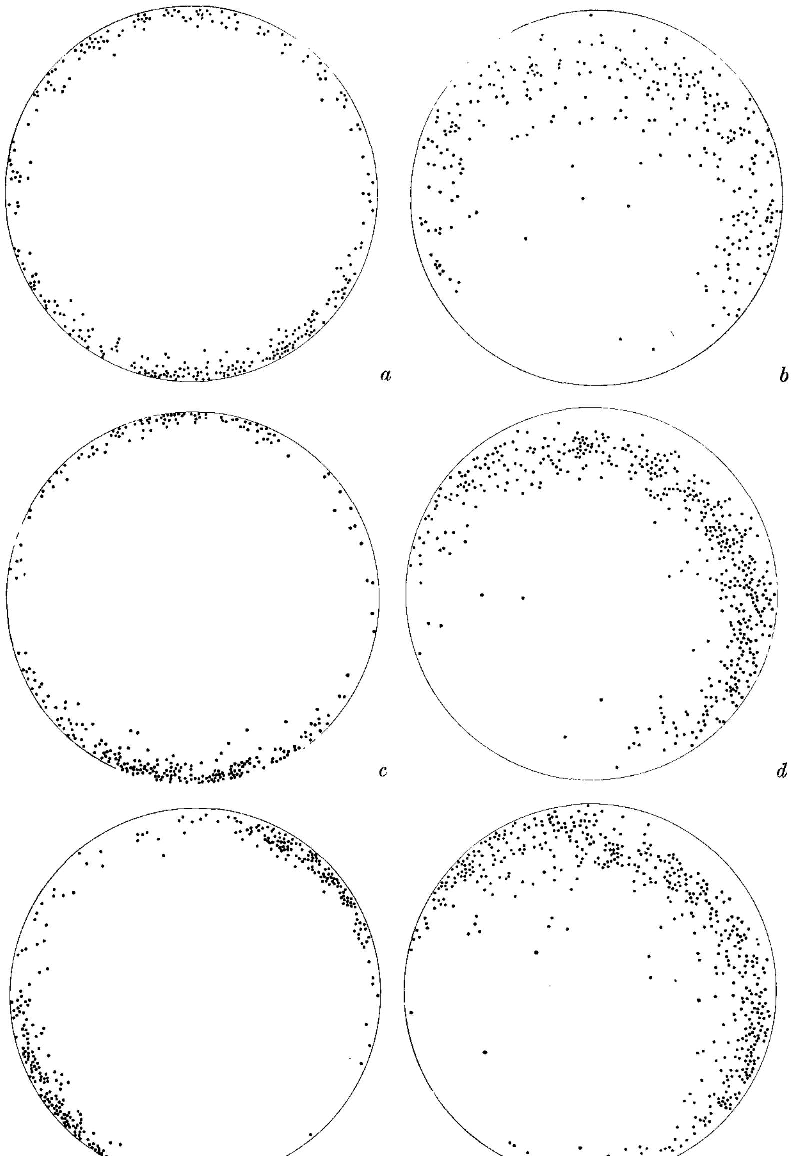
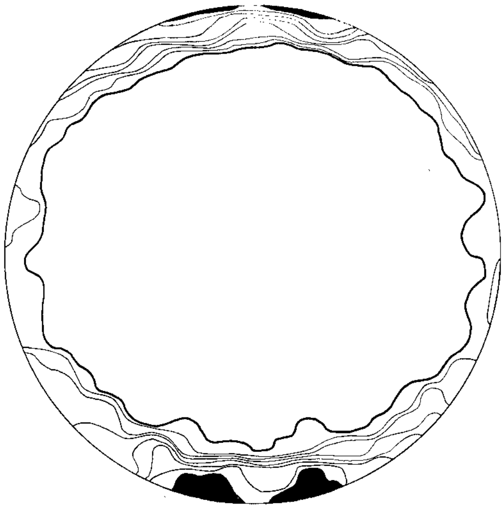


FIG. 1. Scatter diagrams for quartz [0001] and mica {001} poles in quartzites from Broken Hill. All sections cut at right angles to the lineation. (*a*) East–West Fault. 300 muscovite. (*b*) East–West Fault, same section. 300 quartz. (*c*) East–West Fault, another specimen. 300 muscovite. (*d*) East–West Fault, same section. 500 quartz (*e*) British Fault. 300 muscovite. (*f*) British Fault, same section. 500 quartz.



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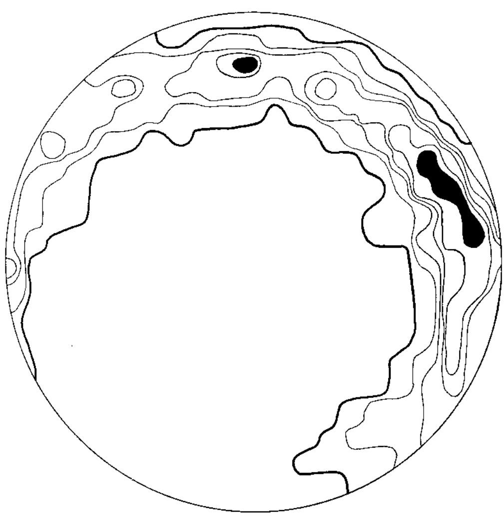

b

FIG. 2. (*a*) Mica diagram of fig. 1*c* contoured. Maxima > 10 %. (*b*) Quartz diagram of fig. 1*d* contoured. Maxima 6 %.

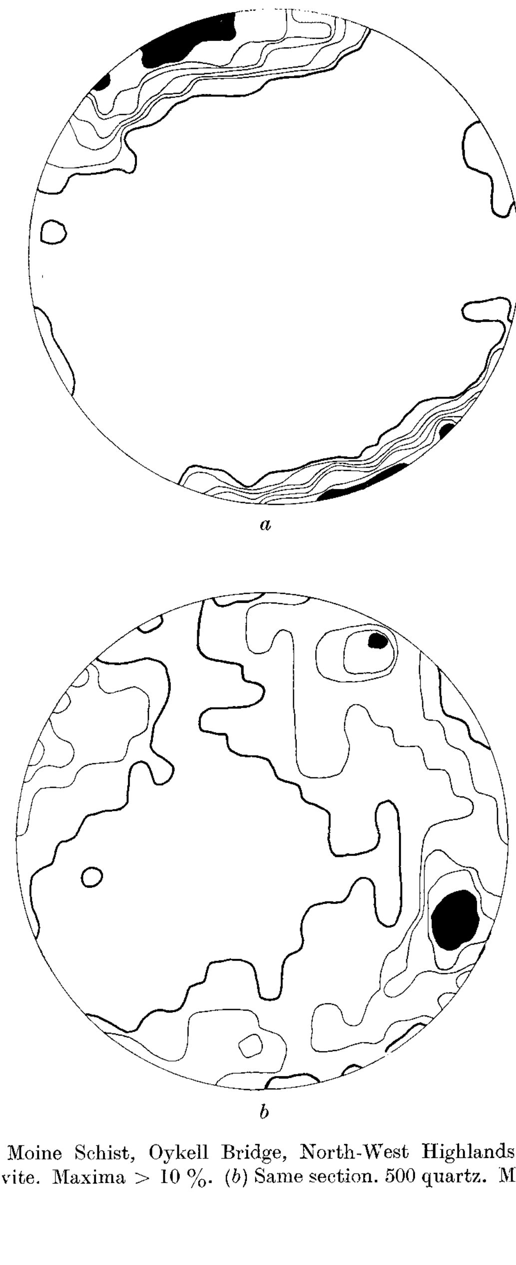

FIG. 3. (*a*) Moine Schist, Oykell Bridge, North-West Highlands of Scotland. 250 muscovite. Maxima > 10 %. (*b*) Same section. 500 quartz. Maxima 5 %.

or mechanical significance in the development of the complete fabric. It seems possible that an alternative explanation, supported by some earlier writers but rejected by Weiss, may apply in this instance. The two sets of faults here considered are known to be associated with considerable horizontal displacements; for the DeBavay Fault this is about 2000 ft, and for the Thackaringa as much as 20 000 ft has been suggested. It is well established that the region has been subjected to several metamorphic episodes, at least three of which are associated with strong deformation (Binns and Miller, 1963), and it seems reasonable to postulate a polymetamorphic origin for the present triclinic fabric of these quartzites.

Problems of overprinting during multiple movements arise in the study of Moine and Dalradian rocks in the Scottish Highlands. Although in materials of this kind the lithological layering may at times play the important role assigned to it by Weiss, there are points of close resemblance between the fabrics of typical Highland mullions, for example, and those of the Broken Hill quartzites. Fig. 3 presents a new set of measurements of quartz and mica from a mullion at Oykell Bridge. The quartz pattern is not as well defined, and is more complex, in comparison with that of the Australian rocks, but the plane of the principal girdle makes an angle of approximately 25° with that of the muscovite girdle which is itself strictly at right angles to the lineated length of the mullion. It has been observed (Clifford, 1960, p. 384) that 'double folding has not the disrupting effect on the mica girdle that appears in the quartz diagrams'. In many of these Highland schists sections parallel to the lineation reveal a gentle flexuring of the mica flakes, which are drawn out into 'tails' apparently without sensible change of orientation.

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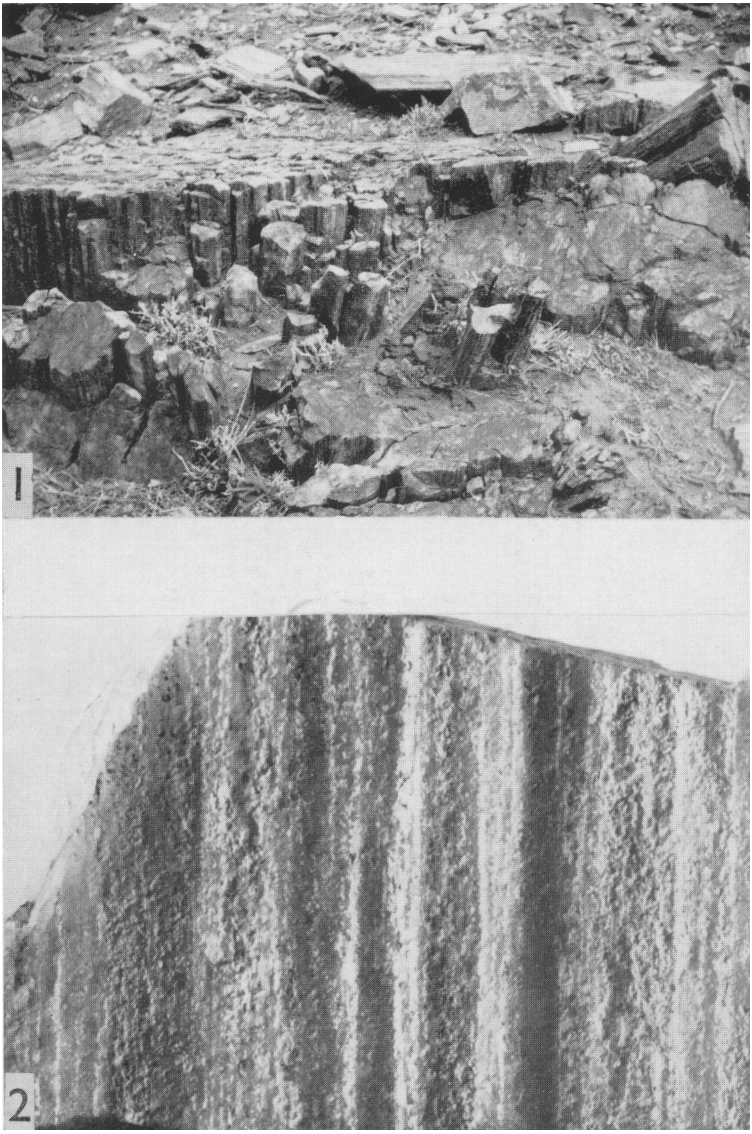
EXPLANATION TO PLATE

PLATE XII

FIG. 1. Rodded quartzite near East–West Fault, north of Copper Blow. The exposed parts of the sub-vertical rods are about 8 inches long.

FIG. 2. Lineated slabby quartzite in British Fault, near Blackwood's Shaft. ×2.



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