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Strain analysis in rocks with pretectonic fabrics: Reply

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I THANK De Paor and Kusky for their comments on algebraic strain methods. In the first part of the discussion they emphasize correctly the 'path independence' of ellipse fabrics undergoing homogeneous strain, which is entirely in accord with the approach used by Wheeler (1984, 1986a,b). The subsequent discussion involves a misunderstanding of the physical meaning of the 'fabric ellipse/ellipsoid'. De Paor and Kusky state: '*To represent a pebble fabric, consider the envelope surface . . . Wheeler suggests that it would be ellipsoidal with the shape of a virtual strain ellipsoid for any primary fabric* . . .'. However, I have never made such a suggestion, nor would it be correct to do so. The fabric ellipse/ellipsoid is defined *mathematically* and always has an elliptical outline, no matter how complex the fabric. It is possible to derive the following relation:

symmetry of fabric ellipse ≥ symmetry of distribution

(Wheeler 1986c, p. 98). This can be proved mathematically and is illustrated in Fig. 1. Equivalently,

symmetry of fabric ellipse
≥ symmetry of enveloping surface.

A random distribution always has a circular/spherical fabric ellipse/ellipsoid. As De Paor and Kusky point out, not all primary sedimentary fabrics can be formed by imposing 'virtual strain' on a random distribution. However, many non-random distributions have circular or spherical average shapes. As an analogy, consider an ordinary numerical average. Suppose we have a large set of numbers selected at random between +1 and −1. The frequency distribution will be symmetric about 0 so the average will be 0. However, it is not *necessary* that a frequency distribution of numbers be random or symmetric about 0 for the average to be 0. For instance the numbers 0.8, −0.5, −0.3 form a lop-sided distribution but average to 0. All that is necessary for the algebraic strain analysis methods to work is that the distribution can be modelled as the result of a 'virtual strain' imposed on a distribution of circular/spherical average shape. This is always possible. For primary sedimentary fabrics, the notional distribution will exist, will have circular/spherical average shape and will be non-random.

If a primary sedimentary fabric, no matter how complex, is symmetric with respect to bedding then its fabric ellipsoid can be defined and will be symmetric to bedding. Thus, given the rule that the fabric ellipse/ellipsoid behaves like a material object during homogeneous

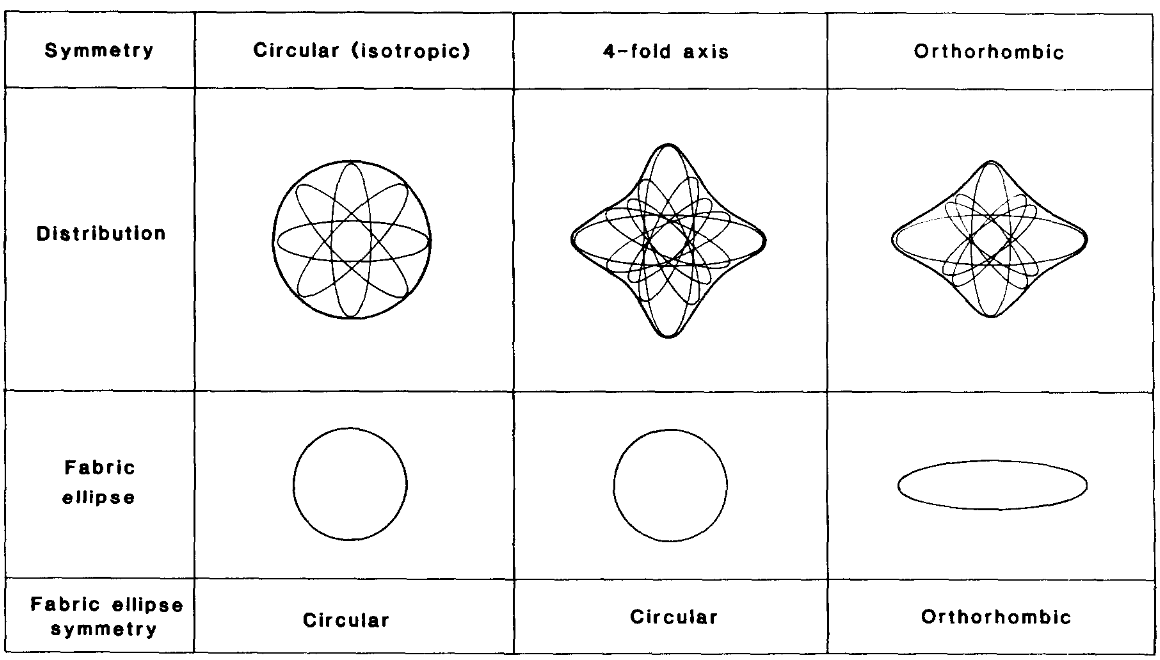

Fig. 1. Sketches of some two-dimensional enveloping surfaces of elliptical distributions and their corresponding fabric ellipses.

deformation, the method of Wheeler (1986b) can be applied to any primary bedding-symmetric fabric. De Paor and Kusky are correct to point out the complexities of real primary sedimentary fabrics, but such complexities do not invalidate the algebraic methodology. The use of two-dimensional methods remains problematic, as noted in Wheeler (1986b) where it is shown that some 'triaxial-symmetric' initial distributions can only be detected using three-dimensional methods.

In summary:

(1) Ellipse fabrics produced by homogeneous strain are independent of strain path.

(2) Some primary sedimentary fabrics may have complex non-ellipsoidal enveloping surfaces.

(3) The 'fabric ellipse/ellipsoid' is defined mathematically from measurable shapes and orientations in *any* distribution.

(4) The fabric ellipsoid is not the same as, and always has the same or greater symmetry than, the enveloping surface of the distribution.

(5) Because of this, strain estimates derived algebraically from fabric ellipse/ellipsoid shapes are always *at least as* reliable as those derived from other techniques (e.g. Dunnet & Siddans 1971, Lisle 1985) which make assumptions about initial fabric symmetry.

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