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Comparison of the algebraic methods for Rf/phi strain analysis

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The three algebraic methods for R_f/ϕ strain analysis by Shimamoto and Ikeda (1976), Mulchrone et al. (2003) and Yamaji (2008) were theoretically compared. The equivalence of the latter two methods was already shown by Yamaji (2003). In this study, it is shown that the three methods yields the same optimal strain ellipse for any set of post-strain elliptical strain markers, though they were originated from different ideas. It is also shown that, in spite of the equivalence of the optimal solutions, the methods have difference in the ability of error estimation.

Each of R_f/ϕ data is composed of a paired data—the aspect ratio and major-axis orientation of an ellipse. Shimamoto and Ikeda's (1976) method defines 2×2 symmetric matrices for the pairs obtained from post-strain elliptical markers, and calculates the paired data of the strain ellipse from the component-wise mean of the matrices. Because of the symmetry, each of the matrices has three independent components. Regarding the three components as rectangular Cartesian coordinates, the matrices are represented in a three-dimensional parameter space by points on the curved surface that is defined by the determinant one of the matrices. Distances between data points on the surface depend on the choice of the reference orientation on the plane where strain markers are observed. The spread of data points has the dependence as well. As a result, the method of Shimamoto and Ikeda (1976) unfortunately has anisotropic resolution. The method is inappropriate for error estimation.

For the appropriate estimation of errors, the parameter space for the analysis must not have such dependence. In addition, the paired data—the aspect ratio and major-axis orientation of ellipses—must have one-to-one correspondence with points in the parameter space. The conventional R_f/ϕ plot, employed by Mulchrone et al. (2003), does not have this property. The parameter space of Yamaji (2008) has not only those properties but also the visualization method to show the spread of the paired data.

References
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