EllipseFit 3: A New Computer Program for Integrated Geological Finite Strain Analysis

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EllipseFit 3 is an entirely new version of EllipseFit, an integrated program for geological finite strain analysis. It is designed for determining two and three-dimensional strain from oriented photographs in field and laboratory based structural geology studies. The graphical interface and multi-platform deployment also make it ideal for teaching introductory or advanced structural geology laboratories. EllipseFit 3 is currently implemented for Windows 32, Macintosh 10.5^{+}, and Linux (Ubuntu) 64 bit platforms. It is free.

EllipseFit is suitable for determining two and three dimensional strain using various objects including center points (Fry analysis), lines, ellipses, and polygons. Polygons include pebbles, fossils, or particles of any initial shape. Dirringer and Vollmer (2013), for example, calculated strain from a population of deformed graptolites using the polygon method. The analysis of strain from deformed populations of initially random polygons is therefore widely applicable to many rocks in thin section, hand sample, or on suitable outcrops.

EllipseFit allows digitizing polygons directly as vector-based polygons, or indirectly by flood fill. The first and second order polygon moments are calculated and converted to equivalent ellipses (e.g., Steger, 1996). The mean ellipse has been shown to be equivalent to the applied strain (Mulchrone and Choudhury, 2004). Mean ellipse calculations include shape-matrix eigenvalue (Shimamoto and Ikeda, 1976), mean radial length (Mulchrone, et al., 2003), and hyperboloidal vector mean (Yamaji, 2008). Error analysis is done analytically and using bootstrap techniques. The initial data set can be unstrained to check variation of the calculated pre-strain fabric. Given three or more oriented sections from a sample, EllipseFit calculates the three dimensional strain using the method of Shan (2008), with calculation of section misfits.

Graphical analysis includes the analytical Wellman method (Vollmer, 2011), normalized Fry (Erslev, 1988), polar Elliott (Elliott, 1970) and Rf/Phi (Dunnet, 1969) diagrams, strain maps, and a variety of polar and cylindrical hyperboloidal projections (stereographic, equal area, etc.) with automatic contouring. The Elliott plot is one of a family of polar hyperboloidal projection, while the Rf/Phi is a type of cylindrical hyperboloidal projection. EllipseFit 3 includes image transformations for straining images, and unstraining them to pre-deformed states. It includes image analysis routines, such as Prewitt, Sobel, and Kirsch edge detection filters, thresholding and pixel remapping. EllipseFit 3 is fully rewritten from EllipseFit 2, with tens of thousands of lines of code, in Free Pascal, a professional open source compiler that runs on over 40 operating systems.