PRIMARY GRAIN SHAPES AND GRAIN PREFERRED ORIENTATIONS: WHY NO ANALYSIS OF FINITE STRAIN IS COMPLETE WITHOUT THEIR INCORPORATION

Primary Grain Shapes and Grain Preferred Orientations: Why NO Analysis of Finite Strain is Complete Without Their Incorporation

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The final shapes and orientations of fabric elements (e.g. quartz grains in a sandstone) used to quantify the intensity of finite strain experienced by a rock is the product of distortions, volume changes, and rotations on a pretectonic primary fabric. Unfortunately, most studies reporting quantitative assessments of finite strain assume initially spherical shapes, non-spherical but randomly or uniformly oriented fabric elements, or that the effect of primary fabrics are identifiable even after straining.

In this study we have compiled the results of $>$150 fabric ellipsoid determinations from a variety of undeformed sedimentary and volcanic rock types including multiple fabric elements (e.g. crystals, pumice) from within the volcanics. While depending greatly upon the rock type and the particular fabric element in question, the primary fabric ellipsoids determined here range from those that only slightly departed from a sphere (e.g. sandstones: 1.3: 1.1: 1; pebbly mudstone1.25: 1.15: 1: HBL in volcanics: 1.2: 1.1: 1) to those which are extremely oblate (e.g. pumice: 3.2:2.4:1; shale: 1.5: 1.4:1). These results highlight the need for caution when selecting the type of fabric element used in strain analyses. This arises from the observation that some populations of fabric elements, such as pumice, not only yield relatively high initial mean axial ratios but also exhibit a broad range of initial axial ratios. Additionally, since the final fabric ellipsoid is the multiplicative product of the primary ellipsoid and the superimposed strain ellipsoid, the data generated in this study indicate that even for the fabric elements that yield relatively small primary fabric intensities the effect on the final ellipsoid may be dramatic. For example, the 2D combination of a primary fabric ellipse with a ratio of 1.3:1 with a strain ellipse of 2:1 would result in a final ellipse of 2.6:1, an apparent 30\% more extension if the preexisting fabric is not accounted for.

Because the orientations of the primary fabric ellipsoids reported here rarely exhibit consistent relationships to bedding directed removal of the primary fabric contribution is not generally possible. We suggest, however, that the most appropriate means of correcting for the affect of a primary fabric is to multiply the finite fabric ellipsoid by the reciprocal of the mean primary fabric ellipsoid axis by axis for every axis combination. This process, therefore, brackets the range of possible final strain intensities.