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Numerical Analysis of finite strain in the Warm Zand Structure

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The distribution of strain and its variation within geologic terranes have always been a matter of great interest to structural geologists. The absence of good markers, especially in metamorphic zones has made strain analysis a very laborious task. A work flow for finite strain analysis is presented in this study. In the development of the work flow two important points were considered; firstly, the work flow should be applicable both for sedimentary and metamorphic rocks and secondly, the methods that would make up the work flow would integrate data that are easy to obtain from geological features. Using The Warm Zand structure as a case-study, we have investigated the finite strain using several advanced numerical methods. The Warm Zand Structure consists of strongly deformed calc-silicates of the Puntsit formation and feldpathic quartzites of the Goede Hoop formation which gradually change into pure quartzites in some locations. The second phase of folding F2 in the calc-silicates gave rise to isoclinal folds. Based on the type of strain markers we encountered, we designed a procedure to estimate the strain of the area of interest; for instance, in the Puntsit formation, folds are common and were used as strain markers. A mathematical analysis of the shape of these folds was first performed using Fold Profiler developed in the MATLAB® environment. As a result we found that the set of folds analysed was best fitted by conic sections and bézier curves. The latter showed that the Warm Zand Structure's folds are close (30<ILA<70) to open (70<ILA<120) folds. The shape parameters (aspect ratio, eccentricity, and normalised area) obtained with the conic section method were used to simulate theoretical folds that best fit the natural folds under consideration, with the aim of investigating the strain pattern. The proposed strain sequence model begins Initial Layer Shortening (ILSH), Tangential Longitudinal Strain (TLS), Flexural Flow (FF) and Flattening (FL). In each fold the intensity of each strain pattern has a small variation compared to each other. FF is less important than TLS and usually occurs after the latter. Viscosity, shortening and strain partitioning were estimated from fold shape parameters using Fold Geometry Toolbox (FGT) developed in the MATLAB® environment. Euhedral quartz crystals grown as a pegmatite of quartz mobilisation sampled from the feldspathic quartzites were used to measure the robustness and reliability of the DTNNM and MRL. The method that would identify the error (due to the quartz crystals oriented in different directions) would be recommended as the most reliable method for strain analysis of elliptical objects. The confidence ellipses for bootstrapped data showed that the DTNNM results are associated with errors.

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