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Dynamic retro-deformation of folded multilayers: Application to turbidites in South-West Portugal

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Two-dimensional numerical finite element models of power-law viscous flow are employed to retro-deform folded multilayers. Our aim is to assess the deformation history of folded turbidites of the South Portuguese Terrane. The folded turbidites of Carboniferous age were mapped in details along a ca. 10m high and 60m long profile. They consist in interlayered quartzwackes and shales. Hinge collapse and sand dikes are characteristic features of the selected section. Sand dikes have been deflected during folding, recording the shearing component of flexural flow in the weak and ductile shale layers. Field observations indicate that quartzwackes were the stronger layers; hinges collapsed by squeezing away the softer shale between quartzwacke limbs. According to these observations, we used power-law viscous model materials. The mapped section was digitized in MATLAB and meshed using a mesh generator. This produced the initial geometry for finite element simulation. The applied two-dimensional finite element code uses 7-node triangular elements, a mixed formulation for incompressible flow and a power-law viscous rheology. The digitized section is numerically stretched orthogonal to the fold axes for various viscosity ratios and power-law exponents between the folded strong layers and the weaker layers. First results show that the collapsed hinges are not retro-deformed to their original horizontal setup. On the other hand, forward models of multilayer folding generate hinge collapses similar to natural cases, which can be retro-deformed to their original geometry. The difficulty in retro-deforming natural hinge collapse structures may be due to (1) rheological effects not included in the finite element model, (2) three-dimensional

effects or (3) later deformation not related to the folding. However, in other kinematic models of retro-deformation, such as balanced cross sections, the collapsed hinges would have been simply stretched conserving the area of the folded layer which is inconsistent with the current numerical results. The application of the here described finite element models, which simulate rock deformation based on continuum mechanics principles, allows retro-deformations that fulfill conservation of mass (or area) and the force balance equations.