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Numerical modelling of domino boudinage under high simple shear strain

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In non-coaxial flow, rigid layers subjected to layer-vertical fracturing result in synthetic rotation of the individual blocky boudin segments into the shear direction. However, in kinematic models of these domino, bookshelf or antithetic-slip boudinage (Goscomb et al., 2004), the bulk finite shear strain is accommodated by rotation of the boudin segments and antithetic slip between the boudins. Intuitively, this mechanism has been compared with tectonic deformation by rotating parallel faults, i.e. the bookshelf mechanism (Mandl, 1987) and therefore the bulk strain recorded in tilted boudins is considered to be only minor (Ramsay and Huber, 1987).
In this work we use the finite element code MILAMIN (Dabrowski et al., 2008) for solving the simple shear deformation of almost rigid rectangular boudins of different aspect ratios. The geometry is defined using an unstructured mesh and periodic boundary conditions perpendicular to the shear direction. Initially, the boudin trains are parallel to the shear plane embedded in a Newtonian viscous matrix.
As long as the sides of the boudins slide antithetically against each other the boudins rotate much slower than an isolated rigid object as predicted by analytical solutions. When the upper corner of the boudin reaches the lower corner of the neighbouring boudin, the objects separate and the rotation rate accelerates. We study the rotation rate as a function of the width of the separation and the aspect ratio of the boudins.
A major result of this work is that for a given finite rotation of the individual boudin segments subjected to layer parallel simple shear, mechanical models demonstrate that significantly more shear strain is needed than the kinematic domino or bookshelf models suggest. Excellent natural examples of antithetic slip boudinage occur in the Western Cyclades (Greece), where quartz layers are fractured perpendicular to the layering into rectangular shaped boudins with various aspect ratios. The host rocks of the quartz boudins are highly deformed calcite/dolomite marble mylonites, which suggest by independent geological criteria considerable high shear strain during formation of the boudinage.

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