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Assessing flow vorticity of a major ductile shear zone using rigid inclusions: a case study from the Nordfjord-Sogn Detachment Zone in Western Norway

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We used rigid inclusions to assess flow vorticity in one of the largest extensional detachments in the world, the Nordfjord-Sogn Detachment Zone (NSDZ) of Western Norway. The study focused in two main areas, at Atløy and near Sandane. Data from Atløy were collected near the top of $\sim$2-3 km thick zone of mylonites, whereas data from Sandane were collected in the lower part of the shear zone. We measured the dip of major principal axes (ϕ) and the aspect ratio (R) of rigid inclusions and plotted them on graphs. We also looked for signs of flow confinement and/or of slipping inclusion/matrix interface. Comparison with theoretical and experimental modelling suggests that the studied section at Gjervik (Atløy) located near the top of the NSDZ has undergone simple shear, without significant components of pure shear during the terminal stages of shearing. The observed antithetic shape preferred orientation can be explained by simple shear associated with a slipping inclusion/matrix interface. The observed fabric at deeper structural levels of NSDZ in Sandane can be produced by general shear (i.e. simple shear plus flattening normal to the shear plane) acting upon rigid inclusions in slipping contact with the matrix. The large scale NSDZ under investigation shows evidence of partitioning of the strain from protomylonites to ultramylonites, and of the simple shear and pure shear components. However, the shear zone as a whole must have had a considerable amount of flattening perpendicular to the shear plane, as shown by the lack of monoclinic symmetry in the mesoscopic strain in great part of the NSDZ, and by the assessed vorticity in the Sandane area. We conclude that flow in the NSDZ was very heterogeneous both at the kilometre and the metre scale.