Shear zones between rock units with no relative movement

Hemin Koyi, Harro Schmeling, Steffi Burchardt, Christopher Talbot, Soumyajit Mukherjee, Håkan Sjöström, Zurab Chemia

Abstract
Shear zones are normally viewed as relatively narrow deformation zones that accommodate relative displacement between two “blocks” that have moved past each other in opposite directions. This study reports localized zones of shear between adjacent blocks that have not moved past each other. Such deformation zones, which we call wakes, form due to the movement of exotic blocks within a viscous medium (denser blocks sinking within a salt structure, the paths between separated boudins), melt in partially molten surroundings (melt movement during migmatisation), or solid blocks sinking through a partially molten magma body (stoping). From the fluid dynamics perspective these shear zones can be regarded as low Reynolds number deformation zones within the wake of a body moving through a viscous medium. While compact moving bodies (aspect ratio 1:1:1) generate axial symmetric (cone like) shear zones or wakes, elongated bodies (vertical plates or horizontal rod-like bodies) produce tabular shear zones or wakes. Unlike conventional shear zones across which shear indicators usually display consistent symmetries, shear indicators on either side of the shear zone or wake reported here show reverse kinematics. Thus profiles exhibit shear zones with opposed senses of movement across their center-lines or -planes.

We have used field observations and results from analytical and numerical models to suggest that examples of wakes are the transit paths that develop where denser blocks sink within salt structures, bodies of melt rise through migmatites, between boudins separated by progressive extension and (perhaps) where slabs of subducted oceanic lithosphere delaminate from the continental crust and sink into the asthenosphere. We also argue that such shear zones may be more common than they have been given credit for and may be responsible for some reverse kinematics reported in shear zones.