Geophysical Research Abstracts
Vol. 15, EGU2013-13716, 2013
EGU General Assembly 2013

Stress, strain and fault interactions; physical explanation of the Båth's law

Jure Žalohar
Koroška cesta 12, 4000 Kranj, SI-Slovenia

Most classical methods for paleostress analysis of fault-slip data are based on few basic assumptions, such as (1) the direction of movement on the faults parallels the shear stress on those faults, (2) the faults do not interact, (3) the blocks bounded by the fault planes do not rotate, and (4) the stress field activating the faults is time-independent and homogeneous. In the last 20 years a considerable development in understanding the effect of block (micro)rotations between the faults was achieved using the Cosserat continuum theory (Twiss et al., 1991, 1993; Twiss and Unruh, 1998, 2007; Twiss, 2009; Žalohar and Vrabec, 2010; Žalohar, 2012). This theory showed that in some cases at least the Earth's crust behaves as a Cosserat continuum. Contrary to the classical theory, the Cosserat theory suggests that the movement along the faults parallels the shear strain defined by (1) the global instantaneous deformation tensor (which describes the deformation of the region) and (2) the relative microrotation tensor (which describes the relative (micro)rotation of individual blocks). The Cosserat theory also suggests that the movement and rotation of the individual block produces coherent movement along all the faults that bound the block. Movement along one fault influences the movement along other faults that bound the same block. This means (1) that faults are not independent, and (2) that the Cosserat theory can describe fault interactions. Žalohar and Vrabec (2010), Žalohar (2012) and Žalohar (2013, in preparation) recognized three types of fault interactions that the Cosserat theory can possibly describe: (1) intersecting-faults interaction, (2) parallel-faults interaction, and (3) parallel-wedges interaction. In the case of the intersecting-faults interaction the movement along two intersecting faults is parallel to the intersection direction between these two faults. The most important result of the Cosserat analysis of the parallel-faults and parallel-wedges interactions is, however, the physical explanation of the Båth's law, which is one of the three well known scaling laws for earthquakes, and whose theoretical origin remained controversial and unexplained in the geophysical literature. Žalohar (2013, in preparation) showed that in the Cosserat continuum the Båth's law is a direct consequence of the frictional properties of natural faults. It was discovered that the Båth's law reflects three possible types of frictional behavior of natural faults; (1) internal friction and formation of new fault planes, (2) static friction and frictional reactivation of pre-existing fault planes, and (3) dynamic friction during progressive sliding and progressive deformation on fault planes or within fault zones. Our theory predicts a complex behavior of the mainshock-aftershock pairs and is in agreement with the Global Earthquake Catalog. Our theory also allows for estimating the average ratios between the coefficients of internal, static, and dynamic friction on natural faults, leading to the results that are in excellent agreement with other independent studies, such as rock-mechanics experiments, paleostress analyses of natural fault systems, and other seismological studies.