Geophysical Research Abstracts
Vol. 15, EGU2013-9112, 2013
EGU General Assembly 2013

Shear heating during post-Caledonian extension: from field observations to numerical quantifications

Alban Souche (1), Sergei Medvedev (2), Marcin Dabrowski (2,3)

(1) Institute for Energy Technology (IFE), Kjeller, Norway (alban.souche@ife.no), (2) Physics of Geological Processes (PGP), University of Oslo, Norway, (3) Computational Geology Laboratory, Polish Geological Institute - National Research Institute, Wroclaw, Poland

The collapse of the Caledonian orogeny and the exhumation of the high-grade Caledonian root, from the late Silurian to early Devonian, were partly accommodated by the development of large-magnitude extensional detachments. The Nordfjord-Sogn Detachment Zone (NSDZ) is one of these post-orogenic detachments and is also the main extensional structure exposed in western Norway. It is represented by a several kilometers thick mylonitic zone associated with normal-shearing and displacement in the order of 100 km. The Hornelen, Kvamshesten and Solund Devonian basins formed as supra-detachment basins in the hangingwall of the NSDZ. The contact between the Devonian basins and the NSDZ occurs along a sharp geological boundary and provides an excellent study area to investigate the thermal structure of the sediments as a function of the distance to the detachment.

The determination of the peak-temperature conditions of the sediments, using Raman spectroscopy on organic carbon, shows a characteristic increase close to the detachment (up to 345 oC adjacent to the detachment contact). These geological observations suggest that the development of the detachment controlled the peak-temperature distribution in the basins, and that sediments close to the detachment may have been exposed to temperature up to 100 oC higher than few kilometers away from the detachment.

Two distinct aspects have to be quantified to understand the geological observations: 1) the heating of the basins adjacent to a relatively “hot” footwall during exhumation, and 2) shear heating from highly-localized rock deformation in the detachment.

We numerically analyze the influence of the rheology and the deformation style within the detachment, the rate of exhumation of the footwall, and the thickness of the sedimentary accumulation on the top of the system. The model reproduces the elevated temperatures observed in the basins where locally 100 oC (25% of the total temperature) can be attributed to shear heating. Shear heating may exceed 100 times the heat produced by radioactivity at depth of 5 to 10 km within the crust, and may increase the peak-temperatures by several tenths of degrees in the basins as far as 5 km away from the detachment contact.