Geophysical Research Abstracts
Vol. 14, EGU2012-10272, 2012
EGU General Assembly 2012

Toward detailed structural analysis of seismic reflection data from crystalline basement: the seismic attribute approach

T. Torvela (1,2), J. Moreau (2), R.W.H. Butler (1), A. Korja (2), and P. Heikkinen (2)

(1) Department of Geology and Petroleum Geology, University of Aberdeen, UK, (2) Department of Geosciences and Geology, University of Helsinki, Finland

During orogenesis, the crust is thickened considerably. The thickening leads to partial melting and, consequently, rheological weakening and extension of the middle and lower crust. The processes and the structures within the weak middle and lower crust are intimately related to the evolution of orogens, but the deep crustal processes are still poorly understood. The mode and the strain distribution of the deformation within the extending middle and lower orogenic crust have attracted increasing attention since the first published models for mid-crustal flow.

Seismic reflection data are often used to interpret deep crustal structures and processes. Conventionally, structural interpretation of the seismic data is done from the amplitude information. Large amplitude changes are, however, often related to lithological changes and do not necessarily correspond to structural boundaries or to deformation fabrics. Furthermore, the deformation processes and the strain distribution between the interpreted structural boundaries remain obscure. On the other hand, field-based observations are often made at a sub-seismic scale. Therefore, reliable correlation of the seismic data with the detailed field structural data is required in order to make conclusions about deep deformation fabrics and mid-crustal processes. To achieve this, more detailed, sub-kilometre-scale information needs to be extracted from seismic data.

This contribution bridges modern seismic interpretation techniques of petroleum industry and field-based structural studies in orogenic belts. We show how a seismic attribute technique enhances 2D seismic data, to reveal detailed information about the deformation fabrics within the orogenic crystalline basement. A case study is presented from southern Finland, where high-resolution deep seismic reflection survey images the middle and lower crust of the Svecofennian orogeny ($\sim$1.89-1.87 Ga). The described technique reveals sub-kilometre-scale penetrative deformation fabrics within the extended middle and lower crust: the syn-orogenic extensional strain is accommodated by mega-scale S-C' structures overprinting earlier structures in the seismic data. Correlation with the outcrop data shows that many of the surface features that might at first be interpreted as contractional, such as large-scale fold structures, in fact indicate extension. The results have implications to other hot orogenies, such as the Himalayas, where syn-orogenic mid-crustal extension and/or flow have been suggested. The presented seismic filtering technique should also be applicable to other seismic datasets from orogenic belts, to enhance the detailed structural interpretation of the data.