Geophysical Research Abstracts
Vol. 17, EGU2015-3445, 2015
EGU General Assembly 2015

Svecofennian orogeny in an evolving convergent margin setting

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The dominant tectonic mode changes from extension to convergence at around 1.9 Ga in Fennoscandian. The lithological record suggests short lived subduction-related magmatic events followed by deformation and low-pressure high temperature metamorphism. At around 1.8 Ga the subduction systems seem to have stabilized implying continuous supply of oceanic lithosphere. The evolution of the convergent margin is recorded in the rock record and crustal architecture of the long lived Svecofennian orogeny (1.9-1.7 Ga).

A closer look at the internal structure of the Svecofennian orogen reveals distinct regional differences. The northern and central parts of the Svecofennian orogen that have been formed during the initial accretionary phase – or compilation of the nucleus – have a thick three-layer crust and with thick mafic lower crust (10-30 km) and block–like internal architecture. Reflection profiles (FIRE1-3) image listric structures flattening on crustal scale décollement zones at the upper-middle crust and middle-upper crust boundaries. The crustal architecture together with large volumes of exposed granitoid rocks suggests spreading of the orogen and the development of an orogenic plateau west of the continental convergence boundary. The architecture is reminiscent of a large hot orogen.

Within the western and southwestern part of the Svecofennian orogen (BABEL B, 1, 2, 3&4), which have been envisioned to have formed during continuous subduction phase, the crust is thinner (45-50 km) and it is hosting crustal blocks having one to two crustal layers. Layering is poorly developed in crustal blocks that are found S-SW of NE-dipping mantle reflections previously interpreted as paleo-subduction zones. Within these blocks, the crustal scale reflective structures dip NE (prowedge) or form pop-up wedges (uplifted plug) above the paleo-subduction zones. Crustal blocks with well-developed two-layer crust are located NE of the paleo-subduction zone.

The architecture can be interpreted to image a series of abandoned accretion zones where the orogenic structure has developed from a young and cold orogen (BABEL 2,3&4) to a transitional (BABEL 1,6,B) one as the plate boundary is retreating during SW wards. The fast retreating rate of the subduction zone may not only have formed continental back-arc environment but may have restricted the thickening of the upper plate and the growth rate of the orogen. Altogether the architecture suggests a long-lived southwesterly retreating subduction system, with continental back-arc formation in its rear parts and well developed system of prowedge-retrowedge-uplifted plug close to a subduction conduit. Changes in the relative velocities of the upper and lower plate may have resulted in repetitive extensional and compressional phases of the orogeny as has been previously suggested for the southern part of the Svecofennian orogen.