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Wedge-tectonics superimposed on channel flow in the Scandinavian Caledonides

D. Gee

Department of Earth Sciences, Uppsala University, Villavägen 16, SE-752 36, Uppsala, Sweden; david.gee@geo.uu.se

Way back in the late 1960's and early 1970's, the vast displacement distances and the essential wedge-shaped geometry of the main allochthons in the Scandes was well established. Nappes derived from the outer margin of Baltica, including the Middle Allochthon and lower parts of the Upper Allochthon were known to pinch out towards the hinterland, this geometry being obviously superimposed on previously more coherent and thicker units. By the mid 1970's, it was also clear that the rock units composing the wedge-shaped allochthons in the foreland were also present in the hinterland as major pinch-and-swell structures, with evidence of both pure and simple shear, apparently the results of gravitational collapse of the mountain belt. Early to Mid Devonian extensional detachments accentuated this geometry.

The core of the composite Scandian wedge is composed of the Seve Nappe Complex, itself usually divisible into three parts - a central very high grade unit with granulite facies migmatites and leuco-granites, and overlying and underlying upper amphibolite facies psammitic and metavolcanic units, all derived from Baltica's, probably attenuated, outermost continental margin. The overlying Koli Nappe Complex, containing ophiolites locally in its lowermost parts, is also influenced by the wedge-tectonics, at least in its lower parts. The highest Koli units also contain ophiolites and arc volcanics that are less penetratively deformed and are inferred to have been derived from the Laurentian margin. The footwall to the Seve Complex includes other wedge-shaped and lenticular bodies with dyke-swarm intruded meta-sandstones (Sarv Nappes), underlain by a sole of mylonitic meta-sandstones. These are known throughout the mountain belt, from Alta in northern Norway via the Swedish Caledonides to Offerdal in Jamtland and (further west) in Oppdal in Trondelag; thence southwards to near Hardangerfjorden in southern Norway.

In the 1970's, the age of the high grade metamorphism of the Seve was not well defined. Fabrics in the amphibolite facies units were Caledonian (WNW-ESE) in trend, but the granulite facies units were considered by many to be Precambrian. However, isotope dating by Rb/Sr and U/Pb zircon methods indicated not only Mesoproterozoic protoliths, but also Caledonian high grade metamorphism (c. 425 Ma) and somewhat younger (c. 415 Ma) leuco-granites and pegmatites (c. 395 Ma). Thus, the ductile character of the "extruding" Scandian wedge was known in the mid 1980's, with inverted metamorphic gradients downwards and also a rapid decrease in grade upwards, capped by a major extensional fault-zone (the Röragen detachment) of Early - Mid Devonian age. The high grade rocks were clearly generated in the Scandian hinterland (west of the present Norwegian coast) and expelled eastwards towards the foreland, during syn-orogenic collapse of the mountain belt.

The Scandian ductile extruding wedge has remained an enigma for nearly two decades. We have much to learn from the Himalaya (and vice versa)! There is a clear need in the Scandes for more precise geochronology to better define the timing of high grade metamorphism, migmatization and crystallization of leuco-granites, allowing better estimates of the rates (in the order of 1-2 cm/year) of migration eastwards over a minimum distance of 400 km, during slow cooling of the allochthon.