Impact of Timanian thrusts on the Phanerozoic tectonic history of Svalbard

Jean-Baptiste Koehl 1,2,3
1Department of Geosciences, University of Oslo, P.O. Box 1047 Blindern, NO–0316 Oslo, Norway (jean-baptiste.koehl@uit.no)
2Research Centre for Arctic Petroleum Exploration (ARCEx), UiT The Arctic University of Norway in Tromsø, N–9037 Tromsø, Norway
3Department of Geosciences, UiT The Arctic University of Norway in Tromsø, N–9037 Tromsø, Norway

Despite more than a century of investigation, the relationship between basement rocks throughout the Svalbard Archipelago is still a mystery. Though these rocks display similar geochronological ages, they show significantly different metamorphic grades and structures. Thus far, Svalbard was believed to be composed of three terranes of rocks formed hundreds–thousands of kilometers apart and accreted in the mid-Paleozoic during the Caledonian and Ellesmerian orogenies.

New evidence from seismic, gravimetric, aeromagnetic, seismological, bathymetric, and field data show that these terranes might have already been juxtaposed in the late Neoproterozoic. Notably, the data show that at least three–four, crustal-scale, WNW–ESE-striking fault systems segment Spitsbergen and merge with Timanian thrusts in the northern Barents Sea and northwestern Russia. These thrusts were reactivated as and/or overprinted by sinistral-reverse oblique-slip faults and partly folded during the Caledonian Orogeny and Eurekan tectonic event, and reactivated as and/or overprinted by sinistral-normal faults during Devonian–Mississippian extensional collapse of the Caledonides, thus offsetting N-S-trending Caledonian grain and post-Caledonian basins, and explaining the juxtaposition of basement rocks with seemingly different origin.

The presence of Timanian faults explains basement heterogeneities throughout the Svalbard Archipelago, strain partitioning during the Caledonian Orogeny and Eurekan tectonic event and, thus, the western vergence of early Cenozoic folds in Devonian rocks in central–northern Spitsbergen (previously ascribed to the Late Devonian Ellesmerian Orogeny) and the arch shape of the early Cenozoic West Spitsbergen Fold-and-Thrust Belt in Brøggerhalvøya, the distribution of Mississippian rocks and Early Cretaceous intrusions along a WNW–ESE-trending axis in central Spitsbergen, the transport of Svalbard in the Cenozoic from next to Greenland to its present position (c. 400 km southwards), the strike and location of transform faults and oceanic core complexes and gas leakage along the Vestnesa Ridge west of Spitsbergen, the continental nature and NW–SE strike of basement fabrics in the Hovgård Ridge between Greenland and Svalbard, and the occurrence of recent (< 100 years old) earthquakes in Storfjorden and Heer Land in eastern
Further implications of this work are that the tectonic plates constituting present-day Arctic regions (Laurentia and Baltica) have retained their current geometry for the past 600 Ma, that the Timanian Orogeny extended from northwestern Russia to Svalbard, Greenland and, potentially, Arctic Canada, that the De Geer Zone does not exist, that the Billefjorden Fault Zone (Svalbard) and the Great Glen Fault (Scotland) were not part of the same fault complex, and that the Harder Fjord Fault Zone (northern Greenland) possibly initiated (or was reactivated) as a Timanian thrust.