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Caledonides of the North Atlantic Region and Occurrence of Ophiolites

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There are few older orogens in the world, like the Caledonides, where it is possible to demonstrate many hundreds of kilometers of translation of allochthons, comparable to those in the Himalaya-Tibet mountain belt. In the North Atlantic region (Gee et al., 2008), the Caledonide Orogen has its main outcrop areas in the Cenozoic mountains of northeastern Greenland and western Scandinavia, with continuation to the north in Svalbard and the Barents Shelf and southwards into the British Isles. This mid Paleozoic mountain belt, resulting from the collision of the Laurentia and Baltica continents during Scandian Orogeny, involved vast thrust systems that were W-vergent along the Laurentian margin and E-vergent along the Baltoscandian margin of Baltica. Ophiolites are only preservedin Scandinavia.

Along the Laurentian margin in northeastern Greenland, the autochthonous successions overlying Archean and Paleoproterozoic crystalline basement are characterized by a Cambro-Ordovician shallow marine carbonate bank, deposited in equatorial latitudes, that extends northwards into Svalbard and southwards, via northern Scotland, to the Appalachian mountains of eastern North America, a distance of over 5000 km. The lower allochthons are dominated by thin-skinned thrust-sheets comprising platform margin successions which reach up into the Silurian in northern areas where they are underlain by thick Neoproterozoic and Mesoproterozoic siliciclastics. Major complexes (Niggli Spids), thrust across these lower, sediment-dominated allochthons, are dominated by Archean and Paleoproterozoic crystalline rocks and, in southern parts,with overlying late Mesoproterozoic met sedimentary rocks (Krummedal Group),all influenced by Caledonian amphibolite to granulite facies metamorphism; in northern parts with eclogites (Nörreland thrust sheet). Most remarkable of the Caledonian allochthons in northeastern Greenland is the uppermost complex, comprising a lower part (Hager Berg) of latest Mesoproterozoic metasediments (Krummedal and Smallefjord groups) that were subject to late Grenville age (early Neoproterozoic) Renlandianorogeny, with HT/LP metamorphism, migmatization and Toniangranite intrusion, overlain by a thick greenschist and lower grade succession of Cryogeniansandstones, shales and carbonates (Eleonore Bay Supergroup) and tillites, Ediacaran sandstones and a Cambro-Ordovician carbonate bank comparable to that in the foreland autochthon. The highest allochthons are inferred to have been transported in the order of 300 km westwards from outer parts of the Laurentian margin.

In western Scandinavia, along the eastern margin of the North Atlantic Caledonides, the autochthonous sedimentary successions have Cambro-Ordovician faunas and lithologies that are very different from Laurentia. Cambrian kerogen-rich shales provide the basal decollement for the Caledonian allochthons throughout the 1800 km long Scandian mountain range. The allochthons include not only well defined Baltoscandian margin assemblages, but also a wide range of ocean (Iapetus) – derived all ochthons, including ophiolites. The highest allochthonous complexes in the Scandes are continental margin assemblages of Laurentian affinities, comparable in many respects to the Hager Berg allochthon in northeastern Greenland, including both late-Grenville age basement-derived complexes and a Caledonian overprint of HT/LP metamorphism, some migmatization and manygranites. The Baltoscandian outer margin allochthons, beneath the Iapetus Ocean-derived terranes, are characterized by Cryogenian siliciclastic sedimentary rocks, including tillites, intruded by abundant 600Ma dolerite dykes. The outermost part of this margin, represented by the Seve Nappe Complex, was subject to HP and UHP metamorphism during Ordovician closure of the Iapetus Ocean and initial (late Ordovician to early Silurian) collision with Laurentia (Gee et al., 2013). The overlying Iapetus-related units, comprising the Köli Nappe Complex, are mainly in greenschist facies and separated from the underlying Seve subduction complex by major extensional faulting, sometimes preserving evidence of previous thrusting. Highly fragmented ophiolites are

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preserved locally in this extensional fault system; only in the higher thrust sheets of the Köli Nappe complex are ophiolite suites better preserved.

The ophiolites in the Scandes (Furnes et al 1985, Stephens et al., 1985) occur throughout the length of the mountain belt from the Lyngen alps in the far north (70 N) to Karmöy in southernmost Norway (59 N). Where it has been possible to date them, they have yielded late Cambrian (c. 495 Ma) to earliest Ordovician (c. 485 Ma) U/Pb ages. A few are younger, in particular the Solund-Stavfjord ophiolite of southwestern Norway (Furnes et al., 2012), which is of earliest Silurian age (c. 443 Ma). A variety of other early Silurian igneous suites, with harzburgites, dunites, gabbros and sheeted-dykes, were apparently emplaced into thin continental crust, the dykes being intruded into rift-related sandstones. In general, the older ophiolites show supra subduction zone affinities and have been interpreted to have originated in marginal basins, proximal to Baltica, or Laurentia (Pedersen et al., 1992). The younger ophiolites and related igneous suites are thought to have originated in back-arc settings, during the early stages of continent collision, perhaps related to subduction-flip prior to underthrusting of Laurentia by Baltica. The ocean-derived allochthons in the Scandes are inferred to have been transported at least 500 km eastwards onto the Baltoscandian platform.

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