Mélange in Trondheim Nappe, central Norwegian Caledonides

THE speculative conclusions of Horne[1] following his contention that mélange is present in the Trondheim Nappe of central Norway are untenable in the light of our current knowledge of this region. Three main objections may be raised.

(1) The crude 'fanning of structural surfaces' across regional strike, which is central to Horne's model, is documented in several tectonic structural studies of the central Scandinavian Caledonides as a product of the Silurian evorogenic deformation, and can in no way be construed as representing a subduction-related accretionary fan-structure.

(2) Accretionary prisms of arc–trench subduction complexes are composed principally of offscraped oceanic sediments, igneous rocks and trench-fill deposits. In Horne's[1] hypothetical model (his Fig. 5) the prism embraces four tectonostratigraphic units ranging from low-grade, Ordo-Silurian volcanites and flyschoid (Köli) metasediments in the east, through high-grade Gula (Seve) migmatites and gneisses of probable Sveconorwegian or older age, and into the low-grade 'Selbusjøen mélange' in the west. An accretionary prism of such extreme age range and embracing long-transported nappes of varying origin[4,5] is incompatible with the composition and derivation of forearc subduction complexes.

(3) Continuing studies of volcanite geochemistry (major, trace and rare earth elements) confirm earlier results[4,6] showing that the Støren Group metabasalts are ocean-floor tholeiites. With the discovery of associated sheeted dolerite dykes and gabbro in one area[7], the interpretation of the Støren as an ophiolite fragment[8] is even more secure. In contrast, the Fundsjø Group contains a greater proportion of acidic extrusives, and basalt geochemistry reveals that both island arc and ocean-floor tholeiites are represented[9]. Horne's[1] diagram, showing the Støren as a magmatic arc and the Fundsjø as an 'oceanic remnant'—with the Støren and Fundsjø transposed—is, therefore, misleading.

Despite these criticisms, the presence of a mélange of latest Cambrian oceanic and trench sediments, with pre-Arenig fan-thrusting and folding, would not be out of place in this ophiolite setting, but detailed mapping would be required to ascertain its true character.

A final point, and one of major importance in a consideration of Horne's hypothesis, is that the concept of Silurian, pre-F_1 obduction[4] has been discarded. Based on analysis of new data from mapping and structural studies, the Støren–Fundsjø obduction, eastward on Gula rocks, is now considered to date to pre-Middle Arenig time[8,10], of Finnmarkian/Grampian age[11], with the Lower Hovin deposited on the folded and uplifted ophiolite fragment[8,12,13]. This situation is comparable with that in the Lower Palaeozoic of western Norway[8,10,11]. Continuing southeastward subduction during Ordovician time, although perhaps located further to the west, produced an Arenig–Llanvirn volcanic arc and marginal basin spreading[12–14]. Horne's[1] interpretations, therefore, conflict with the results of other recent research in the Trondheim region Caledonides[7–14].

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HORNE REPLIES—Roberts' objections to my speculative model for the early development of the Trondheim Nappe do not bear directly on the tenability or applicability of my hypothesis. My brief response to each criticism follows.

(1) Roberts' structural arguments are debatable, yet he offers no evidence to support his contention. Clearly, an inherited fan structure would have been reactivated during and after obduction as the Trondheim Nappe was translated eastward during the Silurian. The problem involves dating the initial deformation and identifying the cause of earliest thrusting. I interpret Roberts' F_1 deformation[1] as occurring synchronously with the accretion process.

(2) Roberts' second criticism contains several inaccuracies. My Fig. 5 (ref. 2) shows that, although I presumed that the Seve and Köli sequences had been bulldozed in front of and obducted with the Trondheim Nappe, I did not consider them to have been incorporated into the forearc region by sea-floor accretion. Comprehensive and comparative studies of forearc regions[3] show that subduction complexes are indeed characterized by heterogeneous stratal assemblages that include various igneous rocks, metamorphic tectonites, chaotic mélanges, and isoclinally folded sequences of bedded sediments that "represent a wide range of oceanic environments" (p. 19, ref. 3). Roberts' supposition that the Gula Group is Precambrian is based on a tenuous correlation with tectonites exposed to the west of the main Trondheim succession that have only been indirectly implicated to be Precambrian[4].

(3) The statement that Støren metavolcanics are ocean-floor tholeiites is misleading. They are spillitic greenstones that have suffered both regional metamorphism and local metasomatic alteration. The presence of associated bedded pyroclastics, including lappili tuff and limestone, certainly argues against a deep marine environment. Notwithstanding recent evidence[5] from modern sea-floor basalts that warns strongly against using trace element composition for tectonic labelling, Roberts has used the trace element distribution within Støren greenstones to ascribe the Støren to either ocean floor or arc settings[6]. Intra-ocean arcs clearly must be built on and from the oceanic lithosphere, and many ensimatic arcs tend to nucleate along transform faults with attendant ophiolite emplacement[7]. The infrastructure of such arcs should indeed comprise ophiolite fragments[8], as Roberts testifies.

Roberts' final point concerning the Hovin having been deposited unconformably on folded Støren metavolcanics contradicts well codumented field evidence from many areas in the Trondheim region. I agree that the age evidence bearing on time of obduction is crucial, and that it demands critical analysis.

Note added in proof: Very recent evidence from Troms[9] casts doubt on the concept of pre-Arenig Sinnmarkian abduction.

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