

Discussion

A reply: Basement-cover relationships on northern Vanna, Troms, Norway

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In a comment to our paper (Opheim & Andresen 1989) dealing with the basement-cover relationships on northern Vanna, Rice (this volume) prefers an alternative explanation for the tectonostratigraphy to the one suggested by us. Instead of correlating the dike-intruded Skipsfjord nappe with the Middle Allochthon, Rice proposes correlating it with the Lower Allochthon. He further argues that the footwall to the Skipsfjord nappe belongs to the Lower Allochthon and not to the autochthonous/parautochthonous basement.

If we have understood Rice correctly his main arguments against our correlations seem to be: (1) that the Middle Allochthon and autochthon in Finnmark were separated by ca. 300 km on a palaeogeographic reconstruction prior to Caledonian orogenesis and that this is not compatible with the lithological similarities between the Skipsfjord nappe (Middle Allochthon) and its footwall (autochthon/parautochthon); and (2) that the cover sequence (Kvalkjeften group) of the Skipsfjord nappe is more likely to correlate with metasediments of the Lower Allochthon than those of the Middle Allochthon.

When writing our paper we were very much aware of the uncertainties in making regional correlations based on the limited portion of the Caledonian tectonostratigraphy available to us on Vanna. This is particularly true in as much as the exposed section on Vanna is composed of a granitoid basement overlain by a dominantly clastic basal sequence, an association found as part of the autochthon, the Lower Allochthon and the Middle Allochthon. In light of these

uncertainties we proposed the following two alternatives '(1) the basement tonalite is allochthonous and forms part of a major basement sheet within the Middle Allochthon but at a lower structural level (than the Skipsfjord nappe), or (2) the basement is truly autochthonous/parautochthonous'. Based on strain differences between the Skipsfjord nappe and its footwall we preferred the second alternative.

However, as seen from our NW-SE cross-section (Opheim & Andresen: Fig. 10) we considered the basement to be considerably shortened by localized NNW-dipping high strain zones with reverse movement. As such it could be considered allochthonous and comparable to the 'basement rocks' exposed in the Rombak Window (Bax 1986, 1989; Andresen & Rykkelid 1989) and by some authors considered part of the Lower Allochthon.

We certainly agree with Rice (this volume) that the lithological similarities between the Skipsfjord nappe and its footwall are striking, and that the difference in metamorphic grade between the two units does not support a displacement on the Skipsfjord thrust in the order of 300 km. Accordingly, no such large displacement has been suggested by us. Instead, we concluded 'The presence of tonalite in the nappe, as well as in the basement, may indicate that the root zone was not too far to the NW'. On the other hand, it has to be kept in mind that the shortening and displacement calculations done for the Komagfjord-Alta Window (Lower Allochthon) in Finnmark are based on a number of assumptions (see Gayer et al. 1987, p. 205 about the Gaissa

Thrust Belt) that may be incorrect. Instead of using the 'Finnmark model' as an argument against our proposed correlation it is probably much more important to clarify the structural position of the windows (and the 'Western Basement Region') relative to the Lower and Middle Allochthon recognized in the thrust front. This is particularly true if late 'out of sequence' thrusts at deep crustal level represent an integral element in the orogenic evolution as described by Andresen & Rykkelid (1989) from the Lofoten Block.

Based on the arguments presented above we find it in general very difficult to decide whether a basement-cover association is part of the parautochthon, Lower Allochthon or Middle Allochthon in the highly strained and metamorphosed interior part of the Caledonides. If someone came up with a set of *objective* criteria that could be used to distinguish basement-cover associations from these three different structural levels we would be very grateful. In particular, what characterizes the thrust separating the Lower Allochthon from the Middle Allochthon in these western areas? As long as these criteria are missing we feel that the name given to a basement-cover assemblage in many cases has been controlled by the *model* rather than observations and objective criteria.

Rice (this volume) argues that our correlation of the Skipsfjord nappe with the Middle Allochthon/Kalak Nappe Complex is highly speculative and not acceptable. We do not think so, although we accept that the depositional age and age of metamorphism of parts of the Kalak Nappe Complex are highly uncertain at the moment (Krill et al. 1988; Krill & Zwaan 1987; Pedersen et al. 1989; Daly et al. 1990). However, we did not in our paper (Opheim & Andresen 1989) try to make a lithostratigraphic correlation between the Kvalkjeften group and the Sørøy Sequence. Rather, we tried to assign an age to the cover sequence and the unconformity. Despite the age uncertainties associated with the Kalak Nappe Complex, there are other important lithological similarities, like the mafic dike swarm, in support of our correlation of the Skipsfjord Nappe with the Middle Allochthon. Also the stratigraphy of the Kvalkjeften Group is comparable to that found in the Middle Allochthon in Troms-Northern Nordland and Northern Sweden (Stephens et al. 1985 and references therein). The Kvalkjeften group is thus considered to be

correlative in age (Late Precambrian) with the cover sequences found on top of the granitoid basement slices dominating the Middle Allochthon.

Finally, we thank Rice (this volume) for pointing out a drafting error in Fig. 6 and a printing error on p. 74. The Geitdalen Formation does not include the brownish weathering calcareous schist above the basal metapsammite. Furthermore, the correct thickness of the mafic layers or sheets found within the Lower mylonite-gneiss sheet should of course be 0.5–5 m and not 0.5–5 mm as stated on p. 74.

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