tion of the cover, and was introduced downward into the basement by a mechanism similar to that recently proposed in more detail by McCaig (1988). This led to the further suggestion that the distribution of water (and not, for example, the thermally activated brittle–ductile transition) may have controlled the detachment of basement thrust sheets in the Scandinavian Caledonides (Bartley 1982).

However, regardless of the mechanism of strain localization, the large-scale geometry of the Lofoten-Tysfjord area implies that Caledonian A-type subduction occurred by *en bloc* underthrusting of an effectively rigid Baltic lower crust and subjacent mantle beneath the nappe complex (Bartley 1982, Hodges *et al.* 1982). The effective rigidity of the Lofoten basement probably was not because it was particularly strong (compared to cold upper crust or underlying upper mantle), but rather because the high-strain zone in which the sheath-nappes formed was extraordinarily weak. The result is that the A-type subduction zone was still in effect thin-skinned to a depth of at least 30 km and far into the 'metamorphic core' of the orogen, even though deformation along and above the detachment in this position was under conditions far into the ductile field.

These considerations lead me to suggest that the sheath-nappes at Oppdal may well be larger examples of precisely the same process recorded at Lofoten-Tysfjord. As the lower boundary of the main Caledonian shear zone migrated downward with time (following an infiltration front of metamorphic water?), basement rocks were sheared ductilely into fold-nappes that refolded thrusts in the cover. This process had the result, certainly at Lofoten-Tysfjord and quite possibly at Oppdal, that the entire Pennine-type nappe complex is underlain by lower continental crust that scarcely participated in Caledonian nappe tectonics.

A computer model of sheath-nappes formed during crustal shear in the Western Gneiss Region, central Norwegian Caledonides: Reply

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I thank Dr Bartley for his comments and for his lucid summary of the relationships between basement and cover in the Lofoten-Tysfjord area. Bartley has pointed out many important similarities between the interpretations I made for the Oppdal area (Vollmer 1988), and the interpretations made for the Lofoten-Tysfjord area (Bartley 1982, Steltenpohl & Bartley 1988). I believe this emphasizes the importance of these interpretations for the deformational histories of the Caledonian and other collisional orogens. The major differences between the two areas appear to be the presence of the rigid basement exposed in Lofoten, and the scale of the basement-cored nappes.

Bartley refers to a sentence in my paper (Vollmer 1988) that compares the style of deformation in the Oppdal district with the style of deformation described by Bartley (1982) on east Hinnøy, north Norway. In that sentence I stated that the deformation in the northern Norwegian Caledonides appeared to be a "more brittle detachment-style deformation" (Vollmer 1988, p. 742). This referred to Bartley's (1982) observation that ductile fold-nappes in the Lofoten-Tysfjord area appear to be essentially detached from the lower, rigid basement gneisses. As clarified by Bartley in his Discussion, the detachment is a gradational mylonite zone, which he does not believe is a major structural discontinuity between two genetically distinct basement blocks.

I am not aware of any similar evidence from the Oppdal area to suggest that a rigid basement block exists below the fold-nappes there, although it may be possible. It seems that within the Oppdal district the deformation began as thin-skinned thrust tectonics, resulting in the formation of the regional tectonostratigraphic framework (Krill 1985), followed by the downward migration of increasingly ductile deformation into the basement gneisses (Vollmer 1988). This appears to be similar to what Bartley has described for the Lofoten-Tysfjord area. However, much of the basement in the western portion of the Oppdal district appears to have been migmatized during Caledonian deformation (Krill 1985), suggesting ductile deformation extends well down into the basement gneisses. It is possible that the deformation within the Oppdal area represents a later stage in the progressive development of these basement-cored nappes. Further mapping within these problematic lower gneisses will be required to clarify their deformational histories.

Steltenpohl & Bartley's paper (1988), which had not been published when my manuscript (Vollmer 1988) was prepared, illustrates many of the similarities Bartley refers to in his present Discussion, including the apparent presence of a refolded sheath-nappe in the Tysfjord area. In terms of regional deformation processes, it is notable that they interpreted gneiss domes in that area to be the result of crustal shortening and fold interference rather than diapirism. This is similar to the suggestion I made for the Oppdal district (Vollmer 1988), although I argued that the major interference patterns there could be explained by a simpler deformation history than they describe from the Ofoten-Tysfjord area.

As Bartley suggests, however, the main fold-nappes in the Lofoten-Tysfjord area may well be smaller examples of the same types of nappes I described from the Oppdal area, and the differences between the two areas could largely be a matter of scale. It is further possible that the deformational processes responsible for the formation of these basement-cored nappes occurred over a longer period of time, or were more intense, in the Oppdal area, resulting in larger nappe structures with more extensive basement involvement.

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