Discussion

The inner shelf of North Cape, Norway and its implications for the Barents Shelf–Finnmark Caledonide boundary. A reply

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It is emphasized that the point of my short article was to highlight the possibility that the 100° trend of the onshore portion of the Trollfjord–Komagelv Fault either changes its orientation to E–W (090°) in the offshore region (as opposed to NW–SE which has been suggested by other workers), or it splays into a series of fault zones as it intersects the other dominant fault trends northwest of Finnmark. This article also outlines some of the problems of the published work on the Caledonian geology of Finnmark, especially those aspects which are frequently applied to the offshore Barents Sea. It is suggested that the fault systems of North Norway need a more detailed examination in order to assess the implications for the structural evolution of the offshore area.

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I would like to thank Gabrielsen and Færseth (1989) for their comments on my short note to *NGT* and for Norsk Hydro for permission to publish the seismic data. The observations put forward by Gabrielsen and Færseth are largely based on seismic data which are often only affordable by oil companies, with academic/consultancy organizations only seeing such data from time to time, or when published. The comments made in the original article were an attempt to form a working model based largely on field observations and shallow seismic data, from which offshore studies may possibly develop. I believe that differences between my short note and the comments of Gabrielsen and Færseth are basically philosophical.

There are two basic principles on which the comments of Gabrielsen and Færseth differ with my article (Townsend 1987a). Firstly, what is the geometry of the Trollfjord–Komagelv Fault offshore to the northwest? Gabrielsen and Færseth take the view that the fault continues offshore to the WNW as a single fault zone, whereas I believe it possible for the fault to splay into a broad faulted zone, or a series of fault zones as it intersects with the northeast trending Vargsundet Fault and Troms–Finnmark Fault Complex and the N–S trending Ringsvassoya–Loppa Fault Complex. The latter may explain why the Trollfjord–Komagelv Fault does not form the same prominent lineament offshore, as it does onshore. That is not to say that the fault strands mapped by Gabrielsen and Færseth are not part of the Trollfjord–Komagelv Fault, rather that they are a small part of a fault system spread over a large area. The second point is whether or not fault zones with different trends should be treated as separate zones, as Gabrielsen and Færseth have done, or together as a complete fault system. As a consequence of these differences in approach to the problems of the Trollfjord–Komagelv Fault and its relationship to adjacent fault systems, different conclusions have been attained.

The aim of my original article (Townsend 1987a) was to attempt to answer the question: what happens when the Trollfjord–Komagelv Fault trend intersects with the NE–SW trending structures, such as the Vargsundet Fault and the Troms–Finnmark Fault Complex? Do the fault zones link in a very abrupt manner, or do they merge in a broad zone where individual fault strands show a variety of orientations between the two trends? I believe these questions have yet to be adequately answered.

Although the comments of Gabrielsen and Færseth are generally useful, they make some inaccurate comments and put forward some mistruths about the geology of Finnmark based on published work.

(1) Gabrielsen and Færseth suggest that a near E–W orientation for the Trollfjord–Komagelv Fault on Nordkinnhalvøya had not previously been documented and is a new interpretation to them. However, this fault orientation can readily be seen on published maps (e.g. Sigmond et al. 1984; Lippard & Roberts 1987) changing across Tanafjord, from 120° on Varangerhalvøya, to 100° on Nordkinnhalvøya.

(2) (Point 5) Gabrielsen and Færseth site the interpretation of Lippard & Roberts (1987) that E–W faults on Nordkinnhalvøya curve into a NW–SE orientation. The NW–SE trend is somewhat misleading, a 120° orientation is perhaps more accurate (i.e. WNW–ESE) for the interpreted offshore portion of the fault zone across Laksefjord (see Lippard & Roberts 1987, pl. 1). Moreover, where the fault strands have been mapped onshore across Nordkinnhalvøya the orientation is 105–110°. This interpreted change in the fault orientation from 105–110° onshore Nordkinnhalvøya to 120° offshore Laksefjord (Lippard & Roberts 1987) is merely a convenient way of explaining the lack of structures on the relatively unknown Sværholthalvøya. This interpretation is followed even though 110° trending faults exist on Sværholthalvøya (see Sigmond et al. 1984; Lippard & Roberts 1987).

Gabrielsen and Færseth also argue that E–W splays along the Trollfjord–Komagelv Fault are abandoned early splays. Although this is the case for such a structure a few kilometres east of Tanafjord, other splays with a similar orientation show no evidence of abandonment; for example, in the duplex structure in central Varangerhalvøya, which was first documented by Johnson et al. (1978). The conclusion drawn at the end of point 5 by Gabrielsen and Færseth is perhaps not as clear cut as they suggest. It is possible for fault zones to change orientation by 10–20°, or form splays at such a low angle to the main fault. In addition, the second philosophical point mentioned at the beginning of this article arises here; whether or not faults of different trends should be treated separately or as a complete linked and interactive system.

(3) (Point 6) Gabrielsen and Færseth suggest that it would be 'more reasonable to look on the E–W trend in connection with the Troms–Finnmark Fault Complex', rather than the Trollfjord–Komagelv Fault. It could be argued, in view of point 2 of this article, that it is 'as reasonable', or to look upon the E–W trend even as some form of linking structure between the Trollfjord–Komagelv Fault and the NE–SW trending structures, such as the Vargsundet Fault and Troms–Finnmark Fault Complex.

(4) (Implications of timing, point 2) Gabrielsen and Færseth have suggested that the onshore portion of the Trollfjord–Komagelv Fault reactivated in Late Palaeozoic times (i.e. shortly after the Caledonian Orogeny) based on the relationship of the fault to the Kalak Nappe Complex (e.g. Roberts 1985) and published radiometric ages of dykes (Beckinsale et al. 1975). The correlation of the northwest corner of Varangerhalvøya with the Kalak Nappe Complex (Levell & Roberts 1977) has recently been questioned (Townsend 1987b), leaving room for considerably more reactivation of the Trollfjord–Komagelv Fault than has previously been accepted. Furthermore, the radiometric ages for the dykes on Varangerhalvøya (Beckinsale et al. 1985) may not withstand the rigours of modern dating techniques (e.g. MSWD was not published) and the ages may not be reproducible, as is the case with other dates published from Finnmark around that time (see Dallmeyer 1988). Even so, all that these radiometric dates for the dykes on Varangerhalvøya tell us is the age of the last large displacement along the Trollfjord–Komagelv Fault and they could not detect the 5–10 km displacements which are being inferred for the offshore portion of the fault by Gabrielsen and Færseth.

One thing that has become apparent is that oil industry geologists base much of their onshore interpretations of the Finnmark geology on previously published work. The published work on the Trollfjord–Komagelv Fault was largely carried out over a decade ago as an academic exercise and without consideration for the offshore geology. Our knowledge of fault geometries and fault systems has advanced enormously in that time. This all points to a need for a comprehensive re-evaluation of the fault systems of north Norway with a great deal of attention to the nearshore geology. Field and oil company geologists need

to work closely together to resolve the correlation between onshore and offshore structures, from which both parties can only gain, with an exchange of information and ideas.

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