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Reply to comment by C.J. Talbot (2008) on “Emplacement of a Silurian granitic dyke swarm during nappe translation in the Scandinavian Caledonides”. Journal of Structural Geology 30, 918–928.

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We appreciate Christopher J. Talbot’s interest in our analysis of the 427 ± 1 Ma Årdal dyke complex in the Upper Jotun Nappe, Norway. In the article, we interpret the geometry of the granitic dykes and associated deformation structures to reflect syntectonic emplacement of the dykes in a top-to-southeast non-coaxial strain field, which we in turn relate to south-eastwards thrusting of the nappe during the Caledonian orogeny.

Talbot (2008) suggests that the structural analysis can benefit from the approach described in e.g. Talbot (1970), and exemplifies this using 3D data from stereoplots and an outcrop photo from the Kaupanger area presented in Lundmark and Corfu (2008).

The first part of Talbot’s analysis, based on 3D data from stereoplots, supports the conclusions of Lundmark and Corfu (2008), and additionally highlights the effects of what is likely a combination of heterogeneous strain, as may well be expected from data from a 1.5 km transect through the nappe, and the influence of discrete top-to-northwest shear zones related to late-/post-Caledonian extension.

The second part of the analysis uses the Årdal dykes shown in Fig 1a as strain markers. The dykes are regarded as linear elements showing finite extension or shortening, and based on their respective orientations it is suggested that horizontal top-to-northwest shearing is the most likely explanation for the observed pattern. Talbot consequently back strips the deformation by applying a top-to-southeast shear to the photo to illustrate this idea (Fig. 2 in Talbot, 2008).

Given the previous interpretation, and looking at the photo, this seems counterintuitive. It is also contradicted by ample field evidence showing primarily top-to-southeast shearing, such as S-C fabrics in the hydrated and deformed mafic parts of the layered host rock, and granitic dykes that are off-set in a top-to-southeast sense by these deformed layers, forming the boudins and folds discussed by Lundmark and Corfu (2008).

We attribute the inverse, top-to-northwest shear sense inferred in Talbot’s analysis to the inherent limitations and uncertainties of interpretations from a photo without direct knowledge of the outcrop it depicts. Talbot points out that his assigned linear elements, taken to represent finite extension and shortening, respectively, yield an uneasy fit with his analysis of the 3D data. This reflects the erroneous assignment of the linear elements in the photo (see Fig. 1a and caption for our interpretation), and disqualifies the ensuing conclusions. None of the deformation structures seen in the photo are inconsistent with our conclusion that the deformation primarily reflects top-to-southeast heterogeneous simple shear parallel to the compositional layering of the country rock. We agree with Talbot when he states that the analysis “emphasises that it is easier to deal with 3D poles rather than 2D lines.”

Talbot also notes that the presence of folds, boudins and internal foliations in the dykes suggest differing rheological behaviour. This raises an interesting question regarding the rheological behaviour of the dykes in an initially heterogenous host rock, some layers of which are interpreted to undergo reaction softening during, and in the aftermath, of the magmatic event (Lundmark and Corfu, 2008). We agree with Talbot that the response of the dykes to the stress field likely reflects the metamorphic grade of the host rock, and perhaps also the relative importance of anorthositic, competent layers, and mafic layers, which can be competent or incompetent compared to the granite depending on metamorphic grade. However, the first author has not recorded any prominent mullions while measuring the dykes in Kaupanger that further support the deformation of the dykes as incompetent layers.

On the request of Talbot (2008), the poles of deformed dyke elements are supplied, plotted on a lower hemispheric stereographic projection (Fig. 1b).

We would like to conclude by thanking C.J. Talbot for his effort to improve our understanding of the Årdal dykes and their relation to the deformation of the Upper Jotun Nappe. For reasons discussed above, the data are not quite suited for the analysis endeavoured upon by Talbot, which is mainly intended for homogenously deformed rock domains (Talbot, 1970). But we appreciate Talbot’s illustration of his approach as a potential avenue to a better understanding of complex deformation.

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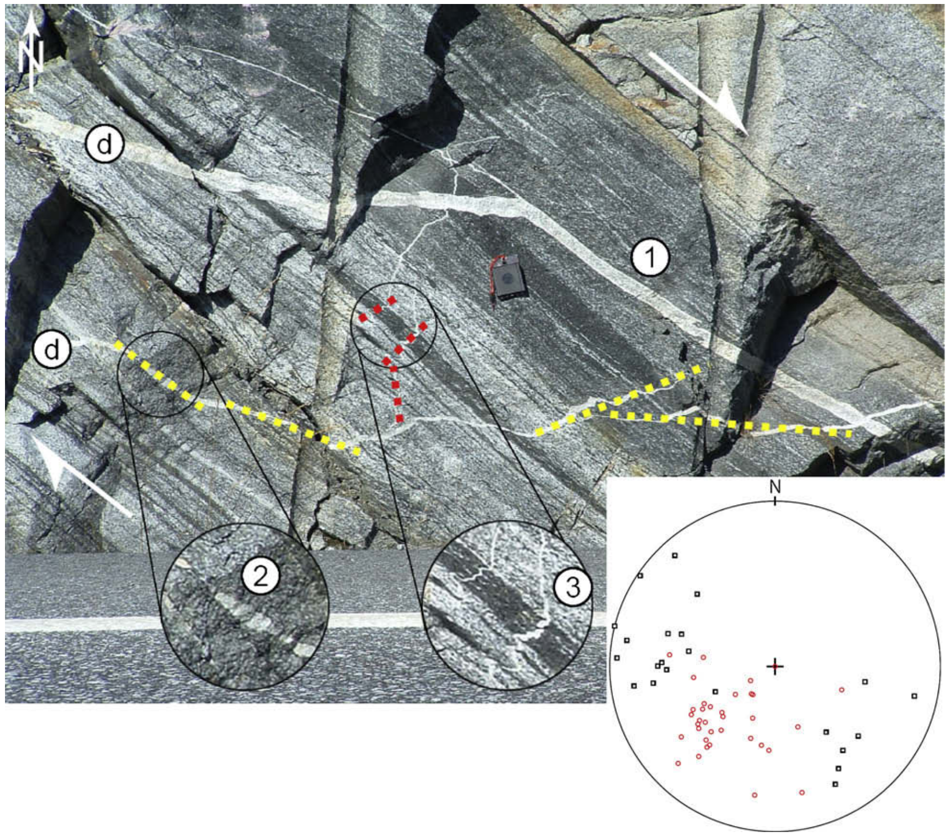

Fig. 1. (a) In the outcrop photo interpreted by Talbot (2008), only 3 dyke segments seem to record unequivocal shortening (red dotted lines). Two of these seem on the verge of being rotated into the extensional part of the strain field. Four segments representing extension are marked by yellow dotted lines. The remaining segments interpreted by Talbot (2008) to represent shortening and extension are either unsheared or cannot be constrained from the photo, or represent, plagioclase rich layers in the host rock, and in one instance likely reflects the intersection of a sub-vertical dyke with the rock face. (b) Poles to envelope of boudinaged dykes (□), $n = 35$, and envelope of folded dykes (○), $n = 22$, along the Kaupanger transect, plotted on a lower hemispheric stereographic projection.

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