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Towards the interpretation of AMS and AAMR magnetic lineations in deformed sedimentary rocks: Examples from Triassic mudstones from the West Spitsbergen Fold-and-Thrust Belt and its foreland

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Magnetic fabric studied by anisotropy of low-field magnetic susceptibility (AMS) has been used in numerous cases of deformed clastic sedimentary rocks as a very efficient tool for assessing the principal strain directions and relative strain intensity. The classical model assumes that in the undeformed sedimentary rocks magnetic susceptibility is predominantly controlled by an assemblage of platy mineral grains (phyllosilicates) resulting in a bedding-parallel, oblate magnetic fabric. In the earliest stages of bedding-parallel compression, the platy grains, as they rotate from the original bedding-parallel orientation, create an embryonic fan and their zone axis reflects the axis of the mesoscopic folds, thus being parallel to the strike of bedding. In this stage, magnetic foliation usually remains parallel to the sedimentary foliation (bedding) whereas magnetic lineation rotates to the direction perpendicular to the maximum compression.

Here, we present the combined magnetic fabric results – namely anisotropy of in-phase magnetic susceptibility (ipAMS), anisotropy of out-of-phase magnetic susceptibility (opAMS), and anisotropy of anhysteretic magnetic remanence (AAMR) – from the Early Triassic mudstones of the West Spitsbergen Fold-and-Thrust Belt and its foreland with an aim to interpret the orientation of magnetic lineation.

In the rocks from the fold belt, the ipAMS fabric is oblate as it reflects the low degree of deformation in a compressional setting with magnetic foliation being sub-parallel to the bedding and magnetic lineation sub-parallel to the bedding strike and mesoscopic fold axes (N - NW to S - SE). While magnetic foliation of opAMS and AAMR is still sub-parallel to the bedding, magnetic lineation is roughly parallel to the bedding dip direction thus roughly perpendicular to ipAMS lineation. As opAMS and AARM fabrics are supposed to be controlled by minor amount of ferromagnetic (s.l.) grains, most probably magnetite, this observed discrepancy is tentatively explained as that the AAMR lineation may reflect the preferred orientation of the longest axes of acicular magnetite grains as they are deformed and reoriented in a simple shear component of the complex deformation imposed on the rocks during thrusting. On regional scale, opAMS and AAMR magnetic lineations (NE - E) may be thus interpreted as thrusting directions.

Inverse fabric ipAMS, sometimes observed in the foreland, is carried by Fe-rich carbonates. The ipAMS fabric is prolate with sub-vertical lineation, perpendicular to the bedding. The opAMS and AARM fabrics, however, are normal with respect to the bedding, oblate with magnetic lineation being parallel to the bedding strike.