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Towards the interpretation of magnetic lineations in deformed sedimentary rocks (West Spitsbergen Fold-and-Thrust Belt) using anisotropy of in-phase and out-of-phase magnetic susceptibility and partial anhysteretic remanence

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Classical models of fabric evolution of deformed siliciclastic sedimentary rocks assume that their magnetic fabric (as studied by anisotropy of magnetic susceptibility, AMS) is predominantly controlled by a preferred orientation of an assemblage of platy mineral grains (usually phyllosilicates). 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 intersection lineation mirrors 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 axis.

The West Spitsbergen Fold-and-Thrust Belt (WSFTB) is an orogenic range parallel to the west Spitsbergen coast formed during the Eurekan orogeny caused by relative plate motion between Greenland and the Canadian Arctic Islands. The orogen forms a narrow, elongated structure and records 10-40 km margin-perpendicular shortening. Here, we present a study of combined magnetic fabric results – namely anisotropy of in-phase magnetic susceptibility (ipAMS), anisotropy of out-of-phase magnetic susceptibility (opAMS), and anisotropy of partial anhysteretic magnetic remanence (pAAMR) – from the Early Triassic mudstones of the WSFTB and its foreland with an aim to interpret the orientation of magnetic lineation.

The sampled rocks from the WSFTB form an east-dipping broad monoclinal structure. The ipAMS fabrics are oblate, with magnetic foliations lying sub-parallel to the bedding and magnetic lineations sub-parallel to the bedding strike and mesoscopic fold axes (N - NW to S - SE). Such a pattern reflects a low degree of internal deformation in a compressional setting. On the contrary, opAMS and pAAMR fabrics (both being roughly coaxial) differ in their orientation from ipAMS. While opAMS and pAAMR magnetic foliations are sub-parallel to the bedding, magnetic lineation does not reflect the bedding strike but lies in the bedding plane at some angle from ipAMS lineation. As opAMS and pAAMR fabrics are supposed to be controlled by minor amount of ferromagnetic (s.l.) grains, most likely magnetite, their magnetic lineations reflect the preferred orientation of the long axes of acicular magnetite grains. The preferred orientation of magnetite grains may reflect a simple shear component of the complex deformation imposed on the rocks during the thrusting. On a regional scale, opAMS and pAAMR magnetic lineations (NE - E) may thus indicate thrusting directions. Alternatively, opAMS and pAAMR lineations may reflect regional extension, which affected the WSFTB after the main compressional event.

In the foreland of the WSTFB, the strata are sub-horizontal, gently dipping northwest. An inverse ipAMS fabric that is prolate with sub-vertical lineation perpendicular to the bedding, is sometimes observed due to the presence of Fe-rich carbonates. Both opAMS and pAAMR fabrics, however, are normal with respect to the bedding, oblate with magnetic lineation being parallel to the bedding strike.