Rock magnetism of the Lower Triassic sedimentary rocks from Spitsbergen

Institute of Geophysics Polish Academy of Sciences

AGICO ADVANCED GEOSCIENCE INSTRUMENTS COMPANY

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KNOW The Leading National Research Centre

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SAMPLING SITES

Oriented hand-samples were collected from 17 sites representing regions of different tectonic framework. The sampling sites are located along the length of the West Spitsbergen Fold-and-Thrust Belt (WSFTB) and west of Sassendalen (Fig. 1). Within the fold belt, samples of the Vardebukta Fm were collected from two areas: the southern (Hornsund, Fig. 1b) and central parts of the WSFTB (Bellsund, Fig. 1c). In contrast, another sampled area (Fig. 1d, Sassenfjorden) is situated ca. 60 km to the east of the main WSFTB line with subhorizontal strata of the Vikinghøgda Fm gently dipping northwest. At each site, six to twelve hand samples with common bedding orientation have been collected. Approximately 840 specimens were analyzed.

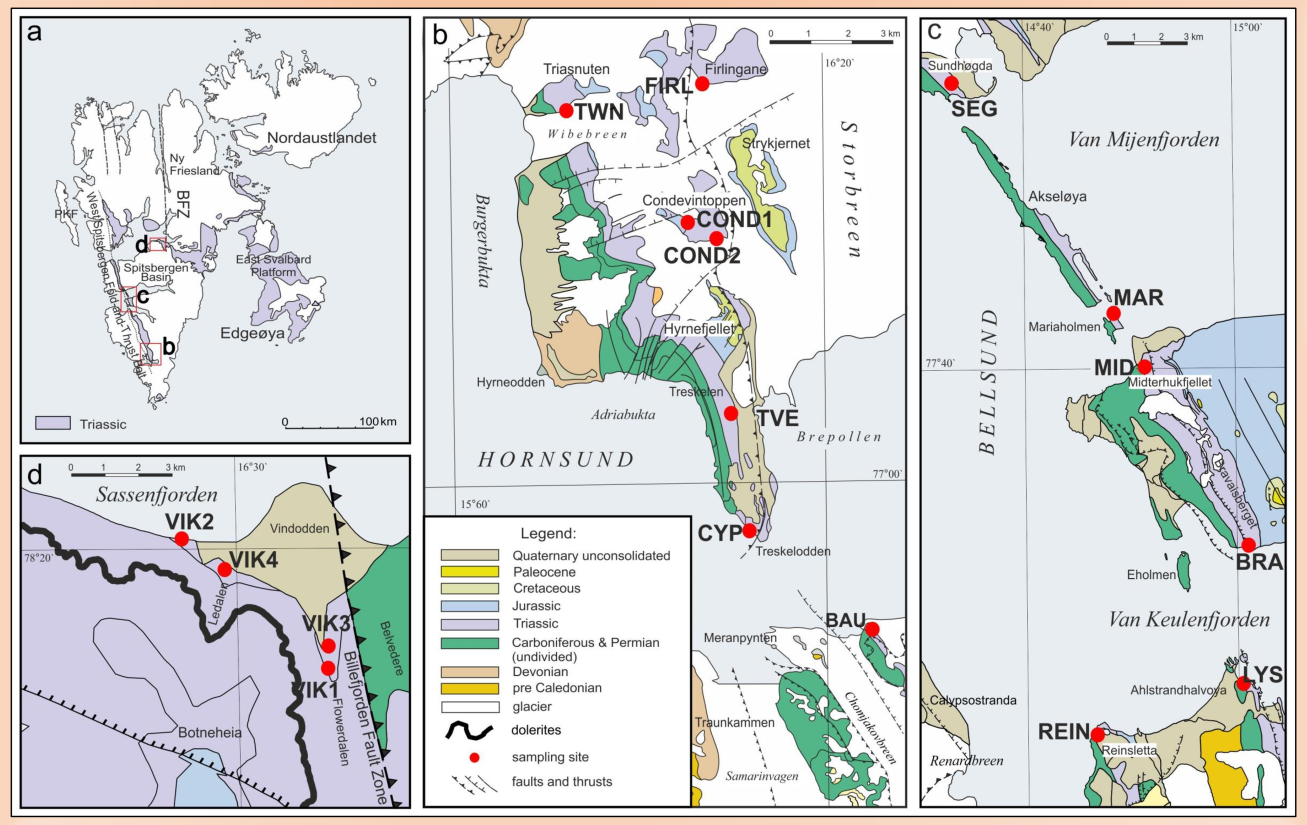


Fig. 1. (a) Map of Svalbard showing a distribution of the Triassic rocks (modified after Harland, 1997). Locations of the study area are marked by rectangles. Geological maps (b-d) of the sampled areas (map modified after Birkenmajer, 1990; Dallmann et al., 2002; Ohta & Dallmann, 1994). Sampling sites are indicated by red dots. Abbreviations: BFZ – Billefjord fault zone, PKF – Prins Karls Forland.

AIM OF THE STUDY

- recognize magnetic mineralogy of the sediments within the investigated areas
- determine the origin of magnetic fabric
- Indicate the tectonic regime mirrored by magnetic fabric

METHODS

Magnetic mineralogy was defined using field and temperature dependence of magnetic susceptibility, hysteresis parameters, backfield IRM and thermal demagnetization of composite three-axis IRM curves. The low-field anisotropy of magnetic susceptibility (AMS) was used to determine the magnetic fabric, whereas isolation of the ferro- and paramagnetic subfabrics was performed using high-field torque magnetometry at room temperature and 77K.

MAGNETIC MINERALOGY

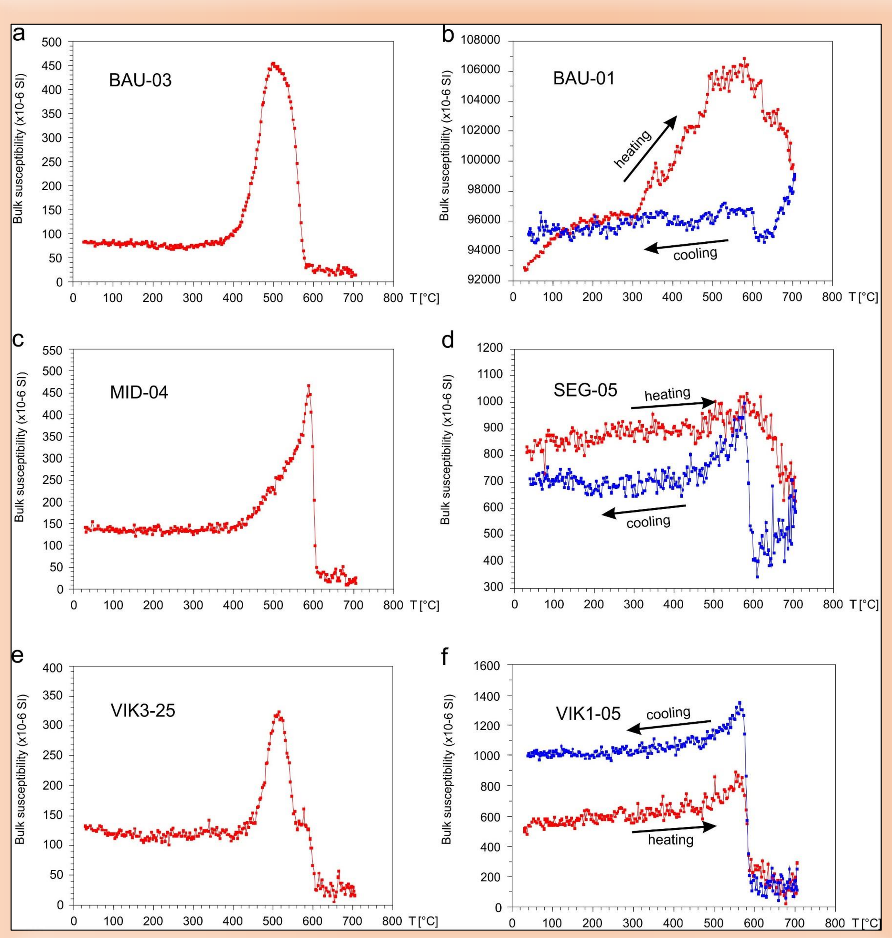


Fig. 2. Temperature dependence of bulk magnetic susceptibility, normalized by volume for selected samples from Hornsund (a,b), Bellsund (c-d) and Sassenfjorden (e-f) areas. Plots on the left were performed on 'whole-rock' specimens and those on the right show thermomagnetic curves for ferromagnetic separates.

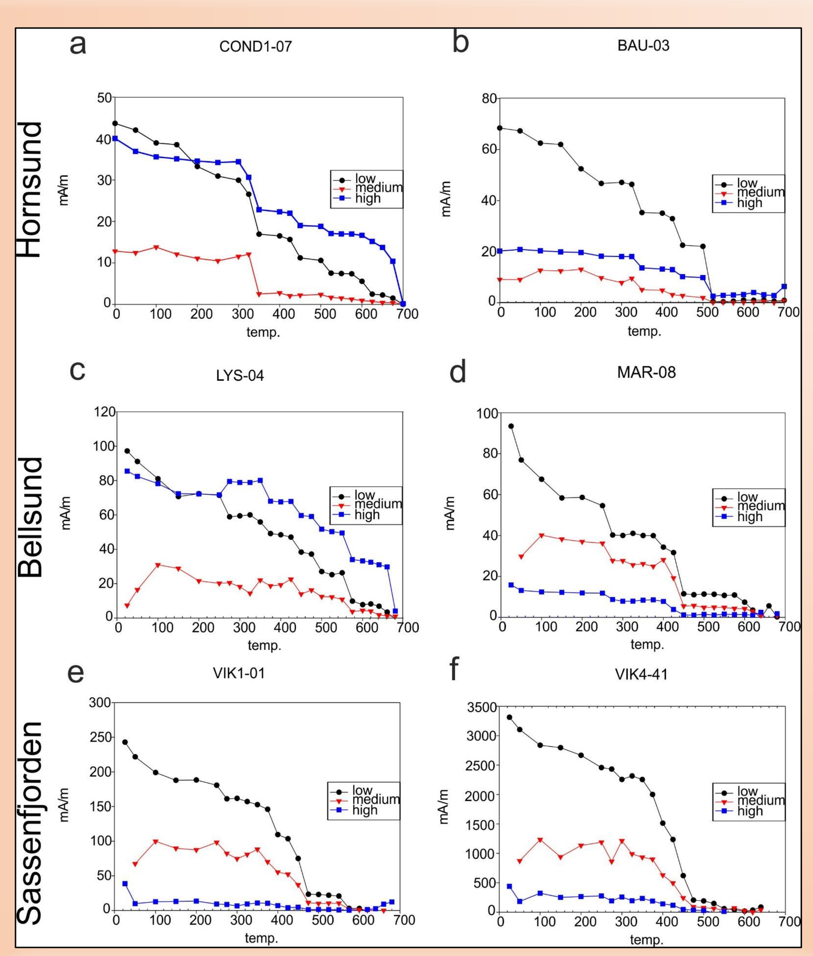


Fig. 3. Examples of the three-component IRM acquisition curves (Lowrie, 1990). Maximum field of 0.12 T, 0.4 T and 3 T were applied to low, medium and high coercivity curves, respectively.

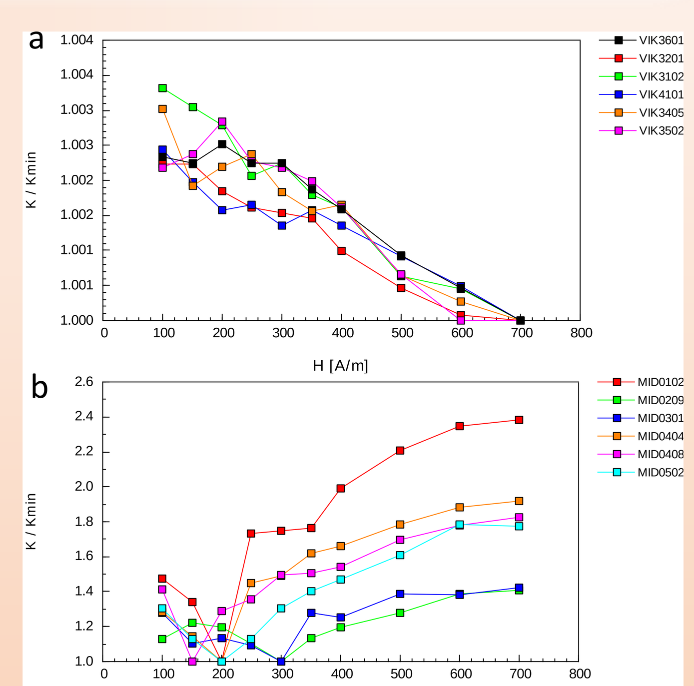


Fig. 4. In-phase (a) and out-of-phase (b) field dependent susceptibility for representative samples normalized by Kmin.

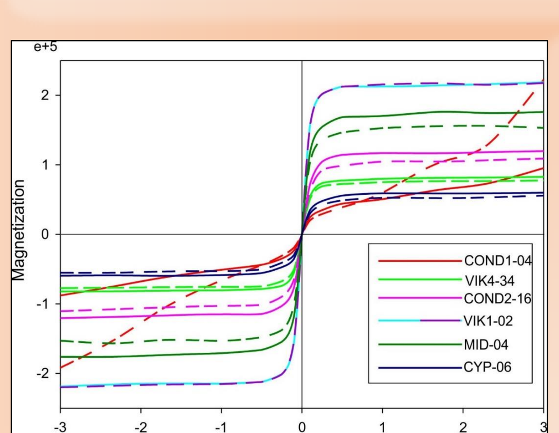


Fig. 5. Acquisition of IRM and back-field IRM for selected samples. Solid line show measurement at room temperature and dashed line indicate measurement at 77 K .

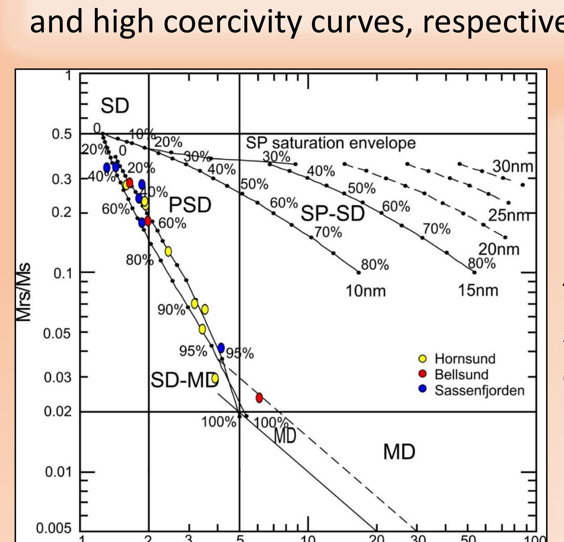


Fig. 6. Hysteresis ratios Mrs/Ms vs Hcr/Hc for ferromagnetic separates shown on Day – Dunlop plot (Day et al. 1977; Dunlop 2002a, 2002b).

- The ferromagnetic mineralogy dominated by the low-coercivity fraction,
- Magnetite (Ti-magnetite) as the dominant carrier of magnetic remanence in all mudrocks,
- Hematite contribution at sandstone sites (Figs. 2b,d; 3a,c)
- Negative field dependence of in-phase susceptibility as indicator of SP particles?
- Contribution of pyrrhotite determined by positive field dependence of out-of-phase susceptbility
- Domination of MD grains at sites along the line of the WSFTB
- Presence of SD grains at Sassenfjorden sites - no difference between IRM acquired at LT and RT
- All areas are dominated by the PSD grains which follow the SD-MD mixing line

MAGNETIC FABRIC

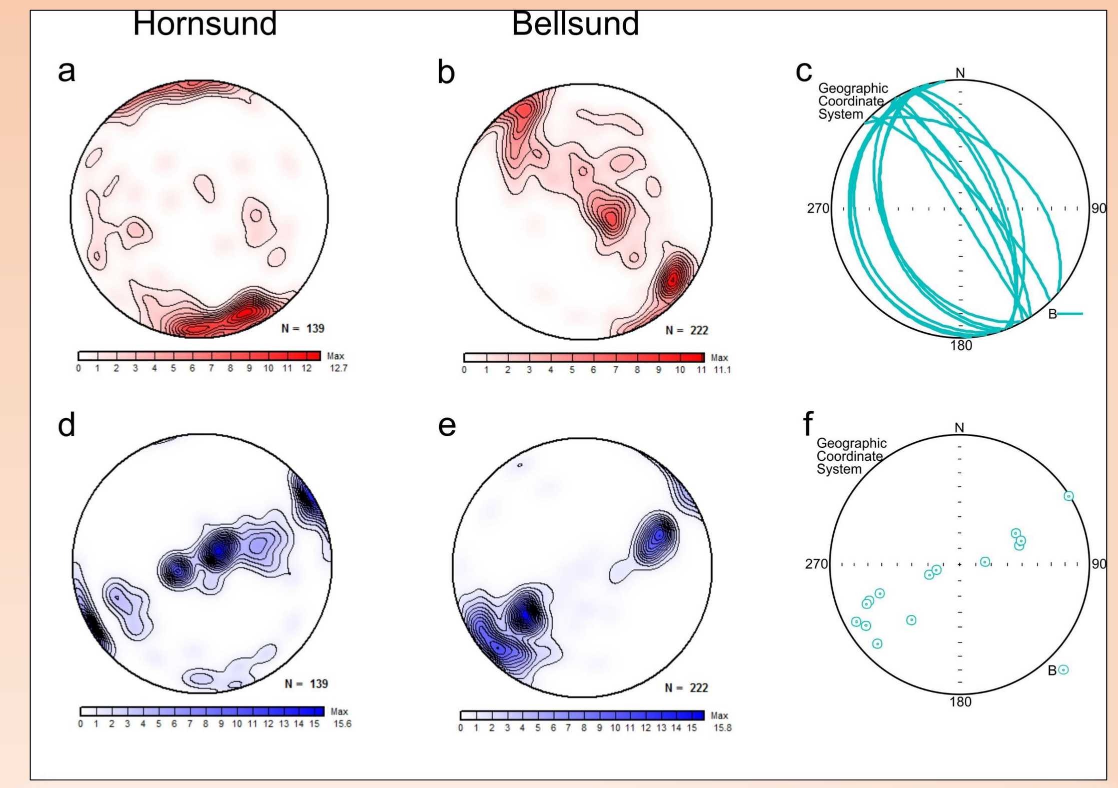


Fig. 7. Contour plots of the distribution of Kmax (a,b) and Kmin (d,e) for areas located along the line of the WSFTB; orientations of bedding (c) and pole bedding (f) are given for all sites with normal fabric.

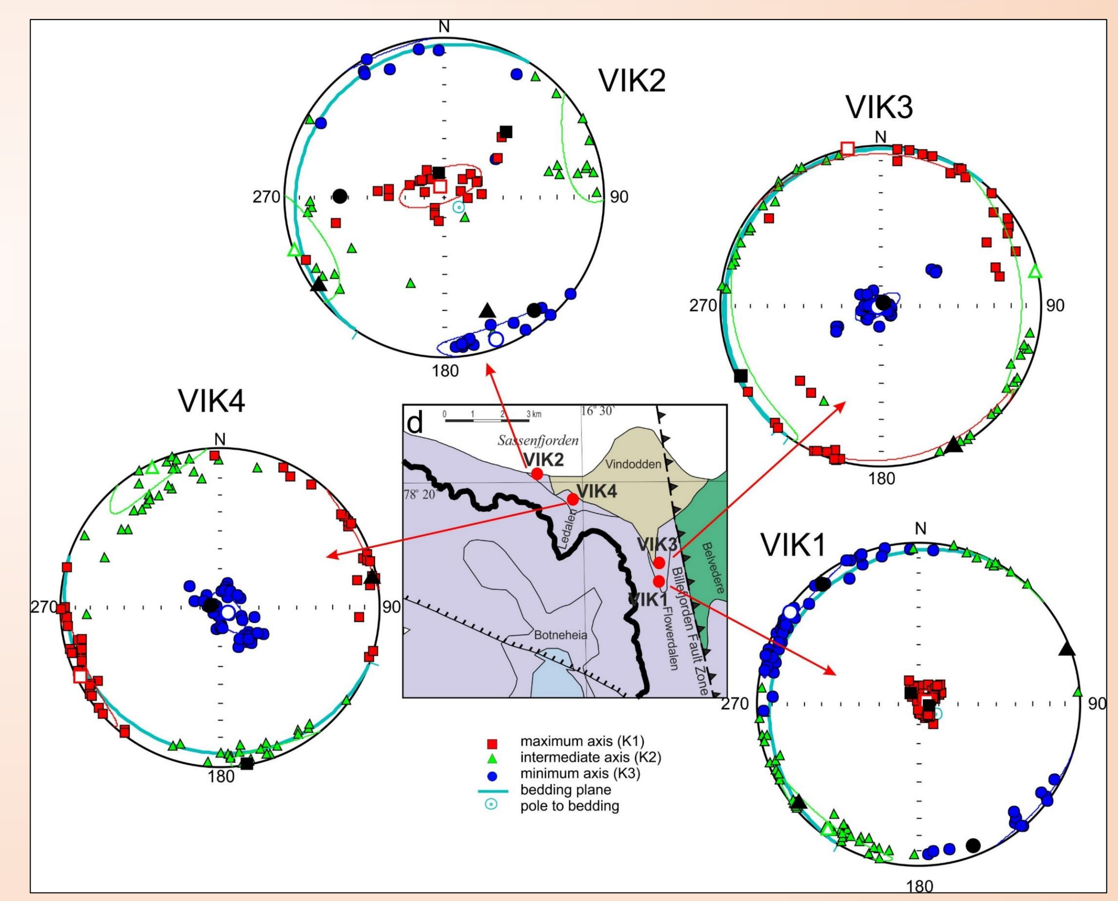
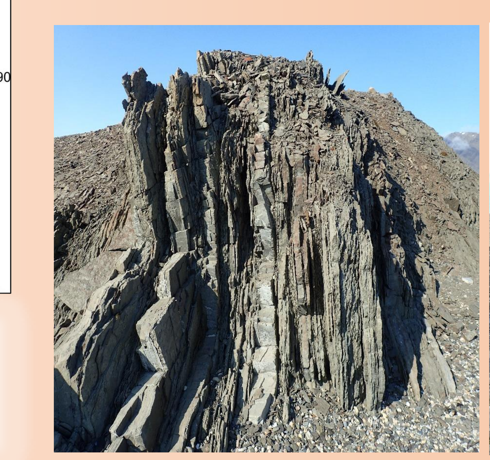


Fig. 8. The low-field and high-field AMS (black symbols) results of sites located along the WSFTB at Sassenfjorden. Equal-area lower-hemisphere projections show results in the geographic coordinate system.

- Normal magnetic fabric in 13 of 17 sites
- Magnetic fabric varies through stratigraphic profile at Sassenfjorden
- Coaxial low- and high field AMS axes
- Paramagnetic minerals control the anisotropy in the sample
- Calculated p77 values (ca. 8.3-9.4) suggest iron-bearing carbonates or phyllosilicates as carriers of magnetic fabric



CONCLUSIONS

- **This study provides information on the magnetic mineralogy of Triassic sediments from the WSFTB and its foreland. Lithology is mostly homogenous in these rocks with (Ti) magnetite as the main ferromagnetic minerals. However, the fold belt sites are dominated mainly by PSD grains whereas on the foreland prevail rather SD grains.**
- **Grains of SP hematite were identified in some of the rocks within fold belt and are highly associated with coarser-grained siliciclastic lithology.**
- **The magnetic fabrics is due to the preferential orientation of paramagnetic minerals, and these can be phyllosilicates or Fe-rich carbonates. The fabric carried by iron carbonates, the most probably siderite, leads to an inverse magnetic fabric.**
- **Although the degree of anisotropy is low, the fabric along the WSFTB reflects the compressional stage of the evolution of the fold belt with a low degree of deformation.**
- **Sites located at Sassenfjorden, on the foreland of the WSFTB, show no deformation and AMS fabric, most likely, reflects Triassic paleocurrent direction.**
- **The variation between normal and inverse fabric within stratigraphic profile is of sedimentary origin and the most probably related to intercalation of Fe-carbonates beds in mudrock and shale unit. However, no gradual change through profile has been found due to different location of particular sites. Thus, further studies concerning the nature of this change are essential.**

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Acknowledgements: G. Manby, K. Nejbert, M. Burzyński and J. Bednarek are thanked for assistance during fieldwork. Ann Hirt is gratefully acknowledged for her encouragement and fruitful discussion during the torque measurements. Stefan Beetschen is thanked for technical assistance during measurements at the Laboratory for Natural Magnetism, ETH Zurich. This work is partially financed from the funds of the Leading National Research Centre (KNOW) received by the Centre for Polar Studies for the period 2014 -2018, and also partially supported within statutory activities No 3841/E-41/S/2017 of the Ministry of Science and Higher Education of Poland.

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