Solid Earth Discuss.,
https://doi.org/10.5194/se-2019-128-RC2, 2019

Interactive comment on "Magnetic properties of pseudotachylytes, Jämtland, central Sweden" *by* Hagen Bender et al.

Ann Hirt (Referee)

ann.hirt@erdw.ethz.ch

Received and published: 10 September 2019

The authors examine the magnetic properties, including magnetic fabric in small samples taken from rocks from the Köli Nappe complex. Although the original goal of the authors was to use magnetic fabrics to gain a better understanding of kinematics of a ductile-to-brittle shear zone, they could only show that very small samples may not accurately reflect detailed kinematic information within the shear zone. There were a number of studies that tried to use magnetic fabrics in large-scale shear zones in the early 1970's thru 1980's to gain kinematic information. Many of these were unsuccessful, which led to the suggestion that non-homogenous deformation within the shear zone, or in some cases, late stage deformation overprinting any earlier fabrics due to retrograde metamorphism were responsible for the observed magnetic fabrics. It was

not until Ferré and co-workers work that this problem has been looked at by focusing on pseudotachylytes.

There are some interesting points made in this paper, such as the fact that one needs to consider whether a "sample" is representative of a larger volume of rock, or what fabric is one observing if a rock has undergone inhomogeneous deformation or multiple deformation phases. The authors, however, need to better develop these points in the manuscript in order that it makes a significant contribution to the field.

The following are comments are in relationship to the magnetic fabrics, and these can be divided into the directional information, or the degree and shape of the AMS ellipsoids. Note that numerous studies have shown that AMS is very good in reflecting preferred directions of deformation. The degree of anisotropy is also often related to the degree of deformation, but not always, and the shape of the AMS ellipsoid is often poorly constrained or at least the most variable parameter.

Directional data from magnetic fabrics agrees with petrofabric and indicates that the host rocks and rocks from the fault developed in the same strain field. Is there any indication that the petrofabric post-dates the faulting? This is an important question in phyllosilicates carry the AMS and these arise from alteration after the faulting event. Can neo-formation of mica and/or biotite account for the common fabric in all rocks? Could Ti-rich oxide be contributing to the paramagnetic contribution? How homogeneous is the mineralogy in the different categories?

There is a clear relationship between the degree of AMS (Pj) and the "not normalized" mean susceptibility, and the error in mean susceptibility versus sample size, which leads the authors conclude the sample size affects Pj. There are a couple of points that need more clarification. 1) How were the samples measure with the manual 15-position scheme, 3 rotation planes, or "single" rotation scheme?

2) What is the analytical error (km standard error) shown in Fig. 12 c; is it obtained from the SAFYR program?

3) Is the higher P-value related to a weak susceptibility? Normally this is found when mean susceptibility is close to “zero”, due to a diamagnetic component of the susceptibility balancing out a para-/ferromagnetic component. In this case is it due to the fact that the small sizes leads to a susceptibility that gets within the accuracy range of the bridge?

4) It appears that the grain size of samples is much smaller that the sample size, but is this really the case, i.e., are there enough grains to reflect the anisotropy of a larger volume? I once tried with a shale/slate sample and a biotite crystal to reduce sample size of a cube to see if this affected the AMS. Although I did not go below a 1-cm edge, I did not see an effect. But in these cases, I had very fine grain sizes with respect to volume or a single crystal.

5) Going back to the point with directional data, how variable is the mineralogy between the different types of samples? How variable is the high-field susceptibility extracted from the magnetization versus field measurements?

6) Shape is often never a good parameter in looking at deformation, and it is not surprising that the shapes are so variable.

Minor comments 1) The authors mention frequency-dependent susceptibility, but do not mention it further in the text. Did they try to measure the AMS at different frequencies, e.g., in the PST APST samples?

2) I am not sure how significant an isolation of a ferromagnetic component is in the host rock or APST. I would put little faith in trying to extract a saturation magnetization. They are surely artefacts and I would not even show. In this case, it would have been better to measure the acquisition of IRM. One could have probably gotten a convincingly significant signal that would allow for comparison.

Line 18: remove hyphen in information

Line 35: 2.1 instead of 1.1

Lines108-109: in the case that T = 1 or -1, then the ellipsoid is rotationally oblate, respectively prolate. The ellipsoid is still oblate for T> 0, and prolate for T < 0.

Line 122: Note that frequency dependence should be detected for particles between ca. 16 to ca. 30 nm for 976 Hz and ca. 15 – ca. 30 nm for 15616 Hz (cf., Hrouda, 2011, GJI).

Line 189: I am not sure what is meant by homogeneous AMS fabrics? Can there be inhomogeneous fabrics?

Note that numerous references within the manuscript or not in the reference list. The authors should go through this carefully. Some reference for generic information are not needed are do not really reflect the authors who originally presented an idea.

Fig. 9: complete figure caption or state that the lower figure shows only the heating curves for a) – c) without labelling.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2019-128, 2019.