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Transition in magnetic fabric types in progressively deformed, fine-grained sedimentary rocks of Central Armorica (Brittany, France)

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The anisotropy of magnetic susceptibility (AMS) of progressively deformed, fine-grained sedimentary rocks is determined for different tectonometamorphic settings in Central Armorica (Brittany, France). Low-temperature AMS and high-field torque magnetometry on a representative selection of samples indicate that the magnetic fabric is dominantly paramagnetic and the ferromagnetic $(s.l.)$ contribution can be neglected. The AMS documents a progressive transition of intermediate fabrics to tectonic fabrics and increasingly stronger developed tectonic fabrics. An integrated magnetic-mineralogical approach is performed in order to assess whether we can use this evolution as a quantitative indicator for the intensity of cleavage development in Central Armorica.

During the magnetic fabric transition, the maximum susceptibility axis (K_1) remains stationary oriented parallel to the bedding – cleavage intersection, whereas the minimum susceptibility axis (K_3) orientation distribution changes from a moderate girdle distribution in the intermediate fabric types, to a strongly clustered distribution parallel to the cleavage pole for the tectonic fabric types. A Woodcock two-axis ratio plot is used to evaluate this change in K_3 distribution. This shows a regional pattern with intermediate fabrics in the southern part of Central Armorica and tectonic fabrics in the northern part of Central Armorica.

Quantitative analysis of the observed magnetic fabrics shows that the fabric transition described above is accompanied by an evolution from prolate susceptibility ellipsoids with a relatively low degree of anisotropy to oblate ellipsoid with an increasingly higher degree of anisotropy. In a graph of the shape parameter T against the corrected degree of anisotropy P_J, this evolution has a hockey-stick shaped pattern with the vertical branch reflecting the actual transition from intermediate to tectonic fabric type and the horizontal branch reflecting progressively stronger developed tectonic fabrics. The analysis confirms the general northward increasing intensity of tectonic fabric development for Central Armorica.

Thus, based on the K_3 orientation distribution and P_J and T values, we could infer a general magnetic fabric transition and an increasingly stronger tectonic fabric development, which is in line with the overall geodynamic model of Central Armorica describing a northward increasing strain gradient. However, exceptions to this general trend do occur with both prolate intermediate fabrics in the northern part of Central Armorica, and oblate tectonic fabrics in the southern part of Central Armorica – resulting in a sometimes relatively large spread in AMS for samples from an area with a homogeneous tectonometamorphic history. This suggests that the amount of strain is not the only major factor determining magnetic fabric development, thus jeopardizing a quantitative AMS interpretation in terms of strain.

Preliminary mineralogical analyses suggest that fabric transition and spread in P_J and T values between samples of a single sampling area, affected by a homogeneous amount of strain, reflect variations in mineralogy, i.e. the relative amount of quartz versus platy clay minerals. This mineralogical influence on the AMS evolution is currently being further investigated in order to get a better understanding of the magnetic fabric transition in deformed, fine-grained sedimentary rocks and assess the applicability of AMS as a (semi)quantitative strain marker in Central Armorica.