Geophysical Research Abstracts
Vol. 16, EGU2014-3441, 2014
EGU General Assembly 2014

Comparison of lattice preferred orientation and magnetic fabric of a chloritoid-bearing slate

Tom Haerinck (1), Hans-Rudolf Wenk (2), Timothy N. Debacker (3), and Manuel Sintubin (1)

(1) KU Leuven, Department of Earth and Environmental Sciences, Leuven, Belgium (tom.haerinck@ees.kuleuven.be), (2) University of California, Department of Earth and Planetary Science, Berkeley, CA, U.S.A., (3) FROGTECH Ltd., Deakin West, ACT, Australia

A regional analysis of the anisotropy of the magnetic susceptibility (AMS) on chloritoid-bearing slates of the Paleozoic Plougastel Formation in the low-grade metamorphic conditions (epizonal) of the Monts d'Arrée slate belt in Central Armorica (Brittany, France) reveals very high values for the degree of anisotropy (P_J), up to 1.43 (Haerinck et al. 2013a). In contrast, stratigraphically equivalent slates free of chloritoid, in the very low-grade metamorphic conditions (anchizonal) of the Crozon fold-and-thrust belt, show a lower degree of anisotropy, with P_J values up to 1.27. Classically, very strong magnetic fabrics (i.e. those with P_J above 1.35) are attributed to a contribution of ferromagnetic ($s.l.$) minerals. Nonetheless, high-field torque magnetometry indicates that the magnetic fabric of the chloritoid-bearing slates is dominantly paramagnetic. The ferromagnetic (sensu lato) contribution to the AMS is less than 10%.

Based on these observations, it would seem that chloritoid has an intrinsic magnetic anisotropy that is significantly higher than that of most paramagnetic silicates and the frequently used upper limit for the paramagnetic contribution to the AMS. Using two independent approaches, i.e. (a) directional magnetic hysteresis measurements, and (b) torque magnetometry, on a collection of single chloritoid crystals, collected from different tectonometamorphic settings worldwide, the magnetocrystalline anisotropy of monoclinic chloritoid has been determined (Haerinck et al. 2013b). The determined paramagnetic high-field AMS ellipsoids have a highly oblate shape with the minimum susceptibility direction subparallel to the crystallographic c-axis of chloritoid and the degree of anisotropy of chloritoid is found to be 1.47 ± 0.06.

The obtained very high magnetocrystalline degree of anisotropy suggests that chloritoid-bearing slates with a pronounced mineral alignment can have a high degree of anisotropy (P_J) without the need of invoking a significant contribution of strongly anisotropic ferromagnetic ($s.l.$)minerals. To validate this assumption a texture analysis has been performed on a representative sample of the chloritoid-bearing slates (P_J = 1.40), using hard X-ray synchrotron diffraction (e.g. Wenk et al. 2010). For estimation of the mineralogical composition and the preferred orientation a Rietveld refinement of the synchrotron X-ray diffraction images has been performed. The Rietveld refinement confirms that the slate contains a significant fraction of chloritoid (21 vol%). The resulting orientation distribution of both muscovite and chloritoid display an approximate axial symmetric (001) pole figure pattern with respect to the minimum magnetic susceptibility axis K_3, that has an extremely strong preferred orientation ($\sim$36 m.r.d. for muscovite and $\sim$19 m.r.d. for chloritoid).

It is therefore fair to conclude that the strong preferred orientation of the chloritoid basal planes parallel to the magnetic fabric, in combination with the pronounced magnetocrystalline anisotropy of chloritoid, explains the very high values for the degree of magnetic anisotropy (P_J) observed in the chloritoid-bearing slates.

References

Haerinck *et al*. 2013a. *Journal of the Geological Society, London* **170**, 263-280, doi:10.1144/jgs2012-062.

Haerinck *et al*. 2013b. *Journal of Geophysical Research: Solid Earth* **118**(8), 3886-3898, doi:10.1002/jgrb.50276.

Wenk *et al.* 2010. *Journal of Structural Geology* **32**(4), 478-489, doi:10.1016/j.jsg.2010.02.003.