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Magnetic anisotropy of Silurian organic-rich shale rocks and calcareous concretions from Northern Poland

Dominika Niezabitowska and Rafał Szaniawski
Institute of Geophysics Polish Academy of Sciences, Department of Magnetizm, Warsaw, Poland (dniezabitowska@igf.edu.pl)

The research has been performed on Wenlockian shales of Pelplin formation from the Pomerania region located in Northern Poland. These organic-rich marine shales were deposited on the western shelf of the Baltica paleo-continent and currently they constitute the cover of East European Platform. The studied shales lie almost completely flat without signs of tectonic deformations. Rock magnetic studies were carried out with the aim of recognizing ferro- and paramagnetic minerals in shales and thus fully understanding the origin of the magnetic anisotropy.

The typical dark shales and spherical calcareous concretions from two boreholes were sampled. Based on deflection of shales beds bordered with a concretions, we deduce that such concretions were formed in the early stage of diagenesis, before the final compaction and lithification of surrounding shales. We obtained similar rockmagnetic results for both of rock types. The results of thermal variation of magnetic susceptibility and hysteresis loops show that the magnetic susceptibility is mainly controlled by paramagnetic minerals, due to domination of phyllosilicate minerals, with a smaller impact of ferromagnetic phase. The results of the hysteresis studies documented the domination of low coercivity ferromagnetic minerals, that is magnetite and pyrrhotite.

The deposition alignment of flocculated phyllosilicates and further compaction determine distinct bedding parallel foliation of the AMS (Anisotropy of Magnetic Susceptibility) in the both drill cores. In one of the drill core the maximal AMS axes are almost randomly distributed in the bedding plane and show only a weak tendency for grouping. In the second drill core the magnetic lineation is better defined.

In the case of concretions the bedding parallel magnetic foliation is also evident but it is much weaker than in shales. In turn, the magnetic lineation in the both drill cores is well developed and the maximal AMS axes are well grouped. In both of the cores the orientation of lineation from concretions complies with site mean lineation from shale rocks.

To summarize, the results imply that the phyllosilicate minerals from shales are typically well aligned in the bedding plane by compaction processes. In the case of calcareous concretions the foliation is less developed due to their earlier cementation of flocculated phyllosicates in the calcareous matrix, which occurred before the end of sediments compaction. A good grouping of the maximal AMS axes within the early cemented concretions suggest that the magnetic lineation is rather sedimentary than tectonic in origin. We suggest that the magnetic lineation is probably related to the orientation of flocculated phyllosilicates due to transportation.

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