Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 423 (C-112), 2018, pp. 113-114
DOI: 10.25171/InstGeoph_PAS_Publs-2018-058
16th Castle Meeting New Trends on Paleo, Rock and Environmental Magnetism, Chęciny, Poland, 2018

Magnetic Mineral Assemblage as a Potential Indicator of Depositional Environment in Gas-bearing Silurian Shale Rocks from Northern Poland

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A b s t r a c t

Our goal was to investigate rockmagnetic properties of two lithofacies of Silurian gas-bearing shales from Northern Poland: Pelplin Formation and Jantar Member which both represent a potential source of unconventional hydrocarbons. The studied rocks are characterized by similar burial evolution, but different amounts of organic matter (Jantar – up to 7 percent, while in Pelplin not exceed 1.5 percent). Moreover, in the Pelplin Formation spherical calcareous concretions were examined. The differences in magnetic minerals composition, if any occur, may help better understand the determinants, which control water chemistry at the bottom of sedimentary basin and thus the preservation of organic matter.

Therefore, low temperature measurements of SIRM in the 10–300 K range were performed, in order to recognize nano-particles, which are not detectible in basic rockmagnetic studies. We detected presence of magnetite (Fig. 1), MD and SP, what we attribute most probably with detrital and chemical origin (illitization or organic maturation), respectively. However, the most interesting observation is the occurrence of hematite in the Pelplin Formation (with lower amount of organic matter) and its absence in organic-rich Jantar Member (Fig. 1). We propose that hematite (mostly SD grains) in mudstones and carbonate concretions, was formed as a product of magnetite reaction in oxic conditions (with probable activity of oxidizing bacteria). This hypothesis is in line with the precipitation of calcareous concretions from Pelplin Formation in oxic conditions at the bottom of the sedimentary basin. Moreover, this is also consistent with lower values of organic matter and the presence of hematite. Furthermore, an occurrence of hematite in mudstones and concretions in the Peplin Formation suggests that during sedimentation of clastic material as well as compaction and cementation of concretions, stable oxic conditions were present at the bottom, allowing preservation of this mineral.

As a main conclusion, we suggest correlation between hematite content and organic matter in sedimentary rocks, what may be a useful factor in understanding the preservation

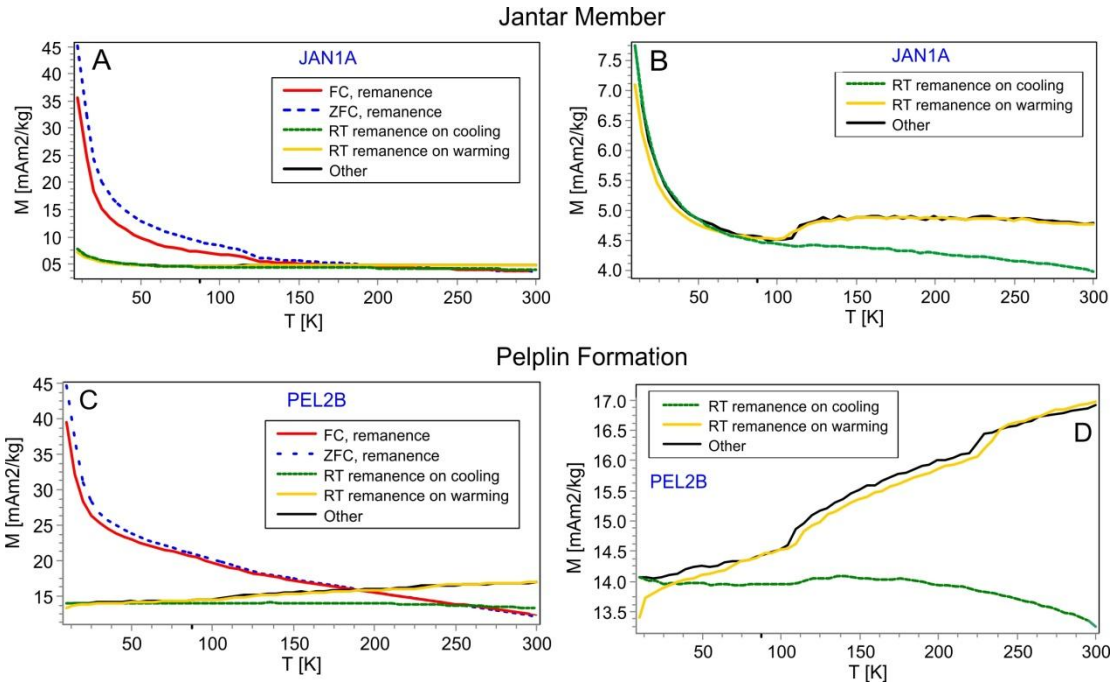

Fig. 1. Results of MPMS measurements of remanence in low temperature range (10–300 K) for selected samples from Pelplin Formation and Jantar Member. Note, typical for magnetite, the Vervey transition in all samples and characteristic for hematite – the Morin transition, which occurs only in Pelplin Formation. Abbreviations: Zero Field Cooled (ZFC), Field Cooled (FC), Room Temperature SIRM, the 'other' curves are results of the RT-SIRM, which was performed in small (+5 μT) induced magnetic field.

of organic matter in shales. However, further investigation is necessary to fully recognize this complex problem.

Keywords: magnetic mineral assemblage, LT measurements, organic-rich shales, depositional system of Baltic Basin.

Acknowledgments. I thank the Institute for Rock Magnetism for Visiting Fellowship, which was funded by the University of Minnesota. The visit has been partially financed from the funds of the Leading National Research Centre (KNOW) received by the Centre for Polar Studies for the period 2014–2018. This work has been also funded by the Polish National Centre for Research and Development within the Blue Gas project (No. BG2/SHALEMECH/14). Samples were provided by the PGNiG SA.