

Magnetometry as a tool to estimate the pollution of marine environment around the small shipwrecks (Gulf of Gdańsk)

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Introduction

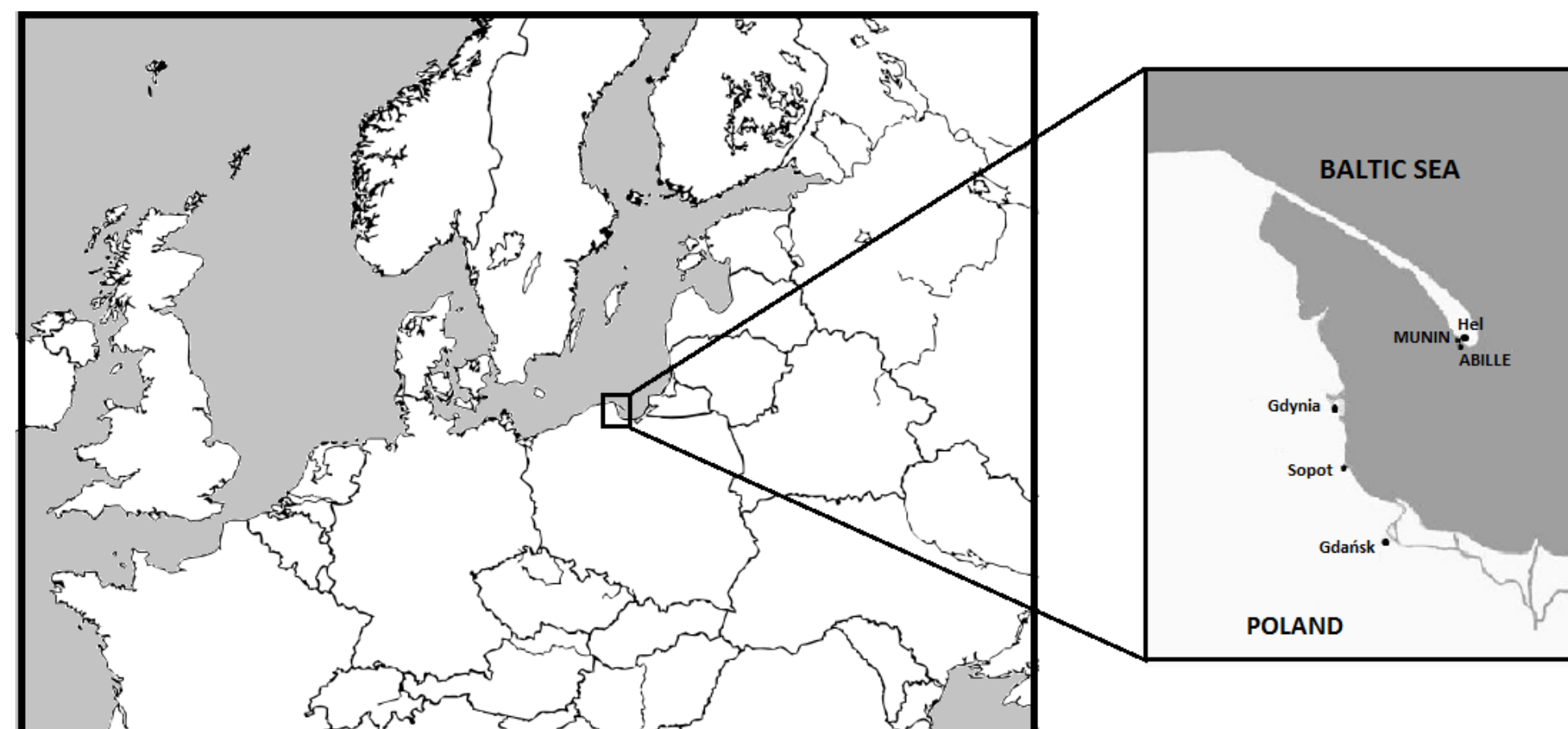
Shipwrecks may pose a serious source of contamination for marine environment. This is a very important reason to use all available methods to estimate the pollution extent of marine environment due to wrecks presence, even these small. In this paper, we present the results of magnetic analyses carried out on surface sediment samples collected around the small shipwrecks (Munin and Abille) in the Gulf of Gdansk (Southern Baltic Sea).

Wreck of Munin, called also Trałowiec, was the warship used by German Navy (Reischmarine and Kreigsmarine), rebuilt from a fishing trawler and launched in 1916. In 1945, the warship had sunk after a collision, close to the port of Hel.

The tugboat Abille was built in 1936 in Leith, France. In 1940 incarnated to Kreigsmarine in Benodet. The ship probably has sunk in winter 1945 while helping another vessel which had problems at Hel's roadstead.

Studied area and samples

The sediment samples were collected around Munin and Abille wrecks at the distance of 100m and 200m. 16 surface samples of weight about 500g (M1-M8, A1-A8) were taken using the Van Veen's grab holder during cruises on k/h Oceanograf 2.

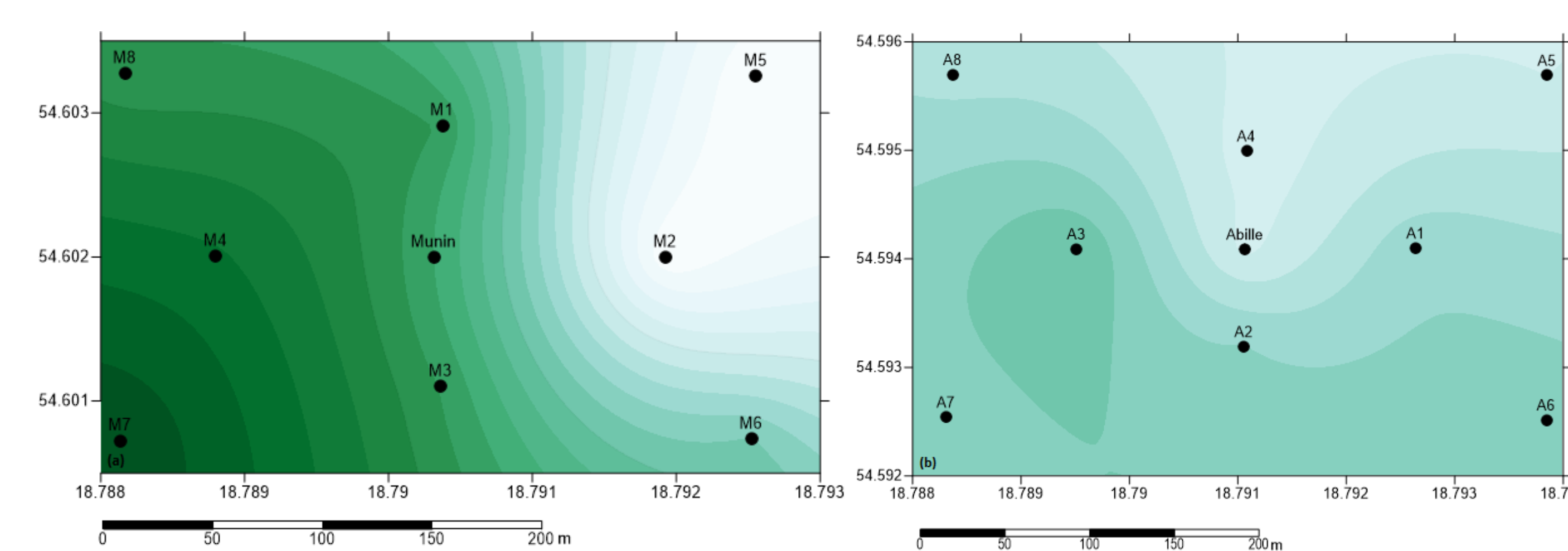


Methods

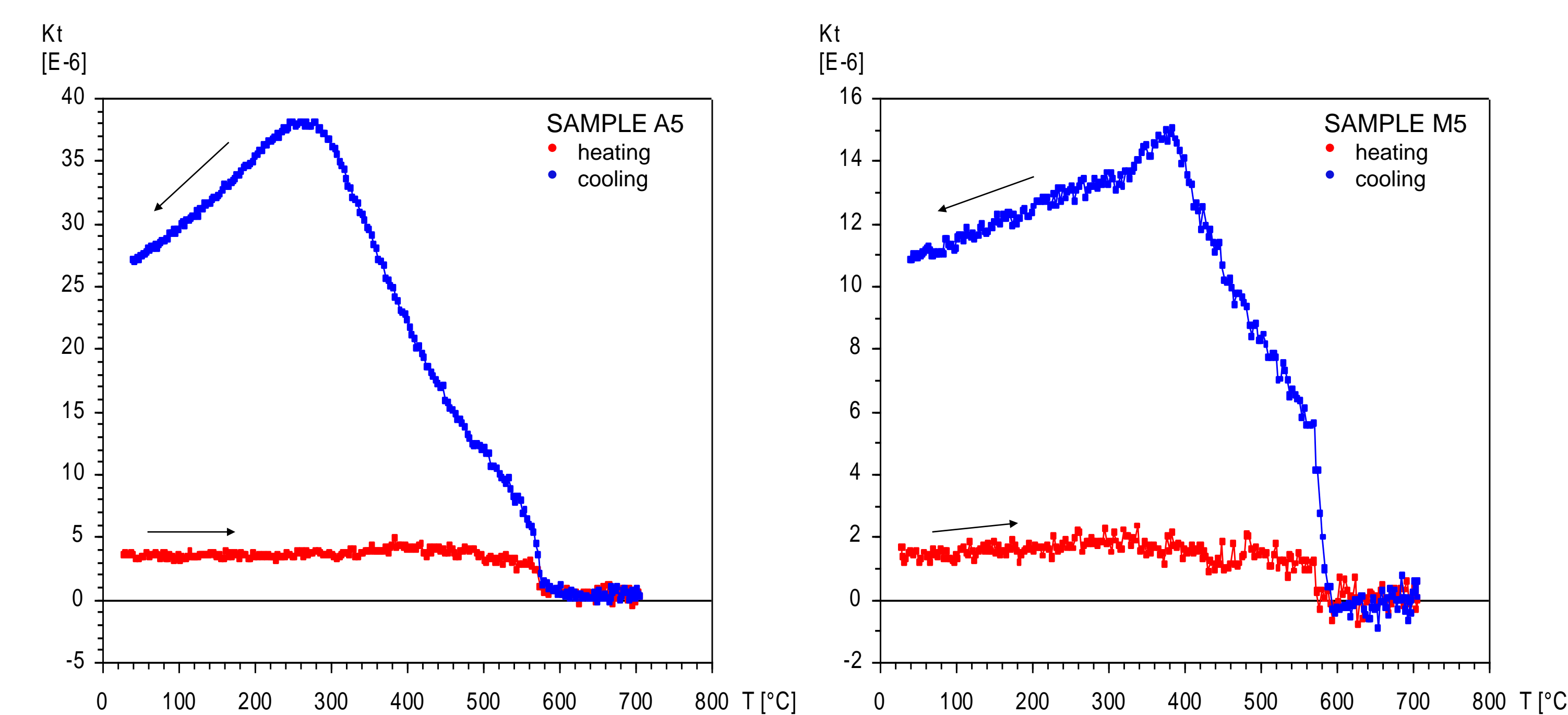
The following magnetic parameters were measured:

- Magnetic susceptibility per unit mass (χ) – Multi-Function Kappabridge MFK1-FA (AGICO, Czech Republic)
- Hysteresis loop parameters – Vibrating Sample Magnetometer (Molspin, Great Britain):
 - Saturation isothermal remanence (M_{rs})
 - Saturation magnetization (M_s)
 - Coercivity (B_c)
 - Coercivity of remanence (B_{cr})
- Thermomagnetic analyses:
 - Saturation isothermal remanent magnetization (SIRM(T)) – device made by the TUS (Poland)
 - Volume magnetic susceptibility dependence on temperature ($\kappa(T)$) – Kappabridge KLY3 with high-temperature extensions CS-3 (AGICO, Czech Republic)

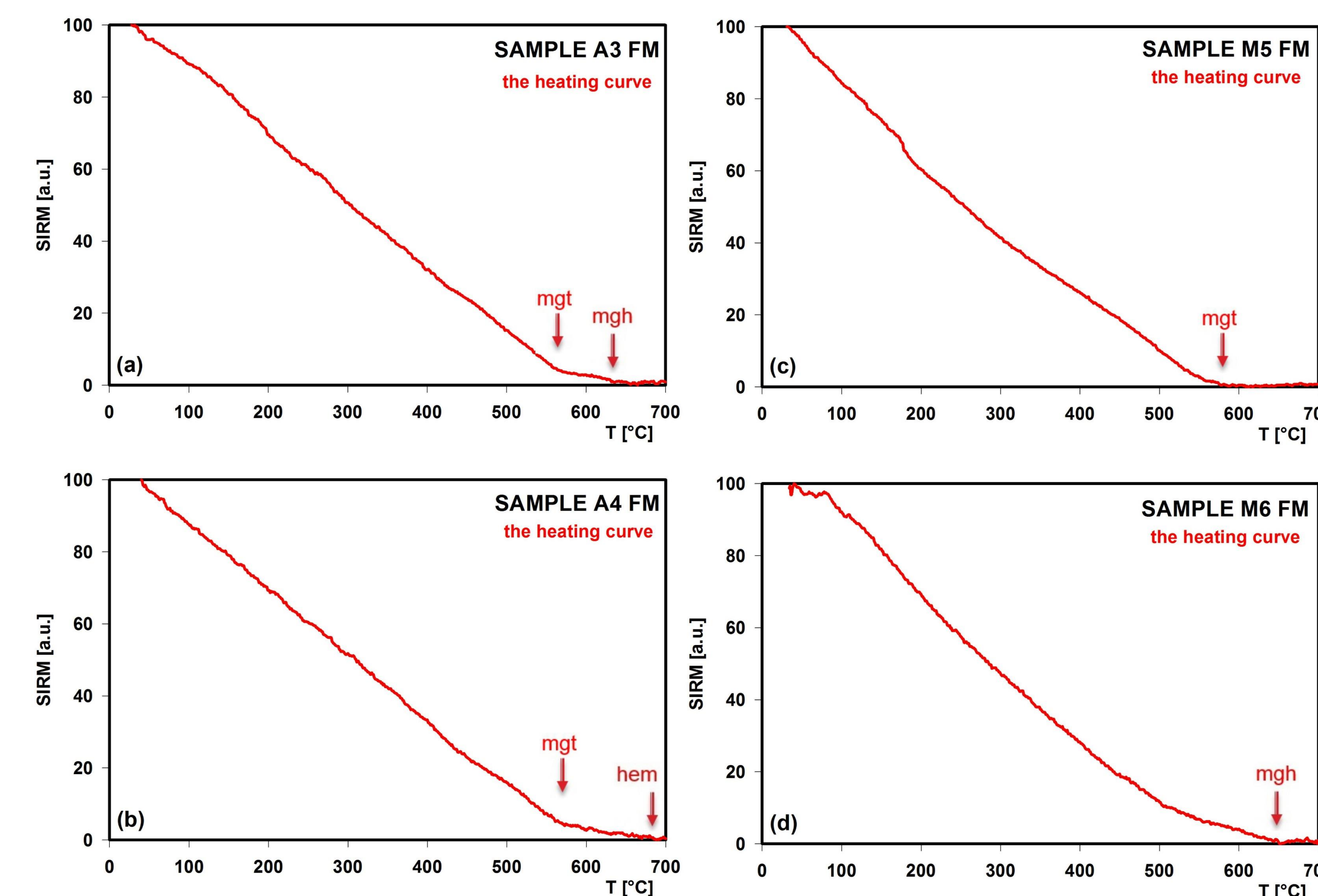
Results



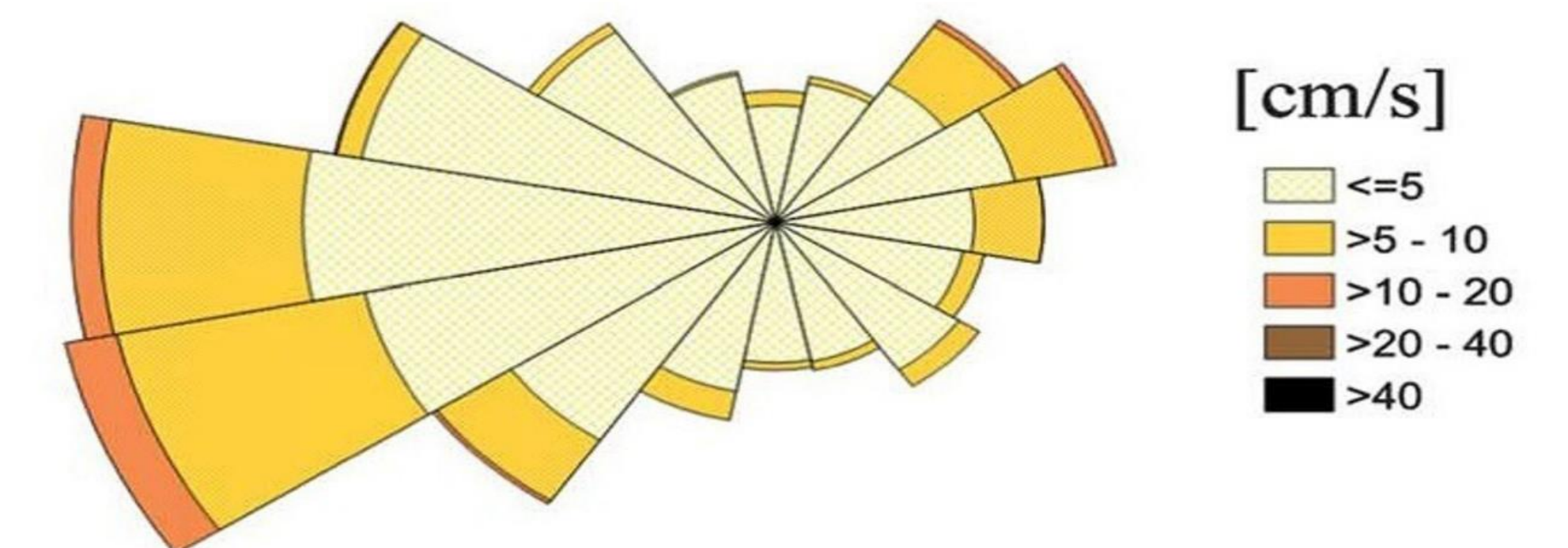
Spatial distribution of mass magnetic susceptibility in the vicinity of (a) Munin and (b) Abille wrecks.



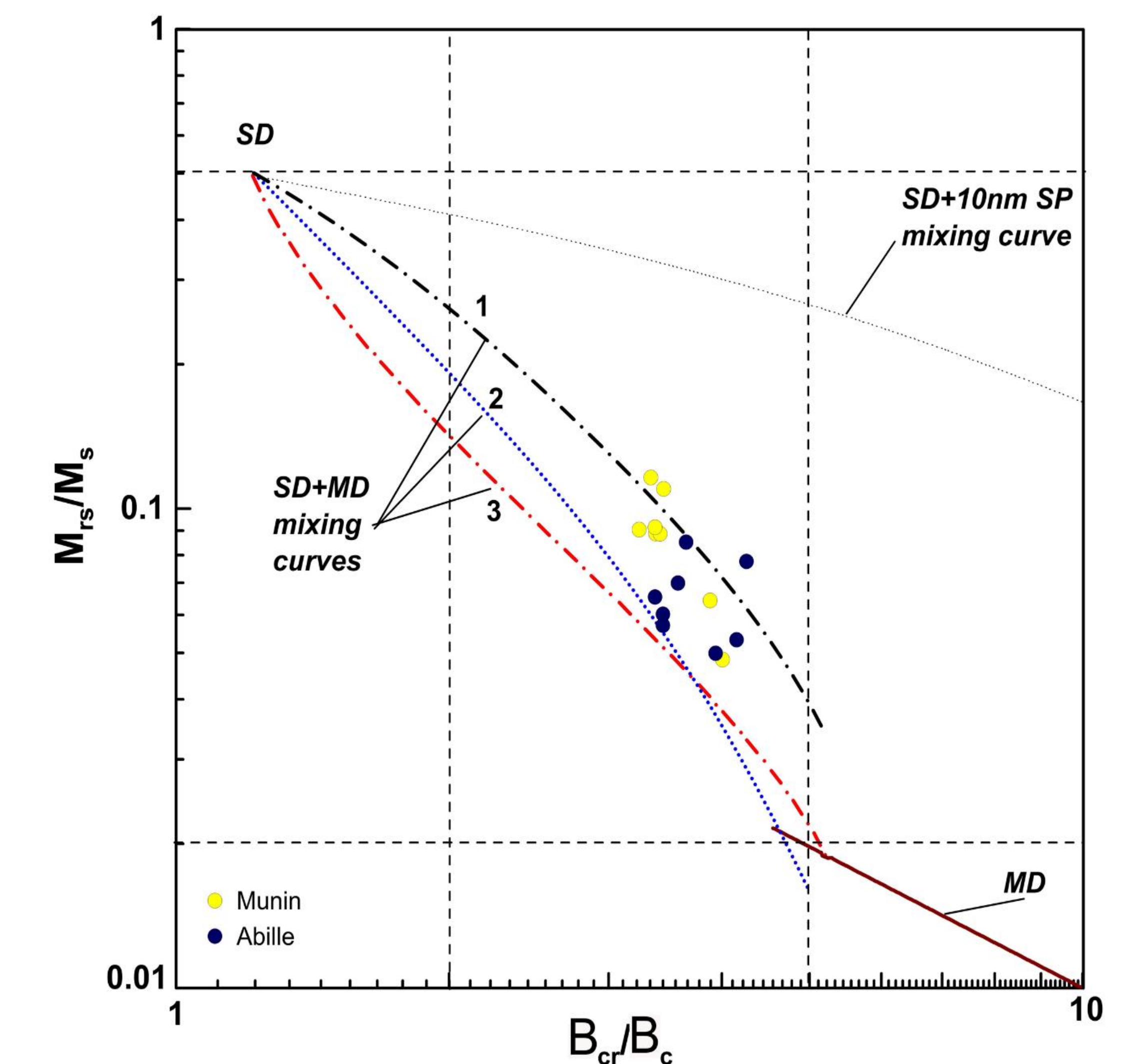
Temperature dependence of volume magnetic susceptibility for selected samples from (a) Abille and (b) Munin wrecks.



Thermal demagnetization of saturation isothermal remanent magnetization (SIRM) for selected sediment sample from (a, b) Abille and (c, d) Munin wrecks.



Water currents distribution in the near-bottom layer (18-24 m) in the western part of the Gulf of Gdańsk (data for 2009 based on the HIROMB model).



Distribution of hysteresis parameters on the Day plot modified by Dunlop.

Conclusions

The results of the study show that the main carrier of magnetic information in the sediment samples, collected around Munin and Abille wrecks, is magnetite with small amount of maghemite and hematite. Low concentration of strong magnetic minerals results in low χ values. In spite of low χ value, which indicate that the contamination in the vicinity of Munin and Abille wrecks is not especially large, it is possible to trace the distribution of magnetic susceptibility correlated with the distribution of currents or wind direction. That in turn allows to determine the direction of contaminant transport.

In the future, it would be worth to compare the results of magnetic study with concentration of heavy metals.

References:

Kudlak, B., J. Rogowska, L. Wolska, M. Kałas, L. Łęczyński, and J. Namieśnik (2012), Toxicity assessment of sediments associated with the wreck of s/s Stuttgart in the Gulf of Gdańsk (Poland), *J. Environ. Monit.* **14**, 1231–1236, DOI: 10.1039/c2em10476h.
<http://www.balticwrecks.com/pl/wraki/> (07.08.2015)