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Iron Sulfide Minerals in Black Sea Sediments

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This study presents a mutidisciplinary geochemical and environmental magnetic approach, integrating advanced mineralogical techniques to better understand the physicochemical syn-sedimentary and post-depositional processes in the anoxic sediments from the northwestern Black Sea. The investigated gravity core GC 214 was retrieved in 2007 during RV METEOR cruise M72/1 west of the Crimean Peninsula in a water depth of 1686 mbsf.

Geochemical analyses of the pore water and solid phase indicate non-steady state sedimentation. The oxygen-depleted water column conditions, anaerobic oxidation of methane (AOM), and related microbial-driven sulfate reduction favor a highly complex iron sulfide mineral assemblage in the sediment column. The detailed magnetic susceptibility and remanence measurements indicate an irregularly stratified depth profile showing intervals of particularly high values. Further environmental magnetic analyses of hysteresis loops depict strongly elevated coercivity values for those depth horizons, suggesting metastable ferrimagnetic greigite (Fe3S4) as the main magnetic carrier phase.

Automated chemical classification (ACC), using electron dispersive spectrometer (EDS) attached to a JEOL 840 scanning electron microscope (SEM) on dispersed particle samples permitted the absolutequantification of the various present iron mineral phases with depth, identified as greigite (Fe3S4), pyrrhotite (Fe7S8), pyrite (FeS2), and monosulfides (FeS), such as troilite or markasite.

The statistically stable ACC analyses were carried out on magnetic extracts and density separates to be able to calculate budgets between the different present iron sulfides. We also obtained excellent correlations between the different iron sulfide concentrations and the magnetic signal, which open the possibility to link the absolute particle concentrations to the magnetic signal. Additional synchrotron based micro-XRD analyses on polished sections yield inside into the details of the sulfidisation pathways along the depth profile of the sediment sequence and help to develop a conceptual process model for this particular geochemical (paleo)environment.

keywords: Black Sea, iron sulfides, environmental magnetism, geochemical pore water analyses, scanning electron microscopy (SEM), automated chemical classification (ACC), electron dispersive spectrometer (EDS), micro-XRD, absolute particle quantification, conceptual process modeling,