

“Physico-Chemical Particle Tracing and Application of Magnetic Proxy Parameters to Marine and Continental Environments”

Habilitation to conduct research (HDR)

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To understand the spatio-temporal development of a given geosystem and to correctly assess the processes acting in a respective geological (paleo-)environment, the understanding of the solid particle flux and its interaction with the dissolved phase is crucial. Certain particle types can be used as excellent tracers for a variety of sedimentary (e.g. sedimentation rate), geochemical (e.g. alteration, diagenesis) or biological (e.g. oxygen milieu) processes. In particular, the ubiquitous metallic fraction, and more specifically the highly reactive ferrous/ferric particle fraction might be of a large variety of origins such as biogenic, anthropogenic, or ‘natural’ inorganic (geologic) genesis. Thus, the ferruginous particle fraction constitutes – if well understood - an excellent tool for the description of geologic (paleo-) environments.

The ferruginous fraction in a geological sample typically consists between a few percent down to some permille depending on the sample type (marine hemipelagic sediments a few wt %, anthropogenic dust samples some wt %). Natural samples typically contain iron oxides and (oxy-) hydroxides or iron sulphides. Anthropogenic samples often have some additional metallic particulate phases, such as scoria, spherules or might consist in substitutions that may be adsorbed or absorbed by natural particles. Anyway, this metallic fraction is well represented by the magnetic (ferromagnetic *in sensu lato*) fraction, with the main exception of some mineral phases such as e.g. the “non-magnetic” pyrite, that fall into the paramagnetic fraction.

Anyway, for multi-parameter studies these “magnetic proxy parameters” can very often be linked to other non-magnetic parameters, for example the magnetic susceptibility is an excellent measure for the iron content/concentration in a given section/sample and can be therefore proportionally correlated (or anti-correlated) to oxygen isotope signals of continental or marine records, loess input in continental sedimentary sections, anthropogenic input of heavy metals, geochemical milieu transitions, etc.

Magnetic, or let’s say “physico-chemical proxy parameters” often have the advantage that they can be acquired in very high spatial resolutions, as they are highly sensitive, and they usually do not chemically alter the specimen (non-destructive). Therefore, they are very handy in case of lack of alternatives for other proxies (e.g. absence of foraminifers to obtain $\delta^{18}\text{O}$ data, no possibility to measure pore water chemistry, etc.). But to be able to interpret all these magnetic proxies correctly and unambiguously, the identification and quantification of the different particle types carrying the respective signal have to be well established.

For this reason, a multidisciplinary approach was always chosen, because the carriers of the respective signal are often in micro- to nanometre scale and occur in non-homogenous mineral and grain size mixtures. Therefore, a well-adapted combination of different physico-chemical techniques showed to be the correct approach to obtain the necessary answers to the scientific questions.

In my habilitation to conduct research manuscript, I resume on my scientific approach disclosing contributions towards resolving methodological, analytical and scientific problems in different interdisciplinary research areas – reconstruction of past environments in Earth’s history; particle tracing in fluvial systems and sediment budgets; tracing ultrafine metallic particles in urban environments to develop future challenging scientific research concerning aspects of high concerns for citizens and the society, including environmental risks related to climate change, erosion, and pollution.