Characterisation of viscous magnetisation with the induction coercivity meter

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Abstract: Besides classical hysteresis parameters – generally used for magneto-granulometric interpretations (e.g. Day-Dunlop plot) – the induction coercivity meter allows more sophisticated measurements and analyses such as for instance monitoring the decay of remanent magnetisation, which is caused by magnetically viscous grains.

The meter measures the remanence decay during a time interval of 100 s with a temporal resolution of 0.068 s. This time frame covers remanence losses from grains around the superparamagnetic (SP) / stable single domain grain size threshold, i.e. a grain size range that is generally not covered by the frequencies used for determining the frequency dependence of susceptibility (F-factor), see Figure 1. Such nanometric grains are of particular importance because they yield for instance information about the degree of soil formation, the extent of chemical weathering or the occurrence of diagenetic processes in various natural materials. In particular haematite and goethite of such size is difficult to detect with the F-factor because of their much lower saturation magnetisation compared to magnetite or maghaemite. Instead, such information is obtained by the viscosity coefficient determined from remanence decay curves.

The presentation will discuss remanence decay curves from different natural, artificial and reference materials as well as from liquid samples. Further relations and differences between the F-factor and the decay viscosity coefficient will be reviewed and illustrated by data sets from Chinese red clay sediments and from polluted Belgian soils.

Keywords: rock magnetism, magnetic viscosity, superparamagnetic grains

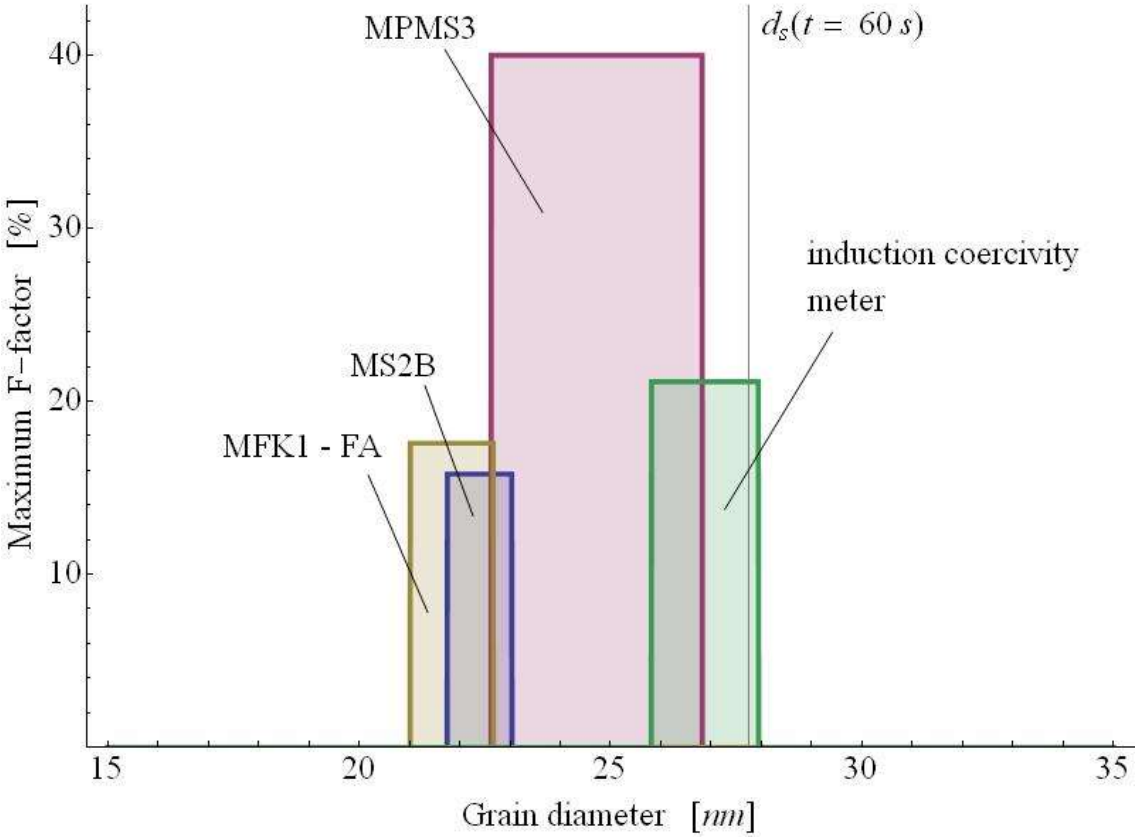

Figure 1: Maximal theoretical F-factors ($F = (\chi_{LF} - \chi_{HF})/ \chi_{LF}$) for different instruments: MFK1-FA from AGICO, MS2B from Bartington, MPMS from Quantum Design and the hypothetical F-factor for the induction coercivity meter. As the individual operating frequency ranges differ between the instruments, the SP grain size thresholds are also different. The calculation refers to slightly elongated magnetite grains at 20 °C. The vertical grey line corresponds to the SP grain size threshold d_s at room temperature for a time scale of 60 s, which is a typical time for laboratory experiments. Grains smaller than d_s show SP behaviour.

References :

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