Characterizing ferrofluid properties for a more reliable and quantitative interpretation of magnetic pore fabrics




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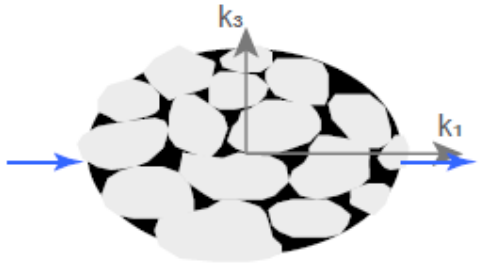
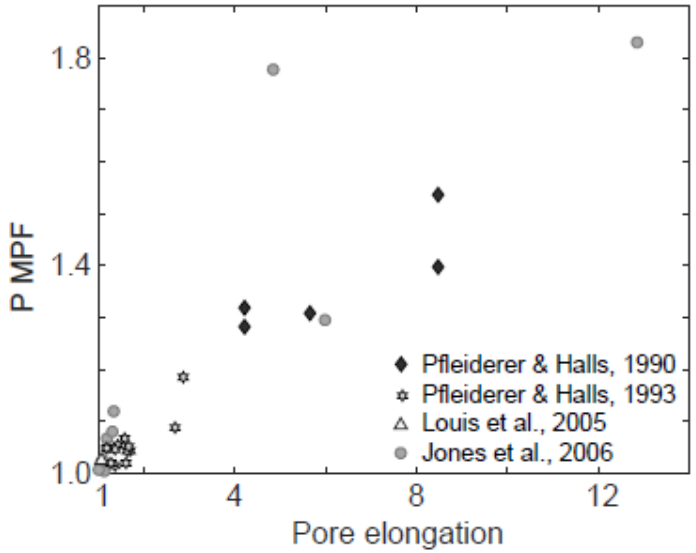
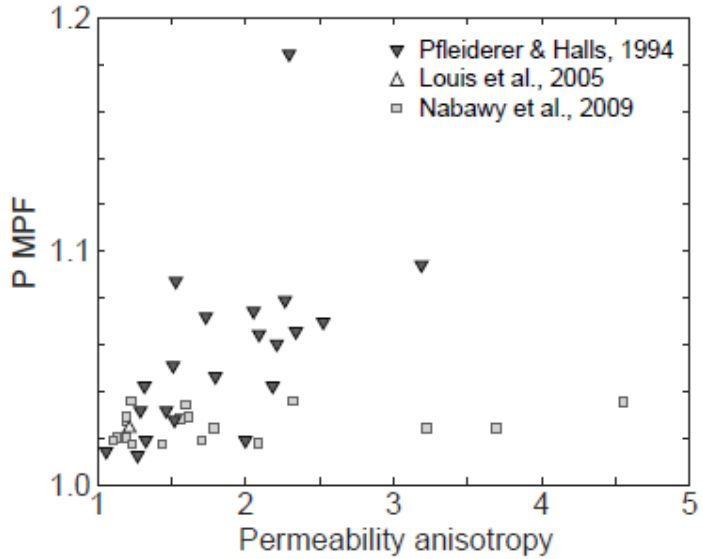
Magnetic pore fabrics show promising empirical relationships to pore space and fluid flow properties – but large variability



Pfleiderer & Hall, 1990; 1993;1994; Hailwood, 1999; Hrouda et al., 2000; Jones et al., 2006





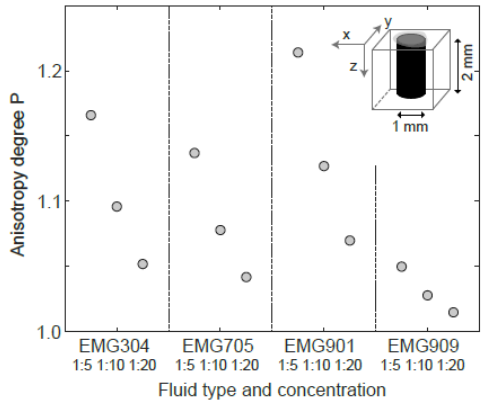
Maximum susceptibility k_1 parallel to pore elongation and preferred flow direction

Larger k_1/k_3 indicates more anisotropic pore space

Larger k_1/k_3 indicates more anisotropic flow properties

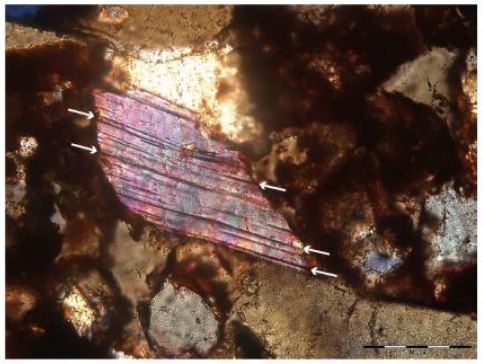
Methods: Measuring magnetic pore fabrics

(a) Synthetic samples and expected MPF properties



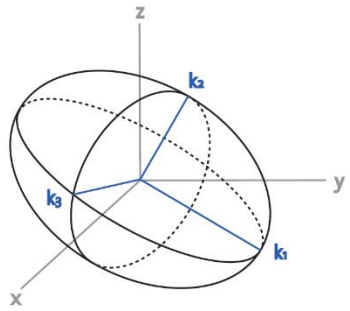
(b) Natural red sandstone samples: Preparation

(c) Natural red sandstone samples: Thin section image



Synthetic sample with known pore geometry, and rock samples

Impregnation



Measure anisotropy of magnetic susceptibility and other magnetic properties over time

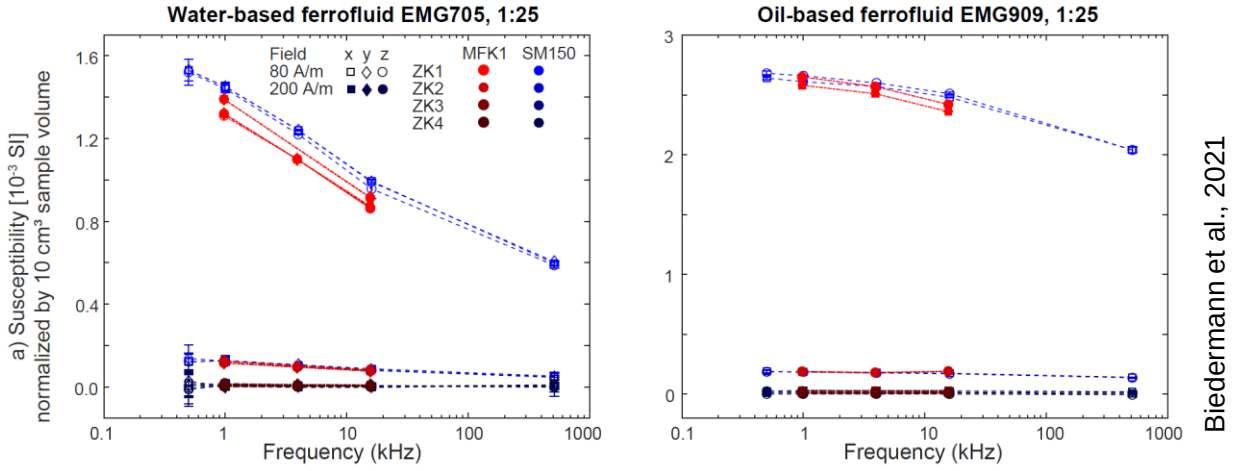
Quantitative interpretation of magnetic pore fabrics is challenging

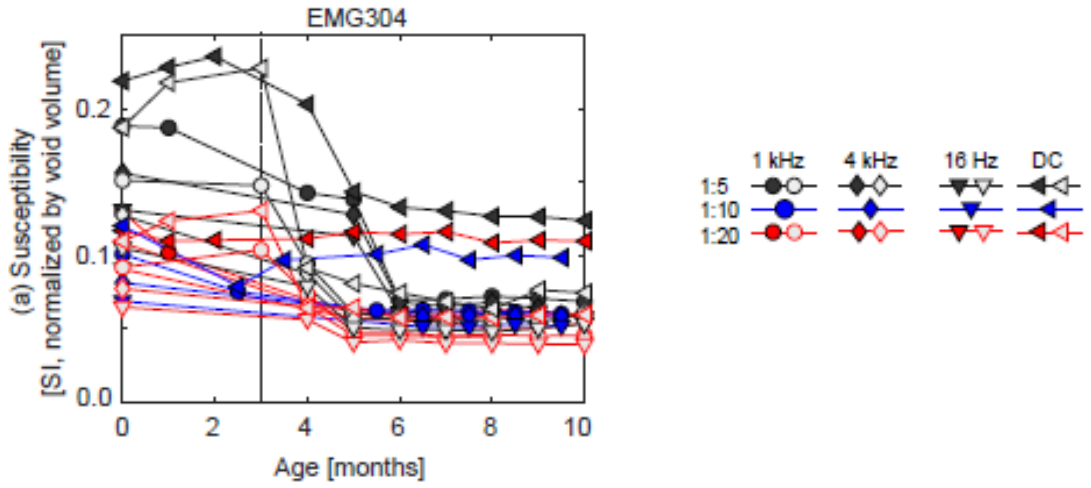
Different ferrofluids have different susceptibilities, and are used in various dilutions

- EMG304: 5.03 SI
- EMG507: 1.63 SI
- EMG705: 4.04 SI
- EMG901: 6.79 SI
- EMG905: 3.52 SI
- EMG909: 1.38 SI

Ferrofluid susceptibility is frequency-dependent

Ferrofluid susceptibility varies over time





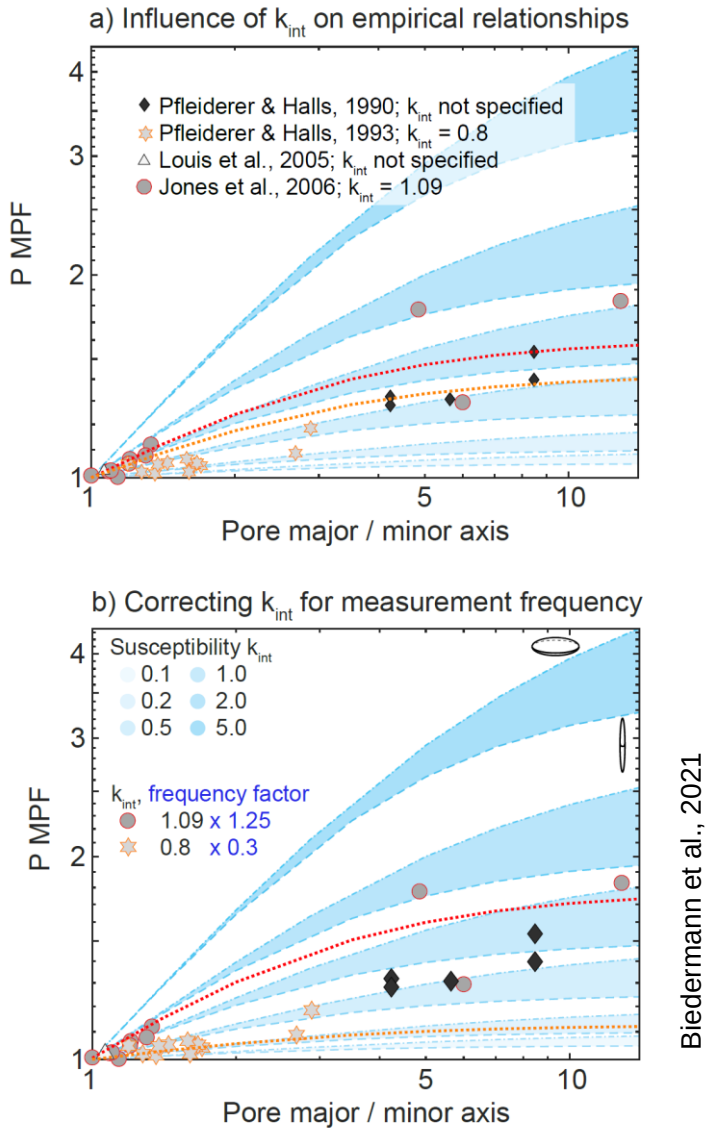
Quantitative interpretation of magnetic pore fabrics is challenging

Why is fluid susceptibility important?

The same pore space geometry leads to higher anisotropy when the fluid susceptibility is larger

-> This explains a large part of the variability in published data

-> Need to measure ferrofluid properties at the time and conditions relevant for measurement



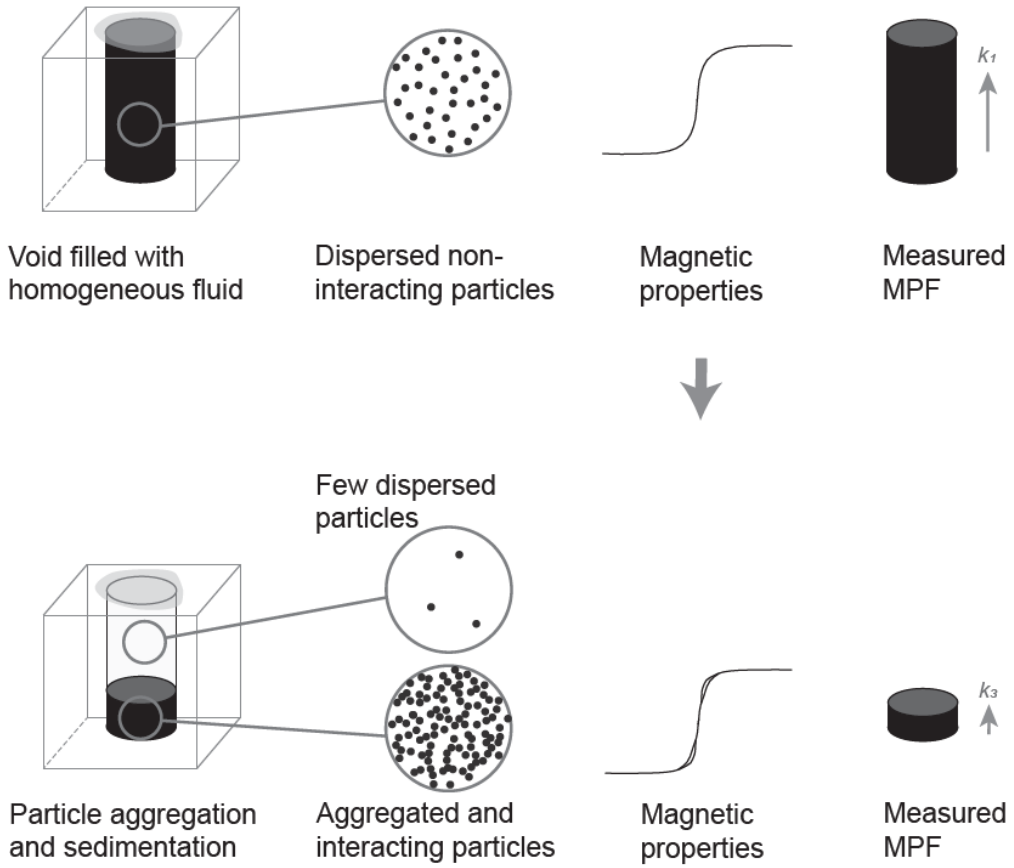
Time-dependence of magnetic properties of ferrofluid

If the fluid properties change, the relationship between magnetic pore fabric and pore space geometry will change

Changes in fluid properties indicate physical or chemical processes

- Oxidation of magnetite particles
- Particle aggregation and sedimentation
- Reaction with rock

-> These processes may hinder impregnation or lead to wrong interpretations



Biedermann & Parés, in review

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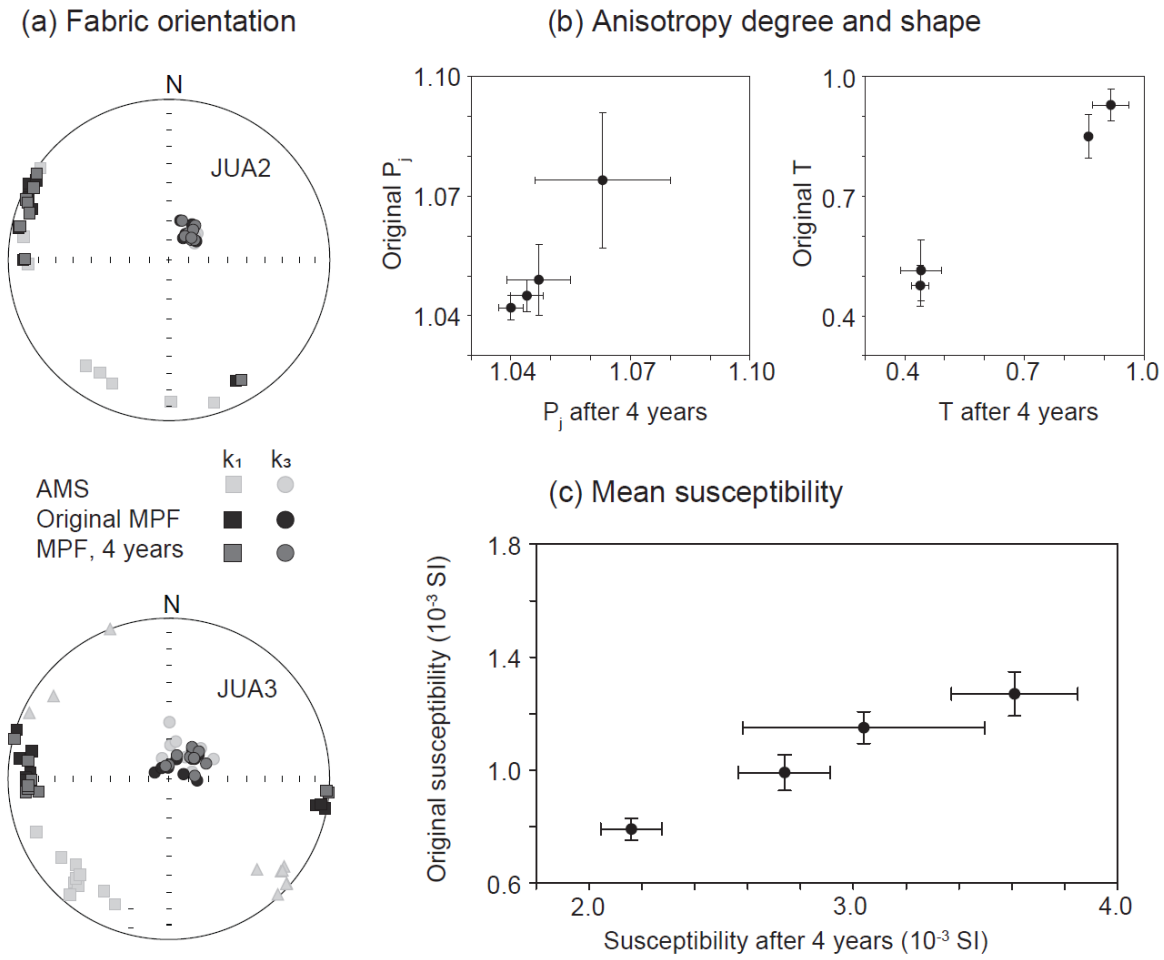

Biedermann & Parés, in review

Want to know more?

Zhou et al., Correlation of magnetic pore fabrics with traditional pore fabric characterization and permeability anisotropy in typical sedimentary rocks and hot isostatically pressed samples,

EGU22-10389

Thu, May 26th, 16:15–16:20

Biedermann, A.R., Pugnetti, M., Zhou, Y., Explaining the large variability in empirical relationships between magnetic pore fabrics and pore space properties. Geophysical Journal International 227, DOI:10.1093/gji/ggab230

Biedermann, A.R., Parés, J.M., Magnetic properties of ferrofluid change over time: Implications for magnetic pore fabric studies

-> hopefully out soon