Portable multi-frequency and multi-amplitude susceptibility meter for direct mass-specific magnetic susceptibility measurements

Heritage Geophsyics
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Motivation

- Magnetic susceptibility at different frequencies
  - Bartington MS2B
  - 0.47 and 4.7 kHz
  - 10^{-5} SI
- Magnetic susceptibility at different amplitudes
  - AGICO KLF-4A/4M (2 kHz, 5-300 A/m, 10^{-6} SI at 300 A/m, 10^{-5} SI at 5 A/m)
  - AGICO KLY-4S (875 Hz, 3-450 A/m, 3×10^{-8} SI at 300 A/m)
- Only laboratory measurements, no tool to measure *in field*
- *Sampling – effect of variable density on volume susc. data -* ***need for mass-specific measurements in field***

Task

- Portable susceptibility meter
- Simple operation
- Weight measurements – built-in balance
- Variable frequencies
- Variable amplitudes
- Comparable sensitivity
- Temperature drift and stability

Result: ZHInstruments SM100

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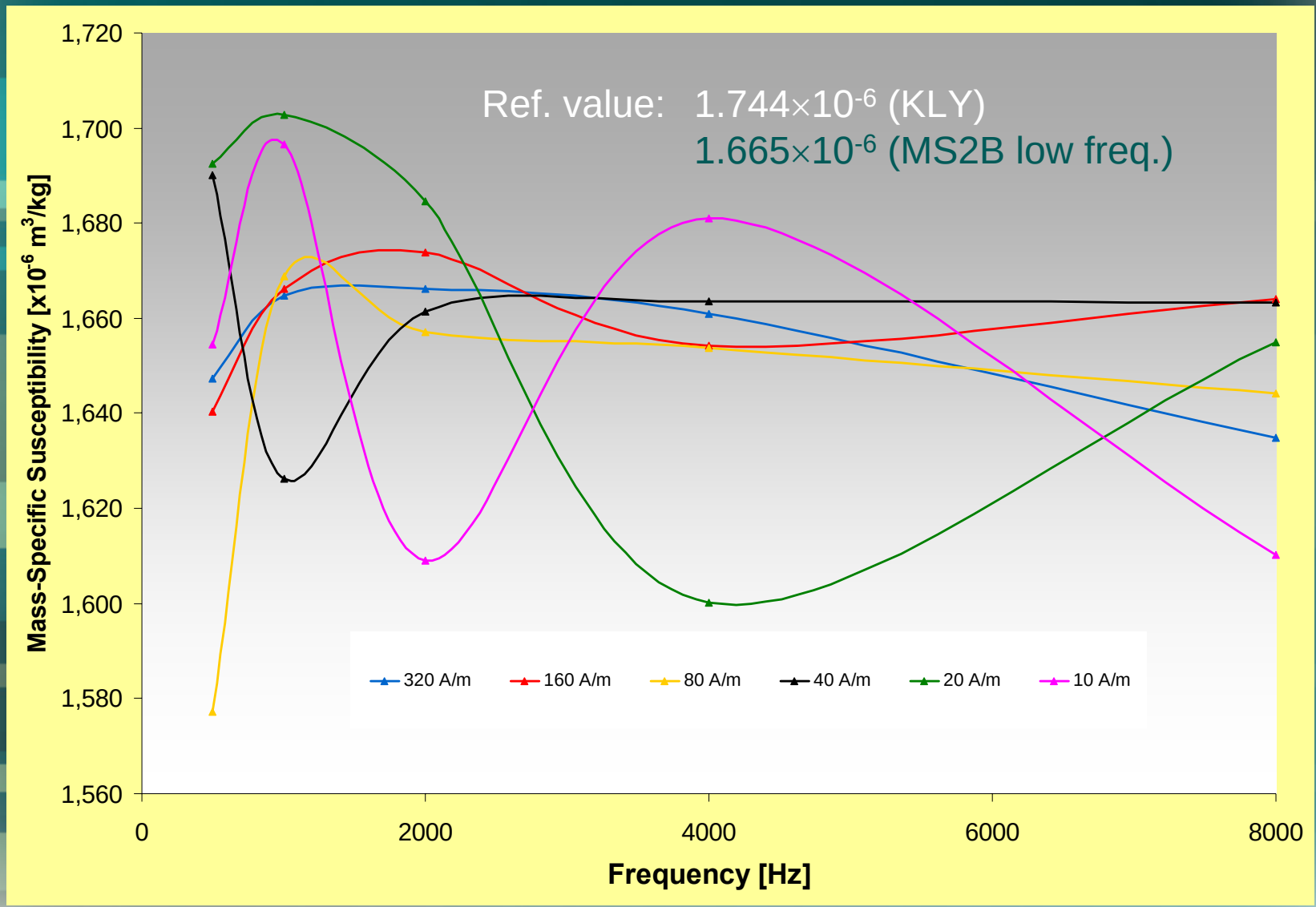
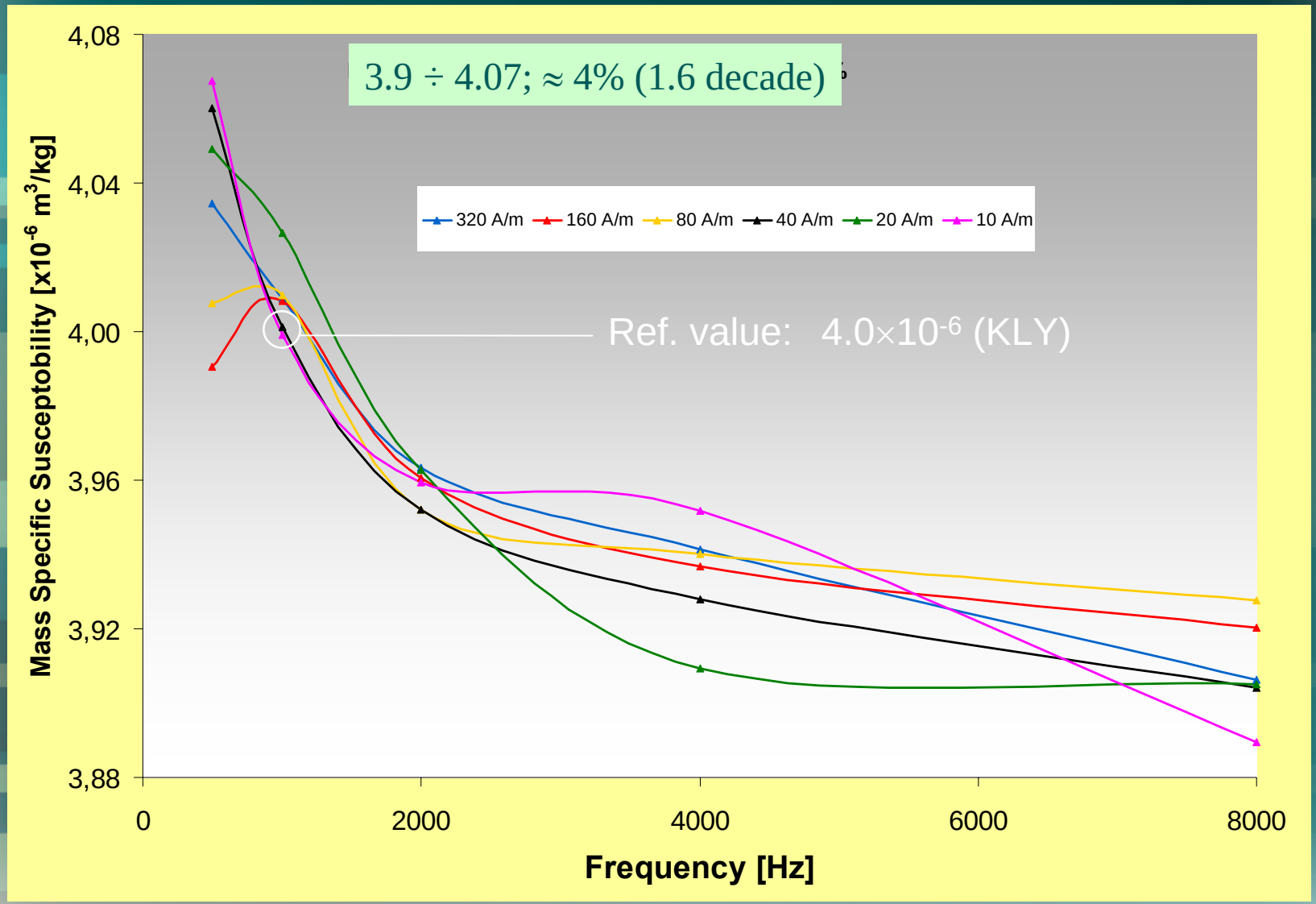
- Built-in tensometric balance
  - noise ≈ 0.03 g
- Operating frequencies
  - **0.5**, 1, 2, **4**, 8 kHz
  - set with error <1%
- Operating amplitudes
  - 10, 20, 40, 80, 160, **320** A/m
  - noise 2×10^{-7} at 8 kHz

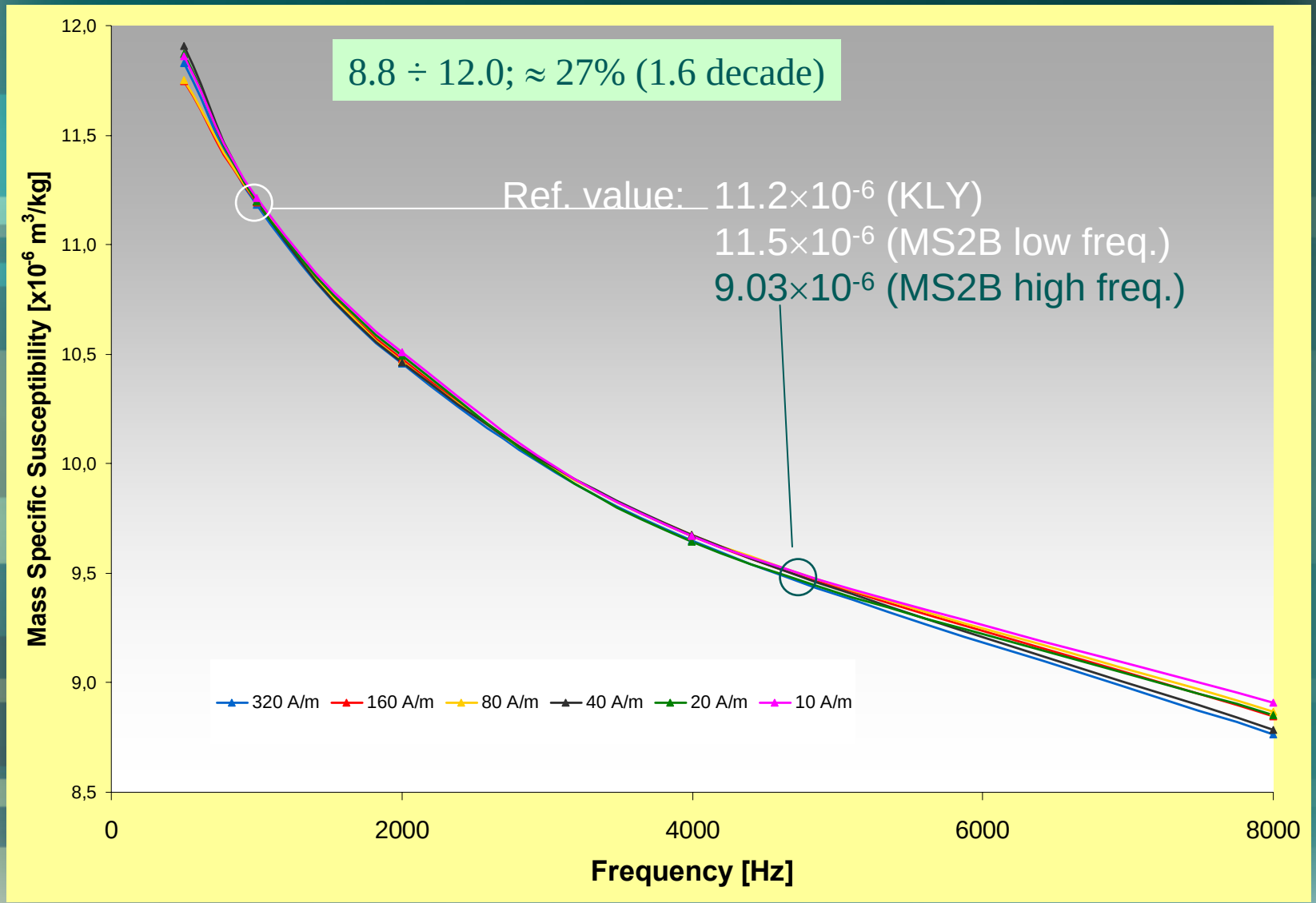
Gd_2O_3


Ref. value: 1.744×10-6 (KLY)
1.665×10-6 (MS2B low freq.)
Mass-Specific Susceptibility [x10-6 m3/kg]
1,720
1,700
1,680
1,660
1,640
1,620
1,600
1,580
1,560
0
2000
4000
6000
8000
Frequency [Hz]
320 A/m
160 A/m
80 A/m
40 A/m
20 A/m
10 A/m

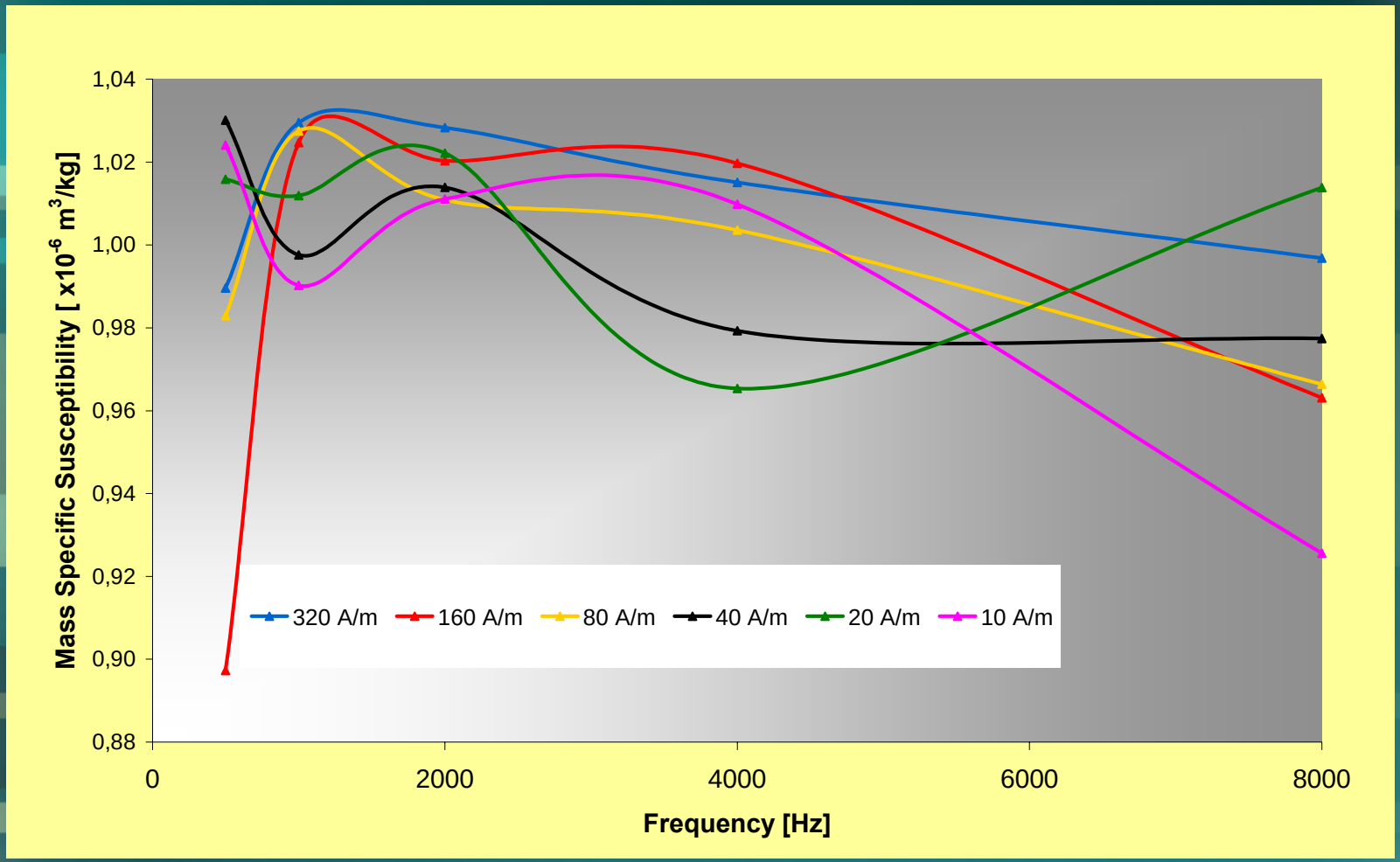
Pozzolana Cement



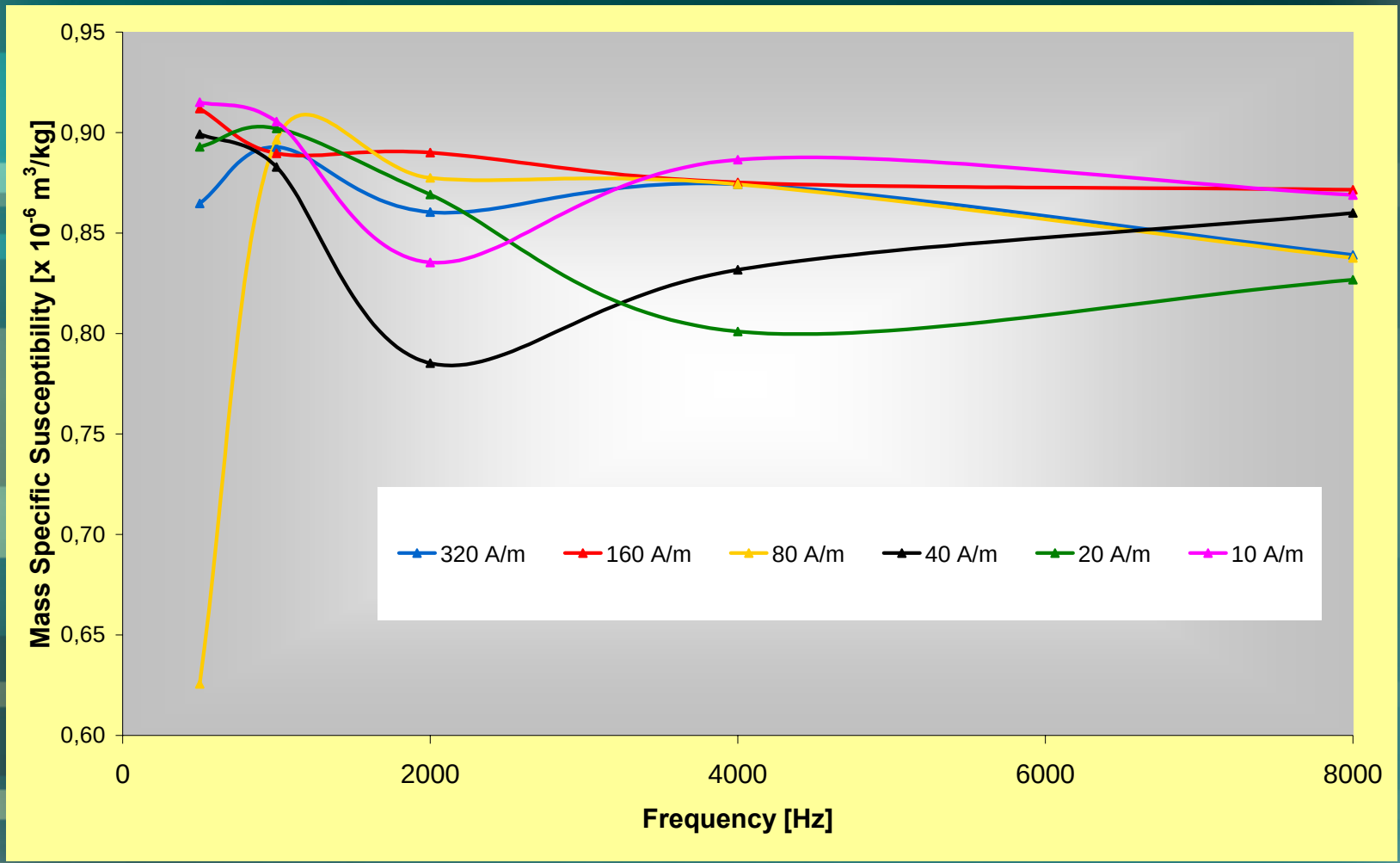
Tiva Canyon Tuff



Fe_3O_4


1,04
1,02
1,00
0,98
0,96
0,94
0,92
0,90
0,88
Mass Specific Susceptibility [x10-6 m3/kg]
0
2000
4000
6000
8000
Frequency [Hz]
320 A/m
160 A/m
80 A/m
40 A/m
20 A/m
10 A/m

γ-Fe_2O_3


0,95
0,90
0,85
0,80
0,75
0,70
0,65
0,60
Mass Specific Susceptibility [x 10-6 m3/kg]
0
2000
4000
6000
8000
Frequency [Hz]
320 A/m
160 A/m
80 A/m
40 A/m
20 A/m
10 A/m

Conclusions

- Portable, battery-charged susceptibility meter
- Direct measurements of mass-specific susceptibility
- 5 different operating frequencies
  - 0.5, 1, 2, 4 and 8 kHz
- 6 amplitudes of magnetizing field
  - 10, 20, 40, 80, 160 and 320 A/m
- Sensitivity of 2×10^{-7} SI at 8 kHz
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