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A paleointensity technique for multidomain igneous rocks

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Topics

- Background of paleointensiy
- This paper
- Examples for MD correction
- Discussion

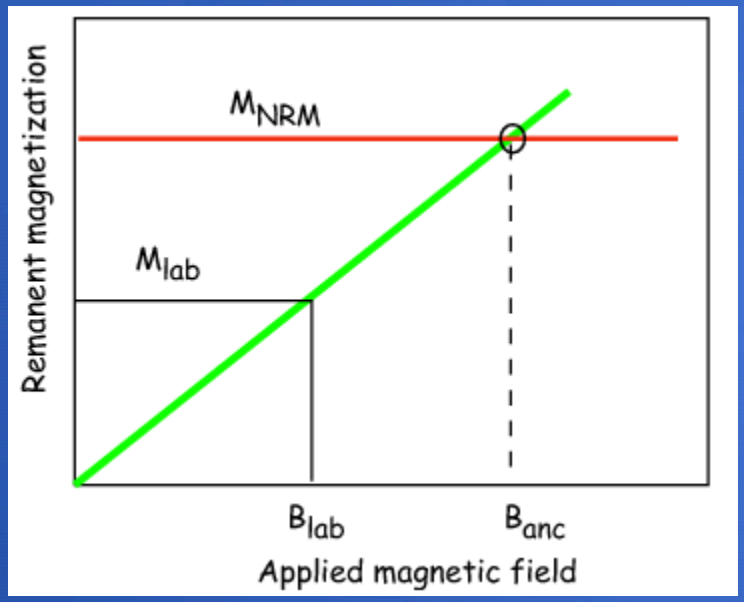
Background of paleointensiy

Why paleointensiy?

- Detect the behavior of geomagnetic field
- Implications on geodynamics
- Effects on life on the Earth
- ……

Background of paleointensiy

Basic theory of paleointensiy



Tauxe et al., 2010

$$M_{NRM} = \alpha_{anc} B_{anc}$$

$$M_{lab} = \alpha_{lab} B_{lab}$$

$$\alpha_{anc} = \alpha_{lab}$$

$$B_{anc} = \frac{M_{NRM}}{M_{anc}} B_{lab}$$

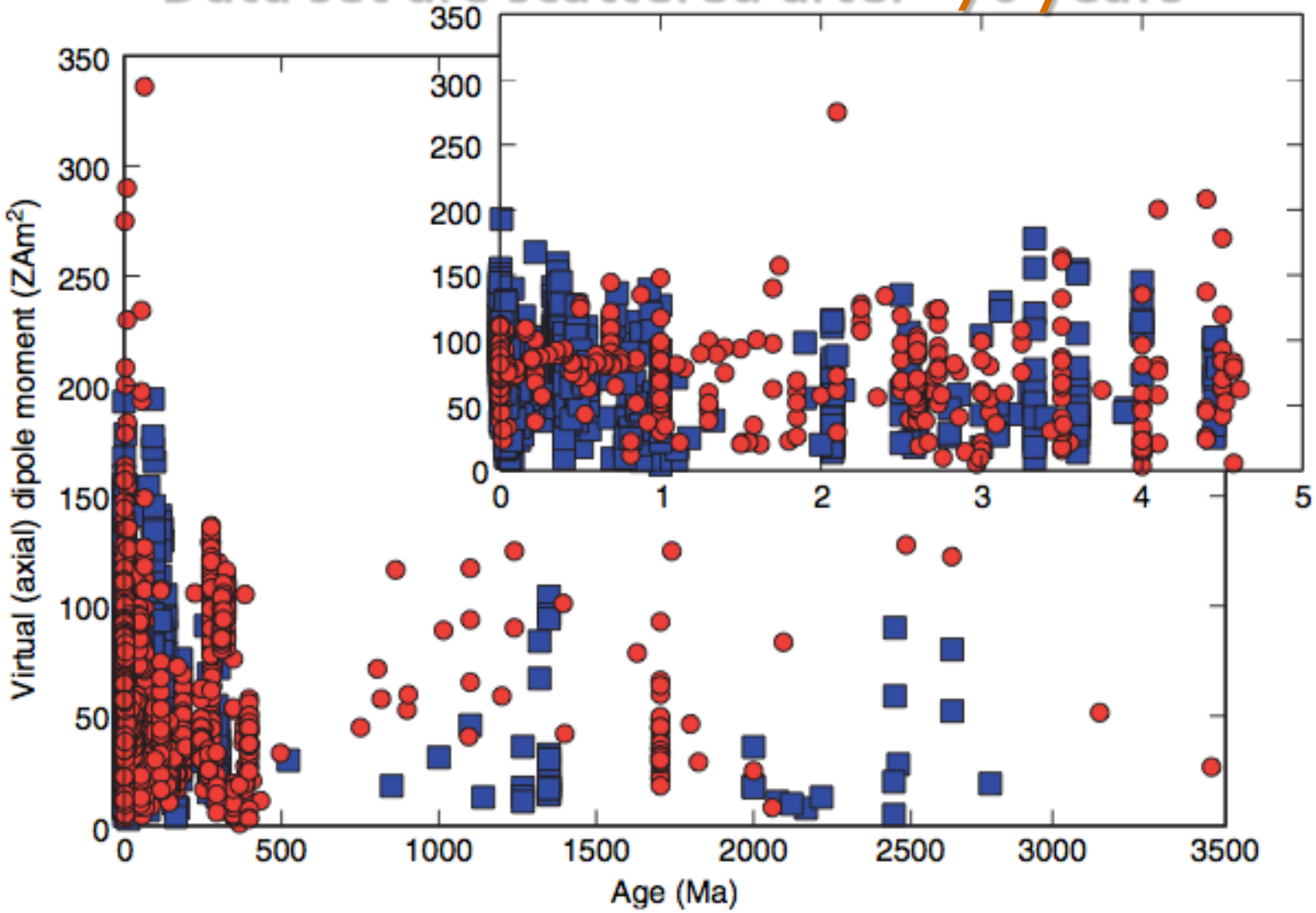
TRM acquistion is proportional to low applied field.

Background of paleointensiy

Paleointensiy methods

- **Thellier Method**
  - Thellier-Thellier method (Thellier, 1959)
  - "ZI" method (Coe,1967a,b)
  - "IZ" method (Aitken,1988)
  - "IZZI" method (Yu. and Lisa Tauxe, 2004,2005)
  - Single-step heating method (Kono,1974,1977)
  - Multiple specimen method (Hoffman, 1989, 2005; Dekkers et al., 2006)
  - Single silicate crystal method (Cottrell and Tarduno, 1999)
  - Submarine basalt glass method (Pick and Tauxe, 1993)
- **Shaw Method**
  - Wilson method (Wilson,1961)
  - Van Zijl method (Van Zijl, 1962)
  - Shaw method (Shaw, 1974)
  - Modified Shaw method (Kono, 1978)
  - Senanayake and McElninny method (Senanayake and McElninny, 1982)
- **Microwave method**
  - Walton et al., 1992, 1993
  - Hill and Shaw, 1999

Data set are scattered after ~70 years



Summary of published paleointensity data.

Fig. 18 from Tauxe and Yamazaki, 2007, chapter 5.13, Treatise

Background of paleointensiy

Factors affect paleointensiy

- $T_b \neq T_{ub}$ (MD)
- Thermal alteration
- TRM anisotropy
- Cooling rate
- Nonlinear of TRM relative to applied field
- Secondary compoment overprints

……

This paper

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A paleointensity technique for multidomain igneous rocks

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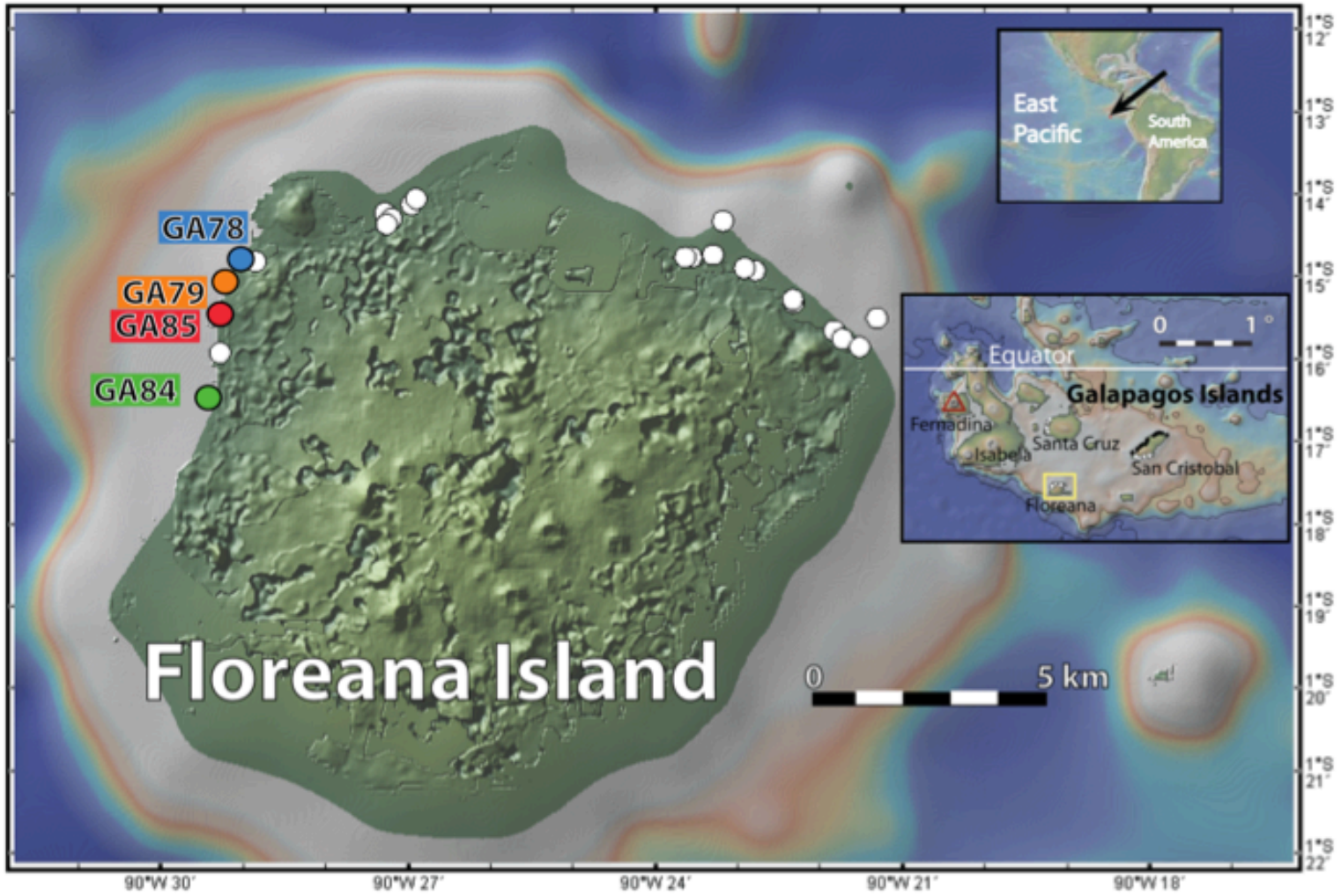


Figure 1. Location map of sites GA78 (blue), GA79 (orange), GA84 (green) and GA85 (red) from Floreana, Galapagos Islands. White dots are sampling sites from *Rochette et al.* [1997] that are not discussed in this paper. The map was generated by GeoMapApp using the Global Multi-Resolution Topography data (GMRT version 2.4)

Study site: 0-3Ma

Main topics of this paper

- BZF protocol
- MD concave-up correction
- Hidden alteration from pTRM checks
- More alteration in SSD grains than MD grains

BZF protocol

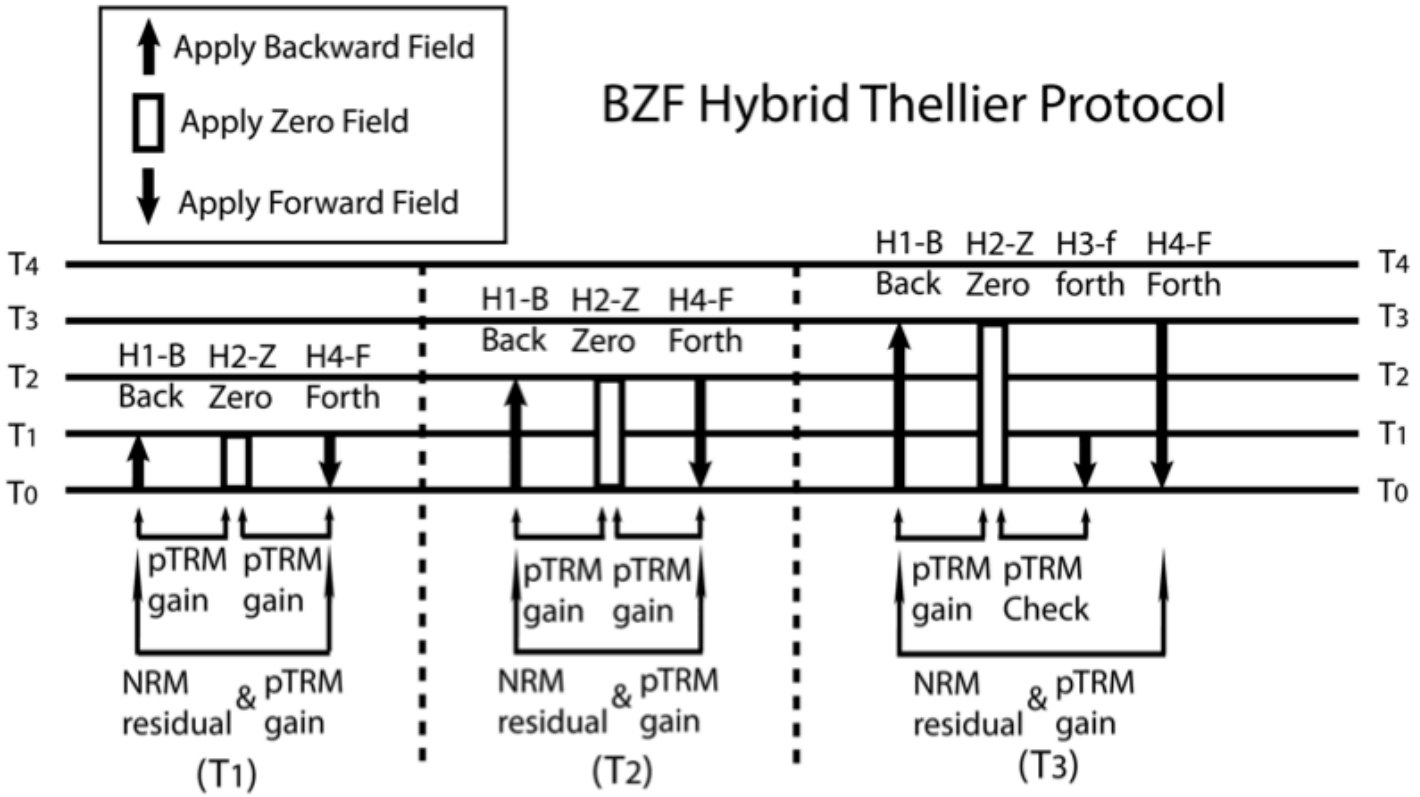
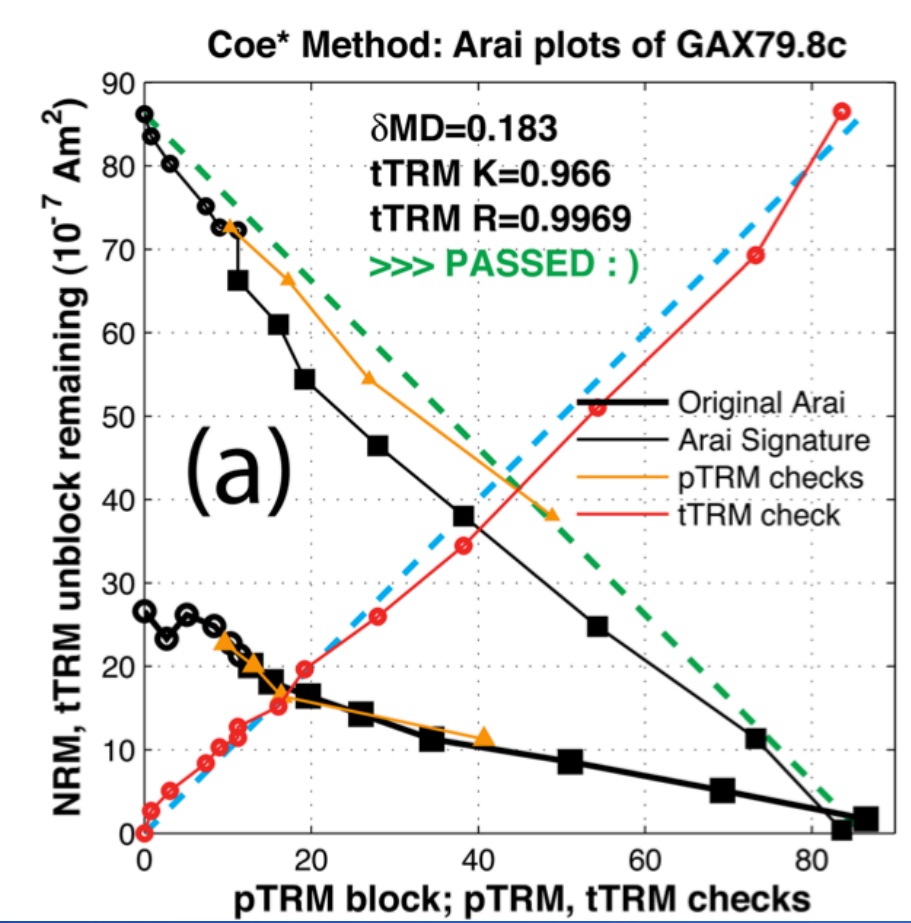


Figure 5. Schematic diagram with heating steps (H1-Backward field, H2-Zero field, H3-forward field to a previous lower temperature to perform pTRM check, H4-Forward field) for target temperatures (T1, T2, T3, . . .) in the proposed hybrid BZF protocol.

Thellier-Thellier (Back-Forth) Aitken（Back-Zero） Coe (Zero-Forth)

MD concave-up correction



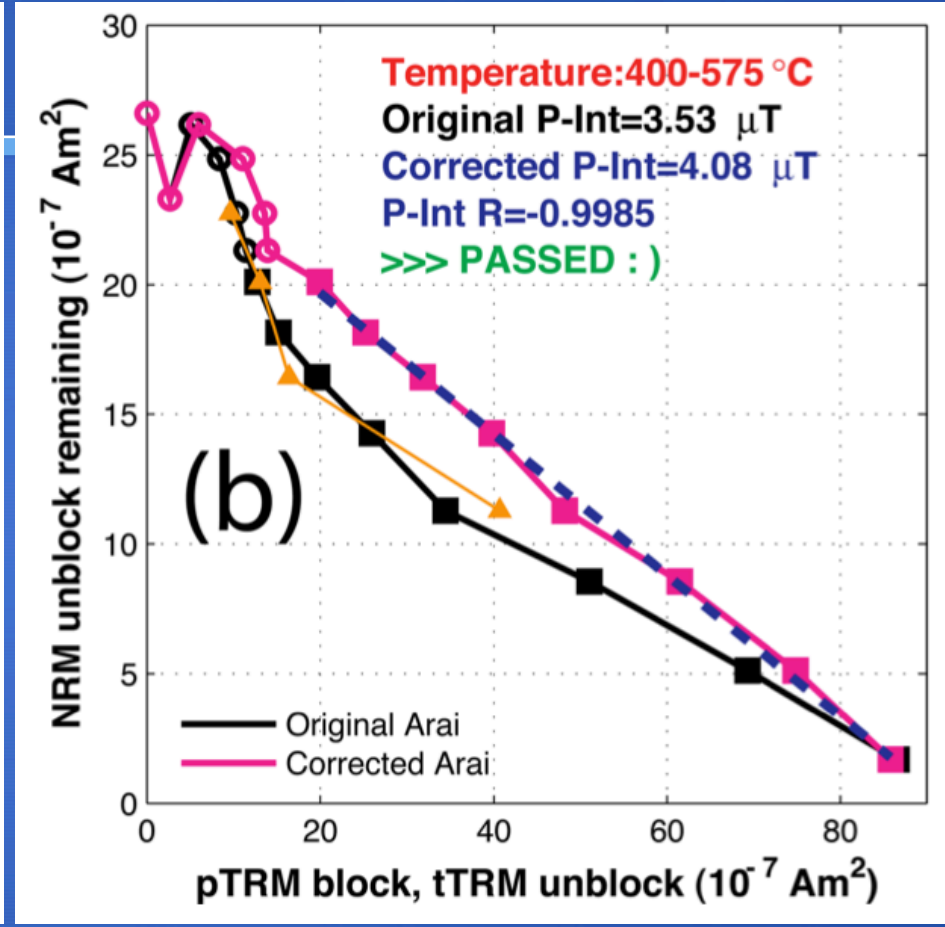
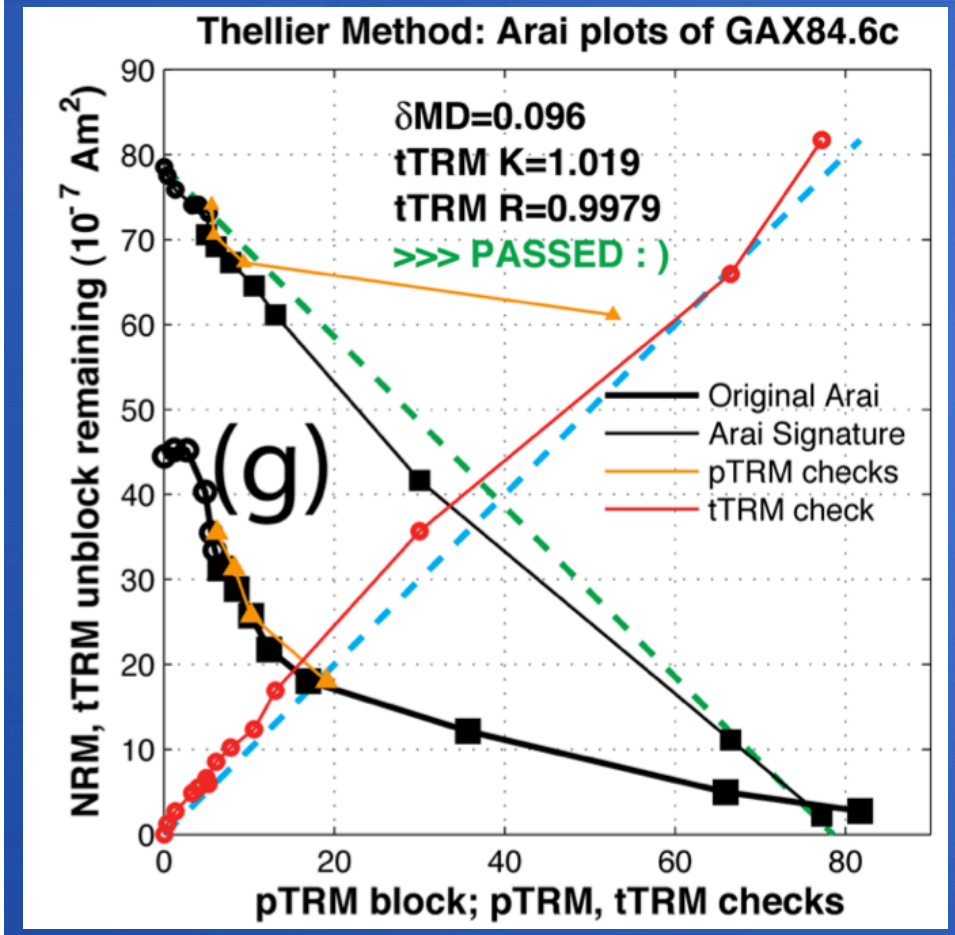


Figure 8. Paleointensity results for GA79.8c from the first and repeated BZF experiments, calculated using the Coe method according to the highest quality control factors.

Failed correction



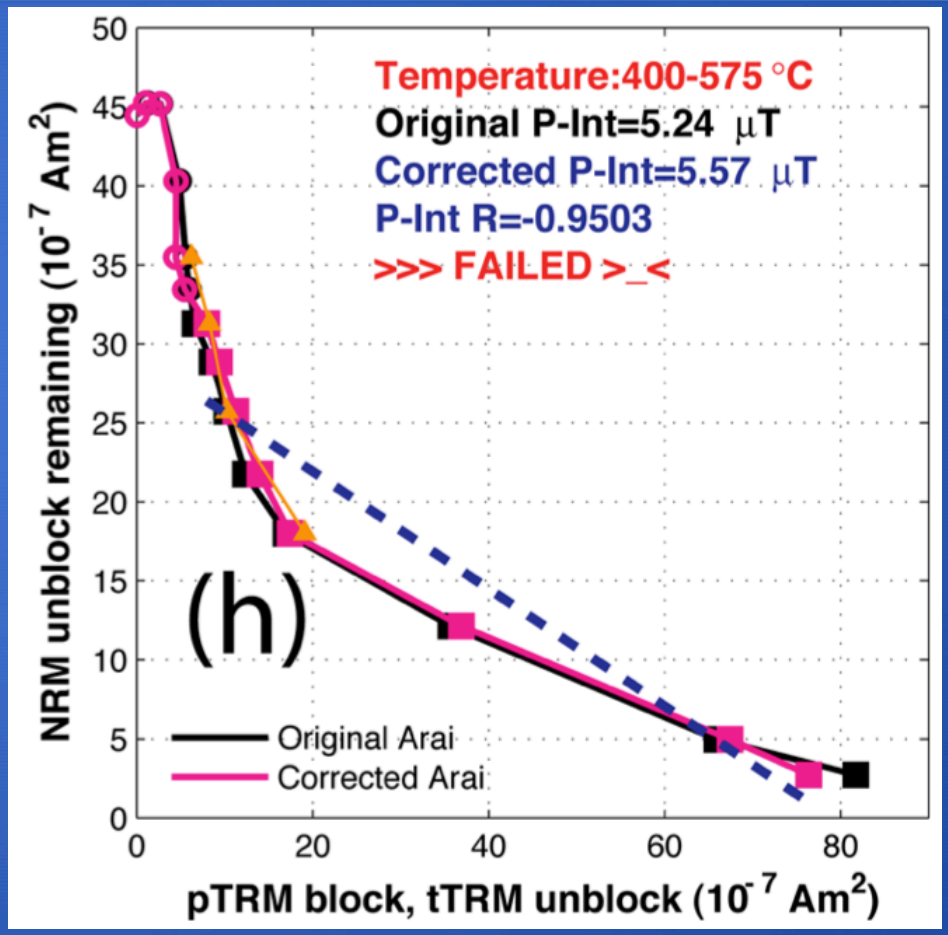
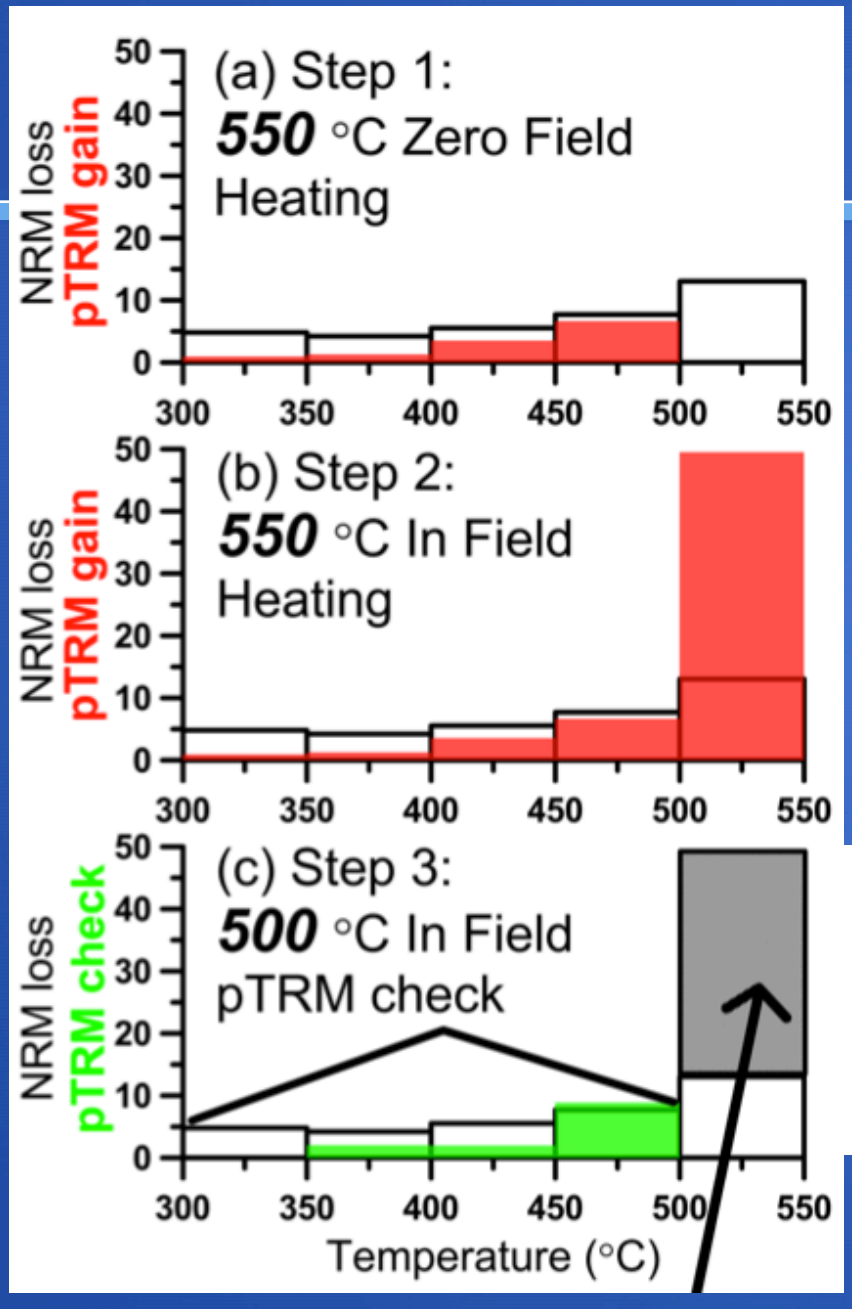


Figure 10 Paleointensity results for the disqualified specimens.

Hidden alteration from pTRM checks



Hidden alteration: T_i-T_{i+1}

pTRM chick: T_i

Fig. 10 pTRM model indicates the hidden pTRM Increase that cannot be detected by pTRM checks.

pTRM check undetectable hidden alteration 500°C to 550°C

More alteration in SSD grains than MD grains

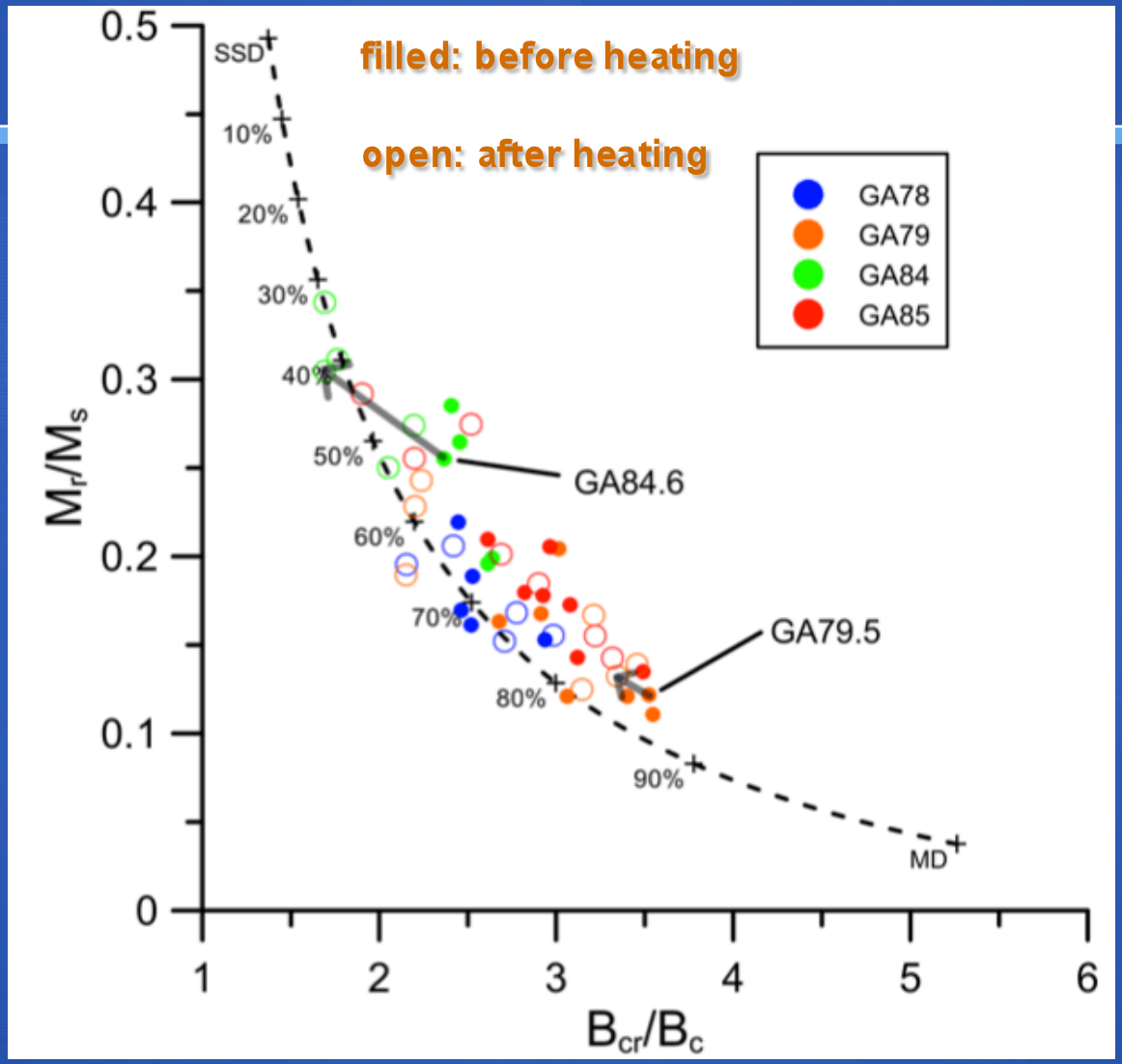
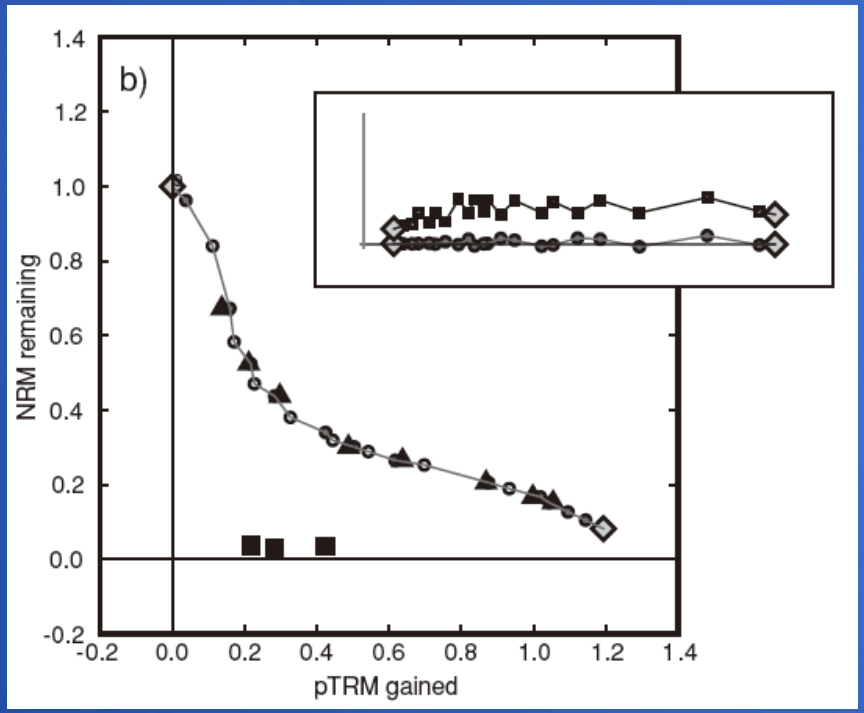


Figure 4. Day plot [Day et al., 1977] for GA-X samples.

Examples for MD correction



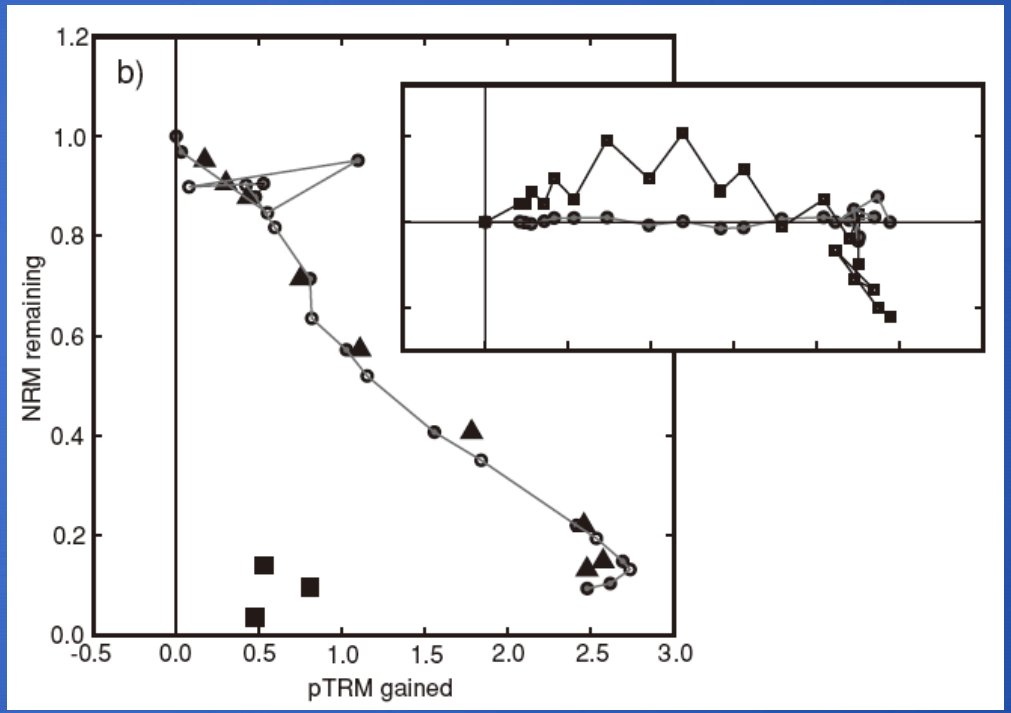


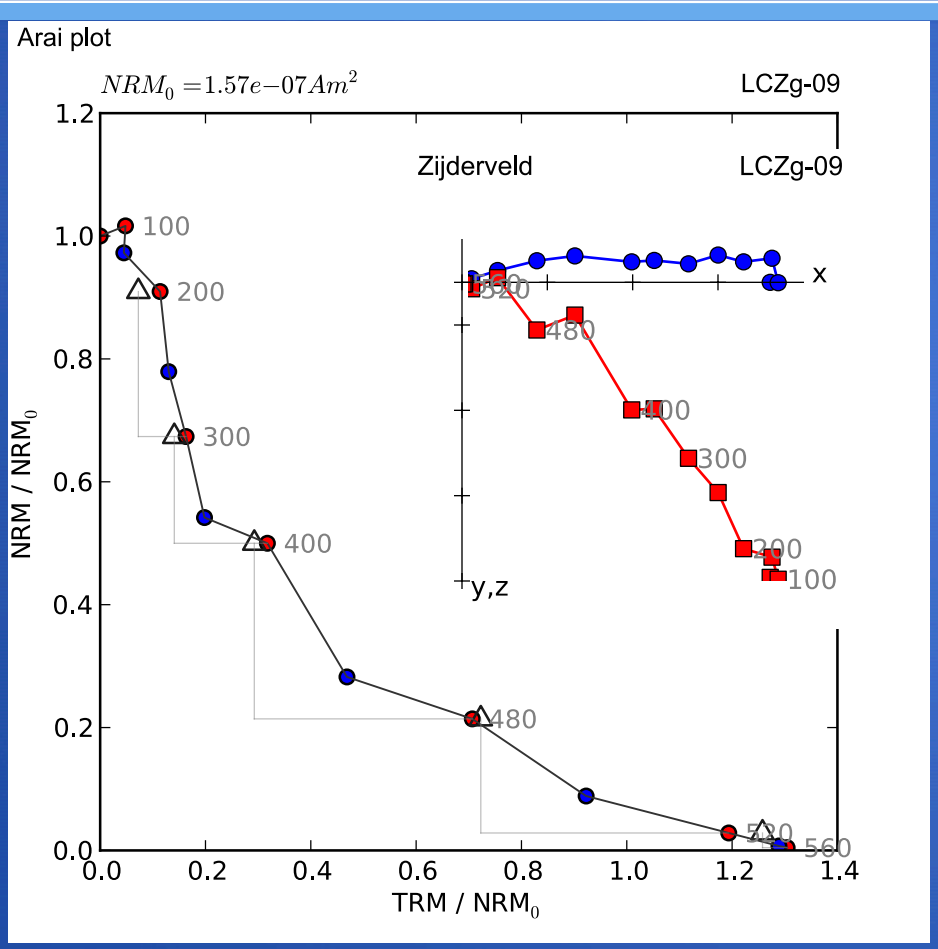
Fig. 8b first IZZI

Fig. 10b second IZ

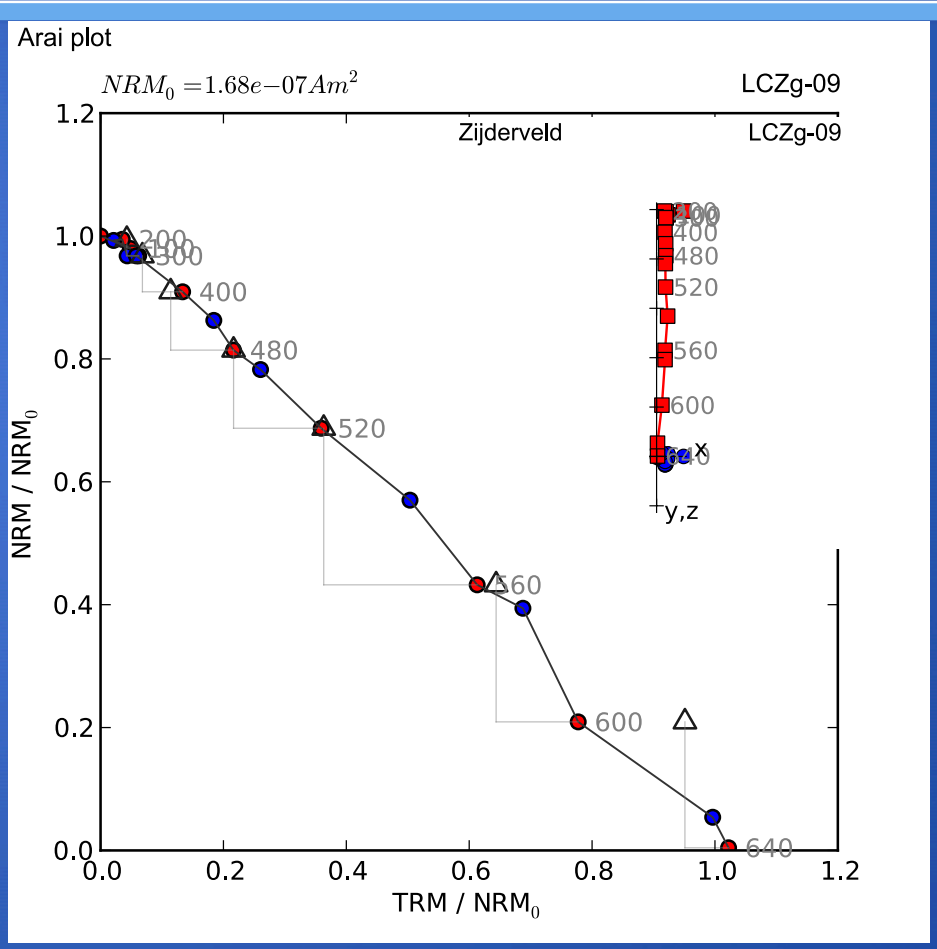
concave-up SSD thermal alteration

(Sbarbori et al., 2009)

Examples for MD correction

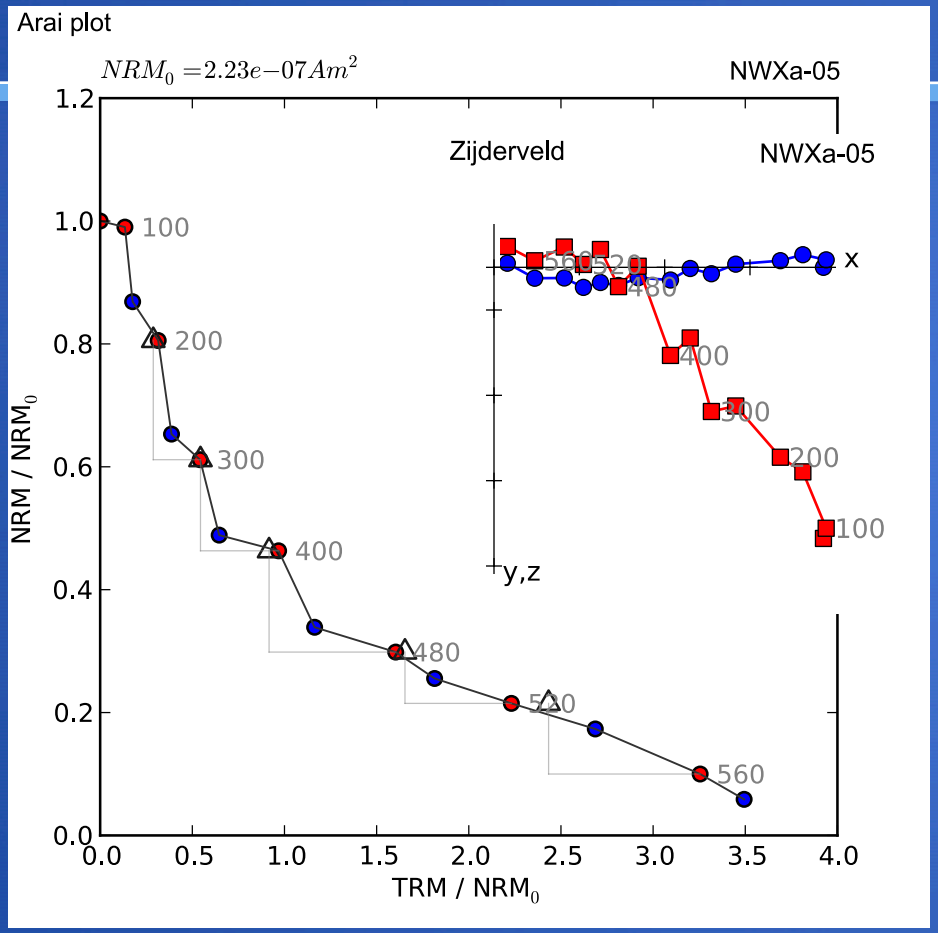


potterty - first IZZI

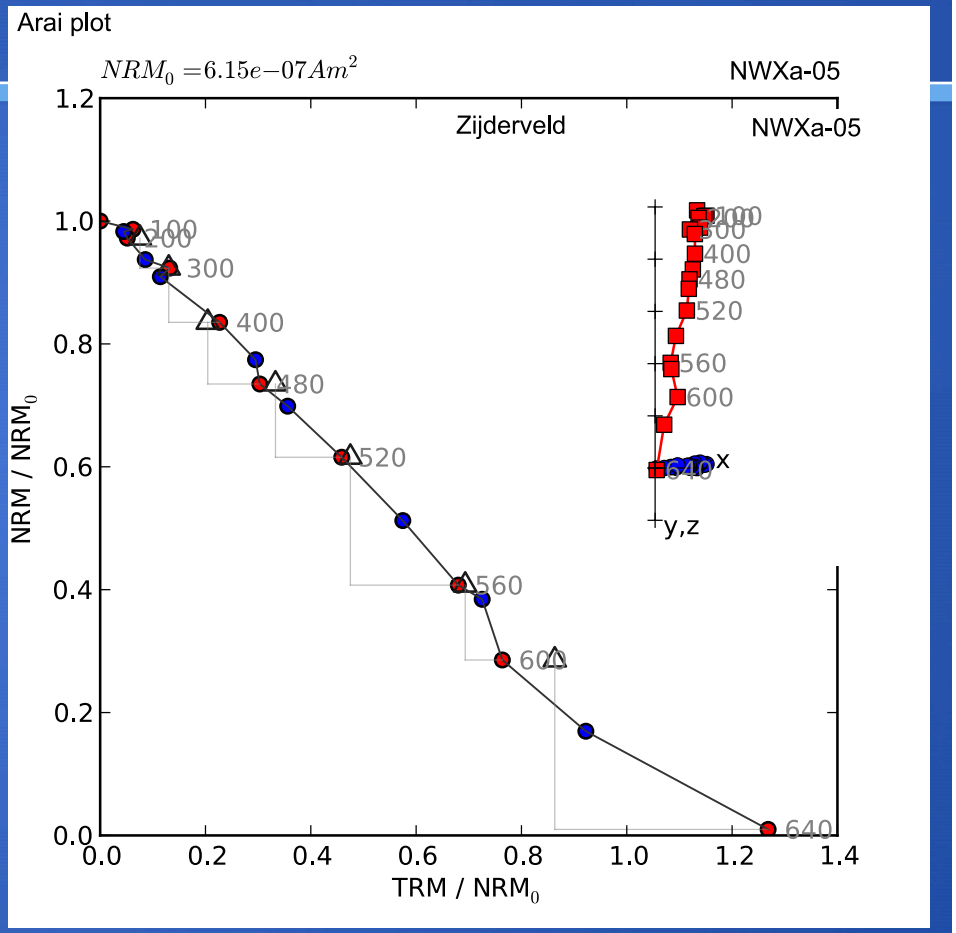


potterty - second IZZI

Examples for MD correction



potterty - first IZZI



potterty - second IZZI

Secondary component? Alteration? SSD?

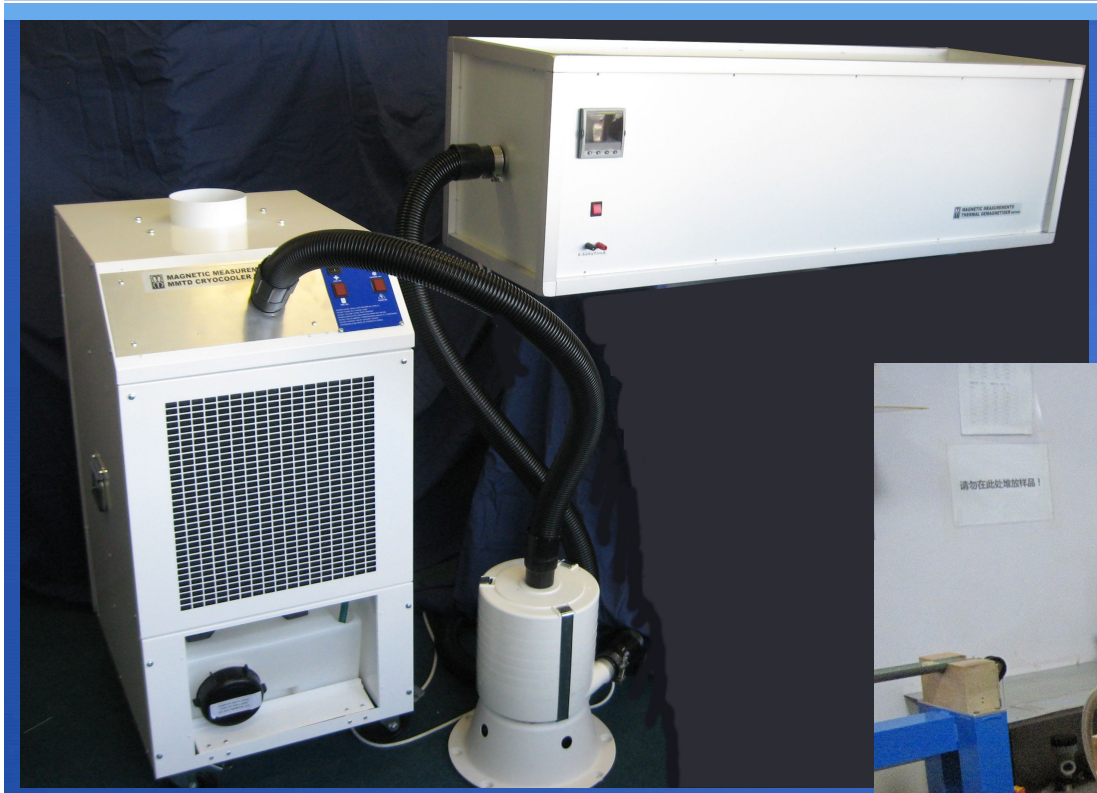
Disscusion

- What do you think of the BZF method?
- Applicability of MD correction?
- Reconsider the effect of pTRM check?
- Can we use two points paleointensity method for a quick estimation?

  paleointensity after correction (this paper): 4.23+/-1.29 μT

  median value of two points method (Kent et al., 2010): 4.14 μT

Paleointensiy ovens in PGL



MMTDSC
~80 1cm cubic specimens
cooling in 50 mins

French oven
~280 1cm cubic specimens
cooling over night