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Relative Paleointensity Records From Mafic Lava Sequences in Kauai (Hawaii) and North-Central Nevada During Four Geomagnetic Polarity Reversals

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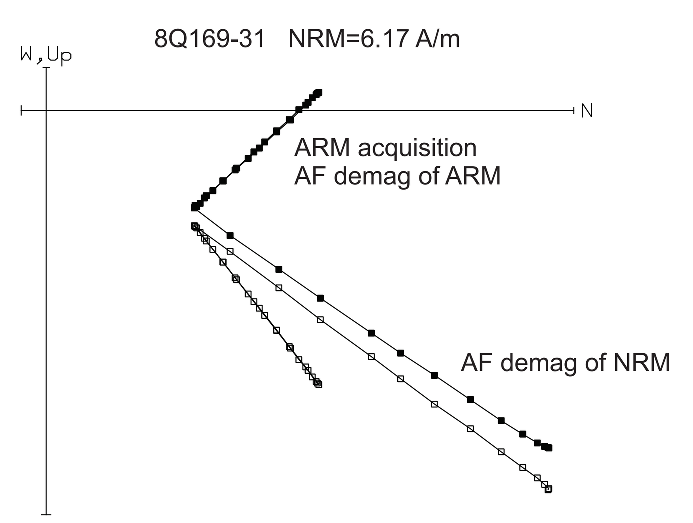
INTRODUCTION

Low success rate in thermal paleointensity experiments has motivated interest in non-thermal relative paleointensity techniques

"Pseudo-Thellier" method compares TRM and ARM in a coercivity interval, with ARM assumed proportional to TRM susceptibility

Lava flow sequences erupted rapidly during geomagnetic polarity reversals offer good chance for success because:
1) geochemical homogeneity and 2) robust geomagnetic signal

RELATIVE PALEOINTENSITY FROM THE "PSEUDO-THELLIER" EXPERIMENT

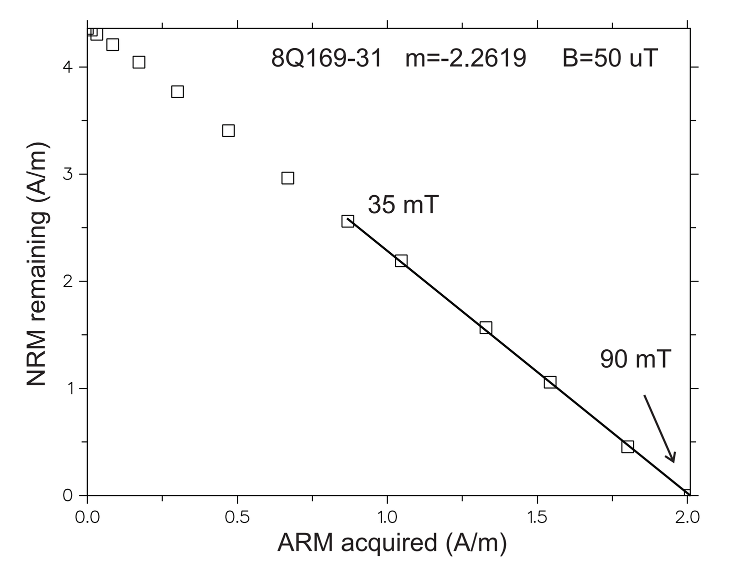


Example of "pseudo-Thellier" experiment

1) 13 step AF demag of NRM to (0-90 mT)

2) 13 step ARM acquisition in 50 uT bias field (0-90 mT)

3) 13 step AF demag of ARM (0-90 mT)



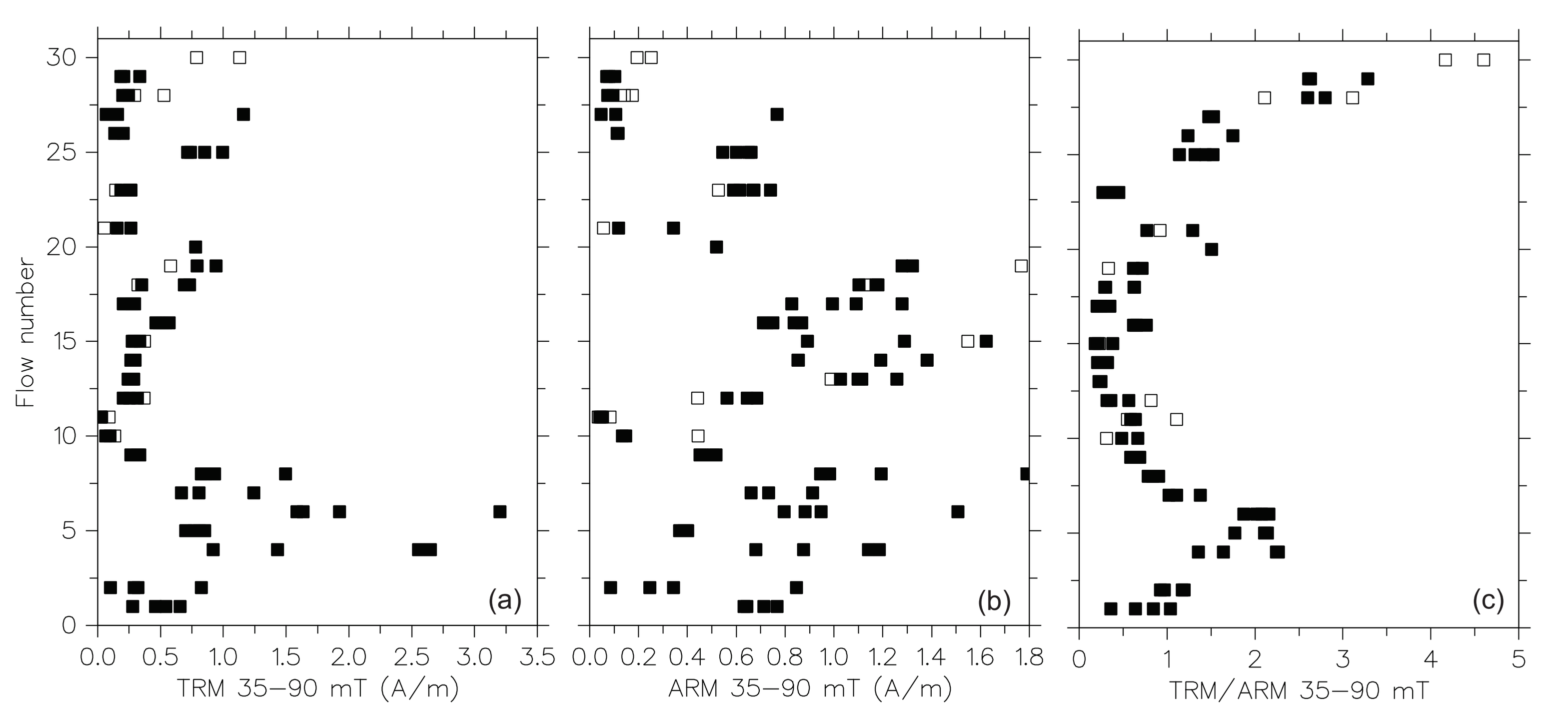
"Pseudo-Arai" plot comparing AF demag of NRM and ARM

NRM and ARM response to AF demag are nearly identical between 35 mT and 90 mT

Slope of line (35-90 mT) provides relative paleointensity estimate

RESULTS 1: OLOKELE N-R TRANSITION ZONE (KAUAI, HAWAII ~4.5 Ma)

a) Effect of ARM normalization



Sample-results, in stratigraphic order. White squares are data rejected because of non-linear segment on pseudo-Arai plot

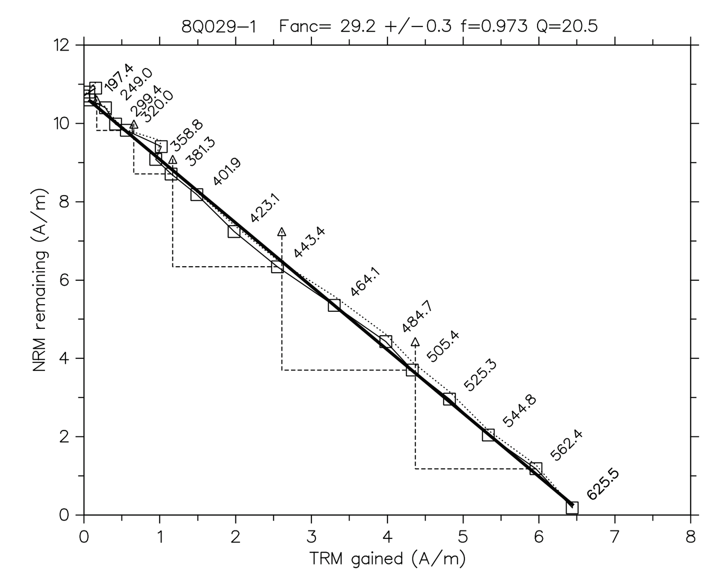
Left: NRM in 35-90 mT coercivity interval interpreted as primary TRM

Middle: ARM (35-90 mT coercivity interval; 50 uT bias field)

Right: TRM/ARM (35-90 mT), interepreted as relative paleointensity

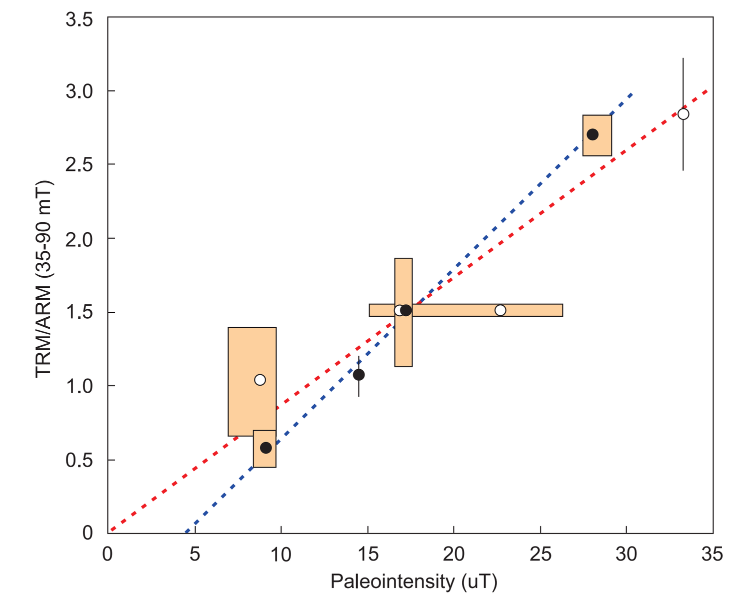
RESULTS 1: OLOKELE N-R TRANSITION ZONE (CONT.)

b) Thermal paleointensities and scaling of TRM/ARM to uT



Thellier double-heating paleointensity experiments:

16 of 86 samples with q>5, but half exhibit obvious sign of nonideal behavior ("hook" at 450 C)

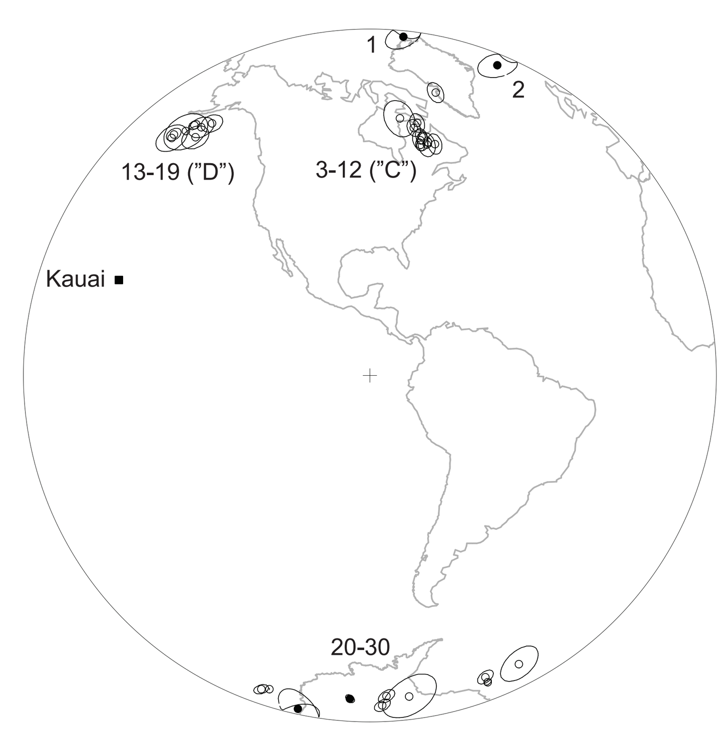


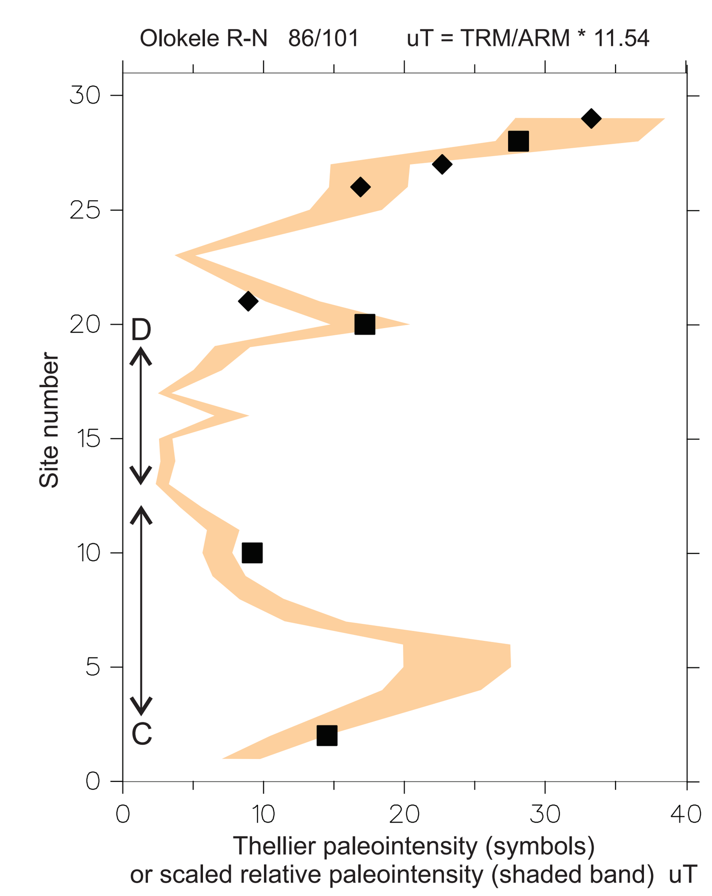
Correlation of relative paleointensity (TRM/ARM) to double-heating paleointensity (absolute)

Blue line: Line fit to 4 flow averages on 8 best sample paleointensities. (X-axis intercept = 4.7 uT)

Red line: Line fit to all 8 flow-averaged results, constrained to origin (uT = TRM/ARM * 11.54)

c) Field behavior during the Olokele N-R





Scaled relative paleointensity and field direction during the Olokele R-N

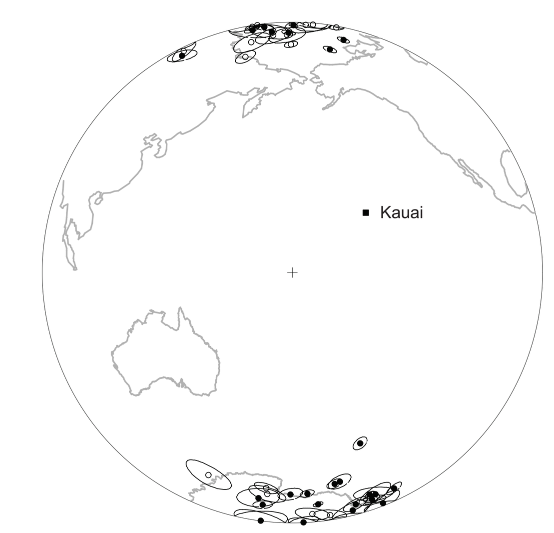
1) As the geomagnetic polarity switched, the field strength apparently dropped by 91% compared to the maximum recorded by the flows.

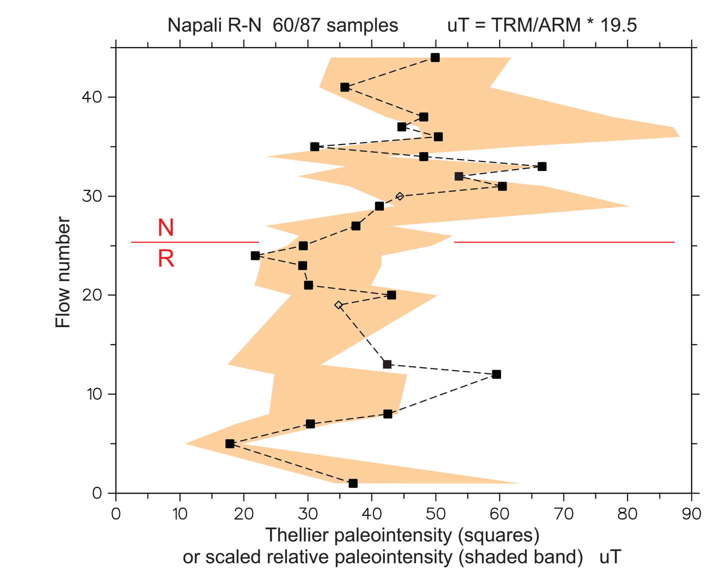
2) This decrease is comparable to that observed in other paleomagnetic studies and numerical simulations.

3) During an interval of NE-down directional stasis recorded by a succession of 10 flows in the lower half of the section, the geomagnetic intensity rose to over 20 uT and then decreased to near 5 uT.

4) This distinctive behavior could mark the waxing and waning of a stationary, inward-directed flux patch on the core mantle boundary centered NE of Kauai.

RESULTS 2: NAPALI R-N TRANSITION ZONE (KAUAI, HAWAII ~4.6 Ma)





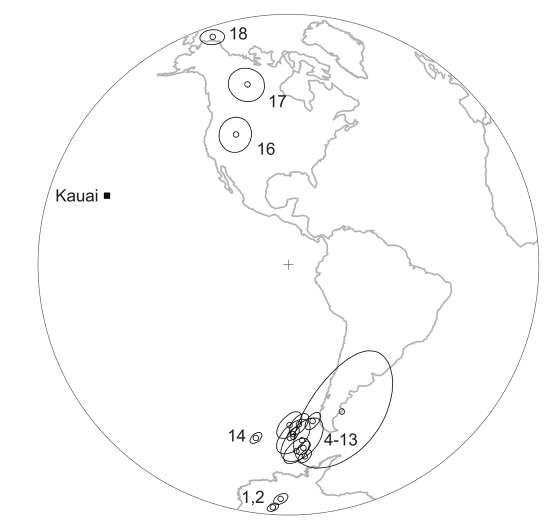
No transitional directions

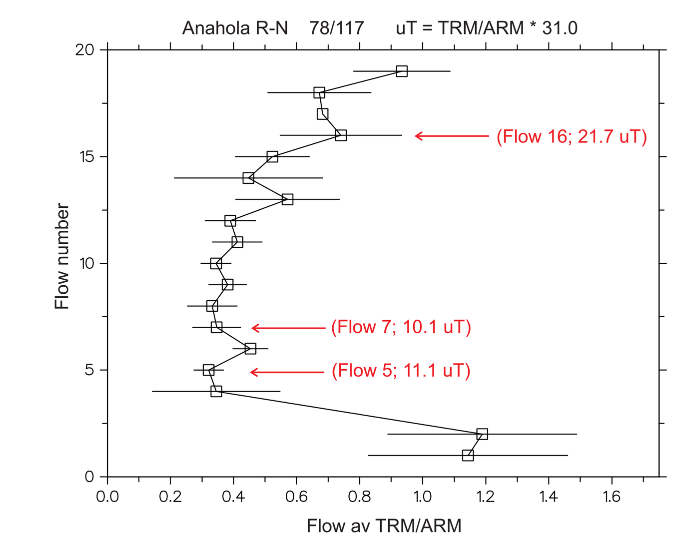
Within-flow scatter of TRM/ARM is greater than observed in Olokele samples

Scaled to absolute paleointensity using Thellier-Thellier results on companion specimens reported by Bogue and Coe (JGR,1984) and Bogue (JGR, 2001); correlation is weaker than observed in Olokele samples

Lack of interval of low paleointensity consistent with lack of transitional directions (no transitional behavior recorded?)

RESULTS 3: ANAHOLA R-N TRANSITION ZONE (KAUAI, HAWAII ~4.3 Ma)



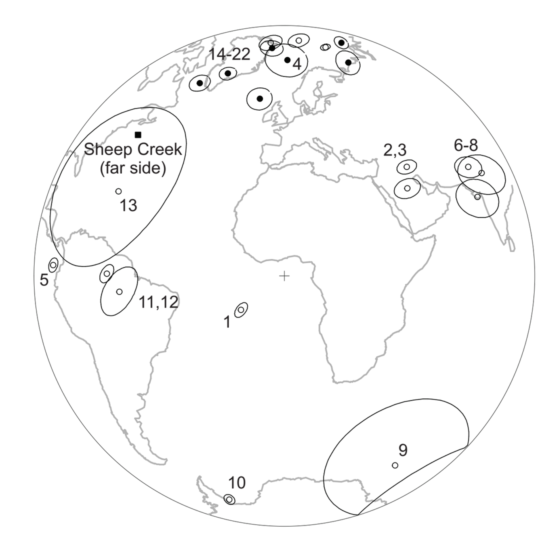


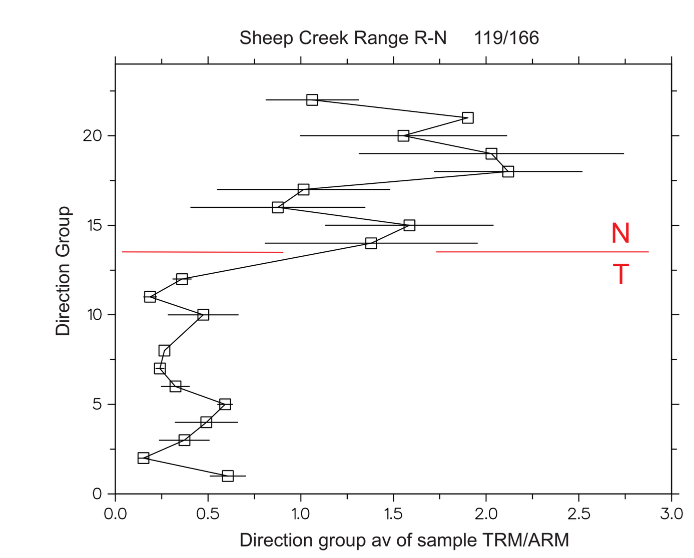
Good correlation between relative paleointensity and 3 Thellier-Thellier paleontensities on companion specimens reported by Bogue and Coe (1984)

Scaling factor (uT = TRM/ARM * 31.0) much higher than observed for Olokele (11.5) or Napali (19.5) flows

Interval of low paleointensity corresponds to shallow, SE directions (southern South American VGPs)

RESULTS 4: SHEEP CREEK R-N TRANSITION ZONE (NEVADA 15.2 Ma)





Low relative paleointensities correspond to transitional directions from Bogue et al. (G-cubed, 2017). No thermal paleointensities for comparison

CONCLUSIONS

"Pseudo-Thellier" method is promising for relative paleointensity within sequences of rapidly-erupted flows

Scaling to absolute paleointensity varies significantly between flow sequences

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