Paleomagnetism of a Sediment Core Taken from the Ontong-Java Plateau: for Better Understanding of the Role of Biogenic Magnetite in Geomagnetic Paleointensity Recording

Jiaxi Li[1], Toshitsugu Yamazaki[2], Yoichi Usui[3], Takuya Sagawa[4], Yoshimi Kubota[5], and Junichiro Kuroda[2]

[1]Atmosphere and Ocean Research Institute
[2]Atmosphere and Ocean Research Institute, The University of Tokyo
[3]JAMSTEC Japan Agency for Marine-Earth Science and Technology
[4]Kanazawa University
[5]National Museum of Nature and Science

November 24, 2022

Abstract

Marine sediments contain considerable amounts and different types of magnetic mineral particles. Magnetic minerals in sediments may be statistically aligned to the direction of the ambient geomagnetic field so that sediments potentially preserve geomagnetic intensity records in the past. However, different types of magnetic minerals should preserve the remanent magnetization in different manners. And the compositional variation of magnetic mineral assemblages in marine sediments may hinder us from extracting reliable geomagnetic paleointensity records. We studied a sediment core taken from the Ontong-Java plateau, from which relative paleointensity (RPI) variations were estimated. The magnetic mineral assemblages of the sediment core are principally a two-component mixture of terrigenous and biogenic magnetite. So it provides an opportunity to assess the influence that compositional variations in marine sediments could bring to RPI estimations and thus to distinguish different contributions of the biogenic and terrigenous components to RPI recording in marine sediments. RPI obtained by normalizing natural remanent magnetization (NRM) with anhysteretic remanent magnetization (ARM) shows downcore decreases, and it has an inverse correlation with the ratio of ARM susceptibility (k_{ARM}) to saturation isothermal remanent magnetization (SIRM) (k_{ARM}/SIRM). This indicates that the RPI signal becomes apparently weaker with increasing proportion of biogenic magnetite. Moreover, NRM-ARM demagnetization diagrams show concave-down curvature, which indicates that the coercivity distributions of NRM and ARM are different. If we assume that the magnetization of the higher coercivity interval is mainly carried by biogenic magnetite while that of the lower coercivity interval is mainly carried by the terrigenous component, RPI recording efficiency of the biogenic component may be lower than that of the terrigenous component. The validity of this assumption was investigated by first-order reversal curve (FORC) measurements, transmission electron microscope (TEM) observations, low-temperature measurements, and extraction of silicate-hosted magnetic inclusion from the sediments, and the results proved that NRM of the higher coercivity interval is carried mainly by biogenic magnetite. But our conclusion contradicts with some previous studies using a similar method, which suggested higher RPI recording efficiency of the biogenic magnetic component than the terrigenous component [Ouyang et al., 2014; Chen et al., 2017]. Different concentrations of silicate-hosted magnetic inclusions due to different sedimentary environments might be a possible reason for the contradiction. The contribution of silicate-hosted magnetic inclusions to the magnetization is minor in our sediments (less than ˜7% of SIRM). This contradiction remains to be studied further. Keywords: geomagnetic paleointensity, silicate-hosted magnetic mineral inclusion, biogenic magnetite, Ontong-Java plateau

AGU FALL MEETING
New Orleans, LA & Online Everywhere
13–17 December 2021

[GP42A-05] 10:13-10:20 CST

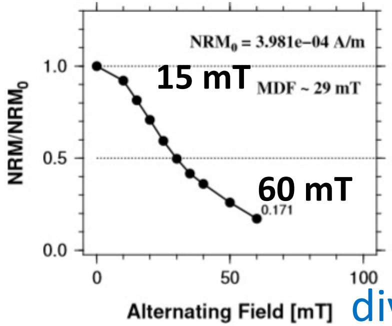
Paleomagnetism of a Sediment Core from the Ontong-Java Plateau: for Better Understanding of the Role of Biogenic Magnetite in Geomagnetic Paleointensity Recording

Jiaxi Li[1], Toshitsugu Yamazaki[1], Yoichi Usui[2], Takuya Sagawa[3], Yoshimi Kubota[4], and Junichiro Kuroda[1]

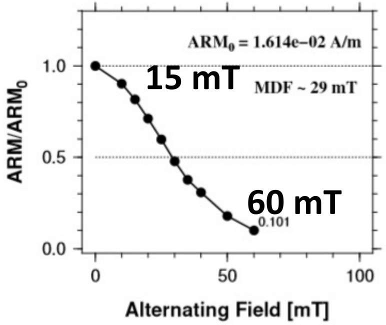
1. Atmosphere and Ocean Research Institute, The University of Tokyo, 2. Japan Agency for Marine-Earth Science and Technology, 3. Kanazawa University, 4. National Museum of Nature and Science

1. Introduction

The basic idea of relative paleointensity (RPI) estimation.



divide



NRM

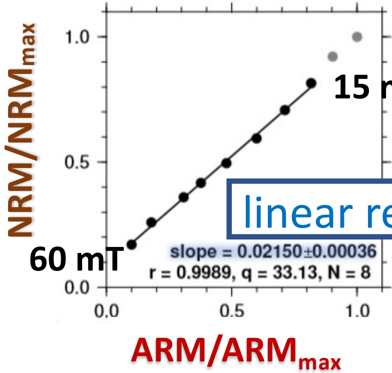
Original paleomagnetic record

normalization

"Magnetizability" of sediments

ARM or IRM

Demagnetization diagram

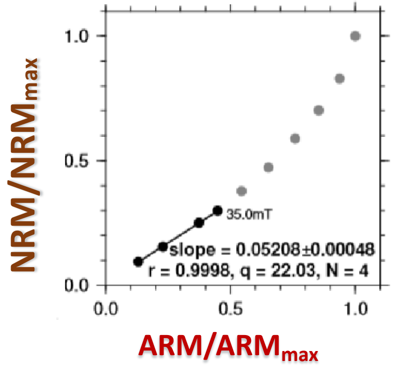


Similar coercivity distributions

linear regression

RPI

Different coercivity distributions

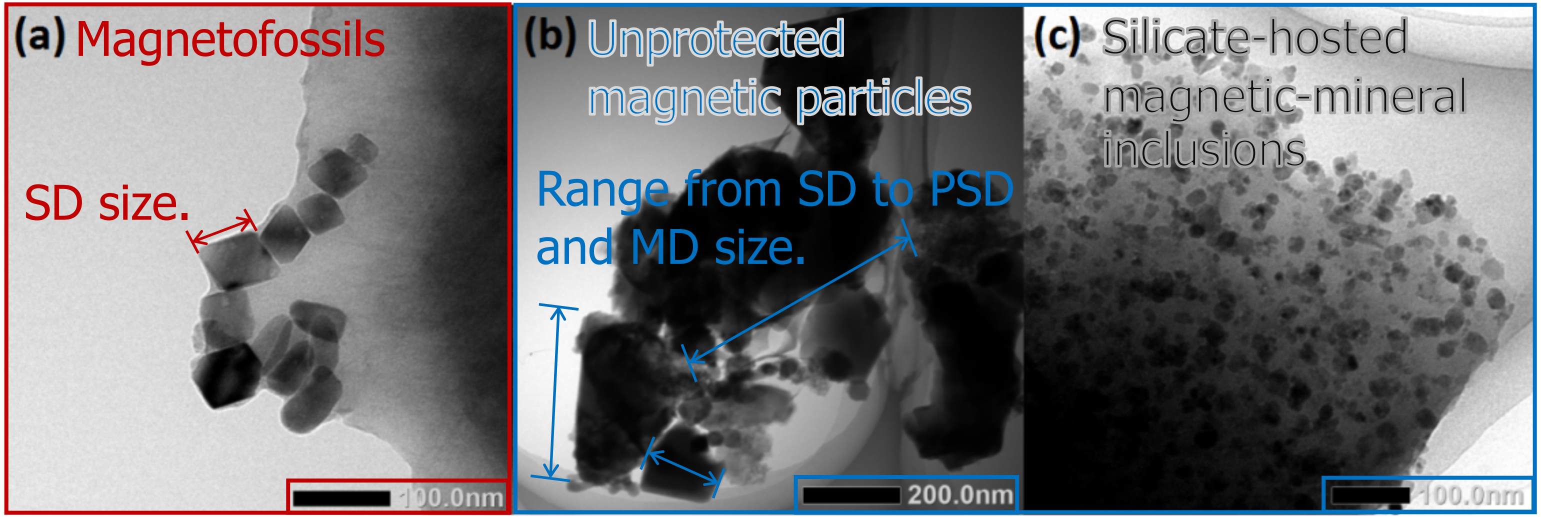


- Compositional complexity of magnetic mineral components in sediment may influence the reliability of RPI estimations.

1. Introduction

Biogenic and terrigenous magnetic components are considered as the two major components.

Biogenic **Terrigenous**



Better recorder of NRM?

Conventional NRM recorder.

Another candidate for preserving stable NRM?

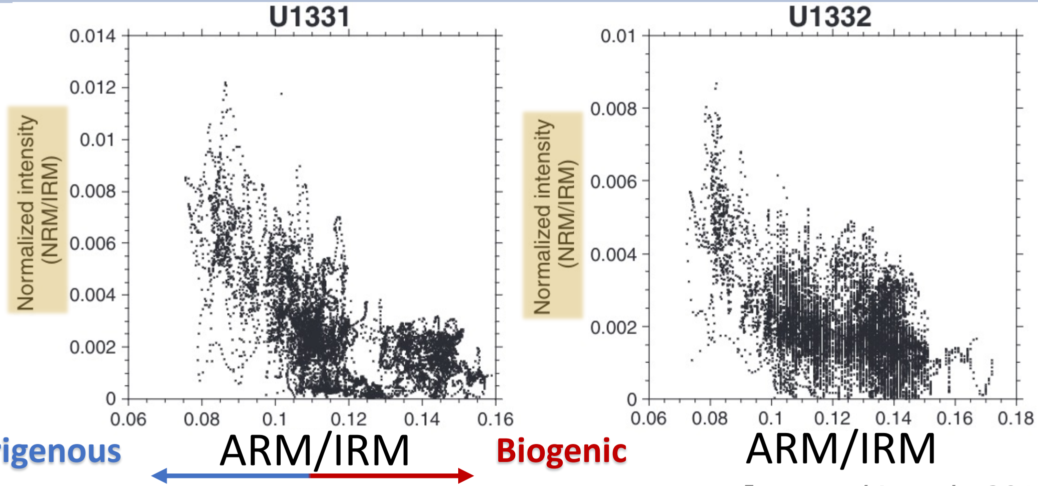
1. Introduction

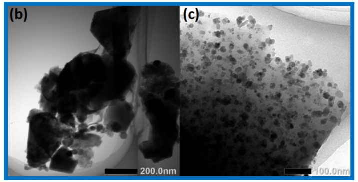
A correlation between ARM/IRM and RPI indicates a lithological contamination.

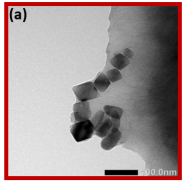
Reliability of RPI estimations

influence

"Lithological contamination" from compositional changes







[Yamazaki et al., 2013]

- It is attributable to differences in RPI recording efficiency between the biogenic and terrigenous components. *[Chen et al., 2017; Ouyang et al., 2014; Yamazaki et al., 2013]*

1. Introduction

Purpose of this study.

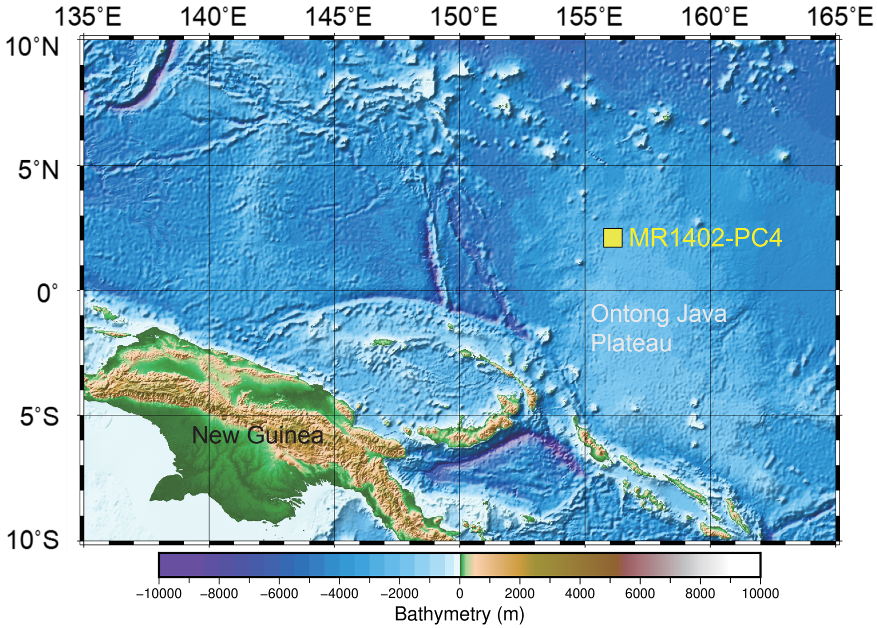
- Try to distinguish and assess different contributions of biogenic and terrigenous magnetic components to RPI recording.

- Give a better understanding on how compositional variations in marine sediments can influence the reliability of RPI estimations.

2. Study materials

Core MR1402-PC4 was taken from the Ontong-Java Plateau in the western equatorial Pacific.

- The water depth (2447 m) is above the CCD.
- Light gray to light olive gray calcareous ooze.
- Mixture of magnetofossils and terrigenous magnetic minerals with carbonate.
- Age estimation was conducted based on $\delta^{18}O$ of benthic foraminifera.

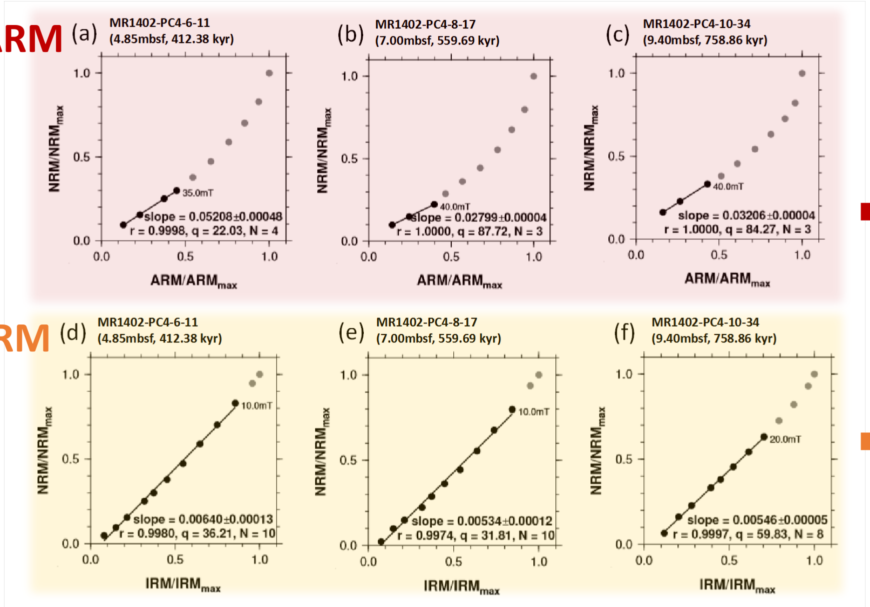


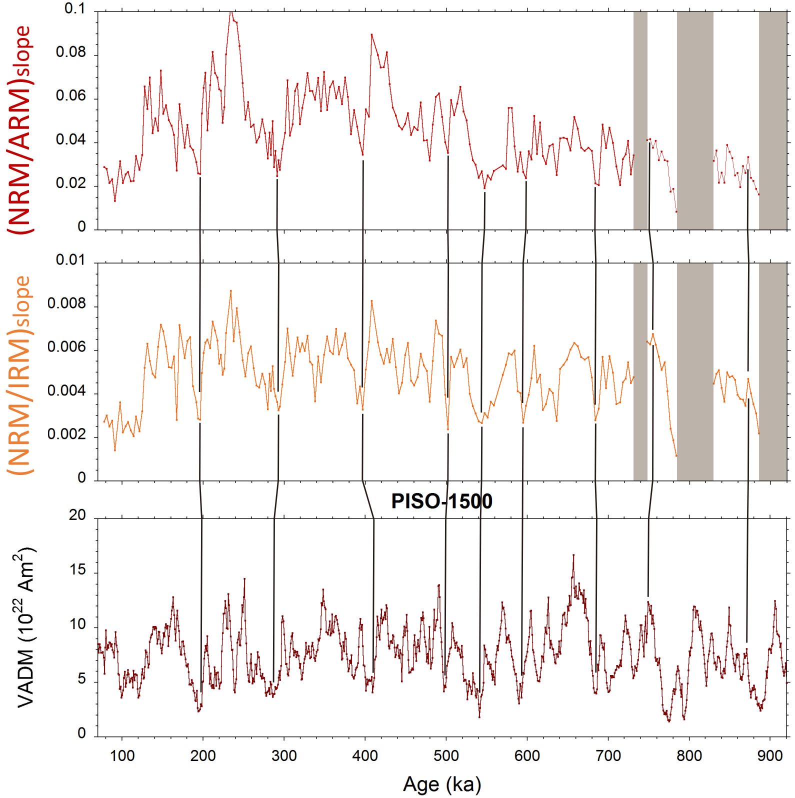
3. Results and interpretations

Different results in demagnetization diagrams and RPI estimations for NRM/ARM and NRM/IRM.

NRM/ARM

NRM/IRM

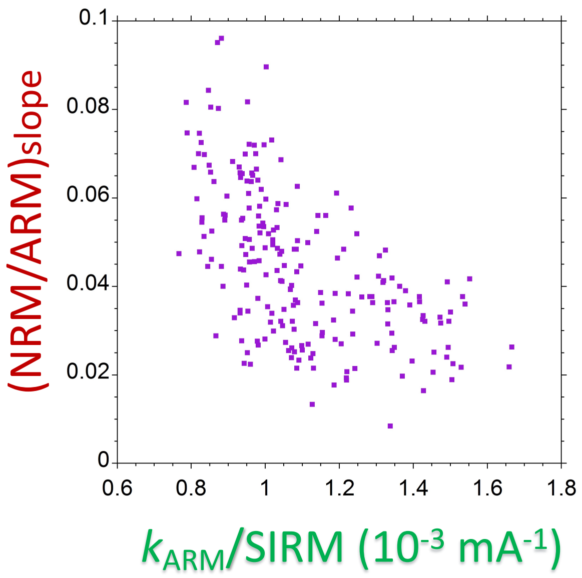


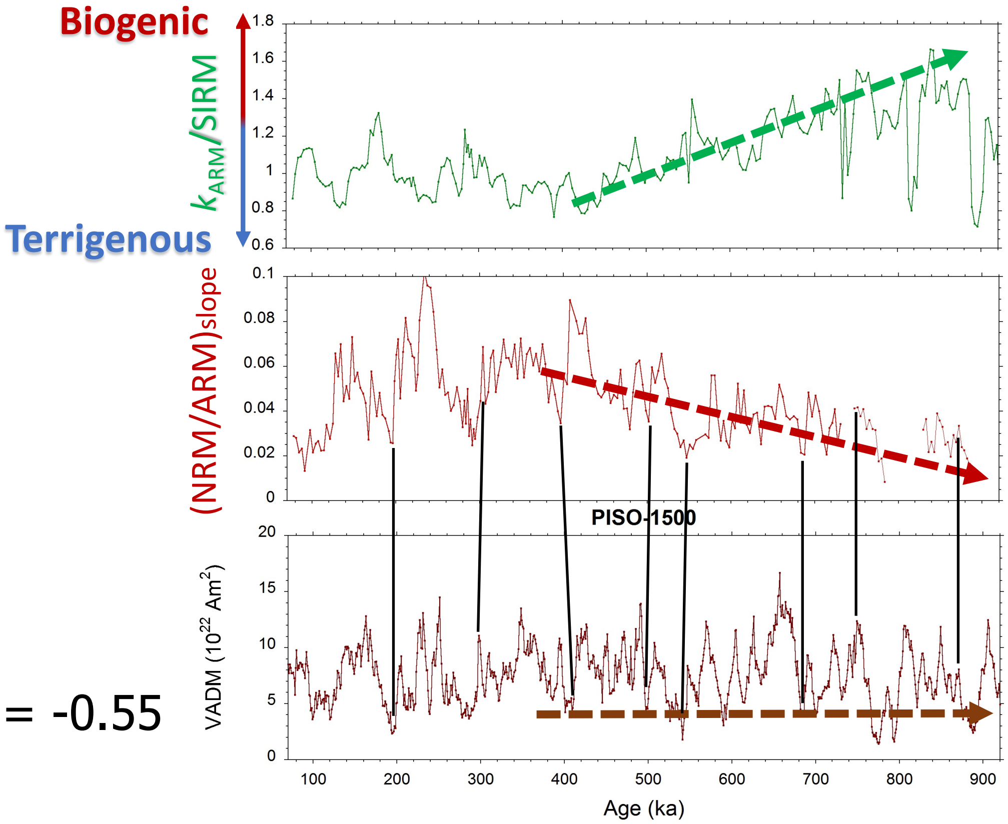


*Examples of RPI estimations obtained from best-fitting slopes on the NRM-ARM and NRM-IRM demagnetization diagrams.

3. Results and interpretations

k_{ARM}/SIRM has a rough inverse correlation with NRM/ARM.



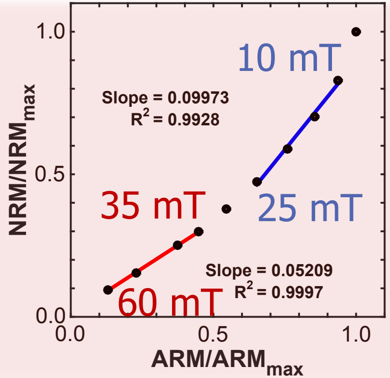


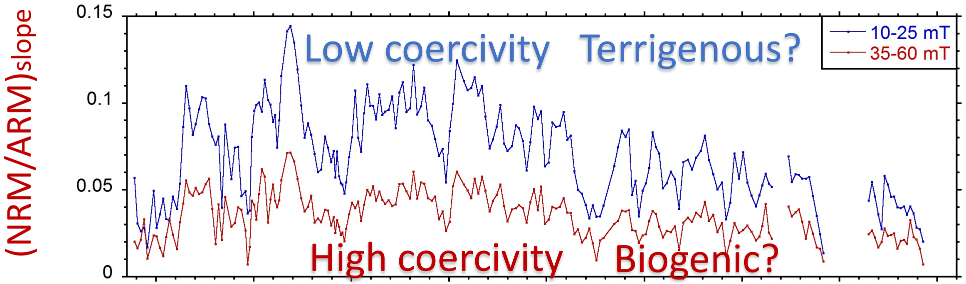
The approximate inverse correlation is indicated by a correlation coefficient ρ = -0.55 with P < 0.01.

3. Results and interpretations

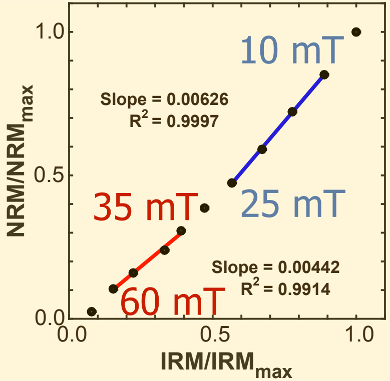
Best fitting slopes on demagnetization diagrams were recalculated for two AF demagnetization intervals.

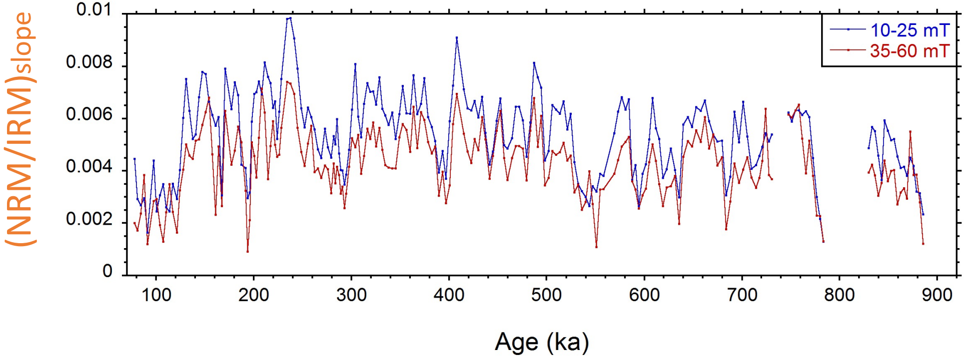
NRM/ARM





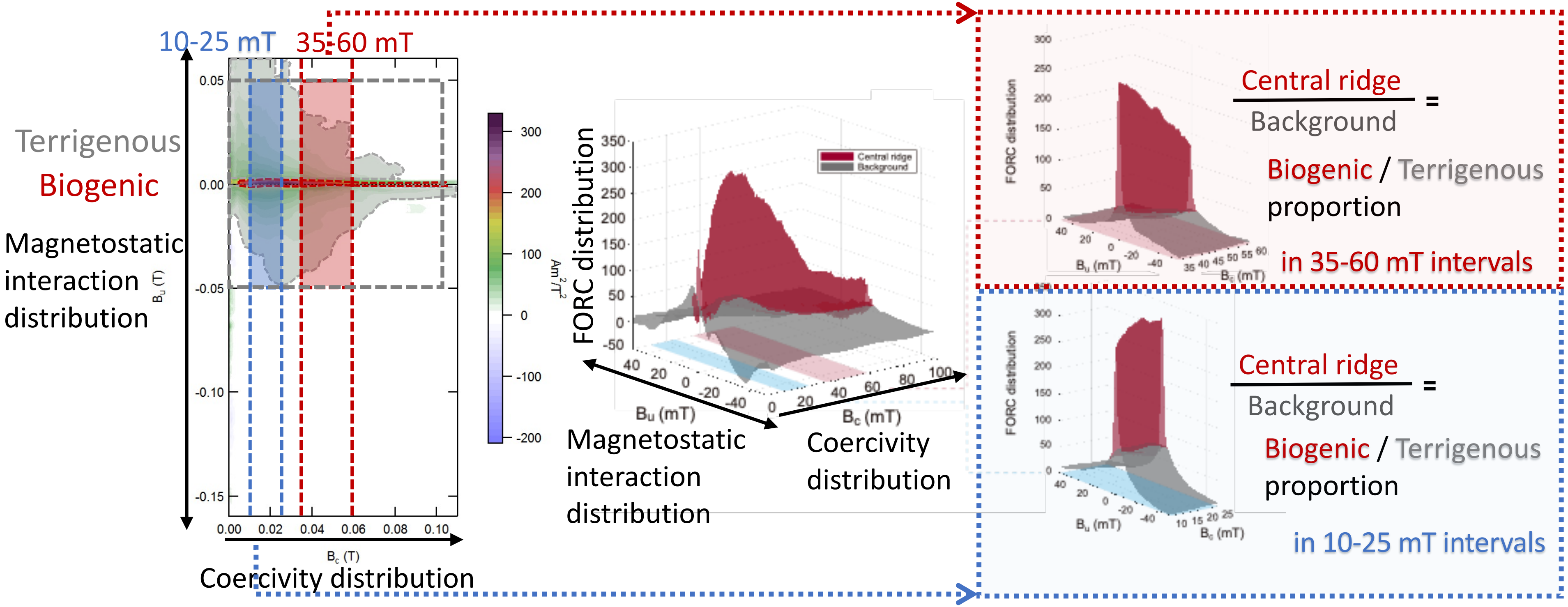
NRM/IRM





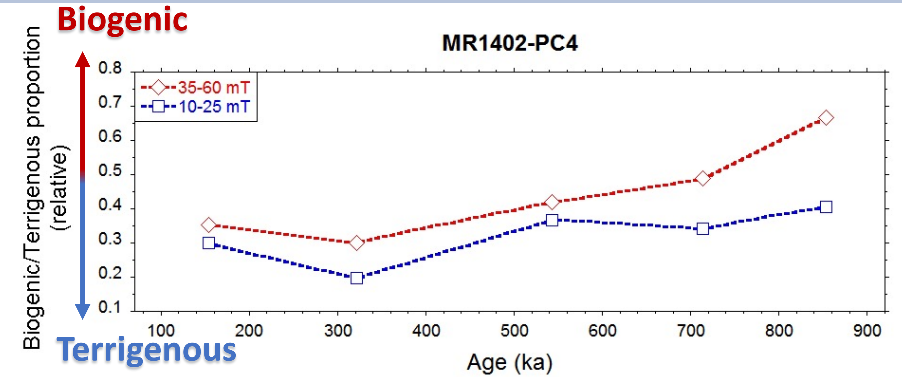
3. Results and interpretations

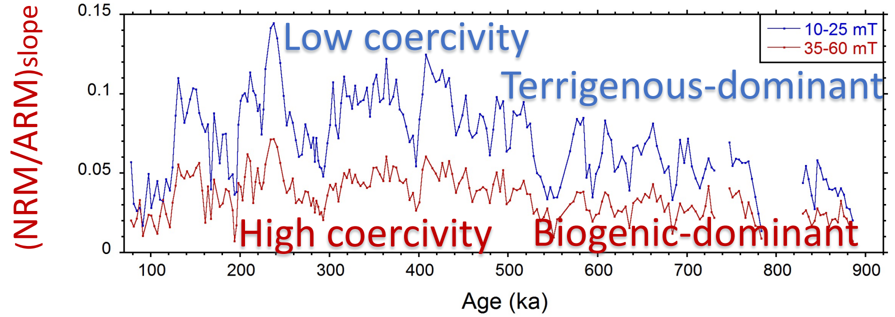
Relative proportions of biogenic to terrigenous components at different coercivity intervals were estimated from FORC diagrams.

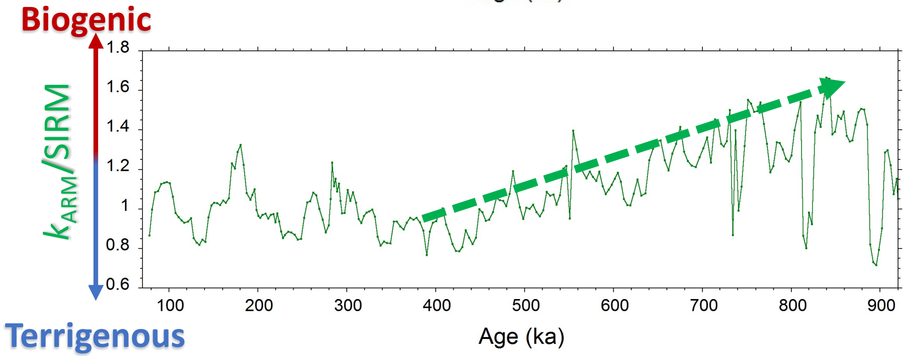


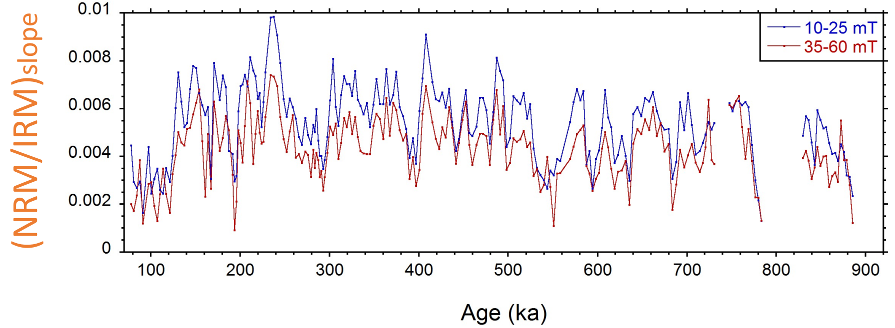
3. Results and interpretations

FORC diagrams indicate that the magnetization of the high-coercivity interval is carried more by biogenic magnetite.



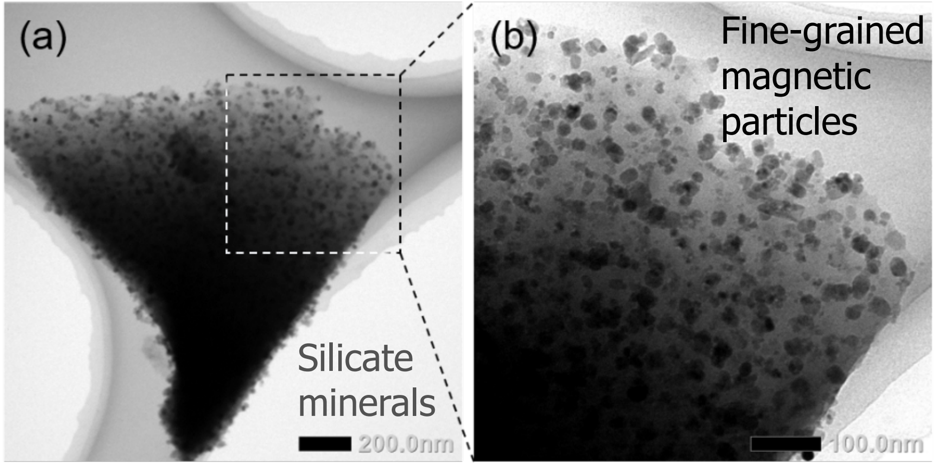






Possibility that silicate-hosted magnetic inclusions contribute to RPI as a major component is excluded.

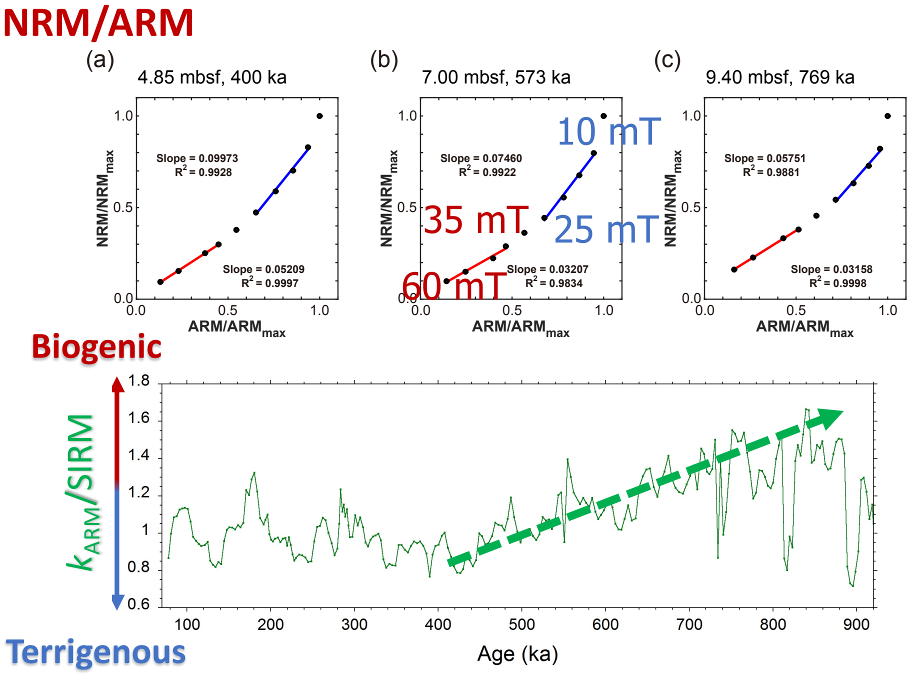
- Silicate-hosted magnetic inclusions (quartz and feldspar) were extracted by chemical procedures.

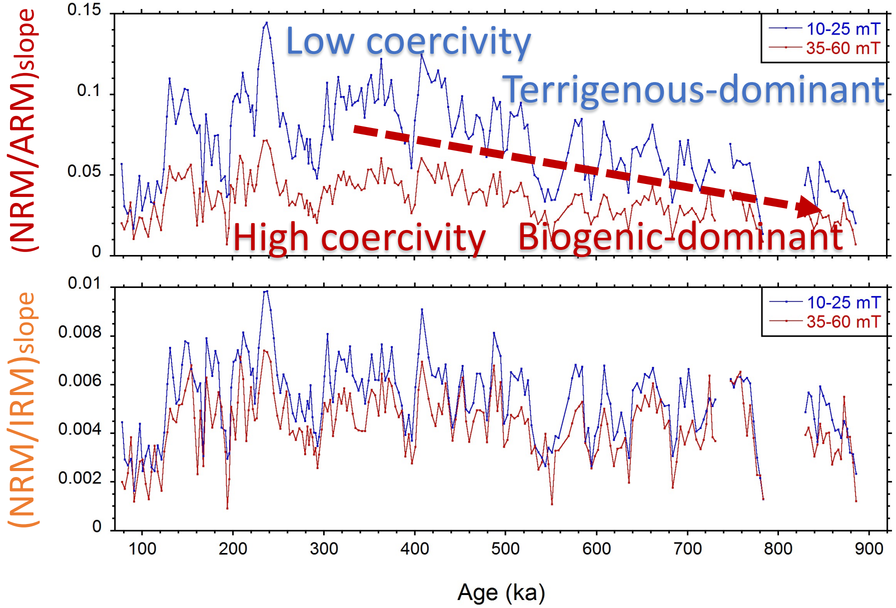


Less than <u>2% in mass</u> and only account for about <u>7% of SIRM</u> fractions.

4. Discussion

ARM normalization is not appropriate for RPI estimation in sediments with changing amount of biogenic magnetite.

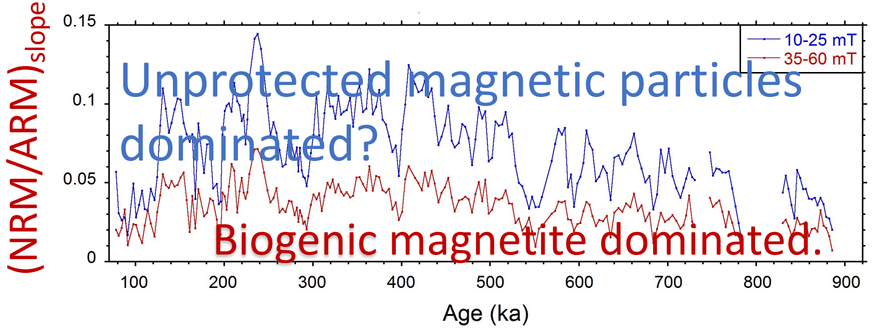




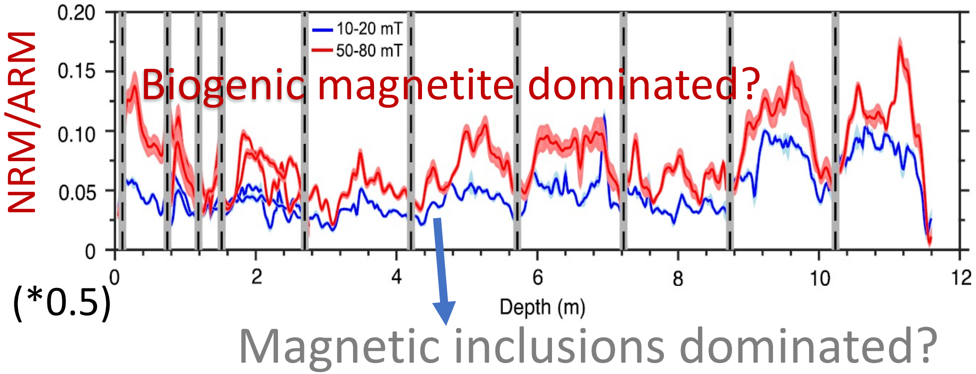
4. Discussion

Different concentrations of silicate-hosted magnetic inclusions might cause our results to be opposite to previous studies.

The western equatorial Pacific (this study)



The eastern equatorial Pacific [Chen et al., 2017]



RPI recording efficiency:

Unprotected magnetic particles > Biogenic magnetite > Magnetic inclusions

■ *Sediment cores were from different sedimentary environments.*

5. Conclusions

- Biogenic magnetite contribute less to the RPI signal compared to the terrigenous magnetic minerals. This contradicts previous studies.

- Different magnetic-mineral components have different RPI recording efficiencies.

- Different silicate-hosted magnetic inclusion concentrations in different sedimentary environments is likely to be responsible for the observed differences among studies.