Are carbonates from the India-Asia collision remagnetized ?

Pierrick Roperch[1] and Guillaume Dupont-Nivet[1,2]
1Géosciences Rennes, Université Rennes1; 2Potsdam University

- There are many clear evidences of remagnetizations in the region, especially when this remagnetization is carried by Pyrrhotite.
- In the presentation we review the evidences for remagnetization in the Tethyan Himalaya.
- We however challenge the interpretation that secondary magnetite are derived from alteration of pyrite.
- Results from a carbonate sequence from the Qiantang indicate that the alteration of pyrite mainly produces iron hydroxides.

Pyrrhotite : plenty of evidences in previous publications

Pyrrhotite remagnetizations in the Himalaya: a review

E. APPEL[1]*, C. CROUZET[2] & E. SCHILL[3]

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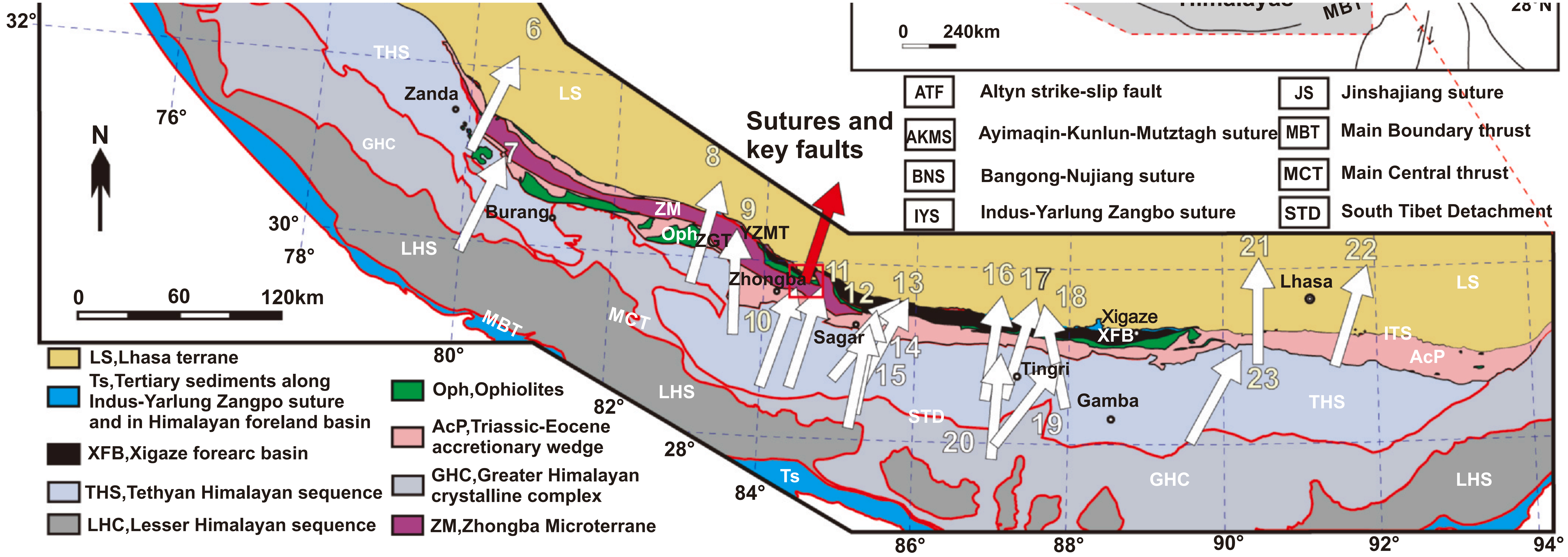
[2]*Institut des Sciences de la Terre, Université de Savoie, CNRS, 73376 Le Bourget du Lac, France*

[3]*Institut de Géologie et d'Hydrogéologie, Université de Neuchâtel, Rue Emile-Argand 11, 2009 Neuchâtel, Switzerland*

**Corresponding author (e-mail: erwin.appel@uni-tuebingen.de)*

More evidences in recent publications



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Journal of Asian Earth Sciences

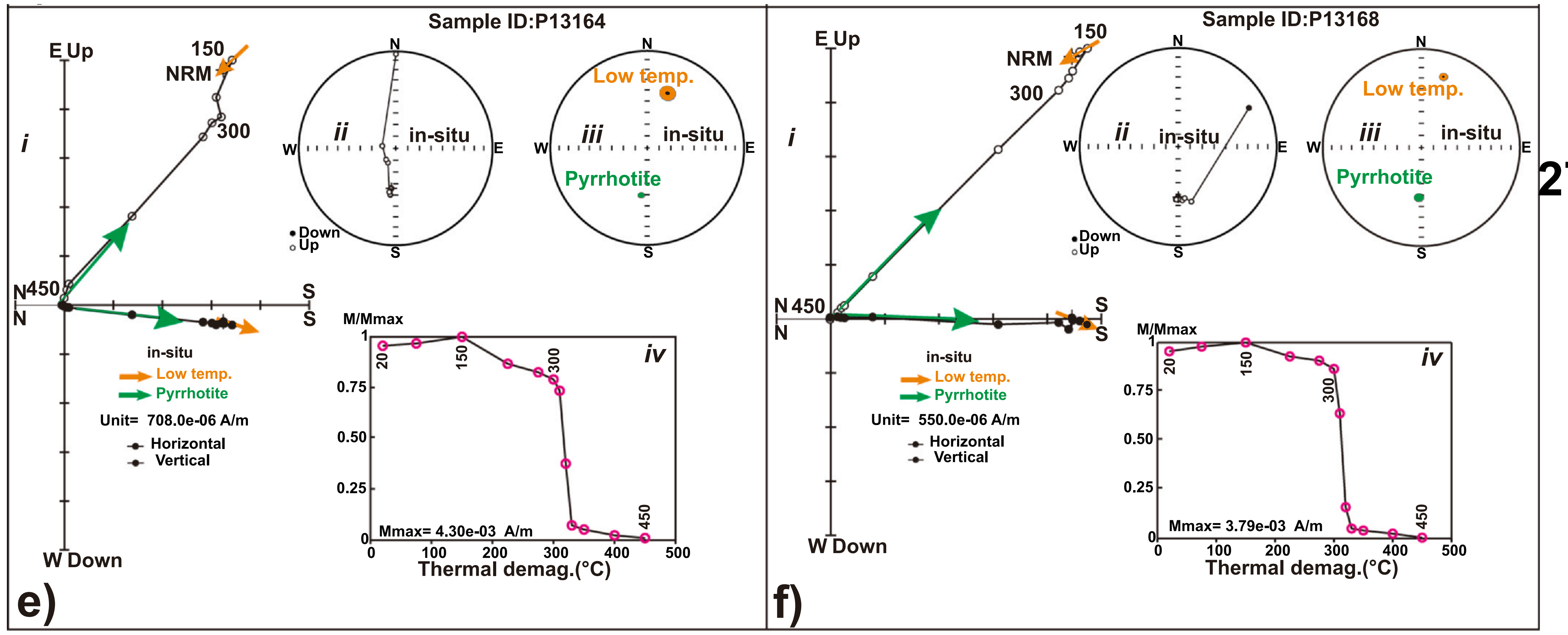
journal homepage: www.elsevier.com/locate/jseaes

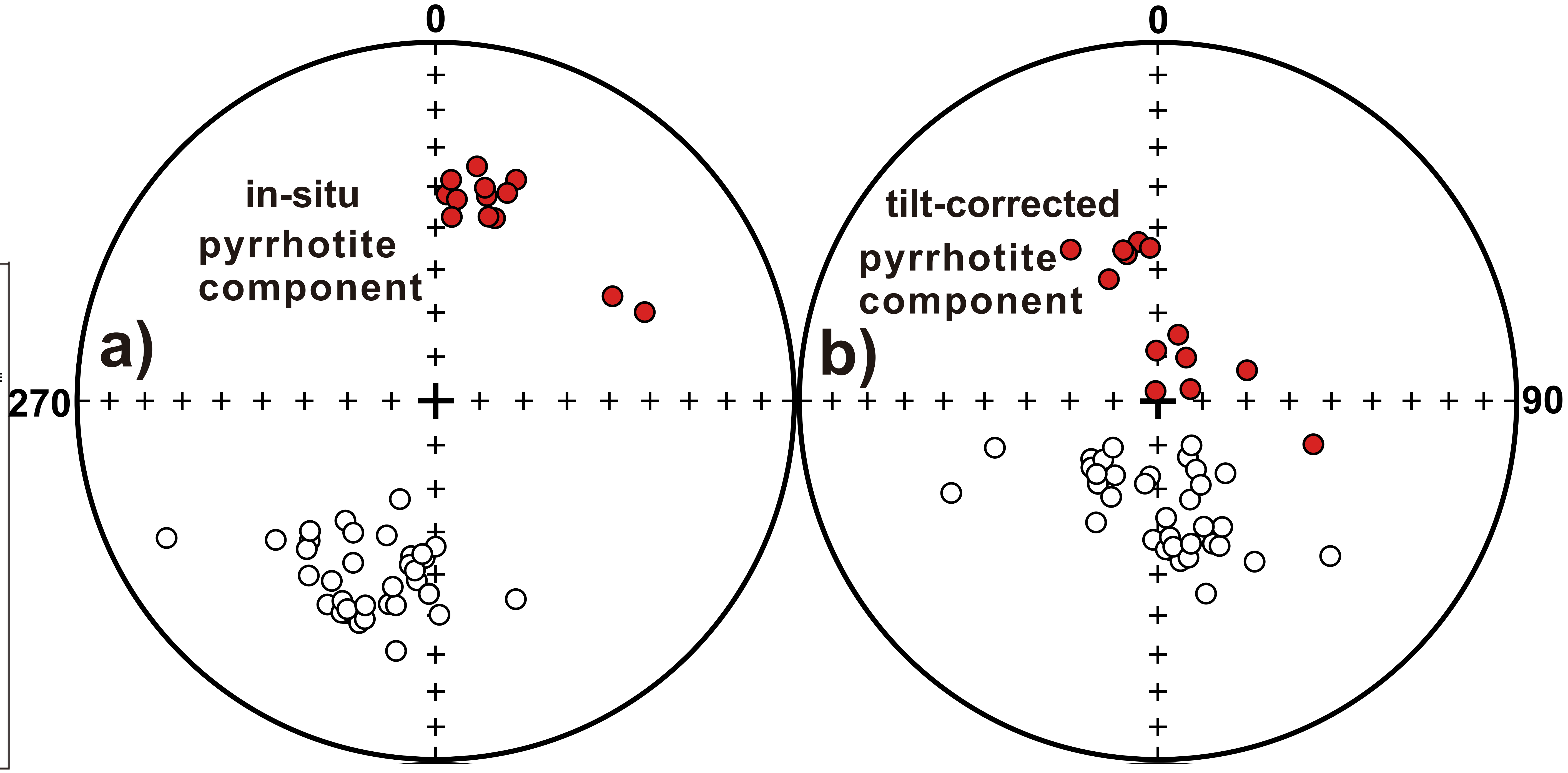
ChRM in permian rocks In the Zhongba terrane

Paleomagnetism and microtextures reveal Neohimalayan deformation pattern in the northwestern Tethys Himalaya

Shuai Li[a], Yalin Li[a,*], Xiaodong Tan[b], Jun Meng[a], Yongmei Shang[c], Yushuai Wei[a], Chengshan Wang[a]

[a] State Key Laboratory of Biogeology and Environmental Geology, School of Earth Sciences and Resources, China University of Geosciences (Beijing), Beijing 100083, China
[b] CAS Key Laboratory of Ocean and Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, 164 West Xin Gang Road, Guangzhou 510301, China
[c] State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing 100029, China



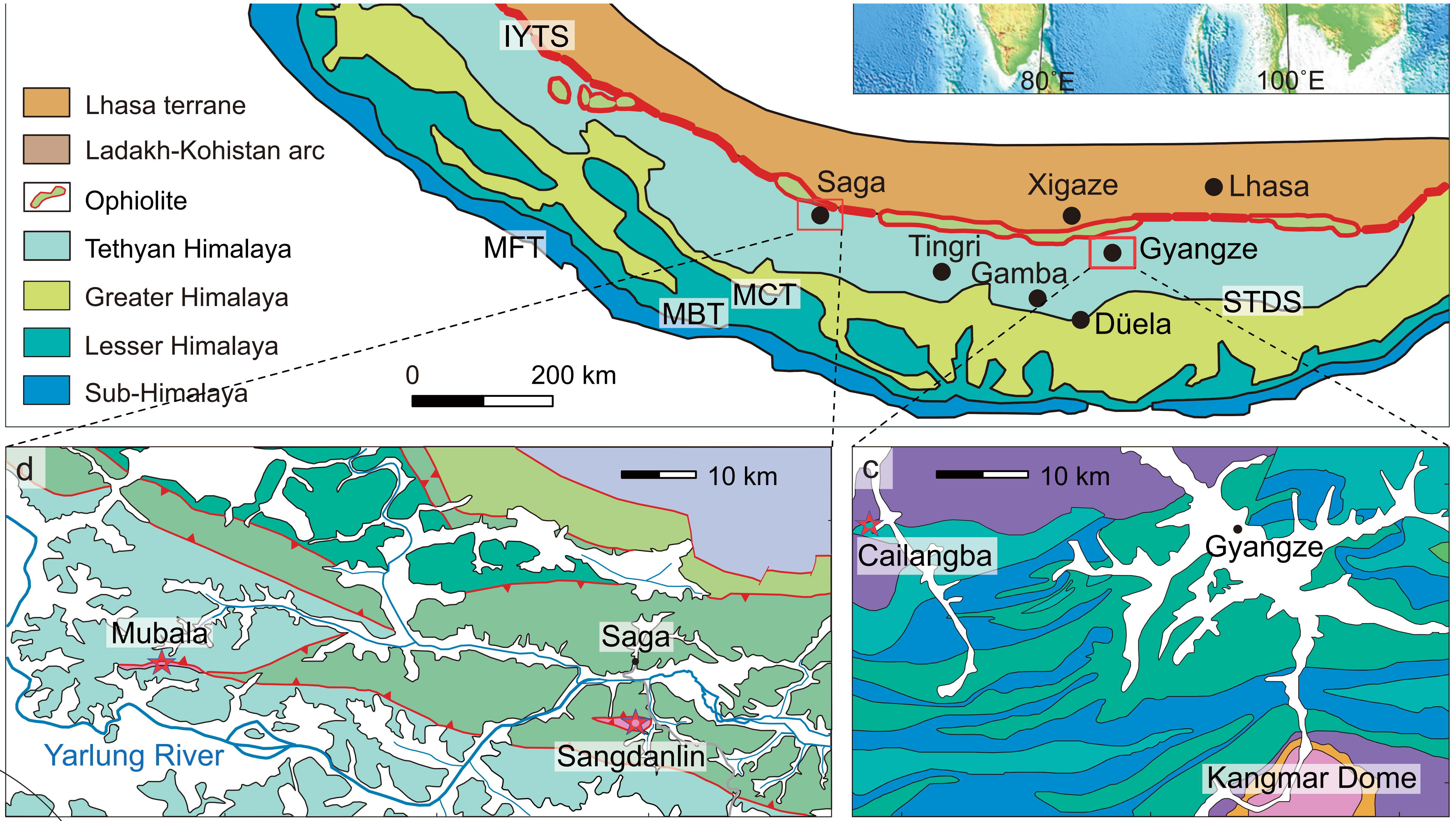


Possible cause of the remagnetization: early Miocene adakitic volcanism

Rapid drift of the Tethyan Himalaya terrane before two-stage India-Asia collision

Jie Yuan[1,2,3], Zhenyu Yang[4,*], Chenglong Deng[1,2,3,*], Wout Krijgsman[5], Xiumian Hu[6], Shihu Li[1], Zhongshan Shen[1,2,3], Huafeng Qin[1,2], Wei An[6], Huaiyu He[1,2,3], Lin Ding[3,7], Zhengtang Guo[2,8,9] and Rixiang Zhu[1,2,3]

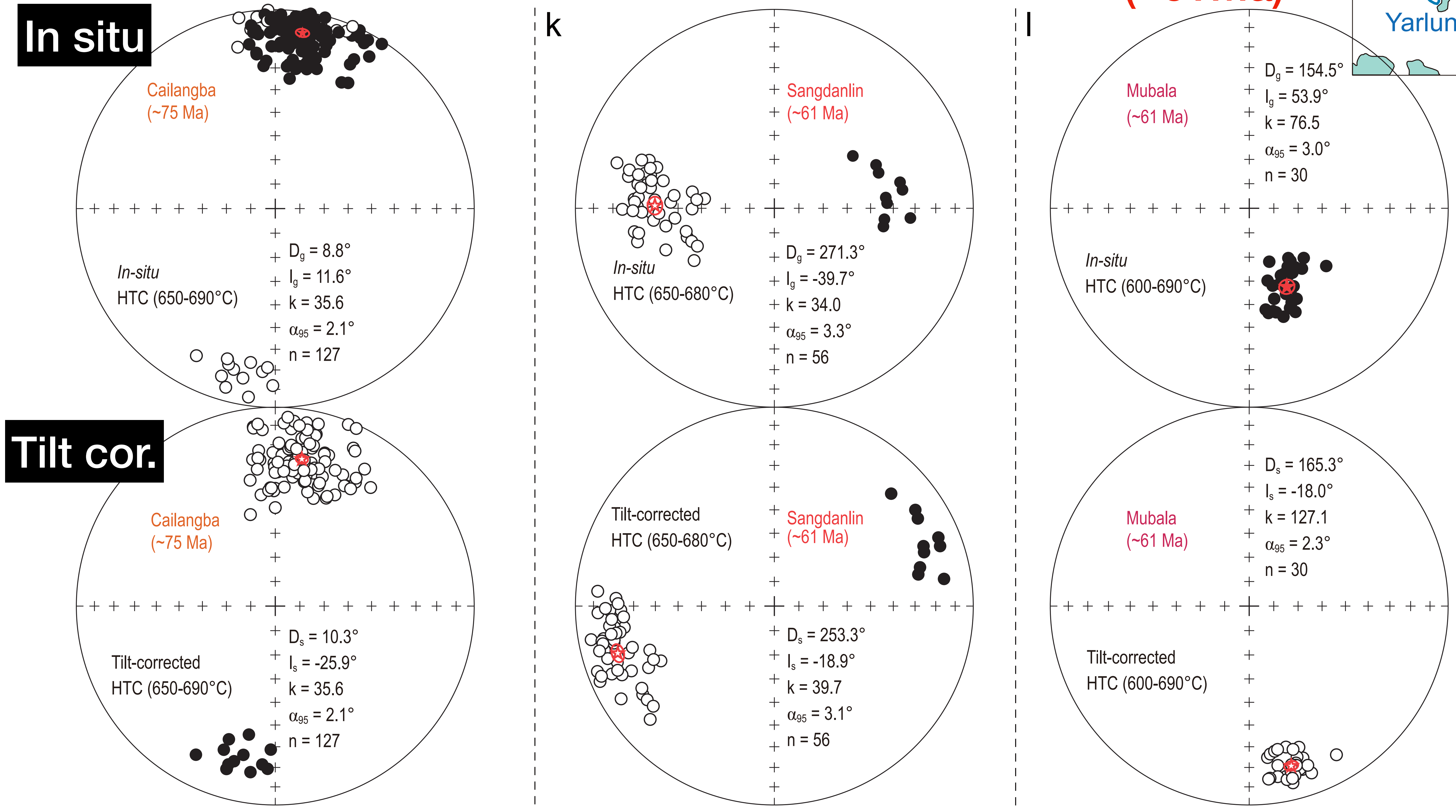
National Science Review 2020 doi: 10.1093/nsr/nwaa173



Cailangba (~75Ma)

Sangdanlin (~61Ma)

Mubala (~61Ma)



Component of magnetization carried by hematite.
Is it primary?

Large rotation at Sangdanlin / no rotation at Mubala

Medium temperature component

Cailangba section | Sangdanlin section

In situ | **Tilt corrected** | **In situ** | **Tilt corrected**

But there is a secondary component with intermediate unblocking temperatures with south declination and negative inclinations

No rotation in the MTC component at Sangdanlin

JGR Solid Earth

RESEARCH ARTICLE

10.1029/2019JB017927

Precollisional Latitude of the Northern Tethyan Himalaya From the Paleocene Redbeds and Its Implication for Greater India and the India-Asia collision

Tianshui Yang[1,2], Jingjie Jin[1,2], Weiwei Bian[1,2], Yiming Ma[2,3], Feng Gao[1,2], Wenxiao Peng[1,2], Jikai Ding[1,2], Suo Wang[1,2], Shihong Zhang[1,2], Huaichun Wu[1], Haiyan Li[1], and Zhenyu Yang[4]

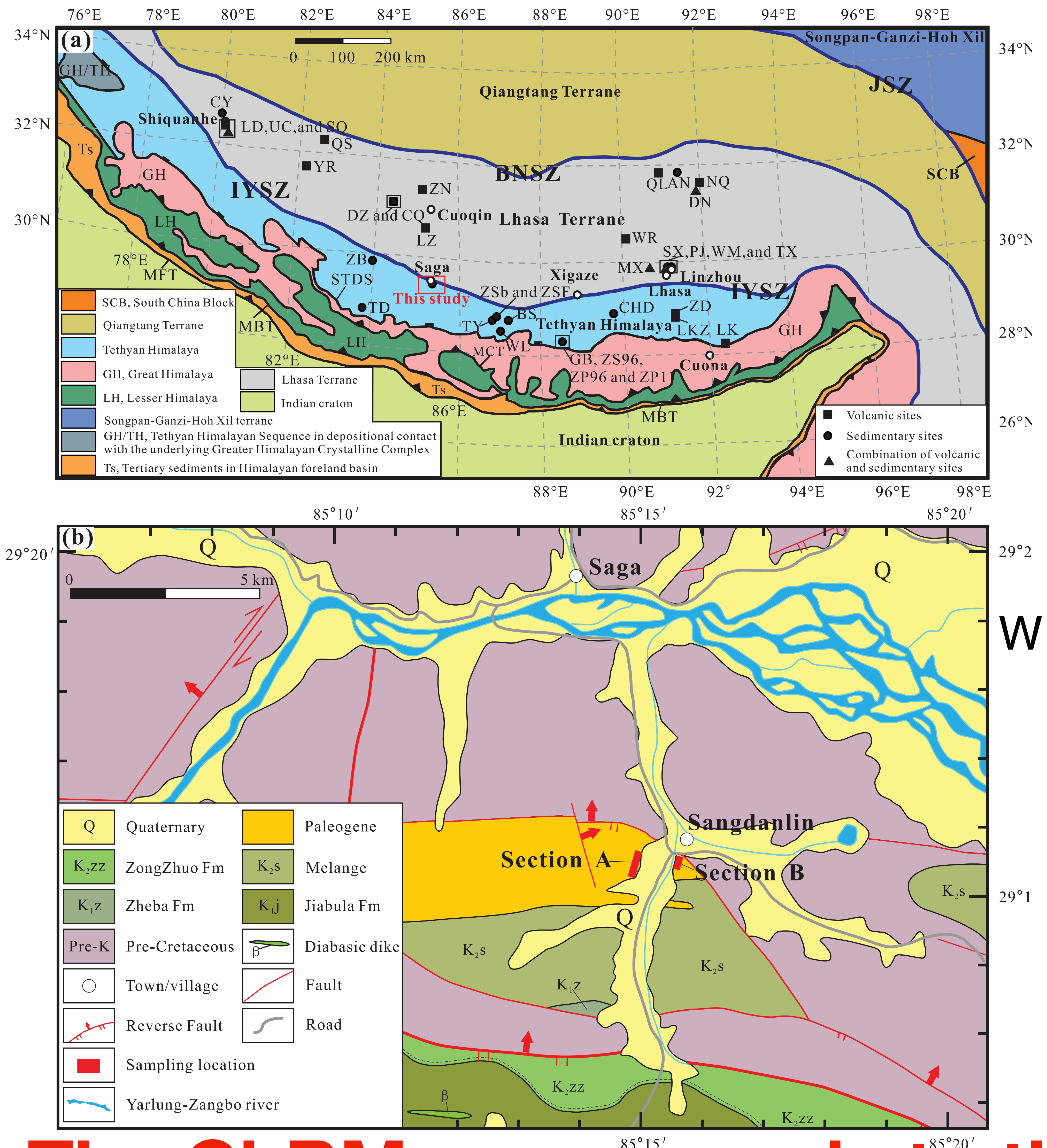
[1]State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Beijing, China, [2]School of Earth Sciences and Resources, China University of Geosciences, Beijing, China, [3]State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, China, [4]College of Resources, Environment and Tourism, Capital Normal University, Beijing, China

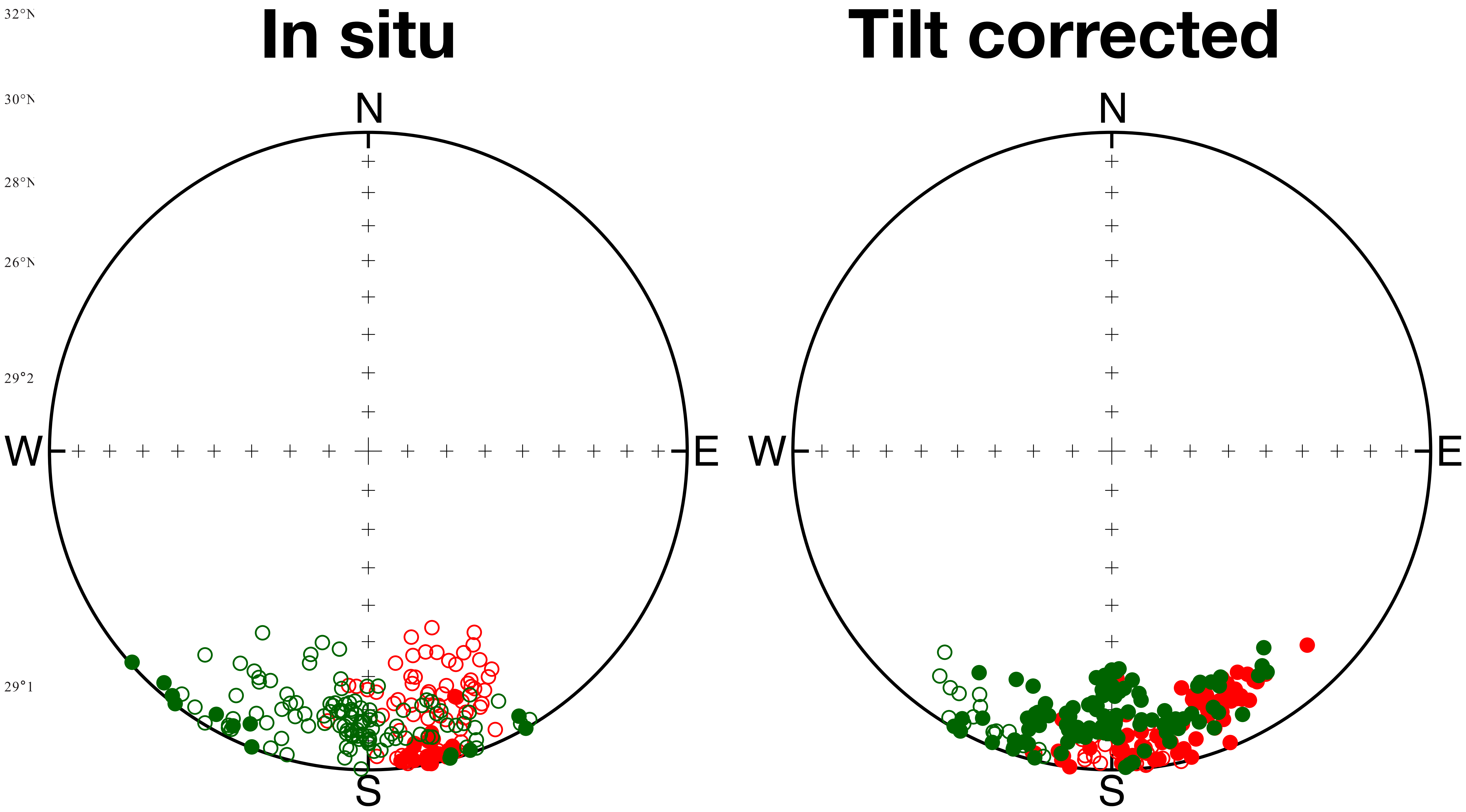
Key Points:

- The Saga area of the northern Tethyan Himalaya at ~59 Ma lay at 6.3°±4.3°S
- Neither wide Ocean extension nor >1,000 km crustal shortening occurred between Indian craton and Tethyan Himalaya after the latest Jurassic
- The India-Asia collision occurred at 47.1±4.5 Ma

Supporting Information:

Conclusion : This reliable paleomagnetic dataset passes positive fold tests and supports that the northern Tethyan Himalaya was located at 6.3±4.3°S during 60−58 Ma.





Same study area : Sangdanlin

The ChRM corresponds to the Intermediate component of the previous paper (Yuan et al.). The fold test is not conclusive

Yuan et al. 2020 *different conclusions* **Yang et al. 2020**

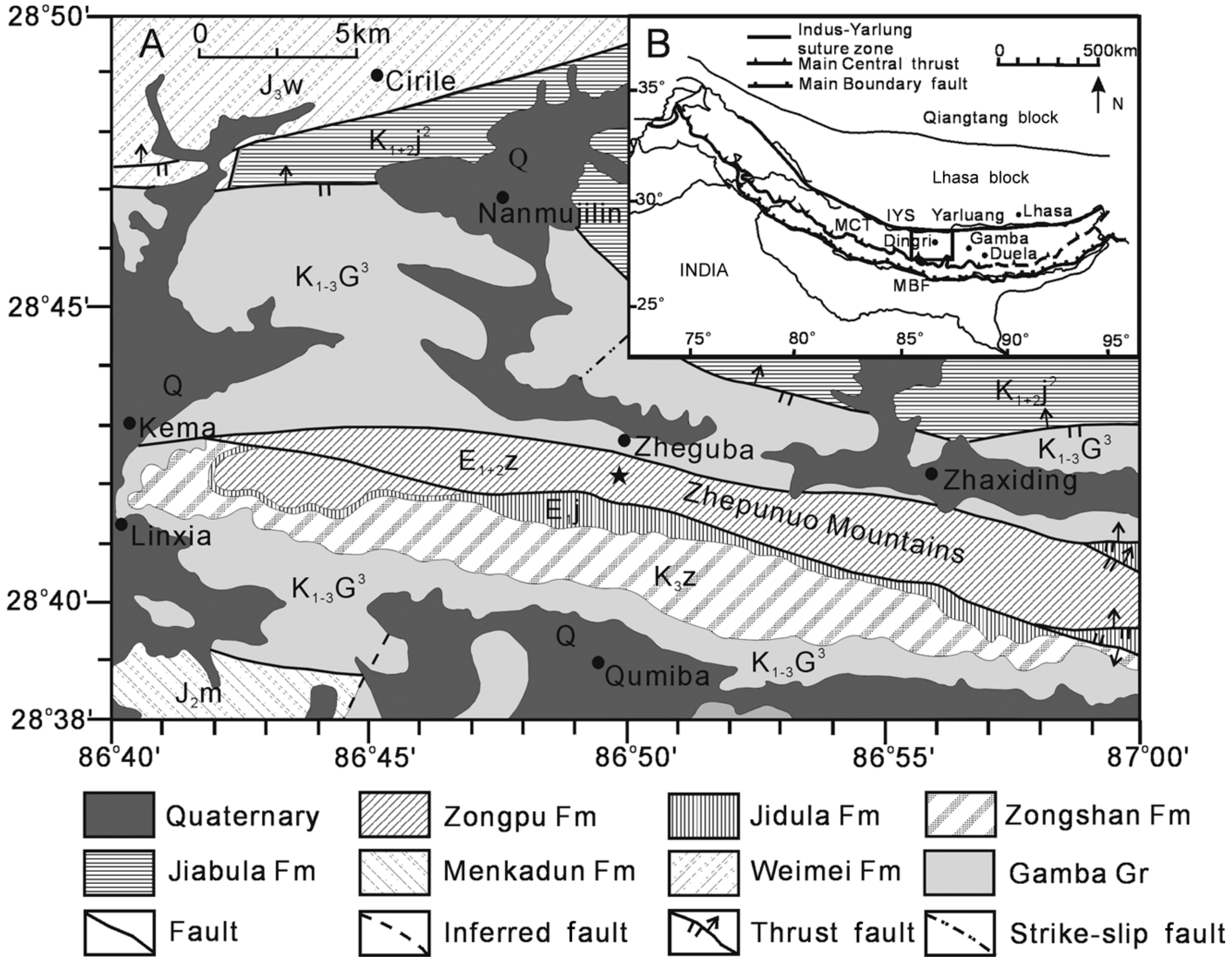
Paleolatitude 13.7±2.5°N at ~61Ma **6.3±4.3°S at 60-58Ma**

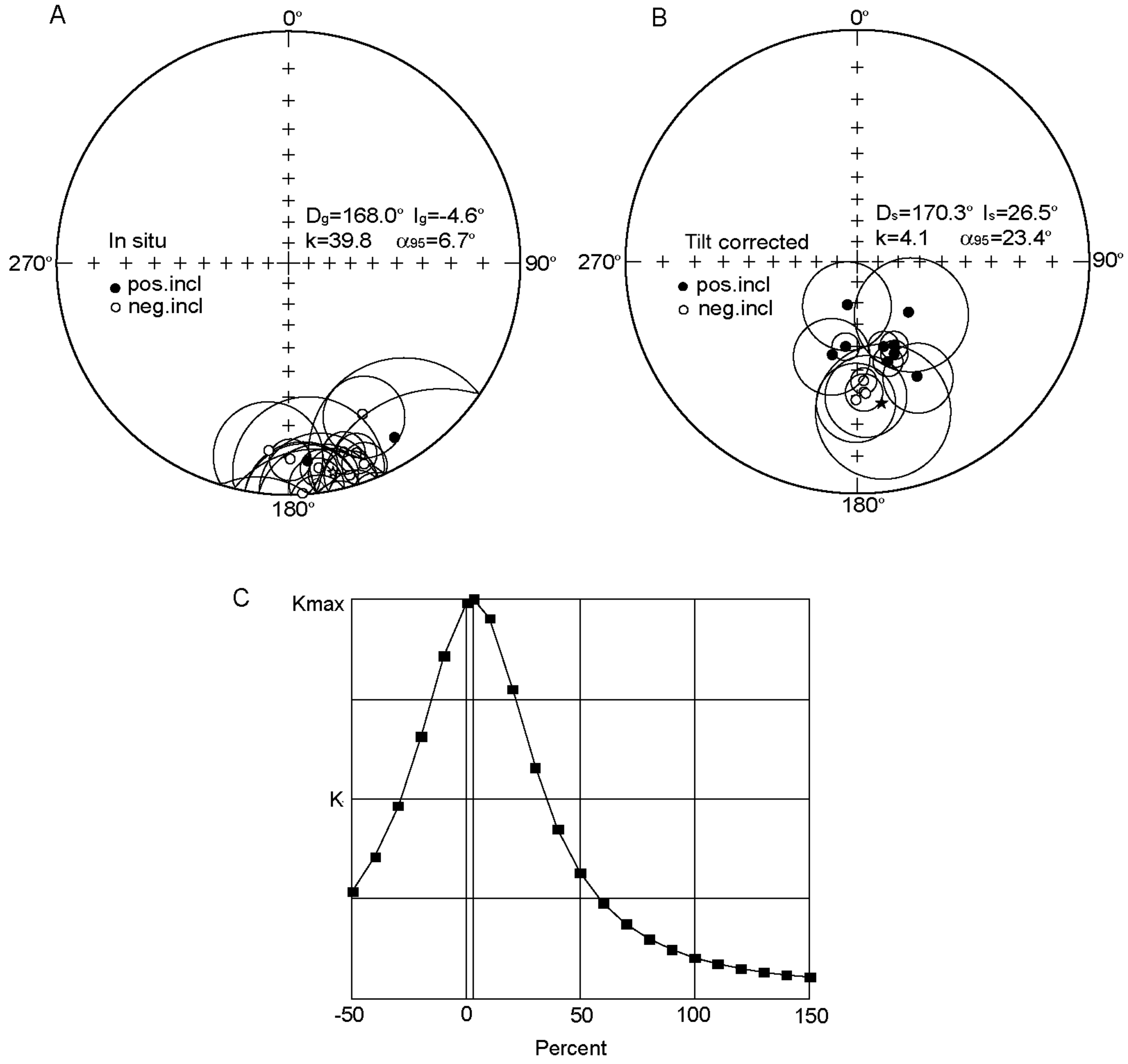
Early Paleocene Paleomagnetic Results from Southern Tibet, and Tectonic Implications

Yabo Tong , Zhenyu Yang , Liandi Zheng , Tianshui Yang , Linfeng Shi , Zhiming Sun & Junling Pei

To cite this article: Yabo Tong , Zhenyu Yang , Liandi Zheng , Tianshui Yang , Linfeng Shi , Zhiming Sun & Junling Pei (2008) Early Paleocene Paleomagnetic Results from Southern Tibet, and Tectonic Implications, International Geology Review, 50:6, 546-562, DOI: 10.2747/0020-6814.50.6.546

To link to this article: http://dx.doi.org/10.2747/0020-6814.50.6.546





Remagnetization in Paleocene carbonates

Same component of magnetization in Paleocene carbonates with south declination and negative low inclinations

ELSEVIER
Earth and Planetary Science Letters
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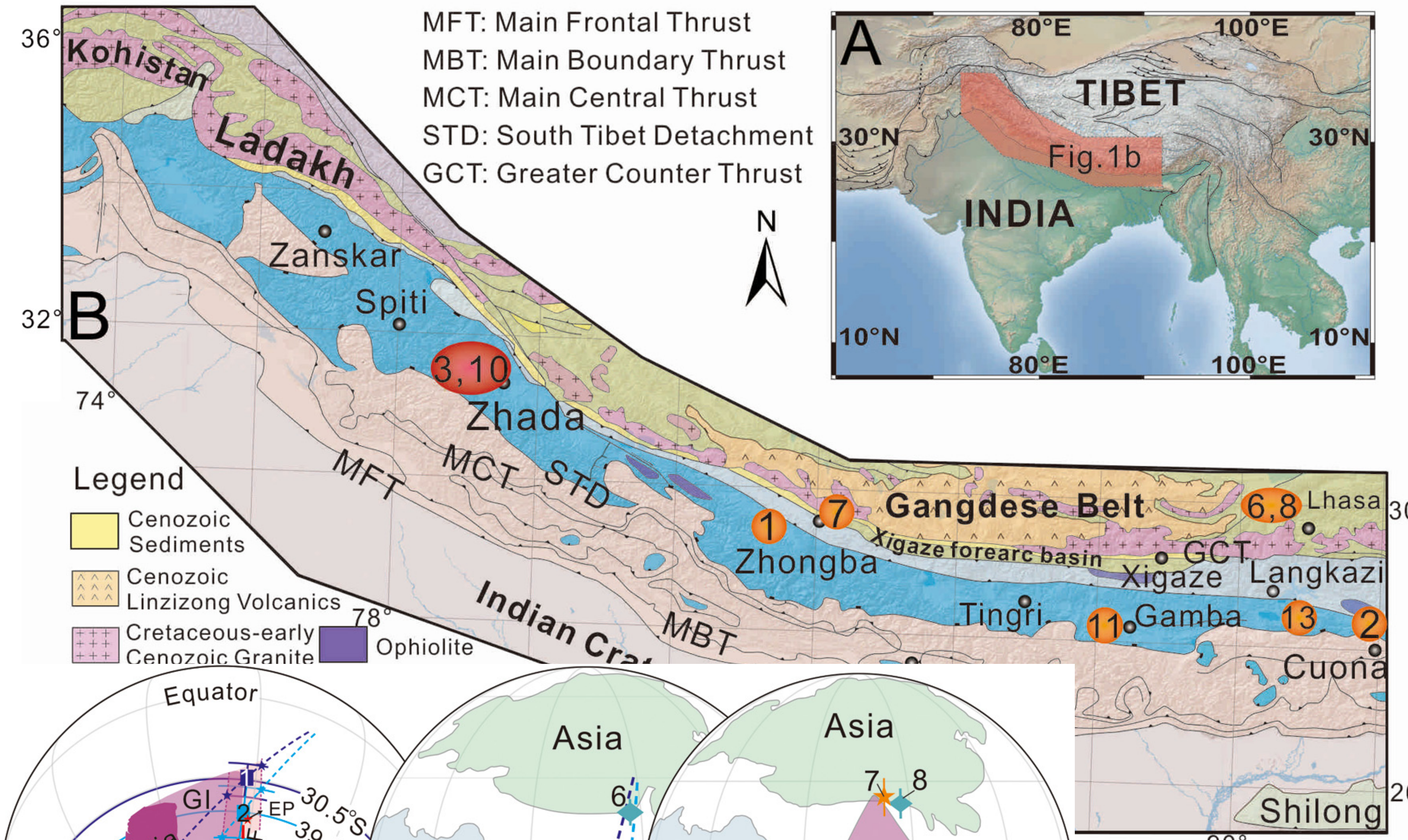
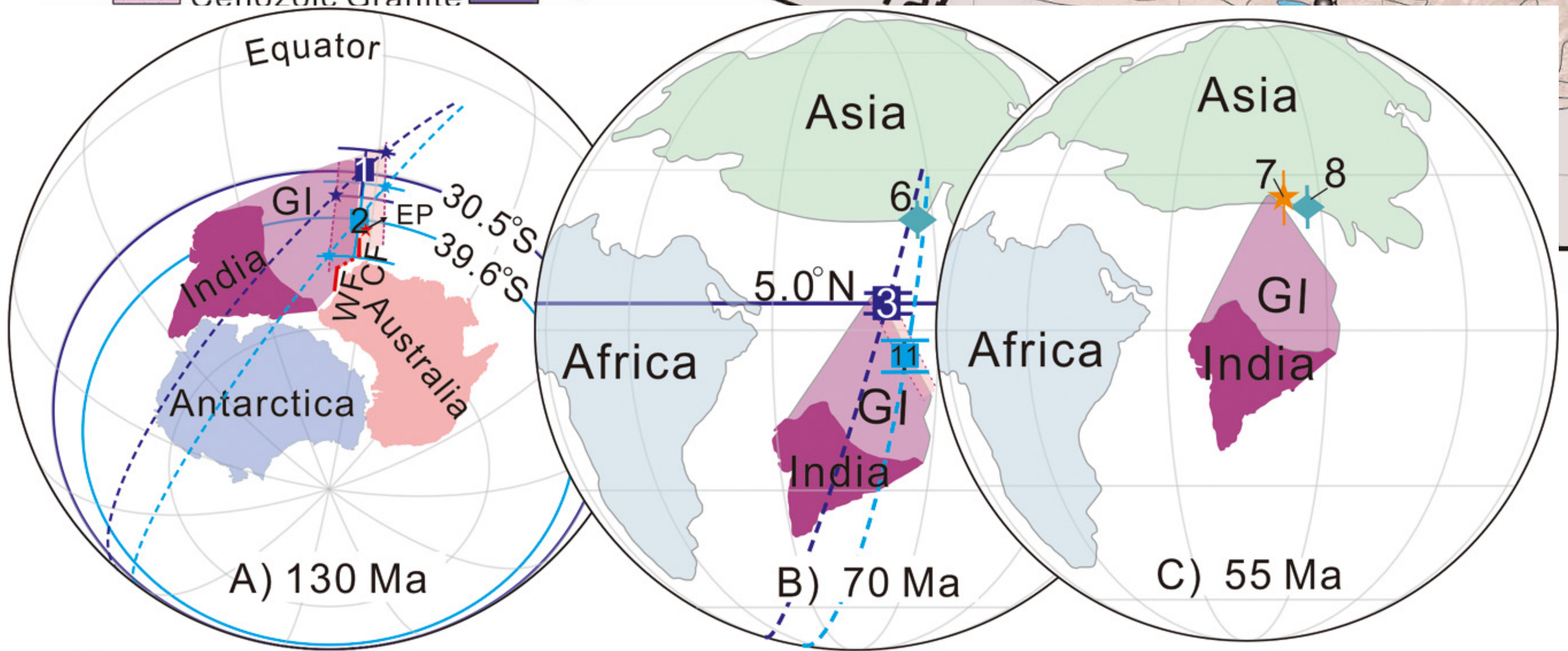
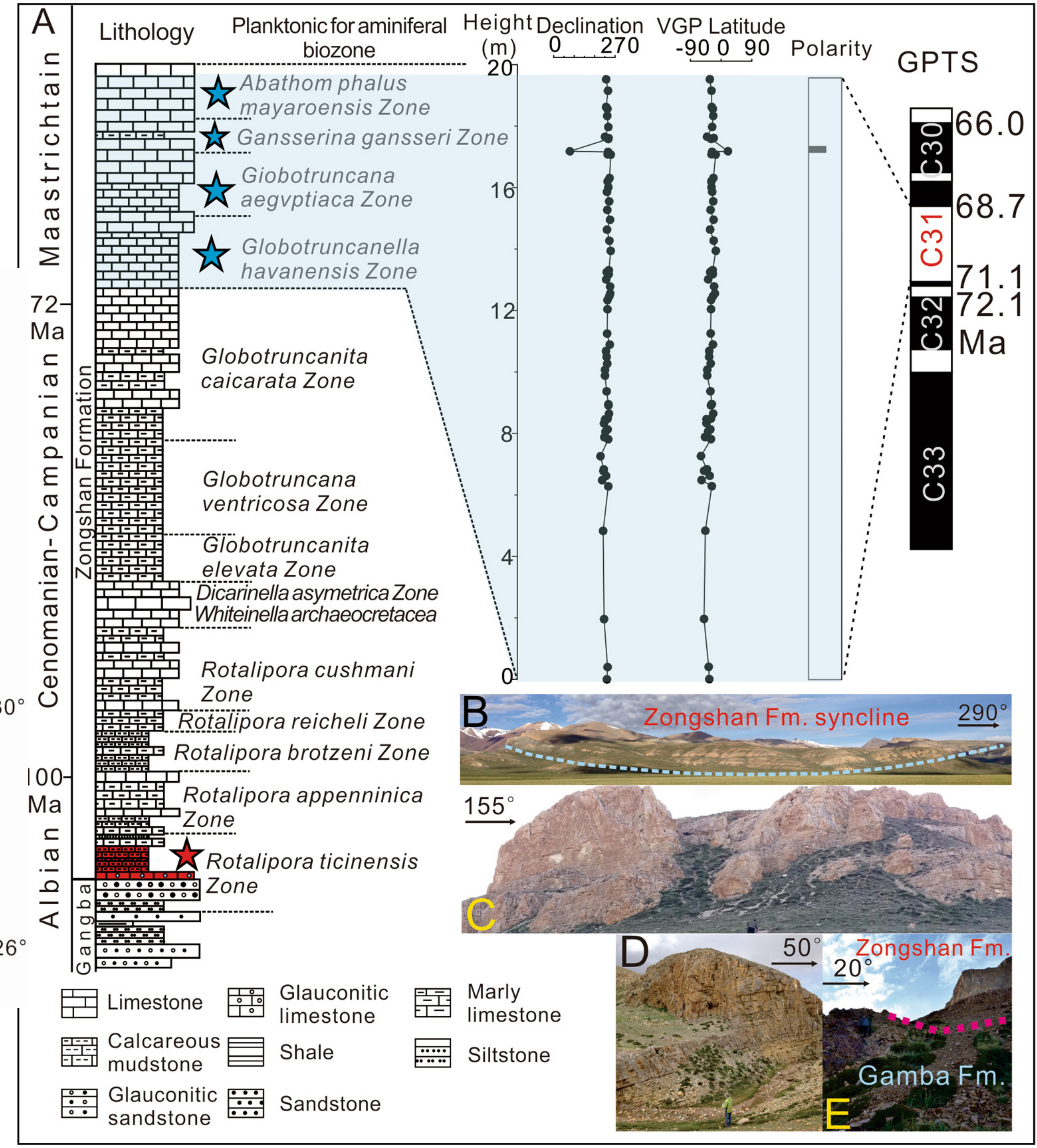
Expanse of Greater India in the late Cretaceous

Jun Meng [a,b,*], Stuart A. Gilder [c], Yalin Li [a], Chengshan Wang [a], Tao Liu [a]

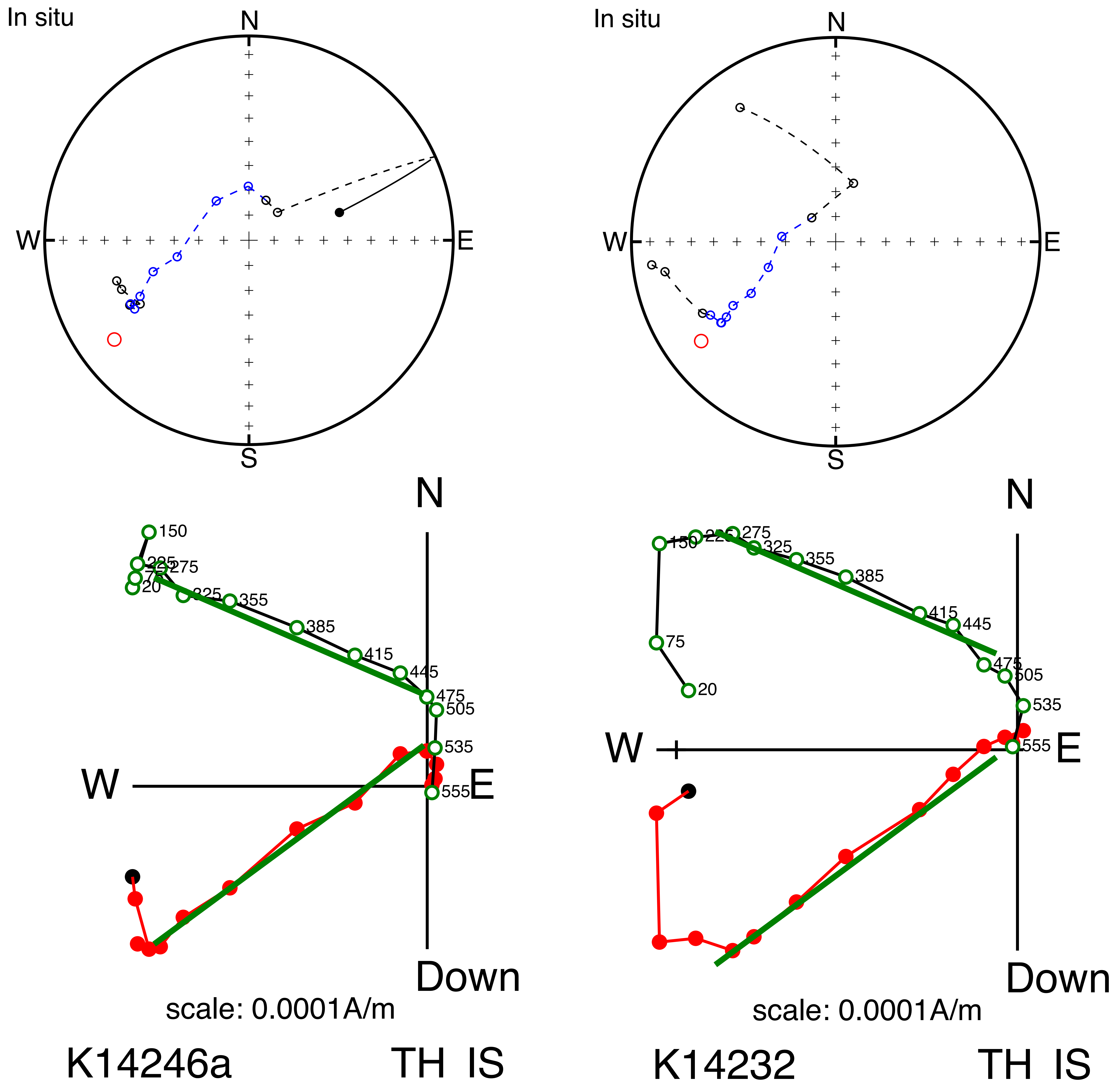
[a] School of Earth Sciences and Resources, China University of Geosciences Beijing, Beijing 100083, China
[b] Key Laboratory of Economic Stratigraphy and Palaeogeography, Chinese Academy of Sciences (Nanjing Institute of Geology and Palaeontology), China
[c] Department of Earth and Environmental Sciences, Ludwig Maximilians University, Theresienstr 41, 80333 Munich, Germany





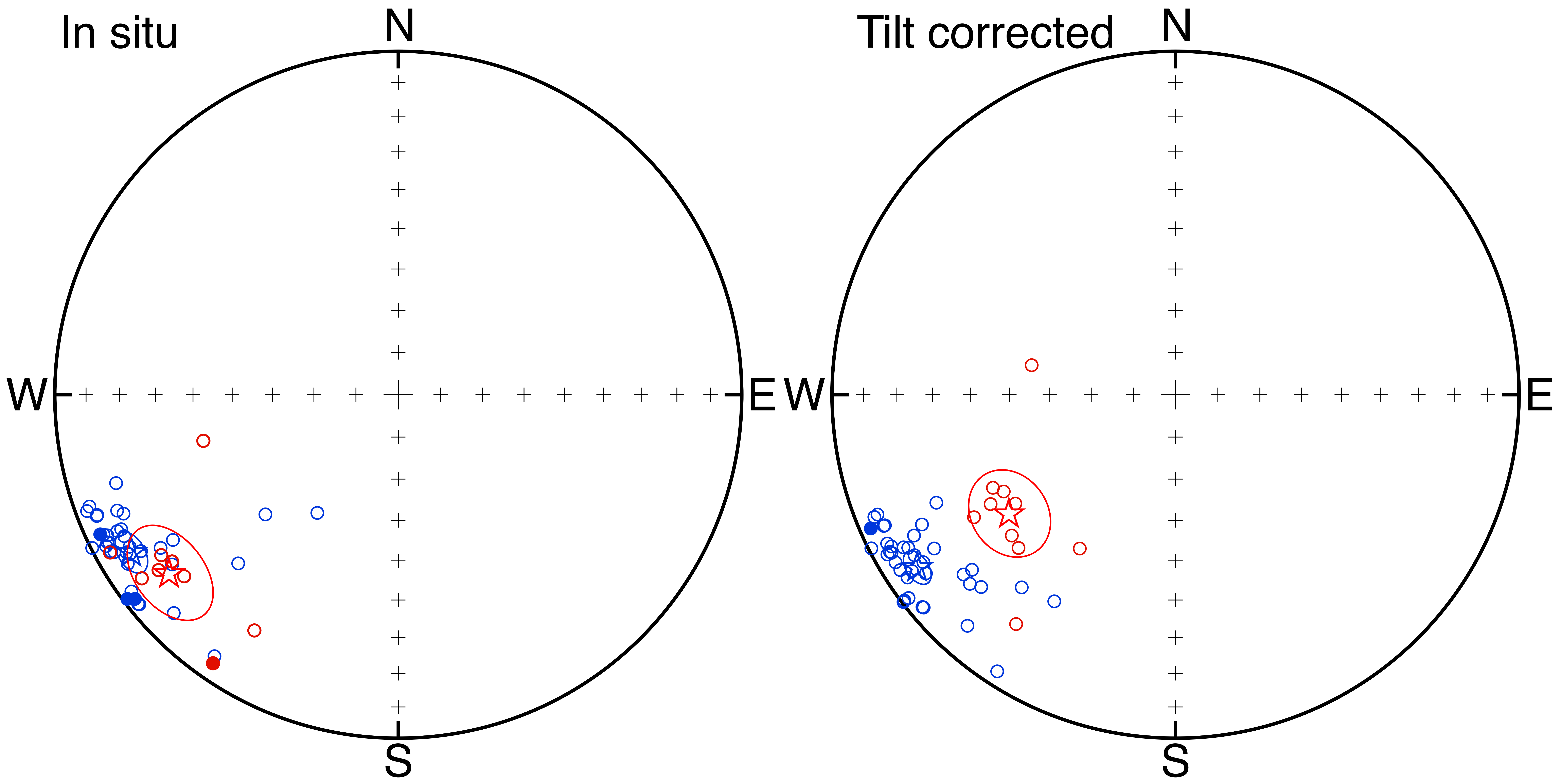


Albian
A
Sample ID: K14246
W UP
M/Mmax
1
0
Temp
555
150
NRM
325
445
475
555
N
Scale:
0.02 mA/m
B
Sample ID: K14232
W UP
N
150
75
NRM
325
385
475
535
555
M/Mmax
1
0
Temp
555
Scale:
0.02 mA/m
C
0
270
180
in-situ
D
0
90
180
tilt-corrected
Maastrichtian
A
Sample ID: K15543
W UP
330
150
510
75
NRM
N
Scale:
0.005 mA/m
M/Mmax
1
0
Temp
510
B
Sample ID: K15559
W UP
150
75
NRM
330
480
N
Scale: 0.01 mA/m
M/Mmax
1
0
Temp
480
C
in-situ
270
180
D = 236.4°
I = -13.2°
α95 = 4.0°
k = 18.3
n = 73
D
tilt-corrected
270
180
D = 233.8°
I = -9.6°
α95 = 3.0°
k= 32.5
n = 73
E
tau_1 (red), CDF (green)
1.0
0.6
0.2
-20
20
60
100
140
% Untilting
96-141% Unfolding



The high temperature component in Albian samples is really poorly defined.

But there is also a secondary component with unblocking temperatures in the range 250-450°C
(Not discussed in the Meng et al. paper)



The secondary component in Albian samples (red circles) is not different from the ChRM in Mastrichtian samples (blue circles).

Is the ChRM in Maastrichtian samples a primary magnetization?

Geochemistry, Geophysics, Geosystems

RESEARCH ARTICLE

10.1002/2014GC005624

Key Points:

- Low Cretaceous volcaniclastic sandstones retain a primary remanence
- Jurassic limestones were chemically remagnetized
- Tibetan Himalaya was part of India plate in Early Cretaceous

Supporting Information:

- Supporting Information

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W. Huang,
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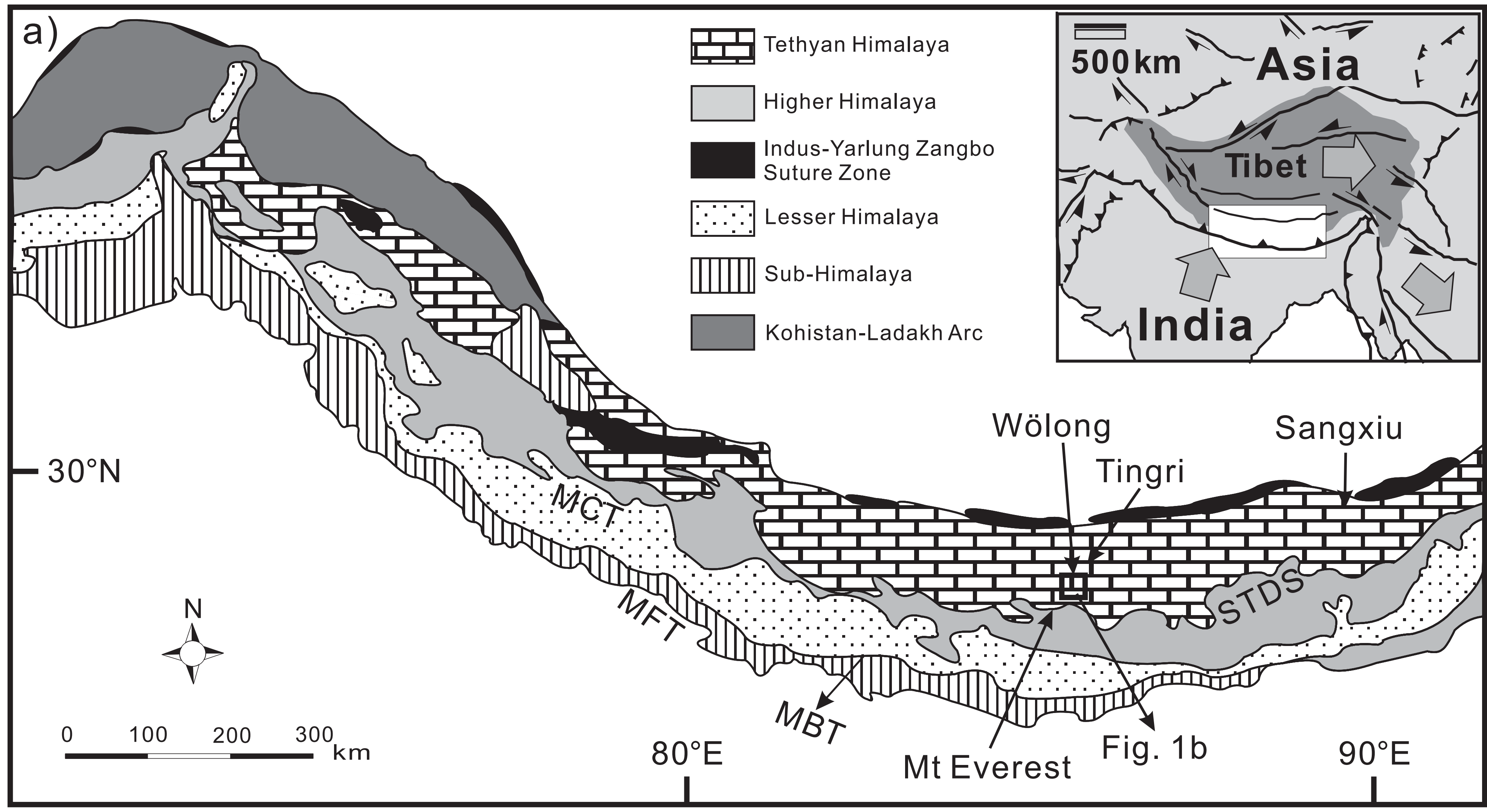
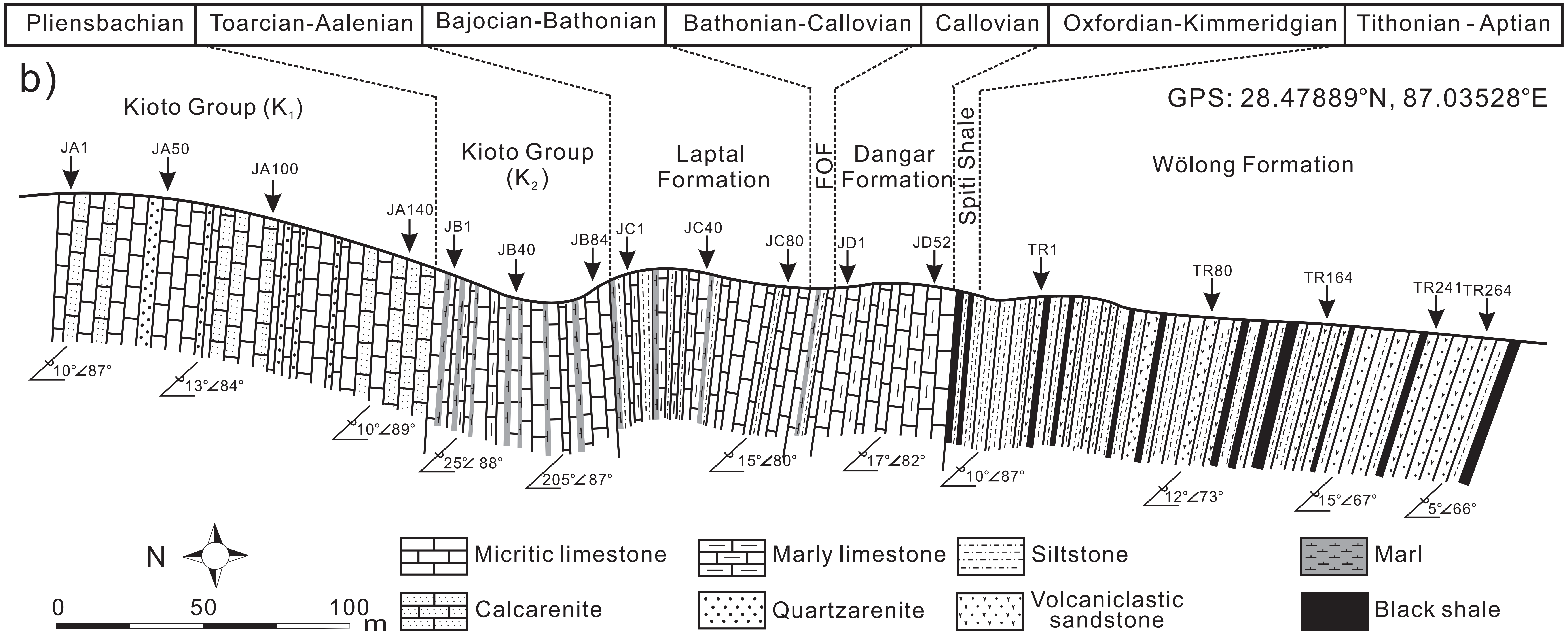
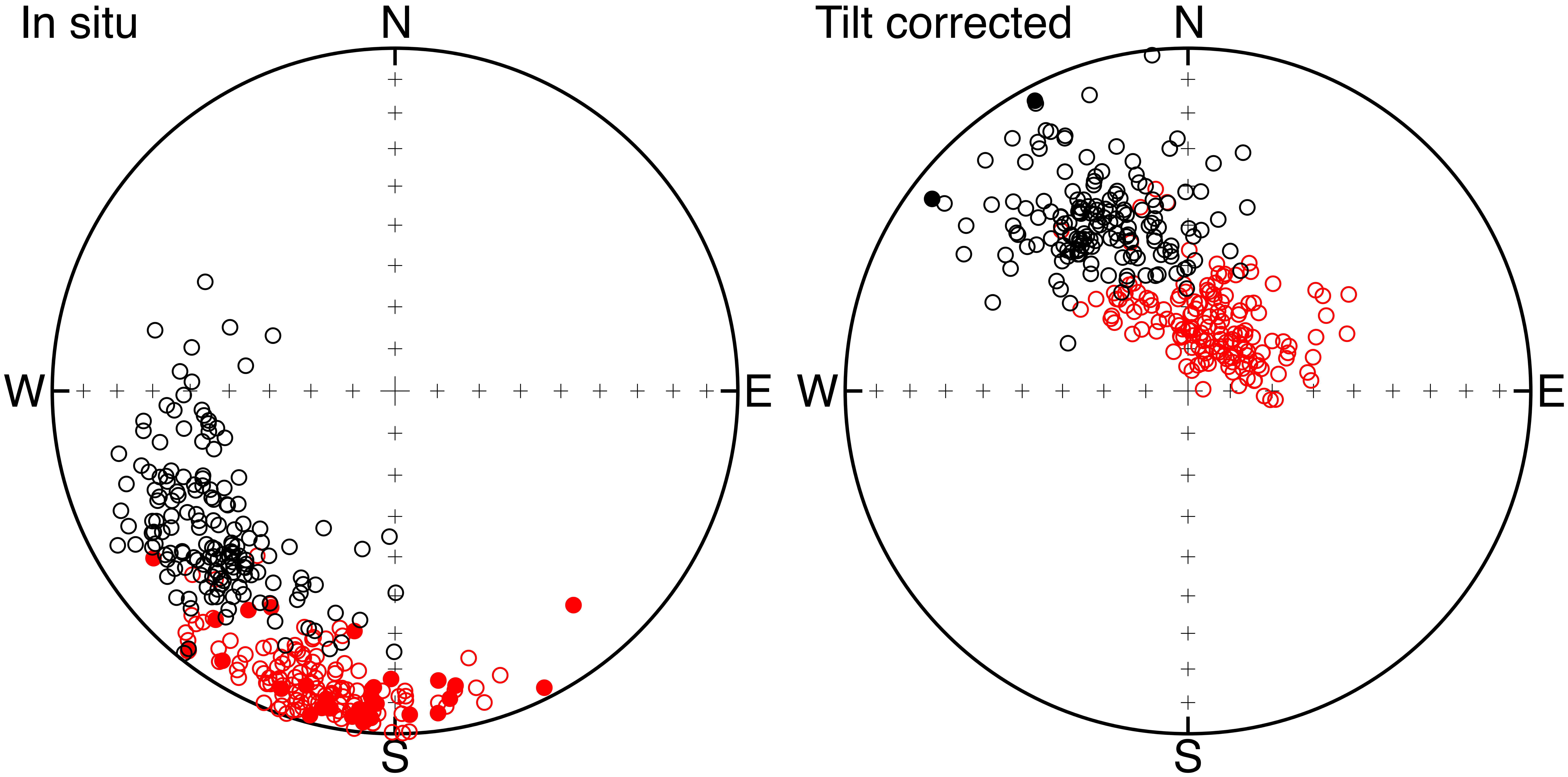
Paleolatitudes of the Tibetan Himalaya from primary and secondary magnetizations of Jurassic to Lower Cretaceous sedimentary rocks

Wentao Huang[1,2], Douwe J. J. van Hinsbergen[2], Mark J. Dekkers[2], Eduardo Garzanti[3], Guillaume Dupont-Nivet[1,2,4,5], Peter C. Lippert[6,7], Xiaochun Li[8], Marco Maffione[2], Cor G. Langereis[2], Xiumian Hu[9], Zhaojie Guo[1], and Paul Kapp[6]

[1]Key Laboratory of Orogenic Belts and Crustal Evolution, Ministry of Education, School of Earth and Space Sciences, Peking University, Beijing, China, [2]Department of Earth Sciences, Utrecht University, Utrecht, Netherlands, [3]Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milano, Italy, [4]Géosciences Rennes, UMR 6118, Université de Rennes 1, Rennes, France, [5]Institute of Earth and Environmental Science, University of Potsdam, Potsdam, Germany, [6]Department of Geosciences, University of Arizona, Tucson, Arizona, USA, [7]Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, USA, [8]Department of Earth Sciences, University of Hong Kong, Hong Kong, China, [9]State Key Laboratory of Mineral Deposit Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing, China







Jurassic carbonates
And
Cretaceous sandstones

Huang et al. consider that the ChRM in the sandstone is primary while it is secondary in the carbonates but pre tectonic

Possibility : both are secondary components similar in in situ coordinates to the components in previous slides

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE

10.1002/2016JB013662

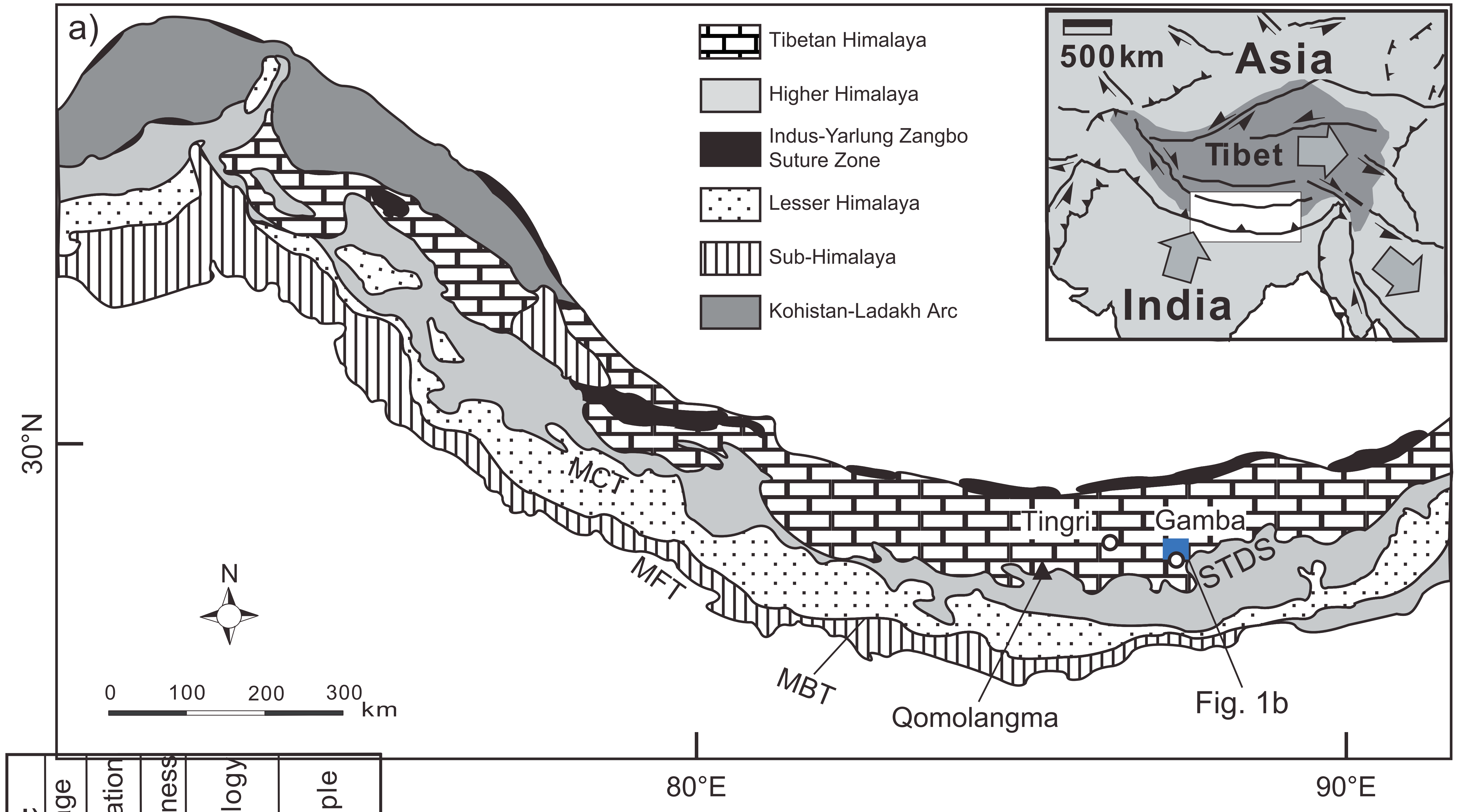
Special Section:
Rock Physics of the Upper Crust

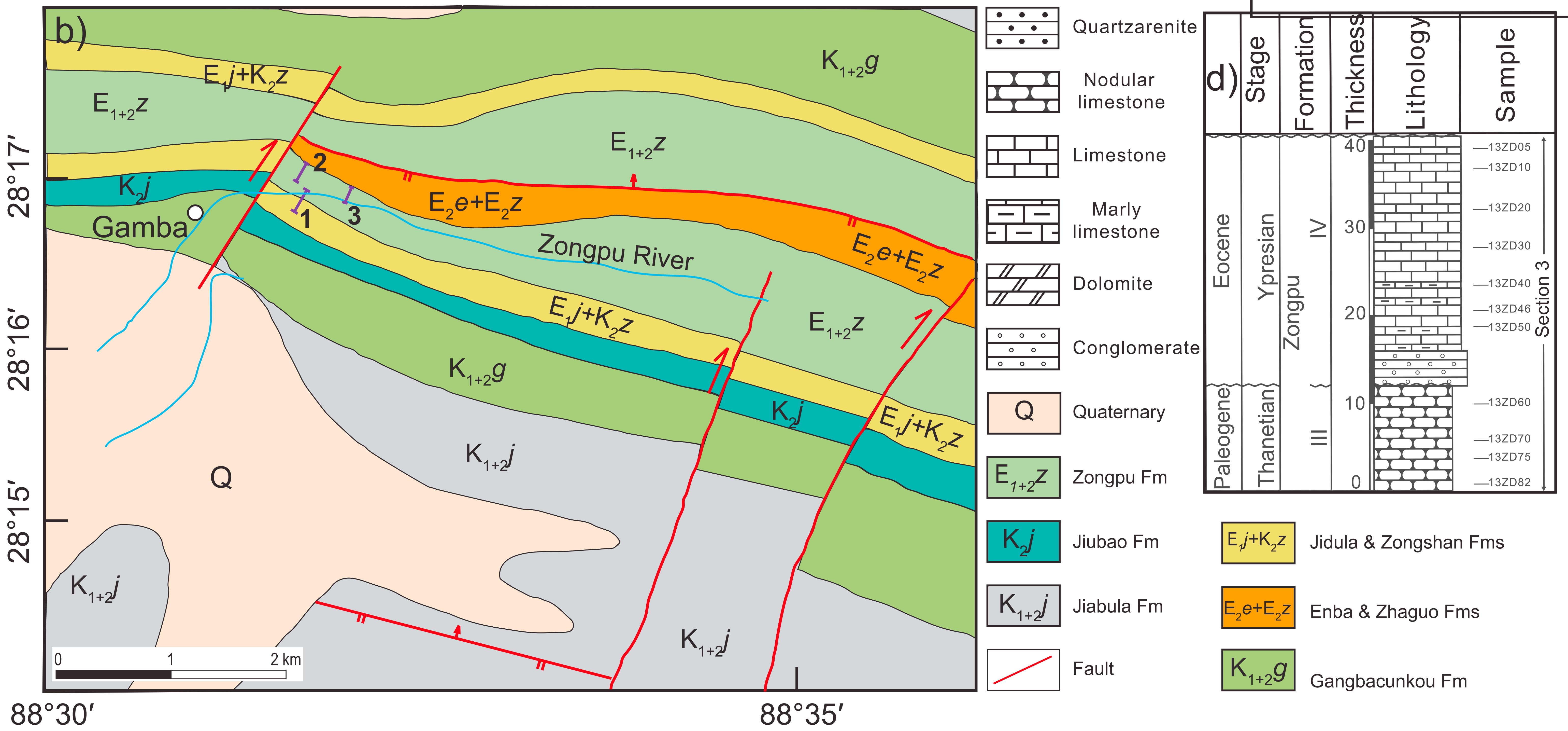
Key Points:
- Zongpu carbonate rocks in the Gamba area of southern Tibet are chemically remagnetized
- Remagnetization was induced by authigenic magnetite formed during oxidation of early diagenetic pyrite
- Collision at ~59 Ma requires a huge Greater India of ~3500–3800 km in early Paleogene, much larger than the width for the Early Cretaceous

Remagnetization of the Paleogene Tibetan Himalayan carbonate rocks in the Gamba area: Implications for reconstructing the lower plate in the India-Asia collision

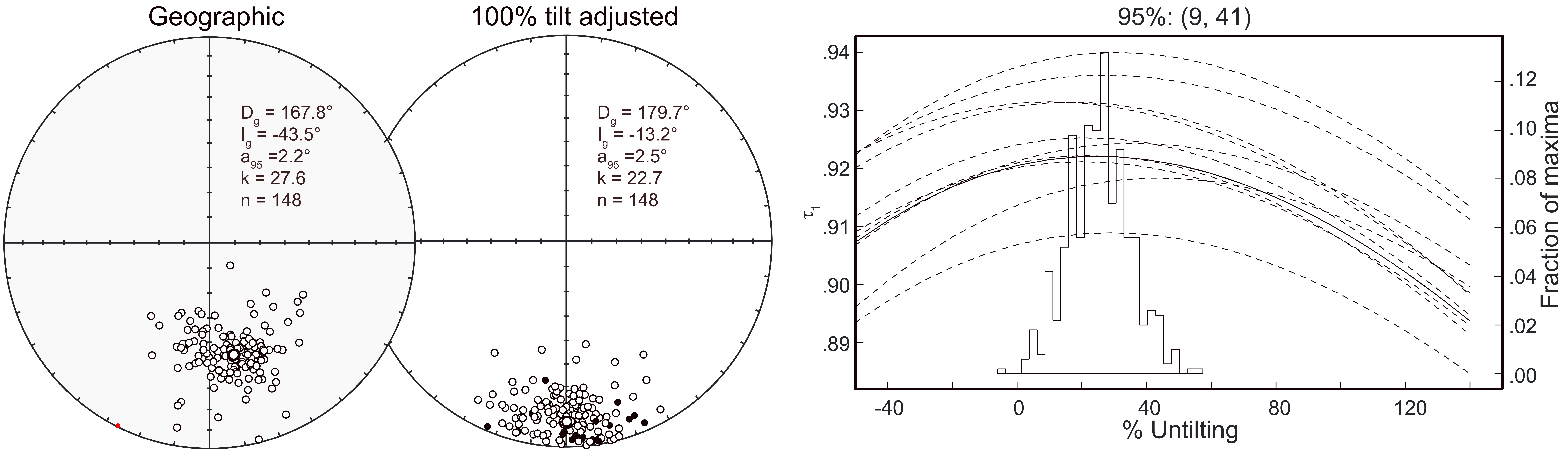
Wentao Huang[1,2,3], Peter C. Lippert[3], Michael J. Jackson[4], Mark J. Dekkers[5], Yang Zhang[1], Juan Li[6], Zhaojie Guo[1], Paul Kapp[2], and Douwe J. J. van Hinsbergen[5]

[1]Key Laboratory of Orogenic Belts and Crustal Evolution, Ministry of Education, School of Earth and Space Sciences, Peking University, Beijing, China, [2]Department of Geosciences, University of Arizona, Tucson, Arizona, USA, [3]Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, USA, [4]Institute for Rock Magnetism, Department of Earth Sciences, University of Minnesota, Minneapolis, Minnesota, USA, [5]Department of Earth Sciences, Utrecht University, Utrecht, Netherlands, [6]State Key Laboratory of Mineral Deposit Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing, China



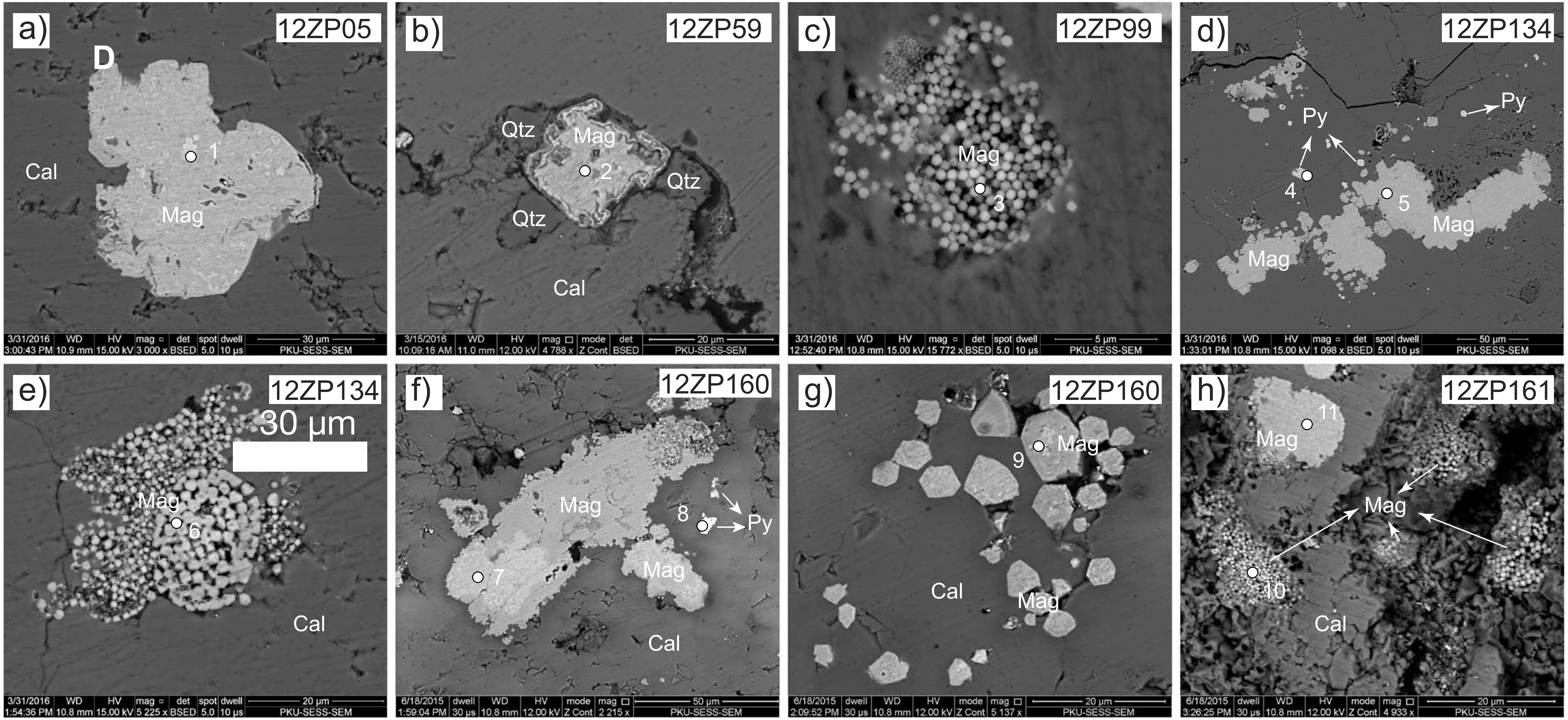


(c) Members I-IV



Fold tests are often ambiguous with most of the samples on the same fold limb.

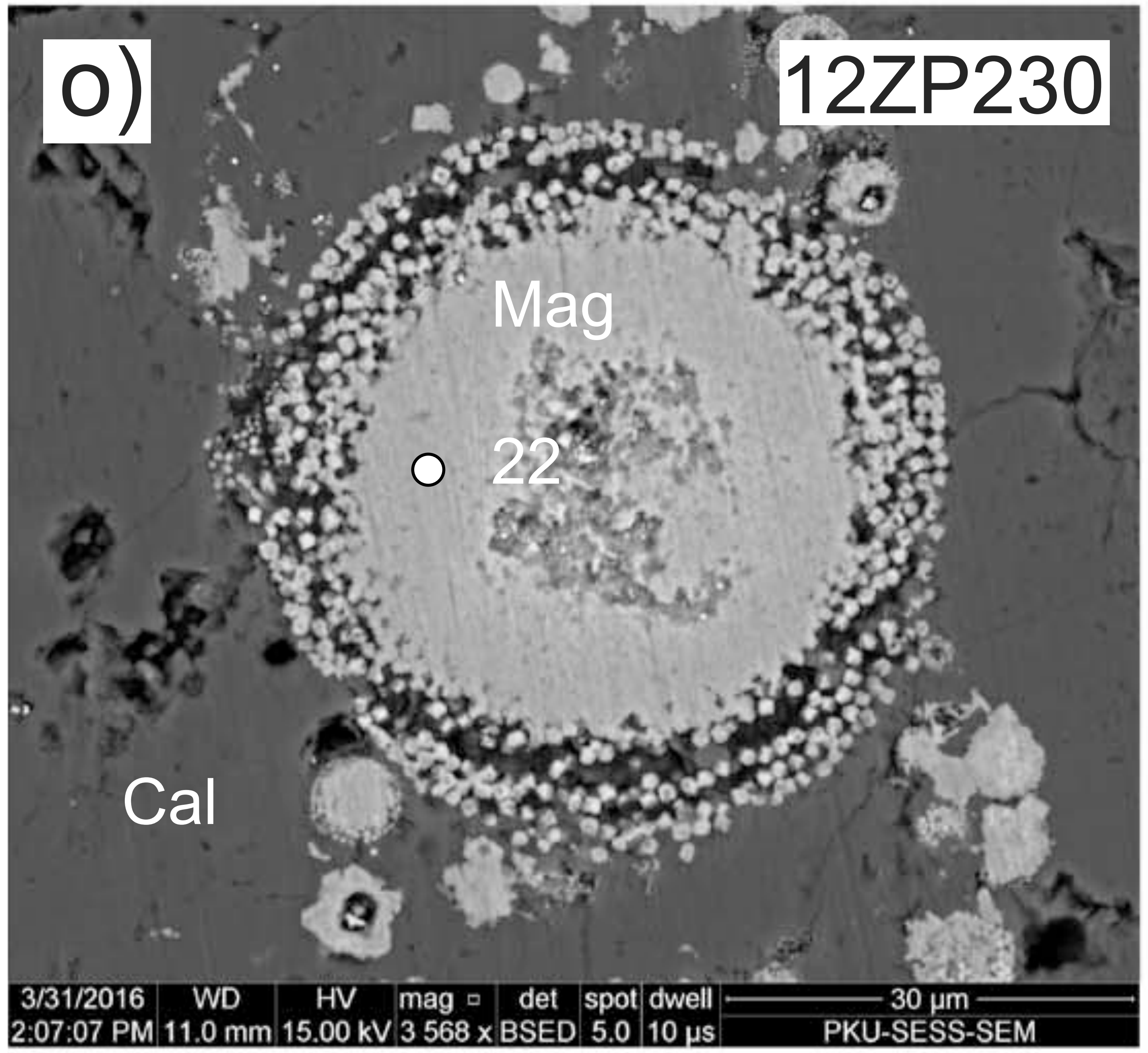
Could the ChRM be secondary?

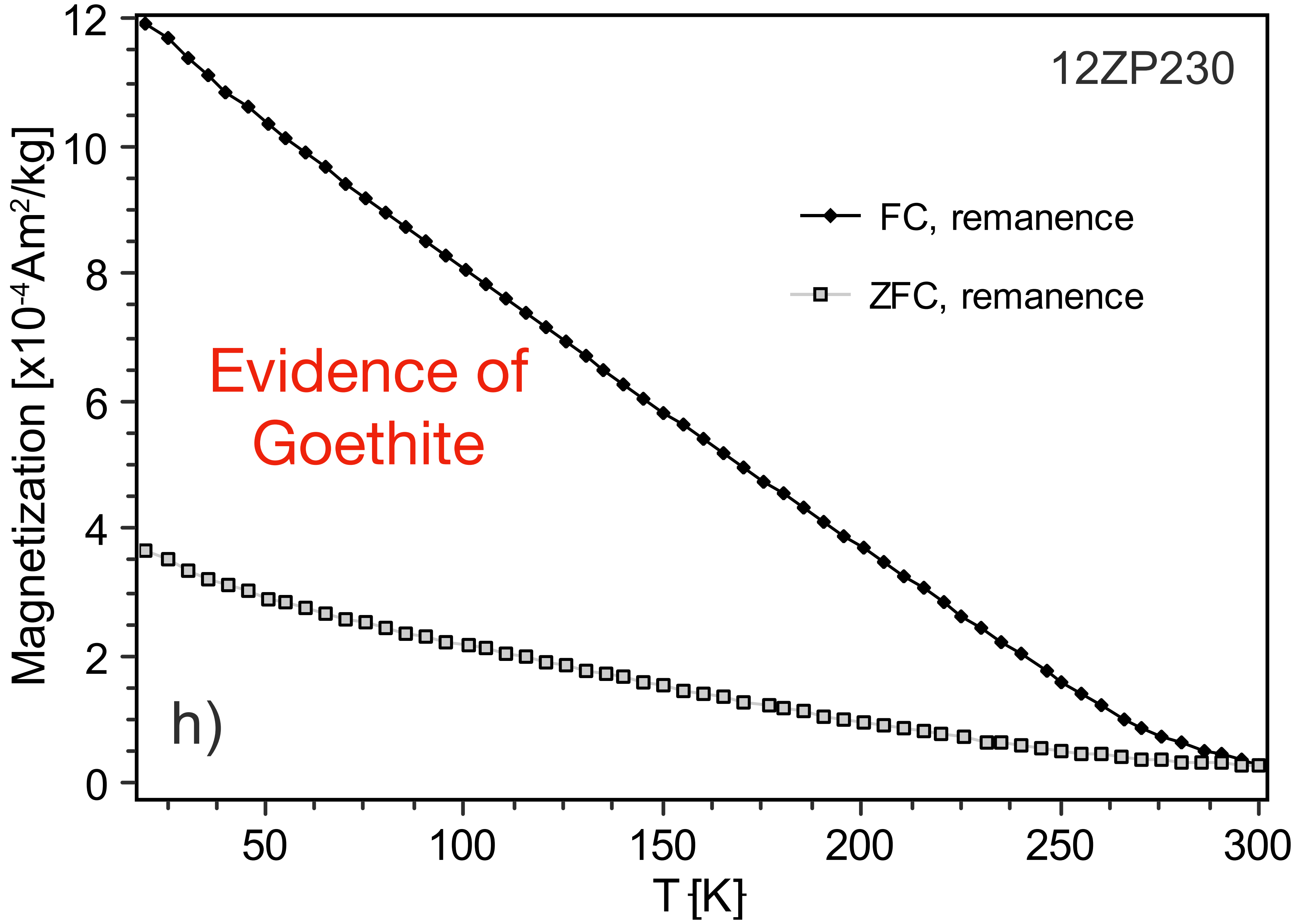


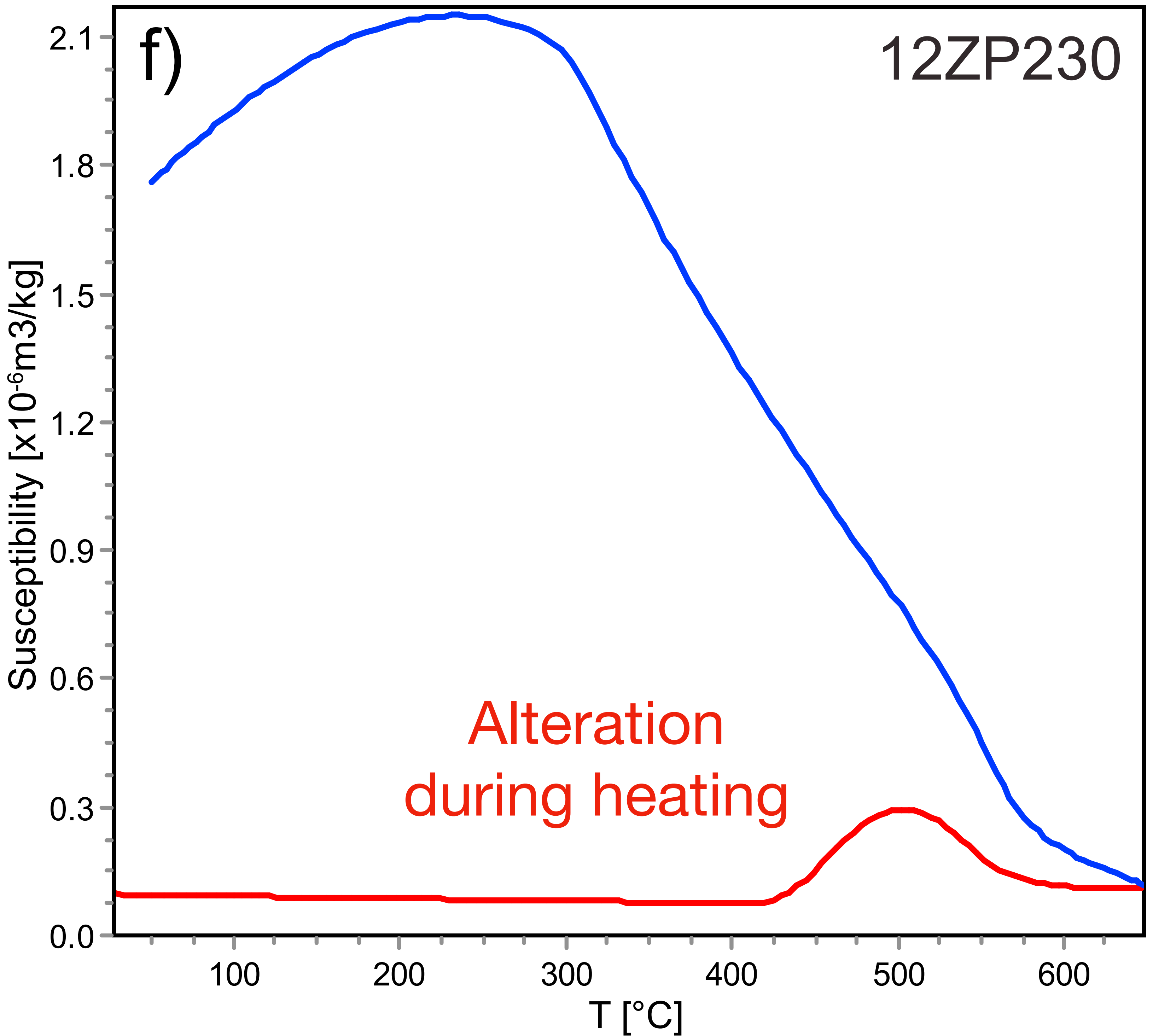
Huang et al. interpret the SEM/EDS data as evidence for the transformation of pyrite to magnetite.

But the amount of magnetite should be huge and should result in strong magnetic properties

and this is not what it is observed







No evidence for a large amount of magnetite in the samples.
But in some cases there is goethite

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE
10.1002/2017JB013987

Key Points:
- Jurassic to Paleogene Himalayan carbonates are pervasively remagnetized by oxidation of diagenetic iron sulfide to fine-grained magnetite
- Lower Cretaceous volcaniclastic rocks retain a primary remanence
- Thorough rock magnetic and petrographic information are more reliable criteria for diagnosing remagnetization in carbonates than filed tests

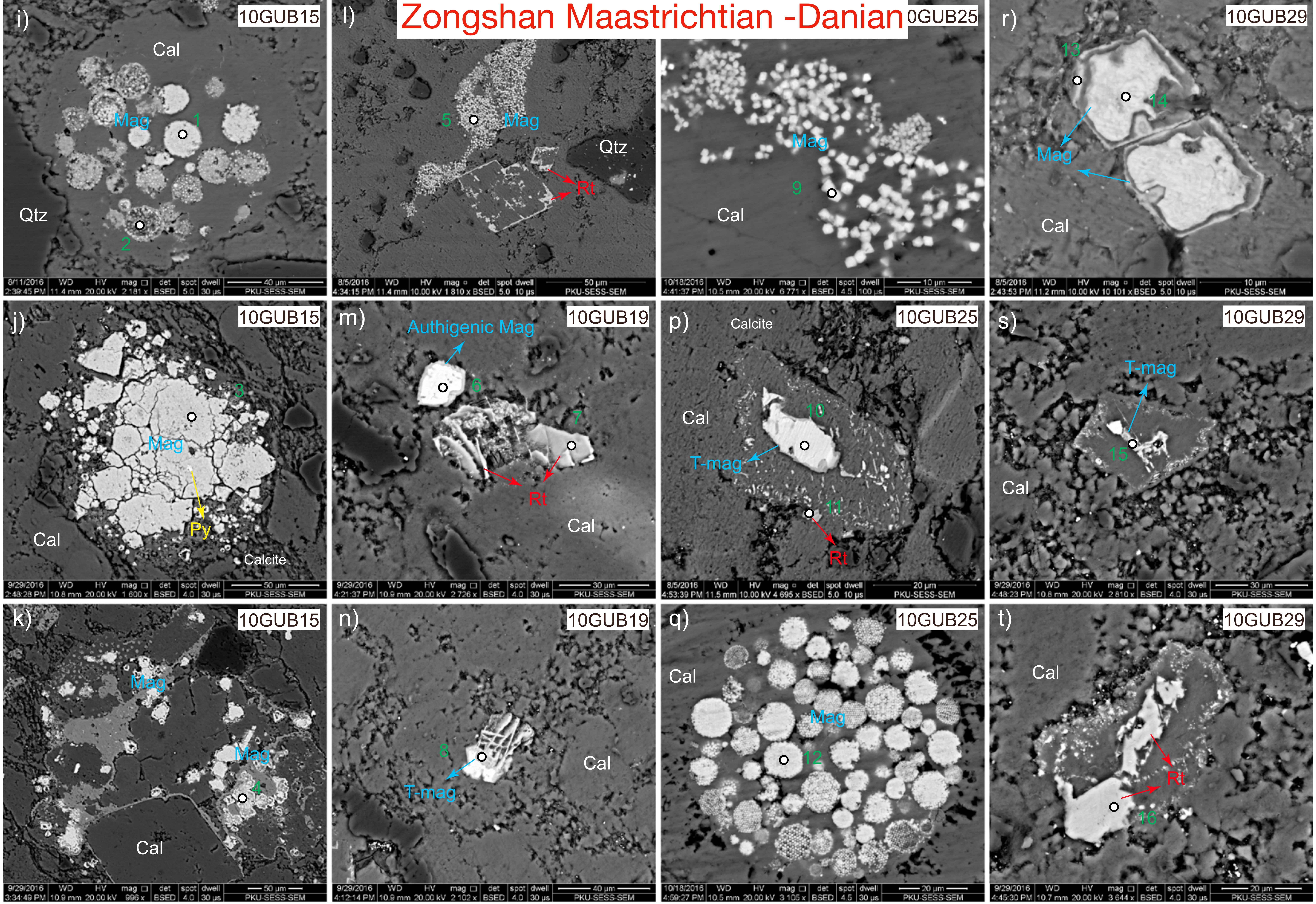
Remagnetization of carbonate rocks in southern Tibet: Perspectives from rock magnetic and petrographic investigations

Wentao Huang[1,2,3], Peter C. Lippert[3], Yang Zhang[1], Michael J. Jackson[4], Mark J. Dekkers[5], Juan Li[6], Xiumian Hu[6], Bo Zhang[1], Zhaojie Guo[1], and Douwe J. J. van Hinsbergen[5]

[1]Key Laboratory of Orogenic Belts and Crustal Evolution, Ministry of Education, School of Earth and Space Sciences, Peking University, Beijing, China, [2]Department of Geosciences, University of Arizona, Tucson, Arizona, USA, [3]Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, USA, [4]Institute for Rock Magnetism, Department of Earth Sciences, University of Minnesota, Twin Cities, Minneapolis, Minnesota, USA, [5]Department of Earth Sciences, Utrecht University, Utrecht, Netherlands, [6]School of Earth Sciences and Engineering, Nanjing University, Nanjing, China

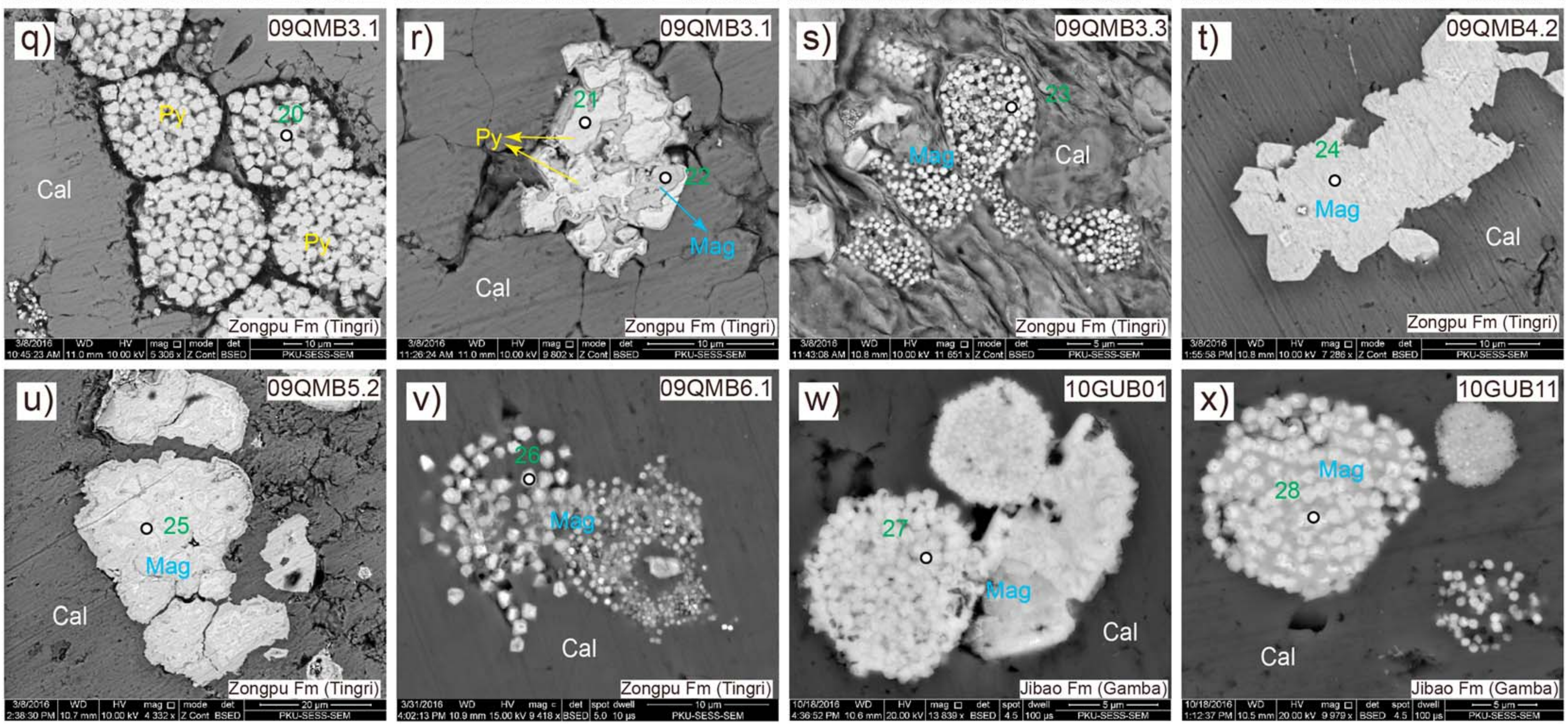
Same interpretation than in the previous paper

Same problems with SEM/EDS data



Zongshan Maastrichtian -Danian
i)
10GUB15
Cal
Mag
1
Qtz
2
l)
5
Mag
Qtz
Rt
0GUB25
Mag
9
Cal
r)
10GUB29
13
14
Mag
Cal
j)
10GUB15
3
Mag
Py
Cal
Calcite
m)
10GUB19
Authigenic Mag
6
7
Rt
Cal
p)
Calcite
10GUB25
Cal
10
T-mag
11
Rt
s)
10GUB29
T-mag
15
Cal
k)
10GUB15
Mag
Mag
4
Cal
n)
10GUB19
8
T-mag
Cal
q)
10GUB25
Cal
Mag
12
t)
10GUB29
Cal
Rt
16

Tingri (Zongpu Fm)- Gamba (Jiubao Fm)



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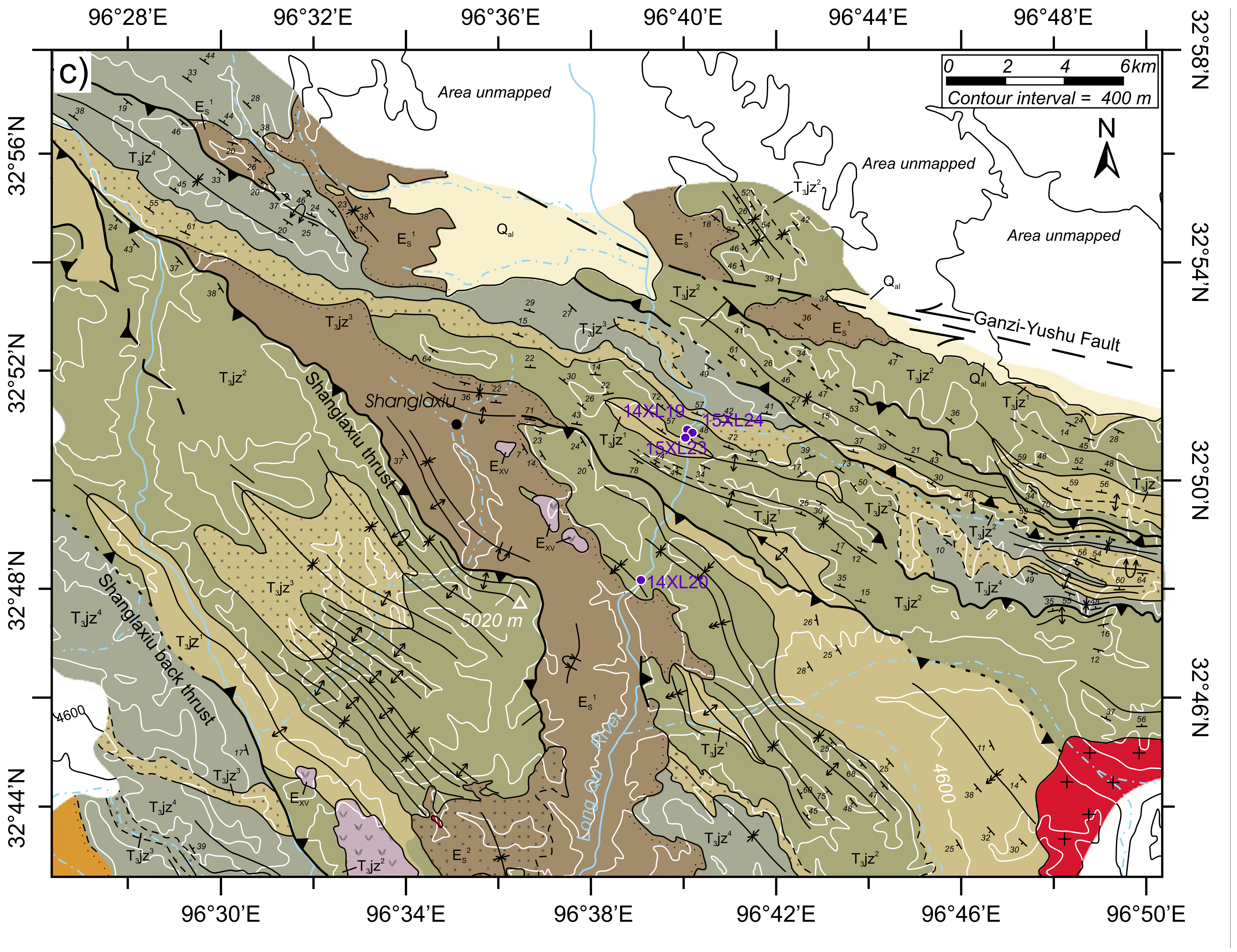
Challenges in isolating primary remanent magnetization from Tethyan carbonate rocks on the Tibetan Plateau: Insight from remagnetized Upper Triassic limestones in the eastern Qiangtang block

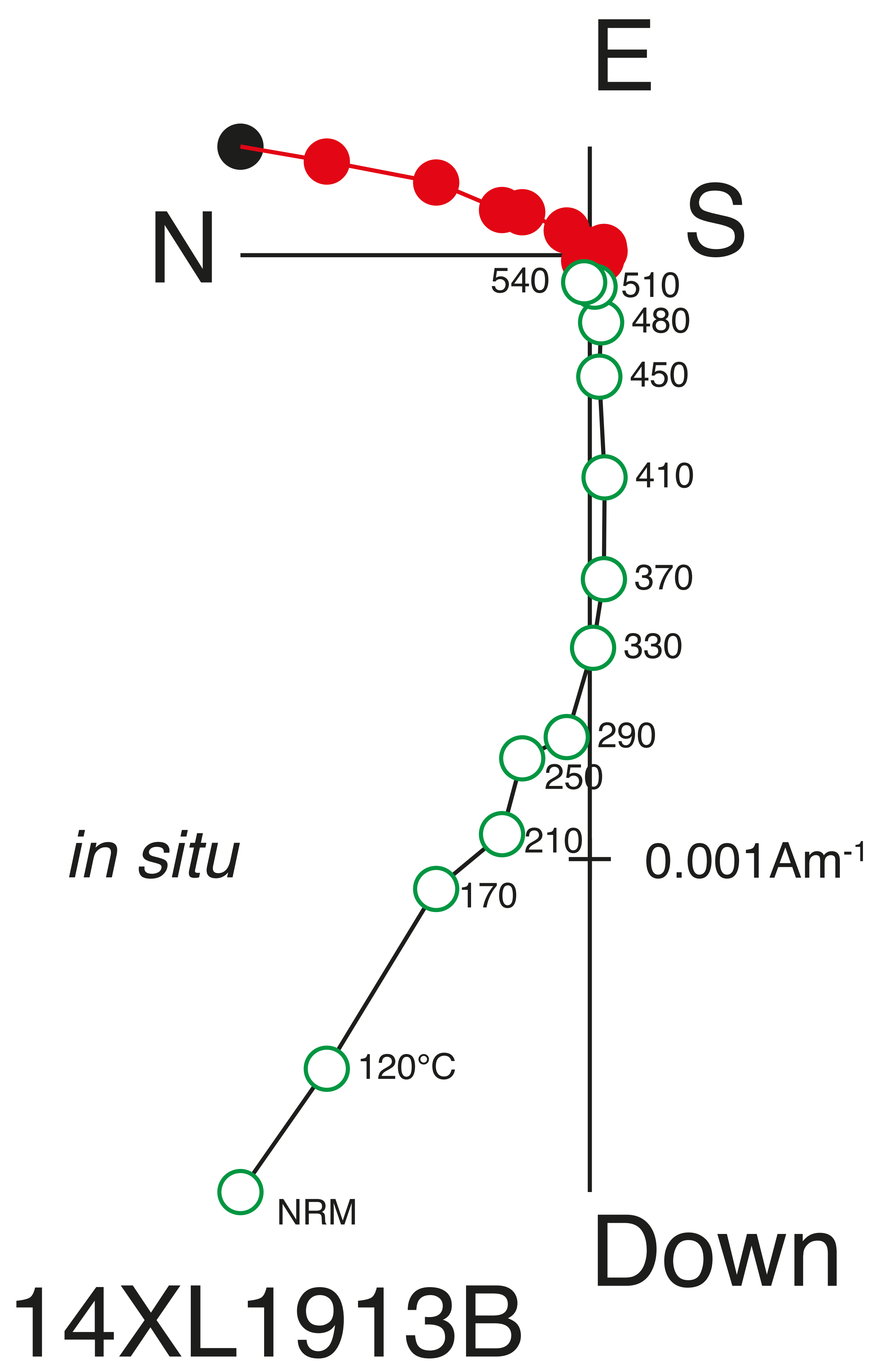
Wentao Huang[a,*], Michael J. Jackson[b], Mark J. Dekkers[c], Yang Zhang[d], Bo Zhang[d], Zhaojie Guo[d], Guillaume Dupont-Nivet[d,e,f]

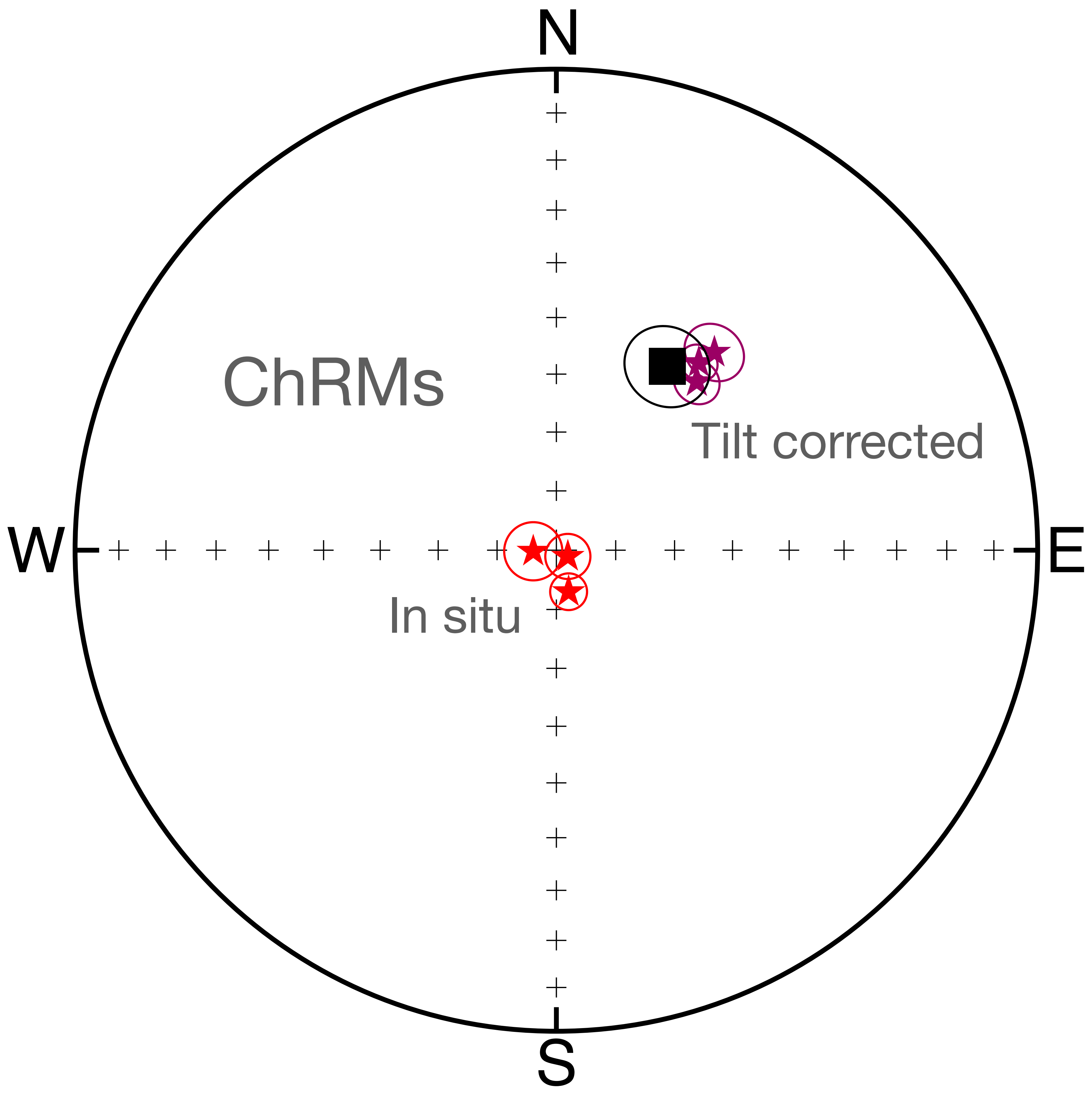
[a] Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY 14627, USA
[b] Institute for Rock Magnetism, Department of Earth Sciences, University of Minnesota, MN, USA
[c] Department of Earth Sciences, Utrecht University, Utrecht, the Netherlands
[d] Key Laboratory of Orogenic Belts and Crustal Evolution, Ministry of Education, School of Earth and Space Sciences, Peking University, Beijing, China
[e] University of Rennes 1, CNRS INSU UMR 6118, Geosciences, Rennes, France
[f] Institute for Earth and Environmental Science, Universität Potsdam, Potsdam, Germany



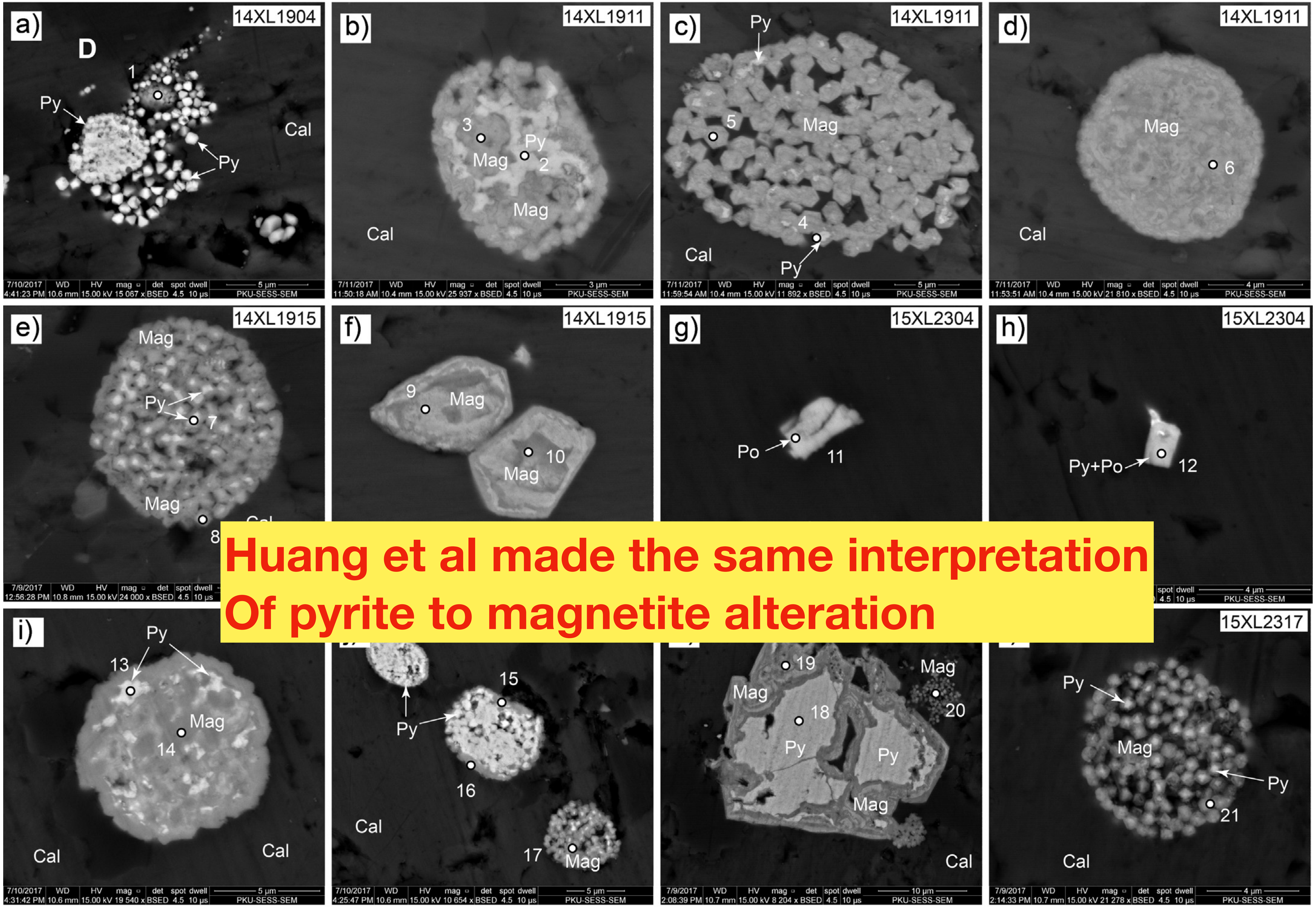
Same story on Triassic carbonates from the eastern Qiangtang.
Huang et al. use SEM/EDS data to interpret the paleomagnetic data.

Thermal demagnetizations just show the removal of a recent-field

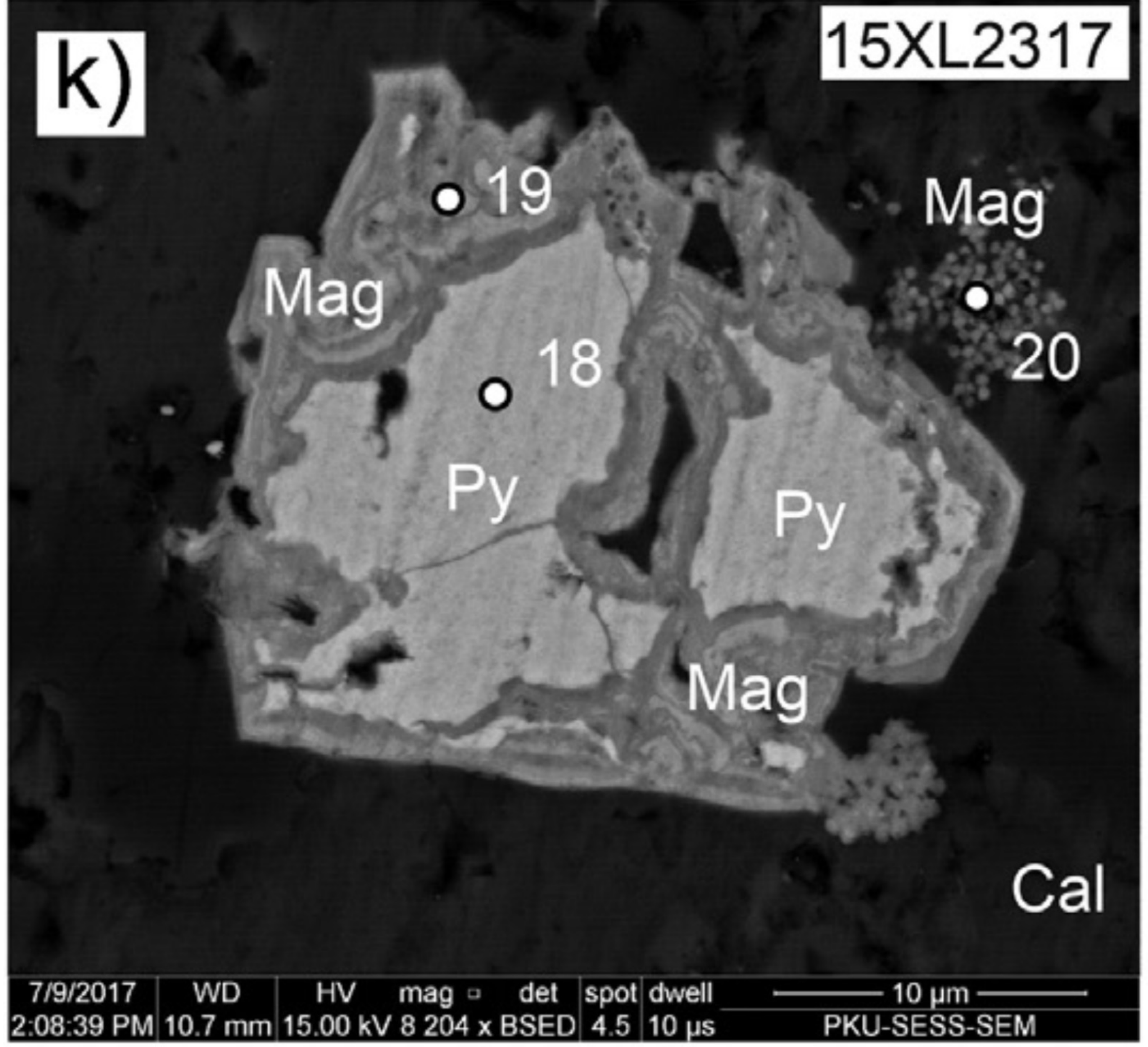


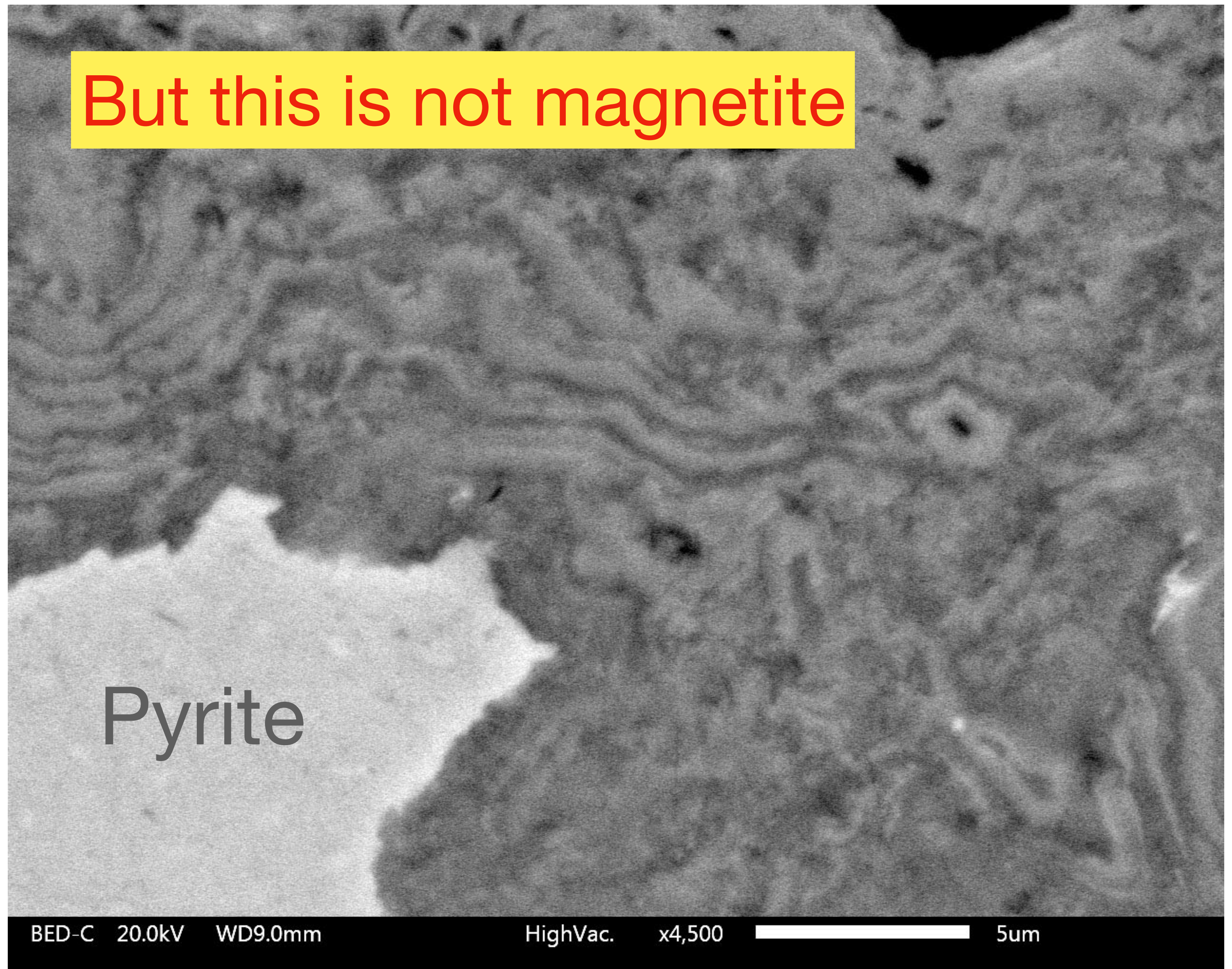


The in situ high temperature component has steep inclination and is clearly pre-tectonic. The tilt corrected inclination is close to the expected one (square).



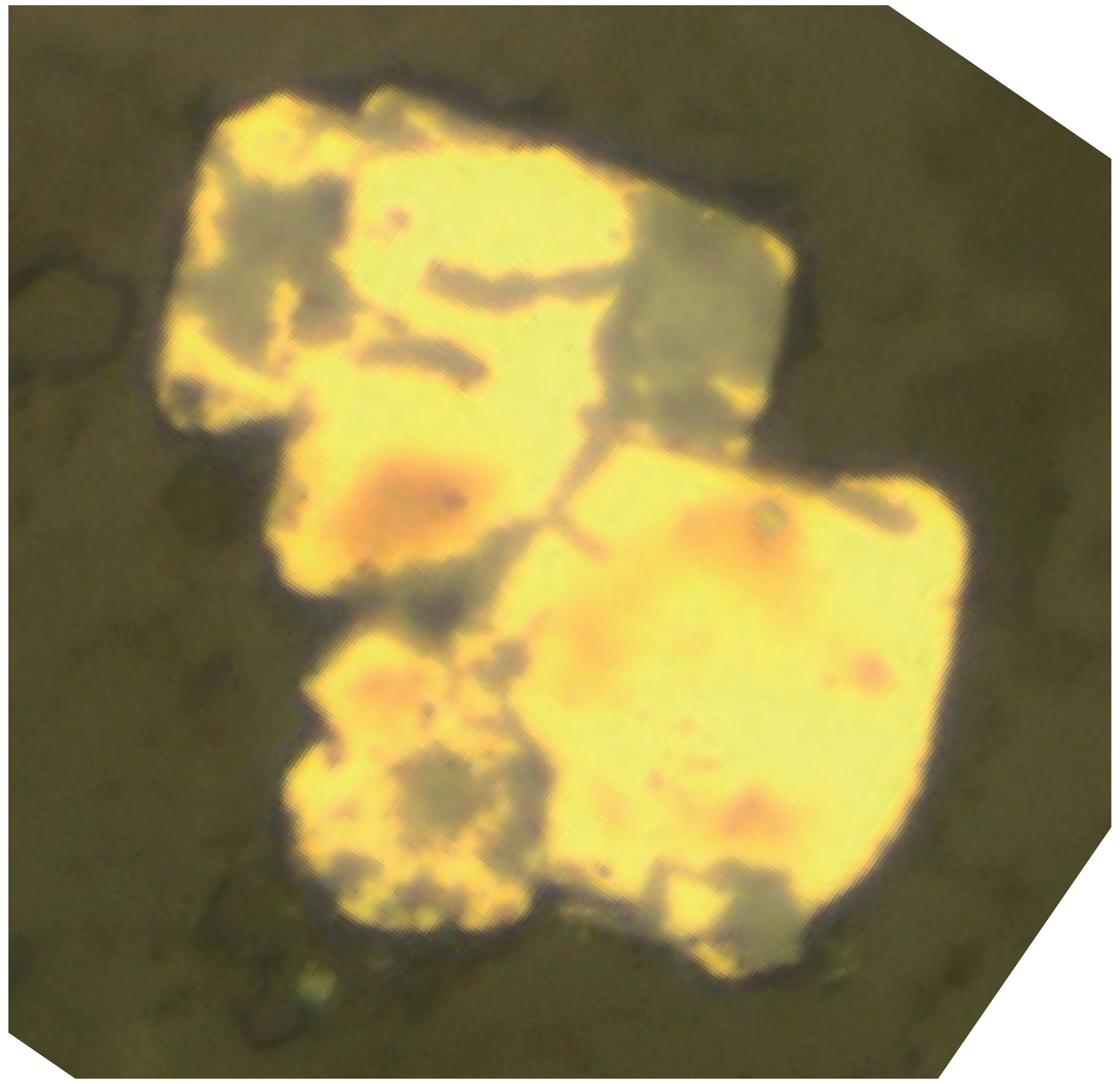
Huang et al made the same interpretation
Of pyrite to magnetite alteration

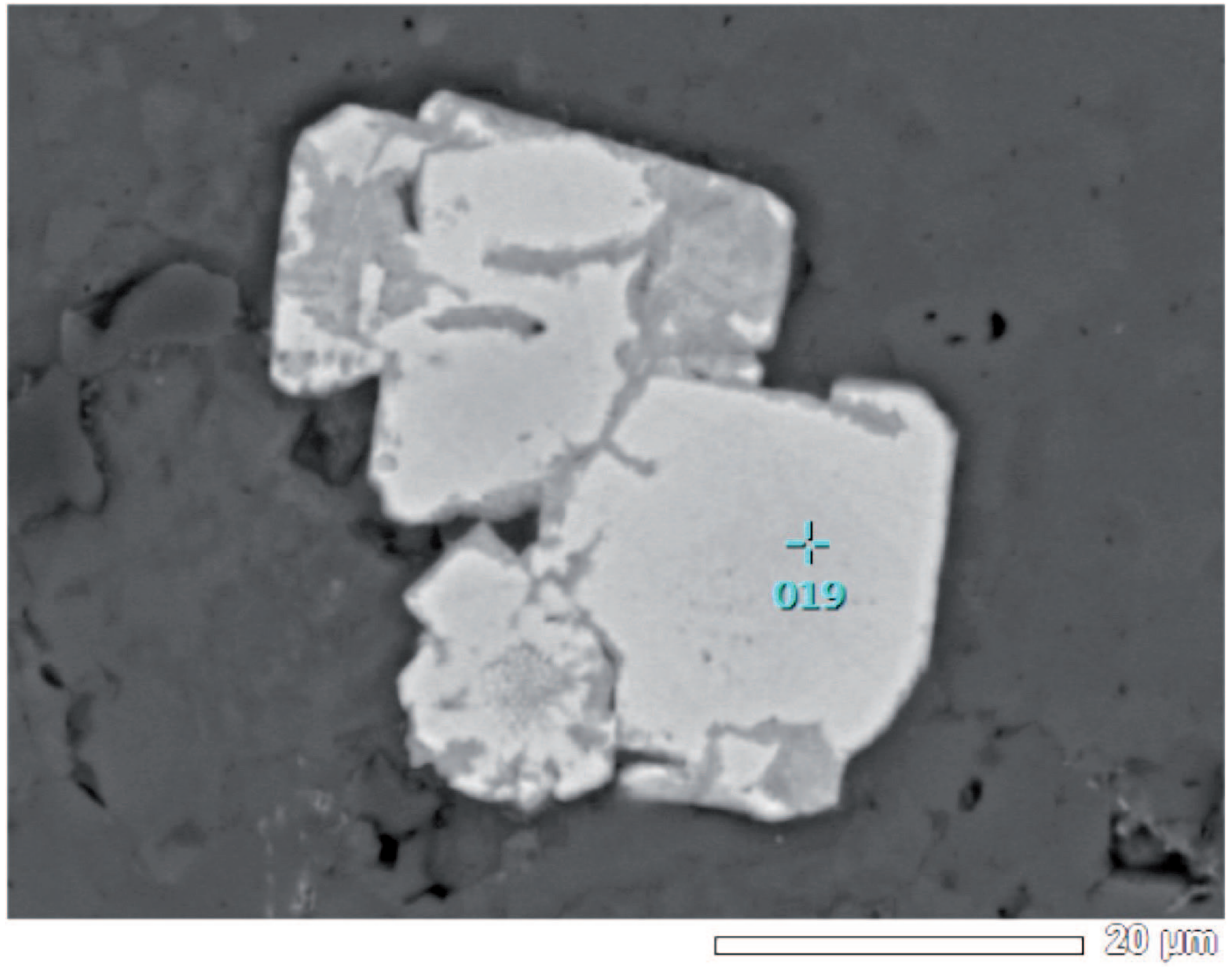


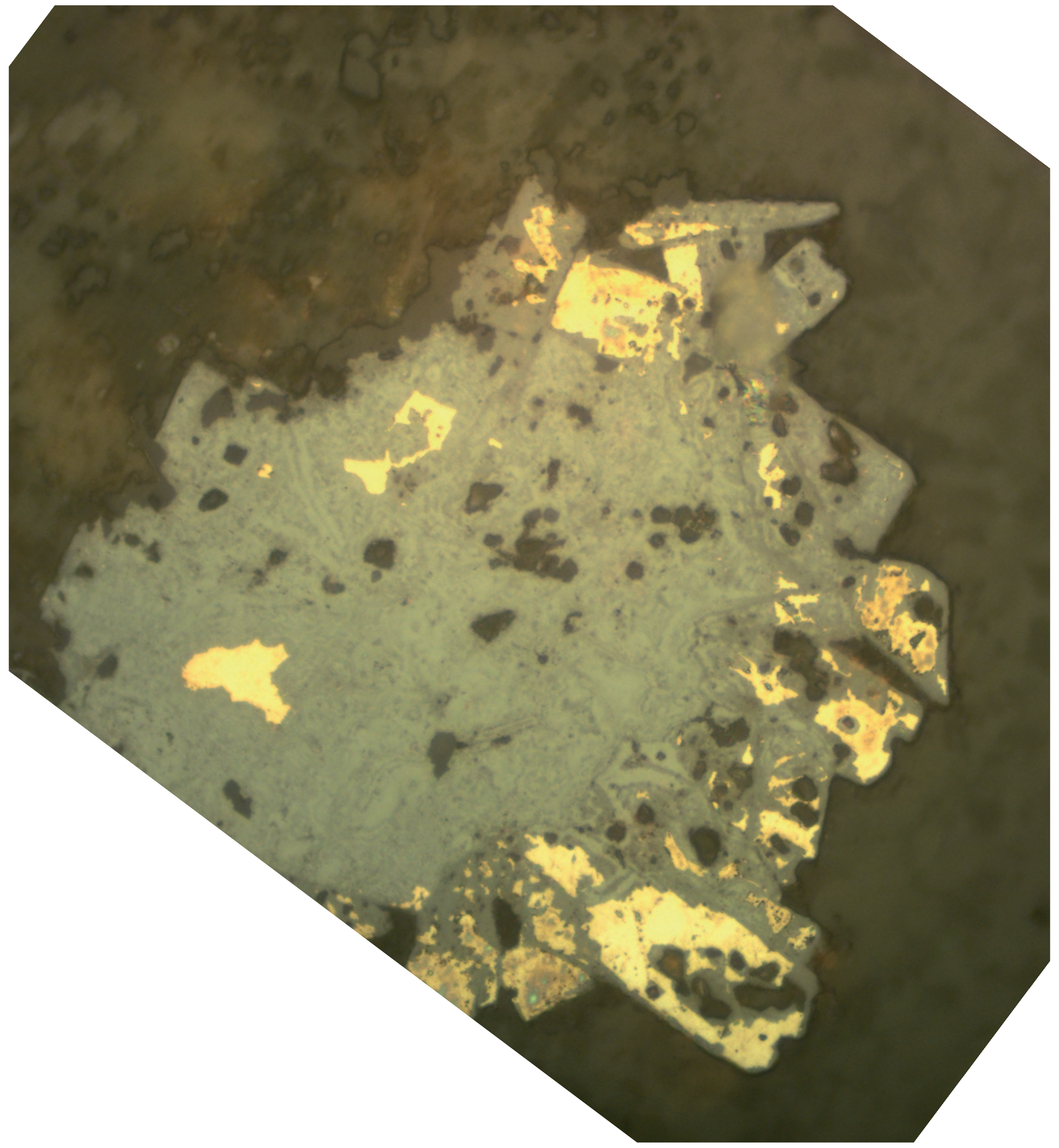


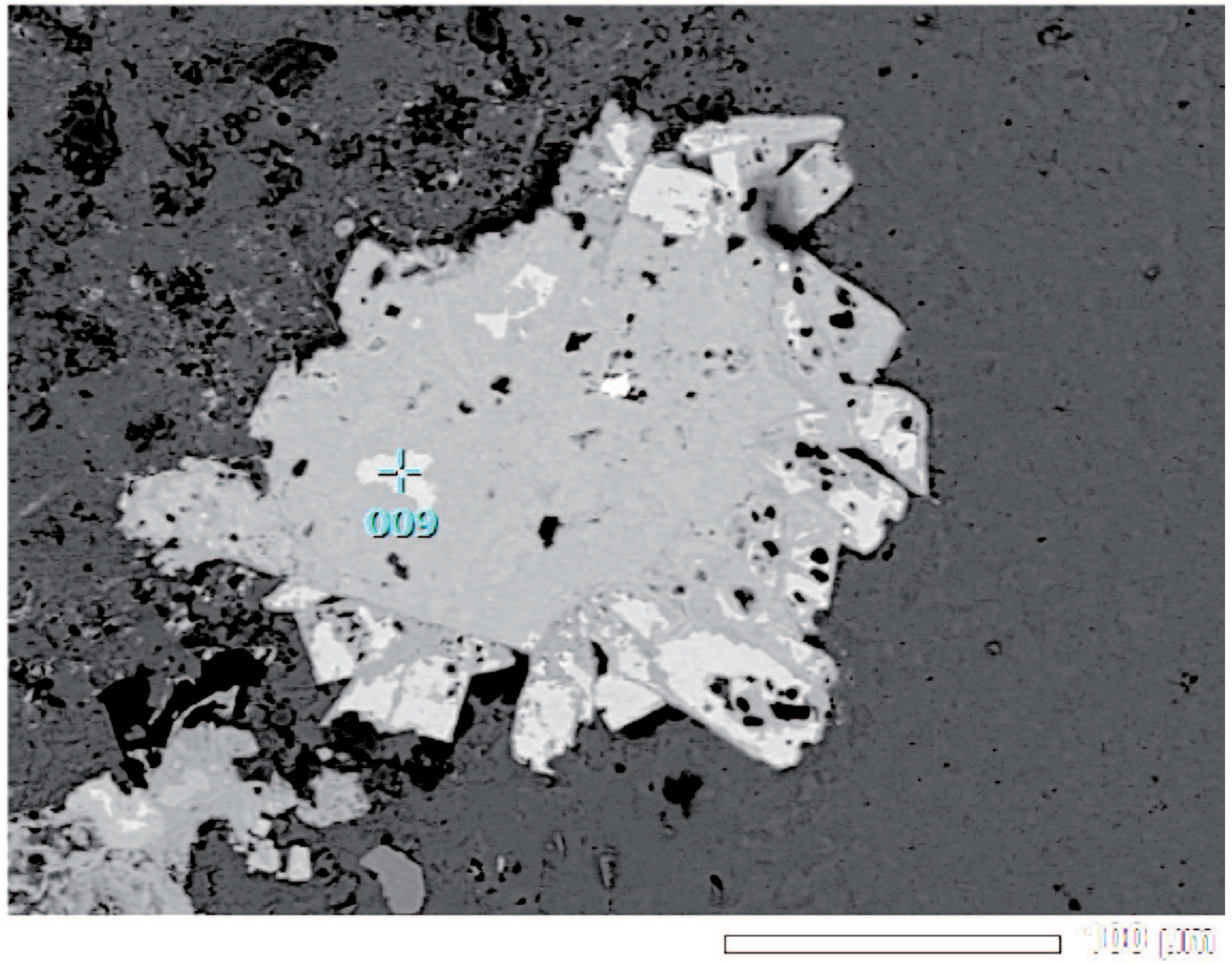
k) from Huang et al.

Left: observation on SEM (this study)
Above: optical observation in reflected light (this study)
The dark blue-grey colour corresponds to pyrite weathering products









Comparison of images in reflected light microscope and SEM images

The dark blue grey is just limonite and various iron hydroxides

EDS data will give Fe **and** O **but it is not magnetite**

Huang et al's interpretation of SEM data is questionned by our observations

Conclusions:

We found no evidence for oxidation of early diagenetic pyrite to magnetite in Triassic carbonates from the Qiangtang. Interpretation of SEM data should not be done without microscope observation in reflected light.

But that does not rule out the presence of a secondary magnetization in the Tethyan Himalaya carbonates.

Is the remagnetization event in the early Miocene associated with pyrrhotite widespread and affecting the carbonates with magnetite ?

Is there still any hope to determine the size of Greater India from Pmag data ?

Recommendation: All the raw demagnetization data should be published in the MAGIC database for a reassessment of all the data