Is the Earth's magnetic field heading for a flip?

Hint from the past

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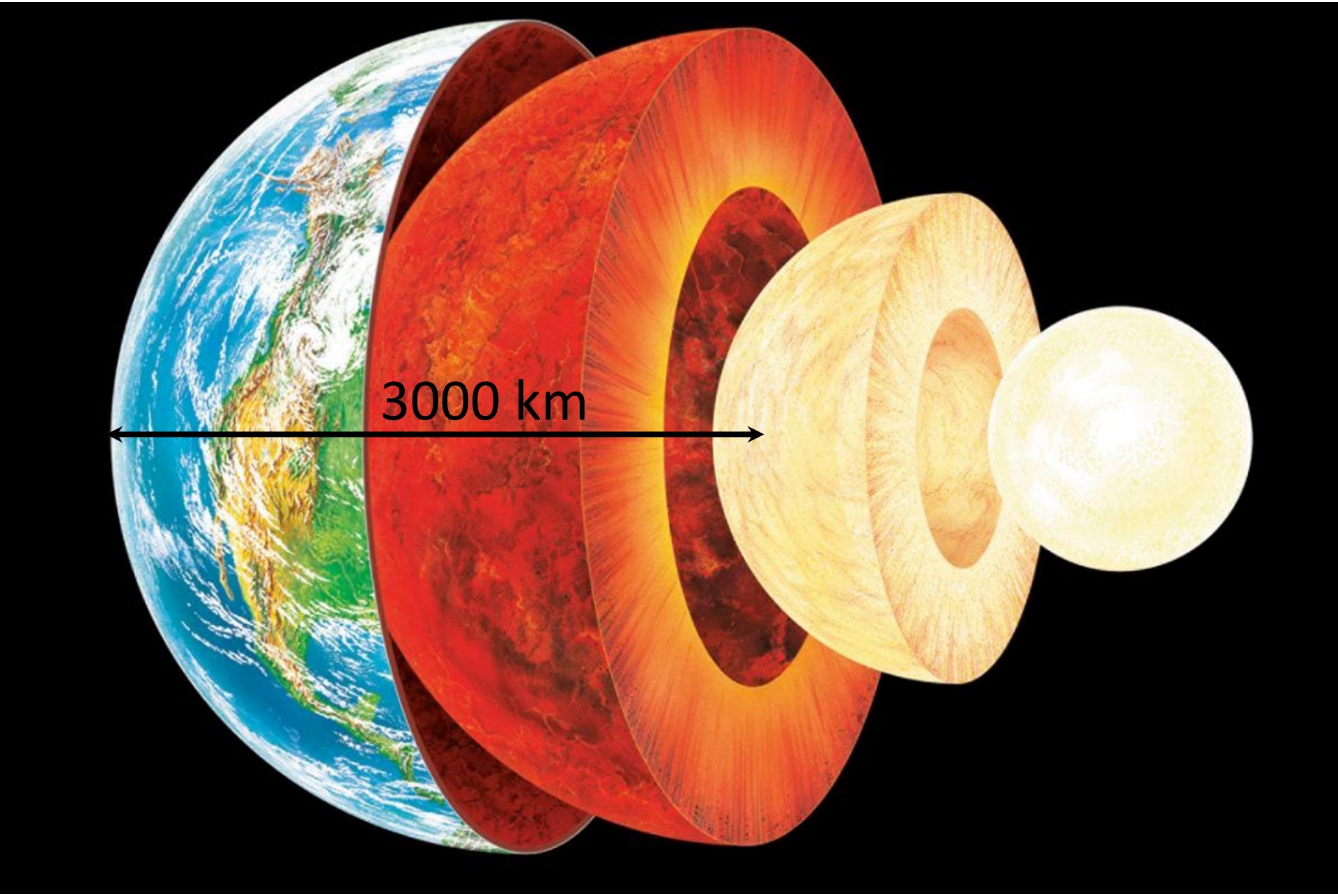
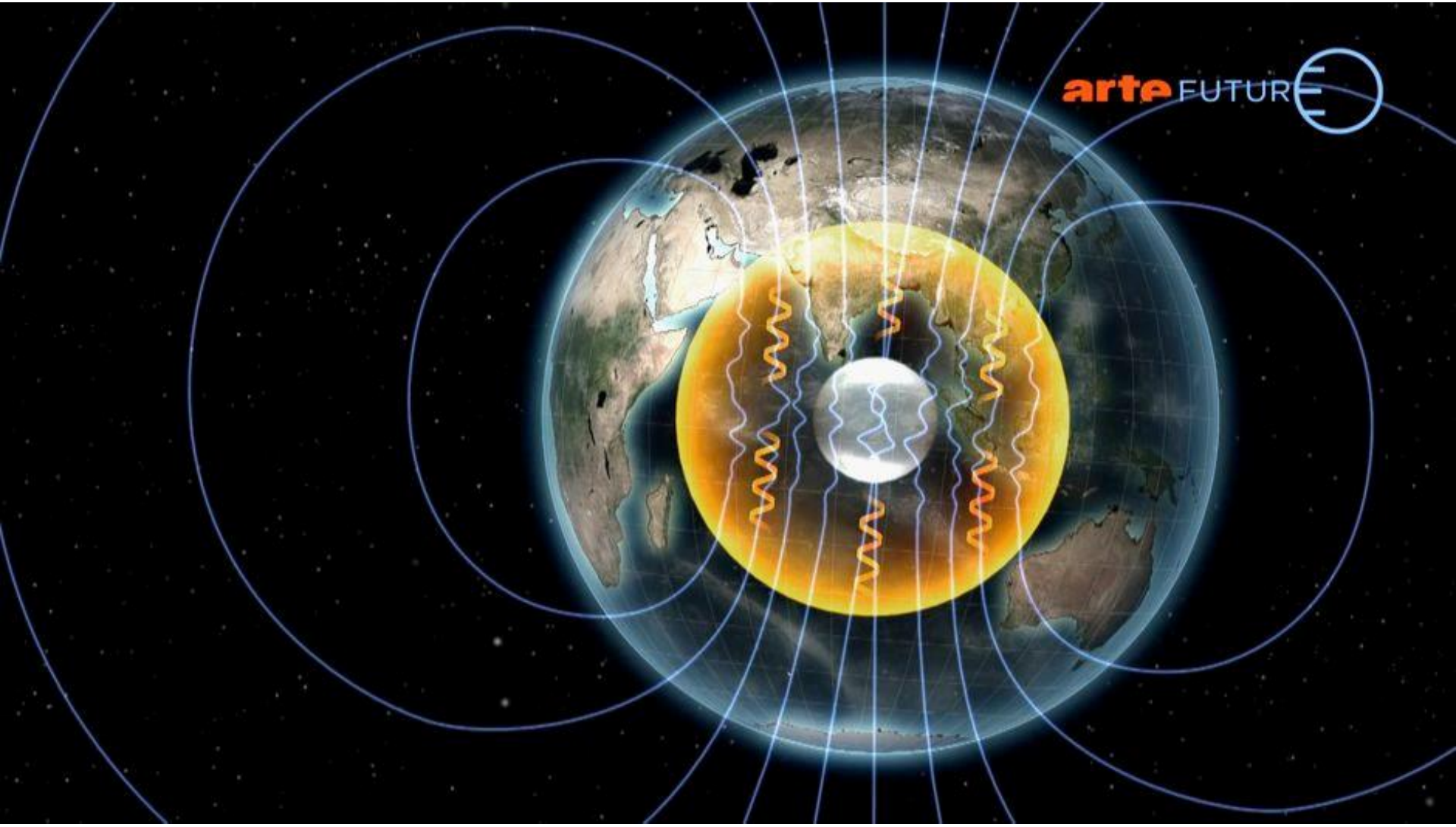
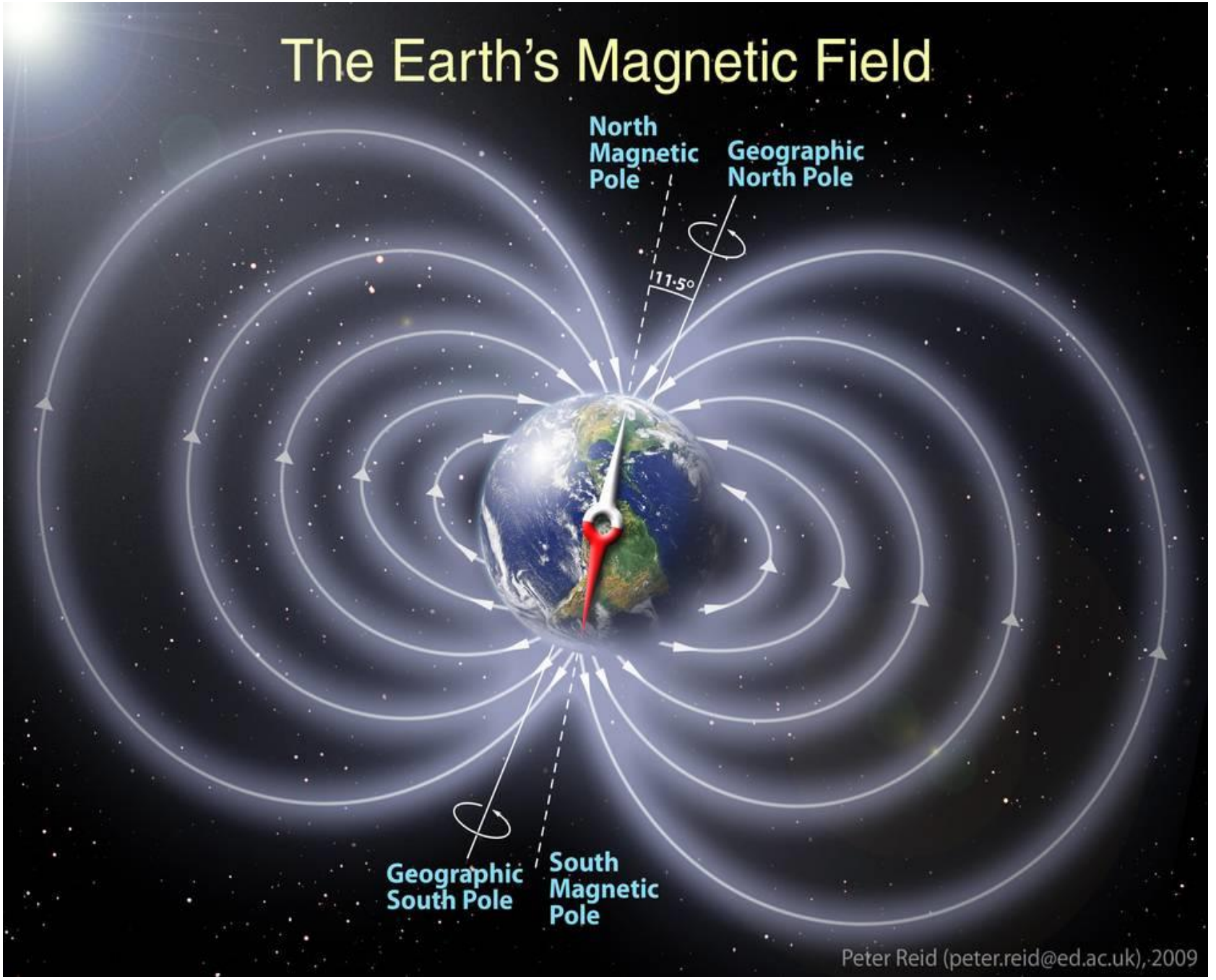
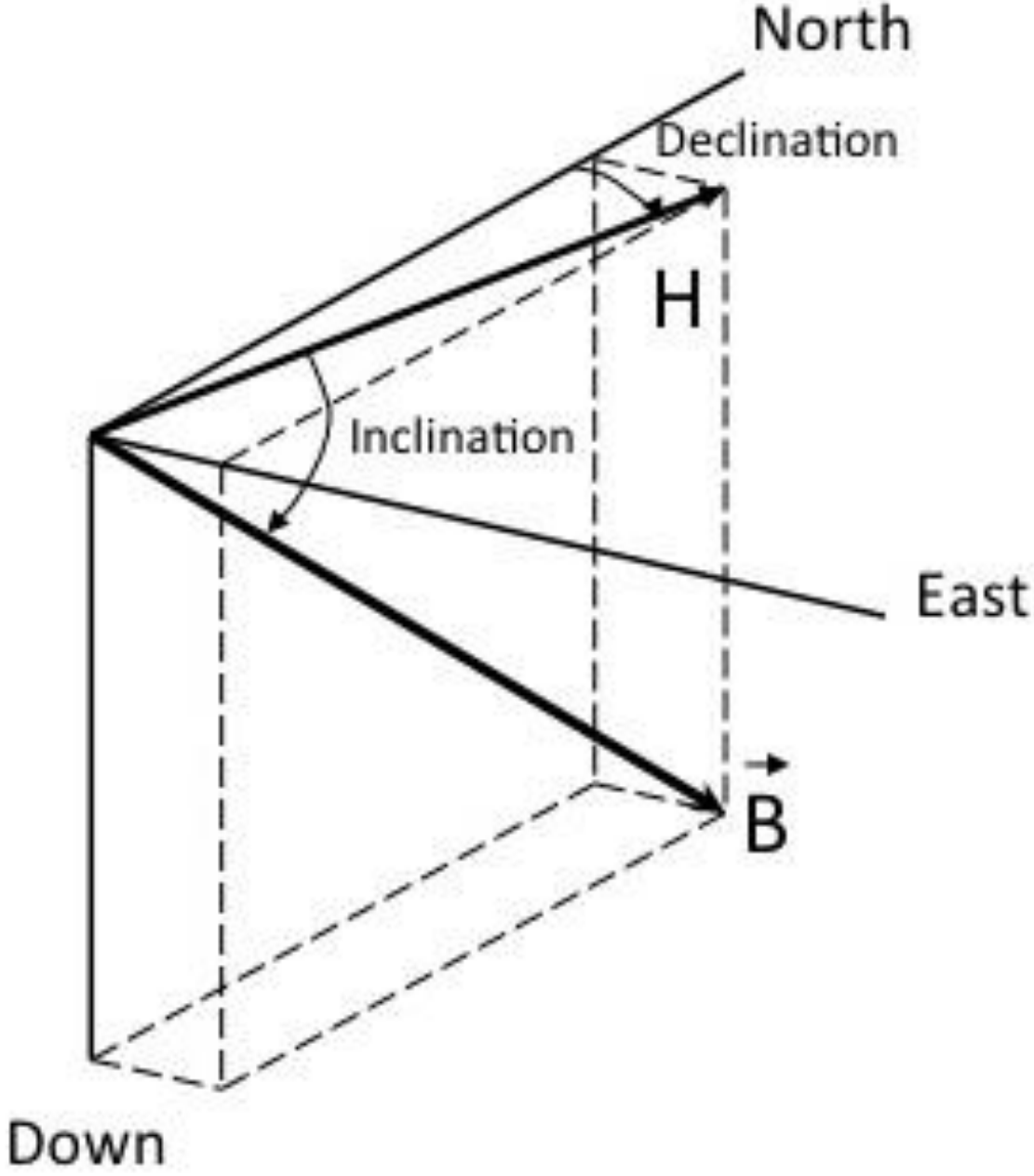
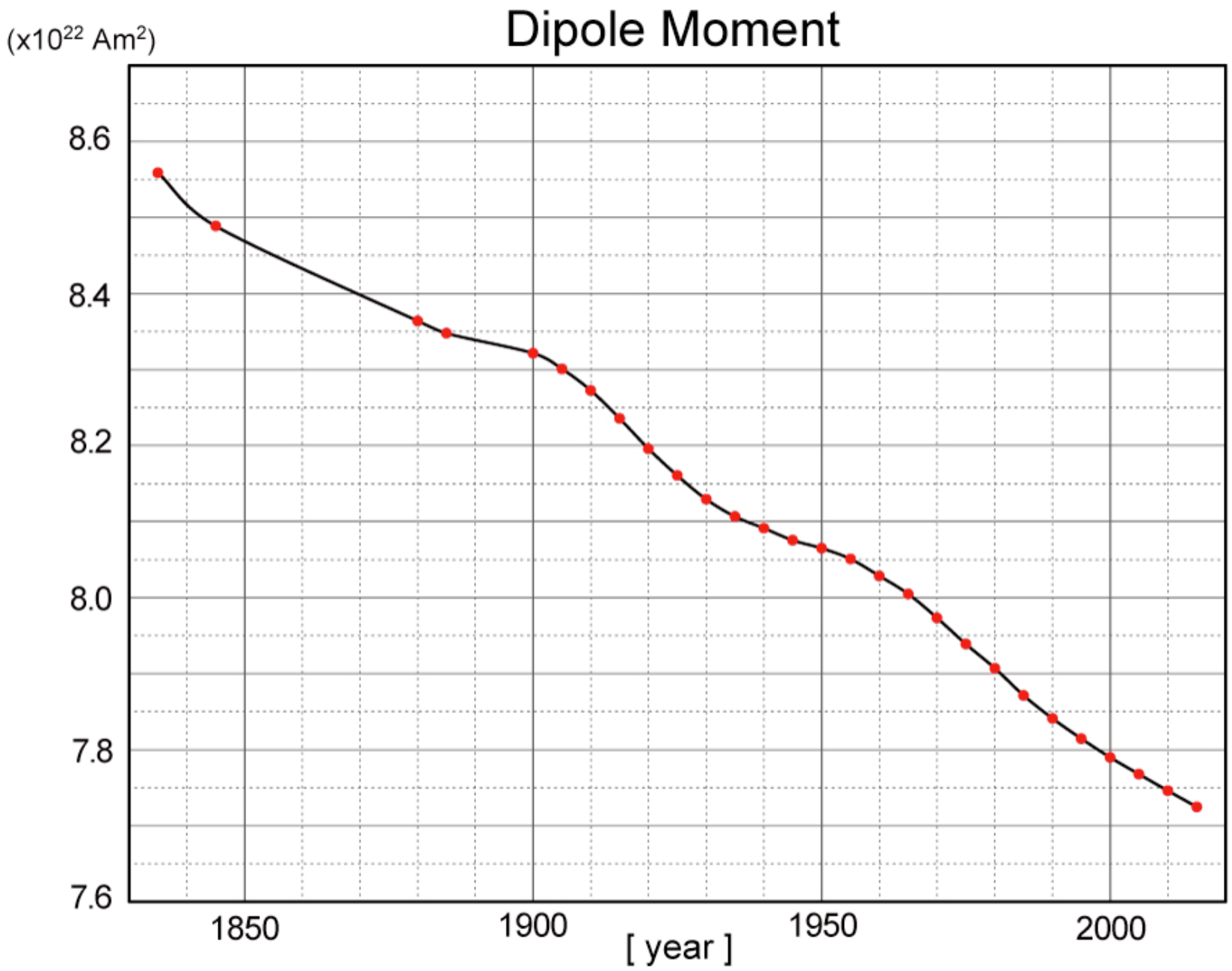
Which are the main characteristics of the present day geomagnetic field?




arte FUTURE


The Earth's Magnetic Field
North Magnetic Pole
Geographic North Pole
11.5°
Geographic South Pole
South Magnetic Pole
Peter Reid (peter.reid@ed.ac.uk), 2009

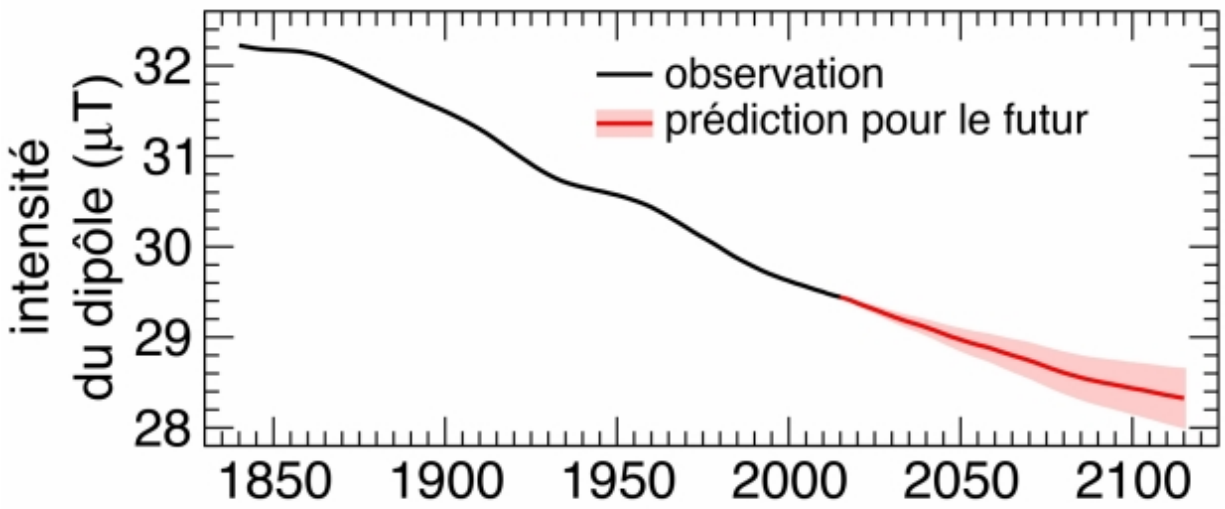

North
Declination
H
Inclination
East
B
Down



http://wdc.kugi.kyoto-u.ac.jp/poles/dmvar.html

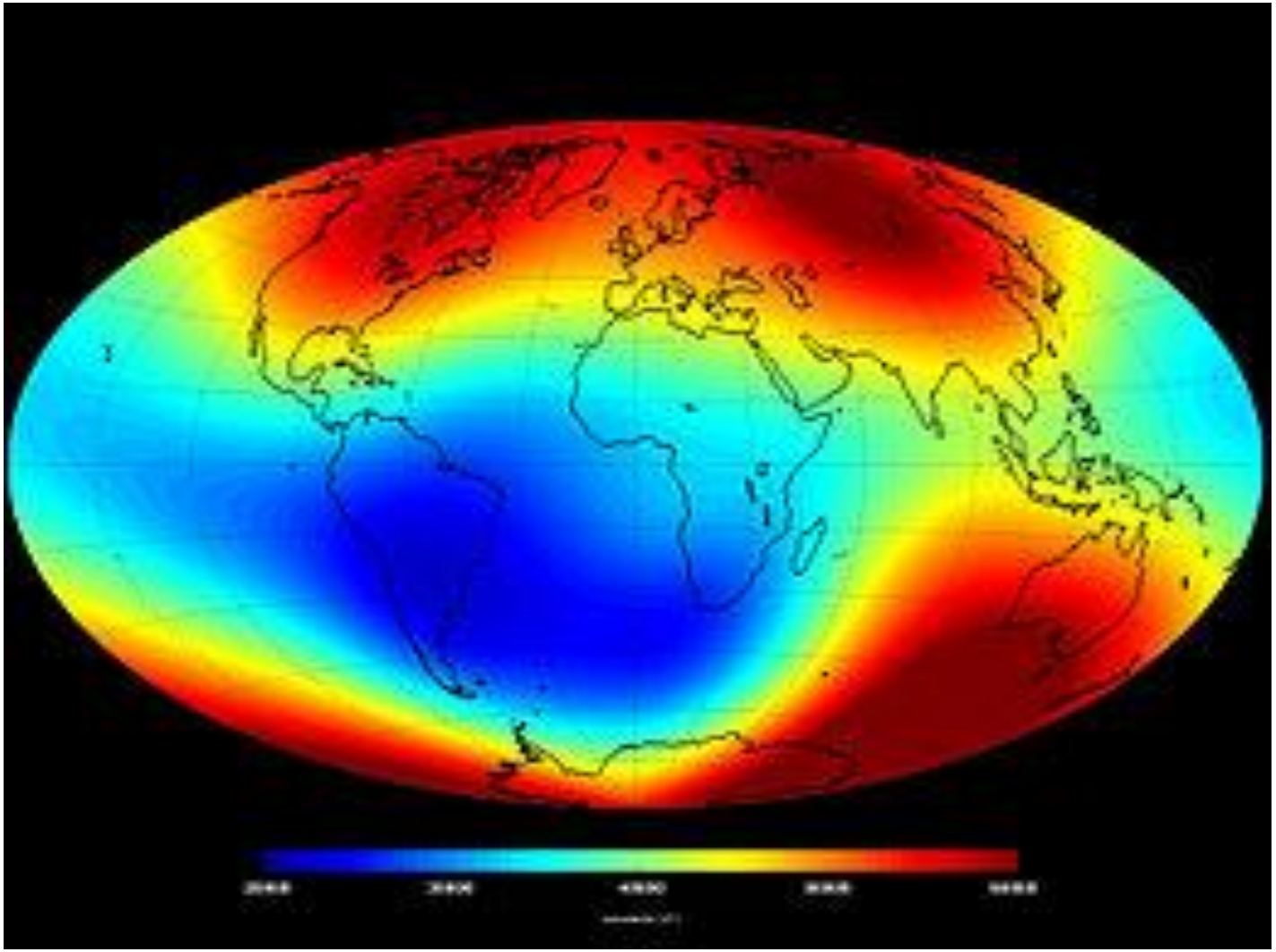
The coefficients since 1900 are by IGRF and before then by Rikitake, T., 1966.

Decay started in **1590** to present at a similar rate before 1840 *(Suttie,N., Holme, R., Hill, M., and Shaw, J., EPSL, 2011)*



J. Aubert. Geophysical Journal International (2015)

500 years of decay at a rate ~ 5 to 10 times faster than that expected for simple decay by diffusion



SWARM 2014

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Mechanism for geomagnetic polarity reversals

David Gubbins

Bullard Laboratories, Department of Earth Sciences,
Madingley Road, Cambridge CB3 0EZ, UK

… a patch of flux of opposite sign to that expected for a dipole field occurrs beneath southern Africa (SAA) …the present fall in the dipole moment is directly related to the intensification and southward movement of these patches and occasionally the fall leads to polarity reversal.

Geophysics

The disappearing dipole

Peter Olson

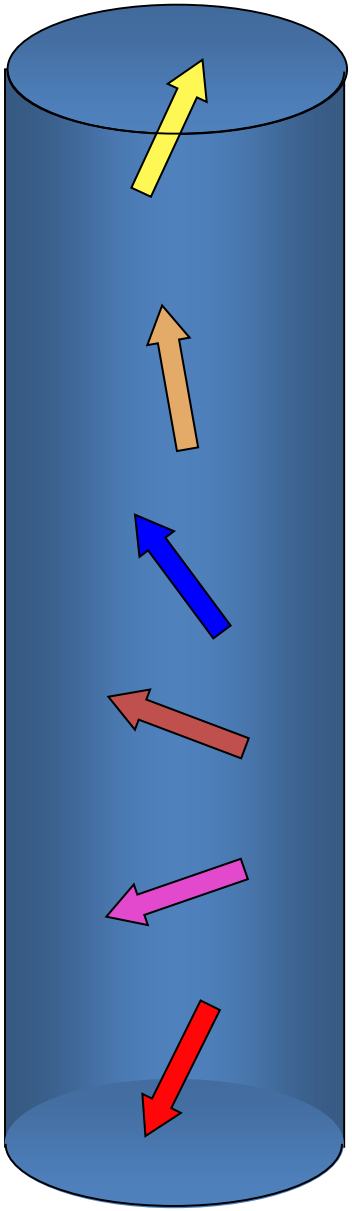
Nature News and Views, 2002

Satellite measurements of the Earth's magnetic field reveal a detailed picture of the circulation in the liquid iron core. The data suggest that the planet could be in the early stages of reversing its magnetic polarity.

What is a polarity reversal?

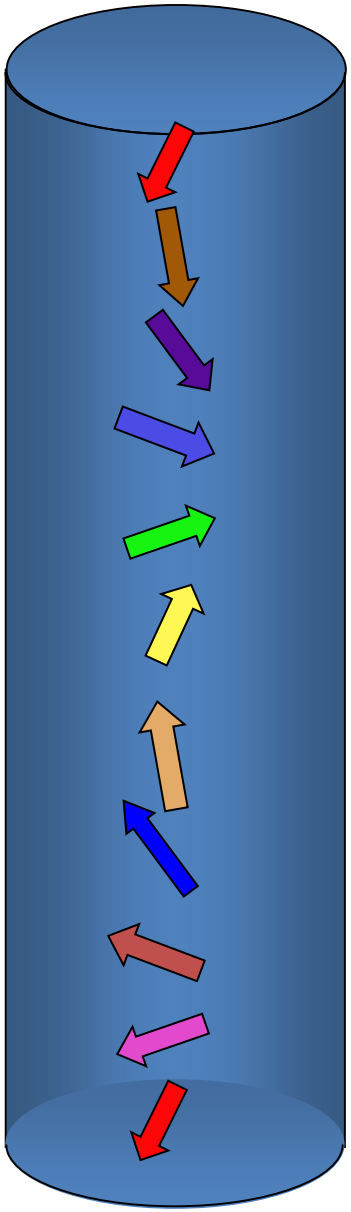
Polarity reversal

The direction of the earth magnetic field totally reverses and remains stable in the opposite direction



Geomagnetic excursions

The direction of the field reverses



Then it comes back to the same position as initally.

=> very short in time and because starting and finishing in the same state, difficult to identify in geological archives

Both directional changes are associated with severe drop in the earth magnetic field intensity

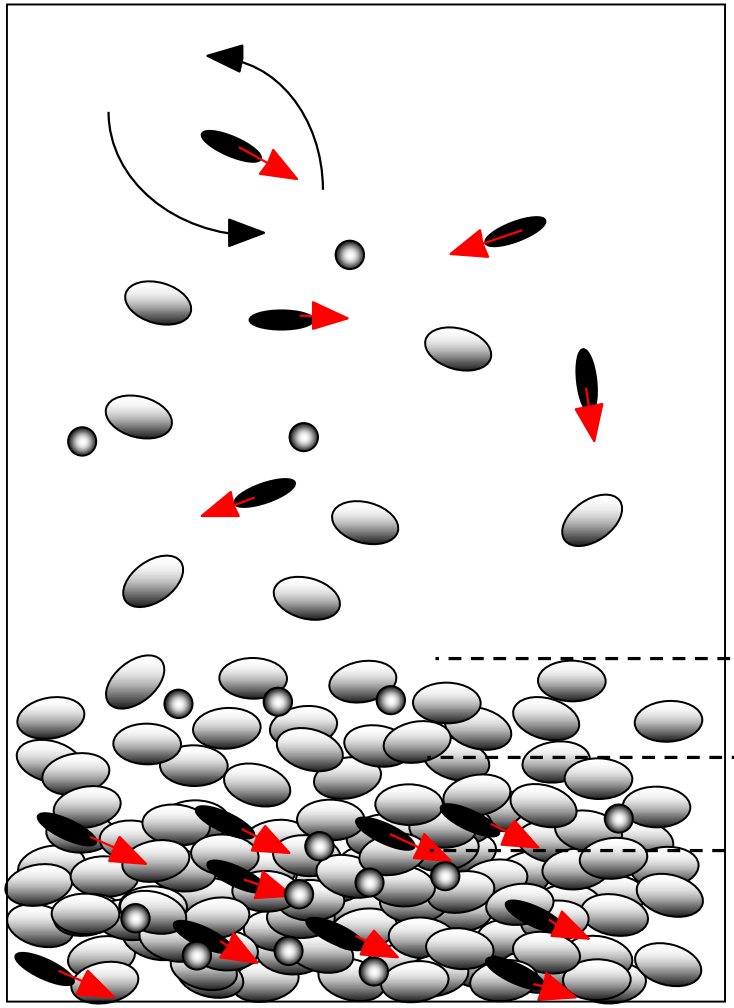
How do we know about the past?

➔ Geological archives

Thermoremanent magnetization (TRM) in lava flows

Cooling beyond the Curie temperatures and blocking temperatures

Detrital remanent magnetization (DRM) in sediments



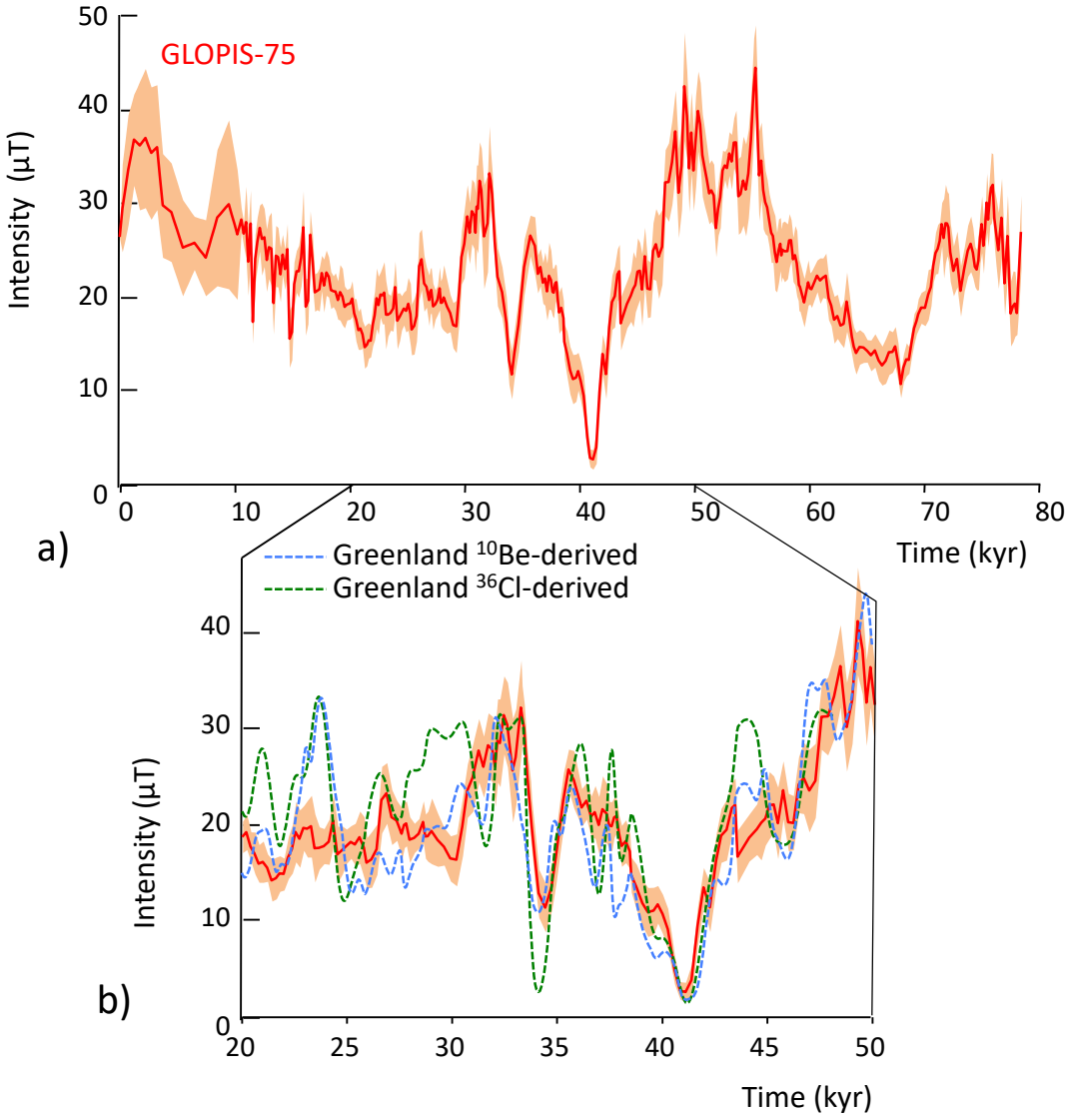
Magnetic particules with a magnetic moment in water – statistical alignment of magnetic moments with the earth magnetic field.

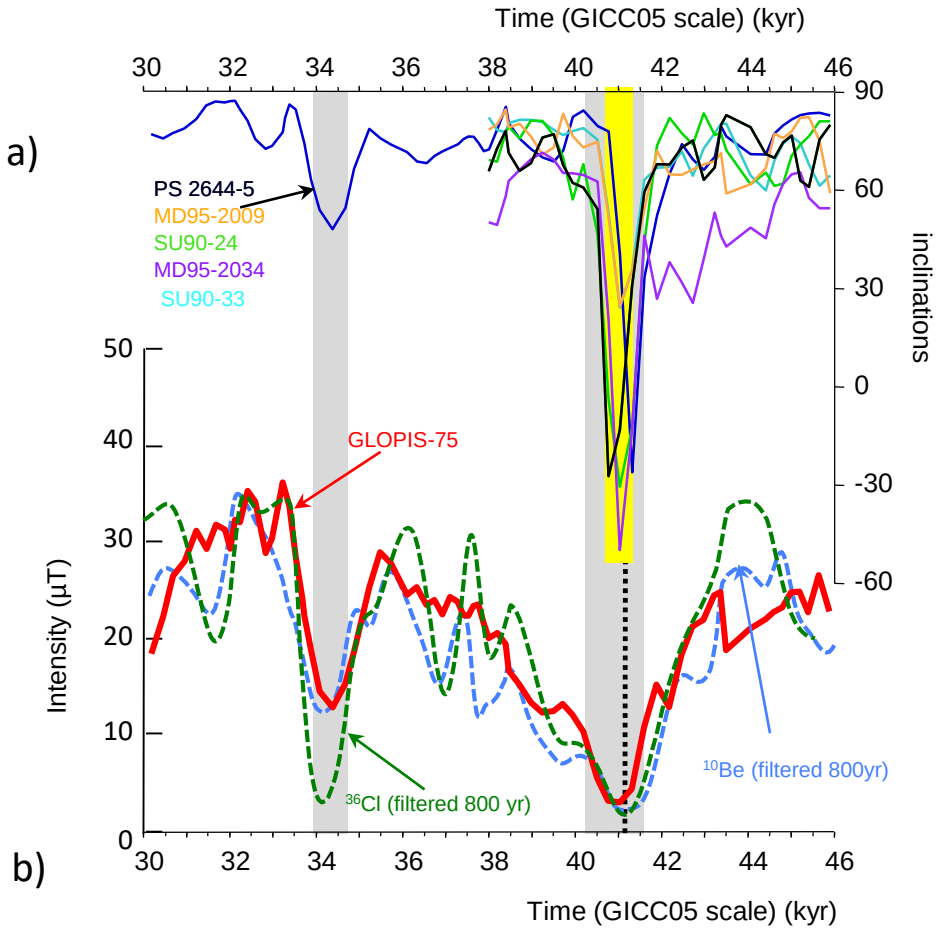
The magnetic grains fall down with their magnetic moment ± // to the field

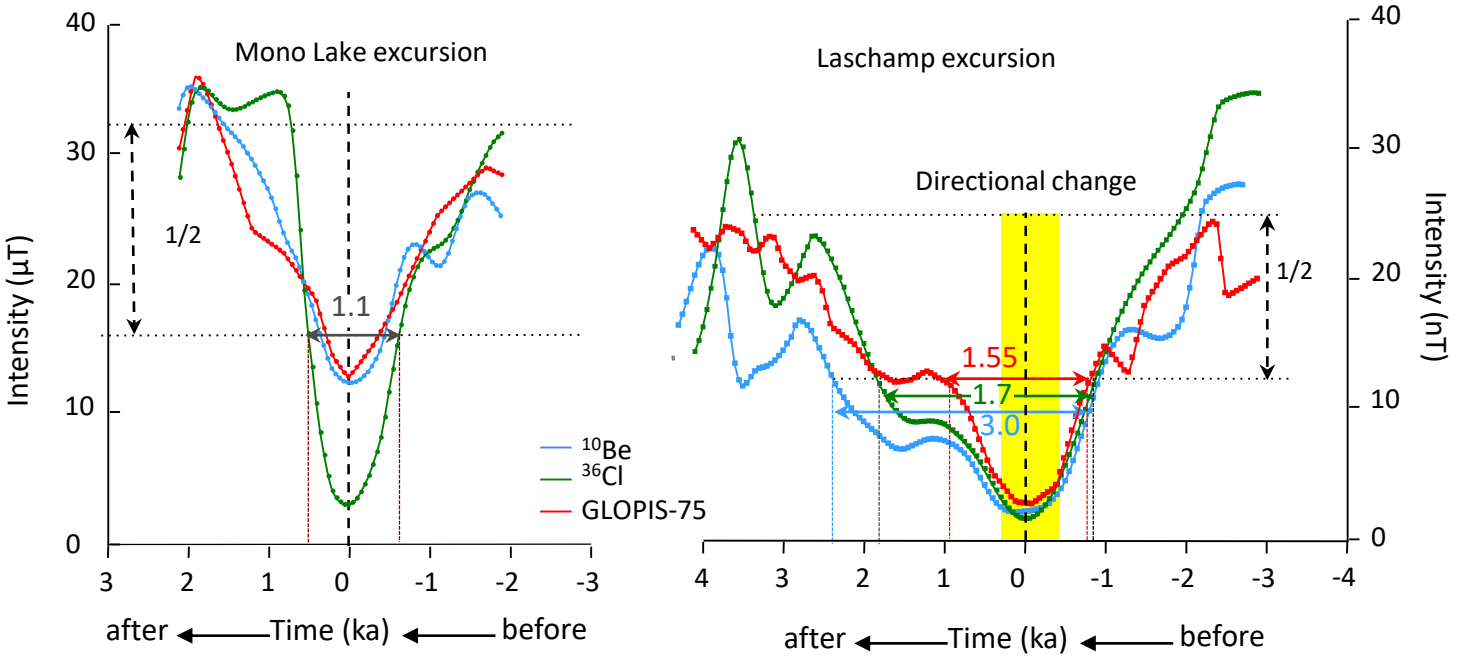
Arrived at the interface, the magnetic grains can still move

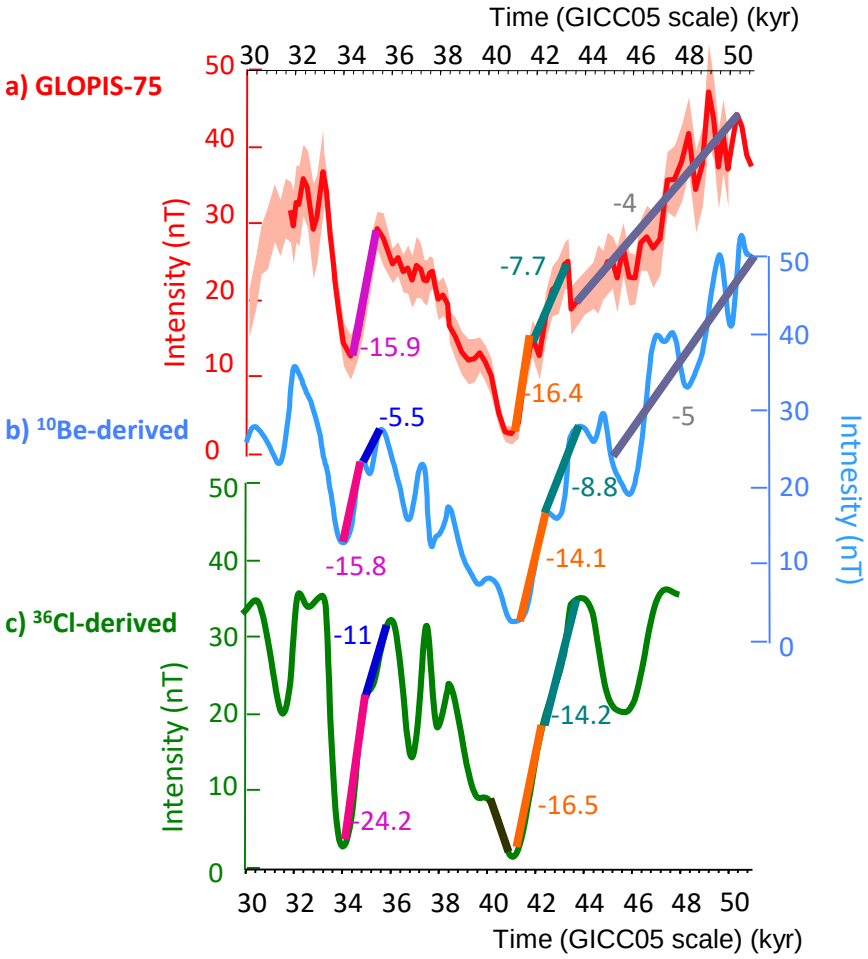
Under the effect of compaction, the magnetic grains are in « blocked » position.


TAAF
CMA CGM
CMA CGM
MARION DUFRESNE


GLOPIS-75
Intensity (μT)
Time (kyr)
a)
Greenland ^{10}Be-derived
Greenland ^{36}Cl-derived
Intensity (μT)
Time (kyr)
b)


a)
b)
Time (GICC05 scale) (kyr)
30
32
34
36
38
40
42
44
46
90
60
30
0
-30
-60
inclinations
PS 2644-5
MD95-2009
SU90-24
MD95-2034
SU90-33
50
40
30
20
10
0
Intensity (µT)
GLOPIS-75
36Cl (filtered 800 yr)
10Be (filtered 800yr)
Time (GICC05 scale) (kyr)


Mono Lake excursion
Intensity (μT)
40
30
20
10
0
1/2
1.1
3
2
1
0
-1
-2
-3
after
Time (ka)
before
10Be
36Cl
GLOPIS-75
Laschamp excursion
Directional change
Intensity (nT)
1/2
1.55
1.7
3.0
4
3
2
1
0
-1
-2
-3
-4


Time (GICC05 scale) (kyr)
30 32 34 36 38 40 42 44 46 48 50
a) GLOPIS-75
Intensity (nT)
50 40 30 20 10 0
-15.9
-7.7
-16.4
-4
b) 10Be-derived
-5.5
-15.8
-8.8
-14.1
-5
Intnesity (nT)
50 40 30 20 10 0
c) 36Cl-derived
Intensity (nT)
50 40 30 20 10 0
-11
-24.2
-14.2
-16.5
30 32 34 36 38 40 42 44 46 48 50
Time (GICC05 scale) (kyr)