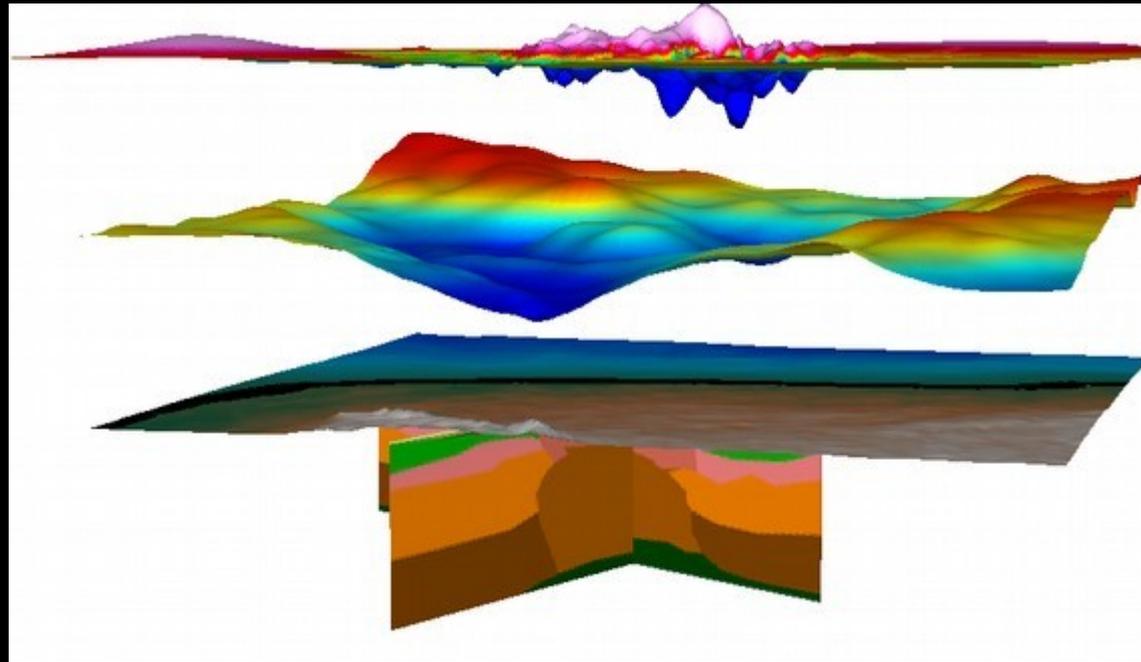


Exemples terrestres et planétaires de modélisation contrainte par des données de champs potentiels



Y. Quesnel
CEREGE, Aix-en-Provence

Potential-field data → anomaly → constraints

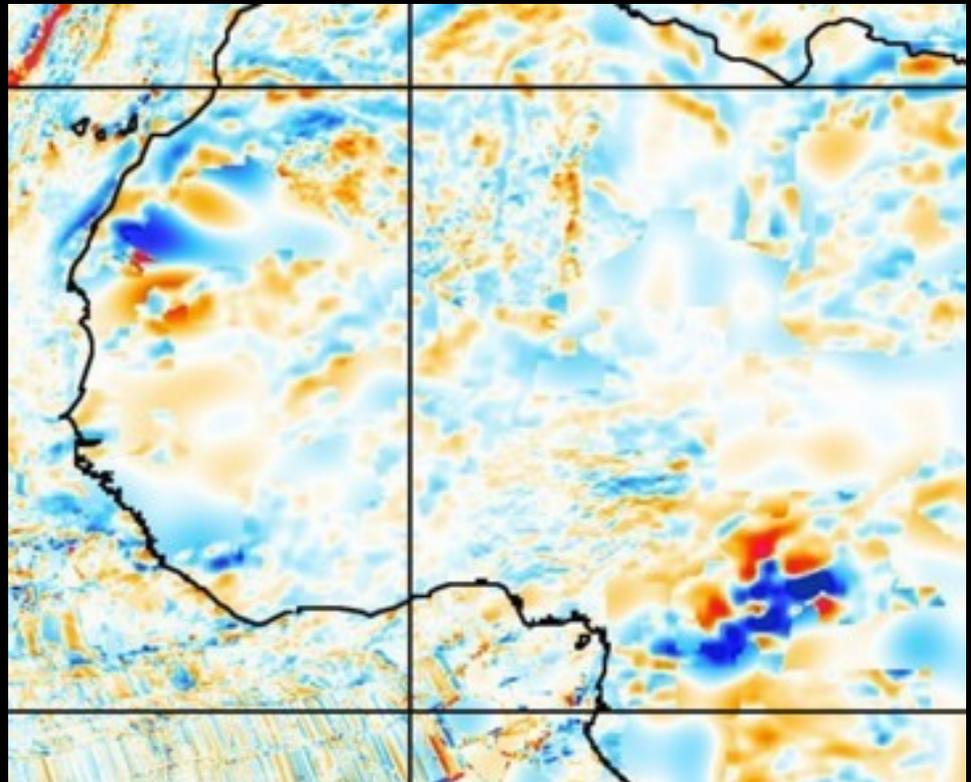
	Magnetic field	Gravity field
Local survey	Remove core and external fields → TF or (bx,by,bz) anomaly	Classical processing... → FA anomaly → Bouguer anomaly
Models	<ul style="list-style-type: none">- WDMAM 2.0 (Dyment et al., 2015)- GRIMM (Lesur et al., 2010)- SWARM data (Thébault et al., 2016)	<ul style="list-style-type: none">- EGM08 (Pavlis et al., 2012)- WGM12 (Bonvalot et al., 2012)

*Case of WDMAM 2.0:
lateral variations of initial data*

1) airborne and marine data grids

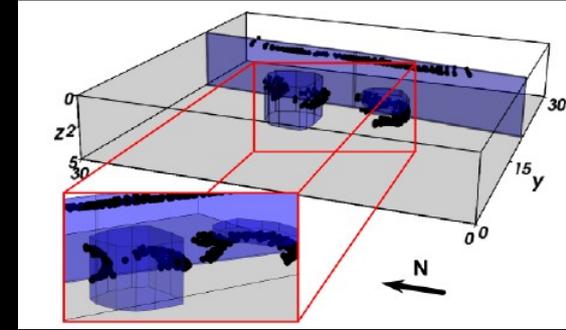
*2) predictions from seafloor
magnetization model*

*3) predictions from satellite
magnetic field model*

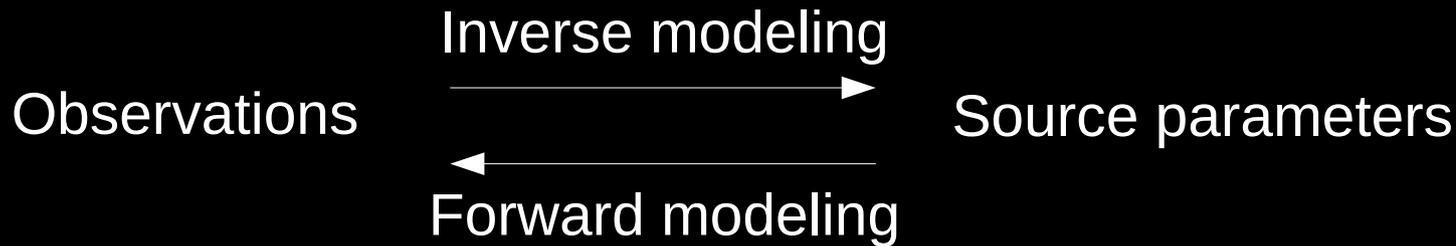


Modeling of geological sources

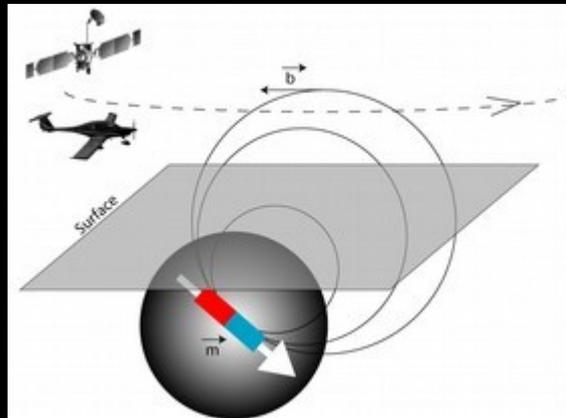
'Extended' data processing (spectral domain) : pseudo-gravity, analytic signal, Euler deconvolution (Blakely, 1995)



Uieda et al., 2014



Case of magnetized sources



- Can be reduced by assuming :
- uniform shapes (prisms, spheres,...)
 - known thicknesses
 - homogeneous dipole grid

A lot of parameters!

$$\vec{B}_{obs} = \sum_i^N B_{obs}^i = \sum_i^N f(x_i, y_i, z_i, \vec{M}_x^i, \vec{M}_y^i, \vec{M}_z^i, shape_i, volume_i)$$

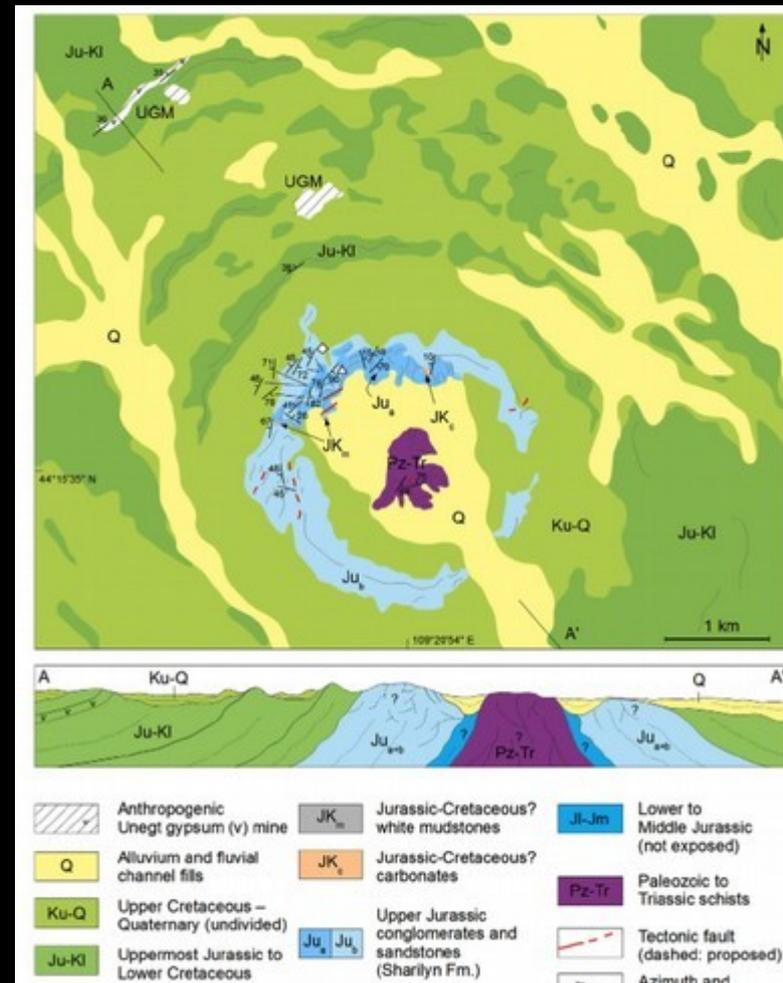
N sources affect the measurement ; (M_x, M_y, M_z): total magnetization components of each sources.

Other constraints

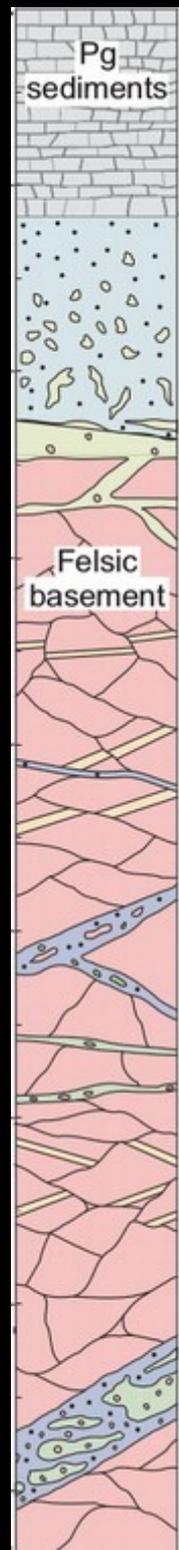
- Geological maps and cross-sections
- Seismic data
- Resistivity data
- MT data
- Geological well data
- Geophysical logs
- Petrophysical data on samples



Superconducting magnetometer



Uneged Uul expected impact structure (Schmieder et al., 2013)

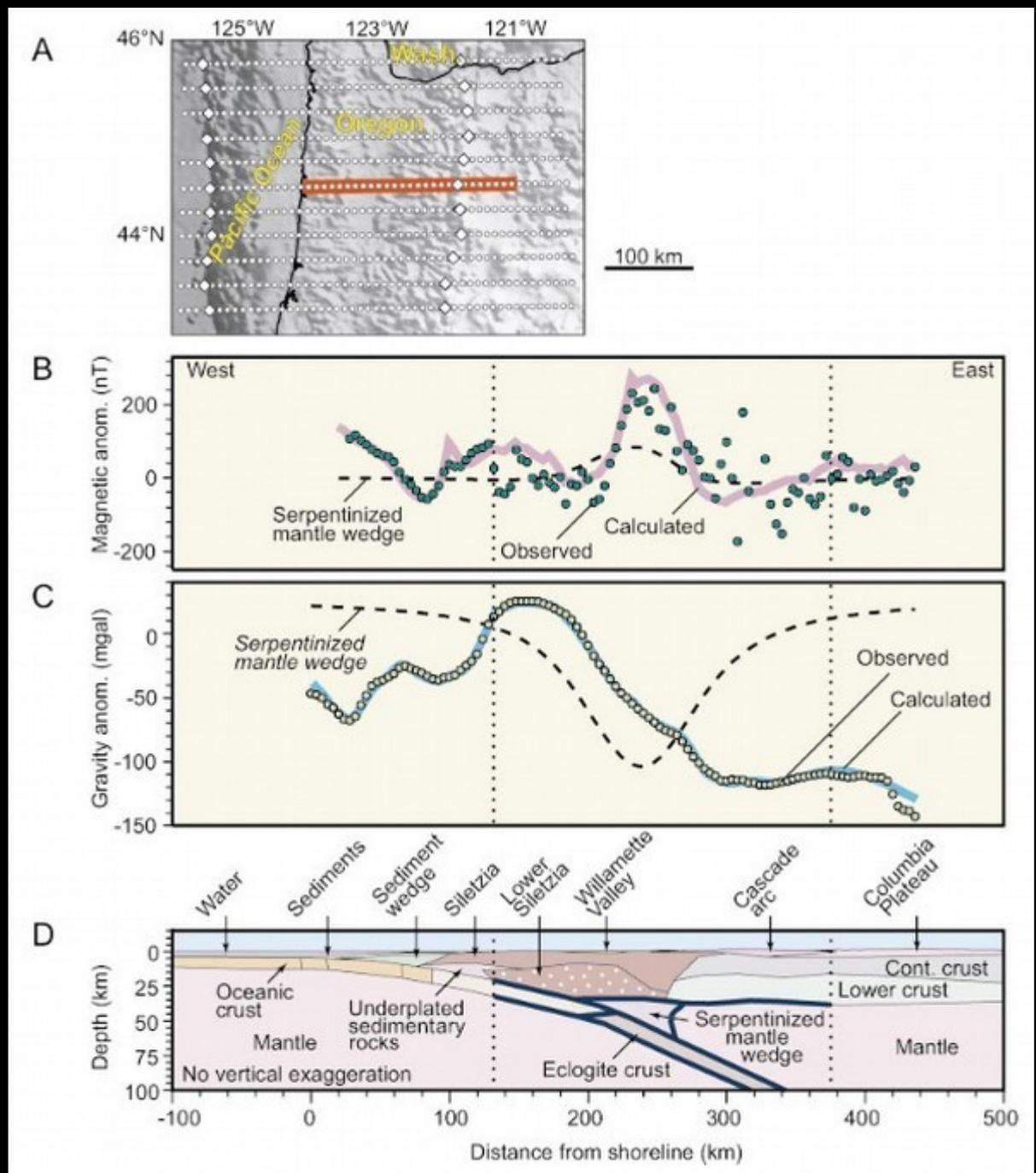


Chicxulub IODP Exp 364 well (Morgan et al., 2016)

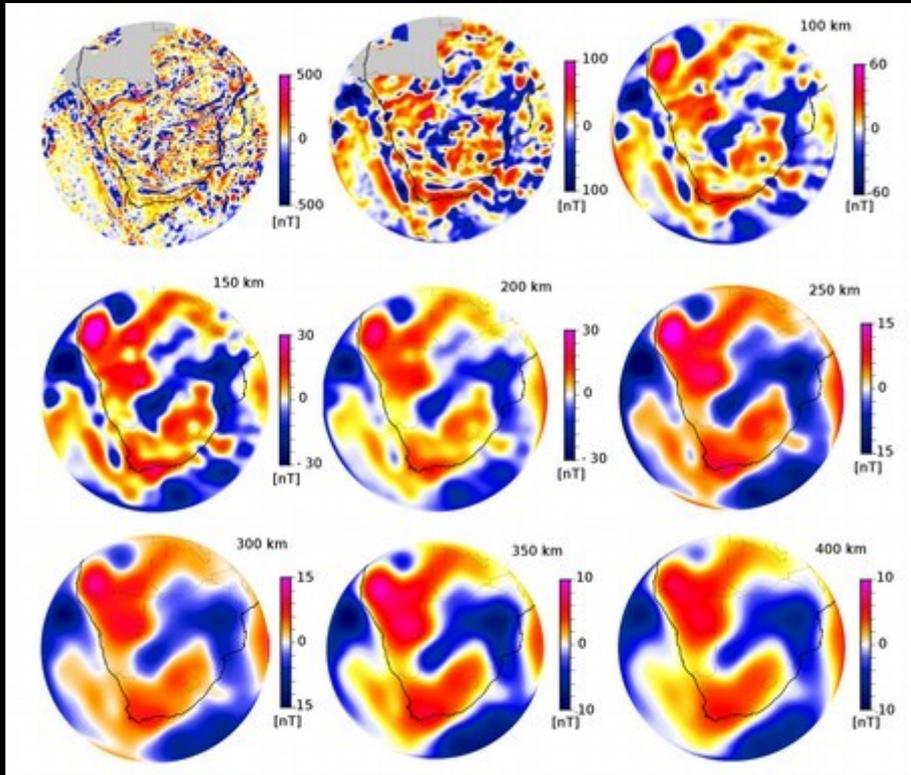
Subduction zones

Forward modeling of gravity and magnetic field data using seismic constraints

Reveals magnetization of serpentized mantle wedge



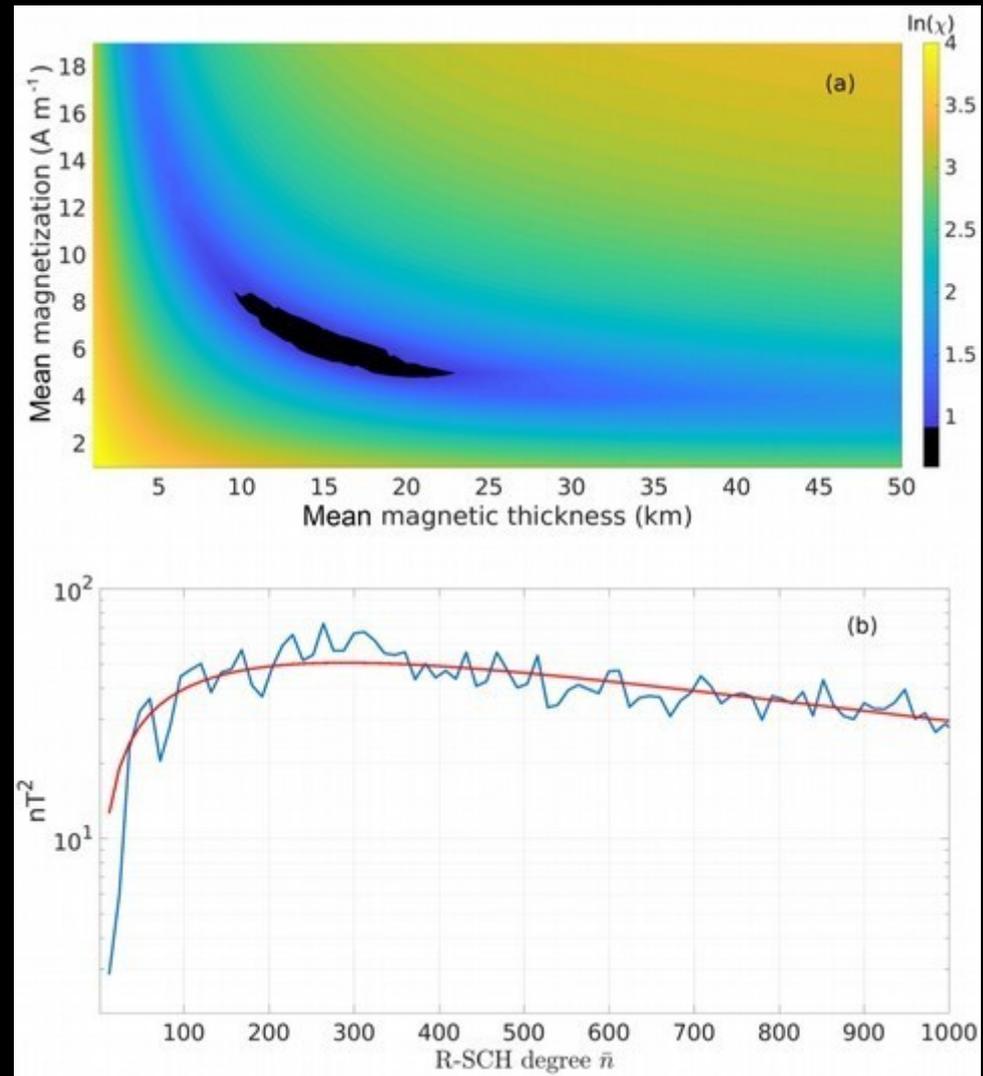
Inversion using magnetic field data only



Lithospheric magnetic field anomaly model over South Africa

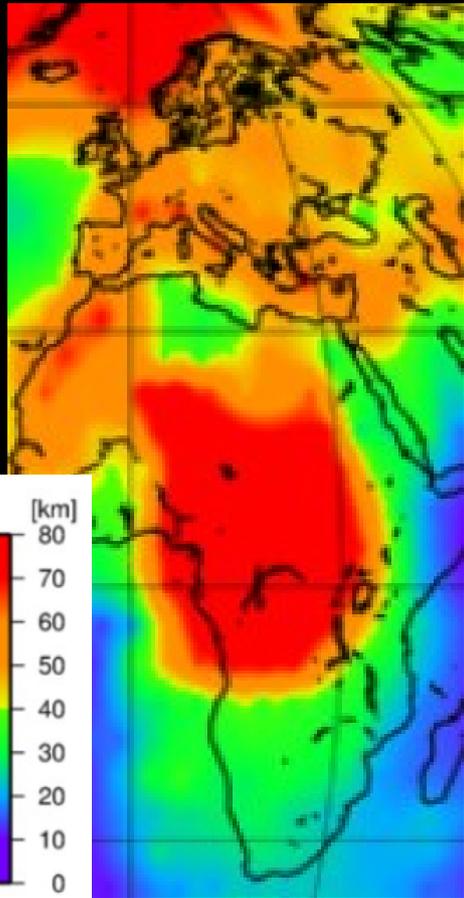
Estimation of magnetization intensity and magnetized thickness using power spectra

Vervelidou et al., 2018

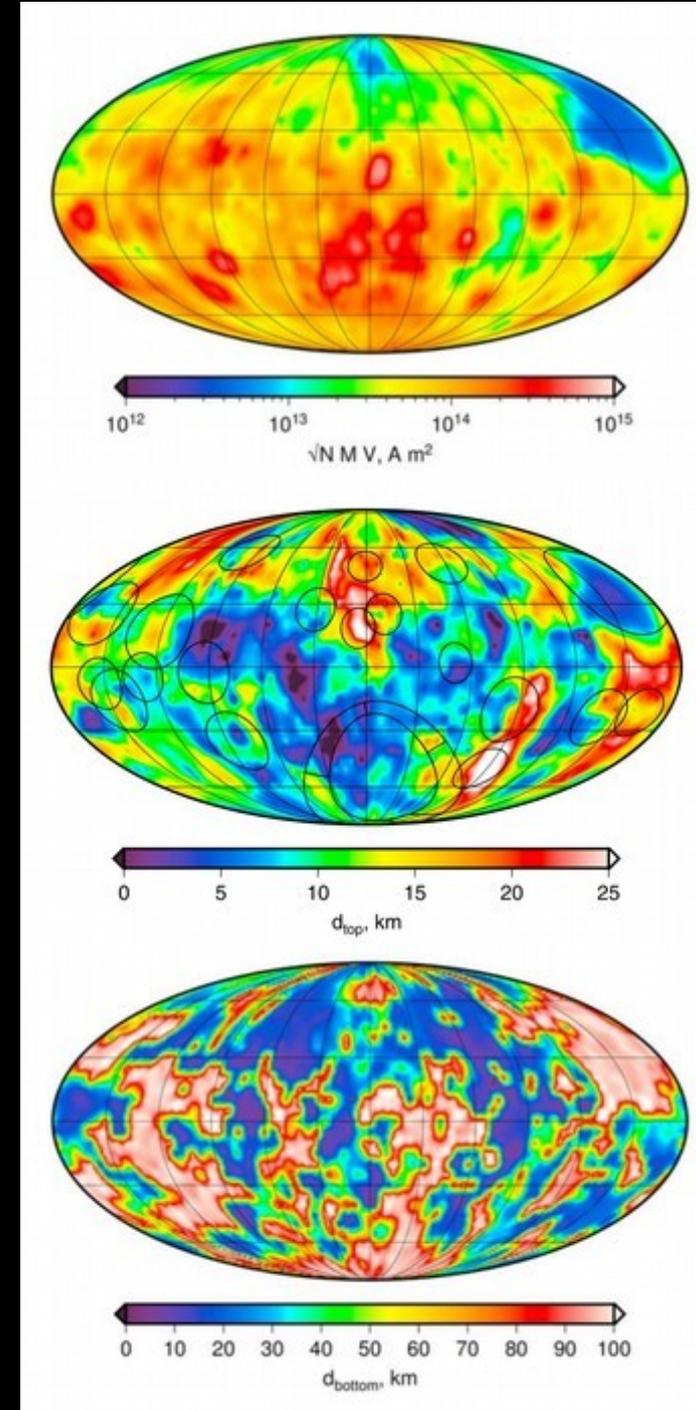
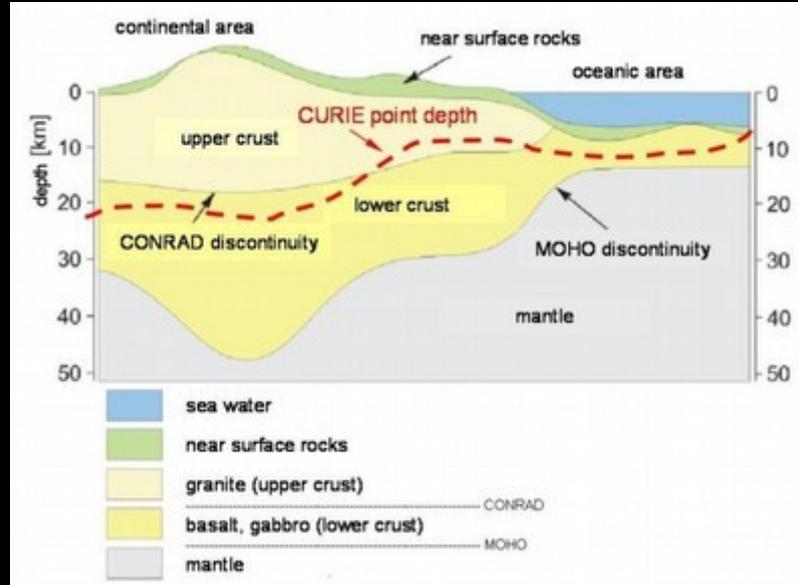


Inversion using magnetic field data only

Geological 'truth'?

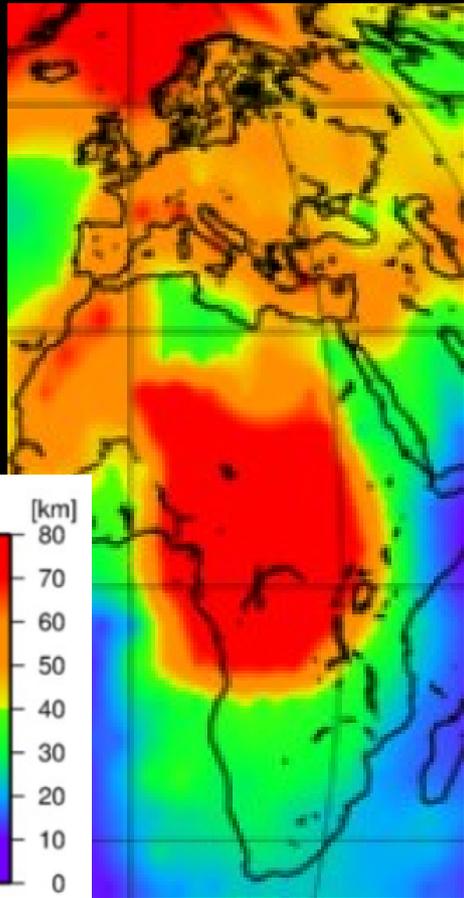


Estimated thickness over Africa (Vervelidou and Thébaud, 2015)



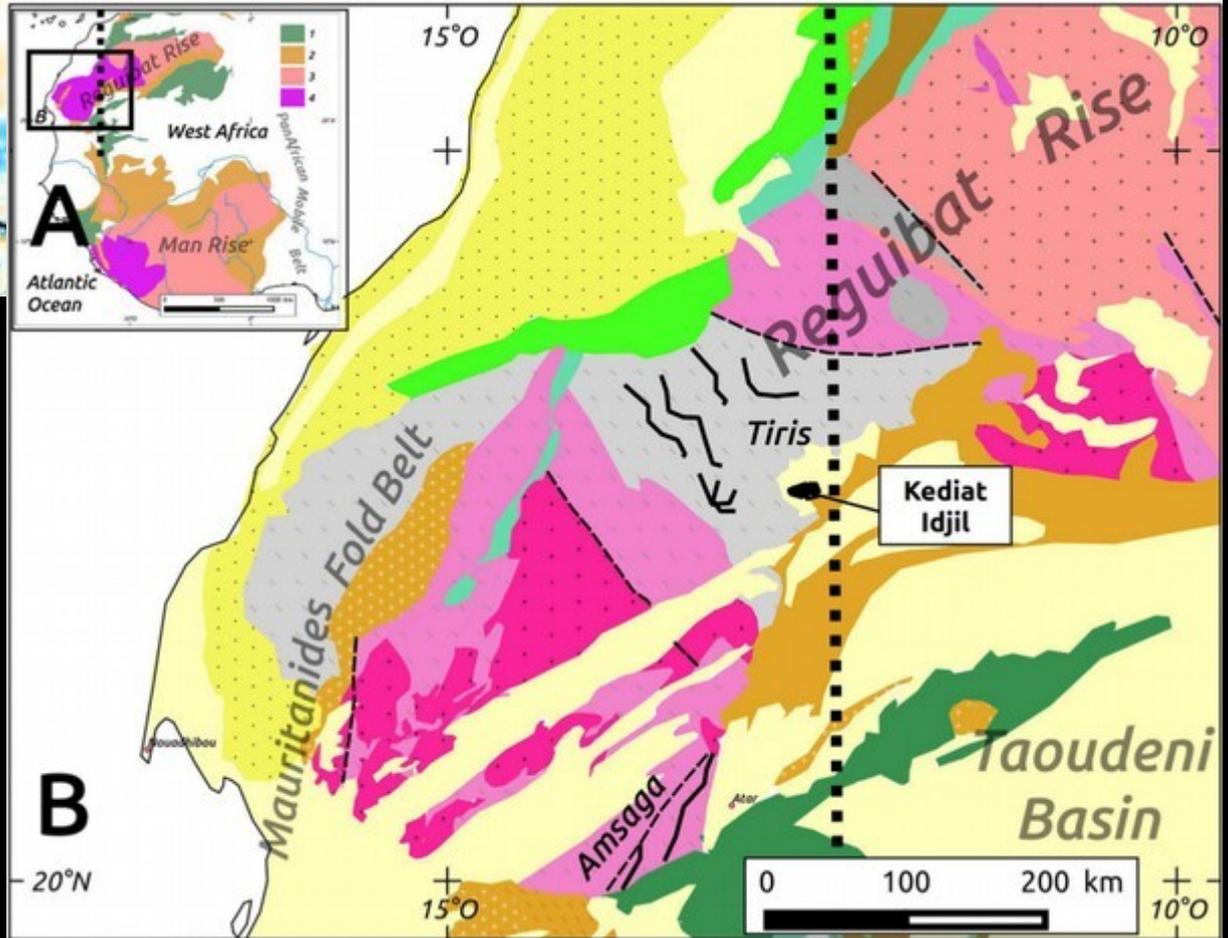
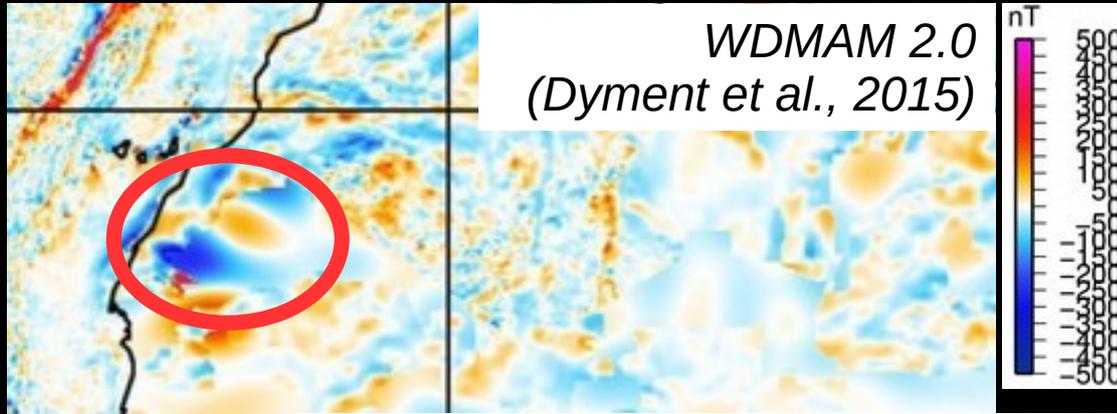
Estimation of lunar magnetization intensity and magnetized thickness using power spectra (Wieczorek, 2018)

West African Magnetic Anomaly

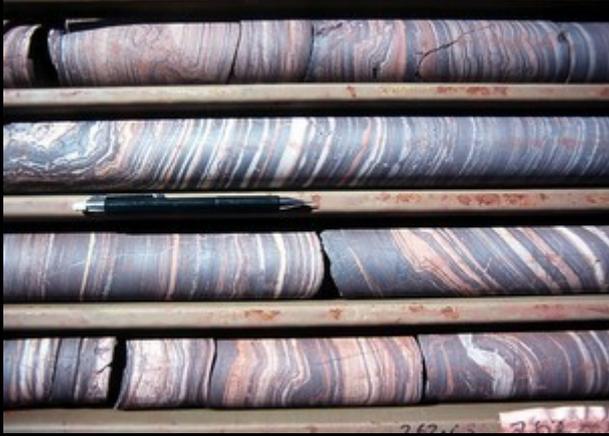


Estimated thickness
over Africa
(Vervelidou and
Thébault, 2015)

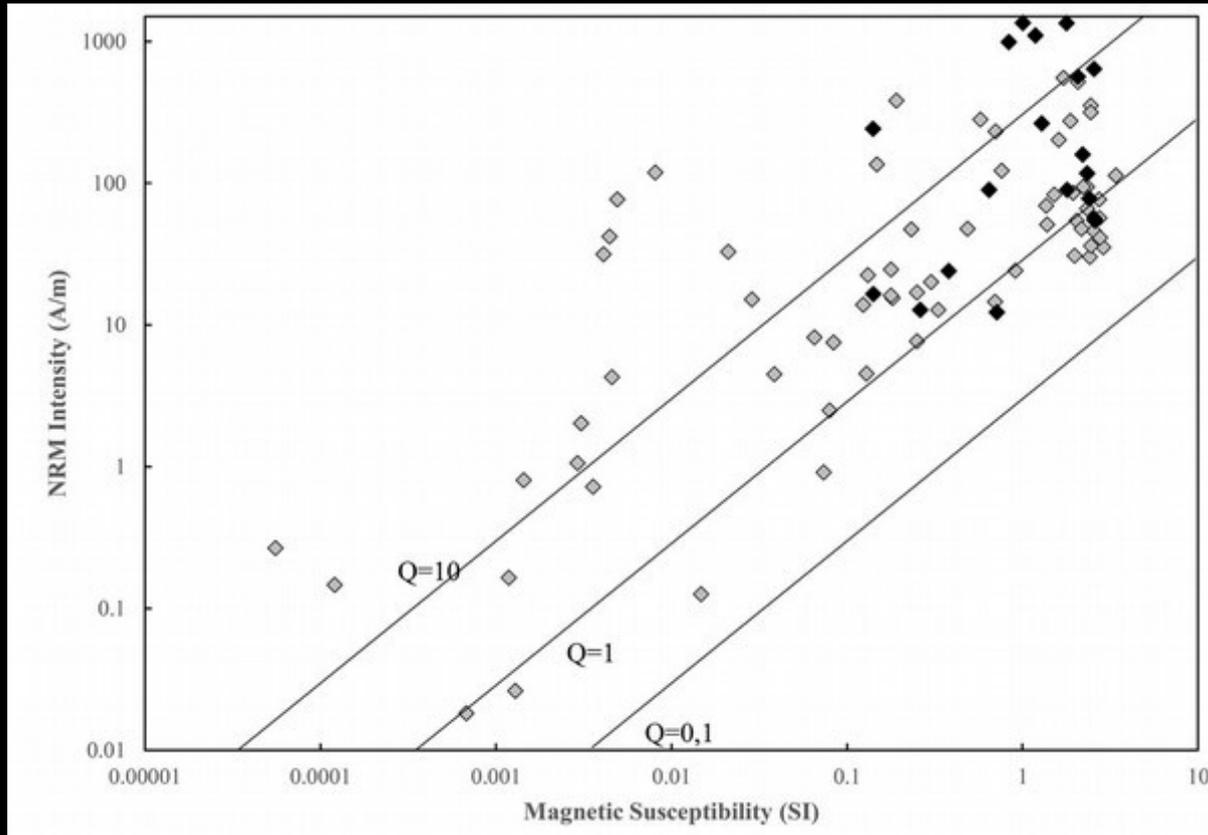
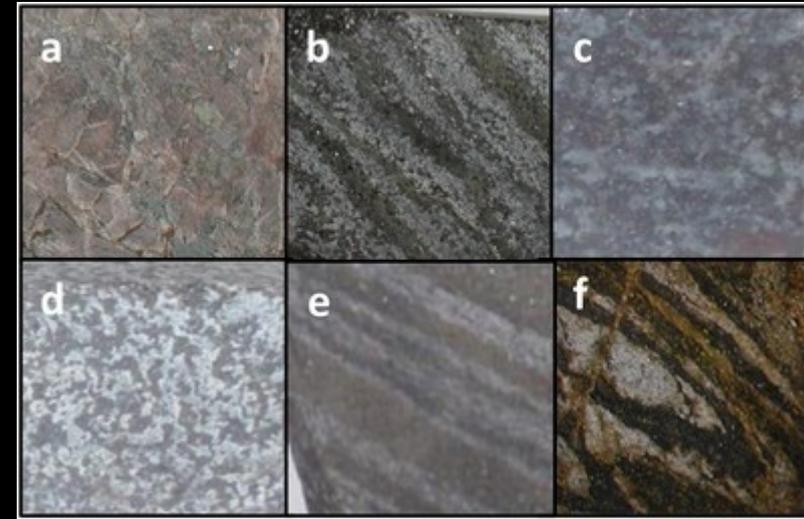
Launay et al., 2018



West African Magnetic Anomaly



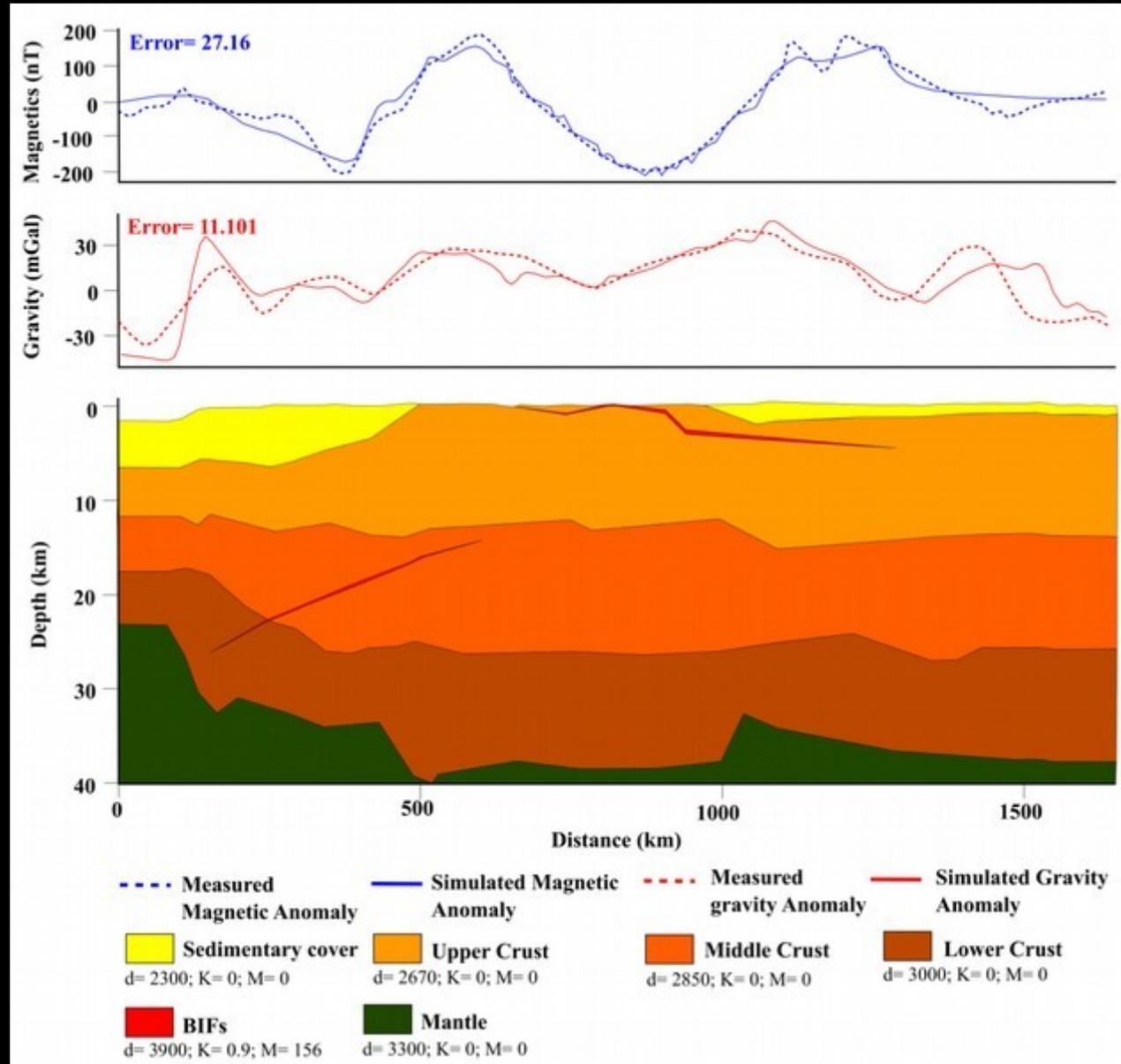
All BIF facies + other metamorphic lithologies from Kediat Idjil, Tiris and Amsaga areas (Mauritania)



*Remanence >> Induction
(Launay et al., 2018)*

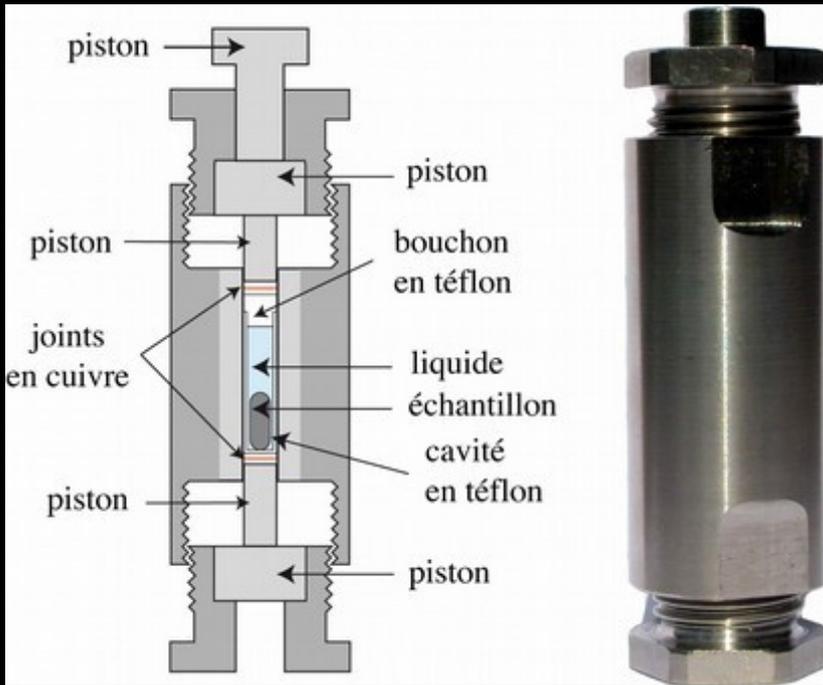
West African Magnetic Anomaly

2D forward modeling using gravity and magnetic field data + constraints from rock mag measurements and large seismic models (Launay, 2018)

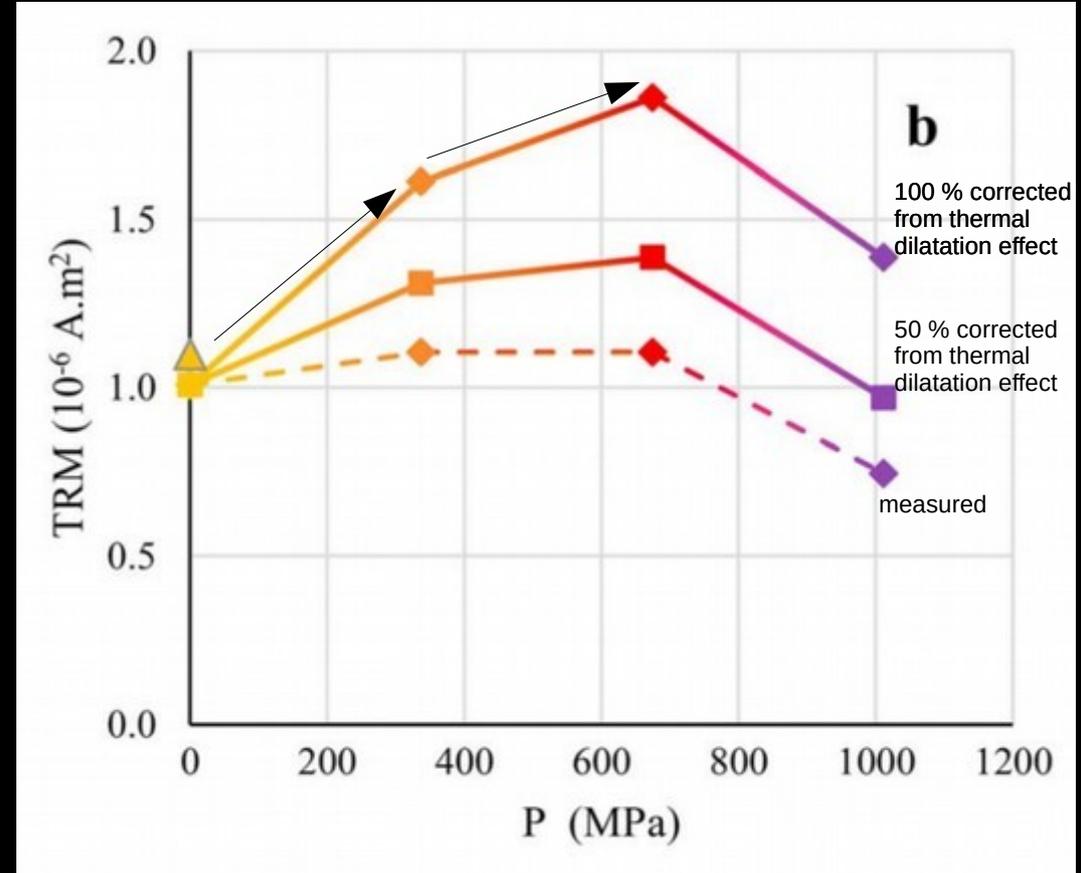


Strongly-magnetized BIF layers are necessary and can reach large crustal depths

Magnetization at depth?



*Magnetic pressure cell (up to 2 GPa)
(Bezaeva et al., 2015)*



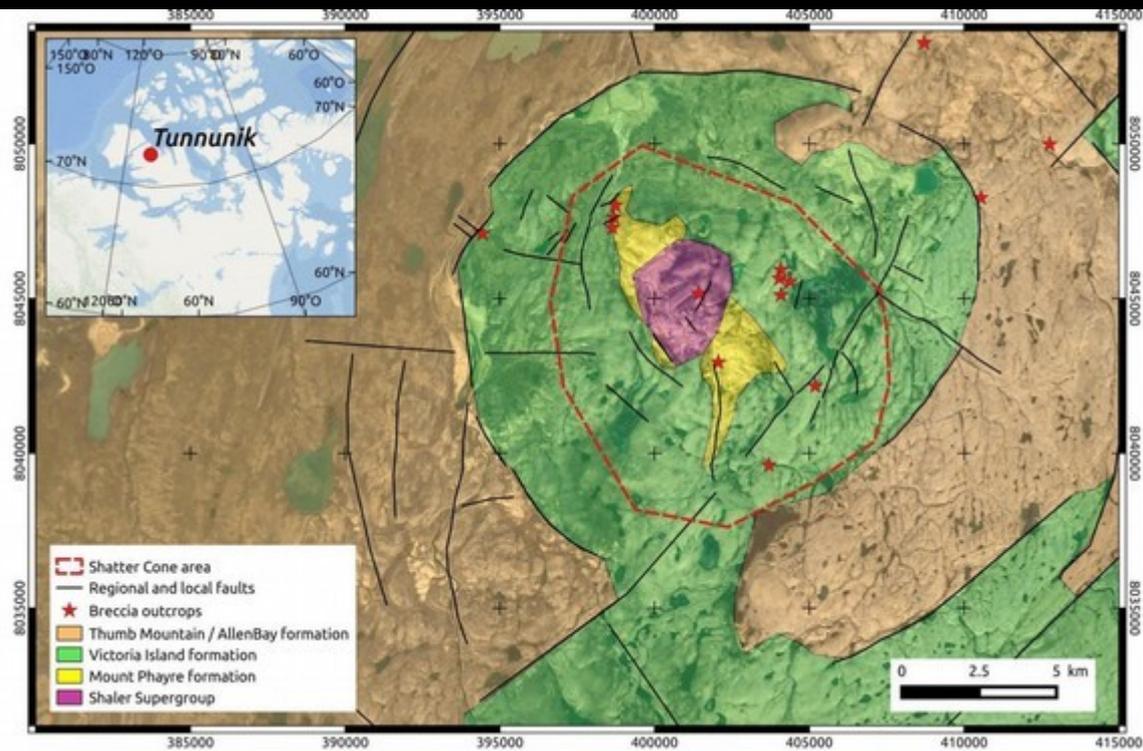
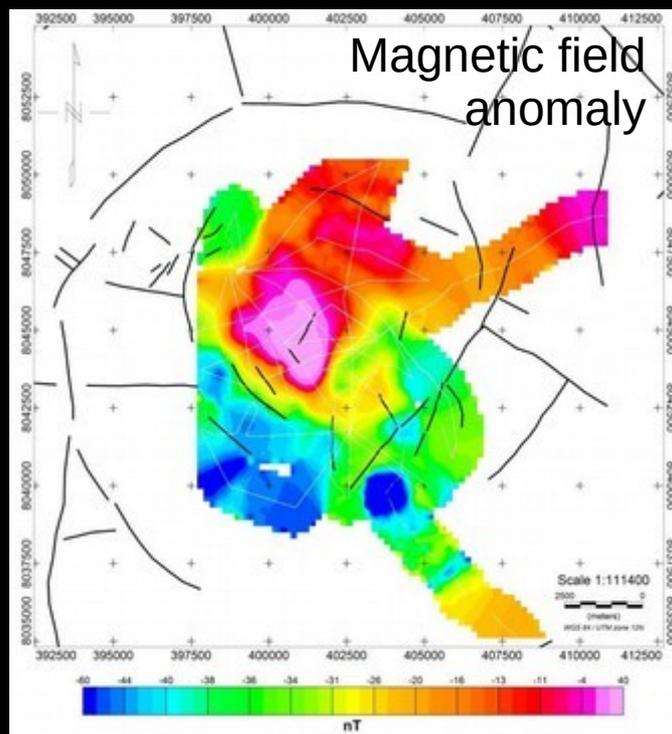
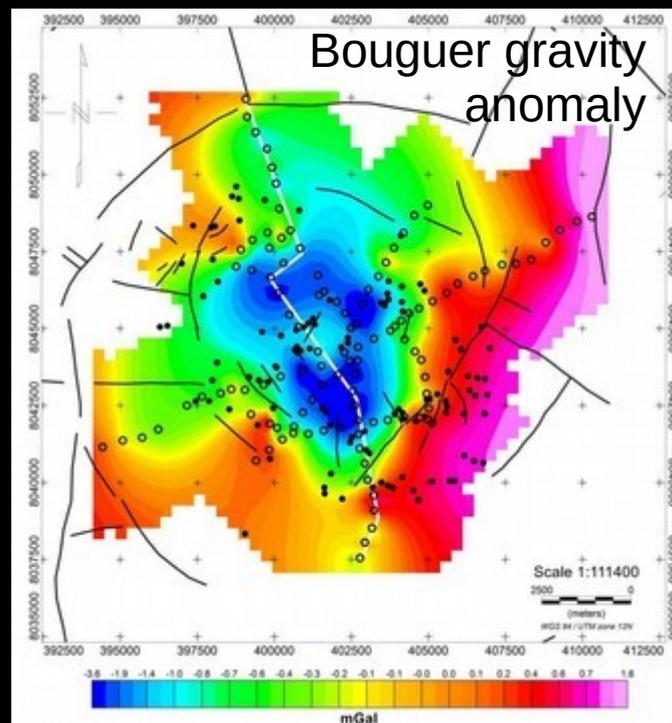
*Magnetization intensity increases at crustal depths
(Launay et al., 2017)*

Crustal pressures may increase remanence effect
→ this can reduce the magnetized thickness to explain large magnetic anomalies

→ Experimental constraints

Tunnunik impact structure

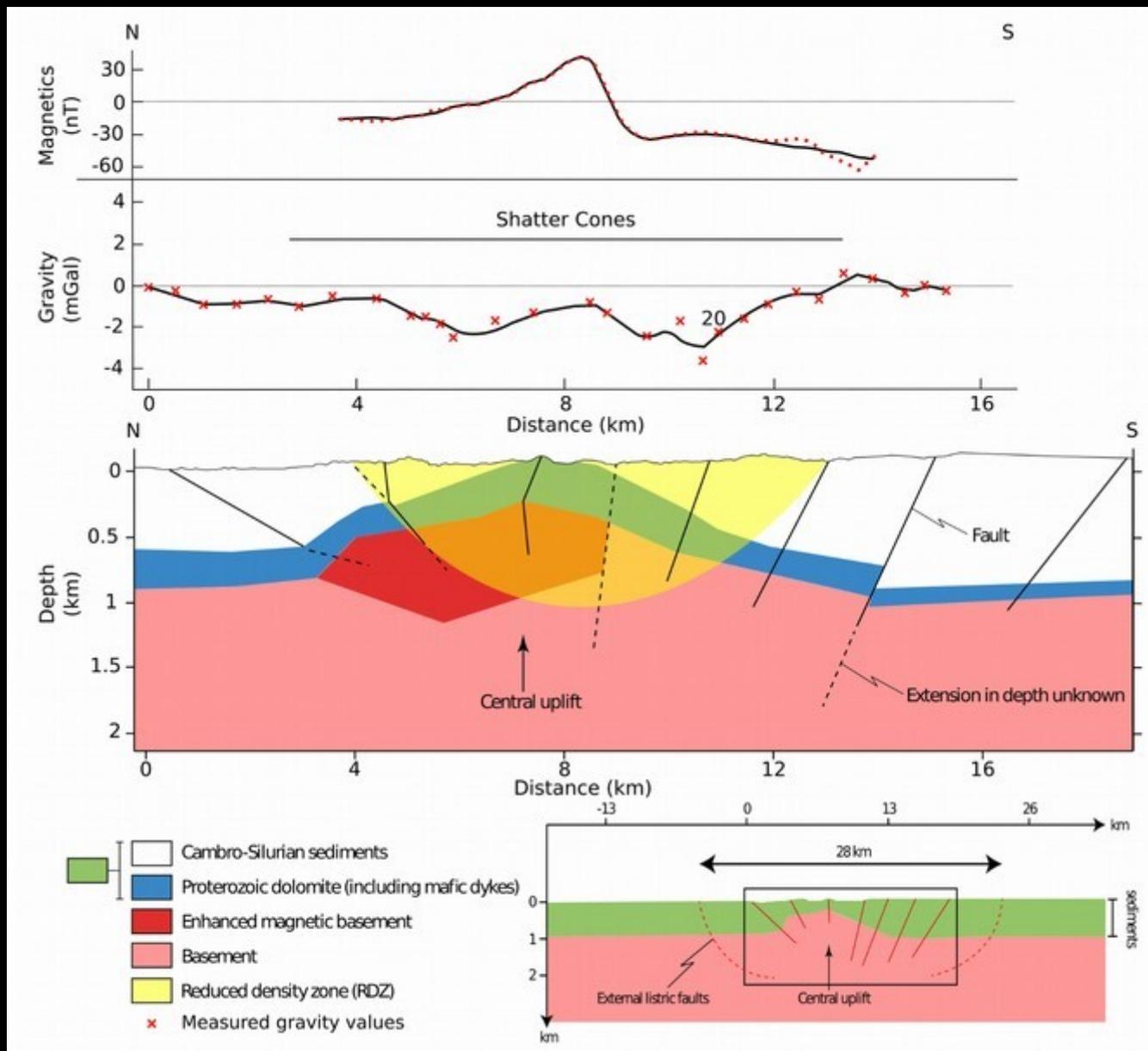
First ground gravity and magnetic field measurements



Significant potential-field anomalies

Tunnunik impact structure

Forward modeling using petrophysical constraints from surface samples, and using geological mapping



Still a 500 m central uplift?

Quesnel et al., in prep.

Conclusions

- Potential-field data constrain density, magnetization and/or shape of geological formations
- Grav-Mag anomaly correlation: not systematically (also true for impacts...)
- Rare cases of true 'joint' modeling or inversion → often grav-mag forward modeling using other constraints (seismic, petrophysics, wells)
- Even well-eroded and/or buried, impact structures can be revealed by potential-field data acquisition and modeling
- Some specific geological processes can be unveiled by magnetized source models: hydrothermalism