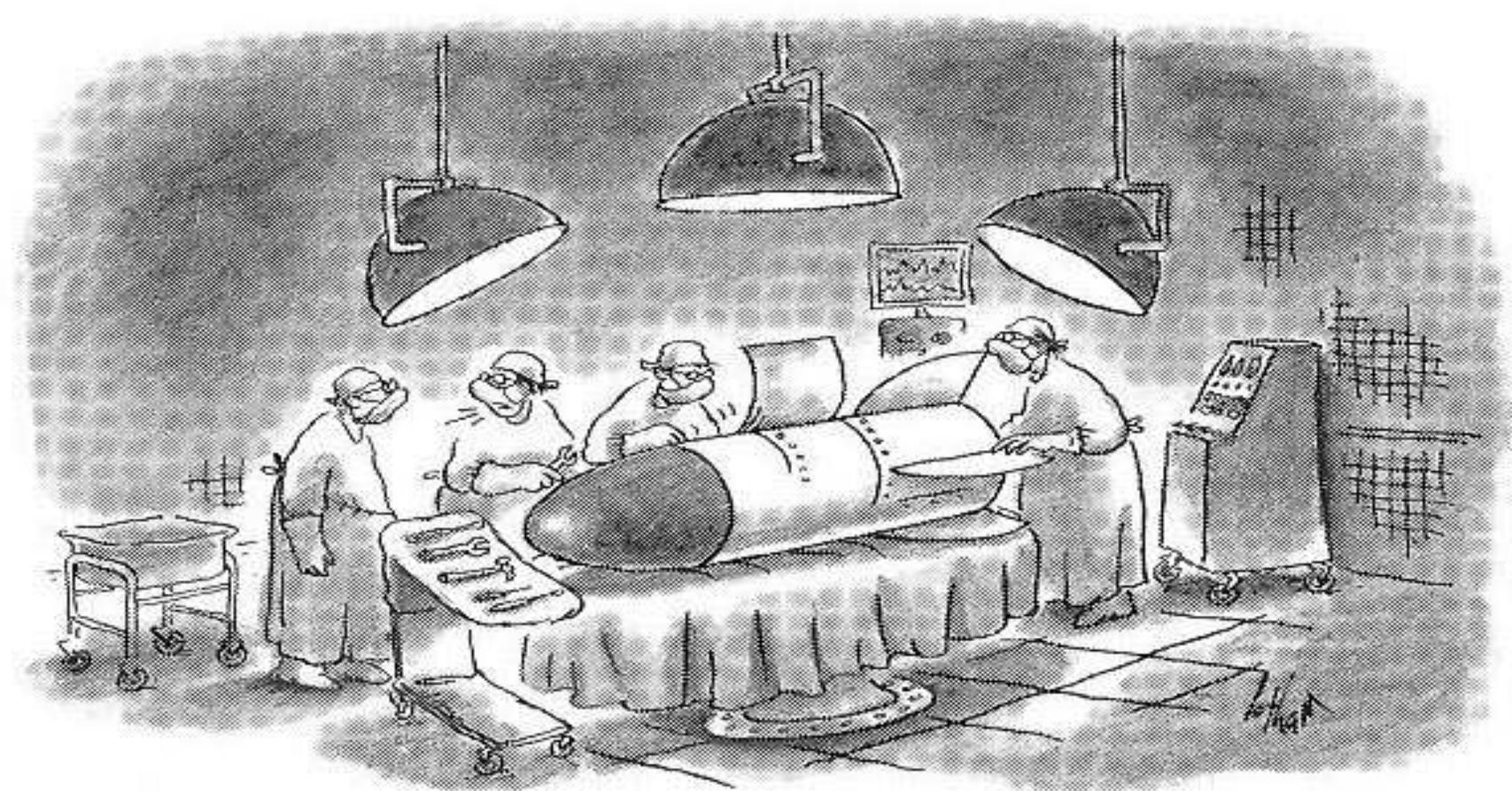


A satellite magnetic perspective of
subduction zones, large igneous
provinces, rifts, and diffuse plate
boundary zones

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Geodynamics Lab, GSFC/NASA)

Kathryn Whaler (School of
GeoSciences, Univ of Edinburgh, UK)

AGU, December 2008



CHAMP

"Damn it, I'm a brain surgeon, not a rocket scientist!"
Richard Haspel, Brookline, Mass.

New Yorker, 10 July 2006

Motivation & Outline

Combining magnetic and seismic information on the depth to the Moho helps better resolve magnetic crustal thickness, and allow inferences on basin development, the thermal state of the crust, and large igneous provinces.

- Previous work
- Combining seismic and magnetic models
 - 3SMAC, WENA, Crust 5.1
 - MF-6, WDMAM, CHAMP
- Resolution, and assumptions, of technique
- Some examples
- Interpretations
- Conclusions

DATA **3SMAC, WENA
or Crust 5.1**

MF-6

$d^{(0)}$

high
pass

$b_{\text{obs, hp}}$

INVERSION

iteration

$d^{(n)}$

forward

$b^{(n)}_{\text{ind, model}}$

high
pass

$b_{\text{obs, ind, hp}}$

-
 $b^{(n)}_{\text{ind, model, hp}}$

+

$d^{(n+1)}$

$\Delta d^{(n)}_{\text{hp}}$

if yes

inversion

$|\Delta b^{(n)}| < |\Delta b^{(n-1)}|$

test

$\Delta b^{(n)}_{\text{ind, hp}}$

Set $m=+1$ to 0

if no

END MODEL

$d^{(n)}$

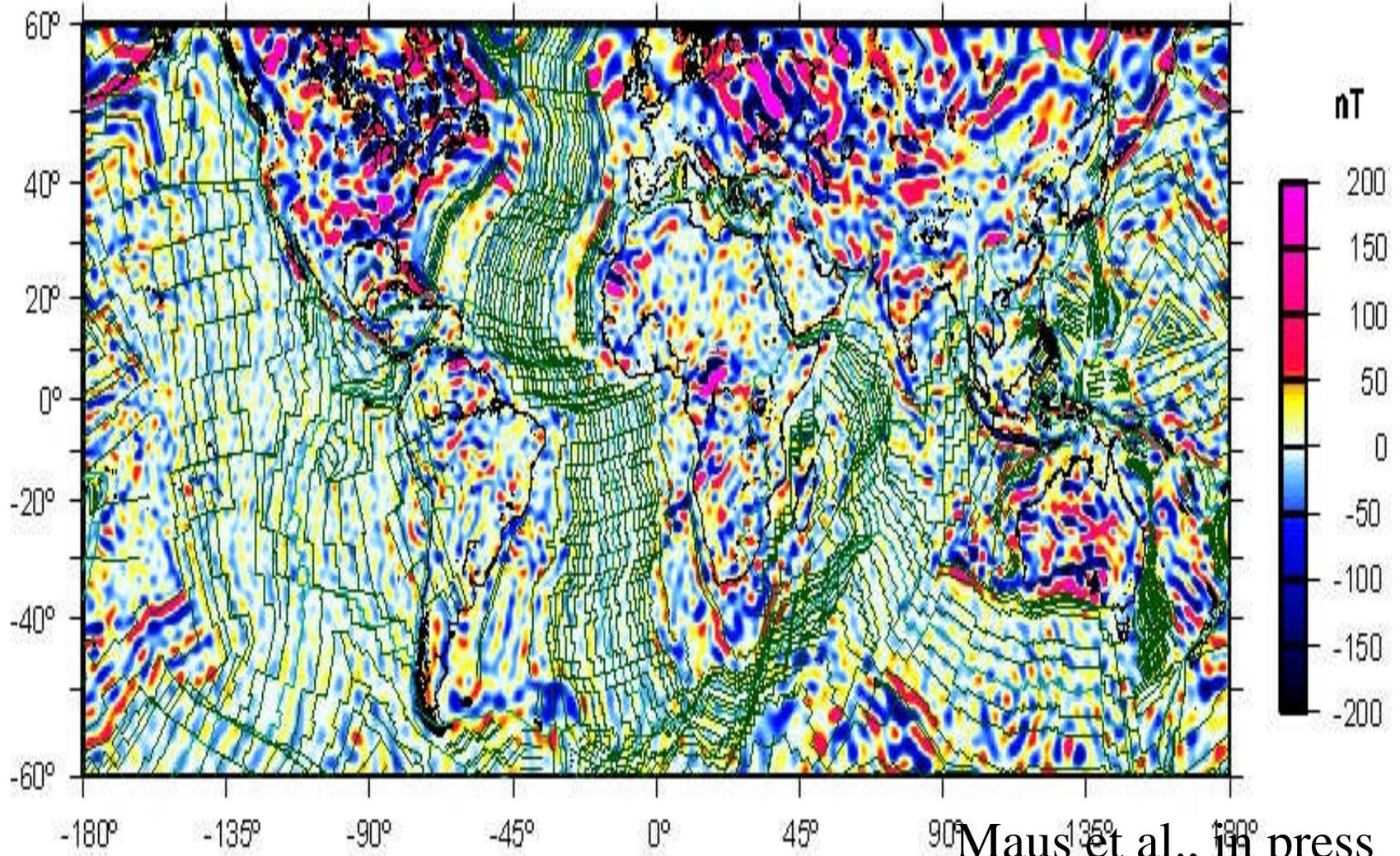
obs: observed
ind: induced
rem: remanent
hp: high pass filtered

Magnetic crustal thickness

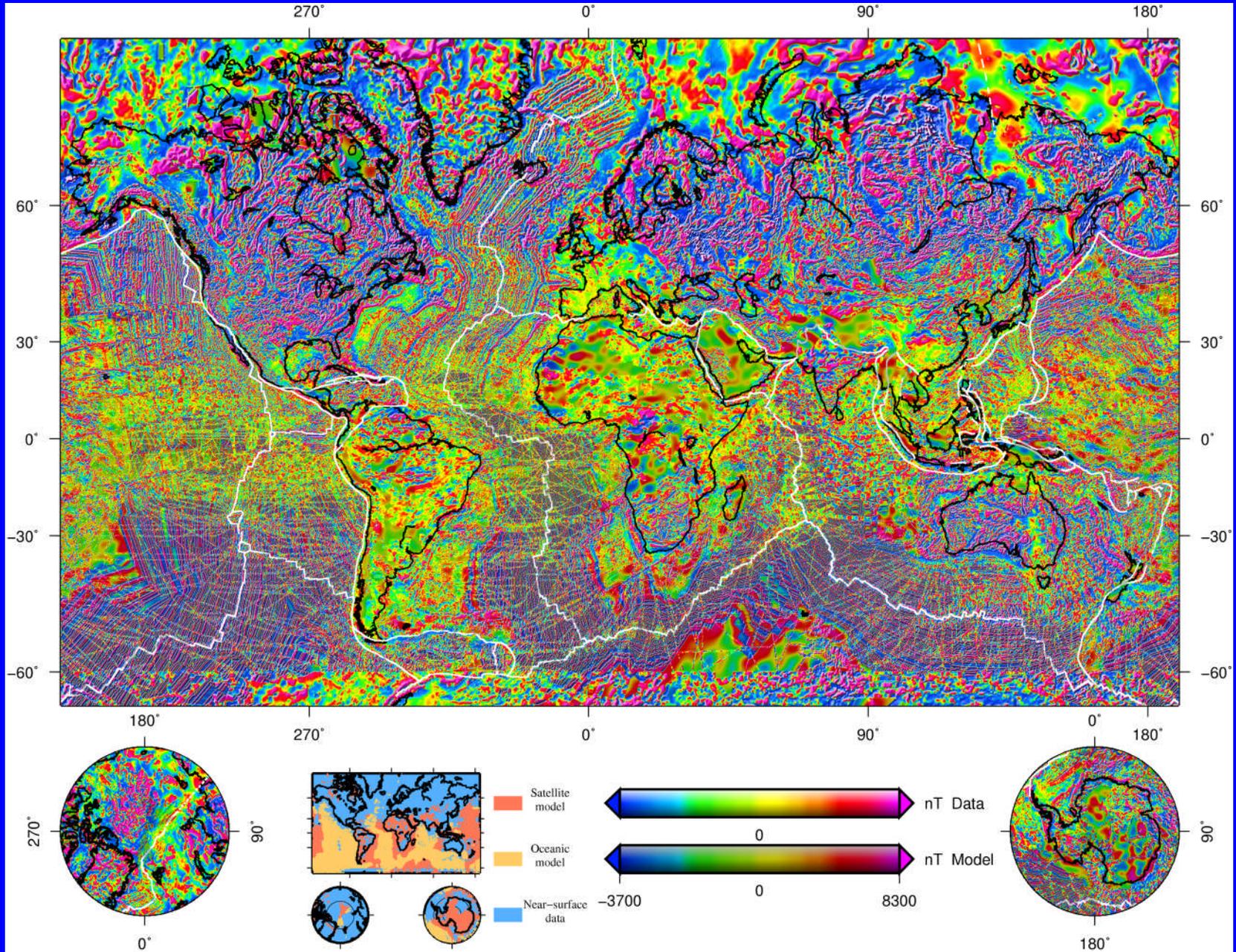
Assumptions/Scale issues

- Magnetic susceptibility is constant
- Areas w. significant magnetic remanence are not used in interpretation (Bangui, Kursk)
- Global seismic and magnetic data sets have comparable resolutions (SHD 120, Wavelength = 333 km for magnetic).
- Seismic data is spatially heterogenous, and of widely different quality
- Magnetic data is spatially homogenous away from high latitude auroral zones.

MF-6 (Vertical field evaluated at surface)

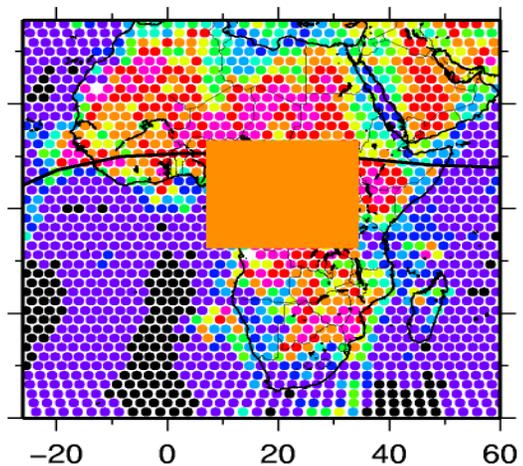


World Digital Magnetic Anomaly Map

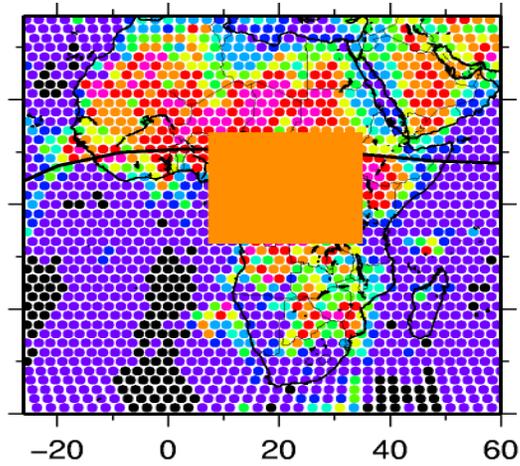


Magnetic crustal thickness using MF-6 and different seismic starting models

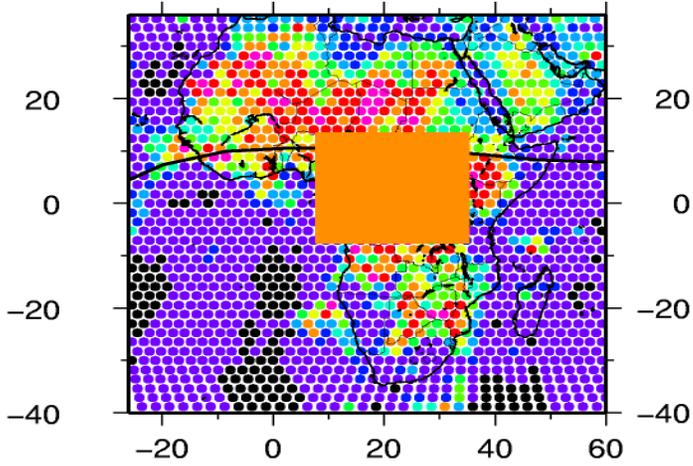
Crust 2.0



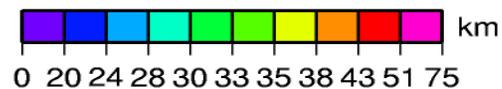
WENA



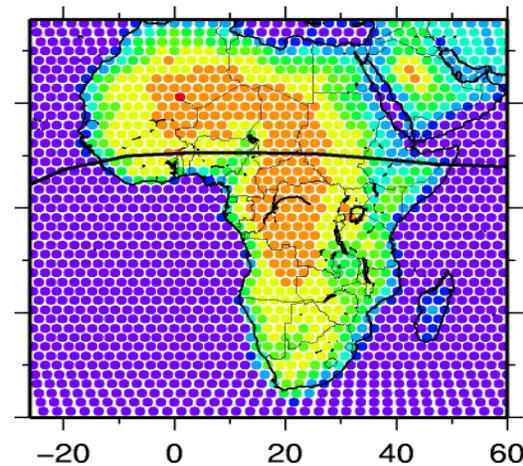
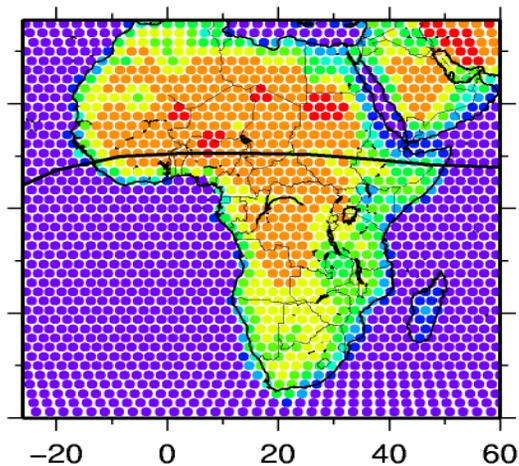
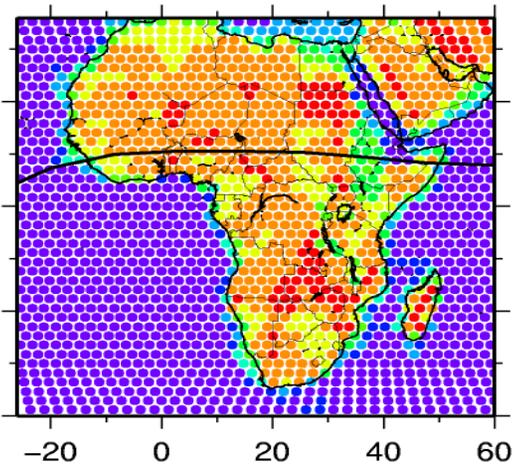
3SMAC



 Bangui region

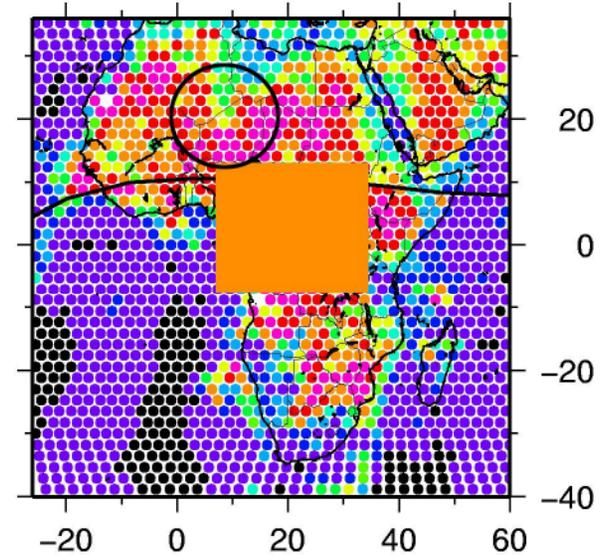
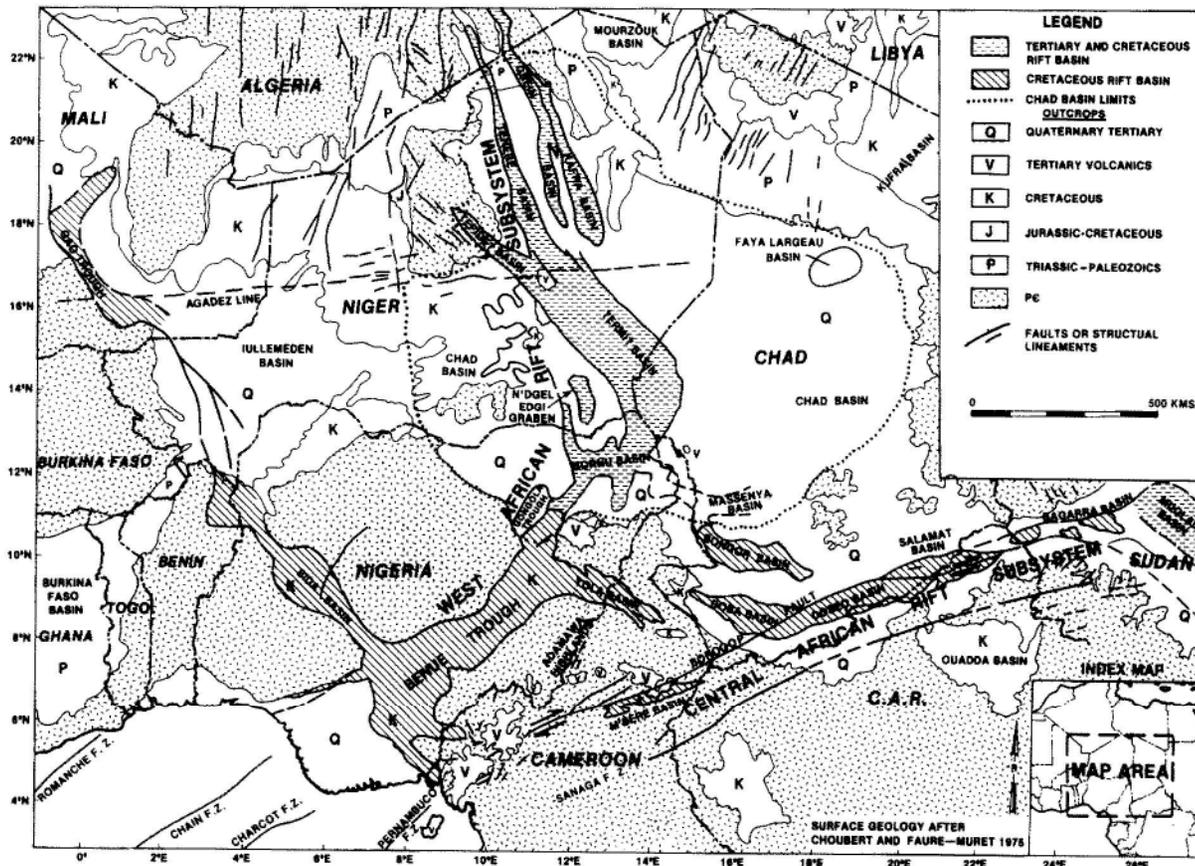


Starting models

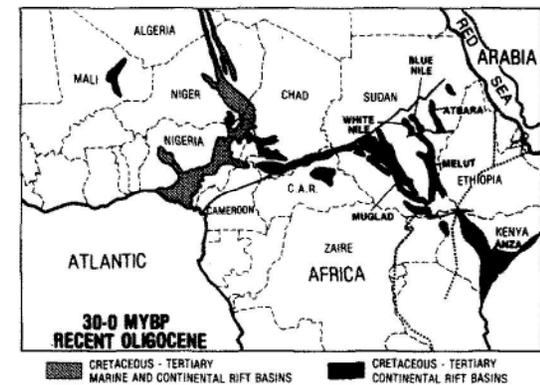


Examples

- Cretaceous rift basins developed on W.African shield
- Red Sea region rifts
- Siberian traps large igneous province
- West Siberian basin/rift

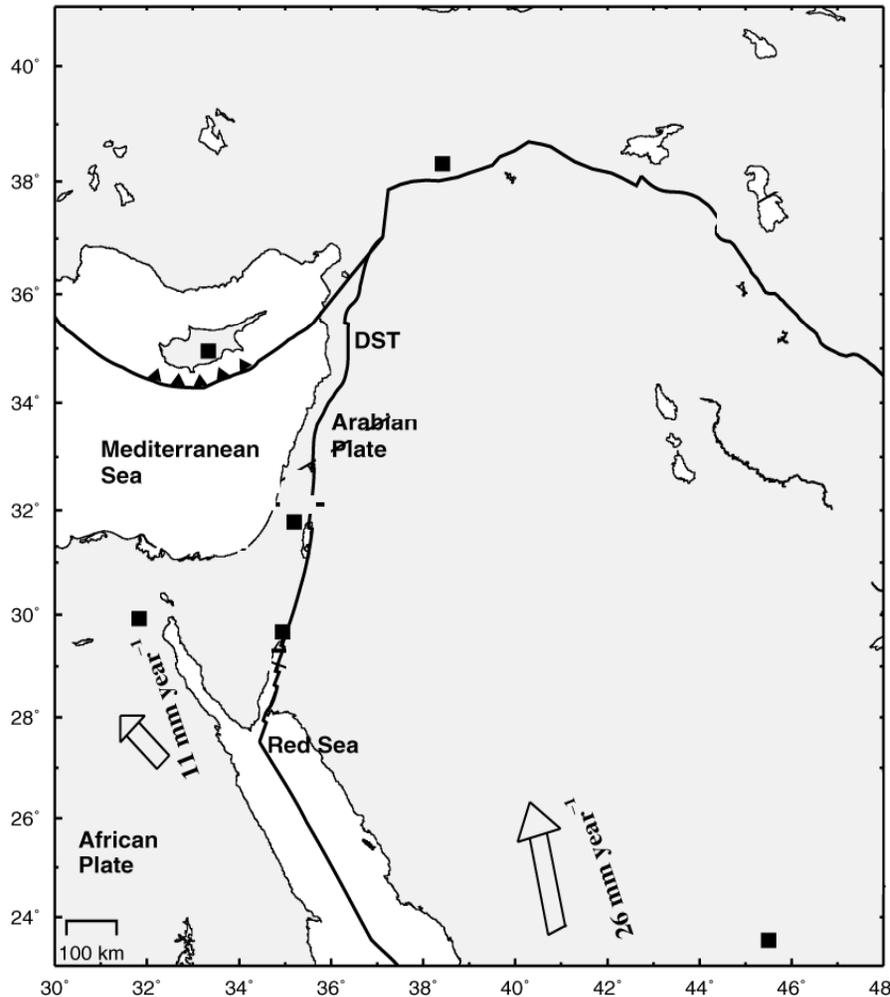


**African rift basins
of Cretaceous age
developed near
edge of West African craton**



Genik, 1992

Regional tectonic setting: Dead Sea region



**Thinned lithosphere from
seismic analysis**

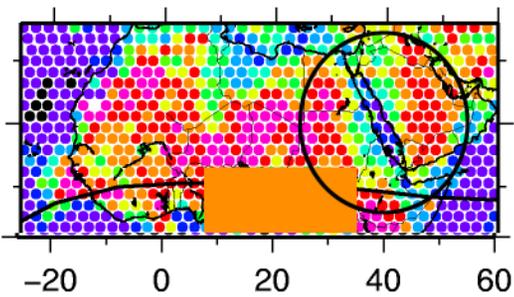
**Xenoliths from western Saudi
Arabia suggest thinned
lithosphere & normal crustal
thickness/low heat flow**

**Magnetic field provides
depth to Curie isotherm,
not Moho depth**

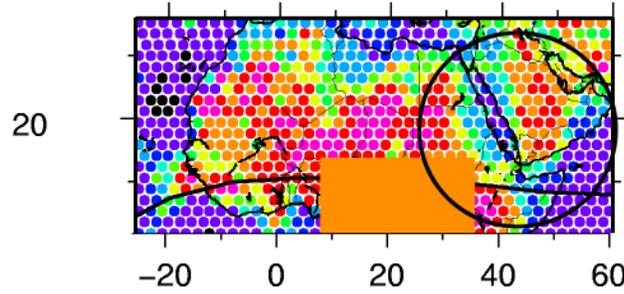
Moshen et al., GJI, 2006

Thermal structure of Red Sea rift basin and surrounding region

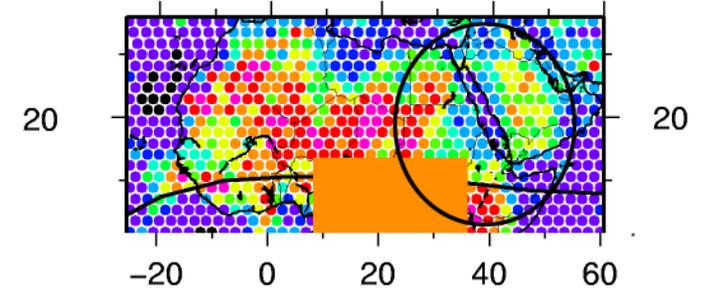
Crust 2.0



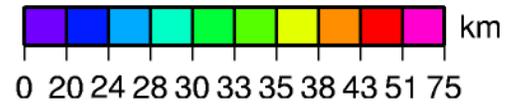
WENA



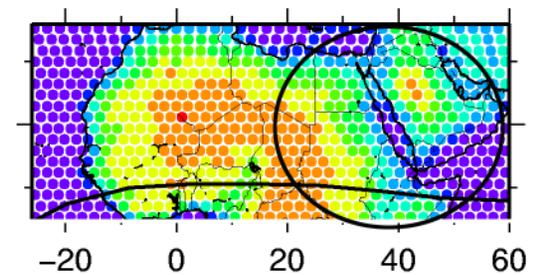
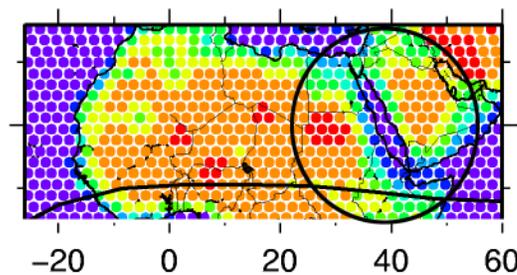
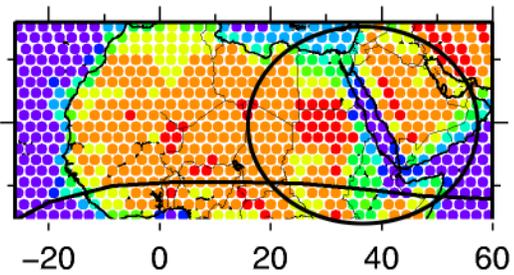
3SMAC



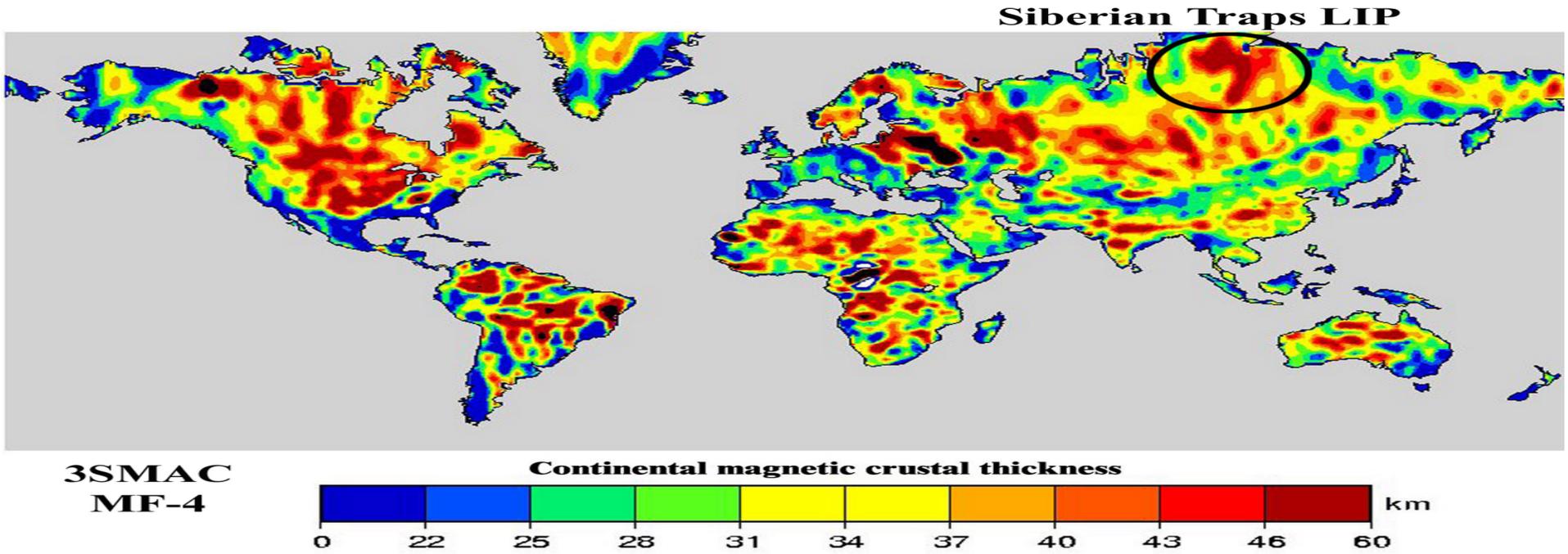
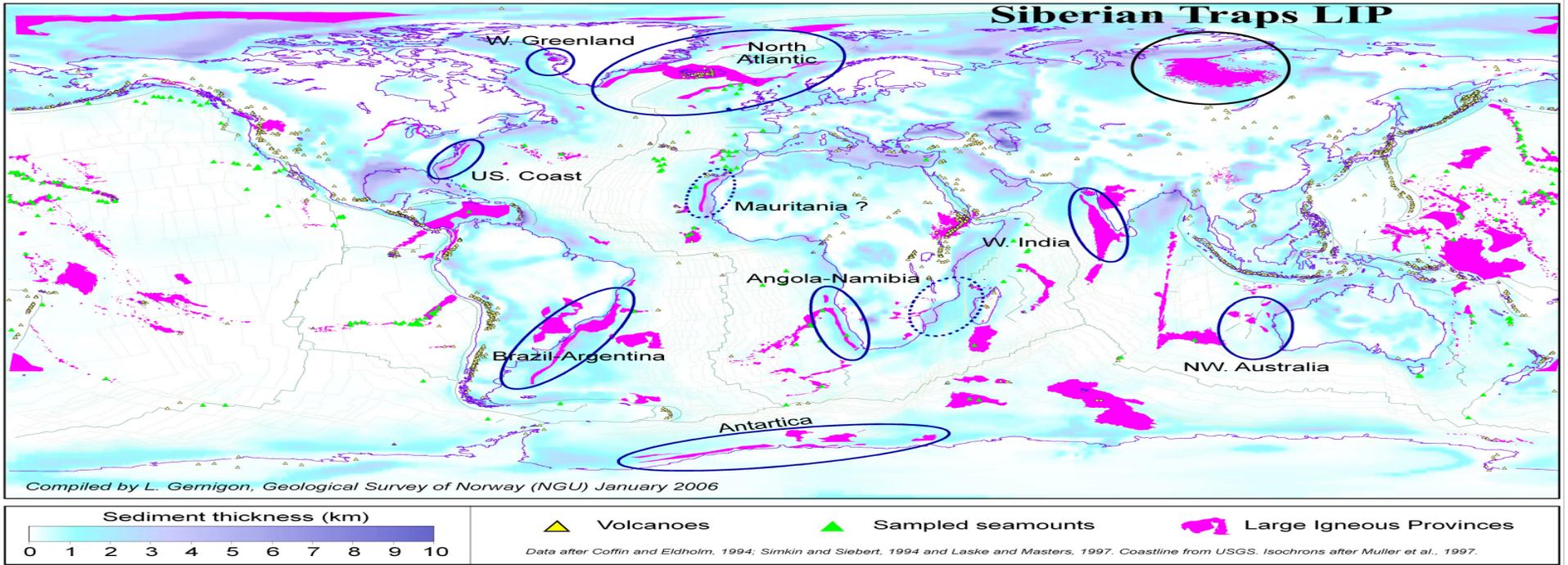
 Bangui region

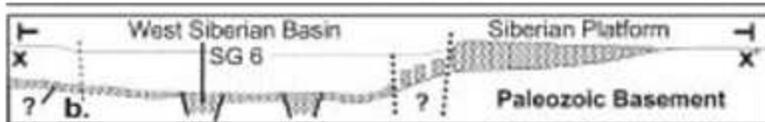
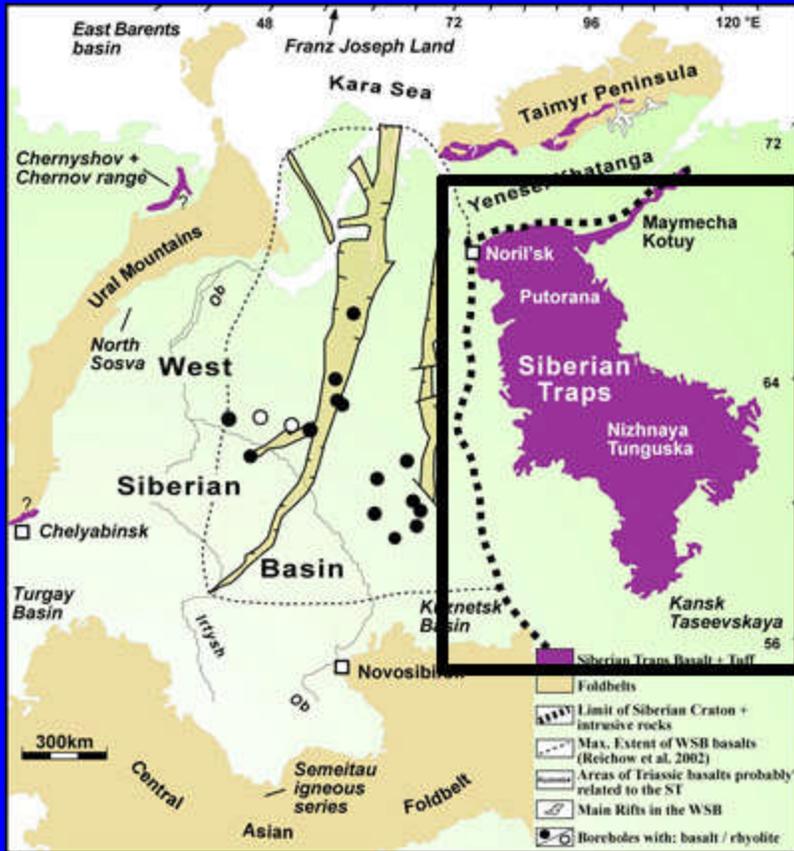


Starting models



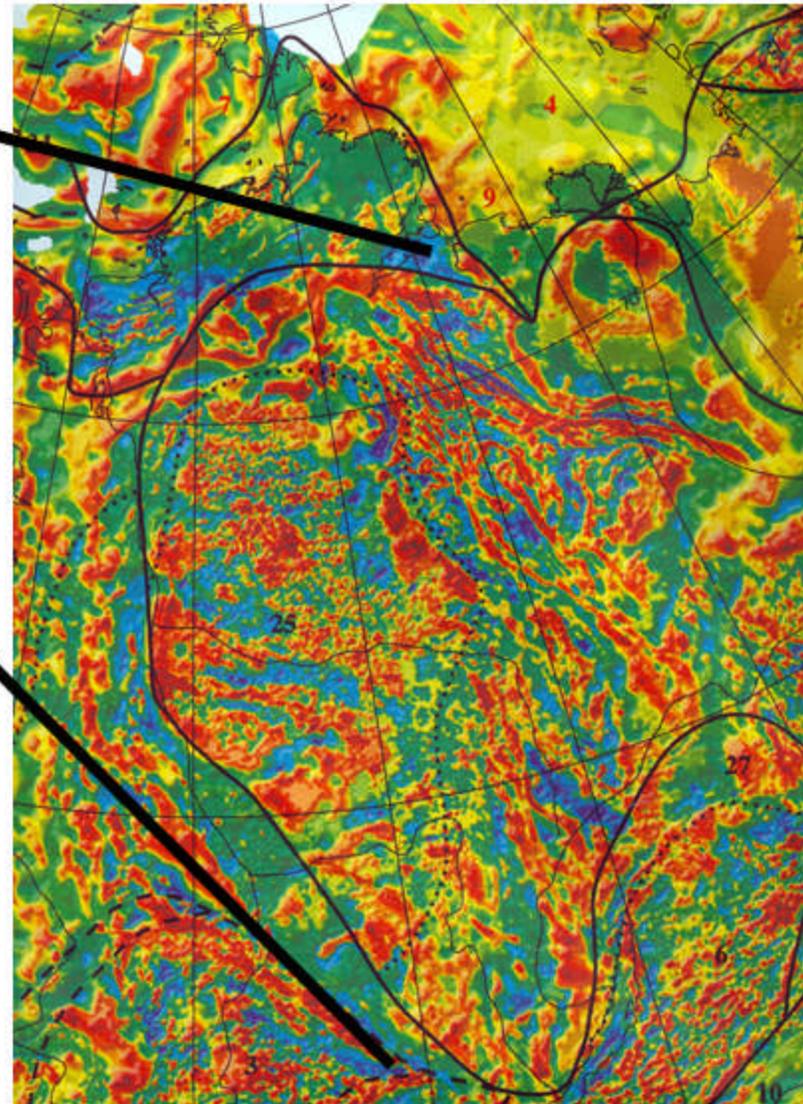
Magnetic crustal thickness using MF-6 and different seismic starting models



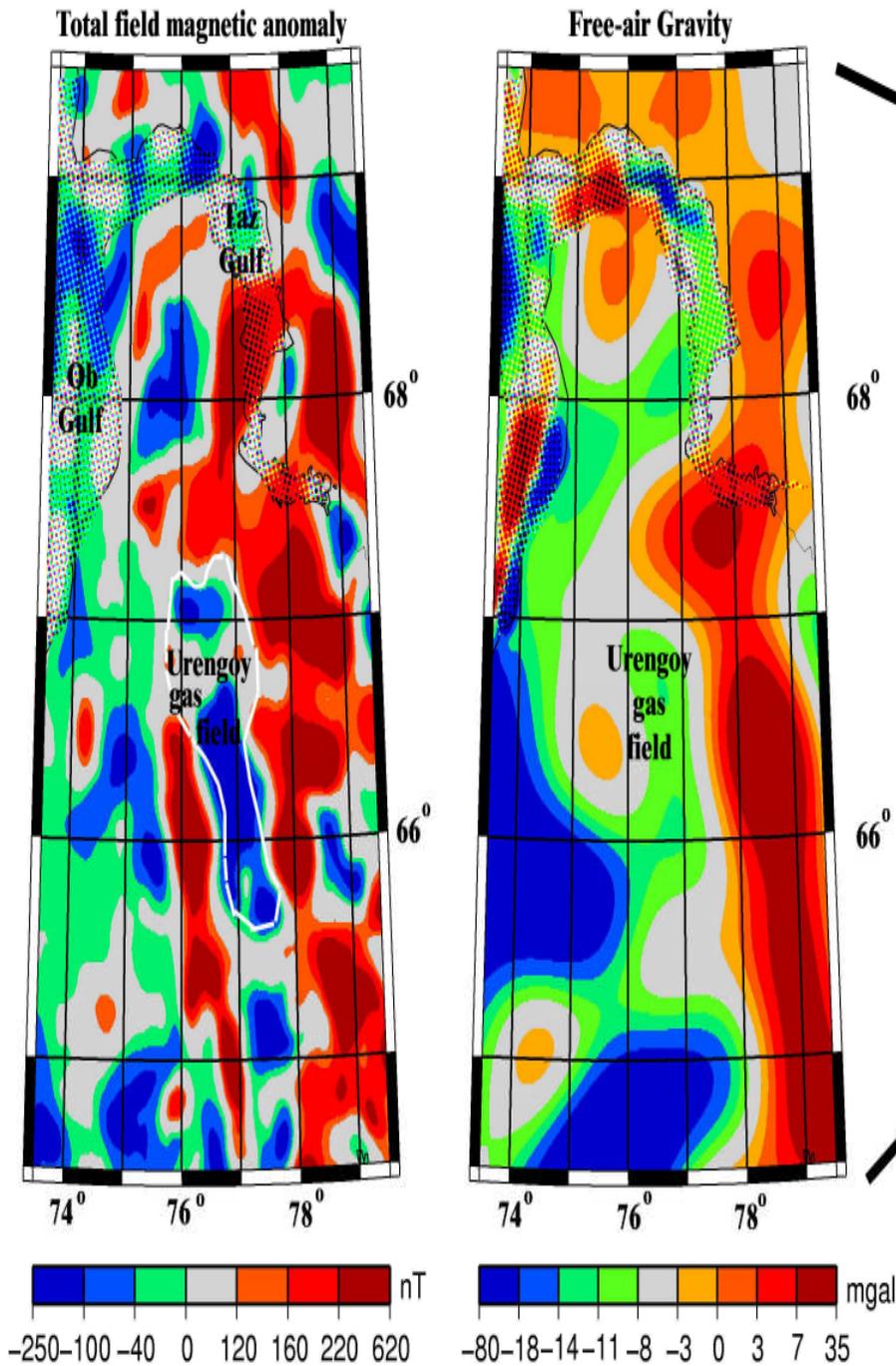


Elkins-Tanton et al., Siberian traps proposal

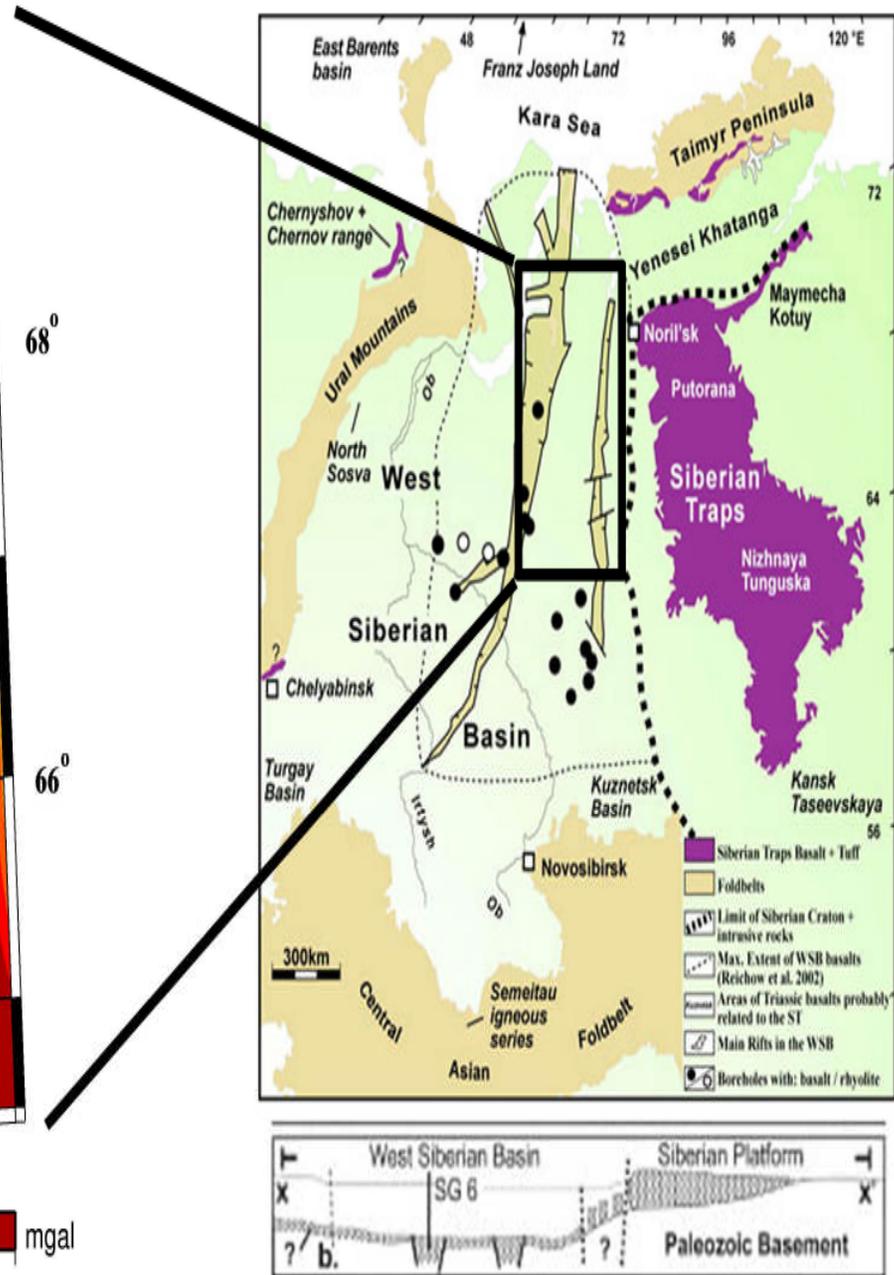
Aeromagnetics



GSC, 1995



Purucker & Whaler, 2007



Elkins-Tanton et al., 2006

Conclusions

- The availability of new seismic and magnetic compilations, and the new CHAMP magnetic map, allow a more detailed view of the development of rift basins, large igneous provinces, and associated thermal anomalies.