



# Density and magnetic susceptibility relationships in non-magnetic granites; a “wildcard” for modeling potential fields geophysical data.

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# Outline



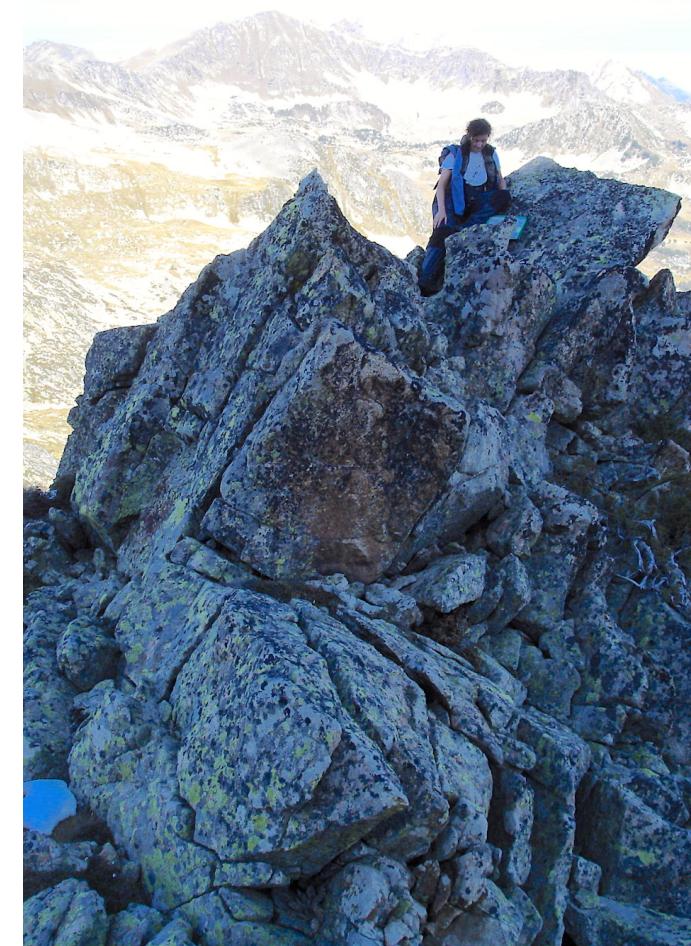
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- Motivation
- Methodology
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# Motivation

- Magnetic susceptibility ( $\kappa$ ) and density ( $\rho$ ) used to keep linear relationships in the paramagnetic domain ( $< 500 10^{-6}$  S.I.) in granitic rocks (usually calc-alkaline ones)
  - Paramagnetic granites (illmenite type) fraction Fe mostly in illmenite and biotite (and very little magnetite (as magnetite type granites))
  - Crystallographic anisotropy coincides with magnetic one (AMS) in phyllosilicates (biotite, mica-schist, etc.) allowing for the rock fabric characterization
  - Since the 90's, AMS have been studied in many granitic bodies worldwide (quick measurements) and have produced very large and dense datasets of magnetic susceptibility
- 
- We aim to merge these concepts and squeeze AMS (data) maps for gravimetric modeling



# Methodology: Sampling

- two types of samples
  - Hand blocks (> 1 dm<sup>3</sup>)
  - Standard AMS/Pmag samples (10 cm<sup>3</sup>)





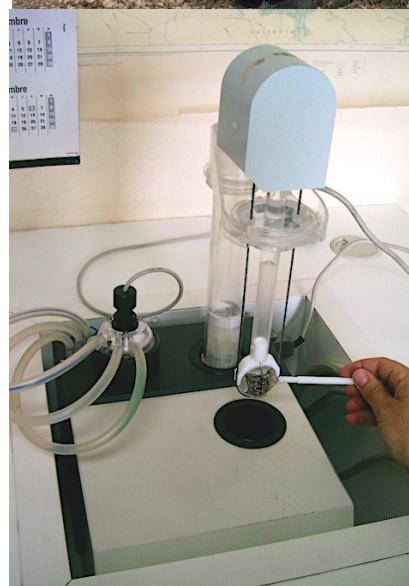
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## Methodology: Magnetic susceptibility

- in the field: SM20 and KT20 (50 to 70 measurements/outcrop)
- In the lab: KLY3/KLY4...



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Formerly KLY2 instruments



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ICTJA  
CSIC  
B  
U



Weighting and measuring (geometry)

&

Archimedes' principle  
Both, blocks and Pmag samples



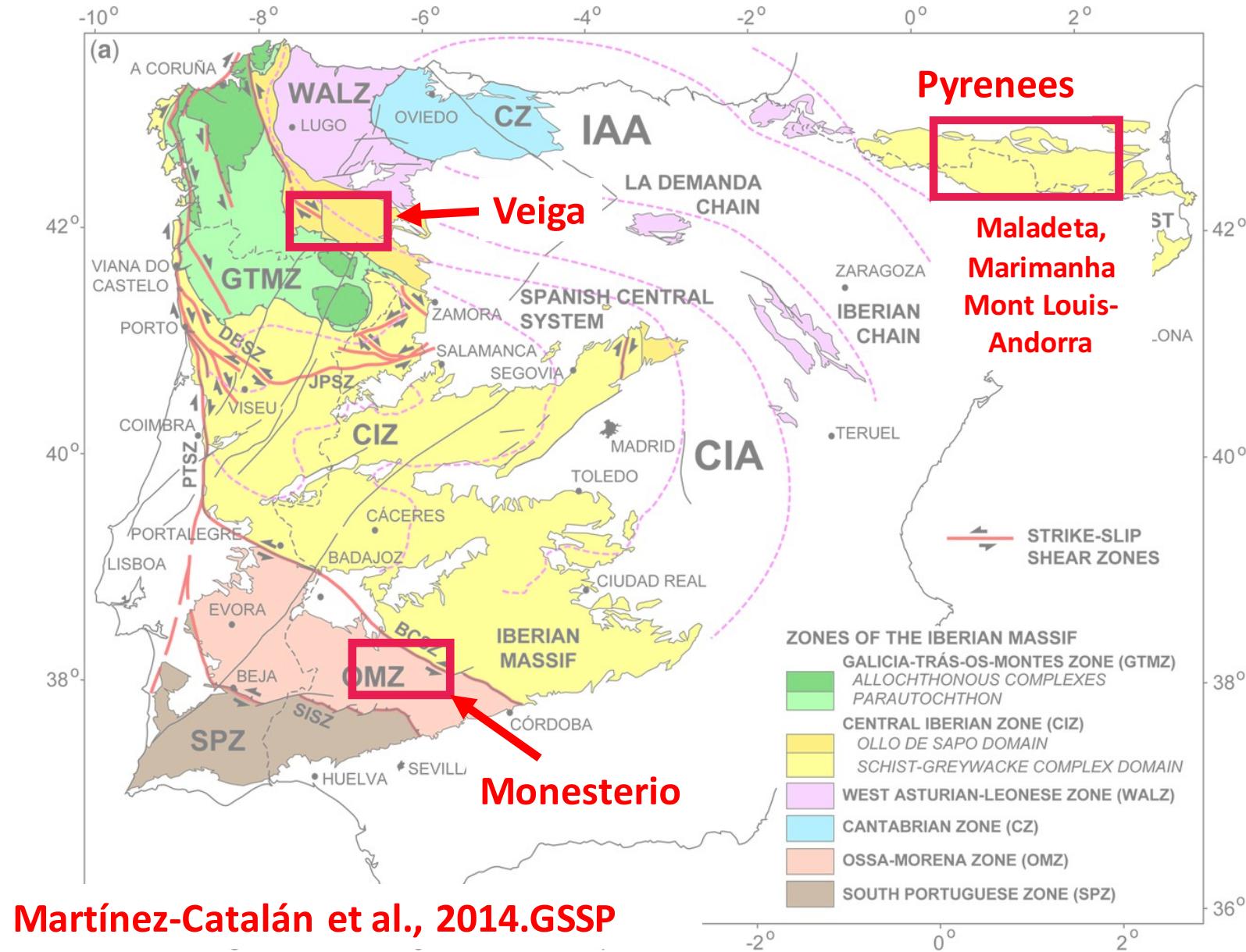
May be measured  
in the field  
with the KT20

## Methodology: Density



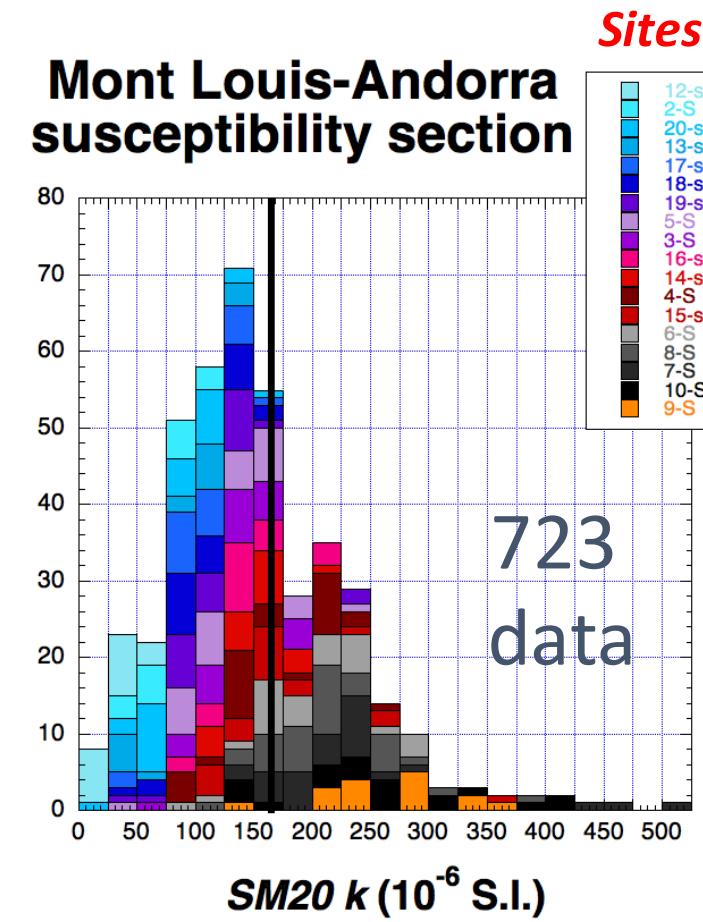
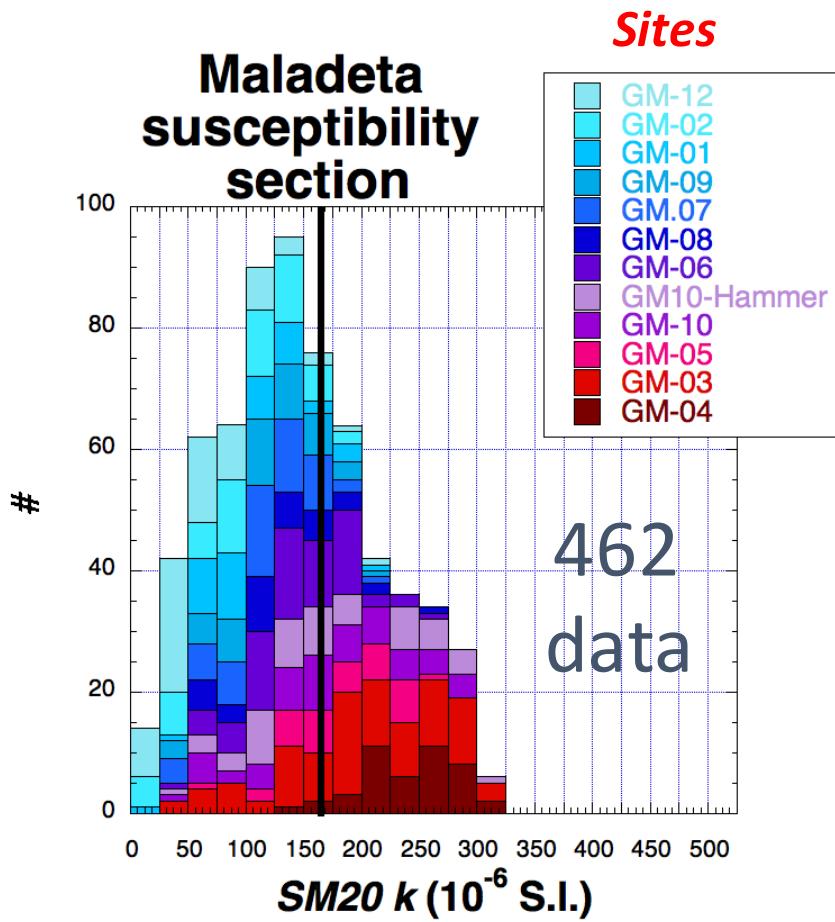
GM-7

# Case studies



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# Individual measurements

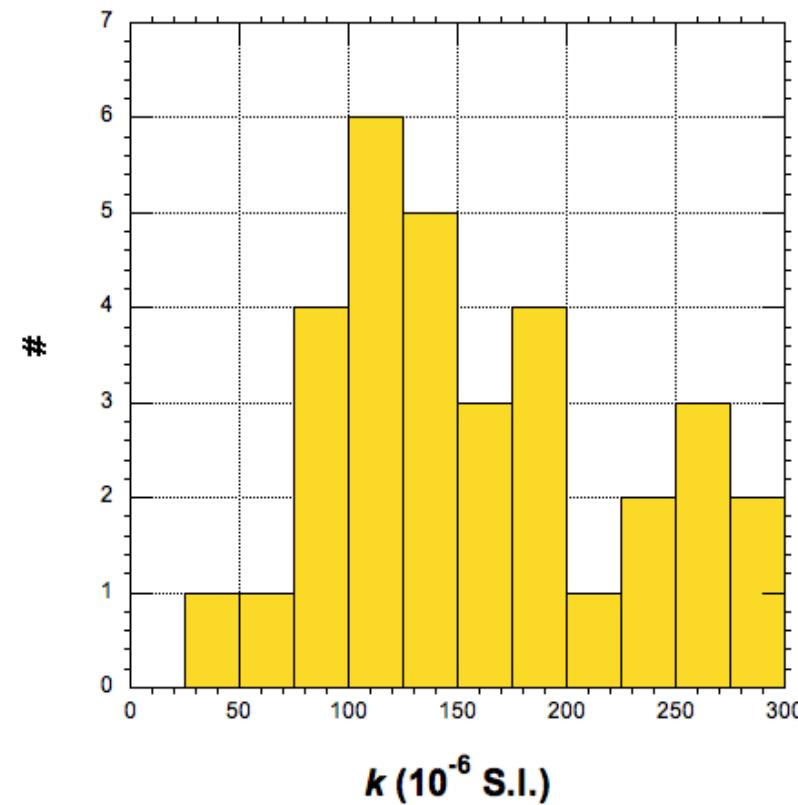


Always in the paramagnetic domain

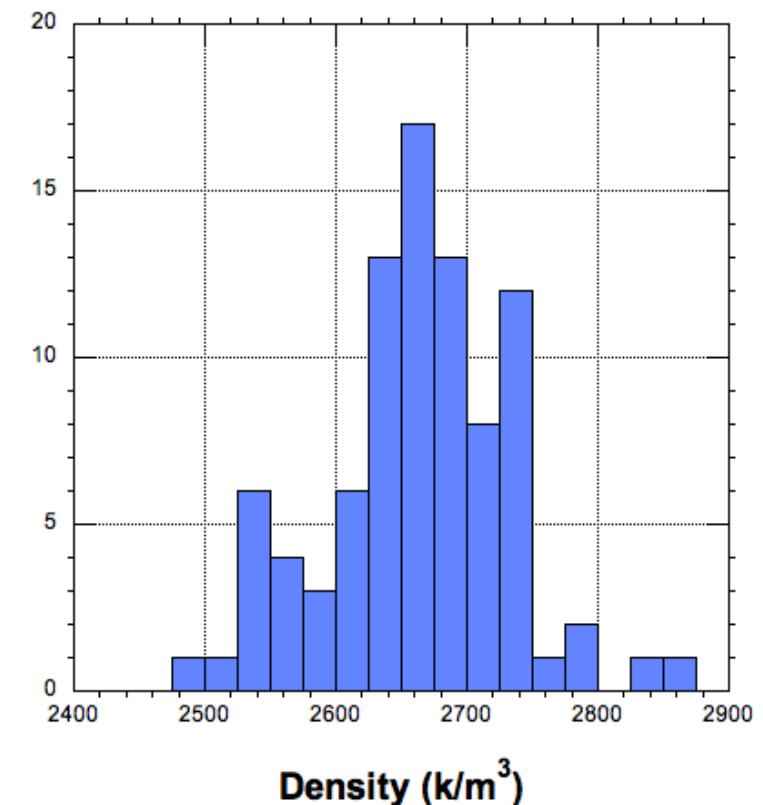
# Results

# Results: Site means $\kappa$ & $\rho$ distributions

Magnetic susceptibility  
(site means)

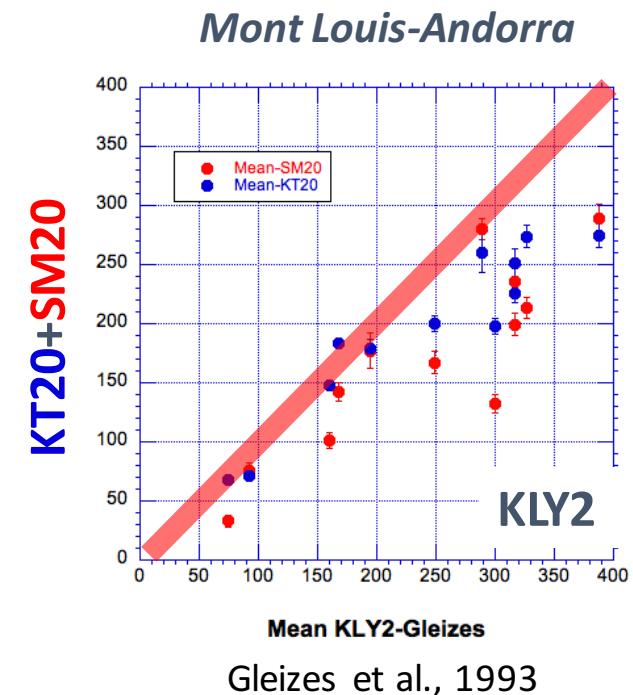
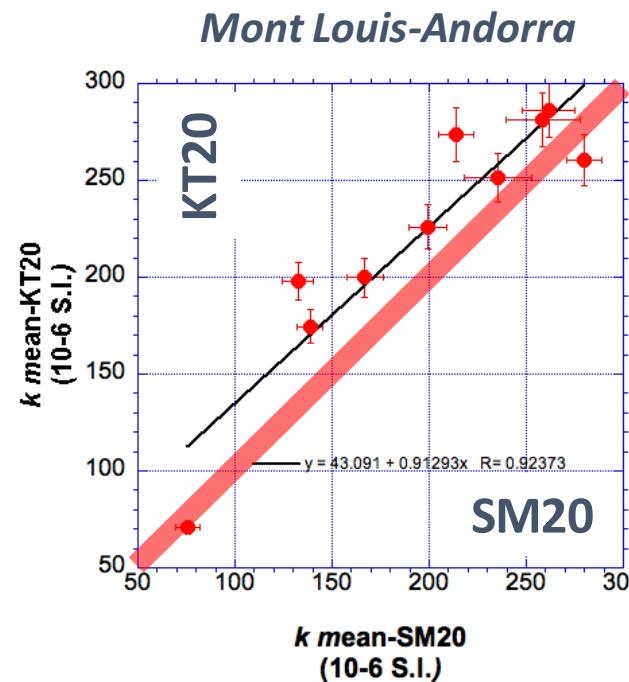
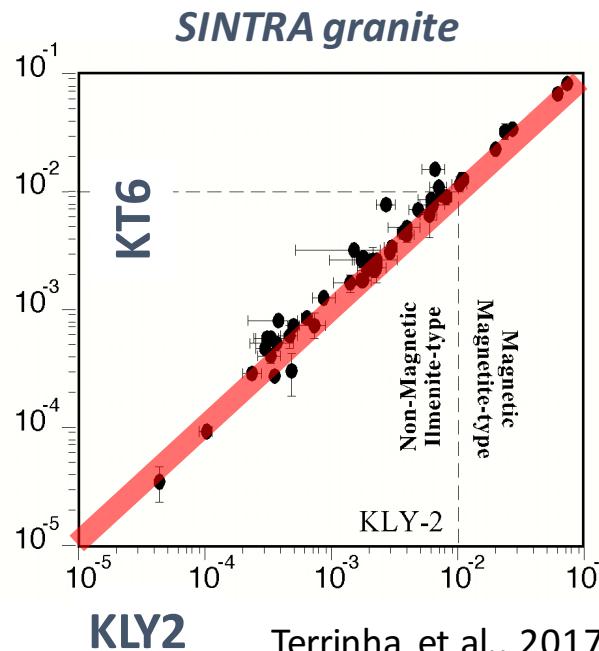


Density histogram



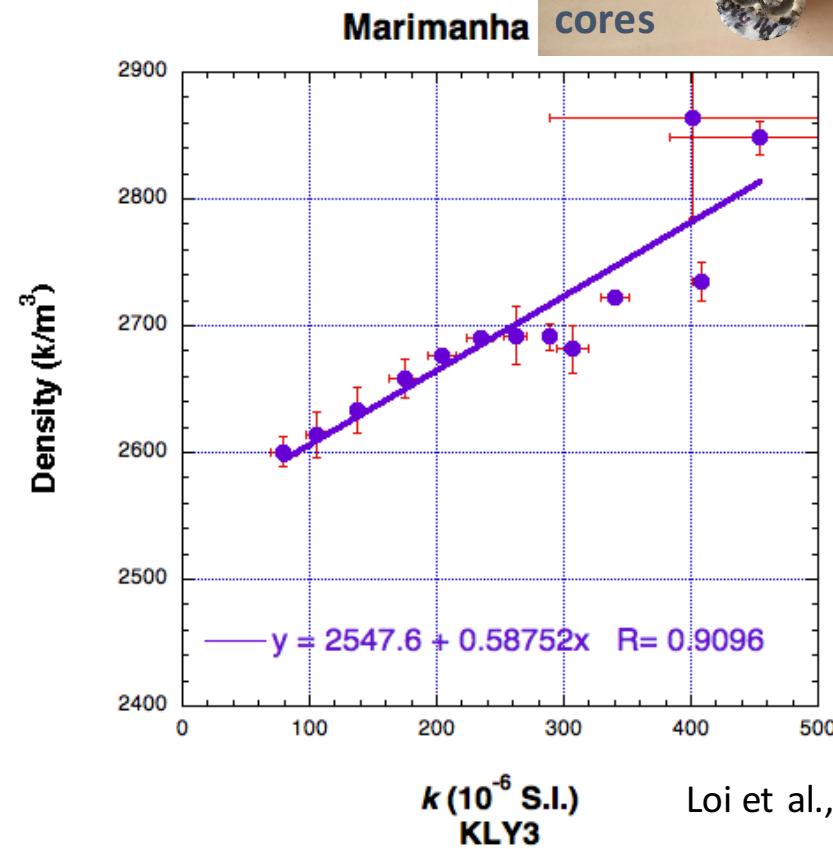
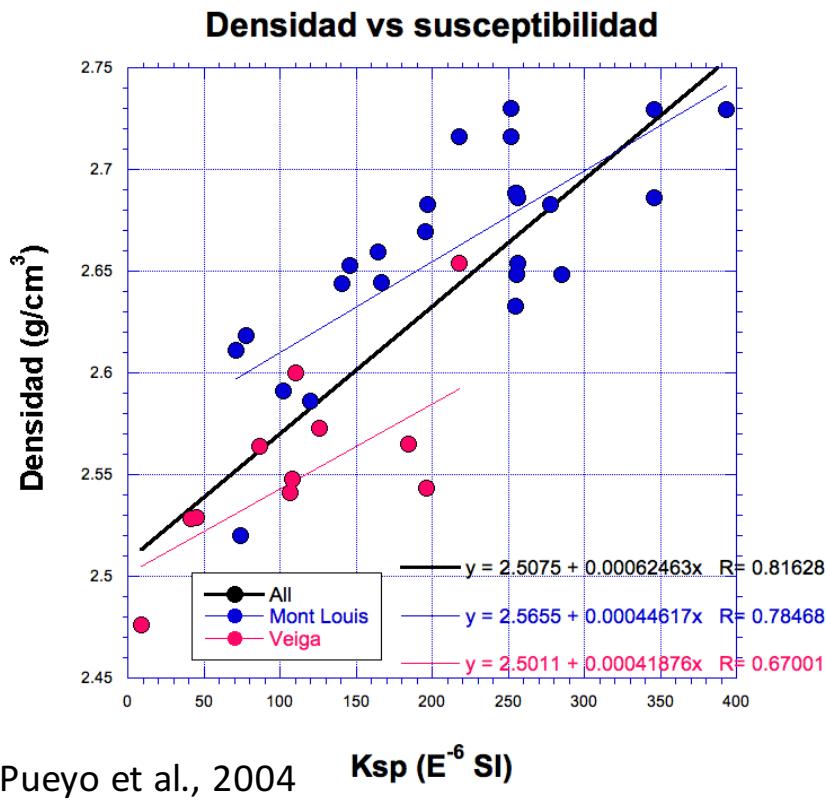
Variable	Min	Max	Mean	Median	RMS	Std Dev	Variance	Std Error	Skew	Kurtosis
Suscept	33.16	289.34	158.68	143.2	172.23	68.02	4626.7	12.02	0.328	-0.8618785
Density	2476.1	2864.6	2663.28	2665.93	2664.20	70.323	4945.31	7.45	-0.085	0.49852488

# Discussion: Calibrations of susceptometers



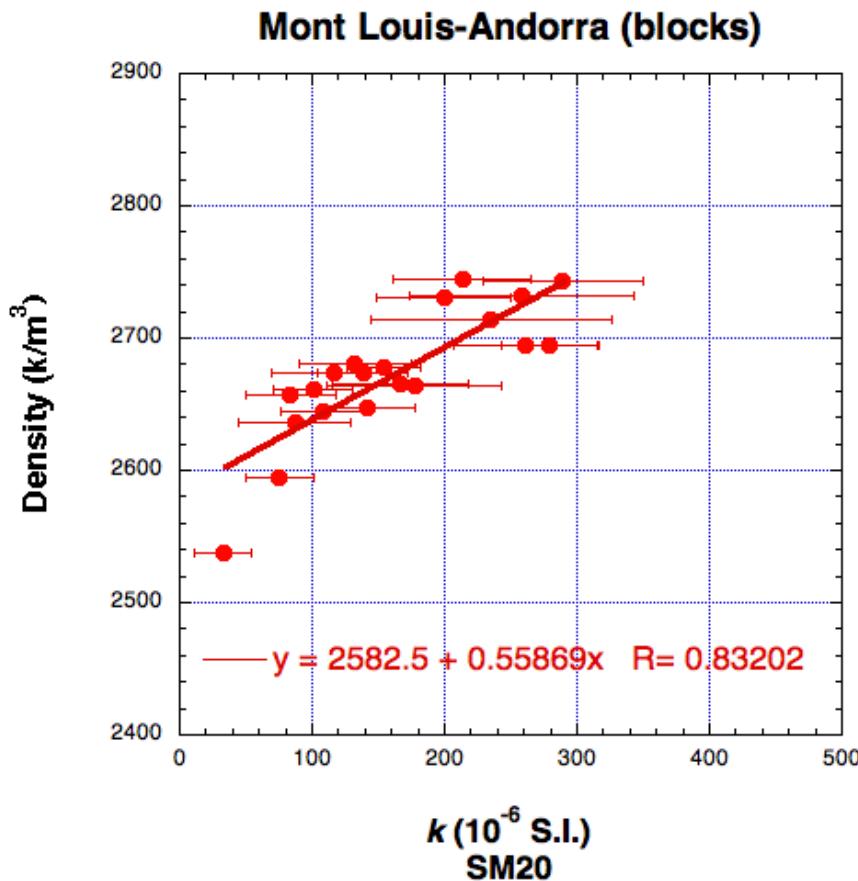
Not always straightforward;  
data must be corrected

## Discussion: $K$ vs $\rho$ relationships at different scales-1: Pmag samples

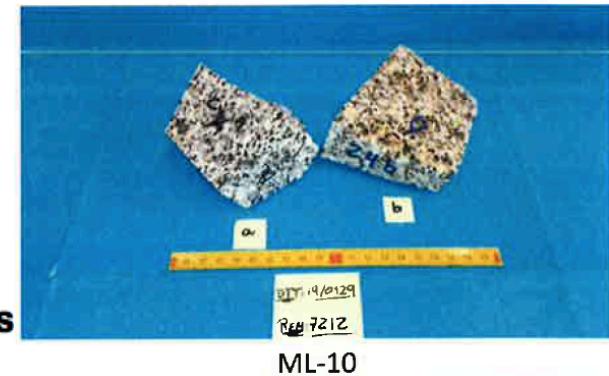
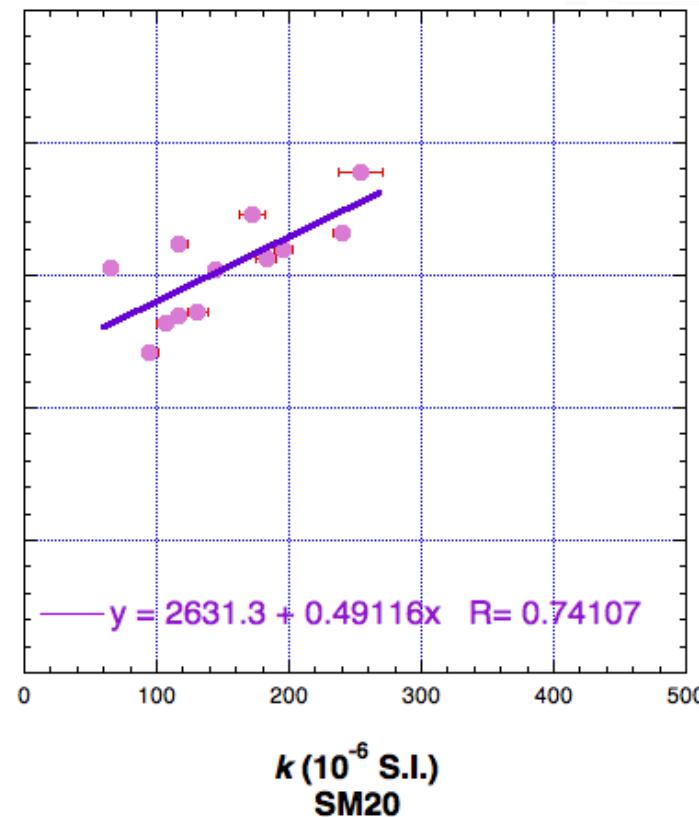


## Discussion: $K$ vs $\rho$ relationships at different scales-2: Hand samples

Mont Louis



**Maladeta (blocks)**



Maladeta

## Discussion: $K$ vs $\rho$ linear regressions

Veiga:  
(cores)

$$\rho = 2501 + 0.496 \kappa$$

$$R = 0.7329$$

Marimanha:  
(cores)

$$\rho = 2548 + 0.587 \kappa$$

$$R = 0.9096$$

Maladeta:  
(blocks)

$$\rho = 2631 + 0.491 \kappa$$

$$R = 0.7411$$

Mont Louis-Andorra:  
(blocks)

$$\rho = 2583 + 0.559 \kappa$$

$$R = 0.8320$$

Mont Louis-Andorra:  
(cores)

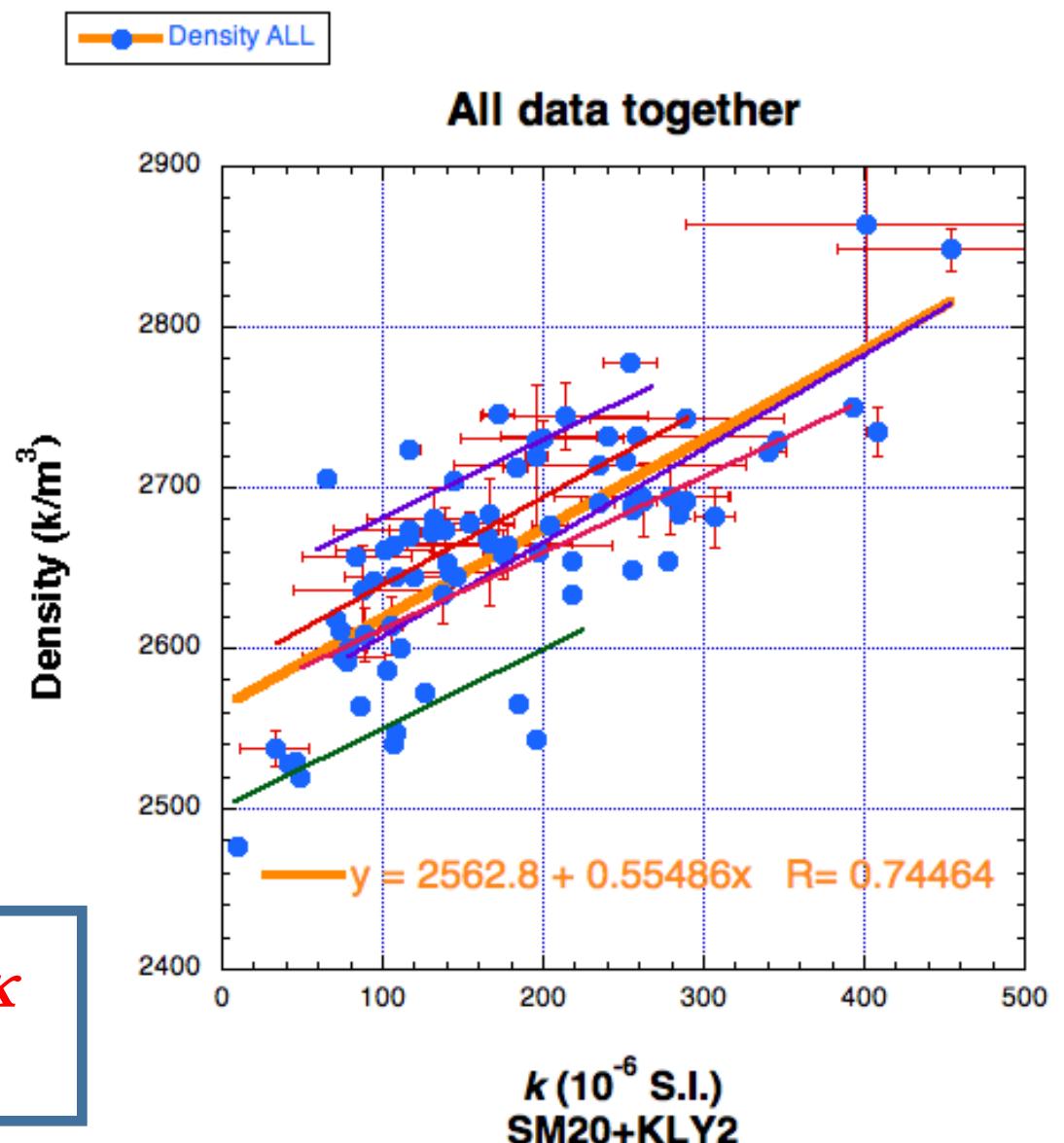
$$\rho = 2568 + 0.465 \kappa$$

$$R = 0.8098$$

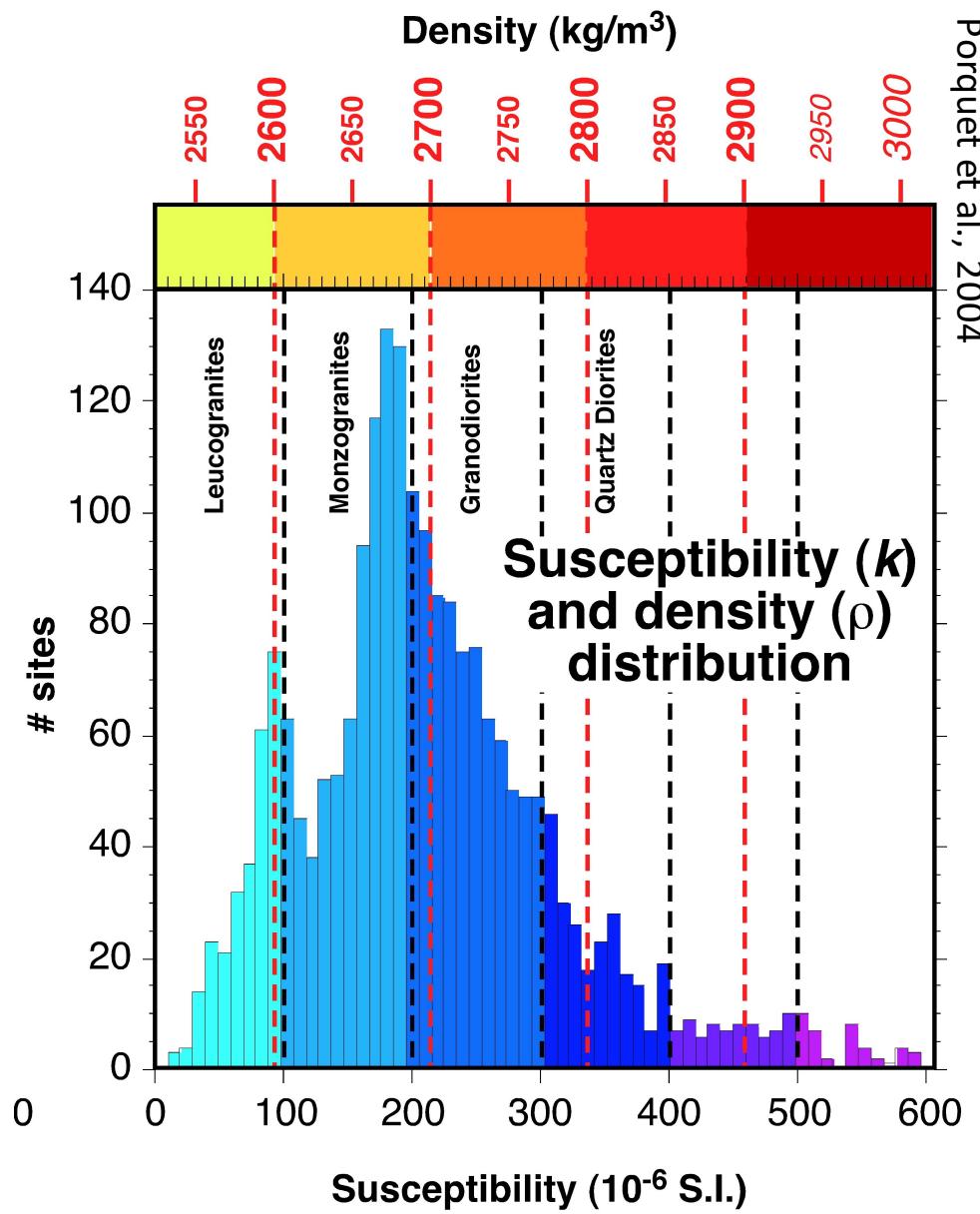
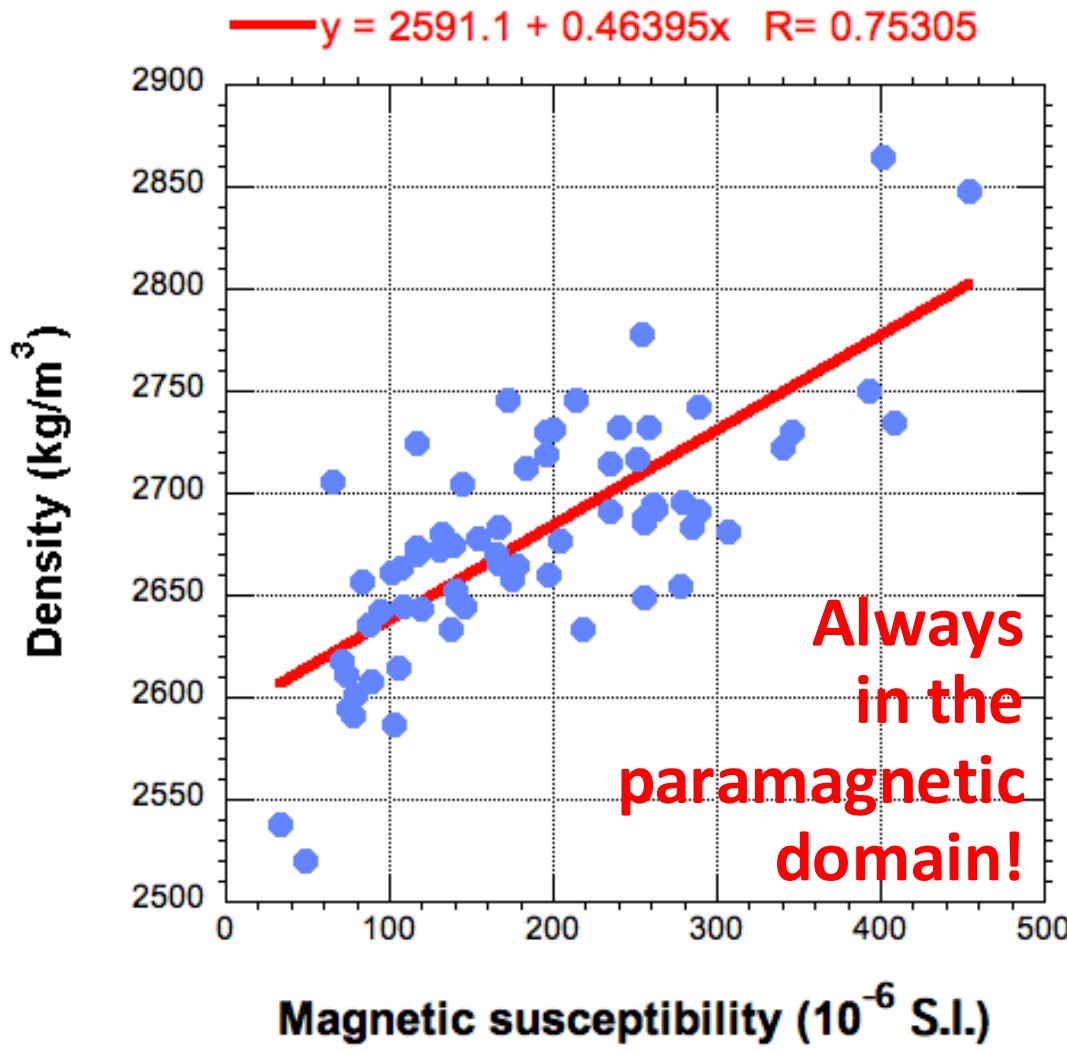
All together:

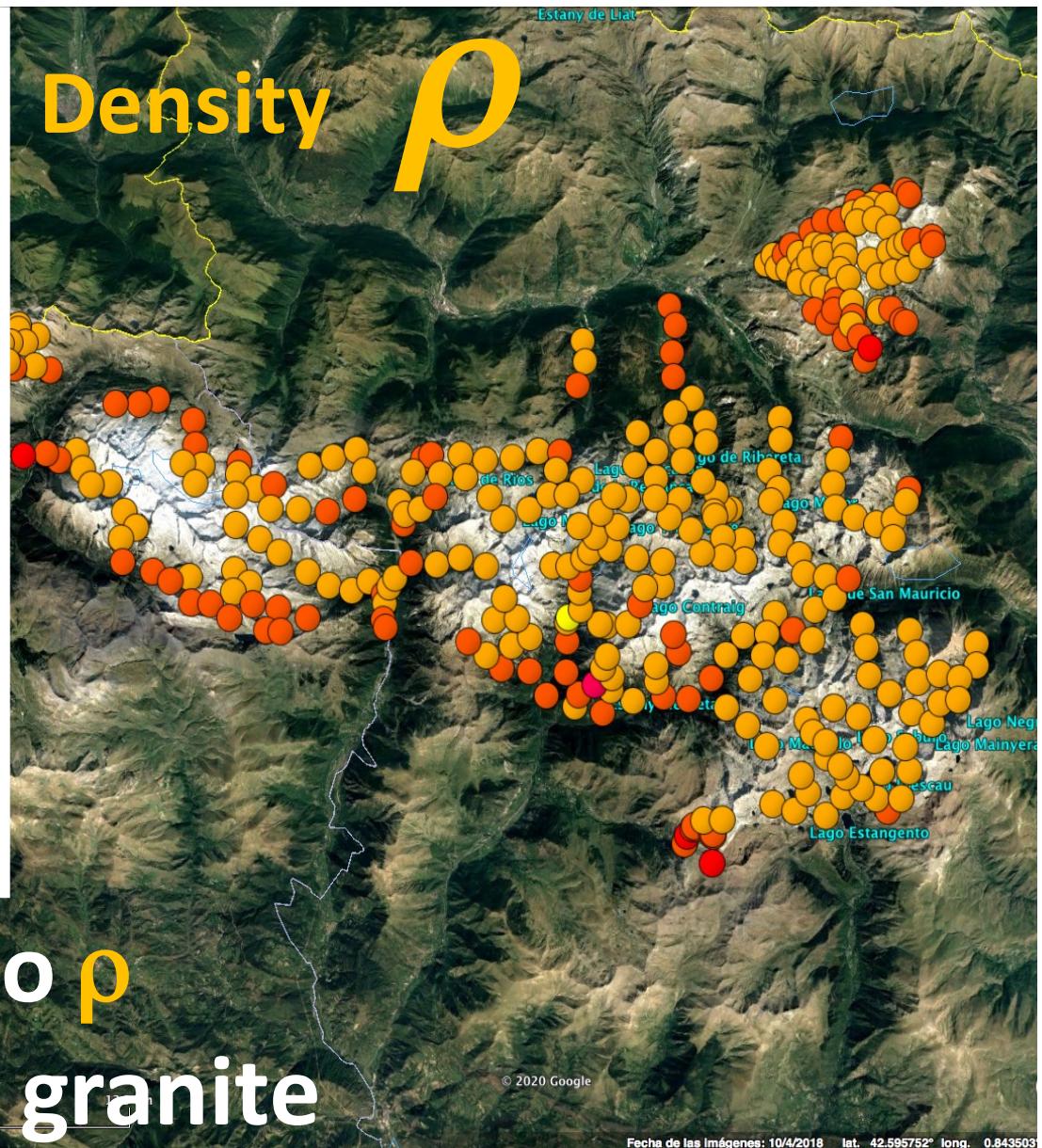
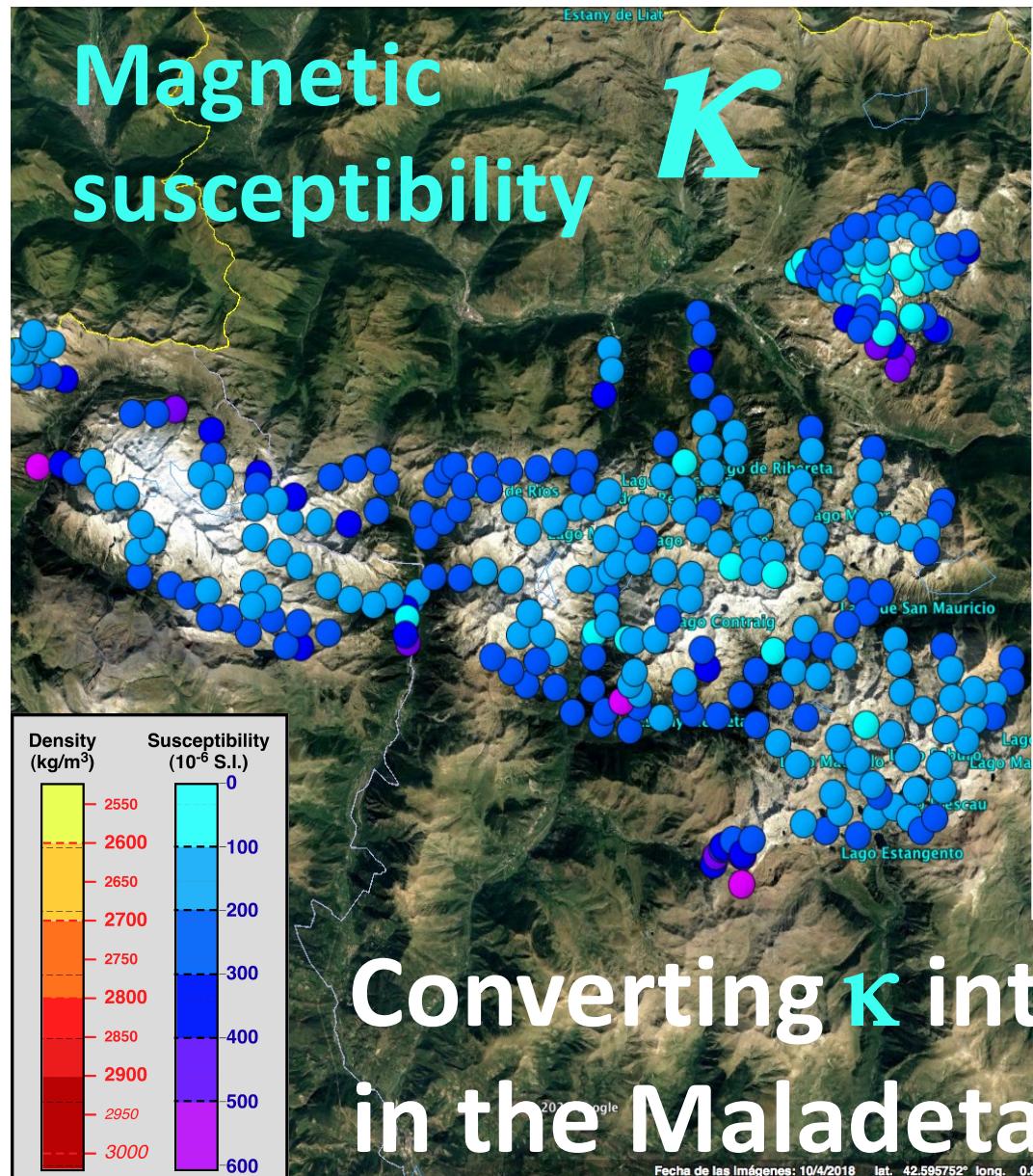
$$\rho = 2563 + 0.555 \kappa$$

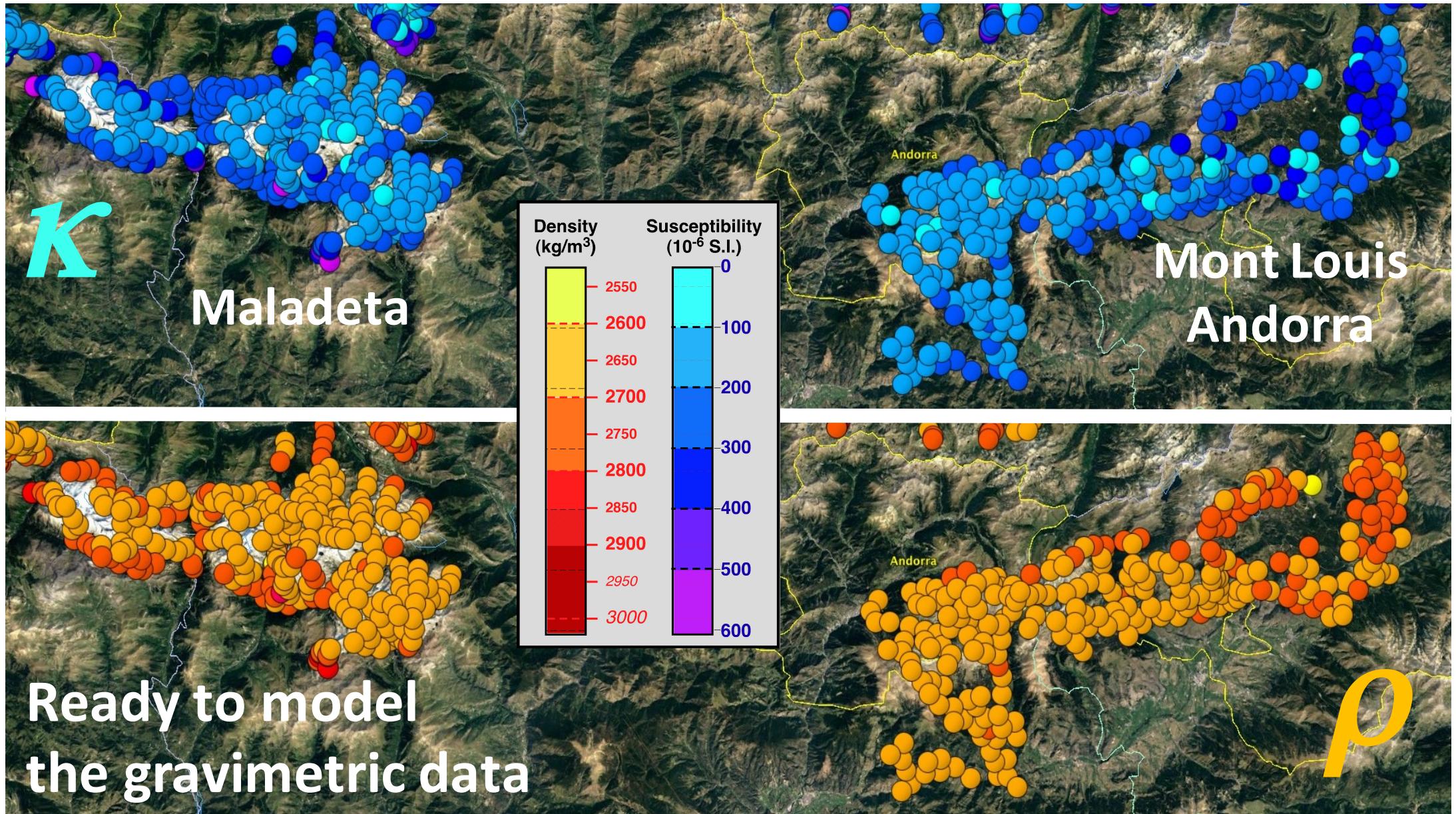
$$R = 0.7446$$



## Merging all Pyrenean granites









# Conclusions



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- We have studied density ( $\rho$ ) and magnetic susceptibility ( $\kappa$ ) relationships in four calc-alkaline variscan granites from Iberia (3 in the Pyrenees and one in NW) at different scales.
- Susceptibility was always within the paramagnetic domain. It was very variable and had to be fully recorded (several measurements; > 50) at the outcrop scale. Density is more stable.
- We found comparable trends in the different bodies:  $\rho = 2563 + 0.555 \kappa$  ( $R=0.7446$ ).
- This function allowed converting thousands of  $\kappa$  data (AMS studies) into  $\rho$  enabling the modeling of the gravimetric signal in future studies



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