Using Archaeological Models For the Inversion of Magnetometer Data

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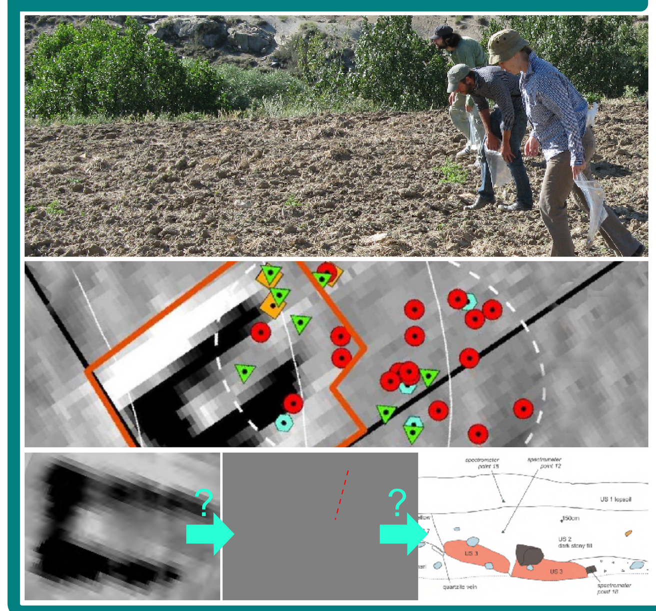
Background



Questions

1. For the *Raganello Archaeological Project* (Calabria): supplement fieldwalking results with geophysical surveys; extract maximum information from magnetometer data.

2. Archaeological interpretation of geophysical data: better delineation of features that cause the anomalies.

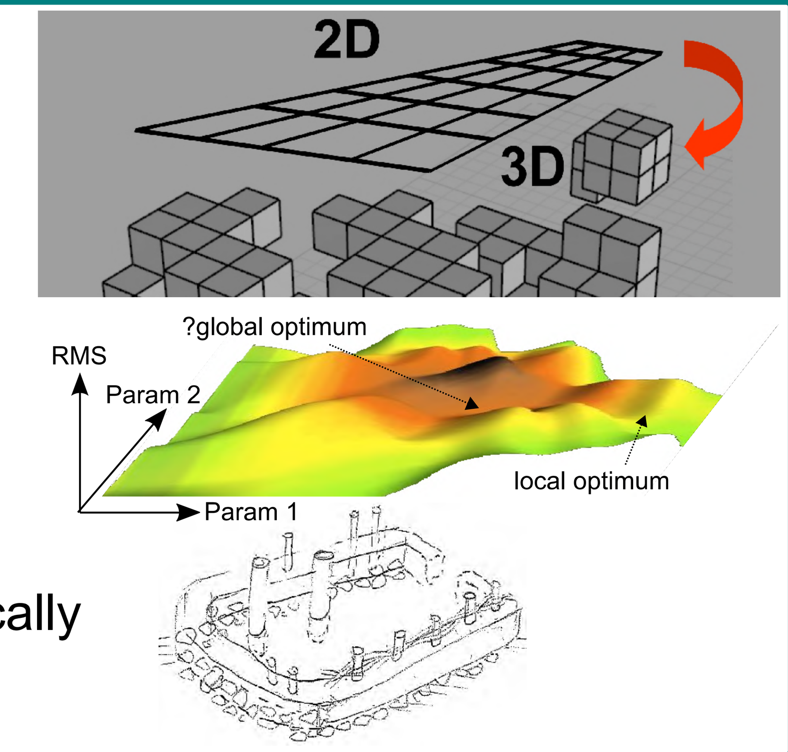
➡ Use archaeological models for inversion of magnetometer data.

Challenges

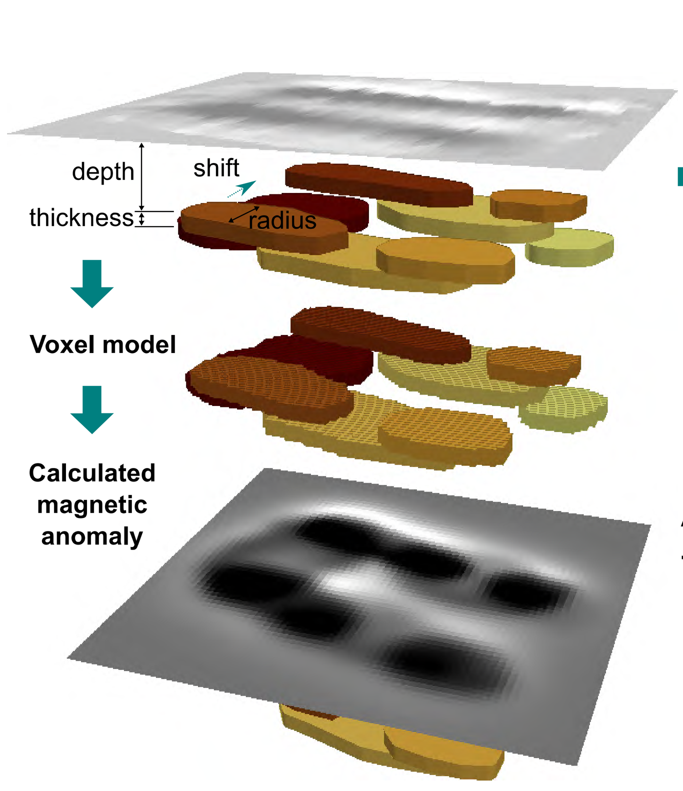
a. Inversion not unique: many models fit data well.

b. Local optima: optimised model parameters depend on search path.

c. Model: must be archaeologically plausible *and* fit the data.



Models



Feature models: small number of parameters (e.g. depth, thickness, magnetic susceptibility, shift, buffer radius).

➡ **Voxel models** ➡ **Magnetic anomalies**

Inversion optimises *parameters* to minimise the RMS-difference to measurements.

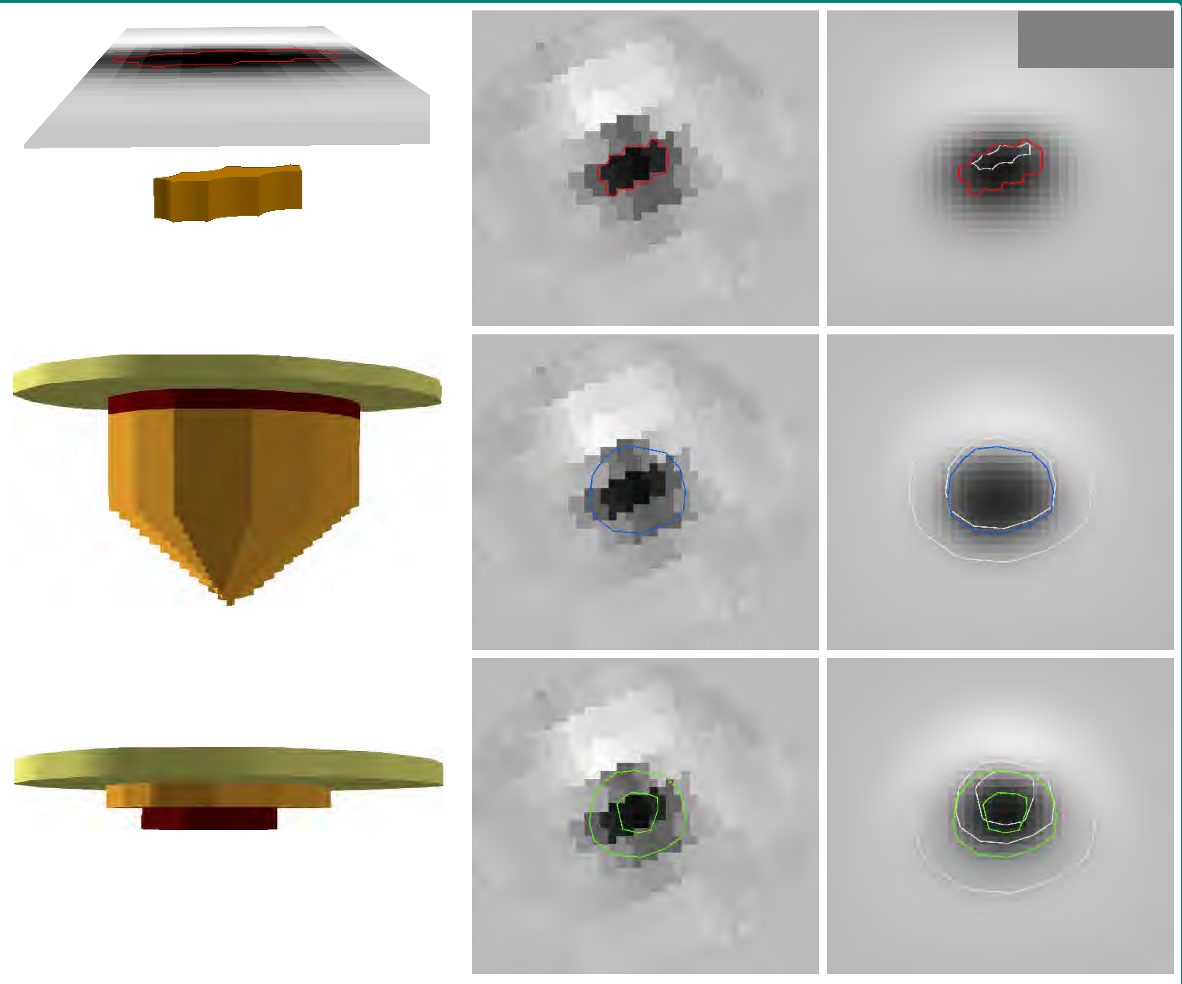
Assumptions: no shape-demagnetisation, thermoremanence in direction of earth's magnetic field.

Use several random searches to find model parameters that approach the global optimum.

Data derived model:
For localised features (e.g. pits) use magnetic contour, e.g. at FWHM.

Archaeological model:
Abstraction of archaeological feature. Pit: three layers forming a shaft capped by a plough layer.

Geophysical model:
Model of polygonal layers that *could* produce the anomalies. Similar to what might be interpreted from the data, but restricted to be archaeologically plausible.

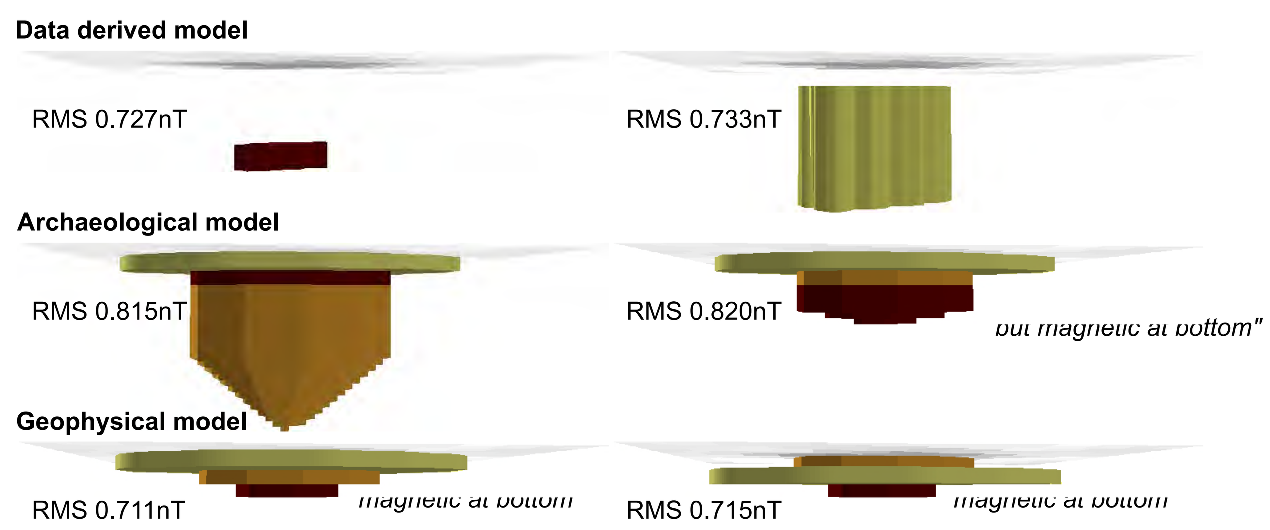


Results

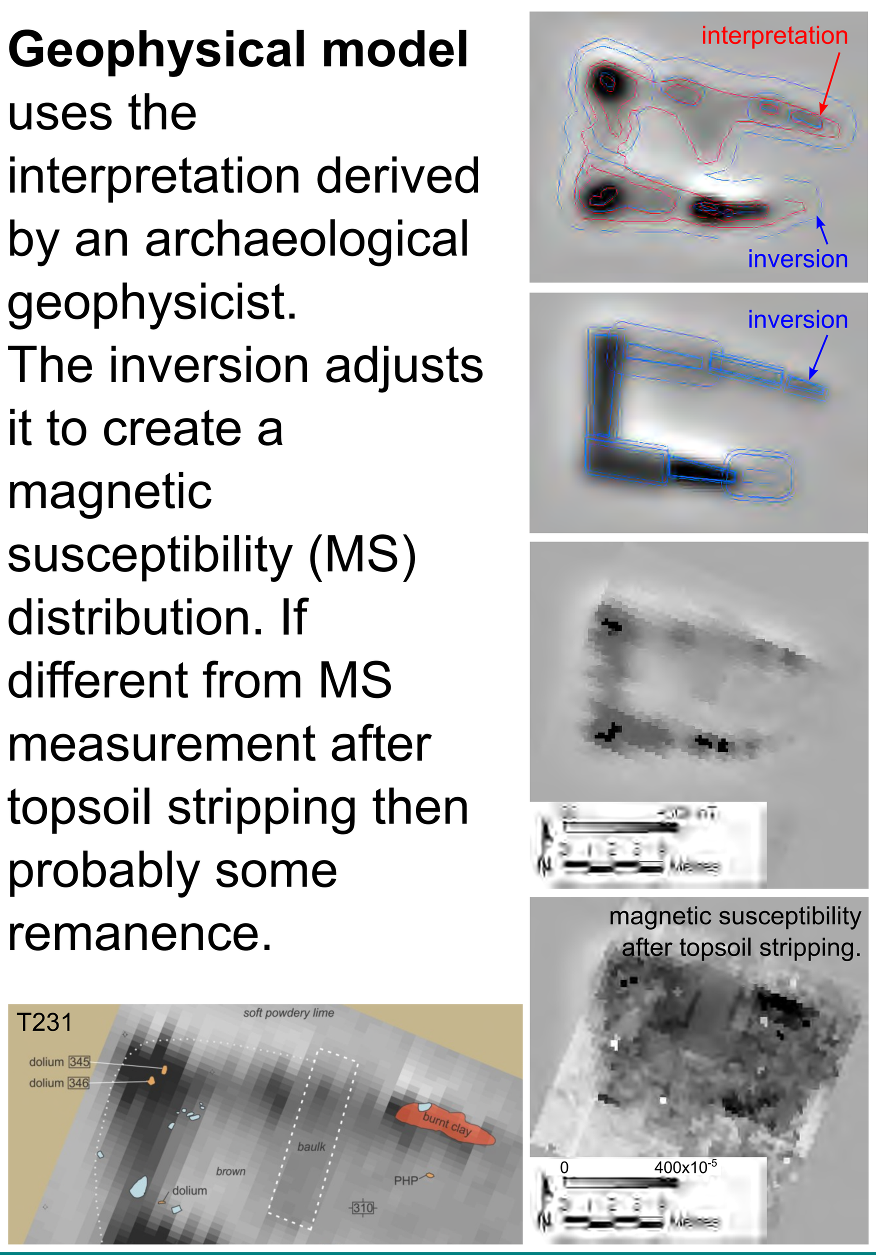
Ambiguous solutions

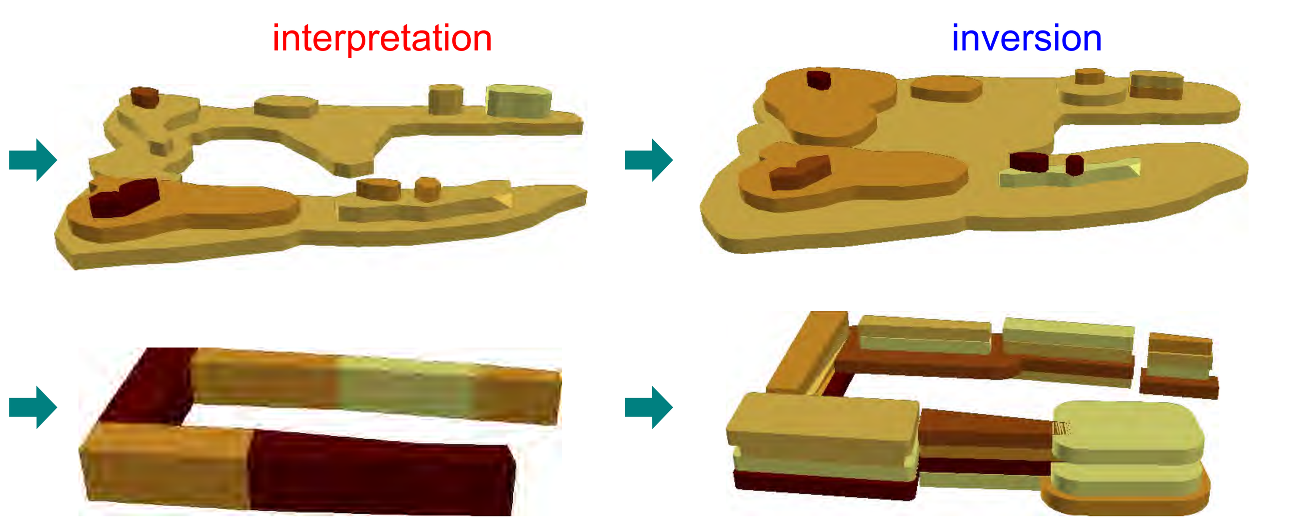
1. Inverting for size *and* depth (data derived and archaeological models): solutions ambiguous as very different models may have similar RMS values; no certainty for selecting the global optimum.

2. Inverting only for position, size and magnetic susceptibility (geophysical model): solutions are reasonably consistent.



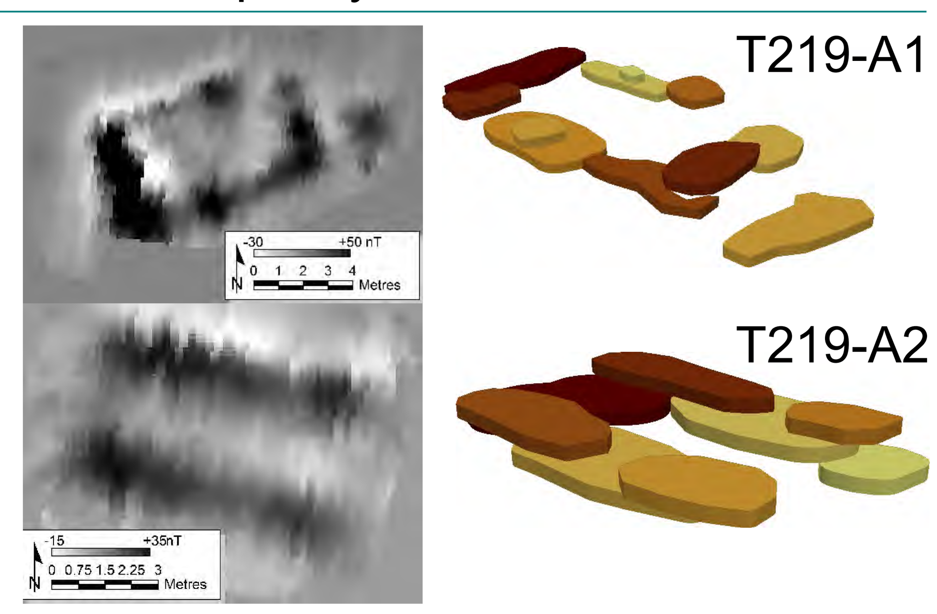
Geophysical model uses the interpretation derived by an archaeological geophysicist. The inversion adjusts it to create a magnetic susceptibility (MS) distribution. If different from MS measurement after topsoil stripping then probably some remanence.





If the starting model ("interpretation") is too idealised the inversion fits the data poorly.

Geophysical models for typical anomalies reflect the heterogeneous magnetic properties of the features.



Conclusions

1. Inversion **improves geophysical models** created from data interpretations and is a useful tool to analyse survey data.

2. Inversion of size *and* depth results in **ambiguous solutions** due the non-uniqueness of magnetic inversion. Idealised models lead to a poor fit with the data. **Models must reflect the data**. 'Clean' archaeological models lead to ambiguous inversion results.

3. Due to often considerable magnetic inhomogeneities (possibly thermoremanence) **polygonal models are not always appropriate**.

4. The apparent magnetic susceptibility calculated by the inversion may be **different from surface measurements**, mostly due to thermoremanence.

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