Integrating geochemical and magnetic surveying by spatial clustering

The case of suburban Sagalassos (SW-Turkey)

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Multi-element soil survey to aid interpretation of geophysical data. Focus on statistical data analysis.
Geographic setting

Sagalassos is located in the eastern suburbium of Sagalassos, approximately 450 meters above sea level.
Historical setting
Magnetic survey results
Magnetic survey results
Soil sampling and analysis

- **Survey strategy:**
  - Regular grid
  - 68 topsoil samples

- **Analytical methods:**
  - < 63 µm
  - Aqua Regia extraction
  - ICP-OES: Al, As, Ba, Ca, Cu, Co, Cr, Fe, K, Mn, Mg, Na, Ni, Pb, Sr, Ti, V, Zn
Geochemical results

Cr, Ni, Mg, Co

V, Fe, Ti

As, Al, Ba

P, K, Cu, Zn
Statistical data analysis

Ward’s clustering + Spatial dimension = Contiguity constrained clustering

Guo, 2008
Statistical data analysis

- Al, As, Ba, (Pb)
- Cu, K, P, Zn, (Pb)
- Sr, Na
- Ti, V, (Fe, Sr, Na)
- Co, Cr, Mg, Mn, Ni, (Fe)
Integrated interpretation

**Al, As, Ba, (Pb):** Weathered limestone bedrock

**Cu, K, P, Zn, (Pb):** Waste material

**Ca, Sr, Na:** Limestone fragments

**Ti, V, (Fe):** Weathered ophiolitic bedrock

**Co, Cr, Ni, Mg, Mn, (Fe):** Ultramafic ophiolitic bedrock
Zoning the magnetometry image

- Personal => Biased?
- Visual limitations due to cut-off values

Statistical zoning of magnetometry image
Clustering using geostatistics

Clustering of chemical data

Contiguity constrained hierarchical clustering

Clustering of chemical data
Conclusions

Integrating geochemical survey and magnetic prospection

- Multi-element geochemical data at unexcavated archaeological sites add a new dimension to the interpretation of survey data. Particularly useful to distinguish between natural and human anomalies.

- The combination of geostatistics and magnetometry can be used to quantitatively zone geophysical images.
Thank you for listening!

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Magnetometry and geostatistics

A: 10 nT
B: 50 nT

Semivariance: \( \frac{(A-B)^2}{2} = 800 \)