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Enhanced Target Area Identification using Topographic LIDAR Data

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Overview of Talk

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- Review of LIDAR
- Examples of range related features
- Focus of this study
- Results
- Summary

- This work has been funded by Dept. of Defense
  - Strategic Environmental Research and Development Program (SERDP)
  - Environmental Security Technology Certification Program (ESTCP)

LIDAR

Light Detection and Ranging

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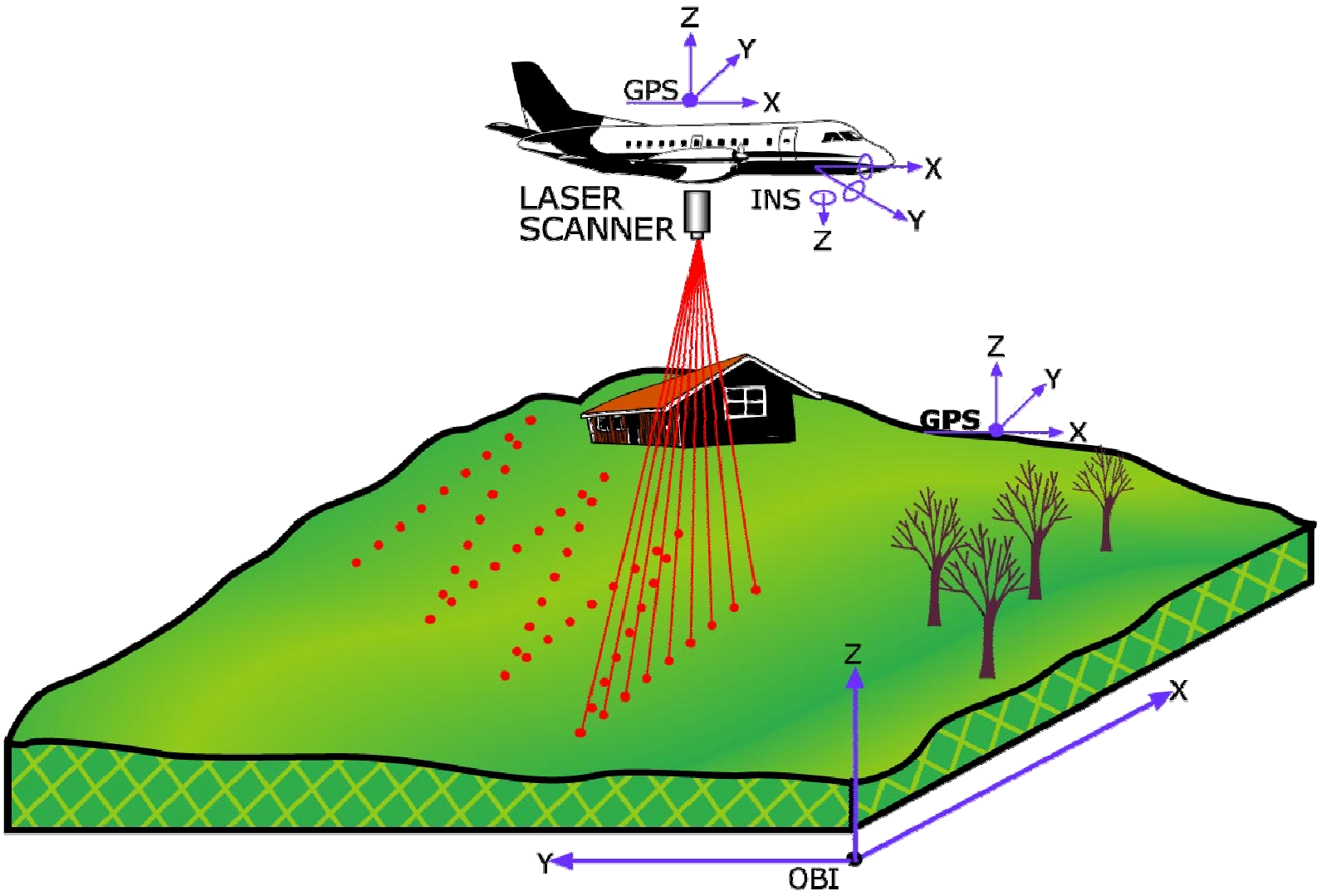

Munitions Related Features in Topographic LIDAR Data

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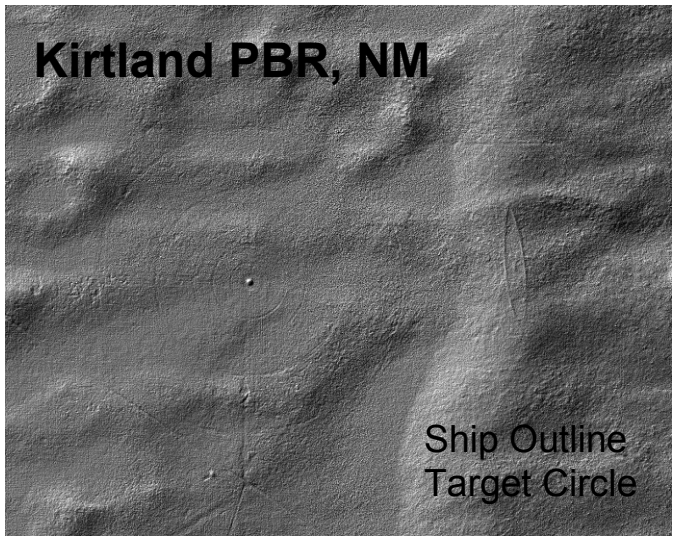

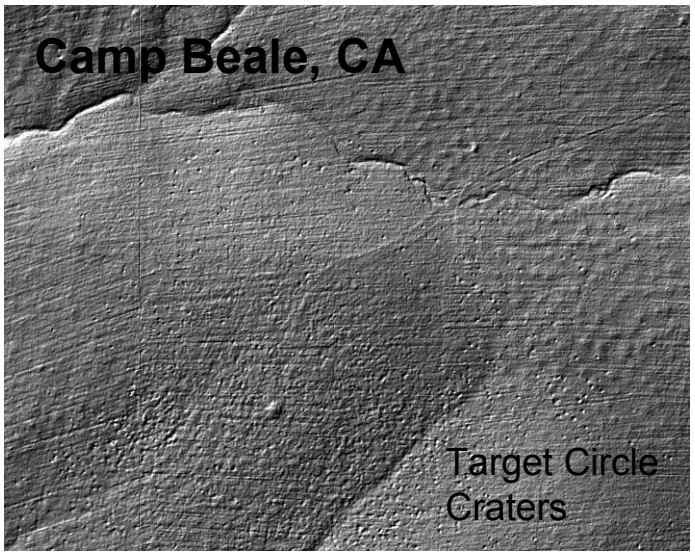

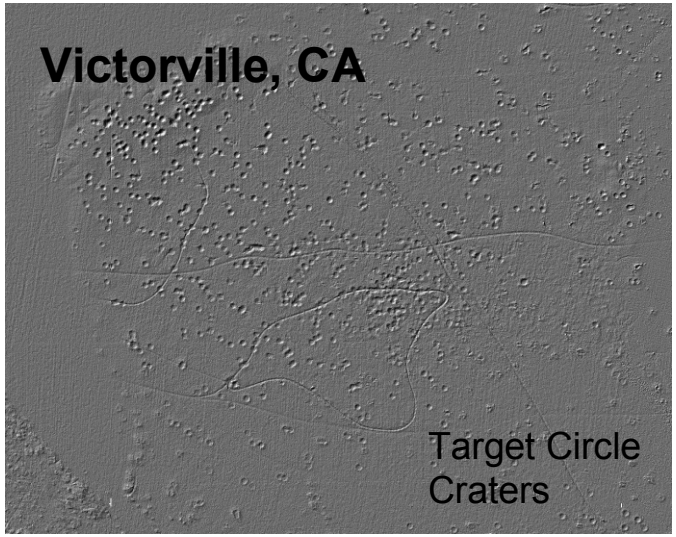

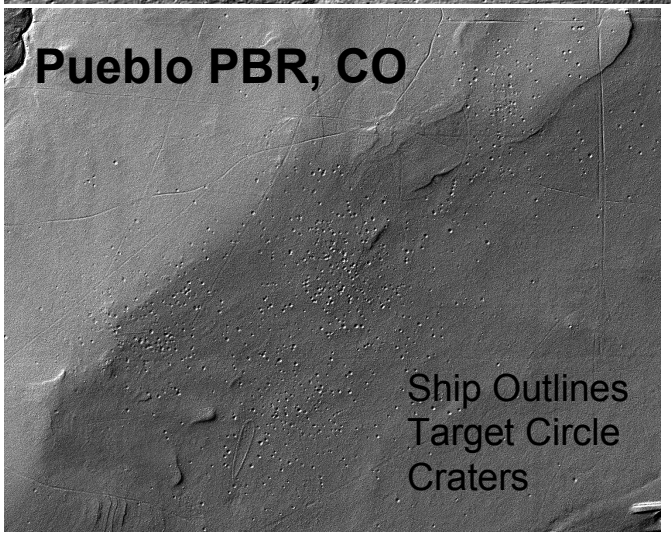

Focus of Study

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- Can munitions-use related features identified in topographic LIDAR data sets be used in conjunction with sparse magnetometer transect data in identifying and characterizing former practice range target locations?
  - Magnetometer data as primary geostatistical variable
  - Crater density as secondary geostatistical variable
- What are the benefits of including secondary information (topographic LIDAR) in target identification and characterization?

Geostatistical Estimation

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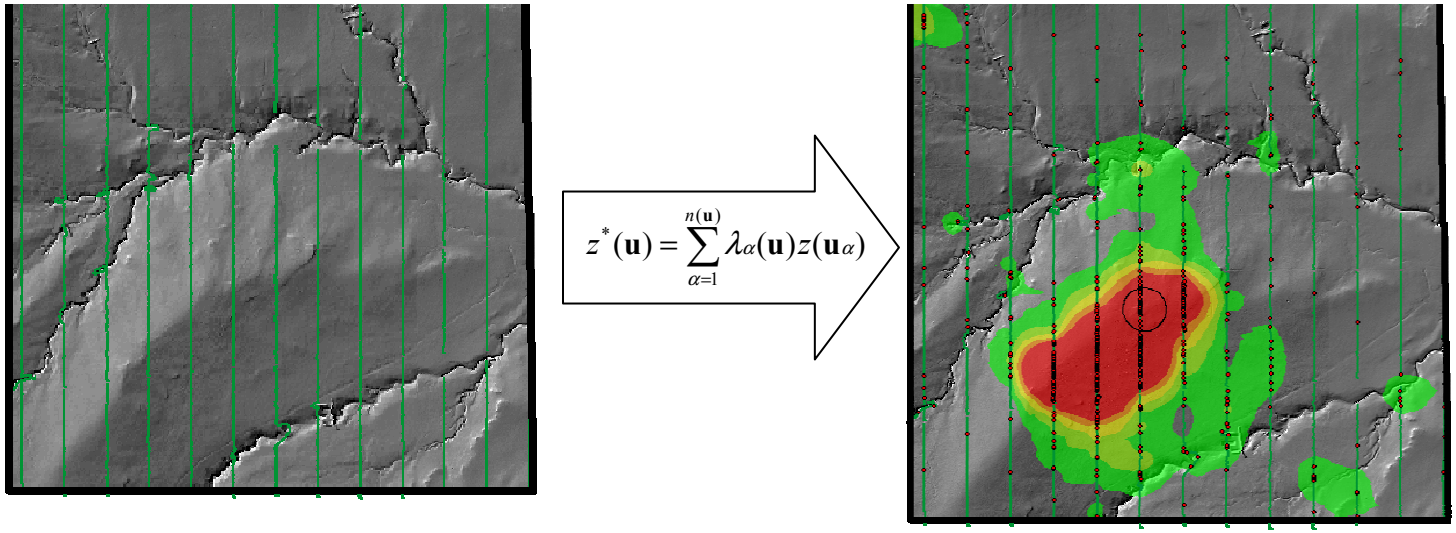
- Ordinary Kriging
  - Using a single variable – magnetic anomaly locations



Estimates at un-sampled locations

What about the inclusion of secondary information from the WAA?

Pueblo Precision Bombing Range #2

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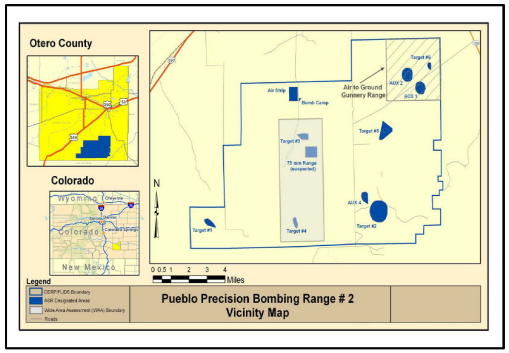

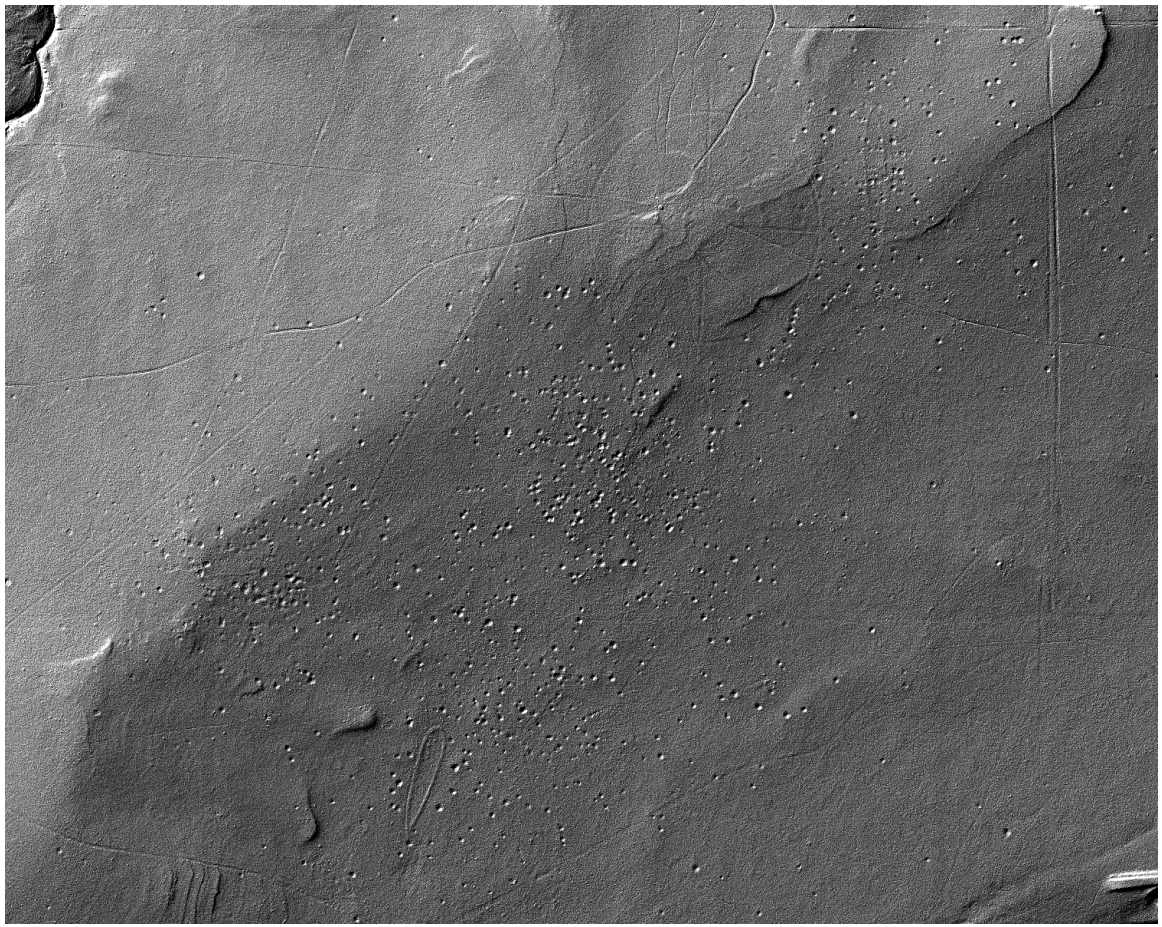

Magnetometer Data
Ordinary Kriging

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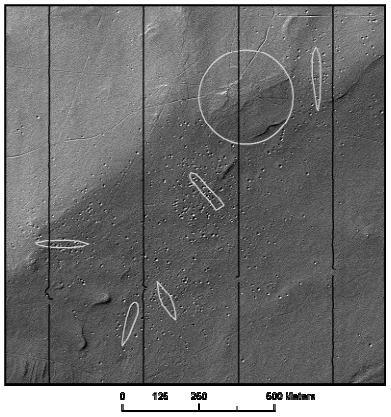
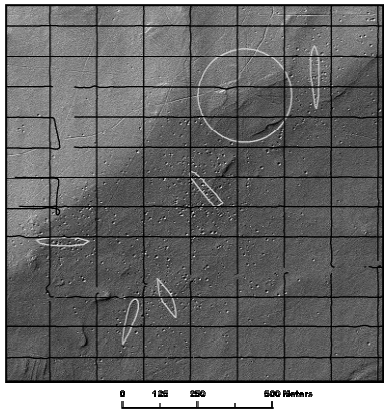
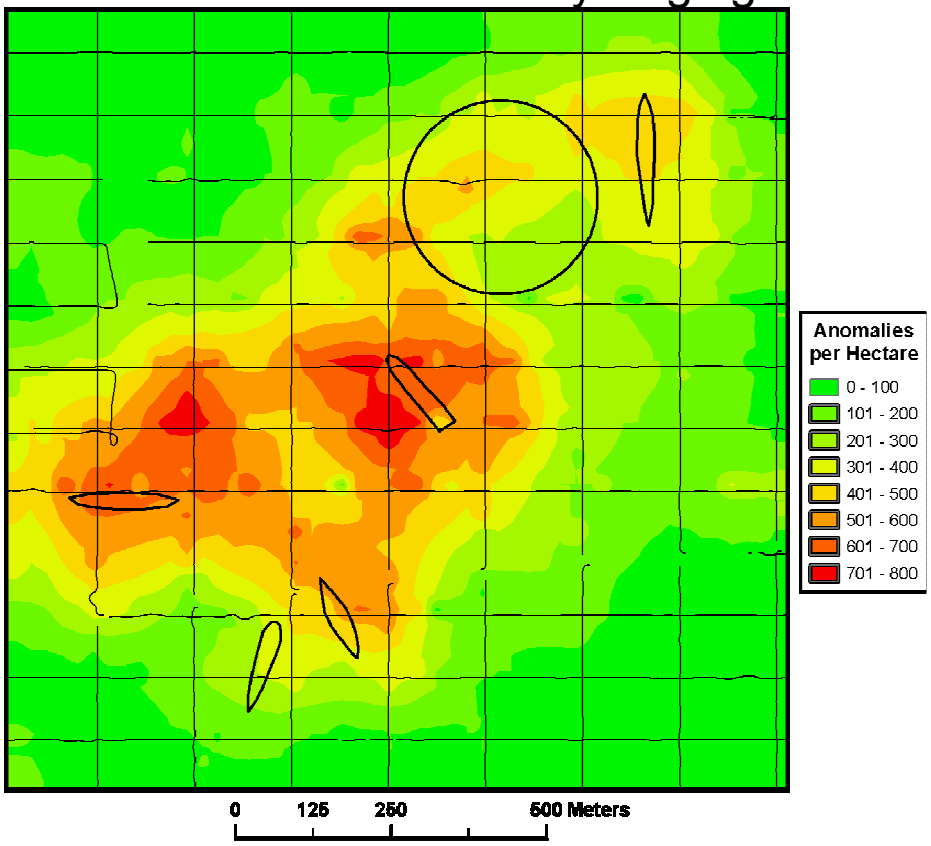
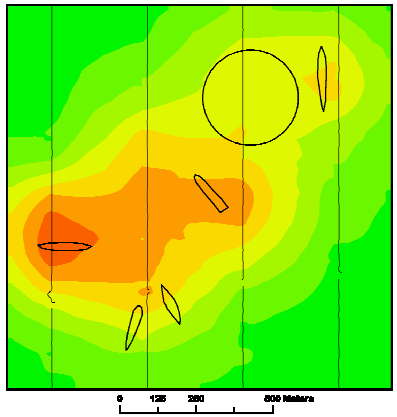




Dense Transect Ordinary Kriging





Secondary Information Crater Density Analysis

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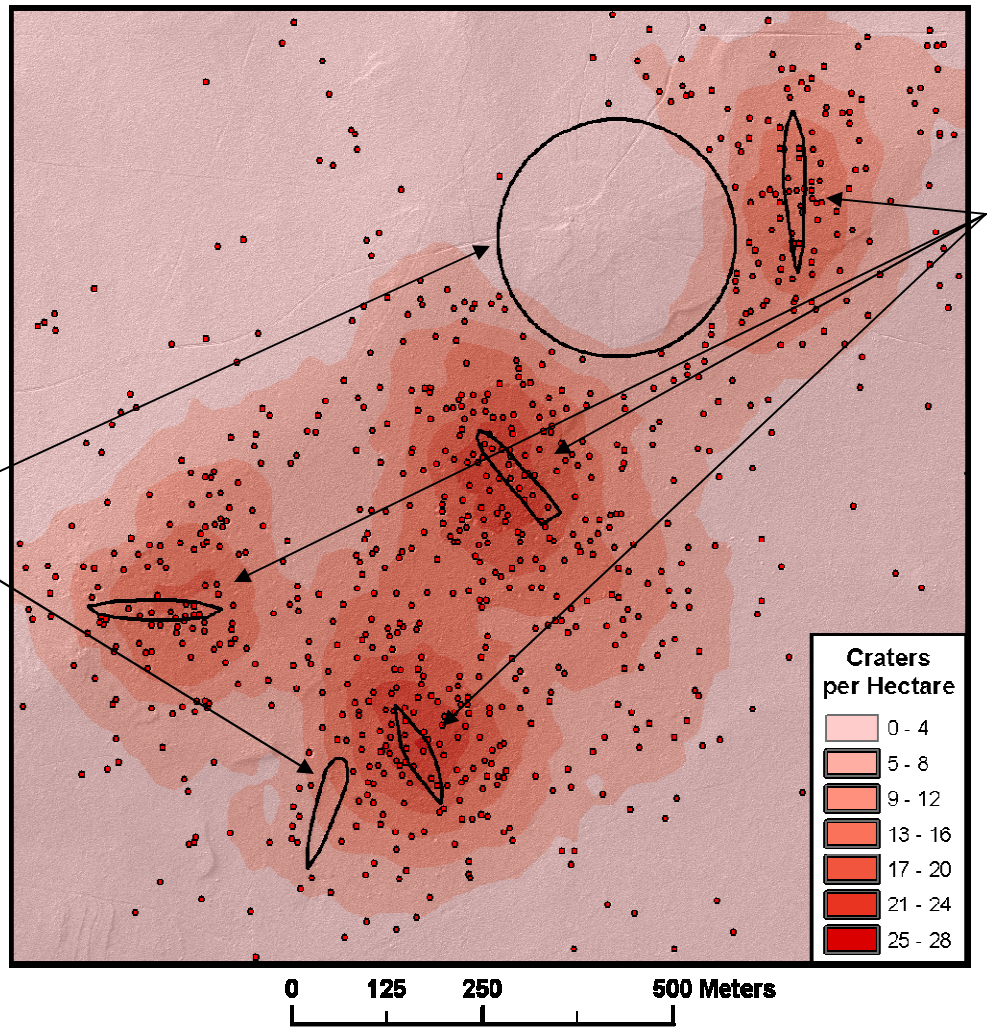
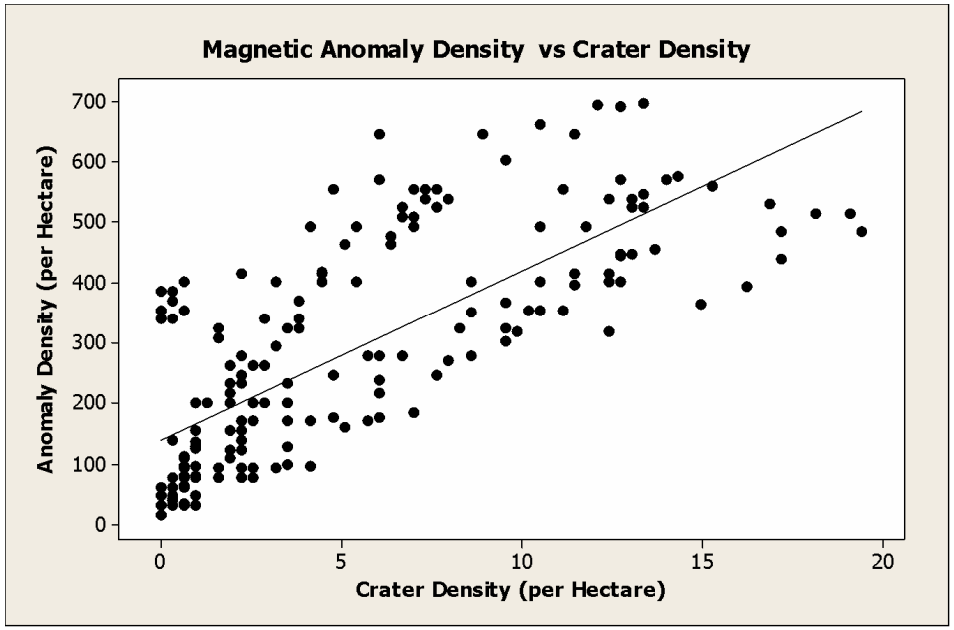
Lack of correlation with other features.

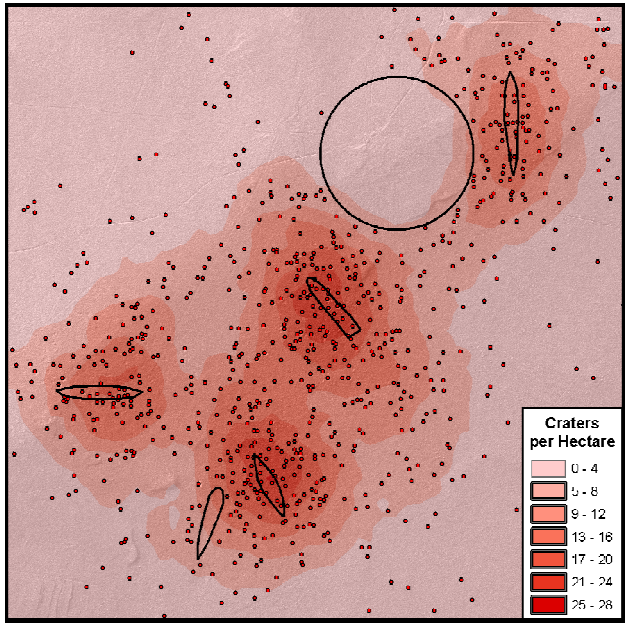


Spatial correlation between crater clusters and target features.

Relationship Between Crater Density and Anomaly Density



Correlation Coefficient = 0.75
n = 200



Using crater density to augment magnetometer data

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Simple Kriging with Locally Varying Means can be used to include a secondary variable (crater density) into kriging estimation

Develop functional relationship between primary and secondary variables

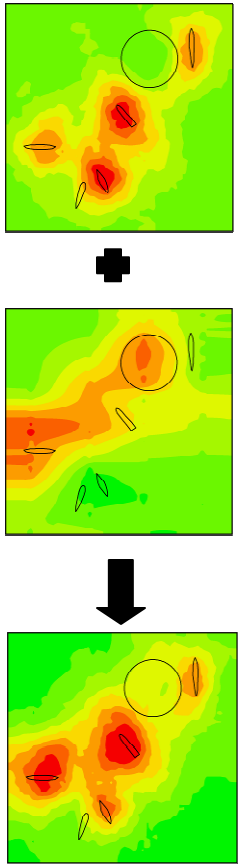
$$z(\mathbf{u}) = 137.44 + 28.08 z_2(\mathbf{u})$$

Compute residuals

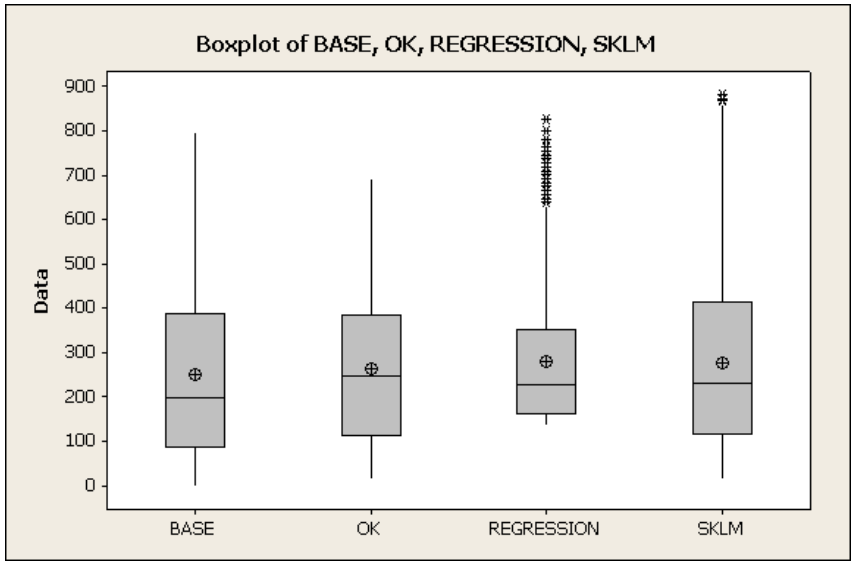
$$r(\mathbf{u}) = z(\mathbf{u}) - f\left[z_2(\mathbf{u})\right]$$

Kriging of residuals and combination of results

$$z^*_{SKLM}(\mathbf{u}) = f\left[z_2(\mathbf{u})\right] + \sum_{\alpha=1}^{n(\mathbf{u})} \lambda^{SK}_{\alpha}(\mathbf{u}) r(\mathbf{u}_\alpha)$$



Quantitative Comparison of Results



Some improvement in range of values

Estimation Technique	MSE Value	IMSE Value	% Change from OK
Ordinary Kriging	5,631	168,784	0 / 0
Linear Regression Model	14,305	306,877	154 / 82
SKLM	5,504	135,667	-2 / -20

Most of improvement in the form of improved spatial representation

Visual Comparison of Results Using Different Techniques

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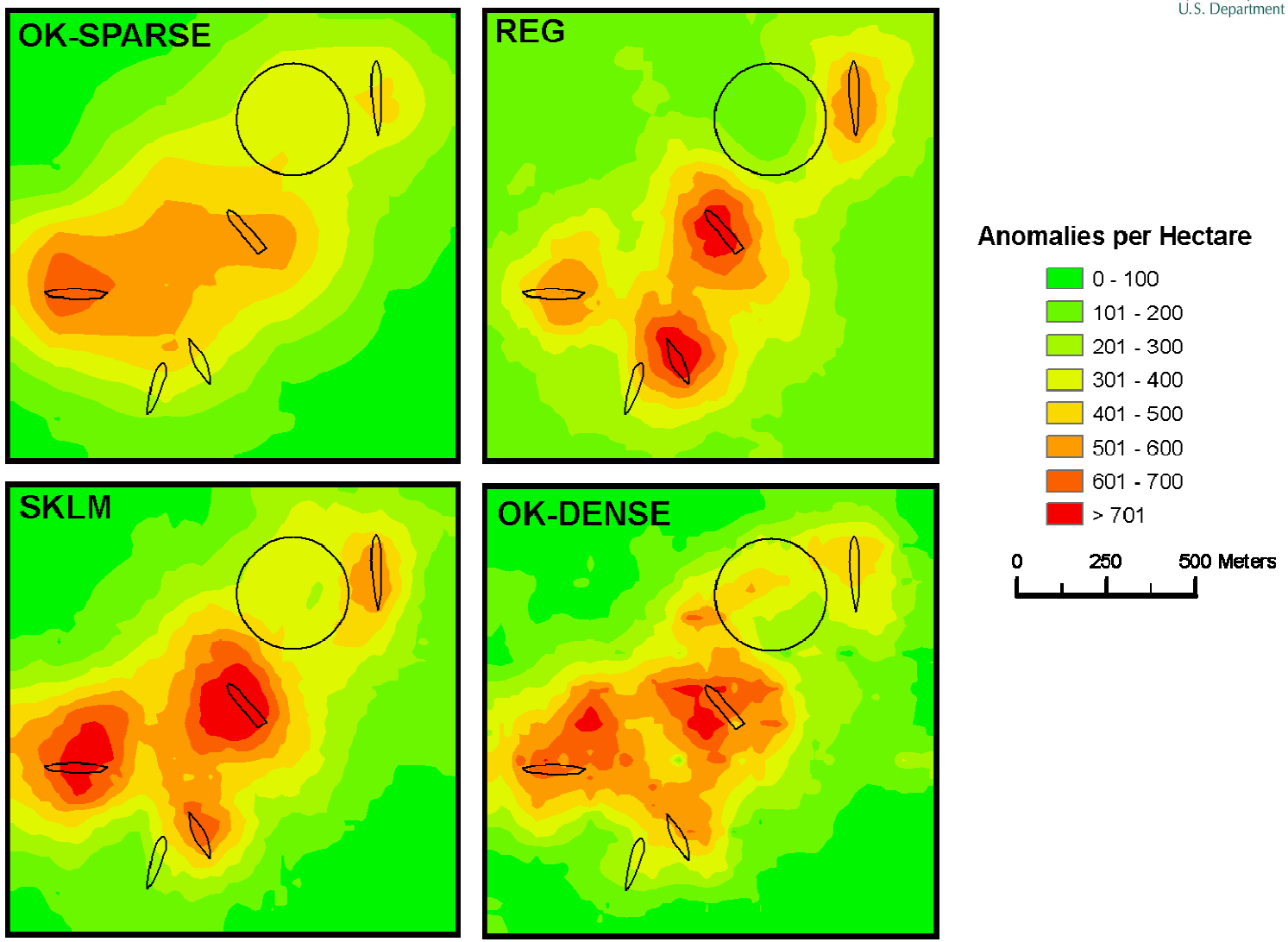
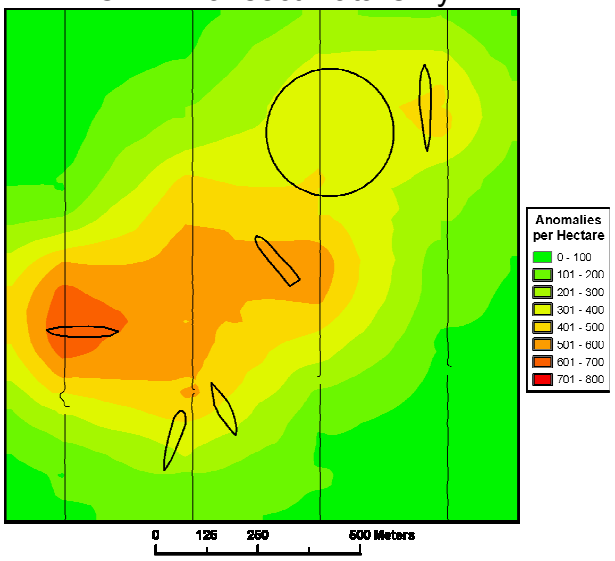


Summary

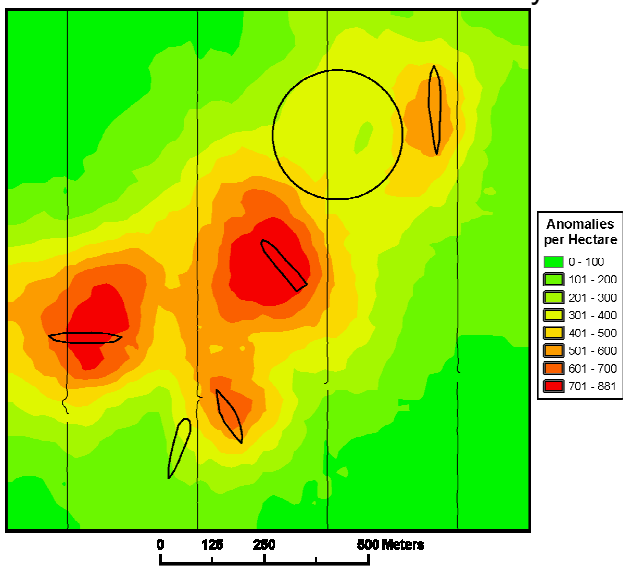
Using secondary information in the kriging of sparse geophysical transect data:

- Improves the spatial quality of magnetic anomaly density estimates developed from very sparse magnetometer transect data
- Can provide identification at scales smaller than the geophysical transect spacing
- Provides a means to take advantage of comprehensive site data and combine this information with geophysical measurements
- Can reduce resource requirements for site characterization

OK – Transect Data Only



SKLM – Transect Data + Crater Density



Questions

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