SIGNAL SEPARATION TO REVEAL SUBTLE FEATURES IN GRAVITY AND MAGNETIC DATA FROM THE BELLEFONTAINE OUTLIER, OHIO

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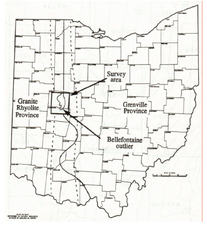
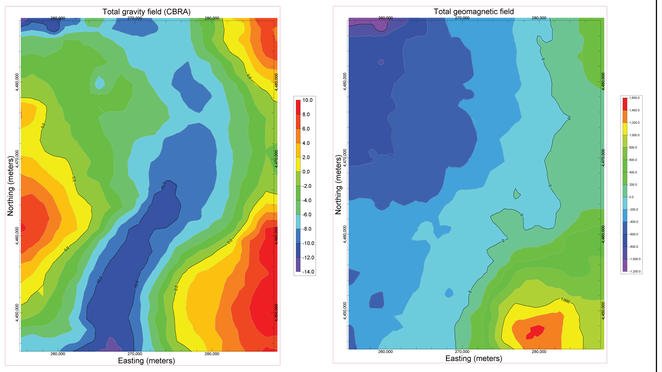
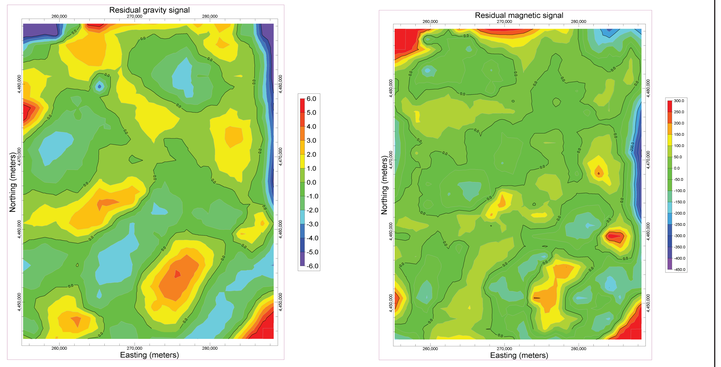


At previous GSA meetings the general basement topography and structure of the Bellefontaine Outlier region of Ohio has been presented in poster format based upon our own detailed gravity and magnetic survey data and the COCORP Ohio #1 seismic survey which crossed the region. Recent experimentation with signal separation has brought new structural details to light. By removing the major gravity and magnetic signals from their respective data sets and re-normalizing the resulting data to isolate small scale variations, many features become visible. Correlation of these new details hidden within the gravity and magnetic survey data sets is presented as well as correlation with surface topographic features.



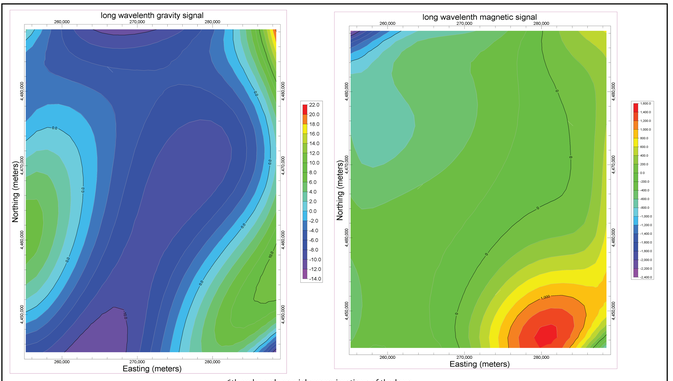
Step 1: Initial Signal

Maps of total geomagnetic field and total gravitational field for the survey area. Note the very strong positive magnetic signal in the south east corner and the apparent dissimilarity between the two field maps.



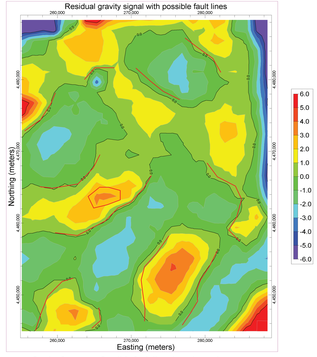
Step 3: Removing the long wavelenth signal

Total gravitational and geomagnetic fields with long wavelength approximation removed. Residual short wavelength, low amplitude signals remain that were previously hidden by the large amplitude overlying signal.

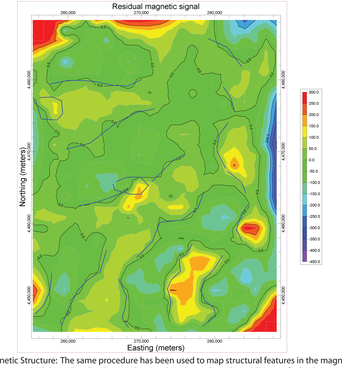


Step 2:
Modeling the long wavelength signal

6th order polynomial approximations of the long wavelength signals of the gravitational and geomagnetic fields.

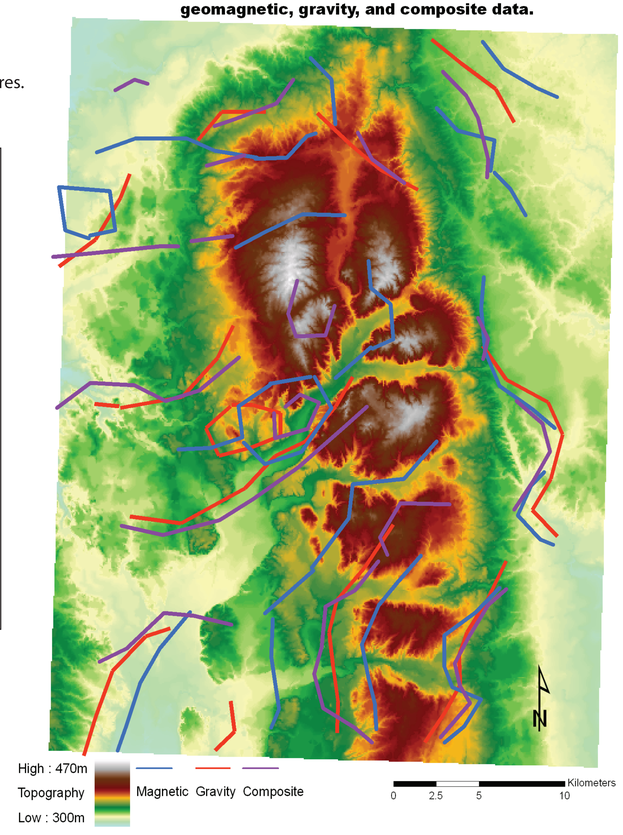


Gravity Structure: Possible fault lines have been drawn along lines where the field moves from positive to negative relative to the major long wavelength signal and shows a relatively high field gradient. This figure roughly shows the position of some of the fault blocks in the basement rock.

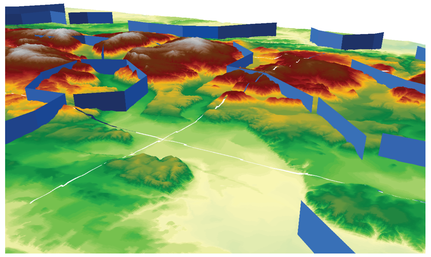


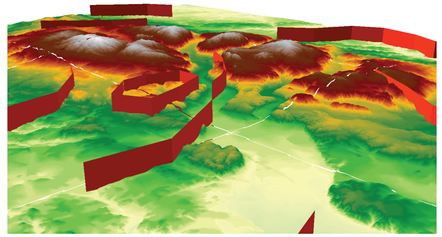
Magnetic Structure: The same procedure has been used to map structural features in the magnetic residual data. This data has not been reduced to pole and in addition to faults the magnetic data shows a possible dipole signature which correlates to a gravitational high bordered to the south by an area of relatively positive signal in a gravitational low valley. I interpret this to be a thin, horizontal, mafic rock layer of some kind associated with the magnetic dipole signal (circled). Another possible dipole is in the northwest edge of the map and it is also associated with a region of positive magnetic signal in a gravitational low valley.

DEM topographic data with possible structure lines from geomagnetic, gravity, and composite data.



The approximate position and trend of faults and other structural features found from the gravitational and geomagnetic residual data show a strong correlation with regional drainage patterns and topographic features when compared with surface topography. (USGS 30m DEM data)





Conclusion:

By removing the dominant, large amplitude signals from the gravity and geomagnetic data, the weaker signals previously hidden within the data may now be examined. These previously hidden details have been used to improve mapping of the subsurface structure, allowing for expanded interpretations of the subsurface in the Bellefontaine Outlier area. This has led to the conclusion that the topography of the Bellefontaine Outlier area is largely controlled by deep basement faulting related to the opening of the East Continent Rift Basin, reactivated by later tectonic events. Interpretation of the geomagnetic data suggests, in addition to the faults, the existence of iron rich mafic bodies directly associated with these faults. These bodies may include mafic dikes, sills or lava flows onto what was once the surface within the rift.

References:

Fidler, M.L. 2003, Three dimensional digital analysis of 2,500 square kilometers of gravity and magnetic survey data, Bellefontaine Outlier area, Ohio. Senior Thesis, The Ohio State University, pp 36

Weaver, J.P., 1994. A Detailed Gravity and Magnetic Survey of the Bellefontaine Outlier, Logan County, Ohio. M.S. Thesis, The Ohio State University, 171 pp.

Acknowledgments:

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