Review of Hellyer Corridor Gravity Data

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Introduction

The mineralization at Hellyer, Que River and Fossey is massive sulfide with barite hosted in volcanic rocks so they have the potential to be significant gravity anomalies. The modeling that Jovan Silic completed on the Fossey deposit indicates that the anomaly should be 0.1-0.5 milligals. This would be a subtle anomaly and would require terrain correction applied to the data. The anomaly produced by Hellyer should be an order of magnitude bigger as shown by Rob Stuart's modeling during the Geoinformatics project. Anomalies can be seen down to approximately 200 m for a Hellyer-size body.

The data came from two different sources. The Sinosteel dataset provided by Bass had terrain corrected data for the northern portion of the project area. The MRT gravity data have terrain corrections applied and include most of the data points in the Aberfoyle data that cover the southern portion of the area.

The terrain corrections applied to these data are probably not the same and therefore merging the datasets could create false anomalies. Because of this, the two datasets were processed separately.

We ran the structure detection filter over these datasets as well. The datasets are not large so only detailed structure was analyzed.

Processing Methods

The forward model indicates that the expected signature of the body is a discrete anomaly that is radially symmetric with approximately 100m radius. Fathom has two processing methods that can be used to highlight discrete anomalies in potential field data. These are the gradient and phase-based blob

detection methods described in Appendix 1. These filters were used to highlight anomalies that have the potential to be a Fossey-like body.

The filters were run in a mode that is independent of the amplitude of the signature so that they are just looking for discrete bodies. These bodies were then attributed with the amplitude of the signal above background so that can be compared with the expected anomaly amplitude from the forward modeling. The expected amplitude is approximately 0.1-5 mgals depending on the size and depth of the body.

The structure detection method is an amplitude independent edge detection method that is good for highlighting subtle structure in gravity data.

Discrete Anomaly Detection Results

Gravity data are often collected in scattered points in an area as opposed to magnetic data that is usually collected on consistently spaced lines. Gridding algorithms tend to create a bumpy surface with a lot of round anomalies when applied to randomly spaced data. Therefore there are likely a lot of false anomalies in this processing. These data should be viewed in the context of the other datasets. The results of the processing are shown in Figures 1 and 2.

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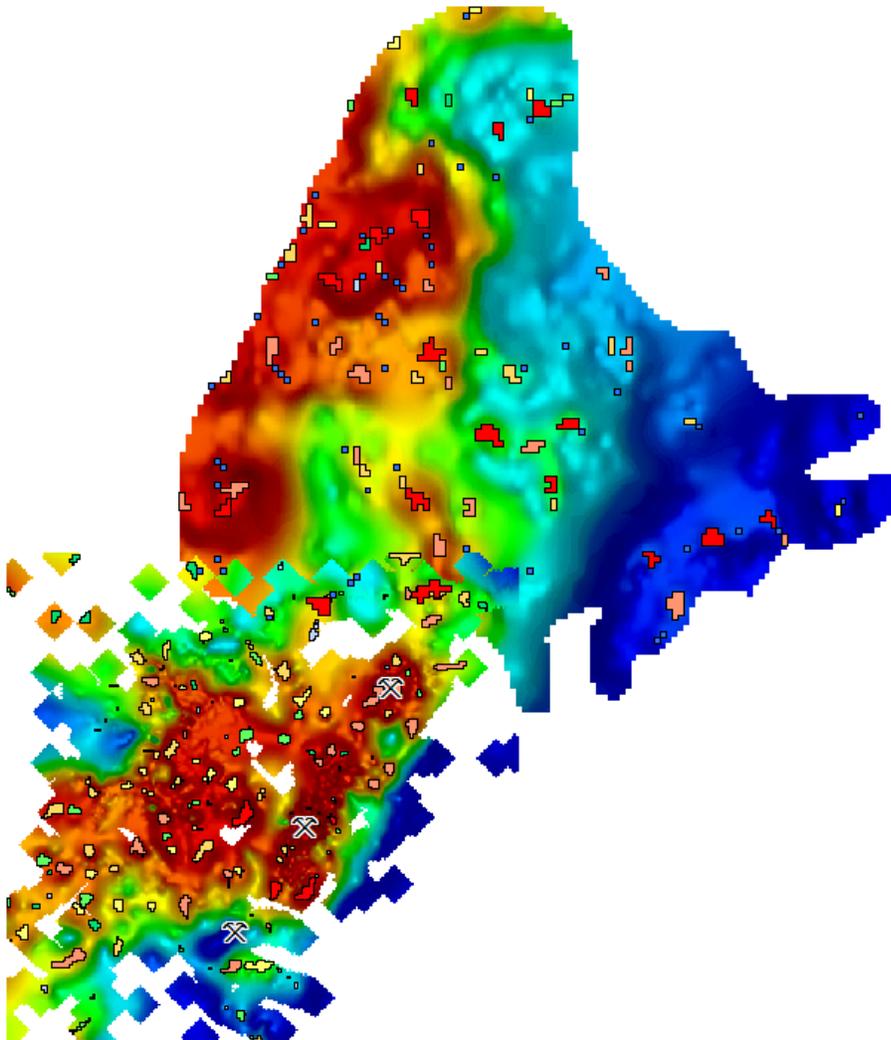amanda@fathomgeophysics.com

Figure 1. Discrete anomalies extracted from the gravity data using the gradient-based method looking for positive anomalies. The anomalies are colored by the amplitude of the anomalies above background. The orange and red anomalies are of most interest in this dataset as they are the right amplitude for the deposits. Background image is the terrain corrected gravity.

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Structure Detection Results

Structure detection on these gravity data cannot be used to highlight broad structure because they do not cover a large enough area. Some interesting detailed structure is highlighted and the results can be used to break out units in the gravity data.

The results are shown in Figure 3. The structure looks like a reasonable interpretation of the gravity data. It is still necessary to compare how this structure compares with structures that have been mapped in the area.
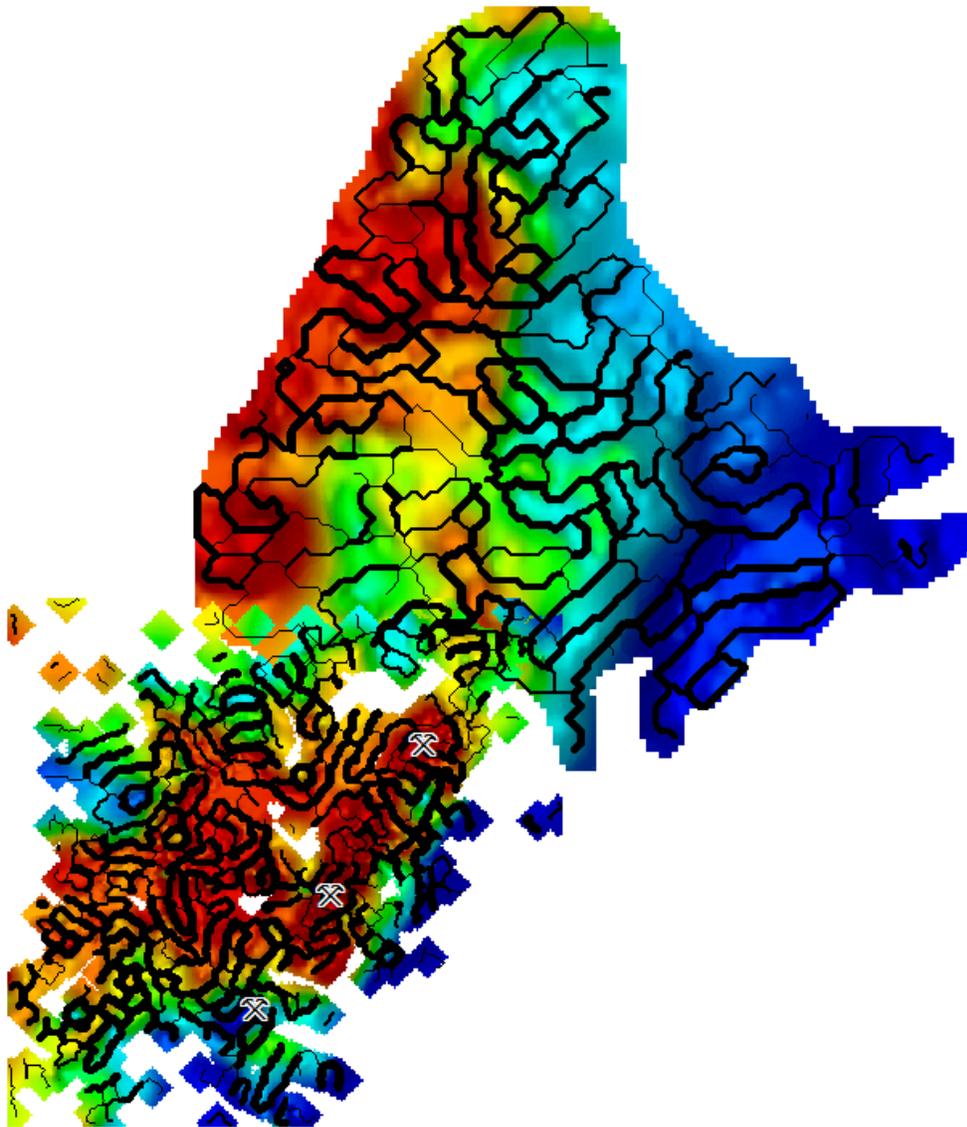
Figure 3. Structure detection results overlain on the terrain corrected gravity.

Appendix 1 – Processing Methods

Discrete anomaly detection

Discrete anomaly detection is done using radial symmetry algorithms. There are a lot of input parameters to these functions that can alter the outcome of the processing. The most important of these are the choice of method, the radius of the anomalies and the noise threshold.

Two methods were used to extract features.

1) A gradient-based filter that is independent of amplitude. This is useful for finding round features of unknown amplitude, such as intrusions associated with porphyry copper deposits or kimberlites.

2) A phase-based filter that is independent of amplitude. This is useful for finding round features of unknown amplitude that are very nearly circular, such as kimberlites and hematite IOCGs.

Both methods were used for this project since the exact features of the anomalies we are trying to locate are unkown. Moderate noise thresholds were chosen for both methods. This was done so that anomalies that are due to noise in the grid were not highlighted while subtle anomalies that are real were still highlighted.

Gradient-based filtering

The gradient-based radial symmetry filter operates in the space domain. The filtering is based on the x- and y-gradients and the horizontal gradient magnitude of the data. To locate positive anomalies, the gradients are used to determine points where the grid slopes away in all direction at the given radius. For negative anomalies, points where the grid slopes toward the point in all directions are located. If the magnitude independent method is used, all slopes are weighted equally and only symmetry is considered. If the magnitude dependent method is used, the symmetry measure is scaled by the steepness of the slope that points to, or away, from the radial anomaly.

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Phase-based filtering

The phase-based radial symmetry filter operates in the frequency domain. It uses local phase to determine points that have symmetry at multiple scales. The standard phase-based filter locates bilateral symmetry in six to eight orientations in the data. The change in the symmetry measure with orientation can be used to determine how radially symmetric an anomaly is. If the symmetry value for an anomaly is similar in all orientations, it is likely to be round. If the symmetry value varies a lot for an anomaly, it is not likely to be round.

Structure detection

The structure detection filter is also a phase-based method that operates in the frequency domain. It uses local symmetry to determine points that have asymmetry at multiple scales. The user can chose the orientations that the filter looks at and in this case that is 6 orientations spread evenly from 0 to 180 degrees.

There are many possible inputs to the structure detection algorithms but the most important besides the number of orientations are the wavelength and the noise threshold. The wavelength is the starting wavelength and the filter looks at features between that value and roughly four times that value.

The noise suppression was set fairly low because the structures are pretty subtle in the Hellyer Corridor. A high noise suppression value would have eliminated structures that are real.

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8