



# Memorandum

To: Lindsay Thomas  
From: Ross Withers, 39083.  
Date: 17/6/99  
Re: Tender for Magnetic Profiles of area northwest of Golden, Colorado.

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## Survey Request

The purpose of this survey is to answer questions that arose over a positive anomaly revealed in an earlier gravity survey of the Golden, Colorado construction site. A proposed elementary school in the area must conform to strict building codes such as foundation stability, earthquake resistance, etc. these are dependent on bedrock depth and configuration.

It has therefore been requested that a magnetic survey of the area has been performed to better determine the nature of the gravity anomaly and whether it will affect the foundation designs with significant impact on cost estimates.

## Interpretation of the Positive Gravity Anomaly

In designing this survey, we have used the previous gravity data to estimate the shape of the anomaly's cause. Slab, cylinder, and sphere models were tested against the data. The slab model proved to best fit the anomaly and gave us the following rough estimates of the dyke.

- North south in orientation
- Location -140m
- Depth ~10m
- Width ~5m

## Survey plan

The survey we have designed is made up of three east-west profiles of the area at 150, 0, and -150. This will give us enough information to determine where or not the dyke is a linear feature and the angle or shape of it.

Local geological features such as bedding faulting etc. all have a north-northwest orientation. We are expecting the dyke too also have a north-northwest orientation. Profile positioning allows all three profiles to show the position of a dyke up to an angle of 36° west of north, while still obtaining results over a reasonable length of dyke.

Profile 1 - (-250,150) to (250,150)

Profile 2 - (-250,0) to (250,0)

Profile 3 - (-250,-150) to (250,-150)

Three readings will be taken from each reading point as this has been calculated to give accurate cost effective data. Spacing for this survey has been calculated to make the most of a full 8 hours of data collection and will be set to 4.8m.

A second Magnetometer will be employed to take readings at a base station located at (0,0). This will produce a continuous analysis of the regional magnetic field and will be used to remove any regional fluctuation in the magnetic field giving very accurate data. A survey design summary is contained in appendix 1.

The purpose survey will take 2 days of fieldwork with a further 2 days of data analysis required to complete the task.

Total cost for this survey will be \$8,400\*

This price includes all aspects of the magnetic analysis.

\*A breakdown of this price is contained in appendix 1.

### **Survey design limitations**

Probability for the success of this survey lies in the properties of an unknown bed rock formation. Modeling of the gravity anomaly shows that the anomaly is almost certainly caused by a dyke however there is a remote chance that the dyke has an unusually low magnetic susceptibility and will therefore be absent on a magnetic profile.

Given all the information at hand we are 95% confident that the survey can locate and yield some information on the dyke.

I hope you find this bid fair and look forward to further correspondence regarding your survey request. If further information about this tender is required, you can contact me by e-mail at [rosswithers@ozemail.com](mailto:rosswithers@ozemail.com).

## APPENDIX 1.

### *Survey Cost Break Down*

Field hand cost + party chief	\$ 800.00
Office cost	\$ 320.00
Subsistence costs	\$ 800.00
Fringe benefits	\$ 280.00
Total HR cost	\$ 2,200.00
Overhead costs	\$ 2,200.00
Depreciation costs	\$ 400.00
Total outgoing	\$ 4,800.00
Standard Contract Fee	\$ 3,600
Total Cost	\$ 8,400

### *Survey Design Summary*

Station spacing	4.8 m
Readings per station	3
Total number of readings	945
Base station location	(0,0)
Number of profiles	3
Survey time	2 days
Data analysis time	2 days
Total time	4 days



**APPENDIX 2.**  
**Survey Logic Statements**

***Tunnel Considerations***

<b>IF THE DYKE IS</b>	<b>THEN IT'S ANOMALY WILL BE</b>
Present	Present and Positive
Deeper	Smaller In amplitude and slightly larger In width
Shallower	Larger In amplitude and slightly smaller In width
Narrower	Smaller In Amplitude and Narrower In Width
Wider	Larger In Amplitude and Wider In Width
More Susceptible	Larger In Amplitude No Width Change
Less Susceptible	Smaller In Amplitude No Width Change

***Survey Considerations***

<b>IF</b>	<b>THEN</b>
Distance Between Stations is Reduced	Resolution of profile will be increased and cost will be increased
The spacing between profiles is increased	Accuracy of the dykes orientation increases but chance of missing the dyke in the profiles increases
The Number of Readings at Each Station is Increased	Accuracy of readings will be increased and cost will be increased



# Memorandum

To: Lindsay Thomas  
From: Ross Withers, 39083.  
Date: 17/6/99  
Re: Preliminary results for Magnetic Profiles.

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## **Preliminary Report**

The magnetic survey of the area north-west of Golden, Colorado was successfully completed within the 8 hour time frame out lined in our tender. A copy of the raw data can be made available on request.

At this stage, we can confirm the dyke crossed all three of the magnetic profiles and that it is a linear feature as expected. Analysis of the data will now commence with the results being delivered within 2 days.

Yours sincerely,  
Ross Withers.



# Memorandum

To: Lindsay Thomas  
From: Ross Withers, 39083.  
Date: 17/6/99  
Re: Results for Magnetic Profiles of area northwest of Golden, Colorado.

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## Survey Request

The purpose of this survey was to determine the cause of the positive gravity anomaly seen in an earlier survey and whether it will adversely affect the foundation designs of the building project.

## Results Summary

The returned data profiles from this survey each had one anomaly in them. This enabled us to determine the following information about the dyke-

- **The dyke is linear**
- **The dyke crosses central (-250,0) to (250,0) profile at -140m**
- **Orientation of dyke = 15° west of north**
- **Width of dyke = 10m**
- **Depth to dyke = 11m**
- **Susceptibility of dyke material =  $8.35 \times 10^{-4}$**

## Recommendation.

The depth of the dyke appears too deep to pose much of a problem to developments in the area. If however more accurate knowledge of the dykes depth and width is required we would recommend a drill hole be made at position (-140,0) to sample the dyke's material. This will give us the depth to the dyke and allow the susceptibility of the rock to be found. From this additional information, we can calculate the exact width of the dyke at each of our profile crossings.

## Summary of Data Reduction and Interpretation Methods.

Raw field data was collected directly onto computers in the field. This underwent two steps of data correction

1/ Removal of regional magnetic fluctuation using the data collected from a on site base station.

2/ Regional gravity was removed from the data.

The resulting profiles were placed into a magnetic slab-modeling program in which properties of the dyke were altered to achieve the best fit to the data.

### **Survey Results and Confidence levels.**

Position of the dyke- has been calculated to be -140m along the central profile, this value is supported by the early gravity analysis of the dyke. The value is estimated to have a maximum error of 0.5m, much less than the dyke's width.

Trend of dyke- This has been measured along a length of over 310m of the dyke and is considered accurate to within half a degree.

Width of dyke- has been estimated at 10m but has the largest error with the width between 8 and 12m, it is dependent on both the depth and susceptibility of the dyke.

Depth to dyke- is 11m again, this has an associated error to it of the order of  $\pm 1$ m.

Susceptibility- This value is not of any structural importance but has been included here as it effects the calculated depth value. This is a rock property and requires a sample of the rock to be determined.

We consider the gravity analysis of the dyke to be of no use in determining the detailed properties of the dyke as the profile is too unreliable in relation to magnetic data.

I trust that information we have provided will aid in your developments of the area. If further information is required concerning this survey, please do not hesitate to contact [rosswithers@ozemail.com](mailto:rosswithers@ozemail.com).

## Appendix 1.

### Procedure for data reduction and interpretation.

- 1/. Raw data collected from the field  
Survey Design Summary

Station spacing	4.8 m
Readings per station	3
Total number of readings	945
Base station location	(0,0)
Number of profiles	3
Survey time	2 days
Data analysis time	2 days
Total time	<b>4 days</b>

Data was returned in the from of

X-Location(m)  
Y-Location(m)  
Time(min)  
Field Strength(nT)  
Base Station Reading(nT)

- 2/. Magnetic variance was remove from data by taking base station readings from the recorded readings. This is based on the assumption that bases station reading variance records the variance for the region.
- 3/. The regional magnetic field was removed from data to give magnetic profiles.

Regional gravity was approximated using a third order polynomial trend line. Using regional data from the National Geophysical Data Center the following equation was found to best fit the regional gravity of this profile.

North West 3.8 nT  
North East 0.7 nT  
South East -2.7 nT  
South West -0.3 nT

These are approximately equal to the regional values, with a constant value of the order of 51350 nT removed.

Regional gravity was calculated from these four readings for each gravity station position. It was then removed from the measured gravity reading.

- 4/. Computer modeling of the different profiles anomalies was used to identify cause of anomalies.

By varying the model parameters of the anomaly, specify the location, orientation, depth, width, and susceptibility of the dyke we can create a model that fits the anomaly.

The complete set of workings for this gravity analysis can be found in the attached Excel File magdat.xls