Airborne Geophysical Survey of the Bathurst Mining Camp

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INTRODUCTION

The Bathurst Mining Camp accounts for 31% and 39%, respectively, of Canada's zinc and lead production, and significant quantities of copper, silver and gold. A multiparameter helicopter-borne magnetic, electromagnetic and radiometric survey completed in 1995 covered the entire mining camp. The radiometric sensor, located in the helicopter, was at a mean terrain clearance (MTC) of 60 m, the magnetic sensor and EM system were at 45 m and 30 m above ground, respectively. Flight lines were 200 m apart and oriented perpendicular to the geological strike of the five blocks flown. Control lines were flown every 7 km perpendicular to the flight lines. Differential GPS navigation was used. Published products include total field magnetic anomaly maps, first vertical derivative maps of the magnetic field, EM anomaly maps, conductivity and radiometric maps.

MAGNETIC DATA

The new published map of the magnetic field has much greater resolution than a previously published map based on surveys flown at 150 m MTC. For example, steeply dipping, sheet-like sulphide deposits up to 100 m thick and rich in pyrrhotite, theoretically, should yield magnetic anomalies 3 to 4 times larger in amplitude than those measured at 150 m elevation.

The new magnetic data enhance considerably the probability for the direct detection of ore bodies. This is demonstrated by the fine detail with which magnetic anomalies over the Devils Elbow, West Branch 44 Mile Brook (Figure 1) and Upsalquitch deposits are defined. All of these deposits are located in the northwest part of the Bathurst camp, where weakly magnetic felsic volcanics dominate the stratigraphy. Accordingly the anomalies stand out prominently against a relatively featureless background field. In the eastern part of the camp, in an area known as the Brunswick belt, distinct magnetic highs are also observed over several deposits. In this area, however, alkali basalts, thin iron formations, pyritic sediments and some older sedimentary sequences comprising interbedded sandstone, siltstone and shale also produce distinct anomalies. Consequently, magnetic highs such as produced by the Brunswick No. 12 and Fab Main Zone deposits which are surrounded by other highs, do not impact on the magnetic field in the same way as the northwestern deposits do. Anomaly selection for follow-up investigation, therefore, presents more challenges to the interpreter.

The few examples cited have amplitudes ranging up to several hundred nanoteslas, which are controlled by sulphide mineralogy and deposit size and shape. All these deposits are at or near the surface. It is important to note that smaller magnetic anomalies should not be dismissed as having little economic potential.

Of potential interest for exploration is the observation that roughly half of the significant mineral deposits in the southwest part of the mining camp are located on the flanks, or within, discrete magnetic highs, not produced specifically by the deposit. Many of the highs can be linked to alkali gabbro, andesitic volcanics, and other mafic volcanic and intrusive units. If such lithologies are associated with or represent subvolcanic sills of a type known to influence the production of volcanogenic sulphide deposits, some of the magnetic highs might be hallmarks of terrane having good potential for hosting sulphide ores.

ELECTROMAGNETIC DATA

Many EM surveys have been flown over this region before. In fact, the first airborne EM discovery in the world was the Heath Steele lead-zinc deposit located about 65 km southwest of Bathurst. This new survey is, however, the first multiparameter survey covering the entire mining camp and produced the first fully homogeneous EM data set of this region. The five-frequency multi-coil HEM system covers a wide frequency range and allows detailed conductivity mapping of the ground. The apparent conductivity map generated from the 4433 Hz coplanar EM data outlines the bedrock geology very well. In the Bathurst area, conductive units are very well defined and can be used to help supplement detailed geological mapping (1:20 000). Moreover, these maps show excellent correlations with the first vertical derivative maps of the

In "Proceedings of Exploration 97: Fourth Decennial International Conference on Mineral Exploration" *edited by* A.G. Gubins, 1997, p. 841–844

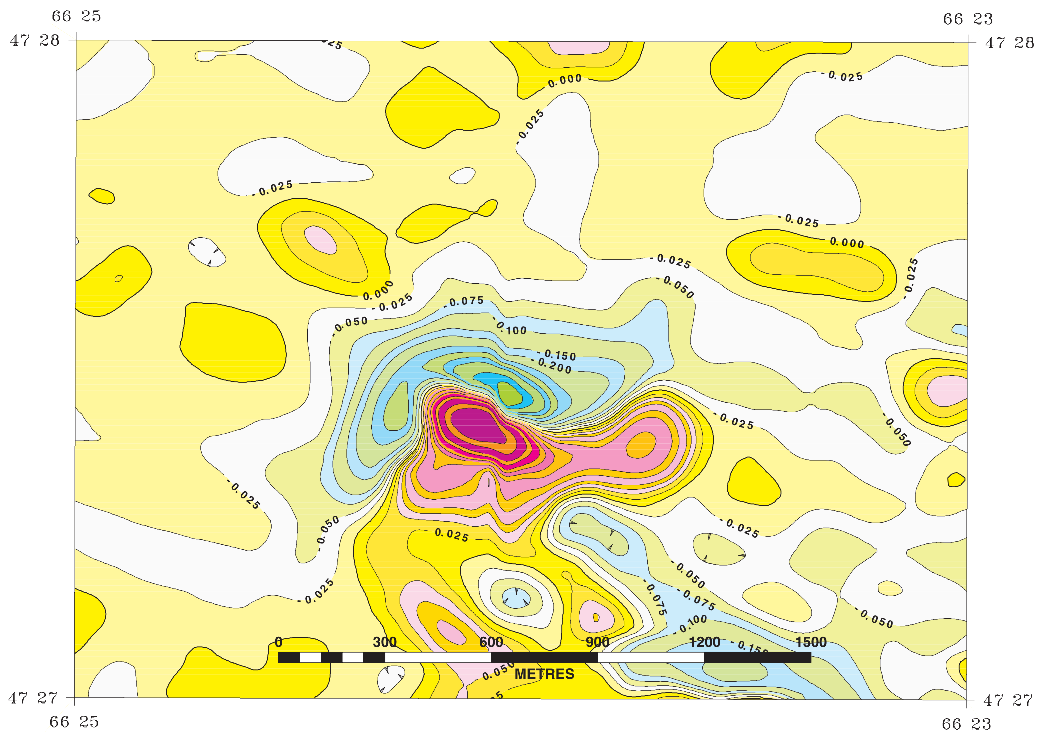

Figure 1: *First vertical derivative of the total field magnetic anomaly over the West Branch 44 Mile Brook deposit. Contours are in nT/m.*

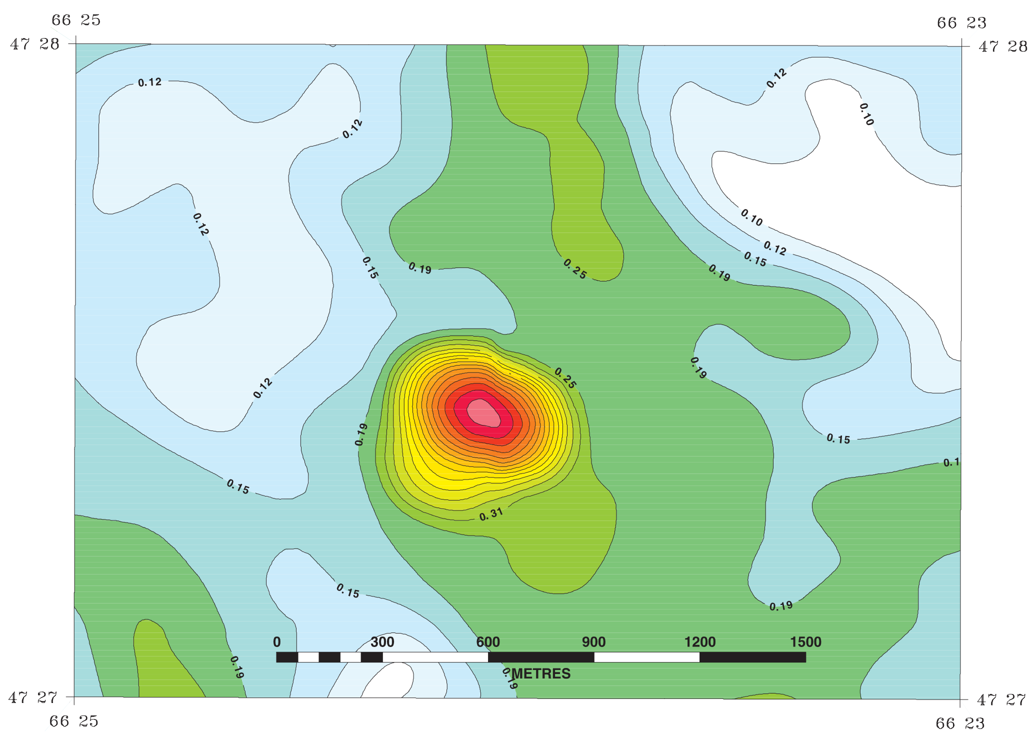

Figure 2: *Conductivity anomaly over the West Branch 44 Mile Brook deposit. Conductivity was calculated from the 4433 Hz electromagnetic response of the coplanar coils. Logarithmic contour intervals are in mS/m.*

total magnetic field, providing a means to distinguish between overburden and bedrock conductivity responses. A typical example of a conductivity anomaly over a sulphide deposit is that over the West Branch 44 Mile Brook deposit illustrated in Figure 2. Conductor maps and profiles, on the other hand, contain information about finite conductors (anomalies) within the Bathurst Camp. Conductivity maps and profiles provide information on location and size of bedrock conductors and can be used, along with the magnetic data, to screen and rank bedrock conductors for ground follow-up. Many ore bodies are associated with discrete, coincident, magnetic and conductivity anomalies. Typical examples are the Devils Elbow, FAB Main Zone and Armstrong 'B' ore bodies.

RADIOMETRIC DATA

Relative to previously published airborne gamma ray spectrometric maps, the new data provide significantly better resolution of radioelement signatures associated with bedrock and surficial features. This is a function of increased flight line density, better line orientation and lower radioelement detector height, relative to the earlier surveys. Chemical variations between felsic and mafic intrusive and extrusive units are reflected in the radioelement patterns through variations in potassium, equivalent uranium and equivalent thorium concentrations and their ratios. These patterns support revision to regional and property scale mapping and can be used to extend deposit-specific chemostratigraphic relationships determined locally. A very cursory examination of only a few of the many base metal deposits within the camp (Devils Elbow, FAB Main Zone, Armstrong 'B', Brunswick No. 12 and Upsalquitch deposits) suggests that deposit-specific patterns may be variable and subtle. A combination of magnetic, conductivity and radiometric signatures may provide key fingerprints to many of the known, and possibly undiscovered, deposits within the camp.

CONCLUSIONS

This recent multiparameter survey allows detailed geophysical mapping of the Bathurst Mining Camp. Magnetic and conductivity data are particularly helpful in improving the geological mapping of the region. Better knowledge and understanding of the geophysical responses of known ore deposits give new exploration guidelines that will help to identify new exploration targets. The high quality of the data will permit sophisticated interpretation and reprocessing of these data sets in the near future.