THE DOUBLE DERIVATIVE INTERPRETATION OF REGIONAL MAGNETIC FIELDS IN THE BRIDGE RIVER MINING CAMP (92J/15, 16)

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INTRODUCTION

The double derivative method of screening aeromagnetic data assists regional geological interpretations. According to theory, the "second vertical derivative" maps the rate of curvature of magnetic fields. The zero contour on the calculated surface has special geological significance and coincides with inflection points on the original magnetic profiles. These inflections commonly trend subparallel to lithological or mineralized boundaries and fault zones.

In the Bridge River mining camp the federal-provincial aeromagnetic maps, Tyaughton Lake (92J/15) and Bridge River (92J/16), at 1:63 360 scale, provide a ready base for analysis. Regional geological control is provided by current mapping and by the Geological Survey Branch (Open File Map 1987-11, *Geology of the Gold Bridge Area*) and previous work by Leech (1953), Roddick and Hutchinson (1973) and Potter (1986).

GEOLOGY

The magnetic signatures of the principal geological formations underlying the Bridge River camp depend on several factors such as the iron content, mineralogy, alteration and metamorphic conditions of the rocks. Ultimately the amount of magnetite and grain size are the most important factors. Generally, igneous rocks have the greatest magnetic susceptibility, having more combined magnetite and ilmenite and coarser grain size than the sedimentary units. Table 1-8-1 gives the total iron, magnetite and ilmenite percentages for a selection of igneous rocks from the area.

The Pioneer volcanic rocks comprise the lowest formation in the Upper Triassic Cadwallader Group. The unit consists mostly of basaltic pillow lavas and breccias ranging up to several hundred metres thick. These volcanics are sandwiched between thick sedimentary sequences characterized by relatively low magnetic susceptibility; the older Fergusson cherts and phyllites lying unconformably below; the slightly younger Hurley argillites, limestones and clastic beds lying conformably above.

Generally the Pioneer volcanic assemblage has been affected by greenschist-grade metamorphism which has destroyed much of the primary mineralogy. Calcic feldspar has been transformed to more sodic varieties and the ferromagnesian minerals partly replaced by chlorite. Individual magnetite grains may have survived the effects of regional metamorphism, however, much of the iron is contained in very fine-grained opaque dust associated with the decomposition of the original mineral and vitreous components. In areas of mineralization, the basaltic walls of quartz veins are commonly carbonated and much of the iron is tied to siderite, hematite and pyrite. These altered rocks have low magnetic susceptibility.

The ultramafic rocks of the President and Shulaps intrusions cut units of the Cadwallader and Fergusson groups. These intrusive bodies, consisting mostly of iron-rich harzburgite (with lesser amounts of diorite and websterite), contain much granular magnetite. The common high magnetic susceptibility of these rocks is in sharp contrast to the low magnetic susceptibility of the adjacent formations. The primary magnetite does not appear to be much changed by serpentinization of the ultramafic rocks, although much new fine-grained, opaque iron oxide has resulted from the conversion of pyroxene to serpentine and talc.

The Bralorne intrusions are relatively small Paleozoic diorite and gabbro bodies that appear to have been emplaced on major rifts in the Fergusson terrane. These plutonic rocks have relatively low iron content and have been extensively affected by retrograde metamorphism resulting in lower than expected magnetic susceptibility.

The Coast intrusions are Upper Cretaceous biotite hornblende granodiorite plutons with diorite and granite phases. These rocks are typically fresh with hypidiomorphic granular texture. The magnetic susceptibility of these rocks is generally low because of low ferromagnesian content, however, the occurrence of magnetic anomalies in adjacent country rocks may be due to the development of skarns and hornfels zones during intrusion.

METHOD OF ANALYSIS

The preparation of second vertical derivative maps is in accordance with the mathematical theory and procedures of Henderson and Zeitz (1949, page 512). The general equation for this purpose:

$$\overline{\Delta T}(r) = \Delta T_0 - \frac{r^2}{4}\frac{\partial^2 \Delta T}{\partial z^2} + \frac{r^4}{64}\Sigma\, \mu_k{}^4 A_k + \cdots$$

reduces to a nine-point system in a square grid

$$\frac{\partial^2 \Delta T}{\partial z^2} = 2(3\Delta T_0 - 4\overline{\Delta T}_1 + \Delta T_2)$$

where T_0 is gamma value at each cell centre in the map grid, T_2 the value at each corner of the cell, and T the value at the mid-points on the sides of the grid.

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

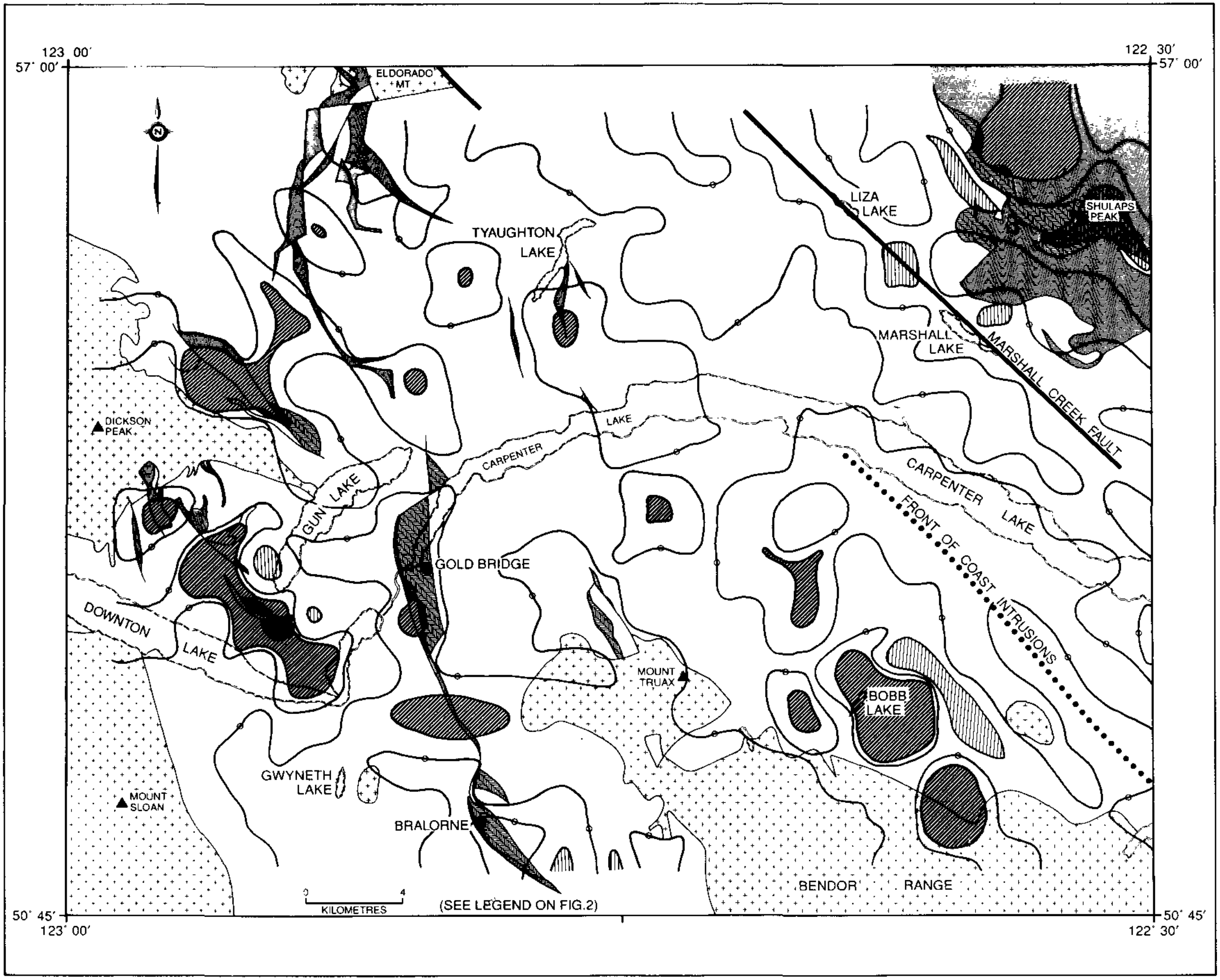

Figure 1-8-1. Tyaughton area (92J/15) showing the principal igneous intrusions and second vertical derivative contours of the total magnetic intensity (computed on a 1-mile grid interval from data on Geological Survey of Canada Map 8552G).

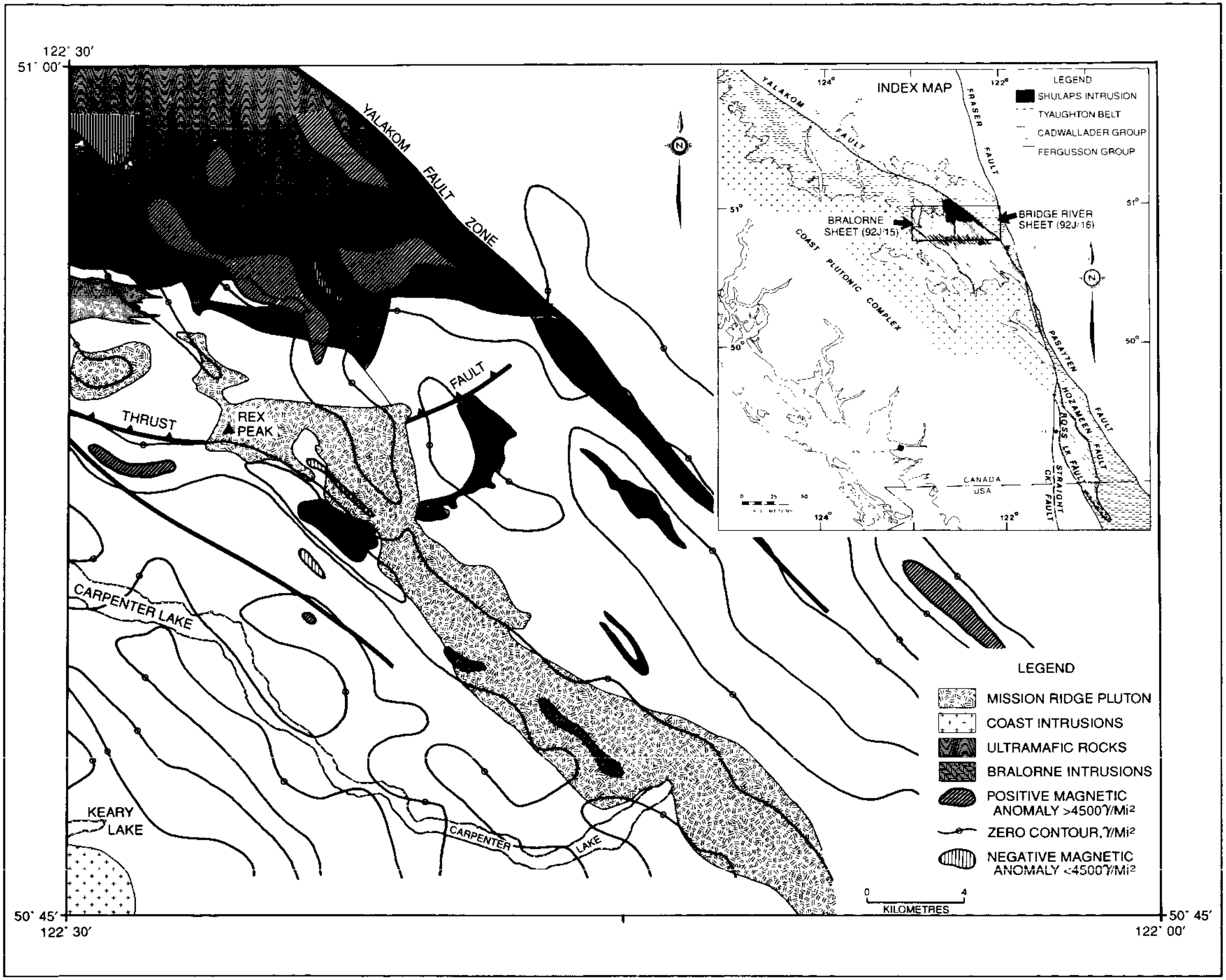

Figure 1-8-2. Bridge River area (92J/16) showing the principal igneous intrusions and second vertical derivative contours of the total magnetic intensity (computed on a 1 mile grid interval from data on Geological Survey of Canada Map 8548G).

For the Bridge River mining camp an orthogonal north-south, east-west grid with a 1-mile spacing is superimposed on the available aeromagnetic maps. A total of 792 grid points is necessary to cover the combined Tyaughton–Bridge River map sheets, each sheet measuring approximately 22 miles east-west and 18 miles north-south. The following general formula (algorithm) is applied to compute the second vertical derivative across the map area. Gamma values are interpolated and recorded at the grid points.

$$X(I,J) = 12X(I,J,) - 4[X(I-1,J) + X(I,J-1) + X(I+1,J) + X(I,J+1)] + X(I+1,J-1) + X(I-1,J-1) + X(I-1,J+1) + X(I-1,J+1)$$

for the interval X(1,1) to X(1,22) through X(18,1) to X(18,22); where I and J represent the rows and columns in the matrix of gamma readings (X). The final product is a contoured map showing gammas per square mile (*see* examples, Figures 1-8-1 and 1-8-2).

DISCUSSION OF RESULTS

The registration of the double derivative contours on the principal geological features of the Bridge River mining camp appears to be very good (*see* Figures 1-8-1 and 1-8-2). For example, the strong northwest-trending fabric delineated by the zero contour across the Bridge River sheet (92J/16) and the easterly part of the Tyaughton sheet (92J/15) conforms with the direction of the Yalakom and Marshall Creek faults and the front of the Coast intrusions. Also conforming well with this pattern is the young (Tertiary age) Mission Ridge pluton. The most anomalous magnetic zones coincide with the Shulaps and President ultramafic intrusions. A series of positive magnetic anomalies follows the hornfelsed margins of the Bendor and Dickson Peak granitic plutons and a series of negative anomalies occurs near a number of small Bralorne "diorite" bodies associated with the Shulaps ultramafic complex.

The broad magnetically flat area northeast of the Yalakom fault is underlain mostly by Cretaceous sedimentary formations characterized by low magnetic susceptibility.

It is concluded that the double derivative method of processing primary magnetic data provides some clear insight into regional structural patterns and lithology continuities in the Bridge River mining camp that may have useful potential for mineral exploration. The various igneous intrusions and adjacent fracture lineaments delineated on the double derivative maps point to possible prospecting targets.

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TABLE 1-8-1
IRON, MAGNETITE AND ILMENITE PERCENTAGES FOR SELECTED IGNEOUS ROCKS

	Fe %	Magnetite + Ilmenite %
Basalt (Pioneer Formation)	0.3–9.4	5.6–7.2
Ultramafic rocks (President intrusions)	5.7–7.8	1.3–6.5
"Diorite" (Bralorne intrusion)	4.5	1.3
Dioritic rocks (Coast intrusions)	3.0–4.5	2.0–2.2
Granitic rocks (Coast intrusions)	0.5–2.3	0.3–1.2