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Helicopterborne Multisensor Geophysical Survey Results over the **Beaton Claims** Kamloops, British Columbia

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Prepared for
Greenvalley Mining Inc. and Lakewood Mine Inc.
at the request of
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Osvaldo Contini (Director)
by
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Geological Survey of Canada
Ottawa
November 16, 2001

Contents

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Introduction

In 1993 a multisensor airborne geophysical survey, combining gamma ray spectrometric (GRS), magnetic total field (MTF) and very low frequency electromagnetic (VLF-EM) sensors was flown over the entire Ironmask Batholith area, near Kamloops, British Columbia. The survey was funded by Teck Exploration Limited (Teck) and flown by Sander Geophysics Limited under contract to the Geological Survey of Canada (GSC).

Comparison of the new airborne survey patterns soon revealed an astonishing correlation with the twenty most significant known deposits, including the then operating copper-gold mines at Afton and Ajax. Following a brief period of exclusivity, results were published at 1:150,000 scale as a series of colour interval maps and stacked profiles (GSC Open File 2817) and as digital data.

Under a GSC-Teck Joint Venture agreement, the airborne data provided regional and local frameworks for bedrock mapping and testing of new exploration strategies, including conventional and selective leach soil analyses (Enzyme Leach methodology), biogeochemical methods, lithogeochemical sampling and ground gamma ray spectrometry. As much of the work was focused within Teck-held property, such as the Rainbow zone, some of the interesting regional targets indicated by the airborne survey may have received little or no attention. The Beaton Claims overlie one of these anomalous zones.

This report summarizes the significance of the airborne survey patterns to mineral exploration in the Kamloops area, and to the exploration potential of the Beaton Claim area.

Gamma Ray Spectrometry

Traditional magnetic and electromagnetic techniques and applications are generally well understood by the exploration community. The gamma ray spectrometric method, however, is generally underutilized, and deserves brief description.

Gamma ray spectrometry has been conducted since the 1960's, evolving from a uranium-only exploration tool to a now well established, multi-element method, applied successfully worldwide to a variety of commodities in diverse geological settings. The technique passively measures the natural radioactivity of all rocks and derived materials, to characterize normal lithological variations and, of exploration significance, to fingerprint alteration of these normal radioactive element signatures by mineralizing

processes. The three most abundant radioactive elements, potassium, uranium and thorium are quantitatively measured, providing major, mobile and immobile trace element (respectively) information. Thus although the technique relies on physics, interpretation must be conducted in geochemical terms. Several Canadian case histories, including those derived from the Ironmask survey, are presented in GSC Open File 3601. In short, the method can be of direct assistance to exploration for many commodities, most obviously for U and Th, but also for Sn, W, REE, Nb, Zr, Au, Ag, Hg, Co, Ni, Bi, Cu, Mo, Pb, and Zn mineralization, either because one or more of the radioactive elements is an associated trace constituent or because the mineralizing process has changed the radioactive element ratios in the surrounding environment.

Conventional geophysical methods may respond to sources at depth, such as buried magnetic intrusions, electromagnetic conductors, or density contrasts. GRS, however, is strictly a "surficial" technique, related to the radioactivity of the top 30 cm of the earth's crust. Despite extensive glaciation throughout Canada, this limitation is less severe if one understands that the radioactive element signatures of underlying bedrock are commonly reflected in related, locally derived overburden. This holds true generally, in the Afton area, based on ground spectrometric follow-up conducted by the author. Interestingly, the same work showed that ground susceptibility measurements on the soil surface detected significant magnetic mineral content (magnetite), which interfered with results of ground magnetometer surveys conducted by Teck. For this reason, Teck staff found that the new airborne magnetic data more reliably reflected bedrock geology and structural features than the ground magnetometer surveys, and incorporated the airborne patterns in their exploration strategies.

The complimentary relationship between aeromagnetic and spectrometric techniques offers a powerful exploration tool, as consistently evident in the combined anomalies related to known mineralization throughout the Ironmask survey area. This clear association is described below, giving strong support to potential economic mineralization in the Beaton Claims area.

Airborne Survey Specifications

As detailed specifications are provided in Open File 2817, only factors pertinent to data interpretation or application are summarized below.

The airborne survey was flown to international standards established by the Radiation Geophysics Section, Geological Survey of Canada, ensuring collection of high quality, properly calibrated data. Gamma ray spectrometric measurements were made using an Exploranium GR820 spectrometer with ten 102 x 102 x 406 mm NaI(Tl) crystals (33.8 litres downward, 8.5 litres upward). Gamma ray spectra were recorded at one second intervals at a mean terrain clearance of 120 m, an air speed of 120 km/h, along NE-SW oriented flight lines spaced at 500 m intervals . With this configuration, each measurement corresponds to a ground area of approximately 50 along track by 100 m across track, with overlapping, consecutive1 second readings every 35 m along the ground. This resolution is maintained on the stacked profile presentations, but gridding required to generate the colour interval maps requires interpolation to 120 m.

Magnetic total field (MTF) measurements were made using a Scintrex cesium vapour magnetic sensor in a bird towed 30 m below the helicopter. Half second readings were

corrected for diurnal variations and the International Geomagnetic Reference Field (IGRF) was removed (hence the magnetic data displayed is referred to as "residual"). Flown control lines were used to level the data, which was then interpolated to a 100 m grid using a minimum curvature algorithm. The magnetic vertical gradient (MVG) was calculated from the magnetic total intensity grid.

VLF total field and quadrature components for two stations were recorded using a Hertz Totem 2A system. The line station was tuned to 24.0 kHz , from station NAA at Cutler, Maine, and the ortho station was tuned to 24.8 kHz from NLK at Seattle, Washington. As the VLF data was collected on a secondary "as-is" basis, no effort was taken to ensure complete coverage. A long wavelength interference signal is evident in the data, and extreme caution must be exercised in any interpretation of the VLF data. For this reason, the VLF data has not shown particular relevance to known mineralization and it is not considered in this report. (Contact the author if additional information is required).

Airborne Survey Results

Results are summarized below using annotated figures created from the original Open File 2817 colour maps and stacked profiles generated using SurView, at regional, local and property scales. A more compete series of digital images is included on CD-ROM, accompanying this report. Site-specific follow-up to these patterns should be based on larger images at improved scales.

The first three figures illustrate regional relationships between equivalent thorium and potassium (shown as eTh/K ratio in Figure 1), residual magnetic total field (Figure 2) and the calculated magnetic vertical gradient (Figure 3), with the 20 known deposits. Note that the deposits include intrusion-related Cu-Au porphyries and precious metal occurrences. All of the deposits lie within blue, low eTh/K ratio areas (Figure 1) and along the flanks of magnetic total field high areas, rather than on the highest magnetic anomalies. At many of the occurrences/deposits, these relatively low-magnetic features represent structurally controlled, magnetite destructive albitization, associated with mineralization. Weak to moderate potassic alteration is also associated with the deposits, but is not obviously evident as potassium highs on either the colour maps, or the stacked profiles.

More detailed views of the deposit signatures are illustrated by 12 stacked profile plots in Figure 4. These clearly show the consistent dip in the eTh/K ratios, along the flanks of magnetic total field highs, or sharp breaks in the magnetic profile. Neither the eTh/K values, nor the magnetic total field patterns can individually provide direct vectoring - it is the combination of the two factors that distinguishes the known deposits in the survey area. Similar features are evident in the Beaton Claims area.

Figures 5, 6 and 7 provide closer views of the eTh/K ratio, residual magnetic total field and calculated magnetic vertical gradient (respectively) for the Beaton-Afton area. Note that the chemical signature of the tailings, waste and altered lithologies at the surface reflect relative lows in the eTh/K ratio. Magnetic lows are best delineated on the gradient map (Figure 7), which clearly shows similar features extending through the Beaton Claim area across the survey grid.

Figures 8, 9 and 10 provide still closer views of the data in the Beaton Claims, showing existing grid lines (yellow), percussion and diamond drill sites (blue, green dots) and the

airborne survey flight lines with fiducials (white). Again, the coincidence of the Th/K ratio low with the linear magnetic features is evident, centered at fiducial 260 on flight line 2056. Corresponding stacked profiles are illustrated in Figure 11, for each of the flight line segments over the Beaton Claims. Yellow bars in Figure 11 are positioned over possible targets suggested by the airborne trends, most evident on lines 2055, 2056 and 2057.

Based on these relationships, in 1996 the author suggested 5 possible drill targets within the Beaton Claim area, to test for mineralization, within the main eTh/K low. At that time, platinum group elements (PGE's) had not been noted within the known deposits. The more recent discovery of PGE's at Afton, and the results of the MMI survey conducted over the Beaton grid, further enhances the potential for economic discoveries. Results for Pa, Au, Ag, Cu, Ni, Co and Zn concentrations detected by the MMI survey are indicated in Figure 12. The spatial relationship between the airborne "geochemistry" and the ground results is clear.

Conclusion

Patterns resulting from a multisensor airborne geophysical survey in the area surrounding the Beaton Claims have been shown to provide direct vectoring to known, intrusion-related, economic mineralization. Similar patterns are evident within the Beaton Claim area, where recent MMI geochemical survey results have detected significantly anomalous base, precious metal and palladium concentrations. In the author's opinion, these factors offer high potential for mineral exploration success and warrant further examination.

Signed, this 16th day of November, in the year two thousand and one:

Robert B. K. Shives

Curriculum Vitae Nov. 2001

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Summary: Geologist/geophysicist with 22 years post-graduate experience in private exploration and public sectors, in a variety of gold (vein, porphyry and epithermal) and uranium environments, with emphasis on application of gamma ray spectrometric techniques to bedrock and surficial mapping and practical exploration for a wide variety of commodities. Recent work includes development and presentation of case histories and short courses nationally and internationally.

Personal

Born May 5, 1956; 3 children; excellent health

Education

1979: B.Sc. Geology, Carleton University, Ottawa, Ontario
1981: "Mineral Logging" short course, applications of digital borehole logging systems, Saskatoon, Saskatchewan
1982: "Lithogeochemistry - effective data analysis", Saskatchewan Research Council, Saskatoon, Saskatchewan
1994: "Alteration and alteration processes associated with ore-forming systems" Waterloo Ontario
1997: "Geochemistry in Lateritic Environments Vancouver, British Columbia
1998-2001: various exploration geochemistry and geophysics courses

Work History

15/07/97 – present

Physical Scientist (PC-4), Geological Survey of Canada, Ottawa. Head, Radiation Geophysics Section, Geological Survey of Canada, Ottawa. Responsible for Section staff and all activities related to collection, maintenance and application of gamma ray spectrometry, magnetic and electromagnetic data to mapping, exploration, health and safety, environment; created, launched new GSC NATGAM Program; continued development of new applications to exploration for hydrocarbons, diamonds; published national/internationally refereed papers.

01/04/92 – 15/07/97

Physical Scientist (PC-3), GSC, Ottawa. Duties as for PC-1 and PC-2 positions below, but including: increased collaboration with provincial/territorial mapping geologists and industry in Canada and internationally; principle author of numerous Canadian workshops and accompanying workshop manuals (ie. GSC Open File 3061); Short courses recently given at Northwest Mining Conference in Washington, USA (1996), at ASEG Conference in Sydney Australia (1997), Exploration '97 in Toronto, Canada (September, 1997), 5Th Annual Brazilian Mining Conference (September, 1997). Increased contract survey monitoring and more focus on Canadian Cordilleran mapping and exploration applications of gamma ray/magnetic/VLF-EM multisensor surveys.

08/01/87 - 01/04/92

Physical Scientist (PC-2), GSC, Ottawa. Plan and coordinate airborne geophysical surveys; provide interpretation and evaluation of airborne and ground gamma ray spectrometry data; demonstrate application of AGRS to geological mapping, mineral deposit studies and environmental radiation monitoring; investigate the distribution of radioactive elements on soils and bedrock of the Canadian landmass and analyze results in conjunction with other geoscience data sets to prepare written and oral interpretations for national and international journals and meetings; compile, publish survey data; provide expert advice to industrial, academic and other representatives regarding application of gamma ray spectrometry to geological mapping, mineral exploration and environmental studies.

05/01/86 - 07/01/87

Physical Scientist (PC-1), GSC, Ottawa. geologist/geophysicist - data processing; compilation of GSC airborne gamma ray spectrometry, mag, VLF data, from raw field tapes to final publication, using Data General MV4000, Vax, Cyber and PC computers; designed, conducted field follow up programs under Canada-New

Regional Scale

Figure 1.
Twenty occurrences, Beaton Claims, on equivalent thorium/potassium ratio.

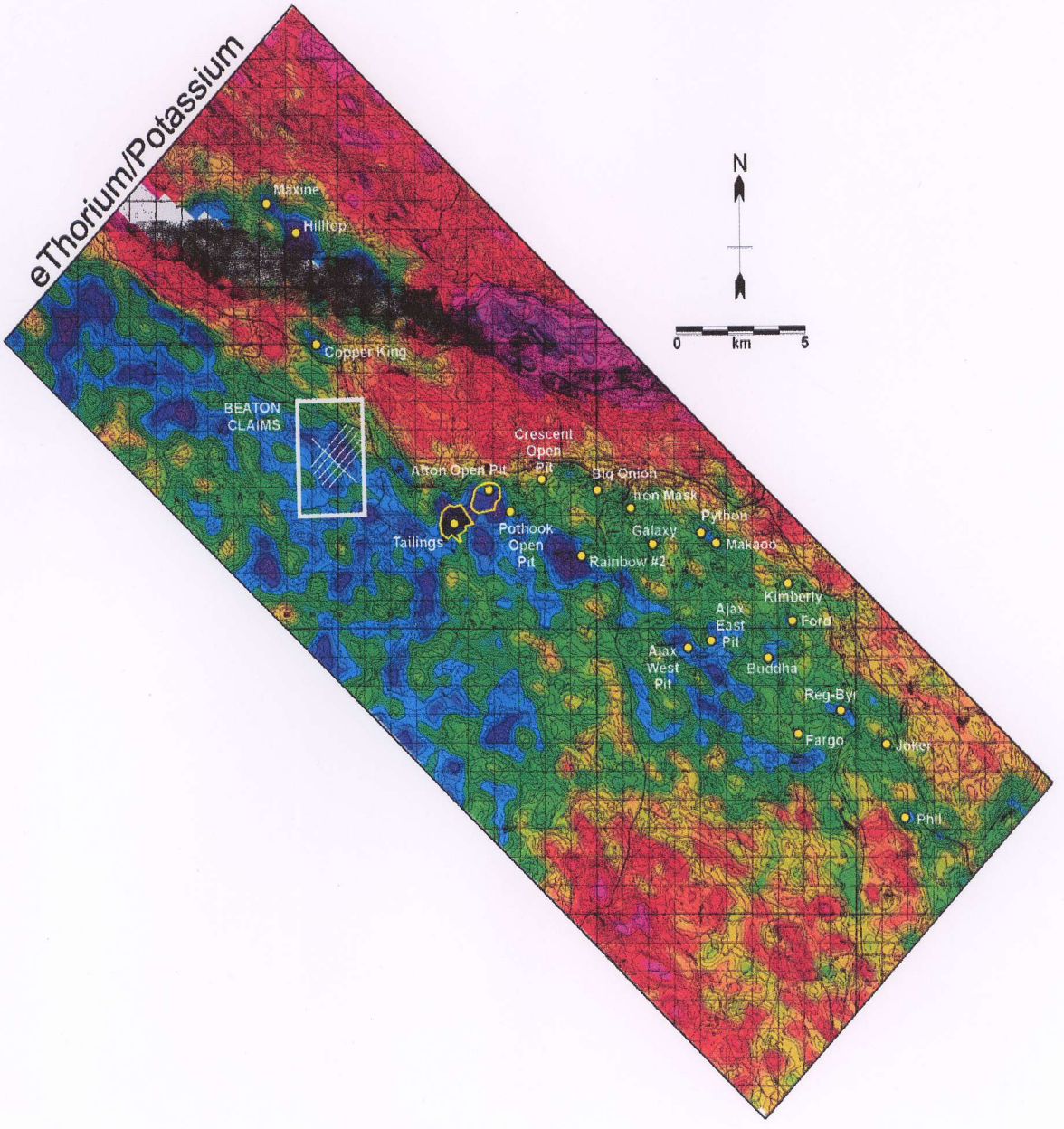


Figure 2
Twenty occurrences, Beaton Claims, on residual magnetic total field.

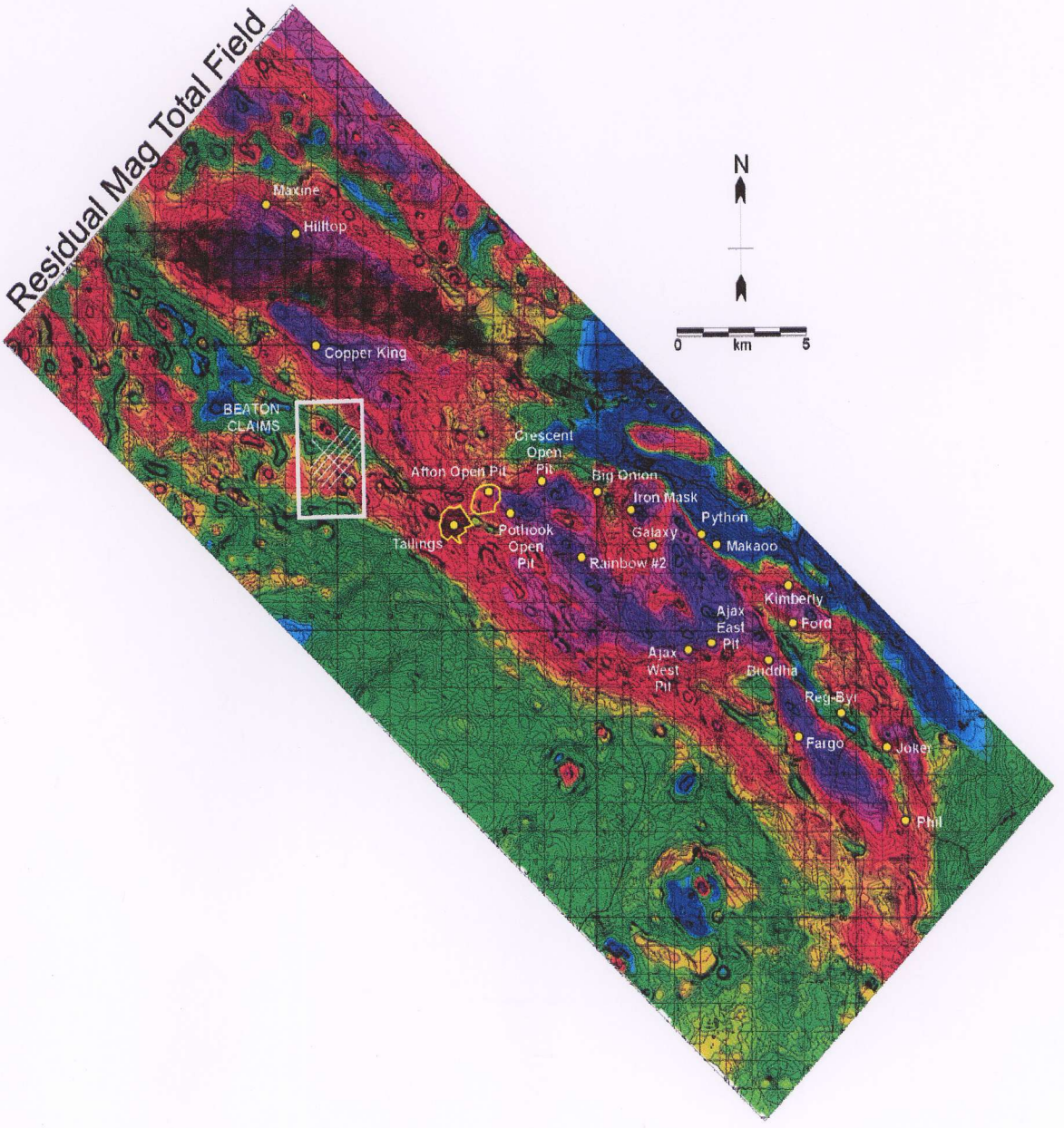


Figure 3
Twenty occurrences, Beaton Claims, on calculated magnetic vertical gradient.

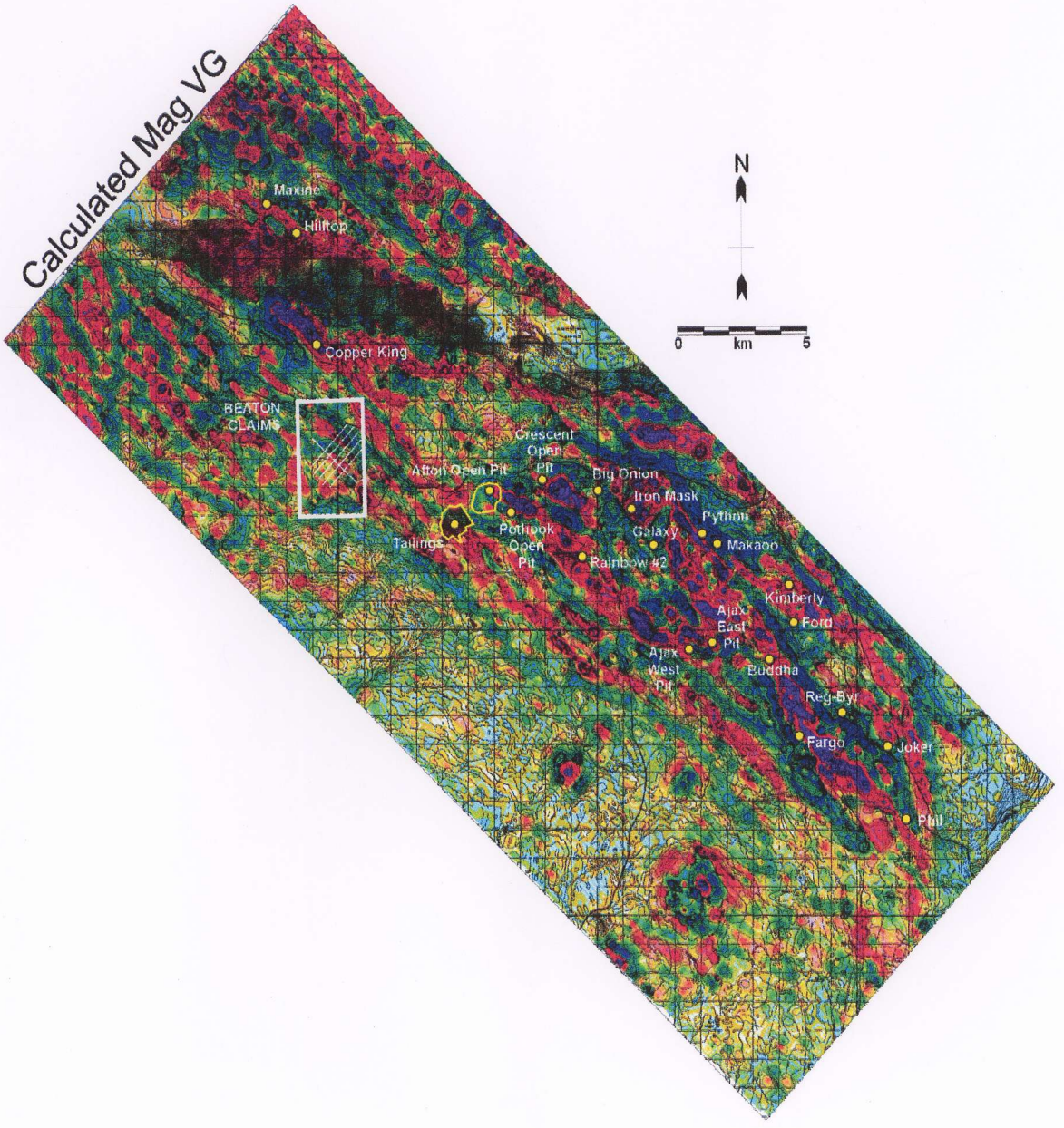
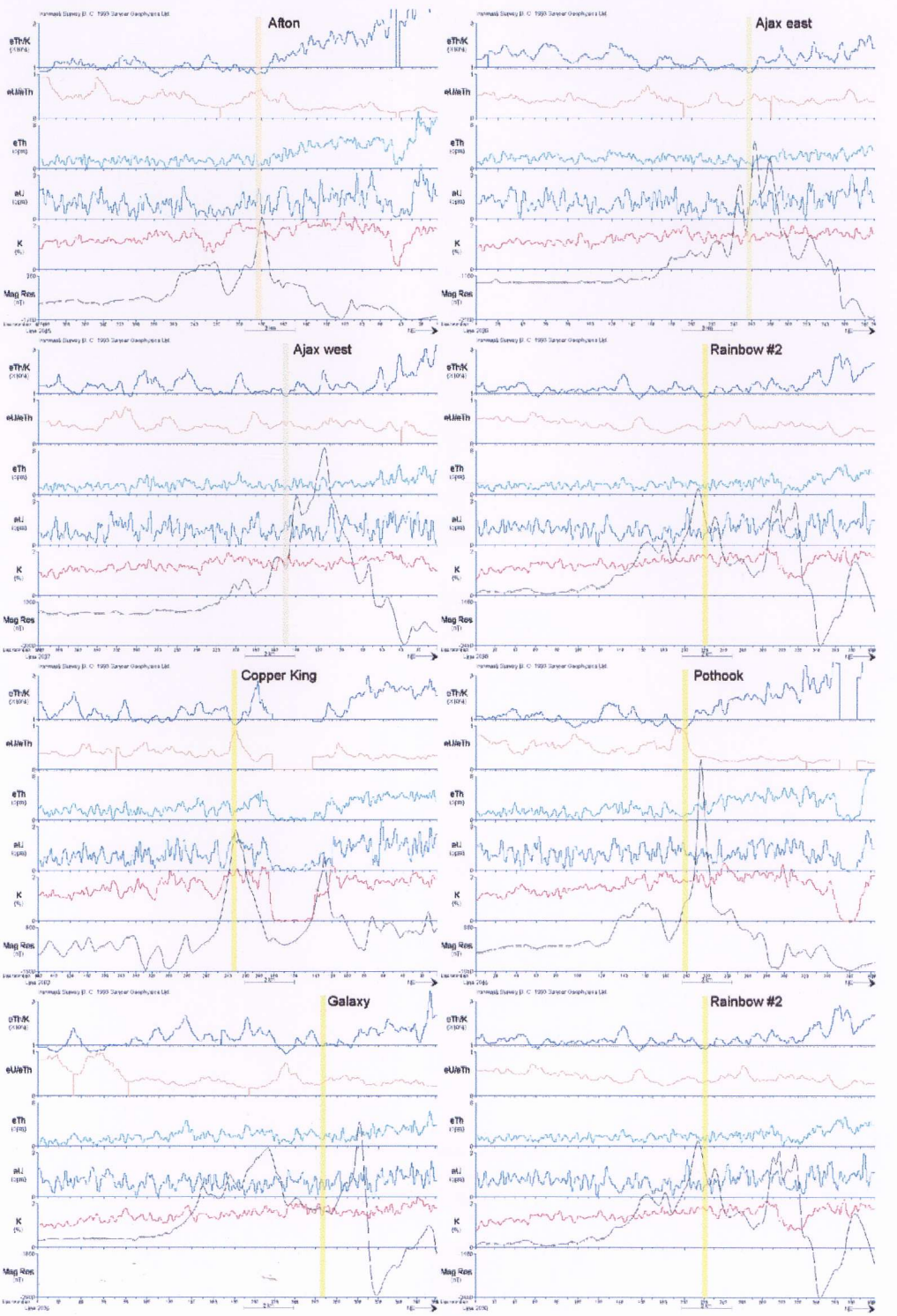
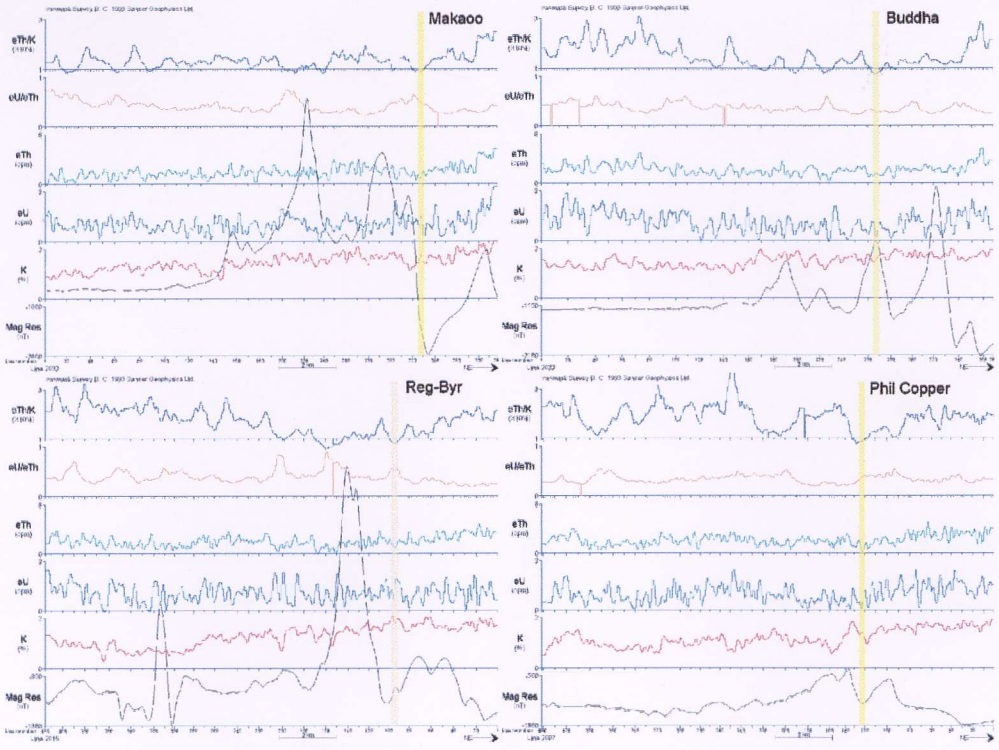


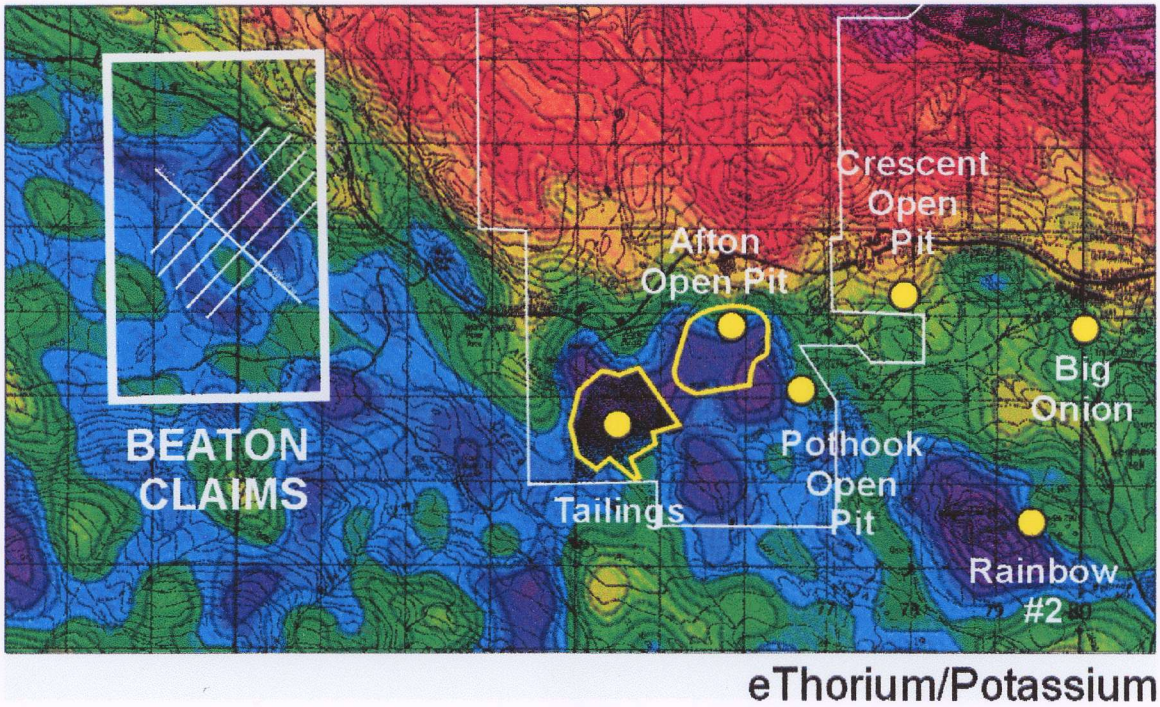
Figure 4.
Stacked profiles, 12 of 20 known deposits in the survey area





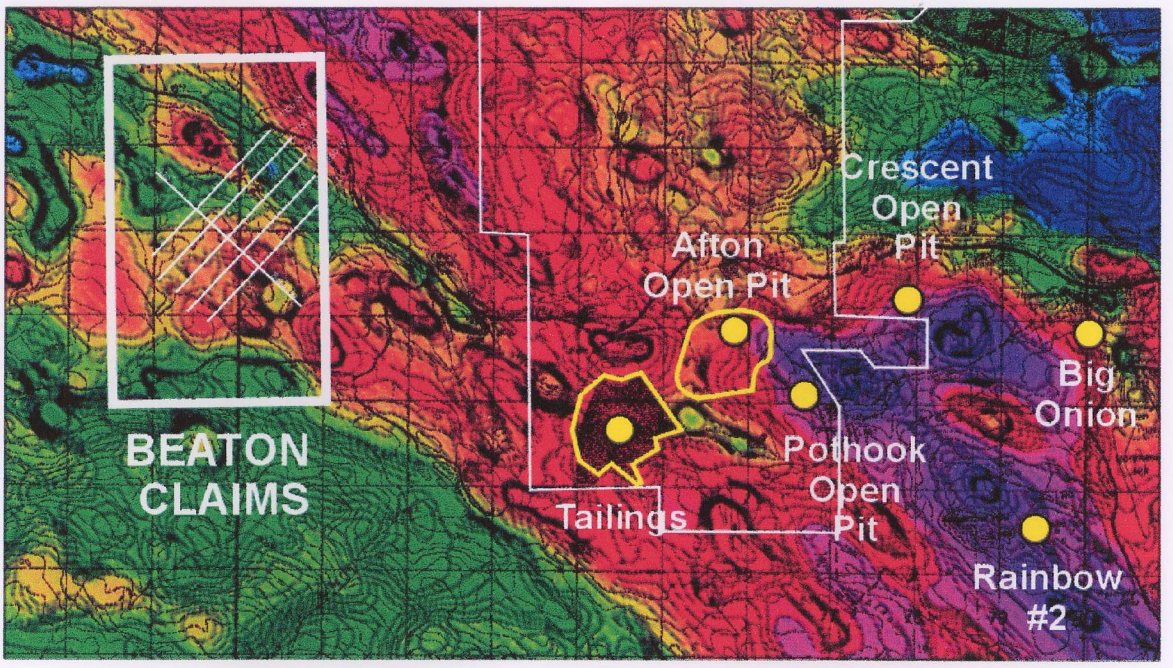
Local Beaton-Afton scale

Figure 5.



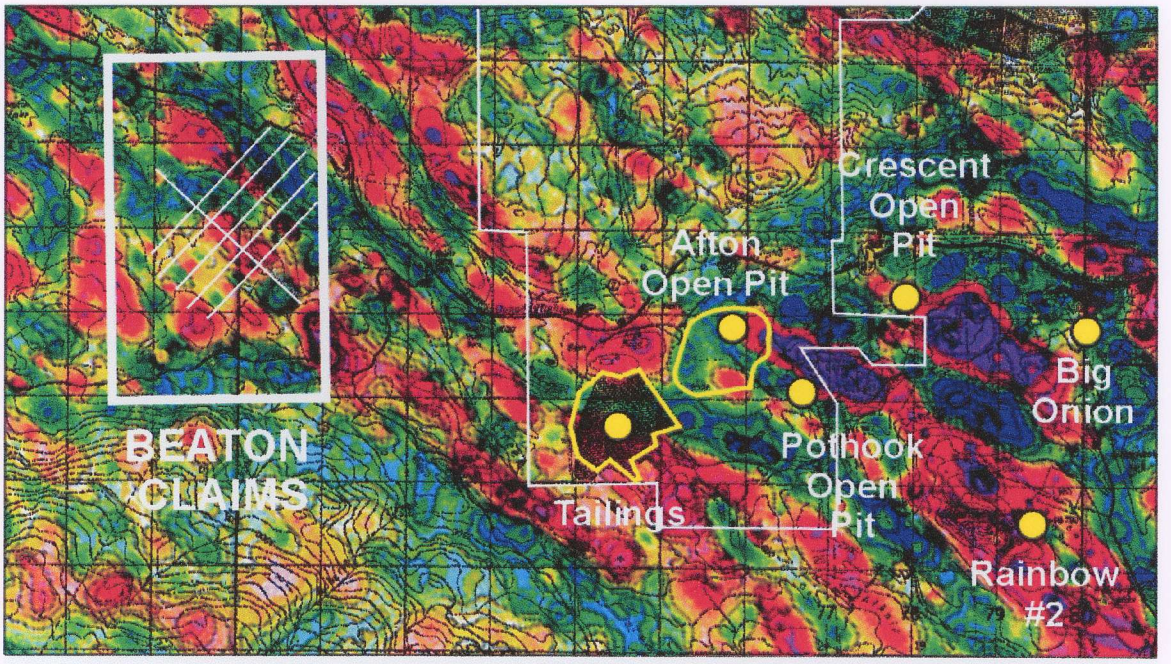
eThorium/Potassium

Figure 6.



Residual Magnetic Total Field (IGRF removed)

Figure 7.



Calculated Magnetic Vertical Gradient

1. Beaton Claims

Figure 8.
Flight lines with fiducials, Beaton grid, on equivalent thorium/potassium ratio.

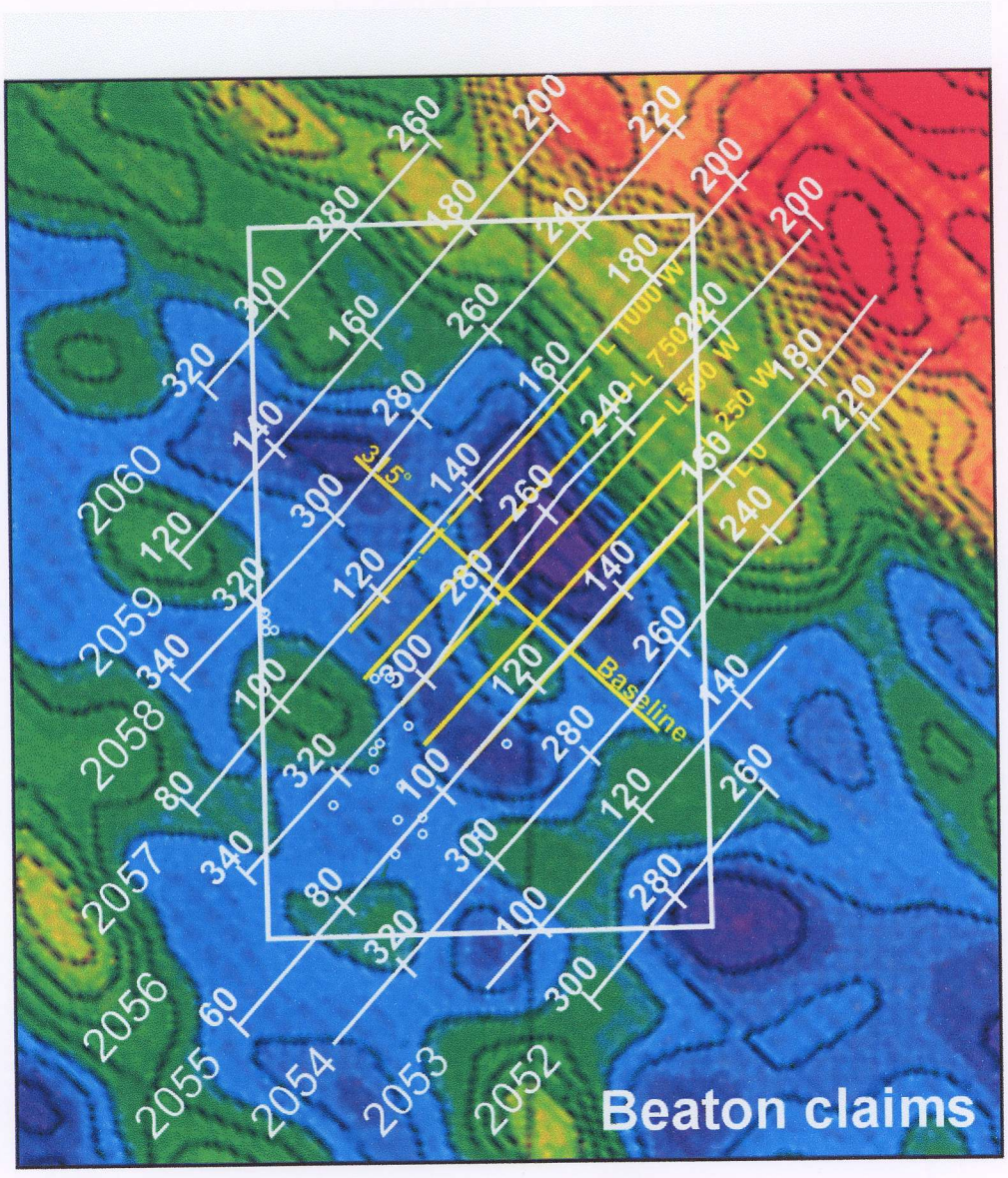


Figure 9.
Flight lines with fiducials, Beaton grid, on residual magnetic total field.

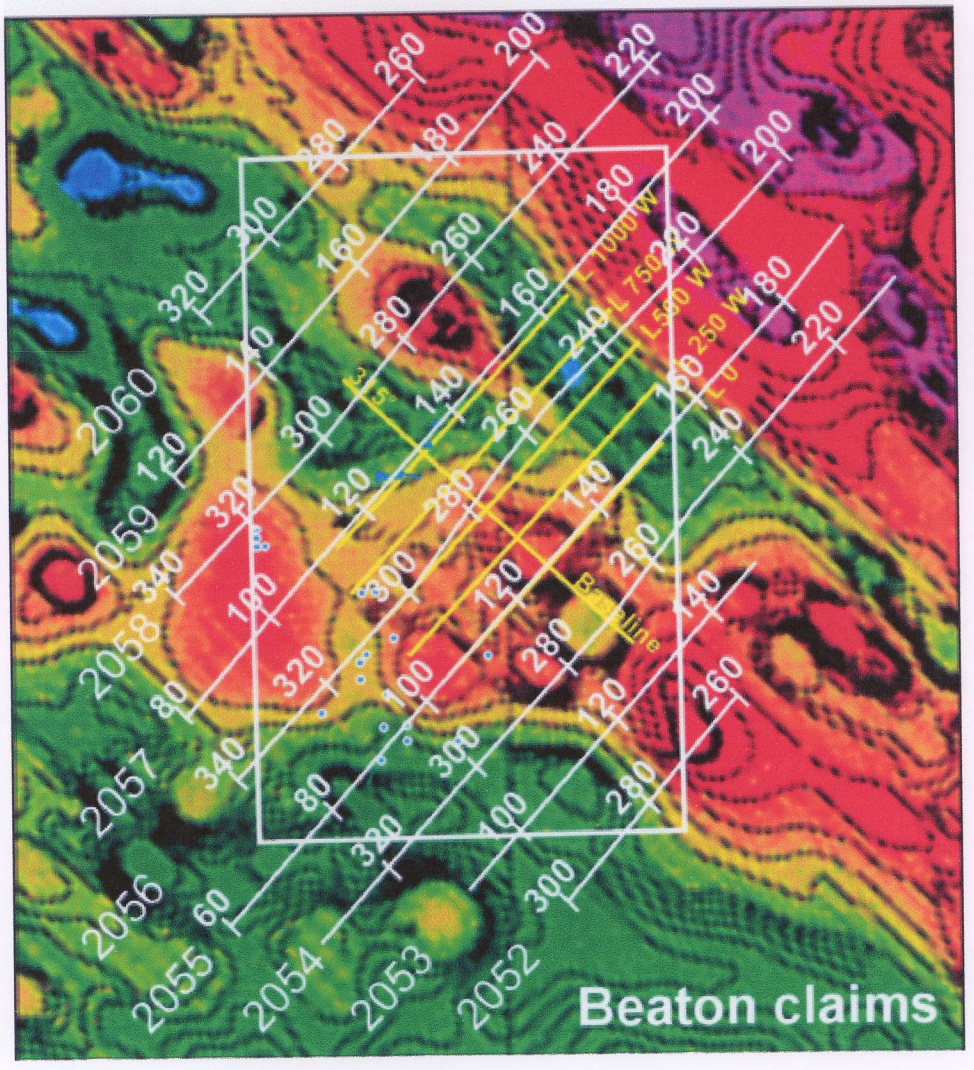


Figure 10
Flight lines with fiducials, Beaton grid, on calculated magnetic vertical gradient.

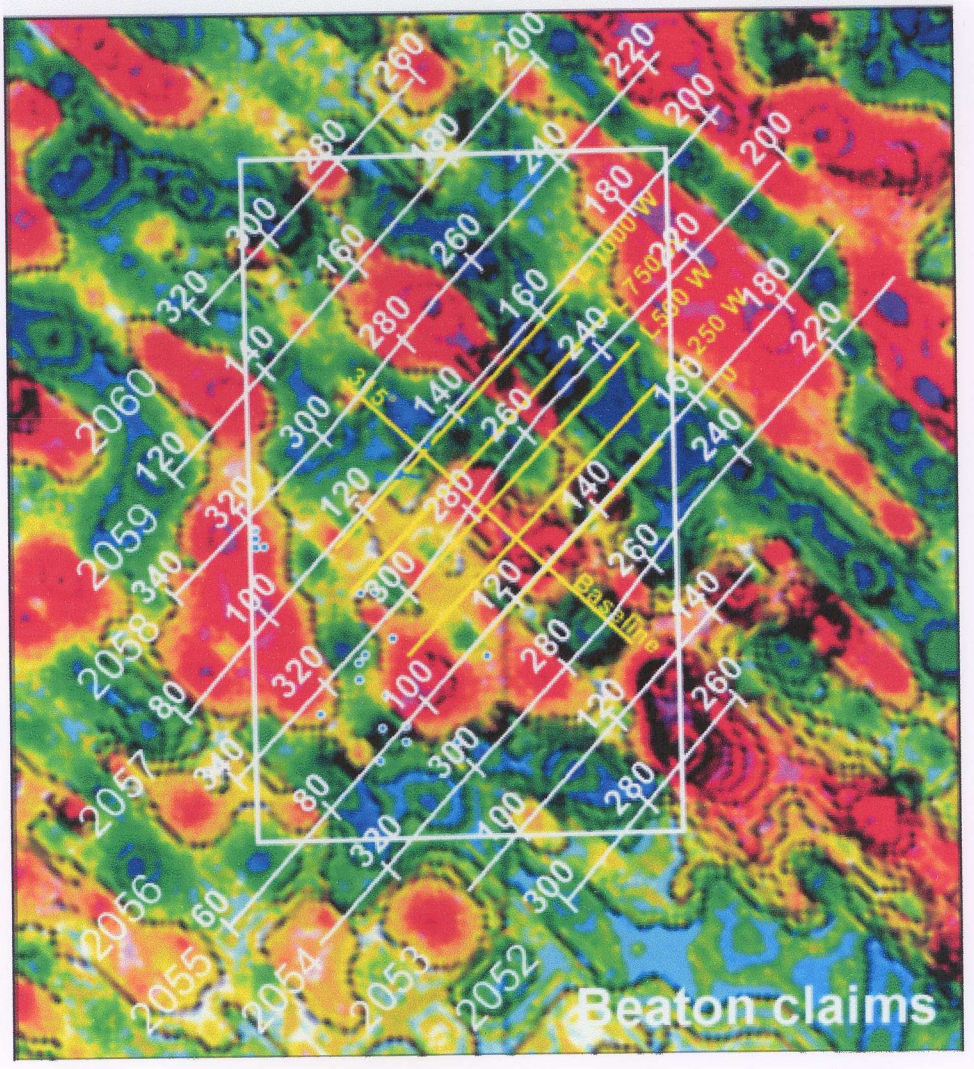


Figure 11.
Stacked profiles, Beaton Claim area. Refer to flight line, fiducial maps, above.
Grey shaded areas indicate flight line segment shown on above images; yellow lines indicate "targets" based on profile data shown.

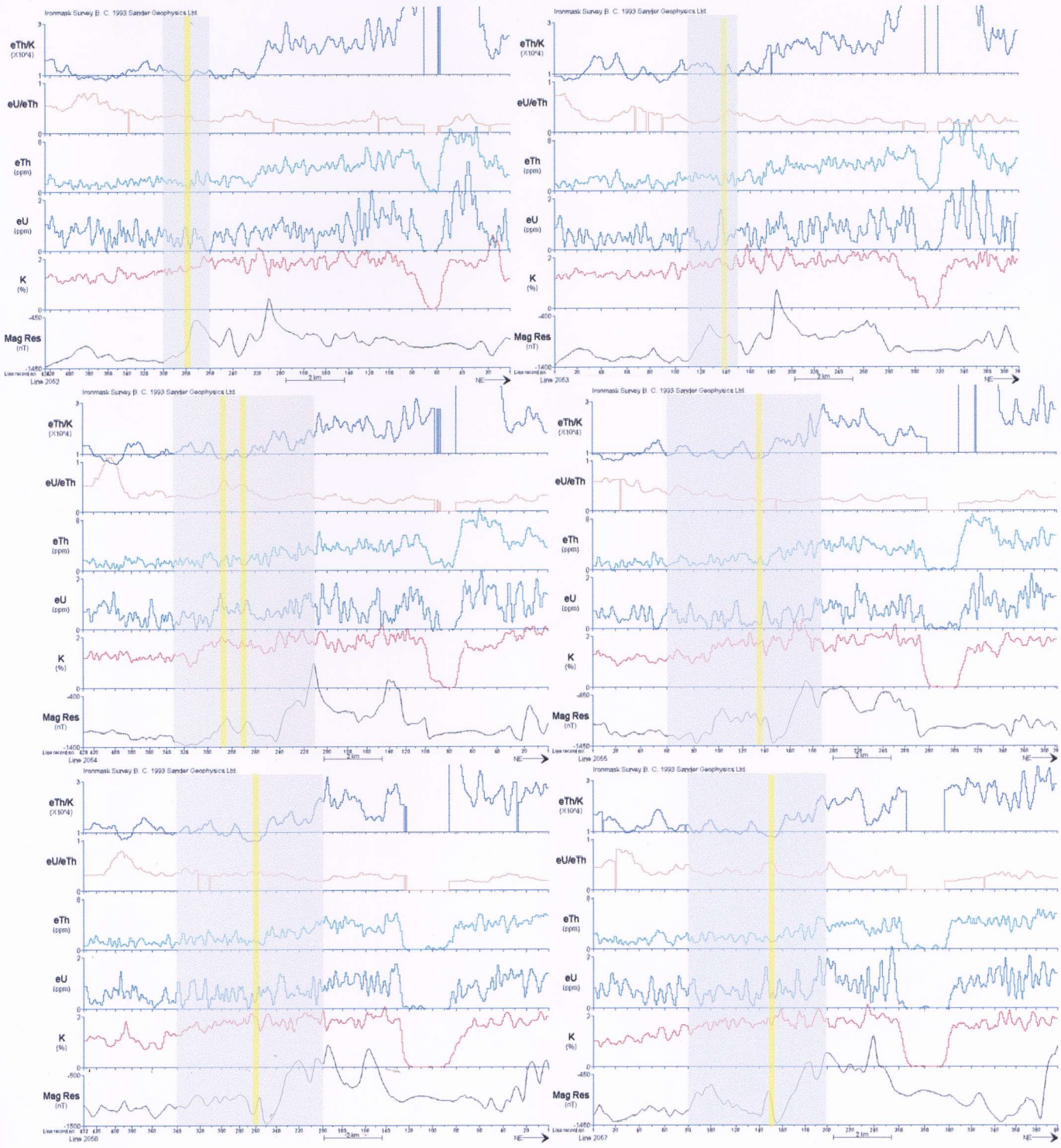


Figure 11 (continued).

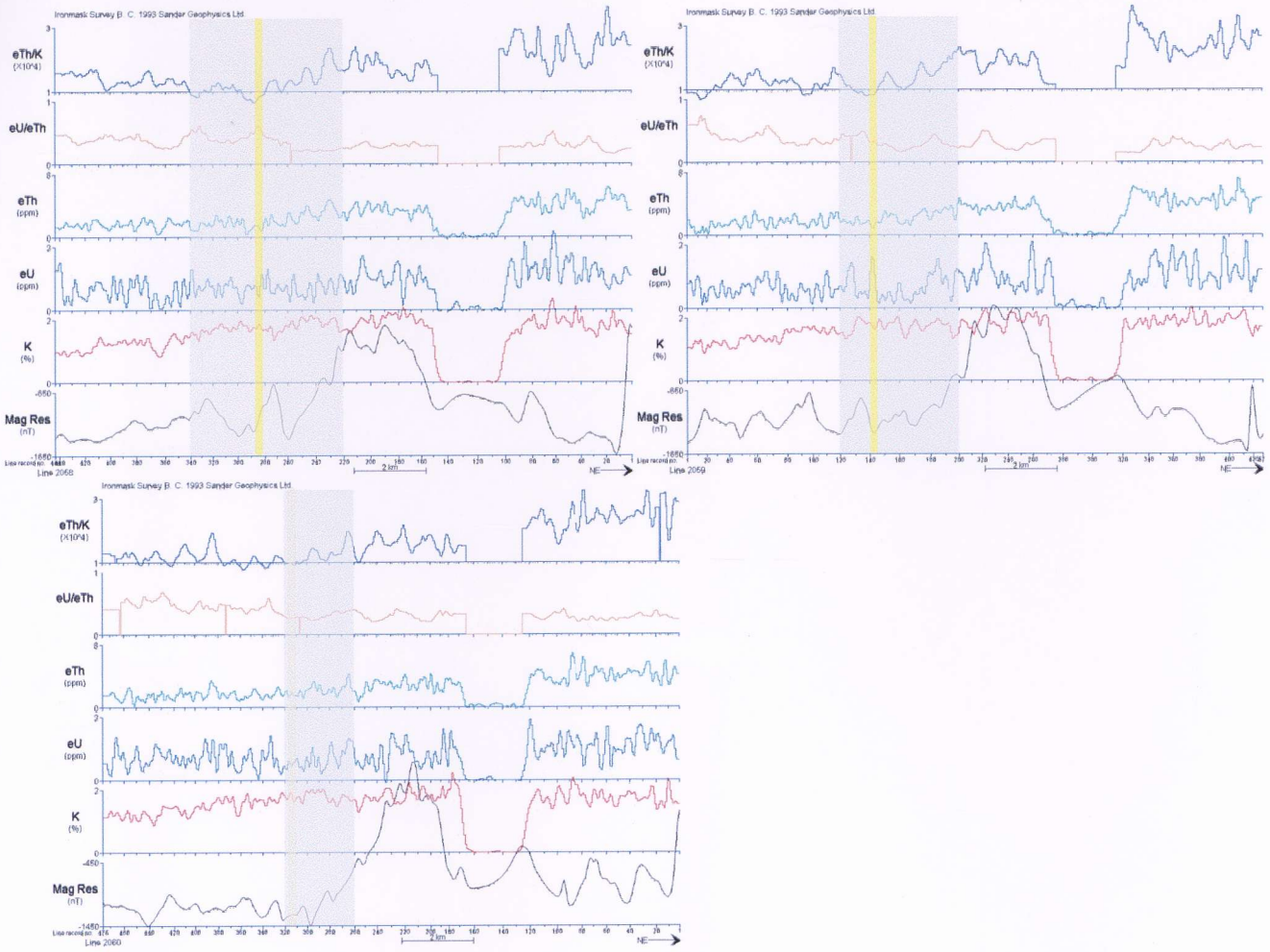
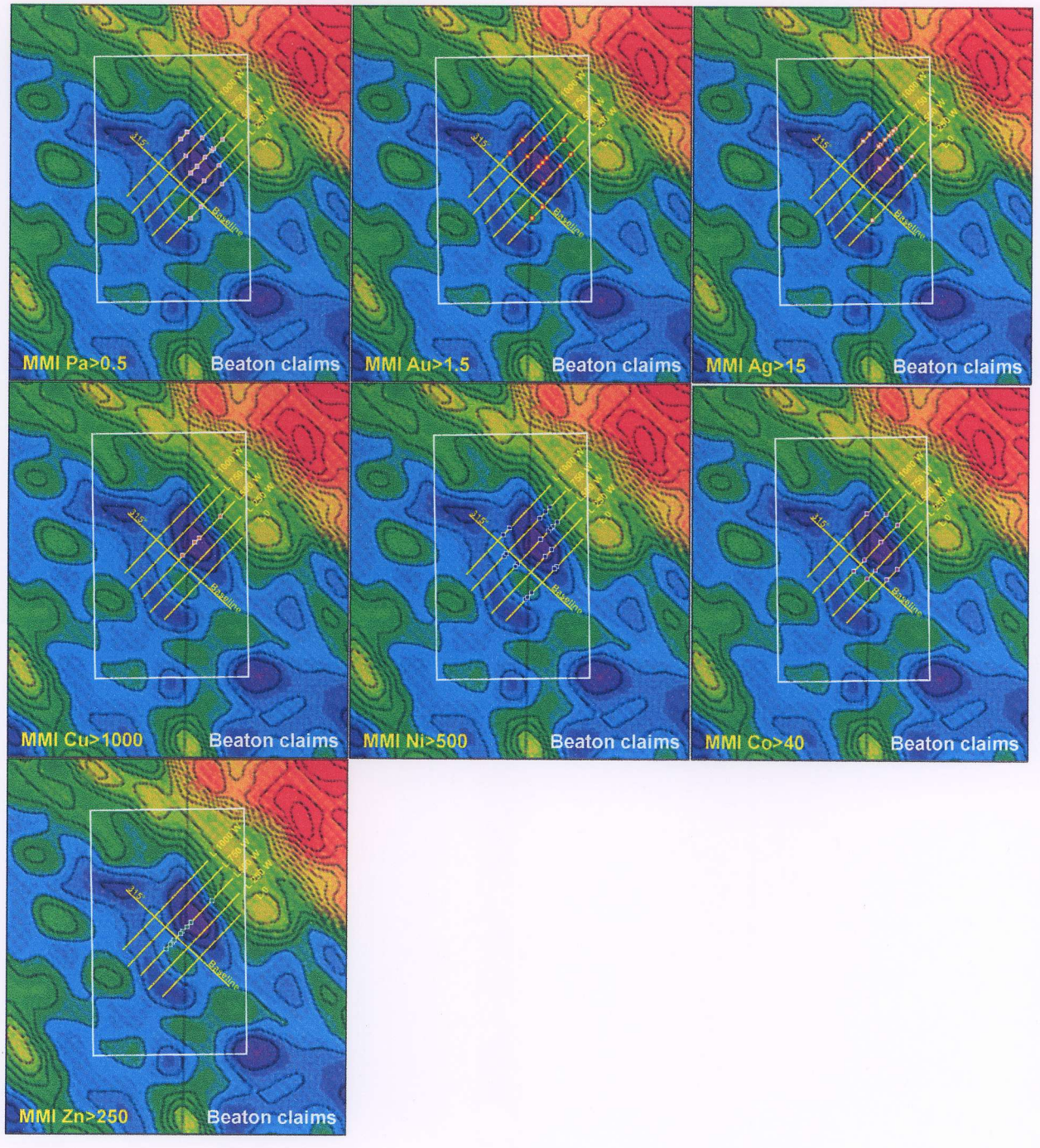


Figure 12.

MMI results (thresholds indicated) on equivalent thorium/potassium



Brunswick Mineral Development Agreement; conducted ground spectrometer; monitoring of contract surveys; preparation of posters for variety of local and national geological conferences; preliminary VLF interpretation of various surveys; worked with computer programmer to design formats and procedures for digital cartographic layout currently used for publication of GSC spectrometric, magnetic and VLF-EM data.

01/08/84 - 15/12/84 **Consulting Geologist**, for three VSE-listed gold exploration companies, Vancouver; assessment file reviews, compilation and on site property evaluations, sampling, assaying; formal reports to Company Presidents included recommendations for property acquisition and comprehensive phased exploration programs to diamond drilling stages.

01/02/84 - 31/07/84 **Senior Geologist**, Goldsil Mining and Milling Inc., and Burrill Exploration Ltd., Saskatoon, Saskatchewan; designed, budgeted, executed highly successful winter drilling and summer mapping-prospecting-soil sampling exploration programs on five large Joint Venture properties within the La Ronge gold belt, Saskatchewan; includes discoveries of significant gold mineralization successfully mined at Mallard Lake, new occurrences near Waddy Lake and increased grade-tonnage estimates at Tower Lake; submitted proposals, reports directly to company president and senior Joint Venture partners; constructed useful three dimensional model of the Tower Lake Deposit.

15/05/83 - 15/09/83 **Project Geologist**, Asamera Inc., Calgary, Alberta; designed, executed 3 month gold exploration program on 4000 acre property near Dryden, Ontario, involving supervision of 8 man crew (mag, VLF, bio- and lithogeochemical sampling, detailed and reconnaissance mapping and design/supervision of follow up diamond drilling program; final report to Manager, Minerals Canada and Joint Venture partner.

07/01/80 - 14/5/83 **Drill Geologist** and **Supervisory Geologist**, Asamera Inc., Saskatoon, Saskatchewan; drill supervision, drill core logging, borehole logging, on major uranium property in Northern Saskatchewan (Athabasca basin); responsibilities expanded following promotion to include supervision of over 30 persons, including several drill geologists, line cutters, drillers, staff and contract geotechnicians and geophysicists, during very active, multi-million dollar programs; reported weekly, monthly, annually to Saskatoon and Calgary offices; designed, supervised, reported on several reconnaissance drilling programs; conceived, conducted various borehole gamma ray logging tests in model boreholes and company drill holes, to provide reliable correction factors for in-situ uranium assays in extremely high grade zones.

Fall, 1979 **Contract Geologist**, 2 months, Agnes and Jennie Mining Co. Ltd., Vancouver; geological mapping, percussion drill supervision, Sharbot Lake U-pegmatites, Ontario.

1977, 1978, 1979 **Student Assistant**, 3 summers, Geological Survey of Canada, Ottawa; office and field duties related to aeromagnetic and airborne gamma ray spectrometric surveys in several localities throughout Canada.

Associations

Fellow: Geological Association of Canada
Member: Canadian Geophysical Union
Mineral Deposits Division of Geological Association of Canada
Prospectors and Developers Association of Canada
British Columbia and Yukon Chamber of Mines

Publications

- over 60 formal talk and poster presentations describing specific application case histories; course notes and manuals for over a dozen workshops; hundreds of Geological Survey of Canada G-Series and Open File maps related to over 50 multisensor (gamma ray spectrometric/magnetic/VF-EM/electromagnetic) airborne surveys. Numerous unpublished reports to private sectors companies through collaborative studies and projects have also been submitted. A list of publications will be provided on request.