Geoscience BC Report 2007-7

Final Report on Results of the Cordilleran Geochemistry Project:

A Comparative Assessment of Soil Geochemical Methods for Detecting Buried Mineral Deposits – 3Ts Au-Ag Prospect, Central British Columbia

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EXECUTIVE SUMMARY

Effective mineral exploration in the Nechako Plateau and adjoining regions of central British Columbia has been hindered for many years by thick forest cover, an extensive blanket of till and other glacial deposits and, locally, widespread Tertiary basalt cover. This report describes methods and results of a multimedia geochemical orientation survey conducted during June and July 2005 over the 3Ts epithermal Au-Ag prospect in the Interior Plateau region. This project, funded by Geoscience BC, investigates the surficial geochemical response in soils and Quaternary materials of epithermal Au-Ag mineralization at 3Ts. This region is highly prospective for the discovery of epithermal Au deposits, among other mineral deposit types, and the low-sulphidation 3Ts prospect is one of the more significant examples in central BC of this type.

The objective of this project is to determine and recommend the most effective field and laboratory geochemical methods for property-scale evaluation of buried mineral targets in drift-covered terrain, by 1) evaluating the most suitable soil media and horizons for field sampling, and 2) evaluating and comparing commercially available analytical methods. No similar publicly available comparative geochemical methodology studies have been conducted in the western Cordillera, and it is this vacuum that the project attempts to fill. This project also complements the parallel Geoscience BC research project on the effective use of halogen geochemistry of soils and vegetation for exploration (Dunn et al., 2006a, b).

New and intercomparable soil geochemical data are provided to help in answering exploration geochemical questions in this region. Brunisolic Bm horizon soils are commonly developed around the 3Ts property, primarily in basal and colluviated tills, which are the dominant glacial parent material in the area. They are also developed in rubbly near-bedrock colluvium, stabilized colluvium and minor glaciofluvial outwash sediments, underlining the importance of the proper identification of Quaternary deposits in interpreting source directions of any anomalous geochemical patterns. The mineral and organic soils sampled as part of this orientation study were analyzed for Au and other elements using a wide spectrum of commercially available analytical techniques. Inorganic analytical methods included total Au determinations (fire assay), near-total to partial determinations (aqua regia digestion) and several types of selective extractions (Enzyme Leach^{SM}, Mobile Metal Ion^{SM} and Na-Pyrophosphate leach), all employing an ICP-MS finish. Two less conventional techniques employing organic compounds in soils (Soil Gas Hydrocarbons^{SM} and Soil Desorption Pyrolysis^{SM}) were also tested. The B horizon soils were the object of all analytical techniques compared, with the exception of C horizon tills (aqua regia–ICP-MS and Au by fire assay) and Na-Pyrophosphate leach of humus.

Project objectives are, in part, to ascertain which of those partial and selective extraction methods undertaken here 1) delineate the presence of mineralization and 2) provide the greatest levels of geochemical contrast, over each of the Tommy and Ted veins at the 3Ts prospect. Project deliverables are the answers to the following questions:

- What are the most appropriate field sampling, preparation and analytical techniques for epithermal Au deposit exploration in this environment?
- Where and what should be sampled?
- Which analytical methods reflect the presence of buried Au mineralization and which do not?
- Which of the methods provide the greatest and most optimal geochemical contrast for property-scale exploration?

Answering these questions will assist mineral exploration companies in conducting more effective geochemical exploration programs for blind targets, thereby increasing the likelihood of discovery. Specific field sampling and analytical recommendations are provided for conducting the most effective property-scale geochemical surveys for similar epithermal gold deposits in the British Columbia Interior Plateau.

Most of the total, near-total to partial, and selective extraction analytical methods tested were successful, to varying extents, in highlighting the presence of Au mineralization at one or both of the mineralized quartz veins on the 3Ts property. Total and near-total to partial Au responses in soil and till by both aqua regia and fire assay methods are similar, with both methods returning substantially similar Au concentrations of 200 to 250 ppb in B horizon soils sampled above the Tommy vein. Both aqua regia (AR) and fire assay (FA) methods were similarly successful in highlighting the location of the Ted vein in both B horizon soils and tills. With maximum Au concentrations of just over 40 ppb in B horizon soils by AR, the absolute magnitude of Ted vein Au results, however, is lower than those reported from the Tommy vein.

Results suggest that, for property-scale geochemical exploration, B horizon mineral soils and LFH horizon organic-rich humus offer similar levels of geochemical contrast for AR-digestible Au and Ag, with the B horizon soils offering a slightly superior contrast overall. Geochemical results vary slightly from vein to vein with variations in primary mineralogy, topography and surficial cover. In general, AR-digestible Au and Ag results at the Tommy vein show slightly greater geochemical contrast, as measured by response ratios, than those at the Ted vein. At the Tommy vein, Au response ratios for B horizon soil and humus over the vein are almost identical. Elevated values of Ag in humus provide a larger geochemical footprint, but Ag in the B horizon soils offers a slightly better anomaly contrast over the mineralization. Rubbly B horizon soils and LFH humus are developed directly over subcropping and outcropping quartz vein mineralization at the Tommy vein, and probably incorporate a significant component of near-residual mineralized fragments. Neither basal nor colluviated till is preserved directly over the vein; however, elevated values of Au and Ag in till immediately to the east are tentatively interpreted to represent, at least in part, glacially transported material that is locally derived from the Tommy vein. The location of the Tommy vein is also outlined by elevated levels of several base metals determined by AR digestion–ICP-MS in B horizon soil.

Concentrations of AR-digestible base metals, such as Zn, are even greater in B horizon soils overlying the Ted vein, which is reported to contain greater primary base metal concentrations than the Tommy vein. Surficial cover is more complex on the Ted orientation line. Localized glaciofluvial outwash sediments and more widespread stabilized near-surface colluvium are present in addition to basal and colluviated tills. As with the Tommy vein, B horizon mineral soils provide the best overall anomaly contrast for property-scale geochemical exploration. Gold and silver in humus, B horizon soil and till all reflect to varying degrees the presence of precious metal mineralization at the Ted vein, although the magnitudes of the geochemical responses are slightly less than those reported for the Tommy vein. In addition, highly elevated Au and Ag concentrations are present in both B horizon soil and C horizon till both above and down-ice from the vein.

Given the extensive historical use of B horizon soils in geochemical exploration in British Columbia, an assessment of the results of selective extraction procedures using these near-surface soils is a major part of this study. A comparison of response ratios for elements determined by aqua regia (AR), Enzyme Leach^{SM} (EL) and Mobile Metal Ion^{SM} (MMI) methods suggest that for many elements, particularly the base metals, EL and MMI provide superior levels of geochemical contrast over known Au mineralization at the Tommy and Ted veins. Mobile Metal Ion results showed positive responses for Au as well as several relevant base metals such as Zn, Pb and Cd in near-surface soils over both the Tommy vein and the Ted vein. Furthermore, MMI results displayed a good geochemical contrast relative to several other analytical methods in spite of field site variations inherent in the recommended 'fixed depth' sampling procedure. Although MMI Au concentrations in the study area are of a low magnitude, Au response ratios are 23 to 24 times line background over both the Tommy vein mineralization and a central anomaly of unknown origin. Similar results are reported from the Ted vein, where a Au response ratio of almost 75 times line background is superior to that for all other methods, including aqua regia. In the case of Ag, there was no anomalous response at the Tommy vein; however, a strong Ag MMI response ratio at the Ted vein (~23 times line median) is superior to that reported by all other methods, including aqua regia.

Contrast ratios indicate that precious metals response by EL is less effective relative to other inorganic analytical methods, since this leach extracts only minor amounts of Au and Ag and relies more heavily here on strong responses from pathfinder elements such as As and Sb. For example, the Au response in the Tommy vein soils, while present, is subdued relative to response ratios of other methods. There is no significant Au response at the Ted vein, and at neither vein does EL Ag in soil exceed analytical detection limits. Enzyme Leach results here are much stronger for a number of important base metals and precious metal pathfinder elements. As measured by calculated response ratios, strong As, Sb, Cu, Pb and Cd responses are present in B horizon soils by EL over the Tommy vein, and strong Sb, Zn, Pb and Cd responses are present over the Ted vein. The relative strengths of base metal responses by selective extractions vary from one element to another. For example, the Zn by MMI response in near-surface soils is superior to that of EL, highlighting all three features along the Tommy transect — the Tommy vein, the central anomaly, and the Larry vein — with response ratios of up to 15 times background values. In the case of the Tommy vein itself, elevated MMI response ratios for Zn are up to 10 times background, and are present at three sites. By way of contrast, poorer although still impressive response ratios of 4 times background and 3 times background occur for EL Zn in soil and AR Zn in soil/humus, respectively, at the Tommy vein. In the case of Pb, both MMI and EL provide strong responses at Tommy vein, with EL response ratios up to 19 times background values, and those by MMI up to 11 times background. In the case of the Ted vein, both EL and MMI results provide substantially similar strong Zn results of 48 to 50 times background levels; however, the strong EL Pb response over the Ted vein, about 15 times background, is not matched by an anomalous MMI Pb response.

Soil Gas Hydrocarbon (SGH) and Soil Desorption Pyrolysis (SDP) studies yielded some positive results at 3Ts. Compound class signature results identified by an in-house evaluation of the B horizon SGH soil data by Activation Laboratories Ltd. identify the locations of known Au mineralization along both the Tommy and Ted transects. On the Tommy line, compound class signature results delineate the locations of the Tommy vein, the central anomaly and the Larry vein, albeit with fairly subtle results of only about 2 to 2.5 times line background values. Compound class signature results are much stronger at the Ted vein, at about 5 times line background at a single soil site over the vein. In the case of SDP results, one compound in particular, C_3H_5F, provides a subtle level of geochemical contrast in B horizon soils over Tommy vein mineralization, with two soil sites showing concentrations that are roughly 2.5 times median levels. Both of the organic compound methods yield 1) relatively poor contrast, particularly for SDP, between results from soils over mineralization compared to those from background areas, and 2) some ambiguity about which organic compounds, or groups of compounds, might be useful for which deposit styles. Anomalous responses for individual compounds, when present over epithermal mineralization, are generally subtle compared to those of either aqua regia or to selective extraction methods such as MMI or EL.

Some key outcomes and recommendations regarding specific field sampling and analytical procedures for conducting effective property-scale geochemical surveys for similar epithermal gold deposits include:

- Near-surface soils are more suitable than tills for detailed geochemical grid sampling at a property scale, in part for reasons of sampling cost but more critically because of their widespread availability. The optimum use of B horizon soils in geochemical surveys, however, is contingent upon samplers being capable of making suitable observations as to the type and origins of parent materials. Although not the focus of this study, till sampling remains the best choice for reconnaissance-level geochemical sampling, producing more comparable geochemical results that are largely unaffected by the pedogenic processes that cause such physical and geochemical variability in near-surface soils.
- Soil geochemical surveys should be considered an important component of property-scale exploration projects in this region.
- Both MMI-M and EL methods offer similarly strong geochemical responses and contrast ratios in near-surface and B horizon soils, respectively, for base metals at 3Ts. These, in some cases, yield geochemical contrast levels that are superior to those of AR digestions. These methods may be suitable substitutes for AR digestion–ICP-MS analyses in areas of concealed mineralization. The same holds true for the SGH and SDP methods using organic compounds, although their background-to-anomaly contrast is more subdued than either MMI or EL. For the near-surface mineralization targeted in this study, however, the AR digestion–ICP-MS multi-element analytical suite provides a more effective combination of 1) suitable geochemical contrast over the Tommy and Ted vein mineralizations and 2) a wide range of reported elements critical to this deposit style, including Au and Ag, precious metal pathfinders such as As and Sb, and relevant base metals such as Zn, Cu, Pb and Cd. In general, the selective extraction analytical suites tested in this project provide most, but not all, of the key elements needed for the detection of epithermal Au-Ag deposits beneath soil and till cover. Some elements are lacking in the selective extraction suites, or if present are at concentrations below stated analytical detection limits; examples include As-Sb (MMI-M suite) and Ag-Au (EL suite). Positive AR results are, however, strongly influenced by the relict lithological signature, in thin soils, of near-surface outcropping and subcropping of resistant quartz veins. The MMI, EL, SGH and SDP methods might prove more useful than AR for detecting more deeply-buried deposits, where such inherited lithological signatures are not present in surface soils. Now that this intermethod comparison is shown to be successful and has been quantified on known, near-surface, epithermal-style mineralization, testing of the technologies needs to be extended to

more deeply buried Au deposits in order to further evaluate their respective usefulness in the Interior Plateau environment of central British Columbia.

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1. INTRODUCTION AND OBJECTIVES

Effective mineral exploration in the Nechako Plateau and adjoining regions of central British Columbia has been hindered for many years by thick forest cover, an extensive blanket of till and other glacial deposits and, locally, widespread Tertiary basalt cover. Where undertaken, regional till and lake sediment geochemical surveys have been effective as reconnaissance exploration techniques. Unfortunately, few publicly-available studies have been conducted in central British Columbia on the use of surficial geochemistry as an aid in prioritizing regional geochemical anomalies, or in carrying out the most effective geochemical surveys at a property scale in areas of exotic cover. In this respect, British Columbia has lagged far behind other provincial and international jurisdictions in undertaking applied geochemical exploration research.

In response to a call from Geoscience BC for geoscience projects to promote resource investment in British Columbia, this project investigates the geochemical response, in soils and Quaternary materials, of a Au-Ag epithermal prospect (3Ts prospect) in central BC (Figure 1). This region is highly prospective for the discovery of epithermal Au deposits, among other mineral deposit types, and the low-sulphidation 3Ts prospect is one of the more significant examples of this type in central BC. The objective of the project is to determine and recommend the most effective field and laboratory geochemical methods for property-scale evaluation of buried mineral targets in drift-covered terrain, by 1) evaluating the most suitable soil media and horizons for field sampling, and 2) evaluating and comparing commercially available analytical methods.

The study comprises an integrated field and laboratory investigation of comparative soil horizons, analytical digestions and selective extraction methods on soils from transects across two of the 3Ts mineralized vein systems, the Tommy vein and the Ted vein. Geochemical analyses were conducted on samples from a range of soil horizons spanning the 3Ts prospect using several commercially available partial and selective extraction methods, including:

- Aqua regia digestion–ICP-MS
- Na-Pyrophosphate leach
- Enzyme Leach^{SM} (EL)
- Mobile Metal Ion^{SM} (MMI)
- Soil Gas Hydrocarbons^{SM} (SGH)
- Soil Desorption Pyrolysis^{SM} (SDP)

This project is envisioned as a smaller, more restricted, Cordilleran analogue of the successful Canadian Mining Industry Research Organization (CAMIRO) ‘Deep Penetrating Geochemistry’ project and its successors. These and similar projects, spearheaded by the Geological Survey of Canada and the Ontario Geological Survey, have provided a wealth of objective data and valuable interpretive results for effective geochemical exploration beneath exotic overburden (e.g.,. Cameron et al., 2004; Bajc, 1998). No similar publicly available comparative geochemical methodology studies have been conducted in the western Cordillera, and it is this vacuum that the project attempts to fill. This project also complements the parallel Geoscience BC research project on the effective use of halogens in soils and vegetation for exploration (Dunn et al., 2006a, b). The 3Ts prospect is one of three mineral deposits of varying types studied for halogen geochemical responses in B horizon soils and vegetation.

Project deliverables are to provide practical recommendations regarding the most appropriate field sampling, preparation and analytical techniques for epithermal Au deposit exploration in this environment. Where and what should be sampled? Which analytical methods reflect the presence of buried mineralization and which do not? Which of the methods provide the greatest and optimal geochemical contrast for property-scale exploration? Answering these questions will assist mineral exploration companies in conducting the most effective geochemical exploration programs for blind targets, thereby increasing the likelihood of discovery. Results of this study will ascertain which of those partial and selective extraction methods undertaken here 1) delineate the presence of mineralization and 2) provide the greatest levels of geochemical contrast, over the Tommy and Ted veins at the 3Ts prospect. Specific field sampling and analytical recommendations are provided for conducting the most effective property-scale geochemical surveys for similar epithermal gold deposits in the British Columbia Interior Plateau.

2. LOCATION, ACCESS AND PHYSIOGRAPHY

The 3Ts Au-Ag prospect is located in the Fawnie Creek map area (NTS 93F/3), about 125 km south of Vanderhoof, in the southern Nechako Plateau region of the Interior Plateau of central British Columbia (Figure 1). The property is reached by following the Kenny Dam Road and then the Kluskus Forestry Road south from Vanderhoof for about 161 km, and then by the Green 9000 Road to the old Tsacha exploration road to the former Teck Corporation campsite. As truck access to the property via the Green 9000 Road is prevented by the recent removal of a bridge, current access is by all-terrain vehicle from the Teck camp site along old exploration roads (Figure 2). Poor access brought about by the removal of the bridge caused a significant increase in the time and expense needed to complete the project.

The prospect is located in the Tommy Lakes region of the Naglico Hills, an area of rolling hills, small lakes and ponds, and minor wetland areas (elevation 1065–1250 m). It is just north of the Blackwater River, which separates the Nechako Plateau to the north from the Fraser Plateau to the south. Quartz veining and associated alteration systems are relatively resistant to weathering and locally form small but prominent ridges between Tommy Lake to the north and Adrian Lake to the east. Lodgepole pine (*Pinus contorta*) and white spruce (*Picea glauca*) are the most common trees on the property (Figure 3). They were the object, in part, of the parallel halogen geochemistry study of Dunn et al. (2006a, b). Aspen (*Populus tremuloides*) is also locally present. The dominant lodgepole pine in the study area has, as elsewhere in central British Columbia, been affected by the recent mountain pine beetle (MPB) infestation.

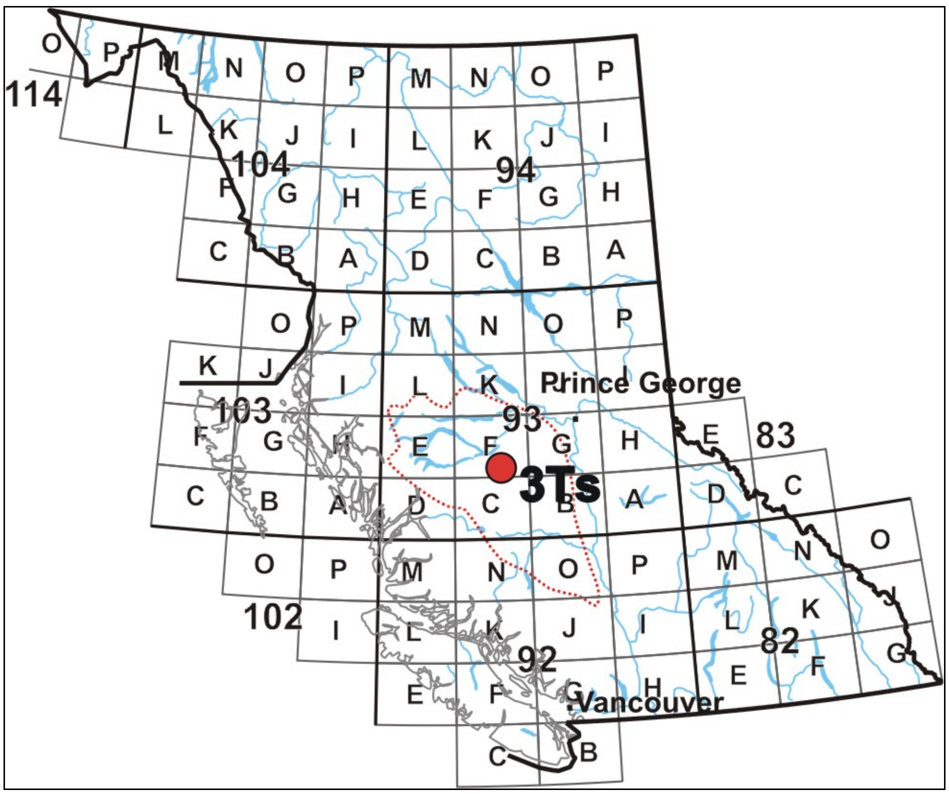


Figure 1. *Location of the 3Ts epithermal Au-Ag prospect and the Cordilleran Geochemistry Project study site in the southern Nechako Plateau area of central British Columbia.*

Figure 2. *South-facing view toward 3Ts Au-Ag project area, showing the Little Adrian Lake drainage and the effects of mountain pine beetle damage on lodgepole pine trees, June 2005.*

Figure 3. *Typical lodgepole pine and white spruce forest and ubiquitous thick surface moss cover at 3Ts property, eastern portion of Ted vein geochemical orientation line (site 570) near Adrian Lake, July 2005.*

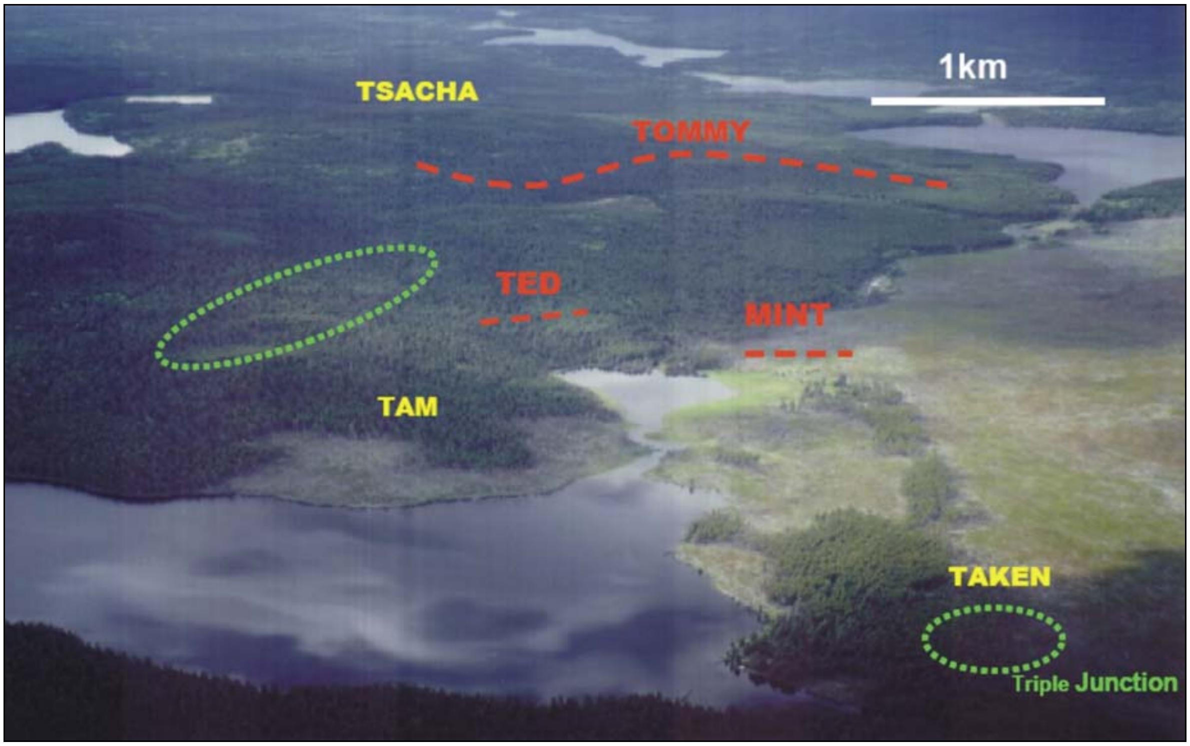


Figure 4. *Westward view of the 3Ts property from the air, showing locations of the Tommy, Ted and Mint veins. Dotted green lines outline the locations of areas of mineralized boulders (Figure 10). The large lake in the foreground is Adrian Lake. Photo taken in 1995 and modified after Southern Rio Resources Ltd., May 2003.*

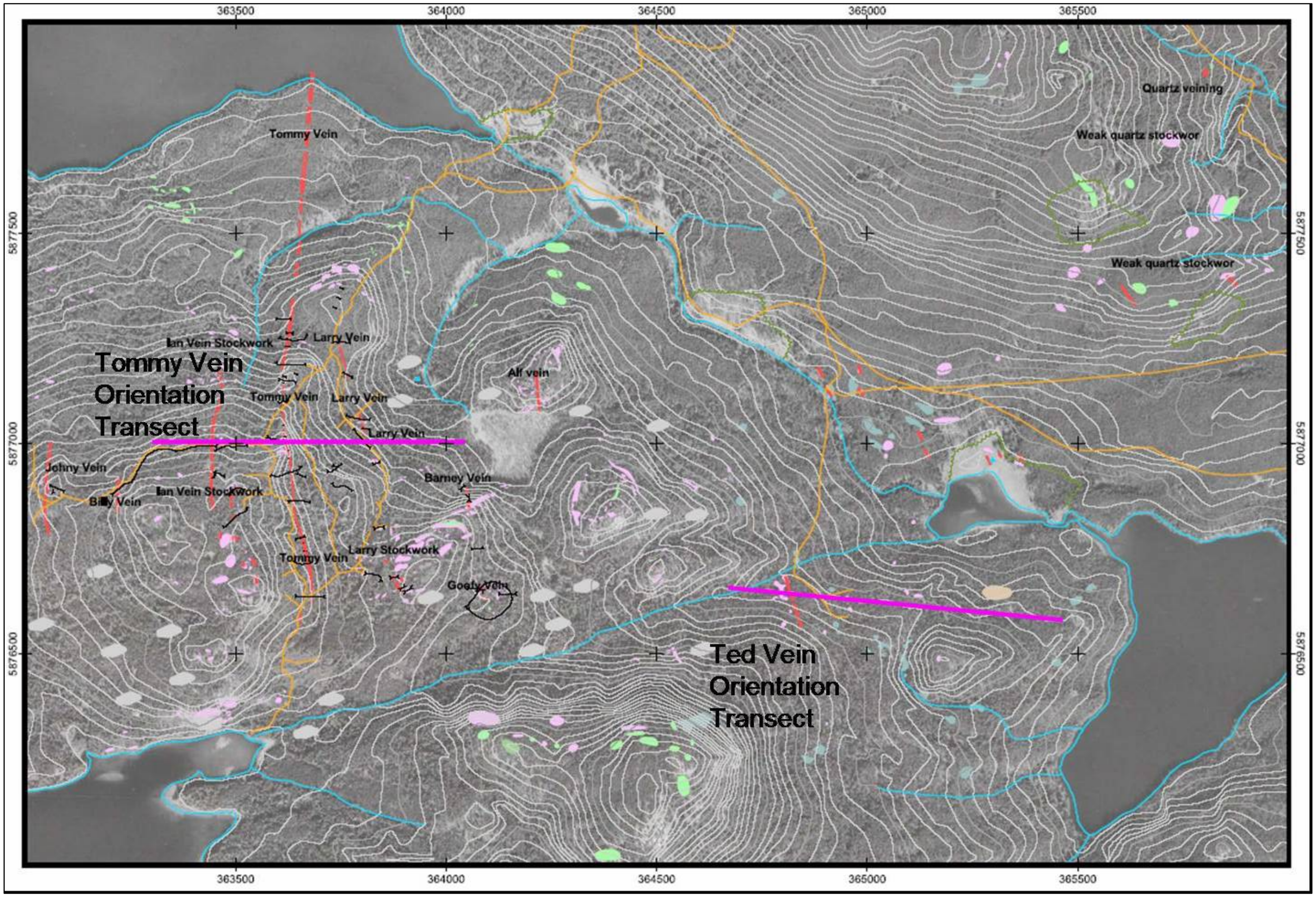


Figure 5. *Air photo compilation of part of the 3Ts Au-Ag property, showing locations of 2005 orientation transects across the Tommy and Ted veins. British Columbia Ministry of Environment airphoto taken in 1975, prior to the onset of logging. GIS compilation by W. Jackaman, using data from D. Pawliuk, Southern Rio Resources Ltd.*

3. BEDROCK GEOLOGY AND MINERAL DEPOSITS

a) Exploration History

The original Tommy vein discovery in what is now the 3Ts project area was staked in early 1994 by Teck Corporation as the Tsacha property (MINFILE 093F 055) following the release of the British Columbia Geological Survey surface rock geochemical data (up to 3.7 g/t gold and 41.8 g/t silver) by Diakow et al. (1994). A bedrock mapping party had discovered an auriferous quartz vein system outcropping on hummocky moss-covered rock knobs in the Tommy Lakes area (Figure 4), and released the gold results at the Cordilleran Roundup conference in Vancouver in January 1994. Other properties staked included the Taken property (MINFILE 093F 068). Release of regional lake sediment geochemical data (Figure 6) for the southern Nechako area during the summer of 1994 (Cook and Jackaman, 1994) helped bring about additional staking in the area. Initial surface sampling across the Tommy vein by Teck returned assays of up to 61.9 g/t gold and 292.5 g/t silver (Pautler, 1995). Exploration of the Tsacha (Teck) and Tam/Taken (Phelps-Dodge) properties during the period of 1994 to 1999 expanded the known mineralized vein system to include several additional veins, including the Ted vein. During this period, 81 holes totalling more than 16 000 m were drilled on the Tsacha property, primarily on the Tommy vein. The inferred resource on the Tsacha property is 470 700 tonnes at 7.4 g/t gold and 65.2 g/t silver, based on a 4 g/t gold cut-off grade (Wallis and Fier, 2002).

After a period of inactivity, Southern Rio Resources (now Silver Quest Resources) restaked the adjacent Tam property in 2001, optioned the Tsacha and Taken properties from Teck-Cominco and Phelps-Dodge, respectively, in 2002 and consolidated the claim groups (~34 km^2) as the 3Ts project. Recent work by Southern Rio has included the continued drilling of the Tommy, Ted and Larry veins, and the discovery of several areas of mineralized boulders.

b) Regional and Property Bedrock Geology

Regional geology of the southern Nechako Plateau was first mapped by Tipper (1963) and more recently by Diakow et al. (1994, 1995) and Diakow and Levson (1997). This part of the Stikine Terrane is dominated by volcanic and sedimentary units of the Lower to Middle Jurassic Hazelton Group. These are intruded by the Late Jurassic Capoose Batholith to the north, and locally overlain by Eocene volcanic units of the Ootsa Lake Group. Miocene–Pliocene Chilcotin Group basalt flows are present in low-lying areas to the south, obscuring the presence of older, more prospective, rock units.

Property-scale mapping was carried out by Pautler et al. (1999). Hazelton Group rocks hosting epithermal quartz vein mineralization in the Tsacha and Tam property areas are characterized by rhyolite ash-flow tuff and lapilli tuff of the Entiako Formation. Of these, the dominant host unit is a maroon quartz-phyric lapilli tuff approximately 400 m thick. Late Cretaceous felsite sills and a Middle Jurassic augite porphyry plug are exposed to the south of the 3Ts vein system. Lane and Schroeter (1997) reported a preliminary U-Pb zircon date of 73.8 ±2.9 Ma for the biotite-phyric felsite sill which intrudes the Tommy vein. Cretaceous fine-grained diorite sills and dykes are exposed to the north of the vein system near the south side of Tommy Lake. One of these, a shallowly dipping sill, which is likely analogous to felsites mapped to the south, is approximately 100 to 150 m thick and cuts the Tommy and Ted veins at depth. Smaller dykes and sills <5 m in thickness are also commonly observed in drillcore (Rhys, 2003; Pawliuk, 2005).

c) Epithermal Gold-Silver Mineralization

The 3Ts gold-silver prospect is a low-sulphidation epithermal gold-silver prospect, which comprises the former Tsacha (MINFILE 093F 055) and Tam/Taken (MINFILE 093F 068) showings. Epithermal precious metal deposits in central British Columbia have been classified as being hosted by either 1) Eocene or younger age rocks, primarily felsic volcanics of the Ootsa Lake Group, such as the Wolf (MINFILE 093F 045) or Clisbako (MINFILE 093C 016) prospects, or 2) older Lower to Middle Jurassic Hazelton volcanics (Lane and Schroeter, 1997). The 3Ts vein mineralization is Late Jurassic in age and belongs to the latter, less well-known, group of older epithermal gold deposits. Argon-argon dating of

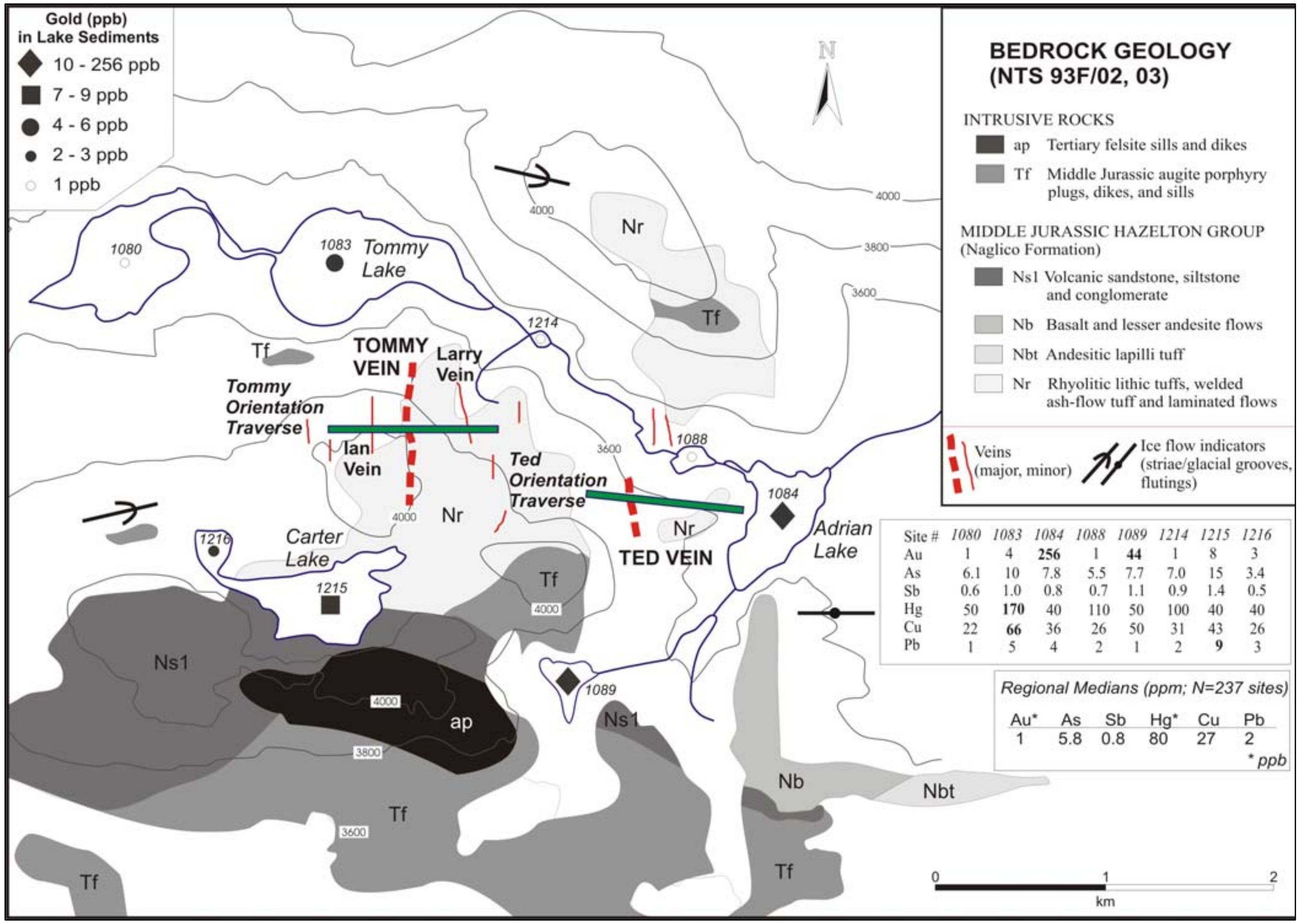


Figure 6. *Bedrock geology of the 3Ts epithermal gold-silver prospect area, southern Nechako Plateau (NTS 93F/2, 3), showing locations of mineralized veins and 2005 soil orientation traverses over the Tommy and Ted veins. Regional geology after Diakow et al. (1994, 1995). Regional lake sediment geochemical data showing elevated gold concentrations (regional median: 1 ppb) around 3Ts vein system from Cook and Jackaman (1994). Glacial striae and flutings from Levson and Giles (1994) and Giles and Levson (1995). Refer to Rhys (2003) for all names of minor veins. Diagram modified from Cook and McConnell (2001).*

potassium feldspar from the altered margin of the Tommy vein at The University of British Columbia returned a Late Jurassic age of 144.7 ±1.0 Ma (Bottomer, 2003a), similar to that of the Capoose intrusive event.

The Tommy and Ted veins are the best explored of the at least nine parallel veins and stockworks that make up the 3Ts quartz veins system (Figures 5 and 6). These, which also include the Larry, Johnny, Ian, Bobby, Barney, Goofy and Alf veins (Tsacha property) and the Mint vein (Tam property), occur over an approximately 2 km^2 area within the host felsic tuff of the Entiako Formation. In general, subvertically dipping mineralized quartz-calcite-potassium feldspar veins on the property strike north-northwesterly and exhibit typical epithermal textures including vein breccia fragments, crustiform banding and comb crystal structures consistent with a shallow depth of formation (Pawliuk, 2005). They are associated with potassium feldspar?-quartz-sericite-pyrite alteration haloes of variable thickness. Gold in quartz vein mineralization has also been intersected below the cross-cutting microdiorite sill at both the Tommy and Ted veins, and each remains open at depth beneath this. The Tommy vein is considered to represent a higher level in the hydrothermal system than the Ted vein based on differences in Ag:Au ratio, base metal content and the extent of wallrock alteration (Bottomer, 2003b). The following descriptions are taken from several sources, including Lane and Schroeter (1997), Southern Rio reports (e.g., Pawliuk, 2005) and the structural study of Rhys (2003).

TOMMY VEIN

The Tommy vein, the largest on the property, is located on the Tsacha claim (MINFILE 093F 055) and is a north-northwesterly-striking subvertical quartz-adularia-calcite-potassium feldspar vein. It is up to 8 m wide (with an average width of 4 m) and has a known strike length of about 640 to 700 m (Figure 7). The vein remains open along strike. It exhibits typical epithermal textures such as breccia features, local crustiform banding, comb crystal structures and drusy cavities, and is cut by a microdiorite sill at an average depth of about 120 m (Figure 8). The Tommy vein has also been traced below the sill, and an 11.3 m drill intersection at 280 m vertical depth returned 8.83 g/t gold and 62.6 g/t silver.

The vein shows some local relief (Figure 7 and Figure 9). It consists of massive clear to milky-white crystalline quartz and subordinate calcite with locally developed colloform bands of pale grey chalcedony, adularia and rare amethyst (Lane and Schroeter, 1997), as well as potassium feldspar (Rhys, 2003). Precious metal mineralization occurs as fine-grained disseminations in colloform banding and bladed veins. Massive vein mineralization is typically flanked by quartz stringers, stockwork or breccia zones. It is of the low sulphidation type and contains less than 1% metallic minerals including chalcopyrite, pyrite, stephanite, argentite, galena, native gold (±electrum) and specularite. Hematite and malachite are minor constituents. The silver:gold ratio in the vein varies in the range <1 to 50, with a mean of about 10.

Wallrock hydrothermal alteration associated with the Tommy vein is patchy, and clay and sericite alteration is only sporadically and distally developed. Lane and Schroeter (1997) reported narrow and locally intense zones of silicification to be associated with broad zones of weak red-coloured clay alteration associated with hematite. Rhys (2003), however, stated that both the Tommy and the adjacent Larry vein are enveloped by broad zones of pale grey to pink potassium feldspar-quartz-sericite-pyrite alteration extending, in some cases, for up to tens of metres into the felsic volcanic host. Alteration was stated to be widest in the central and southern parts of the Tommy and Larry vein system, and weaker in the north. In addition to these, a large (~1000 m × 300–500 m) potassium feldspar?-quartz-sericite-pyrite alteration zone has been mapped within the host rhyolite tuff to the west of the Tommy vein (Rhys, 2003).

The Larry vein, about 200 m east of the Tommy vein (Figure 10), was traversed by the same Tommy geochemical orientation line during this study, as was the Ian vein system to the west. The Larry vein has been traced 590 m along strike and 100 to 200 m downdip, and is open in all directions. No resource estimate has been completed. Rhys (2003) noted that the Larry stockwork more closely resembled a sheeted vein system than a true stockwork.

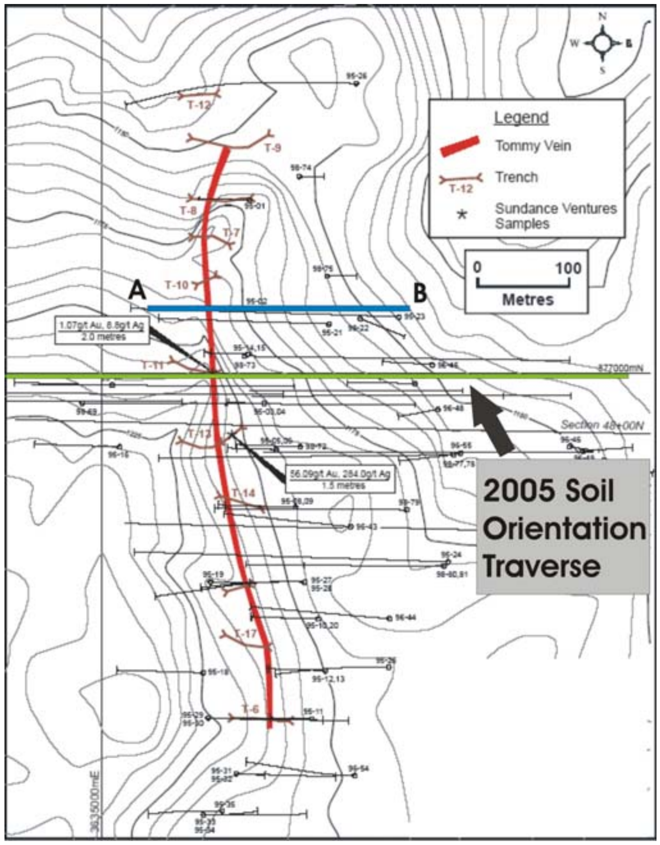


Figure 7. *Surface trace of Tommy vein showing drillhole locations and cross-section location (A-B; see Figure 8 below) relative to location of the 2005 soil orientation line, Tsacha Property, 3Ts Au-Ag prospect (modified after Southern Rio Resources, May 2003).*

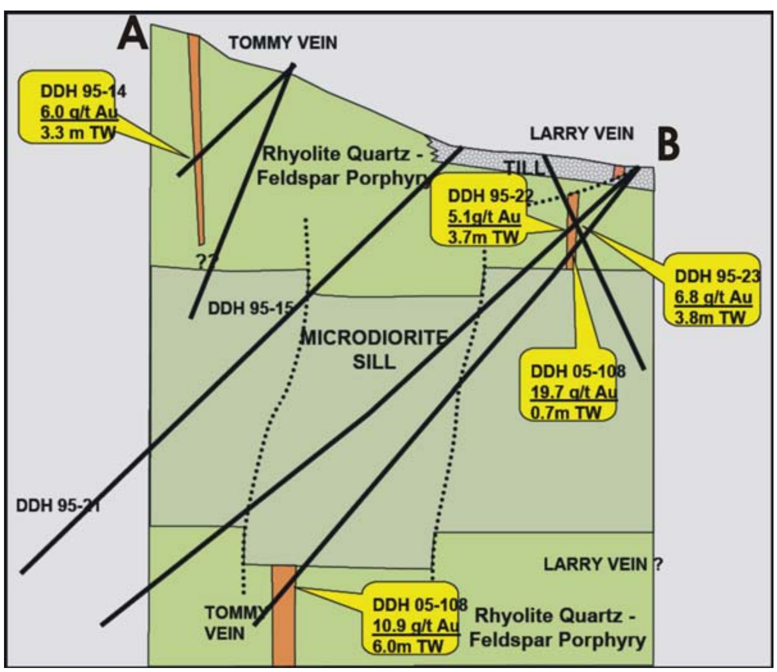


Figure 8. *Schematic cross-section across the Tommy vein, looking to the north (modified from an image on Southern Rio Resources website).*

Figure 9. *View of Tommy vein, showing the sampling of LFH horizon humus (site 591), July 2005.*

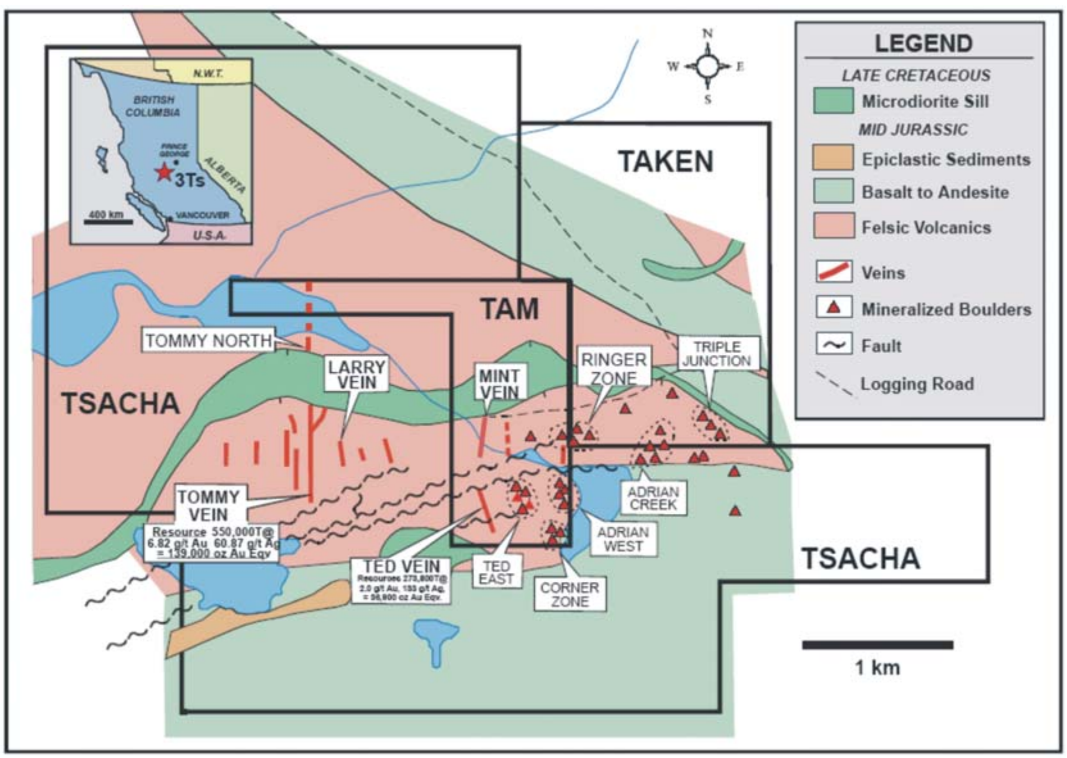


Figure 10. *Schematic diagram showing generalized geology and locations of mineralized vein systems of the 3Ts Au-Ag property. Source: Southern Rio Resources website (2005).*

TED VEIN

Ted vein is located on the Tam claims (MINFILE 093F 068) about 1 km east-southeast of the Tommy vein. It is a similarly north-northwesterly–striking (150°–170°) subvertical quartz-calcite-sulphide vein with epithermal textures. The vein has been traced along strike for at least 300 m (Figure 11) and over an average width of 10 m, and is the widest of the 3Ts veins. It is open along strike both north and south, and to depth (Figure 12). The original Ted vein showing consists of a 50 m wide zone of small outcrops and subcrop of altered rhyolite and quartz stockworks (Figure 13 and Figure 14), one of the veins of which reached 15 m in width. Surface rock samples from this showing were reported to contain 1.5 g/t gold, 82 g/t silver, 0.1% zinc and 0.3% lead (Schimann, 1994). The Ted vein is of the intermediate sulphidation type and may represent a lower level within the hydrothermal system than the Tommy vein on the basis of several factors. These include a higher Ag:Au ratio, higher manganese and base metal contents, greater gangue carbonate component and more extensive wallrock alteration (Bottomer, 2003b; Bottomer, pers. comm., 2005).

Initial drilling of the Ted vein by Phelps-Dodge in 1996 returned a 6.46 m true width intersection of 8.88 g/t gold and 393.6 g/t silver (Fox, 1996). The upper contact of the 70 m thick intrusive sill cutting the Ted vein is at 120 to 140 m in depth, and an above-sill initial inferred resource of 273 800 tonnes at 2.0 g/t gold and 133 g/t silver has been calculated (Wallis and Fier, 2004). More recent drilling (hole TT-04-37) has encountered gold mineralization beneath the sill, at 388.3 to 399.3 m depth, intersecting 11 m (with an estimated true width of 6.5 m) of quartz-carbonate vein returning 3.74 g/t gold and 59.3 g/t silver (Pawliuk, 2005).

The following description of the Ted vein is from Pawliuk (2005) and Rhys (2003). Quartz-calcite veining varies widely in colour from pale grey to creamy white, is finely banded, and exhibits textural evidence for at least three episodes of veining and brecciation. Vein material typically contains 10 to 40% variably silicified fragments of rhyolite porphyry wallrock and about 5 to 10% variably coloured calcite, which occurs as late-stage infilling of brecciated zones and open cavities. Open cavities are reported to form up to 2% of the rock volume. The Ted vein contains approximately 0.5% finely disseminated sulphide minerals, primarily pyrite but also including variable amounts of sphalerite, galena, chalcopyrite, Ag-sulphides, tellurides and sulphosalts, with occasional intervals of semi-massive (10–30%) base-metal–rich sulphides. Early quartz vein fragments within the Ted vein breccias commonly have greater sulphide and sulphosalt? mineral contents than later generations of quartz-calcite infilling. Disseminated red hematite is also locally present within the vein.

High sulphide concentrations are locally present. Pawliuk (2005) reported a 0.45 m drill intersection of deep hole TT-04-37 containing 30% galena and 10% disseminated sulphosalt (?); another galena-bearing vein intersected in the same hole returned 171 g/t silver and 2.27% lead over a narrow 0.43 m wide intersection.

Hydrothermal alteration of the host rhyolite tuff at the Ted vein is similar to that at Tommy. Pervasive silicification and potassium feldspar-quartz±pyrite alteration, grades outwards from the vein to pale bleached alteration (Rhys, 2003).

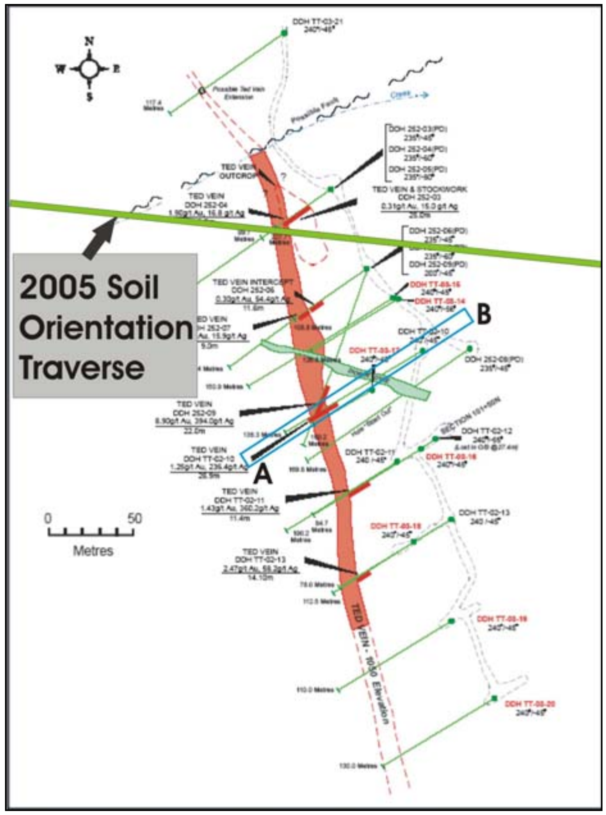


Figure 11. *Surface trace of Ted vein, showing drillhole locations, cross-section (A-B, below) and 2005 soil orientation line, Tam Property, 3Ts Au Project (modified after Southern Rio Resources, May 2003)*

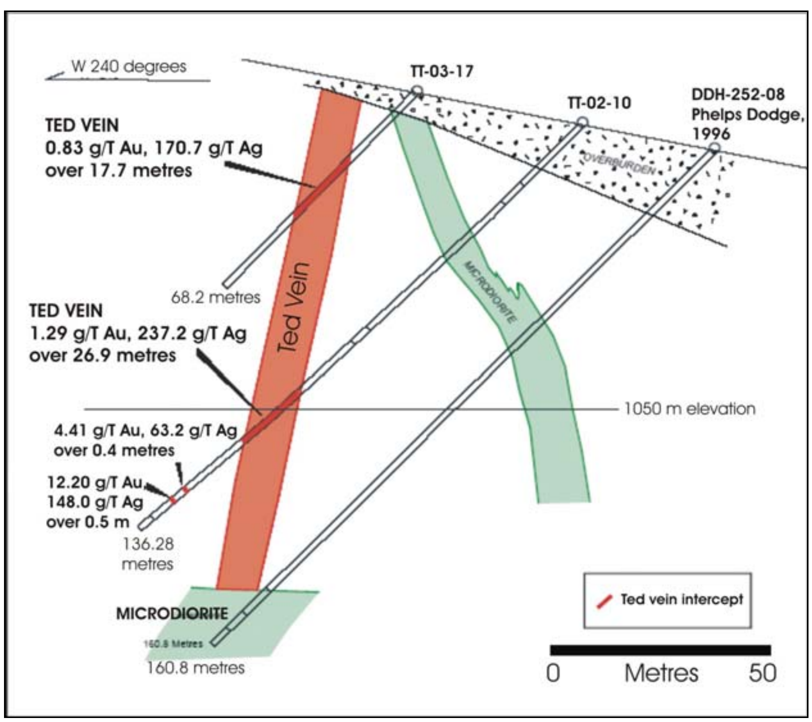


Figure 12. *Schematic cross-section across the Ted vein, Tam Property, 3Ts Project, looking toward the northwest (modified after Southern Rio Resources, May 2003).*

Figure 13. *View of moss-covered outcropping of Ted vein along an exploration road on the 3Ts property, July 2005. The Ted orientation line crosses the vein at this point.*

Figure 14. *Sampling site just downslope of the Ted vein (site 559), July 2005.*

4. SURFICIAL GEOLOGY AND SOILS

a) Regional Surficial Geology and Quaternary History

Surficial geology of the adjacent Fawnie Creek and Tsacha Lake map areas (NTS 093F/02, 03) was mapped by Levson and Giles (1994) and Giles and Levson (1995), respectively. The sediments comprise mainly basal till with subordinate colluvial and glaciofluvial deposits. The entire region was ice-covered during the Late Wisconsinan glacial maximum, and ice flow studies indicate that the dominant glacial direction was to the east-northeast (Giles and Levson, 1994a). Mapped surficial cover at the 3Ts area is mainly thin till veneer <1 m thick, and thin colluvial veneer <1 m thick over discontinuous bedrock. Till veneer predominates in the area around the Tommy vein, while colluvium and adjacent areas of till blanket were mapped near Adrian Lake in the area of the Ted vein (Levson and Giles, 1994). A drift prospecting potential map of the Fawnie Creek map area (Giles and Levson, 1994b) highlighted the 3Ts area, among others, as having a high to very high potential for the use of near-surface geochemical methods in tracing surficial sediment back to its bedrock source. Localized areas of exotic glaciofluvial sands and gravels are restricted to small stream valleys between the lakes. Small Holocene organic wetland deposits occur in a few areas of lower relief. No systematic property-scale Quaternary mapping or section interpretation was attempted as part of this study, but profiling of sample pits at the field site generally confirms, at a property scale, the regional mapping results of Levson and Giles (1994).

b) Till and Soil Development

TILL AND OTHER PARENT MATERIALS

Till is present at most Tommy transect soil profile sites, other than over the relatively weathering-resistant Tommy vein. These occur as both basal and colluviated tills. Basal tills (Figure 15) are typically grey, overconsolidated, locally sandy and are most common on the western part of the transect. Colluviated tills, in contrast, are more widespread on the steeper slope to the east of the Tommy vein. The distribution of parent materials is more complex on the Ted transect line. Most profiles of glacial deposits examined on the Ted transect are basal tills, but glaciofluvial outwash sands (Figure 16) were encountered in three pits along the line. These samples were included with till samples for aqua regia digestion and ICP-MS analysis. Several of the Ted basal till horizons are classed as IIC horizons due to the widespread occurrence of multiple parent materials, in this case coarse angular near-surface colluvium deposits over pre-existing till. No C horizon till or other parent material samples were obtained from four thin rubbly soil sites on the Tommy transect, mostly near the Tommy vein, and from one site on the Ted transect.

SOIL DEVELOPMENT

Two main near-surface soil horizons are found above the widespread basal or colluviated tills at all sample sites: 1) an organic-rich LFH horizon humus layer and 2) a thin B horizon mineral soil of variable genetic origin. All such soils were classified in accordance with the Canadian System of Soil Classification (Agriculture Canada, 1987).

The LFH horizon humus samples comprise a mixture of partially decomposed twigs, needles, cones, moss and other fine-grained organic debris above the underlying mineral soil. They are thin, typically in the range of 2 to 4 cm, and do not exceed 5 cm at any site. The LFH horizon is beneath a widespread surface moss cover, which was not sampled here, and is marginally thicker at sites on the more subdued topography of the Ted transect than on the steeper Tommy transect.

The B horizon mineral soils on the 3Ts property are predominantly brunisols (Figure 15 to Figure 18). They take the form of thin brown to red-brown near-surface Bm horizons, typically of 10 to 20 cm in thickness. These relatively juvenile soils, common in central British Columbia, are formed from the near-surface oxidation and hydrolysis of mineral particles in underlying till and other materials. No podzolic Bf horizons were observed at any site, although there is some evidence for local development of eluviated Aej horizons in rare outwash sand and gravel.

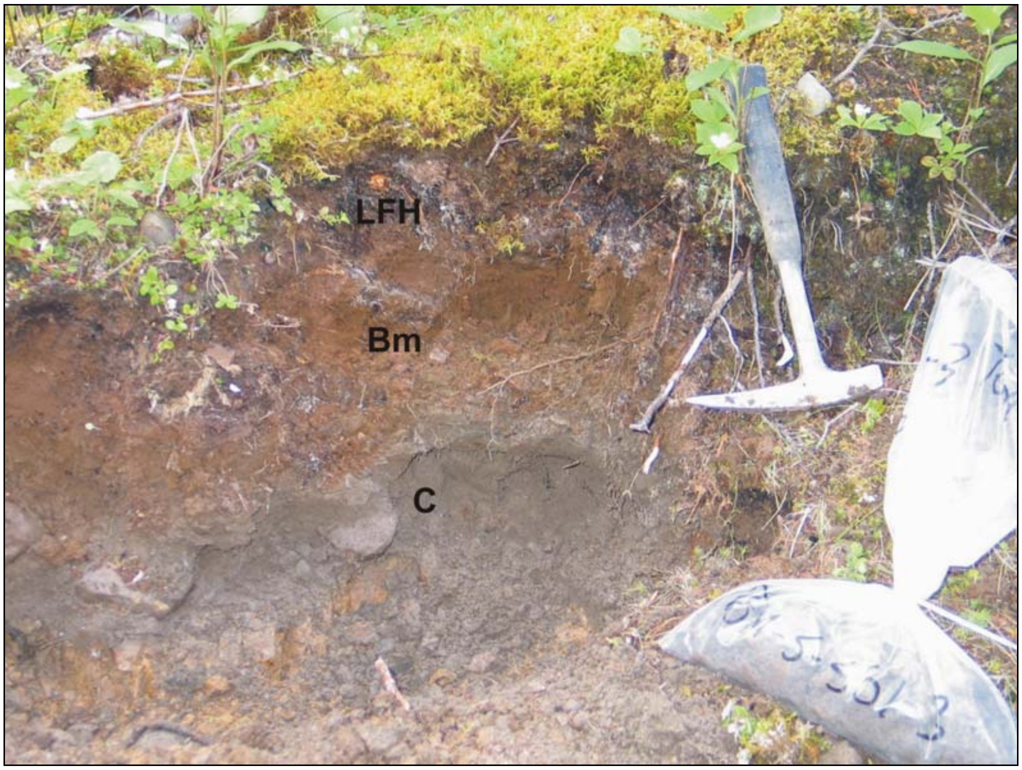


Figure 15. *Typical basal till (site 501) from background area at western end of the Tommy orientation line, showing typical brunisolic Bm soil horizon and LFH horizon humus development.*

Figure 16. *Glaciofluvial outwash sand and Bm soil development (site 576) at western end of the Ted orientation line.*

Figure 17. *Typical 3Ts-area soil profile showing surface humus (LFH horizon) above brunisolic Bm horizon and underlying C horizon till (site 505) from western portion of the Tommy orientation line.*

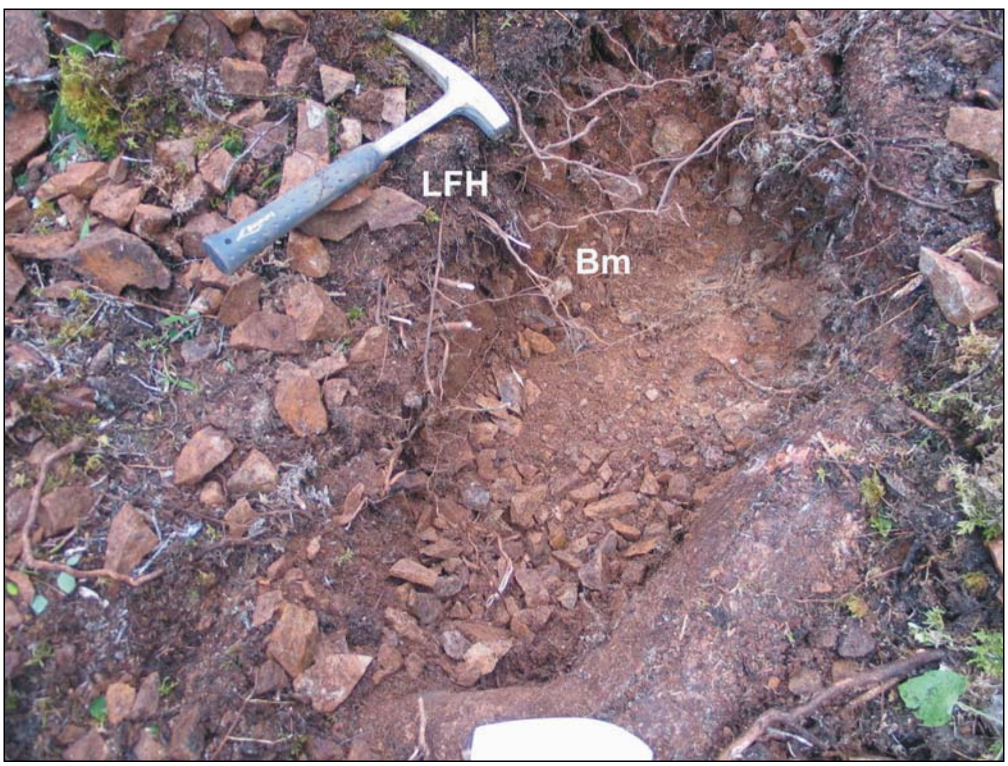


Figure 18. *Thin Bm soil horizon developed in rubble and colluvium directly atop bedrock at the Tommy vein (site 591). No till was present at this site.*

Most Bm horizon soils profiled on the Tommy orientation transect are within relatively simple till or colluviated till parent materials. Four of the soils are, however, developed in angular rubble ±colluvium in rocky areas where no till is present; three of these are immediately around the Tommy vein exposure (Figure 18). Soil development is much more complex on the Ted traverse line, where brunisolic B horizons are developed within till, rubble and colluvium (Figure 19), and localized glaciofluvial outwash sand parent materials. Furthermore, composite soil profiles are present at several sites where Bm horizons are preferentially developed in coarse gravelly near-surface colluvium deposits above the IIC horizon till (Figure 20). The colluvium, therefore, is interpreted to be from an upslope source, in this case to the south, whereas the underlying till has likely originated from an up-ice source to the west. Several such sites are present along the eastern part of the Ted transect line near Adrian Lake, all of which have since been stabilized by forest growth.

Figure 19. *Brunisolic Bm horizon soil developed in loose rubble and colluvium atop weathering bedrock at site 570, near the eastern end of the Ted orientation line. No till is present at this site.*

c) Previous Geochemical Surveys and Studies

The southern Nechako River area, including the Fawnie Creek (NTS 093F/3) map area, was the object of a series of reconnaissance geochemical programs carried out by the British Columbia Geological Survey during the period of 1992 to 1995. These projects, carried out with bedrock mapping programs under the banner of the Interior Plateau Project, included regional lake sediment geochemical surveys (Cook and Jackaman, 1994), lake water geochemical surveys (Cook et al., 1999), Quaternary mapping and till geochemical surveys (Levson et al., 1994; Cook et al., 1995) and till orientation studies (Levson, 2001). The distribution of lake sediment gold results in the Tommy Lakes area clearly outline the location of the original Tommy vein (Figure 6). The single lake sediment sample collected from Adrian Lake returned the highest total (INAA) gold value (256 ppb) in that geochemical survey (regional median gold: 1 ppb). In all, four small lakes containing moderately elevated to highly elevated gold concentrations in the range of 4 to 256 ppb were found to encircle the small hills hosting the original Tommy gold vein discovery at what is now the 3Ts project. In addition to the high gold concentration, which was confirmed by subsequent INAA re-analysis of the sample, this Adrian Lake sediment was also characterized by very low or background-level abundances of other elements, including As (7.8 ppm), Cu (36 ppm) and Pb (4 ppm). Regional till

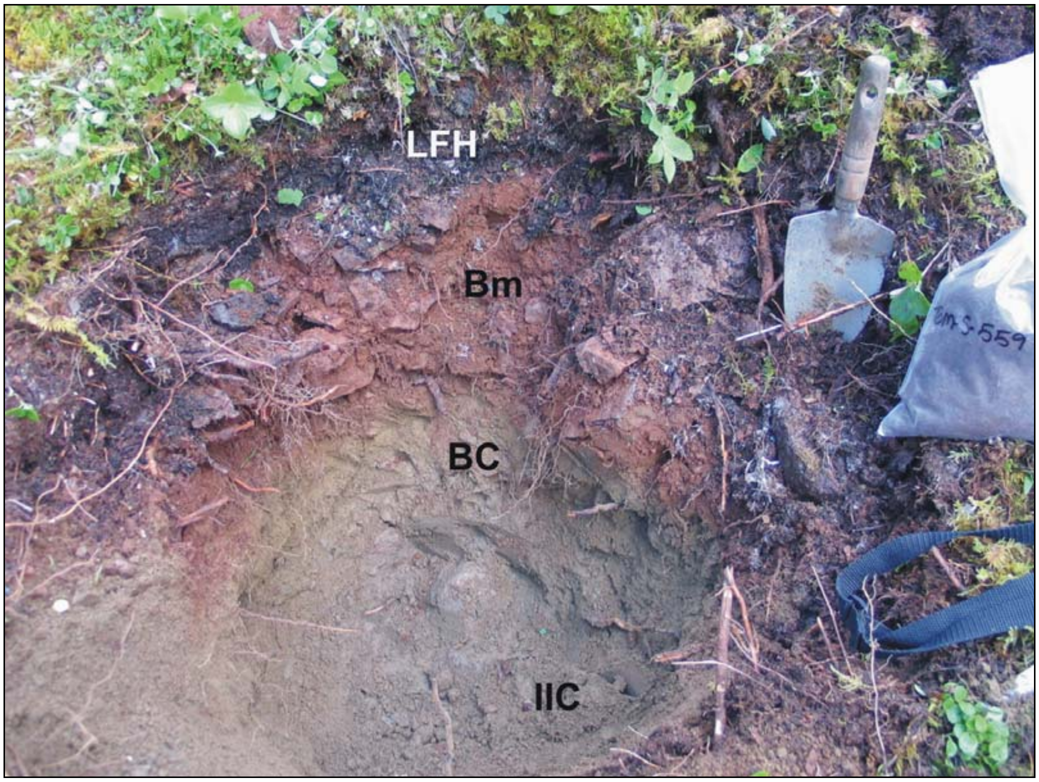


Figure 20. *Composite soil profile showing preferential development of brunisolic Bm horizon within stabilized near-surface angular colluvium atop IIC horizon till. This site (site 559) is immediately down-ice and downslope of the Ted vein exposure.*

geochemical data of Levson et al. (1994) also show the down-ice dispersal of gold in till from the deposit. Of several till samples collected by the BC Geological Survey in 1993 to the northeast of the Tommy vein, two returned elevated Au values of 23 ppb.

Little in the way of soil geochemical surveys appears to have been conducted near the Tommy vein; however, at least three near-surface B horizon soil geochemical surveys of the adjacent Tam and Taken properties were carried out during 1994 to 1998 by Fox Geological (Fox, 1994, 1995, 1996, 1999) on behalf of Phelps-Dodge and others. They include two overlapping soil grids and subsequent infill work (N=832 samples). Line orientations of the two grids (east-west and 060°, respectively) are roughly transverse to the strike of the vein systems; however, they are also roughly parallel to the dominant east- or northeast-trending ice flow direction on the property. This suggests the possibility that any gold or silver geochemical signatures of soils potentially derived from any gold-bearing till dispersal plumes may have been missed in the gaps between the 200 m- or 100 m-spaced grid lines. Nevertheless, the soil geochemical surveys appear to have been sampled in a consistent manner from year to year, and they successfully delineated the areas of the Ted and Mint vein systems.

5. FIELD METHODS AND PROCEDURES

a) Quality Assurance/Quality Control Procedures in the Field

A variety of standard QA/QC procedures were used both in the field and in the laboratory to ensure a uniformly high quality of data. A 20-sample block method of sampling was used, in which field duplicates and standards were collected and inserted at regular intervals (Figure 21). Field duplicates (N=5 pairs) were collected at a rate of 1 every 10 samples, and appropriate CANMET certified reference materials (CRMs) and other standards inserted at a rate of at least 1 in every 20 samples. In practice, CRMs and standards were inserted at more frequent intervals in most of the analytical suites. For those selective extraction methods for which standards are either unavailable or poorly constrained, such as the MMI and EL procedures, multiple insertions of a B horizon bulk sample, prepared as a control, were included as blind drift monitors in batches to monitor analytical precision. This bulk sample was obtained from a background-concentration soil profile located near the Tommy vein. In addition to these proactive QA/QC initiatives, some of the laboratories also report results of their internal QA/QC procedures, such as those for internal standards and analytical replicates. These results, when provided, are reported here.

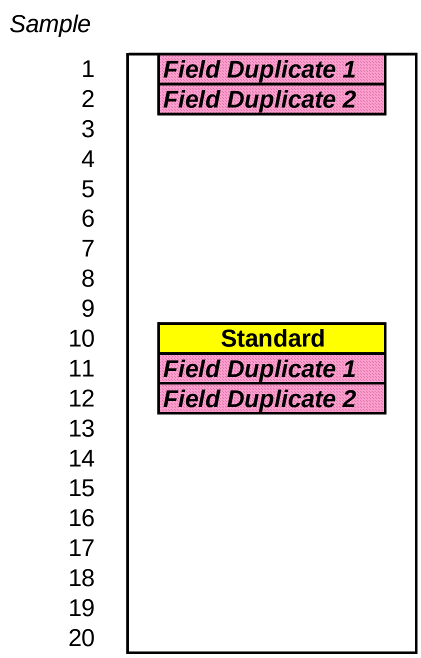


Figure 21. *Typical 20-sample block QA/QC scheme used for sampling and analysis of 3Ts till, soil and humus during the orientation study. The scheme is adapted from similar QA/QC schemes used by the BC Geological Survey and the GSC for regional geochemical surveys.*

b) Field Sampling Procedures

Fieldwork at the 3Ts property was conducted from late June to early July 2005. A series of soil profiles (N=36 sites) were conducted on two approximately 750 m long east-west lines transecting each of the Tommy and Ted veins (Figures 5 and 6). The Tommy transect comprises 20 sites; the Ted transect comprises an additional 16 sites. As shown in the site location map for the two transects (Figure 22), sample sites are spaced at roughly 50 m intervals, although tighter 25 m site spacings were used nearer to the vein systems. Distal sites are locally telescoped to 75 to 100 m spacings. One of the sites directly over the Tommy vein is offset to the south relative to the main sampling line. The eastern end of the Tommy soil transect terminates at a small wetland area, but in the case of the parallel halogen geochemistry study the vegetation transect continues for another 1.5 km to the east (Dunn et al., 2006a, b).

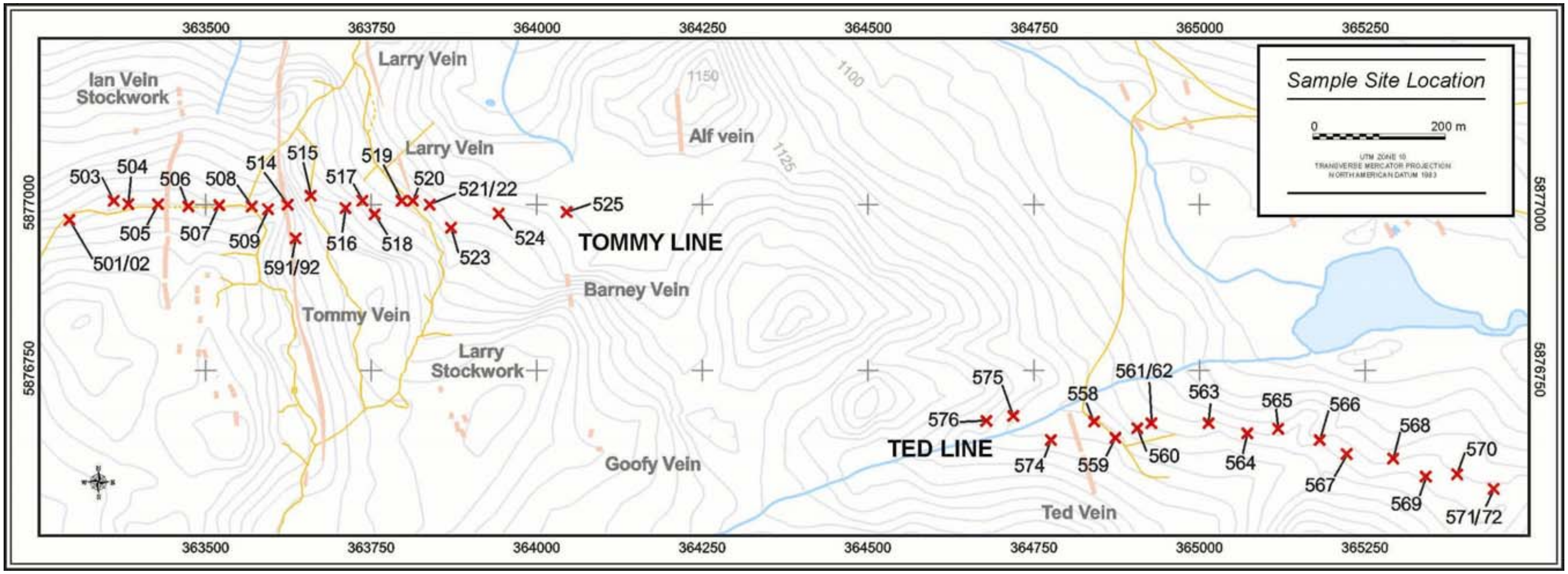


Figure 22. *Location map showing site sample numbers for all soil stations on the Tommy (N=20 sites) and Ted (N=16 sites) veins orientation transects, 3Ts Au-Ag deposit. The five sites showing two sample numbers each (e.g., 521/22) indicate the locations of field duplicate sample pairs.*

A full listing of field site variables and location data collected at each sampling station on the Tommy and Ted orientation transects is shown in Table 1. Traverses were run using compass and topofil chain, and all site locations recorded as North American Datum 1983 (NAD 83) UTM easting and northing coordinates (Zone 10) using a hand-held Garmin Model 12XL GPS unit. Local environmental factors such as slope, drainage and overstory vegetation were noted at each site, and specific soil profile properties such as LFH and mineral soil horizon thickness, soil colour and parent material(s) origin were recorded. As noted earlier, all near-surface mineral soil horizons were classified in accordance with the Canadian System of Soil Classification (Agriculture Canada, 1987).

Three types of organic and mineral samples, exclusive of vegetation (see Dunn et al., 2006b for vegetation results), were collected at each profile site:

- LFH horizon humus,
- B horizon soil, and
- C horizon till

The two sampling transects were purposely chosen to cross the veins at rather arbitrary points, so as not to bias fieldwork toward those parts of the veins known to be most prospective. Quad road access was used where possible, but was not a major factor in siting of the transects. In all, seven separate samples were collected at each site for the range of intended analytical procedures (Figure 23); a total of 14 such samples were collected at each field duplicate site.

A single LFH horizon humus sample (Figure 24 and Figure 25) was collected at each site, using Hubco breathable bags to prevent the rotting of the sample before reaching the lab. Humus samples comprise a mixture of partially decomposed twigs, needles, cones, moss and other fine-grained organic debris above the underlying mineral soil. Surface forest mosses over humus were stripped off prior to humus collection, and were not sampled as part of this study. Humus samples were collected first at each site so as to prevent any inadvertent contamination of this thin horizon (typically <5 cm thickness) from the underlying mineral soil. Each site was closely inspected prior to sampling to ensure that it was pristine and there had been no prior surface disturbance. In the case of roadcut sample sites, the LFH sample was taken further back from the bank to eliminate any possibility of inadvertently collecting material contaminated by soil during earlier road-building operations.

A total of five samples of B horizon or adjacent near-surface soil (Figure 26 and Figure 27) were collected at each site. One B horizon sample was collected for each of aqua regia (AR) digestion, Enzyme Leach (EL), Soil Gas Hydrocarbons (SGH) and Soil Desorption Pyrolysis (SDP). In addition, a fifth sample was collected at a constant depth of 10 to 25 cm at each site for Mobile Metal Ion (MMI) analysis. In practice, this constant depth typically, although not always, corresponded to a mixed Bm-BC sample of the Bm horizon with the underlying transitional BC horizon. All soil samples obtained for proprietary selective extractions were sampled and preserved in accordance with the appropriate laboratory protocols. For example, all samples for MMI, SGH and SDP analysis were collected using Ziploc bags; these were then placed within a protective outer poly bag which was secured with a zap strap or plastic cable tie. Samples collected for AR digestion were also used for other determinations including LOI, pH and, where applicable, gold fire assay. Note that these B horizon samples are also in part the subject of the parallel halogen geochemistry study of Dunn et al. (2006a,b). All soils were classified in accordance with the Canadian System of Soil Classification (Agriculture Canada, 1987).

A single C horizon till sample (mean weight: 4.8 kg) was collected from shallow oxidized till material at most sites (Figure 28 and Figure 29). Tills were typically obtained from a depth of approximately 45 to 60 cm on the Tommy transect, and from about 40 to 60 cm on the Ted transect. No till samples were obtained from four rubbly near-bedrock sites on the Tommy transect, mostly near the Tommy vein, and from one site on the Ted transect. In addition, a few of the C horizon samples on the Tommy line are of glaciofluvial origin. All samples were collected in large poly bags and secured with a zap strap. All samples were shipped to their respective laboratories in hard plastic cases to prevent any possible damage to the samples.

Field duplicate samples (N=5 pairs) of all media were typically collected from pits dug a few metres apart at relevant sites. Overstory vegetation samples were also collected at each site as part of the parallel halogen geochemistry study (Dunn et al., 2006a,b), using a corresponding sample numbering system. These biogeochemical samples consisted of lodgepole pine (*Pinus contorta*) outer bark and white spruce (*Picea glauca*) foliage (Figure 30). Geochemistry of surface mosses (Figure 31) was not considered in this study.

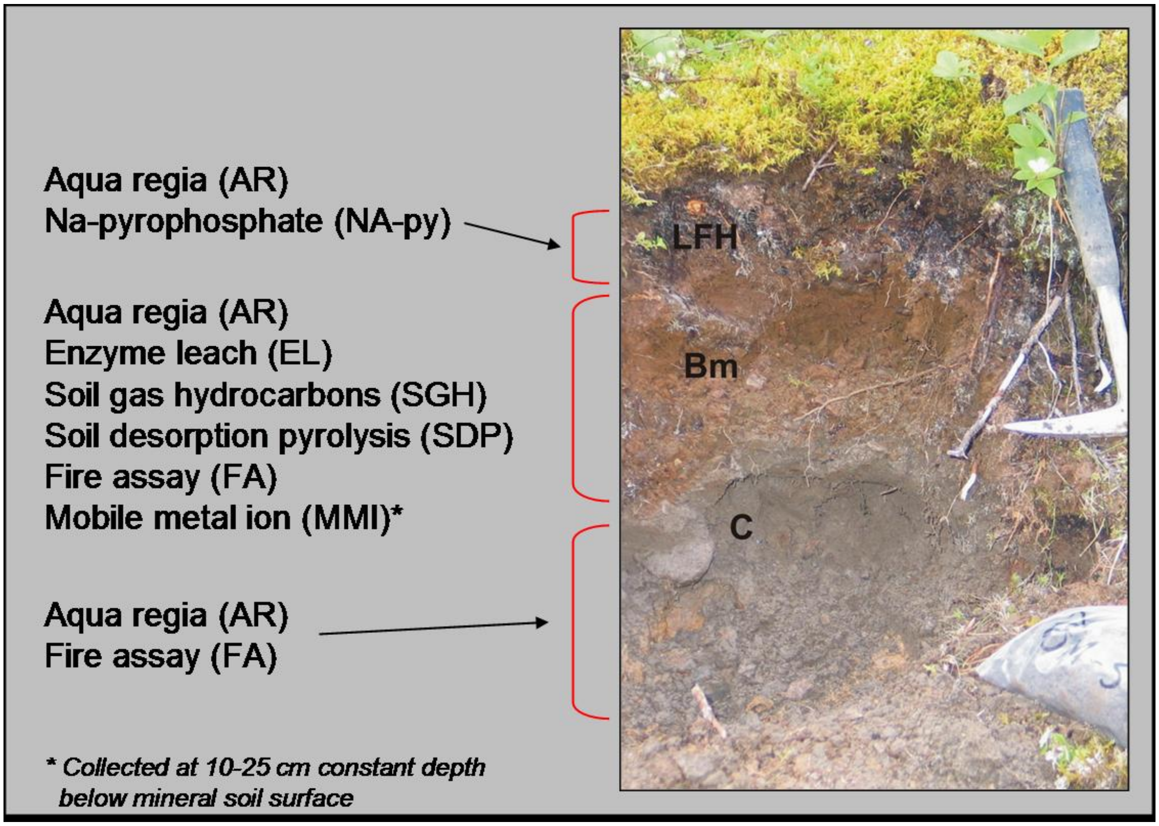


Figure 23. *Schematic diagram showing major analytical procedures conducted on the various LFH, B horizon and C horizon soils, which are typically present at most geochemical orientation sites on the Tommy vein and Ted vein transects, 3Ts Au-Ag prospect.*

Figure 24. *Typical surface organic soil profile showing surface forest mosses and underlying LFH horizon humus. Compare this profile view with the pristine surface moss cover shown later in Figure 30.*

Figure 25. *Typical LFH horizon humus, prior to sampling, following stripping of surface mosses.*

Figure 26. *Collecting bulk sample of a B horizon soil (site 507) just west of the Tommy vein for use as a field soil standard for insertion in all B horizon aqua regia, EL, MMI, SGH and SDP analytical suites.*

Figure 27. *Digging and cleaning out a soil pit in preparation for profiling and sample collection.*

Figure 28. *Typical till pit (site 525) in basal till at the eastern end of the Tommy orientation line. Note the absence of outcrop and the extensive forest moss cover.*

Figure 29. *Till profile from the same site 525 above on the Tommy orientation line, showing LFH humus and brunisolic Bm soil horizons above grey basal till. The bag on the right is C horizon till sample TOM-S-525-3.*

Table 1. *Summary table of field site variables and location data, Tommy and Ted orientation transects.*

SAMPLE ID	TRANSECT LINE	UTMZ	UTME83	UTMN83	REL. GRID (m)	REP STATUS	DUPLICATE COMMENT	LFH (cm)	SOIL HORIZON	SOIL DEPTH (cm)	SOIL COLOUR	SOIL PARENT MATERIAL	SITE SLOPE	SITE DRAINAGE	DATE
TOM S 501	1 Tommy	10	363296	5876976	0	10	Field Duplicate	4	Bm	0-15	Brown	Till	Gentle	Moist	06 28 2005
TOM S 502	1 Tommy	10	363296	5876976	0	20	Field Duplicate	3	Bm	0-20	Brown	Till	Gentle	Moist	06 28 2005
TOM S 503	1 Tommy	10	363363	5877005	63	0		3	Bm	0-10	Brown	Till	Moderate	Moist	06 28 2005
TOM S 504	1 Tommy	10	363385	5877000	85	0		2	Bm	0-15	Brown	Till	Gentle	Moist	06 28 2005
TOM S 505	1 Tommy	10	363430	5877000	130	0		4	Bm	0-18	Brown	Till	Moderate	Moist	06 28 2005
TOM S 506	1 Tommy	10	363475	5876996	175	0		4	Bm/BC	0-18	Tan-brown	Colluviated till?	Moderate	Dry	06 28 2005
TOM S 507	1 Tommy	10	363522	5876998	222	0		2	Bm	0-30	Brown	Till	Moderate-Steep	Dry-Moist	06 28 2005
TOM S 508	1 Tommy	10	363571	5876996	271	0		3	Bm	0-20	Brown	Colluviated till	Steep	Dry	06 28 2005
TOM S 509	1 Tommy	10	363596	5876992	296	0		4	Bm	0-18	Brown	Till	Steep	Moist	06 28 2005
TOM S 514	1 Tommy	10	363625	5876999	325	0		2	Bm	0-10	Brown	Rubble	Moderate	Moist	06 29 2005
TOM S 591	1 Tommy	10	363637	5876948	337	10	Field Duplicate	5	Bm	0-15	Red-brown	Rubble/colluvium	Gentle-Moderate	Dry	07 05 2005
TOM S 592	1 Tommy	10	363637	5876948	337	20	Field Duplicate	3	Bm	0-15	Red-brown	Rubble/colluvium	Steep	Dry	07 05 2005
TOM S 515	1 Tommy	10	363660	5877012	360	0		4	Bm/C?	0-15/20	Brown	Rubble/colluvium	Steep	Moist	06 29 2005
TOM S 516	1 Tommy	10	363713	5876994	413	0		4	Bm/BC	0-15	Brown	Colluviated till	Moderate	Moist	06 29 2005
TOM S 517	1 Tommy	10	363738	5877005	438	0		5	Bm	0-8/10	Lt-brn to brown	Colluviated till	Gentle	Moist	06 29 2005
TOM S 518	1 Tommy	10	363757	5876984	457	0		4	Bm/BC	0-30	Brown	Rubble/colluvium	Moderate	Moist	07 01 2005
TOM S 519	1 Tommy	10	363797	5877005	497	0		2	Bm	0-10/12	Brown	Till	Moderate	Moist	07 01 2005
TOM S 520	1 Tommy	10	363814	5877005	514	0		5	Bm	0-20/30	Brown	Colluviated till	Gentle-Moderate	Moist	07 01 2005
TOM S 521	1 Tommy	10	363840	5876999	540	10	Field Duplicate	2	Bm	0-10/12	Brown	Colluviated till?	Moderate	Moist	07 01 2005
TOM S 522	1 Tommy	10	363840	5876999	540	20	Field Duplicate	2	Bm	0-10/12	Brown	Colluviated till?	Moderate	Moist	07 01 2005
TOM S 523	1 Tommy	10	363872	5876964	572	0		2	Bm	0-12	Red-brown	Colluviated till?	Gentle-Moderate	Moist	07 05 2005
TOM S 524	1 Tommy	10	363944	5876985	644	0		3	Bm	0-12	Red-brown	Colluviated till?	Moderate-Steep	Moist	07 05 2005
TOM S 525	1 Tommy	10	364046	5876988	746	0		2	Bm	0-5/10	Red-brown	Till	Gentle-Moderate	Moist	07 05 2005
TOM S 576	2 Ted	10	364680	5876673	0	0		2	Bm	0-20	Brown	Outwash	Gentle	Dry	07 02 2005
TOM S 575	2 Ted	10	364721	5876680	41	0		4	Bm	0-15	Brown	Outwash	Gentle	Dry	07 02 2005
TOM S 574	2 Ted	10	364777	5876644	97	0		3	Bm	0-10	Brown	Till	Moderate	Moist	07 02 2005
TOM S 558	2 Ted	10	364843	5876672	163	0		3	Bm	0-8/10	Red-brown	Colluvium	Flat-Gentle	Moist	07 02 2005
TOM S 559	2 Ted	10	364875	5876647	195	0		5	Bm	0-10/15	Red-brown	Till	Gentle-Moderate	Moist	07 02 2005
TOM S 560	2 Ted	10	364908	5876662	228	0		3	Bm/BC	0-20	Brown	Till	Gentle-Moderate	Dry	07 02 2005
TOM S 561	2 Ted	10	364929	5876669	249	10	Field Duplicate	3	Bm/BC	0-20	Red-brown	Till	Gentle-Moderate	Moist	07 03 2005
TOM S 562	2 Ted	10	364929	5876669	249	20	Field Duplicate	3	Bm/BC	0-20	Red-brown	Till	Gentle-Moderate	Moist	07 03 2005
TOM S 563	2 Ted	10	365015	5876669	335	0		2	Bm	0/3 - 25	Brown	Outwash	Moderate	Moist	07 03 2005
TOM S 564	2 Ted	10	365074	5876654	394	0		3	Bm/BC	0-5/8	Red-brown	Outwash	Moderate-Steep	Moist	07 03 2005
TOM S 565	2 Ted	10	365120	5876661	440	0		3	Bm	0-5/8	Lt-brown	Till	Moderate	Moist	07 03 2005
TOM S 566	2 Ted	10	365183	5876644	503	0		5	Bm/BC	0-20	Brown	Colluvium	Moderate-Steep	Moist	07 03 2005
TOM S 567	2 Ted	10	365224	5876623	544	0		4	Bm	0-15	Red-brown	Colluvium	Gentle	Moist	07 04 2005
TOM S 568	2 Ted	10	365294	5876616	614	0		3	Bm	0-20	Red-brown	Colluvium	Gentle	Dry	07 04 2005
TOM S 569	2 Ted	10	365343	5876589	663	0		5	Bm	0-20	Red-brown	Colluvium	Gentle	Dry	07 04 2005
TOM S 570	2 Ted	10	365391	5876592	711	0		4	Bm	0-20	Red-brown	Colluvium/rubble	Gentle	Dry	07 04 2005
TOM S 571	2 Ted	10	365446	5876570	766	10	Field Duplicate	4	Bm	0-10/12	Red-brown	Colluvium	Gentle	Dry	07 04 2005
TOM S 572	2 Ted	10	365446	5876570	766	20	Field Duplicate	4	Bm	0-10/12	Red-brown	Colluvium	Gentle	Dry	07 04 2005

Figure 30. *Typical mature forest at the 3Ts property, showing white spruce (Picea glauca) in foreground and extensive surface moss cover near site 563, in central part of the Ted line. Photo courtesy of K. Hulme.*

Figure 31. *Close up view of ubiquitous surface moss cover, showing details of forest mosses and understory vegetation growing atop the LFH humus horizon, which is decomposing beneath. Photo courtesy of K. Hulme.*

6. SAMPLE PREPARATION AND ANALYSIS

Samples from each horizon were analyzed for a range of commercially available partial digestions and proprietary selective extractions (Figure 23 and Table 2). Aqua regia digestion–ICP-MS multi-element analyses and both pH and LOI determinations were common to all three types of soil media, but the majority of the selective extractions were conducted solely on the near-surface B horizon mineral soil samples, which have traditionally been used for property-scale geochemical exploration in British Columbia. These included Enzyme Leach (EL), Mobile Metal Ion (MMI), Soil Gas Hydrocarbons (SGH) and Soil Desorption Pyrolysis (SDP), as well as total gold determination by lead-collection fire assay–ICP-MS. Humus samples from the LFH horizon were also analyzed by Na-Pyrophosphate leach in addition to aqua regia–ICP-MS. All C horizon samples were analyzed by aqua regia digestion–ICP-MS and for total gold by lead-collection fire assay–ICP-MS only.

Aqua regia geochemical work on humus, soil and till, as well as gold fire assay, pH, LOI and other determinations was conducted at Acme Analytical Labs, Vancouver. Specialized proprietary selective extraction procedures and analyses were carried out at ALS Chemex in Perth, Australia (MMI-M); Activation Laboratories in Ancaster, Ontario (EL and SGH); and SDP Pty. in Brisbane, Australia (SDP).

Table 2. *Summary table of digestion and other methods used for the analysis of organic and mineral soil horizons: fire assay fusion, aqua regia digestion, Na-Pyrophosphate leach, enhanced enzyme leach (EL), mobile metal ion (MMI-M), soil gas hydrocarbon (SGH) and soil desorption pyrolysis (SDP).*

	LFH Horizon Humus	**B Horizon Soil**	**C Horizon Till**
Au by Fire Assay		X	X
Aqua Regia/ICP-MS	X	X*	X
Na-pyrophosphate	X		
Enzyme Leach		X	
MMI-M		X**	
SGH		X	
SDP		X	
pH	X	X	X
Loss on Ignition	X	X	X

** With halogen geochemistry project of Dunn et al. (2006a,b)*
*** Sampled at constant depth, typically from Bm/BC horizons*

a) Sample Preparation

Sample preparation procedures for all humus, soil and till samples prepared and analyzed for trace elements by aqua regia digestion–ICP-MS at Acme Analytical Labs, Vancouver are outlined here. Preparation procedures for those LFH and B horizon soils submitted for proprietary selective extraction procedures (Na-Pyrophosphate, EL, MMI-M, SGH and SDP) are described in the appropriate sections that follow. Note that all sample preparation activities were carried out at the relevant laboratories; no prior preparation work was conducted in the Tatelkuz Lake field camp on any samples.

All LFH horizon humus samples were first allowed to air dry in the field prior to shipping, and then were dried at low heat (40°C) in the laboratory, disaggregated within their original bags by pounding with a mallet, and then screened to <250 microns (–60 mesh ASTM) using stainless steel sieves.

All B horizon soil samples were dried at low heat (40°C), sieved in entirety to <180 microns (–80 mesh ASTM) using stainless steel sieves, and 30 g splits taken for each of Group 1F aqua regia–ICP-MS analysis and Group 3B-MS lead collection Au fire assay. The widely used –80 mesh soil fraction was used here, not because of any perceived superiority of this particle size range in geochemical exploration, but to facilitate comparisons with many similar exploration industry soil datasets.

The C horizon till samples were dried at low heat (40°C), and then sieved in entirety to <63 microns (-230 mesh ASTM) using stainless steel sieves in accordance with standard till preparation procedures of the Geological Survey of Canada and the British Columbia Geological Survey. Thirty gram splits were taken for each of Group 1F aqua regia–ICP-MS analysis and Group 3B-MS lead collection Au fire assay.

b) Aqua Regia (AR) Digestion

Aqua regia digestions with ICP-MS finish (Group 1F method) were conducted on all prepared 3Ts humus (LFH horizon), mineral soil (B horizon) and till (C horizon) samples at Acme Analytical Labs in Vancouver. In each case, 30 g analytical subsamples were digested with 180 ml 2-2-2 $HCl-HNO_3-H_20$ at 95°C for one hour, diluted to 600 ml and then analyzed for a 53-element suite by both ICP-MS and ICP-ES on Perkin-Elmer Elan 6000 and SpectroCirus instrumental units, respectively. This relatively weak aqua regia digestion is a partial digestion, providing a partial recovery of numerous silicate-bound and refractory elements such as nickel, barium and chromium. It is typically near-complete for sulphide-associated elements such as copper, zinc, lead, silver and cobalt. Note that no total determinations (e.g., multi-acid digestions) were conducted for comparison purposes, other than total Au determinations in mineral soil horizons by Pb-collection fire assay.

Thirty gram analytical subsamples were used in each case in an attempt to increase sample representativity and minimize gold particle sparcity effect, but aqua regia–digestible gold as reported here may or may not be complete depending on the nature of the silica host.

Subsequent to this, 20 g of prepared B horizon soil pulp was supplied in most cases to the halogen geochemistry study (Dunn et al., 2006a, b) and a further 15 to 30 g removed for conducting Au fire assays on mineral soils. Total gold determinations by lead-collection fire assay were conducted on all mineral soil and till samples to verify the original aqua regia results.

c) Mobile Metal Ion (MMI-M)

The Mobile Metal Ion (MMI) method is a proprietary commercial selective extraction method of Wamtech Pty. Ltd., Australia. Analyses are conducted under license at a limited number of laboratories in Canada and Australia only. There is a paucity of published case studies on the use of MMI geochemistry in the search for epithermal gold deposits in the Cordillera and, in fact, there are only few such studies of any sort in northern glaciated terrain (e.g., Fedikow, 2005; Bajc, 1998). The MMI-M partial extraction suite was conducted on near-surface soils by ALS Chemex at their Perth, Western Australia facility. MMI-M (ALS Chemex code ME-MS17) is one of several MMI analytical suites which use proprietary leach reagents stated to be suitable for the extraction of a suite of target elements, in this case a multi-element suite (MMI-M). The analytical finish of this process is by ICP-MS.

d) Enzyme Leach (EL)

The Enzyme Leach (EL) method is a proprietary commercial selective extraction method of Activation Laboratories Ltd. in Ancaster, Ontario. Enzyme Leach has attracted much attention from the mineral exploration industry but, as with MMI, most published case studies of the method are in non-glaciated areas. Enhanced Enzyme Leach analyses (Activation Laboratories code 7EnhEL) of all B horizon soils were conducted by Activation Laboratories using an ICP-MS finish. The method, although proprietary, is considered to be selective for those metals associated with the amorphous manganese oxide phase coating mineral particles in the near-surface environment. A 1 g sample of <250 micron (–60 mesh ASTM) soil material is leached in a glucose oxidaze solution containing a proprietary enzyme, which reacts with and dissolves any amorphous manganese oxide present. Any metals are reported to be complexed with gluconic acid, and the solutions analyzed using a Perkin-Elmer Elan 6000 or 6100 ICP-MS unit.

e) Soil Gas Hydrocarbons (SGH)

The Soil Gas Hydrocarbon (SGH) method is a proprietary commercial analytical method of Activation Laboratories Ltd. in Ancaster, Ontario. The SGH sample preparation and analysis was conducted on all B horizon soils by Activation Laboratories. Samples were air-dried at no more than 40°C, sieved to <250 microns (–60 mesh) and a 0.5 g sample extracted and analyzed by gas chromatography/MS. The method, although proprietary, targets a range of 162 organic compounds, which are thought to be adsorbed onto clay minerals and amorphous iron and manganese oxides present in the soil. Hydrocarbons in the C5 to C17 range are measured, as these are stated to be more robust from a field sampling perspective, and less affected by decaying biogenic material than hydrocarbons in the C1 to C4 range. The SGH method has been the subject of a recent CAMIRO research study (Sutherland and Hoffman, 2003), but to the best knowledge of the authors, no published case studies on the use of the SGH method are known from the western Cordillera.

f) Soil Desorption Pyrolysis (SDP)

Soil Desorption Pyrolysis (SDP) is a proprietary commercial analytical method of SDP Pty. Ltd., Brisbane, Australia. The B horizon soils were shipped to Australia by air to minimize elapsed time between collection and analysis, and preparation and SDP analysis of the samples was conducted at that facility. The SDP method is stated to measure trace amounts of volatile compounds, such as light hydrocarbons and other gases, which are adsorbed onto clay-size soil particles. Samples are dried at 40°C, the 0.2 to 2 micron clay-sized particle fraction separated by centrifuge, and total adsorbed gases determined by pyrolysis at 450°C. Instrument used is an Agilent GC/MS.

Study of the SDP response here is timely, as most SDP orientation studies have been confined, with a few exceptions, to deposits in arid desert environments of Australia, Chile and Nevada.

g) Sodium Pyrophosphate Leach (Na-py)

Sodium Pyrophosphate leaches (Group 1SLO method) were conducted on all LFH horizon humus samples at Acme Analytical Labs in Vancouver. This is a non-proprietary selective extraction method for organic-rich samples which is widely available at commercial laboratories. The procedure used here involves the leaching of a 1 g prepared humus sample with 10 ml 0.1M Na-Pyrophosphate ($Na_3P_2O_7$) rolled for two hours, followed by ICP-MS determination of a 58-element analytical suite using a Perkin-Elmer Elan 6000 unit. The leach is selective for elements adsorbed by organic matter (humic and fulvic compounds), and was carried out on organic-rich humus samples only. The Na-Pyrophosphate leach method was the only alternative analytical method, relative to aqua regia digestion, which was applied to humus samples at the 3Ts property.

h) Fire Assay for Total Gold Determination

Lead-collection gold fire assays (Group 3B-MS method) with ICP-MS finish were conducted at Acme Analytical Labs in Vancouver on all 3Ts mineral soil and till samples to 1) verify the presence of elevated gold concentrations in soils, and 2) to ascertain by total decomposition of the samples what differences, if any, might exist between partial to near-total (aqua regia digestion) and total gold determinations. Fire assays were carried out using 30 g subsamples of <180 micron (–80 mesh ASTM) B horizon prepared soils and <63 micron (–230 mesh ASTM) prepared tills.

i) Other Determinations

In addition to the above partial and selective extractions, soil pH and Loss on Ignition (LOI) were also determined on samples of all organic and mineral soil horizons at Acme Analytical Labs, Vancouver.

Soil pH was determined in the lab on a 5 g sample slurry in 10 ml distilled/de-ionized water. Field soil pH was not determined. An approximate measure of the organic matter content of the soil horizons, LOI, was determined by loss on ignition at 500°C.

j) Quality Assurance/Quality Control Procedures

A variety of standard QA/QC procedures were both used in the field and in the laboratory to ensure a uniformly high quality of data. A 20-sample block method of sampling was used, in which field duplicates were collected and standards inserted at regular intervals (Figure 21). Field duplicates (N=5 pairs) were collected at a rate of 1 every 10 samples, providing a means of evaluating combined field sampling, preparation and analytical precision. Appropriate CANMET certified reference materials (CRMs) and other control standards were inserted in batches at a rate of at least 1 in every 20 samples to monitor analytical accuracy. CANMET till CRMs (e.g., TILL-1 and TILL-4) were used in mineral soil batches, while organic matter-rich CANMET lake sediment CRMs (e.g., LKSD-4) were used in LFH horizon humus suites. Other surficial material standards used here included the BC Geological Survey's internal gold standard 'Red Dog', and Anglo American internal till ('Little Fort') and humus ('PEAT-1') standards.

For those selective extraction methods for which appropriate standards are either unavailable or poorly constrained, such as MMI or Enzyme Leach procedures, multiple insertions of a B horizon bulk sample were included as blind drift monitors in sample batches to monitor analytical precision. This bulk sample, obtained from a background-concentration soil profile (site 507) near the Tommy vein, was also used to determine precision of organic compounds analyses in the SGH and SDP suites.

In addition to these proactive QA/QC initiatives, some of the laboratories also report results of their internal QA/QC procedures, such as those for internal standards and analytical replicates. Laboratory replicates were reported in all aqua regia, fire assay and Na-Pyrophosphate suites analyzed by Acme Labs, and these results are reported and graphed here. Laboratory replicate results are similarly reported here for the Enzyme Leach and SGH analytical suites of Activation Laboratories; however, no internal lab replicate results were reported by ALS Chemex for the MMI-M suite of analyses, nor by SDP Pty. for the SDP organic compounds suite.

7. RESULTS AND DISCUSSION

a) Quality Assurance/Quality Control Results

For purposes of this report, quality control/quality assurance results presented here are limited to comparative assessment of analytical accuracy and precision for selected elements by aqua regia digestion–ICP-MS relative to results achieved by the other analytical methods. Analytical accuracy is monitored by the insertion and evaluation of results of control standards of known composition. Replicate analyses of these standards also provide an estimation of analytical precision at various concentration levels. CANMET till and lake sediment CRMs were used as standards, as were a variety of internal till, sediment and organic soil standards from both the BC Geological Survey and exploration industry sources. Data for field duplicates and lab replicates are also provided; it should be noted that the population of duplicate samples is small, particularly for lab replicate samples, which typically do not exceed more than two pairs for most analytical methods. In the case of field duplicates, there are five duplicate pairs in most of the soil analytical batches.

Comparative relative standard deviation (RSD) results for all methods are provided in Tables 6 to 8 at the end of this section.

AQUA REGIA LFH HORIZON HUMUS SUITE

Results of multiple insertions of CANMET certified reference material LKSD-4 and Anglo American internal organic soil standard PEAT-1 into the aqua regia (AR)–ICP-MS suite of LFH horizon humus samples at Acme Labs show that analytical accuracy for selected elements (Figures 32 to 35) is within acceptable limits, even at relatively low concentrations. Both LKSD-4 and PEAT-1 are organic-rich surficial standards chosen for their similar loss on ignition (LOI) values and matrix compatibility with organic-rich 3Ts humus samples from the Tommy and Ted veins' transects.

Scatterplots showing duplicate sample results for both field duplicate pairs (N=5) and Acme Labs lab replicates (N=2) are shown for several elements including Ag, Zn, Cd and Au (Figures 36 to 39) in the LFH horizon soil aqua regia digestion–ICP-MS suite for the combined Tommy and Ted vein orientation transects. It is apparent from these results that an adequate degree of reproducibility has been achieved for most elements, although duplicate Au results (Table 3) are erratic. The issue of reproducibility is explored more fully in the accompanying RSD bar charts (Figure 40 and Figure 41), where RSD results are compared, for several sample type groupings, for each element in the aqua regia analytical suite. Four values are shown for each element, comprising 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3), and 4) RSD results of replicate analyses of Anglo American organic soil standard PEAT-1 (pink bars; N=5). Although B horizon soil suites contain multiple insertions of a field B soil standard, no similar such material was analyzed in any of the humus suites.

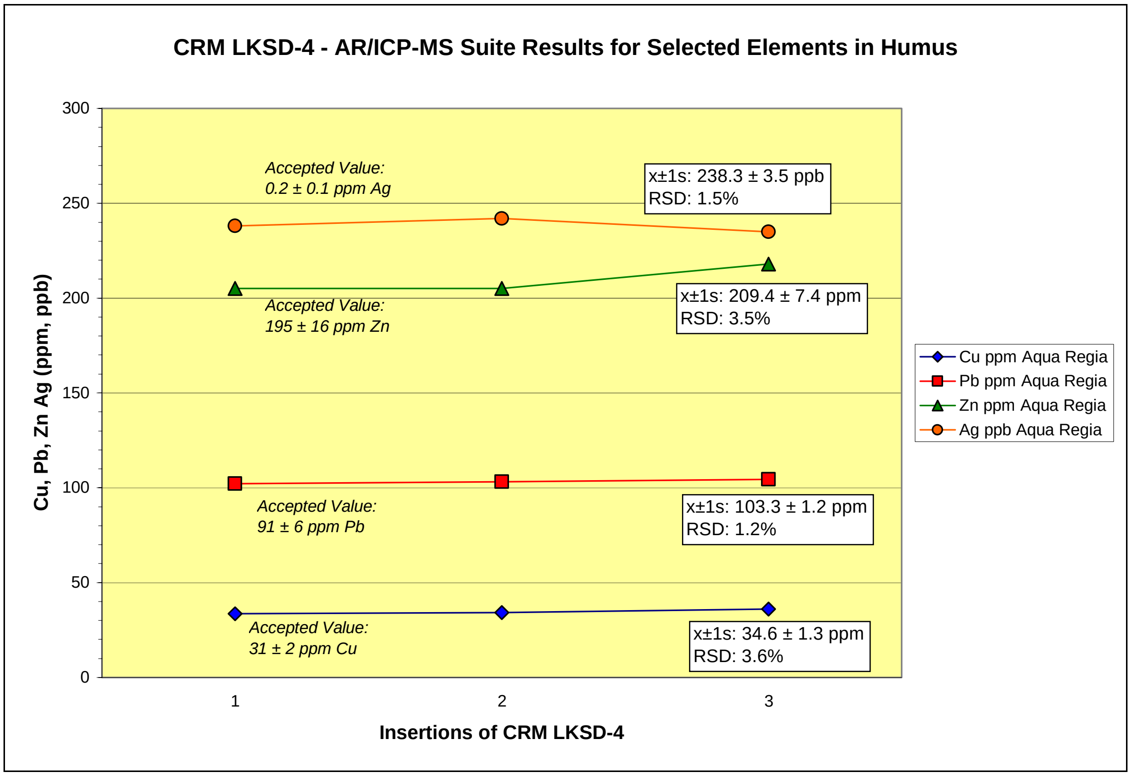
Relative standard deviation (RSD) results for field duplicate samples, which combines field, preparation and analytical variation, are generally greater than those for lab replicates or control standards, which measure analytical variation only. Here, the mean of all mean RSDs for field duplicates is 20.4%, while that for lab replicates is about 5 times better at 4.4%. The mean RSD for multiple insertions of CANMET CRM LKSD-4, at 6.2%, is very similar to that of the lab replicates. The second standard, PEAT-1, returned a slightly higher mean of the mean RSD value (12.3%). This is, however, consistent with the generally very low element concentrations present in this background-level organic soil standard; by definition, precision worsens the nearer the analytical detection limit.

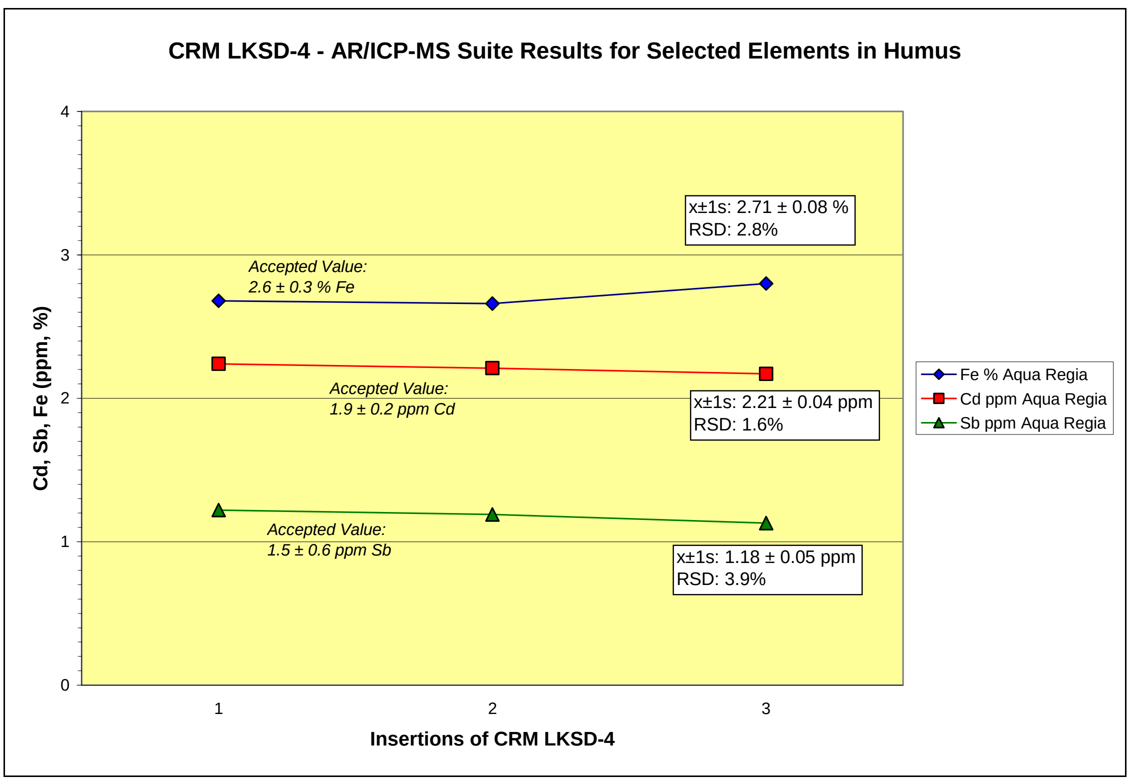
As an example of this relation, RSD values for Cu are 19.5% for field duplicates, where the greatest variation is normally expected. In contrast, RSD results for lab replicates and CRM LKSD-4 insertions, where the least variation may be expected, are similar to each other at only 3.5% and 3.6%, respectively, and less than one-fifth of that for field duplicates. Similar results were received for Ag, with RSD values of 45.3%, 3.5% and 1.5%, respectively. These results indicate that, in general, field sampling is the primary source of variation in the aqua regia suite of LFH horizon results, whereas analytical variation in the laboratory contributes only a relatively minor component. Gold results also roughly conform to this relation, although the calculation of precision estimates is hampered by 1) the very low Au concentrations typically present in these materials, and 2) the absence of standard materials for which reliable certified or recommended Au concentrations are available. In general, however, field duplicate Au results by aqua regia digestion–ICP-MS show very poor reproducibility in spite of elevated Au concentrations in humus directly over Tommy vein mineralization.

Table 3. *Listing of Au results by aqua regia digestion–ICP-MS (Group 1F method) for field duplicate and lab replicate sample pairs in the LFH horizon humus analytical suite*

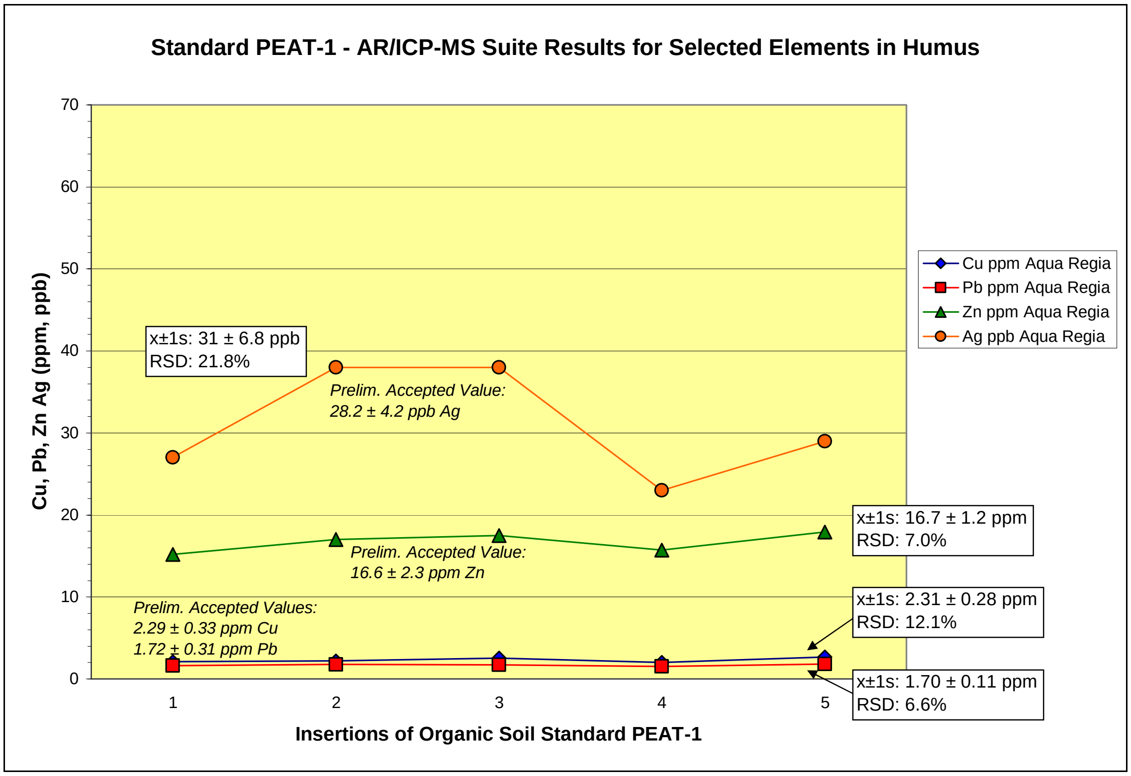
	ID Number of Routine Sample	Au-1 (ppb)	Au-2 (ppb)	Status of Duplicate Samples	Orientation Transect
LFH Horizon Humus Aqua Regia Digestion Suite	TOM-S-501-1	**0.9**	**0.3**	Field Duplicates	Tommy Line
	TOM-S-521-1	**1.2**	**12.2**	Field Duplicates	Tommy Line
	TOM-S-561-1	**0.1**	**0.1**	Field Duplicates	Ted Line
	TOM-S-571-1	**0.1**	**0.1**	Field Duplicates	Ted Line
	TOM-S-591-1	**40.8**	**0.9**	Field Duplicates	Tommy Line
	TOM-S-559-1	***0.1***	***0.1***	*Lab Replicate*	*Tommy Line*
	TOM-S-571-1	***0.1***	***0.1***	*Lab Replicate*	*Ted Line*

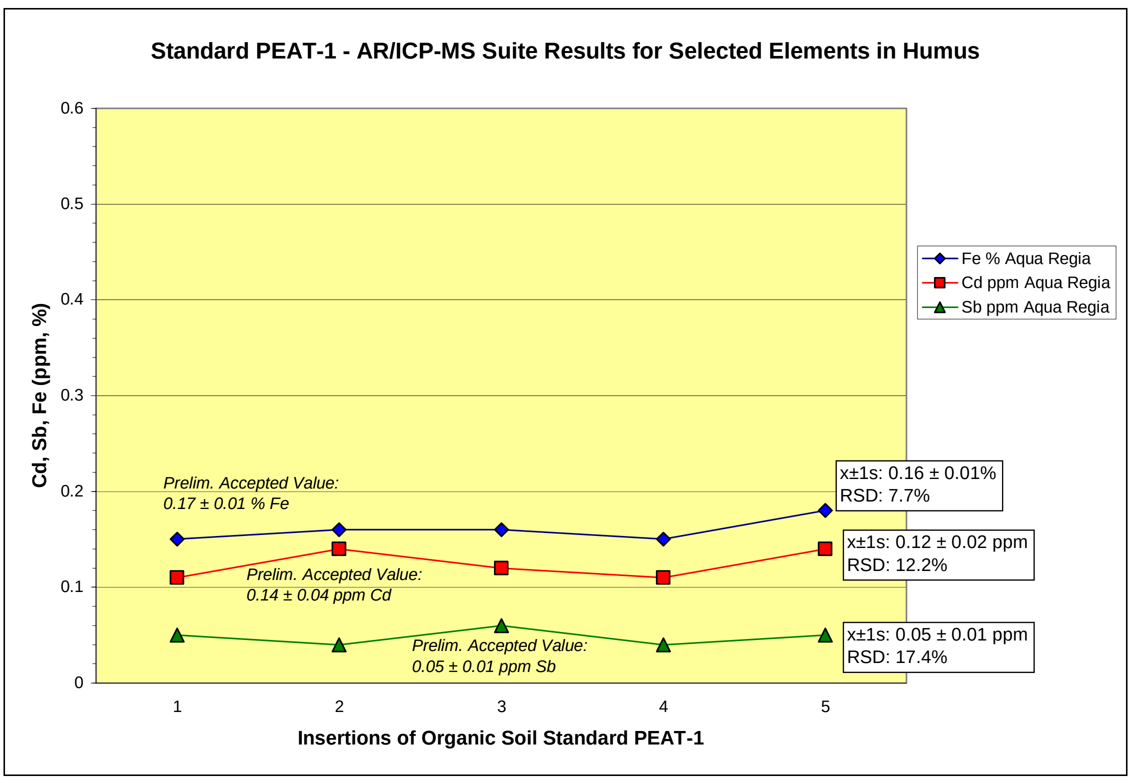
Only the first Au concentration (Au-1) of each duplicate pair is considered to be the routine concentration for plotting and statistical purposes.



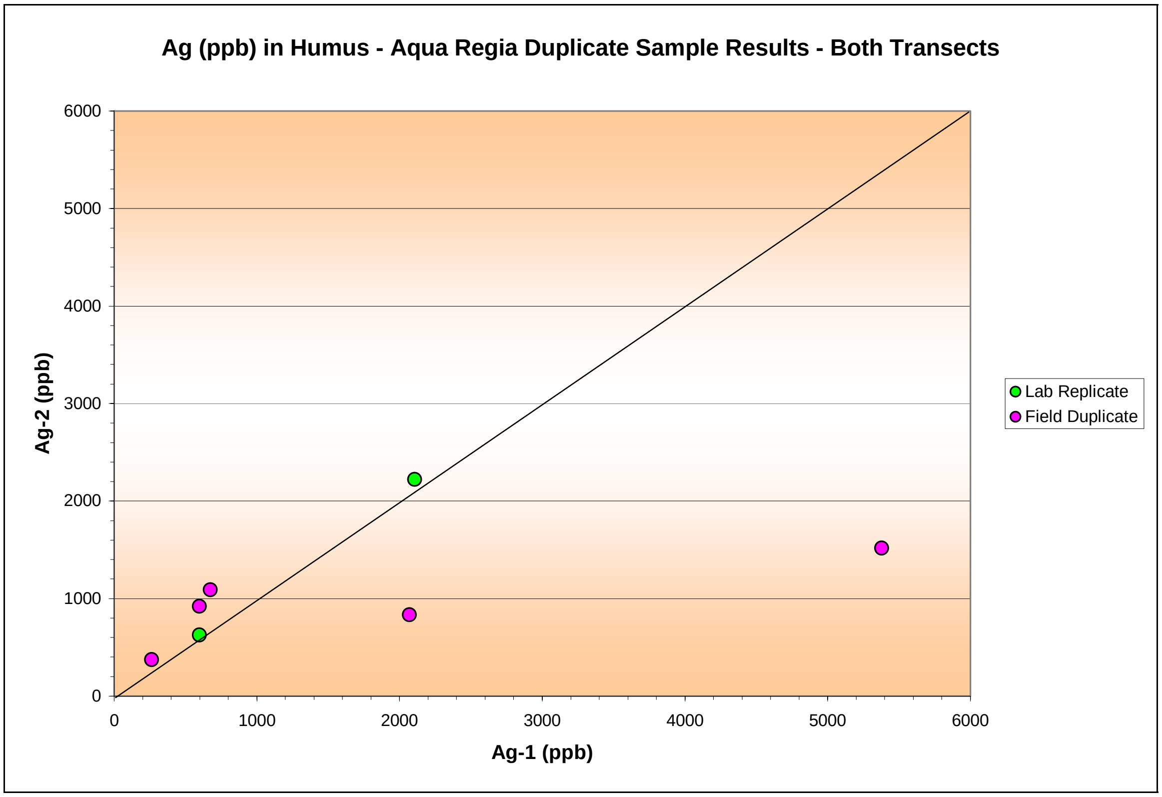


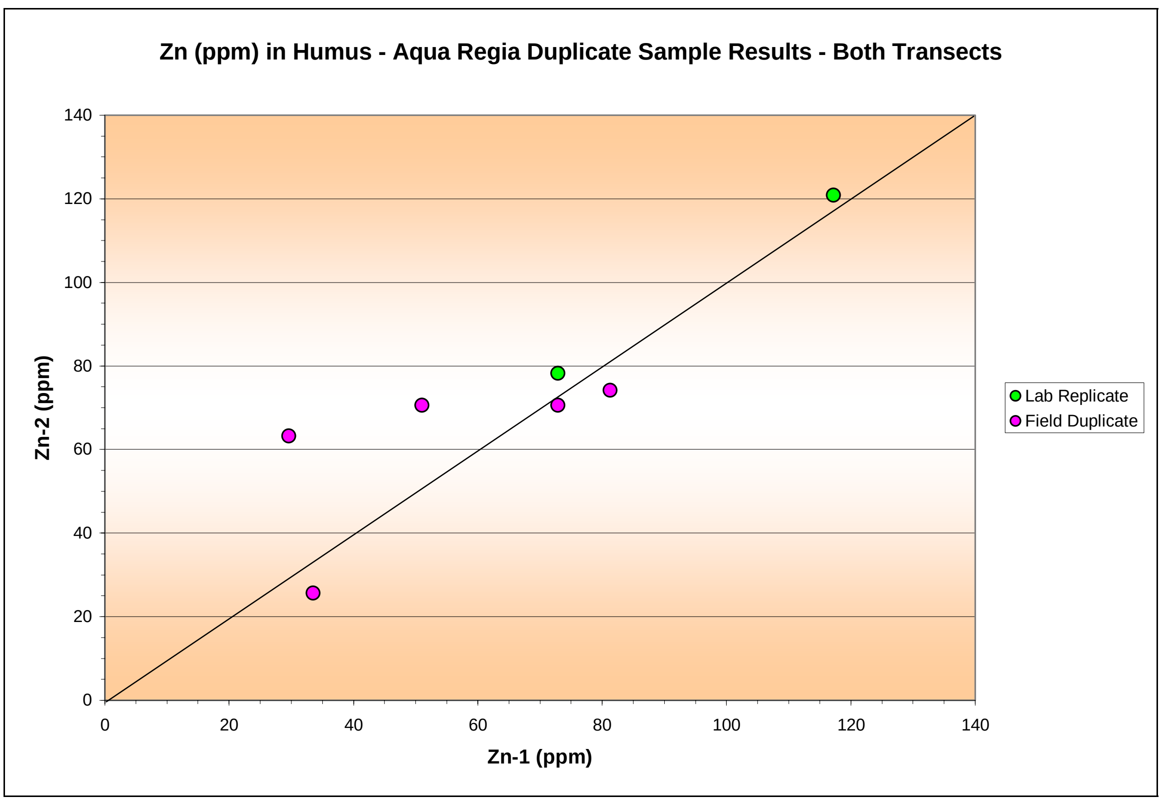
Figures 32 and 33. *Line plots of aqua regia–ICP-MS results for Cu, Pb, Zn and Ag (top) and Fe, Cd and Sb (bottom) for insertions of CANMET certified reference material LKSD-4 (N=3 insertions) in the AR–ICP-MS suite of LFH horizon humus samples from the combined Tommy and Ted veins orientation transects. Accepted element values for LKSD-4 (mean ±1s) are from Lynch (1999).*



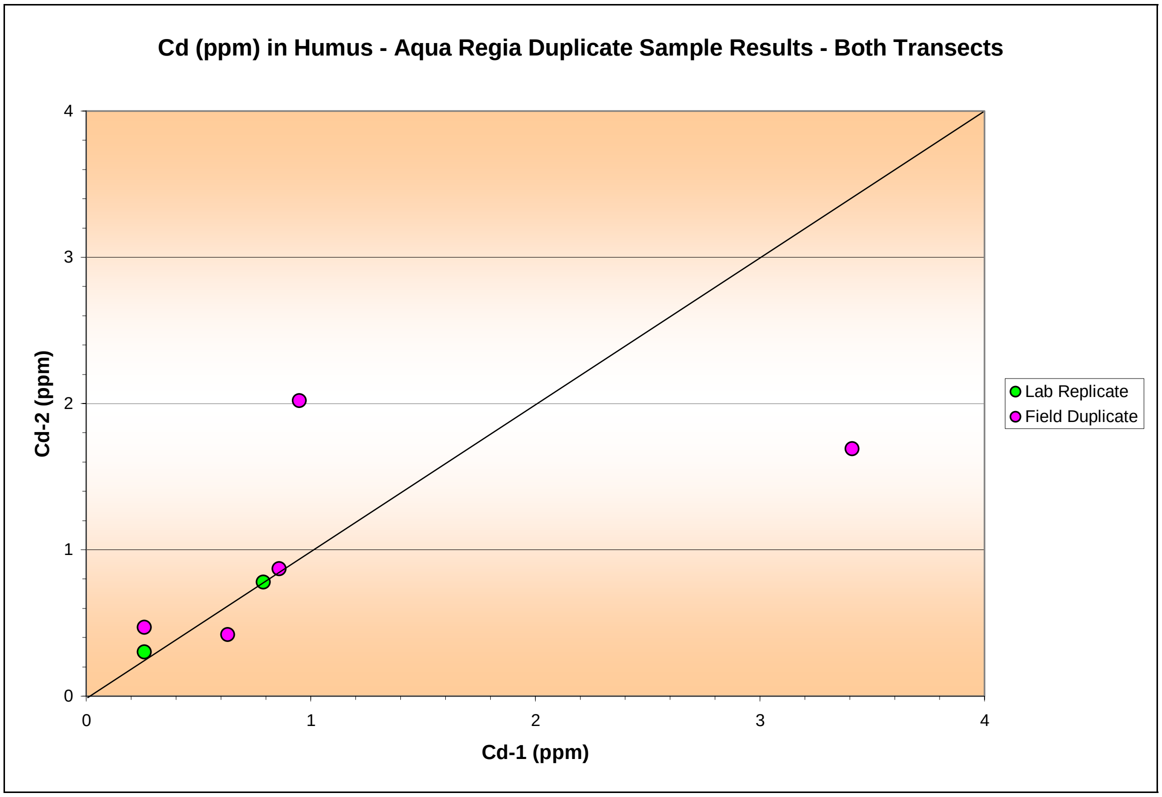


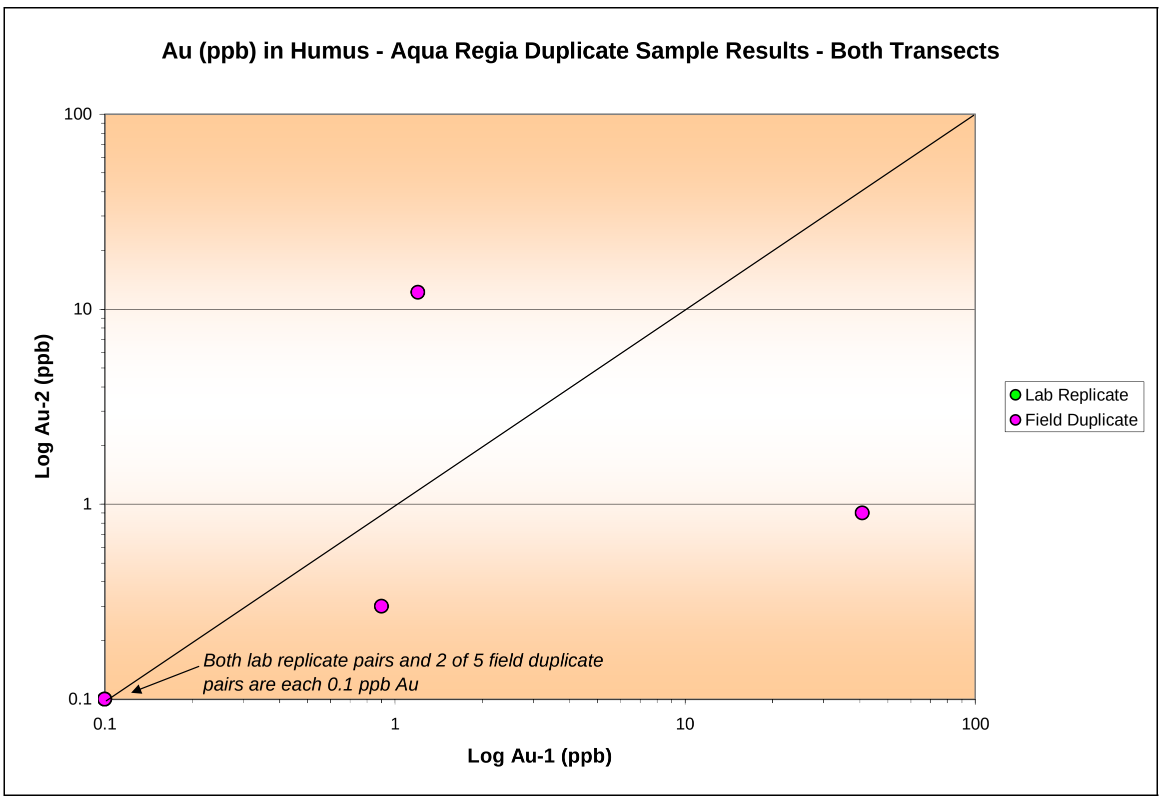
Figures 34 and 35. *Line plots of aqua regia–ICP-MS results for Cu, Pb, Zn and Ag (top) and Fe, Cd and Sb (bottom) for insertions of organic soil standard PEAT-1 (N=5 insertions) in the AR–ICP-MS suite of LFH horizon humus samples from the combined Tommy and Ted veins orientation transects. Preliminary accepted value results for PEAT-1 (mean ±2s) courtesy of Anglo American Exploration (Canada) Ltd., Vancouver.*





Figures 36 and 37. *Scatterplots showing field duplicate sample results (N=5 pairs) and Acme Labs lab replicate sample results (N=2 pairs) for Ag (top) and Zn (bottom) by aqua regia digestion–ICP-MS in organic-rich LFH horizon humus for the combined Tommy and Ted vein orientation transects.*





Figures 38 and 39. *Scatterplots showing field duplicate sample results (N=5 pairs) and Acme Labs lab replicate sample results (N=2 pairs) for Cd (top) and log Au (bottom) by aqua regia digestion–ICP-MS in organic-rich LFH horizon humus for the combined Tommy and Ted vein orientation transects.*

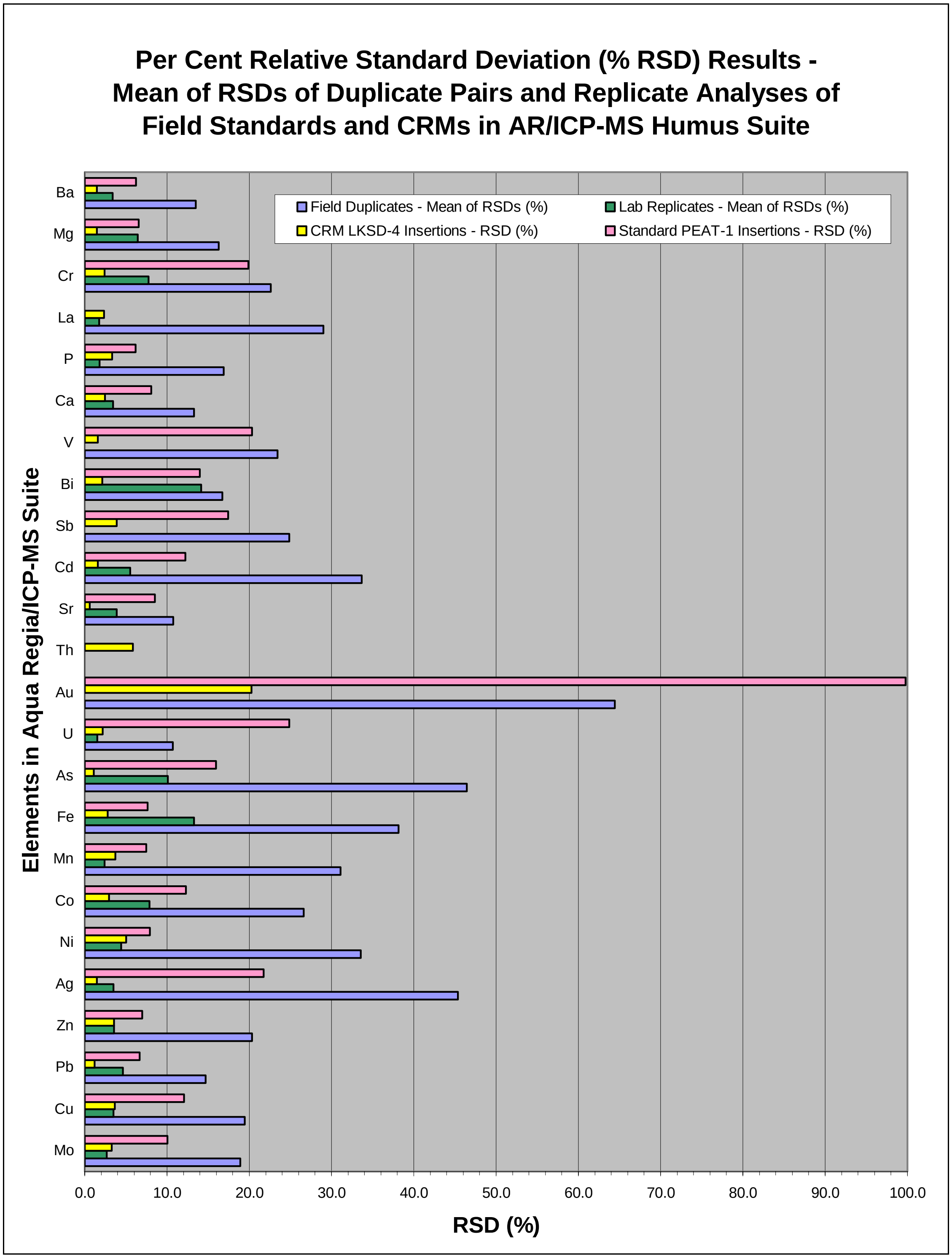


Figure 40. *First of two bar charts showing relative standard deviation (RSD) results for the aqua regia–ICP-MS suite of elements in 3Ts LFH horizon humus from the Tommy vein and Ted vein orientation transects. The chart shows 4 values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3) and 4) RSD results of replicate analyses of organic soil standard PEAT-1 (pink bars; N=5).*

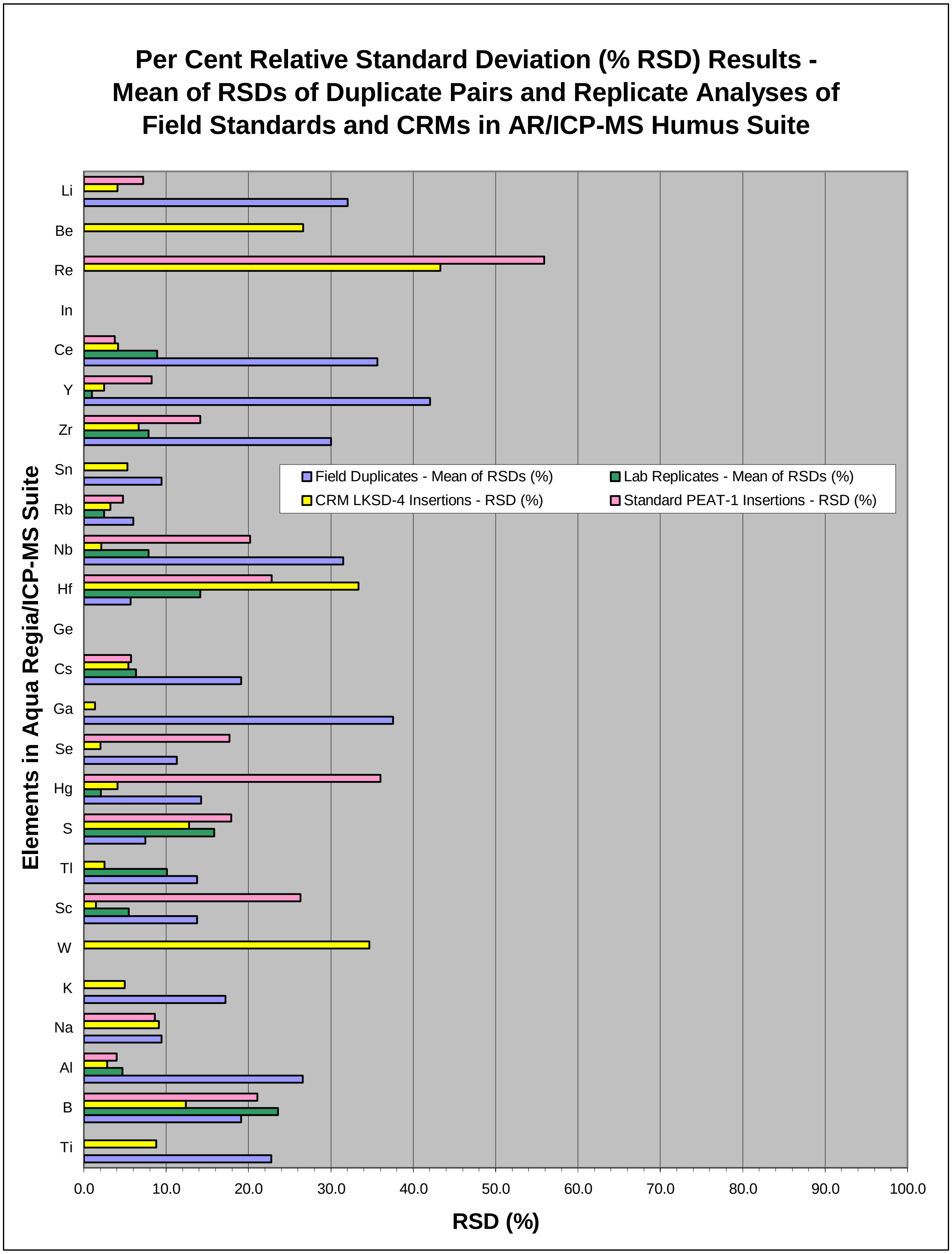


Figure 41. *Second of two bar charts showing relative standard deviation (RSD) results for the aqua regia–ICP-MS suite of elements in 3Ts LFH horizon humus from the Tommy vein and Ted vein orientation transects. The chart shows 4 values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3) and 4) RSD results of replicate analyses of organic soil standard PEAT-1 (pink bars; N=5).*

NA-PYROPHOSPHATE LFH HORIZON HUMUS SUITE

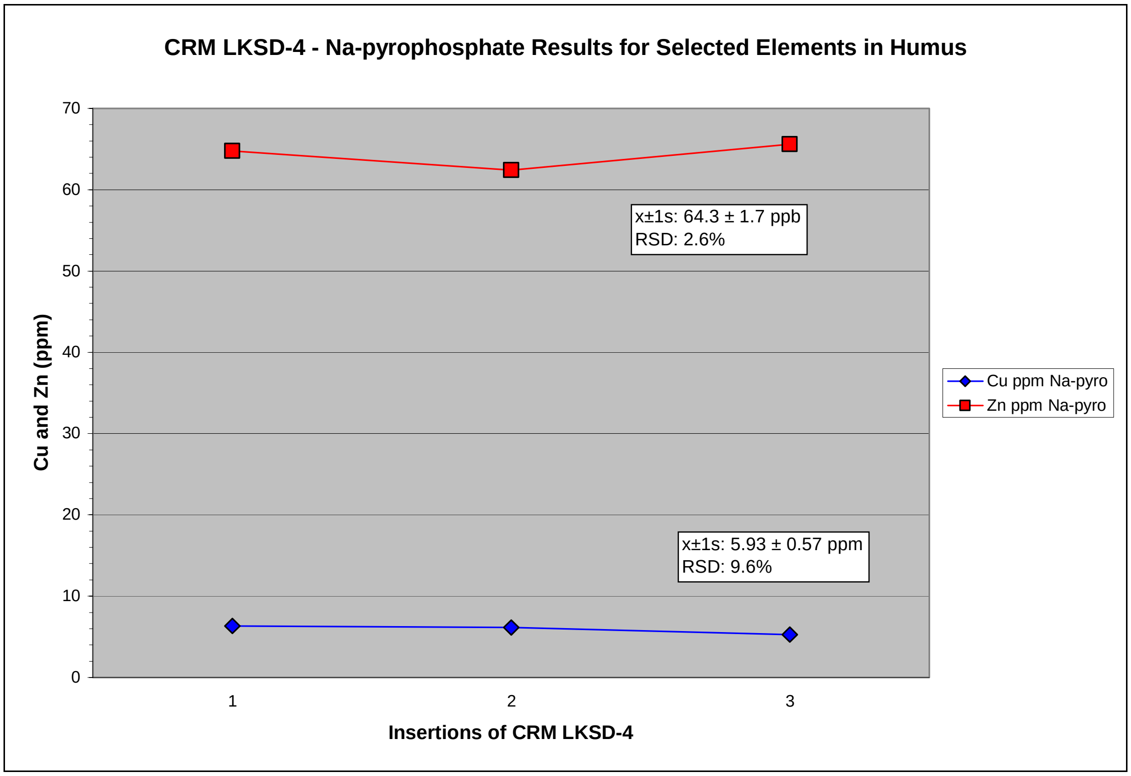
Results of multiple insertions of CANMET certified reference material (CRM) LKSD-4 and Anglo American internal organic soil standard PEAT-1 into the Na-Pyrophosphate leach suite of LFH horizon humus samples at Acme Labs show that analytical reproducibility of selected elements (Figures 42 to 45) is adequate, even at relatively low concentrations. Both LKSD-4 and PEAT-1 are organic-rich surficial standards chosen for their similar loss on ignition (LOI) values and matrix compatibility with organic-rich 3Ts humus sampled from the Tommy and Ted veins transects. No conclusions, however, can be made here regarding analytical accuracy, as no accepted values are available for Na-Pyrophosphate leach selective extractions of these standards.

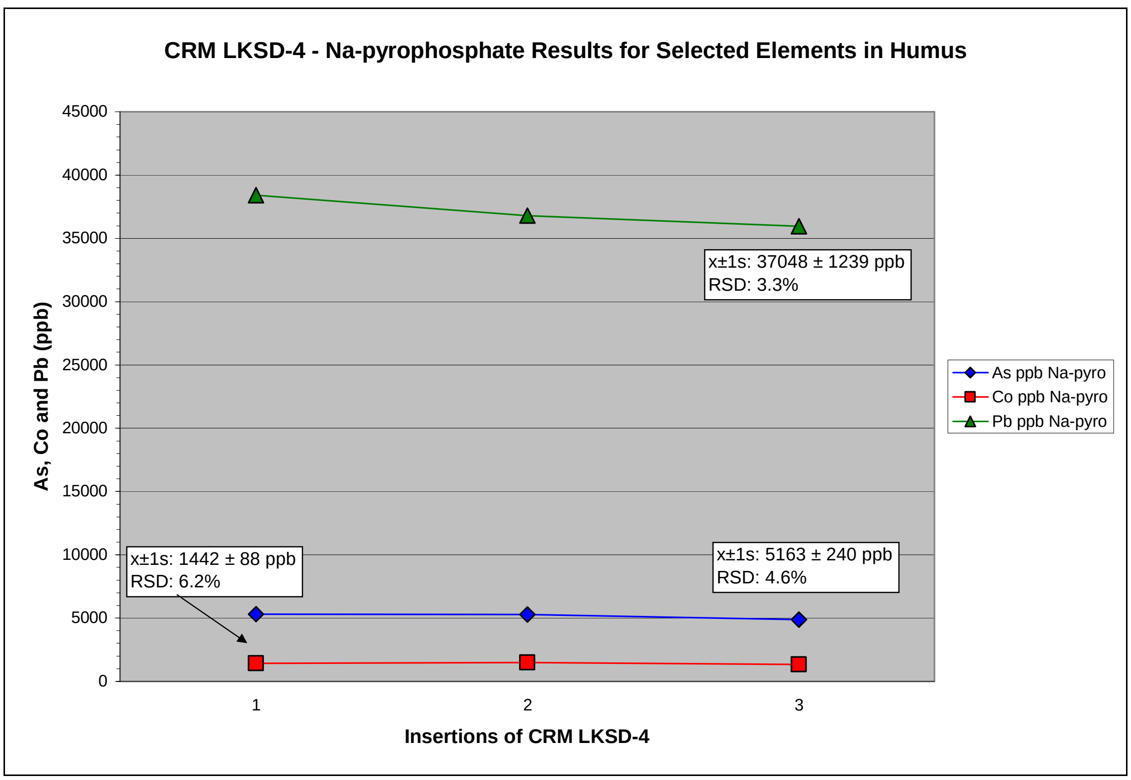
Scatterplots showing duplicate sample results for both field duplicate pairs (N=4) and Acme Labs internal lab replicates (N=2) are shown for several elements including Ag, Zn, Cd, Au, Cu and Pb (Figures 46 to 51) in the LFH horizon soil Na-Pyrophosphate leach suite for the combined Tommy and Ted vein orientation transects. It is apparent from these duplicate results that an adequate degree of reproducibility has been achieved for most elements, although gold results are characteristically erratic. The issue of reproducibility is explored more fully in the RSD bar charts (Figure 52 and Figure 53), where RSD results are compared for several sample grouping for each elements in the aqua regia analytical suite. Four values are shown for each element, comprising 1) the mean of RSD results for field duplicate pairs (blue bars; N=4 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3), and 4) RSD results of replicate analyses of Anglo American organic soil standard PEAT-1 (pink bars; N=5).

Relative standard deviation (RSD) results for field duplicate samples, which measure combined field, preparation and analytical variation, are generally greater than those for lab replicates or control standards, which measure analytical variation only. In this case, the mean of all mean RSDs for field duplicates is 32.9%, while that for lab replicates is about 4 times better at 7.7%. Mean RSD for multiple insertions of CANMET certified reference material (CRM) LKSD-4, at 9.4%, is of a similar magnitude to that of the lab replicates. The second standard, PEAT-1, returned a higher mean RSD value (19.6%). This is, however, consistent with the generally very low element concentrations present in this background-level organic soil standard; by definition, element precision worsens the nearer to the analytical detection limit.

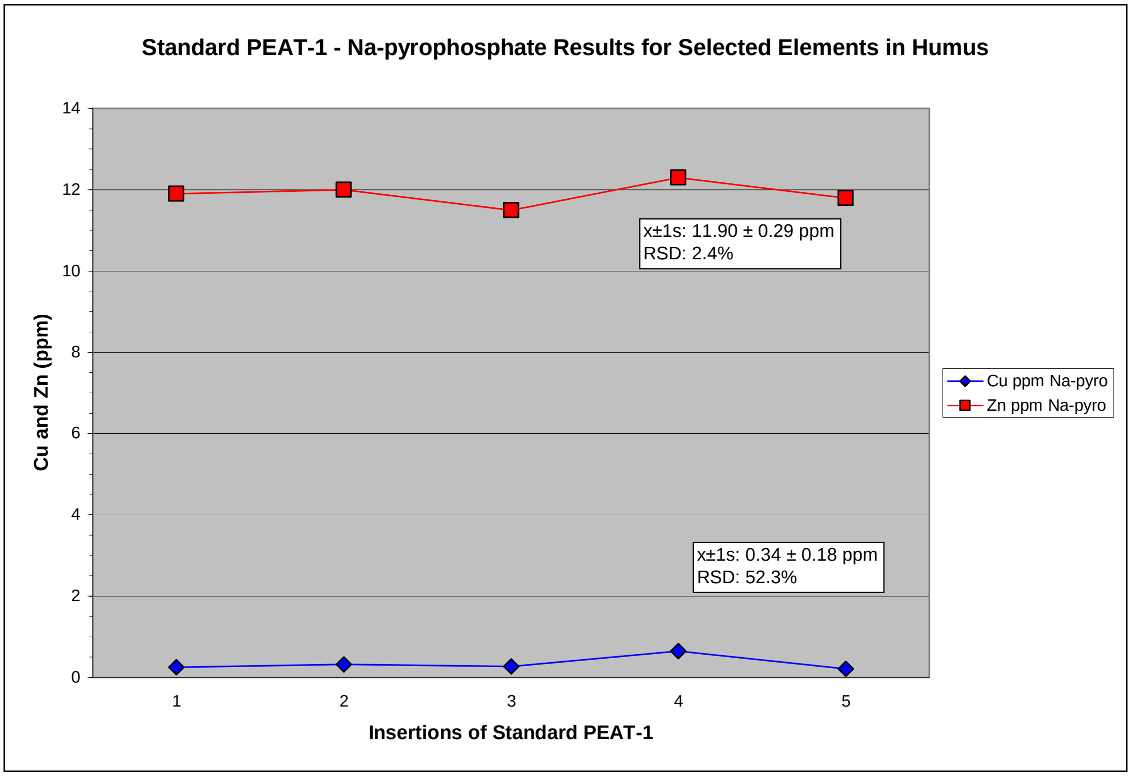
As an example of this relation, RSD values for Cu in humus are 25.6% for field duplicates, where the greatest variation is normally expected. Some pairs of field duplicate samples display very little variation, whereas other pairs display much greater variation in results. Certainly, Au results in field duplicates show very poor reproducibility, with mean of RSDs for field duplicate pairs exceeding 65% (Figure 52). By contrast, RSD results for internal lab replicates and CRM LKSD-4 insertions are much lower at only 0.6% and 9.6%, respectively. Copper RSD results for PEAT-1, where absolute Cu concentrations are much lower, are worse at 52.3%. Similar results were received for Ag, for example, with RSD values of 26.0%, 5.9% and 5.4% in field duplicates, lab replicates and CRM LKSD-4 insertions, respectively. These results indicate that, in general, field sampling is the primary source of within-site variation in the Na-Pyrophosphate leach suite of LFH horizon results, whereas analytical variation in the laboratory contributes only a relatively minor component to the total variation. The relatively minor differences in mean of RSD results for field duplicate sample pairs tend to support this interpretation; in the case of Cu, for example, the mean of RSD for field duplicates is 19.5% for aqua regia digestion and 25.6% for Na-Pyrophosphate digestion. In general, however, the analytical precision of the Na-Pyrophosphate determinations is slightly worse than those by aqua regia, but the differences are minor.

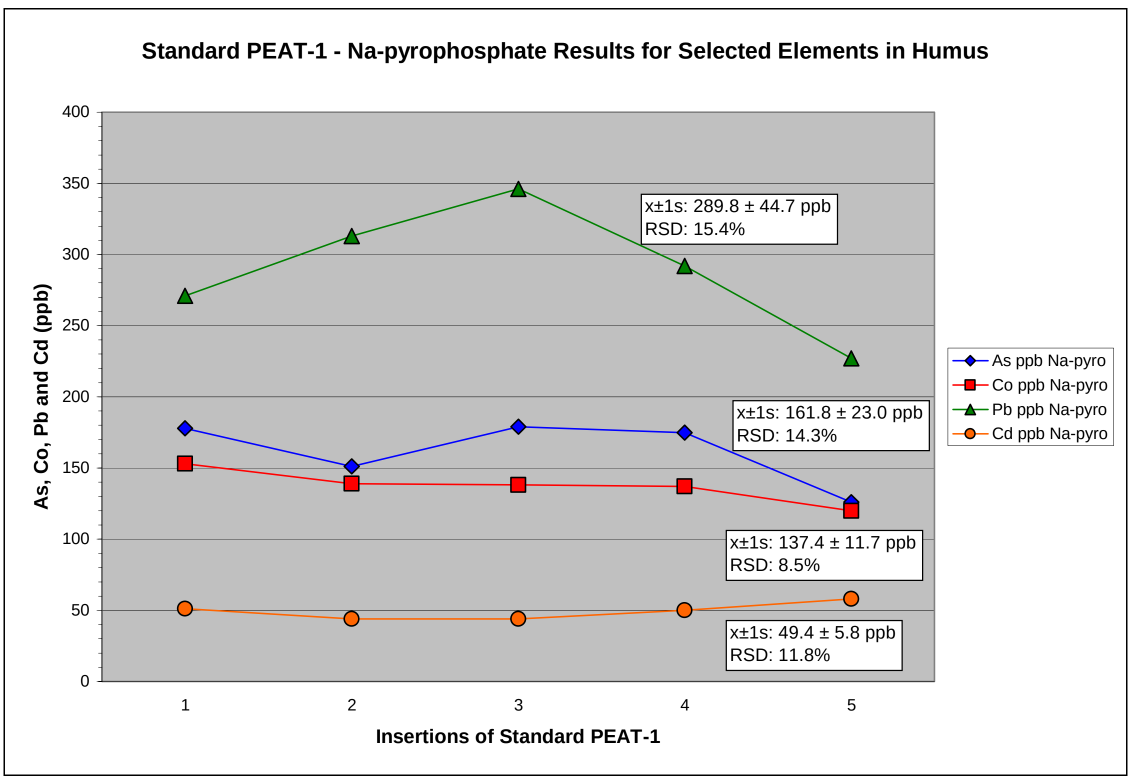
No humus field standard, analogous to the Tommy soil field standard, was collected at 3Ts for insertion into the humus analytical suites. Furthermore, no firm conclusions can be drawn from RSD values for Au in humus results here, as a reliable calculation of precision estimates is hindered by the very low Au concentrations present in both routine field samples and standards.



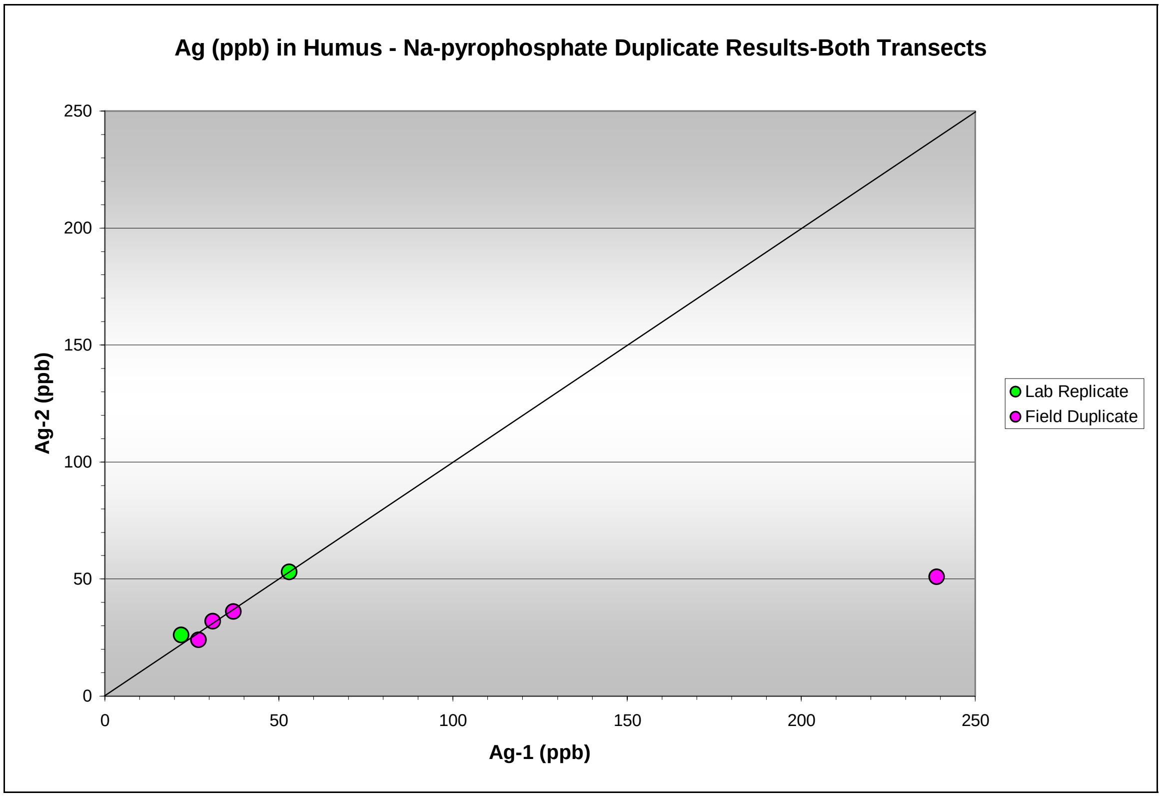


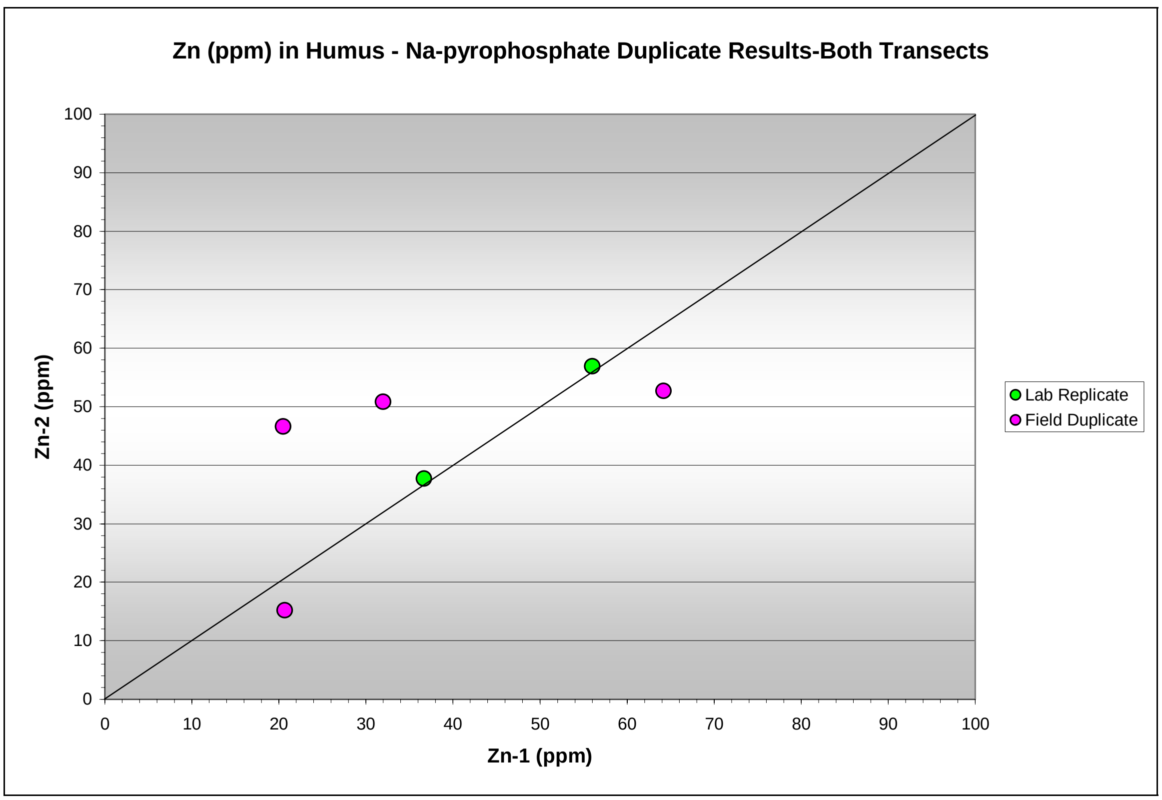
Figures 42 and 43. *Line plots of Na-Pyrophosphate leach results for Cu and Zn (top) and As, Co and Pb (bottom) for insertions of CANMET CRM LKSD-4 (N=3 insertions) in the suite of LFH horizon humus samples from the combined Tommy and Ted veins' orientation transects. Precision results, as RSD, from replicate insertions are shown, but no accepted values are available for this selective extraction.*



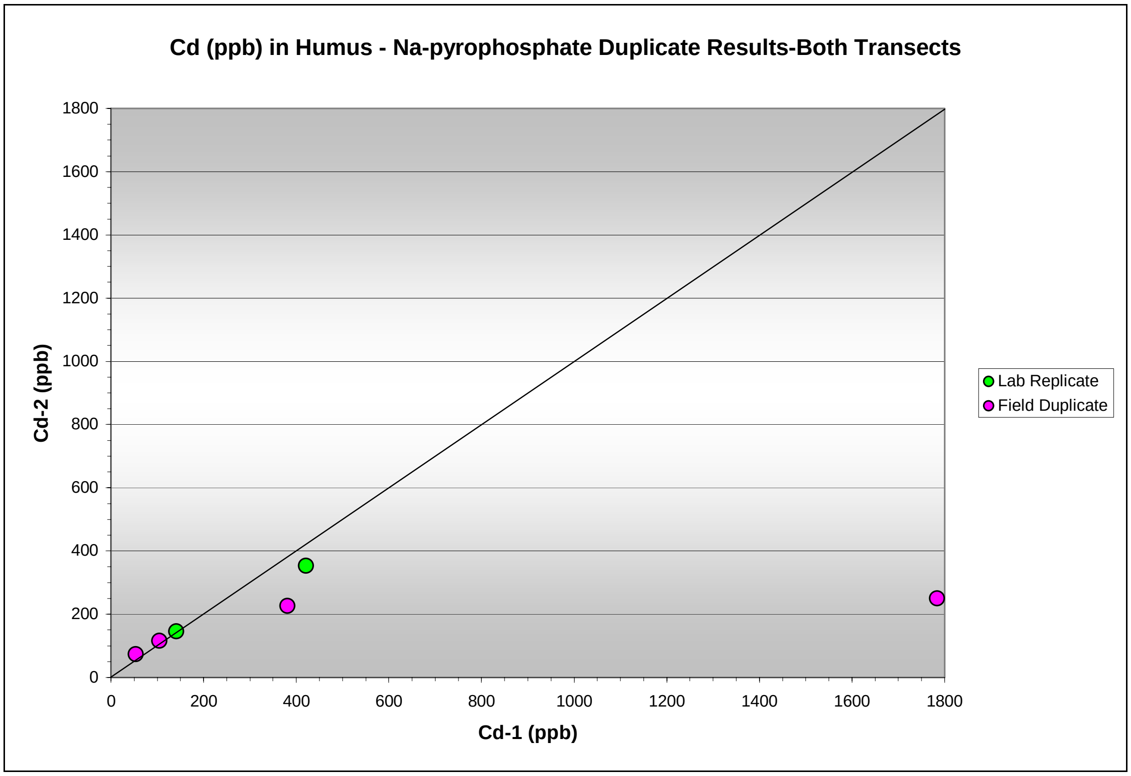


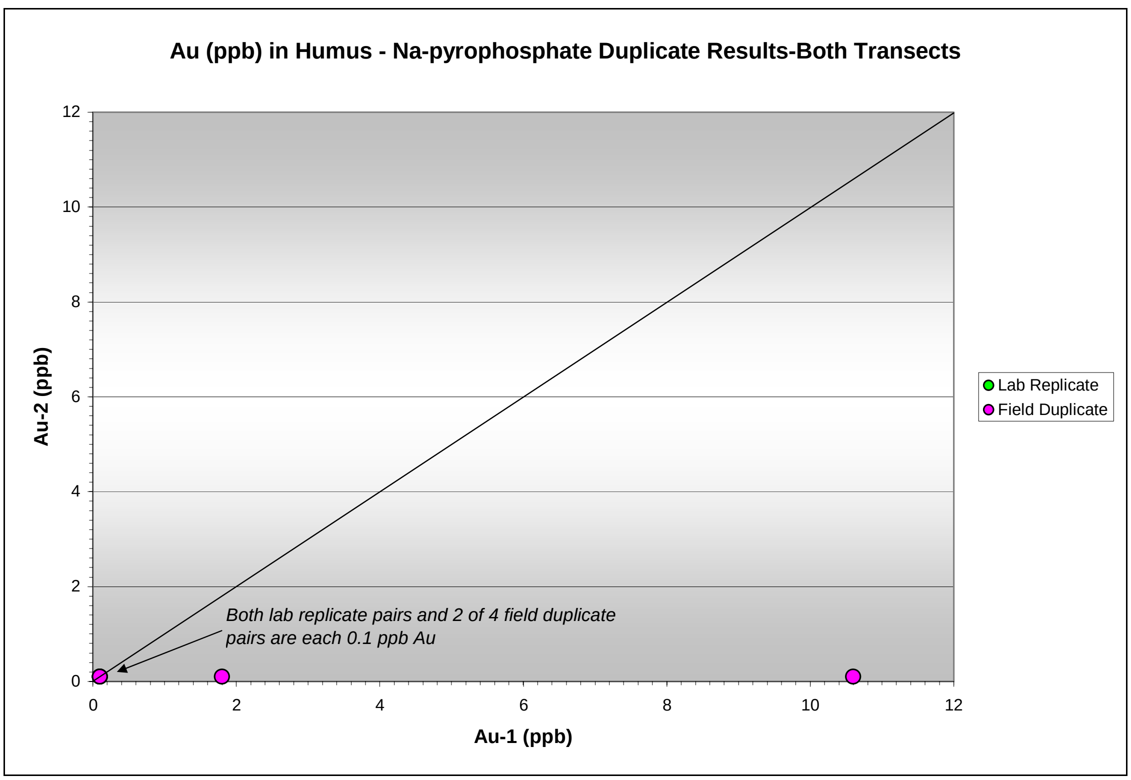
Figures 44 and 45. *Line plots of Na-Pyrophosphate leach results for Cu and Zn (top) and As, Co, Pb and Cd (bottom) for insertions of organic soil standard PEAT-1 (N=5 insertions) in the suite of LFH horizon humus samples from the combined Tommy and Ted veins' orientation transects. Precision results, as RSD, from replicate insertions are shown, but no accepted values are available for this selective extraction.*



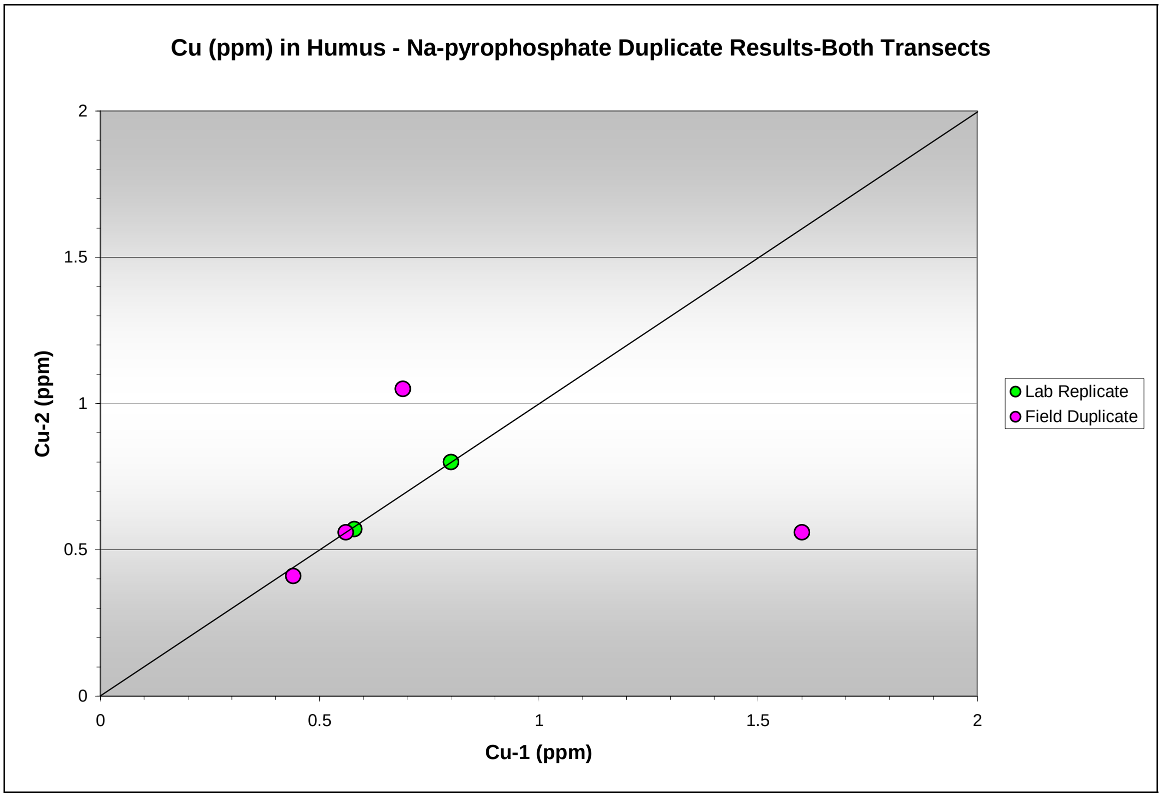


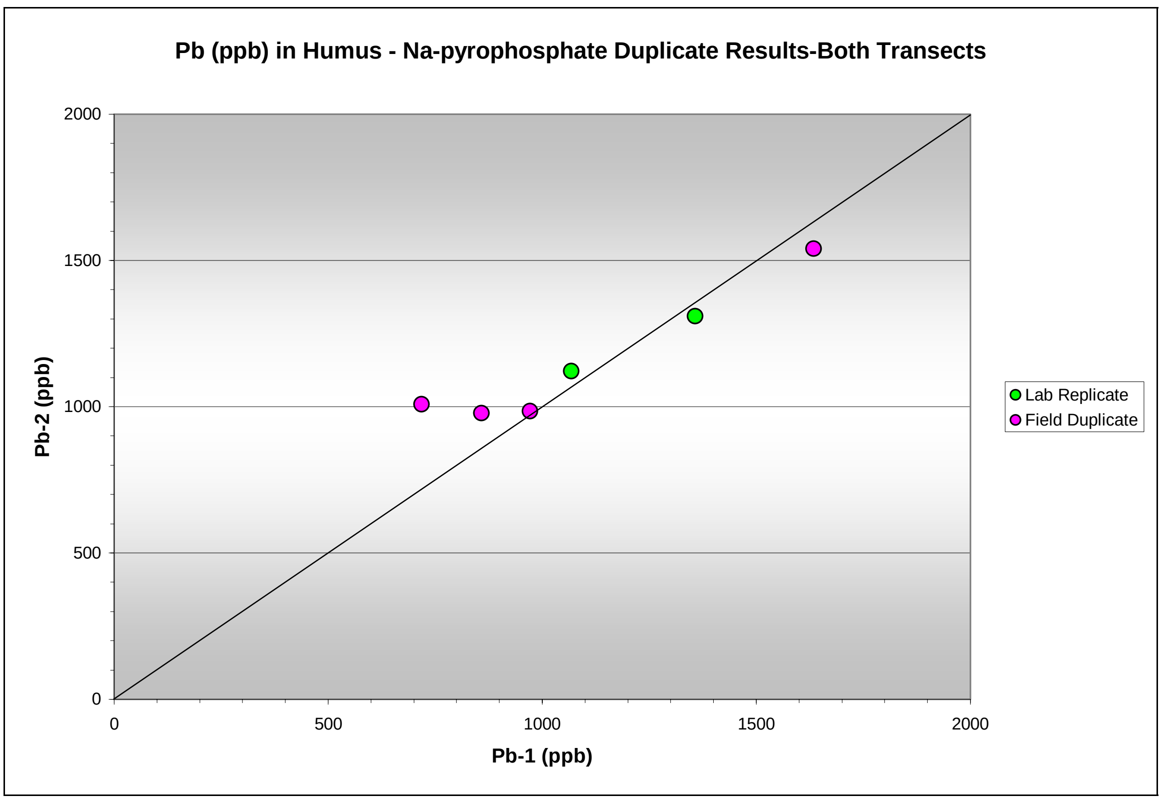
Figures 46 and 47. *Scatterplots showing field duplicate sample results (N=4 pairs) and Acme Labs lab replicate sample results (N=2 pairs) for Ag (top) and Zn (bottom) by Na-Pyrophosphate leach in organic-rich LFH horizon humus for the combined Tommy and Ted vein orientation transects.*





Figures 48 and 49. *Scatterplots showing field duplicate sample results (N=4 pairs) and Acme Labs lab replicate sample results (N=2 pairs) for Cd (top) and Au (bottom) by Na-Pyrophosphate leach in organic-rich LFH horizon humus for the combined Tommy and Ted veins' orientation transects. Note that most pairs of Au results by Na-Pyrophosphate leach are at the analytical detection limit of 0.1 ppb.*





Figures 50 and 51. *Scatterplots showing field duplicate sample results (N=4 pairs) and Acme Labs lab replicate sample results (N=2 pairs) for Cu (top) and Pb (bottom) by Na-Pyrophosphate leach in organic-rich LFH horizon humus for the combined Tommy and Ted vein orientation transects.*

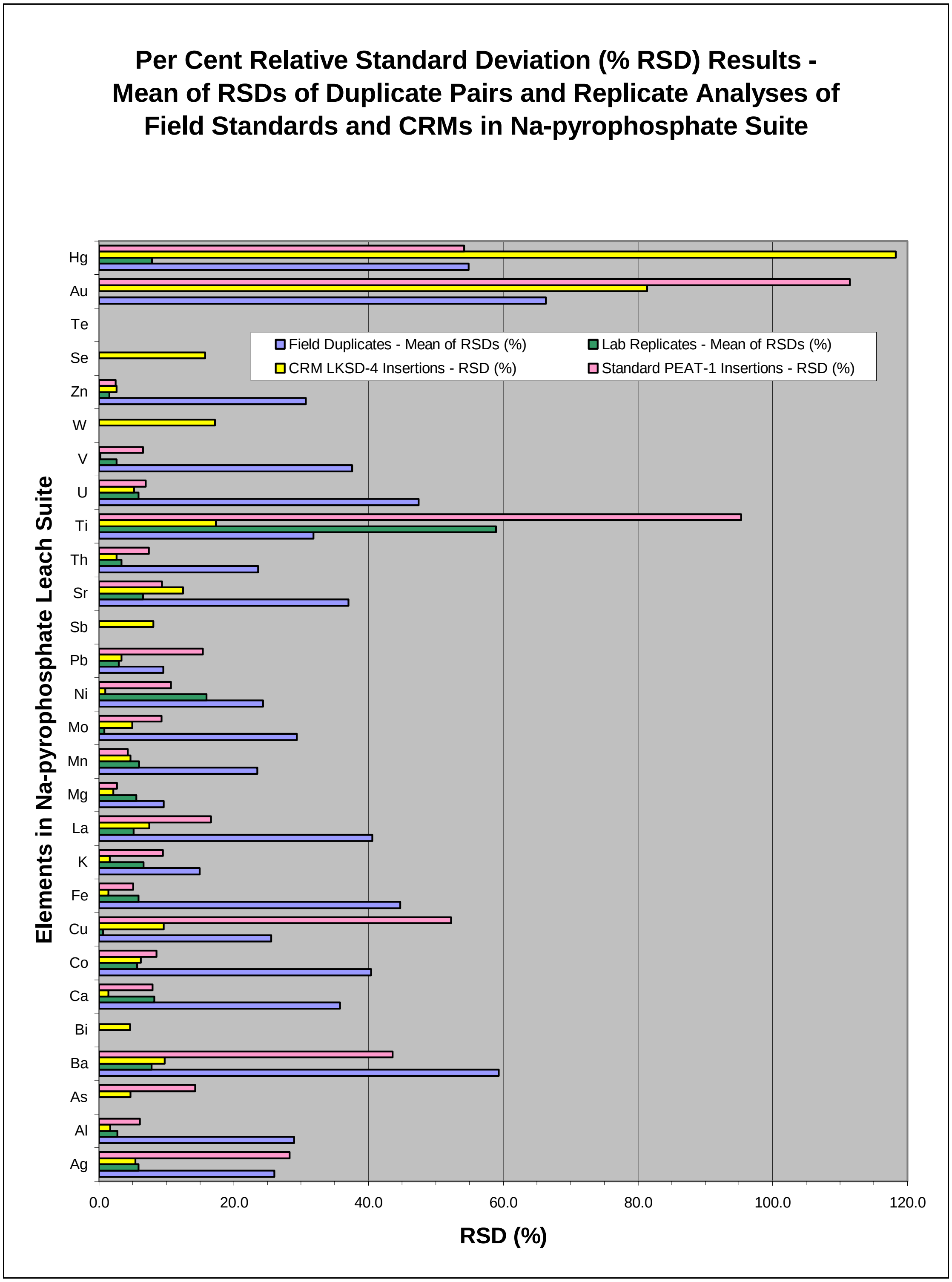


Figure 52. *First of two bar charts showing relative standard deviation (RSD) results for the Na-Pyrophosphate leach suite of elements in 3Ts LFH horizon humus from the Tommy vein and Ted vein orientation transects. The chart shows 4 values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=4 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3) and 4) RSD results of replicate analyses of soil standard PEAT-1 (pink; N=5).*

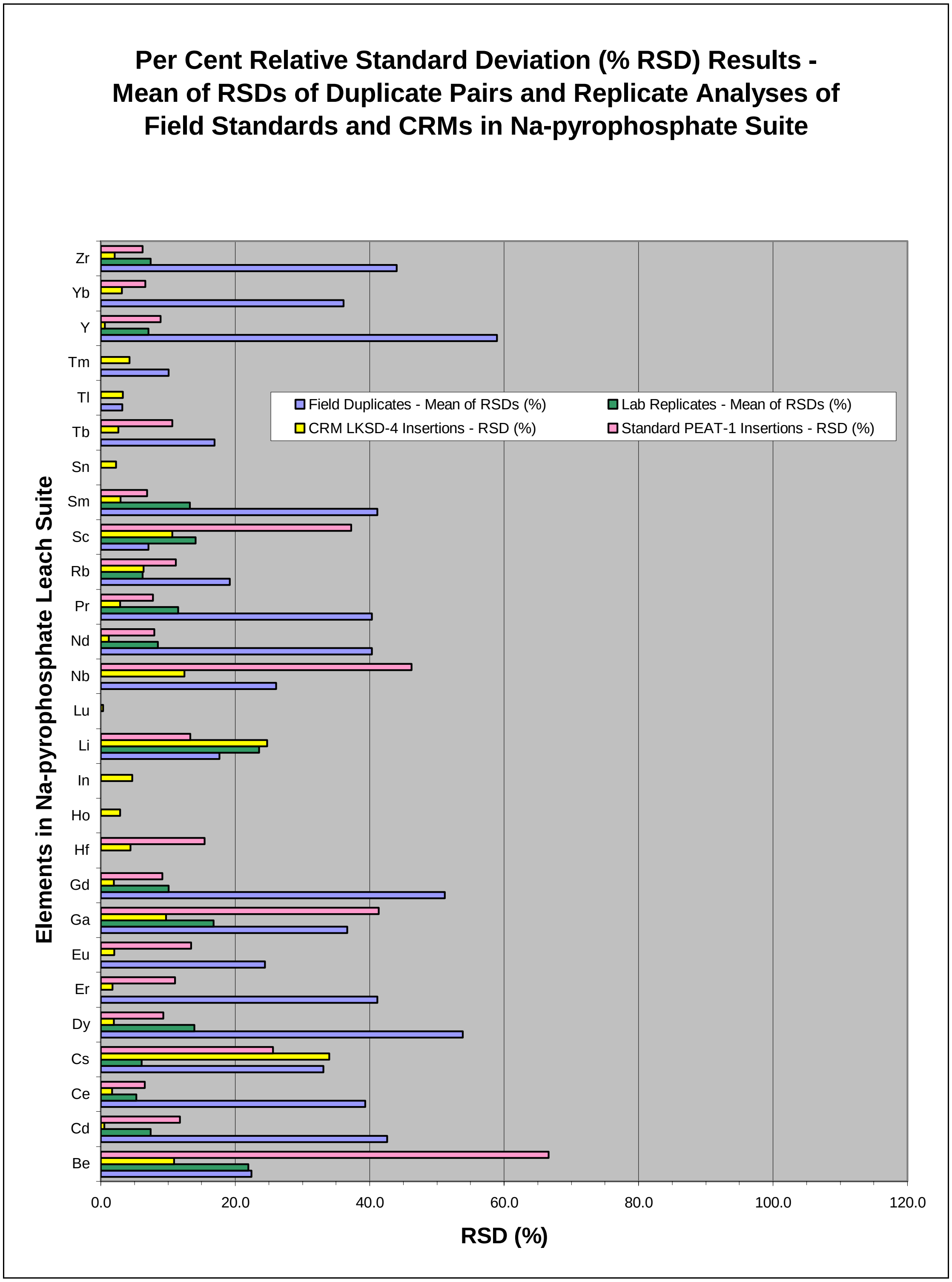


Figure 53. *Second of two bar charts showing relative standard deviation (RSD) results for the Na-Pyrophosphate leach suite of elements in 3Ts LFH horizon humus from the Tommy vein and Ted vein orientation transects. The chart shows 4 values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=4 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of CANMET certified reference material LKSD-4 (yellow bars; N=3) and 4) RSD results of replicate analyses of soil standard PEAT-1 (pink; N=5).*

AQUA REGIA B HORIZON SOIL AND C HORIZON TILL SUITES

The B horizon soil and C horizon till aqua regia digestion–ICP-MS suites included several field duplicate samples to assess combined sampling, preparation and analytical variability of results, as well as a series of certified reference materials (CRMs) and standards of known concentration to monitor analytical accuracy. CANMET certified reference materials TILL-1 and TILL-3 were inserted in the soil suite, along with the Tommy field standard, while CRMs TILL-1 and TILL-4 were inserted in the till suite. Anglo American internal till standard 'Little Fort' was also inserted in the till suite. In addition, results of analytical replicates and internal standards reported by Acme Labs as part of their own QA/QC procedures are also discussed here. Aqua regia digestion control standard and duplicate result diagrams are shown here paired, for each of B horizon soil and underlying C horizon till, for ease of comparison between the two mineral horizons.

Line plots for Cu, Zn, Ag, Pb, As and Sb results of various standards are shown for each of B horizon and C horizon soils (Figures 54 to 65). Analytical accuracy for selected elements is well within acceptable limits for most elements of economic interest. Accepted values for mean ±1s concentrations following dilute HNO_3-HCl digestion are from Lynch (1996). For example, multiple insertions (N=3) of CANMET till standard TILL-3 in the B horizon soils suite returned mean ±1s results of 1410 ±54 ppb silver, relative to the recommended value of 1.4 ±0.2 ppm (1400 ±200 ppb) silver reported by Lynch (1996). At the lower end of the silver concentration range, multiple insertions of CANMET till standard TILL-1 in each of the B horizon soils (N=4) and till (N=3) suites returned mean ±1s results of 206 ±8 ppb and 210 ±12 ppb, respectively, relative to a recommended value of <0.2 ppm (<200 ppb) silver.

Three insertions of each of TILL-1 and TILL-4 in the till suite returned copper results of 48.6 ±1.3 and 224.5 ±9.5 ppm, relative to recommended values of 49 ±2 ppm and 254 ±15 ppm, respectively. TILL-1 Cu results in the B horizon soil suite, at 47.52 ±0.66 ppm, also compare well with the accepted values. Highly accurate results were obtained even on elements such as Pb which, due to its lower abundance in the surficial environment, may display poor analytical precision. Multiple insertions of CANMET TILL-1 in soil and till AR–ICP-MS analytical suites returned Pb concentrations of 14.46 ±0.28 ppm and 15.06 ±0.68 ppm respectively, relative to an accepted value of 14 ±3 ppm. Gold results are not highlighted here, as the CANMET CRMs contain only background-level Au concentrations and were not originally certified for Au analysis.

An examination of precision results show that analytical precision, as determined by replicate analyses of standards, is generally better than 10% for most trace elements of economic interest such as silver, zinc, lead and copper. Precision is defined here as 2 times the relative standard deviation (RSD) of replicate analyses of standards (Fletcher, 1981). For example, replicate analyses of five sets of CANMET and other standards in the till and mineral soil suites by aqua regia digestion–ICP-MS returned precision results in the range of 5.3 to 11.1% for silver, 3.1 to 10.0% for zinc and 3.9 to 9.8% for lead. Replicate blind analyses (N=5) of the B horizon field standard returned very similar precision results of 8.3%, 5.2% and 5.1% for silver, zinc and lead, respectively.

Scatterplots of field duplicate and analytical replicate pairs for Cu, Zn, Ag, Pb, As and Au (Figures 66 to 77) in each of B horizon soil and C horizon till suites show that lab replicates typically show considerably less variability than do those for field duplicate pairs. In B horizon soils, for example, the mean of RSDs calculated from lab replicate results for Cu and Zn is only 2.3% and 0.8%, respectively, relative to much higher mean of RSD results of 18.9% and 12.0%, respectively, for field duplicate pairs. The differences reflect the much greater field, sampling, preparation and analytical variations inherent in field duplicate samples, whereas lab replicates are a measure of analytical variation only. It is clear from these results that geochemical variations are much more likely to be introduced in the field, as within-site variations during the sampling stage, than they are in the analytical laboratory. Even the Tommy bulk field standard returned RSD results of only 4.4% and 2.6% for Cu and Zn, respectively. Note that field duplicate pairs are blind to the assaying laboratory, whereas the choice of lab replicates is made at the lab.

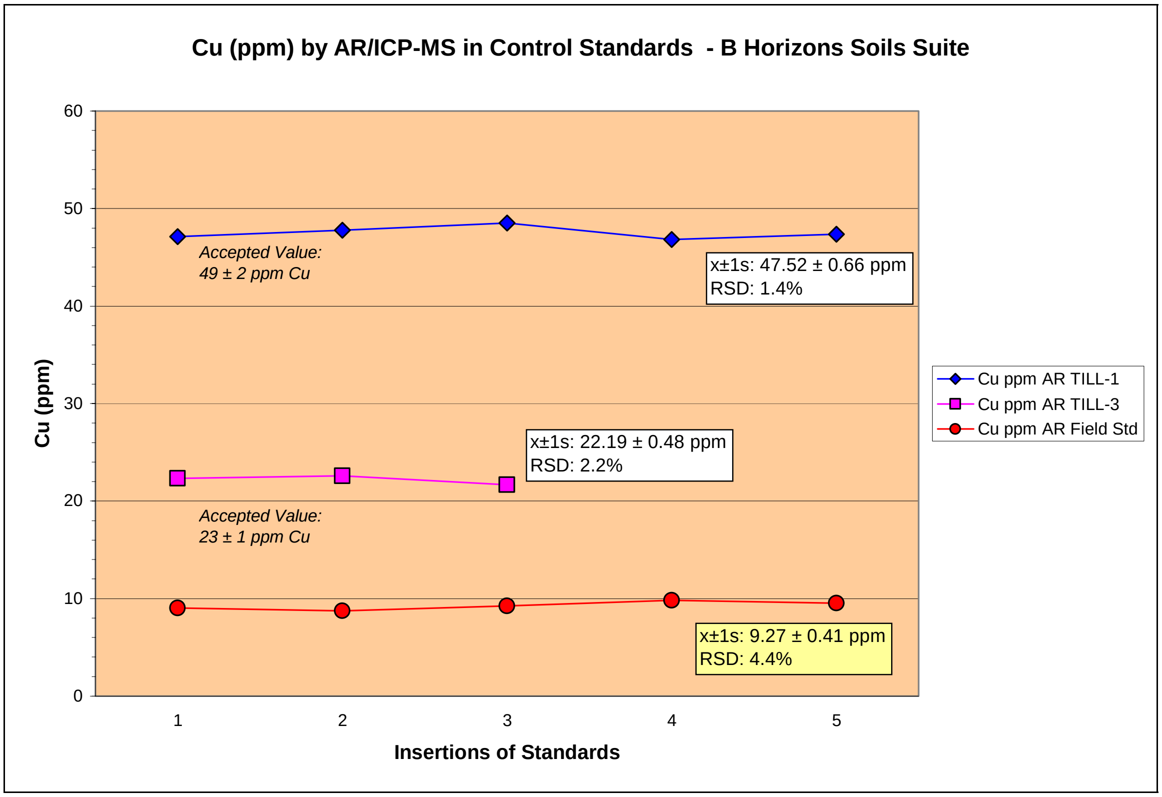
Among field duplicate pairs alone, results for sample pairs from B horizon soils typically show much greater variability than do those for C horizon tills. For example, the mean of RSD results for B horizon Cu and Zn in the field duplicate samples (Figure 78 and Figure 79) noted above are 18.9% and 12.0%, respectively, whereas mean of RSD results for the same elements in C horizon field duplicates are only 5.1% and 3.1%, respectively (Figure 80 and Figure 81). This is interpreted as a consequence of the inherently greater within-site variation in near-surface soils, which are the pedogenic products of varying surficial materials, slope, drainage conditions and other factors, relative to tills, which are more homogenous and less affected by near-surface physical and chemical processes. It is also partially a result, however, of only near-surface B horizon soils being present at some field duplicate sites around the partially exposed Tommy vein, where field duplicate soil pairs yielded widely variable results.

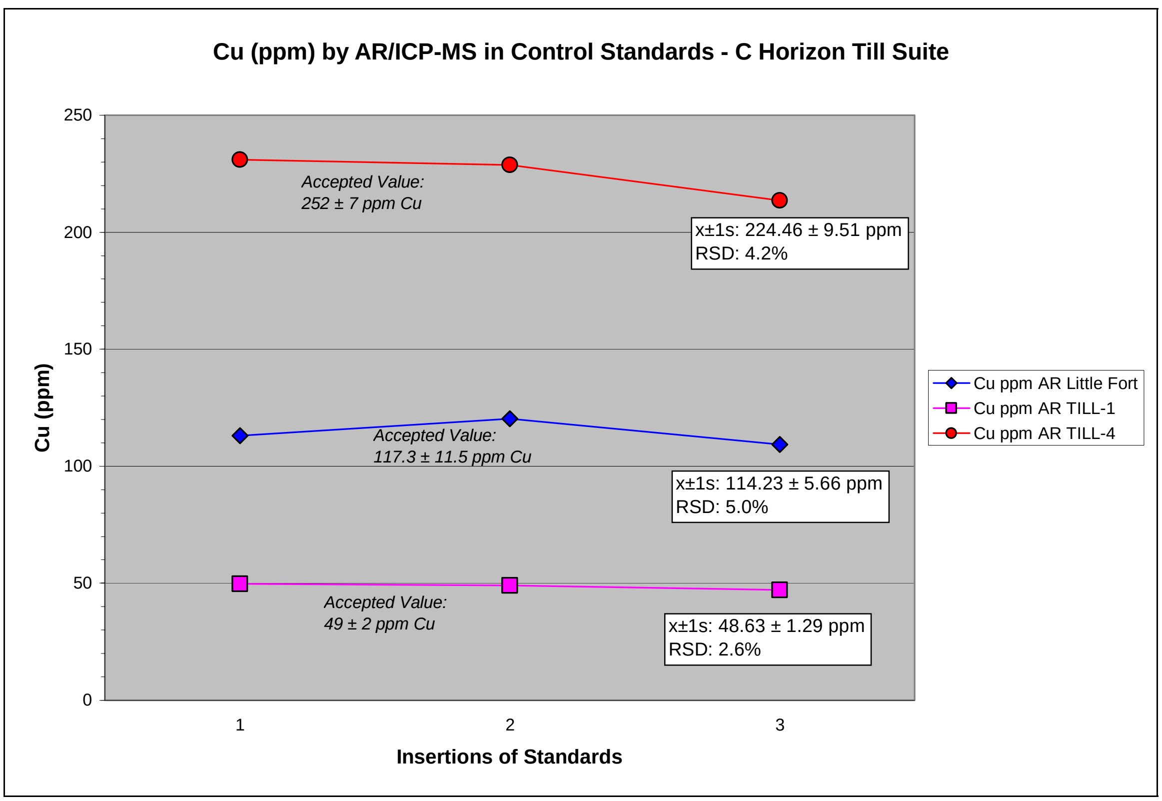
As expected, the mean of RSDs for Cu and Zn in analytical lab replicates here differ little between B horizon soils (0.8–2.3%) and C horizon tills (1.3–3.2%) as they are a measure of analytical variations only. Not unexpectedly, substantially similar RSD results are reported for the replicate analysis of standards, which is similarly a measure of analytical precision. In the case of Cu, for instance, relative standard deviation (RSD) results for CANMET CRM TILL-1 are 1.4% and 2.6% in soil and till suites, respectively. In this case, both Acme lab replicate results and replicate analyses of CRMs suggest that analytical precision for Cu by aqua regia digestion–ICP-MS is about 5% or less.

Table 4. *Listing of Au results by aqua regia digestion–ICP-MS (Group 1F method) for field duplicate and lab replicate sample pairs in the B horizon soil and C horizon till analytical suites.*

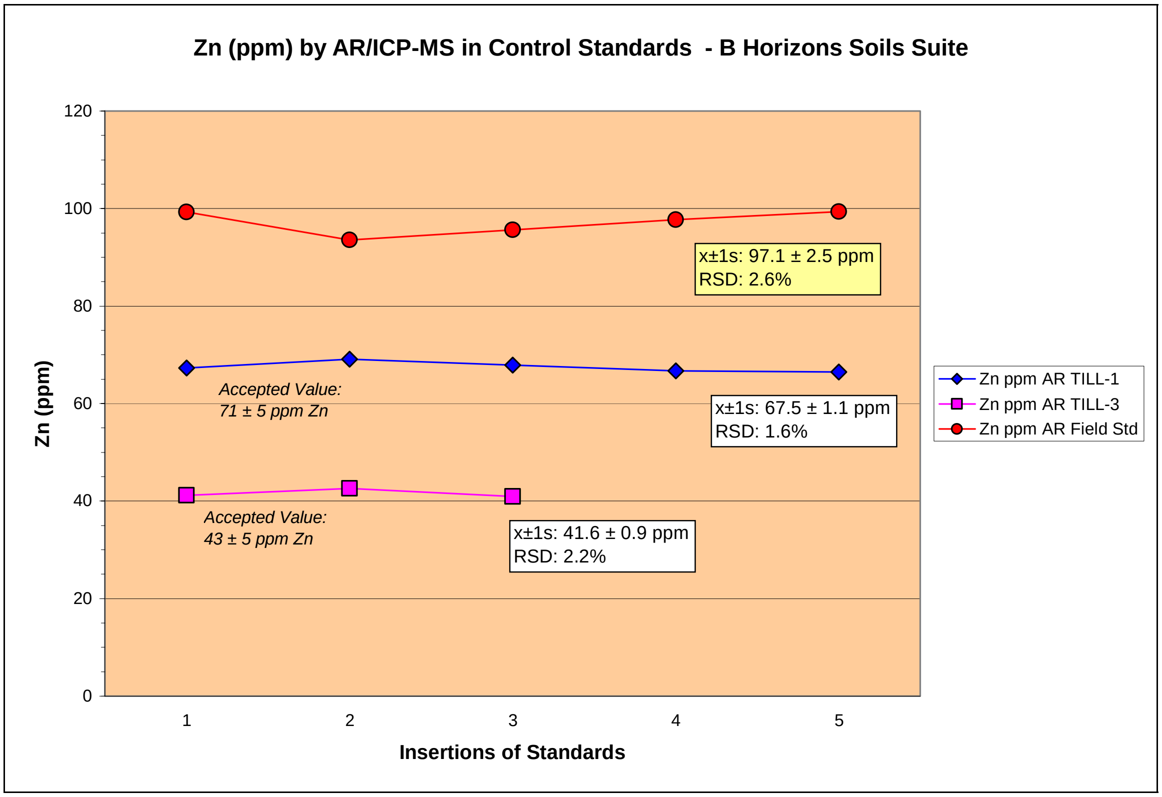
	ID Number of Routine Sample	Au-1 (ppb)	Au-2 (ppb)	Status of Duplicate Samples	Orientation Transect
B Horizon Soil Aqua Regia Digestion Suite	TOM-S-501-2	**1.7**	**0.9**	Field Duplicates	Tommy Line
	TOM-S-521-2	**7.9**	**20**	Field Duplicates	Tommy Line
	TOM-S-561-2	**2.7**	**3.1**	Field Duplicates	Ted Line
	TOM-S-571-2	**0.2**	**1.9**	Field Duplicates	Ted Line
	TOM-S-591-2	**223.1**	**17.7**	Field Duplicates	Tommy Line
	TOM-S-508-2	***5.3***	***3***	*Lab Replicate*	*Tommy Line*
	TOM-S-566-2	***1.3***	***0.9***	*Lab Replicate*	*Ted Line*
C Horizon Till Aqua Regia Digestion Suite	TOM-S-501-3	**1.8**	**2.4**	Field Duplicates	Tommy Line
	TOM-S-521-3	**38.6**	**10.5**	Field Duplicates	Tommy Line
	TOM-S-561-3	**84.9**	**8.1**	Field Duplicates	Ted Line
	TOM-S-571-3	***34.6***	***1***	Field Duplicates	Ted Line
	TOM-S-508-3	***0.8***	***1.4***	*Lab Replicate*	*Tommy Line*
	TOM-S-569-3	***1.4***	***6.4***	*Lab Replicate*	*Ted Line*

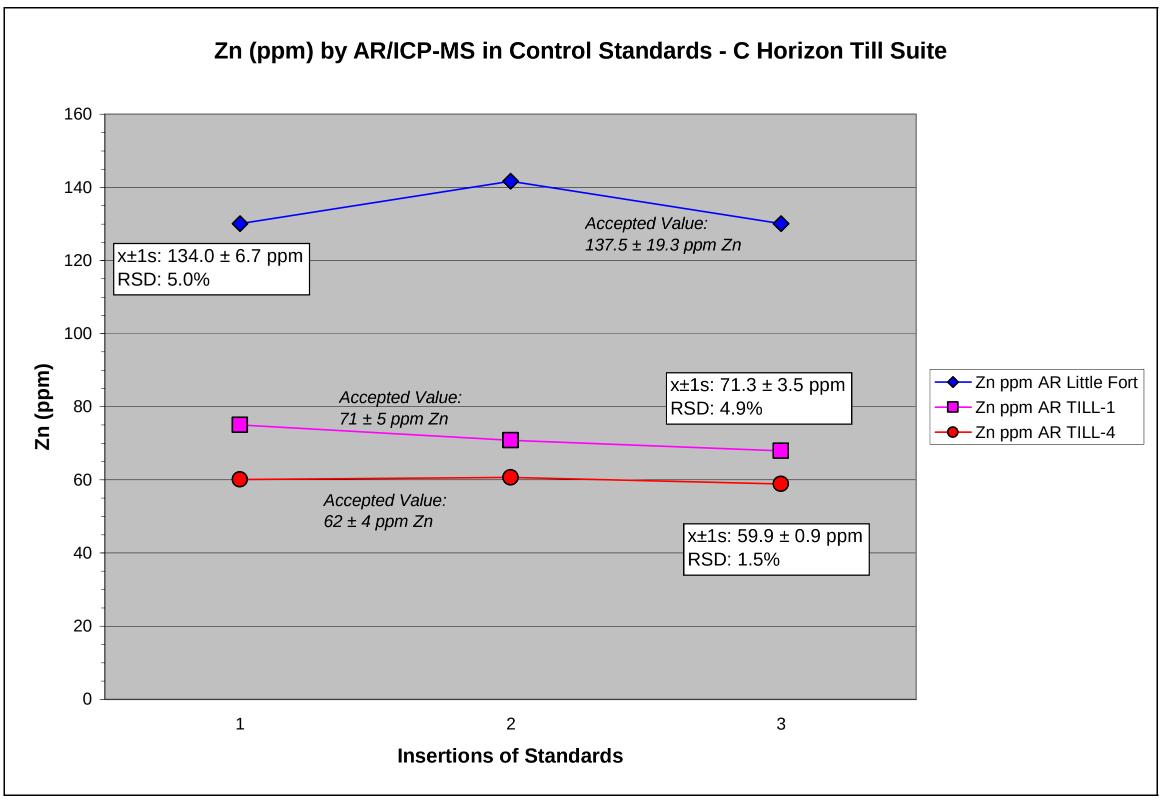
Only the first Au concentration (Au-1) of each duplicate pair is considered to be the routine concentration for plotting and statistical purposes. See Figures 76–*77 for graphed scatterplots of this data.*



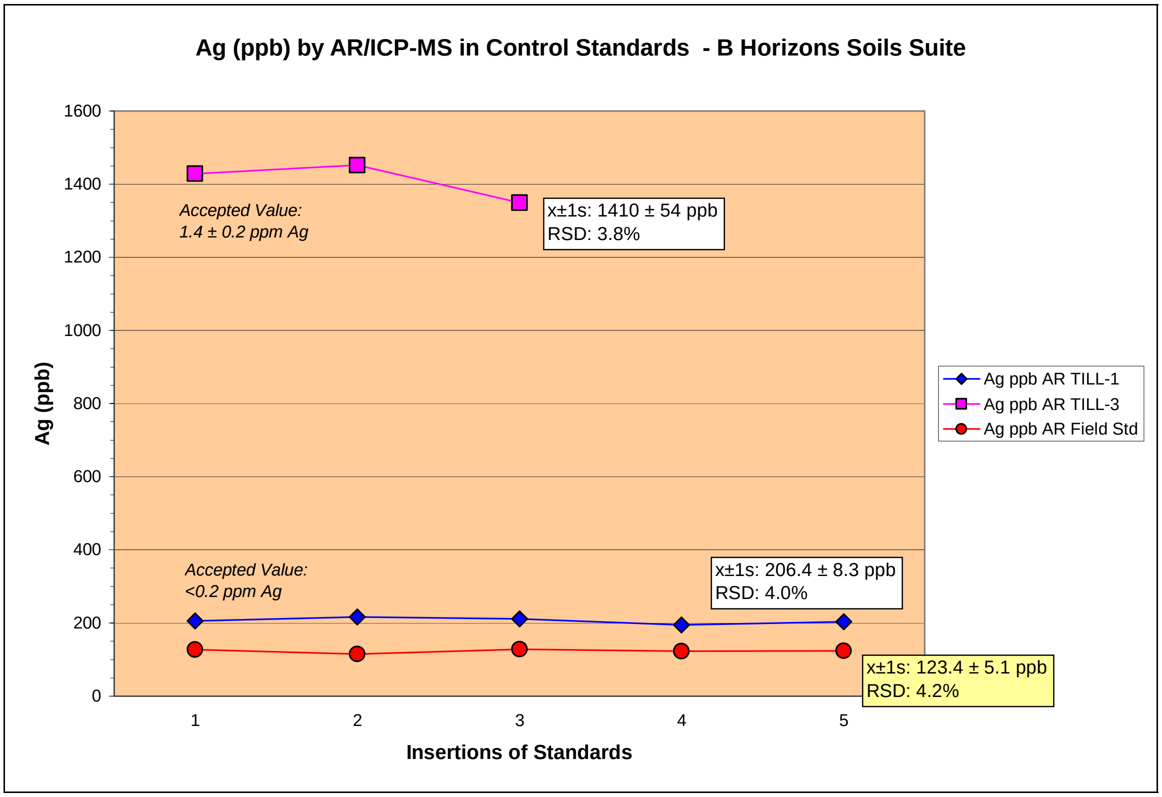


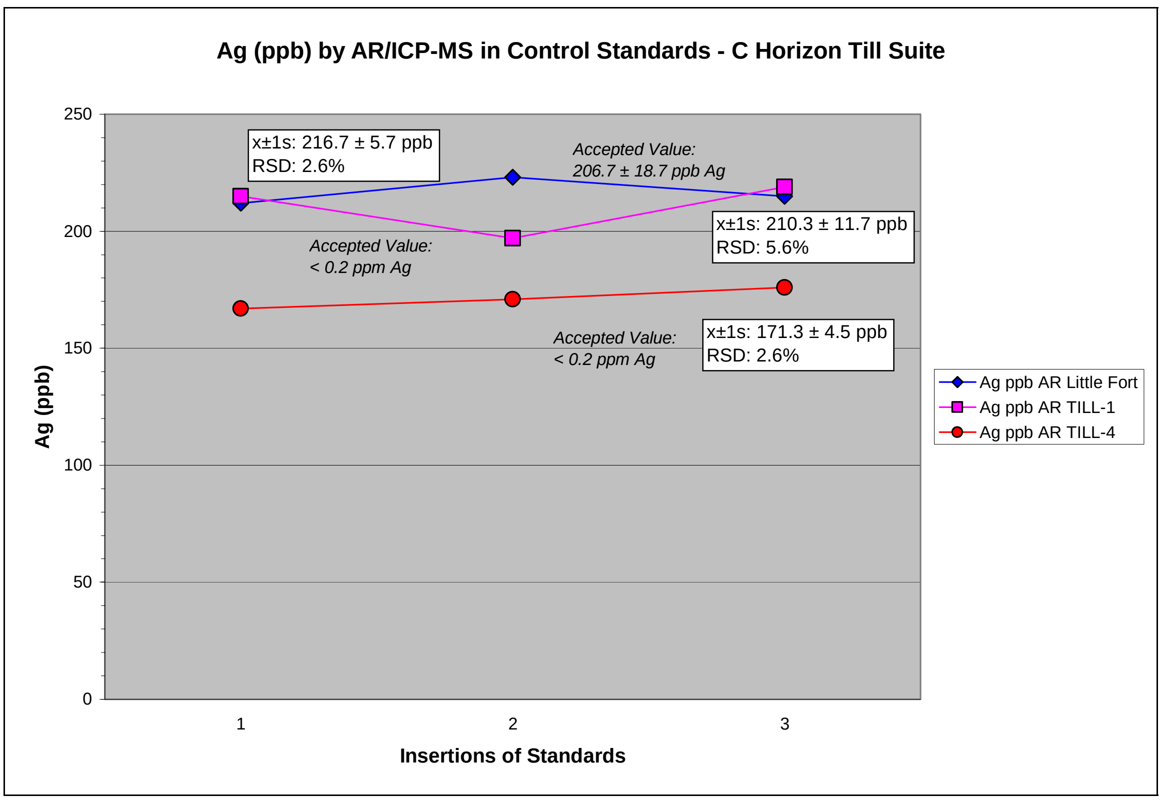
Figures 54 and 55. *Comparative line plots of aqua regia digestion–ICP-MS Cu results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) aqua regia suites. Results for the field soil standard and the Little Fort till standard are also shown.*



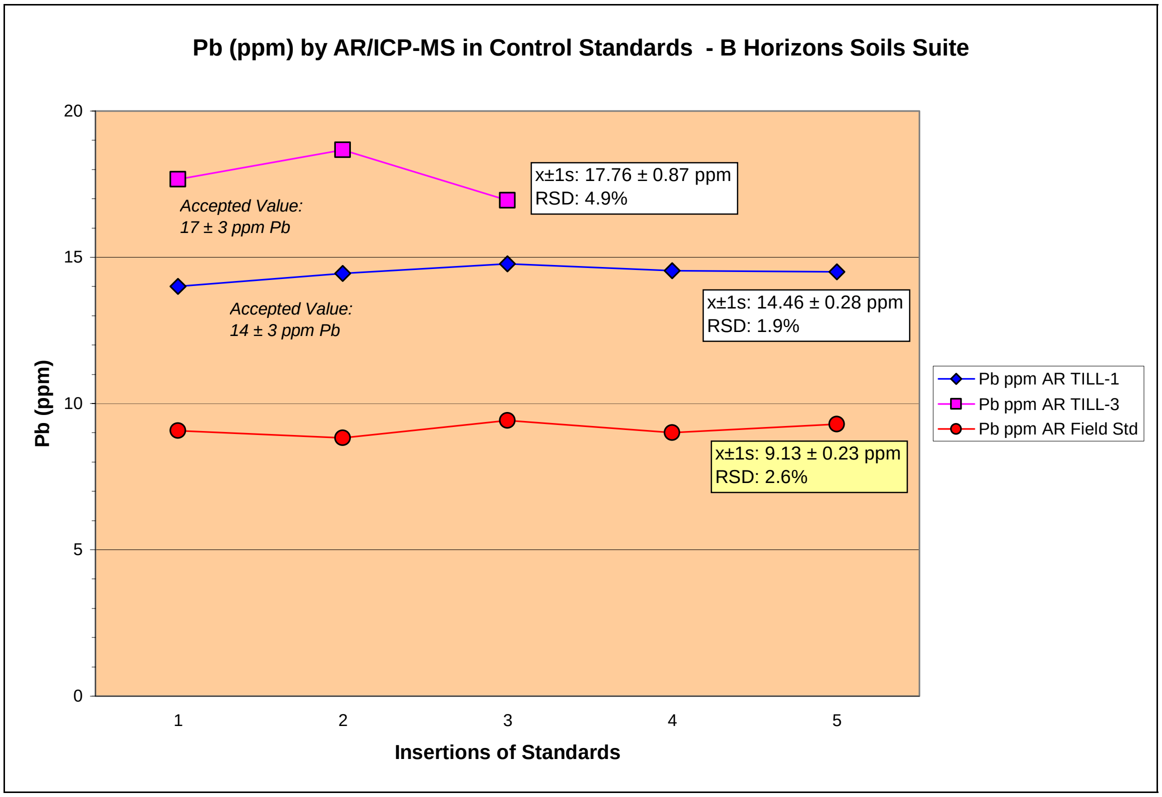


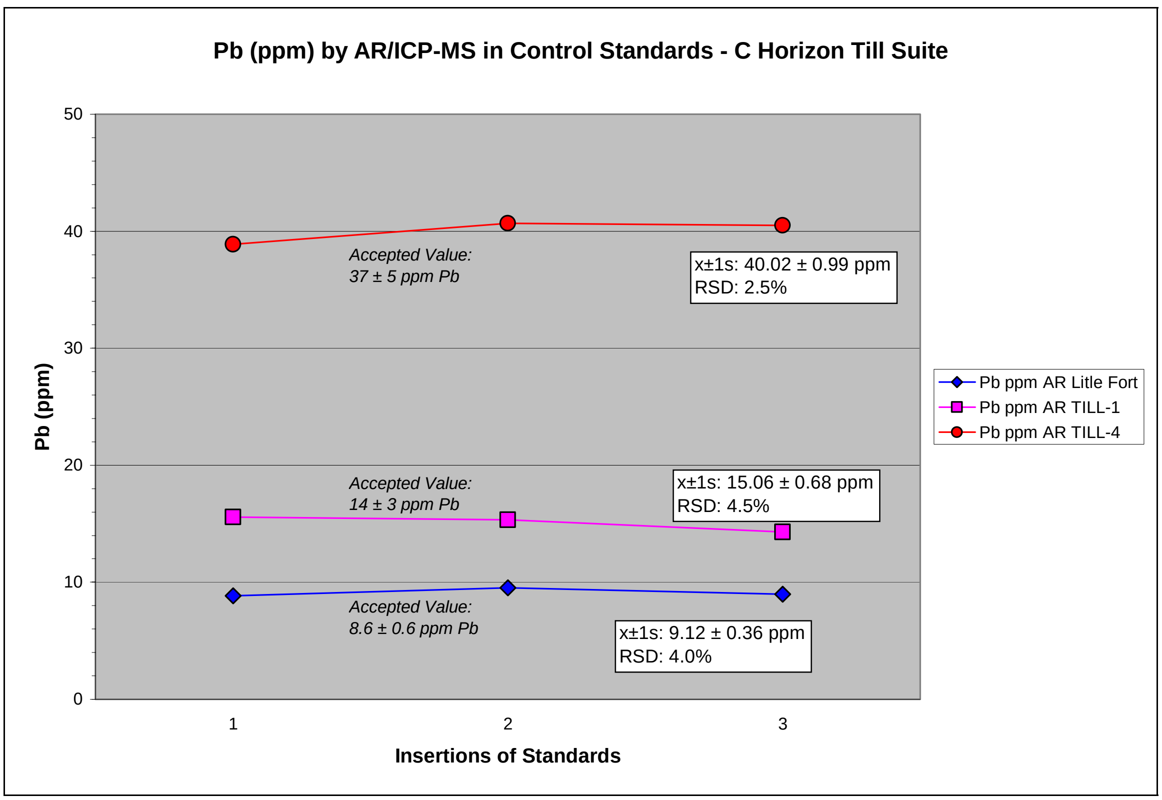
Figures 56 and 57. *Comparative line plots of aqua regia digestion–ICP-MS Zn results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) AR–ICP-MS suites. Results for the B horizon field standard and Little Fort till standard are also shown.*



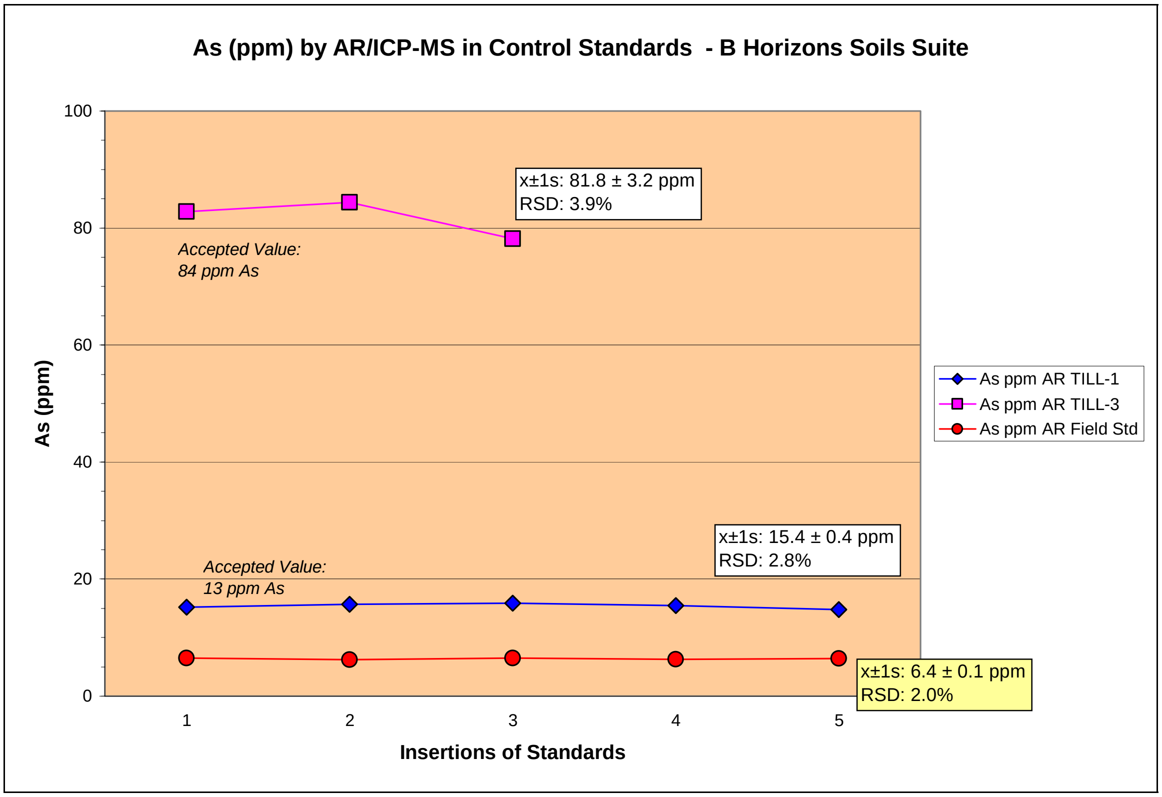


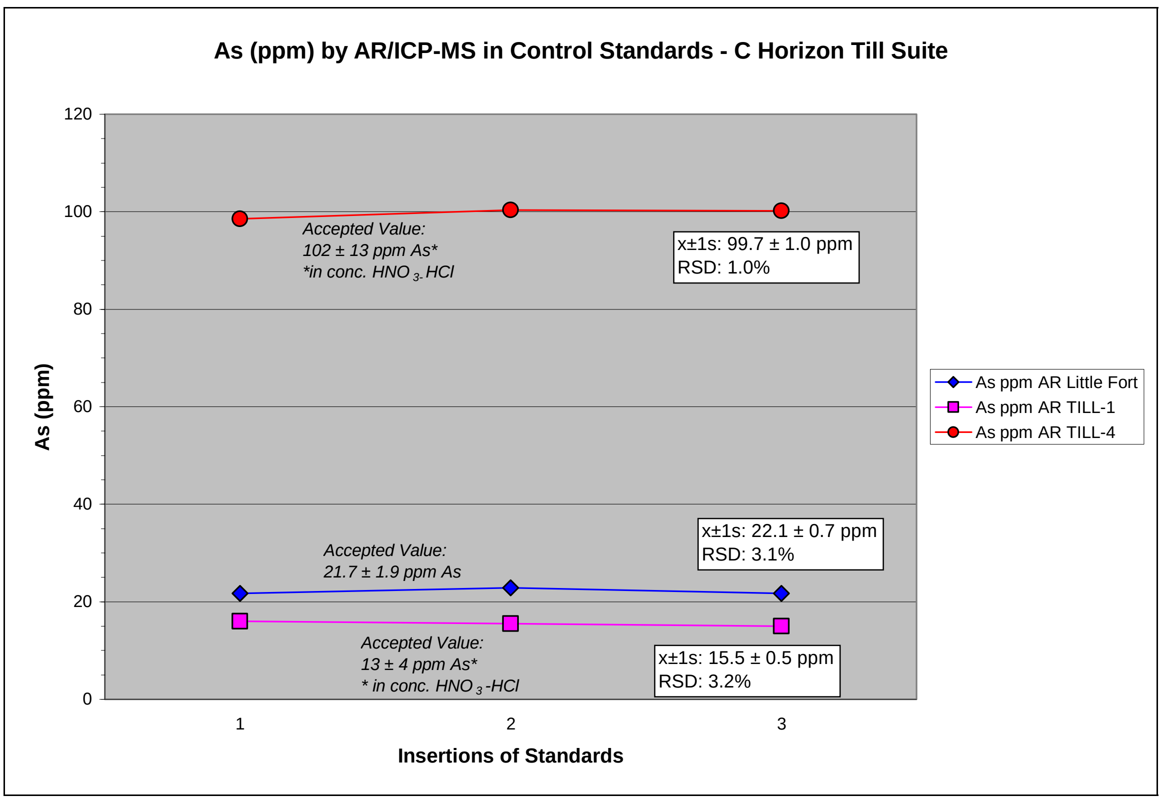
Figures 58 and 59. *Comparative line plots of aqua regia digestion–ICP-MS Ag results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) AR–ICP-MS suites. Results for the field soil standard and Little Fort till standard are also shown.*



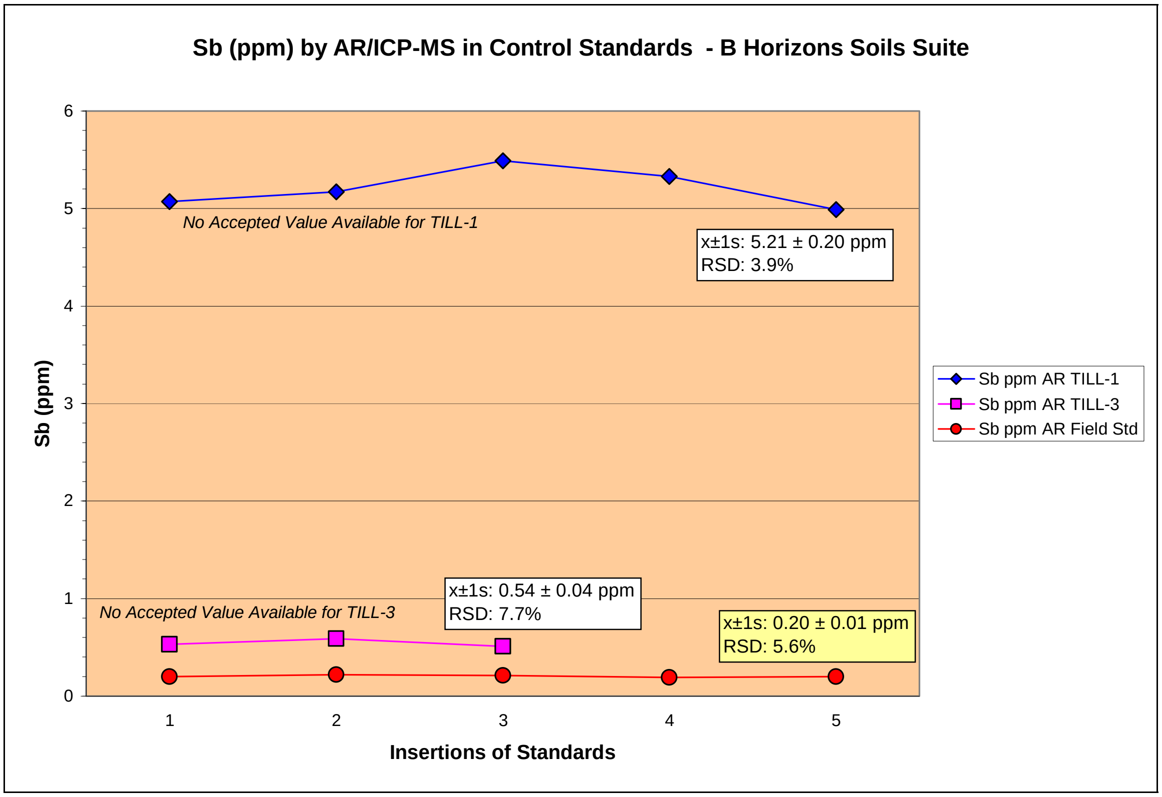


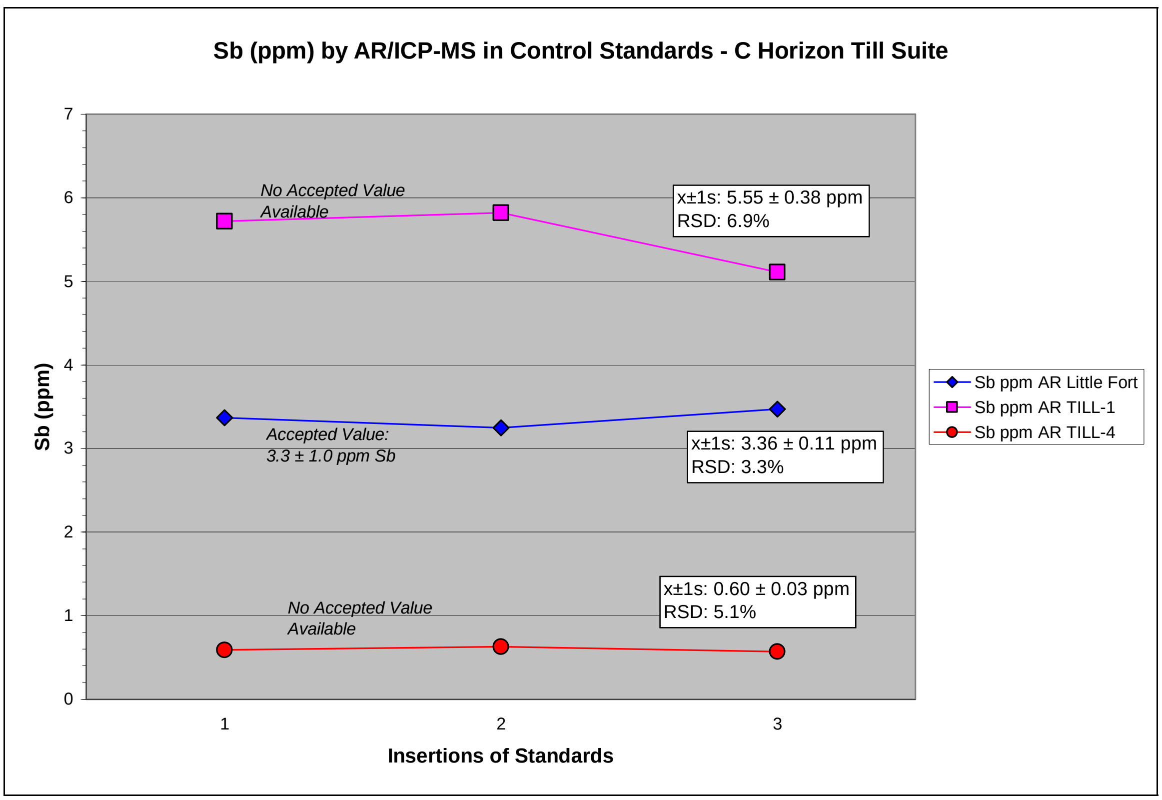
Figures 60 and 61. *Comparative line plots of aqua regia digestion–ICP-MS Pb results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) AR–ICP-MS suites. Results for the B horizon field standard and Little Fort till standard are also shown.*



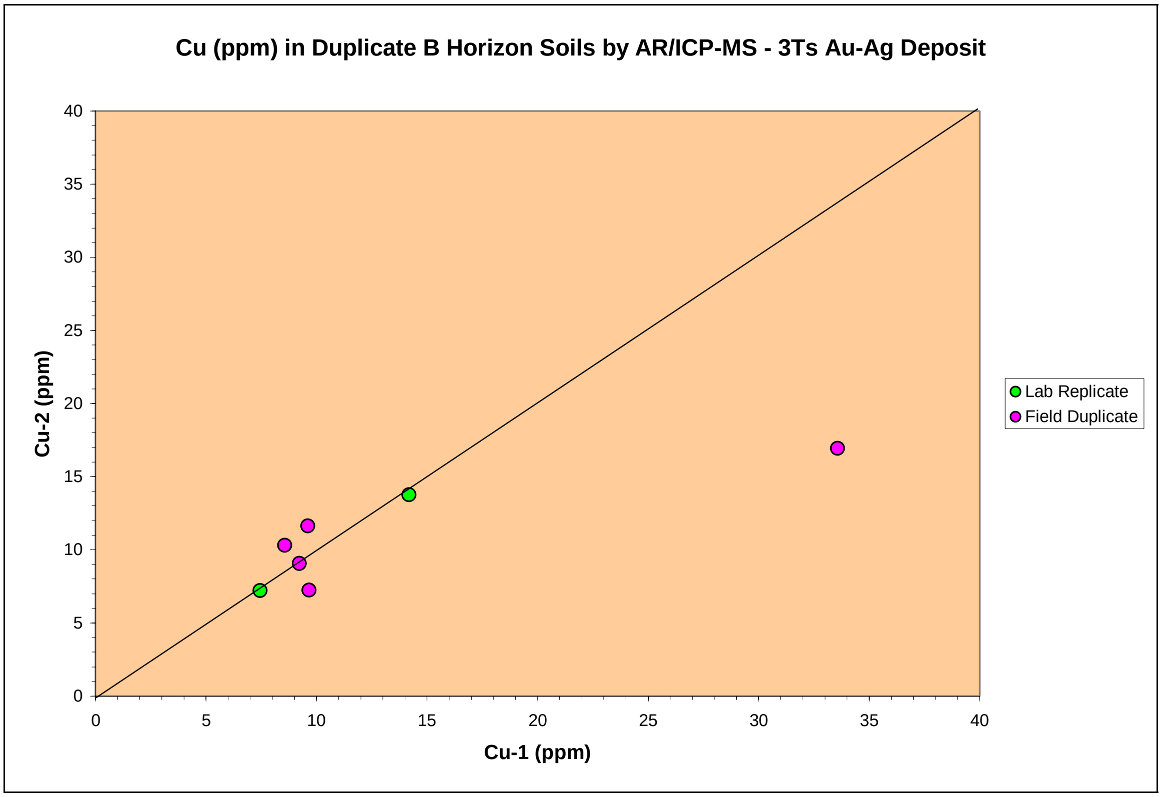


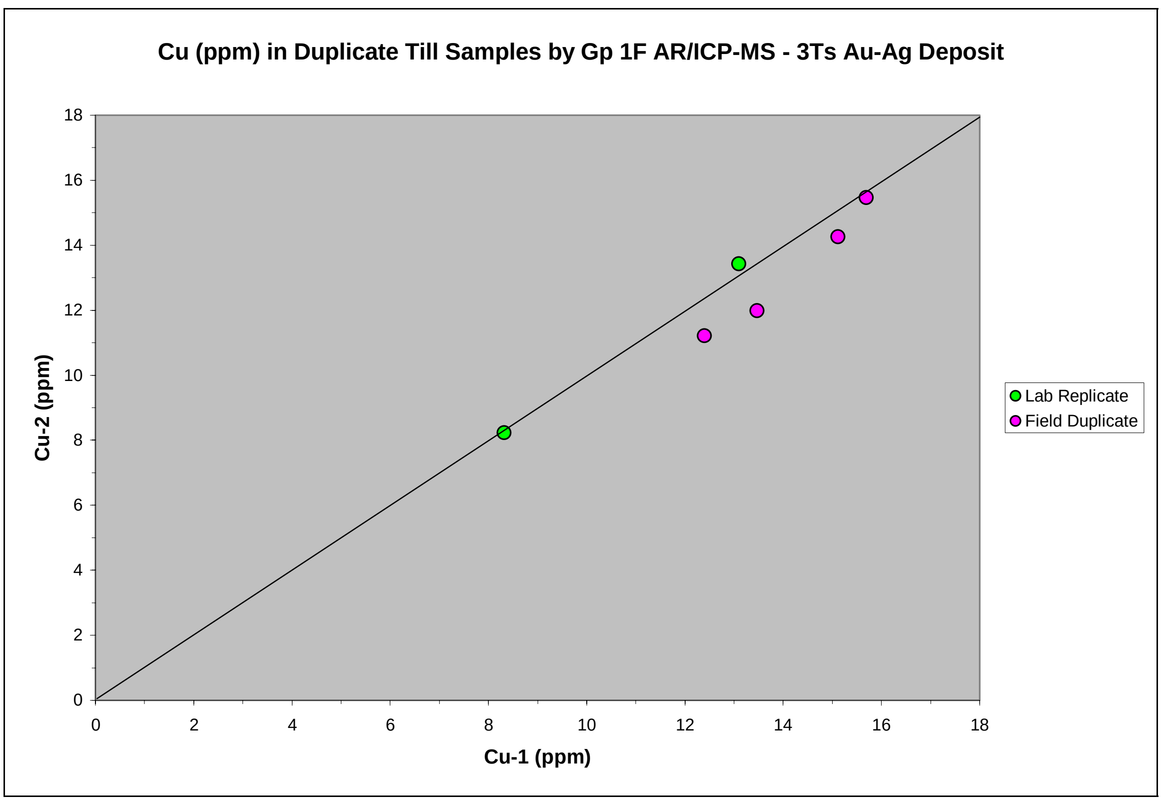
Figures 62 and 63. *Comparative line plots of aqua regia digestion–ICP-MS As results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) AR–ICP-MS suites. Results for the B horizon field standard and Little Fort till standard are also shown.*



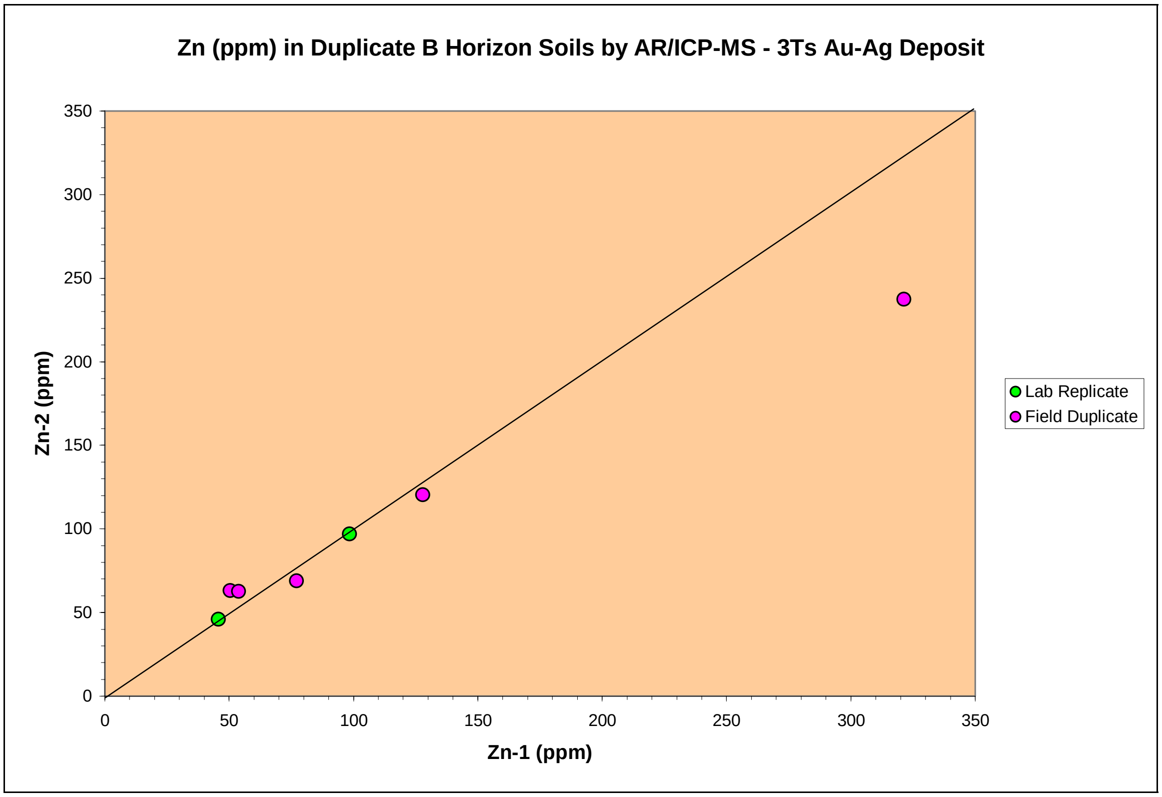


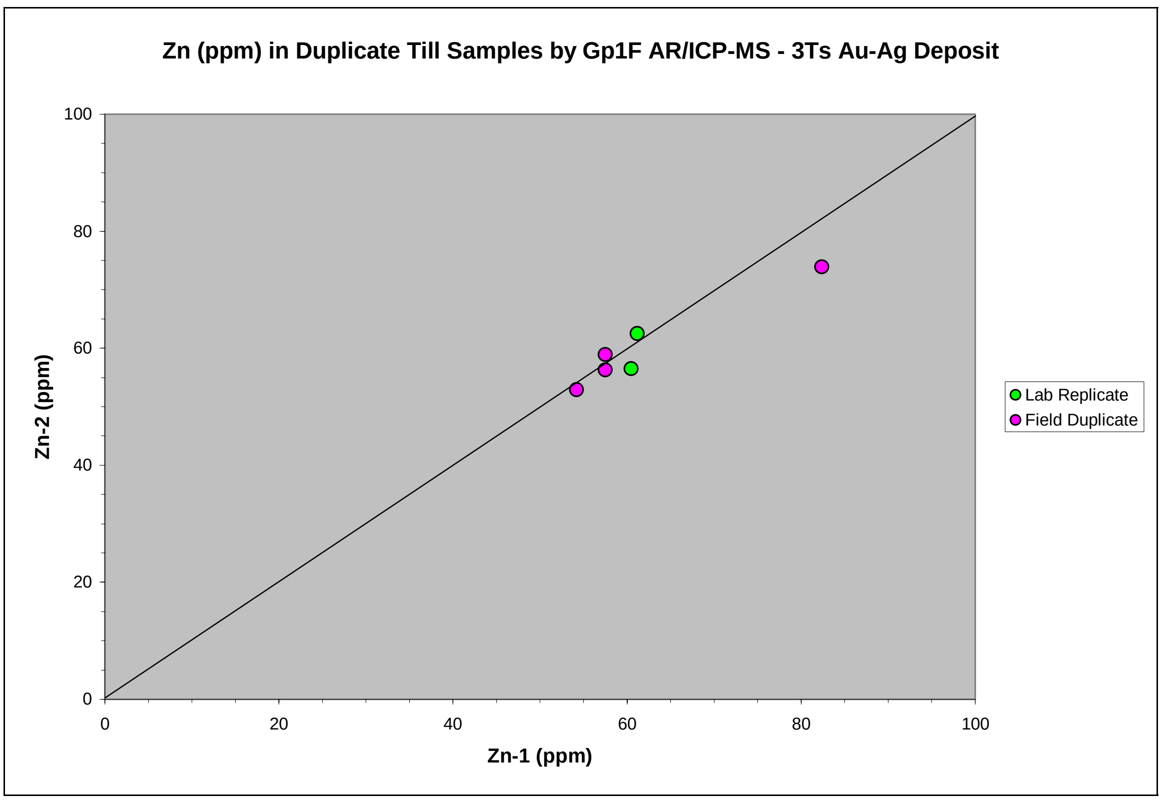
Figures 64 and 65. *Comparative line plots of aqua regia digestion–ICP-MS Sb results for insertions of CANMET CRMs TILL-1 (N=5), TILL-3 (N=3) and TILL-4 (N=3) in B horizon soil (top) and C horizon till (bottom) AR–ICP-MS suites. Results for the B horizon field standard and Little Fort till standard are also shown.*



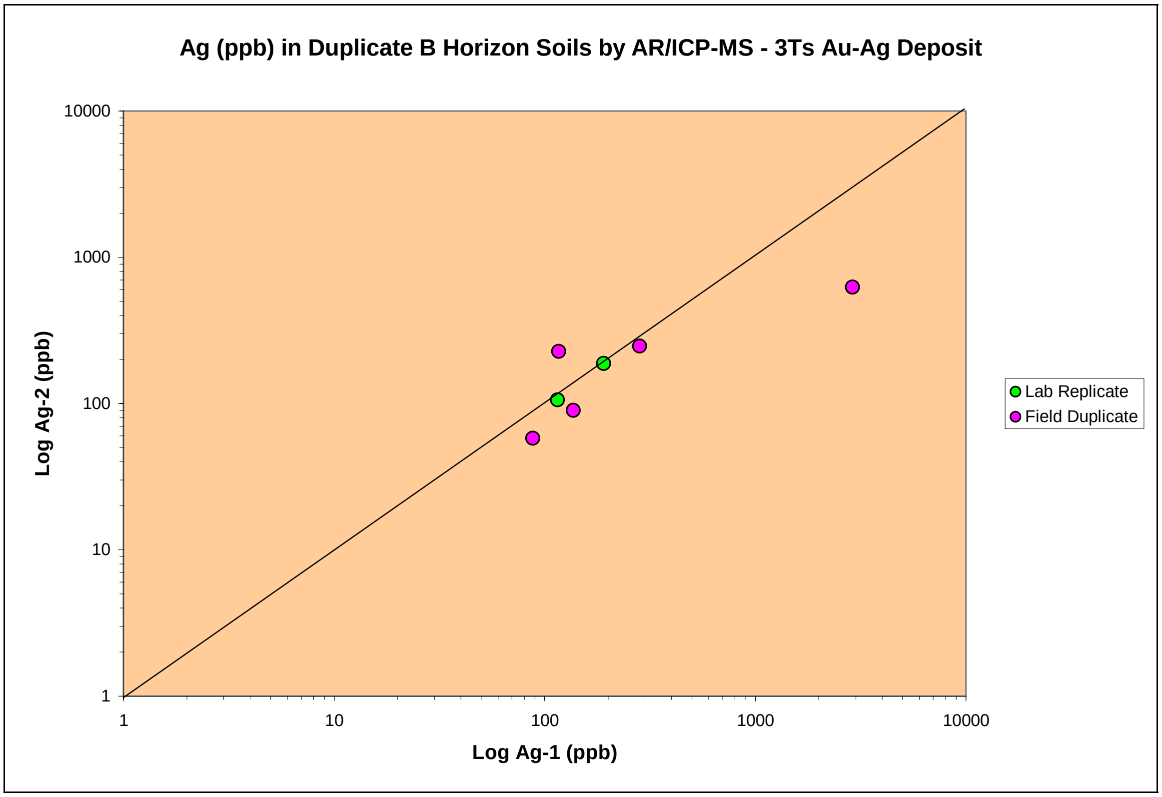


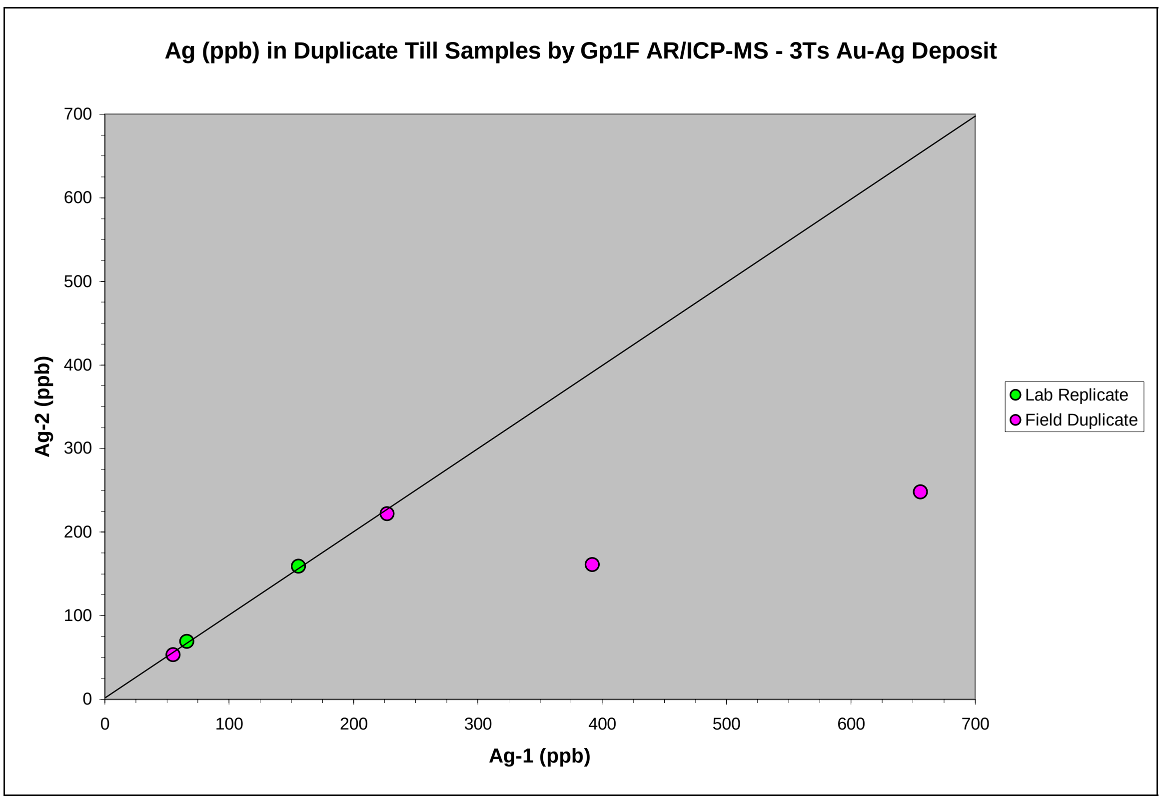
Figures 66 and 67. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for Cu in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects.*



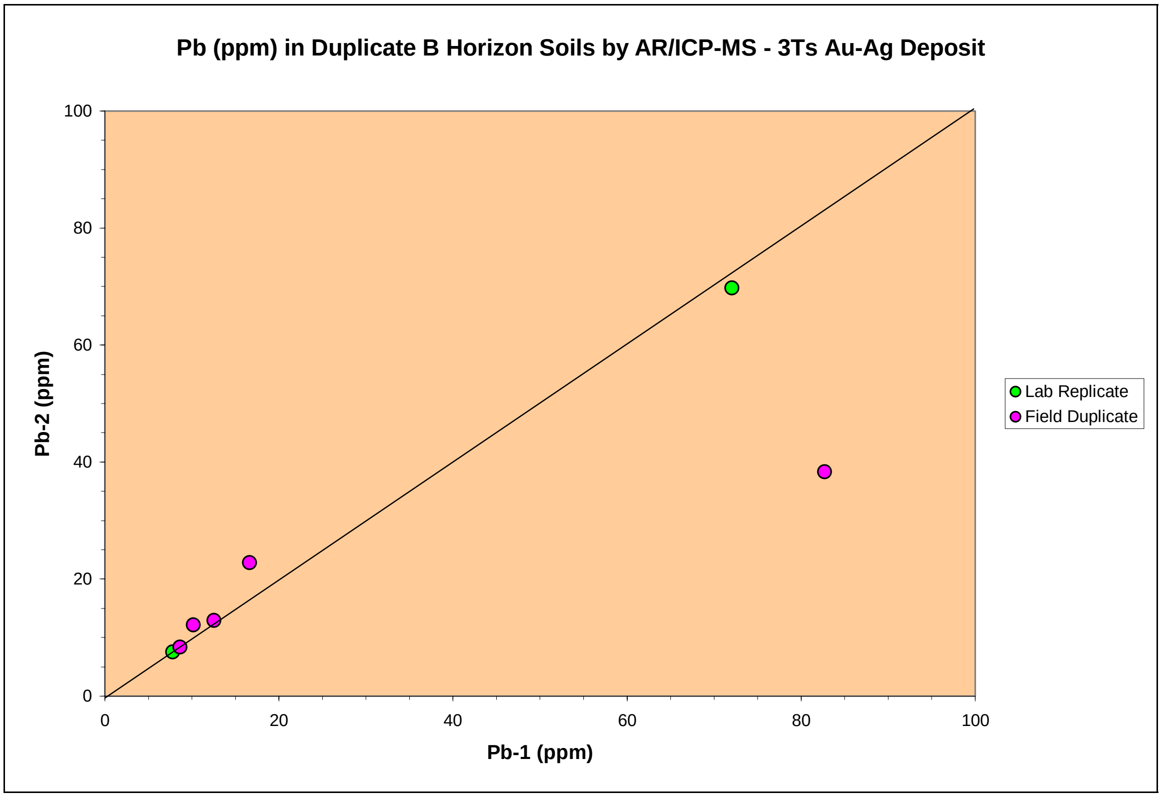


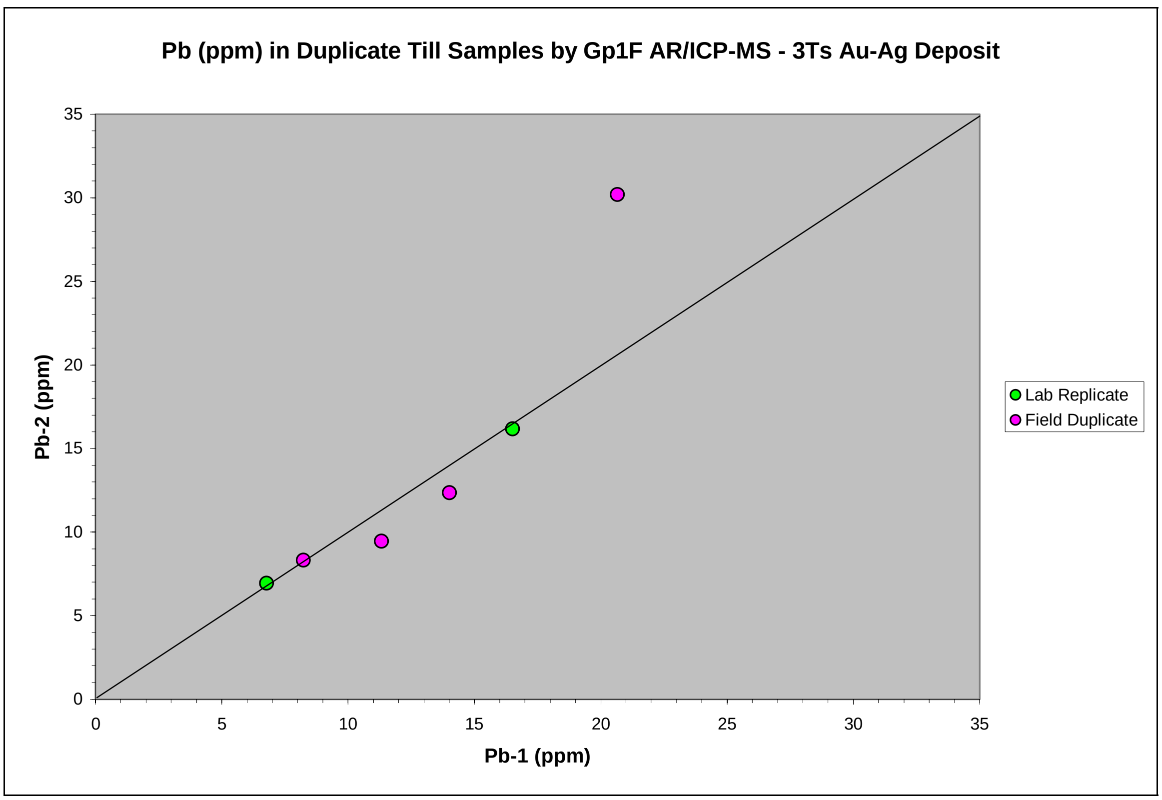
Figures 68 and 69. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for Zn in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects.*



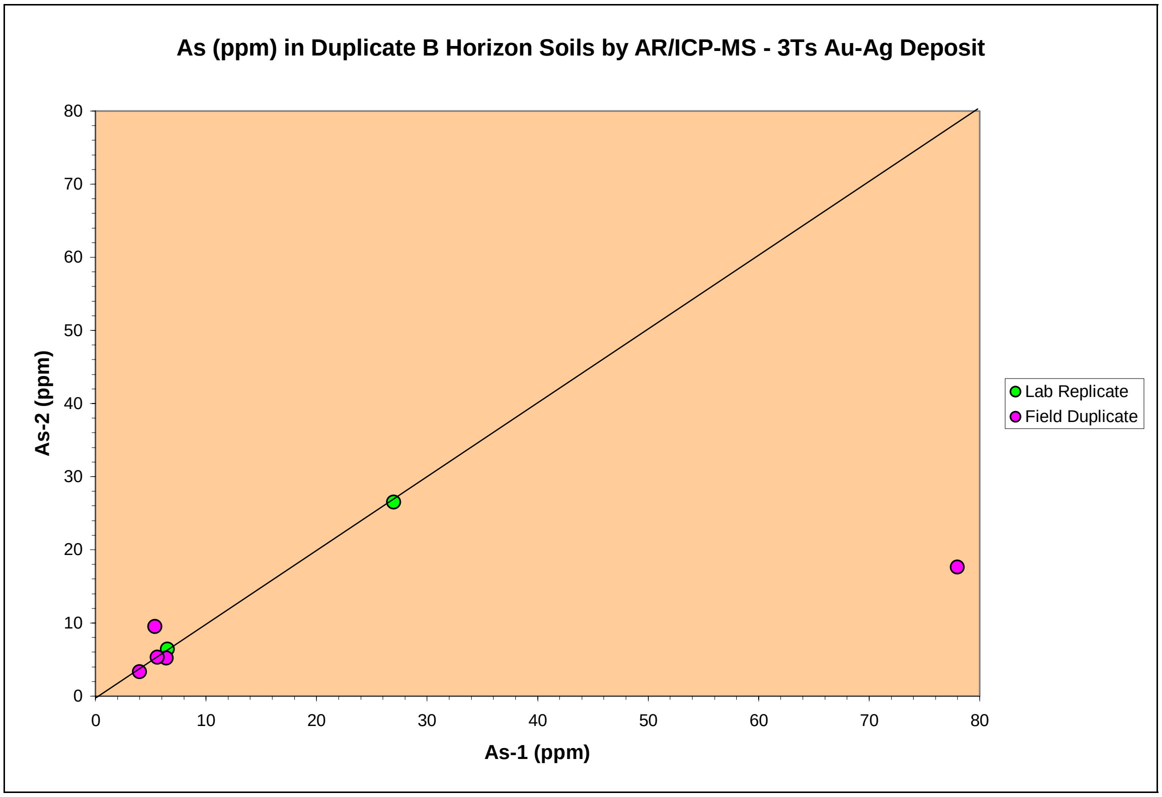


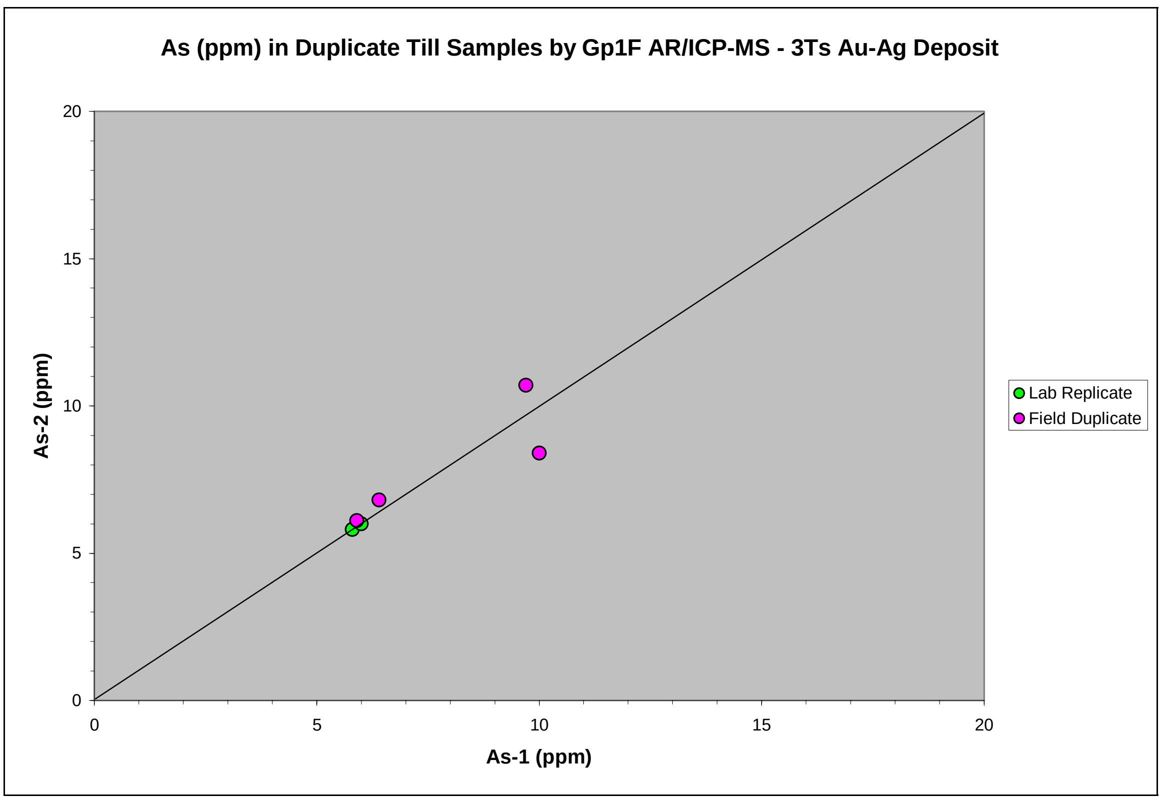
Figures 70 and 71. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for Ag in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects.*



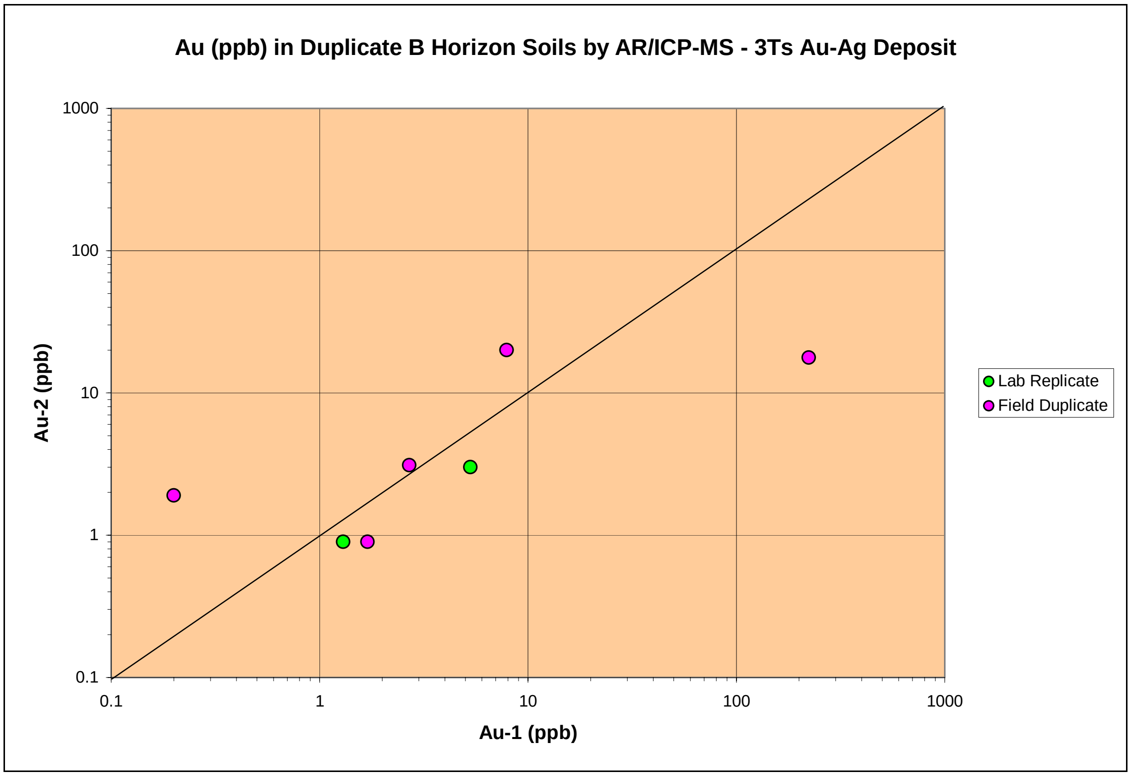


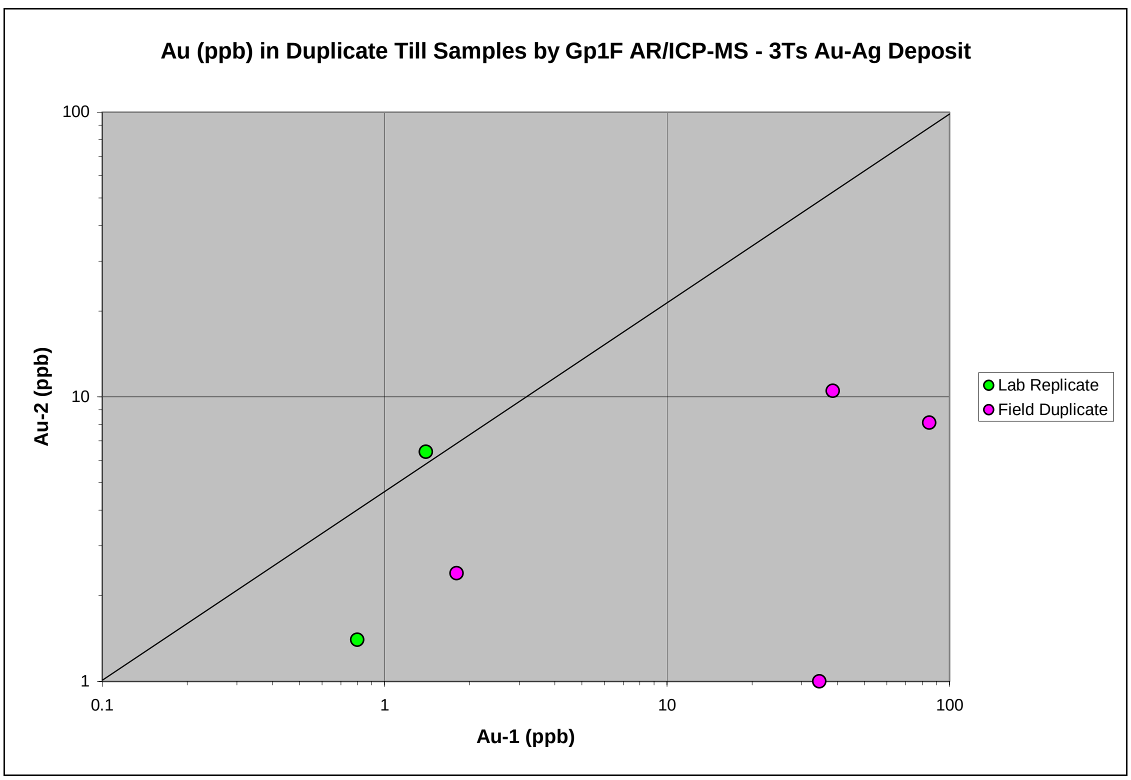
Figures 72 and 73. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for Pb in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects.*





Figures 74 and 75. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for As in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects.*





Figures 76 and 77. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=2 pairs) for Au in each of B horizon soils (top) and C horizon tills (bottom) by aqua regia digestion–ICP-MS (Group 1F suite) for the combined Tommy and Ted vein orientation transects. See* ***Table 4*** *for tabular listings of this duplicate Au data.*

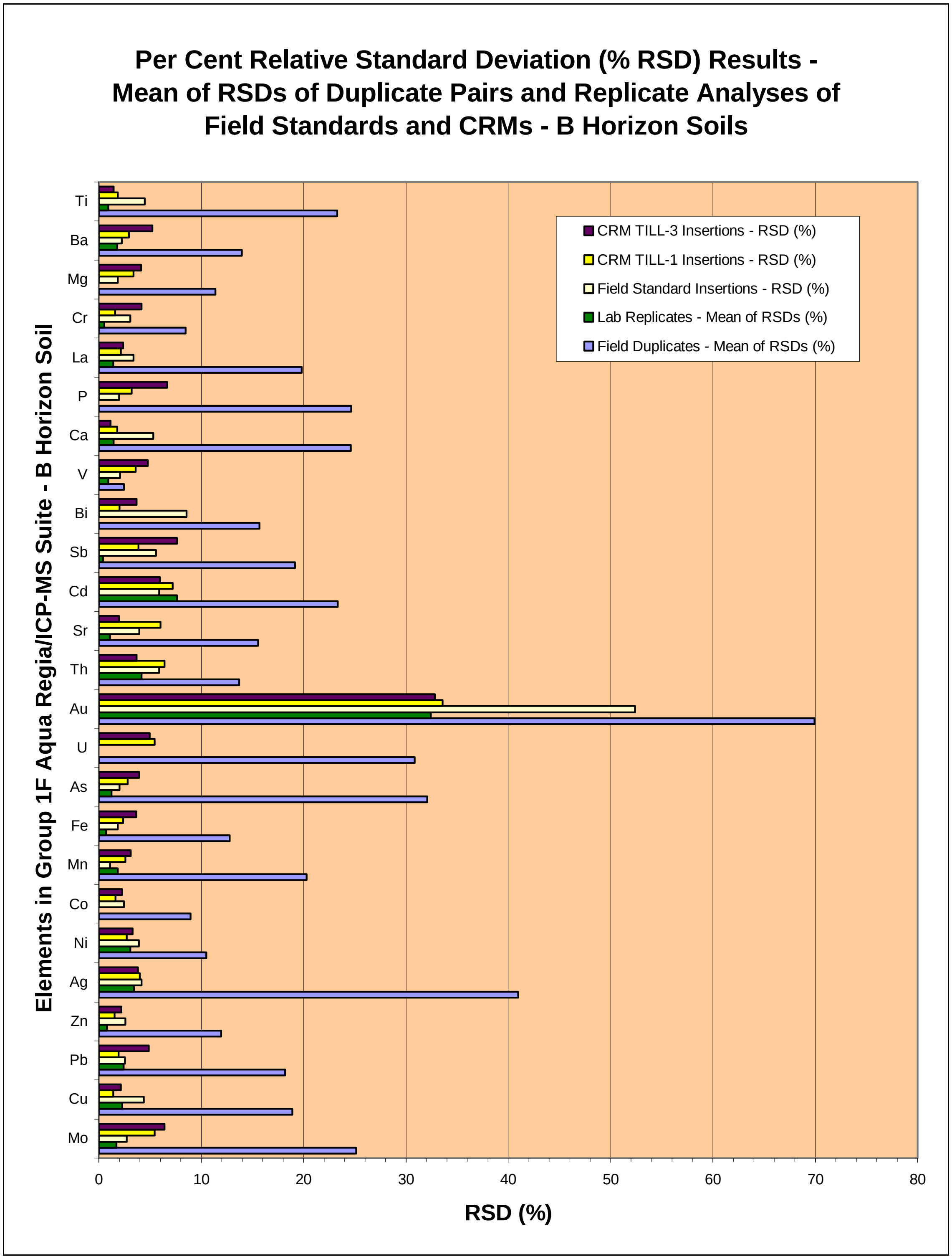


Figure 78. *First of two bar charts showing relative standard deviation (RSD) results for the aqua regia digestion–ICP-MS suite of elements in 3Ts B horizon soils from the Tommy and Ted vein transects. The chart shows five values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of the field soil standard (cream bars; N=5 pairs), and RSD results of replicate analyses of each of CANMET CRMs 4) TILL-1 (N=5 pairs) and 5) TILL-3 (N=3 pairs).*

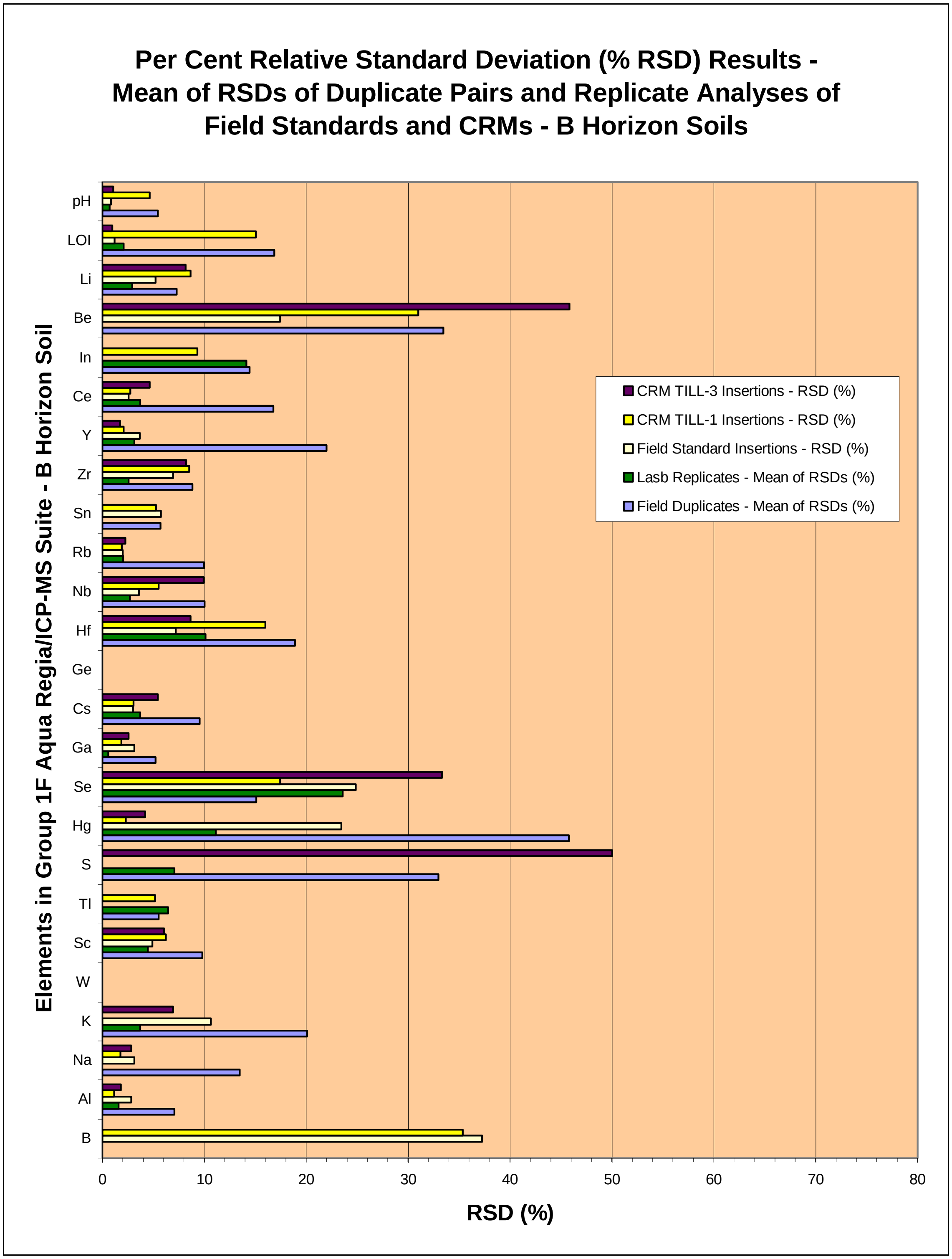


Figure 79. *Second of two bar charts showing relative standard deviation (RSD) results for the aqua regia digestion–ICP-MS suite of elements in 3Ts B horizon soils from the Tommy and Ted vein transects. The chart shows five values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of the field soil standard (cream bars; N=5 pairs), and RSD results of replicate analyses of each of CANMET CRMs 4) TILL-1 (N=5 pairs) and 5) TILL-3 (N=3 pairs).*

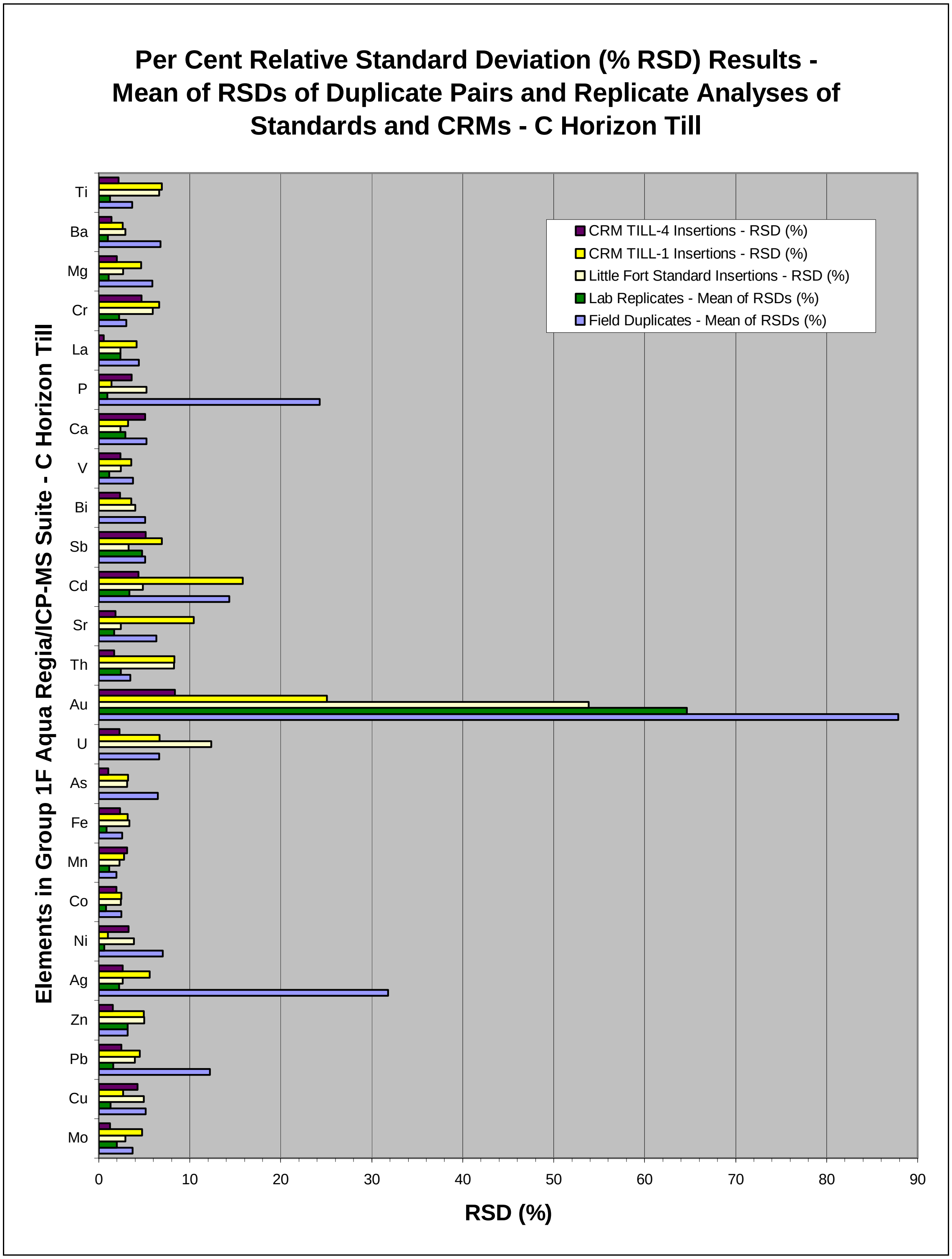


Figure 80. *First of two bar charts showing relative standard deviation (RSD) results for the aqua regia digestion–ICP-MS suite of elements in 3Ts C horizon till from the Tommy and Ted vein transects. The chart shows five values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=4 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of the Little Fort till standard (cream bars; N=3 pairs), and RSD results of replicate analyses of each of CANMET CRMs 4) TILL-1 (N=3 pairs) and 5) TILL-4 (N=3 pairs).*

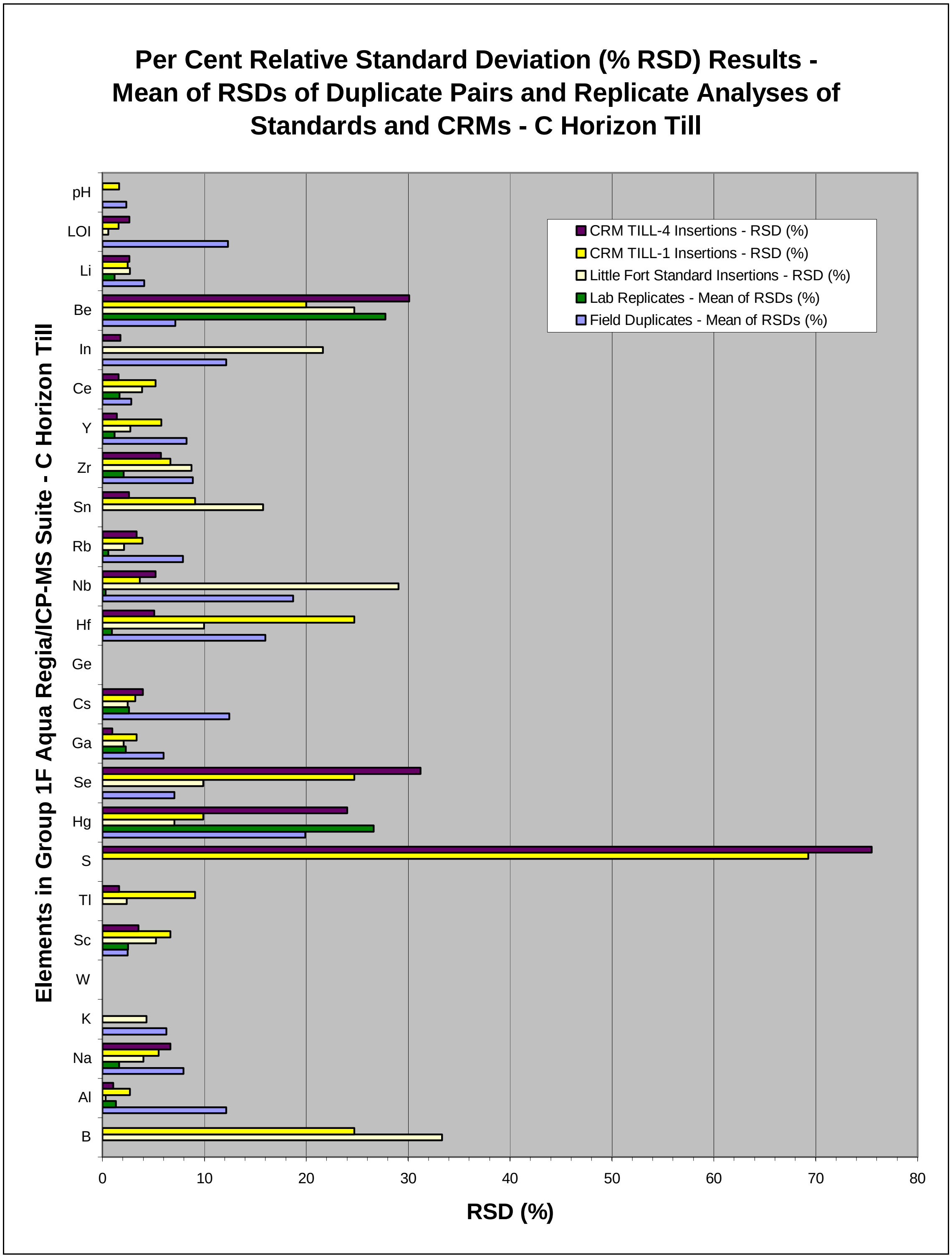


Figure 81. *Second of two bar charts showing relative standard deviation (RSD) results for the aqua regia digestion–ICP-MS suite of elements in 3Ts C horizon till from the Tommy and Ted vein transects. The chart shows five values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=4 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=2 pairs), 3) RSD results of replicate analyses of the Little Fort till standard (cream bars; N=3 pairs), and RSD results of replicate analyses of each of CANMET CRMs 4) TILL-1 (N=3 pairs) and 5) TILL-4 (N=3 pairs).*

FIRE ASSAY B HORIZON SOIL AND C HORIZON TILL SUITES

The soil and till fire assay suites included several field duplicate samples (Table 5) to assess combined sampling, preparation and analytical variability of Au results, as well as standards of known concentration to monitor analytical accuracy. In addition, results of analytical replicates, internal blanks and fire assay standards inserted by Acme Labs are also reported here.

Log scatterplots of field duplicate and lab replicate pairs for each of the B horizon soil and C horizon till suites (Figures 82 to 83) show, unsurprisingly, that fire assay Au results in lab replicates show considerably less variability than do those for field duplicate pairs. It is important to remember that field duplicate pairs are blind to the assaying laboratory, whereas the choice of lab replicates is made at the lab. Among field duplicate pairs alone, Au results for sample pairs from B horizon soils show greater variability (mean of RSDs: 56.8%) than do those for C horizon tills (mean of RSDs: 36.3%; Figure 84). This is interpreted, to some degree, as a consequence of the inherently greater within-site variation in soils, which are the pedogenic products of varying surficial material type, slope, drainage and other factors, and are more physically and geochemically heterogeneous than till. It is also partially a result, however, of only B horizon soil and not till being present at some field duplicate sites around the Tommy vein, where field duplicate soil pairs yielded widely variable results.

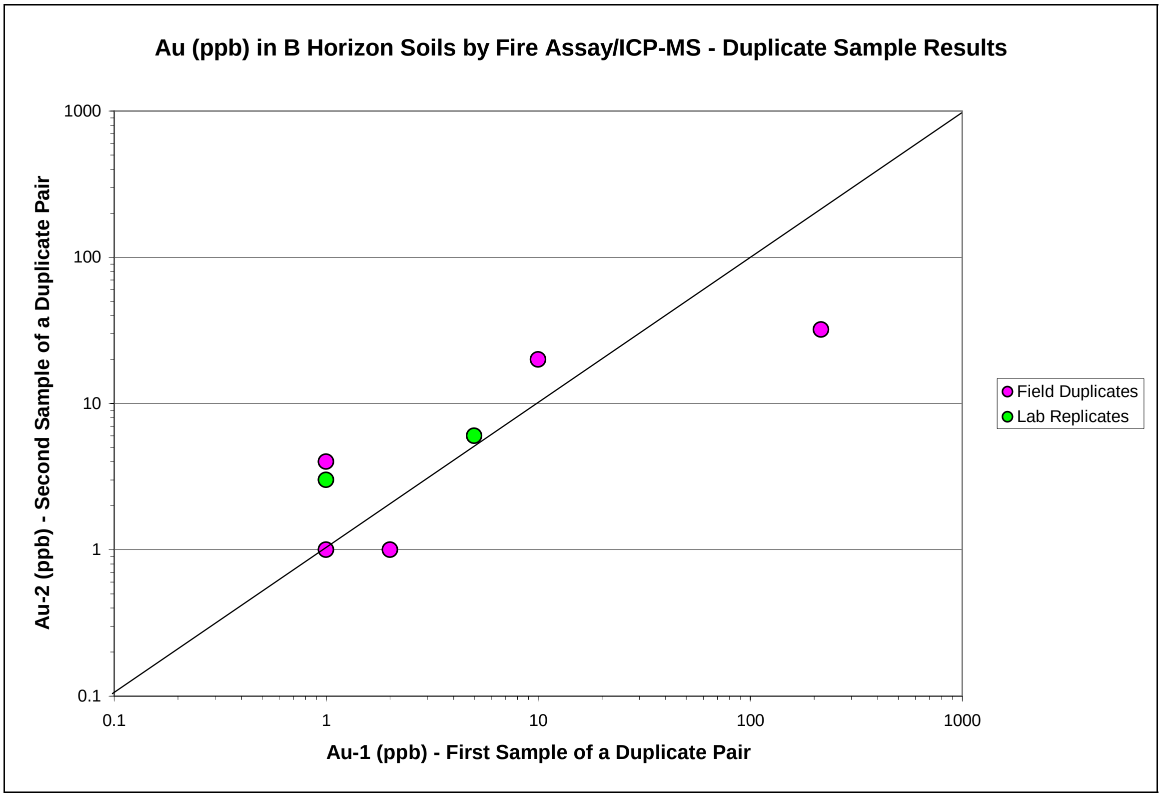
The erratic nature of Au results in soils is also illustrated by results of the multiple insertions (N=5) of the Tommy field soil standard into the B horizon soil fire assay suite (RSD: 141.9%). This background soil returned a median Au concentration of 1 ppb, but Au concentrations as high as 20 ppb were nevertheless reported in fire assay results (Figures 85 and 86) for this material.

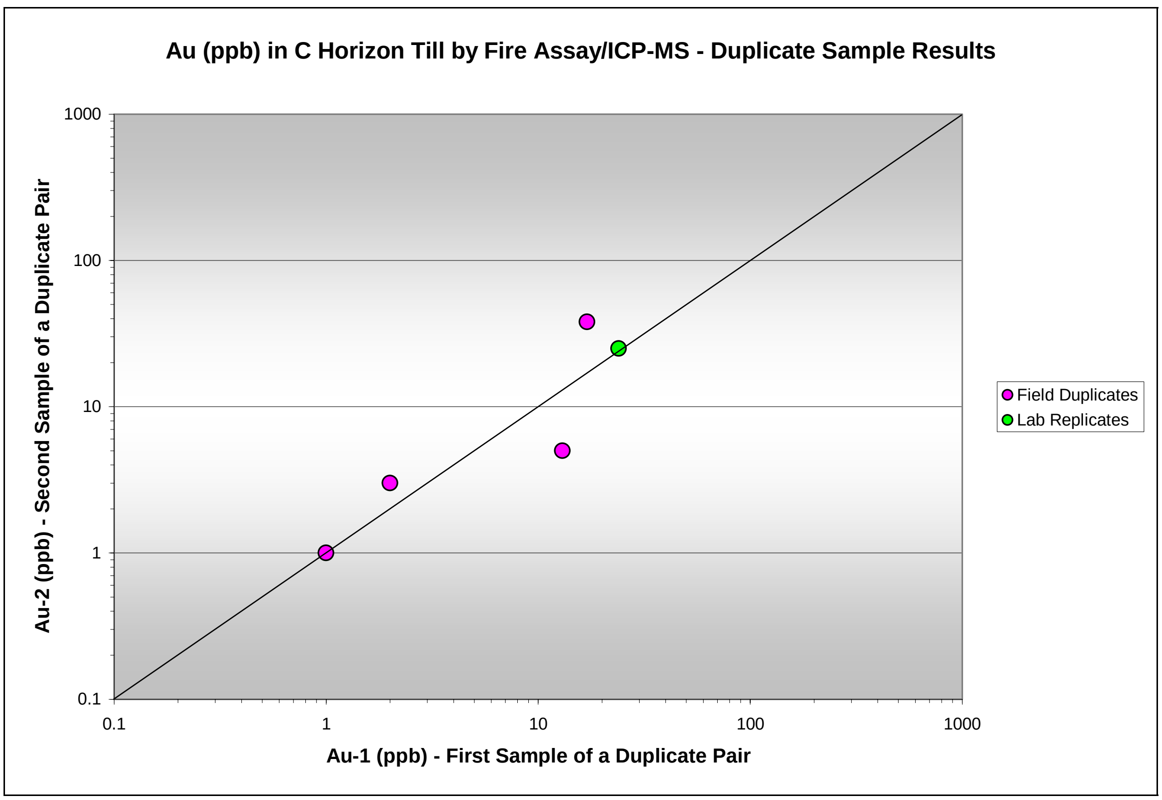
Table 5. *Listing of Au results by lead-collection fire assay–ICP-MS (Group 3B-MS method) for field duplicate and lab replicate sample pairs in the B horizon soil and C horizon till analytical suites.*

	ID Number of Routine Sample	Au-1 (ppb)	Au-2 (ppb)	Status of Duplicate Samples	Orientation Transect
B Horizon Soil Fire Assay Suite	TOM-S-501-2	**1**	**4**	Field Duplicates	Tommy Line
	TOM-S-521-2	**10**	**20**	Field Duplicates	Tommy Line
	TOM-S-561-2	**2**	**1**	Field Duplicates	Ted Line
	TOM-S-571-2	**1**	**1**	Field Duplicates	Ted Line
	TOM-S-591-2	**216**	**32**	Field Duplicates	Tommy Line
	TOM-S-520-2	***5***	***6***	*Lab Replicate*	*Tommy Line*
	TOM-S-590-2	***1***	***3***	*Lab Replicate*	*Field Standard**
C Horizon Till Fire Assay Suite	TOM-S-501-3	**1**	**1**	Field Duplicates	Tommy Line
	TOM-S-521-3	**17**	**38**	Field Duplicates	Tommy Line
	TOM-S-561-3	**13**	**5**	Field Duplicates	Ted Line
	TOM-S-571-3	***2***	***3***	Field Duplicates	Ted Line
	TOM-S-559-3	***24***	***25***	*Lab Replicate*	*Ted Line*

** Lab replicate was prepared from one of the blind insertions (n=5) of the Tommy field soil standard*

Only the first Au concentration (Au-1) of each duplicate pair is considered to be the routine concentration for plotting and statistical purposes.





Figures 82 and 83. *Comparative scatterplots showing field duplicate sample results (N=4–5 pairs) and Acme Labs lab replicate results (N=1–2 pairs) for Au in each of B horizon soils (top) and C horizon tills (bottom) by lead-collection fire assay–ICP-MS (Group 3B-MS method) for the combined Tommy and Ted vein orientation transects.*

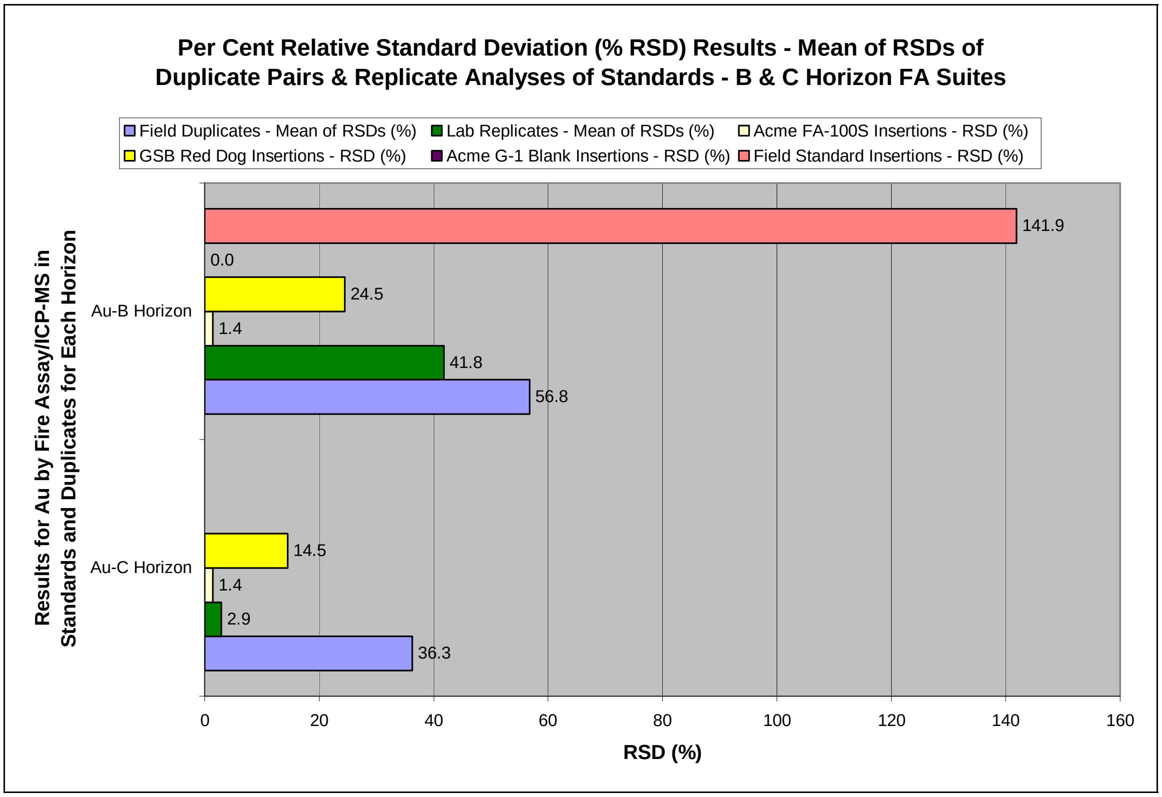
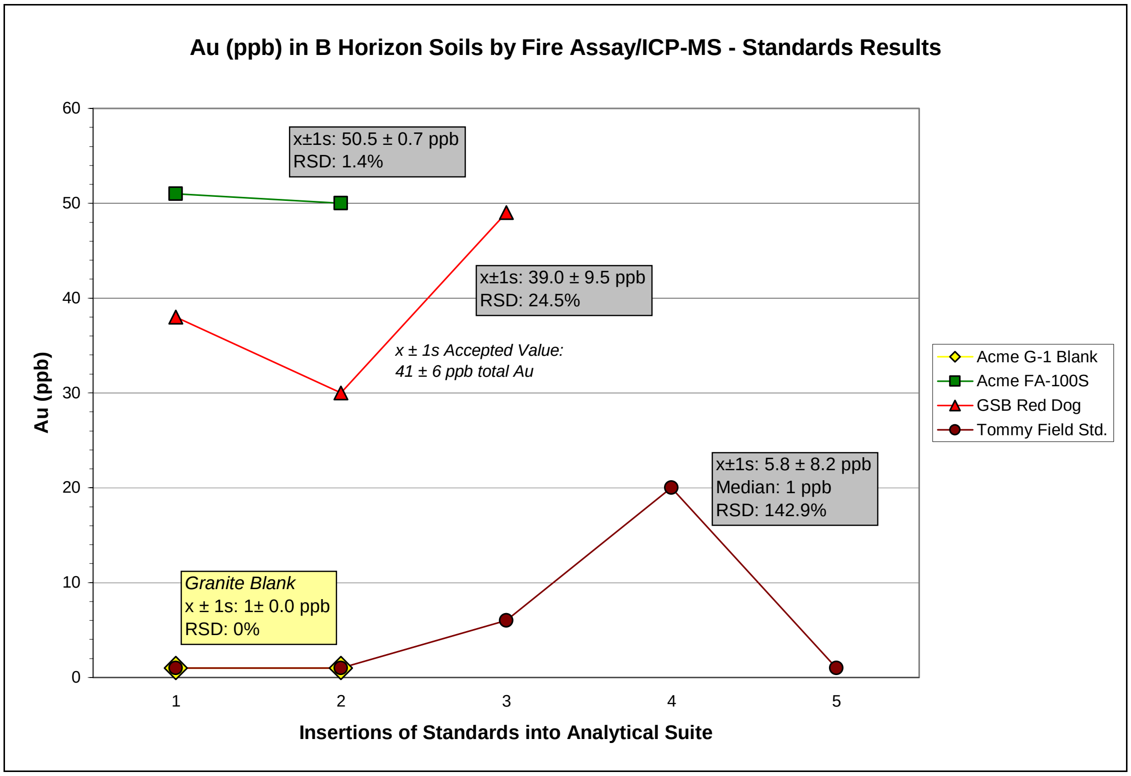
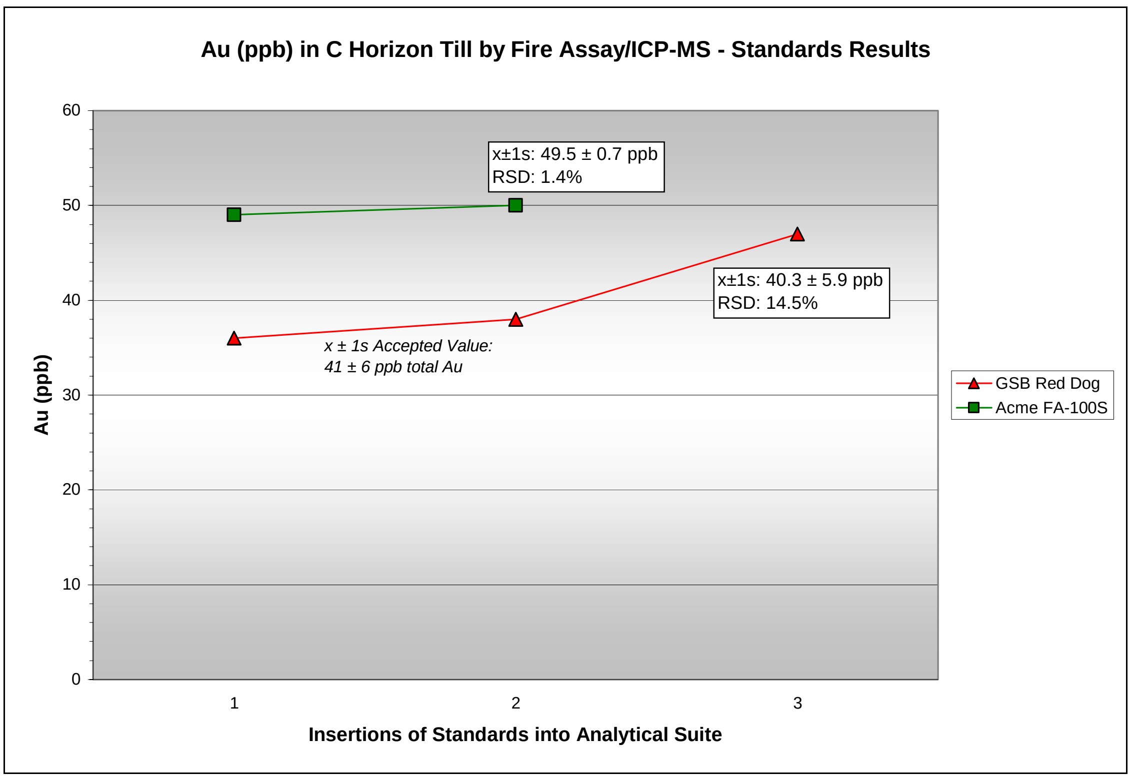


Figure 84. *Bar chart showing relative standard deviation (RSD) results for lead-collection fire assay–ICP-MS Au data in 3Ts B horizon soil and C horizon till from the Tommy and Ted vein transects. The chart shows up to six values for Au in each soil horizon, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=4–5 pairs), 2) the mean of RSD results for Acme Labs internal lab replicates (green bars; N=1–2 pairs), 3) RSD results of replicate analyses of the Acme Labs FA-100S internal standard (cream bars; N=2 insertions), 4) RSD results of replicate analyses of the BC Geological Survey Red Dog Au standard (yellow bars; N=3 insertions), 5) RSD results of replicate analyses of Acme Labs barren granite blank G-1 (N=2 insertions; B horizon soil suite only) and 6) replicate insertions of the Tommy soil field standard (N=5 insertions; pink bars, B horizon soil suite only).*





Figures 85 and 86. *Comparative line plots of lead-collection fire assay–ICP-MS Au results (Group 3B-MS) for multiple insertions of BC Geological Survey Red Dog standard (N=3) and Acme Labs internal standard FA-100S (N=2) in B horizon soil (top) and C horizon till (bottom) fire assay suites. Results for Acme barren granite blank G-1 (N=2) and the Tommy field soil standard (N=5) are also shown for the B horizon suite.*

Analytical accuracy for Au by fire assay is within acceptable limits. Multiple insertions of the BC Geological Survey's sediment standard 'Red Dog' (N=3) and Acme Labs internal fire assay soil standard FA-100S (N=2) were included in each of the soil and till fire assay suites. Red Dog mean ±1s results of 39.0 ±9.5 ppb (B horizons soils) and 40.3 ±5.9 ppb (C horizon till) obtained here correspond closely with accepted values (mean ±1s) of 41 ±6 ppb (R.E. Lett, pers. comm., 2006) for total Au determinations. Similarly, soil and till suite fire assay gold results of 50.5 ±0.7 ppb and 49.5 ±0.7 ppb, respectively, for Acme Labs internal soil standard FA-100S compare favourably with an accepted value of 47 ppb Au for this material. Relative standard deviation results for the standards are far lower, as any variation in prepared standards results are solely due to analytical variations. For example, RSD values for Au by fire assay of both the B and C horizon soil suites here are in the range of 14.5 to 24.5% for Red Dog, and only 1.4% for Acme internal standard FA-100S. Relative standard deviation (RSD) values for lab replicates are similar in the case of C horizon till (RSD: 2.9%), but the very few lab replicates assayed here preclude a serious analysis of duplicate results.

There is no evidence here for analytical contamination of the fire assay gold results. Two insertions of Acme Labs internal blank G-1, a barren granite, which is essentially a low-level standard, were included in the B horizon soil suite and returned results of only 1 ppb.

ENZYME LEACH (EL) B HORIZON SOIL SUITE

No control standard accepted values are available to assess analytical accuracy of Enzyme Leach determinations, but CANMET certified reference material (CRM) LKSD-4 was inserted into the Enzyme Leach suite as a drift monitor to assess analytical precision. Line plots showing results of multiple analyses (N=4 insertions) of this CRM are shown in Figure 87 to 89 for several selected elements including Cu, Zn, Cd and As. Relative standard deviation (RSD) results of these determinations are typically low; RSD results for Zn and Cu, for example, are 3.3% and 5.0%, respectively. Additional information on RSD results of these standards and other materials given in Figure 90 and 91.

Scatterplots showing duplicate sample results for both field duplicate pairs (N=5) and Activation Laboratories lab replicates (N=3) are shown for several elements including Cu, Zn, Pb, Cd, As and Sb (Figures 92 to 97) in the B horizon soil Enzyme Leach suite for the combined Tommy and Ted vein orientation transects. It is apparent from these results that an adequate degree of reproducibility has been achieved for these critical elements. The issue of reproducibility is explored more fully in the relative standard deviation (RSD) bar charts (Figure 90 and Figure 91), where RSD results are compared for several sample groupings for each of 51 selected elements in the 3Ts Enzyme Leach analytical suite. Four values are shown for each element, comprising 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Activation Laboratories internal lab replicates (green bars; N=3 pairs), 3) RSD results of replicate analyses of the field soil standard (brown bars; N=5 analyses) and 4) RSD results of replicate analyses of CANMET CRM LKSD-4 (N=4 analyses). A total of 16 elements, including Ag, were first removed from the Enzyme Leach dataset as results for these were consistently below the limits of analytical detection.

Several important trends are apparent here. First, EL RSD results for field duplicate samples, which represent combined field, preparation and analytical variation, are generally greater than those for the field standard, which is a measure of combined preparation and analytical variation only. In summary, the mean of all mean RSDs for field duplicates is 22.2%, while the mean RSD for the field standards is only 13.9%. Secondly, and unsurprisingly, both of these RSD results are greater than those for lab replicates and insertions of CRM LKSD-4, both of which are measures of analytical variation only. As is shown in Figure 90 and Figure 91, these RSD components are very low; the mean of mean RSD for analysis of lab replicates at Activation Laboratories is only 6.2%, whereas mean RSD for multiple insertions of LKSD-4 is similar at 7.2%.

As an example of this, RSD values for Cu are 19.0% for field duplicates, where the greatest variation might be expected, but only 10.3% for multiple insertions of the field standard. In contrast, RSD results for lab replicates and CRM LKSD-4 insertions, where the least variation may be expected, is only 5.9% and 5.0%, respectively. These results indicate that, in general, field sampling is the primary source of variation in the Enzyme Leach results, whereas analytical variation in the laboratory contributes only a relatively minor component. Nevertheless, analytical variation as measured by replicate analyses of standards is for some key elements shown to be greater for EL digestions relative to aqua regia digestions of the same mineral soil. Relative standard deviation (RSD) results for Pb, Zn and Cd analyses of the B horizon field standard by EL are 25.5%, 106.9% and 25.1% (Figure 90), which is considerably greater than corresponding aqua regia digestion results of 2.6%, 2.6% and 5.9% (Figure 78 and 79). Although the field standard includes a sampling component that is independent of EL analytical digestions, an examination of internal lab replicate results nevertheless yields similar conclusions. Here, the mean of RSD results for Pb, Zn and Cd for Activation Laboratories EL internal lab replicates (19.8%, 10.0% and 9.3%, respectively; N=3 pairs) are higher than mean of RSD results for the same elements by aqua regia digestion (2.4%, 0.8% and 7.7%; N=2 pairs).

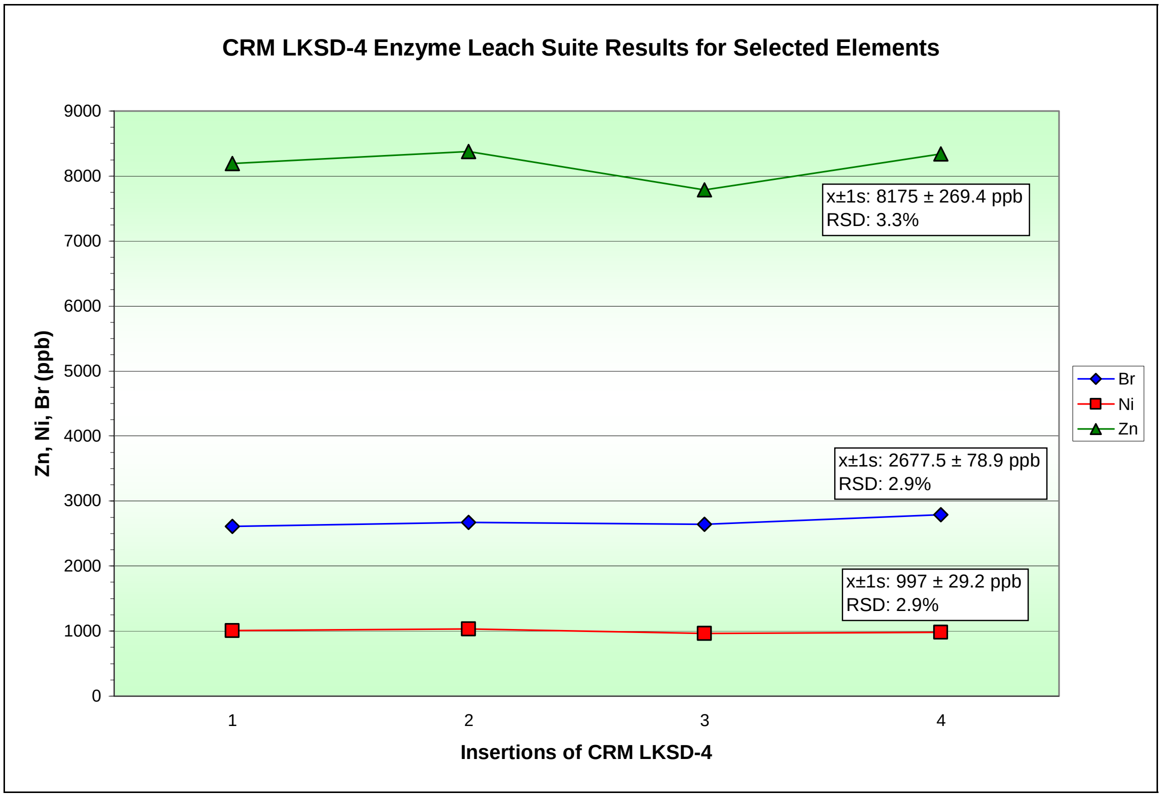
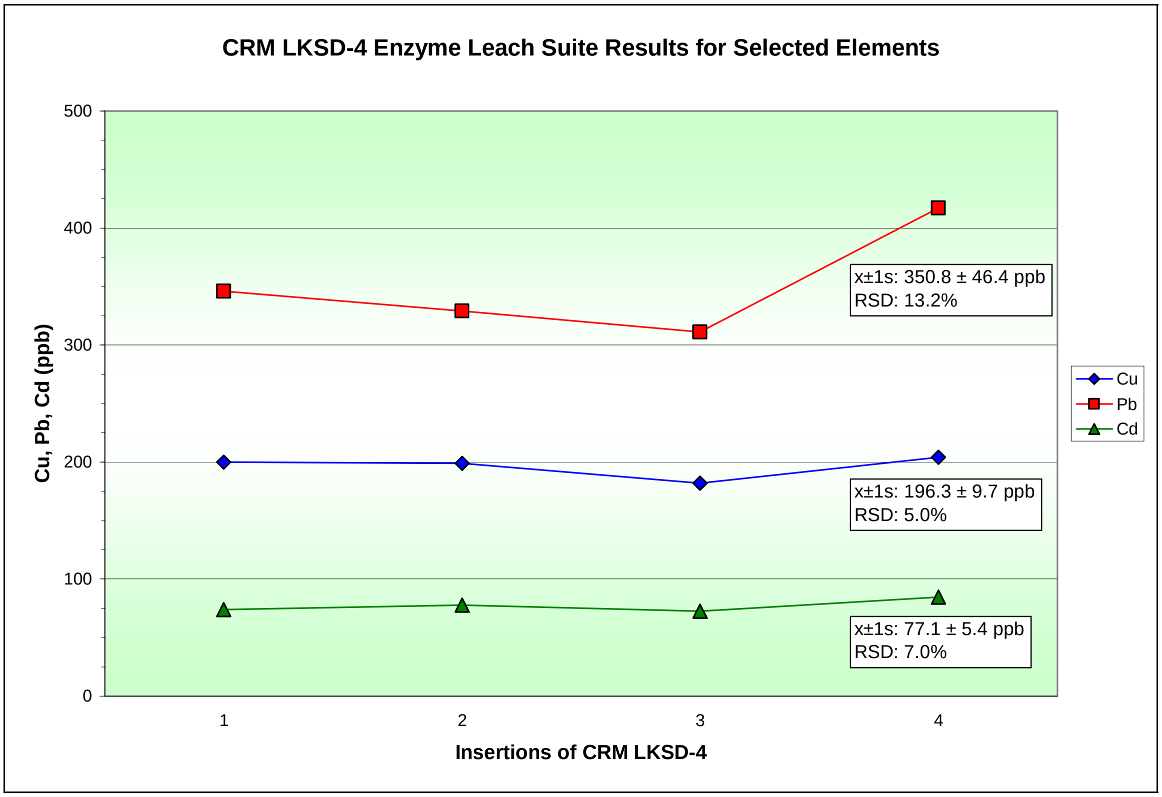
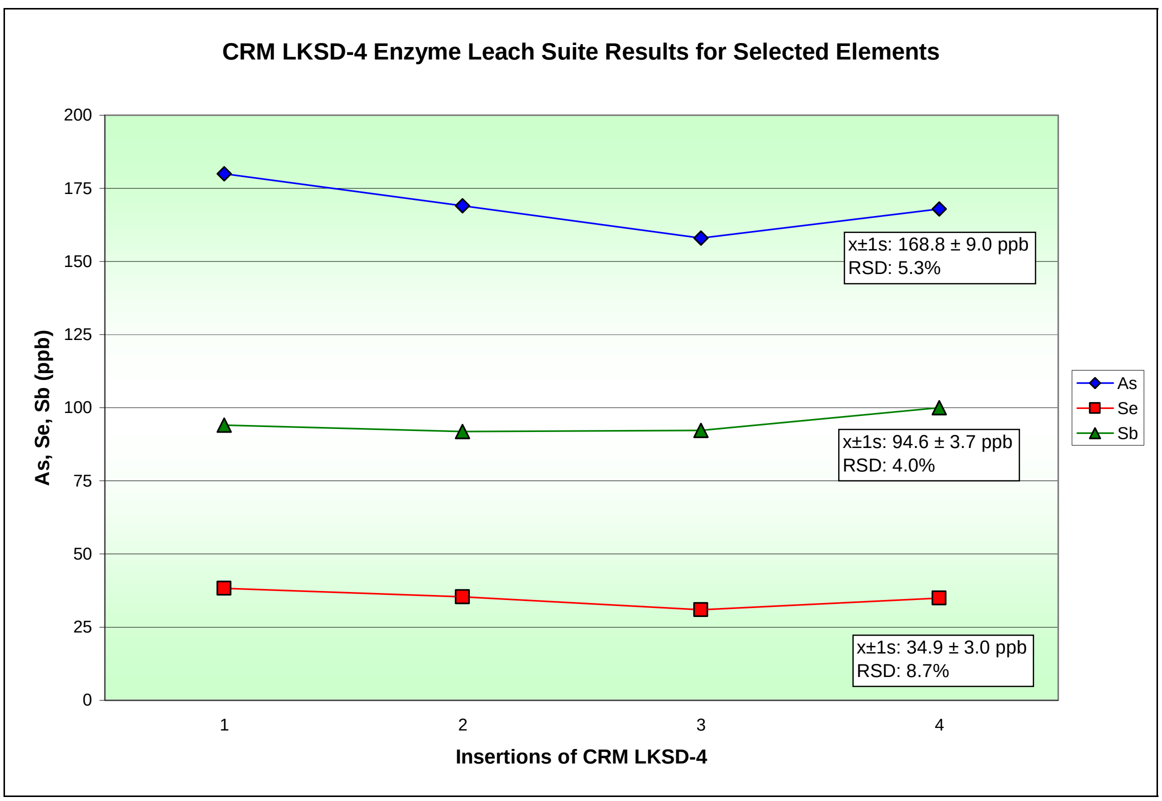


Figure 87. *Line plot showing Enzyme Leach suite Zn, Ni and Br results for multiple insertions (N=4) of CANMET certified reference material LKSD-4.*





Figures 88 and 89. *Line plot showing Enzyme Leach suite Cu, Pb and Cd results (top) and As, Sb and Se results (bottom) for multiple insertions (N=4) of CANMET certified reference material LKSD-4.*

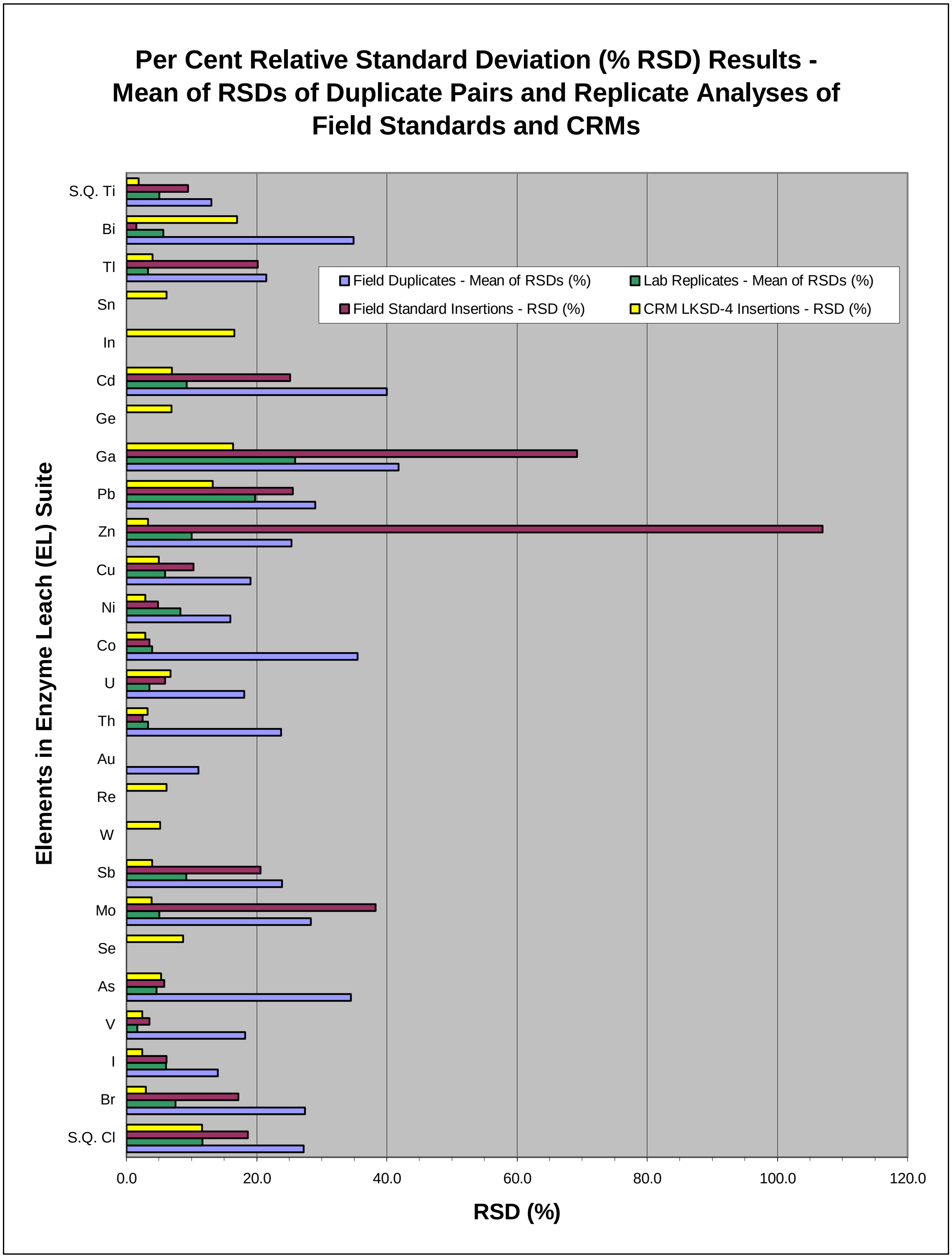


Figure 90. *First of two bar charts showing relative standard deviation (RSD) results for the Enzyme Leach suite of elements in 3Ts B horizon soils from the Tommy vein and Ted vein orientation transects. The chart shows four values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Activation Laboratories internal lab replicates (green bars; N=3 pairs), 3) RSD results of replicate analyses of the field soil standard (brown bars; N=5 analyses) and 4) RSD results of replicate analyses of CANMET CRM LKSD-4 (N=4 analyses).*

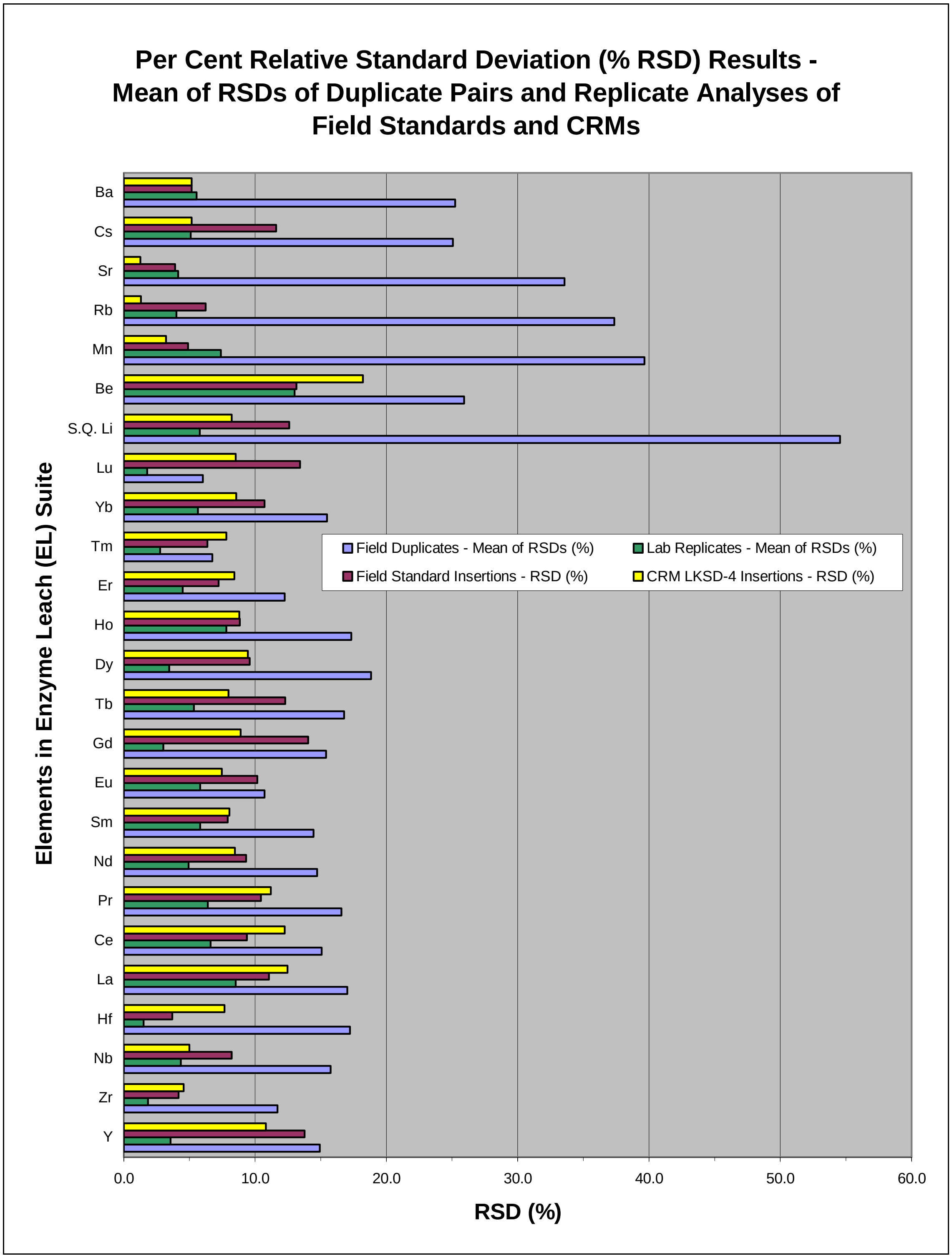
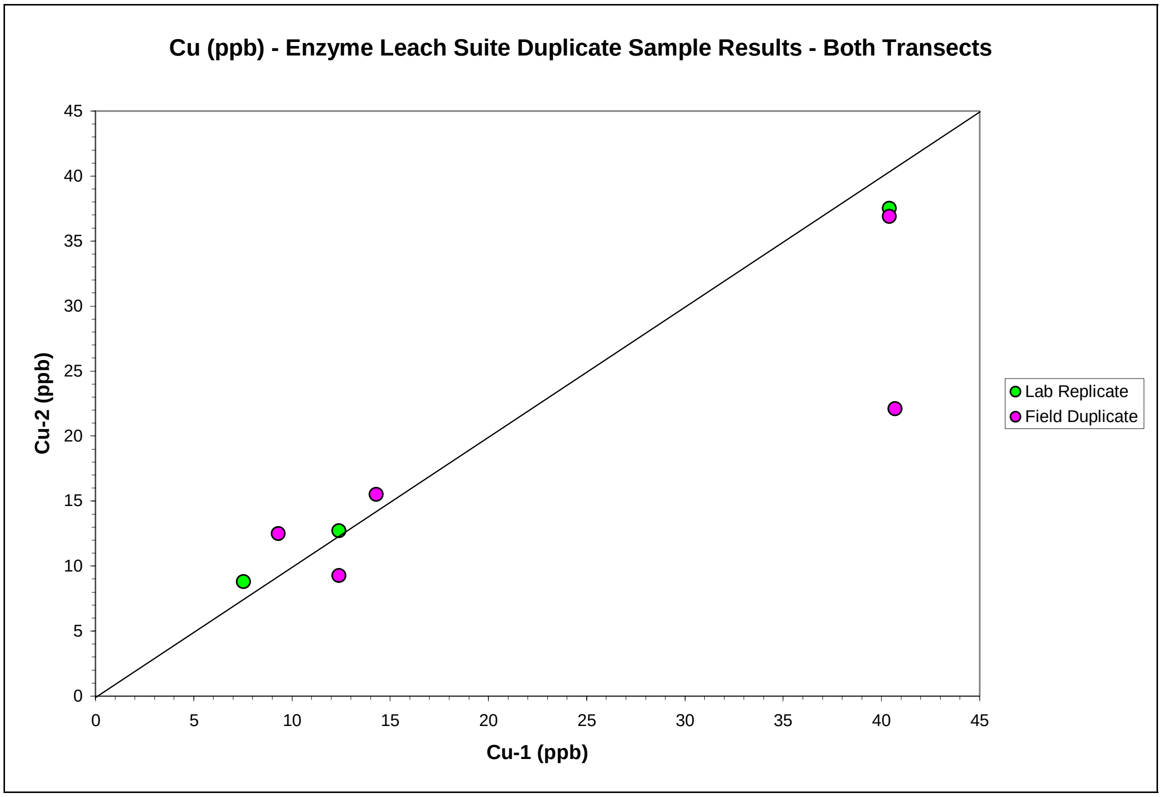
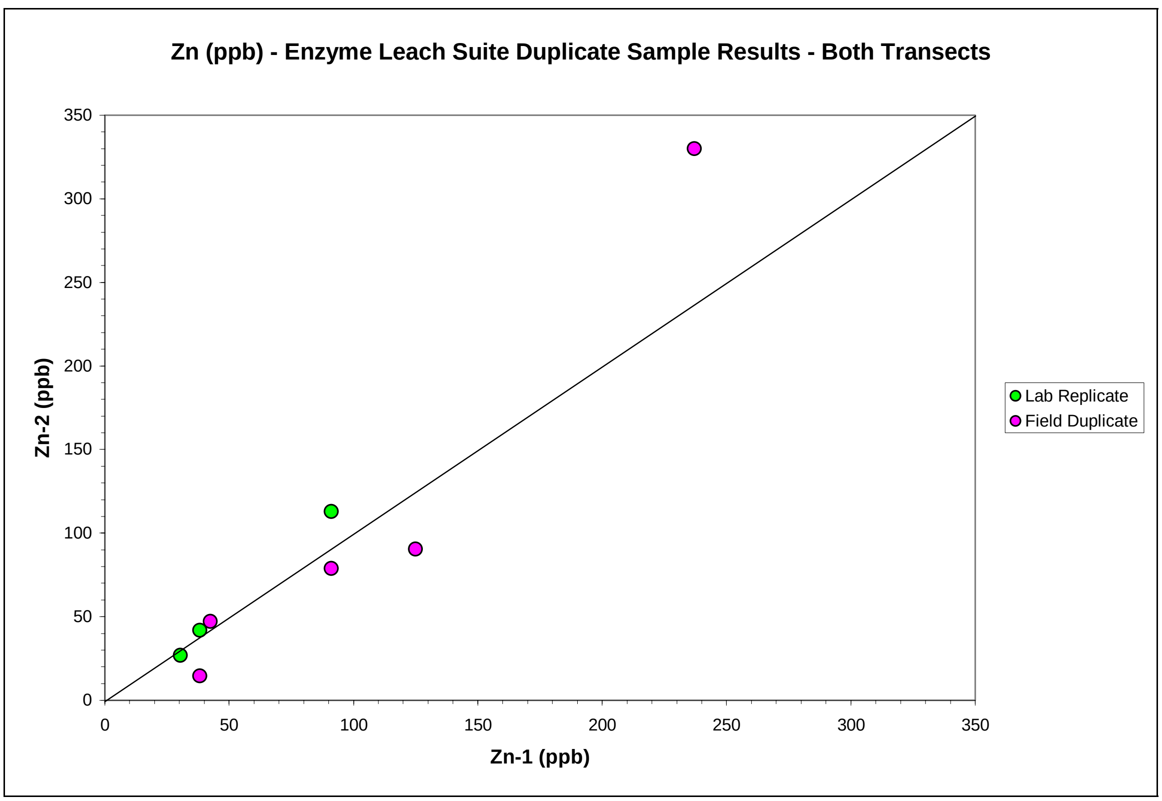
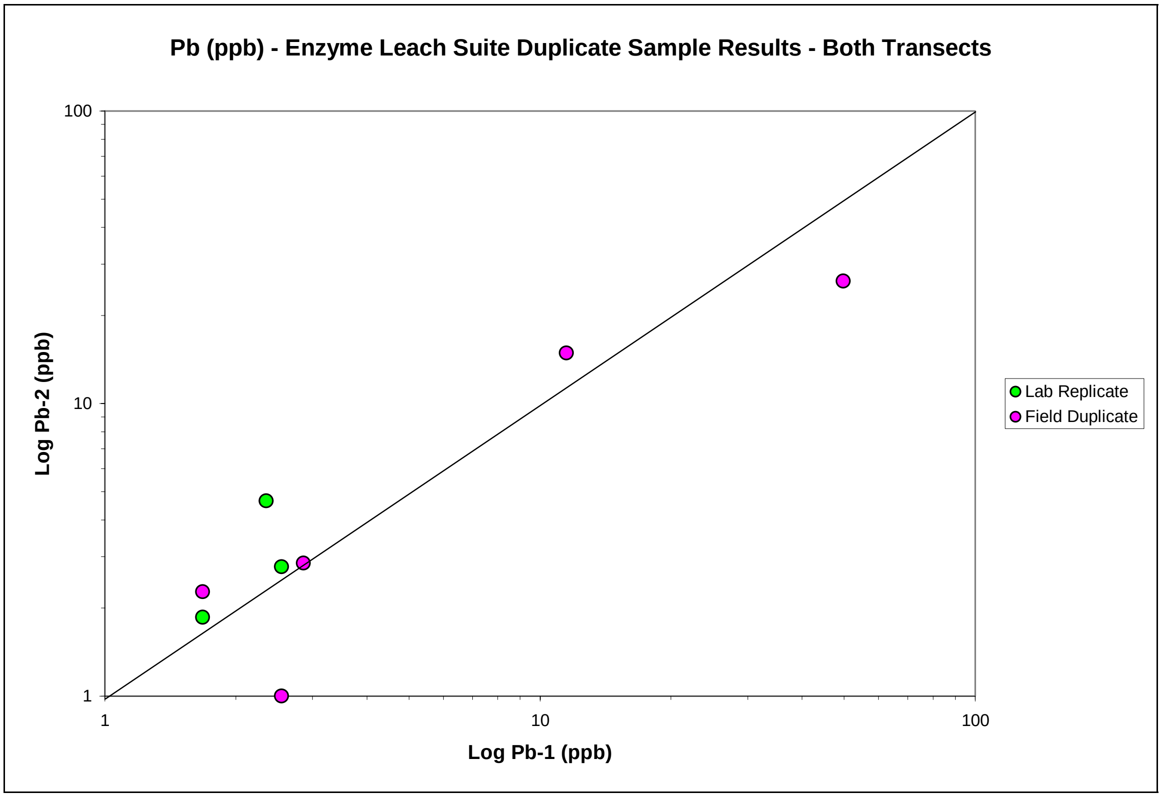


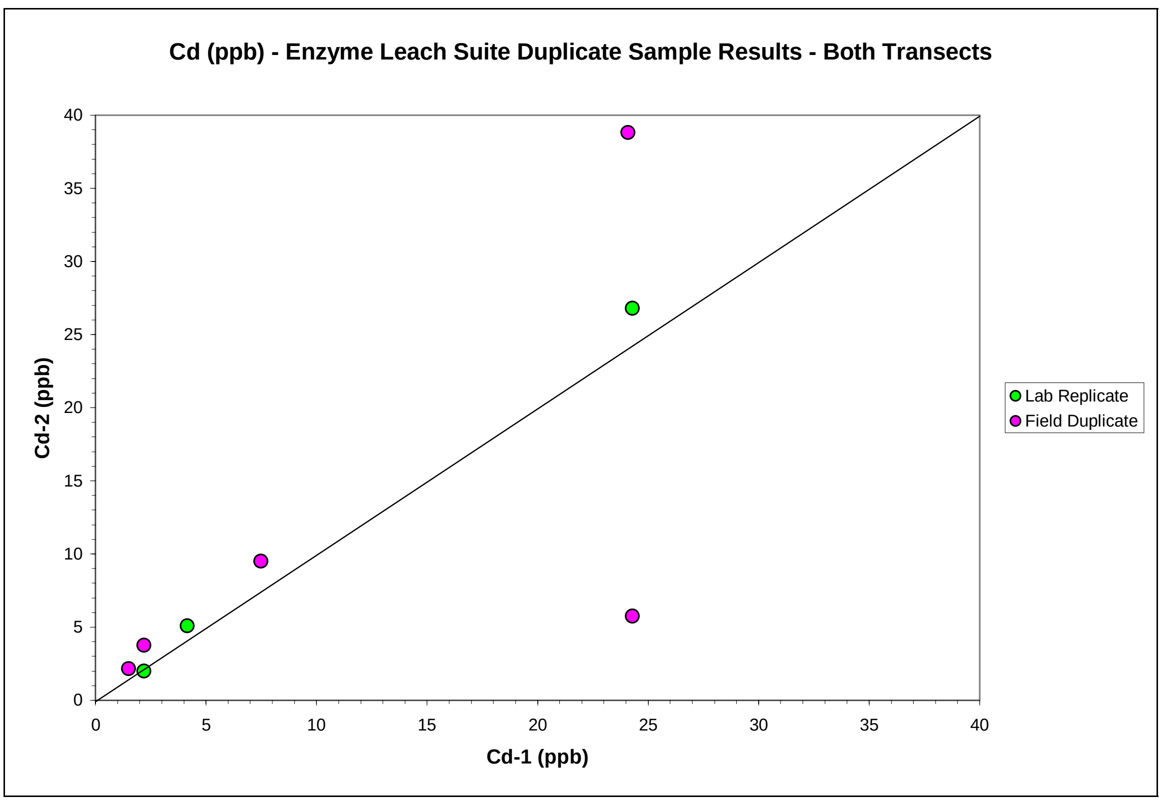
Figure 91. *Second of two bar charts showing relative standard deviation (RSD) results for the Enzyme Leach suite of elements in 3Ts B horizon soils from the Tommy vein and Ted vein orientation transects. The chart shows four values for each element, including 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for Activation Laboratories internal lab replicates (green bars; N=3 pairs), 3) RSD results of replicate analyses of the field soil standard (brown bars; N=5 analyses) and 4) RSD results of replicate analyses of CANMET CRM LKSD-4 (N=4 analyses).*



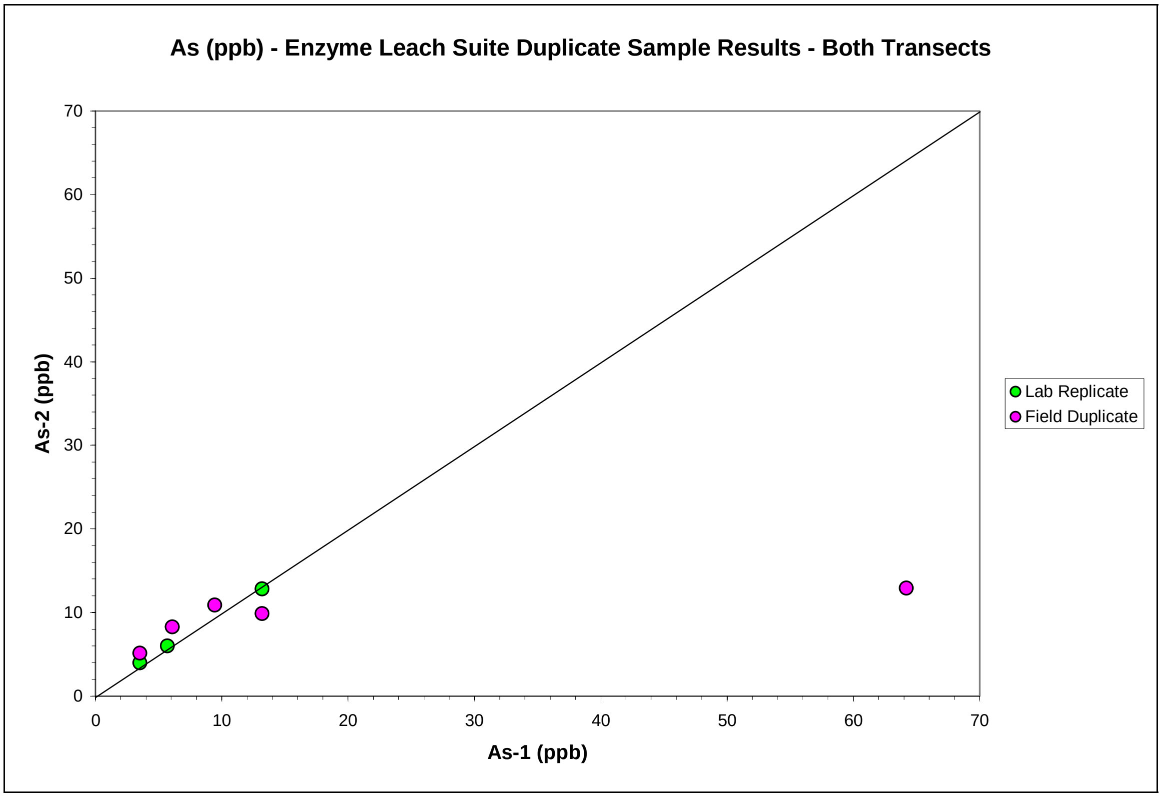


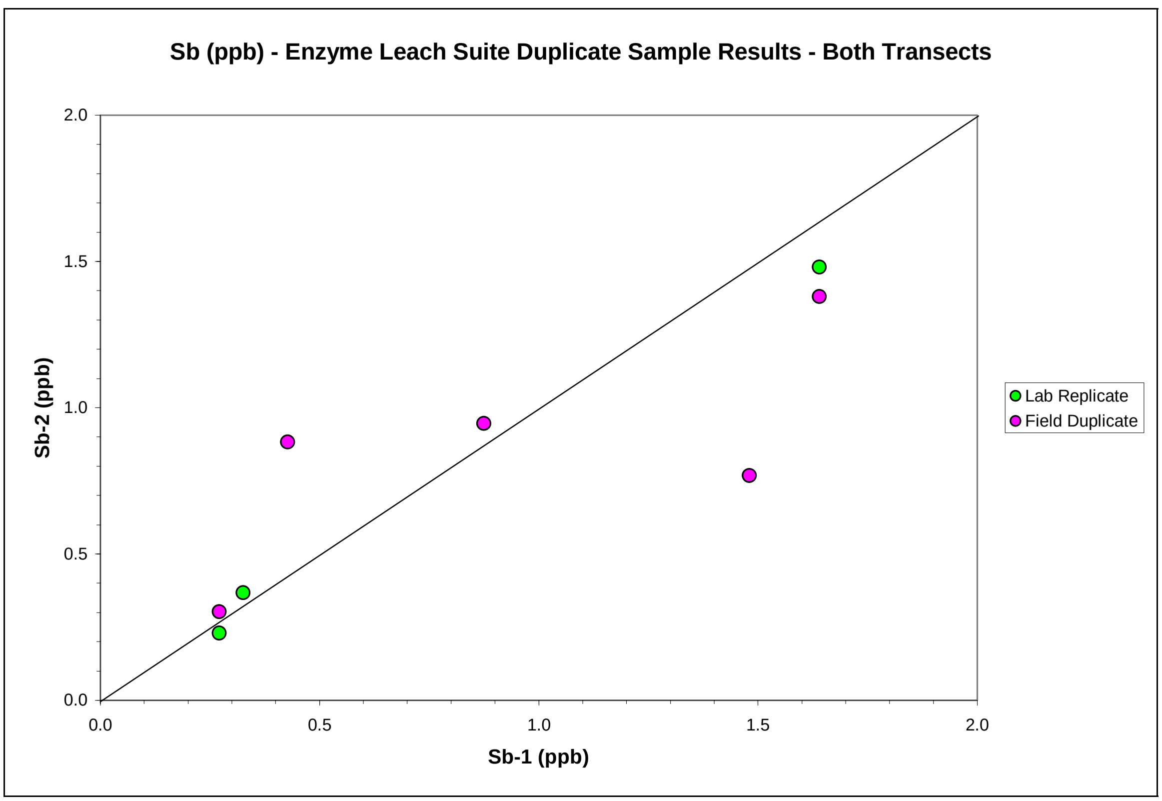
Figures 92 and 93. *Scatterplots showing field duplicate sample results (N=5 pairs) and lab replicate sample results (N=3 pairs) for Cu (top) and Zn (bottom) by Enzyme Leach in B horizon soils for the combined Tommy and Ted vein orientation transects.*





Figures 94 and 95. *Scatterplots showing field duplicate sample results (N=5 pairs) and lab replicate sample results (N=3 pairs) for log Pb (top) and Cd (bottom) by Enzyme Leach in B horizon soils for the combined Tommy and Ted vein orientation transects.*





Figures 96 and 97. *Scatterplots showing field duplicate sample results (N=5 pairs) and lab replicate sample results (N=3 pairs) for As (top) and Sb (bottom) by Enzyme Leach in B horizon soils for the combined Tommy and Ted vein orientation transects.*

MOBILE METAL ION (MMI-M) NEAR-SURFACE SOIL SUITE

No suitable control standards are available for assessing analytical accuracy of the MMI-M suite of elements; however, analytical precision may be estimated in this case from results of multiple insertions (N=5) of the B horizon field soil standard. Field duplicate samples were collected from near-surface mineral soils for MMI analysis, as with other analytical methods, and scatterplots of field duplicate results are shown for several elements including Au (Figure 98) and Ag, Pb, Zn, Co, Cu and Cd (Figures 99 to 100). No MMI internal lab replicate results were provided by ALS Chemex, so none are available for comparison with field duplicate data.

Bar charts showing precision, as estimated by relative standard deviation (RSD), of the field standard and of field duplicate pairs (Figure 101) show, unsurprisingly, that RSD results for field duplicates are worse than those for multiple insertions of the field standard. Relative standard deviation results for the field standard insertions are generally in the range of 6 to 12% for most elements (the mean value is 7.8%). In comparison, mean RSD results for calculated RSDs of field duplicate pairs are typically in the range of 20 to 40% for most elements (mean of mean RSD results: 32.4%). This indicates a level of precision some 4 times worse than for the field standard, which measures only combined sample preparation and analytical variation. As the field duplicate pairs measure, in comparison, the combined field sampling, preparation and analytical variation, this would indicate that sampling is the main source of this variation.

The very specific field sampling requirements for MMI analysis may be a factor in this greater component of variation at the sampling stage. The need to sample in the top 10 to 25 cm range of the mineral soil profile, regardless of the soil horizonation that may or may not be present at any one site, likely introduces an additional source of variation related to the variable mixing of soil horizons into the same sample. This would explain the substantially similar MMI RSD results for the B horizon field soil standard relative to aqua regia digestions (mean of RSDs: 7.8%, versus 6.3% for aqua regia), yet also account for the higher RSD results encountered in field duplicate sample pairs (mean of mean RSDs: 32.4%, versus only 17% for aqua regia results). In examining some individual elements, the mean of RSD for Zn in field duplicate pairs by MMI (37.3%) is some 3 times worse than that for aqua regia digestion (12%), whereas for Cu, the differences are less pronounced (24.5% and 18.9%, respectively). In general, relative standard deviation results for MMI analyses of field duplicates pairs are also slightly worse than that for Enzyme Leach. Conversely, precision results for the Tommy field standard are better by MMI than those achieved by EL, but as the field standard is a B horizon soil, it is not necessarily typical of most MMI field samples.

In spite of these variations in field duplicate sample results, some elements in the MMI-M suite nevertheless proved very effective in highlighting Au in quartz vein mineralization along the Tommy and Ted transects, as shown in the upcoming Results section.

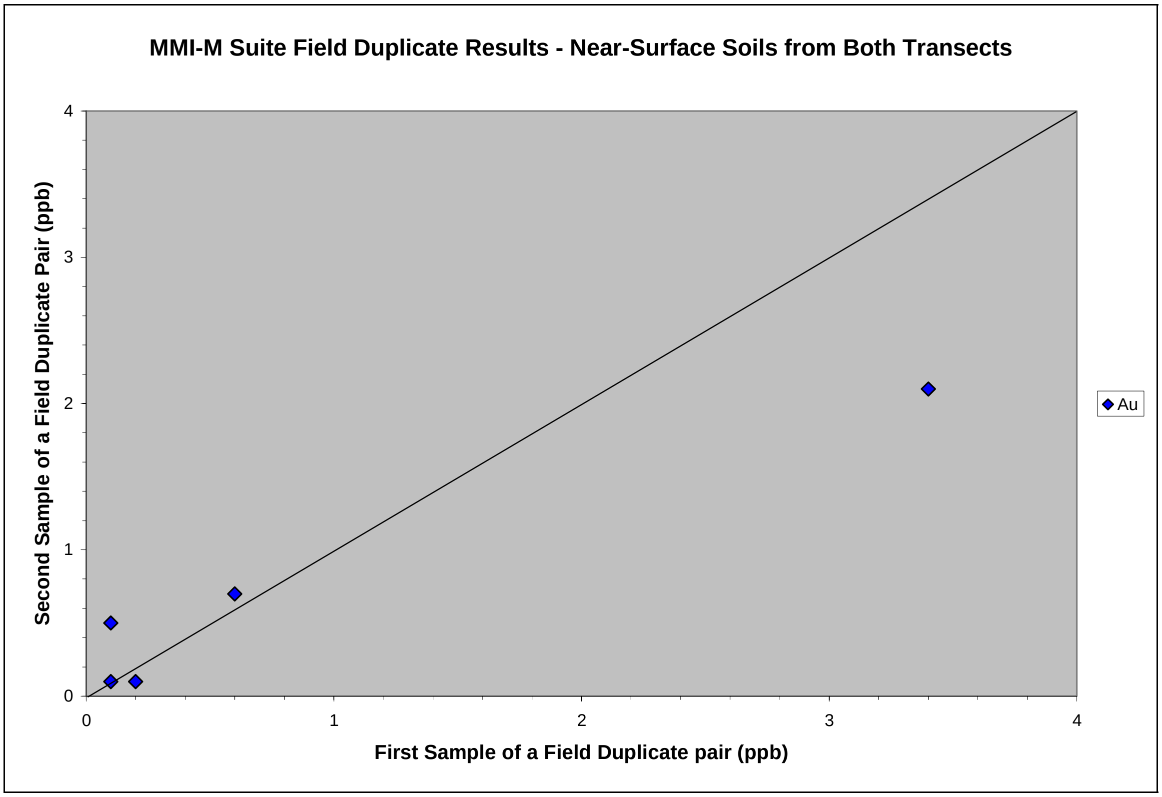
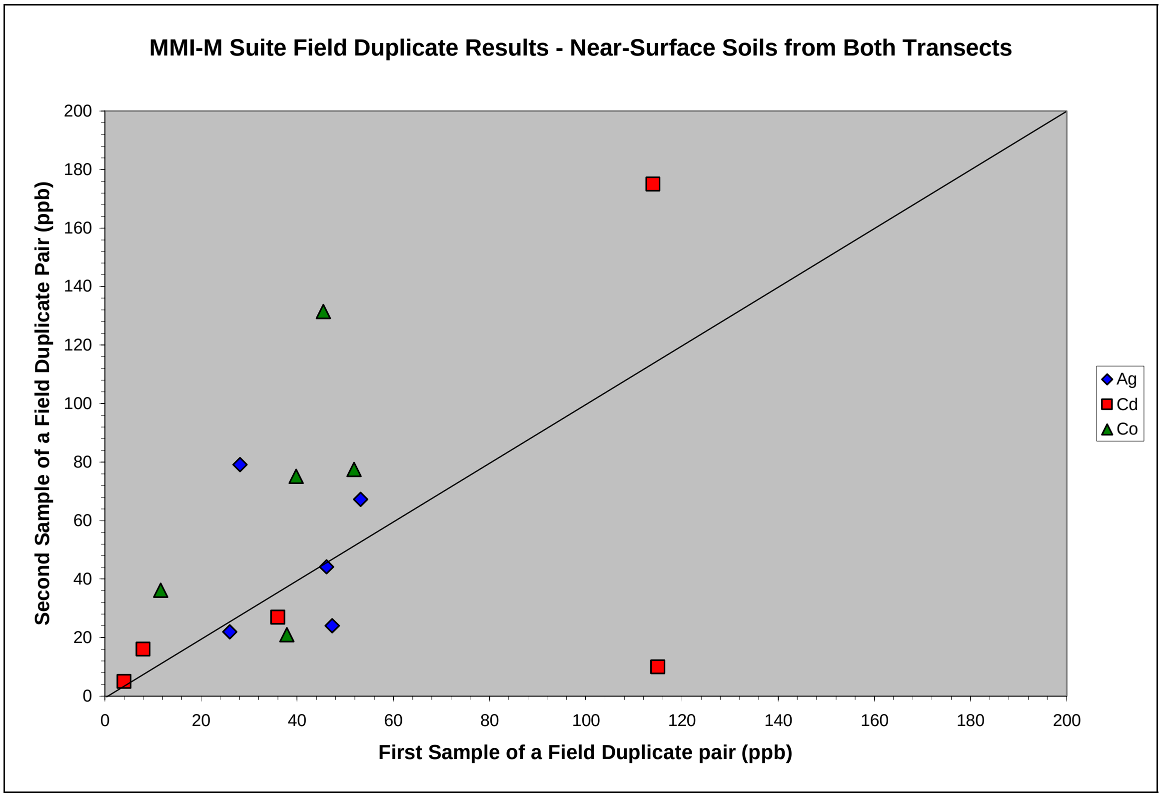
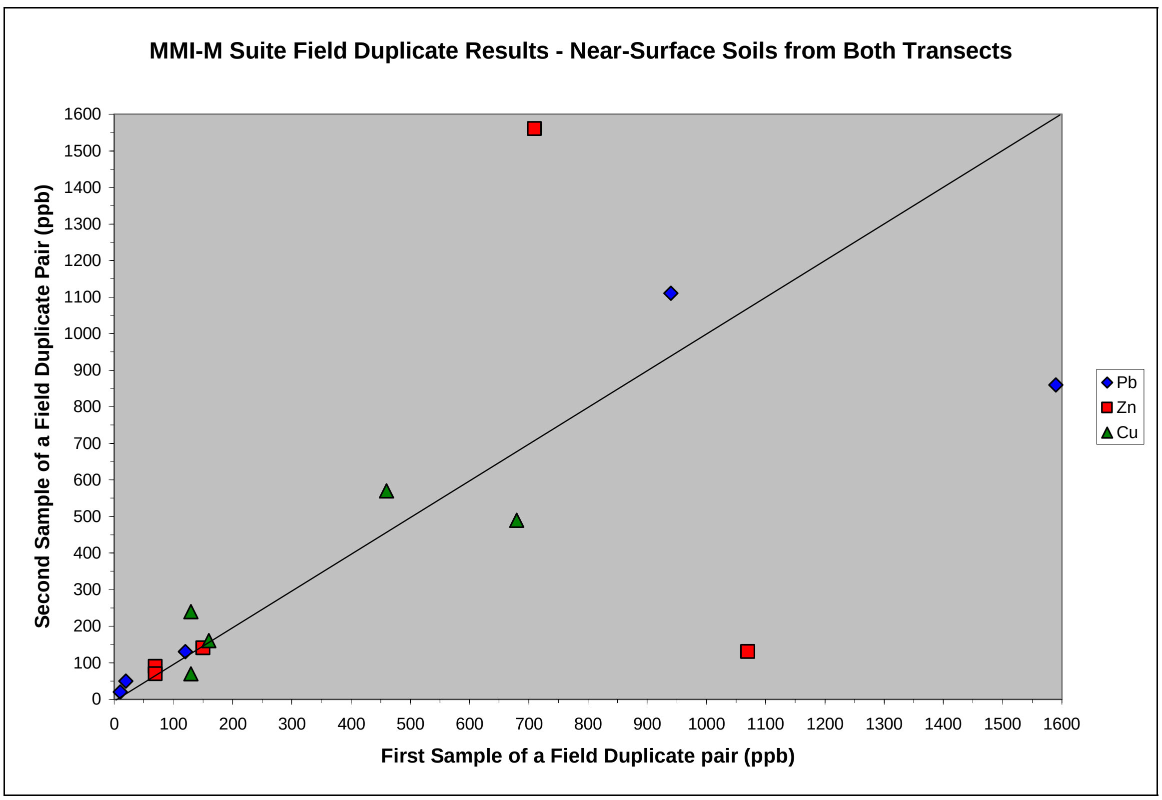


Figure 98. *Mobile Metal Ion (MMI-M) suite field duplicates results (N=5 pairs) for Au in near-surface mineral soils from the combined Tommy and Ted vein transects.*





Figures 99 and 100. *Mobile Metal Ion (MMI-M) suite field duplicate results (N=5 pairs) for Ag, Cd and Co (top) and Pb, Zn and Cu (bottom) in near-surface mineral soils from combined Tommy and Ted vein transects.*

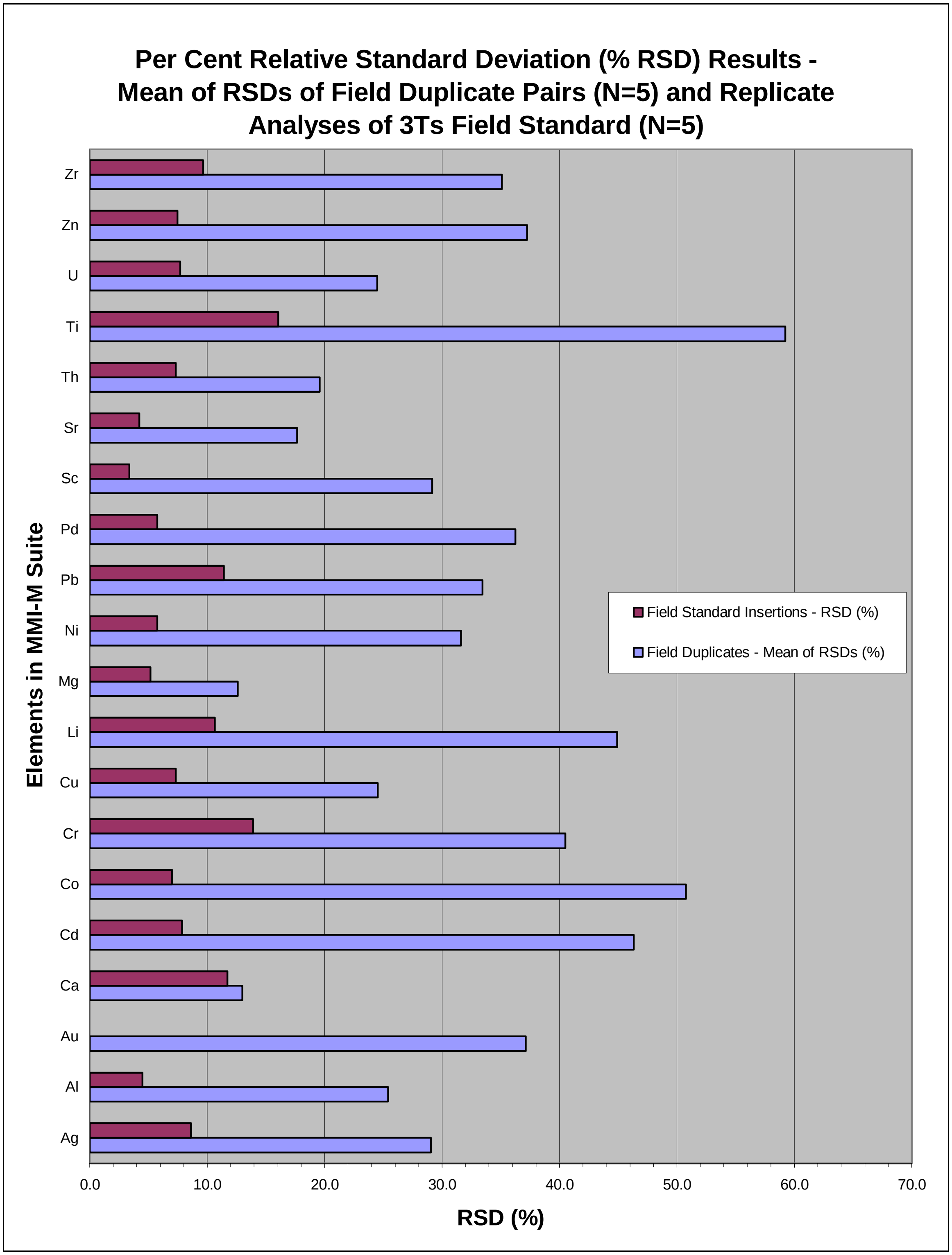


Figure 101. *Relative standard deviation (RSD) results for all 20 elements reported in the Mobile Metal Ion (MMI-M) suite in 3Ts near-surface soils from the Tommy vein and Ted vein orientation transects, showing, for each element 1) the mean of all RSD results (blue bars) for field duplicate pairs (N=5 pairs) and 2) RSD results (brown bars) of replicate analyses of the field soil standard (N=5 analyses).*

SOIL GAS HYDROCARBON (SGH) B HORIZON SOIL SUITE

Results for only 53 of the 162 Soil Gas Hydrocarbons reported in Activation Laboratories Ltd. The SGH analytical suite is discussed here; 109 compounds with median field standard results of 1 or 2 ppt, either at or near the limits of analytical detection, were removed from the dataset. Three additional compounds with median results of 3 ppb, although still near analytical detection limits, were nevertheless retained here.

Lab replicate results for SGH compound class signatures (Figure 102), reported by Sutherland and Hoffman (2005), show good analytical reproducibility. Scatterplots of Soil Gas Hydrocarbon (SGH) field duplicate sample results (N=5 pairs) and lab replicate results (N=3) for five selected SGH compounds in B horizon soils from the combined Tommy and Ted transects are shown in Figures 103 to 104. Line profile results for two of these compounds, 005-C2B and 006-C2B, are discussed in more detail later in the text.

Field standard and field duplicate RSD results for the lighter 27 of these compounds are shown in Figure 105, while corresponding results for the heavier 26 of the 53 compounds are shown in the following Figure 106. There are no control reference standards suitable for use in monitoring accuracy of SGH suite analyses, but replicate analyses of 5 insertions of the Tommy field standard shows analytical precision to be within acceptable limits for most compounds. As shown in the bar charts, RSD results (Figure 105 and Figure 106) for replicate analyses of this material are typically in the range of 10 to 20% for most compounds. Mean RSD, calculated as the overall average of RSD results for each of the 53 Soil Gas Hydrocarbons shown, is 18.0% (the median is 10.9%) for this field standard material.

Relative standard deviation (RSD) results are generally expected to be lower for lab replicate analyses relative to field duplicate analyses; the first is a measure of analytical precision only, while the second measures combined field sampling, preparation and analytical precision. Nonetheless, the precision of lab replicates as measured by RSD is in fact not uniformly better than that of field duplicates, as is evident from selected results in scatterplots (Figures 103 and 104). Mean results of mean RSDs from all 53 sets of duplicate pairs are almost identical — 17.0% for field duplicates and 17.4% for lab replicates — suggesting that laboratory processes, rather than field sampling, is the primary source of variation in SGH results. The similar RSD result (18%) calculated for replicate analyses of the field standard, representing combined preparation and analytical precision, further supports this interpretation.

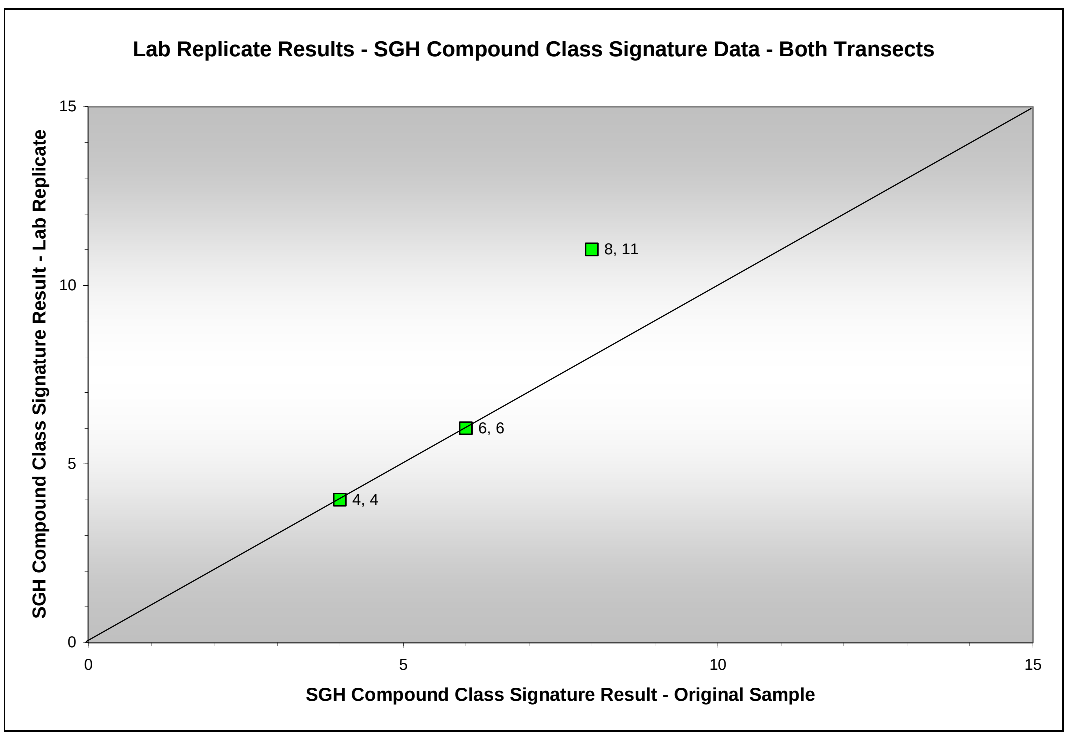
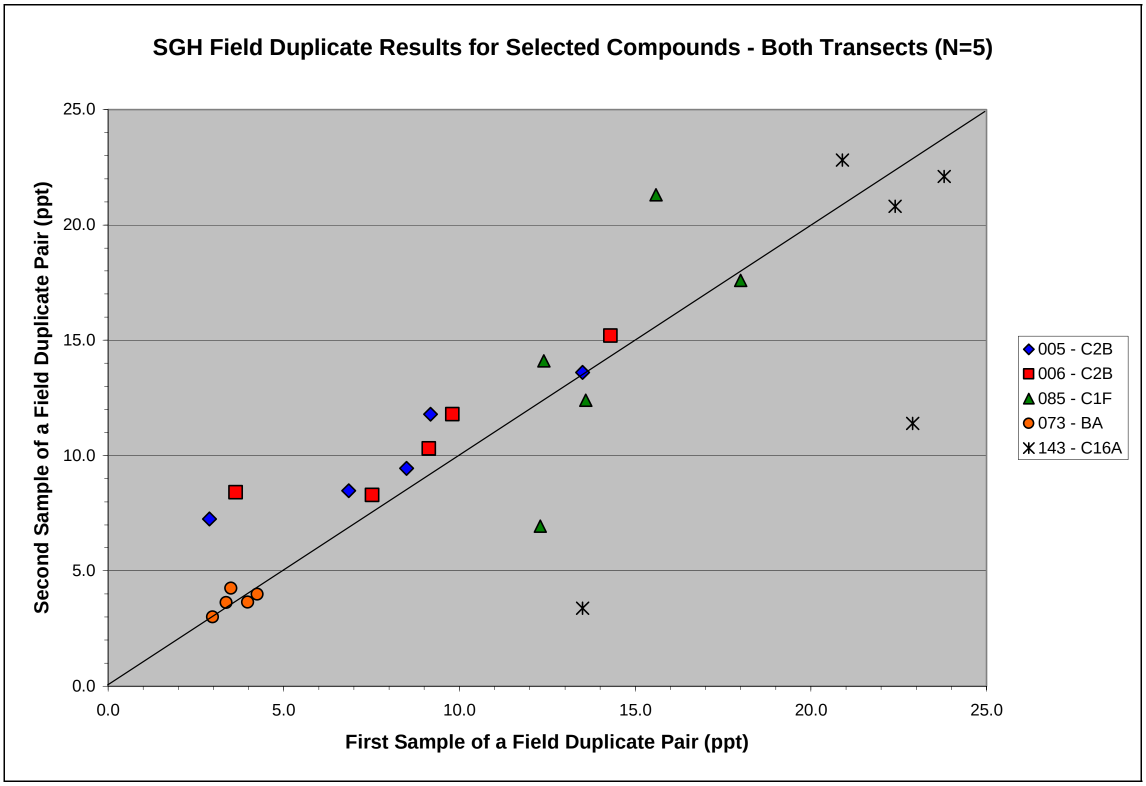
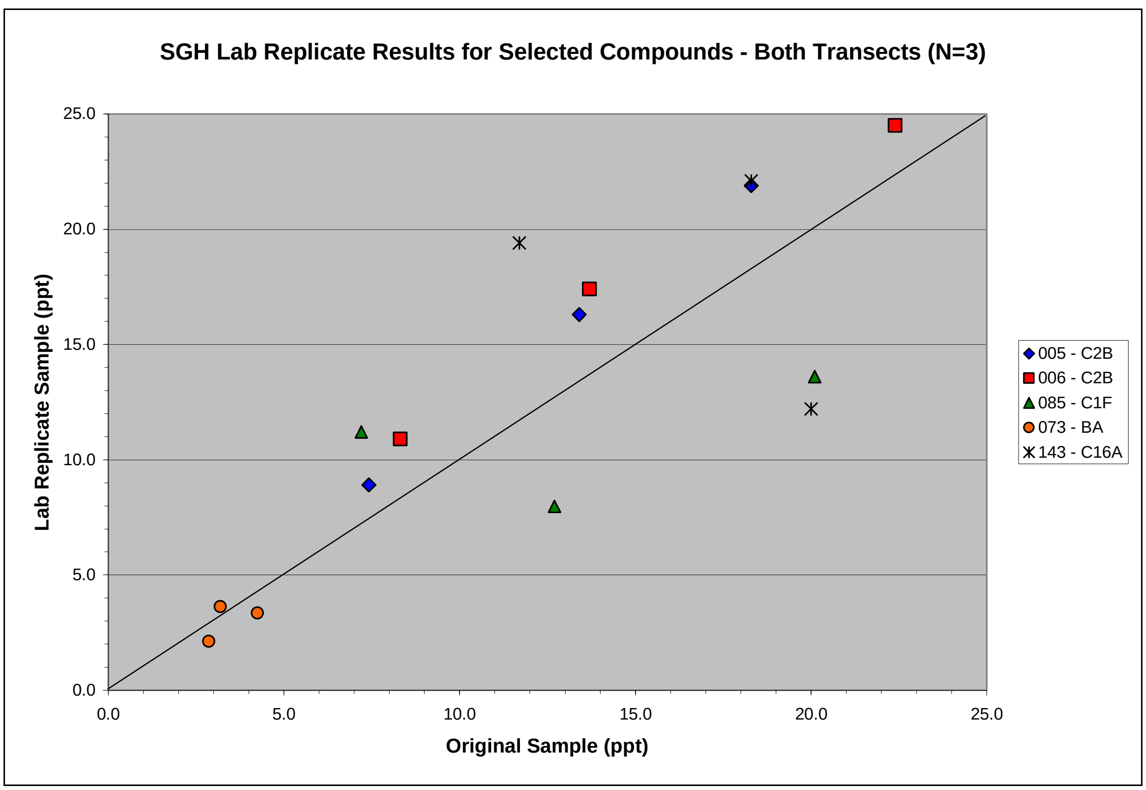


Figure 102. *Lab replicate results (N=3) for SGH compound class signature data, combined 3Ts transects.*





Figures 103 and 104. *Soil Gas Hydrocarbon (SGH) field duplicate results (N=5 pairs; top) and lab replicate results (N=3 pairs; bottom) for five selected compounds in B horizon soils from the combined Tommy and Ted vein transects. Line profile results for 005-C2B and 006-C2B are shown later in the text (Figures 214 and 215).*

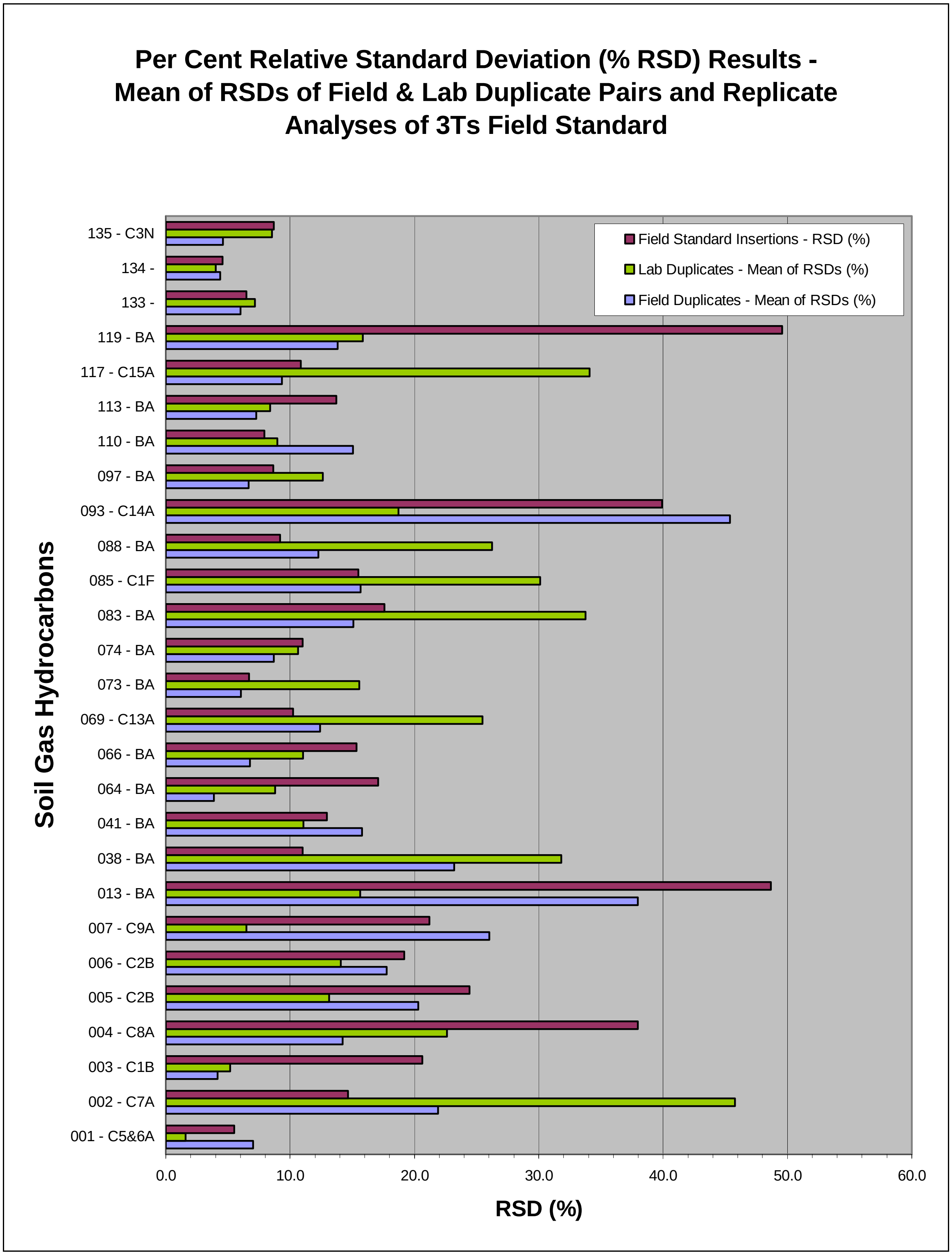


Figure 105. *Relative standard deviation (RSD) results for the lighter 27 Soil Gas Hydrocarbons, of a total of 53 retained from the 162-compound SGH analytical suite, in 3Ts B horizon soils from the Tommy vein and Ted vein orientation transects. The chart shows, for each Soil Gas Hydrocarbon, 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for internal lab replicates (green bars; N=3 pairs) and 3) RSD results of replicate analyses of the field soil standard (brown bars; N=5 analyses).*

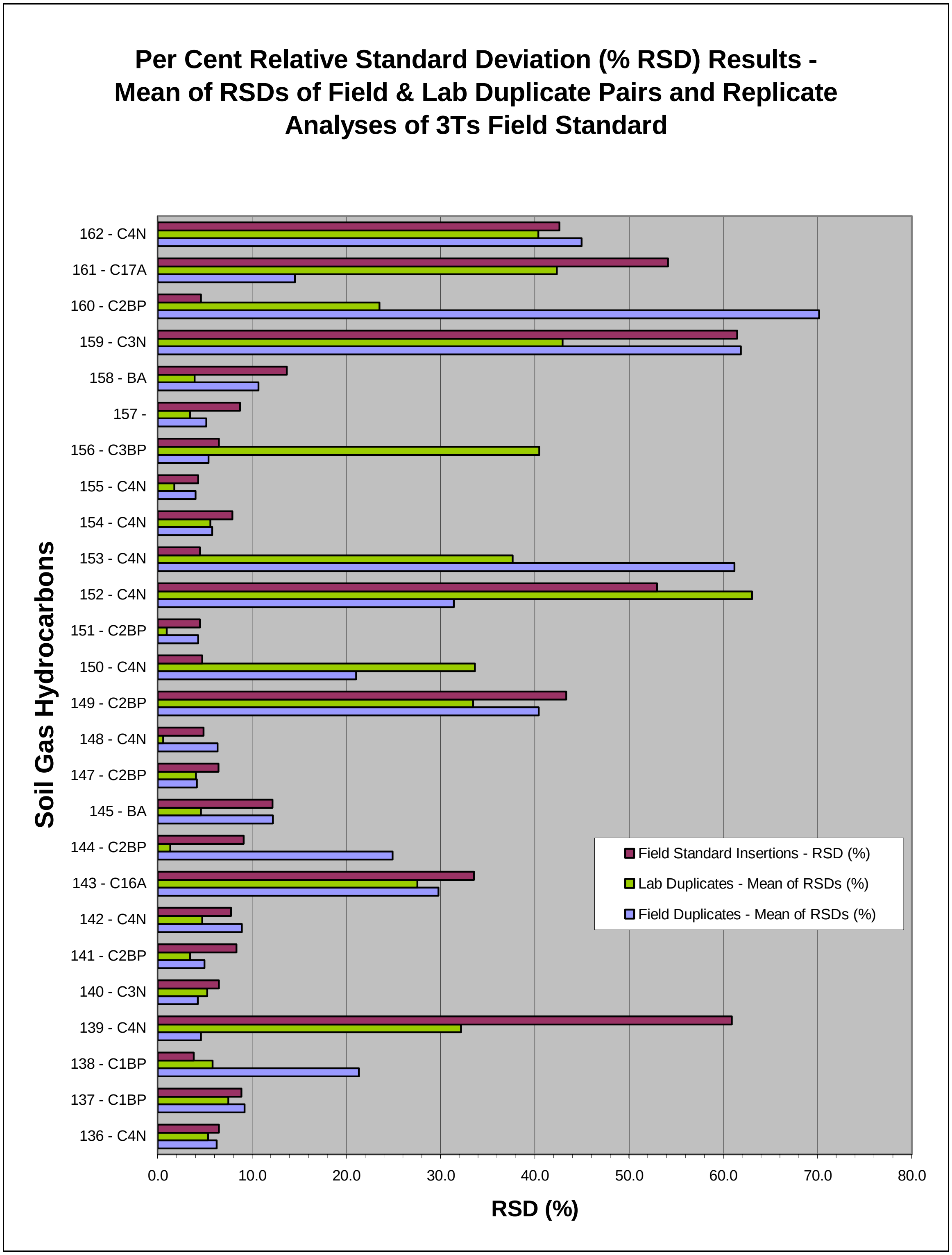


Figure 106. *Relative standard deviation (RSD) results for the heavier 26 Soil Gas Hydrocarbons, of a total of 53 retained from the 162-compound SGH analytical suite, in 3Ts B horizon soils from the Tommy vein and Ted vein orientation transects. The chart shows, for each Soil Gas Hydrocarbon, 1) the mean of RSD results for field duplicate pairs (blue bars; N=5 pairs), 2) the mean of RSD results for internal lab replicates (green bars; N=3 pairs) and 3) RSD results of replicate analyses of the field soil standard (brown bars; N=5 analyses).*

SOIL DESORPTION PYROLYSIS (SDP) B HORIZON SOIL SUITE

Scatterplots of field duplicate sample results (N=5 pairs) for the combined Tommy and Ted transects are shown in Figure 107 to 109 for nine selected elements, which are highlighted in the text discussion. As indicated in the bar chart of relative standard deviation (RSD) results for all field duplicate pairs (Figure 110), the mean RSD of the 39 SDP suite compounds is typically less than 10 to 15% (the mean of all mean RSD results is 11.8%). One hydrocarbon compound, CH_4S, is not included here as 4 of 5 field duplicate pairs reported a result of zero.

There are no control reference standards suitable for use in monitoring accuracy of SDP suite analyses, but replicate analyses of 5 insertions of the Tommy field standard shows that analytical precision is within acceptable limits for most compounds. Relative standard deviation (RSD) results (Figure 110) are typically in the range of 5 to 10% for most compounds. Mean RSD, calculated as the average of RSD results for each of the 39 compounds shown, is only 7.8%. As expected, RSD results are generally lower for replicate analyses of the Tommy soil field standard than for field duplicate pairs; the former is a measure of only preparation and analytical precision, whereas the latter measures combined field sampling, preparation and analytical precision. It should, nevertheless, be noted that the RSD results for the field standard is a measure of analytical precision only for soil compounds at that concentration; obviously it does not represent the full range of compound values that might be expected in the field area.

No SDP internal lab replicate results were reported by SDP Pty., so there is no additional replicate data with which to compare precision estimates from either field duplicates or replicate analyses of the field standard.

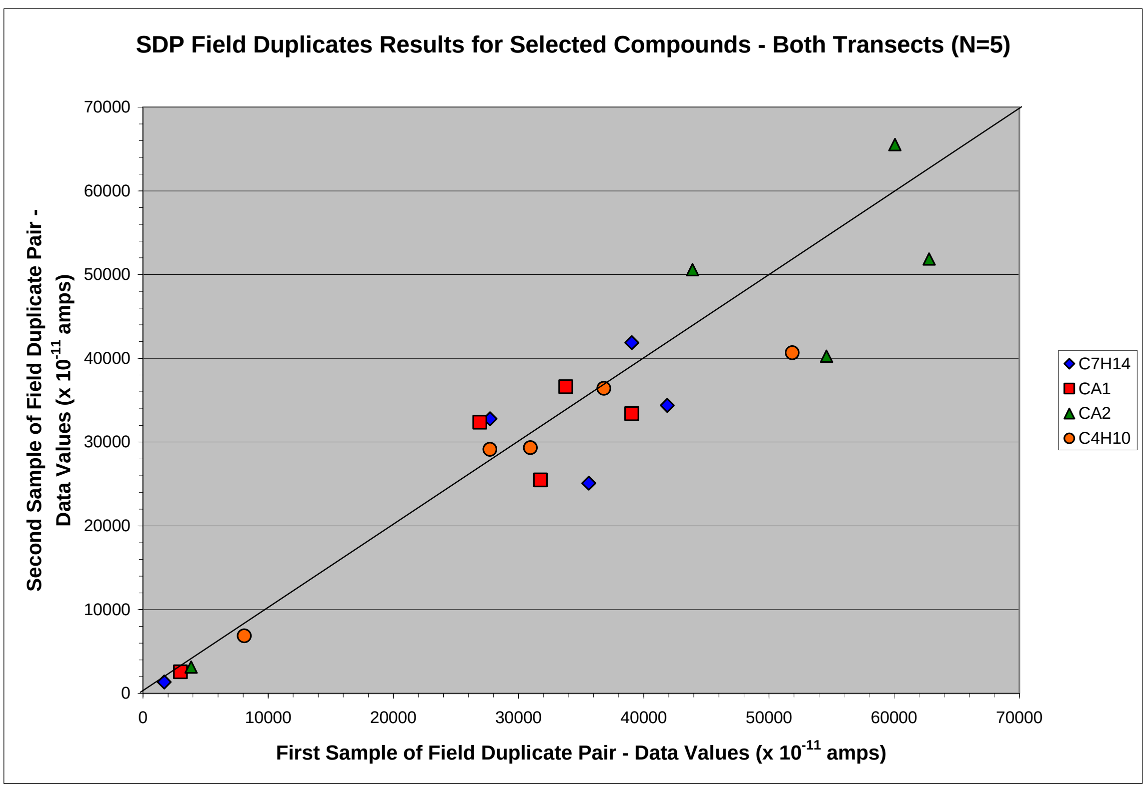
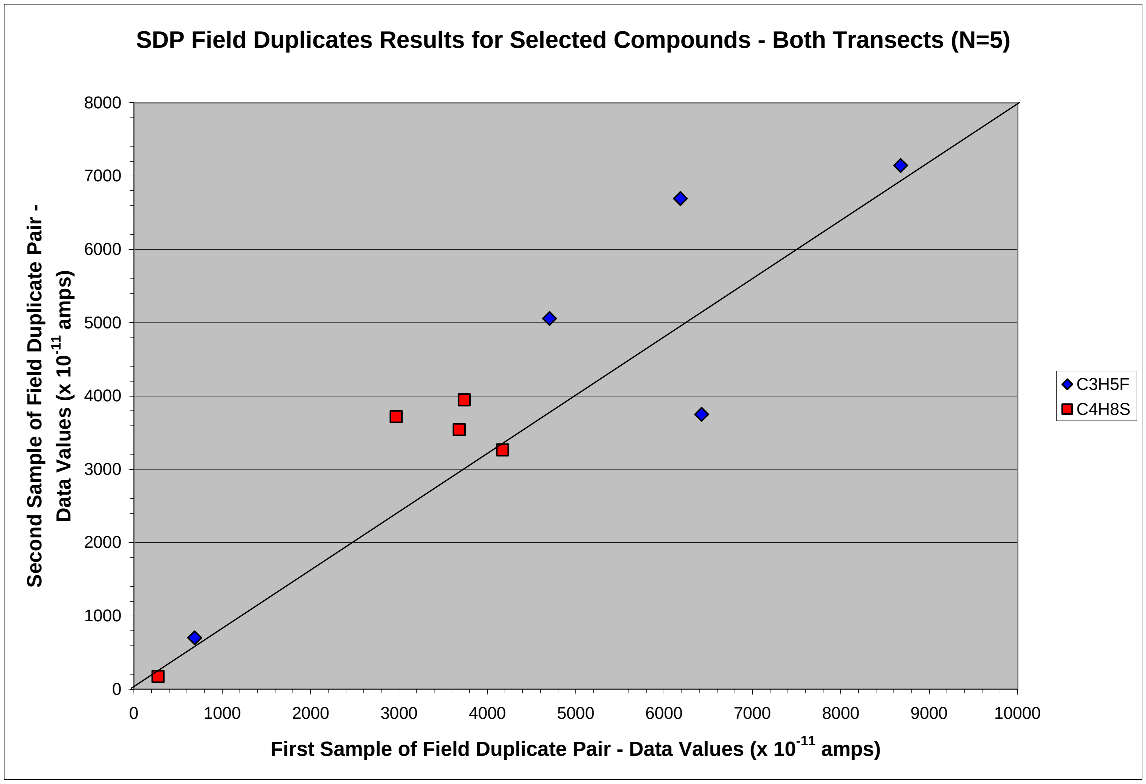
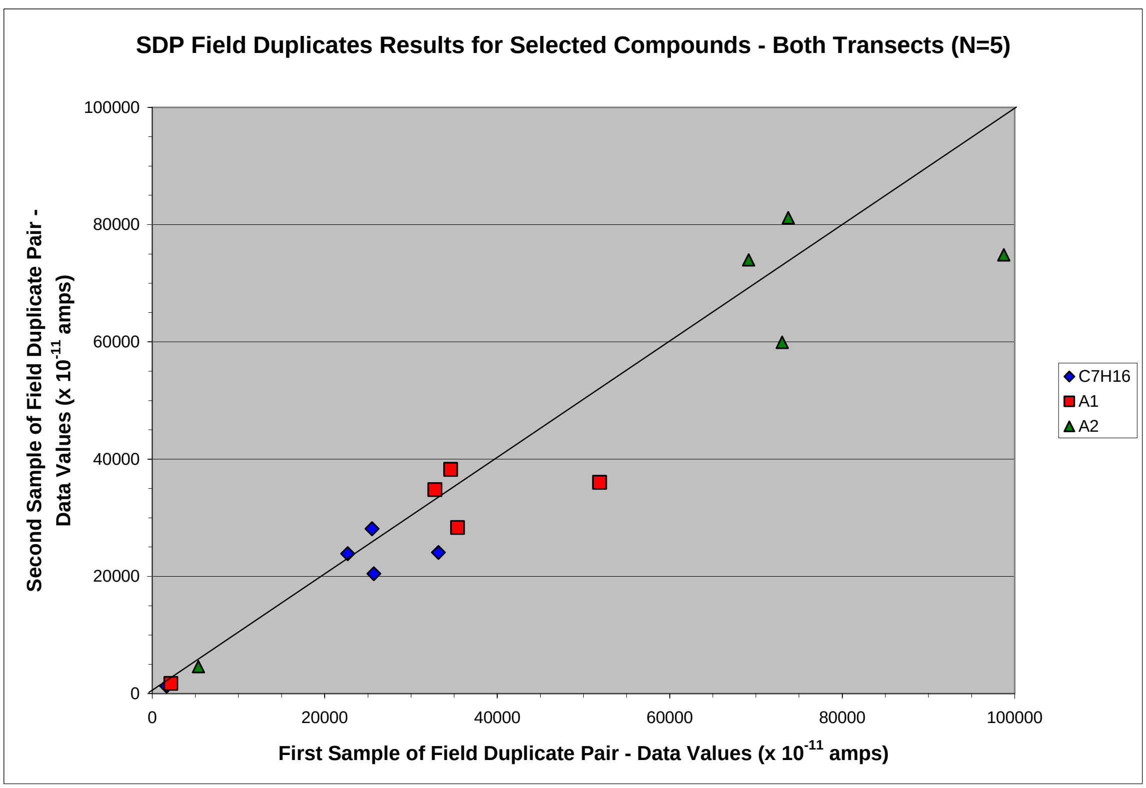


Figure 107. *SDP field duplicate results (N=5 pairs) for selected compounds in B horizon soils from the combined Tommy and Ted vein transects, 3Ts Au-Ag deposit.*





Figures 108 and 109. *SDP field duplicate results (N=5 pairs) for selected compounds in B horizon soils from the combined Tommy and Ted vein transects, 3Ts Au-Ag deposit.*

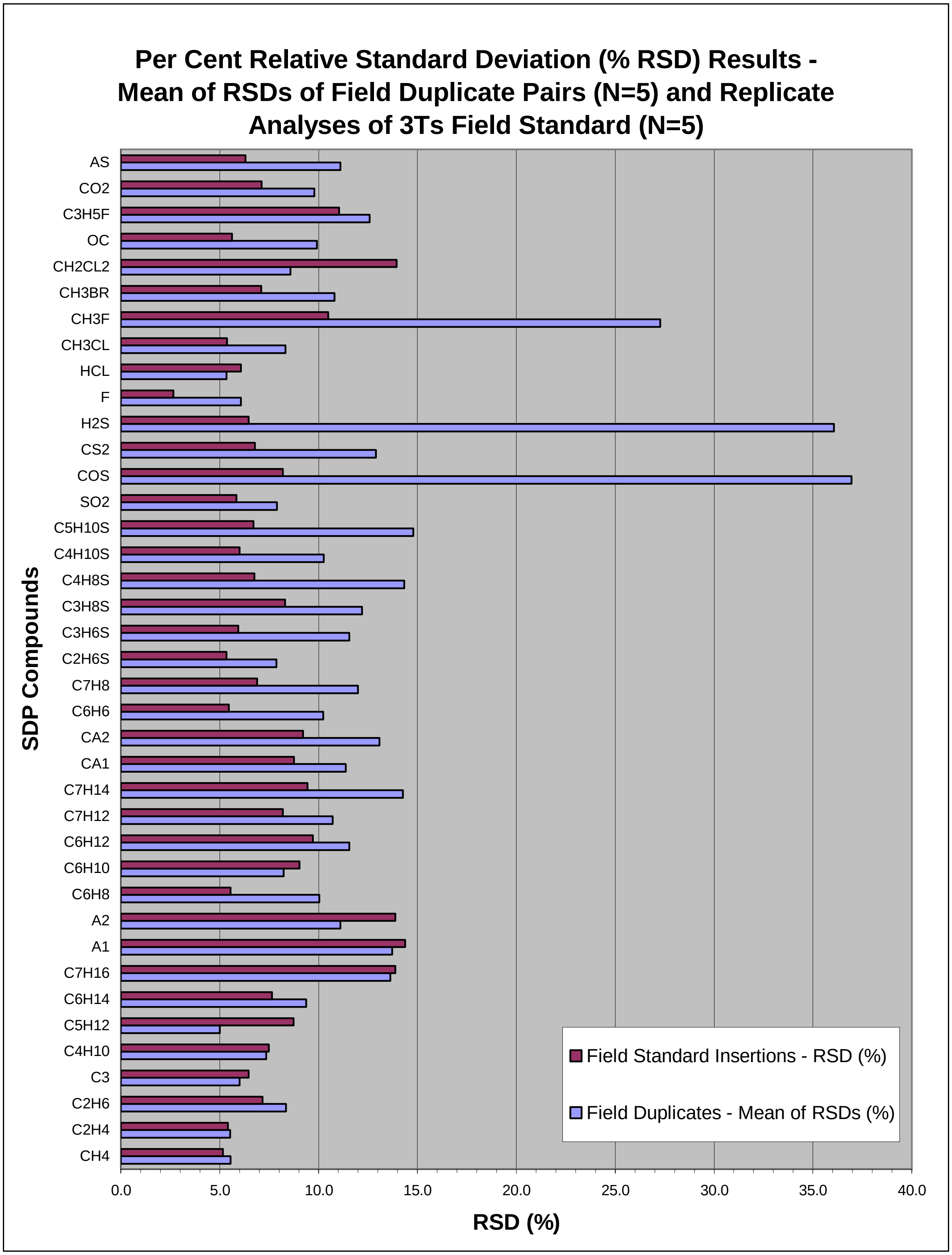


Figure 110. *Relative standard deviation (RSD) results for 39 of 40 SDP (Soil Desorption Pyrolysis) suite compounds in 3Ts B horizon soils from the Tommy vein and Ted vein orientation transects, showing 1) the mean of RSD results, for each compound (blue bars), for field duplicate pairs (N=5 pairs) and 2) RSD results for each compound (brown bars) of replicate analyses of the field soil standard (N=5 analyses).*

The overall precision results reported here for SDP replicate analyses of the Tommy field soil standard are better than those reported by the Soil Gas Hydrocarbon (SGH) method on the same samples, although different individual compounds are measured in each case. The overall mean RSD results for the field standard here (7.8%) are less than half of the overall mean RSD results for the SGH suite (18.0%). These RSD results also compare favourably with corresponding field standard overall mean RSD results by aqua regia digestion and MMI extraction methods (6.3% and 7.8%, respectively), and are better than those achieved by the EL method (13.9%). A possible, although speculative, explanation for the differences in precision attained on the Tommy field standard with the two different organic compound methods may lie in the preparation of the sample prior to GC-MS analysis. Samples for SGH analysis are sieved to a relatively coarse –60 mesh (<250 microns) particle size prior to analysis, whereas those for SDP analysis are first centrifuged to a much finer clay particle size. It is possible that the finer particle size used in the SDP procedure may account for the greater overall precision of results.

The overall SDP field duplicate RSD results, at 11.8%, are more comparable to that achieved using the SGH method (17.8%). It is, however, noteworthy that the level of precision in field duplicate pairs (as overall mean RSD) is superior to all other organic and inorganic analytical methods used here on B horizon mineral soils, including aqua regia digestion (17.0%).

COMPARATIVE RELATIVE STANDARD DEVIATION RESULTS FOR ALL METHODS

Comparative relative standard deviation (RSD) results for duplicates, lab replicates and standards by each method are shown here in Tables 6 to 8 for each of the three soil horizons (LFH, B and C) studied. These results permit a comparative assessment of, for example, analytical precision by each method. These intermethod comparisons are particularly useful for B horizon and near-surface soils, which 1) were analyzed by the widest variety of analytical methods relative to other horizons and 2) have in common, for each method, results for the Tommy soil field standard, which facilitate direct comparisons of combined preparation and analytical variation for each.

Table 6. *Summary of RSD results for selected elements – B horizon soil suites*

Method	QA/QC Details	Au (%)	Cu (%)	Pb (%)	Zn (%)	Ag (%)	Cd (%)	As (%)	Sb (%)	Mean of all Elements or Compounds (%)
Aqua Regia Digestion (Acme Gp. 1F)	Field Duplicates - Mean of RSDs	69.9	18.9	18.2	12.0	41.0	23.4	32.1	19.1	17.0
	Lab Replicates - Mean of RSDs	32.5	2.3	2.4	0.8	3.4	7.7	1.2	0.4	3.5
	Field Standard Insertions - RSD	52.4	4.4	2.6	2.6	4.2	5.9	2.0	5.6	6.3
	CRM TILL-1 Insertions - RSD	33.6	1.4	1.9	1.6	4.0	7.2	2.8	3.9	5.8
	CRM TILL-3 Insertions - RSD	32.8	2.2	4.9	2.2	3.8	6.0	3.9	7.7	6.9
Fire Assay (Acme Gp. 3B-MS)	Field Duplicates - Mean of RSDs	56.8								
	Lab Replicates - Mean of RSDs	41.8								
	Field Standard Insertions - RSD	141.9								
	Acme FA-100S Insertions - RSD	1.4								
	GSB Red Dog Insertions - RSD	24.5								
Enhanced Enzyme Leach* (ActLabs)	Field Duplicates - Mean of RSDs	11.0	19.0	29.0	25.4		40.0	34.5	23.9	22.2
	Lab Replicates - Mean of RSDs		5.9	19.8	10.0		9.3	4.6	9.2	6.2
	Field Standard Insertions - RSD		10.3	25.5	106.9		25.1	5.8	20.6	13.9
	CRM LKSD-4 Insertions - RSD		5.0	13.2	3.3		7.0	5.3	4.0	7.2
	** All Ag and most Au determination by EI are < analytical detection limits*									
MMI-M** (ALS Chemex)	Field Duplicates - Mean of RSDs	37.1	24.5	33.5	37.3	29.0	46.3	*No As or Sb in MMI suite*		32.4
	Field Standard Insertions - RSD		7.3	11.4	7.5	8.6	7.9			7.8
	*** All Au in field standards by MMI < analytical detection limits*									
SGH Suite (ActLabs)	Field Duplicates - Mean of RSDs	*only organic compounds determined*								17.0
	Lab Replicates - Mean of RSDs									17.4
	Field Standard Insertions - RSD									18.0
SDP Suite	Field Duplicates - Mean of RSDs	*only organic compounds determined*								11.8
	Field Standard Insertions - RSD	*only organic compounds determined*								7.8

Relative standard deviation (RSD), also known as the coefficient of variation (C.V.), of 1) multiple analyses of standards and 2) individual duplicate sample pairs is calculated as: (standard deviation/mean) × 100. The mean of RSDs, in the case of suites of duplicate sample pairs, refers to the mean of the RSD results that were individually calculated for each pair. The mean RSD of all elements or compounds (final column in Tables 6–8), for any given analytical procedure, refers to the overall mean of the RSD values individually calculated, from either standards or duplicates, for each reportable element or determination in that analytical suite (those elements reporting below analytical detection limits are not included).

Table 7. *Summary of RSD results for selected elements – LFH horizon humus suites*

Method	QA/QC Details	Au (%)	Cu (%)	Pb (%)	Zn (%)	Ag (%)	Cd (%)	As (%)	Sb (%)	Mean of all Elements (%)
Aqua Regia Digestion (Acme Gp. 1F)	Field Duplicates - Mean of RSDs	64.4	19.5	14.7	20.3	45.3	33.7	46.5	24.9	20.4
	Lab Replicates - Mean of RSDs	0.0	3.5	4.6	3.6	3.5	5.5	10.1	0.0	4.4
	CRM LKSD-4 Insertions - RSD	20.3	3.6	1.2	3.5	1.5	1.6	1.1	3.9	6.2
	Standard PEAT-1 Insertions - RSD	99.8	12.1	6.6	7.0	21.8	12.2	16.0	17.4	12.3
Na-Pyrophosphate Digestion* (Acme Gp. 1SLO)	Field Duplicates - Mean of RSDs	66.3	25.6	9.5	30.7	26.0	42.6			32.9
	Lab Replicates - Mean of RSDs	0.0	0.6	3.0	1.5	5.9	7.4			7.7
	CRM LKSD-4 Insertions - RSD	81.3	9.6	3.3	2.6	5.4	0.5	4.6	8.1	9.4
	Standard PEAT-1 Insertions - RSD	111.5	52.3	15.4	2.4	28.3	11.8	14.3		19.6

** With the exception of LKSD-4, all As and Sb by Na-pyrophosphate leach reported < analytical detection limits*

Table 8. *Summary of RSD results for selected elements – C horizon till suites*

Method	QA/QC Details	Au (%)	Cu (%)	Pb (%)	Zn (%)	Ag (%)	Cd (%)	As (%)	Sb (%)	Mean of all Elements (%)
Aqua Regia Digestion (Acme Gp. 1F)	Field Duplicates - Mean of RSDs	87.9	5.1	12.2	3.1	31.8	14.3	6.5	5.1	8.7
	Lab Replicates - Mean of RSDs	64.6	1.3	1.6	3.2	2.2	3.4	0.0	4.8	3.5
	Little Fort Standard Insertions - RSD	53.8	5.0	4.0	5.0	2.6	4.9	3.1	3.3	7.2
	CRM TILL-1 Insertions - RSD	25.1	2.6	4.5	4.9	5.6	15.8	3.2	6.9	8.0
	CRM TILL-4 Insertions - RSD	8.4	4.2	2.5	1.5	2.6	4.3	1.0	5.1	6.0
Fire Assay (Acme Gp. 3B-MS)	Field Duplicates - Mean of RSDs	36.3								
	Lab Replicates - Mean of RSDs	2.9								
	Acme FA-100S Insertions - RSD	1.4								
	GSB Red Dog Insertions - RSD	14.5								

b) Aqua Regia Digestion Results for All Horizons

OVERVIEW OF RESULTS AND SUMMARY STATISTICS

Summary statistics for 21 selected elements determined by aqua regia digestion–ICP-MS (Acme Labs Group 1F method) for each of LFH horizon humus, B horizon soils and C horizon till and other parent materials are shown for combined lines results (Table 9), and for both individual Tommy vein (Table 10) and Ted vein (Table 11) transect results. Results for LOI and soil pH are also shown in each case.

In all, 48 of the 53 elements in the Group 1F analytical suite are considered and presented in the digital data files included with this report. Five elements (Te, Ta, Re, Pt and Pd) were removed from the dataset as all or most of these results in 3Ts soils are less than the stated analytical detection limits. In the case of Pt and Pd, in particular, the stated detection limits are a relatively high 2 ppb and 10 ppb, respectively. In addition, data for several additional elements including U, Au, Th, B, W, S, Ge, Hf, In and Be are retained here in spite of much of the data reporting as less than stated limits of analytical detection. In these and other cases where data reports as less than stated detection limits, the data is, with the exception of Au, presented as a value equal to the detection limit. In the case of Au, any aqua regia–ICP-MS data reporting as less than the stated detection limits (e.g., <0.2 ppb) is presented here as a value equal to one-half the detection limit (0.1 ppb). Given the relatively high gold concentrations present in soil samples in the vicinity of the 3Ts vein systems, data from only two Ted transect sites are so reported.

Geochemical plot maps showing percentile element distributions are shown here for selected elements by aqua regia digestion–ICP-MS, specifically 1) Au in each of three soil horizons (Figures 111 to Figure 113) and 2) Zn in each of three soil horizons (Figure 114 to 116). In each case, results for the combined Tommy and Ted transects data are displayed using six percentile ranges with common symbol type, size and colour for each: 0 to 25th, 25 to 50th, 50 to 75th, 75 to 90th, 90 to 95th, and 95 to maximum. Element concentrations are posted beside the symbols for each of the upper two percentile ranges.

Table 9. *Summary statistics for selected elements – aqua regia digestion–ICP-MS results for 3Ts comparative soil horizons: combined data for both orientation lines – 1) Tommy Line and 2) Ted Line.*

LFH Horizon Humus	**Au** *ppb*	**Mo** *ppm*	**Cu** *ppm*	**Pb** *ppm*	**Zn** *ppm*	**Ag** *ppb*	**Co** *ppm*	**Mn** *ppm*	**Fe** *ppm*	**As** *ppm*	**U** *ppm*	**Cd** *ppm*	**Sb** *ppm*	**La** *ppm*	**Al** *ppm*	**S** *%*	**Hg** *ppb*	**Cs** *ppm*	**Nb** *ppm*	**Y** *ppm*	**Ce** *ppm*	**LOI** *%*	**pH**
Median	**0.4**	**0.89**	**5.54**	**4.16**	**57.5**	**582**	**0.8**	**885.5**	**0.19**	**0.3**	**0.1**	**0.79**	**0.08**	**0.9**	**0.11**	**0.10**	**214**	**0.42**	**0.28**	**0.45**	**1.4**	**90.8**	**4.6**
Mean	2.28	1.97	5.83	4.49	66.86	1119.47	1.02	1144.47	0.23	0.45	0.25	0.93	0.09	1.98	0.12	0.11	218.31	0.57	0.34	2.68	2.03	89.12	4.82
± 1s	7.09	6.34	2.51	1.39	35.17	1276.32	0.70	864.28	0.17	0.46	0.60	0.80	0.07	6.21	0.09	0.02	50.35	0.42	0.27	12.14	3.35	6.50	0.56
CV (%)	*311.2*	*321.4*	*43.0*	*30.9*	*52.6*	*114.0*	*68.8*	*75.5*	*74.7*	*101.8*	*236.5*	*85.2*	*77.2*	*314.5*	*70.4*	*19.1*	*23.1*	*74.6*	*78.6*	*453.7*	*165.0*	*7.3*	*11.7*
Minimum	0.1	0.18	3.01	2.57	18.8	54	0.2	235	0.04	0.1	0.1	0.2	0.03	0.5	0.03	0.07	145	0.15	0.07	0.13	0.4	70.4	4
Maximum	40.8	38.9	16.42	8.25	189.3	5380	3.1	3742	0.65	2.5	3	3.66	0.45	38.1	0.46	0.14	344	1.68	1.16	73.28	20.9	96.4	6
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

B Horizon Soil	**Au** *ppb*	**Mo** *ppm*	**Cu** *ppm*	**Pb** *ppm*	**Zn** *ppm*	**Ag** *ppb*	**Co** *ppm*	**Mn** *ppm*	**Fe** *ppm*	**As** *ppm*	**U** *ppm*	**Cd** *ppm*	**Sb** *ppm*	**La** *ppm*	**Al** *ppm*	**S** *%*	**Hg** *ppb*	**Cs** *ppm*	**Nb** *ppm*	**Y** *ppm*	**Ce** *ppm*	**LOI** *%*	**pH**
Median	**3.7**	**1.00**	**8.68**	**12.27**	**103.0**	**185.5**	**9.8**	**558.5**	**3.24**	**6.1**	**0.3**	**0.36**	**0.26**	**8.55**	**1.53**	**0.01**	**19**	**2.12**	**2.99**	**4.37**	**15.55**	**8.3**	**5.2**
Mean	15.62	1.31	10.30	21.62	136.58	384.94	9.35	745.69	3.34	10.98	0.48	0.65	0.37	9.53	1.43	0.02	22.22	3.39	2.90	5.78	18.19	8.93	5.18
± 1s	39.70	1.36	5.74	23.36	145.18	563.14	1.97	596.73	0.99	13.92	0.75	0.85	0.29	4.69	0.43	0.02	11.67	2.72	0.88	6.92	7.17	2.96	0.57
CV (%)	*254.2*	*103.7*	*55.7*	*108.0*	*106.3*	*146.3*	*21.1*	*80.0*	*29.6*	*126.8*	*154.9*	*129.6*	*80.0*	*49.2*	*30.0*	*103.6*	*52.5*	*80.2*	*30.5*	*119.8*	*39.4*	*33.2*	*11.1*
Minimum	0.1	0.68	5.38	7.45	37.4	38	4.8	229	2.09	2.6	0.2	0.14	0.14	4	0.49	0.01	6	0.91	0.37	1.03	7.5	5.3	3.8
Maximum	223.1	8.89	33.58	112.52	891.1	2899	14.7	2668	8.27	78	4.5	4.26	1.56	30.4	2.22	0.09	62	10.99	5.5	43.6	43.7	20	6.5
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

C Horizon Till	**Au** *ppb*	**Mo** *ppm*	**Cu** *ppm*	**Pb** *ppm*	**Zn** *ppm*	**Ag** *ppb*	**Co** *ppm*	**Mn** *ppm*	**Fe** *ppm*	**As** *ppm*	**U** *ppm*	**Cd** *ppm*	**Sb** *ppm*	**La** *ppm*	**Al** *ppm*	**S** *%*	**Hg** *ppb*	**Cs** *ppm*	**Nb** *ppm*	**Y** *ppm*	**Ce** *ppm*	**LOI** *%*	**pH**
Median	**3.2**	**0.82**	**13.10**	**11.01**	**61.9**	**145**	**9.5**	**368**	**3.14**	**6.4**	**0.4**	**0.11**	**0.28**	**12.4**	**1.45**	**0.01**	**9**	**1.27**	**1.16**	**8.13**	**29.9**	**4.3**	**6.2**
Mean	11.15	0.84	13.09	21.18	66.08	250.19	9.20	362.42	3.12	8.97	0.48	0.13	0.36	12.42	1.41	0.02	11.19	2.80	1.41	8.49	29.99	4.75	6.11
± 1s	18.00	0.21	2.39	43.30	15.17	272.05	1.29	70.31	0.27	8.38	0.29	0.07	0.27	2.58	0.38	0.03	7.39	2.59	0.74	2.44	6.16	1.56	0.38
CV (%)	*161.5*	*24.5*	*18.3*	*204.5*	*23.0*	*108.7*	*14.0*	*19.4*	*8.6*	*93.4*	*59.4*	*57.9*	*77.2*	*20.7*	*26.9*	*191.5*	*66.0*	*92.7*	*52.1*	*28.8*	*20.5*	*32.8*	*6.3*
Minimum	0.6	0.58	8.32	6.45	41.8	30	6.9	150	2.46	4.7	0.3	0.06	0.2	8.3	0.53	0.01	5	0.61	0.52	4.75	18.4	2.8	5.1
Maximum	84.9	1.67	19.1	250.2	124.5	1271	12.3	549	3.56	52.2	1.7	0.46	1.6	18.8	2.1	0.2	36	9.12	3.34	17.2	45.2	9.2	6.8
N=sites	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31

Table 10. *Summary statistics for selected elements – aqua regia digestion – ICP-MS results for 3Ts comparative soil horizons: 1) Tommy orientation line.*

LFH Horizon	Au	Mo	Cu	Pb	Zn	Ag	Co	Mn	Fe	As	U	Cd	Sb	La	Al	S	Hg	Cs	Nb	Y	Ce	LOI	pH
Humus	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	
Median	**1.0**	**1.04**	**5.94**	**4.16**	**59.6**	**474.5**	**0.9**	**885.5**	**0.21**	**0.4**	**0.1**	**0.92**	**0.07**	**0.85**	**0.10**	**0.10**	**188.5**	**0.58**	**0.33**	**0.45**	**1.45**	**90.7**	**5.0**
Mean	3.89	1.08	6.04	4.59	74.54	1087.15	1.09	1195.10	0.22	0.41	0.12	1.20	0.07	0.91	0.11	0.11	200.10	0.66	0.37	0.50	1.54	89.84	5.00
± 1s	9.28	0.37	1.67	1.58	39.44	1362.36	0.65	864.84	0.15	0.32	0.07	0.94	0.02	0.39	0.06	0.02	43.53	0.45	0.26	0.25	0.86	4.72	0.57
CV (%)	*238.9*	*34.4*	*27.6*	*34.5*	*52.9*	*125.3*	*59.8*	*72.4*	*65.2*	*77.1*	*58.3*	*78.4*	*33.2*	*43.4*	*53.8*	*18.5*	*21.8*	*69.3*	*70.7*	*49.7*	*55.9*	*5.3*	*11.3*
Minimum	0.1	0.53	3.82	2.57	29.6	54	0.4	241	0.04	0.1	0.1	0.39	0.03	0.5	0.03	0.08	145	0.15	0.09	0.18	0.5	78.2	4.2
Maximum	40.8	1.89	10.81	8.25	189.3	5380	2.5	3132	0.6	1.5	0.4	3.66	0.13	1.8	0.23	0.14	301	1.68	0.89	1.16	3.3	95.4	6
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

B Horizon	Au	Mo	Cu	Pb	Zn	Ag	Co	Mn	Fe	As	U	Cd	Sb	La	Al	S	Hg	Cs	Nb	Y	Ce	LOI	pH
Soil	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	
Median	**5.3**	**0.94**	**8.84**	**11.53**	**113.0**	**182**	**10.1**	**593.5**	**3.27**	**6.0**	**0.3**	**0.39**	**0.21**	**9.3**	**1.60**	**0.01**	**20**	**1.90**	**3.26**	**5.46**	**19.9**	**8.8**	**5.4**
Mean	24.34	1.47	10.50	18.25	132.61	460.00	9.91	791.65	3.59	12.61	0.38	0.69	0.32	9.76	1.63	0.01	24.50	3.66	3.19	5.58	19.82	9.67	5.34
± 1s	51.79	1.80	6.07	18.22	57.04	685.15	0.98	564.70	1.17	17.88	0.26	0.70	0.33	3.55	0.26	0.00	13.08	3.21	0.42	2.47	7.14	3.49	0.47
CV (%)	*212.8*	*122.3*	*57.8*	*99.8*	*43.0*	*148.9*	*9.9*	*71.3*	*32.6*	*141.8*	*69.2*	*101.6*	*103.0*	*36.4*	*16.2*	*0.0*	*53.4*	*87.8*	*13.2*	*44.2*	*36.0*	*36.1*	*8.7*
Minimum	0.6	0.68	5.38	7.45	77.2	70	7.8	262	2.85	2.7	0.2	0.17	0.14	6.2	1.03	0.01	9	0.91	2.21	3.03	11.7	6.4	4.7
Maximum	223.1	8.89	33.58	82.72	321.3	2899	11.5	2455	8.27	78	1.3	3.2	1.56	22.4	2.22	0.01	62	10.99	3.94	14.97	43.7	20	6.5
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

C Horizon	Au	Mo	Cu	Pb	Zn	Ag	Co	Mn	Fe	As	U	Cd	Sb	La	Al	S	Hg	Cs	Nb	Y	Ce	LOI	pH
Till	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	*ppb*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	
Median	**3.2**	**0.83**	**13.51**	**10.73**	**64.4**	**72**	**9.5**	**383.5**	**3.23**	**6.4**	**0.4**	**0.12**	**0.26**	**13**	**1.51**	**0.01**	**7.5**	**1.30**	**1.03**	**8.71**	**33.15**	**4.2**	**6.2**
Mean	9.20	0.81	13.64	10.90	69.68	181.13	9.47	394.19	3.25	7.48	0.40	0.14	0.28	13.33	1.53	0.01	9.38	2.39	1.29	8.86	33.40	4.69	6.08
± 1s	12.80	0.07	1.77	3.42	16.22	175.82	1.06	51.22	0.19	2.46	0.05	0.09	0.07	2.39	0.25	0.00	4.16	2.04	0.78	1.52	5.16	1.46	0.29
(CV%)	*139.1*	*8.7*	*13.0*	*31.4*	*23.3*	*97.1*	*11.1*	*13.0*	*6.0*	*32.9*	*12.9*	*68.3*	*26.1*	*18.0*	*16.3*	*0.0*	*44.4*	*85.4*	*60.6*	*17.1*	*15.4*	*31.0*	*4.8*
Minimum	0.8	0.69	10.75	6.78	57.1	30	8.1	334	2.98	4.7	0.3	0.06	0.2	9.5	1.17	0.01	5	0.61	0.56	6.25	23.1	3.1	5.5
Maximum	40.6	0.92	16.3	19.2	124.5	571	11.6	549	3.56	13.3	0.5	0.46	0.47	18.8	2.1	0.01	16	7.48	3.34	11.85	45.2	8.3	6.7
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

Table 11. *Summary statistics for selected elements – aqua regia digestion–ICP-MS results for 3Ts comparative soil horizons: 2) Ted orientation line.*

LFH Horizon Humus	**Au** *ppb*	**Mo** *ppm*	**Cu** *ppm*	**Pb** *ppm*	**Zn** *ppm*	**Ag** *ppb*	**Co** *ppm*	**Mn** *ppm*	**Fe** *ppm*	**As** *ppm*	**U** *ppm*	**Cd** *ppm*	**Sb** *ppm*	**La** *ppm*	**Al** *ppm*	**S** *%*	**Hg** *ppb*	**Cs** *ppm*	**Nb** *ppm*	**Y** *ppm*	**Ce** *ppm*	**LOI** *%*	**pH**
Median	**0.1**	**0.75**	**4.55**	**4.10**	**48.9**	**620.5**	**0.7**	**849.5**	**0.17**	**0.3**	**0.1**	**0.48**	**0.09**	**0.9**	**0.11**	**0.10**	**233**	**0.39**	**0.24**	**0.43**	**1.40**	**91.5**	**4.5**
Mean	0.27	3.09	5.57	4.36	57.26	1159.88	0.93	1081.19	0.23	0.51	0.43	0.60	0.11	3.31	0.14	0.10	241.06	0.46	0.31	5.40	2.65	88.21	4.60
± 1s	0.60	9.56	3.32	1.14	27.19	1202.87	0.77	887.61	0.20	0.60	0.88	0.38	0.10	9.29	0.11	0.02	50.21	0.37	0.29	18.16	4.95	8.29	0.49
CV (%)	*223.1*	*309.5*	*59.7*	*26.0*	*47.5*	*103.7*	*82.8*	*82.1*	*86.7*	*119.1*	*206.6*	*62.8*	*84.1*	*280.6*	*82.3*	*20.5*	*20.8*	*79.9*	*91.8*	*336.6*	*186.9*	*9.4*	*10.7*
Minimum	0.1	0.18	3.01	2.6	18.8	234	0.2	235	0.04	0.1	0.1	0.2	0.05	0.5	0.04	0.07	149	0.2	0.07	0.13	0.4	70.4	4
Maximum	2.5	38.9	16.42	6.35	117.2	4907	3.1	3742	0.65	2.5	3	1.37	0.45	38.1	0.46	0.14	344	1.67	1.16	73.28	20.9	96.4	5.5
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

B Horizon Soil	***Au*** *ppb*	***Mo*** *ppm*	***Cu*** *ppm*	***Pb*** *ppm*	***Zn*** *ppm*	***Ag*** *ppb*	***Co*** *ppm*	***Mn*** *ppm*	***Fe*** *ppm*	***As*** *ppm*	***U*** *ppm*	***Cd*** *ppm*	***Sb*** *ppm*	***La*** *ppm*	***Al*** *ppm*	***S*** *%*	***Hg*** *ppb*	***Cs*** *ppm*	***Nb*** *ppm*	***Y*** *ppm*	***Ce*** *ppm*	***LOI*** *%*	***pH***
Median	**1.8**	**1.05**	**8.41**	**14.32**	**79.75**	**185.5**	**9.1**	**463**	**2.98**	**6.6**	**0.3**	**0.29**	**0.36**	**7.55**	**1.17**	**0.01**	**19**	**2.20**	**2.66**	**3.40**	**13.80**	**7.5**	**5.0**
Mean	4.72	1.10	10.05	25.84	141.53	291.13	8.64	688.25	3.03	8.93	0.61	0.61	0.43	9.25	1.17	0.02	19.38	3.05	2.53	6.04	16.16	8.01	4.98
± 1s	7.20	0.34	5.49	28.61	212.16	358.41	2.62	648.56	0.61	6.26	1.09	1.02	0.24	5.93	0.46	0.02	9.24	1.98	1.16	10.20	6.89	1.85	0.64
CV (%)	*152.5*	*30.6*	*54.6*	*110.7*	*149.9*	*123.1*	*30.4*	*94.2*	*20.0*	*70.0*	*178.0*	*168.3*	*56.5*	*64.1*	*39.6*	*100.7*	*47.7*	*64.9*	*45.7*	*169.0*	*42.7*	*23.1*	*13.0*
Minimum	0.1	0.68	6.61	7.47	37.4	38	4.8	229	2.09	2.6	0.2	0.14	0.19	4	0.49	0.01	6	0.96	0.37	1.03	7.5	5.3	3.8
Maximum	24.4	1.99	29.45	112.52	891.1	1523	14.7	2668	4.05	27	4.5	4.26	0.94	30.4	2.09	0.09	40	8.03	5.5	43.6	37.2	11.5	6.3
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

C Horizon Till	***Au*** *ppb*	***Mo*** *ppm*	***Cu*** *ppm*	***Pb*** *ppm*	***Zn*** *ppm*	***Ag*** *ppb*	***Co*** *ppm*	***Mn*** *ppm*	***Fe*** *ppm*	***As*** *ppm*	***U*** *ppm*	***Cd*** *ppm*	***Sb*** *ppm*	***La*** *ppm*	***Al*** *ppm*	***S*** *%*	***Hg*** *ppb*	***Cs*** *ppm*	***Nb*** *ppm*	***Y*** *ppm*	***Ce*** *ppm*	***LOI*** *%*	***pH***
Median	**3.1**	**0.78**	**12.14**	**16.51**	**58.5**	**156**	**9.0**	**329**	**3.00**	**6.8**	**0.4**	**0.11**	**0.31**	**11**	**1.21**	**0.01**	**10**	**1.25**	**1.43**	**7.32**	**28.5**	**4.5**	**6.2**
Mean	13.23	0.88	12.50	32.14	62.25	323.87	8.91	328.53	2.98	10.55	0.57	0.12	0.44	11.45	1.29	0.03	13.13	3.23	1.54	8.09	26.35	4.80	6.14
± 1s	22.59	0.29	2.86	61.28	13.45	337.94	1.48	73.47	0.27	11.78	0.40	0.05	0.38	2.47	0.46	0.05	9.52	3.09	0.69	3.16	5.03	1.71	0.47
CV (%)	*170.8*	*33.0*	*22.9*	*190.7*	*21.6*	*104.3*	*16.6*	*22.4*	*9.1*	*111.6*	*69.3*	*39.4*	*85.9*	*21.6*	*35.8*	*184.1*	*72.5*	*95.6*	*44.5*	*39.1*	*19.1*	*35.5*	*7.7*
Minimum	0.6	0.58	8.32	6.45	41.8	55	6.9	150	2.46	5.2	0.3	0.06	0.23	8.3	0.53	0.01	5	0.78	0.52	4.75	18.4	2.8	5.1
Maximum	84.9	1.67	19.1	250.2	92.6	1271	12.3	476	3.38	52.2	1.7	0.22	1.6	17.6	2.02	0.2	36	9.12	2.7	17.2	34.9	9.2	6.8
N=sites	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

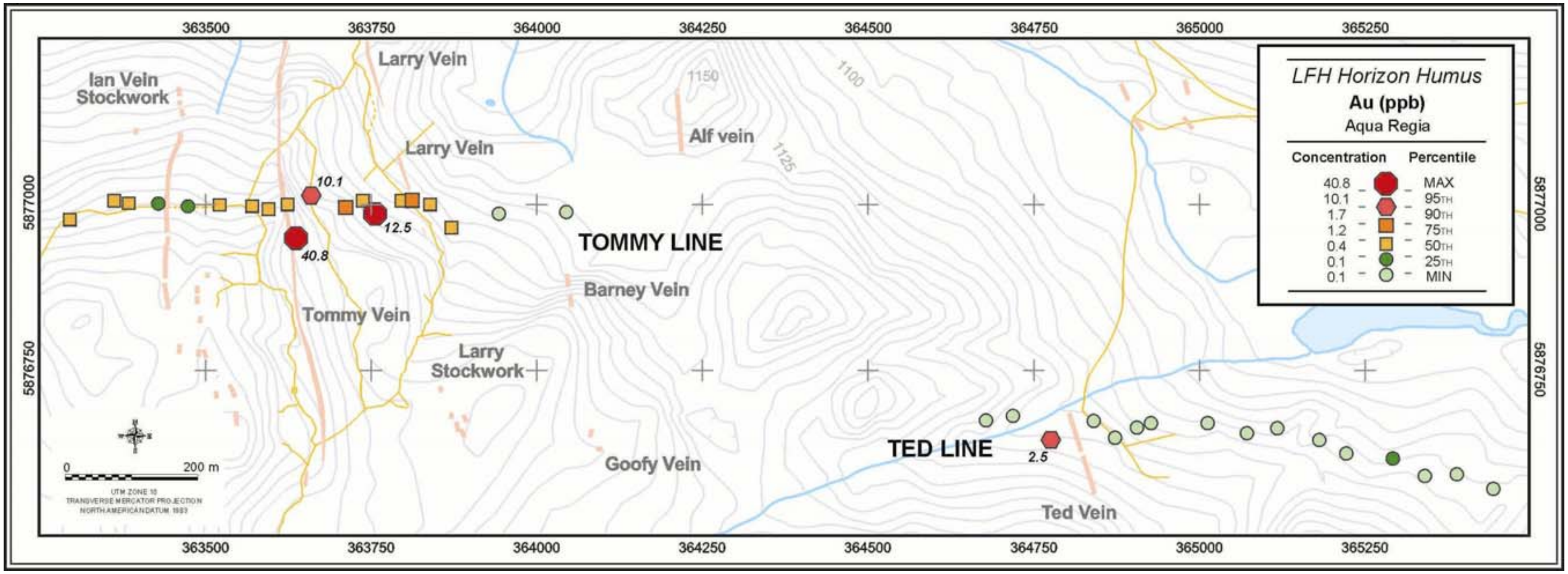


Figure 111. *Distribution of Au (ppb) by aqua regia digestion–ICP-MS in LFH horizon humus on the combined Tommy and Ted orientation transects (N=36 sites).*

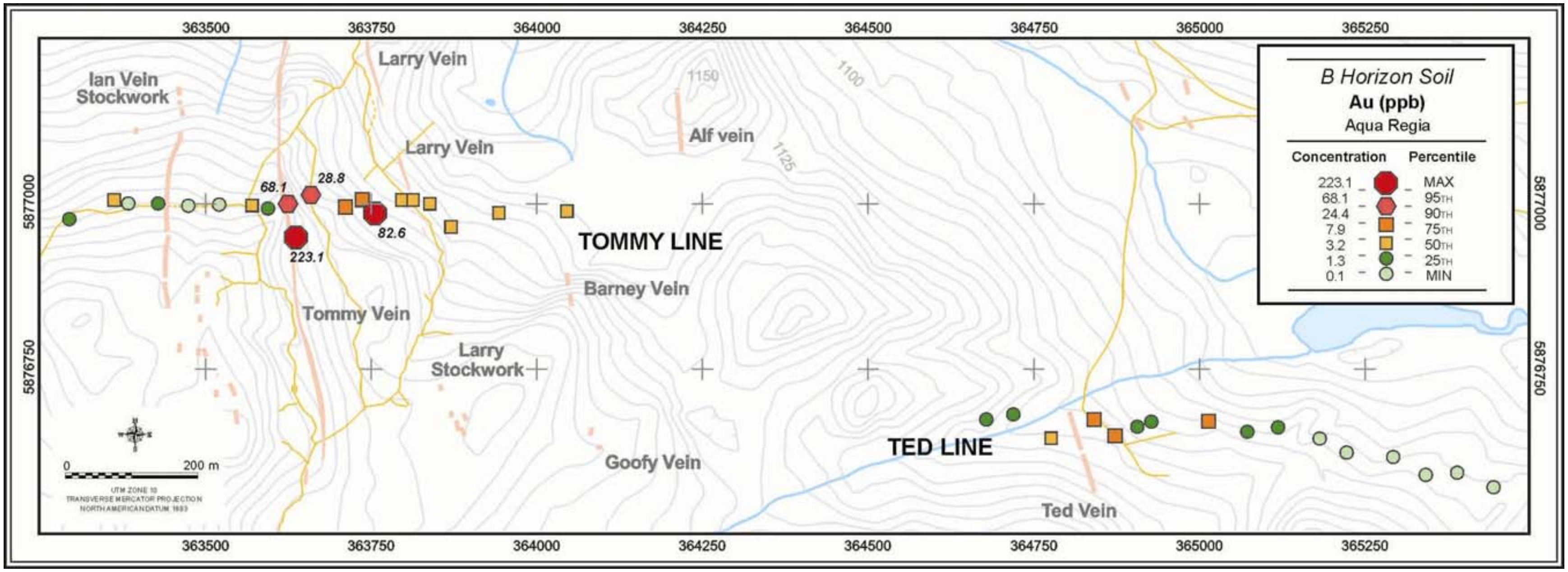


Figure 112. Distribution of Au (ppb) by aqua regia digestion–ICP-MS in B horizon soils on the combined Tommy and Ted orientation transects (N=36 sites).

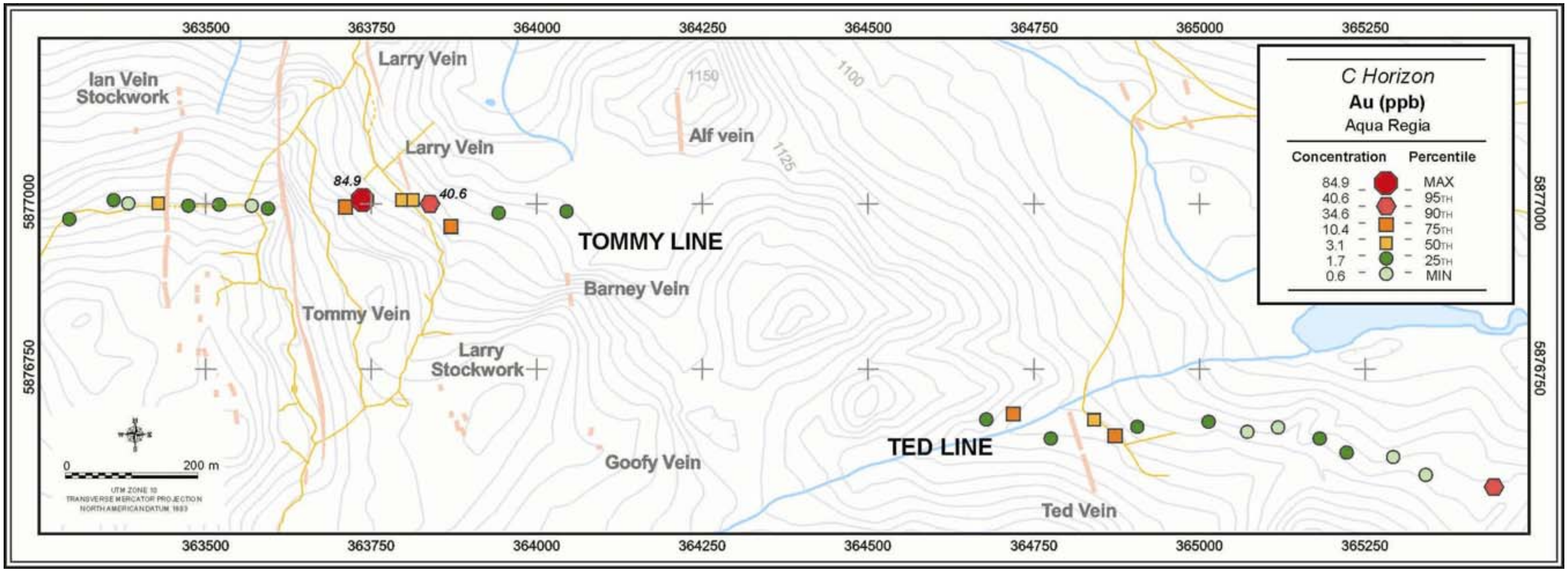


Figure 113. *Distribution of Au (ppb) by aqua regia digestion–ICP-MS in C horizon till and other parent materials on the combined Tommy and Ted orientation transects (N=31 sites). C horizon parent materials were not present at five sites; compare with the Au in B horizon soils map above for locations of the missing sites.*

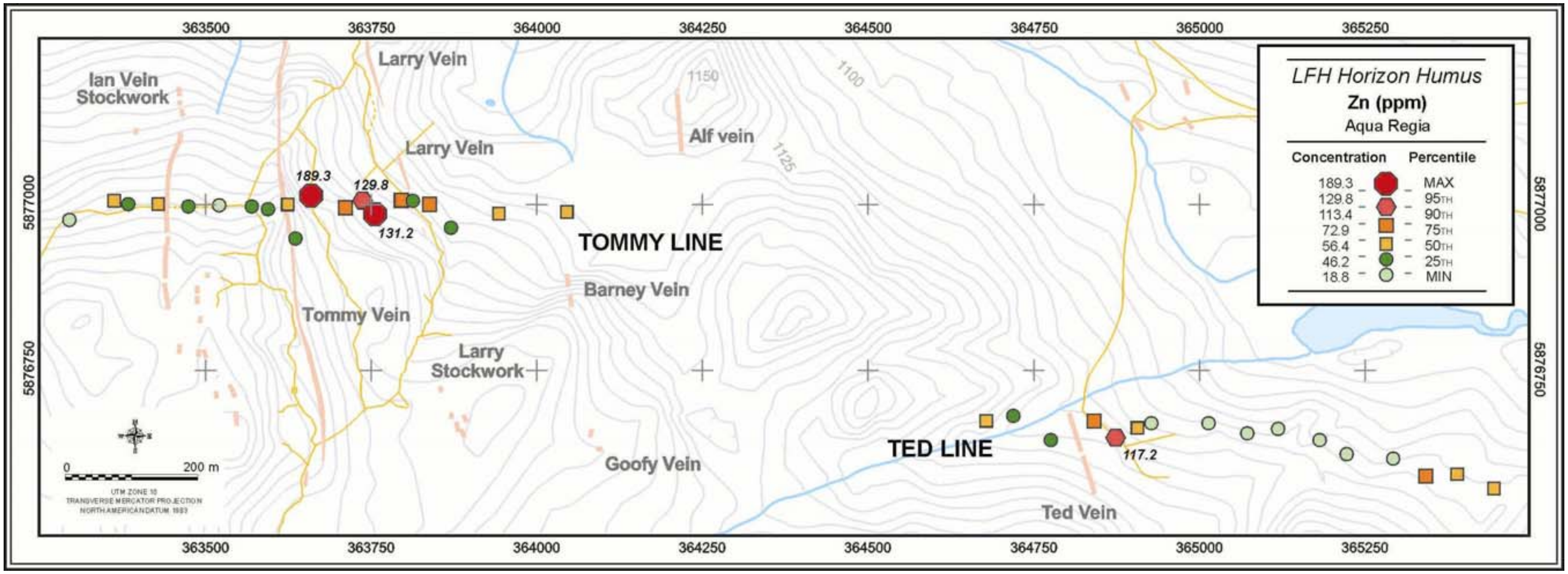


Figure 114. *Distribution of Zn (ppm) by aqua regia digestion–ICP-MS in LFH horizon humus on the combined Tommy and Ted orientation transects (N=36 sites).*

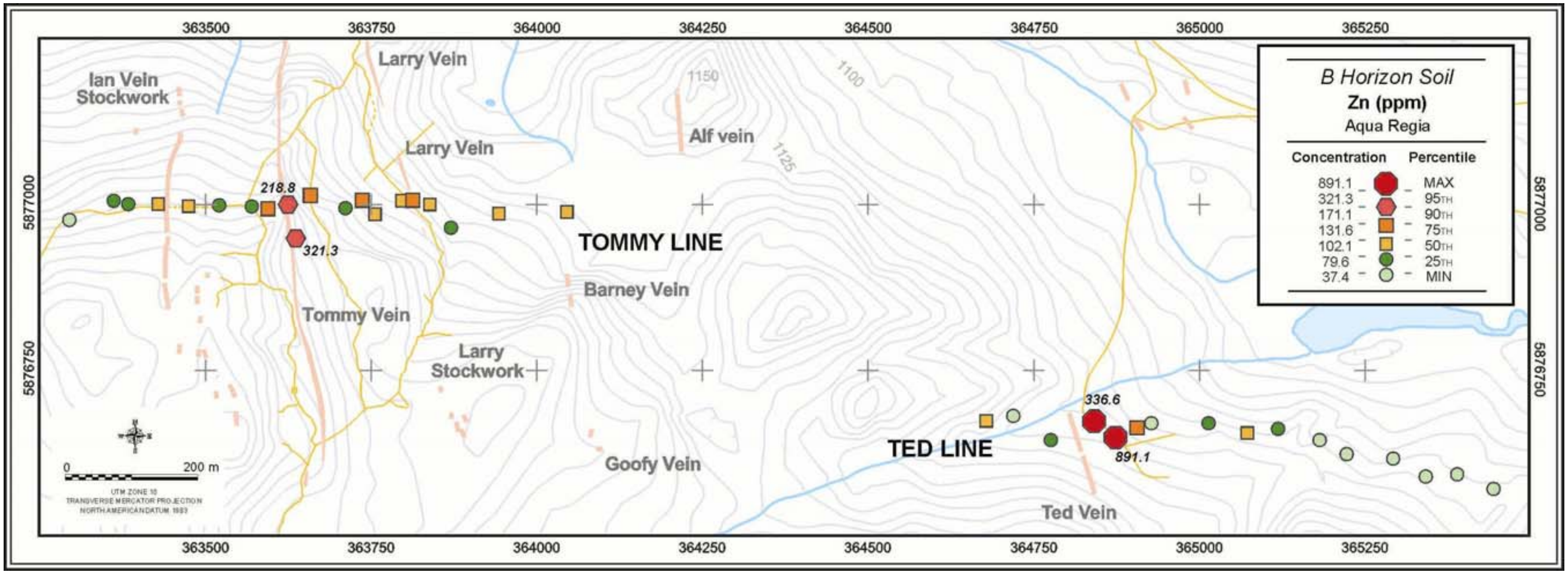


Figure 115. *Distribution of Zn (ppm) by aqua regia digestion–ICP-MS in B horizon soils on the combined Tommy and Ted orientation transects (N=36 sites).*

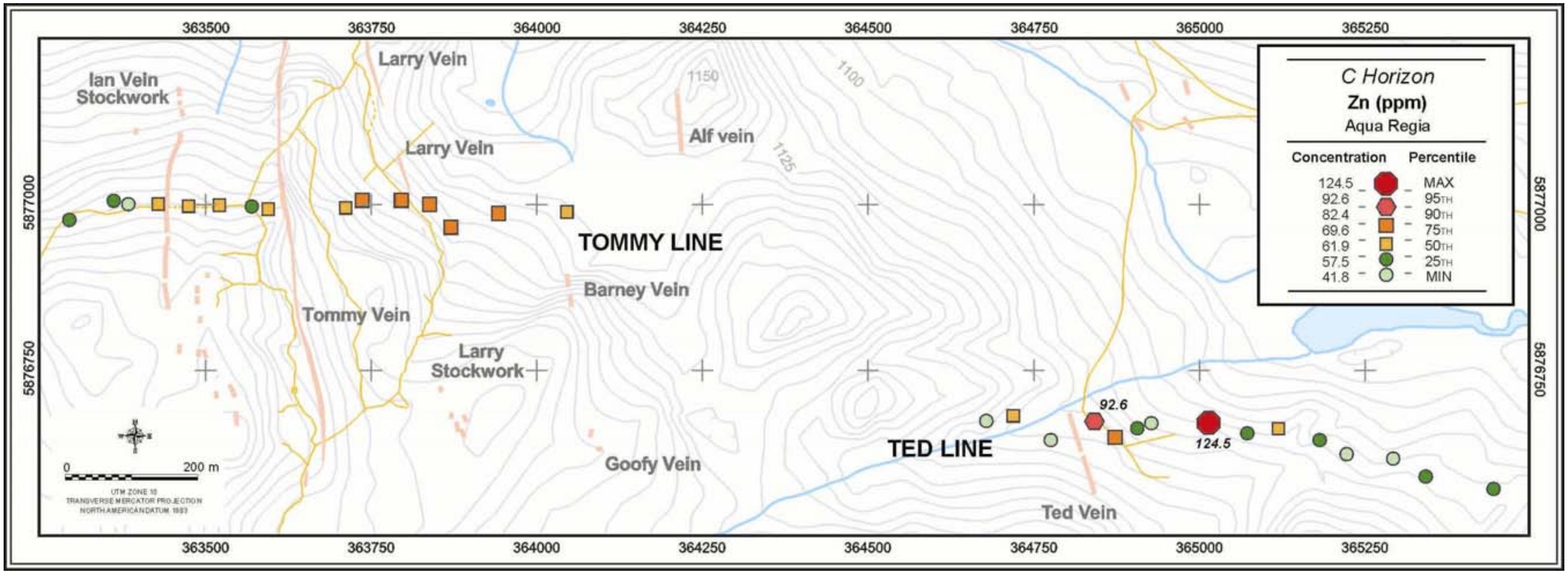


Figure 116. *Distribution of Zn (ppm) by aqua regia digestion–ICP-MS in C horizon till and other parent materials on the combined Tommy and Ted orientation transects (N=31 sites). C horizon parent materials were not present at five sites; compare with the Zn in B horizon soils map above for locations of the missing sites.*

Elevated aqua regia-digestible gold concentrations in mineral soils and humus are present in all Tommy transect horizon suites, and in most Ted transect horizon suites. In most cases, the highest gold concentrations are on the Tommy transect. Here, up to 41 ppb gold is present in LFH horizon humus (median: 1 ppb), up to 223 ppb gold in B horizon soils (median: 5.3 ppb) and up to 41 ppb gold in C horizon till and other parent materials (median: 3.2 ppb). Somewhat lower but nevertheless elevated gold concentrations are also present in Ted transect sample media. These include up to 24 ppb and 85 ppb gold in B horizon soils (median: 1.8 ppb) and C horizon tills (median: 3.1 ppb), respectively. In the case of till, samples from both transects report similar background median results (3.2 ppb and 3.1 ppb), but the highest concentrations are on the Ted transect. Only LFH humus horizons on the Ted orientation transect fail to report any elevated gold concentrations (maximum: 2.5 ppb).

Boxplots showing Au and Ag (ppb) distribution in each of humus, B horizon soil and C horizon till parent materials for the combined Tommy and Ted orientation transects (Figure 117) indicate that elevated gold concentrations greater than 50 ppb are restricted to B and C horizon mineral soils, although one humus gold concentration (41 ppb) from directly over the Tommy vein does approach this level. Conversely, all but one of those samples containing greater than 2000 ppb (2 ppm) silver are organic-rich humus samples from the LFH horizon; mineral soils contain substantially lower background silver concentrations.

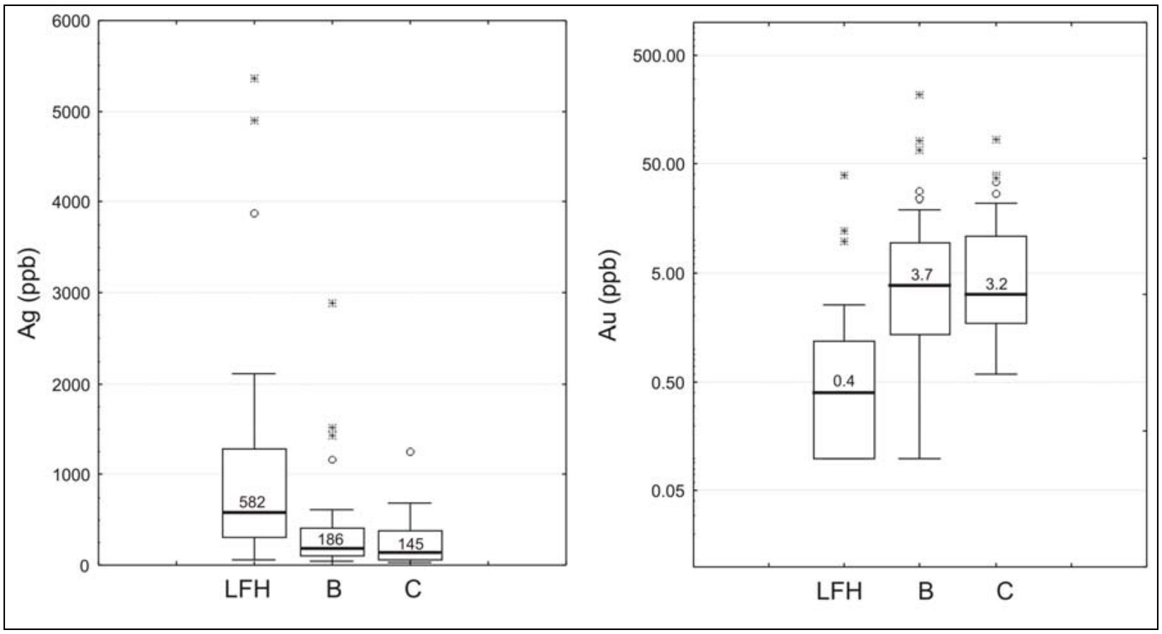


Figure 117. *Boxplots showing distribution of silver (left) and aqua regia-digestible gold (right; log scale) in each of LFH horizon humus (N=36), B horizon soil (N=36) and C horizon till parent materials (N=31) for the two combined Tommy and Ted veins orientation transects, 3Ts project. Median silver and gold concentrations are shown for each. Fifty percent of the data for each lies within the box; the median is denoted by the horizontal line.*

DOWNPROFILE GEOCHEMICAL VARIATIONS WITH SOIL HORIZON

Some general downprofile geochemical relations are apparent in the combined lines statistical summary results (Table 9). A few elements, such as molybdenum, have near-constant median concentrations (range of medians: 0.82–1.00 ppm) with depth, regardless of soil horizon, but absolute concentrations of most elements increase with increasing depth in 3Ts soils. The median concentration of many elements, including those related to epithermal mineralization (e.g., gold and arsenic), in mineral soils are several times greater than those in organic-rich humus, but there is little difference in median results from one mineral horizon to another. In the case of gold (Figure 117), for instance, median concentrations in B horizon soils (3.7 ppb) and C horizon till (3.2 ppb) do not differ appreciably from one another, but are 8 to 9 times greater than that of the overlying humus (0.4 ppb gold). Other elements including copper, cerium, yttrium and zirconium show a more gradual increase in median concentrations with increasing depth in the soil profile.

The median concentrations of several elements, notably silver, cadmium, mercury and sulphur, are much higher in surface humus relative to underlying mineral soils. The median, or background-level, silver concentrations, for example, are 4 times greater in humus (582 ppb) than in the C horizon (145 ppb), as shown in Figure 117. Similarly, the median concentration of mercury in humus (214 ppb) is more than 10 times that present in B horizon mineral soils (19 ppb) and more than 23 times that of the C horizon (9 ppb). The median loss on ignition (LOI) results are similarly much greater in organic-rich humus (90.8%) relative to underlying B horizon soil (11 times) and C horizon parent material (21 times). Whether or not a property-scale Hg enrichment in humus might exist at 3Ts, perhaps reflecting leakage from the epithermal system and subsequent scavenging by overlying organic matter, is an intriguing question but beyond the scope of this investigation.

GEOCHEMICAL CONTRAST OVER GOLD MINERALIZATION

Elevated silver (Figures 118 and 119) and gold (Figures 120 and 121) geochemical responses in all orientation soil media reflect, to varying degrees, the presence of quartz vein-associated epithermal gold mineralization at both the Tommy and Ted veins. At the Tommy vein, for example, silver tends to form more coherent multi-site anomalies, whereas gold, perhaps as a consequence of the particle sparcity effect, more commonly occurs as single-site anomalous values.

The absolute concentrations of elements in soil horizons may be the product of a host of factors, such as bulk composition, lithological origin, surficial cover, topography, weathering and biogeochemical cycling. It is not the absolute magnitude of gold, silver or other elements in a soil horizon that determines its effectiveness for geochemical exploration, but rather the extent of geochemical contrast between results from the mineralized relative to the unmineralized areas. Contrast is measured here with response ratios, which are shown in transect plots for several selected elements in each of humus, B horizon and C horizon results at each vein. Response ratios level all sets of results to a common baseline for intercomparison. They are calculated, for each element, by ratioing each site concentration by its median value for that orientation line. For example, a response ratio of 1 indicates a sample concentration at the median, or 50th percentile, of the dataset; a response ratio of 4 indicates a concentration of 4 times the median, regardless of the absolute magnitude. Tommy vein transect results are shown here for Ag and Au (Figures 118 to 121) and for As, Sb, Cu, Zn, Pb and Cd (Figures 122 to 133). The corresponding Ted vein transect results for these groups of elements are similarly shown in Figures 134 to 137 and Figures 138 to 149, respectively.

In addition to the above, transect results and response ratio plots for each of Ag (Figure 150 to Figure 151) and Au (Figure 152 to Figure 153) are also shown here relative to underlying topography, bedrock geology and surficial cover for each of the Tommy and Ted vein transects.

Tommy Vein Results

Soil geochemical results at Tommy vein show highly elevated silver concentrations in humus of up to 5380 ppb (site 591), which are more than 11 times that of background humus silver concentrations (median: 475 ppb) along the Tommy orientation line. Perhaps even more significantly, elevated silver in humus levels in excess of 2000 ppb persist in humus samples down-ice and downslope along the line for a further 75 to 80 m to the east. This pattern mimics a similar, although slightly lower magnitude and less coherent, silver distribution in B horizon soils; soil silver concentrations at site 591 up to 2899 ppb have response ratios of 8 to 16 times background (median: 182 ppb) and occur directly over and adjacent to the Tommy vein at two sites. Highly elevated soil silver concentrations do not persist as far to the east downslope and down-ice as they do in humus, but nevertheless provide greater geochemical contrast as shown by response ratios.

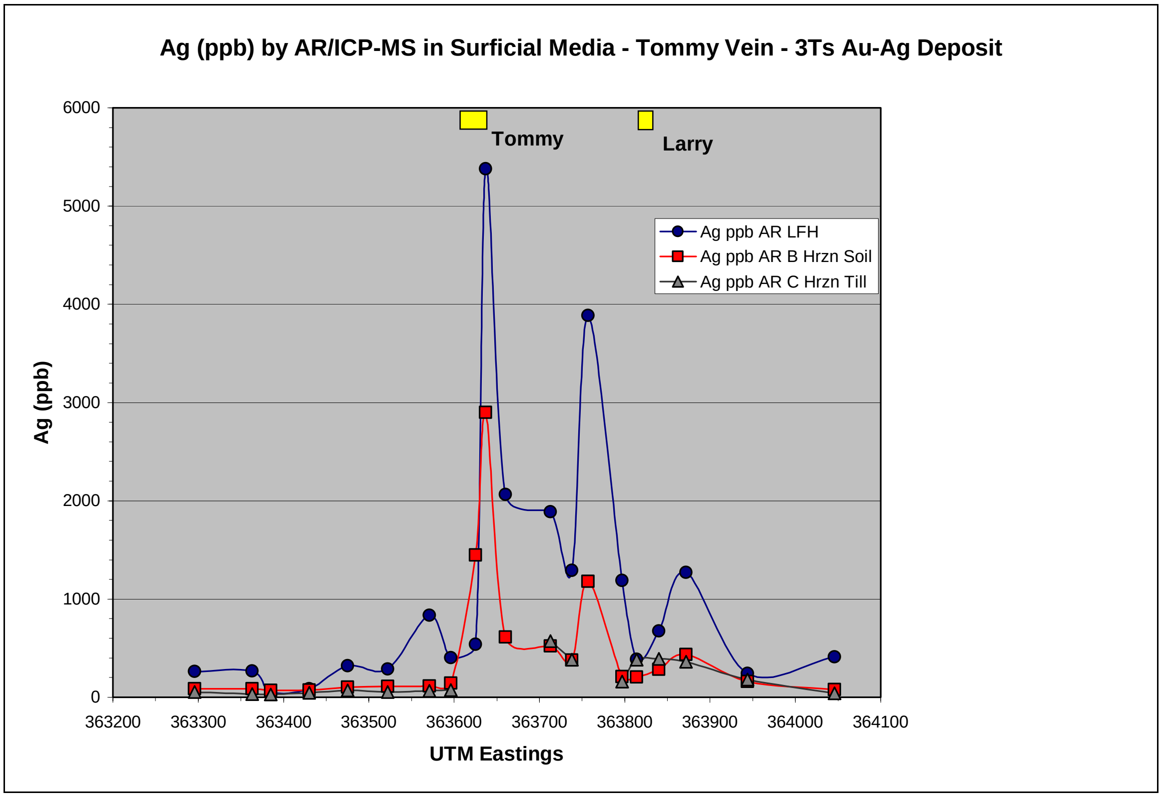
Elevated aqua regia-digestible gold up to 223 ppb is present in B horizon soils (median: 5.3 ppb) at two sites directly above and adjacent to the Tommy vein, and up to 41 ppb in LFH horizon humus (median: 1 ppb). Despite the differences in magnitude between gold results in the two sample media, response ratios indicate that geochemical contrast levels of the two are almost identical. Response ratios for soils at two sites are in the range of 13 to 43 times, whereas those for humus at an overlapping set of sites are in the range of 10 to 41 times. A consideration of all adjacent sites with response ratios >5, however, shows that B horizon soils offer a slightly more coherent geochemical response to Tommy vein mineralization than do humus samples.

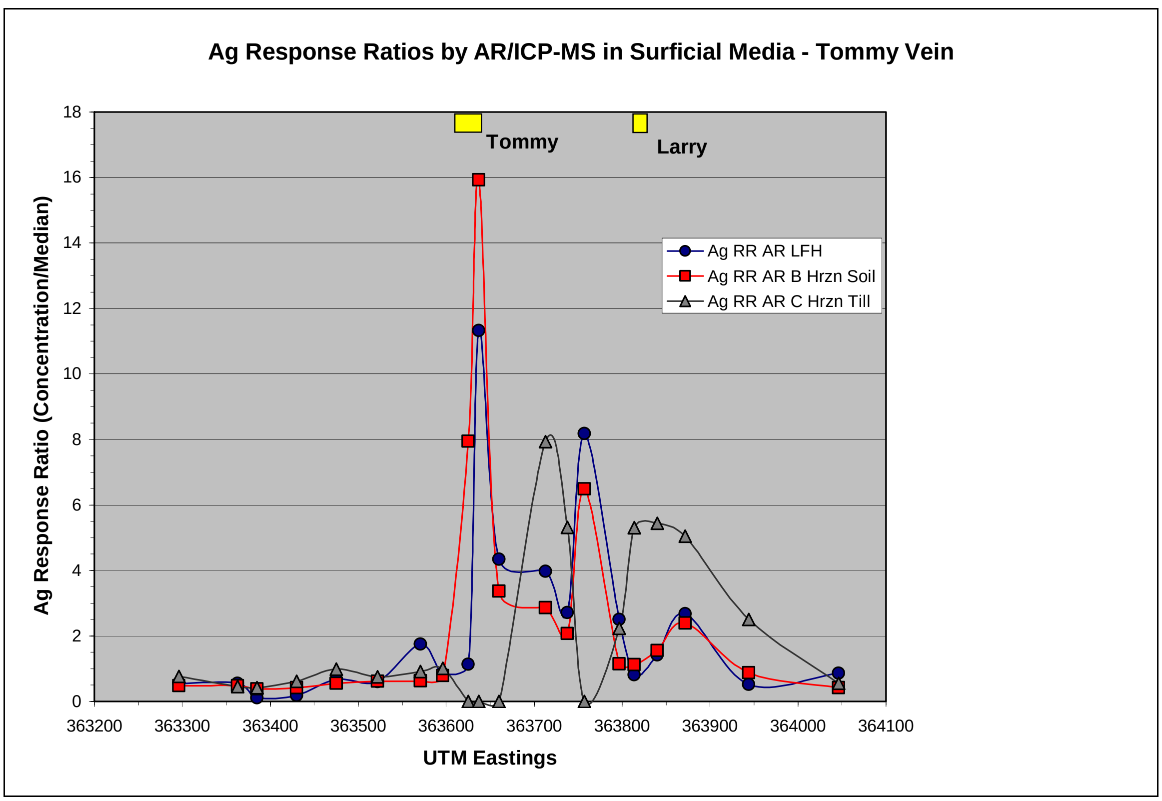
There is no direct silver or gold in till response at the Tommy vein, as no till is present directly over the outcropping and moss-covered vein on the sampling line (Figures 118 to 121); however, elevated silver concentrations up to 571 ppb, up to 8 times background levels (median: 72 ppb), are present at two down-ice sites to the east. Similarly elevated gold concentrations up to 41 ppb at two sites would seem to indicate a local down-ice dispersal of mineralized till material from the Tommy vein of approximately 100 m, although the spotty occurrence of till in this area makes it difficult to quantify more precisely.

In addition, there is also a local gold in C horizon till response (39 ppb; site 521) at the Larry vein to the east. Silver in till concentrations here are a modest 363 to 392 ppb, but these nevertheless correspond to elevated response ratios of approximately 5 times background at three sites over about 60 m at and adjacent to the Larry vein. Corresponding gold in till response ratios are 3 to 12 times background at this location. Interestingly, neither humus nor B horizon soil at Larry vein report any elevated silver or gold concentrations.

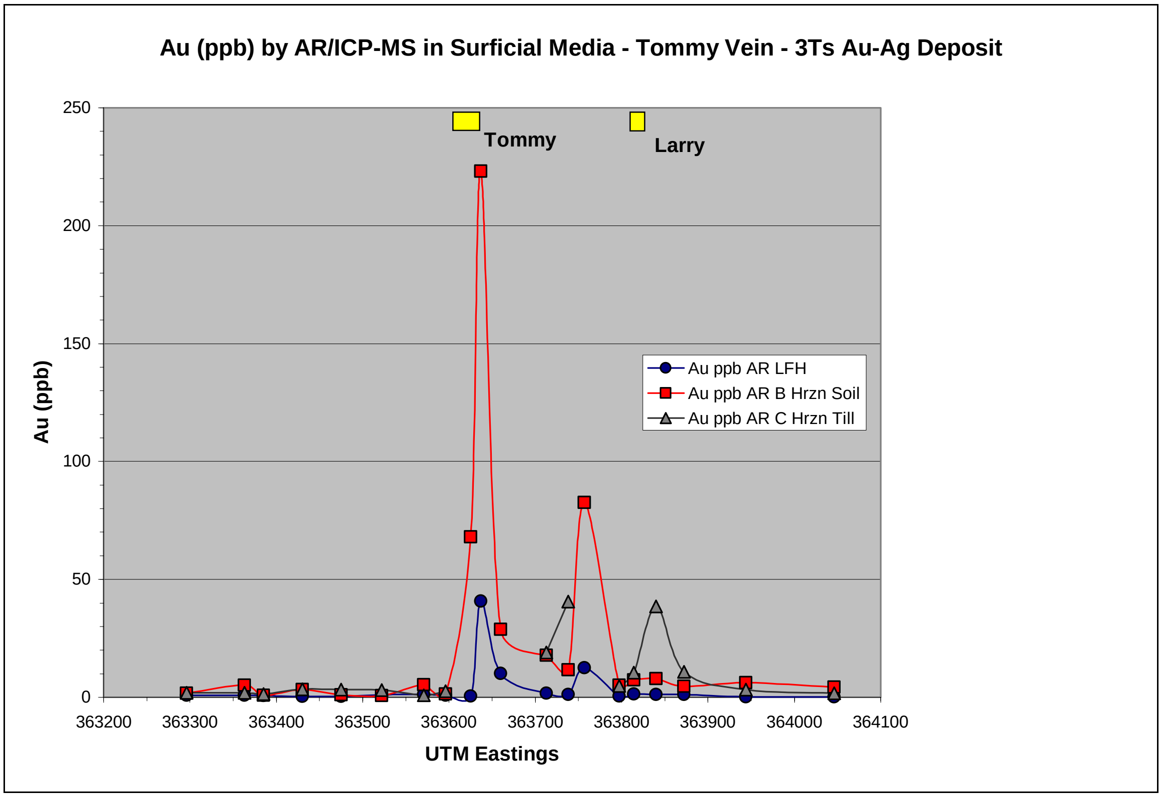
Conversely, elevated silver and gold in both humus and B horizon soils do define a single-site anomalous zone (site 518) between the Tommy and Larry veins. Highly elevated silver concentrations up to 3888 ppb in humus and 1182 ppb in B horizon soil, for example, are reported from predominantly rubble and colluvium; no till was encountered at the site. It is not presently known whether these precious metal concentrations reflect the location of a previously unknown zone, or are simply the product of downslope colluviation of mineralized material from the Tommy vein upslope.

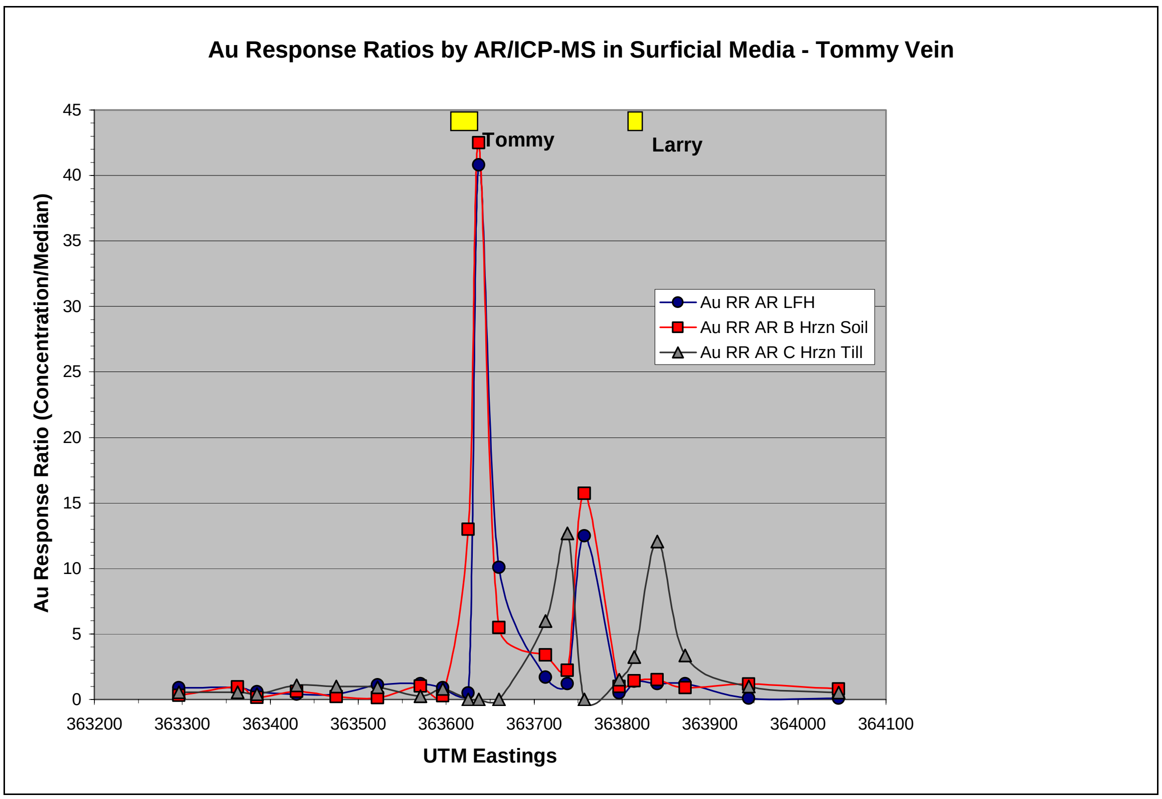
In addition to Au and Ag, the location of the Tommy vein is also highlighted by elevated concentrations of a number of precious metal pathfinder elements and base metals determined by aqua regia digestion, particularly in B horizon soils. In general, metal concentrations in near-surface B horizon mineral soils are greater than in either underlying tills or overlying humus, although the till relation is influenced by the absence of any till beneath some of the highest-concentration soils sampled around the Tommy vein. For example, more than 321 ppm Zn and 82 ppm Pb are locally present in B horizon soils over the Tommy vein, relative to line median concentrations of only 113 ppm and 11.5 ppm, respectively. Some elements, such as Cu, which are present in much more modest concentrations (maximum: 33.6 ppm) over the Tommy vein, are nevertheless highly elevated relative to line median concentrations (8.8 ppm). Aqua regia-digestible base metal results are even greater in B horizon soils overlying the Ted vein, which has been reported to contain greater primary base metal concentrations than the Tommy vein. For example, B horizon soils at the Ted vein contain nearly 900 ppm Zn by aqua regia, relative to a background concentration of only 80 ppm Zn.



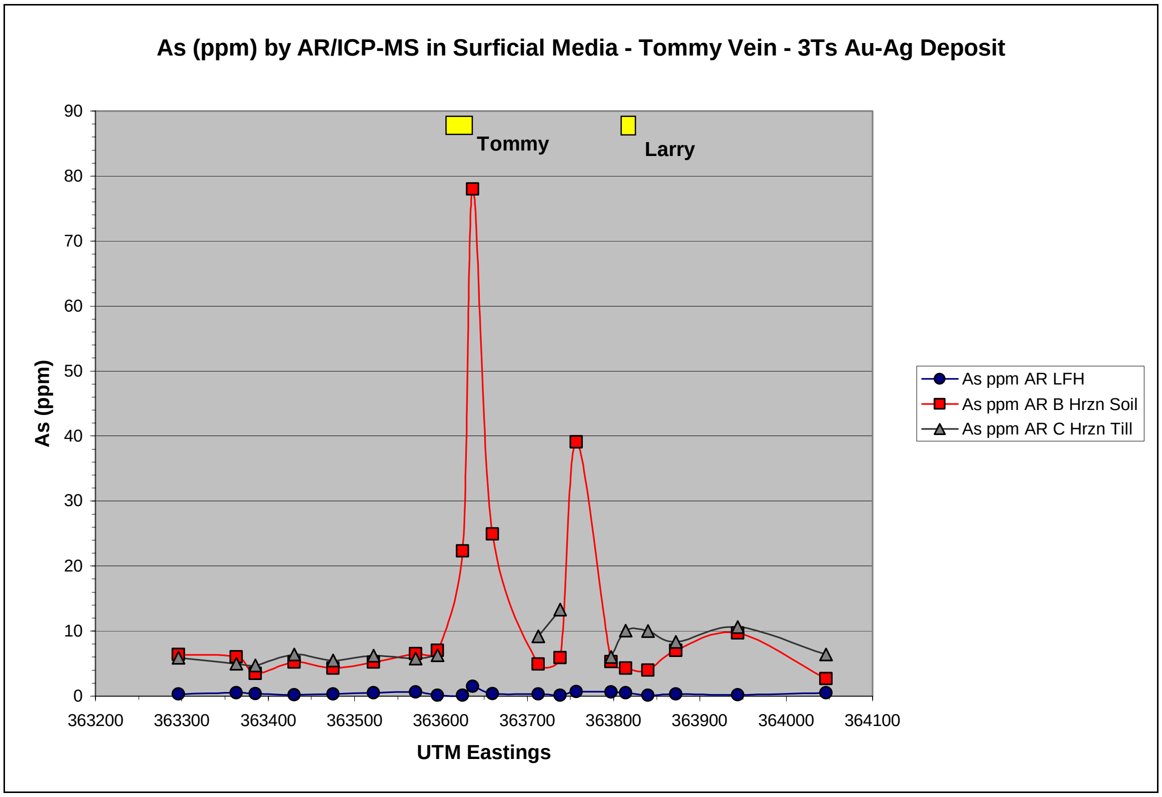


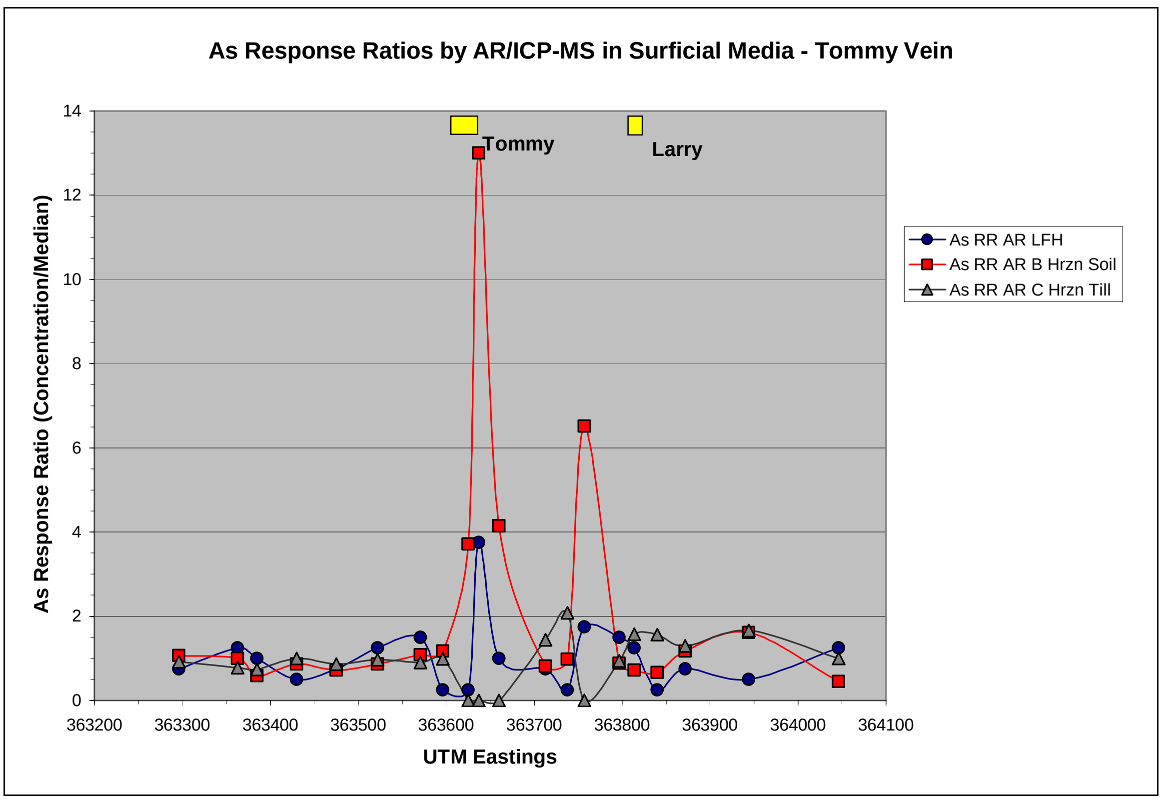
Figures 118 and 119. *Distribution of silver concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*



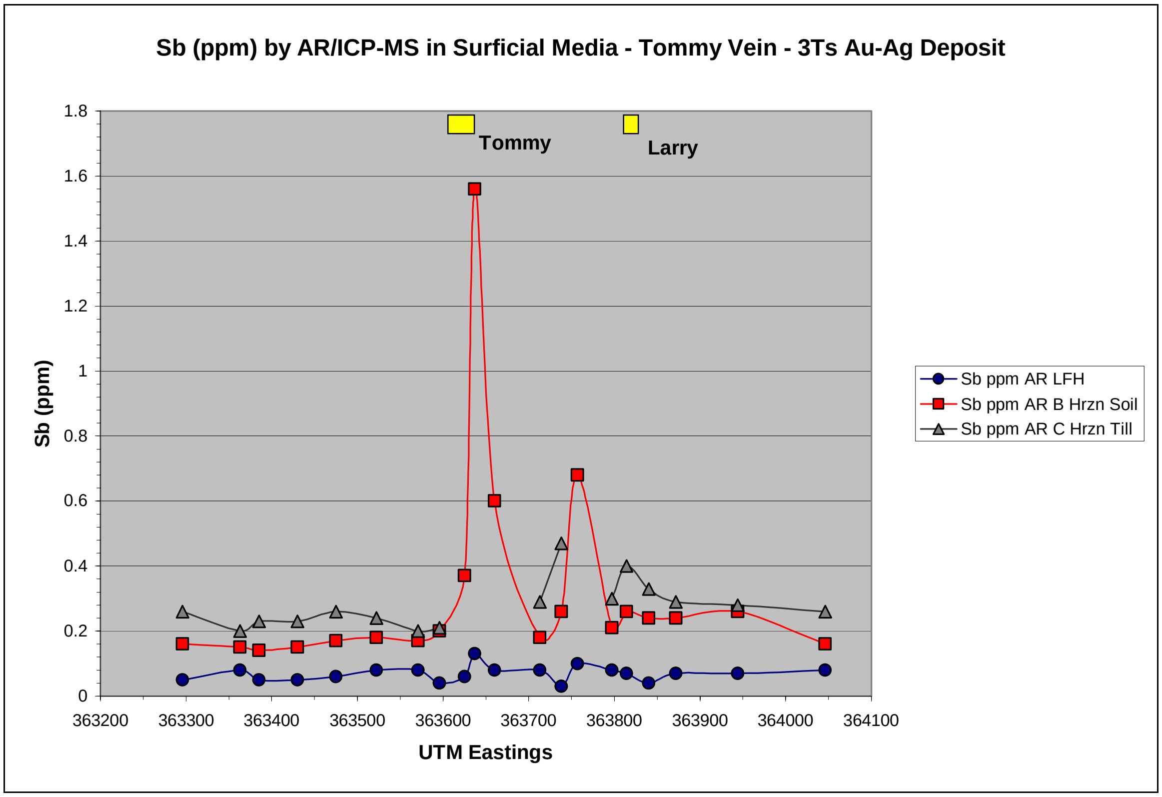


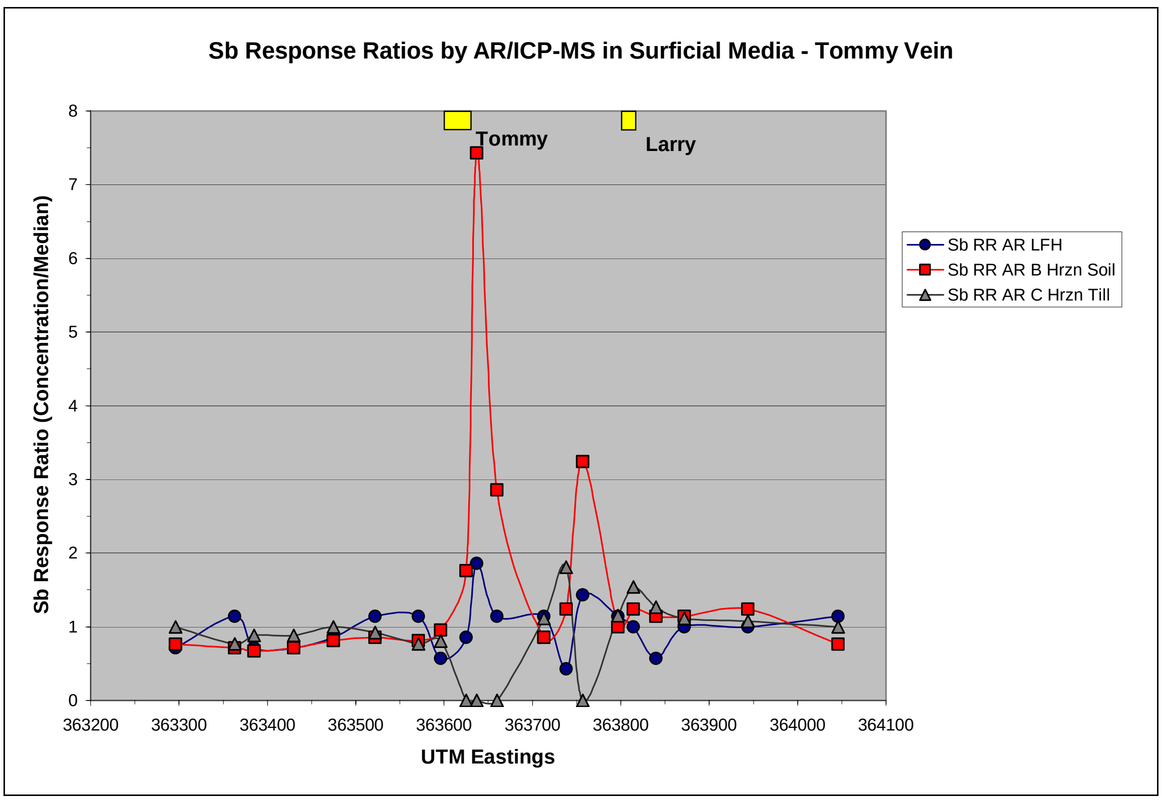
Figures 120 and 121. *Distribution of gold concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*



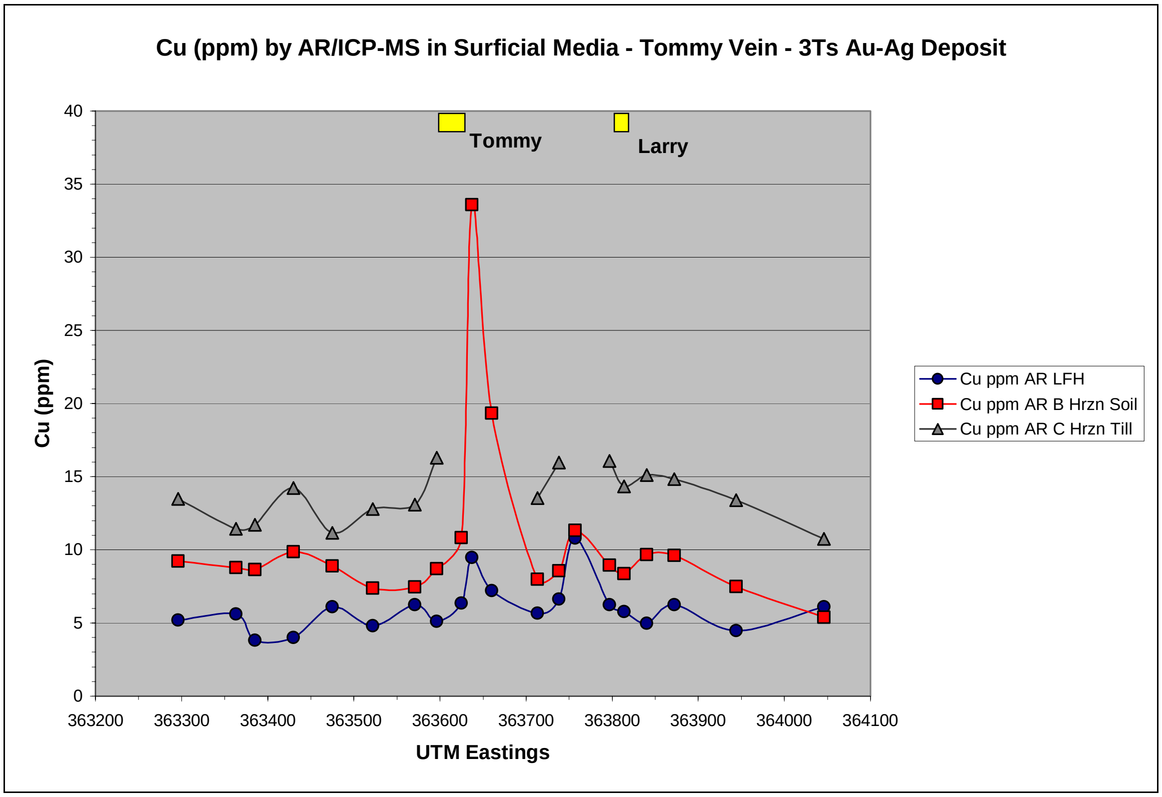


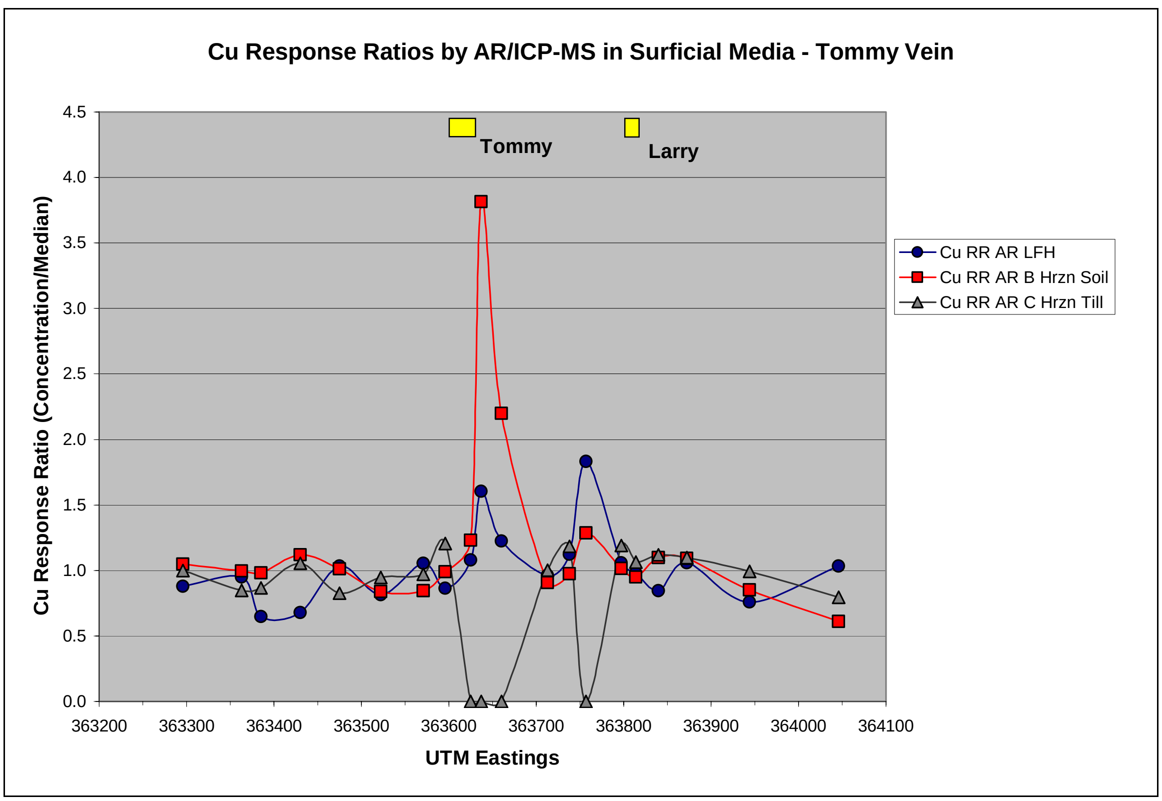
Figures 122 and 123. *Distribution of arsenic concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*



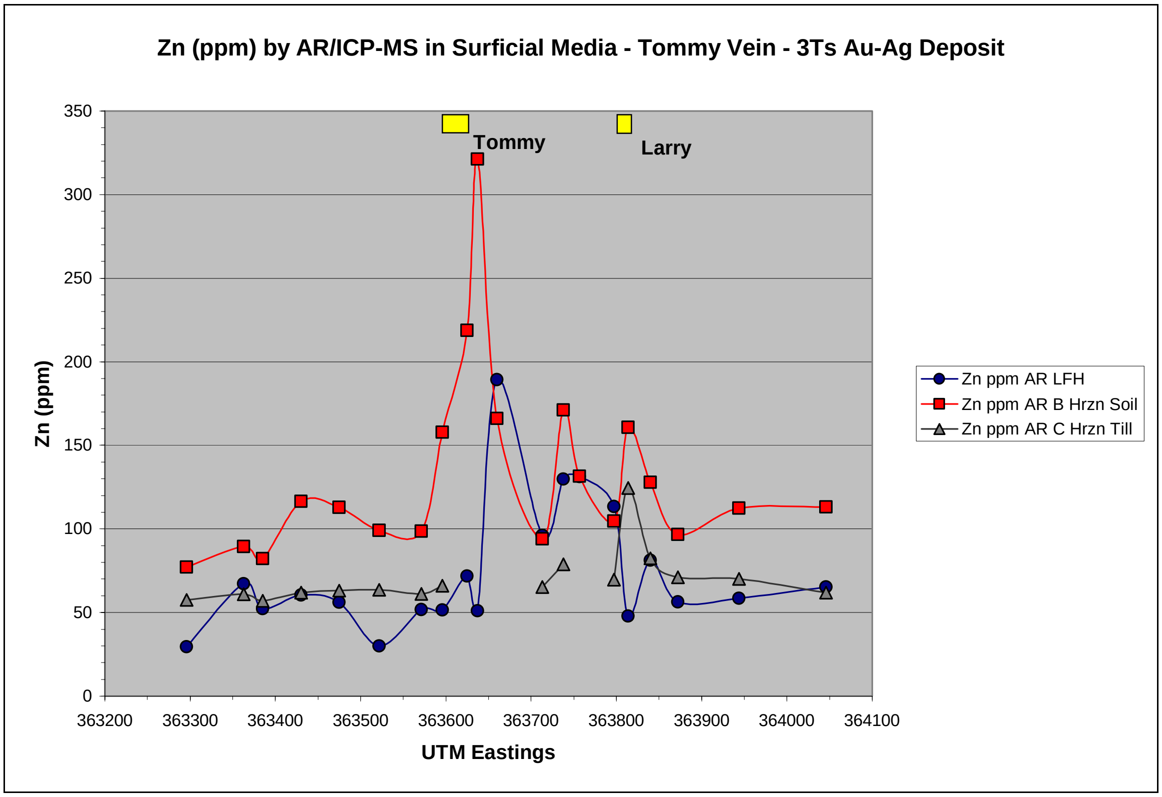


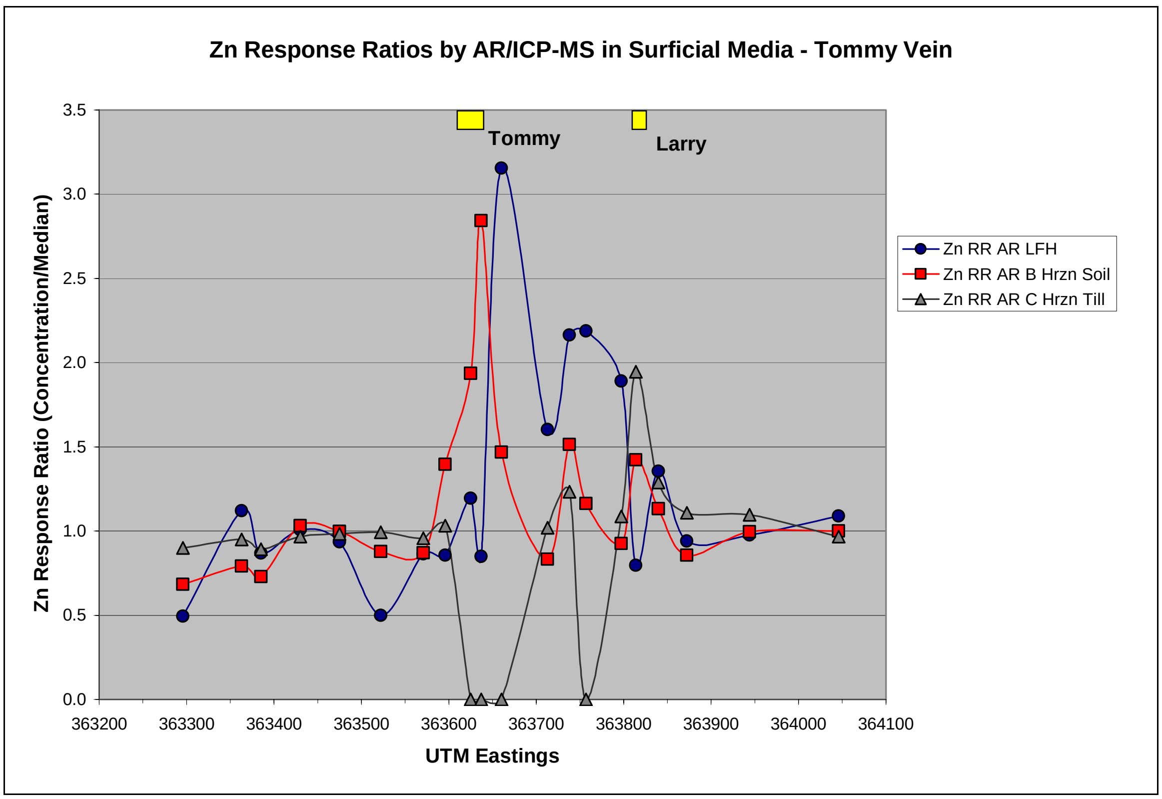
Figures 124 and 125. *Distribution of antimony concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*



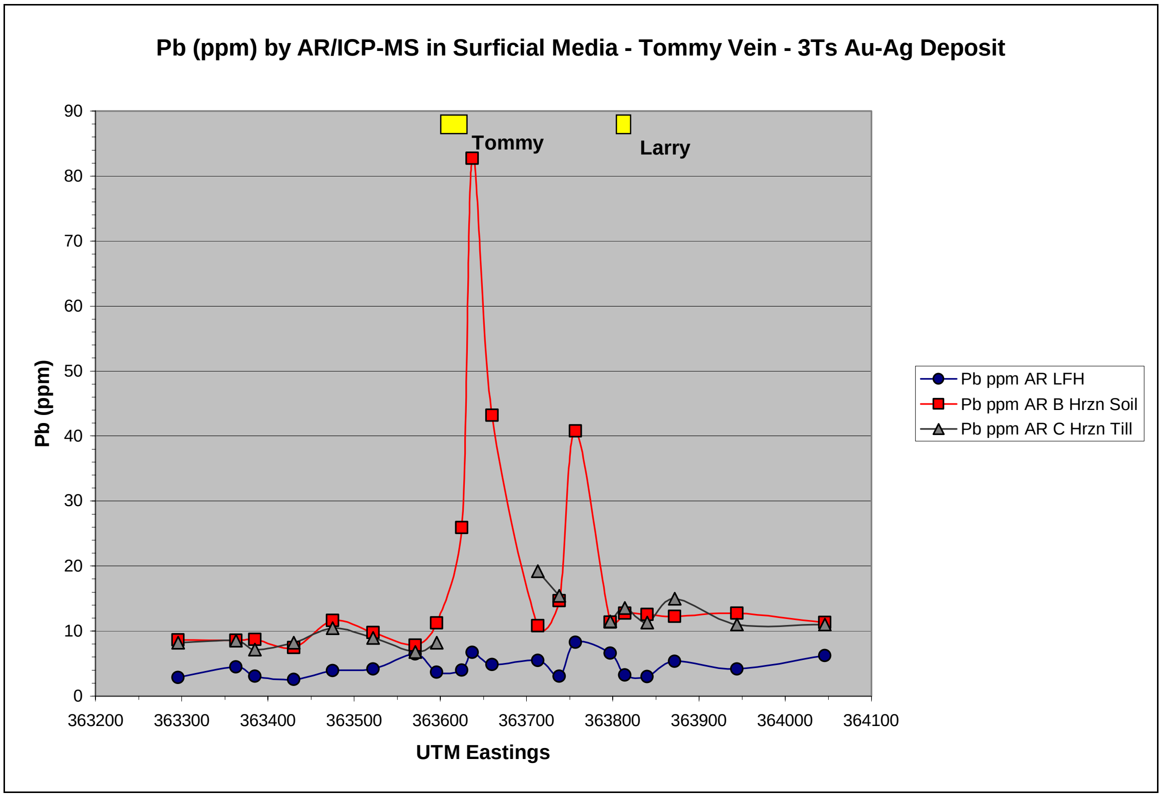


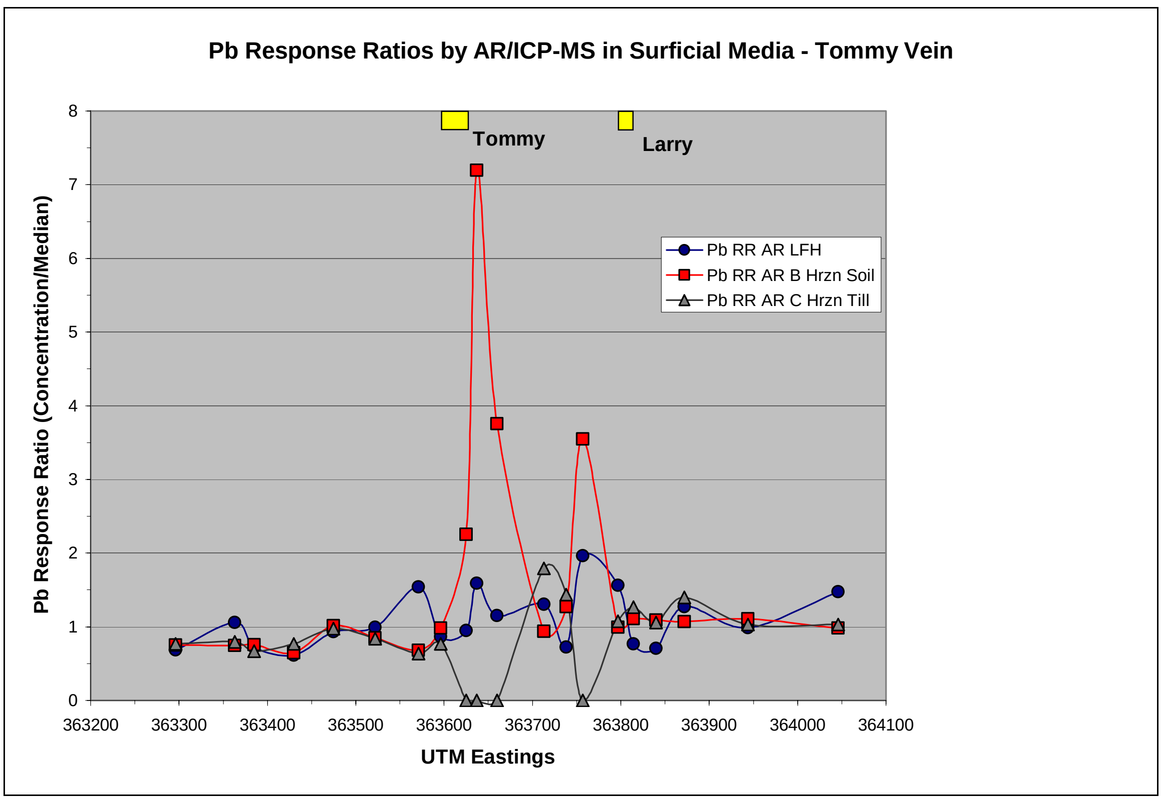
Figures 126 and 127. *Distribution of copper concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*



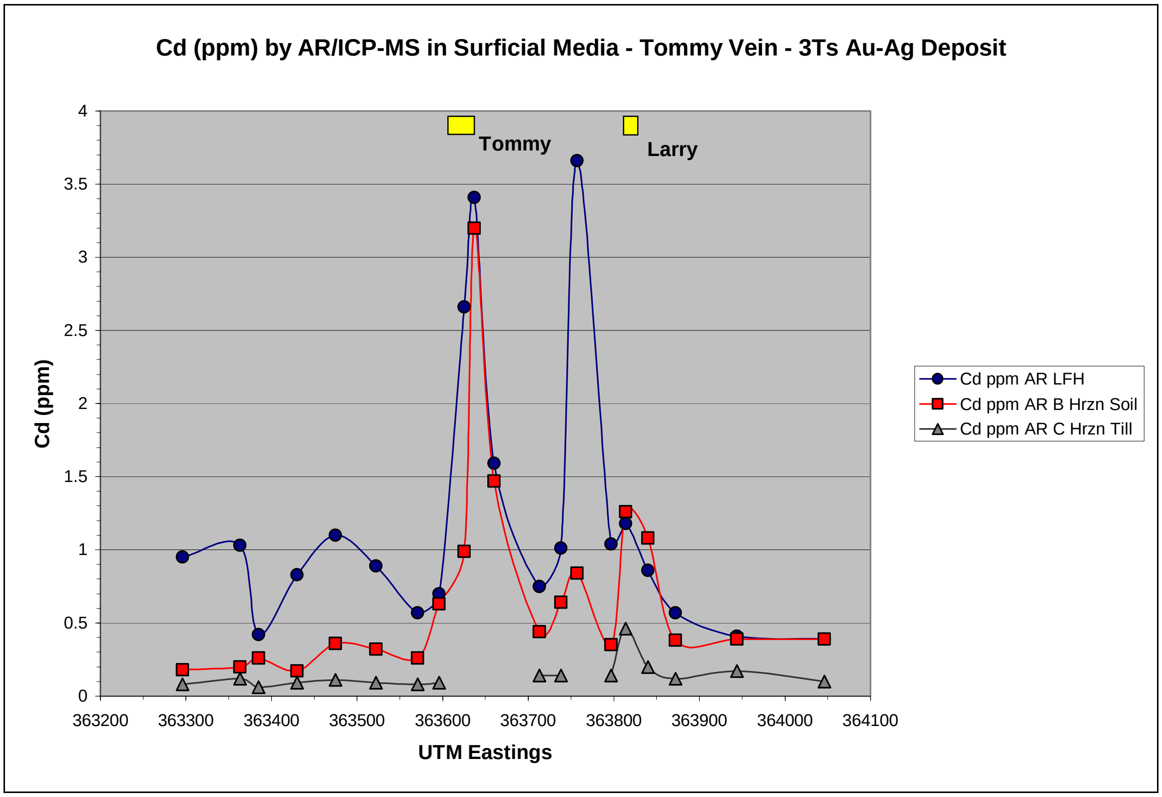


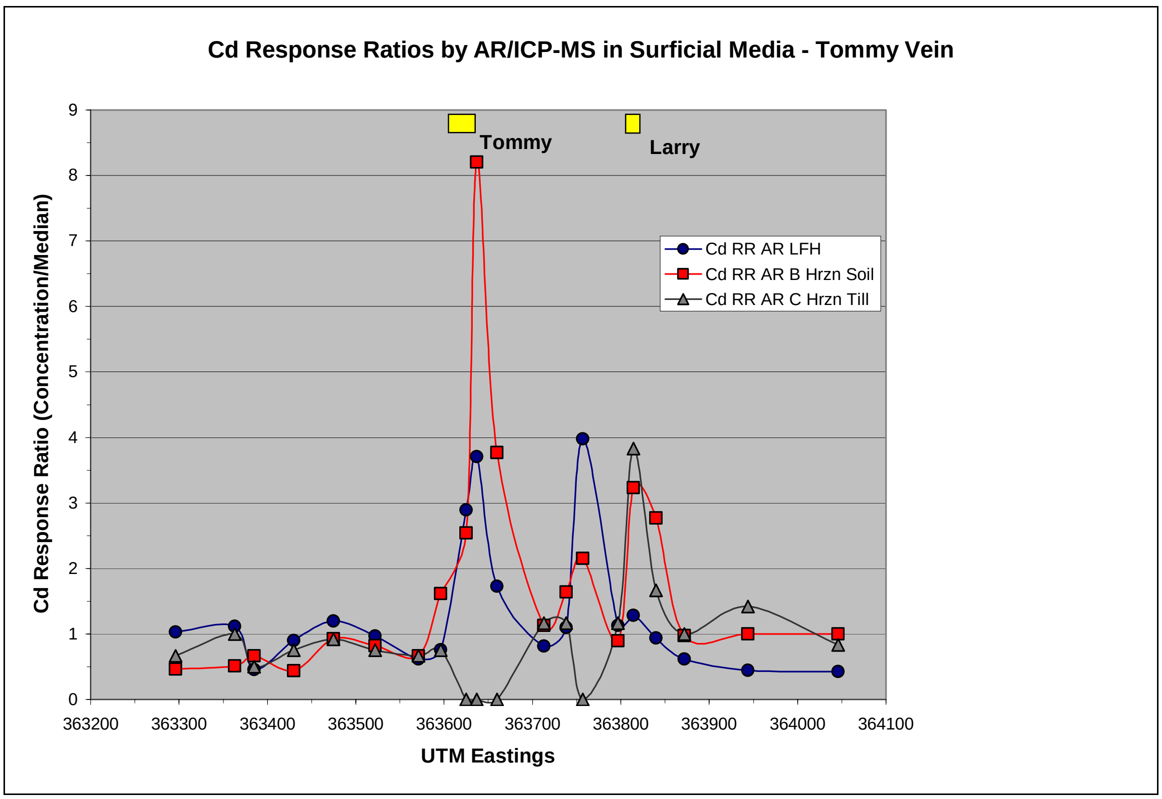
Figures 128 and 129. *Distribution of zinc concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*





Figures 130 and 131. *Distribution of lead concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*





Figures 132 and 133. *Distribution of cadmium concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*

Ted Vein Results

Gold and silver in humus, B horizon soil and till (Figures 134 to 137) all reflect the presence of precious metal mineralization at the Ted vein to varying degrees, although the magnitudes of the geochemical responses for these elements are slightly less than those reported for the Tommy vein. Conversely, soils at the Ted vein contain higher concentrations of certain base metals, such as zinc (maximum: 891 ppm) and lead (maximum: 113 ppm), than do soils at the Tommy vein. These results are consistent with the reported higher sulphide mineral content of the Ted relative to the Tommy vein, where disseminated sulphides are not always observed to be present (Rhys, 2003).

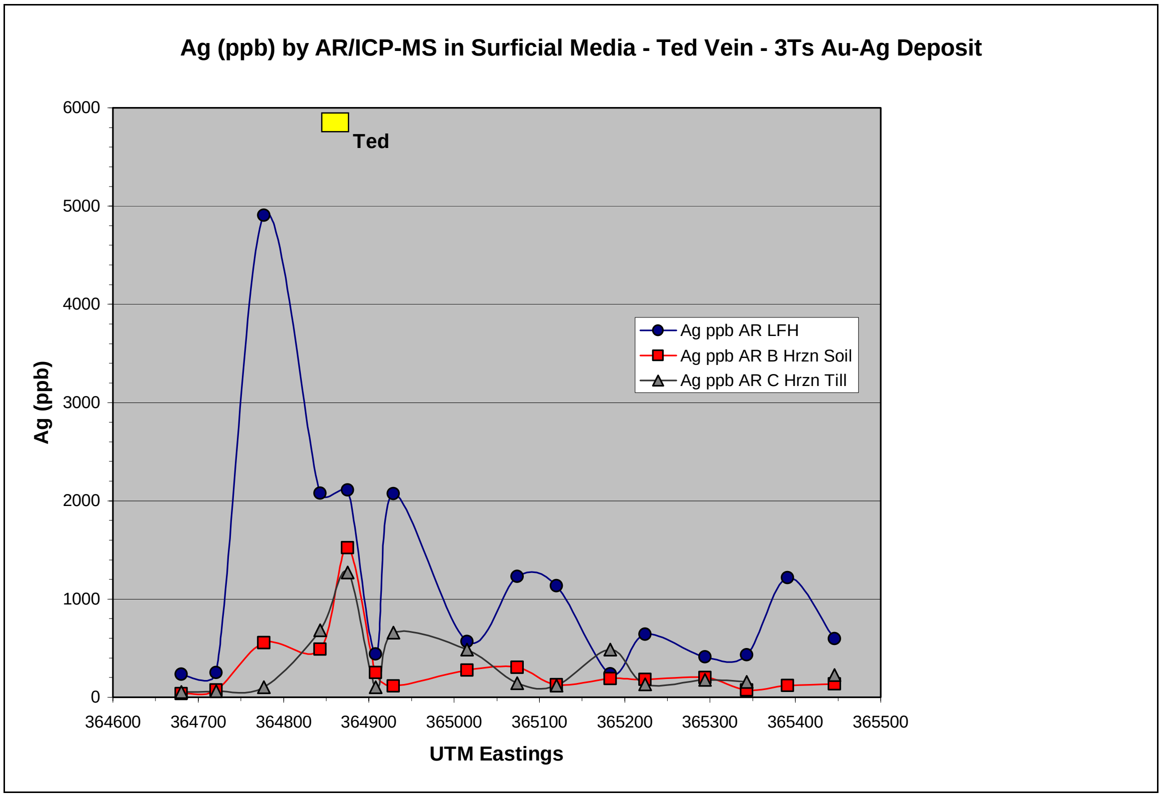
The Ted vein is bracketed by two orientation sites (sites 558 and 559), with the highest precious metals concentrations generally reported at the easternmost of the two (site 559; Figure 6 and Figure 12) immediately downslope and down-ice. Elevated gold concentrations are present in a B horizon soil (24.4 ppb; site 559) at the Ted vein, and at two sites in C horizon till (26.9–84.9 ppb) both above and down-ice of the vein. These correspond, at site 559 closest to the vein, to highly elevated response ratios of 9 times and 14 times background in soil and till, respectively. In the case of silver, elevated values are present in all three media, particularly at the easternmost site 559. Silver concentrations of 1523 ppb in B horizon soils (median: 186 ppb) and 1271 ppb in till (median: 156 ppb) both represent response ratios of about 8 times those of background values. Silver concentrations in LFH horizon humus at both of the Ted vein sites are also very high, in the order of 2000 ppb, but report response ratios of only about 3 times due to the relatively high silver background concentrations in Ted orientation line humus (median: 621 ppb) relative to underlying mineral soils, as well as to Tommy line humus. Interestingly, there are no coincident elevated gold concentrations in LFH horizon humus at the Ted vein, although gold concentrations up to 41 ppb were reported from similar humus above the Tommy vein.

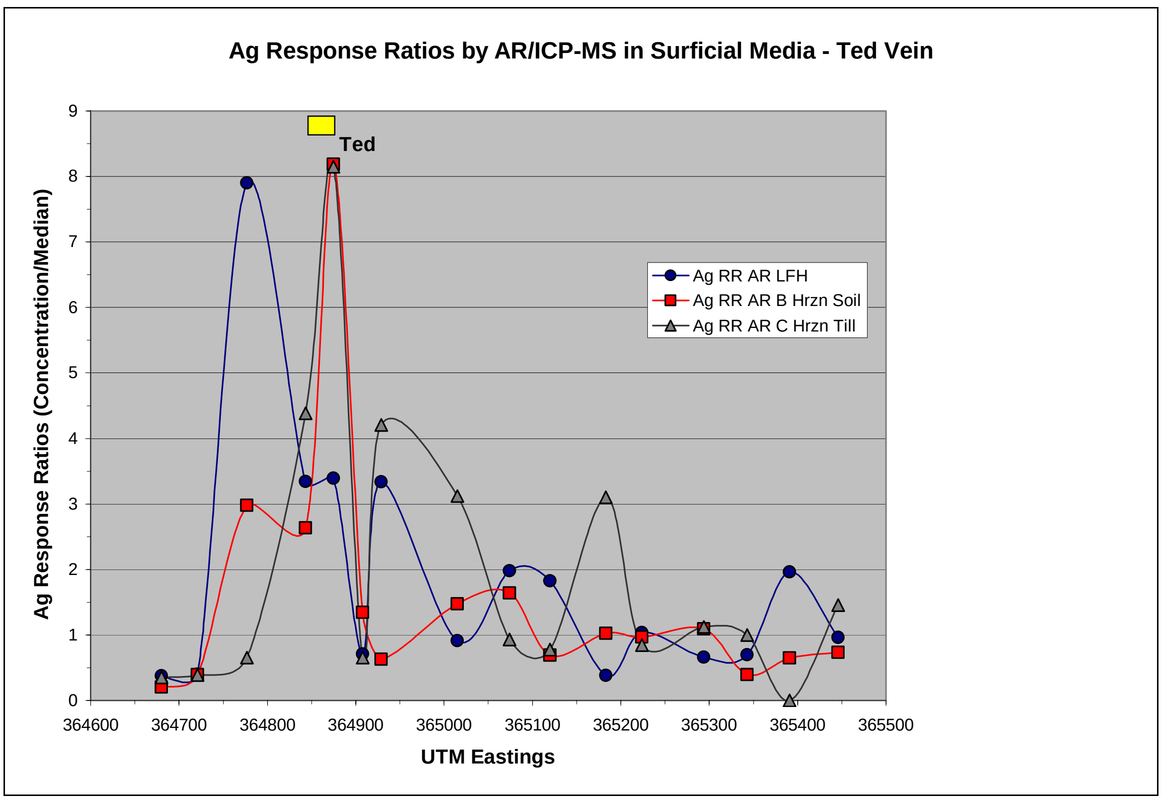
Elevated gold and silver concentrations in both B horizon soil and till at site 559 at the Ted vein are of very similar magnitude (e.g., 24–27 ppb gold), even though the soil in this composite profile is developed in a stabilized colluvial sediment (Figure 20) rather than the underlying IIC horizon till. This is likely, in this particular case, due to the site being both downslope (to the northeast) and down-ice (to the east) of the same Ted vein. Elsewhere, the lower background gold concentrations of Ted line B horizon soils (median: 1.8 ppb) relative to Tommy line B horizon soils (median: 5.3 ppb) may be at least in part due to the widespread presence of now-stabilized surface colluvium from a southerly, apparently unmineralized source area over the tills. Similar relations were reported by Cook and Fletcher (1994) for varying platinum contents of ultramafic colluvium over till in the Tulameen area of southern British Columbia.

Perhaps the most intriguing aspect of the precious metals distribution on the Ted orientation line is the very high silver content (4907 ppb) of humus at one site (574) located to the west of the Ted vein. This highly elevated silver concentration is the highest on the Ted line and corresponds to a response ratio of almost 8 times the median concentration in humus (621 ppb). This LFH horizon is developed on a till-based soil profile in relatively flat terrain. The gold concentration, while only 2.5 ppb, is nevertheless the highest of any of the 16 Ted line humus samples (median: 0.1 ppb) and it reports a response ratio of 25 times background. The underlying B horizon soil contains only background gold content but does report elevated silver content of 554 ppb, the second-highest on the line after the Ted vein itself, with a response ratio of almost 3 times background (median: 186 ppb). The proximity to the adjacent high-silver Ted vein humus sites suggests two possible explanations: It may reflect the presence of a parallel or peripheral mineralized zone, or alternatively, given the similar site elevation to the adjacent Ted vein, it may simply instead reflect local hydromorphic scavenging of metals derived from weathering of the Ted vein mineralization.

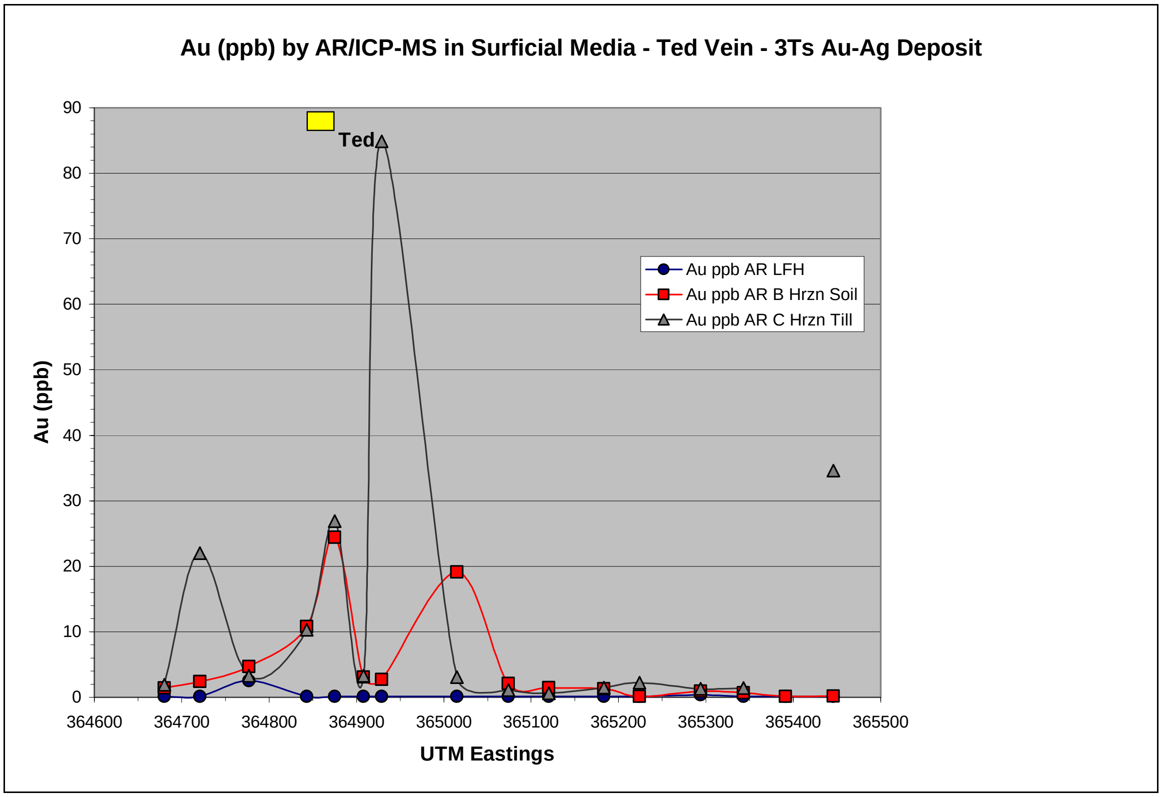
In addition to the above, locally elevated single-site gold concentrations of unknown origin occur in Ted line tills both near its western end (22 ppb) and at its eastern end (34.6 ppb). Neither B horizon soils nor humus are similarly enriched in gold at these sites.

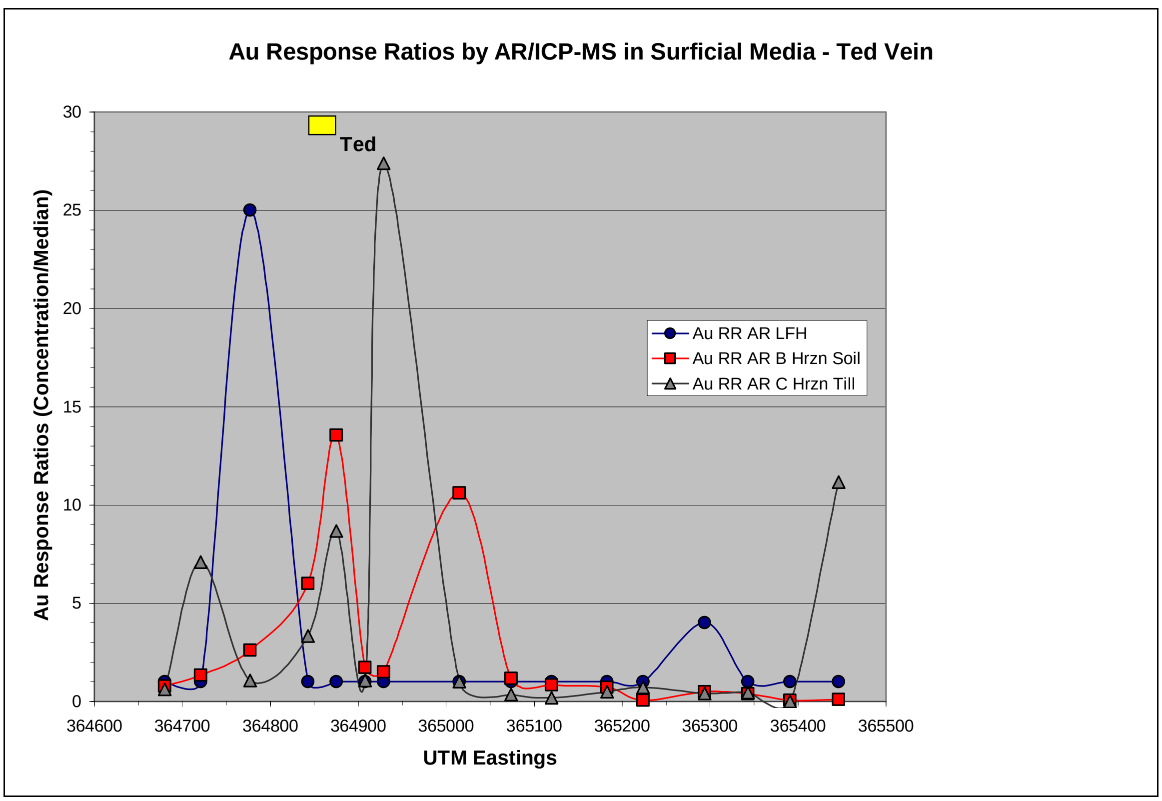
Transect plots and response ratios for various pathfinder elements and base metals are shown in Figures 134 to 149. Aqua regia-digestible base metal results are typically greater in B horizon soils overlying the Ted vein, which have been reported to contain greater primary base metal concentrations, than in Tommy vein soils. For example, B horizon soils at the Ted vein contain 891 ppm Zn by aqua regia relative to a line median background concentration of only 80 ppm Zn. This corresponds to a response ratio of 11 times background for Zn. Similar response ratio results of 8 times background were also obtained for Pb (Figures 146 and 147), and 15 times background for Cd (Figures 148 to 149).



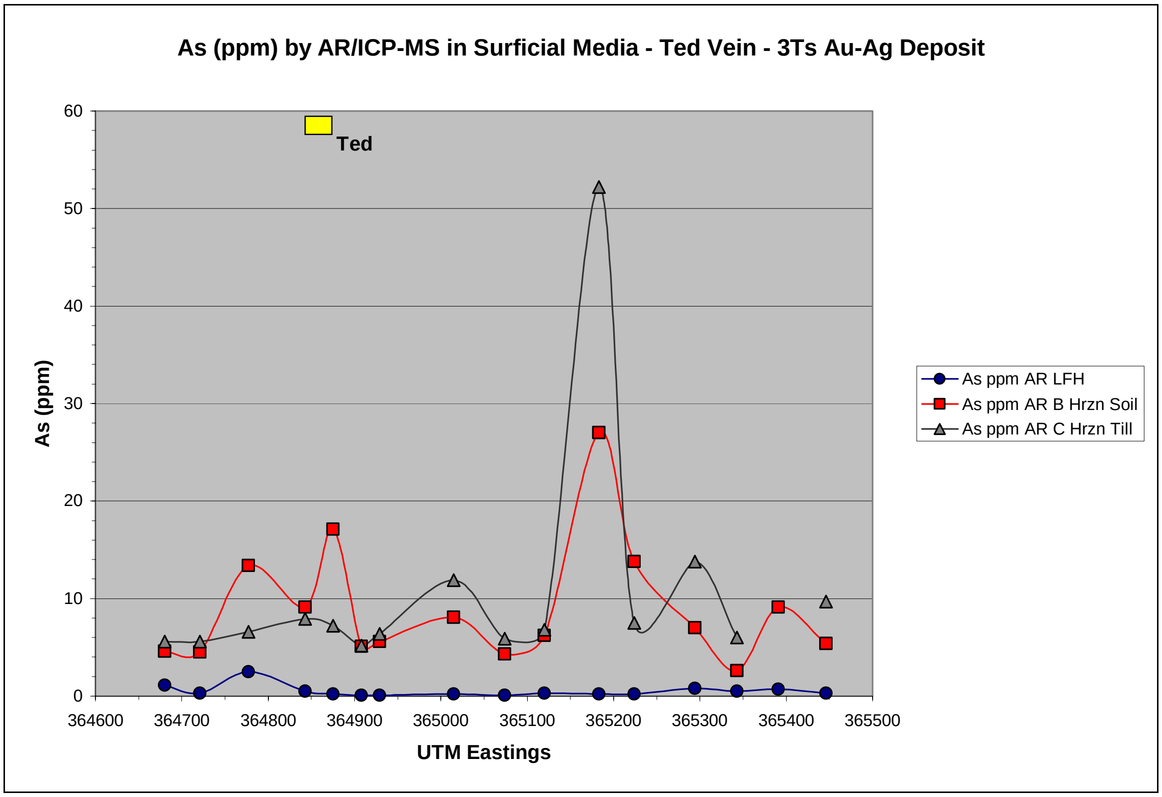


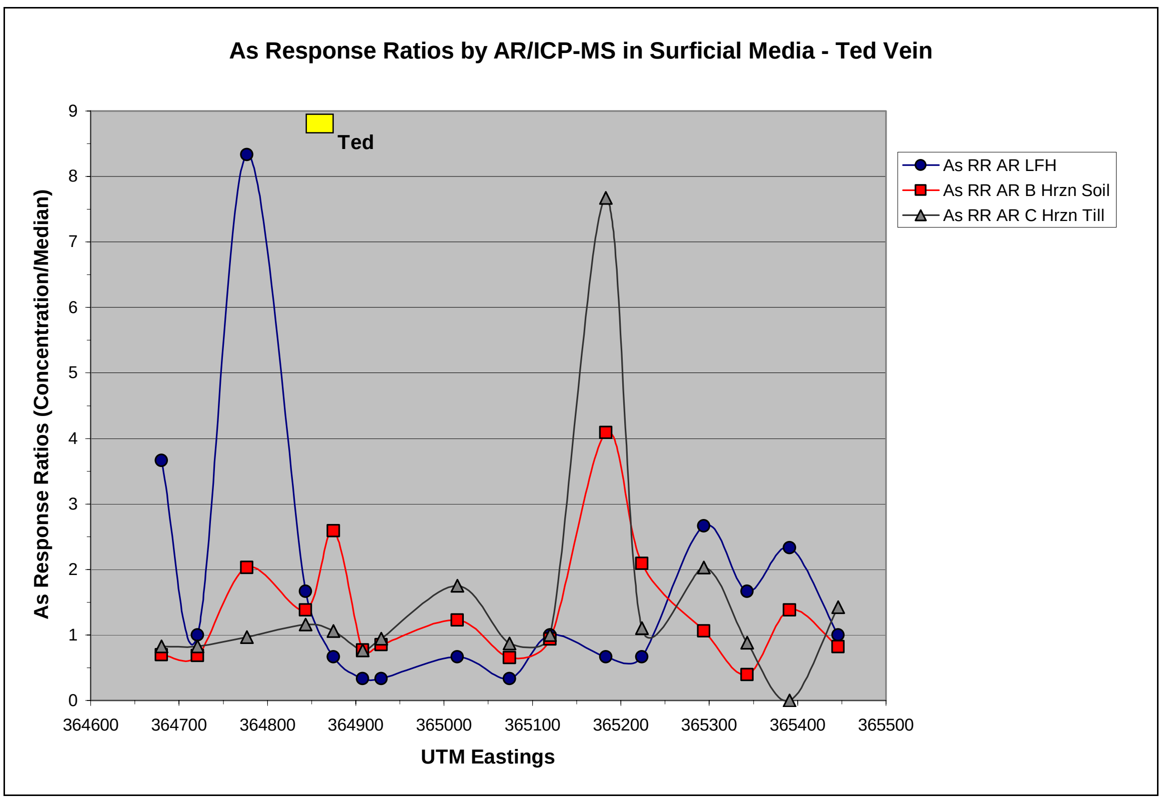
Figures 134 and 135. *Distribution of silver concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*



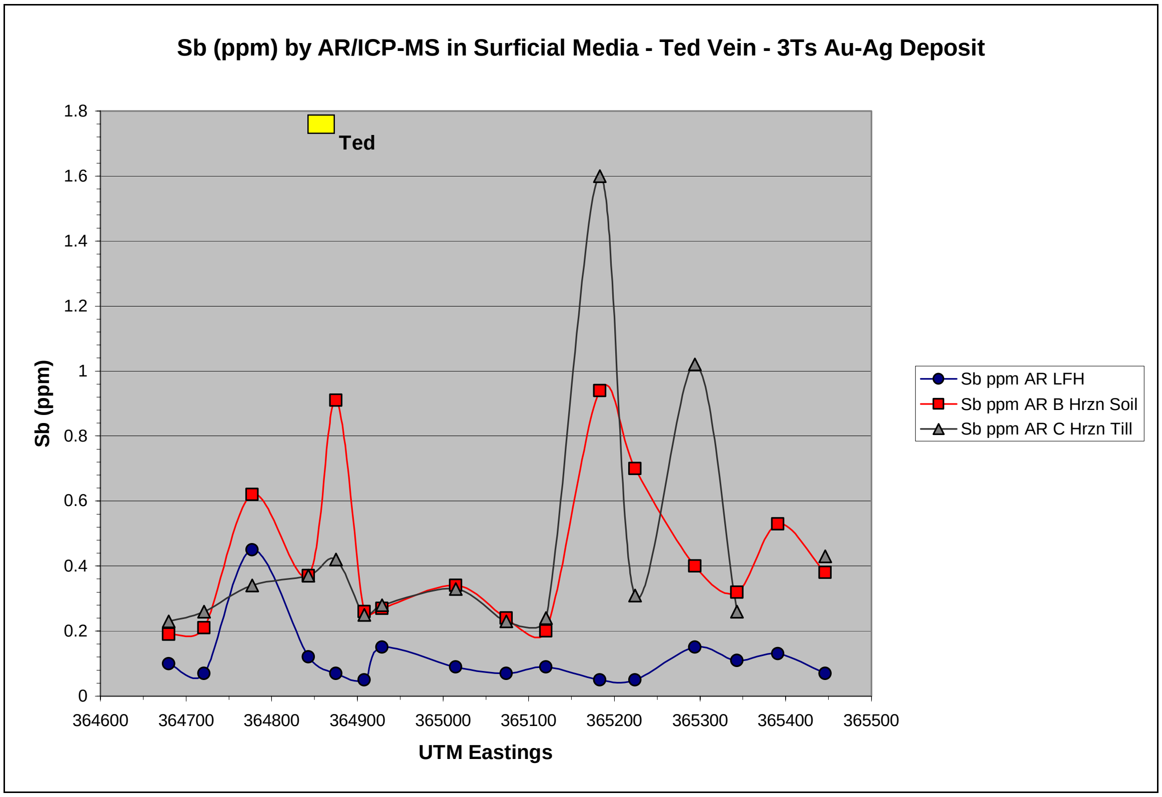


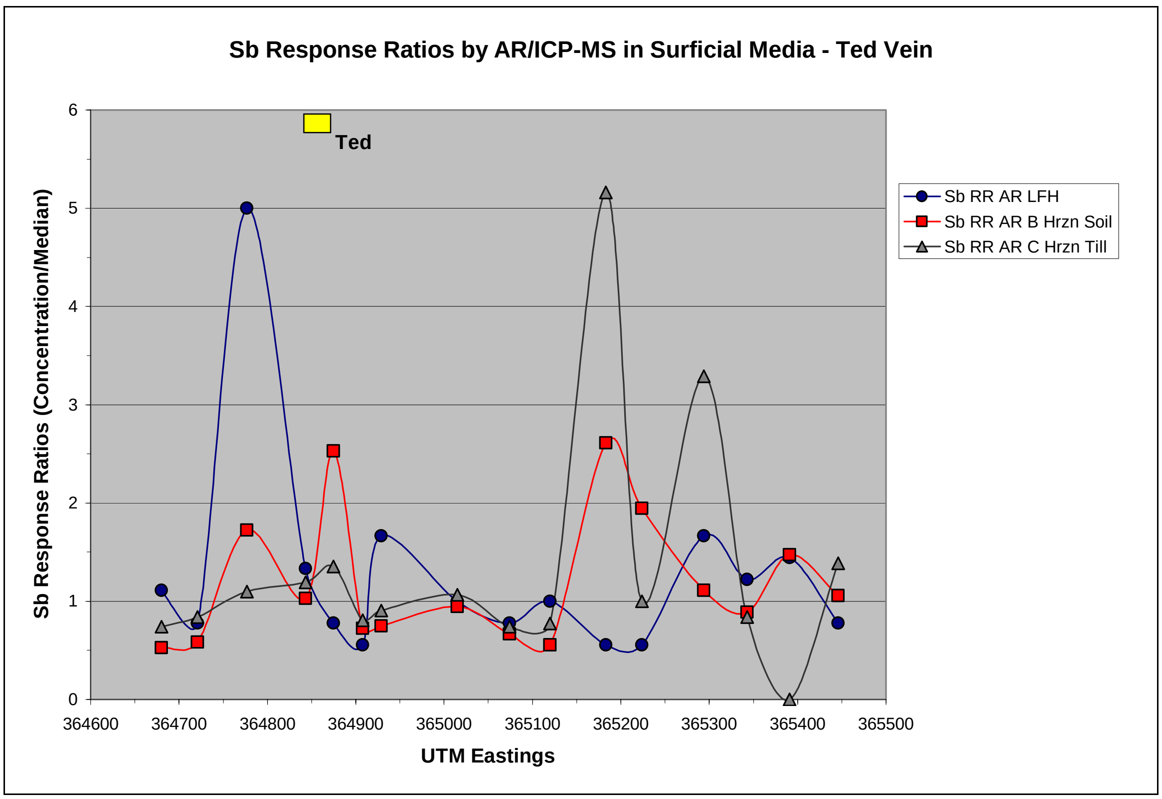
Figures 136 and 137. *Distribution of gold concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*



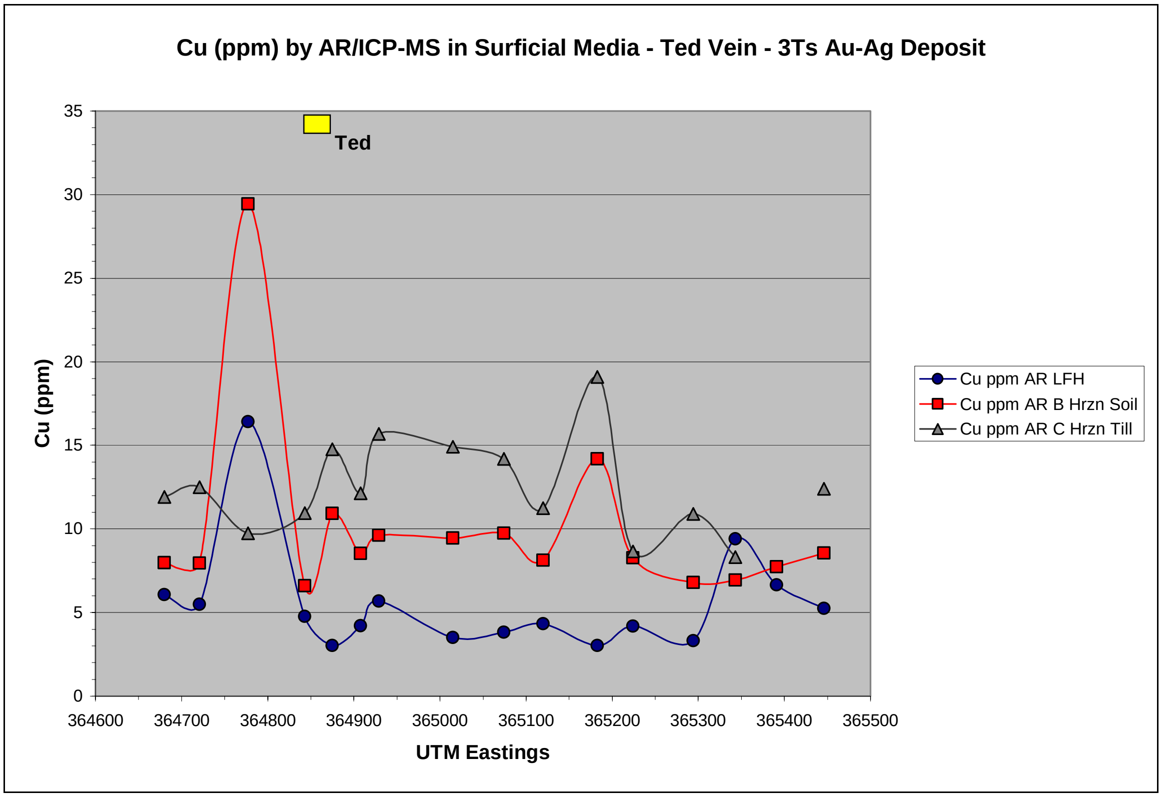


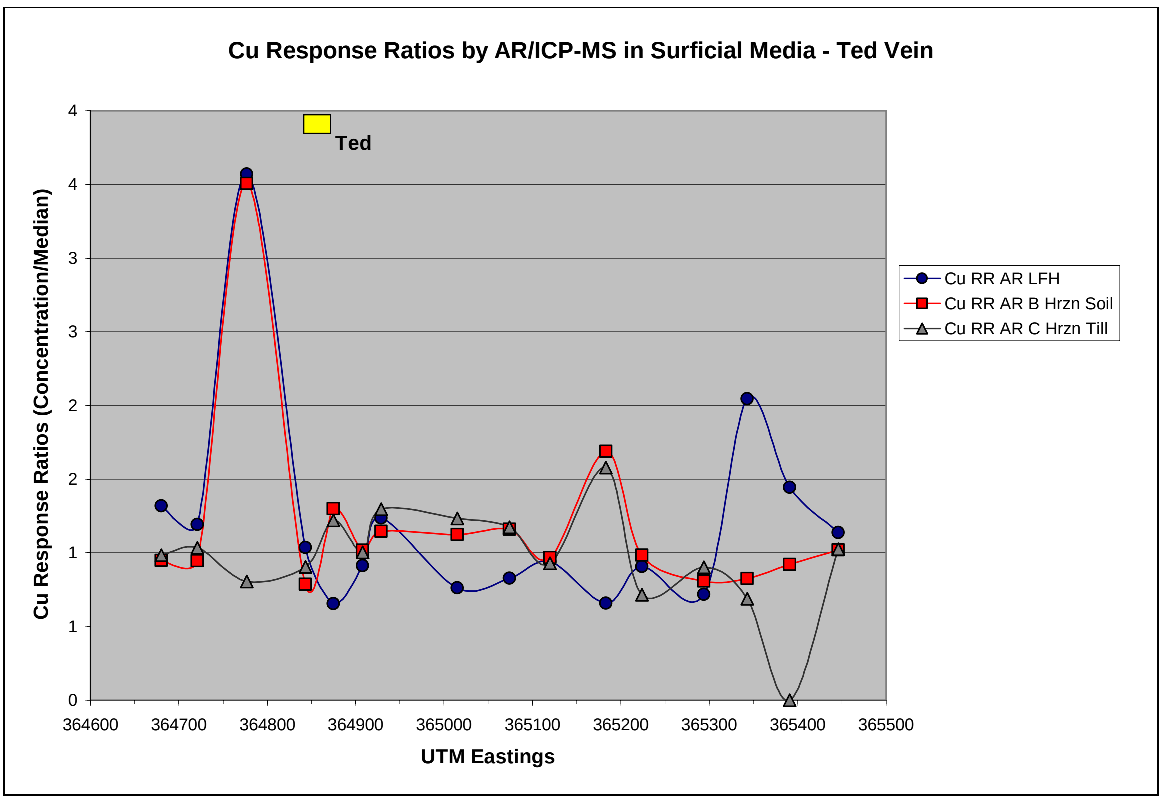
Figures 138 and 139. *Distribution of arsenic concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*



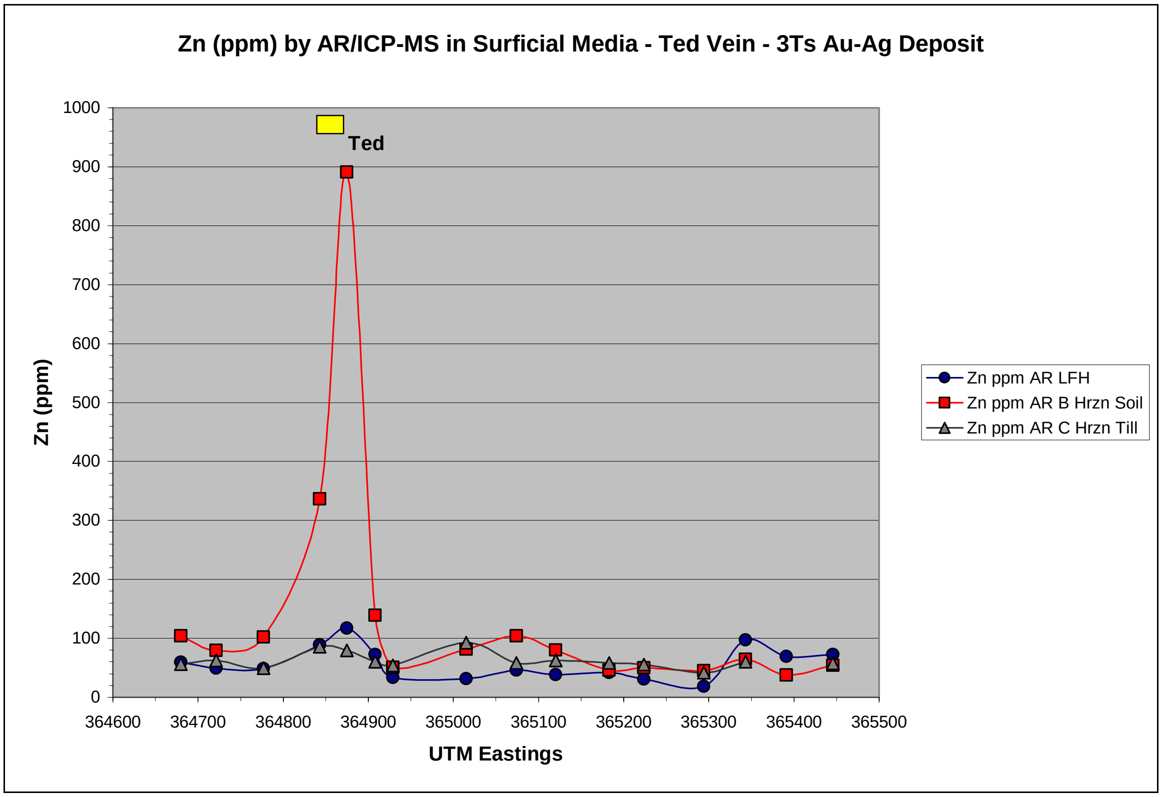


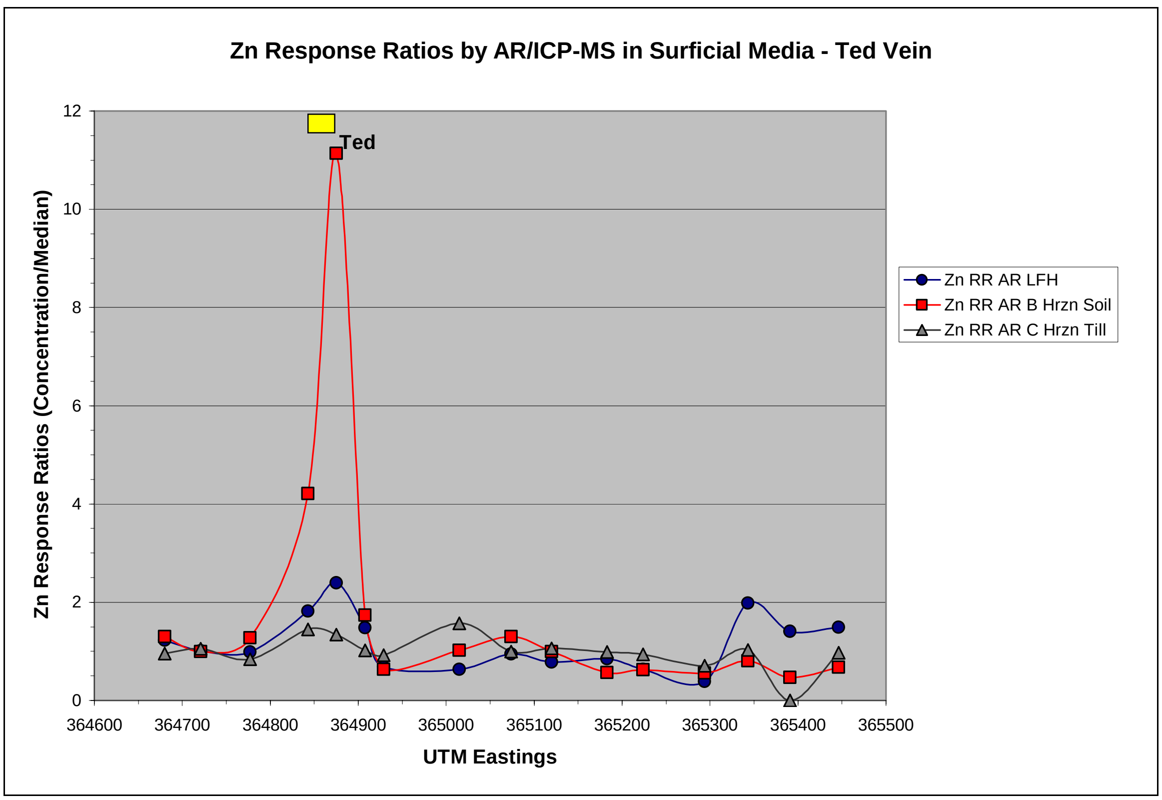
Figures 140 and 141. *Distribution of antimony concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*



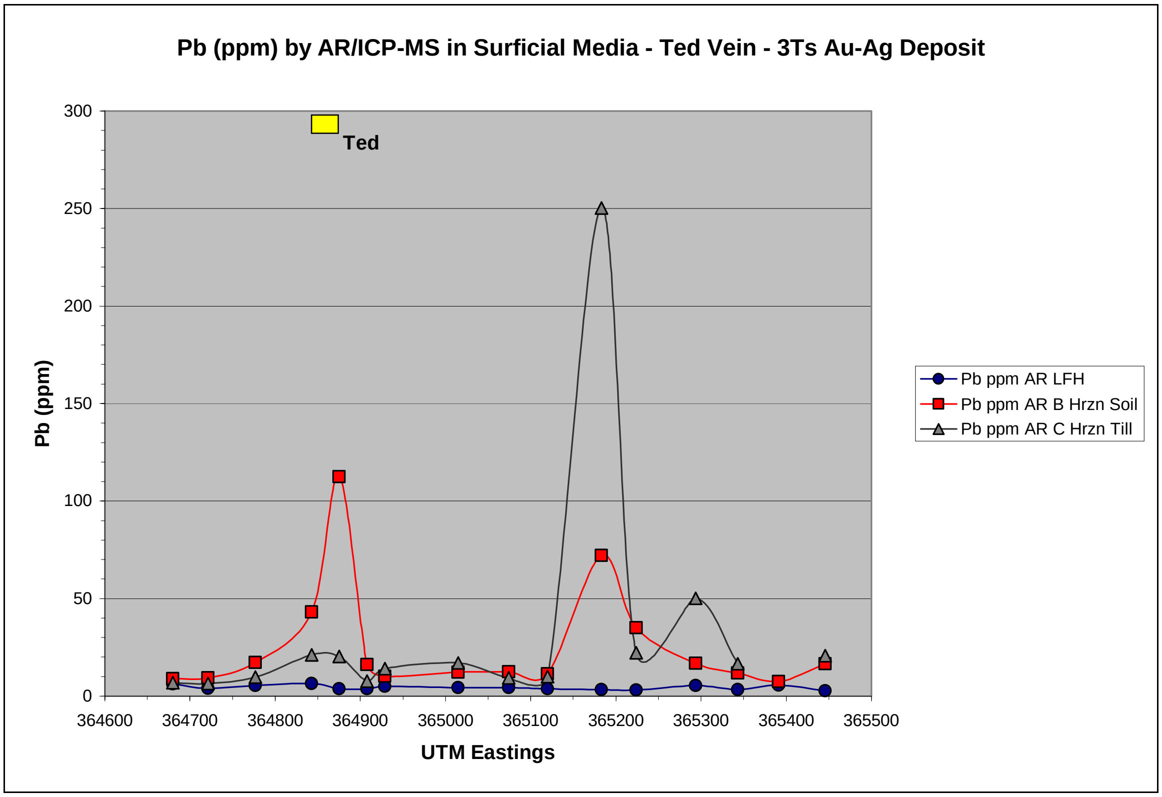


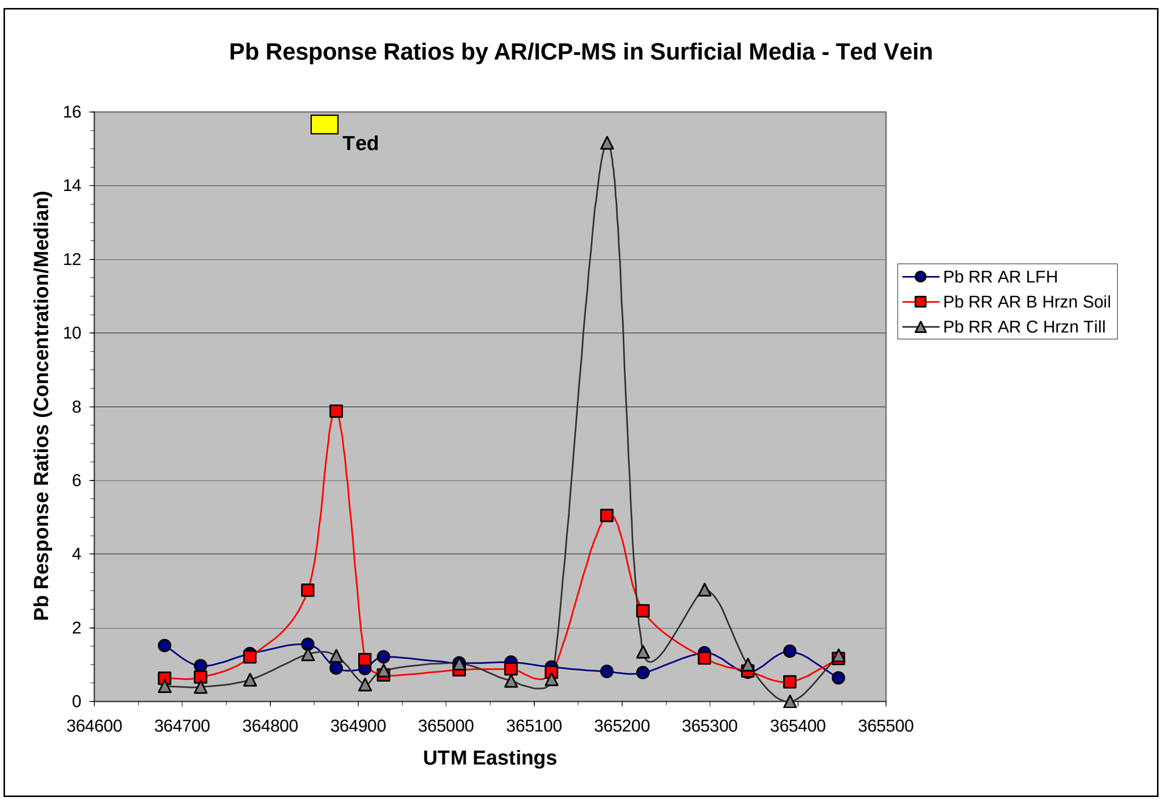
Figures 142 and 143. *Distribution of copper concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*



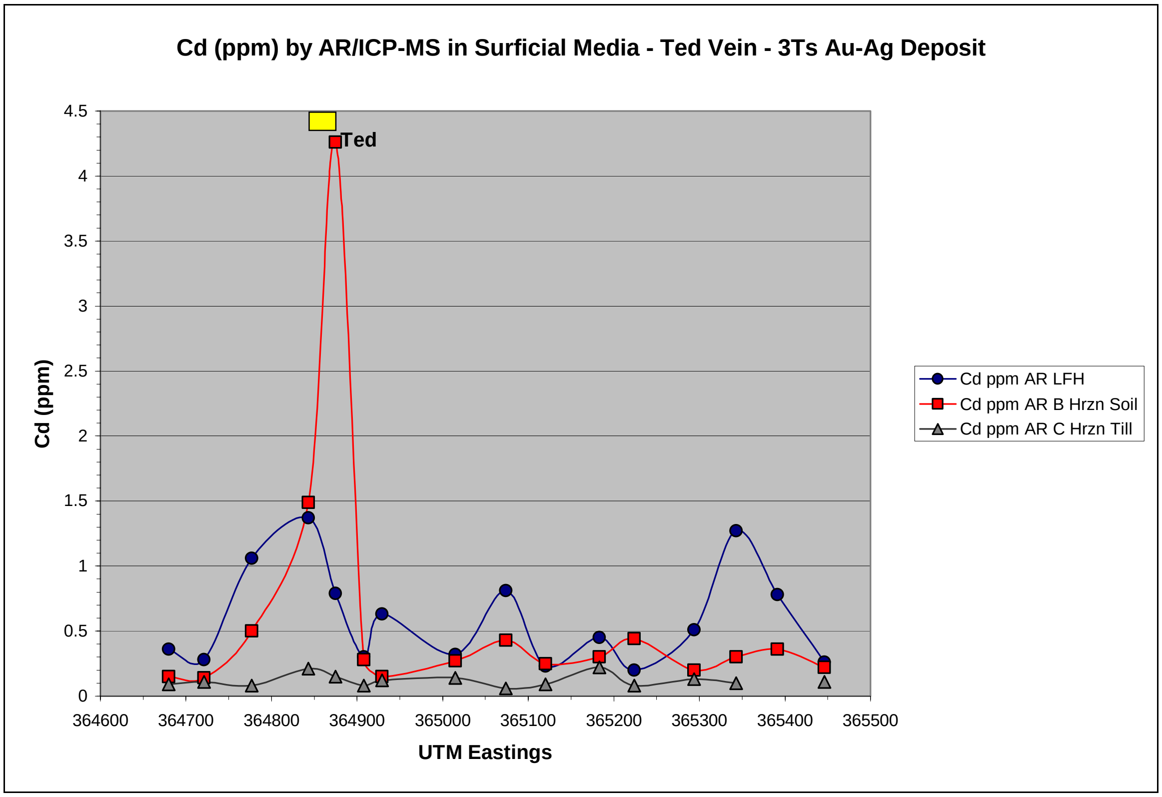


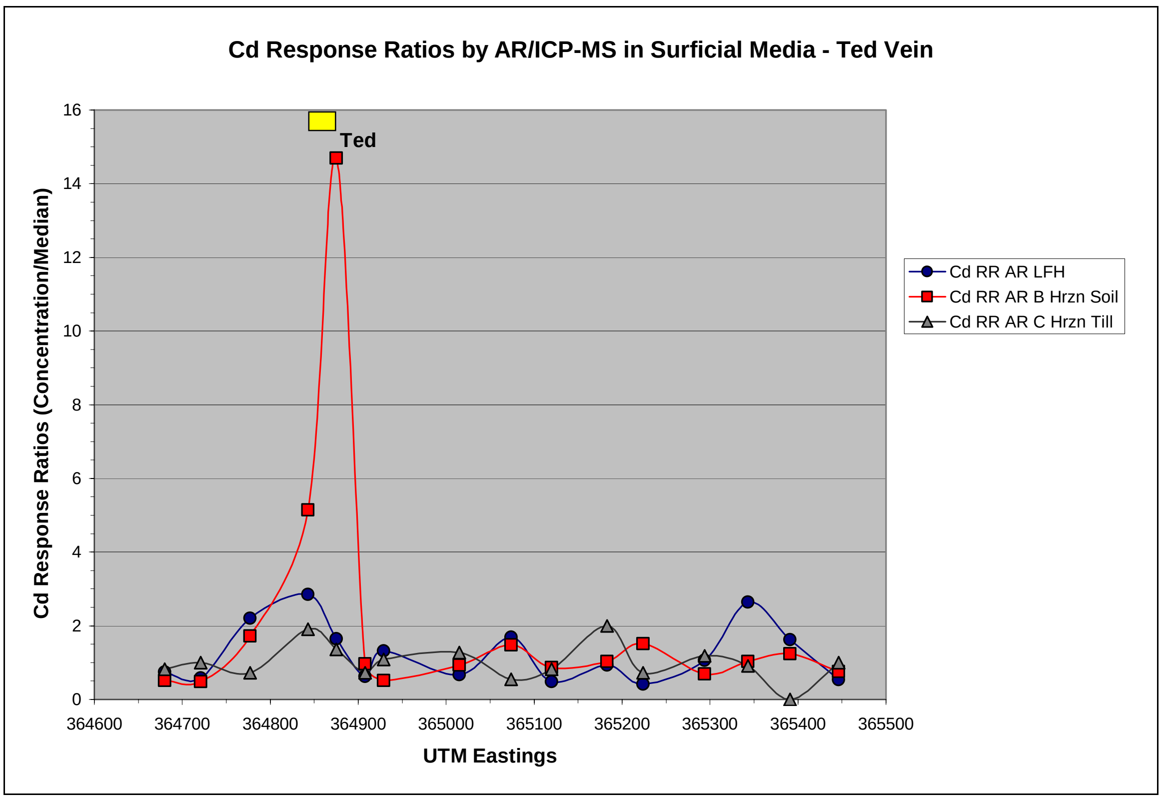
Figures 144 and 145. *Distribution of zinc concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*





Figures 146 and 147. *Distribution of lead concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*





Figures 148 and 149. *Distribution of cadmium concentrations (top) and calculated response ratios (bottom) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*

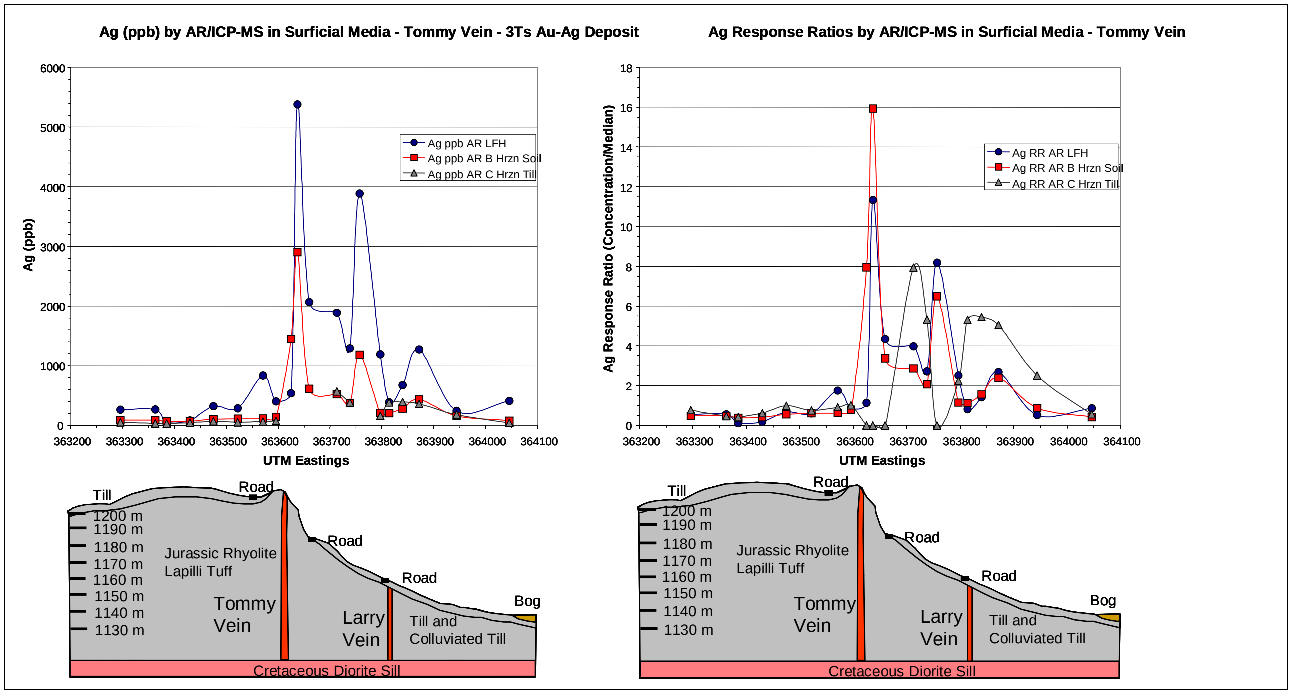


Figure 150. *Distribution of Ag concentrations (left) and calculated response ratios (right) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*

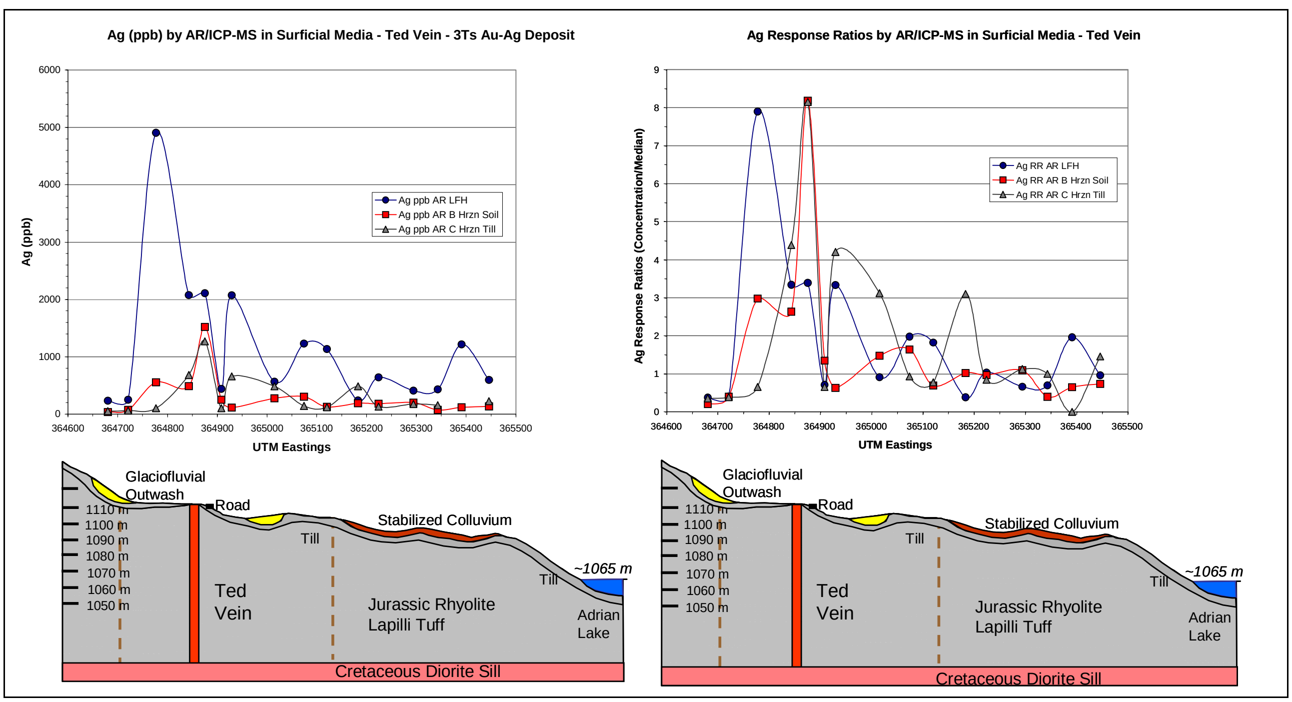


Figure 151. *Distribution of Ag concentrations (left) and calculated response ratios (right) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*

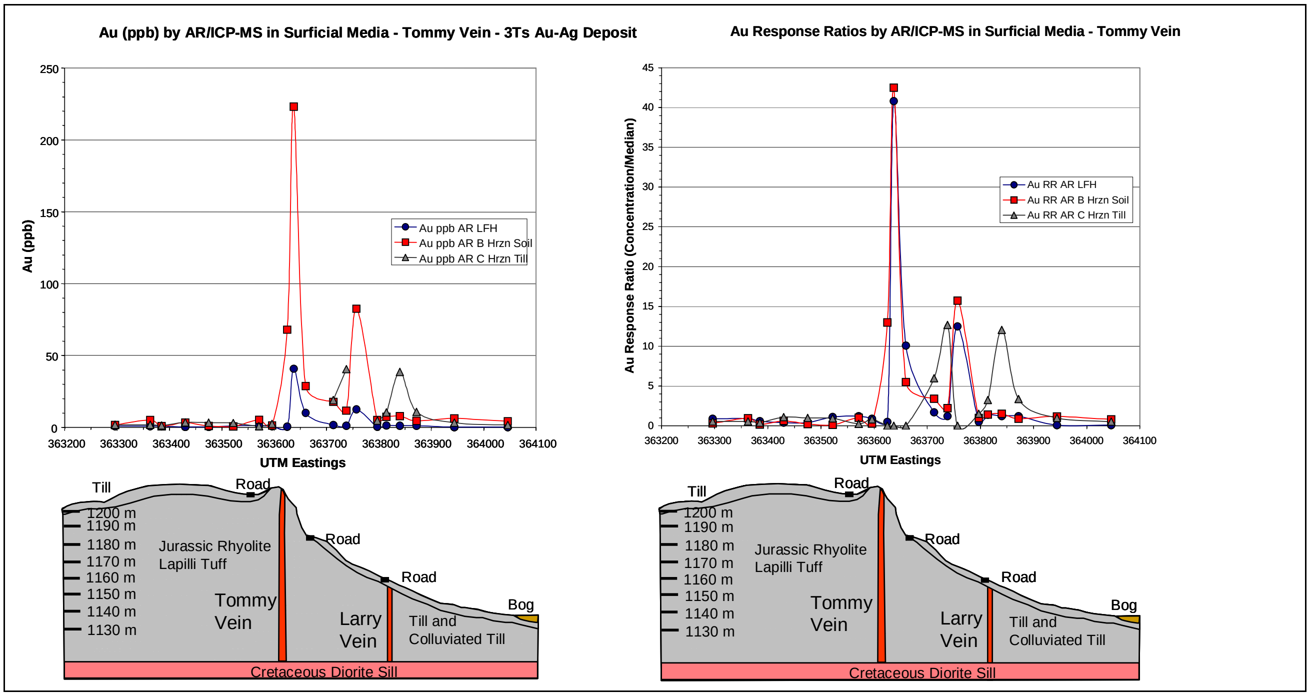


Figure 152. *Distribution of Au concentrations (left) and calculated response ratios (right) in humus, B horizon soil and C horizon till and other parent materials along the east-west Tommy vein orientation transect.*

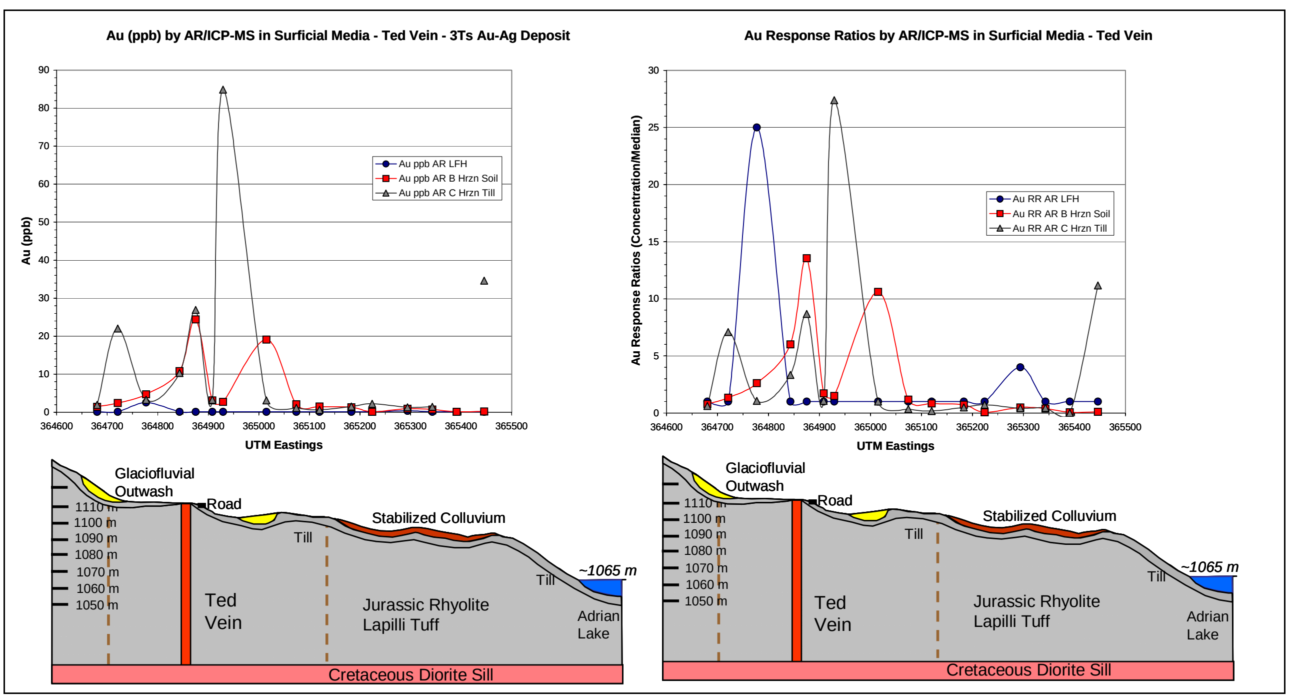


Figure 153. *Distribution of Au concentrations (left) and calculated response ratios (right) in humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Ted vein orientation transect.*

c) Total Gold Fire Assay Results in Mineral Horizons

Total Au concentrations by lead-collection fire assay (Acme Labs Group 3B-MS method; ICP-MS finish) are shown in Table 12, among other methods, for both B horizon mineral soils and C horizon tills at each Tommy transect and Ted transect sample site. Summary statistical results for both total and aqua regia-digestible Au data are further summarized for each horizon in Table 13. The Tommy and Ted vein transect plots showing comparative gold and log gold results by aqua regia digestion and fire assay, as well as calculated response ratios, for each of B horizon soils and C horizon tills at each site are shown in Figures 154 to 157 (Tommy) and Figures 158 to 161 (Ted). Although no fire assay determinations were conducted on organic-rich humus samples, corresponding aqua regia-digestible gold results in LFH horizon samples at each site are also shown here for comparative purposes. As with aqua regia Au results, any determinations below stated analytical detection limits are reported here as a value equivalent to one-half the detection limit. Platinum and palladium results were also reported in the fire assay suite, but most results are below the stated analytical detection limits and are not reported here.

Fire assay fusions represent total decompositions, and Au concentrations determined by the fire assay method are referred to here as 'total Au'. In comparison, aqua regia-digestible Au results may be either partial or near-total, depending on sample mineralogy, particle size and a range of related factors. In general, median total Au concentrations in neither B horizon soil (median: 3 ppb) nor C horizon till and other parent materials (median: 2 ppb) are elevated overall with respect to background levels, which in this part of central British Columbia, are typically in the 1 to 4 ppb range. When subdivided by transect line, however, soil and till on the Tommy transect have considerably greater Au concentrations than those on the Ted transect. For example, the median total Au by fire assay in each of B and C horizons on the Tommy transect is 5.5 ppb and 7 ppb, respectively, compared to the corresponding median concentrations of 1 ppb and 2 ppb on the Ted transect.

Of more interest to explorationists is the nature of the localized Au response in soil and till in the vicinity of the Tommy and Ted vein systems, and in both cases very high concentrations relative to regional background values are reported here. Total Au concentrations up to 216 ppb in B horizon soils are reported from above the Tommy vein, and up to 43 ppb just down-ice of the Ted vein, as shown in the geochemical percentile plot maps for Au by fire assay (FA) in each of the B and C mineral horizons (Figure 162 and 163). In general, elevated Au concentrations in B horizon soils adjacent to epithermal Au mineralization are complemented by roughly similar Au levels in corresponding C horizon tills, but this relation is obscured by the lack of any till at all directly above the mineralized vein exposure on the Tommy transect. In the cases of both the Tommy and Ted veins, however, elevated Au concentrations in near-surface B horizon soils are accompanied by similarly elevated Au in till concentrations a short distance down-ice. This distance is approximately 100 m in the case of the Tommy transect and about 50 m in the case of the Ted transect, and is interpreted to represent a very local down-ice dispersal of Au-bearing till.

Response ratios for Au in soil over the Tommy vein are almost identical for each of aqua regia and fire assay methods, in the range of 39 to 43 times line medians. Comparative response ratio Au results at the Ted vein are similar for B horizon soils by fire assay (43 times), although aqua regia response ratios are marginally lower at 25 times median concentration. In addition to positive Au responses at both Tommy and Ted veins, elevated total Au concentrations in B horizon soils (up to 20 ppb) and till (up to 38 ppb) are also present at and immediately down-ice of the smaller Larry vein prospect. The Larry vein, located to the east of the Tommy vein, was also transected by the Tommy orientation line. Of perhaps even greater interest is the presence of elevated total Au results (up to 183 ppb) in rubbly B horizon soils about mid-way between the Tommy and Larry veins. There is no till at this site, and elevated soil Au concentrations here do not appear to be related to any known sources. This is referred to in this paper as the 'central anomaly'.

Comparative gold concentrations in corresponding soils and tills at each site are sometimes muddied by the absence of till in rocky areas, or the local presence of near-surface colluvium from different sources. All of these factors contribute to the natural within-site and within-line variations in Au concentrations which are observed on the 3Ts property. By comparison, differences between total Au results (by fire assay) and aqua regia-digestible Au results are relatively minor. In most cases, the two are elevated in tandem in soils and tills near the known veins, and relative differences between the methods are minor. For example, total Au and aqua regia-digestible Au in B horizon soils directly over the Tommy vein (site 591) are 216 ppb and 223.1 ppb, respectively, whereas corresponding determinations from soils at the Ted vein are 43 ppb and 24.4 ppb, respectively.

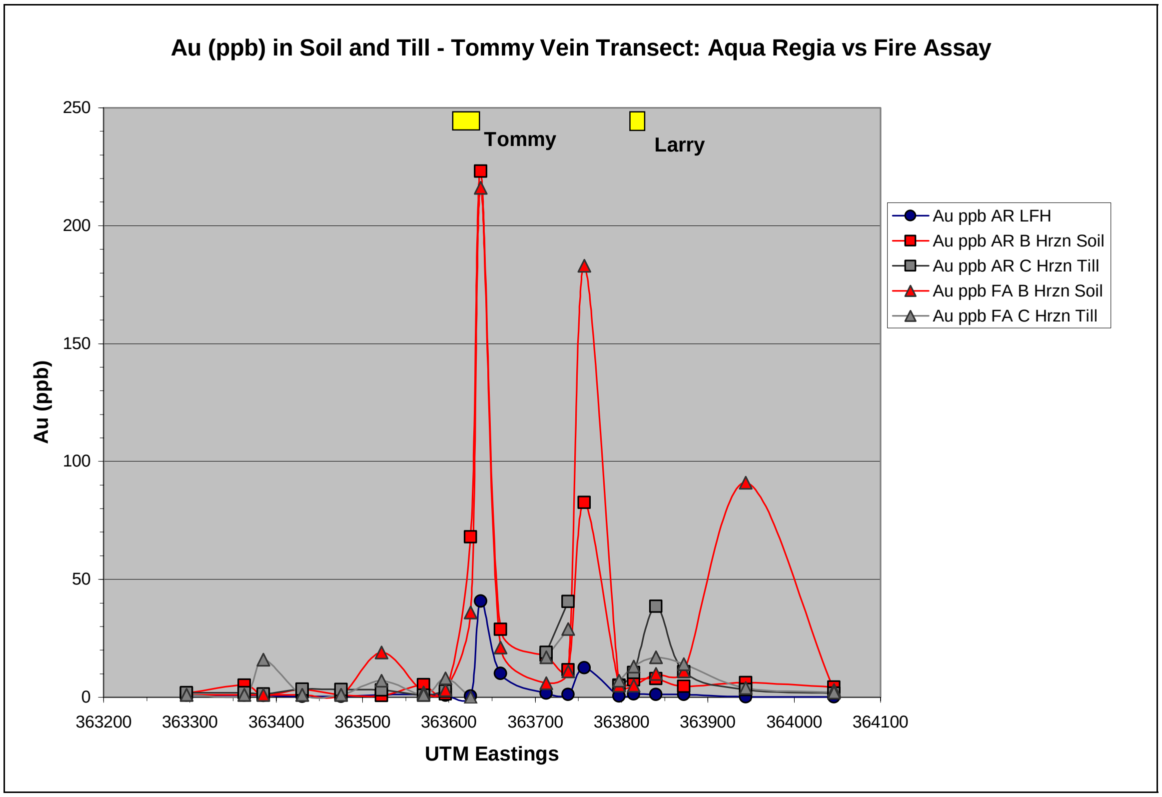
Table 12. *Comparative Au results in mineral soil horizons sampled along the Tommy and Ted vein transects, 3Ts Au-Ag deposit, as determined by both aqua regia and fire assay decompositions.*

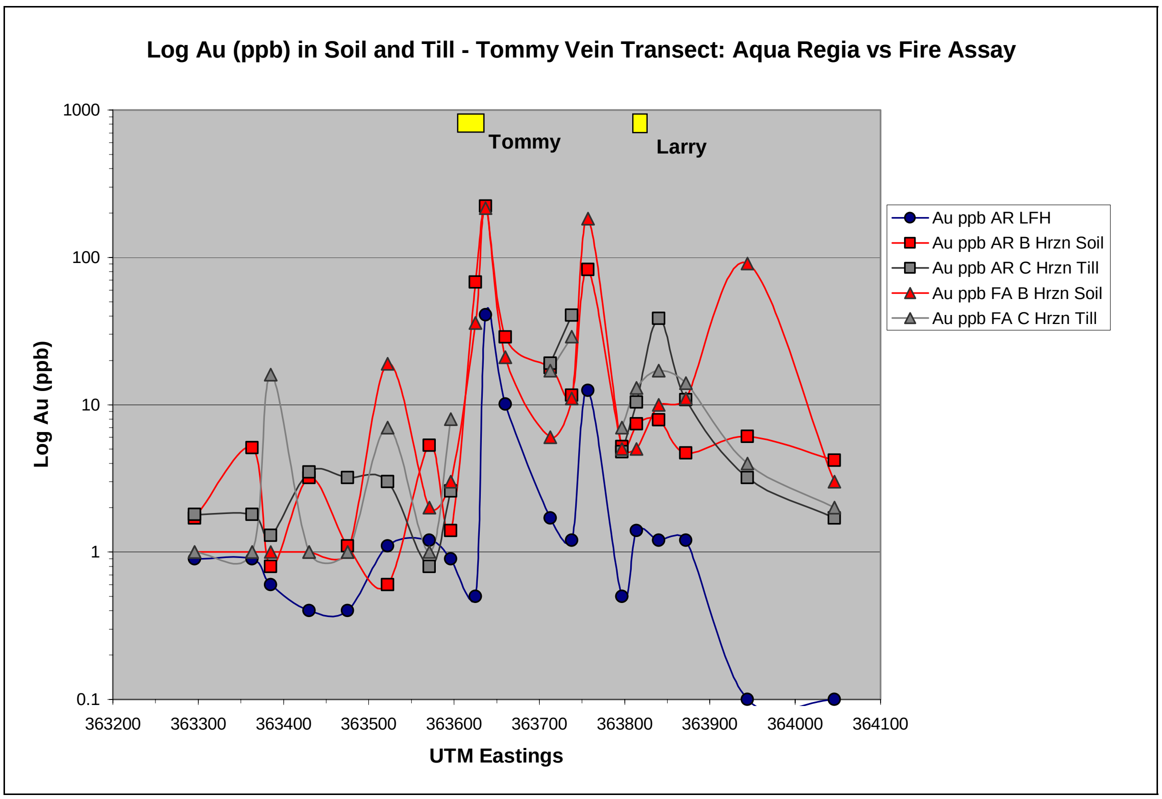
SAMPLE ID	TRANSECT LINE	UTMZ	UTME83	UTMN83	REL. GRID (m)	DUPLICATE COMMENT	SOIL HORIZON	SOIL DEPTH (cm)	SOIL PARENT MATERIAL	B Horizon Au (ppb) Aqua Regia	B Horizon Au (ppb) Fire Assay	C Horizon Au (ppb) Aqua Regia	C Horizon Au (ppb) Fire Assay
TOM S 501	1 Tommy	10	363296	5876976	0	Field Duplicate	Bm	0-15	Till	1.7	1	1.8	1
TOM S 502	1 Tommy	10	363296	5876976	0	Field Duplicate	Bm	0-20	Till	0.9	4	2.4	1
TOM S 503	1 Tommy	10	363363	5877005	63		Bm	0-10	Till	5.1	1	1.8	1
TOM S 504	1 Tommy	10	363385	5877000	85		Bm	0-15	Till	0.8	1	1.3	16
TOM S 505	1 Tommy	10	363430	5877000	130		Bm	0-18	Till	3.2	1	3.5	1
TOM S 506	1 Tommy	10	363475	5876996	175		Bm/BC	0-18	Colluviated till?	1.1	1	3.2	1
TOM S 507	1 Tommy	10	363522	5876998	222		Bm	0-30	Till	0.6	19	3	7
TOM S 508	1 Tommy	10	363571	5876996	271		Bm	0-20	Colluviated till	5.3	2	0.8	1
TOM S 509	1 Tommy	10	363596	5876992	296		Bm	0-18	Till	1.4	3	2.6	8
TOM S 514	1 Tommy	10	363625	5876999	325		Bm	0-10	Rubble	68.1	36	-	-
TOM S 591	1 Tommy	10	363637	5876948	337	Field Duplicate	Bm	0-15	Rubble/colluvium	223.1	216	-	-
TOM S 592	1 Tommy	10	363637	5876948	337	Field Duplicate	Bm	0-15	Rubble/colluvium	17.7	32	-	-
TOM S 515	1 Tommy	10	363660	5877012	360		Bm/C?	0-15/20	Rubble/colluvium	28.8	21	-	-
TOM S 516	1 Tommy	10	363713	5876994	413		Bm/BC	0-15	Colluviated till	17.8	6	19.1	17
TOM S 517	1 Tommy	10	363738	5877005	438		Bm	0-8/10	Colluviated till	11.6	11	40.6	29
TOM S 518	1 Tommy	10	363757	5876984	457		Bm/BC	0-30	Rubble/colluvium	82.6	183	-	-
TOM S 519	1 Tommy	10	363797	5877005	497		Bm	0-10/12	Till	5.2	5	4.8	7
TOM S 520	1 Tommy	10	363814	5877005	514		Bm	0-20/30	Colluviated till	7.4	5	10.4	13
TOM S 521	1 Tommy	10	363840	5876999	540	Field Duplicate	Bm	0-10/12	Colluviated till?	7.9	10	38.6	17
TOM S 522	1 Tommy	10	363840	5876999	540	Field Duplicate	Bm	0-10/12	Colluviated till?	20	20	10.5	38
TOM S 523	1 Tommy	10	363872	5876964	572		Bm	0-12	Colluviated till?	4.7	11	10.8	14
TOM S 524	1 Tommy	10	363944	5876985	644		Bm	0-12	Colluviated till?	6.1	91	3.2	4
TOM S 525	1 Tommy	10	364046	5876988	746		Bm	0-5/10	Till	4.2	3	1.7	2
TOM S 576	2 Ted	10	364680	5876673	0		Bm	0-20	Outwash	1.4	1	1.9	1
TOM S 575	2 Ted	10	364721	5876680	41		Bm	0-15	Outwash	2.4	1	22	5
TOM S 574	2 Ted	10	364777	5876644	97		Bm	0-10	Till	4.7	6	3.3	2
TOM S 558	2 Ted	10	364843	5876672	163		Bm	0-8/10	Colluvium	10.8	5	10.3	15
TOM S 559	2 Ted	10	364875	5876647	195		Bm	0-10/15	Till	24.4	43	26.9	24
TOM S 560	2 Ted	10	364908	5876662	228		Bm/BC	0-20	Till	3.1	7	3.3	3
TOM S 561	2 Ted	10	364929	5876669	249	Field Duplicate	Bm/BC	0-20	Till	2.7	2	84.9	13
TOM S 562	2 Ted	10	364929	5876669	249	Field Duplicate	Bm/BC	0-20	Till	3.1	1	8.1	5
TOM S 563	2 Ted	10	365015	5876669	335		Bm	0/3 - 25	Outwash	19.1	5	3.1	1
TOM S 564	2 Ted	10	365074	5876654	394		Bm/BC	0-5/8	Outwash	2.1	3	1.1	1
TOM S 565	2 Ted	10	365120	5876661	440		Bm	0-5/8	Till	1.5	1	0.6	1
TOM S 566	2 Ted	10	365183	5876644	503		Bm/BC	0-20	Colluvium	1.3	1	1.5	2
TOM S 567	2 Ted	10	365224	5876623	544		Bm	0-15	Colluvium	0.1	1	2.2	1
TOM S 568	2 Ted	10	365294	5876616	614		Bm	0-20	Colluvium	0.9	1	1.3	1
TOM S 569	2 Ted	10	365343	5876589	663		Bm	0-20	Colluvium	0.7	1	1.4	1
TOM S 570	2 Ted	10	365391	5876592	711		Bm	0-20	Colluvium/rubble	0.1	1	-	-
TOM S 571	2 Ted	10	365446	5876570	766	Field Duplicate	Bm	0-10/12	Colluvium	0.2	1	34.6	2
TOM S 572	2 Ted	10	365446	5876570	766	Field Duplicate	Bm	0-10/12	Colluvium	1.9	1	1	3

Table 13. *Summary statistics table of the relative Au content of humic and mineral soils at the 3Ts Au-Ag deposit: comparison of aqua regia–digestible Au and total Au by fire assay.*

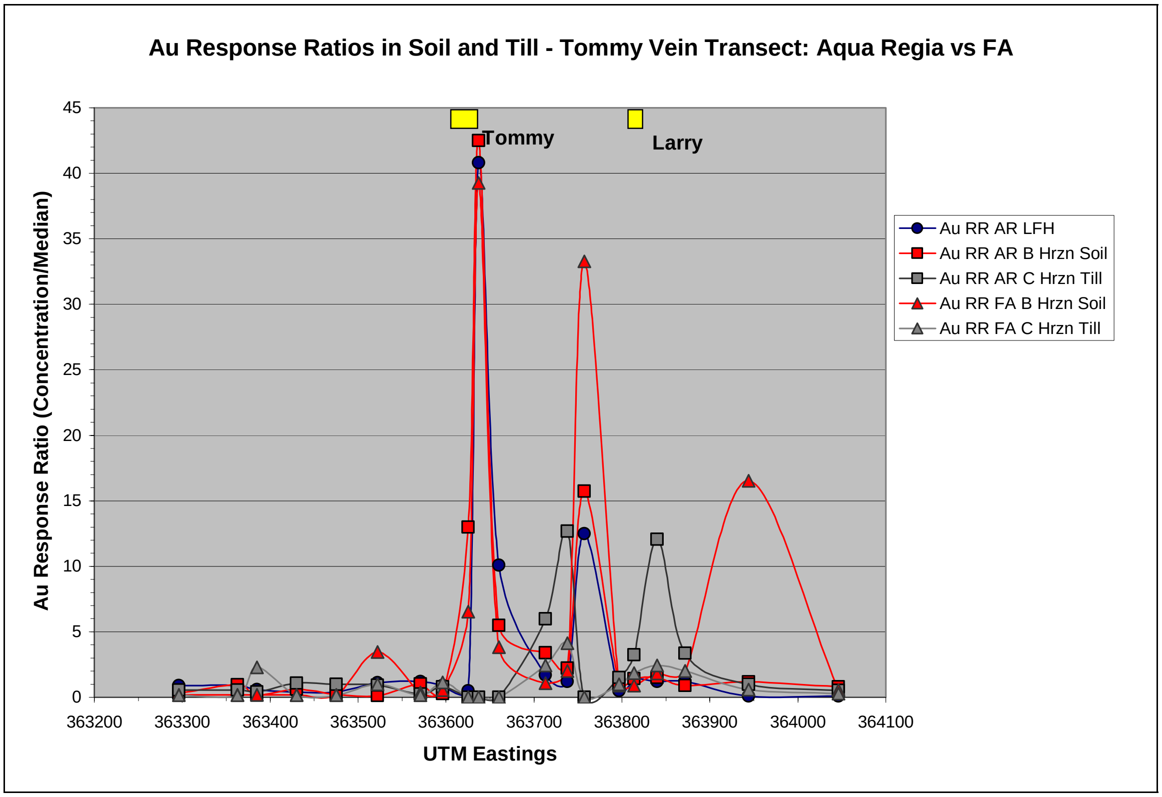
		COMBINED LINES		1) TOMMY LINE		2) TED LINE	
		Au Aqua Regia *ppb*	**Au Fire Assay** *ppb*	**Au Aqua Regia** *ppb*	**Au Fire Assay** *ppb*	**Au Aqua Regia** *ppb*	**Au Fire Assay** *ppb*
LFH Horizon Humus*	**Median**	**0.4**	-	**1.0**	-	**0.1**	-
	Mean	2.28	-	3.89	-	0.27	-
	± 1s	7.09	-	9.28	-	0.60	-
			-		-		-
	CV (%)	*311.2*	-	*238.9*	-	*223.1*	-
	Minimum	0.1	-	0.1	-	0.1	-
	Maximum	40.8	-	40.8	-	2.5	-
	N=sites	36	-	20	-	16	-
B Horizon Soil	**Median**	**3.7**	**3.0**	**5.3**	**5.5**	**1.8**	**1.0**
	Mean	15.62	19.6	24.34	31.4	4.72	5.0
	± 1s	39.70	47.5	51.79	61.3	7.20	10.3
	CV (%)	*254.2*	*242.1*	*212.8*	*195.4*	*152.5*	*206.9*
	Minimum	0.1	1	0.6	1	0.1	1
	Maximum	223.1	216	223.1	216	24.4	43
	N=sites	36	36	20	20	16	16
C Horizon Till	**Median**	**3.2**	**2.0**	**3.2**	**7.0**	**3.1**	**2.0**
	Mean	11.15	6.8	9.20	8.7	13.23	4.9
	± 1s	18.00	7.7	12.80	8.2	22.59	6.9
	CV (%)	*161.5*	*113.3*	*139.1*	*94.9*	*170.8*	*141.9*
	Minimum	0.6	1	0.8	1	0.6	1
	Maximum	84.9	29	40.6	29	84.9	24
	N=sites	31	31	16	16	15	15

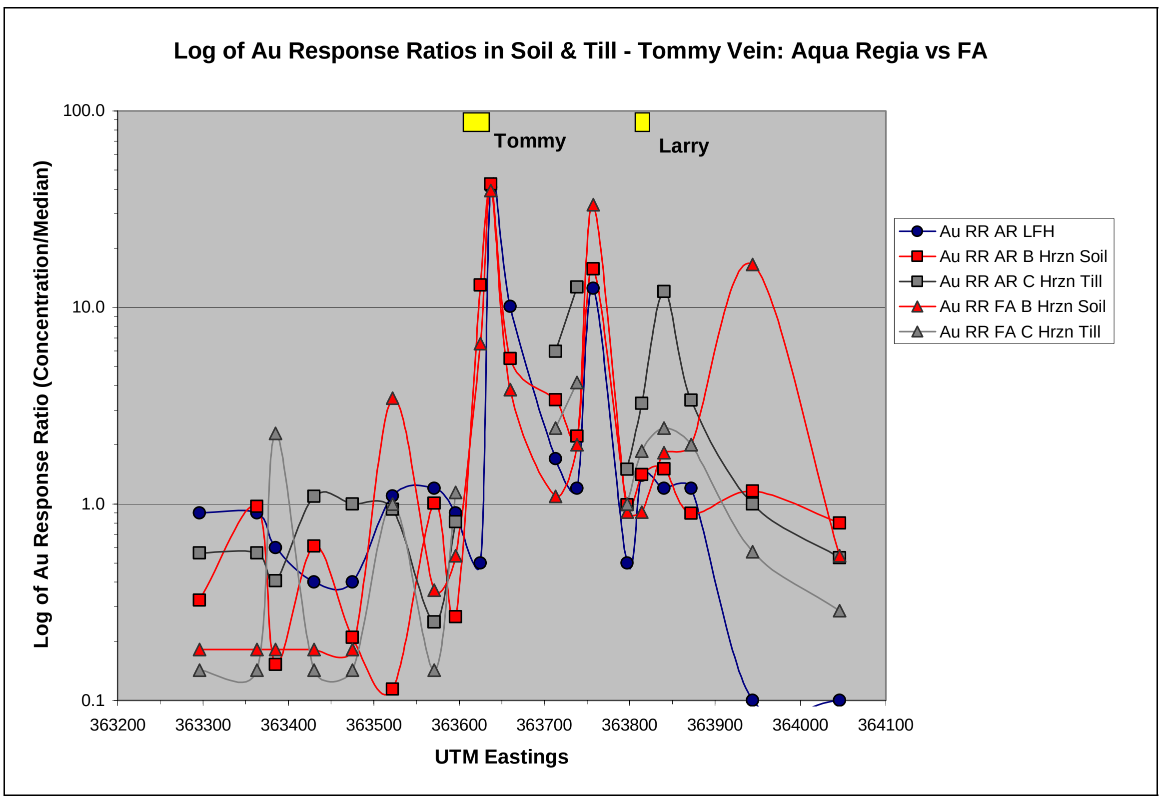
**No fire assay Au determinations were conducted on LFH horizon humus samples; aqua regia Au statistical results for this horizon are shown for comparative purposes only.*



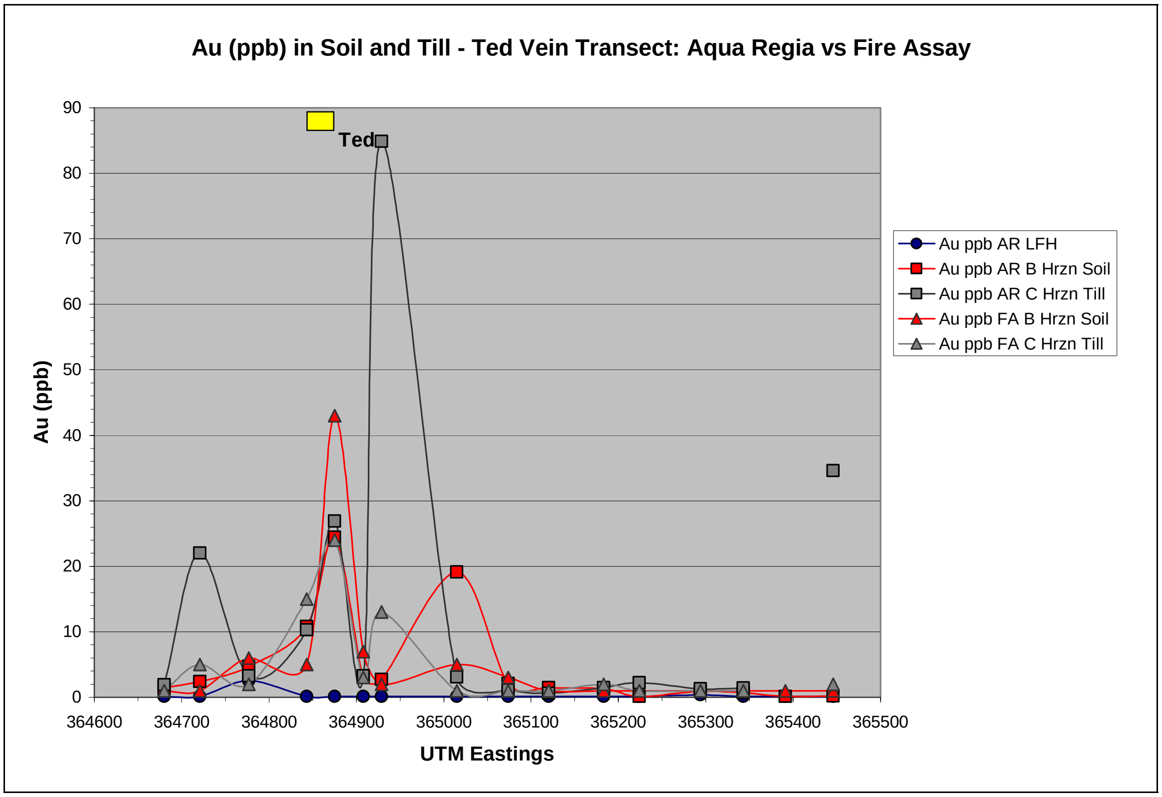


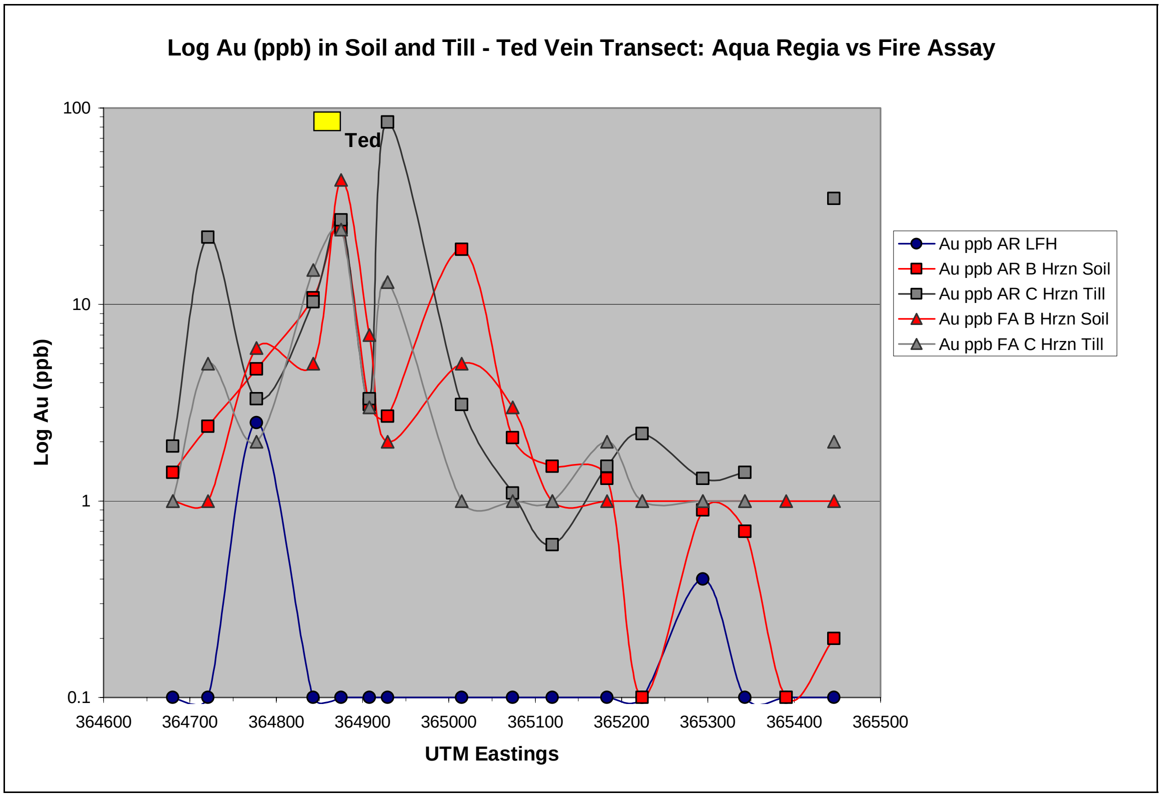
Figures 154 and 155. *Tommy vein transect plots showing comparative gold (top) and log gold (bottom) results by aqua regia digestion and fire assay for B horizon soils (squares) and C horizon tills (triangles) at each site. Aqua regia gold results in LFH horizon humus are also shown.*



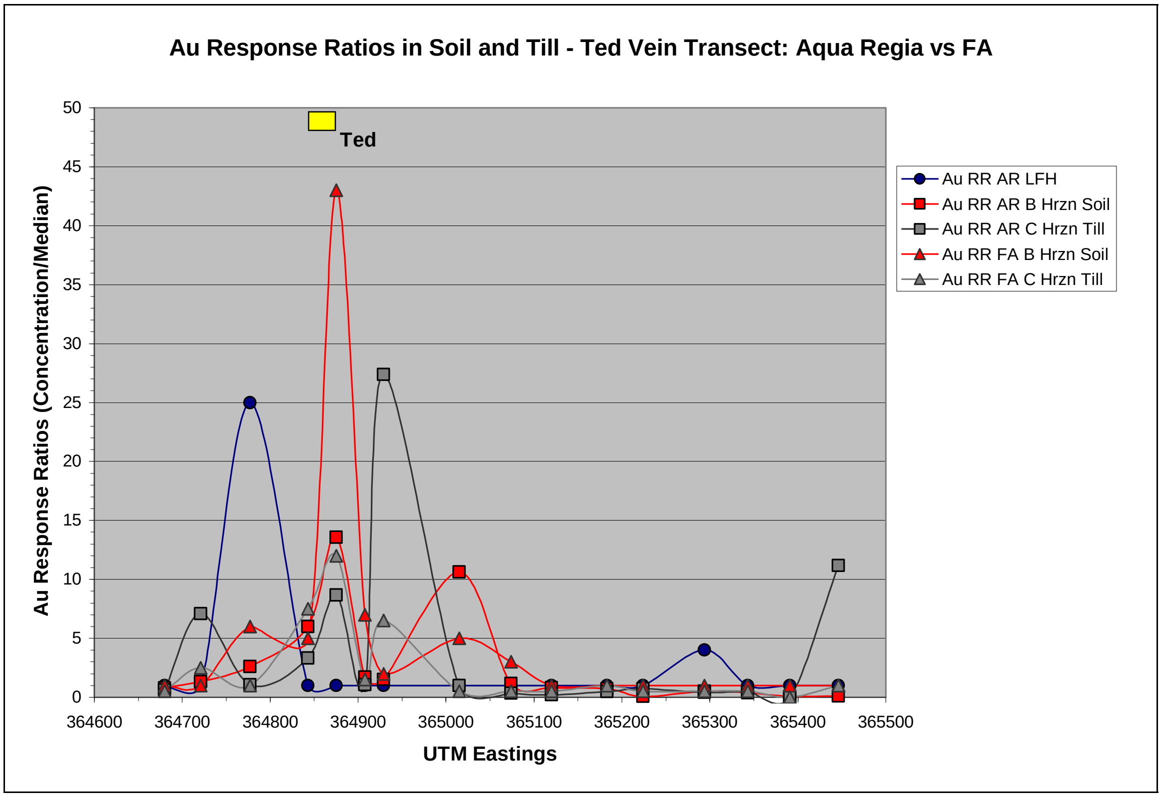


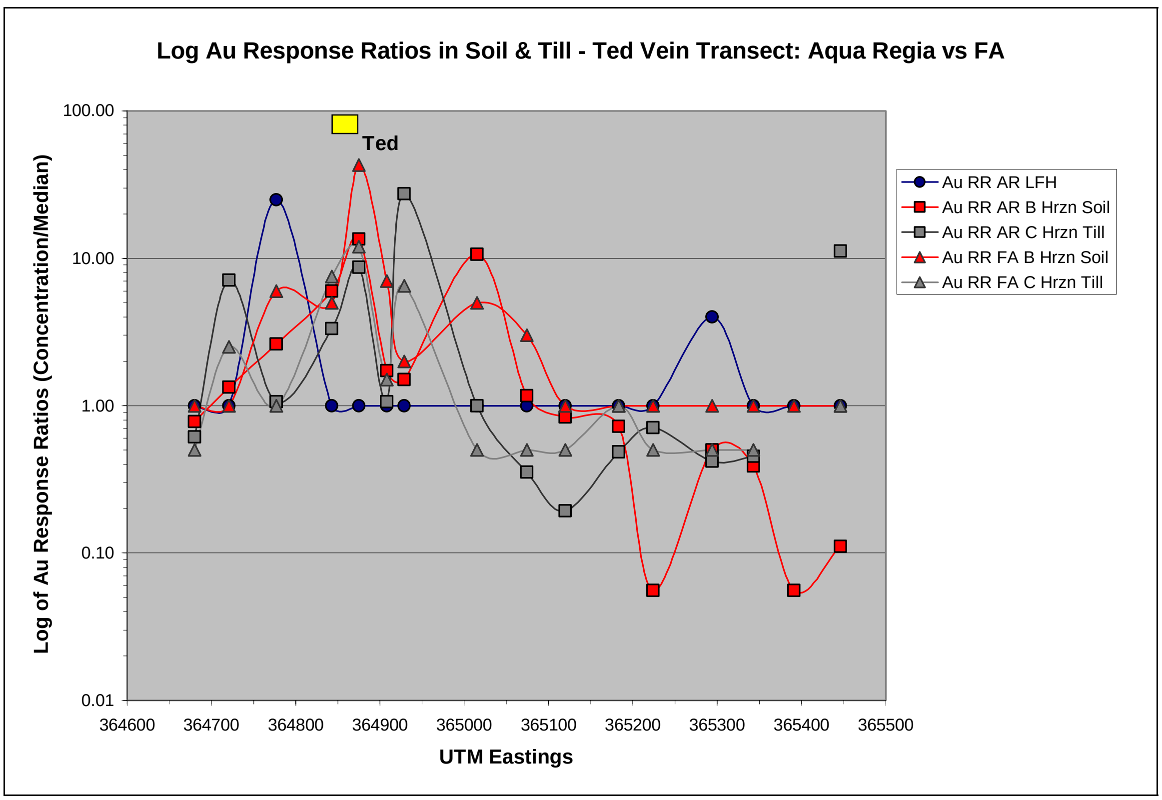
Figures 156 and 157. *Tommy vein transect plots showing calculated response ratios for gold (top) and log gold (bottom) results by aqua regia digestion and fire assay for B horizon soils and C horizon tills at each site. Comparative response ratios for aqua regia gold results in LFH horizon humus are also shown.*





Figures 158 and 159. *Ted vein transect plots showing comparative gold (top) and log gold (bottom) results by aqua regia digestion and fire assay for B horizon soils (squares) and C horizon tills (triangles) at each site. Aqua regia gold results in LFH horizon humus are also shown.*





Figures 160 and 161. *Ted vein transect plots showing calculated response ratios for gold (top) and log gold (bottom) results by aqua regia digestion and fire assay for B horizon soils and C horizon tills at each site. Comparative response ratios for aqua regia gold results in LFH horizon humus are also shown.*

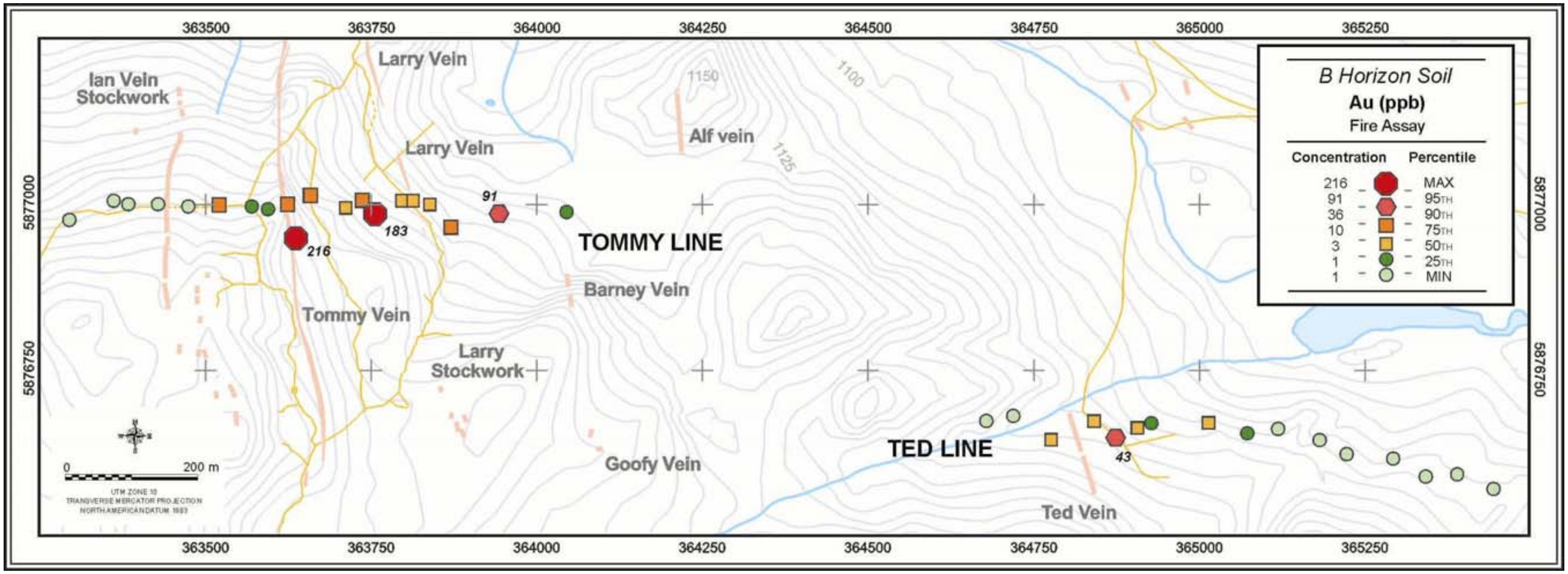


Figure 162. *Distribution of Au (ppb) by lead-collection fire assay decomposition–ICP-MS in B horizon soils on the combined Tommy and Ted orientation transects (N=36 sites).*

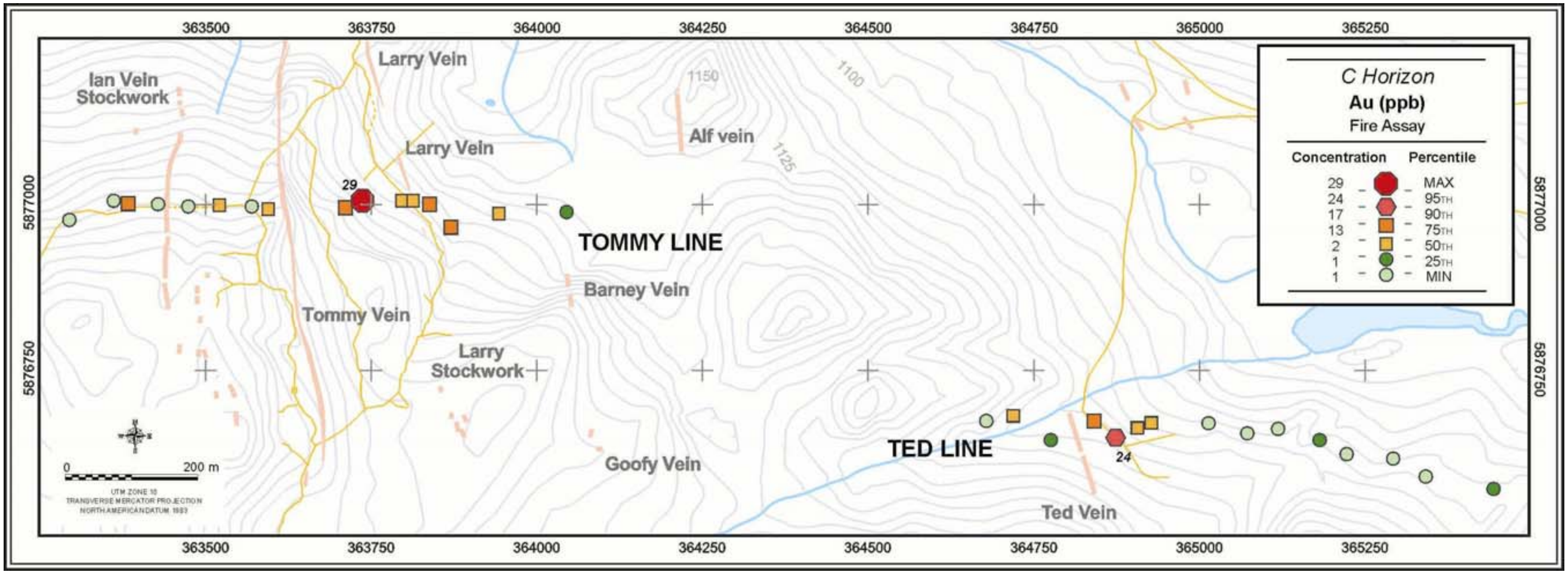


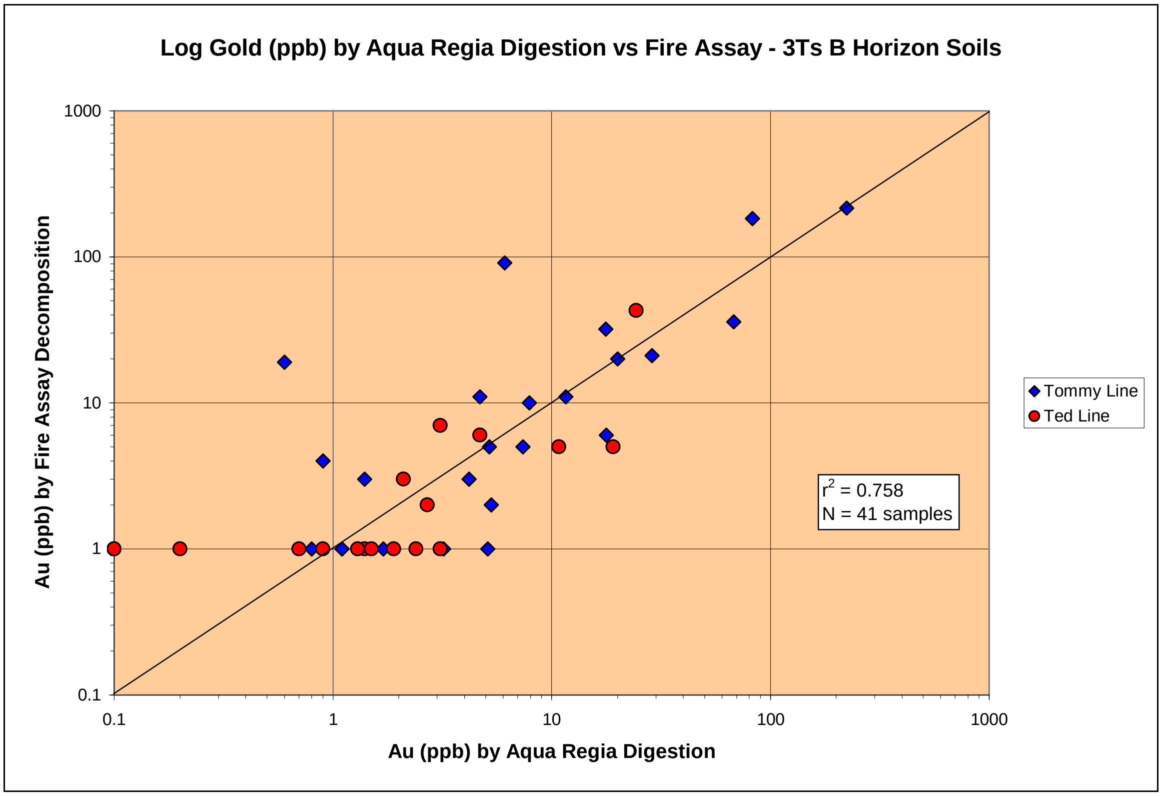
Figure 163. *Distribution of Au (ppb) by lead-collection fire assay decomposition–ICP-MS in C horizon till and other parent materials on the combined Tommy and Ted orientation transects (N=31 sites).*

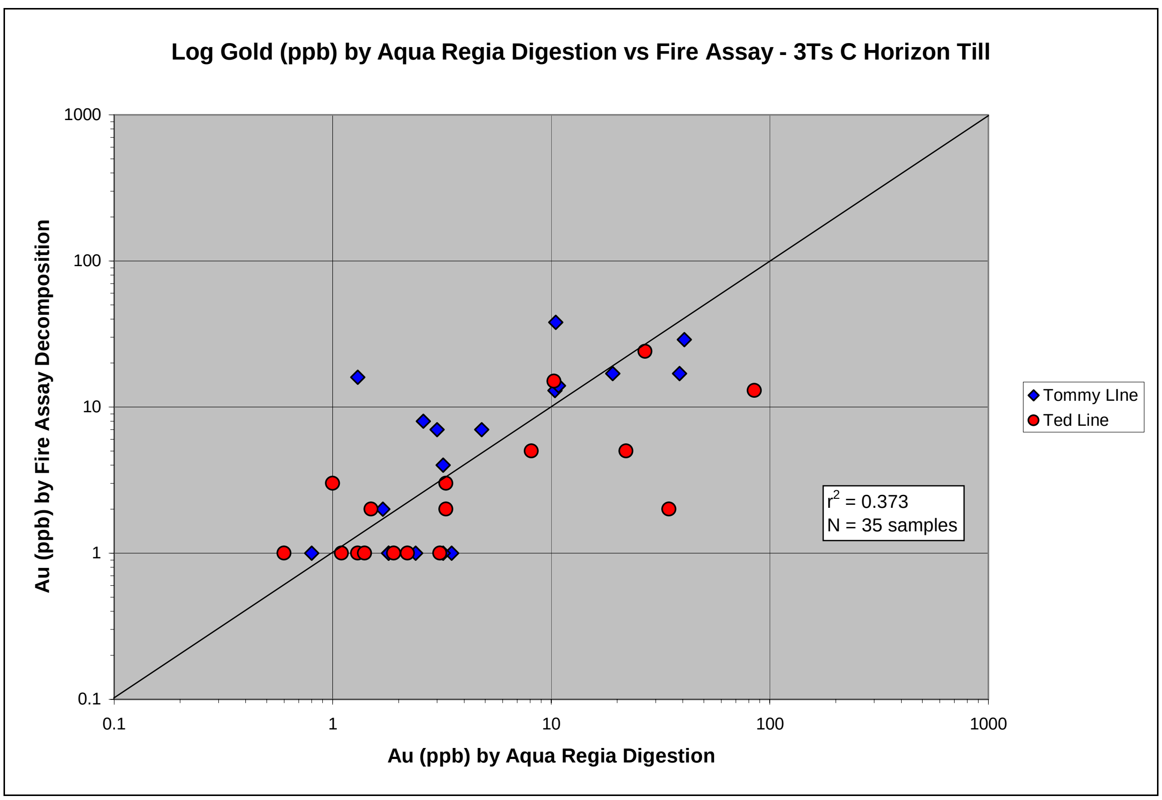
Scatterplots showing comparative Au results by aqua regia digestion versus fire assay decomposition for B horizon soils (Figures 164) and C horizon till and other parent materials (Figure 165) show a correlation between the two methods for both soil and till. Correlation between the two decomposition methods is, however, stronger for Au in soils than for Au in tills. More specifically, elevated Au concentrations >~4 ppb show a strong correlation between aqua regia and fire assay methods in the soils data, but a bias toward higher aqua regia concentrations in the till data.

There are textural differences between the B horizon and C horizon soil samples that are independent of the analytical procedures — the soils were sieved to –80 mesh (<180 microns) as per routine exploration industry practice, while tills were sieved to a much finer-grained –230 mesh fraction (<63 microns) prior to analysis in accordance with standard Geological Survey of Canada and BC Geological Survey till preparation procedures.The breakdown of this data by orientation transect, however, shows that the aqua regia bias appears to be mostly, although not entirely, present in the Ted line till results as opposed to those from the Tommy line. Reasons for this bias are presently unclear. The three pairs of elevated AR:FA till results on the Ted line which are largely responsible for this bias (22, 5; 34.6, 2; and 84.9, 13) are not geographically clustered in any way, but are widely dispersed along the orientation transect. Furthermore, they represent a diverse group of parent materials. Only one of these sites — located just down-ice of the Ted vein exposure — is till; one is in a relatively minor exposure of outwash, while the third is colluvium, which is a common parent material toward the eastern part of the Ted line.

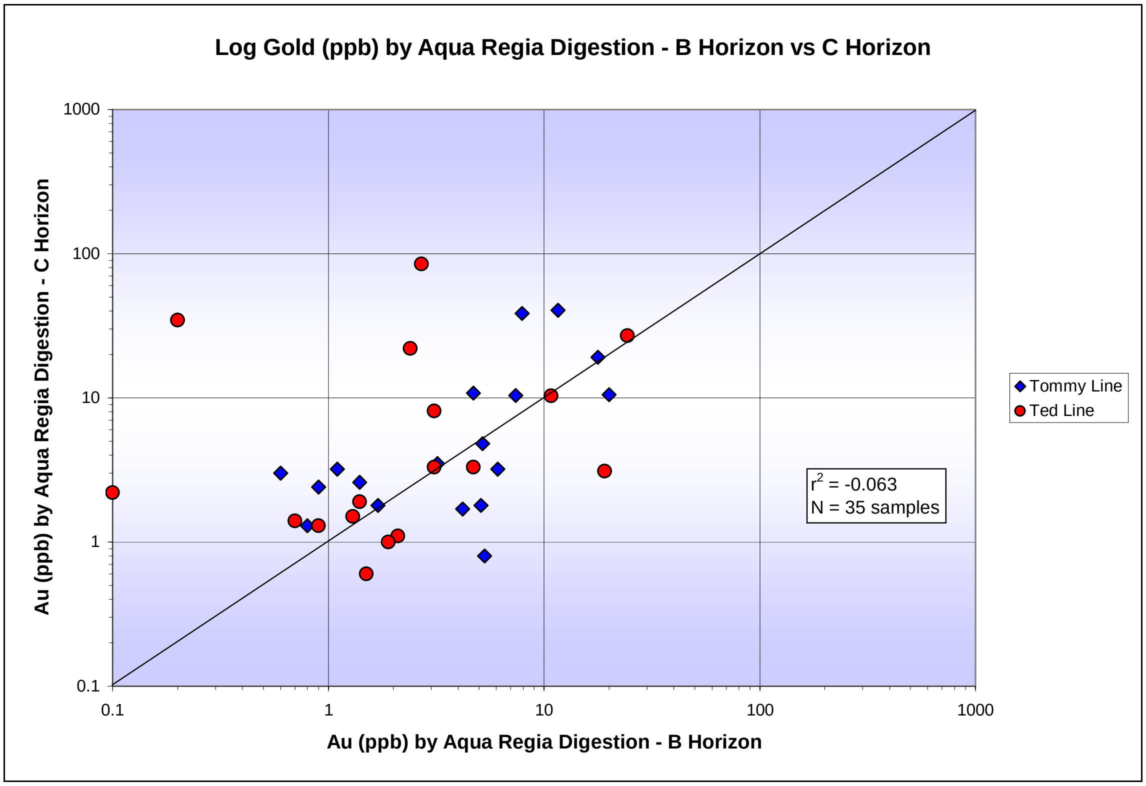
Scatterplots showing comparative Au results in Tommy and Ted line paired B horizon versus C horizon samples (35 pairs) by each of the aqua regia digestion (Figures 166) and fire assay decomposition (Figure 167) methods show that within-profile variation in Au concentrations is greater than that of using different analytical procedures at the 3Ts property. Strikingly, there is no significant correlation between aqua regia-digestible Au results in B horizon versus C horizon soils in the combined Tommy and Ted lines dataset. The breakdown of this data by orientation line suggests that it is the Ted line Au results that are largely responsible for this lack of correlation. This is interpreted as a consequence of the wide diversity of surficial parent materials present on the Ted line, and of the local presence of near-surface colluvium, which may be genetically unrelated to underlying parent material. In way of contrast, there is a much stronger correlation between B and C horizon Au results on the Tommy line, where till is the predominant parent material.

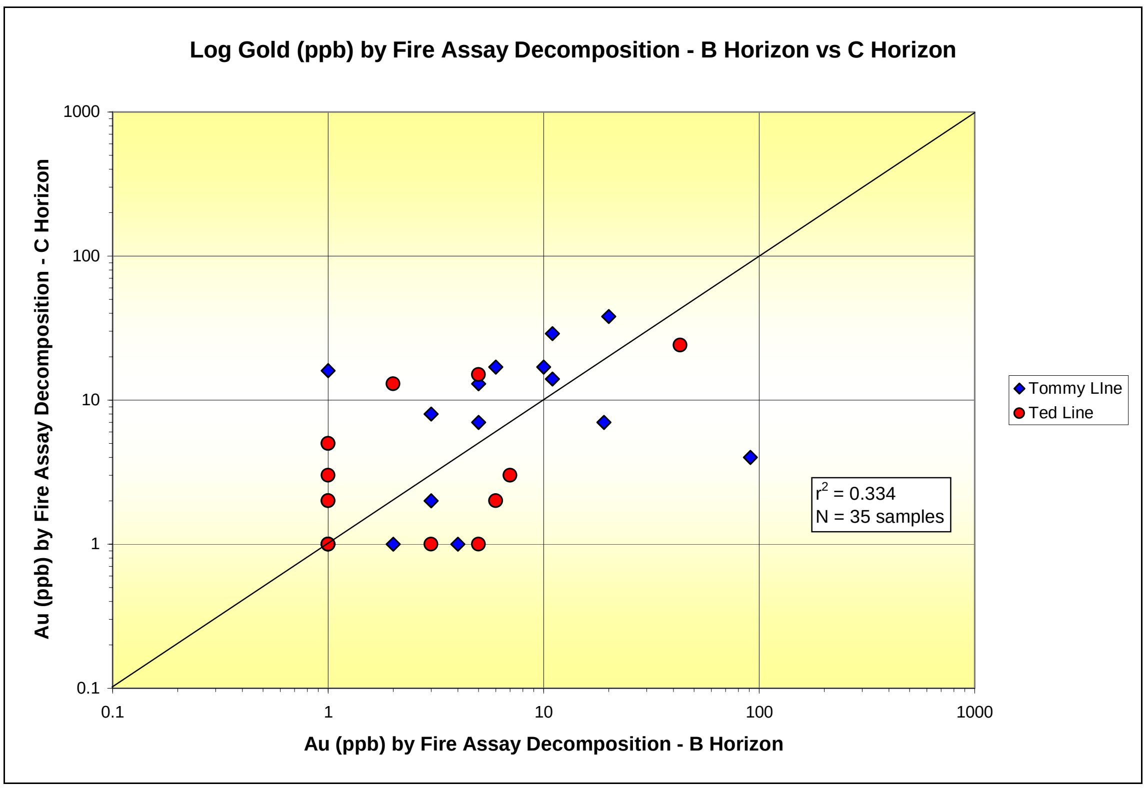
Comparative fire assay Au results between paired B and C horizons at each site are better correlated than those for the aqua regia digestion method, even with the poorer analytical FA detection limit (1 ppb, compared to 0.1 ppb for Au by AR) taken into account. This may merely be a function of the lower fire assay Au concentrations, relative to those by aqua regia, which were reported in the Ted line C horizon samples.





Figures 164 and 165. *Scatterplots showing comparative Au results by aqua regia digestion vs. fire assay decomposition for the Tommy and Ted line B horizon soils (top) and C horizon till and other parent materials (bottom). Field duplicate samples are included for both soil (5 pairs) and till (4 pairs).*





Figures 166 and 167. *Scatterplots showing comparative Au results in the Tommy and Ted line paired B horizon vs. C horizon samples by each of the aqua regia digestion (top) and fire assay decomposition (bottom) methods. Five sites with no C horizons are excluded here, but field duplicate samples (4 pairs) are included.*

d) Mobile Metal Ion (MMI-M) Results in Near-Surface Soils

Summary statistics for 20 elements determined by the Mobile Metal Ion (MMI-M) procedure at ALS Chemex Labs, Perth, in near-surface mineral soils are shown in Table 14 for combined lines results as well as for both individual Tommy vein and Ted vein transect results.

All 20 elements reported in the MMI-M analytical suite (ME-MS17 finish) are presented here and in the accompanying digital data files. Only one element (Au) reported some concentrations to be less than the stated analytical detection limit of 0.1 ppb; in these cases, the values are reported here as being equal to the detection limit (0.1 ppb).

Geochemical plot maps showing percentile element distributions are shown here for two elements, Au (Figure 168) and Zn (Figure 169), which display positive MMI geochemical responses in near-surface soils over the Tommy vein and the Ted vein. Individual MMI transect plots for each of the Tommy and Ted vein orientation transects are not shown here, but are instead shown in later sections of the paper (Sections j and k, respectively), showing comparative results and calculated response ratios for 1) Au and Ag determined by several methods including aqua regia digestion, MMI-M, Enzyme Leach and, in the case of Au, lead-collection fire assay (Figures 170 to 181), and 2) other selected elements, notably pathfinder elements and base metals of economic interest (Figures 182 to 205).

In general, MMI-M results show positive responses in most cases over the Tommy vein and the Ted vein. Although MMI Au concentrations are of a low magnitude, Au response ratios are 23 to 24 times line background over both Tommy vein mineralization and the central anomaly. Similar results were reported from the Ted vein, where a Au response ratio of almost 75 times background is superior to that of all other methods, including aqua regia. In the case of Ag, there was no anomalous response at the Tommy vein, although a response ratio of 6 to 7 times is present over the central anomaly on the Tommy orientation line. At the Ted vein, however, a strong Ag MMI response ratio (approximately 23 times line median) is superior to that reported by all other inorganic methods tested, including aqua regia. Positive MMI responses are also present for several base metals such as Zn, Pb and Cd in near-surface soils over both Tommy and Ted veins.

Table 14. *Summary statistics – MMI-M results for 3Ts near-surface mineral soils*

TOMMY LINE	**Ag**	**Al**	**Au**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Li**	**Mg**	**Ni**	**Pb**	**Pd**	**Sc**	**Sr**	**Th**	**Ti**	**U**	**Zn**	**Zr**
	ppb	*ppm*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*pbb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**27.1**	**93.1**	**0.15**	**239.5**	**12**	**35.05**	**15**	**185**	**1.8**	**16.0**	**61.5**	**145**	**2.5**	**34.5**	**1170**	**8**	**315**	**4**	**105**	**77.5**
Mean	59.17	92.475	0.735	255.02	35.45	44.03	19.65	242	3.585	25.25	84.25	286	2.96	38.3	1914	13.3	516.5	6.5	386	89.75
± 1s	62.85	31.22	1.08	120.63	42.16	38.33	10.04	161.62	3.86	20.51	55.03	374.57	2.09	25.01	1611.62	12.59	544.90	5.07	459.88	60.00
CV (%)	*106.2*	*33.8*	*146.4*	*47.3*	*118.9*	*87.0*	*51.1*	*66.8*	*107.6*	*81.3*	*65.3*	*131.0*	*70.6*	*65.3*	*84.2*	*94.6*	*105.5*	*78.0*	*119.1*	*66.9*
Minimum	12.4	40	0.1	71.4	3	14.4	11	100	0.8	5.64	25	20	1.4	18	290	4	40	3	70	33
Maximum	185.5	153	3.5	476	115	188	51	680	12.4	75.5	229	1590	10.4	128	5260	54	2020	23	1580	314
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TED LINE	**Ag**	**Al**	**Au**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Li**	**Mg**	**Ni**	**Pb**	**Pd**	**Sc**	**Sr**	**Th**	**Ti**	**U**	**Zn**	**Zr**
	ppb	*ppm*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*pbb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**40.2**	**94.2**	**0.1**	**303.5**	**15.5**	**33.9**	**24.5**	**125**	**4**	**24.9**	**98**	**250**	**3.1**	**34**	**1670**	**9.5**	**400**	**5**	**150**	**84.5**
Mean	96.88	88.91	0.64	324.92	21.13	33.33	28.19	215.63	6.51	35.34	99.13	432.50	3.66	37.19	2008.13	13.19	728.75	18.88	791.88	119.44
± 1s	227.43	36.14	1.79	139.63	14.51	15.68	10.34	197.21	5.61	35.94	45.91	615.88	2.68	16.10	1186.31	8.02	754.75	34.45	1774.21	98.71
CV (%)	*234.8*	*40.6*	*280.6*	*43.0*	*68.7*	*47.0*	*36.7*	*91.5*	*86.2*	*101.7*	*46.3*	*142.4*	*73.0*	*43.3*	*59.1*	*60.8*	*103.6*	*182.5*	*224.1*	*82.6*
Minimum	11.9	15.1	0.1	73.2	7	9	12	40	1.2	5.2	36	10	0.8	19	830	7	20	3	60	22
Maximum	944	146.5	7.3	619	60	69.2	51	720	18.4	135.5	226	2500	10.9	80	5520	34	2740	124	7100	394
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

COMBINED LINES	**Ag**	**Al**	**Au**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Li**	**Mg**	**Ni**	**Pb**	**Pd**	**Sc**	**Sr**	**Th**	**Ti**	**U**	**Zn**	**Zr**
	ppb	*ppm*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*pbb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**31.5**	**94.0**	**0.1**	**274.5**	**14**	**33.9**	**21**	**150**	**3.15**	**17.8**	**74.5**	**165**	**2.6**	**34**	**1525**	**8.5**	**355**	**4.5**	**145**	**83.5**
Mean	75.93	90.89	0.69	286.09	29.08	39.28	23.44	230.28	4.88	29.73	90.86	351.11	3.27	37.81	1955.83	13.25	610.83	12.00	566.39	102.94
± 1s	157.08	33.05	1.42	132.27	33.28	30.53	10.91	176.14	4.87	28.42	51.02	494.14	2.36	21.24	1419.64	10.66	645.57	23.70	1227.08	79.71
CV (%)	*206.9*	*36.4*	*204.6*	*46.2*	*114.4*	*77.7*	*46.5*	*76.5*	*99.7*	*95.6*	*56.2*	*140.7*	*72.1*	*56.2*	*72.6*	*80.4*	*105.7*	*197.5*	*216.6*	*77.4*
Minimum	11.9	15.1	0.1	71.4	3	9	11	40	0.8	5.2	25	10	0.8	18	290	4	20	3	60	22
Maximum	944	153	7.3	619	115	188	51	720	18.4	135.5	229	2500	10.9	128	5520	54	2740	124	7100	394
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

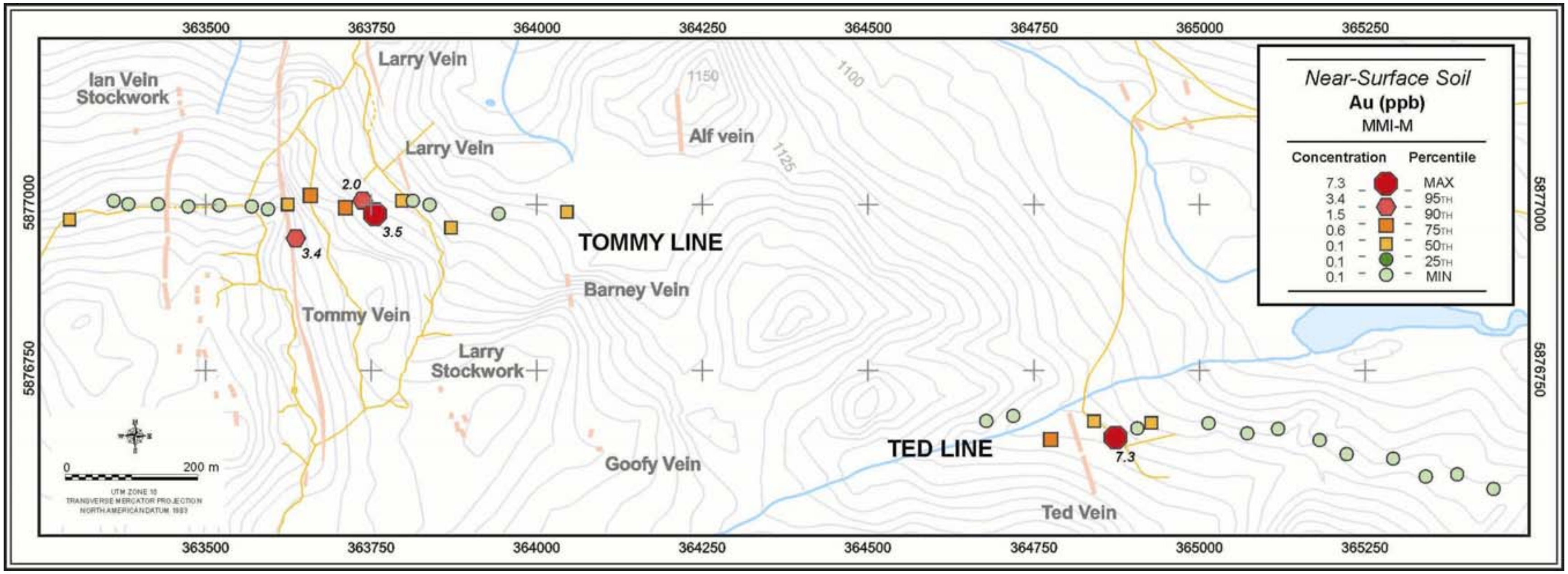


Figure 168. *Distribution of Au (ppb) by MMI-M in near-surface soils on the combined Tommy and Ted orientation transects (N=36 sites).*

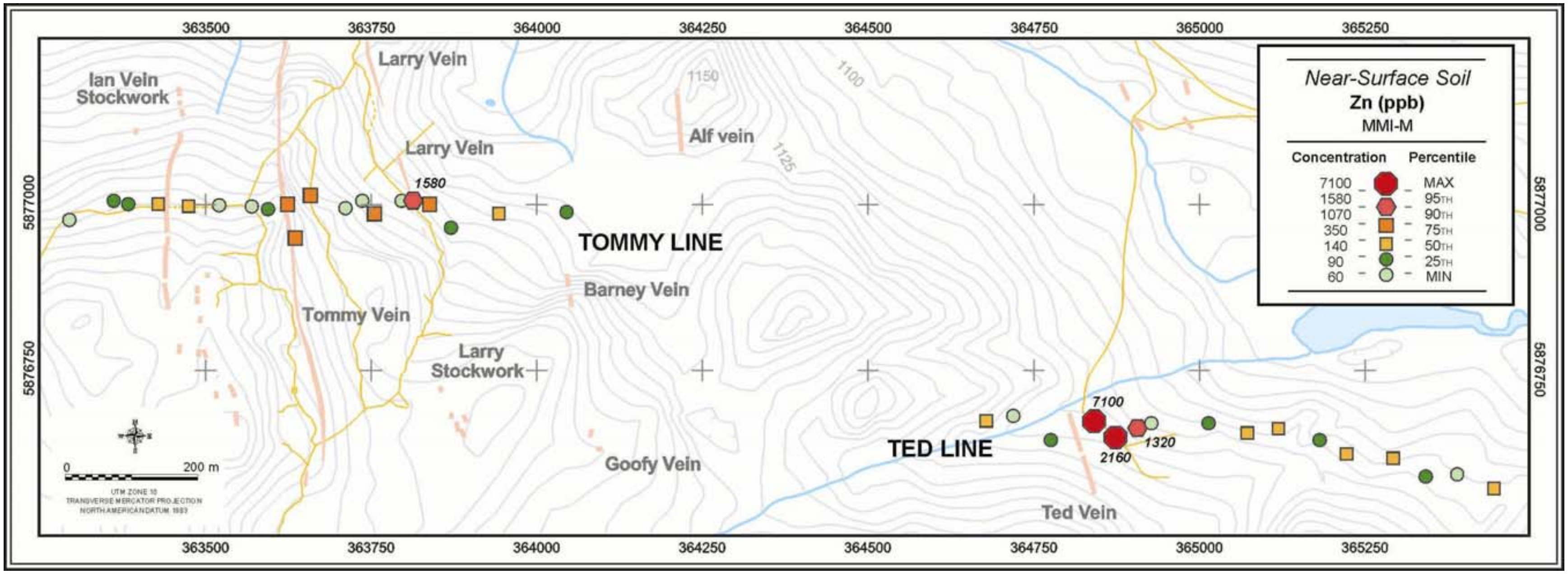
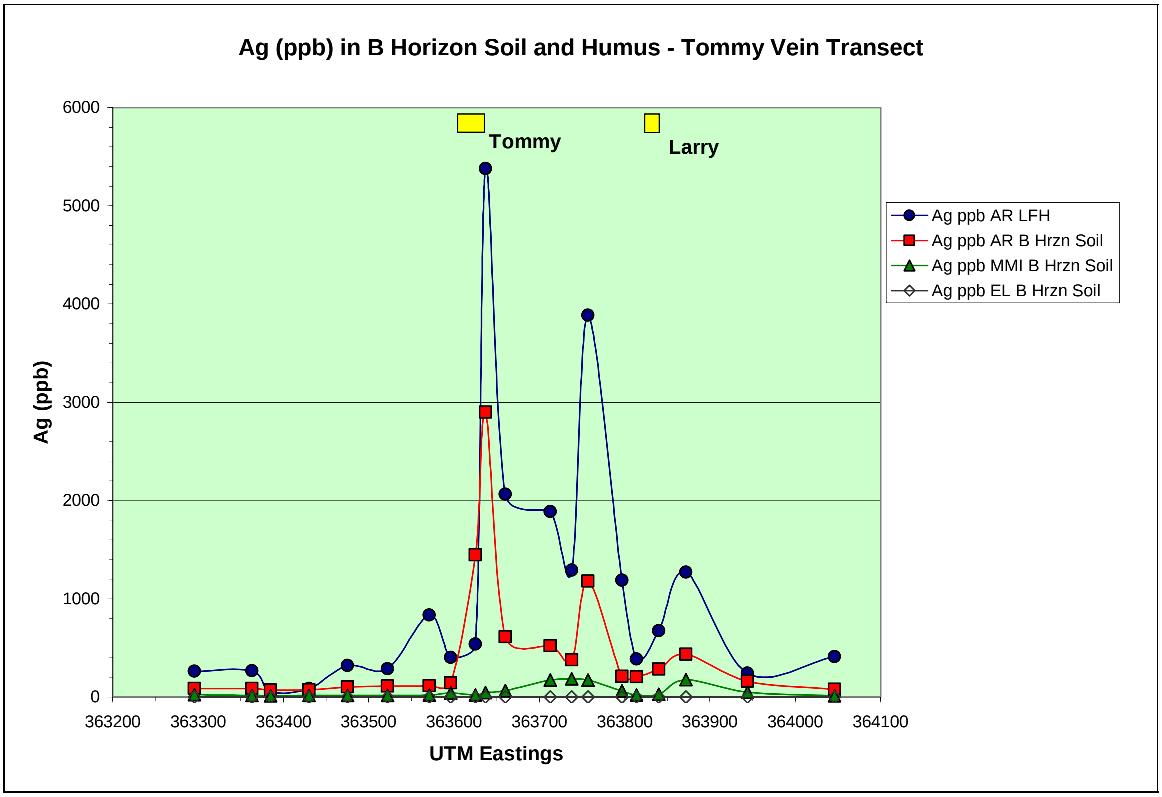
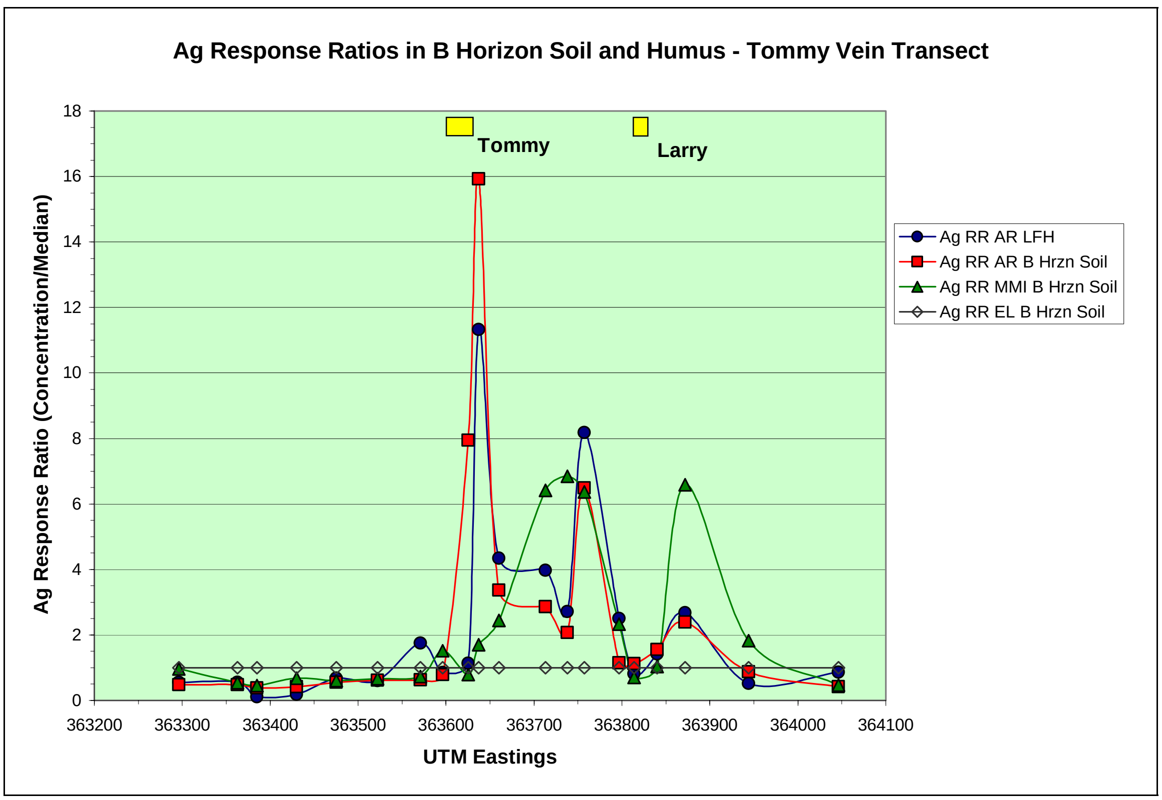
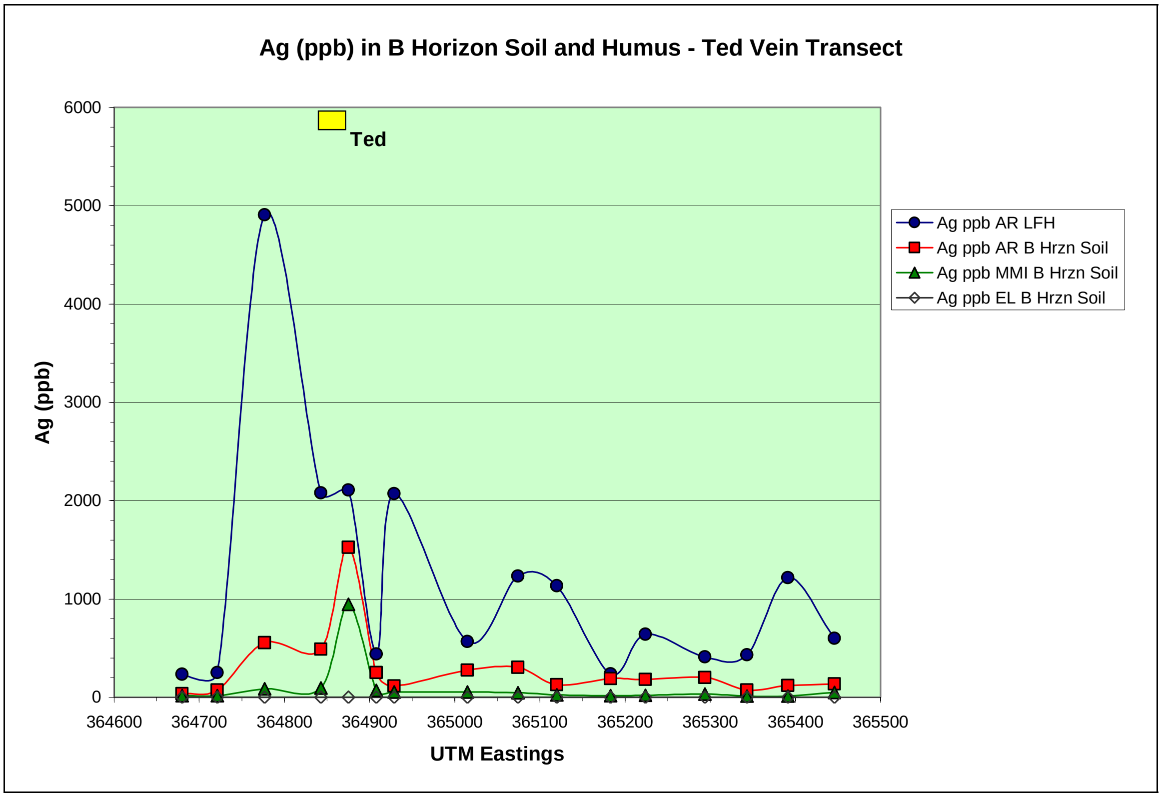


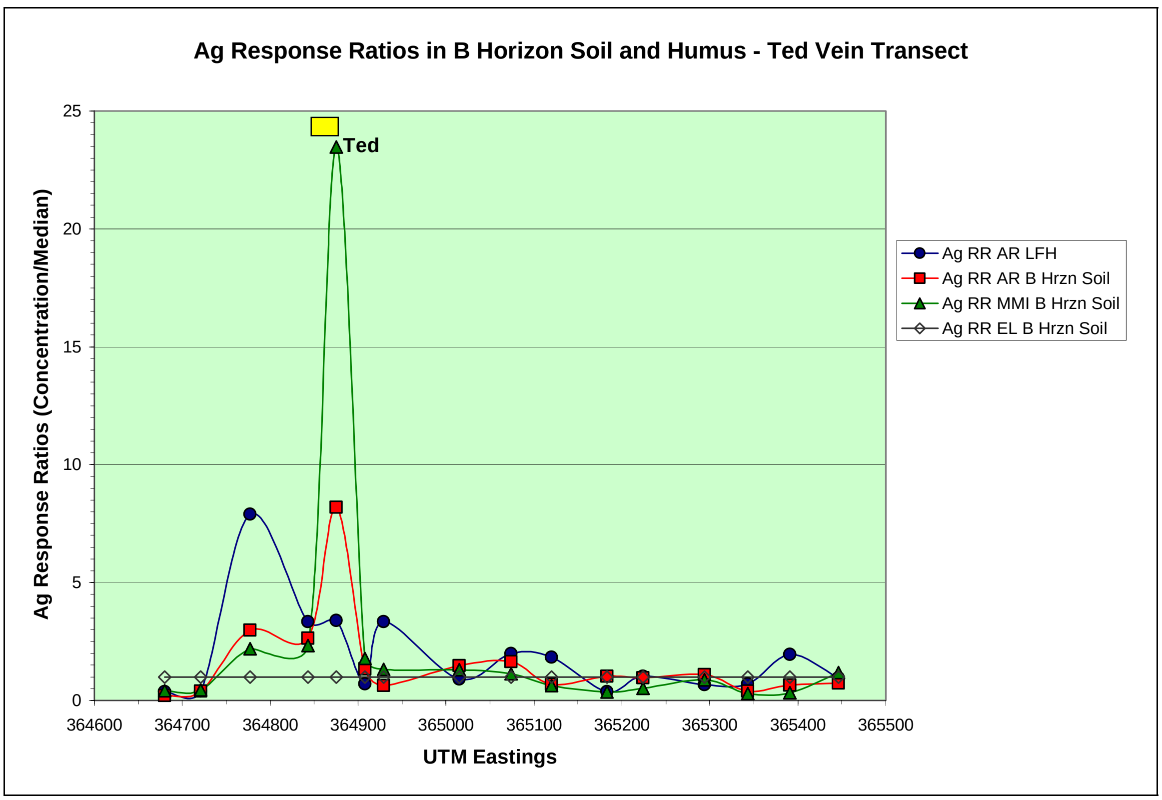
Figure 169. Distribution of Zn (ppb) by MMI-M in near-surface soils on the combined Tommy and Ted orientation transects (N=36 sites).



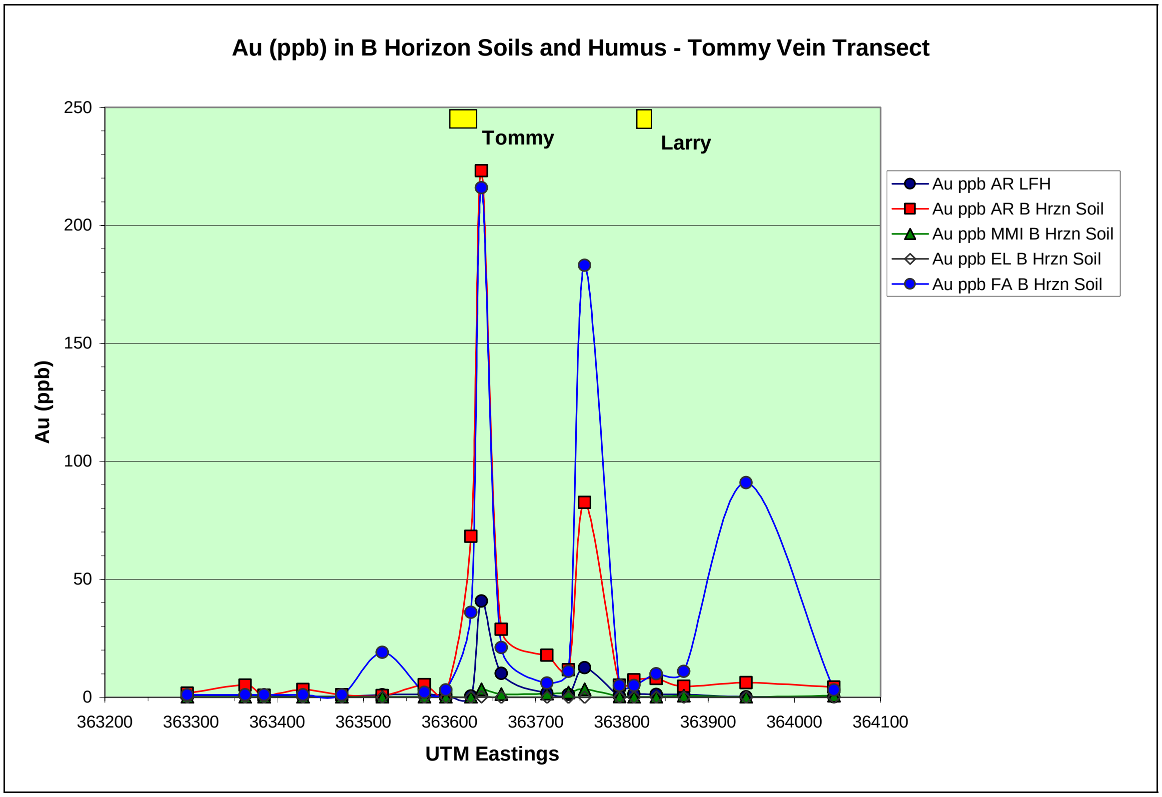


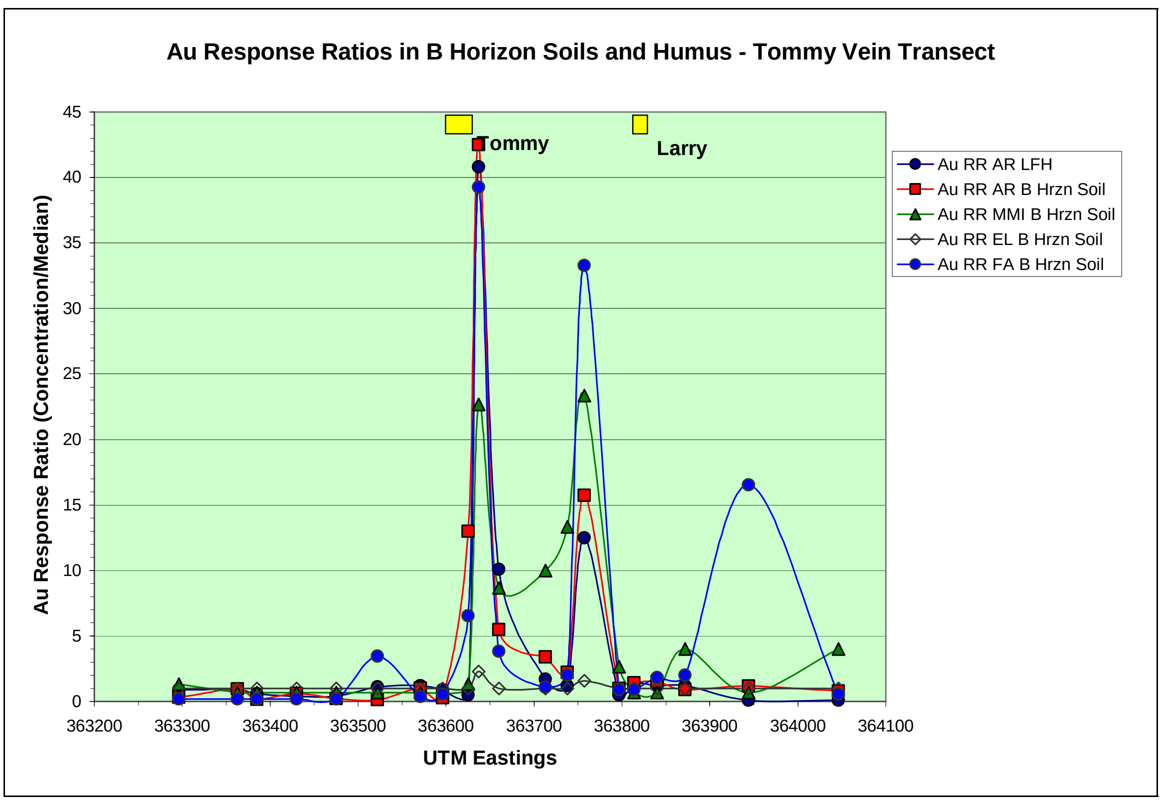
Figures 170 and 171. *Ag concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



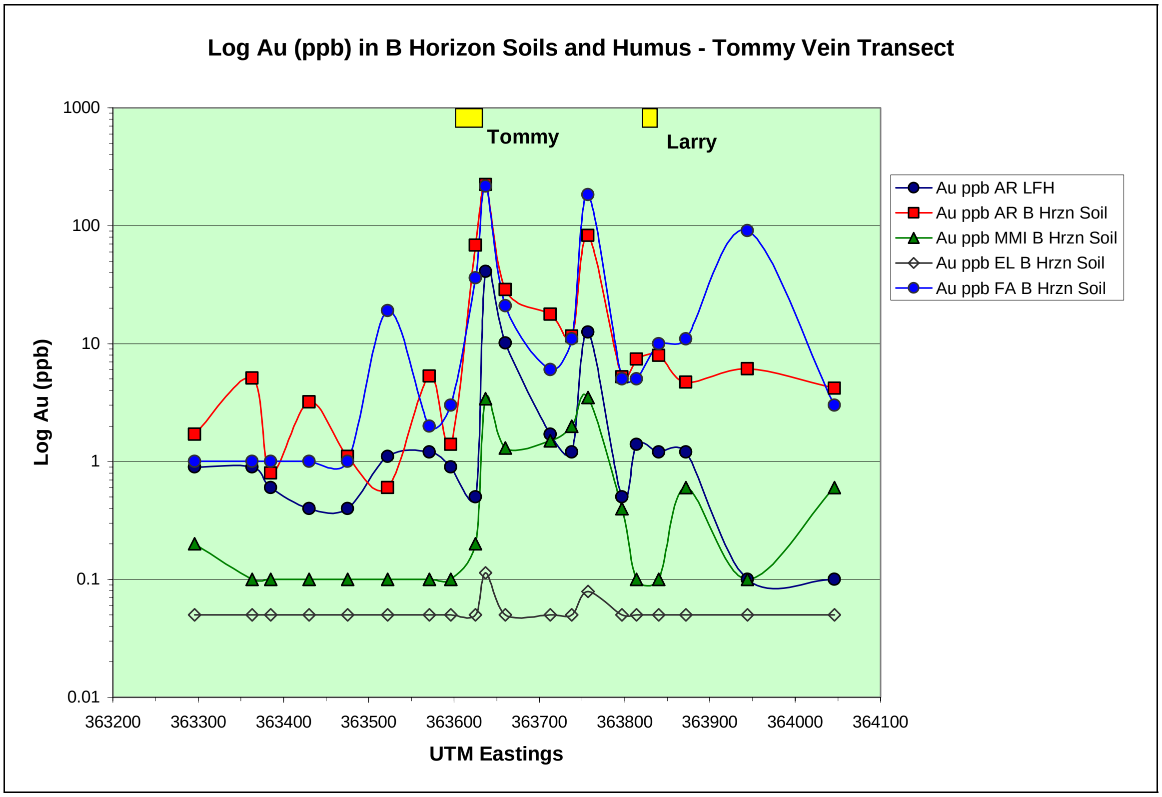


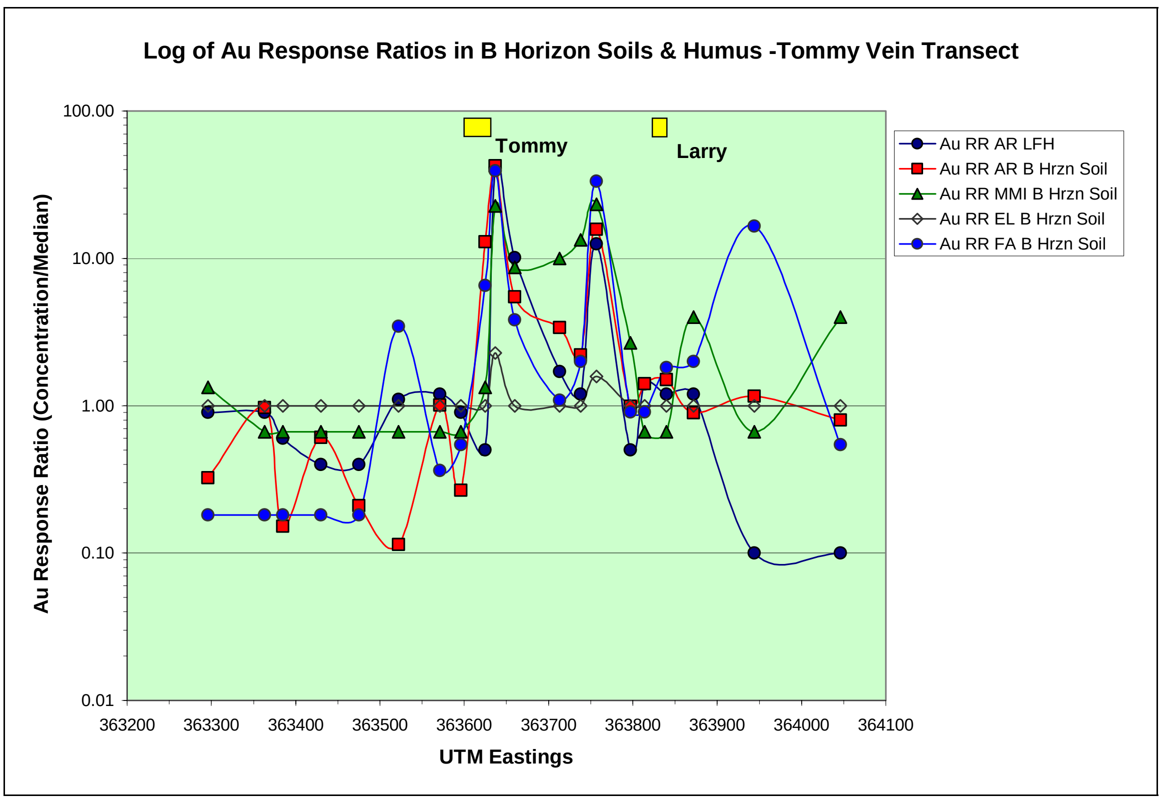
Figures 172 and 173. *Ag concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



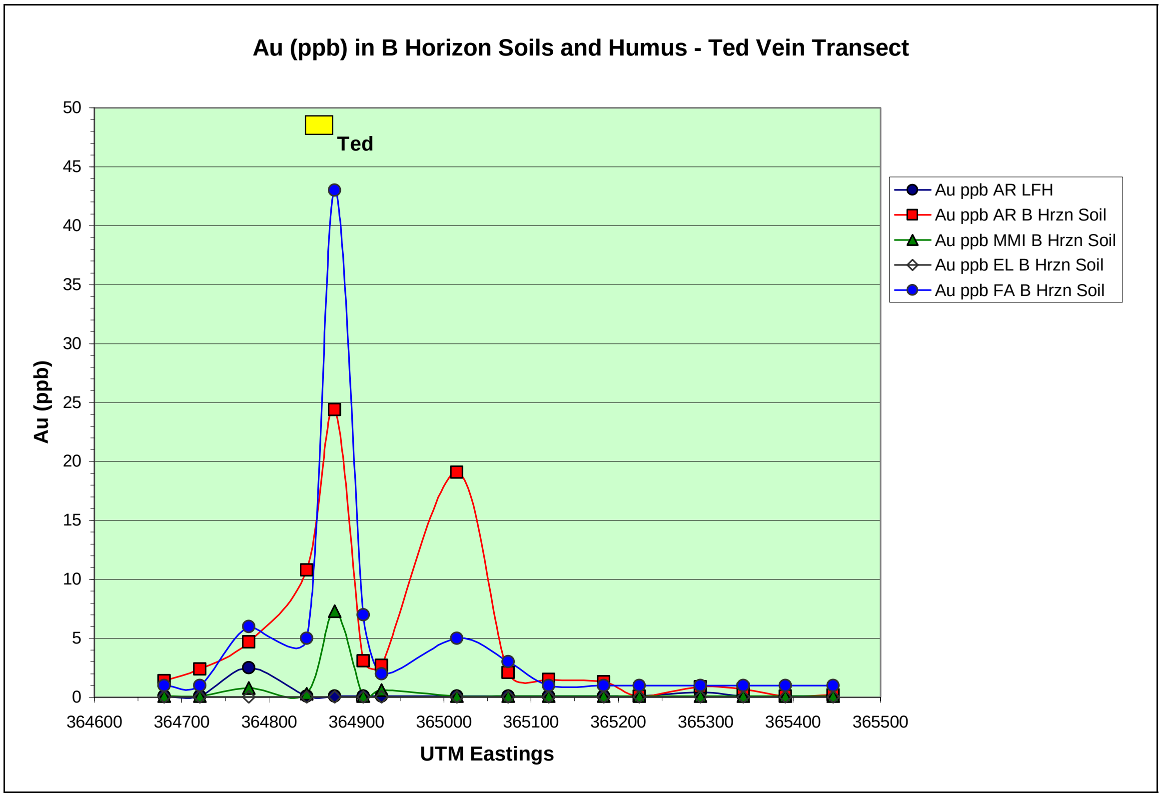


Figures 174 and 175. *Au concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of fire assay, aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*





Figures 176 and 177. *Log Au concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of fire assay, aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



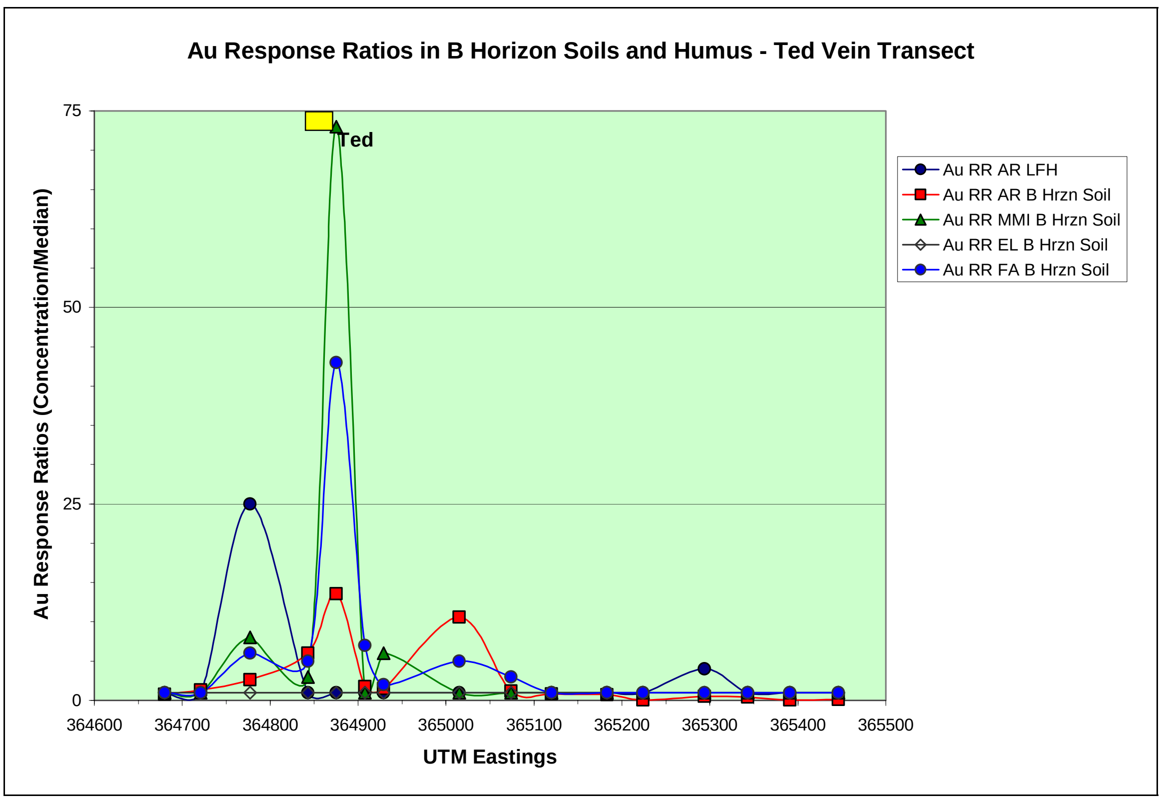
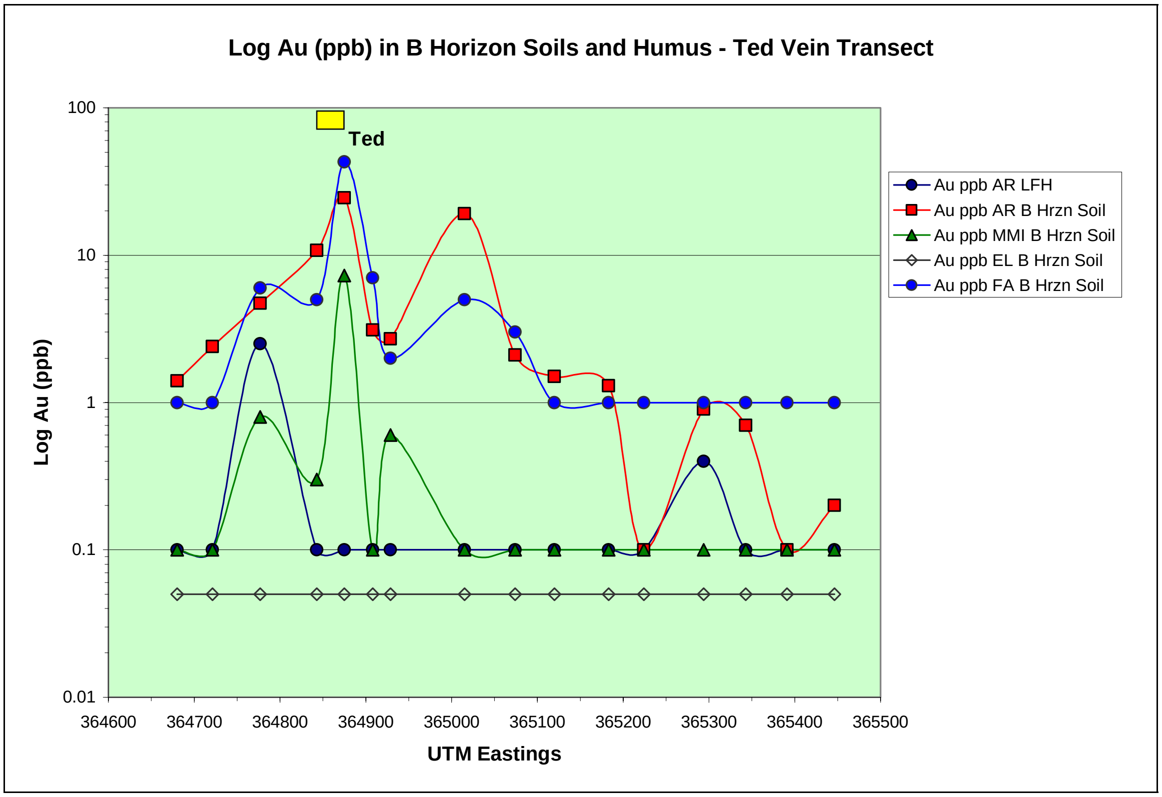


Figure 178 and 179. *Au concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by fire assay, aqua regia digestion, MMI-M and Enzyme Leach methods on the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



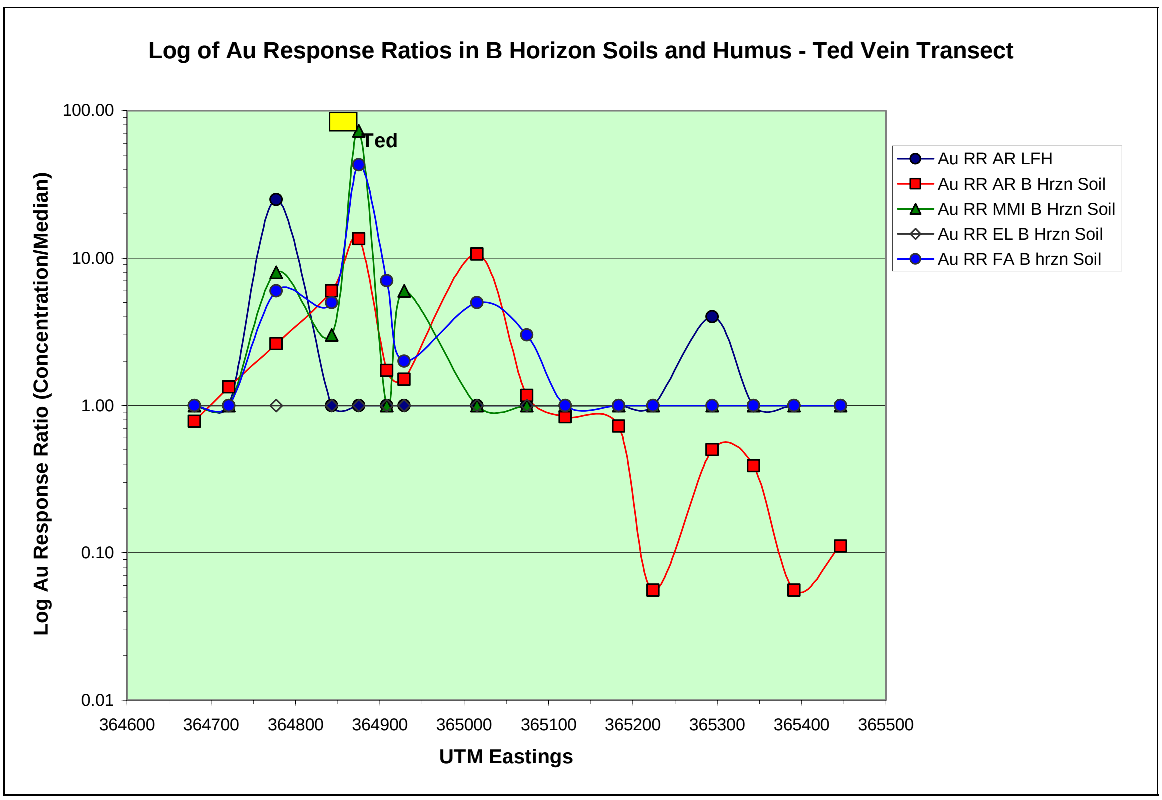
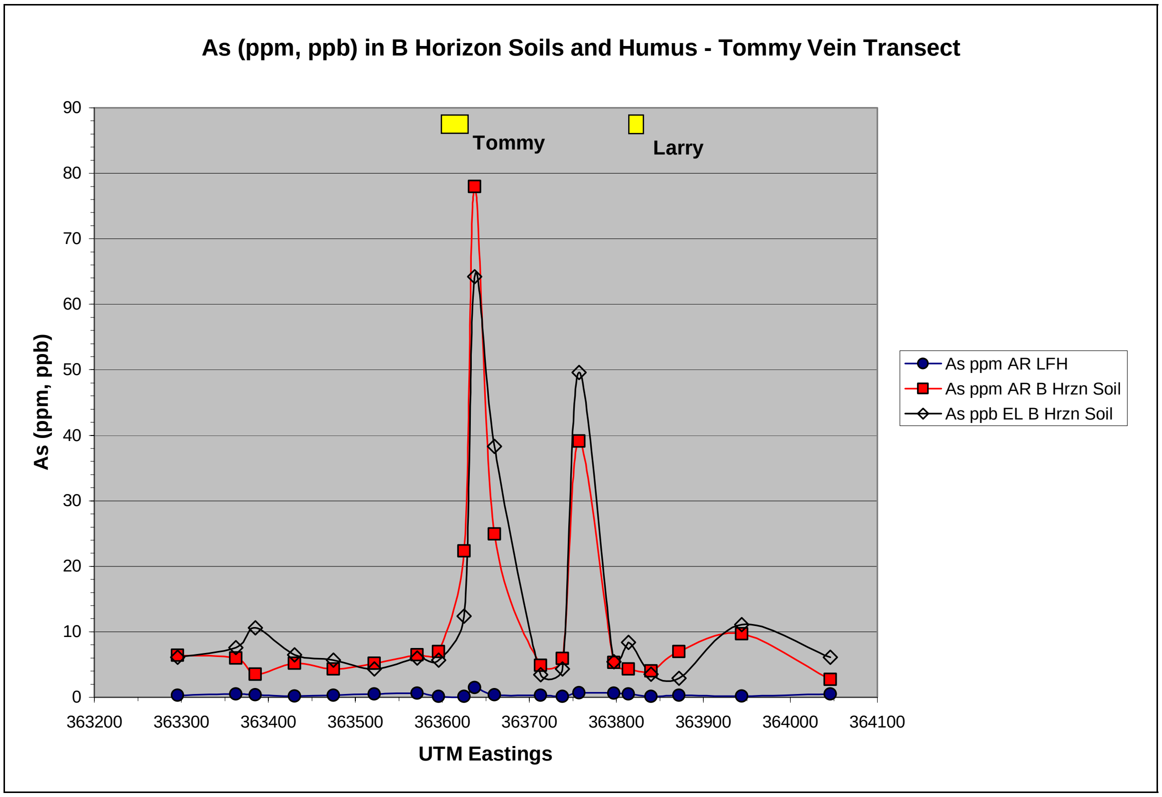
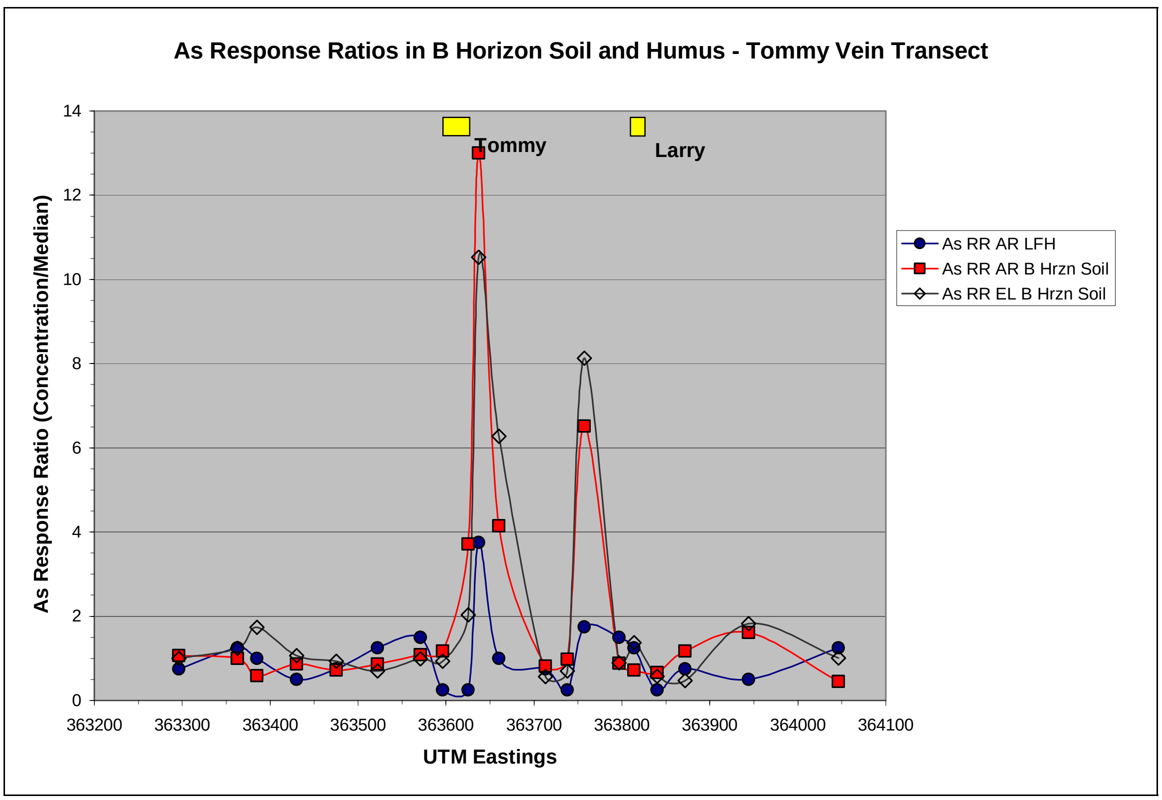
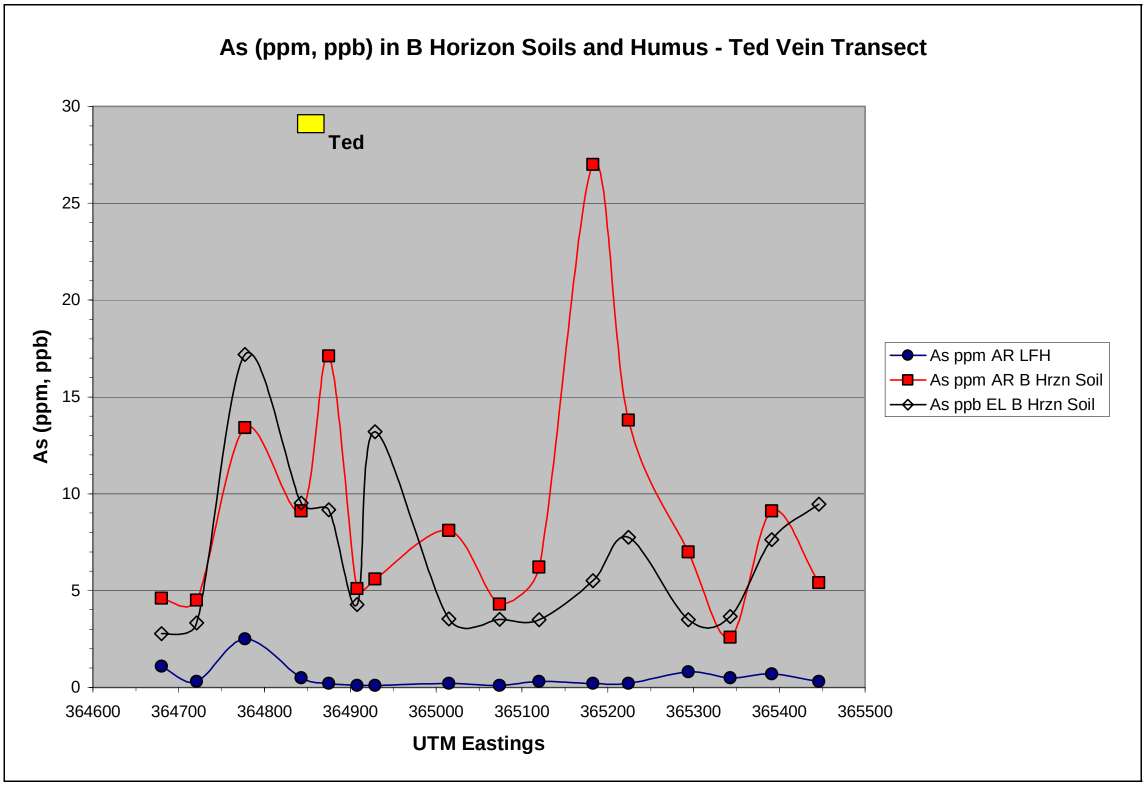


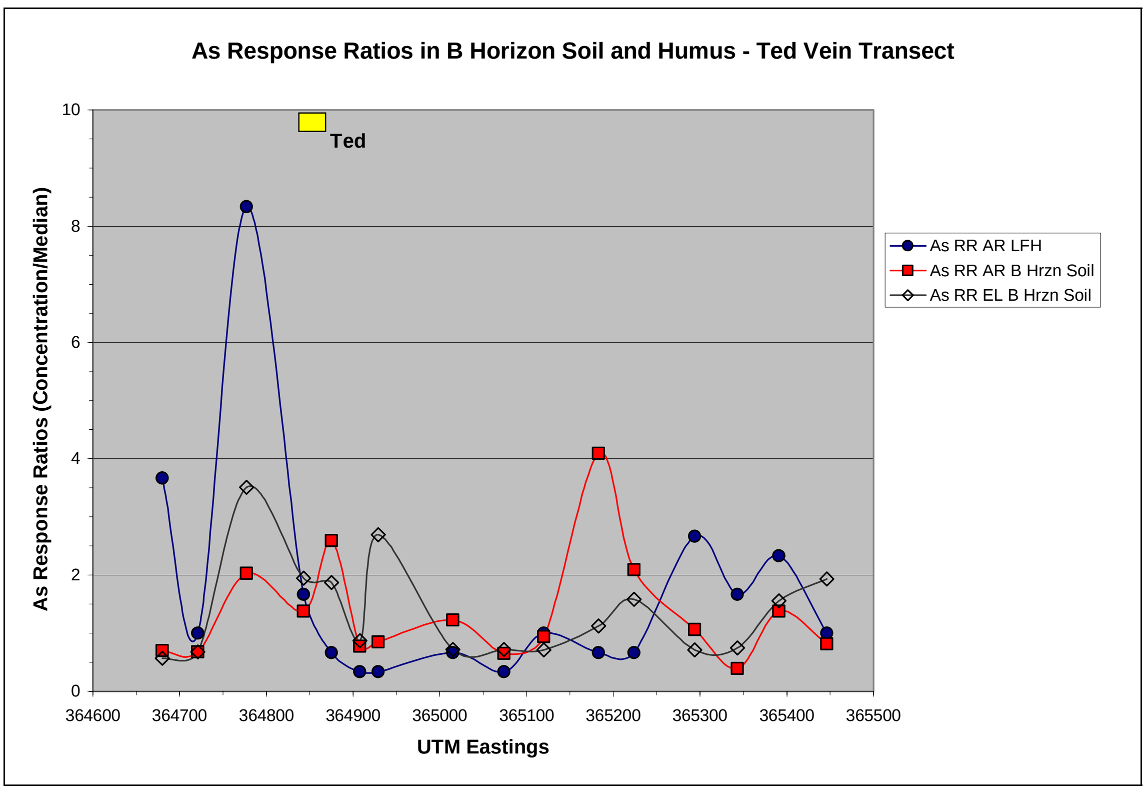
Figure 180 and 181. *Log Au concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by fire assay, aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



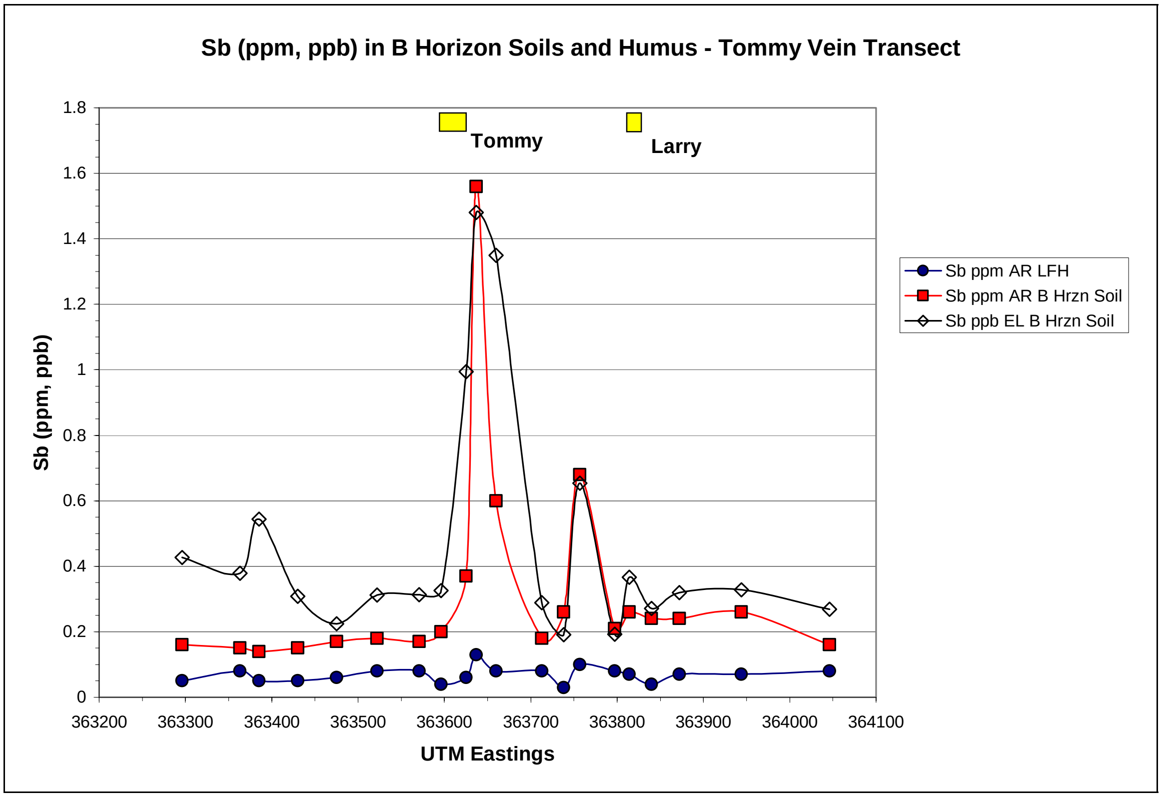


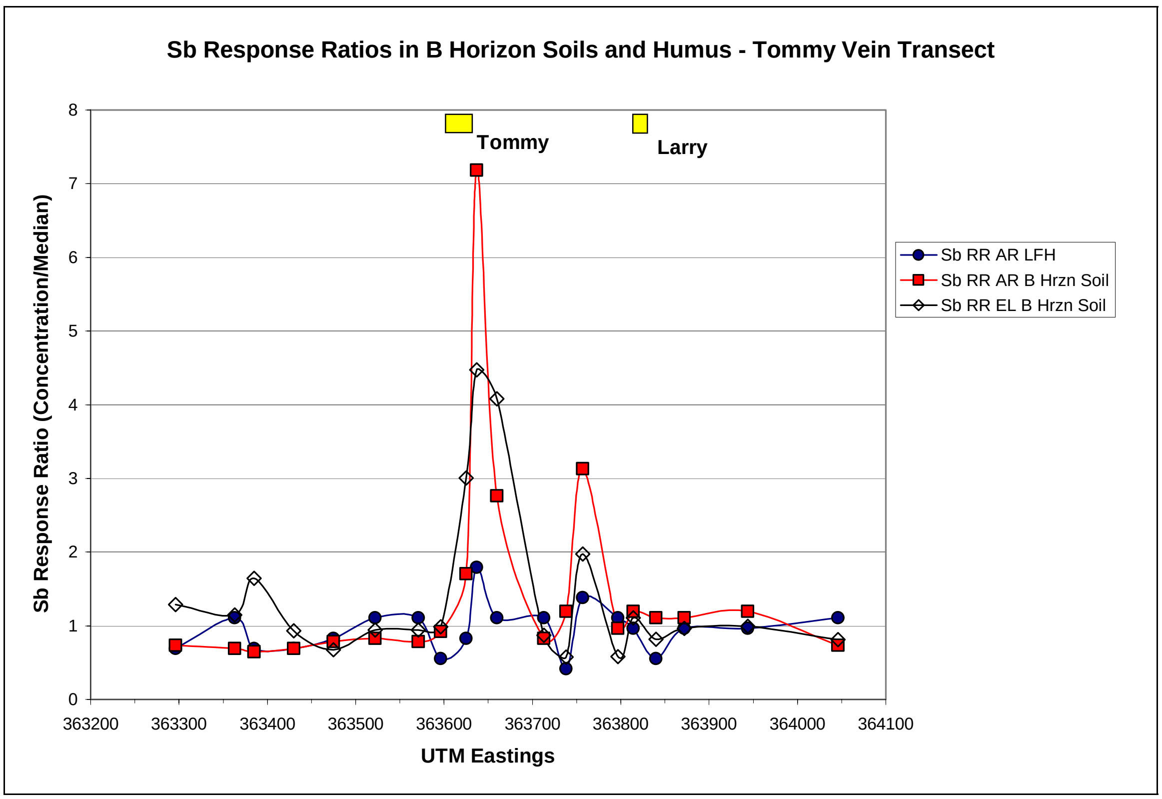
Figures 182 and 183. *As concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



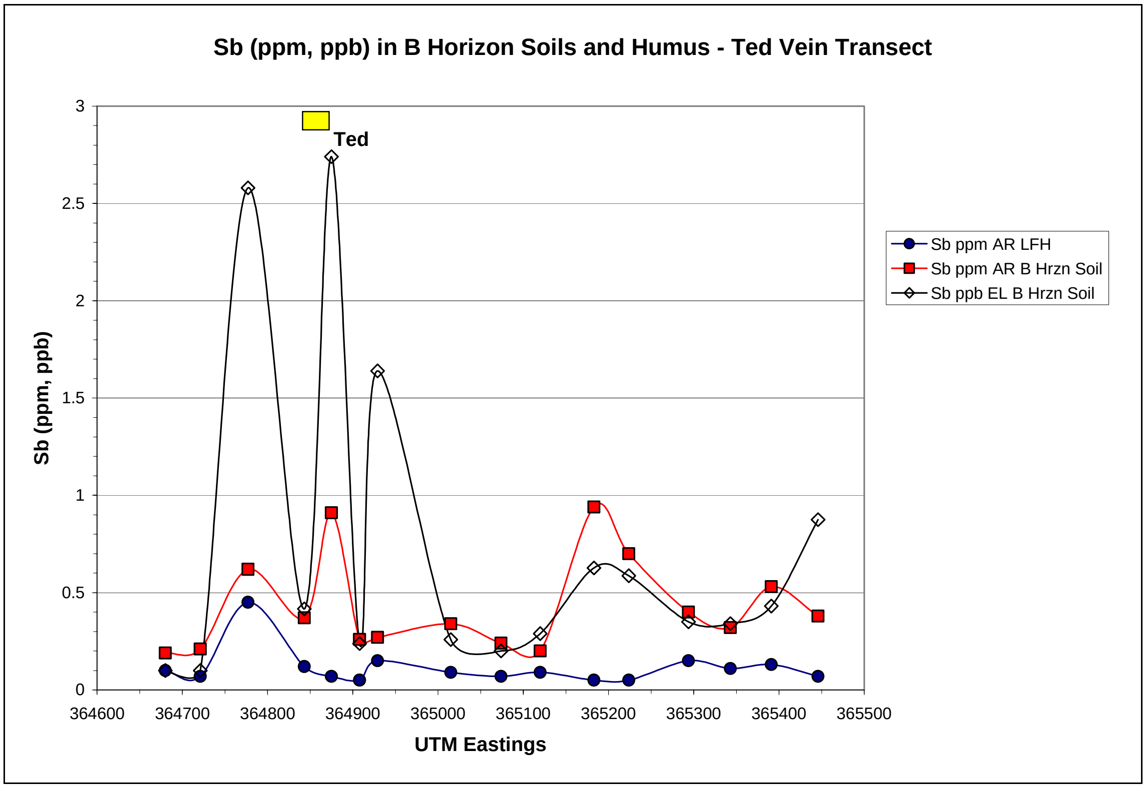


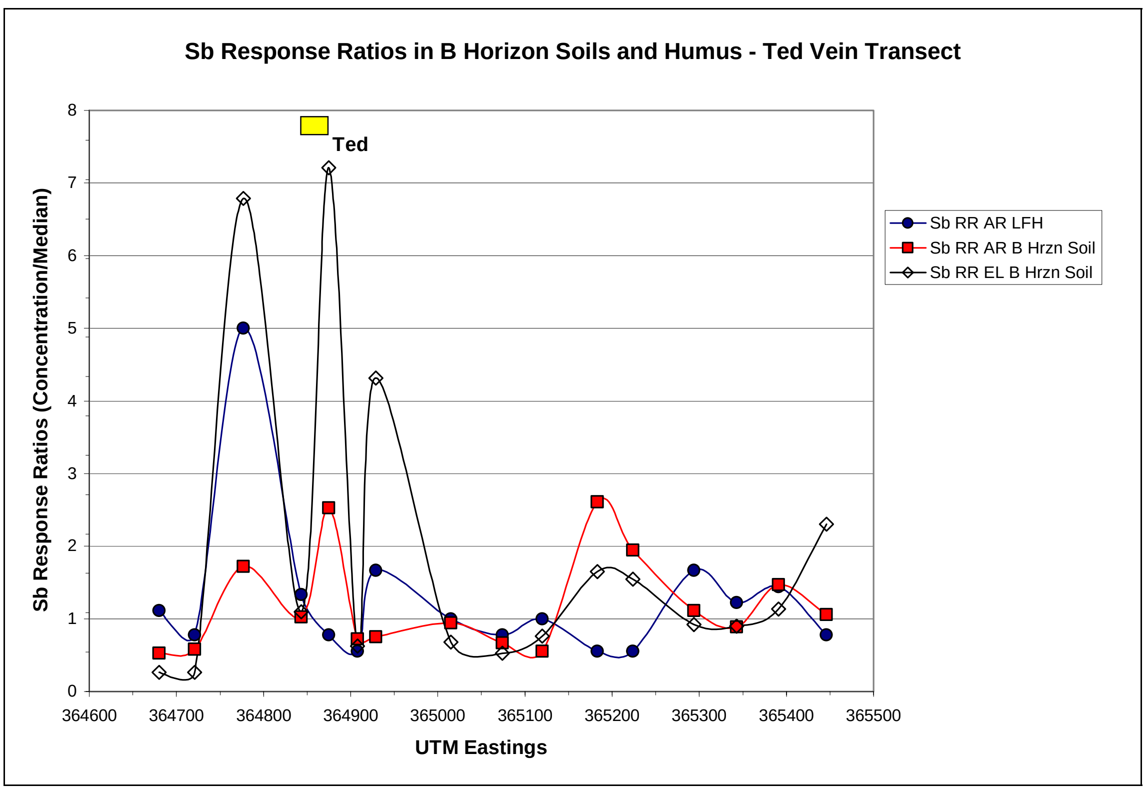
Figures 184 and 185. *As concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



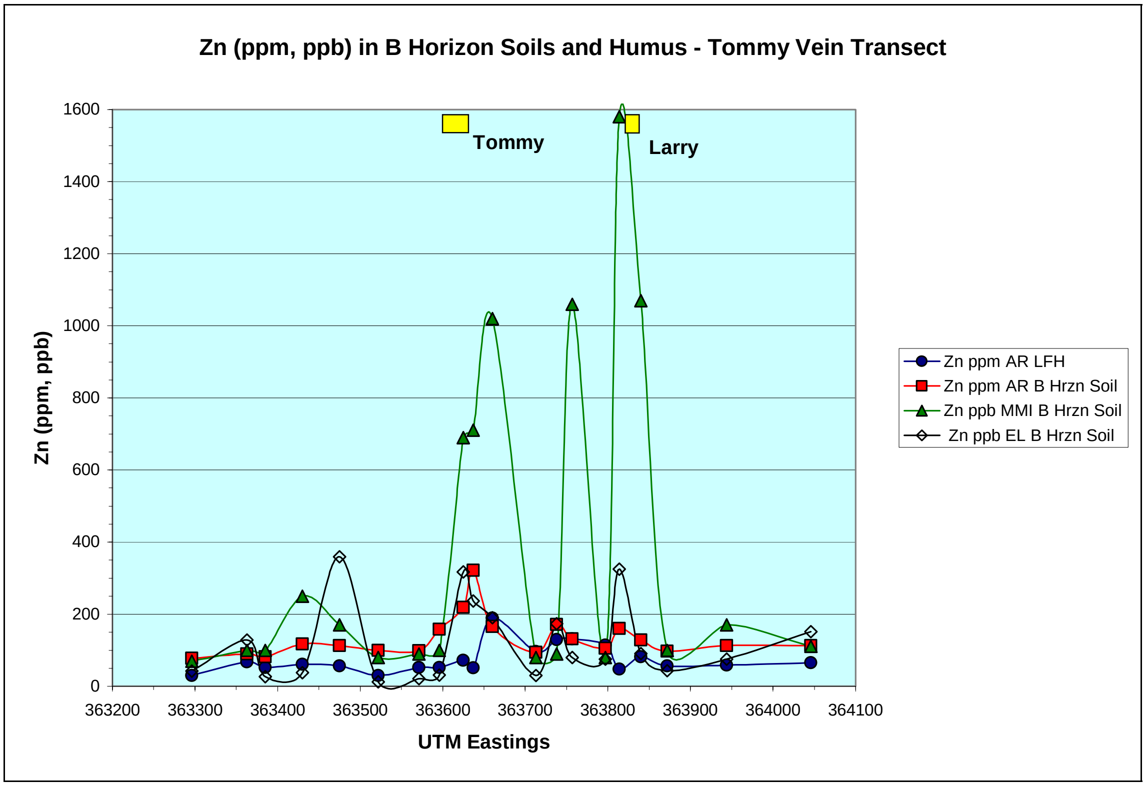


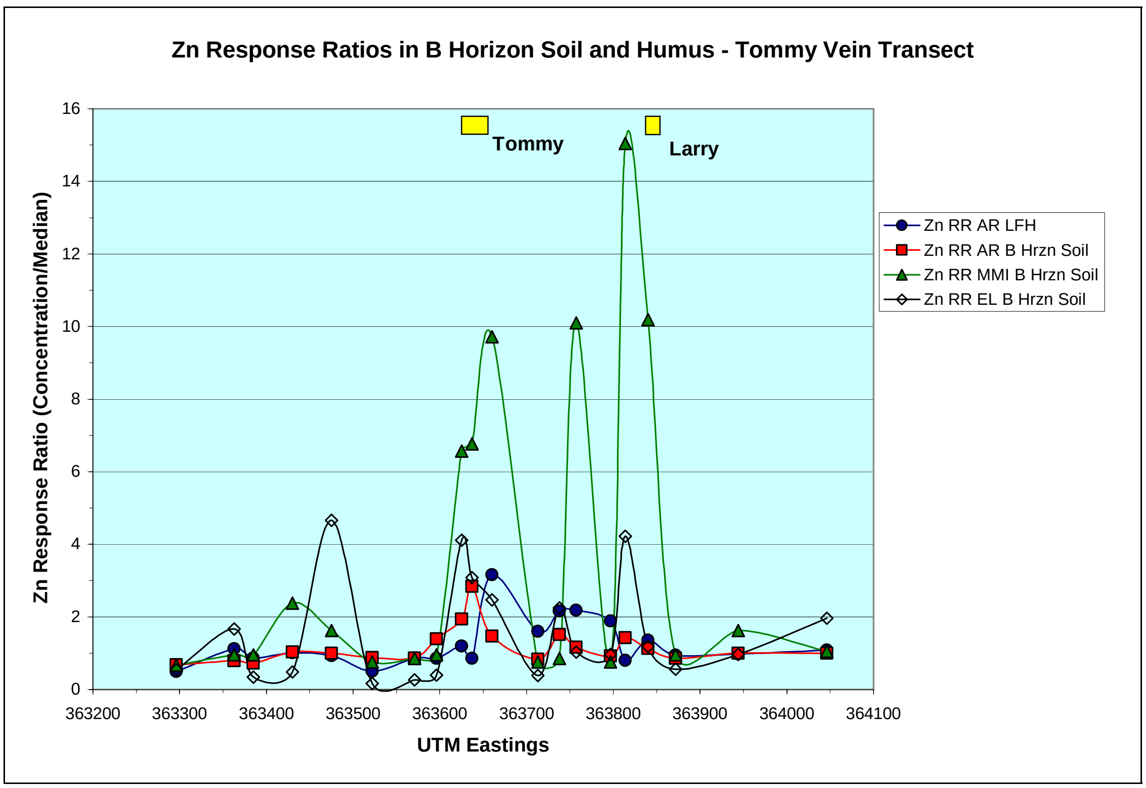
Figures 186 and 187. *Sb concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



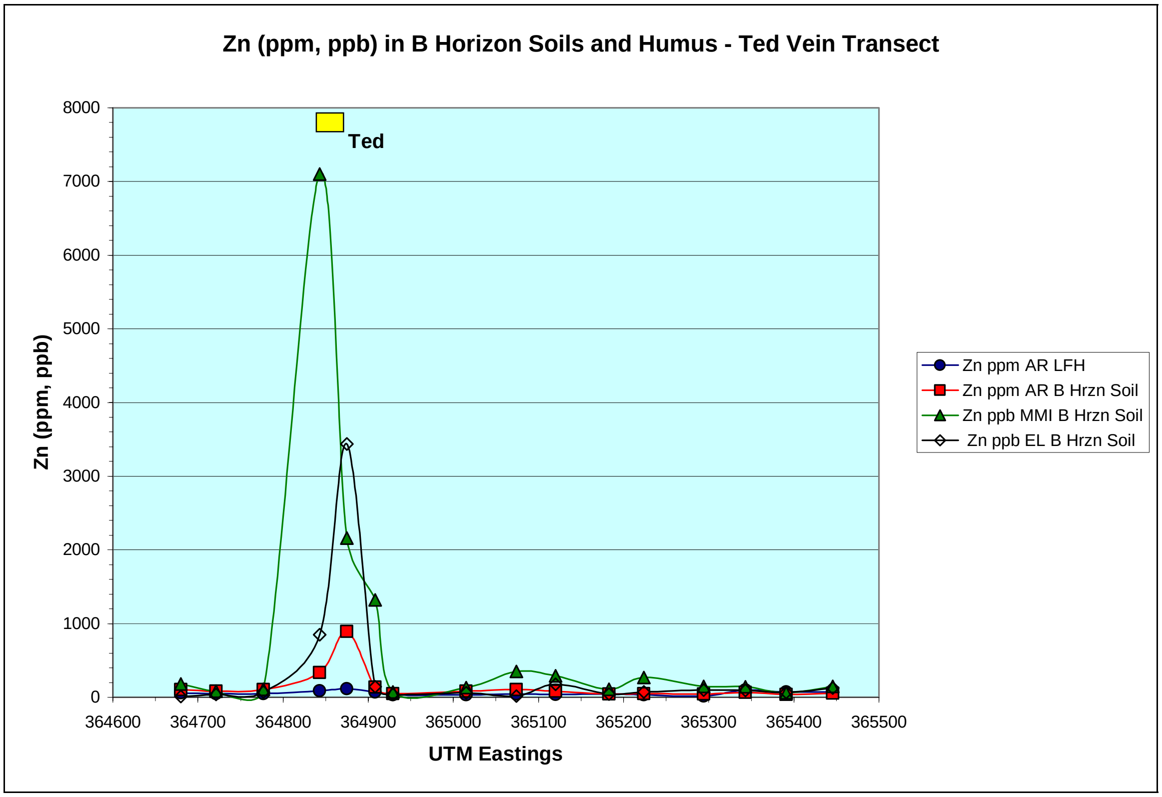


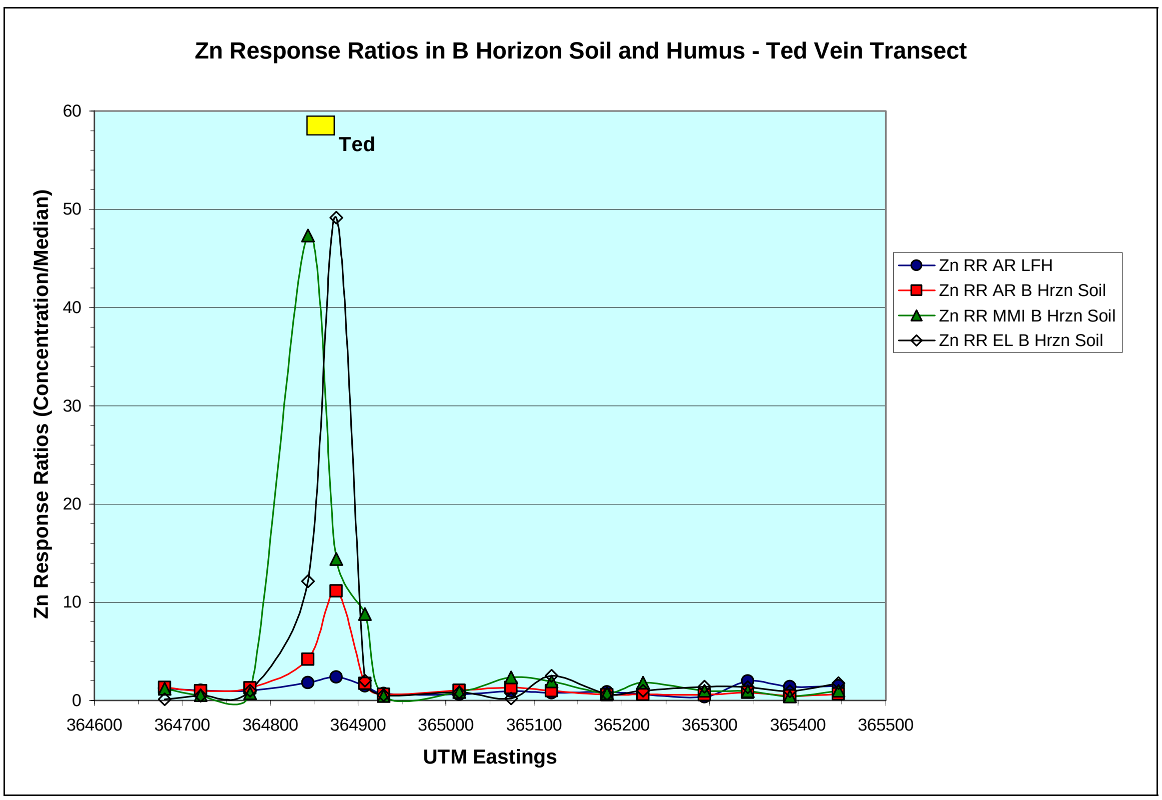
Figures 188 and 189. *Sb concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



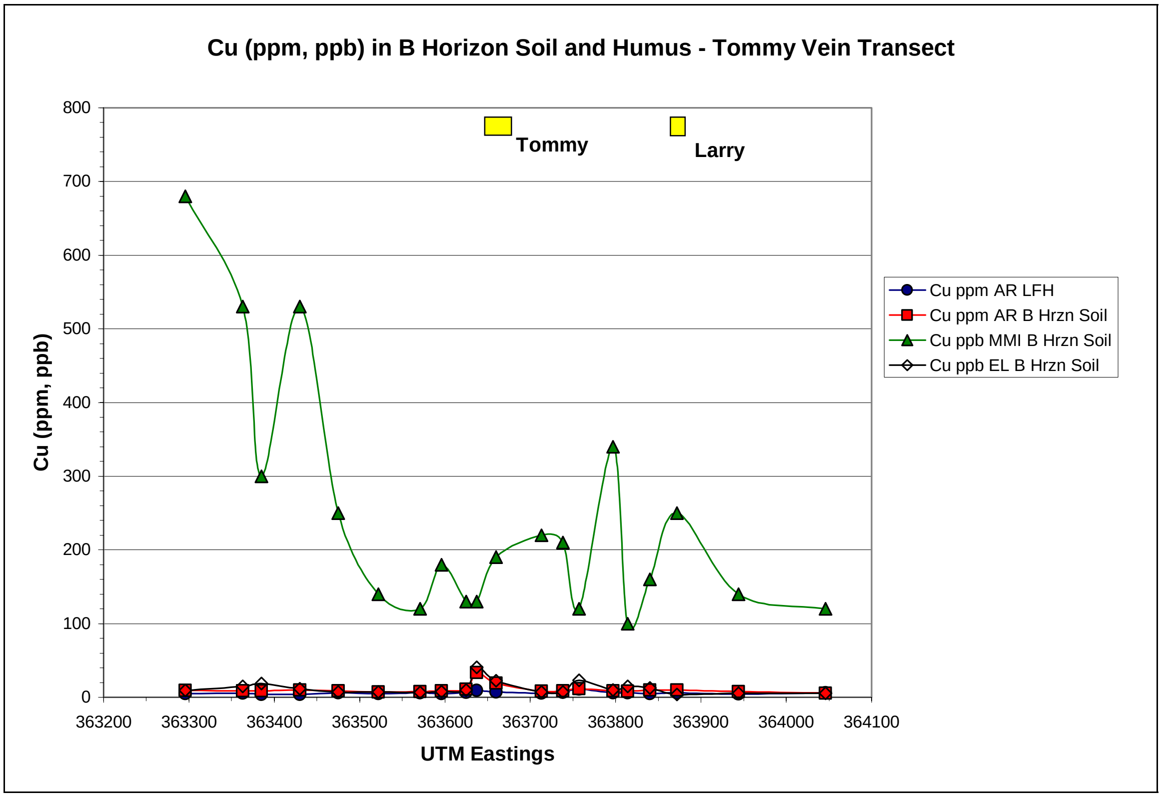


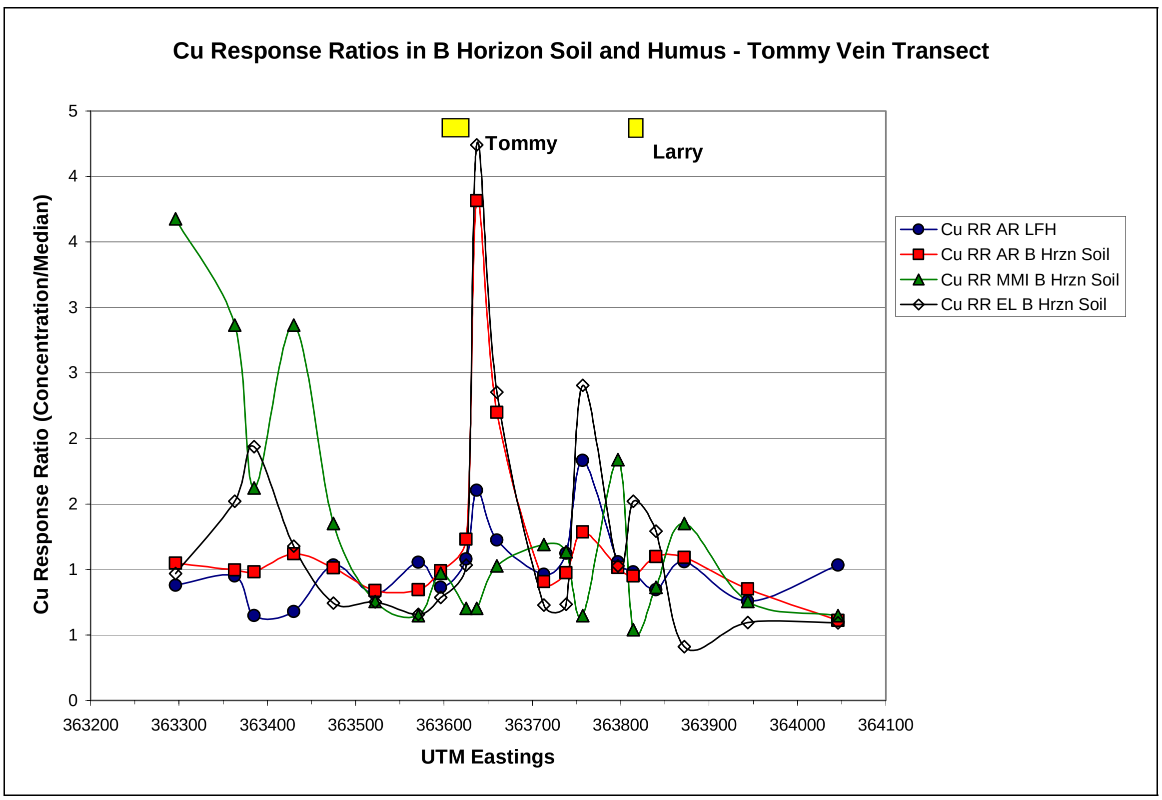
Figures 190 and 191. *Zn concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



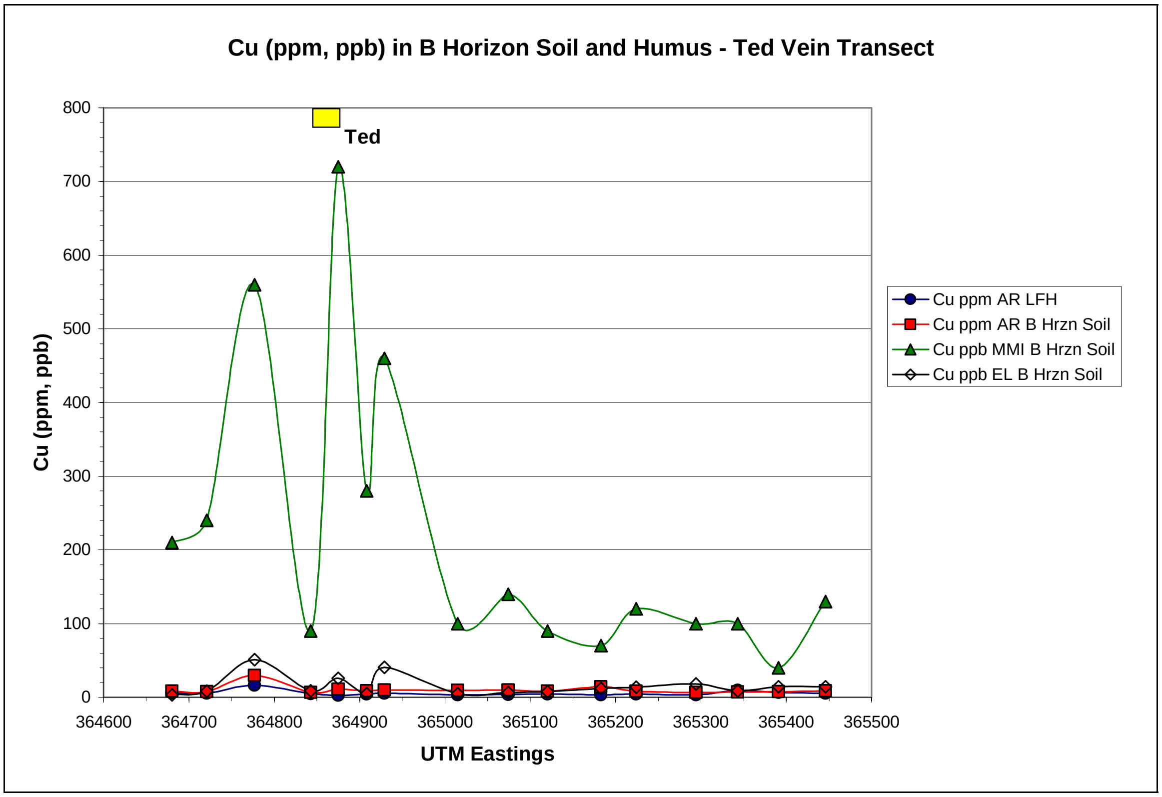


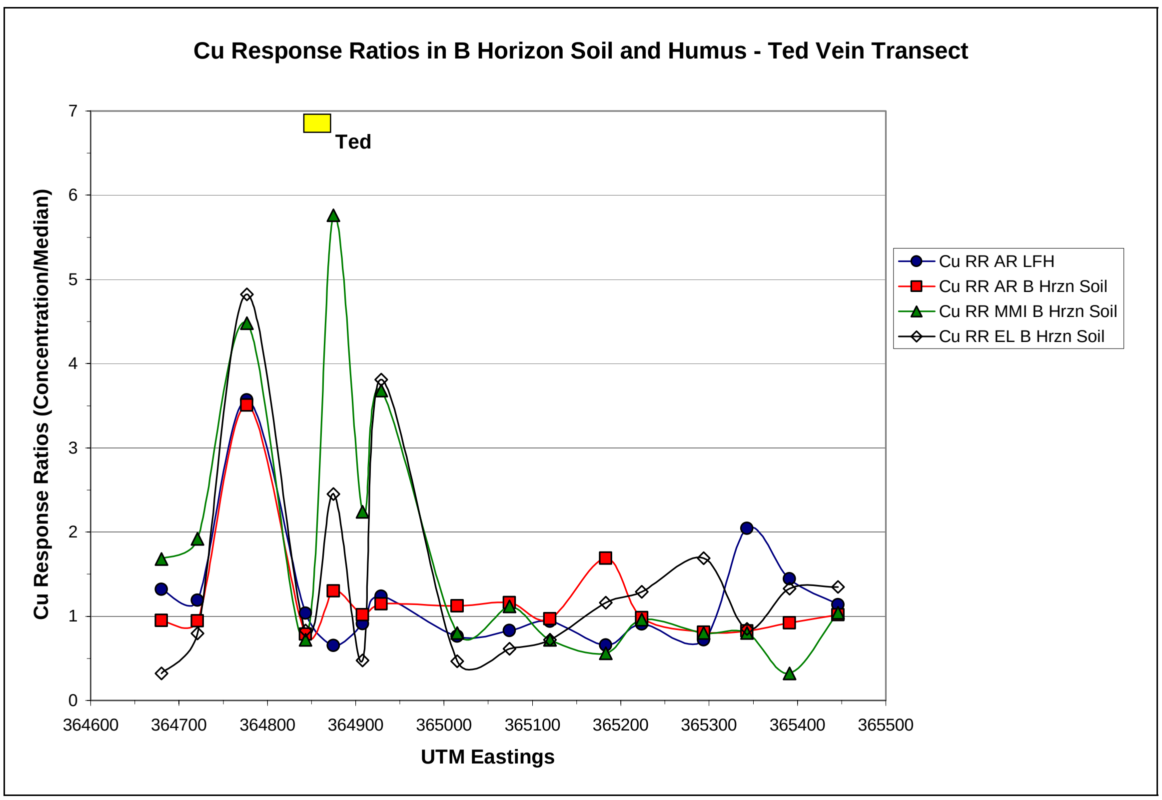
Figures 192 and 193. *Zn concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



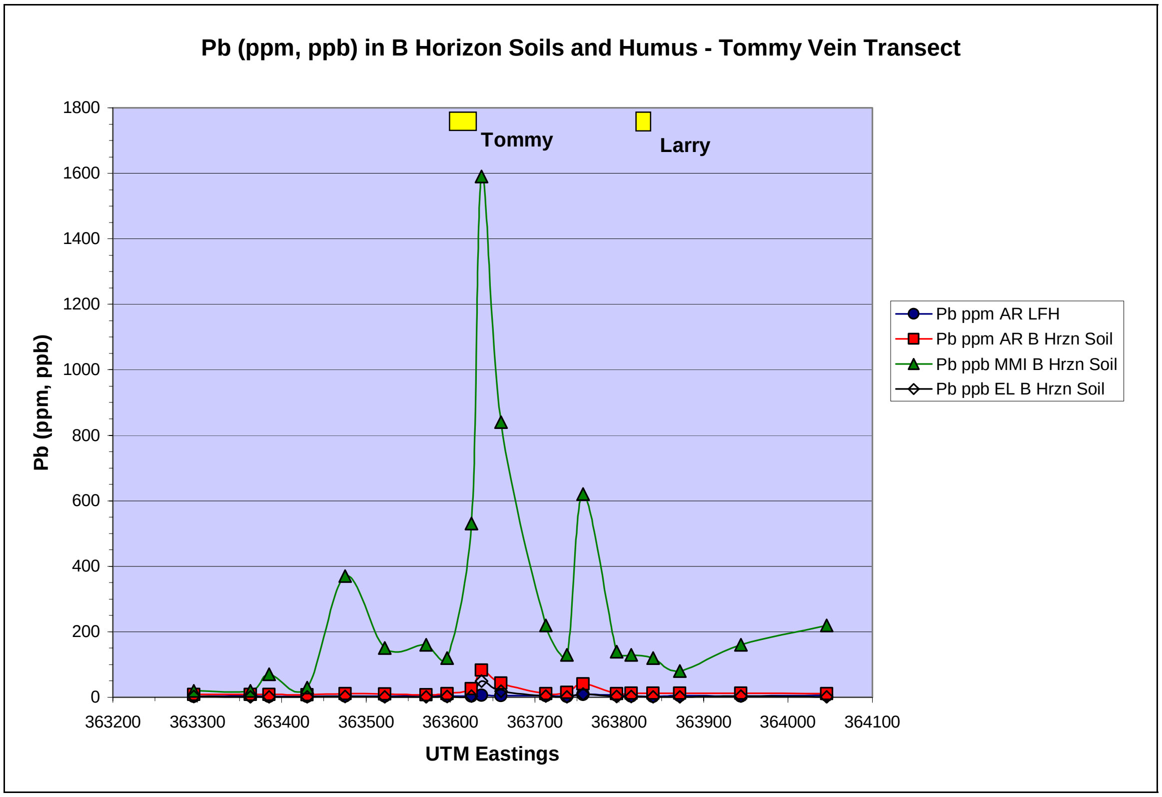


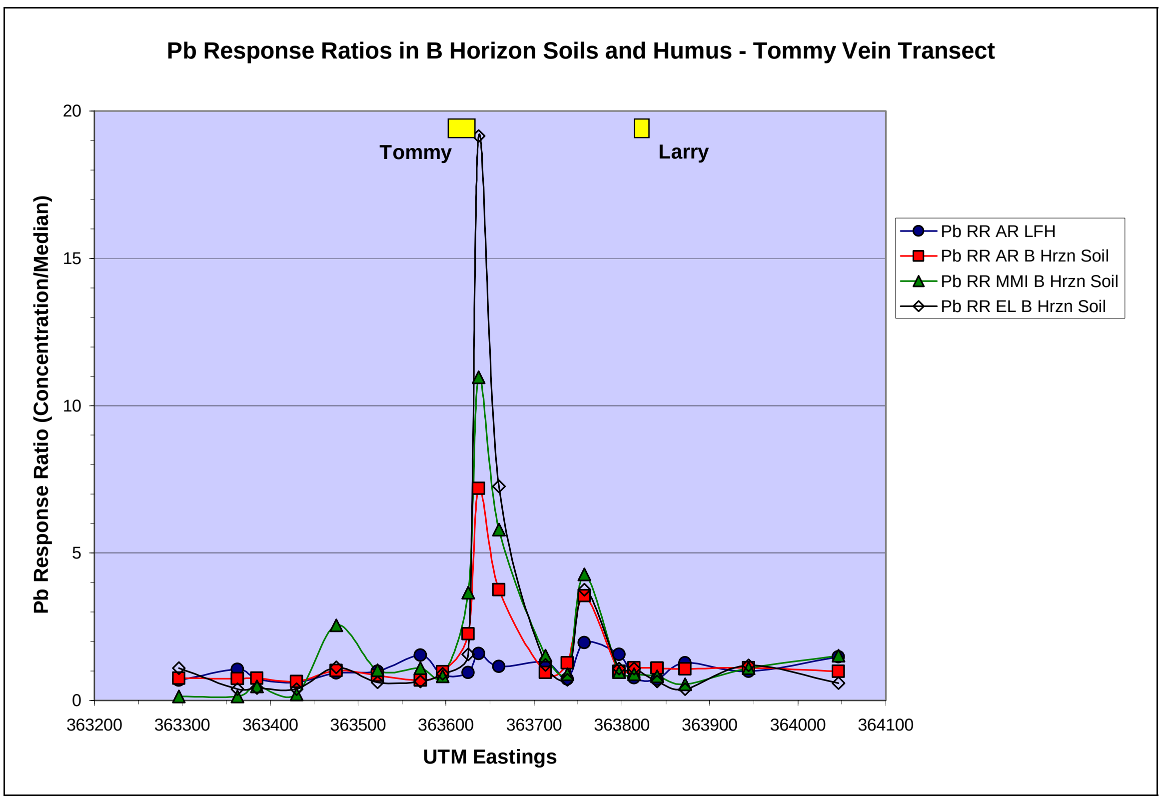
Figures 194 and 195. *Cu concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



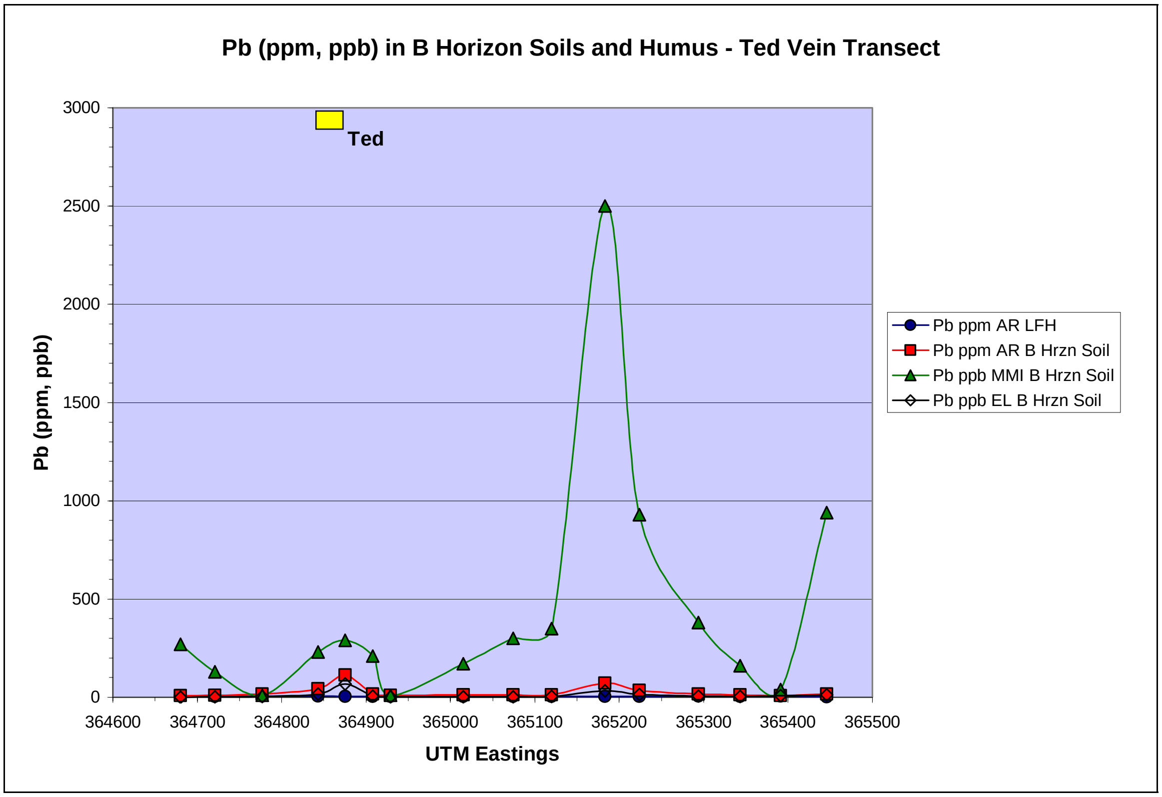


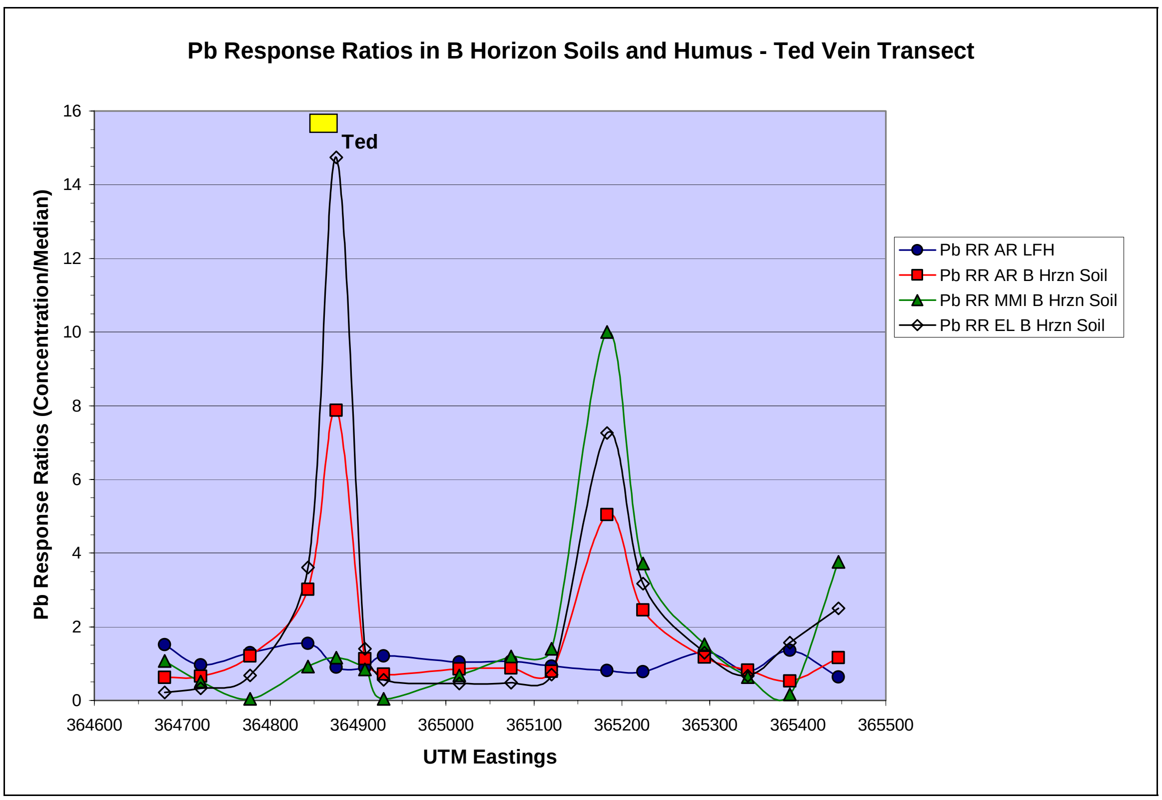
Figures 196 and 197. *Cu concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*



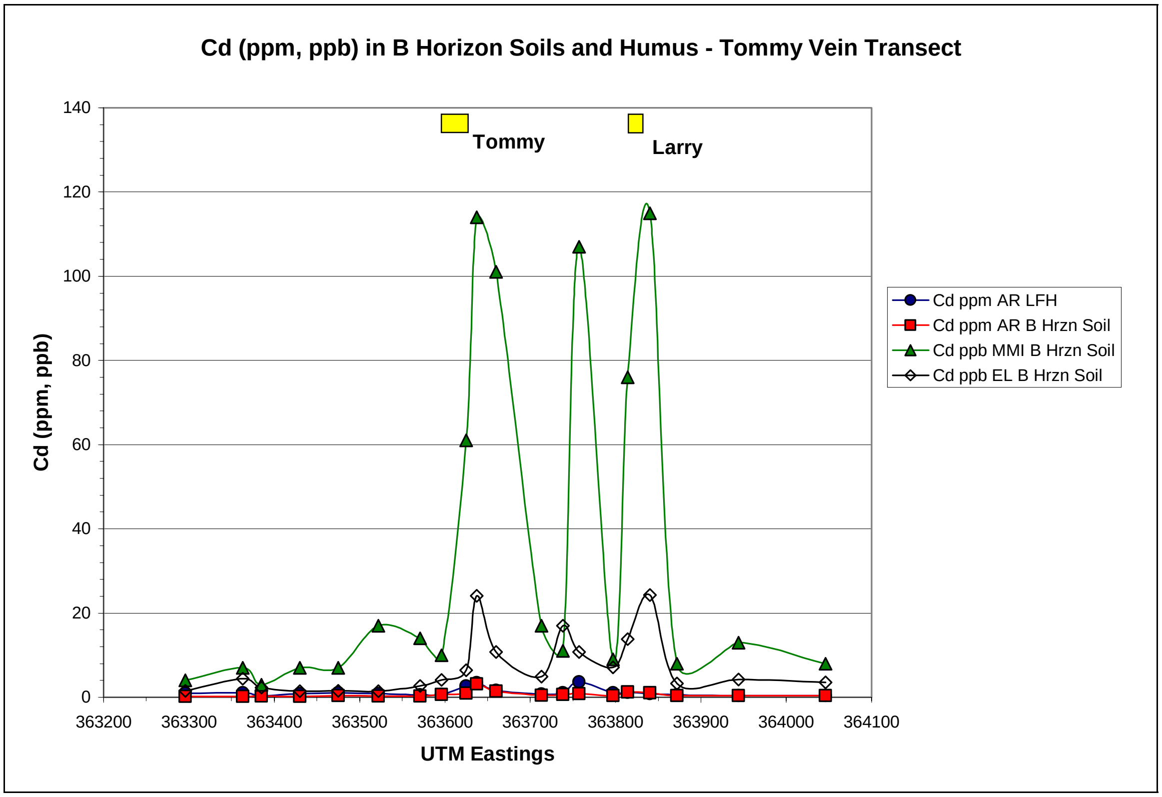


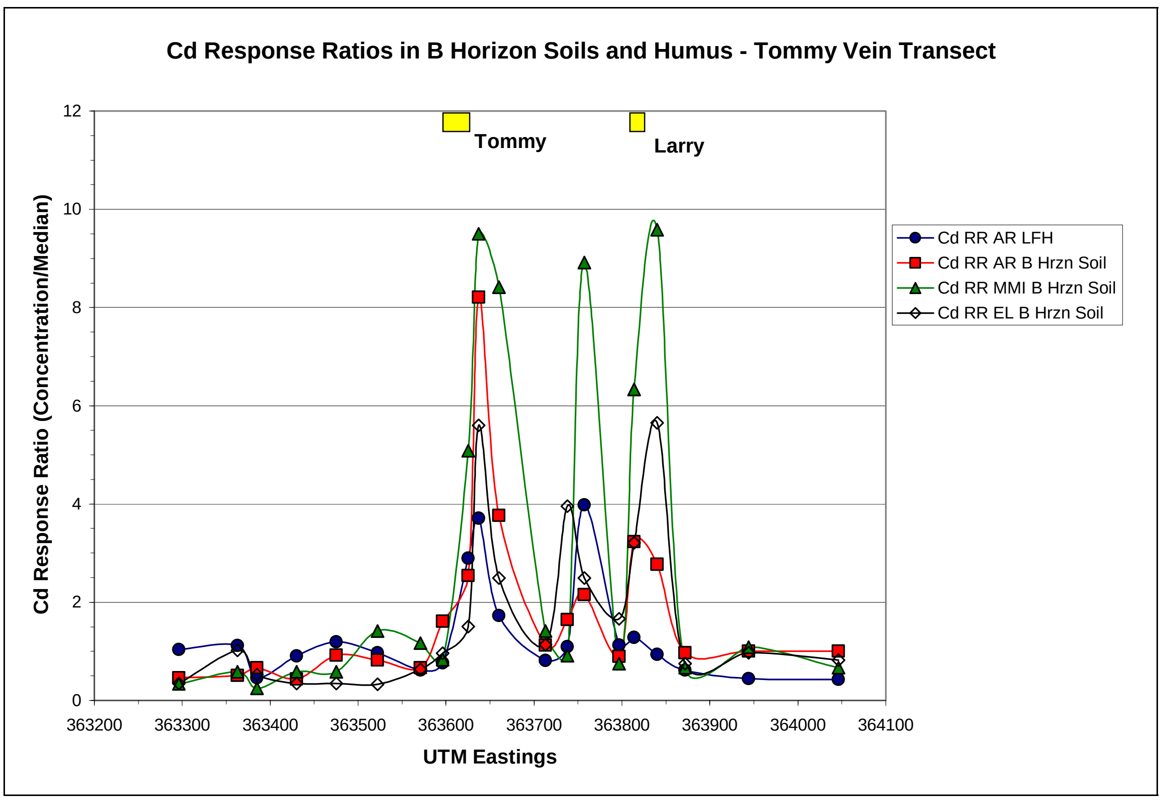
Figures 198 and 199. *Pb concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein orientation transect. Aqua regia results for LFH horizon humus also shown for comparative purposes.*



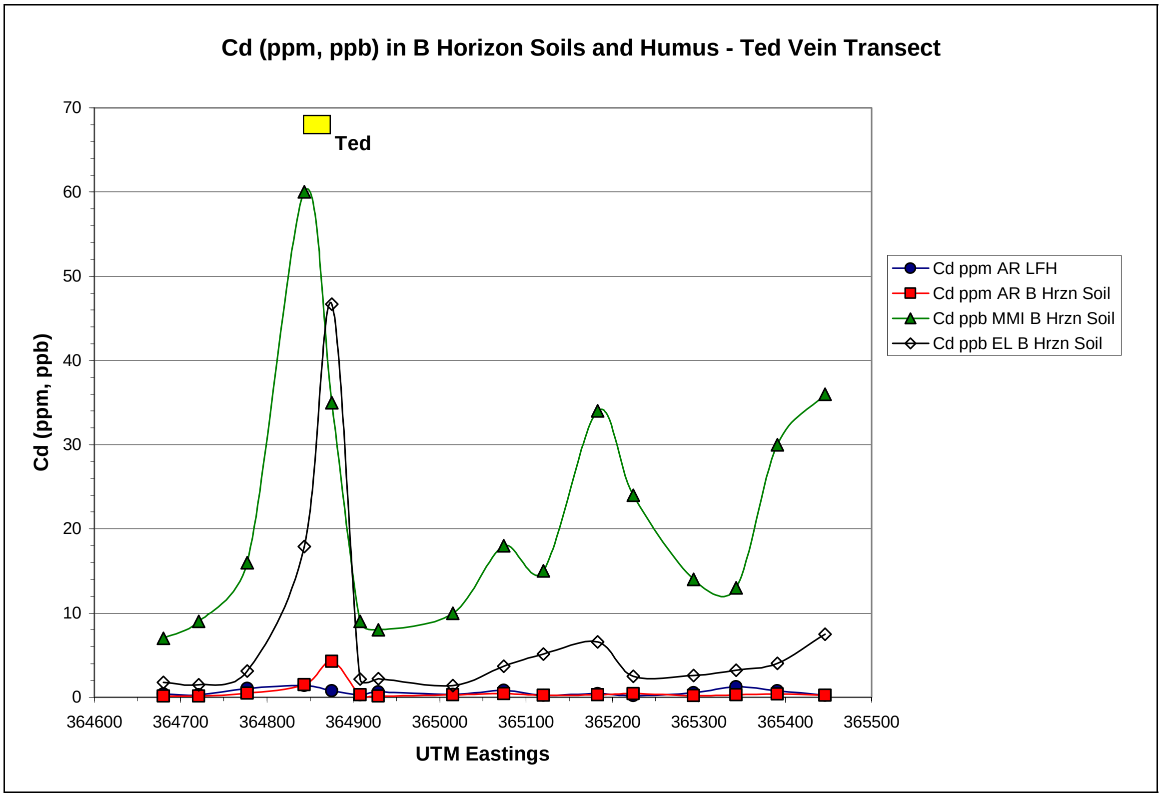


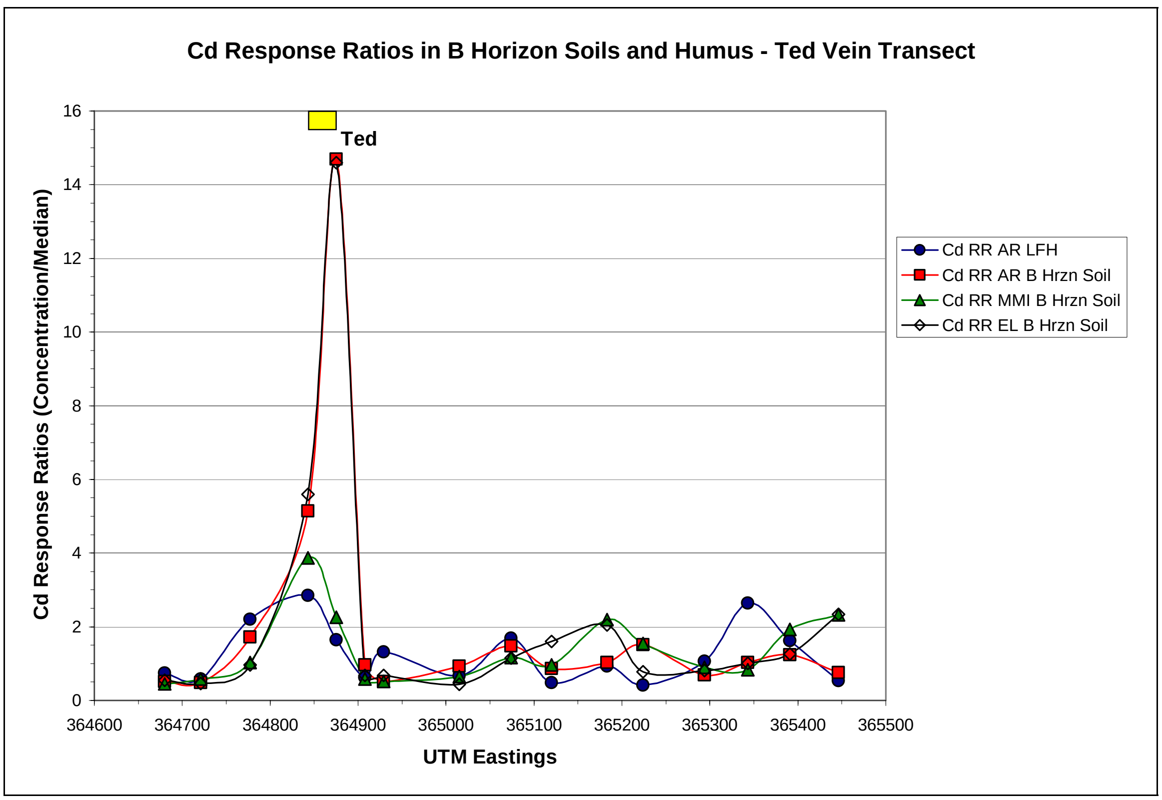
Figures 200 and 201. *Pb concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*





Figures 202 and 203. *Cd concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Tommy vein transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*





Figures 204 and 205. *Cd concentrations (top) and calculated response ratios (bottom) in near-surface B horizon mineral soils by each of aqua regia digestion, MMI-M and Enzyme Leach methods along the Ted vein orientation transect. Aqua regia results for LFH horizon humus are also shown for comparative purposes.*

e) Enzyme Leach (EL) Results in B Horizon Soils

Summary statistics for 45 elements determined by the Enhanced Enzyme Leach (EL) procedure in B horizon mineral soils are shown for combined lines results, and for both individual Tommy vein and Ted vein transect results (Table 15).

In all, 45 of the 61 elements reported by Activation Laboratories Ltd. in the EL analytical suite are considered here and presented in the digital data files accompanying this report. A total of 16 elements (Se, Te, W, Re, Hg, Ge, Ag, In, Sn, Cr, Ta, Sc, Ru, Pd, Os and Pt) were removed from the dataset, as all or most of the results for this group were reported as less than the stated analytical detection limits. For example, Ag results for every sample were less than the stated analytical detection limit of 0.2 ppb, and all but two Se determinations were less than the 5 ppb analytical detection limit. In addition, results for several additional elements, including Au, Bi, Tm, Lu and Li, are predominantly less than the stated analytical detection limits, but are retained here. In these and other cases where data reports as less than stated detection limits, the data are presented as a value equal to the detection limit for all elements, including Au.

Geochemical plot maps showing percentile element distributions are provided here for two elements, Pb (Figure 206) and Sb (Figure 207), which show positive EL responses over Tommy and Ted vein Au mineralizations in B horizon soils. Enhanced Enzyme Leach (EL) transect plots for each of the Tommy and Ted vein orientation transects are not shown here, but are instead shown in later sections (Sections j and k, respectively), showing comparative results and calculated response ratios for 1) Au and Ag determined by several methods including aqua regia digestion, MMI-M, Enzyme Leach and, in the case of Au, lead-collection fire assay (Figures 170 to 181), and 2) other selected elements, notably pathfinder elements and base metals of economic interest (Figures 182 to 205).

Enzyme Leach (EL) does not claim to extract more than small traces of Ag and Au with the weak leach method, and therefore generates lower contrast ratios of these elements than by the other analytical methods tested. For example, the Au response by EL in Tommy vein soils, while present, is subdued relative to response ratios of other methods, and there is no significant Au response at the Ted vein. Furthermore, the usefulness of precious metals obtained by the EL suite is hampered for this deposit type by the relatively high analytical detection limits available for Ag; at neither vein does EL Ag in soil results exceed the stated analytical detection limits. Enzyme Leach results are much stronger; however, for several economically important base metals and precious metal pathfinder elements in 3Ts soils. As measured by response ratios, strong As, Sb, Cu, Pb and Cd responses are present in B horizon soils by EL over the Tommy vein, and strong Sb, Zn, Pb and Cd responses are present over Ted vein. Overall, the EL method provides the best geochemical contrast for some of the critical pathfinder elements. Furthermore, given the strong lithological influence of quartz veins in the thin soils of this property, the EL method might, along with the MMI, SGH and SDP methods, prove more useful than AR for detecting more deeply buried deposits in areas of exotic cover where these relict lithological signatures are not present in the near-surface soils.

Table 15-1. *Summary statistics – enzyme leach (EL) results for 3Ts B horizon mineral soils.*

TOMMY LINE	**S.Q. Cl** *(ppb)*	**Br** *(ppb)*	**I** *(ppb)*	**V** *(ppb)*	**As** *(ppb)*	**Mo** *(ppb)*	**Sb** *(ppb)*	**Au** *(ppb)*	**Th** *(ppb)*	**U** *(ppb)*	**Co** *(ppb)*	**Ni** *(ppb)*	**Cu** *(ppb)*	**Zn** *(ppb)*	**Pb** *(ppb)*	**Ga** *(ppb)*	**Cd** *(ppb)*	**Tl** *(ppb)*	**Bi** *(ppb)*	**S.Q. Ti** *(ppb)*	**Y** *(ppb)*	**Zr** *(ppb)*	**Nb** *(ppb)*
Median	**11500**	**58.7**	**33.8**	**49.65**	**6.11**	**3.80**	**0.32**	**0.05**	**1.18**	**0.65**	**51.35**	**18.45**	**9.58**	**76.95**	**2.58**	**3.47**	**4.29**	**0.15**	**0.8**	**732.5**	**7.41**	**33.35**	**2.71**
Mean	13525.00	69.61	37.90	62.83	13.11	5.58	0.48	0.05	2.00	0.80	51.80	22.65	12.23	122.13	5.74	3.52	7.47	0.19	1.12	756.20	9.22	37.03	2.61
± 1s	7186.21	42.52	14.11	40.47	16.93	5.49	0.37	0.02	2.94	0.58	22.97	10.49	8.66	110.50	11.16	1.33	7.17	0.12	0.65	259.15	6.58	18.65	1.17
CV (%)	*53.1*	*61.1*	*37.2*	*64.4*	*129.2*	*98.3*	*77.5*	*28.2*	*147.1*	*72.4*	*44.3*	*46.3*	*70.8*	*90.5*	*194.3*	*37.9*	*96.0*	*62.1*	*57.8*	*34.3*	*71.4*	*50.4*	*45.0*
Minimum	6850	21.2	16.2	19.5	2.89	1.28	0.191	0.05	0.517	0.296	16.8	7.69	3.93	12.6	1	1.27	1.4	0.1	0.08	370	3.01	16.6	1.02
Maximum	38900	184	64.9	172	64.2	24.1	1.48	0.114	14.2	3.01	108	44.6	40.7	359	49.8	6.33	24.3	0.568	3.19	1400	33.1	98.5	5.44
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TED LINE	**S.Q. Cl** *(ppb)*	**Br** *(ppb)*	**I** *(ppb)*	**V** *(ppb)*	**As** *(ppb)*	**Mo** *(ppb)*	**Sb** *(ppb)*	**Au** *(ppb)*	**Th** *(ppb)*	**U** *(ppb)*	**Co** *(ppb)*	**Ni** *(ppb)*	**Cu** *(ppb)*	**Zn** *(ppb)*	**Pb** *(ppb)*	**Ga** *(ppb)*	**Cd** *(ppb)*	**Tl** *(ppb)*	**Bi** *(ppb)*	**S.Q. Ti** *(ppb)*	**Y** *(ppb)*	**Zr** *(ppb)*	**Nb** *(ppb)*
Median	**9410**	**34.7**	**22**	**35.15**	**4.90**	**2.79**	**0.38**	**0.05**	**1.12**	**0.83**	**31.9**	**21.05**	**10.64**	**69.55**	**4.59**	**2.51**	**3.17**	**0.1**	**0.8**	**612.5**	**6.08**	**23.8**	**2.39**
Mean	9467.50	42.53	28.75	43.08	6.72	4.17	0.74	0.05	1.52	2.02	45.91	21.56	15.22	333.55	11.40	2.42	7.00	0.20	0.82	682.81	15.86	41.46	2.41
± 1s	3472.15	23.04	24.35	34.17	4.16	3.76	0.84	0.00	0.95	3.46	36.64	8.69	13.33	851.78	17.19	1.10	11.32	0.21	0.05	311.59	25.26	48.96	0.88
CV (%)	*36.7*	*54.2*	*84.7*	*79.3*	*61.9*	*90.0*	*113.5*	*0.0*	*62.3*	*171.1*	*79.8*	*40.3*	*87.6*	*255.4*	*150.8*	*45.5*	*161.8*	*105.0*	*5.8*	*45.6*	*159.2*	*118.1*	*36.8*
Minimum	2000	20.8	12.5	11.8	2.78	1.32	0.1	0.05	0.647	0.389	13.5	8.73	3.42	10	1	1	1.41	0.1	0.8	123	1.28	9.03	1.01
Maximum	17100	103	98.2	151	17.2	14.7	2.74	0.05	3.86	11.7	155	38.8	51.1	3440	67.8	4.67	46.7	0.827	0.959	1130	93.4	171	3.44
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

COMBINED LINES	**S.Q. Cl** *(ppb)*	**Br** *(ppb)*	**I** *(ppb)*	**V** *(ppb)*	**As** *(ppb)*	**Mo** *(ppb)*	**Sb** *(ppb)*	**Au** *(ppb)*	**Th** *(ppb)*	**U** *(ppb)*	**Co** *(ppb)*	**Ni** *(ppb)*	**Cu** *(ppb)*	**Zn** *(ppb)*	**Pb** *(ppb)*	**Ga** *(ppb)*	**Cd** *(ppb)*	**Tl** *(ppb)*	**Bi** *(ppb)*	**S.Q. Ti** *(ppb)*	**Y** *(ppb)*	**Zr** *(ppb)*	**Nb** *(ppb)*
Median	**10450**	**48.5**	**29.2**	**40.85**	**6.05**	**3.39**	**0.33**	**0.05**	**1.14**	**0.69**	**37.15**	**19.65**	**9.58**	**74.6**	**2.89**	**2.99**	**3.87**	**0.12**	**0.8**	**696**	**7.21**	**32**	**2.56**
Mean	11721.70	57.58	33.83	54.05	10.27	4.96	0.59	0.05	1.79	1.34	49.18	22.17	13.56	216.09	8.26	3.03	7.26	0.19	0.99	723.58	12.17	39.00	2.52
± 1s	6114.08	37.35	19.58	38.58	13.17	4.79	0.63	0.01	2.27	2.39	29.50	9.61	10.92	573.52	14.22	1.34	9.11	0.16	0.50	281.84	17.55	34.94	1.04
CV (%)	*52.2*	*64.9*	*57.9*	*71.4*	*128.2*	*96.5*	*106.8*	*22.0*	*127.0*	*178.0*	*60.0*	*43.4*	*80.5*	*265.4*	*172.3*	*44.2*	*125.4*	*83.2*	*51.0*	*39.0*	*144.2*	*89.6*	*41.5*
Minimum	2000	20.8	12.5	11.8	2.78	1.28	0.1	0.05	0.517	0.296	13.5	7.69	3.42	10	1	1	1.4	0.1	0.08	123	1.28	9.03	1.01
Maximum	38900	184	98.2	172	64.2	24.1	2.74	0.114	14.2	11.7	155	44.6	51.1	3440	67.8	6.33	46.7	0.827	3.19	1400	93.4	171	5.44
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

Table 15-2. *Summary statistics – enzyme leach (EL) results for 3Ts B horizon mineral soils.*

TOMMY LINE	Hf (ppb)	La (ppb)	Ce (ppb)	Pr (ppb)	Nd (ppb)	Sm (ppb)	Eu (ppb)	Gd (ppb)	Tb (ppb)	Dy (ppb)	Ho (ppb)	Er (ppb)	Tm (ppb)	Yb (ppb)	Lu (ppb)	S.Q. Li (ppb)	Be (ppb)	Mn (ppb)	Rb (ppb)	Sr (ppb)	Cs (ppb)	Ba (ppb)
Median	**1.00**	**4.92**	**14.05**	**1.49**	**6.63**	**1.68**	**0.63**	**1.62**	**0.27**	**1.46**	**0.27**	**0.78**	**0.11**	**0.69**	**0.10**	**2.00**	**2.83**	**12650**	**72.6**	**900**	**0.88**	**1755**
Mean	1.15	5.63	17.12	1.78	7.97	2.01	0.70	1.85	0.33	1.80	0.34	0.96	0.15	0.89	0.14	2.98	3.06	19274.50	74.01	985.60	1.40	2172.65
± 1s	0.53	2.94	10.75	0.99	4.35	1.16	0.28	1.08	0.22	1.26	0.26	0.73	0.10	0.74	0.11	1.69	0.89	22402.32	35.94	413.69	1.16	1120.79
CV (%)	*46.4*	*52.2*	*62.8*	*55.7*	*54.6*	*57.7*	*40.8*	*58.1*	*65.8*	*70.2*	*75.5*	*75.7*	*68.2*	*83.6*	*79.2*	*56.8*	*29.1*	*116.2*	*48.6*	*42.0*	*82.8*	*51.6*
Minimum	0.499	1.91	4.37	0.523	2.64	0.612	0.366	0.64	0.105	0.555	0.103	0.282	0.1	0.251	0.1	2	2	2060	12.2	317	0.303	809
Maximum	2.83	13.3	47	4.26	19.6	5.06	1.36	4.9	1.06	6.17	1.26	3.59	0.548	3.66	0.608	8.81	4.85	93700	165	1880	3.78	4690
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TED LINE	Hf (ppb)	La (ppb)	Ce (ppb)	Pr (ppb)	Nd (ppb)	Sm (ppb)	Eu (ppb)	Gd (ppb)	Tb (ppb)	Dy (ppb)	Ho (ppb)	Er (ppb)	Tm (ppb)	Yb (ppb)	Lu (ppb)	S.Q. Li (ppb)	Be (ppb)	Mn (ppb)	Rb (ppb)	Sr (ppb)	Cs (ppb)	Ba (ppb)
Median	**0.79**	**3.97**	**12.9**	**1.38**	**6.37**	**1.59**	**0.63**	**1.40**	**0.26**	**1.32**	**0.23**	**0.63**	**0.10**	**0.60**	**0.1**	**6.26**	**2.76**	**5115**	**50.5**	**688.5**	**1.14**	**2305**
Mean	1.21	6.48	14.35	2.36	11.08	3.00	0.94	2.81	0.49	2.68	0.54	1.52	0.25	1.51	0.26	10.21	3.09	15395.00	49.32	756.81	1.65	2394.31
± 1s	1.28	7.19	11.67	3.07	14.58	4.20	0.95	3.97	0.68	3.85	0.81	2.35	0.34	2.53	0.40	11.46	1.06	24728.02	21.20	338.23	1.46	924.10
CV (%)	*105.9*	*111.1*	*81.3*	*130.1*	*131.6*	*140.2*	*100.8*	*141.0*	*138.5*	*143.7*	*150.0*	*154.8*	*138.1*	*167.7*	*153.0*	*112.3*	*34.3*	*160.6*	*43.0*	*44.7*	*88.8*	*38.6*
Minimum	0.291	0.31	1.8	0.103	0.565	0.141	0.162	0.185	0.1	0.224	0.1	0.152	0.1	0.177	0.1	2	2	2780	14.9	228	0.41	979
Maximum	4.56	24.3	43.6	10.1	47.9	13.8	3.49	13.8	2.35	12.9	2.91	8.32	1.26	9.14	1.56	45	6.16	89900	87.8	1550	5.48	3800
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

COMBINED LINES	Hf (ppb)	La (ppb)	Ce (ppb)	Pr (ppb)	Nd (ppb)	Sm (ppb)	Eu (ppb)	Gd (ppb)	Tb (ppb)	Dy (ppb)	Ho (ppb)	Er (ppb)	Tm (ppb)	Yb (ppb)	Lu (ppb)	S.Q. Li (ppb)	Be (ppb)	Mn (ppb)	Rb (ppb)	Sr (ppb)	Cs (ppb)	Ba (ppb)
Median	**0.97**	**4.92**	**13.6**	**1.49**	**6.63**	**1.68**	**0.63**	**1.60**	**0.27**	**1.46**	**0.27**	**0.74**	**0.11**	**0.67**	**0.1**	**2.71**	**2.81**	**8730**	**58.15**	**818.5**	**1.00**	**1905**
Mean	1.18	6.01	15.89	2.04	9.35	2.45	0.80	2.28	0.40	2.19	0.43	1.21	0.19	1.16	0.20	6.19	3.07	17550.28	63.04	883.92	1.51	2271.17
± 1s	0.93	5.20	11.09	2.16	10.19	2.92	0.67	2.76	0.48	2.72	0.57	1.65	0.24	1.77	0.28	8.44	0.96	23201.80	32.38	393.99	1.29	1029.75
CV (%)	*78.8*	*86.6*	*69.8*	*106.1*	*109.0*	*119.3*	*82.7*	*121.1*	*119.9*	*124.4*	*132.6*	*137.0*	*124.5*	*152.4*	*143.5*	*136.2*	*31.3*	*132.2*	*51.4*	*44.6*	*85.3*	*45.3*
Minimum	0.291	0.31	1.8	0.103	0.565	0.141	0.162	0.185	0.1	0.224	0.1	0.152	0.1	0.177	0.1	2	2	2060	12.2	228	0.303	809
Maximum	4.56	24.3	47	10.1	47.9	13.8	3.49	13.8	2.35	12.9	2.91	8.32	1.26	9.14	1.56	45	6.16	93700	165	1880	5.48	4690
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

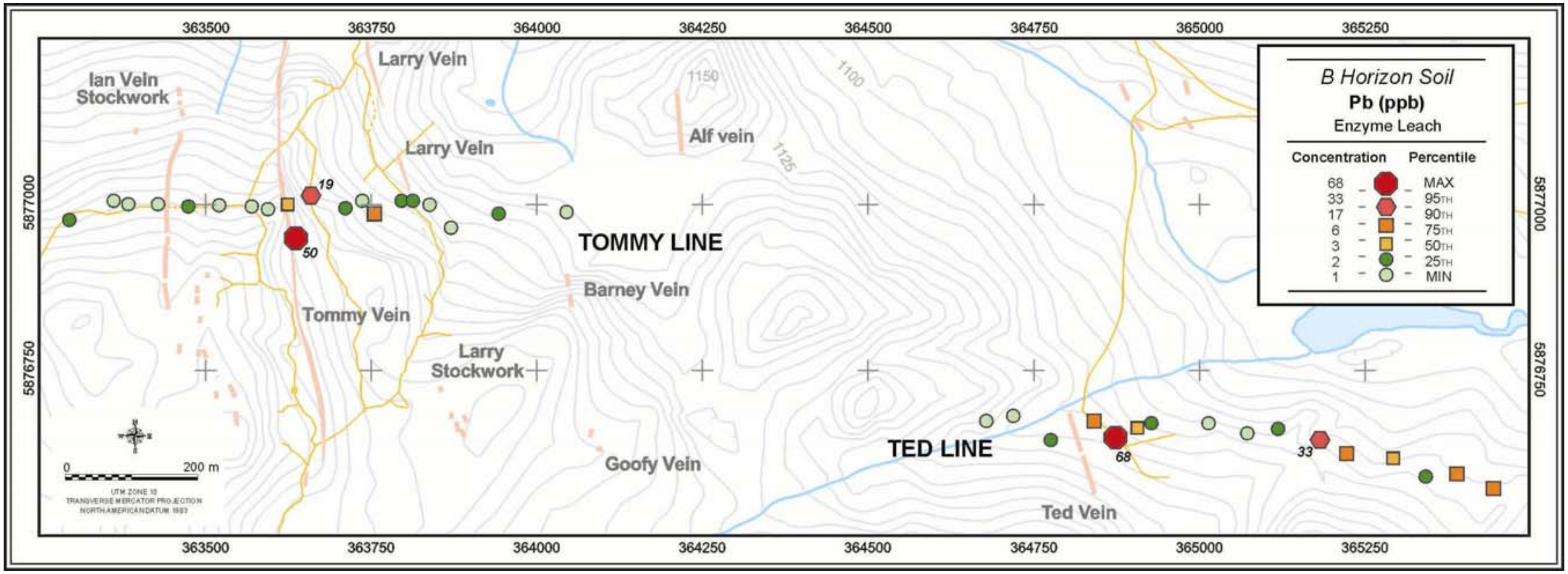


Figure 206. *Distribution of Pb (ppb) by Enzyme Leach (EL) in B horizon soils on the combined Tommy and Ted orientation transects (N=36 sites).*

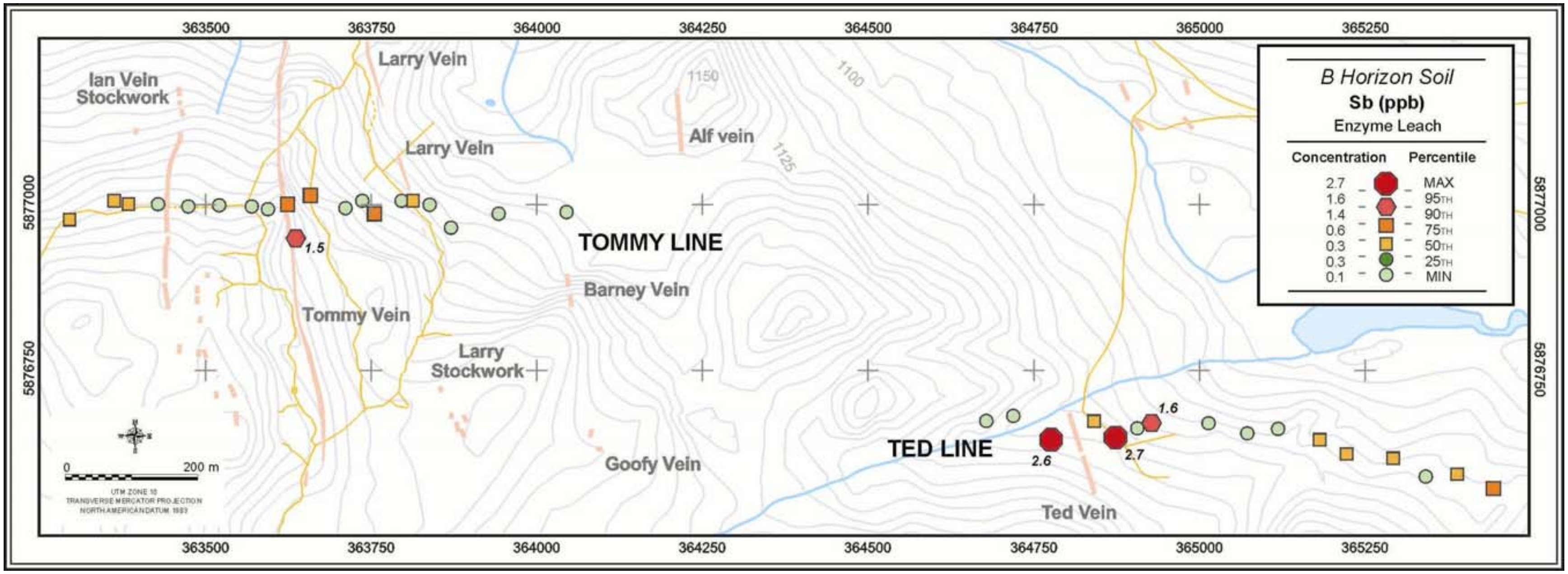


Figure 207. *Distribution of Sb (ppb) by Enzyme Leach (EL) in B horizon soils on the combined Tommy and Ted orientation transects (N=36 sites). Note the peripheral halo pattern to the distribution of Sb by EL around the Ted vein mineralization, and compare to the line transects for Sb shown in Figures 188 and 189.*

f) Soil Gas Hydrocarbon (SGH) Results in B Horizon Soils

The Soil Gas Hydrocarbon (SGH) method is a proprietary commercial analytical method of Activation Laboratories Ltd., Ancaster, Ontario. As noted earlier, SGH sample preparation and subsequent ppt-level analysis by gas chromatograph/MS (mass spectrometry) was conducted on all B horizon soils by Activation Laboratories. The method, although proprietary, targets a range of 162 organic compounds, which are thought to be adsorbed onto clay minerals and amorphous iron and manganese oxides present in the soil. According to Sutherland (2002), hydrocarbons in the C5–C17 range are measured as these are considered to be more robust from a field sampling and shipping perspective than lighter hydrocarbons, and are less variable both diurnally and seasonally. There is to date no measurable interference from surface vegetative decay, microbiological activity, soil variability or local human disruption from either agricultural or transportation activities (Sutherland, 2002). Furthermore, the higher molecular weight C5–C17 range of hydrocarbons are not gaseous at room temperature compared to the C1–C4 range of hydrocarbons used for soil gas analyses, and are stated to be less affected by decaying biogenic material.

INTERNAL DATA INTERPRETATION

Activation Laboratories was requested by the authors to conduct an in-house interpretation of the 3Ts B horizon soil SGH data from each of the two orientation transects. Relative site location data was forwarded to Activation Laboratories for this purpose. The samples were stated to be from two transect lines on a gold-quartz vein property, but no other identifying location or geological information was provided to the lab. The accompanying plan and oblique-view line plots (Figures 208 and 209) are from the report provided to the authors by Sutherland and Hoffman (2005)

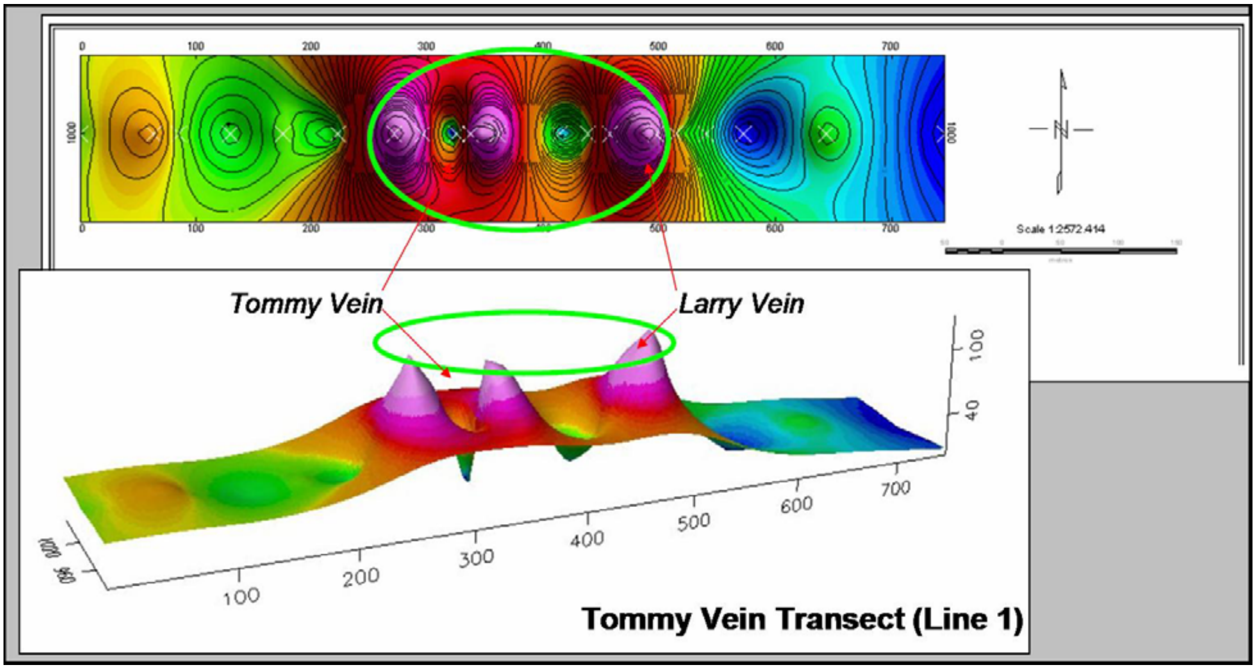
Sutherland and Hoffman (2005) report that an SGH sample signature is defined by the 162 compounds reported in the GC/MS analysis, and describe their method as follows: the compounds are separated into 19 subclasses for review, and the values mapped with Geosoft Oasis Montaj software using a kriging algorithm. The maps are reviewed for coincident gold signatures patterns using visual pattern recognition, and interpretations then made as to both location, and the probability of it representing a gold target. Sutherland and Hoffman (2005) state that specific SGH classes consistently indicate the presence of buried gold deposits, with subjective interpretation following a six-point ratings scale: 1) very high probability, 2) high probability, 3) good probability, 4) fairly good probability, 5) fair probability and 6) low probability.

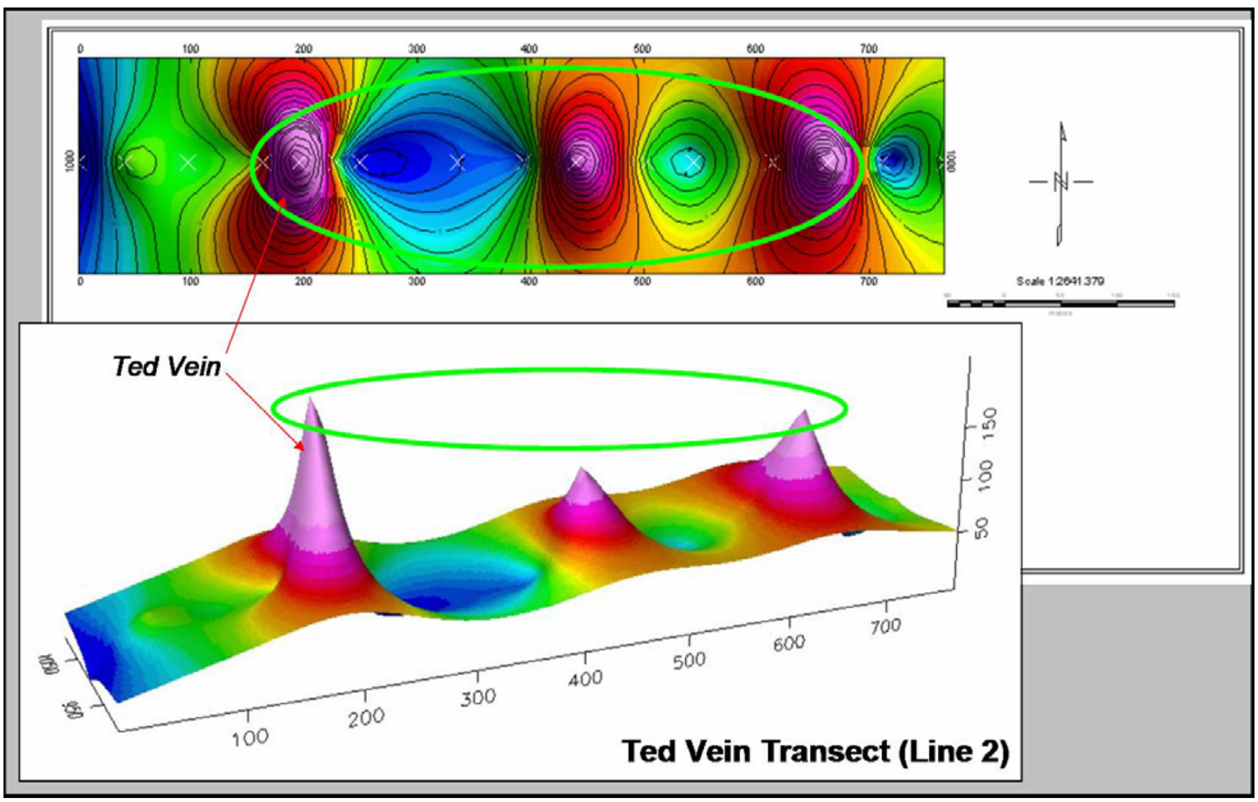
Sutherland and Hoffman (2005) noted that the 20 sites in Line 1 (the Tommy vein transect) and the 16 sites in Line 2 (the Ted vein transect) were less than the 30 samples recommended as a minimum for SGH pattern interpretation. The following conclusions were, however, reported:

- Line 1 (the Tommy vein transect) SGH compound class signatures indicate a ‘high probability’ of the presence of a gold target in the vicinity of the green oval shown in Figures 208. Based on the shape of the anomaly, the gold target was suggested to be ‘moderately deep’, if present. According to Sutherland and Hoffman (2005), a ‘high probability’ rating means that the SGH classes most important to describing a gold signature are all present, and consistently describe the same location with well-defined anomalies. The SGH signatures may not be strong enough to also develop other supporting classes.

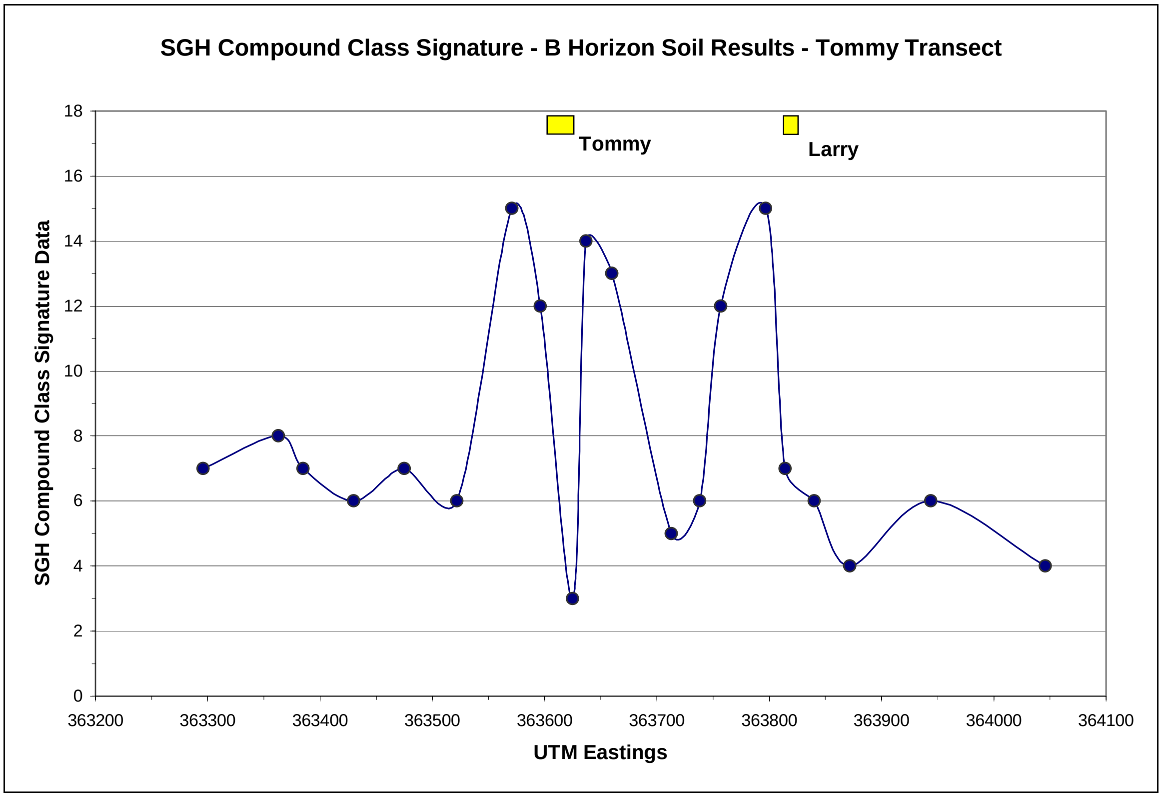
- Line 2 (the Ted vein transect) SGH compound class signatures indicate a ‘good probability’ of the presence of a gold target in the vicinity of the green oval shown in Figure 209. Based on the shape of the anomaly, the gold target was suggested to be ‘moderately deep’, if present. According to Sutherland and Hoffman (2005), a ‘good probability’ rating means that the SGH classes most important to describing a gold signature are mostly present, and describe the same location with well-defined anomalies. Some supporting SGH classes may be present.

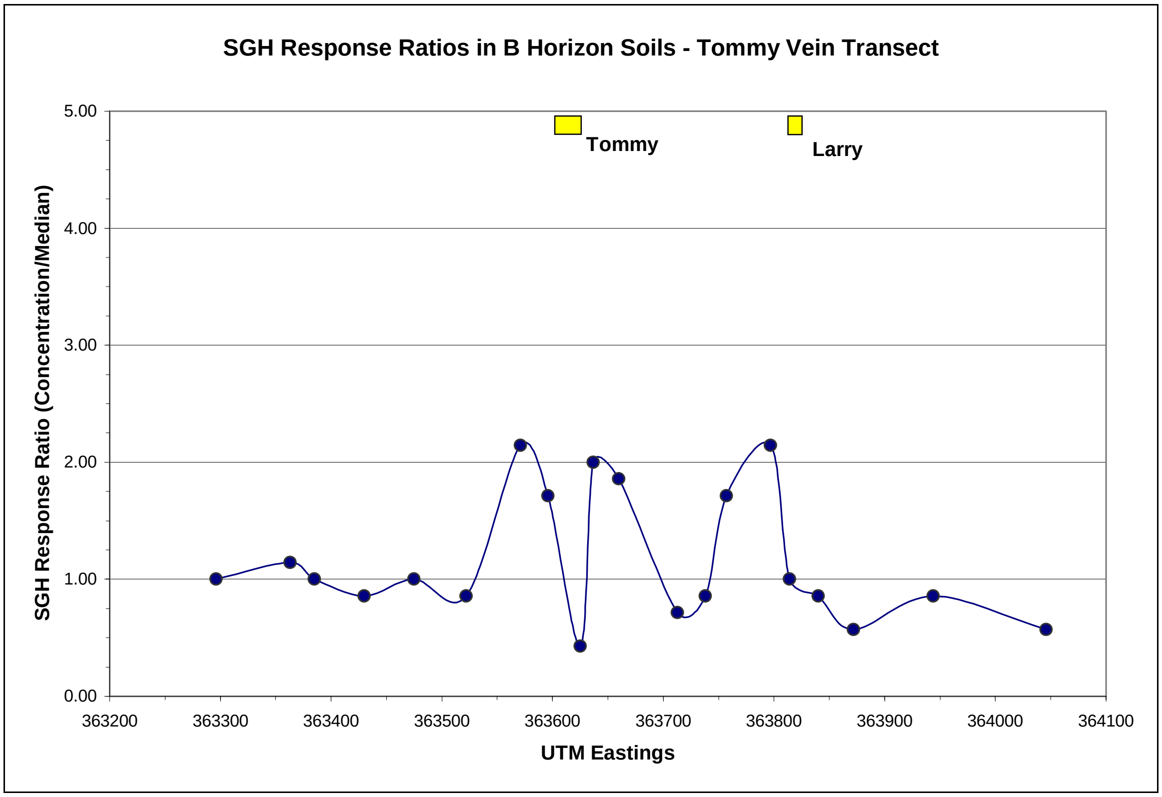
In addition to the foregoing digital compound class signature results for each soil site were provided by Activation Laboratories, and both Tommy and Ted vein transect line plots and response ratios plots constructed with this data (Figures 210 to 213). Response ratios were calculated using individual soil site values (Table 16) ratioed against the median result for each of the two soil transects (median: 7.0, in each case). As the SGH method is a proprietary commercial method of Activation Laboratories Ltd., no specific information was provided, or is available, on the methods used to distill the results for 162 organic compounds in each sample to the single class signature result (Table 16), nor the unit(s) of measurement.



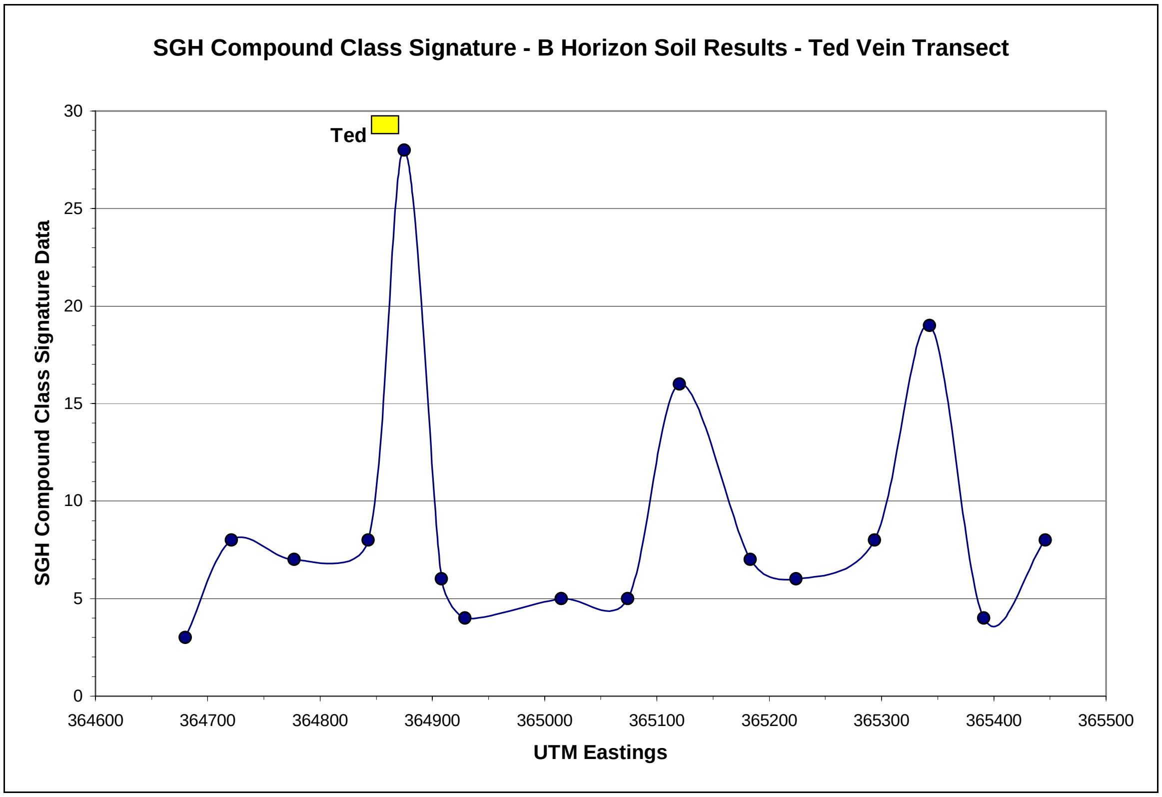


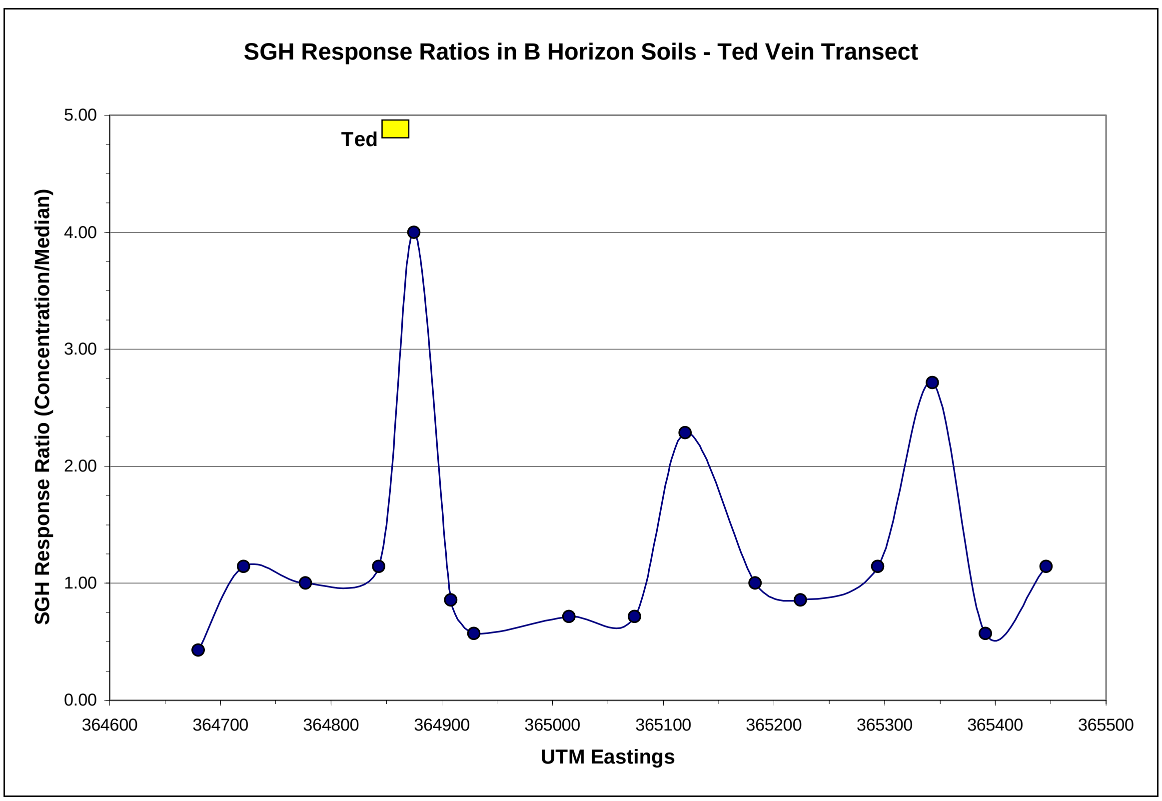
Figures 208 and 209. *Plan and 3D oblique views of B horizon soil GC/MS SGH compound class signature results for each of the Tommy vein (top) and Ted vein (bottom) orientation transects at the 3Ts Au-Ag deposit. Green ovals indicate those areas of best probability of a gold target at depth, as suggested by Sutherland and Hoffman (2005) and described in the accompanying text. Line plot images modified from those of Sutherland and Hoffman (2005); vein location annotations were added by the author.*





Figures 210 and 211. *Distribution of SGH (Soil Gas Hydrocarbon) compound class signatures (top) and calculated response ratios (bottom) in B horizon soils from the Tommy vein orientation transect.*





Figures 212 and 213. *Distribution of SGH (Soil Gas Hydrocarbon) compound class signatures (top) and calculated response ratios (bottom) in B horizon soils from the Ted vein orientation transect.*

Table 16. *SGH compound summary results for B horizon soils – Tommy and Ted vein orientation transects.*

A) Tommy Orientation Transect (N=20 sites)

Sample	ID	UTME83	UTMN83	GRID	SGH Data	Response Ratios
TOM S	501	363296	5876976	0	7	1.00
TOM S	503	363363	5877005	63	8	1.14
TOM S	504	363385	5877000	85	7	1.00
TOM S	505	363430	5877000	130	6	0.86
TOM S	506	363475	5876996	175	7	1.00
TOM S	507	363522	5876998	222	6	0.86
TOM S	508	363571	5876996	271	15	2.14
TOM S	509	363596	5876992	296	12	1.71
TOM S	514	363625	5876999	325	3	0.43
TOM S	591	363637	5876948	337	14	2.00
TOM S	515	363660	5877012	360	13	1.86
TOM S	516	363713	5876994	413	5	0.71
TOM S	517	363738	5877005	438	6	0.86
TOM S	518	363757	5876984	457	12	1.71
TOM S	519	363797	5877005	497	15	2.14
TOM S	520	363814	5877005	514	7	1.00
TOM S	521	363840	5876999	540	6	0.86
TOM S	523	363872	5876964	572	4	0.57
TOM S	524	363944	5876985	644	6	0.86
TOM S	525	364046	5876988	746	4	0.57

B) Ted Orientation Transect (N=16 sites)

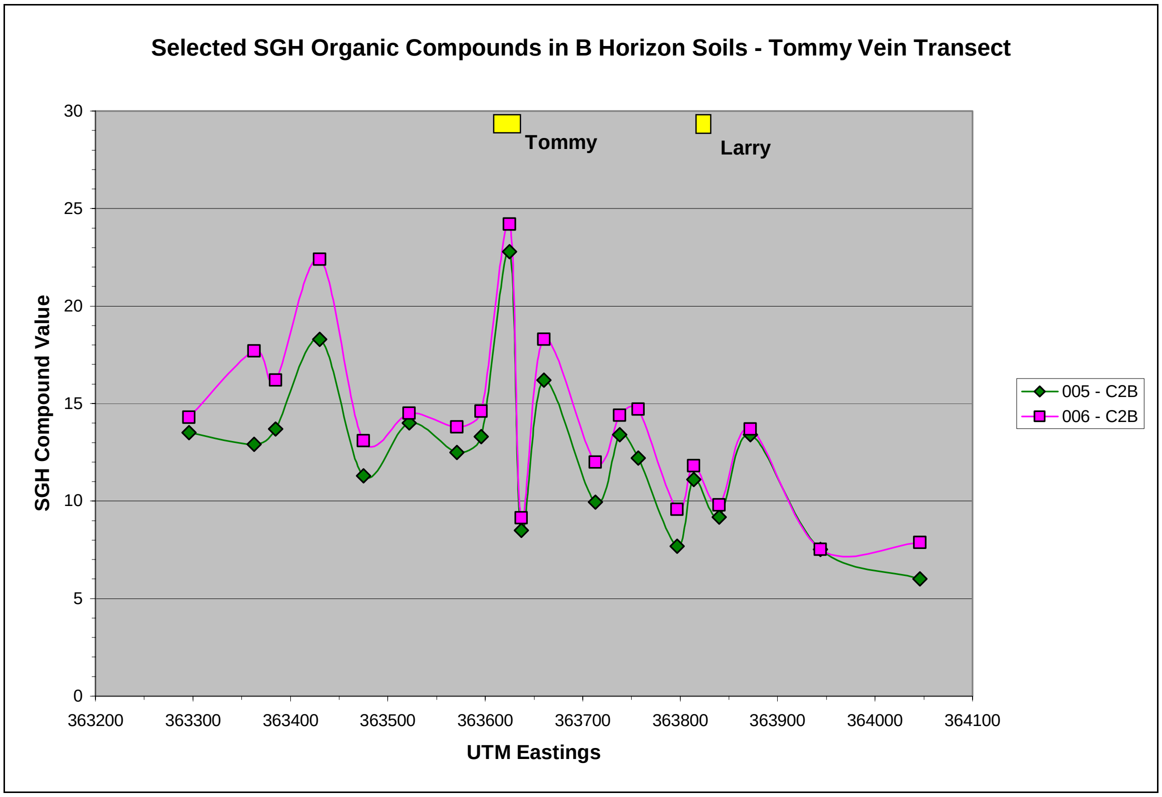
Sample	ID	UTME83	UTMN83	GRID	SGH Data	Response Ratios
TOM S	576	364680	5876673	0	3	0.43
TOM S	575	364721	5876680	41	8	1.14
TOM S	574	364777	5876644	97	7	1.00
TOM S	558	364843	5876672	163	8	1.14
TOM S	559	364875	5876647	195	28	4.00
TOM S	560	364908	5876662	228	6	0.86
TOM S	561	364929	5876669	249	4	0.57
TOM S	563	365015	5876669	335	5	0.71
TOM S	564	365074	5876654	394	5	0.71
TOM S	565	365120	5876661	440	16	2.29
TOM S	566	365183	5876644	503	7	1.00
TOM S	567	365224	5876623	544	6	0.86
TOM S	568	365294	5876616	614	8	1.14
TOM S	569	365343	5876589	663	19	2.71
TOM S	570	365391	5876592	711	4	0.57
TOM S	571	365446	5876570	766	8	1.14

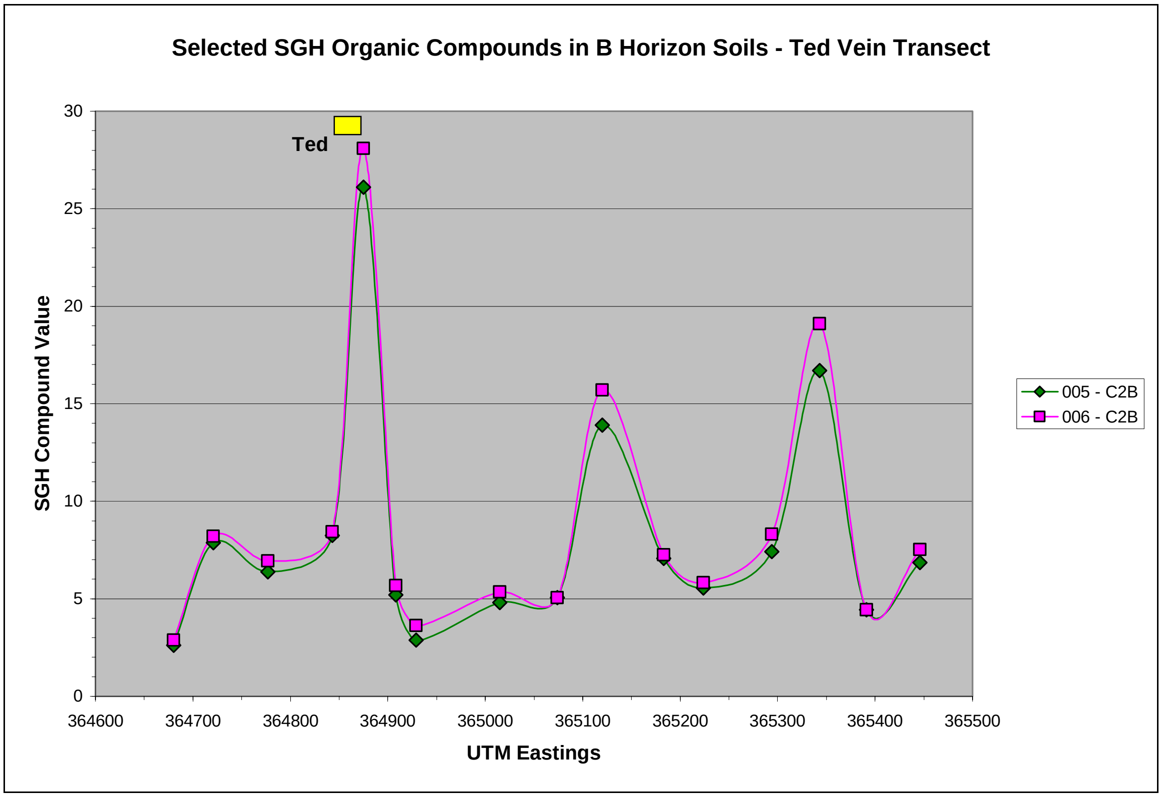
TOMMY VEIN TRANSECT RESULTS

The C5–C17 range of hydrocarbons measured using the SGH method are considered to migrate upwards from the source primarily with a vapour phase, although detailed process studies are lacking for this, and indeed for most other, proposed 'deep-penetrating' geochemical methods. The Tommy vein transect (Line 1) SGH compound class signatures indicate a 'high probability' of the presence of a gold target in the vicinity of the green oval shown in Figures 208 (Sutherland and Hoffman, 2005). The surface cropping of the Tommy vein is located approximately mid-way between the two SGH compound peaks shown in Figures 210; the two peaks are immediately adjacent to the vein. Similarly, the central anomaly and the Larry vein to the east are delineated by the second and third SGH peaks, respectively. The SGH compound response ratios calculated for each site using the transect median value (median: 7.0) similarly delineate the locations of the Tommy and the Larry veins (Figure 211). These anomalous values appear to be spatially robust, with four elevated sites marking the Tommy vein and two additional such sites marking the location of the Larry vein. At just over 2 times background (median) values, however, the Tommy line contrast ratios shown here, while positive, are subdued relative to those of several other analytical methods tested. Transect plots for two SGH compounds (005-C2B and 006-C2B) are shown in Figures 214.

TED VEIN TRANSECT RESULTS

Line 2 (the Ted vein transect) SGH compound class signatures indicate a 'good probability' of the presence of a gold target in the vicinity of the green oval shown in Figure 209 (Sutherland and Hoffman, 2005). The surface expression of the Ted vein is delineated by a single site SGH compound peak. This B horizon soil result on the Ted transect is stronger than any from the Tommy transect. Response ratios calculated for each site using the transect median (median: 7.0) indicate geochemical contrast at this site of 4 times background values. Furthermore, two additional single-site SGH compound peaks are present further to the east along the Ted line; these results are similar in both magnitude and contrast ratio to those over the Tommy and Larry veins on the other orientation transect. Interestingly, the median SGH compound values are identical (7.0) on each of the two transects. Transect plots for two individual SGH compounds (005-C2B and 006-C2B) are also shown in Figure 215.





Figures 214 and 215. *Line plots showing the distribution of two Soil Gas Hydrocarbon organic compounds — 005-C2B and 006-C2B — by GS/MS in B horizon soils along the Tommy orientation transect (top) and the Ted orientation transect (bottom).*

g) Soil Desorption Pyrolysis (SDP) Results in B Horizon Soils

The interpretation of volatile organic compounds results from Soil Desorption Pyrolysis (SDP) of B horizon soils by GC/MS for mineral exploration purposes is less straightforward than interpretation of more traditional inorganic soil constituents, if only because of their greater numbers and, to many geoscientists, their relatively unfamiliar units of measurements. Among the classes of compounds analyzed in the SDP suite are, according to the SDP Pty. website:

- Aliphatic and aromatic hydrocarbons
- Halogens; halogenated hydrocarbons
- Organic sulphur gases
- Carbonyl sulphides
- He and Ar
- SO_2, H_2S and CO_2

In all, 40 compounds were reported in the SDP suite including, among others, alkanes (A1 and A2), cycloalkanes (CA1 and CA2) and organic chlorides (OC). The data values reported are not concentrations per se, but are proportional to concentrations, as stated on data listings received from SDP Pty.:

"The data values are times 10^{-11} amps, which represent detector current for corrected spectrometer peaks and are proportional to compound concentrations. The proportionality factor for each compound is different. Therefore, while the data are internally consistent and accurately show changes in concentrations of individual compounds and changes in relative concentrations between different compounds, the data in this form should not be interpreted as showing the true comparative concentrations of different compounds relative to one another."

Unlike the Activation Laboratories interpretation of Soil Gas Hydrocarbons (SGH) results, which were described in the previous section, no downstream processing of these SDP soil results from the Tommy and Ted transects were undertaken here by SDP Pty. No SDP data was received for one soil sample (567) from the eastern part of the Ted transect, and the location of that missing sample is shown here as a void in the accompanying transect plots.

TOMMY VEIN

Of the 40 compounds and elements reported in the SDP data, Tommy transect line profiles for 26 are shown here (Figures 216 to 228). Corresponding response ratios, calculated by dividing each value over the transect median, are provided in Figures 229 to 233. It is clear from both sets of graphs that several compounds clearly show the presence of Tommy vein mineralization in B horizon soils. It is also clear, however, that geochemical contrast between mineralized and unmineralized areas is not particularly high in most cases, rarely exceeding 1.5 times median values.

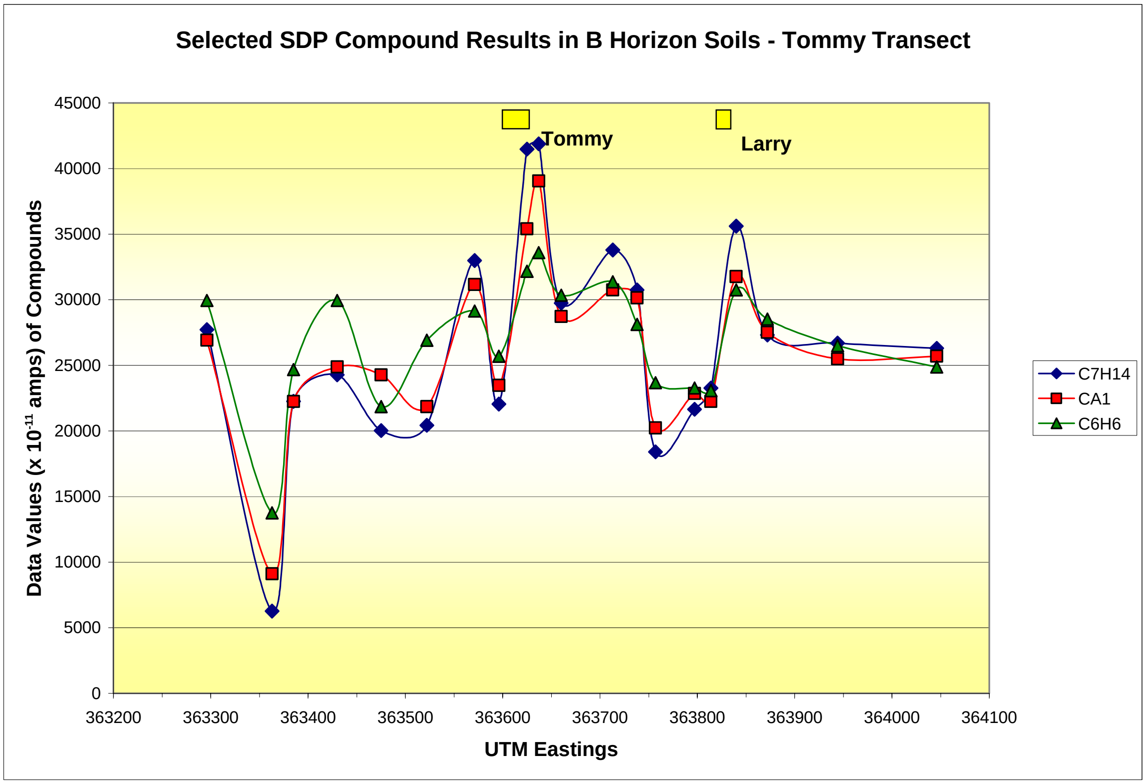
Of all SDP compounds, the greatest and least ambiguous geochemical contrast over the Tommy vein is shown by compound C_3H_5F (Figure 217). The contrast ratio plot for this compound reveals a 2-site anomaly, up to 2.4 times the median value, just east of Tommy vein (Figure 233). Results for C_3H_5F, however, do not clearly delineate the location of the Larry vein to the east. Several other compounds also clearly delineate the Tommy vein, most notably C_4H_{10}, A1 and A2, but contrast ratios over the Tommy vein are very subtle, in the order of only 1.5 to 1.6 times median values. Values of compounds are generally, but by no means always, greater over the Tommy vein relative to the smaller Larry vein. In several cases, SDP results in B horizon soils at the two veins are of similar magnitude.

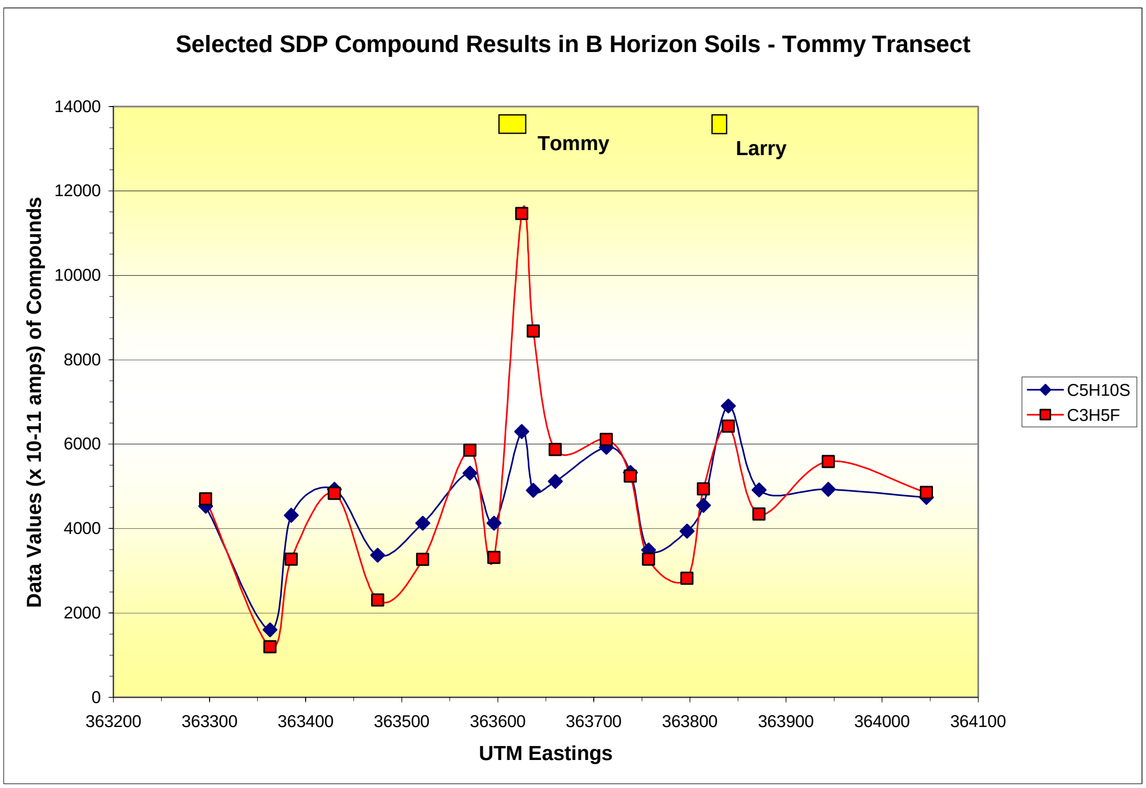
Several other compounds highlight the locations of both the Tommy and Larry veins along the Tommy orientation transect, most notably C_7H_{14} and CA1 (Figures 216), C_4H_8S (Figures 218), C_7H_{16} and C_4H_{10} (Figure 219) and CA2 (Figure 223). The contrast ratios are, however, very subtle, typically in the range of 1.5 to 1.6 times median values for those sites over and around the Tommy vein, and generally less than 1.5 times median values for those sites around the Larry vein. Among other features present in the SDP data are curious patterns of COS and H_2S, both response ratios of which exhibit negative patterns near the Tommy vein, but relatively strong contrast anomalies near the Larry vein.

TED VEIN

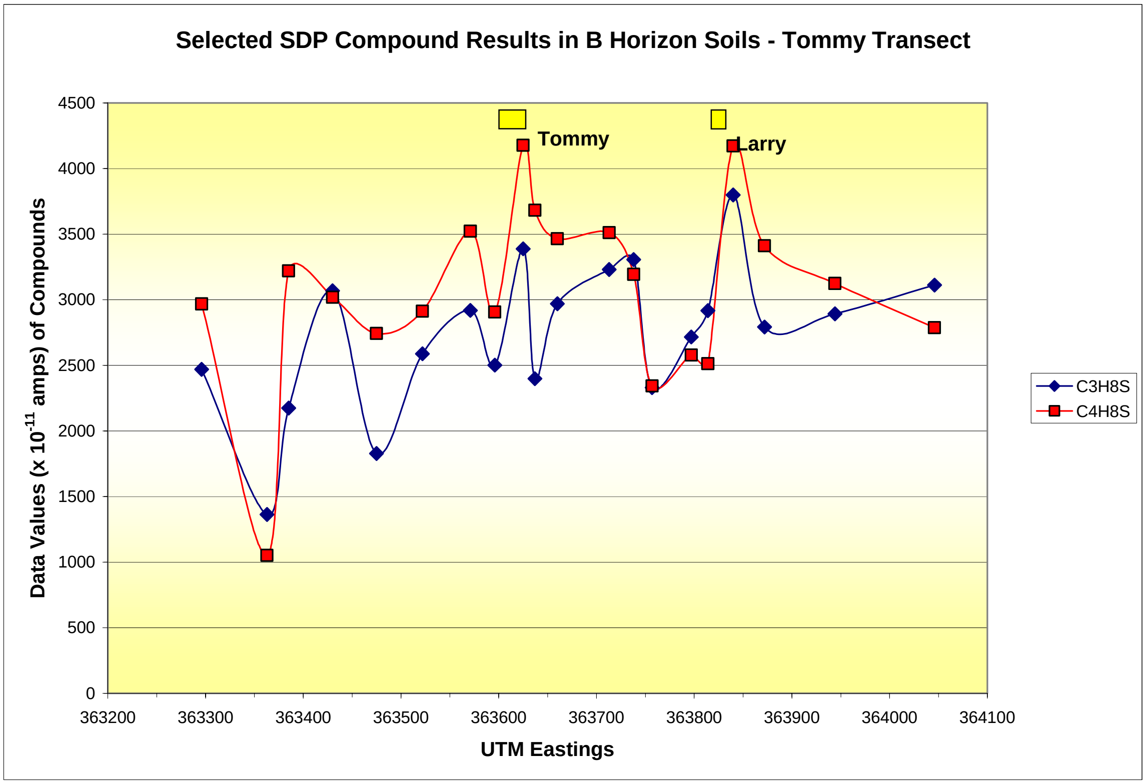
Unlike the case with the Tommy orientation transect, there are few SDP patterns, other than CO_2, which show any discernable geochemical contrast over the Ted vein. Results for 11 SDP compounds and elements are profiled here (Figures 234 to Figure 238). Carbon dioxide (CO_2) exhibits perhaps the best contrast over the Ted vein (Figure 238) of all SDP compounds in B horizon soils. In this case, moderately elevated values up to almost 2 times the transect median are present immediately east and west of the surface expression of the Ted vein (Figure 240). Several constituents show locally, if only slightly, elevated compound values in the immediate vicinity of the Ted vein, including C_6H_6 (Figures 234) and SO_2 (Figures 236). These elevated values are, however, not dissimilar from other compound values present in B horizon soils along the transect; the contrast ratios (Figures 239 and 240) show little difference from overall median values. It is possible that other unknown sources of epithermal mineralization in the eastern and western parts of the transect may be the source of these patterns, but that cannot be shown at this time.

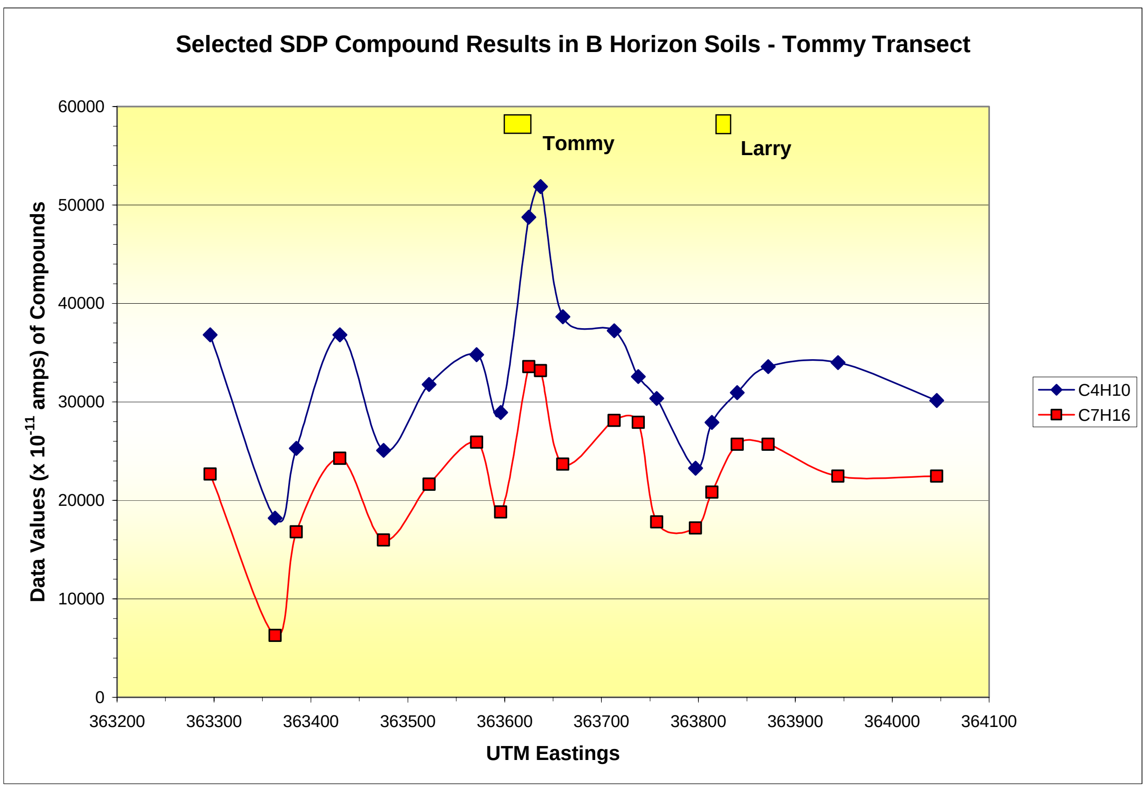
The wide SDP geochemical variations along the Ted line are reflected in the high coefficient of variation (% CV) results, relative to those of the Tommy vein, shown for many of the compounds here. In general, the SDP method is relatively ineffective in highlighting mineralization on the Ted transect.



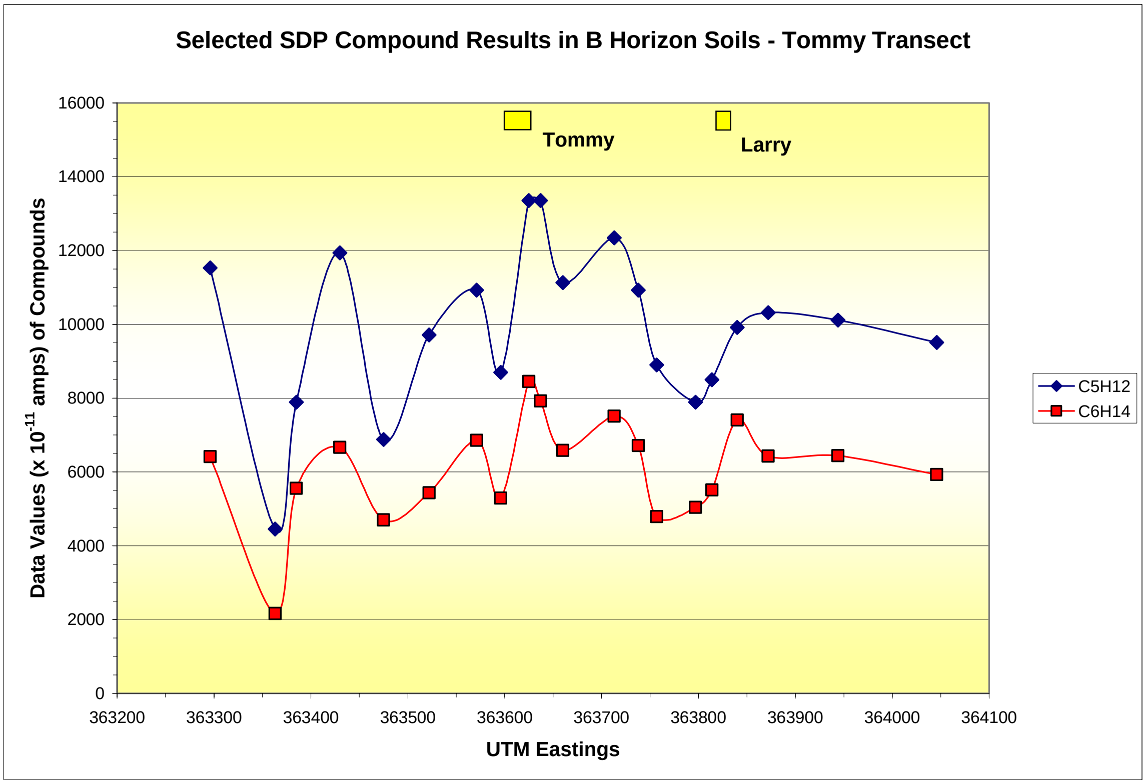


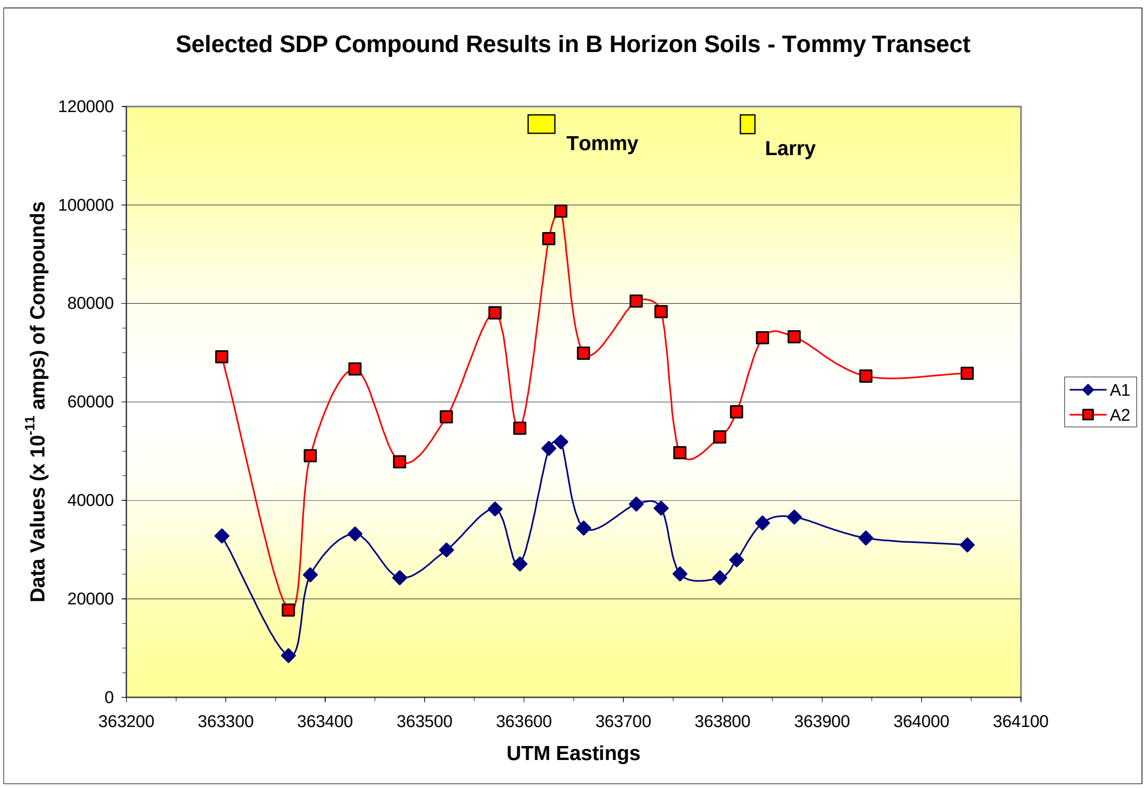
Figures 216 and 217. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*



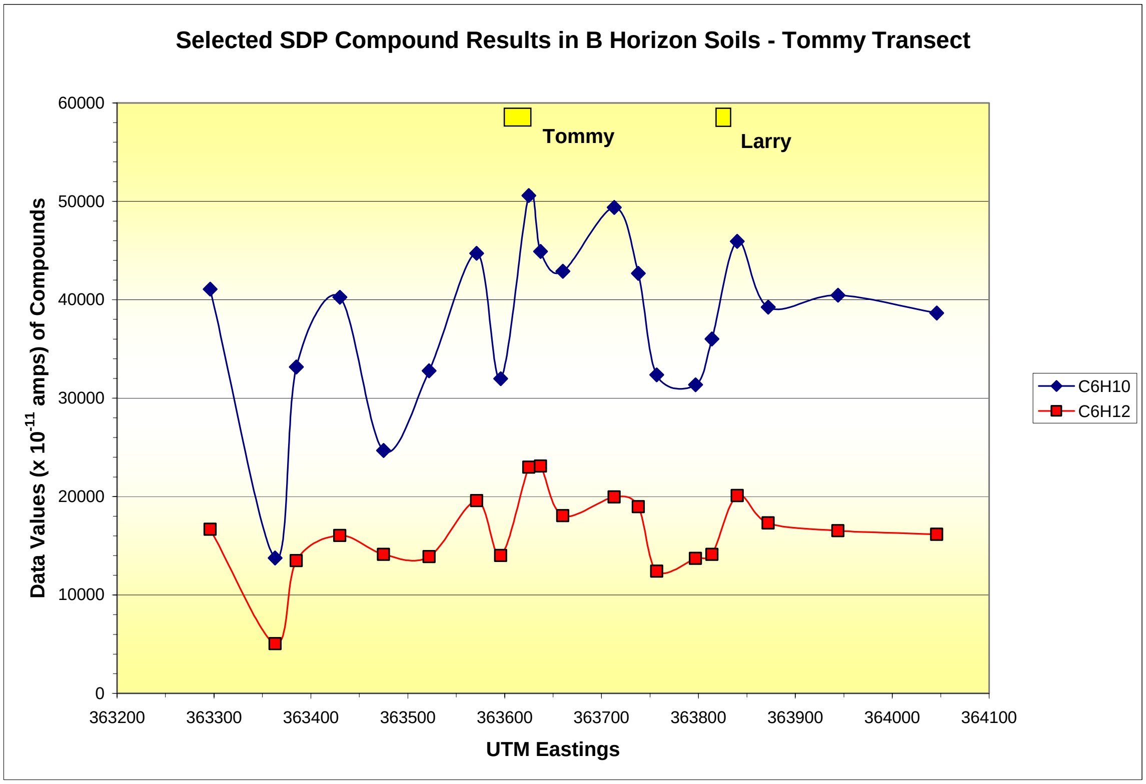


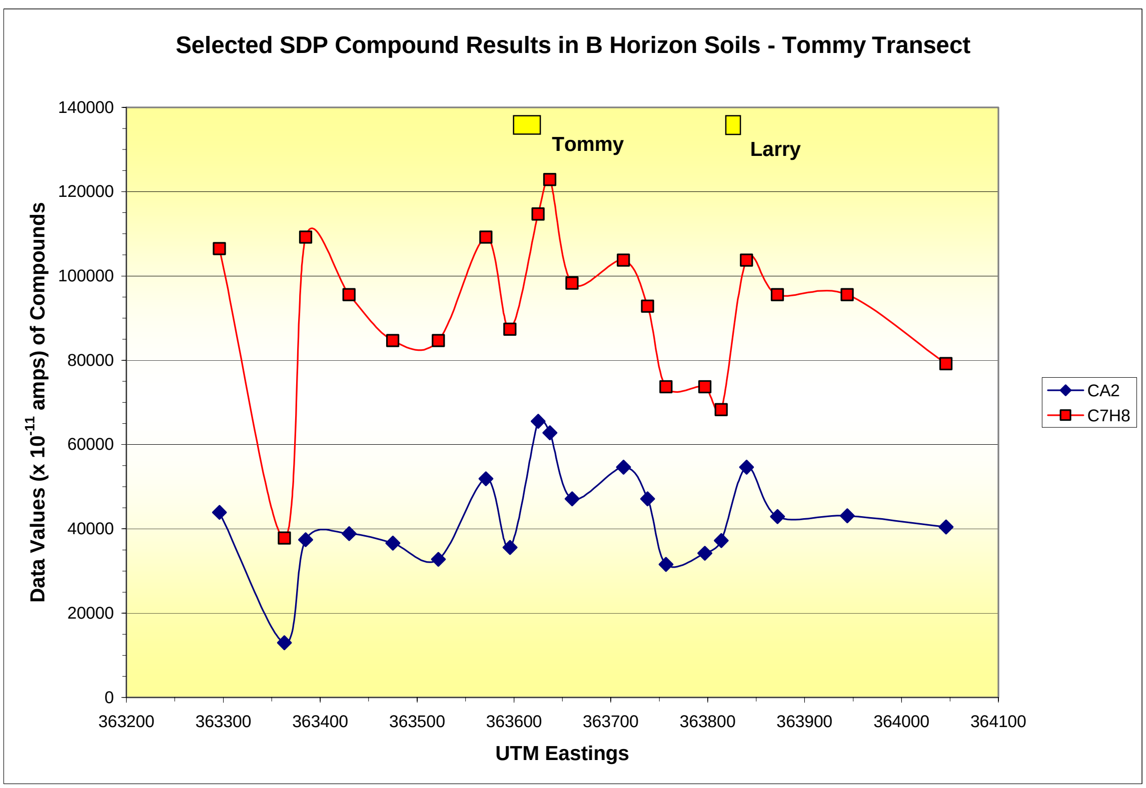
Figures 218 and 219. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*



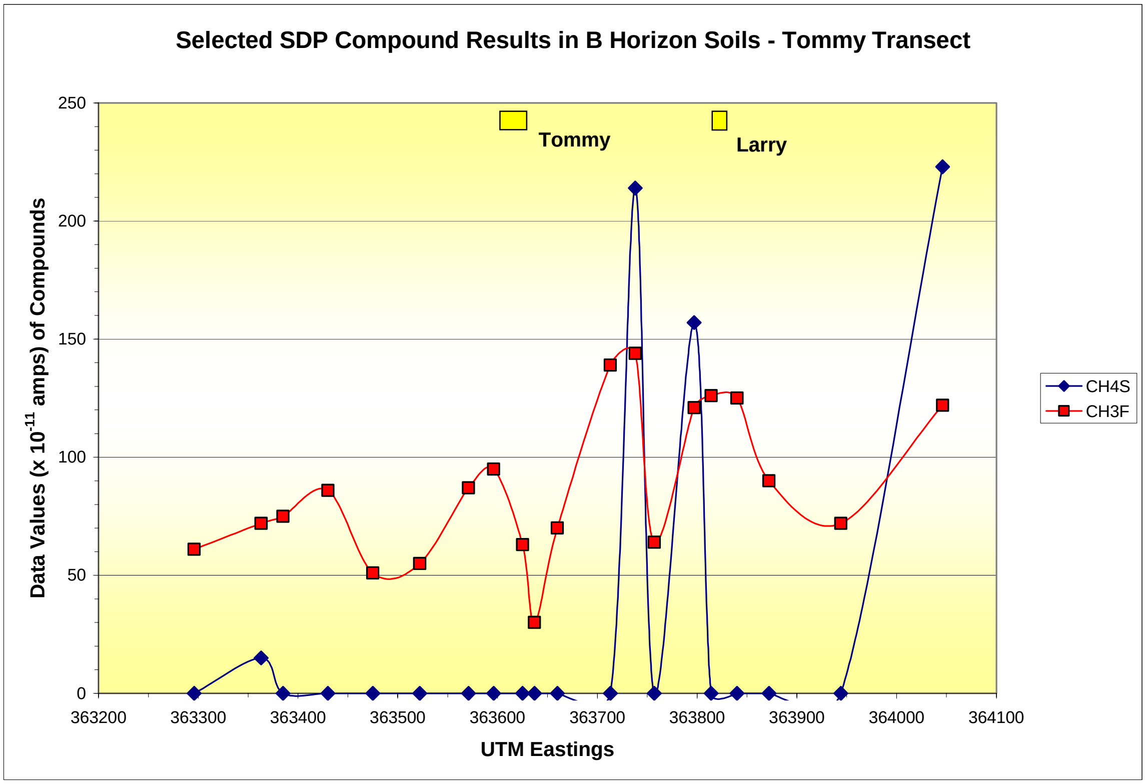


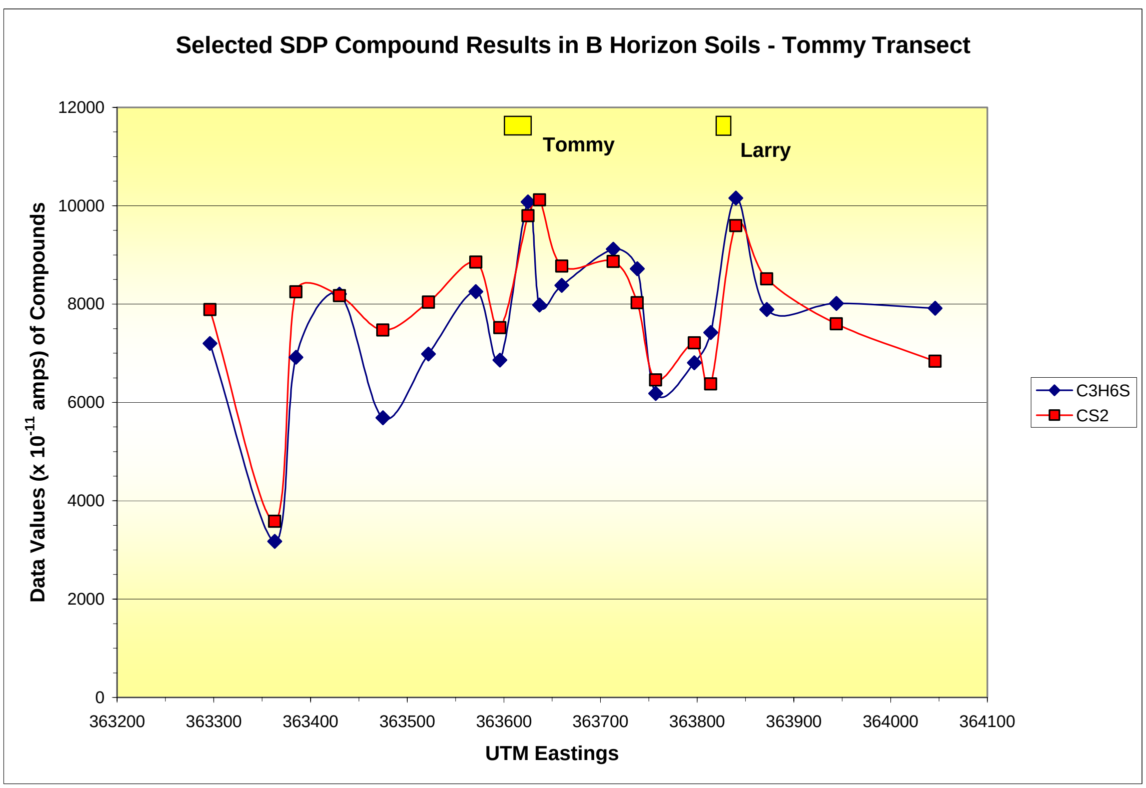
Figures 220 and 221. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*



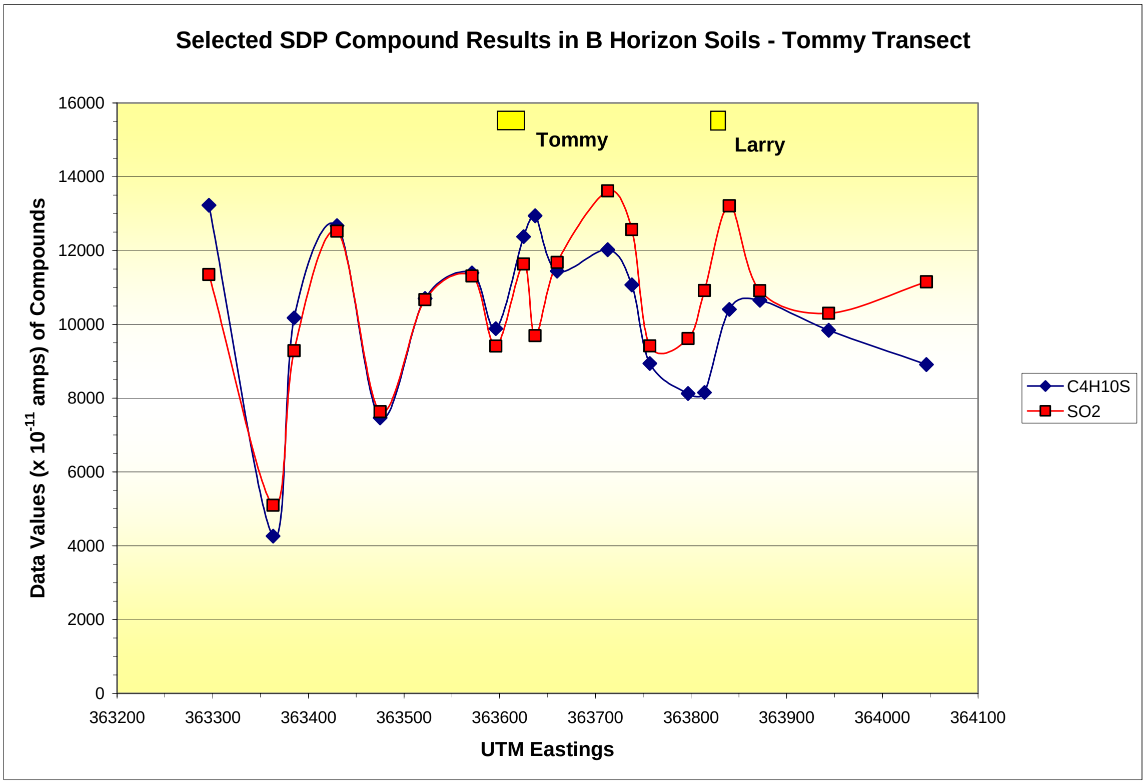


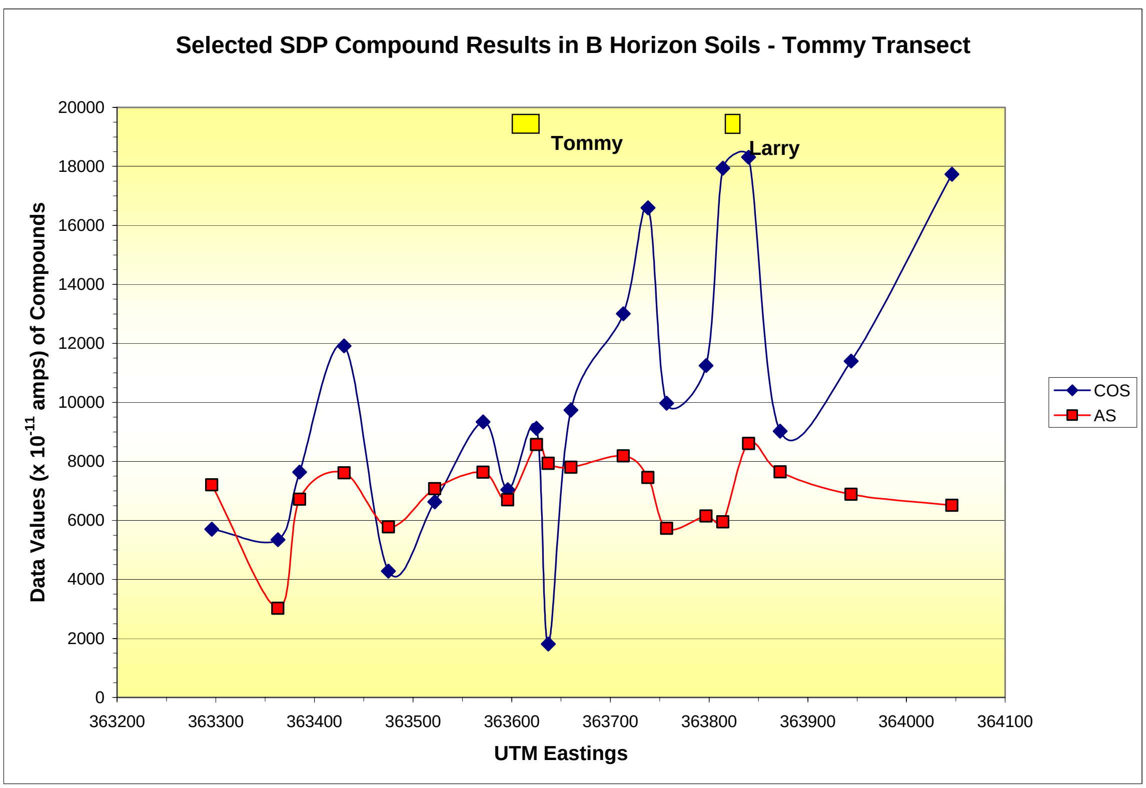
Figures 222 and 223. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*





Figures 224 and 225*. Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*





Figures 226 and 227. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*

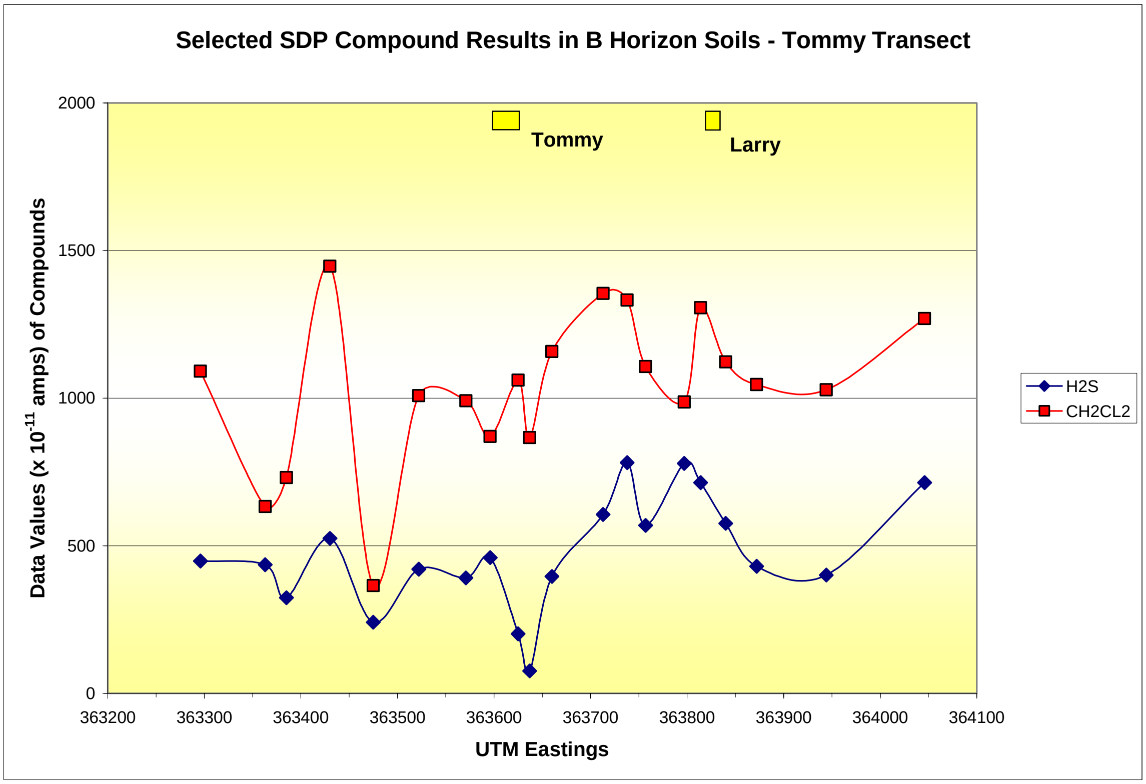
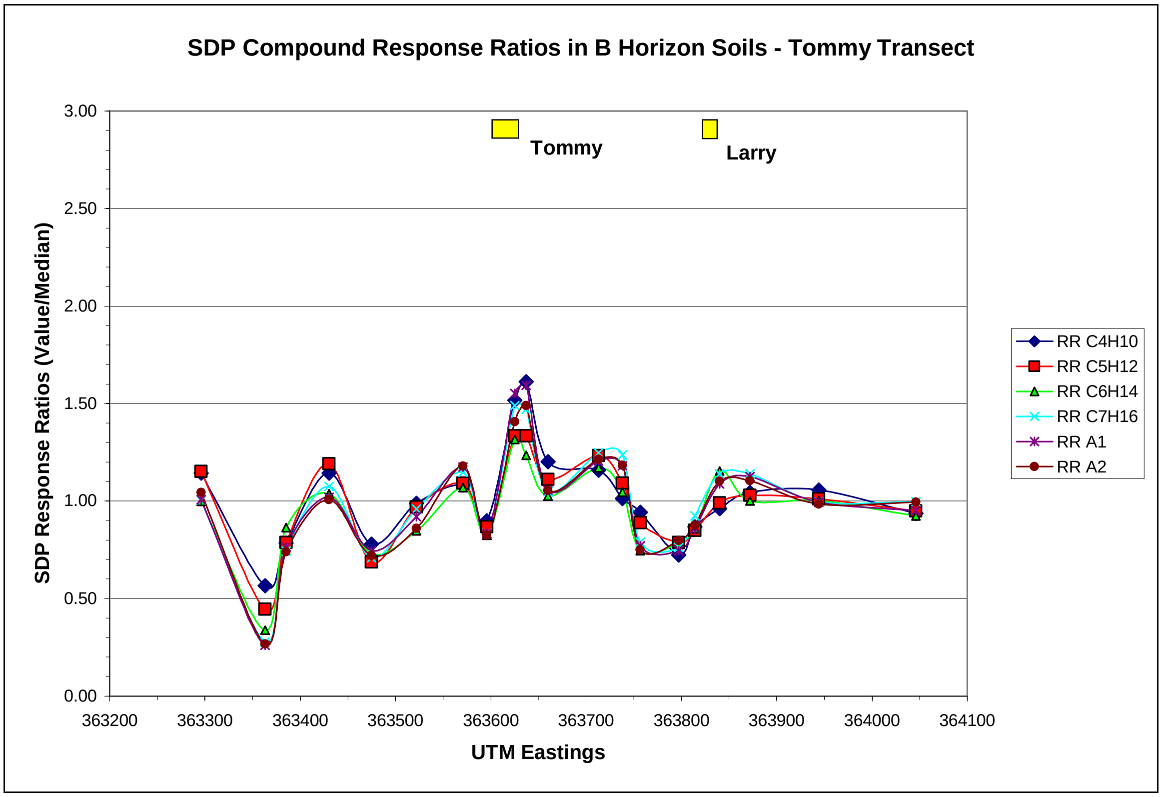
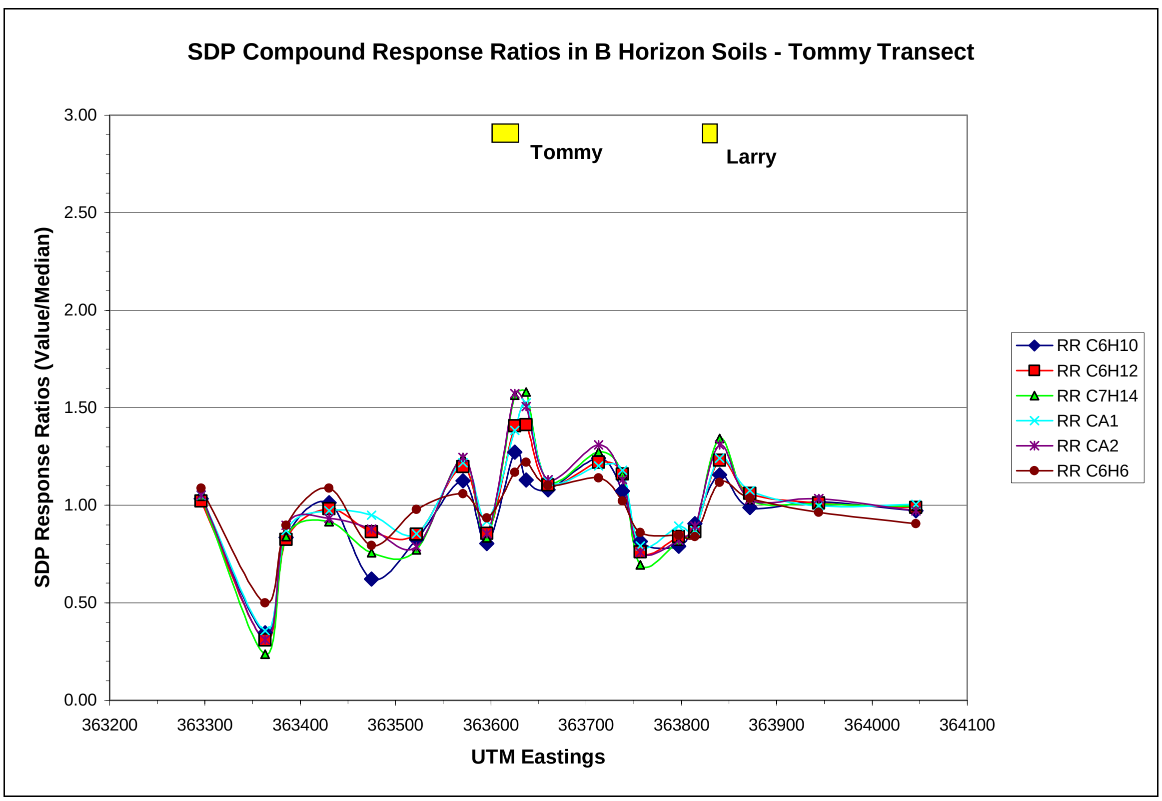
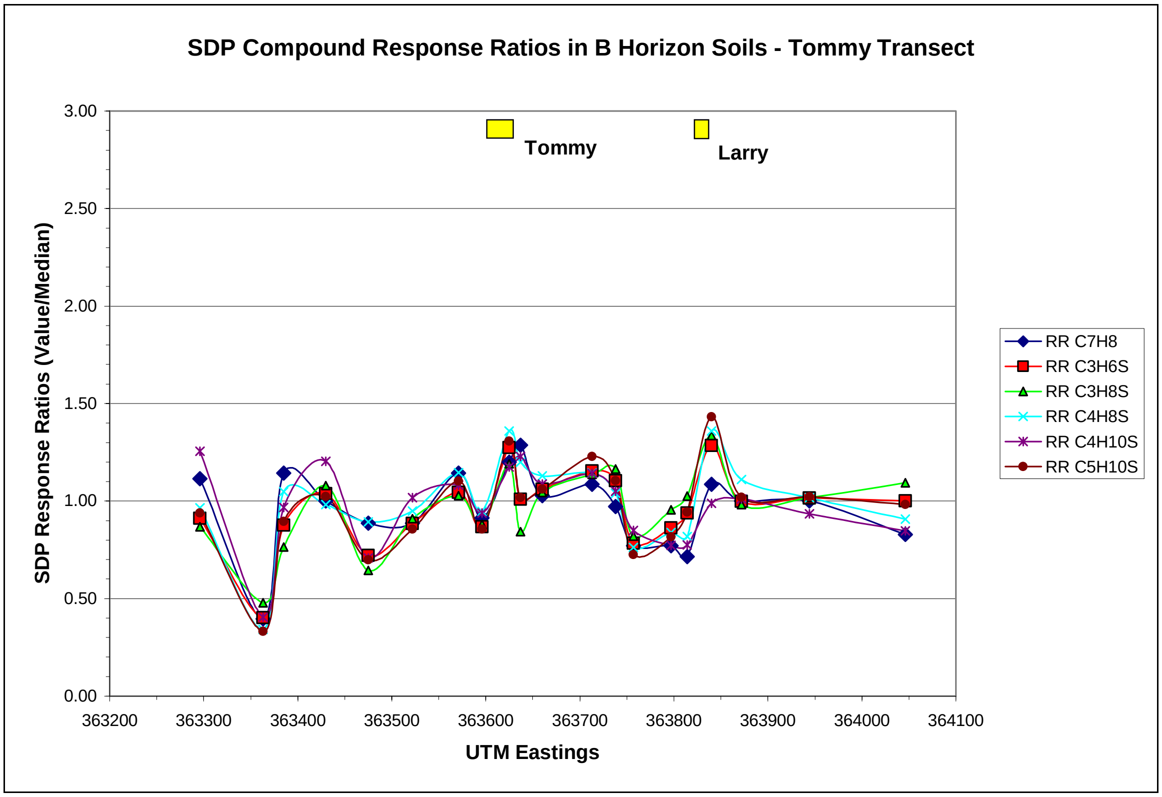


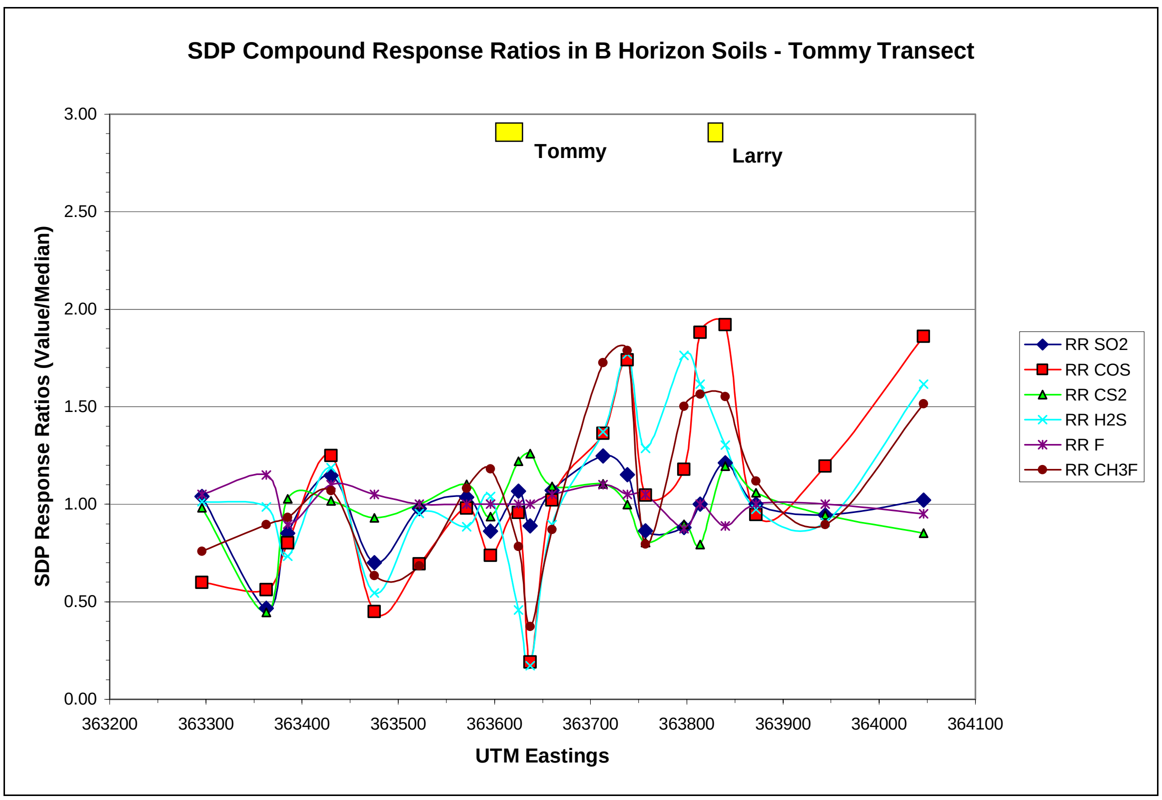
Figure 228. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Tommy vein orientation transect.*





Figures 229 and 230. *Calculated response ratios for Soil Desorption Pyrolysis (SDP) results for selected organic compounds determined by GC/MS in B horizon soils from the Tommy vein orientation transect.*





Figures 231 and 232. *Calculated response ratios for Soil Desorption Pyrolysis (SDP) results for selected organic compounds and fluoride, determined by GC/MS in B horizon soils from the Tommy vein orientation transect.*

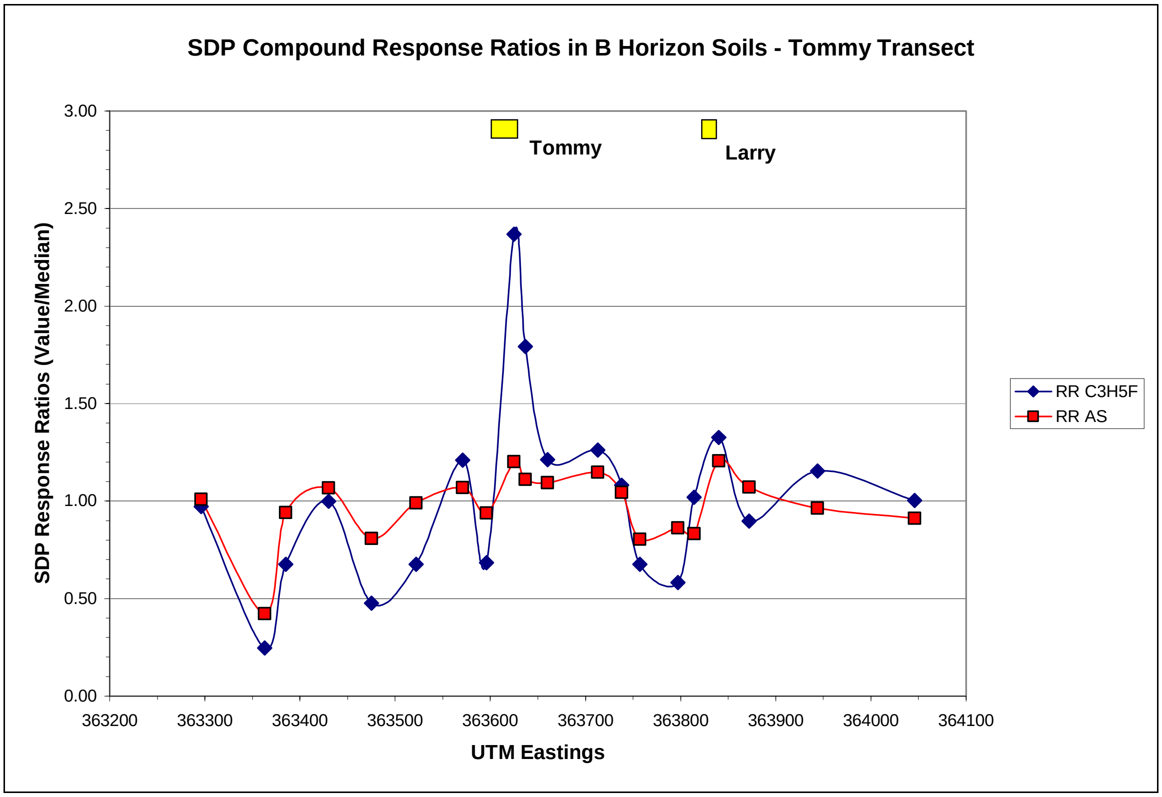
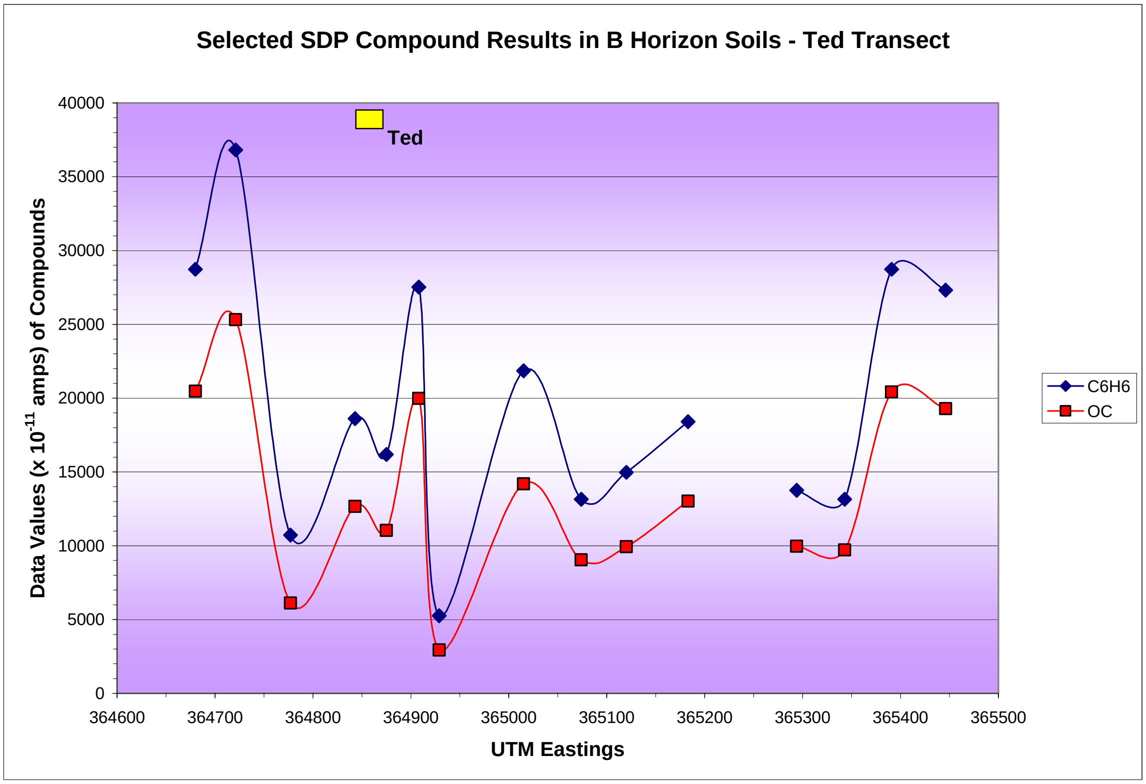
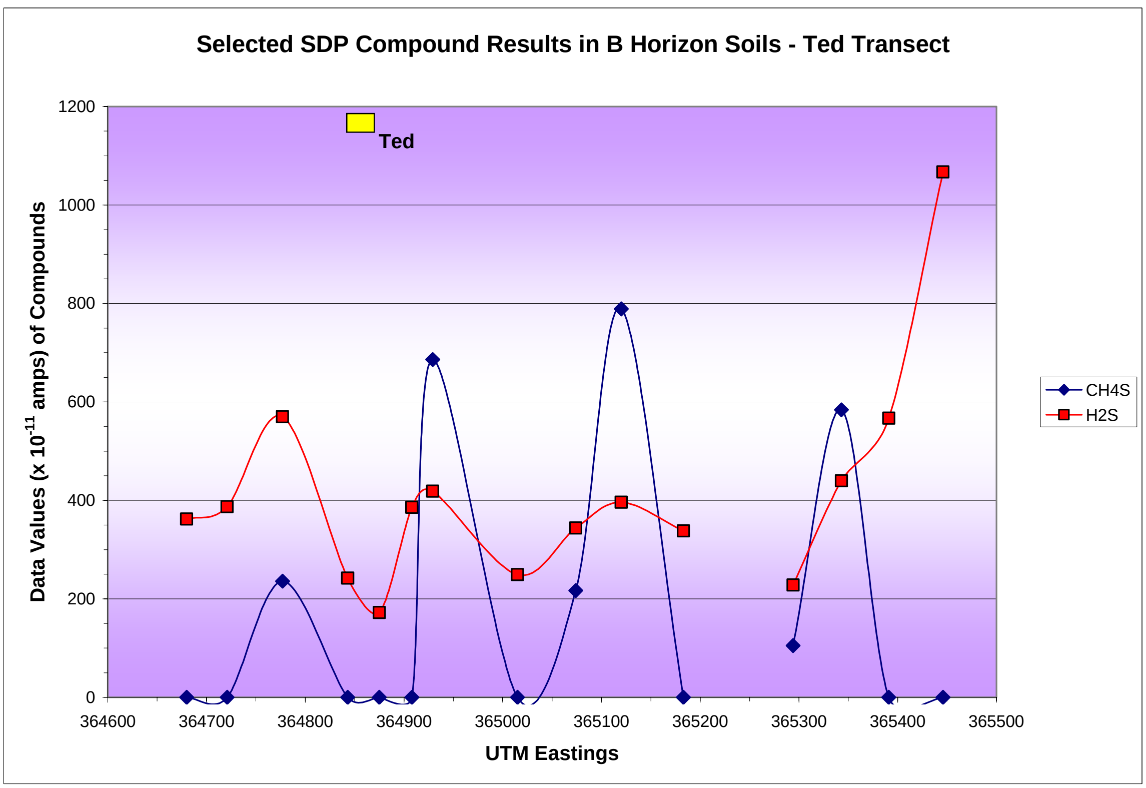
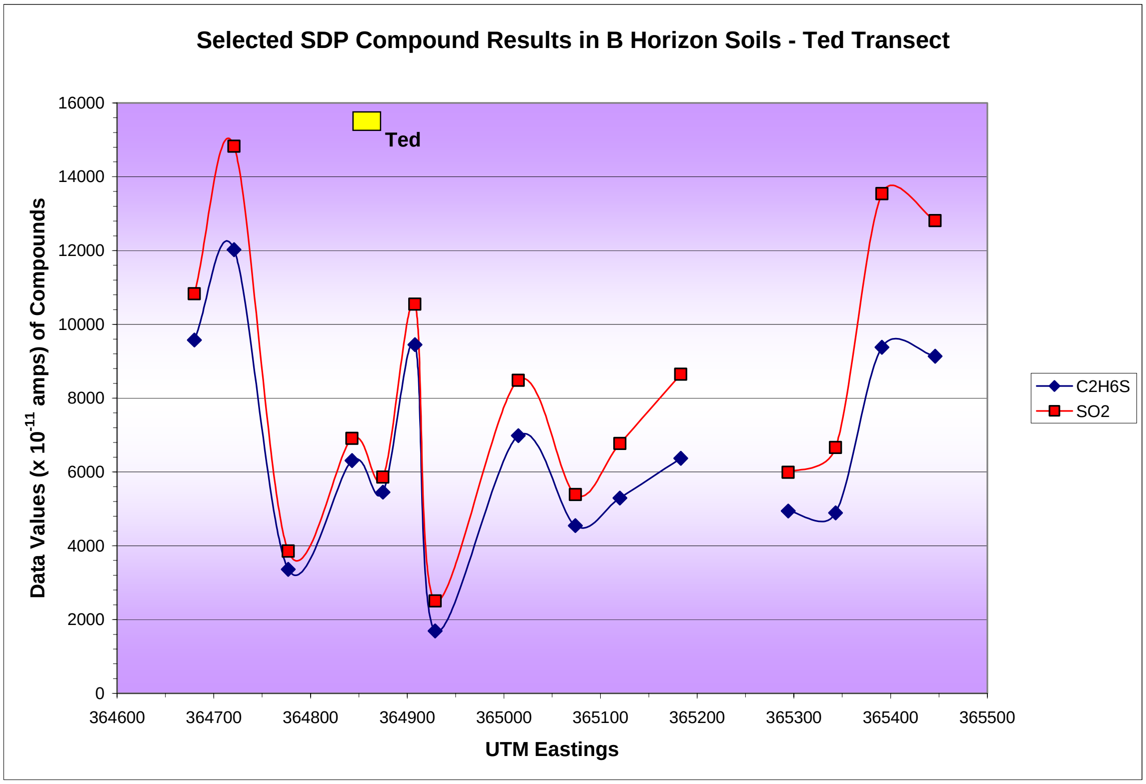


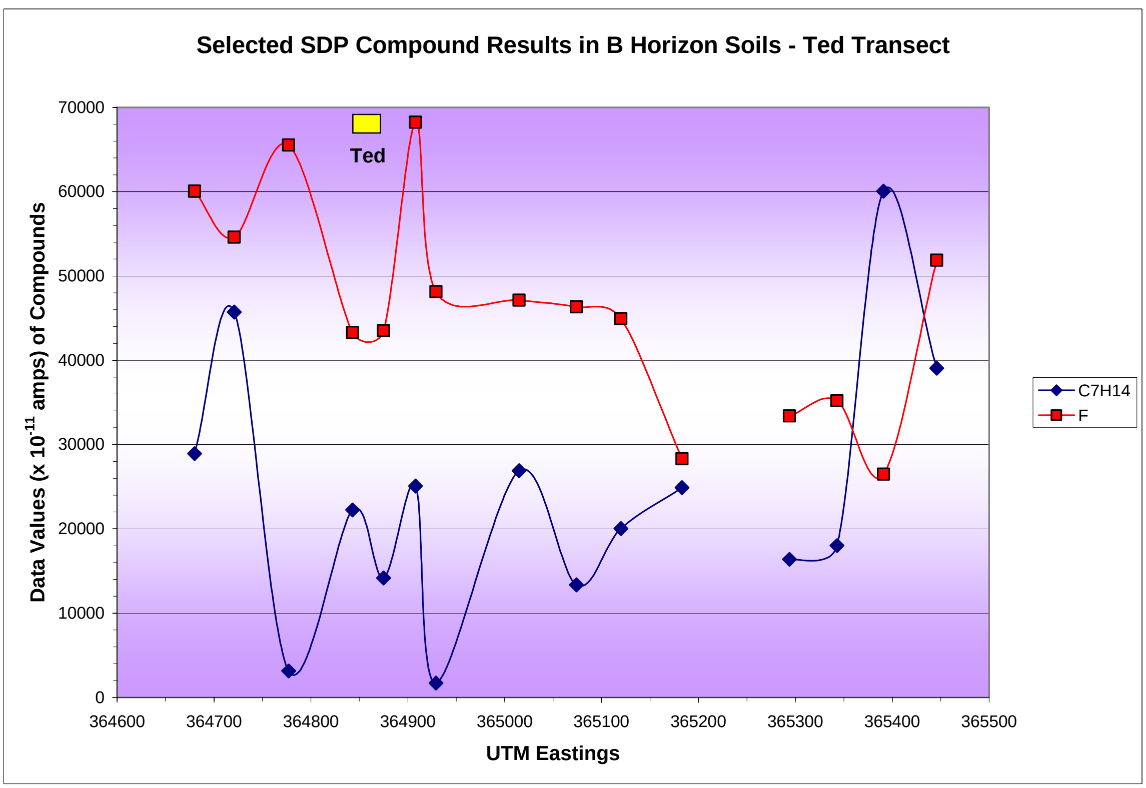
Figure 233. *Calculated response ratios for Soil Desorption Pyrolysis (SDP) results for the organic compound C_3H_5F and arsenic determined by GC/MS in B horizon soils from the Tommy vein orientation transect. Compound C_3H_5F provides the greatest response ratio contrast of any SDP compound over the Tommy vein.*





Figures 234 and 235. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds by GC/MS in B horizon soils from the Ted vein orientation transect. Note that compound distributions here do not reflect the presence of known mineralization here as well as they do at the Tommy vein.*





Figures 236 and 237. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds and fluoride, by GC/MS in B horizon soils from the Ted vein orientation transect.*

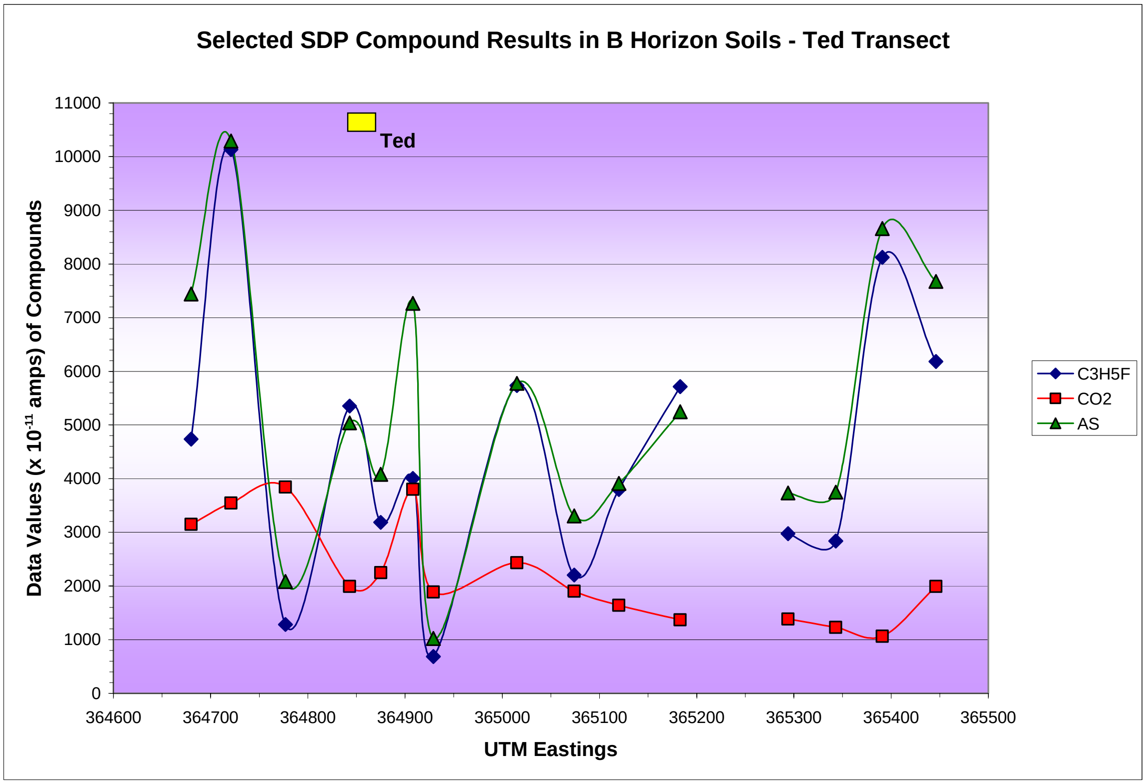
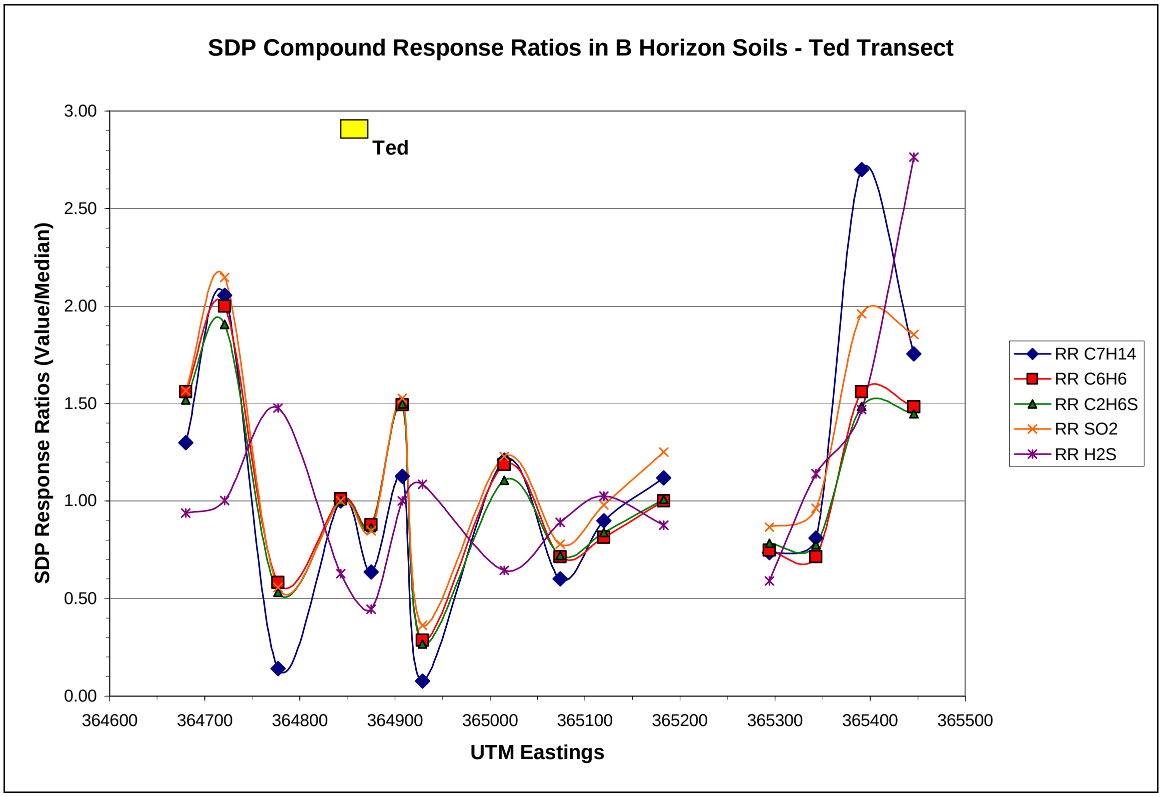
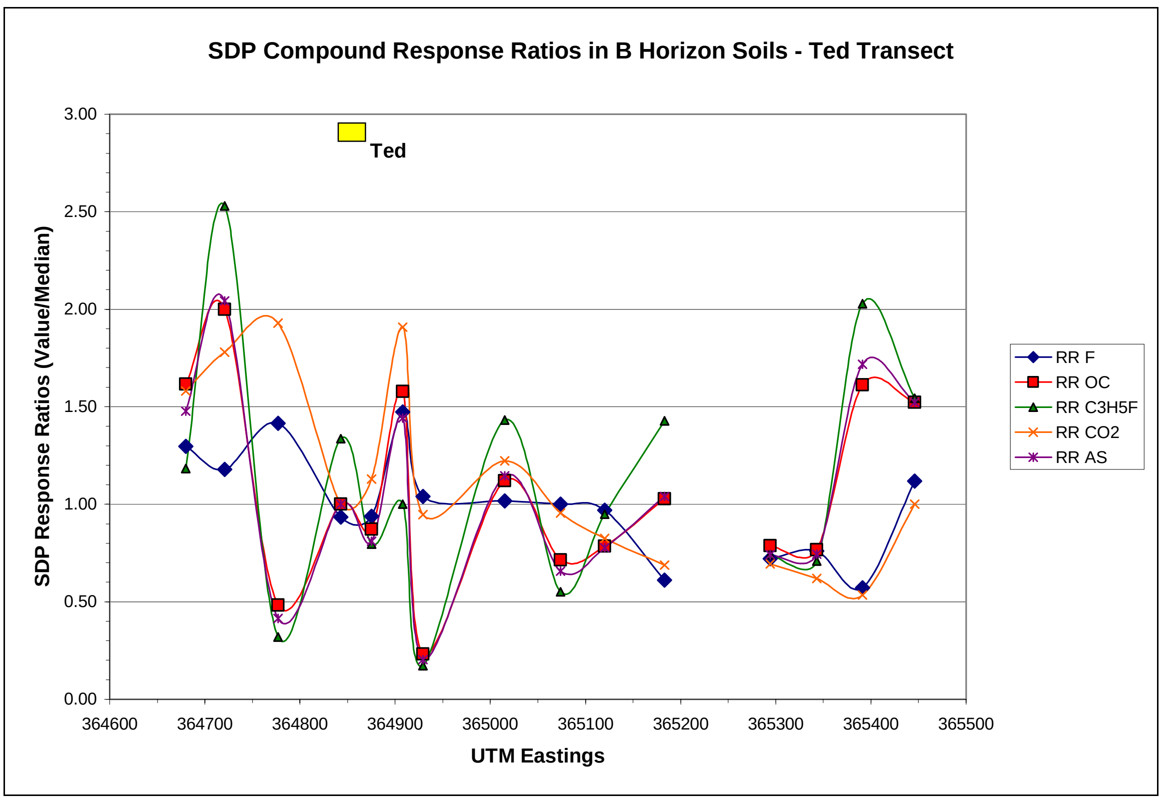


Figure 238. *Soil Desorption Pyrolysis (SDP) results for selected organic compounds and arsenic, by GC/MS in B horizon soils from the Ted vein orientation transect. Note that compound* C_3H_5F*, which provides the best geochemical contrast on the Tommy vein transect, does not clearly reflect the presence of known vein-style Au-Ag mineralization at the Ted vein.*





Figures 239 and 240. *Calculated response ratios for Soil Desorption Pyrolysis (SDP) results for selected organic compounds, as well as fluoride and arsenic, determined by GC/MS in B horizon soils from the Ted vein orientation transect.*

h) Na-Pyrophosphate Leach (Na-Py) Results in Humus

Summary statistics for 44 elements determined by Na-Pyrophosphate leach–ICP-MS (Acme Labs Group 1SLO method) of the 3Ts LFH horizon humus samples are shown for the combined transect results, and for individual Tommy vein and Ted vein orientation transect results (Table 17).

In all, 44 of the 58 elements reported in the Group 1SLO analytical suite are considered here, and are included in the digital data files that accompany this report. Data for 14 elements (As, Bi, Sb, W, Se, Te, Ge, Hf, Ho, In, Lu, Re, Sn and Ta) were removed from this dataset as all or most of the reported results are less than the stated analytical detection limits. For example, W results for every sample is less than the stated analytical detection limit of 10 ppb. In the case of As and Sb, all but 1 or 2 field samples report less than the stated detection limits of 100 ppb and 5 ppb, respectively. The unavailability of some key precious metal pathfinder elements such as As and Sb in the Na-Pyrophosphate leach suite due to inadequate detection limits is a limitation in the use of this method for geochemical exploration for epithermal gold deposits.

Data for several additional elements that mostly report below stated detection limits, including Th, Ti, Au, Hg, Be, Eu, Ga, Li, Nb, Tb, Tl, Tm and Yb, are nevertheless retained here. Results for these elements, with the exception of Au, that are less than the stated detection limits are set to a value equal to the detection limit. In the case of Au, all values less than the stated detection limit of 0.2 ppb are set to one-half this value (0.1 ppb).

Geochemical plot maps showing percentile element distributions are provided here for two elements, Ag (Figure 241) and Au (Figure 242), which show positive responses in humus over Tommy and Ted vein Au mineralizations. Comparative LFH horizon humus transect plots and response ratios showing Na-Pyrophosphate leach results relative to those obtained for aqua regia digestion are shown in Figures 243 to 256 and Figures 2597 to 260 for Au, Ag and base metals, respectively, along each orientation line. These show that aqua regia geochemical response in humus, although not as pronounced as in B horizon soils, is nevertheless effective in highlighting both Tommy and Ted veins. In the case of Ag, for example, comparative response ratios for humus using both aqua regia and Na-Pyrophosphate leach methods show similar patterns, but greater contrast by AR. Aqua regia reports a response ratio of more than 11 times background for Ag over the Tommy vein, whereas that for Na-Pyrophosphate is only 7 times background (Figures 243 and 244). Both methods also provide about 6 to 8 times geochemical contrast over the unknown central anomaly on the Tommy orientation transect with, again, the AR digestion providing the slightly greater contrast value of the two. Neither humus analytical method, however, outlines the location of the smaller Larry vein on this transect. Cadmium by Na-Pyrophosphate leach also displays strong geochemical contrast at the Tommy vein, with calculated response ratios of 10 times line background over Au mineralization (Figures 263 to 264).

Ted vein geochemical responses using either AR or Na-Pyrophosphate leach methods are typically more subdued relative to corresponding mineral soil results. In the case of Zn, for example, AR and Na-Pyrophosphate leach methods reported only an approximately 2.4 to 2.5 times background response in humus over the Ted vein (Figures 257 to 258). The cadmium response, however, is similar to that observed in the Tommy line results. Sodium-pyrophosphate leach response ratios for Cd over the Ted vein mineralization are more than 8 times line background, as defined by the median (Figures 265 to 266).

Table 17-1. *Summary statistics – Na-Pyrophosphate leach–ICP-MS results for LFH horizon humus.*

TOMMY LINE	**Ag**	**Al**	**Ba**	**Ca**	**Co**	**Cu**	**Fe**	**K**	**La**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sr**	**Th**	**Ti**	**U**
	ppb	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppb*
Median	**34**	**374.5**	**28.33**	**1030**	**209.5**	**0.85**	**128**	**414.5**	**83**	**281.5**	**232.5**	**95**	**0.22**	**1188**	**12.18**	**20**	**6**	**12.5**
Mean	54.10	399.95	24.50	1666.45	255.60	0.91	189.15	407.10	98.05	313.75	381.20	97.65	0.22	1220.15	12.57	29.00	10.20	13.70
± 1s	61.40	244.80	16.43	1398.68	177.10	0.38	151.40	109.86	66.06	113.58	273.70	39.82	0.11	406.13	5.10	23.14	12.58	5.65
CV (%)	*113.5*	*61.2*	*67.1*	*83.9*	*69.3*	*42.3*	*80.0*	*27.0*	*67.4*	*36.2*	*71.8*	*40.8*	*49.6*	*33.3*	*40.5*	*79.8*	*123.3*	*41.2*
Minimum	3	87	2.45	752	80	0.5	31	208	30	127	79	45	0.07	661	4.62	20	1	6
Maximum	239	1045	50.01	6417	735	2.14	496	614	317	586	1075	198	0.41	2085	21.85	116	50	28
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TED LINE	**Ag**	**Al**	**Ba**	**Ca**	**Co**	**Cu**	**Fe**	**K**	**La**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sr**	**Th**	**Ti**	**U**
	ppb	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppb*
Median	**37**	**404.5**	**18.64**	**1089.5**	**109.5**	**0.445**	**126**	**262**	**90**	**255**	**275.5**	**51.5**	**0.12**	**1055.5**	**7.35**	**20**	**1**	**14**
Mean	50.19	424.44	26.83	1773.56	127.69	0.61	207.13	261.56	390.63	306.38	352.56	186.19	0.17	967.81	8.29	38.75	3.44	258.38
± 1s	43.54	210.97	28.48	1343.75	77.36	0.41	188.14	80.89	1134.14	165.71	299.29	480.03	0.10	373.91	3.37	35.47	6.29	647.47
CV (%)	*86.8*	*49.7*	*106.2*	*75.8*	*60.6*	*67.8*	*90.8*	*30.9*	*290.3*	*54.1*	*84.9*	*257.8*	*60.2*	*38.6*	*40.6*	*91.5*	*183.1*	*250.6*
Minimum	14	146	2.01	661	50	0.22	45	107	37	103	82	16	0.07	323	2.69	20	1	9
Maximum	151	900	112.04	4783	321	1.72	619	390	4632	820	1314	1971	0.42	1665	16.52	144	25	2031
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

COMBINED LINES	**Ag**	**Al**	**Ba**	**Ca**	**Co**	**Cu**	**Fe**	**K**	**La**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sr**	**Th**	**Ti**	**U**
	ppb	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppb*	*ppm*	*ppm*	*ppm*	*ppb*	*ppm*	*ppb*
Median	**37**	**393.5**	**19.05**	**1030**	**134.5**	**0.69**	**128**	**335**	**88**	**268**	**241**	**68.5**	**0.18**	**1088**	**9.97**	**20**	**1**	**13.5**
Mean	52.36	410.83	25.54	1714.06	198.75	0.78	197.14	342.42	228.08	310.47	368.47	137.00	0.19	1108.00	10.67	33.33	7.19	122.44
± 1s	53.50	227.51	22.26	1356.01	154.10	0.42	166.42	121.39	758.53	137.06	281.53	318.76	0.11	406.98	4.86	29.22	10.70	441.46
CV (%)	*102.2*	*55.4*	*87.2*	*79.1*	*77.5*	*54.1*	*84.4*	*35.5*	*332.6*	*44.1*	*76.4*	*232.7*	*54.6*	*36.7*	*45.6*	*87.7*	*148.7*	*360.5*
Minimum	3	87	2.01	661	50	0.22	31	107	30	103	79	16	0.07	323	2.69	20	1	6
Maximum	239	1045	112.04	6417	735	2.14	619	614	4632	820	1314	1971	0.42	2085	21.85	144	50	2031
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

Table 17-2. *Summary statistics – Na-Pyrophosphate leach–ICP-MS results for LFH horizon.*

TOMMY LINE	**V**	**Zn**	**Au**	**Hg**	**Be**	**Cd**	**Ce**	**Cs**	**Dy**	**Er**	**Eu**	**Ga**	**Gd**	**Li**	**Nb**	**Nd**	**Pr**	**Rb**
	ppm	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**0.13**	**41.05**	**0.1**	**7.5**	**20**	**175**	**173.5**	**63**	**16**	**7**	**5**	**44.5**	**29**	**0.03**	**10**	**111**	**25.5**	**1336**
Mean	0.17	54.60	1.56	11.85	28.10	333.05	224.25	116.95	24.95	12.50	6.65	50.25	36.75	0.04	17.00	136.30	29.90	1557.85
± 1s	0.11	34.80	2.52	12.11	18.87	409.75	177.19	131.97	25.74	14.44	3.54	33.72	29.15	0.02	14.57	95.75	21.05	851.77
CV (%)	*66.4*	*63.7*	*161.7*	*102.2*	*67.2*	*123.0*	*79.0*	*112.8*	*103.2*	*115.5*	*53.3*	*67.1*	*79.3*	*51.1*	*85.7*	*70.2*	*70.4*	*54.7*
Minimum	0.08	16.7	0.1	5	20	54	50	15	5	5	5	20	11	0.02	10	43	9	704
Maximum	0.57	159.8	10.6	58	87	1784	743	536	113	65	17	146	115	0.08	65	425	94	3718
N=sites	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TED LINE	**V**	**Zn**	**Au**	**Hg**	**Be**	**Cd**	**Ce**	**Cs**	**Dy**	**Er**	**Eu**	**Ga**	**Gd**	**Li**	**Nb**	**Nd**	**Pr**	**Rb**
	ppm	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**0.10**	**34.55**	**0.1**	**7.5**	**20**	**112**	**168**	**34.5**	**21**	**8**	**5**	**33**	**30.5**	**0.02**	**10**	**139.5**	**28.5**	**713.5**
Mean	0.16	38.10	0.61	9.69	44.25	192.25	452.44	49.38	284.50	181.81	63.94	46.19	308.88	0.02	19.06	896.56	172.06	795.94
± 1s	0.14	20.36	1.72	6.47	60.73	223.36	974.91	38.03	1010.39	649.12	224.05	29.92	1079.29	0.01	18.82	2969.22	560.12	395.13
CV (%)	*83.8*	*53.4*	*283.5*	*66.8*	*137.2*	*116.2*	*215.5*	*77.0*	*355.1*	*357.0*	*350.4*	*64.8*	*349.4*	*51.8*	*98.7*	*331.2*	*325.5*	*49.6*
Minimum	0.05	5.6	0.1	5	20	41	87	17	8	5	5	20	14	0.02	10	64	12	179
Maximum	0.52	85.7	7	28	255	911	4054	144	4072	2614	904	107	4355	0.07	77	12025	2271	1764
N=sites	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

COMBINED LINES	**V**	**Zn**	**Au**	**Hg**	**Be**	**Cd**	**Ce**	**Cs**	**Dy**	**Er**	**Eu**	**Ga**	**Gd**	**Li**	**Nb**	**Nd**	**Pr**	**Rb**
	ppm	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppm*	*ppb*	*ppb*	*ppb*	*ppb*
Median	**0.13**	**38.5**	**0.1**	**7.5**	**20**	**136**	**172.5**	**52.5**	**18.5**	**7.5**	**5**	**41.5**	**30.5**	**0.02**	**10**	**117**	**26.5**	**981.5**
Mean	0.17	47.27	1.14	10.89	35.28	270.47	325.67	86.92	140.31	87.75	32.11	48.44	157.69	0.03	17.92	474.19	93.08	1219.22
± 1s	0.12	30.07	2.23	9.93	42.89	342.87	661.51	105.99	674.53	433.56	149.51	31.71	720.07	0.02	16.37	1982.47	373.94	779.87
CV (%)	*73.1*	*63.6*	*195.9*	*91.2*	*121.6*	*126.8*	*203.1*	*121.9*	*480.8*	*494.1*	*465.6*	*65.4*	*456.6*	*55.7*	*91.4*	*418.1*	*401.7*	*64.0*
Minimum	0.05	5.6	0.1	5	20	41	50	15	5	5	5	20	11	0.02	10	43	9	179
Maximum	0.57	159.8	10.6	58	255	1784	4054	536	4072	2614	904	146	4355	0.08	77	12025	2271	3718
N=sites	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

Table 17-3. *Summary statistics – Na-Pyrophosphate leach–ICP-MS results for LFH horizon humus.*

TOMMY LINE	**Sc** *ppm*	**Sm** *ppb*	**Tb** *ppb*	**Tl** *ppb*	**Tm** *ppb*	**Y** *ppb*	**Yb** *ppb*	**Zr** *ppb*
Median	**0.2**	**23**	**5**	**5**	**5**	**84.5**	**5.5**	**400.5**
Mean	0.17	30.10	6.20	5.50	5.20	135.55	9.95	391.60
± 1s	0.07	23.26	3.29	0.89	0.89	152.60	11.61	174.89
CV (%)	*38.6*	*77.3*	*53.0*	*16.2*	*17.2*	*112.6*	*116.7*	*44.7*
Minimum	0.1	10	5	5	5	27	5	148
Maximum	0.3	97	17	8	9	657	54	662
N=sites	20	20	20	20	20	20	20	20

TED LINE	**Sc** *ppm*	**Sm** *ppb*	**Tb** *ppb*	**Tl** *ppb*	**Tm** *ppb*	**Y** *ppb*	**Yb** *ppb*	**Zr** *ppb*
Median	**0.2**	**30**	**5**	**6**	**5**	**102**	**7.5**	**341**
Mean	0.38	261.81	46.63	6.81	31.25	2368.31	176.69	564.06
± 1s	0.61	909.70	157.47	2.43	100.56	8282.23	623.49	745.96
CV (%)	*159.5*	*347.5*	*337.7*	*35.6*	*321.8*	*349.7*	*352.9*	*132.2*
Minimum	0.1	12	5	5	5	39	5	209
Maximum	2.6	3672	637	13	408	33346	2510	3302
N=sites	16	16	16	16	16	16	16	16

COMBINED LINES	**Sc** *ppm*	**Sm** *ppb*	**Tb** *ppb*	**Tl** *ppb*	**Tm** *ppb*	**Y** *ppb*	**Yb** *ppb*	**Zr** *ppb*
Median	**0.2**	**26.5**	**5**	**5**	**5**	**95**	**6**	**367**
Mean	0.26	133.08	24.17	6.08	16.78	1127.89	84.06	468.25
± 1s	0.41	607.12	105.11	1.84	67.13	5538.65	416.82	512.49
CV (%)	*157.2*	*456.2*	*434.9*	*30.3*	*400.1*	*491.1*	*495.9*	*109.4*
Minimum	0.1	10	5	5	5	27	5	148
Maximum	2.6	3672	637	13	408	33346	2510	3302
N=sites	36	36	36	36	36	36	36	36

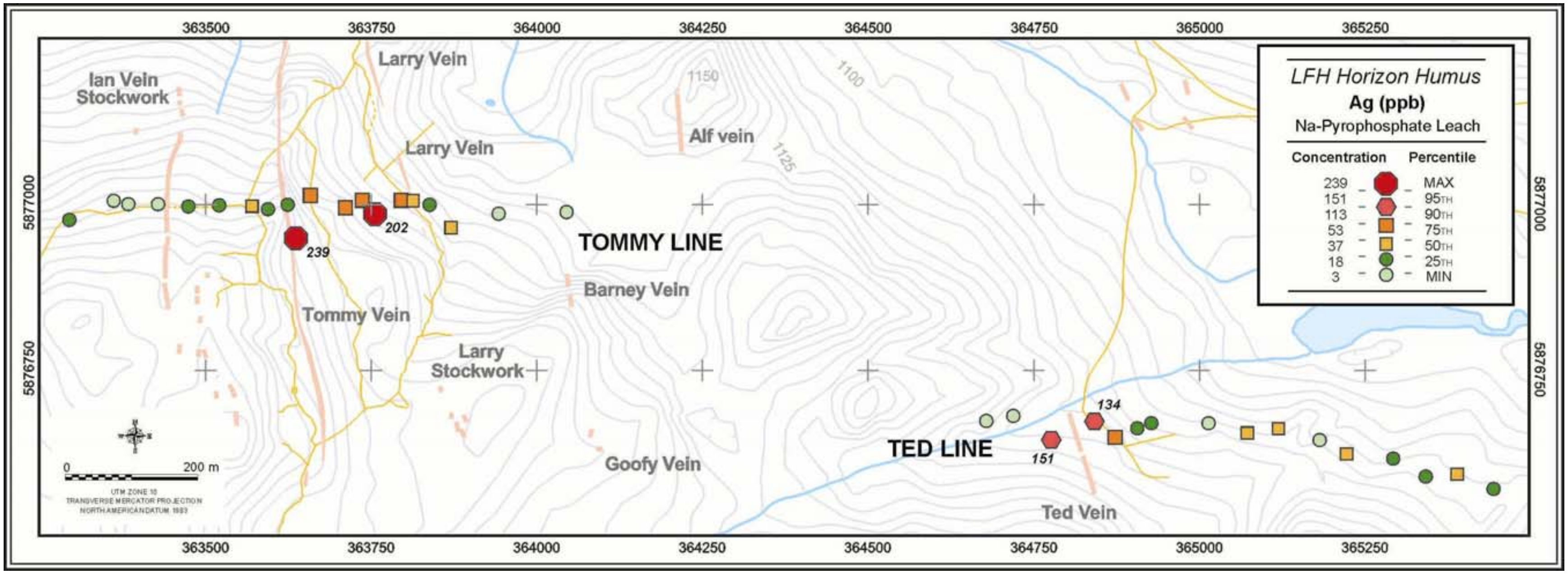


Figure 241. *Distribution of Ag (ppb) by Na-Pyrophosphate leach in organic-rich LFH horizon humus on the combined Tommy and Ted orientation transects (N=36 sites).*

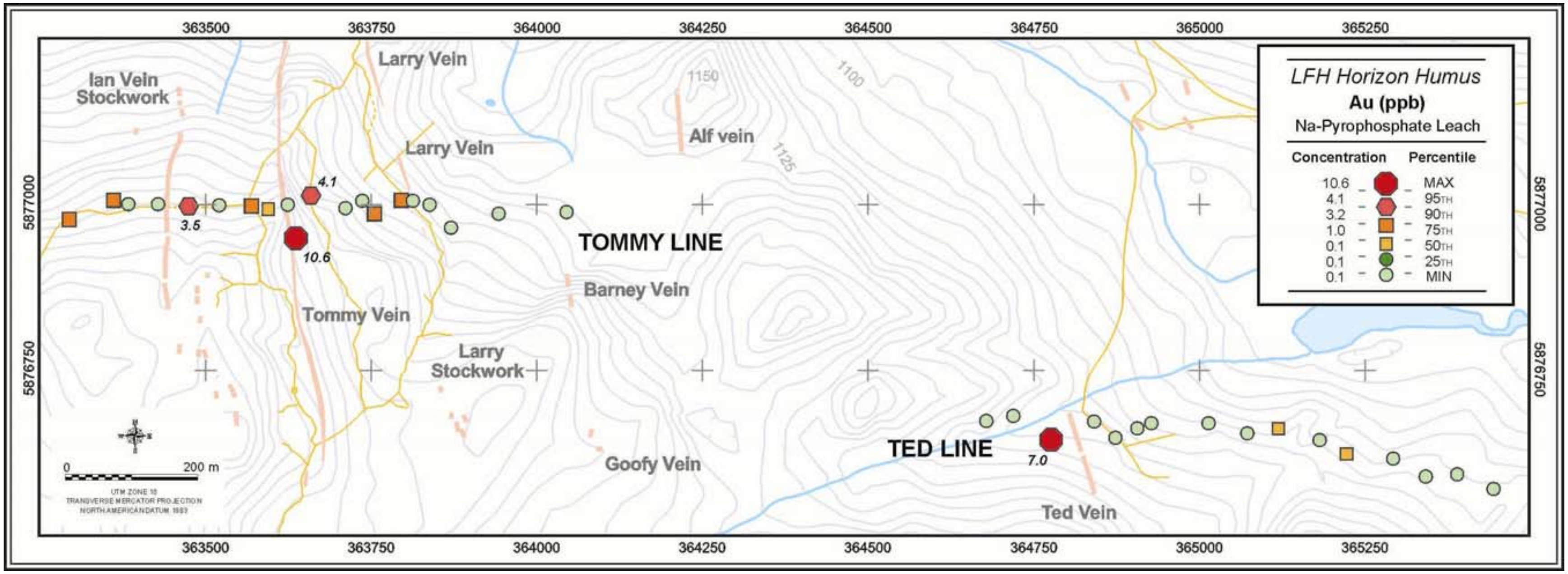
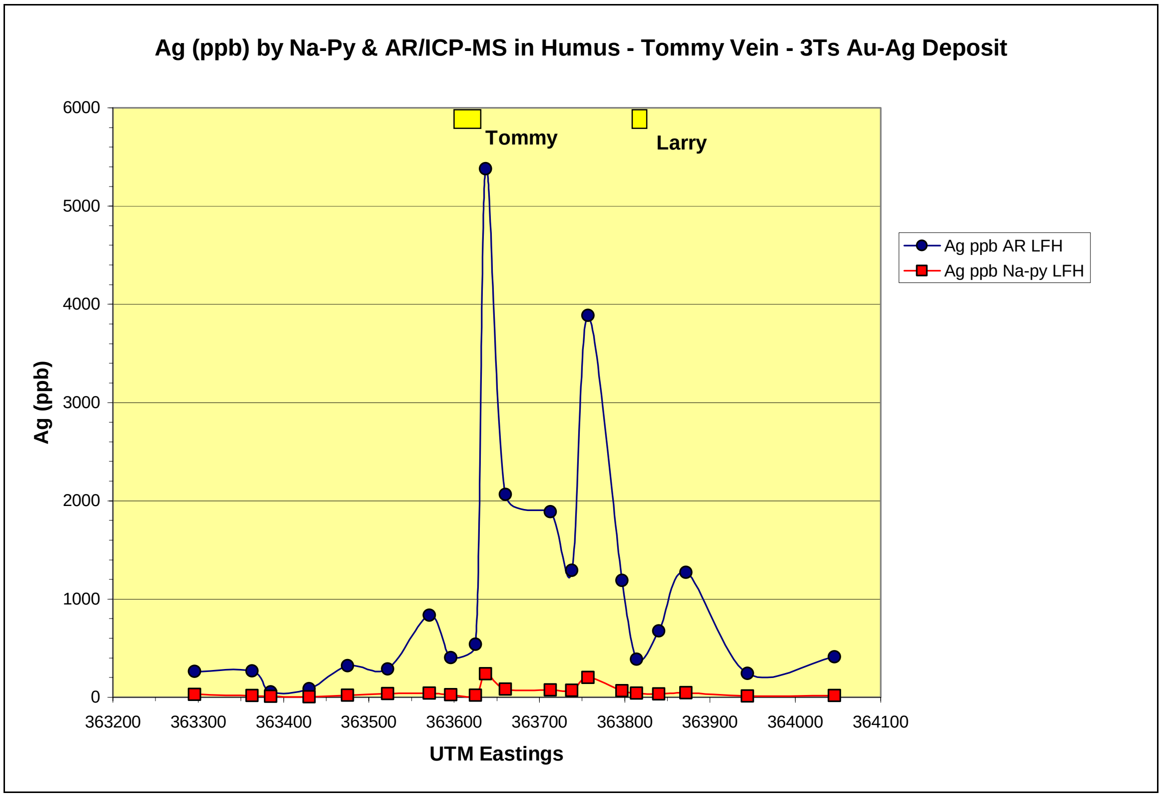
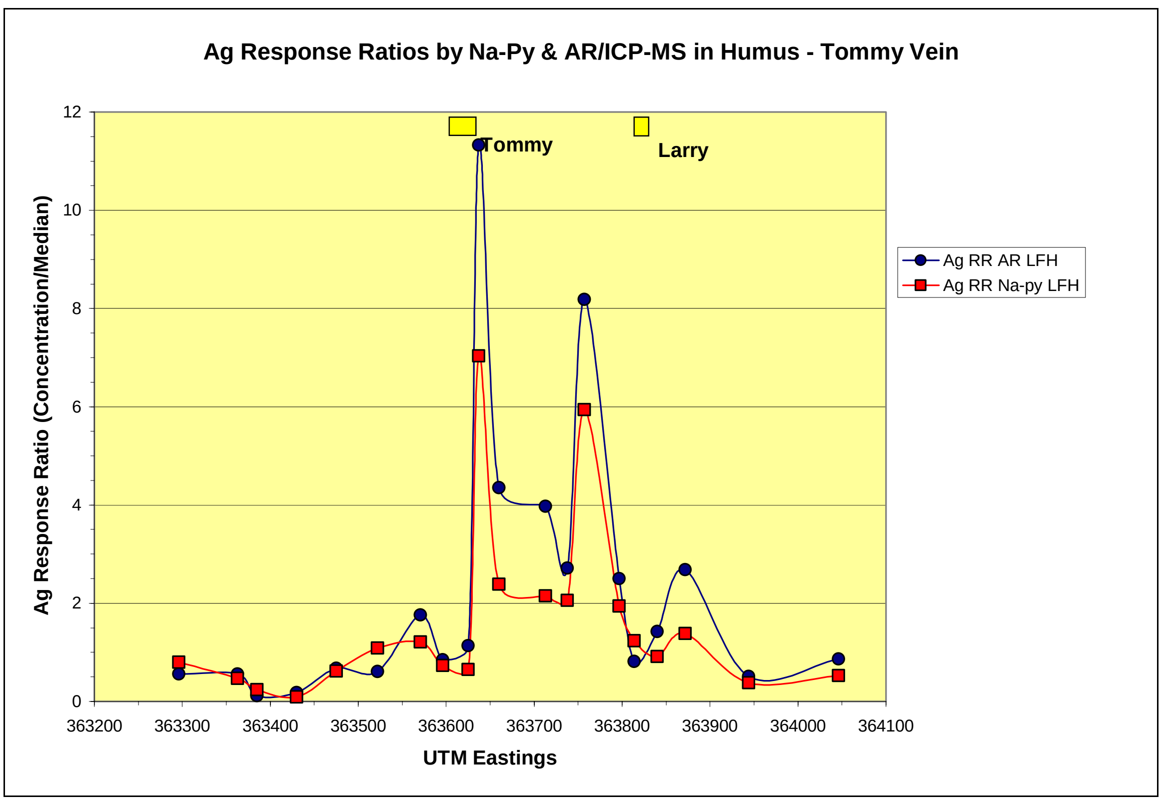
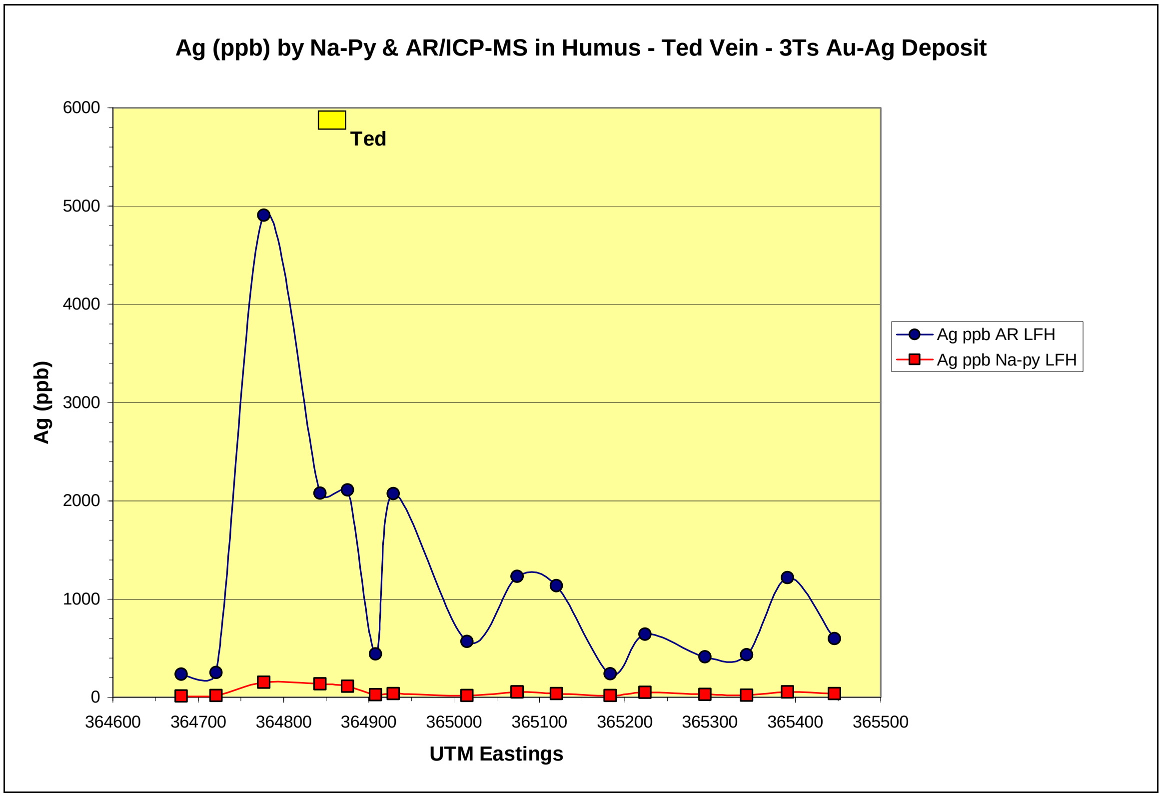


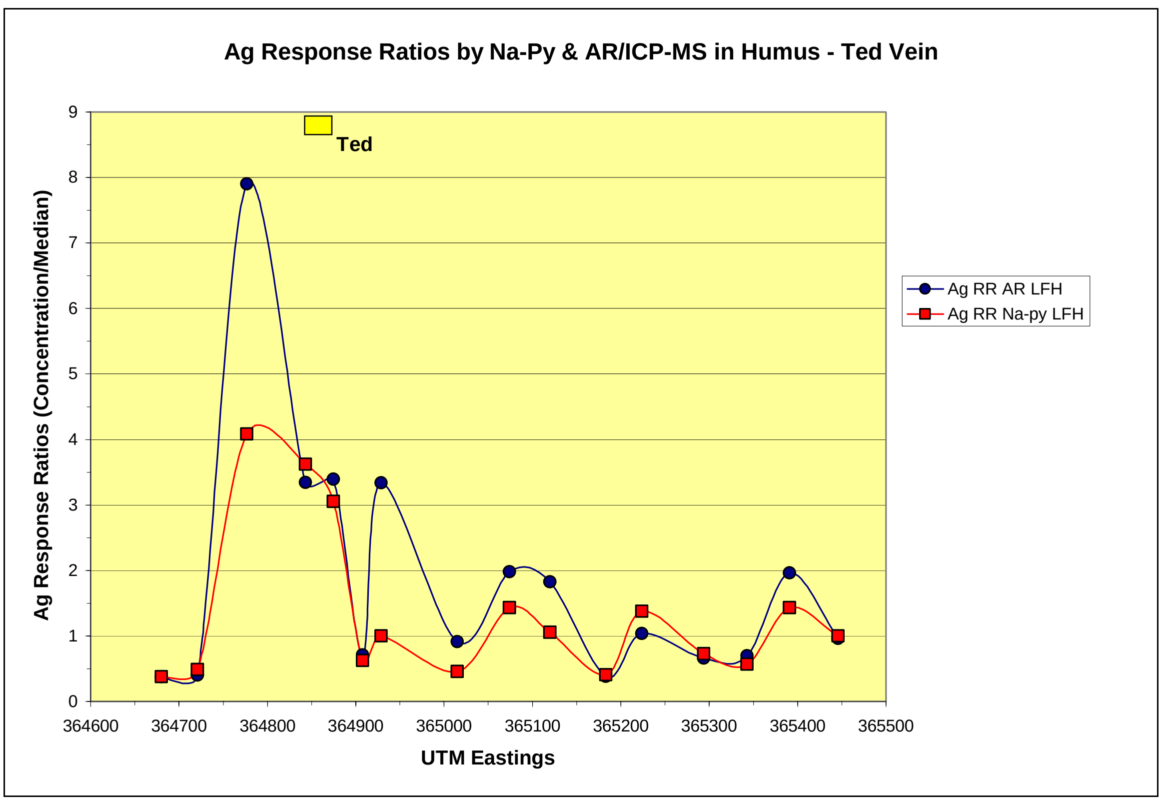
Figure 242. *Distribution of Au (ppb) by Na-Pyrophosphate leach in organic-rich LFH horizon humus on the combined Tommy and Ted orientation transects (N=36 sites).*



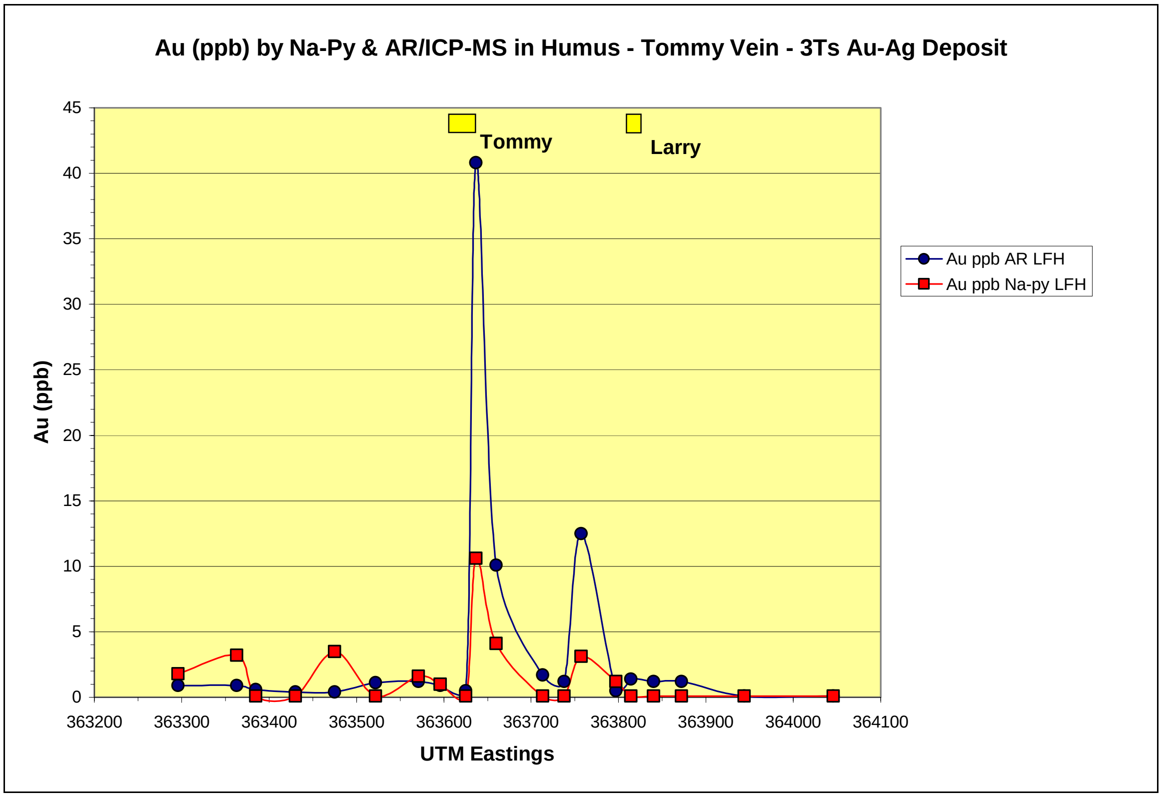


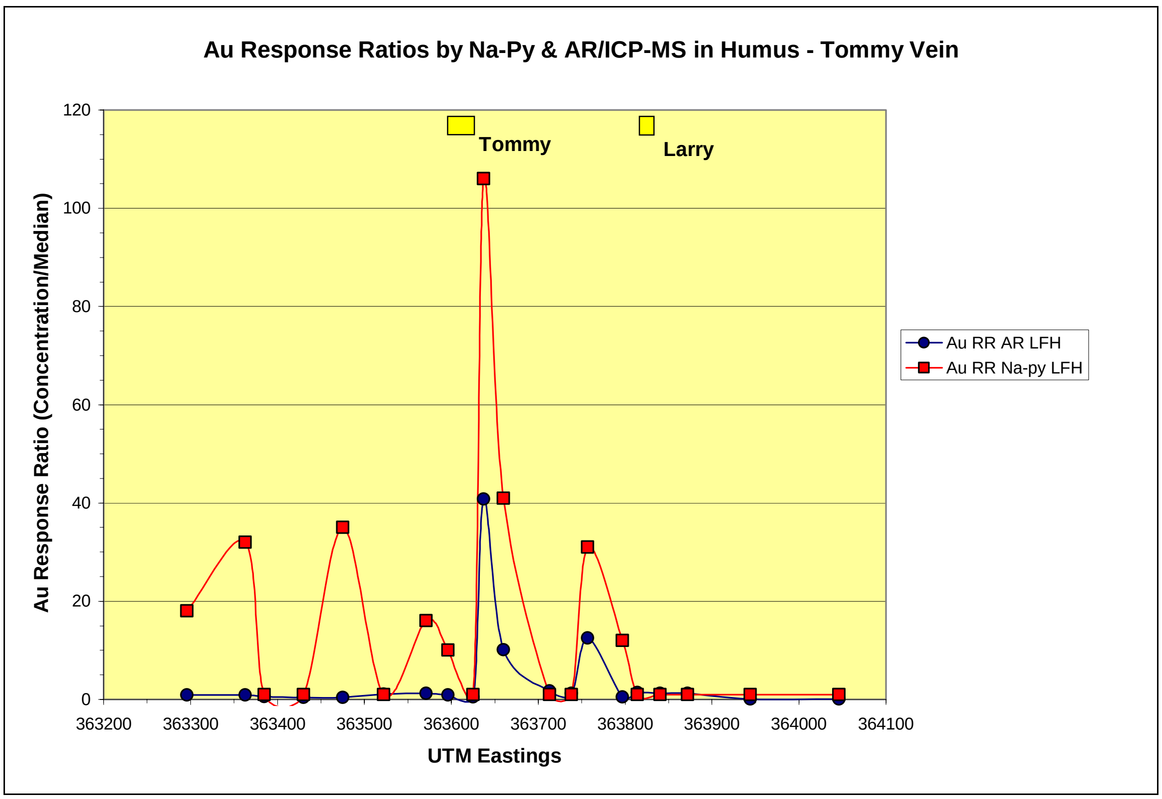
Figures 243 and 244. *Distribution of comparative silver concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*



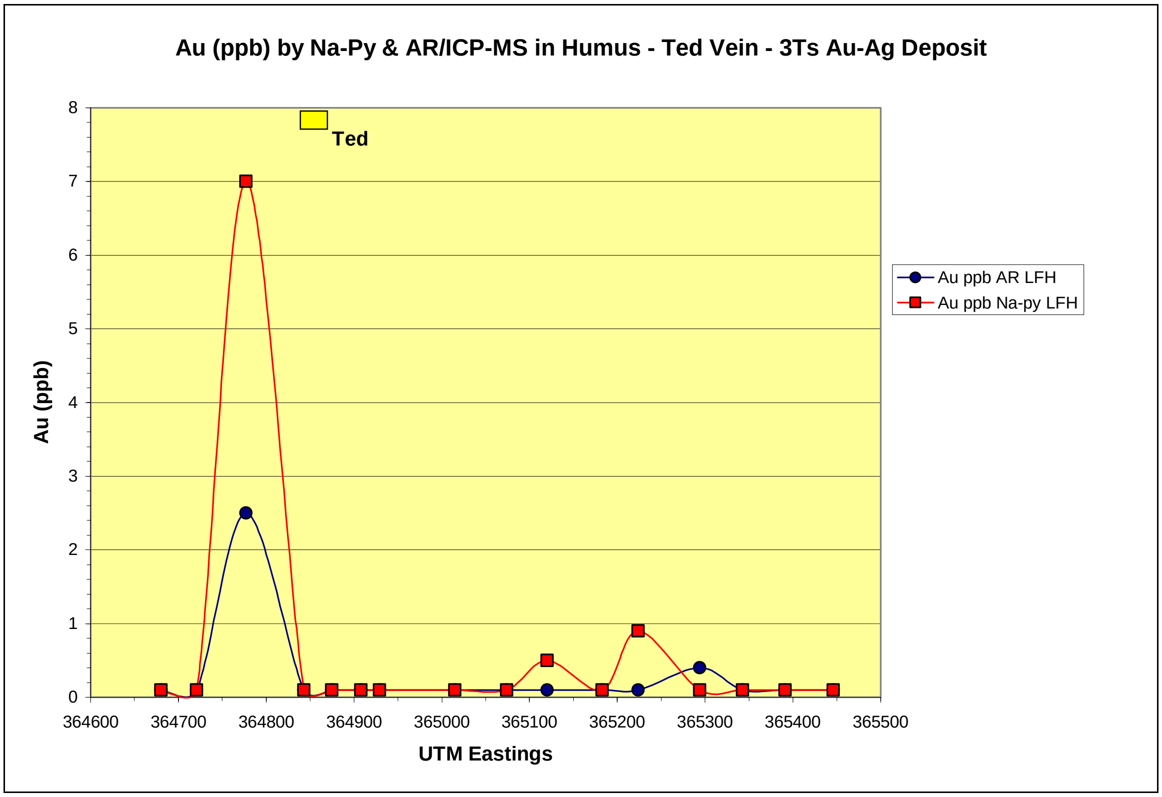


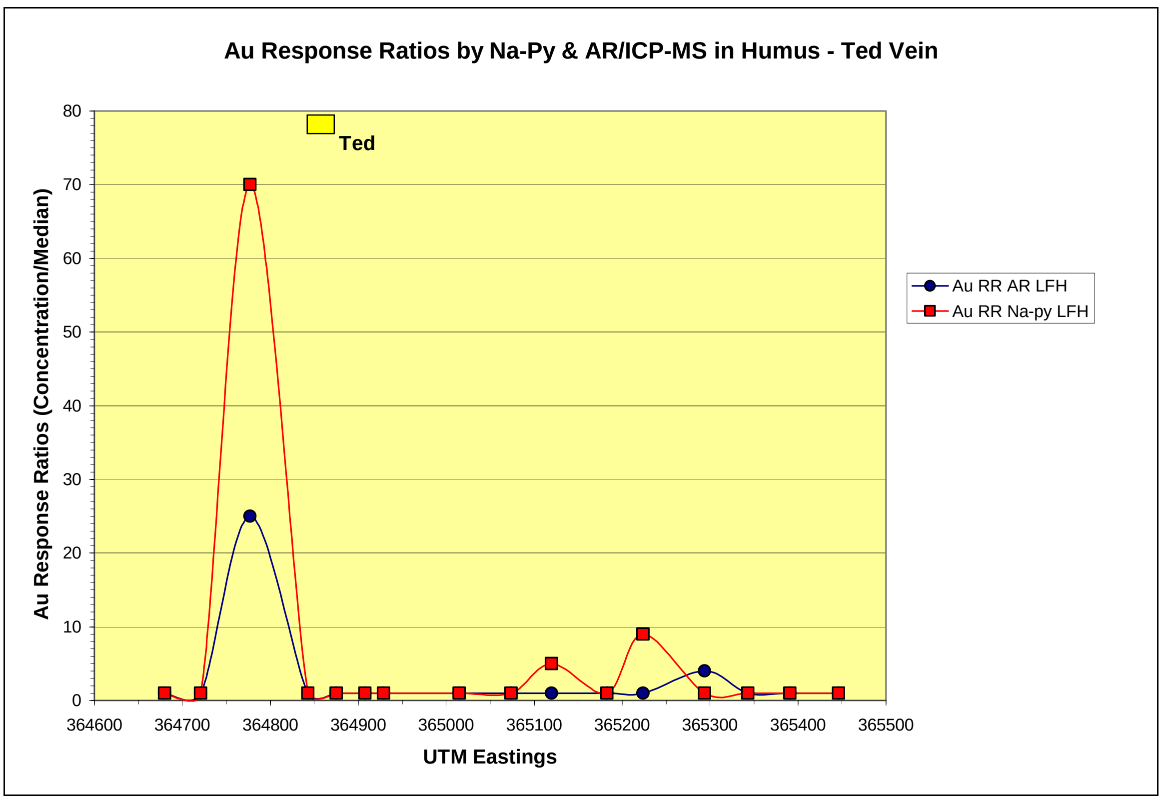
Figures 245 and 246. *Distribution of comparative silver concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*



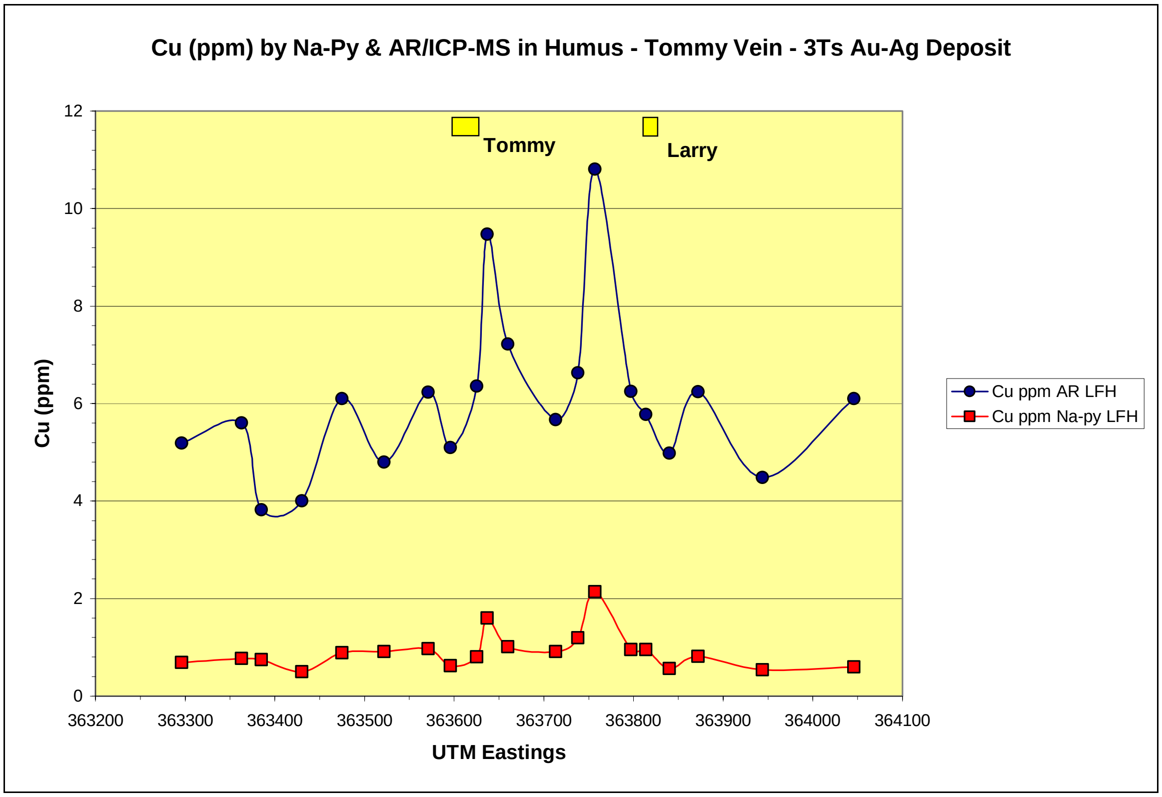


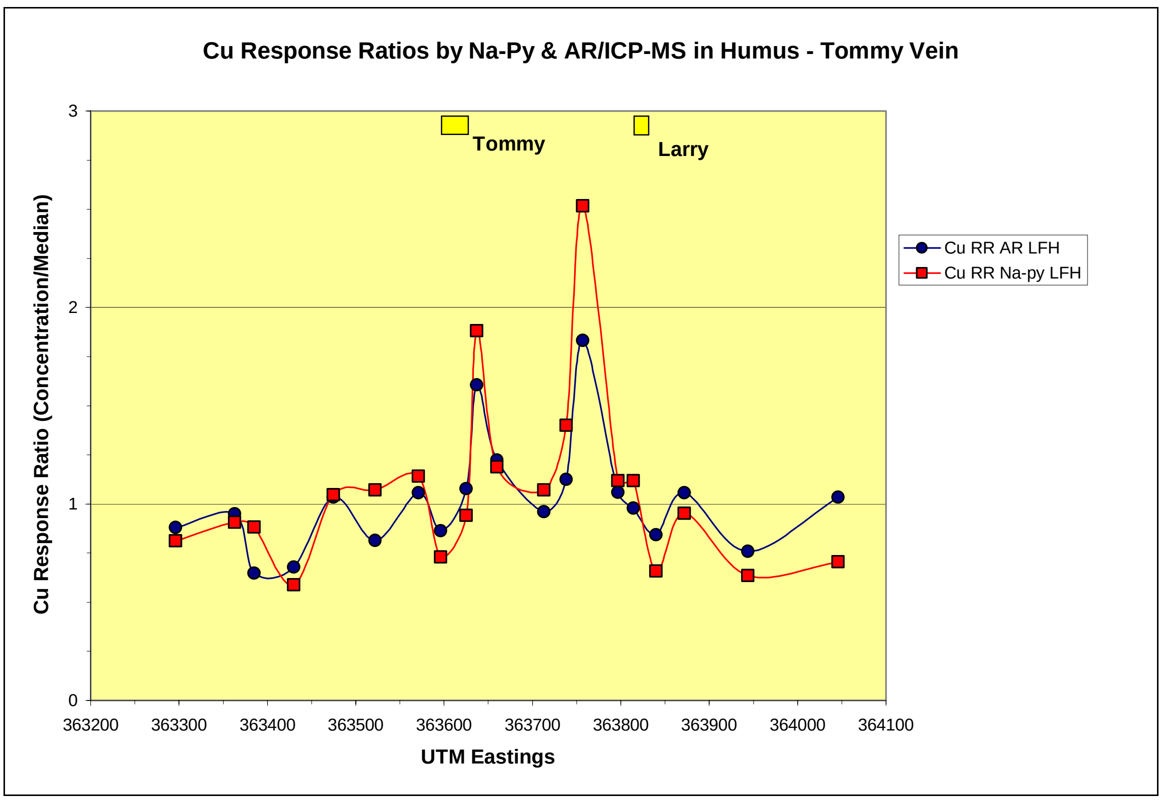
Figures 247 and 248. *Distribution of comparative gold concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*



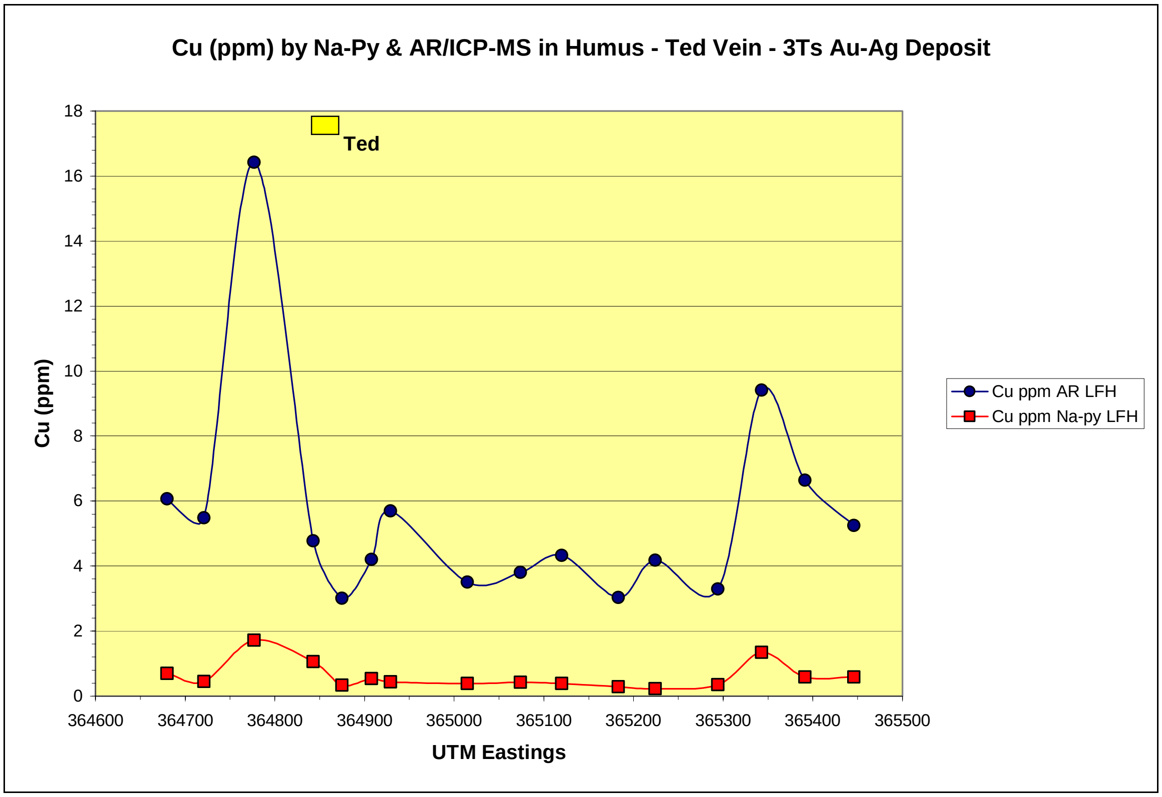


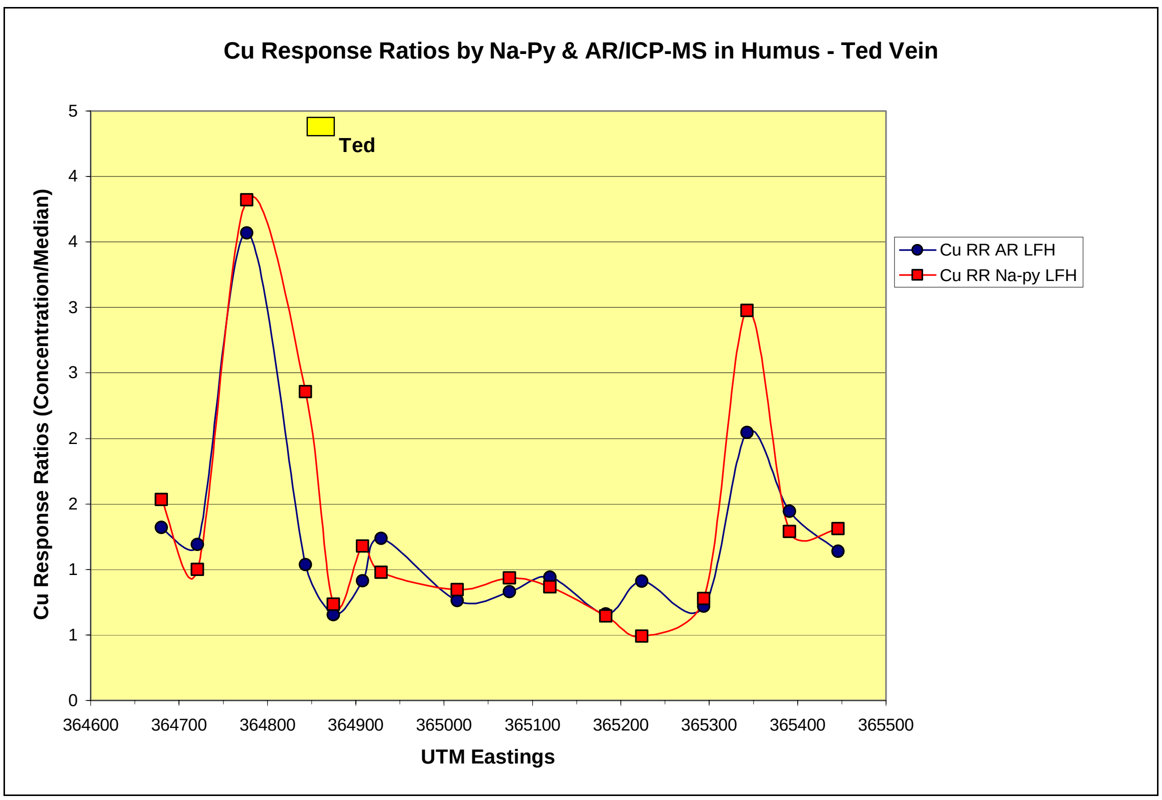
Figures 249 and 250. *Distribution of comparative gold concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*



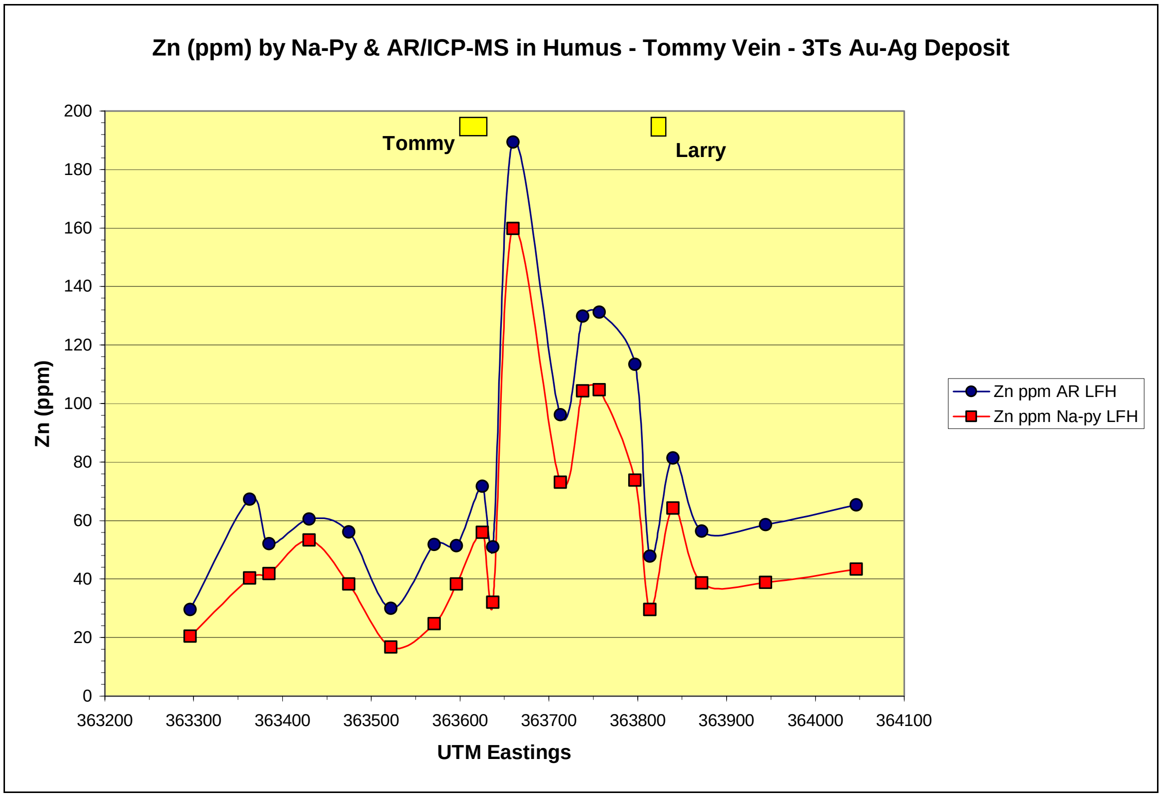


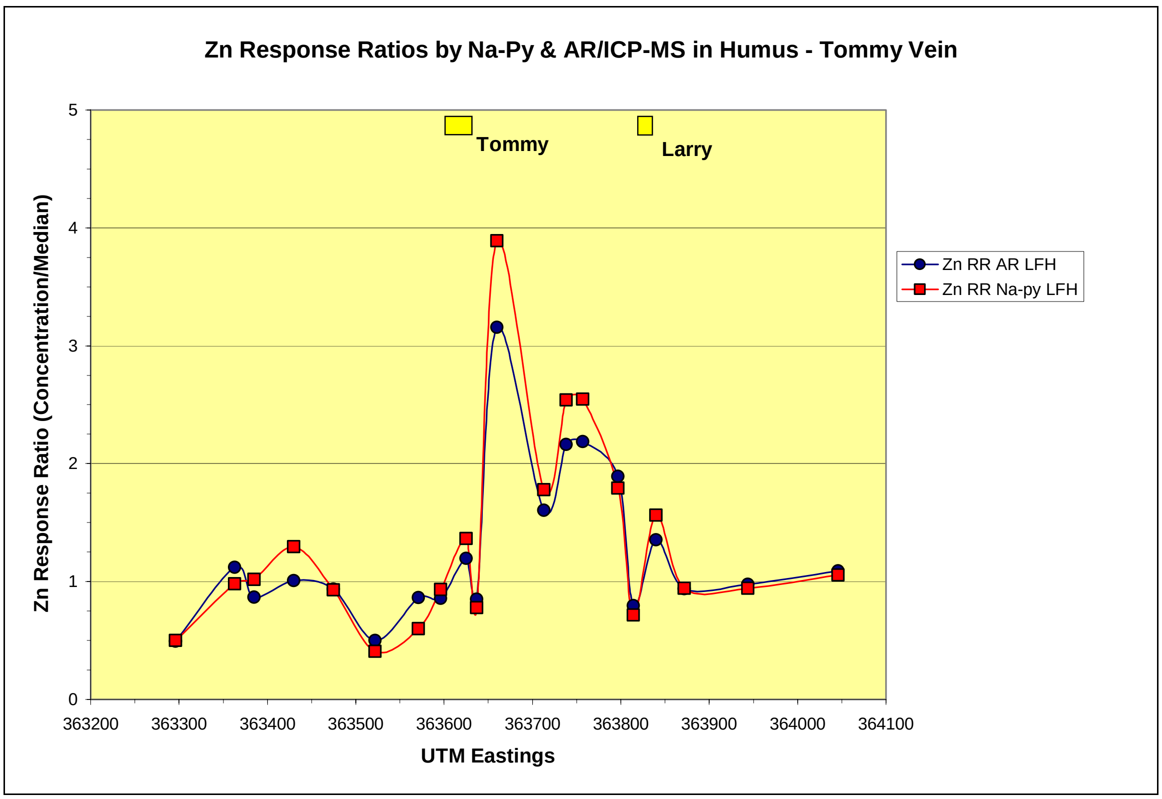
Figures 251 and 252. *Distribution of comparative copper concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*



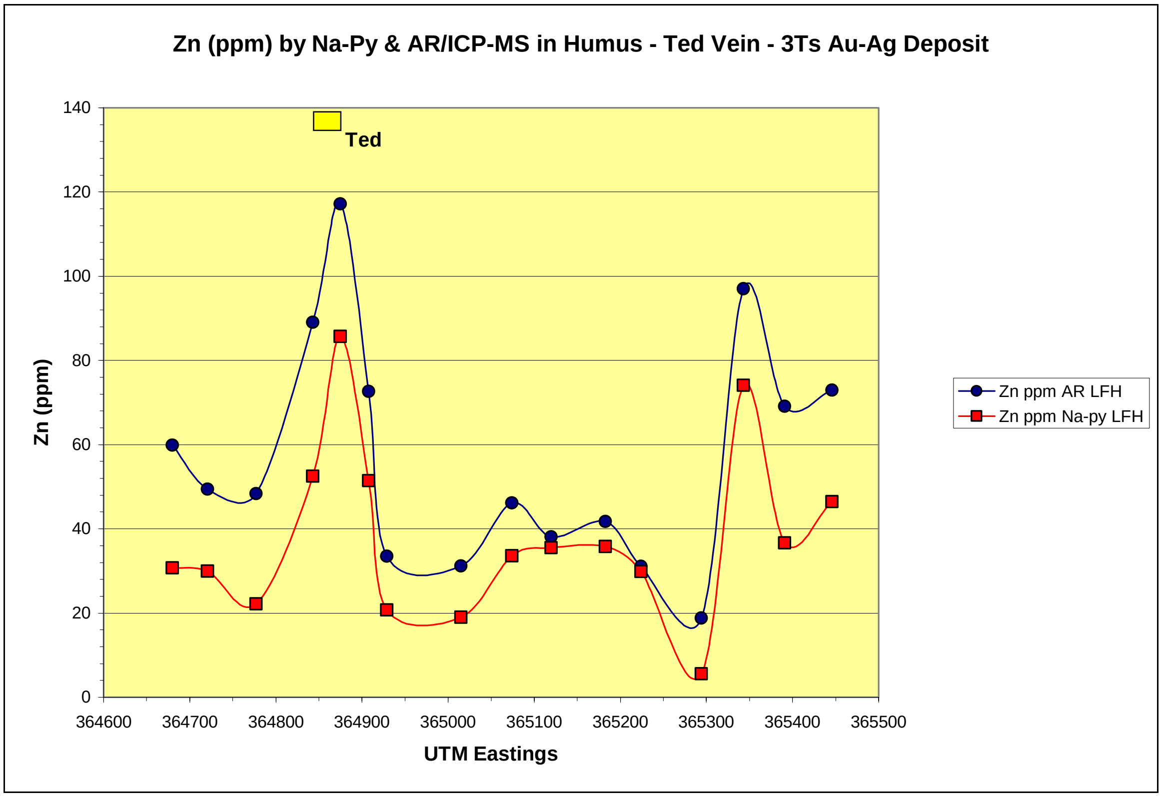


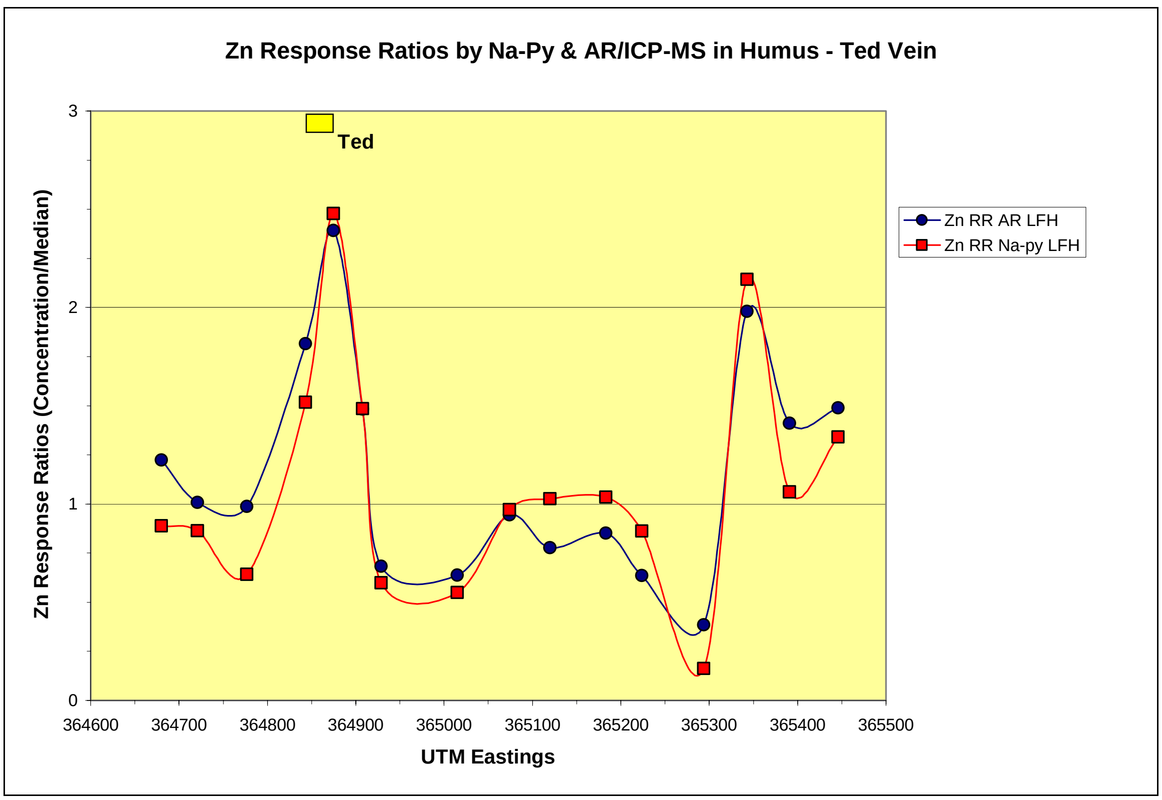
Figures 253 and 254. *Distribution of comparative copper concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*



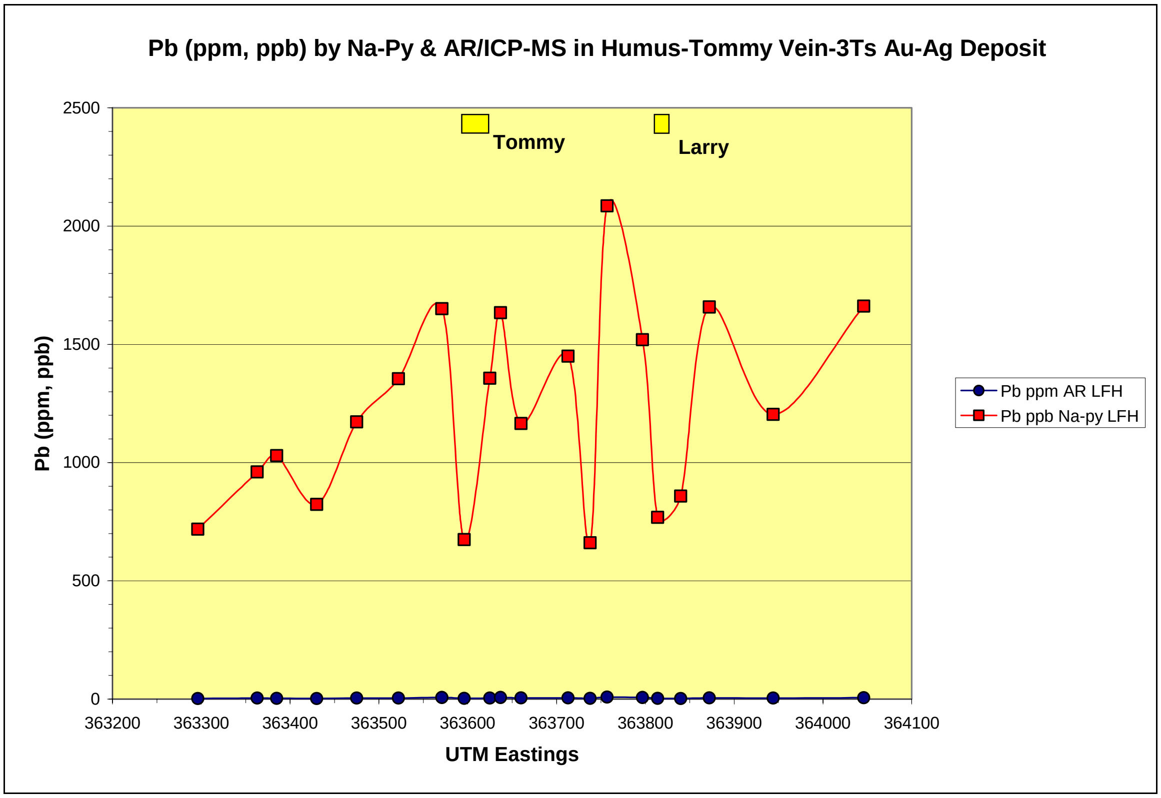


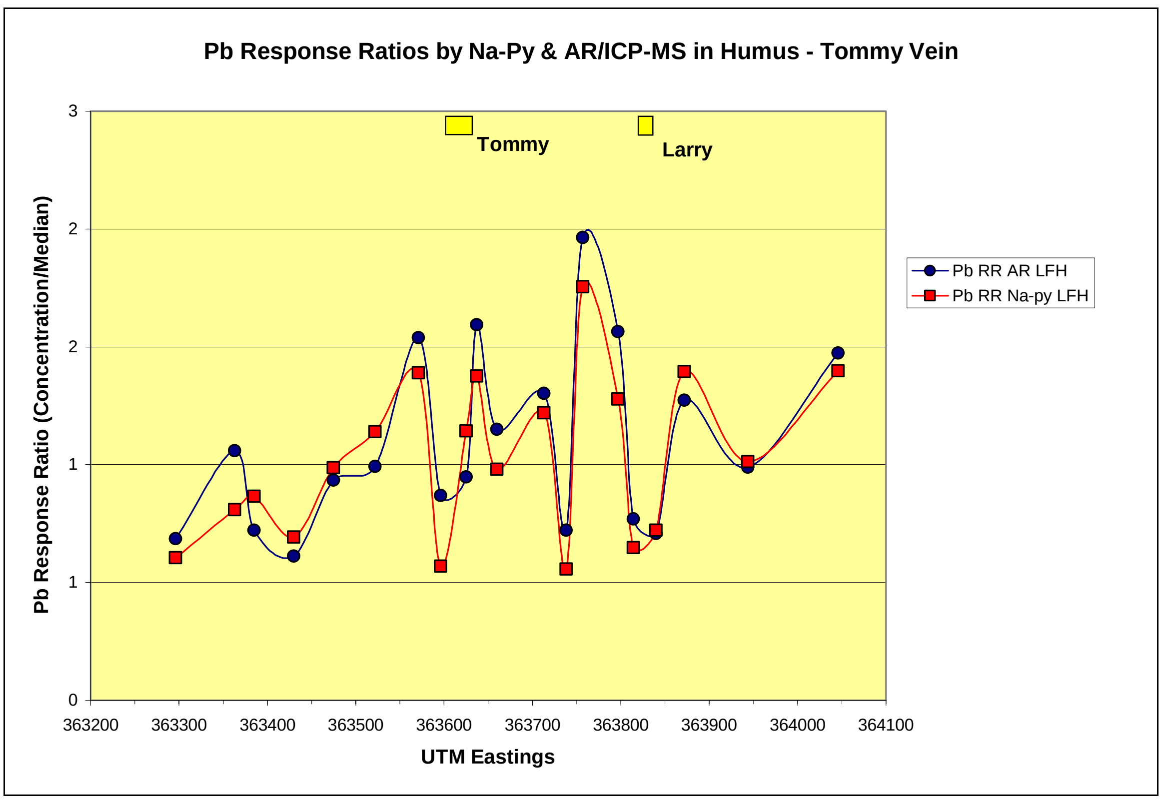
Figures 255 and 256. *Distribution of comparative zinc concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*



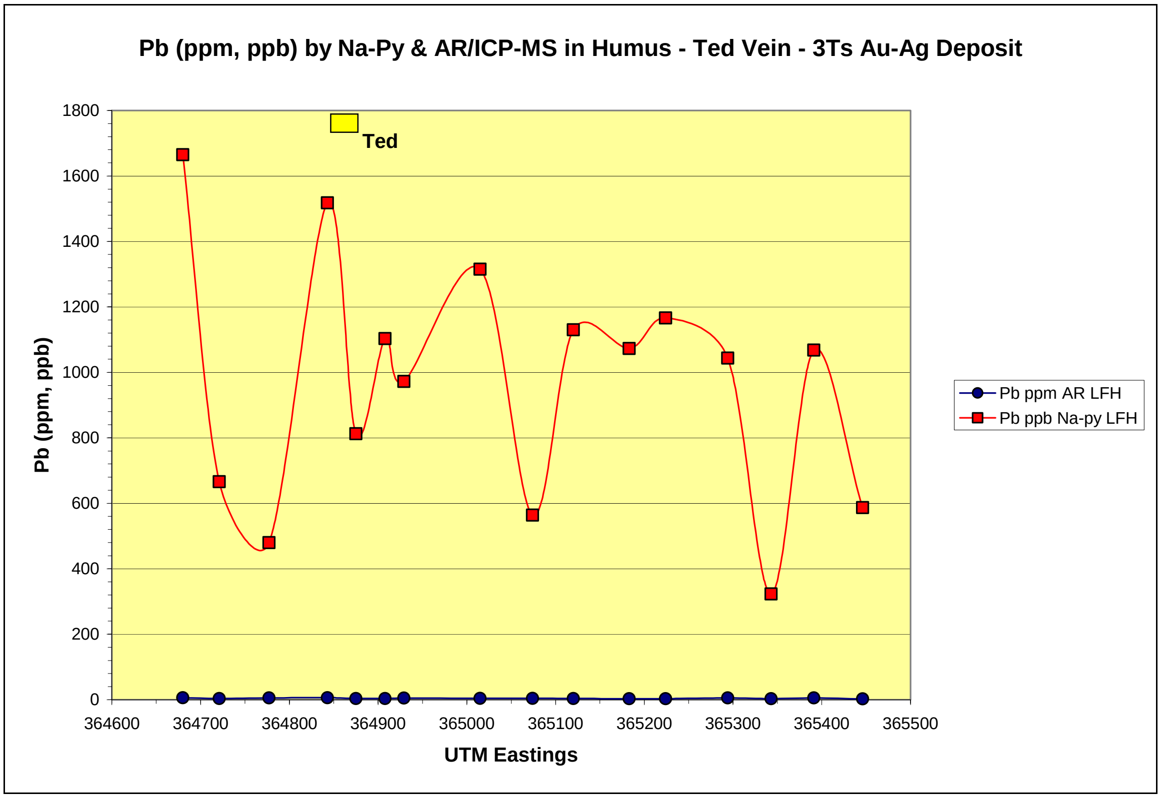


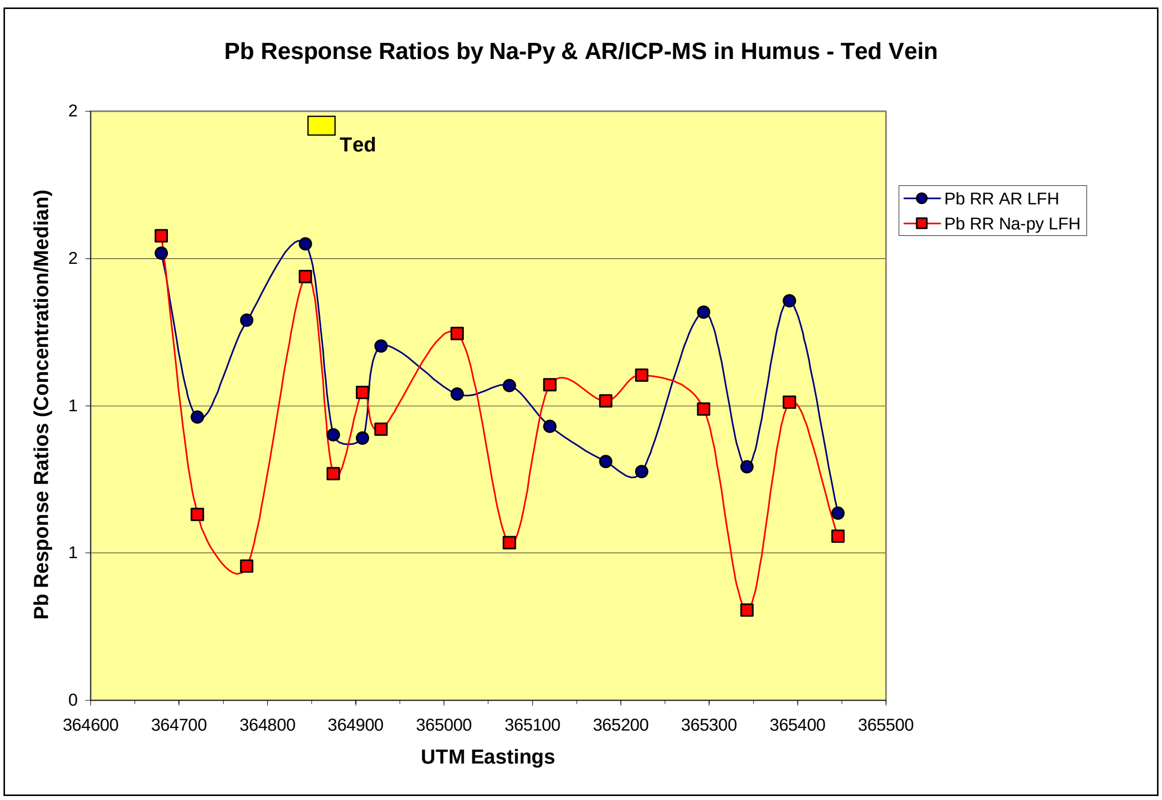
Figures 257 and 258. *Distribution of comparative zinc concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*



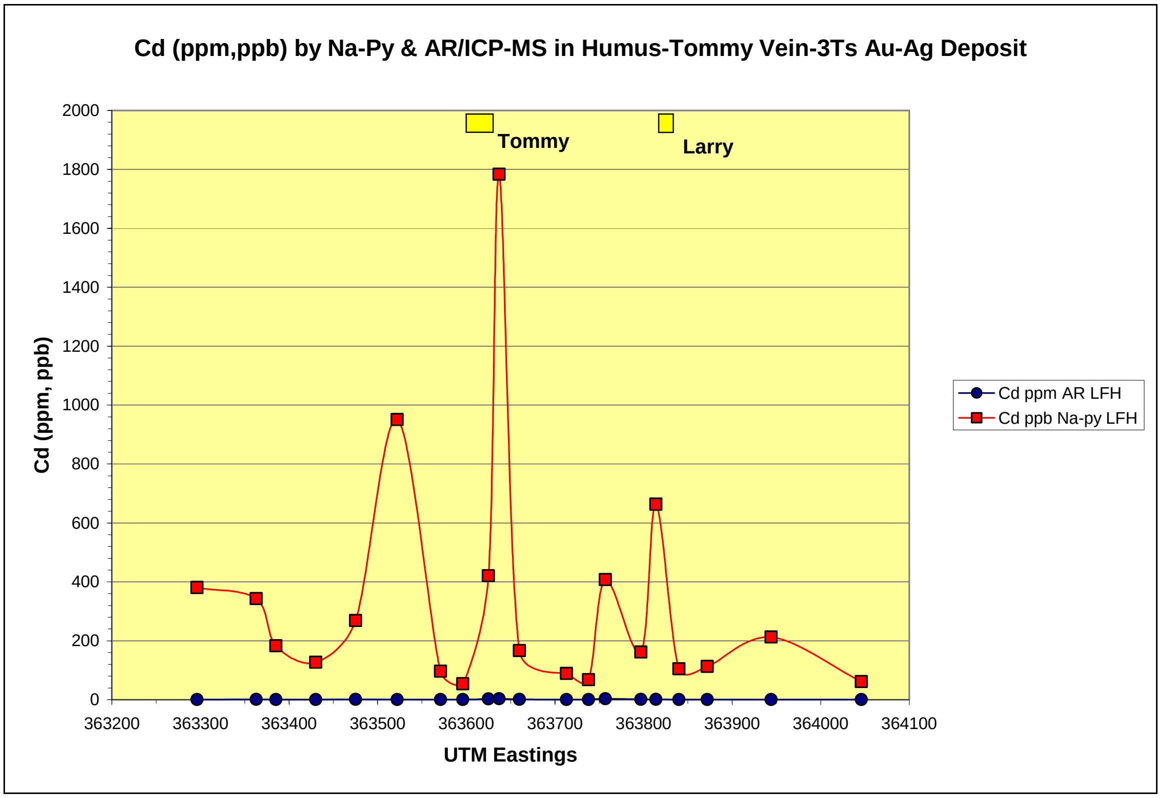


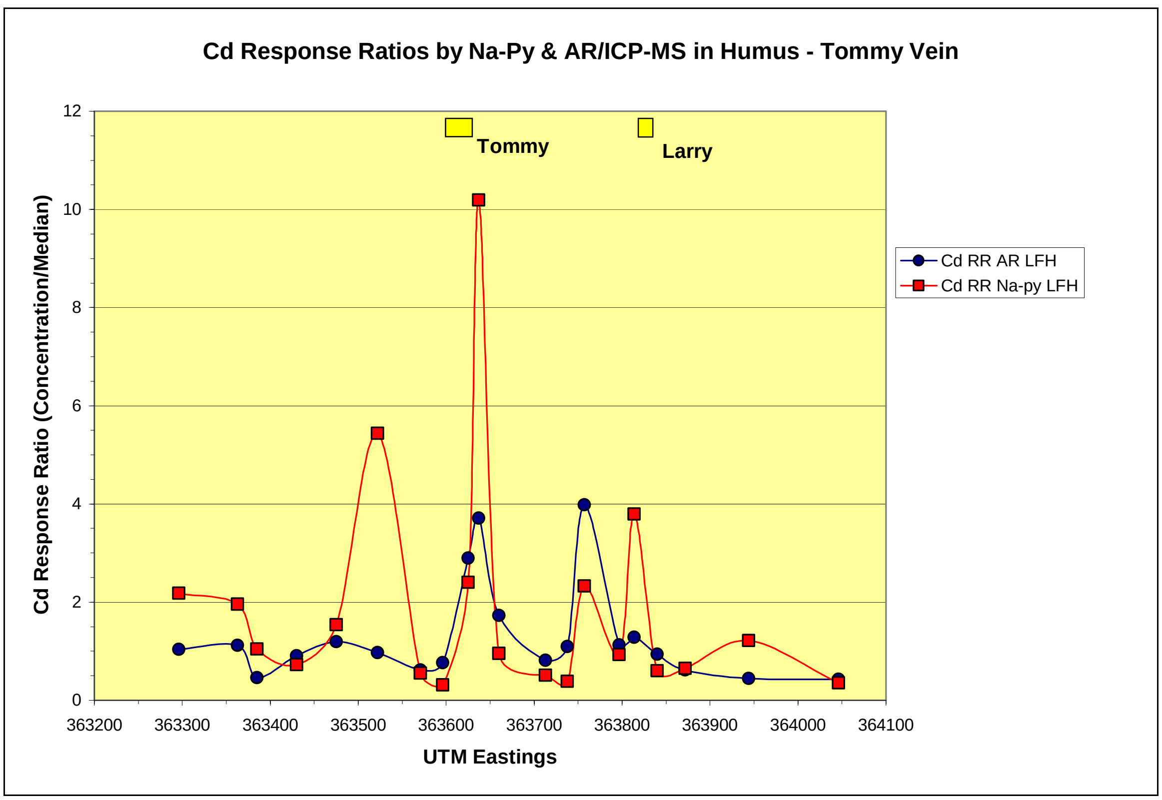
***Figures 259 and 260.** Distribution of comparative lead concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*



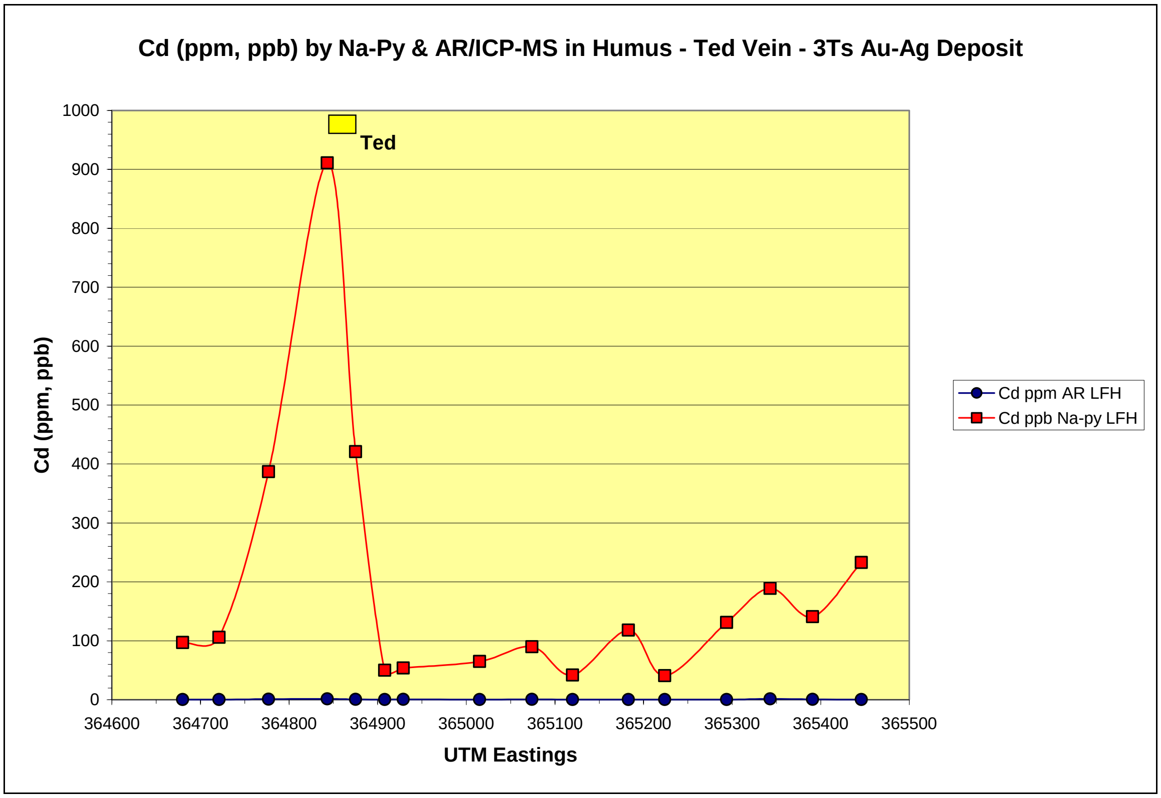


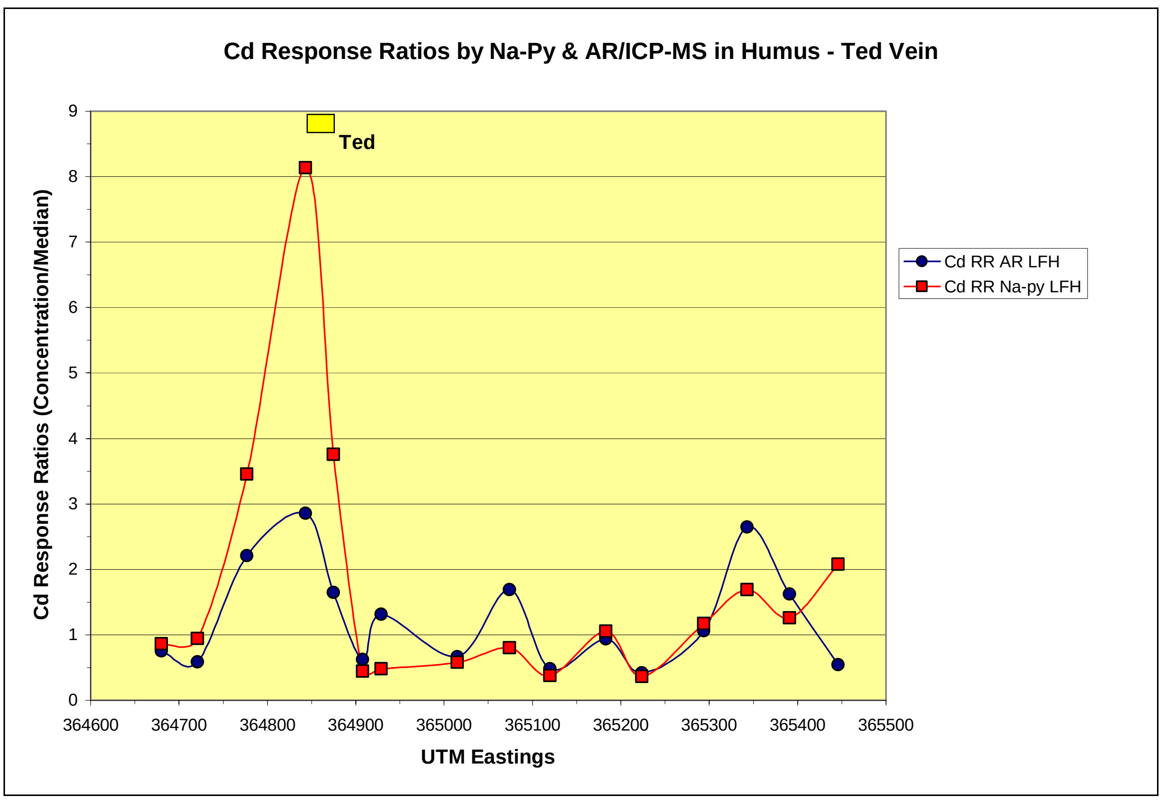
Figures 261 and 262. *Distribution of comparative lead concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*





Figures 263 and 264. *Distribution of comparative cadmium concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Tommy vein orientation transect.*

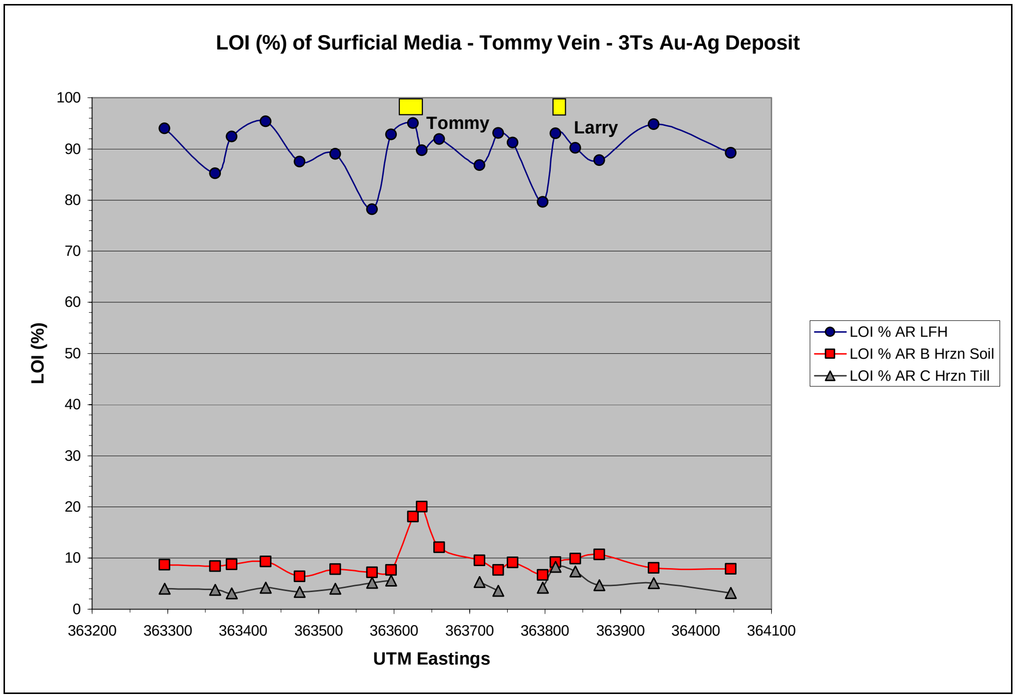


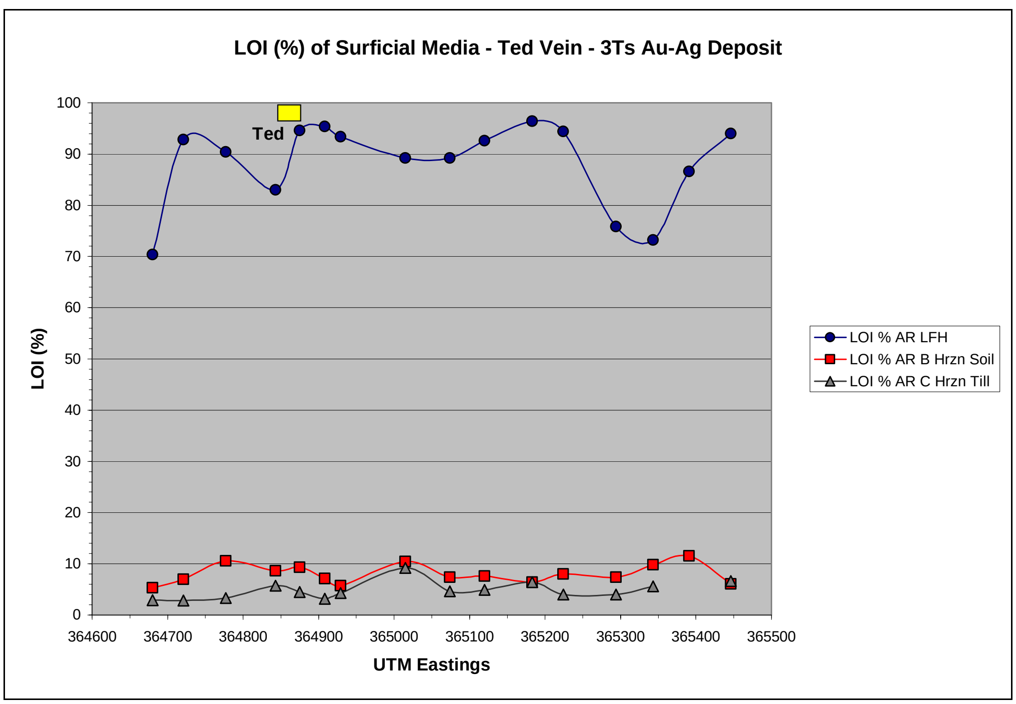


Figures 265 and 266. *Distribution of comparative cadmium concentrations (top) and calculated response ratios (bottom) in humus by aqua regia digestion and Na-Pyrophosphate leach along the Ted vein orientation transect.*

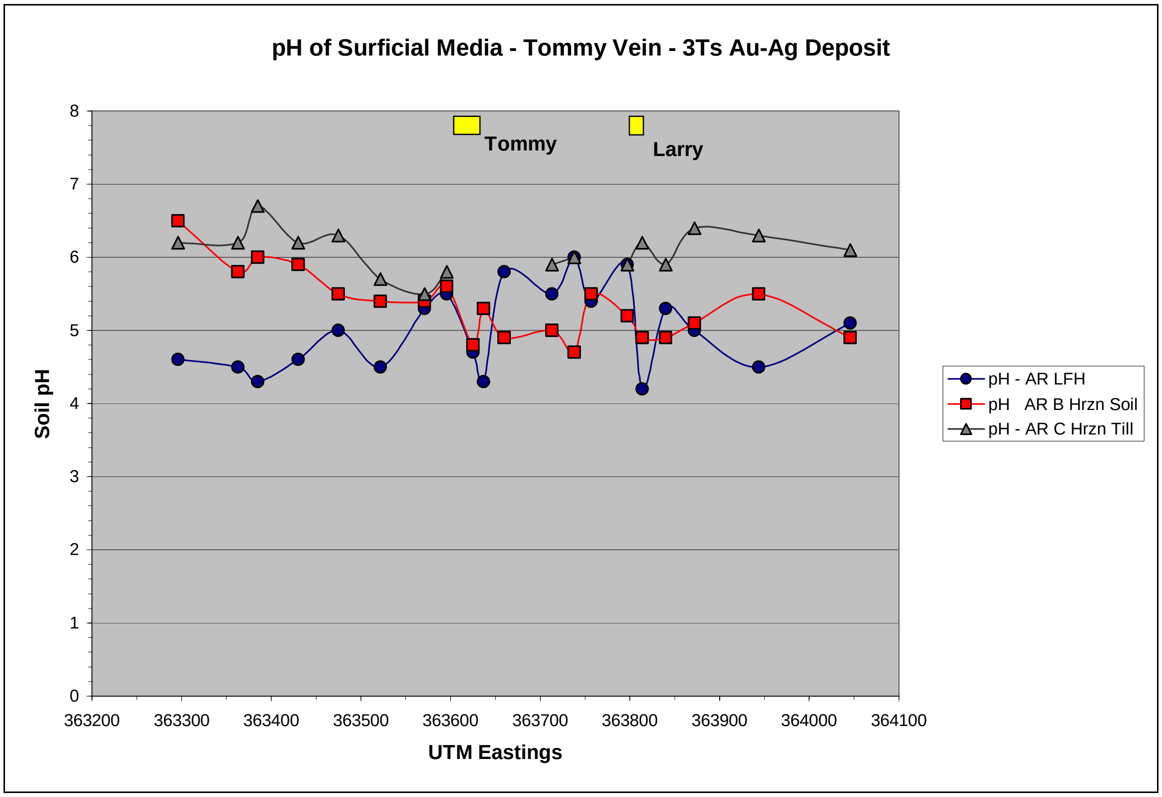
i) Results for Other Determinations

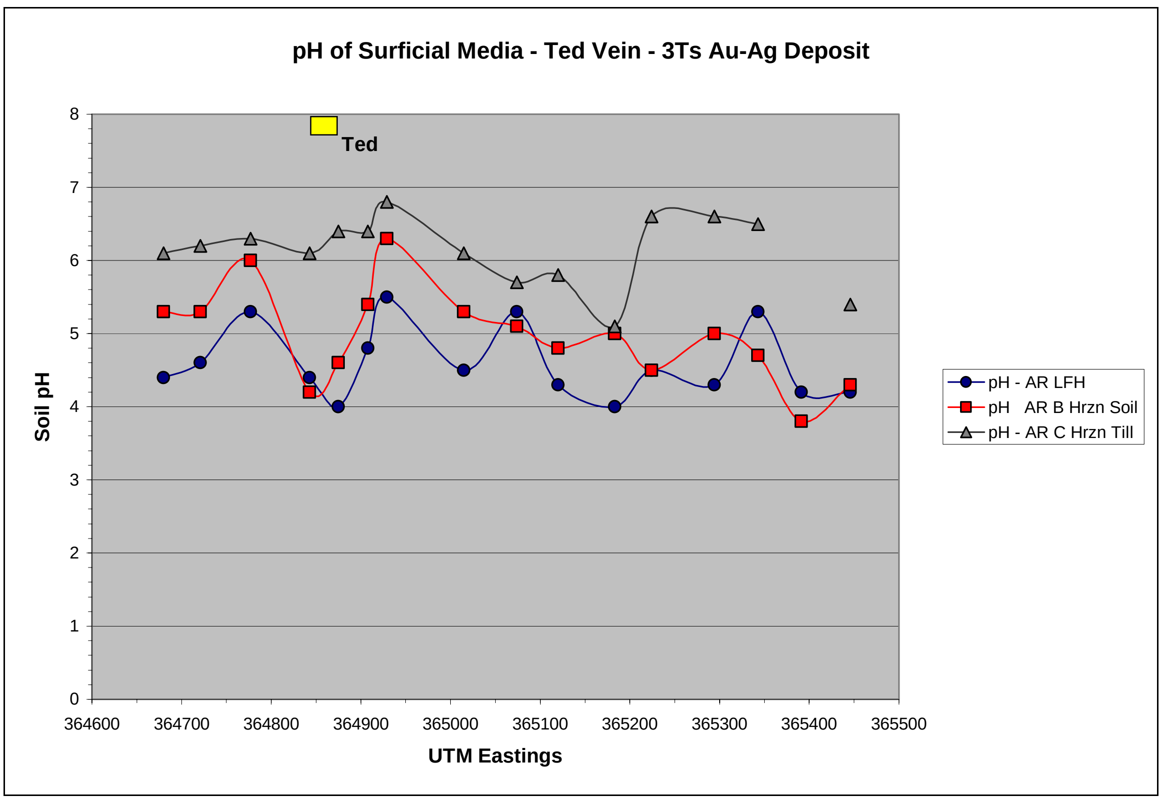
Summary statistics for LOI and soil pH results are included in aqua regia digestion summary statistics for combined lines (Table 9) and for individual transects (Tables 10 and 11). Loss on Ignition (LOI) transect plots for each of the veins (Figures 267 and 268) show that B horizon soils typically have slightly higher LOI contents than underlying till, due to the mixing of surface organic matter into the mineral soil.



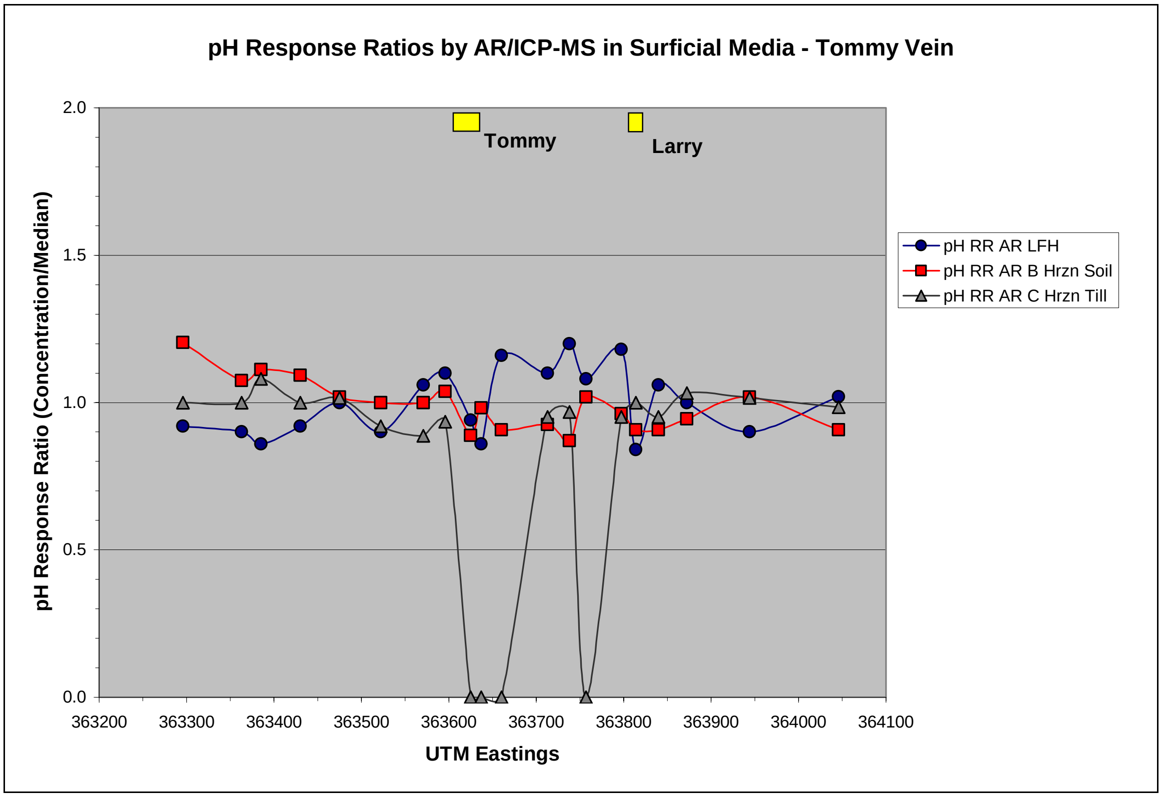


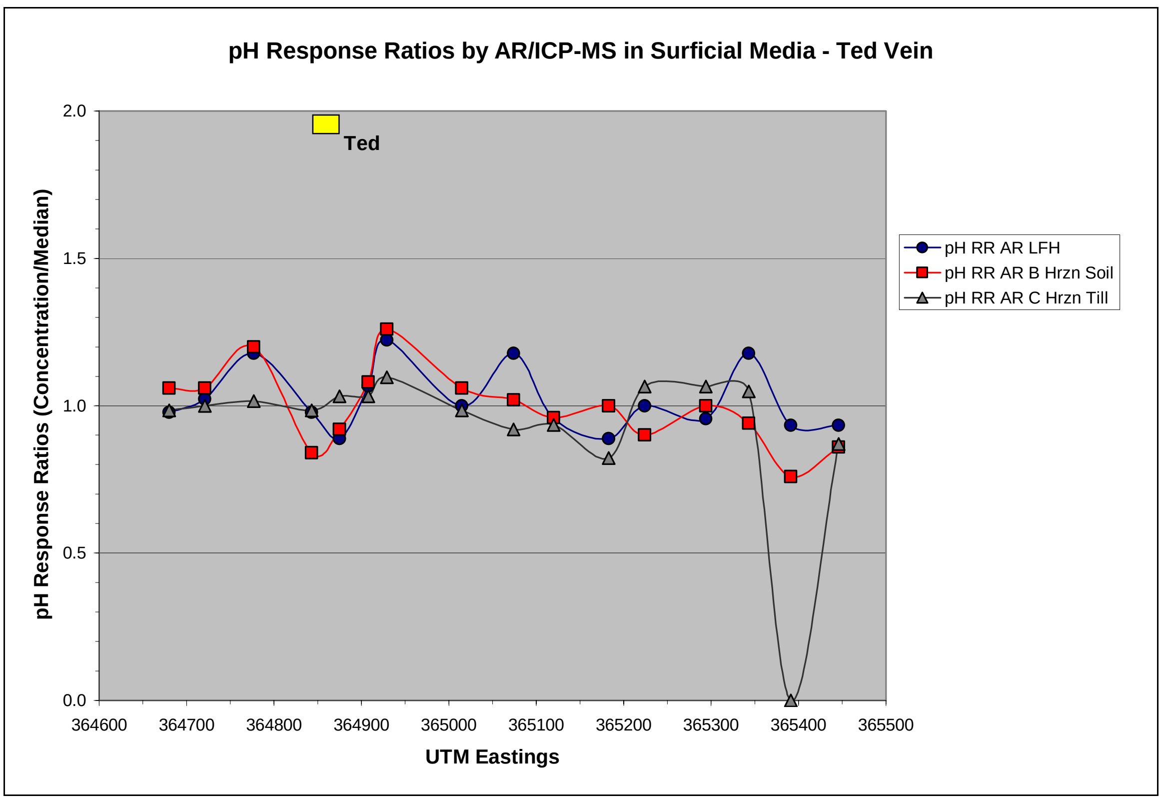
Figures 267 and 268. *Distribution of LOI (%) results in each of humus, B horizon soil and C horizon till and other parent materials along the Tommy vein (top) and Ted vein (bottom) orientation transects.*





Figures 269 and 270. *Distribution of soil pH results in each of humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Tommy vein (top) and the Ted vein (bottom) orientation transects.*





Figures 271 and 272. *Distribution of calculated response ratios for soil pH results in each of humus, B horizon soil and C horizon till and other parent materials along the approximately east-west Tommy vein (top) and the Ted vein (bottom) orientation transects.*

Slightly greater LOI values in B horizon soils at the Tommy vein exposure are considered an artifact of the mixing of organic debris into the near-surface rubble above bedrock at these sites.

The distribution of soil pH results and response ratios in each of humus, B horizon soil and C horizon till and other parent materials along the two transects (Figures 269 to 272) indicates that soil pH does not, in any horizon, reflect the presence of the underlying mineralized veins. This is not surprising, given that epithermal Au in quartz vein mineralization here has a relatively low sulphide mineral content, particularly at the Tommy vein. Some relatively low, slightly more acidic, pH levels are present in B horizon soils and, in particular, LFH horizon humus at each of the Tommy, Larry and Ted veins. These results are, however, too subtle relative to the variation in soil pH observed among other sites along the transects to confidently attribute them to the effects of the weathering of epithermal Au in quartz vein mineralization.

j) Comparative Inorganic Method Results for B Horizon Soils: Gold and Silver

Comparative transect plots for each of the Tommy vein and the Ted vein orientation transects showing comparative results and calculated response ratios for gold and silver determined by aqua regia digestion, MMI-M, Enzyme Leach and, in the case of gold, lead-collection gold fire assay, are shown in Figures 170 to 181. Aqua regia digestion results for near-surface LFH horizon humus are also shown in each case for comparative purposes.

Mobile Metal Ion (MMI-M) results show positive responses for Au and for several relevant base metals such as Zn, Pb and Cd in near-surface soils over both the Tommy vein and the Ted vein. Furthermore, MMI results displayed good geochemical contrast relative to several other analytical methods in spite of the field site variations inherent in the recommended 'fixed depth' sampling procedure. Although MMI Au concentrations in the study area are of a very low magnitude, Au response ratios are very strong at 23 to 24 times line background over both the Tommy vein and the unknown central anomaly. Similar results are reported from the Ted vein, where a Au response ratio of almost 75 times line background is superior to that for all other methods, including aqua regia. In the case of Ag, there was no anomalous response at Tommy vein, although a response ratio of 6 to 7 times is present over the central anomaly; however, a strong Ag MMI response ratio at the Ted vein (~23 times line median) is superior to that reported by all other methods, including aqua regia digestion.

In comparison, precious metals response by Enzyme Leach (EL) is subdued relative to other analytical methods tested. For example, EL Au response in Tommy vein soils, while present, is low relative to response ratios of other methods, and there is no significant Au response in B horizon soils at the Ted vein. Furthermore, the usefulness of the EL suite is hampered for this deposit type by the relatively high analytical detection limits for Ag; along neither vein transect do the EL Ag in soil results exceed analytical detection limits.

Enzyme Leach results are, however, much stronger for a number of important base metals and precious metal pathfinder elements in 3Ts soils. As measured by calculated response ratios, strong EL As, Sb, Cu, Pb and Cd responses are present in B horizon soils over the Tommy vein, and strong EL Sb, Zn, Pb and Cd responses are present over the Ted vein. These responses are discussed in greater detail in the following section.

k) Comparative Inorganic Methods Results for B Horizon Soils: Other Elements

Comparative transect plots for each of the Tommy and Ted vein orientation transects showing comparative results and calculated response ratios for other elements determined by aqua regia digestion (AR), MMI-M and Enzyme Leach (EL) are shown here. Aqua regia digestion results for near-surface LFH horizon humus are also included in each case for comparative purposes. Results for several elements are shown here, including both precious metal pathfinder elements such as As and Sb (Figures 182 to 189) and relevant base metals such as Zn, Cu, Pb and Cd (Figures 190 to 205).

With respect to the precious metal pathfinder elements in B horizon soils, both As and Sb by EL display a strong geochemical contrast over the Tommy vein mineralization and at the central anomaly, although calculated contrast ratios are marginally lower than those by AR digestion. In the case of soils over the Ted vein mineralization, EL results for both As and Sb provide superior geochemical contrast to those determined by AR digestion. Enzyme Leach Sb results here display a halo or 'rabbit ears' pattern around the Ted vein on the transect plot (Figures 188 and 189). Note that there are no MMI-M results here for either As or Sb in near-surface soils.

Both EL and MMI-M methods provide good geochemical contrast for several base metals in B horizon soils, the aforementioned strong AR response in these soils notwithstanding. The relative strengths of these responses vary from one element to another. For example, the values of Zn by MMI response in near-surface soils is superior to that of EL, highlighting all three features along the Tommy transect — the Tommy vein, the central anomaly, and the Larry vein — with response ratios of up to 15 times background values. In the case of the Tommy vein itself, elevated MMI response ratios for Zn are up to 10 times background, and are present at three sites. By way of contrast, lower although still impressive response ratios of 4 times background and 3 times background are reported by soil EL Zn and soil/humus aqua regia Zn results, respectively, at the Tommy vein. A different response is provided by Pb geochemistry at the Tommy vein. Although both MMI and EL provide strong Pb responses here, contrast ratios for EL Pb are up to 19 times background values, whereas those by MMI are up to 11 times background. In the case of the Ted vein, both EL and MMI results here provide very strong Zn results of 48 to 50 times background levels, which are substantially similar. Curiously, however, the strong EL Pb response over the Ted vein, which returned a contrast ratio of about 15 times background concentrations, is not similarly matched by any anomalous MMI Pb response. In the case of Cu, there is a strong Cu response by EL at the Tommy vein, but no discernible MMI response. At the Ted vein, both MMI and EL exhibit strong Cu responses; the EL response takes the form of a halo pattern (Figures 196 and 197) similar to that noted above for Sb.

8. SUMMARY AND CONCLUSIONS

This project, funded by Geoscience BC, provides new and intercomparable soil geochemical data to help in solving practical exploration geochemical problems in the Nechako Plateau area of central British Columbia. Effective mineral exploration in this prospective region has long been hindered by thick forest cover, an extensive blanket of till and other glacial deposits and, locally, widespread Tertiary basalt cover. Mineral and organic soils sampled here as part of a geochemical orientation study of the 3Ts epithermal Au-Ag prospect were analyzed for Au and other elements using a comprehensive range of commercially available analytical techniques. Inorganic analytical methods included total Au determinations (fire assay), near-total to partial determinations (aqua regia digestion) and several types of selective extractions (Enzyme Leach (EL), Mobile Metal Ion (MMI-M) and Na-Pyrophosphate leach), all employing an ICP-MS finish. Two less conventional techniques employing organic compounds in soils (Soil Gas Hydrocarbons (SGH) and Soil Desorption Pyrolysis (SDP)) were also tested. Furthermore, the parallel companion study of Dunn et al. (2006b) has provided new data and recommendations concerning halogen geochemistry results of B horizon soils, lodgepole pine and white spruce at the 3Ts prospect.

In this study, LFH horizon humus, B horizon soil and C horizon till were all analyzed by various methods, but B horizon soils were the primary sample media, with the largest combination of digestion and extraction methods tested. Brunisolic Bm horizon soils are commonly developed around the 3Ts property, primarily on basal and colluviated tills, which are the dominant glacial parent material in the area. They are also developed in rubbly near-bedrock colluvium, stabilized colluvium and minor glaciofluvial outwash sediments, underlining the importance of the proper identification of Quaternary deposits in interpreting source directions of any anomalous geochemical patterns. These B horizon soils were the object of all analytical techniques tested, with the exception of Na-Pyrophosphate leach. Project objectives are, in part, to ascertain which of the partial and selective extraction methods undertaken here 1) delineate the presence of mineralization and 2) provide the greatest levels of geochemical contrast, over the Tommy and Ted veins at 3Ts. Specific field sampling and analytical recommendations are provided for conducting the most effective property-scale geochemical surveys for similar epithermal Au deposits in the British Columbia Interior Plateau.

The interpretation of soil geochemical results was undertaken on two levels: firstly, within the context of traditional aqua regia digestions and fire assay determinations carried out on multiple soil horizons at each sample site and secondly, within the context of a battery of both traditional and non-traditional analytical methods conducted for the most part on B horizon mineral soils alone. In the first case, results show that Au and Ag determined by aqua regia digestion–ICP-MS in each of humus, B horizon soil and C horizon till all reflect, to varying degrees, the presence of Au in epithermal quartz vein mineralization at both the Tommy and the Ted veins. In addition to this, Au and Ag in till alone reflect the presence of the Larry vein, which is transected by the Tommy orientation line. In the second case, the direct comparison of B horizon aqua regia results with corresponding B horizon data by EL, MMI, SGH and SDP methods indicate that each of these is effective to some degree in highlighting the presence of epithermal Au mineralization. For the precious metals, the most effective results and greatest geochemical contrast overall is provided by the aqua regia and MMI-M methods, with EL providing the best contrast for some of the pathfinder elements.

a) Comparison of Aqua Regia Geochemical Results by Individual Soil Horizon

Results suggest that, for property-scale geochemical exploration, B horizon mineral soils and LFH horizon organic-rich humus offer similar levels of geochemical contrast for aqua regia-digestible Au and Ag, with the B horizon soils offering a slightly superior contrast overall. Geochemical results vary slightly from vein to vein, with variations in primary mineralogy, topography and surficial cover. In general, aqua regia-digestible Au and Ag at the Tommy vein show slightly greater geochemical contrast, as measured by response ratios, than do those at the Ted vein. At the Tommy vein, Au response ratios for B horizon soil and humus over the vein are almost identical. Elevated values of Ag in humus provide a larger geochemical footprint, but Ag in the B horizon soils offers a slightly better anomaly contrast over the mineralization. Rubbly B horizon soils and LFH humus are developed directly over subcropping and outcropping quartz vein mineralization at the Tommy vein, and probably incorporate a significant component of near-residual mineralized fragments. There is no direct till response here, as neither basal nor colluviated till is preserved directly over the vein; however, elevated values of Au and Ag in till immediately to the east are tentatively interpreted to represent, at least in part, glacially transported material that is locally derived from the Tommy vein.

Surficial cover is more complex on the Ted orientation line. Localized glaciofluvial outwash sediments and more widespread stabilized near-surface colluvium are present in addition to basal and colluviated tills. As with the Tommy vein results, B horizon mineral soils provide the best overall anomaly contrast for property-scale geochemical exploration. Gold and silver in humus, B horizon soil and till all reflect the presence of precious metal mineralization at the Ted vein to varying degrees, although the magnitudes of the geochemical responses are slightly less than those reported for the Tommy vein. In addition, highly elevated Au and Ag concentrations are present in both B horizon soil and C horizon till both above and down-ice from the vein. Elevated Ag is similarly present in LFH horizon humus here, although Au itself is absent.

b) Comparison of Total, Partial and Selective Extraction Results of B Horizon Soils

FIRE ASSAY AND AQUA REGIA

Most of the 1) total, 2) near-total to partial, and 3) selective extraction analytical methods tested at the 3Ts property were successful, to varying extents, in highlighting the presence of Au mineralization at one or both of the mineralized quartz veins tested. Total and near-total to partial Au responses in soil and till by both aqua regia and fire assay methods are almost identical, with both methods returning substantially-similar Au concentrations of 200 to 250 ppb in B horizon soils sampled above the Tommy vein. Although neither method successfully outlined the smaller Larry vein, both aqua regia and fire assay methods on B horizon soils did highlight the unknown central anomaly on the Tommy orientation line. Both aqua regia and fire assay methods were similarly successful in highlighting the location of the Ted vein in both B horizon soils and tills. With maximum AR Au concentrations of just over 40 ppb in B horizon soils, the absolute magnitude of Ted vein Au results is, however, substantially lower than those reported from the Tommy vein.

The location of the Tommy vein is also outlined by elevated concentrations of several base metals determined by aqua regia digestion–ICP-MS in B horizon soil, in spite of the greater variability of Au results relative to the underlying C horizon. In general, geochemical results in mineral soils are typically greater than in either underlying tills or overlying organic-rich humus, although the relation with the former is influenced by the absence of till beneath some of the highest concentration soils sampled around the Tommy vein. Concentrations of AR-digestible base metals such as Zn are even greater in B horizon soils overlying the Ted vein, which is reported to contain greater primary base metal concentrations than the Tommy vein.

MOBILE METAL ION AND ENZYME LEACH

Given the extensive use made historically of B horizon soils in geochemical exploration in British Columbia, an assessment of selective extraction results on these near-surface soils constitute a major part of this study. The very low, ppb-level, concentrations that are reported in these very weak and selective digestions often preclude a direct comparison with aqua regia methods, which are often total to near-total for many elements occurring in sulphide form such as Zn, Ag or Cu. In these cases, response ratios are calculated to level the geochemical data to a common base, permitting a more direct comparison of results. Comparison of response ratios for elements determined by aqua regia (AR), Enzyme Leach (EL) and Mobile Metal Ion (MMI-M) methods suggest that for many elements, particularly the base metals, EL and MMI provide comparable levels of geochemical contrast over known Au mineralization at the Tommy and Ted veins.

Mobile Metal Ion (MMI) results showed positive responses for Au and for several relevant base metals such as Zn, Pb and Cd in near-surface soils over both the Tommy vein and the Ted vein. Furthermore, MMI results displayed a good geochemical contrast relative to several other analytical methods in spite of the field site variations inherent in the recommended ‘fixed depth’ sampling procedure. Although MMI Au concentrations in the study area are of a very low magnitude, Au response ratios are 23 to 24 times line background over both the Tommy vein and the central anomaly of unknown origin. Similar results are reported from the Ted vein, where a Au response ratio of almost 75 times line background is superior to that for all other methods, including aqua regia. In the case of Ag, there was no anomalous response at the Tommy vein, although a response ratio of 6 to 7 times is present over the central anomaly, but at the Ted vein, a strong Ag MMI response ratio (~23 times line median) is superior to that reported by all other methods, including aqua regia.

Enzyme Leach (EL) does not claim to extract more than small traces of Ag and Au with the weak leach method, and therefore generates lower contrast ratios of these elements than by the other analytical methods. For example, the Au response in Tommy vein soils, while present, is subdued relative to response ratios of other methods, and there is no significant Au response at the Ted vein. Furthermore, the usefulness of precious metals obtained by the EL suite is hampered for this deposit type by the relatively high analytical detection limits for Ag; at neither vein does EL Ag in soil exceed analytical detection limits. Enzyme Leach results are, however, much stronger for a number of important base metals and precious metal pathfinder elements in 3Ts soils. As measured by calculated response ratios, strong As, Sb, Cu, Pb and Cd responses are present in B horizon soils by EL over the Tommy vein, and strong Sb, Zn, Pb and Cd responses are present over the Ted vein.

Both EL and MMI-M methods offer excellent geochemical contrast for several base metals in B horizon soils, the aforementioned strong aqua regia response in these soils notwithstanding. The relative strengths of responses vary from one element to another. For example, the Zn by MMI response in near-surface soils is superior to that of EL, highlighting all three features along the Tommy transect — the Tommy vein, the central anomaly of unknown origin, and the Larry vein — with response ratios of up to 15 times background values. In the case of the Tommy vein itself, elevated MMI response ratios for Zn are up to 10 times background, and are present over three soil sites. Lower, although still effective, response ratios of 4 times background and 3 times background occur for EL Zn in soil and aqua regia Zn in soil/humus, respectively, at the Tommy vein. A different response is provided by Pb geochemistry at the Tommy vein. Although both MMI and EL provide strong Pb responses, contrast ratios for EL Pb are up to 19 times background values, whereas those by MMI are up to 11 times background. In the case of the Ted vein, both EL and MMI results provide very strong and similar Zn signatures of 48 to 50 times background levels. However, the strong EL Pb response over the Ted vein, which returned a contrast ratio of about 15 times background concentrations, is not similarly matched by any corresponding anomalous MMI Pb response.

SGH

Compound class signature results identified by Activation Laboratories' evaluation of the 3Ts B horizon Soil Gas Hydrocarbon (SGH) soil data identify the locations of known epithermal Au mineralization along both the Tommy and Ted transects. On the Tommy line, the compound class signatures delineate the locations of the Tommy vein, the central anomaly, and the Larry vein, albeit with fairly subtle results of only about 2 to 2.5 times background values along that line. Compound class signatures in B horizon soils are much stronger at the Ted vein, at about 5 times line background at a single soil site over the vein. Soil Gas Hydrocarbon results, however, may be difficult to interpret within the context of more traditional inorganic soil geochemical results, in no small part due to the large number of often unfamiliar hydrocarbon compounds that are reported. The identification of specific hydrocarbon compounds or groups of compounds as indicators for individual mineral deposit types would be desirable, as the practical use of the SGH method appears to be hampered here by some ambiguity about which organic compounds, or groups of compounds, might be most useful for which mineral deposit types. In spite of this, results of the SGH method clearly show promise here and should be tested further at similar Au deposits in glaciated settings in an attempt to reproduce these results.

SDP

Soil Desorption Pyrolysis (SDP) results are similarly difficult to interpret, in part due to the large numbers of unfamiliar organic compounds for which analytical data are reported. Many of these compounds show little in the way of geochemical contrast in soils along the two orientation transects; however, one compound in particular, C_3H_5F, does provide a subtle level of geochemical contrast in B horizon soils over the Tommy vein, with two soil sites showing concentrations that are roughly 2.5 times median levels. More problematic with SDP results in this study are the generally low contrast ratios of individual compounds over the mineralized veins, perhaps reflecting their generally low sulphide contents. Anomalous responses for individual compounds, when present over epithermal mineralization, are generally quite subtle compared to those of the inorganic selective extraction methods such as MMI or Enzyme Leach. As with the SGH method, the practical use of the SGH geochemistry may be hampered by some ambiguity about which organic compounds, or groups of compounds, might be most useful to use in any given mineral deposit setting.

AQUA REGIA AND NA-PYROPHOSPHATE DIGESTIONS OF HUMUS

The aqua regia (AR) geochemical response in humus, although not as pronounced as in B horizon soils, is nevertheless effective in highlighting both the Tommy vein and the Ted vein. In the case of Ag, for example, comparative response ratios for humus using both aqua regia and Na-Pyrophosphate leach methods show similar patterns, but greater contrast by AR. Aqua regia reports a response ratio of more than 11 times line background for Ag over the Tommy vein, whereas that for Na-Pyrophosphate is 7 times background. Both methods also provide about 6 to 8 times geochemical contrast over the enigmatic central anomaly on the Tommy orientation transect with, again, the AR digestion providing the slightly greater contrast value of the two. Neither humus digestion method, however, outlines the location of the smaller Larry vein on the same transect. The Ted vein geochemical responses using either AR or Na-Pyrophosphate leach methods are more subdued relative to mineral soil results. In the case of Zn, for example, AR and Na-Pyrophosphate leach methods reported only an approximately 2.4 to 2.5 times background response in humus over the Ted vein.

9. KEY OUTCOMES AND RECOMMENDATIONS

Project objectives are, in part, to ascertain which of those partial and selective extraction methods undertaken here 1) delineate the presence of mineralization and 2) provide the greatest levels of geochemical contrast over each of the Tommy and Ted veins at the 3Ts prospect. Specific field sampling and analytical recommendations are provided for conducting effective property-scale geochemical surveys:

- Near-surface soils are more suitable than tills for detailed geochemical grid sampling at property scale, in part for reasons of sampling cost but more critically because of their widespread availability in areas of thin and discontinuous cover. The thin till veneer on the 3Ts property is not present in all areas, particularly over the resistant quartz veins that host epithermal Au mineralization, whereas some form of brunisolic soil cover is present across the property. The effective use of B horizon soils, however, is contingent upon samplers being capable of making suitable observations as to parent material type and origin. The widespread presence of multiple parent materials — near-surface colluvium over till — on the Ted vein transect, and the consequent differences between corresponding B and C horizon Au concentrations, underlies the importance of recording field observations to assist later interpretation of geochemical data. Till sampling remains a better choice than soils for reconnaissance-level geochemical sampling, producing more comparable geochemical results that are largely unaffected by the pedogenic processes that produce such physical and geochemical variability in near-surface soils.

- Soil geochemical surveys should be considered to be an integral component of any property-scale exploration program in this region. The Ted vein was discovered as a result of follow-up of soil geochemical surveys conducted in the 1990s, but the outcropping Tommy vein property was apparently never systematically covered by a more widespread grid soil survey following its initial discovery. Soil results from the Tommy orientation line presented here suggest the presence of a new anomalous Au-in-soil zone, the central anomaly, between the known Tommy and Larry veins.

- Both MMI-M and EL methods offer similarly strong responses and contrast ratios in near-surface and B horizon soils, respectively, for base metals at 3Ts, in some cases providing geochemical contrast levels that are superior to those of aqua regia digestions. These methods may be suitable substitutes for aqua regia digestion–ICP-MS analyses, particularly in areas of cover.

- The foregoing notwithstanding, the aqua regia digestion–ICP-MS multi-element analytical suite used in this study provides a more useful overall combination of a) suitable geochemical contrast over near-surface Tommy and Ted vein mineralizations, and b) a wide range of key elements reported, including Au and Ag, precious metal pathfinder elements such as As and Sb, and relevant base metals such as Zn, Cu, Pb and Cd. In general, the selective extraction analytical suites provide most but not all of the key elements needed for the detection of epithermal Au-Ag deposits beneath soil cover. Some of these are lacking, or if present, are at concentrations below the stated analytical detection limits; examples of these include As-Sb (MMI-M suite) and Ag-Au (EL suite). While this recommendation holds for the particular aqua regia–ICP-MS multi-element analytical suite tested in this study, the range of elements reported in similar such suites offered by other commercial laboratories vary from one lab to another. It is important to note, given the near-surface and locally subcropping nature of the Tommy and Ted vein Au mineralizations at 3Ts, that both the MMI and EL methods might be much more useful than AR for detecting more deeply buried mineralization, where inherited quartz vein lithological signatures do not exist in surface soils.

- The SGH and SDP methods may similarly prove to be more viable geochemical methods for detection of deeply buried mineralization, rather than the near-surface epithermal Au mineralization, which was tested in this study. As with MMI and EL, further tests on more deeply buried mineralization are required to evaluate geochemical responses in those ‘deep cover’ surficial environments where inherited quartz vein lithological signatures are not present in the surface soils.

Suggestions for Future Work

Several areas of additional work are recommended for any future studies of geochemical dispersal from this or similar epithermal gold deposits in central British Columbia. Chief among these are further method comparisons of both mineral and organic soils, with particular emphasis on the sample preparation procedures that precede geochemical analysis:

- The use of different mesh size fractions in the preparation of mineral soils, to assess any variation in geochemical contrast with varying grain sizes. In the case of B horizon soils, this might include an assessment of a series of finer sieve particle sizes, including the –230 mesh (<63 micron) fraction, which is routinely used for the analysis of till samples.

- The systematic study of sampling and subsampling sizes at all stages of protocols for sampling, preparation and analysis, in an effort to determine optimum sample sizes for representative Au analyses. The determination of most effective field sampling sizes is particularly critical, as many exploration industry soil surveys routinely use the kraft bag approach in collecting soil samples for Au analysis. In the present study, most B horizon or near-surface soil samples were in the approximately 1 kg size range, which is considerably larger than those typically collected in kraft bags. Given the relatively poor precision obtained here for field duplicate samples for some elements such as Au, it is difficult to see how the relatively small-sized samples typically collected using kraft bags in some industry surveys could yield meaningful and reproducible Au results.

- The comparison of different acid digestions offered by commercial geochemical laboratories as part of their multi-element ICP-MS analytical suites. Although fire assay results of this study suggest little difference between total (fire assay) and near-total to partial (aqua regia) gold concentrations, the relative strengths of ‘aqua regia’ digestions themselves do vary slightly from one lab to another. Only one such aqua regia suite from one commercial laboratory was tested in this study. Whether or not any possible variations in the strength of aqua regia used at a different laboratory might significantly affect the geochemical results from this or similar Au deposits remains to be tested.

- In the case of LFH horizon humus samples, a systematic assessment of different sample collection and preparation techniques to assess what combination of field size, pulverizing or disaggregation methods and sieve size might yield the best geochemical contrast for epithermal Au deposit exploration. Studies of this nature into humus geochemistry are lacking, and relative to mineral soil geochemistry there is little data available to help explorationists conduct effective geochemical surveys.

- The present comparisons were conducted over known Au in quartz vein mineralization that is at or close to the surface. Results demonstrate that the locations of both the Tommy and Ted veins may be successfully delineated using mineral soils and organic-rich humus. This does not necessarily mean, however, that similar, but blind, deposits may be successfully detected at greater depths. The felsic tuff that hosts epithermal gold-silver mineralization at 3Ts are only poorly exposed at surface beneath the widespread but thin and discontinuous till veneer and soil, stabilized colluvium and abundant forest moss cover that hinders effective prospecting. Furthermore, the positive aqua regia and other geochemical results reported here are strongly influenced by the relict lithological signature in thin soils, of the near-surface outcropping and subcropping of subvertical, highly resistant quartz veins. The MMI, EL, SGH and SDP methods might prove to be much more useful than AR for detecting more deeply buried mineralization, where such inherited quartz-vein lithological signatures are not present in the surface soils. The continuation of further field studies elsewhere on the property, where the Tommy and Ted veins are known to exist at greater depths, or at other localities where similar deposits are known to be present under transported cover, may help provide useful further data for these methods to help guide effective exploration for buried deposits.

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Figure 273. *The 3Ts project team: from left to right, Colin Dunn, Stephen Cook and Karen Hulme during field sampling at the 3Ts Au-Ag prospect, June 2005.*

11. REFERENCES

Agriculture Canada (1987): The Canadian system of soil classification; second edition. Agriculture Canada Expert Committee on Soil Survey, *Agriculture Canada*, Publication 1646, 164 pages.

Bajc, A.F. (1998): A comparative analysis of enzyme leach and mobile metal ion selective extractions: case studies from glaciated terrain, northern Ontario; *Journal of Geochemical Exploration*, volume 61, pages 113–148.

Bottomer, L. (2003a): Epithermal gold-silver mineralization in the Nechako plateau, central British Columbia; *in* North West Mining Association, Annual Meeting, Program with Abstracts, December 2003.

Bottomer, L. (2003b): The 3Ts epithermal gold-silver project, Nechako region, central B.C.; *in* Cordilleran Round-Up 2003, Program with Abstracts, January 2003.

Cameron, E.M., Hamilton, S.M., Leybourne, M.I., Hall, G.E.M. and McClenaghan, M.B. (2004): Finding deeply buried deposits using geochemistry; *Geochemistry: Exploration, Environment, Analysis*, volume 4, pages 7–32.

Cook, S.J. and McConnell, J. (2001): Lake sediment geochemical methods in the Canadian shield, cordillera and appalachia; *in* Drift Exploration in Glaciated Terrain. M.B. McClenaghan, P.T. Bobrowsky, G.E.M. Hall and S.J. Cook, Editors, *The Geological Society of London*, Special Publication 185, pages 125–149.

Cook, S.J. and Dunn, C.E. (2006): Preliminary Results of the Cordilleran Geochemistry Project: A Comparative Assessment of Soil Geochemical Methods for Detecting Buried Mineral Deposits, 3Ts Au-Ag Prospect (NTS 93F/03), Central British Columbia; *in* Geological Fieldwork 2005, *BC Ministry of Energy, Mines and Petroleum Resources,* Paper 2006-1, pages 237–257.

Cook, S.J., Jackaman, W., Lett, R.E.W., McCurdy, M.W. and Day, S.J. (1999): Regional lake water geochemistry of parts of the Nechako plateau, central British Columbia (93F/2, 3; 93K/9, 10, 15, 16; 93L/9, 16; 93M/1, 2, 7, 8); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1999-5.

Cook, S.J., Levson, V.M., Giles, T.R. and Jackaman, W. (1995): A comparison of regional lake sediment and till geochemistry surveys: a case study from the Fawnie Creek area, central British Columbia; *Exploration and Mining Geology*, volume 4, pages 93-110.

Cook, S.J. and Jackaman, W. (1994): Regional lake sediment and water geochemistry of part of the Nechako River map area (93F/2,3; parts of 93F/6,11,12,13,14); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-19, 31 pages.

Cook, S.J. and Fletcher, W.K. (1994): Platinum distribution in soil profiles of the Tulameen ultramafic complex, southern British Columbia, Canada; *Journal of Geochemical Exploration*, volume 51, pages 161–191.

Diakow, L.J. and Levson, V.M. (1997): Bedrock and surficial geology of the southern Nechako plateau, Central British Columbia (NTS 93F/2,3,6,7); *BC Ministry of Energy, Mines and Petroleum Resources,* Geoscience Map 1997-2.

Diakow, L.J., Webster, I.C.L., Levson, V.M. and Giles, T.R. (1994): Bedrock and surficial geology of the Fawnie Creek map area (NTS 93F/3); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-2.

Diakow, L.J., Webster, I.C.L., Whittles, J.A., Richards, T.A., Levson, V.M. and Giles, T.R. (1995): Bedrock and surficial geology of the Tsacha Lake map area (NTS 93F/2); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1995-16.

Dunn, C.E., Cook, S.J. and Hall, G.E. M. (2006a): Halogens in Surface Exploration Geochemistry: Evaluation and Development of Methods for Detecting Buried Mineral Deposits (NTS 93F/03), Central British Columbia; *in* Geological Fieldwork 2005, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2006-1, pages 259-280.

Dunn, C.E., Cook, S.J. and Hall, G.E. M. (2006b): Results-Halogen geochemistry — development of new geochemical methodology for detecting mineral deposits concealed by volcanic rocks and overburden in central British Columbia; *Geoscience BC*, Final Report.

Fedikow, M.A.F. (2005): Discriminating barren and productive geophysical targets using partial digestion soil geochemistry: discovery of the Hunt gold zone, Manitoba, Canada; *in* Program and abstracts, *Association of Applied Geochemists*, 22nd International Geochemical Exploration Symposium, page 51.

Fletcher, W.K. (1981): Analytical Methods in Geochemical Prospecting. Handbook of Exploration Geochemistry-Volume 1, G.J.S. Govett, Editor. *Elsevier Science Publishers*, 255 pages.

Fox, P.E. (1999): Geological, Geochemical and geophysical report on the Taken property, Omineca mining division; *BC Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 25810, 33 pages.

Fox, P.E. (1996): Diamond drilling, geological and soil geochemical report on the Tam property, Omineca mining division; *BC Ministry of Energy, Mines and Petroleum Resources,* Assessment Report 24710, 92 pages.

Fox, P.E. (1995): Geological report on the Taken 1 claim, Omineca mining division; *BC Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 24203, 21 pages.

Fox, P.E. (1994): Geochemical report on the Taken claim, Omineca mining division; *BC Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 23758, 29 pages.

Giles, T.R. and Levson, T.M. (1995): Surficial geology and Quaternary stratigraphy of the Tsacha Lake area (93F/02); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1995-10.

Giles, T.R. and Levson, V.M. (1994a): Surficial geology and drift exploration studies in the Fawnie Creek area (93F/03); Geological Fieldwork 1993, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 1994-1, pages 27–37.

Giles, T.R. and Levson, T.M. (1994b): Drift prospecting potential of the Fawnie Creek area (93F/03); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-10.

Lane, R.A. and Schroeter, T.G. (1997): A review of metallic mineralization in the Interior Plateau, central British Columbia (parts of 93C, B and F); *in* Interior Plateau Geoscience Project: Summary of geological, geophysical and geochemical studies, L.J. Diakow, J.M. Newell and P. Metcalfe, Editors, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 1996-2.

Levson, V.M. (2001): Regional till geochemical surveys in the Canadian Cordillera: Sample media, methods and anomaly evaluation; in ‘Drift Exploration in Glaciated Terrain’, M.B. McClenaghan, P.T. Bobrowsky, G.E.M. Hall and S.J. Cook (Editors); *Geological Society of London*, Special Publication 185, pages 45–68.

Levson, V.M. and Giles, T.R. (1994): Surficial geology and Quaternary stratigraphy of the Fawnie Creek area (93F/03); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-9.

Levson, V.M., Giles, T.R., Cook, S.J. and Jackaman, W. (1994): Till geochemistry of the Fawnie Creek map area (93F/03); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-18.

Lynch, J. (1999): Additional provisional elemental values for LKSD-1, LKSD-2, LKSD-3, LKSD-4, STSD-1, STSD-2. STSD-3, STSD-4; *Geostandards Newsletter*, volume 23, number 2, pages 251–260.

Lynch, J. (1996): Provisional elemental values for four new geochemical soil and till reference materials TILL-1, TILL-2, TILL-3 and TILL-4; *Geostandards Newsletter*, volume 20, number 2, pages 277–287.

Pautler, J.M., Smith, S.W. and Lane, R.A. (1999): Exploration and geology of the Tsacha epithermal gold deposit; Exploration and Mining in British Columbia – 1998, *BC Ministry of Energy, Mines and Petroleum Resources*, pages B1–B10.

Pautler, J. (1995): 1995 Cordilleran Roundup abstracts: spotlight session on Interior Plateau of British Columbia, page 42.

Pawliuk, D.J. (2005): Summary report on the Ted vein diamond drilling program - November 2004, Tam Property, 3Ts Project, Omineca Mining Division; Report prepared for Southern Rio Resources, April 2005, filed on SEDAR July 8, 2005, 28 pages.

Rhys, D. (2003): Tsacha and Tam properties – structural study; *Panterra Geoservices Inc.*, internal consulting report to Southern Rio Resources, July, 10 2003, 18 pages.

Schimann, K. (1994): Geological and geochemical report on the Tam claims, Omineca Mining Division; *BC Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 23746, 20 pages.

Sutherland, D. and Hoffman, E.L. (2005): SGH - Soil gas hydrocarbon predictive geochemistry for Cook Geochemical – AO5-2231; unpublished internal analytical report for Cook Geochemical Consulting, October 18 2005, 4 pages.

Sutherland, D. and Hoffman, E.L. (2003): SGH - A new soil gas hydrocarbon technique for mineral exploration under deep cover; *in* Program with Abstracts, *Geological Association of Canada–Mineralogical Association of Canada*, joint annual meeting, 1 page.

Sutherland, D. (2002): Soil gas hydrocarbon analysis; Activation Laboratories information sheet, August 2002.

Tipper, H.W. (1963): Nechako River map-area, British Columbia; *Geological Survey of Canada*, Memoir 324, 59 pages.

Wallis, C.S. and Fier, N.E. (2004): Technical report on the Tam property, British Columbia; report prepared for Southern Rio Resources, filed on SEDAR September 2, 2004.

Wallis, C.S. and Fier, N.E. (2002): Technical report on the Tsacha property, British Columbia; report prepared for Southern Rio Resources, filed on SEDAR February 11, 2003.