BRITISH COLUMBIA
Ministry of Energy and Mines
Energy and Minerals Division
Geological Survey Branch

TILL GEOCHEMISTRY OF THE WELLS - STONY LAKE AREA, B. C. (NTS 93H/4N AND 93H/5S)

By P. T. Bobrowsky (P.Geo.) and A. Bichler

OPEN FILE 2001-10

TABLE OF CONTENTS

INTRODUCTION

This report provides the final results, discussion and interpretation of a drift exploration program conducted northwest of Wells by the British Columbia Geological Survey Branch (Figure 1). The till geochemistry project discussed here represents the end product of field investigations undertaken during the summer of 2000 as part of a larger, multidisciplinary, integrated resource assessment program which aims to define the mineral potential of the Cariboo region, British Columbia. This survey complements the long term objectives of the NATMAP Ancient Pacific Margin (APM) project (see Nelson, 2000). The regional till survey discussed here, represents work in the first of a multi-year, integrated exploration program, hereafter called the Barkerville Project. The Barkerville Project follows a series of previous integrated or focused multi-year Geological Survey Branch initiatives completed throughout the province in areas of high mineral potential (e.g. Northern Vancouver Island 1991-1994; Kerr *et al.*, 1992; Bobrowsky and Sibbick, 1996; Nechako/Fraser Plateaus 1991-1995; Levson and Giles, 1997; Eagle Bay 1996-1998; Bobrowsky *et al.*, 1997; Dixon-Warren *et al.*, 1997; Paulen *et al.*, 1998, 1999). These projects demonstrate the utility of integrating surficial geology mapping and exploration geochemical methods to locate buried mineral deposits in areas of drift-covered terrain (*see* Bobrowsky *et al.* (1995) for a review).

The Barkerville Project is centred primarily over rocks of the Barkerville and Slide Mountain terranes (Figure 7). This first year of work evaluated till geochemistry in the southern half of NTS map sheet 93H/05 (Stony Lake) and the northern half of 93H/04 (Wells), located directly northwest of the town of Wells (Figure 1). The study covers an area of approximately 1000 square kilometres of rugged terrain (Figure 2). A number of factors provide the impetus for selecting this project area: 1) the high mineral potential of the terranes for lode gold mineralization and placers; 2) the previous successful industry record for locating new showings using till geochemistry farther south in Eagle Bay rocks (also Barkerville sub terrane); and, 3) the increasing industry exploration activity and the need for this type of data in the Cariboo region. In the past, placer and lode gold deposits supported the local mining industry in the region, but with the more recent realization of VMS potential, exciting new mineral prospects including the Lottie, Frank Creek and the Bonanza Ledge Zone have come to light. The primary purpose of the multi-year survey is to provide reconnaissance level till geochemistry data and regional ice flow pattern information to industry clients as an incentive for further exploration. Although attractive to exploration, the study areas does not currently show many MINFILE occurrences and the known commodity is mainly gold (Figure 3; Table 1).

The thick cover of surficial sediments in the study area has hampered the use of more traditional bedrock exploration techniques making it an ideal location for the implementation of a till geochemistry program. The following objectives provide the direction for the Cariboo region project:

- To further stimulate exploration and economic activity in the Cariboo Mining Division.
- To generate a regional pattern of till geochemistry data to define new anomalies and assist in the discovery of new mineralization.
- To assist the exploration community by demonstrating the use of till geochemistry as a more effective exploration tool in areas of thick overburden compared to conventional soil geochemical surveys.
- To map ice flow indicators and discern both regional and local ice flow patterns to aid drift prospecting.
- To document the dispersal of pathfinder elements down-ice from known sources of mineralization.
- To further expand the use of drift prospecting as both a reconnaissance and property-scale exploration technique.

Drift exploration integrates two allied components: surficial geology mapping and till geochemistry sampling. With this in mind, the objectives of the drift exploration project were to:

- identify types and character of surficial deposits present;
- estimate overburden thickness based on landform assemblage associations;
- define new anomalies which may be used in the discovery of mineralization targets;
- stimulate new exploration and economic activity;
- provide information that will be of use in all areas where mineral exploration has been hampered by thick glacial drift cover and where

traditional prospecting and exploration techniques have proven unsuccessful despite indications of high mineral potential.

The purpose of the surficial mapping component was to document the variability in the types of sediments observed, including their distribution and general character for this particular area. These data, including origin and age of unconsolidated sediments in the glaciated terrain, provide critical constraints to a successful drift exploration program. The Quaternary geologic history which consists of local and regional stratigraphy, sedimentology and glacial ice dynamics, are the focus of much of the work, since the understanding of these parametres provides a framework for any complimentary till geochemistry and pebble lithology sampling program (Salonen, 1988). The till geochemistry consisted of a systematic sampling program (1-5 kilograms) collecting primary basal till, ablation till and colluviated till deposits which were first identified and then targeted during the surficial mapping.

The integration of surficial mapping and till geochemistry with mineral deposit studies and detailed bedrock mapping addresses the main objective of drift prospecting: to provide data that will lead to the discovery of economic mineralization in areas now covered by a blanket of unconsolidated sediments. We do this by interpreting down-ice glacial dispersal patterns (mechanical dispersal trains) that will help locate the sources of geochemical anomalies and clast lithologies (*see* Coker and DiLabio, 1989). For the present survey area, bedrock mapping has already been completed by Campbell (1978) and Struik (1988) and is available for integration. Mineral deposit work is now being pursued regionally by Ray *et al.* (2001). Preliminary Quaternary geology results have been summarized prior to this report (Bichler and Bobrowsky, 2001), and an ice-flow map is in progress.

Open File 2001-10 provides the final summation of the till geochemical data collected in the two half map sheets during 2000. All samples considered reliable and useful for further exploration research are included in this report. This consists of ICP, INAA and whole rock analytical results on some 324 till samples. An important part of this report is the information provided regarding the regional Quaternary geologic history. Finally, the reader will benefit from the discussion regarding the distribution of anomalous values for several elements (Ag, Au, Cu, Cd, Zn, Pb and As) in this area, since it draws on the relevance of sample media, deposit genesis and probable associated mineral prospects.

OPEN FILE FORMAT

Open File 2001-10 consists of the following sections:

- Introduction
- Description of the survey area
- Survey methodology
- Quality control
- Data interpretation and discussion
- Summary and Recommendations
- References
- Guide to field observations (Appendix A)
- Analytical data for ICP Analysis (Appendix B)
- Analytical data for INAA Analysis (Appendix C)
- Analytical data for Whole Rock Analysis (Appendix D)
- Summary statistics and element maps for ICP data (Appendix E)
- Summary statistics and element maps for INAA data (Appendix F)
- Summary statistics and major oxide maps for Whole Rock data (Appendix G)
- Analytical duplicate data for ICP, INAA and Whole Rock Analysis (Appendix H)
- Station Location Map (Appendix I)

Analytical and field data are included here as an ASCII file on a 3.5-inch high density diskette in the back pocket.

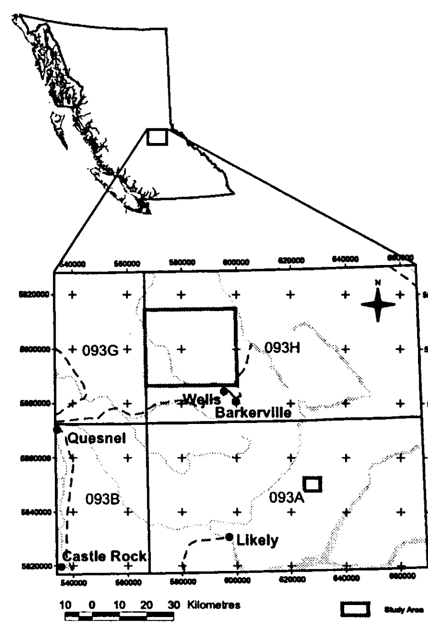


Figure 1. Location of the 2000 till geochemistry survey in the Barkerville area, and ancillary detailed study near Likely, British Columbia.

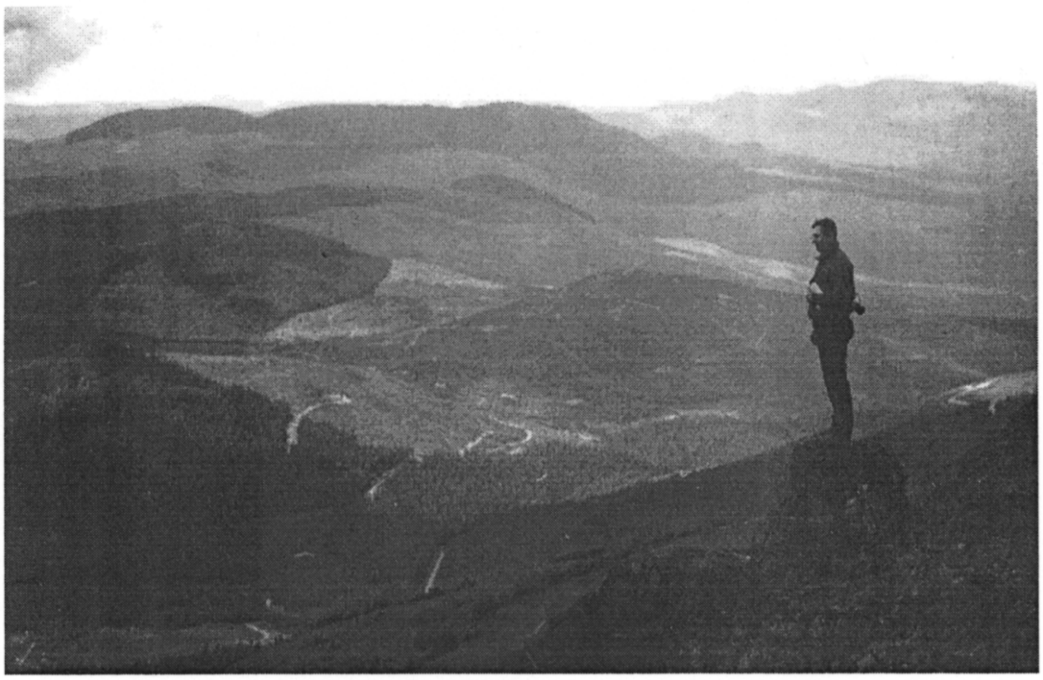


Figure 2. View northwest from Slide Mountain showing typical relief in the Quesnel Highlands.

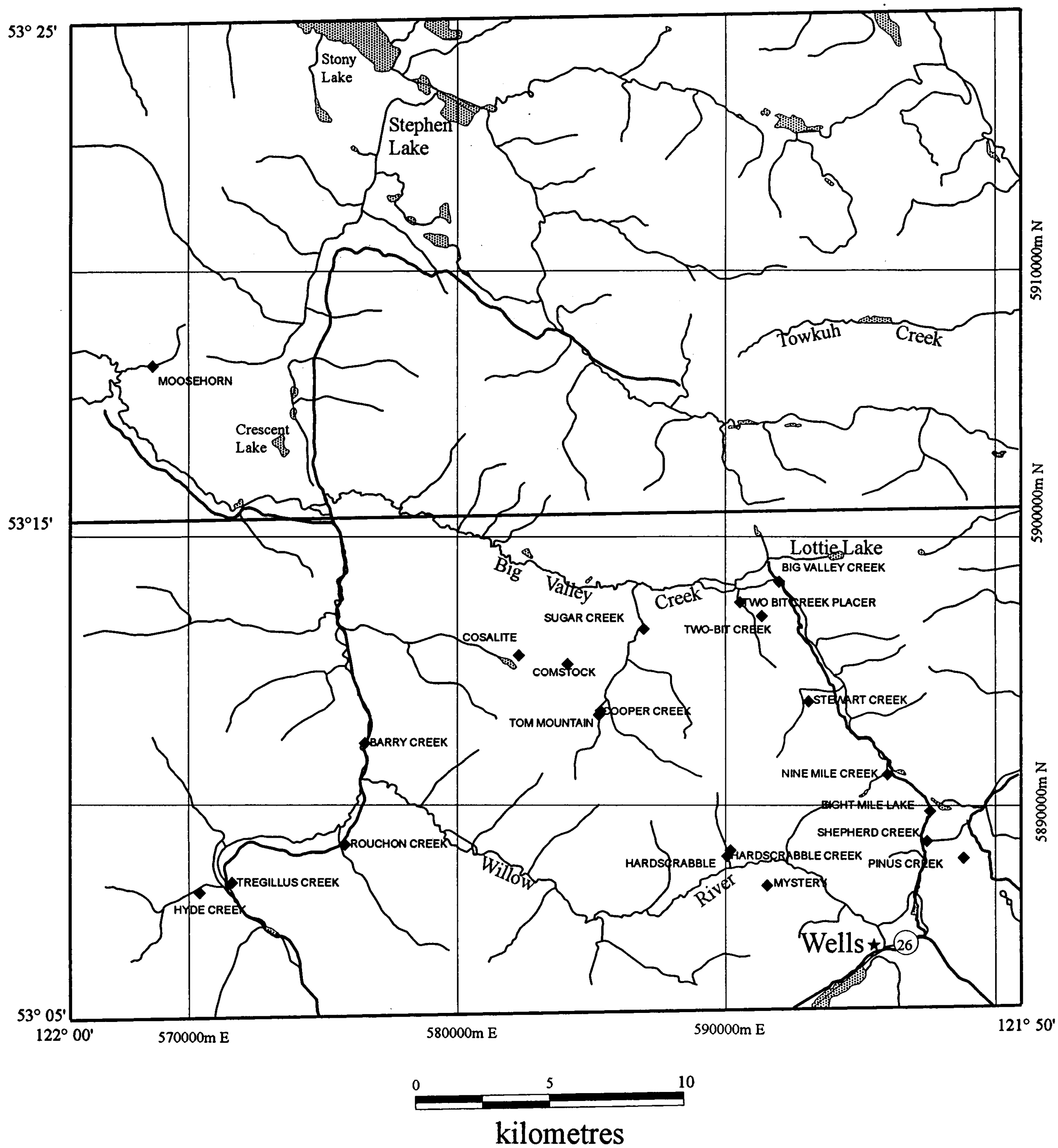


Figure 3. Mineral occurrence locations for NTS 93H/4N and 93H/5S from the MINFILE database, see Table 1 for respective commodity.

TABLE 1

MINERAL OCCURRENCE LOCATIONS FOR NTS 93H/4N AND 93H/5S FROM THE MINFILE DATABASE

NTS	MINFILE	NAME	COMMODITY	STATUS	UTME	UTMN
93H/4	093H 032	Costalite	Pb	Showing	582102	5895409
93H/4	093H 087	Hyde Creek	Au	Past Producer	570225	5886534
93H/4	093H 089	Tregillus Creek	Au	Past Producer	571372	5886922
93H/4	093H 090	Barry Creek	Au	Past Producer	576345	5892130
93H/4	093H 091	Rouchon Creek	Au	Past Producer	575569	5888347
93H/4	093H 013	Pinus Creek	Au	Past Producer	598814	5887842
93H/4	093H 014	Eight Mile Lake	Au	Past Producer	597589	5889579
93H/4	093H 023	Hardscrabble	W, Au, Pb, Zn	Past Producer	590201	5888105
93H/4	093H 031	Comstock	Pb, Zn, Au	Showing	584113	5895042
93H/4	093H 044	Copper Creek	Au	Past Producer	585332	5893301
93H/4	093H 045	Shepherd Creek	Au	Past Producer	597481	5888464
93H/4	093H 064	Two-Bit Creek	Ba	Showing	591373	5896844
93H/4	093H 076	Mystery	Au	Showing	591509	5886801
93H/4	093H 077	Tom Mountain	Au, Ag, Pb, Zn	Showing	585297	5893146
93H/4	093H 084	Tow-Bit Creek Placer	Au	Past Producer	590510	5897353
93H/4	093H 110	Sugar Creek	Au, Ag, Pb	Past Producer	586928	5896359
93H/4	093H 111	Hardscrabble Creek	Au, W	Past Producer	590075	5887886
93H/4	093H 112	Big Valley Creek	Au	Past Producer	591979	5898123
93H/4	093H 113	Stewart Creek	Au	Past Producer	593068	5893662
93H/4	093H 114	Nine Mile Creek	Au	Past Producer	596019	5890938
93H/5	093H 024	Moosehorn	Ag, Pb, Zn, Au	Showing	568659	5906168

DESCRIPTION OF THE SURVEY AREA

PHYSIOGRAPHY AND GEOLOGIC SETTING

The study area occurs within the Interior Plateau physiographic region. The Interior Plateau, in turn, is divided into seven subdivisions, two of which, the Fraser Plateau and the Quesnel Highlands intersect this study area.

The Quesnel Highlands are situated on the eastern boundary of the Interior Plateau and lie to the west of the Cariboo Mountains (Figure 2). They are bounded to the north and west by the Fraser Plateau and to the south by the Shuswap Highlands. The highlands were once plateaus of moderate relief and have since been dissected, leaving upland regions that rise from approximately 1600 metres asl in the west to 2100 metres asl in the east (Holland, 1976). The distinction between the Fraser Plateau and the Quesnel Highlands is an arbitrary one, as there is no visible boundary that can be discerned (Holland, 1976). The eastward rise of the dissected Fraser Plateau continues within the Quesnel Highlands.

The highest peak in the Barkerville study area is Two Sisters Mountain, rising to about 2100 metres asl. The lowest elevation is approximately 980 metres asl, in the Willow River Valley. Throughout, the landscape shows abundant evidence of previous glaciations and post-glacial erosion.

Vegetation

The area occurs mainly within the Sub-Boreal Spruce (SBS) Zone, with minor parts in the Engelmann Spruce-Subalpine Fir (ESSF) Zone. Extending from the valley bottoms up to about 1300 metres, the SBS zone is dominated by white spruce and sub-alpine fir with Douglas fir, lodgepole pine and aspen also common (Meidinger and Pojar, 1991). Luvisolic, podzolic and brunisolic soils are typical. Above 1300 metres the Engelmann Spruce-Subalpine Fir Zone is encountered and is dominated by these two species. The climate is characterized by seasonal extremes; severe snowy winters in contrast to relatively warm, moist and short summers with a moderate annual rainfall (Meidinger and Pojar, 1991).

Geologic setting

The regional bedrock geology of the Cariboo region has been described by Holland (1954), Sutherland Brown (1957, 1963), Tipper (1959, 1961), Campbell *et al.* (1973), Campbell (1978), Struik (1986, 1988), Bloodgood (1989), Panteleyev and Hancock (1989) and more recently Ferri *et al.* (1997), Ferri and Höy (1998a; 1998b) and Ferri (2001).

The project area lies on the western edge of the Omineca tectonic belt, where it abuts the Intermontane Belt. Within the regional project area, there are four terrane units represented; in order of importance: Slide Mountain, Barkerville, Cariboo and Quesnel terranes.

Rocks of the Slide Mountain Terrane underlie the majority of the Barkerville Project area, (~75 percent), and are found in the eastern and northern portions of the region (Figure 7). Slide Mountain rocks are Mississippian to Permian in age and are characterized by oceanic marginal basin volcanic and sedimentary rocks. The dominant rock types are basalts and chert pelite sequences with some intruded diorite, gabbro and ultramafic rocks. The Slide Mountain Terrane is internally imbricated by small thrust faults, but as a whole, the terrane is thrust on top of the Cariboo and Barkerville terranes along the Pundata Thrust Fault (Struik, 1986, 1988).

The Barkerville Terrane makes up the next largest portion of the study area, comprising some 15 percent of the area (Figure 7). The terrane is Precambrian to Palaeozoic in age and is an assemblage of pericratonic marine clastic and volcanic rocks, as well as their metamorphic equivalents. Typical rocks of this terrane consist of siliceous argillite, chert and quartzite. In this area, the Barkerville Terrane is generally considered to be the most metamorphosed of the four terranes represented. The Barkerville Terrane is recognized as the northern extension of the Kootenay Terrane found in south-central British Columbia (Struik, 1986, 1988). The northwest trending Pleasant Valley Fault separates the Barkerville and Cariboo terranes.

The remainder of the regional study area is underlain by rocks of the Cariboo and Quesnel terranes and comprise some 10 percent of the area (9 percent and 1 percent; respectively). Cariboo rocks are Precambrian to Permo-Triassic in age, whereas the younger Quesnel Terrane is upper Triassic to lower Jurassic. Rocks of the Cariboo Terrane are found in the south-central portion of the study area and are characterized by clastic sedimentary rocks of an ancient passive continental margin typified by siltstone, sandstone, chert and shale. This differs markedly from the rocks of the Quesnel Terrane, to the north-west (Figure 7), which are related to a volcanic arc origin; primarily andesite, dacite, rhyolite, shale and siltstone.

SURFICIAL GEOLOGY

The surficial geology component of the Quaternary geology program consisted of terrain evaluation at a scale of 1:50 000 and Terrain Survey Intensity Level B (Resources Inventory Committee, 1996). Work first consisted of compiling and evaluating all existing terrain information available for the area. Soil and landscape maps produced by the Resource Analysis Branch of the British Columbia Ministry of Environment in 1980 provided background data on the type of materials likely to be encountered (Lord and Green, 1980a and b).

Eight types of surficial deposit associations were defined and observed in the map area including: ground moraine as basal till, ground moraine as ablation till, colluvium, fluvial, glaciofluvial, glaciolacustrine, organic, and anthropogenic accumulations. In general, fluvial, glaciofluvial and glaciolacustrine sediments are found in the bottom of valleys below about 1100 metres asl. Underlying these waterlain sediments at depth, deposits of till and other materials are occasionally present. Above about 1100 m asl, ground moraine dominates except where slopes are steep in which case colluvium occurs. Sediments disturbed or derived by anthropogenic activities are found in and around communities, along roads and, in particular, within surface workings such as placer mines. Organic deposits occur locally in all types of terrain. Bedrock outcrops account for less than 25 percent of the total map area, and these are predominately found in the east near Two Sisters Mountain, Mount Wiley and Mount Tom.

Basal Till

Throughout much of the region, the bedrock topography is mantled by variable amounts of massive, very poorly-sorted matrix-supported diamicton (Figure 4). Deposits range in thickness from thin (<1 m) veneers to thick (>10 m) blankets. Characteristics of this diamicton lead us to conclude that it likely represents a lodgement depositional environment (Dreimanis, 1988). Basal till facies were variable with respect to the underlying bedrock, but not areally extensive enough to be subdivided into mappable units. In this region, most of the basal till averages about 3-5 metres in thickness.

In general, basal till (lodgement till) deposits are primarily massive to poorly-stratified, light to dark olive grey, moderately to highly consolidated and derived mainly from basalt and cherty pelites of the Slide Mountain Terrane. The matrix is fissile and has a clayey silt to a silty sand texture. Deposits are dense, compact, cohesive with weak and often irregular jointing patterns. Clast content ranges from 15-40 percent, usually averaging about 25 percent, and clasts range in size from granules to boulders (>2 metres) averaging 1-2 centimetres. The clasts are mainly subrounded to subangular in shape and consist of various lithologies of both local and exotic source. A number of clasts were observed to have striated and faceted surfaces.

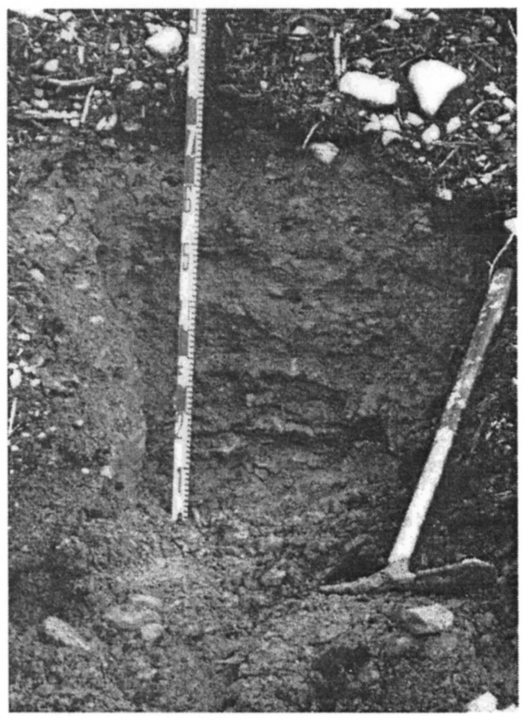


Figure 4. Hand excavated till pit in the Barkerville Project area, exposing basal till at a road cut.

Ablation Till

Massive to crudely stratified, clast-supported diamicton occurs occasionally throughout the study area. Most commonly, deposits of ablation till occur as a thin mantle overlying basal till and/or bedrock on the higher plateaus. Such deposits are generally less consolidated compared to a typical basal till accumulation. The matrix is also sandier than that of a basal till. The ablation tills sampled have a range of clast percentage from 20 to 70 percent; averaging 39 percent. Clast size ranges from granular to ~60 centimetres with a mean of about 4.0 centimetres. The shape of clasts ranges from very angular to subrounded and shows less faceting and striations than those found in a basal till. Deposits also occur in areas of hummocky terrain where evidence of recessional ice and mass-wasting occurred during deglaciation. The diamictons are interpreted as supraglacial or ablation till deposits, resulting from deposition by stagnating glacier ice (cf. Dreimanis, 1988).

Glaciofluvial Sediments

Deposits of massive to well-stratified sand, gravel and silt occur in valleys and as terraces in most of the drainage systems. Deposit characteristics vary considerably from kame terraces to meltwater channels or large deltaic sequences. The prominent glaciofluvial deposits in the Quesnel Highlands primarily occur below *ca.* 1100 metres elevation and provide a proxy indicator of the elevation for the extent of the glaciolacustrine lakes that existed in the area at the close of the Fraser Glaciation. The coarse gravel beds were observed to range from open framework clast-supported beds to very well-stratified beds with normal, reverse or no grading exhibited. Where evident, pebble imbrication, cross-stratified beds, ripples and other structures provide evidence for paleo-stream flow. Often, these are interstratified with finer beds of silty sand, to coarse pebbly sand occasionally with cross-bedding. They likely represent ice-proximal to ice-distal facies deposited during deglaciation. Deposit thickness can range from veneers to tens of metres.

Glaciolacustrine Sediments

Along certain valley sides, small sections of glaciolacustrine sediments can be seen to form terraces above the modern day floodplain. The terraces occur below 1100 metres asl, providing a minimum elevation for a large post-glacial lake in the valleys. The exposures consist of rhythmically laminated, horizontal, tabular beds of massive to normally graded beds of fine sand, silt and clay. Ripple laminations, ball and pillow structures, and flame structures are present occasionally. When present, ice-rafted stones are surrounded by sediments exhibiting penetrative structures. Individual rhythmites may have sharp basal contacts and vary in thickness from a few millimetres to several tens of centimetres. Variations in deposit characteristics indicate differing proximity to the retreating ice front.

Fluvial Sediments

A prolonged period of erosion during the Holocene has resulted in the development of fluvial deposits. Abandoned stream channels and small fluvial fans are known to occur at the edges of the major valleys. Deposits normally consist of clean, well-sorted and stratified sand and gravel. Clasts tend to be well-rounded and reflect both local bedrock and older drift provenance. Fluvial deposits are mainly restricted to the lower elevations, occurring as terraced landforms or discontinuous sediment veneers over modern day floodplains. The deposits tend to be restricted to several tens of metres on either side of the modern creek, stream and river channels.

Colluvium

Holocene erosion and the moderate to high relief topography of the region has produced appreciable amounts of colluvial debris. Deposition and accumulation of colluvial sediments is the result of gravity-induced downslope movement of fractured bedrock and/or unconsolidated sediments. In all cases, the source material contributing to the deposit strongly influences the resulting character. Hence, colluvium varies from massive to crudely-stratified, poorly-sorted to moderately-sorted, matrix to clast-supported, and monolithologic to polylithic. Deposits of colluvium in the region vary from a thin veneer to several metres thick and have been observed to overlie all other types of surficial sediments and bedrock. Clast size ranges from granules to boulders and the shape ranges from subrounded to angular, again depending on source provenance. Deposits can occur as massive cones on bedrock slopes, to broad stratified fans, to thin veneer on steep till slopes. Colluvium, sensu stricto, is not a good material to sample for geochemistry, but we do recognize one variant of weakly reworked till which we call colluviated till. Such deposits represent till which may have moved only a few metres from the original position of deposition, and therefore can no longer be considered in situ till. Colluviated till samples are very suitable for till geochemistry studies.

Organic Deposits

Organic deposits occur locally in areas of poor drainage and are common around major meltwater channels areas underlain by impermeable sediments, where modern day drainage is very poor. On the flat-lying plateaus, organic deposits form between the drumlinoid landforms and roche moutonnées where the bedrock topography traps surface water and forms small highland bogs. Proportionately, organic deposits are insignificant relative to other types of sediments.

Anthropogenic Deposits

Anthropogenic deposits by definition consist of materials modified by human activities to the extent that their initial physical properties and surface expression are drastically altered. Such deposits occur in the mine dumps, along roads and within the numerous surface workings of the placer mines.

QUATERNARY GEOLOGIC HISTORY

The Cariboo region contains abundant evidence of at least two episodes of glaciation during the Pleistocene: the penultimate glaciation and the Fraser Glaciation. During these two events, glaciers generally flowed eastward from the Coast Mountains and westward from the Cariboo Mountains to coalesce over the central Interior Plateau (Tipper, 1971; Fulton, 1991).

Tertiary deposits consisting of broad, stable, gravel fluvial deposits are exposed primarily in deeply incised river valleys (Levson and Giles, 1993). Such deposits are often gold bearing and have been a major focus of activity for the placer industry in the area.

Overlying the Tertiary fluvial deposits are younger glaciofluvial and glacial sediments. Most deposits of this age consist of massive and stratified silt, sand and gravel occasionally intercalated with till. Though very rare, the oldest till deposits are from the penultimate glaciation, and are likely pre-Late Wisconsinan in age (Clague, 1988; Levson and Giles, 1993). Such deposits are described as units of diamicton separated by thin sand and gravel beds (Clague, 1988, 1991). The presence of striated and faceted stones, the texture, and the fabric of the diamictons suggest that in most cases, these are indeed tills. No concrete dates have been assigned to this older till unit as they are beyond the limits of radiocarbon dating.

Once the glaciers of the penultimate glaciation had receded, the region remained ice-free from about 51,000 to 40,000 years ago (Clague *et al.*, 1990). During this time interval, valleys were incised by ancestral rivers to levels similar to present (Clague, 1991). Following this erosional phase, the deposition of thick units of fluvial and lacustrine sediments directly preceded the Fraser Glaciation.

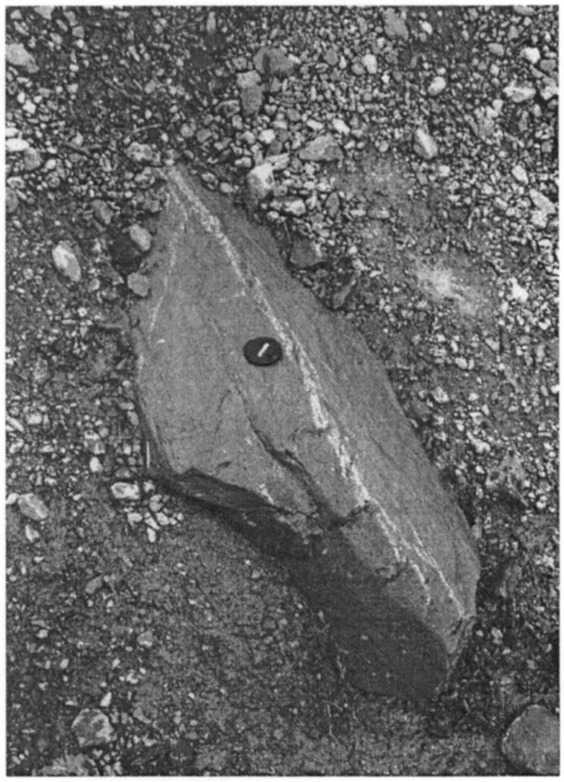


Figure 5. Bullet-shaped boulder found within basal till. The photo was taken from the perspective of looking obliquely down onto the boulder. Boulder only appears to be dipping to viewer, actual dip away from viewer.

Evidence for the last glacial advance, the Fraser Glaciation (Late Wisconsinan), is much more pronounced. Glaciers advancing from the Cariboo Mountains, in the east, deposited thick layers of glacial, glaciofluvial and glaciolacustrine sediments over the landscape. This last event contributed most of the landforms presently observed, including U-shaped valleys, terraces, eskers, drumlins, roche moutonnées and whale backs throughout the region.

The most perplexing aspect of the glacial history in the area is the discordant ice flow indicators. During the course of till sample collection, a suite of paleo-ice flow indicators were encountered and documented. The most common features included fine and coarse striae cut into bedrock, rat-tails and grooving. Bullet-shaped boulders and pebble fabrics in till also provided directional information for past glacier movement. Meso and macro-scale features such as flutes, whale backs, roche moutonnées, and drumlins also provide good indications of paleo-ice flow movements.

Collectively, these ice flow indicators provide a complex picture of movement during the Quaternary (Figure 6). Cross-cutting relationships of striae provide a relative chronological history for ice movement in any one location that reflects multiple flow directions. However, some evidence is present for ice flow occurring in virtually every cardinal direction. In other words, a rose diagram plot of ice-flow directions gives a "star-burst" appearance. The interpretation of this evidence will require significantly more attention in the field than that possible in a single season. Nonetheless, likely factors contributing to the cross cutting relationships is presented here to assist explorationists. In the latter part of the Open File up-ice projections vary because of this regionally discordant pattern of flow.

When interpreting ice flow directions in the Barkerville region, focus should be on local and not regional evidence. In the Barkerville area, the most likely explanations for the cross-cutting evidence in ice flow suggest that the different directional indicators may be the result of one or more of the following:

- separate glacial advances,
- different phases of the same advance,
- shifting ice divides and/or,
- ice draw down.

In British Columbia each factor appears to have gained favor by a suite of proponents. In the case of the Barkerville area, it is likely that each factor has played some role in contributing to the documented but discordant patterns. In the interpretive part of this Open File, the most likely up-ice direction is proposed, but given the variability observed regionally, extreme caution in following a single "up-ice" direction for geochemical anomalies is advised.

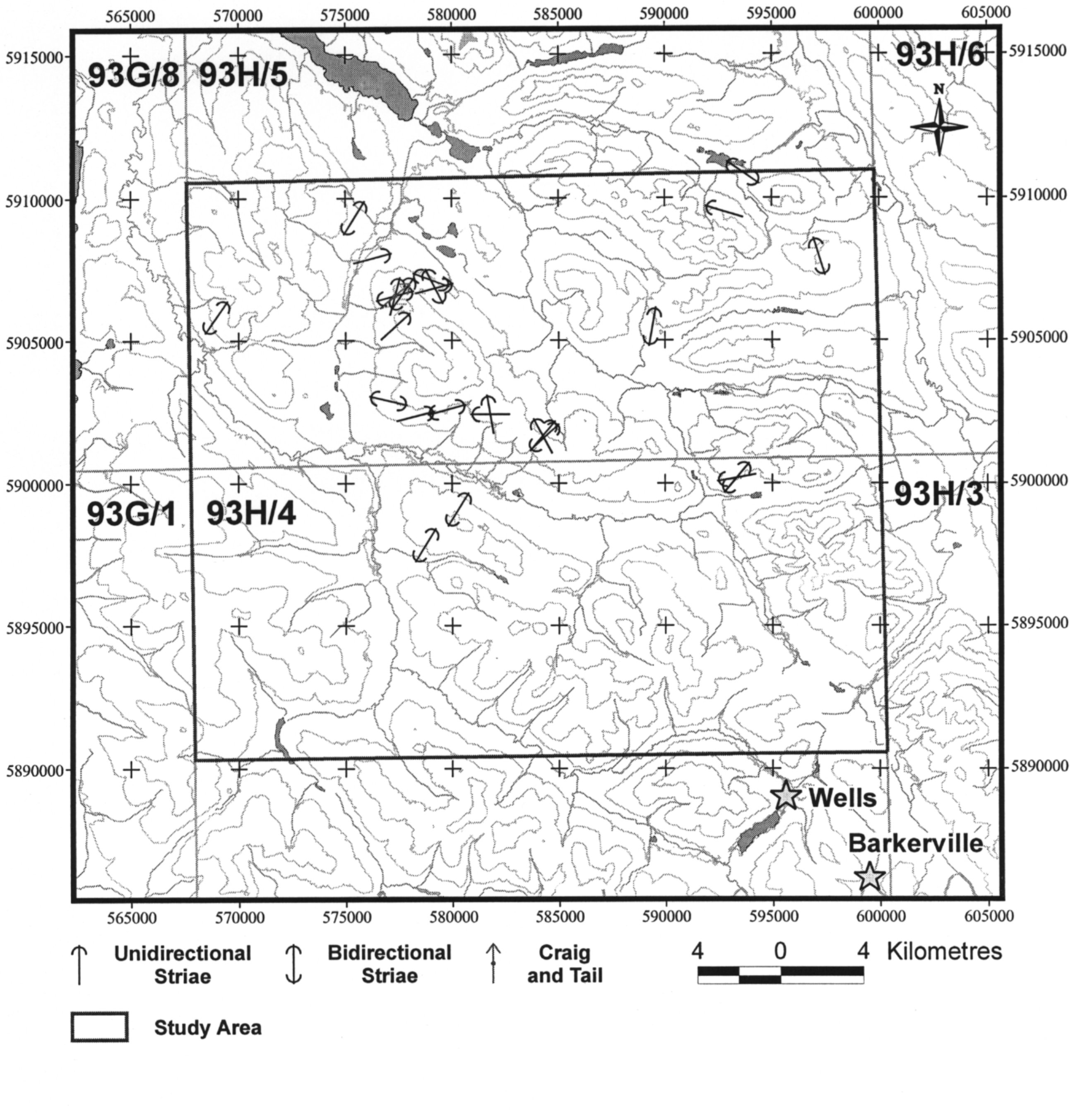


Figure 6. Simplified ice flow map for the Barkerville area.

Bedrock Geology

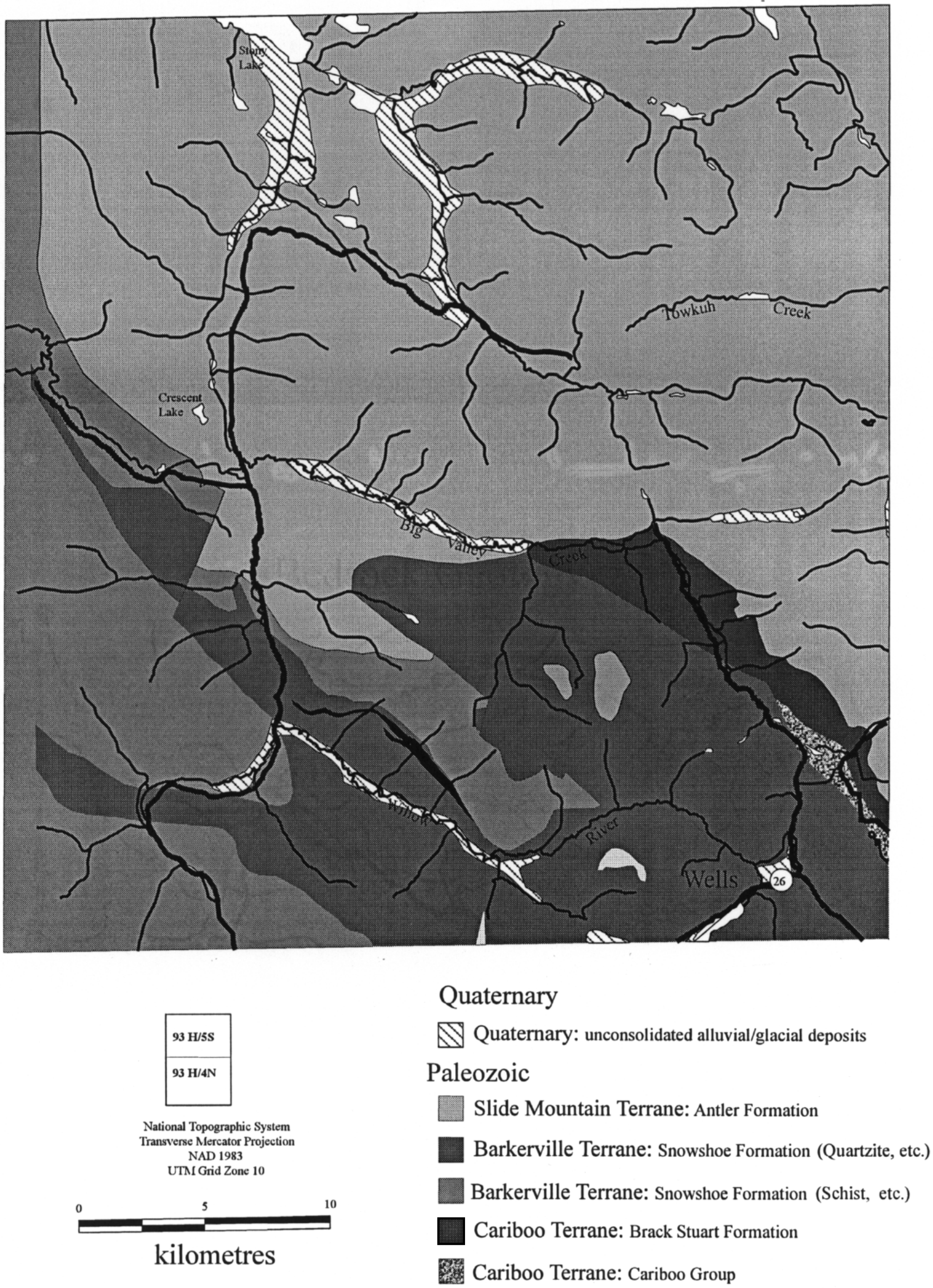


Figure 7. Generalized bedrock geology map showing the distribution of terranes in the vicinity of the Barkerville.

SURVEY METHODOLOGY

SAMPLE COLLECTION

Fieldwork was based out of one base camp in Wells. Access to the full study area is excellent. An extensive network of logging roads intersects most valleys, moderate slopes and all upland areas. The eastern reaches of the study area are at increasingly higher elevation and provide challenges for logging, thus limiting the accessibility afforded to our survey.

The majority of fieldwork was conducted with a 4-wheel drive truck and 4-wheel drive all-terrain vehicles along secondary roads and trails of varying condition. Where road or 4-wheel drive track access was blocked or non-existent, traverses were completed on foot.

Initial work consisted of compiling and evaluating all existing terrain information available for the area. Soil and landscape maps produced by the Resource Analysis Branch of the British Columbia Ministry of Environment (Lord and Green, 1980a and b) provided background data on the type of materials likely to be encountered. Prior to field work, maps of the study area were compiled using GIS software. Data collected were based on digital TRIM II maps as reference. Information on road access was obtained from the Ministry of Forests and West Timber Fraser Ltd., and some geological data were provided by Hudson Bay Mining Co. Vertical aerial photographs of the region were also assembled to assist in both navigation and landform interpretation.

For each field station, including geological stops where no till samples were collected, the following data were collected for the site: UTM location; general geomorphology; terrain polygon unit; average slope; orientation of streamlined landforms, striations and grooves; description of bedrock; elevations of post-glacial deposits; and active geological processes.

For the regional till survey, bulk sediment samples for geochemical analysis were collected throughout the study area to generate a sampling density of approximately one sample per 2.5 square kilometres (Figure 8). Sampling was directed, where possible, towards unweathered, C-horizon basal till. This preferred media represents a first derivative product of glacial deposition (as per Shilts, 1993). Basal till was sampled at maximum depth, utilizing natural exposures and hand excavations (Figure 4). Where basal till was unobtainable, ablation till and colluviated till were collected.

At each till sample site, the following information was recorded: type of exposure (gully, road cut, etc.); depth to sample from surface; total thickness of exposure; stratigraphy and thickness of units within exposure; internal structures; clast percentage, angularity, and size; clast lithology; matrix or clast supported diamicton; matrix texture and colour; consolidation; and geologic interpretation (whether the material being sampled was a basal till, ablation till or colluviated till).

SAMPLE PREPARATION/ANALYSIS

Once collected, labeled and recorded, samples were shipped to Bondar Clegg Laboratories in North Vancouver for sample preparation. Samples were first air dried, split and sieved to -63 μm. The unsieved split sample, along with the pulps and -63 μm samples were then returned to the BCGS sample preparation laboratory. The -63 μm fraction of each sample was further divided into 10 and 30 gram portions. The 10 gram part was subjected to aqua regia digestion and analysed for 30 elements by ICP-MS (inductively coupled plasma mass spectroscopy) and major oxides by $LiBO_2$ fusion ICP-ES (11 oxides, loss on ignition and 7 minor elements). The 30 gram portion was submitted for INAA (instrumental neutron activation analysis) for 30 elements.

Analytical results are provided as Appendix B (ICP), Appendix C (INAA) and Appendix D (Whole Rock). Data for 31 of the 35 INAA elements and 31 of the 35 ICP elements are presented. Elements excluded from the database are those that contained an excessive number of values at or below the detection limit. Detection limits for the included elements for all methods of analysis are shown in Table 2 Summary statistics are included with the element maps.

TABLE 2
DETECTION LIMITS FOR INAA, ICP AND WHOLE ROCK ANALYSIS FOR TILL SAMPLES

	INA	ICP			INAA	ICP		Whole-rock	
Al		0.01%		Mn		1 ppm		SiO_2	0.02%
Ag		2 ppb		Na	0.01%	0.001 %		Al_2O_3	0.03%
As	0.5 ppm	0.1 ppm		Nd	5 ppm			Fe_2O_3	0.04%
Au	2 ppb	0.2 ppb		Ni		0.1 ppm		MgO	0.01%
Ba	50 ppm	0.5 ppm		P		0.001 %		CaO	0.01%
Bi		0.02 ppm		Pb		0.01 ppm		Na_2O	0.01%
B		1 ppm		K		0.01 %		K_2O	0.04%
Br	0.5 ppm			Rb	15 ppm			TiO_2	0.01%
Cd		0.01 ppm		Se	3 ppm	0.1 ppm		P_2O_5	0.01%
Ca	1 %	0.01 %		Sm	0.1 ppm			MnO	0.01%
Ce	3 ppm			Sc	0.1 ppm	0.1 ppm		Cr_2O_3	0.001%
Cr	5 ppm	0.5 ppm		Sr	0.05%	0.5 ppm		LOI	0.01%
Co	1 ppm	0.1 ppm		Sb	0.1 ppm	0.02 ppm		Ba	5 ppm
Cu		0.01 ppm		Ta	0.5 ppm			C	0.01%
Cs	1 ppm			Te		0.02 ppm		Nb	10 ppm
Eu	0.2 ppm			Tb	0.5 ppm			Ni	20 ppm
Fe	0.01 %	0.01 %		Th	0.2 ppm	0.1 ppm		S	0.01%
Ga		0.1 ppm		Ti		0.001 %		Sc	1 ppm
Hg		5 ppb		Tl		0.02 ppm		Sr	10 ppm
Hf	1 ppm			U	0.5 ppm	0.1 ppm		Y	10 ppm
La	0.5 ppm	0.5 ppm		V		2 ppm		Zr	10 ppm
Lu	0.05 ppm			W	1 ppm	0.2 ppm			
Mg		0.01 %		Yb	0.2 ppm				
Mo		0.01 ppm		Zn	50 ppm	0.1 ppm			

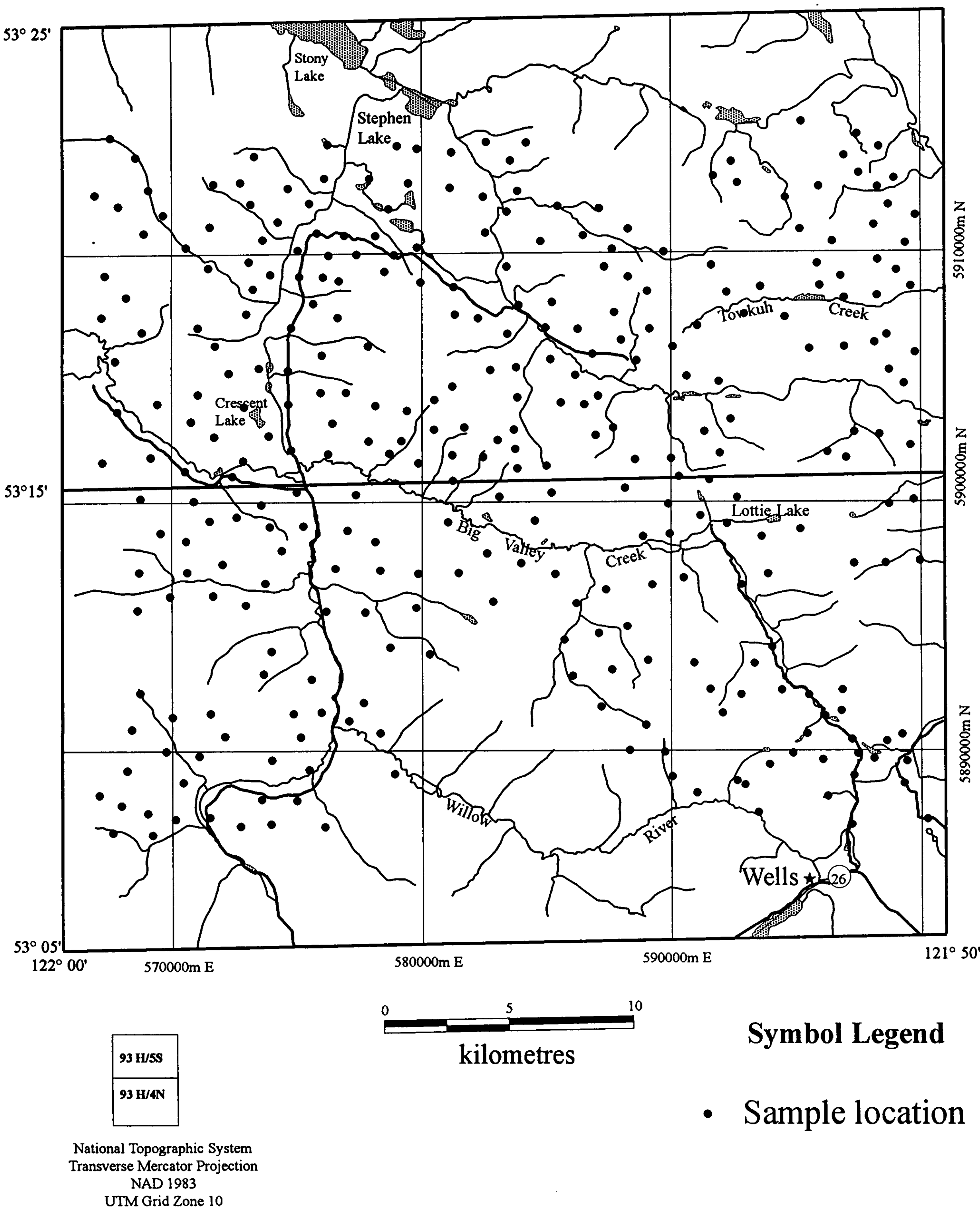


Figure 8. Till sample distribution map for the Barkerville geochemical survey, 2000; a total of 324 locations.

QUALITY CONTROL

METHODOLOGY

Distinguishing geochemical trends caused by geological factors from those variations due to anthropogenic influences, spurious sampling or analytical errors is important for reliably interpreting regional till geochemical data. The routine regional stream and lake sediment geochemical survey quality control methodology developed by the BCGS for monitoring sampling and analytical variability was adapted for this project. In short, control reference standards and analytical duplicates are routinely inserted into sample suites to monitor and assess accuracy and precision of the analytical results. Control reference standards are used to assess analytical accuracy. Sampling and analytical variation can be quantified using estimates of precision within and between sample sites determined by utilizing field and analytical duplicate data. Each block of 20 till samples contains:

- Sixteen routine samples,
- Two additional field duplicate sample collected adjacent to one of the routine samples,
- One blind duplicate sample split from one of the 16 routine samples prior to analysis,
- One control reference standard containing sediment of known element concentrations.

The locations of blind duplicate and control reference samples are selected prior to sampling, whereas field duplicate sites are chosen randomly during fieldwork. The control reference standards consist of CANMET certified and different 'prepared' bulk till of known element concentration. In total, the quality control consisted of 21 pairs of field duplicates and 21 pairs of analytical duplicates (Appendix H). It is common to observe greater variability in the field duplicate pairs as compared to the analytical duplicates. The reason for this difference is that the former represents two different but 'adjacent' samples (= field sampling + preparation + analytical variability), whereas the latter represents two parts of the same sample (= analytical variability).

Scatter plots of the analytical and duplicate pairs were generated to visually facilitate quality control evaluation (Figures 9 through 12). The field duplicate data contained very few outliers, but as can be expected, there are some obvious outliers present for the gold analyses.

In general, the results shows good correlation for most field duplicate pairs. For the ICP data, field duplicate pairs have correlation coefficients ranging from 0.904 0.991. For the oxide data, field data duplicate pairs have correlation coefficients ranging from 0.989 to 0.999. The presence of individual, anomalous samples would have significantly reduced the overall correlation coefficients for each analysis. Analytical duplicate pairs show a much higher degree of correlation. In this case, for ICP analytical data, r values range between 0.956 and 0.996; whereas for the major oxides, analytical data have correlation coefficients of 0.997 and .998.

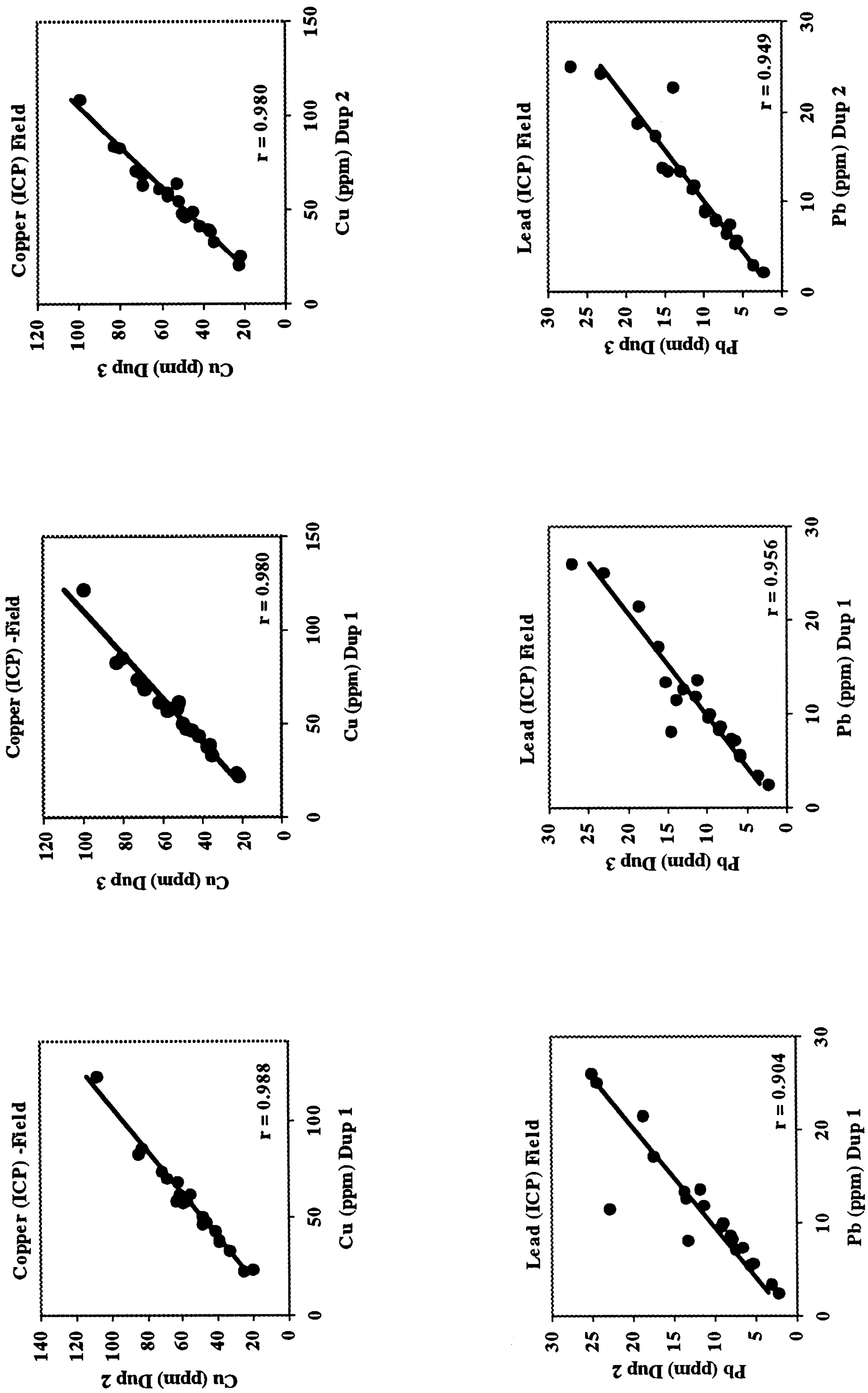


Figure 9. Bivariate scatter plots for field duplicate samples from the Barkerville till survey.

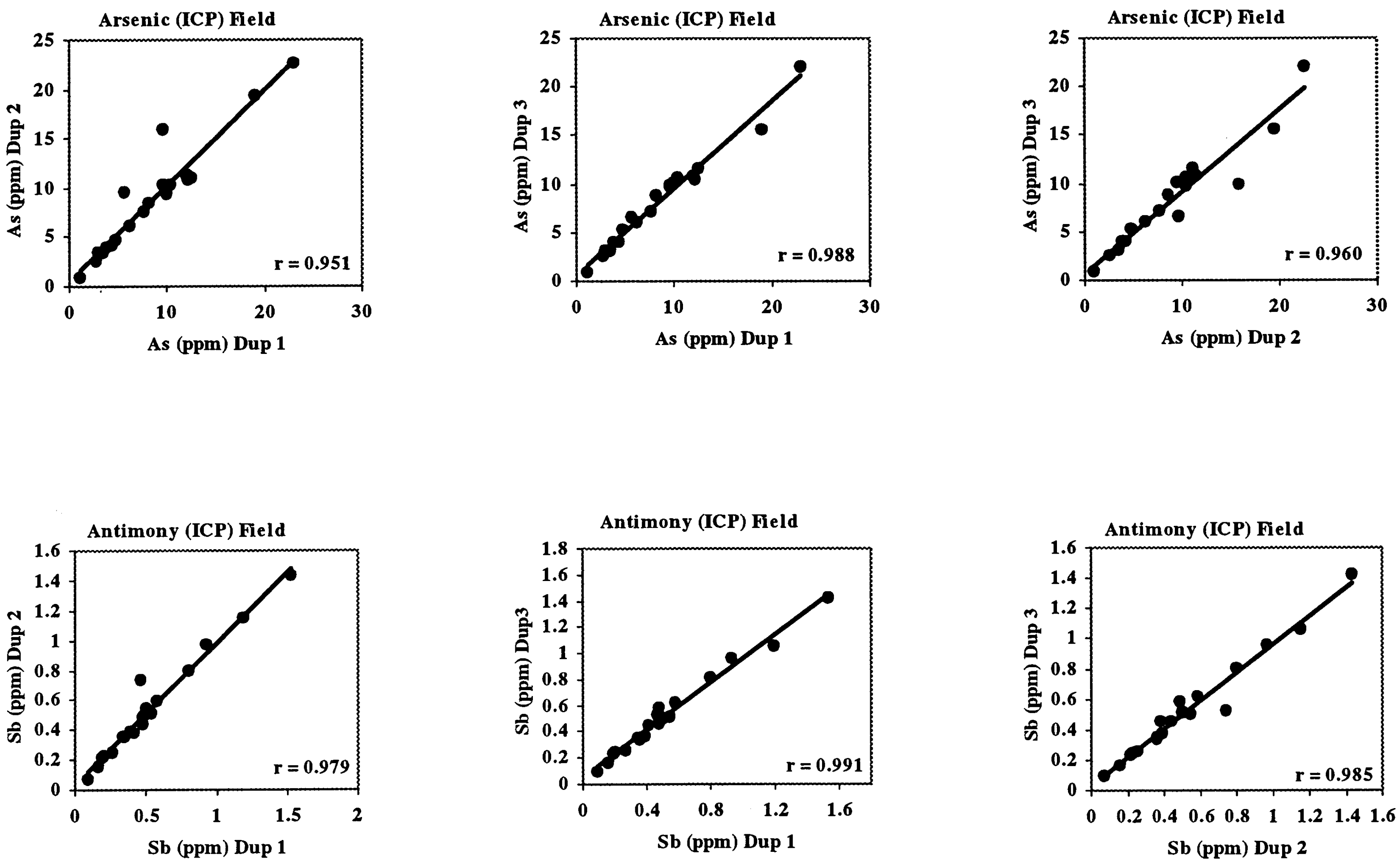
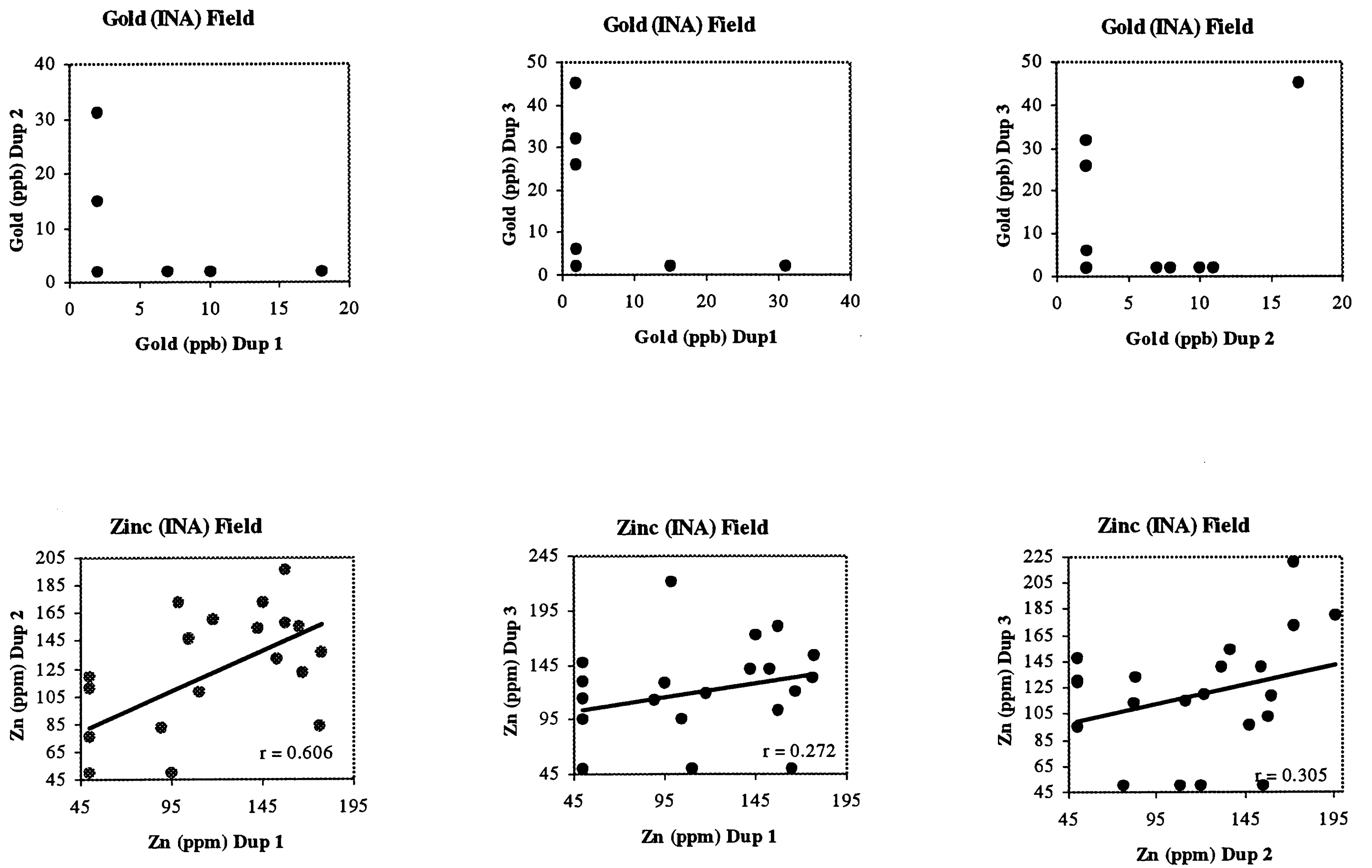


Figure 10. Bivariate scatter plots for field duplicate samples from the Barkerville till survey.

Figure 11. Bivariate scatter plots for duplicate field samples from the Barkerville till survey.



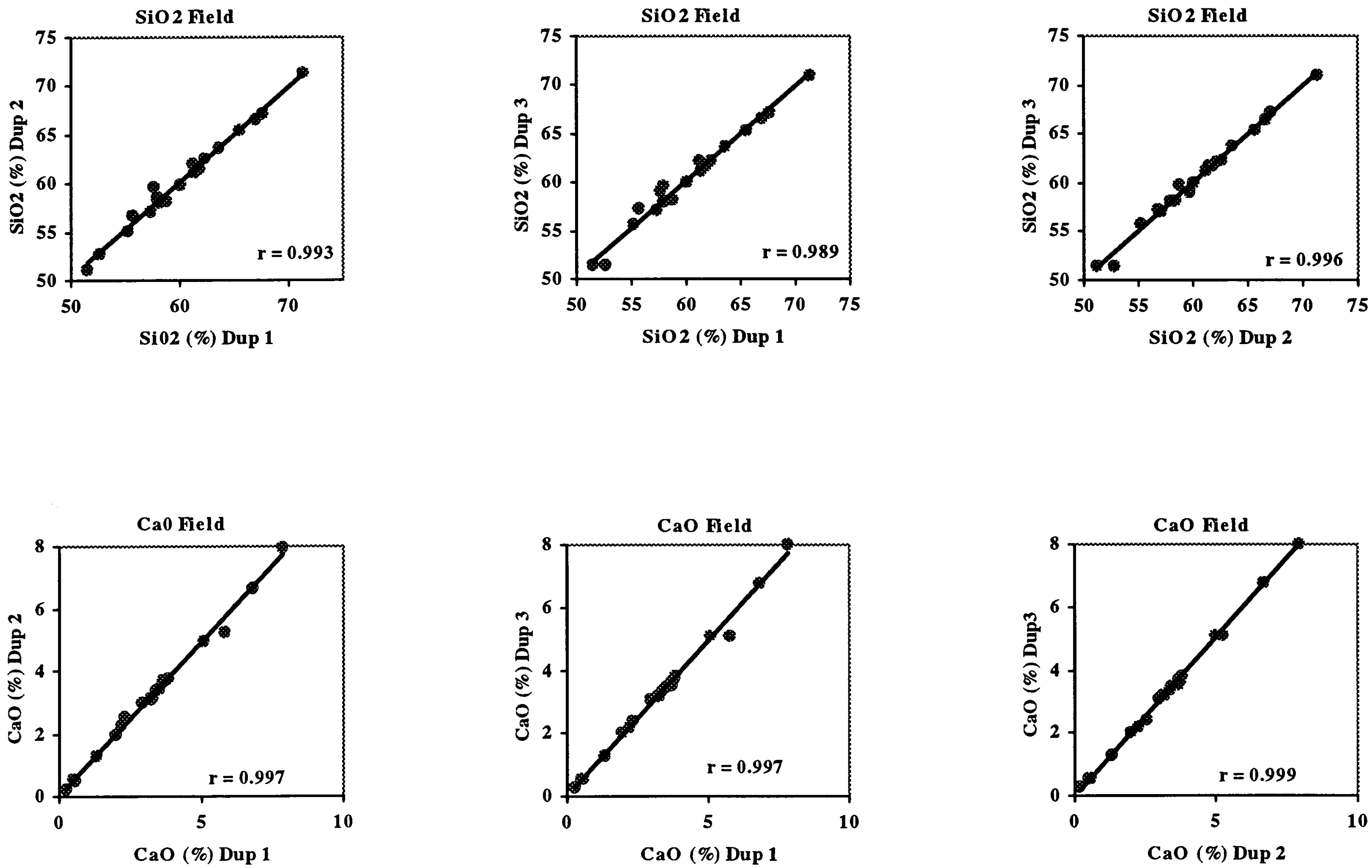


Figure 12. Bivariate scatter plots for duplicate analytical samples from the Barkerville till survey.

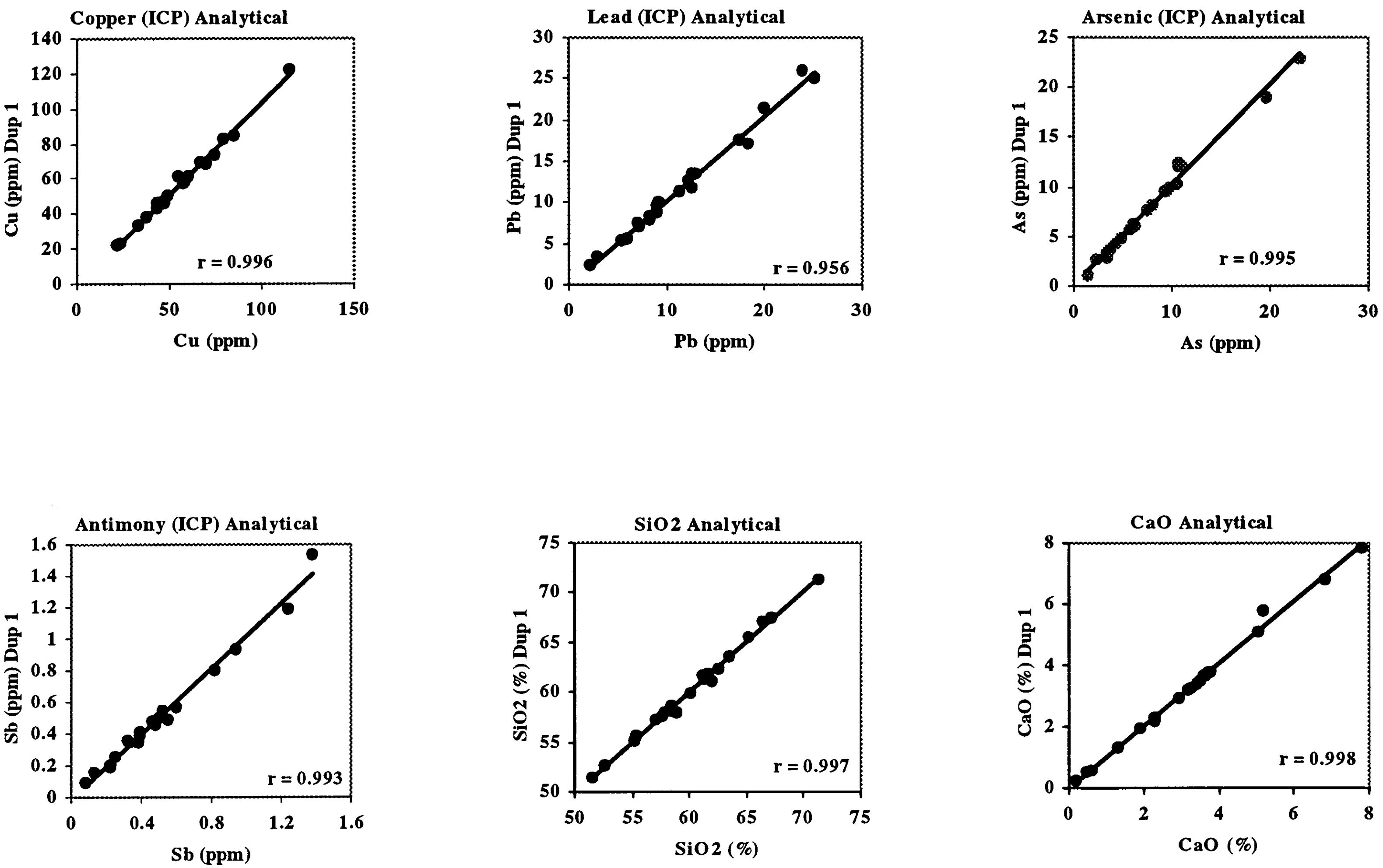


Figure 13. Bivariate scatter plots for duplicate analytical samples from the Barkerville till survey.

DATA INTERPRETATION

This report provides the results of the till geochemical survey in the Barkerville area. The data interpretation provided here establishes a reconnaissance level guide to geochemical patterns established in the two map sheets. From an exploration perspective the relation between "anomalous" or elevated values of certain elements such as copper, gold, silver, lead, zinc, arsenic and cadmium and the surficial geologic history warrants further discussion to ensure that follow-up studies are executed with a good knowledge of probable source areas and a higher likelihood for discovering those source areas.

As noted previously, analytical results for 31 ICP elements (Appendix B) and 27 INAA elements (Appendix C) are presented in this report. The whole rock analysis data provides results of analysis for 11 major oxides, 7 minor elements as well as Loss-On-Ignition (LOI) values (Appendix D). The ICP data in Appendix B consists of a map identification column (NTS), sample number (ID), UTM easting and northing (UTME and UTMN, respectively), replicate sample status (STA), and sample media (MAT). The individual elements are listed along the top of the x-axis under which a unit of measurement (*e.g.* ppm or %) is provided, followed in each case by the level of detection. In Appendix C, the INAA analytical data consists of the same first seven columns as the ICP data. Under each of the elements detailed for the INAA data, units of measurement include ppb, ppm and %, which in turn are underlain by levels of detection. Finally, the whole rock analysis data provided in Appendix D consist of the same first seven columns as in the ICP data, as well as data for major oxides and LOI concentrations presented as a percentage of total; the final column gives the analytical summed value for each sample.

Appendix E provides graphical plots of the 31 elements analyzed by ICP. Each illustration provided consists of an element specific map covering the full sample area (NTS 92H/4N and 92H/5S), geographical reference points (*e.g.* town, lakes, and river names), geographical coordinates (UTM and latitude and longitude), as well as a symbol legend. The symbol legend describes the distribution of values for eight percentile categories, minimum and maximum values within each percentile category, number of samples in this category and a graphic representation of the symbol size used to denote the particular percentile category. The facing page of each element map provides a frequency histogram of the specific distribution, as well as a normal cumulative frequency curve. Analytical summary data presented includes the fraction analyzed, the analytical method and the detection limit. Summary statistics for each element consist of the number of samples, minimum and maximum values, mean, mode, median, lower and upper quartiles, standard deviation and a coefficient of variation.

The graphical representation, analytical summary and statistical summary is duplicated for the 27 elements analyzed by INAA and for the 11 major oxides. These results are provided as Appendix F and G, respectively. The analytical duplicate data for ICP, INAA and whole rock analysis are given in Appendix H. To assist in station identification, a mylar overlay map with all station locations and identification labels is included as Appendix I. Lastly, a digital version of the geochemical data is provided in ASCII format on the 3.5" diskette included in the back cover insert.

The elements presented here are those for which analytical results appear to be both minimally biased and above detection limits. Moreover, the data presented include results for comparable media (tills and colluviated till). Hence, the integrity of the data is interpreted to be exceptionally high in comparison to any discussion centred on mixed media samples (*e.g.* till, colluvium, soils, outwash, etc.). Given the nature of the surficial sediments in the Barkerville area, the media sampled and presented here reflect 'parent' materials or proximal sources which are 'local' in origin; that is, where transport distances are on the order of tens of metres to a few kilometres from source area, rather than tens or hundreds of kilometres as is the case in other regions.

In the following discussion, several of the more important elements associated with mineralization (gold, copper, lead, silver, zinc, cadmium and arsenic) are reviewed. Elevated element concentrations are highlighted and evaluated with reference to known mineral occurrences (see MINFILE 92H). Interpretations regarding likely associations between till geochemistry anomalies and known mineral occurrences are provided. Similarly, as yet unexplained associations are emphasized with suggestions for probable source areas. Local ice flow directions, deposit type and drift thickness is discussed and integrated into the interpretation to assist explorationists with follow up efforts. As noted elsewhere, regional ice flow patterns in the area do not provide a reliable indication for detailed up-ice investigations.

SILVER

The 324 samples collected and analyzed by ICP provided silver concentrations ranging from less than 3 ppb to 3902 ppb. The samples generated a mean concentration of 82 ppb; mode and median values were 16 ppb and 43 ppb, respectively. Most of the samples (319) were in the lower 98.5%, which corresponds to values equal to or lower than 427 ppb. Only the uppermost five samples are discussed in this report. At the present time, none of the highest five values of silver can be confidently related to known mineral occurrences.

A deep (1.3 m) basal till sample from station 009416 located in the far eastern side of the study provided the highest concentration of silver recorded in this suite of analyses (3902 ppb). The site is located at the foot and east side of Two Sisters Mountain near Hobo Gulch. The source area for this elevated silver value is presently unknown, but is most likely within several hundred metres to the east and southeast. This multi-element site also shows the highest values of Cu, Mn, V, Mg, Al and Ga! Appreciably high values of Hg and Mo are also present in this sample.

The second highest concentration of silver in this survey suite is from station 009315 where a value of 466 ppb silver was obtained. This site also had a moderately high value of Hg (204 ppb) and moderately high value of Mo (2.34 ppm). This site was close to an outcrop of graphitic schist (phyllite) and is located on the east-slope of a small ridge north of Yuzkli Creek. The nearest known mineral occurrence is MINFILE 093H-032 (Pb commodity) about 1 km to the southwest. It appears unlikely that the Ag concentration at this site is related to the known nearby showing.

Two elevated silver values of 443 ppb and 427 ppb were obtained for stations 009034 and 009035, respectively. The stations lie within a kilometre of each other along a west-east valley on a till covered slope on the north side of Cornish Mountain, some 5 km northwest of Wells. Several known mineral occurrences containing gold occur within 3 km of the two sites, but none are considered likely source areas for these two anomalies. The bedrock source for this pair of anomalous values, is therefore presently unknown, and is most likely within a few kilometres of the area, directly to the east or southeast. The thin drift cover and appreciable steep slope at the stations further suggests a proximal up-slope source area. Noteworthy, is that station 009035 is a multi-element site that also shows elevated values of As, Mo, Pb, Cu, Zn, and Cd. Site 009035 warrants particular attention for further exploration work.

The final elevated silver value discussed in this report occurs at the bottom of Big Valley Creek, a few kilometres south of Lottie Lake. Station 009428 provided a value of 443 ppb silver. A few known mineral occurrences (Ba and Au listed as commodities) lie within a kilometer to the west, but none are considered potential source areas. It is more likely that the actual source is located within several hundred metres directly west or southwest of the sampled station.

COPPER

Concentrations of copper analyzed by ICP ranged from 19.7 ppm to 327.5 ppm. Mean and median values of 55.7 ppm and 51.4 ppm copper, respectively, are present. The 7 samples above the ninety-seventh percentile, exceed 114 ppm. Of the 324 samples analyzed, the top five values ranged between 125.7 and 327.5 ppm copper. None of the top five copper stations can be related to known mineral occurrences and all, therefore, represent down-ice dispersal for presently unknown copper prospects.

The highest value of copper was obtained from station 009416, where a concentration of 327 ppm is present. The site is located east side of Two Sisters Mountain. As noted elsewhere, the site is the most significant multi-element sample found within this study (also high values of Ag, Mn, V, Mg, Al, Ga, Mo, Hg). The source for this site is presently unknown, but is most likely within several hundred metres to the east and southeast.

Two high values of copper were obtained at stations 009035 and 009425; 181 ppm and 126 ppm, respectively. The two stations occur within 3 km of each other on the east side of Hardscrabble Mountain. Although relatively close to each other, the source areas for the two sites should not the same. Moreover, there are no known mineral occurrences which can be used to explain these elevated silver values. The source area for each site is probably located within a few hundred metres to the east and/or southeast. Station 009035 also supports elevated values of Mo, Pb, Zn, Ag, Ni, Co, Mn, Fe, and As.

At station 009314, a copper concentration of 141 ppm was obtained from a deep basal till sample located on NW-SE trending ridge that separates the drainage of Yuzkli Creek from Big

Valley Creek. The sample is rich in local phyllite and is most likely representative of a bedrock source situated within a few hundred metres to the southeast. Two known mineral occurrences to the south (MINFILE 093H-032) and southeast (MINFILE 093H-031) are not likely candidates for this sample. This sample also contains appreciable amounts of Mo, Hg and Se.

The final sample (009089) under discussion for copper was obtained from a site located on the south slope of a high ridge bordering Towkuh Creek. The 3 meter deep sample provides a value of 131 ppm copper, and the deposit characteristics suggest that the sediment is very proximal to source. The steep slope and proximal character of the deposit suggests that the bedrock source is possibly up-slope (north) and/or slightly up-ice (east). Follow-up studies should concentrate within several hundred metres of this locality. Sample 009089 also has a high value of As.

GOLD

The mean and median concentrations of gold (INAA) are 5.2 ppb and 2 ppb, respectively. Values ranged from <2 to 222 ppb for the 324 samples of till analyzed. There are seven samples in the upper 2.5 percentile, with the top four samples showing values equal to or greater than 31 ppb. The five top values were collected over all the terranes, and none of them can be associated with known mineral occurrences.

The highest gold value was obtained from a basal till sample collected on the east slope of a ridge overlooking the confluence of the Willow River and Tregillus Creek (station 009515 - 222 ppb). The sample lies about 1 km northeast of the fourth highest gold value recorded (station 009518 - 31 ppb). The nearest known mineral occurrence which could be considered a source area for these two anomalies is a past producer at Rouchon Creek (MINFILE 093H 091). However, other sample stations situated between the past producer and the two elevated values are low in gold, thereby casting doubt on the likelihood that this mineral occurrence is a candidate source area. It is more likely that the source for these two anomalous values lies to the southeast of the river/creek confluence.

A value of 34 ppb was obtained from a good basal till at station 009230. Located on a small flat hill top, about three kilometres southwest of Stephen Lake, the bedrock source for this material is not easily determined. This site represents one of the areas that show conflicting ice-flow directions. Up-ice direction is assumed to be to the southwest or southeast.

At station 009005, about six kilometres northeast of Wells, a colluviated till sample yielded a gold value of 32 ppb. No other stations in the vicinity show above average values in gold. A number of mineral occurrences proximal to this station lie to the southwest and northwest, but none are likely sources for this anomalous gold value. A number of gold placer operations are also present in the vicinity. Station 009005 most likely reflects the input from a bedrock source to the southeast, farther upstream of Summit Creek.

The final location discussed here for gold is station 009289 where a value of 29 ppb gold was determined. The sample was collected from good basal till in an area of thin drift cover. The station is situated in the centre of the study region on a flat part of a large ridge which border Big Valley Creek. There are no known mineral occurrences in the vicinity of this elevated gold sample to explain its presence. The bedrock source for this station is expected to lie within a few hundred metres of the site. However, conflicting ice flow directions means that the source may be to the southeast or the southwest.

LEAD

Mean and median concentrations of lead (ICP) are 14.7 ppm and 12.2 ppm, respectively. Lead concentrations ranged from a minimum of 1.8 ppm to a maximum of 94.5 ppm. Of the 324 samples analyzed, the top five had lead values >51 ppm and the top eight had values >39 ppm.

The first (009029) and third (009033) highest values of lead lie within a kilometre of each other directly north of Wells and show concentrations of 95 ppm and 64 ppm, respectively. Three known mineral occurrences (Au only listed as a commodity) occur nearby and any of these may possibly be related to the bedrock source for this pair of anomalous values, although Pb was not recognized as significant in the commodity capsule. All three known occurrences lie to the east and southeast of the sample sites. Noteworthy is that station 009029 also has high values of Zn and Cd; whereas station 009033 also has high values of Cd.

The second (009505) and fourth (009507) highest values of lead also lie near each other, and these are located directly northwest of the Lottie property. About 1 km apart, samples from the two sites provided concentrations of 92.4 ppm and 58.4

ppm, respectively. Ice flow indicators in the area are abundant but show confusing results, providing bidirectional indications parallel to a NE-SW trend. Given this, it is impossible to propose a probable source area for these two anomalies with any confidence. Both samples also had high values Cu and Zn.

The final location discussed here with an elevated valued of lead is from station 009042 (51 ppm) from the south-central part of the study area on the edge NTS map sheet 93H4/N. This station is located on the southwest side of Hardscrabble Mountain. This basal till sample occurs on a steep slope significantly influenced by both groundwater flow and creep processes. The contribution of both hydromorphic and clastic dispersion must be considered. This indicates the bedrock source for 009042 is slightly upslope to the northeast or east. The sample also contains above average values of Mo, As and Cd.

ZINC

Zinc concentrations (ICP) ranged from a minimum of 28.7 ppm to a maximum of 482.9 ppm for the 324 samples included in this report. A mean value of 77.8 ppm and a median value of 71.1 ppm result from this distribution. The highest 5 values (upper 1.5 percentile) are all equal to or greater than 183.3 ppm. The upper tenth percentile distribution contains 34 samples with values exceeding 108.5 ppm. None of the top five high zinc values stations can be associated with a known zinc mineral occurrence.

The highest zinc concentration recorded in our 324 samples is derived from a thick basal till deposit at station 009225 (482.9 ppm). This station also displays the highest Cd concentration of this suite of samples. It is located on the southwest flank of Two Sisters Mountain overlooking the upper reaches of the Big Valley Creek. The source for this sample is most probably up slope and to the southeast.

The fourth and fifth highest values of zinc also occur in this vicinity. Station 009029 (205.4 ppm Zn) and 009035 (183.3 ppm Zn) lie approximately one kilometer south and southwest of station 009225, respectively. Four known mineral occurrences occur near the three elevated Zn stations, but none of these list Zn as a commodity. All three sites lie at the complex intersection of a few terranes (Slide Mountain, Cariboo and Barkerville). Given regional ice flow history in this part of the study, it is likely that bedrock source(s) is very proximal all the samples and occur lies to the southeast. Pb and Cd are also at elevated concentrations in sample 009029, whereas Mo, Pb, Cu, Ag, Ni, Co, Mn, Fe, and As are elevated in 009035.

The second highest recorded value of zinc was obtained from a basal till sample on the north edge of NTS map sheet 93H/4N. Station 009505 is located on a high plateau a few kilometres northwest of Lottie Lake area and is surrounded by glacially sculpted ridges. A concentration of 228.9 ppm zinc was obtained from this till sample. Cu concentrations are also elevated in this sample. The absence of other elevated zinc values in the area precludes the definition of a dispersal train, and coupled with the fact that this area contains the most multi-directional ice flow indicators, estimation as to possible bedrock source area for this sample is impossible.

The third highest concentration of zinc, and the final site discussed here, is from a till sample situated in the center of the study region. Station 009286 provided a zinc concentration of 225.3 ppm. The station occurs in an upland area between Ketcham Creek and Big Valley Creek. There are no known mineral occurrences in the up-ice direction of this elevated zinc value. Other till stations surrounding this point show average values of zinc. Given the discrepant ice flow indicators in this particular area, it is equally impossible to estimate a reliable up-ice direction for further prospection. Noteworthy is that sample 009286 also supports the second highest Cd concentration.

ARSENIC

Concentrations of arsenic determined by ICP for the 324 samples reported here ranged in value from <0.7 ppm to a maximum of 133.8 ppm. The frequency distribution for arsenic is fairly uniform, with 34 samples in the upper 10th percentile. The highest five arsenic values were all equal to or greater than 46.4 ppm. None of the known mineral occurrences in the study list arsenic as a commodity. Only the first and fourth highest samples are located in the vicinity of known mineral occurrences, but the likelihood that they are related is equivocal. Three of the five highest As values occur at multi-element stations.!

The highest arsenic value recorded in our 324 samples is derived from a thick basal till deposit at station 009035 (133.8 ppm). Above average values of Mo, Cu, Zn, Cd, Ag, Hg and Sb were also recorded at this site. As stated elsewhere the bedrock source is likely to the southeast.

The second highest recorded value of arsenic was obtained from a basal till sample at station 009089 (60.5 ppm). The sample from this location also shows an above average value for Cu. Located on the south slope of a high ridge bordering Towkuh Creek. The 3 meter deep sample provides a value of 131 ppm copper, and the deposit characteristics suggest that the sediment is very proximal to source. The steep slope and proximal character of the deposit suggests that the bedrock source is possibly up-slope (north) and/or slightly up-ice (east). Follow-up studies should concentrate within several hundred metres of this locality.

The next highest value of arsenic (59.6 ppm) was obtained from station 009282. The station is located in the center of NTS map sheet 93H/5S. It is located on the northeast facing slope of a moderate peak about ten kilometres south of Stephen Lake overlooking Ketcham Creek valley. Arsenic values from neighboring stations to the southwest and southeast are above average. There is no known mineral occurrence sites in the vicinity of this sample. Although the probable source for this station likely lies within several hundred metres of the sample, the up-ice direction responsible for sample deposition cannot be confidently defined. Ice flow in this area is both to the northwest and to the northeast.

The fourth significant concentration of arsenic discussed in this study was obtained from a multi-element station located on the east face of Hardscrabble Mountain. Station 009425 (48.5 ppm) also contains an elevated Cu and Mo concentration. Moreover, there are no known mineral occurrences which can be used to explain the elevated arsenic value. The source area for the site is probably located within a few hundred metres to the east and/or southeast.

The final elevated arsenic sample discussed here was obtained from sample 009406 (46.4 ppm) in the northeast corner of the study area. The station lies on the east side of a prominent ridge. There are no known mineral occurrences in the region. Ice likely flowed to the northwest in this area, so the bedrock source for this station is most likely to the southeast.

CADMIUM

Cadmium concentrations (ICP) ranged from a low of 0.03 ppm to a high of 1.60 ppm for the 324 samples examined in this report by ICP. A mean value of 0.18 ppm and median value of 0.14 ppm result from the distribution of data. There are 8 samples in top 2.5 percentile with minimum values of 0.49 ppm. Although four of the values lie near known mineral occurrences, none list cadmium as a commodity.

The highest cadmium value obtained in this study comes from a basal till sample recovered at station 009225 (1.60 ppm) which is situated on the southwest slope of Two Sisters Mountain overlooking the upper reaches of the Big Valley Creek. The sample also has the highest Zn concentration. The source for this sample is most probably up slope and to the southeast. Surrounding stations in that direction also show elevated Cd values.

The second highest concentration of cadmium was recorded at station 009286. This sample provided a cadmium concentration of 1.37 ppm Cd. The station is located centrally near the border of the two NTS map sheets. There are no known mineral occurrences in the vicinity of this elevated cadmium value. Several stations nearby show elevated levels of other elements. Discrepant ice flow directions at this site limit interpretation of a reliable up ice direction. However, the thin veneer of drift at the site indicates that the bedrock source for the 009286 Cd concentration is most likely within a few hundred metres of the station.

A cadmium value of 0.82 ppm was obtained from a till sample from station 009029 on the southeast part of the study area. This station lies approximately 1 km south of 009225 and 1 km west of the fifth highest elevated Cd concentration at station (009220 - 0.70 ppm). This sample corresponds to the placer gold operation known as the Thistle Pit. Regional up ice direction for this area is from the southeast.

The final station discussed for cadmium provided a value of 0.71 ppm (009044). Located on the south slope of Mount Wiley and overlooking Hardscrabble Creek, this deep basal till samples was collected in an area of very thin drift cover and steep topography. There are no known mineral occurrences in the vicinity of this site but other till sample stations nearby show elevated values in other elements. The extent of hydromorphic contribution to this sample is hard to confirm but is likely high. Regional ice flow is from the southeast. The characteristics of this deposit suggests that the bedrock source for this anomalous value of Cd may lie up-slope to the northeast or up-ice to the southeast. In either case, the source is likely to occur within a few hundred metres of the station.

GENERAL COMMENTS

The glacial history for this area is complex and is presently not easily resolvable. From the data collected thus far during fieldwork in 2000, it appears that there are two primary ice flow directions that must be considered for any further exploration work. Although the striation chronology has not yet been explained, it is possible that the two dominant ice flow directions represent separate advances and not different phases of the same flow. The reasons for this are that area sampled here for till geochemistry lies at the junction of two competing ice masses, an ice sheet from the Interior in the west (flowed to the northeast here) and the second as montane ice from the Cariboo Mountains in the east (flowed west and northwest here). It highly unlikely that the bidirectional nature of the ice flow is related to shifting ice centre position, since none existed in this region. All other ice flow directions which do not conform to either the northeastward flow or to the westward-northwestward flow, most likely represent localized response to topography during early advance stages of ice development and/or also during late stage flow. In particular, the high relief in this area is ideally suited to undergo the effects of ice draw-down within the many valley situations during stages of deglaciation. In short, where not easily interpreted, up ice directions may be either from the southwest or from the southeast-east.

Regarding the geochemistry of the till samples, it is important to summarize some of the elevated values relative to the station location. The table below lists the top five stations for each of the seven elements discussed in this report. The most important feature is that those stations which are recognized as multi-element samples are highlighted in bold. This number of multi-elements sites is not typical for a till survey and suggests that these locations do in fact reflect mineralogically diverse bedrock sources. These stations warrant particular attention and follow-up studies by the exploration community.

ELEMENT	TILL STATION
Ag	**009416**, 009315, 009034, **009035**, 009428
Cu	**009416**, **009035**, **009425**, 009314, **009089**
Au	009515, 009230, 009005, 009518, 009289
Pb	**009029**, 009033, **009505**, 009507, 009042
Zn	**009225**, **009029**, **009035**, **009505**, **009286**
As	**009035**, **009089**, 009282, **009425**, 009406
Cd	**009225**, **009286**, **009029**, 009220, 009044

ACKNOWLEDGMENTS

The authors would like to thank all those who contributed to the completion and success of this project. First, we appreciate the financial support of the Ministry of Energy and Mines, British Columbia Geological Survey Branch for funding this exploration project. Gib McArthur is thanked for section management. Second we really appreciate the efforts of the hard working and devoted field crew: Beth Brooks, Adrian Hickin, Gloria Lopez, and Roger Paulen. Our thanks to Ray Lett who was instrumental in coordinating and managing the preparation and analysis of all the geochemistry samples. Our sincere gratitude to Jerry Bidwell of Hudson Bay Exploration Co. for logistical support in the field and access to their data. David Lloyd was critical in acquiring field supplies and keeping all functioning. Ministry of Forests and Al Hunter with West Fraser Timber are gratefully acknowledged for providing digital map data. Special thanks to Charlotte Bowman for all GIS work and preparing the document layout for final publication.

REFERENCES

Bichler, A. and Bobrowsky, P.T. (2001): Barkerville Project: Regional Till Geochemistry (93H/4, 5) and Orientation (93A/14) studies; *in* Geological Fieldwork 2000, *B.C. Ministry of Energy and Mines*, Paper 2001-1, p. 383-396.

Bloodgood, M.A. (1989): Geology of the Quesnel Terrane in the Spanish Lake Area, central British Columbia, 93A/11; *in* Geological Fieldwork 1987, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1988-1, p. 139-145.

Bobrowsky, P.T. and Sibbick, S.J. (1996): Till Geochemistry of Northern Vancouver Island Area (92L/5, 6W, 11W, 12); *B.C. Ministry of Employment and Investment*, B.C. Geological Survey Branch, Open File 1996-7.

Bobrowsky, P.T., Leboe, E.R., Dixon-Warren, A. and Ledwon, A. (1997): Eagle Bay Project: Till geochemistry of the Adams Plateau (82M/4) and North Barriere Lake (82M/5) map areas; *in* Geological Fieldwork 1996, D.V. Lefebure, W.J. McMillan and G. McArthur, Editors; *B.C. Ministry of Employment and Investment*, Paper 1997-1, p. 413-421.

Campbell, R.B. (1978): Quesnel Lake 93A Map Area; *Geological Survey of Canada*, Open File 574.

Campbell, R.B., Mountjoy, E.W. and Young, F.G. (1973): Geology of the McBride Map Area, British Columbia; *Geological Survey of Canada*, Paper 72-35, 104 pages.

Clague, J.J. (1988): Quaternary stratigraphy and history, Quesnel, British Columbia; *Geographie physique et Quaternaire*, Volume 42, p. 279-288.

Clague, J.J. (1991): Quaternary stratigraphy and history of Quesnel and Cariboo river valleys, British Columbia: implications for placer gold exploration; *in* Current Research, Part A, *Geological Survey of Canada*, Paper 91-1A, p. 1-5.

Clague, J.J., Hebda, R.J. and Mathewes, R.W. (1990): Stratigraphy and paleoecology of Pleistocene interstadial sediments, central British Columbia; *Quaternary Research*, Volume 34, p. 208-228.

Cook, S.J. and Pass, H.E. (2000): Ancient Pacific Margin Part V: Preliminary Results of Geochemical Studies for VMS Deposits in the Big Salmon Complex, Northern British Columbia (104N/9, 16; 104O/11, 12, 13, 14); *in* Geological Fieldwork 1999; *B.C. Ministry of Energy and Mines*, Paper 2000-1, p. 71-105.

Dixon-Warren, A., Bobrowsky, P.T., Leboe, E.R. and Ledwon, A. (1997): Eagle Bay Project: Surficial geology of the Adams Plateau (82M/4) and North Barriere Lake (82M/5) map areas; *in* Geological Fieldwork 1996, D.V. Lefebure, W.J. McMillan and G. McArthur, Editors; *B.C. Ministry of Employment and Investment*, Paper 1997-1, p. 405-411.

Dixon-Warren, A. and Hickin, A. (2000): Ancient Pacific Margin NATMAP Part IV: Surficial Mapping and Till Geochemistry in the Swift River Area, Northwestern British Columbia; *in* Geological Fieldwork 1999, *B.C. Ministry of Energy and Mines*, Paper 2000-1, p. 47-69.

Ferri, F. (2001): Geological setting of the Frank Creek massive sulphide occurrence near Cariboo Lake, east-central British Columbia (93A/11, 14); *in* Geological Fieldwork 2000, *B.C. Ministry of Energy and Mines*, Paper 2001-1, p. 31-49.

Ferri, F., Höy, T. and Friedman, R.M. (1997): Description, U-Pb age and tectonic setting of the Quesnel Lake Gneiss, east-central British Columbia; *in* Geological Fieldwork 1996, D.V. Lefebure, W.J. McMillan and G. McArthur, Editors; *B.C. Ministry of Employment and Investment*, Paper 1997-1, p. 69-80.

Ferri, F. and Höy, T. (1998a): Zn-Pb deposits in the Cariboo Subterrane, central British Columbia (93A/ NW); *in* Geological Fieldwork 1997, D.V. Lefebure and W.J. McMillan, Editors; *B.C. Ministry of Employment and Investment*, Paper 1998-1, p. 14.1-14.9.

Ferri, F. and Höy, T. (1998b): Stratabound base metal deposits of the Barkerville Subterrane, central British Columbia (093A/ NW); *in* Geological Fieldwork 1997, D.V. Lefebure and W.J. McMillan, Editors; *B.C. Ministry of Employment and Investment*, Paper 1998-1, p. 13.1-13.12.

Fulton, R.J. (1991): A conceptual model for growth and decay of the Cordilleran ice sheet; *Geographie physique et Quaternaire*, Volume 45, no. 3, p. 281-286.

Holland, S.S. (1954): Geology of the Yanks Peak-Roundtop Mountain area, Cariboo District, British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 34, 102 pages.

Holland, S.S. (1976): Landforms of British Columbia, a physiographic outline; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 48.

Kerr, D.E., Sibbick, S.J. and Jackaman, W. (1992): Till Geochemistry of the Quatsino Map Area (92L/12); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1992-21.

Levson, V.M. and Giles, T.R. (1993): Geology of Tertiary and Quaternary gold-bearing placers in the Cariboo region, British Columbia (93A,B,G,H); *B.C. Ministry of Employment and Investment*, Bulletin 89, 202 pages.

Levson, V.M and Giles, T.R. (1997): Quaternary Geology and Till Geochemistry Studies in the Nechako and Fraser Plateaus, Central British Columbia (NTS 93 C/1,8,9,10; F/2,3,7; L/16; M/1); *in* Interior Plateau Geoscience Project: Summary of Geological, Geochemical and Geophysical Studies, L.J. Diakow and J.M. Newell, Editors, *B.C. Ministry of Employment and Investment*, Paper 1997-2, p. 123-146.

Meidinger, D. and Pojar, J. (1991): Ecosystems of British Columbia; *B.C. Ministry of Forests*, Special Report Series, no. 6.

Nelson, J. (2000): Ancient Pacific Margin Part I: BCGS Contributions and Collaborative Activities with GSC and Yukon Geology Program; *in* Geological Fieldwork 1999; *B.C. Ministry of Energy and Mines*, p. 15-18.

Panteleyev, A. and Hancock, K. (1989): Quesnel mineral belt: Summary of the geology of the Beaver Creek- Horsefly River map area; *in* Geological Fieldwork 1988, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1989-1, pages 159-165.

Paulen, R.C., Bobrowsky, P.T., Little, E.C., Prebble, A.C. and Ledwon, A. (1998): Surficial Deposits in the Louis Creek and Chu Chua Creek Area; *in* Geological Fieldwork 1997, D.V. Lefebure and W.J. McMillan, Editors, *B.C. Ministry of Employment and Investment*, Paper 1998-1, p. 16.1-16.12.

Paulen, R.C., Bobrowsky, P.T., Lett, R.E., Bichler, A.J. and Wingerter, C. (1999): Till Geochemistry in the Kootenay, Slide Mountain and Quesnel Terranes; *in* Geological Fieldwork 1998, *B.C. Ministry of Employment and Investment*, Paper 1999-1, p. 307-319.

Ray, G.E., Webster, I., Lane, B., Rhys, D., Ross, K., Hall, R. and Dunne, K.P.E. (2001): Variable geochemistry of the gold mineralization in the Wells-Barkerville Camp; *in* Geological Fieldwork 2000; *B.C. Ministry of Energy and Mines*, this volume.

Shilts, W.W. (1993): Geological Survey of Canada's contributions to understanding the composition of glacial sediments; *Canadian Journal of Earth Sciences*, Volume 30, p. 333-353.

Struik, L.C. (1986): Imbricated Terranes of the Cariboo Gold Belt with Correlations and Implications for Tectonics in southeaster British Columbia; *Canadian Journal of Earth Sciences*, Volume 23, p. 1047-1061.

Struik, L.C. (1988): Structural geology of the Cariboo Gold Mining District, east-central British Columbia; *Geological Survey of Canada*, Memoir 421, 100 pages and four 1:50 000 maps.

Sutherland Brown, A. (1957): Geology of the Antler Creek area, Cariboo District, British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 38, 105 pages.

Sutherland Brown, A. (1963): Geology of the Cariboo River area, British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 47, pages 60.

Tipper, H.W. (1959): Geology, Quesnel, Cariboo District, British Columbia; *Geological Survey of Canada*, Map 12-1959, 1:250 000.

Tipper, H.W. (1961): Geology, Prince George, British Columbia; *Geological Survey of Canada*, Map 49-1960, 1:250 000.

Tipper, H.W. (1971): Multiple glaciations in central British Columbia; *Canadian Journal of Earth Sciences*, Volume 8, p. 743-752.