BRITISH COLUMBIA

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

TILL GEOCHEMISTRY OF THE SHUSWAP HIGHLANDS AREA, B.C. (PARTS OF NTS 83M/3, 82L/13 AND 82L/14)

By R.C. Paulen, P.T. Bobrowsky (P.Geo.), R.E. Lett (P.Geo.), W. Jackaman, A.J. Bichler and C. Wingerter

OPEN FILE 2000-18

Canadian Cataloguing in Publication Data

Main entry under title:

Till geochemistry of the Shuswap Highlands area, B.C. (parts of NTS 83M/3, 82L/13 and 82L/14)

(Open file, ISSN 0835-3530 ; 2000-18)

Includes bibliographical references: p.

ISBN 0-7726-4201-X

1. Geochemical prospecting - British Columbia - Shuswap Highland. 2. Drift - British Columbia - Shuswap Highland. 3. Geochemistry - British Columbia - Shuswap Highland. 4. Geology, Economic - British Columbia - Shuswap Highland. I. Paulen, R. C. II. British Columbia. Geological Survey Branch. III. Series: Open file (British Columbia. Geological Survey Branch) ; 2000-18.

QE515.T54 2000 551.9'09711'68 C00-960122-8

VICTORIA
BRITISH COLUMBIA
CANADA

MARCH 2000

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INTRODUCTION

This report provides the final results, discussion and interpretation of a drift exploration program conducted north of Kamloops 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 1998 as part of a larger, multidisciplinary, integrated resource assessment program aimed at defining the mineral potential of south-central British Columbia. The survey was undertaken as year three of the Eagle Bay Project (*cf.* Paulen *et al.*, 1999) which centred on the eastern part of the Devono-Mississippian rocks of the Eagle Bay Assemblage.

The "Eagle Bay" drift prospecting program is one of several provincial till geochemistry surveys (the most recent being Paulen *et al.*, 2000 in the Chu Chua - Clearwater areas) which have been ongoing since 1990 to 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).

Surficial studies and drift exploration work in 1998 was completed north of Chase in NTS map sheets 82M/3 (Albas) , 82L/13 (Chase) and 82L/14 (Sorrento). The work is a continuation of a till geochemical survey carried out in 1996 (see Bobrowsky *et al.*, 1997a) over the NTS map sheets 82M/4 (Adams Plateau) and 82M/5 (North Barriere Lake) and in 1997 (see Paulen *et al.*, 1998a) in the east half of NTS map sheets 92P/1E (Louis Creek) and 92P/8E (Chu Chua Creek) and part of the NTS map sheet 92P/9 (Clearwater) (see Paulen *et al.*, 1999). The study area encompasses some 700 square kilometres of rugged drift-covered terrain (Figure 2) in the eastern part of the Adams Plateau, within the Interior Plateau. Volcanic massive sulphide (VMS) deposits, volcanogenic sulphide-barite deposits hosted in the Eagle Bay Formation and tombstone-style gold prospects hosted in the Baldy Batholith suggest that the region has considerable mineral potential.

The exploration history and number of occurrences in the MINFILE (Figure 3, Table 1) confirm the high potential for the region. Published detailed bedrock mapping of the area by Schiarrizza and Preto (1987), successful discoveries in correlative rocks located in the Yukon (*i.e.* Kudz Ze Kayah, Wolverine) and recent discoveries of gold associated with the margin of the Baldy Batholith provided the impetus for continued drift prospecting in the region. Previously, the release of Open File 1997-03 (Bobrowsky *et al.*, 1997b) and Open File 1998-06 (Bobrowsky *et al.*, 1998) stimulated renewed exploration by a number of mining companies. Exploration has been given further impetus by the published results of mineral deposit studies (Höy, 1997; 1999), geochemical orientation surveys (Lett *et al.*, 1998; Lett *et al.*, 1999; Lett and Jackaman, 2000) and a stream water survey (Sibbick *et al.*, 1997; Lett *at al.*, 1998), as well as 1:50 000 scale surficial mapping and drift exploration sampling. The latter two components provide vital information for mineral exploration in regions where unconsolidated sediments of variable thickness mask the underlying bedrock.

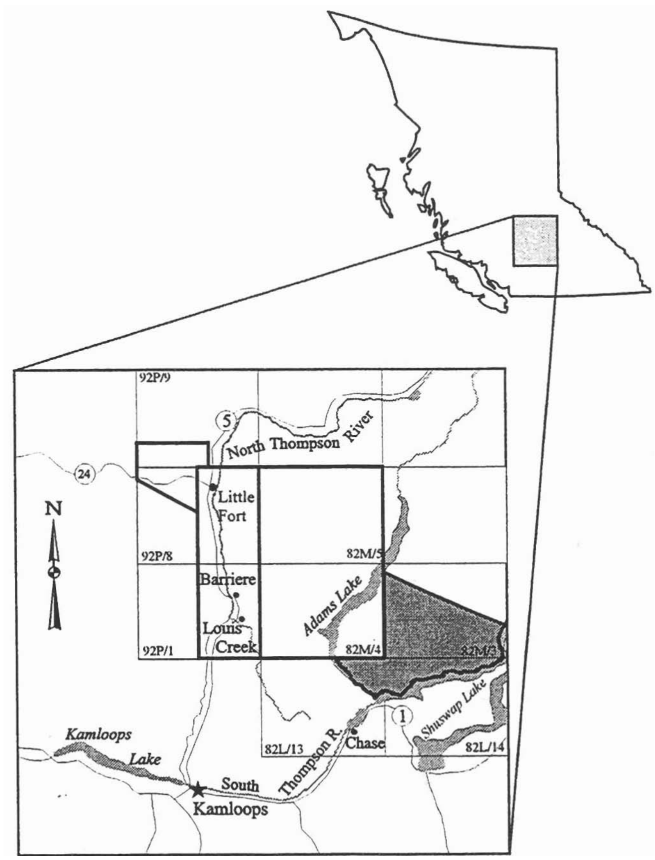

Figure 1. Location of the 1998 till geochemistry survey in south-central British Columbia. Bold outline indicates the 1996-1998 Eagle Bay Project.

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:

- define new anomalies which may be used in the discovery of mineralization targets;

- establish the dispersal of pathfinder elements down-ice from a known source;
- stimulate new exploration and economic activity, especially along the poorly explored margin of the Shuswap Metamorphic Complex;
- document ice flow indicators including both local and regional ice flow patterns to aid drift prospecting in the area; and,
- provide information 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, provide critical constraints to a successful drift exploration program. The Quaternary geological history consisting of local and regional stratigraphy, sedimentology and glacial ice dynamics are the focus of much of the work, since the understanding of these parameters provides a framework for a complementary till geochemistry and pebble lithology sampling program (Salonen, 1988). The till geochemistry program consisted of systematically sampling 2-8 kilograms of 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 accomplish this by interpreting down-ice glacial dispersal patterns (mechanical dispersal trains) that will help us locate the sources of geochemical anomalies and clast lithologies (*cf.* Coker and DiLabio, 1989). Preliminary Quaternary geology results have been summarized in a series of papers (Bobrowsky *et al.*, 1997a; Dixon-Warren *et al.*, 1997a; Paulen *et al.*, 1998a; Paulen *et al.*, 1999;) and four 1:50 000 scale Open File terrain maps (Dixon-Warren *et al.*, 1997b; Leboe *et al.*, 1997; Paulen *et al.*, 1998b; Paulen *et al.*, 1998c).

Figure 2. Typical topography of the study area, looking north up Scotch Creek towards the Adams Plateau.

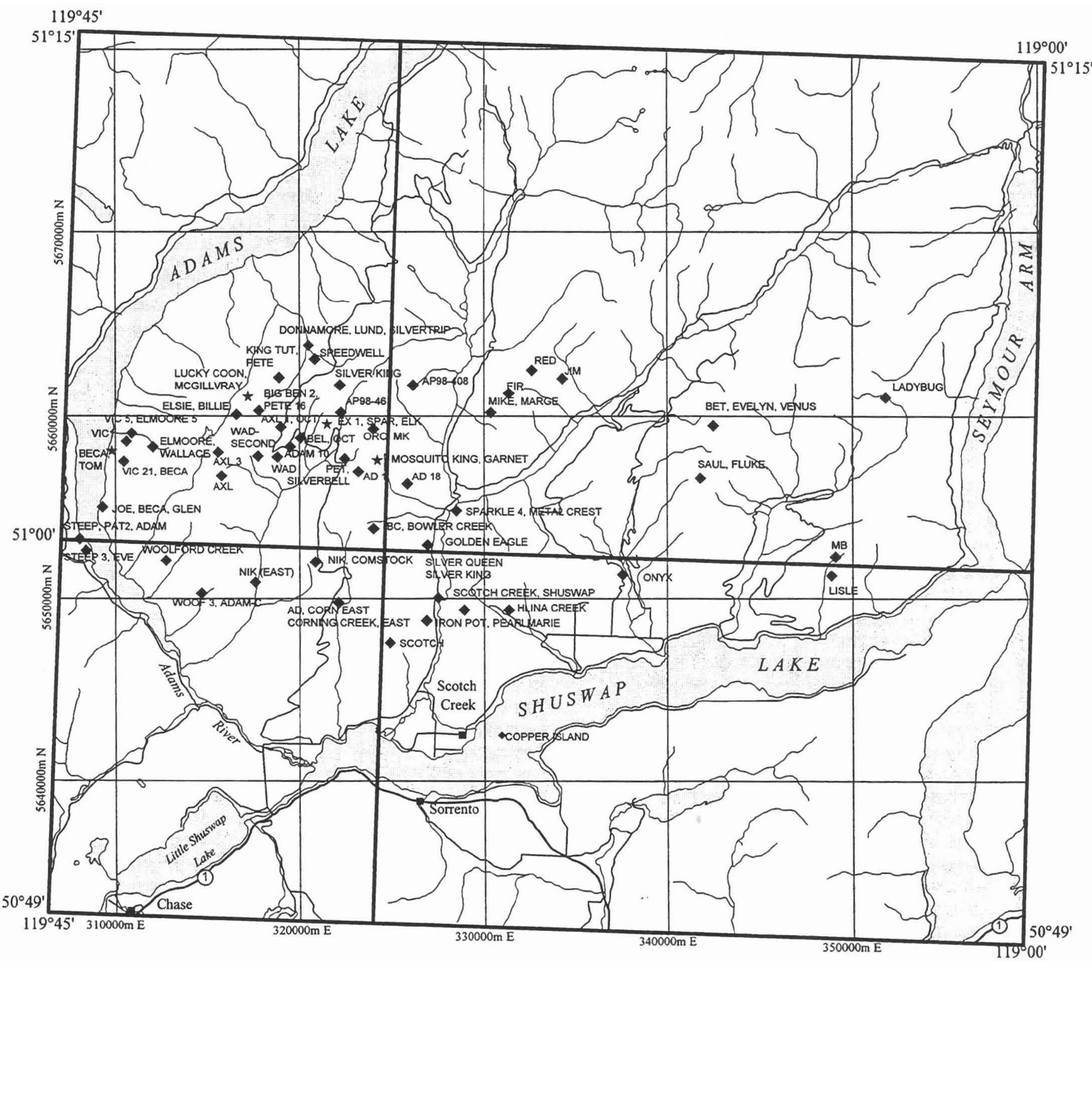

Figure 3. Mineral occurrence locations for NTS 82M/3, 4 and 82L/13, 14 from the MINFILE database, see Table 1 for respective commodity.

TABLE 1
MINERAL OCCURRENCE LOCATIONS FOR NTS 82L/13, 82L/14, 83M/3 AND 82M/4 FROM THE MINFILE DATABASE

NTS	MINFILE	NAME	COMMODITY	STATUS	UTME	UTMN
82M/3	082M 104	Bet, Evelyn, Venus	Ag, Pb, Zn, Au, Sn	Showing	342500	5659500
82M/3	082M 105	Saul, Fluke	Pb, Ag, Sn, Cu, Zn, Au	Showing	341800	5656600
82M/3	082M 154	Red	Pb, Ag, Zn, Mo, Au	Showing	332575	5662490
82M/3	082M 164	Mike, Marge	Ag, Pb, Zn, Mo, Pb	Showing	330350	5660210
82M/3	082M 206	MB	Ag, Pb	Showing	349065	5652300
82M/3	082M 207	Sparkle 4, Metal Crest	Pb, Ag, Cu, Zn	Showing	328480	5654800
82M/3	082M 208	Jim	Pb, Zn, Mo, Ag	Showing	334230	5662050
82M/3	082M 209	Golden Eagle	Cu, Pb, Zn	Showing	326910	5652925
82M/3	082M 210	Fir	Ag, Pb	Showing	331310	5661250
82M/3	082M 216	AD 18	Ag, Au, Zn, Pb, Cu	Showing	325840	5656265
82M/3	082M 265	Ladybug	Zn, Ag, Pb, Cu	Showing	351780	5661050
82M/3	082M 268	AP98-408	Cu, Pb, Zn, Ag	Showing	326150	5661700
82M/4	082M011	Big Ben 2, Pete 16	Pb, Zn, Cu, Ag	Showing	317800	5660300
82M/4	082M012	Lucky Coon, McGillvray	Pb, Zn, Ag, Au, As, Cd	Past Producer	317200	5661100
82M/4	082M013	King Tut, Pete	Ag, Pb, Zn, Au	Showing	318900	5662100
82M/4	082M014	Speedwell	Pb, Zn, Ag	Showing	320850	5663100
82M/4	082M015	Donnamore, Lund	Pb, Zn, Ag, Au	Showing	320500	5663850
82M/4	082M016	Mosquito King, Garnet	Ag, Zn, Pb, Cu, Au, Cd	Past Producer	324200	5657600
82M/4	082M017	Ex 1, Spar, Elk	Pb, Zn, Ag, Cu, Au	Past Producer	321500	5659600
82M/4	082M018	Bel, Oct	Zn, Pb, Ag	Showing	320050	5658800
82M/4	082M019	Elmoore, Wallace	Pb, Zn, Ag, Cu	Showing	312050	5656300
82M/4	082M054	Joe, Beca, glen	Ag, Pb, Cu, Zn, Au	Showing	309300	5655000
82M/4	082M055	Beca, Tom	Ag, Pb, Cu, Zn, Au	Past Producer	319000	5658100
82M/4	082M068	Axl 1, Oct	Cu, Zn, Pb, Ag	Showing	310600	5659400
82M/4	082M111	Vic 1	Pb, Cu, Zn, Ag	Showing	310450	5658600
82M/4	082M113	Vic 21, Beca	Ag, Pb, Zn, Cu	Showing	310450	5657500
82M/4	082M118	Steep, Pat2, Adam	Zn, Pb, Cu, Ag, Au	Prospect	308050	5653250
82M/4	082M129	Silver King	Ag, Pb, Zn	Showing	322200	5661700
82M/4	082M138	Bowler Creek	Ag, Zn, Pb, Cu, Fe, Mo, Au, Cd	Developed	324150	5652850
82M/4	082M139	BC, Bowler Creek	Au, Cd	Developed	324000	5653800
82M/4	082M140	Oro, MK	Cu, Zn	Showing	324000	5659300
82M/4	082M143	Pet, Silverbell	Pb, Zn, Ag, Au, Cu	Showing	324000	5657650
82M/4	082M169	Adam 10	Zn, Cu, Pb, Ag	Showing	322450	5658300
82M/4	082M193	Wad	Cu, Pb, Zn, Ag, Au	Showing	319500	5657750
82M/4	082M211	Wad-Second	Pb, Zn, Ag, Cu	Prospect	318800	5657800
82M/4	082M212	Axl 3	Pb, Zn, Ag, Cu	Showing	317750	5658000
82M/4	082M213	Elsie, Billie	Pb, Zn, Ag	Developed	315608	5660100
82M/4	082M214	Vic 5, Elmoore 5	Pb, Cu, Ag, Zn	Showing	316600	5659050
82M/4	082M215	AD 1	Ag, Au, Zn, Pb, Cu	Showing	310900	5656950
82M/4	082M243	Axl	Pb, Zn, Ag, Cu	Showing	323200	565700
82M/4	082M269	AP98-46	Cu	Showing	315800	5660200
82L/13	082LNW036	Nik, Comstock	Cu, Zn	Showing	320870	5652000
82L/13	082LNW052	Steep 3, Eve	Pb, Au, Cu	Showing	309400	5652620
82L/13	082LNW053	Nik (East)	Cu, Pb, Zn	Showing	317600	5650900
82L/13	082LNW054	AD, Corning Creek	Cu, Zn	Showing	322100	5649800
82L/13	082LNW078	Woof 3, Adam-C	Cu, Zn, Ag, Au	Prospect	314680	5650300
82L/13	082LNW084	Woolford Creek	Cu, Pb	Showing	312750	5652080
82L/14	082LNW012	Onyx	Pb, Ag	Showing	337550	5651300
82L/14	082LNW015	Iron Pot, Pearlmarie	Pb, Zn, Cu, Au, Ni	Showing	326850	5648800
82L/14	082LNW016	Scotch Creek, Shuswap	Au, Ag, Pb, Cu	Prospect	328900	5649380
82L/14	082LNW017	Copper Island	Cu	Showing	330910	5642550
82L/14	082LNW044	Silver Queen, Silver	Pb, Zn, Ag	Showing	327500	5650050
82L/14	082LNW046	Scotch	Cu, Zn, Pb	Prospect	324900	5647600
82L/14	082LNW055	Lisle	Pb, Ag	Showing	348850	5651270
82L/14	082LNW056	Hlina Creek	Au	Showing	331300	5649385

Open File 2000-18 provides the final summation of the till geochemical data collected in the four map sheets during 1998. 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 for some 227 basal till, ablation till and colluviated 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 mineral prospects.

OPEN FILE FORMAT

Open File 2000-18 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 as an ASCII file on a 3.5-inch high density diskette in the back pocket.

DESCRIPTION OF THE SURVEY AREA

PHYSIOGRAPHY AND GEOLOGIC SETTING

The Shuswap Highlands area is located in south-central British Columbia, approximately 50 kilometres northeast of Kamloops (Figure 1). The study area is located on the southeastern part of the Adams Plateau that lies in the southern part of the Shuswap Highland, within the Interior Plateau (Holland, 1976). The region is characterized by moderate to high relief, glaciated and fluvially dissected topography (Figure 2). Elevations range from 370 metres above sea level along the north shore of Shuswap Lake to 1980 metres above sea level at Crowfoot Mountain, west of Seymour Arm (Shuswap Lake). Ground moraine of various thickness dominates the landscape, followed in turn by colluvial, glaciofluvial, fluvial and glaciolacustrine sediments. The latter is restricted to the glacial lakes that once occupied the Shuswap Basin during the most recent glacial event. The ground moraine dominated terrain makes the region highly favorable for a till geochemical survey.

Vegetation

Vegetation is of the Southern Columbia and Interior Subalpine forest regions (Rowe, 1972). Valley bottoms are vegetated with black cottonwood and have been cleared and planted to suit agricultural purposes. Hillsides and plateaus between valley bottoms (at elevations of approximately 1220 m) support a dense vegetation cover of western hemlock, red cedar and Douglas fir. Upper valley slopes up to tree-line support a community of western white and Englemann spruce, and alpine fir. Above tree-line, slopes are either devoid of plant cover or sparsely vegetated with low-lying hardy shrubs. Alder and lodgepole pine are abundant in many disturbed areas.

Hydrologic system

The area is bounded to the west by Adams Lake and to the east and south by Shuswap Lake. These lakes are major systems feeding the South Thompson River, which drains west towards Kamloops. Several creeks flow from the Adams Plateau, the most prominent is Scotch Creek and its tributaries which dissect the plateau. The smaller creeks draining the plateau include Nikwikwaia, Kwikoit, Onyx and Ross creeks flowing south into Shuswap Lake and Five Mile Creek flowing east into Seymour Arm (Shuswap Lake). Very few small lakes (<1 km^2) dot the landscape and these are often associated with small highland bogs.

Geologic setting

The area lies within a belt of structurally complex low-grade metamorphic rocks that occur along the western margin of the Omineca Belt. This belt is flanked by high grade metamorphic rocks of the Shuswap Complex to the east and by rocks of the Intermontane Belt to the west. Lower Paleozoic to Mississippian rocks of the Eagle Bay Assemblage (Kootenay Terrane) underlie a major part of area. These consist of calcareous phyllite, calc-silicate schist and skarn or mafic metavolcanics overlain by felsic and locally intermediate metavolcanics and clastic metasediments. The eastern part of the Adams Plateau and west of Seymour Arm is underlain by the western margin of the Shuswap Metamorphic Complex (Silver Creek Formation, Mount Ida Group). These comprise of strongly foliated and lineated assemblages of Cambrian-Ordovician paragneiss and schists intruded by Jurassic-Cretaceous dykes, sills and small irregular bodies of granitic rocks (Okulitch, 1974).

Polymetallic precious, sedimentary exhalative and Noranda/Kuroko type VMS base metal occurrences are hosted by Devono-Mississippian felsic to intermediate metavolcanic rocks of the Eagle Bay Assemblage. Developed prospects and past producers hosted in these rocks include the Lucky Coon (MINFILE 082M 012), Mosquito King (MINFILE 082M 016), Spar (MINFILE 082M 017), Beca (MINFILE 082M 055) and Bowler Creek (MINFILE 082M 138). The MINFILE database lists a total of 24 occurrences in the study area (Figure 3), and 29 occurrences up-ice in 82M/4. In total, there are 21 occurrences of gold.

SURFICIAL GEOLOGY

Several types of surficial deposits were observed in the study area including: ground moraine (basal till and ablation till), colluvial, fluvial, glaciofluvial, glaciolacustrine, organic, and anthropogenic sediments. General observations suggest the plateaus and hills are mainly covered by combinations of till, colluvium and minor glaciofluvial deposits, whereas glaciofluvial and fluvial sediments occur mainly in the valleys. Glaciolacustrine sediments are found at lower elevations rimming Shuswap Lake. Anthropogenic deposits are not widespread and can be found at the sites of past producers, along the developed shoreline of Shuswap lake and in the towns of Scotch Creek, Celista and Anglemont. Organic deposits occur locally in all types of terrain.

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 metre) veneers to thick (>12 metres) blankets. Characteristics of this diamicton suggest that it most likely formed in a lodgement depositional environment (Dreimanis, 1988). Basal till facies tend to be variable with respect to the underlying bedrock.

Figure 4. Basal lodgement till exposed in a recent roadcut.

In this area, basal till (lodgement) deposits are primarily massive to poorly-stratified, light to dark olive grey, moderately to highly consolidated sediments derived from Eagle Bay metavolcanics and metasediments. The matrix is fissile and has a clayey silt to a silty-sand texture. Deposits are dense, compact, cohesive with irregular jointing patterns. Clast content ranges from 15-35%, averaging about 25%, and clasts range in size from granules to boulders (over 2 metres) but average 1-2 centimetres. The clasts are mainly subrounded to subangular in shape and consist of various lithologies of local and exotic source. A number of clasts have striated and faceted surfaces.

Ablation Till

Massive to crudely stratified clast-supported diamicton occurs 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. Deposits also occur in areas of hummocky terrain where evidence of recessional ice and mass wasting occurred during deglaciation. In contrast to the basal tills, these diamictons are light to medium grey, moderately compact and cohesive. The sandy matrix is poorly consolidated and usually contains less than 5% silt and clay. Clast content ranges from 30-60%, average clast size is 2-5 centimetres and clast lithology is variable. Such diamictons are interpreted as supraglacial or ablation till deposits, resulting from deposition by stagnating glacier ice (Dreimanis, 1988).

Ice Flow Indicators

The striation record in the map area is poor due to the lack of preserved outcrop exposure. Striations were recorded at a few locations where recent logging has exposed fresh bedrock. There is an abundance of sculpted landforms on the plateau tops that provide regional ice flow information which occurred during the peak of glacial activity (Figure 5). Ice flowed in a southerly direction across the Adams Plateau, except in areas of variable relief where topography deflected ice flow. Local paleo-ice flows are documented to be coincident with regional south to southeast flows (Fulton *et al.*, 1986). In the eastern half of the study area, the landforms and striae show a south-southwesterly flow direction as ice was diverted into Shuswap Basin. Exactly where the southeastward and southwestward flowing ice masses converged is unknown due to the poor striation record and an obvious lack of medial moraines, but it likely occurred near the southeastern edge of the Adams Plateau, west of Scotch Creek. Ice flow during deglaciation here would have converged southward, into the Shuswap Basin with a local deviation up to 45 degrees.

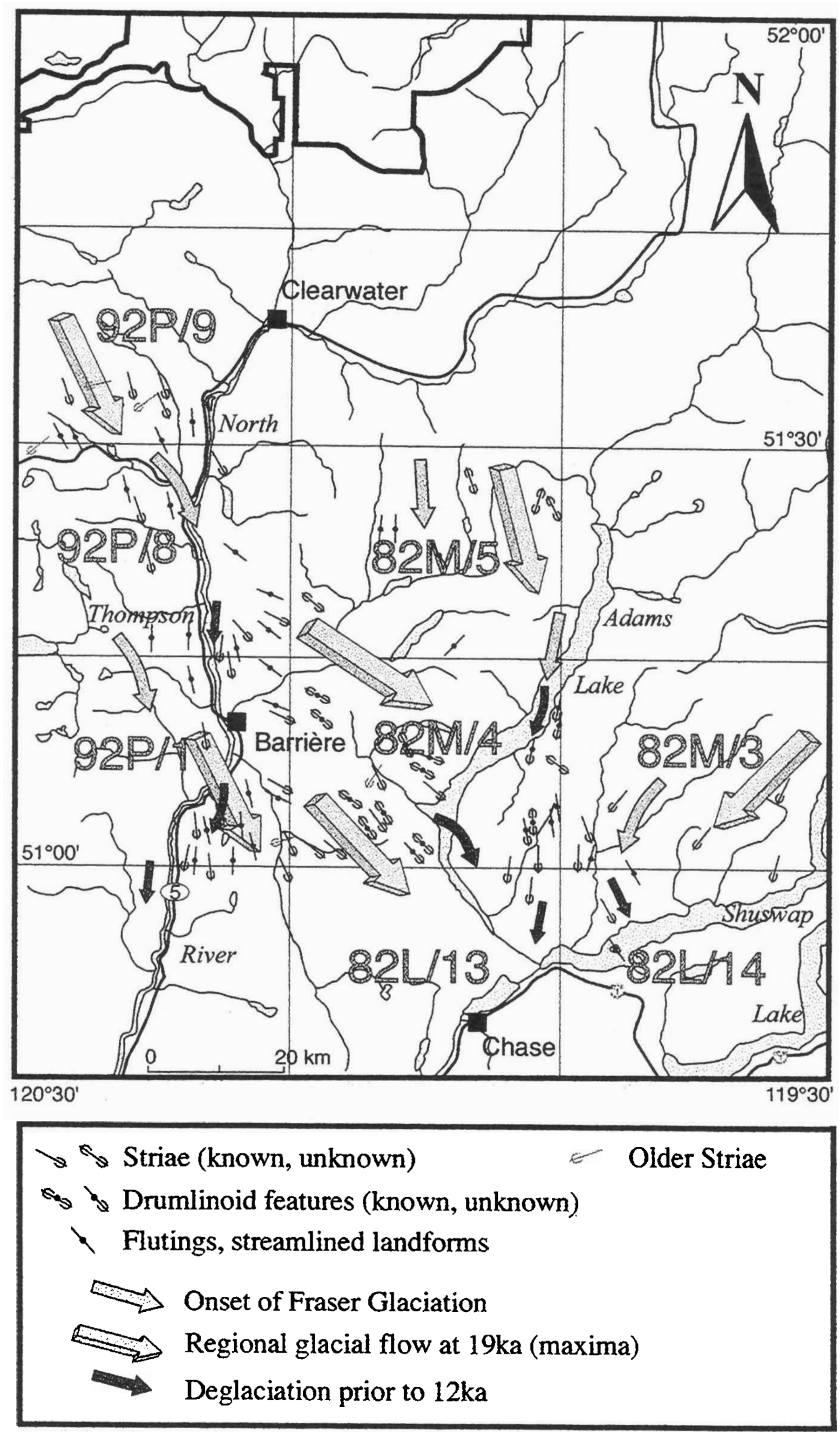

Figure 5. Summary of ice flow indicators for the Eagle Bay Project (1996-1998). Data compiled from the Eagle Bay project terrain geology maps (Dixon-Warren *et al.*, 1997b; Leboe *et al.*, 1997; Paulen *et al.*, 1998b; Paulen *et al.*, 1998c) and 1998 field observations.

GLACIAL HISTORY AND STRATIGRAPHY

According to Fulton and others (Clague, 1989; Fulton, 1975; Fulton and Smith, 1978; Ryder *et al.*, 1991), the present day landscape of south-central British Columbia is the result of two glacial cycles, one interglaciation and vigorous early-Holocene erosion and sedimentation. Evidence for only the latter glacial event and the post-glacial deposits are present in the study area. Although not necessarily present in this area, the following lithological units and their correlative geological climate units have been identified in south-central British Columbia. Stratigraphically oldest and identified only at two locations to the west of the study area, are the interglacial Westwold Sediments. The deposits consist of cross-stratified gravely sand capped by marl, sand, silt, and clay, all of which are equivalent to the Highbury non-glacial interval in the Fraser Lowland (Sangamonian). Next in age are Okanagan Centre Drift deposits, consisting of coarse, poorly-stratified gravel, till and laminated silt. The sediments were deposited during the Okanagan Centre Glaciation, equivalent to the Semiahmoo Glaciation in the Fraser Lowland (early Wisconsinan). Middle Wisconsinan, Olympic Non-Glacial Bessette Sediments overlie the Okanagan Centre Drift. They consist of nonglacial silt, sand and gravel with some organic material and up to two tephras. The Kamloops Lake Drift (20.2 ka; Dyck *et al.*, 1965) overlies the Bessette sediments, and underlies the present-day surface cover of postglacial deposits. This unit consists of silt, sand, gravel and till deposited during the Fraser Glaciation (Late Wisconsinan).

Rare older striae preserved on bedrock surfaces suggest an early glacial advance from the northeast to the southwest, but there is no evidence of this in the sediment record. The surface and near-surface sediments sampled in both the southern and northern regions directly result from the last cycle of glaciation and deglaciation (Fraser Glaciation), as well as ensuing post-glacial activity.

Fraser Glaciation

The onset of Fraser glaciation likely began in the Coast, Cariboo and Monashee mountains. Valley glaciers descended to lower elevations to form piedmont lobes in the Interior Plateau, and eventually coalesced to form a mountain ice sheet (Ryder *et al.*, 1991). Ice sheet margins reached a maximum elevation between 2200 and 2400 metres along rimming mountains; the entire Shuswap Highland was completely buried beneath an ice cap by approximately 19 ka. At Fraser Glaciation maximum, regional ice flow was to the south-southeast on the Adams Plateau with deviations up to 45° (Fulton *et al.*, 1986). This deviation was particularly evident in the eastern part of the study area, where ice from the north and west coalesced with ice flowing from the Monashee Mountains and which in turn was subsequently directed into the Shuswap Basin. Basal till deposits, which range widely in texture with the underlying bedrock, blanket the land surface.

Deglaciation of the Interior Plateau was rapid; the equilibrium line likely rose considerably, reducing the area of accumulation for the Cordilleran ice sheet, as the ice mass decayed by downwasting. Ablation till was deposited by stagnating ice in several high-elevation portions of the region. As uplands were deglaciated before low benches and valleys, meltwater was channeled to valley sides, resulting in kame terraces and ice-contact sediments. Valleys clear of ice above the stagnating glaciers in their lower reaches became the confinement for meltwater blocked from drainage, thereby resulting in local mantling of glaciolacustrine sediments. Radiocarbon dates of 11.3 ka at McGillivary Creek (Clague, 1980), 10.5 ka at Chase (Lowdon and Blake, 1973) and 10.1 and 9.84 ka on Mount Fadear Plateau (Blake, 1986) indicate that deglaciation began about 12 ka and that the modern drainage pattern was established prior to 8.9 ka (Dyke *et al.*, 1965; Fulton, 1969).

Holocene Post-Glacial

Once ice-dammed lakes drained, meltwater carrying heavy sediment loads deposited thick units of stratified sand and gravel in valleys. As sediment loads decreased, deposition was replaced by erosion, and water courses cut down through valley fills, leaving glaciofluvial terraces abandoned on valley sides. Following the complete deglaciation of the region, unstable and unvegetated slopes were highly susceptible to erosion and sedimentation. Intense mass wasting of surface deposits on oversteepened valley slopes resulted in the deposition of colluvial fans and aprons along valley bottoms. Most post-glacial deposition occurred within the first few hundred years of deglaciation, and certainly before the eruption of Mt. Mazama, circa 7000 radiocarbon-years ago, which deposited tephra near the present-day ground surface. Fluvial fan deposits and active talus slopes typify the modern sedimentation in the area.

SURVEY METHODOLOGY

SAMPLE COLLECTION

Fieldwork was based out of one base camp at Magna Bay. Access to the area is excellent. An extensive network of logging roads intersects most moderate slopes and all plateaus. The majority of fieldwork was conducted using a 4-wheel drive vehicle 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. Regional Quaternary mapping completed by the Geological Survey of Canada (Fulton, 1975; Fulton *et al.*, 1986) provided information on the types and distribution of the surficial sediments. Detailed local ice-flow directions were obtained by measuring and determining the directions of striations, grooves and local roche moutonnées. The MINFILE database was examined to gain insight on the local mineral showings with respect to the deposit types and host rock relationships.

At each ground-truthing field station some or all of the following observations were made: GPS-verified UTM location, identifying geographic features (*i.e.* creek, cliff, ridge, plateau, etc.), type of bedrock exposure if present, unconsolidated surface material and expression (terrain polygon unit), general slope, orientation of striations/grooves on bedrock or bullet-shaped boulders, large scale features of streamlined landforms, elevations of post-glacial deposits (glaciofluvial and glaciolacustrine) and active geological processes.

Bulk sediment samples (1-5 kilograms) were collected for geochemical analysis over much of the study area. Emphasis was placed on collecting basal till deposits (first derivative products according to Shilts, 1993), although ablation till, colluviated till and colluvium were also collected under certain circumstances. Natural exposures and hand excavation were used to obtain samples from undisturbed, unweathered C-horizon (parent material) deposits. At each sample site (Figure 6), the following information was recorded: type of exposure (gully, roadcut, etc.), depth to sample from top of soil, thickness of A and B soil horizons, total exposed thickness of the surficial unit, stratigraphy of the exposure, clast percentage, matrix or clast-supported diamicton, consolidation, matrix texture, presence or absence of structures, bedding, clast angularity (average and range), clast size (average and range), clast lithologies, and colour. The samples were evaluated as being derived from one of the three categories; basal till, ablation till, or colluviated/ reworked basal till.

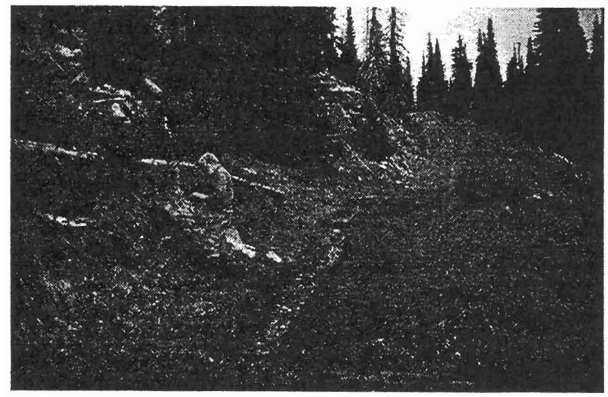

Figure 6. Roadcut exposing basal ground moraine at a sample site.

SAMPLE PREPARATION AND ANALYSIS

Sediment samples were sent to Eco Tech Laboratories in Kamloops for processing. This involved air drying, splitting and sieving to <63 µm. The pulps, <63 µm sample and unsieved split were subsequently returned to the BCGS sample preparation laboratory in Victoria. The -63 µm fraction of each sample was further divided into 10 and 30 gram portions. The smaller portion was sent to Acme Analytical Laboratory, Vancouver, where samples were analysed for 35 elements by aqua regia digestion - Ultratrace-ICP (ultrasonic nebulizer-inductively coupled plasma emission spectroscopy) and for 11 oxides, loss on ignition, carbon, sulphur and 7 minor elements by $LiBO_2$ (lithium borate) fusion - ICP. The larger portion was sent to Activation Laboratories, Ancaster, Ontario, for INAA (instrumental thermal neutron activation analysis) analysis for gold and 34 elements. Instrumental detection limits for the methods are given in Table 2.

Analytical results are provided as Appendix B (ICP), Appendix C (INAA) and Appendix D (Whole Rock). Data for 30 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. For the INAA analysis the excluded elements are Ag, Hg, Ir and Sn. Elements excluded from the ICP results are Au, B, Ni, W and U. Nb was excluded from the Whole Rock results. 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

	INAA	ICP			INAA	ICP		Whole-rock	
Al		0.01%		Mn		1 ppm		SiO2	0.01%
Ag		30 ppb		Na	0.01%	0.01 %		Al2O3	0.01%
As	0.5 ppm	0.5 ppm		Nd	5 ppm			Fe2O3	0.01%
Au	2 ppb			Ni		1 ppm		MgO	0.01%
Ba	50 ppm	1 ppm		P		0.001 %		CaO	0.01%
Bi		0.1 ppm		Pb		0.3 ppm		Na2O	0.01%
B				K		0.01 %		K2O	0.01%
Br	0.5 ppm			Rb	15 ppm			TiO2	0.01%
Cd		0.2 ppm		Se	3 ppm	0.3 ppm		P2O5	0.01%
Ca	1 %	0.01 %		Sm	0.1 ppm			MnO	0.01%
Ce	3 ppm			Sc	0.1 ppm			Cr2O3	0.01%
Cr	5 ppm	1 ppm		Sr	0.05 ppm	1 ppm		LOI	0.01%
Co	1 ppm	1 ppm		Sb	0.1 ppm	0.1 ppm		Ba	5 ppm
Cu		0.2 ppm		Ta	0.5 ppm			C	0.01%
Cs	1 ppm			Te		0.2 ppm		Ni	20 ppm
Eu	0.2 ppm			Tb	0.5 ppm			S	0.01%
Fe	0.01 %	0.01 %		Th	0.2 ppm	1 ppm		Sc	5 ppm
Ga		0.5 ppm		Ti		0.01 %		Sr	10 ppm
Hg		10 ppb		Tl		0.2 ppm		Y	10 ppm
Hf	1 ppm			U	0.5 ppm			Zr	10 ppm
La	0.5 ppm	1 ppm		V		1 ppm			
Lu	0.05 ppm			W	1 ppm				
Mg		0.01 %		Yb	0.2 ppm				
Mo	1 ppm	0.1 ppm		Zn	50 ppm	0.1 ppm			

QUALITY CONTROL

METHODOLOGY

Distinguishing geochemical trends caused by geological changes 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 adopted for this project. Control reference standards and analytical duplicates are routinely inserted into sample suites to monitor and assess accuracy and precision of 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:

- Seventeen routine samples,
- One field duplicate sample collected adjacent to one of the routine samples,
- One blind duplicate sample split from one of the 17 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 11 pairs of field duplicates and 11 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 facilitate quality control evaluation (Figures 7 and 8). The field duplicate data contained very few outliers, but as expected, some were present for the gold analyses.

In general, the results shows good correlation for most field duplicate pairs with correlation coefficients (r) ranging from 0.517 to 9.74, excluding gold which had a correlation coefficient of 0.027. All values of r are significant at the 0.01 level. The presence of individual, anomalous samples would have significantly reduced the overall correlation coefficients for each analysis. Analytical duplicate pairs show a slightly higher degree of correlation with r values ranging between 0.813 and 0.998, and a gold r value of 0.023.

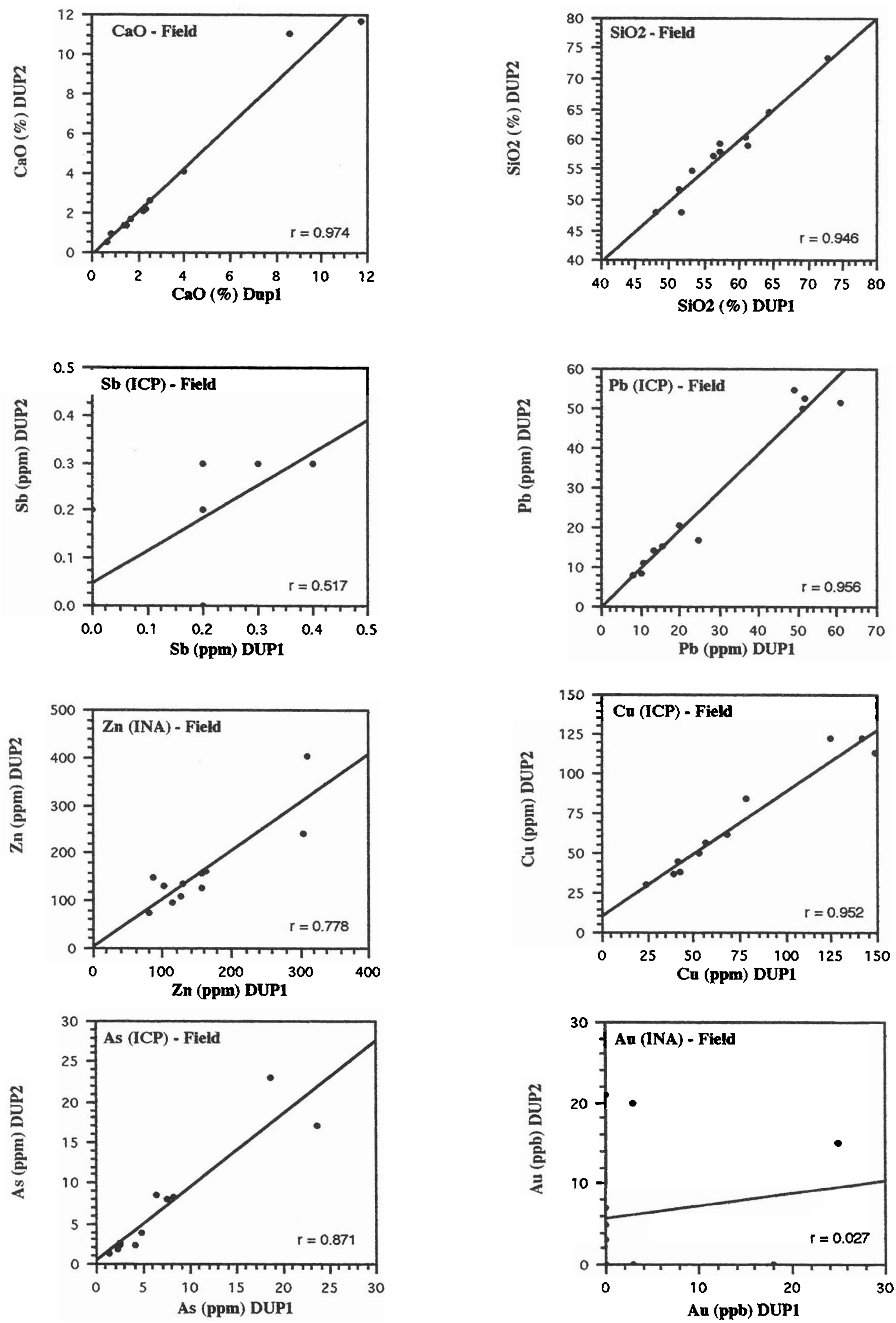

Figure 7. Bivariate scatter plots of field duplicate pairs for the Shuswap Highlands till geochemistry study.

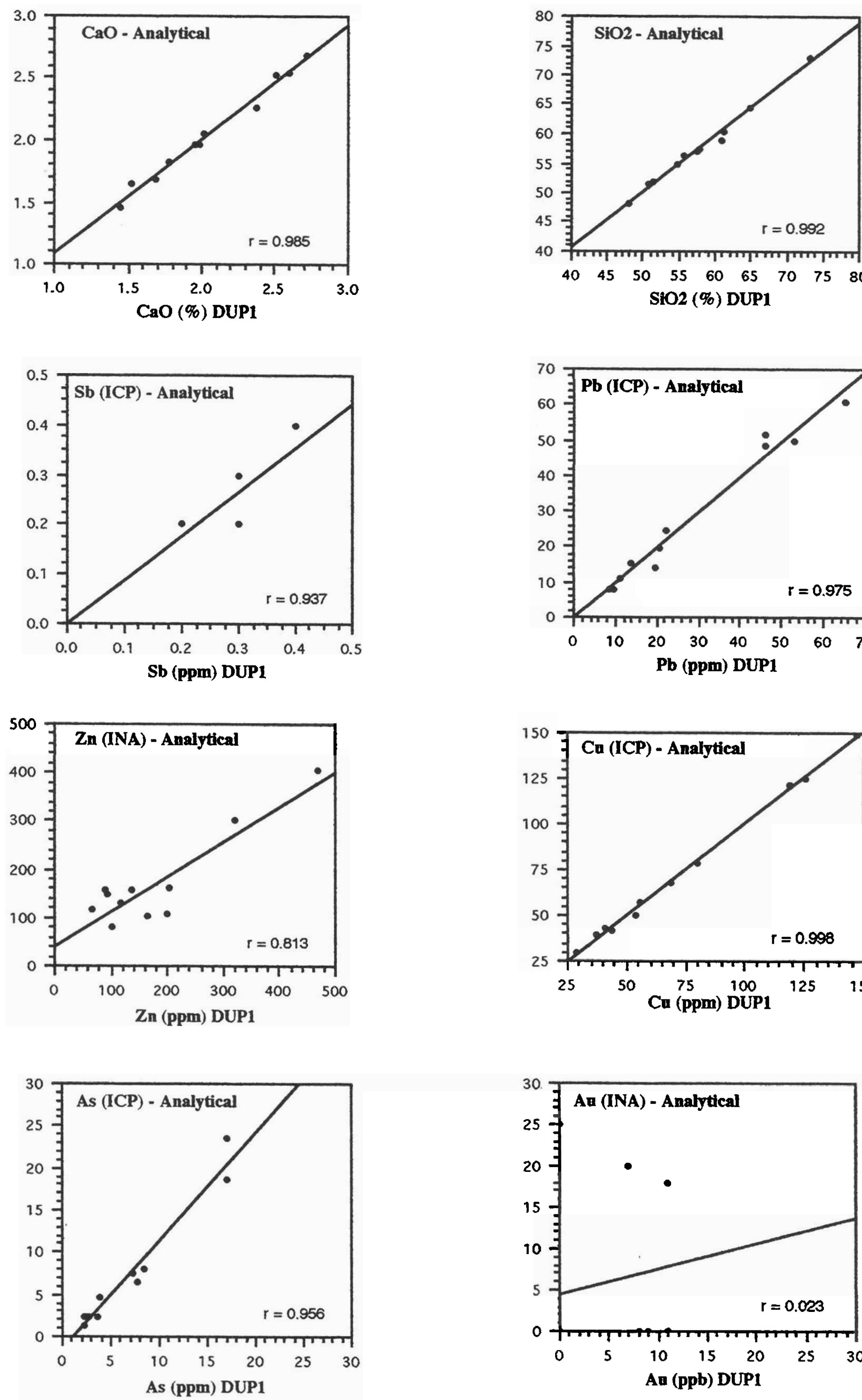

Figure 8. Bivariate scatter plots of analytical duplicate pairs for the Shuswap Highlands till geochemistry study.

DATA INTERPRETATION

This report provides the results of the till geochemical survey which was part of the South Kootenay drift exploration program. The results of the till geochemical survey program provide a reconnaissance level guide to geochemical patterns present in the area. From an exploration perspective the relation between "anomalous" values of certain elements such as copper, gold, silver, lead, zinc, arsenic and cadmium and the surficial geological history warrants further discussion to ensure that follow-up studies are executed with a good knowledge of probable source areas and higher likelihood of discovering such source areas.

As noted previously, analytical results for 31 ICP elements (Appendix B) and 30 of the 35 INAA elements (Appendix C) are presented in this report. The whole rock analysis data provides results of analysis for 11 major oxides, 6 minor elements as well as Loss-On-Ignition (LOI) values (Appendix D). The field data in Appendix A consists of a map identification column (MAP), station identification label (ID), UTM zone (GRID), easting and northing (UTME and UTMN, respectively), field duplicate identification (STA), and sample media. The ICP data in Appendix B consists of an identification label (ID) and field duplicate identification. 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 six 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 (parts of NTS 82M/3, 82L/13 and 82L/14), geographical reference points (*e.g.* towns, villages, and river names), geographical coordinates (UTM as well as latitude and longitude), and a symbol legend. The symbol legend describes the distribution of values for eight percentile categories, minimum and maximum values within each percentile 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 probability 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 30 elements analyzed by INAA and for the 11 major oxides, LOI, carbon, sulphur and minor elements. These results are provided as Appendix F and G, respectively. 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 well 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 Eagle Bay 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 volcanogenic massive sulphide (VMS) deposits, volcanogenic sulphide-barite deposits and gold prospects (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 82M and 82L). Interpretations regarding likely associations between the till geochemistry anomalies and known mineral occurrences are provided. Similarly, as yet unexplained associations are emphasized with suggestions for possible source areas. Glacial ice flow directions, deposit types and drift thickness are discussed and integrated into the element interpretations to assist explorationists with follow up efforts.

SILVER

The 216 till samples collected and analyzed by ICP provided silver concentrations ranging from less than 30 ppb to 1617 ppb. The samples generated a mean concentration of 156 ppb; mode and median values were <30 and 110 ppb, respectively. Most of the sample results occurred in the lower 95th percentile (205 samples) with 8 samples having concentrations of >500 ppb.

A colluviated till sample at station 989430 located approximately 5 km east of the confluence of Kwitoit and Scotch creeks provides the highest concentration of silver recorded (1617 ppb). There are no known mineral occurrences within 7 km of the sample site. Documented ice flow in the region trends southwest. The colluviated material was transported downslope from the small flat plateau separating Scotch and Onyx creeks. Combining the ice flow vector (SW) and hydromorphic vector (NW) indicates a probable source within a few kilometres to the west. The station boasts elevated values in cadmium, antimony, arsenic and zinc.

The second highest concentration of silver was obtained from station 989467 approximately 6 km due north of Magna Bay. The 884 ppb silver value is associated with high arsenic, copper, mercury, antimony and cadmium concentrations. Iron-stained metavolcanic cobbles were noted in abundance at the site. The source of this anomaly is likely the Fluke Claims, approximately 2 km up-ice on Crowfoot Mountain. This showing was worked during the 1930's and grab sample from altered and mineralized schists and marbles have reported up to 5.6 oz/t silver, 0.3% copper, 2.94% lead and 20.62% zinc (Allen, 1977).

The third highest value of silver (797 ppb) was obtained from a thin basal till sample overlying graphitic phyllite bedrock. The station (989110) is located on the hillside 2 km east of Woolford Point, directly northwest of Hustalen Creek. Zinc and lead are also found in moderate concentrations in this sample. The sample site is approximately 700 m down-ice from the Woof 3 showing which is likely the source of the anomaly.

A silver value of 725 ppb was obtained from an ablation till sample at station 989093. The sample was collected from a thin ablation till veneer located on the Comstock Claim Group, near the headwaters of Nikwikwaia Creek. Numerous concentrations of sulphide boulders have been reported on the property and several geochemical and geophysical surveys have been completed. Float in the region has been reported to contain up to 3 oz/t silver and up to 28% combined lead+zinc (Wells, 1987). Documented ice-flow trends southward, parallel to bedrock strike. This is problematic for property scale surveys because multiple point sources are suspected as the sources of the mineralized float. The source of the till anomaly is likely on the Comstock Claims.

The final sample mentioned here was obtained from a colluviated till sample located on the hillside west of Snuffbox Creek. The concentration of silver here was 620 ppb and is associated with elevated values of bismuth, antimony, mercury, arsenic, copper and lead. The sample site is in close proximity to the Jim occurrence and is likely the source of the high multi-element values in the colluviated till.

COPPER

Concentrations of copper analyzed by ICP ranged from 2 ppm to 243 ppm. Mean and median values of 75.35 ppm and 71.1 ppm Cu, respectively, are present. Of the 227 samples analyzed, 20 percent of the samples are above 100 ppm Cu. All of the high copper concentrations can be tentatively associated with known mineral occurrences.

The highest copper value (243 ppm) was obtained from basal till at station 989467. As previously mentioned, this site is located on the southwest flank of Crowfoot Mountain and contains elevated values of silver, antimony, arsenic, mercury and cadmium. The source is likely from the Fluke Claims, some 2 km to the northeast (up-ice).

A value of 231 ppm copper was obtained from a colluviated basal till sample (989427) located on the west flank of Crowfoot Mountain, several hundred metres west of Onyx Creek. The hillside has hydromorphically displaced the anomalous elements in the till downslope (west). The nearest MINFILE occurrence is the Bet showing (082M 104), which is 3 km to the northeast. However, copper is not among the commodities listed for that particular occurrence. Although it is possible the Bet showing is the source of the high copper values in the till, it is probable that an unknown copper source does exist on the upper western flank of Crowfoot Mountain.

The third highest copper value (166 ppm) was obtained from basal till sample 989076. Located at the eastern edge of the Adams Plateau, above Gash Creek, the sample site is proximal to several MINFILE showings, namely AP98-46, AP98-406, Oro and Silver King. These showings contain Cu-Pb-Ag-Zn and are the sources of the high concentrations of copper in the till. Since this region is in the divergent zone of the southeastward and southwestward ice flow directions, pinpointing the exact the source of the sample site to a specific occurrence could prove difficult.

Two high values of copper were obtained at stations 989099 and 989489; 161 and 159 ppm, respectively. The two stations are located on opposite sides of Corning Creek, approximately 3 km apart along an east - west two stations are located on opposite sides of Corning Creek, approximately 3 km apart along an east - west axis. Elevated values of zinc are associated with the copper concentrations. Both are derived from known Cu-Zn showings that are located up-ice from the stations. Sample 989099 is likely derived from the Nik showing (MINFILE 082LNW 036) and sample 989489 is likely derived from the AD-Corning Creek showing (MINFILE 082LNW 054). Both samples are about 2-3 km down-ice from the known mineral occurrences.

GOLD

The mean and median concentrations of gold (INAA) are 4.7 and 2 ppb, respectively. Values ranged from <2 to 138 ppb for the 227 samples of till and colluviated till analyzed. Six samples have gold concentrations between 25 and 50 ppb, three samples have gold values greater than 50 ppb. The top three gold samples are not presently associated with known mineral occurrences.

The highest gold value (138 ppb) was obtained from colluviated basal till sample 989424. The sample site is located approximately 5 km east of the confluence of Kwikoit and Scotch creeks, on a hillside south of Scotch Creek. There are currently no known mineral showings that can be attributed to the high gold value. Slightly elevated values of antimony, molybdenum, silver and zinc are associated with the high gold value. The sample, collected from colluviated till, has two vector dispersal directions; a glacial dispersal from the northeast and a hydromorphic dispersal downslope to the northwest. The source of the gold is probably to the east-northeast, within a few kilometres in the vicinity of Vegetation Creek.

A value of 93 ppb gold was obtained from thick basal till at station 989443. Located on the west flank of Angle Mountain, north of an unnamed tributary of Ross Creek, the gold concentration is not close to any known mineral occurrence. The gold is associated with relatively high mercury and zinc. Pebbles in the till reflect the local schistose metasediments of the Shuswap Metamorphic Complex. The source is likely within 1-2 kilometres up-ice, to the northeast.

At station 989472, about 3 km northwest of Ross Creek, on the south side of Crowfoot mountain, a thick basal till sample yielded a gold value of 50 ppb. Several other samples in the area did not provide elevated gold values. There are no known mineral occurrences recorded for the area which can be considered as possible source candidates for this gold concentration. Local bedrock is marble and 90% of the pebbles in the till are limestone and marble. Local ice flow directions indicate that the source of the gold concentration is located within a few kilometres to the northeast.

Values of 42 ppb (989208) and 39 ppb (989206) were obtained from thick basal till samples on the southern slope of Scotch Hill, north of Copper Island. The two samples are down-ice from Scotch Creek (MINFILE 082LNW 016), a gold prospect. The Scotch Creek is an epigenetic VMS type Au-Ag-Pb-Cu deposit hosted with the lower Eagle Bay Assemblage. Mineralization at the property was reported to be 9 g/t Au and 29 g/t Ag (Neale and Hawkins, 1984). The two samples are probably related to the same dispersal plume that extends down from the Scotch Creek prospect to Shuswap Lake. Gossanous boulders were noted at each sample site. Striations recorded nearby indicate an ice flow direction trending 150°. The higher gold sample is closer to the mineralization, yet is still 2 km down-ice. The decay curve between the two gold values in the till samples is quite flat and provides a good dispersal model to apply within Shuswap Basin, especially at lower elevations.

LEAD

Mean and median concentrations of lead (ICP) are 27.52 ppm and 20.4 ppm, respectively. Lead concentrations ranged from a minimum of 0.3 ppm to a maximum of 255 ppm. Of the 227 samples analyzed, the top six had values >100 ppm. Concentrations of lead are often associated with other elevated elements, such as silver, zinc, bismuth and tellurium..

The top three samples of lead concentration were recorded at station 989095 (255.3 ppm), 989093 (235.7 ppm) and 989079 (177.7 ppm) located on the Adams Plateau above a tributary of Nikwikwaia Creek. The till samples are all clustered within or down-ice of the Comstock Claim Group (MINFILE 082LNW 036). However, the reports do not list lead as a known commodity. Local mineralization does include minor galena and arsenopyrite observed in grab samples (Wells, 1987). Elevated values of bismuth, cadmium, silver and zinc are associated with the lead concentration in the till samples. The bedrock in the area is part of the lower Eagle Bay Assemblage and bedrock strikes parallel to ice-flow directions. Multiple stratabound VMS type deposits do occur to the north (along strike) and so it is likely that there are multiple point sources of lead here from the northward trending metamorphosed sequence of mafic volcanics and immature sediments found in the region (Schiarizza and Preto, 1987). The individual sources are likely with 1-2 kilometres of each sample site.

The fourth highest value of lead was obtained from station 989110, where a concentration of 174.3 ppm is present. The sample was collected from a basal till veneer, adjacent to Hustalen Creek, some 2 km east of Adams Lake. The lead concentration in the till is associated with silver, gold, arsenic, antimony and zinc. Locally associated with the Eagle Bay Group rocks, the

Woof3 (MINFILE 082LNW 078) showing is in the up-ice vicinity of the sample station and can be attributed to the high value of lead observed.

The final location discussed here with an elevated value of lead is from station 989142 (114.1 ppm) from an ablation till sample located at the southeastern edge of the Adams Plateau, between Corning and Scotch creeks. Locally the station is associated with the lower Eagle Bay mafic volcanic and metasedimentary rocks. There are several known Sedex mineral occurrences in the up-ice vicinity of this station and all are candidate source areas contributing to the lead concentration in the till. These include the AD, CU1 and Cu5 and the Golden Eagle showings. However, there are up to 80% quartz-feldspar porphyry pebbles in the till at this site so a possibility does exist that the source is a unknown skarn deposit.

ZINC

Zinc concentrations (ICP) ranged from a minimum of 30 ppm to a maximum of 404 ppm for the 227 samples included in this report. A mean value of 94.66 ppm and median value of 84.4 ppm result from this distribution. The highest nine values of zinc are all greater than 200 ppm. Zinc is often complimented with elevated values of lead, silver and cadmium. All the zinc values are associated with known mineral occurrences.

Two high values of zinc (403.6 and 223.7 ppm) occur in the vicinity of the previously mentioned Comstock Claim Group at stations 989093 and 989079, respectively. As discussed earlier, these stations also recorded high values of lead, silver and bismuth. The bedrock source is likely within the local area, less than 2 km up-ice to the north.

A high zinc value (302.2 ppm) was obtained from a basal till veneer sampled at station 989099. Located 1.5 km west of the headwaters of Corning Creek, there are several known occurrences in the up-ice vicinity of the station. These include Eagle Bay hosted AD, Comstock and Nik showings which occur to the north and northwest of the station. Elevated copper in the till is associated with the zinc. Diverging southeast and southwest ice flow in this region make it difficult to pinpoint a specific source of the zinc concentration so all the mentioned occurrences should be considered as equal candidates for source.

The third highest zinc value recorded in the region is derived from a basal till veneer collected overlying a weathered phyllite at stations 989110 (273.3 ppm). Moderately high silver and lead values were also obtained from this sample. Situated 2 km east of Woolford Point and north of Hustalen Creek, the station is in close proximity to the Woof3 mineral showing. This is likely the source of elevated zinc, silver and lead values in the till.

The final zinc concentration discussed here is from station 989433. The basal till sample was collected at the site of the Ladybug showing (MINFILE 082M 265), in an area with traditionally little or no previous exploration activity. The till collected here provided a zinc value of 251.6 ppm. The site is located near Seymour Arm, approximately 6.5 km up (north) Five Mile Creek. The Ladybug property is a Zn-Ag-Pb-Cu showing and is likely the local source of the elevated zinc value.

ARSENIC

Concentrations of arsenic determined for the 227 samples reported here ranged in value from 0.5 ppm to a maximum of 96.1 ppm. The highest five arsenic values were all greater than 27 ppm, with four of them associated with known mineral occurrences. Concentrations of mercury, molybdenum, antimony, silver, cadmium, nickel and zinc are commonly associated with higher values of arsenic in the till samples.

Three values of arsenic (96.1, 39.2 and 27.7 ppm) occur down-ice from the Fluke showing at stations 989467, 989465 and 989468, respectively. Located on the southwestern flank of Crowfoot Mountain, at headwaters of tributaries flowing into Onyx Creek, these stations also have high values of silver and copper. The bedrock source is likely to the northeast, at the Fluke showing or nearby associated mineralized rocks.

A high arsenic concentration (85.2 ppm) was obtained from an oxidized colluviated basal till veneer overlying a graphitic schist. Located on the edge of a ridge, 1 km west of Snuffbox Creek, the station (989042) is located in the vicinity of the Jim showing (MINFILE 082M 208). The highest mercury and selenium concentrations and high values of silver, bismuth, copper and lead were obtained from this station. The source is likely the Jim showing, which occurs about 200 m up-ice from the sample station.

The final arsenic sample discussed in this report is the 34.7 ppm value obtained from station 989209. The sample was taken from an ablation till sample in the region west of Onyx Creek. Elevated values of antimony and molybdenum are also recorded for this sample. There are no known mineral occurrences up ice (northeast) and uphill (north) within a few kilometres of this station. The colluviated ablation till sample is a difficult media to interpret a possible bedrock source. The source can be anywhere from a few hundred metres to the north-northeast and several hundred metres to the north (upslope) or several tens of kilometers to the northeast. A possible candidate is the Fluke showing, which is some 8 km up-ice.

possible candidate is the Fluke showing, which is some 8 km up-ice.

CADMIUM

Cadmium concentrations (ICP) ranged from a low of <0.2 ppm to a high of 2.4 ppm for the 227 samples examined in this report. A mean value of 0.25 ppm and median value of 0.18 ppm result from this distribution of data. There are six samples in the 97 %tile and better with minimum values of 1.0 ppm. In our samples, cadmium is commonly associated with elevated values of zinc, gold and silver.

The highest cadmium value obtained in this study comes from a basal till sample recovered at station 989107 (2.38 ppm) which is situated on the hillside east of Adams Lake, between Hustalen and Woolford creeks. Several mineral showings occur within the up-ice vicinity of this station are all are equal candidate sources for the elevated cadmium values. These include the Woof3, Woolford Creek and the Steep3 showings.

The second highest concentration of cadmium (1.49 ppm) was recorded at station 989079 at the previously discussed Comstock claims in the southeastern corner of discussed site on the Adams Plateau. As noted earlier, this anomalous multi-element till sample is likely derived from bedrock within Comstock property.

The final station discussed for cadmium provided a value of 1.47 ppm (989430). Located on a ridge between Scotch Creek and Shuswap Lake, approximately 5 km east of the confluence of Kwitoit and Scotch creeks, the sample was collected from a thin colluviated till veneer overlying phyllite. High values of silver, antimony, gold, arsenic and zinc were obtained from the till sample. There are no known mineral occurrences up-ice of the station. As discussed earlier, the till at the site was subjected to glacial and hydromorphic dispersal. Documented ice flow in the region trends southwest. The colluviated material was transported downslope from the small flat plateau separating Scotch and Onyx creeks. Combining the ice flow vector (SW) and hydromorphic vector (NW) indicates a probable source within a few kilometres to the west.

SUMMARY AND RECOMMENDATIONS

This report presents the results of a drift exploration program integrating surficial geology mapping and till geochemistry sampling east of Kamloops, north of Chase. The results of ICP, INAA and whole rock analyses for 227 till and colluviated till samples are presented and discussed. Collectively, these data provide a good reconnaissance level study of the mineral potential of this glaciated and drift covered region.

Much of the area (NTS 82M/3, 82L/13 and 14) is covered by unconsolidated sediment of variable thickness ranging from less than one metre to several metres. Areas at the edge of the Adams Plateau and deeply incised valleys elsewhere support thin veneers of colluvium (<1 m) over bedrock on steep slopes. Thicker blankets of colluvium (>1 m) over till occur on mid slope regions. At lower elevations and over much of the flat lying plateau areas, morainal deposits in the form of ablation and basal till can be found. Ablation till is commonly found as a veneer at higher elevations, overlying either basal till or bedrock. Till accumulations range in thickness from less than a metre to over several tens of metres depending on the relief of the underlying bedrock. Fluvial deposits are restricted to the lowest elevations within the various creek and valley bottoms. Sediments often occur within a few metres elevation above present day creeks, streams and rivers. Thick glaciofluvial sediments occur in the Scotch Creek valley. Elsewhere, glaciofluvial sediments are found in valley settings and as thin veneers over till near meltwater channels. Glaciolacustrine sediments are found in the lowest elevations, rimming the Shuswap Lake basin.

Quaternary geology plays an important role in mineral exploration studies in areas of glaciated terrain. The principles of drift exploration rely on an accurate understanding of the regional geological history, the distribution of various types of sediment, the genesis of individual deposits and the relationship of sediment cover to bedrock lithology (Liverman, 1992). Terrain and surficial geology mapping provides the first step towards attaining this understanding, whereas ground-truthing, including stratigraphic and sedimentological descriptions, further the process. Sampling for till geochemistry and clast lithologies provides two mechanisms to recognize glacial dispersal trains and consequently infer potential mineral occurrences covered by drift. But the successful integration of these data with the surficial geology studies is the key for determining their location.

It is recommended that terrain and surficial geology mapping precede the complementary aspects of drift exploration studies which rely on till geochemistry and pebble lithology analysis. Such mapping not only identifies where preferred sediments for sampling occur, but also provides information regarding drift thickness and paleo-ice flow direction. Unique deposit types must be identified and consistency in sampling such deposits must be maintained to ensure comparability of the results. For example, one recent study of glacial dispersal of till constituents clearly illustrated how both flow-paths and transport distances differed between various types of morainic landforms, further emphasizing the need for good associated surficial mapping (Aario and Paeuraniemi, 1992).

A total of 227 bulk sediment samples (including duplicates) were initially collected for the till geochemistry study. Most of the samples taken for geochemical analysis were representative of basal till, most likely lodgement till. Of these, 202 or 89% were considered acceptable for the objectives of this survey and the results are presented here. Basal till which has undergone slight downslope movement was classified as colluviated till. Samples taken from this type of deposit accounted for 16 samples or 7% of the total. Ablation till only accounted for 9 samples or 4%. Samples were collected at an average depth of 1.5 m below soil surface. Till sample density averaged one per 2.45 km^2 for the total survey area. Assuming average transport lengths of 1.0 kilometre for geochemical anomalies (*cf.* Salminen and Hartikainen, 1985) this level of sampling provides a high level of reconnaissance information for the region.

Previous geochemical studies provide an indication as to the style of mineralization, configuration of anomaly plumes and regional dispersal patterns one can expect for a particular area. Examples of property scale geochemical sampling are described in detail by Paulen (1999).

The distribution of high concentrations of several elements were discussed in detail earlier in this report. Here we summarize the elements and sample locations to further emphasize which locations warrant additional attention. Table 3 lists the 5 or 6 till sample numbers whose concentrations were high for each of seven key elements. As evident in this table, a number of sample locations occur repeatedly, indicating that high multi-element concentrations were determined for the respective samples. Those samples which could not be readily associated with a known mineral occurrence are underlined in this table. These key sites should be the focus of additional exploration attention as detailed under the individual element discussions. Future reconnaissance level till geochemistry and surficial mapping should be pursued in the region given the high mineral potential that this area displays.

ACKNOWLEDGMENTS

This work was completed as part of the British Columbia Geological Survey Branch, Eagle Bay Project. Dave Lefebure is thanked for his role as project manager, and Gib McArthur for section management. We extend our thanks to the Kamloops office of the Ministry of Energy and Mines for providing logistical services. Insight into the bedrock geology and the local mineral deposits were provided by Mike Cathro, regional geologist for the Ministry of Energy and Mines and Ron Wells of Kamloops Geological Services. Our thanks are extended to many of the prospectors who were informative and cooperative. Paul Van Nieuwkuyk and Gillian Moody are thanked for preparing the appendices and documentation layout for final publication.

TABLE 3

SUMMARY OF HIGHEST CONCENTRATION TILL SAMPLES FOR KEY ELEMENTS

ELEMENT	SAMPLE NUMBERS
SILVER	989430, 989467, 989110, 989093, 989042
COPPER	989467, 989427, 989076, 989099, 989489
GOLD	989424, 989443, 989472, 989208, 989206
ARSENIC	989467, 989042, 989465, 989209, 989468
LEAD	989095, 989093, 989079, 989110, 989142
CADMIUM	989107, 989079, 989430, 989457, 989130
ZINC	989093, 989099, 989110, 989433, 989079

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