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MOSS MATS

AS A MEDIUM FOR

STREAM SEDIMENT GEOCHEMISTRY

by

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**MOSS MATS
AS A SAMPLE MEDIUM FOR
STREAM SEDIMENT GEOCHEMISTRY**

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This contribution to our understanding of stream sediment geochemistry owes any insights it may have to the research that has come before. The list of Key References at the end of the paper recognizes some of the many people whom have made positive contributions to our understanding of this subject.

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RESEARCH OBJECTIVES

The objectives of this project were: to assess the collection, handling, and processing of moss mats as a primary sample medium for fine fraction and heavy mineral sediment geochemistry; to assess the data retrieved using these techniques; and to provide information and ideas for further research on stream sediment geochemistry.

INTRODUCTION

Primary sample collection is the greatest source of variability in geochemical surveys. The type of sample collected, the location in the stream where the sample is collected, and even the time of year, can dramatically affect results.

The goal of sediment geochemistry is to identify the potential for a drainage basin to host an economically viable mineral deposit. While this sounds obvious it is very easy to fall into the trap of using sediment geochemistry to explore for anomalies instead of mines. Many of the new mineral discoveries in the Canadian Cordillera have resulted from detailed aggressive follow-up of targets identified with the assistance of regional stream sediment geochemistry. Stream sediment geochemistry is a rapid and cost-effective reconnaissance exploration tool that provides a direct link between the anomalous element or its path-finders, and the element being sought. On one level exploration geochemistry is very simple and intuitive; however at the same time it is very complex and poorly understood.

Traditional -180 micron (80 mesh) size stream sediment sampling techniques employed by government sponsored regional geochemical surveys are fast and effective and are the backbone of a large public geochemical database. More rigorous techniques are recommended for follow-up and detailed surveys.

Previous research addressed optimizing the size fraction of the sediment analyzed in an attempt to reduce subsample variability, to reduce sample site variability, to increase anomaly definition, and to lengthen dispersion trains of the element or elements being sought for geochemistry in till (DiLabio, 1985; McClenaghan, 1992), and in stream sediment (Wiltse, 1988; Fletcher, 1990; Nuchanong et al, 1991). This is compared to the standard, or traditional -180 micron sample size fraction. Selecting a specific size fraction to analyze has shown improved anomaly definition and longer dispersion trains while at the same time providing less erratic data (MacKay, 1994).

Much of the research into size fractions has looked primarily at gold and has focused on splitting the traditional -180 micron size fraction in two to create a -63 or -53 micron fraction and a -180 +63/53 micron fraction. This approach requires a much larger primary sample and creates the problem of separating very fine-grained material. Encouraged by promising research some mineral exploration companies are now separating and analyzing two size fractions for stream sediment geochemistry.

Sample collection and sample preparation methodologies are the major technical challenges in applying this technique to mineral exploration. This project investigates the potential for collecting moss mats as a primary sample medium.

Orientation work using moss mats as a primary sample medium was done on Vancouver Island by the British Columbia Geological Survey. This work demonstrated that moss mats are widely available, easy to collect, and contain abundant fine-grained sediment (Matysek and Day, 1988).

The hydraulic characteristics (energy) of the sedimentation event that deposits sediment in moss mats is hypothesized to be very similar in widely different areas. This is because sediment is deposited into a moss mat only during high water events when sediment-laden water flows over the moss. These high water events may create a somewhat uniform high energy event within the stream. During low flows, high energy locations within the stream are much more localized, with stream energies ranging from very low energy to localized high energy. During the high energy, high water events sediment is deposited within the living portion of the moss mat. After the high water has receded the moss continues to grow, entrapping the newly-deposited sediment under the living portion of the moss mat. Over time a thick mass of sediment is collected. The sediment is bound together by the decaying remnants of the moss and is covered by living moss.

Moss mats collect sediment over a period of years. This reduces the effect of isolated erosional events on the geochemistry of the sediment contained in the moss mat. Single site erosional events such as mud slides can result in the stream sediment being highly over-represented by a small area. Geochemical data derived from moss mat analyses should therefore make interpretations more reliable than traditional sample media.

Another application for moss mat geochemistry may be in exploration for placer minerals.

A dwindling placer gold reserve and the requirement for assessments on areas slated for withdrawal from mineral inventory indicate the need for inexpensive, low impact, and effective placer exploration techniques.

Traditional techniques require locating high energy environments within the stream, collecting a primary sample, and then using a heavy mineral separation technique to identify gravity separation recoverable gold. Identifying high energy environments and collecting primary samples from high energy environments are two problems that limit the usefulness of this technique for regional surveys.

The recovery of coarse gold from moss mats is commonly mentioned, but has not been confirmed in a scientific study. Moss mats may have great potential as a sample medium used to assess unexplored areas for placer gold or other elements that commonly occur as resistant heavy minerals, such as tin or tungsten.

PROJECT OUTLINE

This project involved the collection of moss mat samples from sites throughout Yukon. Sites included: Laura Creek, which drains the Brewery Creek gold deposit; Logjam Creek draining the Logtung tungsten and molybdenum occurrence; Williams Creek which drains the Williams Creek copper deposit; the Vancouver Creek placer drainage; and Eldorado Creek in the Klondike goldfields.

Sample Collection and Processing

The five drainages were selected in order to test moss mat sampling over a wide range of geological, topographical and glacial environments.

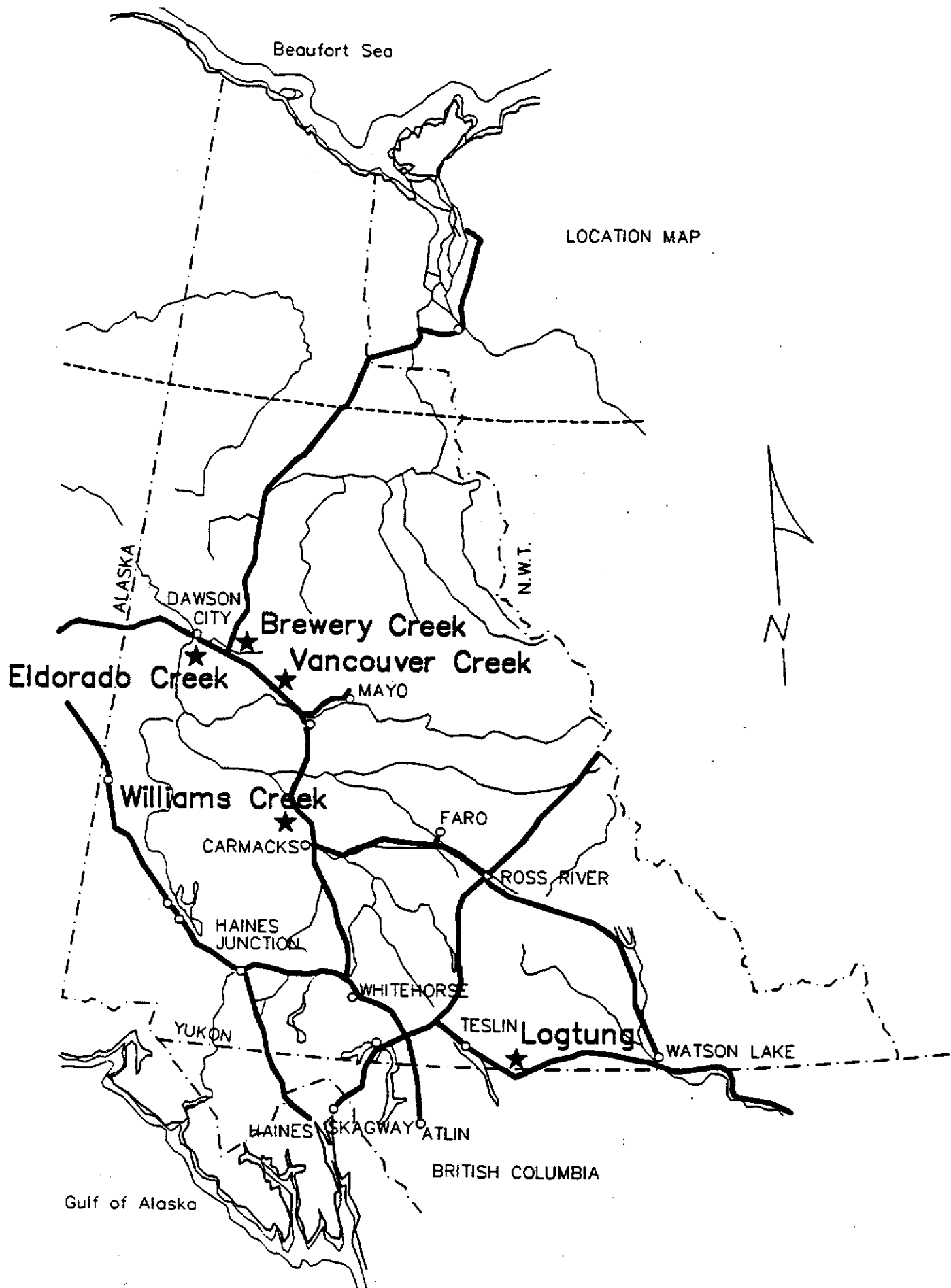
Four sites at approximately one kilometer intervals were selected along each chosen stream. Four moss mat samples were collected from each site (01 - 04). A single traditional silt sample was also collected from each site (05). Two of the moss mat samples from each site were disaggregated and pan-concentrated to approximately 30 grams of heavy minerals and then sent for analysis (03 - 04). The remaining two moss mats from each site were wet-sieved to -53 microns and -180 +53 microns, with both splits analyzed for gold, mercury and multi-elements (01 - 02). A separate split of the 01 series samples was also analyzed for whole rock geochemistry.

The moss mat samples collected weighed approximately 2.0 kg +/- 0.1 kg, as measured in the field by a handheld spring scale. A vertical section of 10 to 20 centimeters of moss mat was collected from all locations. Sample sites were selected to avoid contamination from side bank colluvium. With the exception of areas of placer mining on Vancouver Creek and Eldorado Creek, suitable moss mats were found along all drainages sampled. Suitable moss mats were considerably more common in the drainages studied than suitable traditional stream sediment sample material.

Heavy Mineral Separations

At each site moss mat samples 03 and 04 were collected. The samples were taken to a central processing site and disaggregated and hand panned to approximately 30 grams of heavy minerals. The samples from Logtung were then assayed unsplit for tungsten. The samples from the other creeks were assayed unsplit for gold. By reducing the heavy mineral fraction to a size that is easily assayed the total content of the gravity-recoverable element of interest can be determined.

Two approaches were employed to disaggregate the sediment from the moss mats. The first approach was to disaggregate the sample by hand and continuing to disaggregate during panning. This was very slow and ineffective at adequately separating the sediment from the moss mat. A second technique was developed where the moss mat was wet-sieved through a mechanically agitated 1000 micron screen into a 20 liter pail. The pail was allowed to



overflow, removing the clay fraction and fine organics from the sample. The >1000 micron fraction was then separated from the organic material by flotation with the separated sediment returned to the sample for panning. While neither technique was satisfactory the second approach was much faster and if the sample had been sieved to <2000 microns the coarse fraction could have been rejected with the organic and the <2000 micron fraction could be completely cleaned of the clay fraction, making panning much quicker and easier.

Fine Fraction and -180 +53 Micron Fraction Separations

Moss mats series 01 and 02 collected from each site were wet sieved through a series of mechanically agitated screens. The screen openings ranged from 1000 microns to 53 microns with the -53 micron fraction being collected in a clean 20 liter bucket. Approximately 200 grams of the -180 +53 micron fraction (Fraction C) was collected from the screens and placed in a standard kraft paper sample bag and allowed to air dry. Flocculent was added to the -53 micron fraction and it was allowed to settle for 48 hours before the water was decanted off and approximately 200 grams of -53 micron fraction (Fraction F) was transferred to a standard kraft paper sample bag and allowed to air dry. The sample was labeled with the sample number followed by the letter F. Both fractions of each sample were then sent to a geochemical laboratory in Vancouver, British Columbia for analysis.

The total time required to process a single sample was approximately 30 minutes. The screens were cleaned with a sonic cleaner between each sample and the equipment was thoroughly washed.

Wet sieving provides an advantage over dry sieving in that there is no need to dry the primary sample. The secondary sample must be dried but this sample is much smaller, can be placed in a paper bag, and contains very few organics, resulting in a quicker drying time that does not require specialized equipment. By wet sieving the samples in a central field camp the costs of shipping samples is greatly reduced compared to shipping a large primary sample to an analytical laboratory for analysis. However, potentially the largest advantage for wet sieving is the more thorough separation washing provides. The disadvantages are the need for specialized equipment, the need to settle and decant the sample, and a wet working area.

Sample Analysis and Data

A total of 95 samples were sent to an analytical laboratory for analysis.

The pan concentrated samples were dried, weighed and then assayed for gold or tungsten using the entire sample. Gold results were reported in milligrams of gold, while the results for tungsten were reported in percent WO_3 . In order to compare the tungsten data the weight of analyzed sample must be known so that the percent WO_3 can be converted into grams of pan concentrate recoverable WO_3 .

One of the challenges with pan concentrate data is to ensure that the analyzed sample is representative of the primary sample. Since pan concentrated gold and tungsten generally occur as discrete grains, statistical relevance is lost if the analytical sub-sample contains less than 20 discrete grains (Clifton, 1969). Therefore it is necessary to reduce the pan sample so that the entire concentrated sample can be analyzed. This results in the analyzed samples having varying weights. Assuming no tungsten is lost in panning, a 20 gram tungsten assay returning 1% WO₃ would contain the same amount of pan concentrate recoverable tungsten as the same sample panned to 10 grams assaying 2% WO₃. To be able to compare different samples in this way it is important that the primary samples contain, as near as practical the same mass of sediment.

The -53 micron samples were disaggregated and then two 30 gram splits were fire assayed for gold. A separate split was analyzed for mercury by flameless atomic absorption after an aqua regia digestion. Thirty-two elements were determined by ICP (inductively coupled plasma) after a nitric acid-aqua regia digestion. The -180 +53 micron fraction was treated the same as the -53 micron fraction but did not require disaggregating. The 01 series samples were also analyzed for whole rock.

ICP

No significant analytical problems are apparent in the data. However there is evidence that the dissolution on the 01 series -53 micron (Fraction F) sample batch was considerably more thorough than the other batches. This is highlighted by the variation in values for elements which are expected to have an incomplete digestion in the solution used. In this case the elements most noticeably affected were aluminum, chromium, and potassium.

Figure 1

Chromium in ppm.																			
01F	129	117	117	105	264	247	238	221	186	192	176	235	90	146	73	114	100	100	76
02F	86	59	59	51	71	66	70	34	101	117	107	118	57	53	48	49	60	54	70

*Each value represents a separate analysis on a different sample.

In Figure 1 each 01/02 pair represent two separate samples collected from the same stream within 5 meters of each other. Since they are separate samples the chromium values are expected to be different; however a systematic difference as seen in Figure 1 indicates a systematic error has been introduced into the data. Since a review of the data shows that aluminum and potassium have been similarly affected the most likely source of the error is the dissolution step in the laboratory.

Whole Rock Data

Fine and coarse fractions of the 01 series samples were also analyzed for major oxides. The coarse fraction has higher silica values and lower aluminum values than the fine fraction. Loss on ignition is higher in the fine fraction in all but one sample. Apart from the systematic variation between coarse and fine fraction for SiO₂ (silica oxide), Al₂O₃ (aluminum oxide), and loss on ignition, all other elements showed only random variations between the two size fractions.

Samples collected from different areas show distinct major oxide signatures. The Vancouver Creek samples are anomalously low in CaO (calcium oxide), while the three Logtung samples from closest to the mineralization are all anomalously high in MgO (magnesium oxide) in the coarse fraction. This indicates the potential for whole rock geochemical data to provide useful insight into the broad geochemistry of a drainage.

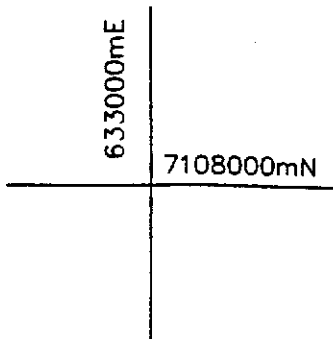
TARGET AREAS

Brewery Creek

Brewery Creek is located approximately 60 kilometers east of Dawson City within the unglaciated area of the Yukon. Local elevation ranges from 550 meters up to 1200 meters with topography characterized by steep permafrost-covered north-facing slopes and gentler south-facing slopes. The geology is characterized by a structurally deformed package of Selwyn Basin sediments intruded by Cretaceous granitic rocks disrupted by further structural deformation. The gold mineralization occurs in nine zones and is associated with highly anomalous arsenic, mercury and antimony values. Gold occurs as grains less than 0.5 microns within very fine sulfides.

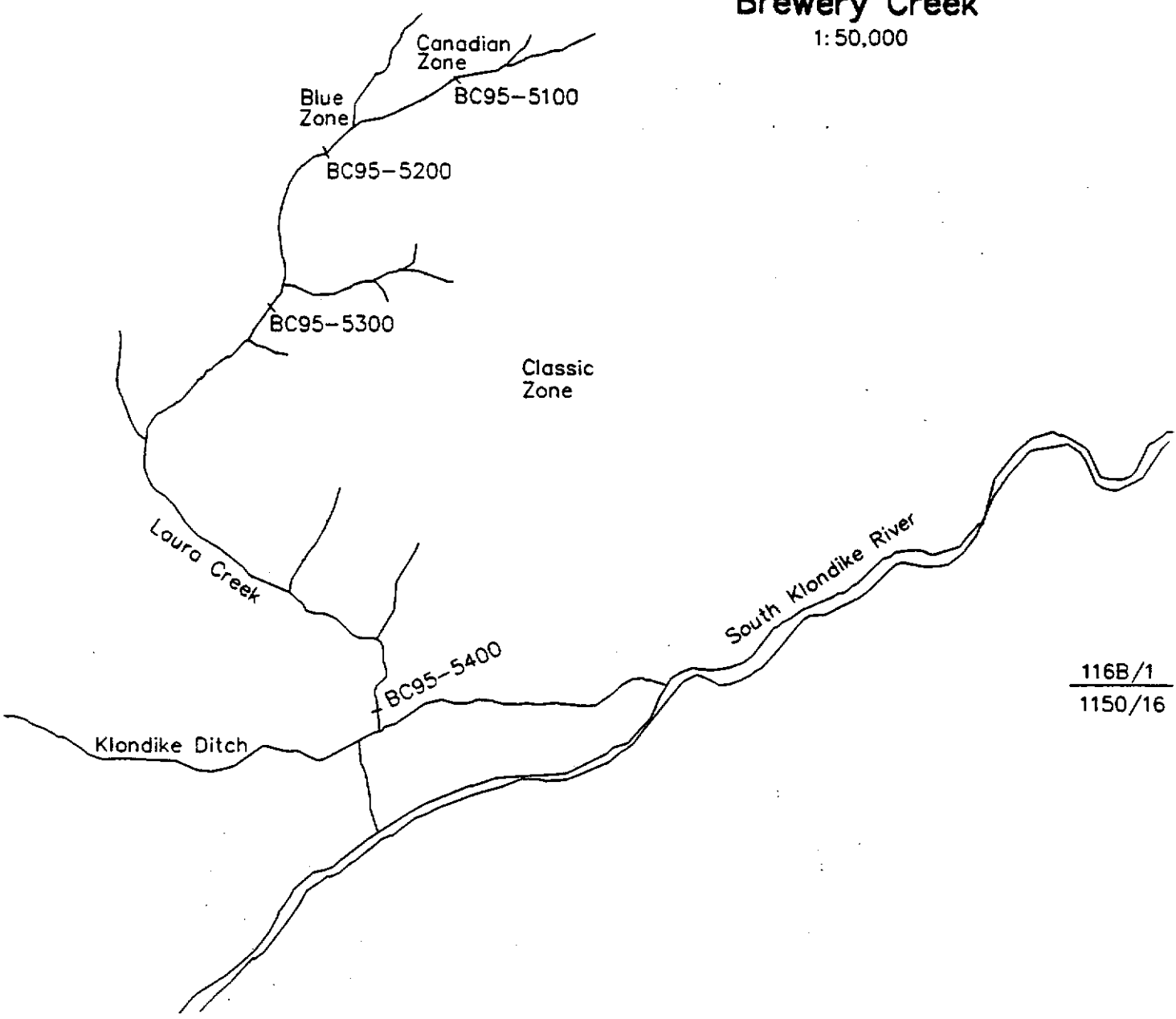
Four sample sites were located on Laura Creek, which drains the Brewery Creek gold deposit. BC95-51 was located near the headwaters of Laura Creek where it bounds the southeast edge of the Canadian Zone mineralization. BC95-52 was located approximately 1.5 kilometers downstream below where the tributary draining the Blue Zone enters Laura Creek from the north. BC95-53 was located a further 1.5 kilometers downstream below where the tributary draining the Classic Zone enters Laura Creek from the south. The final sample site, BC95-54 was located in the South Klondike River valley approximately 8 kilometers downstream from BC95-51 and approximately 75 meters upstream from the Laura Creek confluence with the Klondike Ditch. These Laura Creek sites are approximately the same sites as were used for MacKay Falkiner and Associates', fine sediment geochemistry for gold orientation survey (MacKay, 1994).

Moss mats were found to be ubiquitous along Laura Creek. Thick mats between 10 and 30 centimeters were present at all sample sites. Evidence of recent coarse sedimentation was noted along the drainage at sample site BC95-51.



Brewery Creek

1:50,000



116B/1
1150/16

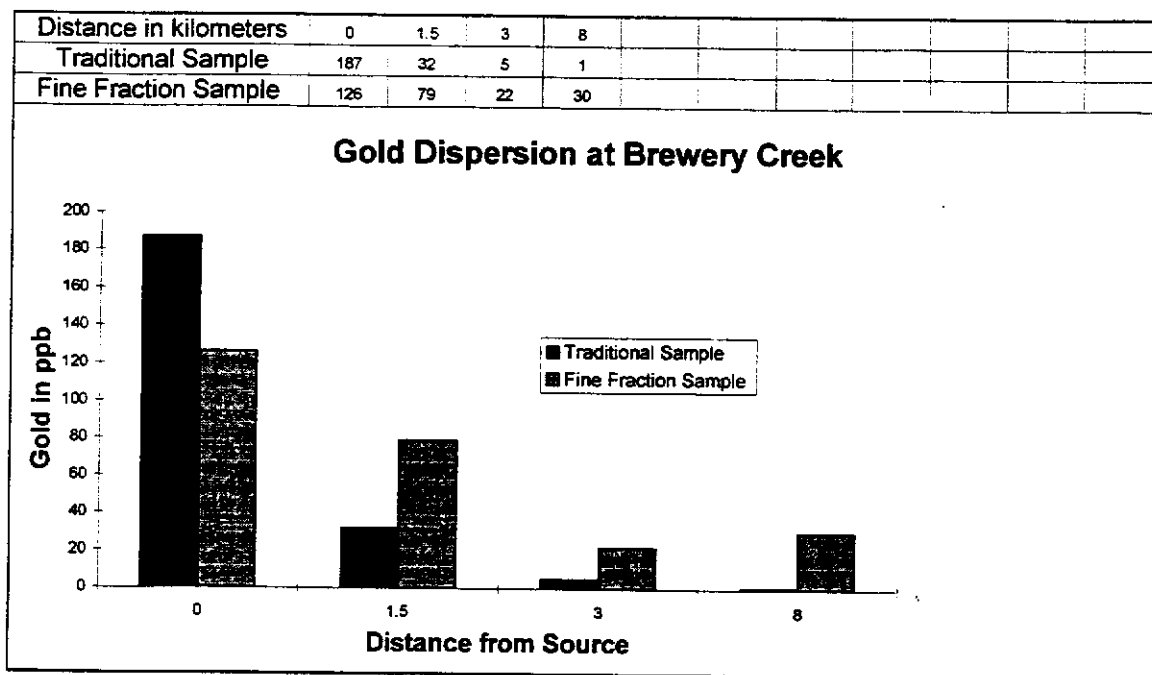
Pan Concentrate Data

Results show a very weak gold anomaly at site BC95-51 and a weak anomaly at site BC95-54. The anomaly at 51 possibly relates to gold-bearing heavy minerals (sulfides) that have not been broken down by weathering. Reverse circulation drill cuttings that intersected unoxidized sulfide-bearing mineralization are exposed near the sample location on Laura Creek and may have contaminated sample 5103. Anomalous values at 54 may be sourced from river terraces along the South Klondike river.

Moss Mat and Sediment Geochemistry

Data for the moss mat samples fine fraction (-53 microns) and coarse fraction (-180 +53 microns), and for traditional -180 micron (-80 mesh) stream sediment samples were also collected and analyzed for gold and 32 other elements. The traditional -180 micron stream sediment sample collected at site 51 reported the highest gold values for Laura Creek. This likely reflects the influx of recent sediment from trenching and drilling of the nearby mineralization. Figure 2 shows the dispersion trains for the fine fraction moss mat and the traditional -180 micron stream sediment samples. The moss mat fine fraction values are the averages of the four analyses of the two samples per site. Sub-sample variability is very low for both the moss mat fine fraction and the traditional silt sample.

Figure 2



With the exception of the sample site nearest to the mineralization, sample site variability is also low for the moss mat fine fraction. While the traditional silt has a higher value very near the source, the moss mat fine fraction has a much longer dispersion train. The same pattern is observed for arsenic, mercury and antimony.

Eldorado Creek

Eldorado Creek is located approximately 15 kilometers south of Dawson City in the historic Klondike gold fields. This area is also in the unglaciated region of the Yukon. Elevations range from 150 meters to 350 meters, and topography is typified by gently rounded hills cut by flat-bottomed valleys. Locally the geology is dominated by quartz muscovite schist and augen-bearing quartz muscovite schist (Mortensen, 1992). The area is famous for its rich deposits of placer gold, and mining has been carried out since the late 1800's.

Three sample sites were located along Eldorado Creek. EC95-41 was located approximately 200 meters up Eldorado Creek from Grand Forks, while 42 and 43 were located a further one and two kilometers upstream respectively. A fourth sample site had been planned but due to recent placer mining no moss mats were found along the next six kilometers of Eldorado Creek north of Chief Gulch. The moss mats located on Eldorado Creek were between 10 and 15 centimeters thick and occurred sporadically. Material for traditional silt samples was common all along the part of the creek where moss mats were collected.

Pan Concentrate Data

All of the pan concentrate samples returned highly anomalous gold values ranging from 0.064 to 0.968 milligrams of gold against a background of <0.002 milligrams of gold. The moss mats effectively identified Eldorado Creek as a source of placer gold.

A larger primary sample than what was collected for this project is recommended to help reduce sample site variability. Further, ensuring that the primary samples contain as close as possible the same sediment mass is also important to avoid excessive sample site variability.

Moss Mat and Sediment Geochemistry

Highly anomalous gold values were returned for both the fine and coarse fractions of the moss mat samples. While sub-sample variation is low, sample site variation (the variation in results from two different samples collected within 5m of each other) is unusually high for both the coarse and fine fraction (Figure 3). Further work is required to address cause of the high sample site variability.

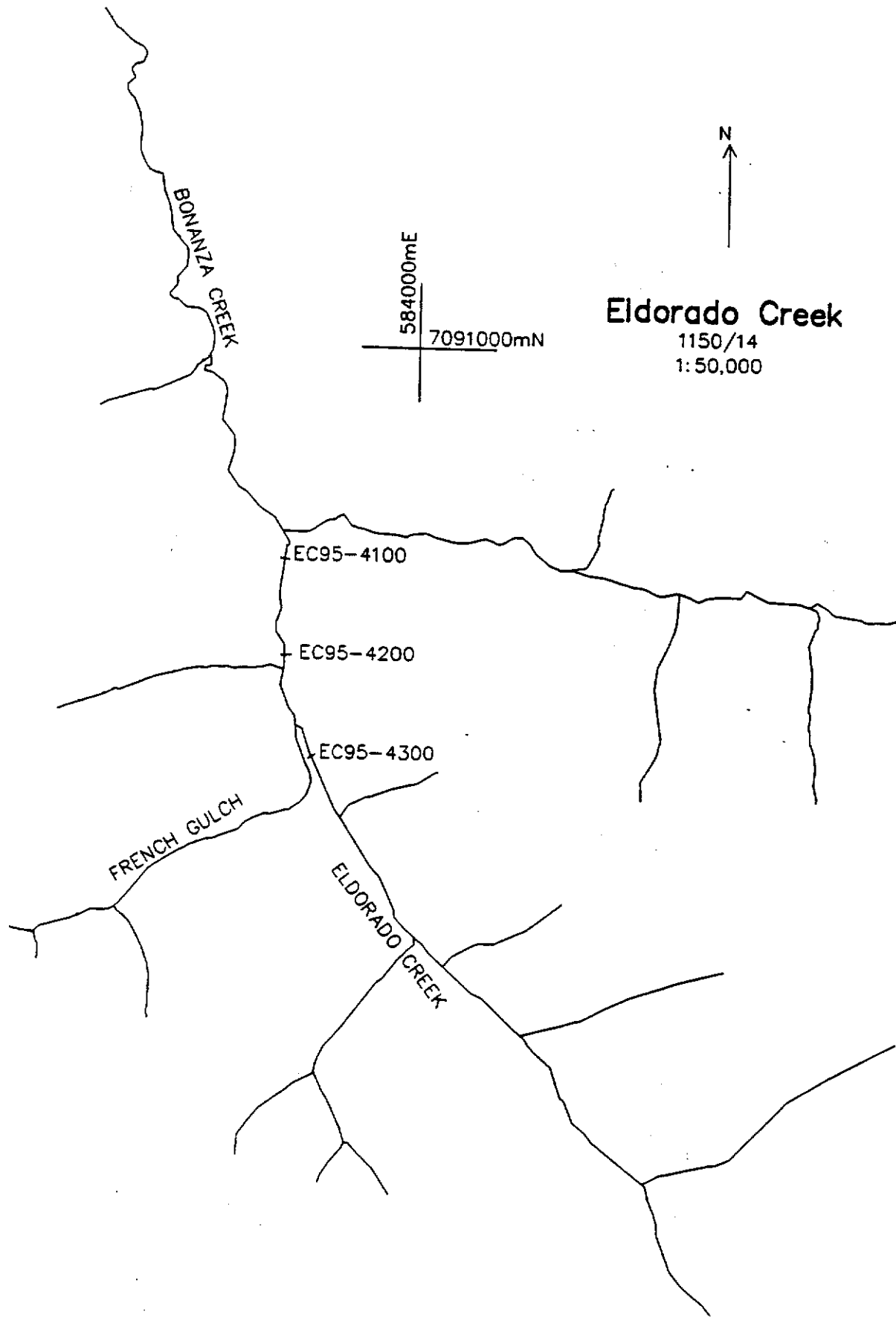


Figure 3

Gold and Mercury Values for Eldorado Creek

Sample Number	Au ppb FA+AA	Au ppb FA+AA	Hg ppb	Sample Number	Au ppb FA+AA	Au ppb FA+AA	Hg ppb
EC95-4101F	385	400	370	EC95-4101C	375	385	80
EC95 4102F	785	755	420	EC95-4102C	840	985	120
EC95-4105	<5	<5	10				
EC95-4201F	130	170	170	EC95-4201C	300	255	30
EC95 4202F	910	920	510	EC95-4202C	2560	2410	150
EC95-4205	<5	<5	10				
EC95-4301F	515	480	200	EC95-4301C	730	950	60
EC95 4302F	270	310	150	EC95-4302C	255	305	20
EC95-4305	10	<5	10				

*Series 01F, 02F are -53 micron moss mat samples. Series 01C, 02C are -180+53 micron moss mat samples. Series 05 are traditional -180 micron silt samples.

The traditional silt samples failed to return any anomalous gold values with only one analysis returning a value above the detection limit. A possible explanation for this is that the sediment which was collected for the traditional silt sample is continuously deposited along the stream during active placer mining. This sediment therefore has been put into the water column from the placer mining and has passed through the very low energy environment of the placer settling pond before entering the main stream and being deposited. The very light mineral fraction would therefore be expected to be highly over-represented in stream sediment along active placer streams. Since the moss mats receive their sediment load during flood events when active placer mining is not occurring the sediment contained in them is much more likely to reflect the true geochemistry of the stream.

Fletcher (1987) documented this effect with coarse gold in Harris Creek, a stream with no active placer mining. He showed that the spring freshet was able to move coarse gold (>100 microns). Therefore sediment samples collected following the spring freshet would contain gold. When Harris Creek resumed its usual flow the stream energy was too low to transport coarse gold, therefore the sediment deposited after the spring freshet contained very little coarse gold.

It is possible that a related occurrence is happening in Eldorado Creek. While fine fraction gold (< 50 microns) would normally be transported in the usual flow of the creek, the very low energy environment of the placer settling pond acts as a trap, removing the fine gold from the sediment load.

The high gold values in the fine fraction suggests a fine fraction source for this gold that may be different from the source of the placer gold (Knight et al., 1994).

Logtung

The Logtung molybdenum tungsten occurrence is located 65 kilometers east of Teslin. This area was glaciated in the last major ice age and evidence of much more recent valley glaciation is present at the headwaters of Logjam Creek. Elevation ranges from 900 meters to 1740 meters. Topography is characterized by steep mountains leveling into a broad valley to the south. The deposit is reported to contain 230 million tonnes grading 0.1 % WO_3 and 0.05% MoS_2 .

Four sample sites were located along southward-flowing Logjam Creek which drains the mineralization. Sample site LT95-11 was located approximately 400 meters below the exploration adit. Sample sites 12 and 13 were located one and two kilometers further downstream from sample site LT95-11 respectively. Sample site 14 was located on Logjam Creek approximately 100 meters upstream from the Alaska Highway, approximately 12 kilometers downstream from site 13.

Moss mats were found to be present along the entire length of Logjam Creek that was investigated for this project. In this drainage, moss mat sample sites are much more common and much easier to sample than traditional silt sample sites.

Pan Concentrate Data

Two pan concentrate samples were collected from each of the four sites. Values for the three sites closest to the mineralization ranged from 1.18% WO_3 to 0.19% WO_3 . Collection of a larger primary sample may help to reduce the variability between samples. Values from sample site 14, which was located approximately 15 kilometers from the mineralization, were only marginally above detection limit.

Moss Mat and Sediment Geochemistry

Anomalous gold values were returned for both fine and coarse fractions of the moss mat samples, while the traditional silt samples returned detection limit gold values.

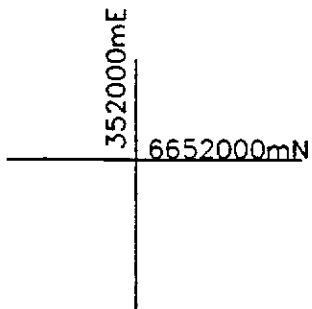
Erratic anomalous gold values in the moss mat coarse fraction indicate that there is some coarse gold associated with the Logtung deposit or its immediate surroundings (Figure 4). The data in Figure 4 is typical for samples containing rare coarse grains of gold.

Figure 4

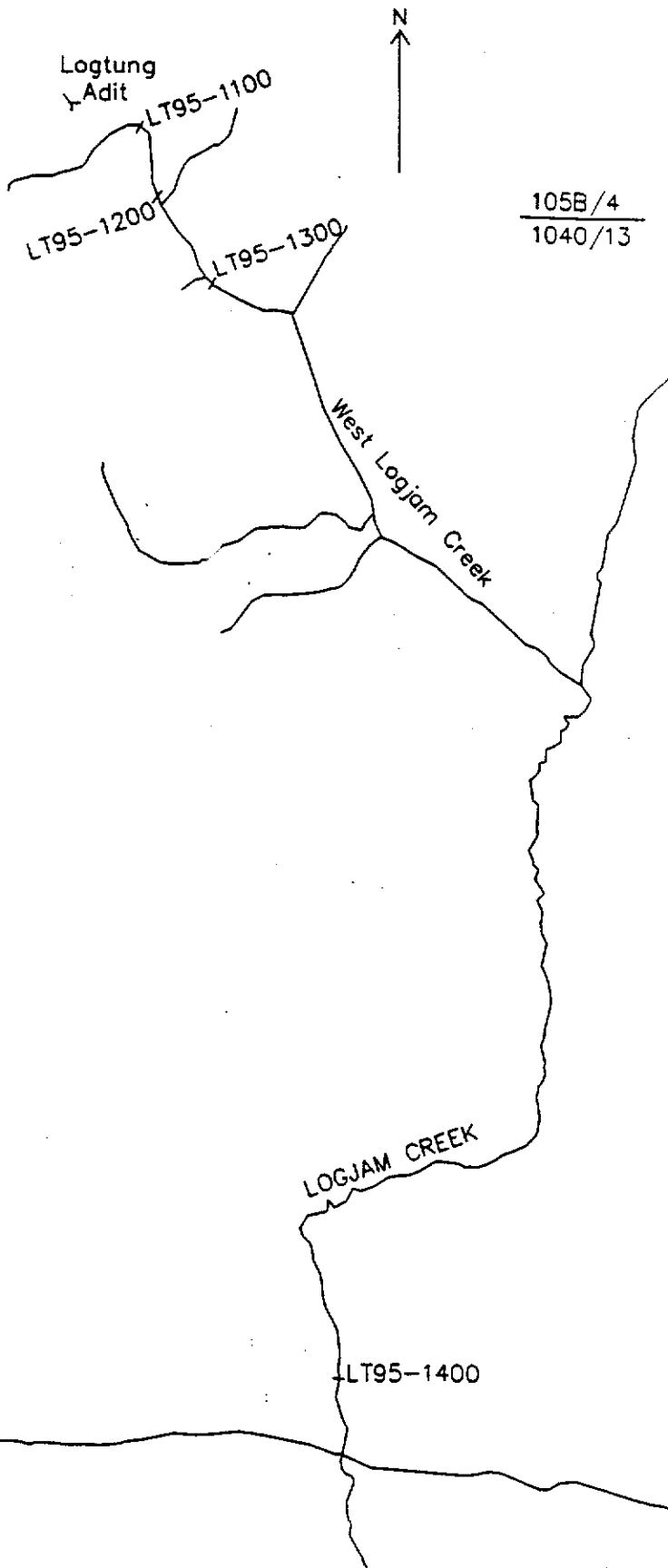
Gold in moss mat coarse fraction (-180+53 microns) at Logtung (ppb).

	1101C	1102C	1201C	1202C	1301C	1302C	1401C	1402C
Au in ppb	155	5	240	<5	<5	<5	<5	180
Au in ppb	20	>5	10	<5	5	<5	260	<5

Yukon Territory
British Columbia



Logtung
1:50,000



The results shown in Figure 5 indicate a weak reverse dispersion train. This may be expected from anomalies created by abraded gold which is formed by abrasion of coarse gold in the stream. This suggests that there is very little primary fine fraction (<50 micron) gold, and the fine fraction gold identified in the analysis has been created in the stream by the abrasion of the coarse gold that is present. The theory proposed is that the longer the coarse gold travels in the stream the more fine gold can be abraded off the coarse grains.

Figure 5

Gold in moss mat fine fraction (-53 microns) at Logtung (ppb).

	1101F	1102F	1201F	1202F	1301F	1302F	1401F	1402F
Au in ppb	10	15	15	15	45	20	5	20
Au in ppb	25	20	25	20	35	10	10	20

The ICP values for Logjam Creek show that beryllium, bismuth, molybdenum and tungsten are strongly anomalous in the first three sample sites, with only a weak molybdenum anomaly in the moss mat fine fraction at sample site 14 (Appendix 1C).

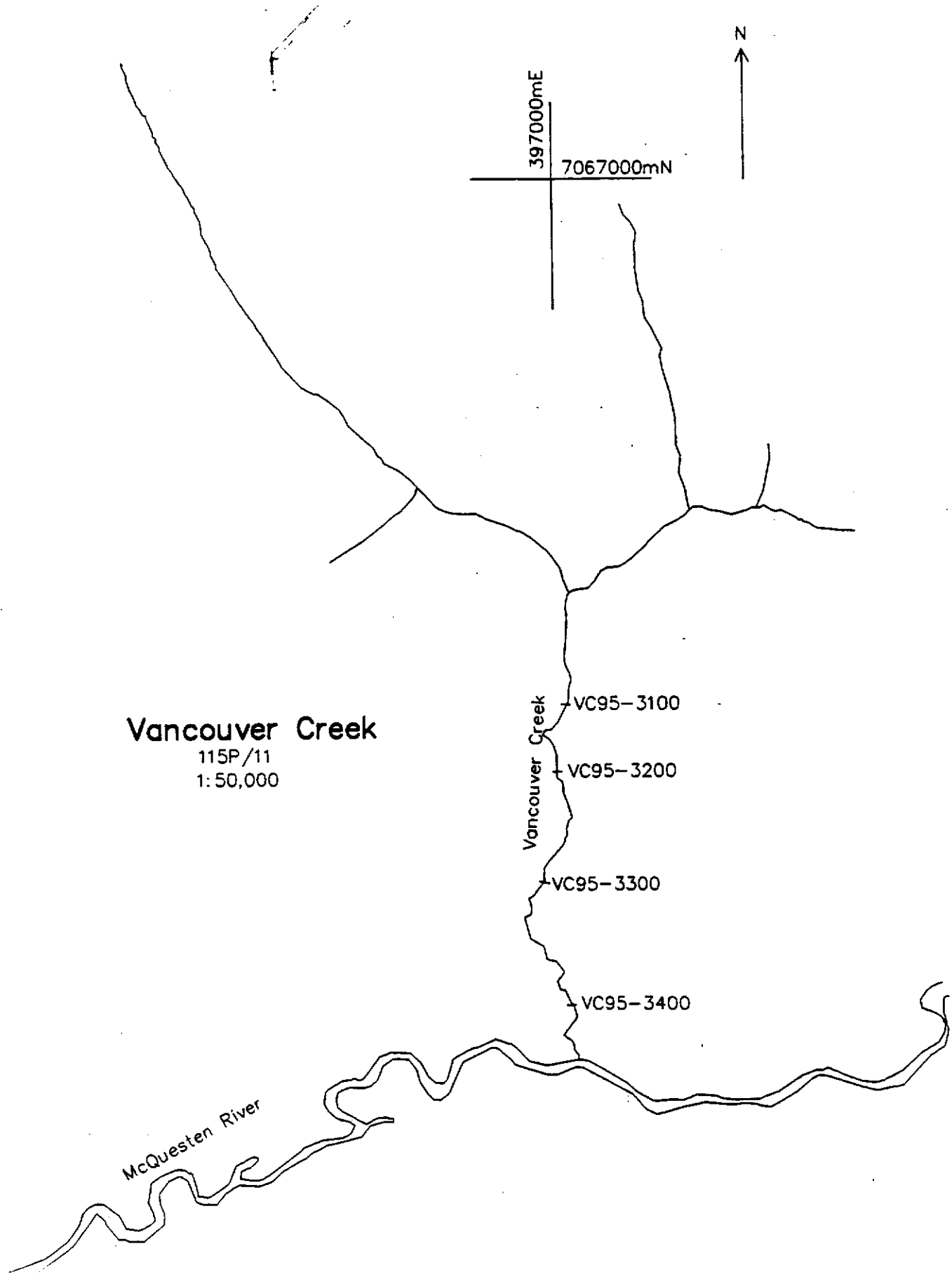
The moss mat coarse fraction returned the best anomaly definition in the anomalous elements. Fine fraction and traditional silts returned lower, but comparable, values.

Vancouver Creek

Vancouver Creek, located approximately 20 kilometers east of the Klondike Highway from McQuesten, has been the site of sporadic placer gold exploration and mining. The geology of the Vancouver Creek area is characterized by metamorphosed gritty sediments of the Hyland Group which are intruded by mid-Cretaceous granitic to quartz monzonitic igneous rocks. This area is unglaciated, with elevations ranging from 500 meters to 1350 meters. Topography is typified by rolling hills cut by flat-bottomed streams.

While some lower parts of Vancouver Creek have been recently placer mined, no active operations were present during sampling.

Four sample sites were located on Vancouver Creek. Sample site 34 was located approximately 600 meters up from the confluence with the McQuesten River, while 33, 32, and 31 were located 1.8 kilometers, 2.9 kilometers, and 3.7 kilometers respectively from the same site.



Vancouver Creek
115P/11
1:50,000

Vancouver Creek
VC95-3100
VC95-3200
VC95-3300
VC95-3400

McQuesten River

Pan Concentrate Data

Pan concentrate data from Vancouver Creek is very erratic. Samples 3203 and 3204, collected approximately 5 meters apart, returned 0.005 milligrams of gold and 0.366 milligrams of gold respectively. While it is very likely that a single random moss mat pan concentrate sample collected from this stretch of Vancouver Creek would return an anomalous value, it is also possible that a single sample may return a detection limit value.

Increasing the size of the primary sample from 2 kilograms to 5 kilograms should help reduce the sample site variability. Consideration of the dynamics of the stream in flood, to avoid low energy, back eddy-type environments, will also aid in selecting better sample sites.

Moss Mat and Sediment Geochemistry

Gold values returned for the moss mat fine fraction and coarse fraction, and for the traditional silt sample also returned erratic values (see appendix 1C).

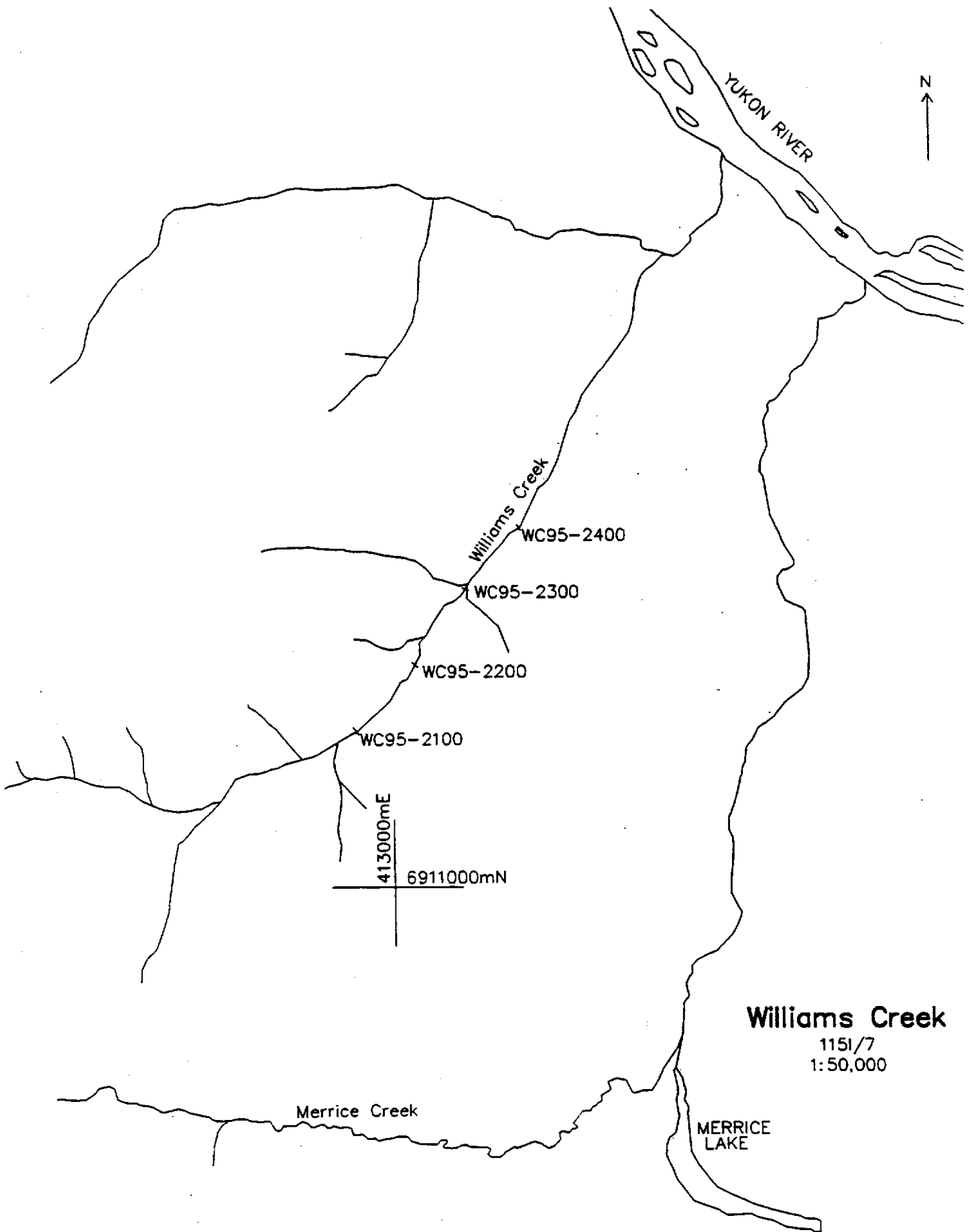
Williams Creek

Williams Creek drains the Carmacks Copper deposit located 40 kilometers northwest of Carmacks. The area is unglaciated and is typified by low rolling hills with flat-bottomed valleys. Elevations range from 600 meters to 1050 meters. Mineralization occurs within a foliated granodiorite and biotite-quartz gneiss. Movable oxide reserves for the Carmacks Copper deposit were reported as 14.2 million tonnes grading 1.01% copper and 0.51 grams per tonne gold (Yukon Exploration and Geology, 1994). Mineralization to date is identified in 13 zones which straddle the upper reaches of Williams Creek.

Four sample sites were located at approximately one kilometer intervals beginning with sample site WC95-2100 at the old exploration camp and continuing downstream.

Pan Concentrate Data

Pan concentrate data for Williams Creek returned below detection limit values for gold in all samples.



Moss Mat and Sediment Geochemistry

The sediment geochemistry from Williams Creek is not significantly above background levels. Under normal soil and sedimentation conditions it could be expected that Williams Creek sediments would report highly anomalous copper and gold concentrations. The assumed reason for the lack of anomalous sediment geochemistry is the presence of an extensive layer of White River volcanic ash in the Williams Creek drainage and the surrounding area. The depth of the White River ash deposits in the Williams Creek area are estimated to be 30 centimeters (Lerberkmo and Campbell, 1969). This forms a blanket over the residual soils and overburden resulting in the White River ash being highly over-represented in the stream sediment compared to the local residual soils.

Figure 6

	SiO ₂	Al ₂ O ₃	MgO	Na ₂ O	K ₂ O	CaO	Fe ₂ O ₃	TiO ₂	Rb	Sr
White River Ash	70.2	13.9	1.6	3.9	2.8	3.3	3.7	0.5	39ppm	624ppm
MM -53 micron	64.88	13.91	1.66	3.14	2.19	3.87	5.11	0.77	55ppm	487ppm
MM -108 +53	69.45	13.61	1.85	3.36	2.09	4.31	4.49	0.73	45ppm	535ppm

*Values for White River ash are an average of 27 samples collected across the ash deposit along the Klondike Highway (Lerberkmo and Campbell, 1969). MM samples are averages of sediment collected from moss mats at four sites at 1 kilometer intervals along Williams Creek.

Figure 6 compares the geochemistry of White River ash (Lerberkmo and Campbell, 1969) to the geochemistry of the sediment samples collected from Williams Creek. The similarity between the whole rock values for White River ash and for Williams Creek sediment suggests that the majority of the sediment sampled from Williams Creek is derived from White River ash deposits and not from local bedrock sources. This highlights the need to understand local surficial geology when designing and interpreting regional and property scale geochemistry programs.

DISCUSSION AND CONCLUSIONS

Moss mats are a fast, easy, and very common medium for primary sample collection. Only in areas of recent placer mining at Eldorado Creek and Vancouver Creek were moss mats not found for this study. The consistent sediment composition and high percentage of fine fraction material should make moss mats a preferred sample medium for fine fraction and traditional silt geochemistry. However, moss mats require slightly more time for wet sieving than standard sediment as the organic material can be slow to clean from the screens.

Sample sites should be selected to ensure that the only source of sediment onto the moss mat is from the active drainage. Seasonal side bank runoff events could be a serious source of contamination. Moss mats are also likely to be sensitive to dust contamination, as any dust that falls on the moss mat during its growing period is likely to be incorporated into the moss mat. Due to the small volume dust would normally represent this would not be expected to be a serious problem. Caution would have to be exercised however, in areas where dust from dry reverse circulation drilling on known mineralization may contaminate moss mats.

The difficulty in separating sediment from the moss mat may restrict the use of moss mats for placer exploration. However, this may be compensated by the speed with which the moss mat samples can be collected. For placer exploration purposes, a 5 kilogram moss mat sample should be collected. The sample can then be sieved at a central processing site to -2000 microns to remove organics and oversize, followed by the removal of fines before pan concentrating the sample. Using this technique, large remote areas could be evaluated for placer gold potential in a fast and cost-effective manner. The 2 kilogram samples collected for this project were effective in identifying streams with placer gold potential and in returning significant tungsten anomalies from Logjam Creek. The larger sample size recommended for future work and study should reduce sample site variability.

Using moss mats as a source for stream sediment appears to have introduced higher sample site variability into fine fraction sediment gold results. The higher sample site variability is most pronounced in Eldorado Creek and in Vancouver Creek and may partly result from a high proportion of the gold in those drainages occurring at around the 50 micron grain size, thereby introducing nugget effect into the data. This possible explanation is not supported by the low subsample variability seen in the same samples.

The results from Eldorado Creek and Williams Creek emphasize the need to understand the possible variables affecting the results. In Eldorado Creek traditional -180 micron (-80 mesh) sediment sampling returned no anomalous values while sediment sampling using moss mats as a source for stream sediment returned highly anomalous values. At Williams Creek, stream sediments that were expected to be anomalous returned near background concentrations. Variables like placer activity and surficial geology can dramatically affect geochemical results and should be factored into the design of a sampling program so that the most appropriate techniques are employed and those variables are considered during interpretation.

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APPENDICES

Gold and Multi-Element Data

Appendix 1A

CERTIFICATE COMMENTS : Brewery Creek												
SAMPLE DESCRIPTION	Au ppb FA+AA	Au ppb FA+AA	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm
BC95-5101F	175	175	0.4	1.55	406	1070	0.5	<2	0.63	3	9	90
BC95 5102F	75	80	0.4	1.31	136	870	0.5	2	0.68	3.5	9	57
BC95-5101C	90	90	0.2	1.09	252	1050	0.5	<2	0.74	3.5	9	26
BC95-5102C	35	35	0.2	0.82	94	680	0.5	<2	0.58	3	8	20
BC95-5105	185	190	0.2	1.31	586	1210	0.5	<2	0.45	1.5	7	29
BC95-5201F	70	100	0.4	1.46	132	1110	0.5	<2	0.66	2	9	146
BC95 5202F	75	70	0.4	1.23	108	980	<0.5	<2	0.64	2	10	53
BC95-5201C	20	15	0.2	0.86	46	1520	<0.5	<2	0.45	1	7	21
BC95-5202C	10	<5	<0.2	1.00	26	330	0.5	<2	0.57	0.5	9	30
BC95-5205	35	30	0.2	1.15	116	1050	<0.5	<2	0.49	1	7	23
BC95-5301F	20	15	<0.2	1.36	40	530	0.5	<2	0.67	1	9	73
BC95 5302F	30	25	0.2	1.32	48	490	0.5	<2	0.67	1	11	48
BC95-5301C	10	105	<0.2	1.22	30	500	0.5	<2	0.58	0.5	9	33
BC95-5302C	5	15	<0.2	0.91	30	420	<0.5	<2	0.58	0.5	7	24
BC95-5305	5	<5	<0.2	1.44	46	610	0.5	<2	0.61	0.5	9	35
BC95-5401F	15	30	<0.2	2.08	52	800	0.5	<2	0.77	0.5	10	114
BC95 5402F	40	35	0.2	1.41	46	580	0.5	<2	0.70	0.5	10	49
BC95-5401C	15	<5	<0.2	1.23	32	1070	0.5	<2	0.61	0.5	8	29
BC95-5402C	5	<5	0.2	0.64	42	500	<0.5	<2	0.45	1	7	16
BC95-5405	<5	<5	<0.2	1.93	24	730	0.5	<2	0.56	<0.5	8	35

Appendix 1A

CERTIFICATE COMMENTS : Brewery Creek												
SAMPLE DESCRIPTION	Cu ppm	Fe %	Ga ppm	Hg ppb	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm
BC95-5101F	33	2.87	<10	940	0.17	10	0.45	425	4	0.02	54	880
BC95 5102F	31	2.46	<10	680	0.11	10	0.42	340	4	0.01	59	870
BC95-5101C	35	2.37	<10	570	0.12	10	0.35	410	3	0.01	47	880
BC95-5102C	27	1.89	<10	400	0.09	10	0.29	265	3	<0.01	44	800
BC95-5105	26	2.66	<10	1060	0.11	20	0.34	495	3	0.01	30	910
BC95-5201F	32	2.68	<10	630	0.20	10	0.42	395	3	0.02	61	910
BC95 5202F	29	2.50	<10	640	0.11	10	0.41	375	3	0.01	45	960
BC95-5201C	28	1.97	<10	380	0.12	10	0.27	225	2	0.01	31	820
BC95-5202C	19	1.93	<10	80	0.07	10	0.50	245	<1	0.01	29	910
BC95-5205	24	2.10	<10	480	0.13	10	0.33	280	3	0.01	29	820
BC95-5301F	23	2.31	<10	180	0.12	10	0.49	405	1	0.01	40	950
BC95 5302F	26	2.27	<10	200	0.09	10	0.51	370	2	0.01	38	930
BC95-5301C	22	2.15	<10	80	0.12	10	0.55	260	1	0.01	29	930
BC95-5302C	19	1.91	<10	100	0.07	10	0.41	250	1	0.01	26	820
BC95-5305	20	2.49	<10	110	0.17	20	0.57	325	1	0.01	30	1070
BC95-5401F	31	2.94	<10	190	0.23	20	0.63	535	2	0.03	42	890
BC95 5402F	26	2.52	<10	160	0.09	10	0.53	400	2	0.01	38	910
BC95-5401C	21	2.12	<10	110	0.12	10	0.48	380	1	0.01	27	890
BC95-5402C	24	1.81	<10	310	0.07	<10	0.25	200	2	<0.01	30	800
BC95-5405	30	2.72	<10	90	0.10	10	0.62	310	<1	0.01	26	550

Appendix 1A

CERTIFICATE COMMENTS: Brewery Creek										
SAMPLE DESCRIPTION	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
BC95-5101F	22	290	6	102	0.02	<10	<10	81	<10	330
BC95 5102F	24	76	4	91	0.02	<10	<10	62	<10	380
BC95-5101C	20	200	4	117	0.02	<10	<10	64	<10	326
BC95-5102C	18	60	3	66	0.01	<10	<10	45	<10	306
BC95-5105	18	468	6	97	0.04	<10	<10	91	<10	176
BC95-5201F	18	78	5	95	0.03	<10	<10	77	<10	264
BC95 5202F	18	64	4	82	0.04	<10	<10	69	<10	280
BC95-5201C	16	36	3	91	0.01	<10	<10	56	<10	208
BC95-5202C	8	<2	2	53	0.03	<10	<10	46	<10	146
BC95-5205	14	82	4	73	0.03	<10	<10	69	<10	178
BC95-5301F	12	8	4	73	0.06	<10	<10	63	<10	180
BC95 5302F	14	14	3	69	0.04	<10	<10	59	<10	202
BC95-5301C	8	<2	3	68	0.06	<10	<10	57	<10	156
BC95-5302C	8	4	2	52	0.02	<10	<10	47	<10	144
BC95-5305	10	6	3	73	0.07	<10	<10	70	<10	138
BC95-5401F	14	10	6	88	0.08	<10	<10	84	<10	190
BC95 5402F	14	8	4	71	0.04	<10	<10	61	<10	194
BC95-5401C	8	10	3	70	0.05	<10	<10	63	<10	148
BC95-5402C	16	24	2	52	<0.01	<10	<10	39	<10	206
BC95-5405	10	<2	5	54	0.07	<10	<10	65	<10	92

Appendix 1B

CERTIFICATE COMMENTS : Eldorado Creek												
SAMPLE DESCRIPTION	Au ppb FA+AA	Au ppb FA+AA	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm
EC95-4101F	385	400	0.2	1.71	26	690	<0.5	<2	0.75	0.5	10	100
EC95-4102F	785	755	<0.2	1.10	20	510	<0.5	<2	0.60	<0.5	9	60
EC95-4101C	375	385	<0.2	0.76	14	300	<0.5	<2	0.43	<0.5	6	18
EC95-4102C	840	985	0.8	0.66	12	270	<0.5	<2	0.44	<0.5	7	18
EC95-4105	<5	<5	<0.2	0.86	6	250	<0.5	<2	0.46	<0.5	4	20
EC95-4201F	130	170	<0.2	1.47	22	590	<0.5	2	0.61	0.5	9	100
EC95-4202F	910	920	0.6	1.33	18	590	<0.5	<2	0.65	<0.5	10	54
EC95-4201C	300	255	<0.2	0.79	14	330	<0.5	<2	0.43	<0.5	6	18
EC95-4202C	2560	2410	2.4	0.73	16	340	<0.5	<2	0.38	<0.5	7	18
EC95-4205	<5	<5	<0.2	0.79	8	370	<0.5	<2	0.53	<0.5	4	21
EC95-4301F	515	480	0.2	1.39	20	690	<0.5	<2	0.62	<0.5	8	76
EC95-4302F	270	310	0.2	1.25	20	480	<0.5	2	0.62	<0.5	9	70
EC95-4301C	730	950	<0.2	0.76	22	300	<0.5	<2	0.50	<0.5	8	17
EC95-4302C	255	305	<0.2	0.68	14	280	<0.5	<2	0.37	<0.5	7	15
EC95-4305	10	<5	<0.2	1.48	18	280	<0.5	2	0.53	<0.5	7	31

Appendix 1B

CERTIFICATE COMMENTS : Eldorado Creek												
SAMPLE DESCRIPTION	Cu ppm	Fe %	Ga ppm	Hg ppb	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm
EC95-4101F	27	3.02	<10	370	0.22	30	0.89	455	1	0.02	32	930
EC95 4102F	18	2.30	<10	420	0.08	20	0.61	300	1	0.01	29	1070
EC95-4101C	13	1.66	<10	80	0.07	10	0.53	220	<1	<0.01	11	1060
EC95-4102C	12	1.68	<10	120	0.06	10	0.42	185	<1	<0.01	11	1180
EC95-4105	9	1.44	<10	10	0.06	10	0.46	210	<1	0.01	10	820
EC95-4201F	22	2.61	<10	170	0.21	20	0.77	450	1	0.02	28	930
EC95 4202F	20	2.63	<10	510	0.10	30	0.71	375	1	0.01	27	1020
EC95-4201C	24	1.65	<10	30	0.08	10	0.51	270	<1	<0.01	11	1070
EC95-4202C	11	1.71	<10	150	0.07	10	0.49	225	<1	<0.01	11	980
EC95-4205	8	1.46	<10	10	0.06	10	0.43	220	<1	<0.01	9	1160
EC95-4301F	19	2.61	<10	200	0.18	30	0.75	350	1	0.02	25	930
EC95 4302F	19	2.37	<10	150	0.09	20	0.68	390	1	0.01	34	1040
EC95-4301C	29	1.89	<10	60	0.07	10	0.51	235	<1	<0.01	11	1330
EC95-4302C	12	1.46	<10	20	0.06	10	0.47	230	<1	<0.01	9	1010
EC95-4305	15	2.49	<10	10	0.10	20	0.96	370	<1	0.01	14	850

Appendix 1B

CERTIFICATE COMMENTS: Eldorado Creek										
SAMPLE DESCRIPTION	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
EC95-4101F	22	<2	6	73	0.08	<10	<10	57	<10	154
EC95 4102F	18	<2	3	48	0.06	<10	<10	46	<10	120
EC95-4101C	10	<2	2	33	0.03	<10	<10	24	<10	70
EC95-4102C	10	<2	2	28	0.03	<10	<10	25	<10	60
EC95-4105	6	<2	2	33	0.05	<10	<10	30	<10	46
EC95-4201F	20	<2	4	57	0.06	<10	<10	47	<10	130
EC95 4202F	20	<2	4	57	0.08	<10	<10	52	<10	110
EC95-4201C	10	<2	2	32	0.03	<10	<10	24	<10	62
EC95-4202C	14	<2	2	27	0.03	<10	<10	24	<10	62
EC95-4205	8	<2	2	36	0.05	<10	<10	30	<10	44
EC95-4301F	18	<2	4	62	0.07	<10	<10	48	<10	100
EC95 4302F	16	<2	4	52	0.06	<10	<10	45	<10	112
EC95-4301C	12	<2	2	142	0.03	<10	<10	26	<10	58
EC95-4302C	10	<2	2	25	0.02	<10	<10	20	<10	58
EC95-4305	8	<2	4	42	0.04	<10	<10	39	<10	76

Appendix 1C

Certificate Comments: LogTung												
SAMPLE DESCRIPTION	Au ppb FA+AA	Au ppb FA+AA	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm
LT95-1101F	10	25	0.2	2.35	44	140	8.5	8	0.90	1	9	186
LT95 1102F	15	20	0.2	2.08	38	120	7.5	8	0.78	1	9	101
LT95-1101C	155	20	0.2	1.77	52	90	8	8	0.70	1	9	59
LT95-1102C	5	<5	0.2	1.71	48	90	7.5	12	0.74	1	10	61
LT95-1105	<5	<5	<0.2	1.34	52	70	2.5	4	0.60	1	8	39
LT95-1201F	15	25	0.2	2.40	68	170	6	8	0.84	1.5	13	192
LT95 1202F	15	20	0.2	1.93	58	130	4	8	0.67	0.5	12	117
LT95-1201C	240	10	<0.2	1.49	68	90	4	18	0.56	0.5	9	54
LT95-1202C	<5	<5	<0.2	1.44	60	90	3	6	0.60	0.5	10	58
LT95-1205	<5	<5	0.2	1.64	72	110	7	14	0.57	1.5	10	53
LT95-1301F	45	35	<0.2	2.24	46	200	4.5	6	0.82	0.5	11	176
LT95 1302F	20	10	<0.2	1.85	46	160	3.5	4	0.66	0.5	10	107
LT95-1301C	<5	5	<0.2	1.25	40	100	3.5	2	0.50	0.5	8	42
LT95-1302C	<5	<5	0.2	1.30	46	100	3	6	0.56	0.5	8	45
LT95-1305	<5	<5	<0.2	1.64	48	140	5	4	0.68	0.5	10	48
LT95-1401F	5	10	<0.2	1.70	26	220	1	2	0.98	0.5	11	235
LT95 1402F	20	20	<0.2	1.41	18	160	0.5	<2	0.78	0.5	11	118
LT95-1401C	<5	260	<0.2	0.68	6	80	<0.5	<2	0.41	<0.5	6	30
LT95-1402C	180	<5	<0.2	0.74	8	80	<0.5	<2	0.43	<0.5	7	35
LT95-1405	<5	<5	<0.2	0.96	12	120	0.5	<2	0.61	<0.5	8	33

Appendix 1C

Certificate Comments: LogTung												
SAMPLE DESCRIPTI	Cu ppm	Fe %	Ga ppm	Hg ppb	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm
LT95-1101F	56	2.82	<10	30	0.20	10	0.84	595	41	0.04	53	1080
LT95 1102F	57	2.66	<10	40	0.15	10	0.83	520	48	0.01	48	1140
LT95-1101C	50	2.55	<10	30	0.10	<10	0.68	535	51	0.01	33	870
LT95-1102C	50	2.49	<10	30	0.11	10	0.69	495	53	0.01	34	840
LT95-1105	34	2.35	<10	20	0.10	10	0.59	480	26	0.01	23	650
LT95-1201F	69	3.08	<10	30	0.25	10	0.87	740	24	0.03	67	1160
LT95 1202F	51	2.79	<10	30	0.16	10	0.79	500	27	0.01	56	1150
LT95-1201C	43	2.63	<10	20	0.13	10	0.67	405	24	0.01	32	750
LT95-1202C	41	2.67	<10	20	0.12	10	0.66	385	29	0.01	33	
LT95-1205	49	2.75	<10	10	0.15	10	0.67	500	24	0.01	34	920
LT95-1301F	45	2.92	<10	30	0.23	10	0.80	630	14	0.03	58	1030
LT95 1302F	39	2.58	<10	60	0.13	10	0.72	510	19	0.01	52	1050
LT95-1301C	30	2.10	<10	20	0.09	<10	0.56	360	14	<0.01	25	650
LT95-1302C	31	2.29	<10	30	0.1	10	0.61	365	16	0.01	26	710
LT95-1305	33	2.70	<10	40	0.12	10	0.61	565	14	0.01	28	920
LT95-1401F	33	2.92	<10	80	0.24	20	0.69	910	3	0.04	62	1050
LT95 1402F	28	2.56	<10	50	0.12	10	0.66	675	3	0.01	60	1070
LT95-1401C	12	1.91	<10	10	0.05	10	0.48	305	<1	<0.01	23	550
LT95-1402C	12	1.94	<10	20	0.06	10	0.51	280	1	<0.01	23	530
LT95-1405	17	2.13	<10	20	0.08	10	0.55	630	1	<0.01	24	700

Appendix 1C

Certificate Comments: LogTung										
SAMPLE	Pb	Sb	Sc	Sr	Ti	Tl	U	V	W	Zn
DESCRIPTI	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LT95-1101F	20	<2	5	68	0.15	<10	<10	81	70	250
LT95 1102F	18	<2	4	56	0.13	<10	<10	75	70	236
LT95-1101C	22	<2	3	55	0.09	<10	10	62	170	226
LT95-1102C	18	<2	4	51	0.11	<10	<10	63	140	206
LT95-1105	24	<2	2	37	0.11	<10	<10	62	70	94
LT95-1201F	20	<2	6	67	0.16	<10	<10	81	70	268
LT95 1202F	22	<2	4	48	0.13	<10	<10	72	90	240
LT95-1201C	18	<2	3	40	0.11	<10	<10	62	220	132
LT95-1202C	20	<2	3	34	0.11	<10	<10	65	330	128
LT95-1205	18	<2	3	34	0.1	<10	<10	64	280	130
LT95-1301F	14	<2	6	62	0.15	<10	<10	72	30	204
LT95 1302F	14	<2	4	47	0.12	<10	<10	63	40	180
LT95-1301C	10	<2	2	40	0.08	<10	<10	49	80	130
LT95-1302C	14	<2	3	38	0.1	<10	<10	53	120	120
LT95-1305	12	<2	3	42	0.1	<10	10	61	60	94
LT95-1401F	10	<2	5	80	0.13	<10	<10	61	<10	164
LT95 1402F	12	<2	4	61	0.11	<10	<10	53	<10	232
LT95-1401C	4	<2	1	29	0.06	<10	<10	40	10	62
LT95-1402C	4	<2	1	26	0.08	<10	<10	44	<10	68
LT95-1405	4	<2	2	38	0.08	<10	<10	44	<10	56

Appendix 1D

CERTIFICATE COMMENTS : Vancouver Creek												
SAMPLE DESCRIPTION	Au ppb FA+AA	Au ppb FA+AA	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm
VC95-3101F	<5	20	<0.2	2.10	24	290	0.5	<2	0.58	0.5	12	264
VC95 3102F	20	<5	<0.2	1.66	22	220	<0.5	<2	0.54	1	13	71
VC95-3101C	<5	<5	<0.2	0.88	18	100	<0.5	<2	0.25	<0.5	8	18
VC95-3102C	5	45	<0.2	0.72	12	80	<0.5	<2	0.23	<0.5	7	18
VC95-3105	<5	<5	<0.2	0.98	18	120	<0.5	<2	0.28	<0.5	8	15
VC95-3201F	35	30	<0.2	2.07	22	290	0.5	<2	0.59	0.5	13	247
VC95 3202F	15	10	<0.2	1.55	22	210	<0.5	2	0.52	1	13	66
VC95-3201C	<5	<5	<0.2	0.83	14	90	<0.5	<2	0.24	<0.5	7	21
VC95-3202C	<5	<5	<0.2	0.75	16	80	<0.5	<2	0.25	0.5	8	17
VC95-3205	<5	<5	<0.2	0.89	18	90	<0.5	<2	0.21	<0.5	8	17
VC95-3301F	<5	<5	<0.2	2.10	18	320	0.5	<2	0.51	0.5	12	238
VC95 3302F	90	100	<0.2	1.58	26	210	<0.5	<2	0.59	0.5	13	70
VC95-3301C	<5	<5	<0.2	0.74	14	70	<0.5	<2	0.18	<0.5	5	16
VC95-3302C	370	160	<0.2	0.84	14	90	<0.5	<2	0.26	<0.5	7	22
VC95-3305	<5	<5	<0.2	0.96	18	110	<0.5	<2	0.25	<0.5	8	15
VC95-3401F	35	10	<0.2	2.01	24	220	0.5	2	0.35	<0.5	15	221
VC95 3402F	45	40	<0.2	1.14	18	150	<0.5	<2	0.42	<0.5	10	34
VC95-3401C	<5	<5	<0.2	0.81	14	70	<0.5	<2	0.15	<0.5	6	15
VC95-3402C	<5	75	<0.2	0.73	6	80	<0.5	<2	0.22	<0.5	6	18
VC95-3405	25	30	<0.2	0.71	14	80	<0.5	<2	0.25	<0.5	7	13

Appendix 1D

CERTIFICATE COMMENTS : Vancouver Creek												
SAMPLE DESCRIPTION	Cu ppm	Fe %	Ga ppm	Hg ppb	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm
VC95-3101F	23	2.95	<10	60	0.31	30	0.51	700	1	0.04	52	670
VC95 3102F	24	2.74	<10	70	0.08	20	0.51	405	1	0.01	42	780
VC95-3101C	26	1.89	<10	10	0.05	10	0.31	360	<1	<0.01	19	380
VC95-3102C	13	1.71	<10	10	0.03	10	0.28	185	<1	<0.01	17	430
VC95-3105	16	2.26	<10	20	0.05	10	0.33	250	<1	<0.01	17	490
VC95-3201F	24	2.99	<10	60	0.27	30	0.53	780	1	0.04	59	700
VC95 3202F	22	2.68	<10	60	0.08	20	0.48	675	1	0.01	40	760
VC95-3201C	20	1.97	<10	10	0.04	20	0.30	315	<1	<0.01	19	440
VC95-3202C	14	1.87	<10	20	0.03	10	0.29	275	<1	<0.01	18	460
VC95-3205	15	2.20	<10	10	0.05	20	0.33	395	<1	<0.01	20	450
VC95-3301F	21	2.87	<10	50	0.28	30	0.52	590	1	0.04	39	650
VC95 3302F	23	2.79	<10	60	0.08	20	0.49	450	1	0.01	43	800
VC95-3301C	11	1.63	<10	<10	0.03	10	0.26	190	<1	<0.01	15	320
VC95-3302C	13	1.85	<10	10	0.04	10	0.31	215	<1	<0.01	20	480
VC95-3305	16	2.22	<10	20	0.04	20	0.35	375	<1	<0.01	19	490
VC95-3401F	25	3.41	<10	20	0.28	30	0.60	635	1	0.04	51	540
VC95 3402F	23	2.28	<10	20	0.04	<10	0.44	260	<1	<0.01	27	790
VC95-3401C	14	1.84	<10	10	0.04	10	0.31	210	<1	<0.01	16	280
VC95-3402C	11	1.55	<10	10	0.03	10	0.28	145	<1	<0.01	16	440
VC95-3405	12	1.94	<10	10	0.03	20	0.26	245	<1	<0.01	15	650

Appendix 1D

CERTIFICATE COMMENTS : Vancouver Creek										
SAMPLE DESCRIPTION	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
VC95-3101F	20	<2	3	65	0.04	<10	<10	41	<10	190
VC95 3102F	20	<2	2	54	0.03	<10	<10	33	<10	206
VC95-3101C	10	<2	1	28	0.02	<10	<10	18	<10	88
VC95-3102C	8	<2	1	19	0.01	<10	<10	15	<10	86
VC95-3105	14	<2	1	26	0.02	<10	<10	21	<10	78
VC95-3201F	20	<2	3	67	0.05	<10	<10	41	<10	248
VC95 3202F	20	<2	2	54	0.03	<10	<10	31	<10	208
VC95-3201C	10	<2	1	24	0.03	<10	<10	20	10	78
VC95-3202C	12	<2	1	22	0.01	<10	<10	16	<10	98
VC95-3205	12	<2	1	21	0.02	<10	<10	17	<10	78
VC95-3301F	20	<2	3	62	0.05	<10	<10	42	<10	168
VC95 3302F	20	<2	2	58	0.03	<10	<10	31	<10	198
VC95-3301C	8	<2	1	21	0.02	<10	<10	17	<10	62
VC95-3302C	10	<2	1	22	0.02	<10	<10	18	10	96
VC95-3305	12	<2	1	23	0.02	<10	<10	18	<10	74
VC95-3401F	22	<2	3	42	0.03	<10	<10	33	<10	154
VC95 3402F	18	<2	1	38	<0.01	<10	<10	18	<10	148
VC95-3401C	6	<2	1	15	0.02	<10	<10	16	<10	68
VC95-3402C	8	<2	1	18	0.02	<10	<10	17	<10	72
VC95-3405	10	<2	1	19	0.04	<10	<10	19	<10	58

Appendix 1E

CERTIFICATE COMMENTS: Williams Creek												
SAMPLE DESCRIPTION	Au ppb FA+AA	Au ppb FA+AA	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm
WC95-2101F	<5	<5	<0.2	1.58	6	200	<0.5	<2	1.27	<0.5	8	129
WC95 2102F	<5	<5	0.2	1.43	4	270	<0.5	<2	1.34	<0.5	10	86
WC95-2101C	<5	<5	<0.2	0.53	<2	70	<0.5	<2	0.52	<0.5	3	17
WC95-2102C	<5	<5	<0.2	0.69	<2	90	<0.5	<2	0.66	<0.5	4	23
WC95-2105	<5	<5	<0.2	0.84	2	140	<0.5	<2	0.89	<0.5	6	22
WC95-2201F	15	<5	<0.2	1.35	4	200	<0.5	<2	1.23	<0.5	6	117
WC95 2202F	<5	<5	<0.2	1.26	4	170	<0.5	2	1.16	<0.5	6	59
WC95-2201C	<5	<5	<0.2	0.57	2	80	<0.5	<2	0.59	<0.5	3	18
WC95-2202C	<5	<5	<0.2	0.74	<2	80	<0.5	<2	0.75	<0.5	5	25
WC95-2205	<5	<5	<0.2	1.04	<2	170	<0.5	<2	1.09	<0.5	5	21
WC95-2301F	<5	<5	<0.2	1.30	2	180	<0.5	<2	1.03	<0.5	6	117
WC95 2302F	<5	<5	<0.2	1.20	4	180	<0.5	<2	1.04	<0.5	6	59
WC95-2301C	<5	<5	<0.2	0.62	<2	80	<0.5	<2	0.50	<0.5	3	16
WC95-2302C	<5	<5	<0.2	0.76	<2	90	<0.5	<2	0.51	<0.5	4	17
WC95-2305	<5	<5	<0.2	0.89	<2	120	<0.5	<2	0.78	<0.5	4	18
WC95-2401F	<5	<5	<0.2	1.49	6	250	<0.5	<2	1.29	<0.5	7	105
WC95 2402F	<5	<5	<0.2	1.32	10	210	<0.5	<2	1.20	<0.5	7	51
WC95-2401C	<5	<5	<0.2	0.85	4	140	<0.5	<2	0.79	<0.5	6	21
WC95-2402C	<5	<5	<0.2	1.00	2	130	<0.5	<2	0.82	<0.5	6	23
WC95-2405	<5	<5	<0.2	1.14	8	330	<0.5	<2	1.29	<0.5	7	22

Appendix 1E

CERTIFICATE COMMENTS: Williams Creek												
SAMPLE DESCRIPTION	Cu ppm	Fe %	Ga ppm	Hg ppb	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm
WC95-2101F	41	2.54	<10	40	0.14	10	0.61	440	1	0.08	36	970
WC95 2102F	22	3.10	<10	40	0.10	<10	0.61	1925	2	0.04	41	1130
WC95-2101C	5	1.40	<10	20	0.03	<10	0.25	145	<1	0.01	8	720
WC95-2102C	4	2.17	<10	10	0.05	10	0.29	250	<1	0.02	9	970
WC95-2105	10	2.46	<10	20	0.06	10	0.37	660	<1	0.02	10	1130
WC95-2201F	45	2.27	<10	40	0.11	10	0.53	605	1	0.09	27	1090
WC95 2202F	18	2.26	<10	30	0.09	10	0.52	545	1	0.04	24	1210
WC95-2201C	6	1.31	<10	10	0.03	<10	0.27	190	<1	0.01	8	980
WC95-2202C	5	1.93	<10	10	0.05	10	0.30	215	<1	0.02	8	1260
WC95-2205	14	2.05	<10	30	0.08	<10	0.44	575	1	0.03	11	910
WC95-2301F	23	2.07	<10	30	0.12	10	0.49	330	1	0.09	29	970
WC95 2302F	20	2.09	<10	30	0.09	<10	0.50	350	2	0.05	27	970
WC95-2301C	6	1.19	<10	10	0.04	<10	0.29	140	<1	0.01	8	760
WC95-2302C	6	1.17	<10	10	0.06	<10	0.33	180	<1	0.02	9	680
WC95-2305	7	1.95	<10	20	0.07	10	0.36	325	<1	0.03	9	940
WC95-2401F	20	2.63	<10	30	0.14	10	0.54	1340	1	0.11	25	970
WC95 2402F	20	2.44	<10	70	0.10	10	0.53	780	1	0.06	24	1020
WC95-2401C	24	1.68	<10	10	0.06	<10	0.40	625	<1	0.02	12	720
WC95-2402C	12	1.72	<10	30	0.08	<10	0.46	390	<1	0.03	13	760
WC95-2405	15	3.12	<10	30	0.09	<10	0.48	2770	<1	0.04	13	1080

Appendix 1E

CERTIFICATE COMMENTS: Williams Creek										
SAMPLE DESCRIPTION	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
WC95-2101F	4	<2	5	129	0.09	<10	<10	58	<10	152
WC95 2102F	6	<2	4	159	0.07	<10	<10	56	<10	236
WC95-2101C	<2	<2	1	41	0.04	<10	<10	37	<10	48
WC95-2102C	2	<2	2	45	0.08	<10	<10	62	<10	60
WC95-2105	2	<2	2	108	0.07	<10	<10	59	<10	52
WC95-2201F	4	<2	4	133	0.09	<10	<10	53	<10	118
WC95 2202F	6	<2	4	121	0.09	<10	<10	56	<10	138
WC95-2201C	<2	<2	1	49	0.04	<10	<10	35	<10	50
WC95-2202C	<2	<2	2	46	0.09	<10	<10	60	<10	54
WC95-2205	2	<2	3	130	0.07	<10	<10	44	<10	48
WC95-2301F	4	<2	4	114	0.09	<10	<10	48	<10	100
WC95 2302F	4	<2	4	112	0.07	<10	<10	47	<10	106
WC95-2301C	<2	<2	1	46	0.04	<10	<10	29	<10	44
WC95-2302C	<2	<2	2	41	0.05	<10	<10	32	<10	46
WC95-2305	2	<2	2	83	0.07	<10	<10	41	<10	36
WC95-2401F	6	<2	5	156	0.09	<10	<10	57	<10	104
WC95 2402F	4	<2	4	133	0.08	<10	<10	50	<10	92
WC95-2401C	2	<2	2	92	0.06	<10	<10	36	<10	64
WC95-2402C	<2	<2	3	75	0.07	<10	<10	39	<10	64
WC95-2405	2	<2	3	175	0.07	<10	<10	52	<10	52