

#### ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: 2012 Geostatistical Geochemical and SWIR-ASTER Analyses, Twin Glacier Property, Northwestern British Columbia

TOTAL COST: \$12,800.00

AUTHOR(S): Alanna Ramsay, Ginette Carter SIGNATURE(S):

d.

Q. L. Bambay Guite Carle

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): STATEMENT OF WORK EVENT NUMBER(S)/DATE(S ): 5402718 Start work 2012/Aug/15; end work 2012/Aug/27

YEAR OF WORK: 2012 PROPERTY NAME: Twin Glacier

CLAIM NAME(S) (on which work was done):

Mineral Tenure Numbers: 734442, 734462, 734482, 734502, 734542, 798282

COMMODITIES SOUGHT: Cu, Au, Pb, Zn, Ag

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: 104B 106

MINING DIVISION: Liard Mining Division NTS / BCGS: **104B** LATITUDE: \_\_131\_ о 58.614 10 \_, \_ 0 " (at centre of work) 44 44.262 LONGITUDE: 56 UTM Zone: 9 EASTING: 366500 NORTHING: 6291200

OWNER(S):

**Dolly Varden Silver Corporation** 

MAILING ADDRESS:

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OPERATOR(S) [who paid for the work]:

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REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude. **Do not use abbreviations or codes**)

The Iskut River Area is underlain by rocks belonging to the Stikine Terrane which are part of the Intermontane Belt. The Stikine Terrane includes three major groups of rocks in this part of the Iskut River District. These include island arc volcanic and sedimentary rocks of the Paleozoic Stikine assemblage. The core of the NNW trending property is underlain by Upper Triassic Stuhini Group marine- arc volcanic and sedimentary rocks, and Hazelton Group rocks consisting of equivalent Lower- Middle Jurassic volcanic and sedimentary rocks. The current geostatistical and remote sensing work that covers the Twin Glacier property shows that there are significant correlations to known deposits proximal to the property, as well as provides illumination with regard to regional trends. The regional geochemical and metallogenic fabrics that were identified show that the property has considerable exploration potential. This work will prove invaluable in designing and executing future field-based exploration programs on the property.

# REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS: Assessment Reports 32857, 17122

TYPE OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH CLAIMS	PROJECT COSTS APPORTIONED (incl. support)
GEOLOGICAL (scale, area)				
-	Ground, mapping			
-	Photo interpretation			
GEOP	HYSICAL (line-kilometres)			
_	Ground			
_	Magnetic			
_	Electromagnetic			
_	Induced Polarization			
-	Radiometric			
_	Seismic			
-	Other	(analysis of ASTER imagery)	734442 734462 734482 734502 734542 798282	\$7,120
-	Airborne			
GEOCHEMICAL (number of samples analysed for) Soil Silt				
-	Rock			¢5.000
_	Other	(analysis of regional RGS data)	734442 734462 734482 734502 734542 798282	\$5,680

DRILLING (total metres, number of holes, size, storage location)		
Core		
Non-core		
RELATED TECHNICAL		
Sampling / Assaying		
Petrographic		
Mineralographic		
Metallurgic		
PROSPECTING (scale/area)		
PREPATORY / PHYSICAL		
Line/grid (km)		
Topo/Photogrammetric (scale, area)		
Legal Surveys (scale, area)		
Road. local access (km)/trail		
Trench (number/metres)		
Underground development (metres)		
Other		
	TOTAL COST	\$12,800

# 2012 Geostatistical Geochemical and SWIR-ASTER Analyses:

# Twin Glacier Property,

# Northwestern British Columbia

Longitude 131° 10' 58.614" E

Latitude 56° 44' 44.262" N

NTS 104B

Liard Mining Division

BC Geological Survey Assessment Report 33397

Prepared for:

Dolly Varden Silver Corporation 355 Burrard Street, Suite 910,

Vancouver, BC, V6C 2G8

Prepared by:

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# EXECUTIVE SUMMARY

Dolly Varden Silver Corporation controls six claims covering 2,182 ha of mineral tenures about 115 km NW of Stewart and 65 km W of Bob Quinn Lake, British Columbia. The Twin Glacier Property is located on south facing slopes along the Iskut River approximately five kilometres northwest of the former producing Snip Gold Mine and the Bronson Creek Airstrip. The claims which comprise the Twin Glacier Property were staked pursuant to the BC Ministry of Energy and Mines MTO system (Mineral Titles Online System).

The Iskut River Area is underlain by rocks belonging to the Stikine Terrane which are part of the Intermontane Belt. The Stikine Terrane includes three major groups of rocks in this part of the Iskut River District. These include island-arc volcanic and sedimentary rocks of the Paleozoic Stikine assemblage. The core of the NNW trending property is underlain by Upper Triassic Stuhini Group marine-arc volcanic and sedimentary rocks, and Hazelton Group rocks consisting of equivalent Lower-Middle Jurassic volcanic and sedimentary rocks underlain by highly prospective Upper Triassic volcanics and sedimentary rocks.

The terrain is glaciated, steep and heavily timbered, with annual precipitation averaging approximately 300 cm. Access to the property is by air from the Bronson or Bob Quinn airstrips.

Although the property was first staked in the mid to late 1980's and was likely prospected during these years, the only assessment report available for the property was filed in 2010 (Einsiedel, 2010). A small geochemical survey program was undertaken at that time, and several anomalous boulders were sampled. A larger geochemical survey and a new geophysical survey were proposed by the author of the report but financial constraints prevented further work from being done.

Two sets of available data were used in the current analysis. A regional RGS database (B.C stream sediment sampling database) was selected to provide a geochemical framework for the property. Dr. Hans Madeisky, P.Geo., was retained to process these data and geostatistically evaluate anomalous trends. Ward Kilby, P.Geo., was retained to evaluate the regional alteration potential using analysis of short wave infrared images derived from SWIR and ASTER images obtained for the area. Both specialists provided their work and reports as the framework of this assessment report.

Significant regional and local insights were gained from both studies. The geostatistical analysis of the selected area provided significant gains in understanding of the relationship between metallic elements and associated elements with regional and local structures, suggesting several prospective fabrics to follow up in the region.

The short wave infrared (SWIR) analysis of five images over and around the property provided significant correlation to known deposits and other regional mineralized zones but failed to highlight area of interest under the claims due to intense tree coverage, glacial deposits, and the general scarcity of exposures. Regionally, alteration signatures matched numerous geochemical trends of interest, most of those with current mineral tenure. Generally speaking, the SWIR analysis proved to be a regional technical success, but has not been shown to be useful on the scale of the Twin Glacier property.

Both independent reports are provided in the appendices and are summarized in the text below.

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## INTRODUCTION

This report summarizes work carried out for the Twin Glacier property in 2012. The Twin Glacier Property is located northwest of the Snip Gold Mine, in northwestern British Columbia (Figure 1).

In 2012, two sets of analysis were performed over the Twin Glacier Property and its surrounding area. On behalf of Dolly Varden Silver Corporation, owner of the property, Dr. Hans Madeisky, P.Geo., (geochemical consultant) analyzed and interpreted a large regional set of stream sediment samples from the BC Regional Geochemical Survey (RGS) database. The results from over 7,000 samples were gridded by kriging and subsequently contoured to define a representative population that would identify geochemical and metallogenic fabrics in and around the property. Ward Kilby, P.Geo., (Cal Data Ltd.) was also retained by Dolly Varden Silver Corporation to assess the alteration and mineralization potential of the area using short wave infrared imaging (SWIR). These images were assembled, queried and filtered for specific wave lengths to highlight alteration minerals, gossans, and the like. Five ASTER images were obtained and analyzed by Mr. Kilby.

The objective of both analyses was to evaluate the potential of this type of work in identifying regional geochemical and metallogenic fabrics that could highlight structural and geochemical trends underlying the property and surrounding area and assist in the evaluation of the mineral potential of the Twin Glacier Property, as well as serving as a guide for exploration.

#### WORK PERFORMED

Work completed in 2012 included the following:

- Compiling/reviewing historic assessment reports and digitizing historic sample data.
- Gridding, kriging and custom colouring the regional stream sediment (RGS) data using the software package Surfer v.10 (Golden Software) and Interpretation of resulting lineaments in light of mapped lithologies and structures.
- Compilation and analysis of available regional ASTER and SWIR images to identify alteration suites and prospective zones in the Twin Glacier Property and surrounding area.
- Preparation of recommendations for future exploration.

The authors of this report have exercised due care and diligence in interpreting, compiling, and reporting the results of the geochemical and ASTER/SWIR survey. To the best of the authors' knowledge, the information supplied by third parties is believed to be accurate and factual. In addition much of the information presented in the sections Accessibility and Infrastructure, History, Geological Setting, Deposit Types, and Mineralization rely heavily on work by Von Einsiedel (2011) in Assessment Report AR32857. The authors of this report are Alanna Ramsay (G.I.T.) and Ginette Carter (P.Geo.). Contributors include Dr. Hans E. Madeisky (P.Geo., RGS data processing and analysis), Ward Kilby (ASTER and SWIR compilation and analysis), Michael E. Caron (P.Geo., senior editor of the document), and David Metvedt (graphics and GIS).



### PROPERTY DESCRIPTION AND LOCATION

The Twin Glacier Property is located approximately 115 km northwest of Stewart, B.C. or 65 km west of Bob Quinn Lake, B.C. (Figure 1) in the Liard Mining Division. The property is found on the north side of the Iskut River within the eastern portion of the Coast Range Mountains. The property is centred at UTM 366500E, 6291200N (NAD 83, Zone 9) or Latitude 56° 44' 44.262" N, Longitude 131° 10' 58.614" W. It straddles map sheets TRIM 104 B 074 and 104 B 075 (1:20,000 scale). The southern portion of the property is on map sheet NTS 104B/11E (1:50,000 scale) and the northern portion of the property is on map sheet NTS 104B/14E.

The Twin Glacier Property is situated on the south facing slopes of the Iskut River, approximately five kilometres northwest of the former producing Snip Gold Mine and Bronson Creek Airstrip. Elevations range from 200 – 1750 metres above sea level.

The north coastal climate has cool wet summers and heavy winter snowfall. Snow accumulations are up to 1 - 2 metres near the Iskut River and normally exceed 5 metres at higher elevations. Work season is usually from June through October, with the main river valleys free of snow around the end of May. Temperatures range from about 20° C in the summer to about -10° C in the winter.

The Twin Glacier Property is within the Boundary Ranges physiographic region and encompasses a rugged, hilly upland area. The physiography of the area is extremely rugged with extensive outcrop along the ridges but the slopes leading to streams within the project area are generally soil or talus covered. The lower elevations of the property are covered by thick, dense undergrowth including willow, alder and devil's club. Larger trees include fir, hemlock, cedar and spruce. Satellite imagery shows that the upper slopes are devoid of vegetation except for alpine forbs and grasses. The most northwestern claim is partially covered by a south-flowing glacier (Twin Glacier).

# LAND TENURE INFORMATION

Dolly Varden Silver Corporation holds a 100% interest in six contiguous mineral tenures (2,182.40 hectares) that cover a northwest-oriented, staircase shaped block of ground located on the north side of the Iskut River in northwestern BC. These tenures comprise the Twin Glacier Property and were staked pursuant to the BC Ministry of Energy and Mines MTO system (Mineral Titles Online System). The location of the property relative to other properties, local communities, and access roads is shown in Figure 1. The individual claim tenures and numbers are shown in Figure 2.

Table 1 summarizes the tenures of the Twin Glacier Property. The mineral claims have not been legally surveyed as they are BC Government established mineral title cell claims.

Tenure No.	Tenure Type	Issue Date	Good To Date	New Good To Date	Hectares
734442	Mineral	2010/mar/25	2012/sep/01	2013/DEC/05	443.32
734462	Mineral	2010/mar/25	2012/sep/01	2013/DEC/05	425.75
734482	Mineral	2010/mar/25	2012/sep/01	2013/DEC/05	425.88
734502	Mineral	2010/mar/25	2012/sep/01	2013/DEC/05	443.76
734542	Mineral	2010/mar/25	2012/sep/01	2013/DEC/05	408.18
798282	Mineral	2010/jun/25	2012/sep/01	2013/DEC/05	35.51

 Table 1. Mineral Claims Held by Dolly Varden Silver Corporation at the Twin Glacier Property



## ACCESSIBILITY AND INFRASTRUCTURE

The area can be accessed by helicopter from either the government-maintained airstrip at Bob Quinn Lake located on the Stewart-Cassiar Highway (Hwy 37) or from the Eskay Mine road (Kilometre 54). It can be accessed by fixed wing aircraft from Smithers to the Bronson Creek airstrip located on the southern side of the Iskut River close to the former Snip Mine. As there is no road access to the property, all personnel and material delivered via the Stewart-Cassiar Highway 37 to Bob Quinn Lake must be transported to the property by helicopter.

A temporary tent camp for crew accommodation will be required for completion of proposed exploration programs. Crews travelling to and from the site can be accommodated at Bell 2 or at facilities in Bob Quinn. The Bronson Creek airstrip is capable of accommodating aircraft as large as a Hercules. Access throughout the property can also be via helicopter from the airstrip. Room and board is available at the fishing lodge adjacent to the Bronson Creek airstrip. Driving time to Bob Quinn from Terrace or Smithers is approximately five to six hours. Experienced field personnel and drilling contractors are available in the communities of Terrace and Smithers.

In general, infrastructure in the vicinity of the subject property is limited. There is an existing road that was constructed to access the proposed Forrest Kerr hydro-electric project on the Iskut River approximately 10 kilometres east of the Property. Trained exploration personnel are available in Smithers, Dease Lake, Stewart, and other nearby communities.

#### HISTORY

The project area was initially explored in the mid to late 1980's after Cominco discovered the Snip deposit on the south side of the Iskut River. In 1986 Delaware Resources acquired the ground to the north of the Snip deposit through option and signed joint venture agreements with American Ore Ltd. and Golden Band Resources Ltd. (referred to as the Iskut Joint Venture) and funded preliminary exploration work and an initial phase of drilling. This exploration work identified the Gregor and Gorge Prospects in an area referred to as the "West Grid" which is located in the north western part of the Iskut Joint Venture property where it adjoins the Twin Glacier Property. Historic claim maps indicate that the ground presently covered by the Twin Glacier Property was staked at the time. Delaware funded work on the Iskut Joint Venture claims; however, there is no published record of any exploration work completed at the time on the present Twin Glacier Property. Figure 3 shows the outline of the Twin Glacier property in relation to mineral claims that were in effect during the late 1980's as referenced in Assessment Report AR17122 (Burson 1987).

Technical information regarding the size and grade of mineralization encountered at the Snip Deposit, the Iskut Joint Venture, and at the Rock and Roll Prospect are included to demonstrate that the rocks underlying the Twin Glacier Property may be prospective for this style of mineralization. The reader is cautioned that there is no assurance that similar mineralization will be identified on the Twin Glacier property.

It is also important to note that the work completed by Delaware Resources in the late 1980's did not evaluate the ground covered by the claims that comprise the Twin Glacier property as they were staked by an unrelated third party. The British Columbia Ministry of Energy and Mines MINFILE database showing 104B 106 named "Twin Glacier" is located in the northwestern portion of the Property (Figure 2) and was referenced in the Stewart-Sulphurets-Iskut Compilation as Showing No. B9 by Equity Preservation Corp. (1988), as well as in a report by Kerr (1948). No additional follow up work subsequent to 1988 has been reported in the BC MINFILE database.

The most significant historic exploration work on the Rock and Roll prospect was carried out by the Prime Equities Group between 1990 and 1991. In 2009, Pacific North West Capital Corp. ("PNWC") optioned the Rock and Roll Property and completed an AERO-TEM3 airborne magneticelectromagnetic survey and a limited drill program designed to verify the historic exploration work reported by Prime Resources. PNWC confirmed that the massive sulphide mineralization at the Rock and Roll Prospect is localized within northwest-striking metasediments and reportedly identified multiple additional new target areas.

In 2008, Newcastle Minerals published a technical report documenting exploration work and drilling on the ISKUT 2 MINFILE prospect (also referred to as the Iskut Porphyry prospect) and concluded that the prospect warranted additional exploration. According to Burgoyne (2008) a mineralized porphyry gold-copper-molybdenum system in the order of 500 to 600 meters in length, 200 to 300 meters in width, and to depth of 200 meters has been defined.

The most recent field work on the property took place during the summer of 2011 and was carried out by Twin Glacier Resources. That field program consisted of prospecting within the moraine areas in the northern part of the property to confirm the presence of massive sulphide float and reconnaissance for future soil geochemistry surveys to test the potential extension of vein type mineralization north of the Gregor and Gorge Prospects. A total of six mineralized boulders were sampled with one sample returning 166.2 ppm molybdenum. This sample may be associated with the ISKUT 2 MINFILE prospect, located a few kilometres to the southeast of the property. In

addition, one sample returned 324.7 ppm copper and two samples returned anomalous arsenic (Von Einsiedel, 2011). These elevated values in altered intrusives may be indicative of the presence of porphyry mineralization (Figure 4).

![](_page_17_Figure_0.jpeg)

![](_page_18_Figure_0.jpeg)

## **GEOLOGICAL SETTING**

#### **REGIONAL GEOLOGY**

This section contains information excerpted from Bulletin 104 published in 2000 by the British Columbia Ministry of Energy and Mines (Logan, Drobe, and McClelland, 2000).

The Iskut River Area is underlain by rocks belonging to the Stikine Terrane which are part of the Intermontane Belt. The Stikine Terrane includes three major groups of rocks in this part of the Iskut River District. These include island-arc volcanic and sedimentary rocks of the Paleozoic Stikine assemblage, Upper Triassic Stuhini Group marine-arc volcanic and sedimentary rocks, and Hazelton Group rocks consisting of equivalent Lower-Middle Jurassic volcanic and sedimentary rocks.

These supracrustal rocks are intruded by stocks, plugs, dikes and sills ranging in age from Mid-Triassic to Tertiary. The intrusive rocks range in composition from diorite to granite with the larger plutons generally comprised of biotite-hornblende granodiorite. Within the project area the regional structural style involves north to northwest striking and east to northeast striking faults.

The Twin Glacier Property lies within an important base and precious metal-rich part of Northwestern British Columbia, termed the "Stikine Arch or Golden Horseshoe" (Lefebure, 1991). The Golden Horseshoe extends from Alice Arm north to the Taku River, east of the Coast Belt, and wraps back around the northwestern edge of the Bowser basin as far east as the Toodoggone River (Figure 5).

Mineral deposits and prospects in the Golden Horseshoe can be grouped into four main categories: calc-alkaline Cu-Mo-Au and alkaline Cu-Au porphyries; Cu and Cu-Au skarns; subvolcanic Cu-Ag-Au (As-Sb) fault- and shear-hosted veins; and stratiform volcanogenic massive sulphide and carbonate hosted Zn-Pb-Ag deposits. The distribution of mineral occurrences in the map area (except stratiform types) shows a direct correlation with north and northeast striking faults and Late Triassic to Early Jurassic intrusive rocks.

#### PROPERTY GEOLOGY

In the Iskut Valley region, the rock units are extensively deformed and are thought to have been emplaced by thrust faulting which were thrust to the south across Middle Jurassic and older units. The Upper Triassic to Lower Jurassic section is comprised of volcanics and sediments which have been correlated with the Unuk River Formation of the Hazelton Group. These rocks are locally referred to as the Snippaker Volcanics and range from andesite and dacite to rhyolite in composition (Figure 6, 6a). Breccias and tuff breccias are common and siliceous pyroclastic rocks are locally abundant. The Middle Jurassic Betty Creek Formation consists of rhyolite breccia, volcaniclastics, conglomerate, carbonate, chert, and volcanics which unconformably overlie the Unuk River Formation.

The Stewart Complex, a large lobe of Lower Jurassic strata exposed along the western margin of the Bowser Basin (Alldrick, 1988) has been invaded by granitic rocks of the Coast Plutonic Complex. Granodiorite is the predominant rock type of the major intrusions, although a large variety of rock types occur as smaller satellite stocks as well as dykes and sills.

Small Quaternary volcanic piles and flows are scattered throughout the Stewart Complex, with the most prominent volcanism in the area at Hoodoo Mountain, a recent volcanic cone near the west margin of the Twin Glacier property.

The volcanic and sedimentary rocks on the Twin Glacier property generally trend northwest. Outcrop on the property is sparse and general trends are extrapolated from float occurrences. Little is known of the detailed structure of the area due in part to the scarcity of outcrop, but also because much of the property remains to be mapped. A discontinuous set of lineaments trending 045° was previously observed from aerial photographs and appears to post-date intrusives. North of the East Grid on the historic Iskut JV ground, previous mapping (Burson 1987) shows one prominent normal fault trending 160°, down dropped to the SW.

![](_page_21_Figure_0.jpeg)

![](_page_22_Figure_0.jpeg)

![](_page_23_Figure_0.jpeg)

Figure 6a. Property Geology Legend

### DEPOSIT TYPES

Potential exists at the Twin Glacier property for discover of at least three deposit types, as described below. This conclusion is based on proximity to known mineralization in the area as well as mineralization described from MINFILE reports from the property. Some portions of the property are underlain by prospective Triassic volcanics and marine sediments, giving potential for the discovery of VMS deposits. There is also potential for intrusive-related vein deposits related to Triassic to Jurassic granitic intrusives. The presence of these proximal intrusives, together with regional northeast and northwest structures crossing the property, also suggests some potential for polymetallic vein deposits.

#### VOLCANOGENIC MASSIVE SULPHIDE (BESSHI TYPE)

The Rock and Roll Deposit located approximately 3 kilometers southeast of the Twin Glaciers Property (Figure 6, 6a) is classified in the MINFILE database as a Besshi type volcanogenic massive sulphide (VMS) deposit (G04). VMS deposits Cu-Zn-Pb (±Au) sulphide ore deposits are associated with and created by volcanic-associated hydrothermal events in submarine environments. These deposits predominantly consist of stratiform accumulations of sulphide minerals that precipitate from hydrothermal fluids on or below the seafloor. The immediate host rocks can be either volcanic or sedimentary. Most VMS deposits have two components. There is typically a mound-shaped to tabular, stratabound body composed principally of massive sulphides, quartz and subordinate phyllosilicates, iron oxide minerals, and altered silicate wall-rock. These stratabound bodies are typically underlain by discordant to semi-discordant stockwork veins and disseminated sulphides. The stockwork vein systems are enveloped in distinctive alteration halos, which may extend into the strata above the VMS deposit.

VMS deposits are grouped according to base metal content, gold content, and host-rock lithology. The base metal classification divides VMS deposits into Cu-Zn, Zn-Cu, and Zn-Pb-Cu groups according to the ratios of these three metals. Gold content has a simple bimodal definition of "normal" versus "Au-rich". Au-rich VMS deposits are arbitrarily defined as those in which the abundance of Au in ppm is numerically greater than the combined weight percent of the base metals (Zn + Cu + Pb). VMS deposit classification by host lithology includes all strata within a host succession defining a distinctive time-stratigraphic event. There are five different groups: bimodal-mafic, bimodal-felsic, felsic-siliciclastic, mafic-back arc, and mafic-siliciclastic. These lithologic groupings generally correlate with different submarine tectonic settings. Mafic-siliciclastic VMS deposits are formed in oceanic extensional environments near continental margins.

The MINFILE classification G04 Besshi-type VMS deposits are mafic-siliciclastic VMS deposits. Deposits of this type typically comprise thin sheets of massive to well-layered pyrrhotite, chalcopyrite, sphalerite, pyrite and minor galena within interlayered, terrigenous clastic rocks and calc-alkaline basaltic to andesitic tuffs and flows. These deposits typically consist of a concordant sheet of massive sulphides up to a few metres thick and up to several kilometres in strike length and dip extent, sometimes occurring as stacked lenses. These VMS deposits occur as seafloor deposition of sulphide mounds within extensional oceanic environments, such as back-arc basins, oceanic ridges close to continental margins, or rift basins in the early stages of continental separation.

In British Columbia, most Besshi type VMS deposits are Cambrian, Late Triassic and less commonly Mississippian-Permian in age.

#### INTRUSION RELATED GOLD PYRRHOTITE VEINS

The two MINFILE showings (Gregor and George) that occur on the historic Iskut JV ground adjacent to the southern boundary of the Twin Glacier property (Figure 6, 6a) are classified as Intrusion-Related Gold Pyrrhotite Veins (I02). In addition, VMS deposits such as Rock and Roll (MINFILE 104B 377) also include this classification as veining is commonly associated with deposition. Other examples of Intrusion-Related Gold Pyrrhotite Veins proximal to the Twin Glacier Property include the Snip Mine (MINFILE 104B 250), 5 kilometers to the south and Johnny Mountain (MINFILE 104B 107), located 6 kilometers to the south.

Intrusion-Related Gold Pyrrhotite Veins are commonly known as mesothermal veins, extension veins, transitional veins or contact aureole veins and commonly contain gold and silver with lesser copper. They occur as parallel tabular to cymoid veins of massive sulphide and/or quartz-carbonate with native gold, electrum and chalcopyrite and are often emplaced in a set of en echelon fractures around the periphery of subvolcanic plutons. Veins vary in width from centimetres to several metres and can sometimes be traced along strike for hundreds of metres. Veins often contain a complex mineralogy, including native gold, electrum, pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, bornite, argentite, arsenopyrite, magnetite, ilmenite, tetrahedrite, tennantite, molybdenite, cosalite, chalcocite, tellurobismuthite, hessite, volynskite, altaite, and native bismuth. Veins may be composed of massive fine-grained pyrrhotite and/or pyrite, or massive bull quartz with minor calcite and minor to accessory disseminations, knots and crystal aggregates of sulphides. These two types of mineralization may grade into each other along a single vein or may occur in adjacent, but separate veins. Some veins have undergone post-ore ductile and brittle shearing that complicates textural and structural interpretations.

Mineralization is controlled by well-defined faults and shears. They occur in volcanic arc terranes near oceanic and continental margins. Host rocks are andesitic tuffs, turbidites, or early intrusive phases found near the margins of phaneritic, locally porphyritic, granodiorite stocks and batholiths. Veins are peripheral to and spatially associated with porphyritic intrusive rocks which may host porphyry copper mineralization.

Alteration halos surrounding the mineralized veins occurs as narrow (4 cm) vein selvages and as moderate alteration haloes extending up to several metres into the country rock. Alteration minerals include chlorite, sericite, pyrite, silica, carbonate, rhodochrosite, biotite, epidote, potassium feldspar, and ankerite.

#### POLYMETALLIC (AG-PB-ZN ± AU) VEIN DEPOSITS

The Twin Glacier prospect (MINFILE 104B 106) that is located on the northern portion of the property (Figure 6, 6a) is classified as polymetallic (Ag-Pb-Zn  $\pm$  Au) Vein Deposits (I05).

Mineralization in structurally controlled Polymetallic (Ag-Pb-Zn  $\pm$  Au) veins is epigenetic and is formed from structurally focused hydrothermal fluids and form deposits of sulphide-rich veins containing sphalerite, galena, silver and sulphosalt minerals in a carbonate and quartz gangue. This type of deposit is generally associated with regional faults, fault sets and fractures and is usually associated with second order structures. Veins typically occur in the central parts of discrete shear zones within a larger regional fault, where rotational or simple shear strains predominate. Vein systems are typically steeply dipping, narrow, tabular, or splayed veins that commonly occur as sets of parallel and offset veins. Individual veins vary from centimetres up to more than 3 m in width and can be followed from a few hundred metres to more than 1000 m in length and down dip extent. Veins may widen to tens of metres in stockwork zones. Precious metal mineralization often occurs as coarse individual grains, occasionally making this type of deposit difficult to evaluate, due to a pronounced "nugget effect" in sample analyses.

These veins can occur in virtually any host rock. Most commonly the veins are hosted by thick sequences of clastic metasediments or by intermediate to felsic volcanic rocks. In many districts felsic to intermediate intrusive bodies and mafic igneous rocks are present but are less common. Many veins are associated with dikes following the same structures.

Macroscopic wall rock alteration is typically limited in extent (measured in metres or less). The metasediments typically display sericitization, silicification, and pyritization. Thin veins of siderite or ankerite may be locally developed proximal to veins. In volcanic and intrusive host rocks the alteration is argillic, sericitic or chloritic and may be quite extensive. The age of this type of mineralization is Proterozoic or younger and is mainly Cretaceous to Tertiary in British Columbia.

### MINERALIZATION

The distribution of mineral occurrences in the map area (except stratiform types) shows a direct correlation with north and northeast-striking faults and Late Triassic to Early Jurassic intrusive rocks. The stratiform mineral occurrences are parallel to local lithology which trends northwest in the area of the Twin Glacier property.

The Twin Glacier property covers two known MINFILE prospects; 104B 106 (Twin Glacier prospect) and 104B 257 (Gregor showing). According to the MINFILE database, the Twin Glacier prospect consists of extensive polymetallic boulders found within the Twin Glacier moraine. These boulders contain considerable chalcopyrite, galena and pyrite. In addition, outcrop containing veins up to 30 centimetres wide and completely oxidized to gossan were reported by Kerr (1948).

The Gregor showing was located in 1988 over coincident gold-in-soil anomalies in the northern part of the West Grid located in the northwestern part of the historic Iskut Joint Venture property on the ISK-1 claim. It is important to note although the MINFILE database shows that the Gregor Showing lies within the property, available technical data indicates that the known mineralization is actually located approximately 300 meters to the south of the property. This showing is comprised of massive to semi-massive magnetite mineralization in sheared mafic volcanics. A continuous chip sample from a trench which partially exposed the zone on surface assayed 4.94 grams per tonne gold over 2.7 metres, including a 0.76 metre interval grading 11.49 grams per tonne gold (American Ore Ltd., 1988).

According to the MINFILE database, the Stuhini Group rocks in the area of the property may host various styles of mineralization including Besshi-type gold and precious metal rich, volcanogenic massive sulphide mineralization (such as Rock & Roll), polymetallic Ag-Pb-Zn-Cu+/-Au vein and stockwork type mineralization and intrusion related vein type mineralization (such as the Snip Deposit).

Located seven kilometres to the SE of the Twin Glacier property, Snip Gold Corporation recently published the results of their 2012 gold soil survey grid. NW-trending gold anomalies are clearly defined in this work (Snip Gold, 2012).

### DATA PROCESSING AND ANALYSIS METHODS

#### **REGIONAL GEOCHEMICAL SURVEY**

Stream sediment data were downloaded directly from the BC RGS database in July, 2012. These data were downloaded and plotted in BC Albers Equal–Area Conic Projection. The RGS data set was plotted and then clipped to extract a large regional data set surrounding the Twin Glacier property (Figure 7). Within this framework, analysis of the Twin Glacier property benefit from examination of regional geochemical fabric analysis over a much larger catchment basin.

A subset of 7,120 samples centered over the property were selected for the purpose of this study. These samples and their kriged contours represent multiple drainages sampled over an area of approximately 78,532 km<sup>2</sup> (masked gaps not included), at an average sample density of approximately 1 sample per 11 km<sup>2</sup>. These results provide a regional meaningful and comparative framework for a number of elements. There are, however, several areas of little to no sampling

near and beneath glaciers. For example, north of the Twin Glacier property, an area of approximately 20 by 40 kilometres is found where there are no RGS samples. This may mask or skew possible trends to the north of the property. The stream sediment samples were collected over several years from 1978 to 1997. Also, the collected data set contains results from multiple analytical methods, including atomic absorption spectroscopy (AAS), neutron absorption (NA), and fire assay (FA).

Once the data were acquired and reviewed, the RGS data set was gridded using 1000 x 1000 m cells, and kriged using a linear variogram (ordinary kriging). As noted above, the data set contains multi-element results from samples collected in different years and analyzed by a several different analytical methods. The grid size was selected to minimize individual sample influence and the contour intervals were selected to emphasize fabrics, and trends, rather than just highly anomalous areas. This is a reasonable approach in that each stream sediment sample is a composite of all material present upstream of that sample, so that each sample represents an entire upstream catchment area. Before the geochemical data was kriged, the broad areas with no RGS samples and the margins of the sample area were masked in Surfer to reduce bias when kriging. Each contour map used the same masked area to maintain continuity between elements and analytical methods. Locally, bias was noted between map sheets to the southeast after kriging, which will be discussed in later sections.

Using Surfer v. 10, Dr. Hans Madeisky created kriged contour maps for each element and for each analytical method. All individual contour maps produced at the regional scale are found in Appendix A. Dr. Madeisky has successfully used this method for many years with a broad range of deposit types.

In 2005, a similar statistical analysis was undertaken by Scandinavian scientists to produce *The Geochemical Atlas of Europe*, which is now available online. (De Vos and Tarvainen, 2006). Shown below are two examples of stream sediment sample and water sample maps from this atlas which clearly outline tectonic zones, the Archean Shield, and metallogenic provinces (Figure 8). A similar geostatistical method applies very well to a large regional data set and validates the analysis of the BC RGS database by Kriging undertaken in this report.

![](_page_29_Figure_0.jpeg)

![](_page_30_Figure_0.jpeg)

Figure 8. Low pH Stream Water samples outlining Precambrian Shield (left panel); Stream Sediment samples outline cupriferous zones and trends (right panel), western Europe (after De Vos and Tarvainen, 2006).

#### ASTER IMAGERY PROCESSING AND ANALYSIS

ASTER imagery covering the Twin Glacier claims and surround area was acquired, processed, and analyzed by Ward Kilby (Cal Data Ltd.), on behalf of Dolly Varden Silver Corporation. Kilby's full Imagery Analysis Report can be seen in Appendix C and this section is based on that report. The ASTER digital image files were identified through the NASA Land Processes Distribution Active Archive Center (LPDAAC) and the five required images were available at no cost from the USGS Earth Resources Observation & Science Center as they were proximal to United States territory. The required Landsat imagery was identified and downloaded from LPDAAC.

The five ASTER images were made on September 24, 2000, August 9, 2003 and August 18, 2004. Each image represents an area of approximately 60 x 60 km and the five images are spatially distributed over an approximate 200 x 200 kilometre area, shown in Figure 9. The Twin Glacier property is located in the northern part of the image made in 2003. Two narrow strips between the three flight lines were not covered by the ASTER imagery. Also, extensive vegetation, snow and ice cover significantly limited the area that could be spectrally examined with the ASTER imagery.

Before analysis, the raw ASTER images were processed to transform the raw data values into relatively standard values, such as relative reflectance and emissivity. This processing included the conversion of the image from digital number format (DN) to radiance and then to relative reflectance values through a process of atmospheric corrections. In addition, the images were orthorectified to compensate for the effects of topography by spatially adjusting the image pixels to conform to the UTM map projection. Four of the ASTER images were orthorectified to UTM Zone 9, WGS 84 datum and the fifth, most westerly image was orthorectified to UTM Zone 8, WGS 84.

The spectral analysis performed on the regional Twin Glacier area used a variety of multispectral and hyperspectral bands, including VNIR, SWIR and TIR bands. Using orthorectified ASTER data, a Natural Colour Image was generated from three VNIR bands, resulting in a near natural colour scene. In addition, a SWIR RGB Image was generated from three SWIR bands, showing the distribution and variation of spectra, which includes vegetation and rock unit features. These types of images are very useful in providing an overview of where spectrally different features are located for further investigation.

The main focus of the ASTER Imagery analysis was on mineral identification and spectral mapping. Two combinations of ASTER bands were used to identify areas likely to contain minerals associated with argillic and phyllic alteration. These areas were used to extract fifteen end member spectra from the ASTER images. These end member spectra were tentatively identified as to the mineral they likely represented. The spectrum were used to classify the five ASTER images and also used to map the spectral angles (SAM) between three reference spectrum and the images, producing the SAM mineral classification map.

The KSM (Kerr-Snowfield-Mitchell) highly mineralized area was contained within the regional area of interest. This area provided a good reference zone to evaluate what spectra were likely to be associated with prospective ground. These mineral mappings provide a significant number of potential targets for investigation.

![](_page_32_Figure_0.jpeg)

## **GEOCHEMISTRY RESULTS:**

#### **REGIONAL GEOCHEMICAL SURVEY**

The following map (Figure 10) shows the sampled area included in this study. The RGS data reports contain analytical results for 21 elements, as well as loss on ignition (LOI) data. All these elements were gridded using kriging and subsequently contoured on annotated maps available in Appendix A. A descriptive page of element behavior for each of these elements was extracted from the Geochemical Atlas of Europe. A suite of elements displaying significant trends was identified and is discussed in more detail in this section. Significantly, no samples were collected within the 20 by 40 km area directly to the north of the claims, mostly due to the glacial coverage (Figure 10). This local data gap results in an apparent elemental low in that general area, tending to skew local geochemical trends.

![](_page_33_Figure_3.jpeg)

Figure 10: Distribution of RGS samples selected for this study.

(Note – image shows the Dolly Varden and Twin Glacier properties and the glacier-induced sample gap immediately north of Twin Glacier)

Regionally (Figure 11), elements such as Th, La, Hf, Cs are clearly lithophile and outline the edge of the arenitic eastern unit (Upper Proterozoic Ingenika Group and the Swannell Formation) and the SW Paleogene and late Cretaceous felsic intrusives, while Cr, Ni, Fe tend to outline mafic units and may also locally define finer anomalous fabrics. These observations confirm the representative value of the data and the validity of the data treatment in its capacity to display prospective finer fabrics or trends associated with metallogenic elements.

![](_page_35_Figure_0.jpeg)

![](_page_35_Figure_1.jpeg)

(Note: thorium is a lithophile element outlining arenaceous Upper Proterozoic sedimentary units in the extreme east and outlining felsic intrusives in SW in RGS data. Thorium data are not available for the Twin Glacier area)
## **REGIONAL GEOCHEMICAL REVIEW**

### Gold:

Regional fire assay gold contours show clearly evident NW and NE-directed fabrics (Figure 12 and Figure 13). When superimposed on the regional geology, some of the highs appear to be associated with regions of intense faulting proximal to intrusives. Areas with samples with very low results to below detection limit are shown in blue and white. The detection limit for fire assay gold data is 2 ppb.

Gold is often associated with epithermal veins and is commonly associated with porphyry Cu and porphyry Mo deposits. It can also be associated with VMS deposits. Gold occurrences are common in Archean greenstone belts, in shear zones and in mesothermal settings. Gold is the primary metal in Carlin type deposits. In the context of the Twin Glacier project, discreet gold trends or fabrics would likely be associated with epithermal veins, VMS, and porphyry settings.



Figure 12. Kriged RGS Au data.



#### Figure 13. Kriged RGS Au data proximal to the Twin Glacier property.

(Note subtle NE-directed trends, possibly indicating structural offsets, and the dominant NW regional metallogenic trend. An oval gold anomaly seen directly NW of property is accentuated by a single sample with low gold values in a drainage to the SW of the property and is further accentuated by a data gap north of property. To the SE of the Twin Glacier property, a broad high NW trending gold zone underlies the Johnny Flat property)

#### Silver:

The strongly chalcophile nature of Ag means that it is widely present as a trace element in sulphide minerals such as galena, sphalerite, tetrahedrite and chalcopyrite, which contain other chalcophile elements such as Pb, Co, Ni, Sb and As (Ure and Berrow, 1982). Silver is found at levels of up to several per cent in galena.

Silver is an important pathfinder element for most gold and silver deposits, as well as sedimentary exhalative (Sedex) or volcanic hosted massive sulphide (VHMS) mineral deposits. Silver shows no consistent preference for felsic or mafic magmas, although Boyle (1968) reports that substitution of Na<sup>+</sup> by Ag<sup>+</sup> can lead to enrichment in alkaline rocks.

Regional silver contours (atomic absorption values) have an evident NW geochemical fabric that extends south of the property and down to the southeast of the Dolly Varden Property. Also, there is a more subtle NE trend to the east of the property. Subtle silver trends appear to coincide with those seen in gold (Figure 14 and Figure 15). Both occur in areas of intense faulting near intrusive rocks.



Figure 14. Kriged RGS Ag data.



#### Figure 15. Kriged RGS Ag data proximal to the Twin Glacier property.

(Note: General low regional silver background. Clear subtle NE and NW fabrics. Southeast of Twin Glacier property, a broad WNW trending silver anomaly parallel to the gold anomaly underlies the Johnny Flat property).

# Copper:

Copper is a chalcophile element forming several minerals, including chalcopyrite (CuFeS<sub>2</sub>), covellite (CuS), and malachite (Cu<sub>2</sub>CO<sub>3</sub>(OH)<sub>2</sub>). Copper is also widely dispersed at trace levels in mica (biotite), pyroxene, and amphibole. It shows a greater affinity for mafic than felsic igneous rocks. Copper can occur in its metallic form in nature (*i.e.*, native copper). Copper may be redistributed during low-grade metamorphism and metasomatism (Senior and Leake 1978), but its mobility is more restricted at higher metamorphic grades (Nicollet and Andriambololona 1980). In common with other chalcophile elements, Cu is strongly concentrated into sulphide minerals during hydrothermal mineralization. Copper is used in geochemical prospecting as an indicator of all types of copper mineralization and is an important pathfinder for many types of gold deposit. Elevated Cu values are, however, more likely to indicate the presence of mafic rocks, although Cr and Ni are less ambiguous indicators. In the search for ultramafic-hosted magmatic nickel deposits, elevated Cu values may enable the discrimination of Ni anomalies associated with sulphide from those derived from unmineralized ultramafic rocks.

On a regional scale the copper (atomic absorption) contours show the NW and NE directed structures which may outline prospective domains (Figure 16 and Figure 17). Also, the copper contour highs are generally associated with Stuhini Group volcanics and sedimentary rocks. Some of these rock packages are faulted or fault bounded, and some of these structures correspond with copper highs on fine NE or NW trends. Paleogene granitic rocks mark a copper low.



Figure 16. Kriged RGS Cu data.



#### Figure 17. Kriged RGS Cu data proximal to the Twin Glacier property.

(Note: Purple area located directly north of the Twin Glacier property corresponds to a data gap. Elsewhere, prominent NE and NW fabrics are seen, with some trends intersecting the Twin glacier property. Large scale structures may represent potential structural preparation)

### Arsenic:

The chemistry and geochemistry of As is most similar to that of Sb. Arsenic is a strongly chalcophile element, and occurs as a variety of sulphide and sulpharsenide minerals, notably arsenopyrite (FeAsS), but also as realgar (AsS) and orpiment ( $As_2S_3$ ). It is also widely present as an accessory element in other sulphide minerals such as galena, pyrite and sphalerite. Arsenic's use as a pathfinder element for Au, Ag and other precious metals is well documented (Boyle and Jonasson 1973, Boyle 1974, Dunn 1989, Plant et al. 1989, 1991). High As anomalies are a common characteristic of epithermal and mesothermal gold deposits. Arsenic is not preferentially enriched in felsic or mafic igneous rocks, though hydrothermal processes lead to its enrichment.

The regional As map displays evident NW and NE directed structures and generally broad areas of elevated values lie along the contacts in association with the intrusives, but the elevated values fall outside of the intrusive rock packages (Figure 18 and Figure 19). As a result, the intrusives result in arsenic lows, but also appear to affect the surrounding rock packages resulting in increased arsenic concentrations there. The more subtle trends outline a fabric that may reflect mineralization trends and structures controlling these trends.



Figure 18. Kriged RGS As data.



Figure 19. Kriged RGS As data proximal to the Twin Glacier property.

### Mercury:

Mercury is a rare heavy metal chalcophile element. Volcanic hot springs and sedimentary rocks altered by phreatic activity are the main sources of Hg mineralization. The principal mineral is cinnabar (HgS), together with the metacinnabar group of minerals in which variable amounts of Zn and Fe substitute for Hg, and Se substitutes for S. Mercury is used in geochemical prospecting as a pathfinder element for Au, Ag, Sb and massive sulphide mineralization. High Hg levels occur in rocks and soil near fault zones.

Locally and more regionally, mercury contours (atomic absorption) show a NE-directed structure to the east of the Twin Glacier property that is associated with regional faulting. In addition, there is a northerly structure shown in Figure 20 and Figure 21 that generally marks the contact of the Bowser Lake Group sedimentary rocks with other rock packages. This is consistent over the area of study where Bowser Lake Group represents moderately to highly anomalous mercury contours shown as the colours bright green to red.



Figure 20. Kriged RGS Hg data.



Figure 21. Kriged RGS As data proximal to the Twin Glacier property.

### Antimony:

Antimony is a low-abundance chalcophile element forming several rather rare minerals including stibnite  $(Sb_2S_3)$ , valentinite  $(Sb_2O_3)$ , and kermesite  $(Sb_2S_2O)$ , but the element is more usually present at trace levels in minerals such as ilmenite, Mg-olivine, galena, sphalerite and pyrite. The highest concentrations (>3 mg kg<sup>-1</sup>) typically occur in the vicinity of hydrothermal deposits of galena and sphalerite. It is occasionally found in its native form. Antimony can be used as a pathfinder element for Au mineralization, especially in combination with other pathfinders such as As and Bi (Boyle 1974, Plant et al. 1989, 1991). Figure 22 and Figure 23 show the distribution of antimony at the Twin Glacier property.



Figure 22. Kriged RGS As data.

(Note: Sb contours closely follow Au contours as shown in Figure 14, above)



TG Antimony

Figure 23. Kriged RGS Sb data proximal to the Twin Glacier property.

(Note: Sb contours outline local NE and NW trends, including a trend that follows the same significant NE-trending fault outlined in Hg contours)

#### Zinc:

Zinc is a chalcophile metallic element that forms several minerals, including sphalerite (ZnS), the most common Zn mineral, smithsonite (ZnCO<sub>3</sub>), and zincite (ZnO), but Zn is also widely dispersed as a trace element in pyroxene, amphibole, mica, garnet and magnetite.

Zinc is used in geochemical prospecting as a pathfinder for various types of Zn mineralization, and is normally accompanied by Cd. Zinc, in association with Cd and Pb strongly suggests the presence of Sedex or VHMS mineralisation. Because of its strong chalcophile nature, Cd may be used to validate a questionable Zn anomaly. Elevated Zn values more likely indicate mafic rocks, or Fe/Mn co-precipitation. Contour maps for Zn are shown in Figure 24 and Figure 25, below.



Figure 24. Kriged RGS Zn data.

(Note: the image above displays both a lithophile signature with its broad association with more mafic units and finer discreet trends likely associated with more prospective fabrics)



Figure 25. Kriged RGS Zn data proximal to the Twin Glacier property.

(Note: Zn contours reflect similar trends to other chalcophile elements. The margin of the Bowser Basin is clearly outlined, suggesting a regional lithophile association. Regionally, the image outlines a large zinc offset along a NE structure bounding the northern part of the Bowser Basin. The regional contours show evidence of NW and NE-directed structures bisecting the Twin Glacier property area. Generally, broad zones of elevated zinc are associated with the Bowser Lake Group sedimentary rocks)

### Barium:

Barium is a lithophile element and is the 14th commonest element in the Earth's crust. The Ba<sup>2+</sup> ion is large and has a high charge ratio (radius/valence), resulting in its concentration in more felsic components of magmas in the later stages of crystallization. It occurs mostly in potassium feldspar and micas through the substitution of K<sup>+</sup> by Ba<sup>2+</sup>, which have similar ionic radii. Barium concentrations tend to be higher in K-feldspars than in phyllosilicates.

The principal Ba mineral, barite (BaSO<sub>4</sub>), is frequently associated with metalliferous mineral deposits. Secondary Ba minerals may include authigenic barite and witherite (BaCO<sub>3</sub>).

Elevated Ba values may indicate the presence of felsic rocks, especially kaolinised intrusives, in association with K, or calcareous rocks, in association with Ca, Mg and Sr.

Barium released from weathered rocks is not readily mobile since it is easily precipitated as sulphate and carbonate, strongly adsorbed by clays, concentrated in Mn and P concretions, and specifically sorbed onto oxides and hydroxides (Kabata-Pendias 2001). Figure 26, below, shows the regional Ba distribution.



Figure 26. Kriged RGS Ba data.

(Note: several distinct NE trends are seen in the regional Ba data. Less well-defined E-W trends may outline lithophile zones associated with felsic units. Ba lows are associated with early Neogene volcanics)

## **Other Significant Elements:**

Other elements that provided useful information when presented as kriged contour maps include molybdenum, manganese, and cobalt. Molybdenum contours (atomic absorption values) have a discernible NW and NE fabric (Figure 27). Mo highs generally form around and sometimes within intrusives and zones of faulting. Contour intervals have been adjusted to highlight subtle features.



Figure 27. Kriged RGS Mo data.

Manganese contours have similar behaviour to iron and a number of NW and NE directed fabrics are evident, as are the granitic intrusives marked by a circular low (Figure 28).



Figure 28. Kriged RGS Mn data.

Cobalt contours have a similar pattern to manganese, where structural and rock type fabrics appear to be evident. In addition, cobalt lows coincide with the granitic intrusives, but may form within rocks between intrusive rock packages (Figure 29).



Figure 29. Kriged RGS Co data.

### Loss on Ignition:

Loss on ignition (LOI) is a test used in inorganic analytical chemistry, particularly in the analysis of minerals. It consists of strongly heating ("igniting") a sample of the material at a specified temperature, allowing volatile substances to escape, until its mass ceases to change. The simple test typically consists of placing a few grams of the material in a tarred, pre-ignited crucible and determining its mass, placing it in a temperature-controlled furnace for a set time, cooling it in a controlled (e.g. water-free, CO<sub>2</sub>-free) atmosphere, and re-determining the mass. The loss on ignition is reported as part of an elemental or oxide analysis of a mineral. The volatile materials lost usually consist of "combined water" (hydrates and labile hydroxy-compounds) and carbon dioxide from carbonates. Figure 30 shows LOI contours for the RGS database.





(Note: Loss on Ignition (LOI) contours represents volatiles lost due to heating of the sample, and includes  $CO_2$ , entrained  $H_2O$ , and possibly sulphur. Note the complete absence of LOI in the core area of the intrusive complex, but its presence in the halo surrounding the intrusive complex (sericite and clays?), and in the NW and NE directed structures)

# ASTER IMAGERY RESULTS

Generally, the entire Twin Glacier Property is covered by vegetation and therefore provides only limited useful spectral information with respect to the rocks present within the Twin Glacier claim group. However to the east of the property, the consultant (Ward Kilby) generated a number of images showing very interesting spectral features. The SWIR RGB image (Figure 31), for instance, shows several areas of pink hues, indicating zones of clay mineralization, located to the immediate east of the property as well as partially within the margins of the property boundary. Zones in yellow further to the east are most likely related to the presence of carbonate units.



Name: Fig31\_TG\_SWIR\_RGB\_Image

Kilby produced another image using a masking technique to highlight areas of potential argillic and phyllic alteration minerals and mask out pixels not representing rock exposures with SWIR spectral features from these two alteration categories. Appendix C provides a more detailed description of the analysis. The image (Figure 32 and Figure 33) shows speckled regions to the east of the property of potential argillic alteration with only a very few specks of potential phyllic alteration. Also, this image highlights the Sulphurets highly mineralized area of Kerr, Snowfield, and Mitchell (KSM) as patches of potential phyllic alteration at the eastern margins of the regional area. This mineralized area is generally marked by porphyry copper-gold mineralization with sericite, chlorite, pyrite, and +/- quartz alteration associated with the phyllic assemblage (BC MINFILE 104B 191 (Kerr) and 104B 179 (Snowfield)). This derived potential argillic and phyllic alteration image demonstrates the significance of this technique in the identification of prospective areas.





The spectral angle mapping (SAM) mineral classification map (Figure 34) shows the distribution of the fifteen library spectra produced in the SAM mapping process. Black or unmapped areas represent pixels with spectrum significantly different from the library. This map displays light to dark purple colours on the south east margin of the claims, representing kaolinite-smectite zones that are associated with argillic alteration. Sky blue zones in this area, locally trending northeast, represents muscovite-bearing zones (sericite) associated with phyllic alteration. Less noticeable are grey zones of alunite, which appear to form along with the dark green zones of possible illite minerals. These same light to dark purple, kaolinite and smectite-bearing zones, are seen near the Kerr, Mitchell, and Snowfield deposits. The Snowfield deposit generally falls within a zone of muscovite (sericite - red and blue) and lesser kaolinite (purple and reddish purple). According to the BC MINFILE database, the Sulphurets (Snowfield) or Snowfield prospect (104B 179) is a porphyry-related gold or subaqueous hot spring silver-gold deposit with sericite, chlorite, and pyrite alteration. This sericite alteration corresponds with the muscovite alteration shown on the SAM



# DISCUSSION AND CONCLUSIONS

## RGS

The relationships between the regional stream sediment (RGS) data and the regional geology and geophysics are clearly evident. This should come as no surprise since chemical and physical properties are both determined by the geology. While this will not define a drilling target on a property scale, it does illustrate relationships at the regional (i.e., 10 km) scale and highlights prospective areas and trends. The repeated NW and NE intersecting geochemical fabrics or trends, as well as the proximity of the Twin Glacier property to strong regional gold, copper, zinc trends suggest that these directions might be significant on the property scale. This will impact the layout of prospecting, mapping, soil sampling or geophysical grids. The Twin Glacier Property appears to fall within geochemical lows for a number of elements, but the property does lie along or at the end of a regional NE and NW geochemical fabric. The property area contains a statistically low number of samples and that no samples have been collected for a few 10s of kilometres in the glaciated area to the north. Secondly, it appears that the most local collected stream sediment samples may derive (upstream) from the less prospective Tertiary Coast Plutonic Complex and Quaternary basalts. One sample, just to the north, appears to be associated with more prospective Triassic to Tertiary Granitic intrusives.

## ASTER IMAGERY

From the five analyzed ASTER images, areas of potential phyllic and argillic alteration minerals were identified throughout the regional area of interest. Unfortunately, due to the extent of vegetation cover within the property and glacial cover, very little rock spectral data could be analyzed within the immediate vicinity of the property. However, the analysis shows that there are several zones of potential argillic alteration, dominantly classified as kaolinite-smectite minerals in the area to the east of the claims. The alteration may continue into the Twin Glacier property, but may be masked by the vegetation. In the future, field-based spectroscopic analysis with a portable SWIR instrument such as a Terraspec or PIMA would eliminate the vegetation problem, but generally work best on a property scale due to scale issues. The analysis of outcrops and sediments may identify alteration minerals and show that the alteration to the east continues into the property.

Overall, on a regional scale the imagery analysis was able to identify significant zones of phyllic and argillic alteration. There are significant zones of argillic alteration minerals to the northeast of the property with a relatively northeast trend that leads onto the Twin Glacier Property. Significant zones of phyllic alteration minerals are found to the southeast of the property, generally with a weak northwesterly trend towards the property. This phyllic alteration trend stops about 10 km to the southeast of the property, but appears to be associated with vegetation cover. Although these argillic and phyllic trends may be weak they do appear to intersect within the Twin Glacier Property. In addition, these same trends were noted from the RGS analysis, with therefore promising implications for potential mineralization within the property that is not currently identified due to the vegetation cover and the lack of stream sediment samples collected within the region.

The ASTER image analysis was able to identify the significant phyllic alteration zones in the southeast region in association with the Kerr, Mitchell, and Snowfield deposits or mineralized zones. In general the mineralization in the area is associated with porphyry-related copper and

gold. According to the BC MINFILE database the Kerr prospect (104B 191) was modeled as a copper-gold porphyry by Placer Dome with a total measured, indicated and inferred resources estimated at 140.8 million tonnes grading 0.75 per cent copper and 0.36 grams of gold per tonne at a 0.40 per cent copper grade cut-off. The reserve has been later increased and updated by Seabridge Gold Inc., but includes additional prospects around Kerr. This adds supporting evidence to the benefits of using ASTER imagery to identify prospective regions of significant mineralization.

In conclusion, both the RGS and ASTER image analysis can be used on a regional scale to identify trends and zones of potential mineralization for future examination. Each data set and method has its own limitations, as the RGS may have gaps of samples or areas void of elemental results and the ASTER image is limited by vegetation and glacier cover. While these limitations affect the Twin Glacier Property, these analyses have shown that the property lies along significant NE and NW elemental and spectral trends and also lies within the zone of intersecting elemental trends. The limitations of this study can be reduced on a property scale by performing stream sediment surveys within the property and the collection of rock and soil sample for spectral analysis by the PIMA or Terraspec SWIR. All these tools will impact the layout of prospecting, mapping, soil sampling or geophysical grids, and provide valuable input on a regional scale to aid in locating zones of potential interest for staking new claims or acquiring existing claims.

# **RECOMMENDATIONS FOR FUTURE WORK**

Work carried out in 2012, along with a review of existing data, suggests potential for mineral deposits at or in the vicinity of the Twin Glacier property. Potential for the discovery of three different deposit types may exist. Further exploration for VMS potential should focus on the Triassic volcanics and marine sediments, which appear in north and central portion of the property. This work should also focus along trend of the Rock and Roll VMS Deposit located approximately 3 kilometers to the southeast of the Twin Glacier property. Exploration for intrusive-related gold mineralization should focus around nearby Triassic to Jurassic intrusives, which are present at surface near the property boundary, and may be present at depth on the property scale structures as the proximal Triassic intrusive may provide a heat source for mineralizing fluids. The RGS data shows that there is a repeated NW and NE regional geochemical fabric with locally intersecting trends and that may be related to regional structures. Further exploration should concentrate along dilation zones along these trends.

Future work to discover these potential deposits should include prospecting within areas of Triassic volcanics and marine sediments nearest to the Triassic to Jurassic granitic intrusives and within areas of structural intersections and geochemical trends. Additionally, a soil geochemistry survey may be laid within the prospecting area with uniform sample spacing and oriented northeast, perpendicular to the northwest regional structure and RGS trends and potential along trend with ISKUT 2 prospect (Iskut Porphyry prospect). According to Burgoyne (2008), a mineralized porphyry gold-copper-molybdenum system has been identified at the ISKUT 2 prospect. The property is generally within steep rugged terrain which may pose some difficulty laying out a soil geochemistry survey. Therefore a property scale stream sediment geochemical survey and prospecting may be recommended and would include collection of high energy and heavy mineral samples along major drainages running through the property. This would help to refine and better identify exploration targets on a property scale, following up on the regional trends seen in the BC RGS data.

# COST STATEMENT FOR THE 2012 PROGRAM

The cost of the 2012 exploration program at the Twin Glacier property is summarized below Total expenditures for the RGS Geostatistical data analysis and GIS work as well a SWIR-ASTER imagery analysis and reports in 2012 further described in this report were approximately \$12,800 (Canadian dollars), as shown in the filing for MTO Event Number 5402718. The total work applied is \$13,752, including a \$952.08 of debited PAC amount and satisfies the assessment filing requirements for the period.

Work carried out at the Twin Glacier property in 2012 included the following:

 Acquisition of data for 7,120 stream sediment samples from the BC Regional Geochemical Survey (RGS) database, data processing, and preparation of a 25-page report (Appendix A). Each sample has analytical data for 38 elements, using up to four different analytical methods. Additional data include Loss on Ignition and pH. This work resulted in the generation of 53 kriged colour images that were considered in the analysis.  Acquisition of five ASTER images, data processing and analysis, and preparation of a 33-page report (Appendix C). Analysis of each ASTER image resulted in the generation of one natural image, one ASTER SWIR 468 image, and two images analyzing phyllic and argillic alteration. In addition, one spectral angle map was generated and a spectral library with 15 spectral end members was extracted from the processed ASTER images.

The following table summarizes the costs for this work:

Provider of Services	Description of Work	Cost (\$CN)
Hans Madiesky, P.Geo., consulting geochemist	Acquisition/analysis of RGS data	\$5,280
Ward Kilby, P.Geo., consulting imagery analyst	Acquisition/analysis of ASTER data	\$6,720
G. Carter, P.Geo., senior geologist, Cambria	Provide geological framework for RGS and	\$800
Geosciences	ASTER analysis	
	Total:	\$12,800

#### Table 2. Cost Statement for the Twin Glacier project

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# **CERTIFICATES OF AUTHORS**

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Mailing Address: 441 Alouette Drive Coquitlam, British Columbia, Canada V3C 4Y6

I, Alanna Ramsay B.Sc., GIT am a Geologist residing in Vancouver, British Columbia, and do hereby certify that:

- I have supervised the exploration work and participated in the preparation of this Technical Report on the Twin Glacier property.
- I graduated from Simon Fraser University in 2008 with a B.Sc. Degree in Earth Science.
- I am a Geoscientist in Training registered in the Association of Professional Engineers and Geoscientists of British Columbia, member #155150.
- From 2008 to the present, I have been actively engaged as a geologist in mineral exploration in Canada.
- I hold a stock option from Dolly Varden Silver Corporation that was granted as a bonus for work performed during the 2011 Wolf exploration season.

a. L. Romsay

Alanna Ramsay, GIT

#### Ginette Carter., P. Geo.

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I, Ginette Carter (nee Freiholz) M.Sc, P.Geo. am a Professional Geologist residing in North Vancouver, British Columbia, and do hereby certify that:

- I have supervised the exploration work and participated in the preparation of this Technical Report on the Twin Glacier Property of Dolly Varden Silver Corp.
- I am a "qualified person" as defined in National Instrument 43-101: Standards of Disclosure for Mineral Projects ("NI 43-101") and my qualifications include the following:
  - I graduated from UQUAM (University du Quebec a Montreal) in 1981 with a B.Sc.
     Degree in Geology.
  - I obtained a M.Sc. Degree in Geology (Economic and Structural Geology) from the University of Calgary in 1984.
  - I am a Professional Geologist registered with the Association of Professional Engineers and Geoscientists of British Columbia, License #19544.
  - From 1982 to the present, I have been actively engaged as an exploration geologist in mineral exploration in Western Canada, Northern Canada, Kyrgistan, Western and Central Africa.
  - I do not hold either shares or stock options from Dolly Varden Silver Corporation.

Suite Carl

Ginette Carter, P. Geo.