

Exploration

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CINOLA

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094E GEN

(SAM GOOSLY) EQUITY

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TOODOGGONE AREA

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# Revised stream sediment geochemistry at selected precious metal deposits in British Columbia

J J Barakso and P Tegart

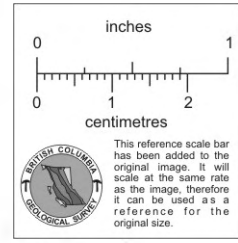


Table 1. Some of the 'classic' heavy minerals of economic interest

MINERAL	Specific Gravity	Au ppm
Diamond "C"	3.5	0.00056 - 0.0031
Rutile TiO <sub>2</sub>	4.2 - 5.5	0.02 - 0.65
Ilmenite FeTiO <sub>3</sub>	4.4 - 4.8	0.0019 - 0.0022
Zircon ZrSiO <sub>4</sub>	4.6 - 4.7	0.01
Chromite FeCr <sub>2</sub> O <sub>4</sub>	4.6	0.01 - 0.2
Monazite (Ce, La, Y, Th) PO <sub>4</sub>	5.0 - 5.3	0.001 - 0.03
Magnetite FeFe <sub>2</sub> O <sub>4</sub>	5.2	0.001 - 0.0120
Thorite Th (SiO <sub>4</sub> )	5.3	0.001 - 0.05
Columbite (Fe, Mn) (Nb, Ta) <sub>2</sub> O <sub>6</sub>	5.3 - 7.3	0.05
Scheelite CaWO <sub>4</sub>	5.9 - 6.1	0.03
Cassiterite SnO <sub>2</sub>	6.2 - 7.0	0.2 - 0.5
Wolframite (Fe, Mn) WO <sub>4</sub>	7.1 - 7.6	0.17
Uraninite UO <sub>2</sub>	9.0 - 9.7	0.025 - 0.1
Thorianite ThO <sub>2</sub>	9.7	0.05
Platinum Pt	14.0 - 19.0	200 - 36,000
Gold Au	15.0 - 19.3	600,000 - 10 <sup>6</sup>

All data from the literature.

**ABSTRACT.** Despite the many prospects which have been discovered by conventional stream sediment geochemistry, the dispersion studies of elements in the vicinity of various existing prospects and orebodies indicate that a revision of stream sediment geochemistry methods for most of the elements including gold, is necessary and inevitable.

Stream sediment sampling has not changed much since it was introduced to us in the late fifties by HE Hawks, J. Riddell; and JAC Fortescue. Our attempt in this paper is to revise the stream sediment sampling for precious metals but our work is carried out as well as for base metals, molybdenum, uranium, etc, but those will be discussed in a separate paper.

In this study emphasis was placed on those areas where conventional stream sediment geochemistry failed to produce anomalies at a reasonable sampling density. For further improvement of stream sediment geochemical techniques a routine low cost heavy mineral sampling technique was worked out and implemented in several areas.

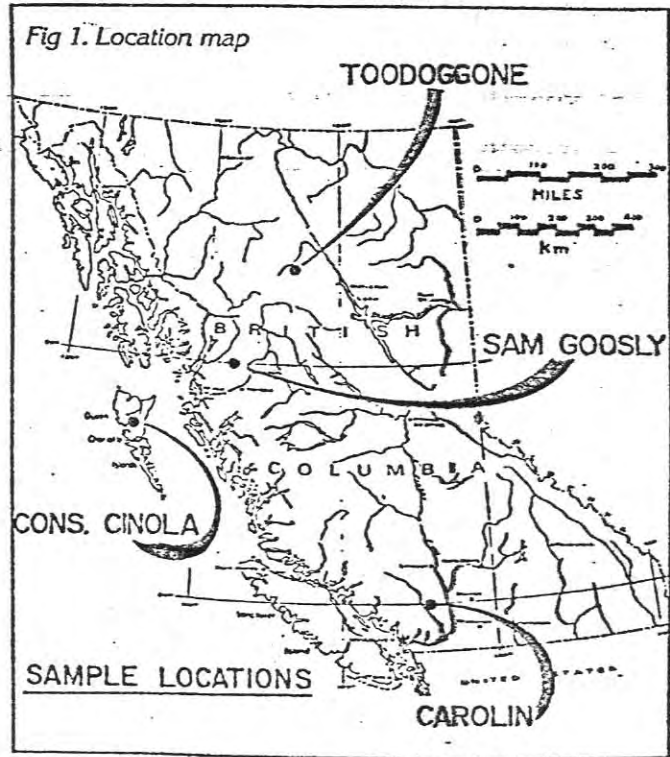
Details of sampling and analytical data together with dispersion processes are discussed at Carolin Mines, Consolidated Cinola Mines, Equity Silver Mines, Toodoggone Area (Baker Mine, Lawyers Creek, Great Western Petroleum).

In conjunction with the environmental aspects of gold and silver dispersion, the applicable pathfinder elements are briefly discussed.

Table 2. Some secondary minerals of stream sediments

MINERAL	Composition	Au ppm
Limonite (Amorphous)	FeO(OH)·nH <sub>2</sub> O	0 - 50.0
Goethite	HFeO <sub>2</sub>	0.01 - 22.00
Hematite	Fe <sub>2</sub> O <sub>3</sub>	0.002 - 0.90
Jarosite	KFe <sub>3</sub> (OH) <sub>6</sub> (SO <sub>4</sub> ) <sub>2</sub>	2.0 - 8000.0*
Pyrolusite (E wad Mn ox)	MnO <sub>2</sub>	0.2 - 35.0*
Argentojarosite	AgFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	0.6 - 20.0
Cerargyrite	AgCl	0.1 - 2.0
<b>Secondary and primary minerals</b>		
Arsenopyrite	FeAsS	0.01 - 750.0*
Pyrrargyrite	Ag <sub>3</sub> SbS <sub>3</sub>	0.10 - 6.5*
Proustite	Ag <sub>3</sub> AsS <sub>3</sub>	32.0*
Pyrrhotite	Fe <sub>1-x</sub> S	0.003 - 500.0*
Marcasite (Pyrite)	FeS <sub>2</sub>	0.01 - 500.0
Heavy Mineral Sulphates		0.01 - 0.17*
Heavy Mineral Sulphides		0.01 - 1,000.0
Gold	Au	600,000 - 10 <sup>6</sup>
Platinum	Pt	200 - 36,000*
Gold Amalgam	Au <sub>2</sub> Hg <sub>3</sub>	20,000 - 400,000*
Argentian Gold (Electrum)	(Au, Ag)	10,000 - 600,000*

\*Data from the literature.



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Introduction: In regional exploration the most rapid and reliable method of finding promising targets in the Cordilleran region is the technique of stream-sediment sampling. Stream-sediment sampling technique has not changed much since it was introduced to us in the late 1950s by HE Hawks, J Riddell and JAC Fortescue. Our attempt in the past few years was to revise stream-sediment geochemistry methods for precious metals, as well as for base metals and molybdenum, tungsten, tin, etc, but the latter ones will be discussed in separate papers.

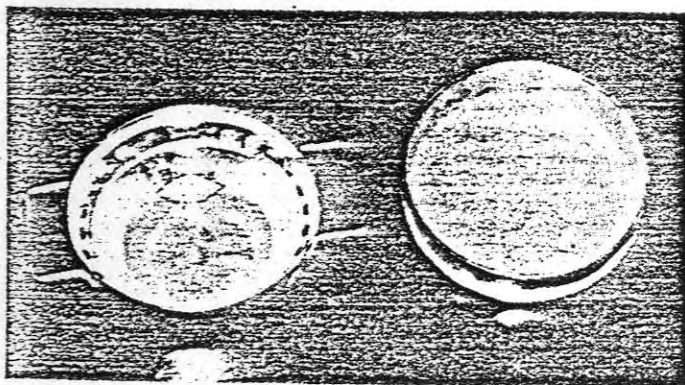
Examination of the validity and reliability of stream-sediment geochemistry of existing deposits particularly in the case of noble metals, led to the conclusion that utilizing heavy mineral techniques increases success in gold and silver exploration. Heavy mineral concentration by panning has been used for centuries in exploration for many metals and minerals.

Since the development of geochemical techniques in



Fig 2A. Heavy mineral sampling method (sampler Ty Balacko, Min-En Labs Ltd)

Fig 2B. Heavy mineral sampling tool



SAMPLE WEIGHT REDUCTION ON HEAVY MINERAL (H.M.) CONCENTRATES:

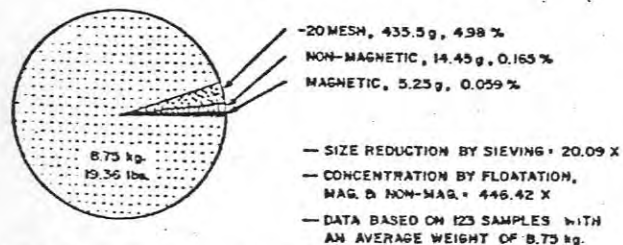


Fig 3. Sample size reduction by the various concentration procedures

exploration, the search in the past twenty years has concentrated on sulphide-bearing ore deposits. This led to the neglect of systematic development of heavy mineral geochemical techniques until the intensified search recently focused on some of the heavy minerals like Sn, W, Au, Ag and Pt which also showed some improved economic interest. This research project was designed to test the validity of our heavy mineral sampling and processing techniques and to compare the data with conventional stream-sediment sampling results. (The locations of samples used in this study are shown in Fig 1).

## REVIEW

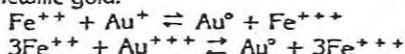
In the middle thirties NH Brundin, in Sweden, (Brundin and Nairis, 1972) (Brundin and Bergstrom, 1977) used pan concentrates of geochemical samples for spectrographic analysis to increase the detection limit and sensitivity of analysis of geochemical samples. In the early history several authors examined and discussed the use of pan concentrates; eg Mertie (1954) Fisher and Fisher (1968), and Wells (1973). Theobald (1957) carried out a systematic heavy mineral study as part of a geochemical survey and succeeded in locating interesting tungsten mineralization. Zeschke (1961) showed that heavy minerals can be dispersed for several kilometres downstream. Varlamoff (1971) reported that tungsten minerals in equatorial and tropical conditions of Central Africa are partly dissolved and partly mixed with the finest products of alluvium and are transported "for distances that may be expressed in kilometres and tens of kilometres". RA Walters et al (1978) reported a systematic reconnaissance utilizing heavy minerals as a successful tool for locating uranium mineralization.

Barakso and Gower (1973) reported tin anomalies in the Yukon and Northern British Columbia which were obtained using specially-designed sieve-and-pan methods developed in the early 1960s. Similar heavy mineral studies were carried out for cassiterite by Zantop et al (1978) using panning methods. Recently Wilhelm et al (1978), in France, carried out a rather interesting research study in base metal prospecting, examining the mineralogy of several stream sediment samples around base metal deposits. They also tested the various fractions (eg. iron hydroxides) for their base metal contents and very closely examined the heavy mineral fractions as an aid in locating orebodies by sampling those fractions.

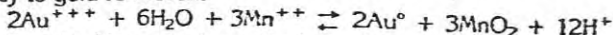
Our involvement with heavy mineral fractions dates back to the early 1960s when ways were found to focus on minerals such as Sn, W, etc. During the early 70s this work led to the use of heavy mineral sampling media to locate base metal targets in the Cordilleran regions. Following much experimentation, these techniques were adapted for use with precious metals in the late 70s. It is not our intention to discuss all the processes of weathering in relation to stream geochemistry. The application of heavy mineral sampling, however, requires an understanding of the basic principles of precious metal deposition in stream-sediments in particular to appreciate the importance of secondary minerals formed in stream beds, and especially in the case of gold since it is the most-studied precious metal and still very little is known about its transformations.

Iron and manganese hydroxides are known to be important co-precipitants and dominant factors in fixing the various elements in the secondary heavy mineral suite of stream beds. Also this can shed some light on the basic principles of the chemical processes which occur in the secondary environment during stream sediment deposition. These in some instances show many similarities to gossan formation in the secondary environment. RW Boyle (1979) notes the two most important reactions of surface processes for gold and silver are the following:

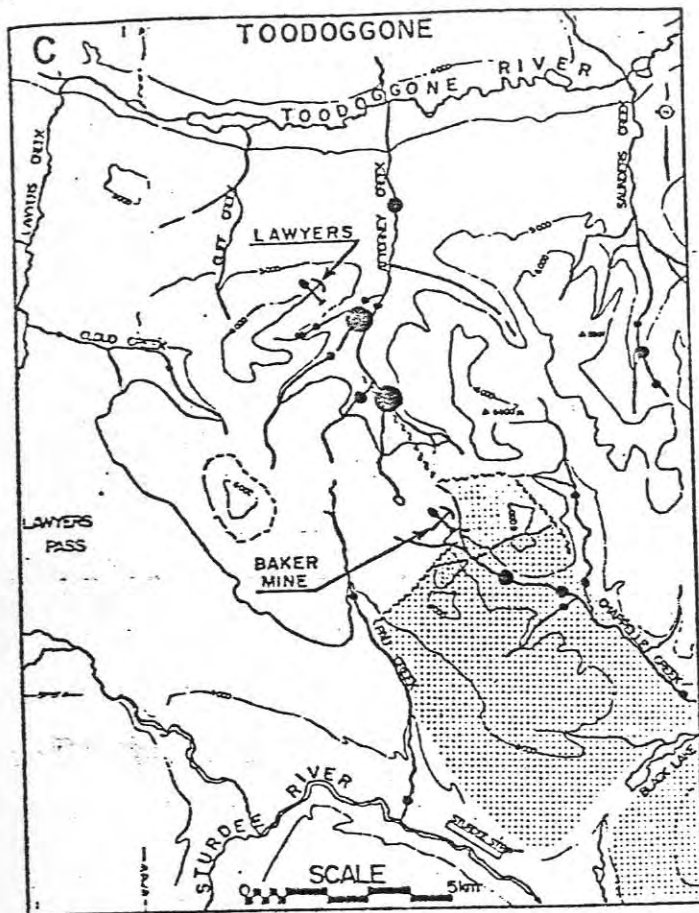
First are the iron reactions in the stream environment producing metallic gold:



The second important reaction involves manganese as the main key to gold reduction:



The third important reaction is the iron sulphide reaction which involves the formation of secondary sulphides as well as assisting in many phases of gold reduction and incorporation into secondary sulphides or the copper reactions involving



**LEGEND:**

- LOWER JURASSIC
  - quartz monzonites, granodiorite
- TOODOGGONE GROUP
- UPPER TRIASSIC
  - TAKLA GROUP
- UPPER PALEOZOIC
  - ASITKA GROUP

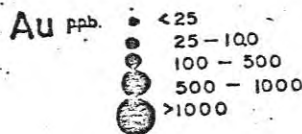
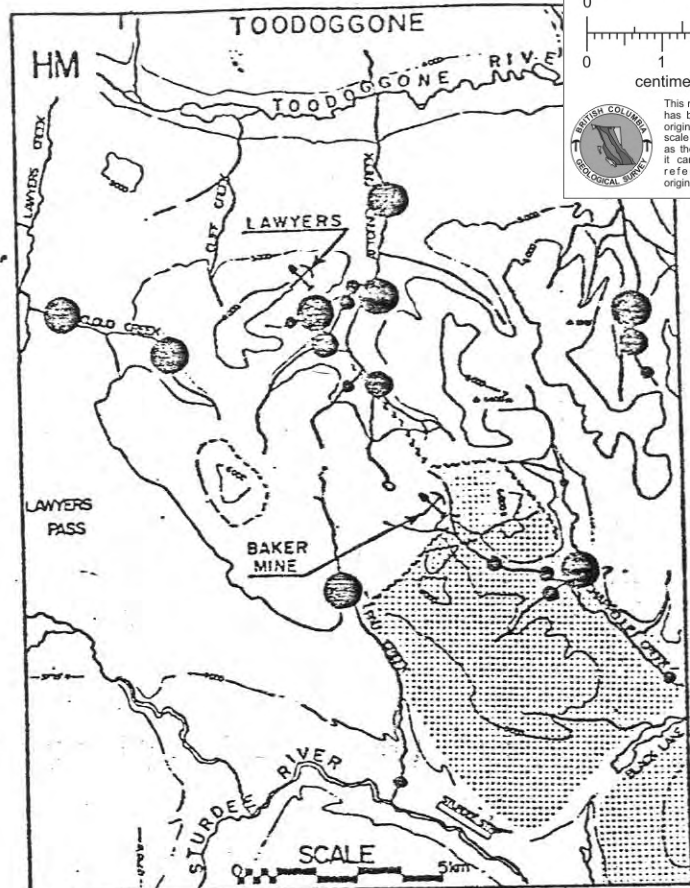


Fig 4A. Gold content of conventional stream sediment samples in the Toodoggone area



**LEGEND:**

- LOWER JURASSIC
  - quartz monzonites, granodiorite
- TOODOGGONE GROUP
- UPPER TRIASSIC
  - TAKLA GROUP
- UPPER PALEOZOIC
  - ASITKA GROUP

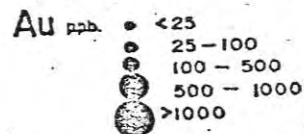
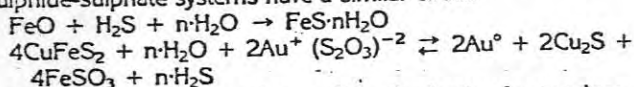


Fig 4B. Gold content of heavy mineral stream sediment samples in the Toodoggone area

sulphide-sulphate systems have a similar effect.



Where some of the products will be the basis of secondary sulphides, sulphates enriched in gold content.

Also the selective chemical attacks (hydrochloric-hydrobromic acid etc), reveal the existence of gold in the various iron and manganese hydroxides. Thus the crystalline limonites (goethite, hematite), jarosite; and the amorphous forms are very important components, together with other secondary minerals as catalysts and co-precipitants from the precious metal point of view, particularly in the case of gold.

The above equations give us insight into gold reduction; with the help of other catalytic reactions they explain to a certain extent the crystallization of gold forming micro-nuggets in stream sediments.

Gold reduction was explained by Latimer in 1952, when he stated that gold can be reduced very easily from the ionic state to the metallic form since it possesses the lowest number electrode potential ( $E^\circ$ ) in the electrochemical series, as shown below.

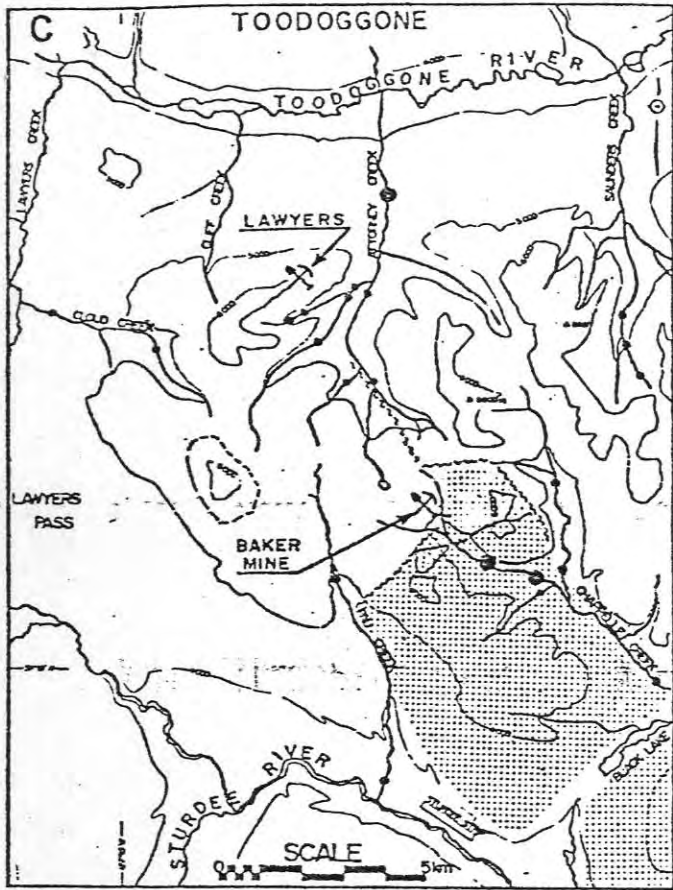
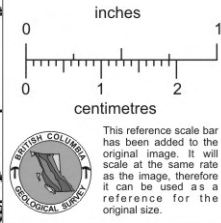
$\text{Cu} = \text{Cu}^{++} + 2e^-$	$E^\circ = -0.337$
$\text{Fe}^{++} = \text{Fe}^{+++} + e^-$	$E^\circ = -0.771$
$\text{Ag} = \text{Ag}^{++} + e^-$	$E^\circ = -0.7991$
$2\text{H}_2\text{O} = \text{O}_2 + 4\text{H}^+ + 4e^-$	$E^\circ = -1.229$
$\text{Mn}^{++} + 2\text{H}_2\text{O} = \text{MnO}_2 + 4\text{H}^+ + 2e^-$	$E^\circ = -1.23$
$\text{Au} = \text{Au}^{+++} + 3e^-$	$E^\circ = -1.50$
$\text{Au} = \text{Au}^+ + e^-$	$E^\circ = -1.68$

This explains why gold is called a "noble" element.

It is often thought that gold is never in true solution in any natural system but rather resides in the form of very finely divided particles, which are hydrated or coated with a variety of natural substances like fine silt silica, iron hydroxide, etc, which stabilize the gold in the aqueous medium. In the past the role of chemistry and the existence of flour gold in stream sediments has been highly debated, but with modern concepts one can accept that the flour gold most often are gold crystals or micro-nuggets resulting from chemical dissolution from primary minerals and, after transportation, deposited by a similar chemical mechanism as the above processes. In this study it has been observed that in some cases up to 70% of the heavy minerals can originate as mechanically transported detrital dispersion products in stream sediments. This point is particularly relevant on the Coast Range of Western Canada, but not necessarily in the interior and in the southern part of the Cordillera, where the chemical deposition of secondary minerals in stream beds is more abundant and can make up to 100% of the metal values of secondary minerals.

On the basis of the above brief review, it is concluded that in any heavy mineral sampling technique it is very important to retain the detritally and chemically secondary dispersed metals, particularly those secondary minerals that carry precious metals. For this reason Table 1 and Table 2 are presented. The first table lists the well-known "classic" suite of heavy minerals on which all panning and other heavy mineral separations are based.

The second table summarizes the secondary minerals which carry important amounts of gold and which are important constituents of stream sediment samples in many districts. These



**LEGEND:**

- LOWER JURASSIC
  - quartz monzonite, granodiorite
- TOODOGGONE GROUP
- UPPER TRIASSIC
  - TAKLA GROUP
- UPPER PALEOZOIC
  - ASITKA GROUP

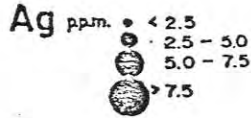
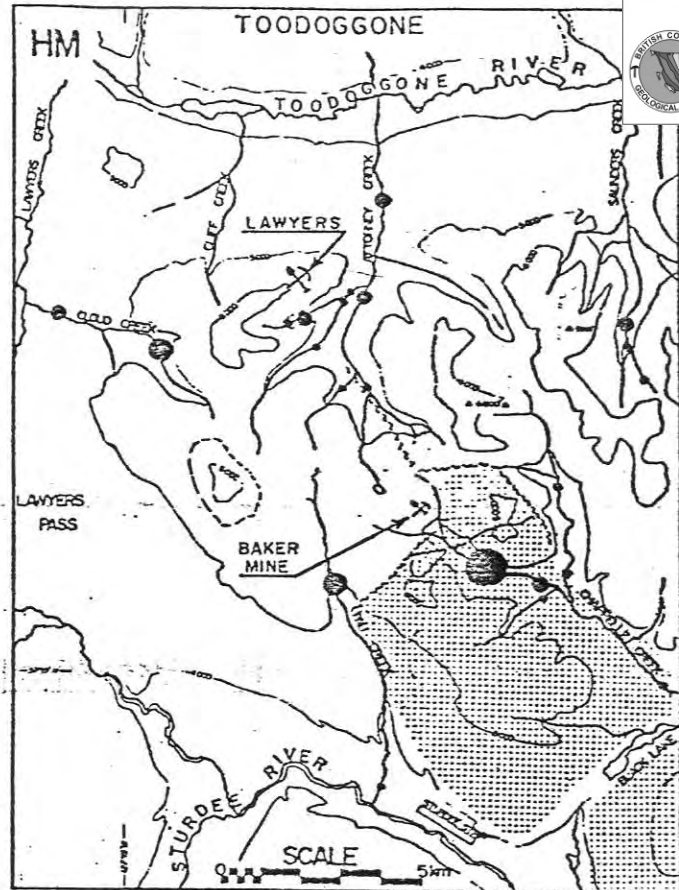


Fig 5A. Silver content of conventional stream sediment samples in the Toodoggone area



**LEGEND:**

- LOWER JURASSIC
  - quartz monzonite, granodiorite
- TOODOGGONE GROUP
- UPPER TRIASSIC
  - TAKLA GROUP
- UPPER PALEOZOIC
  - ASITKA GROUP

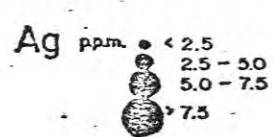


Fig 5B. Silver content of heavy mineral stream sediment samples in the Toodoggone area

two tables are presented to emphasize the importance of those minerals which occur in secondary forms in stream beds, since as Table 2 shows many of them carry a lot more gold than minerals listed in Table 1 (classic heavy minerals).

**METHODS AND MATERIALS**

An orientation survey was carried out around known precious-metal deposits to evaluate the developed heavy mineral sampling procedures and techniques.

Conventional stream-sediment samples were taken routinely at each sample site together with a heavy mineral sieved sample.

The heavy mineral sampling method and the sampling device are indicated by the photographs (Fig 2A and 2B).

Samples were sieved with 40 mesh screens around the Baker Mine, Lawyers, and Goosly, and with 20 mesh screens at Carolin Mines and Consolidated Cinola.

The mesh size is relevant in the concentration technique. During the early stages of heavy mineral evaluation, it was found that on the coast 20 mesh is most satisfactory, whereas in the interior 40 mesh is more applicable.

All collected samples were dried and prepared in laboratory facilities.

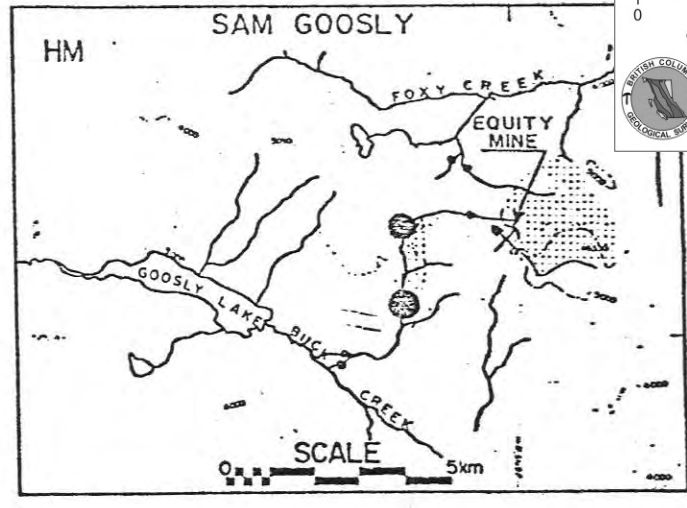
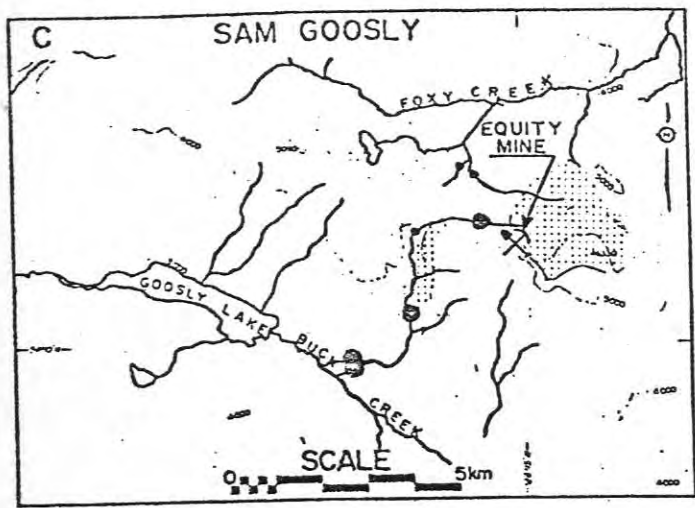
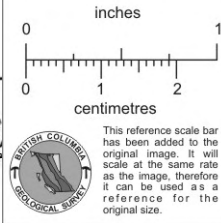
The conventional stream-sediment samples were treated routinely and analyzed for various suites of elements. The magnetic and non-magnetic -20 + 80 mesh fractions of the heavy mineral samples were prepared and floated over a 3.1 specific gravity and material above 3.1 was discarded. Following this, the analyses were carried out in a routine trace analysis

fashion, using the non-magnetic fraction for the discussed elements.

The relative ratios of sample fractions are shown in Fig 3. The experimentation for this figure was carried out in 1978 on 123 samples. The main point of this diagram is the field-sample size reduction on 123 samples. With an average weight of 19.36 lb, the weight reduction is 20.09 times by sieving. The total sample concentration is 446.42 times including magnetic fraction, and 605.53 times excluding magnetic fraction. To test the validity of the heavy mineral method in the Cordilleran region, four test areas were chosen where conventional stream-sediment geochemical methods were unsatisfactory or did not produce anomalous results. The locations of the areas sampled are shown in Fig 1.

**Toodoggone Area**

Gold and silver mineralization in the Toodoggone camp was discovered by detailed reconnaissance geochemistry and prospecting in the late 60s. The host rocks of the gold-silver mineralization in the area are the Triassic Takla Group at the Baker Mine and the Jurassic Toodoggone volcanics as at the Lawyers property. Gold mineralization occurs within a siliceous gangue almost solely in the form of electrum Au, Ag with associated pyritic sulphides at the Baker Mine, or without sulphides at the Lawyers property. Orebodies hosting mineralization include veins at Baker and vein stockworks and breccia fillings at Lawyers, both controlled by contemporaneous faulting. The mineralization appears to be related to Jurassic intrusions in the district.



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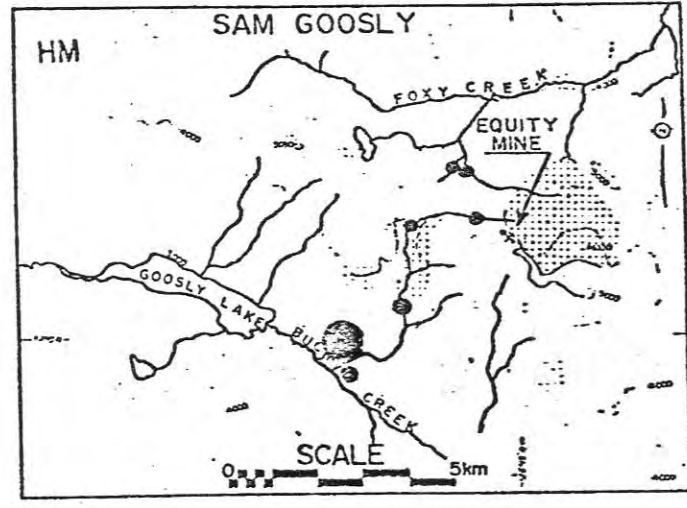
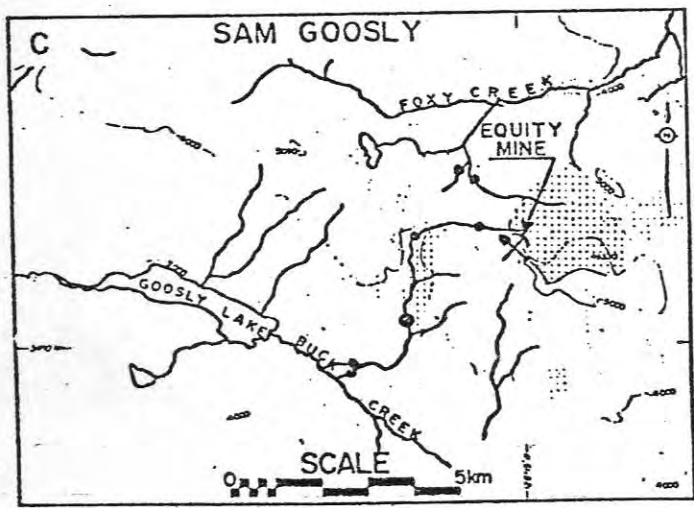
- TERTIARY**
- pyroxene trachyandesite lava
  - pyroclastics, argillite, conglomerate
  - plagioclase porphyry, granitic stocks
- Ag ppm.**
- < 2.5
  - 2.5 - 5.0
  - 5.0 - 7.5
  - > 7.5

Fig 6A. Silver content of conventional stream sediment samples in the Sam Goosly area

**LEGEND:**

- TERTIARY**
- pyroxene trachyandesite lava
  - pyroclastics, argillite, conglomerate
  - plagioclase porphyry, granitic stocks
- Ag ppm.**
- < 2.5
  - 2.5 - 5.0
  - 5.0 - 7.5
  - > 7.5

Fig 6B. Silver content of heavy mineral stream sediment in the Sam Goosly area



**LEGEND:**

- TERTIARY**
- pyroxene trachyandesite lava
  - pyroclastics, argillite, conglomerate
  - plagioclase porphyry, granitic stocks
- Au ppb.**
- < 25
  - 25 - 100
  - 100 - 500
  - 500 - 1000
  - > 1000

Fig 7A. Gold content of conventional stream sediment samples in the Sam Goosly area

**LEGEND:**

- TERTIARY**
- pyroxene trachyandesite lava
  - pyroclastics, argillite, conglomerate
  - plagioclase porphyry, granitic stocks
- Au ppb.**
- < 25
  - 25 - 100
  - 100 - 500
  - 500 - 1000
  - > 1000

Fig 7B. Gold content of heavy mineral stream sediment in the Sam Goosly area

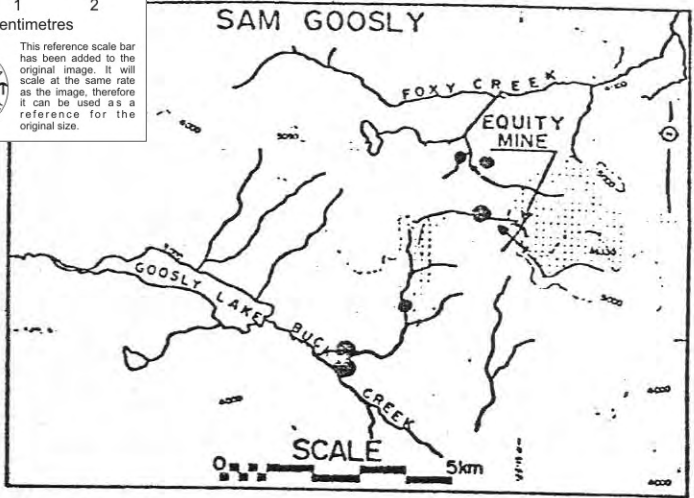
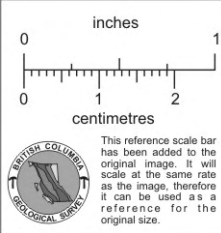
Mineralization found to date appears to be confined to the western margin of the northwesterly trending Orinoca belt and for the present by the proximity of the Lower-to-Middle Jurassic quartz monzonite and granodiorite intrusives. Silver to gold ratios are fairly consistently 20:1 for those showings examined to date.

Samples collected from this area were routinely handled and results for gold and silver are indicated on Fig 4A and 5A for conventional (C) stream sediments and Fig 4B and 5B for heavy mineral (HM) concentrates.

**Sam Goosly Area (Equity Silver Mine)**  
The Sam Goosly Deposit was discovered by fluorine geochemistry by establishing a 10 square mile stream sediment anomaly. This

was followed by regional soil sampling. Sulphides, primarily in the form of chalcopyrite, pyrite and tetrahedrite with associated arsenic and antimonial sulphides and gold, occur within a pyroclastic phase of Mesozoic strata comprising of argillites and conglomerates located immediately to the west of a feldspar porphyry stock and east of a granite monzonite stock. The Mesozoic rocks are exposed in a window eroded in Tertiary cover rocks. The mineralization consists of at least two phases with perhaps three distinct events. However, the relationship of the ore genesis to either intrusive has not been proven.

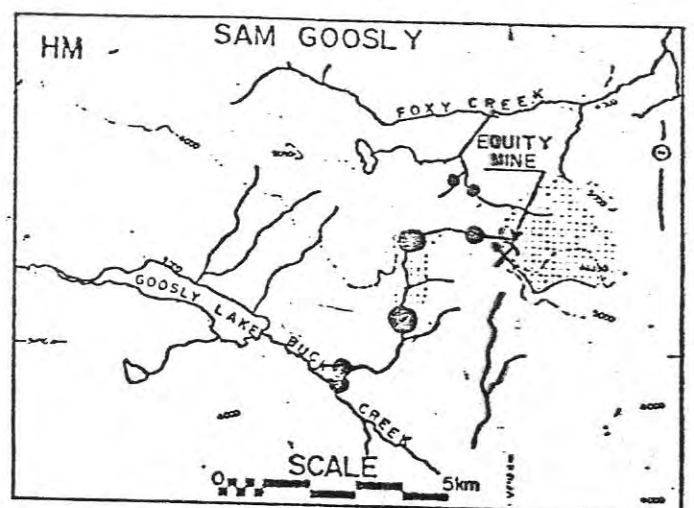
Analytical data obtained for the stream sediments are silver, gold, arsenic, zinc, antimony and mercury as the most known pathfinder elements. The data indicate that heavy mineral



**LEGEND:**

<b>TERTIARY</b>	<b>As p.p.m.</b>	● < 50
pyroxene trachyandesite lava	50 - 150	150 - 350
pyroclastics, argillite, conglomerate	> 350	
plagioclase porphyry, granitic stocks		

Fig 8A. Arsenic content of conventional stream sediment samples in the Sam Goosly area



**LEGEND:**

<b>TERTIARY</b>	<b>As p.p.m.</b>	● < 10
pyroxene trachyandesite lava	10 - 30	30 - 100
pyroclastics, argillite, conglomerate	> 100	
plagioclase porphyry, granitic stocks		

Fig 8B. Arsenic content of heavy mineral stream sediment in the Sam Goosly area

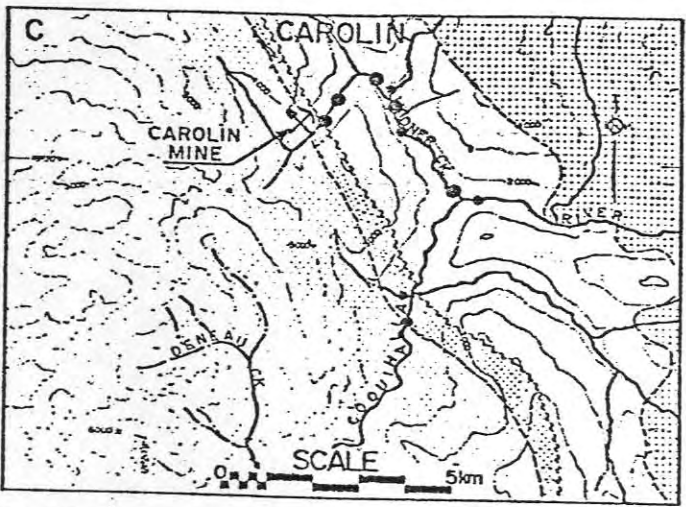
samples produce clear cut anomalies for several miles from the deposits. Again it is clear that the heavy mineral sampling technique is a major improvement over the conventional stream sediment technique, with which many exploration companies failed to detect the orebody during their routine reconnaissance surveys. These figures are presented herewith for silver, gold and arsenic. (Fig 6, 7, 8A and 8B).

**Carolin Area**

The Carolin Deposit was located by examination of old prospects. Arsenopyrite with associated gold occurs within quartz segregations that parallel the schistosity of the Ladner group of

sediments composed of pelites and numerous serpentinite and serpentinitized periodotite bodies which lie adjacent to the northwesterly trending Hozameen Fault. The mineralization occurs in flat-lying elongate lenses subparallel to the sediment of the Ladner group and to the Hozameen Fault, the ends of which crop out in Ladner Creek.

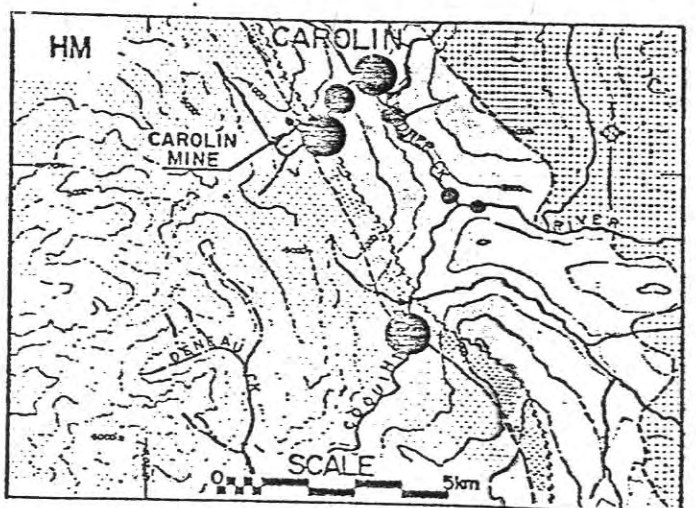
Data from the samples obtained from this area (Fig 9A & B for gold, and 10A & B for arsenic) illustrate the gold and arsenic pattern of stream sediment samples. The 'B' (HM) figures illustrate how the heavy mineral concentrates reflect the presence of the ore body as compared with the conventional stream geochemical data shown on the 'A' figures (C).



**LEGEND:**

<b>TERTIARY</b>	<b>Au ppb.</b>	● < 25
granodiorite, quartz diorite	25 - 100	100 - 500
LADNER GROUP: pelite, volcanic sandstone	500 - 1000	> 1000
<b>DEVONIAN</b>		
ultramafics, serpentinite, peridotite		
HOZAMEEN GROUP: pelite, chert, basic volcanics		

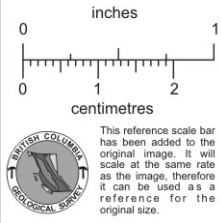
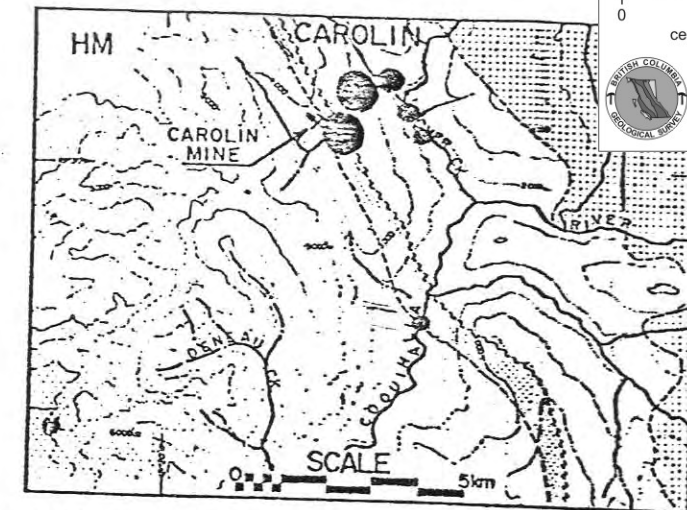
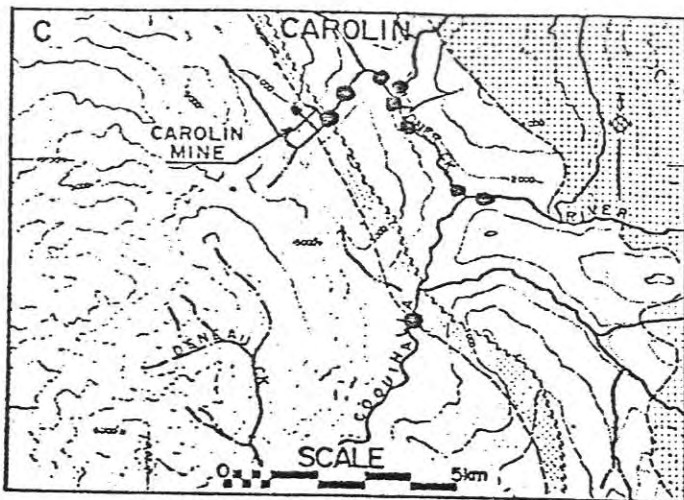
Fig 9A. Gold content of conventional stream sediment samples in the Carolin area



**LEGEND:**

<b>TERTIARY</b>	<b>Au ppb.</b>	● < 25
granodiorite, quartz diorite	25 - 100	100 - 500
LADNER GROUP: pelite, volcanic sandstone	500 - 1000	> 1000
<b>DEVONIAN</b>		
ultramafics, serpentinite, peridotite		
HOZAMEEN GROUP: pelite, chert, basic volcanics		

Fig 9B. Gold content of heavy mineral stream sediment in the Carolin area



**LEGEND:**

- TERTIARY**
- granodiorite, quartz diorite
  - LADNER GROUP: pelite, volcanic sandstone
- DEVONIAN**
- ultramafics, serpentinite, peridotite
  - HOZAMEEN GROUP: pelite, chert, basic volcanics
- As ppm**
- <50
  - 50 - 150
  - 150 - 350
  - >350

Fig 10A. Arsenic content of conventional stream sediment samples in the Carolin area

**LEGEND:**

- TERTIARY**
- granodiorite, quartz diorite
  - LADNER GROUP: pelite, volcanic sandstone
- DEVONIAN**
- ultramafics, serpentinite, peridotite
  - HOZAMEEN GROUP: pelite, chert, basic volcanics
- As ppm**
- <50
  - 50 - 150
  - 150 - 350
  - >350

Fig 10B. Arsenic content of heavy mineral stream sediment samples in the Carolin Mine area

**Cinola Area**

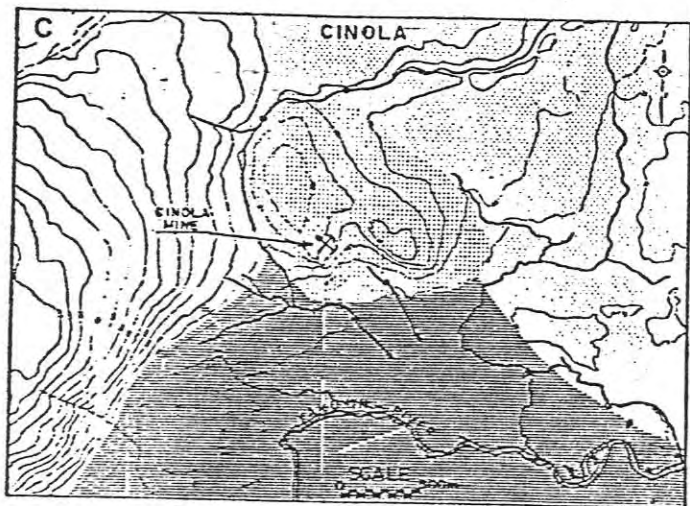
The Cinola Deposit was discovered by prospectors. In British Columbia it is the best example of what might be called a sub-microscopic (colloidal) gold deposit. Micron gold is hosted by silicified Cretaceous Haida shales and Mio-Pliocene Skonum Formation conglomerates, arkosic grits, minor shales and carbonaceous wood fragments are of an outcrop on a hill along the trace extension of the Sandspit Fault. The best gold grades appear proximal in part to a normal fault, which brings the Skonum Formation into contact with a shale sequence of the Haida Formation. This zone appears to be the most heavily silicified, along with selected strata in the Skonum sediments, a feature that appears to account for the upgraded gold content radiating outward from the footwall zone. The surface area of

mineralization is relatively small, being overlain by unsilicified Pliocene Skonum Formation and Quaternary alluvium to the north and east.

Among all the presented test cases, the Cinola deposit was thought to be the least successful. It did not exhibit any stream sediment anomalies when conventional stream-sediment geochemical prospecting techniques were used. It was, therefore, a pleasant experience to obtain the heavy mineral values which demonstrated definite anomalies, particularly for gold, antimony and mercury. These figures are shown in Fig 11 and 12A and B.

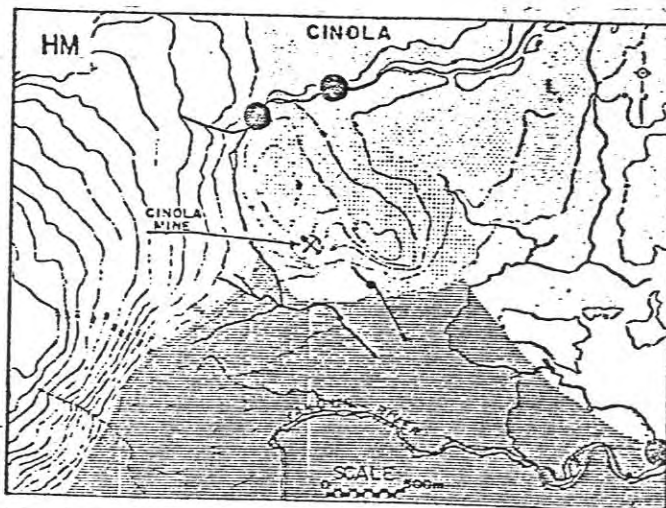
**CONCLUSIONS**

This study indicates that the mechanism of chemical dispersion of gold carries a great importance in stream sediment geochemistry.



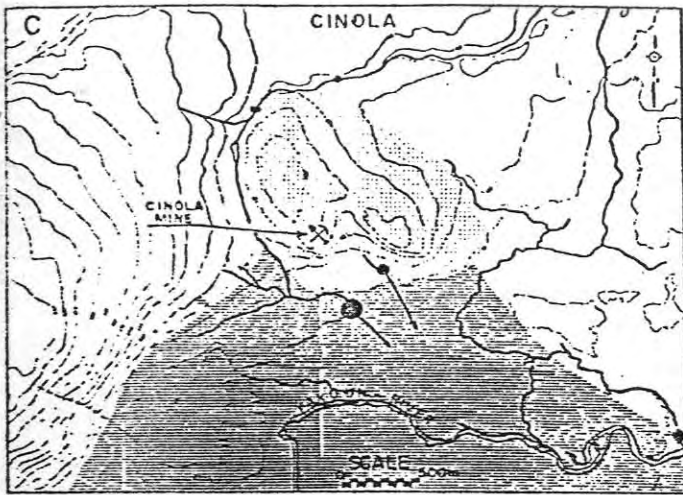
- LEGEND:**
- TERTIARY**
- SKONUM FORMATION
  - MASSET FORMATION
- CRETACEOUS**
- HONNA FORMATION
  - HAIDA FORMATION
- Au ppb**
- <25
  - 25 - 100
  - 100 - 500
  - 500 - 1000
  - >1000

Fig 11A. Gold content of conventional stream sediment samples in the Cinola area



- LEGEND:**
- TERTIARY**
- SKONUM FORMATION
  - MASSET FORMATION
- CRETACEOUS**
- HONNA FORMATION
  - HAIDA FORMATION
- Au ppb**
- <25
  - 25 - 100
  - 100 - 500
  - 500 - 1000
  - >1000

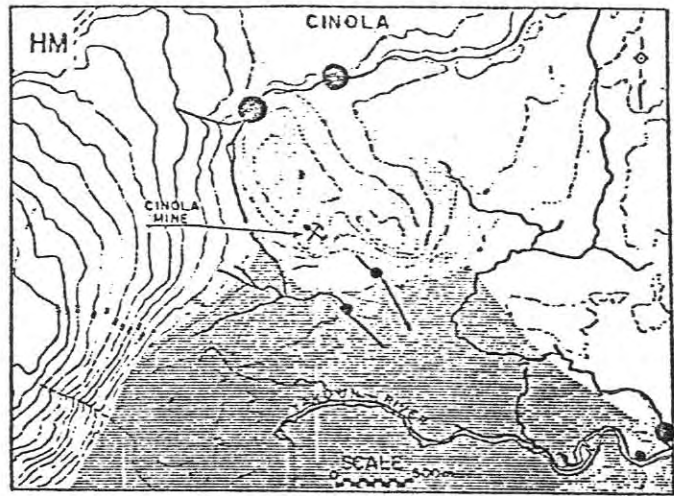
Fig 11B. Gold content of heavy mineral stream sediment samples in the Cinola area



**LEGEND:**

**TERTIARY**  
 SKOLUN FORMATION  
 MASSET FORMATION  
**CRETACEOUS**  
 HONNA FORMATION  
 HADA FORMATION

**Sb ppm**  
 • < 50  
 ● 50 - 100  
 ● 100 - 300  
 ● > 300



**LEGEND:**

**TERTIARY**  
 SKOLUN FORMATION  
 MASSET FORMATION  
**CRETACEOUS**  
 HONNA FORMATION  
 HADA FORMATION

**Sb ppm**  
 • < 50  
 ● 50 - 100  
 ● 100 - 300  
 ● > 300

Fig 12A. Antimony content of conventional stream sediment samples in the Cinola area

Fig 12B. Antimony content of heavy mineral stream sediment samples in the Cinola area

Also in conjunction with this study it has been established that the presence of flour gold most often are gold crystals or micro-nuggets resulting from chemical dispersion.

All four areas examined with heavy mineral stream geochemistry indicated marked improvement over conventional stream sediment sampling, and those which did not produce anomalous values for precious metals by the latter technique showed well-defined anomalies when the heavy mineral technique was employed.

The advantages of the heavy mineral procedure can be summarized as follows:

1. In contrast to conventional stream sediment samples heavy mineral stream samples are less dependent on seasonal variations.
2. Heavy mineral samples reduce the contamination possibilities since the main absorbing materials (organic clay) are eliminated in the wet screening process.
3. Heavy mineral samples exhibit a more pronounced contrast between the anomalies and the background values, and combine the emphasis on primary-(detrital) and secondary-minerals.
4. Heavy mineral samples significantly eliminate the glacial dilution effects of stream sediment samples.
5. To acquire a large initial heavy mineral sample, stream beds must be sampled to a deeper stratum, thus evaluating a much longer period of stream sediment deposition.

Theobald PK (1957). The gold pan as a quantitative geologic tool. *US Geol Surv Bull* 1071A, p54.

Theobald PK and Thompson CE (1960). Geochemical prospecting with heavy-mineral concentrates used to locate a tungsten deposit. *US Geol Survey Circular* 411 p13.

Varlamoff N (1971). Behavior of tungsten minerals and ores in the weathering zone under equatorial and tropical conditions-possibilities of geochemical exploration and prospecting (abstr). *Canadian Inst Mining and Metallurgy, Special Volume* 11, p279.

Wilhelm E and Laville-Timsit L (1980). *Compte Rendu de Fin de Recherche. BRGM* 77.7.1526.

Walters RA and Sagala FP (1978). Geochemical reconnaissance for uranium and base metals using heavy mineral separates in Central and Southern Sumatra. *Proc Seventh Int Geochem Expl Symp, Golden, Colorado* p317-327.

Wells JH (1973). Placer examination-principles and practice. *US Dept of Interior, Bur Land Management Tech Bull* 4, p204.

Zantop H and Nespereia (1978). Heavy-mineral panning techniques in the exploration for tin and tungsten in Northwestern Spain. *Proc Seventh Int Geochem Expl Symp, Golden, Colorado* p329-336.

Zeschke G (1961). Prospecting for ore deposits by panning heavy minerals from river sands. *Econ Geol* 56 p1250-1257.

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**REFERENCES**

Barakso JJ and Gower JA (1973). Geochemical prospecting for tin. *Western Miner* Feb 1973 pp37-44.  
 Brundin NH and Nairis B (1972). Alternative sample types in regional geochemical prospecting. *J Geochem Expl* 1:7-46.  
 Brundin NH and Bergstrom J (1977). Regional prospecting for ores based on heavy minerals in Glacial Till. *J Geochem Expl* 7:1-19.  
 Boyle RW (1979). The geochemistry of gold and its deposits. Energy, Mines and Resources Canada; Bulletin 280.  
 Fisher RP and Fisher FS (1968). Interpreting pan concentrate analysis of stream sediments in geochemical exploration for gold. *US Geol Survey Circular* 592:1-9.  
 Hawkes HE (1976). The downstream dilution of stream sediment anomalies. *J Geochem Expl* 6:345-358.  
 Mertie JB (1954). The goldpan: A neglected geological tool. *Econ Geol* v49 p639-651.  
 Ong HL and Swanson VE (1969). Natural organic acids in the transportation deposition of gold. *Colo Sch Mines Q* v64 #1 p395-425.

**CORRECTION**

In the article 'The development of biogeochemistry as a practical prospecting tool for gold' (Warren and Barakso, WM Feb'82 p27-32), the name of John J Hajek, well known in the geochemical field, was misspelled (as Hazek). We know that many who work in this field will attribute the references correctly, and we wish to put the record straight for our other readers.

