British Columbia Geological Survey
Geological Fieldwork 1988

1988 REGIONAL GEOCHEMICAL SURVEY, NORTHERN VANCOUVER ISLAND AND ADJACENT MAINLAND* (92E, 92K, 92L, 102I)

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KEYWORDS: Regional geochemical surveys, moss-mat, stream sediments, stream waters, multi-element analyses, mineral potential, Nootka Sound, Bute Inlet, Alert Bay, Cape Scott.

INTRODUCTION

The Geological Survey Branch conducted three regional geochemical surveys (RGS) on northern Vancouver Island and the adjacent mainland during the 1988 field season. In June and August a reconnaissance stream water and sediment sampling program covered an area of 30 000 square kilometres in the Nootka Sound (92E), Bute Inlet (92K), Alert Bay (92L) and Cape Scott (102I) map sheets (Figure 5-2-1). This report describes the sampling program and reviews the mineral potential of the area.

HIGHLIGHTS

There has been very little sustained and systematic exploration within the survey area in recent years, despite the relative ease of access and the occurrence of nearly 20 past or currently producing mines. Regional geochemical surveys were conducted in order to stimulate exploration in this neglected but high-potential area. A number of technical modifications were adopted based on earlier field, laboratory and research studies to optimize the applicability of these surveys to northern Vancouver Island and the adjacent mainland. These include: .

- Systematic sampling of moss-mat sediments on Vancouver Island.
- Addition of precious metal pathfinder elements, bismuth and chromium, to the analytical suite.

Results from the 1988 survey will be released in early June as an Open File map series and on floppy diskettes.

RGS SURVEY AREA FEATURES

PHYSIOGRAPHY AND GEOLOGY

Three physiographic terrains dominate the 1988 RGS area (Figure 5-2-2). The Coastal Trough represented by the Queen Charlotte Strait and the Nahwitti and Hecate lowlands divides the Insular Mountains of Vancouver Island from the Coastal Mountains on the mainland. The Coastal Trough also marks the divide between two major geological provinces. The Insular Belt, comprising Paleozoic to Mesozoic volcanic and sedimentary rocks intruded by Jurassic to Tertiary felsic plutons, underlies most of Vancouver Island. The Coast Complex, consisting predominantly of granodioritic to quartz dioritic plutons and batholiths of Jurassic to Eocene age, with highly elongate pendants of Proterozoic to Cretaceous metasediments and volcanics, forms the adjacent mainland. Table 5-2-1 is an abridged description of the physiography (Holland, 1976; Howes, 1981) and the geology (Muller 1977; Muller *et al.*, 1974, 1981; Roddick, 1977).

MINERALIZATION AND EXPLORATION POTENTIAL

Mineral deposits on northern Vancouver Island and the adjacent mainland can be divided into four main types, namely; (1) iron, copper or lead-zinc skarn, (3) massive sulphide, (3) stockwork, and (4) gold-quartz veins. Deposit categories are based on work by Muller and Carson, (1969) and Muller *et al.* (1974). Stockwork subcategories have been combined for clarity as have epithermal and mesothermal gold occurences. Salient geological and mineralogical features of these deposit types are listed in Table 5-2-2. The distribution of representative examples on northern Vancouver Island is illustrated in Figure 5-2-3.

Nine producing and potentially producing mines are located within the survey area (Preliminary Map 65, 1987). On northern Vancouver Island, the Island Copper porphyry copper deposit has proven reserves of 45 million tonnes of 0.52 per cent copper, 0.017 per cent molybdenum and 0.24 gram per tonne gold. In the Zeballos camp, the Privateer and Spud Valley mesothermal gold-quartz vein deposits, have reported proven and probable reserves of 123 000 tonnes of 9.15

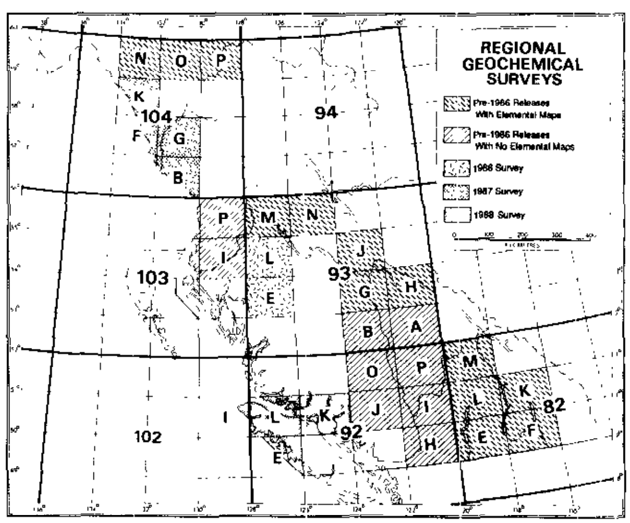

Figure 5-2-1. Present status of the British Columbia Regional Geochemical Survey.

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1988, Paper 1989-1.

TABLE 5-2-1

ABRIDGED DESCRIPTION OF PHYSIOGRAPHY AND GEOLOGY OF 1988 RGS PROJECT AREA

PHYSIOGRAPHY

AREA	UNIT	SUBUNIT	LOCATION	QUATERNARY GEOLOGY	DESCRIPTION
VANCOUVER ISLAND	Coastal Trough	Nahwitti Lowland	Northern tip of Vancouver Island	Thin mantle of colluvium and till on hills, thick (glacio-) fluvial sediments and till in lowlands	Low relief, rounded hills, narrow valleys, broad lowlands and valleys
		Suquash Basin	Eastern margin of Nahwitti Lowland	As Nahwitti Plateau	Rolling to level topography below 300 m a.s.l. scattered rounded hillocks and uplands
		Nanaimo Lowland	Eastern coast of Vancouver Island south of Sayward	Thin mantle of colluvium and till on hills, thick (glacio-)fluvial sediments and tills in lowlands and along coast	Rolling hills below 600 m a.s.l., ridges separated by narrow valleys, box-like canyons of deeply incised overburden along coast
	Vancouver Island Mountains	Estevan Coastal Plain	3 kilometre strip along west coast	Mantle of bedrock-derived colluvium, (glacio-)fluvial sediments, till and marine sediments along coast	Flat, featureless, rock cliffs and platforms, pocket beaches
		Fiord-land	Peninsulas and islands along west coast	Colluvial materials on steep valley walls and summits; till on lower valley slopes	Land rises abruptly to 600 to 900 m a.s.l.; rounded, timbered hill-tops
		Vancouver Island Range Mountains	NW/SE oriented ranges, north central Island	Very similar to fiord-land; fluvial and glacio-fluvial deposits in valleys	Very rugged; U-shaped valleys, dissected Tertiary surface
		Nimpkish River Valley	Central portion of Island	Dominantly till mantling bedrock on valley sides and bottoms,	Broad, U-shaped valleys; valley floor broken by a few peaks
MAINLAND	Coastal Trough	Hecate Lowland	West coast of mainland, 15-40 kilometre strip	Thin mantle of colluvium and till on hills and slopes, fluvial deposits in valleys	Tertiary erosion surface rising towards Coast Mtns with increasing dissection, dividing line is 600 m elevation, broad valleys
	Coast Mountains	Pacific Ranges	Adjacent to Hecate Lowland, 125-160 kilometre-wide strip	Tertiary erosion surface, upper to mid-slopes covered by colluvium and till, thick fluvial and glacio-fluvial deposits in valleys	Tertiary surface rises, becoming more dissected towards east untill old surface is completely eroded, jagged peaks, broad U-shaped valleys

TABLE 5-2-1 CONT'D

GEOLOGY

VANCOUVER ISLAND

Stratified Rocks

NAME	AGE	DESCRIPTION
Queen Charlotte Island Group	Cretaceous	Conglomerate, greywacke, siltstone, shale, coal
Westcoast gneiss complex	Jurassic	Gneiss, metaquartzite, marble, agmatite, amphibolite
Bonanza Group	Lower Jurassic	Andesitic to rhyolitic lava, tuff breccia
Vancouver Group		
Parsons Bay Formation	Upper Triassic	Calcareous siltstone, shale, limestone, greywacke, conglomerate, breccias
Quatsino Formation	Upper Triassic	Limestone, marble
Karmutsen Formation	Upper Triassic	Basaltic pillow lava, breccia, minor limestone
Sicker Group	Pennsylvanian	Lower basaltic to rhyolitic volcanic package, upper sediment and limestone units

Plutonic Rocks

NAME	AGE	DESCRIPTION
Intrusives	Eocene	Quartz diorite (e.g. Zeballos stock)
Island Intrusives	Jurrassic	Quartz diorite, granodiorite, quartz monzonite, quartz feldspar porphyry

MAINLAND

Stratified Rocks

NAME	AGE	DESCRIPTION
Gambier Group	Upper Cretaceous	Greenstone, volcanic breccia, argillite, minor conglomerate, limestone and schist
Vancouver Group		
Karmutsen Formation	Upper Triassic	Basaltic pillow lava, breccia and minor limestone
Metamorphics	Paleozoic to Lower Triassic	Amphibolite, schist, quartzite minor crystalline limestone, greenstone

Plutonic Rocks

NAME	AGE	DESCRIPTION
West Coast Complex	Cretaceous to early Tertiary	Quartz monzonite, granodiorite, quartz diorite, diorite, gabbro

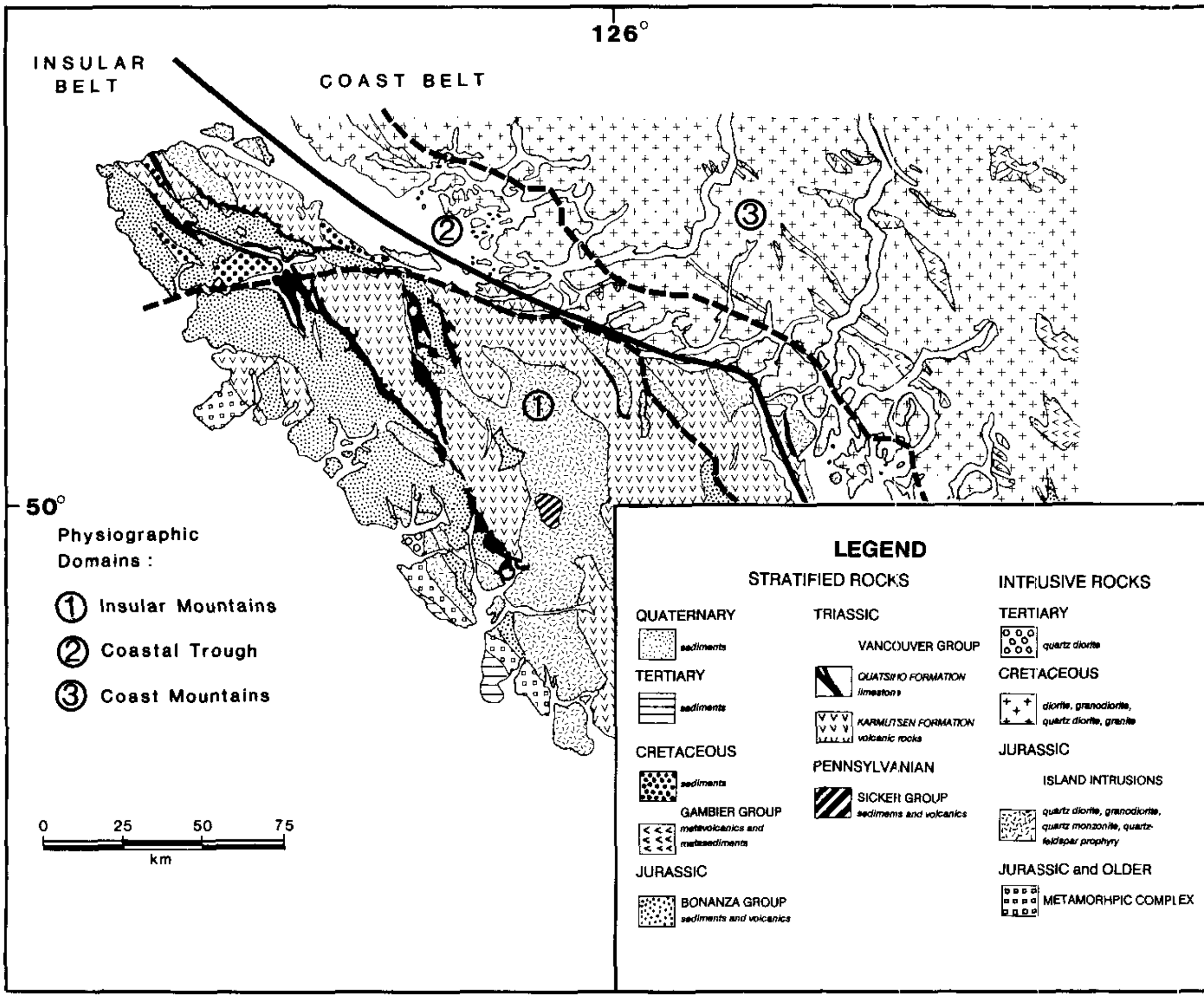

Figure 5-2-2. Physiography and Geology of the 1988 RGS program area.

grams per tonne gold and 224 000 tonnes of 14.1 grams per tonne gold, respectively. On the mainland, the Lucky Jim skarn deposit has reported reserves of 12 700 tonnes of 2 per cent copper, 11 grams per tonne silver and 17 grams per tonne gold.

The level of exploration activity in the project area as indicated by assessment report filings, is summarized in Table 5-2-3. A cursory scan of the table shows that despite the proven mineral potential of the survey area, the general level of activity is low. The following observations can be made:

- During the peak period from 1982 to 1984, only 30 assessment reports were filed per year.
- While most of British Columbia was experiencing a sharp increase in exploration activity from 1985 onwards, due largely to flow-through share financing, northern Vancouver Island saw a general drop in activity.
- Exploration of the Bute Inlet area (92K) has been largely neglected since 1983.
- The Cape Scott area remains essentially unexplored.
- Iron skarns, which accounted for up to a third of the activity in the early eighties, were generally ignored later in the decade.
- Exploration efforts from 1982 onwards focused on copper-molybdenum stockwork and gold-bearing sulphide vein deposits, and can be mainly attributed to grassroots level programs by two major companies.

More than 80 per cent of assessment work filings represent the grassroots or intermediate stages of exploration, suggesting that most properties have received only a cursory examination. A few of the potential targets that could be highlighted by the results of the 1988 RGS survey are:

- Jurassic Island intrusions reclassified as Tertiary intrusions with the possibility of epithermal gold (Mount Washington) and porphyry copper (Catface) potential.
- The recognition of mineralogically favourable S-type versus unfavourable I-type granites in the Island intrusions and the Coast plutonic complex.

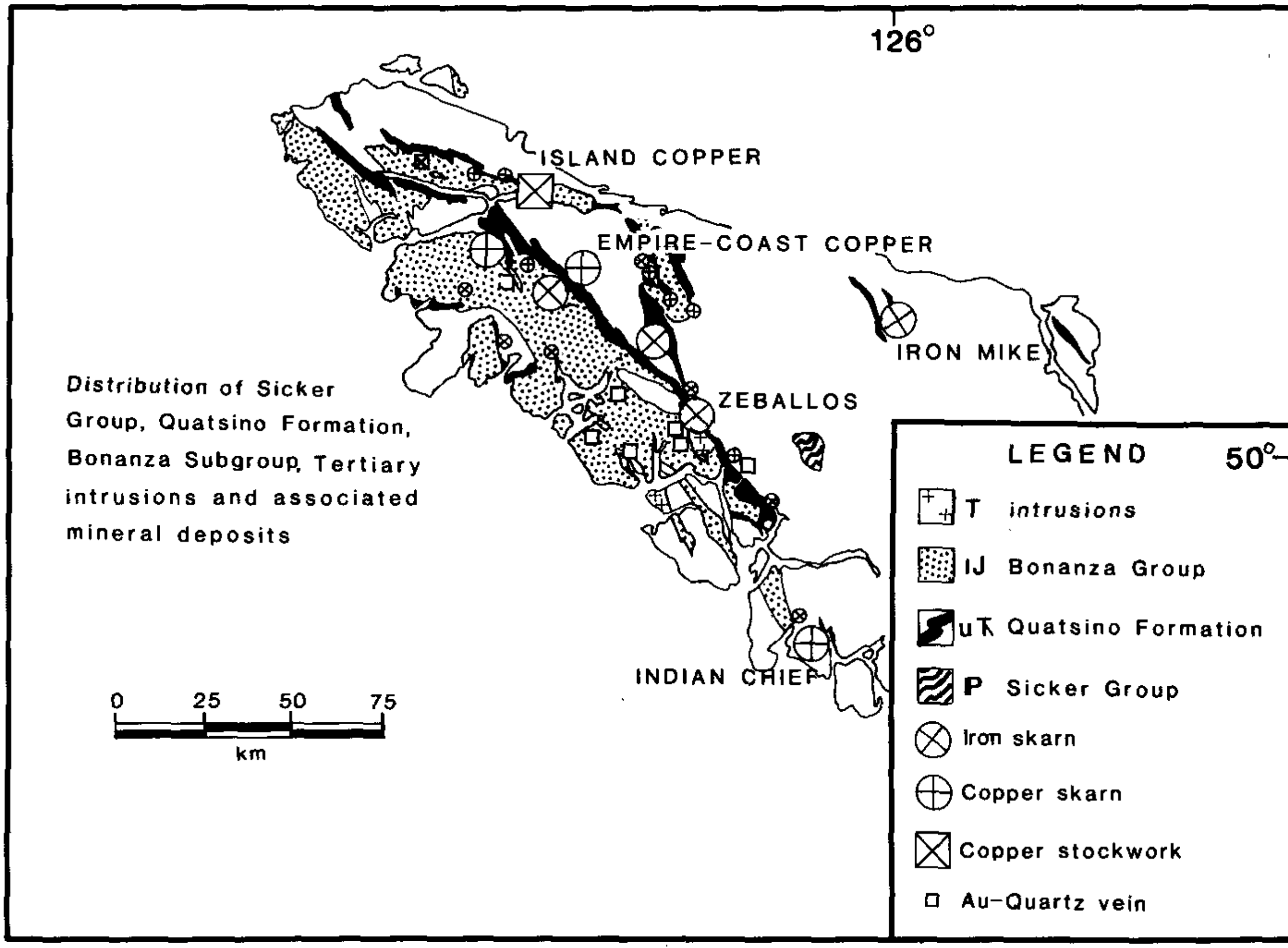

Figure 5-2-3. Distribution of mineral deposits on northern Vancouver Island.

- Unrecognized outliers of Sicker Group volcanics with potential for volcanogenic massive sulphide deposits.
- Massive sulphide, skarn and mesothermal gold deposits associated with the roof pendants in the scantily explored Coast plutonic complex.

1988 SAMPLING PROGRAM

BACKGROUND

Orientation studies (Matysek and Day, 1988) were conducted within the survey area prior to the 1988 RGS sampling program for the purpose of establishing the optimum sampling medium; recognizing new region-specific field observations to be recorded by the samplers; and defining elemental dispersion patterns from mineral occurrences typical of the area.

Results indicated that collection of conventional 1 to 2-kilogram stream-sediment samples (fine sands to silts) is difficult in regions of heavy annual rainfall, such as northern Vancouver Island. Sediment deposited by these highly active streams is often flushed clean of all material finer than medium sand, which includes the fraction used for analytical determinations. Collection of moss-mat samples was initiated to circumvent this problem; they can be quickly and easily sampled and are relatively ubiquitous in the survey area. More importantly, they are found to contain significant amounts of fine-grained particulate matter.

Analytical results for 100 paired moss-mat and stream-sediment samples within the survey area indicated no significant differences for molybdenum, copper, lead, cobalt, iron, arsenic, boron, mercury and selenium (Matysek and Day, 1988). More importantly, elements dispersed as heavy minerals appear to be concentrated by the mats. As a result, analytical reproducibility is improved, anomalous dispersion trains are longer, and the background-to-anomaly contrast for gold is up to an order of magnitude greater than in stream sediments.

The subsequent Regional Geochemical Surveys on Vancouver Island are based on moss-mat sediment samples. For comparative purposes, one stream-sediment check sample was collected for every 20 moss-mat samples. Conventional stream-sediment samples were taken on the mainland because the availability of moss mats was unknown and most of the streams are glacier fed and would have a high proportion of dilutant rock flour in the moss-mat sediments.

SAMPLE COLLECTION

The highly varied terrains, ranging from marshy coastal lowlands to glacier-covered mountain ranges, required an

TABLE 5-2-2 Deposit Types and Mode of Occurrance in the 1988 RGS Project Area (Muller et al. 1974)					
DEPOSIT CLASS	SUBCLASS	TYPE DEPOSIT	COMMODITIES	HOST ROCK	INTRUSIONS
Gold-quartz veins	Gold-qtz veins	Zeballos Au Camp	Au, As, (Pb, Zn, Cu, As)	Sicker Group, Vancouver Group Nanaimo Group, intrusive rocks	Tertiary quartz diorite intrusions
	Gold-qtz shears	Alexandria	Au, Ag, Cu (Zn, Pb)	Shear zones in Coast intrusions in pendants and along sheared intrusion/pendant contacts	Mid-Jurrassic Coast complex quartz diorites and granodiorites
	Gold-sulphide veins	Sin	Au, Ag, (Cu, Fe)	Parsons Bay Formation occassionly seen as Fe-sulfide skarn	Jurassic Island intrusions
Iron ± copper ± lead-zinc skarns	Iron skarn	Empire	Fe, (Cu)	Quatsino Formation and/or surrounding skarnified volcanic and intrusive rocks	Jurassic Island intrusions
	Copper skarn	Coast Copper	Cu, (Au, Ag, Fe)	Quatsino-Karmutsen contact, limestone units in Quatsino, Karmutsen or Sicker, skarnified volcanic and sedimentary rocks	Same as above
	Lead-zinc skarn	H.P.H.	Pb, Zn, (Cu, Au, Ag)	Limestone of Sicker Group, upper Quatsino and Karmutsen Formations	Same as above
Stock-work	Porphyry copper	Island Copper	Cu, (Mo)	Bonanza pyroclastics of basic to intermediate composition	High-level Jurassic Island intrusions
	Porphyry Cu-Mo	Don	Cu, Mo	Quartz-feldspar porphyry in composite porphyritic biotite granite stock	Early Tertiary Coast intrusions
	Stockwork copper	Quatsino King	Cu, (Mo, Ag, Au, Zn)	Sicker Group, Karmutsen Fm., Bonanza volcanics, granitic rocks	Basic to felsic and porphyritic Island intrusions
Massive sulphide	-	Buttle Lake	Zn, Cu, Pb (Ag, Au, Ba)	Upper volcanic sequence in lower formation of Sicker Group	None

innovative approach to designing the sampling program. McElhanney Engineering Services Limited of Surrey, B.C., was awarded the sampling contract based on both its design and competitive bid.

A multiphase sampling program was employed with truck and boat-supported crews making an initial pass through the area, followed by a helicopter crew to sample remote sites. The senior author was on site during the program to provide crew training, to answer questions and to maintain quality control.

Sediment and water sampling were restricted to primary and secondary streams having drainage-basin areas less than 10 square kilometres. On average, 49 sites were sampled per day between June 11 and August 5, for a total of 2746 sites. Of the total sites, 1657 were sampled for moss-mats, and 1089 for stream sediment (Table 5-2-4). The average sampling density was 1 site every 10.9 square kilometres. In general the samplers found moss mats were abundant in all drainage basins on Vancouver Island and easier to locate than suitable low-energy sites bearing sufficient fine stream sediment.

FIELD PREPARATION (MOSS-MAT SEDIMENT SAMPLES)

The collection of moss-mat samples presented several new problems, in particular for field preparation of samples. Unless the samples are dried soon after collection, the mats will rot, making sample disaggregation nearly impossible.

Once a sample had been thoroughly dried, it was placed in a large Pyrex bowl and gently pounded with a wooden mallet. The pounding helped to disaggregate the fine sediment from the moss fronds without breaking the plant fibres. Sieving of the sample through a 1-millimetre (18 mesh ASTM) screen recovered the sediment finer than coarse sand while removing nearly all undecomposed plant material. Sieving each moss-mat and stream-sediment sample vastly reduced sample bulk and subsequently shipping costs, while allowing a qualitative assessment of the amount of fine sediment. The −1-millimetre fraction was returned to the original sample bag and set aside for later inspection by the senior author. Routine sieving to −177 microns (−80 mesh ASTM) of at least one sample in each block of twenty, or those appearing deficient in fines, ensured that such samples

TABLE 5-2-3
EXPLORATION ACTIVITY COMPILED FROM FILED ASSESSMENT REPORTS

NTS MAP SHEET	YEAR																																		
	1981					1982					1983					1984					1985					1986					1987				
	DT	I	II	III	IV	DT	I	II	III	IV	DT	I	II	III	IV	DT	I	II	III	IV	DT	I	II	III	IV	DT	I	II	III	IV	DT	I	II	III	IV
92E	5I	1	3		1	2I	2				3I	1	1	1		2I	2				1G	1				2I	1	1			1I	1			
	1G		1								1G	1				1M			1							2G		2			1G			1	
	1S		1													1S	1									1M			1						
																										1S		1							
92K	3G	2	1			3G	1	2			3I		3			2G	2				2M	1	1			2G	1			1	3G	1	1	1	
	1M	1				3I	2	1			3G	1	1		1	2M	1	1								1S		1			1I		1		
	1S		1			2M	2				1S		1			1I	1														1S		1		
						2S			2																										
92L	3G	2		1		11G	9	1	1		7G		4	3		7G	4	3			5G	4		1		6G	3	3			6G	3		3	
	3I		2	1		4I	2		2		6I	3	1	2		7S	3	2	2		5I	2	2	1		6S		4	2		5S		4	1	
						2S			2		5S	1	3	2		5I	3	2			1S			1		2I	1	1			2I	2			
																1M		1																	
102I						1I	1									1I	1																		
Total	18	6	9	2	1	30	19	4	7		29	6	14	8	1	30	18	9	3		14	8	3	3		21	6	12	3	1	20	7	7	6	

LEGEND

Deposit Type (DT)

G = Gold + Quartz Veins
I = Iron ± copper ± lead-zinc Skarn
M = Massive sulphide
S = Copper ± Molybdenum Stockwork

Exploration Activity

I = Grassroots: prospecting, minor geochemical sampling
II = Intermediate: mapping, moderate-scale geophysical and geochemical surveys
III = Advanced: drilling, trenching, extensive ground surveys
IV = Development: underground development, i.e. drifting, drilling

Example:

	1981				
	DT	I	II	III	IV
92E	5I	1	3		1

Interpretation: During 1981, on map sheet 92E, (5) five assessment reports were filed on properties hosting (I) iron ± copper ± lead-zinc skarn type deposits. Of the five, one was at the grassroots stage of exploration, three were at the intermediate stage, and one was at the development stage.

had the requisite minimum of 40 grams of fines for subsequent chemical analyses. Only four sites were resampled due to insufficient fine sediment in the original sample.

LABORATORY PREPARATION

Within a month of completion of the sampling program, all water and sediment samples were sent to Kamloops Research and Assay Laboratory. In cooperation with the Ministry, a routine was designed that would minimize sample contamination while optimizing efficiency. Sample preparation comprises the following steps:

(1) checking for samples missing or destroyed during transit,
(2) drying and sieving to -177 microns (-80 mesh ASTM),
(3) weighing the coarse and fine fractions of each sample, and
(4) inserting analytical duplicates and control reference material into the sample sequences.

Critical to the success of the program is the ability to distinguish anomalous and background elemental concentrations. Determination of background can only be accomplished by assessing the sources of variation, these being the geology (including mineralization), characteristics of the sample site, subsampling problems, and analytical techniques.

Each group of twenty RGS samples includes a field duplicate (to test sample site variability), a blind duplicate (to test laboratory subsampling variability) and a control reference (to test analytical variability). The positions of these samples are unknown to the analytical laboratory, thereby removing any potential bias.

ANALYTICAL DETERMINATIONS

Following sample preparation, all samples are sent to an analytical contractor chosen by a competitive bid. Over the 13-year history of the RGS program, the list of elements analysed has grown steadily. Currently, sediment samples are analyzed for antimony, arsenic, barium, cadmium, cobalt, copper, fluorine, gold, iron, lead, manganese, mercury, molybdenum, nickel, silver, tin, tungsten, uranium, zinc and organic matter by loss on ignition (LOI). Determinations for bismuth and chromium will also be included this year. Stream-water samples are analyzed for uranium, fluoride ions and pH.

The analytical methodology for each element is based on standards set by the Geological Survey of Canada National Reconnaissance Program. The techniques were established to optimize extraction of each element at its lowest detection limit while providing nation-wide consistency between surveys. The quality of the analytical results is evaluated using the determinations from the inserted analytical duplicate and

TABLE 5-2-4 SAMPLE DISTRIBUTION IN 1988 RGS PROGRAM AREA

92E - NOOTKA SOUND					
MAP SHEET	MOSS MAT	STREAM SEDS	TOTAL SITES	AREA KM^2	DENSITY SITES/KM^2
08	55	0	55	570	10.4
09	85	0	85	930	10.9
10	35	0	35	425	12.1
14	22	0	22	225	10.2
15	97	0	97	840	8.7
16	92	0	92	985	10.7
TOTAL	386	0	386	4042	10.5

92K - BUTE INLET[a]					
MAP SHEET	MOSS MAT	STREAM SEDS	TOTAL SITES	AREA KM^2	DENSITY SITES/KM^2
01	78	0	78	920	11.8
02	42	24	66	700	10.6
03	0	50	50	660	13.2
04	0	104	104	985	9.5
05	18	54	72	810	11.3
06	23	39	62	690	11.1
07	63	13	76	785	10.3
08	77	0	77	960	12.5
09	85	0	85	995	11.7
10	91	0	91	865	9.5
11	84	0	84	950	11.3
12	89	0	89	850	9.6
13	86	0	86	860	10.0
14	79	0	79	975	12.3
15	65	0	65	890	13.7
16	52	0	52	980	18.8
TOTAL	932	284[b]	1216	13,875	11.4

92L - ALERT BAY[a]					
MAP SHEET	MOSS MAT	STREAM SEDS	TOTAL SITES	AREA KM^2	DENSITY SITES/KM^2
01	97	0	97	985	10.2
02	97	0	97	980	10.1
03	94	0	94	800	8.5
04	41	0	41	320	7.8
05	75	0	75	770	10.3
06	96	0	96	950	9.9
07	84	0	84	955	11.4
08	90	2	92	900	9.8
09	41	38	79	730	9.2
10	9	0	9	120	13.3
11	33	0	33	640	19.4
12	91	0	91	890	9.8
13	39	0	39	400	10.3
14	0	12	12	365	30.4
15	18	52	70	610	8.7
16	9	53	62	800	12.9
TOTAL	914	157[b]	1071	11,215	10.5

102I - CAPE SCOTT					
MAP SHEET	MOSS MAT	STREAM SEDS	TOTAL SITES	AREA KM^2	DENSITY SITES/KM^2
09	47	0	47	550	11.7
16	26	0	26	240	9.2
TOTAL	73	0	73	790	10.8

[a] Stream sediments collected from Mainland only
[b] Does not include check samples

control reference samples to ensure strict adherence to national standards.

RELEASE INFORMATION

Results will be distributed in three Open File map packages (RGS 21 – 92E, Nootka Sound; RGS 22 – 92K, Bute Inlet; RGS 23 – 92L, Alert Bay and 102I, Cape Scott) and floppy diskettes. Individual packages will consist of both 1:100 000 and 1:250 000-scale sample-location maps, geochemical maps (1:250 000 scale) for each analysed element, detailed listings of field and analytical results, brief statistical analysis and updated 1:250 000 Mineral Inventory maps. Complete listings of analytical and field data will also be available on standard MS-DOS 5¼ inch double-sided, double-density floppy diskettes.

Release of data is tentatively planned for early June. Final details on costs, distribution centres and dates will be made available at a later date.

ACKNOWLEDGMENTS

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NOTES