



British Columbia Geological Survey
Geological Fieldwork 1987

Applied Geochemistry

APPLIED GEOCHEMISTRY SUBSECTION, OVERVIEW OF THE FIRST TWO YEARS*

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INTRODUCTION

British Columbia has challenging problems in the application of exploration geochemical techniques in Canada because of its complex geological history, mountainous terrain and mantle of glacial deposits. Baseline geochemical surveys, complimentary research and orientation surveys are essential prerequisites for the successful application of exploration geochemistry. Since 1976, the Geological Survey Branch has provided regional geochemical sediment and water data, largely with the cooperation of the Geological Survey of Canada. The Applied Geochemistry Subsection was formed in 1986 to provide better direction to the branch's geochemical surveys and to initiate research and development projects to promote more effective use of geochemistry by industry. It is committed to a spectrum of programs designed to aid, stimulate and promote the growth of the exploration and mining industry in British Columbia. This paper summarizes the status of the branch's 1986 and 1987 geochemical programs, and projects funded by the branch undertaken by Dr. W.K. Fletcher at The University of British Columbia.

To ensure that the branch's geochemical projects are timely and appropriate, an advisory group of six geochemists has been assembled from the exploration community (four), The University of British Columbia (one) and the Geological Survey of Canada (one). The purpose of this group is to obtain industry, university and federal contributions to the conception and formulation of the branch's geochemical programs. The committee meets with the branch at least twice a year to comment on proposed geochemical projects, review results and comment on their effectiveness.

1986-1988 GEOCHEMICAL PROGRAMS

RESPONSIBILITIES AND RESOURCES

The Applied Geochemistry Subsection is responsible for: (1) providing baseline geochemical data by conducting Regional Geochemical Surveys (RGS); (2) conducting field orientation studies and complimentary geochemical research; (3) demonstrating the usefulness of geochemical techniques; (4) developing methods in the processing and assessment of geochemical data by statistical and computer techniques; and (5) providing assistance and scientific leadership to the Geological Survey Branch, and the academic and exploration communities.

Staffing and funding of the subsection increased in 1987 to include contract geochemists Stephen Day and John Gravel and an operating budget of approximately \$500 000. Funding for subsection activities comes in part from the enhanced Geological Survey Branch budget and the Canada/British Columbia Mineral Development Agreement. The bulk of 1987 funds (75 per cent) was spent on reconnaissance multi-element stream sediment and water surveys; the remainder was allocated to orientation surveys, research and development. Figure 5-1-2 and the accompanying Table 5-1-1 summarize 1987 geochemical projects that involved the subsection. Relevant details and highlights of these and earlier projects are described in this paper.

REGIONAL GEOCHEMICAL SURVEY PROGRAMS (RGS)

Since 1976, the Geological Survey Branch, in cooperation with the Geological Survey of Canada, has conducted regional geochemical surveys as part of the National Reconnaissance Program. This database represents multi-element determinations and field observations of reconnaissance sediment and water sampling of twenty-eight 1:250 000 National Topographic System (NTS) map areas (Figure 5-1-1). High quality analytical results are ensured by using specific and sensitive determination techniques and by monitoring analytical variation by duplicates and standards. Results from the RGS program are used by the exploration industry to assist in area selection and target identification and, in the longer term, as an indicator of regional geological or geochemical provinces that contain favourable exploration targets. To date, 41 per cent of British Columbia (approximately 390 00 square kilometres) has been sampled at an average density of one sample per 13 square kilometres (31 000 samples). Complete reconnaissance coverage of the province is anticipated by 1997 at current sampling rates. Details of the RGS Program are described by Matysek (1987). In an ongoing effort to improve the quality of the RGS Program, the Applied Geochemistry Subsection has introduced a number of enhancements in field procedures, data management, presentation and interpretation.

FIELD ENHANCEMENTS

Beginning in 1986, thanks to improved funding for the program, the branch was able to re-establish the policy of having a staff member responsible for quality control of the sampling program on a day-to-day basis. A ministry presence ensured that all aspects of sample collection, data recording, drying, packing and shipping were in accordance with standards set by the National Geochemical Reconnaissance Program.

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement. British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

**TABLE 5-1-1
ACTIVITIES OF THE APPLIED GEOCHEMISTRY SUBSECTION, 1987**

Number	Location	Description	Objectives	Results/Status
1	93L, E	Release of RGS 1986 stream and lake sediment data.	Provide baseline geochemical data. Results are used to identify both regional metallogeny and as a guide to locating mineral occurrences.	Over 100 data packets sold. Tabulation and assessment of new staking being compiled by D. V. Lefebure and M. H. Gunning in Exploration in British Columbia, 1987 (in preparation).
1a	93E	Evaluation of an ICP-ES geochemical package using 1986 RGS data.	Make recommendations concerning the selection of the most cost-effective and reliable technique for future RGS programs.	Preliminary analysis by Day, Matysek and Johnson in Geological Fieldwork, 1987.
2	104K, F, G, B, C	RGS 1987. Collection of stream sediments.	Provide baseline geochemical data.	Sampling completed over 35 000 km ² area. 2726 samples collected at a density of one sample per 13 km ² . All samples will be analysed for gold plus 19 other elements. Further details by Gravel and Matysek in Geological Fieldwork, 1987. Release date, summer 1988.
3	92E, L, 102I	Orientation studies for RGS 1988.	Define appropriate sampling, preparation and analytical techniques for successful application of exploration geochemistry on Vancouver Island.	Samples currently being prepared and analysed. Preliminary results discussed by Matysek and Day in Geological Fieldwork, 1987.
4	Giant Nickel	Platinum in stream sediments.	Define exploration geochemical guidelines for the search for platinum and palladium in soils and stream sediments.	Samples currently being prepared and analysed.
5	Tulameen ultramafic complex	Platinum in soils and stream sediments (with UBC).	As above.	As above.
6	Franklin Camp	Platinum in soils and stream sediments (with UBC).	As above.	As above.
7	Scottie Creek	Platinum in soils and stream sediments (UBC).	As above.	As above.
8	Harris Creek	Gold in stream sediments (UBC).	Examine seasonal variations in gold content of sediments.	Full discussion by Fletcher and Day in Geological Fieldwork, 1987.
9	Mount Washington	Gold in stream sediments (UBC).	On-going study of distribution and behaviour of gold in stream sediments.	Samples currently being prepared and analysed. Results will be available by March 1988.
10	82F/11, 14	Detailed geochemical sampling by 1:50 000 mappers — Kokanee.	Integrate geochemical and geological data, to aid in the assessment of the mineral potential of the survey area.	141 conventional stream sediment and 12 bulk heavy mineral samples collected. Geochemical results will be released with 1:50 000 mapping open file.
11	93N/09	Detailed geochemical sampling by 1:50 000 mappers — Manson Creek.	As above.	23 conventional stream sediment and 21 bulk heavy mineral samples collected. Geochemical results will be released with 1:50 000 mapping open file.
12	104M/15	Detailed geochemical sampling by 1:50 000 mappers — Atlin.	As above.	93 conventional stream sediment and 24 bulk heavy mineral samples collected. Geochemical results will be released with 1:50 000 mapping open file.
Office	Province	RGS data on floppy diskettes.	To ensure a complete and consistent database. To make RGS data more readily accessible to the exploration community.	17 full sets (22 map sheets) and a number of single map sheets have been sold. Diskettes for 1986 and 1987 releases will be available by February 1988.
Office		Software development of a geochemical plotting and statistical package.	To develop internal geochemical open file production capabilities.	System to be completed by March 1988.

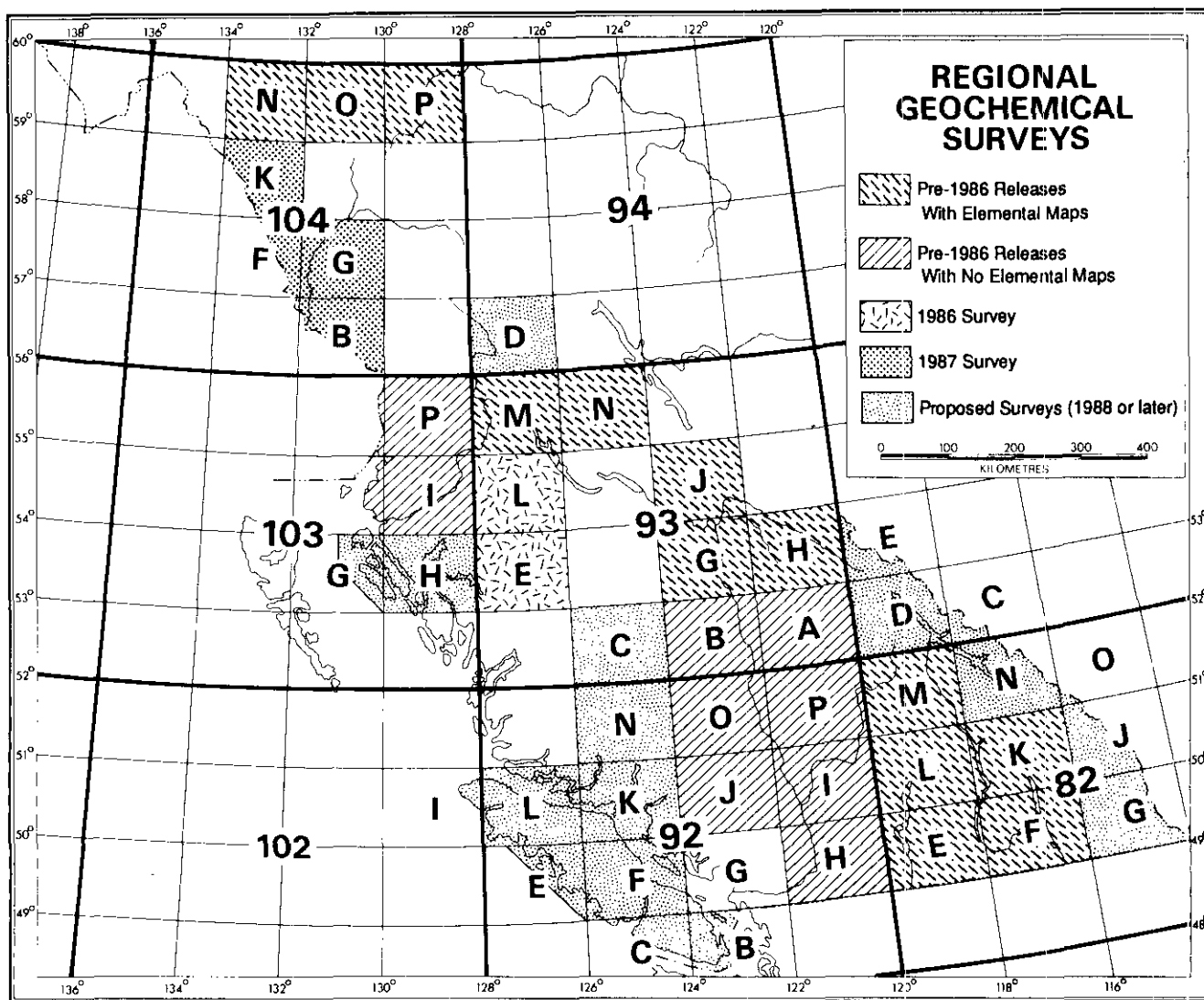


Figure 5-1-1. Areal distribution of the Regional Geochemical Survey Program.

A number of field enhancements were introduced in this year's sampling program to ensure that the samples are of a very high quality.

- Sample efficiency, in terms of site selection and ease of access in glacier-fed streams, increased, due in part to the use of neoprene dry-suits.
- To ensure that a sufficient amount of sediment was collected for at least two (10-gram) gold analyses, all samples were dry-sieved in the field to -18 mesh (<1 millimetre) to assess fines content. Samples suspected to be rich in organic material or consisting predominantly of gravel were dry-sieved to the analytical size, -80 mesh (<177 microns). If they contained less than 40 grams of fine sediment, a new sample was collected. Sample quality was routinely checked by sieving one sample in each block of twenty to -80 mesh.
- To aid in the follow-up of survey results, highly visible aluminum tags (5 centimetres by 10 centimetres) bear-

ing a unique RGS sample number were used to mark every sample site.

ANALYTICAL ENHANCEMENTS

Since 1976, most trace element concentrations in RGS have been determined by atomic absorption spectroscopy (AAS) samples after a Le Fort aqua regia digestion. However, inductively coupled plasma emission spectroscopy (ICP-ES) may represent an inexpensive alternative to AAS if the high standards of the RGS database can be maintained. As a preliminary test of the quality of ICP-ES data, two sets of similarly prepared and digested stream and lake sediment samples from the Whitesail Lake area (1987 release) were analysed by commercially available ICP-ES and AAS packages for a number of comparable elements. Preliminary results show that elements copper, zinc, iron, manganese, lead, cobalt and nickel could be determined by ICP-ES without reducing the quality of the database. Further details

of this study (Day, Matysek and Johnson, 1988) are outlined in this volume.

DATA PREPARATION AND DATABASE ENHANCEMENTS

In an effort to develop in-house expertise in the data processing of results of RGS surveys for publication, data preparation services that have traditionally been provided by the Geological Survey of Canada, such as cartography, data entry and digitizing of sample site locations, are now the responsibility of the Applied Geochemistry Subsection. Microcomputer software is currently being developed and appropriate hardware has been purchased so that in-house computing, plotting and text production capabilities will be available. These capabilities will not only provide the subsection flexibility in selection of release dates, data presentation and interpretation of results, but will also streamline management of the program.

In 1986, British Columbia became the first province to make regional geochemical survey data publicly available on floppy diskettes. All previous RGS data were edited, systematically formatted and downloaded from magnetic tapes onto standard MS-DOS, double-sided, double-density, 5¼-inch floppy diskettes on a map sheet basis. This ensures that the RGS database is stored in a complete and consistent manner and makes the data more readily accessible to a wider segment of the exploration industry. The increased accessibility will promote a more thorough and refined assessment, and bring about a closer realization of the data's potential. Delineation of regional geochemical trends, a geochemical base for remote sensing studies and incorporation of the RGS database into private sector computerized geochemical databases are some of the applications that have been attempted by industry. Floppy diskette versions of 1986 (93G, 93H and 93J) and 1987 (93E and 93L) survey data are presently available.

1986 RGS RELEASES

Data from the joint federal-provincial reconnaissance Regional Geochemical Survey completed in the summer of 1986 were released on 29 July 1987 in Smithers, Vancouver and Victoria as the following open files [Figure 5-1-2, (1)]:

Geological Survey of Canada		British Columbia	
Open File			
93E	Whitesail Lake	1360	BC RGS 16
93L	Smithers	1361	BC RGS 17

Each map sheet covers approximately 14 500 square kilometres with an average sample density of one sample per 13 square kilometres. A total of 1848 stream and 457 lake sediment samples were analysed for zinc, copper, lead, nickel, cobalt, silver, manganese, arsenic, molybdenum, iron, mercury, loss on ignition, uranium, cadmium, antimony, tungsten and barium. Corresponding stream and lake waters were analyzed for uranium, fluorine and pH. Addition of tin, vanadium, fluorine and especially gold analyses on samples collected from the Smithers map sheet were of considerable interest to the exploration industry.

Each open file consists of a sample location map, a current mineral inventory map, individual maps for each element analysed, and a text of field, analytical and statistical data. A total of 101 data packages has been sold to October 31, 1987, with nearly equal sales for each of the two map sheets. The high mineral potential, relatively good access, recent 1:50 000 geological mapping and inclusion of gold analyses in the survey data probably contributed to the high level of interest.

1987 RGS SURVEYS

In 1987, the British Columbia Geological Survey and the Geological Survey of Canada cooperated to systematically sample and analyse stream sediments and waters from a 35 000-square-kilometre rugged and remote region of north-western British Columbia [Figure 5-1-2, (2)]. In total, 2726 sites were sampled at a density of one sample per 12 square kilometres. All stream sediments will be analysed for gold and the routine RGS 19-element suite (zinc, copper, lead, nickel, cobalt, silver, manganese, cadmium, iron, molybdenum, vanadium, arsenic, uranium, antimony, loss on ignition, tungsten and barium) and stream waters will be analysed for uranium, fluorine and pH. Survey results will be released in midsummer in a format similar to the 1986 RGS. Further details of this year's sampling program are outlined in this volume by Gravel and Matysek.

FUTURE DEVELOPMENTS

In the next 5 years, the Geological Survey Branch proposes to complete Regional Geochemical Surveys in the following areas (Figure 5-1-1): Vancouver Island (92B, 92C, 92E, 92F, 92G, 92K, 92L and 102I), Rocky Mountain Trench area (82G, 82J, 82N, 83D and 83E), central Coast Mountains (103G and 103H), Toadogone camp (94E) and Cariboo area (92N and 93C). The sequence and selection of sampling areas will be dependent upon a number of factors such as available funding, feedback from the exploration community to proposed areas, and integration with the 1:50 000 geological mapping program. Assuming funding continues at the present level, sampling is planned for northern Vancouver Island (92E, 92L and 102I) in 1988.

Due to funding and logistical constraints during the period 1979 to 1981, data from nine 1:250 000 Regional Geochemical Surveys (Figure 5-1-1) were released with only a sample location map, a text containing detailed listings with no elemental maps and a statistical summary of the analytical data. This form does not allow identification of anomalies on the ground or resolution of geochemical trends, without first plotting individual points on an overlay or having access to computer plotting facilities. One project that the subsection will carry out is to produce elemental maps for these survey areas in 1988.

To encourage mineral exploration in previously sampled RGS areas, the branch is considering adding other elements to the existing RGS database through nondestructive analysis (Instrumental Neutron Activation Analysis, INAA) of archived RGS pulps. The RGS pulp and reject library contains approximately 31 000 samples, representing sampling from twenty-nine 1:250 000 map sheets. Most of these sediment samples have only been analysed for 12 elements (zinc,

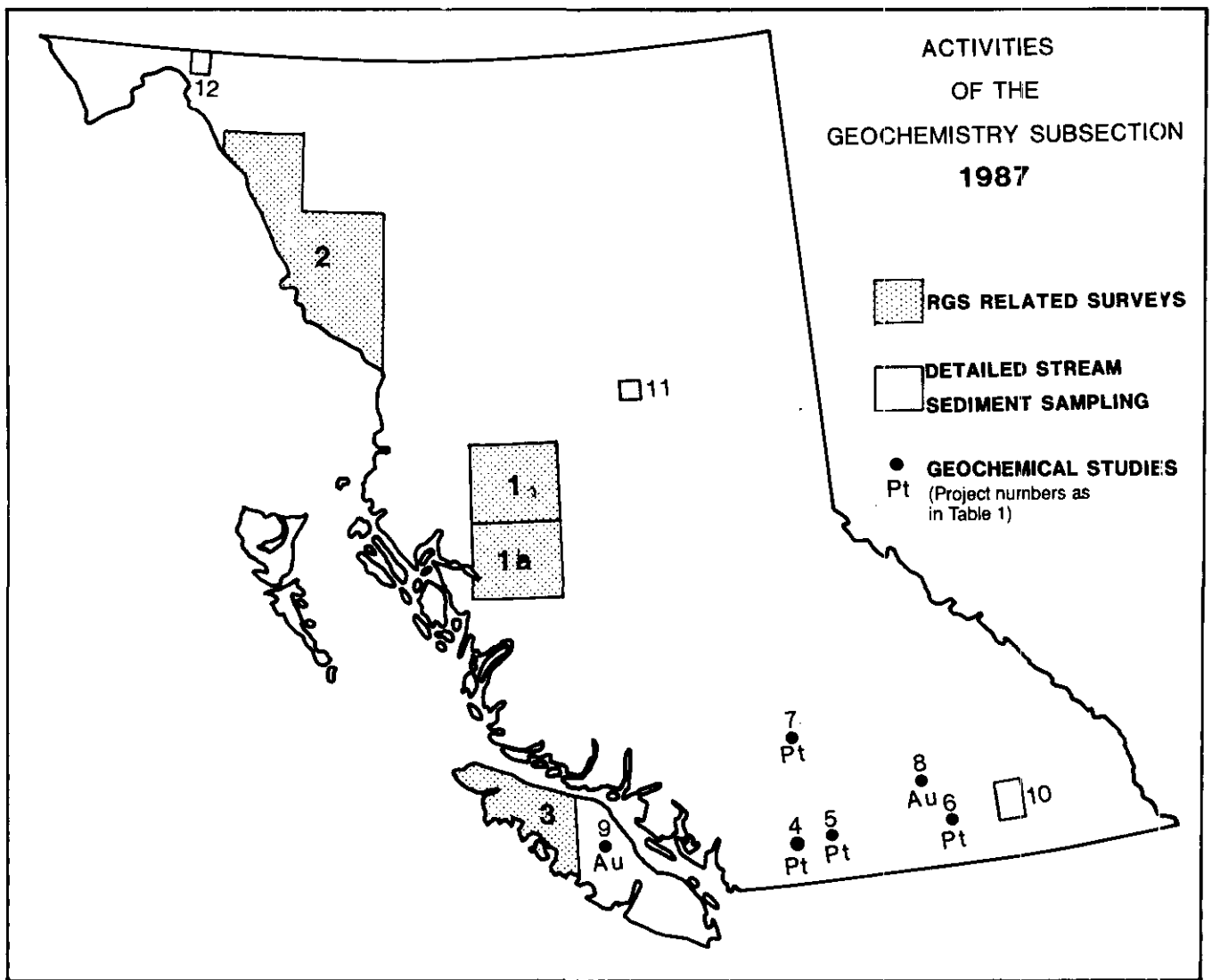


Figure 5-1-2. Locations of 1987 Applied Geochemistry Subsection Programs.

copper, lead, nickel, cobalt, silver, manganese, iron, molybdenum, mercury, uranium and tungsten) therefore addition of gold, arsenic, antimony and the rare earths is planned. A decision on funding and priorities is expected shortly.

RESEARCH PROJECTS

The branch's geochemical research projects aim is to provide guidelines in applying exploration geochemistry in the province. Results from these studies should provide effective methods for using geochemical techniques in the complex British Columbia setting.

VANCOUVER ISLAND

In preparation for RGS sampling on northern Vancouver Island in 1988, an orientation survey [Figure 5-1-2, (3)] was conducted in 1987 which included collection of 320 sediment samples from 30 streams draining areas with a variety of precious and base metal occurrences. Barren areas were

included in the orientation to provide an indication of geochemical background. Four types of samples (conventional RGS sediment samples, moss-mat samples, sieved -10 mesh 10-kilogram heavy mineral samples and 10-kilogram unsieved sandy to fine sediment samples) were collected from one sampling station on all 30 streams. On selected streams draining mineralized areas, conventional RGS and moss-mat samples were collected at 500-metre intervals and unsieved bulk sediment samples were collected at 1000-metre stations to determine dispersion characteristics for 3 to 4 kilometres downstream from mineralization. Standard RGS sample preparation and digestion techniques will be used for analysing moss-mat, conventional RGS and unsieved samples. The relative merit of using other than the usual -80-mesh fraction for determination of base and precious metals is being tested by means of bulk fine sediment samples. Further details of sample locations, collection, processing, analytical methods and preliminary results are provided in Matysek and Day in this volume.

PLATINUM IN SOILS AND STREAM SEDIMENTS

There are few geochemical guidelines to assist exploration companies in the search for platinum group elements in British Columbia. The subsection, in cooperation with Dr. W.K. Fletcher at The University of British Columbia, is undertaking a study of the dispersion of platinum and palladium in stream sediments and soils. Four geologically distinct platinum occurrences were visited in August and September 1987 [Figure 5-1-2; Table 5-1-1; (4-7)]. Five types of sample were collected from 11 streams using the same methods as for the northern Vancouver Island project. Bulk-sieved samples were collected at up to six locations on three streams to determine downstream dispersion of platinum and related elements. Due to uncertainty about the mode of occurrence of platinum in the samples, duplicate-sieved samples were collected at several sites to provide an indication of within-site variability. Soil samples were collected from two or three pits over anomalous zones defined by exploration companies. Each soil horizon was sampled in duplicate, including the surface LFH organic layer, typically yielding six samples per station.

Both soils and -10 mesh field-sieved stream sediments are being processed by wet sieving followed by heavy mineral separation in heavy liquids and finally magnetic and electrostatic separations, to determine the speciation of platinum and palladium. Conventional fine-sediment samples (sieved to several fractions including -80 mesh) will provide a useful comparison with heavy mineral sampling techniques. The study also includes an evaluation of lead collection fire assay followed by a graphite furnace atomic absorption for determination of platinum and palladium.

Sample preparation and analytical work are in progress with results expected in early March. A preliminary open file report can be anticipated by late spring, with a full discussion of the results in Geological Fieldwork, 1988.

GOLD IN STREAM SEDIMENTS

Geochemical data from a detailed study of gold in stream sediments by Matysek and Saxby (1987) will be available as an open file in mid-1988. This study, carried out in the Smithers area (93L), includes dispersion and replicate sampling studies for nine streams draining several types of gold mineralization. Eighty sieved bulk sediment samples were processed by wet sieving and heavy mineral separation and analysed by instrumental neutron activation. Results from this study will address the reliability of conventional stream sediment and heavy mineral samples for various sizes of gold particles.

Several branch-funded stream sediment sampling projects [Figure 5-1-2; Table 5-1-1; (8, 9)] are currently in progress at The University of British Columbia under the direction of Dr. W.K. Fletcher. A study of the seasonal variation of gold concentrations in sediments collected from a single bar of Harris Creek (82L/02) is in its second year. Interpretations are still tentative but show that gold concentrations are greatest following the spring meltwater flood, then steadily decrease over the summer and autumn. Samples collected are also being used in comparative studies of three analytical methods (fire assay with atomic absorption spectroscopy finish, instrumental neutron activation analysis, and cyanida-

tion followed by graphite furnace atomic absorption). Stream sediments are also being collected on Mount Washington (92F/14), from nine sites on McKay, Murex, Tsolum and Piggott creeks, to study gold dispersion downstream from mineralization. Results will be available by March 1988. For details of the work completed to date see Day and Fletcher (1987), Fletcher and Day in this volume and Fletcher and Horsky (in press).

DETAILED STREAM SEDIMENT SAMPLING

Under the guidance of section geochemists, geologists mapping 1:50 000 map sheets in three areas of British Columbia [Figure 5-1-2; Table 5-1-2; (10-12)] collected conventional RGS samples (2 kilograms of fine sediment) and field-sieved -10 mesh bulk sediment samples. The former will be analysed for gold and by a standard 30-element ICP-ES package with selected elements determined by hydride generation techniques. Concentration of gold, tungsten and rare earth elements in bulk samples will be determined by instrumental neutron activation analysis. In areas previously covered by the Regional Geochemical Surveys (82F, 93N) these programs will increase sample density and provide information on the distribution of heavy minerals. The number of samples collected in each project is summarized in Table 5-1-1. Sample locations are given by Brown and Logan, Ferri and Melville and Mihalyuk and Rouse in this volume. Geochemical results will be released as open files.

FUTURE RESEARCH AND DEVELOPMENT

Future research and development will be directed toward:

- Refinement of field and analytical techniques used in reconnaissance and detailed surface geochemical surveys of all types, but especially those based on stream sediments, lake-bottom sediments, soils and heavy minerals.
- Delineation of geochemical provinces in British Columbia and their relationship to tectonic terranes, metallogenic provinces and mineral deposits.
- Elucidation of the nature of primary and secondary dispersion halos and trains associated with mineral deposits.
- Refinement of regional and detailed geochemical exploration techniques in glaciated terranes of British Columbia.
- Development of more efficient methods for the processing and assessment of geochemical data by statistical and computer techniques.
- Improved understanding of the factors controlling the migration of elements in the surficial environment.
- Integration of remote sensing techniques and regional geochemical data.

REFERENCES

- Brown, D.A. and Logan, J.M. (1988): Geology and Mineral Evaluation of Kokanee Glacier Provincial Park, South-eastern British Columbia (82F/11,14), *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.

- Day, S.J. and Fletcher, W.K (1987): Seasonal Variation of Gold Content of Stream Sediments, Harris Creek, near Vernon (82L/02), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1 pages 401-403.
- Day, S.J., Matysek, P.F. and Johnson, W.M. (1988): The Regional Geochemical Survey: Evaluation of an ICP-ES Package, *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.
- Ferri, F. and Melville, D.D. (1988): Mason Creek Mapping Project (93N/09), *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.
- Fletcher, W.K. and Day, S.J. (1988): Seasonal Variation of Gold Content of Stream Sediments, Harris Creek, near Vernon (82L/02): II, *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.
- Fletcher, W.K. and Horsky, S. (1987): Determination of Gold by Cyanidation and Graphite Furnace Atomic Absorption Spectroscopy, *Journal of Geochemical Exploration*, In Press.
- Gravel, J.L. and Matysek, P.F. (1988): Regional Geochemical Surveys RGS 18–Iskut River 104B, RGS 19–Sumdum 104F and Telegraph Creek 104G and RGS 20–Tulsequah 104K, *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.
- Lefebvre, D.V. and Gunning, M.H. (1988): 1986 Regional Geochemical Survey of Smithers (93L) and Whitesail Lake (93E) Map Sheets: An Assessment, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Exploration in British Columbia, 1987, in preparation.
- Matysek, P.F. (1987): A New Look for the Regional Geochemical Survey Data, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 385-394.
- Matysek, P.F. and Day, S.J. (1988): Geochemical Orientation Surveys: Northern Vancouver Island, Fieldwork and Preliminary Results, *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.
- Matysek, P.F. and Saxby, D.W. (1987): Comparative Study of Reconnaissance Stream Sediment Sampling Techniques for Gold: Fieldwork, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 395-400.
- Mihalynuk, M. and Rouse, J. (1988): Geology of the Tutshi Lake Area, *B.C. Ministry of Energy, Mines and Petroleum Resources*, This Volume.