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STREAM GEOCHEMICAL SURVEY GUIDE

Ray Lett[1] and Wayne Jackaman[2]

1. Ministry of Energy and Mines, PO Box 9333 Stn. Prov. Govt., Victoria, BC, V8W 9N3
2. 3011 Felderhof Road, Sooke, BC, V0S 1N0

TABLE OF CONTENTS

INTRODUCTION

Stream sediment geochemistry has been described as a very robust, successful mineral exploration technique and has proven to be effective even when sampling was poorly carried out (Fletcher, 1997). Much of its early success for discovering new mineral deposits in British Columbia can be traced to the pioneers of exploration geochemistry who recognized the ability of more mobile elements such as copper and zinc to concentrate in sediment from broad range of stream environments. This proved to be an advantage in the 1950's when exploration focused primarily on the search for porphyry copper deposits. Sediment sampling techniques could afford to be less rigorous because formation of copper stream geochemical anomalies was less susceptible to the variations in sample site environment. However, it became apparent that geochemical surveys for gold and other heavy minerals needed more careful collection of sediment from a specific energy environment so that maximum anomaly contrast could be achieved.

Figure 1. Helicopter supported stream sediment and water sampling. The sampler is working fast, but carefully to fill the bag with sediment from a sand-gravel bar so that the helicopter landing time is minimized. Sediment and water and data recording will typically take between 3 to 5 minutes. Commonly, the helicopter will carry a crew of two who will "leapfrog" to alternate sample sites during the traverse.

The BC Regional Geochemical Survey (RGS) is typical of reconnaissance scale stream geochemical surveys that aim primarily to identify regions with a high mineral potential using sampling density in the order of one sample per fifteen square kilometers (Figure 1). This density is suitable for outlining regional geochemical anomalies for a broad range of economic elements (e.g. Cu, Pb, Zn, U), but higher sample density (e.g. 1

sample/ 5Km^2) and a different sampling approach (e.g. collecting a heavy mineral concentrate) are preferable for detecting individual mineral deposits. Geofile 2004-07 outlines methods used by the B.C. Regional Geochemical Survey (RGS) program to collect, prepare, store and ship drainage sediment and water samples. It is not intended for designing a geochemical stream sediment survey and for interpreting the data, but rather can be used as a guide for field procedures. Those interested in a broader range of exploration geochemistry topics should consult the books by Rose, Hawkes and Webb (1979) and Levinson (1979). There are also several papers and publications listed in the References about different aspects of stream sediment surveys in BC such as the used of heavy minerals and the reporting of survey data. The BC RGS procedure is based on that established by the Geological Survey of Canada for the National Geochemical Reconnaissance Program (Garrett, 1980).

SAMPLE COLLECTION

COLLECTION SUPPLIES

The following sample collection supplies are needed to complete a stream sediment-water survey:

1. Copies of 1:50 000 or 1:20 000 scale NTS maps showing the location of proposed sample sites. These maps are used to control survey coverage, guide the site selection process and act as a master record of the survey.
2. Sediment Sample Bags: Minimum size to collect an adequate sample should be 10 x 26 cm high, wet strength, gusset, and KRAFT paper bags.
3. Water Bottles: 250 ml PVC bottles.
4. Aluminum Tags/Flagging/Staple Guns: Permanent marking of sample sites.
5. Field Cards: Used for recording information on sample media, sample site and local terrain.
6. Crates and pails for storage and transport of sediment and water samples in the field.
7. Permanent markers/transparent packing tape.

SITE SELECTION

The following factors should be considered in choosing a sample site for a regional survey with an average sample density of 1 sample per 13 square kilometers:

- Active flowing first or second-order streams (Figure 2) that have a drainage basin area between 2 and 15 square kilometers (first order streams only will generally be sampled for more detailed surveys e.g. 1 sample/5 K^2).
- Within the active stream channel (subject to annual flooding).
- ~60 metres upstream from sources of possible contamination.
- ~60 metres upstream from a confluence.
- ~60 metres upstream from the high tide mark
- Upstream from lakes, ponds and marshes.

In the field the actual sample site selected may be different from the proposed location marked on the survey design sample-site maps depending on the nature of the area. Streams containing abundant fine-grained sediment (silts and clays) that have clean flowing water are the most preferred and very high or very low energy sites should be avoided if possible. Figure 3 shows typical sand-gravel bars with the preferred RGS site marked. Streams with contamination from mining activity, logging, road culverts, etc. are also to be avoided either by choosing an alternate stream or sampling upstream from the identified source of contamination.

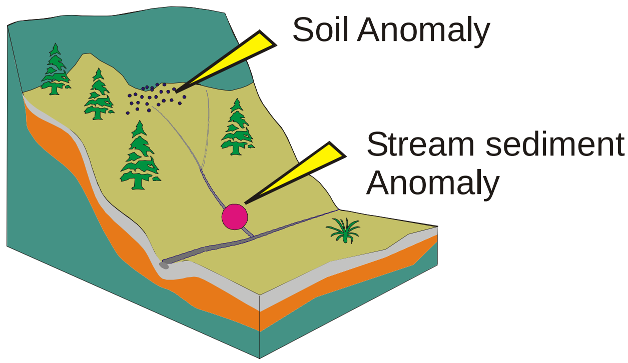

Figure 2. A typical RGS Site showing formation of a stream sediment geochemical anomaly from an up-stream mineralized source close to a soil anomaly.

The sampler should make every reasonable effort to collect a sample of sediment and water at every proposed site or alternative site. If the stream is dry, the collection of only a sediment sample is acceptable, provided that there is evidence of recent stream water flow. However, under no circumstance is it acceptable to collect only a water sample.

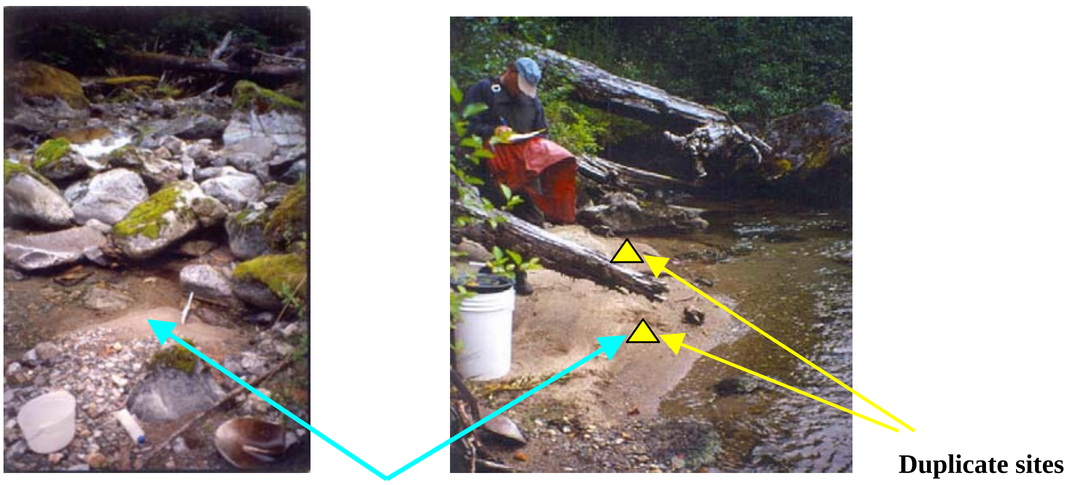

Figure 3. Stream bars with preferred sediment samples sites. A PVC pail and 1 mm stainless steel screen to wet sieve a bulk (10-12 Kg) sample for later heavy mineral separation is shown on the right.

The sampler should also collect a field site duplicate sediment and water sample for every 17 sites visited. Site selection for duplicate samples is based on the availability of sufficient fine-grained material for two sediment samples. The sampler should also make every effort to collect material representative of a similar sediment depositional environment, but from separate sites that are 2 to 4 metres apart (Figure 3)

SAMPLE MEDIA

Stream Sediment

A minimum of 50 grams of -80 mesh (< 0.177 mm) stream sediment is required for subsequent analyses and archiving. Typically a sample bag full of fine-grained sediment (2 kg) is needed to produce 50 grams of -80 mesh fraction. **If in doubt, collect two bags of material.** Only active (in the process of being hydraulically moved), fine-grained stream sediment found within the active stream channel is acceptable. Samples with a dominant component of gravel, sand, glacial rock flour, bank material, organics (weeds, roots or wood fragments) are not acceptable. Should only coarse sand and gravel be present and an alternate stream not available, then at least **two** full bags of sediment will be needed. Typical fine-grained sediment is shown in Figure 4.

Figure 4. Fine-grained sediment.

While storing and transporting samples in the field care must be taken to minimize cross-contamination. The analytical methods used for metals in stream sediments are very sensitive and samplers should avoid wearing jewelry (e.g. gold rings) or using certain sun-block lotion (Zn-rich) because handling the sediment can lead to significant contamination of the sample. A small plastic scoop can be used to simplify collection and reduce possible contamination.

Stream Water

Stream water sampling involves collecting unfiltered water into 250 millilitre PVC bottles at every sample site. The water samples are intended for later determination of such parameters as fluoride, sulphate and pH, but are not suitable for metal analysis. The following factors should be considered when collecting acceptable water samples:

- Clear water devoid of suspended solids (organic material and sediment).
- Water bottles must be two-thirds full. Do not fill to maximum capacity.

Moss Mat Samples

Moss mat samples (Figure 5) can be taken as an alternative to stream sediment from high-energy streams (high rainfall, mountainous areas) where there is only a small amount of silt and clay sized material in the material. The moss tends to capture fine-grained sediment (and heavy minerals such as gold) suspended in the water especially during flood events. Moss should be live and taken from mats on logs or boulders in the active channel above the water flow. Feeling the moss can assess the abundance of captured sediment. There is a good comparison between the results of stream and moss mat geochemistry by Matysek *et al.,* (1987).

Figure 5. Moss mat sampling from a boulder in mid channel and the moss-captured sediment.

SITE TAGS

Ideally, 5 cm x 10 cm aluminum site tags and flagging are used for marking sample sites. The sample ID number should be written on the tag and the tag firmly attached to a permanent feature such as a tree using a staple gun. The tag must be clearly visible from the stream to allow easy follow-up in later surveys.

SAMPLE COLLECTION MAPS

Master 1:50 000 Sample Location Maps

1:50 000 scale NTS map sheets of the survey area are most suitable for traverse planning. These maps identify the proposed sample collection sites and will be used to control all aspects of collection coverage and for recording sample sites and sample ID numbers at the end of each collection day. Daily recording should be done neatly and in waterproof ink since it is the master paper copy of the survey. An inspection at any time should show the exact status of the survey. These maps must remain in the base camp.

1:50 000 Traverse Field Maps

These are 1:50 000 scale NTS map sheets used by the sample collection crews in the field. Sample collection traverses are planned prior to sample collection and are marked on these traverse maps. The field crews will use these maps to record sample sites and their associated ID numbers where samples were collected during their daily traverses. This information is transferred to the Master 1:50 000 Sample Location Maps at the end of each day.

DATA RECORDING

Field Observations

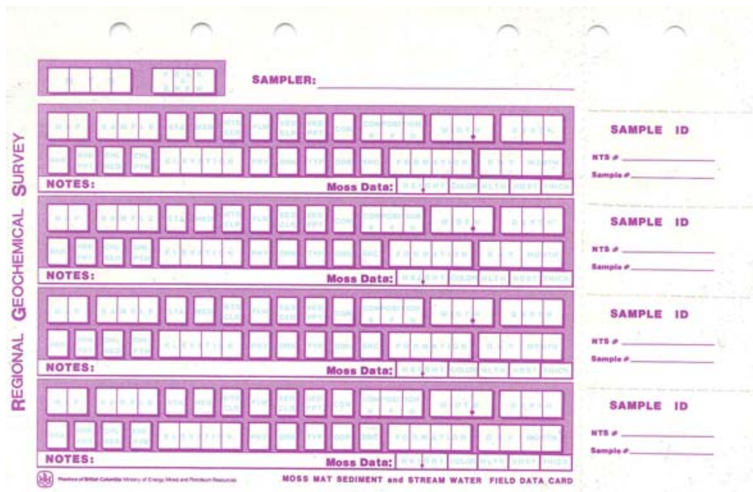

Figure 6. Data recording in the field and an RGS data card.

Field observations regarding sample media, sample site and local terrain are required for interpreting the analytical data. This information is recorded on specially designed field cards (Figure 6) and should be checked daily for accuracy and completeness.

Sample Numbering

All sediment sample bags, water bottles, site tags and field cards should be labeled with the following information:

NTS: ***93E*** SAMPLE ID: ***1002***

The sample numbering system is based on blocks of 20 consecutive numbers (e.g., 93E 1001 to 1020). In every block, there will be 18 numbers for collected samples (which includes one field duplicate), and two reserved numbers for quality control samples (analytical duplicate and control reference samples) which will be inserted at a later date by the laboratory during preparation.

- **Routine Field Samples**: Sediment and water samples collected at proposed sample sites and are allocated non-reserved sample numbers.

- **Field Duplicate Samples**: Two (2) separate samples collected at the same site. Site selection is based on the presence of abundant fine-grained material available to sample. The field duplicate will be given the next consecutive sample number. For example, if the first of the field duplicate pair is given the number 93E 1005 then the sample representing the second field duplicate must be given the sample number 93E 1006. Duplicate samples must be clearly identified in the sample records.

- **Analytical Duplicate Sample**: The first sample in each block of 20 is always held in reserve for the analytical duplicate sample (e.g. 93E 1001, 93E 1021, 93E 1041, etc.).

- **Control Reference Sample**: The position of the control reference sample in each block will vary randomly. A list of their location in each block of 20 should be established. Numbered empty bags and bottles set aside for the quality control samples are inserted into the each block of 20 prior to shipping.

ID	Status	ID	Status
93E 1001	***analytical duplicate***	93E 1011	routine field sample
93E 1002	routine field sample	93E 1012	routine field sample
93E 1003	routine field sample	93E 1013	routine field sample
93E 1004	routine field sample	93E 1014	routine field sample
93E 1005	routine field sample	93E 1015	routine field sample
93E 1006	routine field sample	93E 1016	routine field sample
93E 1007	routine field sample	***93E 1017***	***field duplicate 1***
93E 1008	routine field sample	***93E 1018***	***field duplicate 2***
93E 1009	***control reference***	93E 1019	routine field sample
93E 1010	routine field sample	93E 1020	routine field sample

Table 1. Example of sample number system - block 93D 1001 to 1020.

SAMPLE PREPARATION

STREAM SEDIMENT SAMPLE DRYING

Sample drying should be initiated within 12 hours of sample collection. It is estimated that up to 300 samples will be drying at any given time during the peak of the survey. As such, an estimated 300 square foot drying area will be needed to handle this large number of samples. Drying racks must be designed that will allow good airflow across the samples to promote drying, and minimize cross contamination between samples.

Figure 7. An example of a sediment sample drying area. Tags have been inserted between the bags identify individual sample batches.

Sample drying can be carried out in large canvas tents, shipping containers or buildings with auxiliary propane or fuel oil heaters, or air-tight heaters, and racks or netting to support the samples. Control of heating is required to maintain a temperature range from a minimum of 30^{o}C to a maximum of 50^{o}C. The drying area should be protected from all sources of contamination found inside (e.g. paint) and outside of the dry facility (e.g. wind borne dust from gravel roads). The drying racks should be constructed of non-contaminating materials (Figure 7).

All sediment sample bags should be placed in batches of 10 sample bags (93D 1001 to 10, 12 to 20, etc.) and laid out on racks or netting to dry. At this point, checks are carried out to ensure the sequential numbering system is correct, and damaged bags are replaced. The tops of the bags may be left open to promote rapid drying. Under normal conditions, two or three days are usually sufficient for drying conventional sediment samples. Moss mats require more time. The sediment samples must be completely dry before further processing can take place.

SEDIMENT SAMPLE SIEVING

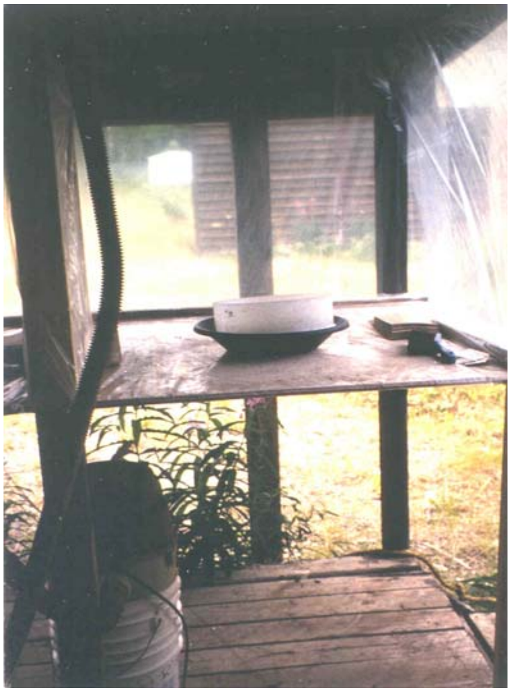

Figure 8. Preparation work area.

When completely dry, stream sediment samples should be dis-aggregated by mortar and pestle, and then sieved to completion through an -18 mesh nylon screen (< 1 mm). This reduces the size of the sample by removing all pebbles and organic material thereby allowing greater ease in packing and proper evaluation of the fines content. Quality checks should be made by routinely sieving 1 in every block of 20 samples using an -80 mesh sieve. If necessary stream should be re-sampled if the sample is found to be deficient in fines (<40 grams). Sieves, mortar and pestle should be thoroughly cleaned between each sample using a vacuum cleaner or compressed air.

The sample preparation work area must be situated away from the sample dry to avoid contamination. During preparation, care and attention must be taken to ensure samples are not cross-contaminated. All processing equipment must be thoroughly cleaned after every sample is processed (Figures 8 and 9).

Figure 9. Processed stream sediment sample. The 1 mm nylon screen is shown on the right with a gold pan utilized to capture the < 1 mm sediment.

PACKING AND SHIPPING

STREAM SEDIMENT

Samples should be shipped from the field camp to a designated laboratory in suitable containers. Dried and processed sediment samples are packed into plastic pails. Partial blocks of 20 samples are not shipped if there are further samples in the sequential numbering system to be collected. Samples should not be shipped in a disorganized manner. Numbers in each container should form a complete sequence and packing slips must be used to explain missing numbers, etc. Samples **must not** be shipped wet or damp. The sequence(s) of sample numbers should be clearly written on the outside of the container and on the packing slip. Sediment and water samples **must never** be shipped in the same container. A record must be kept of the sequence(s) of numbers in each shipping container, the number of containers in each shipment, the date, bill of lading, invoice, carrier(s), origin, and destination.

Figure 10. Packing water bottles.

STREAM WATER

Stream water containers should be shipped in pails or boxes (Figure 10) . Sequential numbering series must be complete, e.g., where the stream was dry, an empty water container numbered and marked "DRY" will be shipped with other water samples. Bags and bottles for the control reference standard and blind duplicate positions are added prior to shipment according to instructions. All water containers must be securely tightened for shipment.

SAMPLE ANALYSIS

The laboratory will be responsible for:

- Screening the dry, < 1 mm sample to – 80 (<0.177 mm) size.
- Inserting analytical duplicate samples and standard reference materials into each batch of 20 samples.
- Analysing the sediment sample for trace elements and loss on ignition. Most commonly a split of the prepared sediment is analysed for gold and 32 element by instrumental neutron activation (INAA) and for up to 40 elements by aqua regia digestion-inductively coupled plasma mass spectrometry (ICP/MS).

Standards and blanks are added to water sample batches which are typically analysed for pH and sulphate.

EQUIPMENT

Experience has shown that drainage sediment and water surveys proceed efficiently when field sample collection, handling and recording supplies are well organized and of sufficient quantity and quality. Equipment requirements are relatively few but are critical to achieving program success. The following list outlines equipment supplied needed for a typical RGS.

Sample Collection:

- sediment sample bags
- 250 mL water bottles
- site tags and flagging
- light weight staple guns plus staples
- notebooks for holding data cards
- water-insoluble black felt tip markers
- transparent packaging tape

Sediment Drying/Sieving:

- thermometers
- -18 mesh sieves with pans
- vacuum cleaner

Packaging/Shipment:

- cotton string
- sample shipment forms
- plastic pails with lids
- shipping boxes

Data Recording:

- data cards for recording field observations
- sample number lists
- master 1:50,000 NTS map sheets

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