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BRITISH COLUMBIA REGIONAL GEOCHEMICAL SURVEY

NTS 92H - HOPE

STREAM SEDIMENT AND WATER GEOCHEMICAL DATA

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INTRODUCTION

Open File BC RGS 39 / GSC OF 2665 is one of three open files published in January, 1994 as part of the British Columbia Regional Geochemical Survey (RGS) Program. This Open File includes **new** analytical data for 26 elements in stream sediments. These results were obtained by analyzing archived sediment pulps collected during a 1981 joint Federal-Provincial stream sediment and water survey conducted in NTS map sheet 92H - Hope. Also included in this package are the original field and analytical results from Open File BC RGS 7 / GSC OF 865 published in 1982 for 14 elements in stream sediments plus uranium, fluoride and pH in stream waters. Open File BC RGS 39 / GSC OF 2665 supersedes all previous publications.

The 1981 survey was managed and funded by the British Columbia Ministry of Energy, Mines and Petroleum Resources (MEMPR) as part of the Regional Geochemical Survey Program. Data management was provided by the Geological Survey of Canada (GSC).

Initiated in 1990, as part of the Ministry's RGS Archive Program, the sediment samples collected from earlier surveys were retrieved from GSC storage facilities in Ottawa and analyzed by instrumental neutron activation analysis (INAA). This project was funded in part by the *Canada-British Columbia Mineral Development Agreement* (1985-1990).

Analytical results and field observations compiled by the RGS Program are used in the development of a high quality geochemical database suitable for resource assessment, mineral exploration, geological mapping and environmental studies. Sample collection, preparation and analysis are closely monitored to ensure consistency and conformance to national standards (Ballantyne, 1991).

ACKNOWLEDGMENTS

1981 STREAM SEDIMENT and WATER RGS PROGRAM

Contracts were let to the following companies for sample collection, preparation and analysis and were managed by staff of the MEMPR.

COLLECTION : Rooi Enterprises Ltd., Victoria, B.C.
PREPARATION : Kamloops Research Assay and Laboratory, Kamloops, B.C.
ANALYSIS : Chemex Laboratories Ltd., North Vancouver, B.C. (Sediments)
Novatrack Analysts Ltd., Vancouver, B.C. (U in Sediments)
Bondar Clegg Ltd., North Vancouver, B.C. (Waters)

1993 RGS ARCHIVE PROGRAM

The 1993 RGS Archive Program was managed by Geological Survey Branch staff of the MEMPR. *P.F. Matysek* and *W. Jackaman* coordinated the operational activities of contract and MEMPR staff.

W. Jackaman coordinated the production of this open file. *S.J. Cook* assisted with the analysis and interpretation of the data. *K. J. Colbourne* provided production support.

PREPARATION : Rob Phillips, Ottawa, Ont.
ANALYSIS : Bècquerel Laboratories, Mississauga, Ont.
Activation Laboratories, Ancaster, Ont.

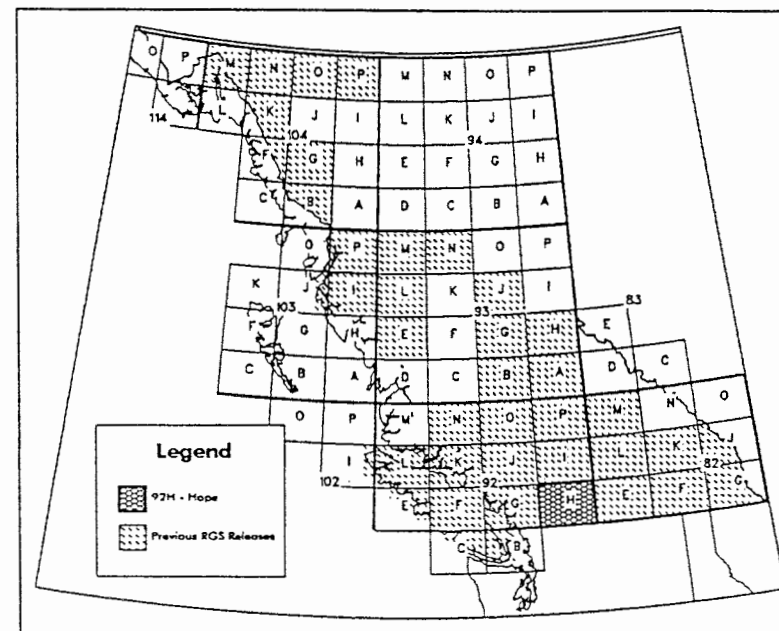


Figure 1. Location map.

OPEN FILE FORMAT

Open File BC RGS 39 / GSC OF 2665 includes a data booklet, a map booklet and a 3.5" floppy diskette.

The data booklet is divided into the following sections. *Please refer to notes preceding each section for important information on data presentation format.*

- survey details and RGS data evaluation,
- listings of field and analytical data,
- listings of analytical duplicate data,

- threshold tables,
- summary statistics, and
- sample evaluation charts.

The map booklet contains the following maps :

- 4 - 1: 100 000 scale sample location maps,
- 1 - 1: 500 000 scale sample location clear overlay and map,
- 1 - 1: 500 000 scale bedrock geology clear overlay and map,
- 1 - 1: 500 000 scale surficial geology map,
- 43 - 1: 500 000 scale symbol and value maps for individual elements,
- 1 - 1: 500 000 base metal anomaly map, and
- 1 - 1: 500 000 precious metal anomaly map.

Analytical and field data is included as an ASCII file on a 3.5", high-density diskette. Document files detailing data format specifications and survey details are also included.

SURVEY DETAILS

PHYSIOGRAPHY and GEOLOGY

The Hope map sheet covers an area of approximately 16 000 square kilometres and includes the Pacific Ranges, Cascade Mountains and Thompson Plateau physiographic units (Holland, 1976). At elevations greater than 2500 metres, mountain peaks and high ridges are serrate and show the effects of intense alpine glaciation. Mountains at lower elevations tend to be relatively smooth and gently sloping. Rock with discontinuous deposits of colluvium, talus and till are present on the mountain slopes and thick deposits of fluvial and glaciofluvial sediments are found within the valleys. The Thompson Plateau is characterized by rolling hills of low relief and is covered by a thick layer of glacial drift (Map 3, after Fulton *et al.*, 1982).

The survey area straddles the boundary between the Coast and Intermontane tectonic belts. In the west, the Coast crystalline belt is comprised of Cretaceous granites and granodiorites. Within the Coast belt, roof pendants of gneiss, amphibolite, metasediments and metavolcanics represent metamorphosed remnants of volcanic-arc rocks (Roddick and Tipper, 1985). To the east, successions of Upper Jurassic to Lower Cretaceous volcanic and sedimentary rocks of the Methow Terrane and Permian to Middle Jurassic chert, argillite, basalt and alpine-type ultramafic rocks of the Bridge River and Hozomeen terranes mark the transition between the major tectonic belts (Wheeler *et al.*, 1988). The Intermontane belt is dominated by rocks of the Quesnel Terrane and includes Upper Triassic to Lower Jurassic arc volcanics, volcanoclastic and comagmatic rocks overlain by Jurassic arc-derived clastic rocks. Granitic rocks of the Coast Plutonic Complex intrude rock units throughout the Intermontane Belt. Major fault systems found in the map area include the Fraser fault, Pasayten fault, Ross Lake fault and Straight Creek fault. The bedrock geology base map (MAP 2) used in this Open File is Roddick *et al.*, 1979.

The British Columbia mineral deposits database lists 791 mineral occurrences for map sheet 92H (MINFILE 092HSE, 092HSW, 092HNE, 092HNW). The major types of metallic deposits include copper porphyries, gold-bearing skarns, precious metal epithermal deposits and precious metal bearing quartz veins. Currently, Hedley Tailings, Nickel Plate and Similco are the only operating metal mines located in the survey area.

SAMPLE COLLECTION - 1981

Helicopter and truck-supported sample collection was carried out during the summer of 1981. A total of 995 stream sediment and 983 stream water samples were systematically collected from 940 sites. Average sample site density was 1 site per 17 square kilometres over the 16 000 square kilometre survey area. Field duplicate samples were routinely collected in each analytical block of twenty samples.

Fine grained stream sediment material (< 1mm) weighing 1-2 kg was obtained from the active (subject to annual flooding) stream channel and placed in kraft bags. Unfiltered water samples were collected in 250 ml bottles, precautions were taken to exclude suspended solids when possible. Field observations regarding sample media, sample site and local terrain were also recorded.

SAMPLE PREPARATION - 1981

Field dried sediment samples were shipped to Kamloops Research Assay and Laboratory for final sample preparation. The samples were air-dried and the -80 mesh (<177 microns) fraction was obtained by dry sieving. Quality control reference standards and analytical duplicate samples were inserted into each analytical block of twenty sediment samples. Any -80 mesh sediment remaining after analyses was archived for future analyses.

SAMPLE ANALYSIS - 1981

Chemex Laboratories (North Vancouver) analyzed the sediment samples for: antimony, arsenic, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, silver, tin, tungsten and zinc. Uranium in stream sediments was determined by Novatrack Analysts Ltd. (Vancouver). Water samples were analyzed for fluoride, uranium, and pH by Bondar Clegg Ltd. (North Vancouver). Concentrations reported below the detection limit are presented in the data listings as a value equivalent to one-half of the detection limit. Detection limits for each element are listed in Table 1.

For the determination of copper, cobalt, iron, lead, manganese, nickel, silver, and zinc, a 1 gram sample was reacted with 3 ml of concentrated HNO₃ for 30 minutes at 90°C. Concentrated HCl (1 ml) was added and the digestion was continued at 90°C for an additional 90 minutes. The sample solution was then diluted to 20 ml with metal free water and mixed. Concentrations were determined by atomic absorption spectroscopy (AAS) using an air-acetylene flame. Background corrections were made for Pb, Ni, Co and Ag.

Antimony was determined using a 2 gram sample digested with concentrated HCl in a hot water bath. The iron was reduced to Fe(II) and the antimony extracted with trioctyl phosphine oxide MIBK and measured by AAS with background correction.

Arsenic was determined by hydride generation/atomic absorption spectroscopy (AAS-H) on an aliquot of solution taken from the sample solution prepared for the base metal analyses.

Molybdenum was determined by AAS using nitrous oxide acetylene flame. A 0.5 gram sample was reacted with 1.5 ml concentrated HNO₃ at 90°C for 30 minutes. At this point 0.5 ml of concentrated HCl was added and the digestion continued for an additional 90 minutes. After cooling, 8 ml of 1250 ppm Al solution was added and the sample solution diluted to 10 ml before aspiration by AAS.

Element	Detection Limit	Method	Element	Detection Limit	Method		
Antimony	Sb	0.2 ppm	AAS	Cerium	Ce	10 ppm	INAA
Arsenic	As	0.5 ppm	AAS-H	Cesium	Cs	0.5 ppm	INAA
Cobalt	Co	2 ppm	AAS	Chromium	Cr	5 ppm	INAA
Copper	Cu	2 ppm	AAS	Cobalt	Co	5 ppm	INAA
Iron	Fe	0.02 %	AAS	Hafnium	Hf	1 ppm	INAA
Lead	Pb	2 ppm	AAS	Iron	Fe	0.20 %	INAA
Manganese	Mn	5 ppm	AAS	Lanthanum	La	5 ppm	INAA
Mercury	Hg	10 ppb	AAS-F	Lutetium	Lu	0.2 ppm	INAA
Molybdenum	Mo	2 ppm	AAS	Molybdenum	Mo	1 ppm	INAA
Nickel	Ni	2 ppm	AAS	Nickel	Ni	10 ppm	INAA
Silver	Ag	0.2 ppm	AAS	Rubidium	Rb	5 ppm	INAA
Tungsten	W	2 ppm	COLOR	Samarium	Sm	0.5 ppm	INAA
Uranium	U	0.2 ppm	NADNC	Scandium	Sc	0.5 ppm	INAA
Zinc	Zn	2 ppm	AAS	Sodium	Na	0.10 %	INAA
Fluoride - water	FW	20 ppb	ION	Tantalum	Ta	0.5 ppm	INAA
Uranium - water	UW	0.05 ppb	LIF	Terbium	Tb	0.5 ppm	INAA
pH - water	pH	0.1	GCE	Thorium	Th	0.5 ppm	INAA
Gold	Au	2 ppb	INAA	Tungsten	W	2 ppm	INAA
Antimony	Sb	0.1 ppm	INAA	Uranium	U	0.2 ppm	INAA
Arsenic	As	0.5 ppm	INAA	Ytterbium	Yb	2 ppm	INAA
Barium	Ba	100 ppm	INAA	Zirconium	Zr	200 ppm	INAA
Bromine	Br	0.5 ppm	INAA				

TABLE 1 ANALYTICAL SUITE OF ELEMENTS: NTS 92H

Mercury was determined using a 0.5 gram sample reacted with 20 ml concentrated HNO₃ and 1 ml concentrated HCl in a test tube for 10 minutes at room temperature and for 2 hours in a 90°C water bath. After digestion the sample was cooled and diluted to 100 ml with metal free water. The Hg present was reduced to the elemental state by the addition of 10 ml of 10% weight per volume SnSO₄ in H₂SO₄. The Hg vapor was flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrometer (AAS-F). Measurements were made at 253.7 nm. This method is described in detail by Jonasson, *et al.* (1973).

Uranium in sediments was determined using a neutron activation method with delayed neutron counting (NADNC). A 1 gram sample was weighed in a seven dram polyethylene vial, capped and sealed. Irradiation was provided by the Triumf Cyclotron with an operating flux of 10¹² neutrons/cm²/second. Each sample was irradiated for 60 seconds. Following a 20 second delay, the sample was counted for 60 seconds with six BF3 detector tubes embedded in paraffin.

Tungsten was determined colourimetrically after a pyrosulfate fusion and a dithiolcarbonate complexing for the generation of the colour (COLOR).

Uranium in waters was determined by a fluorometric method (LIF). The U was initially preconcentrated by evaporation. The residue was fused with a mixture of Na₂CO₃, K₂CO₃ and NaF in a platinum dish. After cooling the fluorescence of the fused pellet was measured using a Turner Fluorometer.

The determination of fluoride in waters involved an aliquot of sample being mixed with an equal volume of total ionic strength adjustment buffer (TISAB II solution). The fluoride was measured using a Corning 101 Electrometer with an Orion Fluoride Electrode (ION).

pH in waters was measured using an aliquot of sample in a clean dry beaker by a Fisher Accumet pH Meter (GCE).

SAMPLE PREPARATION - 1993 RGS Archive Program

Of the 940 sediment samples collected during the original survey, 922 samples contained sufficient material to be analyzed by instrumental neutron activation analysis (INAA). New quality control reference standards were inserted into each analytical block of twenty samples and existing analytical and field site duplicate samples were checked and verified.

SAMPLE ANALYSIS - 1993 RGS Archive Program

The determination of antimony, arsenic, barium, bromine, cerium, cesium, chromium, cobalt, gold, hafnium, iron, lanthanum, lutetium, molybdenum, nickel, rubidium, samarium, scandium, sodium, tantalum, terbium, thorium, tungsten, uranium, ytterbium and zirconium by INAA was conducted by Becquerel Laboratories (Mississauga). A total of 148 sediment samples were not included in the original INAA work. These samples were analyzed by INAA by Activation Laboratories (Ancaster) and do not include zirconium determinations. Instrumental neutron activation analysis involves irradiating the sediment samples, which range from 1 to 50 grams (average 21 grams), for 20 minutes in a neutron flux of 10¹¹ neutrons/cm²/second. After a decay period of approximately 1 week, gamma-ray emissions from the elements were measured using a gamma-ray spectrometer with a high resolution, coaxial germanium

detector. Counting time was approximately 15 minutes per sample. Table 1 lists the associated detection limits reported by this analytical technique.

Repeat analysis by INAA have been performed by Activation Laboratories on the original split for samples returning gold values exceeding 20 ppb and are reported as Au2 in Appendix A. This level represents the 95th percentile for gold based on the total RGS data set for map sheets 92H, 92I and 92J.

RGS DATA EVALUATION

The ability to discriminate real trends, related to geological and geochemical conditions, from those that result from spurious factors such as sampling and analytical errors is of considerable importance in the success of geochemical data interpretation. An estimate of precision allows sampling and analytical variation to be quantified, and is an integral part of the evaluation of geochemical data. Estimates of analytical precision and element variability within and between sample sites can be determined by utilizing control reference, analytical duplicate and field duplicate data.

Control reference standards, analytical duplicates and field duplicates are routinely inserted to monitor and assess accuracy and precision of analytical results. Each analytical block of twenty sediment samples consists of :

- 17 routine samples,
- 1 field duplicate sample collected adjacent to one of the 17 routine samples (Listed in Appendix A),
- 1 analytical duplicate sample; a subsample taken from one of the 17 routine samples prior to analysis (Listed in Appendix B), and
- 1 control reference standard sample containing sediment of known element concentrations.

Analytical blocks of corresponding water samples differ slightly in that they contain two control reference standard samples but no analytical duplicate samples.

ANALYTICAL REPRODUCIBILITY

Scatterplots of analytical results of field duplicate pairs and analytical duplicate pairs are presented for Cu, Pb, Ni, Zn (AAS sediment data) and Au, As (INAA sediment data). A total of 125 field and analytical duplicate pairs from the 1994 data set (NTS map sheets 92H, 92I and 92J) were included in this analysis. Field duplicate data and analytical duplicate data (Figures 2a and 2b) show very good reproducibility, particularly for those trace elements with concentration levels well above detection limits. This gives a high degree of confidence in the quality of both the field sampling and the analytical methods. Poor reproducibility for gold is primarily due to the influence of the particle sparsity effect (see section : Interpretation of Gold Data).

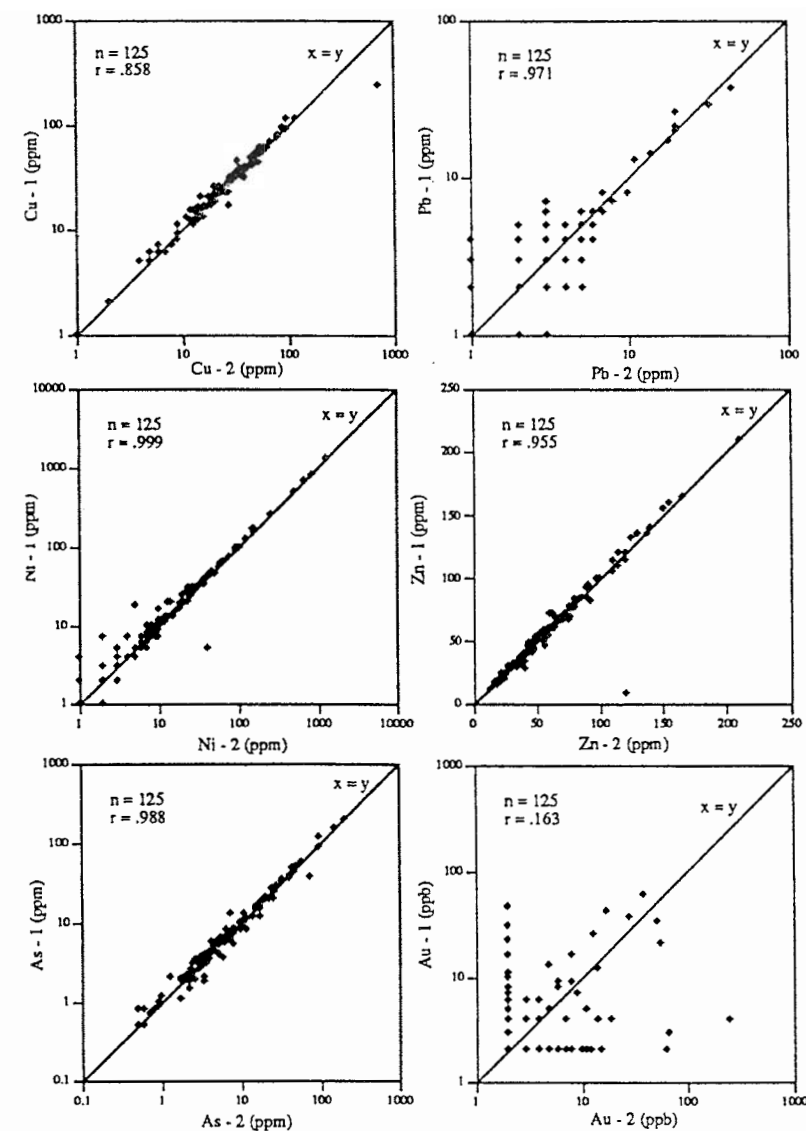


Figure 2a. Scatterplots showing field duplicate pairs for Cu, Pb, Ni, Zn (1981 data) and As, Au (1993 data).

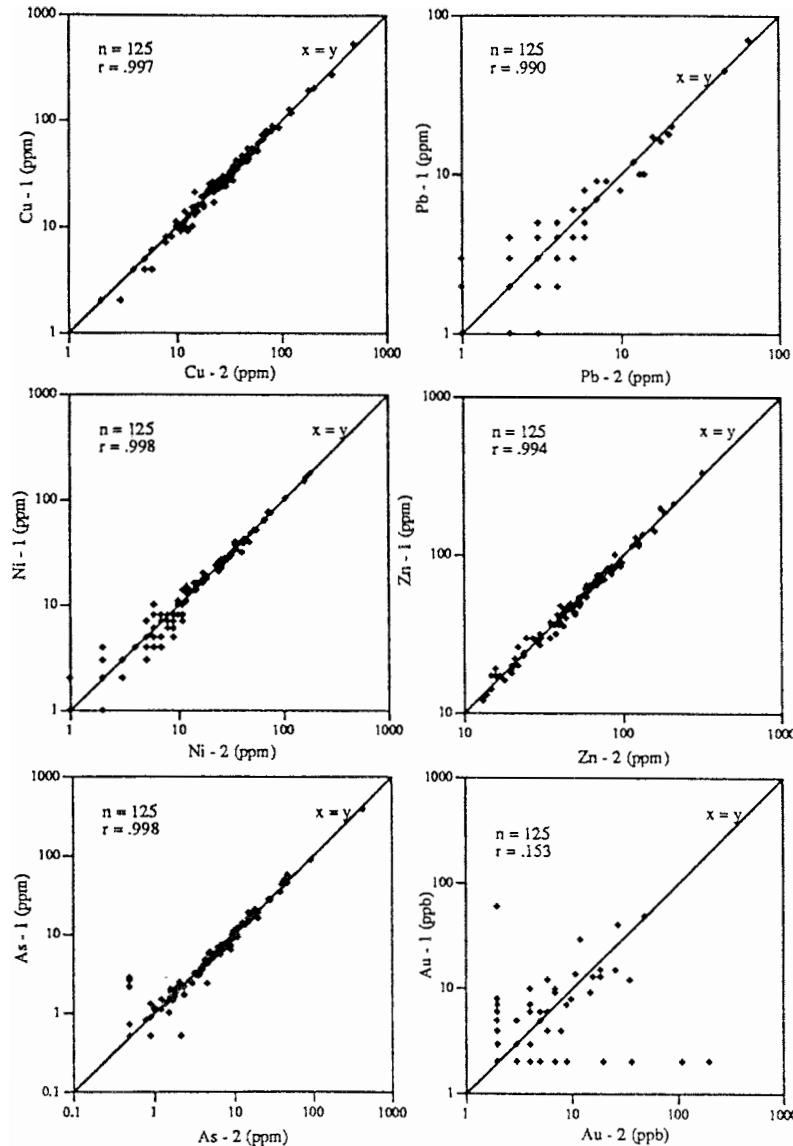


Figure 2b. Scatterplots showing analytical duplicate pairs for Cu, Pb, Ni, Zn (1981 data) and As, Au (1993 data).

PRECISION ESTIMATES

Precision estimates for selected elements were calculated using 125 analytical duplicate pairs from the total 1994 analytical data set using the Thompson and Howarth (1973, 1976, 1978) method.

Their method involves dividing 50 or more analytical duplicate pairs (x_1, x_2) into groups with narrow concentration ranges. For each group, the median value of absolute differences between duplicate pairs ($|x_1 - x_2|$) is used as an estimation of the standard deviation (s), whereas the mean value of all the duplicate pair means $(x_1 + x_2)/2$ is used as an estimation of the average concentration. Repetition of this procedure for successive groups of concentration ranges produces a set of corresponding mean concentration and standard deviation estimates for the entire range of data. Linear regression of the estimates provides slope and intercept values from which precision of the data set can be calculated using the equation:

$$P_c = 200(K/c + S_0)$$

where S_0 (coefficient of slope) is the standard deviation at zero concentration and K (intercept) is a constant. This linear function has been determined in practical cases (Matysek and Sinclair, 1984) to be a satisfactory model for the expression of analytical variation.

Precision estimates were calculated as follows:

- Step 1. A list of duplicate means and corresponding absolute differences was calculated for each sample pair.
- Step 2. The list was sorted in increasing order of concentration means.
- Step 3. The mean concentration and the median difference between pairs for the first group of 11 analytical pairs were determined.
- Step 4. Step 3 was repeated for each successive group of 11 pairs ignoring any remainder less than 11.
- Step 5. The linear regression of the median differences on the means was calculated. The resultant intercept and coefficient of the calculated line are multiplied by 1.048 and were used to estimate precision.

Precision estimates were determined for Cu, Fe and Zn (AAS), and As (INAA). This particular suite of elements was selected on the following basis:

- Their distributions approximated a Gaussian (normal) curve, and
- The majority of their concentrations were well above their detection limits.

This methodology may not be applicable for elements characterized by non-normal distributions. These distributions are recognized when the following conditions arise:

- Element abundance is dependent on rare grains,
- Concentration levels are at or near the detection limit, and/or
- Data contains outliers.

RESULTS

Precision estimates calculated at different concentration levels using the Thompson and Howarth method are presented in Table 2 and Figure 2. Precision estimates for As averaged 16.1% at the 50th percentile (5.3 ppm As), 13.9% at the 80th percentile (14.0 ppm As) and 13.0% at the 95th percentile (44.0 ppm As). Precision estimates for Cu, Fe and Zn were lower, averaging 10.5% at the 50th percentile, 9.7% at the 80th percentile, and 9.0% at the 95th percentile. These estimates are of similar magnitude to those obtained from studies on error evaluation in stream sediment surveys (Plant, 1971; Chork, 1977; Fletcher, 1981). These studies generally concluded that precision ranges of 10 to 15% at the 95% confidence level are often encountered and considered acceptable for laboratory variability in most exploration programs.

Element	r	Intercept	Slope	50th (ppm)	Precision	80th (ppm)	Precision	95th (ppm)	Precision
Copper	0.8116	0.382	0.0426	26	12%	46	11%	80	10%
Iron	0.8194	0.015	0.0397	1.85	10%	2.70	9%	3.95	9%
Zinc	0.7752	0.716	0.0334	55	10%	80	9%	140	8%
Arsenic	0.9043	0.090	0.0600	5.3	16%	14.0	14%	44.0	13%

TABLE 2 THOMPSON AND HOWARTH PRECISION ESTIMATES

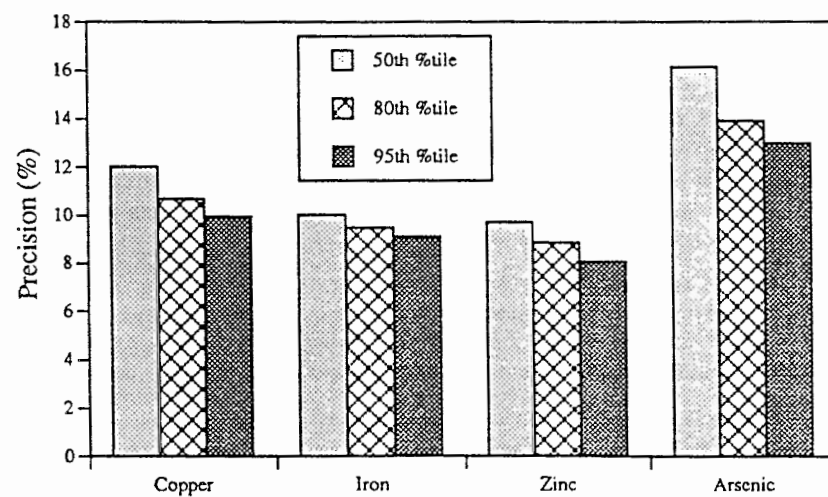


Figure 3. Bar graph showing precision estimates.

COMPARISON of INAA and AAS TECHNIQUES

Several elements (Sb, As, Co, Fe, Mo and Ni) were determined by both atomic absorption spectroscopy (AAS) and by instrumental neutron activation analysis (INAA). Variations observed between original (AAS) and subsequent (INAA) results are due largely to differences in the analytical methods. AAS requires dissolution of the sample with acids prior to analysis. Aqua regia, a combination of hydrochloric and nitric acids, was used to dissolve RGS sediment samples. Gold and sulphide minerals are dissolved, whereas silicates and some oxides (*i.e.* magnetite) are only partially digested. Conversely, INAA does not require sample digestion prior to analysis. Concentrations determined by INAA generally represent the *total* content of that element in the sample. Due to this difference between methods, INAA generally reports slightly higher concentrations than aqua regia AAS.

Using the 92H data set, Figure 4 represents a comparison of the two techniques for iron and nickel. In both cases, INAA gives higher results. A strong correlation is noted for nickel ($r = .907$). The slightly higher INAA results are probably due to the presence of minute quantities of nickel within the lattices of silicates (*i.e.* feldspars). Iron demonstrates substantial concentration differences between analytical methods and a weaker correlation ($r = .569$). These results are probably due to the presence of variable amounts of magnetite and hematite commonly found in stream sediment samples.

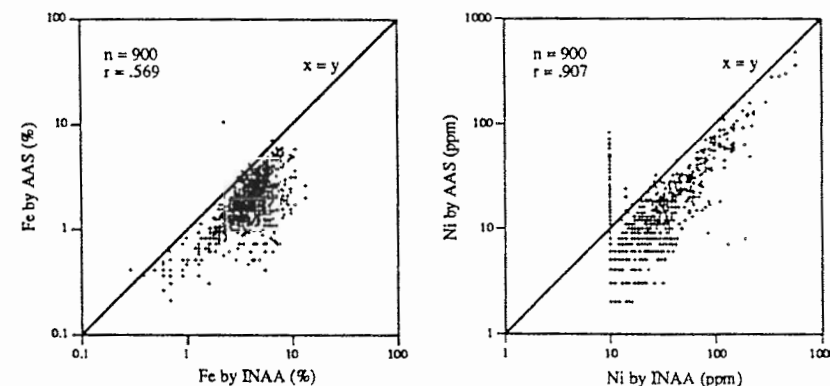


Figure 4. Scatterplots comparing INAA and AAS results for Fe and Ni.

INTERPRETATION OF GOLD DATA

Understanding gold geochemical data from regional stream sediment surveys requires an understanding of the chemical and physical characteristics of gold in the surficial environment.

Gold is a soft, malleable element of high density (19.3 g/cm^3). Gold is chemically inert and commonly occurs in native form (pure Au) or as electrum (alloyed with silver). Sub-micron sized gold is often bound to clays, adsorbed onto Fe-Mn oxides or contained within organic colloids. At normal surface

temperatures, gold will dissolve under rare conditions of high oxidation potential and high acidity where ions such as chloride (Cl⁻), thiosulphate (S₂O₃²⁻) or cyanide (CN⁻) are present. Normal background concentrations for gold in bedrock vary, but are generally less than 5 ppb. Background levels encountered for stream sediments seldom exceed 10 ppb and commonly are near the detection limit of 2 ppb.

Gold generally occurs as rare, discrete particles. In many instances a geochemical subsample may or may not contain a gold grain. This is known as the 'nugget effect'. Generally, larger geochemical sample sizes are required to minimize the nugget effect and more accurately represent gold concentrations. (Clifton *et al.*, 1969; Harris, 1982). Neutron activation analyses for the RGS Archive program utilized samples weighing on average 20 grams.

Follow-up investigations of gold anomalies should be based on careful consideration of related geological and geochemical information and an understanding of the variability of gold geochemical data. Once an anomalous area has been identified, field investigations should be designed to include detailed geochemical follow-up surveys and collection of large, representative samples. Analysis of field and analytical duplicate samples enables assessment of the reliability of gold results and permits better data interpretation.

ANOMALY RATING PROCEDURE

Stream sediments collected downstream from mineralized sources commonly exhibit enhanced concentrations for ore and pathfinder elements. An interpretive technique has been developed by Matyssek *et al.* (1991) to highlight sample sites characterized by anomalous, multi-element signatures (Figure 5). As an example of this methodology, sample evaluation charts (Appendix D) and 1:500 000 scale anomaly maps (Map Booklet) have been produced which outline areas considered to have relatively higher base metal and precious metal potential.

METHODOLOGY

Step 1 - Subset analytical data by lithology.

Element concentrations for stream sediment samples typically reflect the underlying geology found within the sampled drainage basin. Considerable variability in element concentrations are associated with different lithologies and must be considered in order to distinguish samples which most likely reflect mineralized sources from lithological units characterized by high background values. Consequently, analytical data is initially subset on the basis of the underlying lithology found at each sample site.

Step 2 - Calculate 90th, 95th and 98th percentiles (threshold values) for each lithology.

The 90th, 95th and 98th percentiles are calculated for lithologies having 10 or more sample sites. Lithologies having less than 10 sample sites list threshold values determined from the current provincial RGS data set. The results are listed in a threshold table (Appendix D). To better estimate element variability within lithologies, data from adjoining survey areas (NTS map sheets 92H, 92I, 92J, 92N, 92O, and 92P) have been included.

Step 3 - Assign anomaly ratings to each sample.

Element concentrations for each sample are then compared to the calculated threshold values and assigned the following anomaly ratings :

- an anomaly rating of 1 for concentrations \geq 90th but $<$ 95th percentile,
- an anomaly rating of 2 for concentrations \geq 95th but $<$ 98th percentile, and
- an anomaly rating of 3 for concentrations \geq 98th percentile.

Sample evaluation charts graphically display the anomaly rating for individual elements. In addition, the summed element ratings provide a measure of the anomalous multi-element nature of each sample. Anomaly maps produced from the sample evaluation charts highlight the spatial relationships between anomalous samples.

Utilizing the above technique, sample evaluation charts (Appendix D) and anomaly maps (Map Booklet) have been generated to aid the user in identifying potential base metal and precious metal targets. The element suite used for the identification of base and precious metal multi-element anomalies include Cu - Pb - Zn - Ag and Au - Sb - As - Hg - Ag, respectively.

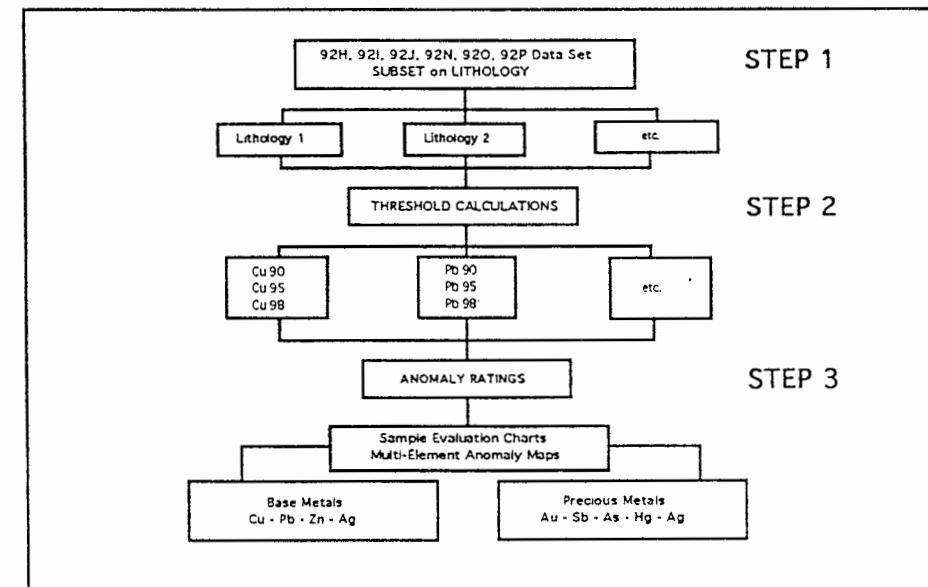


Figure 5. Anomaly Rating Flowchart.

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BRITISH COLUMBIA REGIONAL GEOCHEMICAL SURVEY

NTS 92H HOPE

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APPENDIX A

FIELD OBSERVATIONS AND ANALYTICAL DATA

Notes:

- AAS results less than the detection limit are reported as one half the detection limit.
- Repeat analysis of Au by INAA have been performed on the original split for samples reporting Au values exceeding 20 ppb and are reported as Au2. This level represents the 95th percentile for Au based on the total RGS data set for map sheets 92H, 92I and 92J.
- Analytical duplicate results for Au are also reported as Au2.
- Missing data is reported as blanks.

Table A-1. Reference Guide for Geological Formations (Roddick *et al.*, 1979)

STRATIFIED ROCKS	
QUATERNARY	
Pleistocene and Recent	
Qs	glacial deposits, drift
TERTIARY	
Oligocene	
OC	Coquihalla Group : basalt, rhyolite
Eocene	
EPS	Princeton Group : shale, sandstone
EPV	Princeton Group : andesite, basalt
CRETACEOUS AND/OR TERTIARY	
Upper Cretaceous	
KTC	Chuckanut : arkose, conglomerate
uKKW	Kingsvale Group : arkose, conglomerate, greywacke
uKKV	Kingsvale Group : andesite, breccia, basalt
Lower Cretaceous	
LKJM	Jackass Mountain Group : greywacke, conglomerate
IKP	Pasayten Group : grit, shale, lava
IKBP	Brokenback Hill and Peninsula : tuff, agglomerate, sandstone
IKSB	Spences Bridge Group : andesite, basalt
JURASSIC	
Middle Jurassic	
mJS	Billhook Creek, Mysterious Creek and Echo Island : tuff, sandstone, pelite
mJHL	Harrison Lake : acidic flows
Lower and Middle Jurassic	
JL	Ladner Group : pelite, volcanic sandstone
TRIASSIC AND JURASSIC	
TJC	Cultus : pelite, sandstone, conglomerate
TRIASSIC	
Upper Triassic	
uTN	Nicola Group : andesite, basalt, limestone, argillite
PALEOZOIC AND TRIASSIC	
PTH	Hozameen Group : chert, pelite, limestone
PTHV	Hozameen Group : basalt, andesite
CARBONIFEROUS AND PERMIAN	
CPCH	Chilliwack Group : greywacke, pelite, andesite, basalt
CPVS	Bradshaw, Independence, Shoemaker and Old Tom : argillite, andesite, limestone
PALEOZOIC	
PD	Darrington Phyllite, greenschist, slate
PC	Custer Gneiss

PROTEROZOIC AND PALEOZOIC	
Yellow Aster Complex	
PPYA	Ordovician quartz diorite orthogneiss and Paleohelikian and/or older pyroxene gneiss
INTRUSIVE ROCKS	
TERTIARY	
Late Tertiary	
LTgd	granodiorite
LTqd	quartz diorite
Early Tertiary	
ETqm	quartz monzonite
ETgd	granodiorite
CRETACEOUS AND/OR TERTIARY	
KTg	Otter : granite, granodiorite
CRETACEOUS	
Kqm	Remmell : quartz monzonite, granodiorite, quartz diorite
Late Cretaceous	
LKgd	granodiorite
LKqd	Lightning Creek and Black Peak : quartz diorite
JURASSIC	
Jgd	granodiorite, quartz diorite
Jgdn	gneissic granodiorite
Middle Jurassic	
MJgd	granodiorite
TRIASSIC	
Late Triassic	
LTyb	syenogabbro, augite, diorite, pegmatite
LTub	Iron Mask : peridotite, pyroxenite, syenogabbro
MESOZOIC	
Mp	phyllite, schist
Mpc	graphitic quartzose phyllite
PERMIAN AND TRIASSIC	
PTub	serpentinite, peridotite, Shulaps : ultramafic rocks
PENNSYLVANIAN AND PERMIAN	
PPub	peridotite, pyroxenite, gabbro
AGE UNKNOWN	
Coast Plutonic Complex	
di	diorite
sk	pelitic kyanite schist, amphibolite

Table A-2. Reference Guide for Field Observations

MAP	1:50 000 NTS map sheet number
SAMPLE ID	Sample Number
UTM ZONE	UTM Zone
UTM EAST	UTM East Coordinate
UTM NORTH	UTM North Coordinate
STA	Replicate Sample Status: Routine Sample 10 1st Field Duplicate 20 2nd Field Duplicate
MED	Sample Media Collected: 1 Stream Sediment 6 Stream Sediment and Water
FORM	Geological Formations (see Table A-1)
WAT COL	Water Color: 0 Colorless 2 White Cloudy 1 Brown Clear 3 Brown Cloudy
FLW	Water Flow Rate: 0 Stagnant 3 Fast 1 Slow 4 Torrent 2 Moderate

SED COL	Sediment Color: R Red O Olive-Green W White-Buffer G Grey-Blue B Black P Pink Y Yellow T Tan-Brown
SED PPT	Sediment Precipitate : N = None (otherwise, same as SED COL)
CON	Site Contamination: N None A Agricultural P Possible D Domestic M Mining F Forestry
SED COMP	Sediment Composition : Estimate of Sand-Fines-Organic Content 0 Absent 1 Minor (<1/3 of total) 2 Moderate (>1/3 but <2/3 of total) 3 Major (<2/3 of total)
STRM WPTH	Stream Width (metres)
STRM DPTH	Stream Depth (centimetres)
BNK	Bank Composition: U Unknown G Glacial Outwash A Alluvium R Rock C Colluvium S Scree, talus T Till O Organic

BNK PPT	Bank Precipitate : N = None (otherwise, same as SED COL)
PHY	Physiography: L Lowland H Hilly S Swamp M Mature Mts P Plateau Y Youthful Mts
DRN	Drainage Pattern: D Dendritic I Interrupted H Herringbone G Glacially deranged R Rectangular
TYP	Stream Type: P Permanent R Re-emergent S Seasonal
ODR	Stream Order: 1 Primary 3 Tertiary 2 Secondary 4 Quaternary
SRC	Stream Source: U Unknown S Spring Runoff G Groundwater M Meltwater
DATE	Sample Collection Date (day-month)
WT	Weight of Sample Analyzed by INAA

Field Observations and Analytical Data

										Stream Sediment																									
MAP	SAMPLE ID	UTM ZONE	UTM EAST	UTM NORTH	STA	MED	FORM	Au1 ppb INAA	Au2 ppb INAA	Sb ppm INAA	As ppm INAA	Ba ppm INAA	Br ppm INAA	Ce ppm INAA	Cs ppm INAA	Cr ppm INAA	Co ppm INAA	Hf ppm INAA	Fe ppm INAA	La ppm INAA	Lu ppm INAA	Mo ppm INAA	Ni ppm INAA	Rb ppm INAA	Sm ppm INAA	Sc ppm INAA	Na ppm INAA	Ta ppm INAA	Tb ppm INAA	Th ppm INAA	W ppm INAA	U ppm INAA	Yb ppm INAA	Zr ppm INAA	Wt 0.01 g :DL :Unit :Mthd
2H06	811002	10	616844	5461435		6	ETgd	5		0.3	3.2	820	0.6	88	1.7	100	22	4	4.3	43	0.6	1	57	56	6.1	20.3	2.6	1.6	1.4	7.0	2	2.7	4	200	38.20
2H03	811004	10	617726	5455753	10	6	PC	4		0.2	8.2	620	7.9	88	2.3	85	20	5	5.1	38	0.5	1	58	38	5.7	21.8	2.9	1.7	1.2	6.7	2	5.3	3	680	37.90
2H03	811005	10	617726	5455753	20	6	PC	2		0.2	8.3	640	7.4	76	2.2	92	24	5	4.9	37	0.5	1	45	40	5.6	21.6	2.8	1.1	1.1	6.4	2	5.1	4	200	34.90
2H03	811006	10	619060	5452276		6	ETgd	2		4.0	20.0	540	6.4	87	4.8	89	16	6	4.2	34	0.4	4	45	42	4.8	15.0	2.2	1.0	1.1	8.0	2	7.4	3	200	28.60
2H03	811007	10	619662	5450975		6	PC	7		0.4	14.0	380	15.0	50	1.8	100	13	3	3.2	21	0.3	1	48	29	3.2	15.0	2.2	0.7	0.5	4.0	2	6.8	2	200	18.90
2H03	811008	10	621492	5447752		1	ETgd	2		0.3	4.7	810	1.2	84	2.4	73	28	8	5.1	40	0.6	1	37	68	5.6	19.0	2.9	1.9	1.1	10.0	2	5.8	4	630	35.20
2H03	811009	10	624971	5444199		1	PC	6		1.4	22.0	980	10.0	84	4.7	190	47	3	7.3	37	0.8	1	140	59	5.4	30.3	1.4	1.8	1.1	5.5	2	2.5	4	200	27.70
2H03	811010	10	626776	5444246		1	PTHV	10		1.9	16.0	800	3.2	62	4.8	150	47	3	6.7	31	0.6	1	110	57	5.1	27.0	1.1	1.8	1.3	4.1	2	1.9	3	200	33.80
2H03	811011	10	627629	5443349		6	PTH	2	2	0.6	8.8	450	5.7	41	2.3	93	18	4	3.6	18	0.4	1	53	27	3.6	20.0	2.6	1.0	1.0	3.2	2	3.7	3	420	29.60
2H03	811012	10	627231	5439924		6	LTgd	2		3.3	7.6	300	17.0	61	5.8	13	14	6	3.4	17	0.4	4	10	37	3.4	16.0	2.1	0.6	0.9	4.3	2	12.0	4	430	18.20
2H03	811013	10	627755	5442501		6	PTH	2		1.2	13.0	500	2.4	49	2.3	48	14	5	3.5	20	0.7	1	24	52	3.9	20.0	2.7	0.6	1.1	4.3	2	2.8	4	200	35.20
2H03	811014	10	623139	5441342		6	LTgd	2		0.5	19.0	350	25.0	56	2.5	160	19	5	3.3	18	0.3	2	56	26	3.1	17.0	2.1	0.6	0.8	4.0	3	10.0	3	200	23.70
2H03	811015	10	628204	5430895		6	PTHV	3		2.3	24.0	560	4.9	46	2.6	50	21	3	5.0	18	0.7	1	10	52	3.6	25.7	2.5	0.5	0.8	4.1	2	2.4	3	200	30.80
2H03	811016	10	627409	5431558		6	PTHV	2		0.5	4.7	520	2.0	45	1.2	95	12	3	3.0	22	0.3	1	53	28	3.6	15.0	3.0	0.5	0.7	4.1	2	1.9	2	200	33.90
2H03	811017	10	627221	5433657		6	PTHV	2		0.4	9.2	420	6.4	38	2.2	170	18	4	3.9	18	0.3	1	84	24	3.1	17.0	2.3	0.5	0.6	3.5	2	3.8	2	200	26.40
2H03	811018	10	627072	5437072		6	PTHV	2		2.3	18.0	350	9.3	36	3.6	60	17	7	4.4	17	0.6	1	13	24	3.7	21.9	2.4	0.5	1.1	2.9	2	3.2	3	420	26.70
2H03	811019	10	623811	5444737		6	PC	2		0.6	6.8	500	3.1	37	2.3	72	14	5	3.4	16	0.4	1	40	33	3.9	17.0	2.3	0.5	0.7	2.9	2	2.4	2	200	34.40
2H03	811020	10	618771	5439535		6	PC	2		0.3	3.8	450	2.9	41	0.8	83	12	4	3.3	15	0.4	1	38	21	3.6	15.0	2.9	0.5	0.6	2.7	2	2.2	2	380	34.90
2H03	811022	10	617694	5440724		6	PC	2		0.7	10.0	330	8.6	38	1.6	180	10	3	2.8	16	0.3	1	69	5	2.5	14.0	2.6	0.5	0.5	2.3	2	2.1	2	200	26.80
2H03	811023	10	619305	5443740	10	6	PC	2		0.3	7.3	680	2.0	39	2.9	130	27	2	6.6	14	0.6	7	66	29	3.0	28.5	2.4	0.5	0.6	2.1	2	2.6	3	200	37.10
2H03	811024	10	619305	5443740	20	6	PC	2		0.2	6.1	610	1.6	19	3.3	98	27	2	6.1	13	0.6	5	55	35	2.8	25.8	2.3	0.5	0.5	1.7	2	2.4	2	200	33.90
2H03	811025	10	620478	5443202		6	PC	3		0.3	5.5	420	13.0	47	2.4	380	26	3	4.1	19	0.6	1	150	26	3.4	18.0	2.0	0.5	0.5	3.9	2	3.3	2	200	19.30
2H03	811026	10	616412	5445257		6	PC	2		0.3	6.3	320	36.0	30	1.7	120	5	2	2.3	15	0.3	1	40	5	2.6	14.0	2.3	0.5	0.7	2.3	2	5.6	2	200	24.40
2H03	811027	10	618063	5446666		6	PC	2		0.2	0.9	520	0.5	54	1.0	140	17	4	2.4	23	0.6	1	58	18	4.1	12.0	3.4	0.5	0.8	4.3	2	2.0	2	400	41.20
2H03	811028	10	619422	5449407		6	PC	2		0.9	6.8	520	1.6	41	1.7	100	17	3	3.0	18	0.4	1	56	24	3.4	15.0	2.8	0.5	0.7	3.1	2	2.0	2	320	35.20
2H03	811029	10	615190	5452125		6	PC	72	80	0.5	5.7	480	1.1	130	1.2	280	20	22	14.0	63	0.8	1	34	25	6.4	20.0	2.4	1.2	1.4	134.0	2	39.0	6	1800	41.70
2H03	811030	10	616782	5451834		6	PC	2		0.2	2.3	420	9.2	53	2.2	240	24	3	3.6	22	0.3	1	130	27	4.0	15.0	2.1	0.5	0.7	5.5	2	7.2	2	200	25.50
2H06	811031	10	614153	5462354		6	LTgd	2		1.4	20.0	600	3.1	63	2.8	110	23	8	4.7	25	0.5	1	34	29	4.8	24.5	2.8	0.5	0.9	12.0	2	5.8	4	440	30.90
2H06	811032	10	612302	5464570		6	LTgd	9		1.1	11.0	570	3.8	51	1.9	65	11	4	3.9	20	0.6	1	20	32	3.3	16.0	3.0	0.5	0.7	3.4	2	2.2	3	510	35.80
2H06	811033	10	611507	5466346		6	KTC	2		1.0	8.0	540	0.7	46	1.1	120	24	7	4.7	20	0.6	1	34	29	4.0	20.7	3.3	0.5	0.7	3.3	2	2.1	3	200	40.40
2H06	811034	10	610598	5467209		6	KTC	348	450	6.2	1400.0	400	5.5	26	2.4	110	36	5	4.8	13	0.5	1	77	15	4.1	21.8	1.5	0.5	0.5	2.0	2	1.1	2	200	33.50
2H03	811035	10	629086	5449075		6	PTH	15	19	3.9	28.0	1200	3.3	83	5.4	230	48	4	8.4	36	0.6	5	110	76	5.4	35.9	1.4	1.9	0.9	6.2	3	2.7	4	200	36.00
2H03	811037	10	628421	5448979		6	PTHV	9		2.2	41.0	1100	3.6	74	4.2	150	35	3	6.6	34	0.6	1	88	59	5.3	31.9	1.5	2.0	1.2	5.4	2	2.5	3	200	37.20
2H03	811038	10	629040	5450014		6	PTH	15		3.1	28.0	560	146.0	36	4.4	93	27	2	3.5	13	0.2	3	67	5	2.6	13.0	0.4	0.9	0.5	3.5	2	3.9	2	200	5.19
2H03	811039	10	628693	5452121		6	PTH	5		2.1	46.0	810	51.3	66	8.3	120	34	2	4.5	24	0.5	2	88	52	4.1	18.0	1.0	1.3	0.7	5.5	2	3.6	2	200	15.10
2H03	811040	10	627927	5451354		6	PTH	9		1.4	16.0	870	1.7	67	2.8	120	34	3	5.4	33	0.6	1	66	42	6.0	27.1	1.4	2.1	1.5	4.1	2	1.8	3	200	35.50
2H03	811042	10	631189	5452931		6	PTH	19		2.7	24.0	2000	16.0	63	7.0	130	21	4	5.1	28	0.3	4	130	100	5.1	18.0	0.8	0.5	0.5	7.2	2	3.5	3		12.04
2H03	811043	10	628513	5456177		6	PTHV	4		2.0	11.0	1600	3.6	50	5.0	110	24	4	7.0	21	0.5	1	10	73	4.6	22.0	1.2	0.5	0.5	4.7	2	2.5	3		28.05
2H06	811044	10	627406	5456653	10	6	PTHV	2		0.9	6.6	590	3.8	69	2.0	130	24	6	6.0	33	0.3	1	210	52	6.1	23.0	1.9	2.3	1.1	5.5	2	3.1	4		23.87
2H06	811045	10	627406	5456653	20	6	PTHV	4		0.8	6.7	580	3.9	72	2.0	130	24	6	6.0	34	0.6	1	10	42	6.1	24.0	1.9	2.8	0.8	6.5	2	2.9	4		21.59