

**GEOLOGICAL SURVEY OF CANADA OPEN FILE 2175
(106D; PARTS OF 106C, 106E AND 106F)
CANADA – YUKON ECONOMIC DEVELOPMENT PROGRAM (1989–1990)**

**REGIONAL STREAM SEDIMENT AND WATER GEOCHEMICAL DATA,
EAST CENTRAL YUKON**



INDEX MAP

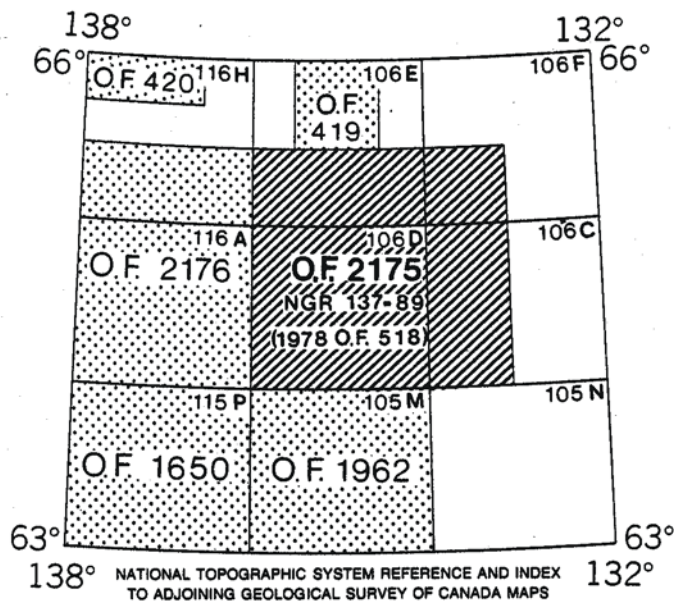
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NATIONAL GEOCHEMICAL RECONNAISSANCE
STREAM SEDIMENT AND WATER GEOCHEMICAL DATA
YUKON 1990
GEOLOGICAL SURVEY OF CANADA OPEN FILE 2175, NGR 137-1989
NTS 106D; PARTS OF 106C, 106E AND 106F



Open File 2175 represents a contribution to the Canada – Yukon Economic Development Program (1989-1990). This project was managed by the Geological Survey of Canada.

TABLE OF CONTENTS

	pages
INTRODUCTION	I-1
CREDITS	I-1
DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT.....	I-1
ANALYTICAL PROCEDURES	I-1
PRESENTATION AND INTERPRETATION OF GOLD DATA	I-2
SUMMARY OF ANALYTICAL DATA AND METHODS	I-4
REFERENCES	I-5
FIELD DATA LEGEND	I-6
DATA LISTINGS	II-1 to II-171
SUMMARY STATISTICS.....	III-1 to III-3
ELEMENT SYMBOL-TREND PLOTS	in pocket
SAMPLE LOCATION OVERLAY	in pocket
GEOLOGY OVERLAY	in pocket
SAMPLE LOCATION MAP (1:250 000 SCALE)	in pocket
GOLD VALUE MAP (1:250 000 SCALE)	in pocket

**REGIONAL STREAM SEDIMENT AND WATER GEOCHEMICAL DATA, YUKON 1990,
GSC OPEN FILE 2175, NGR 137-1990
NTS 106D; PARTS OF 106C, 106E AND 106F**

INTRODUCTION

Open File 2175 contains new data for gold and 25 other elements obtained by re-analyzing stream sediments collected in 1976 and 1977 from areas of central and eastern Yukon Territory. Original analytical data selected from Open File 518 (published in 1978) for 13 elements in sediments, and uranium, pH and fluoride values in concomitant waters, are also included in this open file.

The original reconnaissance surveys were carried out by the Geological Survey of Canada under the Federal Uranium Reconnaissance Program. Funds for the determination of mercury in sediments at this time were provided by Fisheries and Environment Canada. Analyses of archived samples for Open File 2175 were undertaken under the Canada - Yukon Economic Development Program (1989-1990).

Analytical results and field observations are used to build a national geochemical data base for resource assessment, mineral exploration, geological mapping and environmental studies. Sample collection and preparation procedures and analytical methods are strictly specified and carefully monitored to ensure consistent and reliable results regardless of the area, the year or the analytical laboratory.

CREDITS

E.H.W. Hornbrook directed the surveys.

P.W.B. Friske coordinated the operational activities of contract and Geological Survey of Canada staff.

Contracts were let to the following companies for sample preparation and analysis and were managed by the following staff of the Regional Geochemical Studies section:

Preparation: Bondar-Clegg & Company
Ottawa, Ontario
J.J. Lynch

Analysis: Bondar-Clegg and Company
Ottawa, Ontario
J.J. Lynch

M. McCurdy edited open files and coordinated production.

A.C. Galletta managed the digital geochemical data and provided computer processing support.

The personal computer data base and software programs used for data entry, verification, processing and presentation in the publication of reports were designed and programmed by Harry Gross, Geochemical Data Manager for the Exploration Geochemistry Subdivision.

Sample location and gold value maps were plotted by Canada Lands Data Systems staff at Environment Canada, Hull, Quebec. Symbol-trend maps were prepared by GSC staff.

Pat Doyle, C.C. Durham and Rob Phillips provided technical assistance.

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Helicopter-supported sample collection was carried out during the summers of 1976 and 1977. Stream sediment and water samples were collected at an average density of one sample per 13 square kilometres throughout the 23,800 square kilometres of the eastern and central Yukon survey.

Sample site duplicate samples were routinely collected in each analytical block of twenty samples.

Field observations were recorded on standard forms used by the Geological Survey of Canada (Garrett, 1974).

The sample site positions were marked on appropriate 1:250 000 scale NTS maps in the field. These maps were digitized at the Geological Survey in Ottawa to obtain the sample site UTM coordinates.

In Ottawa, field dried samples were air-dried and sieved through a minus 80 mesh (177 micron) screen, and ball-milled before analyses. At this time, control reference and blind duplicate samples were inserted into each block of twenty sediment samples. For the water samples, only control reference samples were inserted into the block. There were no blind duplicate water samples.

The sample site coordinates were checked as follows: a sample location map was produced on a Calcomp 1051 drum plotter using the digitized coordinates; the original sample location map produced in the field was then overlain on the Calcomp map; the two sets of points were checked for coincidence. The dominant rock types in the stream catchment basins were identified on appropriate geological maps used as the bedrock geological base on NGR maps.

Thorough inspections of the field and analytical data were made to check for any missing information and/or gross errors.

Quality control and monitoring of the geochemical data was undertaken by a standard method used by the Exploration Geochemistry Subdivision at the Geological Survey of Canada.

ANALYTICAL PROCEDURES

Instrumental Neutron Activation Analysis (INAA)

The weighed sample (generally 10 to 40 g) is irradiated epithermally for 20 minutes in a neutron flux with an approximate density of 1×10^{11} neutrons/cm²/second. Counting begins seven days after irradiation. The counting time is somewhat variable (6 to 11 minutes) and is matrix dependent. Counting is done on a germanium-lithium co-axial counter. The counting data is accumulated on a VAX computer and is subsequently converted to concentrations. Numerous international

reference samples are irradiated with each batch of routine samples. Elements determined by INA analyses include: Na, Sc, Cr, Fe, Co, Ni, Zn, As, Se, Br, Rb, Zr, Mo, Ag, Cd, Sn, Sb, Te, Cs, Ba, La, Ce, Sm, Eu, Tb, Yb, Lu, Hf, Ta, W, Ir, Au, Th, and U. The sample weight is also reported. Data for Zn, Se, Zr, Ag, Cd, Sn, Te, and Ir are not published because of inadequate detection limits and/or precision.

Atomic Absorption Spectroscopy (AAS) and Other Analyses

For the determination of Zn, Cu, Pb, Ni, Co, Ag, Mn and Fe, a 1 gram sample was reacted with 3 mL concentrated HNO₃ in a test tube at 90° C and held at this temperature for 30 minutes. At this point, one mL of concentrated HCl was added and the digestion continued for another 90 minutes. The sample solution was then diluted to 20 mL with metal-free water and mixed. Zn, Cu, Pb, Ni, Co, Ag, Mn and Fe were determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections were made for Pb, Ni, Co and Ag.

Molybdenum was determined by atomic absorption spectroscopy using a 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 concentrated HCl was added and the digestion continued at 90° C for an additional 90 minutes. After cooling, 8 mL of 1250 ppm Al solution were added and the sample solution diluted to 10 mL before aspiration.

Mercury was determined by the Hatch and Ott procedure with some modifications. The method is described by Jonasson *et al.* (1973). A 0.5 gram sample was reacted with 20 mL concentrated HNO₃ and 1 mL concentrated HCl in a test-tube for 10 minutes at room temperature prior to two hours of digestion with mixing at 90° C in a hot water bath. After digestion, the sample solutions were cooled and diluted to 100 mL with metal-free water. The Hg present is reduced to the elemental state by the addition of 10 mL 10% w/v SnSO₄ in M H₂SO₄. The Hg vapour was then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrophotometer. Absorption measurements were made at 253.7 nm.

Barium was determined by atomic absorption spectroscopy using a nitrous oxide-acetylene flame. A 0.5 g sample was decomposed with 5 mL concentrated HF, 5 mL concentrated HClO₄ and 2 mL concentrated HNO₃. The sample was then heated to fumes of perchloric acid. Three mL concentrated HClO₄ were added to the residue, heated to light fumes and then 5 mL of water were added. The sample solution was transferred to a test tube calibrated at 25 mL, containing 0.5 mL ionization buffer solution (0.05 g NaCl/mL). The sample solution was diluted and 25 mL, mixed and analysed.

Tungsten was determined as follows: a 0.2 g sample of lake sediment was fused with 1 g K₂S₂O₇ in a rimless test tube at 575° C for 15 minutes in a furnace. The cooled melt was then leached with 10 mL concentrated HCl in a water bath heated to 85° C. After the soluble material had completely dissolved, the insoluble material was allowed to settle and an aliquot of 5 mL transferred to another test tube. 5 mL of 20% SnCl₂ solution were

then added to the sample aliquot, mixed and heated for 10 minutes at 85° C in a hot water bath. A 1 mL aliquot of dithiol solution (1% dithiol in iso-amyl acetate) was added to the test solution and the test solution then heated for 4 - 6 hours at 80° - 85° C in a hot water bath. This solution was removed from the hot water bath, cooled and 2.5 mL of kerosene added to dissolve the globule. The colour intensity of the kerosene solution was measured at 630 nm using a spectrophotometer. The method is described by Quin and Brooks (1972).

Uranium was determined using a neutron activation method with delayed neutron counting. A detailed description of the method is provided by Boulanger *et al.* (1975). In brief, a 1 gram sample was weighed in a 7 dram polyethylene vial, capped and sealed. The irradiation was provided by the Slowpoke reactor with an operating flux of 10¹² neutrons/cm²/second. The samples were pneumatically transferred from an automatic loader to the reactor, where each sample was irradiated for 60 seconds. After irradiation, the samples were again transferred pneumatically to the counting facility where, after a 10 second delay, the sample was counted for 60 seconds with six BF₃ detector tubes embedded in paraffin. Following counting, the samples were automatically ejected into a shielded storage container. Calibration was carried out twice a day as a minimum, using natural materials of known uranium concentration.

Water Analyses

Fluoride in water samples was determined using a specific ion electrode. Prior to measurement an aliquot of the sample was mixed with an equal volume of TISAB buffer solution (total ionic strength adjustment buffer). The fluoride was measured initially with a Chemtrix and subsequently with a Fisher Accument expanded scale meter, using an Orion fluoride electrode.

For the determination of pH, an aliquot of the water sample was transferred to a clean dry beaker. The pH was measured using a Chemtrix expanded scale meter with a Corning combination electrode.

Uranium in waters was determined by a fluorometric method. The uranium was initially preconcentrated by evaporation. The residue after evaporation was fused with a mixture of NaF and LiF in a platinum dish. After cooling, the fluorescence of the fused pellet was measured using a Jarrel-Ash Fluorometer Model 26-000.

A summary of analytical methods and detection limits is provided in Table 1.

PRESENTATION AND INTERPRETATION OF GOLD DATA

The following discussion reviews the format used to present the Au geochemical data and outlines some important points to consider when interpreting this data. This discussion is included in recognition of the special geochemical behaviour and mode of occurrence of Au in nature and the resultant difficulties in obtaining and analyzing samples which reflect the actual concentration level at a given site.

To correctly interpret Au geochemical data from regional stream sediment or lake sediment surveys requires an appreciation of the unique chemical and physical characteristics of Au and its mobility in the surficial environment. Key properties of Au that distinguish its geochemical behaviour from most other elements include (Harris, 1982):

- (1) Gold occurs most commonly in the native form which is chemically and physically resistant. A significant proportion of the metal is dispersed in micron-sized particulate form, and the high specific gravity of gold results in heterogeneous distribution, especially in stream sediment and clastic-rich (low LOI) lake sediment environments. Gold distribution appears to be more homogeneous in organic-rich fluvial and lake sediments.
- (2) Gold typically occurs at low concentrations in the ppb range. Whereas gold concentrations of only a few ppm may represent economic deposits, background levels encountered from stream and centre-lake sediments seldom exceed 10 ppb, and commonly are near the detection limit of 2 ppb.

These factors result in a particle sparsity effect wherein very low concentrations of gold are heterogeneously enriched in the surficial environment. Hence, a major problem facing the geochemist is to obtain a representative sample. In general, areas where concentrations of gold in sediments are low, and/or grain sizes of the gold present relatively high, proportionally larger samples are required to reduce the uncertainty between subsample analytical values and actual values. Conversely, as actual gold concentrations increase or grain size decreases, the number of gold particles to be shared in random subsamples increases and variability of results decreases (Clifton *et al.*, 1969; Harris, 1982). The limited amount of material collected during the rapid, reconnaissance-style regional surveys and the need to analyze for a broad spectrum of elements, precludes the use of a significantly large sample weight for the gold analyses. Therefore, to obtain representative samples, grain size is reduced by sieving and ball milling of the dried samples.

The following control methods are currently employed to evaluate and monitor the sampling and analytical variability which are inherent in the analysis of gold in geochemical media:

- (1) For each block of 20 samples:
 - (a) random insertion of a standard reference sample to control analytical accuracy and long-term precision;
 - (b) collection of a field duplicate (two samples from one site) to measure sampling variance;
 - (c) analysis of a second subsample (blind duplicate) from one sample to measure and control short-term precision.
- (2) For both stream and lake sediments, routine repeat analyses on a second subsample are performed for all samples having values that are

statistically above approximately the 90th percentile of total data set.

- (3) For lake sediments only, a routine repeat analysis on a second subsample is performed on those samples with LOI values below 10%, indicating a large clastic component. Ongoing studies suggest that the gold distribution in these samples is more likely to be variable than in samples with a higher LOI content.

The presentation of gold data, statistical treatment and the value map format are different than for other elements. Gold data listed in the open file may include initial analytical results, values determined from repeat analyses, together with sample weights and corresponding detection limits for all analyzed samples. The gold, statistical parameters and regional symbol-trend plots are determined using only the first analytical value. Gold values less than the detection limit are set to half that limit. On the value map, initial values are followed by a comma and a value obtained by a second analysis, where determined. Samples weights used can be found in the text. Following are possible variations in data presentation on a value map.

+ *	No data
+27	Single analysis
+27,14	Repeat analysis
+ <1	Single analysis, less than detection limit

In summary, geochemical follow-up investigations for gold should be based on a careful consideration of all geological and geochemical information, and especially a careful appraisal of gold geochemical data and its variability. In some instances, prospective follow-up areas may be indirectly identified by pathfinder element associations in favourable geology, although a complementary gold response due to natural variability may be lacking. 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. Subsequent repeat subsample analyses will increase the reliability of results and permit a better understanding of natural variability which can then be used to improve sampling methods and interpretation.

FIELD DATA LEGEND

Table 2 describes the field and map information appearing on the following pages preceding the analytical data for each sample site.

TABLE 1. Summary of Analytical Data and Methods

ELEMENT	DETECTION LEVEL	METHOD
<u>SEDIMENTS:</u>		
Zn Zinc	2 ppm	AAS
Cu Copper	2 ppm	AAS
Pb Lead	2 ppm	AAS
Ni Nickel	2 ppm	AAS
Co Cobalt	2 ppm	AAS
Ag Silver	0.2 ppm	AAS
Mn Manganese	5 ppm	AAS
Mo Molybdenum	2 ppm	AAS
Fe Iron	0.02 pct	AAS
Ba Barium	40 ppm	AAS
W Tungsten	4 ppm	COL
U Uranium	0.2 ppm	NADNC
Hg Mercury	10 ppb	CV-AAS
Na Sodium	0.02 pct	INAA
Sc Scandium	0.2 ppm	INAA
Cr Chromium	20 ppm	INAA
Fe Iron	0.2 pct	INAA
Co Cobalt	5 ppm	INAA
Ni Nickel	10 ppm	INAA
As Arsenic	0.5 ppm	INAA
Br Bromine	0.5 ppm	INAA
Rb Rubidium	5 ppm	INAA
Mo Molybdenum	1 ppm	INAA
Sb Antimony	0.1 ppm	INAA
Cs Cesium	0.5 ppm	INAA
Cs Barium	50 ppm	INAA
La Lanthanum	2 ppm	INAA
Ce Cerium	5 ppm	INAA
Sm Samarium	0.10 ppm	INAA
Eu Europium	1 ppm	INAA
Tb Terbium	0.5 ppm	INAA
Yb Ytterbium	2 ppm	INAA
Lu Lutetium	0.2 ppm	INAA
Hf Hafnium	1 ppm	INAA
Ta Tantalum	0.5 ppm	INAA
W Tungsten	1 ppm	INAA
Th Thorium	0.2 ppm	INAA
U Uranium	0.2 ppm	INAA
Wt Weight	0.01 g	-
Au Gold	2 ppb	INAA
<u>WATERS:</u>		
F Fluoride	20 ppb	ISE
pH Hydrogen ion activity	- -	GCM
U Uranium	0.05 ppb	LIF

- AAS - atomic absorption spectrometry
 COL - colorimetry using dithiol
 CV-AAS - cold vapour (flameless) atomic absorption
 GCM - glass Calomel electrode and pH meter
 INAA - Instrumental Neutron Activation Analysis
 ISE - ion selective electrode
 LIF - laser-induced fluorescence
 NADNC - neutron activation, delayed neutron counting

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- Harris, J.F.** (1982) Sampling and analytical requirements for effective use of geochemistry in exploration for gold; *in* Levinson, A.A., Editor, Precious Metals in the Northern Cordillera, proceedings of a symposium sponsored by the Association of Exploration Geochemists and the Cordilleran Section of the Geological Association of Canada, pp. 53-67.
- Jonasson, I.R., Lynch, J.J. and Trip, L.J.** (1973) Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys; No. 12, Mercury in Ores, Rocks, Soils, Sediments and Water, Geol. Surv. Can. Paper 73-21.

TABLE 2. Field Observations Legend

FIELD RECORD	DEFINITION	TEXT CODE
MAP SHEET	National topographic system (NTS); lettered quadrangle (1:250 000 scale or 1:50 000 scale).	106C, 106D, 106E or 106F
SAMPLE ID	Remainder of sample number: Year of collection Field crew Sample sequence number	76 or 77 1, 3, 5 or 9 001-999
REP STAT	Replicate status; relationship of the sample to others within the survey: Routine sample site First of a duplicate pair Second of a duplicate pair	00 10 20
UTM	Universal Transverse Mercator UTM co-ordinate system; digitized sample location coordinates	
ZN	Zone (7 to 22)	
EASTING	UTM Easting in metres	
NORTHING	UTM Northing in metres	
ROCK UNIT	Major rock type of stream catchment area: grit glacial material..... granite diorite argillite..... sandstone..... slate alluvium shale..... limestone quartzite..... conglomerate dolomite quartz chlorite schist..... greenstone graphite schist phyllite..... granodiorite siltstone mudstone iron formation unknown	GRIT GLCM GRNT DORT ARGL SNDS SLTE ALVM SHLE LMSN ORTZ CGLM DLMT QZCS GRNS GPSC PLLT GRDR SLSN DMSN IRFM UNKN
ROCK AGE	Stratigraphic age of dominant rock type in catchment basin: Unknown Quaternary Cretaceous Jurassic Triassic Mesozoic-Paleozoic Permian..... Mississippian Carboniferous Devonian Silurian-Devonian Ordovician-Silurian Cambrian..... Proterozoic-Paleozoic Paleozoic (undivided) Hadrynian..... Helikian Proterozoic Precambrian (undivided)	50 44 36 34 32 31 24 21 20 18 17 15 12 11 10 09 07 04 01

FIELD RECORD	DEFINITION	TEXT CODE
SAMPLE TYPE	Sample material collected: Stream bed sediment only Stream water only Simultaneous stream sediment and water	SedOnly Strm Sed/Water
STREAM WIDTH	Stream width in feet	
STREAM DEPTH	Water depth in tenths of feet	
SAMPLE CONT.	Contamination; human or natural: None Possible Definite	- Possible Definite
BANK TYPE	Bank type; the general nature of the bank material adjacent to the sample site: Alluvial Colluvial (bare rock, residual or mountain soils)..... Glacial till..... Glacial outwash sediments Bare rock..... Talus scree Organic predominant (debris, peat, muskeg, swamp)	Alluv Colluv Till Outwash Bare Rk Tal/Scr Organic
WATER COLOUR	Water colour; the general colour and suspended load of the sampled water: Clear Brown transparent White cloudy Brown cloudy	Clear BnTrans WhCl'dy BnCl'dy
STREAM FLOW	Water flow rate: Stagnant Slow..... Moderate Fast Torrential.....	Stagnt Slow Modert Fast Torrnt
SAMPLE COLOUR	Predominant sediment colour: Red-brown White-buff Black..... Yellow Green..... Grey, blue grey Pink Buff to brown Brown	Rd-Bn Wh-Bf Black Yellow Green Gy-Blu Pink Bf-Bn Brown
SAMPLE COMP.	Sediment composition; description of the bulk mechanical composition of the collected sample on a scale of 1 to 3, the total of the column must add up to 3 or 4 or 5: Size fractions are divided as follows: Column 1 >0.125 mm (sand) Column 2 <0.125 mm (fines – organic silt, clay) Column 3 organic material Amount of size fraction: sum of amounts = 3 4 5 Absent 0 0 0 Minor <33% 25% 20% Medium 33-67% 50% 40% Major >67% 75% 60%	0 1 2 3

FIELD RECORD	DEFINITION	TEXT CODE
BOTTOM PCPT	Precipitate or stain; the presence of any coatings on pebbles, boulders or stream bottoms: None Red-brown White or buff Black Yellow Green Grey Pink Buff to brown	Rd-Bn Wh-Bf Black Yellow Green Grey Pink Bf-Bn
BANK PCPT	Distinctive precipitate, stains or weathering on rocks in immediate area of catchment basin or stream bank: None Red, brown (eg., Fe) White, buff (eg., Co ₃ , Zn) Black (e.g., Fe, Mn, sulphides) Yellow (e.g., Pb, U, Fe, Mo, REE) Green (Cu, Ni, U, Mo, As, Fe) Bluish (Zn, P) Pink (Co, As)	- Rd-Bn Wh-Bf Black Yellow Green Blue Pink
STREAM PHYSIOG	General physiography of the drainage basin: Plain Muskeg, swampland Peneplain, plateau Hilly, undulating Mountainous, mature Mountainous, youthful (precipitous)	Plain Swamp Penpln Hill Moun/M Moun/Y
STREAM DRAINAGE	Drainage pattern: Poorly defined, haphazard Dendritic Herringbone Rectangular Trellis Discontinuous shield type (chains of lakes) Basinal Others	Poor Dendrc Herrbn Rectln Trellis Discnt Closed Other
STREAM TYPE	Stream type: Undefined Permanent, continuous Intermittent, seasonal Re-emergent, discontinuous	Undfnd Permnt Intermit Re-emerg
STREAM CLASS	Classification based on proximity to source: Undefined Primary Secondary Tertiary Quaternary	Undfnd Pri'ary Sec'ary Ter'ary Qua'ary
STREAM SOURCE	Source of water: Unknown Groundwater Snow melt or spring run-off Recent precipitation Ice-cap or glacial meltwater	Unknown Ground Sp'gMelt RecRain Glacier
Miscellaneous	Missing data in any field.....	*

ADDENDUM

ADDITIONAL GOLD DATA

Repeat analysis on a second subsample is carried out on all sediment samples having gold values that are statistically above approximately the 90th percentile of the total data set, provided sufficient material is left over from the initial analysis. Following are additional gold repeat data, not available at the time of production, for Open File 2175. Please note that these results do not appear on the 1:250 000 scale gold value map.

Mapsheet	Sample ID	Au1 (ppb)	Au1/Wt (gm)
106D	779043	<5	3.54
106D	779059	47	7.26
106D	779064	13	9.61
106D	779153	6	3.23
106D	779162	6	3.75
106D	779196	<2	8.20
106D	779197	8	3.50
106D	779210	26	2.24
106D	779235	9	6.99
106D	779238	7	7.87
106D	779246	21	4.81
106D	779251	79	7.92
106D	779305	12	6.84
106D	779340	2	8.63
106D	779360	<5	1.94
106D	779374	8	2.31
106D	779375	<2	3.38
106D	779387	4	5.51
106D	779412	47	2.71
106D	779423	11	7.21
106D	779450	19	3.86
106D	779478	<4	1.84