Geochemical Reanalysis of Archived Till Samples

TREK Project

Interior Plateau, central BC

(parts of NTS 093C, 093B, 093F & 093K)

GEOSCIENCE BC REPORT 2015-09

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MAY 2015

Introduction

The TREK surficial geochemistry project is developing a comprehensive and comparable geochemical dataset for the project area (Sacco et. al, 2014; Sacco and Jackaman, 2015). This objective is being supported by the reanalysis of till samples archived from previous regional geochemical surveys (Table 1; Figure 1). Many of these projects were completed in the 1990's when sampling protocols were less strict and a considerable amount of the original results were generated using analytical methods that are now outdated. Reanalysis by modern laboratory techniques and genetic interpretations of the sample medium have significantly upgraded the till geochemical data set and the information is now directly comparable with new till data collected during the TREK project (Jackaman and Sacco, 2014).

A total of 1456 archive till samples plus quality control samples were analyzed for minor and trace elements by inductively coupled plasma–mass spectrometry (ICP-MS; 53 elements) following an aqua-regia digestion. A total of 873 archive till samples plus quality control samples were also analysed for major and minor elements by inductively coupled plasma–emission spectrometry (ICP-ES) following a lithium borate fusion and dilute acid digestion (11 major oxides, 13 elements and loss on ignition).

Table 1. Till geochemical data reports for surveys previously conducted in the TREK project area, central British Columbia.

Open File	Year	Samples	Map Area	Map Sheets	Reference
BCGS OF 1994-18	1993	171	FAWNIE CREEK	093F/03	Levson et al., 1994
BCGS OF 1997-11	1994	143	CHEDAKUZ CREEK	093F/07	Weary et al., 1997
BCGS OF 2002-11	1997, 98	264	TETACHUCK LAKE-MARILLA	093F/05, 12	Levson et al., 2002
BCGS OF 2006-01	1992	330	CHEZACUT	093C/01, 08, 09, 16	Lett et al., 2006
BCGS OF 2009-09	2008	124	REDSTONE-LOOMIS LAKE	093B/04, 05	Ferbey, 2009
GSC OF 3687	1996, 97	387	NORTHERN NECHAKO RIVER	093F	Plouffe and Williams, 1998
GSC OF 4166	1994, 98	292	NECHAKO RIVER	093F	Plouffe et al., 2001

Methods

In cooperation with the Geological Survey of Canada and the BC Ministry of Energy and Mines, original till sample material was retrieved from storage facilities located in Ottawa and Victoria. Representative 2 gram splits of -0.063 mm size fraction material was successfully recovered from a total of 1456 samples. Due to a deficiency of available material, it was not possible to recover material from 255 targeted samples.

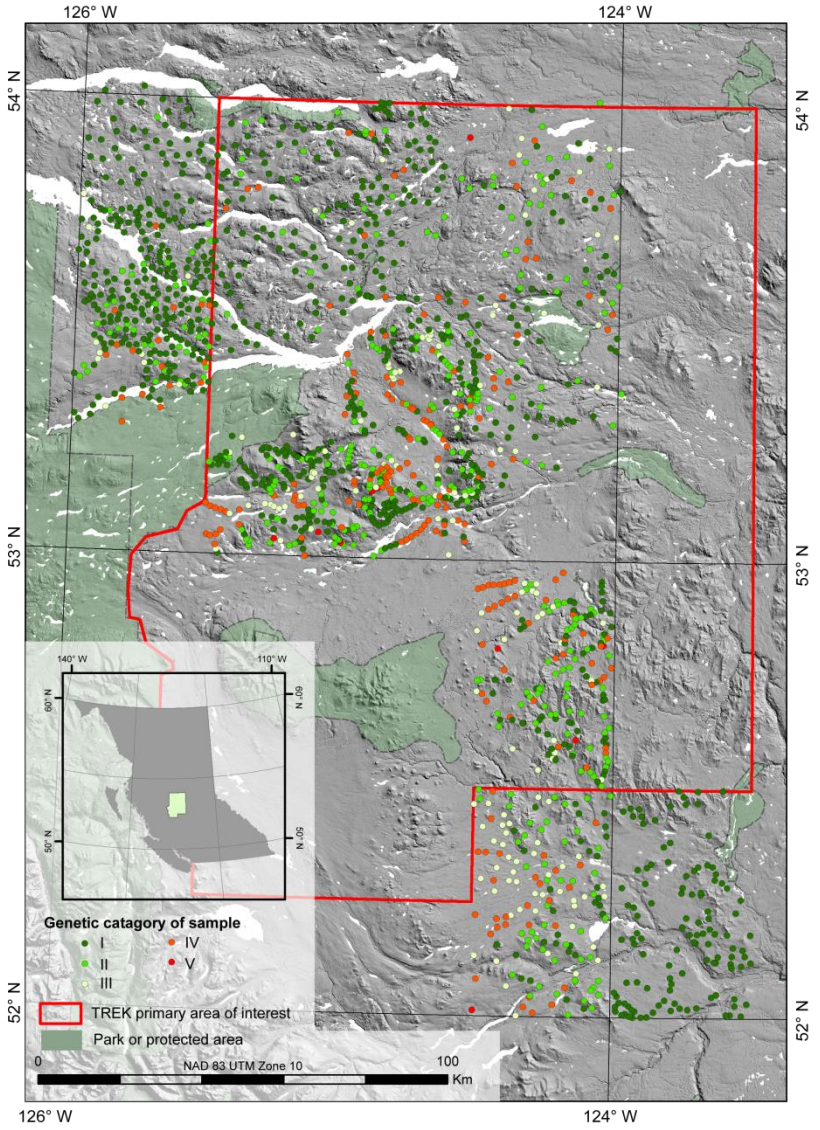

Figure 1. Location of samples and their genetic interpretations for surveys previously conducted in the TREK project area, central British Columbia.
(Refer to Table 4 for definitions of genetic categories.)

Prior to analysis, analytical duplicate and control reference samples were inserted to monitor and assess the accuracy and precision of the new analytical results. The samples were delivered to Bureau Veritas Commodities Canada Ltd. (Vancouver) and were analyzed by an ultra-trace aqua-regia digestion (0.5 g) ICP-MS package for 53 elements and for major and minor elements by lithium borate fusion ICP-ES. Tables 2 and 3 provide a complete listing of the analytes and detection levels.

Table 2. Ultra-trace aqua-regia ICP-MS elements and their lower detection limits used for the till sample reanalysis initiative, TREK project area, central British Columbia.

(Abbreviations: D.L., detection limit; ppm, parts per million; ppb, parts per billion; pct, percent.)

ELEMENT		D.L.		METHOD	ELEMENT		D.L.		METHOD
Aluminum	Al	0.01	pct	ICP-MS	Strontium	Sr	0.5	ppm	ICP-MS
Antimony	Sb	0.02	ppm	ICP-MS	Sulphur	S	0.02	pct	ICP-MS
Arsenic	As	0.1	ppm	ICP-MS	Tellurium	Te	0.02	ppm	ICP-MS
Barium	Ba	0.5	ppm	ICP-MS	Thallium	Tl	0.02	ppm	ICP-MS
Bismuth	Bi	0.02	ppm	ICP-MS	Thorium	Th	0.1	ppm	ICP-MS
Boron	B	20	ppm	ICP-MS	Titanium	Ti	0.001	pct	ICP-MS
Cadmium	Cd	0.01	ppm	ICP-MS	Tungsten	W	0.05	ppm	ICP-MS
Calcium	Ca	0.01	pct	ICP-MS	Uranium	U	0.05	ppm	ICP-MS
Chromium	Cr	0.5	ppm	ICP-MS	Vanadium	V	2	ppm	ICP-MS
Cobalt	Co	0.1	ppm	ICP-MS	Zinc	Zn	0.1	ppm	ICP-MS
Copper	Cu	0.01	ppm	ICP-MS	Beryllium	Be	0.1	ppm	ICP-MS
Gallium	Ga	0.1	ppm	ICP-MS	Cerium	Ce	0.1	ppm	ICP-MS
Gold	Au	0.2	ppb	ICP-MS	Cesiun	Cs	0.02	ppm	ICP-MS
Iron	Fe	0.01	pct	ICP-MS	Germanium	Ge	0.1	ppm	ICP-MS
Lanthanum	La	0.5	ppm	ICP-MS	Hafnium	Hf	0.02	ppm	ICP-MS
Lead	Pb	0.01	ppm	ICP-MS	Indium	In	0.02	ppm	ICP-MS
Magnesium	Mg	0.01	pct	ICP-MS	Lithium	Li	0.1	ppm	ICP-MS
Manganese	Mn	1	ppm	ICP-MS	Niobium	Nb	0.02	ppm	ICP-MS
Mercury	Hg	5	ppb	ICP-MS	Rhenium	Re	1	ppb	ICP-MS
Molybdenum	Mo	0.01	ppm	ICP-MS	Rubidium	Rb	0.1	ppm	ICP-MS
Nickel	Ni	0.1	ppm	ICP-MS	Tantalum	Ta	0.05	ppm	ICP-MS
Phosphorus	P	0.001	pct	ICP-MS	Tin	Sn	0.1	ppm	ICP-MS
Potassium	K	0.01	pct	ICP-MS	Yttrium	Y	0.01	ppm	ICP-MS
Scandium	Sc	0.1	ppm	ICP-MS	Zirconium	Zr	0.1	ppm	ICP-MS
Selenium	Se	0.1	ppm	ICP-MS	Platinum	Pt	2	ppb	ICP-MS
Silver	Ag	2	ppb	ICP-MS	Palladium	Pd	10	ppb	ICP-MS
Sodium	Na	0.001	pct	ICP-MS					

Table 3. Major and minor elements plus their lower detection limits used for the till sample reanalysis initiative, TREK project area, central British Columbia.

(Abbreviations: D.L., detection limit; ppm, parts per million; ppb, parts per billion; pct, percent.)

ELEMENT		D.L.		METHOD	ELEMENT		D.L.		METHOD
Silicon dioxide	SiO_2	0.01	pct	ICP-ES	Cobalt	Co	20	ppm	ICP-ES
Aluminium oxide	Al_2O_3	0.01	pct	ICP-ES	Copper	Cu	5	ppm	ICP-ES
Iron(III) oxide	Fe_2O_3	0.04	pct	ICP-ES	Nickel	Ni	20	ppm	ICP-ES
Magnesium oxide	MgO	0.01	pct	ICP-ES	Niobium	Nb	5	ppm	ICP-ES
Calcium oxide	CaO	0.01	pct	ICP-ES	Scandium	Sc	1	ppm	ICP-ES
Sodium oxide	Na_2O	0.01	pct	ICP-ES	Strontium	Sr	2	ppm	ICP-ES
Potassium oxide	K_2O	0.01	pct	ICP-ES	Yttrium	Y	3	ppm	ICP-ES
Titanium dioxide	TiO_2	0.01	pct	ICP-ES	Zinc	Zn	5	ppm	ICP-ES
Phosphorus pentoxide	P_2O_5	0.01	pct	ICP-ES	Zirconium	Zr	5	ppm	ICP-ES
Manganese oxide	MnO	0.01	pct	ICP-ES	Loss on Ignition	LOI	0.1	pct	GRAV
Chromium(III) oxide	Cr_2O_3	0.002	pct	ICP-ES	Total/C	C	0.02	pct	Leco
Barium	Ba	5	ppm	ICP-ES	Total/S	S	0.02	pct	Leco
Cerium	Ce	30	ppm	ICP-ES					

Genetic interpretation of archive samples

Basal till is deposited by lodgement and meltout processes at the base of a glacier. It is the primary target in recent geochemical surveys because it is a first derivative of bedrock (Shilts, 1993), its source area can be determined by reconstructing ice-flow histories, and it produces a geochemical signature that is areally more extensive than the bedrock source (Levson, 2001). Other types of till and other glacial diamicts consist of material with various sources, and more complex transport histories and depositional processes making the bedrock source area difficult or impossible to determine. Geochemical results from these materials can indicate changes in regional bedrock composition, but are less useful in determining zones of potential mineralization. The TREK reanalysis data set is composed of geochemical results of archive sample material from previous surveys in which basal till was the primary target. However, diamicts of various geneses were collected for their regional application. Sediments with different geneses must be evaluated independently to reduce variability in the data set and improve anomaly recognition, thus provided here is a genetic interpretation for the TREK archive samples.

The archive samples have been categorized based on sediment genesis with relation to basal till (Table 4, 5; Figure 1). The interpretation is based on the original sample notes, air photo and satellite imagery, existing mapping (BTP, surficial and bedrock), and ground truthing during fieldwork for the TREK project. The genetic category for each sample is included in the field note listings, and where applicable, comments on the local depositional environment and an interpretation of the sediment genesis are included. Samples assigned to category I and II are confidently interpreted to be in-situ or slightly resedimented (i.e. down slope) basal till. Category III represents samples whose genesis cannot be determined because of minimal or ambiguous information. In some cases a suggestion of genesis may be included, but these samples should be evaluated with caution. Samples that are placed in Category IV are interpreted as other types of till (e.g. ablation) or other glacial diamicts. Category V is used for any other glacial or nonglacial material. Although some samples may be interpreted as basal till, sample details that could indicate a change in geochemistry since deposition (e.g. depth, oxidation) should be considered when evaluating the data.

Data Presentation

Results from the TREK till samples reanalysis initiative have been determined to be complete and accurate. The raw digital data files containing original field observations and analytical results plus new reanalysis data have been included in Microsoft® Excel (XLS) format. These files are described as follows:

File 1: ARCHIVE TILL ORIGINAL FIELD DATA.XLS

File includes field observation data from original digital data files or transcribed from hard-copy notes. The information is presented as originally published.

File 2: ARCHIVE TILL ORIGINAL TRACE METAL DATA.XLS

File includes original analytical data and genetic interpretations. The analytical data is presented as originally published.

Table 4. Genetic categories, definitions and their exploration significance used in the genetic interpretation of the TREK archive till samples. Basal till potential (BTP) is based on previously released BTP mapping (Sacco and Jackaman, 2015).

Genetic catagory	Definition	Genetic interpretation	Exploration significance
I	Characteristics consistent with basal till; high BTP.	Basal till.	Local transport in direction of ice flow.
II	Some to most characteristics consistent with basal till and high BTP; most characteristics consistent with basal till and med to low BTP.	Most likely basal till or basal till that has been resedimented a short distance by gravity.	Local transport in the direction of ice flow; resedimented material may have been transported downslope after deposition by ice.
III	Some characteristics consistent with basal till; med to low BTP.	May be basal till or other glacial diamict; requires more information for confident interpretation.	Local to distal transport; local to regional indication.
IV	Few characteristics consistent with basal till; low BTP.	Most likely another glacial diamict (e.g. ablation or supraglacial flow till, debris flow into glacial lake, etc.); may be derived from basal till.	Local to distal transport; regional indication; transport direction related to, but not necessarily consistent with ice flow.
V	Inconsistent characteristics with basal till.	Other glacial or non glacial material.	Distal transport; regional indication; potential complex transport history combining glacial, glaciofluvial and/or glaciolacustrine processes. Locally derived colluvium represents local bedrock.

Table 5. Number of samples in each genetic category for previous surveys in the TREK archive data set.

Genetic category	BCGS OF 1994-18	BCGS OF 1997-11	BCGS OF 2002-11	BCGS OF 2006-01	BCGS OF 2009-09	GSC OF 3687	GSC OF 4166
I	90	61	200	84	124	291	131
II	37	34	38	108	0	52	72
III	20	18	9	66	0	15	30
IV	20	30	17	68	0	28	57
V	4	0	0	4	0	1	2

File 3: ARCHIVE TILL REANALYSIS TRACE METAL DATA.XLS

File includes new reanalysis data plus genetic interpretations. The compilation combines some original results with new determinations. The original analytical data is presented as initially published.

Refer to NOTES and DETECTION LEVEL TABS for more information on data file structure, detection levels and explanation of codes and abbreviations.

Acknowledgements

This program was funded by Geoscience BC[1]. Contributions by A. Plouffe, A. Grenier and A. Therriault (Geological Survey of Canada) and A. Hickin, T. Ferbey and A. Rukhluv (BC Ministry of Energy and Mines) have assisted with the development and application of this project.

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[1] Geoscience BC, 440 - 890 West Pender Street, Vancouver, B.C., Canada, V6C 1J9 URL: http://www.geosciencebc.com/s/Home.asp