Quaternary Geology, Ice-Flow History and Till Geochemistry of the Huckleberry Mine Region, West-Central British Columbia

by

Travis Ferbey
B.Sc., University of Victoria, 1999

A thesis submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

in the School of Earth and Ocean Sciences

© Travis Ferbey, 2004
University of Victoria

All rights reserved. This thesis may not be reproduced in whole or in part, by photocopy or other means, without the permission of the author.

Supervisor: Dr. V.M. Levson

ABSTRACT

The Huckleberry Mine region experienced a complex ice-flow history during the Late Wisconsinan Fraser Glaciation. Cross-cutting and superimposition relationships observed in the field, constrain the relative timing of ice-flow events and indicate that a westerly-directed ice-flow event was followed by a smaller magnitude east to northeast event. This ice-flow reversal can be explained by the existence of an ice divide in the central interior of British Columbia during the Fraser Glaciation maximum. Although ice thickness exceeded relief in the region during the glacial maximum, and glaciers flowed west, up-valley towards the Coast Mountains, locally, ice-flow direction appears to still have been influenced by topography.

Basal tills dominate the local Quaternary stratigraphy. These grey, overconsolidated, clayey-silt diamictons typically overlie Early Jurassic Telkwa Formation andesites, but they can also locally overlie advance-phase glaciofluvial sands and gravels. In the vicinity of the Main and East Zone areas, it is common to find visible pyrite and chalcopyrite grains (up to 3 mm in size), and mineralized clasts (pyrite +/- chalcopyrite) in the till matrix. At a 19 m vertical exposure, multiple till units were identified. These basal tills are distinguished primarily by changes in colour, matrix texture, and gravel content. Stratigraphic, sedimentological, lithological, and geochemical data from this exposure provide evidence of an ice-flow reversal in the Huckleberry Mine region during the Fraser Glaciation maximum.

Till geochemical data define the locations of known sources of copper mineralization in the Huckleberry Mine region. Maximum, minimum, and median copper values in near-surface basal till samples are 8924 ppm, 29 ppm, and 216 ppm, respectively (n=106), while those for sub-surface basal till samples are 4167 ppm, 18 ppm, and 187, respectively (n=230). Locally developed dispersal trains indicate that mineralization from these sources has been transported towards the east and west. These dispersal trains are detectable in both near-surface and sub-surface basal till samples and also provide further evidence of an ice-flow reversal in the Huckleberry Mine region. Two westward-directed dispersal trains, that are isolated or disconnected from dispersal of the Main Zone area, suggest and that there could be undiscovered bedrock mineralization on Huckleberry Mine property.

TABLE OF CONTENTS

ABSTRACT ii
TABLE OF CONTENTS iv
LIST OF TABLES viii
LIST OF FIGURES ix
ACKNOWLEDGEMENTS xi
1 INTRODUCTION 1
1.1 OVERVIEW 1
1.2 DESCRIPTION OF STUDY AREA 3
1.2.1 Location 3
1.2.2 Physiography 6
1.2.3 Climate 10
1.2.4 Vegetation 10
1.2.5 Recent Hydrologic Change 11
1.3 BEDROCK GEOLOGY 12
1.3.1 Regional Bedrock Geology 12
1.3.2 Bedrock Geology of Huckleberry Mine 14
1.4 QUATERNARY GEOLOGIC-CLIMATE FRAMEWORK 19
1.4.1 Fraser Glaciation 19
1.4.2 Postglacial 19

2 SURFICIAL GEOLOGY 20
2.1 INTRODUCTION 20
2.2 PREVIOUS WORK 20
2.3 METHODS 21
2.4 MAP UNITS 25
2.4.1 Pre-Quaternary Bedrock 25
2.4.2 Late Pleistocene Morainal Deposits 27
2.4.3 Holocene 29
2.4.3.1 Colluvial Deposits 29
2.4.3.2 Fluvial Sediments 30
2.4.3.3 Organic Deposits 32
2.5 SURFICIAL GEOLOGY AND QUATERNARY HISTORY 34

3 ICE-FLOW HISTORY 37
3.1 INTRODUCTION 37
3.2 PREVIOUS WORK 37
3.3 METHODS 43
3.3.1 Measurement of Ice-Flow Indicators 44

3.4 ICE-FLOW INDICATORS OF THE STUDY AREA 45
3.4.1 Small-Scale 45
3.4.2 Intermediate to Large-Scale 50
3.5 RESULTS 56
3.5.1 Ice-Flow Indicators at Elevations <1500 Metres 56
3.5.2 Ice-Flow Indicators at Elevations ≥1500 Metres 63
3.5.3 Stagnant-Ice Features 64
3.6 DISCUSSION 64

4 QUATERNARY STRATIGRAPHY 68
4.1 INTRODUCTION 68
4.2 REGIONAL QUATERNARY STRATIGRAPHY 68
4.2.1 Pre-Late Wisconsinan 69
4.2.2 Late Wisconsinan 70
4.2.3 Holocene 71
4.3 METHODS 72
4.4 QUATERNARY STRATIGRAPHY OF THE HUCKLEBERRY MINE REGION 74
4.4.1 Late Wisconsinan Advance-Phase Sediments 76
4.4.2 Late Wisconsinan Glacial Sediments 84
4.4.3 Late Wisconsinan Retreat-Phase Sediments 95
4.4.4 Holocene Deposits 96
4.5 SUMMARY 102

5 TILL GEOCHEMISTRY 104
5.1 INTRODUCTION 104
5.2 SURFICIAL GEOCHEMICAL SURVEYS 104
5.2.1 Previous Work 104
5.2.2 Review of Till Geochemical Surveys 106
5.3 METHODS 109
5.3.1 Field Methods 109
5.3.2 Laboratory Methods and Quality Control 117
5.3.3 Analysis of Precision 119
5.3.4 Presentation of Analytical Data 127
5.4 KNOWN SOURCES OF MINERALIZATION 129
5.5 RESULTS 132
5.5.1 Near-surface Samples 132
5.5.2 Sub-Surface Samples 150
5.5.3 Partitioning Effects in Till 162
5.6 INDICATIONS OF UNDISCOVERED MINERALIZATION 165
5.7 EVIDENCE FOR ICE-FLOW REVERSAL IN TILL GEOCHEMISTRY 167

6 CONCLUSIONS 170

REFERENCES 174
APPENDIX A – Section Descriptions 182
APPENDIX B – ICP-MS Analytical Data for Near-surface and Vertical Profile Samples 214
APPENDIX C – ICP-MS Analytical Data for Becker Hammer Boreholes 254
APPENDIX D – ICP-MS Analytical Sequential Leach Data 282
APPENDIX E – ICP-MS Analytical Data for Very Coarse Sand, Coarse Sand, Medium Sand, Fine Sand, and Very Find Sand Size Fractions 289

LIST OF TABLES

Table 1.1. Geochemical signature of calcalkaline porphyry Cu ± Mo ± Au deposits in British Columbia. 22

Table 3.1. Summary of prevalent theories on drumlin formation. 55

Table 5.1. Summary of geochemical surveys conducted in the Huckleberry Mine area. 107

Table 5.2. Elements and detection limits for ICP analyses. 118

Table 5.3. Elements and detection limits for INAA analyses. 120

Table 5.4. Percent relative standard deviation values for BCGS reference materials. 126

Table 5.5. Mineral occurrences near Huckleberry Mine. 130

Table 5.6. Summary statistics for near-surface till samples. 133

Table 5.7. Selective leach data for a subset of near-surface till samples. 141

Table 5.8. Near-surface till samples collected within 100 cm of bedrock. 144

Table 5.9. Near-surface samples with >95 percentile concentration for any of the five selected elements. 147

Table 5.10. Summary statistics for sub-surface till samples. 151

LIST OF FIGURES

Figure 1.1. Location of study area. 4

Figure 1.2. Physiography of Huckleberry Mine area. 5

Figure 1.3. Physiographic divisions, and local features, of the study area. 7

Figure 1.4. Topography and mining features of the Huckleberry Mine area. 9

Figure 1.5. Bedrock geology, ore zones, and mineral occurrences within the Huckleberry Mine regions. 15

Figure 2.1. A key to surficial geology polygon labels. 23

Figure 2.2. Surficial geology of the Huckleberry Mine region. *mp

Figure 3.1. Ice-flow History of Tahtsa Lake – Ootsa Lake Region. *mp

Figure 3.2 . Location of interior ice divide of the Cordilleran Ice Sheet in central British Columbia, during Fraser Glaciation maximum. 42

Figure 3.3. Bedrock outcrop with glacial striae. 47

Figure 3.4. Bedrock outcrop with glacial grooves. 48

Figure 3.5. Rat-tail preserved on bedrock outcrop. 49

Figure 3.6. Outcrop-scale roche moutonnée. 51

Figure 3.7. Flutings, drumlins, crag-and-tail ridges, east of Shelford Hills. 53

Figure 3.8. Summary of ice-flow indicator measurements. 57

Figure 3.9. Large-scale roche moutonnée. 60

Figure 3.10. Cross-cutting striae preserved on bedrock outcrop. 62

Figure 4.1. Location of stratigraphic sections. 73

Figure 4.2. Representative stratigraphic sections from Huckleberry Mine property. 75

Figure 4.3. Advance-phase glaciofluvial sands and gravels (Unit 1). 77

Figure 4.4. Advance-phase glaciolacustrine sediments (Unit 2). 79

Figure 4.5. Basal rain-out diamictons observed at section TFE00-2. 80

Figure 4.6a. Advance-phase glaciolacustrine sediments (Unit 2) with dropstones. 81

Figure 4.6b. Deformed advance-phase glaciolacustrine sediments (Unit 2). 81

Figure 4.7. Lower half of section TFE00-2. 83

Figure 4.8. Basal till (Unit 3). 85

Figure 4.9. Shear planes in basal till. 86

Figure 4.10. Looking south at section TFE00-12 at melt-out facies till. 88

Figure 4.11. Section TFE00-1. 90

Figure 4.12. Striated clast pavement at section TFE00-1. 92

Figure 4.13. Organics (Unit 5) overlying retreat-phase glaviofluvial gravels (Unit 4). 97

Figure 4.14. Organic rich muds (Unit 6). 99

Figure 4.15. Alluvial fan gravels (Unit 7). 101

Figure 5.1. Characteristics of a dispersal train. 108

Figure 5.2. Location of near-surface till samples. 110

Figure 5.3. Location of Becker Hammer boreholes and stratigraphic sections. 111

Figure 5.4. Examples of near-surface till sample sites. 113

Figure 5.5. A Becker Hammer borehole rig, used in this study to collect samples of basal till up to 30 m below surface. 114

Figure 5.6. Example of vertical profile sample site in basal till. 116

Figure 5.7. Field duplicate scatter plots. 122

Figure 5.8. Analytical duplicate scatter plots. 123

Figure 5.9. Copper concentration in near-surface till samples. 134

Figure 5.10. Molybdenum concentrations in near-surface till samples. 135

Figure 5.11. Gold concentrations in near-surface till samples. 136

Figure 5.12. Silver concentrations in near-surface till samples. 137

Figure 5.13. Zinc concentrations in near-surface till samples. 138

Figure 5.14. Amorphous copper precipitate, found on ore-grade bedrock above Main Zone pit. 139

Figure 5.15. Near-surface till samples collected within 100 cm of bedrock. 145

Figure 5.16. Near-surface till samples with >95 percentile element concentrations. 148

Figure 5.17. Cross-section through 10 Becker Hammer boreholes. 152

Figure 5.18. Copper and other element concentration in basal tills at section TFE00-1. 153

Figure 5.19. Copper and other element concentration in basal tills at section TFE00-16. 154

Figure 5.20. Sub-surface copper values in basal tills. 158

Figure 5.21. A comparison of copper values in till samples collected from borehole OB00-74, with diamicton samples collected at section TFE00-2. 160

Figure 5.22. Copper concentrations for various grain size fractions of select samples. 163

*MP – see map pocket

ACKNOWLEDGEMENTS

Financial, field, and office support for this research were provided by the British Columbia Geological Survey. In-kind support was received from Huckleberry Mines Limited and Imperial Metals Corporation. D. Mate, J. Doyle, and T. O'Connor-Parsons are thanked for their assistance in the field. Dr. M. English is gratefully acknowledged for his generosity during the author's stay at the Cold Regions Research Centre, Wilfred Laurier University. The advisory committee, Drs. K. Telmer, D. Smith, and J. Bednarski, are all thanked for their ideas and invaluable comments.

This research would not have been possible without the support, guidance, and encouragement of many individuals. I must first start by thanking Dr. V. Levson, the person who gave me my first big break, for which I am grateful. His knowledge and integrity, attention to detail, insistence on doing things right, and his keenness to do just one more field station are skills and qualities that I will always work towards. Vic has been, and still remains, a mentor and a great friend.

The unique and accomplished group of geologists of British Columbia Geological Survey have greatly influenced my professional career and for that I thank them. In particular, I would like to acknowledge Dr. R. Lett for enlightening me on the intricacies of all things geochemical. Although not a committee member on the official books, he certainly was in mine.

In recent years, I have been fortunate enough to work with many other exceptional geologists from whom I've learned much about the features and processes we study. Dr. T. Little shared with me his contagious enthusiasm for the Quaternary, and took me under his wing to help out with his work in the Keewatin. D. Mate offered his thoughts and ideas on the Quaternary geology of the Nechako Plateau, and spent many hours in the field convincing me that there really is something big going on out there. Although not directly involved with research presented here, I have benefited immensely from time spent in the field with Drs. J. Bednarski, I. McMartin, A. Plouffe, H. Sandeman, and R. Smith, and conversations with A. Bichler, A. Hickin, and D. Utting. I could go on. I wish to thank them all.

My family has been extremely supportive and understanding throughout my time spent in graduate school, regardless of how many family dinners I missed. In particular I would like to thank my mom and dad for always taking an interest in what I am doing, regardless of what it is, and encouraging me to take the odd chance.

Lastly, I could not possibly thank Trisalyn Nelson enough. One of my primary goals for this past year was to complete one degree before Trisalyn (soon to be PhD) finished two. I am happy to have met this goal, but could not have without her encouragement, polite prodding, and perhaps most importantly her unquestioned support. Having gotten through this together, I have not doubt we will one day be able to successfully hang wallpaper together. Trisalyn, you are the best.

1 INTRODUCTION

1.1 OVERVIEW

This thesis presents results of Quaternary geological studies conducted in the Huckleberry Mine region. The goal of the thesis is to provide an understanding of the geological processes that have been operating in this region through Late Wisconsinan and Holocene time. This study builds on previous research conducted on the glacial history of west-central British Columbia by describing glacial maximum and late glacial conditions during the Late Wisconsinan Fraser Glaciation, and by interpreting the sediments deposited during this glaciation. It also contributes to drift prospecting studies conducted in the Nechako Plateau by documenting metal values in till around a producing porphyry copper-molybdenum mine, and investigating the two and three-dimensional geometry of dispersal trains in till, in an area with a complex ice-flow history. This thesis is the first detailed Quaternary geology study conducted in the Huckleberry Mine region.

There are three main research objectives of this thesis:

1. to delineate and describe the types and distribution of surficial sediments found in the study area, and the timing of their deposition;
2. to build a local ice-flow model for the study area for the Late Wisconsinan through the identification and interpretation of streamlined and erosional forms in the Tahtsa Lake – Ootsa Lake region, and compare with regional models for west central British Columbia; and

3. to model dispersal of mineralization in till in the Huckleberry Mine region using selected clast lithologies and trace element geochemistry, and to assess the relationship between interpreted dispersal directions and the interpreted ice-flow history of the Tahtsa Lake – Ootsa Lake region.

In the chapters that follow, these objectives will be addressed in discussions on surficial geology, ice-flow history, stratigraphy, and till geochemistry.

Insights into these topics are meaningful to both academic and industry researchers working on related topics in the region. For example, slope stability or aggregate potential studies in the region could benefit from surficial geology data presented here. Data and interpretations presented in this thesis build on the current ice-flow model for west-central British Columbia, and could be used by ice sheet and climate modellers to further refine the configuration of the Cordilleran Ice Sheet through the Late Wisconsinan, or to elucidate on such important variables as ice-flow direction, ice thickness, and relative magnitude of glacial phases during the Fraser Glaciation. For the mineral exploration community working in west-central British Columbia, or areas with similar physical and geological characteristics and glacial histories, results presented here could be used to further develop conceptual models of glacial dispersal and provide guidance on how to interpret till geochemical data. From an environmental baseline or impact assessment perspective, documentation of till geochemical values around an ore-grade mineral deposit could help characterize natural geochemical values in undisturbed surficial sediments.

1.2 DESCRIPTION OF STUDY AREA

1.2.1 Location

The study area is located in west-central British Columbia, approximately 100 km southwest of Houston, British Columbia (Figure 1.1). The area includes both detailed and regional studies. In the Huckleberry Mine area itself, centred in the north-central part of NTS map area 93E/11, Quaternary sediments were studied in detail and basal till samples were sampled for trace element geochemical analyses. At a more regional scale, studies of streamlined and erosional landforms and features were conducted in NTS map areas 93E/10-11, 14-16 to determine the Late Wisconsinan ice-flow history of the Tahtsa Lake – Ootsa Lake region (Figure 1.1). The study area is accessed by a moderately dense network of Forest Service and private mine roads. Abandoned mine roads, and a private forestry barge were also utilized to access some of the more remote parts of the study area. Quaternary exposures along the shores of Ootsa Lake, Tahtsa Lake, and Tahtsa Reach were accessed by boat. Remote mountain peaks in the study area were reached by helicopter.

Huckleberry Mine, located in the Tahtsa Lake Mining District, is a producing porphyry copper-molybdenum open pit mine with minor recoverable amounts of gold and silver. During fieldwork the main zone of Huckleberry Mine was actively being mined and a starter pit in the East Zone had been completed which produced excellent Quaternary exposures with easy access. Currently, the East Zone orebody is actively being mined (see Figures 1.2a and b). An on-site mill and concentrator facility has a production rate of 21 000 tonnes/day ore and produces a copper and molybdenum concentrate. The

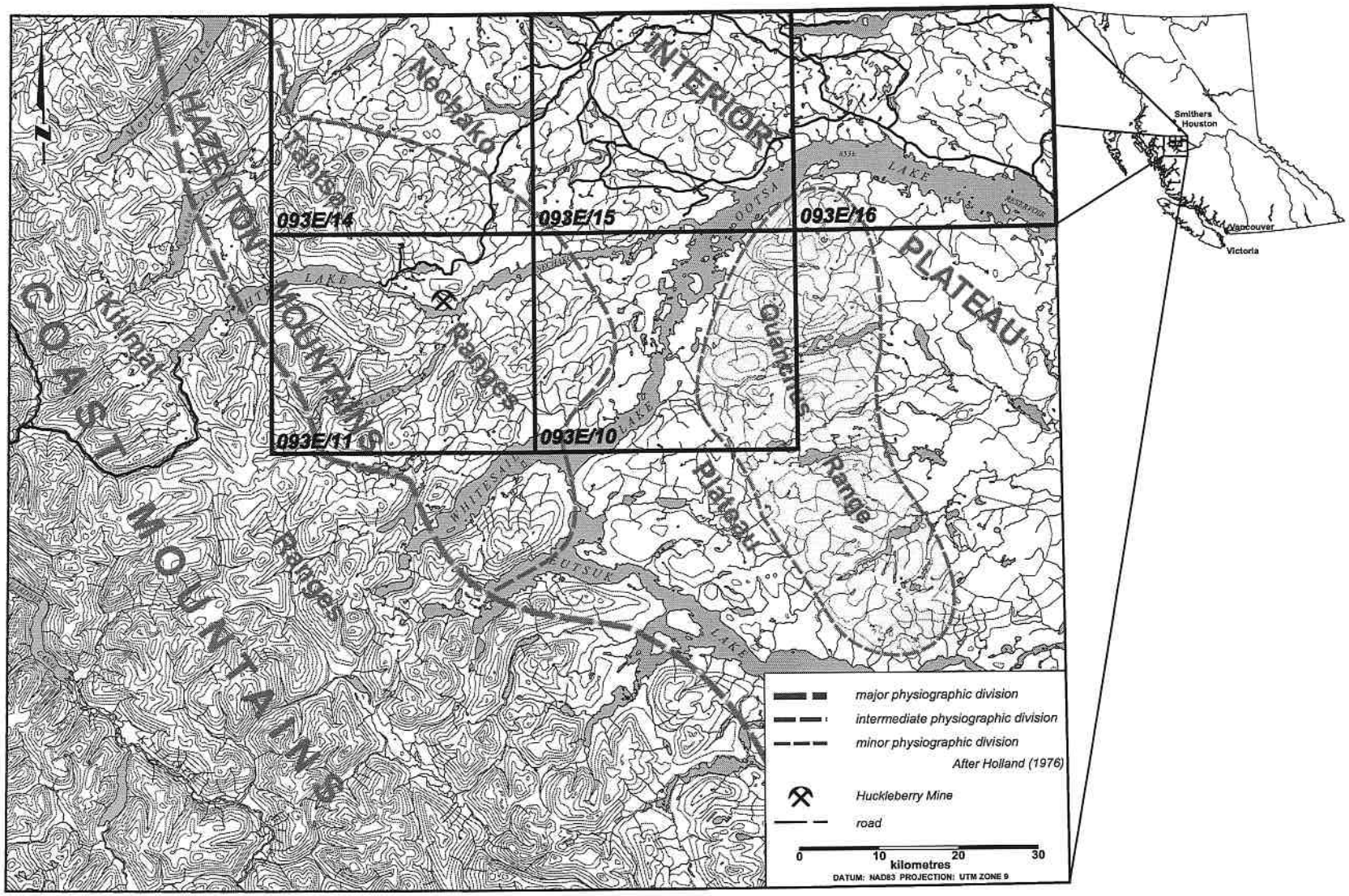
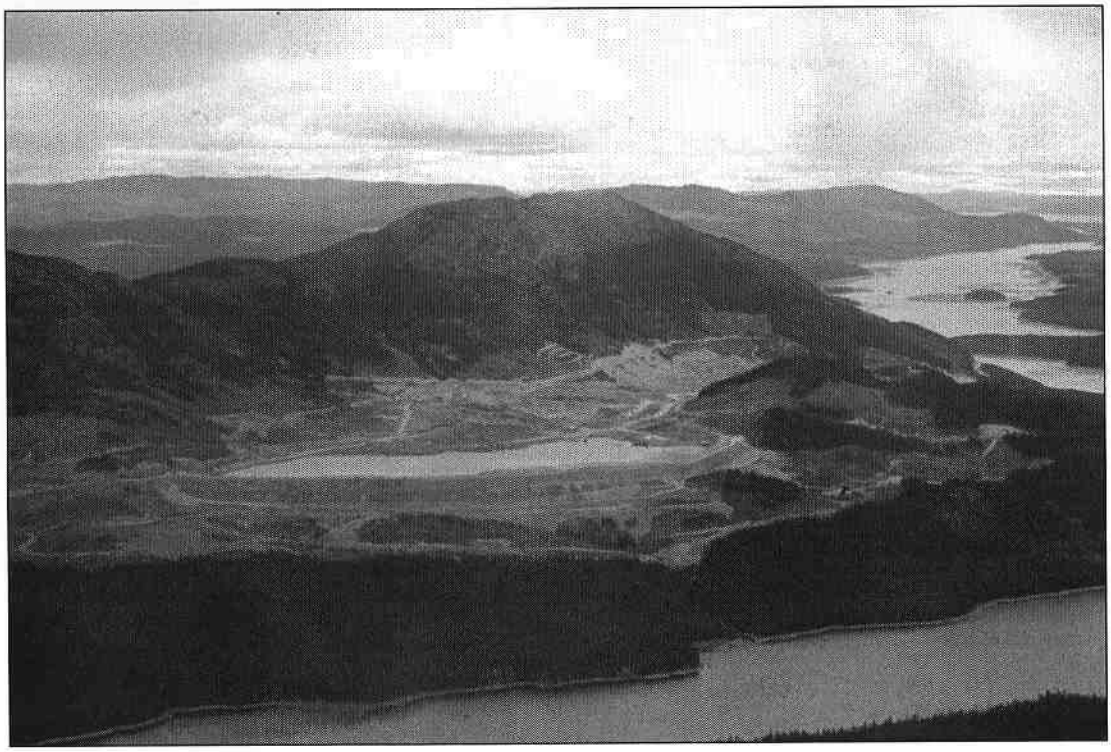


Figure 1.1. Location of study area.

a)



b)

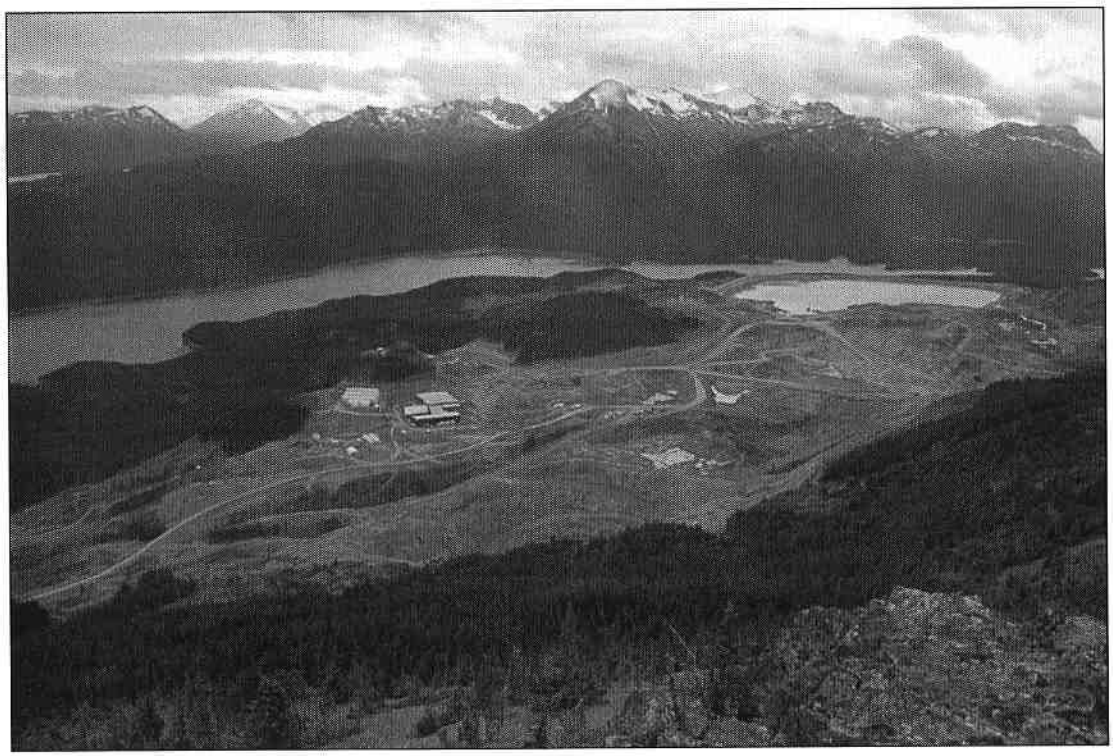


Figure 1.2. Physiography of Huckleberry Mine area. a) Looking northeast across Huckleberry Mine towards the Nechako Plateau; Tahtsa Reach and tailings pond in foreground and Huckleberry Mountain at centre (photo: D.J. Mate). b) Looking southwest from Huckleberry Mountain, over Huckleberry Mine, across Tahtsa Reach towards Mount Carl Borden in the Coast Mountain physiographic region (Main and East Zone pits, and mine buildings, can been seen in centre of photo, with the tailings pond in upper right).

copper concentrate is trucked to Stewart, British Columbia, where it is shipped by freighter to Japan. The molybdenum concentrate is trucked and sold in Vancouver, British Columbia. Mine life is expected to continue through to 2007 (Imperial Metals Corporation, 2003).

1.2.2 Physiography

The Ootsa Lake region, or east half of the study area, is situated in the Nechako Plateau, a subdivision of the Interior Plateau (Figures 1.1 and 1.3). The Nechako Plateau is an area of low relief with flat or gently rolling topography that lies between 1200 and 1500 m a.s.l. (Figure 1.2a). It is bounded by the Hazelton Mountains to the west, the Skeena and Omineca Mountains to the north (most peaks in these ranges are at or below 2300 m a.s.l.), and by the Fraser Basin and Fraser Plateau to the east and south respectively (Holland, 1976). The Fraser Basin lies at an elevation of approximately 800 m a.s.l. while the Fraser Plateau is very similar in elevation to that of the Nechako Plateau.

Most of the Nechako Plateau is covered by a thick package of glacial sediments. Although bedrock outcrop is relatively uncommon, some exposures can be found at the stoss end of crag-and-tail forms, and along lake shorelines. Isolated monadnocks exist on the plateau and Michel Peak (2255 m a.s.l.), located west of Whitesail Lake in Tweedsmuir Provincial Park, is the highest of these (Holland, 1976; Figure 1.3). More common to the Nechako Plateau, however, are features such as the rounded, undulating, low relief Shelford and Mosquito Hills (Figure 1.3). In general, these areas, and those further east, have fluted, crag-and-tail, or drumlinized topography.

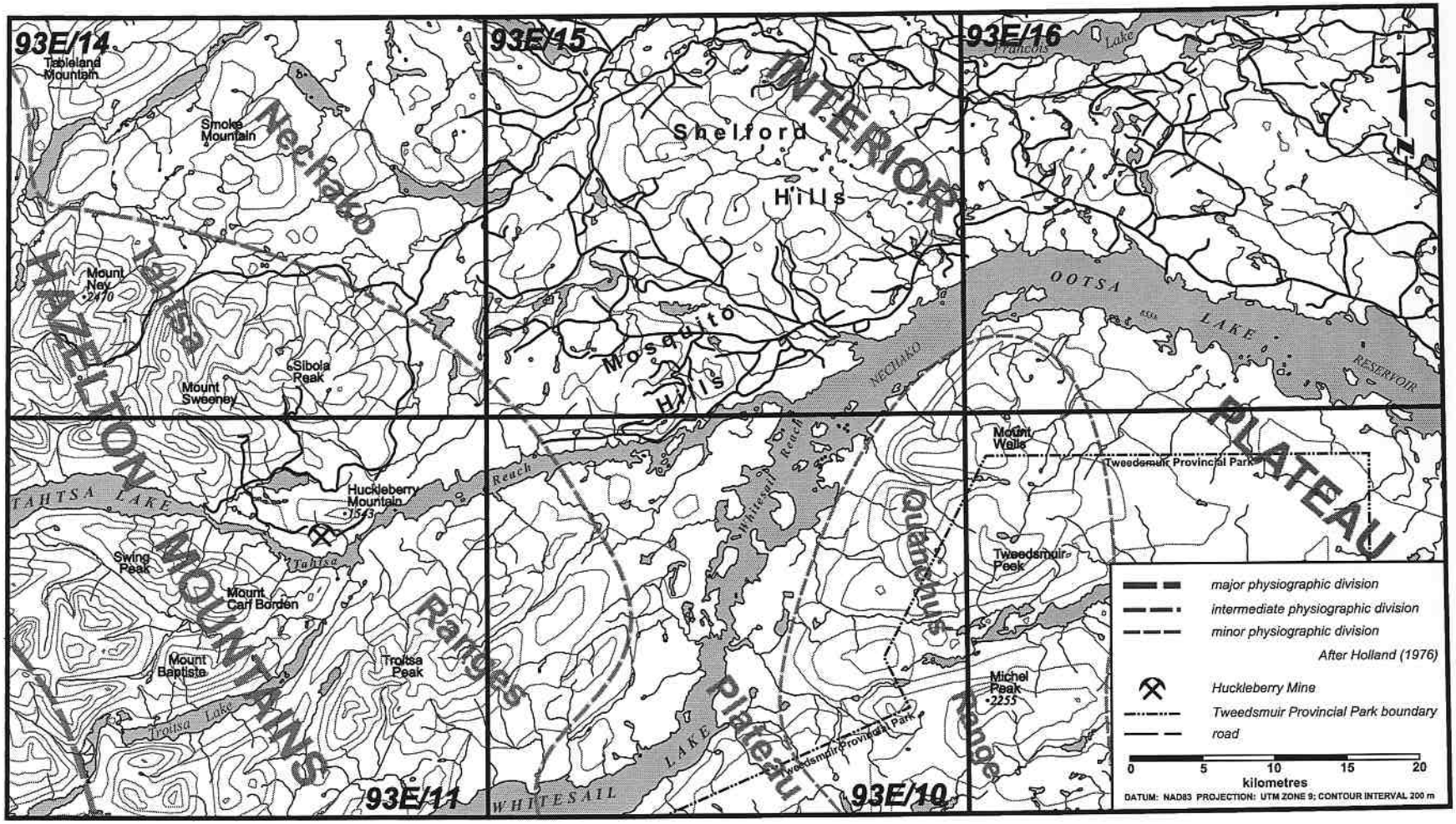


Figure 1.3. Physiographic divisions, and local features, of the study area.

The Tahtsa Lake region, or west half of the study area, is situated in the Tahtsa Ranges a belt of non-granitic mountains 15 to 25 km wide with a general northwest trend (Figures 1.1 and 1.3). These ranges are within the Hazelton Mountains physiographic division (Holland, 1976), which is situated between the Coast Mountains to the west and the Nechako Plateau to the east. Peaks and ridges in the Tahtsa Range show evidence of cirque glaciation, with some of the highest peaks still having cirque glaciers on north and northeast facing slopes. Mount Ney (2470 m a.s.l.), the highest point in these ranges, is located in NTS map area 93E/14 (Figure 1.3).

The Tahtsa Ranges are dissected by major valleys trending east to northeast which are occupied by prominent lakes (*e.g.* Eutsuk, Ootsa, Tahtsa, Troitsa, and Whitesail lakes occur at elevations around 850 to 900 m a.s.l.). Valley bottoms and mountain flanks are largely covered by thick sequences of Quaternary sediments with little bedrock exposure. Upper slopes and peaks extend into subalpine and alpine environments where bedrock outcrop is abundant (Figure 1.2b).

The Huckleberry Mine study area is located on the north side of Tahtsa Reach (Figure 1.3). The minesite itself is located in a poorly drained, arcuate valley at the foot of Huckleberry Mountain, at approximately 1050 m a.s.l. (Figure 1.4). In this thesis this valley is referred to as Huckleberry Valley. Drainage from this valley is directed to the southeast and to the west-southwest by a network of narrow, low-discharge streams

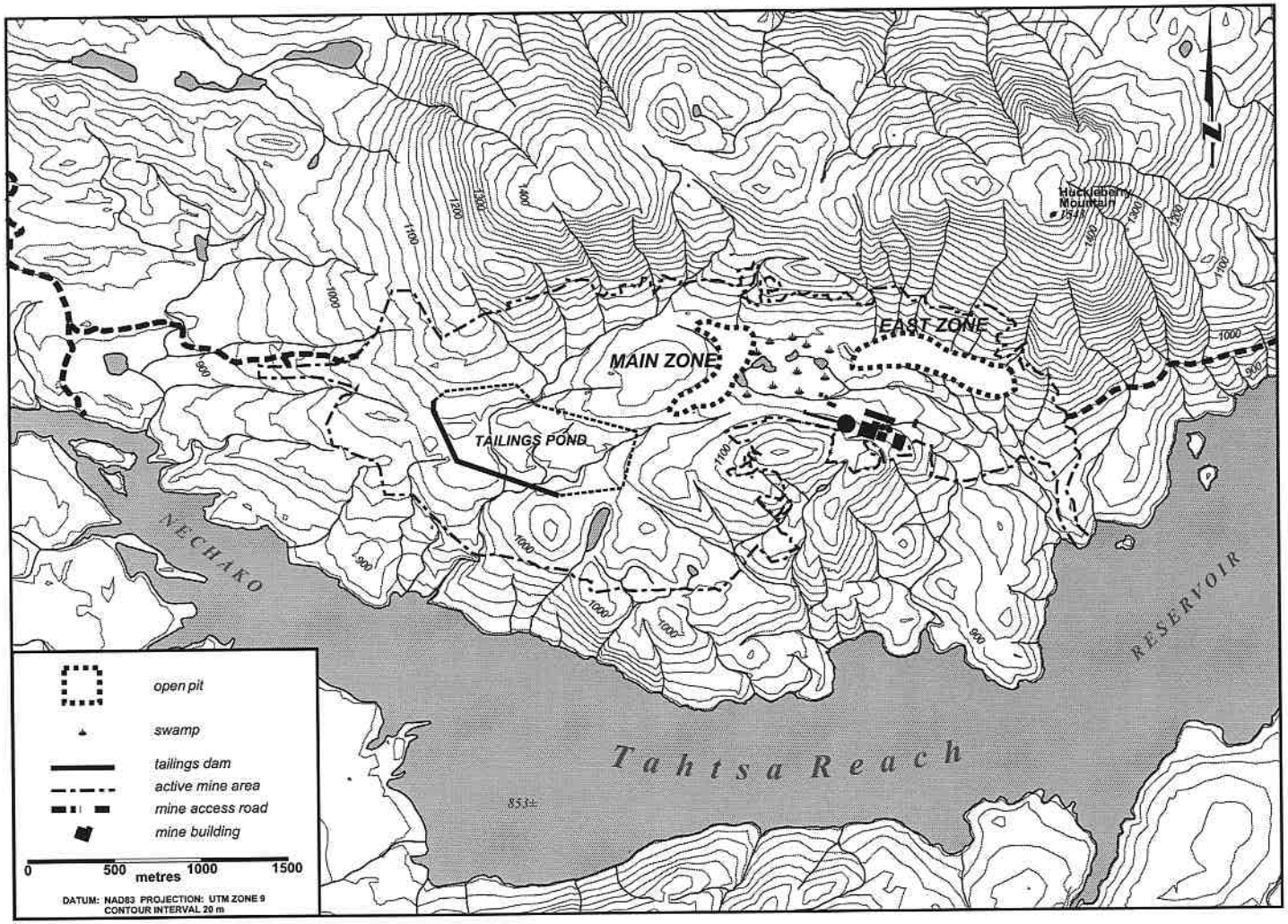


Figure 1.4. Topography and mining features of the Huckleberry Mine area. The main mine access road approaches from the east, while the original single track road used during early exploration work approaches from the west. Much of the land within the active mine boundary (thin dashed line) has been cleared of vegetation (Note: roads within active mine area not shown).

which empty into Tahtsa Reach. Bedrock outcrops are rare within the valley, due to the thick Quaternary cover, except where local topographic highs occur.

1.2.3 Climate

The general climate of the study area is humid continental. Climate data are recorded at a station located at the west end of Tahtsa Lake (Climate Id: 1087950; Environment Canada, 2004), the closest weather station to the Huckleberry Mine region. For the Tahtsa Lake area over the period 1971-2000, the lowest daily mean temperature occurred in January (-6.7°C) while the highest occurred in August (11.7°C). Daily extreme low and high temperatures of -35.6°C and 33.0°C occurred in the same months. November typically had the highest precipitation with 124 mm of rain and 178 cm of snow. The maximum snow depth during this period was 390 cm recorded in February, 1999 (Environment Canada, 2004).

1.2.4 Vegetation

Lodgepole pine (*Pinus contorta* var. *latifolia*) is the dominant tree species of the study area and covers nearly 50% of forested regions and is typically found below 1200 m a.s.l.. Lodgepole pine can be found growing in mixed stands with grand fir (*Abies grandis*), subalpine fir (*Abies lasiocarpa*), black spruce (*Picea mariana*), and white spruce (*Picea glauca*), but also grows in pure stands. Lodgepole pine's dominance over the other tree species in the study area may be due to its colonizing nature and (or) to current forest management practices that promote pure, mature stands of this species.

Subalpine fir is the second most common tree species and covers 30% of forested regions of the study area. Above 1100 m a.s.l. on mountain flanks subalpine fir is typically found growing As the primary tree species in a mixed stand. It can however, be a secondary or minor species at just about any elevation in a variety of topographic positions.

Black spruce are commonly found in poorly drained areas. They grow around the margins of bogs, fens, or swamps, and also grow on islands within these poorly drained areas.

1.2.5 Recent Hydrologic Change

In 1952, Alcan Canada completed the Kenny Dam and the Skins Lake Spillway, both located east of the study area on Ootsa Lake (Figure 1.1). These structures were built as part of the Kitimat-Kemano Project which saw the construction of an aluminium smelter in Kitimat and a hydroelectric generation station in Kemano to meet the electrical needs of the smelter, both of which are located west of the study area at tidewater (Figure 1.1). With the completion of Kenny Dam and the Skins Lake Spillway, the Tahtsa, Ootsa, and Whitesail lake systems became the Nechako Reservoir (Figure 1.1). The hydroelectric generators at Kemano are fed water from the west end of Tahtsa Lake (the west end of the Nechako Reservoir) by a 16 km-long penstock that was constructed under Penteuch Pass and Mount Dubose (in the Coast Mountains).

The creation of the Nechako Reservoir increased water level in Tahtsa Lake by 5 m, in Whitesail Lake by 32 m, and in Ootsa Lake by 40 m. Tahtsa River, once connecting

Tahtsa and Ootsa lakes, and Whitesail River, once connecting Whitesail and Ootsa lakes, were renamed Tahtsa Reach and Whitesail Reach, respectively. Trees were not logged prior to flooding the reservoir and standing timber (partially and fully submerged) is common along the shores of the Nechako Reservoir. Water no longer flows from Ootsa Lake directly into Nechako River. Instead it now flows out of the Skins Lake Spillway, into Cheslatta River and Nechako River. Most water in the Nechako Reservoir flows west towards the penstock at the west end of Tahtsa Lake. A noticeable westward current can be observed in the Nechako Reservoir, especially where it narrows as in Tahtsa Reach.

1.3 BEDROCK GEOLOGY

1.3.1 Regional Bedrock Geology

The study area was included by Hedley (1935) in his 1:250 000-scale bedrock geology map of the Tahtsa-Morice area. Duffel (1952) also worked in the area and completed a regional-scale bedrock geology map of the Whitesail Lake map area (NTS 93E). More detailed 1:50 000-scale bedrock geology mapping was completed by Diakow and Mihalynuk (1987), which included the eastern half of NTS map area 93E/11.

Other geological work completed in the study area has focused on specific aspects of bedrock and mineral deposit geology. For example, Carter (1981) investigated the age of intrusions and associated mineralization of porphyry copper and molybdenum deposits of west-central British Columbia, and their geologic and tectonic settings. MacIntyre (1985) narrowed his study to the Tahtsa Lake District and describes the geology and mineral deposits found there. Numerous other, more detailed, studies on mineral

occurrences and deposits have been carried out by prospectors and exploration and mining companies within the study area. Results from many of these studies are made available through the British Columbia Ministry of Energy and Mines Assessment Report Indexing System (ARIS), and the MINFILE (mineral occurrence) database.

The Tahtsa Lake district lies within the Intermontane Tectonic Belt, just east of the Coast Crystalline Belt. It is underlain mainly by Early to Middle Jurassic Hazelton Group volcanic and sedimentary rocks. These rocks are predominantly fragmental, red and green in colour, lapilli, lithic, and crystal tuffs, and tuff breccias (MacIntyre, 1985). Minor intercalations of porphyritic andesite, tuffaceous siliceous argillite, and pebble conglomerate also occur, and locally these rocks can include grey cherts and light-coloured felsic volcanics (*e.g.* ryholites). The Hazelton Group is unconformably overlain in areas by Middle to Late Jurassic Bowser Lake Group marine sedimentary rocks and Early Cretaceous Skeena Group turbidites and local basalt flows. These rocks are, in turn, unconformably overlain by felsic pyroclastics, felsic flows, and younger basaltic flows of Early to Late Cretaceous Kasalka Group volcanics. Many small to medium-sized, Late Cretaceous to Early Tertiary stocks have intruded these volcanic and sedimentary rocks (e.g. Bulkley Intrusions; MacIntyre, 1985; Jackson and Illerbrun, 1995). Late Cretaceous to Early Tertiary rhyolitic to basaltic dike swarms occur throughout the area with general northwest trends.

Rocks of the study area have a complex history of faulting and regional uplift related to the evolution of the Pacific Orogen and the formation of the Coast Crystalline Belt. The

major structural features are northwest-trending, high-angle normal and reverse faults. There are minor northeast to north-trending faults that typically run between these major faults, that bound uplifted, down-faulted, and tilted blocks. Other minor features such as fractures and dykes follow the major northwest and minor northeast trends (MacIntyre, 1985).

Hazelton Group and Skeena Group rocks can be broadly to tightly folded. Late Cretaceous Kasalka Group volcanics are themselves cut by the northwest and northeast-trending faults mentioned above with offsets greatest south of Swing Peak where blocks have been down-dropped by as much as 1000 m. The Kasalka Range (*e.g.* Swing Peak, Mount Baptiste; Figure 1.3), located south of Tahtsa Reach, appears to have been a structural depression, which may be of volcanic origin (*e.g.* caldera or cauldron subsidence complex). Bulkey Intrusion rocks, and associated porphyry copper mineral occurrences and deposits, occur on the periphery of this structural depression (MacIntyre, 1985).

1.3.2 Bedrock Geology of Huckleberry Mine

The bedrock geology of Huckleberry Mine consists of two porphyritic hornblende-biotite-feldspar granodiorite stocks of the Late Cretaceous Bulkley Intrusions (Figure 1.5). These stocks intrude Early Jurassic Telkwa Formation pyroclastic andesites of the Hazelton Group (Figure 1.5; Blower, 2000) and may have been constrained by several east-west-trending fault and shear zones. Hazelton Group rocks that occur on the Huckleberry Mine property are different from those described above in that they are grey

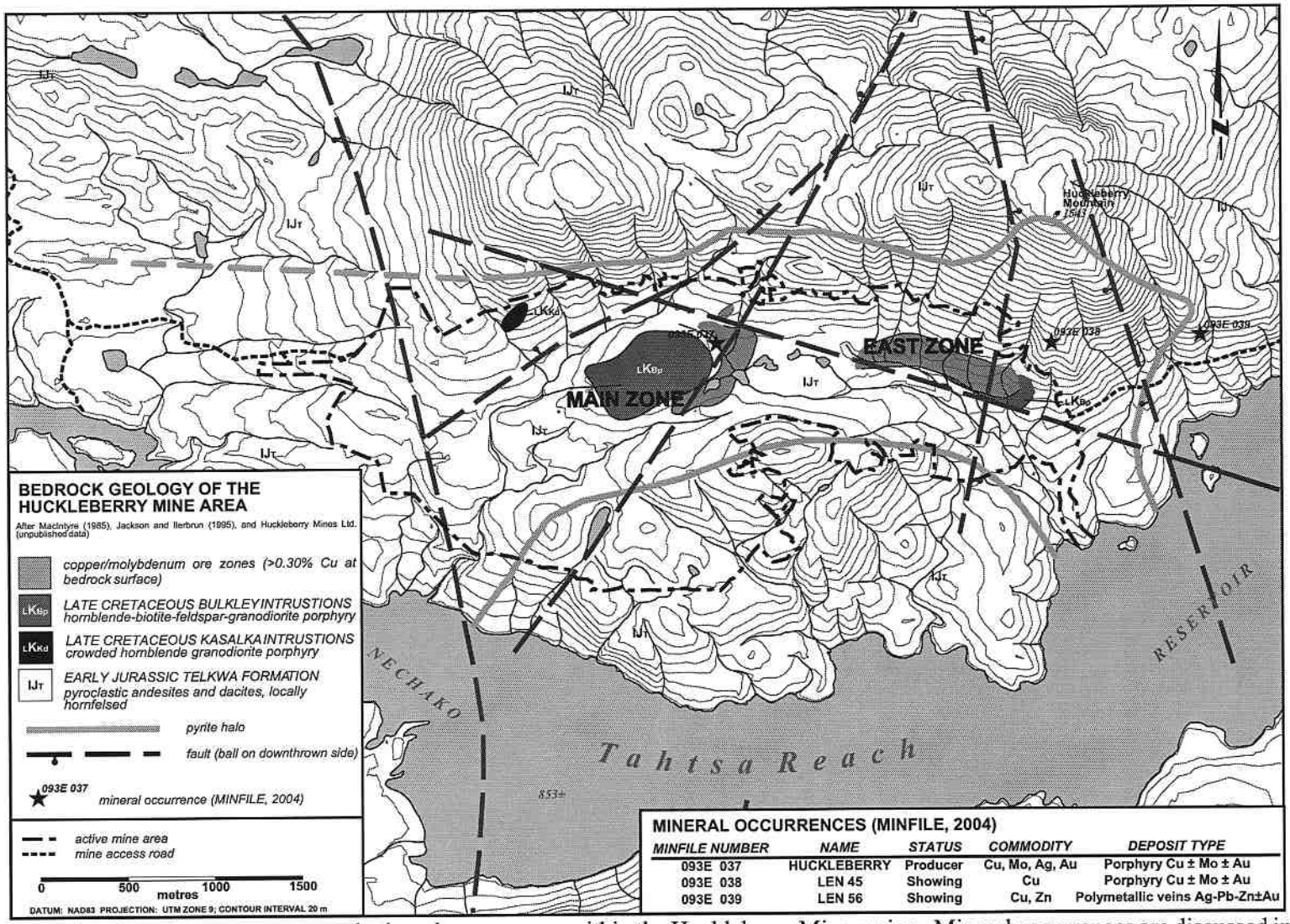


Figure 1.5. Bedrock geology, ore zones, and mineral occurrences within the Huckleberry Mine region. Mineral occurrences are discussed in detail in Chapter 5.0 (Till Geochemistry).

to black in colour and much harder. This change in colour and competency is likely due to biotite hornfelsing of these rocks which is associated with the emplacement of the Late Cretaceous intrusions (MacIntyre, pers. comm., 2004). Hornfelsed andesitic rocks do not just occur proximal to these intrusions, but are areally more extensive. This, and a flattening of the granodiorite stocks with depth (as observed in drill core results), suggests that rocks of the Late Cretaceous Bulkley Intrusion may underlie Hazelton Group rocks outside the Huckleberry Mine property (MacIntyre, 1985; Jackson and Illerbrun, 1995). The two Bulkley Intrusion stocks, and associated mineralized zones, make up Huckleberry Mine's Main and East Zones (Figure 1.5).

Mineralization of the Main and East zone orebodies is associated with hydrothermal alteration of the host rock intrusions and wall rock (Panteleyev, 1995). Mineralization occurs within a stockwork system of fractures and veinlets in the hornfelsed, fragmental Telkwa Formation andesites. Within the core of the mineralized areas, sulphide mineralization consists of chalcopyrite (1 to 3%), molybdenite (<0.3%), and pyrite (1 to 3%) (Blower, 2000). Mineralization grades outward from this to a pyrite rich halo (1 to 5%) with minor chalcopyrite (0 to 0.3%). Supergene chalcocite and native copper are only rarely observed near the bedrock/till contact. Minor malachite and tenorite can also occur on bedrock surfaces, in particular on hill-flanks outside of the Main and East Zone pit limits (Blower, 2000).

The dominant control on emplacement of mineralization is the contact of the stocks themselves. The orebodies occur as annular shells along the margins of, and adjacent to, the stocks. The grade of mineralization is dependent on the intensity of potassic

alteration of the intrusive and host rocks, and the density of fractures in the host rocks (MacIntyre, 1985; Jackson and Illerbrun, 1995; Panteleyev, 1995). Although there is copper and molybdenum mineralization within both stocks, nearly all the ore mined is from the adjacent volcanic rocks (S. Blower, pers. comm., 2000).

The Main zone, now mined out, extended east from the Main Zone stock into the adjacent volcanic rocks. This ore zone was approximately 750 m long and 350 m wide and wrapped around the eastern margin of Main Zone stock, centred on an easterly extending apophysis of the stock (Figure 1.5). Although the dominant control on emplacement of mineralization was the contact of the stock and apophysis, mineralization also appears to have been focused along a northeasterly-trending, steeply dipping shear zone that occurs along the east side of the Main zone stock (MacIntyre, 1985; Jackson and Illerbrun, 1995).

The East zone stock, approximately 500 m long, up to 150 m wide at the east end, and 20 m wide at the west end, is bounded on the south by a prominent northwesterly-trending fault zone (Figure 1.5). The East Zone orebody, peripheral to the East Zone stock, is a northwest-trending feature that is 175 m wide and almost 900 m long, and extends east into the adjacent stock volcanic rocks (MacIntyre, 1985; Jackson and Illerbrun, 1995). This orebody now exclusively supplies feed to Huckleberry Mine's mill and concentrator facility. At a 0.26% cut off the East zone has probable reserves of 36 719 000 tonnes of ore, grading at 0.489% copper, 0.013% molybdenum, 0.056 g/t gold, and 2.884 g/t silver (Imperial Metals, 2003).

Panteleyev (1995) described the Huckleberry deposit as a classic calcalkaline copper ± molybdenum ± gold porphyry. These deposits are zoned laterally outwards from: 1) a pyritic low-grade potassic/propylitic altered core (approximately Late Cretaceous Bulkley intrusions, Figure 1.5); to 2) potassic or phyllic alteration zones with associated ore-grade copper-molybdenum mineralization (approximately Main and East Zone ore bodies, Figure 1.5); to 3) a barren propylitic pyritic halo (see pyrite halo, Figure 1.5; Jackson and Illerbrun, 1995; Panteleyev, 1995). In general, the geochemical signature of calcalkaline porphyry Cu ± Mo ± Au deposits are related to the lateral zoning of mineralization. Central zones containing copper mineralization are commonly associated with molybdenum, gold, and silver, and possibly bismuth, tungsten, boron, and selenium. Peripheral to this copper zone, lead, zinc, manganese, vanadium, antimony, arsenic, selenium, tellurium, cobalt, barium, rubidium, and possibly mercury enrichment can be observed. Deposit zonation, and associated element and mineral characteristics, are summarized in Table 1.1.

Approximately 500 m northwest of the Main Zone stock, a small Late Cretaceous stock of the Kasalka Intrusions intrudes Telkwa Formation andesites (Figure 1.5). Outcropping on Huckleberry Mountain, this small stock is approximately 250 m long and 150 m wide and trends northeast. Kasalka Intrusion rocks are typically porphyritic andesites and diorites (MacIntyre, 1985). There are no reports of mineralization in the vicinity of this small stock, but evidence provided later in this thesis suggests that mineralization may be associated with this stock.

1.4 QUATERNARY GEOLOGIC-CLIMATE FRAMEWORK

Following the subdivision of Quaternary events and deposits in British Columbia, as reviewed by Ryder and Clague (1989), two geologic-climate units will be used in discussions that follow.

1.4.1 Fraser Glaciation

The Fraser Glaciation was the last major (ice sheet) glacial event to occur in British Columbia. Ice build-up began in high mountainous areas (*e.g.* Coast Mountains) about 20 000 to 25 000 years BP and expanded until the Cordilleran Ice Sheet reached its maximum size by about 15 000 years BP, covering most of British Columbia. Deglaciation was rapid, with coastal areas being ice-free by about 13 000 years BP; the province as a whole is thought to have been ice free before 9000 years BP (Clague, 1981). In most areas the Fraser Glaciation geologic-climate unit falls within the Late Wisconsinan sub-stage (23 000 to 10 000 years BP). Locally, however, it could extend into late-Middle Wisconsinan time (30 000 years BP; Clague, 1981; Clague, 1989a; Fulton, 1989; Ryder and Clague, 1989).

1.4.2 Postglacial

The Postglacial geologic-climate unit includes the period of time from deglaciation (approximately 9000 years BP) to present. In most areas the Postglacial unit falls within the Holocene epoch. Locally, however, it can extend into latest-Late Wisconsinan time (*i.e.* before 10 000 years BP; Clague, 1981; Clague, 1989a; Fulton, 1989; Ryder and Clague, 1989).

2 SURFICIAL GEOLOGY

2.1 INTRODUCTION

The objective of this chapter is to map the surficial sediments present in the Huckleberry Mine region through observations and descriptions recorded in the field and from aerial photographic interpretation. The chapter begins with a review of previous Quaternary geological work conducted in, and adjacent to, the study area. A review of field and laboratory methods used to map the surficial sediments of the Huckleberry Mine region follows. Material types identified in the area are characterized with sedimentologic and geomorphologic descriptions. The chapter ends with a summary of the surficial geology and Quaternary history of the Huckleberry Mine region.

2.2 PREVIOUS WORK

Previous surficial geology work conducted within the Whitesail Lake map area (NTS 93E) was limited to terrain mapping projects. Researchers with the British Columbia Ministry of Environment were the first to map the area, producing 1:50 000-scale soils and landforms maps (British Columbia Ministry of Environment, 1976). A more detailed 1:10 000-scale map of the Huckleberry Mine property, and surrounding area, was produced by New Canamin Resources (1993) as part of an advanced exploration program on mineral claims that now make up Huckleberry Mine. In both cases, these maps are limited to generalized mapping of surficial sediments. Interpretations of the ice-flow history or Quaternary stratigraphy were not included.

Quaternary geological studies have been conducted in areas adjacent to the Huckleberry Mine area. To the north and northwest, Clague (1984), Levson (2001a), and Levson *et al.* (2002) discuss the Quaternary geology and geomorphic features of NTS map areas 93L, M and 103I, P. To the northeast, Plouffe (1994; 1996a, b) mapped the surficial deposits, and described the Quaternary stratigraphy, of NTS map area 93K. Mate (2000) conducted a similar study to the east in NTS map area 93F/12. Mate also studied the types of, and factors responsible for, landslides in Pleistocene sediments of the area.

All of these study areas have an extensive cover of Late Wisconsinan Fraser Glaciation morainal material and fresh streamlined and erosional forms indicating that central British Columbia was extensively covered by glaciers during Late Wisconsinan time. Other surficial materials common to these areas include Pleistocene glaciofluvial and glaciolacustrine sediments, and Holocene colluvial, fluvial, and organic deposits.

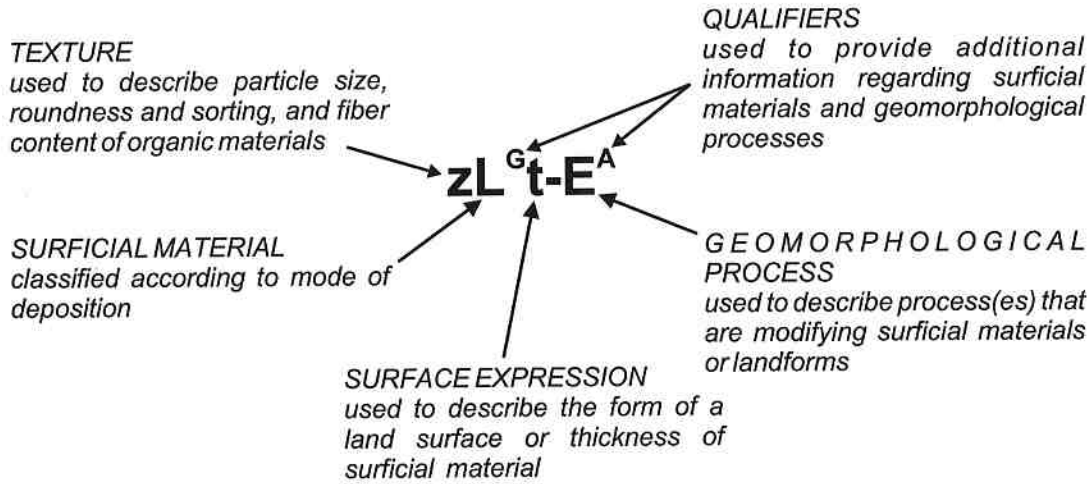
2.3 METHODS

Black and white, 1:15 000-scale, aerial photographs were used to interpret the type and areal extent of surficial sediments present in the Huckleberry Mine region. Polygons were labelled using the mapping conventions outlined by Howse and Kenk (1997). Composite symbols are used when homogenous units are too small to map individually. Figure 2.1 provides a key to reading the polygon labels used to map the surficial sediments of the Huckleberry Mine region.

ZONE	ELEMENT/MINERAL CHARACTERISTICS
core	low-grade, pyritic
ore zone, peripheral to core	Cu; coincident Mo, Au, and Ag; possible Bi, W, B, and Sr
preripheral to ore zone	Pb, Zn, Mn, V, Sb, As, Se, Te, Co, Ba, Rb; possible Hg
widespread aureole or halo, outwards from mineralization	barren, pyritic

Table 1.1 - Geochemical signature of calkalkaline porphyry Cu ± Mo ± Au deposits in British Columbia (After Panteleyev, 1995).

a)



b)

Ov	*organic veneer*
Mb·R	*morainal blanket and bedrock materials are roughly equal*
Cv/R	*bedrock materials are less than colluvial veneer*
Mv//R	*bedrock materials are significantly less than morainal veneer*
sgF^{G}t-H	*kettled glaciofluvial sand and gravel terrace*

Figure 2.1. A key to surfical geology polygon labels. The individual components of a polygon label are defined in a) while examples of different polygon labels are provided in b) (modified from Howse and Kenk, 1997). As seen here there can be many components to a polygon label, with each component having many different possible values. More than one label can be used for a single polygon by using delimiters (/, //, .) or stratigraphic symbols (—).

During the 2000 field survey, surficial geology mapping was conducted in conjunction with till sampling traverses, ice-flow studies, and other fieldwork on the ground. Traverses were conducted by foot, boat, truck, and helicopter. All of the area shown on Figure 2.2 was studied in the field, but sediment samples were mainly collected on Huckleberry Mine property itself. In all, 102 near-surface till sample sites and 16 vertical exposures were described on the mine property (see Figure 2.2 for locations). Data collected at each site included map unit, topographic position, aspect, slope angle, and sedimentological characteristics of sediments at exposures.

Two hundred and thirty-five sub-surface samples, from 47 boreholes, were also used to evaluate surficial geology map unit interpretations. Due to the numerous vertical exposures on the Huckleberry Mine site, as well as these sub-surface samples, much of the local Quaternary stratigraphy could be evaluated. Stratigraphic relationships are discussed in detail in Chapter 4.0 (Quaternary Stratigraphy).

Polygon boundaries were defined directly on aerial photographs. Aerial photographs were then in turn scanned and a digital orthophoto was produced. In a geographical information system (GIS), polygons were manually traced from this digital orthophoto. Polygons in Figure 2.2 are assigned colours based on the primary material type. A cross-hatched symbol is used to show various types of sediment veneers (Figure 2.2). In total, an area of approximately 50 km^2 was mapped.

2.4 MAP UNITS

Five major map units have been defined for the Huckleberry Mine region: pre-Quaternary bedrock, Late Pleistocene morainal deposits, and non-glacial Holocene colluvial, organic, and fluvial deposits (Figure 2.2).

It should be noted that surficial materials within the active mine area have been significantly modified since the start-up of Huckleberry Mine. As seen today, much of the active mine area would be mapped as anthropogenic material (see Figure 2.2 for an outline of the active mine area). The aerial photographs used to the map surficial materials of the Huckleberry Mine region pre-date the start-up of Huckleberry Mine. As such, Figure 2.2 depicts the type and distribution of surficial sediments prior to mine preparation and extraction activities.

2.4.1 Pre-Quaternary Bedrock

Large areas of bedrock outcrop (R) are limited to the higher elevations of Huckleberry Mountain (Figure 2.2). In addition, flooding of the Nechako Reservoir, and resulting wave-wash processes, have created narrow discontinuous bedrock outcrops along the shores of Tahtsa Reach (Figure 2.2). Locally, smaller areas of bedrock outcrop are also found in steeper colluviated areas above the north shore of Tahtsa Reach. Bedrock, as a primary map unit, occurs on Huckleberry Mountain and along the shores of Tahtsa Reach only. Bedrock is found more commonly with colluvial and morainal material as a primary or secondary map unit. Although showing signs of physical and perhaps biological and chemical weathering, bedrock exposed at surface is typically competent; in

particular hornfelsed andesites. As a primary map unit, bedrock (R) accounts for only 2% of the area mapped (Figure 2.2).

Bedrock outcrops in the vicinity of Huckleberry Mine are rare. The two stocks, of the Late Cretaceous Bulkley Intrusions, that occur on the property were mainly covered by morainal deposits prior to mining. Mineralized rocks adjacent to these stocks, constituting the Main and East zones, respectively, were entirely buried by thick glacial and organic deposits prior to mining. In Figure 2.2, the locations of these orebodies are approximated by the areas outlined as active pits. A detailed discussion of the bedrock geology of the study area is provided in Chapter 1.0 (Introduction).

Bedrock surfaces in the Huckleberry Mine region are commonly glacially abraded. Well preserved ice-flow indicators with westerly and easterly trends occur on many bedrock exposures in the area. The majority of these features are glacial striae that rarely extend up to 0.5 m in length. Small-scale uni-directional ice-flow indicators such as rat-tails are only occasionally observed. More common, however, are centimetre-scale, polished (stoss) and plucked (lee) surfaces (*i.e.* small-scale roches moutonnées). Larger-scale, moderately to well preserved, uni-directional ice-flow indicators, such as roches moutonnées (a few to many metres in length), are seen in wave-washed bedrock exposures along Tahtsa Reach. The orientation of uni-directional features in the Huckleberry Mine area clearly indicate ice-flow towards both the east and west. The opposing orientations of these features suggests that there must have been an ice-flow reversal sometime during the last glaciation.

The locations of ice-flow stations within the Huckleberry Mine area, and orientations of ice-flow indicators, are provided in Figure 2.2. These features, and their relevance to the regional ice-flow history, are discussed in more detail in Chapter 3.0 (Ice- Flow History).

2.4.2 Late Pleistocene Morainal Deposits

Morainal deposits consist primarily of massive and matrix supported, overconsolidated, sandy-silt diamictons. These diamictons are typically fissile, well jointed, and contain striated clasts. They are interpreted as basal tills and are a product of comminution and reworking of bedrock and pre-existing surficial deposits by glacial ice during Fraser Glaciation. Locally there are examples of gravelly-sand diamictons, with undulating sand and gravel interbeds and discontinuous sandy and gravelly lenses. These sediments are variously interpreted as deformation till, debris flow deposits, and basal melt-out till deposited at the base of, or proximal to, stagnant ice. Morainal deposits commonly have been modified by post-glacial slope processes especially in areas of steeper terrain. Morainal deposits are the dominant material type found in the Huckleberry Mine region, and account for 82% of the area mapped (Figure 2.2).

Morainal blankets (Mb), by definition, are >1m in thickness. These units generally conform to underlying topography but mask small-scale irregularities. Morainal blankets form an extensive cover in valley bottoms and on the lower and mid-slopes of highland areas (Figure 2.2). They reach a maximum known thickness of approximately 30 m in the vicinity of the Main and East Zone pits. Mineralized granodiorite and andesite clasts

(pyrite +/- chalcopyrite) are commonly found in tills of the Main and East Zone areas. In these same areas, visible pyrite and chalcopyrite crystals are also common within the till matrix. Morainal blankets can be locally mantled by organic or colluvial deposits. These morainal deposits are locally incised along the lower reaches of the Sweeney Lake outlet stream.

Gullied morainal deposits (Mb-V) have the same general characteristics as morainal blankets but have been deeply incised by fluvial processes. These units are typically found on the steeper flanks of Huckleberry Mountain and on the northern slopes of Tahtsa Reach. At TFE00-5, bedrock is exposed in the base of a gully (Figure 2.2).

Glacially streamlined features in the Huckleberry Mine region are typically formed in morainal deposits. They are detectable on the ground but are most easily observed and studied in aerial photographs. Good examples occur in an area to the west of Huckleberry Mine property, north of Tahtsa Reach, where well defined flutings and a crag-and-tail occur (Figure 2.2). Although both landforms are similar in size (up to 150 m wide and 500 m long), the crag-and-tail is the most pronounced feature as it stands highest above the surrounding ground (~40 m). The crag-and-tail is of particular interest as its orientation indicates that glacial ice flowed west, up-valley, towards the Coast Mountains sometime during Fraser Glaciation. As with ice-flow indicators observed on bedrock surfaces, the orientation of larger-scale streamlined features also suggests that an ice-flow reversal must have occurred during the last glaciation. These streamlined

features, and the other examples that occur in the Huckleberry Mine region, are discussed in more detail in Chapter 3.0 (Ice-Flow History).

Glacially streamlined features also occur in an area of elevated bedrock ridges and isolated bedrock knobs where intervening lows are covered by organic deposits and small ponds or lakes. A similar, although more subdued, topographic setting occurs south of Huckleberry Mine where morainal blankets (Mb) and veneers (Mv) are common.

Morainal veneers (Mv) are ≤1 m in thickness. These units conform to minor surface irregularities of the underlying material which is typically bedrock. Morainal veneers can be discontinuous and contain small areas of thicker colluvial and morainal material. Morainal veneers (Mv) commonly form a transition zone between morainal blankets (Mb) and areas of exposed bedrock (R; see Figure 2.2). These bedrock exposures can be areally extensive (*e.g.* peak of Huckleberry Mountain) or can be smaller and discontinuous within a dominantly morainal veneer cover.

2.4.3 Holocene

2.4.3.1 Colluvial Deposits

Colluvial deposits consist of poorly sorted, angular gravels and sandy diamictons. These deposits are the product of down-slope transport and deposition of weathered bedrock by gravity processes. Colluvial deposits can also be derived from pre-existing Quaternary sediments but they were only mapped as such if they are significantly different from their parent material. Colluvial deposits derived from pre-existing Quaternary sediments

typically resemble their parent material in texture, but they may be locally distinguished by geomorphic or sedimentological characteristics. For example, reworked till mapped as colluvium is typically less dense, more porous, and a better stratified diamicton than its parent material. As a primary material type, colluvium accounts for 6% of the area mapped (Figure 2.2).

Colluvial blankets (Cb), >1 m in thickness, generally conform to underlying topography but mask small-scale irregularities. These units are found mainly on moderately steep (~15° to 20°), lower elevation slopes mantling glacial units (*e.g.* Mb) or bedrock. Locally, colluvium forms thick talus deposits below steep slopes (*e.g.* west of Huckleberry Mine property, and north of Tahtsa Reach; see Figure 2.2). As a primary material type, colluvial blankets are found only locally (*e.g.* south shore of Sweeney Lake, west of Sweeney Lake, and east of Huckleberry Mountain; see Figure 2.2).

Colluvial veneers (Cv), ≤1 m in thickness, conform to minor surface irregularities of the underlying material. This unit is found on steep to very steep slopes (~25° to 35°), where it is interspersed with morainal deposits or bedrock exposures (Figure 2.2).

2.4.3.2 Fluvial Sediments

Fluvial deposits are typically composed of silts, sands, and rounded to subrounded gravels that have been transported and deposited by streams and rivers. They are usually stratified and, with the exception of alluvial fans, are moderately to well sorted. As a primary material, fluvial deposits account for 5% of the area mapped (Figure 2.2).

Alluvial fans (Ff) are constructional forms that occur at the mouth of gullies or confined valleys. Longitudinal profiles along these features range from straight, or smoothly convex to concave (Clague, 1984), with slopes of up to 15°. Smaller alluvial fans mapped along the northern shore of Tahtsa Reach approach this slope angle (Figure 2.2). All alluvial fans within the map area are forested and therefore relatively inactive. These units are dominantly fluvial in origin but likely also include debris flow sediments.

The distal margin of an alluvial fan was mapped in the north-eastern quadrant of Figure 2.2. The apex of this fan is 1 km to the north and is situated at the narrow mouth of Whiting Creek valley. The main channel of modern day Whiting Creek flows southeast through the centre of this 100 ha fan. To construct this fan, the position of the main channel of Whiting Creek would have to have shifted back and forth over the fan surface. It is believed that during the Holocene Whiting Creek periodically flowed through the swamp (Ob) situated at its base, and emptied into Sweeney Lake; currently it empties into Tahtsa Reach.

Fluvial plains (Fp) are very gently sloping, planar surfaces that can be constructional or erosional (Clague, 1984). Those mapped within the study area are thought to be mainly constructional. This map unit includes overbank deposits, terraces, abandoned and active channels of Whiting and Rhine creeks, and the Sweeney Lake outlet stream. These features are also densely forested in the study area. Locally this unit includes small areas of organic deposits along Whiting Creek that are areally too small to map individually.

A fluvial plain, mapped at the eastern end of Sweeney Lake, is widest at the western margin (600 m) where it borders the lake but towards the east it narrows to approximately 70 m, and maintains this width for approximately 1 km farther east (Figure 2.2). This plain is currently occupied by a narrow, low discharge, underfit stream that drains an extensive swamp (Ob) to the east. As described above, it is believed that through Holocene time, Whiting Creek has periodically flowed through this swamp (Ob) and emptied into Sweeney Lake. This fluvial plain is thought to be the product of sediment being carried by Whiting Creek flow. It is possible that it formed as a fan-delta or delta. This feature is now densely treed, suggesting that it has been some time since Whiting Creek last flowed through the area.

Another fluvial plain has been mapped in the western portion of Figure 2.2. This feature is approximately 1.3 km wide at its distal end and narrows upslope to approximately 100 m across. Rhine Creek flows along the eastern margin of this fluvial plain where it has incised into it. This is the largest fluvial plain mapped in the study area, 152 ha in size.

2.4.3.3 Organic Deposits

Organic deposits are composed primarily of fibric to mesic peats, mosses, and organic soils. Organic map units are typically unforested but the deposits can contain vegetative and woody debris such as grasses/sedges, twigs, conifer cones, tree limbs and stumps. Locally (*e.g.* at sections TFE00-10 and 14), organic deposits can be mantled by brown organic muds (gyttja; Figure 2.2). These gyttjas also contain vegetative matter such as

conifer needles, bark, and small twigs. The presence of organic deposits in the Huckleberry Mine area suggest that the pre-mine water table was quite shallow and commonly extended to the surface. As a primary material type, organics accounts for 5% of the area mapped (Figure 2.2).

Organic blankets (Ob), >1 m in thickness, are typically swamp-like in character and occur in poorly drained areas (Figure 2.2); small ponds or lakes commonly occur within these deposits. Adjacent units can be connected by narrow, low discharge, streams. Organic deposits can occupy relatively large areas. For example, an organic blanket approximately 83 ha in size lies east of Sweeney Lake (Figure 2.2). This unit is funnel shaped, and widens towards the north where it borders an alluvial fan, and narrows to <100 m to the west, where it borders a fluvial plain. Within this extensive organic blanket are islands of morainal material.

Another large organic deposit lies between the Main and East Zone Pits (Figure 2.2). This organic blanket is 22 ha in size and is drained to the east by a small stream that empties into Tahtsa Reach. Vertical exposures on the Huckleberry Mine property (*e.g.* sections TFE00-10 and 14, Figure 2.2) show this deposit to be over 3 m thick and is underlain by up to 3 m of retreat-phase sands and gravels and up to 10 m of glacial till. Much of the Main Zone was covered by thick organic deposits.

Organic veneers (Ov) commonly border ponds, lakes, and streams, but also occur along swamp (*i.e.* Ob) margins (Figure 2.2). These deposits are much less extensive than organic blankets and are typically 1 to 2 ha in size.

2.5 SURFICIAL GEOLOGY AND QUATERNARY HISTORY

The Huckleberry Mine region was covered by glaciers during the Late Quaternary. Glacially abraded and streamlined bedrock surfaces provide ample evidence for this, as does the ubiquitous cover of Late Pleistocene morainal deposits.

Morainal material, or till, is thought to have been deposited by glaciers that flowed from the Coast Mountains in the west, although local glaciers coming out of the Rhine Craig/Mount Sweeney area, and out of the Troitsa Lake valley, may have played a larger role in depositing till in the earlier and later stages of Fraser Glaciation. Morainal material covers the valley bottoms and mid-slopes of highland areas at elevations up to 1400 m a.s.l. The surface elevation of the Cordilleran Ice Sheet during Fraser Glaciation was at least 1400 m a.s.l. Thinner morainal deposits (<1 m thick) form a transition zone between thicker morainal deposits and exposed bedrock.

There may be evidence for an early postglacial, or late retreat-phase-glacial, sediment dammed lake in the Sweeney Lake area. Poorly exposed, fine grained sediments, in the vicinity of the Mount Sweeney and Sweeney Lake Road intersection, were observed in the field 5 to 10 m above present day lake level. These sediments may be lacustrine sediments which would suggest that the Sweeney Lake outlet was at some point dammed.

The fluvial plain mapped on the east shore of Sweeney Lake is a product of Whiting Creek flow west across the fluvial fan that occurs in the northeast corner of the map area. The Whiting Creek main channel has since shifted back across the large fluvial fan towards the southeast and at present empties into Tahtsa Reach.

Holocene colluvium occurs throughout the study area, on or below moderate to steep slopes. Some of these deposits are devoid of vegetation suggesting that mass-wasting process are still active today. Organic deposits, although also distributed throughout the study area, occur more locally along the margins of small ponds, lakes, and narrow, low discharge streams. The most extensive organic deposit occurs east of Sweeney Lake as an 83 ha swamp. The distribution of these organic, typically swamp-like, deposits in the Huckleberry Mine region indicate that the water table is quite shallow and commonly extends to the surface.

Holocene fluvial deposits occur along present day stream courses. Large fluvial fans, now forested and up to 152 ha in size, have been mapped in the study area. The creeks that have produced these deposits drain areally extensive, high elevation areas to the north where icefields continue to supply meltwater. This continuous supply of meltwater to these streams over Holocene time helps account for the size of these deposits. It would appear that these larger, constructional, alluvial fans have been largely inactive for some time.

In comparison with areas mapped to the north (*e.g.* Levson *et al.*, 2002), northeast (*e.g.* Plouffe, 1994; 1996a, b), and east (*e.g.* Mate and Levson, 2000) of the study area, there is a notable absence of glaciofluvial and glaciolacustrine deposits at the surface. Similar to these areas, however, are ice stagnation features such as continuous, undeformed, eskers that were observed in aerial photographs on the south shore of Tahtsa Reach and in Troitsa Lake valley. Although they occur outside the map area, features such as these, and melt-out facies tills within the map area, suggest that stagnant ice masses also existed in the Huckleberry Mine region during deglaciation.

3 ICE-FLOW HISTORY

3.1 INTRODUCTION

The objectives of this chapter are to build a detailed ice-flow model for the Tahtsa Lake – Ootsa Lake region for the Late Wisconsinan through the identification and interpretation of streamlined and erosional forms and to compare this model with the current regional model. Evidence will be provided for the existence of a migrating ice-divide in central British Columbia.

This chapter begins with a summary of Late Wisconsinan ice-flow models for west-central British Columbia, followed by a review of the methods used to study ice-flow indicators in the Tahtsa Lake-Ootsa Lake region. Observations and interpretations resulting from the 2000 field survey and aerial photograph work are then presented and the Late Wisconsinan ice-flow history of the study area is described. Throughout this chapter the reader will be directed to Open File 2001-8: *Ice-flow History of Tahtsa Lake – Ootsa Lake Region* (Ferbey and Levson, 2001a; in map pocket). Hereafter, this map sheet is referred to as Figure 3.1.

3.2 PREVIOUS WORK

The ice mass that occupied British Columbia during the last glacial maximum First termed the Cordillera glacier by Dawson (1891) but today is more commonly referred to as the Cordilleran Ice Sheet (Clague, 1989b). Kerr (1934) was the first to propose a four phase conceptual model for inception and growth of the Cordilleran Ice Sheet, based on observations he made while conducting work in northwestern British Columbia,

combined with data provided by earlier workers (*e.g.* Dawson, 1891). With some modification to Kerr's model, Davis and Mathews (1944) proposed their own four-phase model. In their model, particular attention is paid to inferred ice thickness during each phase, relative to topographic relief, and erosional features unique to each phase. Examples of glacial histories in southern British Columbia were used to provide evidence for their model of Cordilleran Ice Sheet inception and growth. These two models are commonly cited by researchers working in the Canadian Cordillera and are summarized below.

The first phase of glaciation is an alpine-style of glaciation where accumulation centres are in high mountain areas (e.g. cirques). In this phase relief of the land surface greatly exceeds that of ice thickness and ice movement in this phase is almost entirely topographically controlled. During the second phase of glaciation, relief of land is only slightly greater that of ice thickness. This phase corresponds to a more intense alpine-style of glaciation where coalescing mountain and valley glaciers form a branching glacier system. Ice movement is topographically controlled with the majority of flow distributed through major trunk valleys. During the third phase of glaciation, ice thickness slightly exceeds the relief of land. This phase corresponds to a mountain ice sheet-style of glaciation where ice advances across interior plateaus and lowlands. In this third phase the underlying topography still has some influence on ice-flow direction. During the fourth and ultimate phase of glaciation, ice thickness greatly exceeds relief. This corresponds to a continental ice sheet-style of glaciation, analogous to the style of glaciation currently taking place on the Greenland and Antarctic continents. In this

phase, nunataks and exposed ridges are less common and underlying topography has little influence on ice-flow direction. Instead, ice-flow direction is entirely dependent on ice surface slope. The positions of major accumulation centres, or high surface elevations, may or may not correspond to initial centres of accumulation, such as the axes of major mountain systems.

Kerr (1934) suggested that the growth and decay of the Cordilleran Ice Sheet produced two versions of each phase – one as ice advanced and another as ice retreated (*e.g.* advance and retreat alpine-style glaciation). Fulton (1967, 1991) modified the deglacial model for the Cordilleran Ice Sheet by proposing a model specific to inland plateau settings. Instead of marginal retreat of active glaciers back to the initial accumulation centres, Fulton suggested that thinning or downwasting of interior ice exposed higher elevation areas first, which isolated large masses of ice in low lying areas (*e.g.* valleys) that became stagnant. Features such as lateral meltwater channels, eskers, kettles, and an apparent lack of recessional and lateral moraines, are all suggestive of the presence of stagnant ice masses during deglaciation (Armstrong and Tipper 1948; Fulton, 1967; Tipper, 1971a, b; Fulton, 1991; Levson *et al.*, 2002). In some areas of British Columbia, deglacial models that combine frontal retreat of active ice and ice stagnation have been proposed (Ryder and Maynard, 1991; Ryder *et al.*, 1991; Plouffe, 2000).

It has also been suggested by various authors (Dawson, 1891; Kerr, 1934; Fulton, 1967) that, at sometime during the Pleistocene, an ice dome existed inland of the Coast Mountains, but the timing of this event has been debated. Tipper (1971a, b, 1994)

observed features in the central interior of British Columbia that indicate ice-flow west towards the Coast Mountains. He acknowledged that an ice dome must have existed in the central interior sometime during the Pleistocene and that the ice flowed radially from this ice dome through and over the Coast Mountains to the west and the Rocky Mountains to the east. He concluded that this ice dome was formed during a pre-Late Wisconsinan glacial event because he believed it was larger in magnitude than that of the Fraser Glaciation. Similarly, Ryder *et al.* (1991) concluded that the lack of a radiating ice flow pattern in glacially streamlined features occurring in central British Columbia indicate that an interior ice dome did not develop during the Fraser Glaciation.

Tipper's (1971a, b) interpretation was based on a model of ice-surface elevation. He thought that lateral meltwater channels observed at about 1300 m a.s.l., southeast of Prince George estimated he maximum ice-surface elevation in the area during Fraser Glaciation. Consequently, he concluded that striae observed above these channels (>1600 m a.s.l.), and drumlins located above 1600 m a.s.l. in the Canadian Rocky Mountains, could not have been produced by Fraser Glaciation ice but during an earlier, more extensive glaciation.

More recently, there has been a growing number of observations of glacial features in central British Columbia that suggest that glaciers flowed west towards the Coast Mountains during the Late Wisconsinan (Levson and Giles, 1997; Levson *et al.*, 1998; Levson *et al.*, 1999; Ferbey and Levson, 2001b; Levson, 2001; Mate and Levson, 2001). Stumpf *et al.* (2000) compiled ice-flow indicators covering a large portion of central

British Columbia, which showed further evidence of ice flow towards the west from central British Columbia. This included directional landforms such as rock drumlins and crag-and-tail ridges, exposed on mountains and valleys of the southern Nechako Plateau, that indicate ice-flow towards the west. In northern Nechako Plateau, and in Skeena and Hazelton mountains, they identified erratics of distinctive bedrock lithologies that have been transported west of their source. In the southern Skeena Mountains they identified features such as rock drumlins, roches moutonnées, rat-tails, and striae at >2000 m a.s.l. that indicate cross-valley ice movement towards the west. In agreement with Tipper (1971a, b, 1994), these researchers also suggest that these features were produced by westerly ice-flow from an ice divide situated in central British Columbia, however, they suggest that this ice divide existed during the Late Wisconsinan Fraser Glaciation maximum (Figure 3.2). The preservation of westward-directed ice-flow indicators in both valley and mountain settings are cited as evidence for this. Areas located between the central ice divide and the Coast Mountains, would have experienced reversals in ice flow direction during build up to the glacial maximum.

These studies suggest that phase four of Kerr (1934) and Davis and Mathews (1944) was reached during the Fraser Glaciation maximum. The close proximity of the Tahtsa Lake – Ootsa Lake region to the Coast Mountains suggests that there should be evidence of an ice-flow reversal here.

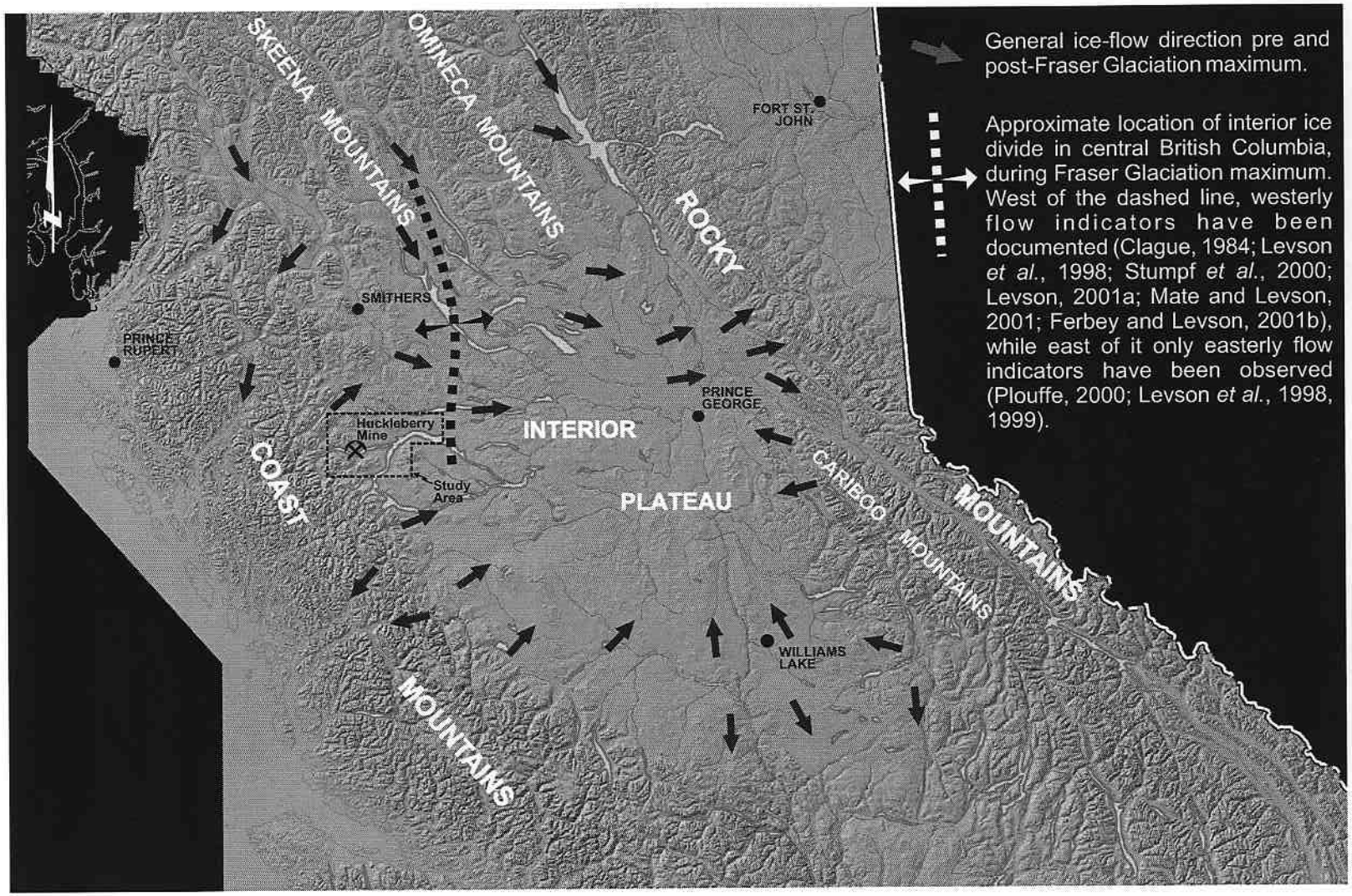


Figure 3.2. Location of interior ice divide of the Cordilleran Ice Sheet in central British Columbia, during Fraser Glaciation maximum. Figure after Levson (2002).

3.3 METHODS

During the 2000 field season, ice-flow data were observed and recorded at over 120 field sites in the Tahtsa Lake – Ootsa Lake region (NTS 93E/10-11, 14-16; see Figure 1.1). Various small-scale (*e.g.* grooves, striae, rat-tails, and small roches moutonnées) and intermediate to large-scale (*e.g.* drumlins, crag-and-tail ridges, roches moutonnées, and flutings) streamlined and erosional forms were studied. Most iceflow forms were observed in valley bottom settings along roads and along the shorelines of Tahtsa Reach, Tahtsa Lake, and Ootsa Lake, and were accessed by truck and boat. Streamlined and erosional forms were also studied at elevations over 1500 m a.s.l. on six mountain peaks, the majority of which were accessed by helicopter. Figure 3.1 shows the locations and orientations of ice-flow indicators identified in the field (see "Field Data" in legend).

Data collected at each ice-flow station included: general site description (topographic position, aspect, slope); orientation and dimensions of form; and relative degree of preservation of form. Particular attention was given to: stoss (up-ice) and lee (down-ice) side relationships; the bedrock or substrate the form was created and preserved in; and any cross-cutting and (or) superimposition relationships with other forms. Such relationships are important not only when interpreting ice-flow direction, but also for determining the timing of multiple ice-flow events.

Some of the sites visited were in human-disturbed areas. As a consequence, care was taken to identify any striae-like scratches in bedrock that could be attributed to the movements of heavy machinery during clearing or road building activities. Non-glacial

striae-like features were also observed in more natural settings, along the south side of Tahtsa Reach, where wave-washed driftwood had scratched and gouged soft, weathered bedrock. In these settings it was important to correctly identify linear, erosional forms that were the product of glacial abrasion, versus those that were produced by other natural processes or human activities.

In addition to field sites, larger streamlined landforms (*e.g.* drumlins, crag-and-tail ridges, roches moutonnées, and flutings) were also studied using 1:15 000 and 1:60 000-scale aerial photographs. In all, 207 moderately well to well-preserved glacial forms were identified and interpreted, with a location and orientation recorded for each. Figure 3.1 shows the locations and orientations of the streamlined forms identified in aerial photographs (see "Airphoto Interpretation" in legend).

3.3.1 Measurement of Ice-Flow Indicators

In the field, orientations of small-scale features were measured by lining the side of a compass against the linear feature. As multiple striae were commonly observed on single bedrock outcrops, a series of measurements were taken at each site to try and determine the range of orientations. Cross-cutting sets of striae were occasionally identified in the field. Close examination of these striae sets usually enabled the relative timing of their formation to be determined. (*i.e.* in a relative sense, which set is younger in age and which is older). Cross-cutting relationships are key to interpreting the timing of multiple ice-flow directions (*e.g.* Syverson, 1995). Orientations of grooves, rat-tails, and small-scale roches moutonnées were measured in a similar manner. Cross-cutting sets of

grooves or rat-tails were not observed in the field. However, striae were observed cross-cutting grooves and rat-tails.

Intermediate to large-scale features were measured in the field and in aerial photographs. In the field, the orientation of a feature was measured by standing on the feature and sighting down its long axis. When measured in an aerial photograph, the edge of the compass was aligned with the long axis of the feature.

Bi-directional features (*e.g.* striae, flutings) were recorded as having a trend (*e.g.* ice-flow towards 045°-225°). Uni-directional features (*e.g.* crag-and-tail ridges, drumlins, roches moutonnées) were recorded as having an orientation (*e.g.* ice-flow towards 045°).

3.4 ICE-FLOW INDICATORS OF THE STUDY AREA

Ice-flow indicators studied can be divided into two groups based on size – small-scale and intermediate to large-scale. The streamlined and erosional features of these two groups are characterised below.

3.4.1 Small-Scale

Small-scale ice-flow indicators are most commonly observed in the western half of the study area where bedrock outcrop is abundant. They can, however, be observed throughout the study area either on bedrock outcrop exposed along wave-washed shorelines (*e.g.* Ootsa and Tahtsa lakes) or on bedrock surfaces in alpine settings (*e.g.* ≥1500 m a.s.l.). Of these small-scale features, glacial striae are the most commonly

observed (Figure 3.3). These are linear, erosional features that are the product of debris-rich glacier ice sliding and scraping over a bedrock surface (Benn and Evans, 1998). They are typically 1 to 2 mm wide and deep and rarely up to 0.5 m long. Striae are oriented with their long axis parallel to ice flow direction, and although they can be interpreted as uni-directional, those observed in the study area are considered to be bi-directional ice-flow indicators and indicate a trend in ice-flow (*i.e.* they suggest two possible directions of ice flow, each 180° of the other). Glacial grooves, produced in a similar fashion to striae, but larger in size (Benn and Evans, 1998), are also commonly observed in the study area. These features can be up to 30 cm deep, vary in width from 5 to 60 cm, and can extend for up to 5 m (Figure 3.4).

Rat-tails are uni-directional ice-flow indicators that are occasionally observed in the study area (Figure 3.5). They are the product of ice sliding and scraping over a bedrock surface. When a more resistant lithology is encountered, like a quartz vein, erosion down-ice is hindered and a tapered tail is created on the down ice-side (lee-side) of the more resistant lithology (Benn and Evans, 1998). Rat-tails are commonly observed in conglomerates and breccias. Rat-tails in the study area vary from 1 mm to 10 cm wide and up to 20 cm long; rarely do they exceed 3 cm in height. Small-scale roches moutonnées, also a uni-directional ice-flow indicator, were observed on many bedrock outcrops in the study area. These features have a gently inclined, smooth, and often striated, up-ice (stoss-side) surface and steep, rough down-ice (lee-side) surface, the product of glacial abrasion and quarrying, respectively (Benn and Evans, 1998). These features are typically 1 to 10 cm wide, 5 to 15 cm long, and up to 10 cm in height.

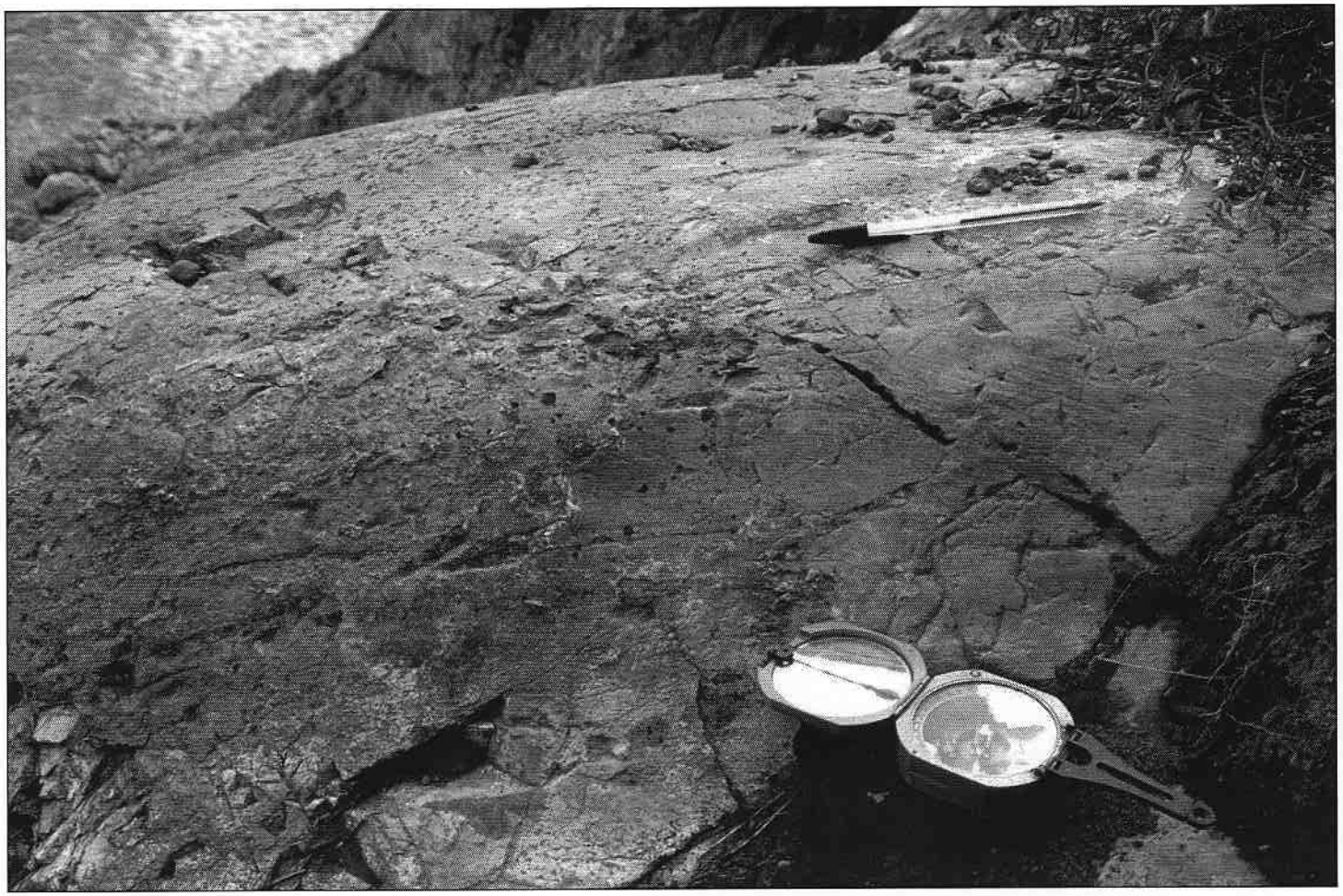


Figure 3.3. Bedrock outcrop with glacial striae. The striae record two different ice-flow directions. One set of striae are trending parallel with the pen and another that are trending parallel with the compass. The degree of preservation, density, length, width, and depth of the striae shown here are typical of the striae observed in the study area.

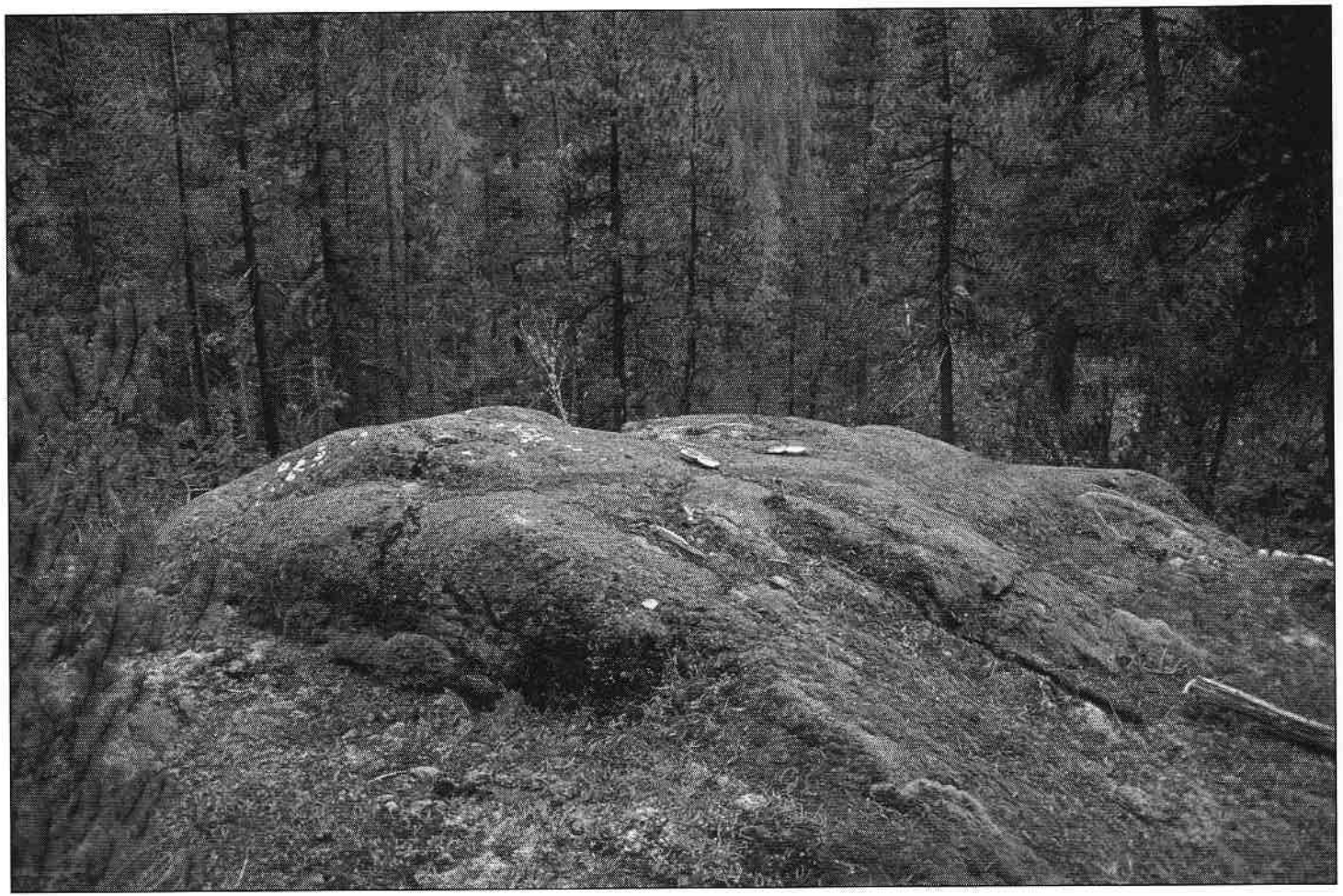


Figure 3.4. Bedrock outcrop with glacial grooves. Located east of Sweeney Lake, above Sweeney Lake Road, this outcrop has two sets of grooves preserved on it (trends are indicated with compasses). View in this photograph is towards the southeast.

Figure 3.5. Rat-tail preserved on bedrock outcrop. This rat-tail was observed on Huckleberry Mine property and indicates ice-flow towards 106°.

Small-scale ice flow features were observed from valley bottoms to mountain peaks >2000 m a.s.l. Occasionally, striae with differing orientations were observed cross-cutting one another. Cross-cutting relationships were used to determine the timing of multiple ice-flow directions. Within the study area it is common to observe small-scale ice-flow indicators with diametric orientations, on opposite sides of the same outcrop. It is thought that these features record separate ice-flow events that had opposing ice-flow directions. The aspect of outcrop surfaces is an important factor in the preservation of these ice-flow indicators. Features of an earlier ice-flow event are preserved if they occur on the lee-side of the outcrop to the later ice-flow event (*i.e.* on a surface that dips in the same direction as the direction of ice-flow during the later event). It appears that ice-flow down the lee-side of these outcrops was more extensional in nature, creating a low pressure zone on this down-ice surface (or a lee-side cavity), and was unable to erase evidence of the earlier ice-flow event.

3.4.2 Intermediate to Large-Scale

Roches moutonnées are common in the Tahtsa Lake – Ootsa Lake region. These are formed by the same processes as the small-scale versions discussed above, and also are uni-directional, but are greater in size. These larger-scale roches moutonnées vary from <1 to 3 m across, 1 to 5 m long, and up to 1.5 m in height (Figure 3.6). Also like the smaller-scale versions, larger roches moutonnées were observed in valley bottoms and on mountain peaks >2000 m a.s.l. They are more common in the western half of the study area where bedrock outcrop is more abundant.

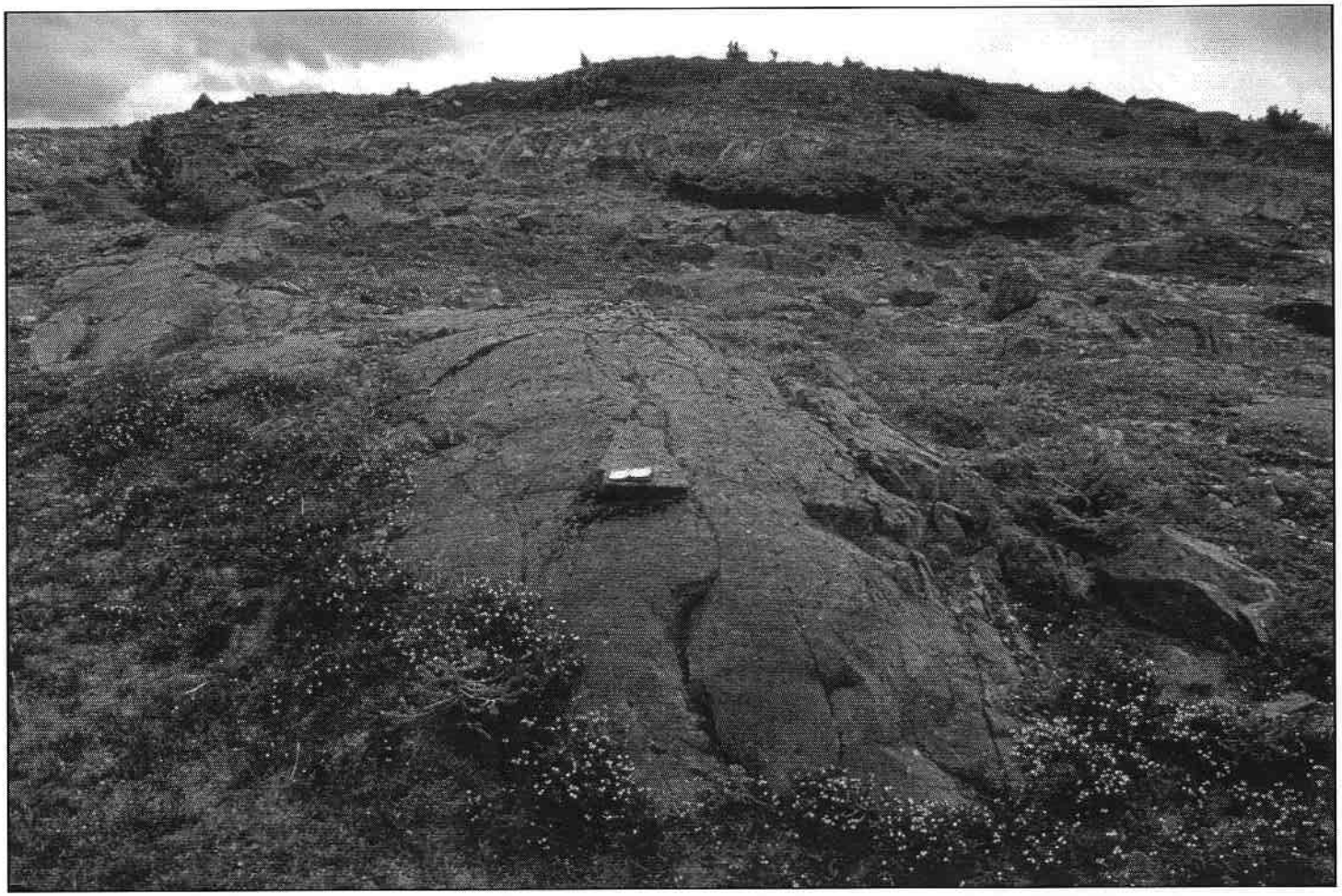


Figure 3.6. Outcrop-scale roche moutonnée. Observed on Smoke Mountain at ~1600 m elevation. This feature has a smooth and striated stoss surface, and a steep plucked or quarried lee-end. View in this photo is towards the south. Ice flow from left to right (west).

Flutings are streamlined landforms that are oriented with their long axis parallel to ice-flow. As they do not have a discernible stoss or lee-end, these features are considered to be bi-directional ice-flow indicators. In the study area they can be 100-700 m long and 60-120 m wide, and are typically <5 m in height. Flutings are more easily studied in aerial photographs as they are often difficult to identify on the ground, especially in forested areas.

Drumlin and crag-and-tail features, in comparison to flutings, have steeper stoss and more gently tapering lee sides with an obvious flow direction. They have similar dimensions to flutings but are up to 40 m in height and are therefore more easily identified in the field. Some crag-and-tail ridges observed in the field had smaller-scale ice-flow indicators superimposed on them. These smaller-scale features were almost always oriented parallel to sub-parallel with the same orientation as the larger feature they were found on. However, smaller-scale, uni-directional features, such as rat-tails and roches moutonnées, can indicate an ice-flow direction opposite to that suggested by the larger feature they occur on. Although the orientations of the larger features could be determined in aerial photographs, these smaller-scale features, and their orientations, could only be identified during field investigations.

Flutings, drumlins, and crag-and-tail are common to the study area, but they occur in higher densities east of Huckleberry Mountain and Sibola Peak and in the Mosquito and Shelford Hills areas (Figure 3.7). Flutings and drumlins are typically found at lower

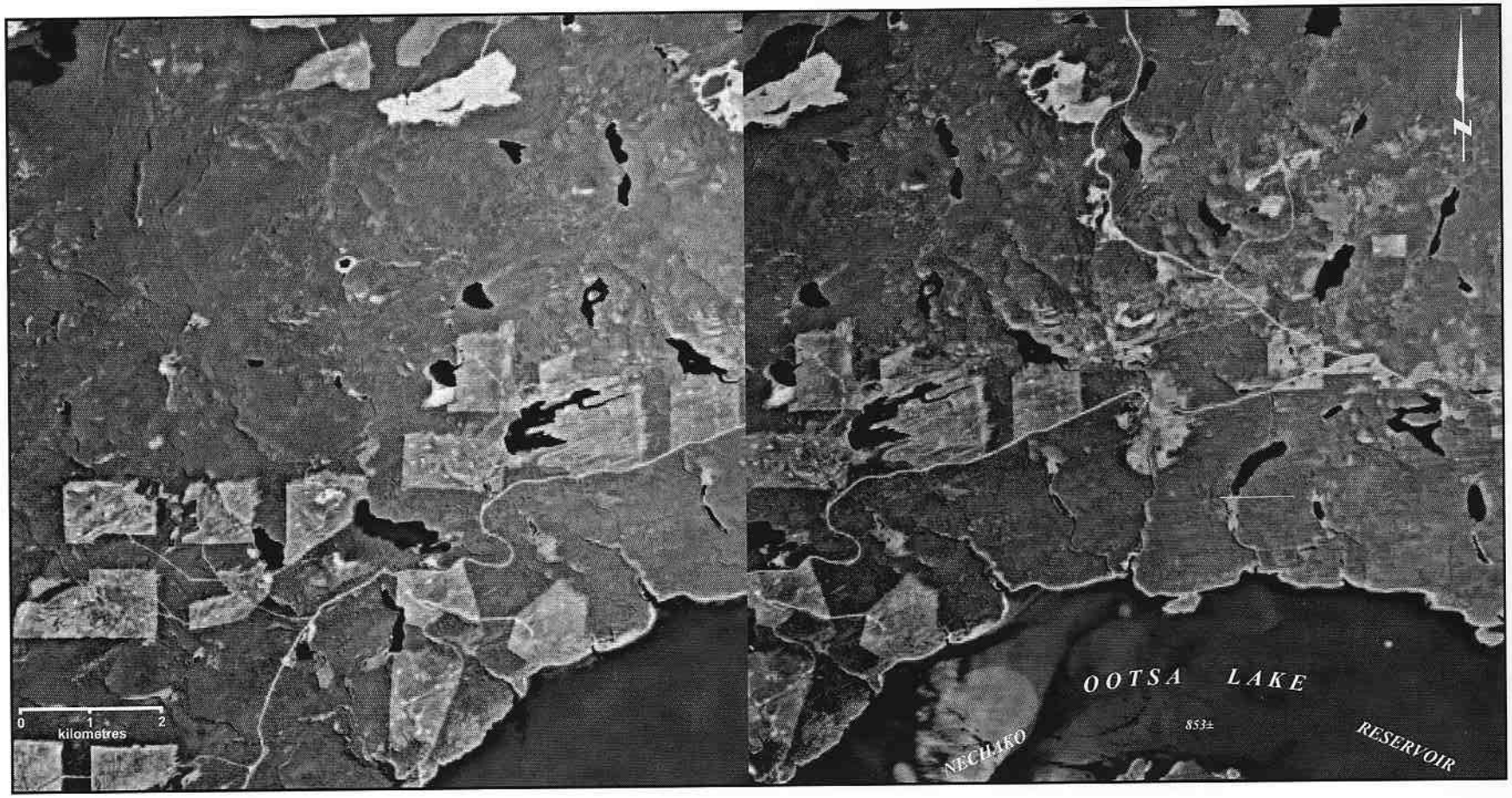


Figure 3.7. Flutings, drumlins, crag-and-tail ridges, east of Shelford Hills. This stereogram straddles the border between NTS map areas 93E/15 and 16. Orientations of uni-directional features indicate ice-flow towards the east-northeast. Province of British Columbia photos BC88041-080, 081.

elevations, formed in thicker morainal units. Crag-and-tail ridges are found at any elevation, typically formed in thinner morainal units where there are discontinuous bedrock exposures.

The genesis of streamlined landforms such as flutings, crag-and-tail ridges, and drumlins is controversial. There are two basic schools of thought, both suggesting that these landforms are formed subglacially. One, however, advocates for an origin due to glacial processes, while the other argues for a glaciofluvial origin (*i.e.* catastrophic meltwater floods).

Investigations into fluting, crag-and-tail, and drumlin formation were not conducted as part of this study. Less than 100 km east of the study area, however, Mate (2000) conducted an investigation into their formation. He compared field observations to the prevalent models of crag-and-tail and drumlinoid formation, to develop a hypothesis for the formation of those occurring in the southern Nechako Plateau (prevalent models are summarized in Table 3.1). In the course of his investigation, two key observations were made. Firstly, the long axes orientations of streamlined forms were typically in agreement with trends of striae in the same area. Secondly, he noted that crescent-shaped depressions, oriented transverse to ice-flow, often occurred at the stoss-end of drumlinoid ridges, and that these depressions locally contained a clast-supported cobble-sized lag that was directly underlain by till. Mate concluded that the streamlined landforms occurring in the southern Nechako Plateau were the product of a two step process: 1)

Hypotheses	Authors
Accretion Theory (accretion of lodegement till around obstacles)	Boulton (1970, 1971)
Till Squeeze Theory	Dyson (1952); Stalker (1960)
Dilatancy Theory (changes in geotechnical properties of subglacial debris due to pressure variations)	Smalley and Unwin (1968); Crozier (1975); Menzies (1989)
Frost Heave Theory	Baranowski (1969)
Glacial Kinematic Fluting Theory	Shaw and Freschauf (1973)
Pressure differences at base of glacier	Evenson (1971)
Cavity Fill Hypothesis	Shaw (1983)
Subglacial Meltwater Erosion Theory	Shaw and Sharpe (1987)
Formation by molding previously deposited material within the subglacial environment where a limited amount of subglacial metlwater activity occurs	Whittecar and Mickelson (1979)

Table 3.1. Summary of prevalent theories on drumlin formation (After Mate, 2000; summarized by Menzies (1979), Barnett (1992), and Menzies and Shilts (1996)).

subglacial erosion and deposition; and 2) in some cases an accentuation of the original form by meltwater erosion.

Similar observations to those made by Mate were recorded in the Tahtsa Lake – Ootsa Lake region. The long axes orientations of streamlined forms are typically in agreement with striae trends in the same area. Crescent-shaped scours also occur at the stoss-end of streamlined forms observed in the study area, particularly those occurring in the Shelford Hills area and further east. It is therefore thought that flutings, crag-and-tail ridges, and drumlins occurring within the study area are firstly a product of glacial processes, but that their original form may have been accentuated by later meltwater erosion. What is most important however, is that their orientations reflect the direction of glacier movement.

3.5 RESULTS

Figure 3.8 shows that the dominant trend of ice flow in the Tahtsa Lake – Ootsa Lake region is between 60°-240° and 90°-270°. The following discussion will show that this trend can be divided into two dominant ice-flow directions that record three main ice-flow events: i) early ice-flow towards the east; ii) late ice-flow towards the west; and iii) final ice-flow towards the east.

3.5.1 Ice-Flow Indicators at Elevations <1500 Metres

Evidence for both eastward and westward ice-flow can be found in the orientations of intermediate to large-scale glacial features within the study area. Mosquito and Shelford Hills, and areas farther east between Ootsa and Francois Lake, are dominated by well

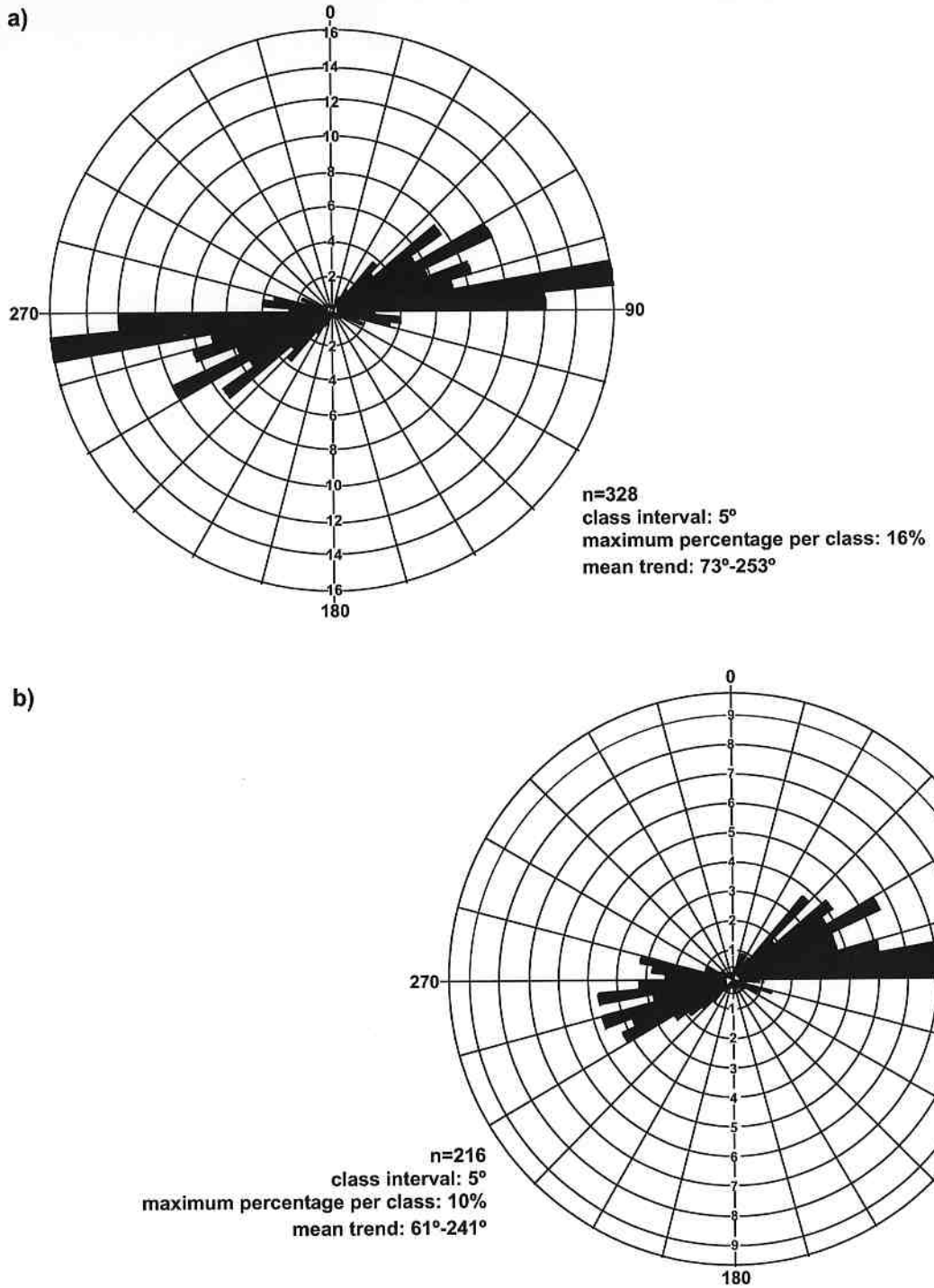


Figure 3.8. Summary of ice flow indicator measurements. a) Plotted as non-directional vectors, this rose diagram plot includes all small and intermediate to large-scale, bi-directional and uni-directional features measured in the field and in aerial photographs. b) Plotted as directional vectors, this rose diagram plot includes all small and intermediate to large-scale, uni-directional features measured in the field and in aerial photographs.

preserved drumlins and crag-and-tails with orientations between 40° and 88° (Figure 3.1). Flutings in the same area trend between 38°-218° and 86°-266°. Ice-flow deflection by topography sin this area is subtle, but does occur around some of the more areally extensive, elevated areas (*e.g.* Shelford Hills). There is no clear evidence for westward ice-flow in the orientations of these larger-scale features.

The distribution of drumlin and crag-and-tail features is less concentrated northwest and southwest of Sibola Peak, in the vicinity of the Tahtsa Ranges. The orientations of these moderately well to well preserved features, in contrast to those described in the eastern portion of the study area, indicate ice-flow towards the west (246° to 278°). Seen in aerial photographs, a particularly good example of a westward oriented crag-and-tail ridge occurs west of Huckleberry Mine, on the north side of Tahtsa Reach. Other examples can be seen in aerial photographs north of Sibola Peak.

Trends of flutings in this area also differ slightly from those observed towards the east, ranging between 82°-262° and 98°-278°. It is interesting to note that intermediate to large-scale features observed at elevations <1500 m a.s.l. are roughly parallel to larger topographic barriers such as the Tahtsa and Ootsa lake valleys, regardless of the ice-flow direction they indicate (Figure 3.1).

A series of drumlins and flutings with divergent orientations are found at the mouth of the Troitsa Lake valley, on the north side of Tahtsa Reach (see Photo 2, Figure 3.1). These features form a fan-like pattern that is oriented obliquely to the flutings, drumlins,

and crag-and-tails that occur in the vicinity of Huckleberry Mine (Figure 3.1). This oblique orientation, and fan-like pattern, suggests that these features may have been produced by local ice flowing northeast out of Troitsa Lake valley, perhaps during the later stages of Fraser Glaciation.

The orientations of smaller-scale features such as rat-tails and small-scale roches moutonnées, also show eastward and westward ice-flow patterns (Figure 3.1). These features can be observed throughout the region including the Mosquito and Shelford Hills areas were there is very little exposed bedrock outcrop. Well preserved, larger-scale roches moutonnées indicating near-valley-parallel flow towards the west, were observed along the shores of Tahtsa Lake and Tahtsa Reach (Figure 3.9).

Striae trends throughout the study area are in close agreement with the trends of larger-scale features such as flutings. As previously mentioned, it is common to find small-scale ice-flow indicators with diametrically opposed orientations, on opposite sides of the same outcrop. In almost all cases, ice-flow indicators suggesting westward flow are preserved on surfaces exposed and dipping towards the east; the opposite is true for ice-flow indicators that suggest eastward flow.

Cross-cutting striae were occasionally observed on bedrock exposures at <1500 m a.s.l. The relative age of the opposing east and west ice-flow directions recorded by these relationships can be summarized with two examples. In the first example, located on the northern shore of Ootsa Lake, in the eastern portion of the study area, an exposure has

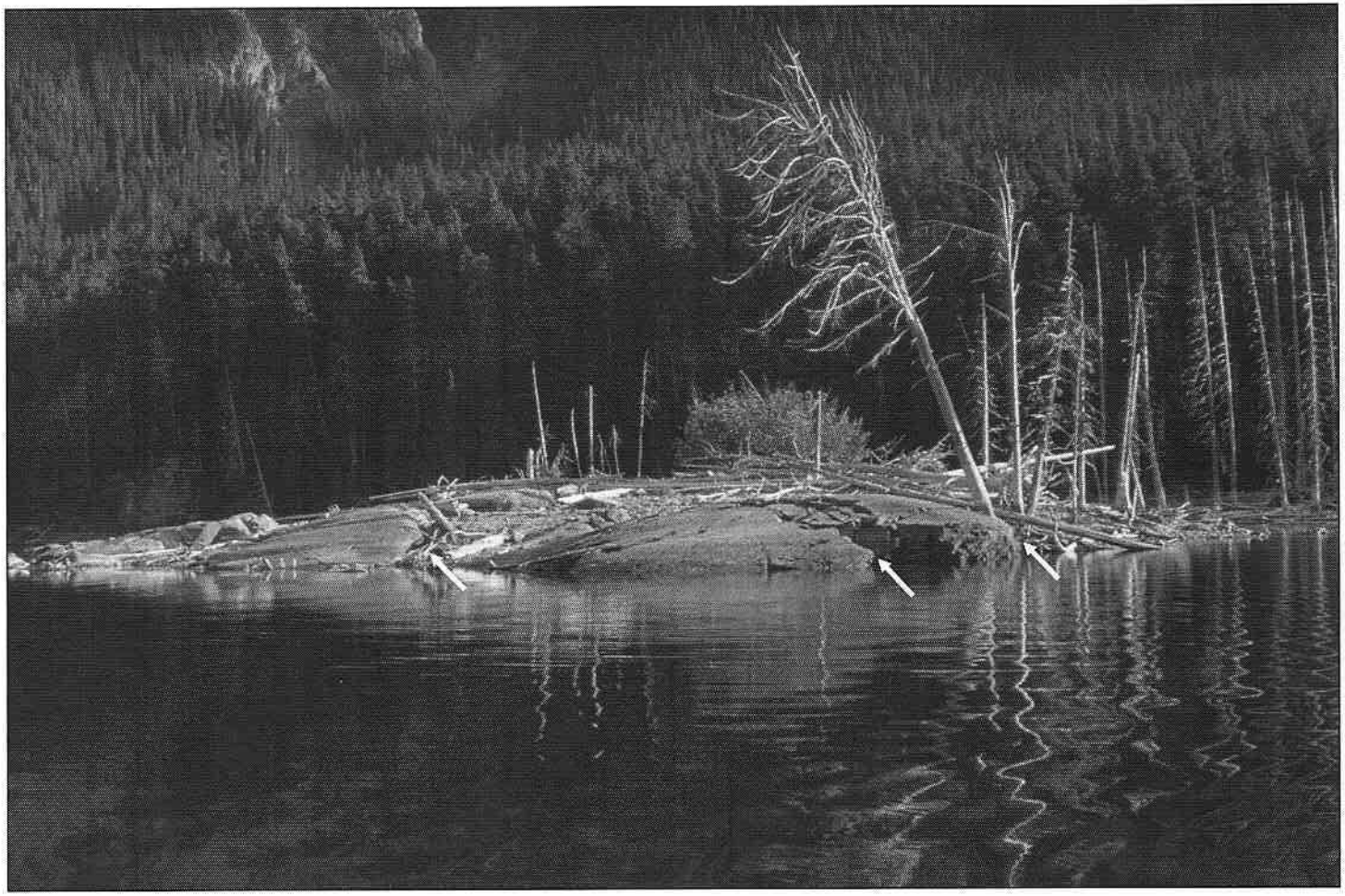


Figure 3.9. Large-scale roche moutonnée. Observed along the southern shore of Tahtsa Lake, this roche moutonnée dips more gently towards the east (photo left), and dips more steeply towards the west (photo right). Arrows indicate possible locations of bedrock quarrying by glacial ice. View in this photograph is towards the south. Ice-flow direction, as indicated by this roche moutonnée, is from left to right (west).

striae trending at 250°-70° that cross-cut another set trending at 120°-300°; both sets were moderately preserved. Associated with the striae trending at 250°-70° were small-scale roches moutonnées that indicated flow towards the west. The striae trending at 120°-300° could be traced down from the top of this outcrop, to a surface that dipped steeply towards the west. Wrap-around striae suggesting flow towards the southeast, were also observed near the bottom of this steeply dipping surface. The cross-cutting relationship recorded at this exposure indicates that a westward-directed ice-flow event was preceded by an eastward-directed ice-flow event. Of the sites visited in the field, this was the only one that provided good evidence of an earlier eastward ice-flow event.

Cross-cutting striae sets measured on an island in Tahtsa Reach, tell a different story. In this example, a set of striae trending at 25°-205° were observed cross-cutting a set trending at 240°-60° (Figure 3.10). Rat-tails oriented at 30° and small-scale roches moutonnées that indicated flow towards the west are found on nearby bedrock outcrops. The cross-cutting relationship observed here indicates that an eastward-directed ice-flow event was preceded by a westward-directed ice-flow event. As seen in Figure 3.10, a facet separates the two surfaces that preserve these opposing ice-flow directions. Similar faceted bedrock exposures have been observed near areas of shifting ice divides or areas with a complex ice-flow history (Parent *et al.*, 1995; McMartin and Henderson, 1999). The sharp change in slope across the faceted edges is thought to be instrumental in protecting earlier-generation striae from those produced by later changes in ice-flow direction.

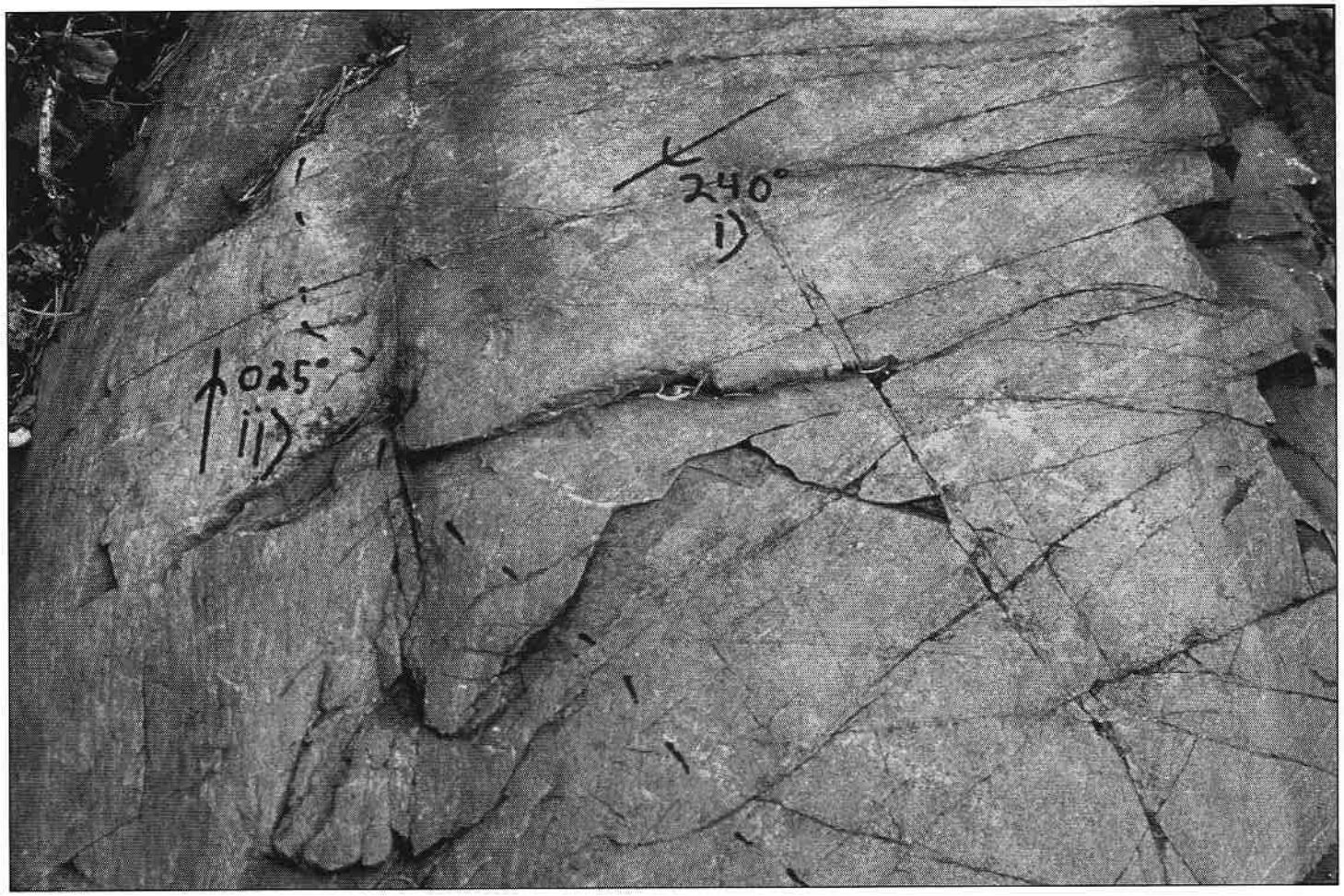


Figure 3.10. Cross-cutting striae preserved on bedrock outcrop. Observed on an island in Tahtsa Reach, striae on this bedrock outcrop record two different ice-flow directions. The striae set trending 025° cross-cut the set trending 240°, indicating that ice-flow towards the northeast occurred last. The dashed line delineates a facet that separates two planar surfaces with different dip angles and dip directions. These surfaces, as with the striae found on them, were created by two different ice-flow directions.

Other, more complex, cross-cutting relationships were observed at sites south of Tahtsa Reach and at sites adjacent to the northern flank of Sibola Peak (Figure 3.1). Here, large-scale landforms such as crag-and-tails or drumlins indicating ice flow in one direction (*e.g.* west), had superimposed on them smaller-scale features such as roches moutonnées that indicated ice flow in the opposite direction (*e.g.* east). The relative timing of ice-flow events could also be deciphered at these sites.

3.5.2 Ice-Flow Indicators at Elevations ≥1500 Metres

Unequivocal evidence of west to southwest ice-flow is seen above 1500 m a.s.l. well preserved features such as roche moutonnée, striae, and rat-tails. Good examples of these features were observed on Tableland and Smoke mountains, and on Mount Carl Borden/Swing Peak (Figures 3.1 and 3.6). At these sites, only features indicating west to southwest ice-flow are preserved.

On Mount Sweeney, striae and grooves were observed trending between 110°-290° and 170°-350° (Figure 3.1). These features were observed along upper valley slopes or ridges, and are oriented valley parallel; ice fields and possibly small glaciers can been seen at the heads of both valleys. Due to their proximity to these present day ice fields, and possible glaciers, and orientations that closely follow local topography, these features are likely the product of a local, topographically controlled ice-flow event. Unexplainable by such a local ice-flow event, however, are numerous small-scale roches moutonnées observed on the top of Mount Sweeney, above 1900 m a.s.l., that

consistently indicate ice-flow towards 245°. These features have orientations that are oblique to the trends of adjacent ridges and (or) smaller-scale valleys.

3.5.3 Stagnant-Ice Features

Eskers are the only features found in the study that could be interpreted as stagnant-ice features. They are relatively rare and are constrained geographically to the three areas: 1) Mosquito and Shelford Hills areas; 2) in the bottom of Troitsa Lake valley; and 3) on the southern shores of Tahtsa Reach at the foot of Mount Carl Borden. These features are not mapped in Figure 2.2 or 3.1 but can be seen in aerial photographs. These narrow narrow, sinuous ridges are typically 50 m wide and up to 1.5 km long but those found on the southern shores of Tahtsa Reach are substantially shorter in length. Eskers in the study area appear to be continuous and are not truncated, deformed, or segmented/beaded. Formed in an supragalcial, englacial, and (or) subglacial environment, these glaciofluvial features appear to drape over local topography and can be oriented roughly valley-parallel. Although not ice-flow indicators themselves, eskers are mentioned here as they provide some insight into ice conditions during deglaciation of the study area.

3.6 DISCUSSION

The Tahtsa Lake – Ootsa Lake region area experienced a complex ice-flow history during the Late Wisconsinan. Measured orientations of small, intermediate, and large-scale streamlined and erosional forms suggest there are two dominant ice-flow directions in the region – east-northeast and west-southwest. Field observations suggest that ice-flow

direction, and the preservation of ice-flow indicators, are dependent, in part, on topography and (or) elevation. In addition, aerial photograph interpretation alone locally yields incomplete results without field studies. For example in the region east of the Huckleberry Mine, on the south side of Tahtsa Reach, the orientation of intermediate to large-scale erosional and streamlined landforms suggests a dominant ice-flow direction of east to northeast. However, field investigations of these landforms and small-scale features suggest a more complex ice-flow history with an earlier westerly flow event followed by the east to northeast event.

At relatively high elevation sites (≥1500 metres), west to southwest flow is clearly indicated in well preserved landforms and features such as roches moutonnées, rat-tails, and striae. At these sites there is little evidence of topographic control as these features are observed with orientations that cross mountain tops and ridges and do not necessarily conform to the trends of adjacent valleys. At lower elevations, in valley bottoms and along lake shores in particular, the preserved record of ice-flow direction is much more complicated. In these settings it is common to find westerly and easterly ice-flow indicators preserved on opposite sides of the same outcrop. It is also common to find one ice-flow direction superimposed on a landform which indicates ice flow in a different direction. Features preserved along the shores of Tahtsa Reach and Tahtsa and Ootsa lakes suggest that, locally, glaciers flowed both up and down-valley at different times.

The westerly ice-flow event appears to be earlier and of a larger magnitude than the later east to northeast event. This interpretation is based on: 1) cross-cutting and

superimposition relationships; 2) the degree of landform preservation; 3) the presence of large-scale crag-and-tail ridge features at low elevations (<1500 m a.s.l.) indicating ice-flow towards the west; and 4) well preserved roche moutonnée and rat-tails at high elevations (≥1500 m a.s.l.) indicating ice-flow towards the west. The Tahtsa Lake – Ootsa Lake region was dominated by west ice-flow during the Fraser Glaciation maximum, which was followed at some low elevations by a weaker, possibly shorter lived, east to northeast ice-flow event. These results are in general agreement with those discussed by Levson *et al.* (1998), Stumpf *et al.* (2000), Levson (2001a), Mate and Levson (2001), which indicate the presence of an ice divide in central British Columbia during the Fraser Glaciation maximum east of the study area. Ice thickness exceeded relief in the Tahtsa Lake – Ootsa Lake region suggesting that the fourth phase of glaciation, as defined by Kerr (1934) and Davis and Mathews (1944), may have been attained during Fraser Glaciation.

With the development of this ice divide, ice that initially flowed east from the Coast Mountains now flowed west to southwest back through valleys and over neighbouring mountain peaks, producing the observed west to southwest ice-flow indicators. West-directed ice-flow indicators observed on Mount Sweeney suggest that the ice surface elevation of the Cordilleran Ice Sheet was >2000 m a.s.l. during the glacial maximum in that area. Towards the end of the Late Wisconsinan this divide locally shifted west, back towards the Coast Mountains, as the ice sheet began to thin, and ice-flow resumed topographically controlled patterns, producing the east to northeast ice-flow indicators observed in air photos and in the field. Evidence of early eastward ice-flow from Coast

Mountains was probably obliterated in most areas by the later westward flow event. Of the over 120 sites visited in the field, only one provided good evidence of an earlier eastward ice-flow event. In many cases however, without cross-cutting relationships, it would difficult to differentiate early and late easterly ice-flow indicators.

As seen in Figure 3.2, Levson *et al.* (2002) proposed a location for this ice divide. Located east of the study area, it is northerly-trending and crosses Ootsa Lake at its most eastern end. Data presented here agree with this position, as westward indicating ice-flow features were still observed on the northern shore of Ootsa Lake, in the eastern portion of the study area. Although speculation, the lack of larger-scale, west-indicating, ice-flow features east of Shelford Hills might also support this interpretation. It is possible that the expected lower ice velocities beneath this ice-divide, hindered the development of larger-scale streamlined and erosional features during the westward-directed ice-flow event.

The style of deglaciation within the Tahtsa Lake – Ootsa Lake region is most apparent in the Mosquito and Shelford Hills areas where features such as eskers indicate that deglaciation was dominated by ice stagnation. Eskers occurring locally at the foot of Mount Carl Borden, and in the Troitsa Lake valley, suggest the same.

4 QUATERNARY STRATIGRAPHY

4.1 INTRODUCTION

The purpose of this chapter is to describe and interpret the Quaternary stratigraphy of the Huckleberry Mine region. Advance-phase, full-glacial, and retreat-phase Fraser Glaciation sediments all occur in the study area. Holocene age peats and other sediments are also extensive. Timing of deposition of these Quaternary sediments is provided by correlations to Late Wisconsinan glacial deposits that overlie dated Middle Wisconsinan organic-rich sediments elsewhere in west-central British Columbia. A sample of wood collected in Holocene sediments further constrains the age of Quaternary deposits in the region.

This chapter begins with a review of field methods used during the 2000 field season. Sedimentological and stratigraphic data collected during this field survey are then presented and evaluated in relation to the ice-flow history described in Chapter 3.0 (Ice-Flow History). The interpretation of depositional environments for sediments occurring in the study area are also provided.

4.2 REGIONAL QUATERNARY STRATIGRAPHY

The Late Pleistocene and Holocene stratigraphy of Nechako Plateau region was discussed by Plouffe (2000), Levson (2001a), Mate and Levson (2001), Plouffe and Levson (2001), Levson *et al.* (2002), and Levson and Mate (2002). Clague (1984) discussed the Quaternary geology of the Smithers-Terrace-Prince Rupert area, which borders the

Nechako Plateau region to the northwest. This work, and other studies conducted at specific sites in the region, are briefly summarized below.

4.2.1 Pre-Late Wisconsinan

Pre-Late Wisconsinan sediments are not commonly observed in the region because these sediments were usually eroded by Fraser Glaciation ice or buried by Wisconsinan to Holocene age deposits. Rare exposures of penultimate glaciation drift, however, have been reported east of the study area (NTS map area 93 F; Mate and Levson, 2001; Plouffe and Levson, 2001). Interpreted as basal tills, these sediments are typically massive, matrix supported, dense, clayey-silt diamictons. Age constraint is provided by overlying, dated, Middle Wisconsinan sediments or successions of sands and gravels and Late Wisconsinan Fraser Glaciation till.

Middle Wisconsinan sediments occur at four sites near the study area. One hundred kilometres east of Huckleberry Mine on Cheslaslie Arm, Levson *et al.* (1998) reported on organic rich sediments underlying Late Wisconsinan (Fraser Glaciation) till with a radiocarbon age of 27 790 ± 200 BP (Beta-101017). Farther east in the Nechako Plateau, non-glacial sediments have yielded radiocarbon ages from 38 000 to 43 000 years BP (Plouffe and Jetté, 1997; Plouffe and Levson, 2001). Approximately 200 km north of the study area, at the Bell Mine (Babine Lake area), Harington *et al.* (1974) described an exposure of interglacial sediments overlain by Fraser Glaciation till. Single fragments of spruce (*Picea* sp.) and fir (*Abies* sp.) found within these non-glacial lacustrine sediments have radiocarbon ages of 42 900 ± 1860 BP (GSC-1657) and 43 800 ± 690 BP (GSC-

1687) respectively. Mammoth bone collagen also recovered from these sediments produced a radiocarbon age of 34 000 ± 690 BP (GSC-1754).

It is interesting to note that till fabric analyses, conducted at some of these pre-Late Wisconsinan sites, indicates that ice flow direction was similar to that which occurred during Fraser Glaciation. Paleocurrent indicators, also studied at some of these pre-Late Wisconsinan sites, indicates that river drainage directions were similar to today. Plouffe (2000) however, mentions drainage anomalies that may have resulted from disruption of drainage directions by Pleistocene glaciers. Some of these drainages have remained altered since Late Pleistocene time.

4.2.2 Late Wisconsinan

Late Wisconsinan glacigenic sediments are prevalent throughout west-central British Columbia. These deposits are include massive, matrix supported, dense, clayey to silty basal lodgement tills and massive to crudely bedded, gravelly to sandy melt-out tills. Advance and retreat-phase glaciolacustrine and glaciofluvial sediments are found stratigraphically below and above these tills.

Glacigenic debris flow deposits are also often common throughout the Nechako Plateau region. These gravel-rich, massive to stratified, silty to sandy diamictons are typically interbedded with advance and retreat-phase glaciolacustrine and glaciofluvial sediments. These debris flow deposits are thought to have been deposited at or near ice margins in both sub-aerial and sub-aqueous environments.

Thick sequences of horizontally bedded fine sands, silts and clays interpreted to be lacustrine sediments are also observed in many exposures in west-central British Columbia. Often found above present day lake levels, these sediments were deposited in lakes dammed during both the advance and the retreat phases of the Fraser Glaciation. Also observed in valley settings are elevated or raised deltas and fan-deltas that are thought to be coeval with retreat-phase glaciolacustrine sediments. These elevated features have been used to reconstruct paleolake levels.

4.2.3 Holocene

Holocene deposits in west-central British Columbia are varied. The type and distribution of these deposits is largely determined by local physiography. For instance, in flat areas where drainage is poor, organic deposits like peats commonly overlie clay-rich tills or lacustrine sediments. In mountainous and high relief areas, colluvial deposits dominate. These deposits typically overlie bedrock but on lower slope settings could overlie sediments such as till.

Fluvial sands and gravels are commonly found in flood plain, low terrace, and fan features. In the Nechako River valley, a discontinuous veneer of eolian silts and sands has been observed overlying glaciolacustrine, glaciofluvial, and alluvial deposits (Plouffe and Levson, 2001).

4.3 METHODS

During the 2000 field survey, 16 vertical exposures of varying thicknesses were studied on Huckleberry Mine property (Figure 4.1) where stratigraphic and sedimentological data were collected. These data included grain size distribution, petrology, clast shape, type and orientation of primary and secondary sedimentary structures or features, colour, density, cementation, within unit variability, and type and orientation of unit contacts. Lithostratigraphic units were defined and thicknesses of each unit recorded. Most of the exposures studied on Huckleberry Mine property were located in the valley bottom. Large exposures were typically the product of mine activities such as road construction, removal of material from borrow pits, and clearing of land during the early stages of mine development. Other smaller exposures, studied on valley sides, were typically the product of fluvial and gully processes. Section descriptions are provided in Appendix A.

To investigate till provenance, pebble fabric analyses were conducted on three till units at a key stratigraphic section (section TFE00-1; Figure 4.1). Approximately 25 prolate or bladed-shaped clasts were selected from within each unit. For each, clast a-axis orientation (azimuth, plunge, and plunge direction) and shape were recorded. A detailed description of till composition was made at pebble fabric sites, as was the stratigraphic position of the fabric.

Pebble counts were also conducted to investigate till provenance. At select till exposures in the study area, up to 100 medium to large pebble-sized clasts were analyzed for lithologies. Data collected at each site included stratigraphic position of the pebble

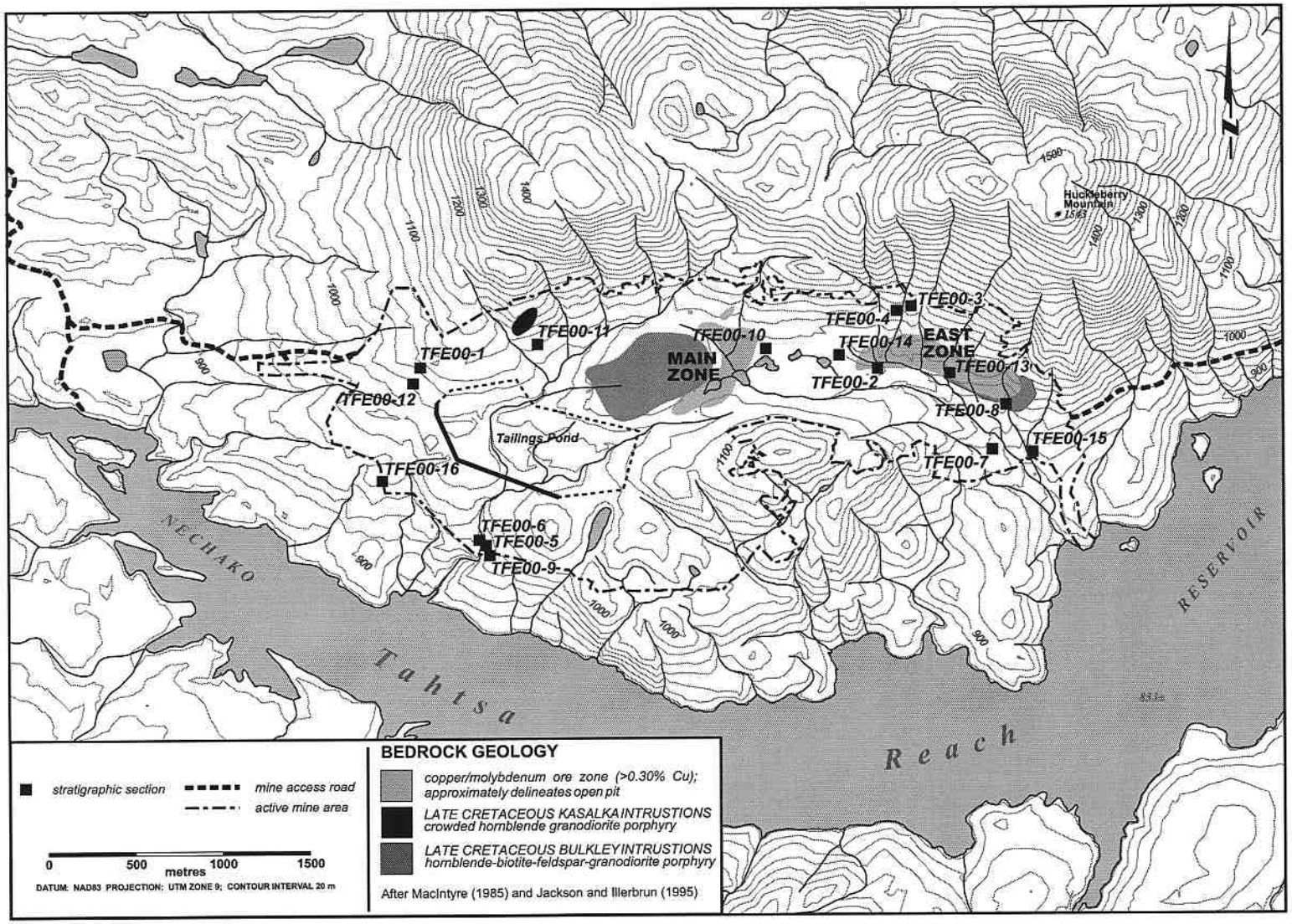


Figure 4.1. Location of stratigraphic sections.

count, description of host sediment, clast lithology and roundness, and abundance and type of mineralization in clasts, if any. Particular attention was given to the location of pebble count sites relative to the Main and East Zone stocks. In the discussion that follows, the percent content of clasts from these porphyritic granodiorites is used to infer transport direction and provenance of till units (*cf.* Szabo *et al.*, 1975; Aario and Peuraniemi, 1992; Parent *et al.*, 1995).

4.4 QUATERNARY STRATIGRAPHY OF THE HUCKLEBERRY MINE REGION

Although no sub-till radiocarbon dates have yet been found within NTS map area 93E, the Quaternary sediments in the Huckleberry Mine region are believed to correlate with similar sediments found in adjacent areas which overlie dated lacustrine and organic rich deposits discussed above. The Quaternary sediments of the Huckleberry Mine area are, therefore, interpreted to be Late Wisconsinan to Holocene in age. It is possible, however, that older diamicton and lacustrine sediments described at the bottom of a thick Quaternary sequence in the East Zone area (section TFE00-2) were deposited during the penultimate glaciation.

The Quaternary stratigraphy of the study area is summarized in Figure 4.2 (see Figure 4.1 for section locations). Seven lithostratigraphic units are identified on the six representative sections shown in Figure 4.2. These units are grouped within four inferred allostratigraphic units: 1) Late Wisconsinan advance-phase sediments; 2) Late

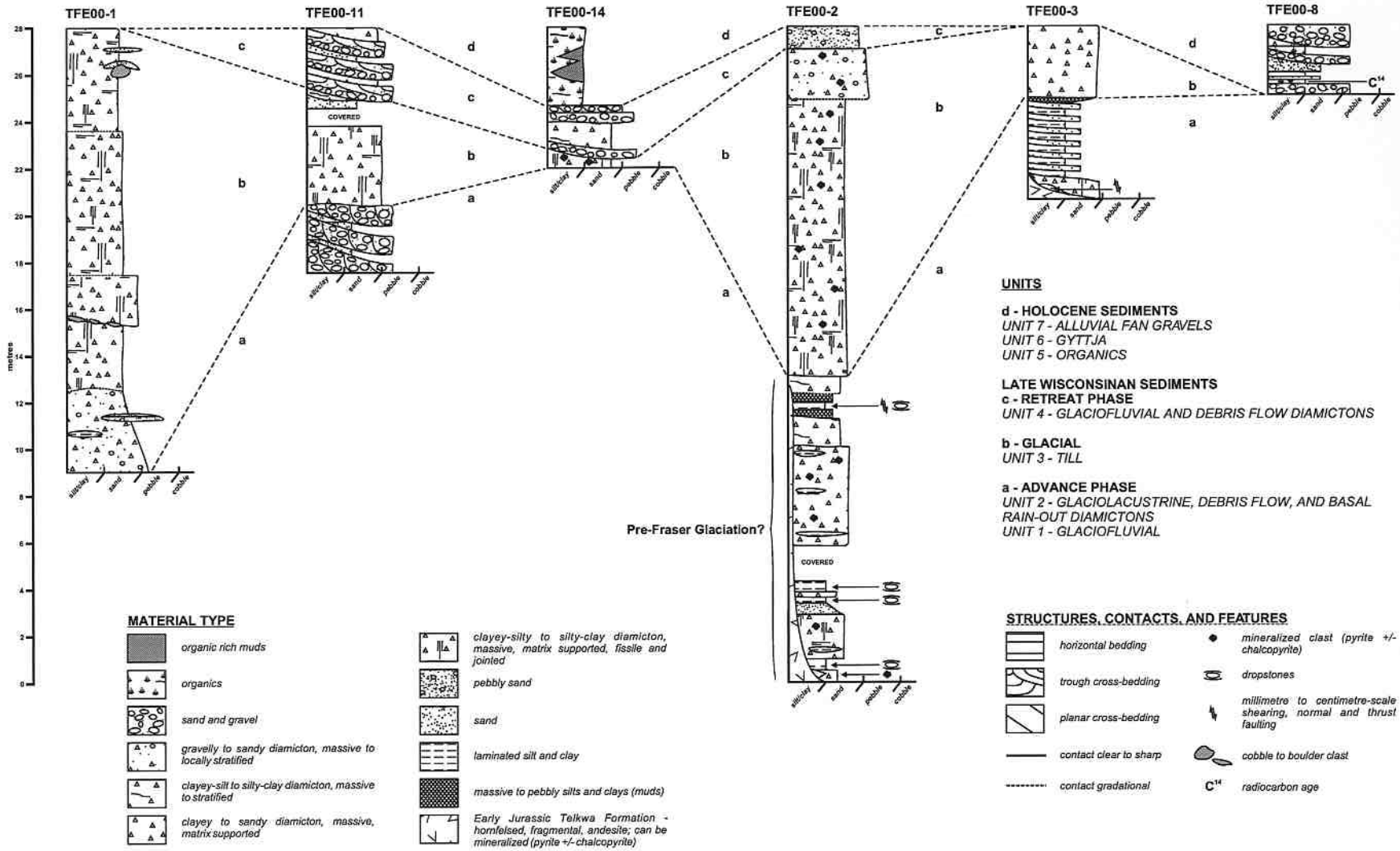


Figure 4.2. Representative stratigraphic sections from Huckleberry Mine property. Late Wisconsinan and Holocene lithostratigraphic units are shown here with descriptions given in text; inferred allostratigraphic units are labeled. Figure 4.1 provides locations for these exposures.

Wisconsinan glacial sediments; 3) Late Wisconsinan retreat-phase sediments; and 4) Holocene sediments.

4.4.1 Late Wisconsinan Advance-Phase Sediments

UNIT 1: advance-phase glaciofluvial gravels

Unit 1 sediments are composed primarily of clast supported, pebble to cobble-sized gravels that have a fine to coarse sand matrix (Figure 4.3). Subrounded to rounded clasts, sorting, coarse clast size, and horizontal bedding suggest that these sediments were deposited in a glaciofluvial environment. Trough cross-bedding, also observed in these sediments, (up to 5 m wide and 2 m deep) suggests that flow was locally channelized. Locally, the gravels contain medium to coarse sand lenses up to 3 m wide and 10 cm thick or interbeds of fine to coarse sands, reflecting fluctuating stream energy levels. In combination, these characteristics suggest deposition in a glaciofluvial, braided stream environment.

Gravels in this unit generally coarsen up from granules and pebbles to pebbles and cobbles (section TFE00-9). Stratification becomes more crude as the unit coarsens and near the top of this gravel sequence, is a poorly exposed, large cobble gravel to gravelly diamicton. The coarsening up sequence of sands, gravels and diamicton is thought to reflect an increasingly ice-proximal depositional environment.

Unit 1 sediments are directly overlain by tills (see Unit 3 descriptions below) and are therefore interpreted as being advance-phase glaciofluvial sediments. They were

Figure 4.3. Advance-phase glaciofluvial sands and gravels (Unit 1). Photograph taken at section TFE00-9. In the background (top left of photo) is a till unit (Unit 3) that caps these sands and gravels.

observed only at sections TFE00-9 and 11. They are believed to have been deposited in proglacial stream environments in front of glaciers advancing up into Huckleberry Valley from the west and northwest.

UNIT 2: advance-phase glaciolacustrine, debris flow and basal rain out diamictons

In the vicinity of the East Zone pit area is a complex sequence of horizontally bedded and laminated silts and clays, pebbly muds (Figure 4.4), and silty to sandy diamictons (Figure 4.5). Bedding in this unit is typically sub-horizontal. Individual clay beds are up to 20 cm thick and laterally traceable for tens of metres. At section TFE00-2, bedded and laminated silts and clays can be up to 1.0 m thick and are thought to have been deposited in a glaciolacustrine environment. Within these strata are small to medium pebble-sized intraclasts that deform underlying sediments and, in turn, have sediments draped over them (Figure 4.6a). Interpreted as dropstones, they suggest an ice-proximal glaciolacustrine depositional setting for these sediments. Common in the upper portions of these glaciolacustrine sediments are millimetre-scale shears, faults, and folds (Figure 4.6b). These deformation features indicate that these sediments accommodated some stress during deposition of the overlying sediments.

Interbedded with these glaciolacustrine sediments are poorly sorted, moderately dense to dense, silty to sandy diamictons. These sediments can be crudely stratified with strata defined by discontinuous silt laminae (Figure 4.5). Clasts found within these diamictons are most often sub-angular and striated. These clasts deform underlying strata and are draped by overlying sediments. These sediments are interpreted to be basal-rain out

Figure 4.4. Advance-phase glaciolacustrine sediments (Unit 2). The laminated and bedded silts and clays shown here were photographed in the gulley at section TFE00-2 (see Figure 4.6 for location). Visible portion of pick is approximately 45 cm long.

Figure 4.5. Basal rain-out diamicton observed at section TFE00-2. Pen is approximately 15 cm long.

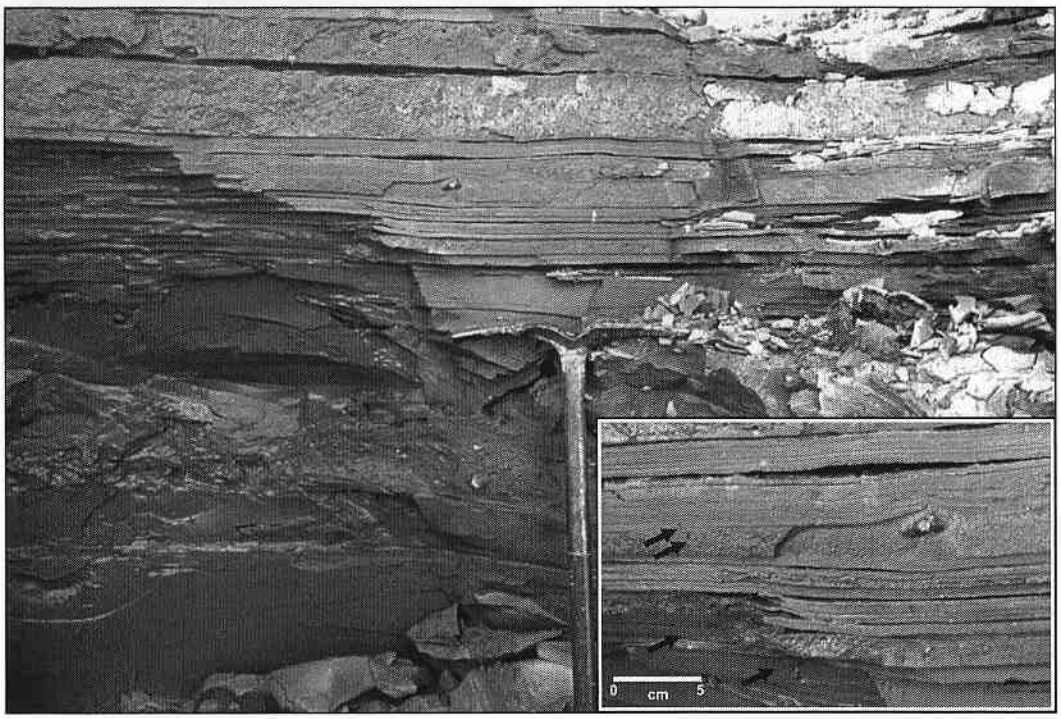


Figure 4.6a. Advance-phase glaciolacustrine sediments (Unit 2) with dropstones. Dropstones vary in size from pebble to granule (see inset; smaller dropstones are identified with arrows). Visible portion of pick is approximately 55 cm long. Photographed in gulley at section TFE00-2 (see Figure 4.7).

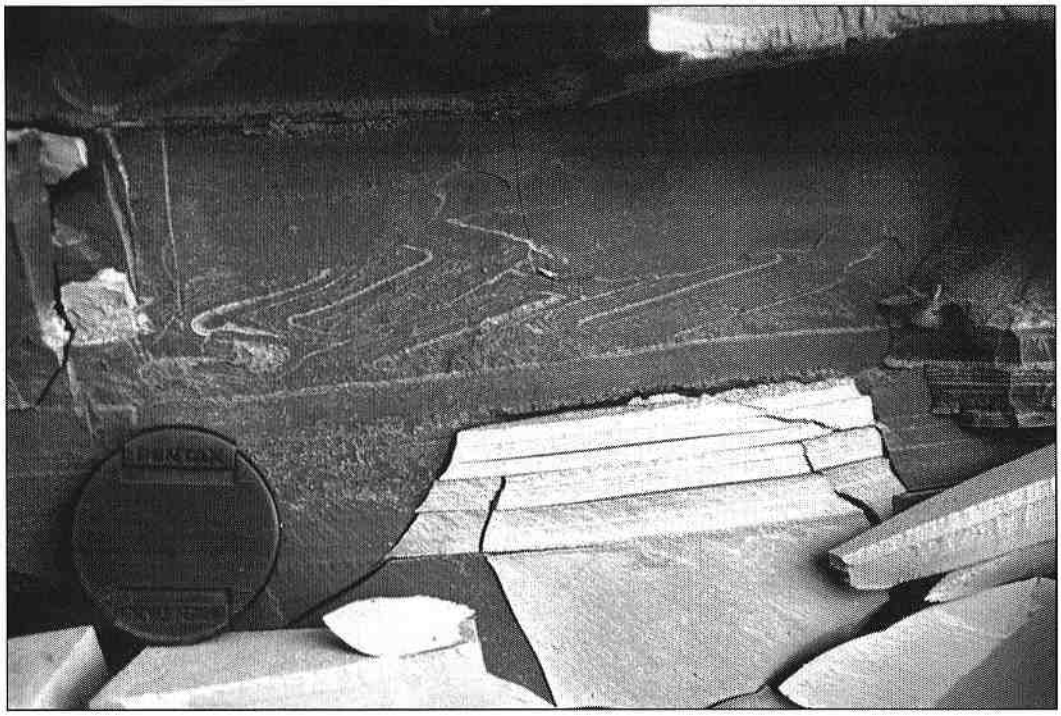


Figure 4.6b. Deformed advance-phase glaciolacustrine sediments (Unit 2). The sheared and overturned sediments shown here were photographed in the upper portion of the gully at section TFE00-2 (see Figure 4.7). Lens cap is 6 cm in diameter.

diamictons. Where there are concentrations of dropstones, these diamictons might be more accurately termed dropstone diamictons (Benn and Evans, 1998).

There is a second diamicton present in this sediment package. Exposed at section TFE00-2 is a massive, 4 m thick, silty-clay diamicton that locally contains lenses of laminated, and bedded silts and clays (see stratigraphic log, Figure 4.7). These lenses can be laterally continuous for distances ranging from a few to tens of metres. This thicker diamicton is also different from others described at section TFE00-2, in that it is denser. As seen in Figure 4.7, this massive diamicton sits stratigraphically between two glaciolacustrine sediment packages. Other massive and stratified diamictons, observed lower in this section, directly overlie ore-grade bedrock and laterally interfinger with bedded, fine-grained sediments. These diamictons are similar to those described by Plouffe (2000) and Mate and Levson (2001) and are interpreted as subaqueous debris flow diamictons. These debris flows could have originated from nearby ice or from adjacent, unstable slopes.

Stratigraphically, Unit 2 sediments are not in contact with those of Unit 1, but are overlain by till (see Unit 3 descriptions below) and are therefore interpreted to be advance-phase deposits. In the East Zone area, Unit 2 sediments partially infill a bedrock depression that opens to the east. In order for a lake basin to form in this area, a sediment or ice dam likely existed somewhere farther east that prevented free drainage of glacial meltwater to the east. This dam may have been within, or located along, the eastern end of Huckleberry Valley. Compared to similar sediments described in the Nechako Plateau

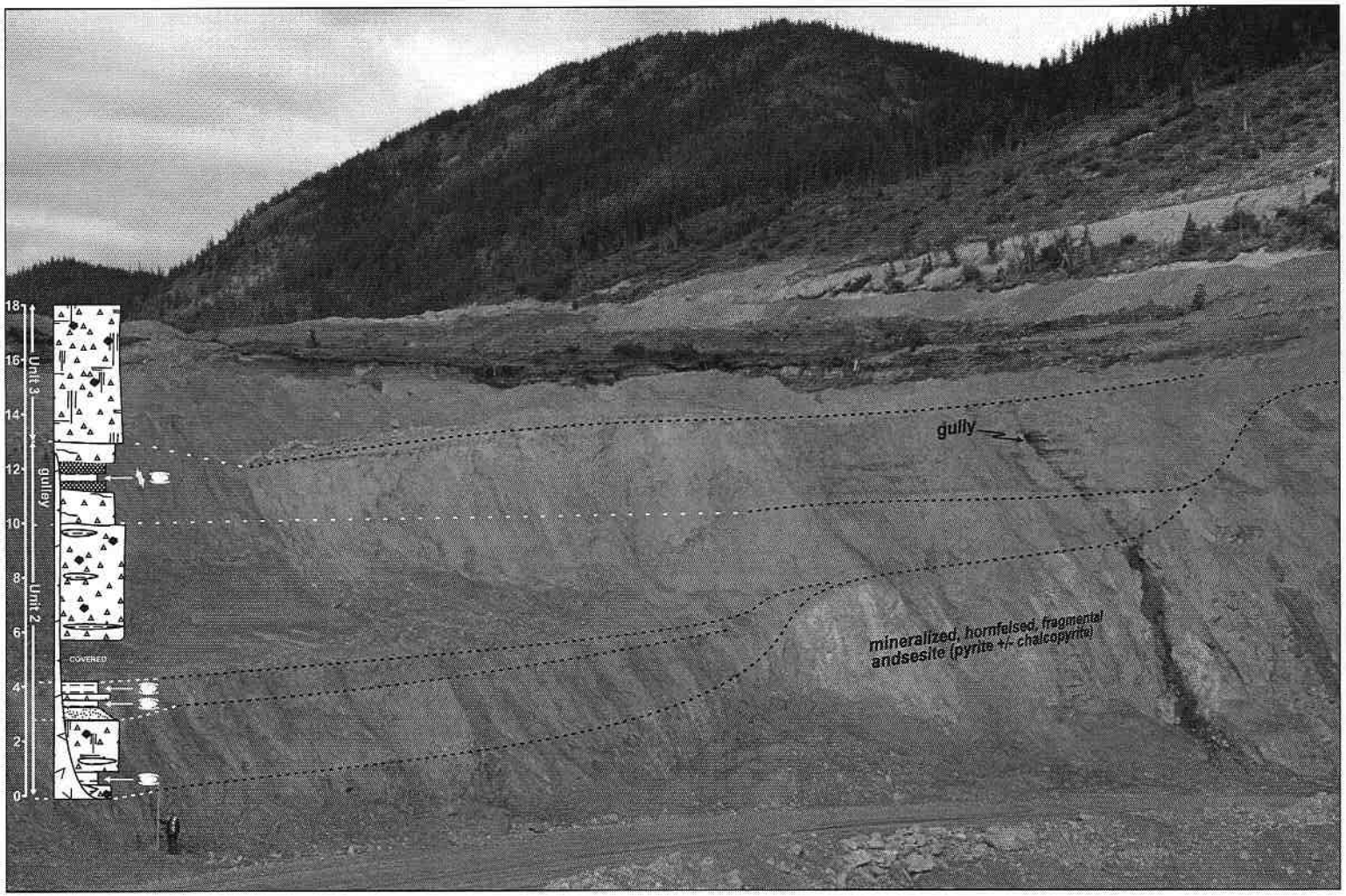


Figure 4.7. Lower half of section TFE00-2. Photograph taken above the East Zone pit. Vertical scale along stratigraphic column are in metres (see Figure 4.2 for stratigraphic column legend). Unit 2 is composed of advance-phase glaciolacustrine, debris flow, and basal rain-out diamictons. Unit 3 is till. Note person in lower left corner for scale.

region (*e.g.* Plouffe, 2000; Levson, 2001), and areas to the northwest (*e.g.* Clague, 1984), advance-phase glaciolacustrine sediments of the Huckleberry Mine region are relatively thin and discontinuous.

It should be noted that some Unit 2 sediments could be pre-Late Wisconsinan in age (*e.g.* penultimate glaciation). The bedrock depression they occupy, which is located in the lee of the Main Zone stock, may have protected these sediments from Fraser Glaciation ice. However, as Unit 2 sediments are not underlain or interbedded with dateable organic material, an absolute age for them cannot be determined. In the absence of interglacial organics, a Late Wisconsinan age is assumed.

4.4.2 Late Wisconsinan Glacial Sediments

UNIT 3: till

This unit can be divided into two facies. The first primarily consists of a grey, very dense, massive and matrix supported, sandy-silt diamicton interpreted to be basal lodgement till (Figure 4.8; *cf.* Dreimanis, 1989). Much like other valley and plateau settings in west-central British Columbia (Clague, 1984; Plouffe, 2000; Mate and Levson, 2001; Levson, 2001), basal lodgement tills are ubiquitous in the Huckleberry Mine region and are commonly in vertical exposures. These sediments are typically fissile and well jointed giving them a blocky structure. Locally these tills can have sub-horizontal shear planes (Figure 4.9). Modal clast size is small to medium pebbles, with the majority of clasts being striated. Clast content generally varies from 30-40%, but can be as low as 20% in diamictons with a clayey-silt to silty-clay matrix. In the East Zone area, the basal

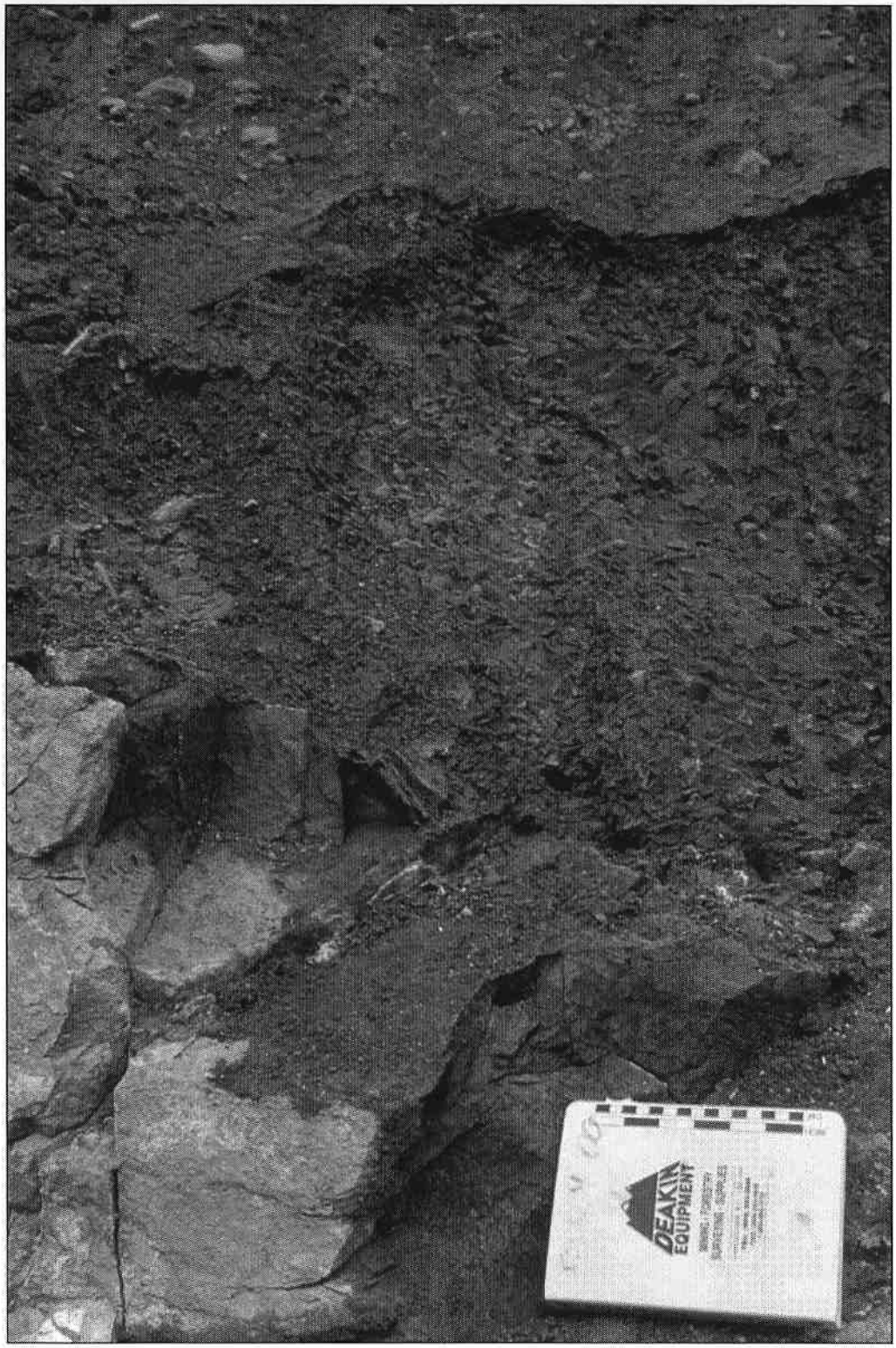


Figure 4.8. Basal till (Unit 3). A typical example of a dark grey, overconsolidated, clayey-silt diamicton, interpreted to be a basal till. These sediments are typically well jointed and fissile, giving them a blocky appearance. Photograph taken at base of section TFE00-13, where Unit 3 overlies mineralized andesite (pyrite +/- chalcopyrite) of the East Zone orebody.

Figure 4.9. Shear planes in basal till. Locally developed shear planes in basal till lie just above the northern margin of Main Zone pit, overlying mineralized andesite (pyrite +/- chalcopyrite). This was the only exposure where shear planes were observed in basal tills.

tills are up to 30 m thick, and typically overlie bedrock, but they also overlie advance-phase glaciofluvial gravels (Unit 1), or glaciolacustrine sediments and debris flow diamictons (Unit 2). Lower contacts of Unit 3 are usually sharp, and horizontal to undulating. Although, this unit is very similar to basal lodgement tills described in surrounding areas, atypical of regional tills, tills of the Main and East Zone areas have numerous mineralized porphyritic granodiorite and andesite clasts (pyrite +/- chalcopyrite). Visible pyrite and chalcopyrite crystals are also common within the till matrix.

The second till facies of Unit 3 is interpreted to be melt-out till, and is most clearly observed at section TFE00-12, where occurring in the upper portion of this exposure has a clayey-silt diamicton with discontinuous beds of gravelly diamicton and sands and gravels (Figure 4.10). The gravelly diamicton forms lenses 20-100 cm thick and continuous for up to 5 m, which can be crudely bedded. Relative to the clayey-silt diamicton, clast content in these sediments increases (up to 40 to 50%), as does the sand component of the matrix. Also within the clayey-silt diamicton, are lenses of silt to fine sand laminae (up to 2 cm thick and 10 cm wide) that drape over boulder-sized clasts. Contacts with these lenses and the surrounding clayey-silt till are subhorizontal to undulating and diffuse.

This facies is thought to have been deposited during deglaciation/ice-stagnation. In the case of sediments described at section TFE00-12, they appear to be lenses or beds of gravelly melt-out till deposited within a clay-rich basal lodgement till (*cf.* Dreimanis,

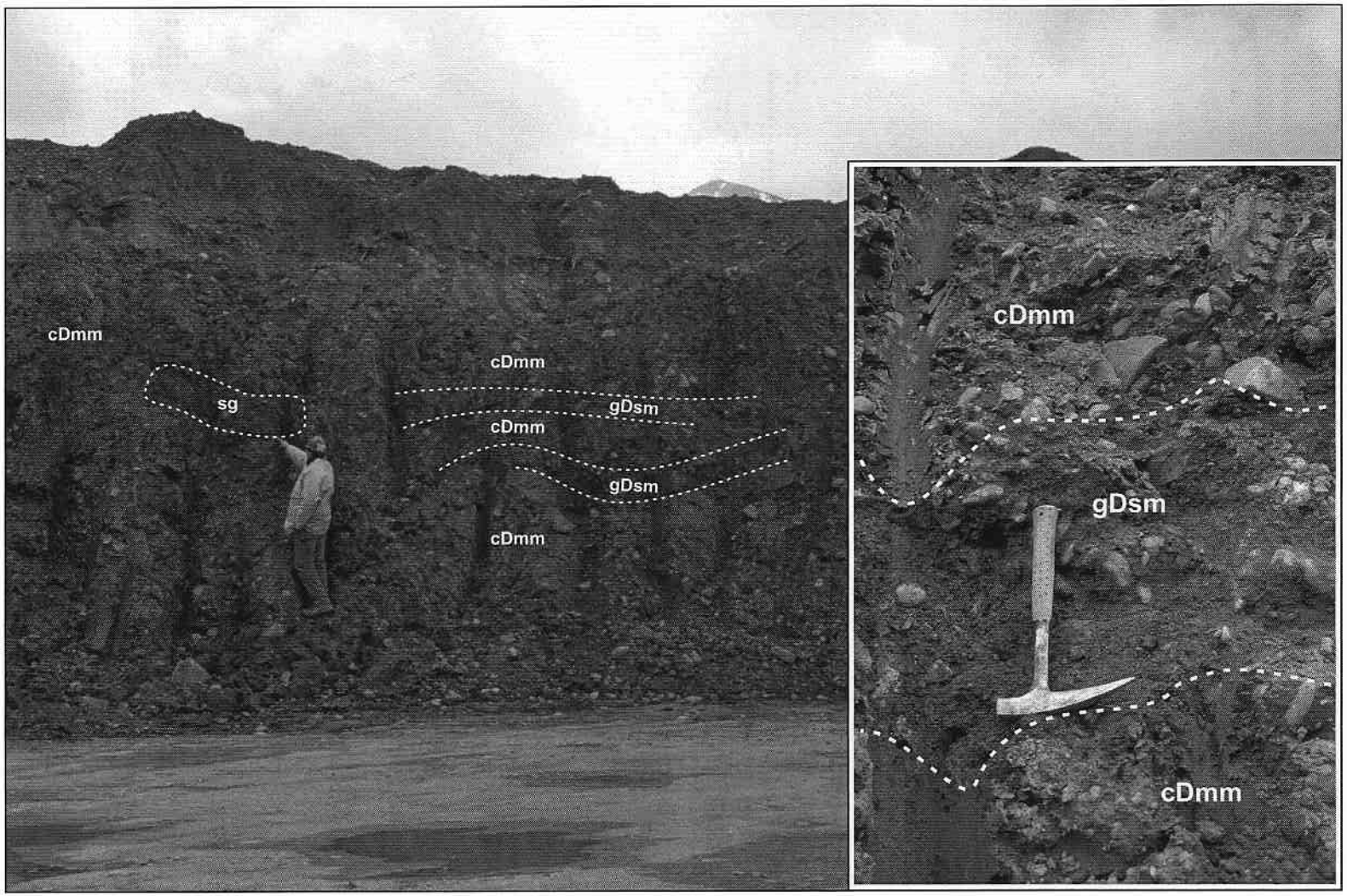


Figure 4.10. Looking south at section TFE00-12 at melt-out facies till. At this exposure is a clay-rich diamicton (cDmm) with discontinuous, massive to crudely stratified beds of gravelly diamicton (gDsm) and sands and gravels (sg). The gravelly diamicton beds are 20 to 100 cm thick and laterally continuous for up 5 m.

1989). These gravelly diamictons could have been deposited at the base of a stagnant glacier or a stagnant slab of ice under an active glacier. The silt and fine sand drapes indicate that there was ponding of water under this ice. Diamicton units, observed towards the top of other exposures in the Huckleberry Mine region, which are less dense and that have a coarser matrix texture and higher clast content than underlying diamicton units (*e.g.* section TFE00-2), are also probably melt-out tills.

MULTIPLE TILL UNITS

At section TFE00-1, four subunits of Unit 3 have been identified labelled as 1, 2, 3a and b, and 4 in Figure 4.11, based primarily on changes in matrix texture, colour, and percent clast content. For example, clast content in the upper portions of subunit 4 is up to 50%. This is an increase over the typical 20 to 30% values observed in lower portions of this exposure. Also occurring in the upper portion of subunit 4 is a change in matrix colour to a dark brown. All till subunits described below this are light to dark grey in colour.

Distinct changes in colour hue distinguish subunits 1, 2 and 3. Subunits 3a and 3b are distinguished by changes in matrix texture from a silty-fine sand in subunit 3a to a silty-clay in subunit 3b. Density also increases in subunit 3a. Locally, subunit 3b directly overlies subunit 2, when subunit 3a is absent from the stratigraphy.

Other primary features such as fissility, jointing, and density also change between subunits. These primary features seem to be better developed in subunits with higher silt/clay and lower clast content. Although most subunits are massive, subunits 1 and 4

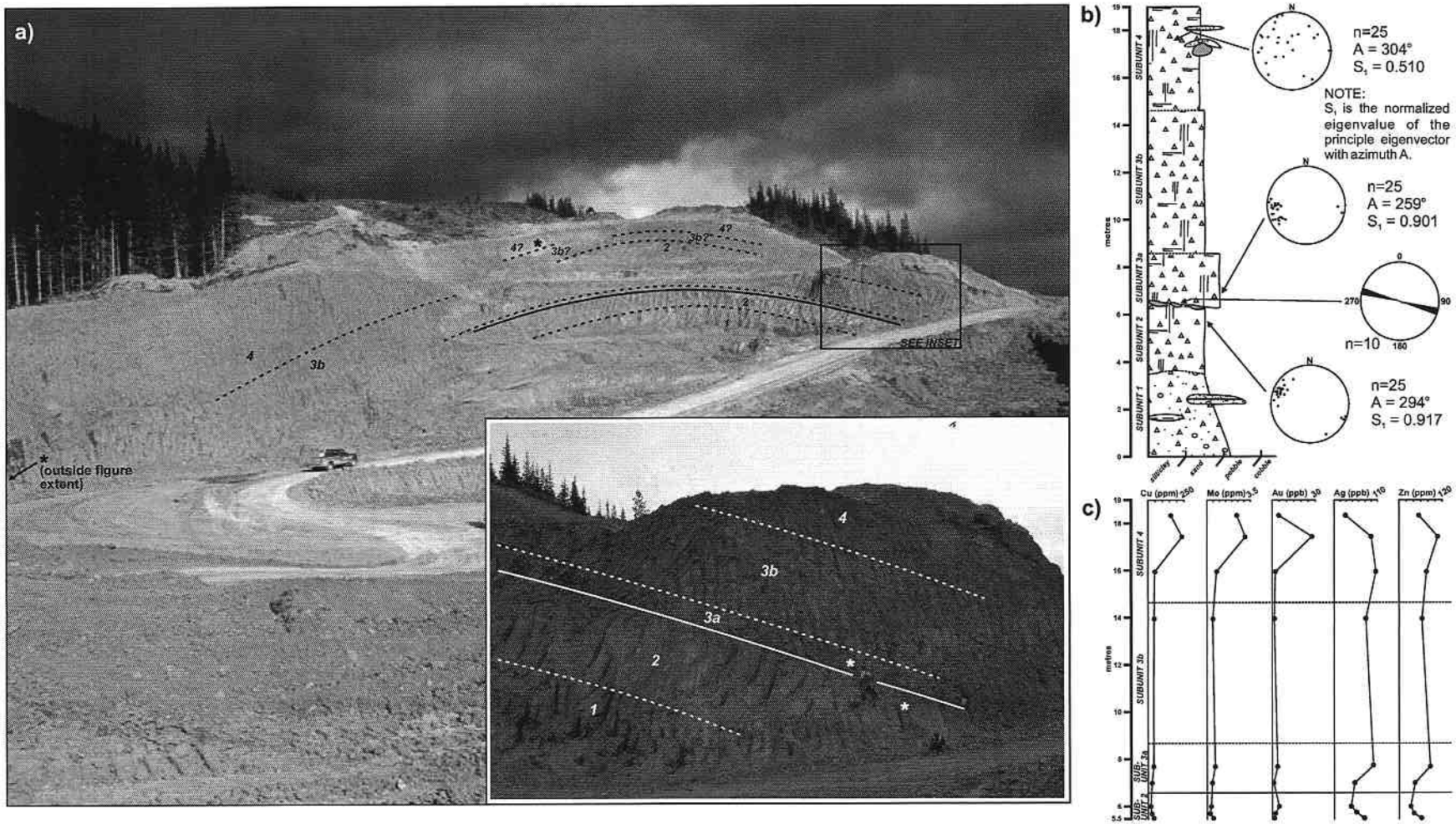


Figure 4.11. Section TFE00-1. a) Looking east into West Borrow Pit, location of section TFE00-1. Pebble count and fabric analysis sites are indicated in the main photo and inset with an asterisk (*). b) Till fabrics (depicted in Schmidt equal area stereonets) are presented next to stratigraphic column (see Figure 4.2 for material type legend). Arose diagram of striae orientations from the striated clast pavement is also presented here. Subunits 1 to 4 of Unit 3 (Late Wisconsinan till) are labelled in the stratigraphic column and in photographs. c) Geochemical values for select elements are provided to characterize the geochemical signature of these sediments. These data are discussed in detail in Chapter 5.0 (Till Geochemistry).

can locally be crudely stratified. This stratification can take the form of sandy to gravelly lenses or discontinuous, sub-horizontal, silt/clay laminae found within the till matrix. In the upper portions of subunit 4, poorly sorted gravelly-sands were observed draping over large boulders.

The subunit 2/3a contact forms a spectacular, clear to sharp contact that true dips 23° towards 200° (Figure 4.11). This contact generally parallels the surface slope. Contacts of the other subunits are generally parallel to the subunit 2/3a contact.

Pebble fabrics in subunits 2 and 3a show strongly preferred clast orientations that indicate deposition during southeastward to eastward ice-flow events (Figure 4.11). High S_1 values and a uni-modal distribution of pebble fabric measurements suggests that these tills were deposited by lodgement processes (Hicock *et al.*, 1996). These data provide stratigraphic evidence of an early, eastward-directed, ice flow event that may correspond to the earliest eastward even described in Chapter 3 (Ice-Flow History).

Deposition during a southeastward to eastward ice-flow event is further supported by the characteristics of a striated clast pavement, located at the subunit 2/3a contact (Figure 4.12). Sitting with faceted tops directly on this contact are numerous striated large pebble to boulder-sized clasts. Striations on these clasts indicate ice-flow direction to the east-southeast (Figure 4.11). A-axes orientations of striated prolate or bladed clasts at this contact are often parallel to striae orientations. Rat- tails and smoothed and plucked faces, that again indicate movement of glacial ice across this clast pavement towards the

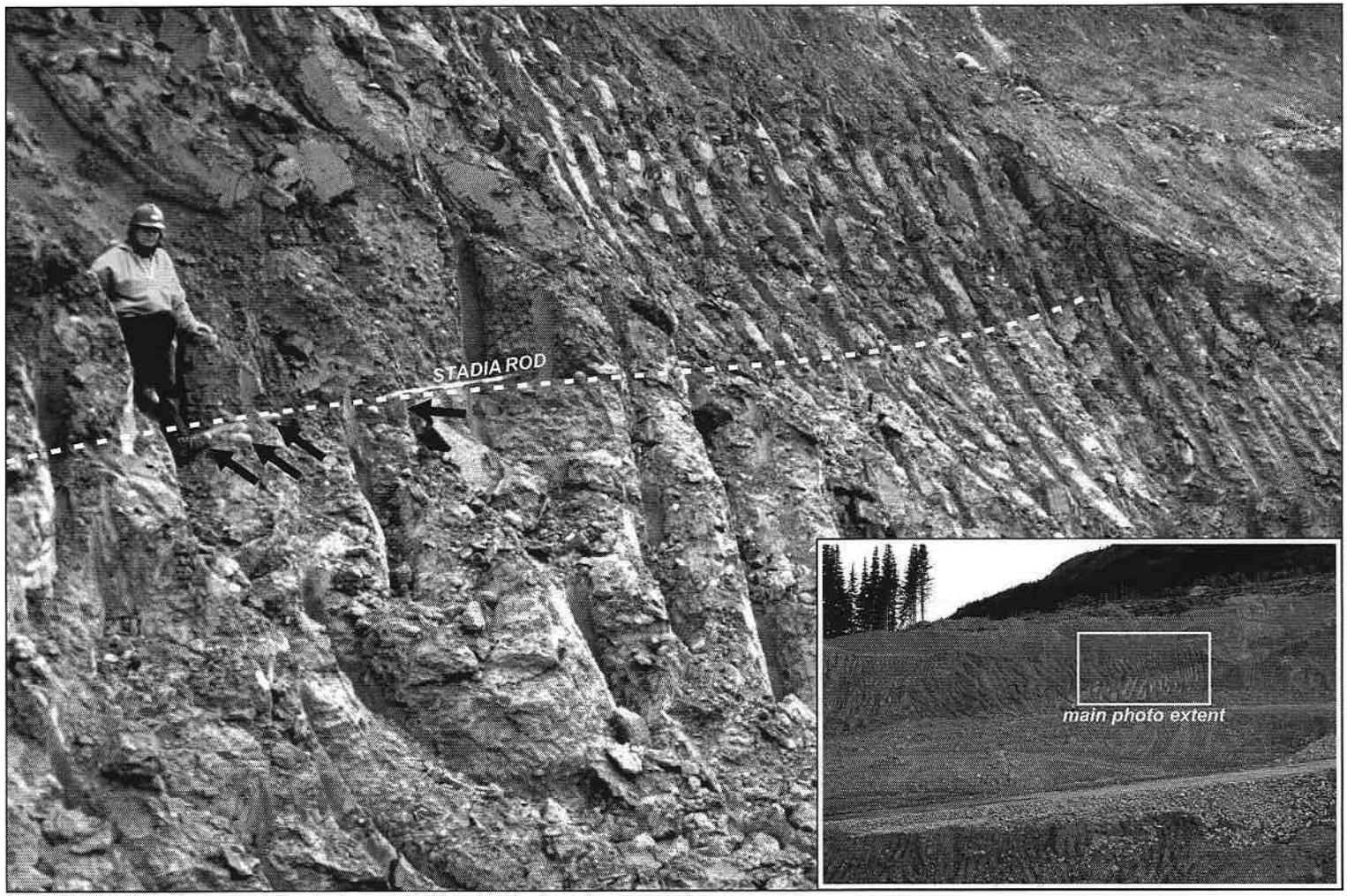


Figure 4.12. Striated clast pavement at section TFE00-1. Looking east, the dashed line approximates the subunit 2/3a contact (see Figure 4.11). Sitting with tops directly on and parallel with this contact are striated large pebble to boulder-sized clasts (see arrows in main photo); stadia rod is lying on boulder tops.

east-southeast, were also Observed locally on these clasts. Pebble fabric and ice-flow indicator data suggest that ice-flow during deposition of subunit 2 was parallel to Tahtsa Reach (*i.e.* valley-parallel flow). This is what would be expected, as flow direction of relatively thin glaciers initially advancing into the Huckleberry Mine region would have been constrained by topography. Pebble fabric data in subunit 3a indicate a more easterly-directed ice-flow event. These data suggest that, as Fraser Glaciation progressed, the valley glaciers thickened and began to flow more easterly through the east-west trending Huckleberry Valley, as would be expected.

In addition to providing evidence of an early eastward ice-flow event in the Huckleberry Mine region, the striated clast pavement observed at the subunit 2/3a contact may also provide some insight into sub-glacial depositional conditions during this ice-flow event. Several theories have been proposed in the literature for the formation of striated clast pavements. Given the characteristics of this particular striated clast pavement, there are three that could explanation its formation: 1) basal lodgement processes whereby clasts being transported in basal ice are lodged into an underlying rigid sediment (Boulton and Paul, 1976); 2) the presence of low-strength deforming sediments at the base of a glacier that would facilitate the settling of heavy clasts to an underlying more rigid sediment (Clark, 1991); or 3) excavational deformation at the base of a deforming layer that would preferentially mobilize fine material and leave behind a lag of larger particles that resist entrainment (Boulton, 1996). Given the high S_1 values of pebble fabrics in subunits 2 and 3a, and uni-modal distribution of clast orientations, and the physical characteristics of

subunits 2 and 3a (*e.g.* overconsolidation), a basal lodgement origin for this striated clast pavement seems most likely.

Pebble counts provide further evidence of an early eastward-directed ice-flow event (see Figure 4.11). Of the clasts collected in subunits 2 and 3a, <5% are porphyritic granodiorites. There are no documented outcrops of granodiorite west of section TFE00-1, but <1 km to the east is the Main Zone stock (*i.e.* porphyritic granodiorite; see Figure 4.1). This general lack of granodiorite clasts in the lower till units at section TFE00-1 suggests a western provenance for these sediments.

At section TFE00-1, in the upper portions of subunit 4, there is also evidence for the later westward-directed ice-flow event described in Chapter 3. Pebble counts conducted in Unit 4, ~2.0 m below surface at this section (see Figure 4.11 for location) yielded quite different results than those conducted near the subunit 2/3a contact. In this horizon, approximately 10% of clasts in till are porphyritic granodiorite. Also occurring at this horizon is an increase in percent clast content, and change in matrix colour from grey to dark brown. Approximately 50 m west of section TFE00-1, the percentage of granodiorite clasts is even higher. A similarly brown coloured till, collected from a similar stratigraphic position to that of subunit 4, had a granodiorite clast content of 27%.

The enrichment of grandiorite clasts in this near-surface till subunit is believed to be the result of a change in provenance, as well as changes in matrix colour and texture. The closest known source for these granodiorite clasts is the Main Zone stock, <1 km to the

east, which suggests that ice-flow direction, during deposition of this subunit, was towards the west.

If subunit 4 was deposited during the westward-directed ice-flow event that occurred during the Fraser Glaciation maximum, the 15 m of till in subunits 1 to 3 were deposited during the early eastward-directed ice-flow that led up to this event. This contrast in till thickness could be the result of differences in rates of erosion or deposition of opposing ice-flow events, or some combination thereof. However, if other factors were equal, the greater thickness in subunits 1 to 3 suggest a relatively long period of eastward flow compared to westward flow. This is what would be expected as the advance-phase of glaciation was undoubtedly much longer in duration (Clague, 1981; Clague, 1989b) and also likely had a greater thickness of weathered or unconsolidated material to erode.

4.4.3 Late Wisconsinan Retreat-Phase Sediments

UNIT 4: retreat-phase glaciofluvial and debris flow diamictons

Unit 4 deposits consist primarily of clast-supported, large pebble to cobble-sized gravels with a coarse sand matrix which are thought to have been deposited in a glaciofluvial environment. Clasts are typically rounded to subrounded but angular and subangular clasts can also be observed. The gravels are most often massive, have chaotic fabrics, and are poorly sorted, suggesting rapid deposition. Locally, in upper portions of this unit, are medium to coarse sand lenses, 5 to 30 cm thick and a few to several metres wide, that suggest discharge in this glaciofluvial system fluctuated.

Debris flow diamictons are found interbedded with these sands and gravels. These silty to sandy diamictons have lithological and primary depositional features similar to the subaqueous debris flow facies described in Unit 2, however, Unit 4 diamictons occur in association with glaciofluvial gravels and are therefore thought to have been deposited in a subaerial environment. The lower contacts of gravel beds are typically clear to sharp, and trough shaped (up to several metres wide and one metre deep), indicating channel deposits, but the lower contacts of the debris flow diamictons are clear and conformable with the sands and gravels, indicating that the debris flows were largely non-erosive.

At section TFE00-11, Unit 4 sediments directly overlie till (Unit 3) and are interpreted as retreat-phase sediments that were probably deposited in front of retreating, or stagnating, ice in a proglacial stream environment. The presence of debris flow interbeds suggests that Unit 4 sediments were deposited in an ice-proximal setting.

4.4.4 Holocene Deposits

UNIT 5: organics

Thick organic deposits are commonly found in vertical exposures in the central portion of Huckleberry Valley (Figure 4.13). Recognizable vegetative matter increases upsection as humic peats grade through mesic peats up into more fibric peats. Cones, small twigs, and logs are all commonly found in mesic to fibric peat beds. Locally, larger wood fragments laying at the surface protrude down into humic peats. Holocene forest fires are recorded in this unit with charcoal fragments observed in lower portions of these deposits. Lenses

Figure 4.13. Organics (Unit 5) overlying retreat-phase glaciofluvial gravels (Unit 4). Photograph taken at section TFE00-14.

of interbedded silt, fine sand, and diamicton (up to 25 cm thick and 4 m wide) were observed at some exposures underlying Unit 5.

These materials are found overlying retreat-phase glaciofluvial sediments with sharp and sub-horizontal to undulating lower contacts. Within the unit, lower contacts between individual peat units are typically gradational.

UNIT 6: gyttja

Organic rich (gyttja) mud is found in the swampy area between sections TFE00-2 and 10, directly overlying fibric peats of Unit 5. This deposit is thickest in the central portion of the swamp and pinches out at swamp margins (Figure 4.14). Originally deposited in a subaqueous environment, this gyttja is now exposed subaerially because the area between the Main and East zones was drained during mine preparation activities.

Crude bedding in the gyttja is defined by changes in the organic content, which results in colours ranging from light to medium brown. This unit weathers to a buff white when dry. As suggested by a lack of shells and reaction to diluted hydrochloric acid, carbonate content of this unit is negligible. The size of coniferous needles, bark, and small twigs increase in size towards the top of the unit. At swamp margins, Unit 6 deposits can be observed interfingering with Unit 5 peat deposits. This stratigraphic relationship suggests a fluctuation of water levels in this swamp prior to it being drained. These fluctuations might reflect an adjustment of the local water table, and (or) growth rates of local flora, to some change in climate.

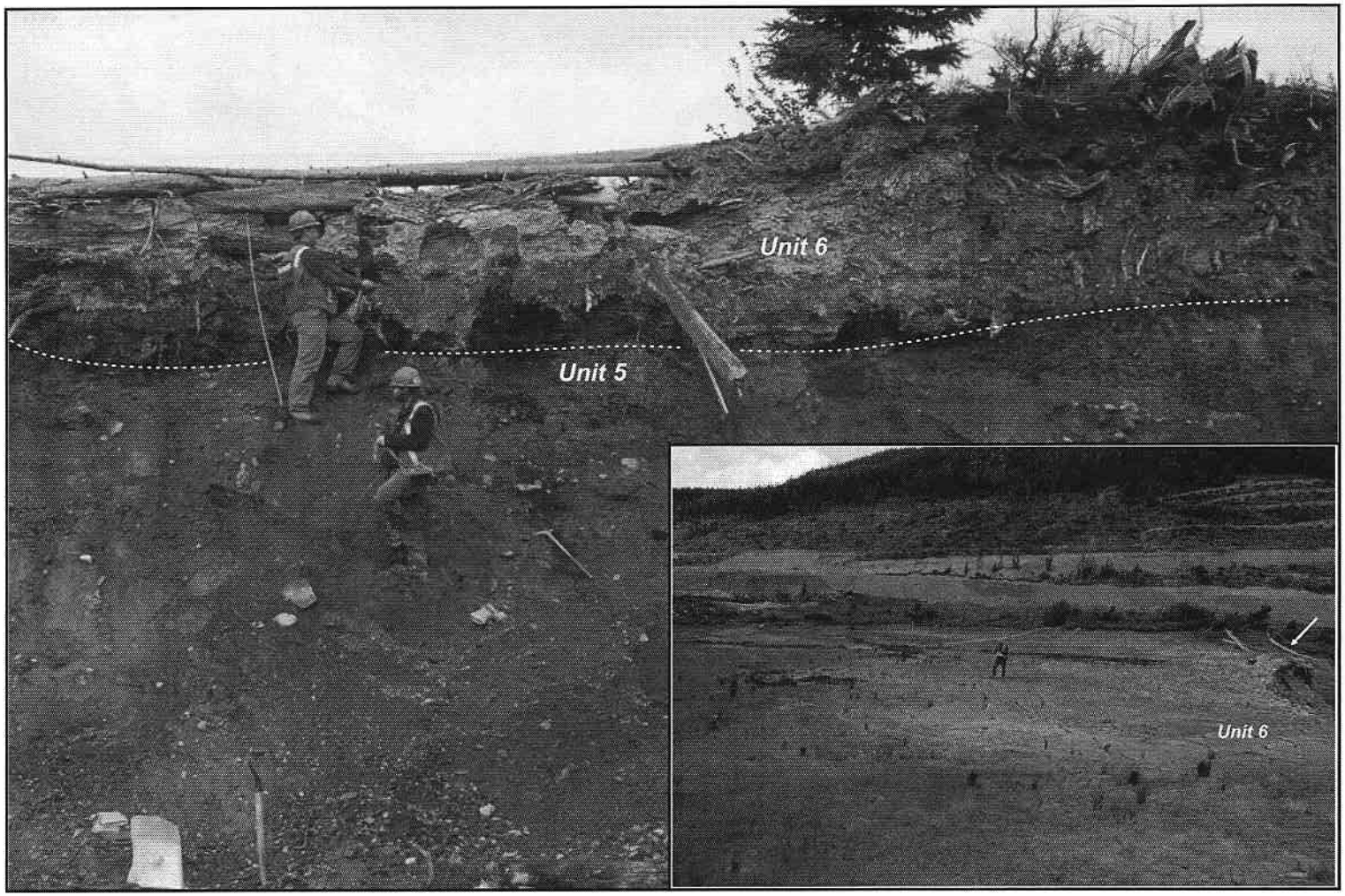


Figure 4.14. Organic rich muds (Unit 6). Only observed at section TFE00-14, this deposit thins toward the right where it interfingers with Unit 5 organics.

UNIT 7: alluvial fan gravels

Unit 7 consists of clast supported, matrix filled, sandy, small to large pebble-sized gravels (Figure 4.15). Interpreted as alluvial fan gravels, Unit 7 sediments were only exposed at section TFE00-8 in a gully exposure. The angular clasts that dominate this unit suggest a local, bedrock. Unit 7 is interbedded with organic rich silts, fibric peats, loose, massive, matrix supported diamictons, and rarely with fine to medium sands. As suggested by the weakly developed soil horizons observed in some peat interbeds, this fan was inactive, more than once, for extended periods of time. Individual fan gravel beds are relatively thin, reaching a maximum thickness of 50 cm at the top of this section. Where exposed, the lower contacts of these gravels are sharp and undulating to trough shaped. The lower contact of this unit with underlying sediments and (or) bedrock is covered.

Wood fragments are common within two organic and peat horizons at this section. In the lower bed, a horizontally-lying wood fragment (20 cm long and 5 cm in diameter) yielded a conventional radiocarbon age of 7120 ± 60 BP (Beta 158482). This Holocene age is in agreement with radiocarbon ages of basal peats collected in NTS map areas 93N and K (Plouffe, 2000), and provides a minimum age for the development of a treed environment in the local area around Huckleberry Mine region. Clague (1981) suggests that interior British Columbia valleys and plateaus were ice-free by 10 000 to 9500 years BP.

Figure 4.15. Aluvial fan gravels (Unit 7). Seen here are Unit 7 sediments interbedded with organics in a gully exposure at section TFE00-8. A wood fragment 20 cm long and 5 cm in diameter, collected from an organic horizon in the lower portion of this exposure, yielded a radiocarbon age of 7120 ± 60 BP (Beta 158482). Other large wood fragments are indicated with arrows. Pick is approximately 65 cm long.

4.5 SUMMARY

Several vertical exposures, in some cases continuous from surface to bedrock and up to 28 m in height, were studied in Huckleberry Valley. Most of these exposures were created during mine preparation and extraction activities at Huckleberry Mine, however, others were the product of natural fluvial processes. As a result of these studies, seven lithostratigraphic units have been identified in the Huckleberry Mine region.

The earliest of these deposits are advance-phase glaciofluvial gravels that are thought to have been deposited in a braided stream environment on the west end of the valley. These deposits generally coarsen up, indicating an increasing ice-proximal depositional environment. A complex sequence of advance phase glaciolacustrine and debris flow deposits was observed occupying a bedrock depression in the central portion of Huckleberry Valley. Numerous dropstones within these sediments suggest an ice-proximal, or even subglacial, depositional setting. It is possible that a topographic high located to the west of the bedrock depression these sediments occupy, protected them from glacial ice flowing through Huckleberry Valley. Although interpreted here as Late Wisconsinan sediments, no absolute dating control means they could also be pre-Late Wisconsinan in age.

As the Fraser Glaciation progressed, ice flowing east from accumulations centres in the Coast Mountain range moved into Huckleberry Valley and deposited thick tills. The majority of the tills in the region were deposited by lodgement processes, however, towards the top of some sections, gravel-rich and crudely stratified diamictons can be

observed, which are thought to be melt-out facies tills. Visible grains of pyrite and chalcopyrite (up to 3 mm in size) and mineralized andesite clasts (pyrite +/- chalcopyrite) are commonly found in the matrix of tills in the central portion of Huckleberry Valley are.

Multiple till units were identified at one section, located in the western portion of Huckleberry Valley. These till units are distinguished primarily by changes in colour, matrix texture, and changes in clast content. Lithologic, stratigraphic, and sedimentological data collected at this exposure provide evidence for the westerly, and early-easterly, Late Wisconsinan ice-flow events described in Chapter 3 (Ice-Flow History).

As Fraser Glaciation ice left Huckleberry Valley, sequences of retreat-phase glaciofluvial gravels were deposited. These gravels can be interbedded with debris flow deposits that are thought to have originated from local debris-rich glacial ice or stagnant ice blocks. Since deglaciation, thick organic deposits have locally accumulated on top of these gravels in low lying, poorly drained areas. Organic rich muds, or gyttjas, locally, interfinger with these organic deposits.

5 TILL GEOCHEMISTRY

5.1 INTRODUCTION

This chapter has two main objectives. The first is to investigate the dispersal of mineralized detritus in basal till of the Huckleberry Mine region from known bedrock sources. The second objective is to assess the relationship between the interpreted transport directions and the complex ice-flow history of the Tahtsa Lake – Ootsa Lake region discussed in Chapter 3.0 (Ice-Flow History). Near-surface basal till samples were collected to investigate the surficial dispersal pattern while sub-surface samples were collected to investigate the dispersal in three dimensions.

This chapter begins with a discussion on field, laboratory, and analytical methods used in collecting, processing, and analysing basal till samples from the Huckleberry Mine region. Quality control measures are also reviewed.

5.2 SURFICIAL GEOCHEMICAL SURVEYS

5.2.1 Previous Work

The Len Claims, now the Huckleberry Mine property, were staked in 1962 by Kennco Explorations (Western) Limited, as a result of follow-up work on anomalous stream sediment samples collected in 1960 (Jackson and Illerbrun, 1995). Chalcopyrite, tenorite, and malachite were found in a small outcrop of granodiorite (Blower, 2000). This outcrop has since become known as the Main Zone stock. Shortly after staking, Hornbrook (1970) conducted a biogeochemical and soil survey as part of a comparative study on the effectiveness of biogeochemical surveys for detecting buried mineral

deposits. Hornbrook was able to define the location of known copper and molybdenum mineralization in the Main Zone area and concluded that second year alpine fir twigs and needles were the most effective sample media for doing this.

Four soil geochemistry surveys have been conducted on the Huckleberry Mine property. The first three were conducted as part of advanced exploration programs (Stevenson, 1970; Bradish *et al.*, 1989; Myers and Roney, 1990). A more recent survey was conducted by Huckleberry Mines Limited west of the Main Zone, below the tailings pond. Results from this program, in combination with results of an induced polarization and magnetic survey conducted in the same area (Blower, 2000), identified a number of areas that warranted further geological investigation. This area has since been tested with a diamond and rotary drill program, but economic mineralization was not detected in any of the drill holes.

On a regional scale, the British Columbia Ministry of Energy and Mines and the Geological Survey of Canada conducted a Regional Geochemical Survey (RGS) of NTS map area 93E using stream water and sediment as sample media (BCRGS 16, 1987). A sample was collected from a stream that runs parallel to Huckleberry Mine's East Zone, that empties into Tahtsa Reach to the southeast (see Figure 1.5). This sample site was located towards the east end of the orebody and returned a value of 840 ppm copper, which was the third highest copper concentration of all samples collected during this regional-scale survey. The two higher copper values (1160 and 920 ppm) came from stream sediment samples collected in the cirque that hosts the Berg porphyry Cu-Mo-Ag

occurrence (MINFILE, 2004), a developed prospect located near the summit of Mount Ney, approximately 20 km northwest of Huckleberry Mine.

A summary of geochemical surveys conducted on Huckleberry Mine, including sample media used, is provided in Table 5.1.

5.2.2 Review of Till Geochemical Surveys

Till geochemistry surveys employ glaciological principles to determine the provenance of distinct lithologies, minerals, and trace elements occurring in till (Figure 5.1). In these surveys, basal tills are the sample media of choice. They are considered a first derivative of bedrock (DiLabio, 1989; Shilts, 1993), they are created, transported, and deposited in a subglacial environment (Dreimanis, 1989), and they are transported linearly, parallel to ice-flow, down-ice of their bedrock source (Shilts, 1993; Levson 2001b). As such, relative to sediments with more complex histories of erosion, transport, and deposition (*e.g.* glaciofluvial), identifying the provenance of basal till is simpler (DiLabio, 1989; Levson 2001b).

The objective of a till geochemical survey is to identify dispersal trains of distinct material at surface, which can be traced back to its bedrock source. Dispersal trains are defined by sharp contrasts in values over short distances across their lateral margins. Higher values occur within the train while lower values occur outside of it. The highest values in a dispersal train are observed at its head (Figure 5.1). Numerous studies have demonstrated that the decrease in values down-ice from the head of a dispersal train to its

SAMPLE MEDIA	CONDUCTED BY	YEAR	REFERENCES
stream sediment	Kennco Explorations Ltd.	1960	Jackson and Illerbrun, 1995
soil	Kennco Explorations Ltd.	1969	Stevenson, 1970
stream water and sediment[3]	BCGS[1], GSC[2]	1986	Johnson *et al.*, 1987
soil	Noranda Exploration Company Ltd.	1989	Bradish *et al.*, 1989
	Noranda Exploration Company Ltd.	1989	Myers and Roney, 1990
basal till	BCGS[1]	2000	Ferbey and Levson, 2000

[1] British Columbia Geological Survey

[2] Geological Survey of Canada

[3] Lake water and sediments were as well collected during his survey, however not on Huckleberry Mine property

Table 5.1. Summary of geochemical surveys conducted in the Huckleberry Mine area.

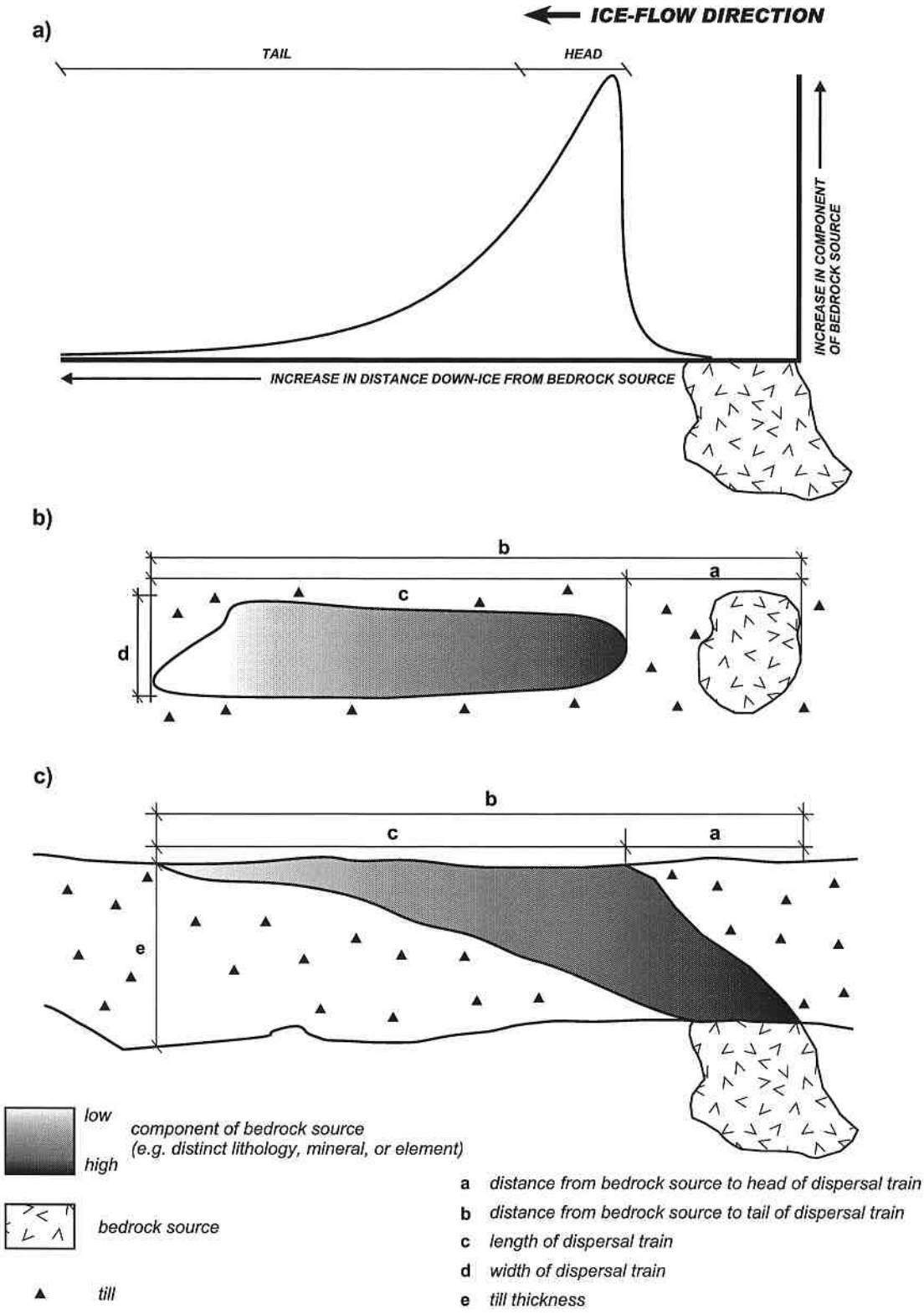


Figure 5.1. Characteristics of a dispersal train. a) A graph illustrating an idealized dispersal curve, with the head and tail of a dispersal train labelled (Shilts, 1976). The geometry and orientation of a dispersal train a) in plan view and b) in profile.

tail is exponential (*e.g.* Shilts, 1976; Klassen, 1999; see Figure 5.1). In areas with a relatively simple glacial history, dispersal trains with a point source are typically elongate with length/width ratios of 3:1 to 5:1 (Levson, 2001b; "c:d" in Figure 5.1). Transport distance from the bedrock source is generally a function of till thickness ("e" in Figure 5.1), with an increase in till thickness resulting in an increase in transport distance (*e.g.* Paulen, 2001; Levson *et al.*, 2002; "b" in Figure 5.1). A till geochemical survey can be an effective method for detecting buried mineralization as dispersal plumes in till are areally many times the size of their bedrock source, and therefore provide a larger target for a mineral exploration program (Coker and DiLabio, 1989; Levson, 2001b).

5.3 METHODS

5.3.1 Field Methods

During the course of the 2000 field season, 336 two to five kilogram samples of basal till were collected in the study area. Of these, 101 were collected from near-surface exposures (Figure 5.2) and 235 were collected from sub-surface units (Figure 5.3). Sample sites were selected to obtain maximum spatial coverage of the study area while taking into account ice flow direction and location of ore bodies. Although a spatially uniform sampling scheme is preferred, absence of appropriate sample media in some areas, and human disturbance limited sample site selection (*e.g.* construction of the tailings pond on the mine property, disturbance of sediments by heavy machinery, construction of road beds).

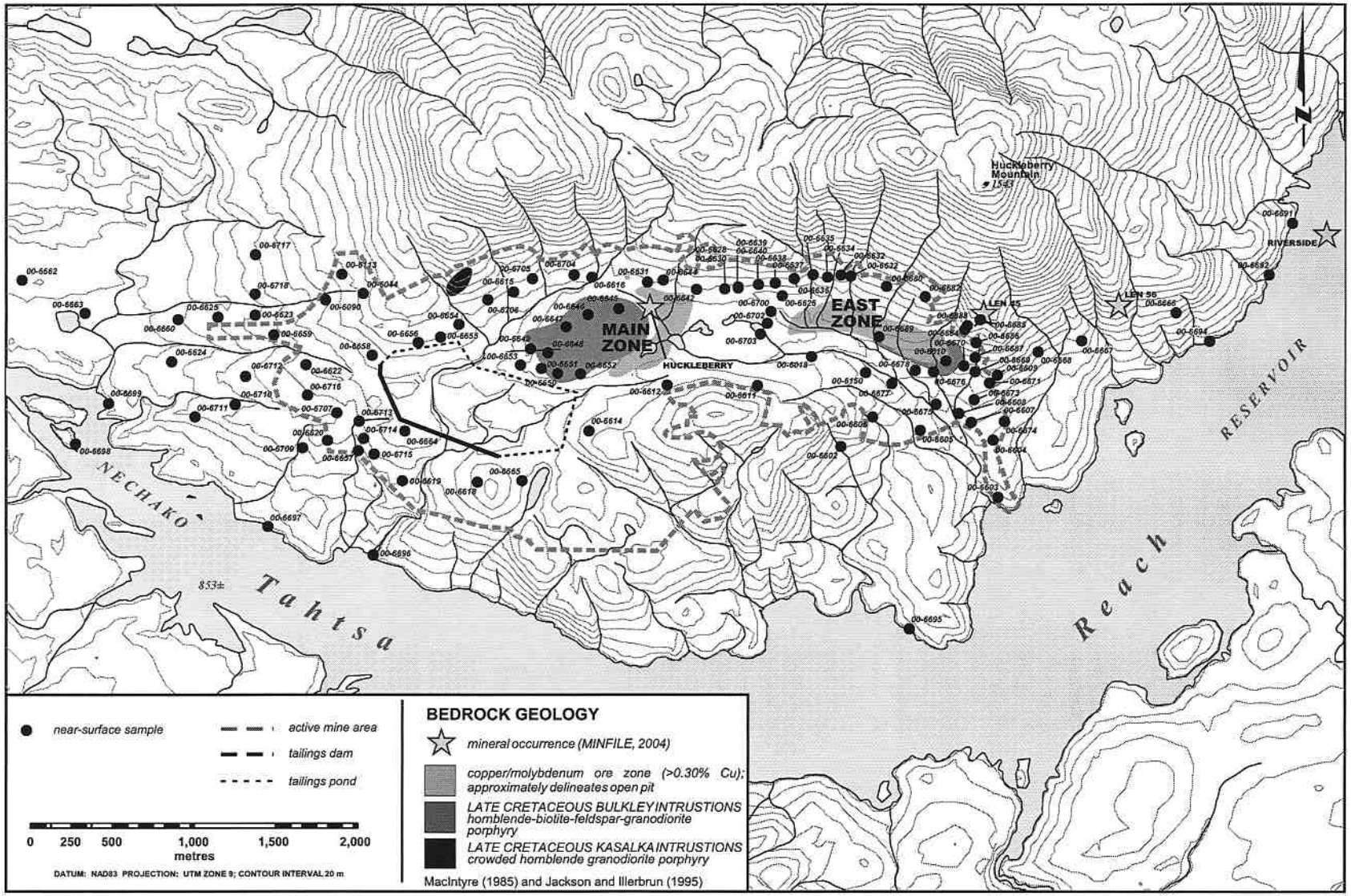


Figure 5.2. Location of near-surface till samples.

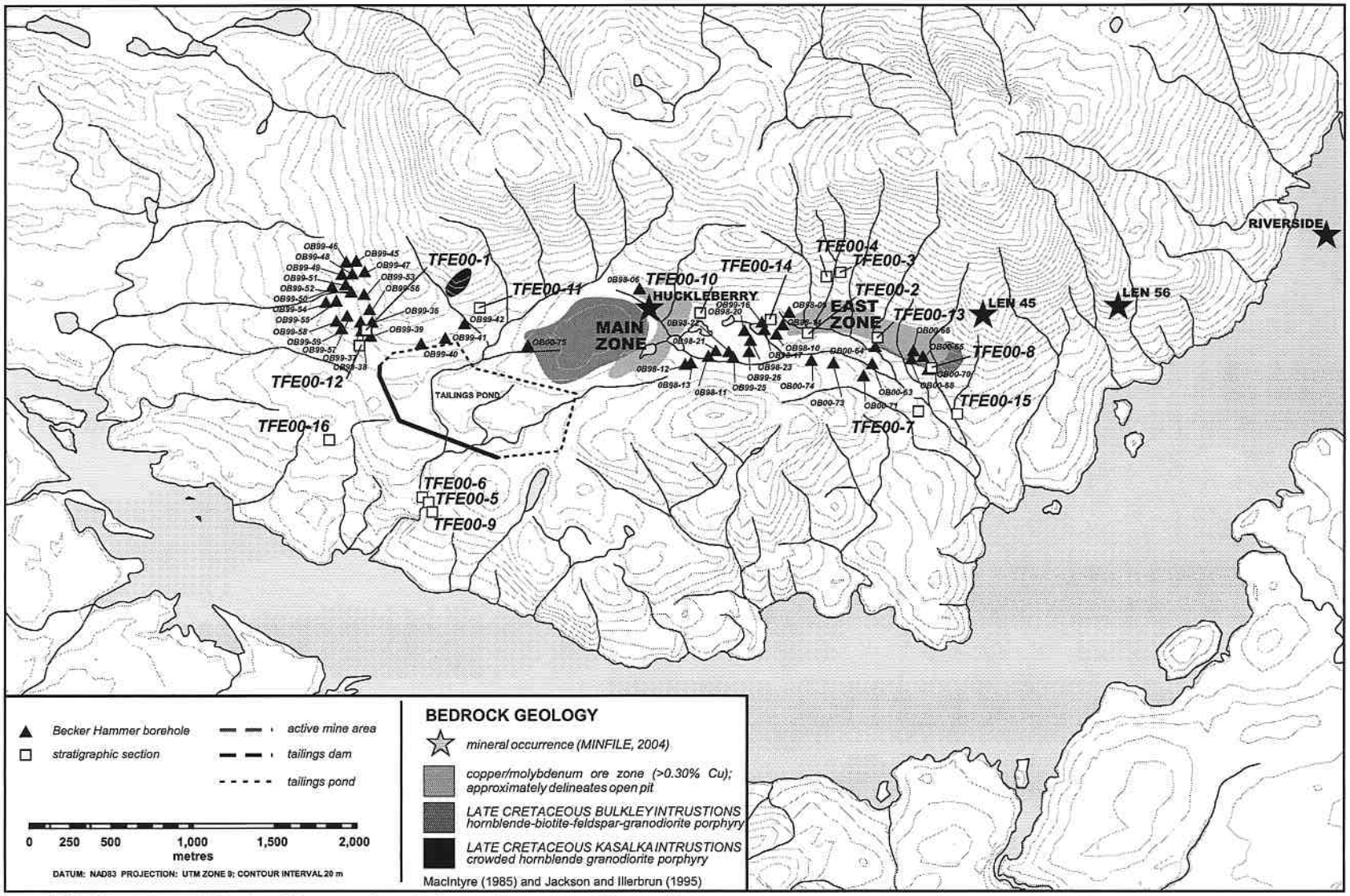


Figure 5.3. Location of Becker Hammer boreholes and stratigraphic sections.

Near-surface samples were collected along road cuts (Figure 5.4a), in hand-dug soil pits (Figure 5.4b), and in naturally eroded sites such as gullies and wave-cut banks on lake shorelines. Samples were collected up to 4 km west of the Main Zone orebody, and up to 2 km east of the East Zone orebody. Near-surface sample depths range from <1 m up to 3 m.

Becker Hammer boreholes and stratigraphic sections provided the sub-surface samples. From 1998-2000, 75 Becker Hammer boreholes were drilled by Huckleberry Mines Limited (HBL). This borehole program was conducted as part of on-site geotechnical investigations to locate appropriate tailings dam construction material. The inherent shear strength, compactability, and low permeability of basal tills make them ideal for building dams. As part of the geotechnical investigation, basal till samples were collected at 1 to 2 m intervals from the boreholes, to a maximum depth of 30 m.

A Becker Hammer drill rig hydraulically pounds a hollow drill stem into the substrate to be sampled (Figure 5.5). Compressed air then forces sediments back up the hollow drill stem to the surface where they are decelerated in a cyclone and collected in a sample pan. Cohesive sediments, like basal till, come up the drill stem in clumps 10-15 cm in diameter. Although all sediment types encountered were described by HBL in drill logs, only samples of basal till were collected. When bedrock was encountered, the depth to the bedrock surface and its lithology were noted.

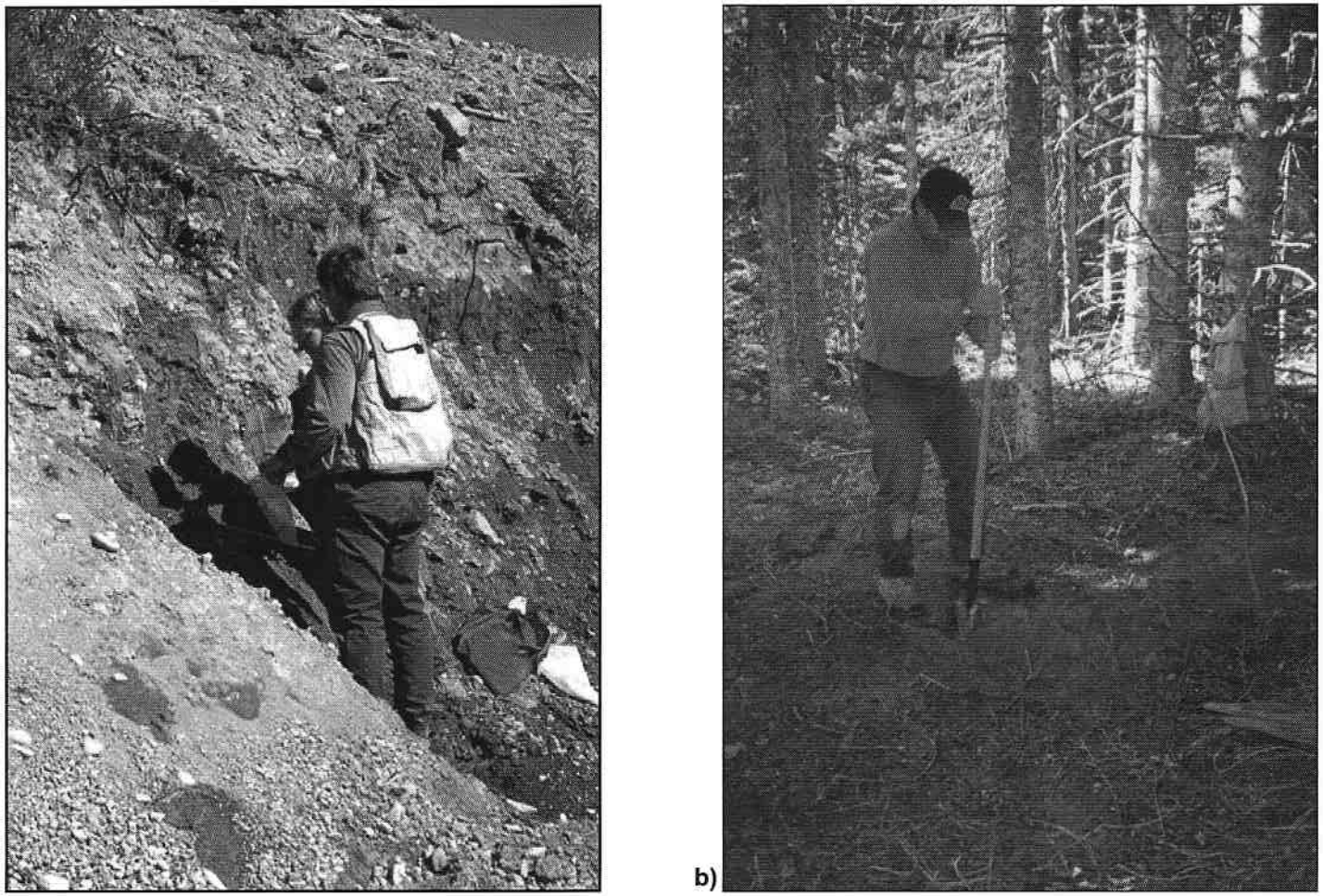


Figure 5.4. Examples of near-surface till sample sites. Near-surface till samples were commonly collected from a) roadcuts, but were also collected from b) hand-dug pits.

Figure 5.5. A Becker Hammer borehole rig, used in this study to collect samples of basal till up to 30 m below surface. This type of borehole rig is effective in most Quaternary sediments and provides good samples of cohesive sediments.

For this study, till samples from 47 Becker Hammer boreholes were obtained. The remaining boreholes either did not contain till, or occurred near another borehole, making only one representative sample necessary. The outside surface of all samples was removed to avoid cross-sample contamination. Samples were examined for possible reconstitution that may have occurred as the original sample was brought up the drill stem.

To supplement the drill samples, vertical profile sampling was conducted at several sites on Huckleberry Mine property (Figure 5.3). An example of a sample site is shown in Figure 5.6. Profile sampling was conducted in excavations ranging in depth from 2 to 28 m below surface (*e.g.* road cuts, vertical walled borrow pits, and trenches). Detailed stratigraphic descriptions were completed at all sites and samples were collected of each stratigraphic unit. At some sites, A and B soil horizons and peats were sampled in addition to till.

Descriptions of each till sample included the following sedimentological data: matrix texture, colour, and density; primary and secondary structures; and clast size and abrasion characteristics (*e.g.* striae). Notes were also made on type of exposure, terrain map unit, geomorphology (*e.g.* topographic position, aspect, slope, drainage), local stratigraphy, clast lithology, and especially on any evidence of mineralization. The proximity of sample sites to bedrock outcrops and the lithologies at these outcrops were also noted.

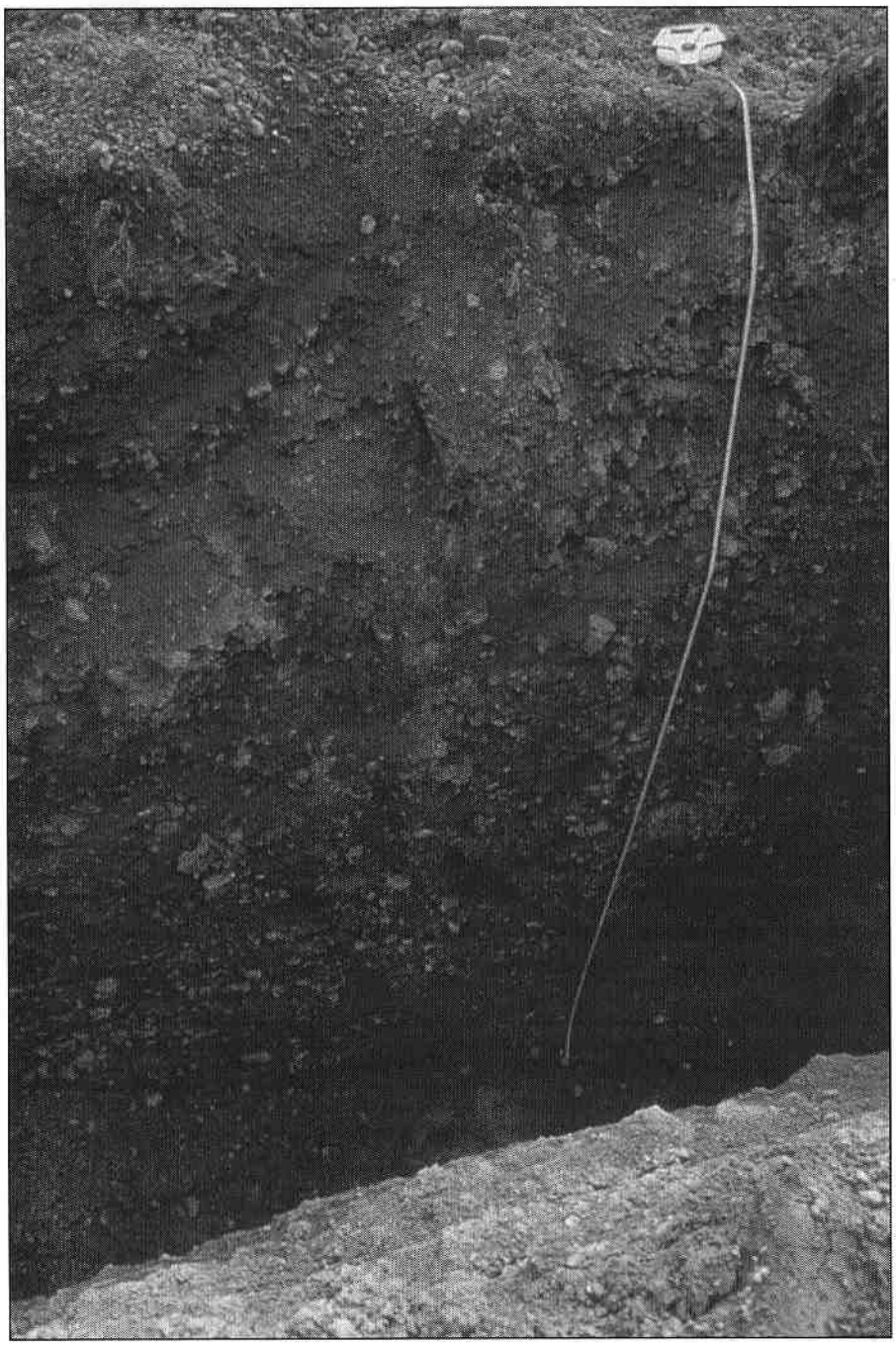


Figure 5.6. Example of vertical profile sample site in basal till. This 5.5 m deep trench was dug with an excavator.

5.3.2 Laboratory Methods and Quality Control

The 336 samples collected for this study were air dried, disaggregated, and sieved to <0.063 mm (or –230 mesh) at Bondar Clegg Canada, Limited, Vancouver, British Columbia. Sample-splits of 19 bulk samples were used to investigate the distribution of copper in different grain-size fractions. These samples were air dried, disaggregated, and sieved to very coarse sand (1.0 to 2.0 mm), coarse sand (0.50 to 1.0 mm), medium sand (0.25 to 0.50 mm), fine sand (0.125 to 0.25 mm), very fine sand (0.063 to 0.125 mm) size fractions. Clay separations were not completed as part of this investigation.

For each sample, or grain-size fraction, a 1.0 g split was analyzed for a total of 37 trace elements by ICP-MS following an acid digestion (a 1 g sample is leached with 6 ml of hydrochloric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20 ml). These analyses were conducted at Acme Analytical Laboratories Limited, Vancouver, British Columbia. The elements determined for using this analytical method, and detection limits, are summarized in Table 5.2. ICP-MS determinations for near-surface and vertical profile samples are provided in Appendix B.

A 25 to 30 g sample-split was also analyzed for 35 elements by instrumental neutron activation analysis (INAA) at Activation Laboratories, Limited, Ancaster, Ontario. Samples and standards were irradiated together with neutron flux monitors in a two-megawatt pool type reactor. After a decay period of seven days, samples were measured on a high resolution germanium detector. Typical count times are 500 seconds. The

ELEMENT		DETECTION LIMIT	UNIT
Aluminum	**Al**	0.01	%
Antimony	**Sb**	0.02	ppm
Arsenic	**As**	0.1	ppm
Barium	**Ba**	0.5	ppm
Bismuth	**Bi**	0.02	ppm
Boron	**B**	1	ppm
Cadmium	**Cd**	0.01	ppm
Calcium	**Ca**	0.01	%
Chromium	**Cr**	0.5	ppm
Cobalt	**Co**	0.1	ppm
Copper	**Cu**	0.01	ppm
Gallium	**Ga**	5	ppm
Gold	**Au**	1	ppb
Iron	**Fe**	0.01	%
Lanthanum	**La**	0.5	ppm
Lead	**Pb**	0.01	ppm
Magnesium	**Mg**	0.01	%
Manganese	**Mn**	1	ppm
Mercury	**Hg**	33	ppb
Molybdenum	**Mo**	0.01	ppm
Nickel	**Ni**	0.1	ppm
Phasphorus	**P**	0.001	%
Potassium	**K**	0.01	%
Scandium	**Sc**	0.1	ppm
Selenium	**Se**	0.2	ppm
Silver	**Ag**	2	ppb
Sodium	**Na**	0.001	%
Strontium	**Sr**	0.5	ppm
Sulphur	**S**	0.02	%
Tellurium	**Te**	0.08	ppm
Thallium	**Tl**	0.02	ppm
Thorium	**Th**	0.1	ppm
Titanium	**Ti**	0.001	%
Tungsten	**W**	0.2	ppm
Uranium	**U**	0.1	ppm
Vanadium	**V**	2	ppm
Zinc	**Zn**	0.1	ppm

Table 5.2. Elements and detection limits for ICP analyses.

elements determined for using this analytical method, and detection limits, are summarized in Table 5.3.

Quality control measures were implemented in both the field and laboratory. For each block of 20 samples submitted for analysis, one field duplicate (taken at a randomly selected sample site), one analytical duplicate (a sample split after sample preparation but before analysis), and one reference standard were included. Reference standards were either certified Canada Centre for Mineral and Energy Technology (CANMET) standards or one of several British Columbia Geological Survey (BCGS) geochemical reference materials. Field duplicate samples are used to measure the combined sampling and analytical variability, whereas analytical duplicate samples only indicate analytical variability. The analyses of field and analytical duplicate samples are used to estimate the precision of a geochemical dataset, while reference standards are typically used to measure the accuracy of an analytical method. In this study, however, reference standards are used to measure analytical precision.

5.3.3 Analysis of Precision

Copper, molybdenum, gold, silver, and zinc were selected for analysis of precision, as they are the main commodities in the Huckleberry Mine region (Panteleyev, 1995; Jackson and Illerbrun, 1995; MINFILE, 2004). Although not mined for specifically at Huckleberry Mine, zinc is included, as it is a reported commodity at the Len 56 and Riverside mineral occurrences. These five elements are also used in the discussion that

ELEMENT		DETECTION LIMIT	UNIT
Antimony	**Sb**	15	ppm
Arsenic	**As**	0.5	ppm
Barium	**Ba**	50	ppm
Bromine	**Br**	0.5	ppm
Calcium	**Ca**	1.0	%
Cerium	**Ce**	3	ppm
Cesium	**Cs**	1	ppm
Chromium	**Cr**	5	ppm
Cobalt	**Co**	1	ppm
Europium	**Eu**	0.2	ppm
Gold	**Au**	2	ppb
Hafnium	**Hf**	1	ppm
Iridium	**Ir**	5	ppb
Iron	**Fe**	0.02	%
Lanthanum	**La**	0.1	ppm
Lutetium	**Lu**	0.05	ppm
Mercury	**Hg**	1	ppm
Molybdenum	**Mo**	1	ppm
Neodymium	**Nd**	5	ppm
Nickel	**Ni**	20	ppm
Rubidium	**Rb**	15	ppm
Samarium	**Sm**	0.1	ppm
Scandium	**Sc**	0.1	ppm
Selenium	**Se**	3	ppm
Silver	**Ag**	5	ppm
Sodium	**Na**	0.01	%
Strontium	**Sr**	500	ppm
Tantalum	**Ta**	0.05	ppm
Terbium	**Tb**	0.5	ppm
Thorium	**Th**	0.5	ppm
Tin	**Sn**	100	ppm
Tungsten	**W**	1	ppm
Uranium	**U**	0.5	ppm
Ytterbium	**Yb**	0.2	ppm
Zinc	**Zn**	50	ppm

Table 5.3. Elements and detection limits for INAA analyses.

follows on the transport of mineralized detritus in till from known mineralization in the Huckleberry Mine region.

Figures 5.7a-b and 5.8a-b are scatter plots of trace elements measured in field and analytical duplicates, respectively. High correlation coefficients (R^2 >0.9) for most elements indicate good reproducibility, and suggest a relatively high degree of both sampling and analytical precision. Copper in the field duplicates, however, produced an unusually weak correlation (R^2=0.342). Much stronger field duplicate correlations have been reported for copper in till samples collected in the Babine porphyry copper belt (R^2=0.933; Levson *et al.*, 2002), and in the Tetachuck Lake and Marilla map areas (R^2=0.954; Levson and Mate, 2002). The outlier in the bottom right of this plot (Figure 5.7a; sample 00-6671; 1111 and 181 ppm Cu) is mainly responsible for the low R^2 value. This same sample is also an outlier in plots of gold values in field duplicates. When this sample is not included, a stronger correlation is observed (R^2 = 0.881). Sample 00-6671, and its field duplicate, were collected directly above hornfelsed pyritic andesite, approximately 300 m southeast of the East Zone orebody, in a dense, brown, sandy-silt diamicton. Given that visible sulphides (up to 3 mm in size) and mineralized clasts were observed in the till matrix of many samples (pyrite +/- chalcopyrite), the nugget effect (the occurrence minerals or native metals within the sample matrix as rare, discrete grains) could explain the general poor reproducibility of copper values in some field duplicates. Evidence of a nugget effect in copper is unusual and this may be the first documented case of this effect in basal tills. Certainly, it has not been described before in detailed studies of copper in tills in central British Columbia (*e.g.* Levson 2001a; Levson

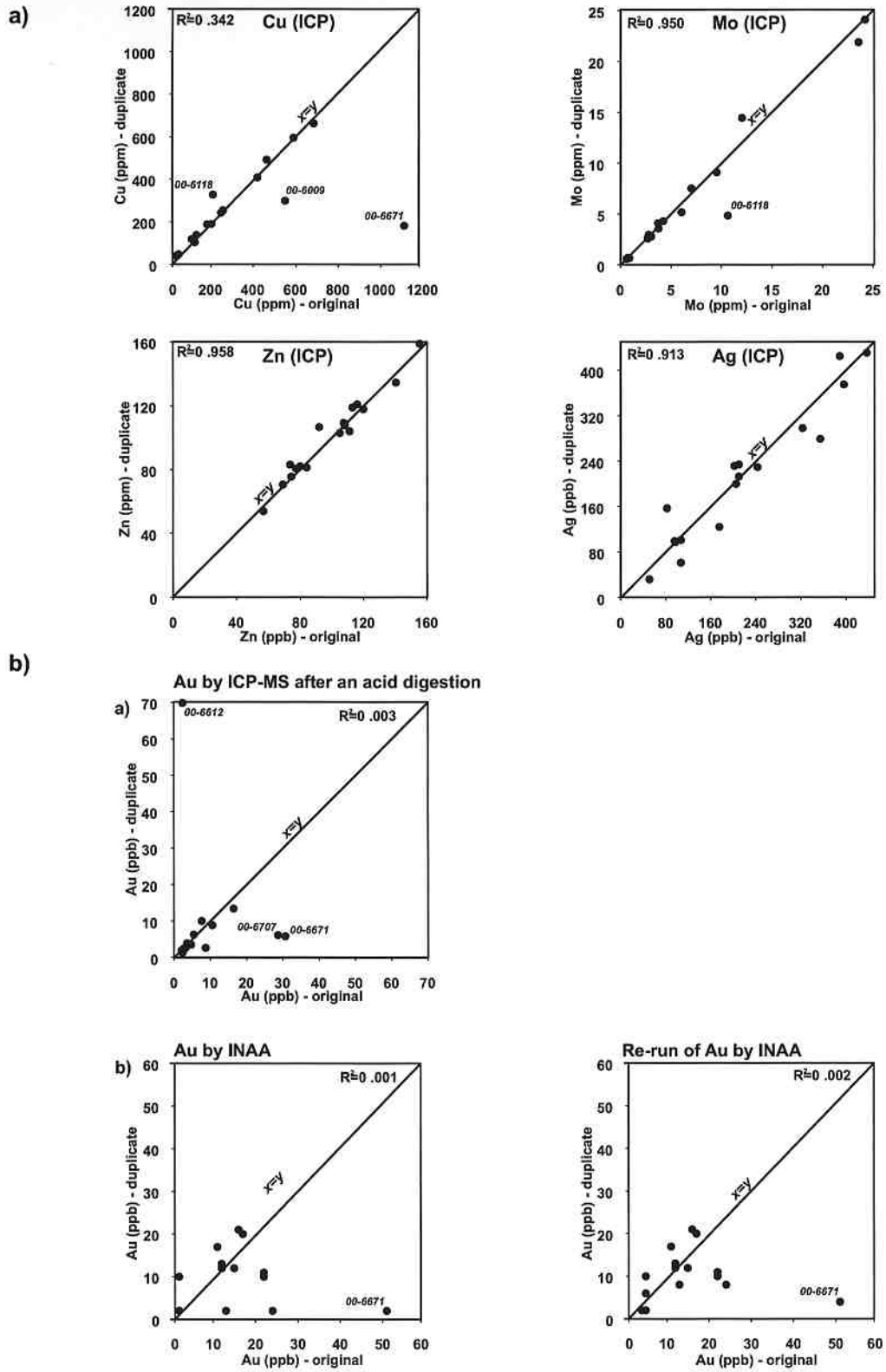


Figure 5.7. Field duplicate scatter plots. a) Copper, molybdenum, silver, and zinc (n=17). Determinations for these elements were by ICP-MS following an acid digestion. b) Gold (n=17). Determinations for gold were by ICP-MS following an acid digestion and by INAA. Weak correlation values from initial determinations prompted a re-run of the samples by INAA.

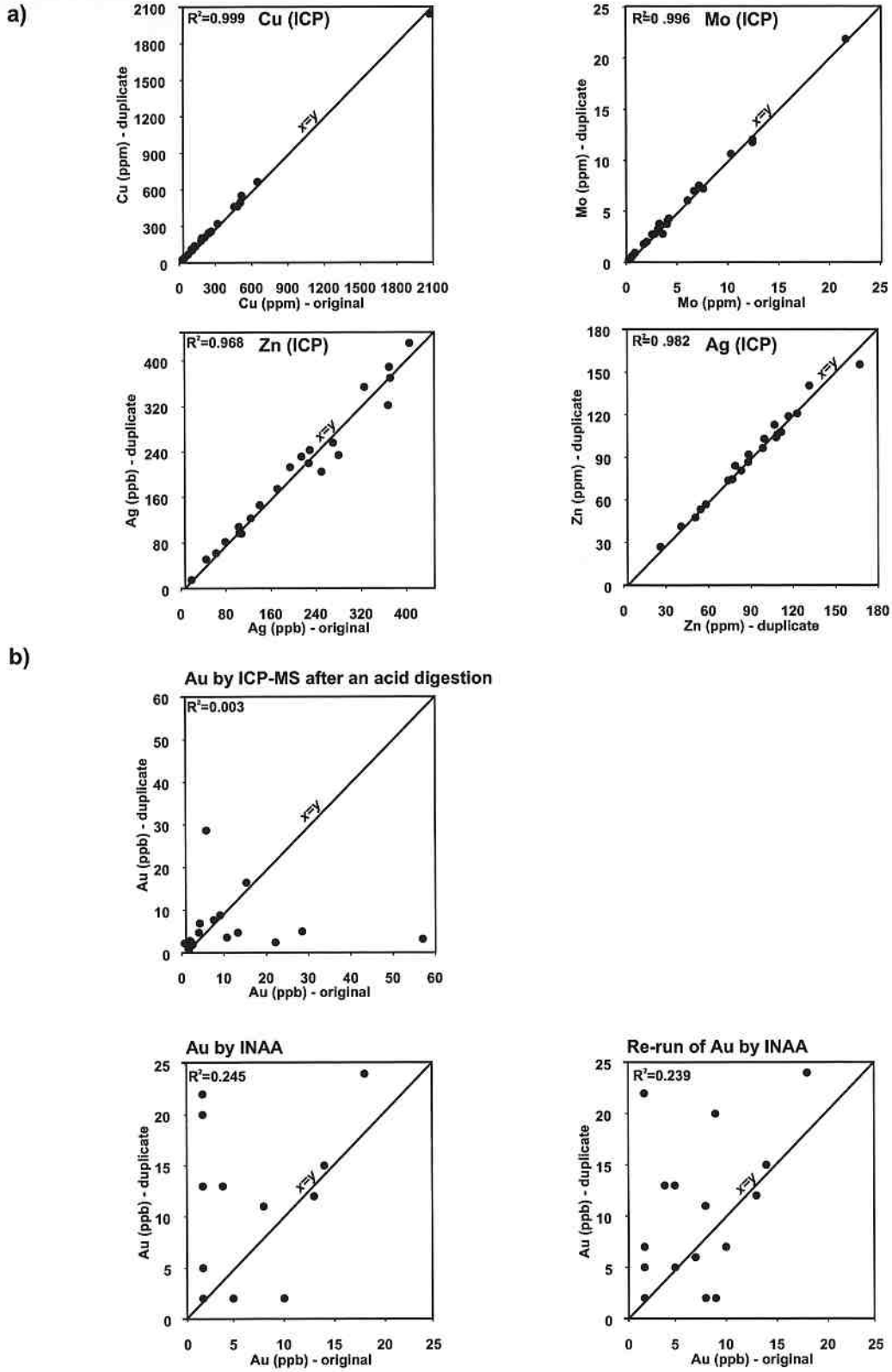


Figure 5.8. Analytical duplicate scatter plots. a) Copper, molybdenum, silver, and zinc (n=21). Determinations for these elements were by ICP-MS following an acid digestion. b) Gold (n=21). Determinations for gold were by ICP-MS following an acid digestion and by INAA. Weak correlation values from initial determinations prompted a re-run of the samples by INAA.

et al., 2002). An alternative explanation for poor reproducibility of copper values in some field duplicates could be contamination during preparation in the laboratory. Other possible geological variables that might effect the reproducibility of copper might include variability in bedrock mineralogy (i.e. which copper bearing minerals are present), grain size analyzed, or variability of hydromorphic dispersion of copper in basal till.

Copper values in samples 00-6609 and 6118, and molybdenum values in sample 00-6118, also appear to be outliers (Figure 5.7a). These two samples were collected from approximately 2.5 m below surface in two adjacent Becker Hammer boreholes (OB99-40 and 41). Although visible sulphides and mineralized clasts were not observed in these two samples specifically, they were in the lower sample collected from borehole OB99-41, to the west in samples collected from borehole OB00-75, and to the south in the upper portion of section TFE00-2 (Figure 5.3). Although not as extreme an example as above, the low reproducibility could also be explained by the nugget effect. However, this could also be the result of contamination as the sample was brought up to surface in the Becker Hammer drill stem, or during sample preparation in the laboratory.

Figures 5.7b and 5.8b are scatter plots of gold values for field and analytical duplicates, respectively. As seen in these figures, scatterplots of gold values in field and analytical duplicates, determined by ICP-MS, both have R^2 values of 0.003. The correlation between field duplicate samples appears to be even weaker for gold values determined by INAA (R^2=0.001). The opposite is true in the case of analytical duplicate samples as the correlation between gold values in duplicate pairs, determined by INAA, improves

(R^2=0.245). A re-run of the same field and analytical duplicate samples, using INAA, produced similarly poor results. It is interesting to note that in addition to being an outlier in copper plots, sample 00-6671 is also an outlier in gold values of field duplicate samples. Differences in variability between ICP-MS and INAA determinations could be the result of differences in the size of sample analysed (1 g and 25 to 30 g, respectively). Overall poor reproducibility in gold values, using either method, is attributed to the nugget effect. For all elements except gold, there is an increase in R^2 values for analytical duplicate plots. This suggests that there is more variability in sample material at a sample site than variability within a given sample, as you would expect.

Another measure of analytical precision is provided in Table 5.4. In this table, repeat determinations, conducted as part of this study, for two BCGS geochemical reference materials are presented; six for GSB Till 99 (B) and eight for Red Dog 97. Percent relative standard deviation values (%RSD; a measure of data dispersion around the mean) have been calculated for the five elements by dividing the standard deviation by the absolute value of the mean and multiplying by 100. As seen in Table 5.4, %RSD values vary from 1.8 to 7.6. Copper and molybdenum typically have lower %RSD values, while gold in both reference materials, has the highest. In exploration geochemistry, %RSD values of 10 to 15 are considered acceptable (R. Lett, pers. comm., 2004). Percent relative standard deviation values presented here, therefore, indicate that the analytical precision for data used in this study is high.

SAMPLE	REFERENCE MATERIAL	Cu ppm 0.01	Mo ppm 0.01	Pb ppm 0.01	Au ppb 1	Ag ppb 2	Zn ppm 0.1
00-6033	STD (GSB Till 99 (B))	159.08	0.77	212.85	23	1252	355.5
00-6106	STD (GSB Till 99 (B))	162.02	0.77	221.73	25.8	1299	353.3
00-6137	STD (GSB Till 99 (B))	165.96	0.82	214	24.9	1296	346.1
00-6163	STD (GSB Till 99 (B))	163.64	0.78	205.65	27.8	1445	357.6
00-6420	STD (GSB Till 99 (B))	156.21	0.85	221.76	17.9	1265	333.3
00-6453	STD (GSB Till 99 (B))	160.68	0.86	201.6	30.3	1301	344.9
	Mean	165.96	0.86	213.04	21.6	1361	345.8
	Standard deviation	4.01	0.04	7.75	1.6	41	6.3
	%RSD	**2.42**	**4.08**	**3.64**	**7.4**	**3**	**1.8**
00-6077	STD(RED DOG 97)	172.2	13.14	7.19	23.5	70	49.1
00-6084	STD(RED DOG 97)	172.19	14.07	7.82	43.7	74	48.9
00-6155	STD(RED DOG 97)	165.1	12.96	7.7	32.2	62	54.4
00-6188	STD(RED DOG 97)	168.72	14.27	7.57	28.8	73	53
00-6207	STD(RED DOG 97)	166.32	14.27	7.66	23.8	76	55
00-6433	STD(RED DOG 97)	161.71	13.83	7.39	44.5	76	50.5
00-6469	STD(RED DOG 97)	169.76	13.92	7.41	32.9	73	55.7
00-6643	STD(RED DOG 97)	173.82	13.6	7.83	22.8	79	50.4
	Mean	171.04	13.41	7.56	23.8	74	50.0
	Standard deviation	5.42	0.38	0.43	1.8	4	3.1
	%RSD	**3.17**	**2.84**	**5.74**	**7.6**	**6**	**6.2**

Table 5.4. Percent relative standard deviation (%RSD) values for BCGS reference materials. Analytical data presented here were produced for this study.

5.3.4 Presentation of Analytical Data

During compilation of the geochemical data, till samples were removed from analysis if descriptions indicated the possibility of an origin other than basal till. Till samples with descriptions that indicated only a minor component of downslope movement (*i.e.* colluviation or re-mobilization) were, however, included in a final dataset. Although primary depositional characteristics such as density, jointing and fissility, and orientation of pebble fabrics may have been altered, it is believed that these till samples still dominantly reflect the transport of mineralized detritus in the subglacial environment.

To improve on the spatial coverage of near-surface samples, five shallow Becker Hammer samples are included in the near-surface data (00-6018, 6044, 6090, 6113, and 6150; Figure 5.3). The average depth of these samples is 2.5 m, with the maximum being 3.5 m (00-6018). Compositionally, these till samples are very similar to near-surface till samples.

Element concentrations in near-surface samples have been categorized into percentile classes following a commonly used method for presenting geochemical data (BC RGS 46, 1988; Cook *et al.*, 1999; Plouffe, 2000; Bobrowsky and Bichler, 2001; Cook and McConnell, 2001; Plouffe, 2001; Levson *et al.*, 2002). For this study, five percentile classes were used: 0-50, >50-70, >70-90, >90-95, >95, and samples with >90 percentile concentrations are here referred to as "elevated". It should be noted, however, that this term is used only in describing and comparing analytical data specific to this study because these data are from samples collected in the vicinity of ore-grade bedrock with

sample density up to 17 samples/km^2. Consequently, the majority of data presented here would be considered elevated when compared to usual data from a lower-sample-density (*e.g.* 1 sample/5 km^2) regional till sampling programs.

An east/west cross-section of Becker Hammer borehole till samples was constructed to investigate dispersal from the Main and East zone orebodies in the third dimension. The selection of boreholes for this cross-section was limited to those located down-ice (*i.e.* east/west) of, and between, the Main and East zones, and to those boreholes having more than one sample throughout their length. In total, ten Becker Hammer boreholes were selected for the cross-section. Four are located west of the Main Zone area (OB99-39, 41, 58, and OB00-75), three between the Main and East Zone areas (OB98-10, 12, 21), and three towards the eastern end of the East Zone area (OB00-65, 71, 74) (Figure 5.2). ICP-MS determinations for Becker Hammer samples are provided Appendix C.

The boreholes range in depth from 7 to 30 m; eight boreholes reached bedrock. In total, 82 samples were used to produce profiles of copper concentrations. Till sampled from these boreholes was typically a dense diamicton with a clayey-silt to a silty-clay matrix and numerous striated clasts, pointing to a sub-glacial origin. Sulphide grains (up to 3 mm in size) and mineralized andesite clasts (pyrite +/- chalcopyrite) were abundant in many of the samples.

5.4 KNOWN SOURCES OF MINERALIZATION

There are five known sources of mineralization in the study area, and the locations are included in all symbol plots that follow. The two largest sources are the Main and East Zone orebodies (see Figure 5.2). The Main Zone orebody is approximately 750 m long and 350 m wide, and wraps around the Main Zone stock. The Main Zone orebody is the most westerly occurring known source of mineralization. The Huckleberry Cu-Mo-Ag-Au occurrence (MINFILE, 2004; see Figure 5.2; Table; 5.5) is located on the northwest end of the Main Zone orebody. The East Zone orebody is approximately 175 m wide and almost 900 m long, and extends east into the adjacent stock.

These large deposits contain copper and molybdenum mineralization with minor recoverable amounts of gold and silver. Mineralization occurs within a stockwork system of fractures and veinlets mainly in the hornfelsed, fragmental andesites of the Early Jurassic Telkwa Formation. Within the core of the mineralized areas, sulphide mineralization consists of chalcopyrite (1 to 3%), molybdenite (<0.3%), and pyrite (1 to 3%) (Blower, 2000). Mineralization grades outward from this to a pyrite rich (1 to 5%) halo with minor chalcopyrite (O to 0.3%). Supergene chalcocite and native copper are only rarely observed in the bedrock. Minor malachite and tenorite can also occur on bedrock surfaces, in particular on hill-flanks outside of the Main and East Zone pit limits (Blower, 2000).

The dominant control on emplacement of mineralization is the contact of the stocks themselves. The orebodies occur as annular shells along the margins of, and adjacent to,

MINFILE NO	NAME	STATUS	COMMODITY	DEPOSIT TYPE
093E 036	RIVERSIDE	Showing	Au, Ag, Cu, Zn	Polymetallic veins Ag-Pb-Zn±Au
093E 037	HUCKLEBERRY	Producer	Cu, Mo, Ag, Au	Porphyry Cu ± Mo ± Au
093E 038	LEN 45	Showing	Cu	Porphyry Cu ± Mo ± Au
093E 039	LEN 56	Showing	Cu, Zn	Polymetallic veins Ag-Pb-Zn±Au

Table 5.5. Mineral occurrences near Huckleberry Mine.

the stocks. The grade of mineralization is dependant on the intensity of potassic alteration of the intrusive and host rocks, and the density of fractures in host rocks (MacIntyre, 1985; Panteleyev, 1995; Jackson and Illerbrun, 1995). Although there is copper and molybdenum mineralization within both stocks, nearly all ore mined is from the adjacent volcanic rocks (S. Blower, pers. comm., 2000). A detailed description of these deposits is provided in Chapter 1.0 (Introduction). It should be noted that the orebodies are approximately delineated by economic mineralization (*i.e.* >0.30% Cu) and that mineralization, although at lower concentrations, extends out from these orebodies.

The remaining three sources of known mineralization are mineral showings. The Len 45 Cu showing is located approximately 250 m northeast of the East Zone intrusion (MINFILE, 2004; see Figure 5.2; Table 5.5). Occurring as isolated stringers of chalcopyrite within hornfelsed Telkwa Formation rocks, this porphyry copper showing appears to be related to a narrow northwest-trending, Tertiary-age, feldspar porphyry dyke (MacIntyre, 1985; Panteleyev, 1995; MINFILE, 2004). MacIntyre (1985) mapped another northwest-trending dyke, of similar composition <300 m east of this occurrence but there is no documented mineralization associated with this dyke.

The second source, located almost 1 km east of Len 45, is Len 56 (MINFILE, 2004; see Figure 5.2; Table 5.5). This is a hydrothermal vein-type Cu-Zn showing that occurs as quartz and calcite veinlets that are up to 10 cm wide, and spaced erratically within an area approximately 250 m by 125 m. These veinlets contain arsenopyrite, chalcopyrite, pyrite, and sphalerite mineralization (Lefebure and Church, 1996; MINFILE, 2004).

Lastly, the most easterly known source of mineralization is the Riverside showing (MINFILE, 2004; see Figure 5.2; Table 5.5). This is a replacement vein-type Au-Ag-Cu-Zn showing with veins and fractures up to approximately 36 cm wide, carrying arsenopyrite and minor amounts of pyrite, sphalerite, and chalcopyrite (Lefebure and Church, 1996; Alldrick, 1996; MINFILE, 2004). Riverside is now underwater following the flooding of the Nechako Reservoir.

There is one other bedrock unit worth mentioning here. Cropping-out 500 m northwest of the Main Zone stock is a small Late Cretaceous stock that has intruded Telkwa Formation andesites. Belonging to the Kasalka Intrusions, this stock is approximately 250 m long and 150 m wide and trends northeast (MacIntyre, 1985). There are no reports of mineralization in the vicinity of this small stock.

5.5 RESULTS

5.5.1 Near-surface Samples

The mean and median copper concentrations for near-surface basal tills of the Huckleberry Mine region are 489 and 216 ppm, respectively (n=106). The minimum concentration is 29 ppm while the maximum is 8924 ppm. Other summary statistics for selected elements are provided in Table 5.6. Proportional symbol plots and frequency histograms for each element in near-surface samples are given in figures 5.9 to 5.13.

	Cu	Mo	Au	Ag	Zn
n =	106	106	106	106	106
maximum	8924.03	216.13	110.9	1721	207.1
minimum	29.14	0.53	0.7	7	34.0
mean	488.64	8.63	11.9	165	88.7
median	216.31	3.09	6.1	105	85.5
standard deviation	1028.12	23.17	16.4	196	28.2

Table 5.6. Summary statistics for near-surface till samples.

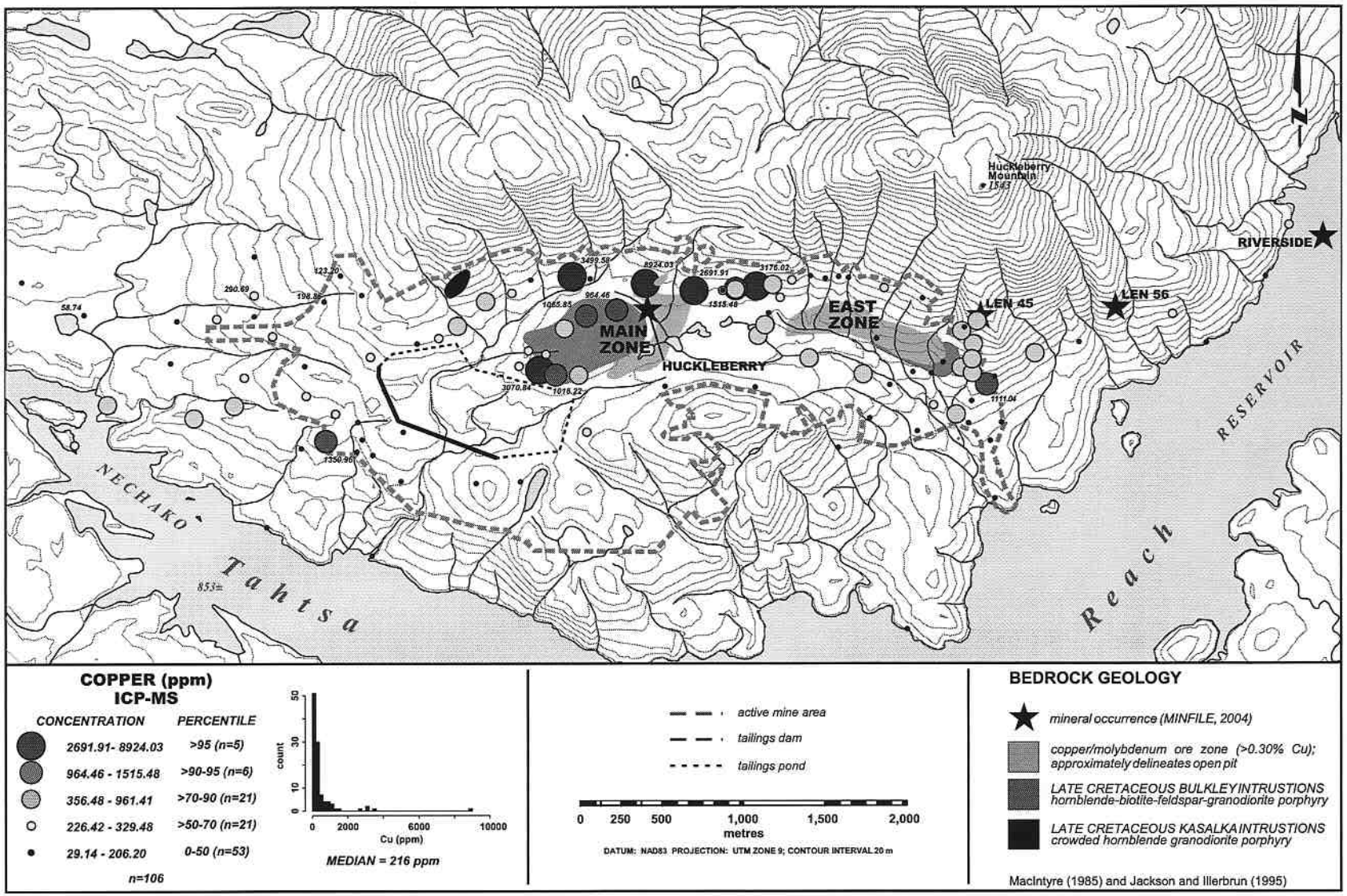


Figure 5.9. Copper concentrations in near-surface till samples. Greater than 90 percentile concentrations are labelled.

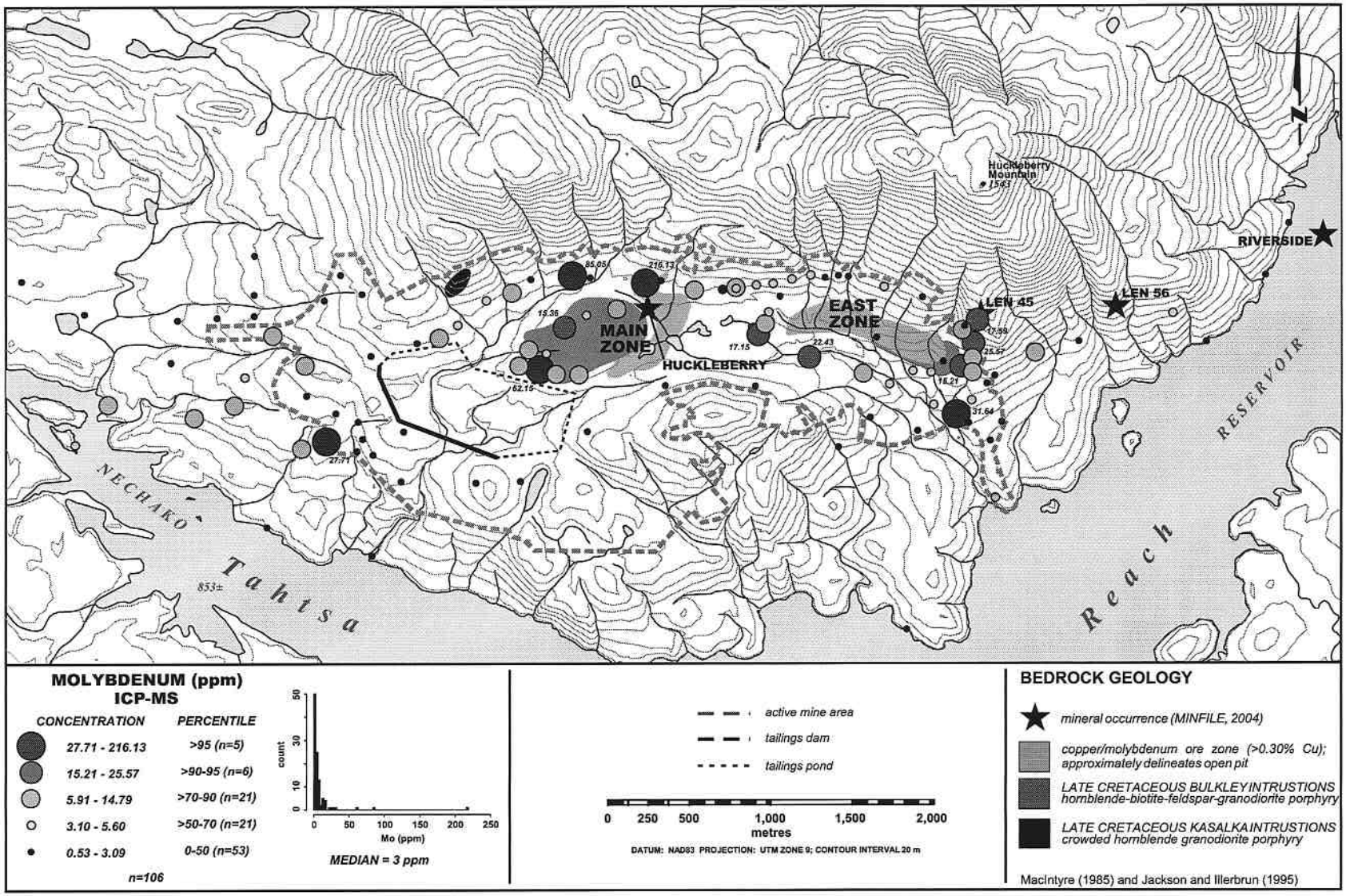


Figure 5.10. Molybdenum concentrations in near-surface till samples. Greater than 90 percentile concentrations are labelled.

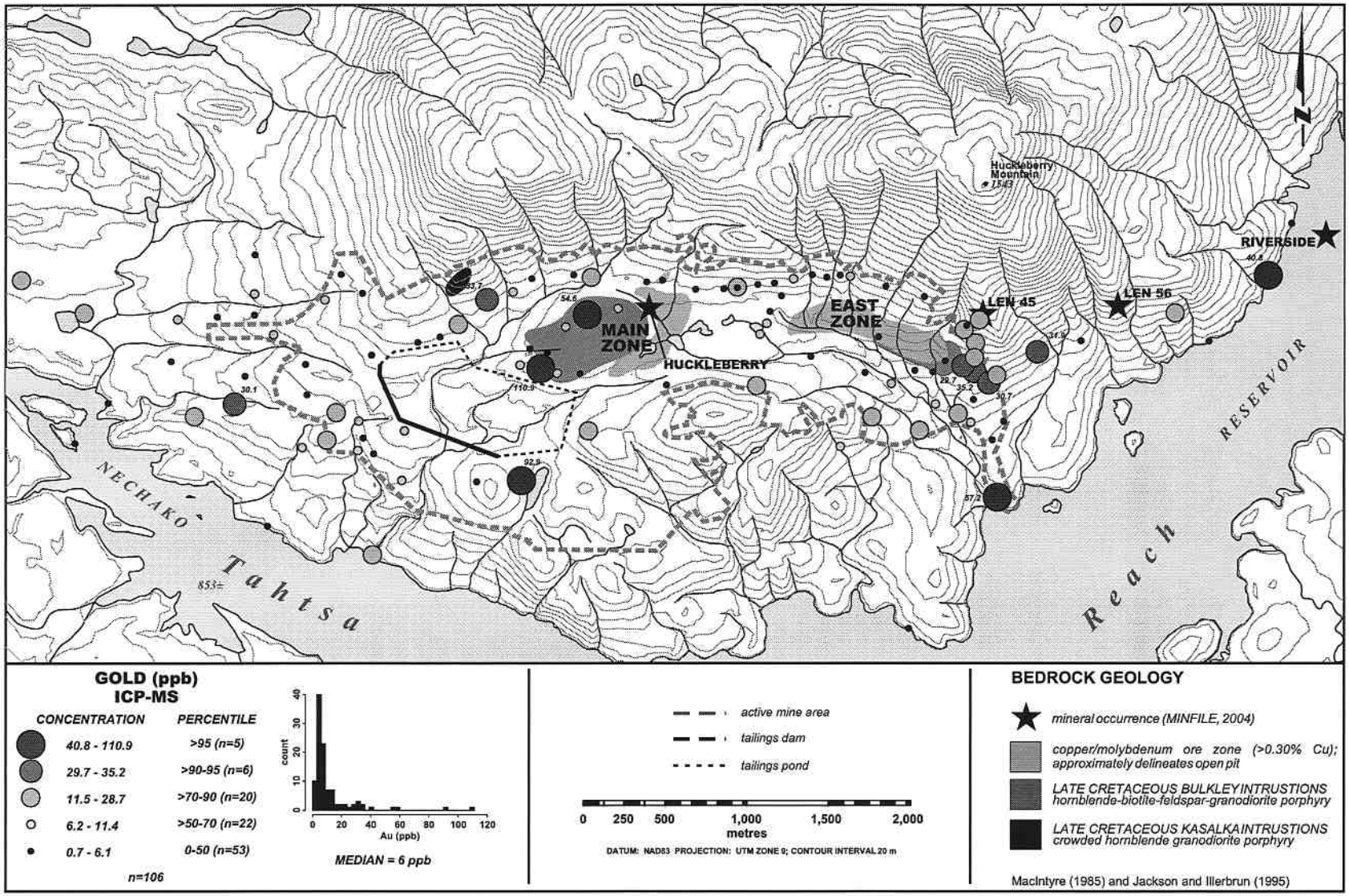


Figure 5.11. Gold concentrations in near-surface till samples. Greater than 90 percentile concentrations are labelled.

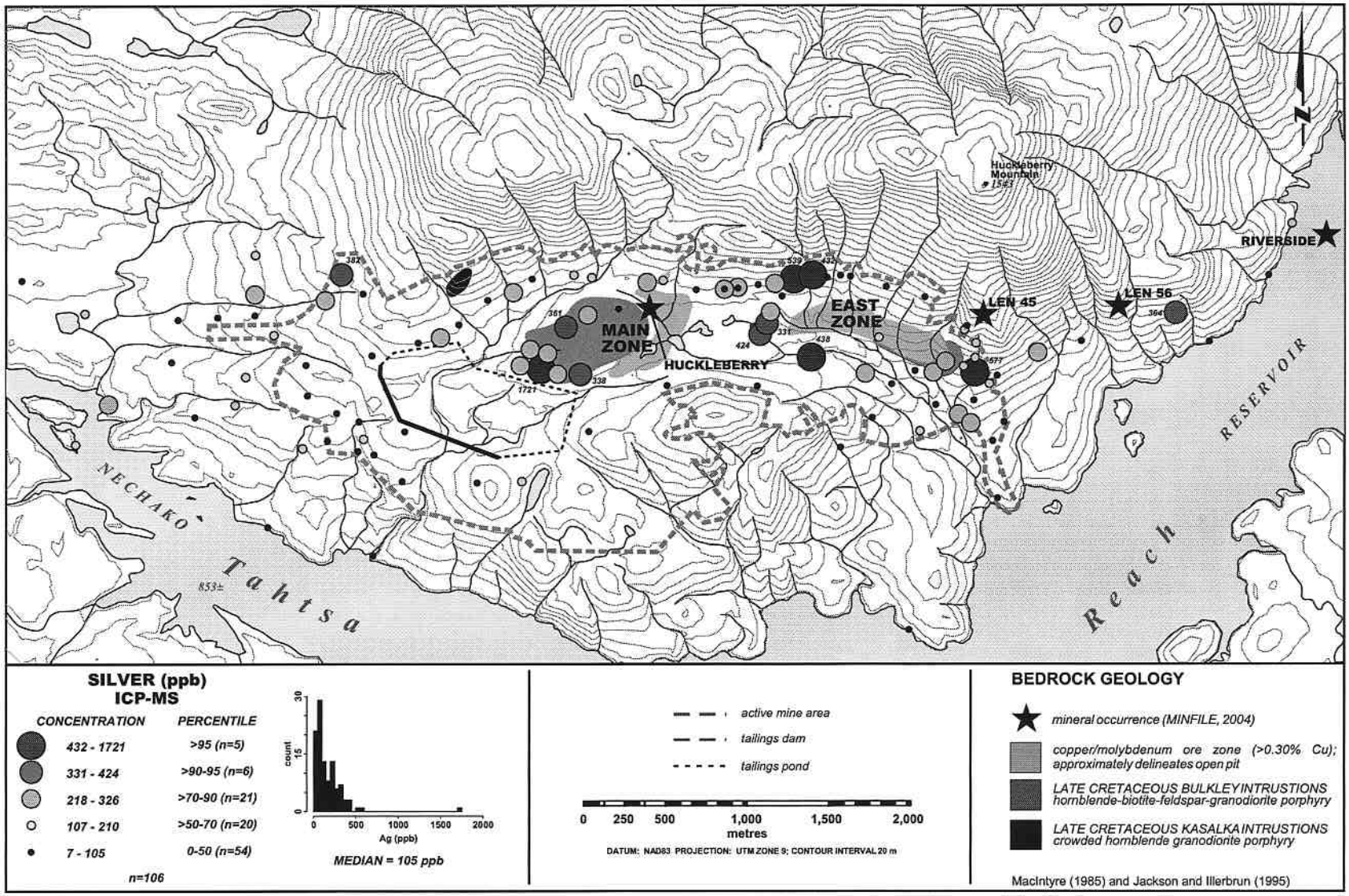


Figure 5.12. Silver concentrations in near-surface till samples. Greater than 90 percentile concentrations are labelled.

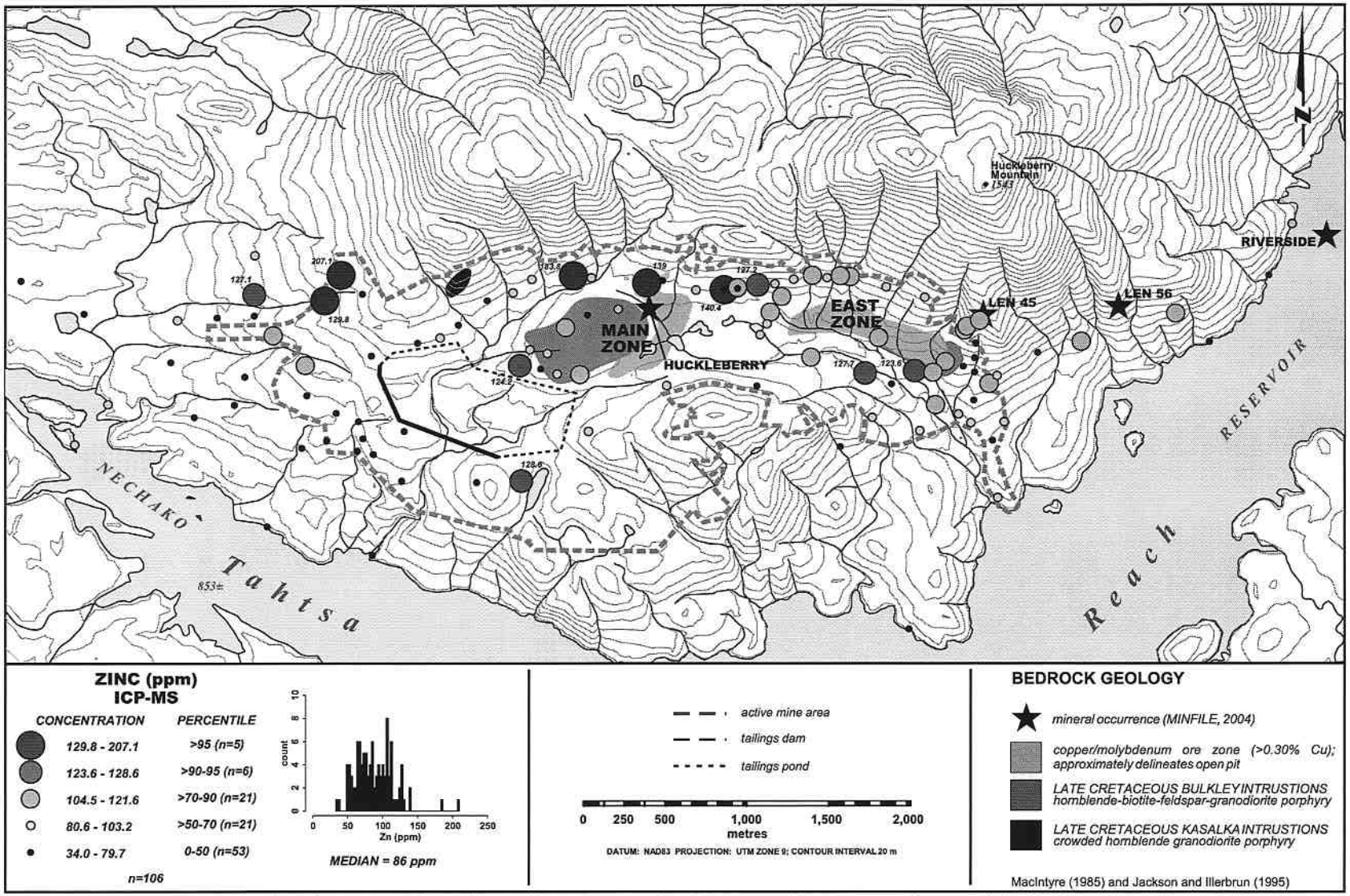


Figure 5.13. Zinc concentrations in near-surface till samples. Greater than 90 percentile concentrations are labelled.

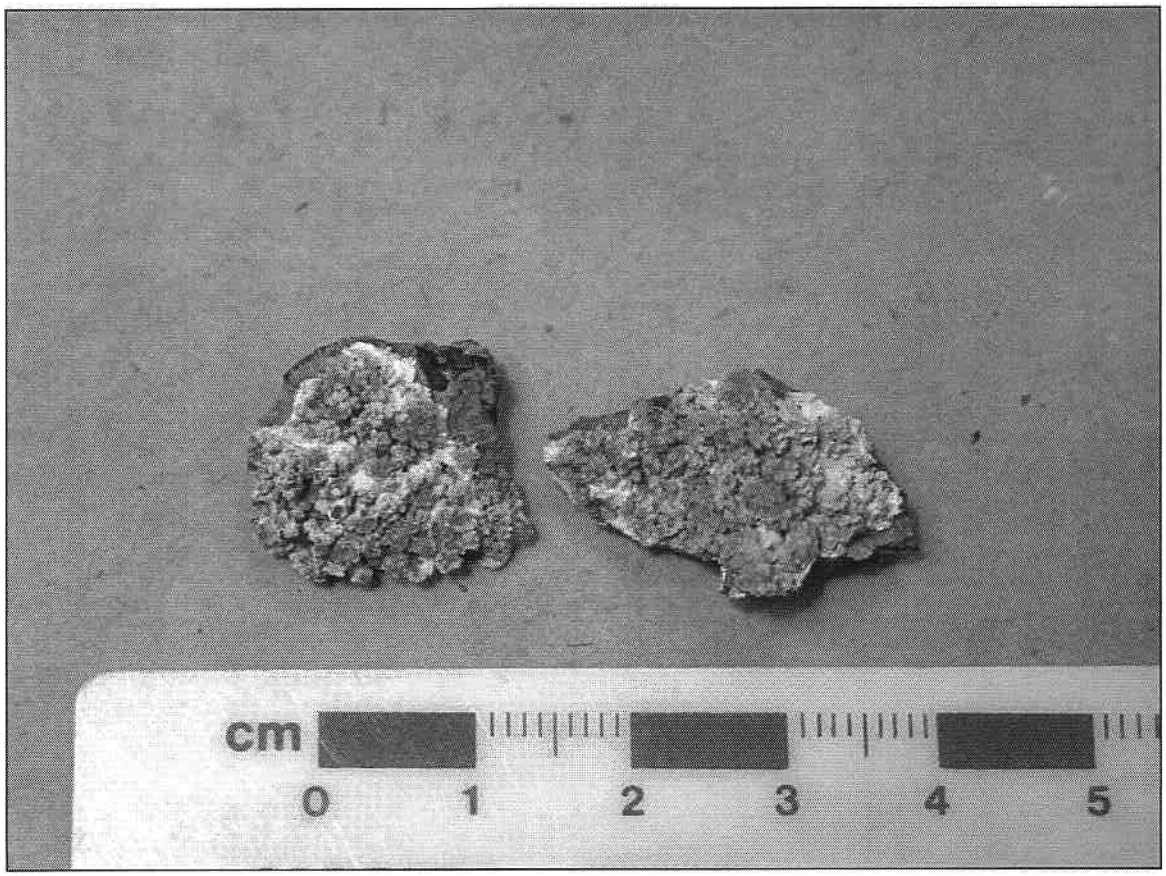


Figure 5.14. Amorphous copper precipitate, found on ore-grade bedrock above Main Zone pit.

Clearly, elevated element concentrations in near-surface till samples are associated with mineralization in the Huckleberry Mine region. All samples with >95 percentile copper values, occur within 500 m of the Main and East Zone orebodies. Greater than 90 percentile copper concentrations can occur up to 2 km down-ice of known mineralization. Maximum gold and silver values (111 and 1721 ppb, respectively) occur over the western end of the Main Zone stock.

The highest copper and molybdenum values in the study (8924 ppm and 216 ppm, respectively) occur in one sample at the west end of the Main Zone. This sample was collected 30 cm above mineralized andesite of the Main Zone orebody. A 0.5 to 1.0 cm thick amorphous copper precipitate was found on bedrock at this sample site (Figure 5.14). The presence of this precipitate suggests that copper in the area is being transported in solution and reprecipitated, at least locally. A selective leach experiment performed using a hydroxylamine leach, on a subset of the near-surface till samples, indicates that in most cases the majority of copper present in till is detrital (Table 5.7; see Appendix D for all ICP-MS determinations). Selective leach data presented here, however, must be used with caution, as the low pH hydroxylamine leach used in this experiment probably liberated some of the copper attributed to detrital as well as to hydromorphic transport (R. Lett, pers. comm., 2004). These results are supported by a similar selective leach experiment performed by Levinson and Carter (1979) in tills near the past producing Bell porphyry copper mine, which used an ammonium oxalate treatment, and also showed that mechanical transport of copper dominated.

SAMPLE	HYDROXYLAMINE LEACH[1] Cu (ppm)	ACID DIGESTION[2] Cu (ppm)	SUM[3] (Cu ppm)	PECENTAGE OF Cu EXTRACTED BY HYDROXYLAMINE LEACH %
00-6018	249	650	899	28
00-6149	197	346	543	36
00-6620	609	718	1327	46
00-6631	5755	2991	8746	66
00-6646	115	1107	1222	9
00-6651	273	3490	3763	7
00-6666	54	42	96	56
00-6668	208	269	477	44
00-6699	111	131	242	46
00-6703	227	875	1102	21
00-6711	44	264	308	14

[1] Cu values obtained from hydroxylamine leach (a 1 g sample is leached in 10ml of 0.1M hydroxylamine hydrochloric at 60°C for 1 hour, diluted to 20 ml, then analyzed by ICP-MS)

[2] Cu values obtained from acid digestion after hydroxylamine leach (remaining pulp is leached with 6 ml of hydrochloric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20 ml, then analyzed by ICP-MS)

[3] sum (sum of copper values obtained by hydroxylamine leach and acid digestion)

[4] percentage of Cu in sample extracted by hydroxylamine leach (sum divided by Cu obtained from hydroxylamine leach)

Table 5.7. Selective leach data for a subset of near-surface till samples.

As mentioned above, copper concentrations in the tills of the Huckleberry Mine region are higher than those found in regional data sets. For example, east of the Huckleberry Mine region, in NTS map areas 93F/5 and 12, the median copper value is reported to be 24 ppm (Levson and Mate, 2002) compared to a median of 216 ppm reported in this study. Copper concentrations in this study are also higher than values reported in another detailed study conducted on the Nechako Plateau. For example, at the Nak porphyry copper prospect, in the Babine copper-porphyry belt, maximum and median copper values in basal tills are 962 ppm and 66 ppm, respectively, compared to a maximum copper concentration in this study of 8924 ppm. Maximum copper concentrations in basal till samples collected in the Babine porphyry belt, around the Morrison deposit and now reclaimed Bell mine are 230 ppm and 1550 ppm, respectively. These case study data are part of a regional dataset that has a median copper value of 44 ppm (Levson *et al.*, 2002).

A more realistic approximation of median copper values for the Huckleberry Mine region might come from tills that have an unmineralized bedrock source. For example, lower till units at section TFE00-1, located 2 km west of the Main Zone, are thought to have a provenance somewhere to the west of Huckleberry valley, where currently there are no documented mineral occurrences. The median copper value of seven deep sub-surface Becker Hammer borehole samples north of section TFE00-1 (up to 27 m below surface), and one sample collected from the lower till unit at section TFE00-1 (13.5 m below surface), is 41 ppm. A similarly low median copper value of 44 ppm comes from two samples collected along the north shore of Tahtsa Reach, directly south of the Huckleberry mine site. The values suggest that an appropriate approximation of median

copper values in the Huckleberry Mine region might be in the 40 to 50 ppm range, which is in-line with the above-mentioned, regional datasets.

Although there is a good spatial relationship between element concentrations in till and mineralized bedrock, there is significant variability in the details of this relationship. For example, over 80% of the samples with >90 percentile concentrations for copper, molybdenum and silver occur within 500 m of the Main and East Zone orebodies, but only about 50% of the samples with >90 percentile gold and zinc concentrations occur within the same area. Similarly, some samples located directly adjacent to or on top of the East Zone orebody, or located between the Main and East zones, have <50 percentile elemental concentrations. Samples with >90 percentile multi-element concentrations are not found north or northeast of the East Zone area. This variability is clearly illustrated in samples collected near bedrock. Twenty near-surface samples were collected in areas of thin till within 1 m of bedrock (Table 5.8). The bedrock below these samples was mostly hornfelsed, fragmental andesite of the Early Jurassic Telkwa Formation and only two were collected near porphyritic, granodiorites of the Late Cretaceous Bulkley Intrusions (Figure 5.15). Some of these outcrops and subcrops had visible mineralization (pyrite +/- chalcopyrite) while others did not.

Copper values of the near bedrock samples range from 86 to 8924 ppm. The median copper value is 347 ppm, compared to the median value of 216 ppm for the whole dataset. Other element values for these samples are presented in Table 5.8. Less than 50 percentile concentrations of copper can be found on top of ore-grade bedrock. For

a)

Sample	Height Above Bedrock (cm)	Cu	Mo	Au	Ag	Zn	Comments on Bedrock
00-6609	100	186.98	2.58	13.5	36	80.7	oxidized, pyritic (~1%), jointed, andesite
00-6631	30	8924.03	216.13	4.6	220	139	ore-grade andesite; collected above Main Zone pit
00-6632	32	111.54	2.62	4.2	77	107.1	andesite
00-6634	12	93.15	1.96	5.9	78	82.1	andesite
00-6635	50	165.46	4.54	4.9	432	105.4	andesite
00-6636	5	282.47	3.53	8.3	539	101.9	andesite
00-6637	100	397.41	4.54	5.8	318	82.2	andesite
00-6638	15	3176.02	4.96	5.1	102	127.2	andesite
00-6639	35	1515.48	5.91	23	296	106.2	andesite
00-6640	15	452.57	5.21	4.8	79	72	andesite
00-6642	100	2691.91	8.04	3.9	58	87.7	andesite
00-6646	10	1065.85	3.73	54.6	258	67.2	collected above Main Zone stock
00-6647	20	539.44	15.36	7.6	361	106.3	collected above Main Zone stock
00-6658	50	267.93	2.62	5.6	42	77.8	oxidized and altered, heterolithic, volcanic conglomerate
00-6666	100	297.39	4.77	11.8	364	110.1	andesite
00-6667	63	86.42	1.63	3.3	59	108.9	pyrictic (<1%) andesite
00-6668	30	961.41	7.66	31.9	305	51.7	pyrictic (<1%) andesite
00-6671	0	1111.04	2.7	30.7	107	116	hornfelsed, pyrite-rich, andesite
00-6673	0	131.46	3.18	4.2	74	73.3	oxidized, pyritic (~1%), andesite
00-6689	63	124.1	3.03	2.6	210	111.2	mineralized, andesite; collected above East Zone pit

b)

	n=	Cu	Mo	Au	Ag	Zn
Median values from samples collected within 100 cm of bedrock	20	347.40	4.14	5.7	159	103.7
Median values from near-surface samples	106	216.31	3.09	6.1	105	85.5

Table 5.8. Near-surface till samples collected within 100 cm of bedrock. a) ICP-MS analytical results. b) Median values from samples collected near bedrock compared against those from near surface samples.

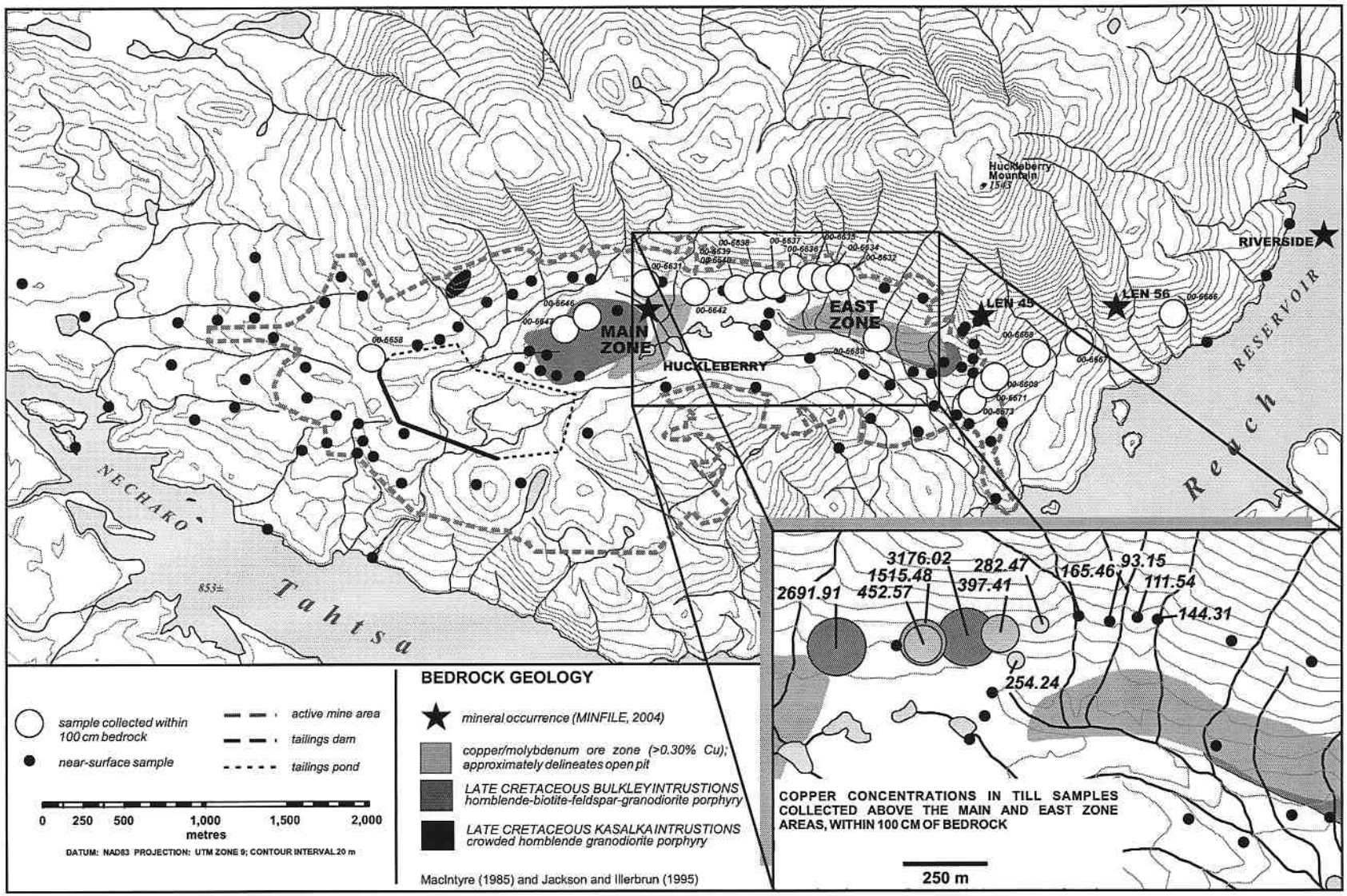


Figure 5.15. Near-surface till samples collected within 100 cm of bedrock.

example, sample 00-6689 was collected from a dense, dark grey, clay-silt till, 50 to 75 cm above ore-grade andesite at the top of the East Zone pit. This sample has copper and molybdenum values of 124 and 3 ppm, respectively (Table 5.8). In contrast to this, sample 00-6631, collected from a dense, brown, sheared basal till, 30 cm above ore-grade, fragmental, hornfelsed andesite of the Main Zone orebody, has 8924 ppm copper and 216 ppm molybdenum. As previously mentioned, this sample has the highest copper and molybdenum values of all basal tills collected in the Huckleberry Mine region. A possible explanation for the variability in the till is what it reflects the variation of the same elements within the bedrock itself. Also, tills sampled are not a product of the bedrock they directly overlie as they have been transported some distance down-ice of their source. Therefore, basal tills could overlie mineralized bedrock, but could also be derived from unmineralized bedrock located up-ice.

There are 18 near-surface samples with >95 percentile element concentrations (Table 5.9; Figure 5.16). Three of these samples have >95 percentile element concentrations for more than one element. In these samples, >95 percentile copper values occur with molybdenum, gold, silver, or zinc. It is interesting to note that sample 00-6651, located at the west side of the Main Zone stock, is the only sample to have elevated concentrations of copper, molybdenum, gold, and silver (*i.e.* the metals mined for at Huckleberry Mine). Though not considered a commodity at Huckleberry Mine, >95 percentile zinc concentrations occur with >95 percentile copper concentrations at two sites north of the Main Zone. This relationship with elevated copper values, and the distribution of >90 percentile zinc values around the Main and East zones orebodies,

Sample	Element(s)	Sample	Element(s)
00-6018	Ag	00-6636	Ag
00-6090	Zn	00-6638	Cu
00-6113	Zn	00-6642	Cu
00-6603	Au	00-6646	Au
00-6608	Mo	00-6651	Cu, Mo, Au, Ag
00-6620	Mo	00-6665	Au
00-6628	Zn	00-6669	Ag
00-6631	Cu, Mo, Zn	00-6692	Au
00-6635	Ag	00-6704	Cu, Mo, Zn

Table 5.9. Near-surface samples with >95 percentile concentrations for any of the five selected elements.

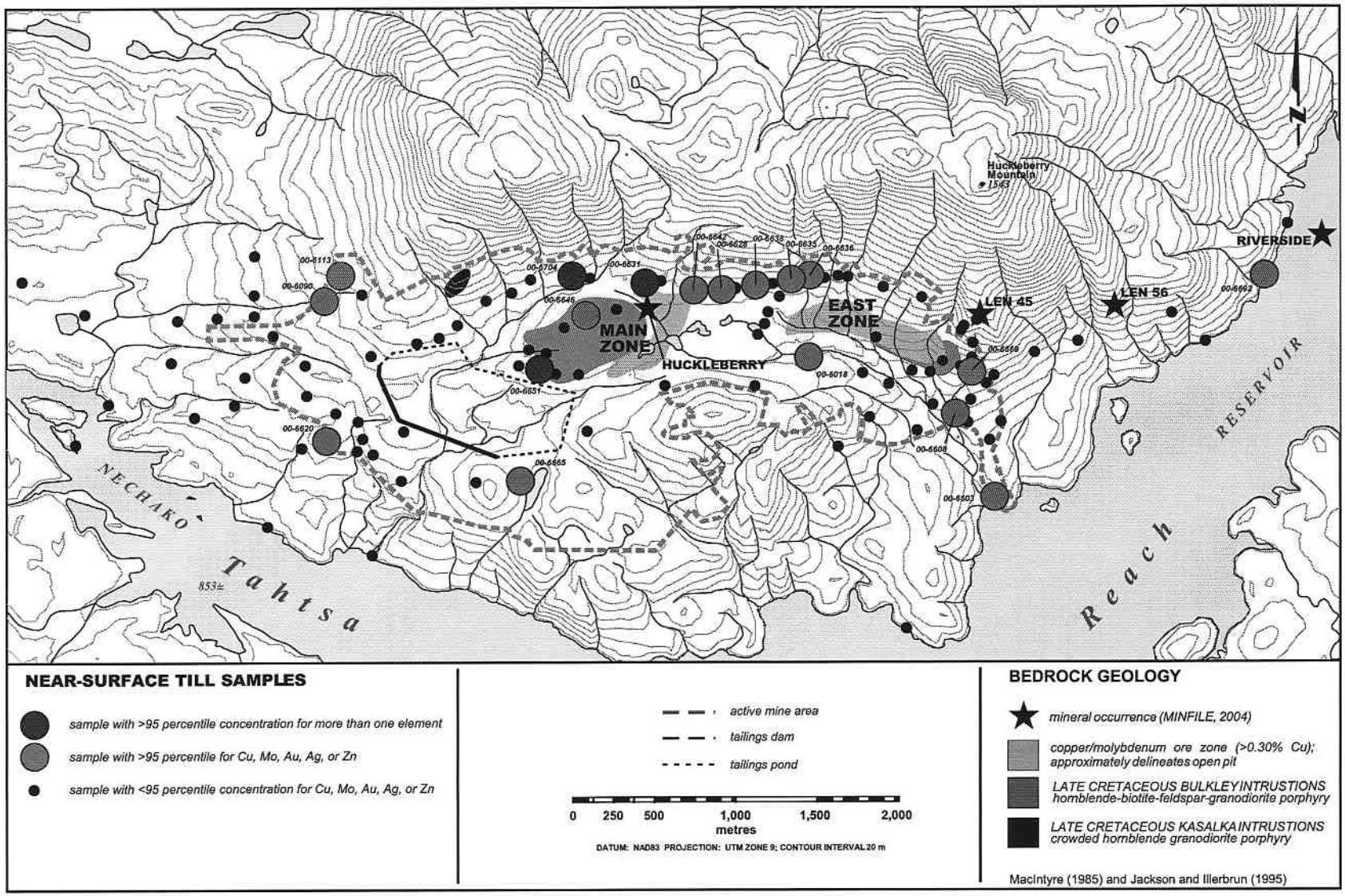


Figure 5.16. Near-surface till samples with >95 percentile element concentrations.

suggests that zinc could be used as a pathfinder element (*i.e.* element that has a geochemical association with a target element) for the style of mineralization that occurs at Huckleberry Mine.

Elevated element concentrations in samples located both east and west of the Main and East Zone areas are thought to reflect down-ice dispersal of mineralization from the Main and East zone orebodies. General east/west dispersal of gold and silver values is also suggested in two samples located between the Len 56 and Riverside showings. Sample 00-6692 contains 41 ppb gold while sample 00-6666 contains 364 ppb silver. The low sample density east and west of these two showings makes it difficult to suggest which is a more likely source for these elevated element values.

Eastward dispersal is, however, illustrated in samples 00-6632 to 6642. These samples were collected in road cuts east of the Main Zone, and north of the East Zone (Figure 5.15), between 5 and 100 cm above bedrock (up to 3 m below surface). These samples form an east/west transect across the north-central portion of the Huckleberry Mine property. This transect is close to slope-parallel, but the most western sample is approximately 30 m lower in elevation than that of the most eastern sample. In general, copper concentrations are highest in samples at the western end of this transect. The most western sample contains 3176 ppm copper (00-6638), while the most eastern sample contains 112 ppm copper (00-6632). There is a general decrease in copper and molybdenum values east of 00-6638. Although not a completely consistent trend, this trend suggests that mineralized till has been transported eastward from the Main Zone.

Given the proximity of these samples to surface, this dispersal train is more likely a product of the late Fraser Glaciation ice-flow from the east that is identified and discussed in Chapter 3.0 (Ice-Flow History).

5.5.2 Sub-Surface Samples

The mean and median copper concentrations for sub-surface basal tills of the Huckleberry Mine region are 299 and 187 ppm, respectively (n=230), with a range of 18 to 4167 ppm. The summary statistics for the other elements are provided in Table 5.10.

As with the near-surface samples, significant variability in the distribution of copper occurs in the sub-surface till samples. In areas of thick till cover (*e.g.* >1 m), elevated copper values can occur near bedrock or close to surface. The range of copper values in sub-surface samples can be quite high. For example, copper ranges for boreholes OB98-12 and OB00-74 are 132 ppm to 606 ppm and 44 ppm to 944 ppm, respectively (Figure 5.17). All 10 boreholes shown in Figure 5.17, and vertical profiles shown in Figures 5.18 to 5.19, have at least one sample with a copper value >100 ppm.

These results differ slightly from the only other similar study conducted in the region. Levson *et al.* (2002) reports on copper concentrations in subsurface till samples from the Nak porphyry copper prospect, collected from diamond drill holes at depths of up to 60 m. In the majority of these samples, copper concentrations are relatively uniform and overall concentrations are low compared to this study. For example, in one drill hole, 17 samples collected over a 30 m interval have a range of copper concentrations of 53 to 83

	Mo	Cu	Zn	Ag	As	Au
n=	230	230	230	230	230	230
maximum	82.88	4167.46	207.1	728	73.7	120.2
minimum	0.24	18.46	32.3	31	3.1	0.7
mean	7.91	298.88	102.1	266	27.2	6.4
median	4.00	186.81	105.8	262	27.9	4.2
standard deviation	10.22	364.72	26.2	145	18.1	9.6

Table 5.10. Summary statistics for sub-surface till samples.

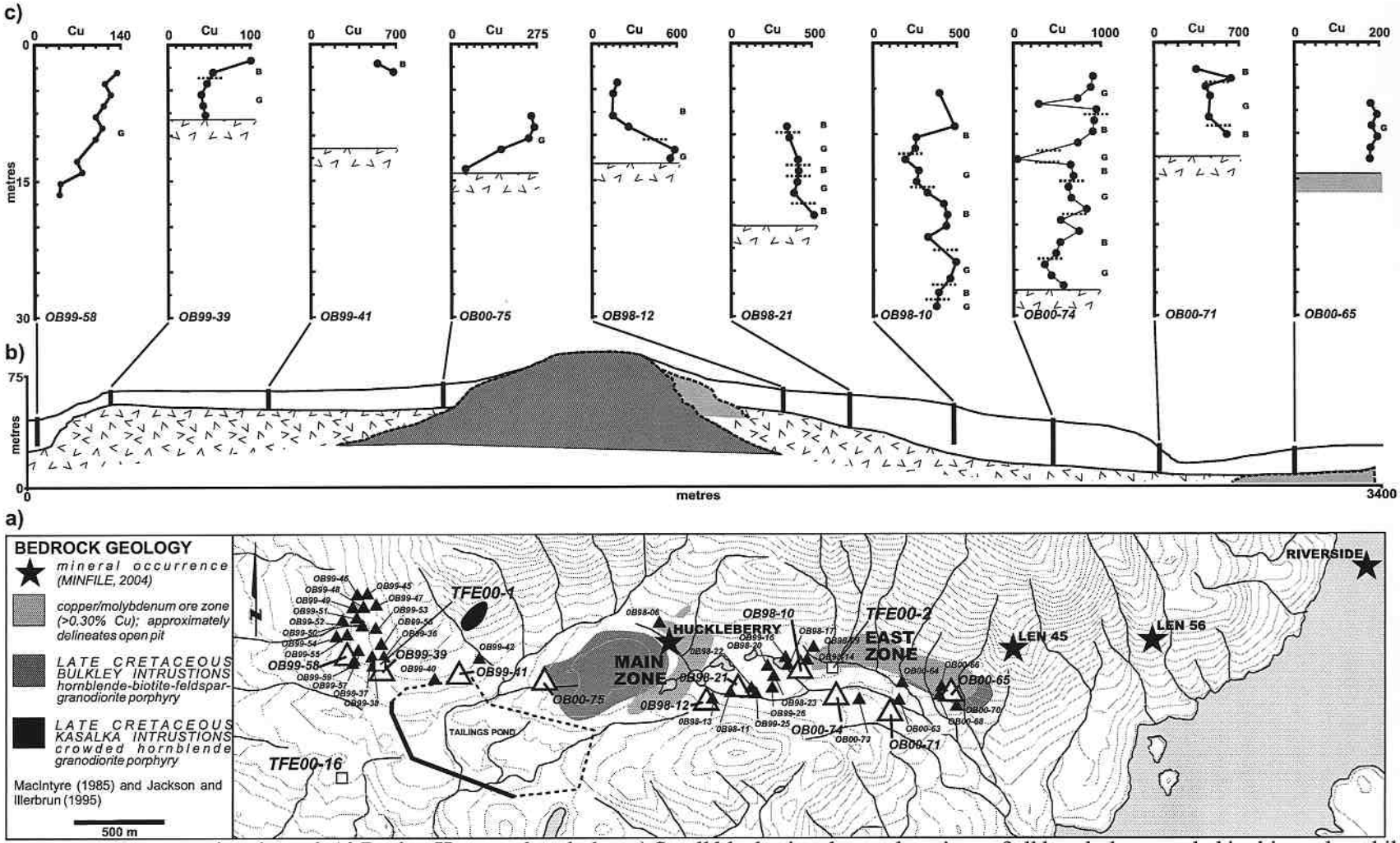


Figure 5.17. Cross-section through 10 Becker Hammer boreholes. a) Small black triangles are locations of all boreholes sampled in this study, while large white triangles identify boreholes used to produce b) the east/west cross-section through the mine property. c) Copper concentrations with depth are shown for the same boreholes. In these plots, copper values are in ppm, while y-axis values are metres below surface. B=brown coloured till, while G=grey coloured till.

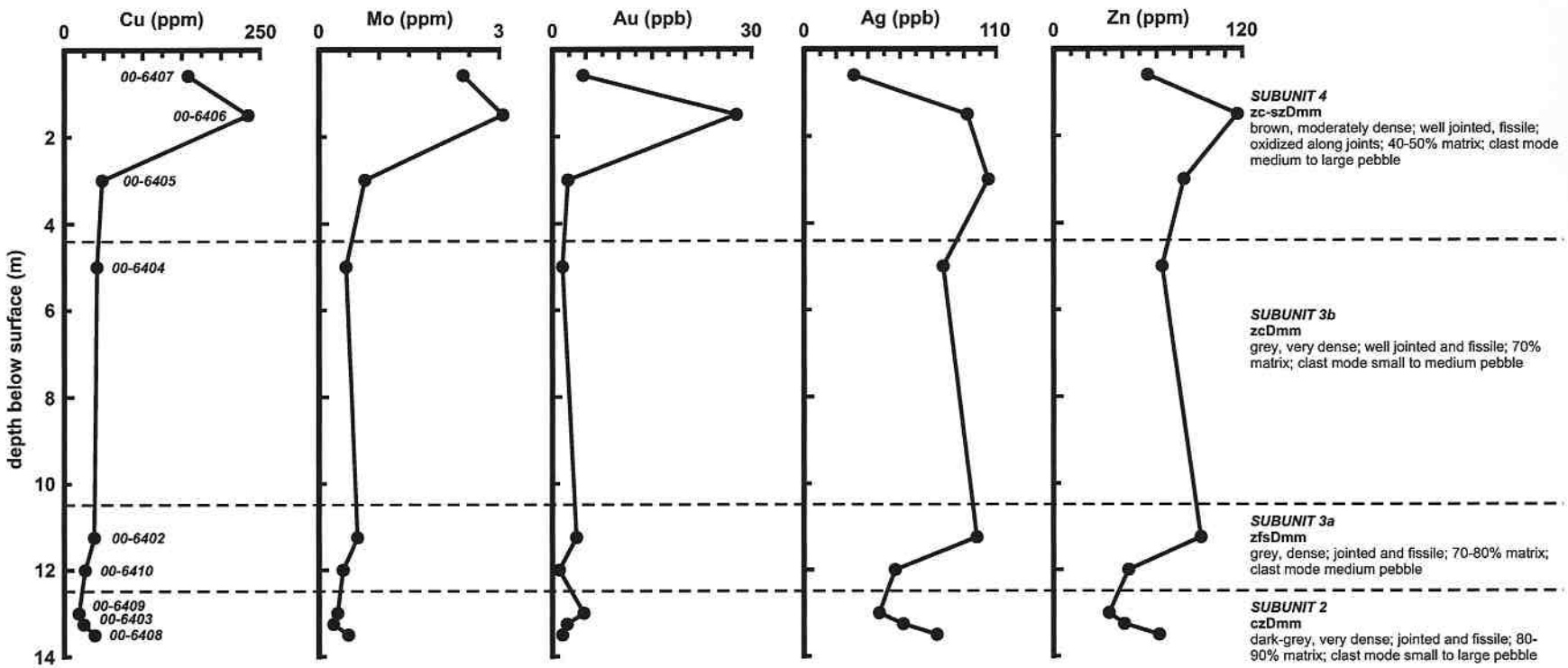


Figure 5.18. Copper and other element concentrations in basal tills at section TFE00-1. Dashed lines separate basal till subunits. The reader is directed to Chapter 4.0 (Stratigraphy) for a more detailed description of the sediments in this vertical profile. Sample labels are provided in the plot of copper values.

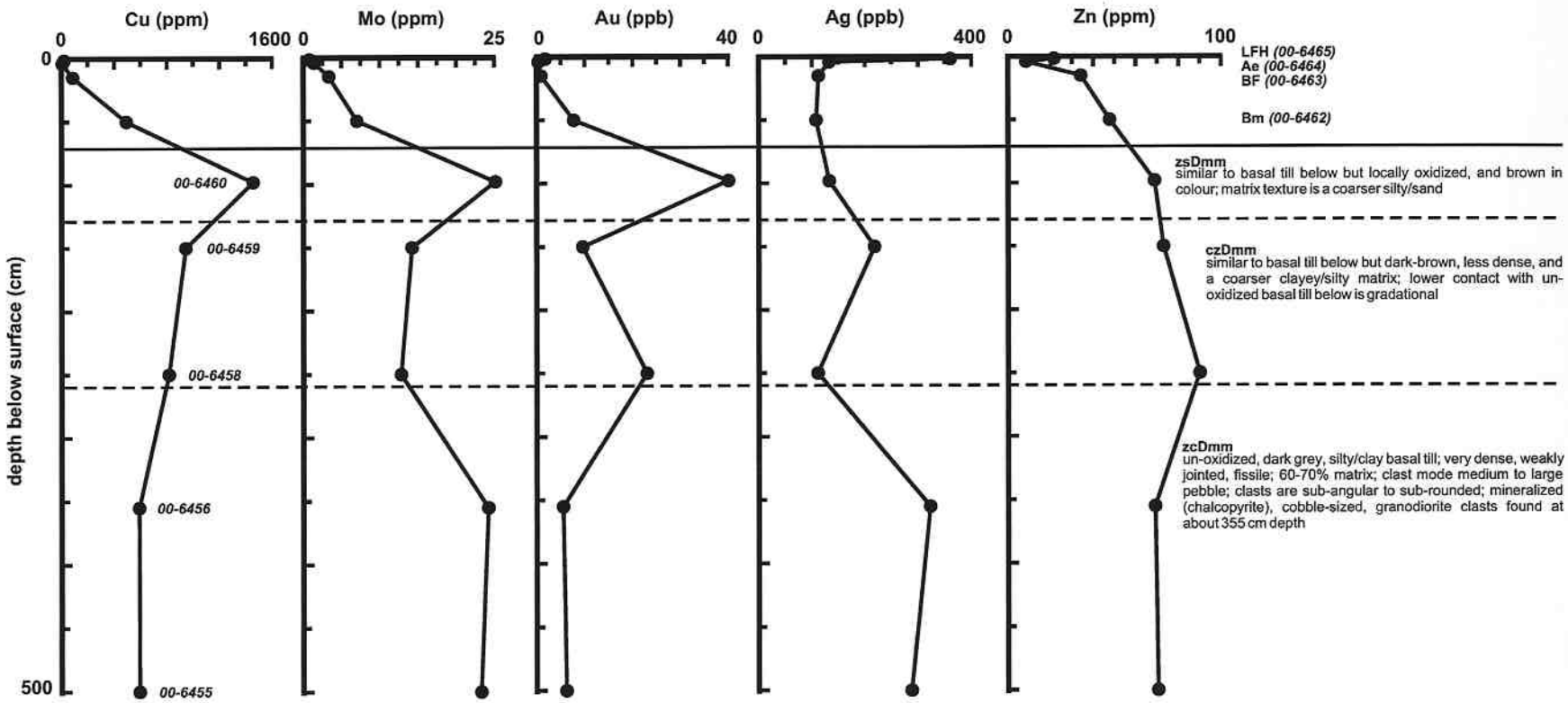


Figure 5.19. Copper and other element concentrations in basal tills at TFE00-16. The deepest four samples were collected in a 5.5 m deep trench, located approximately 10 m southwest of sample 00-6620. The five samples closest to surface were collected in a 1 m road cut at sample site 00-6620. Sample 00-6460 is a resample of sample 00-6620. Till sample labels are provided in the plot of copper values.

ppm. Also, in the drill holes where more than one till sample was collected, only three had copper concentrations >100 ppm. Levson suggests that this uniformity in copper concentrations in many subsurface samples is due to the size of the porphyry target that underlies the tills of this area. In one drill hole, however, >900 ppm copper concentrations were maintained for an interval of 12 m, from 32 to 44 m below surface. He suggests that these values may represent a more concentrated dispersal plume within a larger area of less elevated copper concentrations in till, possibly reflecting a higher grade zone within the overall deposit.

WEST OF MAIN ZONE

In boreholes located west of the Main Zone, there is a general increase in copper values as surface is approached, a trend most pronounced in boreholes OB00-75 and OB99-39 (Figure 5.17). In contrast to this, only two samples, collected in borehole OB99-41, show an upward decreasing trend in copper. However, the limited number of samples in this borehole makes it difficult to evaluate the significance of this trend. It is, however, worth noting that copper values in this borehole (550 and 678 ppm) are higher than in any of the other boreholes west of the Main Zone, and that these relatively high copper values occur only 2 to 3 m below surface. As seen in Figure 5.17, in borehole OB99-39 there is a change in till colour from grey to brown that occurs ~3 m below surface. At this particular borehole, minimum copper values occur in the lower grey-coloured till while maximum copper values occur in the overlying brown till.

Similar trends were observed in till samples collected at sections west of the Main Zone (*e.g.* TFE00-1, and 16; Figures 5.18 and 19). Maximum copper values (from 234 to 1457 ppm) at these sections occur between 1 and 2 m below surface (Figures 5.18 to 5.19). Maximum values for other elements such as molybdenum and gold can also occur within this horizon. With increasing depth, copper values decrease, but the range of copper values at each section differs. For example, copper values at TFE00-1 range only from 18 to 234 ppm (Figure 5.18), while those at TFE00-16 vary from 594 to 1457 ppm (Figure 5.19).

The change in till colour observed in borehole OB99-39 is also observed at section TFE00-1. As discussed in Chapter 4.0 (Stratigraphy), the lower tills are grey in colour and have a different provenance than the upper brown-coloured tills. The lower grey tills are interpreted to have a provenance to the west in unmineralized rocks, while the upper brown tills are thought to be a product of mineralized granodiorite of the Main Zone. This interpretation further supported by the geochemical data from this section because maximum copper values occur in the upper till unit and mineralized rocks of the Main Zone are the most likely source for this till unit. Copper values in the lower till units are much lower and provide further evidence that these tills are derived from unmineralized bedrock located towards the west.

The trend of increasing copper concentrations close to surface, in these sub-surface samples, is thought to reflect the dispersal of mineralization from the Main zone. In borehole OB99-39 (Figure 5.17), the highest copper values are near surface, and

concentrations are, overall, lower that those to the west in OB00-41. This suggests that OB99-39 is located towards the distal end of this dispersal train (or tail; see Figure 5.1). The relatively high copper values seen in the lower portions of OB00-75 suggest that this borehole is located towards the proximal end of this dispersal train. These general trends in copper concentrations are illustrated in Figure 5.20. In this figure, higher copper values occur closer to surface as distance west of the Main Zone stock increases.

Given the data presented in Figure 5.17, the head of this dispersal train is likely somewhere in between OB00-75 and OB99-41. Therefore, transport distance from mineralized bedrock of the Main Zone to this head (*i.e.* "a" in Figure 5.1) is approximately 500 m.

MAIN AND EAST ZONE AREAS

At two sites located just east of the Main Zone orebody (OB98-12 and 21), copper values generally decrease towards surface (Figure 5.17). For example, the lower two samples in borehole OB98-12 (collected within 1.5 m of bedrock) have copper concentrations of 606 and 583 ppm. Copper concentrations in the remaining four samples in this borehole, collected over the interval of 9.1 to 4.3 m below surface, vary from 132 to 263 ppm. The decreasing trend in copper values observed in borehole OB98-21 is much more gradual. It is interesting to note that in borehole OB98-12 there is also a change in till colour from grey to brown. The samples in the grey coloured till were collected close to bedrock and have higher copper values than in samples in the brown till.

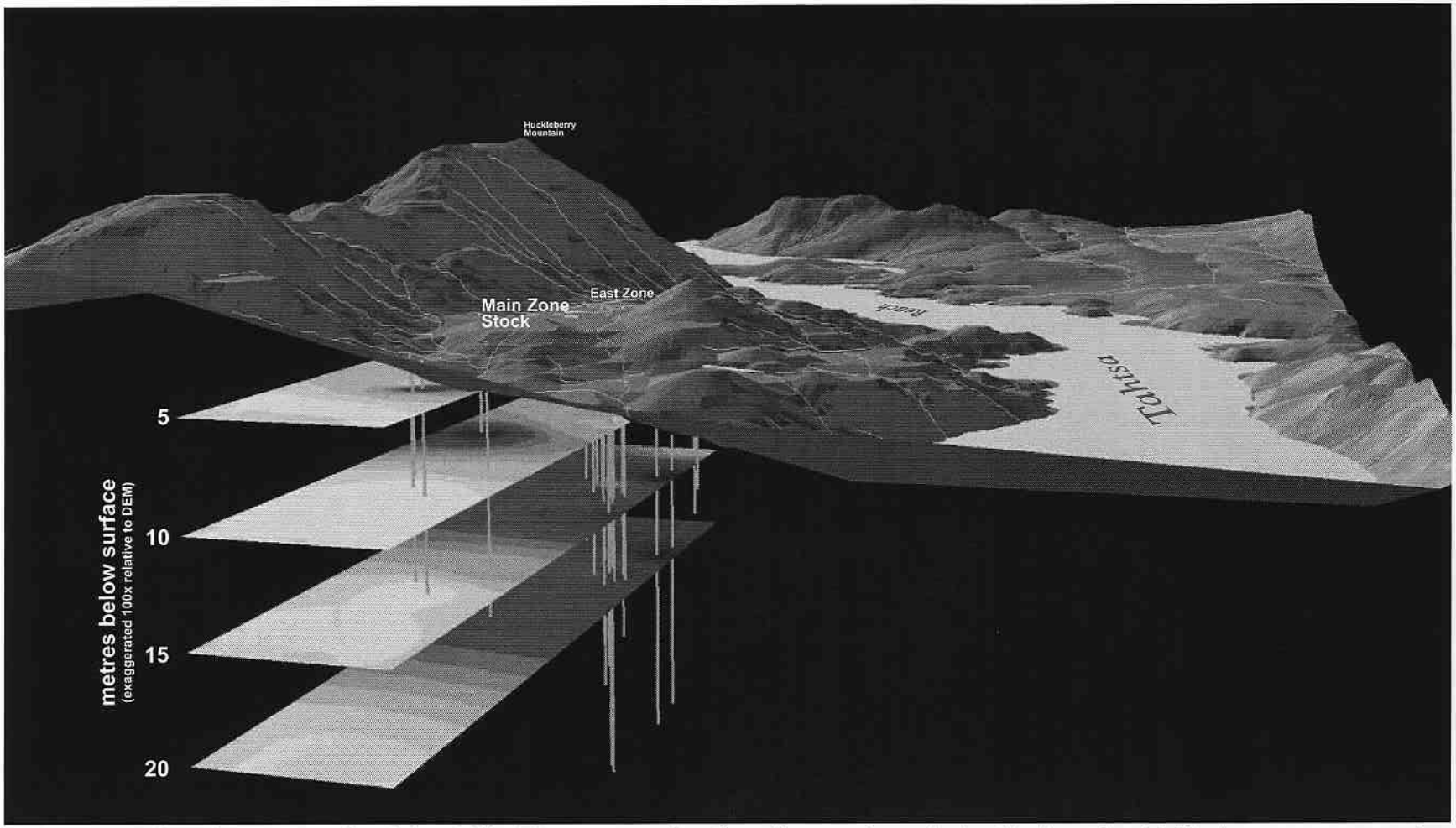


Figure 5.20. Sub-surface copper values in basal tills. These contoured surfaces illustrate the vertical and horizontal variability in copper concentrations in basal tills (dark=high copper concentration, light=low copper concentration). Copper values used to create these contoured surfaces are from sub-surface Becker Hammer borehole samples (boreholes are shown with grey vertical lines). In the interest of clarity, a bedrock surface has not been included in this figure. It should be noted however that the Main Zone stock does crop-out at surface (*i.e.* these contoured copper surfaces are projected through this bedrock surface). View is towards the east, and is similar to the view shown in Figure 1.3a.

Copper values in boreholes OB98-10 and OB00-74 are more variable than those in any other borehole presented here (Figure 5.17). For example, maximum and minimum copper values in OB98-10 are 492 and 192 ppm, respectively, and in OB00-74 they are 944 and 44 ppm, respectively. There does not appear to be a relationship between till colour and copper concentration, as high and low values all occur in grey coloured tills. Borehole OB98-10 is located between the two orebodies and is directly on trend with the East Zone. As seen in Figure 5.20, copper values are generally high east of the Main Zone stock.

Borehole OB00-74 is located approximately 150 m south of the East Zone where section TFE00-2 was described (Figure 4.2; Figure 5.17). Borehole OB00-74 ends in Telkwa Formation andesites, while the sediments described at section TFE00-2 directly overlie the same rocks (section TFE00-2 is described in Chapter 4.0 (Stratigraphy)). The tops of borehole OB00-74 and section TFE00-2 are very close to the same elevation. Assuming that sediments described at section TFE00-2 are continuous for at least 150 m north towards OB00-74, correlations between sediments found at each should be possible.

At section TFE00-2, samples were collected from four different diamicton units. Copper concentrations of these diamicton units, and of samples collected from borehole OB00-74, are presented in Figure 5.21 next to section TFE00-2. As described in Chapter 4.0 (Stratigraphy), the lower 13 m of TFE00-2 is interpreted to be an interbedded sequence of advance-phase glaciolacustrine and glacigenic debris-flow sediments (Unit 2 of Figure

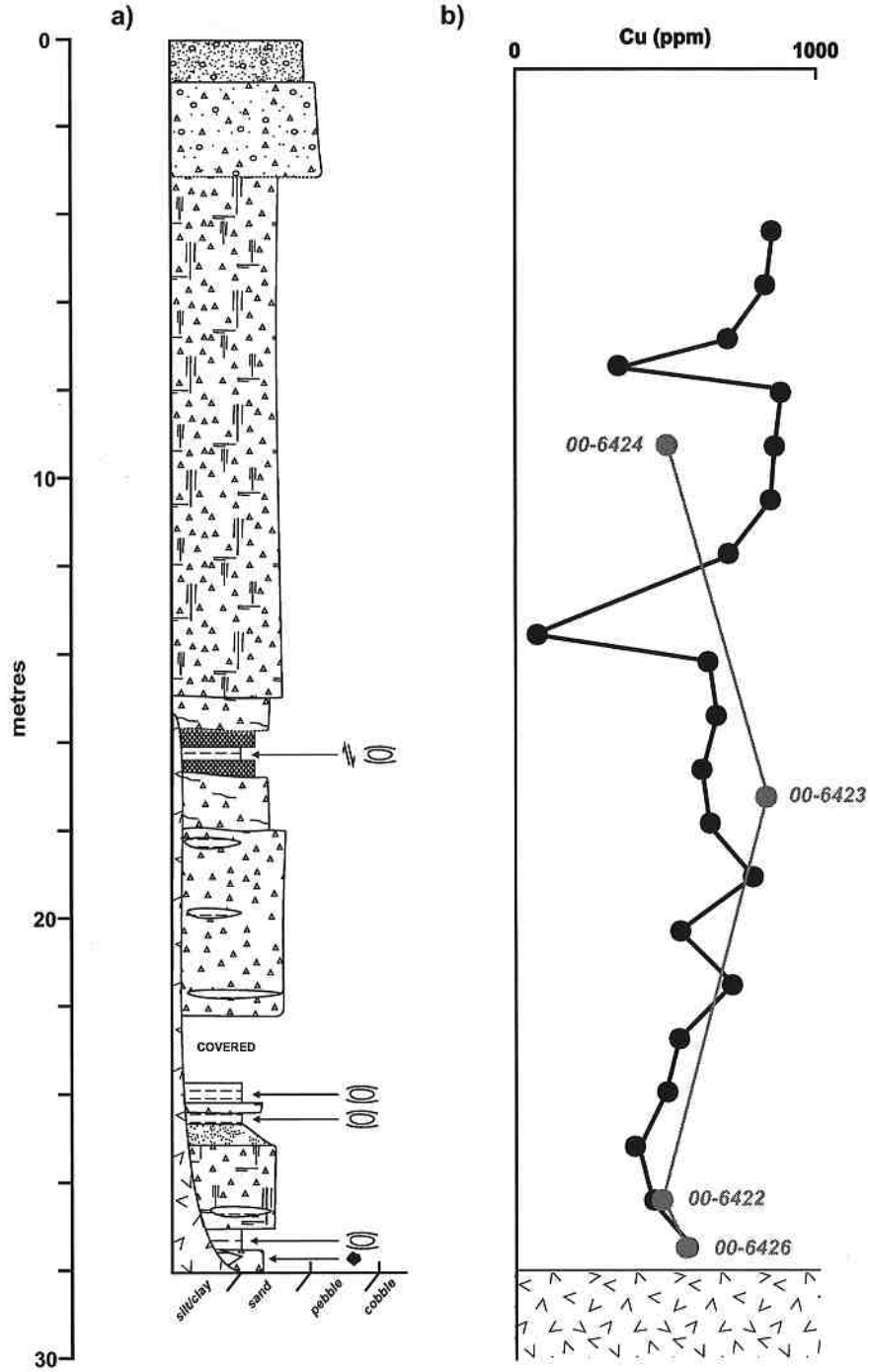


Figure 5.21. A comparison of copper values in till samples collected from borehole OB00-74, with diamicton samples collected at section TFE00-2. In a) the stratigraphy at section TFE00-2 (see Figure 4.2 for legend). Copper values are shown in b). Those from borehole OB00-74 are in black, while those from diamicton samples collected at section TFE00-2 are in grey. The common datum is bedrock.

4.7). This sequence is directly overlain by basal tills of the Late Wisconsinan Fraser Glaciation that extend to approximately 3 m below surface (Unit 3 of Figure 4.7).

As seen in Figure 5.21, there is a striking similarity in trends of copper values in the lower 11 m of borehole OB00-74 and section TFE00-2. Although absolute copper values are greater in diamictons sampled at section TFE00-2, they closely follow the overall increasing trend in copper values in the lower 11 m of OB00-74. Given the slight differences in surface elevation between the two, a correlation between the lower 13 m of section TFE00-2 and lower 15 m of borehole OB00-74 seems reasonable. The lower 15 m of borehole OB00-74, therefore, could also be advance-phase glaciolacustrine and glacigenic debris-flow sediments (Unit 2 of Figure 4.7), while the upper 9 m are probably basal tills (Unit 3 of Figure 4.7). If so, the variability observed in copper values in the lower 15 m of borehole OB00-74 may be explained by the complexity of sediments types in that interval.

A very interesting trend in copper values is observed in the upper part of borehole OB00-74, where basal till is expected to occur, based on the correlation with section TFE00-2. There is a general increase in copper values up-section from 12.5 m, as would be expected due to easterly ice-flow and dispersal of mineralization in till from the Main Zone towards the east. The decrease in copper values higher up in this sequence suggests a possible change in ice-flow direction and, therefore, a different till provenance. This decrease may indicate a later westerly-directed ice flow event, while a shift back to high copper values in the uppermost tills may reflect a shift back to easterly flow. Although

the details of this interpretation are speculative, large fluctuations in copper values within this thick till sequence are consistent with the fluctuating ice-flow model presented in Chapter 3.0 (Ice-Flow History). The variability in copper values in the Main and East Zone areas, makes modelling the dispersal of mineralization difficult. It is thought, however, that the high copper values in basal tills of the lower portion of borehole OB98-12, reflect dispersal from the Main Zone orebody towards the east.

5.5.3 Partitioning Effects in Till

Nineteen archived sample splits of near-surface till samples were selected for grain-size analysis. These samples roughly follow an east/west transect through Huckleberry Valley and are located in areas east and west of known mineralization (Figure 5.22). As seen in Figure 5.22, twelve of these samples are located within approximately 500 m of the Main or East Zone orebodies. This analysis was conducted to investigate the distribution of copper in different grain sizes, and at different distances down-ice from areas of known mineralization. All ICP-MS determinations are provided in Appendix E.

Nearly all samples show a slight trend of increasing copper concentrations with a decrease in grain size, and maximum copper values occur in the silt-clay fraction (-0.063 mm). The second highest concentration of copper occurs in the fine-sand fraction (-0.25+0.125 mm) and there is typically a drop in copper values in the very fine-sand fraction (-0.125+0.063 mm). This pattern is most obvious in samples 00-6631 and 00-6638, which have the highest copper concentrations, and it becomes more subtle when, copper concentrations decrease. Sample 00-6651 shows a slightly different trend of

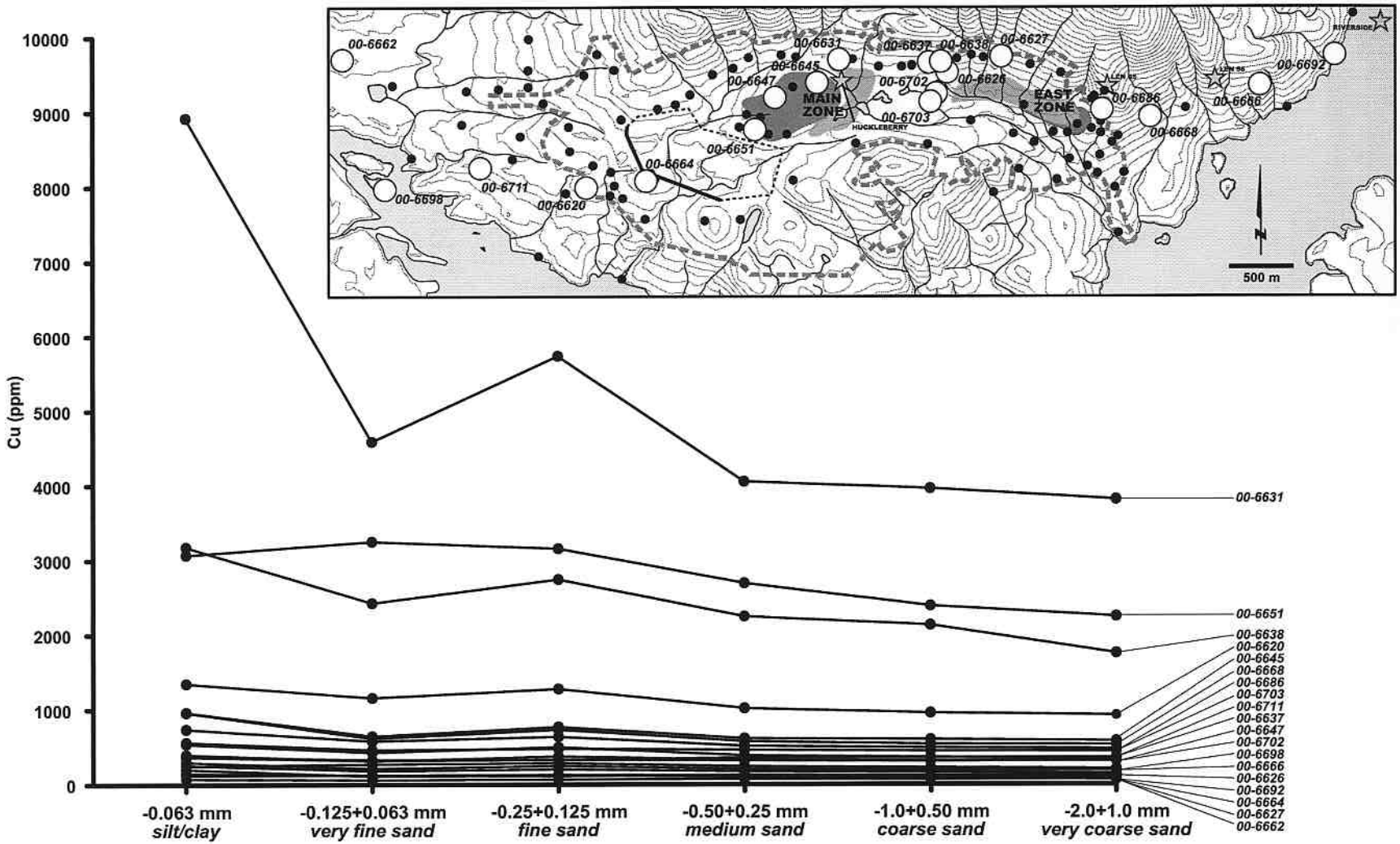


Figure 5.22. Copper concentrations for various grain size fractions of select samples. Samples labelled in inset map correspond to samples in graph.

copper concentrations in the five grain-size fractions, having a maximum concentration of copper in the very fine-sand fraction.

A very similar distribution of median copper values, in these same grain-size fractions, are reported for basal tills collected around the Mount Milligan porphyry copper-gold deposit, 150 km northwest of Prince George, British Columbia (Sibbick and Kerr, 1995). In samples collected in the Huckleberry Mine region, the contrast between these two fractions is most pronounced in samples with overall higher copper concentrations. For the most part, as distance from known mineralization increases the contrast between copper concentrations, of different grain-sizes fractions, decreases and copper concentration versus grain size curves flatten out. Exceptions to this are samples located between the Main and East Zone areas.

A possible explanation for the bimodal distribution of copper in basal tills could be a similar bimodal distribution of copper-bearing minerals in rocks of Huckleberry Valley. This could be caused by differences in original grain size; copper being carried in minerals with differing physical properties; or copper in silt/clay fraction being more thoroughly comminuted than copper in the fine sand range. It also possible that hydromorphic dispersion of copper may in part be contributing to this bimodal distribution. It is interesting that, given the visible pyrite and chalcopyrite grains (up to 3 mm in size) and mineralized clasts (pyrite +/- chalcopyrite) in the till matrix, copper concentrations in samples located more proximal to known mineralization are not higher in the coarser-grained fractions (*e.g.* medium to coarse sand-sized fractions).

5.6 INDICATIONS OF UNDISCOVERED MINERALIZATION

Indications of undiscovered bedrock mineralization occur in two areas. The first is located approximately 2 km west-southwest of the Main Zone, where sample 00-6620 contains 1351 ppm copper, 28 ppm molybdenum, 12 ppb gold, and 86 ppb silver. This is the only >90 percentile copper and molybdenum sample located >500 m from either the Main or East Zone areas. These values were confirmed with a second sample collected at the same site (00-6460, 1457 ppm Cu, 25 ppm Mo, 40 ppb Au, 133 Ag). Approximately 10 m southwest of this sample, in a 5.5 m deep trench, four till samples were collected from 5 to 1.5 m below surface (*i.e.* lower four samples at section TFE00-16). Copper values in this vertical profile increase towards surface and range from 594 to 943 ppm. West of sample 00-6620 copper values at surface decrease from 372 to 246 ppm over a distance of 1.5 km. Several cobble and boulder-sized clasts with chalcopyrite and molybdenite mineralization were also observed at two sites west of sample 00-6620, at shallow depths; one yielded an assay of 0.62% copper. To the east, copper values abruptly drop from 180 to 66 ppm, over a distance of 250 m. These data suggest a west-trending dispersal plume with the head near the sample 00-6020.

Although it is possible that these data could represent southwest dispersal from the Main Zone, a number of factors suggest that this dispersal train may be isolated or disconnected from dispersal from the Main Zone area and that there may be an undiscovered bedrock source for the mineralization near sample 00-6620. These factors include: the relatively long distance of the high copper tills from the Main Zone (about 2 km); the very high concentration of copper (1351 ppm) in till at 00-6620; the sharp

decrease in copper to the east of that site; and the presence of mineralized clasts in till west of sample 00-6620. It is also possible that the source of the copper in the tills could be mineralized volcanics located under the tailings pond (approximately 750 m to the east). However, another possible target source area occurs <100 m northwest of sample 00-6620, in a low swampy area. This site is geomorphologically similar to the poorly drained areas that originally obscured much of the Main and East zones. Late in 2001, a diamond and rotary drill program conducted by HBL west of the tailings dam failed to identify a mineralized bedrock source west of the Main Zone orebody. However, this area still may have potential to host mineralized bedrock as drilling was not conducted directly up-ice (east) of sample 00-6620.

The second area that suggests the presence of undiscovered bedrock mineralization occurs 2 km west of the northern portion of the Main Zone orebody. Samples 00-6090 and 00-6113 have zinc concentrations ranging from 130 to 207 ppm, and silver concentrations ranging from 326 to 382 ppb. Copper values in these samples are 199 and 123 ppm, respectively. To the east of samples 00-6090 and 00-6113 there is a dramatic decrease in zinc values, while to the west there is a more gradual decrease. For example, sample 00-6044, located about 200 m east, has zinc and silver values of 68 ppm and 65 ppb, respectively. Sample 00-6718, located about 500 m west of sample 00-6090, has 127 ppm zinc, 226 ppb silver, and 291 ppm copper. Another kilometre farther west at sample site 00-6663, zinc, silver, and copper concentrations are 50 ppm and 126 ppb, and 59 ppm, respectively.

As with the previous example, there is a gradual decrease in element values (in this case Zn and Ag) towards the west as would be expected with westerly dispersal. Although this trend is not as well defined with copper values, there is a decrease in copper values west of sample 00-6718 to sample 00-6663. The decrease in zinc, silver, and copper values is thought to define a westward-directed dispersal train, with its head situated near samples 00-6113 and 00-6090. As with the first example, it is possible that these data could represent dispersal from the Main Zone, but several factors suggest that there may be an undiscovered bedrock source for the mineralization in this area. These factors include: the relatively long distance from the Main Zone (about 2 km); the sharp decrease in silver and zinc values to the east of these sites; and the occurrence of <50 percentile concentrations of zinc and silver due west of the southern portion of the Main Zone orebody. It is thought that the most likely source of mineralization is 600 m east of the high zinc and silver till sites, in the area around a small stock of the Late Cretaceous Kasalka Intrusions.

5.7 EVIDENCE FOR ICE-FLOW REVERSAL IN TILL GEOCHEMISTRY

Evidence of the complex Late Wisconsinan ice-flow history of the Tahtsa Lake – Ootsa Lake region is observed in the lateral and vertical distribution of element concentrations in tills of the Huckleberry Mine region. Westward flow during the Late Wisconsinan glacial maximum, and both early and late eastward ice-flow from the Coast Mountains (as discussed in Chapter 3.0), has created complex dispersal patterns in Huckleberry Valley. Interpreting these dispersal patterns is further complicated by the existence of multiple known sources of mineralization in and adjacent to Huckleberry Valley (*i.e.* the

Main and East Zone orebodies, and the Len 45, Len 56 and Riverside mineral occurrences). Nevertheless, evidence of east and west dispersal of mineralization in till from these sources can be observed in the distribution of indicator element concentrations in specific areas as discussed below.

The most convincing geochemical evidence of an early-glacial eastward ice-flow event is seen in the older till units exposed at section TFE00-1, and the deeper till samples collected in Becker Hammer boreholes just to the north of that site. These samples all have well below median copper concentrations, with the lowest copper value of all samples collected in this study (28 ppm) occurring 13 m below surface in borehole OB99-56. These low copper values support the interpretation, discussed in Chapter 4.0, that lower till units located west of the Main Zone were probably deposited during an early-eastward advance of Coast Mountain glacier ice, because these tills are likely derived from un-mineralized bedrock located west of Huckleberry Mine.

Evidence of westward ice-flow during the Late Wisconsinan glacial maximum is apparent in surface and near-surface till samples, west of the Main Zone orebody. In both vertical profiles and Becker Hammer boreholes in this area till samples closest to the surface have copper values higher than those collected from deeper intervals. Over half of the samples with >90 percentile copper values occur either on top, or to the west, of known mineralization, with a general decrease in copper values farther west of the Main Zone orebody.

Westward dispersal is probably best illustrated by the change in copper values west of sample 00-6620 (1351 ppm Cu), as previously discussed. Copper concentrations at that site gradually decrease to 246 ppm, 1.5 km to the west at sample 00-6698. A similar example can be found north of TFE00-1, in the surface samples collected on the west-southwest aspect slope of Huckleberry Mountain, where >95 percentile zinc and >90 percentile silver concentrations occur. Here again, element values gradually decrease to the west, with <70 percentile zinc and silver concentrations occurring 1.6 km away. It should be noted that these near-surface examples do not indicate only westward dispersal of mineralization, but rather a net dispersal direction to the west as a resumption of eastward ice-flow during the later stages of glaciation would likely have transported these sediments some distance back to the east.

There are examples of eastward dispersal of mineralization, attributable to the latest eastward ice-flow event of the Late Wisconsinan glaciation. The clearest example is probably in a series of seven near-surface samples, collected from thin till over bedrock, northeast of the Main Zone (Figure 15.15). East of sample 00-6642 (2692 ppm Cu) there is a gradual decrease in copper values at several sites ending at 00-6632 (112 ppm Cu) suggesting an eastward-directed dispersal of mineralization. The proximity of these samples to the surface (*i.e.* ≤3 m) suggests that this easterly dispersal is most likely attributed to the late-easterly ice-flow event described in Chapter 3.0 (Ice-Flow History). A series of samples located east of the East Zone area, that are elevated in copper, molybdenum, gold, and silver, also likely indicate late eastward dispersal, this time from the East Zone.

6 CONCLUSION

Morainal deposits are the dominant surficial material in the Huckleberry Mine region, and form a ubiquitous cover in valley bottoms and lower and mid-slopes of the highland areas. Glacially eroded and streamlined features were observed on mountain peaks at even higher elevations (>2000 m), suggesting that the ice-surface elevation during Fraser Glaciation was >2000 m.

Ice-flow patterns during this last glaciation were complex. Orientations of various small-scale (*e.g.* striae, rat-tails) and intermediate to large-scale (*e.g.* crag-and-tail ridges, roches moutonnées, and flutings) streamlined and erosional forms indicate that there were two dominant ice-flow directions in the region – east-northeast and west-southwest. Cross-cutting and superimposition relationships observed in the field constrain the relative timing of ice-flow events and indicate that a westerly-directed ice-flow event was followed by a smaller magnitude east to northeast event. This ice-flow reversal can be explained by the westward migration of an ice divide from the central interior of British Columbia, to the Coast Mountains, during the Fraser Glaciation maximum. This ice divide was oriented roughly north/south, and was located east of the study area.

The most convincing evidence of westward ice-flow comes from well preserved landforms and features such as roches moutonnées, rat-tails, and striae at higher elevations (≥1500 metres). These features have orientations that do not necessarily conform to the trends of mountain topography or adjacent valleys. Also convincing are the large-scale crag-and-tail ridge features, that occur in low elevation settings (<1500 m

a.s.l.), that have westerly orientations despite a later eastward-directed ice-flow event in the area. Although, during the Fraser Glaciation maximum, ice thickness exceeded relief in the and glaciers flowed west, up-valley towards the Coast Mountains, the orientations of some of these features suggest that ice-flow in the lower portions of the Cordilleran Ice Sheet were still locally influenced by topography.

As a result of mine preparation and extraction activities, numerous Quaternary exposures exist on Huckleberry Mine property. These exposures can be up to 28 m thick, forming a transect through a small montane valley, and enabled much of the local Quaternary stratigraphy to be evaluated. Exposures such as these are uncommon in the region, and are relatively rare elsewhere. Basal lodgement tills dominate the local stratigraphy. These grey, overconsolidated, clayey-silt diamictons typically overlie Early Jurassic Telkwa Formation andesites, but can also locally overlie advance-phase glaciofluvial sands and gravels. In the vicinity of the Main and East Zone pits it is common to find visible pyrite and chalcopyrite grains (up to 3 mm in size) and mineralized clasts (pyrite +/- chalcopyrite) in the till matrix. retreat-phase glaciofluvial sediments and organic deposits overlie these tills.

Multiple till units were identified at a 19 m vertical exposure (TFE00-1) which were distinguished by changes in colour, matrix texture, and changes in clast content. Strongly preferred clast orientations in the lower till units indicate deposition during a southeastward to eastward ice-flow event, while an increase in granodiorite clasts and a change in colour to brown in the upper tills suggest a change in provenance. This is in

part supported by high copper values in the upper parts of this exposure, compared to lower values in the lower till units. The Main Zone stock is the only known occurrence of granodiorite in the area, and the Main Zone orebody is closest known source of copper mineralization. This suggests that the upper tills in this exposure were deposited during a westerly-directed ice-flow event providing further evidence of an ice-flow reversal in the Huckleberry Mine region and the existence of an ice-divide over central British Columbia during the Fraser Glaciation maximum.

Median copper values in till for the Huckleberry Mine region are in the 40 to 50 ppm range. Elevated till geochemical data are clearly associated with known mineralization on Huckleberry Mine property. Maximum, minimum, and median copper values in near-surface basal till samples are 8924 ppm, 29 ppm, and 216 ppm, respectively (n=106), while those for sub-surface basal till samples are 4167 ppm, 18 ppm, and 187, respectively (n=230). The complex ice-flow history of the region is illustrated in locally developed dispersal trains, which indicate that mineralization has been transported towards the east and west. These dispersal trains are detectable in both near-surface and sub-surface basal till samples.

Copper, molybdenum, zinc and silver values in basal tills suggest that there may be undiscovered mineralization on Huckleberry Mine property. Two westward-directed dispersal trains have been identified, which are isolated or disconnected from dispersal of the Main Zone area. One dispersal train is delineated by contrasts in copper and molybdenum values, while the other is most clearly defined by contrasts in zinc and

silver values. These dispersal trains suggest that there could be undiscovered bedrock mineralization on Huckleberry Mine property as there are no documented occurrences of mineralization directly up-ice of them. The zinc-silver dispersal train may be associated with mineralization from a small Kasalka Intrusion stock that crops out on Huckleberry Mountain.

Deglaciation of the Huckleberry Mine region appears to have been influenced at least in part by stagnant ice masses. This is suggested by the presence of continuous, undeformed eskers observed in aerial photographs on the south shore of Tahtsa Reach at the foot of Mount Carl Borden, in Troitsa Lake valley, and east of Huckleberry Mine in the Mosquito and Shelford Hills areas. Melt-out tills occurring in the upper portions of some exposures on Huckleberry Mine property provide further evidence of ice stagnation during deglaciation of the region.

REFERENCES

Aario, R. and Peuraniemi, V. (1992): Glacial dispersal of till constituents in morainic landforms of different types; *Geomorphology*, Volume 6, pages 9-25.

Alldrick, D. J.(1996): Intrusion-related Au Pyrrhotite Veins; *in* Selected British Columbia Mineral Deposit Profiles, Volume 2 - Metallic Deposits; Lefebure, D.V. and Höy, T, Editors, *British Columbia Ministry of Employment and Investment*, Open File 1996-13, pages 57-58.

Armstrong, J.E. and Tipper, H.W. (1948): Glaciation in north central British Columbia; *American Journal of Science*, Volume 246, pages 283-310.

Benn, D.I. and Evans, D.J.A (1998): Glaciers and glaciation; *Arnold*, London, 734 pages.

Blower, S. (2000): A geophysical report on an induced polarization and magnetic survey on the Huckleberry Mine property; submitted by Omineca Mining Division, *British Columbia Ministry of Energy and Mines*, AR26200, 29 pages.

Bobrowsky, P.T. and Bichler, A. (2001): Till geochemistry of the Wells – Stony Lake area, B.C.; *British Columbia Ministry of Energy and Mines*, Open File 2001-10, 256 pages.

Boulton, G.S. (1996): Theory of erosion, transport, and deposition as a consequence of subglacial sediment deformation; *Journal of Glaciology*, Volume 42, pages 43-62.

Boulton, G.S. and Paul, M.A. (1976): The influence of genetic processes on some geotechnical properties of glacial tills; *Quarterly Journal of Geological Engineering*, Volume 9, pages 159-194.

Bradish, L., Myers, D.E. and Roney, C. (1989): Geological, geochemical and geophysical report on the Huckleberry property, NTS 093E/11E, Omineca Mining Division; submitted by Noranda Exploration Company Ltd., *British Columbia Ministry of Energy and Mines*, AR19087, 217 pages.

British Columbia Ministry of Environment, Lands, and Parks (1976): Landforms 93E/10, 11, 14, 15, 16; *epartment of Lands and Forests*, 1:50,000 scale maps.

Carter, N.C. (1981): Porphyry copper and molybdenum deposits, west-central British Columbia; *British Columbia Ministry of Energy and Mines and Petroleum Resources*, Bulletin 64, 150 pages.

Clague, J.J. (1981): Late Quaternary geology and geochronology of British Columbia, Part 2: Summary and discussion of radiocarbon-dated Quaternary history; *Geological Survey of Canada*, Paper 80-35, 41 pages.

Clague, J.J. (1984): Quaternary geology and geomorphology, Smithers-Terrace-Prince Rupert Area, British Columbia; *Geolgoical Survey of Canada*, Memoir 413, 71 pages.

Clague, J.J. (1989a): Introduction- Quaternary geology of the Canadian Cordillera; *in* Quaternary geology of Canada and Greenland; Fulton, R.J., Editor, *Geologial Survey of Canada*, Geology of Canada, No.1, pages 19-22.

Clague, J.J. (1989b): Cordilleran Ice Sheet; *in* Quaternary geology of Canada and Greenland; Fulton, R.J., Editor, *Geologial Survey of Canada*, Geology of Canada, No.1, pages 40-43.

Clark, P.U. (1991): Striated clast pavements: products of deforming subglacial sediment?; *Geology*, Volume 19, pages 530-533.

Coker, W.B. and DiLabio, R.N.W (1989): Geochemical exploration in glaciate terrain: geochemical responses; *in* Proceedings of Exploration 1987: Third Decennial International Conference on Geophysical Geochemcial Exploration for Minerals and Groundwater; Garland, G.D, Editor, *Ontario Geological Survey*, pages 336-383.

Cook, S.J, Jackaman, W., Lett, R. E., McCurdy, M.W. and Day, S.J. (1999): Regional lake water geochemistry of parts of the Nechako Plateau central British Columbia (NTS 93F/2, 3; 93K/9, 10, 15, 16, 93L/9, 16; 93M/1, 2, 7, 8); *British Columbia Ministry of Energy and Mines*, Open File 1999-5, 161 pages.

Cook, S.J. and McConnell, J.W. (2001): Lake sediment geochemical methods in the Canadian Shield, Cordillera and Appalachia; *in* Drift Exploration in Glaciated Terrain; McClenaghan, M.B, Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J., Editors, *The Geological Society,* Special Publication No. 185, pages 125-149.

Council of Forest Industries (2004): Epidemic expansion facts; Council of Forest Industries Mountain Pine Bettle Task Force, URL <www.mountainpinebeetle.com/ epidemic_facts.html>, [Mar 2004].

Davis, N.F.G. and Mathews, W.H. (1944): Four phases of glaciation with illustrations from southwestern British Columbia; *Journal of Geology*, Volume 52, pages 403-413.

Dawson, G.M. (1891): On the later physiographical geology of the Rocky Mountain region in Canada, with special reference to changes in elevation and to the history of the glacial period; *Royal Society of Canada*, Transactions, Volume 8, pages 3-74.

Diakow, L. and Mihalynuk, M. (1987): Geology of the Whitesail Reach and Troitsa Lake areas (93E/10W, 11E); *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-4.

DiLabio, R.N.W (1989): Terrain geochemistry in Canada; *in* Quaternary geology of Canada and Greenland; Fulton, R.J., Editor, *Geologial Survey of Canada*, Geology of Canada, No.1, pages 647-666.

Dreimanis, A. (1989): Tills: their genetic terminology and classification; *in* Genetic Classification of Glacigenic Deposits; Goldthwait, R.P. and Matsch, C.L., Editors, *A.A. Balkema*, Rotterdam, pages 17-83.

Duffel, S. (1952): Whitesail Lake map-area; *Geological Survey of Canada*, Paper 52-21, 20 pages.

Environment Canada (2004): Canadian climate normals or averages 1971-2000: station Tahtsa Lake west; URL <http://climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html>, [Feb 2004].

Ferbey, T. and Levson, V.M. (2001a): Ice flow history of the Tahtsa Lake – Ootsa Lake region; *British Columbia Ministry of Energy and Mines*, Open File 2001-8, 1:110,00 scale map.

Ferbey, T. and Levson, V.M (2001b): Quaternary geology and till geochemistry of the Huckleberry Mine area; *in* Geological Fieldwork 2000, *British Columbia Ministry of Energy and Mines*, Paper 2001-1, pages 397-409.

Ferbey, T. and Levson, V.M. (2003): Surficial geology of the Huckleberry Mine area; *British Columbia Ministry of Energy and Mines*, Open File 2003-2, 1:15000 scale map.

Fulton, R.J. (1967): Deglaciation studies in Kamloops region, an area of moderate relief, British Columbia; *Geological Survey of Canada*, Bulletin 154, 36 pages.

Fulton, R.J. (1989): Forward to the Quaternary geology of Canada and Greenland; *in* Quaternary geology of Canada and Greenland; Fulton, R.J., Editor, *Geologial Survey of Canada*, Geology of Canada, no.1, pages 1-11.

Fulton, R.J. (1991): A conceptual model for growth and decay of the Cordilleran Ice Sheet; *Géographie physique et Quaternaire*, Volume 45, pages 333-339.

Harington, C.R., Tipper, H.W. and Mott, R.J. (1974): Mammoth from Babine Lake, British Columbia; *Canadian Journal of Earth Sciences*, Volume 11, pages 285-303.

Hedley, M.S. (1935): Tahtsa – Morice area, Coast District, British Columbia; *Geological Survey of Canada*, Map 367A.

Hicock, S.R., Goff, J.R., Lian, O.B. and Little, E.C. (1996): On the interpretation of subglacial till fabric; *Journal of Sedimentary Research*, Volume 66, pages 928-934.

Holland, S.S. (1976): Landforms of British Columbia: a physiographic outline; *British Columbia Ministry of Energy and Mines, and Petroleum Resources*, Bulletin 48, 138 pages.

Hornbrook, E.H.W. (1970): Biogeochemical prospecting for copper in west-central British Columbia; *Geological Survey of Canada*, Paper 69-49, 39 pages.

Howes, D. E. and Kenk, E. (1997): Terrain classification system for British Columbia (revised Edition); *British Columbia Ministry of Environment*, Manual 10 (Version2), 102 pages.

Imperial Metals Corporation (2003): 2002 Annual Report; 41 pages.

Jackson, A. and Illerbrun, K. (1995): Huckleberry porphyry copper deposit, Tahtsa Lake District, west-central British Columbia; *in* Porphyry Deposits of the Northwestern Cordillera of North America, Schroeter, T.G., Editor, *Canadian Institute of Mining, Metallurgy, and Petroleum*, Special Volume 46, pages 313-321.

Kerr, F.A. (1934): Glaciation in northern British Columbia; *Royal Society of Canada*, Transactions, Volume 28, pages 17-31.

Klassen, R.A. (1999): The application of glacial dispersal models to till geochemistry in Labrador, Canada; *Journal of Geochemical Exploration*, Volume 67, pages 245-269.

Lefebure, D.V. and Church, B. N. (1996): Polymetallic Veins Ag-Pb-Zn+/-Au, *in* Selected British Columbia Mineral Deposit Profiles, Volume 2 - Metallic Deposits; Lefebure, D.V. and Höy, T, Editors, *British Columbia Ministry of Energy of Employment and Investment*, Open File 1996-13, pages 67-70.

Levinson, A.A. and Carter, N.C. (1979): Glacial overburden profile sampling for porphyry copper exploration: Babine Lake area, British Columbia; *Western Miner*, Volume 5, pages 19-32.

Levson, V.M. (2001a): Quaternary geology of the Babine Porphyry Copper District: implications for geochemical exploration; *Canadian Journal of Earth Sciences*, Volume 38, pages 733-749.

Levson, V.M. (2001b): Regional till geochemical surveys in the Canadian Cordillera: sample media, methods and anomaly evaluation; *in* Drift Exploration in Glaciated Terrain; McClenaghan, M.B, Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J., Editors, *The Geological Society,* Special Publication No. 185, pages 45-68.

Levson, V.M. and Giles, T.R. (1997): Quaternary geology and till geochemistry studies in the Nechako and Fraser Plateaus, central British Columbia (NTS 93C/1, 8, 9, 10; F/2, 3, 7; L/16; M/1); *in* Interior Plateau Geoscience Project: Summary of Geological, Geochemical, and Geophysical Studies; Diakow, L.J. and Newell, J.M., Editors,

Geological Society of Canada, Open File 3448, and *British Columbia Ministry of Employment and Investment*, Paper 1997-2, pages 121-145.

Levson, V.M. and Mate, D.J. (2002): Till geochemistry of the Tetachuck Lake and Marilla map areas (NTS 93F/5 and F/12); *British Columbia Ministry of Energy and Mines*, Open File 2002-11, 180 pages.

Levson, V. M., Mate, D.J. and Stuart, A.J. (1999): Quaternary geology and drift prospecting studies in the north central Nechako Plateau (93F and K); *in* Geological Fieldwork 1998, *British Columbia Ministry of Energy and Mines*, Paper 1999-1, pages 15-24.

Levson, V.M., Stumpf, A.J., Cook, S.J., O'Brien, E.K., Weary, G., Churchill, C., Hobday, J., Huntley, D.H., Meldrum, D., Lett, R., Ferbey, T., Jackaman, W., Cleary, K.E., Dubois, J. and Rocha, C. (2002): Quaternary geology and till geochemistry of the Babine Porphyry Copper Belt, British Columbia (NTS 93 L/9,16, M/1, 2, 7, 8); *British Columbia Ministry of Energy and Mines*, Bulletin 110, 278 pages

Levson, V.M., Stumpf, A.J. and Stuart, A.J. (1998): Quaternary geology and ice-flow studies in the Smithers and Hazelton map areas (93L and M): implications for drift prospecting; *in* Geological Fieldwork 1997, *British Columbia Ministry of Employment and Investment*, Paper 1998-1, pages 15-23.

MacIntyre, D.G. (1985): Geology and mineral deposits of the Tahtsa Lake District, west-central British Columbia; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Bulletin 75, 82 pages.

McMartin, I. and Henderson, P.J. (1999): A relative ice-flow chronology for the Keewatin Sector of the Laurentide Ice Sheet, Northwest Territories (Kivalliq region, Nunavut); *in* Current Research 1999-C, *Geological Survey of Canada*, pages 129-138.

Mate, D.J. (2000): Quaternary geology, stratigraphy and applied geomorphology in southern Nechako Plateau, central British Columbia; unpublished MSc thesis, *Univeristy of Victoria*, 253 pages.

Mate, D.J. and Levson, V.M. (2000): Quaternary Geology of the Marilla map sheet (NTS 93F/12); *in* Geological Fieldwork 1998, *British Columbia Ministry of Energy and Mines*, Paper 1999-1, 1:50,000 scale map.

Mate, D.J. and Levson, V.M. (2001): Quaternary stratigraphy and history of the Ootsa Lake – Cheslatta River area, Nechako Plateau, central British Columbia; *Canadian Journal of Earth Sciences*, Volume 38, pages 751-765.

MINFILE 093E, Foye, G.R., Owsiacki, G. and Riddell, J.M., (2004): Whitesail Lake map sheet (NTS 093E) mineral occurrences; *British Columbia Ministry of Energy and*

Mines, MINFILE, <http://www.em.gov.bc.ca/Mining/Geolsurv/Minfile/mapareas/93ecov.htm>, [March 2004].

Myers, D.E. and Roney, C. (1990): Geological and geochemical report on the Huckleberry Property, NTS 093E/11E, Omineca Mining Division; submitted by Noranda Exploration Company Ltd., *British Columbia Ministry of Energy and Mines*, AR19764, 46 pages.

New Canamin Resources Ltd. (1993): Surficial geology, Huckleberry Mountain; drafted by McElhanney Resources Ltd, 1:10,000 scale map.

Panteleyev, A. (1995): Porphyry Cu ± Mo ± Au; *in* Selected British Columbia Mineral Deposit Profiles, Volume 1 - Metallic and Coal; Lefebure, D.V. and Ray, G.E., Editors, *British Columbia Ministry of Employment and Investment*, Open File 1995-20, pages 87-92.

Parent, M., Paradis, S.J. and Boisvert, É. (1995): Ice-flow patterns and glacial transport in the eastern Hudson Bay region: implications for the late Quaternary dynamics for the Laurentide Ice Sheet; *Canadian Journal of Earth Sciences*, Volume 32, pages 2057-2070.

Parent, M., Paradis, S.J. and Doiron, A. (1996): Palimpsest glacial dispersal trains and their significance for drift prospecting; *Journal of Geochemical Exploration*, Volume 56, pages 123-140.

Paulen, R.C. (2001): Glacial transport and secondary hydromorphic metal mobilization: examples from the southern interior of British Columbia, Canada; *in* Drift Exploration in Glaciated Terrain; McClenaghan, M.B, Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J., Editors, *The Geological Society,* Special Publication No. 185, pages 323-337.

Plouffe, A. (1994): Surficial geology, Tezzeron Lake, British Columbia (NTS 93K/NE); *Geological Survey of Canada*, Open File 2846, 1:100,000 scale map.

Plouffe, A. (1996a): Surficial geology, Cunningham Lake, British Columbia (NTS 93K/NW); *Geological Survey of Canada*, Open File 3183, 1:100,000 scale map.

Plouffe, A. (1996b): Surficial geology, Burns Lake, British Columbia (NTS 93K/SW); *Geological Survey of Canada*, Open File 3184, 1:100,000 scale map.

Plouffe, A. (2000): Quaternary geology of the Fort Fraser and Manson River map areas, central British Columbia; *Geological Survey of Canada*, Bulletin 554, 62 pages.

Plouffe, A. (2001): The glacial transport and physical partitioning of mercury and gold in till: implications for mineral exploration with examples from central British Columbia, Canada; *in* Drift Exploration in Glaciated Terrain; McClenaghan, M.B,

Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J., Editors, *The Geological Society,* Special Publication No. 185, pages 287-299.

Plouffe, A. and Jetté, H. (1997): Middle Wisconsinan sediments and paleoecology of central British Columbia: sites at Necoslie and Nautley Rivers; *Canadian Journal of Earth Sciences*, Volume 34, pages 200-208.

Plouffe, A. and Levson, V.M. (2001): Quaternary geology of the north half of the Nechako map area (NTS 93F); *Canadian Journal of Earth Sciences*, Volume 38, pages 719-731.

RGS 094E, Jackaman, W. (1988): British Columbia regional geochemical survey (NTS 094E); *British Columbia Ministry of Energy and Mines*, BC RGS 46.

RGS 093E, Johnson, W.M., Hornbrook, E.H.W. and Friske, P.W.B. (1987): Whitesail Lake, British Columbia (NTS 93E); *British Columbia Ministry of Energy, Mines, and Petroleum Resources*, BC RGS 16, *Geological Survey of Canada,* Open File 1360.

Ryder, J.M. and Clague, J.J. (1989): British Columbia: Quaternary stratigraphy and history, Cordilleran Ice Sheet; *in* Quaternary geology of Canada and Greenland; Fulton, R.J., Editor, *Geologial Survey of Canada*, Geology of Canada, No.1, pages 48-58.

Ryder, J.M., Fulton, R.J. and Clague, J.J. (1991): The Cordilleran Ice Sheet and the glacial geomorphology of southern and central British Columbia; *Géographie physique et Quaternaire*, Volume 45, pages 365-377.

Ryder, J.M. and Maynard, D. (1991): The Cordilleran Ice Sheet in northern British Columbia; *Géographie physique et Quaternaire*, Volume 45, pages 281-286.

Shilts, W.W (1976): Glacial till and mineral exploration; *in* Glacial Till: A Symposium; Legget, R.F., Editor, *Royal Society of Canada, Special Publication*, Volume 12. pages 205-224.

Shilts, W.W (1993): Geological Survey of Canada's contribution to understanding the composition of glacial sediments; *Canadian Journal of Earth Sciences*, Volume 30, pages 333-353.

Sibbick, S.J and Kerr, D.E. (1995): Till geochemistry of the Mount Milligan area, north-central British Columbia; Recommendations for drift exploration for porphyry Cu-Au mineralization; *in* Drift Exploration in the Canadian Cordillera; Bobrowsky, P.T., Sibbick, S.J., Newell, J.M. and Matysek, P.F, Editors, *British Columbia Ministry of Energy and Mines*, paper 1995-2 pages 167-180.

Stevenson, R.W. (1970): Report on soil geochemical survey Len No. 3 Group (Len Mineral Claims No. 15-18, 29-32, 35-38, 42FR, 45-58FR, 84 FR), NTS 093E/11E,

Omineca Mining Division; submitted by Kenneco Explorations (Canada) Ltd., *British Columbia Ministry of Energy and Mines*, AR02691, 10 pages.

Stumpf, A.J., Broster, B.E. and Levson, V.M. (2000): Multiphase flow of the Late Wisconsinan Cordilleran Ice Sheet in western Canada; *Geological Society of America Bulletin*, Volume 112, pages 1850-1863.

Syverson, K.M. (1995): The ability of ice-flow indicators to record complex, historic deglacition events, Burroughs Glacier, Alaska; *Boreas*, Volume 24, pages 232-244.

Szabo, N.L., Govett, G.J.S. and Lajtai, E.Z. (1975): Dispersion trends of elements and indicator pebbles in glacial till around Mt. Pleasant, New Brunswick, Canada; *Canadian Journal of Earth Sciences*, Volume 12, 1534-1556.

Tipper, H.W. (1971a): Glacial Geomorphology and Pleistocene History of Central British Columbia; *Geological Survey of Canada*, Bulletin 196, 89 pages.

Tipper, H.W. (1971b): Multiple glaciation in central British Columbia; *Canadian Journal of Earth Sciences*, Volume 8, pages 743-752.

Tipper, H.W. (1994): Preliminary interpretations of glacial and geomorphic features of Smithers map area (93L), British Columbia; *Geological Survey of Canada*, Open File 2837, 7 pages.

APPENDIX A

SECTION DESCRIPTIONS

TFE00-1
WEST BORROW PIT
Easting 618595
Northing 5949486
NAD 83

Along north and east walls of west borrow pit. Described from bottom up.

UNIT 1
0-3.5 m

- gravelly sand to sandy diamict (minimal silt), massive (although locally stratified), matrix supported; moderately dense (significantly more loose than overlying unit); matrix 60%; clasts are rounded to subrounded; clast range is medium to large pebble; some striated clasts but not particularly so in upper units
- unit fines upwards
    - silt content of matrix increases and clast content drops off
    - might be a slight increase in cobble sized clasts up-unit, likely contact with next unit
- unit forms a convex lens 50 m long and 4 m thick (at it's thickest point in this exposure)
- tapers off and ends at either end
- found in one spot, minor areas of discontinuous, sub-horizontal silt/clay laminae
- locally there is very distinct, crude stratification, possibly due to gravelly lenses
- more moist than overlying units and a brown to dark brown colour
- lower contact covered at base (a bench in borrow pit)
- pebble count taken ~1 m from section base

UNIT 2
3.5-6.5 m

- clayey/silt diamict, massive, matrix supported; very dense; 80-90% matrix; clasts are subangular to subrounded with abundant striae; clasts are mainly small to large pebbles with numerous large pebbles to small cobbles, maximum clast size 30 cm (~5% large pebbles and cobbles – rare boulders); many striated clasts in unit; many clasts are flat, disc shaped
- boulder of amygdaloidal andesite, larger calcite (?)
- soft dark green (chlorite?) amorphous, oblong as well as very spherical
- minor late epidote
- striae and rat-tails
    - suggest flow towards ~100°
- bottom is flat and overall oblong and running E-W
- this boulder is located in the upper 1 m of unit 2 (just below contact with unit 3)
- locally there are diffuse patches of diamict (~1 m wide and 0.5 m high) which have a greater water content (has a higher fine sand and less silt content)
- contact with upper unit appears to be distinctive but not sharp
- lower contact is convex and gradational over ~25 cm

UNIT 3

- numerous cobbles, boulders, and large pebbles occur at contact – many are aligned easterly and lie parallel to the contact
- striae also parallel the contact
- boulder tops sit right at contact
    - some show NE flow (from plucking, etc.)
    - boulder at base of Unit 2 has some striae trend (110°) with small rat-tail
    - one boulder on other side of pit has striae and rat-tails suggesting flow towards 100°
- Unit 2/3a contact is gradational in most places
- above contact, Unit 3 diamict is more silt rich, less clay, and as well a higher proportion of large clasts than in Unit 2 (which only has <5% large pebbles and boulders)
- 2 m above contact the till contains up to 10% large pebbles and boulders
- here contains elongated clasts and good fabric trending ENE
- locally there seems to be a concentration of cobbles along contact
    - contact is gradational over an area of 10-50 cm
- locally the upper unit (within 1 m of contact) has a matrix of silty/fine sand
- matrix is more loose than in Unit 2 (i.e. moderately dense), and is more massive with less developed jointing
- in the sandy matrix area, the clasts seem to be only pebbles (i.e. no boulders); this is consistent for up to a couple of metres
- this sandy area grades upwards into a better jointed and more fissile till with a silty matrix

UNIT 3a
6.5-8.3 m

- contains more silt rich (less clay) than unit
- has a higher proportion of clasts than below the contact (locally >10% large pebble and cobbles, some boulders)
- elogated clasts and good fabric trending east/northeast
- matrix is a silty/fine sand; massive
- lower contact of Unit 3a is clear to sharp and dips 14° towards 255° or 22° towards 216° (apparent dips)
    - see notes on unit 2/3 contact area

UNIT 3b
8.3-14.5 m

- silty/clay diamict, massive, matrix supported; very dense; fissile and good verticle jointing; matrix 70% (lower than unit 2); clasts are subangular to subrounded; clast size predominantly small to medium pebbles, and ~5% very large pebbles to small cobbles; many disc shaped clasts; striated clasts abundant
- lower contact of 3b is gradational
    - locally 3a is not present and 3b sits on 2 (i.e. unit 3a is discontinuous and diffuse)

UNIT 4
14.5-19.0 m

- described along section from 1-4 m below surface
- clayey/silt diamict, massive, matrix supported; moderate density; well developed fissility and jointing (Mn and Fe oxide staining along joints); ~60% matrix; clasts mainly medium to large pebble, with the maximum ~10 cm (rare cobbles and boulders); with striated clasts common
    - the large well developed vertical joint planes are oriented at ~130°
    - secondary joint plane at ~0
- possible local concentration of cobbles near base of unit
- unit thickens to the southwest where it becomes less jointed, significantly less oxidized (although is still brown) and lacks a blocky structure
- gravel content up 40-50% (matrix 50-60%)
- matrix still silty/clay
- on upper bench (above measured section) unit 3-4 contact is
- rare lenses of poorly sorted gravelly sand, sub-horizontal, and discontinuous, locally drape over large boulders
- sand/diamict contacts are clear-diffuse over a few centimetres (both top and bottom of)
- diamict above and below sand lens is similar
    - good blocky texture; sz texture
- 25-30 cm Cca horizon overlain by a 20-25 cm Bm horizon
- lower contact undulatory and gradational (over 25-50 cm)

TFE00-2
EAST ZONE SECTION 1
Easting 621301
Northing 5949418
NAD 83

East zone pit. Described from bottom up.

UNIT 1
0-1.0 m

- interbedded silt, minor clay, and diamict
- horizontal bedding, sharp contacts
    - silts are finely laminated (1-2 mm) thick with numerous dropstones (small to medium pebble) that deform underlying laminae
        - some thin clay beds are 15-20 cm thick
    - diamict beds are silty/clay (higher clay content locally), massive and matrix supported; 70-80% matrix; clasts are angular to subangular; clasts range from small to medium pebble; some clasts are mineralized
        - beds 5-8 cm thick (~4 in unit)
        - lower contact sharp and trough shaped
    - locally a 20-30 cm thick clay diamict, massive and matrix supported, overlies bedrock
    - elsewhere a 2-5 cm thick silt diamict, massive and matrix supported overlies bedrock, locally with oxidized matrix
- Unit 1 directly overlies bedrock (mineralized andesite) and therefore follows bedrock topography, filling in low areas and pinching out where bedrock rises

UNIT 2
1.0-2.8 m

- silty/clay diamict, massive and matrix supported; moderate density; good fissility and jointing; 60% matrix; light grey-brown in colour; clasts are angular to subrounded; clast mode is medium pebble, but range from small pebble to small cobble; numerous striated clasts; many oxidized and mineralized clasts
    - mainly massive but fine silt laminae are observed in lower ~0.5 m
- lower contact is sharp and horizontal
- sample 00-6420 taken at ~2.0 m

UNIT 3
2.8-4.25 m

- same as Unit 1 except lower 8 cm is a massive fine sand that fines up into massive clay bed 8-10 cm thick with 1-2 cm of laminated silt in between
    - clay is fissile and jointed with rare small pebbles
- diamict beds have numerous silt laminae <1 mm thick
    - ~4 diamict beds, each 5-25 cm thick
- lower contact is sharp and horizontal

4.25-5.75 m covered (likely mainly a diamict, massive and matrix supported)

UNIT 4
5.75-10.0 m

- unit is mainly a silty/clay diamict, massive and matrix supported, with rare silt/clay laminae and lenses
    - diamict beds are dense; good jointing but not fissile; 80% matrix; brown in colour; clasts are angular to subrounded; clasts are mainly medium to large pebble, but range up to large boulders; many local angular rocks, some mineralized (visible sulphide grains); some oxidized clasts
    - silt and clay laminae are <1 mm thick and locally occur together in zones ~10 cm thick; lenses are 5-10 cm wide and 1-2 cm deep
    - laterally these laminae and lenses are continuous for at least a few metres and probably many metres (observed zone is ~1.5 m from base of unit)
- two other silt and clay zones occur at 8.0-8.5 m and 9.5-9.75 m
    - these zones have more abundant silt and fine sand laminae and the diamict beds are less stony (~90% matrix)
- lower contact covered

UNIT 5
10-13 m (directly overlying bedrock)

- silty/clay diamict, massive and matrix supported, interbedded with silt and clay and fine sand

Unit 5a

- lower 1.5 m of unit is a diamict, massive and stratified, with a clayey/silt matrix (70%); dense; moderate fissility and jointing; clasts are subangular to subrounded with some angular; clasts range from small to large pebble;
- beds are 30-50 cm thick; beds defined by changes in clast content ranging from 60-70%
    - some beds up to 80-90% matrix; clasts are less angular in less stony beds and with rare <1 mm laminae

Unit 5b

- middle 0.75 m of unit is mainly small pebbly mud with interbeds of laminated and bedded silt
    - laminae are <1mm thick fine sand with 0.5-3 cm silt beds)
    - pebbly mud has ~95% matrix
- bed contacts sharp and undulating

Unit 5c

- upper 0.75 m of unit is the same as lower 1.5 m; subunit contacts diffuse and sub-horizontal
    - lower contact diffuse and subhorizontal
- unit 5 thickens to the north, mainly in unit 5b

UNIT 6
13-25 m

- clayey/silt diamict, massive and matrix supported; dense; good jointing, moderate fissility; 60% matrix; clasts are subangular to subrounded, with some angular; clast mode is small to medium pebble, maximum size small boulder; some mineralized clasts
- 250 m southwest (~250°) of gully, Unit 6 is ~16 m thick
    - matrix is clay rich with some pyrite crystals
- pebble count in this unit, ~10 m below surface
- lower contact clear and horizontal
- sample 00-6422 taken ~10 m below surface

UNIT 7
25-27 m

- gravelly diamict, massive and stratified; dense; crude horizontal bedding with mainly large pebble in lower half of unit, and small to medium pebbles in upper half; clast content 40-50%; subangular to subrounded clasts, with some mineralized
- lower contact diffuse and horizontal

UNIT 8
27-28 m

- silty/sand with scattered pebbles and cobbles
- modern Bm (50 cm) and Ah (20 cm) horizons, with a 20 cm Lfh
- lower contact is gradational

Additional Notes:

- exposure in gully at top of Unit 3
- interbedded diamicts, pebbly muds and laminate silts, clays and fine sands
- there is 50 cm of massive mud, with 5% pebbles
- there are some faint, highly deformed laminations in it; it locally includes pods of diamict
- on top of this is ~10 cm of laminated slits, clays and fine sands
- then above this is a 15 cm thick bed of fine muds, deformed
    - overturned folds, injections of diamict into that mud from above
    - there is a lens of diamict that thickens up to 20 cm and pinches out into the mud, over ~5 m
- there is a massive pebbly mud that sits on top and pinches out in the opposite direction
- there is a 10 cm thick thinly bedded silt and clay unit with some silt and clay laminae
    - overturned folds and probably thrust faults
    - laminations thin and thicken and are at various orientations
    - definitely deformed beds which as well includes normal faulting and low angle thrust faults
    - on top of this is 75 cm of finely bedded silts, clays, sand and diamicts

- many dropstones; horizontal bedding; diamicts have small lenses of sands and gravelly sands
- many drape structures over dropstones and deformation under dropstones

TFE00-3
EAST ZONE SECTION 2
Easting 621499
Northing 5949783
NAD 83

Located on high road above middle of east zone. Described from bottom up.

UNIT 1
0-1.1 m

- sandy/silt diamict, massive and matrix supported; dense; fissle, well jointed; dark brown; lots of striated clasts, some boulders
- sample 00-6632
- unit directly overlies bedrock and drapes the bedrock topography which is undulatory and dipping about 15 towards the valley centre (south); unit thins and thickens
- lower contact sharp and undulating

UNIT 2
1.1-4.0 m

- interbedded clayey silt and moderately dense blocky sand; parallel bedding; beds dip (~20 to the south) towards valley centre parallel to bedrock
- clayey/silt laminae 1-10 mm thick; sands 1-5 mm thick
- some medium sand beds 1-5 cm thick with fine sand laminae (<6 beds ?) with rare small pebbles, sands beds thicken at top
- some interbedded sandy diamict, massive and matrix supported, near base of unit; one bed is 5-10 cm thick and things downslope
    - contacts sharp and planar between this diamict and silts
    - lower contact of this diamict shows small scale undulations – possible erosional (0.5-1.0 cm deep, 5-30 cm wide)
    - clasts up to small cobble
- sandy diamict bed is a lens ~2-3 m wide pinching out up and down slope
- laminated sands and silts overlie and laterally drape the underlying unit 1 (szDmm)
- locally massive silts and sands underlie unit 1 and directly overlie bedrock; they show very crude discontinuous beds and lenses that interfinger and appear to be tectonized and sheared (probably subglacial shearing)

UNIT 3
4.0-7.4 m

- sandy/silt diamict, massive and matrix supported; moderately dense; no jointing or fissility; 60-70% matrix; clasts are subangular to subrounded, with rare angular; clast mode is small pebble, with a maximum size of boulder; moderate oxidation;
- lower contact is sharp (locally diffuse with pebbly mud at base) and subhorizontal, dipping gently to valley centre
- Bm and weak Ah soil horizon development in top of unit

TFE00-4
EAST ZONE SECTION 3
Easting 621417
Northing 5949774
NAD 83

Road above east zone, west of gully section. Described from bottom up.

UNIT 1
0-3.5 m

- interbedded silt and clay and fine sand
- 1 m of massive to thickly bedded muds at bottom
- dense
- above this start getting into interbedded silt and clay and fine sand
    - silt and clay quite massive, 3-10 cm thick
    - sand beds 1-5 cm thick
        - this is observed over 0.5 m
- up from this 20 cm of thickly laminated muds and fine sand
- 50 cm of massive muds
    - few pebbles
- then up section thickly laminated to thinly bedded silt, clay, and sands
- Mn oxidation along joint planes
- package ~1 m thick
    - laminae dip 15 towards 205
- then massive muds about 65 cm thick
- Mn oxidation along joint planes
- some discontinuous sand laminae

UNIT 2
3.5-4.5 m

- sandy/silt diamict, massive, matrix supported; dense; good fissility, with Mn oxidation along joint planes; 70-80% matrix; clast mode medium to large pebble, with clasts up to small cobble; striated clasts common
- lower contact with muds is clear and subhorizontal, across ~5 cm zone

UNIT 3
4.5-5.0 m

- bedded fine sand and massive muds
- dense
- appears to be sheared sand lenses
- in upper 0.5 m have common sheared/deformed/brecciated sands – subhorizontal shear fabric

UNIT 4
5.0-8.0 m

- poorly exposed sandy/silt diamict, massive, matrix supported; dense; good fissility, good jointing, with development increasing up-unit; lower part of unit 70-80% matrix, decreasing to 60% near top; clasts are angular to sub-angular; striated clasts common
- lower contact is gradational over 0.5 m and dips 5° towards 270°
    - massive muds become pebbly towards top and grade into diamict

TFE00-5
CONGLOMERATE GULLEY SECTION – LOW EAST
Easting 618972
Northing 5948366
NAD 83

South of east end of tailings dam, on east side of small creek. Described from bottom up.

UNIT 1
0-2.0 m

- directly overlies bedrock but is poorly exposed up until top 30 cm
- top 30 cm is a silty diamict, massive and matrix supported; loose (i.e. not dense); no primary structure (i.e. fissility and jointing), although perhaps very minor/weak fissility present; 60-70% matrix; grey in colour; clasts are subangular to subrounded clasts with rare angular; clast mode is medium pebble, with maximum clast size of 15 cm; many andesites clasts with some granodiorite/intrusives
- lower contact covered

UNIT 2
2.0-3.0 m

- lower half of unit is medium to coarse sands, with the upper half of unit consisting of large pebble to small cobble sandy gravel
- sands are laminated (4-6 m wide and 1-2 m deep trough), with an apparent dip of 15° towards the northwest
    - laminae are fine sands, and are planar to weakly undulating (1-10 cm wide, 50-100 cm deep)
- sands are also jointed (i.e. break out in blocks) where Fe oxide staining and minor cementation occur
- within the sands there are clay/silt lenses
- gravels are massive, clast supported, matrix filled; clasts are subangular to subrounded with rare angular
- lower half of gravels are large pebble to small cobble and then fine up to a small to large pebble, clast supported, matrix filled (medium to coarse sand), sandy gravel

UNIT 3
3.0-3.5 m

- large pebble to boulder gravel, massive, clast supported, matrix filled
- clasts are angular to subrounded with some rounded
- unit has many angular large cobble to small boulders of conglomerate (similar to bedrock below)
- clasts that are found between these are mainly subrounded to rounded small pebble to medium cobbles, that sit in a medium to coarse sand matrix
    - as well, within the sands are very angular, mainly thin (0.5-1.5 m), flat, medium to large pebble clasts
- lower contact is clear and subplanar, dipping 15° to the northwest

UNIT 4

3.5-6.0 m

- interbedded medium to coarse sands, and large pebble to medium to large cobble sand gravels
- sands are interbedded, planar, and cross trough bedded medium to coarse sands
    - planar 3-5 cm thick; cross trough beds 2-3 cm thick
    - cross trough beds are 0.5-1 cm deep and 10-15 m wide
- gravel (i.e. colluvium) is clast supported, matrix filled, large pebble to small cobble, massive, with angular to subangular clasts, and some subrounded and rounded
    - matrix is medium to coarse sand with small to medium angular to subangular pebbles
- this sequence repeats 4 times
    - there is one gravel (i.e. colluvial) bed that is more medium to large pebble to small cobble, with angular to subangular clasts
- units appear to be sub-horizontal; dips measured were in fact the dip of slope or gully side into/towards creek

TFE00-6
CONGLOMERATE GULLY SECTION – WEST SIDE
Easting 618928
Northing 5948397
NAD 83

Opposite to Section TFE00-5. Described from bottom up.

UNIT 1
0-1.0 m

- medium pebble gravel with large scale trough cross beds (~5 m wide)
- poorly sorted, clast supported, matrix filled
- matrix is mainly fine sand
- crude bedding, poorly exposed
- lower contact is covered

UNIT 2
1.0-1.5 m

- interbedded medium to coarse sand and small to medium pebble gravel
- medium scale trough cross beds (2 m wide, 0.2 m deep)
- sandy beds are poorly sorted, show weak trough cross laminae, and usually have a medium to large pebble lag at base
- gravelly beds are moderately well sorted, clast supported, open work
- minor Fe oxide staining
- rare laminated mud clasts at base of unit, also rare striated clasts within the unit
- lower contact is sharp and trough shaped

UNIT 3
1.5-2.2 m

- cobble to boulder gravel
- massive; fabric is chaotic
- some steep channel fill structures, cobbles at base fining up into a large pebble gravel
    - these scours are 2 m wide, 0.5 m deep
- clast supported, matrix filled
- matrix is medium sand up to pebbles
- clasts are mainly subrounded to rounded, but there are some subangular boulders
- lithologies are highly variable and include conglomerates, feldspar porphyrys, basalts, andesites, granodiroites, sandstones
- most of the subangular clasts are local conglomerate; one subangular feldspar porphyry boulder was observed
    - boulders are up to 0.5 m in diameter
- gravel is moderately well cemented (probably Fe oxide cement, although ti is not very red-stained)
- more striated clasts than Unit 2
- lower contact is sharp and trough shaped; troughs are 1-3 m wide and 0.1-0.2 m deep

TFE00-7
PUMPHOUSE SECTION
Easting 621983
Northing 5948931
NAD 83

Rock quarry on east end of property, just off road to pumphouse. described from bottom up.

UNIT 1
0-0.75 m

- massive sandy/silt diamict, massive and matrix supported; moderate to high density; good fissility, moderate – well jointed with Mn oxidized joint planes; unit is slump covered unit so clast %, etc., difficult to determine
- unit is not laterally extensive/continuous; seems like its found in pockets or lows in bedrock
- large (50 cm) angular boulder was found sitting at Unit 1 and Unit 2 boundary
- diamict is gray/brown and contains weathered clasts; overall diamict is quite weathered
- lower contact is undulating and overlies bedrock

UNIT 2
0.75-1.75 m

- interbedded sands and gravel
    - lower unit is fine to medium sand, ~15 cm thick and contains contains heavy mineral and silt laminae
    - upper gravel unit is clast supported and matrix filled; matrix medium to coarse sand; clasts are subangular to well rounded, on average more subangular; unit is 30 cm thick
    - lower contact is trough shaped and sharp
    - seems to pinch out towards 130
- 65 cm of interbedded fine to coarse sands and gravels
    - planar bedding gently undulating
    - seems to be coarsenupwards (?)
        - 10 cm of fine sand near contact with gravel (bottom contact)
    - unit contains rare coasre sand to medium pebble gravel lenses 5-10 cm thick, and appear to be continuous
- lower contact is trough shaped and clear; parts of are however slump covered

UNIT 3
1.75-3.25 m

- poorly sorted sands and gravels
    - gravels range from small pebble to cobble, and are matrix filled (f to c sand)
- unit appears to be crudely bedded; unit contains rare pods of matrix supported gravels (fine to coarse sand)

TFE00-8
MAIN ROAD GULLY
Easting 622065
Northing 5949199
NAD 83

Gully west of main road (peats in gully). Described from bottom up,

UNIT 1
0-0.3 m
- sandy gravel; clast supported, matrix filled
- lower contact mostly covered but locally overlies black organic silts

UNIT 2
0.3-0.5 m
- peat with thin sand interbeds
- lower half is Bf
- upper half is mainly Ah
- C^{14} sample taken of wood (laying horizontal) at the base of this unit (~30-35 cm)

UNIT 3
0.5-0.6 m
- gravelly sand
- significant amount of angular rock

UNIT 4
0.6-0.95 m
- peat lens; a woody organic silt with some charcoal
- possible burried Ah, and Bm in upper parts (5 cm)
- unit thins upslope

UNIT 5
0.95-1.0 m
- unoxidize fine-medium sand

UNIT 6
1.0-1.1 m
- organic silt overlain (?)
- a few Ah layers or beds in base – organic rich
- Fe oxidation at top

UNIT 7
1.1-1.3 m
- sandy gravel
- clast supported; local angular clasts, rare rounded

- undulating, trough shaped lower contact; steeply dipping (10°) down valley (south)

UNIT 8
1.3-1.6 m
- oxidized silt
- abundant wood fragments and rootlets
- possible, in situ, rooted tree trunk

UNIT 9
1.6-1.7 m
- sandy, clast supported, matrix filled, small to medium pebble gravel lens (0.5 m wide); pinches out toward valley side
- minor Fe oxidation and yellow staining/oxidation (limonitic)

UNIT 10
1.7-2.0 m
- woody layer (fibric peat)
    - small wood pieces up to 0.5 m long and 0.1 m diameter
    - C^{14} sample of wood (laying horizontal) at top of unit at ~195-200 cm
- there is the odd small trough shaped gravel lends within the peat

UNIT 11
2.0-2.2 m
- silty diamict, massive and matrix supported; angular clasts common with some rounded
- low density; 50-60% matrix

UNIT 12
2.2-2.3 m
- fibric peat, similar to Unit 10

UNIT 13
2.3-2.5 m
- silty diamict, massive and matrix supported; same as Unit 11 except that upper half is highly Fe oxidized

UNIT 14
2.5-3.0 m
- large pebble gravel fining up to small pebble gravel
- more rounded clasts (20-25%)
- top of unit has a weak to minor Ah development (5-10 cm) and common rootlets
- rest of unit is quite red; possible modern Bf soil development
- lower contact is sharp and trough shaped

TFE00-9
HIGH EAST CONGLOMERATE GULLY SECTION
Easting 618997
Northing 5948321
NAD 83

Above road. Described from bottom up.

0-1.5 m covered

UNIT 1
1.5-2.4 m

- interbedded sands and gravels
- horizontally bedded to low angle trough cross beds
- sand beds vary from 5-25 cm thick; gravel beds vary from 5-15 cm thick
- sand beds dominate
- sands are medium to coarse, moderate to well sorted
    - coarse sand beds are 1-5 cm thick; fine sand beds are 1-2 cm thick
- beds are granular to small pebbly
- most are horizontally bedded, with some small scale trough cross bedding
- gravels are massive, small pebble to small cobble; clast supported, matrix filled
    - matrix is coarse sand; clasts are subangular to subrounded, rare angular
- fabric is chaotic
- sands drape over gravels; gravels grade upwards to the sand beds
- there is a gravel lag at the base of the sands

UNIT 2
2.4-4.4 m

- large pebble to small cobble gravels with some sand lenses
- mainly horizontal to low angle large scale trough cross beds
- the gravels are imbricated and suggest apparent flow to the SE
- bedding is crude and defined by coarser and finer gravel strata (generally about 50 cm thick); bed tops are locally marked by sand lenses
    - sand lenses are 5-10 cm thick by 50-300 cm wide
- gravels are clast supported, matrix filled (medium to coarse sand)
- sand lenses are medium to coarse with fine to medium sand interbeds
- the coarser and finer sand beds are up to 2 cm thick
- mainly horizontally bedded with some small scale trough cross beds
    - the troughs are 50 cm to 300-400 cm wide and 20-40 cm deep
    - troughs indicate flow to the ESE
- lower contact is sharp and undulating or trough shaped

UNIT 3
4.4-6.5 m (poorly exposed)

- gravel to gravelly diamict

- where exposed, the gravels are mainly large cobbles with rare sand lenses

UNIT 4
6.5-11.5 m

- silty/sand to sandy/silt diamict, massive and matrix supported; extremely dense; moderate fissility and good jointing; 60% matrix; unoxidized (grey in colour); clasts are subangular to subrounded; clast mode is medium to large pebble, with maximum clast size of 15 cm; abundant striated clasts
- lower contact is clean and horizontal, but poorly exposed
- on steep part of slope in the upper 1.5 m the fissility is slope parallel (slope is ~40)
- this unit grades upwards into 1 m of gravelly sands with some soil oxidation
- on top of colluviated till is locally a laminated clayey/silt lens that is ~5 m long and 0.75 m deep
- above this is a silty sand dimaict; massive, matrix supported; low density; no primary structures (i.e. fissility or jointing); clasts are subrounded to rounded with some subangular; clast mode is medium to large ?, with maximum clast size ~10 cm;
- grades up into a pebbly med-coarse sand; this is the start of the Bf/Bm (i.e. soil profile)
- some of the silt/clay laminae are oxidized along bedding planes
- many small-large pebble dropstones

TFE00-10
MAIN ZONE PEAT SECTION
Easting 620640
Northing 5949550
NAD 83

Peat section located on east wall of main zone, at entrance to pit. Described from bottom up.

UNIT 1
0-6.0 m

- clayey/silt diamict, massive and matrix supported; moderate density; moderate fissility, good jointing; 70-80% matrix (visible sulphides in matrix); unoxidized, grey in colour; sediment is moist; clasts subangular to subrounded; clast mode is medium to large pebble, with maximum size 15 cm; many striated clasts; most clasts are andesites (some containing chalco), with a few granodirorites
- sample 00-6467 at base (2.0 m)
- sample 00-6468 at top (5.5 m)
- sample 00-6470 at top – oxidized (5.8-6.0 m)
- sample 00-6470 is in the upper 0.2 m which is a brown (oxidized) layer sharply overlying the unoxidized till
- lower contact covered

UNIT 2
6.0-9.0 m

- large pebble to small cobble gravel, clast supported, matrix filled
- horizontally bedded (beds ~1.5 m thick)
    - some beds with mainly rounded to subrounded clasts
    - some beds with mainly angular to subangular clasts, clast and matrix supported, and matrix filled
    - poorly sorted; chaotic fabric; matrix mainly coarse sand
- some Fe staining and cementation
- rounded to subrounded gravel beds better sorted; some open work with Mn staining and cementation; some with yellowish staining
- bed contacts sharp to clear and gently undulating
- some medium to coarse sand lenses (0.05-0.3 m thick and a few to several metres wide
- lower contact sharp and trough shaped (several metres wide and 0.5-1.0 m deep)

UNIT 3
9.0-9.3 m

- black, silty, organic, humic peat, water saturated
    - significant amounts of recognizable reeds/rushes; some twigs/wood debris 0.5-2.0 cm diameter (some flattened); some rootlets; rare angular to

subangular, small to large pebbles; one organic silt bed ~2-3 cm thick (light brown in colour)

- lower contact is sharp and undulating (Units 3-5 infill low troughs/basins – see photos)
- sample 00-6471 collected in lower 0.1 m of unit (at ~9.0-9.1 m)

UNIT 4
9.3-10.3 m

- mesic peat, composed mainly of recognizable reeds/rushes and woody debris; some humic peat
    - wood debris 1-40 cm in diameter (i.e. twigs and logs); some _(?) rooted stumps; wood is laying horizontal to subhorizontal, and is less decomposed than Unit 3 (colour still there)
- unit weathers whitish, with some moss growing on this whitish surface crust
- lower contact gradational
- sample 00-6472 collected at 9.8-10.0 m

UNIT 5
10.3-11.5 m

- fibric peat composed of almost entirely recognizable organic fibers (reeds/rushes), wood debris from a few millimetres to ~30 cm diameter; probably mosses; generally smaller wood than in Unit 4
- unit weathers yellowy/grey
- lower contact gradational over ~10 cm
- sample 00-6473 collected at 10.8-11.0 m

TFE00-11
TAILINGS DAM GRAVEL SECTION
Easting 619281
Northing 5949575
NAD 83

West of main zone and east of tailings dam; just north of west abutment. Described from bottom up.

UNIT 1
0-3.0 m (gravels probably to 4-5 m)

- sandy, large pebble to cobble gravel, interbedded with very fine to fine sand; clast supported, matrix filled; generally medium to coarse sand matrix; abundant Fe oxidation and cementation of pebble to cobble gravel beds
- medium to large scale trough cross-bedding (dip 25° towards SE), 2-3 m wide and 0.5-0.75 m deep; some several metres wide and 1-2 m deep (mainly poorly exposed)
- lower contact covered

UNIT 2
3.0-6.3 m

- silty/sand to sandy/silt diamict; massive and matrix supported; very dense; good fissility and jointing; ~70% matrix; predominantly unoxidized (dark grey in colour) except at base; clast mode medium to large pebble, with maxium clast size 20 cm; abundant striated clasts
- lower contact sharp and subhorizontal with undulations 1-5 m wide and 0.5 m deep

6.3-7.0 m covered

7.5-8.0 m same as Unit 2

UNIT 3
8.0-10.5 m

- interbedded silty/sand to sandy/silt diamict (massive and matrix supported) and large pebble to cobble gravel and sands
- large scale trough cross-bedding defined by sand beds ~0.5-0.75 m thick dipping ~10° towards 090°(paleo flow probably ~SE)
- sands are well sorted fine to very fine up to moderate to poorly sorted medium to coarse pebbly sands; beds are 1 to several centimetres thick; fine sands laminated (parallel), coarse sands exhibit small scale trough cross-beds
    - some Fe staining in fine sand beds
- gravelly beds are poorly sorted, massive, clast supported and matrix filled with medium to coarse sand matrix; gravels occur in trough-bases ~0.5 m thick under sands; gravels sit steeply on diamict with clean trough-shaped lower contact over diamict
- massive, matrix supported to stratified diamict has small laminated sand and silt lenses; exhibits moderate jointing and fissililty; moderately dense; clast mode is

medium to large pebble, maximum clast size is 10 cm; 60% matrix; not oxidized in matrix, however mildly on joints; dark brown in colour

- lower contact of diamict is sharp and trough shaped over sands
- lower contact of unit is sharp and trough shaped

TFE00-12
HUCKLEBERRY SOIL PROFILE 1
Easting 618516
Northing 5949351
NAD 83

Bottom unit in profile, north facing cut, west end of west borrow pit. Described from bottom up.

UNIT 1
0-5.5 m

- clay diamict with discontinuous beds of gravelly diamict and sands and gravels
    - clay diamict unoxidized
- gravelly diamict generally more of a sandy matrix with gravel content 40-50%
- lower 1-3 m of unit is massive clay diamict that pinches out to west
- upper part is interbedded gravelly diamict and sands and gravels and clay diamict
    - gravelly diamict beds 20-100 cm, are laterally continuous for 520 m, are mostly sub-horizontal, undulatory, with mostly diffuse contacts
    - some clasts you have sandy lenses/stringers >1 cm
- sand and gravel zones have Fe oxidation and Mn staining
- one lace where large boulder was stuck in gray clay diamict above sand/gravel lens that may have scours on the boulder
- matrix varies from a clean coarse sand to a diamict (i.e. silt rich sediment)
- within clay diamict there are 2 cm (cm or m?) thick, 10 cm wide silt laminae that drape over clasts
- crude bedding in some sand and gravel lenses/beds/pockets
- samples 00-6415 and 00-6416 sampled at 5.5 m and 7.5 m from surface

TFE00-13
EAST END OF EAST ZONE PIT
Easting 621731
Northing 5949400
NAD 83

East end of East Zone pit. Described from bottom up.

UNIT 1
0-0.75 m

- clayey-silt diamict, massive, matrix supported; dark grey
- moderately developed fissility, well jointed; very dense
- clast mode medium to large pebble; subangular to subrounded
- matrix 80%
- striated clasts common
- unit directly overlies grooved and striated bedrock (grooves and striae oriented at 105°, on flat surface)
- unoxidized
- sample 00-6689 (depth 300-325 cm)

UNIT 2
0.75-2.75 m

- silty-sand to sandy-silt diamict, massive, matrix supported; dark grey to brown
- fissility weak, well developed joints; moderate density
- moderately oxidized
- 80% matrix; clast mode medium to large pebble, subangular to subrounded
- striated clasts common
- sample 00-6434 (depth 200 cm)

UNIT 3
2.75-3.30 m

- silty-sand to sandy-silt diamict, massive, matrix supported; orangey-brown
- 80% matrix; clast mode medium to large pebble, subangular to subrounded
- striated clasts common
- oxidation moderate to high
- strong Mn staining along joints
- sample 00-6435 (depth 100 cm)
- just above sample site this unit gets more gravelly
    - brown gravelly, sandy-silt

UNIT 4
3.30-3.75 m

- soil horizon, which working upsection goes through:
    - Bm, light yellow; soil sample 00-6477 (depth 40 cm)

- Ah/Ae, light brown to grey silt; sample 00-6478 (depth 25 cm)
- Ah, dark brown to black organic silt; sample 00-6479 (depth 15 cm)
- LFh, wood and woody peat (fibric); sample 00-6480 (depth 5)

TFE00-14
EAST ZONE BORROW PIT
Easting 621012
Northing 5949455
NAD 83

Above East Zone borrow pit; sits stratigraphically above glacial tills in TFE00-2. Described from bottom up.

UNIT 1
0-1.37 m

- sandy-silt diamict, massive, matrix supported; dark grey
- matrix has some clay (i.e. ribbons between fingers
- moderately dense, moderately fissile, well jointed, unoxidized
- clasts subangular to subrounded (some angular)
- clast mode small to medium pebble, max. ~20 cm
- has abundant visible sulfides in matrix
- striated clasts are abundant
- upper 10 cm of unit is slightly oxidized (light brown colour); fissility is better in oxidized zone although sediment is less dense
- matrix is 70-80%
- lower contact is covered
- sample 00-6436 (at 60-70 cm)
- samples 00-6700 to 6704 were taken in the top of the East Zone borrow pit on a N/S transect just below this section and this unit.

UNIT 2
1.37-1.42 m

- sandy medium pebble to small cobble gravel
- massive, clast supported, matrix filled
- strong Fe oxide staining
    - coating on lower part of cobbles and weak cementation in matrix
    - clasts subangular to subrounded with some angular and rounded
    - matrix mainly clean coarse sand
    - lower contact sharp and trough shaped (troughs are 1-2 m wide and 30-50 cm deep)

UNIT 3
1.42-1.97 m

- sandy-silt diamict, matrix supported, massive to stratified
- massive in lower two-thirds, crudely bedded in upper third
- Dmm is moderately dense; moderately fissile; moderately jointed; matrix 70%; clasts subangular to subrounded (some angular); clast mode small to medium pebble, max. 8 cm; grey in colour; unoxidized although there are some oxidized clasts

- in Dms bedding defined by changes in matrix texture from sandy-silt to silty-sand and colour change (orange red to light grey); clasts as in Dmm; less dense, fissile and jointed than Dmm; but more oxidized
- contact between Dmm and Dms is gradational over 2-5 cm
- lower contact of unit is clear and trough shaped (i.e. is conformable with Unit 2 troughs)

UNIT 4
1.97-2.61 m

- interbedded
- large pebble to small cobble with granular small pebble gravel clast supported
- 3 beds ~20cm thick each
- lower bed is large pebble to small cobble gravel with medium sand matrix in upper half and open work in upper half
- abundant Fe nodes and organic fiber in upper half, also minor Fe cementation
- chaotic fabric
- some large cobbles and small pebbles at bed base that penetrate into the top of unit 3
- middle bed is small pebble gravels
- clast supported mainly open work and crude planar cross-bed dipping up to 28° towards 070 apparent
- beds 2-5cm thick, heavy iron oxide staining upper bed is a poorly sorted, medium to large pebble gravel matrix; supported matrix is medium-coarse sand. Some iron oxide straining; few highly weathered clasts; clasts are angular to subangular; lower contact is clear and undulating;
- sample 00-6444 (265-270cm) - undulating are 2-5m wide and 10-15cm deep.

UNIT 5
2.61-3.48 m

- sample 00-6445 (261-266 cm) humic peat with ~10-25% wood fragments (1cm twigs to 5cm branches)
- sample 00-6439 (330 – 340cm) some larger logs appear to be intruding from above; scattered angular to subangular large pebble classes in the lower 15-20cm; also some fine sand to silt lenses (5 to 10 x ½ to 2 cm thick) in lower 15-20cm; some charcoal frags
- sample 00-6438 (280-300cm) lower half is blacker organics and upper is more brown (sample 00-6440 (340 to 348cm)); lower contact sharp and subhorizontal
- laterally (N) this unit is underlain by a lenses (~25cm thick by 4m wide) of interbedded sand, silt and Dmm (base up) & beds are ~10-15cm thick; sand and silt beds with organic rich beds
- very top has some reeds/rushes

UNIT 6
3.48-4.71 m

- massive to crudely bedded; locally bedding defined by slight changes in colour; light brown to medium brown changes in organic material; unit weathers to a white colour

when dry; numerous lodgepole pine needles through unit; also bar and small twigs (up to 0.5cm diameter) throughout; some well preserved pine cones at top and spruce

- sample 00-6443 (370-390cm) – 4 samples at 450 to 470
- numerous wood (log) debris that seem to increase in size upwards from 5 to 10 cm at base to 10 to 20 cm at top; randomly oriented, mostly flat lying but a few plunge steeply into underlying unit
- sample 00-6442 (348-35?cm) lower ~10cm of marl is locally more organic with rich darker layer; has 1 pine cone; no shells seen, no fizzing, probably gyttja
- this unit trends to 0 towards the bog margin (N) and thickens towards the south (bog center; along the bog margin the marl is overlain by up to 1.5 m of very woody peat.
- lower contacted of marl is sharpe (~50m wide & ~2m deep).

UNIT 6
4.71- 5.00 m

- sample 00-6646 (500-515cm) – fibric to woody peat; very crudely bedded wood mainly at the surface; light brown colour; lower contact gradation; sample looks like bark mulch
- note – in the bog center the upper 75 cm is well laminated to thinly bedded with alternating light grey and black layers; also visible organics; large mud cracks 10cm wide by 75cm deep cover the old bog bed (sample 00-6447)

TFE00-15
SAMPLE 00-6608
Easting 622220
Northing 5948930
NAD 83

At site of near-surface sample 00-6608. Described from top down.

SOIL HORIZON
1.8-2.0m
- sample 00-6448; sand to silt; Dmm to gravel sands; moderate density

1.3-1.5m
- sample 00-6449, 6608; Dmm; some variable sorting of matrix

0.8-1.0m
- sample 00-6450; stony mud; brown; silt to fine sand matrix; massive; possibly was bedded; <10% stones

0.4-0.5m
- sample 00-6451; gravel-silt; 5-10% stones; massive; medium density; weak jointing and mild oxidation; reduced along roots

0.1-0.15m
- sample 00-6452; Bm soil horizon, gravel sand to silt; 15% gravel; massive; lower contact gradational and irregular

0-0.1m
- sample 00-6454, 6453; LFL & this (0-3cm) Ah; lots of needles and fiber wood
- site is located on a small (~2cm) ridge running down slope with a small depression just upsloe & to the west a bit
- ~25 m upstream (W) of site there is an exposure with 1m of organic silts with buried BF & AL layers (several of each) overlaying ~1m of poorly sorted sand and gravel; sampled; likely Bm weathering white at surface; wet poorly drained site with horsetail and hemlock

TFE00-16
SAMPLE 00-6620
Easting 618361
Northing 5948765
NAD 83

At site of near-surface sample 00-6620. Lower 5.5m was described in a trench 10m to the southwest. Upper 1m described in road cut at sample 00-6620. Described from bottom up.

UPPER
0-3m
- sample 00-6465; LFH (<0 to 1cm of Ah) Ah is very thing

3-5m
- sample 00-6464; Ae locally absent

10-20m
- sample 00-6463; BF – silt to very find sand with pebbles and some rootlets; massive reddish (rusty) range; lower contact gradual

45-55m
- sample 00-6462; Bm; stony fine sand; massive; 70-80% matrix; yellowish brown; clasts subangular to subrounded; loose; very week to no fissility; clasts up to 10cm; medium to large pebble

60-100m
- sample 00-6466; lower contact clean and undulating; very weather clasts in till; about 30 separate classes; mostly granites by volume; also some rusty and small andesites and sandstone(?) clasts; larges ~3-4cm.

LOWER
UNIT 1
0.75-1.25 m
- similar to basal till below but very oxidized, and brown in colour; texture is a coarser silty/sand

UNIT 2
1.25-2.6 m
- similar to basal till below but moderately oxidized and dark-brown, less dense, and a coarser clayey/silty matrix; lower contact with un-oxidized basal till below is gradational

UNIT 3
2.6-5.5 m

- un-oxidized, dark grey, silty/clay basal till; very dense, weakly jointed, fissile; 60-70% matrix; clast mode medium to large pebble; clasts are sub-angular to sub-rounded; mineralized (chalcopyrite), cobble-sized, granodiorite clasts found at about

APPENDIX B

ICP-MS ANALYTICAL DATA FOR NEAR-SURFACE AND VERTICAL PROFILE SAMPLES

LOCATION OF VERTICAL PROFILE SAMPLES

SAMPLE	DEPTH (m)	MATERIAL	LOCATION
00-6402	11.25	till	TFE00-1
00-6403	13.25	till	TFE00-1
00-6404	5.00	till	TFE00-1
00-6405	3.00	till	TFE00-1
00-6406	1.50	till	TFE00-1
00-6407	0.60	till	TFE00-1
00-6408	13.50	till	TFE00-1
00-6409	13.00	till	TFE00-1
00-6410	12.00	till	TFE00-1
00-6411	0.10-0.25	organic silt	TFE00-12
00-6412	0.25-0.40	Bf	TFE00-12
00-6413	0.45-0.65	Bm	TFE00-12
00-6414	1.20-1.35	till	TFE00-12
00-6415	5.50	till	TFE00-12
00-6416	7.50	till	TFE00-12
00-6418	8.00	till	TFE00-1
00-6419	1.05	till	TFE00-1
00-6422	2.0 above bedrock (Unit 2)	debris flow	TFE00-2
00-6423	1.0 above unit 5	till	TFE00-2
00-6424	6.0 from bottom unit 6	till	TFE00-2
00-6425	1.0 above bedrock (Unit 1)	till, debris flow (?)	TFE00-2
00-6426	0.50 above bedrock (Unit 1)	till, debris flow (?)	TFE00-2
00-6427	2.50	till	near-surface east/west, East Zone borrow pit
00-6428	1.50	till	near-surface east/west, East Zone borrow pit
00-6429	2.00	till	near-surface east/west, East Zone borrow pit
00-6430	~5 to 7 m	till	east/west transect, bottom of East Zone borrow pit, at gully
00-6431	~5 to 7 m	till	east/west transect, bottom of East Zone borrow pit, 7 m west of 6430
00-6432	~5 to 7 m	till	east/west transect, bottom of East Zone borrow pit, 50 m west of 6431

LOCATION OF VERTICAL PROFILE SAMPLES

SAMPLE	DEPTH (m)	MATERIAL	LOCATION
00-6434	2.00	mildly oxidized till	TFE00-14
00-6435	1.00	strongly oxidized till	TFE00-14
00-6436	4.70-4.80	till	TFE00-14
00-6437	3.80-3.90	debris flow	TFE00-14
00-6438	2.40-2.60	black peat	TFE00-14
00-6439	2.00-2.10	brown peat	TFE00-14
00-6440	1.92-2.00	reeds	TFE00-14
00-6442	1.82-1.92	darker marl	TFE00-14
00-6443	1.50-1.70	marl	TFE00-14
00-6445	2.74-2.79	dark organics	TFE00-14
00-6446	0.25-0.40	fibric peat	TFE00-14
00-6447(a)	0.0-0.25	modern bog seds	TFE00-14
00-6447(b)	0.0-0.25	modern bog seds	TFE00-14
00-6447(c)	0.0-0.25	modern bog seds	TFE00-14
00-6448	1.80-2.00	till	TFE-0015
00-6449	1.30-1.50	till	TFE-0015
00-6450	0.80-1.00	stony mud	TFE-0015
00-6451	0.40-0.50	gravelly silt	TFE-0015
00-6452	0.10-0.15	Bm	TFE-0015
00-6454	0.0-0.10	Lfl and thin Ah	TFE-0015
00-6455	5.00	till	TFE00-16
00-6456	3.50-3.60	till	TFE00-16
00-6458	2.50	till	TFE00-16
00-6459	1.50	till	TFE00-16
00-6460	0.95-1.00	till	TFE00-16
00-6462	0.45-0.55	Bm	TFE00-16
00-6463	0.10-0.20	Bf (zvfS)	TFE00-16
00-6464	0.03-0.05	Ae	TFE00-16

LOCATION OF VERTICAL PROFILE SAMPLES

SAMPLE	DEPTH (m)	MATERIAL	LOCATION
00-6465	0.0-0.03	Lfh and very thin Ah	TFE00-16
00-6466	0.60-1.00	crushed clasts from till	TFE00-16
00-6467	9.50	till	TFE00-10
00-6468	6.00	till	TFE00-10
00-6470	5.70-6.00	till	TFE00-10
00-6471	2.40-2.50	black organic z	TFE00-10
00-6472	1.50-1.70	mesic peat	TFE00-10
00-6473	0.50-0.70	fibric peat	TFE00-10
00-6474	2.50-2.70	sandy gravel	TFE00-10
00-6475	<1.0	till	bog northwest of 00-6620
00-6476	<1.0	soil	bog northwest of 00-6620
00-6477	0.37	Bm	TFE00-13
00-6478	0.25	Ah/Ae	TFE00-13
00-6479	0.15	Ah	TFE00-13
00-6480(a)	0.05	Lfh	TFE00-13

LOCATION OF NEAR-SURFACE TILL SAMPLES

SEE FIGURE 5.2

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6001	ADUP 00-6009	6.03	517.46	16.52	106.9	326	29.3	19.2	770	4.08	35.3	0.4	4.1
00-6007	STD (GSB Till 99)	0.8	189.93	243.4	360.8	1367	229.7	53.6	1670	6.74	61.8	0.4	21.6
00-6009	10	6.05	549.73	16.03	113	354	31.5	19.4	814	4.27	37.5	0.4	4.7
00-6010	20	5.16	299.18	16.36	119.1	279	32.1	19	868	4.27	39.2	0.4	3.5
00-6021	ADUP 00-6022	3.13	133.03	15.82	116.8	227	28.9	15.6	936	3.8	27	0.5	2.2
00-6033	STD (GSB Till 99 (B))	0.77	159.08	212.85	355.5	1252	201.9	46.1	1308	6.2	55.7	0.5	23
00-6037	10	9.51	420.06	20.31	119.9	396	34.2	18.1	828	4.28	62.7	0.6	7.6
00-6038	20	9.09	407.94	20.42	118	375	33.7	16.6	820	4.2	62.9	0.5	10
00-6041	ADUP 00-6060	4.2	130.04	16.24	111.6	194	28.2	17	938	3.69	19.2	0.7	2.1
00-6055	STD (TILL 1 (330))	0.63	45.67	17.72	66.8	204	17	13.3	1156	3.05	16.8	0.9	6.3
00-6059	10	4.21	131.73	15.38	108.1	210	29.5	16.3	966	3.81	18.7	0.7	8.7
00-6060	20	4.28	138.29	16.1	107.7	213	30.1	16.1	961	3.81	19.1	0.8	2.7
00-6061	ADUP 00-6079	7.18	246.49	12.59	83.1	214	32	16.6	800	3.66	23.7	0.5	2.6
00-6077	STD (RED DOG 97)	13.14	172.2	7.19	49.1	70	12.9	11.3	453	4.04	5.9	0.4	23.5
00-6078	10	7.03	248.51	12.13	77.5	202	31.2	15.4	778	3.55	21.4	0.5	2.1
00-6079	20	7.51	243.28	12.5	80.7	232	30.7	16	789	3.61	23.9	0.5	1.9
00-6081	ADUP 00-6094	0.6	38.97	15.74	79	104	31.6	13.4	800	3.28	7.5	0.5	2.2
00-6084	STD (RED DOG 97	14.07	172.19	7.82	48.9	74	13.6	11.6	459	4.14	6.3	0.4	43.7
00-6094	10	0.61	38.56	16.04	84.1	97	31	13.5	804	3.26	7.2	0.4	2.3
00-6095	20	0.58	39.54	14.12	81.3	97	30.7	13.6	804	3.27	6.8	0.4	1.3
00-6101	ADUP 00-6118	10.33	212.93	10.03	74.1	171	29.7	14.7	744	3.33	6.7	0.4	1.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6106	STD (GSB Till 99 (B))	0.77	162.02	221.73	353.3	1299	210.1	44.4	1331	6.29	55.4	0.4	25.8
00-6118	10	10.63	210.01	9.26	73.8	175	29.3	14.6	730	3.26	6.5	0.4	2.8
00-6119	20	4.84	327.84	11.82	83.2	124	29.3	18.5	872	3.61	14.4	0.3	2.5
00-6121	ADUP 00-6139	21.64	649.64	16.05	99.5	406	29.6	16.4	760	3.88	26.7	0.4	9.1
00-6137	STD (GSB Till 99 (B))	0.82	165.96	214	346.1	1296	208	47.1	1339	6.37	59.9	0.5	24.9
00-6138	10	23.57	683.99	14.58	105	437	30.3	17	781	4.03	28	0.5	10.6
00-6139	20	21.9	662.7	15.43	103.1	431	30.4	17	775	3.99	27.7	0.5	8.8
00-6141	ADUP 00-6153	12.44	483.16	21.45	167.2	370	32.4	17.2	848	4.33	63.7	0.5	15.3
00-6153	10	12.04	462.98	21.69	155.3	389	30.7	16	799	3.95	61.7	0.5	16.4
00-6154	20	14.44	492.54	21.32	158.9	425	31.3	16.6	830	4.07	63.7	0.5	13.4
00-6155	STD (RED DOG 97)	12.96	165.1	7.7	54.4	62	12	10.8	456	4.32	6.8	0.4	32.2
00-6161	ADUP 00-6169	0.87	47.9	17.81	77	108	33	15	733	3.36	5.8	0.4	1.3
00-6163	STD (GSB Till 99 (B))	0.78	163.64	205.65	357.6	1445	218.2	39.6	1290	6.48	55.7	0.4	27.8
00-6169	10	0.89	47.05	18.71	74.5	96	28.7	14.2	745	3.57	6.4	0.4	2.3
00-6170	20	0.65	46.56	11.68	75.6	99	33.2	14.5	753	3.43	5.7	0.4	1.3
00-6181	ADUP 00-6196	4.01	182.45	14.81	110.9	250	24.9	13.5	874	3.78	30.5	0.6	57
00-6188	STD (RED DOG 97)	14.27	168.72	7.57	53	73	12.8	11.2	450	4.01	6.2	0.4	28.8
00-6196	10	3.73	182.03	16.1	107.6	205	28.5	15.6	875	3.63	27.8	0.5	3.2
00-6197	20	4.1	188.59	15.89	109.3	200	29.2	15.9	879	3.67	28.4	0.6	2.7
00-6201	ADUP 00-6212	12.43	458.02	17.76	109	372	32.9	16.7	810	4.28	46.3	0.5	28.5
00-6207	STD (RED DOG 97)	14.27	166.32	7.66	55	76	13	11.7	457	4.05	6.7	0.4	23.8

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6221	ADUP 00-6224	1.71	73.13	20.37	88.1	140	32.9	13.8	842	3.5	9	0.5	2
00-6401	ADUP 00-6403	0.24	24.78	5.12	40.8	63	16.7	8.7	477	2.59	3.6	0.4	0.7
00-6402		0.64	38.13	10.42	86	108	30.1	13.5	766	3.29	8.5	0.4	3.6
00-6403	ADUP	0.24	24.66	4.82	41.3	62	15.8	8.1	464	2.52	3.5	0.3	2.2
00-6404		0.45	41.49	6.62	63.2	87	26.7	13.7	724	3.21	5.4	0.4	1.5
00-6405		0.76	47.94	12.39	76	115	30.7	14.8	754	3.41	7.8	0.4	2.3
00-6406		3.06	234.38	17.77	107.1	102	30.8	19.9	1063	4.14	26.9	0.4	27.7
00-6407		2.4	157.84	9.93	54.7	31	18.1	8.8	410	2.48	11.7	0.4	4.6
00-6408		0.49	38.81	6.93	61.7	83	26.3	12.6	653	3.05	5	0.4	1.5
00-6409		0.31	18.46	3.9	32.3	47	14.2	6.8	391	2.24	3.3	0.3	4.7
00-6410		0.4	26.39	5.36	43.8	57	18.5	9.3	505	2.66	4	0.4	1
00-6411		1.87	98.14	24.87	117.2	272	22.9	10.4	775	3.32	15.9	0.3	3.1
00-6412		2.12	87.88	16.93	146	553	23	11.1	346	3.98	24.2	0.5	5
00-6413		1.82	140.68	17.39	73.3	629	29.1	15.3	422	3.33	22.1	0.5	5
00-6414		2.66	4167.46	23.16	76.7	259	28.7	17	912	3.81	12.5	0.5	120.2
00-6415		0.83	72.75	9.73	72.9	96	31.9	13.2	809	3.3	6.3	0.4	3.3
00-6416	10	0.76	40.47	9.53	80	107	30.8	12.9	730	3.12	8.1	0.4	2.8
00-6417	20	0.69	41.4	10.88	82	101	32	13.3	752	3.2	7.7	0.4	2.3
00-6418		0.76	44.38	8.78	69.8	106	32.4	15.2	711	3.34	5.2	0.4	12.6
00-6419		0.37	21.56	4.71	35.7	48	14.9	7.6	420	2.42	3.1	0.4	2
00-6420	GSB Till 99 (B)	0.85	156.21	221.76	333.3	1265	204.4	45.5	1288	6.2	53.2	0.4	17.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6421	ADUP 00-6434	4.06	242.74	16.43	122.9	270	30	15.7	815	3.82	54.9	0.5	4.3
00-6422		11.35	464.02	9.82	69	246	29	13.7	672	3.32	9.4	0.5	5.5
00-6423		38.84	854.65	12.98	84.8	728	32.1	16.9	675	3.73	42.2	0.5	8.9
00-6424		17.71	476.04	16.32	98.8	440	34	15.2	765	3.78	42.3	0.5	16
00-6425		10.18	435.02	12.7	82.2	289	30.7	15.5	713	3.83	23	0.4	4.9
00-6426		14.92	545.16	9.89	78.5	376	36.9	13.7	639	4.34	16.4	0.3	6.5
00-6427		11.12	321.26	16.21	102.7	305	31.7	15	800	3.57	31.8	0.5	6.4
00-6428		23.24	1809.72	18.79	93	501	31.2	15.2	707	3.7	29.4	0.5	93.8
00-6429		30.91	1414.91	16.37	89.1	508	29.5	16.2	677	3.74	27.9	0.5	26.3
00-6430		23	700.07	18.04	91.2	530	36.3	15.4	666	4.08	39.7	0.4	8.2
00-6431		10.76	616.34	19.12	105.6	403	40.5	18.5	743	4.56	60.4	0.5	9
00-6432		10.68	2262.88	17.44	85.4	452	41.8	18.3	690	4.51	31.8	0.5	52.9
00-6433	RED DOG 97	13.83	161.71	7.39	50.5	76	12.5	10.9	433	3.9	5.9	0.4	44.5
00-6434	ADUP	4.08	244.52	17.42	120.8	256	29	16.8	812	3.78	57.1	0.4	6.9
00-6435		6.94	390.76	15.67	106.8	152	32.3	20.8	1028	4.27	45.6	0.6	26.5
00-6436		9.28	409.44	14.31	98.4	307	32.2	16	867	3.82	34.1	0.5	5.2
00-6437		3.77	388.04	16.59	81.6	293	28.4	18.1	382	4.71	26.7	0.6	185.2
00-6438		1.03	4142.23	1.41	92.7	303	32.5	101.1	82	2.31	1.9	0.7	3.3
00-6439		1.44	4515.83	0.94	120.9	181	28.2	68.9	119	2.12	3	0.6	2.3
00-6440		1.37	3831.98	0.88	120.2	204	33.6	103.7	125	2.25	2.8	0.6	1.7
00-6441	STD (?)	9.01	45.58	75.77	296.9	545	11	7.5	445	1.7	34.2	7.2	1.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6442		0.36	1998.73	0.85	24.8	93	8.3	10.6	57	0.67	1.7	0.2	1.4
00-6443		0.4	1427.44	0.65	89.2	68	36.7	57.9	25	0.52	1	0.1	1.1
00-6444		WOOD											
00-6445		0.93	2790.28	2.21	38.1	77	14.2	47.1	103	1.58	5.6	0.4	1.9
00-6446		0.57	330.54	1.08	45.9	60	12.5	5.9	20	0.09	1.9	<0.1	0.5
00-6447(a)		0.33	1497.78	1.21	100.4	89	39.6	62.3	22	0.51	1.5	0.1	0.8
00-6447(b)		0.43	1375.22	0.58	66.1	71	32	41.9	24	0.25	0.9	<0.1	0.9
00-6447(c)		4.56	1449.34	1.89	93.6	138	33.5	49.4	96	0.67	2.6	0.2	1.4
00-6448		23.19	411.43	20.5	99.4	235	30.1	18.1	1411	4.04	35	0.5	9.6
00-6449		36.94	440.01	16.75	87.7	205	30.6	16.6	1684	3.88	30.9	0.5	9.2
00-6450		13.21	428.76	12.9	77.8	44	25.7	12.3	531	3.83	27.6	0.5	12.3
00-6451		4.65	253.14	13.2	63.4	18	21.5	13.9	567	3.45	22.1	0.3	4.4
00-6452		7.89	76.95	14.24	75.4	87	21.9	12.7	344	3.74	15.8	0.4	4
00-6453	GSB Till 99 (B)	0.86	160.68	201.6	344.9	1301	205.5	44.1	1309	6.26	58.3	0.5	30.3
00-6454		32.09	543.83	10.72	60.2	187	22.4	49.6	698	3.01	16.2	0.5	5.1
00-6455		23.3	594.19	10.74	70.6	288	27.6	14.8	734	3.45	8	0.5	6.2
00-6456	10	24.2	590.02	9.86	69.1	323	25.9	15.4	704	3.36	8.5	0.5	5.5
00-6457	20	24.09	595.21	11.64	70.7	298	26.6	14.4	721	3.49	9.8	0.6	6.3
00-6458		12.81	816.98	12.48	90.1	111	32.8	16.7	789	4.09	12.3	0.4	23
00-6459		14.23	943.44	24.74	73.1	218	27.7	16.9	760	4.01	12.5	0.4	9.6
00-6460		25.14	1456.6	15.11	68.8	133	27.2	19.3	698	5.06	20.2	0.6	40.1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6461	ADUP 00-6462	6.67	506.71	10.33	50.9	103	18.6	11.4	355	3.72	9	0.7	7.6
00-6462	ADUP	7	493.24	10.12	47.7	108	18.3	10.7	348	3.66	9.7	0.8	7.7
00-6463		3.37	86.84	9.14	34.3	113	12.3	6.7	202	2.85	10.5	0.4	0.9
00-6464		1.41	6.2	6.92	8.3	133	1.4	0.6	70	0.58	1.3	<0.1	0.4
00-6465		0.84	20.74	4.41	21.5	361	2.9	0.7	130	0.5	1.3	<0.1	1.8
00-6466		62.48	1282.96	23.37	43.1	96	18.7	21.5	754	9.24	34.4	2	20.3
00-6467		22.93	811.94	12.86	71.1	349	27.3	16	722	3.46	7.5	0.6	20.7
00-6468		8.21	313.85	11.54	72.6	200	30	16.8	755	3.42	7.4	0.4	3.5
00-6469	RED DOG 97	13.92	169.76	7.41	55.7	73	13.2	12	460	4.05	5.8	0.4	32.9
00-6470		6.56	1447.3	21.56	150.8	162	35.7	18	925	4.3	44.7	0.5	6.2
00-6471		5.46	5668.93	11.99	22.8	1931	11.8	40	359	1.54	7.5	2.7	4.5
00-6472		1.66	15708.3	0.89	30.9	367	10.4	47.3	649	0.55	1.5	0.5	2.2
00-6473	ADUP	2.01	2040.47	0.97	27.1	123	4.8	54.9	775	0.89	1.1	<0.1	0.7
00-6474		13.91	1197.07	20.76	45.4	329	11.6	12.2	313	2.85	27	0.8	7.6
00-6475		2.28	45.66	14.56	51.1	97	14.2	8.6	229	2.08	11.1	0.5	2
00-6476		1.04	37.91	8.43	7.6	247	4	1.9	58	0.86	2.6	0.3	1.8
00-6477		3.04	165.38	20.78	131.6	348	29.6	17.8	681	3.53	39	0.9	3.2
00-6478		2.91	123	17.9	101.4	395	25.7	17	536	3.57	35.9	0.6	1.6
00-6479		1.83	106.9	18.05	89.4	382	21.3	10.6	360	3.03	27.6	0.4	1.5
00-6480(a)		3.36	246.04	12.44	189.4	316	18	10.1	938	2.06	15.5	0.6	11.4
00-6480(b)	ADUP 00-6473	2.02	2073.72	1.02	26.2	124	5.2	58.1	795	0.93	1	<0.1	1.7

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6601	ADUP 00-6612	2.54	102.43	13.24	88.4	79	22.5	14.9	1417	3.49	20.5	0.4	22.1
00-6602		1.44	109.09	7.93	48.5	75	19.6	18.3	873	3.64	7.2	0.3	8.2
00-6603		3.22	99.37	11.46	83.6	57	33.7	18.6	1140	4.05	22.4	0.3	57.2
00-6604		0.94	63.01	10.18	67.8	36	24.6	13.1	695	3.14	17.9	0.3	3.7
00-6605		2.61	196.6	16.74	103.1	125	35.4	20	869	4.98	59.9	0.3	11.8
00-6606		2.8	163.24	15.26	84.8	22	25	16.9	854	4.06	23.7	0.4	16.5
00-6607		2.16	94.8	13.5	99.4	218	22.6	12.1	613	3.47	25.1	0.4	7
00-6608		31.64	445.5	17.31	95.6	261	30.6	17.1	1378	4.1	32.5	0.5	22.8
00-6609		2.58	186.98	23.27	80.7	36	31.5	27.7	875	3.81	22.3	0.7	13.5
00-6610		2.98	126.18	17.51	113	218	28.3	16.2	877	3.77	27.9	0.5	4.4
00-6611		2.9	181.08	13.56	53.4	55	14.7	14.2	611	3.6	21.4	0.6	12.8
00-6612	10	2.71	109	15.41	92	82	23.6	16.4	1481	3.63	22.5	0.4	2.4
00-6613	20	2.57	118.41	17.42	106.7	157	28.5	18.7	1271	3.81	22.3	0.4	69.8
00-6614		2.92	240.85	19.73	85.2	50	23.9	21.3	806	5.25	37	0.4	19.8
00-6615		6.01	272.06	20.54	100.7	250	24.8	16.1	1025	3.83	35.7	0.5	11.4
00-6616		3.09	135.9	13.84	83.9	205	18.2	11.6	535	3.42	45	0.3	13
00-6617	STD (CANMET Till-1)	0.67	45.54	15.7	69.2	207	17.6	12.3	1173	3.03	15.9	0.8	18.5
00-6618		0.66	52.03	11.12	72.2	23	32.3	16.9	796	3.74	10.9	0.4	3.1
00-6619		0.71	51.48	11.62	67.9	44	26.4	12.6	677	3.42	12.4	0.5	11.4
00-6620		27.71	1350.96	13.28	70.3	86	25.8	19.9	658	4.92	13.9	0.6	11.8
00-6621	ADUP 00-6628	3.25	187.01	18.73	131.4	229	29.3	29.3	508	4.11	18.9	0.4	10.7

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6622		7.01	161.78	14.19	105.6	92	23.5	14.8	901	3.83	23.3	0.4	3.7
00-6623		2.26	139.87	13.74	75	23	19.7	9.8	548	3.12	20.1	0.4	2.9
00-6624		2.34	140.31	9.22	53.3	28	17.6	8.8	436	2.94	13.3	0.4	3.8
00-6625		2.2	294.14	14.05	77.4	53	22.2	13.2	633	3.8	21.5	0.4	5.4
00-6626		2.19	254.24	25.36	105.8	69	28.1	30.3	1162	4.69	61.4	0.8	4.7
00-6627		1.87	144.31	21.82	112.1	21	27.8	16.3	894	4.55	52.1	0.5	7.8
00-6628	10	3.76	202.24	19.54	140.4	243	31.8	30.7	549	4.43	20	0.6	3.6
00-6629	20	3.58	189.07	19.81	134.7	230	30.8	29.9	528	4.25	20.7	0.4	3.9
00-6630		2.55	237.95	20.26	64.3	22	18	8.4	369	4.75	42.5	1.4	4
00-6631		216.13	8924.03	25.33	139	220	29.1	99.1	1070	6.56	33.4	0.9	4.6
00-6632		2.62	111.54	20.4	107.1	77	27.4	16	1119	3.92	40	0.5	4.2
00-6633	STD (RD 2000 (A))	23.03	173.16	10.62	51.9	174	14.2	12.1	418	5.99	8.7	0.3	533.1
00-6634(a)		1.96	93.15	16.7	82.1	78	22.7	13.1	744	3.81	28.3	0.5	5.9
00-6634(b)		1.79	86.4	13.21	74.6	49	19.4	10.7	531	3.28	21.8	0.5	3.5
00-6635		4.54	165.46	33.74	105.4	432	37.6	24.6	987	6.55	65	0.7	4.9
00-6636		3.53	282.47	30.11	101.9	539	30.1	74.9	1432	4.34	76.1	1.3	8.3
00-6637		4.54	397.41	18.93	82.2	318	24.4	17.1	539	4.17	27	1.2	5.8
00-6638		4.96	3176.02	15.36	127.2	102	27.6	42.7	706	4.92	32.3	0.4	5.1
00-6639		5.91	1515.48	28.27	106.2	296	33.6	120.6	2133	5.7	76.5	1.2	23
00-6640		5.21	452.57	16.47	72	79	23.1	19	552	5.52	69	1.7	4.8
00-6641	ADUP 00-6649	7.59	319.87	16.48	98.5	368	30.6	18.9	809	3.81	52.8	0.5	13.3

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6642		8.04	2691.91	13.28	87.7	58	36	56.1	1214	3.69	9.2	0.4	3.9
00-6643	STD (RED DOG 97)	13.6	173.82	7.83	50.4	79	12	11.3	453	4.05	5.7	0.4	22.8
00-6644		2.67	90.47	9.61	71.8	159	26.9	13.9	760	3.26	8.8	0.4	3
00-6645		13.29	964.46	17.66	91.9	73	29.6	19.3	679	4.57	38.7	0.5	8.5
00-6646		3.73	1065.85	15.95	67.2	258	16.2	16.1	563	4.42	37.5	0.4	54.6
00-6647		15.36	539.44	17.89	106.3	361	31.4	20.8	878	4.11	43.4	0.6	7.6
00-6648		5.6	238.34	14.86	95	297	24.3	13.8	720	3.44	30.8	0.5	4.1
00-6649		7.21	319.12	16.18	96.4	322	30.4	18.3	800	3.77	46	0.4	4.7
00-6650		14.79	1016.22	12.73	85.9	231	32.4	16.7	729	3.8	10.9	0.3	8.7
00-6651		62.15	3070.84	16.19	65.3	1721	17.2	11.7	554	2.7	10.9	0.9	110.9
00-6652		11.19	406.94	15.62	111.1	338	30.2	16.8	777	3.89	27.5	0.4	5.5
00-6653		6.74	329.48	19.61	124.2	253	29.7	18	976	4.1	45.1	0.5	8.9
00-6654		5.5	478.59	9	56.9	15	18.3	12.1	561	3.39	10.2	0.4	14.2
00-6655		13.83	307.12	19.27	97.2	219	28.6	21.5	941	4.73	35.8	0.6	5.8
00-6656		0.61	33.66	5.37	34	7	14.6	11.7	431	2.58	3.8	0.3	2.2
00-6657		2.28	183.34	9.08	57.3	21	21.5	11.4	613	3.32	12.3	0.4	7.4
00-6658		2.62	267.93	12.22	77.8	42	25.7	13.7	800	3.46	24.7	0.6	5.6
00-6659		6.23	245.33	34.33	121.6	114	31.6	19.8	1153	4.26	34.7	0.3	8.6
00-6660		2.46	197.36	14.13	85.7	37	24.9	15.5	799	4.03	25.5	0.5	6.4
00-6661	ADUP 00-6707	2.81	265.27	9.69	58.2	45	20.2	11.2	585	3.4	14	0.4	5.9
00-6662		0.65	73.91	11.69	68.5	82	19.9	12.2	762	3.09	12.4	0.3	14.2

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6663		1.06	58.74	12.86	50.2	126	16.8	9.3	435	3.18	12.2	0.4	20.8
00-6664		2.09	147.95	12.77	74.6	27	21.9	13.3	740	3.89	21.7	0.4	6.3
00-6665		1.31	108.03	42.49	128.6	183	15.9	25.3	743	5.18	143.4	0.4	92.9
00-6666		4.77	297.39	18.42	110.1	364	28.4	22.7	943	4.83	25.7	0.4	11.8
00-6667		1.63	86.42	15.73	108.9	59	26.3	16.3	1145	3.72	19	0.4	3.3
00-6668		7.66	961.41	10.72	51.7	305	25.8	22.2	629	4.42	8.1	0.5	31.9
00-6669		13.21	631.47	18.39	53.8	577	23.2	27.4	669	8.29	8.3	0.5	35.2
00-6670		15.21	851.62	9.39	65.2	165	21.9	19.5	574	4.61	8.6	0.5	29.7
00-6671	10	2.7	1111.04	17.72	116	107	37.9	31.2	936	4.27	36.4	0.4	30.7
00-6672	20	2.64	181.03	19.56	121	61	39.1	34.8	1002	4.26	42.3	0.5	5.8
00-6673		3.18	131.46	16.01	73.3	74	24.4	18.6	658	3.91	24.1	0.6	4.2
00-6674		1.31	63.06	19.19	93.2	36	20.8	12.5	1020	3.33	22.3	0.5	3.3
00-6675		3.6	303.2	27.09	113.7	78	32.6	39.9	634	4.83	30.7	0.6	6.8
00-6676		3.67	183.43	17.16	110.6	244	30.9	17.9	946	3.6	28.5	0.6	3.5
00-6677		3.58	148.26	15.32	62.2	74	17	16.2	702	4.18	43.6	0.6	6.6
00-6678		3.24	136.11	19.59	123.6	82	31.8	20.5	1189	4.29	42.2	0.5	6.1
00-6679	STD (RD 2000 (A))	24.03	168.65	8.83	57.1	107	14.5	13.9	419	6.16	9	0.4	158.8
00-6680		3.1	226.42	20.4	100	105	44.3	23.8	889	5.4	57.4	0.9	5.9
00-6681	ADUP 00-6690	3.58	109.52	20.36	108.1	280	30	19.1	1009	3.75	23	0.8	2.6
00-6682		1.72	105.72	16.64	85.5	50	23.2	13	775	3.59	22.1	0.5	4.2
00-6683		4.44	5933.2	35.71	101.3	473	36	14.8	980	4.28	18.4	0.6	292.8

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6684		6.1	602.46	25.08	111.4	180	29.4	22.1	884	4.41	45.4	0.4	11.5
00-6685		17.59	634.87	34.95	104.5	105	34.9	44.4	1069	5.24	251.4	0.7	16.8
00-6686		25.57	739.07	12.08	66	192	41.5	22.4	479	5.49	9.2	0.4	24.2
00-6687		13.36	356.48	12.86	60.5	122	30.5	29.4	864	4.17	9.8	0.5	13.2
00-6688		3.03	139.63	16.55	107.2	75	30.1	18	1094	3.86	61.4	0.5	5.7
00-6689	10	3.03	124.1	18.31	111.2	210	30.8	15	989	3.69	26.6	0.6	2.6
00-6690	20	2.78	103.31	15.55	104	234	26.1	14.8	1004	3.9	22.2	0.6	2.1
00-6691		2.71	234.65	18.38	85.8	108	29.6	20.1	874	4.3	30	0.4	5.1
00-6692		1.77	123.66	13.29	63.3	61	19.5	12.6	586	3.64	15.8	0.4	40.8
00-6693	STD (STSD 1 (443))	1.14	33.59	40.78	143.3	338	20.3	13.8	3330	2.85	15.8	7	4.9
00-6694		1.31	93.65	14.97	79.7	33	26.1	13.8	702	3.62	20.6	0.4	3.1
00-6695		0.53	29.14	10.8	48.8	43	17.9	9.4	542	2.68	11.9	0.5	1.6
00-6696		0.75	58.01	12.02	72.5	36	20.9	11.7	816	3.38	15.5	0.4	11.5
00-6697		1.09	112.38	8.26	48.4	30	20.3	11.6	562	3.08	7.5	0.4	2.3
00-6698		5	246.05	10.51	80.6	162	25.6	14.6	827	3.38	14	0.4	3.4
00-6699		8.52	359.36	26.65	92.7	224	33.3	23.3	1010	5.05	35.9	0.4	4.7
00-6700		4.12	175.05	18.59	107.1	229	31.2	15.8	1015	3.77	26.6	0.6	2.8
00-6701	NO ADUP												
00-6702		8.52	366.92	16.63	103.2	331	37.6	16.5	961	4.03	39.6	0.5	6.3
00-6703		17.15	564.33	18.27	97.8	424	36.3	15.8	833	4.02	41.9	0.5	6.8
00-6704		85.05	3499.58	18.31	183.8	146	28.4	13.6	628	4.2	43.7	0.7	6.1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1
00-6705		2.89	136.85	22.65	94.5	103	24.9	21.5	1072	4.02	23.9	0.5	3.3
00-6706		4.14	424.19	17.36	76.4	59	24.3	19.7	831	4.19	31.7	0.7	33.7
00-6707	10	2.78	256.78	9.32	56.9	51	19.2	11.3	568	3.33	13.8	0.4	28.7
00-6708	20	2.94	254.32	9.42	53.9	32	18.4	10.4	526	3.31	14.8	0.4	6.1
00-6709		7.57	206.2	8.12	38.1	180	16.5	9.5	421	2.43	8.4	0.5	6.2
00-6710		6.52	365.37	16.23	58	119	16.9	11.3	487	3.58	18.1	0.5	30.1
00-6711		6.46	372.44	9.53	55.3	57	18	13.1	554	3.28	11.5	0.4	14.1
00-6712		3.75	266.89	9.15	65.9	181	25	11.6	431	3.43	14.9	0.5	4.5
00-6713		2.44	179.95	12.93	75.4	44	22.1	12.8	672	3.68	20.2	0.5	6.6
00-6714		1.08	82.45	14.45	71.8	208	21.1	13.5	683	3.35	18.2	0.3	2.5
00-6715		0.94	66.4	11.65	64.9	73	24.8	11.4	563	3.36	13.5	0.4	3.5
00-6716		1.56	237.73	9.01	69.1	57	27.6	14.1	617	3.36	16.1	0.5	2.8
00-6717		1.45	165.37	17.23	89.5	124	25.8	15.8	728	3.82	26.7	0.4	4.5
00-6718		2.84	290.69	16.13	127.1	226	32.6	18.6	850	4.63	32.6	0.4	7

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6001	ADUP 00-6009	2.1	63.9	0.28	1.75	0.98	97	0.75	0.089	11.1	40	1.18	159.5	0.085	4
00-6007	STD (GSB Till 99)	3.7	19.7	0.66	11.06	0.28	108	0.34	0.116	15	287.5	3.07	325.9	0.098	<1
00-6009	10	2.1	66.9	0.27	1.69	0.99	102	0.78	0.092	11.4	43.2	1.24	167.3	0.089	2
00-6010	20	2.1	68.8	0.33	1.7	1.03	98	0.79	0.094	12	42.9	1.18	176.3	0.082	<1
00-6021	ADUP 00-6022	2.2	79.7	0.34	1.1	0.86	82	1.41	0.098	12	34.4	1.21	207.6	0.07	1
00-6033	STD (GSB Till 99 (B))	4.5	21.4	0.64	10.43	0.29	90	0.32	0.116	18.4	242.2	2.66	308.1	0.094	1
00-6037	10	2	87.8	0.33	2.07	3.09	97	1.37	0.098	10.8	60.2	1.48	186.9	0.085	2
00-6038	20	2	90.3	0.34	2.17	2.74	94	1.34	0.097	10.8	57	1.44	183.7	0.083	1
00-6041	ADUP 00-6060	2.9	70.7	0.26	0.87	0.66	75	1.26	0.097	13.6	36.1	1.23	184.4	0.071	3
00-6055	STD (TILL 1 (330))	3.3	11.8	0.2	5.79	2.23	54	0.3	0.091	21.8	29.9	0.56	84.9	0.079	2
00-6059	10	2.9	70.3	0.29	0.99	0.74	80	1.32	0.104	12	36.7	1.26	189.1	0.076	2
00-6060	20	3	75.6	0.3	1.06	0.82	80	1.32	0.101	12.9	39.5	1.26	190	0.075	2
00-6061	ADUP 00-6079	2.1	78.9	0.22	1.45	0.83	82	1.7	0.098	9.3	47.2	1.24	175.2	0.077	2
00-6077	STD (RED DOG 97)	1.2	50.4	0.21	0.23	0.56	99	0.73	0.058	4.5	20.8	0.72	57.9	0.146	1
00-6078	10	1.8	70.2	0.19	1.19	0.61	80	1.66	0.092	9	46.1	1.2	175.4	0.078	3
00-6079	20	2	76.4	0.22	1.32	0.77	81	1.67	0.088	9	47.5	1.21	173.9	0.077	3
00-6081	ADUP 00-6094	2.2	82	0.21	0.41	0.19	71	1.75	0.093	11.2	42.6	1.13	209.2	0.073	4
00-6084	STD (RED DOG 97	1.2	52.3	0.24	0.25	0.61	100	0.74	0.059	4.8	23.6	0.73	57.1	0.145	1
00-6094	10	2	69.2	0.2	0.4	0.18	72	1.74	0.089	11.3	42.7	1.12	208.7	0.074	3
00-6095	20	1.8	65.6	0.21	0.4	0.18	73	1.77	0.09	10.9	43.5	1.13	209.3	0.073	2
00-6101	ADUP 00-6118	1.6	52.1	0.2	0.52	0.46	79	1.72	0.085	8.8	46.9	1.17	169.9	0.078	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6106	STD (GSB Till 99 (B))	3.9	17.3	0.67	10.49	0.27	100	0.34	0.107	18.5	248.5	2.87	300.7	0.104	<1
00-6118	10	1.6	49.7	0.21	0.5	0.4	79	1.69	0.082	8.9	44.6	1.16	164.5	0.076	<1
00-6119	20	1.7	43.8	0.19	0.78	0.71	87	0.73	0.084	11.7	45	1.13	160.8	0.096	<1
00-6121	ADUP 00-6139	2	59.5	0.31	1.27	1.57	93	1.41	0.087	9.5	49.6	1.34	176	0.088	1
00-6137	STD (GSB Till 99 (B))	4	16.5	0.64	9.6	0.26	103	0.33	0.109	16.3	249.9	2.73	316.6	0.1	<1
00-6138	10	2.3	63.4	0.29	1.26	1.78	101	1.45	0.09	9.1	47.1	1.38	187.1	0.087	1
00-6139	20	2.3	63.9	0.29	1.23	1.59	99	1.44	0.089	9.5	43.7	1.37	184.4	0.086	<1
00-6141	ADUP 00-6153	1.8	91.3	0.52	1.34	1.28	111	1.5	0.085	8.5	53.7	1.49	175.6	0.109	1
00-6153	10	1.7	80.6	0.48	1.28	1.61	104	1.43	0.079	7.8	52.2	1.41	161.5	0.089	<1
00-6154	20	1.8	83.5	0.54	1.22	1.5	108	1.47	0.079	8.7	55.5	1.46	170.3	0.093	<1
00-6155	STD (RED DOG 97)	1.4	48	0.2	0.22	0.66	106	0.68	0.056	4.6	19.2	0.7	59.6	0.156	<1
00-6161	ADUP 00-6169	1.8	66.9	0.17	0.29	0.15	77	1.58	0.089	8.2	45.7	1.18	146.2	0.065	2
00-6163	STD (GSB Till 99 (B))	3.9	17.4	0.6	10.5	0.25	92	0.36	0.102	16.7	253.8	2.69	289.7	0.129	<1
00-6169	10	1.8	72.9	0.17	0.32	0.17	78	1.51	0.084	8.3	49.7	1.13	154	0.081	2
00-6170	20	1.9	69.1	0.19	0.29	0.14	78	1.64	0.082	8.3	48.7	1.23	144	0.07	2
00-6181	ADUP 00-6196	2.5	67.3	0.33	1.54	0.89	73	1.22	0.083	11.1	37.5	1.08	182	0.081	1
00-6188	STD (RED DOG 97)	1.1	48.5	0.22	0.23	0.53	97	0.71	0.057	4.7	20.8	0.71	56.2	0.14	<1
00-6196	10	2.5	64.8	0.35	1.43	1	76	1.35	0.09	12.4	36.4	1.15	185.6	0.075	2
00-6197	20	2.5	61.9	0.36	1.38	0.89	77	1.37	0.092	12.6	38.3	1.17	184.2	0.077	1
00-6201	ADUP 00-6212	1.9	82.2	0.41	2.28	2.44	104	1.45	0.085	9.7	59.7	1.5	184.9	0.093	1
00-6207	STD (RED DOG 97)	1.4	56	0.22	0.25	0.62	97	0.75	0.06	5.3	20.8	0.74	56.6	0.145	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6221	ADUP 00-6224	2.3	76.8	0.23	0.48	0.29	75	1.79	0.094	12.5	45	1.15	219.3	0.075	2
00-6401	ADUP 00-6403	1.4	58.2	0.1	0.26	0.07	74	1.41	0.086	8	36.8	0.71	94.7	0.104	3
00-6402		1.9	75.7	0.21	0.48	0.18	76	1.86	0.087	10.8	41.4	1.08	231.6	0.062	2
00-6403	ADUP	1.3	59.5	0.1	0.28	0.06	71	1.37	0.085	8.2	35.3	0.7	91.9	0.101	1
00-6404		1.6	67.2	0.15	0.39	0.1	83	1.7	0.088	9	46.9	1.17	141	0.096	2
00-6405		1.7	67	0.17	0.43	0.2	79	1.81	0.081	9.2	44.2	1.1	179.6	0.058	3
00-6406		1.8	45.6	0.35	1.31	0.63	92	0.67	0.085	11.2	44.1	0.93	159.4	0.08	1
00-6407		1.6	32.8	0.06	1.1	0.48	65	0.29	0.013	10.9	32.9	0.68	180.5	0.088	<1
00-6408		1.6	64	0.15	0.38	0.11	79	1.54	0.084	8.6	45.9	1.06	146.9	0.09	1
00-6409		1.2	48.5	0.07	0.26	0.05	67	1.15	0.075	6.6	32.8	0.57	79.8	0.089	2
00-6410		1.4	62.4	0.09	0.29	0.06	74	1.51	0.091	8.1	38.7	0.77	102.5	0.098	1
00-6411		0.3	32.2	0.28	0.63	0.66	79	0.34	0.112	5.5	32.4	0.43	155.1	0.044	2
00-6412		0.5	23.2	0.38	0.72	0.77	88	0.27	0.117	10.9	33.6	0.63	95.4	0.062	1
00-6413		1.1	23.9	0.23	0.74	0.56	73	0.26	0.083	10.9	36.9	0.75	133.1	0.057	1
00-6414		2.1	37.2	0.19	0.91	0.47	89	0.47	0.069	11.7	35.2	0.85	154.2	0.097	1
00-6415		2	67.3	0.15	0.32	0.18	74	1.82	0.089	9.7	44.6	1.18	196	0.086	2
00-6416	10	1.8	64.7	0.23	0.35	0.2	67	1.68	0.084	9.7	42.5	1.03	225.1	0.067	3
00-6417	20	1.9	64.3	0.26	0.41	0.21	69	1.72	0.084	10	42.1	1.05	234.9	0.069	3
00-6418		1.7	65.4	0.16	0.29	0.16	75	1.62	0.088	8.2	44	1.11	175.2	0.063	2
00-6419		1.3	51.7	0.08	0.25	0.08	69	1.28	0.085	7.4	32.1	0.61	86.9	0.109	1
00-6420	GSB Till 99 (B)	3.6	17.2	0.64	8.35	0.25	96	0.34	0.108	16.1	243.1	2.83	318.7	0.117	<1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6421	ADUP 00-6434	2.4	54.1	0.31	1.52	1.14	84	1.06	0.09	10.8	38.7	1.09	155	0.089	2
00-6422		1.7	55.1	0.18	0.84	1.14	80	1.53	0.078	7.7	45.9	1.12	164.1	0.086	2
00-6423		1.4	63.3	0.33	2.42	1.97	103	1.28	0.076	6.9	59.9	1.36	156.1	0.096	1
00-6424		1.8	69.6	0.22	1.89	2	93	1.35	0.08	8.1	57.3	1.34	183.8	0.088	2
00-6425		1.5	61.7	0.29	0.93	1.87	94	1.45	0.079	7	52.6	1.25	153.6	0.092	1
00-6426		1.3	92.9	0.22	0.75	1.65	134	1.47	0.074	5.8	86	1.94	162.6	0.139	1
00-6427		2.2	59.6	0.37	1.59	1.53	79	1.29	0.082	10	46	1.2	177.5	0.081	1
00-6428		2	62	0.32	1.47	1.57	92	1.29	0.082	8.2	45.8	1.23	163.1	0.083	2
00-6429		1.8	68.4	0.3	1.28	1.58	91	1.43	0.081	7.4	46.4	1.28	170.5	0.086	1
00-6430		1.4	79.8	0.3	2.43	2.58	112	1.32	0.078	6.6	74.9	1.53	168.3	0.1	1
00-6431		1.5	79.3	0.38	2.17	3.41	112	1.44	0.088	7.8	73.5	1.58	170.7	0.104	1
00-6432		1.5	81.6	0.21	1.52	3.12	111	1.54	0.077	6.8	69.7	1.42	157.1	0.101	2
00-6433	RED DOG 97	1.2	48.6	0.19	0.24	0.55	92	0.71	0.057	4.5	20.7	0.7	56.4	0.139	<1
00-6434	ADUP	2.2	47.3	0.32	1.66	1.14	83	1.05	0.096	11.2	42.5	1.09	152.4	0.086	1
00-6435		2.2	52.8	0.36	1.47	1.31	97	0.71	0.088	11.6	45.5	1.11	147.2	0.108	1
00-6436		1.9	68.1	0.29	1.45	2.01	90	1.36	0.085	9	50.2	1.28	181.3	0.087	1
00-6437		2.1	49.1	0.12	1.78	2.05	100	0.64	0.072	8.4	59.1	1.08	235.9	0.096	1
00-6438		0.3	49.4	0.73	0.35	0.05	9	0.54	0.218	16.6	8.5	0.05	27.9	0.013	3
00-6439		0.2	44.9	0.84	0.18	0.02	9	0.9	0.171	17.7	5.6	0.03	16.2	0.003	4
00-6440		0.2	45.1	0.8	0.2	0.02	7	0.72	0.181	18	5.5	0.03	17.7	0.003	4
00-6441	STD (?)	1.3	64.9	1.1	0.54	0.96	21	6.79	0.068	10.6	13.5	0.52	92.2	0.039	6

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6442		0.1	42.3	0.2	0.06	0.02	4	1.6	0.124	7.9	3.7	0.02	18.1	0.002	2
00-6443		0.1	15.4	0.54	0.06	0.02	3	0.27	0.037	2.7	1.9	0.02	20.2	0.002	1
00-6444															
00-6445		0.2	64.6	0.32	0.3	0.08	35	2.66	0.172	13.3	15.7	0.07	36.9	0.042	2
00-6446		<0.1	68	0.23	0.06	<0.02	3	2.23	0.041	0.6	2.7	0.03	16.3	0.002	2
00-6447(a)		0.1	19.8	0.55	0.08	<0.02	3	0.42	0.031	2.9	2.2	0.02	15.9	0.002	1
00-6447(b)		<0.1	16.8	0.42	0.05	<0.02	3	0.38	0.024	2.6	1.6	0.02	13.1	0.001	<1
00-6447(c)		0.1	33	0.54	0.37	0.16	14	0.88	0.036	3.5	7.1	0.18	22.8	0.01	<1
00-6448		1.7	52.8	0.19	1.32	0.88	97	0.93	0.088	9.5	50.1	0.94	260.2	0.101	2
00-6449		1.8	55.4	0.13	1.3	0.99	93	0.83	0.078	10.1	46	0.89	251.1	0.093	1
00-6450		1.9	44.1	0.08	1.16	1.03	95	0.73	0.063	10.4	47.1	0.87	195.8	0.092	3
00-6451		1.5	26.1	0.06	1.08	0.98	89	0.45	0.021	8.4	41.5	0.86	107.2	0.113	1
00-6452		1.3	17.7	0.11	0.66	0.54	88	0.24	0.025	6.3	35.1	0.66	81.6	0.085	1
00-6453	GSB Till 99 (B)	3.6	17.5	0.59	10	0.24	99	0.34	0.099	15.6	263.3	2.73	342.5	0.128	<1
00-6454		0.9	22.7	0.14	0.57	0.52	73	0.54	0.044	5.7	29.9	0.59	53.2	0.056	<1
00-6455		1.7	54.8	0.15	0.9	0.57	84	1.71	0.084	9.1	45.6	1.18	169.1	0.086	2
00-6456	10	1.9	54.3	0.17	0.99	0.61	79	1.67	0.08	8.9	41.8	1.15	151.4	0.087	1
00-6457	20	2	54	0.17	0.99	0.63	83	1.72	0.088	9.4	44.2	1.16	177.7	0.089	1
00-6458		1.9	45.5	0.28	1.22	0.62	94	0.8	0.09	11.4	46.2	1.17	165.4	0.102	3
00-6459		2	44.5	0.19	1.25	0.78	98	0.69	0.088	11.4	48.1	1.08	188.4	0.111	1
00-6460		2.1	45.6	0.23	1.3	1.01	117	0.63	0.078	12.2	50.7	1.29	185.1	0.11	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6461	ADUP 00-6462	1.4	19.9	0.07	0.73	0.5	110	0.19	0.061	17.2	38.6	1.03	140.5	0.116	1
00-6462	ADUP	1.5	20.7	0.08	0.79	0.51	106	0.18	0.062	16.9	37.7	1.01	137.1	0.113	1
00-6463		1.2	11.1	0.09	0.67	0.21	69	0.11	0.052	5.1	26.9	0.33	55.3	0.08	1
00-6464		0.3	10.8	0.02	0.24	0.19	29	0.1	0.015	4.8	7.2	0.04	35.4	0.059	1
00-6465		<0.1	17.5	0.06	0.13	0.12	16	0.17	0.044	3	6.3	0.05	97.9	0.009	<1
00-6466		4.6	26	0.15	2.09	2.12	201	0.28	0.235	21.6	40.5	1.12	122.9	0.097	1
00-6467		1.8	62.3	0.19	1.33	0.53	85	1.48	0.089	9.7	44	1.17	191	0.102	2
00-6468		1.8	54.8	0.18	0.85	0.32	78	1.66	0.091	9.4	47.2	1.13	199.4	0.089	2
00-6469	RED DOG 97	0.9	41.3	0.26	0.22	0.45	96	0.75	0.054	4.3	23	0.74	60.8	0.141	1
00-6470		2	45.4	0.4	1.62	1.22	84	0.81	0.08	17.6	43.2	0.99	198.6	0.087	2
00-6471		0.2	54.1	0.09	0.67	1.53	59	1.62	0.068	31.5	14.5	0.26	48.9	0.037	<1
00-6472		0.1	88.7	0.79	0.26	0.03	4	2.51	0.103	27.9	3.7	0.04	60.7	0.006	<1
00-6473	ADUP	<0.1	103.1	0.17	0.13	0.04	3	3.21	0.032	2.5	2.7	0.06	38.2	0.004	1
00-6474		1.4	38.7	0.07	1.64	2.33	111	0.42	0.049	7.4	27.6	1.04	141.9	0.124	1
00-6475		1.2	17.1	0.14	0.8	0.31	71	0.19	0.038	11.7	30.4	0.43	87.9	0.084	2
00-6476		<0.1	33.5	0.17	0.37	0.18	37	0.28	0.071	22.1	9.9	0.07	100.9	0.016	<1
00-6477		1.3	31.1	0.31	1.26	0.67	74	0.43	0.104	14.2	34.2	0.66	181.1	0.05	2
00-6478		0.4	41.1	0.47	1.1	0.92	89	0.5	0.115	10.4	37.7	0.71	155.5	0.045	2
00-6479		0.3	33.3	0.67	0.94	0.91	78	0.43	0.12	8.8	29.7	0.46	162	0.047	2
00-6480(a)		0.8	78.1	2.95	0.63	0.68	53	1.13	0.133	6.9	27.3	0.46	240.3	0.035	1
00-6480(b)	ADUP 00-6473	<0.1	107.3	0.15	0.13	0.05	3	3.29	0.032	2.6	2.6	0.06	40.8	0.004	2

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6601	ADUP 00-6612	1.9	43.4	0.44	1.2	0.41	76	0.65	0.088	11.7	31.1	0.74	132.1	0.072	<1
00-6602		1.3	25.3	0.1	0.81	0.43	83	0.34	0.091	6.5	38.3	0.65	91.9	0.056	<1
00-6603		1.7	41.3	0.21	1.08	0.4	88	0.51	0.079	11.2	42.1	0.9	158.2	0.088	<1
00-6604		1.6	31.9	0.12	0.89	0.33	73	0.42	0.068	13.3	36.7	0.82	142.2	0.083	<1
00-6605		1.6	59.8	0.15	1.66	1.41	106	0.71	0.085	10.3	50.1	1.17	197.7	0.105	<1
00-6606		1.9	37.1	0.14	1.06	0.73	94	0.35	0.037	13.1	40.5	0.91	190.4	0.105	<1
00-6607		2.3	51.9	0.23	1.35	0.67	75	1.23	0.091	12.3	32.2	0.84	186.2	0.068	<1
00-6608		1.9	65.1	0.11	1.11	1.05	95	0.83	0.084	10	47.2	0.91	357.6	0.085	<1
00-6609		2.6	18.1	0.16	1.25	0.35	82	0.19	0.097	6.7	33.5	0.72	70.8	0.099	<1
00-6610		2.7	67.1	0.24	1.18	0.89	81	1.25	0.101	11.9	36	1.16	174	0.074	<1
00-6611		1.6	30.3	0.13	1.23	0.73	77	0.26	0.071	10.1	28.1	0.66	110.9	0.078	<1
00-6612	10	2.3	47.5	0.49	1.26	0.48	81	0.67	0.102	12.4	32.5	0.77	137.4	0.077	<1
00-6613	20	2.5	49.1	0.37	1.27	0.53	82	0.7	0.094	12.9	36.7	0.98	163.3	0.082	<1
00-6614		1.7	40.3	0.18	1.04	0.78	126	0.24	0.061	9.7	47.9	1.17	198.2	0.122	<1
00-6615		1.9	55.8	0.29	1.96	1.61	91	0.71	0.098	10.8	36.8	0.99	136.2	0.097	<1
00-6616		1.8	43.8	0.25	1.53	0.78	83	0.95	0.103	10.1	30.8	0.75	96	0.085	<1
00-6617	STD (CANMET Till-1)	2.9	11	0.23	6.32	2.21	57	0.3	0.082	18.6	27.5	0.58	88.1	0.081	1
00-6618		2.1	26.5	0.16	0.44	0.19	89	0.34	0.082	10	50	0.99	225.8	0.102	<1
00-6619		2	40.7	0.1	0.63	0.19	83	0.41	0.075	12.2	42.6	0.84	203.9	0.103	<1
00-6620		2.1	48.1	0.2	1.36	1.08	111	0.54	0.081	12.3	44.8	1.22	174.3	0.105	<1
00-6621	ADUP 00-6628	2	52.1	0.34	1.3	1.32	98	0.7	0.092	11.5	37	1.22	129.6	0.081	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6622		1.8	60.8	0.32	1.43	0.54	81	2.25	0.079	10.1	36.2	0.96	138	0.072	1
00-6623		1.8	34.2	0.1	1.14	0.51	76	0.37	0.057	12.6	32.6	0.82	147.8	0.096	<1
00-6624		1.5	28	0.11	0.71	0.38	73	0.27	0.032	9.3	30.2	0.68	163.9	0.101	1
00-6625		1.5	35.4	0.16	1.16	0.64	97	0.4	0.071	11.9	37.3	1.03	158.3	0.113	<1
00-6626		2.8	20.1	0.2	1.92	1.56	103	0.21	0.136	6.9	40.2	0.91	263.1	0.122	<1
00-6627		2.3	50.8	0.15	1.89	0.71	103	0.39	0.055	17.9	39.9	1.04	222.1	0.125	<1
00-6628	10	2.2	56.1	0.4	1.49	1.5	107	0.74	0.104	12.3	40	1.3	141	0.086	1
00-6629	20	2	54.4	0.37	1.45	1.37	100	0.71	0.097	11.8	38.8	1.24	137.3	0.079	1
00-6630		2.4	35.3	0.02	1.7	1.76	105	0.2	0.046	6.8	43.8	0.89	138.9	0.152	<1
00-6631		2	35.6	0.27	7.67	1.33	140	0.51	0.141	57.2	49.5	1.35	110.6	0.126	1
00-6632		2.4	62.7	0.18	1.79	0.57	88	0.62	0.08	14.2	37	0.88	203.1	0.093	1
00-6633	STD (RD 2000 (A))	1.1	36	0.2	0.3	0.83	175	0.57	0.058	4.3	31	0.68	48.9	0.146	1
00-6634(a)		2.1	41.8	0.14	1.73	0.52	89	0.49	0.033	15	34.6	0.79	182.6	0.104	1
00-6634(b)		1.8	40.8	0.1	1.1	0.39	80	0.45	0.024	14	32.2	0.79	187.9	0.101	1
00-6635		1.7	90.9	0.36	2.21	1.59	181	0.82	0.107	14.7	71.4	1.69	252.3	0.147	1
00-6636		2.2	22.3	0.31	2.14	1.08	100	0.18	0.107	7.1	41.9	0.96	128.6	0.114	1
00-6637		2	21.1	0.12	1.51	1.07	105	0.19	0.05	8.2	41.7	1.07	141.8	0.138	1
00-6638		1.3	29.9	0.34	1.48	1.49	128	0.27	0.096	10.8	30.3	1.1	257	0.135	1
00-6639		2.4	21	0.27	2.01	2.15	136	0.19	0.127	10.4	53	1.37	110.6	0.159	1
00-6640		2.3	56.4	0.06	1.52	1.78	150	0.42	0.117	9.5	51.4	1.38	127.2	0.148	1
00-6641	ADUP 00-6649	1.7	66.7	0.24	2.2	1.16	89	1.67	0.079	9.2	47.8	1.29	173.5	0.08	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6642		1.7	36.4	0.34	0.95	0.45	90	0.64	0.082	21.5	53.1	0.98	147.4	0.102	1
00-6643	STD (RED DOG 97)	1	43.4	0.18	0.2	0.63	97	0.71	0.051	4.8	23.2	0.72	58.4	0.139	1
00-6644		1.8	52.5	0.18	0.45	0.39	75	1.57	0.076	9.4	45.6	1.04	179.2	0.08	2
00-6645		1.6	43.3	0.28	1.91	1.83	106	0.58	0.079	11.8	51.3	1.12	161.4	0.113	1
00-6646		1.5	16.2	0.21	11.25	1.52	123	0.17	0.059	11.1	27.1	0.94	161.1	0.159	1
00-6647		2.1	56.9	0.34	2.11	1.69	100	0.92	0.073	11.4	50.9	1.23	175.2	0.095	1
00-6648		2.2	51.6	0.26	1.37	0.96	78	1.32	0.082	11.4	37.8	1.02	159.2	0.086	1
00-6649		1.5	58.7	0.26	2.02	0.99	86	1.65	0.077	8.7	47.1	1.28	171.6	0.08	1
00-6650		2	46.3	0.26	1.25	0.71	87	1.03	0.08	10.9	50.5	1.18	153.4	0.088	2
00-6651		5.2	70.9	0.3	4.22	3.77	71	2.7	0.07	18.3	29	1.26	308.7	0.085	1
00-6652		1.9	100	0.29	1.38	1.23	93	1.45	0.081	10.3	48.1	1.29	195.2	0.089	2
00-6653		2.4	49.7	0.31	1.57	1.1	96	0.8	0.084	13.1	45.7	1.14	170.8	0.097	1
00-6654		1.6	34.5	0.1	0.79	0.72	94	0.43	0.05	11.5	37	0.95	157.8	0.141	1
00-6655		2	56.2	0.22	1.49	1.16	108	0.72	0.08	14.8	41	1.11	190.7	0.112	1
00-6656		1.2	28	0.08	0.28	0.09	73	0.42	0.079	7.9	35.8	0.47	124.9	0.106	<1
00-6657		1.7	36.2	0.12	0.78	0.29	84	0.38	0.067	10.9	38.7	0.8	168.9	0.097	<1
00-6658		2	42.3	0.06	1.22	0.91	87	0.47	0.053	10.4	41.7	1.01	185.8	0.11	<1
00-6659		1.6	51.3	0.31	2.27	0.94	99	0.65	0.077	10.7	46.2	1.16	189.2	0.097	1
00-6660		1.9	40.8	0.15	1.37	0.81	102	0.51	0.052	13.5	39.2	1.06	191.2	0.123	<1
00-6661	ADUP 00-6707	1.8	41.5	0.1	0.99	3	86	0.56	0.088	11.4	38.1	0.72	155.7	0.105	<1
00-6662		1.5	39.8	0.14	0.87	0.32	74	0.51	0.085	9.6	35.8	0.64	129.9	0.085	<1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th ppm 0.1	Sr ppm 0.5	Cd ppm 0.01	Sb ppm 0.02	Bi ppm 0.02	V ppm 2	Ca % 0.01	P % 0.001	La ppm 0.5	Cr ppm 0.5	Mg % 0.01	Ba ppm 0.5	Ti % 0.001	B ppm 1
00-6663		2	15.5	0.12	1.07	0.25	79	0.2	0.104	6.4	34.2	0.43	59	0.082	1
00-6664		2.1	47.9	0.13	1.1	0.48	94	0.44	0.068	13.4	37.7	0.88	184.7	0.114	1
00-6665		2	36.3	0.27	3.38	2.75	93	0.18	0.065	8.3	24	0.7	114.4	0.117	1
00-6666		1.7	53.1	0.38	0.92	1.13	107	0.83	0.073	9.7	48.3	1.11	165.4	0.109	1
00-6667		2.2	42.4	0.3	0.99	0.36	80	0.66	0.089	15.3	35.5	0.8	165.9	0.092	1
00-6668		1.5	51.4	0.13	0.84	1.1	142	0.51	0.082	12.4	62.7	1.4	163.1	0.141	1
00-6669		1.1	60.5	0.17	0.63	1.51	150	0.61	0.154	9.9	43.4	1.17	125.1	0.092	1
00-6670		1.3	46.8	0.12	0.68	1.16	118	0.57	0.076	8.3	39.7	1.24	158.4	0.139	1
00-6671	10	1.8	28.8	0.19	1.11	0.61	91	0.39	0.064	13.3	38.8	0.96	167.8	0.1	1
00-6672	20	2.5	31.1	0.16	1.27	0.64	92	0.33	0.073	19.6	45.3	0.98	184.5	0.111	<1
00-6673		2.4	40.3	0.1	1.12	0.5	91	0.25	0.044	19.8	41.1	0.82	150	0.11	1
00-6674		2.5	36.8	0.22	1.38	0.44	75	0.44	0.091	18.4	28.8	0.59	149.9	0.101	1
00-6675		2.7	43.3	0.13	2.09	1.65	103	0.59	0.085	16.6	40.2	1.01	144.1	0.093	1
00-6676		2.7	50.9	0.37	1.41	1.01	75	1.26	0.081	11.9	38.3	1.13	185	0.074	2
00-6677		2.3	25.7	0.14	1.36	0.83	94	0.25	0.09	13.6	33.5	0.64	150.9	0.095	1
00-6678		2.7	59.3	0.24	1.29	1.12	89	0.7	0.089	16.2	40.5	1.08	195.4	0.109	1
00-6679	STD (RD 2000 (A))	1.1	34.6	0.28	0.29	0.91	176	0.54	0.057	4.9	31.3	0.67	43.8	0.148	1
00-6680		1.7	69.2	0.24	1.93	1.1	134	0.74	0.069	10.3	76.8	1.43	167.4	0.14	1
00-6681	ADUP 00-6690	3.2	56.6	0.25	1.02	0.65	81	1.44	0.099	17.4	38.3	1.2	208.4	0.084	1
00-6682		2.4	37.8	0.13	1.06	0.56	84	0.38	0.051	14.9	35.5	0.81	158.8	0.097	1
00-6683		2.7	49.4	0.21	1.36	0.58	97	0.69	0.085	13.5	37.6	0.87	193.2	0.08	3

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th ppm 0.1	Sr ppm 0.5	Cd ppm 0.01	Sb ppm 0.02	Bi ppm 0.02	V ppm 2	Ca % 0.01	P % 0.001	La ppm 0.5	Cr ppm 0.5	Mg % 0.01	Ba ppm 0.5	Ti % 0.001	B ppm 1
00-6684		2.3	36.7	0.13	1.54	1.48	100	0.63	0.073	14.2	44.1	1.05	173.9	0.111	<1
00-6685		2.1	25.9	0.35	3.88	2.77	108	0.2	0.072	17	43.9	0.88	134.7	0.107	<1
00-6686		1.5	76.3	0.09	0.44	1.47	155	0.75	0.057	9.5	105.7	1.91	206.1	0.16	<1
00-6687		1.6	47.8	0.15	0.58	1.22	109	0.69	0.083	11.6	57.2	1.05	143.6	0.115	<1
00-6688		2.5	51.5	0.28	1.28	0.73	83	1.42	0.087	11.4	38.5	0.96	163.8	0.089	2
00-6689	10	2.6	65.9	0.3	1.24	0.85	79	1.41	0.089	12.6	39.1	1.22	202.9	0.079	3
00-6690	20	2.5	68.9	0.27	1.18	0.6	80	1.38	0.094	12.5	39.2	1.17	210.8	0.097	5
00-6691		1.6	54.2	0.07	1.57	0.77	111	0.55	0.052	14.8	50.3	1.24	168.9	0.14	1
00-6692		1.7	44.2	0.07	0.97	0.52	89	0.49	0.061	12.8	37.8	0.84	133	0.116	1
00-6693	STD (STSD 1 (443))	0.7	19.9	0.65	2.1	0.38	40	1.4	0.125	24	27.7	0.71	277.7	0.028	5
00-6694		2.1	41.6	0.1	0.98	0.39	84	0.39	0.061	14	38.1	0.91	172.5	0.101	1
00-6695		1.6	29.2	0.07	0.92	0.2	65	0.31	0.046	9.9	30.6	0.58	131.4	0.079	1
00-6696		2.1	42.5	0.11	1.43	0.27	75	0.49	0.088	13.8	30.7	0.7	160.6	0.097	<1
00-6697		1.6	35.2	0.1	0.5	0.26	78	0.44	0.078	9.7	39.5	0.83	123.3	0.104	<1
00-6698		1.8	45.7	0.28	0.86	0.45	79	1.28	0.088	8.9	39	1.04	151.7	0.081	2
00-6699		1.5	68.4	0.26	1.55	1.11	127	0.88	0.083	8.3	55.2	1.32	178.2	0.114	1
00-6700		2.5	61.1	0.29	1.32	0.91	85	1.35	0.083	11.2	43.5	1.23	194.7	0.082	2
00-6701	NO ADUP														
00-6702		2	80.2	0.3	1.76	1.73	98	1.51	0.077	9.3	60.8	1.41	198.4	0.092	2
00-6703		1.8	75.7	0.31	1.96	2.02	105	1.4	0.075	8.7	64.7	1.47	180	0.092	2
00-6704		2	48.7	0.24	3.02	1.65	106	0.72	0.087	15.6	51.7	1.24	122.6	0.136	2

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
		ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
		0.1	0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
00-6705		1	31.4	0.15	1.5	0.88	97	0.37	0.032	7.8	38.8	0.99	139.5	0.078	< 1
00-6706		1.8	42.7	0.18	1.8	1.03	100	0.48	0.089	14.9	38.3	0.9	160.9	0.117	1
00-6707	10	1.7	41.2	0.09	0.88	2.88	81	0.54	0.085	10.8	38	0.69	149.2	0.101	1
00-6708	20	1.7	41.3	0.09	1.05	0.38	83	0.53	0.083	11.4	37.1	0.69	157.4	0.102	1
00-6709		1.7	27.2	0.03	0.66	0.3	62	0.32	0.046	9.5	33.2	0.65	146.3	0.088	1
00-6710		1.8	21.7	0.1	0.88	0.6	81	0.25	0.112	11.6	32.5	0.66	145.9	0.089	< 1
00-6711		1.7	30.6	0.07	0.81	0.53	80	0.35	0.065	10.2	39.5	0.85	113.3	0.098	1
00-6712		1.2	25.2	0.13	0.67	0.52	83	0.31	0.071	8.9	38.7	0.97	168.1	0.088	1
00-6713		2	42.2	0.14	1.03	0.45	85	0.5	0.079	12.3	36.9	0.85	279.9	0.1	1
00-6714		1.8	50.2	0.11	1.11	0.39	75	0.75	0.1	11.7	32.9	0.74	142.1	0.089	1
00-6715		2	27	0.05	0.82	0.33	80	0.31	0.07	11	40.9	0.86	234.5	0.094	< 1
00-6716		1.9	37.9	0.08	0.78	0.63	84	0.44	0.024	10.9	40.7	0.9	437.3	0.099	< 1
00-6717		1.3	27.8	0.15	1.42	0.69	89	0.31	0.062	7.9	37.1	1.07	178.7	0.088	1
00-6718		1.8	26.8	0.19	1.61	0.81	108	0.32	0.09	8.8	49.2	1.2	206.1	0.123	1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6001	ADUP 00-6009	2.4	0.052	0.24	0.5	n/a	0.19	0.04	31	0.6	0.14	7.4
00-6007	STD (GSB Till 99)	3.19	0.008	0.05	<0.2	n/a	0.1	<0.01	325	0.8	0.3	9.4
00-6009	10	2.49	0.053	0.24	0.5	n/a	0.2	0.03	34	0.7	0.15	7.4
00-6010	20	2.53	0.053	0.23	0.4	n/a	0.18	0.05	32	0.5	0.15	7.6
00-6021	ADUP 00-6022	2.19	0.049	0.19	<0.2	n/a	0.08	0.19	34	0.4	0.1	6.3
00-6033	STD (GSB Till 99 (B))	2.87	0.005	0.05	<0.2	14	0.1	<0.01	355	0.4	0.31	9.7
00-6037	10	2.65	0.076	0.36	0.9	8.4	0.34	0.23	50	0.5	0.26	8.1
00-6038	20	2.61	0.072	0.36	1	8.2	0.3	0.26	49	0.5	0.24	8.1
00-6041	ADUP 00-6060	2.26	0.045	0.21	0.2	6.8	0.09	0.13	27	0.2	0.09	6.7
00-6055	STD (TILL 1 (330))	1.65	0.023	0.06	<0.2	3.7	0.1	0.04	100	0.3	0.02	6.6
00-6059	10	2.22	0.049	0.23	0.3	6.5	0.1	0.15	26	0.3	0.14	6.8
00-6060	20	2.21	0.046	0.23	0.2	6.6	0.11	0.19	29	0.3	0.12	7.2
00-6061	ADUP 00-6079	2.16	0.047	0.24	0.3	6.6	0.1	0.14	30	0.3	0.12	6.8
00-6077	STD (RED DOG 97)	2	0.021	0.04	<0.2	4.2	0.03	0.5	22	3.2	0.45	5.8
00-6078	10	2.13	0.043	0.22	0.3	6.1	0.09	0.12	26	0.2	0.12	6.2
00-6079	20	2.15	0.045	0.23	0.3	6.3	0.1	0.1	29	0.2	0.15	6.3
00-6081	ADUP 00-6094	2.05	0.056	0.19	<0.2	5.2	0.05	0.1	18	0.2	0.08	6.2
00-6084	STD (RED DOG 97	2	0.021	0.04	<0.2	4.2	0.03	0.55	25	3.4	0.5	6.1
00-6094	10	2.15	0.061	0.19	<0.2	5.2	0.04	0.07	19	0.1	0.07	6.1
00-6095	20	2.11	0.058	0.18	<0.2	5.1	0.04	0.1	16	0.2	0.06	6.1
00-6101	ADUP 00-6118	2.13	0.04	0.19	0.2	5.8	0.06	0.13	21	0.5	0.05	6.5

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6106	STD (GSB Till 99 (B))	3.08	0.005	0.05	<0.2	10.9	0.1	0.03	353	0.5	0.24	9.6
00-6118	10	2.1	0.036	0.16	0.2	5.8	0.06	0.12	18	0.4	0.05	6.2
00-6119	20	2.41	0.032	0.18	0.3	7.2	0.11	0.03	23	0.1	0.1	7.2
00-6121	ADUP 00-6139	2.42	0.055	0.32	0.5	6.4	0.18	0.28	35	0.9	0.15	7.6
00-6137	STD (GSB Till 99 (B))	2.9	0.005	0.04	<0.2	10.9	0.1	<0.01	359	0.5	0.26	8.9
00-6138	10	2.46	0.053	0.34	0.5	6.9	0.18	0.31	29	0.8	0.17	7.2
00-6139	20	2.44	0.054	0.35	0.5	7.1	0.19	0.32	30	0.7	0.16	7.5
00-6141	ADUP 00-6153	2.58	0.066	0.35	1	7.6	0.22	0.39	36	0.8	0.15	7.8
00-6153	10	2.48	0.063	0.35	1	7.4	0.22	0.37	33	0.7	0.19	7.2
00-6154	20	2.57	0.063	0.37	0.9	7.7	0.22	0.33	26	0.7	0.15	7.2
00-6155	STD (RED DOG 97)	1.92	0.02	0.04	<0.2	4.4	0.04	0.5	24	3.2	0.52	5.6
00-6161	ADUP 00-6169	2.17	0.047	0.15	<0.2	5.2	0.04	0.11	24	0.1	0.04	5.8
00-6163	STD (GSB Till 99 (B))	2.87	0.006	0.05	<0.2	10.7	0.09	0.01	377	0.6	0.26	8.1
00-6169	10	2.1	0.05	0.17	<0.2	5.3	0.04	0.11	20	0.2	0.07	5.8
00-6170	20	2.21	0.047	0.15	<0.2	5.3	0.04	0.09	31	0.1	0.03	6.1
00-6181	ADUP 00-6196	2.02	0.04	0.21	0.3	5.4	0.09	0.18	40	0.3	0.12	6
00-6188	STD (RED DOG 97)	2.1	0.02	0.04	<0.2	3.7	0.03	0.5	24	3.3	0.44	6.1
00-6196	10	2.22	0.041	0.2	0.3	5.4	0.1	0.19	36	0.3	0.08	6.9
00-6197	20	2.28	0.042	0.19	0.2	5.5	0.09	0.19	35	0.4	0.11	6.9
00-6201	ADUP 00-6212	2.74	0.07	0.38	1.1	7.2	0.32	0.3	46	1	0.25	8
00-6207	STD (RED DOG 97)	2.13	0.021	0.04	<0.2	4	0.02	0.53	26	3.6	0.54	6.5

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6221	ADUP 00-6224	2.31	0.048	0.23	<0.2	5.1	0.05	0.11	27	0.2	0.08	6.5
00-6401	ADUP 00-6403	1.4	0.06	0.09	<0.2	4	0.02	0.04	10	0.3	0.03	4
00-6402		1.97	0.046	0.2	<0.2	5.2	0.05	0.11	18	0.3	0.06	5.8
00-6403	ADUP	1.36	0.058	0.09	<0.2	4	0.02	0.01	11	0.2	0.04	4
00-6404		1.95	0.049	0.14	<0.2	5.5	0.03	0.03	18	0.3	0.06	5.5
00-6405		2.02	0.038	0.17	<0.2	5.8	0.04	0.1	27	0.4	0.08	5.9
00-6406		2.17	0.036	0.16	0.3	7.3	0.12	0.01	38	0.4	0.18	6.4
00-6407		2.12	0.016	0.05	0.2	6.2	0.11	0.01	35	0.3	0.08	5.4
00-6408		1.86	0.054	0.13	<0.2	5.2	0.03	0.06	19	0.3	0.04	5.4
00-6409		1.15	0.052	0.07	<0.2	3.3	0.02	0.03	10	0.1	0.02	3.3
00-6410		1.5	0.053	0.09	<0.2	4.3	0.02	0.05	11	0.2	0.04	4.2
00-6411		1.88	0.009	0.07	<0.2	2.4	0.04	0.03	34	0.1	0.09	8.1
00-6412		2.82	0.009	0.07	<0.2	3.7	0.07	0.04	53	0.3	0.13	9.6
00-6413		2.98	0.012	0.08	0.2	4.5	0.1	0.02	68	0.3	0.11	6.4
00-6414		2.21	0.043	0.13	<0.2	5.2	0.1	0.07	30	0.2	0.09	7
00-6415		2.15	0.041	0.17	<0.2	5	0.04	0.13	17	0.2	0.05	6.3
00-6416	10	1.91	0.041	0.17	<0.2	4.3	0.04	0.12	14	0.1	0.06	5.2
00-6417	20	1.97	0.041	0.17	<0.2	4	0.04	0.13	21	0.2	0.06	5.7
00-6418		2.05	0.053	0.14	<0.2	4.9	0.03	0.16	23	0.2	0.06	6
00-6419		1.25	0.053	0.07	<0.2	3.2	0.02	0.06	7	0.1	0.04	3.9
00-6420	GSB Till 99 (B)	2.92	0.005	0.04	<0.2	9.9	0.09	<0.01	335	0.5	0.26	8.7

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6421	ADUP 00-6434	2.21	0.044	0.21	<0.2	6.5	0.15	<0.01	45	0.3	0.16	6.4
00-6422		2.1	0.045	0.25	0.3	5.7	0.11	0.22	21	0.4	0.09	6
00-6423		2.25	0.054	0.32	1	6.8	0.21	0.37	36	0.8	0.17	6
00-6424		2.35	0.058	0.32	0.8	6.7	0.22	0.27	36	0.7	0.23	6.8
00-6425		2.3	0.061	0.29	0.8	5.5	0.22	0.34	26	0.7	0.15	6.9
00-6426		2.97	0.098	0.49	0.7	9.1	0.4	0.36	18	0.7	0.14	8.3
00-6427		2.14	0.042	0.24	0.5	5.5	0.15	0.26	39	0.5	0.18	6.6
00-6428		2.14	0.058	0.29	0.6	5.8	0.18	0.31	33	0.7	0.17	6.3
00-6429		2.24	0.056	0.31	0.6	6.3	0.19	0.41	29	1.1	0.2	6.4
00-6430		2.58	0.066	0.42	1.1	7.3	0.34	0.46	27	1	0.22	7.4
00-6431		2.71	0.081	0.45	1.8	6.8	0.46	0.51	40	0.9	0.31	8.3
00-6432		2.72	0.098	0.42	1.1	6.5	0.39	0.55	30	0.8	0.28	7.7
00-6433	RED DOG 97	1.94	0.019	0.04	<0.2	3.7	0.03	0.56	23	3.2	0.54	6.1
00-6434	ADUP	2.17	0.042	0.18	0.3	5.1	0.15	<0.01	57	0.4	0.16	6.9
00-6435		2.3	0.048	0.2	0.5	7.4	0.22	<0.01	38	0.3	0.15	6.9
00-6436		2.37	0.045	0.28	0.5	6.4	0.19	0.25	32	0.6	0.2	7.3
00-6437		2.65	0.032	0.21	0.8	7.5	0.26	0.49	41	0.7	0.21	6.4
00-6438		4.29	0.006	0.02	0.3	2.7	0.78	2.49	84	1	<0.02	0.8
00-6439		7.68	0.006	0.02	<0.2	2.3	1.07	2.63	46	1.4	<0.02	<0.1
00-6440		7.18	0.007	0.02	<0.2	2.5	0.74	2.73	63	1.6	<0.02	<0.1
00-6441	STD (?)	0.39	0.015	0.05	0.7	1.4	0.17	1.34	108	1.2	<0.02	2

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6442		3.77	0.011	0.03	<0.2	1.1	0.39	1.93	36	0.5	<0.02	0.1
00-6443		0.72	0.005	0.02	<0.2	3.5	1.2	0.7	18	0.7	<0.02	0.1
00-6444												
00-6445		3.34	0.005	0.03	0.4	2.5	0.36	2.77	31	0.5	<0.02	1.9
00-6446		0.15	0.001	0.01	<0.2	0.4	0.15	1.34	66	0.8	<0.02	0.1
00-6447(a)		0.6	0.014	0.03	<0.2	5.2	1.1	0.86	32	1.3	<0.02	0.2
00-6447(b)		0.46	0.014	0.03	<0.2	4.6	0.9	0.53	40	0.9	<0.02	0.1
00-6447(c)		0.74	0.025	0.07	0.5	3.8	0.98	0.87	57	1	<0.02	0.9
00-6448		2.63	0.062	0.24	0.4	6.4	0.16	0.03	25	0.5	0.13	7
00-6449		2.56	0.044	0.25	0.5	6.9	0.16	0.03	35	0.4	0.13	6.9
00-6450		2.66	0.029	0.22	0.5	7	0.17	<0.01	26	0.4	0.13	6.6
00-6451		2.12	0.016	0.14	0.4	4.9	0.12	0.03	17	0.3	0.09	5.7
00-6452		2.29	0.011	0.08	0.2	3.4	0.08	0.05	31	0.2	0.07	7.3
00-6453	GSB Till 99 (B)	2.98	0.006	0.05	<0.2	10.4	0.09	0.01	346	0.6	0.31	8.1
00-6454		2.54	0.009	0.08	0.4	3.1	0.12	0.09	54	0.8	0.16	6.8
00-6455		2.25	0.039	0.2	<0.2	4.9	0.08	0.22	20	0.6	0.1	6.1
00-6456	10	2.24	0.038	0.2	0.2	6	0.08	0.22	24	0.6	0.11	5.7
00-6457	20	2.28	0.039	0.22	0.2	6.1	0.08	0.24	24	0.6	0.11	6.2
00-6458		2.42	0.039	0.21	0.4	6.6	0.12	0.03	20	0.3	0.12	6.4
00-6459		2.49	0.031	0.18	0.3	7	0.11	0.02	24	0.3	0.12	6.7
00-6460		2.74	0.031	0.21	0.5	9.4	0.18	0.01	21	0.8	0.14	7.1

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6461	ADUP 00-6462	3.04	0.013	0.11	0.3	8.8	0.13	0.01	42	0.6	0.06	7.8
00-6462	ADUP	2.98	0.014	0.1	0.2	8.9	0.13	0.03	48	0.6	0.08	7.8
00-6463		2.24	0.008	0.03	0.2	2.7	0.05	<0.01	54	0.3	0.04	4.5
00-6464		0.31	0.007	0.03	<0.2	0.6	0.03	0.01	11	0.1	<0.02	3.7
00-6465		0.25	0.005	0.07	<0.2	0.3	0.05	0.04	59	<0.1	<0.02	1.8
00-6466		2.46	0.01	0.21	4.6	12.4	0.29	0.04	29	5	0.34	8.1
00-6467		2.2	0.038	0.26	<0.2	6.5	0.09	0.15	24	0.6	0.09	6.3
00-6468		2.24	0.043	0.17	<0.2	5.2	0.06	0.11	21	0.4	0.08	6.1
00-6469	RED DOG 97	2.15	0.021	0.03	<0.2	3.6	0.02	0.43	19	3.2	0.56	5.7
00-6470		2.36	0.042	0.17	0.3	5.8	0.16	<0.01	41	0.5	0.17	6.3
00-6471		2.6	0.009	0.07	0.4	8.1	0.26	1.49	88	2	0.09	5
00-6472		1.56	0.003	<0.01	<0.2	1.8	0.22	1.47	64	4.9	<0.02	0.3
00-6473	ADUP	0.2	0.004	0.01	<0.2	0.6	0.12	1.75	56	1.8	<0.02	0.3
00-6474		2.64	0.018	0.23	0.6	10.5	0.42	0.53	36	2.5	0.22	8.6
00-6475		2.75	0.013	0.04	<0.2	4	0.07	<0.01	50	0.3	0.06	6.5
00-6476		0.96	0.006	0.01	<0.2	1	0.02	0.13	70	0.2	0.02	3.9
00-6477		3.29	0.014	0.1	0.3	4.3	0.16	0.03	67	0.6	0.09	7.9
00-6478		2.34	0.015	0.12	0.7	3.2	0.09	0.04	36	0.5	0.12	8.2
00-6479		1.75	0.011	0.1	0.4	2.3	0.07	0.05	28	0.3	0.07	7.9
00-6480(a)		1.24	0.012	0.12	0.9	2	0.1	0.09	83	0.3	<0.02	5.2
00-6480(b)	ADUP 00-6473	0.21	0.004	0.01	<0.2	0.6	0.12	1.86	58	2	0.02	0.3

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6601	ADUP 00-6612	1.63	0.037	0.13	0.2	5.7	0.13	<0.01	23	0.3	0.31	5.1
00-6602		2.05	0.013	0.06	<0.2	5.9	0.06	<0.01	20	0.3	0.11	6.7
00-6603		2.48	0.024	0.1	<0.2	7.8	0.1	<0.01	28	0.3	0.12	5.8
00-6604		2.16	0.012	0.11	<0.2	6.5	0.1	<0.01	29	0.3	0.25	8.7
00-6605		2.89	0.063	0.21	0.3	9.8	0.22	<0.01	23	0.3	0.17	7.2
00-6606		2.64	0.019	0.15	0.2	8.1	0.17	<0.01	37	0.3	0.11	5.8
00-6607		1.93	0.034	0.15	<0.2	6	0.08	<0.01	22	0.5	0.14	7.3
00-6608		2.41	0.046	0.25	0.4	8.1	0.15	0.01	34	0.5	0.12	6
00-6609		2.8	0.013	0.14	<0.2	6.2	0.19	0.02	27	0.4	0.11	6.5
00-6610		2.05	0.041	0.19	<0.2	6.6	0.09	0.1	22	0.7	0.29	5.8
00-6611		2.12	0.016	0.07	0.4	5.1	0.12	0.01	31	0.3	0.11	5.6
00-6612	10	1.65	0.041	0.13	0.3	5.6	0.14	0.01	37	0.3	0.14	6.3
00-6613	20	1.98	0.042	0.17	<0.2	6.8	0.15	0.01	16	0.8	0.18	9.6
00-6614		3.41	0.022	0.23	0.3	9.3	0.22	<0.01	43	0.5	0.17	6.3
00-6615		1.91	0.05	0.19	0.6	7.3	0.18	0.05	48	0.3	0.14	4.7
00-6616		1.45	0.039	0.13	0.3	5.3	0.08	0.11	95	0.4	0.04	6.3
00-6617	STD (CANMET Till-1)	1.64	0.024	0.05	<0.2	3.6	0.1	0.02	17	0.3	0.06	7.7
00-6618		3.09	0.015	0.14	<0.2	6.3	0.06	0.03	21	0.3	0.07	6.8
00-6619		2.65	0.015	0.1	<0.2	6.1	0.07	0.01	20	0.7	0.12	7.2
00-6620		2.43	0.024	0.22	0.4	10.5	0.17	0.01	36	0.3	0.14	7
00-6621	ADUP 00-6628	2.2	0.045	0.23	2.3	8.3	0.26	0.27	46	0.2	0.09	6.2

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6622		1.99	0.037	0.18	0.3	7.7	0.12	0.02	34	0.3	0.08	6
00-6623		2.08	0.014	0.08	0.2	7.1	0.11	0.02	15	0.5	0.04	5.3
00-6624		2.11	0.015	0.06	<0.2	4.7	0.09	0.01	37	0.3	0.12	7.1
00-6625		2.58	0.017	0.12	0.4	9.9	0.16	<0.01	52	0.5	0.21	7.9
00-6626		3.48	0.014	0.18	0.3	8.5	0.22	0.03	49	0.4	0.11	9.1
00-6627		3.3	0.022	0.17	0.2	10.1	0.23	0.02	28	0.4	0.13	7.5
00-6628	10	2.35	0.049	0.25	2.4	9.4	0.29	0.28	25	0.5	0.12	7
00-6629	20	2.24	0.045	0.24	2.4	8.3	0.26	0.31	28	0.6	0.19	9.4
00-6630		3.73	0.012	0.22	0.4	15.3	0.33	0.07	21	0.8	0.17	8.9
00-6631		3.04	0.02	0.27	0.7	13.2	0.48	0.03				
00-6632		2.48	0.036	0.14	0.3	6.9	0.14	0.02	40	0.2	0.14	7.5
00-6633	STD (RD 2000 (A))	1.61	0.012	0.03	<0.2	3.5	0.02	0.69	22	6.4	0.71	6.6
00-6634(a)		2.38	0.028	0.1	0.2	6.6	0.14	0.03	35	0.5	0.1	7
00-6634(b)		2.15	0.026	0.08	0.2	5.7	0.11	<0.01	29	0.2	0.07	6.3
00-6635		3.24	0.071	0.22	0.6	12.9	0.47	0.04	48	0.8	0.25	10.6
00-6636		4	0.017	0.15	0.5	8.9	0.36	0.02	50	0.6	0.25	8.3
00-6637		3.83	0.013	0.21	0.3	7.3	0.3	0.01	39	1	0.13	8.4
00-6638		3.13	0.018	0.45	0.5	9.9	0.57	0.13	21	0.9	0.16	8.4
00-6639		4.3	0.012	0.24	1.4	9.5	0.62	0.02	80	1.8	0.21	9.7
00-6640		3.64	0.017	0.34	0.8	14.9	0.52	<0.01	27	0.5	0.25	9.5
00-6641	ADUP 00-6649	2.35	0.041	0.24	0.5	6.7	0.14	0.18	54	0.4	0.22	6.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6642		2.33	0.02	0.15	0.2	5.9	0.13	<0.01	21	0.2	0.1	6.5
00-6643	STD (RED DOG 97)	2.04	0.017	0.03	<0.2	3.3	0.02	0.42	27	3.3	0.49	5.8
00-6644		1.99	0.031	0.13	<0.2	5.1	0.04	0.09	28	0.3	0.09	5.5
00-6645		2.52	0.03	0.19	1.8	6.8	0.27	0.02	37	0.4	0.26	6.5
00-6646		2.36	0.01	0.19	0.6	8.1	0.17	<0.01	33	0.5	0.16	6.9
00-6647		2.66	0.042	0.21	1.2	6.7	0.22	0.16	60	0.8	0.21	6.8
00-6648		1.98	0.035	0.18	0.3	5.3	0.1	0.17	37	0.3	0.13	5.7
00-6649		2.32	0.043	0.2	0.5	5.7	0.13	0.18	50	0.5	0.22	6.6
00-6650		2.34	0.035	0.21	0.3	5.6	0.1	0.04	22	0.3	0.12	6.4
00-6651		1.98	0.02	0.35	0.3	4.8	0.14	0.22	31	1.6	0.31	7.1
00-6652		2.38	0.041	0.21	0.4	6.3	0.15	0.16	40	0.5	0.17	6.4
00-6653		2.45	0.046	0.18	0.3	7	0.18	0.03	43	0.2	0.14	7.4
00-6654		2.13	0.02	0.15	0.5	8.3	0.13	0.01	23	0.1	0.1	6.6
00-6655		2.56	0.043	0.19	0.7	9.3	0.21	0.03	37	0.2	0.16	7.8
00-6656		1.63	0.012	0.04	<0.2	3.7	0.05	0.02	9	0.1	0.03	3.9
00-6657		2.4	0.015	0.08	<0.2	7.2	0.08	0.01	24	0.2	0.08	6.2
00-6658		2.63	0.018	0.15	0.3	8	0.14	0.03	37	0.2	0.1	7.4
00-6659		2.62	0.038	0.16	0.2	9.8	0.16	0.01	43	0.3	0.22	7.4
00-6660		2.61	0.026	0.15	0.2	9.6	0.17	0.02	33	0.2	0.14	7.4
00-6661	ADUP 00-6707	1.97	0.021	0.08	0.2	6.5	0.07	<0.01	27	0.1	0.16	5.2
00-6662		1.78	0.017	0.07	<0.2	5.9	0.08	0.01	44	<0.1	0.07	4.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6663		1.75	0.01	0.04	0.3	3.9	0.06	0.02	27	0.2	0.06	3.8
00-6664		2.66	0.019	0.13	0.2	8.2	0.15	<0.01	27	0.2	0.15	7.1
00-6665		2.96	0.011	0.18	<0.2	6.6	0.3	0.03	145	0.6	1.46	6
00-6666		2.56	0.078	0.21	0.5	8.6	0.21	0.02	31	0.3	0.25	7.7
00-6667		2.18	0.032	0.12	<0.2	5.7	0.14	0.01	36	0.1	0.11	6.3
00-6668		3.18	0.031	0.22	0.9	10.4	0.28	0.03	17	0.5	0.09	9.2
00-6669		2.68	0.066	0.19	0.7	9.2	0.24	0.04	24	2.3	0.3	8.2
00-6670		2.63	0.032	0.26	0.7	11	0.24	0.01	25	0.4	0.14	7.2
00-6671	10	2.75	0.034	0.13	0.2	6.2	0.18	0.03	37	0.4	0.23	7.7
00-6672	20	2.96	0.016	0.16	0.2	8.3	0.21	0.05	41	0.6	0.18	8.3
00-6673		2.46	0.013	0.11	<0.2	6.8	0.2	0.04	44	0.4	0.12	7.4
00-6674		1.8	0.016	0.09	<0.2	5.5	0.11	0.03	54	0.2	0.09	5.6
00-6675		2.6	0.025	0.19	0.2	8.9	0.28	0.02	67	0.3	0.18	7.6
00-6676		2.14	0.032	0.18	<0.2	6.9	0.1	0.16	52	0.3	0.13	6.3
00-6677		2.19	0.013	0.08	0.6	5.6	0.15	0.02	34	0.6	0.24	5.9
00-6678		2.56	0.044	0.18	0.4	8.4	0.18	0.05	46	0.3	0.13	8.3
00-6679	STD (RD 2000 (A))	1.54	0.011	0.02	<0.2	3.7	0.02	0.72	29	6.3	0.75	6.2
00-6680		3.21	0.066	0.27	1.8	7.5	0.44	0.05	52	0.4	0.19	8.6
00-6681	ADUP 00-6690	2.28	0.036	0.18	<0.2	5	0.13	0.05	61	1.2	0.17	8.3
00-6682		2.3	0.015	0.13	<0.2	5.3	0.12	0.01	33	0.1	0.08	6.5
00-6683		2.22	0.068	0.17	<0.2	5.2	0.11	0.03	46	0.1	0.12	6.8

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6684		2.56	0.038	0.19	0.5	7.2	0.28	<0.01	69	1.2	0.18	9.6
00-6685		2.72	0.01	0.2	1.4	7.1	0.45	<0.01	137	2.5	0.7	9.4
00-6686		3.81	0.078	0.64	1.1	9.1	0.82	0.35	14	2.3	0.27	11.5
00-6687		2.53	0.044	0.19	1	5.6	0.34	0.02	32	1.1	0.19	7.6
00-6688		2.23	0.046	0.16	0.2	6	0.18	0.01	44	0.1	0.13	6.2
00-6689	10	2.28	0.039	0.22	<0.2	5.5	0.1	0.14	33	0.2	0.1	6.7
00-6690	20	2.17	0.042	0.2	<0.2	5.4	0.1	0.12	36	0.2	0.1	6.3
00-6691		3.06	0.028	0.17	0.4	7.8	0.21	0.02	35	0.1	0.18	8.6
00-6692		2.09	0.021	0.12	0.3	6.6	0.14	0.02	26	0.2	0.09	6.5
00-6693	STD (STSD 1 (443))	1.03	0.015	0.06	0.2	1.9	0.23	0.12	156	2.9	0.07	4.1
00-6694		2.55	0.016	0.15	<0.2	6.2	0.16	0.03	33	0.1	0.1	7.4
00-6695		1.67	0.011	0.07	<0.2	4	0.05	0.01	28	0.1	0.03	4.8
00-6696		2.01	0.016	0.09	<0.2	6.9	0.1	0.02	44	0.2	0.09	5.6
00-6697		1.93	0.015	0.08	<0.2	5.2	0.06	0.01	20	0.2	0.08	5.3
00-6698		2	0.042	0.16	<0.2	6.2	0.1	0.09	30	0.2	0.09	5.6
00-6699		2.79	0.097	0.28	1	10.7	0.36	0.07	35	0.4	0.2	8.2
00-6700		2.33	0.042	0.24	0.3	5.9	0.14	0.12	38	0.3	0.13	6.6
00-6701	NO ADUP											
00-6702		2.57	0.053	0.33	0.6	6.6	0.24	0.28	43	0.7	0.16	6.9
00-6703		2.62	0.053	0.37	0.9	7.2	0.27	0.31	48	0.8	0.19	7.1
00-6704		2.47	0.056	0.22	2.4	9.1	0.17	0.02	62	0.2	0.22	7.6

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

SAMPLE	TYPE	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
		%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
		0.01	0.001	0.01	0.2	0.1	0.02	0.02	33	0.2	0.08	5
00-6705		2.87	0.014	0.1	0.4	5.4	0.15	0.02	55	0.5	0.15	7.4
00-6706		2.69	0.023	0.17	0.5	7.1	0.23	0.01	45	0.1	0.16	7
00-6707	10	1.89	0.02	0.07	0.2	6.3	0.08	< .01	32	0.1	0.17	5.3
00-6708	20	1.94	0.022	0.07	0.2	6.1	0.08	0.01	27	< .1	0.08	5.2
00-6709		2.28	0.013	0.05	< .2	4.9	0.08	0.03	35	0.5	0.06	5.2
00-6710		2.63	0.012	0.07	0.3	5.7	0.11	0.03	52	0.6	0.1	6.6
00-6711		2.08	0.012	0.11	0.2	5.7	0.12	0.02	30	0.4	0.08	5.9
00-6712		3.23	0.015	0.14	0.3	7	0.14	0.02	67	0.7	0.1	7.5
00-6713		2.69	0.015	0.12	< .2	7.2	0.12	0.03	24	0.3	0.1	6.8
00-6714		1.74	0.037	0.09	< .2	5.1	0.07	0.03	34	0.3	0.12	4.9
00-6715		2.82	0.012	0.09	< .2	6.2	0.09	0.02	31	0.3	0.08	7
00-6716		2.58	0.018	0.09	< .2	7.3	0.11	0.02	33	0.3	0.09	6.5
00-6717		3.49	0.013	0.11	0.3	6.5	0.15	0.02	59	0.4	0.18	7.9
00-6718		3.78	0.017	0.15	0.6	8	0.2	0.01	66	0.7	0.21	8.9

ADUP - analytical duplicate
10, 20 - field duplicate
STD - reference standard

APPENDIX C

ICP-MS ANALYTICAL DATA FOR BECKER HAMMER BOREHOLES

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB98-06	00-6166	19-24	82.88	1005.42	22.71	115.4	723	23.5	15.6	998	3.67	25.9	0.6	28.8	2.1
OB98-09	00-6129	24-28	3.56	150.63	17.1	113.8	213	29.1	17.5	985	3.75	28.6	0.6	2.3	2.8
OB98-09	00-6127	32-36	8.34	388.47	21.31	121.1	416	31.2	16.9	871	4.18	60.4	0.5	4.7	1.9
OB98-09	00-6128	36-40	12.36	527.46	17.07	103.2	404	36.3	18.6	815	4.56	42.7	0.5	5.4	1.7
OB98-09	00-6130	44-48	8.94	448.5	20.4	111.9	399	33.9	17.2	795	4.12	58.9	0.4	7.2	1.7
OB98-09	00-6131	48-49	10.03	524.34	17.99	97.1	441	33	16.8	705	4.31	43.5	0.4	18.8	1.5
OB98-10	00-6034	16-20	12.58	395.18	23.49	123.7	387	33.4	18	860	3.86	57.1	0.6	7.5	2.5
OB98-10	00-6032	28-32	16.44	485.43	24.35	123.4	459	33.9	17.8	850	3.98	64.5	0.6	4.5	2.4
OB98-10	00-6026	32-36	6.55	256.72	23.33	123.1	262	35.7	18.5	872	3.75	42.5	0.8	4.3	3.7
OB98-10	00-6025	36-40	6.66	250.09	32.55	131.8	377	33.1	18.8	905	3.81	58.3	0.5	10.3	2.5
OB98-10	00-6024	40-44	4.69	191.59	26.98	132.9	281	31.3	17.4	919	3.74	56.7	0.6	2.5	2.7
OB98-10	00-6031	44-48	6.88	271.59	23.48	128.4	300	31.5	17.3	902	3.88	61.2	0.6	3.1	2.6
OB98-10	00-6030	48-52	6.45	258.09	24.63	130.4	298	32.6	16.9	909	3.91	61.2	0.6	2.7	2.7
OB98-10	00-6039	52-56	8.88	323.26	19.94	122.5	335	32.6	17.7	858	4.15	63.1	0.5	4.5	2.1
OB98-10	00-6037	56-60	9.51	420.06	20.31	119.9	396	34.2	18.1	828	4.28	62.7	0.6	7.6	2
OB98-10	00-6040	60-64	10.01	441.87	18.26	108.3	353	33	16.9	811	4.2	44.6	0.5	6	2.1
OB98-10	00-6042	64-68	10.03	435.07	19.19	112.3	355	31.8	16	813	4.02	50	0.6	3.7	2.1
OB98-10	00-6036	68-72	7.94	326.06	21.56	129.5	359	32.9	17.7	872	4.22	66.5	0.6	2.4	2.2
OB98-10	00-6028	76-82	8.89	492.32	24.14	121.3	418	35.8	18.6	842	4.43	60.2	0.7	3.5	2.2
OB98-10	00-6027	82-87	8.76	458.12	23.44	115.2	375	40.7	19.8	788	4.77	47	0.7	5.4	2
OB98-10	00-6035	87-92	8.37	389.83	22.18	125.7	378	35	18.4	837	4.31	65.5	0.6	5.2	2
OB98-10	00-6029	92-97	7.89	376.6	26.52	138.8	414	34.8	17.8	896	4.35	73.7	0.6	3.3	2.3
OB98-11	00-6012	24-28	5.31	143.65	15.93	116.6	227	28.5	16.7	902	3.85	24	0.5	2.6	2.4
OB98-11	00-6112	36-40	6.81	268.72	18.33	119.1	273	30.2	15.4	893	3.62	31.5	0.5	3.1	2.3

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB98-12	00-6057	12-16	3.07	178.74	19.53	121.8	175	32.3	19.6	1177	3.82	31.6	0.6	4.4	2.8
OB98-12	00-6058	16-20	3.6	149.78	16.81	117.5	206	30.6	17.2	941	3.82	27.2	0.6	3.8	2.8
OB98-12	00-6080	24-28	7.69	262.97	17.58	111.4	287	31.1	16.3	899	3.76	31.2	0.8	18.6	2.7
OB98-12	00-6059	28-32	4.21	131.73	15.38	108.1	210	29.5	16.3	966	3.81	18.7	0.7	8.7	2.9
OB98-12	00-6062	36-40	14.47	606.01	13.15	84.2	338	29.2	16.1	751	3.71	16.9	0.6	15	2.1
OB98-12	00-6064	40-43	15.75	582.97	12.6	82.2	319	30.4	15.9	757	3.69	16.4	0.6	4.8	2.1
OB98-13	00-6004	24-28	5.98	229.74	16.92	115.2	235	29.3	18	901	3.79	27.7	0.6	2.6	2.3
OB98-13	00-6005	24-28	7.03	155.44	18.6	139.3	207	31	20.4	1076	3.91	31.7	0.7	2.1	2.6
OB98-13	00-6192	28-32	6.8	280.45	17.89	114.7	254	30.1	16.8	913	3.77	29.6	1.1	4	2.7
OB98-14	00-6124	16-20	5.44	222.48	16.85	107.5	263	27	15.4	924	3.59	44.3	0.6	17	2.4
OB98-15	00-6123	14-16	3.05	154.62	18.18	120.6	180	31.8	19.1	1212	3.85	32.2	0.7	3.5	2.6
OB98-16	00-6159	10-12	4.79	211	21.31	142.8	329	34.3	18.5	606	4.07	61.3	0.4	35.2	2.7
OB98-16	00-6158	12-13	7	238.22	17.15	115.9	316	31.3	15.8	885	3.66	29.1	0.7	6	2.6
OB98-17	00-6116	16-20	12.94	505.99	17.12	99.1	349	31.8	16.5	771	4.07	40.9	0.5	6.3	1.8
OB98-18	00-6117	16-20	14.18	448.79	18.39	111.4	394	31.9	15.7	814	3.8	43.5	0.5	18.2	2
OB98-20	00-6210	22-24	8.88	357.28	15.3	101	302	31.3	14.6	791	3.95	37.1	0.5	4.3	2.1
OB98-20	00-6209	28-32	9.44	379.02	16.42	109.3	345	32	15.5	852	4.07	50.8	0.5	4.8	2.1
OB98-20	00-6211	32-36	11.16	453.99	16.46	106.7	339	33.3	16.1	826	4.23	43.3	0.5	4.4	1.9
OB98-20	00-6212	36-40	11.76	460.76	17.05	106.2	370	32.5	15.5	800	4.22	48.7	0.5	5	1.9
OB98-20	00-6213	40-44	11.18	436.21	15.97	108.7	380	33.4	16.2	829	4.32	54	0.5	9	1.8
OB98-20	00-6215	44-48	12.63	494.46	16.39	102.2	439	33	16.3	796	4.26	46.1	0.5	3.9	1.9
OB98-20	00-6214	52-56	10	416.65	18.27	108.2	354	33.3	16.4	846	4.16	46.7	0.5	4.2	2.1
OB98-20	00-6216	56-60	5.79	195.62	17.75	115.1	265	30	14.9	893	3.89	47.9	0.5	2.9	2.5
OB98-21	00-6063	28-32	9.59	345.53	17.47	115.6	304	32.5	16.1	851	3.88	37.4	0.6	4.4	2.5

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB98-21	00-6066	32-36	8.7	360.13	16.97	113.3	318	32.9	15.9	881	3.84	34.6	0.6	4.7	2.5
OB98-21	00-6065	40-44	11.53	413.09	16.94	106.3	351	32.6	15.2	834	3.77	35.6	0.6	4	2.2
OB98-21	00-6067	44-48	11.4	417.18	16.98	108.6	333	33.1	15.7	864	3.86	36.9	0.5	5.4	2.3
OB98-21	00-6068	48-52	10.85	408.7	17.59	109.2	331	33	16.1	859	3.87	36.9	0.6	5.4	2.3
OB98-21	00-6069	52-56	10.62	388.85	16.58	110	329	33.5	15.8	892	3.86	36.4	0.6	4.7	2.5
OB98-21	00-6070	60-64	16.64	511.06	16.42	107.3	368	31.7	16.7	837	3.81	30.6	0.6	4.4	2.5
OB98-22	00-6125	16-20	5.2	233.9	17.15	117.4	263	29.7	15.5	884	3.64	40.3	0.6	3.6	2.7
OB98-23	00-6189	24-28	13.82	416.08	19.8	112.8	345	32.6	16.2	848	3.89	42.3	0.5	5.3	2.2
OB98-42	00-6003	16-20	0.47	56.65	11.66	86.8	126	31.3	18.2	784	3.6	9.7	0.4	2.3	2.1
OB99-11	00-6011	40-44	12.46	424.23	19.61	116.4	400	29.7	17.3	848	3.78	33.1	0.5	5.6	2.3
OB99-16	00-6173	16-20	2.23	121.02	52.61	144.1	395	28.6	16.6	1231	3.96	34.7	0.5	4	1.9
OB99-25	00-6022	24-28	3.24	133.5	15.35	118.9	220	29.4	16.3	940	3.81	28.4	0.5	2.2	2.3
OB99-26	00-6013	28-32	8.94	294.62	17.77	127.6	340	33.1	17.8	900	3.92	41.3	0.5	3.3	2.3
OB99-26	00-6023	50-54	21.49	634.06	18.29	120	464	31.3	15.8	811	3.91	30.5	0.5	7.3	2.1
OB99-36	00-6008	8-12	0.63	44.08	10.01	78.3	115	31.1	16.1	822	3.37	6.8	0.4	1.6	1.8
OB99-36	00-6020	12-16	0.64	43.24	10.36	81	118	31.8	14.5	806	3.39	7.5	0.4	8.8	1.8
OB99-36	00-6126	16-20	0.69	42.04	8.87	75.3	95	31.3	14.7	774	3.31	6.6	0.5	1.2	2.3
OB99-37	00-6006	8-12	1.47	84.96	11.3	85.8	193	31.3	17.6	836	3.42	9.9	0.4	1.2	1.7
OB99-38	00-6120	6-12	1.4	68.24	13.25	90	87	34.8	17.2	1017	3.59	10.6	0.4	1.5	2.3
OB99-39	00-6179	3.5-8	1.99	100.88	12.26	91.8	141	32.3	14.4	863	3.47	14.6	0.4	3.7	2
OB99-39	00-6180	8-12	1.05	54.92	11.09	86.6	126	33.9	14.3	826	3.46	9.3	0.5	1.5	2.1
OB99-39	00-6182	12-16	0.76	47.46	10.53	74	105	33	15.1	817	3.39	6	0.4	2.5	1.7
OB99-39	00-6183	16-20	0.6	40.67	9.56	73.5	92	32.6	14.1	734	3.28	6.3	0.4	1.8	1.8
OB99-39	00-6185	20-24	0.5	42.74	9.56	69.1	87	31.6	14.2	707	3.27	5.4	0.4	1.3	1.8

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB99-39	00-6184	24-27	0.64	45.31	9.21	77	85	30.1	14.3	844	3.61	5.7	0.4	2.5	2
OB99-40	00-6118	8-12	10.63	210.01	9.26	73.8	175	29.3	14.6	730	3.26	6.5	0.4	2.8	1.6
OB99-41	00-6009	6-8	6.05	549.73	16.03	113	354	31.5	19.4	814	4.27	37.5	0.4	4.7	2.1
OB99-41	00-6047	8-12	22.23	677.87	15.14	91.3	389	26	14.9	649	4.18	23.8	0.5	6.1	1.7
OB99-42	00-6202	9-12	1.46	66.95	9.47	61.6	37	25.7	14.3	729	3.46	7.5	0.5	2.3	2.1
OB99-42	00-6191	12-16	2.56	141.8	27.22	100.8	344	27.2	17.5	1051	3.67	31.5	0.4	4	1.8
OB99-42	00-6203	12-16	0.67	57.82	10.87	88	106	32.2	18	852	3.77	9.4	0.4	1.3	2.4
OB99-42	00-6205	20-24	0.5	57.59	12.13	89.7	149	33.8	17.8	717	3.74	9.3	0.4	1.7	2.5
OB99-42	00-6204	24-28	0.56	57.66	10.73	88.5	143	33.8	17.4	768	3.69	9.3	0.4	1.8	2.3
OB99-42	00-6206	28-32	0.46	52.67	10.5	81.6	188	30.4	16.6	845	3.59	8.6	0.4	2.3	2.3
OB99-42	00-6208	32-37	0.65	47.96	10.15	78.1	157	29.4	16	716	3.43	8.8	0.4	1.6	2
OB99-45	00-6167	12-16	2.09	123.84	48.94	143.1	391	26.8	15.9	1283	4.07	31	0.4	4.2	1.7
OB99-46	00-6168	9-12	2.18	116.11	25.6	135.6	421	30.2	16.4	1104	3.88	36	0.4	3.3	2.1
OB99-46	00-6176	12-16	2.51	126.34	28.55	145.9	416	29.8	17.2	1249	4.04	39.4	0.5	4.5	2
OB99-46	00-6171	20-24	2.59	129.06	39.27	149.5	432	30.6	16.6	1214	4.05	40.9	0.5	4.2	2
OB99-46	00-6178	44-48	1.19	93.63	28.01	123.1	285	25.6	16.1	1322	3.94	12.1	0.4	7.1	1.5
OB99-46	00-6177	48-52	1.4	116.55	68.64	138.1	310	26.7	16.1	1295	3.98	14.4	0.4	3.9	1.6
OB99-46	00-6187	52-56	1.2	79.27	26.99	107.8	236	29.8	16.5	1037	3.66	13	0.5	3.1	1.9
OB99-46	00-6174	55-60	0.77	49.27	15.79	76.5	113	32.3	14.5	818	3.38	7.4	0.4	1	1.8
OB99-48	00-6049	12-16	1.25	105.15	26.65	114.2	335	27.5	16.7	1117	3.78	21.4	0.4	2.4	1.7
OB99-49	00-6113	4-8	1.45	123.2	47.81	207.1	382	26.8	19.6	1365	4.15	30.2	0.4	5.5	1.6
OB99-51	00-6048	20-24	0.88	72.48	25.66	103.1	205	29.1	17.1	1008	3.58	12.4	0.4	2.3	1.7
OB99-51	00-6050	24-28	0.85	51.92	21.81	90.4	122	31.7	15.6	816	3.38	10.2	0.4	2.9	2
OB99-51	00-6052	28-32	0.79	48.82	16.39	88.2	127	31	14.7	813	3.33	10.5	0.5	0.9	2.2

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB99-51	00-6051	32-36	0.66	41.63	15.75	84.1	135	31.7	15.5	805	3.28	7.9	0.4	1.2	1.9
OB99-51	00-6053	36-40	0.64	40.85	17.16	85.4	105	31	14.8	790	3.3	9.1	0.4	1.1	2.1
OB99-51	00-6056	40-44	0.61	45.21	10.99	68.9	85	29.6	15.7	759	3.28	4.9	0.4	0.9	1.6
OB99-51	00-6054	44-49	0.62	42.26	14.63	68.6	83	28.8	13.9	729	3.22	5.1	0.4	0.8	1.7
OB99-52	00-6045	8-12	1.37	147.59	23.73	109.4	279	29.1	19.1	1059	3.87	14.3	0.4	6.2	1.8
OB99-53	00-6044	8-12	0.55	46.21	9.96	67.5	65	30	16.7	777	3.23	5.4	0.4	0.7	1.7
OB99-54	00-6090	4-8	2.38	198.86	40.79	129.8	326	35.5	22	1273	4.51	38.7	0.3	7.2	1.4
OB99-54	00-6091	8-12	1.88	165.37	26.14	113.7	324	33	17.6	972	3.89	28.5	0.3	2.9	1.6
OB99-54	00-6092	32-36	1	75.2	109.72	114.1	131	31.4	15.2	848	3.49	9.4	0.4	2.3	1.8
OB99-54	00-6096	36-40	0.58	42.15	25.42	77.4	94	29.7	13.6	770	3.25	5.7	0.5	2.6	1.9
OB99-54	00-6093	40-44	0.6	34.08	11.94	79.2	85	29.6	12.9	799	3.18	6.9	0.4	1.2	2
OB99-54	00-6094	44-48	0.61	38.56	16.04	84.1	97	31	13.5	804	3.26	7.2	0.4	2.3	2
OB99-54	00-6097	48-52	0.68	41.13	18.74	90.7	110	33	14.1	831	3.35	7.9	0.4	1.7	2
OB99-54	00-6100	52-56	0.72	42.94	32.83	95.4	127	32.9	13.5	807	3.26	8.6	0.4	2.5	2.2
OB99-54	00-6099	56-60	0.7	42.29	47.45	99.1	126	33	13.9	799	3.24	9.7	0.4	1.9	2.1
OB99-54	00-6107	60-64	0.71	41.27	17.34	97.6	125	34.3	13.8	805	3.26	9	0.4	2.8	2.1
OB99-54	00-6098	64-68	0.72	42.66	22.08	90.4	111	33.3	14	795	3.26	8.3	0.4	1.4	2
OB99-54	00-6102	68-72	0.62	40.43	12.55	79.6	113	30.8	13.8	764	3.18	7.6	0.5	1.5	1.9
OB99-54	00-6105	72-76	0.55	42.15	13.67	72.2	88	29.7	13.9	761	3.26	5	0.4	1.6	1.7
OB99-54	00-6108	76-80	0.54	40.45	10.8	66.6	88	28.7	13.8	725	3.21	5	0.5	3.6	1.8
OB99-54	00-6103	80-84	0.55	41.36	11.76	67.8	90	28.8	13.9	732	3.18	5	0.4	1	1.7
OB99-54	00-6104	84-88	0.46	38.36	13.97	62.6	78	25.6	12.6	669	3	4.3	0.4	0.9	1.7
OB99-54	00-6109	88-92	0.44	37.03	16.78	62.5	81	25.3	12.3	669	2.96	3.9	0.4	0.9	1.7
OB99-55	00-6043	8-12	2.15	170.7	29.25	109.6	300	32.9	20.4	964	3.85	27.8	0.4	2.6	1.6

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB99-56	00-6085	8-12	0.56	43.59	21.53	72.9	88	30.6	14.3	741	3.37	6.2	0.5	1.3	1.9
OB99-56	00-6086	12-16	1	63.86	14.84	80	136	33.2	14.4	798	3.45	7.5	0.4	1.1	2
OB99-56	00-6087	16-20	0.69	45.19	30.82	89	119	33	14.1	825	3.41	7.3	0.5	0.9	2.3
OB99-56	00-6089	20-24	0.57	43.2	14.84	72.5	97	30.5	14.7	730	3.4	6	0.5	1.4	2
OB99-56	00-6088	24-28	0.6	43.63	14.86	72.4	103	32	15.3	753	3.42	5.5	0.5	1	2.1
OB99-56	00-6169	28-32	0.89	47.05	18.71	74.5	96	28.7	14.2	745	3.57	6.4	0.4	2.3	1.8
OB99-56	00-6172	32-36	0.41	31.91	8.72	48.7	83	21.9	9.9	619	2.82	4.5	0.4	2.3	1.7
OB99-56	00-6175	40-44	0.47	28.12	24.93	50	63	17	8.1	542	2.82	4.1	0.3	1.2	1.4
OB99-57	00-6115	12-16	1.65	120.62	24.97	94.2	212	30.5	15.6	926	3.56	16.4	0.4	1.8	1.6
OB99-58	00-6015	8-12	2.03	134.55	30.82	153.6	620	28	21.9	1372	4.19	38.8	0.3	5.8	1.2
OB99-58	00-6217	12-16	1.98	114.75	29.25	101.7	332	31.4	16.8	881	3.95	30	0.4	5.2	1.5
OB99-58	00-6218	16-20	1.98	124.4	75.41	133	446	32	17.5	953	4.03	34.1	0.5	3.2	1.5
OB99-58	00-6219	20-24	2	112.69	47.7	165.1	550	30.4	19.1	1327	4.23	64.7	0.4	4.4	1.5
OB99-58	00-6220	24-28	2.31	99.67	43.49	168.7	629	35.5	18	1174	4.06	63.7	0.4	3.5	1.7
OB99-58	00-6222	28-32	2.12	110.42	40.55	159.2	557	38.1	19.6	1149	4.08	59.7	0.4	2.9	1.6
OB99-58	00-6223	32-36	1.93	99.4	28.58	102	339	28.4	16.2	998	3.76	18.6	0.4	2.6	1.7
OB99-58	00-6224	40-44	1.74	69.05	21.39	86.6	146	32.5	13.7	805	3.39	8.9	0.5	1.7	2.2
OB99-58	00-6225	44-48	1.46	77.4	26.62	92.5	223	29.8	14.7	893	3.52	12.3	0.4	7.4	1.8
OB99-58	00-6226	48-52	0.8	42.11	17.15	88.2	111	33.4	14.9	833	3.37	7.9	0.5	1.8	2
OB99-58	00-6227	52-56	0.71	40.47	17.44	82.1	110	32.4	14	812	3.36	7	0.4	1.9	1.9
OB99-59	00-6193	8-12	3.97	136.58	54.38	88.4	171	29.3	14.9	825	3.45	9.7	0.4	1.7	1.9
OB99-63	00-6110	16-20	9.5	438.44	19.23	120.6	348	30.3	16.1	888	3.75	39.9	0.5	7	2.1
OB00-63	00-6014	12-16	8.38	451	16.47	124.5	330	30.1	17.4	766	3.82	35.4	0.4	4.2	1.7
OB00-63	00-6194	16-20	10.04	454.94	19.12	117.4	314	30.3	17.6	899	3.88	36.7	0.5	6.9	2.1

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB00-63	00-6195	20-23	8.87	406.47	16.46	117.4	296	29.9	17.9	815	3.81	37.6	0.4	5.6	2
OB00-64	00-6114	16-20	2.41	117.62	20.74	127.5	68	29.3	18.6	1051	4.09	43.8	0.5	3.6	2.8
OB00-65	00-6016	20-24	3.5	179.75	16.46	116.4	230	30	16.1	872	3.73	30.7	0.6	3.1	2.3
OB00-65	00-6160	24-28	3.65	194.23	18.15	113.7	279	30.9	14.7	856	3.59	36.8	0.6	6.3	2.7
OB00-65	00-6196	28-32	3.73	182.03	16.1	107.6	205	28.5	15.6	875	3.63	27.8	0.5	3.2	2.5
OB00-65	00-6164	32-36	4.04	195.29	15.76	114.3	261	30.3	14.4	871	3.56	30	0.6	3.8	2.6
OB00-65	00-6165	36-40	4.02	179.81	16.09	113.1	243	30.6	14.1	865	3.54	30.3	0.5	6.7	2.6
OB00-65	00-6162	40-44	3.92	178.02	15.74	113.1	244	30.5	14.3	879	3.62	29.3	0.5	3	2.6
OB00-66	00-6019	12-16	3.44	179.73	15.68	118.6	236	31.1	16.5	840	3.73	36	0.4	3.6	2.4
OB00-66	00-6190	18-22	3.69	174.15	17.44	116.8	227	29.6	15.4	753	3.72	34.9	0.5	2.8	2.6
OB00-68	00-6186	4-8	2.94	134.34	17.83	122.5	193	30.1	16	830	3.69	63.5	0.5	5.7	2.4
OB00-70	00-6122	4-6	2.41	109.94	16.39	107.3	197	25.8	15.1	886	3.56	24.5	0.6	3	2.6
OB00-70	00-6198	6-11	2.55	112.19	15.88	110.5	200	28	16.2	977	3.78	23.5	0.7	1.9	2.8
OB00-70	00-6199	11-16	2.76	115.83	15.75	112.6	192	32.8	16.7	955	3.87	22.7	0.6	2.3	2.7
OB00-70	00-6200	16-20	3.16	125.35	16.82	113.8	199	28.4	17.1	944	3.79	25.6	0.6	1.6	2.8
OB00-71	00-6150	7-10	9.95	365.57	19.26	127.7	309	31.9	16.8	671	3.94	42.2	0.5	6	2.1
OB00-71	00-6151	10-15	14.88	620.47	21.39	149.8	365	34.8	19	828	4.17	59.2	0.6	10.2	1.7
OB00-71	00-6152	15-17	9.06	405.52	23.34	167.5	359	30.8	17.2	884	3.95	66.6	0.5	7.6	1.9
OB00-71	00-6153	17-21	12.04	462.98	21.69	155.3	389	30.7	16	799	3.95	61.7	0.5	16.4	1.7
OB00-71	00-6157	24-31	9.12	424.53	22.61	170.2	393	32.6	17	835	3.95	68.7	0.5	13.8	1.7
OB00-71	00-6156	31-36	10.23	594.26	17.71	127.4	386	31.6	16.8	819	3.83	43.1	0.5	8	1.8
OB00-73	00-6002	12-16	11.27	478.4	17.97	115.2	326	28.7	19	825	3.71	37.9	0.5	9.7	2
OB00-73	00-6111	19.5-22	7.49	404.82	18.9	124.4	280	28.7	16.5	854	3.64	39.9	0.5	6	1.8
OB00-74	00-6018	10-14	22.43	908.14	17.56	117.7	438	30.9	16.3	895	3.85	34.9	0.5	5.7	2.4

BOREHOLE	SAMPLE	DEPTH (ft)	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1
OB00-74	00-6072	14-18	26.5	880.74	16.29	105.3	565	31.1	16.1	790	3.85	31.9	0.6	12.5	2.7
OB00-74	00-6071	18-22	31.82	730.34	16.47	101.6	532	31	15.7	783	3.92	30.8	0.6	18.7	2.7
OB00-74	00-6074	20-24	7.08	287.75	13.64	92.4	245	31.2	15.2	723	3.75	24.3	0.5	4.7	1.9
OB00-74	00-6073	22-26	43.48	944.29	15.02	86.6	578	30.7	16.7	706	4.05	23.2	0.5	17.2	2.6
OB00-74	00-6132	26-30	44.13	919.5	14.9	95.1	608	30.3	17.2	716	4.09	26.9	0.8	17.1	2.6
OB00-74	00-6133	30-34	44.74	902.85	14.32	92.5	603	30.2	16.9	711	4.12	26.4	0.6	24.6	2.7
OB00-74	00-6134	34-38	35.21	732.81	14.68	93.3	514	30.2	17.2	737	4.07	25.8	0.6	16	2.5
OB00-74	00-6082	40-44	0.91	44.26	8.62	66.5	99	29.9	13.9	774	3.25	6.1	0.5	1.3	2.1
OB00-74	00-6135	42-46	25.8	649.81	14.46	98.4	443	31.6	16.3	762	4.13	28.9	0.5	16.4	2.1
OB00-74	00-6138	46-50	23.57	683.99	14.58	105	437	30.3	17	781	4.03	28	0.5	10.6	2.3
OB00-74	00-6136	50-54	21.85	625.17	16.17	112.9	418	29.8	16.7	791	3.97	27.8	0.5	8.6	2.4
OB00-74	00-6140	54-58	26.04	658.89	15.22	109.9	478	32.9	18.2	817	4.2	30.6	0.5	13.5	2.3
OB00-74	00-6142	58-62	34.8	833.38	16.05	94.8	578	31.9	17.2	762	4.04	33	0.5	10.2	2.2
OB00-74	00-6143	62-66	20.27	538.86	19.1	118.1	428	32.4	17.2	906	4.05	39	0.6	7.9	2.2
OB00-74	00-6145	66-70	26.16	747.72	16.43	104.9	493	35.1	17.7	841	4.22	37.5	0.6	9	2.2
OB00-74	00-6144	70-74	18.17	532.13	17.76	112.7	458	33.2	17.5	834	4.05	39.6	0.5	8.6	2.2
OB00-74	00-6147	74-78	15.44	483.9	17.6	119.9	394	32.7	16.8	868	3.99	32.8	0.5	9.2	2.2
OB00-74	00-6146	78-82	12.78	352.49	18.3	116.5	335	33.1	17.6	911	4.03	33.9	0.5	9.1	2.2
OB00-74	00-6148	82-86	11.11	430.97	18.32	122.8	338	30.8	16.8	872	3.82	36.8	0.5	4.8	2.1
OB00-74	00-6149	86-89	16.04	567.08	16.4	109.2	506	30.1	17.6	818	4.03	38.3	0.5	7.8	2
OB00-75	00-6017	24-28	7.73	256.94	12.98	88.4	248	31.2	18.2	798	3.71	24.6	0.4	9.4	1.6
OB00-75	00-6075	28-32	7.25	266.59	12.34	80.4	218	31.5	16	805	3.61	20.3	0.5	4.4	2
OB00-75	00-6078	32-36	7.03	248.51	12.13	77.5	202	31.2	15.4	778	3.55	21.4	0.5	2.1	1.8
OB00-75	00-6076	36-40	3.24	160.25	9.66	69.5	142	29.2	13.6	753	3.27	8.7	0.5	9.5	2.1

BOREHOLE	SAMPLE	DEPTH (ft)	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th
			ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm
			0.01	0.01	0.01	0.1	2	0.1	0.1	1	0.01	0.1	0.1	1	0.1
OB00-75	00-6083	44-46.5	1.19	45.46	8.28	66.4	103	30.3	13.5	774	3.35	5.6	0.5	1.2	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB98-06	00-6166	19-24	51.5	0.7	3.18	1.82	94	0.75	0.093	12.1	32	0.93	105.7	0.108	1
OB98-09	00-6129	24-28	58.5	0.28	1.24	0.91	85	1.41	0.095	12.6	37.7	1.18	211.4	0.075	2
OB98-09	00-6127	32-36	67.4	0.38	2.58	2.89	97	1.58	0.085	8.8	49.2	1.28	189.6	0.078	1
OB98-09	00-6128	36-40	84.8	0.26	1.79	3.71	117	1.38	0.085	7.7	68.4	1.49	167.7	0.098	1
OB98-09	00-6130	44-48	75.7	0.3	2.62	3.12	102	1.5	0.086	8	55.5	1.35	171.7	0.091	1
OB98-09	00-6131	48-49	87.6	0.27	1.97	4.92	111	1.38	0.083	6.8	63.2	1.35	157.3	0.096	1
OB98-10	00-6034	16-20	80.6	0.44	2.32	2.27	85	1.31	0.091	11.7	49.3	1.35	185.7	0.074	3
OB98-10	00-6032	28-32	93.4	0.4	2.67	2.56	92	1.33	0.099	11.5	53.9	1.43	188.5	0.077	3
OB98-10	00-6026	32-36	62.4	0.38	1.73	1.63	75	1.15	0.099	13.9	43.4	1.18	190.3	0.083	2
OB98-10	00-6025	36-40	71.4	0.43	2.01	2.08	78	1.36	0.103	12.7	43.5	1.22	196	0.071	3
OB98-10	00-6024	40-44	70.2	0.44	1.88	1.67	74	1.34	0.105	13.7	40.2	1.2	195.1	0.069	3
OB98-10	00-6031	44-48	77.6	0.39	2.08	2.05	81	1.36	0.108	13	44.6	1.27	196	0.073	4
OB98-10	00-6030	48-52	79.5	0.38	2.07	2.25	80	1.36	0.11	13.7	40.6	1.28	203.1	0.074	2
OB98-10	00-6039	52-56	79.6	0.36	2.1	2.23	92	1.35	0.091	11.1	53.2	1.42	193.4	0.083	2
OB98-10	00-6037	56-60	87.8	0.33	2.07	3.09	97	1.37	0.098	10.8	60.2	1.48	186.9	0.085	2
OB98-10	00-6040	60-64	93.3	0.29	1.71	1.98	95	1.41	0.09	10.6	56.9	1.44	187.2	0.085	2
OB98-10	00-6042	64-68	82.2	0.3	1.87	2.21	91	1.39	0.094	10.8	51.9	1.38	183.6	0.078	2
OB98-10	00-6036	68-72	88.5	0.37	2.21	2.34	95	1.42	0.099	11.3	51.2	1.41	195.2	0.081	2
OB98-10	00-6028	76-82	101.2	0.35	2.04	2.93	102	1.44	0.103	10.9	62.8	1.56	190.2	0.092	2
OB98-10	00-6027	82-87	110.1	0.33	1.87	3.58	115	1.42	0.1	9.6	78.7	1.76	182.6	0.104	2
OB98-10	00-6035	87-92	89.9	0.35	2.34	3.1	96	1.46	0.09	9.9	60.5	1.48	182.3	0.086	2
OB98-10	00-6029	92-97	90.2	0.4	2.52	3.44	93	1.48	0.098	11.3	54.5	1.46	190.5	0.084	1
OB98-11	00-6012	24-28	71.4	0.28	1.14	0.77	83	1.38	0.094	13.1	32.3	1.17	192.6	0.072	2
OB98-11	00-6112	36-40	55.6	0.35	1.39	1.31	79	1.37	0.088	11.5	39.4	1.19	181.2	0.075	<1

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB98-12	00-6057	12-16	57.3	0.54	1.42	1.21	79	0.72	0.101	13.2	33.8	0.94	144.1	0.081	2
OB98-12	00-6058	16-20	67.3	0.3	1.32	1.08	78	1.29	0.102	12.3	39.8	1.15	200.4	0.074	2
OB98-12	00-6080	24-28	67.8	0.35	1.4	1.17	80	1.32	0.096	12	39.6	1.22	188.8	0.076	1
OB98-12	00-6059	28-32	70.3	0.29	0.99	0.74	80	1.32	0.104	12	36.7	1.26	189.1	0.076	2
OB98-12	00-6062	36-40	77.5	0.25	1.21	1.33	88	1.69	0.092	8.9	44.7	1.34	172.3	0.069	1
OB98-12	00-6064	40-43	82.7	0.24	1.05	1.22	87	1.7	0.09	9.3	46	1.34	174.9	0.07	1
OB98-13	00-6004	24-28	64.9	0.32	1.15	0.95	84	1.4	0.089	10.9	35.6	1.2	191.1	0.074	1
OB98-13	00-6005	24-28	61.5	0.31	1.28	0.87	85	1.29	0.093	12.9	35.8	1.07	198.6	0.072	2
OB98-13	00-6192	28-32	63	0.39	1.46	1.21	80	1.39	0.096	12.3	39.7	1.21	194.3	0.083	1
OB98-14	00-6124	16-20	50.6	0.34	1.82	1.37	86	1.25	0.09	10.7	39.1	1.08	166.9	0.078	1
OB98-15	00-6123	14-16	52	0.42	1.3	0.89	96	0.85	0.098	12.7	39.7	1.09	183.9	0.085	2
OB98-16	00-6159	10-12	58	0.27	1.84	1.61	84	0.83	0.091	11.9	40.1	0.99	182.5	0.088	1
OB98-16	00-6158	12-13	63.6	0.37	1.15	0.94	78	1.33	0.087	10.9	38.7	1.22	180.4	0.073	2
OB98-17	00-6116	16-20	65.5	0.26	1.87	2.07	99	1.31	0.084	9.1	54.6	1.35	156	0.085	<1
OB98-18	00-6117	16-20	60.4	0.38	2.09	1.86	92	1.3	0.082	9.7	51.5	1.35	176.6	0.081	1
OB98-20	00-6210	22-24	64.5	0.4	1.76	1.57	99	1.32	0.083	10.3	54.3	1.33	179.2	0.093	1
OB98-20	00-6209	28-32	76.1	0.33	2.23	2.07	97	1.4	0.081	10	54	1.41	209	0.091	1
OB98-20	00-6211	32-36	75.2	0.35	1.99	2.01	104	1.44	0.086	9.4	58.7	1.47	189.7	0.095	2
OB98-20	00-6212	36-40	77.9	0.38	2.17	2.39	102	1.44	0.084	9.5	58.3	1.48	183.9	0.091	1
OB98-20	00-6213	40-44	78	0.42	2.14	2.34	106	1.47	0.081	9.2	60.9	1.5	188	0.095	1
OB98-20	00-6215	44-48	80.9	0.34	2.08	2.68	104	1.45	0.083	9.3	60.8	1.49	182.3	0.093	1
OB98-20	00-6214	52-56	76.4	0.36	2.01	2.16	100	1.5	0.086	10.4	57	1.43	192.5	0.092	1
OB98-20	00-6216	56-60	76.2	0.41	1.98	1.44	84	1.46	0.094	12.5	41.8	1.19	202.9	0.087	1
OB98-21	00-6063	28-32	69.3	0.4	1.88	1.77	84	1.38	0.097	10.9	44.5	1.26	185.6	0.078	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB98-21	00-6066	32-36	68.8	0.38	1.82	1.99	84	1.33	0.091	11	45.2	1.3	193.3	0.078	2
OB98-21	00-6065	40-44	70.7	0.33	1.8	1.71	89	1.36	0.089	10	49.1	1.3	185.9	0.079	2
OB98-21	00-6067	44-48	71	0.35	1.83	1.75	87	1.37	0.09	10.5	50.3	1.33	193.1	0.08	2
OB98-21	00-6068	48-52	71.1	0.4	1.92	1.65	88	1.37	0.091	10.6	48.9	1.32	193.7	0.08	2
OB98-21	00-6069	52-56	78.3	0.37	1.82	2.4	88	1.34	0.088	10.5	50.2	1.33	197.8	0.079	2
OB98-21	00-6070	60-64	80.8	0.36	1.53	1.47	86	1.39	0.089	10.3	44.9	1.28	194	0.08	2
OB98-22	00-6125	16-20	57.7	0.39	1.68	1.63	82	1.3	0.092	11.2	36.8	1.15	184.8	0.072	1
OB98-23	00-6189	24-28	68.8	0.45	2.25	1.99	91	1.34	0.091	10.7	51.3	1.37	190.9	0.085	2
OB98-42	00-6003	16-20	48.7	0.21	0.47	0.28	81	1.01	0.085	10.1	46.2	1.17	149.6	0.075	3
OB99-11	00-6011	40-44	74.5	0.34	1.37	1.36	83	1.3	0.089	10.1	36.9	1.26	182.5	0.071	2
OB99-16	00-6173	16-20	67.9	0.46	1.9	0.67	82	1.95	0.084	9.6	37.8	1.31	175.6	0.072	1
OB99-25	00-6022	24-28	83.2	0.34	1.11	0.83	82	1.42	0.097	12.5	33.6	1.22	208.9	0.07	<1
OB99-26	00-6013	28-32	70.9	0.43	1.82	1.55	84	1.33	0.093	11.5	43.8	1.29	185.9	0.07	3
OB99-26	00-6023	50-54	71.9	0.36	1.36	1.54	89	1.38	0.085	9.7	41.7	1.33	186.6	0.077	2
OB99-36	00-6008	8-12	73.8	0.19	0.42	0.17	77	1.92	0.089	10	42.5	1.16	180.7	0.067	4
OB99-36	00-6020	12-16	74.3	0.19	0.37	0.19	76	1.88	0.088	9.9	43.4	1.18	189.8	0.067	3
OB99-36	00-6126	16-20	67.2	0.2	0.35	0.17	76	1.76	0.084	9.1	43.5	1.13	182.1	0.064	2
OB99-37	00-6006	8-12	72.2	0.24	0.49	0.31	75	1.86	0.084	9.3	39.7	1.18	190.5	0.061	7
OB99-38	00-6120	6-12	45.6	0.22	0.6	0.27	78	0.77	0.09	13.3	40.2	0.94	189.2	0.071	<1
OB99-39	00-6179	3.5-8	57.9	0.25	0.64	0.35	78	1.41	0.087	10.9	43.3	1.08	176.2	0.078	1
OB99-39	00-6180	8-12	69.4	0.24	0.43	0.19	76	1.74	0.084	10.3	45.6	1.22	195.8	0.077	2
OB99-39	00-6182	12-16	68	0.19	0.32	0.13	77	1.77	0.088	8.9	48.3	1.29	174.6	0.086	2
OB99-39	00-6183	16-20	66.6	0.21	0.34	0.13	72	1.64	0.081	8.6	45.1	1.15	158.9	0.066	1
OB99-39	00-6185	20-24	65.7	0.18	0.3	0.13	76	1.54	0.084	8.3	45.7	1.08	168.2	0.064	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB99-39	00-6184	24-27	70.7	0.17	0.36	0.14	74	1.54	0.085	8.4	44.4	1.17	156.1	0.073	2
OB99-40	00-6118	8-12	49.7	0.21	0.5	0.4	79	1.69	0.082	8.9	44.6	1.16	164.5	0.076	<1
OB99-41	00-6009	6-8	66.9	0.27	1.69	0.99	102	0.78	0.092	11.4	43.2	1.24	167.3	0.089	2
OB99-41	00-6047	8-12	80.1	0.17	1.46	1.54	106	1.39	0.087	11	40.4	1.33	158	0.106	2
OB99-42	00-6202	9-12	61.2	0.11	0.68	0.44	92	0.85	0.095	13.5	48.7	0.98	163.9	0.144	<1
OB99-42	00-6191	12-16	61.1	0.51	1.55	0.78	85	1.75	0.089	10.1	41.1	1.13	168.7	0.081	2
OB99-42	00-6203	12-16	53.8	0.27	0.52	0.28	85	0.81	0.09	11.2	53.1	1.15	165.9	0.094	1
OB99-42	00-6205	20-24	51.9	0.2	0.49	0.29	83	1.01	0.091	11	49	1.32	172.1	0.094	1
OB99-42	00-6204	24-28	55.6	0.23	0.5	0.27	82	1.06	0.083	10.9	49.7	1.27	172	0.09	1
OB99-42	00-6206	28-32	51.4	0.23	0.45	0.28	81	0.94	0.096	10.7	47	1.19	162.2	0.09	1
OB99-42	00-6208	32-37	51.3	0.2	0.43	0.22	79	1.19	0.093	9.9	48.2	1.13	157.1	0.092	1
OB99-45	00-6167	12-16	68.5	0.46	2.07	0.77	84	2.17	0.076	9.1	36.4	1.3	200.4	0.072	1
OB99-46	00-6168	9-12	61.2	0.45	1.83	0.71	81	1.78	0.082	10.3	39.3	1.31	175.1	0.076	1
OB99-46	00-6176	12-16	69.2	0.49	1.8	0.65	84	1.93	0.079	10.1	38.4	1.35	180.6	0.076	2
OB99-46	00-6171	20-24	72	0.48	1.84	0.67	84	1.94	0.079	9.6	39.2	1.35	194.8	0.074	2
OB99-46	00-6178	44-48	65.6	0.42	2.02	0.69	76	2.2	0.075	9	34	1.21	185.5	0.067	1
OB99-46	00-6177	48-52	70.1	0.44	1.86	0.81	79	2.17	0.076	8.9	32.2	1.22	191.3	0.07	2
OB99-46	00-6187	52-56	73.8	0.35	1.2	0.66	75	1.87	0.083	9.8	41.4	1.17	194.3	0.069	2
OB99-46	00-6174	55-60	69.2	0.18	0.38	0.15	78	1.75	0.086	9.5	48.4	1.24	170	0.085	2
OB99-48	00-6049	12-16	77.3	0.36	1.59	0.52	76	2.11	0.081	9.9	39.3	1.26	184.2	0.061	2
OB99-49	00-6113	4-8	54.6	0.85	2.55	0.88	89	2.37	0.077	9.6	39.8	1.23	153.7	0.077	<1
OB99-51	00-6048	20-24	71.5	0.32	1.09	0.43	71	1.9	0.08	10.1	40.1	1.19	176.2	0.06	2
OB99-51	00-6050	24-28	74.1	0.21	0.42	0.29	71	1.7	0.095	11.5	42.2	1.13	199	0.062	2
OB99-51	00-6052	28-32	74.7	0.23	0.47	0.29	69	1.7	0.095	12.2	41.6	1.12	205.6	0.062	3

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB99-51	00-6051	32-36	71.6	0.21	0.34	0.18	69	1.76	0.093	11.3	44.3	1.15	198.7	0.067	2
OB99-51	00-6053	36-40	75.8	0.21	0.36	0.2	68	1.68	0.089	12.2	40.5	1.14	208.8	0.07	2
OB99-51	00-6056	40-44	66.9	0.16	0.25	0.13	73	1.75	0.088	9.6	48.7	1.25	141.6	0.078	1
OB99-51	00-6054	44-49	71.1	0.17	0.26	0.12	71	1.64	0.091	9.3	45.9	1.15	144.1	0.07	2
OB99-52	00-6045	8-12	64.1	0.35	1.28	0.81	76	1.97	0.088	10.6	41.6	1.21	181.2	0.064	2
OB99-53	00-6044	8-12	53.1	0.16	0.27	0.11	73	1.74	0.092	9.6	46.2	1.07	150.7	0.079	1
OB99-54	00-6090	4-8	59.8	0.38	2.45	1.54	106	0.96	0.074	8.2	56.1	1.43	162.2	0.1	1
OB99-54	00-6091	8-12	61.6	0.43	2.02	1.14	90	2.12	0.077	9.1	47.5	1.27	154.5	0.079	1
OB99-54	00-6092	32-36	61.8	0.23	0.59	0.35	75	1.73	0.089	10.4	47	1.18	193.5	0.068	3
OB99-54	00-6096	36-40	71	0.19	0.4	0.17	75	1.79	0.088	10.4	45.1	1.15	173.8	0.077	2
OB99-54	00-6093	40-44	70.6	0.18	0.37	0.17	71	1.72	0.093	12.6	36	1.07	184.1	0.077	3
OB99-54	00-6094	44-48	69.2	0.2	0.4	0.18	72	1.74	0.089	11.3	42.7	1.12	208.7	0.074	3
OB99-54	00-6097	48-52	67.3	0.24	0.45	0.21	72	1.82	0.091	12.2	45.9	1.16	274.2	0.066	3
OB99-54	00-6100	52-56	71.1	0.27	0.48	0.26	70	1.72	0.087	12	42.6	1.12	231.9	0.06	1
OB99-54	00-6099	56-60	68.3	0.24	0.5	0.26	67	1.7	0.085	12	42.5	1.11	233.3	0.057	2
OB99-54	00-6107	60-64	65.5	0.26	0.59	0.26	66	1.68	0.087	11.8	42.2	1.14	242.5	0.055	2
OB99-54	00-6098	64-68	67.6	0.24	0.51	0.26	69	1.71	0.089	11.2	46.4	1.15	226.6	0.061	2
OB99-54	00-6102	68-72	68.5	0.2	0.46	0.2	70	1.72	0.086	10.5	46.2	1.13	233.5	0.068	2
OB99-54	00-6105	72-76	59.7	0.18	0.35	0.15	77	1.77	0.092	9.7	48.7	1.21	101.8	0.083	1
OB99-54	00-6108	76-80	63.7	0.16	0.35	0.14	79	1.77	0.092	9.7	44.7	1.17	89.6	0.089	<1
OB99-54	00-6103	80-84	58.5	0.18	0.35	0.14	75	1.71	0.092	9.3	46.2	1.15	99.1	0.082	1
OB99-54	00-6104	84-88	59.6	0.16	0.34	0.13	75	1.59	0.087	9.3	45.1	1.03	105.3	0.095	1
OB99-54	00-6109	88-92	54.1	0.15	0.29	0.13	74	1.59	0.086	8.7	42.8	1.02	102.6	0.093	<1
OB99-55	00-6043	8-12	81.9	0.36	1.6	1.1	84	2.01	0.085	9.2	49.3	1.4	177.4	0.071	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB99-56	00-6085	8-12	71.3	0.16	0.32	0.14	77	1.75	0.09	8.5	46.8	1.15	170.5	0.078	2
OB99-56	00-6086	12-16	77.4	0.2	0.45	0.22	75	1.79	0.093	10.4	46.7	1.16	205.7	0.071	3
OB99-56	00-6087	16-20	81	0.24	0.42	0.22	75	1.87	0.094	10.9	48.2	1.16	217.5	0.071	2
OB99-56	00-6089	20-24	76.3	0.18	0.35	0.15	78	1.66	0.093	9.2	46.8	1.18	139.1	0.074	3
OB99-56	00-6088	24-28	77.9	0.15	0.32	0.15	76	1.74	0.088	8.9	47.2	1.2	160.8	0.076	2
OB99-56	00-6169	28-32	72.9	0.17	0.32	0.17	78	1.51	0.084	8.3	49.7	1.13	154	0.081	2
OB99-56	00-6172	32-36	61.2	0.14	0.32	0.11	76	1.62	0.092	8.8	40.6	0.92	111.1	0.106	1
OB99-56	00-6175	40-44	51.9	0.14	0.32	0.08	73	1.35	0.081	7.8	39	0.73	119.8	0.118	1
OB99-57	00-6115	12-16	59.9	0.27	1.01	0.48	77	1.83	0.08	8.7	44.1	1.2	175.8	0.068	<1
OB99-58	00-6015	8-12	73.9	0.58	2.13	0.67	96	2.68	0.073	7.6	39.9	1.51	159.8	0.072	3
OB99-58	00-6217	12-16	68.2	0.37	1.5	0.5	85	1.86	0.083	8.5	47.9	1.32	162.9	0.085	2
OB99-58	00-6218	16-20	75.8	0.45	1.88	0.52	84	1.98	0.079	8.8	45.6	1.35	175.8	0.082	1
OB99-58	00-6219	20-24	75.6	0.61	2.68	0.62	87	2.43	0.078	9.8	43.2	1.42	187	0.076	1
OB99-58	00-6220	24-28	74.9	0.63	2.78	0.51	82	2.26	0.081	9.7	49.2	1.48	212.5	0.079	1
OB99-58	00-6222	28-32	73.8	0.61	2.42	0.68	85	2.22	0.079	9.1	49.4	1.51	207.7	0.081	1
OB99-58	00-6223	32-36	71.6	0.29	0.96	0.58	76	2	0.081	9.2	38.9	1.21	202.8	0.073	2
OB99-58	00-6224	40-44	77.6	0.22	0.43	0.28	71	1.74	0.092	11.8	42.4	1.12	212.5	0.072	3
OB99-58	00-6225	44-48	72.9	0.24	0.76	0.4	76	1.83	0.083	9.7	38	1.18	194.5	0.076	3
OB99-58	00-6226	48-52	72	0.23	0.38	0.2	72	1.89	0.085	9.9	45.1	1.15	236	0.071	4
OB99-58	00-6227	52-56	66.8	0.2	0.32	0.17	74	1.83	0.088	10.2	41.9	1.17	219.8	0.08	3
OB99-59	00-6193	8-12	73.1	0.22	0.69	0.69	78	1.85	0.09	10	45.2	1.15	180.5	0.08	2
OB99-63	00-6110	16-20	62	0.34	1.54	1.55	86	1.53	0.085	10.8	41	1.25	167.7	0.079	<1
OB00-63	00-6014	12-16	61	0.32	1.71	1.23	87	1.49	0.086	9.5	41.2	1.22	160.2	0.071	2
OB00-63	00-6194	16-20	70.3	0.39	1.65	1.69	86	1.53	0.087	10.4	42.9	1.28	181.7	0.085	1

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB00-63	00-6195	20-23	63.7	0.36	1.75	1.36	83	1.43	0.085	10.1	42.2	1.23	185.1	0.081	2
OB00-64	00-6114	16-20	55.5	0.27	1.86	0.77	92	0.78	0.097	16.7	43.6	1.07	163.8	0.114	<1
OB00-65	00-6016	20-24	64.6	0.3	1.37	0.86	78	1.34	0.09	11.3	36.9	1.2	171.3	0.066	3
OB00-65	00-6160	24-28	61.1	0.38	1.46	1.15	75	1.27	0.09	11.1	38.6	1.16	170.3	0.071	2
OB00-65	00-6196	28-32	64.8	0.35	1.43	1	76	1.35	0.09	12.4	36.4	1.15	185.6	0.075	2
OB00-65	00-6164	32-36	63.5	0.34	1.25	0.84	75	1.33	0.083	10.9	36.6	1.16	178.2	0.07	2
OB00-65	00-6165	36-40	59.9	0.31	1.27	0.8	75	1.31	0.088	11	35.9	1.15	177.2	0.07	2
OB00-65	00-6162	40-44	58	0.33	1.16	0.81	76	1.33	0.087	10.9	38.1	1.16	181.4	0.071	2
OB00-66	00-6019	12-16	52.5	0.27	1.43	0.94	78	1.27	0.089	11	36.6	1.21	166.2	0.064	3
OB00-66	00-6190	18-22	58.1	0.22	1.51	0.94	77	1.27	0.092	13	39.6	1.13	202.1	0.077	2
OB00-68	00-6186	4-8	52.6	0.35	1.2	0.66	78	1.16	0.09	12.7	37.8	1.03	142.1	0.076	1
OB00-70	00-6122	4-6	64.5	0.27	1.15	0.81	78	1.34	0.098	13.7	34.1	1.13	176	0.076	<1
OB00-70	00-6198	6-11	78.3	0.3	1.22	0.85	81	1.45	0.099	14.4	33.5	1.22	193.5	0.087	2
OB00-70	00-6199	11-16	72.2	0.32	1.11	0.78	85	1.38	0.096	13.8	41.4	1.42	195.4	0.092	1
OB00-70	00-6200	16-20	68.2	0.34	1.24	1.24	80	1.35	0.096	14	35.5	1.24	197.5	0.085	3
OB00-71	00-6150	7-10	59.4	0.45	1.19	1.65	101	0.79	0.088	10.2	50.5	1.31	141.3	0.088	<1
OB00-71	00-6151	10-15	80.9	0.49	1.19	1.34	112	1.45	0.08	8.4	62.2	1.5	173	0.094	<1
OB00-71	00-6152	15-17	67.4	0.58	1.44	1.26	96	1.55	0.086	9.2	46.4	1.29	170.2	0.079	<1
OB00-71	00-6153	17-21	80.6	0.48	1.28	1.61	104	1.43	0.079	7.8	52.2	1.41	161.5	0.089	<1
OB00-71	00-6157	24-31	71.8	0.66	1.23	1.15	96	1.5	0.078	7.7	54	1.33	161	0.086	2
OB00-71	00-6156	31-36	66.5	0.41	1.06	1.1	89	1.45	0.079	8.3	44.3	1.28	169.1	0.083	1
OB00-73	00-6002	12-16	69.6	0.33	1.61	1.39	82	1.46	0.085	10	39.1	1.17	161	0.07	3
OB00-73	00-6111	19.5-22	55.8	0.39	1.45	1.25	79	1.49	0.083	9.6	40.8	1.17	166	0.075	1
OB00-74	00-6018	10-14	64.1	0.32	1.46	1.85	83	1.38	0.087	10.4	37.5	1.24	178.7	0.067	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB00-74	00-6072	14-18	66.7	0.36	1.54	2.4	84	1.32	0.089	9.5	45.2	1.3	186.2	0.084	2
OB00-74	00-6071	18-22	72.8	0.32	1.56	2.27	90	1.32	0.091	9.5	45.6	1.33	197.1	0.087	1
OB00-74	00-6074	20-24	61	0.33	1.23	0.86	88	1.64	0.09	9.2	46.6	1.17	156	0.084	2
OB00-74	00-6073	22-26	70.7	0.28	1.38	2.65	97	1.29	0.089	8.7	49.7	1.4	194.9	0.096	2
OB00-74	00-6132	26-30	66.4	0.27	1.3	2.16	103	1.32	0.087	8.6	46.7	1.4	194	0.09	1
OB00-74	00-6133	30-34	67.4	0.23	1.2	2.31	104	1.32	0.089	8.6	46	1.41	197.6	0.092	1
OB00-74	00-6134	34-38	67.4	0.24	1.2	2.05	101	1.36	0.084	8.6	47.7	1.39	192.2	0.089	1
OB00-74	00-6082	40-44	71.7	0.15	0.38	0.18	75	1.77	0.093	9.8	44.8	1.17	166.5	0.084	2
OB00-74	00-6135	42-46	63.2	0.28	1.34	1.75	103	1.36	0.086	8.6	50.8	1.42	183.7	0.09	1
OB00-74	00-6138	46-50	63.4	0.29	1.26	1.78	101	1.45	0.09	9.1	47.1	1.38	187.1	0.087	1
OB00-74	00-6136	50-54	62.4	0.3	1.2	1.49	96	1.43	0.09	9.2	42.7	1.34	189	0.084	<1
OB00-74	00-6140	54-58	69.6	0.28	1.41	1.65	104	1.48	0.092	9.4	44.5	1.54	200.3	0.108	<1
OB00-74	00-6142	58-62	71.8	0.29	1.41	1.96	106	1.42	0.088	9	51	1.46	179.8	0.089	<1
OB00-74	00-6143	62-66	72.6	0.3	1.61	1.91	99	1.5	0.085	9.5	49.8	1.39	169.3	0.081	1
OB00-74	00-6145	66-70	74.9	0.25	1.78	1.73	110	1.5	0.085	9	54.1	1.53	191.1	0.093	2
OB00-74	00-6144	70-74	67.2	0.28	1.7	1.67	102	1.48	0.09	10	50.8	1.42	188.8	0.085	<1
OB00-74	00-6147	74-78	64.8	0.29	1.45	1.43	96	1.52	0.088	9.7	46.3	1.36	175.5	0.081	<1
OB00-74	00-6146	78-82	64.3	0.26	1.47	1.38	95	1.43	0.089	10	47	1.4	194.9	0.08	<1
OB00-74	00-6148	82-86	57.5	0.37	1.36	1.25	89	1.54	0.087	9.9	40.2	1.25	166.6	0.077	<1
OB00-74	00-6149	86-89	65.5	0.33	1.34	1.6	99	1.49	0.087	8.6	48.2	1.35	170.6	0.078	<1
OB00-75	00-6017	24-28	73.7	0.18	1.12	0.9	86	1.72	0.085	8.7	42.9	1.29	164.7	0.07	2
OB00-75	00-6075	28-32	71.7	0.21	1.07	0.65	82	1.69	0.089	8.9	46.4	1.25	185.3	0.08	2
OB00-75	00-6078	32-36	70.2	0.19	1.19	0.61	80	1.66	0.092	9	46.1	1.2	175.4	0.078	3
OB00-75	00-6076	36-40	70.1	0.18	0.59	0.3	75	1.71	0.092	10.1	45.1	1.12	189.2	0.085	2

BOREHOLE	SAMPLE	DEPTH (ft)	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B
			ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm
			0.5	0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1
OB00-75	00-6083	44-46.5	67.4	0.14	0.37	0.17	78	1.79	0.097	9.3	49.6	1.19	154.6	0.089	2

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB98-06	00-6166	19-24	1.94	0.038	0.19	0.6	7.1	0.25	0.23	74	0.6	0.2	6
OB98-09	00-6129	24-28	2.26	0.041	0.2	<0.2	5.6	0.12	0.13	32	0.2	0.11	7.1
OB98-09	00-6127	32-36	2.41	0.051	0.32	1.3	6.6	0.28	0.33	48	0.6	0.3	7.2
OB98-09	00-6128	36-40	2.79	0.07	0.44	1.7	7	0.49	0.44	28	0.8	0.31	8.3
OB98-09	00-6130	44-48	2.51	0.056	0.34	1.5	6.5	0.34	0.31	43	0.7	0.29	7.5
OB98-09	00-6131	48-49	2.58	0.066	0.36	1.8	6.7	0.41	0.44	28	0.7	0.37	7.1
OB98-10	00-6034	16-20	2.4	0.053	0.31	0.6	7.8	0.2	0.19	45	0.4	0.16	7.3
OB98-10	00-6032	28-32	2.51	0.065	0.35	0.6	9	0.22	0.24	62	0.6	0.18	7.7
OB98-10	00-6026	32-36	2.25	0.045	0.2	0.3	6	0.14	0.12	44	0.2	0.13	6.6
OB98-10	00-6025	36-40	2.26	0.056	0.22	0.3	6.9	0.14	0.19	51	0.2	0.13	7
OB98-10	00-6024	40-44	2.22	0.051	0.21	0.3	6.4	0.12	0.14	47	0.2	0.15	6.8
OB98-10	00-6031	44-48	2.33	0.053	0.26	0.4	7.4	0.16	0.21	55	0.3	0.15	7.5
OB98-10	00-6030	48-52	2.36	0.059	0.28	0.3	8	0.18	0.17	43	0.3	0.15	7.5
OB98-10	00-6039	52-56	2.55	0.065	0.35	0.7	8.1	0.28	0.2	53	0.7	0.19	7.5
OB98-10	00-6037	56-60	2.65	0.076	0.36	0.9	8.4	0.34	0.23	50	0.5	0.26	8.1
OB98-10	00-6040	60-64	2.62	0.069	0.38	0.6	8.3	0.29	0.25	47	0.7	0.21	7.9
OB98-10	00-6042	64-68	2.49	0.063	0.33	0.7	8.4	0.22	0.23	49	0.7	0.22	7.5
OB98-10	00-6036	68-72	2.56	0.071	0.33	0.7	8.4	0.27	0.18	53	0.7	0.21	7.6
OB98-10	00-6028	76-82	2.8	0.084	0.45	0.9	9.9	0.4	0.32	60	0.7	0.22	8.8
OB98-10	00-6027	82-87	3.09	0.1	0.55	1.5	10.1	0.54	0.45	40	0.6	0.28	9.4
OB98-10	00-6035	87-92	2.66	0.076	0.41	1.1	8.5	0.34	0.27	50	0.6	0.34	8
OB98-10	00-6029	92-97	2.64	0.073	0.42	0.9	8.7	0.34	0.26	60	0.6	0.27	8.4
OB98-11	00-6012	24-28	2.2	0.043	0.19	<0.2	n/a	0.08	0.21	36	0.5	0.1	6.9
OB98-11	00-6112	36-40	2.23	0.04	0.22	0.2	5.6	0.11	0.17	32	0.4	0.12	7.1

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB98-12	00-6057	12-16	2.06	0.041	0.19	0.4	6.7	0.18	0.01	32	0.1	0.1	6.4
OB98-12	00-6058	16-20	2.19	0.043	0.2	0.2	6.9	0.13	0.06	36	0.2	0.11	6.9
OB98-12	00-6080	24-28	2.17	0.047	0.22	0.3	5.9	0.12	0.15	42	0.3	0.12	6.7
OB98-12	00-6059	28-32	2.22	0.049	0.23	0.3	6.5	0.1	0.15	26	0.3	0.14	6.8
OB98-12	00-6062	36-40	2.34	0.051	0.28	0.5	6.7	0.18	0.34	19	0.7	0.13	6.7
OB98-12	00-6064	40-43	2.35	0.05	0.28	0.5	7	0.17	0.3	23	0.7	0.12	6.9
OB98-13	00-6004	24-28	2.25	0.045	0.21	0.3	n/a	0.11	0.24	29	0.4	0.13	6.7
OB98-13	00-6005	24-28	2.24	0.046	0.2	<0.2	n/a	0.12	0.03	38	0.3	0.12	6.9
OB98-13	00-6192	28-32	2.39	0.045	0.24	0.3	6.1	0.12	0.17	38	0.4	0.13	7.6
OB98-14	00-6124	16-20	2.07	0.039	0.2	0.5	5.6	0.16	0.18	42	0.4	0.13	6.2
OB98-15	00-6123	14-16	2.4	0.058	0.19	0.3	6.3	0.18	0.04	30	0.1	0.1	7.1
OB98-16	00-6159	10-12	2.37	0.035	0.22	0.4	6.3	0.23	0.05	59	0.3	0.14	6.6
OB98-16	00-6158	12-13	2.26	0.044	0.23	0.3	5.6	0.11	0.19	47	0.4	0.11	6.5
OB98-17	00-6116	16-20	2.53	0.054	0.34	0.9	7.1	0.26	0.36	36	1	0.19	7.6
OB98-18	00-6117	16-20	2.41	0.051	0.3	0.8	7	0.22	0.22	47	0.6	0.15	7.1
OB98-20	00-6210	22-24	2.51	0.051	0.28	0.5	6.6	0.2	0.23	31	0.8	0.16	6.8
OB98-20	00-6209	28-32	2.63	0.056	0.34	0.7	7.1	0.25	0.23	42	0.9	0.21	7.2
OB98-20	00-6211	32-36	2.74	0.067	0.35	0.9	7.1	0.27	0.24	42	0.8	0.23	7.4
OB98-20	00-6212	36-40	2.71	0.065	0.37	0.9	7.4	0.31	0.31	49	1	0.3	7.8
OB98-20	00-6213	40-44	2.79	0.069	0.38	0.9	7.1	0.31	0.27	42	0.9	0.21	7.6
OB98-20	00-6215	44-48	2.74	0.068	0.38	0.9	7.2	0.31	0.31	41	1.1	0.32	7.8
OB98-20	00-6214	52-56	2.66	0.062	0.34	0.8	6.7	0.26	0.27	46	0.9	0.18	7.7
OB98-20	00-6216	56-60	2.36	0.047	0.24	0.3	5.9	0.14	0.18	58	0.5	0.12	6.7
OB98-21	00-6063	28-32	2.2	0.045	0.25	0.5	6.9	0.16	0.2	40	0.4	0.13	6.9

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB98-21	00-6066	32-36	2.25	0.048	0.26	0.4	6.5	0.17	0.16	40	0.4	0.14	6.8
OB98-21	00-6065	40-44	2.23	0.051	0.26	0.6	6.8	0.17	0.2	38	0.5	0.15	6.6
OB98-21	00-6067	44-48	2.3	0.054	0.28	0.5	6.8	0.18	0.2	42	0.5	0.14	7.1
OB98-21	00-6068	48-52	2.29	0.055	0.27	0.5	6.6	0.18	0.22	40	0.5	0.14	6.8
OB98-21	00-6069	52-56	2.3	0.05	0.27	0.4	7	0.16	0.18	46	0.5	0.16	6.9
OB98-21	00-6070	60-64	2.24	0.051	0.29	0.4	6.9	0.15	0.21	32	0.6	0.18	7
OB98-22	00-6125	16-20	2.16	0.041	0.21	0.3	5.6	0.12	0.17	42	0.3	0.14	6.8
OB98-23	00-6189	24-28	2.51	0.058	0.29	0.6	6.7	0.2	0.22	39	0.6	0.17	7.3
OB98-42	00-6003	16-20	2.2	0.042	0.16	<0.2	n/a	0.07	<0.01	17	0.1	0.08	6.2
OB99-11	00-6011	40-44	2.24	0.047	0.24	0.3	n/a	0.11	0.25	34	0.7	0.13	6.8
OB99-16	00-6173	16-20	2.3	0.043	0.2	0.3	6.2	0.1	0.13	70	0.2	0.12	6.7
OB99-25	00-6022	24-28	2.21	0.05	0.19	<0.2	n/a	0.08	0.2	32	0.4	0.11	6.6
OB99-26	00-6013	28-32	2.27	0.051	0.23	0.3	n/a	0.12	0.27	45	0.5	0.15	6.9
OB99-26	00-6023	50-54	2.35	0.052	0.28	0.3	n/a	0.13	0.32	31	0.9	0.15	6.7
OB99-36	00-6008	8-12	2.16	0.046	0.18	<0.2	n/a	0.04	0.14	13	0.3	0.05	6.1
OB99-36	00-6020	12-16	2.16	0.045	0.18	<0.2	n/a	0.04	0.15	20	0.2	0.07	5.7
OB99-36	00-6126	16-20	2.12	0.043	0.16	<0.2	5.3	0.04	0.12	22	<0.1	0.07	6
OB99-37	00-6006	8-12	2.11	0.043	0.17	<0.2	n/a	0.04	0.17	26	0.3	0.07	6.2
OB99-38	00-6120	6-12	2.31	0.038	0.17	<0.2	5.8	0.08	0.04	21	0.1	0.1	7.2
OB99-39	00-6179	3.5-8	2.21	0.04	0.17	<0.2	5.4	0.08	0.03	32	0.1	0.07	6.2
OB99-39	00-6180	8-12	2.23	0.037	0.19	<0.2	5.4	0.04	0.09	20	0.2	0.06	6.1
OB99-39	00-6182	12-16	2.22	0.044	0.15	<0.2	5.3	0.04	0.08	17	0.1	0.05	6.1
OB99-39	00-6183	16-20	2.14	0.04	0.16	<0.2	4.9	0.03	0.13	25	0.2	0.05	5.8
OB99-39	00-6185	20-24	2.14	0.041	0.16	<0.2	5	0.03	0.11	25	0.1	0.04	6

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB99-39	00-6184	24-27	2.18	0.04	0.17	<0.2	5.5	0.04	0.16	18	0.1	0.04	6.1
OB99-40	00-6118	8-12	2.1	0.036	0.16	0.2	5.8	0.06	0.12	18	0.4	0.05	6.2
OB99-41	00-6009	6-8	2.49	0.053	0.24	0.5	n/a	0.2	0.03	34	0.7	0.15	7.4
OB99-41	00-6047	8-12	2.49	0.056	0.36	0.9	10.2	0.27	0.04	26	0.4	0.16	8.2
OB99-42	00-6202	9-12	2.51	0.035	0.11	<0.2	6.7	0.07	0.02	21	0.1	0.08	7.1
OB99-42	00-6191	12-16	2.21	0.047	0.17	0.3	5.8	0.1	0.15	53	0.3	0.14	6.8
OB99-42	00-6203	12-16	2.49	0.037	0.17	<0.2	5.5	0.07	<0.01	16	<0.1	0.09	6.8
OB99-42	00-6205	20-24	2.46	0.035	0.18	<0.2	5.6	0.06	0.01	17	0.2	0.08	6.9
OB99-42	00-6204	24-28	2.41	0.036	0.17	<0.2	5.4	0.06	<0.01	18	0.1	0.07	6.6
OB99-42	00-6206	28-32	2.28	0.037	0.16	<0.2	5	0.04	0.01	18	0.1	0.09	6.4
OB99-42	00-6208	32-37	2.16	0.035	0.14	<0.2	4.7	0.04	0.02	17	0.3	0.05	5.9
OB99-45	00-6167	12-16	2.31	0.036	0.19	0.3	6.5	0.1	0.13	91	0.2	0.15	6.6
OB99-46	00-6168	9-12	2.34	0.041	0.2	0.3	5.8	0.1	0.11	65	0.2	0.16	6.8
OB99-46	00-6176	12-16	2.38	0.042	0.19	0.3	6.5	0.1	0.12	68	0.2	0.13	6.7
OB99-46	00-6171	20-24	2.39	0.047	0.2	0.2	6.3	0.1	0.11	65	0.2	0.09	6.7
OB99-46	00-6178	44-48	2.2	0.037	0.17	0.3	5.9	0.09	0.12	119	0.2	0.13	6.3
OB99-46	00-6177	48-52	2.2	0.036	0.18	0.5	6.2	0.09	0.14	119	0.2	0.12	6.3
OB99-46	00-6187	52-56	2.16	0.041	0.19	0.3	6	0.07	0.1	66	0.2	0.11	6.4
OB99-46	00-6174	55-60	2.17	0.042	0.16	<0.2	5.1	0.04	0.07	23	0.2	0.06	5.7
OB99-48	00-6049	12-16	2.17	0.041	0.16	<0.2	7	0.07	0.12	67	0.1	0.14	6.4
OB99-49	00-6113	4-8	2.33	0.041	0.17	0.6	7.1	0.14	0.04	111	0.3	0.19	7.3
OB99-51	00-6048	20-24	2.12	0.039	0.16	<0.2	6.4	0.06	0.08	75	0.2	0.11	5.9
OB99-51	00-6050	24-28	2.12	0.046	0.16	<0.2	5.5	0.05	0.09	25	0.2	0.1	5.9
OB99-51	00-6052	28-32	2.09	0.045	0.18	<0.2	5.7	0.04	0.11	24	0.1	0.1	6.2

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB99-51	00-6051	32-36	2.09	0.049	0.15	<0.2	5.5	0.04	0.1	21	0.2	0.06	5.7
OB99-51	00-6053	36-40	2.21	0.054	0.18	<0.2	5.2	0.04	0.09	19	0.1	0.07	6.1
OB99-51	00-6056	40-44	2.09	0.046	0.12	<0.2	5.4	0.03	0.11	13	0.2	0.05	6
OB99-51	00-6054	44-49	2.03	0.047	0.13	<0.2	5.6	0.03	0.11	16	0.1	0.04	5.8
OB99-52	00-6045	8-12	2.23	0.036	0.18	0.7	7	0.08	0.1	85	0.2	0.13	6.7
OB99-53	00-6044	8-12	2.09	0.038	0.12	<0.2	5.1	0.03	<0.01	17	<0.1	0.04	5.8
OB99-54	00-6090	4-8	2.66	0.066	0.21	0.3	8.9	0.21	<0.01	98	0.1	0.29	7.9
OB99-54	00-6091	8-12	2.36	0.046	0.19	0.3	6.9	0.1	0.03	74	0.1	0.2	7.2
OB99-54	00-6092	32-36	2.16	0.053	0.17	<0.2	5.5	0.05	0.1	32	0.2	0.08	6.3
OB99-54	00-6096	36-40	2.1	0.057	0.18	<0.2	5.3	0.04	0.11	20	0.1	0.05	6.5
OB99-54	00-6093	40-44	2.15	0.066	0.2	<0.2	4.9	0.05	0.1	20	0.1	0.05	6.5
OB99-54	00-6094	44-48	2.15	0.061	0.19	<0.2	5.2	0.04	0.07	19	0.1	0.07	6.1
OB99-54	00-6097	48-52	2.11	0.057	0.2	<0.2	5	0.05	0.1	21	0.2	0.06	6.1
OB99-54	00-6100	52-56	2.03	0.053	0.21	<0.2	4.8	0.05	0.13	22	0.2	0.06	6.2
OB99-54	00-6099	56-60	1.98	0.052	0.21	<0.2	5	0.05	0.14	19	0.2	0.08	6.1
OB99-54	00-6107	60-64	1.99	0.051	0.2	<0.2	4.5	0.05	0.14	13	0.2	0.06	5.8
OB99-54	00-6098	64-68	1.99	0.051	0.21	<0.2	5	0.04	0.13	17	0.2	0.07	5.9
OB99-54	00-6102	68-72	1.97	0.054	0.19	<0.2	5	0.04	0.11	20	0.1	0.05	5.8
OB99-54	00-6105	72-76	2.09	0.06	0.16	<0.2	5.1	0.04	0.11	16	0.2	0.04	6.2
OB99-54	00-6108	76-80	2.02	0.061	0.15	<0.2	5.3	0.03	0.12	16	0.1	0.04	6.2
OB99-54	00-6103	80-84	2.02	0.062	0.15	<0.2	5.2	0.03	0.12	26	0.1	0.06	6.1
OB99-54	00-6104	84-88	1.86	0.059	0.13	<0.2	5	0.03	0.05	14	0.1	0.04	5.5
OB99-54	00-6109	88-92	1.83	0.058	0.12	<0.2	4.6	0.03	0.07	13	0.1	0.05	5.1
OB99-55	00-6043	8-12	2.36	0.055	0.18	0.3	6.8	0.1	0.14	59	0.2	0.24	7.1

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB99-56	00-6085	8-12	2.05	0.047	0.17	<0.2	5.6	0.04	0.09	18	0.2	0.05	5.8
OB99-56	00-6086	12-16	2.11	0.047	0.2	<0.2	5.4	0.04	0.11	19	0.2	0.08	6.2
OB99-56	00-6087	16-20	2.06	0.046	0.22	<0.2	5.5	0.05	0.13	21	0.2	0.07	6
OB99-56	00-6089	20-24	2.08	0.05	0.17	<0.2	5.7	0.03	0.13	21	0.1	0.05	6.3
OB99-56	00-6088	24-28	2.09	0.051	0.17	<0.2	5.9	0.04	0.1	22	0.2	0.09	5.9
OB99-56	00-6169	28-32	2.1	0.05	0.17	<0.2	5.3	0.04	0.11	20	0.2	0.07	5.8
OB99-56	00-6172	32-36	1.78	0.053	0.12	<0.2	4.3	0.03	0.05	10	<0.1	0.02	4.7
OB99-56	00-6175	40-44	1.45	0.044	0.09	<0.2	3.5	0.02	0.04	7	0.2	0.03	3.7
OB99-57	00-6115	12-16	2.12	0.041	0.16	0.3	5.5	0.07	0.14	38	0.2	0.11	6.3
OB99-58	00-6015	8-12	2.36	0.041	0.17	<0.2	n/a	0.09	0.25	79	0.6	0.19	7.2
OB99-58	00-6217	12-16	2.35	0.045	0.17	<0.2	5.4	0.1	0.14	36	0.5	0.15	6.2
OB99-58	00-6218	16-20	2.3	0.047	0.19	<0.2	5.9	0.1	0.17	46	0.4	0.16	6.4
OB99-58	00-6219	20-24	2.39	0.047	0.19	<0.2	6.4	0.1	0.17	70	0.3	0.19	6.9
OB99-58	00-6220	24-28	2.33	0.044	0.19	<0.2	6.6	0.1	0.19	52	0.3	0.11	6.6
OB99-58	00-6222	28-32	2.34	0.043	0.16	<0.2	6.3	0.09	0.18	51	0.2	0.13	7.2
OB99-58	00-6223	32-36	2.15	0.042	0.16	<0.2	5.2	0.07	0.11	46	0.2	0.13	6.2
OB99-58	00-6224	40-44	2.13	0.046	0.19	<0.2	5.2	0.05	0.12	23	0.1	0.1	6.6
OB99-58	00-6225	44-48	2.11	0.045	0.17	<0.2	5.4	0.06	0.12	42	0.2	0.12	6.4
OB99-58	00-6226	48-52	2.1	0.048	0.2	<0.2	4.6	0.04	0.08	20	0.1	0.06	5.9
OB99-58	00-6227	52-56	2.16	0.05	0.17	<0.2	4.4	0.04	0.1	20	0.2	0.05	6.3
OB99-59	00-6193	8-12	2.19	0.044	0.18	0.3	5.8	0.06	0.13	27	0.3	0.12	6.6
OB99-63	00-6110	16-20	2.29	0.044	0.28	0.4	6.6	0.14	0.29	30	0.5	0.14	7.3
OB00-63	00-6014	12-16	2.26	0.044	0.23	0.3	n/a	0.11	0.33	33	0.6	0.13	6.8
OB00-63	00-6194	16-20	2.45	0.048	0.29	0.3	6.6	0.15	0.25	38	0.5	0.14	7.6

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB00-63	00-6195	20-23	2.38	0.045	0.24	0.4	6.3	0.13	0.23	30	0.6	0.13	7.1
OB00-64	00-6114	16-20	2.52	0.056	0.18	0.3	6.9	0.19	0.02	41	0.1	0.1	8.4
OB00-65	00-6016	20-24	2.16	0.038	0.19	<0.2	n/a	0.07	0.23	38	0.5	0.12	6.5
OB00-65	00-6160	24-28	2.14	0.038	0.21	0.3	5.2	0.09	0.16	48	0.3	0.14	6.2
OB00-65	00-6196	28-32	2.22	0.041	0.2	0.3	5.4	0.1	0.19	36	0.3	0.08	6.9
OB00-65	00-6164	32-36	2.16	0.038	0.2	0.3	5.3	0.08	0.15	43	0.3	0.09	6.3
OB00-65	00-6165	36-40	2.15	0.039	0.2	0.3	5.3	0.09	0.16	40	0.3	0.11	6.3
OB00-65	00-6162	40-44	2.17	0.037	0.21	0.2	5.3	0.08	0.16	39	0.3	0.11	6.1
OB00-66	00-6019	12-16	2.18	0.035	0.19	<0.2	n/a	0.08	0.22	44	0.4	0.11	6.3
OB00-66	00-6190	18-22	2.35	0.039	0.21	0.2	6	0.1	0.09	34	0.3	0.15	7.4
OB00-68	00-6186	4-8	2.17	0.039	0.17	<0.2	5.7	0.14	0.01	39	0.2	0.08	6.4
OB00-70	00-6122	4-6	2.12	0.041	0.18	<0.2	5.6	0.09	0.14	34	0.3	0.1	6.9
OB00-70	00-6198	6-11	2.35	0.046	0.2	<0.2	6.1	0.1	0.12	31	0.2	0.12	7.3
OB00-70	00-6199	11-16	2.49	0.049	0.24	<0.2	6	0.13	0.12	35	0.3	0.1	7.8
OB00-70	00-6200	16-20	2.39	0.045	0.21	0.2	5.7	0.09	0.14	26	0.3	0.32	7.6
OB00-71	00-6150	7-10	2.47	0.052	0.27	0.6	7	0.2	0.29	34	0.5	0.13	7.2
OB00-71	00-6151	10-15	2.66	0.057	0.37	0.8	7.9	0.24	0.32	29	0.7	0.15	7.7
OB00-71	00-6152	15-17	2.42	0.054	0.27	0.6	6.2	0.17	0.31	30	0.5	0.13	7.4
OB00-71	00-6153	17-21	2.48	0.063	0.35	1	7.4	0.22	0.37	33	0.7	0.19	7.2
OB00-71	00-6157	24-31	2.51	0.067	0.29	0.8	6.1	0.18	0.37	29	0.6	0.13	6.7
OB00-71	00-6156	31-36	2.41	0.054	0.29	0.6	5.7	0.14	0.34	31	0.6	0.12	6.2
OB00-73	00-6002	12-16	2.16	0.049	0.23	0.4	n/a	0.12	0.34	37	0.6	0.13	6.4
OB00-73	00-6111	19.5-22	2.21	0.049	0.23	0.4	5.7	0.12	0.24	31	0.4	0.14	6.6
OB00-74	00-6018	10-14	2.27	0.042	0.24	0.4	n/a	0.11	0.32	43	0.7	0.16	6.6

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB00-74	00-6072	14-18	2.28	0.043	0.3	0.9	6.7	0.19	0.21	43	1.1	0.19	6.9
OB00-74	00-6071	18-22	2.33	0.047	0.36	0.8	7.3	0.2	0.23	34	1.1	0.19	7.2
OB00-74	00-6074	20-24	2.23	0.046	0.23	0.4	7.1	0.13	0.03	32	0.5	0.11	6.6
OB00-74	00-6073	22-26	2.43	0.054	0.42	0.8	7.6	0.24	0.27	27	1.2	0.21	7.4
OB00-74	00-6132	26-30	2.5	0.053	0.38	1	7.1	0.23	0.29	29	1.3	0.21	7.3
OB00-74	00-6133	30-34	2.53	0.051	0.4	0.9	7	0.22	0.33	30	1.3	0.22	7.6
OB00-74	00-6134	34-38	2.51	0.055	0.38	0.8	7.1	0.23	0.3	24	1	0.18	7.3
OB00-74	00-6082	40-44	1.99	0.045	0.18	<0.2	5.5	0.04	0.09	17	0.1	0.06	6
OB00-74	00-6135	42-46	2.55	0.057	0.36	0.7	6.6	0.23	0.26	29	0.9	0.16	7.4
OB00-74	00-6138	46-50	2.46	0.053	0.34	0.5	6.9	0.18	0.31	29	0.8	0.17	7.2
OB00-74	00-6136	50-54	2.44	0.053	0.32	0.6	7	0.18	0.25	33	0.8	0.15	7.4
OB00-74	00-6140	54-58	2.84	0.061	0.36	0.8	7.5	0.23	0.29	26	0.9	0.16	7.8
OB00-74	00-6142	58-62	2.57	0.059	0.36	0.8	7.4	0.24	0.28	30	1	0.19	7.3
OB00-74	00-6143	62-66	2.54	0.059	0.34	0.6	7.7	0.22	0.25	37	0.7	0.16	7.6
OB00-74	00-6145	66-70	2.7	0.063	0.38	0.7	8	0.25	0.28	30	0.8	0.15	7.5
OB00-74	00-6144	70-74	2.54	0.057	0.34	0.7	7.1	0.22	0.27	34	0.6	0.18	7.6
OB00-74	00-6147	74-78	2.47	0.056	0.31	0.6	6.9	0.17	0.24	34	0.6	0.14	7.1
OB00-74	00-6146	78-82	2.49	0.053	0.3	0.6	6.6	0.21	0.23	33	0.5	0.16	7.4
OB00-74	00-6148	82-86	2.33	0.051	0.26	0.4	6.3	0.15	0.25	33	0.5	0.1	7.2
OB00-74	00-6149	86-89	2.5	0.056	0.27	0.6	7.1	0.18	0.34	25	0.6	0.23	7.2
OB00-75	00-6017	24-28	2.26	0.046	0.21	0.3	n/a	0.08	0.2	28	0.4	0.15	6.5
OB00-75	00-6075	28-32	2.22	0.046	0.24	0.3	6.6	0.1	0.1	25	0.3	0.1	6.4
OB00-75	00-6078	32-36	2.13	0.043	0.22	0.3	6.1	0.09	0.12	26	0.2	0.12	6.2
OB00-75	00-6076	36-40	1.97	0.043	0.21	<0.2	5.5	0.05	0.09	22	0.2	0.06	6

BOREHOLE	SAMPLE	DEPTH (ft)	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te	Ga
			%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm	ppm
			0.01	0.001	0.01	0.2	n/a	0.02	0.02	5	0.1	0.02	0.02
OB00-75	00-6083	44-46.5	2.03	0.042	0.17	<0.2	5.7	0.04	0.09	22	0.1	0.06	5.7

APPENDIX D

ICP-MS ANALYITICAL SEQENTIAL LEACH DATA

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5	Cd ppm 0.01
00-6018	SLM	16	248.81	4188	27.3	15	6.11	3829	427	4445	2200	62	0.3	<20	27.25	248
00-6018	AD AFTER SLM	23.16	649.68	12.89	79	398	25.1	12.9	517	3.29	34.4	0.5	7.8	2.8	28.4	0.05
00-6018	AD	20.84	918.91	15.33	107.3	410	28.4	17.2	923	3.63	32.6	0.5	5.8	2.3	56.2	0.25
00-6149	SLM	20	197.35	3613	26.9	43	5.24	4289	347	3781	2927	48	<0.2	<20	29.56	219
00-6149	AD AFTER SLM	15.15	345.66	12.7	69.7	335	24.7	14	491	3.44	38	0.3	9.7	1.9	40.3	0.05
00-6149	AD	16.83	584.65	15.98	101.6	380	29.1	18.7	857	3.91	35	0.4	16.6	1.7	70.4	0.28
00-6620	SLM	78	608.56	4304	13.9	90	4.64	9282	341	9015	303	122	<0.2	<20	22.69	108
00-6620	AD AFTER SLM	28.35	717.95	8.25	50.3	22	21.5	9.3	353	3.63	14.7	0.4	9.4	2	23.1	0.05
00-6620	AD	27.65	1493.77	12	63.1	77	26.5	22.1	711	4.61	13.1	0.6	11.5	1.8	45.8	0.15
00-6631	SLM	5334	5754.54	6512	36.2	188	4.22	80178	646	17773	3795	100	<0.2	<20	9.41	193
00-6631	AD AFTER SLM	235.51	2990.53	14.77	84.1	56	24.2	17.6	443	4.08	29.8	0.6	2.6	1.9	22.7	0.02
00-6631	AD	234.91	10564.23	23.13	130.2	227	29.5	111.8	1167	6.11	32.2	0.8	4	1.7	36	0.25
00-6646	SLM	23	115.38	5419	2.5	216	0.61	3570	224	2478	2893	145	<0.2	34	4.03	78
00-6646	AD AFTER SLM	3.99	1106.8	9.59	65.7	96	17.1	11.6	349	3.89	43.1	0.2	28.2	1.6	11.9	0.14
00-6646	AD	4.09	1124.35	15.46	63	246	16.5	14.6	592	4.4	37.5	0.4	19.9	1.5	17.5	0.17
00-6651	SLM	52	272.95	494	2.5	92	0.12	544	202	245	498	<5	<0.2	<20	46.05	142
00-6651	AD AFTER SLM	62.78	3489.76	16.44	60.4	1369	17.8	13.4	376	2.47	12.4	0.9	138.7	6.2	38.8	0.06
00-6651	AD	61.63	3731.5	17.2	63.3	1490	17.5	12.7	601	2.65	11.1	0.9	81.8	5.7	88.9	0.22
00-6666	SLM	19	53.72	3882	27.7	327	5.76	11824	584	5416	523	59	0.2	<20	16.74	259
00-6666	AD AFTER SLM	4.63	269.24	14.5	82.2	70	22.9	10.4	349	4.08	25.5	0.2	6.7	1.6	33	0.12
00-6666	AD	4.55	308.01	18.35	105.9	305	28	23.9	1003	4.87	22.9	0.3	5.3	1.5	50.3	0.37
00-6668	SLM	22	207.94	2525	7.4	270	2.14	8986	291	4586	320	127	<0.2	<20	24.23	61
00-6668	AD AFTER SLM	7.31	855.4	7.36	43.5	86	24.3	13.3	360	3.66	7.6	0.3	12.1	1.3	21.9	0.04
00-6668	AD	7.84	1066.92	10.2	52.2	283	26.4	24.1	702	4.57	7.1	0.5	21	1.4	48.2	0.11
00-6699	SLM	42	110.53	5563	22.8	157	6.45	10641	546	5178	893	56	<0.2	<20	25.22	128
00-6699	AD AFTER SLM	8.63	263.93	18.81	68.6	32	26	10.6	351	3.78	36.2	0.3	5.4	1.5	44.2	0.08
00-6699	AD	8.22	351.82	23.03	88	168	31.7	21.7	968	4.53	30	0.4	2.4	1.4	64.9	0.2

SLM - hydroxylamine leach.

AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

SAMPLE	TYPE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5	Cd ppm 0.01
00-6703	SLM	40	226.96	2363	23.5	76	5.41	4383	362	3557	3853	60	<0.2	<20	25.74	218
00-6703	AD AFTER SLM	17.61	356.81	15.62	73.7	325	31.5	13.8	487	3.44	41.8	0.3	8.6	1.8	55.4	0.03
00-6703	AD	15.64	587.98	15.88	94.5	387	33.6	16.4	861	3.86	38.7	0.4	5.4	1.6	74.1	0.28
00-6711	SLM	44	44.32	3638	5.3	52	1.23	5520	247	2711	647	116	<0.2	<20	8.6	43
00-6711	AD AFTER SLM	7.39	387.52	6.07	51.1	23	19.7	8.8	349	2.85	12.7	0.3	10	1.7	15	0.05
00-6711	AD	6.73	403.45	9.66	55.2	49	19.3	14.2	614	3.24	11.1	0.4	6	1.6	25.2	0.08

SLM - hydroxylamine leach.

AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

		Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W
		ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm
		0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2
SAMPLE	**TYPE**															
00-6018	SLM	22	<5	10.4	10736	404	3212	NODATA	1486	92.85	4	NODATA	1386	NODATA	270	<10
00-6018	AD AFTER SLM	1.75	1.65	73	0.26	0.05	6.9	39.5	1.11	93.7	0.055	1	1.87	0.029	0.2	0.5
00-6018	AD	1.37	1.54	81	1.28	0.089	10.1	39.9	1.12	170.1	0.054	1	1.93	0.035	0.2	0.5
00-6149	SLM	20	6	10.83	10933	363	2462	NODATA	1497	84	4	NODATA	1479	NODATA	318	<10
00-6149	AD AFTER SLM	1.51	1.58	84	0.31	0.046	5.4	47	1.22	93	0.058	1	2.06	0.038	0.22	0.6
00-6149	AD	1.41	1.61	96	1.41	0.088	8.4	48	1.28	168.2	0.061	1	2.18	0.052	0.23	0.7
00-6620	SLM	16	5	27.93	3690	190	3700	NODATA	2064	90.32	3	NODATA	2164	NODATA	126	14
00-6620	AD AFTER SLM	1.29	0.95	82	0.16	0.063	7.6	39	1.01	76.2	0.077	1	1.9	0.015	0.16	0.4
00-6620	AD	1.16	0.97	109	0.52	0.078	12.7	44.2	1.16	164.1	0.083	<1	2.19	0.024	0.16	0.3
00-6631	SLM	484	5	31.29	3362	485	5983	NODATA	319	40.09	3	NODATA	1341	NODATA	139	28
00-6631	AD AFTER SLM	7.28	1.17	107	0.15	0.088	51.4	44.3	1.3	74.3	0.107	1	2.53	0.013	0.22	0.6
00-6631	AD	7.58	1.26	139	0.5	0.135	56.2	47.5	1.28	106.7	0.104	<1	2.79	0.019	0.23	0.8
00-6646	SLM	201	44	8.4	448	171	2890	NODATA	101	63.59	10	NODATA	2805	NODATA	57	14
00-6646	AD AFTER SLM	12.48	1.57	124	0.09	0.049	7.3	29.5	1.01	83.2	0.136	1	1.78	0.009	0.2	0.5
00-6646	AD	12.5	1.4	130	0.15	0.065	10.6	28.7	0.9	153.9	0.14	<1	2.08	0.014	0.19	0.5
00-6651	SLM	51	<5	1.83	21735	21	926	NODATA	445	22.82	<1	NODATA	22	NODATA	412	<10
00-6651	AD AFTER SLM	4.69	3.79	75	0.62	0.077	18	27.2	1.29	275.4	0.069	1	1.66	0.016	0.3	0.3
00-6651	AD	4.44	4	77	2.74	0.084	18.2	29.2	1.22	293.7	0.066	1	1.68	0.023	0.34	0.1
00-6666	SLM	<5	<5	18.08	3698	185	2273	NODATA	2139	74.44	2	NODATA	2267	NODATA	128	<10
00-6666	AD AFTER SLM	0.87	1.12	99	0.33	0.069	6.2	44.8	0.93	66.7	0.078	1	2.03	0.069	0.17	0.4
00-6666	AD	0.84	1.07	112	0.77	0.082	8.4	49.9	1.08	153.5	0.089	2	2.28	0.079	0.18	0.3
00-6668	SLM	5	6	26.09	2654	214	3795	NODATA	1921	78.16	4	NODATA	2426	NODATA	123	<10
00-6668	AD AFTER SLM	0.75	1.04	129	0.16	0.073	7.2	56.5	1.24	67.3	0.117	1	2.46	0.022	0.18	0.8
00-6668	AD	0.8	1.36	159	0.49	0.093	12	66.9	1.41	171.1	0.127	1	2.91	0.03	0.19	0.9
00-6699	SLM	7	<5	21.82	3721	218	1972	NODATA	2306	78.16	2	NODATA	2252	NODATA	170	<10
00-6699	AD AFTER SLM	1.51	1.07	107	0.33	0.058	6.1	50.7	1.03	70.9	0.079	1	2.21	0.06	0.21	0.9
00-6699	AD	1.44	0.97	125	0.76	0.079	8.1	50.7	1.19	161.1	0.089	1	2.45	0.066	0.22	0.9

SLM - hydroxylamine leach.

AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

		Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W
		ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm
		0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2
SAMPLE	**TYPE**															
00-6703	SLM	21	<5	11.99	8956	359	2144	NODATA	1478	17.11	3	NODATA	1458	NODATA	424	<10
00-6703	AD AFTER SLM	2.14	2.22	98	0.3	0.043	6.4	60.2	1.38	155.5	0.068	1	2.12	0.046	0.27	0.6
00-6703	AD	1.77	2.11	105	1.29	0.079	7.9	62.8	1.37	162	0.071	1	2.2	0.049	0.29	0.7
00-6711	SLM	7	11	9.97	1150	215	3190	NODATA	418	59.25	4	NODATA	2351	NODATA	164	<10
00-6711	AD AFTER SLM	0.8	0.64	76	0.13	0.043	6.7	37.5	0.83	38	0.074	<1	1.73	0.009	0.09	0.2
00-6711	AD	0.71	0.57	85	0.28	0.061	9.9	36.7	0.8	105.3	0.081	1	1.95	0.013	0.1	0.2

SLM - hydroxylamine leach.

AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

SAMPLE	TYPE	Tl ppm	Hg ppb	Se ppm	Te ppm	Ga ppm
		0.02	33	0.2	0.08	5
00-6018	SLM	6	<5	<0.2	52	29
00-6018	AD AFTER SLM	0.13	76	<0.1	0.1	6.8
00-6018	AD	0.11	75	0.4	0.15	6.4
00-6149	SLM	10	<5	<0.2	89	27
00-6149	AD AFTER SLM	0.17	32	0.2	0.1	6.8
00-6149	AD	0.16	37	0.2	0.15	6.9
00-6620	SLM	30	<5	0.3	<20	50
00-6620	AD AFTER SLM	0.14	19	0.5	0.11	7.3
00-6620	AD	0.15	23	<0.1	0.09	7.1
00-6631	SLM	103	<5	0.7	22	37
00-6631	AD AFTER SLM	0.35	19	0.3	0.12	8.1
00-6631	AD	0.44	31	0.2	0.12	8.8
00-6646	SLM	29	<5	<0.2	<20	283
00-6646	AD AFTER SLM	0.16	27	0.4	0.15	7.5
00-6646	AD	0.17	27	<0.1	0.15	7.3
00-6651	SLM	6	<5	0.3	32	<20
00-6651	AD AFTER SLM	0.15	46	1.4	0.26	7.2
00-6651	AD	0.15	43	1.6	0.25	7.3
00-6666	SLM	14	<5	<0.2	<20	59
00-6666	AD AFTER SLM	0.24	26	<0.1	0.21	8.3
00-6666	AD	0.22	24	<0.1	0.2	7.9
00-6668	SLM	41	<5	<0.2	<20	97
00-6668	AD AFTER SLM	0.27	14	<0.1	0.09	9.5
00-6668	AD	0.31	16	<0.1	0.12	9.4
00-6699	SLM	38	<5	0.2	<20	47
00-6699	AD AFTER SLM	0.33	26	<0.1	0.16	8.9
00-6699	AD	0.3	27	<0.1	0.13	8

SLM - hydroxylamine leach.

AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

SAMPLE	TYPE	Tl ppm	Hg ppb	Se ppm	Te ppm	Ga ppm
		0.02	33	0.2	0.08	5
00-6703	SLM	14	<5	<0.2	69	30
00-6703	AD AFTER SLM	0.28	54	<0.1	0.13	7.6
00-6703	AD	0.25	43	0.2	0.15	7
00-6711	SLM	19	<5	0.2	<20	191
00-6711	AD AFTER SLM	0.11	20	<0.1	0.07	6.4
00-6711	AD	0.11	15	<0.1	0.07	5.9

SLM - hydroxylamine leach.
AD - 1g sample is leached with 6ml of hydrocholoric acid, nitric acid, and distilled, deionized water (2:2:2 v/v) at 95°C for one hour and then diluted to 20ml.

APPENDIX E

ICP-MS ANALYTICAL DATA FOR VERY COARSE SAND, COARSE SAND, MEDIUM SAND, FINE SAND, AND VERY FIND SAND SIZE FRACTIONS

SAMPLE	MESH SIZE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5
00-6620	-10+18	18.55	921.9	8.33	58.1	138	22.4	18.2	630	3.49	9	0.5	3.5	1.9	43.2
00-6620	-18+35	19.79	956.19	9.14	58.3	186	23.2	19.9	704	3.52	9.1	0.4	34.6	1.9	48.3
00-6620	-35+60	21.25	1016.68	10.12	60.7	188	23.3	23.7	765	3.65	9.7	0.4	7	1.7	43.5
00-6620	-60+120	26.28	1279.11	15.18	58.2	126	22.4	21.6	656	4.22	12.8	0.5	10.4	1.8	42.8
00-6620	-120+230	24.22	1156.16	13.88	61.9	166	23.3	24.8	760	3.83	10.8	0.5	9.3	1.7	41.9
00-6626	-10+18	1.45	145.52	12.15	75.3	52	17.7	14.6	643	3.09	25.9	0.5	1.6	2.2	17.2
00-6626	-18+35	1.82	163.15	13.78	78.3	60	17.3	16.7	732	3.16	28.1	0.5	5	2.1	18.3
00-6626	-35+60	2.16	171.17	14.87	81.2	66	19.5	20.1	815	3.15	30.2	0.5	1.6	2	18.3
00-6626	-60+120	1.94	202.72	21.11	79.8	58	23.5	32.4	1103	3.49	43.3	0.6	4	2.3	14.8
00-6626	-120+230	1.69	182.13	18.32	80.8	41	21.8	26.8	955	3.18	34.1	0.6	2.8	2.1	15.4
00-6627	-10+18	1.85	93.53	15.28	88.5	12	21.1	15.2	856	3.48	31.7	0.4	3.1	2.1	40.8
00-6627	-18+35	2.15	100.24	16.29	87.7	21	22.4	15.4	893	3.5	32.8	0.4	3.6	2.1	43.4
00-6627	-35+60	1.61	99.84	16.7	87.9	23	21.4	14.7	830	3.31	31.8	0.4	3.5	1.8	37.8
00-6627	-60+120	1.73	122.44	19.75	88.6	23	23.1	15.4	789	3.5	37.2	0.4	3.3	2	40.9
00-6627	-120+230	1.61	107.47	19.02	87.6	19	22.3	15.3	794	3.34	34.2	0.4	5.1	1.9	39
00-6631	-10+18	76.42	3815.09	10.16	107.6	178	24.1	58.6	831	3.73	15.6	0.5	2.3	1.9	35.5
00-6631	-18+35	74.68	3960.99	10.97	106	182	23.6	70.2	949	3.66	15.6	0.4	2.8	1.8	34.8
00-6631	-35+60	82.05	4050.98	12.19	108.3	159	24.1	98.1	1096	3.59	16.3	0.6	3	1.7	32.2
00-6631	-60+120	160.42	5733.27	23.21	106.9	181	22.7	149.4	1353	4.44	22.6	0.6	2.8	1.7	29.4
00-6631	-120+230	98.09	4586.17	18.14	109	136	23.5	143.4	1351	3.7	17.3	0.5	3.5	1.7	29.5
00-6637	-10+18	3.12	310.76	14.6	78.1	95	20.7	17.8	625	3.34	19.1	0.7	2.5	2.3	22
00-6637	-18+35	3.12	316.66	14.69	81.6	103	21.8	16.6	598	3.37	19.4	0.7	2.3	2.2	21.6
00-6637	-35+60	3.03	325.94	15.33	84	142	21	16.6	571	3.43	19.8	0.8	3.1	2.1	20.2
00-6637	-60+120	4.87	372.64	17.23	76	391	22.2	16.2	497	3.87	27.9	1	3.1	2	17.9

SAMPLE	MESH SIZE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5
00-6637	-120+230	3.55	310.71	16.56	79.3	250	20.2	16.5	525	3.46	21.7	0.9	3.1	2.1	19
00-6638	-10+18	4.77	1755.25	11.14	90.2	89	23.4	96.3	1249	4.02	20.6	0.3	2.1	1.4	32.5
00-6638	-18+35	5.89	2131.63	14.65	97.1	133	26.3	147.2	1779	4.23	23.8	0.4	2.6	1.6	34.9
00-6638	-35+60	6	2249.39	15.4	100	136	26.4	147.5	1567	4.23	26.1	0.4	8.7	1.4	34.5
00-6638	-60+120	5.82	2742.58	15.88	100.6	90	26.4	81.7	903	4.7	33.9	0.4	5.8	1.4	30.6
00-6638	-120+230	5.52	2425.33	16.23	101.5	92	26.6	129.5	1302	4.24	28	0.4	2.8	1.5	29.6
00-6645	-10+18	9.01	577.81	10.76	70.6	241	24.8	15.2	582	3.52	24.1	0.4	5.6	1.5	48.9
00-6645	-18+35	9.77	600.49	11.62	70.3	254	25.8	16	609	3.56	25.7	0.4	11.1	1.6	52
00-6645	-35+60	9.46	615.05	12.18	71.4	188	23.2	17.9	647	3.49	26.4	0.4	7.9	1.4	44.8
00-6645	-60+120	12.87	767.73	16.22	69.4	73	23.7	22	689	3.87	34	0.5	5.9	1.4	43
00-6645	-120+230	10.41	642.69	13.52	67.7	123	24.5	22.1	711	3.42	27.3	0.4	4.5	1.4	41.4
00-6647	-10+18	8.88	335.29	12.02	81.8	230	25.4	17.3	688	3.6	31.6	0.4	7.3	1.7	60.8
00-6647	-18+35	8.7	360.46	12.51	81.2	232	27.2	20.6	701	3.66	29.9	0.4	5.3	1.8	62.8
00-6647	-35+60	11.45	386.17	13.04	80.9	259	27.9	21.4	704	3.71	30.8	0.4	16.8	1.7	60.9
00-6647	-60+120	11.55	497.68	14.94	80.8	1124	27.7	22.4	798	3.69	36.3	0.4	5479.6	1.8	54.4
00-6647	-120+230	11.73	427.11	15.46	78.8	252	26.7	23.4	752	3.57	29.8	0.4	4.8	1.6	52.3
00-6651	-10+18	50.59	2249.8	10.28	46.9	938	13.1	9.4	404	2.15	8.3	0.7	55.2	4.2	57.5
00-6651	-18+35	47.34	2390.49	11.97	49	926	13.4	9.4	418	2.17	8.1	0.6	41.1	4.2	63.3
00-6651	-35+60	51.71	2694.77	11.87	51.3	1092	13.9	10.2	436	2.33	9.1	0.7	50.3	4.1	65.1
00-6651	-60+120	73.59	3155.44	12.81	52.8	1300	14.8	11.4	475	2.42	10	0.7	60.5	4.5	68.7
00-6651	-120+230	54.71	3247.37	12.88	60.3	1362	13.9	10.9	448	2.34	7.8	0.7	51.8	4.2	64.9
00-6662	-10+18	1.35	65.57	10.1	70.5	647	21.9	13.1	744	3.27	11	0.3	4.1	1.6	45.3
00-6662	-18+35	1.17	67.34	10.2	65.7	387	21.3	12.9	750	3.07	10.9	0.3	3.8	1.5	39.9
00-6662	-35+60	1.1	72.32	10.35	64.7	366	20.2	12.7	763	2.92	10.6	0.3	5.5	1.4	38

SAMPLE	MESH SIZE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5
00-6662	-60+120	0.64	65.77	10.15	59.6	518	18.5	12.4	671	2.8	11.1	0.2	3.8	1.4	31.6
00-6662	-120+230	0.6	58.13	9.74	60	436	18.7	12.9	684	2.66	9.6	0.2	3	1.3	29.9
00-6664	-10+18	2.06	107.63	11.22	67.2	23	19.9	15.1	772	3.43	16	0.4	2.8	2	45.7
00-6664	-18+35	1.93	113.69	11.81	66.9	39	19.5	15.2	784	3.43	16.3	0.4	2.6	2	45.7
00-6664	-35+60	1.92	117.75	11.99	67.9	34	20.3	15.1	765	3.36	16.4	0.4	3	1.8	45.3
00-6664	-60+120	1.98	127.8	13.09	63.3	34	19.6	14.1	703	3.6	20	0.4	4.5	1.8	42.7
00-6664	-120+230	1.82	122.23	12.73	65.1	29	19.4	15.4	731	3.33	17	0.4	3.8	1.8	41.2
00-6666	-10+18	3.04	187.18	9.22	89.1	136	26.6	16.8	708	3.76	13.6	0.3	2.4	1.5	56.4
00-6666	-18+35	3.43	192.03	10.03	88	134	27.8	17.9	752	3.67	13.9	0.3	3.5	1.5	59.2
00-6666	-35+60	3.35	203.52	10.59	91.3	129	29.1	21.3	853	3.7	14.7	0.3	4.7	1.4	53.1
00-6666	-60+120	4.03	246.1	14.86	91.1	193	28.5	29.1	1081	4.13	18	0.2	4.3	1.3	47
00-6666	-120+230	3.43	211.42	11.19	88.4	113	29.5	26.5	992	3.58	14.7	0.2	5.3	1.3	46
00-6668	-10+18	6.35	531.37	6.66	46.8	253	22.2	17.2	562	3.6	5.4	0.4	11.4	1.6	42.4
00-6668	-18+35	6.49	535.64	10.75	46.8	252	22.8	18.5	572	3.45	5.4	0.4	5.7	1.5	42.2
00-6668	-35+60	6.45	576.6	7.45	46.6	251	21.7	20	603	3.53	5.6	0.3	10.9	1.4	42.9
00-6668	-60+120	6.83	733.09	8.2	44.5	170	22.2	24.9	633	3.96	6.5	0.4	11.9	1.3	39.5
00-6668	-120+230	7.4	614.97	8.02	44.1	187	21.6	24	636	3.54	5.8	0.4	7.8	1.3	37.4
00-6686	-10+18	14.26	473.19	5.4	49.8	178	31.2	18.1	480	4.31	4.6	0.3	7.3	1.1	87.6
00-6686	-18+35	15.28	489.34	6.63	47.7	179	31.3	19	489	4.27	4.8	0.3	7	1.1	90.2
00-6686	-35+60	16.67	513.46	6.95	47.5	167	30.6	19.7	454	4.25	5.1	0.3	28.9	1.1	87.1
00-6686	-60+120	20.31	636.88	7.69	47.1	115	34.4	21.6	458	4.81	5.8	0.3	21.5	1.1	92.7
00-6686	-120+230	19.31	577.38	7.59	45.9	101	32	21.4	460	4.52	5.3	0.3	9.5	1.1	88.4
00-6692	-10+18	2.22	125.46	10.97	68.8	43	24.9	17.4	758	3.59	14	0.3	3.3	1.7	48.4
00-6692	-18+35	2.17	120.46	11.99	65.1	67	23.8	18.2	809	3.41	14.3	0.3	3.8	1.6	43.7

SAMPLE	MESH SIZE	Mo ppm 0.01	Cu ppm 0.01	Pb ppm 0.01	Zn ppm 0.1	Ag ppb 2	Ni ppm 0.1	Co ppm 0.1	Mn ppm 1	Fe % 0.01	As ppm 0.1	U ppm 0.1	Au ppb 1	Th ppm 0.1	Sr ppm 0.5
00-6692	-35+60	2.06	125.15	13.01	66	56	23.4	19.9	862	3.42	14.9	0.3	5.1	1.6	42.8
00-6692	-60+120	1.81	111.01	12.27	55	46	19.4	15.2	634	3.2	14.3	0.3	5.4	1.5	34.1
00-6692	-120+230	1.81	121.85	12.91	60.9	43	21.3	18.1	739	3.27	14.6	0.3	4.1	1.5	39.5
00-6698	-10+18	4.19	209.07	8.6	68.1	142	23.8	14.9	691	3.25	12.3	0.3	4.7	1.7	49.1
00-6698	-18+35	4.79	222.89	8.87	66.8	149	23.6	15	718	3.19	12.3	0.7	3.4	1.7	51.1
00-6698	-35+60	4.31	241.59	9.37	69.6	164	23.6	16.6	743	3.19	12.8	0.3	2.6	1.5	46
00-6698	-60+120	5.74	284.36	9.69	62.3	163	24.7	19.3	1037	3.06	12.5	0.4	4.9	1.5	39.5
00-6698	-120+230	6.39	268.88	9.56	67.2	158	24.3	18.4	835	3.15	11.6	0.2	5.8	1.5	42.3
00-6702	-10+18	7.27	319.72	13.6	91.4	284	32.1	19.2	784	4.13	35.2	0.4	2	1.8	93.2
00-6702	-18+35	7.99	308.12	13.9	94.2	256	32.8	18.6	774	4.04	34.9	0.4	1.9	1.8	92.1
00-6702	-35+60	7.38	319.21	14.52	93.5	296	32.6	20	782	4.08	36.5	0.4	2.8	1.8	84
00-6702	-60+120	7.99	328.94	14.54	90	281	30.5	17.5	789	3.78	36.8	0.4	6.7	1.7	80
00-6702	-120+230	7.27	316.4	15.26	89.5	276	30.7	18	775	3.86	45.2	0.4	5.1	1.6	79.4
00-6703	-10+18	14.57	440.89	12.6	83.9	308	30.2	17.5	682	3.9	35.6	0.3	3.4	1.5	80.8
00-6703	-18+35	13.66	445.45	13.79	87.8	331	31.4	18	685	3.88	40.7	0.3	8.5	1.6	84.1
00-6703	-35+60	14.25	459.98	13.82	86.5	340	31.7	18.6	684	3.9	35.4	0.3	4.4	1.5	75.2
00-6703	-60+120	13.49	478.12	15.59	82.9	652	29.5	16.9	667	3.65	40.1	0.3	859.1	1.4	70.3
00-6703	-120+230	13.1	458.72	13.31	82.1	326	30.6	18.4	671	3.77	39.5	0.3	3.9	1.4	68.3
00-6711	-10+18	7.5	358.33	9.12	58.8	46	21.5	17.6	734	3.46	11.7	0.3	8.9	1.8	29.3
00-6711	-18+35	7.82	360.23	10.67	64.3	122	21.9	20	835	3.44	12.2	0.4	7	1.9	31.9
00-6711	-35+60	7.34	356.14	10.59	57.6	67	20.6	19.4	795	3.28	11.9	0.3	6.1	1.7	26.1
00-6711	-60+120	6.09	327.16	9.26	50.4	45	17.5	13	528	3.01	11	0.3	21	1.6	23.6
00-6711	-120+230	6.35	325.82	9.47	51	47	17.6	15.6	617	3	11	0.3	6.6	1.6	23.5

SAMPLE	MESH SIZE	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W
		ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm
		0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2
00-6620	-10+18	0.13	0.77	0.7	80	0.49	0.063	8.8	36.9	1.06	124.6	0.068	1	2	0.027	0.17	0.4
00-6620	-18+35	0.12	0.73	0.74	83	0.51	0.062	9	38.9	1.08	143.1	0.069	<1	2.2	0.05	0.23	0.8
00-6620	-35+60	0.15	0.75	0.72	84	0.5	0.062	9.2	39.9	1.07	139.8	0.072	<1	2.09	0.039	0.19	0.5
00-6620	-60+120	0.18	1.15	0.85	96	0.48	0.077	10.9	37.9	1.08	127.3	0.085	<1	1.88	0.02	0.15	0.4
00-6620	-120+230	0.18	1.15	0.74	86	0.47	0.064	9.7	34.1	1.08	131.1	0.073	1	1.89	0.022	0.13	0.3
00-6626	-10+18	0.1	0.99	0.64	68	0.21	0.066	6.7	27.7	0.76	136.3	0.081	1	2.37	0.023	0.17	0.3
00-6626	-18+35	0.12	0.91	0.7	70	0.21	0.071	6.5	28.8	0.77	140.2	0.08	<1	2.6	0.028	0.18	0.3
00-6626	-35+60	0.14	0.91	0.71	69	0.21	0.072	6.4	29.9	0.74	145.9	0.08	<1	2.6	0.026	0.16	0.3
00-6626	-60+120	0.18	1.71	1.15	76	0.17	0.099	5.9	28.3	0.71	154.6	0.08	<1	2.49	0.011	0.12	0.3
00-6626	-120+230	0.16	1.51	1.73	67	0.17	0.076	5.9	25.2	0.73	146.8	0.073	1	2.48	0.012	0.11	0.2
00-6627	-10+18	0.13	1.25	0.48	79	0.34	0.045	12	32.3	0.86	134.2	0.083	1	2.3	0.026	0.15	0.2
00-6627	-18+35	0.11	1.16	0.47	79	0.35	0.044	11.8	32.5	0.86	149.2	0.086	<1	2.48	0.04	0.17	0.4
00-6627	-35+60	0.13	1.11	0.46	73	0.32	0.04	11.2	30.1	0.8	139.8	0.078	<1	2.27	0.022	0.12	<0.2
00-6627	-60+120	0.14	1.81	0.54	79	0.31	0.043	13.2	32.7	0.82	159.2	0.08	<1	2.43	0.015	0.11	<0.2
00-6627	-120+230	0.13	1.74	0.53	74	0.3	0.04	12.7	27.3	0.8	149	0.075	1	2.28	0.017	0.1	<0.2
00-6631	-10+18	0.17	3.63	0.73	91	0.47	0.069	21.2	34.1	1.06	94.5	0.082	1	2.65	0.027	0.24	0.4
00-6631	-18+35	0.16	3.31	0.65	87	0.48	0.072	23.7	31.6	1.03	97.7	0.082	1	2.64	0.039	0.25	0.5
00-6631	-35+60	0.14	3.26	0.76	84	0.45	0.069	29.2	38	0.99	90.4	0.08	<1	2.44	0.024	0.2	0.4
00-6631	-60+120	0.16	6.39	1	98	0.42	0.093	42	39.8	0.98	84.2	0.077	<1	2.26	0.015	0.17	0.6
00-6631	-120+230	0.18	5.45	0.9	85	0.43	0.073	35.1	32.3	1	86.5	0.073	1	2.33	0.019	0.15	0.4
00-6637	-10+18	0.12	1.08	0.65	71	0.2	0.039	7.6	31.6	0.85	99	0.078	1	3.05	0.026	0.19	0.3
00-6637	-18+35	0.1	0.91	0.63	71	0.19	0.041	7.3	30.9	0.87	104.2	0.077	<1	3.22	0.033	0.17	0.3
00-6637	-35+60	0.12	0.87	1.41	73	0.19	0.039	7.6	30.4	0.86	106.5	0.077	<1	3.18	0.02	0.15	<0.2
00-6637	-60+120	0.12	1.46	0.72	91	0.15	0.053	8.2	37.3	0.92	102.4	0.089	<1	3.12	0.011	0.16	0.3

SAMPLE	MESH SIZE	Cd ppm 0.01	Sb ppm 0.02	Bi ppm 0.02	V ppm 2	Ca % 0.01	P % 0.001	La ppm 0.5	Cr ppm 0.5	Mg % 0.01	Ba ppm 0.5	Ti % 0.001	B ppm 1	Al % 0.01	Na % 0.001	K % 0.01	W ppm 0.2
00-6637	-120+230	0.12	1.39	0.57	72	0.15	0.042	8.1	23.9	0.84	103.3	0.069	<1	3.04	0.011	0.11	<0.2
00-6638	-10+18	0.3	1.72	0.99	95	0.36	0.081	8	24.8	1.12	151.8	0.091	1	2.39	0.047	0.4	0.9
00-6638	-18+35	0.37	1.35	1.18	97	0.33	0.093	8.9	25	1.08	173.3	0.09	1	2.54	0.063	0.4	2.2
00-6638	-35+60	0.39	1.34	3.78	96	0.29	0.087	9	28.9	1	177	0.088	<1	2.43	0.036	0.35	1
00-6638	-60+120	0.35	1.88	1.48	111	0.23	0.095	9	27.8	0.91	190.8	0.084	<1	2.45	0.018	0.35	0.6
00-6638	-120+230	0.36	1.59	1.17	96	0.23	0.086	9.1	22	0.95	179.2	0.076	<1	2.34	0.019	0.32	0.4
00-6645	-10+18	0.2	1.22	1.2	83	0.55	0.068	8.1	43.3	0.99	108.6	0.084	<1	2.02	0.055	0.23	2
00-6645	-18+35	0.22	1.22	1.5	84	0.56	0.07	8.3	40.1	0.98	118.1	0.086	1	2.08	0.078	0.26	2.5
00-6645	-35+60	0.22	1.25	1.51	80	0.5	0.068	8.3	39.8	0.94	109.6	0.085	1	1.88	0.048	0.2	2
00-6645	-60+120	0.28	1.78	1.59	88	0.45	0.074	9.2	40.4	0.88	107.6	0.079	<1	1.74	0.029	0.17	2
00-6645	-120+230	0.23	1.66	1.18	77	0.42	0.063	8.2	36.6	0.87	102.1	0.072	<1	1.65	0.029	0.16	1.3
00-6647	-10+18	0.22	1.54	1.03	84	0.87	0.073	8.4	35.6	1.03	124	0.075	1	2.1	0.053	0.24	0.5
00-6647	-18+35	0.23	1.28	1.07	82	0.89	0.074	8.3	36.5	1.03	130.9	0.078	1	2.18	0.086	0.26	1.3
00-6647	-35+60	0.24	1.4	1.27	81	0.85	0.068	8.4	41.8	0.99	133.8	0.076	1	2.14	0.073	0.26	3.5
00-6647	-60+120	0.3	2.05	1.34	83	0.78	0.073	8.5	40.2	0.98	121	0.067	<1	1.93	0.035	0.17	0.6
00-6647	-120+230	0.24	1.81	1.15	75	0.75	0.068	8.2	31.4	0.95	119.6	0.066	1	1.84	0.036	0.17	0.8
00-6651	-10+18	0.17	2.9	2.49	60	2.1	0.073	12.1	21.7	0.97	201.3	0.064	<1	1.42	0.026	0.35	1
00-6651	-18+35	0.17	2.08	2.52	57	2.18	0.069	11.6	26.7	0.97	208.9	0.059	<1	1.49	0.033	0.36	1.1
00-6651	-35+60	0.18	2.1	2.8	63	2.23	0.069	13	24.6	1.02	221.9	0.058	<1	1.51	0.032	0.36	0.6
00-6651	-60+120	0.14	2.97	2.52	65	2.55	0.092	14.7	27.2	1.12	205.2	0.066	<1	1.42	0.017	0.34	<0.2
00-6651	-120+230	0.18	2.92	4.03	60	2.64	0.089	14.2	23.1	1.02	195.1	0.064	<1	1.32	0.018	0.3	<0.2
00-6662	-10+18	0.15	0.72	0.26	81	0.57	0.071	9.5	39.4	0.87	110	0.091	1	1.92	0.042	0.13	0.7
00-6662	-18+35	0.14	0.65	0.25	72	0.52	0.072	9.3	35.3	0.81	100	0.083	1	1.74	0.035	0.1	0.6
00-6662	-35+60	0.14	0.63	0.28	70	0.5	0.069	9.3	31.1	0.77	99.1	0.081	1	1.64	0.03	0.1	0.4

SAMPLE	MESH SIZE	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W
		ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm
		0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2
00-6662	-60+120	0.14	0.81	0.26	68	0.41	0.07	8.9	33.1	0.65	95.5	0.069	<1	1.48	0.016	0.06	<0.2
00-6662	-120+230	0.13	0.73	0.22	62	0.39	0.061	8.2	26.6	0.68	87.7	0.067	1	1.41	0.016	0.06	<0.2
00-6664	-10+18	0.12	0.82	0.38	78	0.42	0.054	10.9	31.3	0.85	130.9	0.09	<1	2.16	0.03	0.15	0.3
00-6664	-18+35	0.14	0.72	0.4	79	0.43	0.057	11.2	30.8	0.85	136.5	0.088	<1	2.18	0.039	0.15	0.4
00-6664	-35+60	0.14	0.71	0.38	78	0.42	0.054	11.1	30	0.83	138.7	0.088	1	2.12	0.03	0.14	0.3
00-6664	-60+120	0.13	0.99	0.41	85	0.38	0.068	11.8	32.6	0.78	136.2	0.087	<1	1.96	0.018	0.11	0.2
00-6664	-120+230	0.12	0.98	0.39	77	0.36	0.055	11.6	28.4	0.79	135.4	0.082	1	1.95	0.018	0.1	<0.2
00-6666	-10+18	0.26	0.68	0.62	93	0.83	0.076	7.5	40.1	1.03	130.9	0.088	1	2.32	0.081	0.23	0.6
00-6666	-18+35	0.29	0.65	0.67	88	0.85	0.075	7.4	40.1	1	134.9	0.087	1	2.34	0.103	0.25	0.8
00-6666	-35+60	0.34	0.64	0.66	89	0.82	0.073	7.6	37.6	0.99	134.3	0.085	1	2.28	0.093	0.23	0.8
00-6666	-60+120	0.45	0.83	0.74	94	0.74	0.072	7.1	42.9	0.95	124.7	0.08	1	2.03	0.073	0.18	0.4
00-6666	-120+230	0.39	0.8	0.61	85	0.71	0.067	6.8	34.5	0.94	123.2	0.074	1	2	0.07	0.17	0.4
00-6668	-10+18	0.1	0.6	0.68	96	0.44	0.063	7.8	40.1	1.04	127.8	0.098	<1	2.6	0.035	0.2	0.9
00-6668	-18+35	0.1	0.58	0.7	94	0.43	0.069	8	40.7	1.04	125.8	0.094	1	2.58	0.058	0.19	0.9
00-6668	-35+60	0.09	0.58	0.69	97	0.42	0.063	8.1	41.5	1.05	131.6	0.098	1	2.57	0.035	0.19	0.9
00-6668	-60+120	0.1	0.79	0.94	119	0.4	0.081	9	51.6	1.11	121.7	0.1	<1	2.42	0.024	0.17	0.8
00-6668	-120+230	0.09	0.8	0.71	98	0.36	0.065	8.3	40.2	1.03	125.2	0.09	<1	2.36	0.019	0.15	0.7
00-6686	-10+18	0.05	0.33	1.38	120	0.69	0.048	5.8	71.1	1.51	135.5	0.122	<1	2.85	0.085	0.46	1
00-6686	-18+35	0.05	0.31	1.12	117	0.68	0.048	6	69	1.48	140.9	0.123	<1	2.89	0.096	0.47	1.2
00-6686	-35+60	0.05	0.31	1.28	114	0.63	0.045	6.2	67.1	1.42	143.4	0.118	1	2.73	0.076	0.47	1
00-6686	-60+120	0.06	0.48	1.34	131	0.64	0.052	6.5	86.1	1.62	165.5	0.126	1	3	0.073	0.55	0.9
00-6686	-120+230	0.06	0.44	1.33	122	0.59	0.047	6.1	73	1.51	158.2	0.119	<1	2.78	0.068	0.49	0.8
00-6692	-10+18	0.08	0.8	0.47	86	0.51	0.059	10.3	40.3	0.98	138.5	0.093	<1	2.38	0.04	0.17	0.6
00-6692	-18+35	0.08	0.71	0.48	80	0.48	0.056	10.3	34.7	0.91	127.6	0.087	<1	2.16	0.039	0.15	0.7

SAMPLE	MESH SIZE	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W
		ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm
		0.01	0.02	0.02	2	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2
00-6692	-35+60	0.09	0.71	0.46	81	0.46	0.054	10.9	33.2	0.88	128.1	0.092	1	2.1	0.031	0.13	0.5
00-6692	-60+120	0.07	0.83	0.45	76	0.38	0.053	10.6	30.6	0.72	102.5	0.076	<1	1.66	0.018	0.08	0.3
00-6692	-120+230	0.08	0.89	0.46	75	0.4	0.052	11.1	32.2	0.8	116	0.078	1	1.83	0.02	0.08	0.3
00-6698	-10+18	0.21	0.65	0.38	75	1.14	0.079	8	33.8	0.98	121.9	0.074	1	1.86	0.055	0.2	0.6
00-6698	-18+35	0.24	0.62	0.38	73	1.15	0.079	8	34.3	0.98	116	0.074	1	1.79	0.06	0.18	0.6
00-6698	-35+60	0.25	0.61	0.44	72	1.1	0.076	7.7	34.4	0.96	120.8	0.073	1	1.76	0.057	0.17	0.4
00-6698	-60+120	0.41	0.74	0.39	70	0.97	0.071	7	34	0.88	107.6	0.06	1	1.5	0.037	0.13	<0.2
00-6698	-120+230	0.27	0.74	0.36	68	1.04	0.075	7.5	30.8	0.94	106.8	0.062	1	1.59	0.037	0.13	<0.2
00-6702	-10+18	0.26	1.31	1.48	96	1.45	0.08	8.4	51.8	1.36	172.8	0.082	1	2.5	0.074	0.37	1.1
00-6702	-18+35	0.26	1.23	1.4	93	1.44	0.081	8.4	47.9	1.34	167.3	0.081	2	2.47	0.088	0.37	0.9
00-6702	-35+60	0.26	1.28	2.23	92	1.39	0.078	8.4	49.4	1.31	173.5	0.079	2	2.37	0.072	0.34	1.4
00-6702	-60+120	0.26	1.54	1.47	85	1.38	0.076	7.9	51.2	1.24	149.6	0.069	1	2.04	0.053	0.27	0.7
00-6702	-120+230	0.25	1.5	1.37	85	1.37	0.079	7.9	49.6	1.27	156.6	0.069	1	2.1	0.055	0.27	0.5
00-6703	-10+18	0.26	1.54	1.72	95	1.32	0.076	7	51.8	1.36	145.3	0.078	1	2.37	0.068	0.36	1
00-6703	-18+35	0.26	1.4	1.61	93	1.32	0.077	7.4	52.8	1.35	146	0.079	1	2.36	0.082	0.36	1.1
00-6703	-35+60	0.25	1.41	1.58	92	1.29	0.073	7.5	51.5	1.32	148	0.076	2	2.27	0.071	0.34	0.9
00-6703	-60+120	0.27	1.71	2.2	86	1.23	0.075	7	50.9	1.22	125.8	0.065	2	1.96	0.049	0.28	0.6
00-6703	-120+230	0.24	1.7	1.51	85	1.22	0.072	6.8	45.4	1.25	129.9	0.066	1	2	0.048	0.27	0.8
00-6711	-10+18	0.08	0.68	0.53	81	0.35	0.063	9	36.3	0.99	114.1	0.094	<1	2.23	0.021	0.17	0.4
00-6711	-18+35	0.08	0.66	0.54	83	0.36	0.062	9.6	36.9	0.98	113.6	0.094	<1	2.29	0.029	0.18	0.9
00-6711	-35+60	0.08	0.68	0.49	79	0.32	0.061	9	30.7	0.91	103.5	0.089	<1	2.05	0.017	0.13	0.4
00-6711	-60+120	0.06	0.68	0.47	71	0.27	0.061	8.6	32.6	0.77	85.8	0.076	<1	1.74	0.01	0.09	0.2
00-6711	-120+230	0.06	0.75	0.46	70	0.27	0.059	8.4	30	0.79	88.3	0.077	<1	1.76	0.01	0.09	0.2

SAMPLE	MESH SIZE	Sc ppm	Tl ppm	S %	Hg ppb	Se ppm	Te ppm	Ga ppm
		0.1	0.02	0.02	33	0.2	0.08	5
00-6620	-10+18	5.6	0.13	0.03	12	0.5	0.1	6.4
00-6620	-18+35	5.9	0.14	0.03	17	0.4	0.1	6.7
00-6620	-35+60	5.9	0.14	0.05	19	0.6	0.08	6.5
00-6620	-60+120	7.1	0.15	0.01	18	0.8	0.11	6.6
00-6620	-120+230	5.9	0.14	0.08	25	0.6	0.1	6.3
00-6626	-10+18	4.8	0.13	<0.01	22	0.2	0.11	6.4
00-6626	-18+35	4.9	0.14	0.01	22	0.2	0.12	6.3
00-6626	-35+60	4.8	0.15	<0.01	25	0.3	0.11	6.5
00-6626	-60+120	5.2	0.16	0.02	28	0.3	0.2	6.3
00-6626	-120+230	4.7	0.16	0.02	25	0.2	0.13	6.1
00-6627	-10+18	5.5	0.16	<0.01	30	0.3	0.07	7.3
00-6627	-18+35	5.4	0.16	<0.01	32	0.2	0.09	7.5
00-6627	-35+60	5.1	0.16	<0.01	38	0.3	0.08	6.9
00-6627	-60+120	6	0.19	<0.01	32	0.3	0.12	7.4
00-6627	-120+230	5.3	0.17	0.01	37	0.3	0.1	7
00-6631	-10+18	6.5	0.27	0.02	16	0.5	0.08	7.6
00-6631	-18+35	6.1	0.28	0.02	20	0.3	0.08	7.2
00-6631	-35+60	5.9	0.28	0.01	21	0.5	0.08	7.1
00-6631	-60+120	6.9	0.35	0.02	18	0.7	0.12	7
00-6631	-120+230	5.9	0.33	0.03	20	0.4	0.11	6.9
00-6637	-10+18	4.6	0.14	<0.01	20	0.4	0.07	7.2
00-6637	-18+35	4.4	0.14	<0.01	23	0.4	0.06	7.1
00-6637	-35+60	4.4	0.16	<0.01	28	0.5	0.07	7.3
00-6637	-60+120	5.4	0.24	0.01	37	1	0.1	7.5

		Sc	Tl	S	Hg	Se	Te	Ga
		ppm	ppm	%	ppb	ppm	ppm	ppm
		0.1	0.02	0.02	33	0.2	0.08	5
SAMPLE	**MESH SIZE**							
00-6637	-120+230	4.4	0.17	0.01	31	0.6	0.1	7.1
00-6638	-10+18	6.9	0.45	0.11	13	0.5	0.1	7.7
00-6638	-18+35	6.9	0.48	0.17	17	0.7	0.11	7.6
00-6638	-35+60	6.5	0.5	0.18	14	0.8	0.12	7.7
00-6638	-60+120	7.4	0.47	0.19	16	1.1	0.17	7.4
00-6638	-120+230	6.5	0.46	0.19	11	0.8	0.13	7.1
00-6645	-10+18	5.4	0.22	0.04	17	0.3	0.17	6.5
00-6645	-18+35	5.5	0.23	0.04	18	0.3	0.16	6.5
00-6645	-35+60	5	0.23	0.04	23	0.3	0.16	6.1
00-6645	-60+120	5.5	0.25	0.04	21	0.4	0.27	5.7
00-6645	-120+230	4.7	0.23	0.04	16	0.3	0.21	5.6
00-6647	-10+18	5.1	0.2	0.34	24	0.7	0.12	6.7
00-6647	-18+35	5.1	0.2	0.48	31	0.7	0.11	6.8
00-6647	-35+60	5	0.2	0.58	32	0.8	0.15	6.9
00-6647	-60+120	5.1	0.19	0.48	91	0.9	0.17	6.2
00-6647	-120+230	4.6	0.18	0.58	29	0.8	0.16	6
00-6651	-10+18	3.9	0.12	0.26	13	1.4	0.26	6.2
00-6651	-18+35	3.8	0.13	0.28	17	1.4	0.19	6.1
00-6651	-35+60	3.9	0.13	0.34	16	1.6	0.23	6.6
00-6651	-60+120	4.1	0.12	0.27	13	1.8	0.25	6.5
00-6651	-120+230	3.8	0.12	0.34	14	1.9	0.25	5.9
00-6662	-10+18	5	0.09	<0.01	27	0.2	0.05	6.1
00-6662	-18+35	4.5	0.08	<0.01	27	0.1	0.06	5.6
00-6662	-35+60	4.3	0.08	<0.01	28	0.2	0.05	5.4

SAMPLE	MESH SIZE	Sc ppm	Tl ppm	S %	Hg ppb	Se ppm	Te ppm	Ga ppm
		0.1	0.02	0.02	33	0.2	0.08	5
00-6662	-60+120	4.2	0.06	<0.01	34	0.2	0.06	4.8
00-6662	-120+230	3.7	0.06	<0.01	26	0.1	0.05	4.7
00-6664	-10+18	5.3	0.13	<0.01	20	0.3	0.09	6.9
00-6664	-18+35	5.2	0.13	<0.01	23	0.2	0.08	6.8
00-6664	-35+60	5	0.13	<0.01	23	0.2	0.08	6.8
00-6664	-60+120	5.6	0.13	<0.01	22	0.4	0.12	6.5
00-6664	-120+230	5	0.13	<0.01	24	0.2	0.11	6.3
00-6666	-10+18	5.6	0.15	0.02	9	0.3	0.1	7.3
00-6666	-18+35	5.8	0.16	0.01	11	0.2	0.11	7.3
00-6666	-35+60	5.5	0.17	0.01	12	0.2	0.13	7.1
00-6666	-60+120	5.7	0.18	0.03	14	0.3	0.18	6.8
00-6666	-120+230	5.3	0.17	0.01	12	0.2	0.15	6.5
00-6668	-10+18	5.5	0.18	0.03	6	0.4	0.07	7.1
00-6668	-18+35	5.5	0.19	0.03	9	0.4	0.09	7.1
00-6668	-35+60	5.5	0.19	0.03	10	0.4	0.08	7.2
00-6668	-60+120	6.5	0.21	0.03	12	0.5	0.09	7.5
00-6668	-120+230	5.4	0.2	0.03	6	0.4	0.11	7
00-6686	-10+18	6.9	0.38	0.25	7	0.7	0.1	8
00-6686	-18+35	7	0.41	0.26	11	0.7	0.11	7.8
00-6686	-35+60	6.5	0.42	0.28	7	0.8	0.12	7.7
00-6686	-60+120	7.8	0.49	0.36	6	1.1	0.16	8
00-6686	-120+230	6.9	0.46	0.32	6	0.9	0.15	7.6
00-6692	-10+18	6.1	0.15	<0.01	17	0.3	0.1	7.3
00-6692	-18+35	5.7	0.14	<0.01	16	0.3	0.11	6.8

SAMPLE	MESH SIZE	Sc ppm	Tl ppm	S %	Hg ppb	Se ppm	Te ppm	Ga ppm
		0.1	0.02	0.02	33	0.2	0.08	5
00-6692	-35+60	5.6	0.16	<0.01	20	0.3	0.11	6.7
00-6692	-60+120	5.2	0.13	0.02	15	0.3	0.11	5.8
00-6692	-120+230	5.4	0.14	<0.01	17	0.3	0.12	6.1
00-6698	-10+18	4.7	0.1	0.25	17	0.4	0.07	6.1
00-6698	-18+35	4.5	0.1	0.27	21	0.4	0.06	5.8
00-6698	-35+60	4.3	0.1	0.31	17	0.4	0.07	5.6
00-6698	-60+120	4.3	0.1	0.24	21	0.4	0.07	5
00-6698	-120+230	4.1	0.1	0.31	17	0.4	0.08	5.3
00-6702	-10+18	5.9	0.24	0.47	24	0.8	0.15	7.6
00-6702	-18+35	6	0.25	0.51	28	0.8	0.13	7.6
00-6702	-35+60	5.7	0.23	0.55	36	0.8	0.16	7.4
00-6702	-60+120	5.3	0.21	0.45	141	0.9	0.17	6.5
00-6702	-120+230	5.3	0.22	0.48	31	0.8	0.18	6.7
00-6703	-10+18	6.1	0.24	0.52	21	0.9	0.17	7.1
00-6703	-18+35	6.1	0.23	0.56	28	0.9	0.14	7.2
00-6703	-35+60	5.8	0.24	0.58	30	1	0.14	7.1
00-6703	-60+120	5.5	0.21	0.53	24	1	0.19	6.2
00-6703	-120+230	5.3	0.21	0.61	27	0.9	0.17	6.2
00-6711	-10+18	4.6	0.12	<0.01	10	0.4	0.07	6.5
00-6711	-18+35	4.6	0.13	<0.01	14	0.4	0.07	6.8
00-6711	-35+60	4.3	0.13	0.01	13	0.4	0.07	6.2
00-6711	-60+120	4	0.1	<0.01	12	0.4	0.08	5.3
00-6711	-120+230	3.8	0.1	<0.01	13	0.3	0.07	5.4