Trace-Element Analysis of Clay-Sized Fraction of Archived Till Samples, Babine Porphyry Copper District, West-Central British Columbia (NTS 093L/09, /16, 093M/01, /02, /07, /08)

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Introduction

The Babine porphyry copper district has high potential to host porphyry copper deposits. Situated north of Houston, British Columbia, the district has a rich mineral exploration history and has hosted two producing porphyry copper mines (Bell and Granisle; Figures 1, 2). There are numerous mineral showings in the district, including four developed prospects (Morrison, Dorothy, Hearne Hill, Fireweed; Figure 2). There is unstaked ground within the Babine porphyry copper district and, relative to districts to the east and northwest, it remains underexplored.

Levson (2001a, 2002) mapped the surficial geology of the Babine porphyry copper district and collected 937 basal till samples for trace-element geochemical analyses on the silt-plus clay-sized fraction (<0.063 mm). As a result of this work, 66 multisite, multi-element geochemical exploration targets were identified, over 13 of which are situated within unstaked ground (Levson, 2002). An additional 18 multisite, single-element geochemical exploration targets are situated within unstaked ground. These targets were identified by assessing the magnitude of elevated metal concentrations in till within the context of glacial dispersal patterns and transport direction, other geochemical datasets, and surficial and bedrock geology data (Levson, 2002).

The objectives of this study are to

- conduct trace-element geochemical analyses on the clay-sized fraction of archived till samples collected in the Babine porphyry copper district; and
- use these new geochemical data to further constrain and better define previously identified geochemical targets within the Babine porphyry copper district and possibly identify new targets.

Keywords: *Babine porphyry copper district, till geochemistry, clay-sized fraction*

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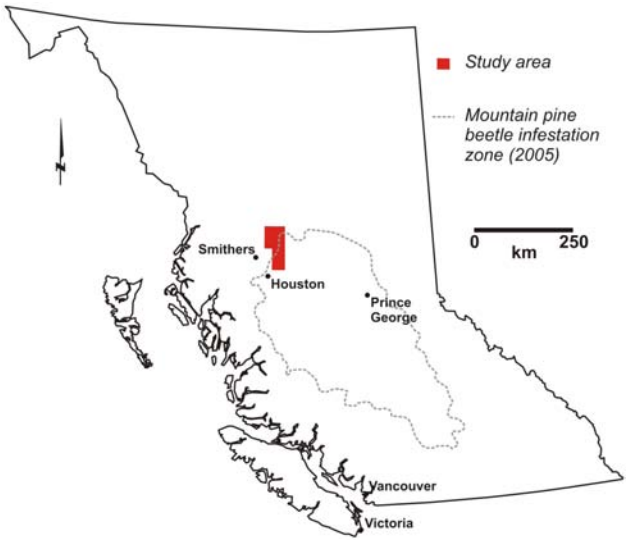

Figure 1. Location of study area in west-central British Columbia.

The goal of this study is to provide to the mineral exploration community a new, high quality, regional-scale, geochemical dataset that will help guide exploration efforts in the Babine porphyry copper district. This study will also serve as a reintroduction to the original surficial geology and till geochemistry work completed by Levson (2001a, 2002), and the other geological and geochemical data collected as part of the Nechako NATMAP project (Struik and MacIntyre, 2000). It is hoped that the new geochemical data generated as part of this study will contribute toward longer-term benefits from increased mineral exploration activity in an area adversely affected by the mountain pine beetle infestation.

Study Area

The Babine porphyry copper district is situated in west-central BC, in NTS map areas 093L/09, /16, 093M/01, /02, /07, /08 (Figure 2), and falls within the Nechako Plateau physiographic region. This region can be characterized as having low relief and gently rolling topography (Holland, 1976). Large, elongate, southwest-trending lakes are common in lower valley settings (e.g., Babine, Takla, Morrison,

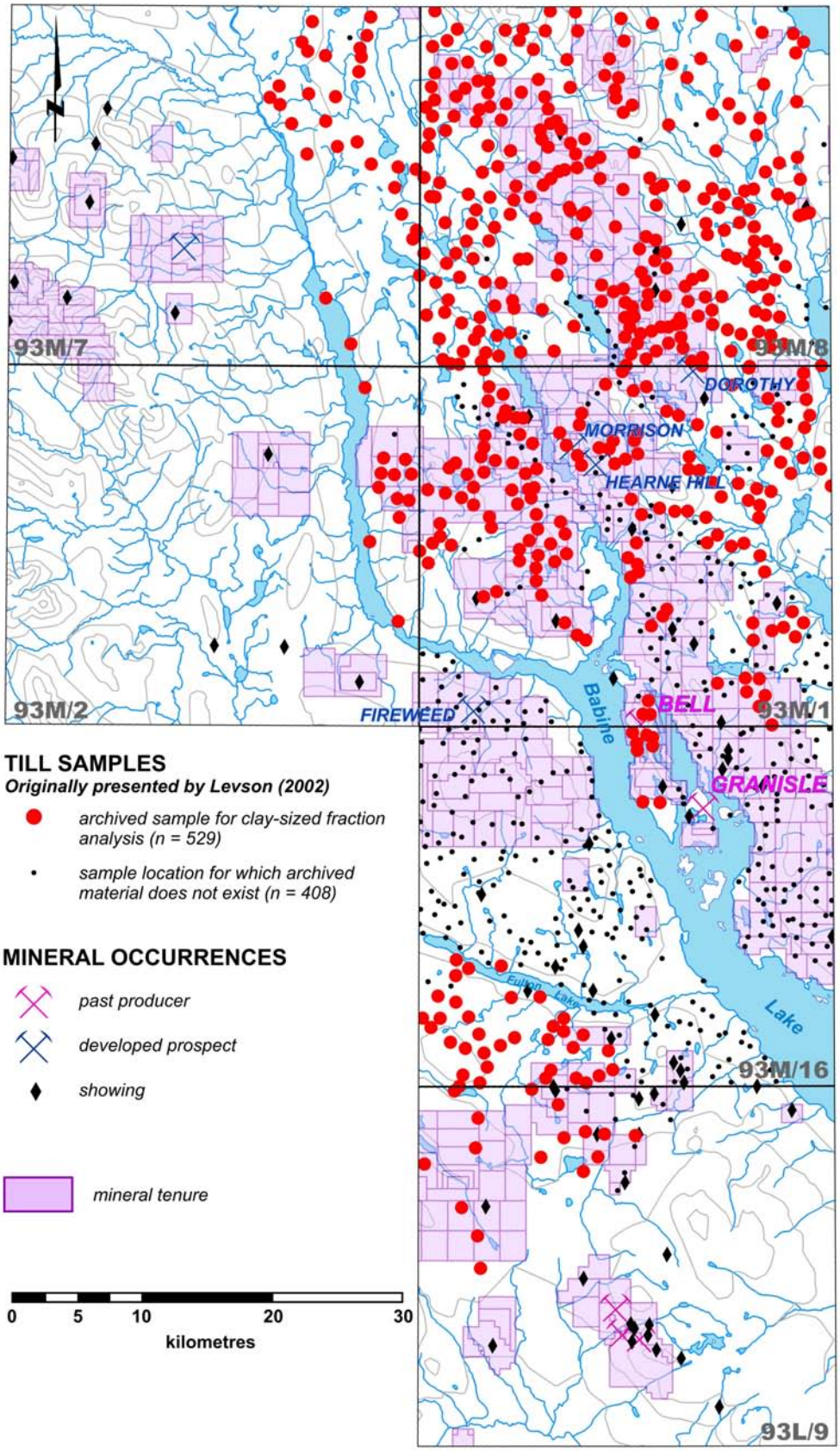

Figure 2. Location of till samples collected within the Babine porphyry copper district, west-central British Columbia. Locations of past-producing mines, developed prospects and showings are also shown.

Nakinilerak and Fulton lakes). Although the study area does become more mountainous in the north, as the Skeena Mountains are approached, bedrock outcrop in this region is limited as a ubiquitous cover of Late Wisconsinan drift dominates the landscape. These sediments have at least partially covered the Eocene Babine intrusive rocks which, along with neighbouring country rocks, host the copper-gold mineralization that occurs within the Babine porphyry copper district.

Till is the dominant surficial deposit in the study area. These deposits vary in thickness from less than one to several metres and can be ridged or rolling, hummocky or a subdued representation of underlying bedrock topography. On steeper slopes, in the northern part of the study area in particular, the till begins to thin and is closely associated with colluvial deposits and discontinuous bedrock outcrop. Continuous bedrock outcrop is limited to some of the higher peaks in the study area, such as Frypan and Trail (Levson, 2002). Streamlined glacial features, produced by moving ice (e.g., flutes and drumlins) can be found in the study area and are typically oriented subparallel to major valleys (Levson, 2002). Hindering mineral exploration are thick glaciolacustrine units that can be associated with the larger lakes, in particular Babine Lake. Glaciofluvial deposits also occur in the study area and are typically interpreted to be associated with areas of stagnant ice along with ice-proximal and subglacial fluvial systems.

Previous Work

Levson (2002) presents high quality, regional-scale, till geochemical data for the Babine porphyry copper district. Included in these regional till geochemical data are property-scale, orientation till surveys conducted in the vicinity and down-ice of past-producing porphyry copper mines (Bell and Granisle) and developed prospects. In his study, till samples collected down-ice of nearly all existing mineral properties (0.5 km or more) have >95th percentile metal concentrations, commonly of more than one metal. For example, till samples in the vicinity of the developed prospects of Morrison and Hearne Hill (porphyry copper, molybdenum, gold) have >98th percentile concentrations of copper, lead, gold, silver and antimony.

The utility of till-based surveys in the region is proven by a study south of the study area, in the Fawnie Creek map area (NTS 093F/03). Cook et al. (1995) conducted a comparative study on the ability of regional lake sediment and till geochemistry surveys to identify known mineral occurrences. In this study, tills identified all seven known prospects in the study area with >95th percentile element concentrations. Nine of eleven potential new prospects presented in this study were also identified with till samples, which had >95th percentile concentrations of multiple elements.

Other work has been conducted in areas adjacent to the Babine porphyry copper district. Tipper (1994) describes the ice-flow history of the Smithers map area (NTS 093L). Tipper (1971) also describes glacial features and glacial histories of areas south of the study area. Plouffe and Ballantyne (1993) and Plouffe (1997, 2000) have also mapped Quaternary deposits and conducted till geochemistry surveys for areas south and west of the study area. Ferbey (2008) provides a geographically referenced list of drift prospecting surveys that have been conducted in BC.

Methodology

Till geochemical surveys can detect known sources of mineralization and identify new geochemical exploration targets (e.g., Sibbick and Kerr, 1995; Plouffe, 1997; Ferbey and Levson, 2007). Till geochemical surveys are well suited to assessing the mineral potential of ground covered by glacial drift. Basal till, a specific type of drift and the sample medium used in these surveys, is ideal for these assessments as it has a relatively simple transport history, is deposited directly down-ice of its source, and produces a geochemical signature that is aerially more extensive than its bedrock source and therefore at a regional-scale can be more easily detected (Levson, 2001b).

To date, regional till geochemical surveys conducted by the British Columbia Geological Survey (BCGS) have only used the silt- plus clay-sized fraction of tills (i.e., <0.063 mm fraction). Trace-element geochemical analyses on clay separations, or heavy mineral analyses, have not been conducted. Producing a clay-sized fraction from tills has in the past been cost prohibitive. With an increase in interest in this size fraction by clients, however, preparation labs now offer clay separations at reasonable and competitive prices.

Clay separations have been routinely used for geochemical interpretations by the Geological Survey of Canada (GSC) since 1973 (Shilts, 1995). Analysis of the clay-sized fraction in basal tills is ideal for exploration targets such as porphyry copper deposits as it has been shown that base metals (more specifically, some chalcophile elements) tend to concentrate in this fraction due to clay-sized particles' (dominated by phyllosilicate) high cation exchange capacity (Nikkarinen et al., 1984; Shilts, 1984, 1995; DiLabio, 1995). In the context of base-metal exploration, trace-element analyses of the clay-sized fraction of tills (<0.002 mm) can increase the contrast between elevated and background element concentrations, as compared to the same analyses using silt- plus clay-sized fraction (<0.063 mm). This is due to the fact that minerals such as quartz and feldspar are reduced in clay-sized fraction and therefore do not dilute the geochemical signature of the sample. As a result, elevated geochemical values can be identified with more certainty. It is hoped that this increase

in geochemical contrast will further constrain and better define the geochemical targets previously identified by Levson (2002) within the Babine porphyry copper district, and possibly identify new ones.

Sample Preparation and Analysis

Analytical determinations by inductively coupled plasma emission spectrometry (ICP-ES) and instrumental neutron activation analysis (INAA) have already been carried out on the silt- plus clay-sized fraction (<0.063 mm) of 937 basal till samples collected within the Babine porphyry copper district, and are presented in detail by Levson (2002). Of the original 937 samples, material from 529 samples remains in BCGS archives (Figure 2).

As part of this study, the clay-sized fraction of the 529 archived till samples will be separated following the procedures outlined by Girard et al. (2004). It is imperative that a regimented procedure be followed, in particular the length of time samples are spun in a centrifuge and the velocity at which the centrifuge operates, in order for a clay-sized separation (<0.002 mm) to be consistently produced. For this study, de-ionized water will be used throughout the centrifuge and decanting process, instead of the sodium hexametaphosphate solution suggested by Girard et al. (2004).

For each reprocessed sample, a 0.5 g split will be analyzed for a total of 37 elements by inductively coupled plasma mass spectrometry (ICP-MS) following an aqua regia digestion. These analyses will be conducted at Acme Analytical Laboratories Ltd. (Vancouver).

Quality Control

Quality control measures were implemented during the initial collection of the archived samples. For each block of 20 samples submitted for analysis, one field duplicate (taken at a randomly selected sample site) was included. As part of this study, one analytical duplicate (a sample split after sample preparation but before analysis) and one reference standard will be included for each block of 20 samples. Reference standards will either be certified Canada Centre for Mineral and Energy Technology (CANMET) standards or one of several BCGS geochemical reference materials. Field duplicate samples will be used to measure the combined sampling and analytical variability, whereas analytical duplicates will provide a measure of analytical variability only. Certified reference standards will be used to measure the accuracy of each analytical method and BCGS geochemical reference materials will be used to measure analytical precision.

Summary and Future Data Release

At present, clay separations are being produced for 529 archived till samples from the Babine porphyry copper district. Upon completion of separations, these samples will be analyzed by ICP-MS following an aqua regia digestion. Analytical determinations on the clay-sized fraction (<0.002 mm) can increase the contrast between elevated and background element concentrations, as compared to the same analyses using the silt- plus clay-sized fraction (<0.063 mm). These new, high quality, geochemical data will be used to further constrain and better define geochemical targets within the Babine porphyry copper district and targets previously identified by Levson (2002) using determinations on the silt- plus clay-sized fraction of these till samples, and to potentially identify additional geochemical exploration targets.

An update on this study will be given at the Mineral Exploration Roundup 2009 poster session. The new geochemical data generated from this study will be released in the spring of 2009. This release will include interpretations of these data and an integration of them with work presented by Levson (2002), including the region's ice-flow history and inferred detrital transport direction(s) in basal till.

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