CHAPTER 7

QUATERNARY GEOLOGY

Quaternary geology studies in the Babine region indicate that ice erosion during the last glaciation was extensive and removed most of the older Quaternary deposits. These sediments are preserved mainly in valley bottom settings and are only rarely exposed along deeply incised rivers or in road and mine site excavations. Sediments dating from the last interglacial occur in the Bell Mine area (Harington et al., 1974) and along the Babine River (Levson, 2001a). These sediments are mainly lacustrine in origin. Recovered pollen data indicate that a shrub tundra vegetation existed in the area prior to the last glacial period. No conclusive stratigraphic evidence of glaciation prior to the last event is observed.

Late Wisconsinan glaciers first advanced into the region from the Skeena Mountains to the north along major valleys such as the Babine and Takla. Damming of tributary drainage and the development of proglacial lakes occurred in some valleys. Meltwater streams flowing from the advancing glaciers deposited coarse-grained proglacial outwash plains in the valley bottoms. Deltas developed where the streams entered the proglacial lakes. Debris-flow sediments formed in conjunction with the outwash and proglacial lake sediments. Eventually the glaciers advanced over the entire region and much of the pre-existing surficial cover was removed by the ice.

Throughout the last glacial period, widespread ice erosion of bedrock also occurred. The eroded materials were transported down-ice and deposited mainly as basal lodgment and meltout tills. Basal tills form a cover, varying in average thickness from a few to several metres in low-lying areas, to less than a metre in upland regions. Late Wisconsinan ice flow indicators are generally valley parallel despite a somewhat complex glacial history. Ice-flow studies conducted over several years indicate that in most areas in the Babine porphyry district, the dominant flow-direction was southeasterly. Glacial dispersal patterns are dominated by this regional direction. This is supported by detailed studies at several sites (e.g. Levson et al., 1997b; Stumpf et al., 1997; Levson 2001a). As a result, marginal sediments deposited during the last glaciation provide an excellent sampling medium for drift exploration programs and the direction of derivation is readily determined.

In some areas, topographically controlled flow occurred during both early and late stages of glaciation. Effects of these modifications to glacial dispersal patterns are restricted mainly to areas of relatively high relief. For example, alpine glaciers in high mountainous areas, such as the Bait Range, formed cirque basins on the north and east facing sides of some mountains. During the maximum build up of ice, probably late in the last glaciation, a topographically independent westerly ice-flow event occurred. Evidence of westerly flow is best preserved in the southern Babine Mountains and farther south and west. Westerly ice flow in this part of the Nechako Plateau is regionally anomalous and occurred when a late-glacial ice divide, or series of divides, migrated eastward into the interior from the Coast Mountains (Levson et al., 1997a; Levson and Stumpf, 1998; Stumpf et al., 2000; Levson, 2001a). This event apparently did not greatly influence mineral dispersal in the Babine porphyry district. However, the local presence of late, westerly flow indicators suggests that minor dispersal from the east may have occurred.

Basal tills are commonly covered by loose, sandy gravely diamictons which were deposited by debris flows during deglaciation. Glaciofluvial deposits including esker and kame complexes, raised deltas and gravely outwash plains generally occur in valley bottom settings. Glaciofluvial sediments consist mainly of poorly to well sorted, stratified, pebble and cobble gravels and sands. Glaciolacustrine sediments, generally consisting of clay, silt and sand veins, are common in large valleys, such as the Babine Lake valley. They are thickest at elevations below 750 m where they limit the usefulness of detailed till geochemical surveys although regional samples can still be obtained by utilizing deep Quaternary exposures. During postglacial times, the surficial geology of the area was modified mainly by fluvial activity and the local development of alluvial fans in the valley bottoms, as well as by colluvial reworking of glacial deposits along the valley sides. Post-glacial washing and resedimentation on slopes caused widespread modification of surface tills and undisturbed basal till samples commonly can be obtained only at depths below about one metre (Figure 9b).

TILL GEOCHEMISTRY

A total of 937 regional till samples were collected as part of this study, the largest regional basal till geochemical database collected to date in British Columbia. Results are presented for various analytical techniques including INAA for 26 elements, ICP-ES for 23 elements, and whole rock analysis for 11 major oxides, 7 minor elements and loss on ignition. The greater than 98th percentile class in this large data set contains 19 sites, and the task of evaluating even the upper two percentile data for some elements of interest is onerous (e.g. 19 sites x 12 elements = 228 data points). However, due to the large size and high quality of the data set and the consequent potential for the discovery of new exploration targets, substantial effort was applied to interpret the data.

In addition to anomaly magnitude, emphasis is placed on glacial dispersal patterns, dispersal direction, multi-element anomalies, multi-site anomalies, comparisons with geochemical data around known mineral deposits, surficial geology controls and bedrock geology. Using these criteria, 66 new exploration targets are highlighted (Figure...
Figure 40. Summary of areas of geochemical interest highlighted in the text. Circled areas largely reflect broad dispersal zones, not specific areas recommended for exploration. The latter areas generally are much smaller and occur to the northwest (up-ice) of the outlined areas. Each area is discussed in the text under the element indicated in the legend.
Element concentrations and dispersal patterns in these new areas are comparable to those observed in the vicinity of known mineral occurrences. These new prospective areas, containing no recorded mineral occurrences, include multi-element anomalies with greater than 98th percentile concentrations of one or more elements of exploration significance. These include copper, lead, zinc, gold, silver, molybdenum, nickel, chromium, cobalt, arsenic, antimony and mercury.

Nineteen new areas, which contain elevated (at least 95th percentile) concentrations of copper, are highlighted. At many of these sites concentrations of copper, and at least one other important element, exceed the 98th percentile. An additional 14 areas, which contain elevated concentrations of lead and/or zinc, are also highlighted. All of these areas are indicated by multi-element anomalies, commonly with >98th percentile concentrations of at least one element. In addition, anomalous concentrations of metals occur at multiple adjacent sites in most of these areas and anomaly patterns are commonly compatible with southeasterly glacial dispersal from previously unidentified source areas. Three additional areas with >98th percentile gold and four with >95th percentile gold are also presented. Elevated (generally at least 95th percentile) concentrations of silver occur in 5 additional areas, molybdenum in four areas, arsenic and/or antimony in nine areas, mercury in four areas and nickel, chromium and/or cobalt in four areas. A total of 66 distinct areas are highlighted. Sites within these areas represent about 7 percent of the total number of till sites sampled during the course of this study.

The wide variety of surficial sediment types which occur in the Babine region, as in other mountainous areas, requires that effective geochemical sampling programs be media specific. Basal till geochemistry is clearly one exploration tool that can be used effectively in such regions for locating buried mineralization. In spite of the masking effects of extensive glaciolacustrine, glaciofluvial and other surficial deposits in the Babine porphyry district, elevated concentrations of metals are found in regional till samples in the vicinity of most mineral occurrences. Till geochemical anomalies can be traced in the up-ice direction (generally northwesterly) mainly using the orientations of large streamlined landforms.

Zones of elevated metal concentrations associated with glacial dispersal of mineralized bedrock in the Babine area, as in other parts of the Nechako Plateau, are typically up to a few kilometres long and several hundred metres or more wide. Isolated anomalies and erratics associated with the dispersal plumes may cover much larger areas and be up to several kilometres long. They are typically elongated parallel to the dominant ice-flow direction, with mineralized source rocks occurring at or near the up-ice end of the dispersal plumes. For example, element concentrations at most till sites around mineral occurrences are typically highest in the tills to the southeast of outcropping mineralized rocks, reflecting down-ice dispersal. Till geochemistry reflects up-ice bedrock sources and not the immediately underlying bedrock. In areas of thick till, near-surface anomalies may be displaced by 0.5 km or more down-ice from their bedrock sources. Subsurface exploration targets in these areas should be up-ice, rather than at the heads, of the anomalies.

Tills near and down-ice of virtually all existing mineral properties in the region show metal concentrations above the regional 95th percentile. For example, tills collected at the Bell mine and Nak prospect contain >95th percentile concentrations of copper, lead, zinc, gold, chromium and cobalt, as well as >98th percentile concentrations of arsenic and antimony, >85th percentile molybdenum and mercury, and >70th percentile nickel. Greater than 98th percentile concentrations of copper, lead, zinc also occur in the Nak area and at one site adjacent to (but not down-ice of) the Bell mine. In addition, greater than 98th percentile concentrations of gold and molybdenum occur in the Nak area while >98th percentile silver occurs in the Bell mine area.

The density of sampling in the Bell and Nak areas is greater than in most parts of the study area as they were also the focus of detailed case study investigations. The situation down-ice of the Granisle mine, where only one sample was collected, is more typical of the regional sample distribution. At that site, >95th percentile concentrations of copper, >85th percentile molybdenum and >75th percentile gold occur in till. However, other elements are not highly elevated, reflecting the limited sampling. This situation, where only two or three elements are elevated at one site, is probably representative of the regional data base, down-ice of buried mineralization.

In the vicinity of the Morrison and Hearne Hill developed prospects, >98th percentile concentrations of copper, lead, gold, silver and antimony, and >85th percentile molybdenum occur in regional till samples. Till at the Morrison deposit also has >98th percentile concentrations of arsenic and mercury, and >90th percentile nickel while till at Hearne Hill also has >95th percentile concentrations of cobalt and chromium. Arsenic concentrations in till at the Morrison deposit are the highest in the study area (122 ppm). A similar relationship between highest element concentrations and mineral deposits, is seen at several other properties. For example, the highest molybdenum concentration (38 ppm) occurs at a site directly down-ice of the Wolf prospect. The highest and second highest zinc concentrations occur at two sites in the vicinity of the Trail Peak porphyry, the highest lead (78 ppm) occurs in till at the Copper showing, the highest silver (1.4 ppm) occurs at the Bell mine and the highest chromium (220 ppm) occurs down-ice of the Mine occurrence (MINFILE 093L 164).

Tills at most other mineral occurrences contain at least 95th percentile concentrations of one or more elements of significance. For example, >98th percentile copper concentrations occur in till at the Sat, Mine, Donna, Cougar and Babs showings. Likewise, copper concentrations, above the regional 95th percentile (70 ppm), occur in the vicinity of the Bab, Sparrowhawk, Fort, Totem, Kare, and Jill copper showings (MINFILE numbers 093 L 199, 220 and 242, respectively). Similarly, elevated lead and/or zinc concentrations in till occur in the vicinity, or directly down-ice, of the Dorothy, Fireweed, Lennac, Trail Peak, Friday, Lynn, Copper and Jill properties. High gold occurs around the Friday Green, Morrison, Hearne Hill, Bell, Lennac, Bab, Mast,
Babs and Sparrowhawk properties. Concentrations of silver above the 95th percentile (> 0.4 ppm) occur in the vicinity of several showings including the Friday Green, Lynn, Alp and Cortina showings. Greater than 98th percentile (> 3 ppm) molybdenum concentrations occur in regional till sites near or directly down-ice of the Trail Peak, Nak, Wolf, Mast, Fort, Fireweed, Sat and Donna properties. In addition to reflecting known mineralization, geochemical results around some mineral properties indicate that further exploration in those areas may be warranted.