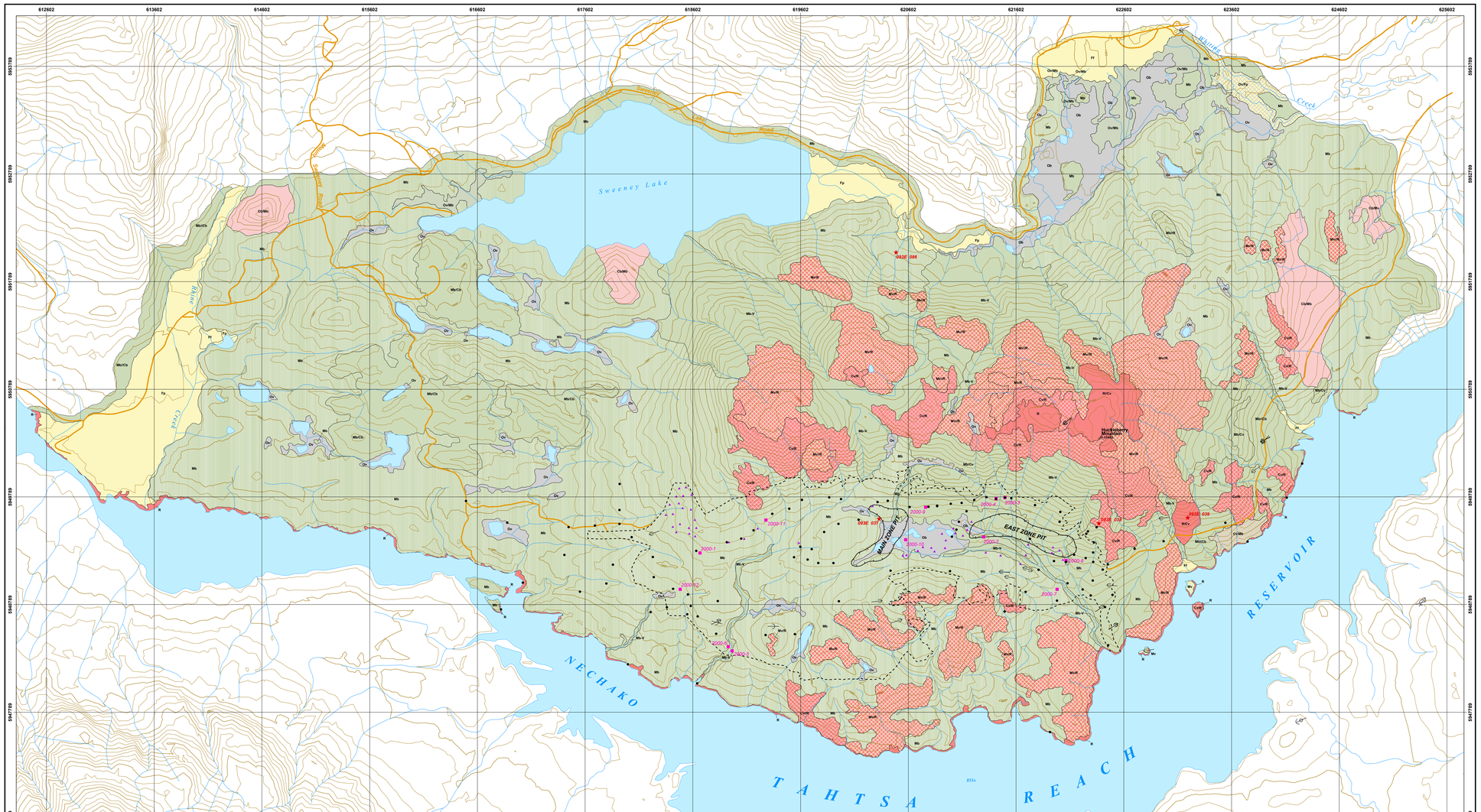

British Columbia
Ministry of Energy and Mines
Resource Development Division

Geological Survey Branch

OPEN FILE 2003-2

SURFICIAL GEOLOGY OF THE HUCKLEBERRY MINE AREA

NORTH-CENTRAL NTS 93E/11

T. Ferbey and V.M. Levson (PGeo)

Cartography by T. Ferbey

SCALE 1:15 000

1,000 0 1,000 2,000
Metres

datum: NAD 83 projection: UTM Zone 9
elevation in metres above mean sea level; contour inteval 20 m

Field survey carried out July to September, 2000

GEOLOGY

QUATERNARY SEDIMENTS

HOLOCENE

Colluvial Deposits: *poorly sorted, angular gravels and sandy diamicts, found on moderate to steep slopes, associated with the down-slope transport and deposition (by gravity processes) of weathered bedrock and pre-existing Quaternary sediments.*

Cb — ***Colluvial Blanket:*** *colluvial deposit >1 m in thickness, generally conforming to underlying topography but masking small scale irregularities; found mainly on moderately steep (~15° to 20°), lower elevation slopes capping glacial units; locally forms talus deposits below steep slopes.*

Cv — ***Colluvial Veneer:*** *colluvial deposit 1 m or less in thickness, that conforms to minor surface irregularities of the underlying material; commonly found at higher elevations on steep to very steep slopes (~25° to 35°), where it is interspersed with areas of bedrock or morainal deposits.*

Fluvial Deposits: *silt, sand, and gravel deposited by streams and creeks; usually stratified, and with the exception of alluvial fans, is moderately to well sorted.*

Fp — ***Fluvial Plain:*** *thick fluvial deposit (>1 m) found on gently sloping surfaces; includes overbank deposits, terraces, abandoned and active channels of Whiting and Rhine Creeks, and the Sweeney Lake outlet; locally includes small areas of organic deposits along Whiting Creek; includes a deltaic deposit located at the east end of Sweeney Lake.*

Ff — ***Alluvial Fan:*** *thick deposits (>1 m) found at the mouth of a gully or confined valley; these deposits are dominantly fluvial in origin but likely include debris flow sediments.*

Organic Deposits: *bog or swamp like, unforested, composed primarily of moss and organic soils, with a shallow water table found at or near the surface.*

Ob — ***Organic Blanket:*** *organic deposit >1 m in thickness, found in poorly drained areas that overlie thick morainal and fluvial deposits; typically fibric to mesic peats with identifiable organic material ranging in size from twigs and cones to tree limbs and stumps; can be capped by organic muds or gyttja; small ponds are present with small, low discharge, streams running through or from them; these deposits occupy relatively large areas east of Sweeney Lake and on the Huckleberry Mine property between the Main and East Zone Pits.*

Ov — ***Organic Veneer:*** *organic deposit 1 m or less in thickness; commonly borders ponds, lakes, and streams, but is also associated with bog (i.e.* ***Ob****) margins;* ***Ov*** *is cross-hatched where other surficial units are also extensive.*

LATE PLEISTOCENE DEPOSITS

Morainal Deposits: *typically massive, matrix-supported, sandy-silt, light brown to light grey, poorly sorted diamicts, originally deposited by or from glacial ice; these deposits are predominantly overconsolidated basal tills with vertical jointing and good sub-horizontal fissility; striated clasts are common; locally these tills can have a more sand rich matrix and can contain discontinuous lenses, and in some cases interbeds, of poorly sorted gravelly sands; at Huckleberry Mine, mineralized andesite and granodiorite clasts are common immediately adjacent to, and west of, the Main and East Zone pits; pyrite and chalcopyrite grains are also common here within the diamict matrix which is locally dark grey and clay-rich.*

Mb — ***Morainal Blanket:*** *morainal deposit >1 m in thickness, with a known maximum thickness of approximately 30 m in the vicinity of the Main and East Zone pits; generally conforms to underlying topography but masks small scale irregularities; these deposits form an extensive cover in valley bottoms and on the lower and mid-slopes of highland areas; gullied morainal deposits (****Mb-V****) have the same general characteristics but have been deeply incised by fluvial processes, and are typically found on the steeper flanks of Huckleberry Mountain and on the northern slopes of Tahtsa Reach.*

Mv — ***Morainal Veneer:*** *morainal deposit 1 m or less in thickness, that conforms to minor surface irregularities of the underlying material; typically a basal till that is found in higher relief areas (e.g. north shore of Tahtsa Reach and south of mine area) and higher elevations of Huckleberry Mountain; associated with bedrock outcrop, but can also contain small areas of colluvial and morainal blanket material;* ***Mv*** *is cross-hatched where other map units are also extensive.*

PRE-QUATERNARY BEDROCK

R — ***Bedrock:*** *large areas of bedrock outcrop are limited to the higher elevations of Huckleberry Mountain; flooding of the Nechako Reservoir, and resulting wave-wash processes, have created discontinuous bedrock outcrop along the shores of Tahtsa Reach; small areas of bedrock outcrop are also found locally in steeper colluviated areas above the north shore of Tahtsa Reach; bedrock of the Huckleberry Mine area is typically hornfelsed, fragmental, andesite of the Early Jurassic Telkwa Formation (MacIntyre, 1985); at Huckleberry Mine, mineralization occurs within a stockwork system of fractures and veinlets associated with two porphyritic hornblende-biotite-feldspar granodiorite intrusions (Late Cretaceous Bulkley Intrusions); these stocks are adjacent to or within the Main and East Zone pits (MacIntyre, 1985; 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).*

NOTE: Composite delimiters on the map separate more extensive (single back-slash, /) and considerably more extensive (double back-slash, //) surficial units from less extensive units (e.g. Mv//R - Mv is considerably more extensive than R).

SYMBOLS

- surface till sample
- sub-surface till sample (collected using Becker-hammer drill)
- stratigraphic section site (section number) — 2000-10
- mineral occurrence (MINFILE number) — 093E 037
- geologic contact (approximate)
- active pit outline
- active mine area
- road

GLACIAL FEATURES

- roche moutonnee, crag and tail, flute (uni-directional)
- ridge, flute (bi-directional)
- groove
- rat-tail
- striae (uni-directional)
- striae (bi-directional)

INTRODUCTION

During the 2000 field season, geochemical studies were conducted on the Huckleberry Mine property in northwest British Columbia (Figure 1). Glacial history and ice flow studies were also completed on the property (north-central NTS 93E/11) and in the surrounding area (NTS 93E/10-11, 93E/14-16), which included detailed stratigraphic and sedimentologic studies conducted at 12 exposures on the Huckleberry Mine property. Ferbey and Levson (2001a, b, c) provide an overview of the 2000 field program and preliminary interpretations of the resulting till geochemical data sets and report on the complex ice-flow history of the Huckleberry Mine area.

This surficial geology map is a product of the 2000 field survey of the Huckleberry Mine area and interpretations of 1:15,000 scale aerial photographs. The terrain mapping conventions used here are based on those of Howse and Kenk (1997), and focus primarily on surficial materials and surface expression. A composite stratigraphic section (Figure 2), based on the detailed stratigraphic and sedimentologic studies conducted on the mine property, is included to assist in characterizing the Quaternary sediments of the Huckleberry Mine area.

LOCATION AND PHYSICAL SETTING

The Huckleberry Mine area falls within the transition zone between the Nechako Plateau to the east and the Coast Mountains to the west (Figure 1). This area, the Tahtsa Ranges, is a belt of mountains 16-24 km wide, oriented northwest-southeast, with peaks ranging from 2100 to 2400 m in elevation. The Tahtsa Ranges are divided roughly east-west by major valleys that are occupied by large lakes (e.g. Tahtsa, Troitsa, and Whitesail Lakes). These lakes are prominent features of the Tahtsa Ranges and occur at relatively high elevations (784 to 930 m) therefore reducing the overall relief of the area (Holland, 1976). Valley bottoms and mountain flanks are forested and have thick sequences of Quaternary sediments with little bedrock exposure. Upper slopes and peaks extend into sub-alpine and alpine environments.

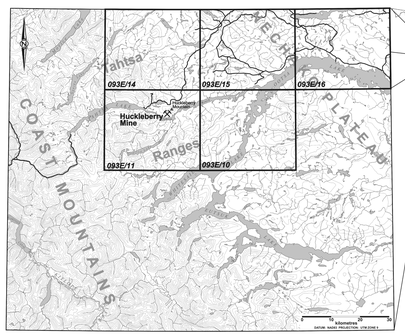

Figure 1 - NTS 93 E, Whitesail Lake, with study area location. At Huckleberry Mine, Quaternary sediments were studied in detail while surface and sub-surface basal till samples were collected for trace element geochemical analyses. A study of streamlined and erosional landforms and features extended into NTS 93E/10-11, 14-16, to help determine the Late Wisconsinan ice-flow history of the Huckleberry Mine area.

Huckleberry Mine (MINFILE No. 093E 037) is located on the north side of Tahtsa Reach, approximately 120 km southwest of Houston, British Columbia, and is accessed via Forest Service and private mine roads (Figure 1). The mine site is located in a poorly drained, boggy, arcuate, U-shaped valley (averaging 1015 m elevation), adjacent to the southern flank of Huckleberry Mountain (1543 m). Huckleberry Mine is a porphyry copper-molybdenum open pit mine, with minor recoverable amounts of gold and silver, and has a production rate of 21,000 tonnes/day ore (Huckleberry, 2000). A more detailed discussion on local bedrock types and the style of mineralization can be found in the map unit descriptions. Other mineral occurrences found near Huckleberry Mine are listed in Table 1, with locations shown on the map.

MINFILE NUMBER	NAME	STATUS	COMMODITY	DEPOSIT TYPE
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
093E 086	WEE	Showing	Cu, Mo	Porphyry Cu ± Mo ± Au
093E 113	WHITING CREEK (SWEENEY)	Showing	Cu, Mo	Porphyry Cu ± Mo ± Au

Table 1 - Mineral Occurrences located near Huckleberry Mine. Locations, with MINFILE number, are shown on the map with a star.

PREVIOUS WORK

The surficial geology of the study area was first mapped by the British Columbia Ministry of Environment, Lands and Parks (1976) at a scale of 1:50 000, while a more detailed 1:10 000 scale map of the Huckleberry Mine property was produced by New Canamin Resources (1993). In both cases, these maps are limited to the delineation and interpretation of surficial sediments only; identification and interpretation of ice flow indicators such as striae and streamlined landforms are not included.

Other Quaternary geological studies have been conducted in areas adjacent to the Whitesail Lake map area (NTS 93 E). Immediately north, Tipper (1994) and Levson *et al.* (1998) discuss the Quaternary geology and glacial and geomorphic features of NTS 93 L and M. Again to the north, a detailed report on the Quaternary geology and till geochemistry of the Babine Copper Belt (NTS 93L/9, 16; M/1, 2, 7-8) is provided by Levson (2001) and Levson *et al.* (2002). Similar studies by Levson and Giles (1997), Levson *et al.* (1999), Plouffe and Levson (2001), Levson and Mate (2002), focus on areas bordering to the northeast, east, and southeast, within NTS 93 K, F, and C respectively. Stumpf *et al.* (2000) discuss the timing of the Fraser Glaciation in central British Columbia, and associated ice-flow events.

Quaternary geological studies within NTS 93 E have not yet revealed any Middle Wisconsinan (Olympia nonglacial) ages. However 100 km east of the Huckleberry Mine area, on Cheslaslie Arm, organic rich sediments that underlie Late Wisconsinan (Fraser Glaciation) till have produced radiocarbon ages that range from approximately 27,000 to >45,000 years B.P. (Levson and Giles, 1997; Levson *et al.*, 1998). As well, nonglacial sediments under till that have yielded finite radiocarbon ages occur in a number of other localities farther east in the Nechako Plateau (Plouffe and Jetté, 1997; Plouffe and Levson, 2001) and approximately 200 km north of the study area at the Bell Mine on Babine Lake (Harington *et al.*, 1974; Levson, 2001). The Quaternary sediments of the Huckleberry Mine area are believed to be correlative with those found in areas adjacent to NTS 93 E which overlie the dated organic rich and lacustrine deposits and are therefore interpreted as being Late Wisconsinan (Fraser Glaciation) to Holocene in age.

QUATERNARY GEOLOGY

Although the Quaternary landscape depicted on this map is dominated by Late Wisconsinan morainal deposits, it has been modified significantly by post-glacial (or Holocene) fluvial and colluvial activity, peat forming processes and soil development. In comparison with areas mapped adjacent to it, a notable characteristic of the Huckleberry Mine area is an absence of glaciofluvial and glaciolacustrine deposits at the surface. The following is a discussion of the glacial and de-glacial phases of the Cordilleran Ice Sheet, pertaining to the Huckleberry Mine area, and the resulting general sediment types deposited. A more detailed description of these sediments is provided in Figure 2 and in the map unit descriptions.

Ice-flow History

The Huckleberry Mine area has a complex ice-flow history. The orientation of streamlined landforms initially suggests a dominant ice flow direction of east to northeast during the last glacial maximum. However, field investigations of these landforms and small scale features on bedrock weakly exposed within them suggest a more complex ice flow history with an earlier west to southwesterly flow event followed by the east to northeast event.

Based on the relative degree of landform preservation, the timing of opposing ice flow events inferred from cross-cutting and/or superimposition relationships, and the absence of all but west to southwest ice-flow indicators at high elevation sites (>1500 m), the west to southwest event appears to be earlier than the east to northeast event, and the product of a thicker ice sheet. This west to southwest event is therefore interpreted as the dominant ice-flow direction during the Fraser Glaciation maximum which was followed in some low elevation areas by a weaker, possibly shorter lived, east to northeast ice flow event. Evidence of easterly ice flow out of the Coast Mountains, which undoubtedly dominated during the relatively long build-up phases of the Fraser Glaciation, is preserved at only a few sites as most evidence was likely obliterated by the subsequent events.

These results are in general agreement with those discussed by Levson *et al.* (1998, 1999), and Stumpf *et al.* (2000), and indicate the presence of an ice dome in central British Columbia during the Fraser Glaciation maximum. With the development of this ice dome, ice that once flowed east from the Coast Mountains during early Late Wisconsinan time now flowed west to southwest back towards and over these peaks producing the observed west to southwest ice flow indicators. Towards the end of the Late Wisconsinan this divide locally shifted west, back towards the Coast Mountains. As the ice sheet began to thin, ice flow again was influenced by topography producing the east/northeast ice flow indicators observed on air photos and in the field.

For a more thorough discussion and presentation of ice flow data for the Huckleberry Mine area, the reader is directed to Ferbey and Levson (2001c).

Advance Phase and Glacial Deposits

Advance phase sediments in the Huckleberry Mine area are only seen in vertical exposures and are composed primarily of clast supported, matrix filled, rough cross-bedded, large pebble to cobble gravels; bottom contacts are not exposed (e.g. Stratigraphic Section 2000-11). These deposits, interpreted as advance phase glaciofluvial sediments, are observed peripheral to, and slightly down-elevation from, the central part of the arcuate valley that hosts the Huckleberry Mine deposit. Up-section these deposits are interbedded with matrix supported, massive to stratified, sandy-silt to silty-sand diamictons interpreted to be debris flow deposits.

In the vicinity of the Main Zone Pit and in the East Zone Pit area, seen in vertical exposures in the valley bottom (approximately 1040 m), are laminated silts and clays, pebbly muds, and massive fine sands. These fine sediments are locally deformed (e.g. millimetre scale shears, normal and thrust faults), and contain small to medium pebble-sized dropstones (Stratigraphic Section 2000-2). They infill a bedrock depression that opens to the east where a sediment dam may have prevented free drainage to the east. Similar sediments are observed in gully exposures on the southern flank of Huckleberry Mountain (Stratigraphic Section 2000-3 and 4), at approximately 1120 m. These fine grained sediments are interpreted as advance phase ice-marginal or sub-glacial glaciolacustrine sediments. At all exposures, these glaciolacustrine sediments are interbedded with massive, matrix supported diamictons. These poorly sorted sediments typically exhibit some degree of jointing and fissility, are moderately dense, can have striated clasts, and in some cases contain fine silt/clay laminae or lenses up to 10 cm thick. These diamicton interbeds are interpreted as subaqueous glacigenic debris flow or basal rain-out till deposits.

Full glacial deposits are the dominant Quaternary deposit and form a ubiquitous cover in the Huckleberry Mine area. A product of commination and reworking of bedrock and existing Quaternary deposits by glacial ice during the Fraser Glaciation, these deposits consist primarily of a massive and matrix supported, overconsolidated, sandy-silt diamicton, that is typically fissile and well jointed. These deposits are interpreted as basal tills and form thick blankets (**Mb**) in valley bottoms and on the lower and mid-slopes of valley sides. Locally there are examples of gravelly-sand diamictons, with undulating sand and gravel interbeds and discontinuous sandy and gravelly lenses. These sediments are interpreted as basal meltout tills. In the vicinity of the East Zone Pit, basal tills reach a maximum known thickness of approximately 30 m where they overlie striated, ore-grade bedrock.

Morainal deposits commonly occur at the surface but locally are covered by organic (**Ob**) or colluvial blankets (**Cb**). Morainal blankets typically overlie either bedrock (**R**) (e.g. Stratigraphic Sections 2000-1, 2000-3, and 2000-7) or glacial-fluvial gravels (e.g. Stratigraphic Section 2000-11). The exception to this would be east of the Main Zone Pit and in the East Zone Pit area, where in addition to overlying bedrock, basal tills are found overlying the previously described glaciolacustrine sediments (Stratigraphic Section 2000-2). At higher elevations, and on steeper slopes, till forms a thin veneer (**Mv**) that mantles bedrock (**R**) or is found as a discontinuous cover in association with colluvial veneers (**Cv**).

At Stratigraphic Section 2000-1, multiple till units were identified. The units are distinguished primarily by differences in physical characteristics such as clast size, clast content, matrix texture and colour. The contacts between units are typically gradational over 20 to 30 cm. The presence of multiple till units (each 2 to 6 m in thickness) could be attributed to: the complex ice-flow history of the area and changes in ice flow direction which resulted in a change in provenance for individual till units; a change in depositional facies (e.g. from basal lodgement to basal meltout); or a combination of both.

Retreat Phase and Holocene Deposits

De-glacial phase deposits consist primarily of interbedded gravels and sands. Gravel beds are clast-supported and include both moderately to poorly sorted, matrix-filled, large pebble to cobble gravels and open work, small to medium pebble gravels. Sands are poorly sorted and mainly medium to coarse grained. These sands and gravels were observed on the Huckleberry Mine property in vertical exposures only (e.g. Stratigraphic Sections 2000-5 to 7, and 2000-10), directly over till. They are interpreted as glacio-fluvial sediments, deposited as ice retreated from the area.

Organic deposits are the dominate Holocene surficial material in the Huckleberry Mine area. They probably accumulated over much of the Holocene as indicated by wood fragments from a peat horizon overlying fan gravels that yielded a radiocarbon age of 7120 years B.P. (+60 years B.P.) (Beta 158482). Organic veneers (**Ov**), swamp-like in character, commonly border bodies of standing water, bogs, and streams, while organic blankets (**Ob**), or bogs, are aerially more extensive and substantially thicker, occupying large depressions in poorly drained areas. Other Holocene deposits in the area include fluvial fans (**Ff**) and fluvial plains (**Fp**), such as those deposited by Whiting Creek in the northeast corner of the map area and by Rhine Creek in the southwest. Both creeks drain aerially extensive, high elevation areas to the north where glaciers continue to supply meltwater, helping account for these sizeable deposits.

Throughout the Holocene the main channel of Whiting Creek has moved laterally across the more open area at the mouth of the confined Whiting Creek valley. The decrease in stream competency as Whiting Creek exits the confined valley has resulted in sediment aggradation and formation of a large fluvial fan (**Ff**; northeast corner of the map area). At some point during early Holocene time, Whiting Creek flow shifted across this developing fluvial fan, and flowed southwest into Sweeney Lake. Deposition of the fluvial plain (**Fp**) on the east shore of Sweeney Lake may be the product of resultant increased lake levels which were likely maintained until a sediment dam at the west end of Sweeney Lake was topped and incised by the present day outlet. Seen in the field are poorly exposed, fine grained sediments, in the vicinity of the Mount Sweeney and Sweeney Lake Road intersection; these may be lacustrine sediments, perhaps also a product of increased lake levels. The Whiting Creek main channel has since shifted back across the large fluvial fan towards the southeast and at present empties into Tahtsa Reach.

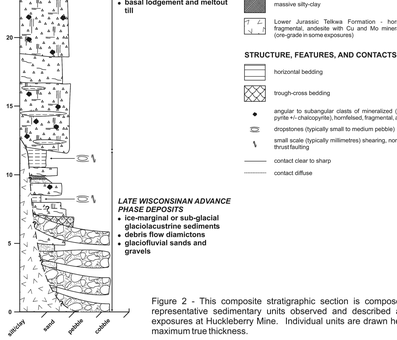

Figure 2 - This composite stratigraphic section is composed of representative sedimentary units observed and described at 12 exposures at Huckleberry Mine. Individual units are drawn here in maximum true thickness.

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