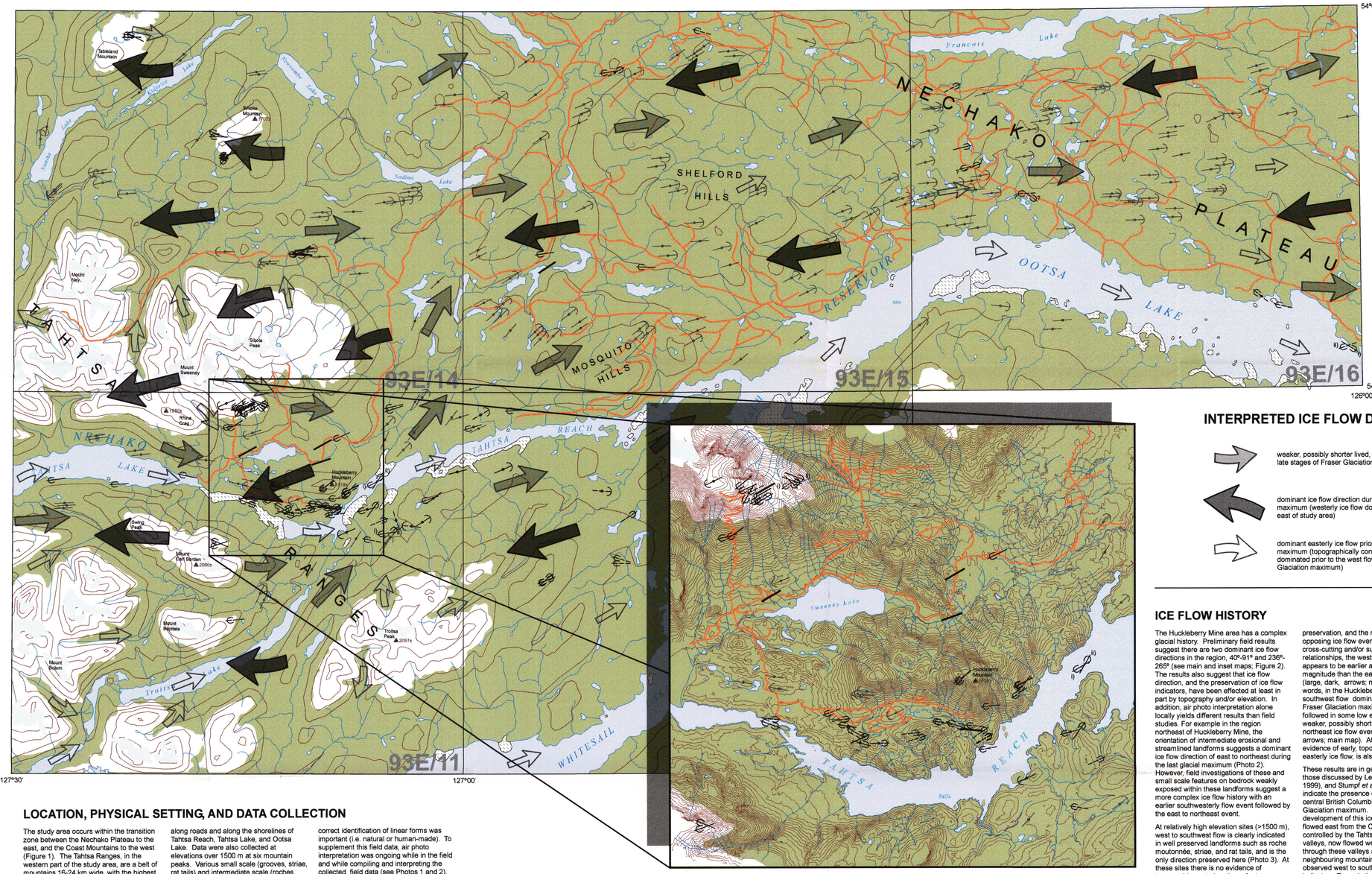

BRITISH COLUMBIA
Ministry of Energy and Mines
Energy and Minerals Division

Geological Survey Branch
OPEN FILE 2001-8
(Sheet 1 of 1)

ICE FLOW HISTORY OF TAHTSA LAKE - OOTSA LAKE REGION

NTS 93E/10,11,14,15,16

Travis Ferbey and Victor M. Levson (P.Geo.)

scale 1:111,000

5 0 5 10 15
kilometres
datum: NAD 83 projection: UTM Zone 9
elevation in metres above mean sea level

Field survey carried out July to September, 2000

INTERPRETED ICE FLOW DIRECTION

- weaker, possibly shorter lived, ice flow direction during late stages of Fraser Glaciation
- dominant ice flow direction during Fraser Glaciation maximum (westerly ice flow dominant with ice divide east of study area)
- dominant easterly ice flow prior to Fraser Glaciation maximum (topographically controlled easterly flow dominated prior to the west flow reversal at the Fraser Glaciation maximum)

ICE FLOW INDICATORS

FIELD DATA

- drumlin; crag and tail; roche moutonnée; flute (direction definite, direction probable, direction unknown)
- groove
- striae (direction definite, direction probable, direction unknown)
- rat tail (direction definite, direction probable)

AIRPHOTO INTERPRETATION

- drumlin; crag and tail; roche moutonnée; flute (direction definite, direction unknown)

ICE FLOW HISTORY

The Huckleberry Mine area has a complex glacial history. Preliminary field results suggest there are two dominant ice flow directions in the region, 40º-91º and 236º-265º (see main and inset maps; Figure 2). The results also suggest that ice flow direction, and the preservation of ice flow indicators, have been effected at least in part by topography and/or elevation. In addition, air photo interpretation alone locally yields different results than field studies. For example in the region northeast of Huckleberry Mine, the orientation of intermediate erosional and streamlined landforms suggests a dominant ice flow direction of east to northeast during the last glacial maximum (Photo 2). However, field investigations of these and small scale features on bedrock weakly exposed within these landforms suggest a more complex ice flow history with an earlier southwesterly flow event followed by the east to northeast event.

At relatively high elevation sites (>1500 m), west to southwest flow is clearly indicated in well preserved landforms such as roche moutonnée, striae, and rat tails, and is the only direction preserved here (Photo 3). At these sites there is no evidence of topographic control as these features are observed with orientations that cross mountain tops and do not conform to the trend of the 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. Along the shores of Tahtsa Reach and Tahtsa and Ootsa Lakes for example, ice flow was topographically controlled and appears to have flowed parallel to the valleys, regardless of the regional ice flow direction. At these lower elevation sites it is common to find west to southwest and east to northeast ice flow indicators on opposite sides of the same outcrop (Photo 4). It is also common to find evidence of one flow direction superimposed on a landform which indicates flow in the opposite direction.

Based on the relative degree of landform preservation, and the magnitude of these opposing ice flow events inferred from cross-cutting and/or superimposition relationships, the west to southwest event appears to be earlier and of a larger magnitude than the east to northeast event (large, dark, arrows; main map). In other words, in the Huckleberry Mine area west to southwest flow dominated during the Fraser Glaciation maximum and was followed in some low elevation areas by a weaker, possibly shorter lived, east to northeast ice flow event (smaller, light, arrows; main map). At a few sites, evidence of early, topographically controlled easterly ice flow, is also preserved.

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, controlled by the Tahtsa and Ootsa Lake valleys, now flowed west to southwest back through these valleys and over neighbouring mountain 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, and as the ice sheet began to thin, ice flow again was influenced by topography producing the east/northeast ice flow indicators observed in air photos and in the field. Some of the features interpreted as late glacial ice-flow indicators may have been enhanced or formed by subglacial water erosion.

Evidence of early ice flow eastward out of the Coast Mountains was probably obliterated in many areas by the westward flow event; of the 136 ice flow stations visited, only a few provided good evidence of an earlier eastward ice flow event although in many case it is difficult to differentiate early and late easterly flow indicators.

Photo 3. Roche moutonnée on Smoke Mountain (1707 m) showing evidence of southwest ice flow (in photo, ice flow direction is from left to right).

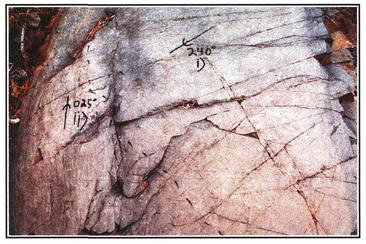

Photo 4. Typical striated outcrop observed at lower elevation sites (Tahtsa Reach), with evidence of two ice flow events i) earlier southwest ice flow; ii) later northeast ice flow.

LOCATION, PHYSICAL SETTING, AND DATA COLLECTION

The study area occurs within the transition zone between the Nechako Plateau to the east, and the Coast Mountains to the west (Figure 1). The Tahtsa Ranges, in the western part of the study area, are a belt of mountains 16-24 km wide, with the highest peak being 2431 m; the remaining peaks typically range from 2100 to 2250 m. These ranges are divided into east-west trending ranges 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 are found at a relatively high elevations (784 to 930m), 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, while upper slopes and peaks extend into subalpine and alpine environments (Photos 1 and 2) (Ferbey and Levson, 2001).

During the 2000 field season, ice flow data were observed and recorded at over 130 ice flow stations. Most striated outcrops were observed in valley bottom settings along roads and along the shorelines of Tahtsa Reach, Tahtsa Lake, and Ootsa Lake. Data were also collected at elevations over 1500 m at six mountain peaks. Various small scale (grooves, striae, rat tails) and intermediate scale (roches moutonnées, crag and tails, flutes, and drumlins) streamlined forms, were studied to better understand the ice flow history of the Huckleberry Mine area. The distribution of selected clast lithologies in till were as well investigated for this same reason.

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) face relationships, the media the form was created and preserved in, and cross-cutting and/or superimposition relationships with other forms. These observations are important not only when interpreting ice flow direction, but in determining the timing and magnitude of multiple ice flow events. As most of these sites are in human-disturbed areas, correct identification of linear forms was important (i.e. natural or human-made). To supplement this field data, air photo interpretation was ongoing while in the field and while compiling and interpreting the collected field data (see Photos 1 and 2).

In addition to this, fabric measurements and pebble counts were taken in undisturbed till, at Huckleberry Mine. For fabric measurements, clast shape, a-axis trend and plunge, and the presence and orientation of striae on clasts relative to a-axis orientation, were recorded. In the case of pebble counts, clasts were first categorized based on lithology and then described in terms of their relative roundness and presence of mineralization. Stratigraphic and sedimentologic descriptions were completed at each of the fabric and pebble count sites, with particular attention given to site locations relative to the ore zones currently being mined (Ferbey and Levson, 2001). Preliminary analyses of fabric and pebble count data support the interpretations based on ice flow station data.

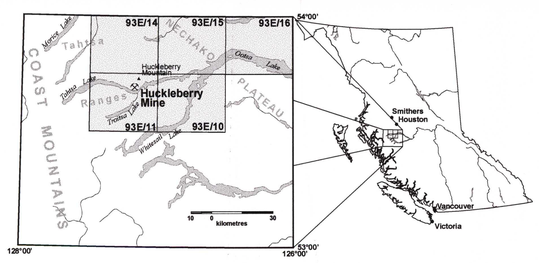

Figure 1. Study area location map.

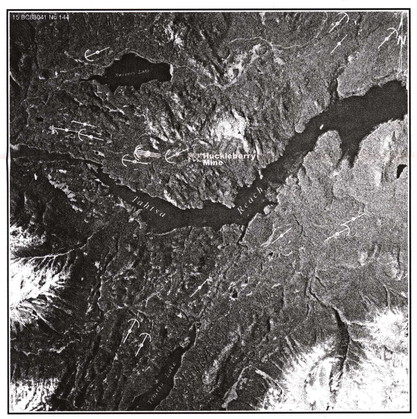

Photo 1. Airphoto interpretation in the immediate vicinity of Huckleberry Mine produces contrasting ice flow directions. Field investigations focused on determining the timing and magnitude of these multiple ice flow events. The aerial extent of this airphoto is close to that of the inset map above.

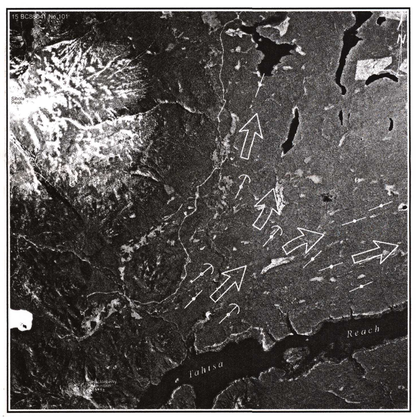

Photo 2. Fluted and drumlinoid topography northeast of Huckleberry Mine. As seen here, airphoto interpretation alone would suggest northeast ice flow during the last glacial maximum. Field studies however, show that this east to northeast ice flow event was preceded by a westerly ice flow event which is interpreted as being the dominant ice flow direction during the Fraser Glaciation maximum.

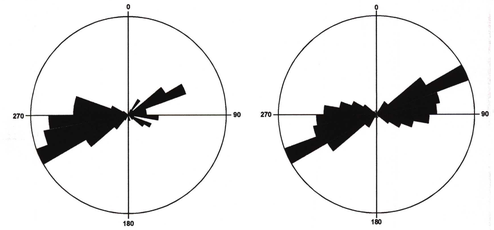

Figure 2. Summary of ice flow indicator orientations observed in the field, plotted as directional vectors (left) and non-directional vectors (right).

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REFERENCES

Ferbey, T., and Levson, V.M. (2001): 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 397-410.

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.

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.

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.

Stumpf, A.J., Broster, B.E. and Levson, V.M. (2000): Multi-phase flow of the Late Wisconsinan Cordilleran ice sheet in western Canada; *Geological Society of America*, Bulletin, Volume 112 (12), pages 1850-1863.