Geodetic Activities During the 1997 Juneau Icefield Research Program Field Season

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1. Introduction

The surveying program of the summer Institute of the Juneau Icefield Research Program (JIRP) program served initially the determination of glacial surface velocities. With the continuous improvement of the surveying instruments, the scope of tasks broadened. The maintenance and enlargement of geodetic networks as a reference frame for the investigations of adjacent geosciences, the derivation of glacial strain rates, the monitoring of short and long term height changes and numerous special investigations (e.g. determination of the position of the terminus of the Taku Glacier) are nowadays routine tasks. All efforts aim at a better understanding of the system "glacier" and its complex interaction with long and short term variations of the climate. Besides those scientific tasks, JIRP is a rigid training course in field work for students of geosciences. Participating in various surveying projects, the students are taught the set-up and logistical aspects of surveying tasks, various surveying techniques, evaluation procedures and the critical interpretation of the obtained results.

2. Survey projects

Using Real-Time-GPS (RT-GPS) intensively in 1997 the survey campaign was mainly focused on the re-establishment of the exact 1996 profile locations to gather reliable data for the varying surface velocities and the long term height changes. The unusual small amount of accumulation during the preceding winter made it impossible to survey the profiles on the lower section of the Taku Glacier (Profiles II and III). Six profiles on the Taku, Matthes and Vaughan-Lewis Glacier were re-established in their last years positions, covering the elevations from about 1100 m to 1800 m. Four new profiles were set up: two on the NW-Branch of the Taku Glacier, one on the Llewellyn Glacier in a better location than 1995 (LANG, 1995) and a movement grid on the high plateau. That and the double-lined Profile IV were used for strain rate determination, too.

Taking advantage of the high productivity provided by RT-GPS four profiles on the Lemon Creek Glacier, covering the uppermost quarter of the glacier, and two profiles on the Ptarmigan Glacier covering about 40% of the glacier were surveyed to quantify the obviously dramatic loss in volume of both glaciers. Totaling some 120 points and some of the reference points of the local Camp 17 network, the survey was completed in about 6 hours including helicopter loading and flight time from and to Camp 10!

Using RT-GPS, seven benchmarks in the Camp 18 sector could be recovered. Two benchmarks were integrated in the ITRF93 coordinate system using static GPS observations and a new one established at F10 Peak to have a reliable reference for RT-GPS applications on the Canadian side of the High Plateau.

All measurements were carried out using GPS, mostly in real time mode. Theory, principles and evaluation of GPS observations are not described in this report; they are well known and can be reviewed in many publications (e.g. WELLS et al., 1986; SEEBER, 1993).

In Fig. 1 the locations of all survey projects on the Juneau Icefield in 1997 are shown, a related timetable is given in Table 1. Coordinates of all points measured this summer can be found in Appendix B1 (movement profiles, pp. 33-45) and B2 (miscellaneous projects, pp. 49-53).

Profile Project resp.	Location	Survey Dates	Purpose	Type of measure-ment	No. of pts.
Profile IV	Taku Glacier (C-10 - Shoehorn Peak)	July 22, 1997 July 28, 1997	AB, HC, MV MB, SR	RT-GPS RT-GPS	31 31
Profile V	Taku Glacier SW Branch (SW Taku Pt. - Juncture Peak)	July 21, 1997 July 28, 1997	AB, HC MV	RT-GPS RAPID	12 12
Profile VIb	Taku Glacier NW Branch (NW Taku Pt. - Taku C)	July 23, 1997 July 29, 1997	AB MV	RT-GPS RT-GPS	15 15
Profile VIc	Taku Glacier NW Branch (Knowl - Tricouni Peak)	July 27, 1997 July 31, 1997	AB MV	RAPID RT-GPS	13 13
Profile VId	Taku Glacier NW Branch (Tricouni Peak - Glacier King)	July 26, 1997 July 31, 1997	AB MV	RAPID RAPID	14 14
Profile VII	Matthes Glacier (Camp 9 - Centurian Peak)	July 25, 1997 July 29, 1997	AB, HC MV	RT-GPS RAPID	16 16
Profile VIIa	Matthes Glacier (Taku C - Taku D)	July 24, 1997 July 29, 1997	AB, HC MV	RT-GPS RT-GPS	14 14
Profile VIII	Matthes Glacier (Blizzard Pt. - Camp 8)	August 5, 1997 August 11, 1997	AB, HC MV	RT-GPS RT-GPS	12 12
Profile IX	Vaughan Lewis Glacier	August 7, 1997 August 13, 1997	AB, HC MV	RT-GPS RAPID	8 8
Profile XI	Llewellyn Glacier (F-10 Peak - Sloko Ridge)	August 6, 1997 August 12, 1997	AB, MV SR	RAPID RT-GPS	12 12
Divide Grid	Matthes / Llewellyn Glacier	August 4, 5 and 8, 1997 August 13, 1997	AB, MP, MV, SR	RT-GPS RT-GPS	30 30
1996 Flags	Vaughan Lewis Glacier	August 14, 1997	MV	RT-GPS	3
Height changes	Lemon Creek Glacier Ptarmigan Glacier	August 2, 1997 August 2, 1997	HC	RT-GPS RAPID	95 14
C-10 Hill Map	C-10 Hill	July 21, 1997	POS	GPS	5
JIRP network	C 18 area and F-10 Peak	August 6, 8, 9 and 10, 1997	POS	RT-GPS RAPID	9 2
Met Pack, Seismic,Test-pit locations	Taku/Matthes/Llewellyn Gla-cier	July and August 1997	POS	GPS	14

Explanation:

Purpose of survey:
AB = Ablation
HC = Height comparison
MB = Mass balance
MP = Mapping
MV = Movement
POS = Position
SR = Strain rates

Type of measurement:
RAPID = Rapid Static GPS survey
RT-GPS = Real-Time GPS survey
GPS = Handheld P-Code (Rockwell) receiver GPS survey

Table 1: Timetable of the survey work carried out during the 1997 JIRP campaign

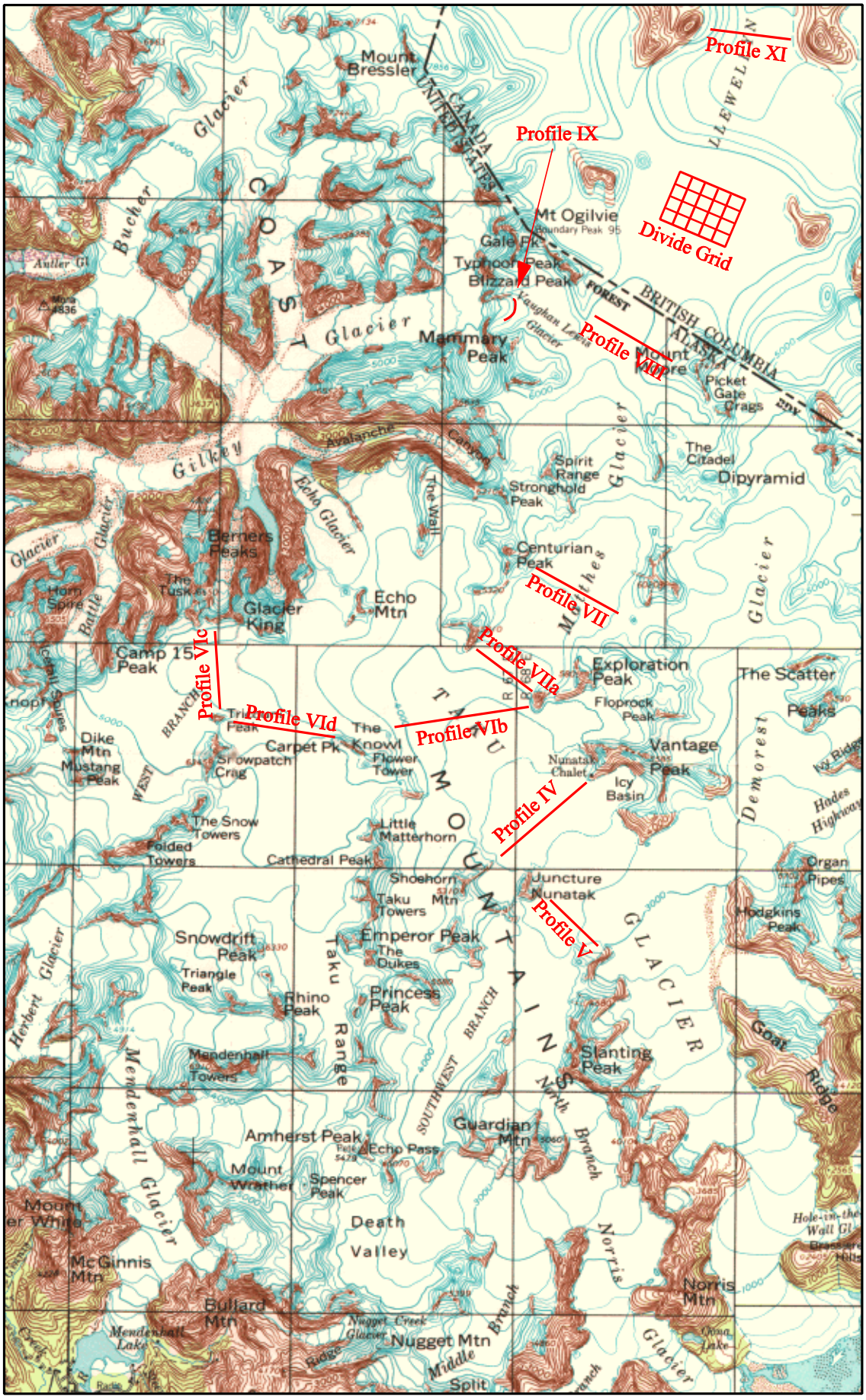

Fig. 1: Location of the 1997 survey projects on the Juneau Icefield

2.1. Verification of benchmarks in the C-18 area

Until 1995 three unconnected local networks existed on the Juneau Icefield. In the course of the 1995 survey campaign the Taku network around Camp 10 and the Gilkey network in the Camp 8/18 sector were connected to each other and tied to a worldwide coordinate system (LANG, 1995). Due to various extensions (KERSTING, 1986) the local Gilkey network was inhomogenous. To improve the network, eight benchmarks, mainly on the upper section of the Cleaver and the rock slope east of Camp 18 were found by RT-GPS could be provided with new coordinates. Point "Ruby" (without a benchmark) had to be deleted from the coordinate list. The new coordinates differ up to 1 m from the previously determined, emphasizing that only GPS determined benchmarks provide a reliable reference. All GPS determined benchmarks in the Camp 8/18 area are shown in Fig. 2, their coordinates are listed in Appendix A (pp. 29-30).

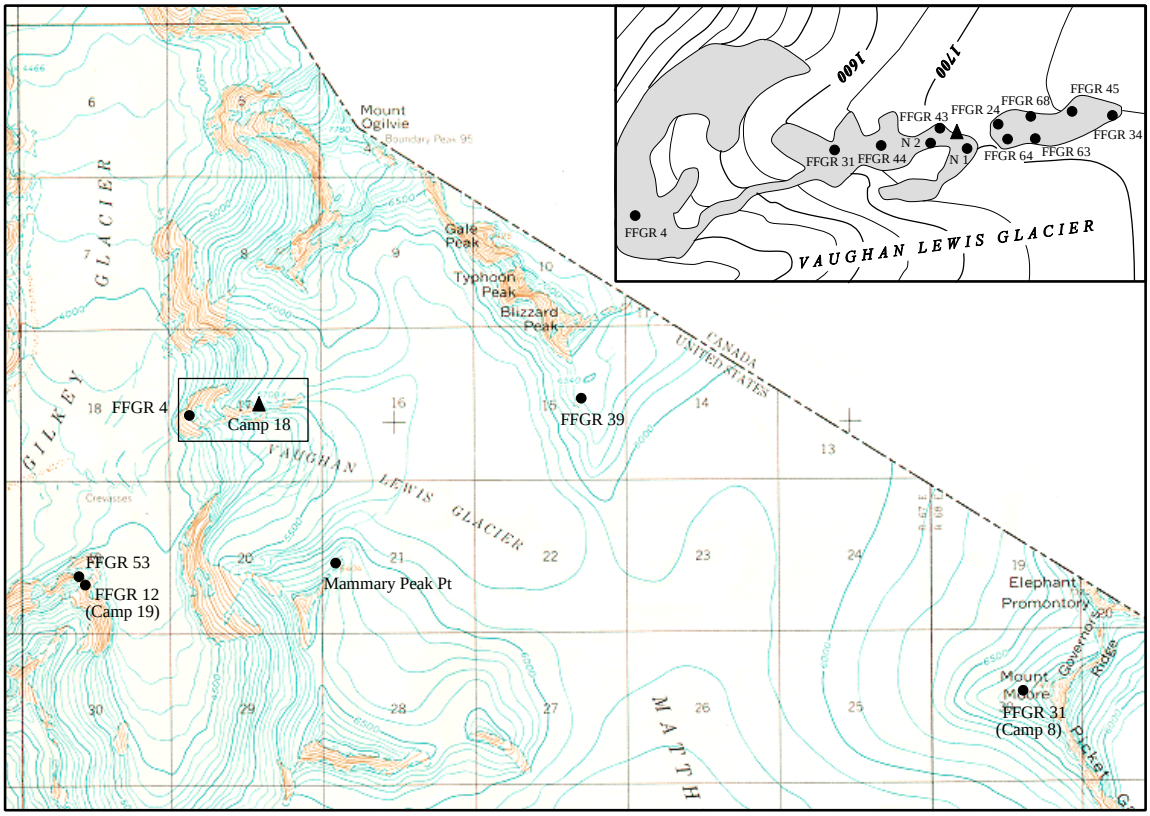

Fig. 2: Locations of benchmarks in the Camp 8/18 area whose positions were derived using GPS

2.2. Movement vector determination

Differential GPS observations provide a high relative accuracy. Using short baselines (< 5 km) standard deviations of 1 cm in position and about 3 cm in height can be achieved with Rapid Static or RT-GPS measurement techniques. Taking into account that usually a 1 x 2 inch flagpole is used as a point marker on the glacier surface, an total accuracy of 5 cm each in position as well in height can be achieved. In the appendices C1 (pp. 57-65) and C2 (pp. 69-79) all movement vectors and height changes are shown. Insignificant values are marked in grey.

2.2.1. Main Taku Glacier and SW-Branch

Profile IV, consisting of two parallel lines some 300 m apart, traverses the main Taku Glacier between Camp 10 and the northeast ridge of Shoehorn Mountain. The movement pattern on both lines is nearly identical: parabolic flow. A mean velocity of 37 cm/day for Profile IV was calculated. Fig. 3 depicts the measured and adjusted velocities for Profile IV in 1997. The results show a parabolic flow with a broadened central zone (LANG and WELSCH, 1997). Since 1993 identical positions have been used for the movement vector determination at Profile IV. During that timespan the magnitude and orientation of each movement vector has shown a high degree of yearly accordance. In general the differences in velocity and orientation do not exceed 2 cm/day and 2 degrees resp., showing impressively that there is no change in glacial behavior taking place in this area.

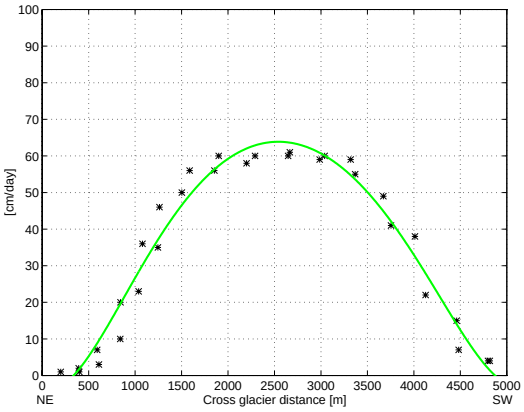

Fig. 3: Profile IV - measured (*) and adjusted (-) velocities

The Southwest Branch covering some 40 km^2 forms the smallest contributary within the Taku Glacier system. Profile V is located on a line from SW Taku Point to Juncture Peak about 500 m above the confluence area with the main Taku Glacier. That location allows to monitor all the ice masses formed by the tributary with the lowest elevation of the Taku Glacier system. The flow pattern is perfectly parabolic and the variations of the movement vectors of different years are in general negligible. The maximum velocity of 10 cm/day and a mean of 6 cm/day corresponds very well with the values obtained by LANG and WELSCH (1997). In Fig. 4 the observed and adjusted velocities for Profile V are shown.

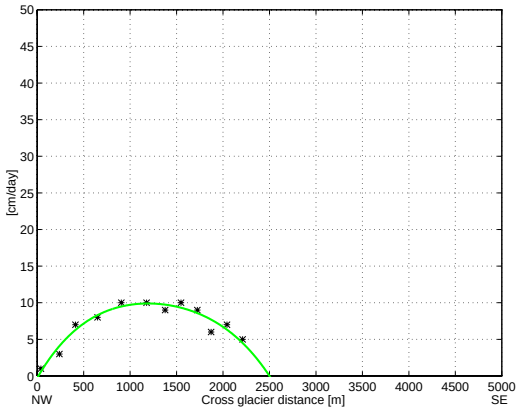

Fig. 4: Profile V - measured (*) and adjusted (-) velocities

2.2.2. Lower Matthes Glacier and Taku Glacier NW-Branch

The Northwest Branch of the Taku Glacier and the Matthes Glacier are two of the main tributaires of the Taku Glacier system They cover about 150 km^2 each. The NW-Branch itself is nourished by the small West-Branch (appr. 35 km^2) extending northeast of the divide area of Eagle, Herbert and Thiel Glacier towards Glacier King and Tricouni Peak and an unnamed branch west of the Taku Range having about twice the size. Except one survey in the late 1950's (MILLER, 1963) no movement vector determination has been carried out during the last decades in that area. In order to lay the foundation for detailed investigations in the future two movement profiles were established to monitor the ice masses flowing from the West-Branch and the unnamed branch resp.

Profile VIc is located on a line from Tricouni Peak to the saddle between Glacier King and The Tusk at the bottleneck of the West-Branch. Neglecting the northern end of the profile with insignificant movements, a parabolic type of flow is found (Fig. 5a). The maximum (12 cm/day) and mean velocities (7 cm/day) are about 20 % greater than that of the SW-Branch which is comparable in area. The glacier's depth is supposed to be similar to that of the SW-Branch. The preliminary results of seismic soundings reveal a maximum ice thickness of about 900 m (SPRENKE, 1997); this is the size known from the SW-Branch, so thta the conclusion is supported.

Profile VId traverses the unnamed branch between Tricouni Peak and Knowl. The flow pattern has to be characterized as an asymmetrical channel flow (Fig. 5b). The most eastern part of the profile shows an insignificant movement. A 1.5 km zone of parabolic acceleration follows to the west. In continuation to the west an area of uniform movement of about 17 cm/day spreads for about 2 km. The velocity on the western end, some 300 m off the glacier margin, is surprisingly high (14 cm/day).

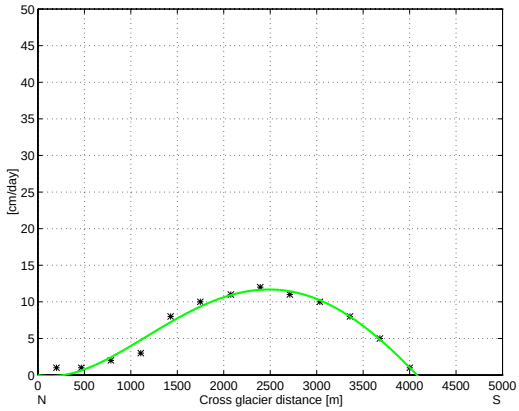

Fig. 5a: Profile VIc - measured (*) and adjusted (-) velocities

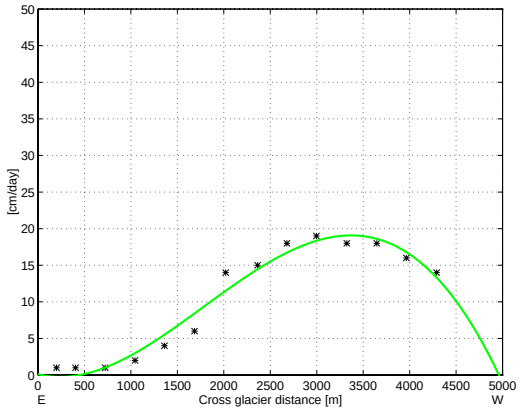

Fig. 5b: Profile VId - measured (*) and adjusted (-) velocities

Profile VIb traversing the confluence area of the Taku NW-Branch and the Matthes Glacier on a line from NW Taku Point to Taku C. It was set to get an impression how far the Matthes Glacier pushes into the Taku Glacier valley. It is obvious that the complex interaction of two merging glaciers cannot be revealed with only one profile. The following discussion intends to point out a probable conclusion and to define the area of interest for detailed investigations in the future.

The diagram of cross-glacier distance versus velocity in Fig. 6 shows three different sections of Profile VIb. At the eastern end of the profile a zone of parabolic increase of velocity can be seen, which stretches about 2 km. In continuation to the west there is an area covering some 3 km where the velocity decreases linearly. It is followed by a section of parabolic decrease of velocity extending 1.5 km on the western end of the profile.

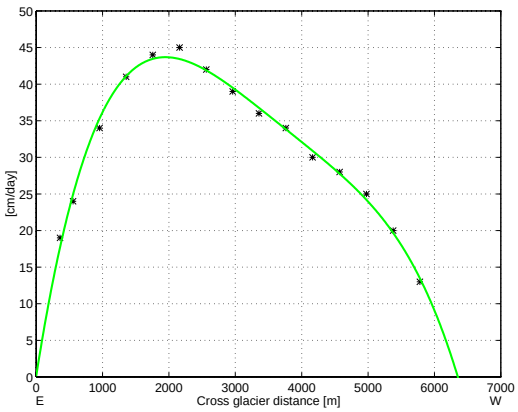

Fig. 6: Profile VIb - measured (*) and adjusted (-) velocities

Comparing the first section with the corresponding one of Profile VIIa on the

Matthes Glacier, between Taku C and Taku D 1 km above the confluence, reveals a high degree of accordance. The maximum velocity is similar (Profile VIb: 45 cm/day; Profile VIIa: 43 cm/day) whereas the mean velocity is exactly equal (32 cm/day). These facts indicate that the flow of the glacier margin at Taku C up to point No. 6 of Profile VIb is controlled by the Matthes Glacier only.

A similar situation can be found on the western end of the profile: the matching part of Profile VIa on the NW-Branch, located between NW Taku Point to Taku D 1 km above the confluence area, reveals identical key parameters (maximum velocity: 25 cm/day; mean velocity for that particular section: 16 cm/day). Profile VIa was not observed in 1997, therefore the adjusted values from LANG and WELSCH (1997) were used for the comparison. The conclusion can be drawn that the flow of Profile VIb from the glacier margin at NW Taku Point to point No. 13 is solely influenced by the NW-Branch.

An estimation can be made how far the Matthes Glacier affects the mode of flow on Profile VIb: the maximum velocity found at Profile VIa over the last decade was 31 cm/day, the corresponding location is about 2.5 km northeast of NW Taku Point (LANG and WELSCH, 1997). Point No. 10 of Profile VIb, located approximately in the same distance east of NW Taku Point, is the first point where the velocity exceeds the maximum for two reasons. First, the Matthes Glacier pushes into the Taku Glacier valley increasing the mass to be transported. Second, the faster moving Matthes Glacier occupying the eastern part of the Taku Glacier valley applies a drag to the NW-Branch nearby. Whether the first or the second possibility or a combination of both fits the reality cannot be clarified due to the insufficient data base. Assuming the border between the Matthes Glacier and the NW-Branch in the vicinity of point No. 10 of Profile VIb, the Matthes Glacier occupies about two thirds of the Taku Glacier valley. This is in agreement with the statement of FRIEDMANN (1997), that 60 % of the ice volume passing through Profile IV are formed by the Matthes Glacier.

Further movement determination in combination with seismic depth soundings are necessary to depict the whole picture of the confluence of both glaciers.

Profile VII traverses the Matthes Glacier from Camp 9 to Centurian Peak and is located about 5 km above the confluence with the NW-Branch. The mode of flow found is parabolic with a broadened central zone of uniform velocity. The insignificant movement of the eastern end of the profile reflects the outflow of the small basin below Camp 9 towards the Matthes Glacier. The maximum velocity is 35 cm/day and the mean velocity 24 cm/day. Compared to 1996, where the points of the profile had the same positions, the movement vectors do not differ more than 2 cm/day in velocity and 5 degrees in orientation. The deviations are insignificant so that an identical flow patterns can be assumed.

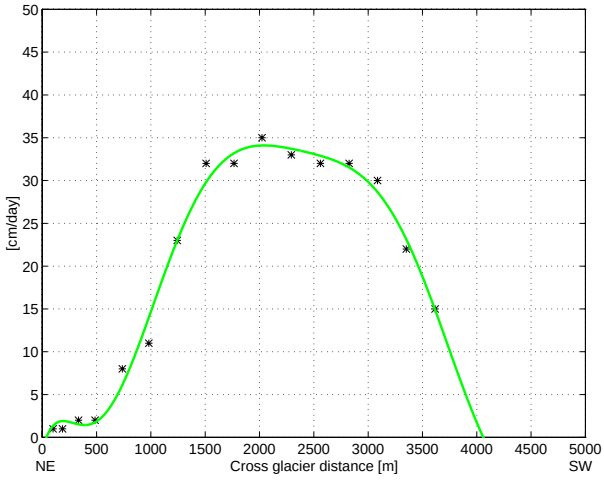

Fig. 7: Profile VII - measured (*) and adjusted (-) velocities

It is recommended to rearrange the point positions on Profile VII. While the points No. 1-4 experience an insignificant movement, which is not caused by the

Matthes Glacier, the profile is at its western end too short to cover the area where the movement becomes negligible. At least point No.1 and 2 should not be measured anymore, instead the profile should be extended for some 500 m (2 or 3 points) as mentioned above.

Towards the confluence with the NW-Branch of the Taku Glacier the Matthes Glacier valley narrows substantially. The glacier's width diminishes from 4 km on Profile VII to some 3 km at Profile VIIa over a distance of only 5 km. In that section no mass is added to the Matthes Glacier; thus the gain in velocity is caused only by the narrowing. The increase of the maximum and mean velocities up to 43 cm/day and 30 cm/day resp. is proportional to the decrease in width. The flow pattern is nearly perfect parabolic (Fig. 8); the differences to the movement vectors derived in 1996 at the same positions are negligible (1 cm/day in velocity and 3 degrees in orientation are the maximum values). This supports the previous statement, that there is no detectable change in the flow pattern on the Lower Matthes Glacier.

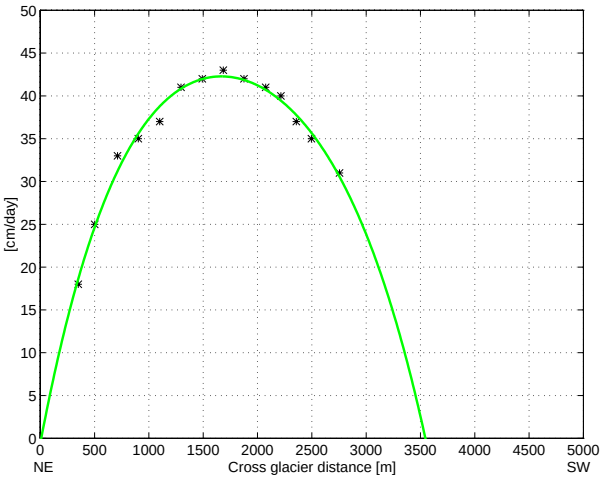

Fig.8: Profile VIIa - measured (*) and adjusted (-) velocities

Substantial movement rates (eastern end: 18 cm/day; western end: 31 cm/day) occur at both ends of the existing profile. It is therefore suggested to add two points at both ends of the profile (perhaps three on the western end) to verify the sharp drop in velocity which can be seen in the adjusted velocities of Fig. 8.

2.2.3. Nevé area of the Matthes, Vaughan Lewis and Llewellyn Glacier

Profile VIII traverses the Matthes Glacier from Blizzard Point to Camp 8 some 5 km down-glacier from its highest regions. The flow on the western and eastern ends of the line reflects the downhill movement from Blizzard Peak and Mount Moore resp. and reaches substantial values up to 10 cm/day. The mode of flow is parabolic (Fig. 9) with a mean velocity of 8 cm/day and maximum velocities of 16 cm/day. These values are comparable to the numbers derived in previous years at the same positions. It is suggested to add at least two more flags on the eastern end of the existing line to verify the theoretical course of the adjusted curve shown in Fig 9.

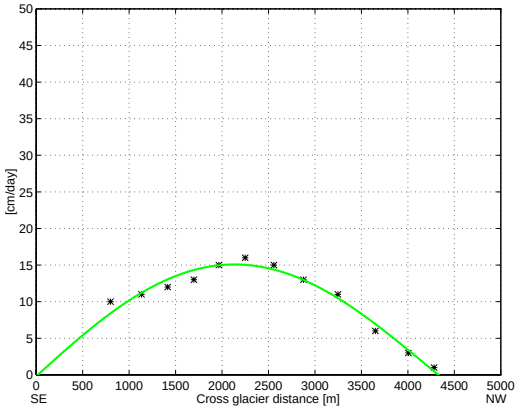

Fig. 9: Profile VIII - measured (*) and adjusted (-) velocity

Considering the close vicinity to the highest elevations of the Matthes Glacier combined with a small gradient (< 1 °) the numbers are surprisingly high. A great depth of the glacier in this area, providing the mass for internal deformation may serve as an explanation. MILLER et al. (1995) and SPRENKE et al. (1997) report glacial depths of about 900 m at Profile

VIII and the High Plateau resp. supporting that statement.

Profile IX is located about 1 km above the Vaughan Lewis Glacier Icefall. The profile follows the semi circle shape of the basin from the Storm Range to the western ridge of Mammary Peak. A plot of velocity versus cross glacier distance is not given for Profile IX to avoid misleading interpretations. Due to the circle form the profile is in contrast to all other profiles not a representation of a transect. All determined movement vectors are orientated towards the centerline of the Vaughan Lewis Glacier, which is identical with the center of the basin's curvature. The maximum velocity of 1997 is 12 cm/day and the mean velocity 8 cm/day. These numbers match the figures of the previous year closely. Flags No. 1, 2 and 3 set in August 1996 could be found still standing up in the firn. Comparing the summer movements derived from the data gathered in August 1997 with the yearly movements (August 1996 - August 1997) a high degree of accordance is obvious. The orientation of the corresponding movement vectors differs up to 14 gon (Appendix C3, page 89); the reason can be found in the fact that a distinct point in this area moves on a curved line from the basin's margin towards its center. The velocity is identical, indicating that there are no or only insignificant seasonal velocity variations of the Vaughan Lewis Glacier.

The dramatic reduction in velocity between 1995 and 1996 is in contrast with the above findings. It ranges from 30 to 60 %. The numbers for 1995 are backuped by the previous seasons, for example the maximum velocity has always been in the range of 30 to 35 cm/day, even the positions had variations up to 300 m in relation to the top of the icefall. The total accumulation area of the Vaughan Lewis Glacier of about 30 km^2 (90 % are located above Profile IX) is relatively small, so that the glacier can quickly respond to changes in icethickness. In the timespan 1995/96 the height of Profile IX was diminished by 1 m in average, but this cannot explain the change: First, the velocity of a glacier is roughly proportional to the forth power of the thickness of the ice. Therefore the percentage of reduction in velocity corresponds with a loss of icethickness of 10 to 20 %. Even assuming that the accumulation area of the Vaughan Lewis Glacier could be extremely shallow, the decrease cannot be explained. Second, during the timespan 1996/97 Profile IX experienced an average loss in height of about 2 m and no change in velocity could be noticed. A conclusive answer for that unusual change in glacial behavior is not yet available.

Beginning in 1995 observations were made to find the divide between the Llewellyn Glacier and the Matthes/Taku Glacier system on the High Plateau. To verify the approximately known position a wide area survey was initiated. Five rows of 6 flags each 300 m apart and covering in total an area of some 2 km^2 form a rectangular grid. Fig. 10 shows no clearly defined pattern of a divide between the both glacier systems. The ice masses radiate down from the high flat areas east of Mount Ogilvie. With the exception of the most southern line of the grid sall points move in northeasterly and easterly directions. The velocities ranges from 3 to 9 cm/day, an unexpected high value considering that the area is only about 50 m below the highest elevations of the Matthes/Taku/Llewellyn Glacier complex. The obvious decrease in velocity from east to west may result from the glacier bed topography, the deepest section of the glacier is located at the western margin of the grid area (SPRENKE ET AL., 1998).

For the first time a profile was established allowing to monitor all icemasses formed on the High Plateau and flowing towards Atlin Lake. Profile XI crosses the Llewellyn Glacier from F10 Peak to the south end of Sloko ridge. The mode of flow is parabolic with a broadened central zone some 2 km wide of similar velocity. The maximum velocity reaches

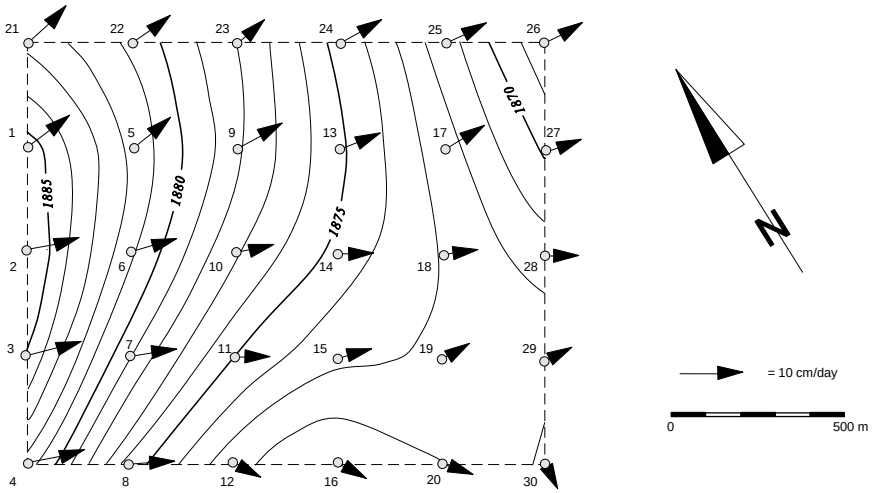

Fig. 10: Matthes/Llewellyn Glacier divide: Movement vectors and isolines

27 cm/day whereas the mean velocity is 20 cm/day (Fig. 11). The numbers are similar to those at Profile III (Demorest Glacier in the convergence area with the Taku Glacier) and Profile VI (NW-Branch of Taku Glacier), see LANG and WELSCH (1997)). Compared with the other profiles the distance to the highest elevations for the other profiles (20 and 15 km resp. versus 8 km) and the height difference (400 m and 600 m resp. versus 150 m) are significantly smaller while the width of glacier at all profiles is similar. Those facts suppose that the Llewellyn Glacier has a deep channel in the area of Profile XI, a verification with geoseismic methods is suggested. At the eastern end of Profile XI a velocity of 16 cm/day was found. As a consequence two more flags should be added at this end in future years.

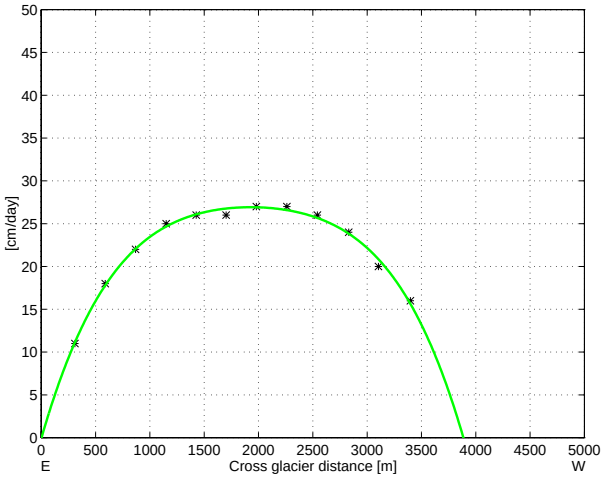

Fig. 11: Profile XI - measured (*) and adjusted (-) velocity

2.3. Height changes

The change of height of a certain point moving with the glacier between two surveys is a result of two processes: first the ablation and second the height change due to the downhill movement of the glacier. In general, the gradient of the glacier at a certain profile is not known exactly on the Juneau Icefield. Therefore the height change of a marked point is not corrected for the influence of the glaciers gradient. To make a clear difference to the term “ablation” the numbers derived are named “short term height change” (Appendix C3, pp 83-91).

The accuracy of a height derived using GPS is about 3 cm. In addition the rough snow surface is not an accurate reference; the total accuracy of a height can be assumed to be 5 cm. This leads to a total standard deviation of about 7 cm. The timespan between two surveys is some 6 days in average; therefore the standard deviation of the daily height

changes is in the range of 1 cm/day.

Using the same position year after year, a comparison of absolute glacial heights can be achieved. It is desirable to carry out the height determinations on the same date of the year to be able to compare the heights without any hypothesis. In pratice this can rarely be done without interpolation. This leads to a still higher inaccuracy of a “long term” height difference which is about 10 cm, so that though all changes bigger than 30 cm (see Appendix D, pp. 95-99) vcan be regarded as significant.

2.3.1. Short term height changes

Plots of all short term height changes are shown in Appendix C2 (pp. 69-79), numbers are given in Appendix C3 (pp. 83-91). In general the short term height changes of an individual profile show great variations without any regional patterns. One would expect lesser height change in higher elevations, but the opposite trend can be seen in the data. With comparable weather conditions between the survey epochs, Profile V at an elevation of about 1070 m lost 4.3 cm/day in height in average, whereas the value for Profile VII at an elevation of 1430 m is 6.9 cm/day. Even assuming the gradient of Profile VII three times steeper as that of Profile V, the difference cannot be explained. The highest short term height changes are found on the High Plateau, averaging 9.0 cm/day for the Divide Grid Profile. Between the two surveys, storms with long periods of heavy rainfall on the High Plateau may have caused this unusually high ablation. That is probably the reason for the great numbers of the other profiles in close vicinity, too (Profile VIII: 8.5 cm/day, Profile IX: 7.1 cm/day and Profile XI: 7.9 cm/day).

The results of the GPS derived short term height changes can be cross-checked with the ablation data determined by FERBER (1997) and GARNER (1997) available for some of the profiles. The constant offset of about 1 cm/day for most of the points of Profile VIb, VIc, VII, VIIa and XI prove the correctness of both methods. The bigger difference of about 4 cm/day for Profile VIII appears questionable.

2.3.2. Long term height changes

The values of the long term height changes can be found in Appendix D (pp. 95-99). It can clearly be seen that all profiles experienced a loss in height from 1996 to 1997. As a rule of thumb it can be stated that the higher the elevation the profile is, the bigger the loss is.

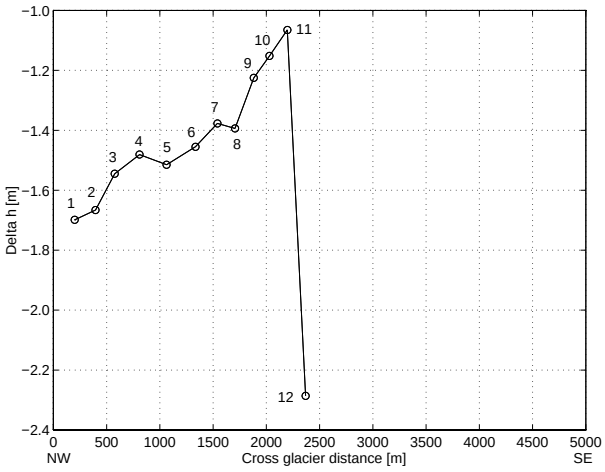

Fig 12: Profile V - height change 1996-1997

The 1995 point positions of Profile V were used again this summer. The average loss in height is 1.5 m (Fig. 12) . Whereas the loss decreases from Juncture Peak (point No. 1) towards SW Taku Point, point No. 12, the closest to the southwest of the profile experienced a height change of -2.3 m. As an error in the observations can be excluded, local

influences may have caused this peculiarity.

The heights of all points of Profile IV were reduced by 0.5 m in average (Fig. 13). Analyzing the changes for the upper and lower line separately, no systematic patterns can be found, although a general trend can be seen.

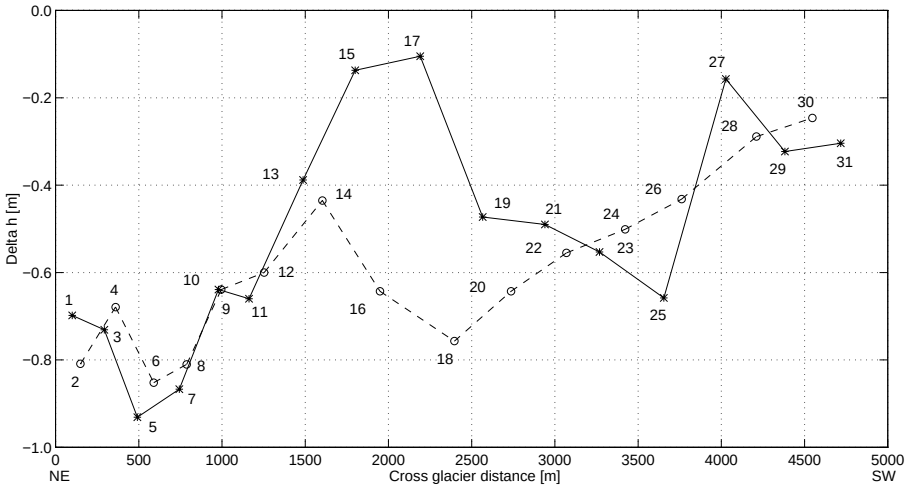

Fig 13: Profile IV - height change 1996-1997. Upper profile: solid line, points marked (*) in black, lower profile: dashed line, points marked (○).

Profiles VII and VIIa situated 300 m and 200 m resp. higher, lost about 0.9 m in average (Figs. 14a, b). Whereas the loss increases from Taku D towards Taku C (Profile VIIa), the biggest differences are found in the center of the glacier (Profile VII). Towards both margins the loss in height decreases, this pattern is supposedly caused by catabatic winds.

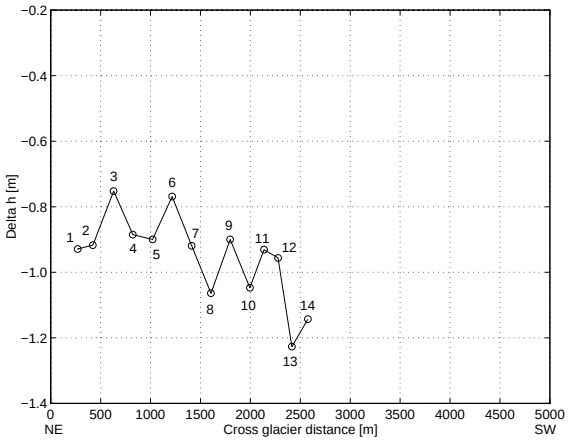

Fig. 14a: Profile VIIa - height change 1996-1997

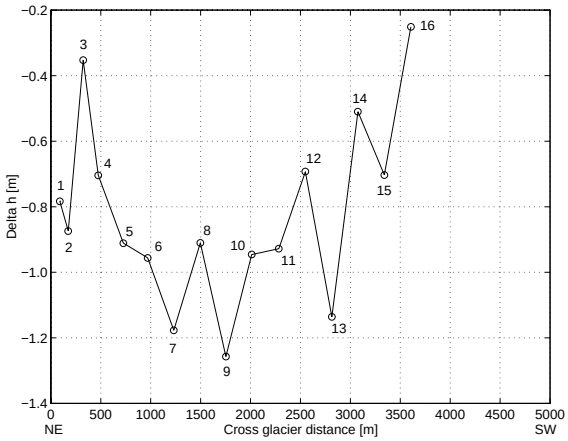

Fig. 14b: Profile VII - height change 1996-1997

On the High Plateau, some 700 m in elevation above Profile IV, the loss in height is 1.3 m for Profile VIII and 2.1 m for Profile IX (Figs 15a, b). Despite the close vicinity, Profile IX lost about two thirds more. Whether this is an isolated event or indicates a shift of winter precipitation patterns cannot yet be concluded. Further yearly height comparisons of identical points on the High Plateau are necessary, preferably including points in the area of the Divide and on the Canadian side of the Icefield (Profile XI e.g.).

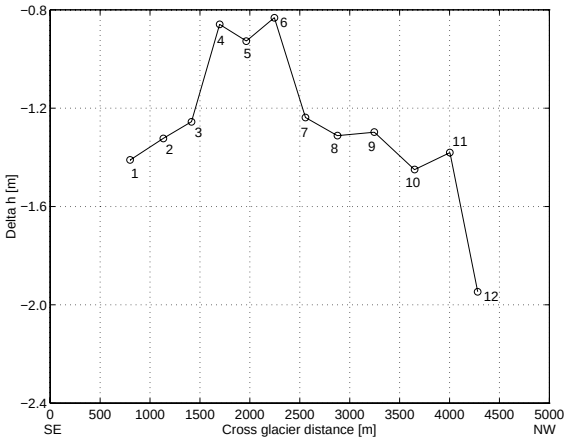

Fig. 15a: Profile VIII - height change 1996-1997

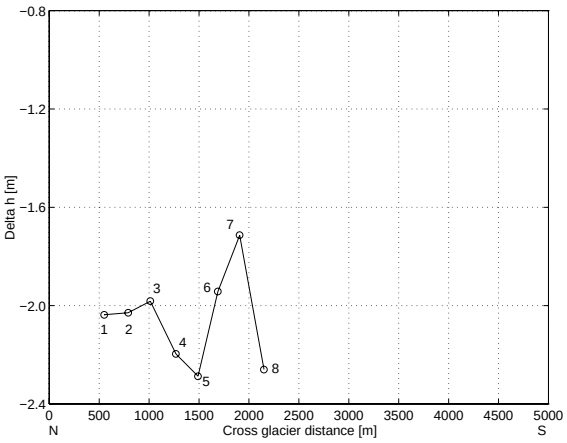

Fig. 15b: Profile IX - height change 1996-1997

2.3.3. Lemon Creek and Ptarmigan Glacier height comparison

MARCUS et al. (1995) reported an overall loss of about 14.6% in volume for the Lemon Creek Glacier for the period 1957-1989. A height comparison using a single profile in the Camp 17 area in 1993 revealed the continuation of this trend (LANG, 1993). Using the 1989 Lemon Creek Glacier map (MARCUS and MILLER, 1994) as a base, a more detailed study of the nevé area was carried out this summer. At the same time a network of control points was observed on the Ptarmigan Glacier for future monitoring.

Only eight hours were available for the completion of that task, including flight time from and to Camp 10. 113 points were measured, the majority by real-time GPS. 95 points forming four profiles are located on the Lemon Creek Glacier (Fig. 16) covering about 25% of the glacier's surface. The 14 points on the Ptarmigan Glacier, arranged in two traverses cover the central part of the glacier.

After a transformation of the point coordinates onto the map system, the accuracy of the points on the glacier can be estimated to be 0.25 m in height and up to 1 m where the glacier is steep.

The loss of volume on the Lemon Creek Glacier continues dramatically. An average of 10.5 m in height was lost (Fig. 17) during the timespan from 1989 to 1997. With exception of the marginal zones of the glacier the loss is consistent. A similar pattern can be seen for the Ptarmigan Glacier, where a comparison was possible (points P1-P3). The aerial photographs for the Lemon Creek Glacier map were taken on August 28, 1989, the observations of this summer were carried out on August 2, 1997. Based on the ablation rates found by HEUSSER and MARCUS (1964), the height differences are at least one meter greater. With some caution it can be estimated that the loss in volume in the investigated area is $1 \cdot 10^7$ m^3 from 1989 to 1997. In 1989 the total area of the Lemon Creek Glacier was found to be 11.73 km^2, that is roughly six times the area covered by the observations in 1997. This leads to an overall loss of $6 \cdot 10^7$ m^3, representing about 6.6 % of the 1957 volume. The mean yearly loss of volume in the period 1989-1997 is nearly twice that from 1957-1989 ($7.5 \cdot 10^6$ m^3 versus $4.1 \cdot 10^6$ m^3 (MARCUS et al. (1995)). Although these numbers have to be taken with some caution, they document that the mass wastage of the Lemon Creek Glacier is at least constant for the last decade; an acceleration is likely.

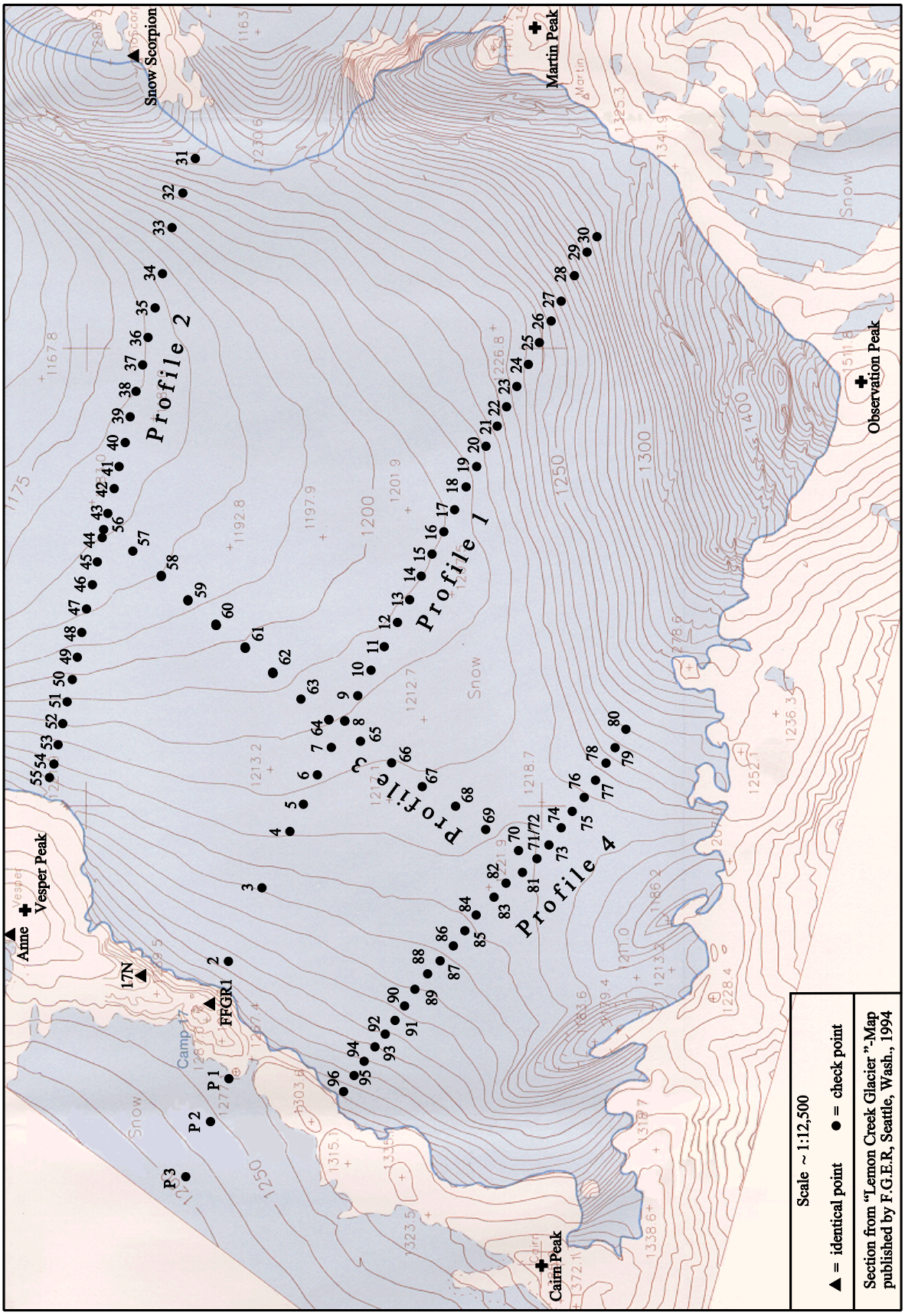

Fig. 16: Locations of the check points on the Lemon Creek Glacier

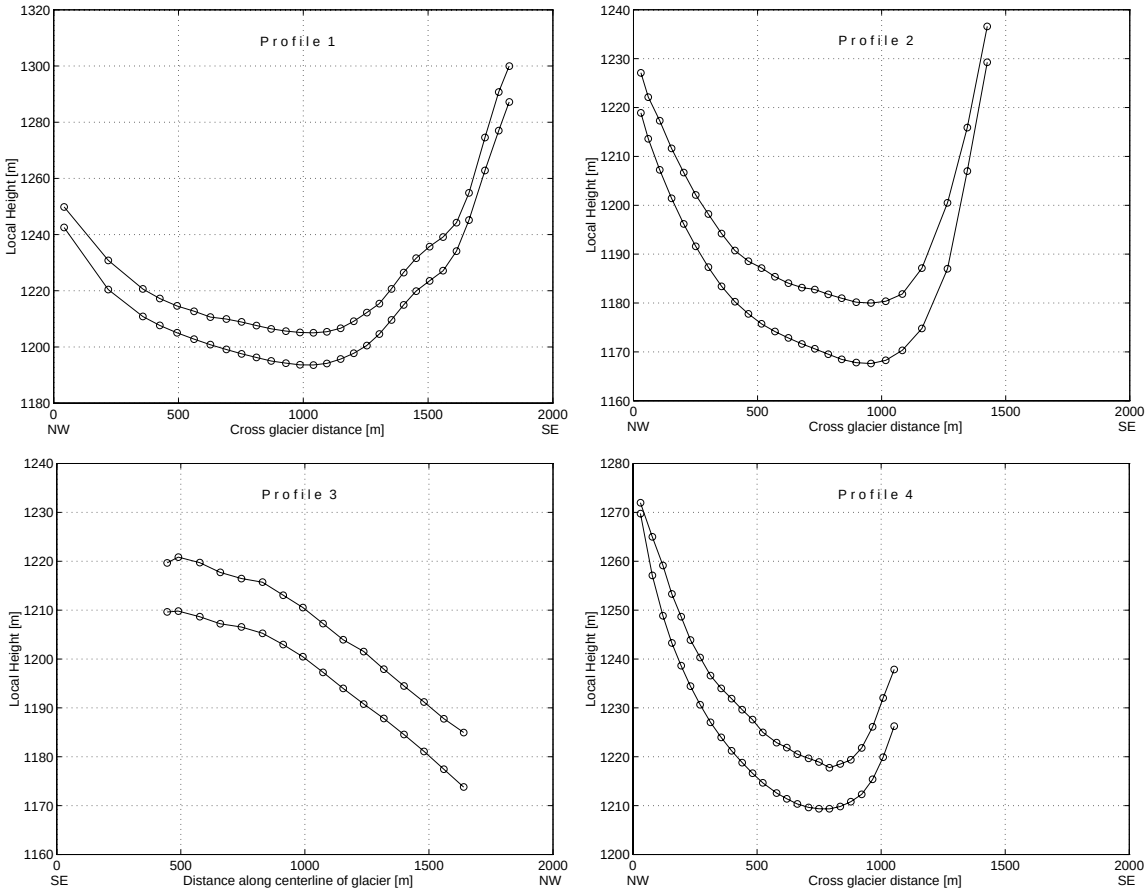

Fig. 17: Lemon Creek Glacier height changes 1989-1997: Profile 1-4. Upper line: glacier surface 1989, lower line: glacier surface 1997.

2.4. Volume changes

MCGEE (1997) discussed the use of GPS for the determination of local surface mass balance. All mass balance data are given in the unit “water equivalent”. The implication herein is a good knowledge of the densities of firn or ice. Traditionally mass balance data are sampled digging snow pits, a method allows to determine reliable density data and to find the margin in depth of the last year’s firn layer. In contrast, GPS observations can only give the height change of distinct points, which may be caused by accumulation or ablation or by other events e.g. kinematic waves. In contrast to the traditional mass balance results, the GPS results are called in “volume changes” this report.

It is in principle possible to use the short term height changes of Profile IV and the Divide Grid Profile for the calculation of the volume changes. The numbers of the volume changes during the summer of 1997 are given in Appendix E (pp. 103-106).

The loss of volume on Profile IV is about $0.5 \cdot 10^6$ m^3. from 1996 to 1997. This number is comparable to the previous, illustrating the obvious trend of mass wastage in the lower and middle elevations of the Taku Glacier system.

2.5. Strain

According to WELSCH (1997) strain rates can be derived from repeated observations of geometrical figures like triangles. Strain rate measurements are a contribution to stress and strain relations which are the basis for further glacier studies applying methods of continuum mechanics.

The distribution of the strain rates across the main Taku Glacier at Profile IV is consistent over the years. As an example the maximum principle strain rate e_1 is shown in Fig. 18. At the eastern end very small strain rates are dominant, indicating only little stress within the first 500 m of the profile. This is in accordance with the small increase of velocity in this area. Within the next 1 km the maximum principle strain rates magnify by a factor of 10 caused by the rapid increase of the glaciers flow rate. As a consequence numerous shear crevasses are found in the area. In the central section of Profile IV a more or less homogeneous movement is indicated by strain rates which are as low as at the eastern end. Here no crevasses at all can be seen on the glaciers surface. Towards the western end the velocity slows down causing again a peak of maximum principle strain. Again a lot of shear crevasses are present in this section of the glacier. The velocity and the strain rates at the western end of the profile, being 2-4 times bigger than those on the eastern end, show the disturbing influence of the ice flow from the basin between Shoehorn Mountain and Juncture Peak.

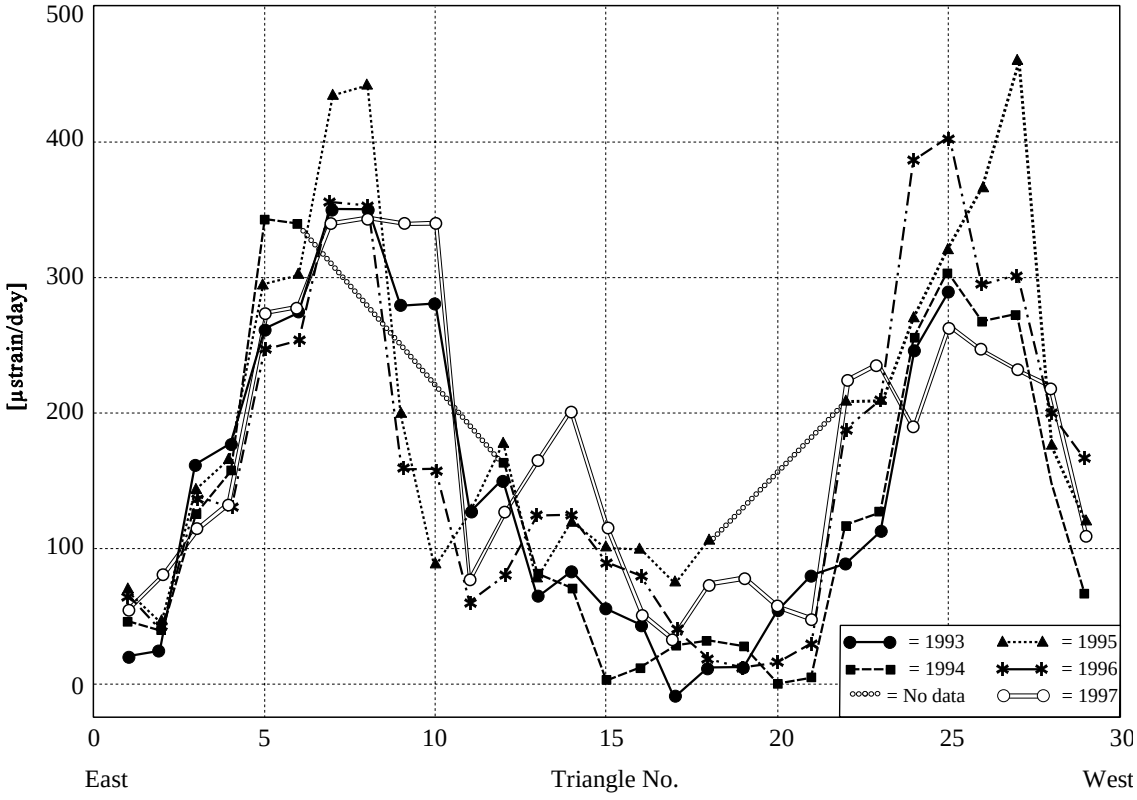

Fig. 18: Maximum principle strain rate (e1) on Profile IV, 1993-1997.

The principle aim of the investigations on the Divide Grid Profile was to find a place for a bore hole research project involving deep drilling. Criteria are: maximal ice depth, minimal surface strain and insignificant movement at the site of investigation. The combination of the movement vectors,strain rates and the seismic depth determination shows that

the criteria cannot be realized within the Divide Grid zone. The strain ellipses (Fig. 19) show significant compressional forces in the areas of the smallest flow rates, whereas the principle strains are negligible in the area, where the flow rates are relatively high.

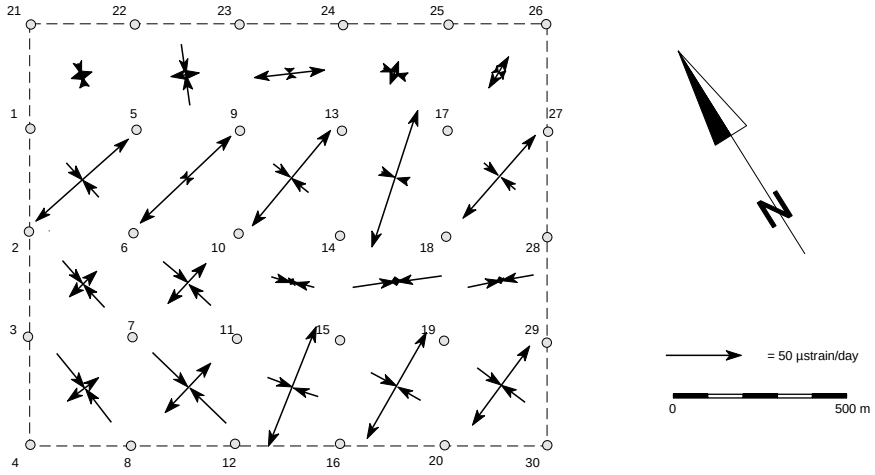

Fig. 19: Strain ellipses for the Divide Grid Profile

The area of the greatest glacial depth has medium movement and strain rates. As a “perfect” place could not be found, it is proposed to establish a future drill site at the deepest part of the glacier.

The values of the strain rates for Profile IV and the Divide Grid Profile are given in Appendix F (pp. 109-110).

3. Prospect

The surveying program of the summer was a good compromise between keeping up the records of the traditional movement profiles, investigating new areas and special topics and, last but not least the teaching of the students. It is suggested to keep up a similar schedule in the future. That will allow to measure about 5-7 old profiles each season and leaves enough time to establish 2-4 new profiles. Special investigations like the Lemon Creek Glacier height comparison will still be possible.

Some of the existing profiles should be rearranged (see chapter 2.2.2. and 2.2.3.). For reliable short term height changes a greater timespan between the surveys is advised. A grid similar to the Divide Grid in the confluence area of the NW-Branch of the Taku Glacier and the Matthes Glacier can provide use information anout the merging process of both glaciers. A profile on the Matthes Glacier from the Spirit Range to The Citadel will help to close the existing gap between Profile VII and VIII.

A possible focus for the survey work in the near future is the Demorest and the Llewellyn Glacier. Two profiles can easily be established on the Demorest Glacier in areas which are accessible without any hazards. A profile east of Picket Gate Crags covering the nevé area and a profile east of Camp 9 covering the central part will give additional information of the flow pattern of the Demorest Glacier. Profiles on the Llewellyn Glacier in similar elevations as on the Taku Glacier will provide a lot of information. Especially long

term height change data for the comparison of the maritime (Taku Glacier) and the continental side (Llewellyn Glacier) of the Icefield will lead to a better understanding of the entire Icefield and the complex processes controlling the fluctuations of the glaciers in that area.

4. Acknowledgment

The professional support and the excellent logistics provided by Prof. Dr. M. M. Miller made the completion of this summer's survey program possible. Scott McGee contributed substantially to the success of the surveying program with his endless energy and invaluable surveying experience on the Icefield. All this could not have became reality without the excellent off ice logistics handled perfectly by Joan Miller, Rebecca Dayton and Kristi Carroll and the all the participants of the 1997 summer Institute who always were of great help.

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Appendix A

Coordinate Listing
JIRP benchmarks (ITRF93)

Date of last revision:
October 1, 1997

Camp 10 area					
Point name	Point number	GPS	Easting [m]	Northing [m]	Height [m]
FFGR 19	1	*	488001.819	6503290.614	1180.835
FFGR 19B	1.1	-	488383.812	6503660.530	1241.866
FFGR 19D	1.2	-	488260.073	6503696.172	1254.266
FFGR 19C	1.3	*	487983.650	6503410.034	1197.999
Taku B Lower	1.4	-	488291.605	6503745.868	-
Camp 10 North	1.5	-	487953.316	6503398.642	-
SW-Taku	2	-	487333.574	6495903.938	-
SW-Taku East	2.1	-	487312.700	6495908.412	-
SW Taku Lower	2.2	*	487320.590	6495968.918	1133.487
Taku A	3	-	490529.133	6501653.627	1512.038
Taku B	4	-	488584.437	6504541.022	1590.036
Taku B Cairn	4.1	-	488583.775	6504540.870	-
Taku C	5	-	485696.044	6506827.041	1545.431
Taku C Lower	5.1	-	485645.149	6506713.779	1528.351
Sunday Point	6	-	490254.409	6500611.311	-
Sunday Point Cairn	6.1	-	490235.701	6500682.263	-
Taku D	7	-	482941.369	6509777.053	-
Taku D Cairn (FFGR65)	7.1	*	482942.071	6509779.957	1774.108
Taku D Lower	8	*	482601.539	6509092.743	1399.212
Camp 9	9	-	489442.404	6510665.079	1556.223
Camp 9 Cairn	9.1	-	489443.183	6510663.361	-
NW Taku	10	*	479186.763	6505147.717	1402.060
NW Taku Cairn	10.1	*	479188.345	6505144.663	1402.149
Shoehorn Peak	11	-	482657.922	6500295.567	1326.342
Juncture Peak	12	-	485056.994	6498619.047	1339.311
Juncture Peak Lower	12.1	-	485424.713	6498221.909	-
Bavaria Point	13	-	489420.666	6501375.002	-
Glacier King	14	-	474734.289	6509446.896	1481.238
Glacier King Cairn	14.1	-	474736.005	6509445.705	-
Camp 10 A	15	*	489181.351	6501882.011	1105.757
Vantage Peak	16	-	490390.615	6504291.679	1709.737
Twin Peak Geodetic	17	-	500177.078	6499821.685	-
Scott	19.1	*	487963.303	6503372.111	1189.739
Exploration Peak	-	-	487450.796	6507809.503	-

Camp 18 area					
Point name	Point number	GPS	Easting [m]	Northing [m]	Height [m]
FFGR 45 (Camp 18 Hill)	1	*	484309.150	6524412.394	1746.191
Camp 8	2	-	492140.788	6521149.048	-
FFGR 31 (Camp 8)	2.1	*	492136.624	6521147.773	2051.576
FFGR 39 (Blizzard Pt.)	4	*	487443.145	6524360.975	1984.385
FFGR 68 (Camp 18 Hill)	5	*	484425.554	6524412.335	1751.611
FFGR 24 (Camp 18 Hill)	6	*	484189.635	6524371.872	1733.416
FFGR 43 (Camp 18)	7	*	483990.101	6524352.738	1703.762
FFGR 44 (Cleaver)	8	*	483834.598	6524280.382	1669.572
FFGR 31 (Cleaver)	9	*	483705.534	6524279.606	1623.548
FFGR 49 (Cleaver)	11	-	483244.123	6524040.612	-
FFGR 48 (Cleaver)	12	-	483375.593	6524007.974	-
Camp 19	14	-	482226.811	6522614.250	-
FFGR 18 (Camp 19)	15	-	482294.684	6522477.554	-
FFGR 12 (Camp 19)	16	*	482221.820	6522621.728	1292.865
Mammary Peak Pt.	17	*	484896.620	6522670.609	1928.018
Mt. Moore	18	-	492458.688	6521225.686	2176.952
Mt. Moore Cairn	18.1	-	492460.494	6521228.959	-
FFGR 63 (Camp 18 Hill)	22	*	484315.335	6524309.996	1723.699
FFGR 64 (Camp 18 Hill)	23	*	484219.214	6524334.390	1727.783
Camp 19TL	25	-	482224.893	6522611.681	-
FFGR 04 (Cleaver)	26	*	483309.746	6524118.094	1388.753
FFGR 53 (Camp 19)	27	*	482195.157	6522670.922	1277.773
FFGR 42	28	-	483435.183	6524134.408	1426.096
N1 (Camp 18)	29	*	484073.444	6524262.764	1698.457
N2 (Camp 18)	30	*	483956.314	6524239.526	1682.217
FFGR 34 (Camp 18 Hill)	31	*	484554.464	6524402.905	1734.890
FFGR 62 (F10 Pt.)	32	*	492497.562	6535469.195	1860.563

* = Coordinates derived using GPS measurements

Appendix B1

Coordinate Listing of Movement Profile Flags

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) - Lower Line

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Taku IV 01	487743.724	6503056.471	1117.944	22.07.97	11:48
Taku IV 03	487602.452	6502924.920	1120.819	22.07.97	12:00
Taku IV 05	487453.677	6502793.168	1120.749	22.07.97	12:13
Taku IV 07	487267.487	6502623.364	1118.266	22.07.97	12:29
Taku IV 09	487091.213	6502466.225	1118.868	22.07.97	12:43
Taku IV 11	486956.797	6502341.042	1119.700	22.07.97	12:53
Taku IV 13	486716.014	6502123.051	1119.389	22.07.97	13:07
Taku IV 15	486483.861	6501914.610	1115.572	22.07.97	13:21
Taku IV 17	486195.301	6501648.454	1120.088	22.07.97	13:36
Taku IV 19	485918.890	6501397.068	1126.323	22.07.97	14:28
Taku IV 21	485641.441	6501146.467	1132.773	22.07.97	14:47
Taku IV 23	485397.523	6500927.317	1134.987	22.07.97	15:01
Taku IV 25	485112.102	6500667.301	1136.490	22.07.97	15:13
Taku IV 27	484836.829	6500415.769	1137.642	22.07.97	15:33
Taku IV 29	484572.856	6500178.544	1141.073	22.07.97	15:44
Taku IV 31	484323.404	6499952.875	1145.206	22.07.97	15:54
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Taku IV 01	487743.773	6503056.407	1117.662	28.07.97	14:06
Taku IV 03	487602.562	6502924.834	1120.508	28.07.97	14:26
Taku IV 05	487454.038	6502792.903	1120.433	28.07.97	14:39
Taku IV 07	487268.409	6502622.554	1117.948	28.07.97	14:49
Taku IV 09	487092.818	6502464.756	1118.540	28.07.97	14:56
Taku IV 11	486958.900	6502339.169	1119.317	28.07.97	15:03
Taku IV 13	486718.585	6502120.856	1119.070	28.07.97	15:10
Taku IV 15	486486.552	6501912.137	1115.534	28.07.97	15:17
Taku IV 17	486198.136	6501646.181	1119.640	28.07.97	15:25
Taku IV 19	485921.812	6501394.858	1125.850	28.07.97	15:32
Taku IV 21	485644.326	6501144.296	1132.246	28.07.97	15:41
Taku IV 23	485400.206	6500925.402	1134.468	28.07.97	15:49
Taku IV 25	485114.148	6500665.868	1136.059	28.07.97	15:59
Taku IV 27	484837.956	6500415.104	1137.201	28.07.97	16:08
Taku IV 29	484573.238	6500178.422	1140.667	28.07.97	16:20
Taku IV 31	484323.582	6499952.998	1144.852	28.07.97	17:07

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) - Upper Line

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Taku IV 02	487528.304	6503205.756	1124.493	22.07.97	18:54
Taku IV 04	487379.543	6503056.926	1123.546	22.07.97	18:49
Taku IV 06	487221.658	6502890.468	1120.931	22.07.97	18:40
Taku IV 08	487085.257	6502746.894	1119.999	22.07.97	18:32
Taku IV 10	486935.904	6502602.220	1119.703	22.07.97	18:24
Taku IV 12	486756.500	6502417.529	1119.637	22.07.97	18:12
Taku IV 14	486484.699	6502198.360	1121.290	22.07.97	18:04
Taku IV 16	486222.841	6501970.414	1120.194	22.07.97	17:55
Taku IV 18	485893.123	6501668.919	1126.130	22.07.97	17:43
Taku IV 20	485641.908	6501440.390	1132.192	22.07.97	17:30
Taku IV 22	485393.050	6501217.929	1136.723	22.07.97	17:21
Taku IV 24	485125.906	6500988.292	1137.186	22.07.97	17:08
Taku IV 26	484860.184	6500776.812	1139.032	22.07.97	16:54
Taku IV 28	484512.048	6500494.605	1139.156	22.07.97	16:24
Taku IV 30	484251.171	6500280.802	1140.417	22.07.97	16:07
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Taku IV 02	487528.386	6503205.766	1124.233	28.07.97	19:00
Taku IV 04	487379.682	6503056.800	1123.238	28.07.97	18:52
Taku IV 06	487222.103	6502890.035	1120.629	28.07.97	18:46
Taku IV 08	487086.266	6502745.995	1119.703	28.07.97	18:40
Taku IV 10	486937.518	6502600.855	1119.431	28.07.97	18:35
Taku IV 12	486758.712	6502415.507	1119.274	28.07.97	18:28
Taku IV 14	486487.274	6502196.172	1120.883	28.07.97	18:22
Taku IV 16	486225.564	6501968.200	1119.753	28.07.97	18:16
Taku IV 18	485895.931	6501666.653	1125.602	28.07.97	18:09
Taku IV 20	485644.745	6501438.274	1131.711	28.07.97	18:03
Taku IV 22	485395.906	6501215.842	1136.258	28.07.97	17:55
Taku IV 24	485128.248	6500986.532	1136.785	28.07.97	17:47
Taku IV 26	484862.039	6500775.515	1138.660	28.07.97	17:37
Taku IV 28	484512.850	6500494.176	1138.731	28.07.97	17:29
Taku IV 30	484251.354	6500280.606	1140.108	28.07.97	17:19

Profile V (Taku Glacier SW Branch, Juncture Peak - SW Taku Pt.)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
SW Taku 01	485734.958	6498030.011	1058.704	21.07.97	12:16
SW Taku 02	485859.453	6497874.597	1061.445	21.07.97	12:32
SW Taku 03	485961.007	6497734.730	1064.850	21.07.97	12:55
SW Taku 04	486105.434	6497544.894	1067.128	21.07.97	13:09
SW Taku 05	486272.703	6497352.005	1067.030	21.07.97	13:21
SW Taku 06	486450.486	6497147.004	1066.584	21.07.97	13:52
SW Taku 07	486577.699	6496992.822	1069.789	21.07.97	17:28
SW Taku 08	486689.655	6496863.633	1074.156	21.07.97	14:14
SW Taku 09	486805.859	6496732.201	1077.721	21.07.97	14:28
SW Taku 10	486904.582	6496621.615	1079.193	21.07.97	14:49
SW Taku 11	487011.920	6496489.075	1080.345	21.07.97	14:56
SW Taku 12	487116.867	6496357.149	1082.324	21.07.97	18:02
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
SW Taku 01	485734.972	6498030.059	1058.478	28.07.97	13:54
SW Taku 02	485859.594	6497874.769	1061.164	28.07.97	14:13
SW Taku 03	485961.321	6497735.103	1064.488	28.07.97	14:30
SW Taku 04	486105.782	6497545.350	1066.853	28.07.97	14:46
SW Taku 05	486273.171	6497352.526	1066.709	28.07.97	15:04
SW Taku 06	486450.918	6497147.560	1066.347	28.07.97	15:19
SW Taku 07	486578.096	6496993.300	1069.388	28.07.97	15:36
SW Taku 08	486690.070	6496864.170	1073.817	28.07.97	15:54
SW Taku 09	486806.173	6496732.724	1077.418	28.07.97	16:09
SW Taku 10	486904.839	6496621.994	1078.891	28.07.97	16:24
SW Taku 11	487012.125	6496489.500	1080.025	28.07.97	16:40
SW Taku 12	487117.078	6496357.414	1081.955	28.07.97	16:54

Profile VIb (Taku Glacier NW Branch, Taku C - Taku NW Pt.)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku B 01	485121.412	6506722.356	1250.698	23.07.97	18:16
NW Taku B 02	484928.637	6506693.730	1255.065	23.07.97	18:09
NW Taku B 03	484531.314	6506640.747	1251.871	23.07.97	18:00
NW Taku B 04	484137.879	6506568.639	1244.836	23.07.97	17:41
NW Taku B 05	483753.113	6506454.268	1242.193	23.07.97	17:31
NW Taku B 06	483366.532	6506339.367	1242.732	23.07.97	17:21
NW Taku B 07	482982.183	6506218.768	1240.640	23.07.97	17:12
NW Taku B 08	482601.544	6506102.841	1246.020	23.07.97	17:03
NW Taku B 09	482223.346	6505984.767	1247.995	23.07.97	16:53
NW Taku B 10	481836.238	6505864.458	1251.208	23.07.97	16:40
NW Taku B 11	481434.884	6505827.959	1258.023	23.07.97	16:08
NW Taku B 12	481031.136	6505772.317	1265.424	23.07.97	15:58
NW Taku B 13	480633.750	6505701.447	1273.018	23.07.97	15:47
NW Taku B 14	480243.416	6505604.649	1275.833	23.07.97	15:25
NW Taku B 15	479852.242	6505506.565	1276.411	23.07.97	15:07
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku B 01	485121.166	6506721.251	1250.216	29.07.97	19:10
NW Taku B 02	484928.375	6506692.275	1254.593	29.07.97	19:14
NW Taku B 03	484531.095	6506638.706	1251.338	29.07.97	19:23
NW Taku B 04	484137.834	6506566.152	1244.336	29.07.97	19:28
NW Taku B 05	483753.358	6506451.575	1241.756	29.07.97	19:32
NW Taku B 06	483367.046	6506336.700	1242.307	29.07.97	19:35
NW Taku B 07	482983.050	6506216.346	1240.193	29.07.97	19:39
NW Taku B 08	482602.739	6506100.761	1245.592	29.07.97	19:43
NW Taku B 09	482224.694	6505982.988	1247.637	29.07.97	19:47
NW Taku B 10	481837.681	6505862.960	1250.867	29.07.97	19:52
NW Taku B 11	481436.321	6505826.769	1257.744	29.07.97	19:55
NW Taku B 12	481032.514	6505771.310	1265.145	29.07.97	19:58
NW Taku B 13	480635.078	6505700.635	1272.672	29.07.97	20:03
NW Taku B 14	480244.541	6505604.195	1275.586	29.07.97	20:06
NW Taku B 15	479852.996	6505506.229	1276.041	29.07.97	20:10

Profile VIc (Taku Glacier NW Branch, Tricouni Peak - The Tusk)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku C 01	472014.117	6506140.968	1471.861	27.07.97	13:34
NW Taku C 02	471984.365	6506461.620	1463.985	27.07.97	13:54
NW Taku C 03	471954.643	6506782.878	1461.022	27.07.97	14:12
NW Taku C 04	471924.422	6507105.638	1462.074	27.07.97	14:28
NW Taku C 05	471894.431	6507426.774	1461.957	27.07.97	14:44
NW Taku C 06	471864.719	6507744.693	1463.109	27.07.97	15:02
NW Taku C 07	471835.399	6508060.705	1464.429	27.07.97	15:20
NW Taku C 08	471805.099	6508385.935	1464.547	27.07.97	15:36
NW Taku C 09	471775.477	6508704.891	1464.904	27.07.97	15:54
NW Taku C 10	471745.478	6509027.206	1466.058	27.07.97	16:13
NW Taku C 11	471715.674	6509347.051	1469.719	27.07.97	16:30
NW Taku C 12	471686.354	6509663.441	1485.874	27.07.97	16:46
NW Taku C 13	471660.028	6509929.260	1515.221	27.07.97	17:01
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku C 01	472014.132	6506140.984	1471.674	31.07.97	13:33
NW Taku C 02	471984.560	6506461.690	1463.848	31.07.97	13:40
NW Taku C 03	471954.961	6506782.930	1460.871	31.07.97	13:45
NW Taku C 04	471924.526	6507105.647	1461.928	31.07.97	13:53
NW Taku C 05	471894.848	6507426.835	1461.754	31.07.97	14:00
NW Taku C 06	471865.191	6507744.728	1462.955	31.07.97	14:05
NW Taku C 07	471835.838	6508060.710	1464.247	31.07.97	14:11
NW Taku C 08	471805.500	6508385.981	1464.330	31.07.97	14:22
NW Taku C 09	471775.776	6508704.949	1464.738	31.07.97	14:40
NW Taku C 10	471745.584	6509027.194	1465.915	31.07.97	14:52
NW Taku C 11	471715.733	6509347.073	1469.605	31.07.97	14:57
NW Taku C 12	471686.365	6509663.459	1485.688	31.07.97	15:02
NW Taku C 13	471660.027	6509929.314	1515.074	31.07.97	15:06

Profile VId (Taku Glacier NW Branch, Knowl - Tricouni Peak)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku D 01	476050.143	6505072.173	1438.571	26.07.97	13:03
NW Taku D 02	475727.933	6505122.223	1437.591	26.07.97	13:45
NW Taku D 03	475413.381	6505173.884	1433.937	26.07.97	14:02
NW Taku D 04	475094.358	6505228.182	1431.445	26.07.97	14:28
NW Taku D 05	474771.115	6505283.671	1428.985	26.07.97	14:46
NW Taku D 06	474456.972	6505338.505	1427.836	26.07.97	15:03
NW Taku D 07	474145.819	6505393.636	1429.098	26.07.97	15:28
NW Taku D 08	473807.809	6505453.301	1431.071	26.07.97	15:45
NW Taku D 09	473477.727	6505511.856	1431.075	26.07.97	16:02
NW Taku D 10	473157.937	6505568.582	1430.488	26.07.97	16:21
NW Taku D 11	472845.837	6505624.057	1436.250	26.07.97	16:48
NW Taku D 12	472529.285	6505678.645	1443.931	26.07.97	16:57
NW Taku D 13	472214.784	6505732.894	1451.076	26.07.97	17:15
NW Taku D 14	472013.142	6505768.250	1469.333	26.07.97	17:37
Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW Taku D 01	476050.330	6505072.838	1438.227	31.07.97	12:44
NW Taku D 02	475728.150	6505122.997	1437.256	31.07.97	13:02
NW Taku D 03	475413.584	6505174.762	1433.623	31.07.97	13:20
NW Taku D 04	475094.543	6505229.059	1431.073	31.07.97	13:40
NW Taku D 05	474771.416	6505284.546	1428.692	31.07.97	14:01
NW Taku D 06	474457.209	6505339.361	1427.536	31.07.97	14:19
NW Taku D 07	474146.062	6505394.344	1428.776	31.07.97	14:37
NW Taku D 08	473808.010	6505453.979	1430.825	31.07.97	14:57
NW Taku D 09	473477.793	6505512.137	1430.851	31.07.97	15:14
NW Taku D 10	473158.035	6505568.640	1430.254	31.07.97	15:34
NW Taku D 11	472845.888	6505624.119	1436.036	31.07.97	15:53
NW Taku D 12	472529.329	6505678.671	1443.685	31.07.97	16:10
NW Taku D 13	472214.807	6505732.963	1450.859	31.07.97	16:18
NW Taku D 14	472013.086	6505768.292	1469.025	31.07.97	16:14

Profile VII (Matthes Glacier, Camp 9 - Centurian Peak)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Camp_9 01	489082.709	6510949.289	1466.688	25.07.97	15:14
Camp_9 02	489006.141	6510988.915	1453.550	25.07.97	15:23
Camp_9 03	488875.166	6511058.422	1439.913	25.07.97	15:32
Camp_9 04	488742.080	6511130.974	1430.560	25.07.97	15:39
Camp_9 05	488520.264	6511248.510	1426.053	25.07.97	15:47
Camp_9 06	488305.218	6511364.311	1426.793	25.07.97	15:58
Camp_9 07	488074.660	6511486.327	1425.932	25.07.97	16:07
Camp_9 08	487840.016	6511611.836	1424.341	25.07.97	16:15
Camp_9 09	487613.713	6511732.449	1423.301	25.07.97	16:23
Camp_9 10	487386.404	6511854.272	1416.030	25.07.97	16:37
Camp_9 11	487148.009	6511981.926	1409.890	25.07.97	16:46
Camp_9 12	486912.430	6512108.572	1414.457	25.07.97	16:55
Camp_9 13	486678.385	6512231.394	1421.543	25.07.97	17:03
Camp_9 14	486446.295	6512351.348	1418.352	25.07.97	17:10
Camp_9 15	486214.135	6512479.197	1417.698	25.07.97	17:16
Camp_9 16	485981.137	6512606.714	1425.399	25.07.97	17:23
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Camp_9 01	489082.698	6510949.232	1466.406	29.07.97	12:12
Camp_9 02	489006.145	6510988.941	1453.145	29.07.97	12:30
Camp_9 03	488875.110	6511058.384	1439.617	29.07.97	12:50
Camp_9 04	488742.043	6511131.024	1430.324	29.07.97	13:05
Camp_9 05	488520.023	6511248.320	1425.804	29.07.97	13:22
Camp_9 06	488304.941	6511363.987	1426.505	29.07.97	13:41
Camp_9 07	488074.078	6511485.633	1425.589	29.07.97	13:57
Camp_9 08	487839.248	6511610.848	1424.053	29.07.97	14:16
Camp_9 09	487612.078	6511730.081	1422.714	03.08.97	17:55
Camp_9 10	487385.584	6511853.180	1415.755	29.07.97	14:52
Camp_9 11	487147.317	6511980.847	1409.589	29.07.97	15:12
Camp_9 12	486911.686	6512107.548	1414.175	29.07.97	15:29
Camp_9 13	486677.704	6512230.312	1421.186	29.07.97	15:49
Camp_9 14	486445.682	6512350.349	1418.062	29.07.97	16:04
Camp_9 15	486213.861	6512478.390	1417.331	29.07.97	16:20
Camp_9 16	485981.037	6512606.113	1425.176	29.07.97	16:37

Profile VIIa (Lower Matthes Glacier, Taku D - Taku C)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Lowmat 01	483727.100	6509199.389	1300.728	24.07.97	14:25
Lowmat 02	483847.460	6509107.244	1299.906	24.07.97	14:56
Lowmat 03	484017.010	6508983.944	1300.598	24.07.97	15:07
Lowmat 04	484171.470	6508870.278	1300.333	24.07.97	15:15
Lowmat 05	484330.117	6508753.176	1300.007	24.07.97	15:24
Lowmat 06	484487.969	6508637.182	1299.439	24.07.97	15:32
Lowmat 07	484645.838	6508520.657	1300.535	24.07.97	15:45
Lowmat 08	484802.020	6508406.801	1307.740	24.07.97	15:54
Lowmat 09	484955.092	6508294.676	1316.329	24.07.97	16:01
Lowmat 10	485116.470	6508176.868	1320.315	24.07.97	16:36
Lowmat 11	485229.923	6508093.528	1321.064	24.07.97	16:42
Lowmat 12	485343.758	6508009.678	1322.813	24.07.97	16:50
Lowmat 13	485455.759	6507927.277	1323.179	24.07.97	17:01
Lowmat 14	485584.256	6507833.596	1323.008	24.07.97	17:10
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Lowmat 01	483726.485	6509198.701	1300.412	29.07.97	17:55
Lowmat 02	483846.655	6509106.260	1299.626	29.07.97	18:01
Lowmat 03	484015.948	6508982.635	1300.313	29.07.97	18:07
Lowmat 04	484170.289	6508868.953	1300.016	29.07.97	18:10
Lowmat 05	484328.768	6508751.826	1299.683	29.07.97	18:13
Lowmat 06	484486.560	6508635.629	1299.104	29.07.97	18:15
Lowmat 07	484644.366	6508519.114	1300.232	29.07.97	18:18
Lowmat 08	484800.429	6508405.279	1307.352	29.07.97	18:22
Lowmat 09	484953.546	6508293.202	1315.971	29.07.97	18:26
Lowmat 10	485115.034	6508175.368	1319.938	29.07.97	18:29
Lowmat 11	485228.407	6508092.143	1320.722	29.07.97	18:31
Lowmat 12	485342.314	6508008.464	1322.444	29.07.97	18:34
Lowmat 13	485454.480	6507926.053	1322.792	29.07.97	18:39
Lowmat 14	485583.142	6507832.489	1322.616	29.07.97	18:42

Profile VIII (Upper Matthes Glacier, Camp 8 - Blizzard Pt.)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Matthes 01	490902.949	6522005.067	1830.266	05.08.97	17:27
Matthes 02	490612.980	6522169.022	1818.973	05.08.97	17:17
Matthes 03	490366.203	6522305.763	1795.165	05.08.97	17:06
Matthes 04	490119.632	6522443.121	1789.758	05.08.97	16:59
Matthes 05	489885.021	6522574.532	1790.772	05.08.97	16:52
Matthes 06	489637.400	6522711.777	1794.300	05.08.97	16:43
Matthes 07	489366.538	6522859.478	1799.489	05.08.97	16:33
Matthes 08	489088.820	6523015.843	1802.873	05.08.97	16:21
Matthes 09	488765.995	6523197.158	1807.531	05.08.97	16:10
Matthes 10	488415.568	6523396.817	1812.972	05.08.97	16:00
Matthes 11	488106.420	6523570.748	1826.964	05.08.97	15:52
Matthes 12	487864.588	6523707.134	1848.212	05.08.97	15:45
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Matthes 01	490902.399	6522004.891	1829.797	11.08.97	13:16
Matthes 02	490612.442	6522168.707	1818.471	11.08.97	13:02
Matthes 03	490365.750	6522305.265	1794.629	11.08.97	12:48
Matthes 04	490119.222	6522442.473	1789.273	11.08.97	12:32
Matthes 05	489884.622	6522573.763	1790.281	11.08.97	12:14
Matthes 06	489637.057	6522710.941	1793.849	11.08.97	11:59
Matthes 07	489366.218	6522858.661	1799.029	11.08.97	11:44
Matthes 08	489088.656	6523015.116	1802.256	11.08.97	11:27
Matthes 09	488765.881	6523196.548	1806.996	11.08.97	11:10
Matthes 10	488415.618	6523396.461	1812.527	11.08.97	10:54
Matthes 11	488106.464	6523570.608	1826.506	11.08.97	10:37
Matthes 12	487864.645	6523707.165	1847.744	11.08.97	10:21

Profile IX (Upper Vaughan Lewis Glacier)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Vaughan 01	485620.480	6524358.090	1730.137	07.08.97	15:38
Vaughan 02	485747.145	6524153.899	1731.330	07.08.97	15:51
Vaughan 03	485830.071	6523948.128	1734.913	07.08.97	16:08
Vaughan 04	485874.261	6523693.826	1739.747	07.08.97	16:21
Vaughan 05	485877.342	6523472.539	1744.912	07.08.97	16:32
Vaughan 06	485794.807	6523293.039	1749.709	07.08.97	16:51
Vaughan 07	485670.284	6523112.636	1754.470	07.08.97	17:11
Vaughan 08	485442.121	6523028.171	1764.945	07.08.97	17:33
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Vaughan 01	485620.164	6524357.735	1729.706	13.08.97	16:08
Vaughan 02	485746.649	6524153.732	1731.194	13.08.97	15:38
Vaughan 03	485829.476	6523948.135	1734.634	13.08.97	15:05
Vaughan 04	485873.772	6523694.143	1739.347	13.08.97	14:45
Vaughan 05	485876.771	6523472.936	1744.515	13.08.97	14:28
Vaughan 06	485794.354	6523293.610	1749.220	13.08.97	14:16
Vaughan 07	485670.053	6523113.179	1754.005	13.08.97	14:01
Vaughan 08	485442.060	6523028.573	1764.452	13.08.97	13:44

Divide Grid (Matthes/Llewellyn Glacier)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Grid 01	490493.921	6527357.998	1885.721	04.08.97	15:21
Grid 02	490359.933	6527089.935	1886.268	04.08.97	15:28
Grid 03	490227.049	6526821.963	1885.304	04.08.97	15:32
Grid 04	490091.980	6526552.018	1882.054	04.08.97	15:38
Grid 05	490762.197	6527223.032	1882.224	04.08.97	15:14
Grid 06	490629.094	6526955.470	1881.407	04.08.97	15:09
Grid 07	490495.007	6526687.307	1879.205	04.08.97	14:49
Grid 08	490360.468	6526418.406	1875.834	04.08.97	14:57
Grid 09	491031.565	6527088.902	1878.494	04.08.97	16:16
Grid 10	490898.193	6526821.510	1877.264	04.08.97	16:07
Grid 11	490763.203	6526553.263	1875.009	04.08.97	16:00
Grid 12	490628.068	6526284.358	1872.339	04.08.97	15:51
Grid 13	491299.551	6526956.015	1875.265	04.08.97	16:22
Grid 14	491164.879	6526686.845	1874.654	05.08.97	14:35
Grid 15	491031.057	6526418.465	1873.248	05.08.97	14:27
Grid 16	490897.134	6526149.497	1871.176	05.08.97	14:13
Grid 17	491567.976	6526821.939	1872.488	04.08.97	17:59
Grid 18	491434.248	6526552.486	1872.985	04.08.97	17:52
Grid 19	491299.039	6526285.199	1872.963	04.08.97	17:45
Grid 20	491164.886	6526015.697	1872.109	04.08.97	17:35
Grid 21	490629.119	6527625.650	1882.827	08.08.97	13:20
Grid 22	490896.417	6527492.440	1880.973	08.08.97	13:31
Grid 23	491165.013	6527358.088	1878.197	08.08.97	13:37
Grid 24	491432.939	6527223.977	1874.852	08.08.97	13:44
Grid 25	491702.288	6527089.990	1871.617	08.08.97	13:52
Grid 26	491970.566	6526956.073	1867.975	08.08.97	13:59
Grid 27	491836.738	6526687.888	1869.759	08.08.97	14:05
Grid 28	491702.112	6526417.988	1871.305	08.08.97	14:11
Grid 29	491567.379	6526149.934	1872.897	08.08.97	14:16
Grid 30	491433.609	6525883.058	1873.198	08.08.97	15:22

Divide Grid (Matthes/Llewellyn Glacier) - continued

Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Grid 01	490494.619	6527358.131	1884.985	13.08.97	15:34
Grid 02	490360.657	6527089.794	1885.803	13.08.97	14:37
Grid 03	490227.800	6526821.783	1884.562	13.08.97	14:33
Grid 04	490092.741	6526551.781	1881.250	13.08.97	13:41
Grid 05	490762.845	6527223.180	1881.562	13.08.97	15:30
Grid 06	490629.724	6526955.373	1880.687	13.08.97	14:52
Grid 07	490495.597	6526687.103	1878.504	13.08.97	14:28
Grid 08	490361.014	6526418.143	1875.122	13.08.97	13:47
Grid 09	491032.271	6527088.945	1877.803	13.08.97	15:26
Grid 10	490898.708	6526821.370	1876.232	13.08.97	15:09
Grid 11	490763.610	6526553.069	1874.402	13.08.97	14:20
Grid 12	490628.324	6526284.031	1871.661	13.08.97	13:52
Grid 13	491300.121	6526955.978	1874.641	13.08.97	15:22
Grid 14	491165.225	6526686.661	1873.722	13.08.97	15:03
Grid 15	491031.419	6526418.406	1872.620	13.08.97	14:16
Grid 16	490897.286	6526149.279	1870.578	13.08.97	13:56
Grid 17	491568.580	6526822.008	1871.887	13.08.97	15:18
Grid 18	491434.641	6526552.366	1872.086	13.08.97	15:07
Grid 19	491299.281	6526285.208	1872.339	13.08.97	14:12
Grid 20	491165.050	6526015.529	1871.442	13.08.97	14:01
Grid 21	490629.499	6527625.772	1882.212	13.08.97	15:42
Grid 22	490896.776	6527492.502	1880.382	13.08.97	15:46
Grid 23	491165.278	6527358.164	1877.607	13.08.97	16:01
Grid 24	491433.318	6527224.012	1874.341	13.08.97	16:05
Grid 25	491702.621	6527090.013	1871.202	13.08.97	16:09
Grid 26	491970.946	6526956.096	1867.474	13.08.97	16:13
Grid 27	491836.978	6526687.865	1869.125	13.08.97	15:14
Grid 28	491702.291	6526417.897	1870.608	13.08.97	15:10
Grid 29	491567.475	6526149.937	1872.480	13.08.97	14:08
Grid 30	491433.614	6525882.994	1872.777	13.08.97	14:35

Profile XI (Llewellyn Glacier, F10 Peak - Sloko Ridge)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Llewellyn 01	492977.553	6535458.168	1751.998	06.08.97	14:02
Llewellyn 02	493256.451	6535472.598	1735.540	06.08.97	14:20
Llewellyn 03	493534.616	6535487.459	1728.714	06.08.97	14:35
Llewellyn 04	493816.791	6535501.810	1727.611	06.08.97	14:50
Llewellyn 05	494092.844	6535516.718	1729.727	06.08.97	15:05
Llewellyn 06	494367.125	6535531.346	1730.168	06.08.97	15:20
Llewellyn 07	494645.675	6535546.045	1727.610	06.08.97	15:35
Llewellyn 08	494926.270	6535561.045	1725.765	06.08.97	15:52
Llewellyn 09	495206.397	6535576.264	1726.561	06.08.97	16:09
Llewellyn 10	495494.533	6535591.996	1728.268	06.08.97	16:25
Llewellyn 11	495767.858	6535607.000	1729.841	06.08.97	16:40
Llewellyn 12	496061.395	6535622.790	1728.587	06.08.97	16:57
	Epoch 1				
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Llewellyn 01	492977.974	6535458.716	1751.419	12.08.97	14:31
Llewellyn 02	493256.885	6535473.578	1734.999	12.08.97	14:35
Llewellyn 03	493535.047	6535488.678	1728.264	12.08.97	14:38
Llewellyn 04	493817.267	6535503.222	1727.150	12.08.97	14:43
Llewellyn 05	494093.182	6535518.223	1729.263	12.08.97	14:46
Llewellyn 06	494367.527	6535532.861	1729.676	12.08.97	14:51
Llewellyn 07	494646.042	6535547.631	1727.179	12.08.97	14:58
Llewellyn 08	494926.559	6535562.628	1725.291	12.08.97	15:05
Llewellyn 09	495206.620	6535577.798	1726.095	12.08.97	15:13
Llewellyn 10	495494.670	6535593.413	1727.883	12.08.97	15:18
Llewellyn 11	495767.893	6535608.197	1729.374	12.08.97	15:22
Llewellyn 12	496061.389	6535623.767	1728.131	12.08.97	15:31

Appendix B2

Coordinate Listing of Locations related to various projects

Reference Points Geological Mapping Camp 10 Hill

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Geomap 02	488177.031	6503548.552	1202.922	21.07.97	14:59
Geomap 03	488259.821	6503696.337	1254.716	21.07.97	15:23
Geomap 04	488362.040	6503783.482	1300.729	21.07.97	15:53
Geomap 11	488507.108	6503950.027	1381.816	21.07.97	16:23
Geomap 12	488268.472	6504377.916	1385.921	21.07.97	17:24

Testpit Locations

Point		Easting [m]	Northing [m]	Height [m]	Date	Time
Testpit G-b	*	484542.000	6504749.000	1199.000	25.07.97	-
Testpit H	*	484002.000	6505875.000	1207.000	25.07.97	-
Testpit I		484472.132	6507965.432	1292.671	23.07.97	18:53
Testpit O	*	489670.000	6525391.000	1848.000	04.08.97	-
Testpit M	*	490785.000	6521788.000	1789.000	04.08.97	-
Testpit R	*	493656.000	6535916.000	1713.000	06.08.97	-
Testpit Q	*	492980.000	6533436.000	1786.000	06.08.97	-
Testpit P	*	491393.000	6529720.000	1789.000	06.08.97	-

* P-code handheld GPS-receiver ($\sigma_{3d\text{-}position}$ ~ 10 m) used for position determination, coordinates given to the nearest meter

Seismic Locations

Point		Easting [m]	Northing [m]	Height [m]	Date	Time
Icy Basin 01	*	488845.000	6502579.000	1105.000	28.07.97	-
Icy Basin 02	*	488593.000	6502358.000	1095.000	28.07.97	-
Icy Basin 03	*	488302.000	6502101.000	1093.000	28.07.97	-

* P-code handheld GPS-receiver ($\sigma_{3d\text{-}position}$ ~ 10 m) used for position determination, coordinates given to the nearest meter

Metpack Locations

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Mpack Taku *	487795.000	6503053.000	1118.000	28.07.97	-
Mpack Blob *	491338.000	6528108.000	1871.000	06.08.97	-
Mpack Grid *	489895.000	6525055.000	1835.000	09.08.97	-

* P-code handheld GPS-receiver ($\sigma_{3d\text{-}position}$ ~ 10 m) used for position determination, coordinates given to the nearest meter

Relocated 1996 Flags

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Vaughan 01-96	485595.876	6524340.583	1728.958	13.08.97	16:21
Vaughan 02-96	485716.553	6524147.162	1730.405	13.08.97	15:51
Vaughan 03-96	485794.792	6523950.533	1733.768	13.08.97	15:19

Height Comparison Lemon Creek and Ptarmigan Glacier (1)

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
FFGR1 (C-17)	478573.838	6472234.227	1301.709	02.08.97	-
17N	478624.728	6472387.461	1311.988	02.08.97	-
Scorpion Peak	480616.092	6472571.532	1319.967	02.08.97	-
Anne	478690.490	6472677.349	1376.031	02.08.97	-
Lemon 02	478658.773	6472199.367	1258.284	02.08.97	12:28
Lemon 03	478825.761	6472140.711	1236.160	02.08.97	12:30
Lemon 04	478955.347	6472091.082	1226.599	02.08.97	12:32
Lemon 05	479018.473	6472066.248	1223.424	02.08.97	12:33
Lemon 06	479082.858	6472041.331	1220.796	02.08.97	12:36
Lemon 07	479146.550	6472015.902	1218.520	02.08.97	12:37
Lemon 08	479207.331	6471991.859	1216.550	02.08.97	12:38
Lemon 09	479265.727	6471967.550	1214.846	02.08.97	12:38
Lemon 10	479322.276	6471944.393	1213.332	02.08.97	12:41
Lemon 11	479377.218	6471920.214	1212.007	02.08.97	12:42
Lemon 12	479431.758	6471896.959	1210.740	02.08.97	12:43
Lemon 13	479485.573	6471876.177	1210.026	02.08.97	12:44
Lemon 14	479539.042	6471855.323	1209.384	02.08.97	12:45
Lemon 15	479588.710	6471835.379	1209.366	02.08.97	12:46

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Lemon 16	479638.607	6471814.288	1209.920	02.08.97	12:48
Lemon 17	479689.181	6471793.154	1211.444	02.08.97	12:49
Lemon 18	479738.538	6471773.328	1213.544	02.08.97	12:51
Lemon 19	479786.813	6471755.481	1216.292	02.08.97	12:52
Lemon 20	479833.450	6471736.813	1220.322	02.08.97	12:53
Lemon 21	479879.293	6471719.573	1225.397	02.08.97	12:58
Lemon 22	479924.333	6471702.135	1230.698	02.08.97	12:59
Lemon 23	479970.134	6471682.090	1235.653	02.08.97	13:01
Lemon 24	480020.382	6471662.371	1239.282	02.08.97	13:02
Lemon 25	480070.848	6471642.305	1242.871	02.08.97	13:03
Lemon 26	480120.555	6471621.547	1249.886	02.08.97	13:05
Lemon 27	480166.802	6471602.135	1260.945	02.08.97	13:07
Lemon 28	480225.983	6471577.888	1278.544	02.08.97	13:10
Lemon 29	480276.530	6471556.314	1292.768	02.08.97	13:12
Lemon 30	480313.359	6471536.120	1302.960	02.08.97	13:14
Lemon 31	480404.864	6472429.271	1245.015	02.08.97	14:42
Lemon 32	480326.933	6472450.575	1222.744	02.08.97	14:44
Lemon 33	480248.897	6472466.382	1202.753	02.08.97	14:45
Lemon 34	480146.617	6472478.347	1190.550	02.08.97	14:47
Lemon 35	480068.094	6472488.274	1186.092	02.08.97	14:48
Lemon 36	480002.313	6472497.014	1184.044	02.08.97	14:49
Lemon 37	479942.948	6472504.770	1183.384	02.08.97	14:50
Lemon 38	479883.794	6472512.567	1183.559	02.08.97	14:51
Lemon 39	479826.201	6472520.914	1184.223	02.08.97	14:52
Lemon 40	479772.228	6472528.430	1185.291	02.08.97	14:54
Lemon 41	479718.723	6472535.186	1186.392	02.08.97	14:55
Lemon 42	479666.554	6472542.574	1187.413	02.08.97	14:56
Lemon 43	479613.320	6472550.112	1188.602	02.08.97	14:58
Lemon 44	479559.952	6472556.716	1189.909	02.08.97	14:59
Lemon 45	479506.041	6472563.268	1191.476	02.08.97	15:00
Lemon 46	479453.060	6472568.945	1193.557	02.08.97	15:01
Lemon 47	479399.094	6472576.420	1196.038	02.08.97	15:03
Lemon 48	479346.223	6472582.858	1199.168	02.08.97	15:04
Lemon 49	479292.927	6472589.391	1203.080	02.08.97	15:05
Lemon 50	479242.723	6472595.800	1207.363	02.08.97	15:07
Lemon 51	479194.536	6472602.043	1211.933	02.08.97	15:09
Lemon 52	479146.188	6472608.029	1217.178	02.08.97	15:10

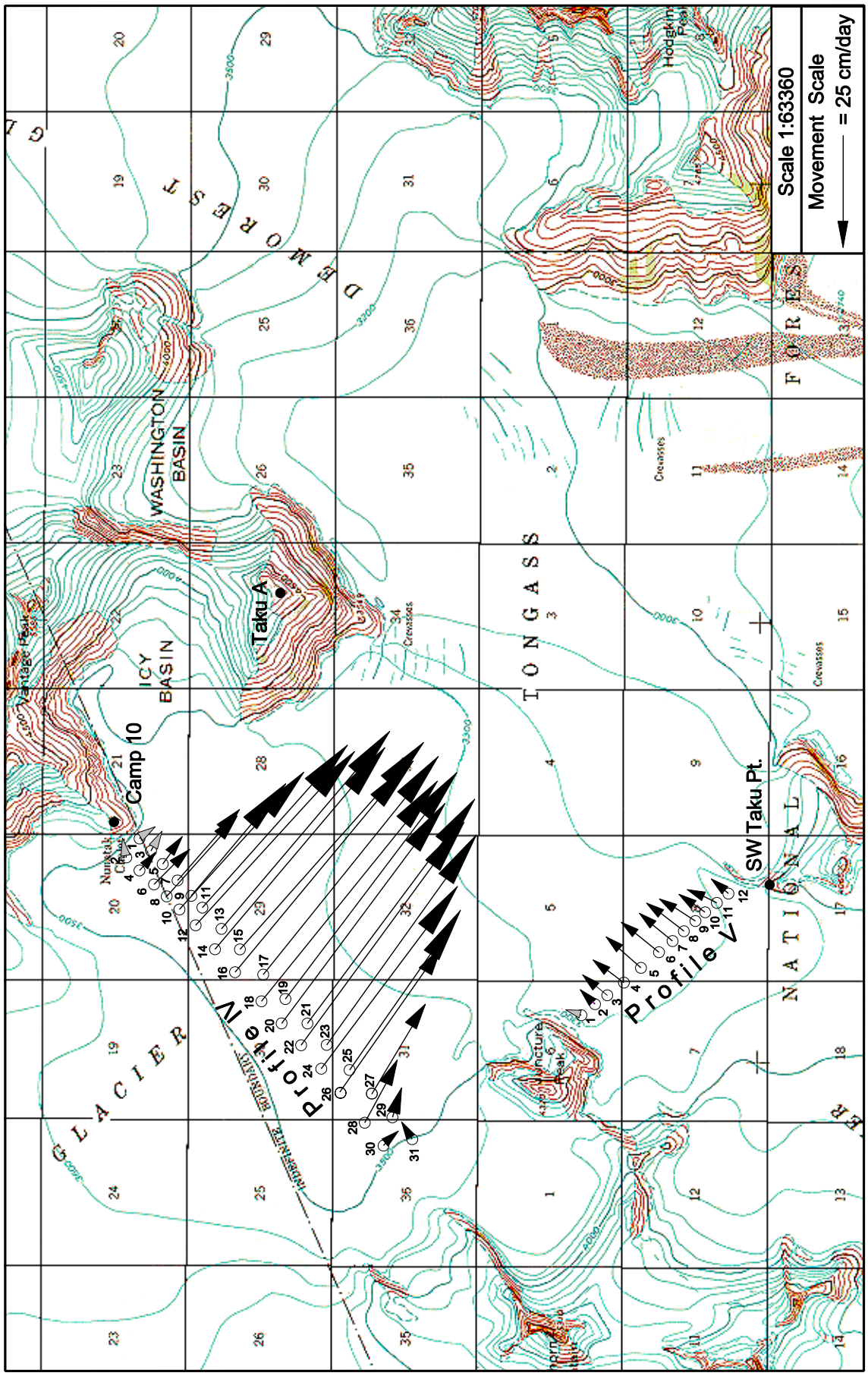
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Lemon 53	479098.475	6472613.328	1223.013	02.08.97	15:11
Lemon 54	479053.031	6472618.290	1229.346	02.08.97	15:13
Lemon 55	479024.206	6472626.197	1234.681	02.08.97	15:14
Lemon 56	479573.491	6472554.590	1189.546	02.08.97	15:21
Lemon 57	479532.242	6472486.532	1193.215	02.08.97	15:23
Lemon 58	479485.054	6472421.695	1196.867	02.08.97	15:25
Lemon 59	479437.714	6472356.623	1200.286	02.08.97	15:26
Lemon 60	479391.411	6472289.719	1203.587	02.08.97	15:29
Lemon 61	479343.967	6472223.934	1206.565	02.08.97	15:32
Lemon 62	479295.735	6472156.800	1209.719	02.08.97	15:34
Lemon 63	479246.919	6472091.757	1213.044	02.08.97	15:36
Lemon 64	479201.993	6472024.125	1216.207	02.08.97	15:38
Lemon 65	479167.125	6471952.625	1218.699	02.08.97	15:40
Lemon 66	479123.512	6471881.315	1221.039	02.08.97	15:41
Lemon 67	479078.934	6471809.086	1222.311	02.08.97	15:43
Lemon 68	479041.381	6471732.691	1222.966	02.08.97	15:45
Lemon 69	478996.769	6471662.915	1224.407	02.08.97	15:46
Lemon 70	478958.915	6471585.466	1225.571	02.08.97	15:48
Lemon 71	478942.224	6471543.847	1225.366	02.08.97	15:58
Lemon 72	478942.595	6471543.783	1225.402	02.08.97	16:00
Lemon 73	478978.274	6471520.808	1225.109	02.08.97	16:06
Lemon 74	479013.551	6471497.440	1225.095	02.08.97	16:07
Lemon 75	479052.390	6471476.660	1225.595	02.08.97	16:08
Lemon 76	479087.544	6471454.110	1226.565	02.08.97	16:09
Lemon 77	479125.931	6471432.855	1228.072	02.08.97	16:10
Lemon 78	479165.046	6471412.359	1231.125	02.08.97	16:12
Lemon 79	479203.707	6471395.811	1235.643	02.08.97	16:13
Lemon 80	479244.458	6471376.617	1241.990	02.08.97	16:17
Lemon 81	478909.510	6471574.531	1226.098	02.08.97	16:22
Lemon 82	478883.199	6471607.039	1227.144	02.08.97	16:24
Lemon 83	478851.522	6471633.652	1228.336	02.08.97	16:25
Lemon 84	478807.932	6471667.229	1230.395	02.08.97	16:27
Lemon 85	478770.990	6471688.098	1232.392	02.08.97	16:28
Lemon 86	478736.442	6471711.103	1234.569	02.08.97	16:29
Lemon 87	478702.149	6471736.243	1236.984	02.08.97	16:30
Lemon 88	478669.705	6471762.393	1239.711	02.08.97	16:31
Lemon 89	478633.758	6471786.384	1242.814	02.08.97	16:33

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
Lemon 90	478596.779	6471805.342	1246.385	02.08.97	16:34
Lemon 91	478562.375	6471824.018	1250.187	02.08.97	16:35
Lemon 92	478529.998	6471843.750	1254.395	02.08.97	16:36
Lemon 93	478498.556	6471863.396	1259.031	02.08.97	16:37
Lemon 94	478467.309	6471881.522	1264.605	02.08.97	16:39
Lemon 95	478429.534	6471901.926	1272.856	02.08.97	16:40
Lemon 96	478386.717	6471922.557	1285.523	02.08.97	16:44
Ptarmigan 01	478412.237	6472170.081	1280.722	02.08.97	12:54
Ptarmigan 02	478305.225	6472205.183	1249.250	02.08.97	13:09
Ptarmigan 03	478180.646	6472247.918	1208.047	02.08.97	13:23
Ptarmigan 04	478045.309	6472297.152	1175.817	02.08.97	13:38
Ptarmigan 05	477907.811	6472314.776	1164.026	02.08.97	13:53
Ptarmigan 06	477799.790	6472348.755	1153.970	02.08.97	14:09
Ptarmigan 07	477615.025	6472384.796	1133.634	02.08.97	14:26
Ptarmigan 08	477837.456	6473037.410	1011.832	02.08.97	14:58
Ptarmigan 09	477906.001	6473012.435	1007.382	02.08.97	15:12
Ptarmigan 10	477973.048	6472986.694	1008.625	02.08.97	15:26
Ptarmigan 11	478066.835	6472963.284	1012.882	02.08.97	15:42
Ptarmigan 12	478156.827	6472952.949	1014.872	02.08.97	15:56
Ptarmigan 13	478250.477	6472945.192	1022.458	02.08.97	16:16
Ptarmigan 14	477829.899	6472661.276	1113.649	02.08.97	16:52

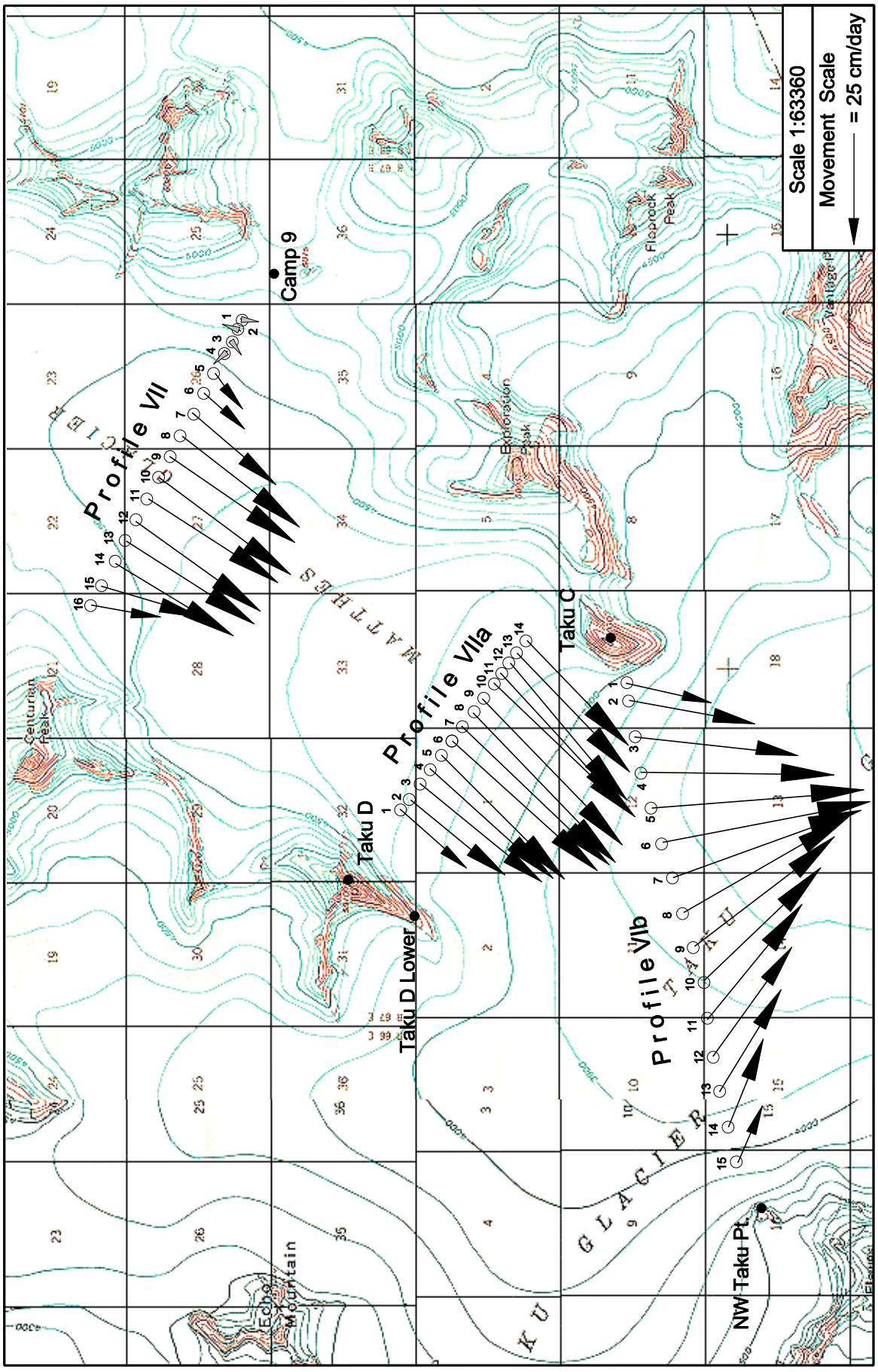
(1) All coordinates for the Lemon Creek and Ptarmigan Glacier height comparison project are based on a single point position for point FFGR 1 (Camp 17).

Appendix C1

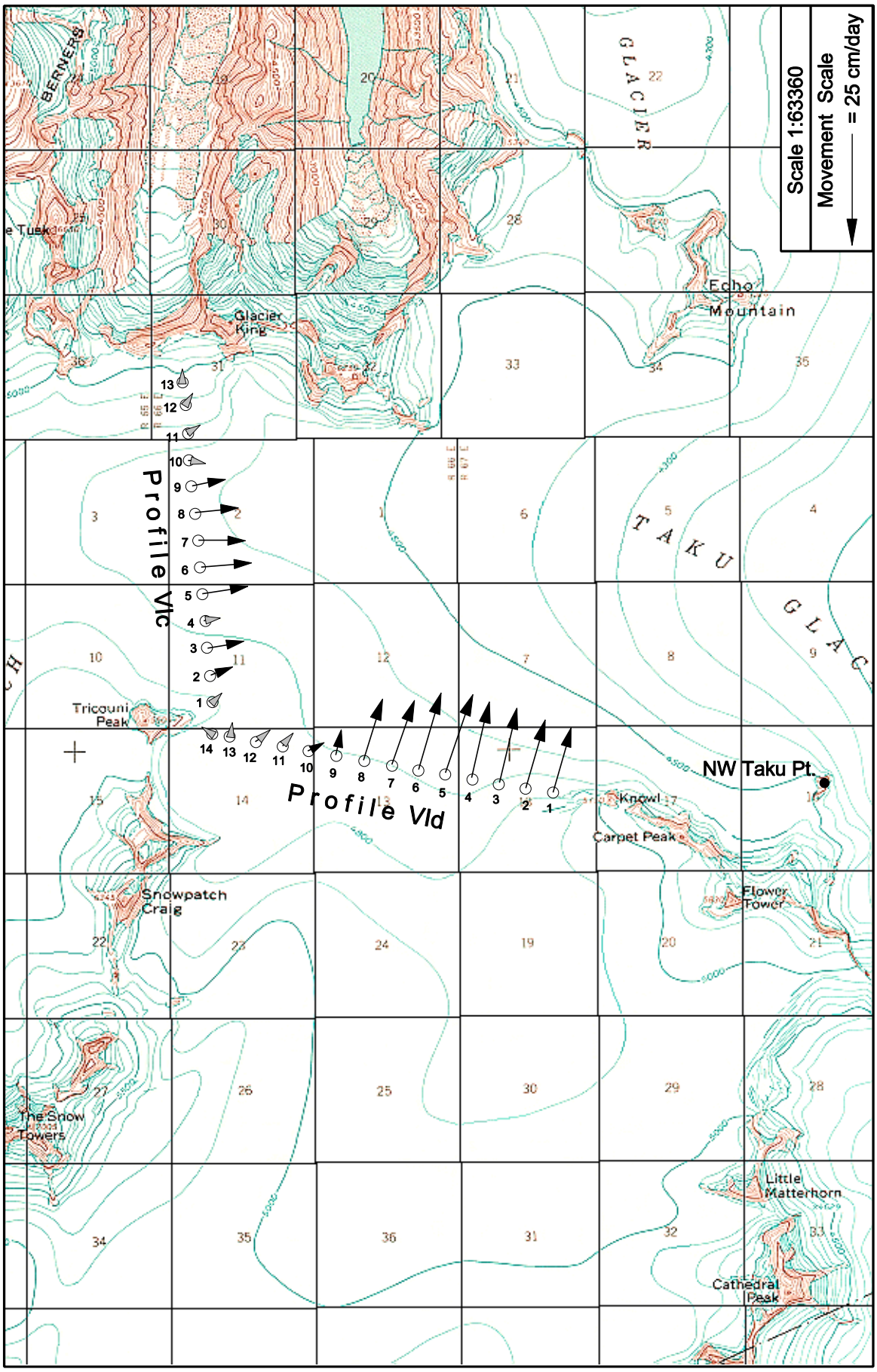
Plots
of Movement Vectors



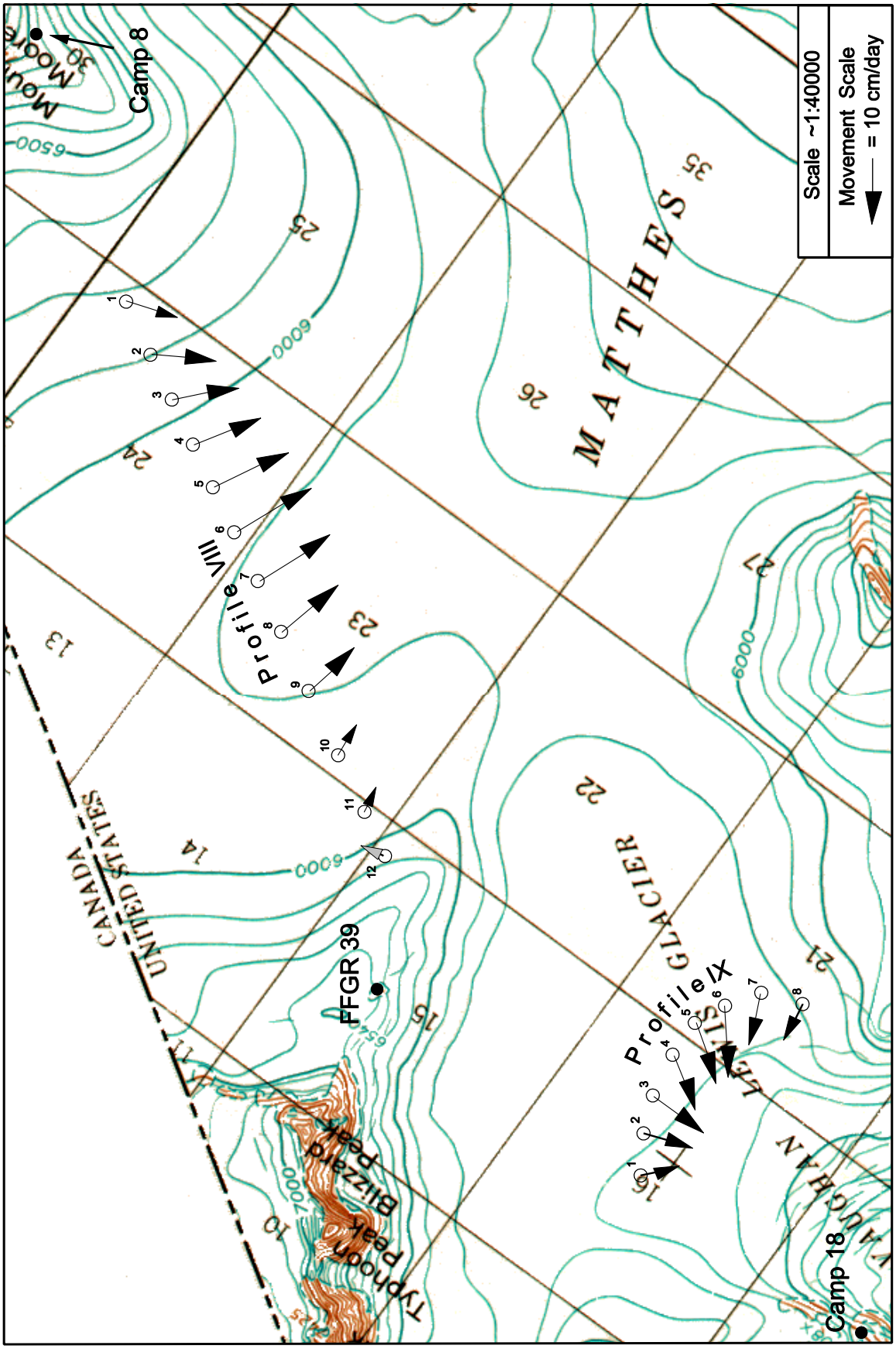
Movement profiles on the Taku Glacier



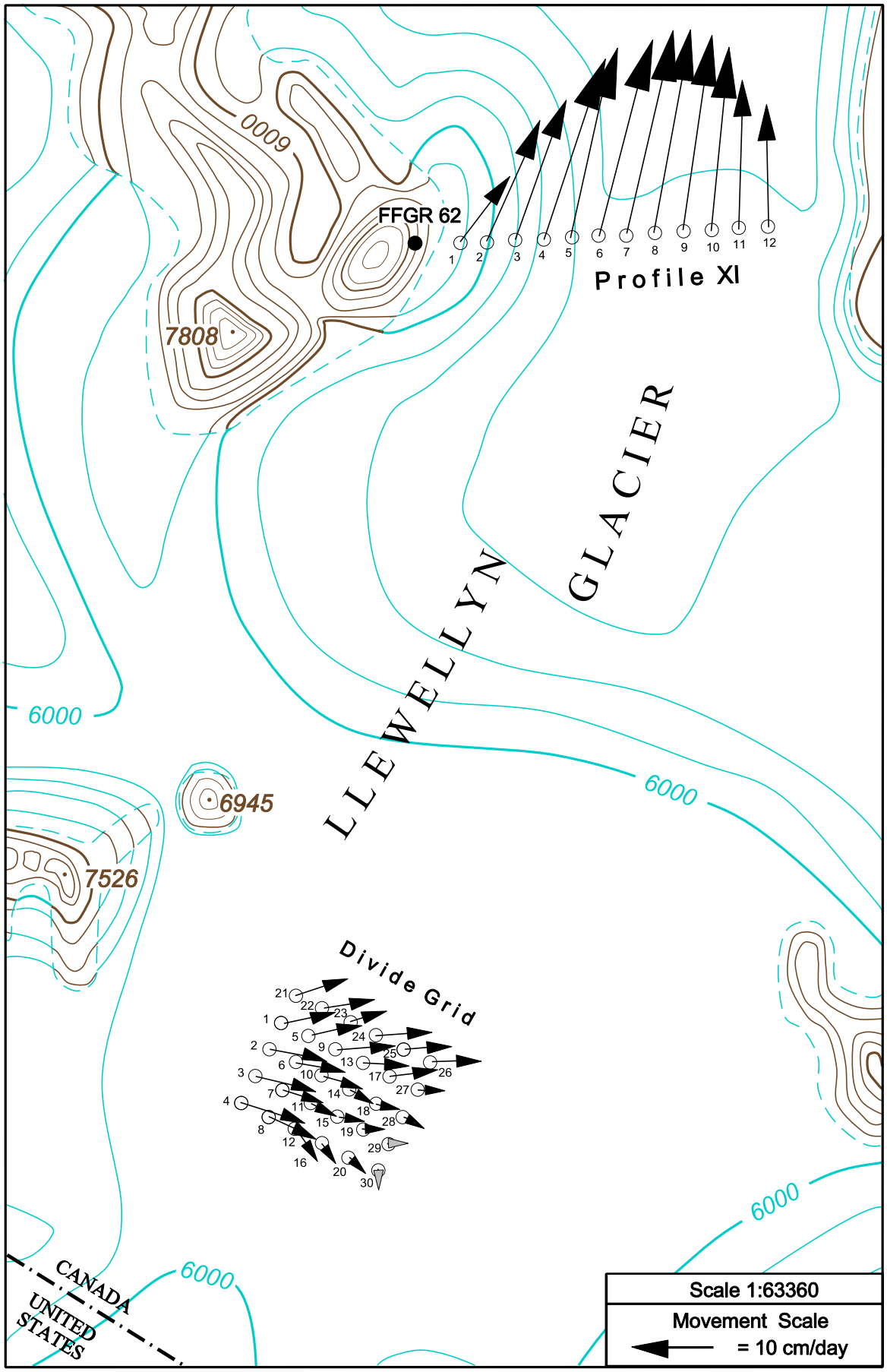
Movement profiles on the Lower Matthes and Taku Glacier



Movement profiles on the NW-Branch of Taku Glacier



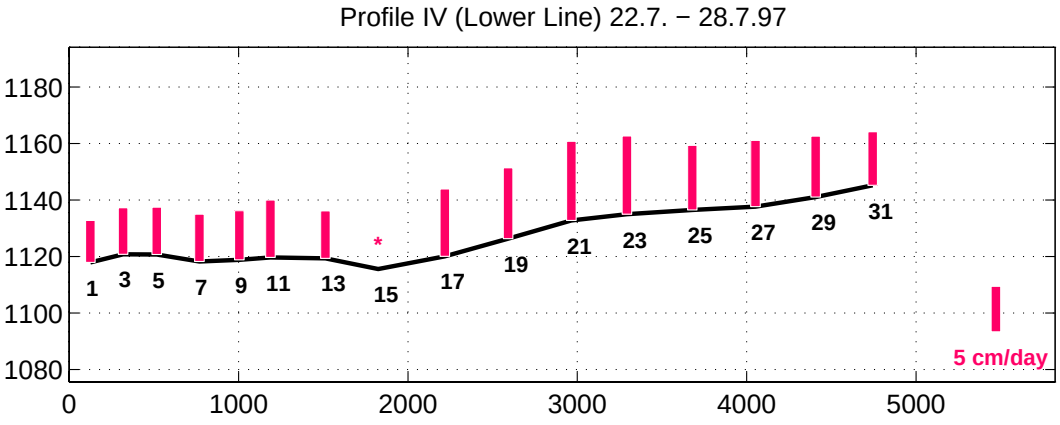
Movement profiles on the high plateau

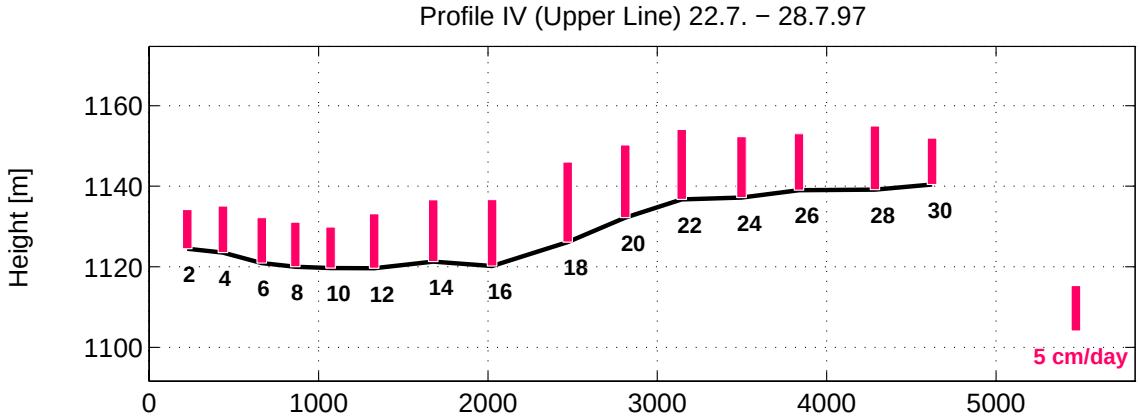


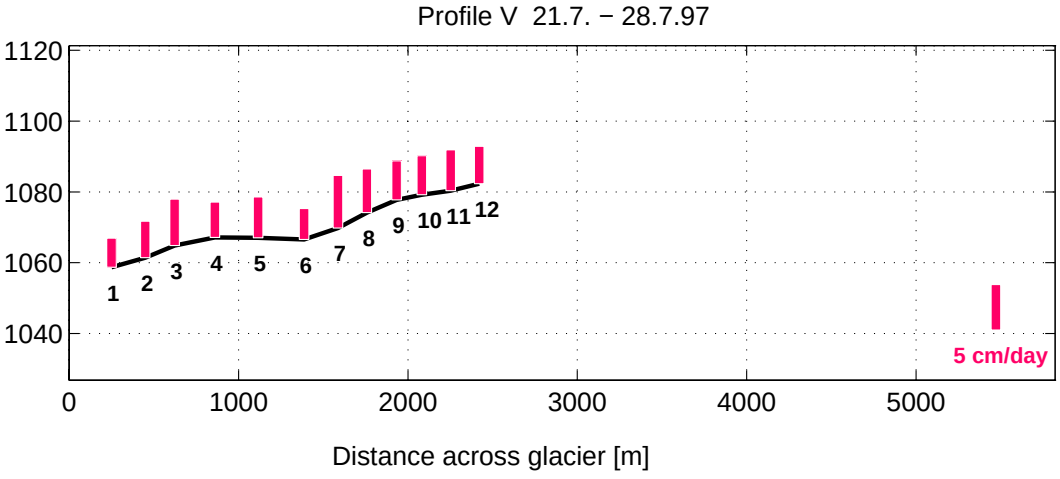
Movement profiles on the Llewellyn Glacier

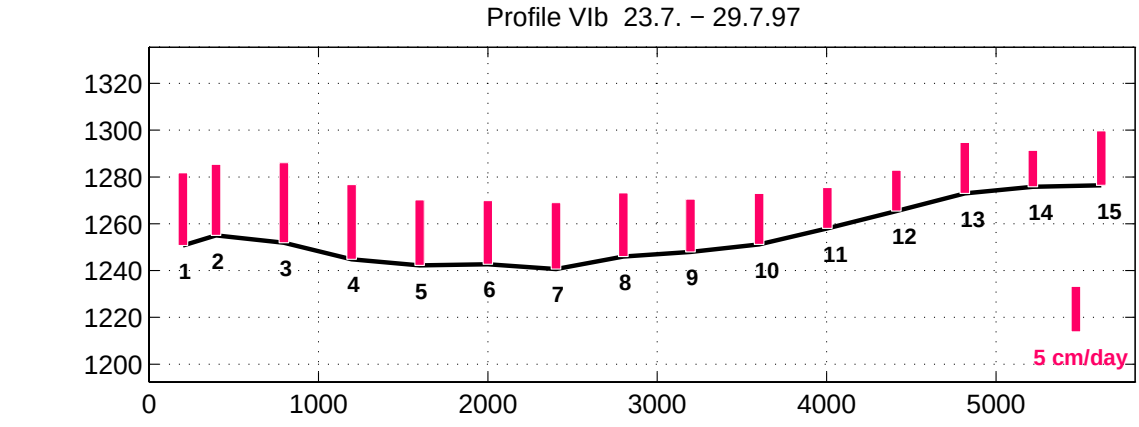
Appendix C2

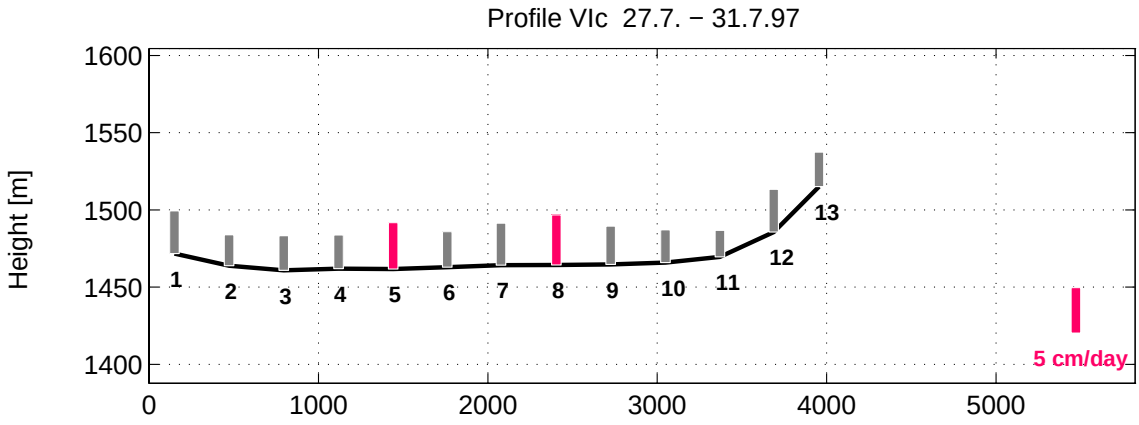
Plots
of Short Term Height Changes

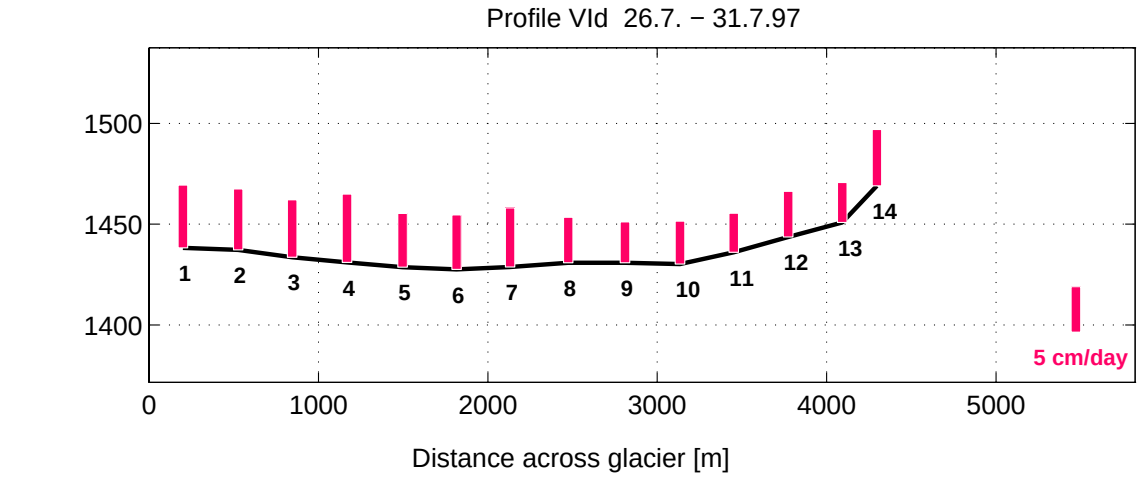

Profile IV (Lower Line) 22.7. − 28.7.97
1180
1160
1140
1120
1100
1080
0
1000
2000
3000
4000
5000
1 3 5 7 9 11 13 * 15 17 19 21 23 25 27 29 31
5 cm/day

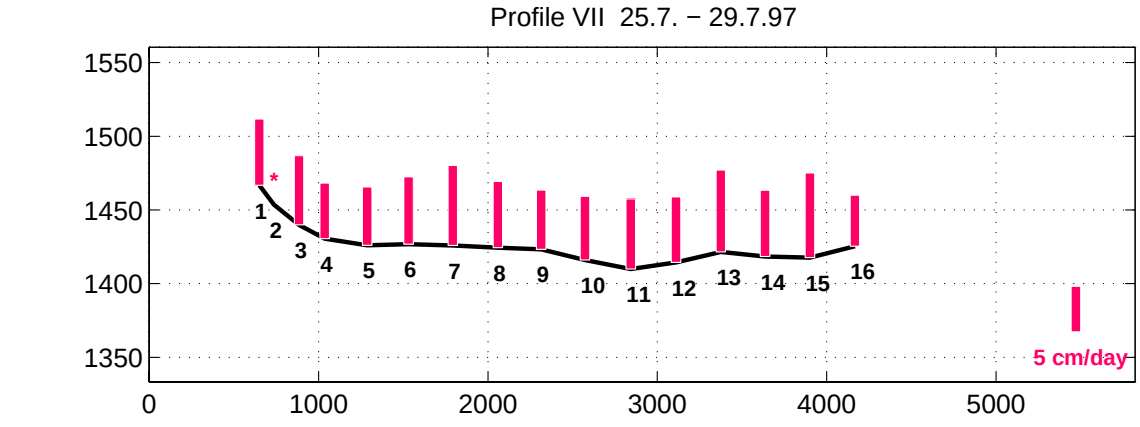

Profile IV (Upper Line) 22.7. − 28.7.97
Height [m]
1160
1140
1120
1100
0
1000
2000
3000
4000
5000
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
5 cm/day

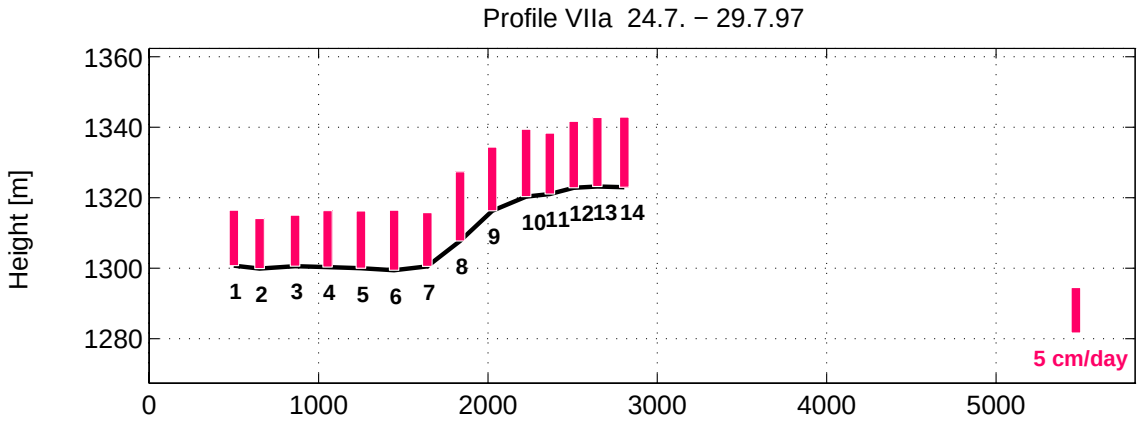

Profile V 21.7. − 28.7.97
1120
1100
1080
1060
1040
0
1000
2000
3000
4000
5000
1 2 3 4 5 6 7 8 9 10 11 12
5 cm/day
Distance across glacier [m]

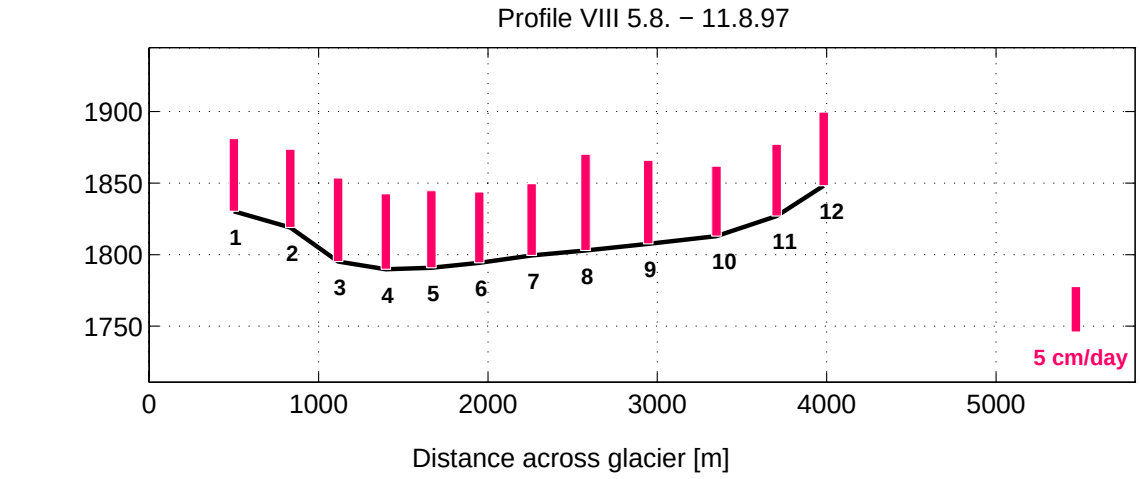

Profile VIb 23.7. − 29.7.97
1320
1300
1280
1260
1240
1220
1200
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
5 cm/day

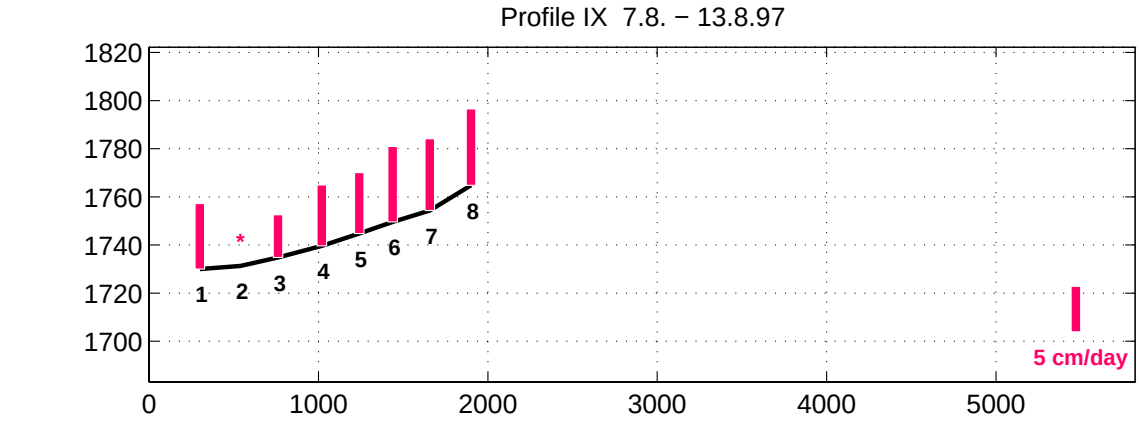

Profile VIc 27.7. − 31.7.97
Height [m]
1600
1550
1500
1450
1400
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
13
5 cm/day

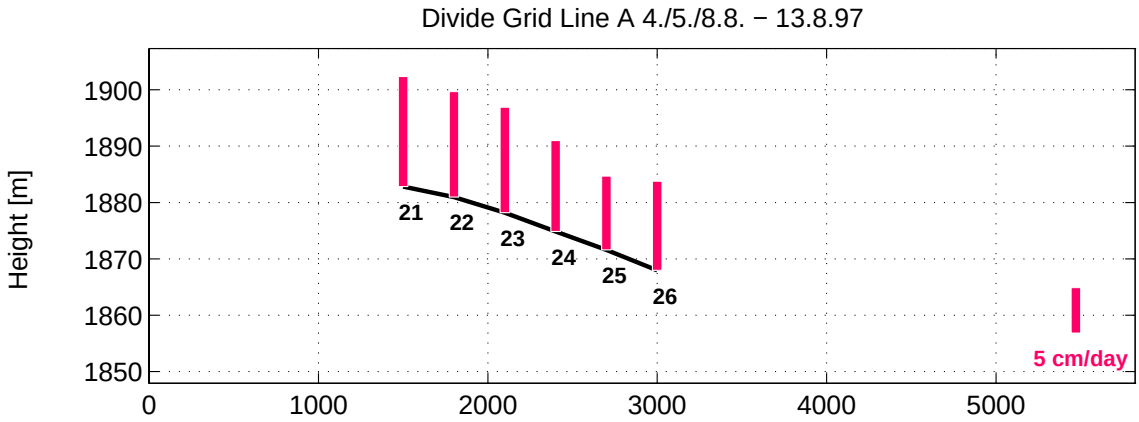

Profile VId 26.7. − 31.7.97
1500
1450
1400
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5 cm/day
Distance across glacier [m]

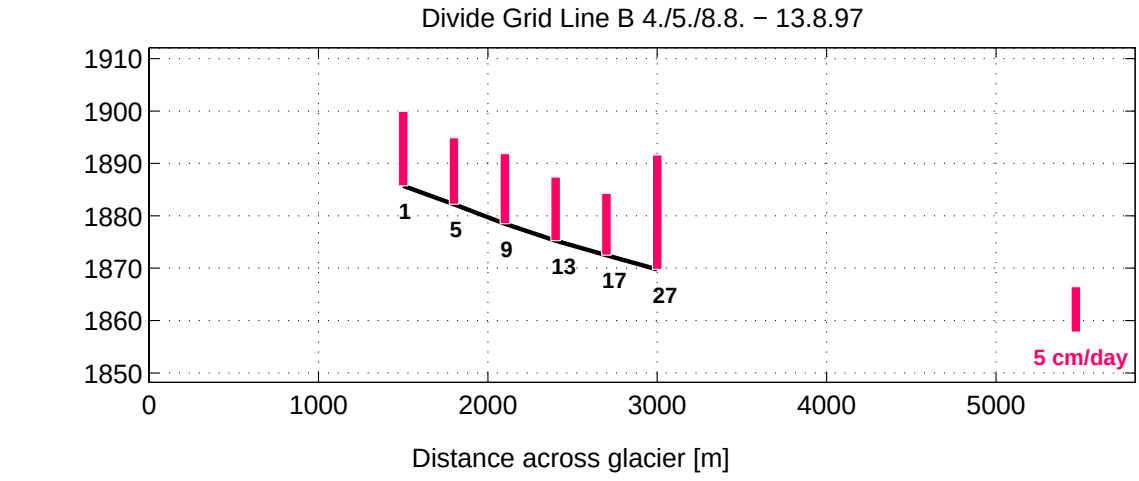

Profile VII 25.7. − 29.7.97
1550
1500
1450
1400
1350
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
5 cm/day

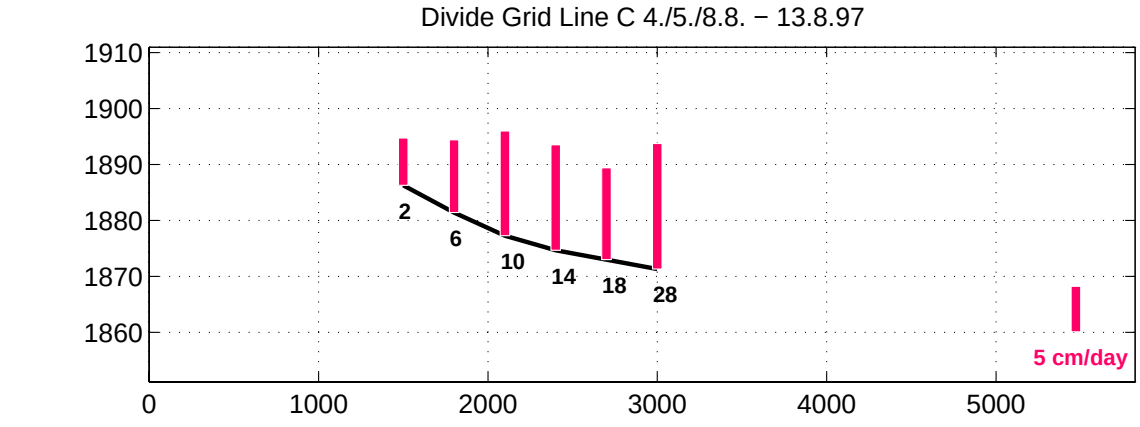

Profile VIIa 24.7. − 29.7.97
Height [m]
1360
1340
1320
1300
1280
0
1000
2000
3000
4000
5000
1 2 3 4 5 6 7
8
9
10 11 12 13 14
5 cm/day

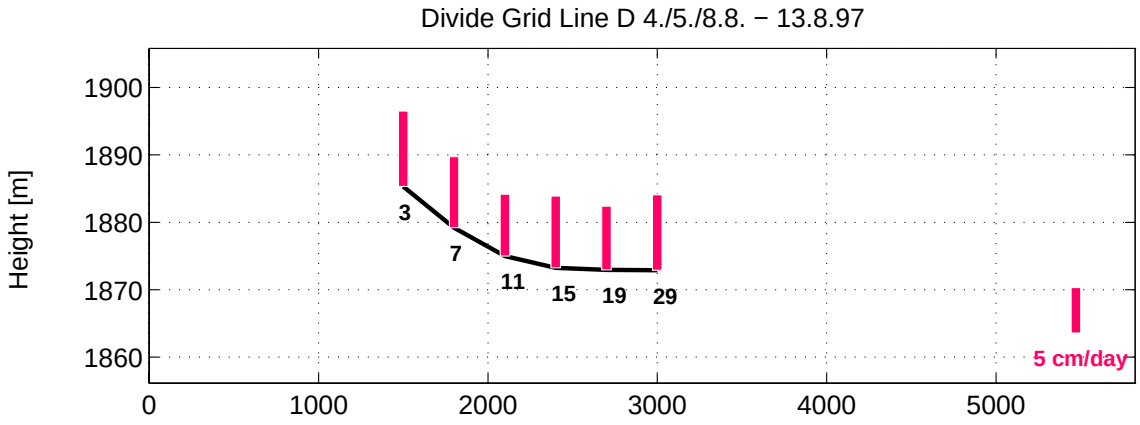

Profile VIII 5.8. − 11.8.97
1900
1850
1800
1750
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
5 cm/day
Distance across glacier [m]

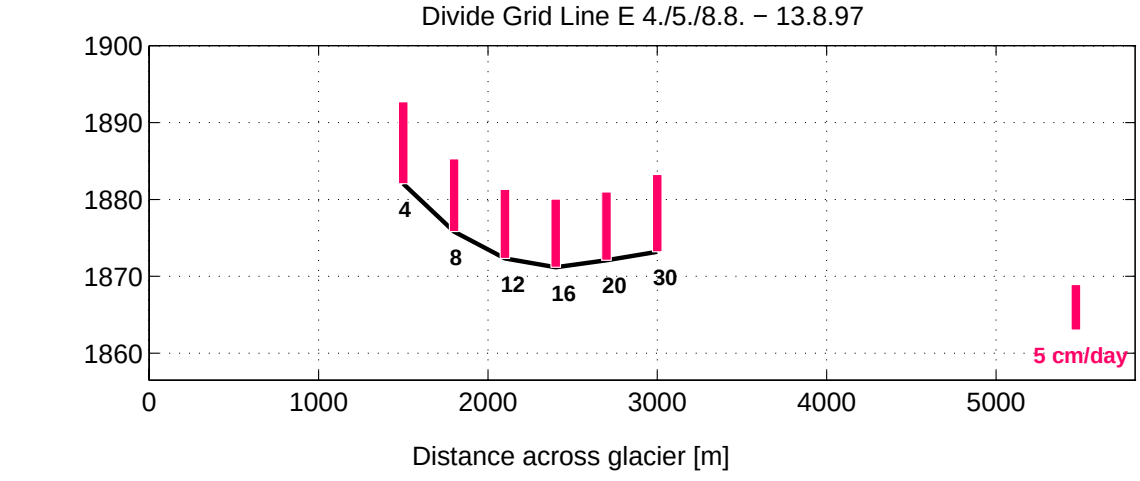

Profile IX 7.8. − 13.8.97
1820
1800
1780
1760
1740
1720
1700
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
5 cm/day

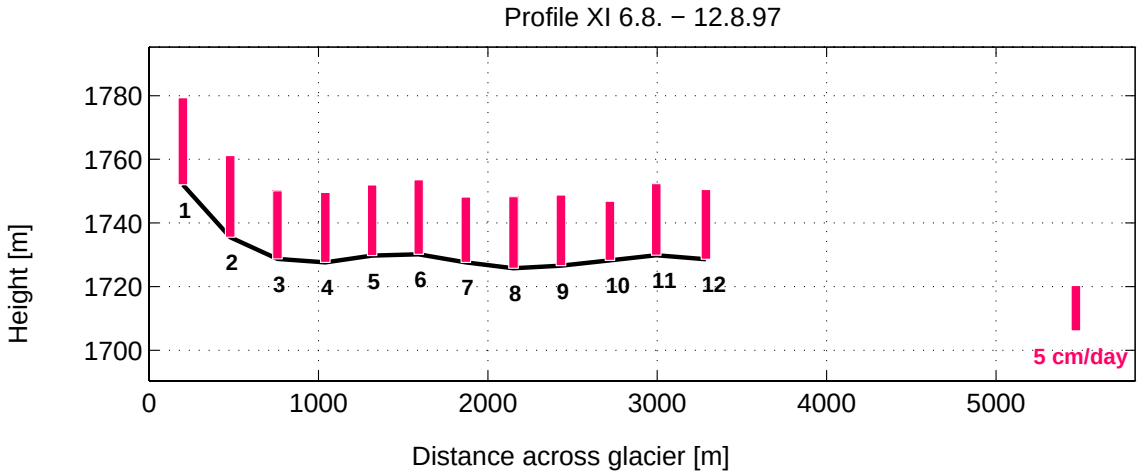

Divide Grid Line A 4./5./8.8. − 13.8.97
Height [m]
1900
1890
1880
1870
1860
1850
0
1000
2000
3000
4000
5000
21
22
23
24
25
26
5 cm/day


Divide Grid Line B 4./5./8.8. − 13.8.97
1910
1900
1890
1880
1870
1860
1850
0
1000
2000
3000
4000
5000
1
5
9
13
17
27
5 cm/day
Distance across glacier [m]


Divide Grid Line C 4./5./8.8. − 13.8.97
1910
1900
1890
1880
1870
1860
0
1000
2000
3000
4000
5000
2
6
10
14
18
28
5 cm/day


Divide Grid Line D 4./5./8.8. − 13.8.97
Height [m]
1900
1890
1880
1870
1860
0
1000
2000
3000
4000
5000
3
7
11
15
19
29
5 cm/day


Divide Grid Line E 4./5./8.8. − 13.8.97
1900
1890
1880
1870
1860
0
1000
2000
3000
4000
5000
4
8
12
16
20
30
5 cm/day
Distance across glacier [m]


Profile XI 6.8. − 12.8.97
Height [m]
1780
1760
1740
1720
1700
0
1000
2000
3000
4000
5000
Distance across glacier [m]
1
2
3
4
5
6
7
8
9
10
11
12
5 cm/day

Appendix C3

Movement Vectors
and
Short Term Height Changes
(Tables)

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) - Lower Line

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Taku IV 01	0.00	0.00	0.08	0.01	158.40	28.2	4.6
Taku IV 03	193.01	193.01	0.14	0.02	142.24	31.1	5.1
Taku IV 05	198.66	391.67	0.45	0.07	140.31	31.6	5.2
Taku IV 07	251.95	643.61	1.23	0.20	145.89	31.8	5.2
Taku IV 09	236.08	879.69	2.18	0.36	147.19	32.8	5.4
Taku IV 11	183.59	1063.28	2.82	0.46	146.32	38.3	6.3
Taku IV 13	324.67	1387.95	3.38	0.56	144.99	31.9	5.2
Taku IV 15	312.09	1700.05	3.65	0.60	147.31	*	*
Taku IV 17	392.32	2092.37	3.63	0.60	143.02	44.8	7.4
Taku IV 19	373.52	2465.89	3.66	0.61	141.22	47.3	7.8
Taku IV 21	373.87	2839.76	3.61	0.60	141.07	52.7	8.7
Taku IV 23	327.89	3167.65	3.30	0.55	139.46	51.9	8.6
Taku IV 25	386.25	3553.90	2.50	0.41	138.90	43.1	7.1
Taku IV 27	373.05	3926.94	1.31	0.22	133.94	44.1	7.3
Taku IV 29	355.10	4282.04	0.40	0.07	119.68	40.6	6.7
Taku IV 31	336.37	4618.41	0.22	0.04	61.51	35.4	5.9

* = outlier

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) - Upper Line

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Taku IV 02	0.00	0.00	0.08	0.01	92.27	26.0	4.3
Taku IV 04	210.48	210.48	0.19	0.03	146.88	30.8	5.1
Taku IV 06	229.44	439.92	0.62	0.10	149.13	30.2	5.0
Taku IV 08	197.99	637.91	1.35	0.23	146.33	29.6	4.9
Taku IV 10	207.83	845.74	2.11	0.35	144.69	27.2	4.5
Taku IV 12	257.54	1103.27	3.00	0.50	147.15	36.3	6.0
Taku IV 14	348.98	1452.25	3.38	0.56	144.84	40.7	6.8
Taku IV 16	347.08	1799.33	3.51	0.58	143.46	44.1	7.3
Taku IV 18	446.75	2246.08	3.61	0.60	143.23	52.8	8.8
Taku IV 20	339.49	2585.57	3.54	0.59	140.80	48.1	8.0
Taku IV 22	333.76	2919.33	3.54	0.59	140.17	46.5	7.7
Taku IV 24	352.45	3271.79	2.93	0.49	141.03	40.1	6.7
Taku IV 26	339.70	3611.49	2.26	0.38	138.85	37.2	6.2
Taku IV 28	448.42	4059.91	0.91	0.15	131.27	42.5	7.0
Taku IV 30	337.63	4397.54	0.27	0.04	152.18	30.9	5.1

Profile V (Taku Glacier SW Branch, Juncture Peak - SW Taku Pt.)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
SW Taku 01	0.00	0.00	0.05	0.01	18.07	22.6	3.2
SW Taku 02	199.11	199.11	0.22	0.03	43.72	28.1	4.0
SW Taku 03	172.79	371.90	0.49	0.07	44.55	36.2	5.1
SW Taku 04	238.49	610.38	0.57	0.08	41.50	27.5	3.9
SW Taku 05	255.34	865.73	0.70	0.10	46.59	32.1	4.5
SW Taku 06	271.30	1137.03	0.70	0.10	42.05	23.7	3.4
SW Taku 07	199.93	1336.95	0.62	0.09	44.12	40.1	5.8
SW Taku 08	170.92	1507.87	0.68	0.10	41.89	33.9	4.8
SW Taku 09	175.38	1683.25	0.61	0.09	34.42	30.3	4.3
SW Taku 10	148.31	1831.56	0.46	0.06	37.93	30.2	4.3
SW Taku 11	170.48	2002.05	0.47	0.07	28.61	32.0	4.5
SW Taku 12	168.71	2170.75	0.34	0.05	42.81	28.8	4.1

Profile VIb (Taku Glacier NW Branch, Taku C - Taku NW Pt.)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
NW Taku B 01	0.00	0.00	1.13	0.19	213.95	48.2	8.0
NW Taku B 02	194.96	194.96	1.48	0.24	211.34	47.2	7.8
NW Taku B 03	400.88	595.83	2.05	0.34	206.80	53.3	8.8
NW Taku B 04	399.90	995.73	2.49	0.41	201.15	50.0	8.2
NW Taku B 05	401.19	1396.91	2.70	0.44	194.22	43.7	7.2
NW Taku B 06	403.03	1799.94	2.72	0.45	187.88	42.5	7.0
NW Taku B 07	402.42	2202.36	2.57	0.42	178.12	44.7	7.3
NW Taku B 08	397.49	2599.85	2.40	0.39	166.80	42.8	7.0
NW Taku B 09	395.97	2995.81	2.23	0.36	158.72	35.8	5.8
NW Taku B 10	405.20	3401.01	2.08	0.34	151.19	34.1	5.6
NW Taku B 11	402.99	3804.00	1.87	0.30	144.03	27.9	4.5
NW Taku B 12	407.60	4211.60	1.71	0.28	140.18	27.9	4.5
NW Taku B 13	403.67	4615.27	1.56	0.25	134.94	34.6	5.6
NW Taku B 14	402.27	5017.54	1.21	0.20	124.42	24.7	4.0
NW Taku B 15	403.61	5421.15	0.83	0.13	126.69	37.0	6.0

Profile VIc (Taku Glacier NW Branch, Tricouni Peak - The Tusk)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
NW Taku C 01	0.00	0.00	0.02	0.01	47.95	18.7	4.7
NW Taku C 02	322.07	322.07	0.21	0.05	78.06	13.7	3.4
NW Taku C 03	322.60	644.67	0.32	0.08	89.68	15.1	3.8
NW Taku C 04	324.15	968.82	0.10	0.03	94.50	14.6	3.7
NW Taku C 05	322.56	1291.37	0.42	0.11	90.75	20.3	5.1
NW Taku C 06	319.27	1610.65	0.47	0.12	95.29	15.4	3.9
NW Taku C 07	317.34	1927.99	0.44	0.11	99.27	18.2	4.6
NW Taku C 08	326.68	2254.67	0.40	0.10	92.73	21.7	5.5
NW Taku C 09	320.35	2575.02	0.30	0.08	87.80	16.6	4.2
NW Taku C 10	323.66	2898.68	0.11	0.03	107.18	14.3	3.6
NW Taku C 11	321.27	3219.95	0.06	0.02	77.28	11.4	2.9
NW Taku C 12	317.75	3537.69	0.02	0.01	34.92	18.6	4.7
NW Taku C 13	267.16	3804.85	0.05	0.01	398.82	14.7	3.8

Profile VId (Taku Glacier NW Branch, Knowl - Tricouni Peak)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
NW Taku D 01	0.00	0.00	0.69	0.14	17.45	34.4	6.9
NW Taku D 02	326.06	326.06	0.80	0.16	17.40	33.5	6.7
NW Taku D 03	318.80	644.86	0.90	0.18	14.46	31.4	6.3
NW Taku D 04	323.63	968.49	0.90	0.18	13.24	37.2	7.5
NW Taku D 05	327.86	1296.34	0.93	0.19	21.09	29.3	5.9
NW Taku D 06	318.95	1615.30	0.89	0.18	17.20	30.0	6.0
NW Taku D 07	315.97	1931.26	0.75	0.15	21.05	32.2	6.5
NW Taku D 08	343.27	2274.53	0.71	0.14	18.35	24.6	5.0
NW Taku D 09	335.30	2609.83	0.29	0.06	14.69	22.4	4.5
NW Taku D 10	324.71	2934.55	0.11	0.02	65.98	23.4	4.7
NW Taku D 11	317.04	3251.58	0.08	0.02	43.82	21.4	4.3
NW Taku D 12	321.23	3572.81	0.05	0.01	66.02	24.6	5.0
NW Taku D 13	319.17	3891.98	0.07	0.01	20.48	21.7	4.4
NW Taku D 14	204.79	4096.77	0.07	0.01	340.97	30.8	6.2

Profile VII (Matthes Glacier, Camp 9 - Centurian Peak)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Camp_9 01	0.00	0.00	0.06	0.01	212.14	28.2	7.3
Camp_9 02	86.24	86.24	0.03	0.01	9.72	*	*
Camp_9 03	148.30	234.54	0.07	0.02	262.04	29.6	7.6
Camp_9 04	151.60	386.14	0.06	0.02	359.44	23.6	6.1
Camp_9 05	251.10	637.24	0.31	0.08	257.50	24.9	6.4
Camp_9 06	244.21	881.45	0.43	0.11	245.03	28.8	7.4
Camp_9 07	260.95	1142.40	0.91	0.23	244.43	34.3	8.8
Camp_9 08	266.13	1408.53	1.25	0.32	242.07	28.8	7.3
Camp_9 09	256.56	1665.09	2.88	0.32	238.47	58.7	6.5
Camp_9 10	257.78	1922.87	1.37	0.35	241.00	27.5	7.0
Camp_9 11	270.31	2193.19	1.28	0.33	236.30	30.1	7.7
Camp_9 12	267.54	2460.72	1.27	0.32	240.00	28.2	7.2
Camp_9 13	264.23	2724.96	1.28	0.32	235.76	35.7	9.0
Camp_9 14	261.23	2986.19	1.17	0.30	235.04	29.0	7.3
Camp_9 15	264.83	3251.02	0.85	0.22	220.84	36.7	9.3
Camp_9 16	265.56	3516.58	0.61	0.15	210.50	22.3	5.6

* = outlier

Profile VIIa (Lower Matthes Glacier, Taku D - Taku C)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Lowmat 01	0.00	0.00	0.92	0.18	246.44	31.6	6.1
Lowmat 02	151.61	151.61	1.27	0.25	243.65	28.0	5.5
Lowmat 03	209.63	361.24	1.69	0.33	243.39	28.5	5.6
Lowmat 04	191.69	552.93	1.77	0.35	246.35	31.7	6.2
Lowmat 05	197.06	749.99	1.91	0.37	249.98	32.4	6.3
Lowmat 06	195.96	945.95	2.10	0.41	246.91	33.5	6.6
Lowmat 07	196.16	1142.11	2.13	0.42	248.50	30.3	5.9
Lowmat 08	193.17	1335.28	2.20	0.43	251.41	38.8	7.6
Lowmat 09	189.75	1525.03	2.14	0.42	251.52	35.8	7.0
Lowmat 10	199.91	1724.94	2.08	0.41	248.61	37.7	7.4
Lowmat 11	140.64	1865.58	2.05	0.40	252.87	34.2	6.7
Lowmat 12	141.34	2006.92	1.89	0.37	255.50	36.9	7.3
Lowmat 13	139.19	2146.11	1.77	0.35	251.40	38.7	7.6
Lowmat 14	159.09	2305.19	1.57	0.31	250.20	39.2	7.7

Profile VIII (Upper Matthes Glacier, Camp 8 - Blizzard Pt.)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Matthes 01	0.00	0.00	0.58	0.10	280.28	46.9	8.0
Matthes 02	333.03	333.03	0.62	0.11	266.28	50.2	8.6
Matthes 03	281.97	615.00	0.67	0.12	246.99	53.6	9.2
Matthes 04	282.14	897.14	0.77	0.13	235.91	48.5	8.3
Matthes 05	268.84	1165.98	0.87	0.15	230.47	49.1	8.5
Matthes 06	283.03	1449.01	0.90	0.16	224.79	45.1	7.8
Matthes 07	308.50	1757.51	0.88	0.15	223.77	46.0	7.9
Matthes 08	318.62	2076.13	0.75	0.13	214.12	61.7	10.6
Matthes 09	370.27	2446.40	0.62	0.11	211.76	53.5	9.2
Matthes 10	403.30	2849.70	0.36	0.06	191.12	44.5	7.7
Matthes 11	354.83	3204.53	0.15	0.03	180.61	45.8	7.9
Matthes 12	277.71	3482.24	0.06	0.01	68.29	46.8	8.1

Profile IX (Upper Vaughan Lewis Glacier)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Vaughan 01	0.00	0.00	0.48	0.08	246.35	43.1	7.2
Vaughan 02	240.03	240.03	0.52	0.09	279.36	*	*
Vaughan 03	221.65	461.69	0.60	0.10	300.77	27.9	4.7
Vaughan 04	257.83	719.51	0.58	0.10	336.60	40.0	6.7
Vaughan 05	221.23	940.74	0.70	0.12	338.69	39.7	6.7
Vaughan 06	197.36	1138.10	0.73	0.12	357.33	48.9	8.3
Vaughan 07	219.10	1357.20	0.59	0.10	374.38	46.5	7.9
Vaughan 08	243.19	1600.39	0.41	0.07	390.35	49.2	8.4
Vaughan 96-01	-	-	30.18	0.08	260.72	-	-
Vaughan 96-02	-	-	31.60	0.09	284.71	-	-
Vaughan 96-03	-	-	36.73	0.10	307.35	-	-

* = outlier

Divide Grid (Matthes/Llewellyn Glacier)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Grid 01	-	-	0.71	0.08	88.01	73.6	8.2
Grid 02	-	-	0.74	0.08	112.24	46.5	5.2
Grid 03	-	-	0.77	0.09	114.98	74.2	8.3
Grid 04	-	-	0.80	0.09	119.22	80.4	9.0
Grid 05	-	-	0.66	0.07	85.71	66.2	7.3
Grid 06	-	-	0.64	0.07	109.73	72.0	8.0
Grid 07	-	-	0.62	0.07	121.19	70.1	7.8
Grid 08	-	-	0.61	0.07	128.58	71.2	8.0
Grid 09	-	-	0.71	0.08	96.13	69.1	7.7
Grid 10	-	-	0.53	0.06	116.90	103.2	11.5
Grid 11	-	-	0.45	0.05	128.32	60.7	6.8
Grid 12	-	-	0.42	0.05	157.72	67.8	7.6
Grid 13	-	-	0.57	0.06	104.13	62.4	7.0
Grid 14	-	-	0.39	0.05	131.12	93.2	11.6
Grid 15	-	-	0.37	0.05	110.29	62.8	7.9
Grid 16	-	-	0.27	0.03	161.24	59.8	7.5
Grid 17	-	-	0.61	0.07	92.76	60.1	6.8
Grid 18	-	-	0.41	0.05	118.87	89.9	10.1
Grid 19	-	-	0.24	0.03	97.63	62.4	7.0
Grid 20	-	-	0.23	0.03	150.77	66.7	7.5
Grid 21	-	-	0.40	0.08	80.22	61.5	12.1
Grid 22	-	-	0.36	0.07	89.11	59.1	11.6
Grid 23	-	-	0.28	0.05	82.22	59.0	11.6
Grid 24	-	-	0.38	0.07	94.14	51.1	10.0
Grid 25	-	-	0.33	0.07	95.61	41.5	8.1
Grid 26	-	-	0.38	0.07	96.15	50.1	9.8
Grid 27	-	-	0.24	0.05	106.08	63.4	12.6
Grid 28	-	-	0.20	0.04	129.94	69.7	13.8
Grid 29	-	-	0.10	0.02	98.01	41.7	8.3
Grid 30	-	-	0.06	0.01	195.04	42.1	8.5

Profile XI (Llewellyn Glacier, F10 Peak - Sloko Ridge)

Point	Point to point distance [m]	Sum of distances [m]	Total movement [m]	Daily movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
Llewellyn 01	0.00	0.00	0.69	0.11	41.70	57.9	9.6
Llewellyn 02	279.31	279.31	1.07	0.18	26.54	54.1	9.0
Llewellyn 03	278.57	557.88	1.29	0.22	21.64	45.0	7.5
Llewellyn 04	282.59	840.47	1.49	0.25	20.70	46.1	7.7
Llewellyn 05	276.32	1116.80	1.54	0.26	14.06	46.4	7.8
Llewellyn 06	274.74	1391.53	1.57	0.26	16.51	49.2	8.2
Llewellyn 07	278.91	1670.44	1.63	0.27	14.48	43.1	7.2
Llewellyn 08	280.92	1951.35	1.61	0.27	11.50	47.4	7.9
Llewellyn 09	280.47	2231.83	1.55	0.26	9.19	46.6	7.8
Llewellyn 10	288.47	2520.30	1.42	0.24	6.14	38.5	6.5
Llewellyn 11	273.62	2793.92	1.20	0.20	1.86	46.7	7.9
Llewellyn 12	293.91	3087.83	0.98	0.16	399.61	45.6	7.7

Appendix D

Long Term Height Changes (Tables)

Profile IV (Taku Glacier) height differences 1996/1997
Reference Day: July, 28

Lower line

Point	Position difference [m]	Delta height [m]
Taku IV 01	0.5	-0.70
Taku IV 03	0.6	-0.73
Taku IV 05	0.5	-0.93
Taku IV 07	1.6	-0.87
Taku IV 09	2.5	-0.64
Taku IV 11	2.9	-0.66
Taku IV 13	3.8	-0.39
Taku IV 15	3.3	-0.14
Taku IV 17	3.8	-0.10
Taku IV 19	3.5	-0.47
Taku IV 21	3.8	-0.49
Taku IV 23	3.0	-0.55
Taku IV 25	2.4	-0.66
Taku IV 27	1.6	-0.16
Taku IV 29	0.4	-0.32
Taku IV 31	0.6	-0.30

Upper line

Point	Position difference [m]	Delta height [m]
Taku IV 02	0.5	-0.80
Taku IV 04	0.4	-0.68
Taku IV 06	0.7	-0.85
Taku IV 08	0.6	-0.81
Taku IV 10	1.6	-0.64
Taku IV 12	2.9	-0.60
Taku IV 14	3.2	-0.44
Taku IV 16	2.8	-0.64
Taku IV 18	3.1	-0.76
Taku IV 20	3.6	-0.64
Taku IV 22	3.4	-0.56
Taku IV 24	3.4	-0.50
Taku IV 26	1.9	-0.43
Taku IV 28	0.9	-0.29
Taku IV 30	0.7	-0.25

Profile V (Taku Glacier SW Branch) height differences 1995/1997
Reference day: July, 27

Point	Position difference [m]	Delta height [m]
SW Taku 01	0.1	-1.70
SW Taku 02	0.2	-1.67
SW Taku 03	0.0	-1.54
SW Taku 04	0.7	-1.48
SW Taku 05	0.1	-1.52
SW Taku 06	0.5	-1.46

Point	Position difference [m]	Delta height [m]
SW Taku 07	0.1	-1.38
SW Taku 08	0.2	-1.39
SW Taku 09	0.1	-1.22
SW Taku 10	0.4	-1.15
SW Taku 11	0.1	-1.06
SW Taku 12	0.2	-2.29

Profile VII (Matthes Glacier near Camp 9) height differences 1996/1997
Reference day: July, 27

Point	Position difference [m]	Delta height [m]
Camp_9 01	1.1	-0.78
Camp_9 02	1.0	-0.87
Camp_9 03	1.1	-0.35
Camp_9 04	0.1	-0.70
Camp_9 05	1.4	-0.91
Camp_9 06	0.9	-0.96
Camp_9 07	1.4	-1.18
Camp_9 08	0.9	-0.91

Point	Position difference [m]	Delta height [m]
Camp_9 09	2.7	-1.26
Camp_9 10	1.4	-0.95
Camp_9 11	1.6	-0.93
Camp_9 12	1.1	-0.69
Camp_9 13	1.3	-1.14
Camp_9 14	0.8	-0.51
Camp_9 15	0.6	-0.70
Camp_9 16	0.5	-0.25

Profile VIIa (Lower Matthes Glacier) height differences 1996/1997
Reference day: July, 29

Point	Position difference [m]	Delta height [m]
Lowmat 01	0.9	-0.93
Lowmat 02	2.8	-0.92
Lowmat 03	0.7	-0.75
Lowmat 04	0.8	-0.88
Lowmat 05	1.0	-0.90
Lowmat 06	0.9	-0.77
Lowmat 07	1.4	-0.92

Point	Position difference [m]	Delta height [m]
Lowmat 08	1.2	-1.06
Lowmat 09	1.0	-0.90
Lowmat 10	0.6	-1.05
Lowmat 11	0.8	-0.93
Lowmat 12	0.8	-0.96
Lowmat 13	1.1	-1.23
Lowmat 14	1.0	-1.14

Profile VIII (Upper Matthes Glacier) height differences 1996/1997
Reference day: August, 10

Point	Position difference [m]	Delta height [m]
Matthes 01	0.3	-1.41
Matthes 02	0.3	-1.32
Matthes 03	0.2	-1.26
Matthes 04	0.5	-0.86
Matthes 05	0.6	-0.93
Matthes 06	0.7	-0.83

Point	Position difference [m]	Delta height [m]
Matthes 07	1.0	-1.24
Matthes 08	0.8	-1.31
Matthes 09	0.2	-1.30
Matthes 10	0.5	-1.45
Matthes 11	0.4	-1.38
Matthes 12	1.0	-1.95

Profile IX (Upper Vaughan Lewis Glacier) height differences 1996/1997
Reference day: August, 9

Point	Position difference [m]	Delta height [m]
Vaughan 01	0.5	-2.04
Vaughan 02	0.9	-2.03
Vaughan 03	1.7	-1.98
Vaughan 04	1.0	-2.20

Point	Position difference [m]	Delta height [m]
Vaughan 05	1.0	-2.29
Vaughan 06	0.2	-1.94
Vaughan 07	1.5	-1.71
Vaughan 08	0.9	-2.26

Lemon Creek Glacier height differences August 28, 1989/August 2, 1997

Point	Delta height [m]
Lemon 02	-7.3
Lemon 03	-10.4
Lemon 04	-9.8
Lemon 05	-9.6
Lemon 06	-9.5
Lemon 07	-10.0
Lemon 08	-9.8

Point	Delta height [m]
Lemon 09	-10.8
Lemon 10	-11.3
Lemon 11	-11.3
Lemon 12	-11.5
Lemon 13	-11.4
Lemon 14	-11.6
Lemon 15	-11.4

Lemon Creek Glacier height differences August 28, 1989/August 2, 1997 (cont.)

Point	Delta height [m]
Lemon 16	-11.3
Lemon 17	-11.0
Lemon 18	-11.4
Lemon 19	-11.7
Lemon 20	-10.8
Lemon 21	-11.1
Lemon 22	-11.6
Lemon 23	-11.7
Lemon 24	-12.2
Lemon 25	-12.0
Lemon 26	-10.1
Lemon 27	-9.6
Lemon 28	-11.7
Lemon 29	-13.7
Lemon 30	-12.8
Lemon 31	-7.3
Lemon 32	-8.9
Lemon 33	-13.5
Lemon 34	-12.3
Lemon 35	-11.5
Lemon 36	-12.1
Lemon 37	-12.4
Lemon 38	-12.4
Lemon 39	-12.5
Lemon 40	-12.2
Lemon 41	-12.1
Lemon 42	-11.5
Lemon 43	-11.2
Lemon 44	-11.2
Lemon 45	-11.4
Lemon 46	-10.7
Lemon 47	-10.5
Lemon 48	-10.8
Lemon 49	-10.9
Lemon 50	-10.5

Point	Delta height [m]
Lemon 51	-10.5
Lemon 52	-10.2
Lemon 53	-10.0
Lemon 54	-8.5
Lemon 55	-8.2
Lemon 56	-11.2
Lemon 57	-10.4
Lemon 58	-10.1
Lemon 59	-10.0
Lemon 60	-10.1
Lemon 61	-10.7
Lemon 62	-10.0
Lemon 63	-10.0
Lemon 64	-10.1
Lemon 65	-10.1
Lemon 66	-10.4
Lemon 67	-9.9
Lemon 68	-10.5
Lemon 69	-11.1
Lemon 70	-11.0
Lemon 71	-10.1
Lemon 72	-10.0
Lemon 73	-9.6
Lemon 74	-8.4
Lemon 75	-8.7
Lemon 76	-8.6
Lemon 77	-9.5
Lemon 78	-10.7
Lemon 79	-12.1
Lemon 80	-11.6
Lemon 81	-10.2
Lemon 82	-10.5
Lemon 83	-10.3
Lemon 84	-10.4
Lemon 85	-11.0

Lemon Creek Glacier height differences August 28, 1989/August 2, 1997 (cont.)

Point	Delta height [m]
Lemon 86	-10.8
Lemon 87	-10.7
Lemon 88	-10.0
Lemon 89	-9.6
Lemon 90	-9.7
Lemon 91	-9.5

Point	Delta height [m]
Lemon 92	-10.0
Lemon 93	-10.0
Lemon 94	-10.3
Lemon 95	-7.9
Lemon 96	-2.2

Ptarmigan Glacier height differences August 28, 1989/August 2, 1997

Point	Delta height [m]
Ptarmigan 1	-4.9
Ptarmigan 2	-9.0

Point	Delta height [m]
Ptarmigan 3	-10.4

Appendix E

Volume Changes

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) 1996, July 28 - 1997, July 28

	July 28, 1996			July 28, 1997				
Triangle points	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Delta Area [m^2]	Delta Volume [m^3]
1 2 3	24660.8	6.81	167940.0	24715.3	6.06	149774.7	54.5	-18165.3
2 3 4	26391.4	8.66	228549.5	26412.8	7.92	209189.4	21.4	-19360.1
3 4 5	24530.4	7.43	182260.9	24502.4	6.65	162941.0	-28.0	-19319.9
4 5 6	26997.6	7.51	202752.0	26992.3	6.69	180578.5	-5.3	-22173.5
5 6 7	28729.8	5.81	166920.1	28770.3	4.93	141837.6	40.5	-25082.6
6 7 8	21407.5	5.53	118383.5	21502.1	4.68	100629.8	94.6	-17753.6
7 8 9	24998.4	4.76	118992.4	25209.1	3.99	100584.3	210.7	-18408.1
8 9 10	21266.2	5.18	110158.9	21392.7	4.48	95839.3	126.5	-14319.6
9 10 11	18785.9	5.00	93929.5	18865.1	4.35	82063.2	79.2	-11866.3
10 11 12	25348.3	5.23	132571.6	25377.1	4.60	116734.7	28.8	-15836.9
11 12 13	30970.3	5.03	155780.6	31024.5	4.48	138989.8	54.2	-16790.8
12 13 14	35553.8	5.48	194834.8	35589.2	5.00	177946.0	35.4	-16888.8
13 14 15	32913.6	4.08	134287.5	32877.3	3.75	123289.9	-36.3	-10997.6
14 15 16	36948.3	4.39	162203.0	37085.5	3.98	147600.3	137.2	-14602.7
15 16 17	42526.8	3.86	164153.4	42791.1	3.57	152764.2	264.3	-11389.2
16 17 18	48832.9	7.43	362828.4	48938.9	6.92	338657.2	106.0	-24171.3
17 18 19	40973.6	9.40	385151.8	40803.5	8.96	365599.4	-170.1	-19552.5
18 19 20	37211.0	13.61	506441.7	37090.5	12.98	481434.7	-120.5	-25007.0
19 20 21	40755.4	15.73	641082.4	40734.8	15.19	618761.6	-20.6	-22320.8
20 21 22	36479.8	19.23	701506.6	36530.1	18.66	681651.7	50.3	-19854.9
21 22 23	36016.6	20.07	722853.2	35921.5	19.53	701546.9	-95.1	-21306.3
22 23 24	39408.4	21.58	850433.3	39362.2	21.05	828574.3	-46.2	-21859.0
23 24 25	44131.2	21.55	951027.4	44034.3	20.98	923839.6	-96.9	-27187.7
24 25 26	41214.0	22.96	946273.4	41194.1	22.43	923983.7	-19.9	-22289.8
25 26 27	46770.4	22.98	1074783.8	46751.7	22.57	1055185.9	-18.7	-19597.9
26 27 28	59665.0	23.75	1417043.8	59537.7	23.46	1396754.4	-127.3	-20289.3
27 28 29	48784.5	24.38	1189366.1	48939.7	24.13	1180915.0	155.2	-8451.1
28 29 30	47587.6	25.38	1207773.3	47733.2	25.09	1197626.0	145.6	-10147.3
29 30 31	48975.9	27.43	1343408.9	49035.8	27.13	1330341.3	59.9	-13067.7
sum	1038837.4	363.24	14633695.0	1039716.8	347.21	14105637.1	879.4	-528057.9

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.) 1997, July 22 - July 28

	July 22, 1997			July 28, 1997				
Triangle points	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Δ A [m^2]	Δ V [m^3]
1 2 3	24714.3	6.35	156935.8	24715.3	6.06	149774.7	1.0	-7161.1
2 3 4	26406.4	8.21	216796.5	26412.8	7.92	209189.4	6.4	-7607.2
3 4 5	24503.9	6.96	170547.1	24502.4	6.65	162941.0	-1.5	-7606.2
4 5 6	26991.8	7.00	188942.6	26992.3	6.69	180578.5	0.5	-8364.1
5 6 7	28757.0	5.24	150686.7	28770.3	4.93	141837.6	13.3	-8849.1
6 7 8	21506.6	4.99	107317.9	21502.1	4.68	100629.8	-4.5	-6688.1
7 8 9	25205.3	4.30	108382.8	25209.1	3.99	100584.3	3.8	-7798.5
8 9 10	21390.2	4.78	102245.2	21392.7	4.48	95839.3	2.5	-6405.9
9 10 11	18861.0	4.68	88269.5	18865.1	4.35	82063.2	4.1	-6206.3
10 11 12	25357.6	4.94	125266.5	25377.1	4.60	116734.7	19.5	-8531.9
11 12 13	31039.9	4.84	150233.1	31024.5	4.48	138989.8	-15.4	-11243.4
12 13 14	35583.1	5.37	191081.2	35589.2	5.00	177946.0	6.1	-13135.2
13 14 15	32849.4	4.01	131726.1	32877.3	3.75	123289.9	27.9	-8436.2
14 15 16	37055.6	4.28	158598.0	37085.5	3.98	147600.3	29.9	-10997.7
15 16 17	42787.4	3.88	166015.1	42791.1	3.57	152764.2	3.7	-13250.9
16 17 18	48926.4	7.40	362055.4	48938.9	6.92	338657.2	12.5	-23398.2
17 18 19	40810.0	9.44	385246.4	40803.5	8.96	365599.4	-6.5	-19647.0
18 19 20	37090.8	13.48	499984.0	37090.5	12.98	481434.7	-0.3	-18549.3
19 20 21	40715.8	15.69	638830.9	40734.8	15.19	618761.6	19.0	-20069.3
20 21 22	36520.6	19.16	699734.7	36530.1	18.66	681651.7	9.5	-18083.0
21 22 23	35932.9	20.09	721892.0	35921.5	19.53	701546.9	-11.4	-20345.1
22 23 24	39331.2	21.56	847980.7	39362.2	21.05	828574.3	31.0	-19406.4
23 24 25	44014.2	21.48	945425.0	44034.3	20.98	923839.6	20.1	-21585.4
24 25 26	41187.5	22.83	940310.6	41194.1	22.43	923983.7	6.6	-16327.0
25 26 27	46755.4	22.98	1074439.1	46751.7	22.57	1055185.9	-3.7	-19253.2
26 27 28	59550.6	23.87	1421472.8	59537.7	23.46	1396754.4	-12.9	-24718.4
27 28 29	48928.4	24.55	1201192.2	48939.7	24.13	1180915.0	11.3	-20277.3
28 29 30	47727.0	25.48	1216084.0	47733.2	25.09	1197626.0	6.2	-18458.0
29 30 31	49051.4	27.49	1348423.0	49035.8	27.13	1330341.3	-15.6	-18081.7
sum	1039553.7	358.33	14516117.9	1039716.8	347.21	14105637.1	163.1	-410480,8

Divide Grid (Matthes/Llewellyn Glacier) 1997, August 8 - August 13

	August 8, 1997			August 13, 1997				
Triangle points	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Δ A [m^2]	Δ V [m^3]
21 1 22	44748.5	18.06	808157.9	44754.9	17.53	784553.4	6.4	-23604.5
1 22 5	45164.3	17.76	802118.0	45156.6	17.31	781660.7	-7.7	-20457.2
22 5 23	45169.5	15.36	693803.5	45152.8	14.85	670519.1	-16.7	-23284.4
5 23 9	45188.1	14.43	652064.3	45194.4	13.99	632269.7	6.3	-19794.6
23 9 24	44986.8	12.07	542990.7	45002.3	11.58	521126.6	15.5	-21864.0
9 24 13	44748.1	11.01	492676.6	44751.9	10.59	473922.6	3.8	-18754.0
24 13 25	45009.6	8.81	396534.6	45015.3	8.39	377678.4	5.7	-18856.2
13 25 17	44957.1	7.94	356959.4	44952.9	7.58	340743.0	-4.2	-16216.4
25 17 26	44928.3	5.60	251598.5	44931.4	5.19	233194.0	3.1	-18404.5
17 26 27	44976.2	4.98	223981.5	44981.8	4.50	202418.1	5.6	-21563.4
1 2 5	45011.6	19.46	875925.7	45026.6	19.12	860908.6	15.0	-15017.1
2 5 6	44966.0	18.03	810737.0	44976.1	17.68	795177.4	10.1	-15559.5
5 6 9	44984.4	15.40	692759.8	45011.8	15.02	676077.2	27.4	-16682.5
6 9 10	44921.6	13.69	614976.7	44935.6	13.24	594947.3	14.0	-20029.4
9 10 13	44701.1	11.66	521214.8	44714.7	11.23	502146.1	13.6	-19068.7
10 13 14	44962.4	10.37	466260.1	44974.6	9.87	443899.3	12.2	-22360.8
13 14 17	45167.9	8.84	399284.2	45186.3	8.42	380468.6	18.4	-18815.6
14 17 18	45296.7	8.04	364185.5	45316.6	7.56	342593.5	19.9	-21592.0
17 18 27	45156.6	6.52	294421.0	45169.2	6.03	272370.3	12.6	-22050.8
18 27 28	45175.4	6.21	280539.2	45184.1	5.61	253482.8	8.7	-27056.4
2 3 6	44992.7	19.04	856661.0	44985.8	18.68	840334.7	-6.9	-16326.3
3 6 7	44954.9	16.65	748499.1	44953.1	16.25	730487.9	-1.8	-18011.2
6 7 10	45064.2	13.93	627744.3	45066.9	13.47	607051.1	2.7	-20693.2
7 10 11	45013.7	11.81	531611.8	45007.9	11.38	512189.9	-5.8	-19421.9
10 11 14	44851.9	10.28	461077.5	44852.8	9.79	439108.9	0.9	-21968.6
11 14 15	44946.0	9.02	405412.9	44929.9	8.58	385498.5	-16.1	-19914.4
14 15 18	45134.5	8.30	374616.4	45120.8	7.81	352393.4	-13.7	-22222.9
15 18 19	44814.5	7.77	348208.7	44795.6	7.35	329247.7	-18.9	-18961.0
18 19 28	44861.6	7.19	322554.9	44853.3	6.68	299620.0	-8.3	-22934.9
19 28 29	45063.3	7.30	328962.1	45051.0	6.81	306797.3	-12.3	-22164.8
3 4 7	45255.3	16.86	763004.4	45247.7	16.44	743872.2	-7.6	-19132.2
4 7 8	45079.4	13.70	617587.8	45070.1	13.29	598981.6	-9.3	-18606.2
7 8 11	45069.5	11.39	513341.6	45061.7	11.01	496129.3	-7.8	-17212.3
8 11 12	45033.6	9.10	409805.8	45030.0	8.73	393111.9	-3.6	-16693.9
11 12 15	45123.8	8.27	373173.8	45134.4	7.89	356110.4	10.6	-17063.4

	August 8. 1997			August 13. 1997				
Triangle points	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Area [m^2]	Σ (h/3) [m]	Volume [m^3]	Δ A [m^2]	Δ V [m^3]
12 15 16	45217.2	7.00	316520.4	45229.8	6.62	299421.3	12.6	-17099.1
15 16 19	44970.4	7.22	324686.3	44977.6	6.85	308096.6	7.2	-16589.7
16 19 20	45068.7	6.82	307368.5	45081.9	6.45	290778.3	13.2	-16590.3
19 20 29	45230.9	7.47	337874.8	45241.9	7.09	320765.1	11.0	-17109.8
20 29 30	44714.9	7.64	341621.8	44716.3	7.23	323298.8	1.4	-18323.0
sum	1800693.2	447.00	19851528.8	1800815.4	429.69	19073457.8	119.2	-778068.0

Appendix F

Strain Rates

Profile IV (Taku Glacier, Camp 10 - Shoehorn Mt.)

Triangle points	e_1 [µstrain/day]	e_2 [µstrain/day]	e_3 [µstrain/day]	Θ [gon]
1 2 3	56.4	-51.0	-5.4	115.08
2 3 4	81.5	-43.5	-38.0	86.79
3 4 5	118.1	-130.2	12.1	109.63
4 5 6	135.9	-138.0	2.1	99.38
5 6 7	271.9	-203.9	-68.0	105.85
6 7 8	277.0	-327.5	50.5	103.46
7 8 9	332.8	-327.7	-5.1	101.40
8 9 10	338.1	-345.7	7.6	106.94
9 10 11	329.1	-318.5	-10.6	106.19
10 11 12	329.9	-233.2	-96.7	102.40
11 12 13	59.7	-174.8	115.1	99.22
12 13 14	102.0	-106.4	4.4	122.40
13 14 15	150.8	-41.6	-109.2	97.90
14 15 16	181.0	-79.5	-101.5	121.96
15 16 17	90.0	-106.6	16.6	137.00
16 17 18	27.3	-12.2	-15.1	132.43
17 18 19	11.6	-55.4	43.8	167.73
18 19 20	66.3	-76.4	10.1	169.29
19 20 21	70.4	-1.2	-69.2	155.76
20 21 22	53.6	-17.2	-36.4	140.92
21 22 23	45.0	-102.0	57.0	4.35
22 23 24	230.2	-101.9	-128.3	198.90
23 24 25	238.9	-164.1	-74.8	1.05
24 25 26	188.8	-162.9	-25.9	198.71
25 26 27	268.3	-281.8	13.5	6.26
26 27 28	252.6	-285.7	33.1	7.72
27 28 29	236.8	-198.1	-38.7	7.05
28 29 30	221.5	-200.8	-20.7	19.28
29 30 31	111.8	-164.1	52.3	1.47

Divide Grid (Matthes/Llewellyn Glacier)

Rectangle points	e_1 [µstrain/day]	e_2 [µstrain/day]	e_3 [µstrain/day]	Θ [gon]
1 5 21 22	15.6	-18.4	2.8	110.13
5 9 22 23	22.6	-45.6	23.0	121.26
9 13 23 24	51.4	-8.4	-43.0	122.74
13 17 24 25	19.7	-16.2	-3.5	54.80
17 25 26 27	27.1	-7.7	-19.4	65.51
1 2 5 6	89.9	-33.9	-56.0	83.03
5 6 9 10	91.1	1.1	-92.0	81.30
9 10 13 14	90.0	-32.3	-57.7	73.96
13 14 17 18	103.9	-19.3	-84.6	50.75
17 18 27 28	78.9	-31.7	-47.2	76.16
2 3 6 7	28.0	-47.4	19.4	82.65
6 7 10 11	40.1	-46.9	6.8	77.54
10 11 14 15	-2.2	-31.6	33.8	44.68
14 15 18 19	-6.8	-65.6	72.4	22.92
18 19 28 29	4.3	-50.2	45.9	18.45
3 4 7 8	27.7	-65.1	37.4	86.54
7 8 11 12	50.3	-75.6	25.3	78.78
11 12 15 16	92.7	-41.2	-51.5	54.01
15 16 19 20	87.6	-42.3	-45.3	62.19
19 20 29 30	70.2	-42.5	-27.7	69.20