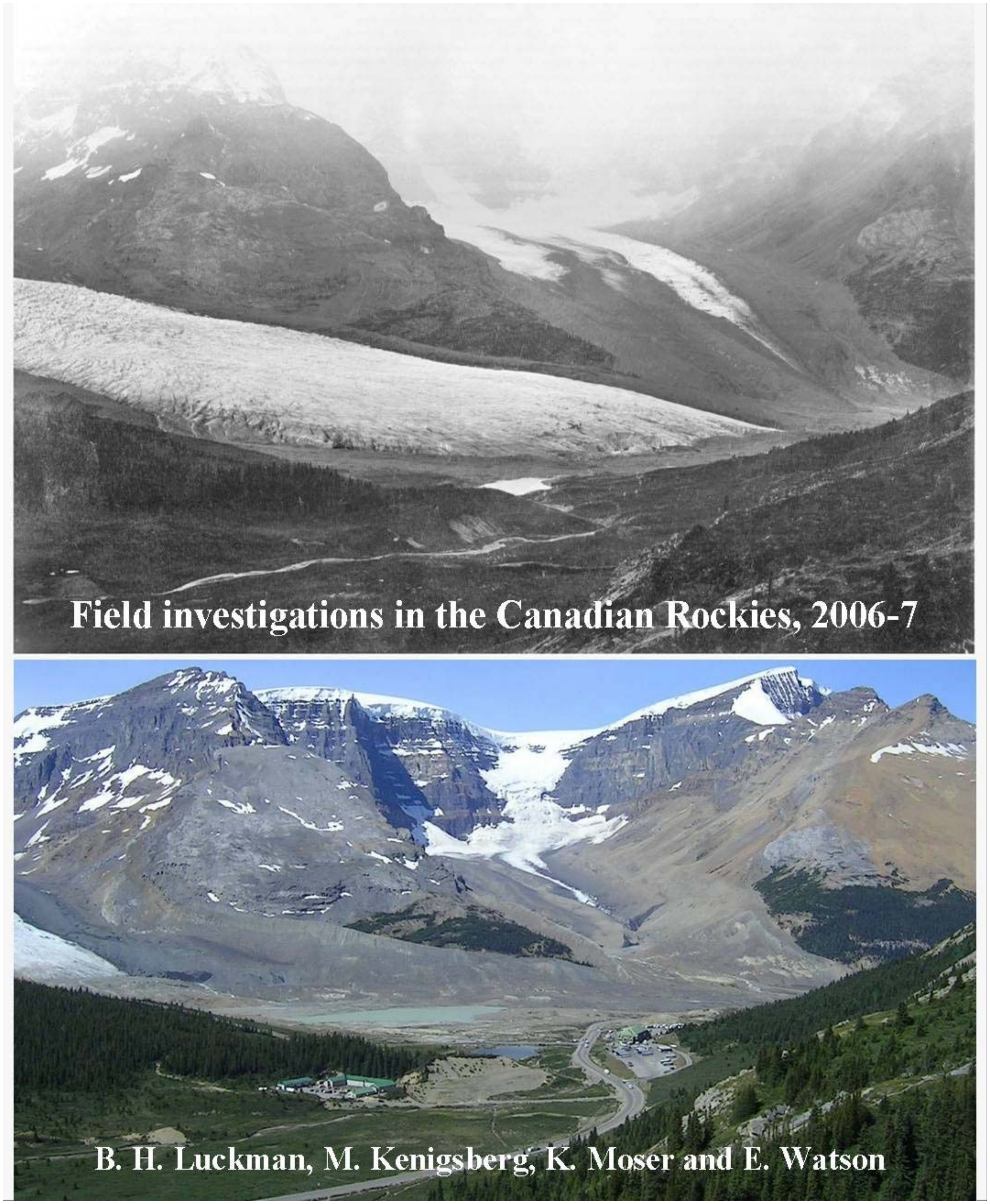

Athabasca and Dome Glaciers 1906 (Mary Schäffer) and 2006 (Emma Watson)

Field Investigations in the Canadian Rockies in 2006 and 2007

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Introduction

This report briefly summarizes research in Jasper National Park carried out under research permits in 2006 and early in 2007. It also will report briefly on work in Mount Robson Park in 2007 and the results from work in 2004.

Name	Affiliation	Position
Dr Brian.Luckman	Department of Geography, UWO	Professor
Dr Emma Watson	Environment Canada Climate Research Branch	Post Doctoral Fellow
David.Luckman	Chateau Lake Louise	Assistant
Dr Erik Schiefer	Geography, UNBC, Prince George	PDF, assistant (Robson)

Table 1: Personnel, July field party

Jasper National Park 2006

Field work took place in Jasper between July 17-20 in connection with ongoing studies at the Athabasca Glacier. The last available aerial photography of the Columbia Icefield was taken in 1992 although large scale colour photography (ca 1:5,000) was taken of the Athabasca forefield and lower glacier on September 13th, 1999. The primary goal of the 2006 visit was to obtain photography of the Athabasca toe in preparation for detailed field mapping of recent changes. As this required a helicopter this opportunity was also used to obtain photographs of most of the glaciers from the Columbia Icefield.

Despite several passes over the Athabasca we were unable to get ideal, fully illuminated imagery of the glacier toe because of cloud shadow but good quality photographs were obtained of the recent annual moraines and changes in the configuration of the proglacial drainage since the change in the major portal in July 2003. Two images of these changes are shown as Figures 1 and 2.

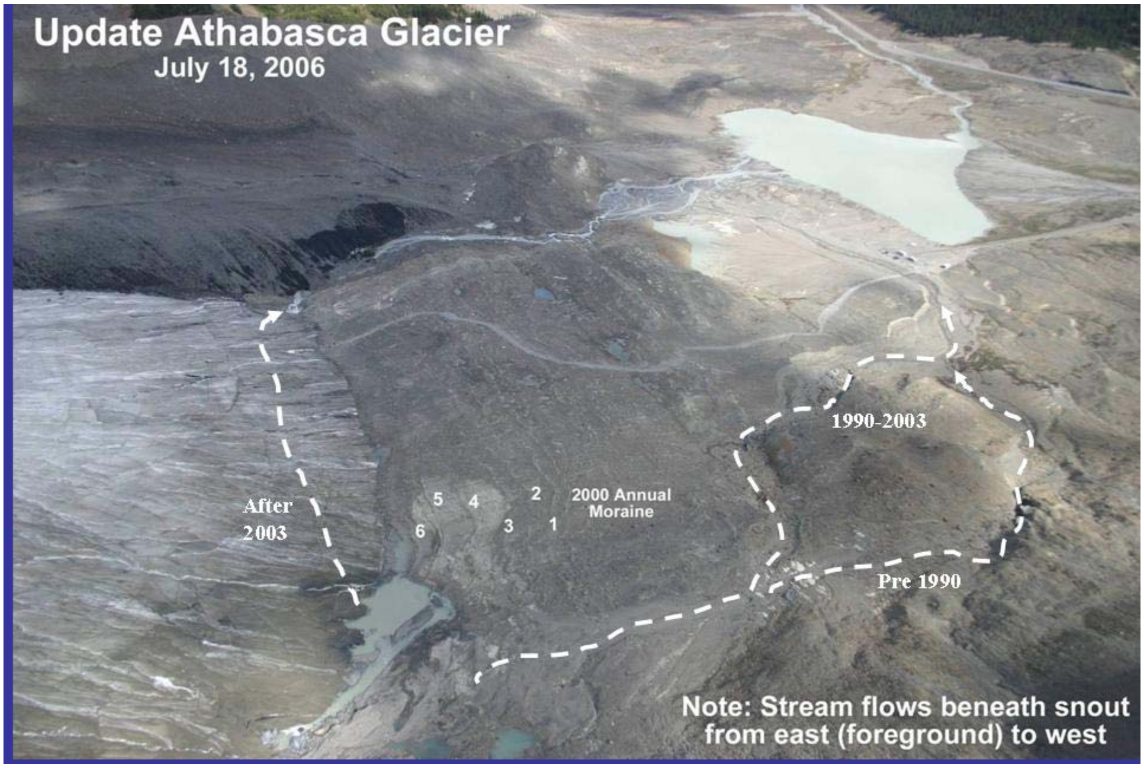


Figure 1: Athabasca Forefield showing recent changes in meltwater discharge

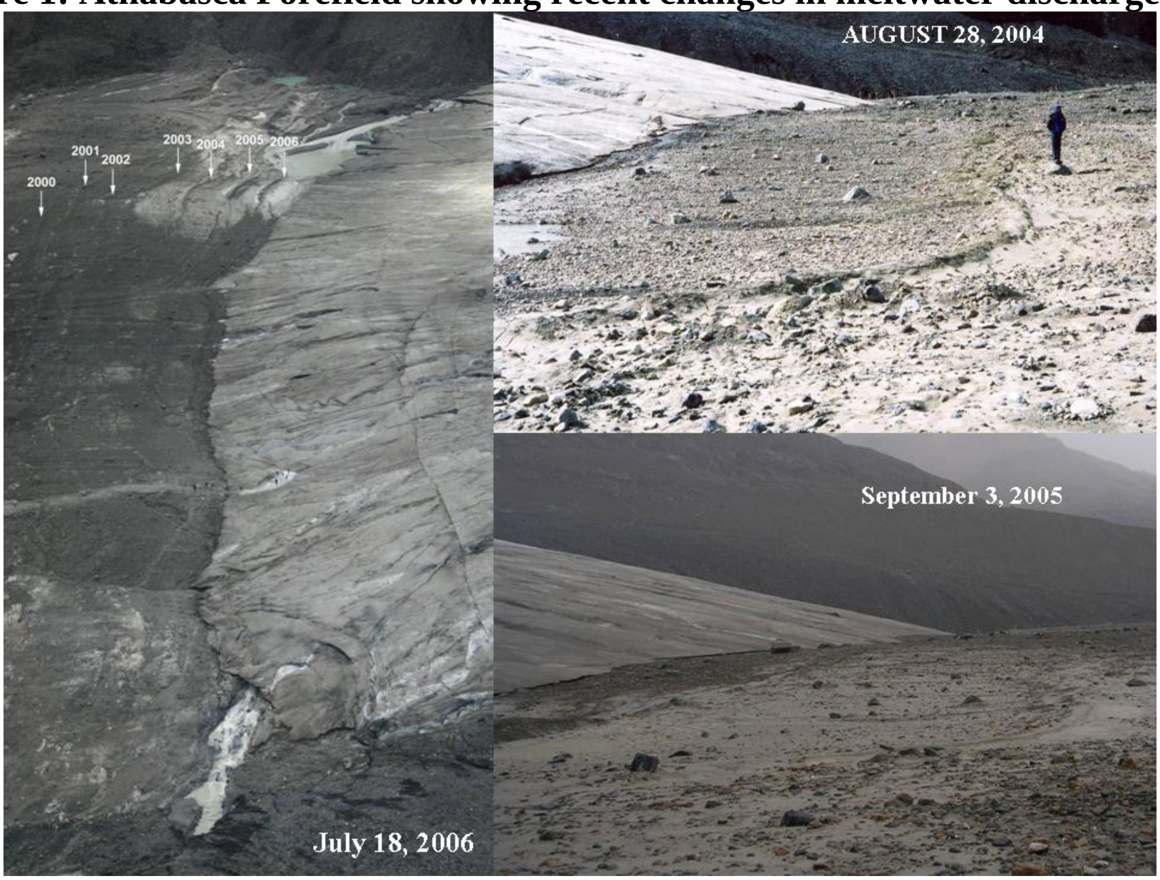


Figure 2: Annual moraines at Athabasca Glacier

Detailed photographs of the toe area have been taken once a year since ca 1980. During the 2007 field season it is planned to use these photographs as the basis for a detailed GPS survey to map the position of most of the annual moraines from the 1958 position to the present snout to supplement the maps in Luckman 1986a, 1986b and provide a detailed history of glacier recession. A new set of 1:5,000 photography would be ideal for this purpose but to my knowledge the park has no plans to refly this area in the near future. In addition, there is still, despite several requests and suggestions in previous reports, no systematic recording of the ice front position of this glacier. Although the toe markers were repositioned several years ago, recent discussions with an individual on that work crew indicated that in some cases positioning was somewhat arbitrary and an accurate map might encourage a more precise emplacement of these markers. Luckman has seen reports by school children and others who believe that these dates are correct and calculate rates of recession based on these data. In addition, despite the fact that the earliest documented position of the glacier is 1906, there is still an outermost marker with a fictional date. The only pre-1906 marker should be at 1844 close to the present road junction.

While at the Icefield we reoccupied the position from which Mary Schäffer took the first photograph of Dome and Athabasca Glaciers in 1906 (Luckman et al 1999) and took several photographs to set up a 1906-2006 comparison. One version is shown on the cover of this report.

Cavell Glacier was visited on July 20th to continue the time series of photographs of Cavell and Angel Glaciers that have been taken in most years since the 1970s.

The overflight of the Icefield was very successful and good imagery was taken of the snouts of all of the major outlet glaciers including Columbia, Manitoba, Castleguard, Saskatchewan, Hilda, Dome, Stutfield, Kitchener etc. The most obvious change is seen at the Columbia Glacier that feeds the Athabasca River. Comparison with the 1992 aerial photography of this site indicates that the glacier has receded ca 1.5km over this period (see Figure 3), mainly due to calving in the unnamed (to our knowledge) lake at the glacier toe. The glacier has receded over a kilometer since we worked at this site in 1996 (Robinson 1998) and the toe is considerably upvalley of the site where we sampled trees and active landslide debris on the ice in 1996. Significant changes were also noted in Saskatchewan and Dome Glaciers since the last ground visits to these sites. Detailed comparison of 2006 ice front positions and the 1992 imagery will be carried out in the near future.

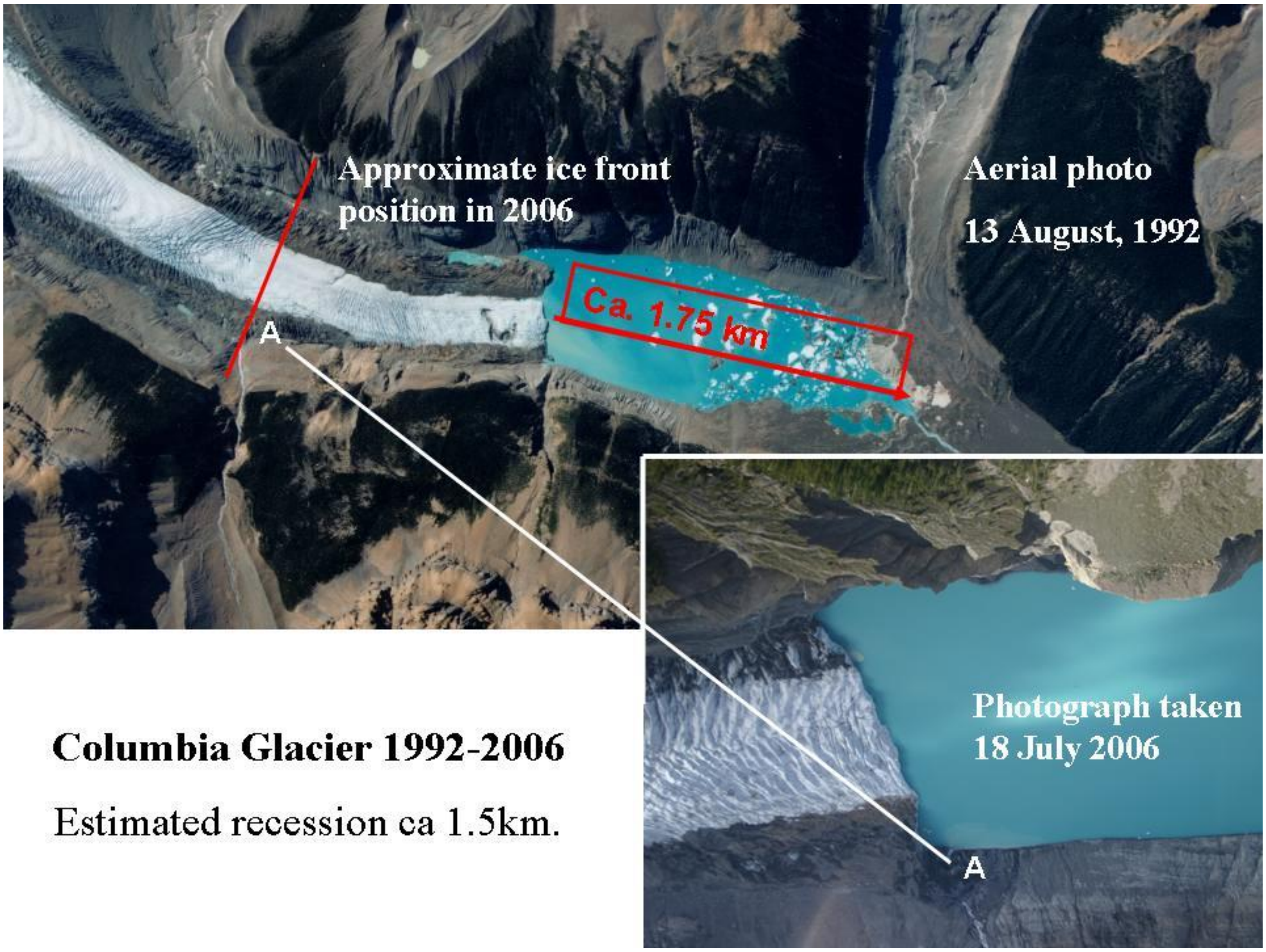


Figure 3: Changes at Columbia Glacier

Robson Glacier

Robson Glacier was visited on July 21 to examine recent changes in the toe area (where we had previously sampled a 3000 year old buried forest) and to do some simple GPS measurements of these sites. Erik Schiefer from UNBC surveyed the present ice margin and some of the annual moraines at this site and his results are shown in Figure 4. Based on previous field observations we would date these moraines between ca 1990 and 2000 although the precise dating may be one year out. Detailed comparison with 1995 ground photographs should enable verification of the 1995 date and thereby allow the other moraines to be precisely dated.

Dr Schiefer also mapped the 1996 ice front position on Figure 4 derived from an orthophoto of the glacier. However, this would appear to be inaccurately positioned as we know from field observations that the ice front was actively forming annual moraines in the middle of the annual moraine sequence in 1995 whereas the mapping shows that the 1996 icefront is upvalley of the innermost clear annual moraine that we would date ca. 2000. These difficulties should be resolved in the near future.

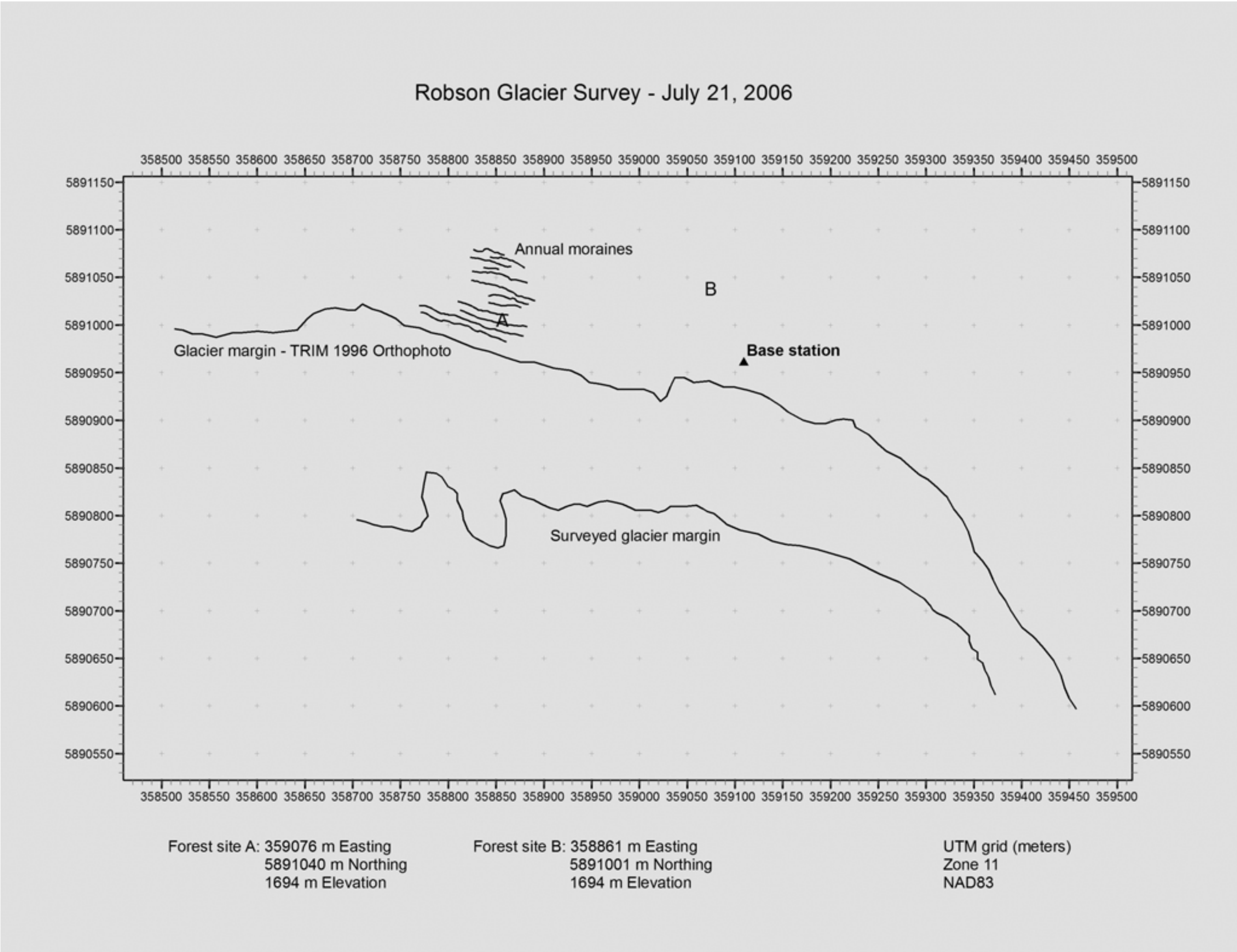


Figure 4: Survey of Robson Glacier July 21, 2006 (E. Schiefer)

In 2004 we sampled wood from a new site at Extinguisher Tower that included trees that were in situ and grew on a former paleosol at this site. (Figure 5). These trees were killed approximately 4800 radiocarbon years ago and are considerably older than other material we have found at the glacier. This is the oldest evidence for a Neoglacial glacier advance in the Rockies and indicates that the Robson Glacier was advancing at this time over a forested landscape with well developed soils that has been exposed for several hundred years. The oldest trees at this site contain approximately 437 rings and we have developed a floating (undated) chronology of 533 years from these trees (Table 2). If time permits we plan to possibly resample at this site in 2007.

Crossdated trees

Core	Time-span	Comments
RO301A	255-609	
RO301B	255-556	
RO401A	343-632	
RO401B	343-630	
RO402A	366-587	tight rings
RO402B	368-595	tight rings
RO403A	100-499	tight rings, broken
RO403B	101-537	tight rings, broken
RO404A	396-596	
RO404B	396-596	
RO416A	297-566	tight rings
RO416B	279-539	tight rings
RO417A	169-323	reaction wood, branch
RO417B	171-344	reaction wood
RO418A	113-415	reaction wood

Undated trees

Core	Time-span	Comments
RO411A	1008-1156	Broken
RO411B	1011-1145	
RO413A	1030-1245	tight rings
RO413B	1030-1225	tight rings
RO414A	1049-1258	tight rings
RO414B	1047-1231	tight rings, reaction wood
RO414C	1049-1245	tight rings
RO415A	1181-1245	
RO415B	1183-1245	
RO415C	1183-1247	
RO4152	1129-1245	reaction wood
RO419A	1094-1245	
RO419B	1085-1245	
RO419C	1083-1245	

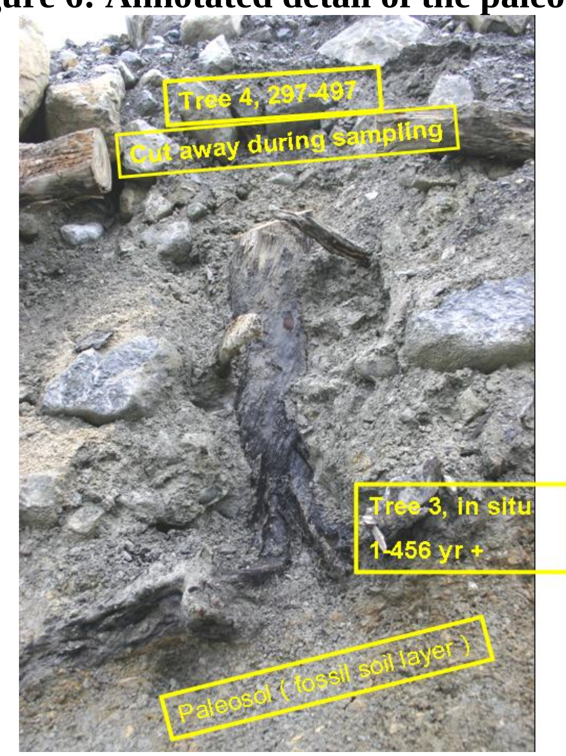
Table 2: Subfossil trees at the Robson (Extinguisher Site) site sampled in 2003 and 2004

Note: The crossdated trees form a "floating" chronology of 533 years (100-632) that are correctly dated relative to each other but their calendar ages are unknown. The "undated" trees are assigned arbitrary years that are not equivalent between trees. The 2003 tree was sampled by BC parks personnel who alerted the authors to this new site

The new site at Robson indicates that it probably has the most complete record of glacier advances yet discovered in the Canadian Rockies with two or three advances at ca 4700, perhaps 3400 and 3100 14C years before present (ca. 5400, 3700 and 3200 cal Yr B.P.) plus several advances during the Little Ice Age (Luckman 1995). We cannot presently determine whether the forests at the glacier toe and earlier finds at Extinguisher Tower (Luckman et al 1993) represent trees killed by the same or two different glacier advances.

Figure 5: The new Extinguisher site (above)

Figure 6: Annotated detail of the paleosol site and standing snag (below)



Tree 0 was cut by Chris in 2003. Trees 1-4 were cut on our visit in 2004

Tree 3 is in place and grew on the former soil horizon, the outer layers have shrunk and partially rotted with probably 20-30 years or more missing.

The ring values are set as 1 for the oldest (first formed ring) and 533 is the youngest (last formed). The existing chronology is ca 533 years.

Based on the 14C date this probably covers the period ca 4700-5200 years ago

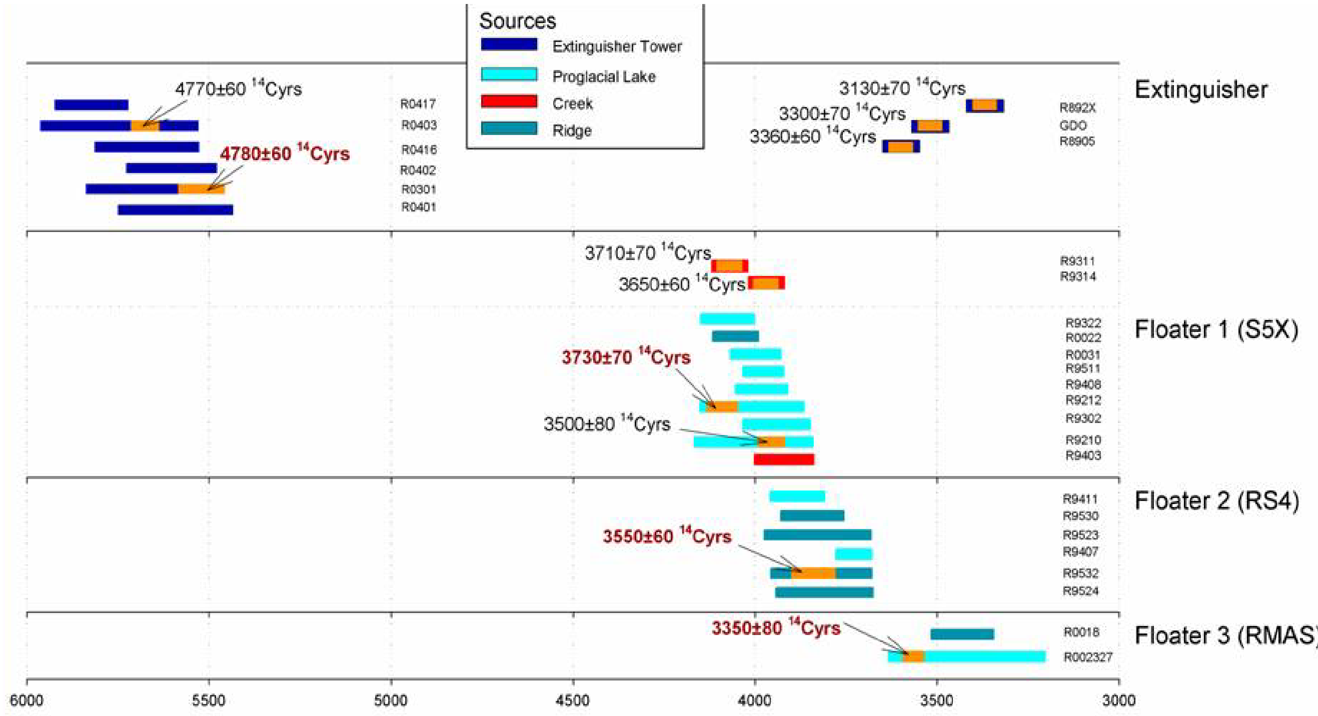


Figure 7: Dating of subfossil trees from Robson Glacier

Note. The relative temporal position of these trees is aligned according to their radiocarbon dates (plotted as calendar equivalents not ^{14}C years and shown in orange) and the calendar ages of the record in each crossdated tree. Many more trees have been sampled but these are the only crossdated samples from the four separate "floating " chronologies. The trees from the younger Excelsior site were sampled in 1989 (see Luckman et al., 1993)

Jasper 2007

Field activities were also carried out in Jasper National Park between February 24th and March 1st, 2007 and were of an exploratory nature. The main aim was to explore the potential of small lakes in this area for future paleolimnological studies[1]. During the visit to Jasper Dr. Luckman and Dr. Moser gave a public presentation entitled "Glaciers, tree rings and climate change in the Central Canadian Rockies" at the Jasper Museum on February 27th.

Name	Affiliation	Position
K.A. Moser	Department of Geography University of Western Ontario	Associate Professor
R. English	University of Western Ontario	Assistant to above
B.H. Luckman	Department of Geography University of Western Ontario	Professor
M.R. Kenigsberg	Department of Geography University of Western Ontario	Ph.D. Candidate

Table 3: Personnel, February field party

[1] Paleolimnology is the study of past environments through the investigations of lake sediments

Lake Reconnaissance and Sampling

The goal of this trip was to identify (and sample if possible) a number of lakes with sediment records suitable for determining past changes in effective moisture (precipitation minus evaporation) using microfossils, specifically diatoms, preserved in the sediments. Diatoms are single celled algae which are characterized by a cell wall composed of opaline silica and are one of the most widely used bioindicators. Ideally these lakes should be relatively small with a regular and even shoreline (ideally circular) to minimize the chances of sediment focusing. Targeted lakes should be sensitive to changes in effective moisture (i.e.,low in elevation and hydrologically isolated with little ground water connectivity and with few or no inflows or outflows). These lakes effectively act as surrogate rain gauges as their water levels are primarily controlled by precipitation and evaporation. Decreases in effective moisture cause lake levels to fall and salinity to increase, which in turn lead to shifts in the community composition of diatoms Dr. Moser has used this approach in the Sierra Neveda, in California and in the Uinta Mountains in Utah to determine long records of drought, but has not attempted this approach in the Rockies. Other researchers working in southern British Columbia have also used a similar approach (Cumming et al., 2005).

A number of candidate lakes were identified from aerial photography as possible sites for future studies close to the Jasper Town Site and the Maligne Road. Two of the most promising sites were sampled using a gravity corer which captures the sediment-water interface and the top ≤1m of sediment. Long cores with greater sediment depths were obtained from both lakes using a Livingston corer. The two sites sampled were Deadman's Hole and Little Trefoil Lake (#3). Both sites are small circular kettle lakes, which have no visible in or outflows and are easily accessible. The retrieved samples are currently in the early stages of processing.

Deadman's Hole

Deadman's Hole is located directly southeast of the Jasper Town Site adjacent to the Tekarra Lodge. The ice was 49cm thick and the sediment surface was 8.75m below the top of the ice. The gravity corer captured the top 53.5cm of sediment (Figure 8). The sediment was largely composed of organic matter and was clearly laminated indicating the sediments were largely undisturbed by any possible ground water inflows. Two overlapping long cores were taken which extended the length of the retrieved sediment profile to approximately 1.5m. The corer would not penetrate any further into the sediment indicating bedrock, a large solid object or possibly tephra layer was hit. One large wood sample which was found at a depth of 45.5cm in the sediment profile and has been submitted for radiocarbon dating.

Figure 8: Right- short core from Deadman's Hole showing laminations in the sediment. Left- M. Kenigsberg immersing the gravity corer.

Little Trefoil Lake (#3)

Little Trefoil Lake (#3) is located directly northeast of the Jasper Town Site and is between the new road to Jasper Park Lodge and the Athabasca River. The ice was 45cm thick and the sediment surface was only 4.75m below the surface of the ice. The gravity corer captured the top 46cm of the sediment profile and overlapping long cores were used to extend the length of recovered sediment profile to approximately 5m. Though much longer than the core from Deadman's Hole this core was similarly composed of organic matter and was also stratified. At least three possible tephras were identified at depths of and 3.25m, 4.15m and 4.75m in the sediment profile (Figure 9). Further examination into these white layers is required to determine if they are in fact tephras.

Figure 9: A long core from Little Trefoil Lake (#3) showing a possible Tephra layer

Dendrochronology

A number of large Douglas fir grow on the steep slopes bordering Deadman's Hole. Fourteen of these trees were cored on February 24th to determine their ages and possibly update earlier tree-ring chronologies from the Jasper area. Sampling of Douglas fir took place at Pyramid Lake in 1995 and 1997 and at Maligne Canyon, Lake Annette and Prairie de la Vache in 1997 and the results are presented in Watson 1998. Annual precipitation at Jasper from 1710-1994 was reconstructed from these cores and earlier collections made at Pyramid Lake by the Laboratory of Tree-Ring Research at Tucson in 1964 and is discussed in Watson 1998 and Watson and Luckman 2001.

core	start	core	start	comment
J0701N	1813	J0701S	1801	
J0702S	1727	J0702W	1777	Huge, over 1 meter diameter
J0703N	1673	J0703W	1739	dead top, 80-90cm diameter
J0704N	1777	J0704S	1838	rot in middle
J0704W	1781			
J0705N	1805	J0705E	1836	
J0706N	1811	J0706W	1797	just below break in slope
J0707N	1785	J0707S	1785	outer end fire scar (N)
J0708N	1781	J0708S	1781	smaller tree, burnt wood on the ground, Fire scar on N
J0709W	1765	J0709N	1763	
J0710W	1838	J0710N	1825	
J0711W	1762	J0711W	1788	best stump seen upslope of this tree
J0712N	1774	J0712W	1760	monster tree, 30 inches diameter,rot on W, Add 15 rings
J0713E				Rotten, Big old dead tree 7m above lake
J0714N	1809	J0714W	1695	ca. 10m E of 13

Table 4: Douglas fir cores sampled by Luckman at Deadman's Hole Feb. 24, 2007

The trees sampled are listed in Table 4 and the oldest dates back to 1673. These trees are presently being measured and will be used to update the Pyramid Lake chronology to 2006. A couple of the trees have fire scars that appear to date from the nineteenth century and will be checked against the fire years reported in Tande 1979.

Concluding remarks

The results presented above are clearly preliminary. Sample processing and further analysis will be forthcoming both as published papers and as graduate theses. Both sets of investigations are continuing projects and it is anticipated that further sample collection and /or fieldwork will take place at these sites in 2007. We thank Yellowhead Helicopters, Mike Wesbrook and other members of Parks personnel for their assistance and advice during both field projects. Funding for this research is provided by the Natural Sciences and Engineering Research Council of Canada through operating grants to Luckman and Moser.

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