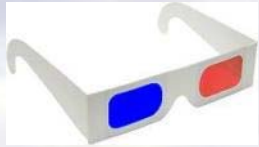


Preparing Parker Calkin's Brooks Range Work for the 21st Century

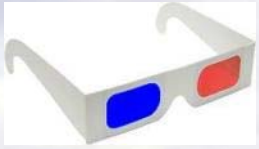


Jim Ellis
Ellis GeoSpatial
Remote Sensing & GIS

One of Parker's grad students 1976-1982 ☺

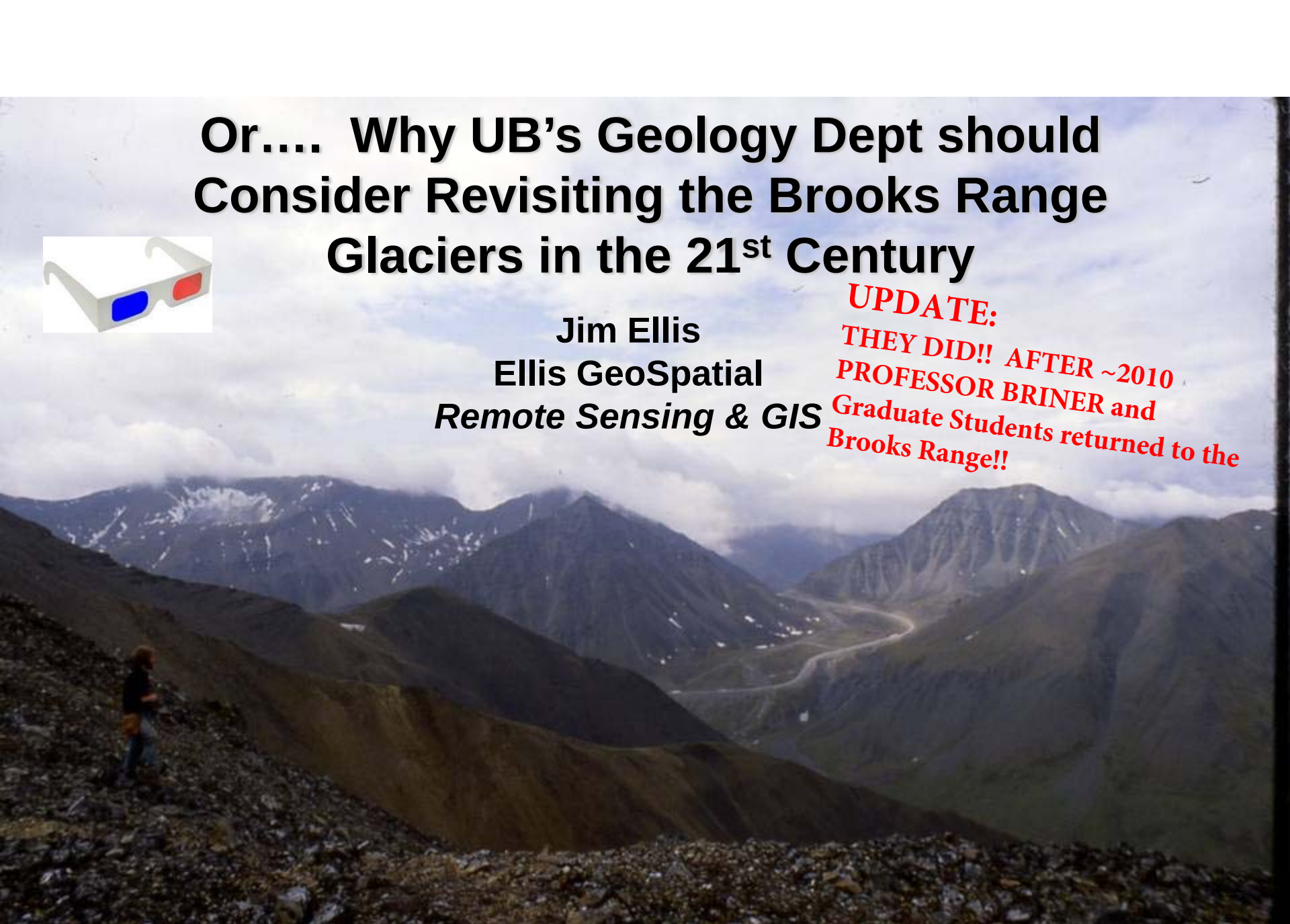
NE Section GSA
27-29 March 2008
Buffalo, NY

Or.... Why UB's Geology Dept should Consider Revisiting the Brooks Range Glaciers in the 21st Century



Jim Ellis
Ellis GeoSpatial
Remote Sensing & GIS

UPDATE:
THEY DID!! AFTER ~2010
PROFESSOR BRINER and
Graduate Students returned to the
Brooks Range!!





Outline

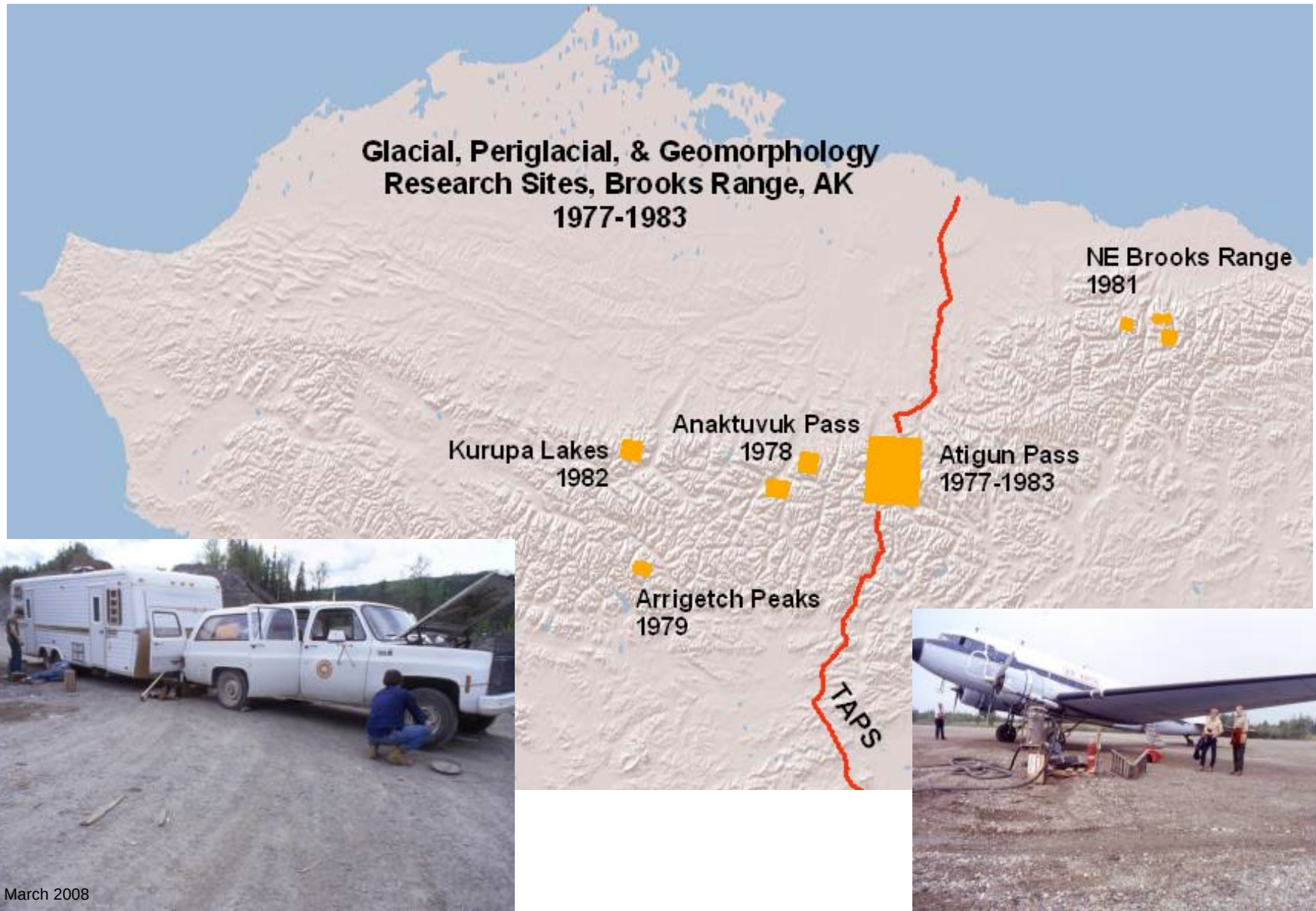


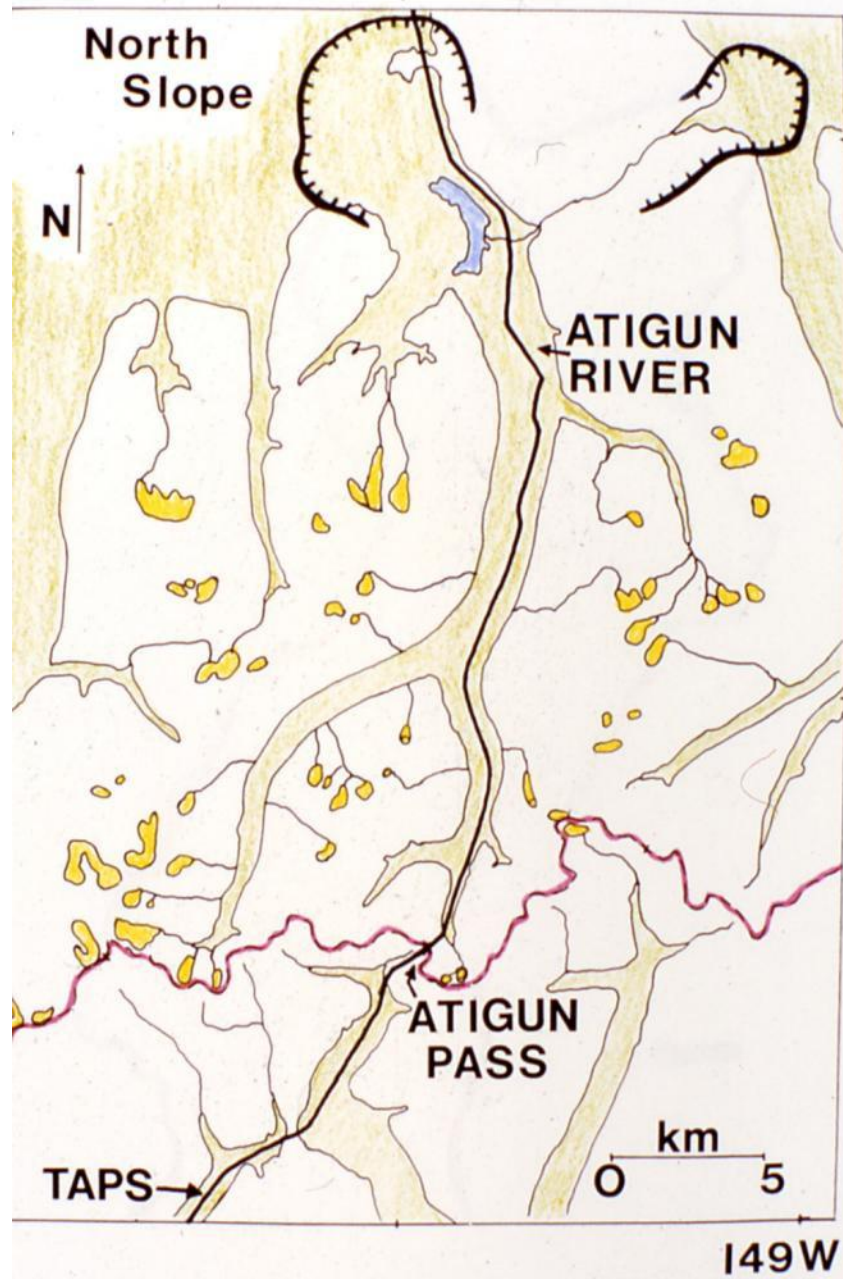
- 1. Baseline work done 25-30 years ago**
- 2. Moving Parker Calkin's work into the 21st Century with GeoSpatial Technology**

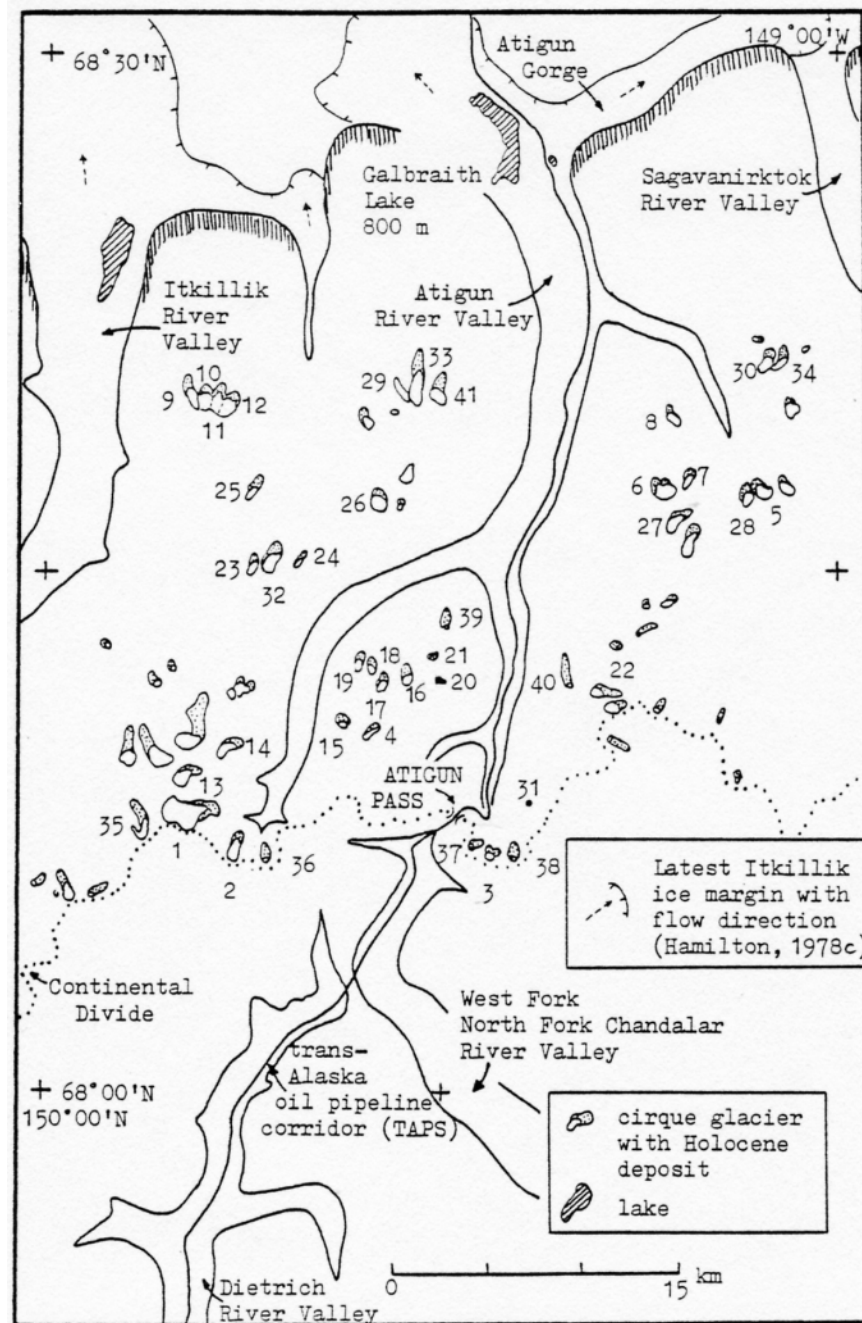
3. Education & Research Opportunities

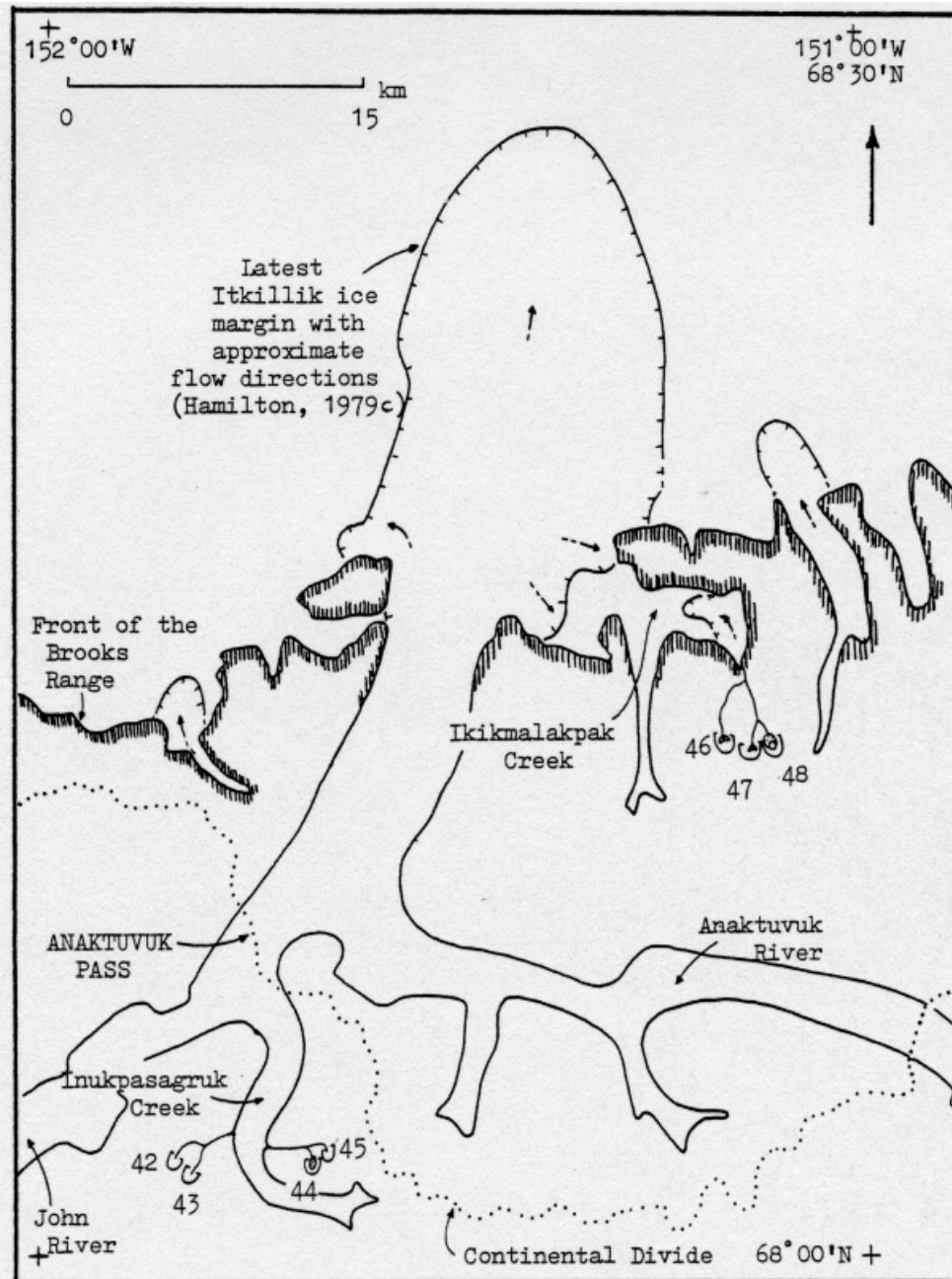
Document glacier changes over 30 years using: 1) Photogrammetry, 2) Orthorectification, 3) Conversion of original maps into GIS layers with attributes, 4) Modeling, 5) Statistical Analyses, 6) Extensive GeoSpatial Lab work in preparation for Field work

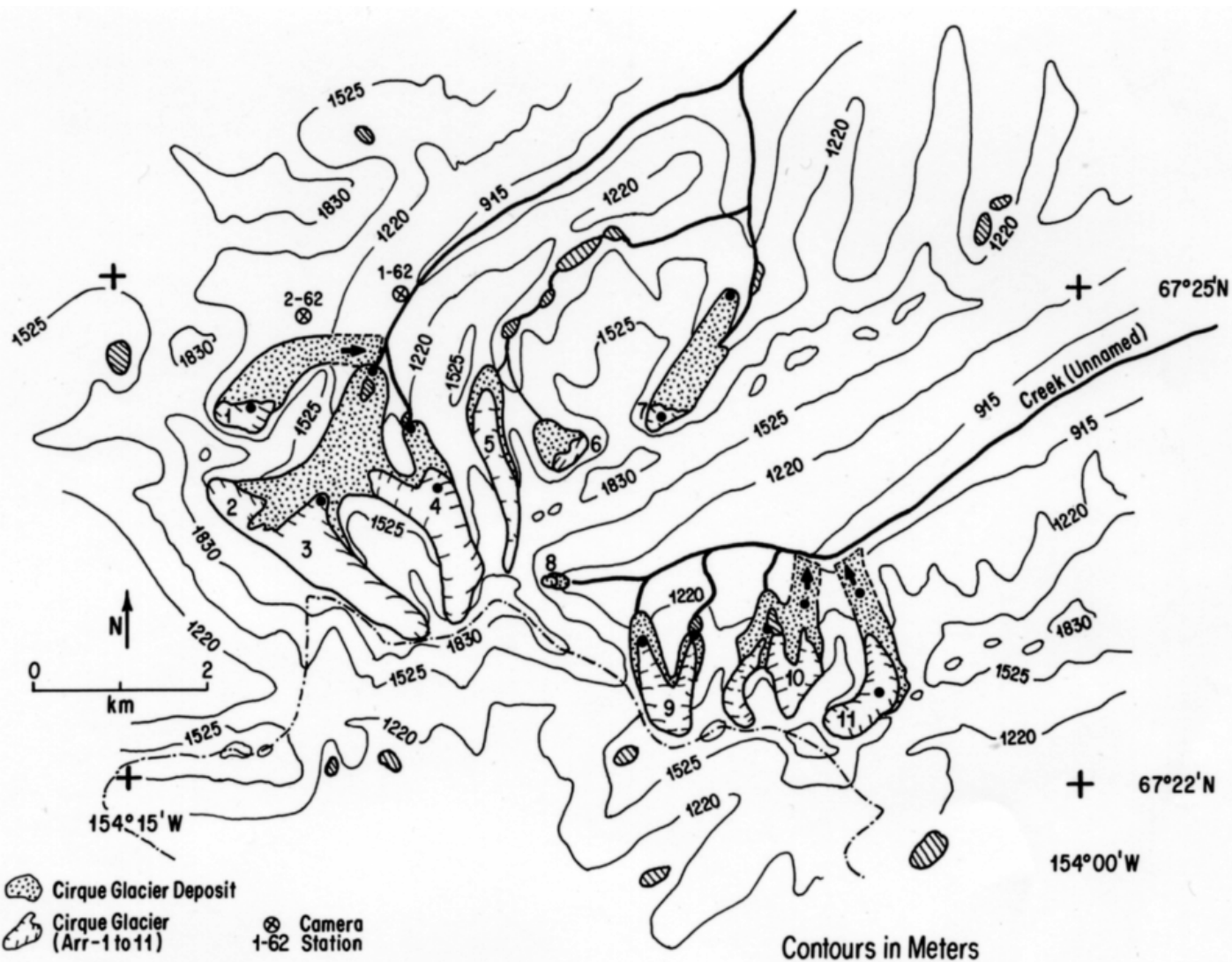
1. Baseline work done 25-30 years ago – Visited over 100 cirques & mapped Holocene glacier deposits











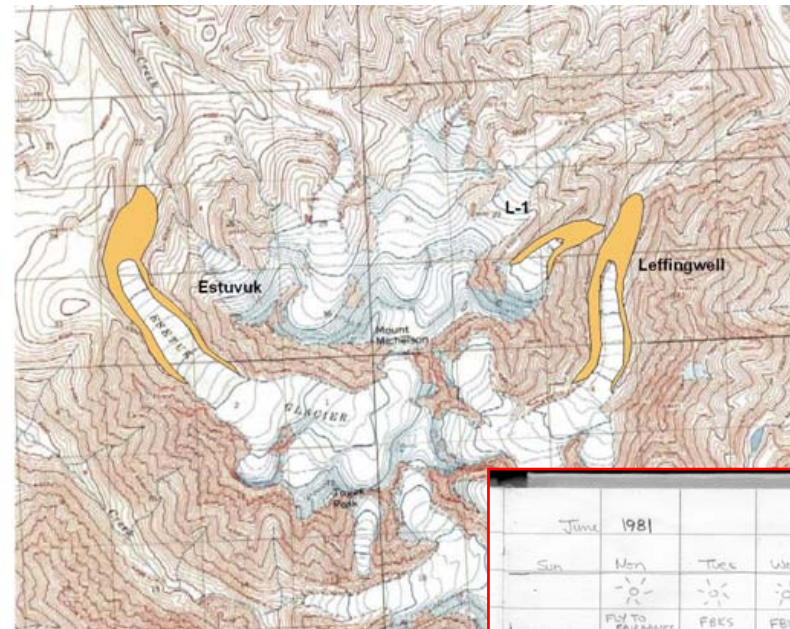
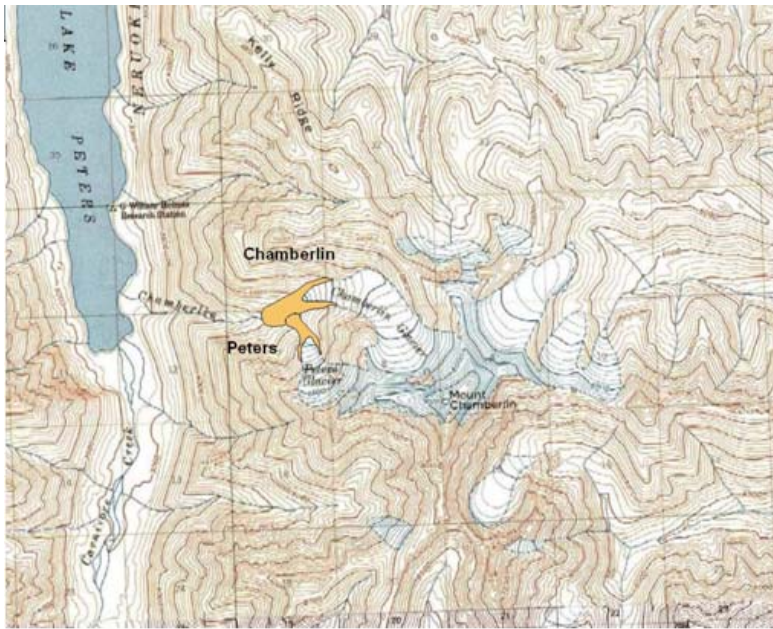
Key

- Continental Divide
- Cascading Glacial Deposit
- Lake

- Cirque Glacier Deposit
- Cirque Glacier (Arr-1 to 11)
- Horizon Survey Site

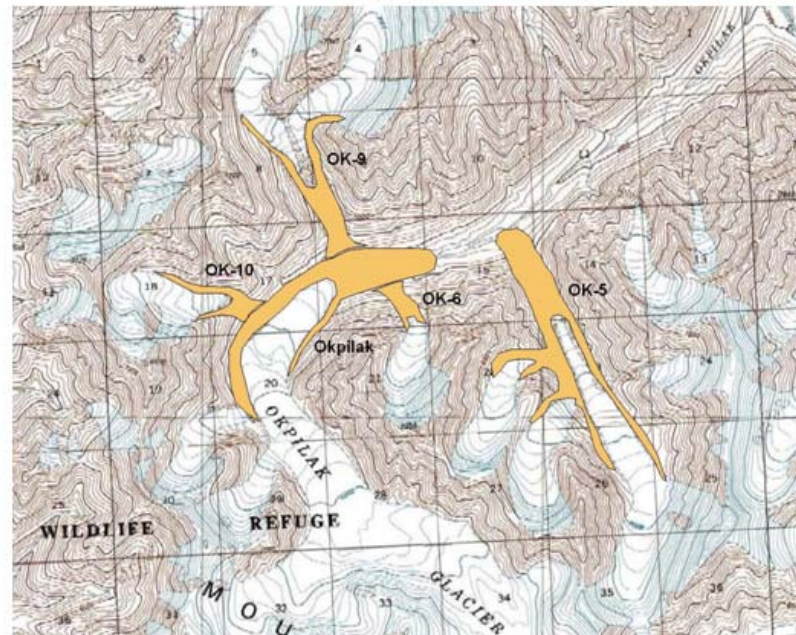
Camera Station
1-62

Contours in Meters



NE Brooks Range
Holocene Moraines
Mapped &
Photographed
in 1981

J. Ellis & P. Calkin
University of Buffalo
1981



June 1981						159	
Sun	Mon	Tues	Wed	Thurs	Fri	Sat	
	FLY TO FAIRBANKS 22	FBKS 23	FBKS 24	FLY TO BARTER 25	CLDY GOULDER 26	CLDY GOULDER 27	
CLDY GOULDER	CLDY GOULDER	CLDY GOULDER	CLDY GOULDER	COLD CLIPPING	BARTER	BARTER	
28 BARTER	29 BARTER	30 BARTER	1 BARTER	2 BARTER	3 BARTER	4 Hils	
5 Hils	6 Hils	7 Hils	8 Hils	9 Hils	10 Hils	11 Hils	
12 Hils	13 Hils	14 Hils	15 Hils	16 Hils	17 Hils	18 Hils	
19 Hils	20 Hils	21 Hils	22 Hils	23 Hils	24 Hils	25 Hils	
26 Hils	27 Hils	28 Hils	29 Hils	30 Hils	31 Hils		



Students who worked in the Brooks Range

Phil Burns*
Michael Bruen*
Jim Ellis*
Leah Evison*
Beth Lamb*

*Went off to Industry
& Agencies!!*



Ed Aguado
Tom Lowell
Ron Harding
Doug von Brock
Steve Walti

**Masters & PhDs*

Support from:
NSF Grants
University of Buffalo
Indiana University (Larry Onesti)
USGS (Dr. Thomas Hamilton),
U of AK, Alyeska, CRREL
+ *many others*



~~Nothing~~ has been done with the cirque glaciers & rock glaciers of the Brooks Range since the early 1980's!!

**NOT TRUE
ANY LONGER!!**

This presentation was done in 2008.

Since then work has been done on glaciers and their deposits in the Brooks Range!

Shawnee Kasanke completed a plant succession study around Grizzly Glacier and other older sites. She unsuccessfully searched for lichenometric stations established in the late 1970s at Grizzly Glacier. Excessive moraine surface disruption as the glacier disappeared?

CORRECTION: Professors J. Briner and D. Kaufman, along with grad students M. Badding and S. Pendleton started field work on glaciers and their deposits after ~2010. Some publications are on this website.

***Who's going to pick up
the ball in the 21st Century
and run with it???***



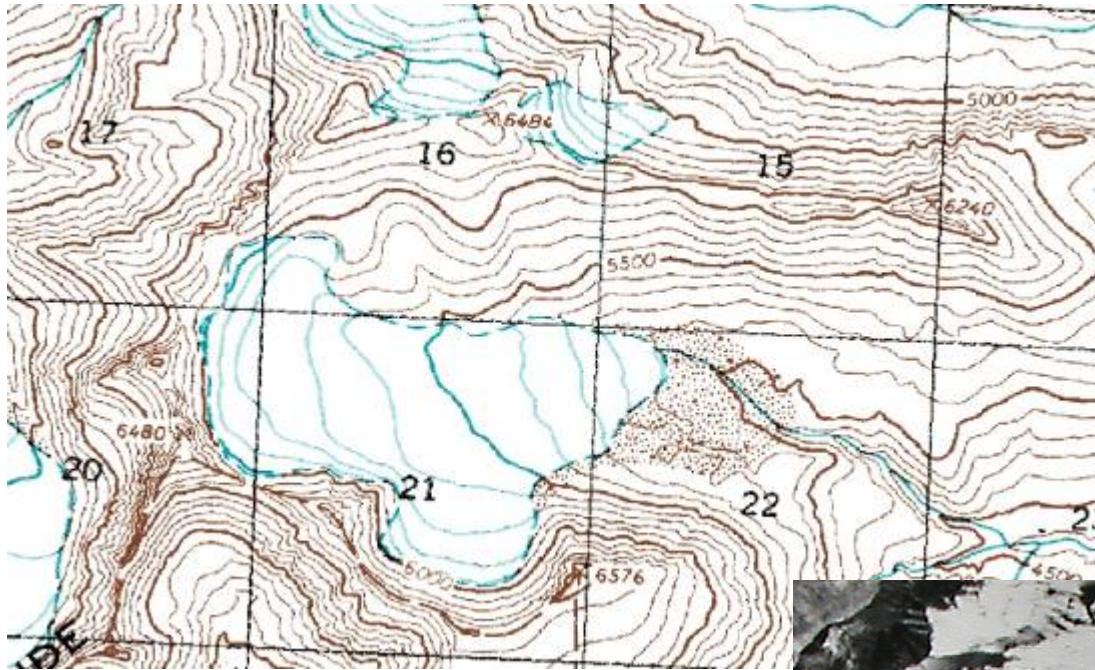


1977-1984: A lot of Fieldwork!!



The Base for Mapping 25 - 30 Years Ago

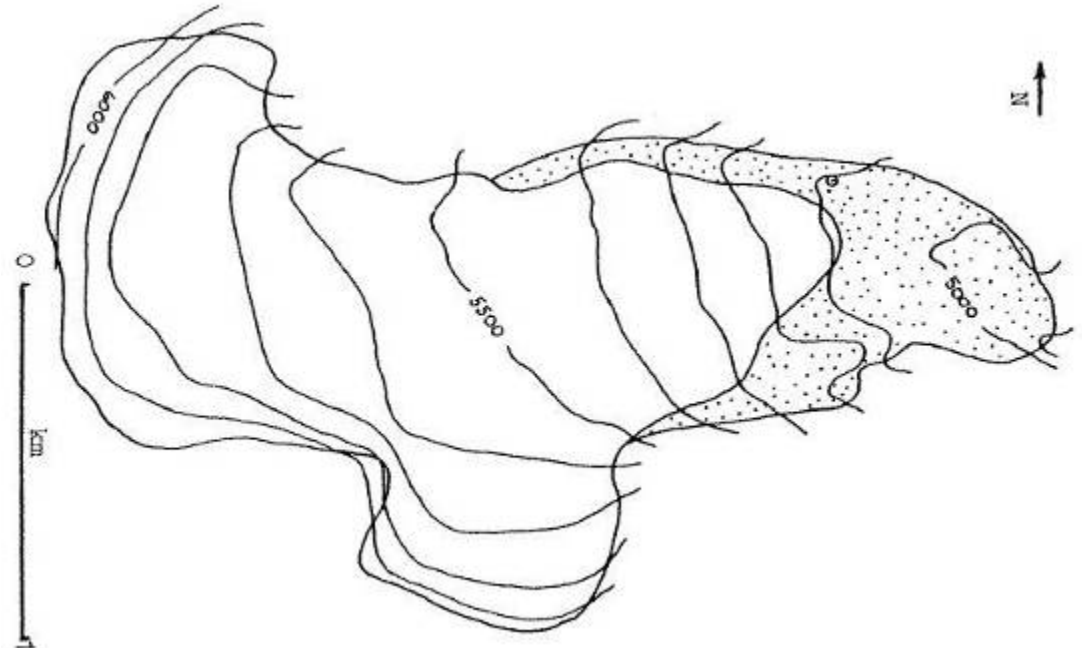
Paper Prints of
USGS 1:63,000
Topo Sheets
(1" = 1 mile!)



Paper Prints of
1:60,000 B&W
Air Photos



Enlarge USGS Topo Maps & Air Photos

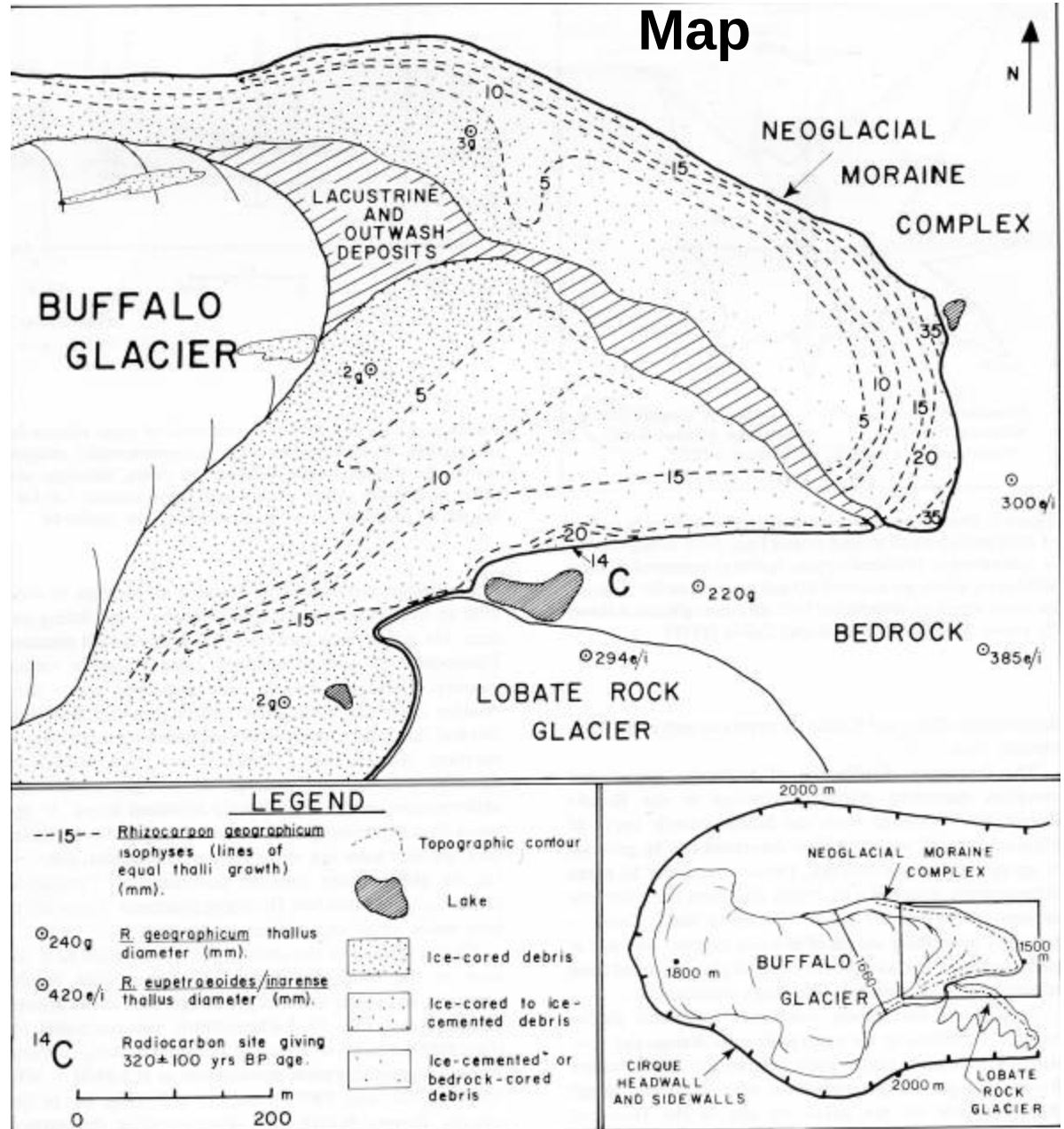


Lichenometry

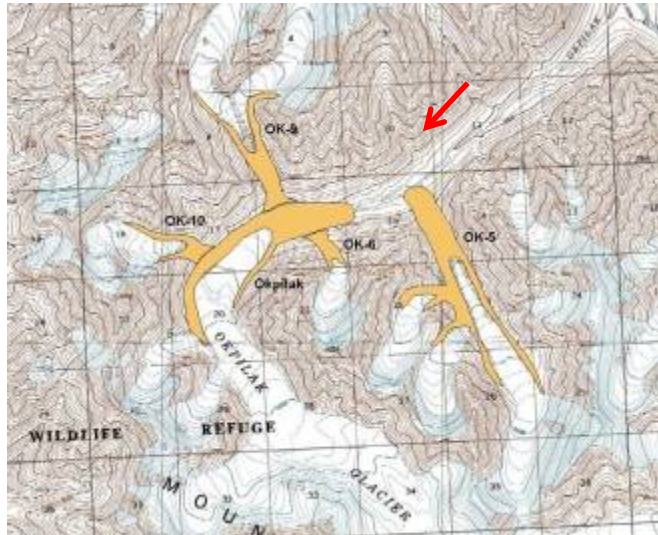




Lichenometric Map



20th Century Change (Leffingwell)



Okpilak Glacier

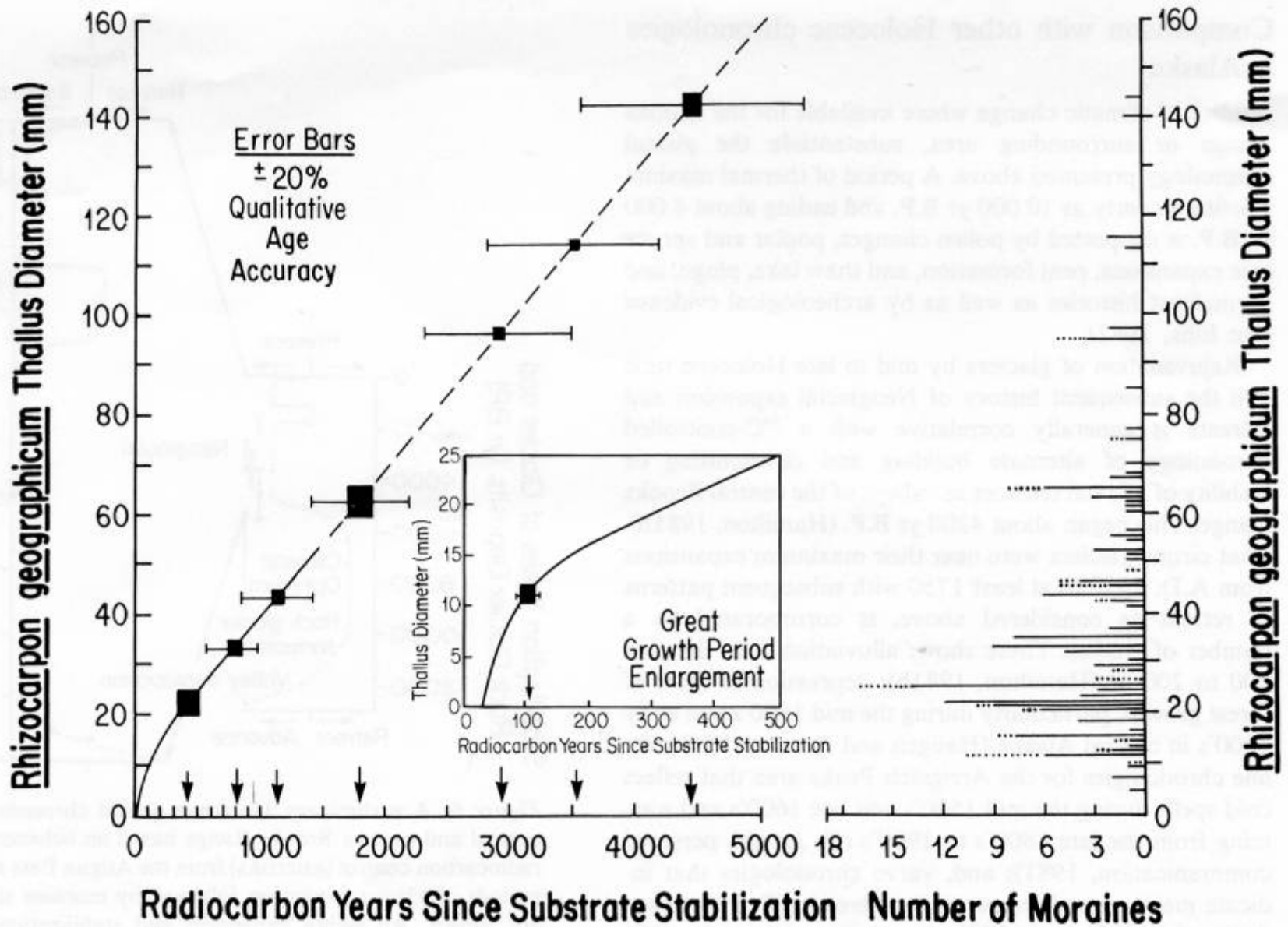


20th Century Change (Leffingwell)



Okpilak-6 Hanging Glacier

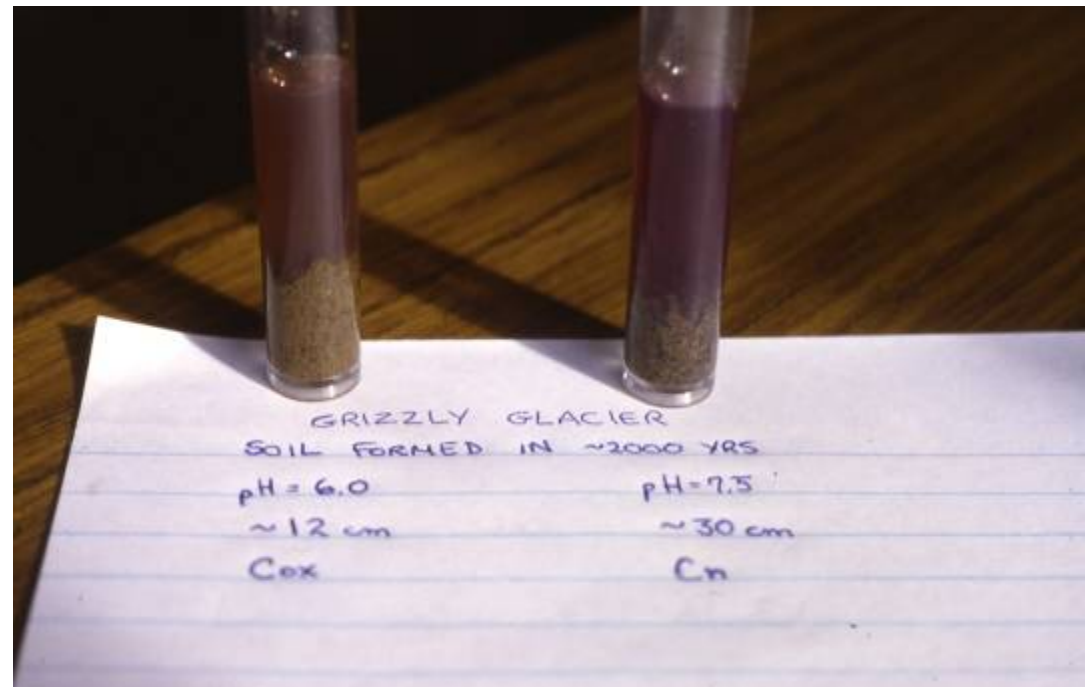
Lichenometry



Let's Core Some Trees

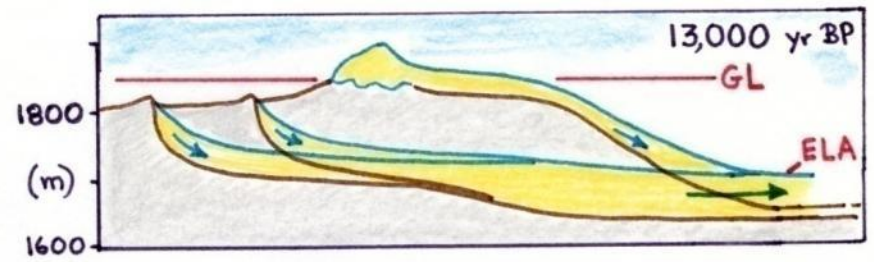


Dig Soil Pits

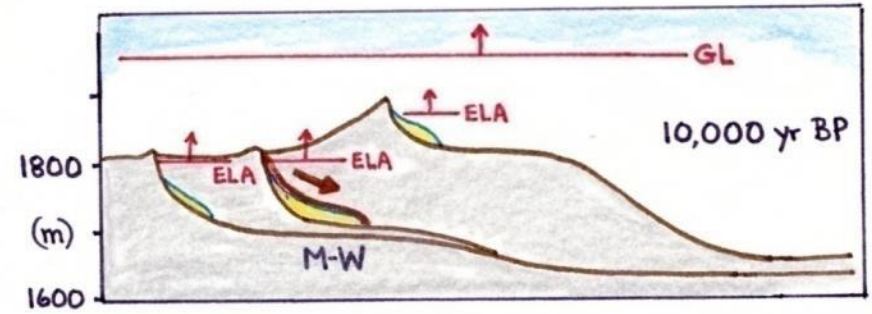
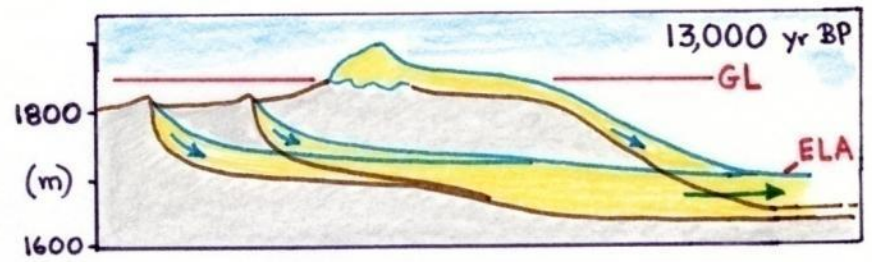


GRIZZLY GLACIER
SOIL FORMED IN ~2000 YRS
pH = 6.0 pH = 7.5
~12 cm ~30 cm
Cox Cn

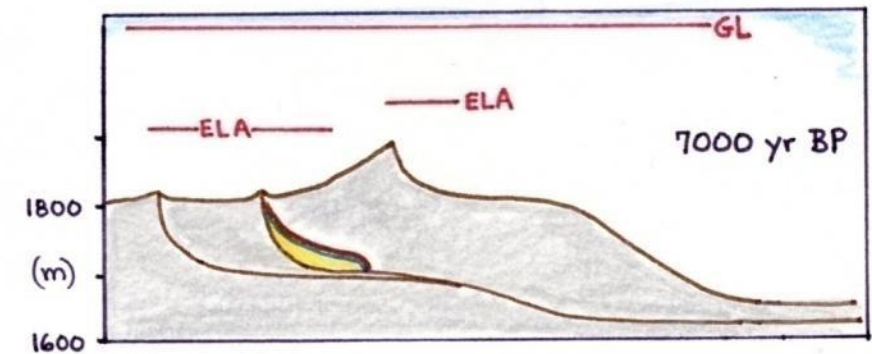
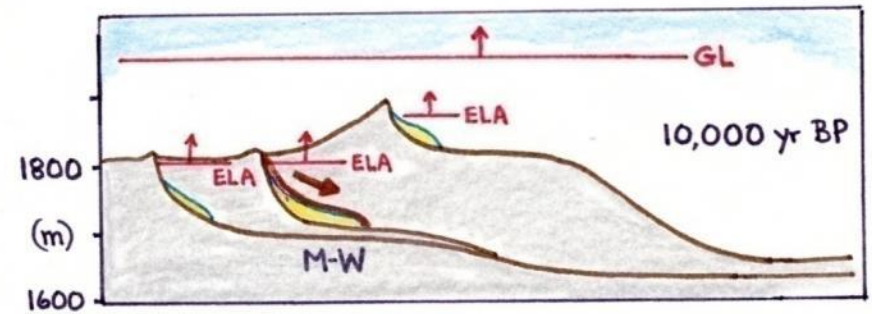
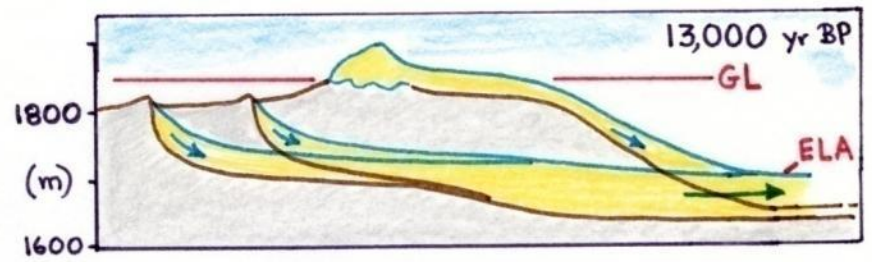
The Glacier Story



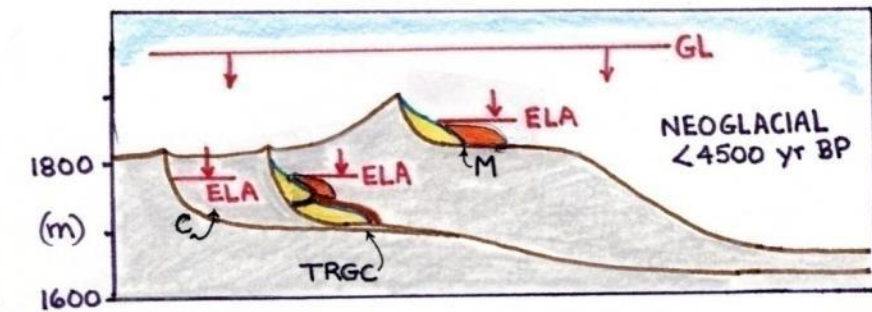
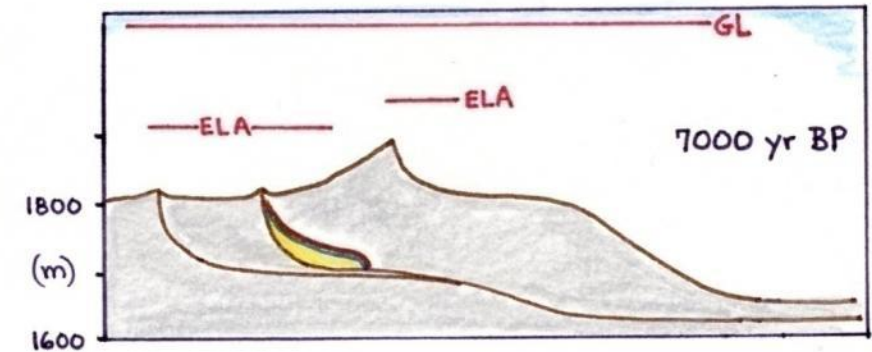
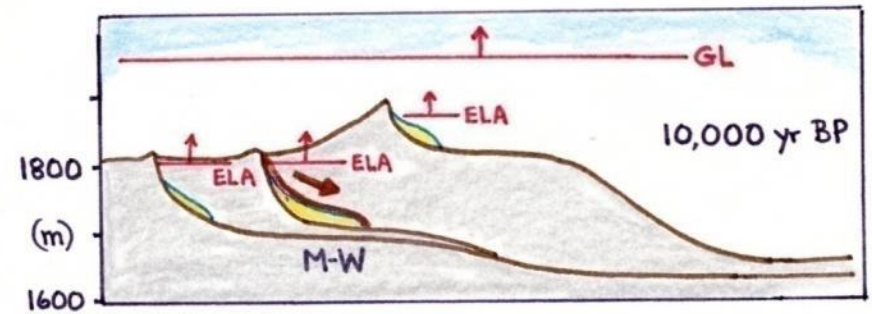
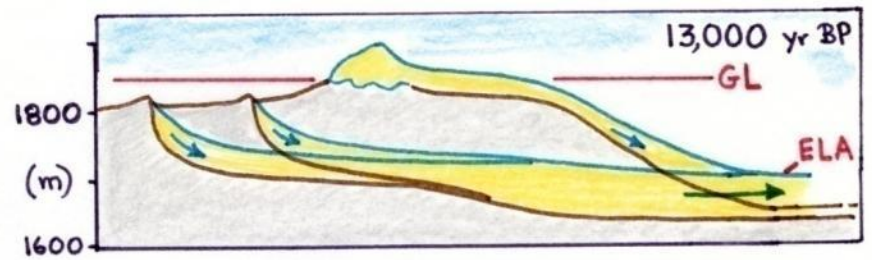
The Glacier Story



The Glacier Story

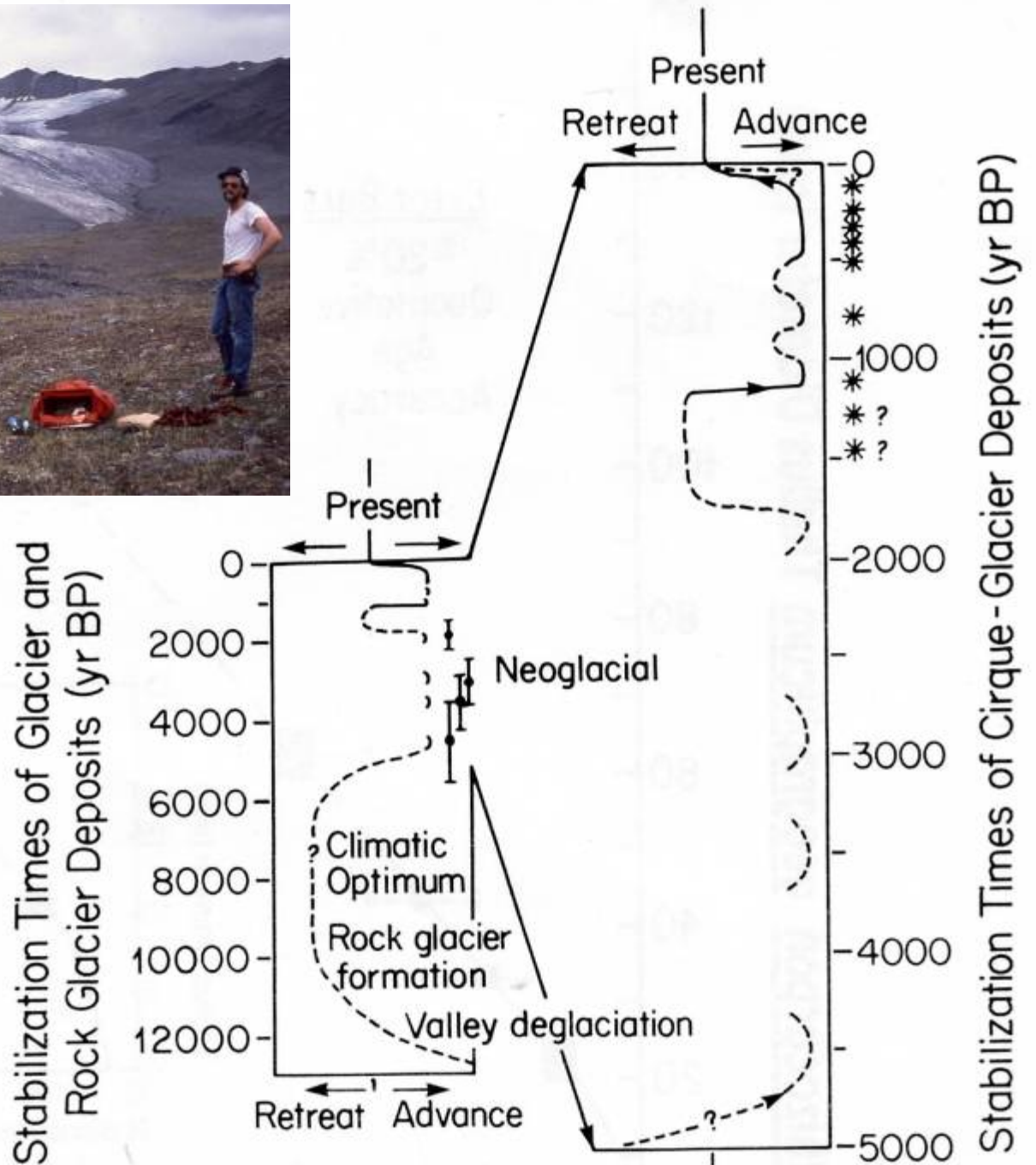


The Glacier Story





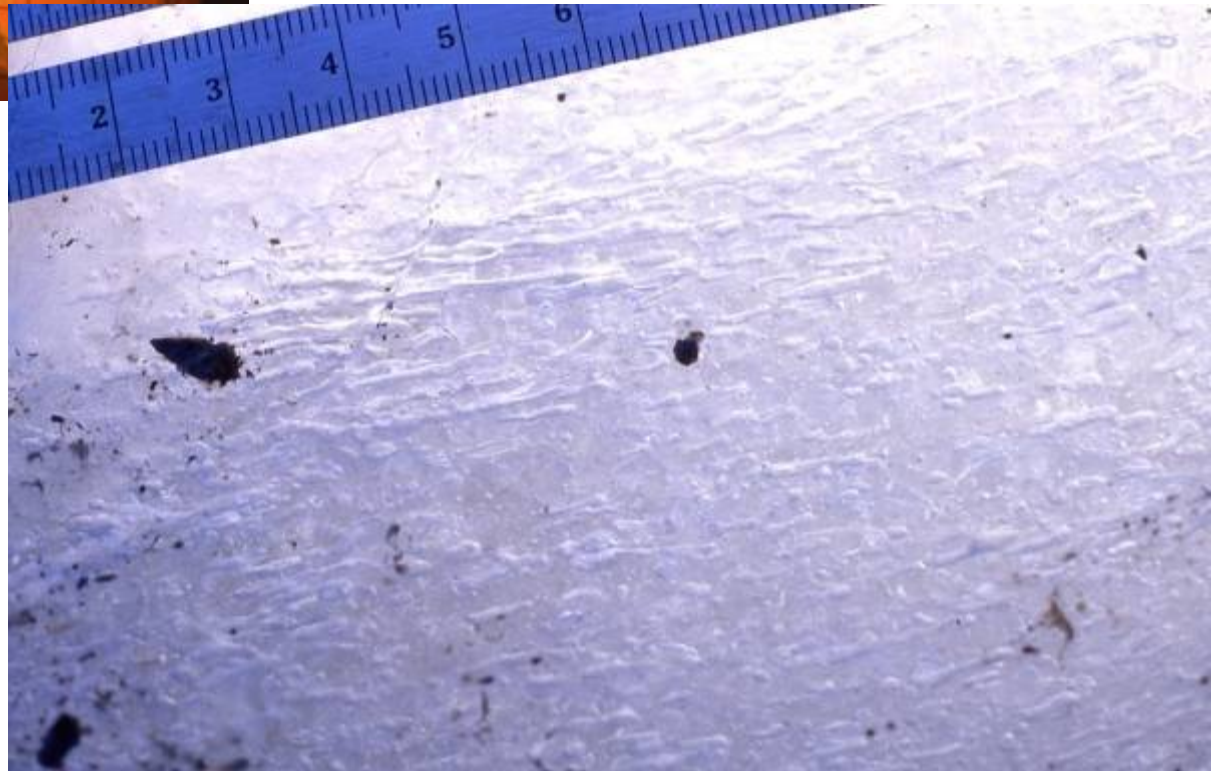
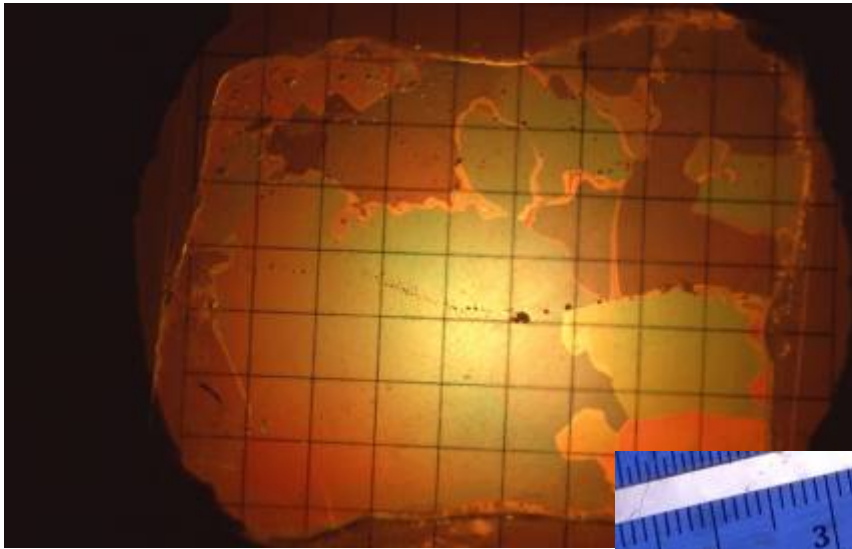
Holocene Chronology



What about the ICE?



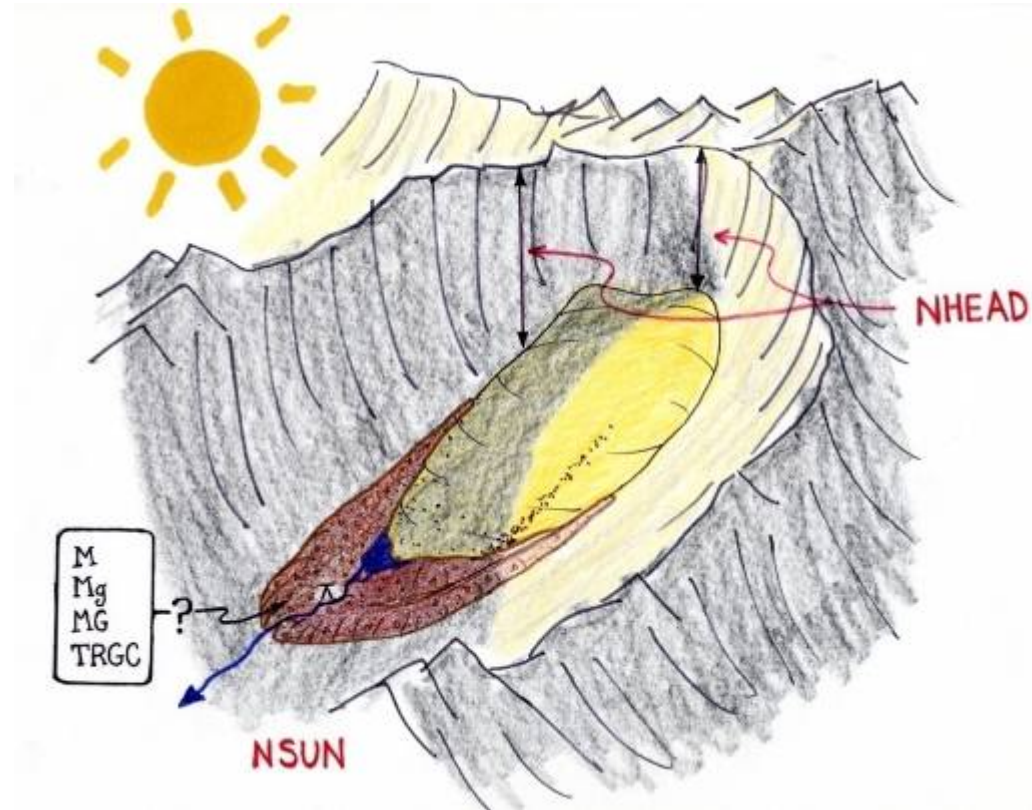
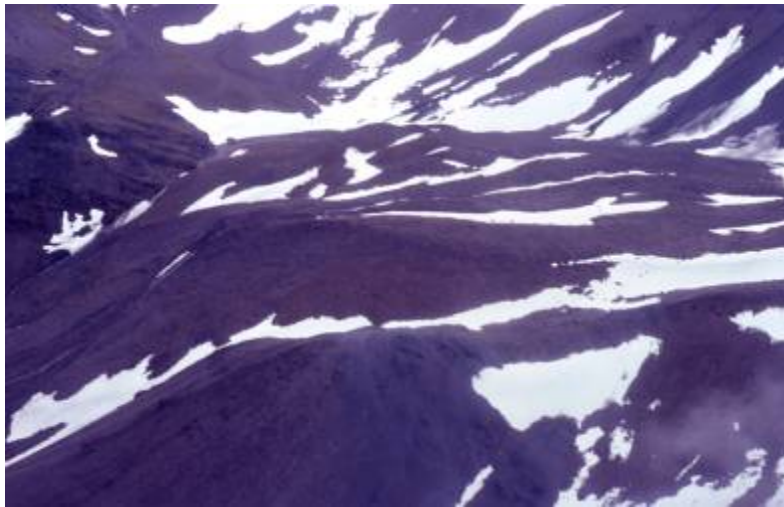
Elongated Bubbles



Michael Bruen, Morphology & Process..., UB MA Thesis, 1980



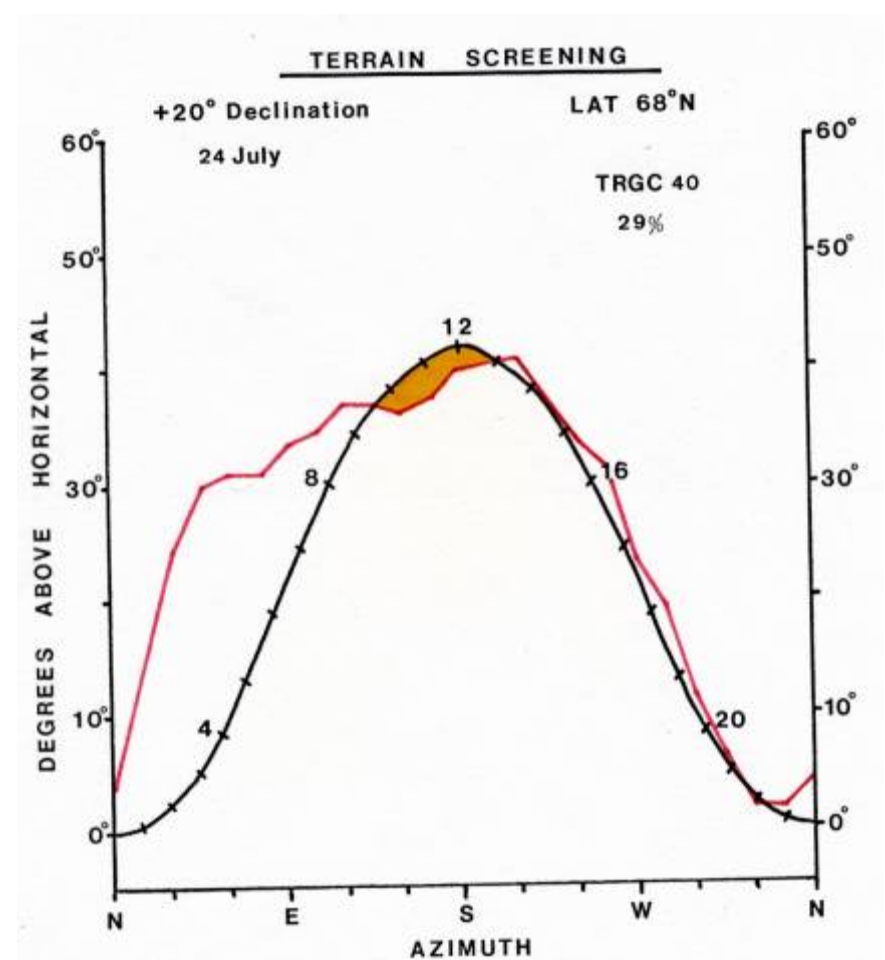
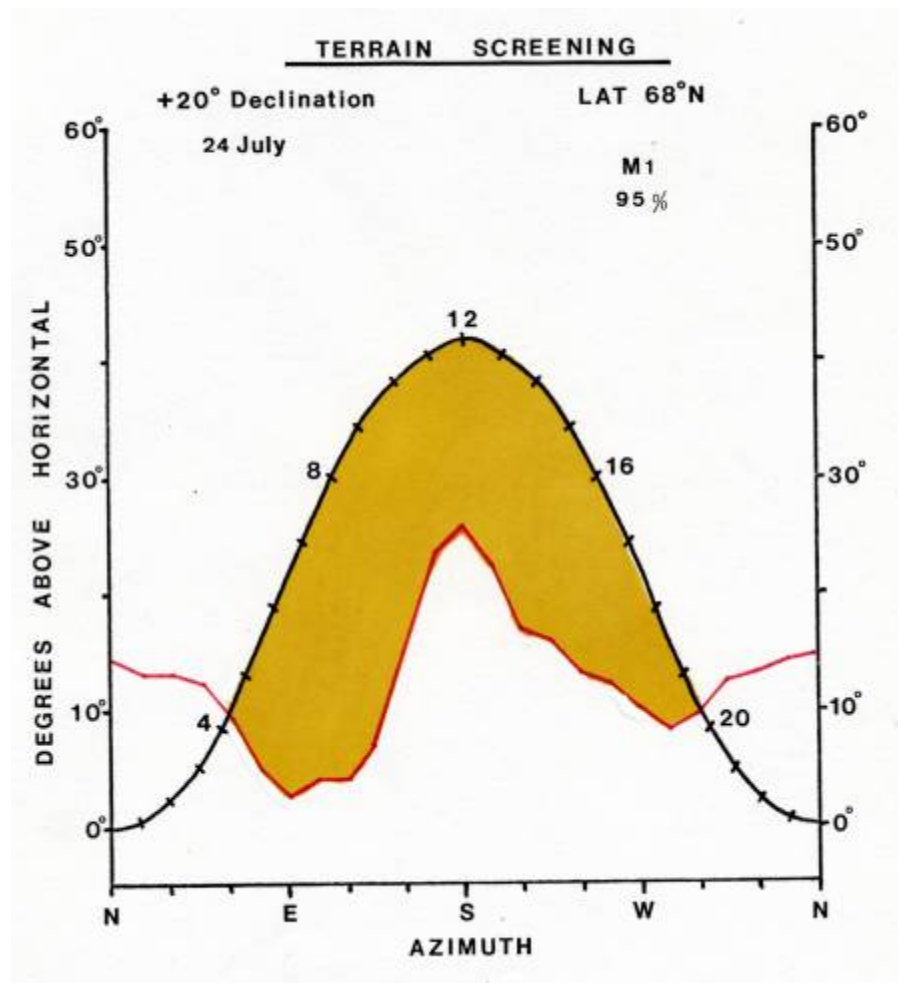
Why different types of cirque glacier deposits??



Measure the Horizon



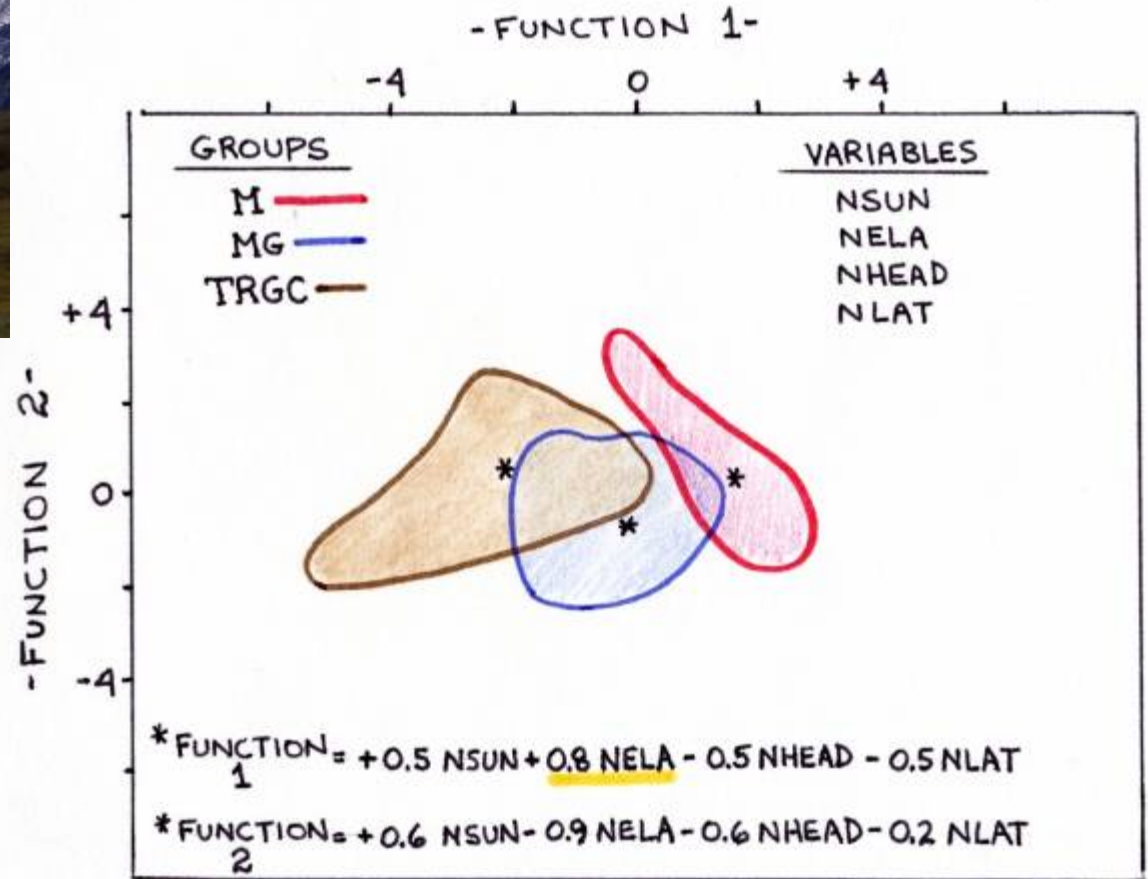
Calculate Solar Insolation



Landform Analysis



DISCRIMINANT ANALYSIS 1 SCATTERPLOT



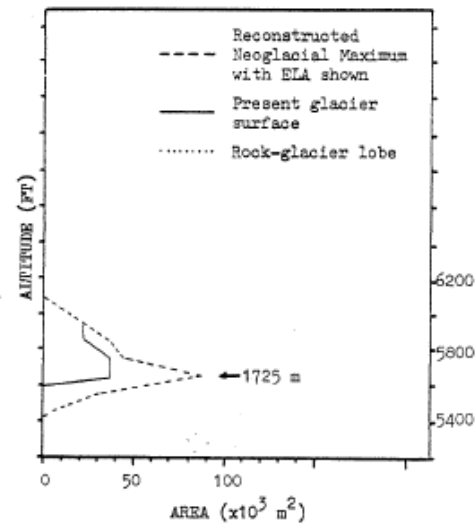
* CLOSER "STANDARDIZED CANONICAL COEFFICIENTS" TO ± 1.0 , LARGER CONTRIBUTION VARIABLE MAKES TO DISCRIMINATION OF GROUPS.

** MORAINES ONLY IN SEDIMENTARY TERRAIN.

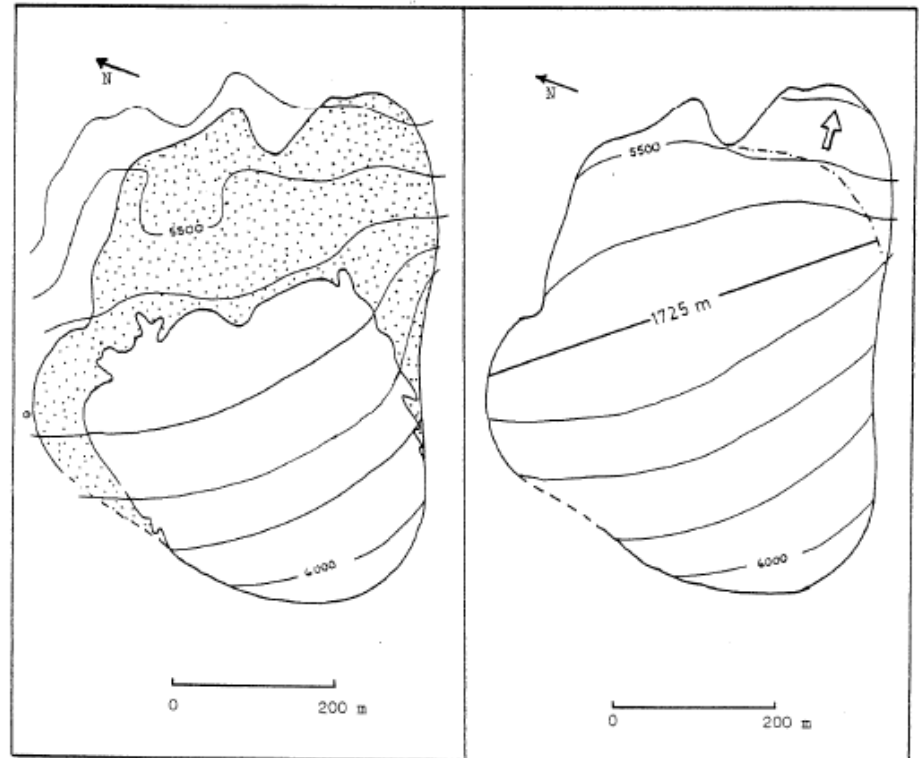
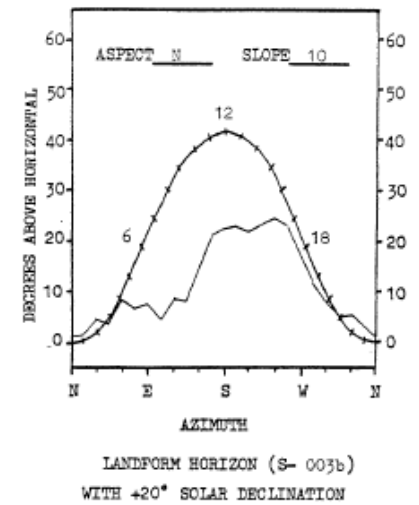
Completed Physical Inventory of Glacial & Periglacial Landforms in Each Cirque Visited (55 in Ellis Dissertation)



APPENDIX B. PHYSICAL INVENTORY (Grizzly Glacier, no. 3)



NEOGLACIAL MAXIMUM AND PRESENT
AREA-ALTITUDE DISTRIBUTIONS



PRESENT ICE SURFACE WITH DEPOSIT

NEOGLACIAL MAXIMUM SURFACE

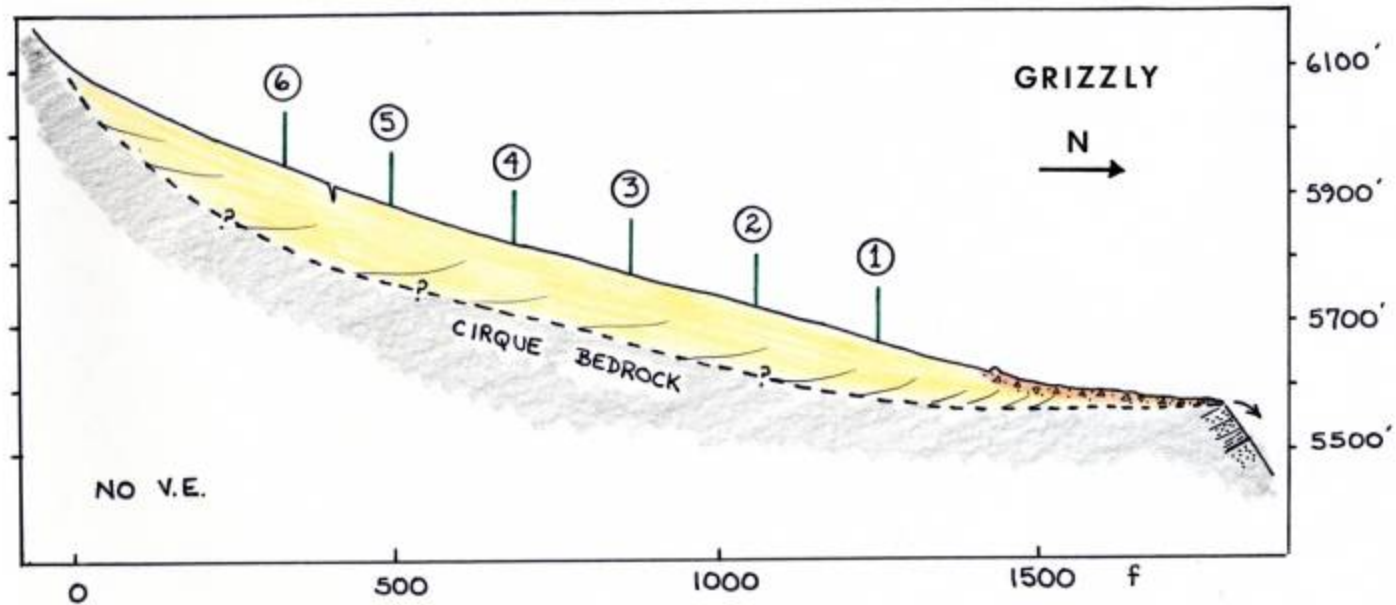
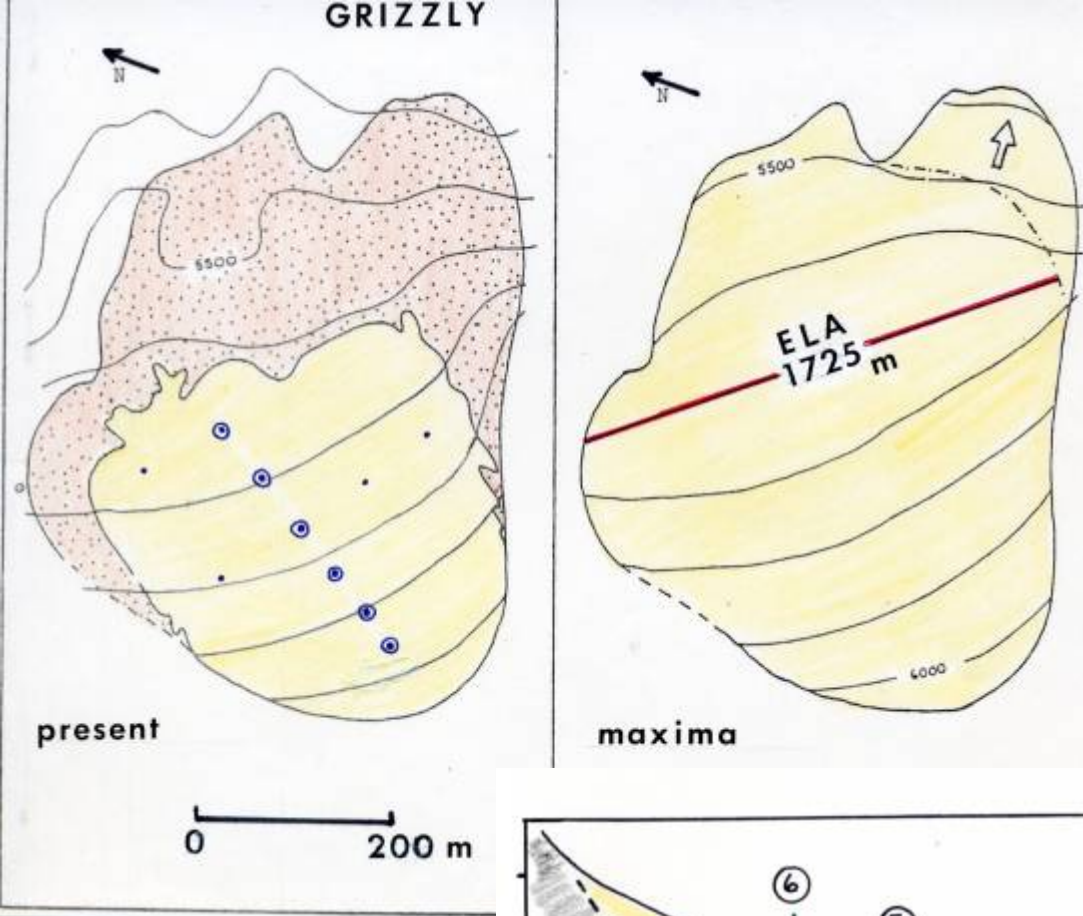
What's the Current Condition of Glaciers?



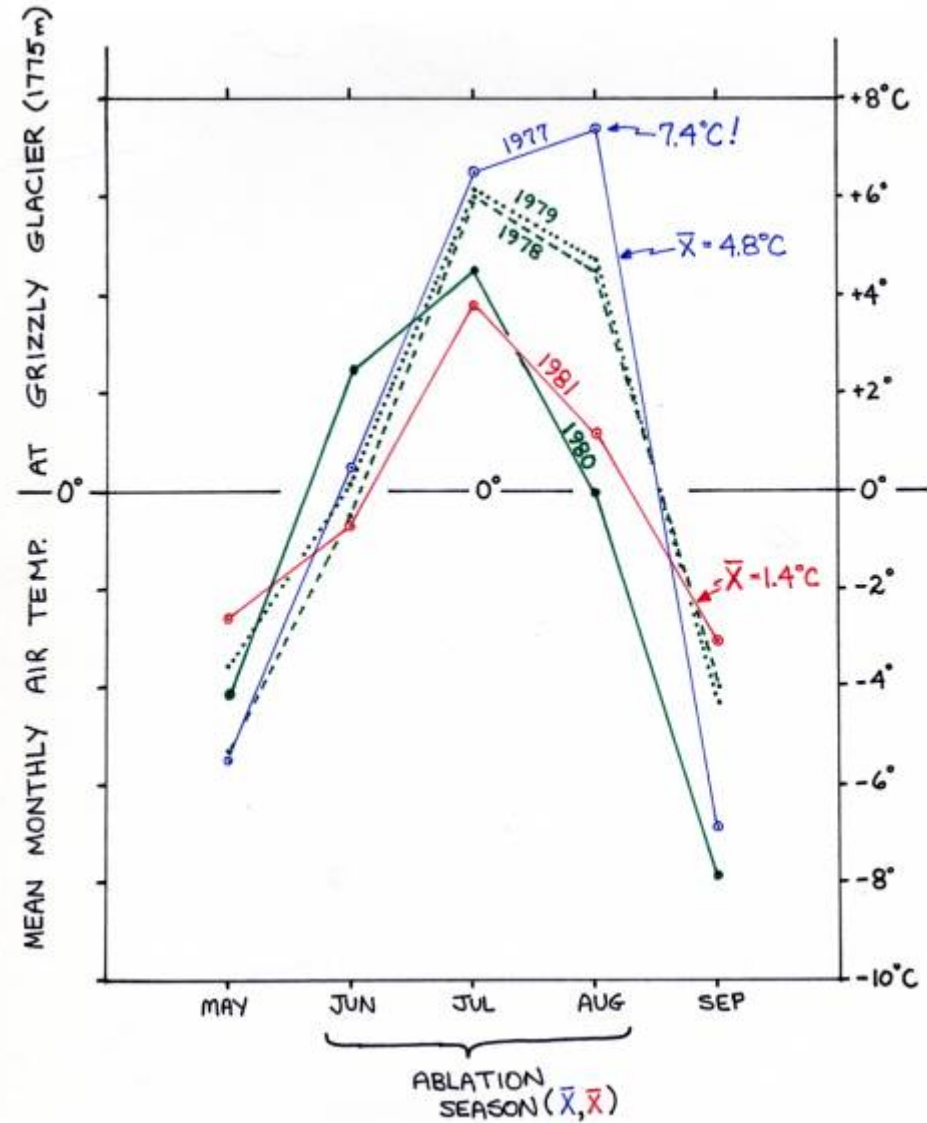
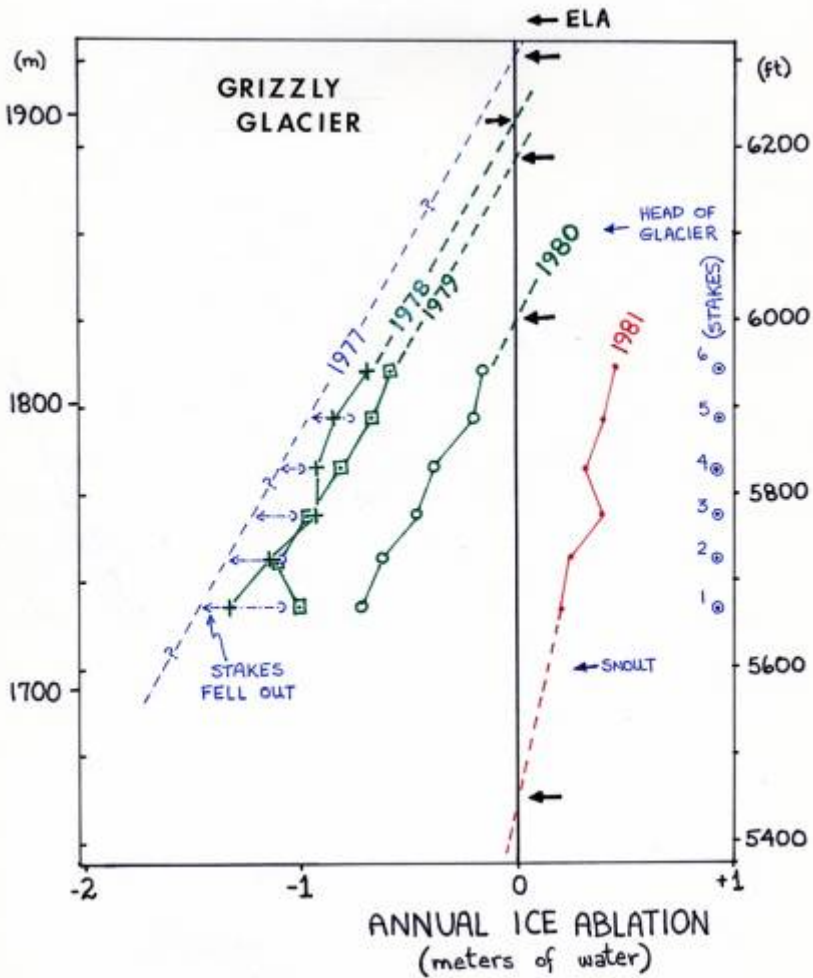
Stakes Drilled in Ice maintained for 5 years!



Stakes Drilled in Ice 1977 – 1982



Calculating Ice Ablation & Snowline 1977-1981



Phil Burns, The Regime of Grizzly Glacier, UB MA Thesis, 1984

Let's Survey these Glaciers!

Maps never published

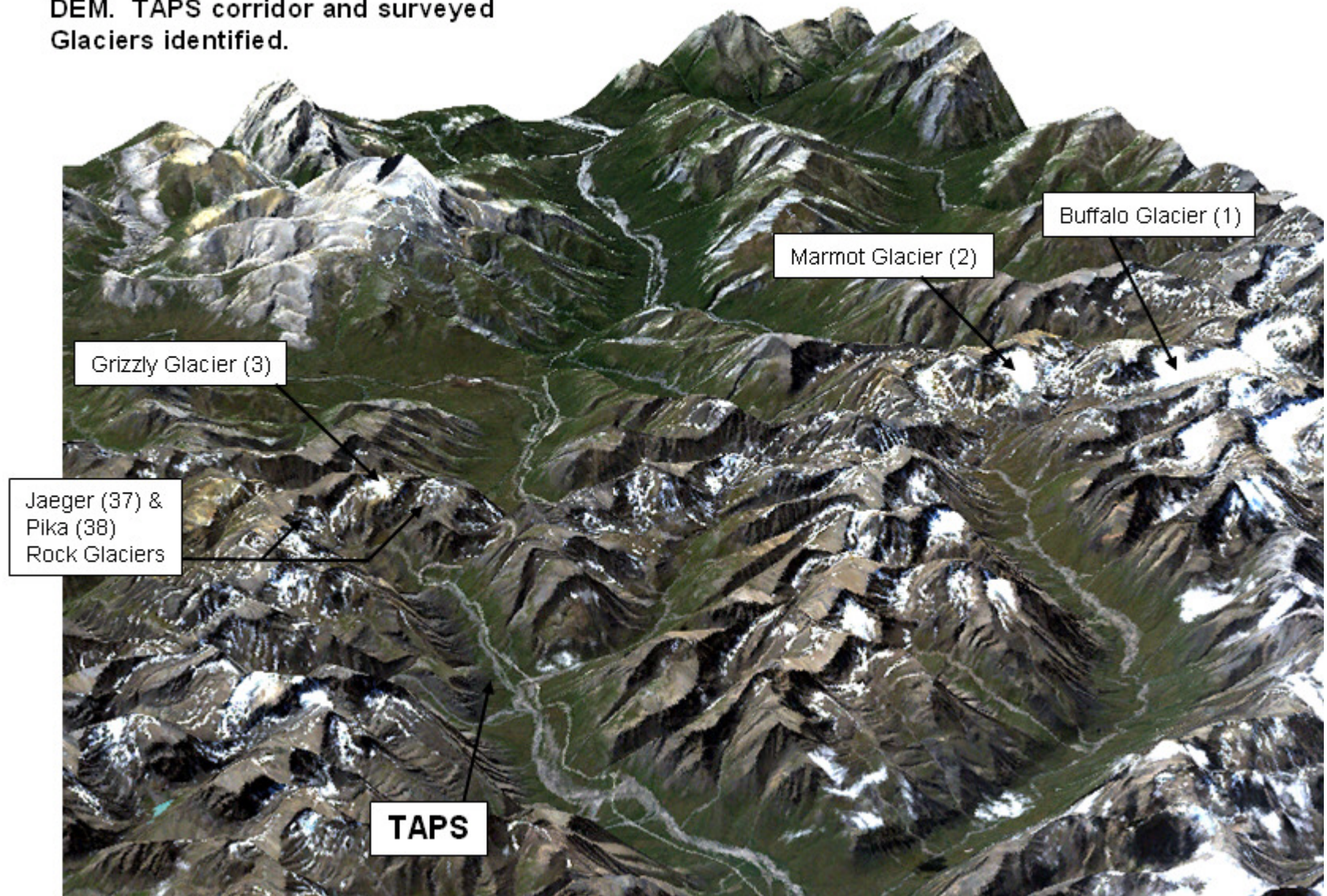


*Parker arranged for
Theodolite & Stadia
From UB's Engineering Dept.*

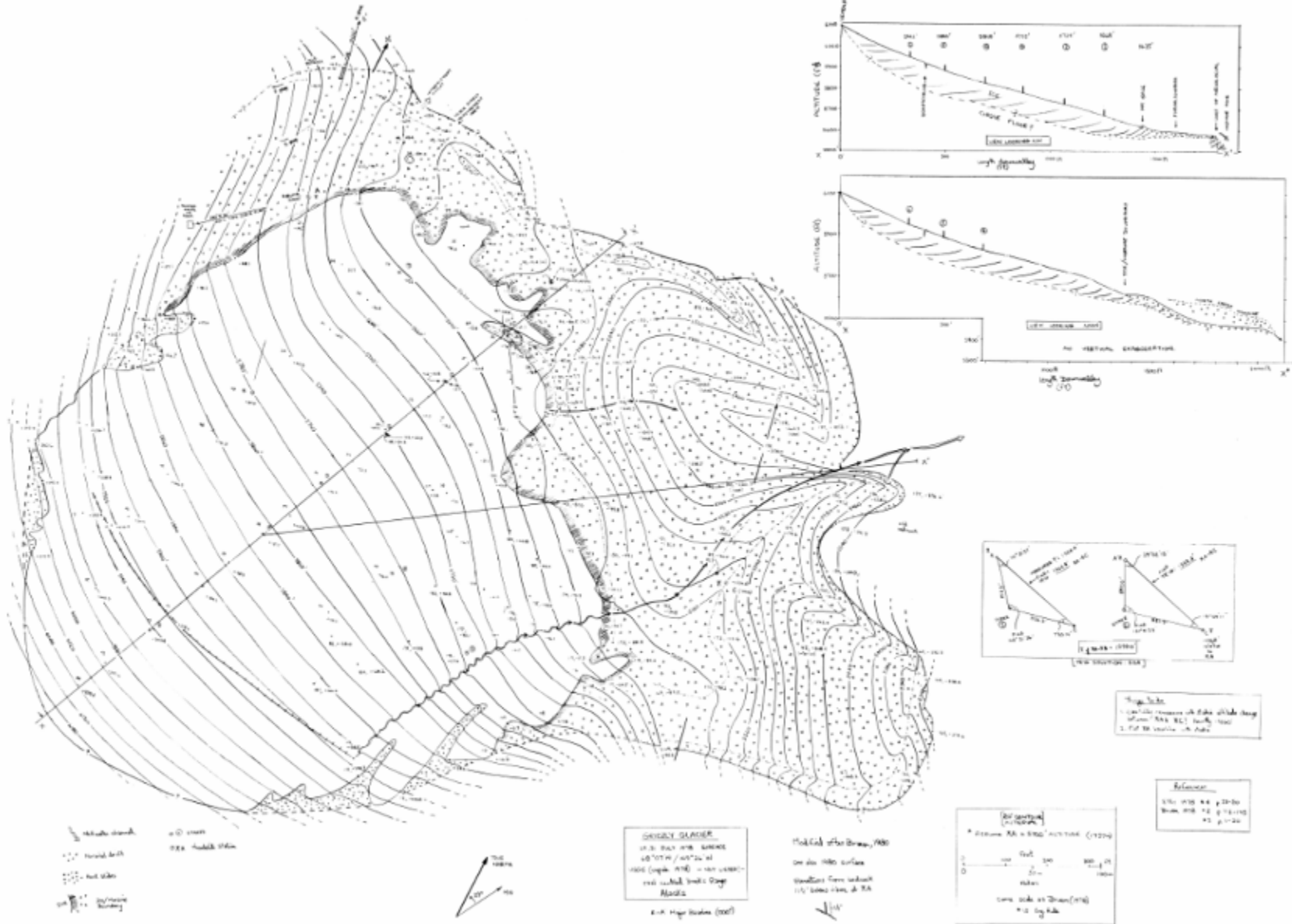


View looking South across Eastern Brooks Range. July 1999 Landsat as natural color image draped on USGS DEM. TAPS corridor and surveyed Glaciers identified.

Surveying with a Theodolite 1978, 1979, 1980, 1983



1978 Grizzly Glacier Survey Map



1978 Pika Rock Glacier Survey Map



1978 -1983 Pika Rock Glacier Profile

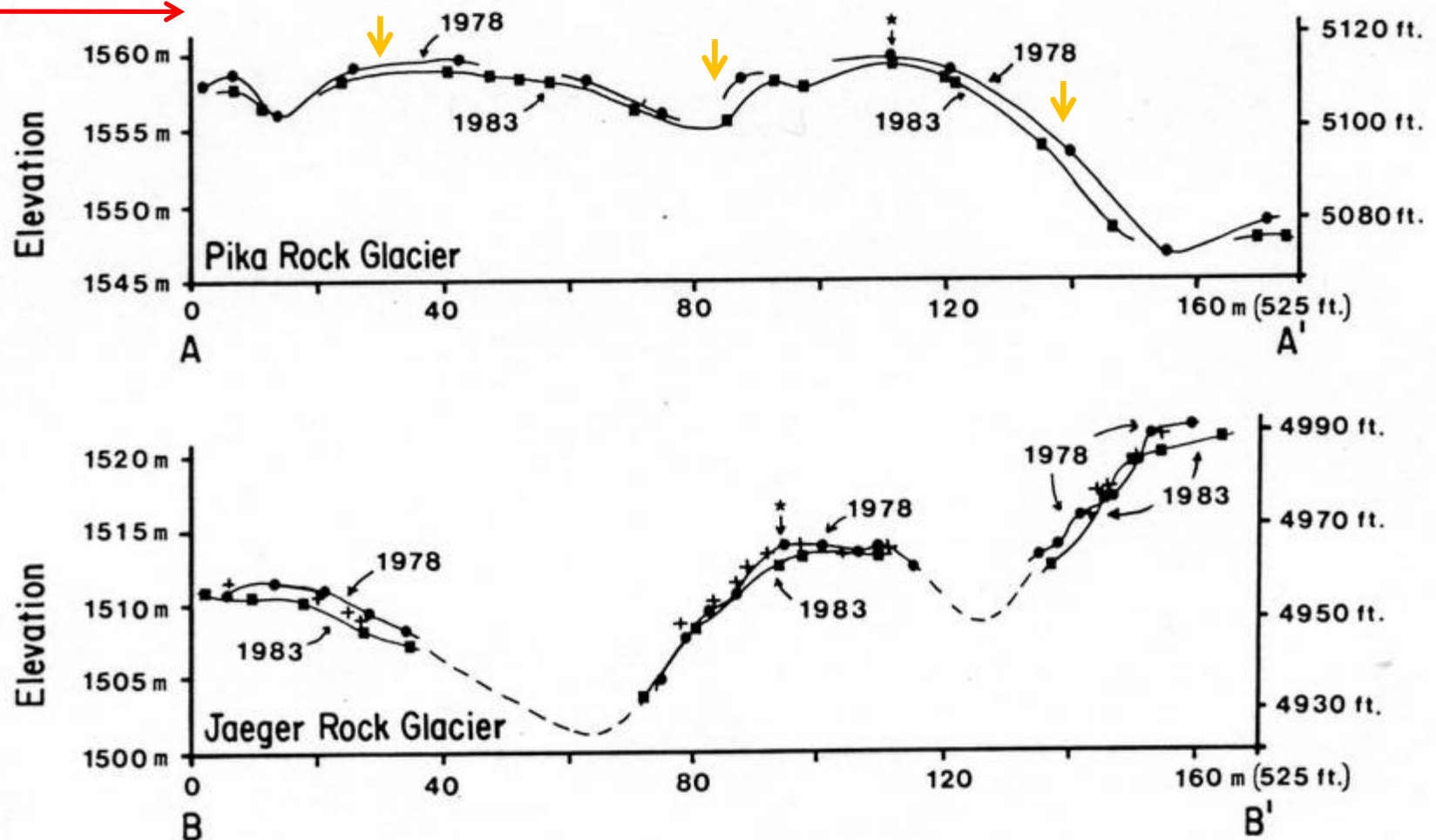
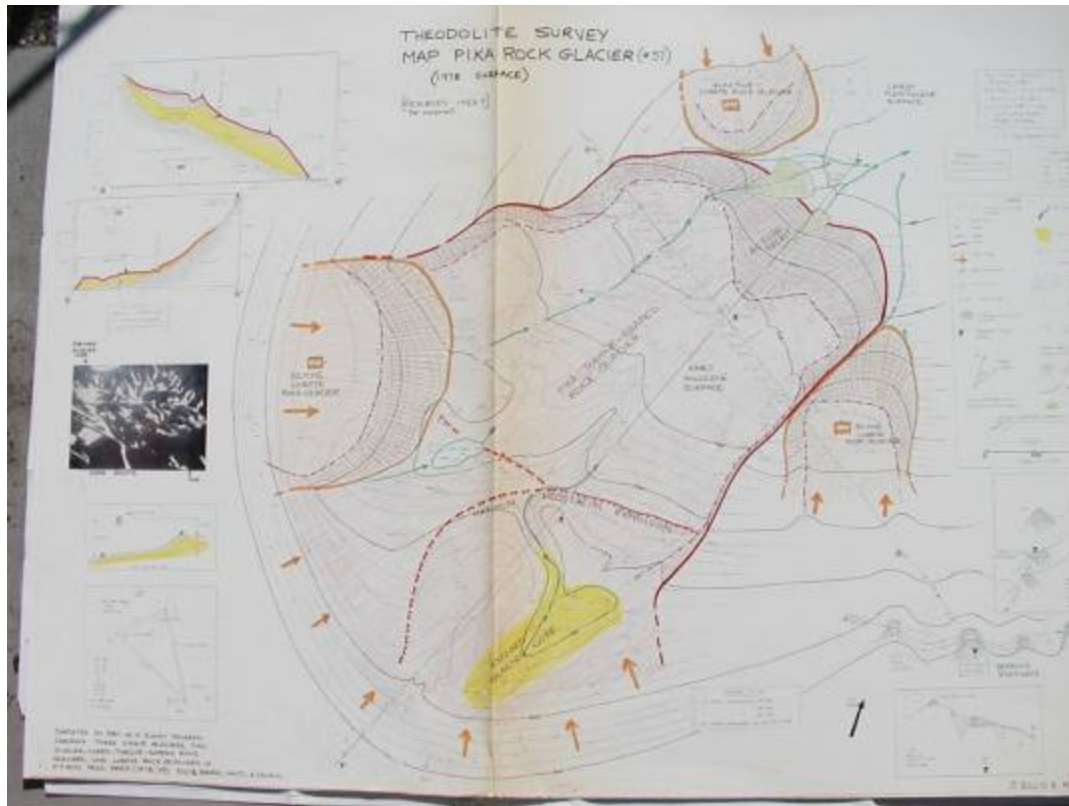


Figure 6.11 A) Surface displacement along fixed traverses of Pika rock glacier, and B) Jaeger rock glacier. Elevations were measured by theodolite shots on stadia

Leah Evison, Holocene Glacial Chronologies..., UB PhD Dissertation, 1988

2. Moving Parker Calkin's work into the 21st Century with GeoSpatial Technology



Go Digital.....

1. Scan paper maps
2. Website
3. Google Earth
4. Build a GIS
5. Find aerial photos & satellite images
6. Use DEMs & Stereo
7. Correct original maps to support new fieldwork

Website

THIS WEBSITE
REPLACED IN
APRIL 2022

SAME
ADDRESS
AS BELOW

www.ellis-geospatial.com

The screenshot shows the Ellis GeoSpatial website. At the top, there's a navigation bar with links like 'Customize Links', 'Free Hotmail', 'Windows Marketplace', 'Windows Media', and 'Windows'. Below this is a blue header with 'Ellis GeoSpatial' on the left and 'Imaging & Mapping Solutions' on the right. A sidebar on the left contains a vertical menu with buttons for 'HOME', 'SERVICES', 'EXPERIENCE', 'CASE HISTORIES', 'BUSINESS', and 'BROOKS RANGE' (which is highlighted with a mouse cursor). The main content area is titled 'Brooks Range Glaciers 1977-1982 Field Maps & Photographs'. It includes a table with links to download various maps and publications. Below the table, there's a section with text about the project, followed by three images: a photograph of a glacier, a map of the Brooks Range, and a Landsat image. At the bottom, there are three ZIP file icons with links to download them.

Download 1982 Dissertation	1978-1982 Publications	Glacier Change Photos	Maps Showing Field Sites	1979 Buffalo Survey Map
1979-80 Horn of Dunes Map	1979 Grassy Dunes Map	1980 Grassy Dunes Map	1979 Jagerst Dunes Map	1979 Pika Dunes Map

**Brooks Range Glaciers
1977-1982 Field Maps & Photographs**

Click on Blue Boxes **Above** to see more Photographs, Survey Maps, 1982 Dissertation, & Satellite Images

Click on Icons **Below** to Download Maps & Images for Displaying in GoogleEarth

Double-click on **Thumbnail** Images to see a Larger Version

During 1977-1982, Jim Ellis hiked across the Brooks Range of northern Alaska with Dr. Parker Calkin and graduate students from University of Buffalo, Department of Geological Sciences. He created maps of many cirque glaciers and rock glaciers, compiled physical data on each landform, and surveyed 3 glaciers and 3 rock glaciers with a theodolite. He's converting these paper maps to digital files and georeferencing them into GIS to increase access to this unique climatic-change archive. As far as he knows, no one has gone back over the past 25 years!

Data were collected in four areas: east-central Brooks Range (centered about Abigun Pass and the Trans-Alaska Pipeline), Amigetch Peaks, Anabuvuk Pass, and Northeastern Brooks Range. This website provides maps and photographs showing the extent of glaciers during 1977-1982.

Regional maps of the 4 study areas and Landsat images are formatted to display in Google Earth. Zips of kmz files are at the bottom of this page. Download the zip, open the kmz and the GIS layers will display in Google Earth. You can fade the map over the image. At each glacier there will be a posting with a ground photograph from 1977-1982 and physical characteristics listed.

Jim hopes some energetic earth scientists are able to take a hike and revisit some of these glaciers, moraines, and rock glaciers to find out what is happening to these landforms as the 21st Century evolves. Resurveying the 6 Holocene Glacial landforms would provide accurate information on landform changes over the past ~30 years. In 1978 we found relict vegetation emerging from the toe of a retreating glacier. The vegetation was dead, buried during a glacial advance ~1150 years ago. Time is running out for scientists to find relict vegetation emerging from the rapidly disappearing (?) glaciers in the Brooks Range.

1979 Buffalo Glacier

1970 and 1980 Buffalo Glacier

1980 Buffalo & Marmot Glaciers on 1000 Landsat

Atigun Pass Glaciers GoogleEarth 18MB kmz

Anabuvuk Pass Cirques 5MB kmz

Amigetch Peaks, Brooks Range Glaciers

NE Brooks Range Moraines

Website

THIS WEBSITE
REPLACED IN
APRIL 2022

SAME ADDRESS
AS BELOW

www.ellis-geospatial.com

Website screenshot showing the Ellis GeoSpatial website interface. The browser address bar displays <http://www.ellis-geospatial.com/brooksrange/download1982dissertation>.

The website header includes "Ellis GeoSpatial" and "Imaging & Mapping Solutions". A navigation menu on the left lists: HOME, SERVICES, EXPERIENCE, CASE HISTORIES, BUSINESS, and BROOKS RANGE.

A table of links is displayed:

Download 1982 Dissertation	1978-1987 Publications	Glacier Change Photos	Map of Showing Field Sites	1979 Lurble Dunes Map
1979-80 Brooks of Dunes	1979 Grassy Dunes Map	1980 Grassy Dunes map	1979 Jager Dunes Map	1979 Pike Dunes Map

The main content area features the heading: "1982 Dissertation discussing the Holocene Glaciation of the Central Brooks Range, Alaska - download it today!"

A photograph shows a glacier (Cirque Glacier) perched on folded-faulted rock.

Below the photo, text describes the 390-page dissertation, a compilation of field, lab, and statistical work done between 1977 and 1982. The field areas include the Abigun Pass area, Anaktunuk Pass, and Anigetch Peaks. The topics include:

- 1) Geographical Setting and Climate
- 2) Methods
- 3) Glaciers, NeoGlacial Moraines, and Rock Glaciers
- 4) Development of a Holocene Glacial Chronology
- 5) Climatic Analysis of Cirque Glaciation

Appendices A - J
Figures 1 - 50
Tables 1 - 15

Unpublished 1978-1980 survey maps of 3 glaciers & 2 glacier-cored rock glaciers in the Abigun Pass area are provided on other website pages.

In addition, eight Holocene valley glacier moraines in the rugged northeastern Brooks Range were areas mapped and photographed in 1981. The areas mapped and photographs will be provided as GoogleEarth overlays & postings in the near future. These maps & photographs have not been published.

A PDF icon is shown, representing the "Ellis 1982 Dissertation - Central Brooks Range Holocene Glaciers 30MB zip".

Three small photographs are displayed at the bottom:

- Dall Sheep near Abigun Pass
- Caribou under TAPS, Abigun Valley, Summer 1979
- A child holding a stick.

Website

**THIS WEBSITE
REPLACED IN
APRIL 2022**

**SAME ADDRESS
AS BELOW**

www.ellis-geospatial.com



Website

**THIS WEBSITE
REPLACED IN
APRIL 2022**

**SAME ADDRESS
AS BELOW**

www.ellis-geospatial.com

The screenshot shows a web browser window with the address bar displaying <http://www.ellis-geospatial.com/brooksrange/1979buffalosurveymap.htm>. The website has a blue header with "Ellis GeoSpatial" and "Imaging & Mapping Solutions". A left sidebar contains a navigation menu with buttons for HOME, SERVICES, EXPERIENCE, CASE HISTORIES, BUSINESS, and BROOKS RANGE. The main content area features a table of links, a map of Buffalo Glacier, and a grid of photos.

Download 1982Dissertation	1978-1987 Publications	Glacier Change Photos	Maps Showing Field Sites	1979 Buffalo Survey Map
1979-80 Marmot Survey Map	1978 Grizzly Survey Map	1980 Grizzly Survey map	1978 Jaeger Survey Map	1978 Pika Survey Map

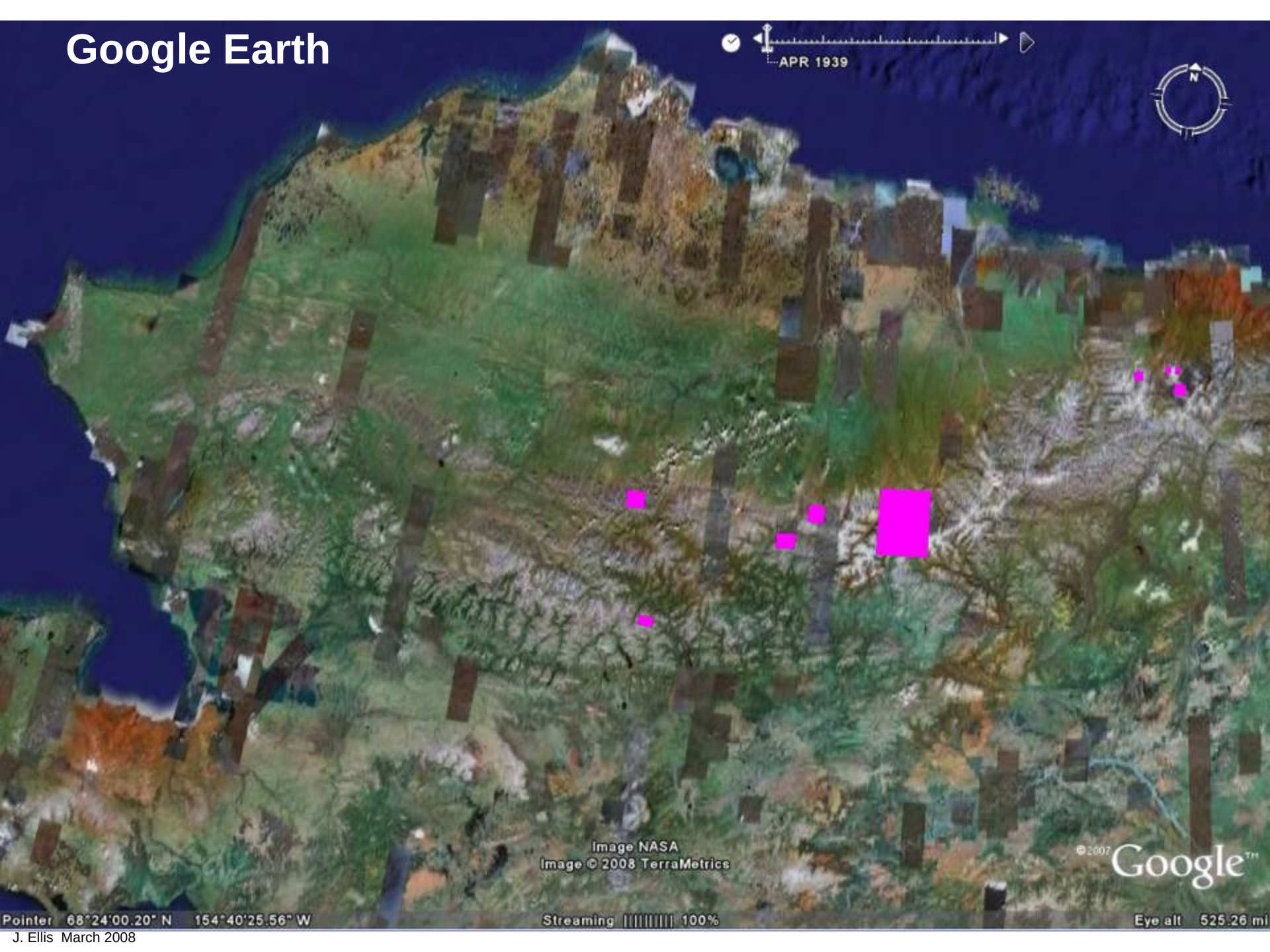
1979 Survey Map of Buffalo
Glacier

[Download 9 MB jpg of Buffalo Glacier Survey Map \(thumbnail image above\)](#)

1977-1981 Annual
Ice Ablation (melt)

9 Aug 1978 Buffalo Glacier	9 Aug 1978 Buffalo Glacier	28 Jul 1979 Buffalo Glacier
26 Jul 1977 Buffalo Glacier	12 June 1978 Buffalo Glacier	25 Jul 1977 Buffalo Glacier

Google Earth



APR 1939



Image NASA
Image © 2008 TerraMetrics

© 2007 Google™

Pointer 68°24'00.20" N 154°40'25.56" W

Streaming ||||| 100%

Eye alt 525.26 mi

J. Ellis March 2008

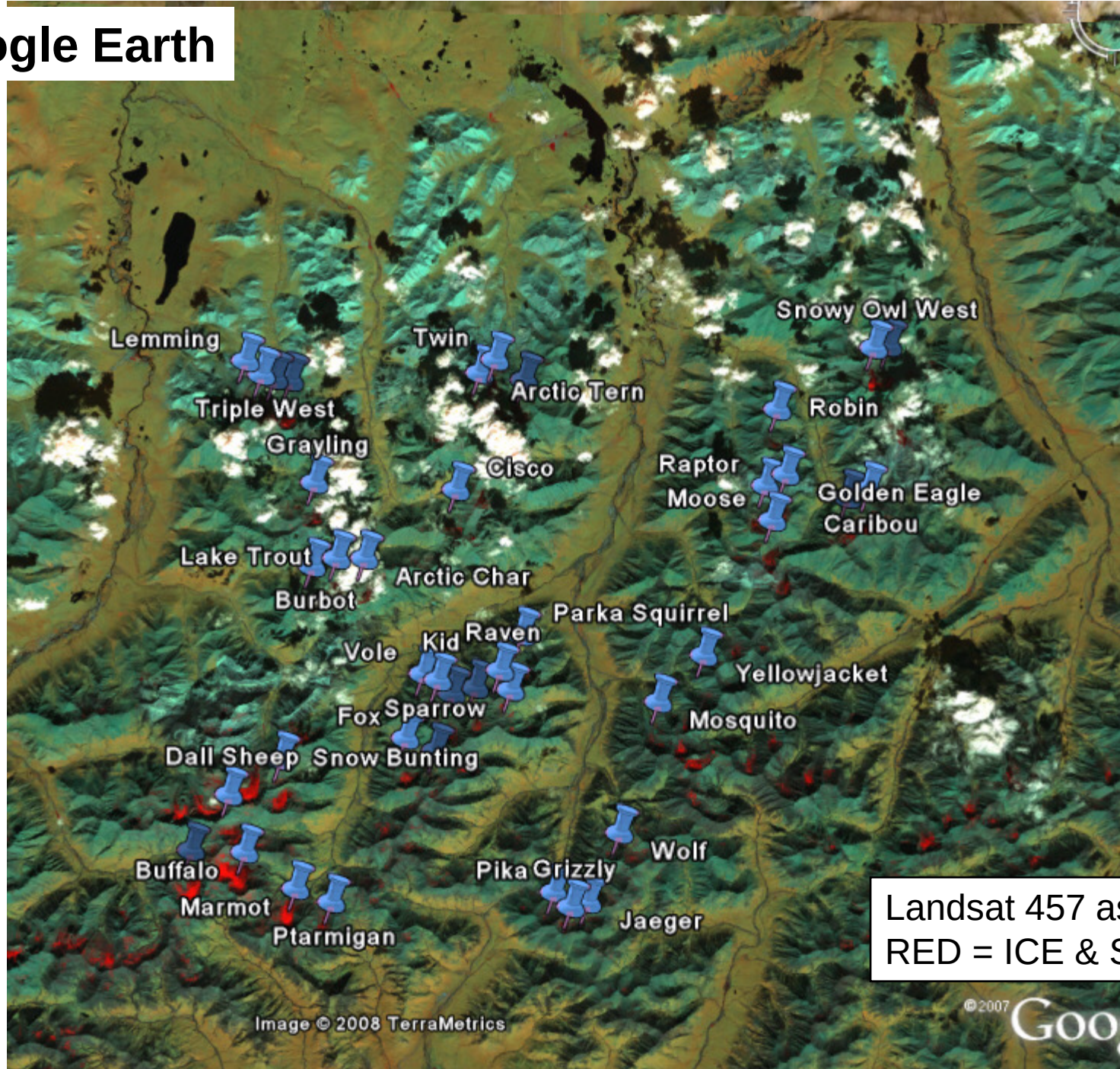


Itikmalakpak - A Triple West Snowy Owl East
Itikmalakpak - B
Inukpasagruk - A Buffalo Ptarmigan
Arrigetch - 11
Arrigetch - 1

Image NASA
Image © 2008 TerraMetrics

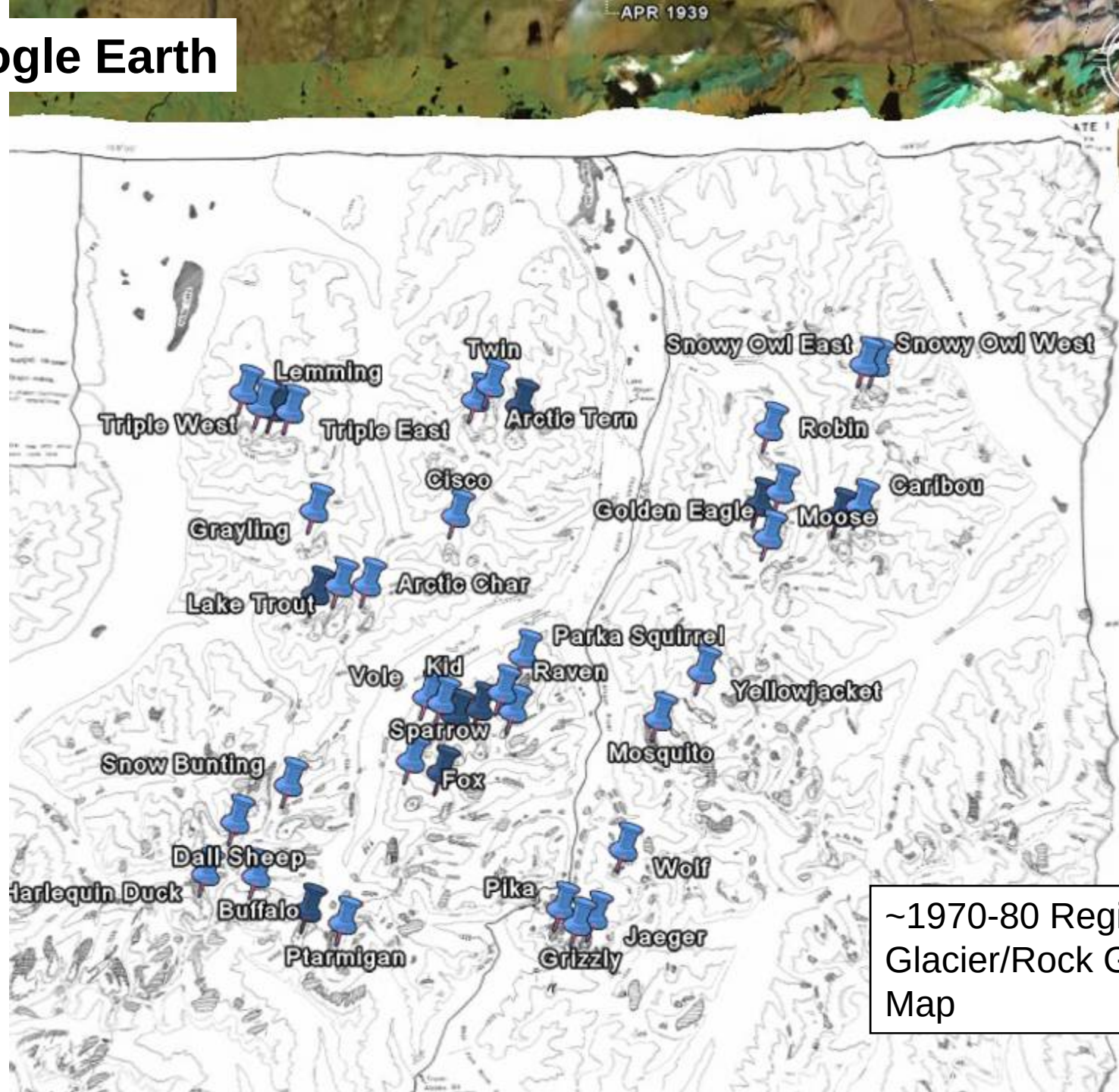
© 2007 Google™

Google Earth

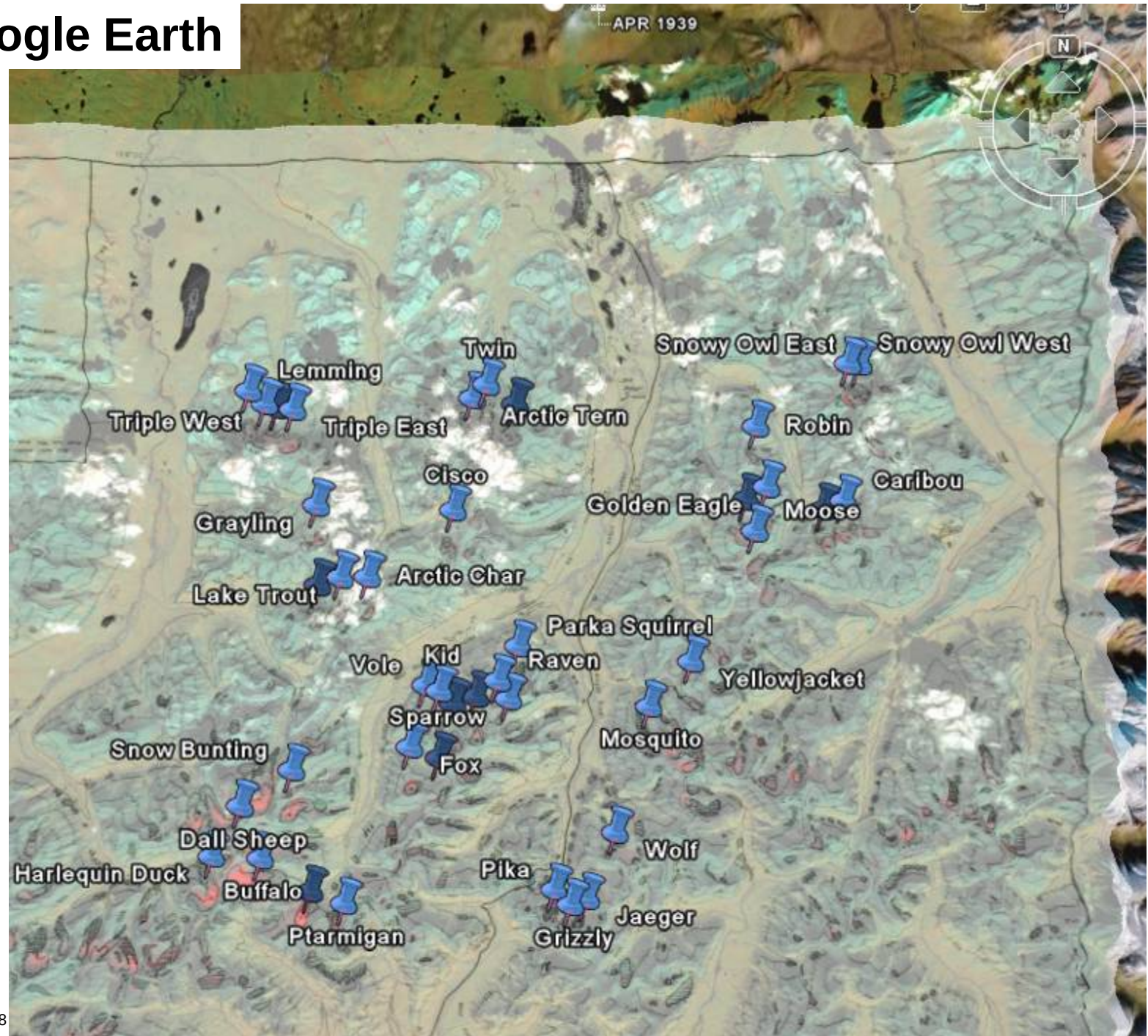


Landsat 457 as RGB
RED = ICE & SNOW

Google Earth



Google Earth

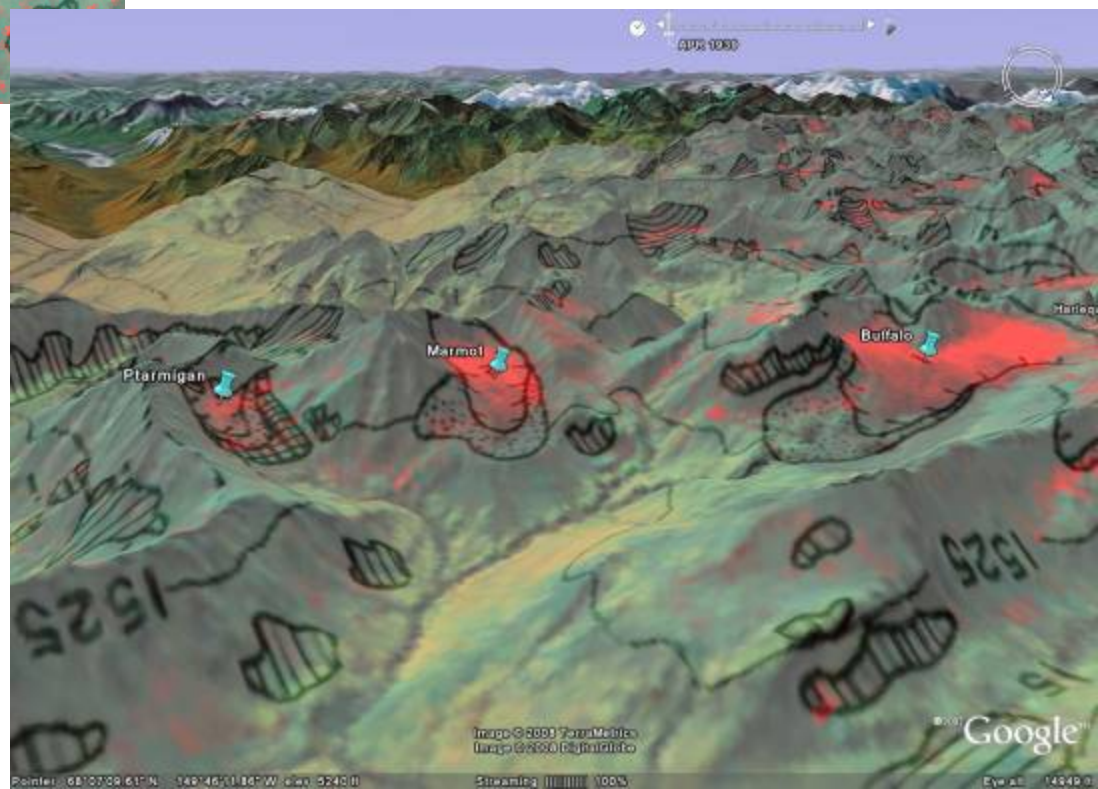


Google Earth

1999 Buffalo & Marmot Glaciers

With 1970-80 Regional Map

Landsat 457 as RGB
RED = ICE & SNOW



Google Earth



Marmot

Cirque glacier
Brooks Range, Alaska



2. MARMOT (view S)
30 JUNE 1979

Data

(Determined from 1970 USGS aerial photographs; 1977-82 fieldwork)

Glacier area: 0.62 km²

Neoglacial area^a: 1.08 km²

Neoglacial expansion: 74 %

Mean glacier altitude: 1650 m

Glacier length: 1430 m

Glacier relief: 250 m

Present past slope^b: 10/9 °

Head Wall^c: 150 m

^aDetermined from lichenometric mapping and geomorphology.

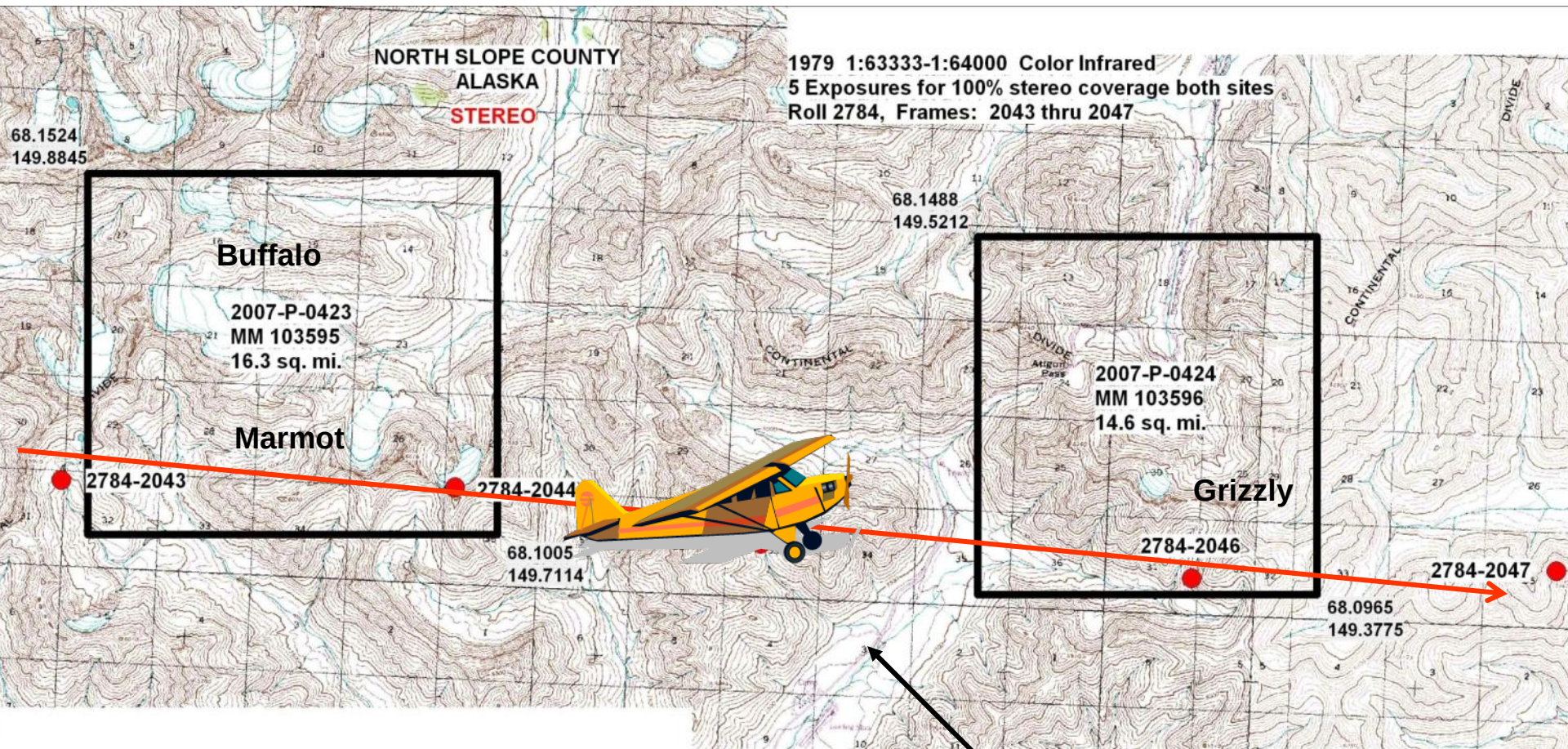
^b Determined as $\tan(\text{slope angle}) = (\text{Glacier relief})/(\text{Glacier length})$ for 1970 glacier surface and Neoglacial maximum surface.

^c Estimated height of bedrock exposed in cirque cliffs (potential debris supply).

Directions: [To here](#) - [From here](#)

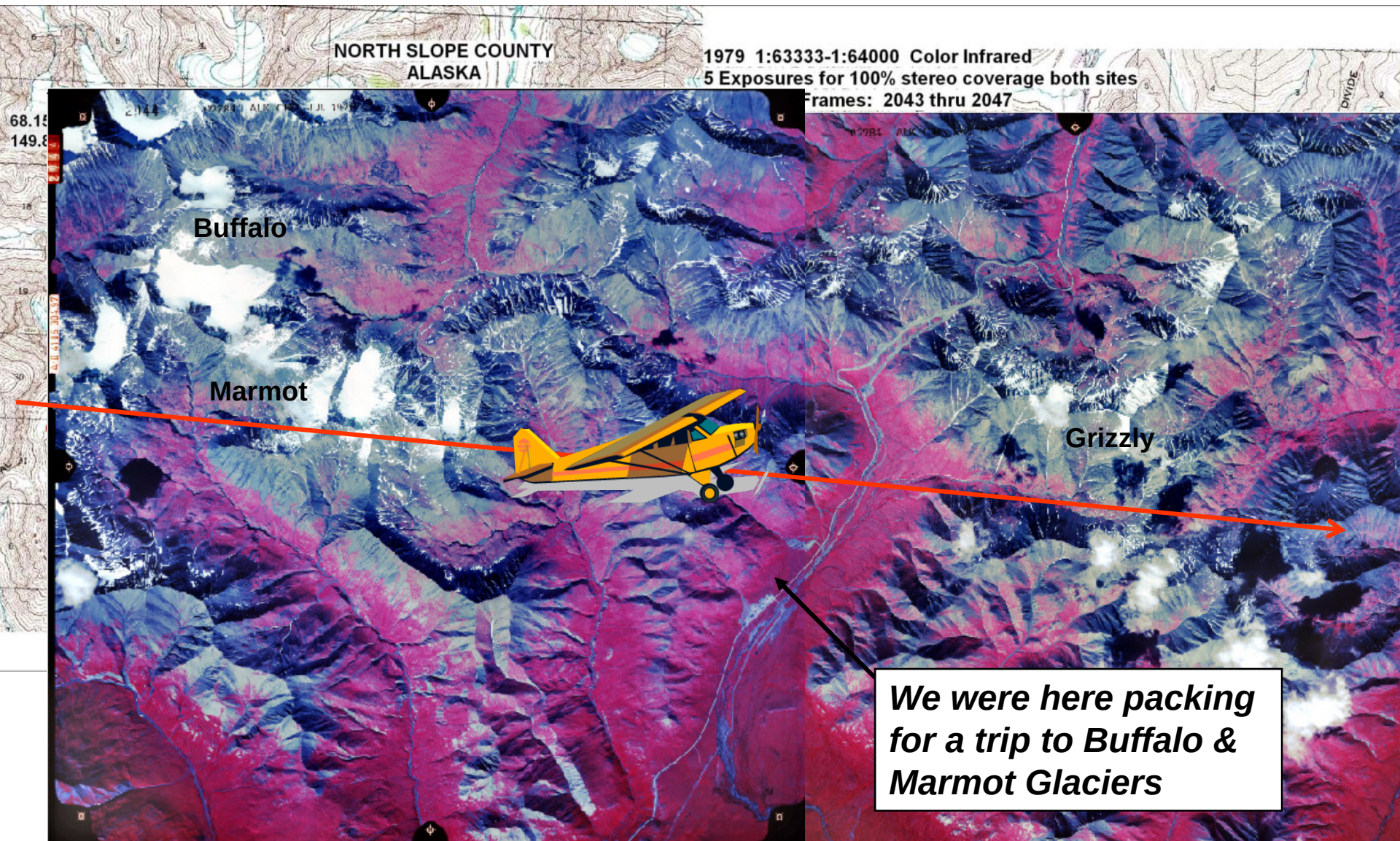
Image © 2008 TerraMetrics
Image © 2008 DigitalGlobe

Airphotos Acquired by USGS on 24 July 1979!



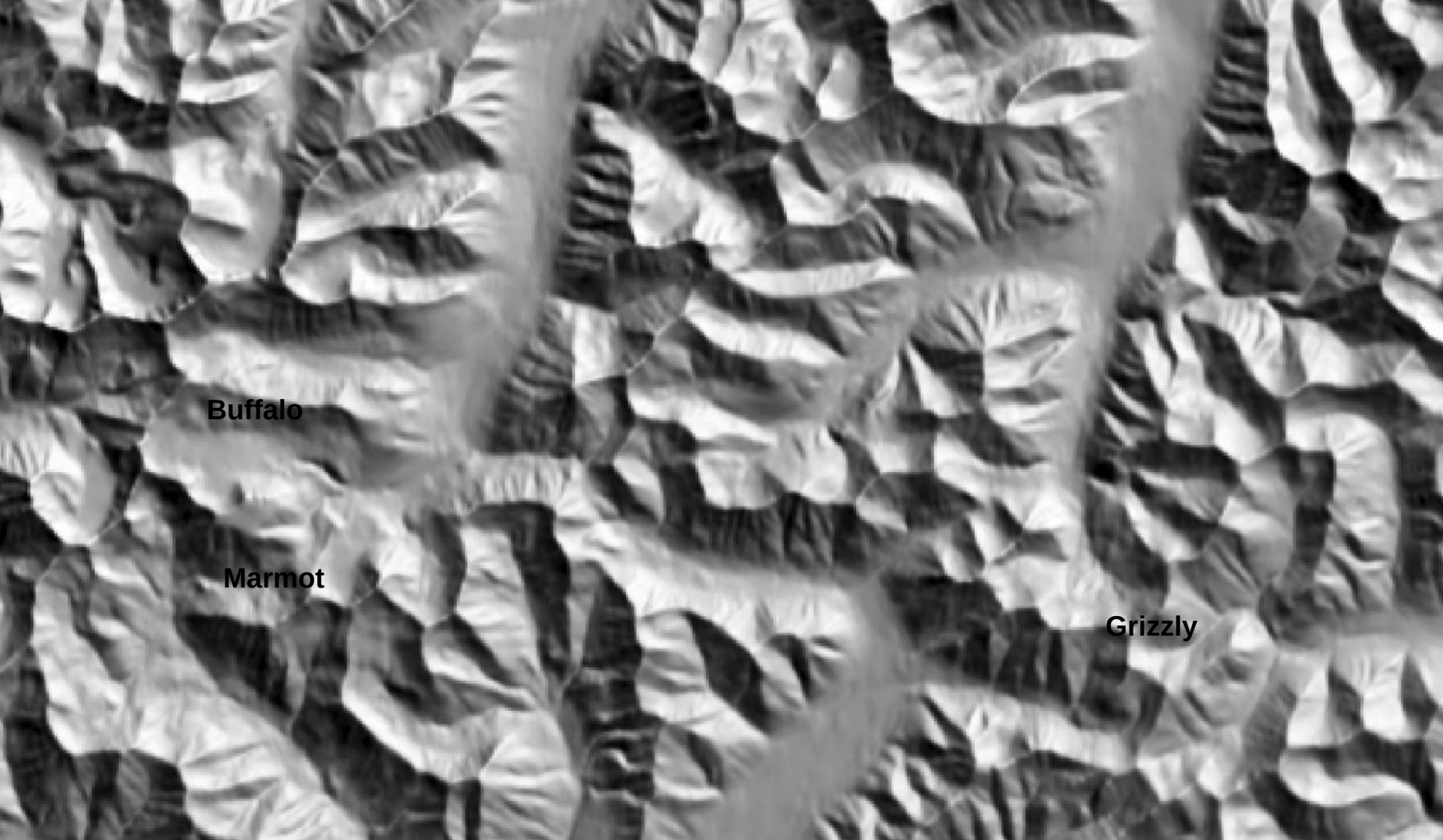
*We were here packing
for a trip to Buffalo &
Marmot Glaciers*

USGS Overlapping CIR Air Photos 1:64,000 on 24 July 1979



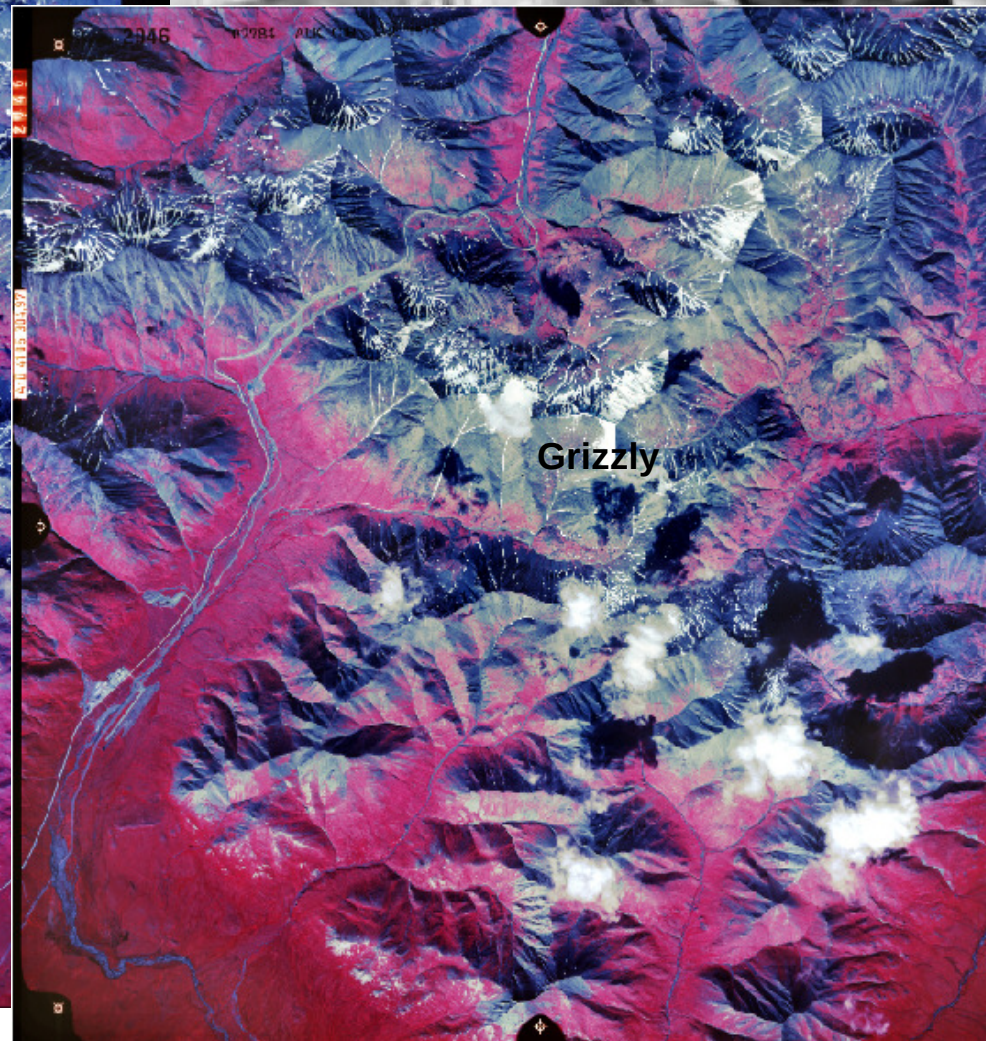
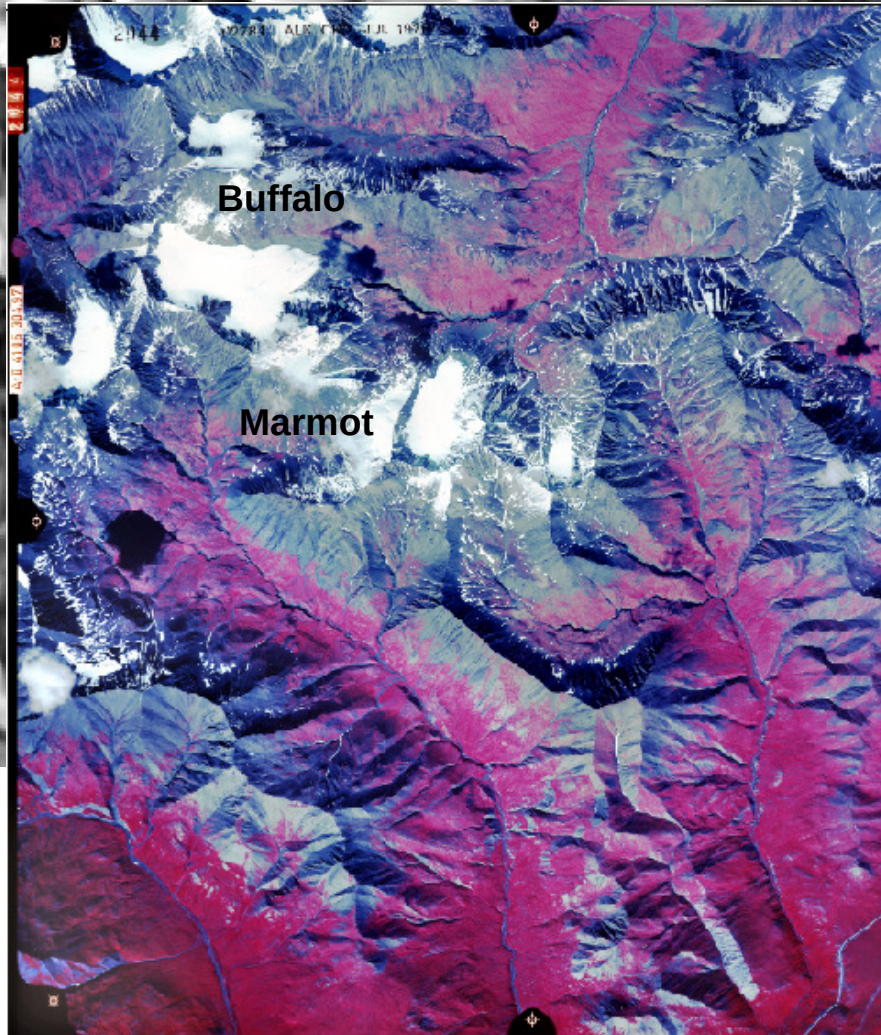


Now the DEM used for the USGS Topo Sheets is Available

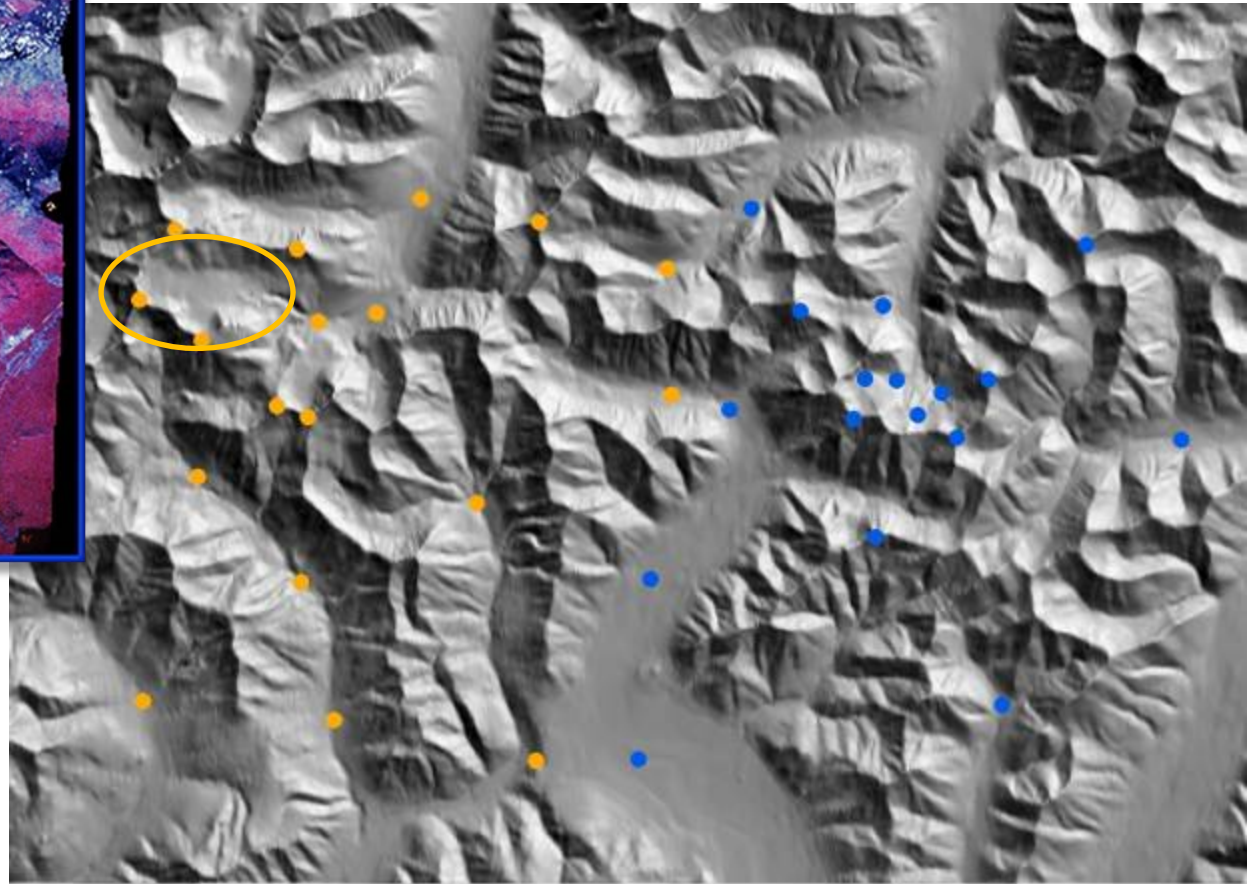
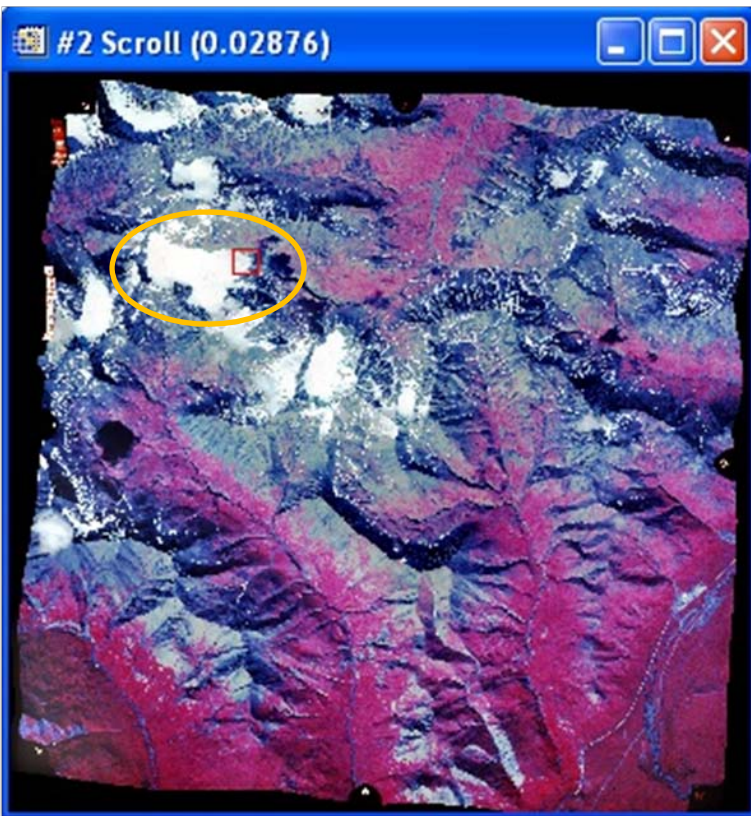


USGS 50-m DEM

Let's Orthorectify the 1979 Airphotos Using the USGS DEM

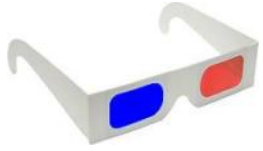


Orthorectify the 1979 Airphotos – Buffalo Glacier



*Minimize mapping error
due to elevation & lens
distortion*

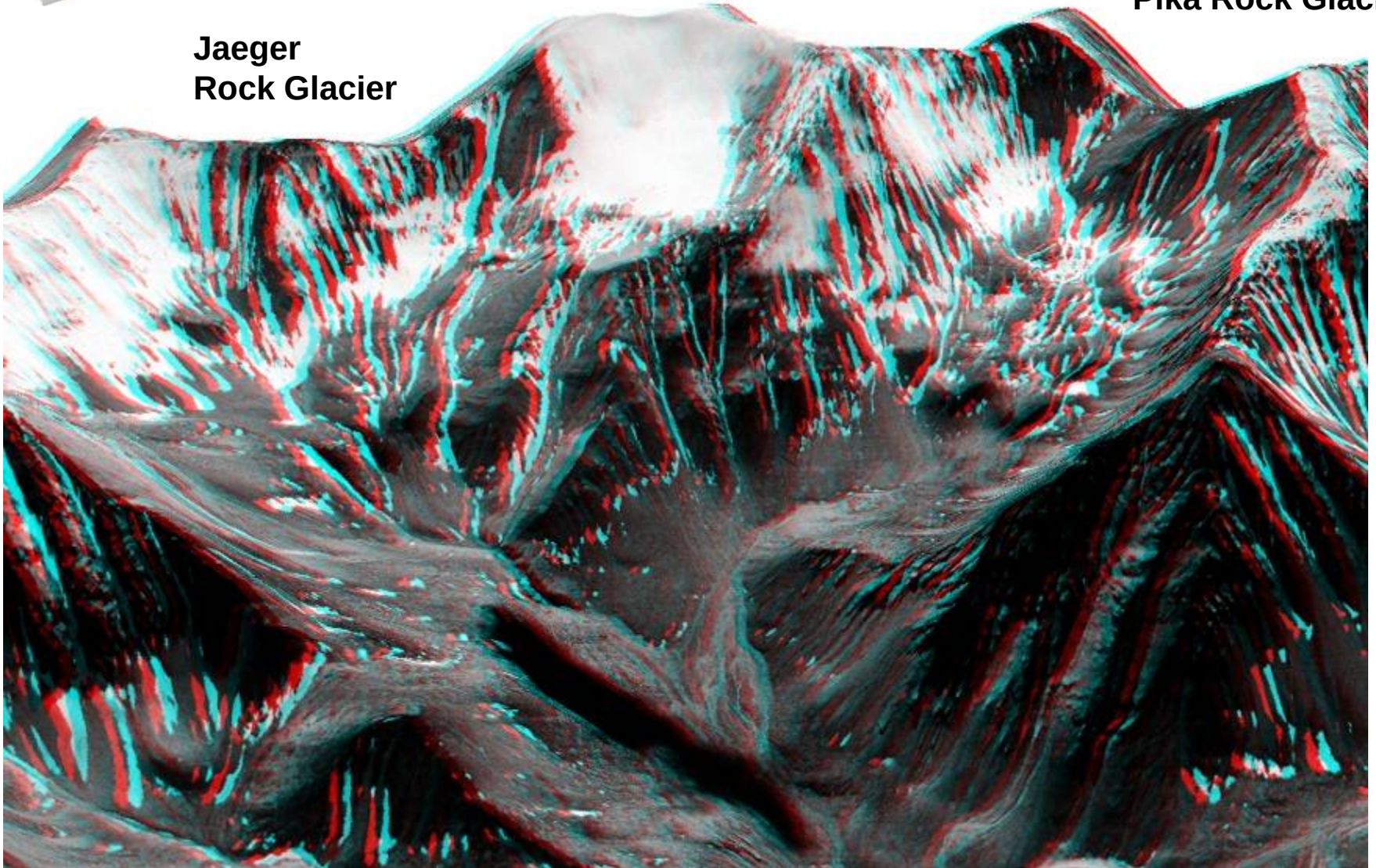
With a DEM, we can look at the 1979 landforms in 3D perspective

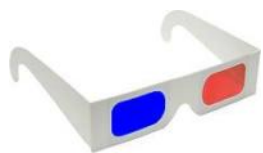


Grizzly Glacier

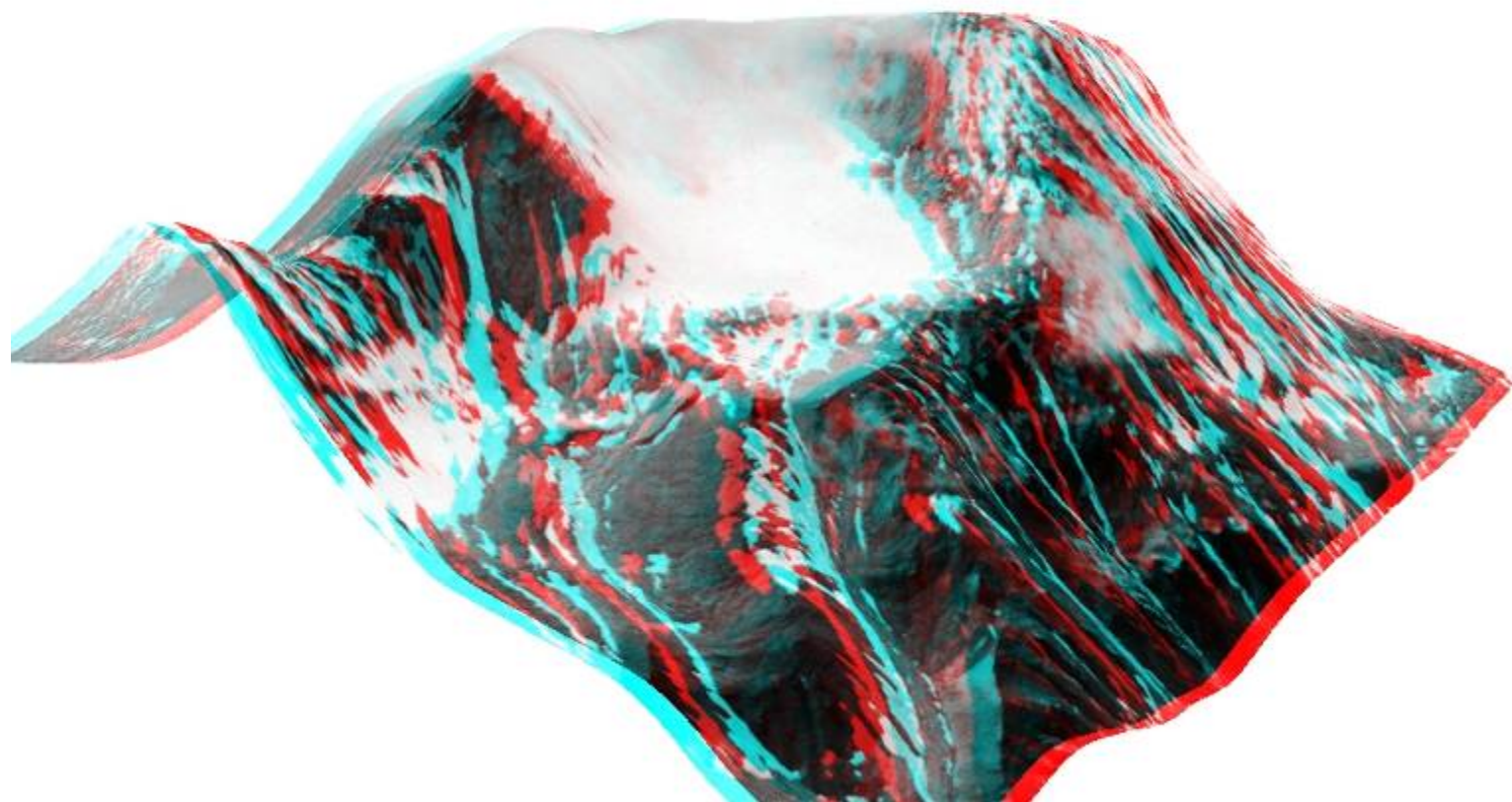
Pika Rock Glacier

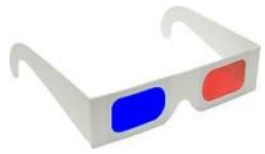
**Jaeger
Rock Glacier**





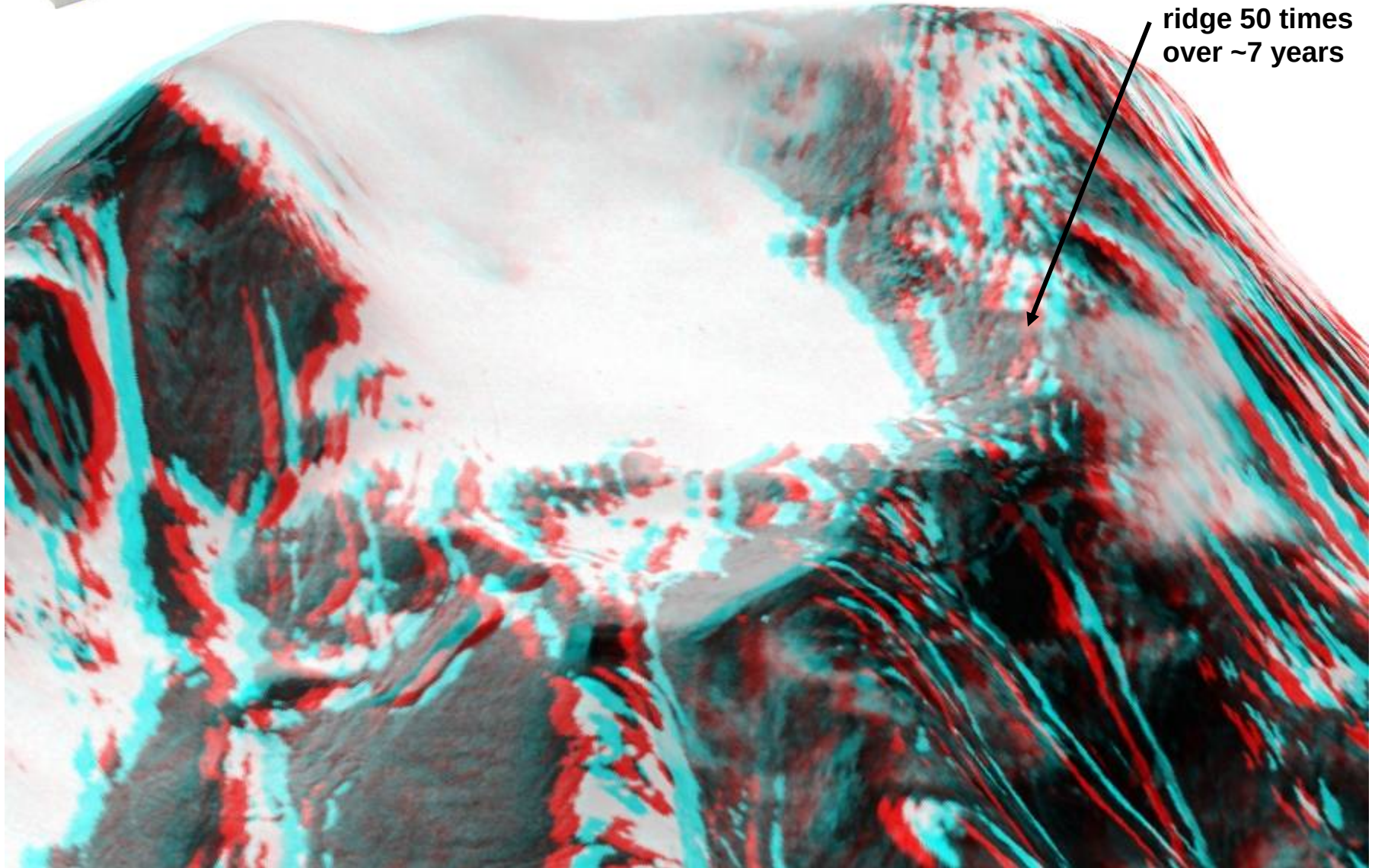
1979 Grizzly





1979 Grizzly

Parker probably
hiked up on this
ridge 50 times
over ~7 years



**How good is the
orthorectification??**



1979

Orthorectified 1.5 m Airphoto



2006

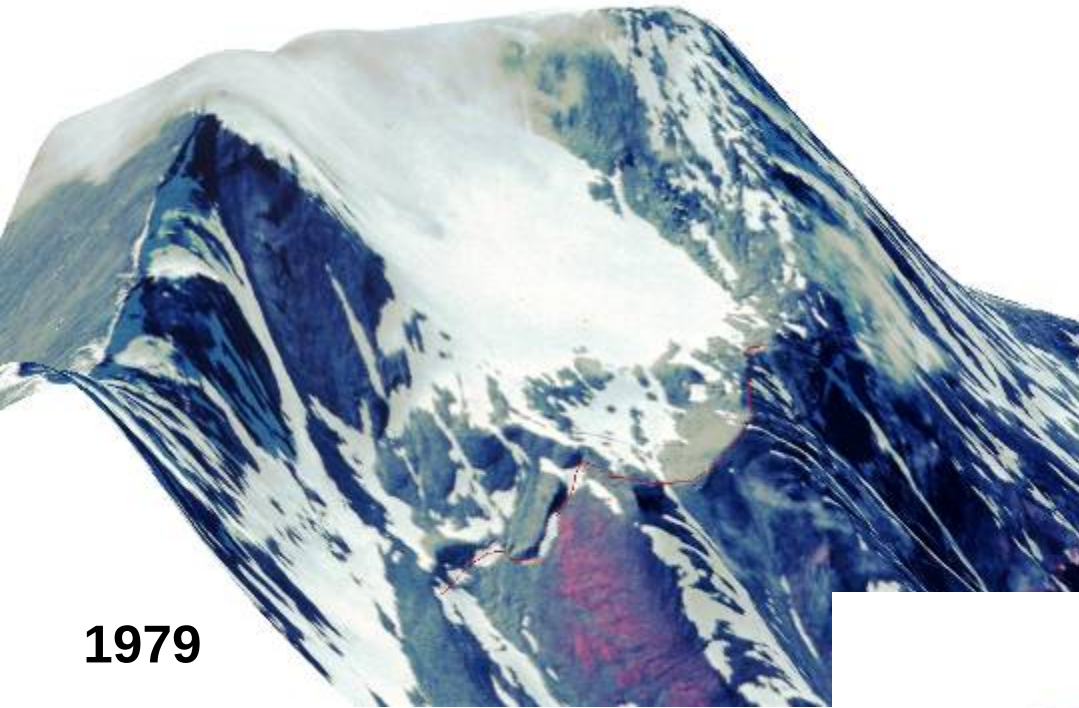
Orthorectified 0.6 m Quickbird image

Change Detection at Grizzly Glacier

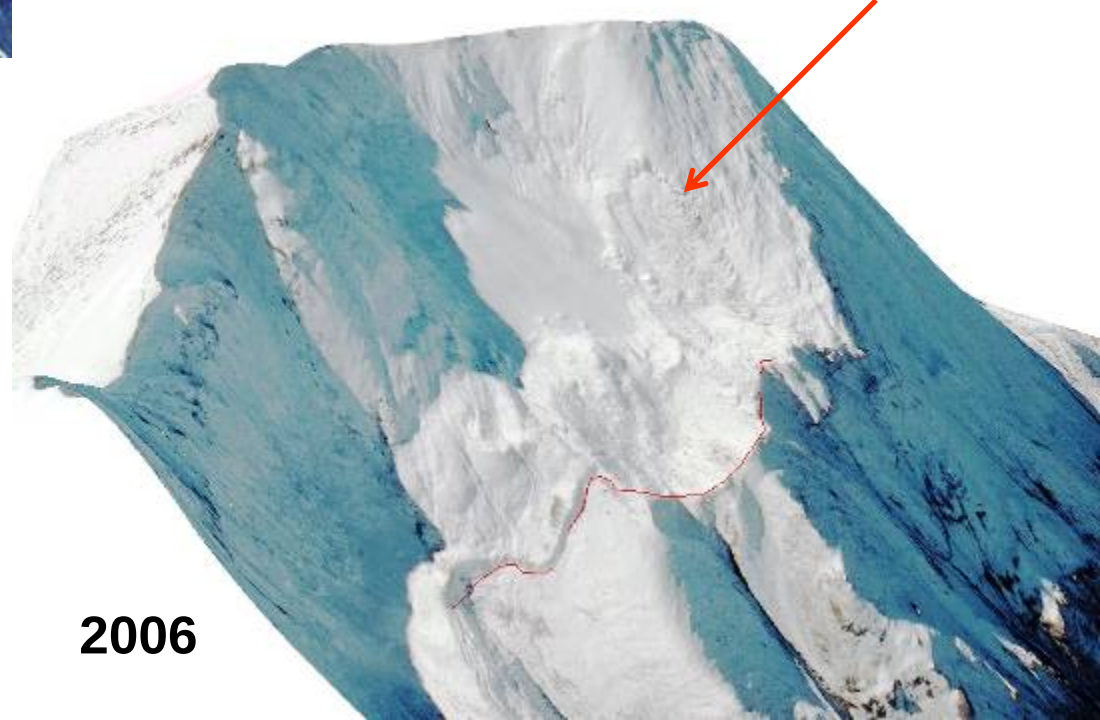
**Accuracy & x,y,z
resolution depends
on DEM**

*(here 50m resampled
to 10m grid)*

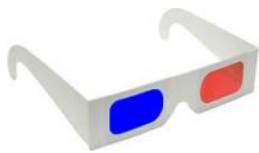
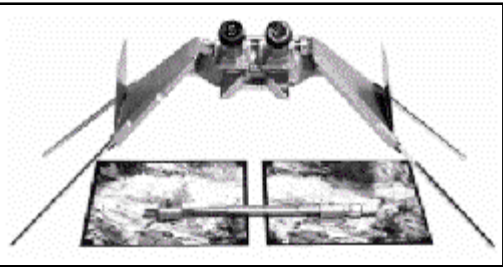
1979



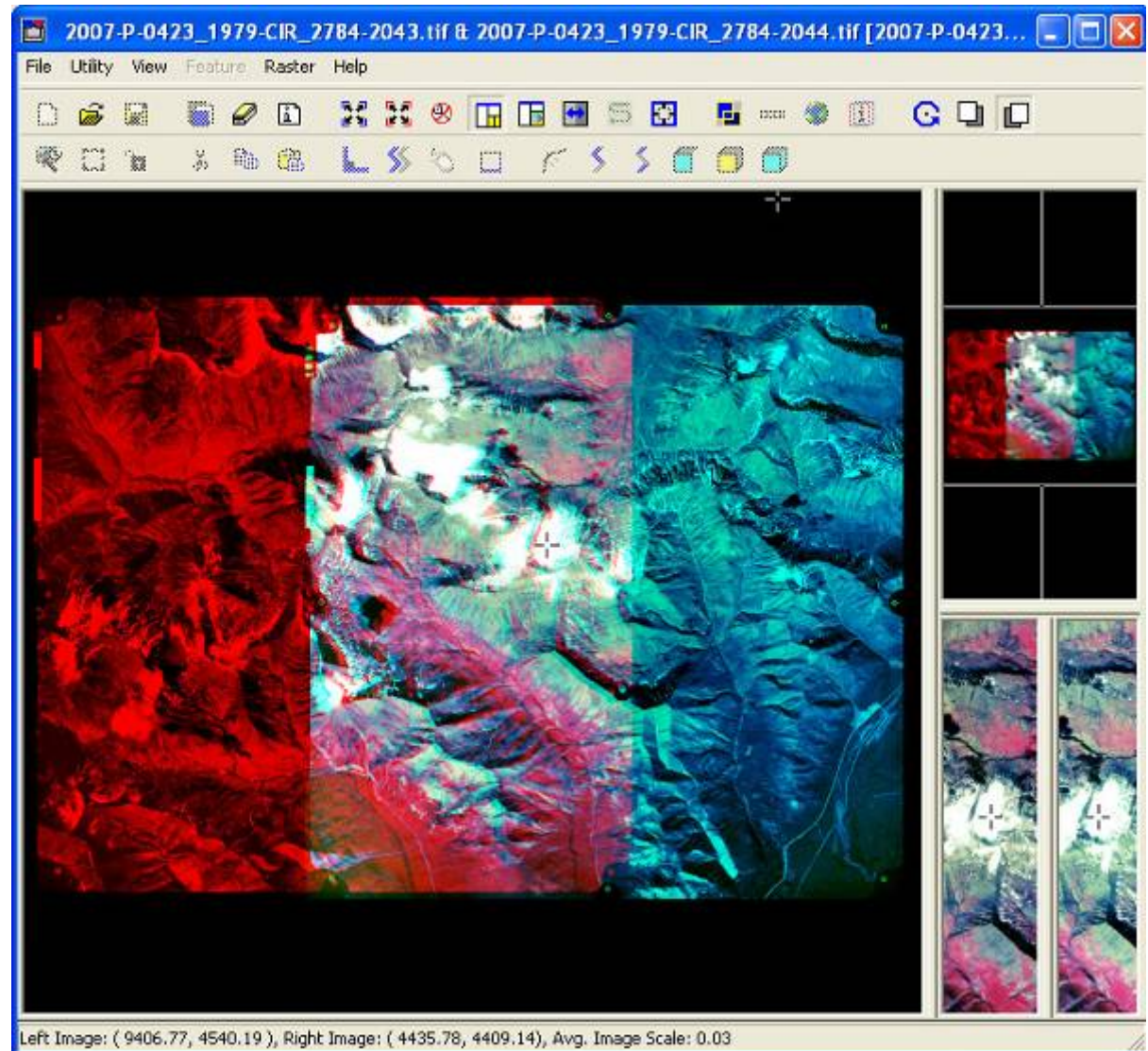
2006



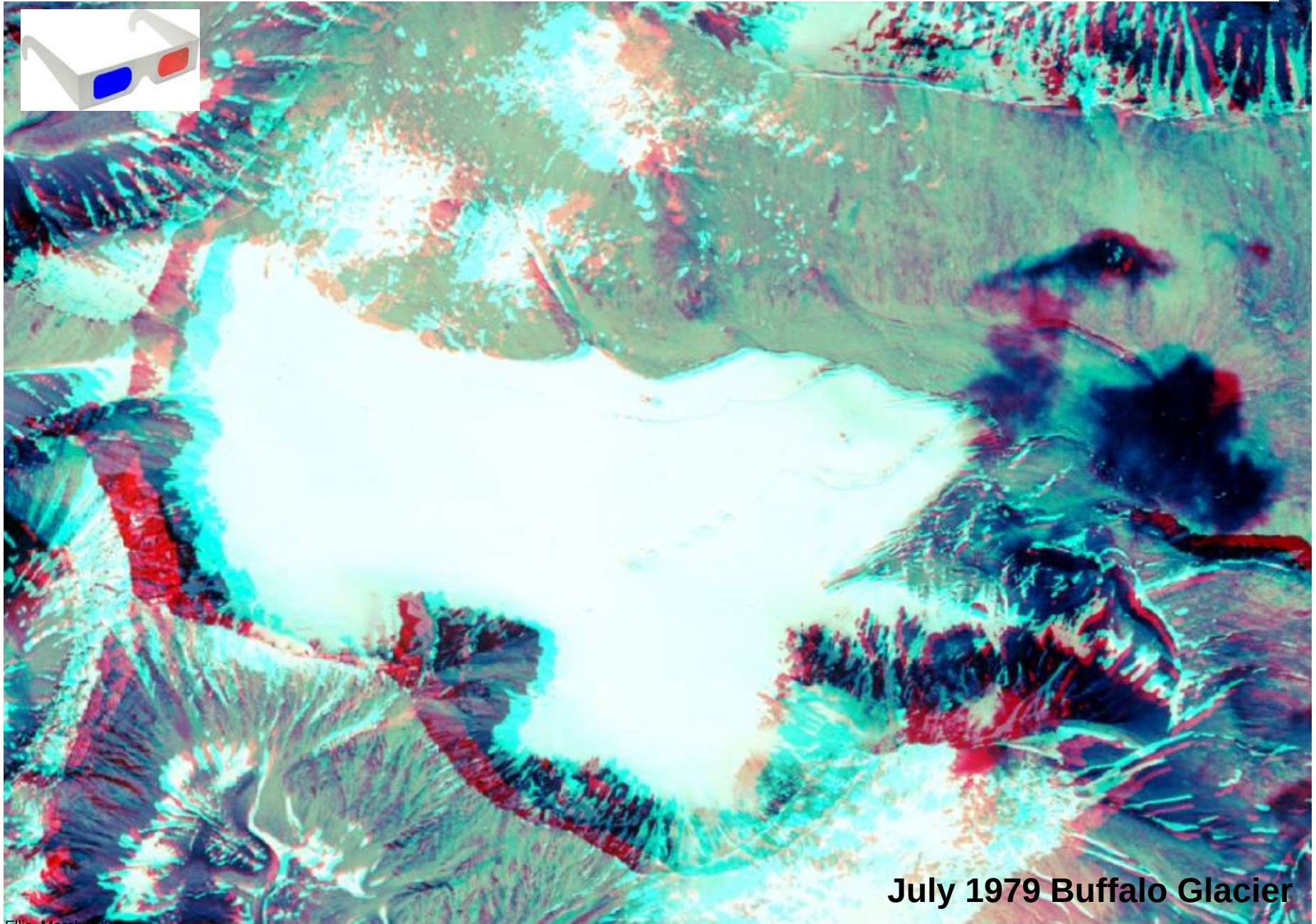
Stereo mapping of overlapping ~1979 airphotos enables *detailed* mapping of moraines ridges, etc.



Softcopy
Photogrammetry

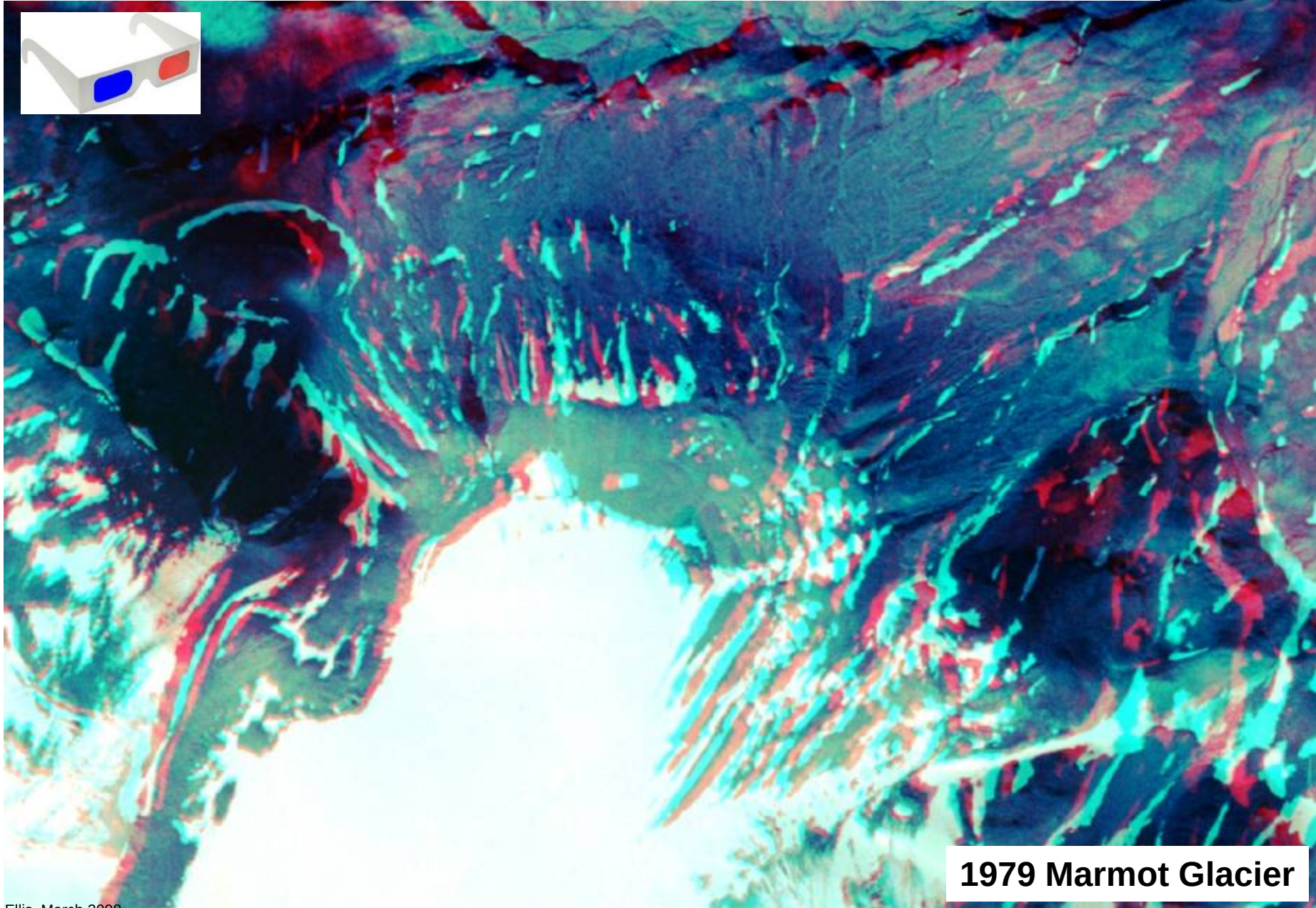


View 1979 Buffalo Glacier in 3D – see more detail than on DEM?



July 1979 Buffalo Glacier

Yes, Stereo Airphotos support detailed 3D mapping!



1979 Marmot Glacier

3. Education & Research Opportunities

Education

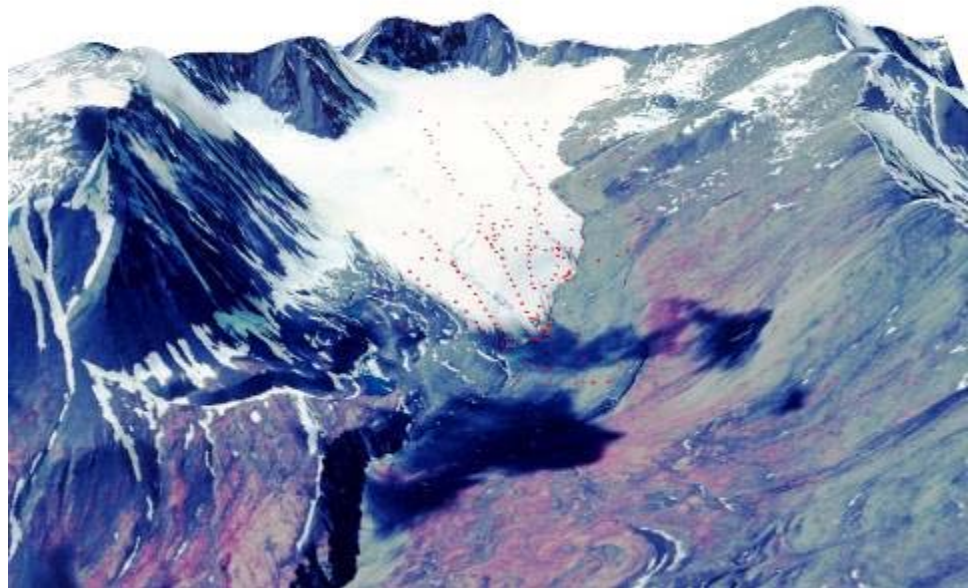
GIS

GeoPDFs

Research

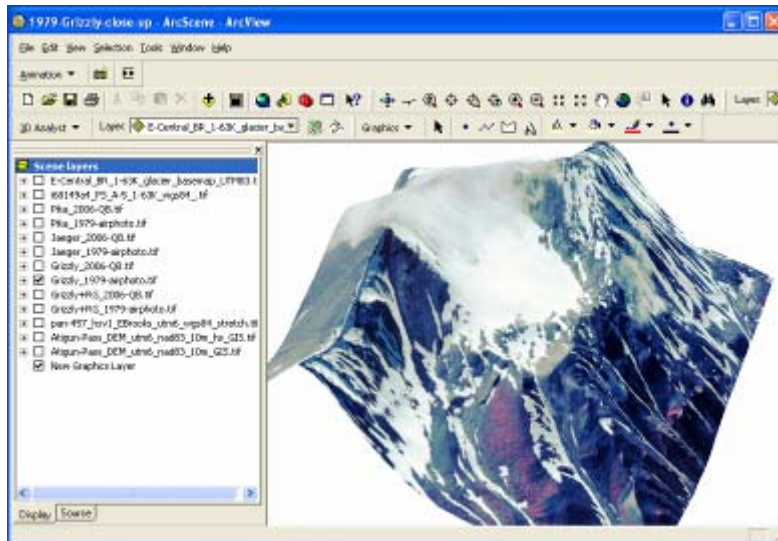
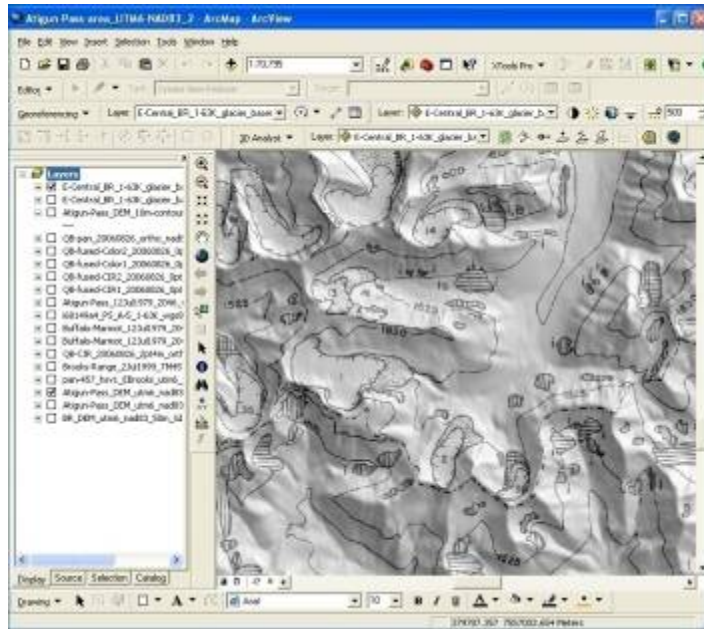
Lab

Field

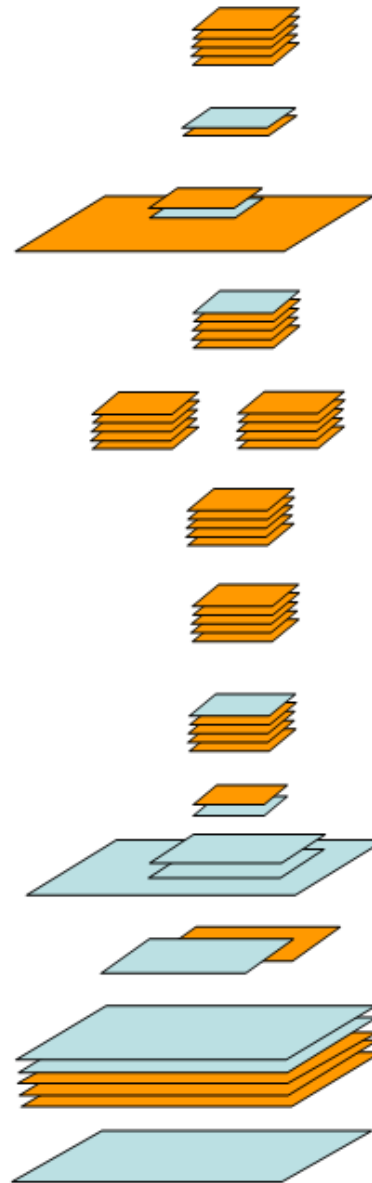


***Large-scale mapping to support new fieldwork only
tested at Buffalo Glacier.... so far.....***

Education - GIS



GIS Stack of Images & Maps for Brooks Range



New Interpretations

Glacial & Periglacial Landforms in GIS

Stereo Airphoto Anaglyphs

Mapping ridges on Neoglacial deposits



Stereo DTM Anaglyphs

Use USGS or Surveyed DTM; drape images on DTM



1978-81 Theodolite Survey Maps

Convert to GIS layer point files
contour, create TIN & DTMs

1977-1982 Lichenometry Maps

Convert to accurate GIS shapefiles

1978-82 Physical Measurements

Screening, soils, mass balance, etc.
Support GIS Spatial Analysis

GPS, Alyeska TAPS, Other Research

photoidentifiable GCPs, weather records,
Atigun Pass maps & images, etc.

Historic Aerial Photographs

Orthorectified Base Images for 1979

2006-2008 Quickbird Imagery

0.6 fused color, orthorectified

USGS 1:63K Topo Maps

Landsat Imagery – 15 m fused

1999-2001 RED=ice/snow

Regional Landsat Imagery 30-m

1999-2001 color satellite image

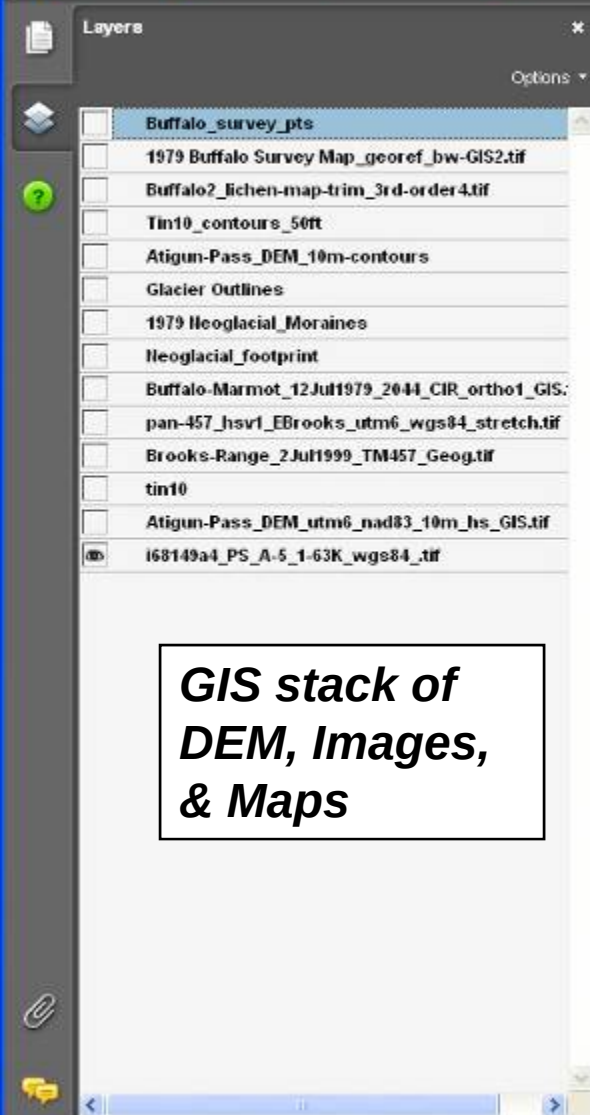
Regional USGS 30-m DTM (National Elevation Data)

Preliminary GIS is 3.6 GB

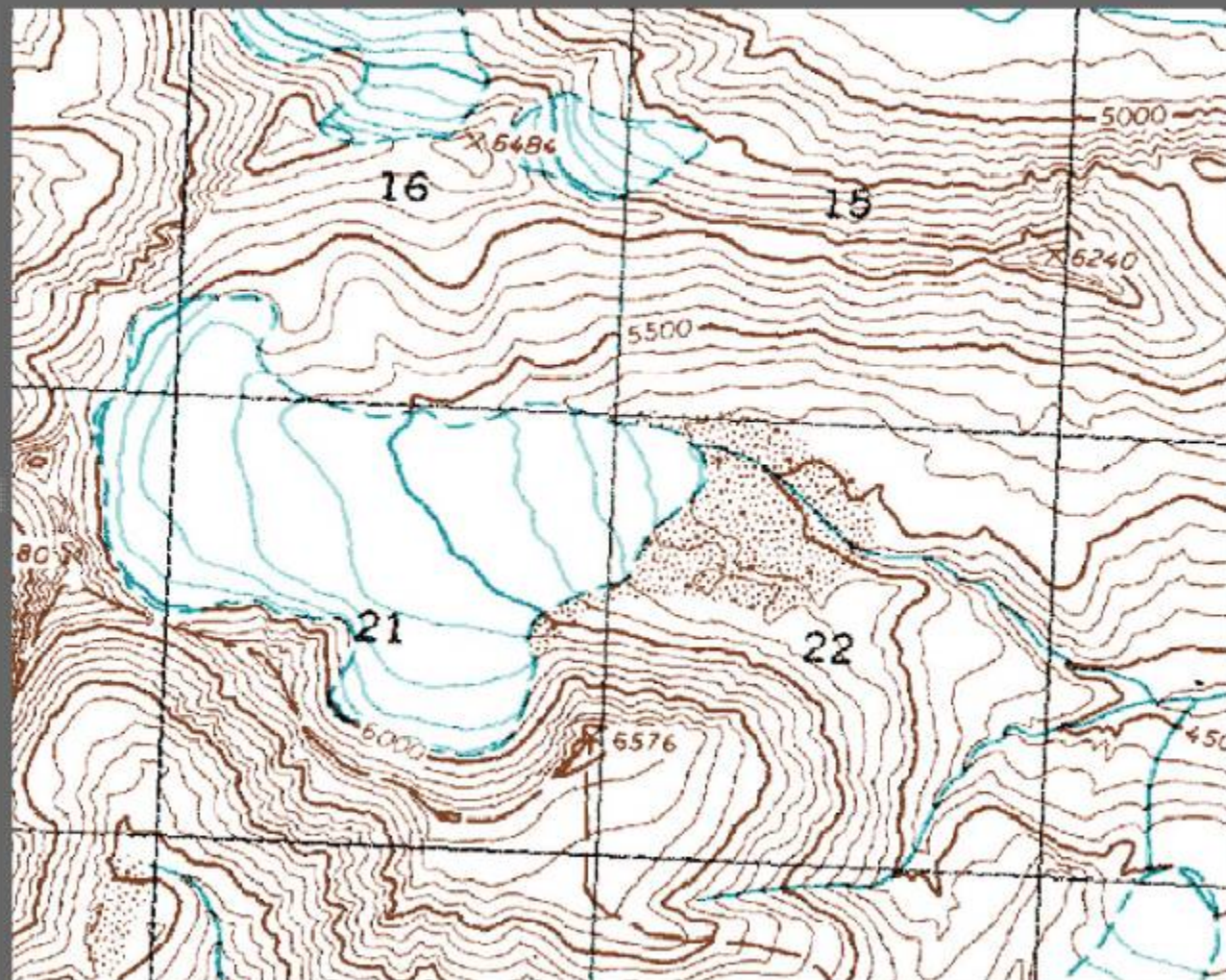
DONE

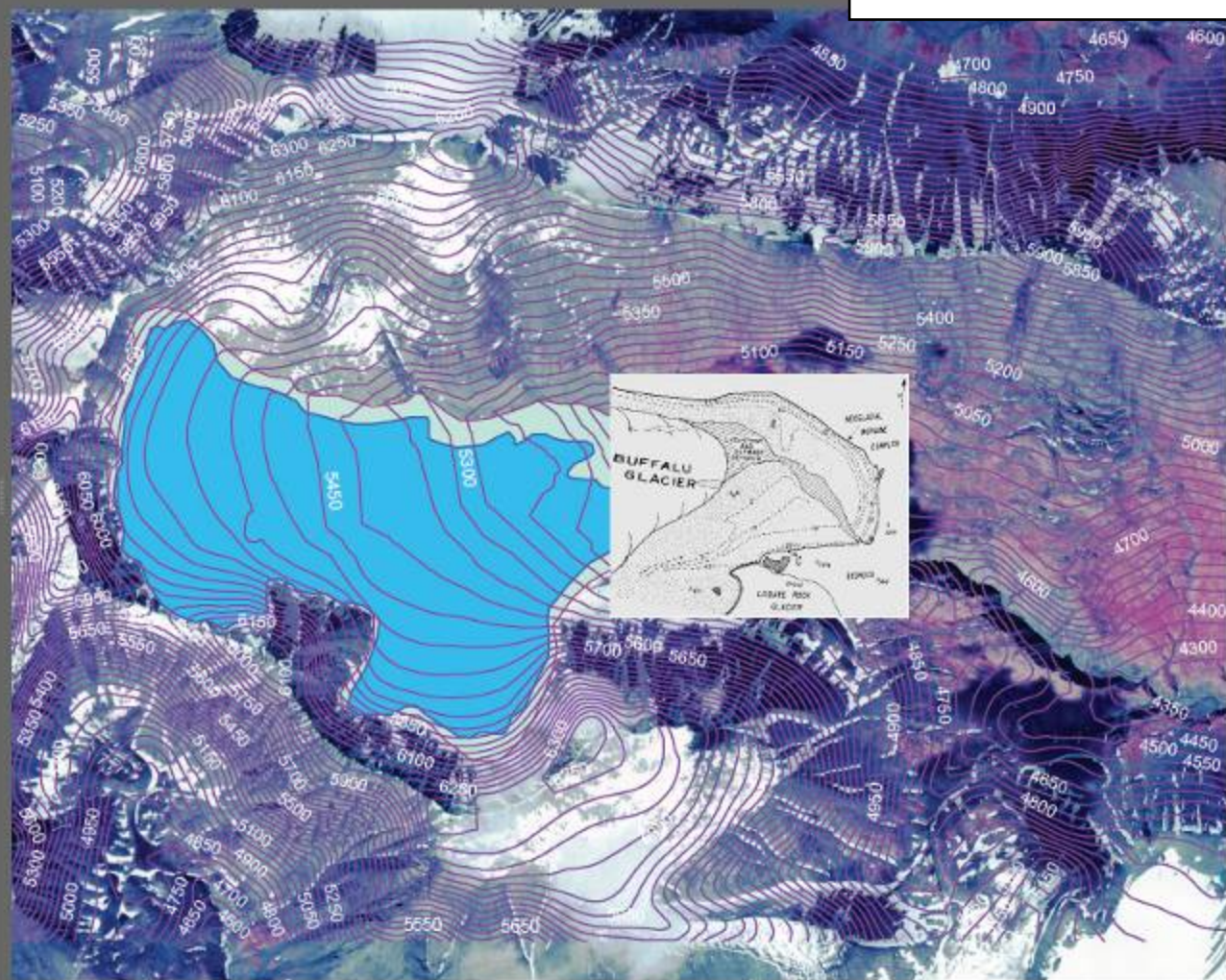
PLANNING

Education: GIS → GeoPDFs



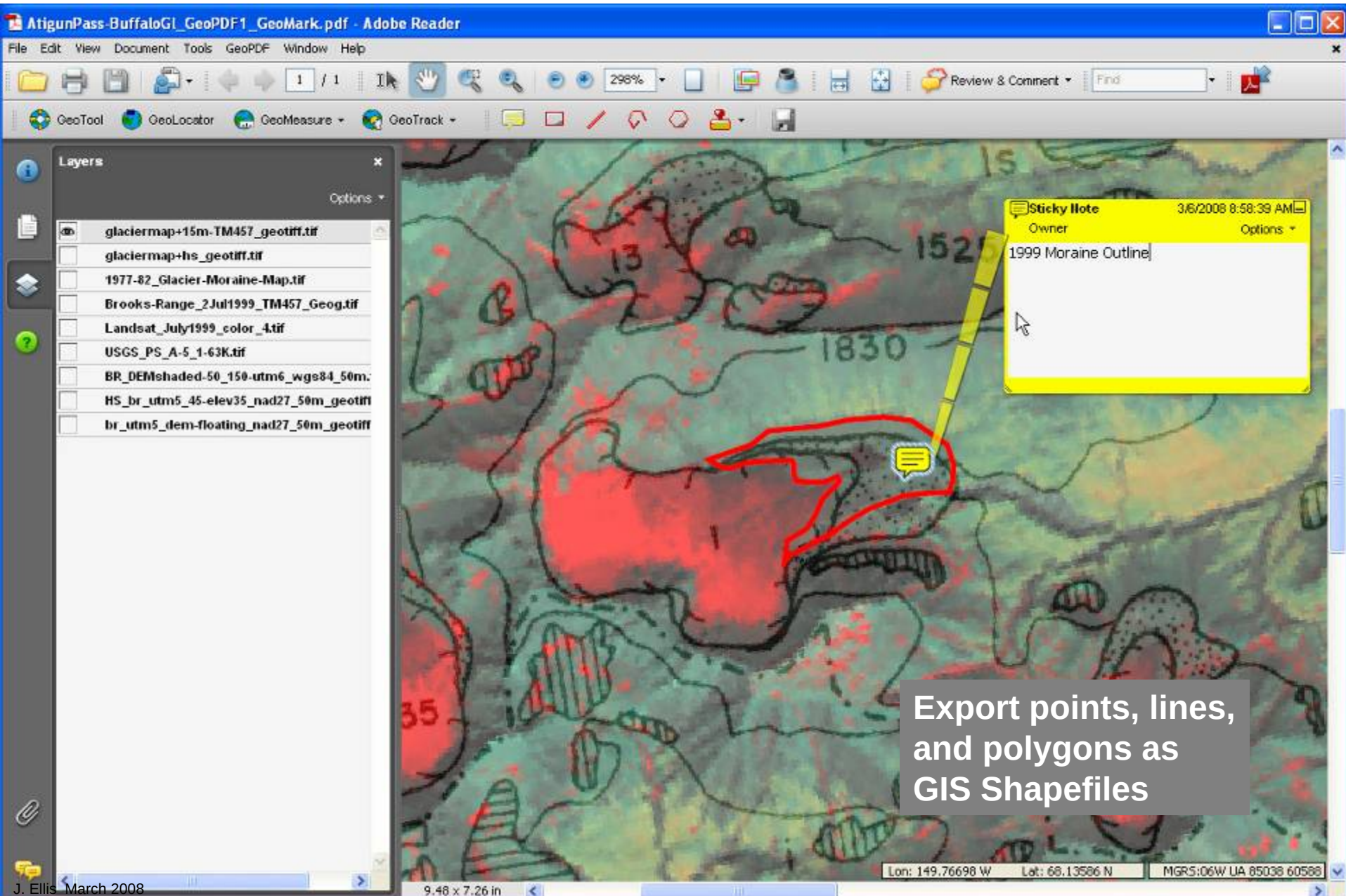
*GIS stack of
DEM, Images,
& Maps*



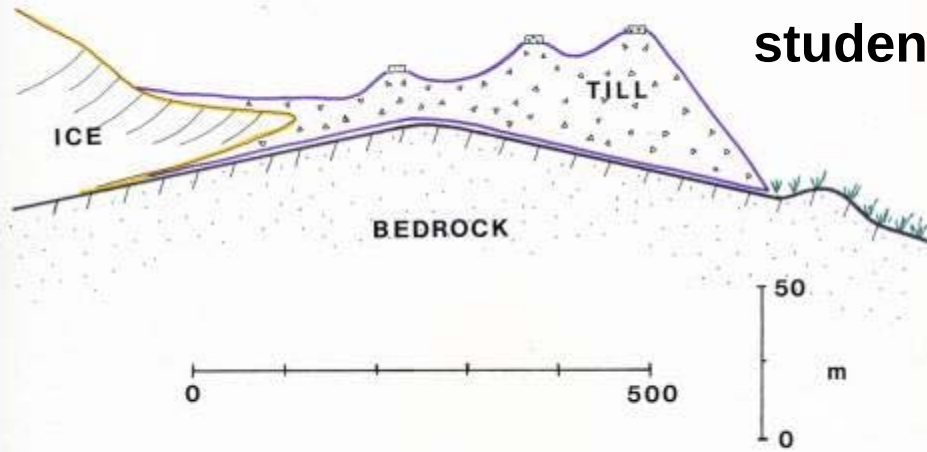


**Education:
Turn Layers
On & Off**

Education: Interpret in Map Space



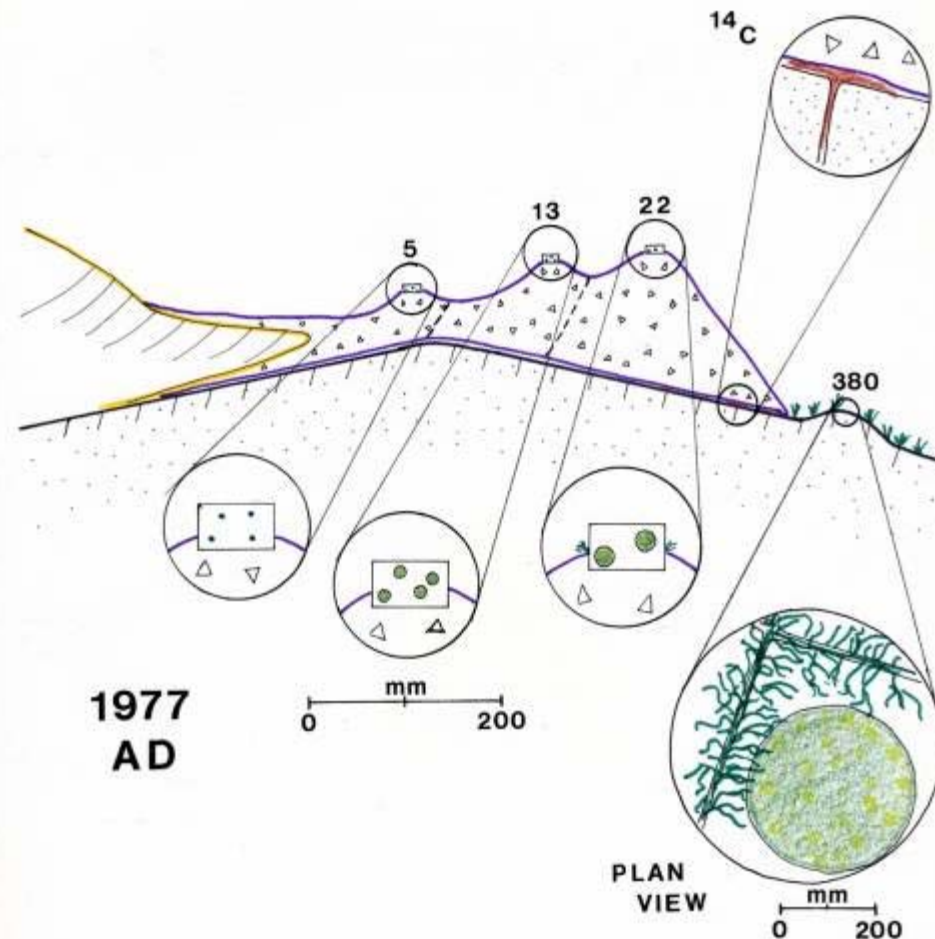
1977 AD



PROFILE

What Parker & his students saw....

Research Lab & Field



1977
AD

What Parker & his students mapped

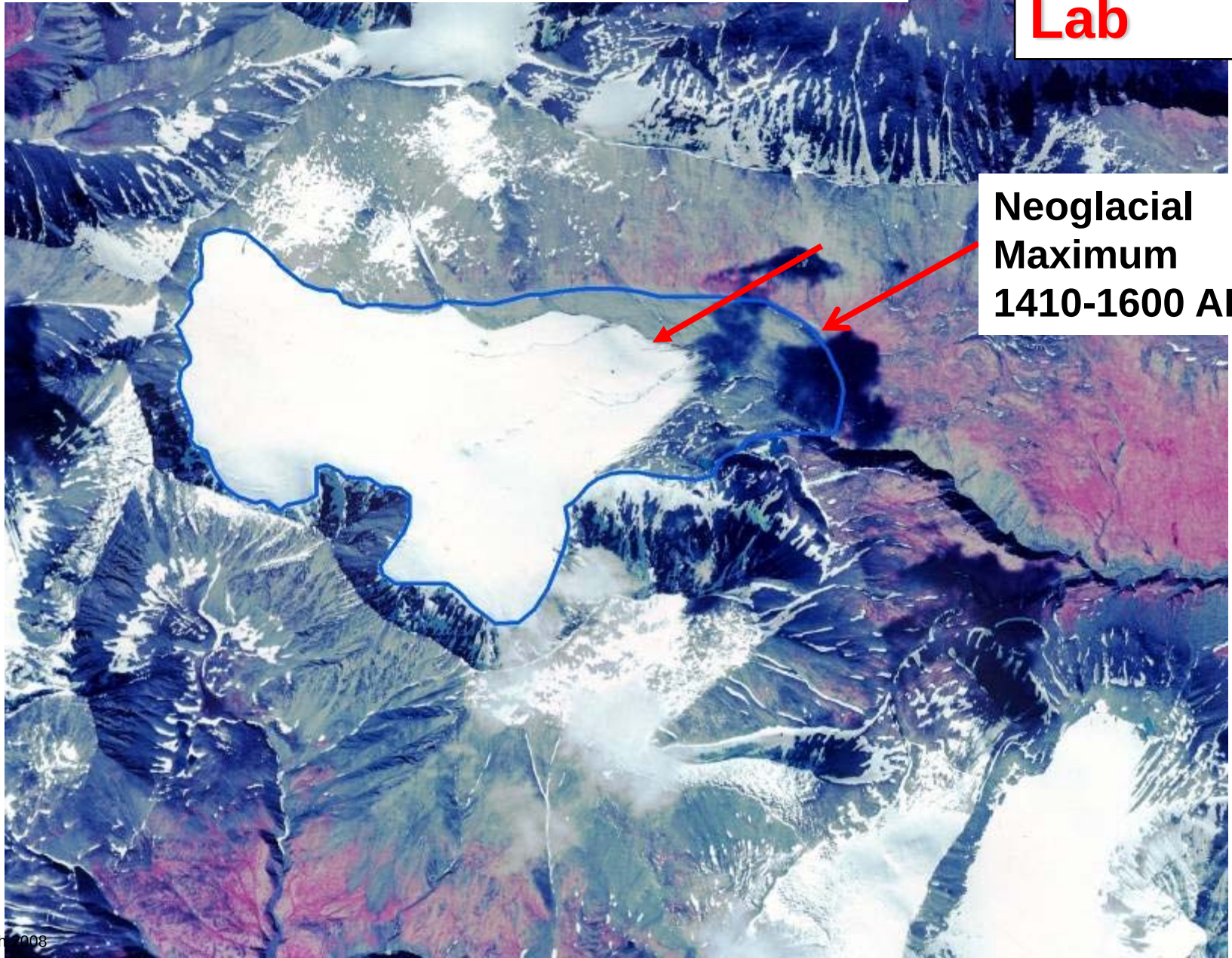
PLAN
VIEW

0 200
mm

Orthorectify 1979 USGS Aerial Photographs - *July 1979 Orthorectified Buffalo Glacier in GIS*

**Research
Lab**

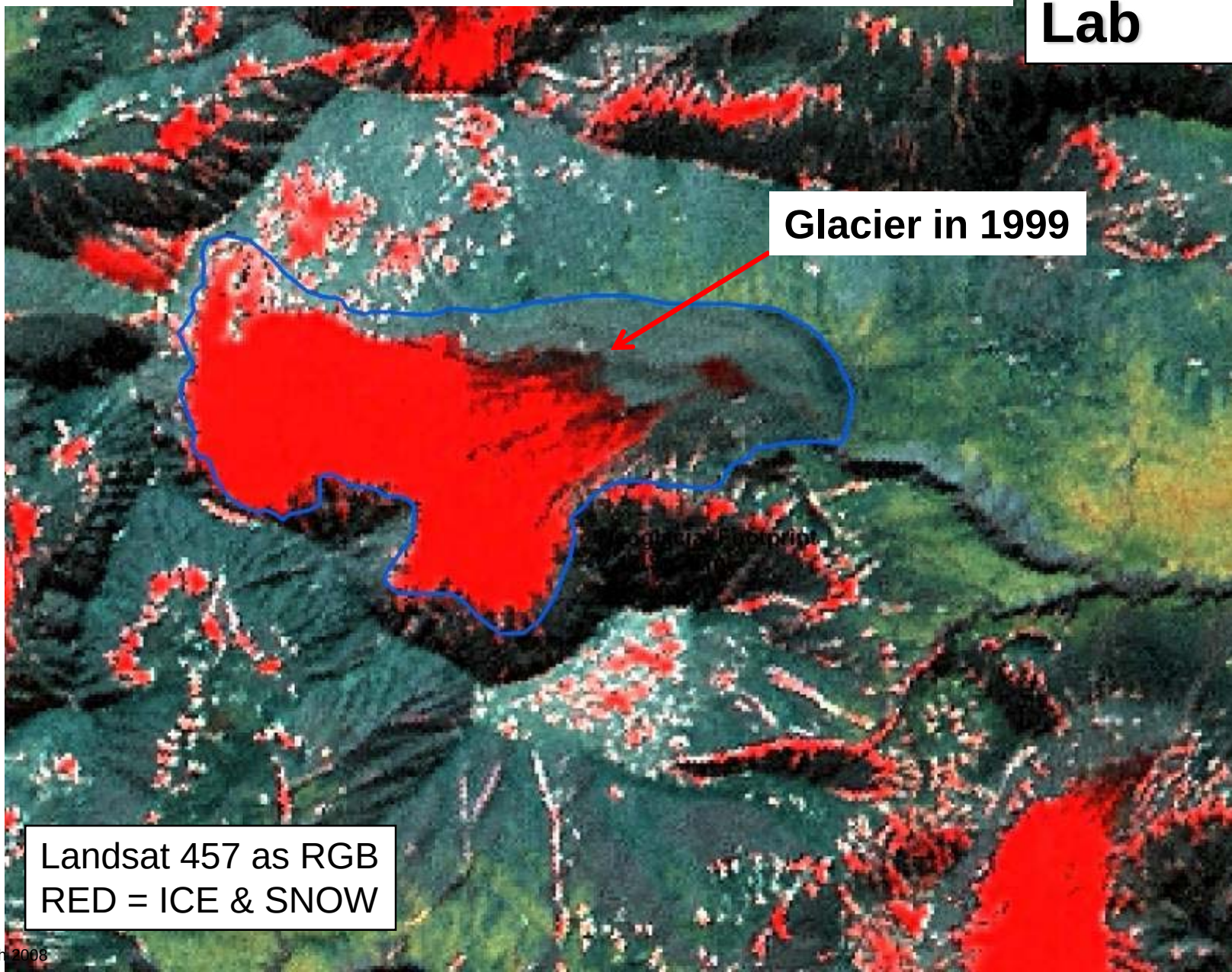
**Neoglacial
Maximum
1410-1600 AD**



Process Satellite Imagery

- *Buffalo Glacier – 1999 Landsat TM (Total IR) in GIS*

**Research
Lab**



Landsat 457 as RGB
RED = ICE & SNOW

Orthorectify Satellite Imagery

- Grizzly Glacier in GIS (ESRI ArcScene)

**Research
Lab**

Glacier in 1979



Glacier in 2006

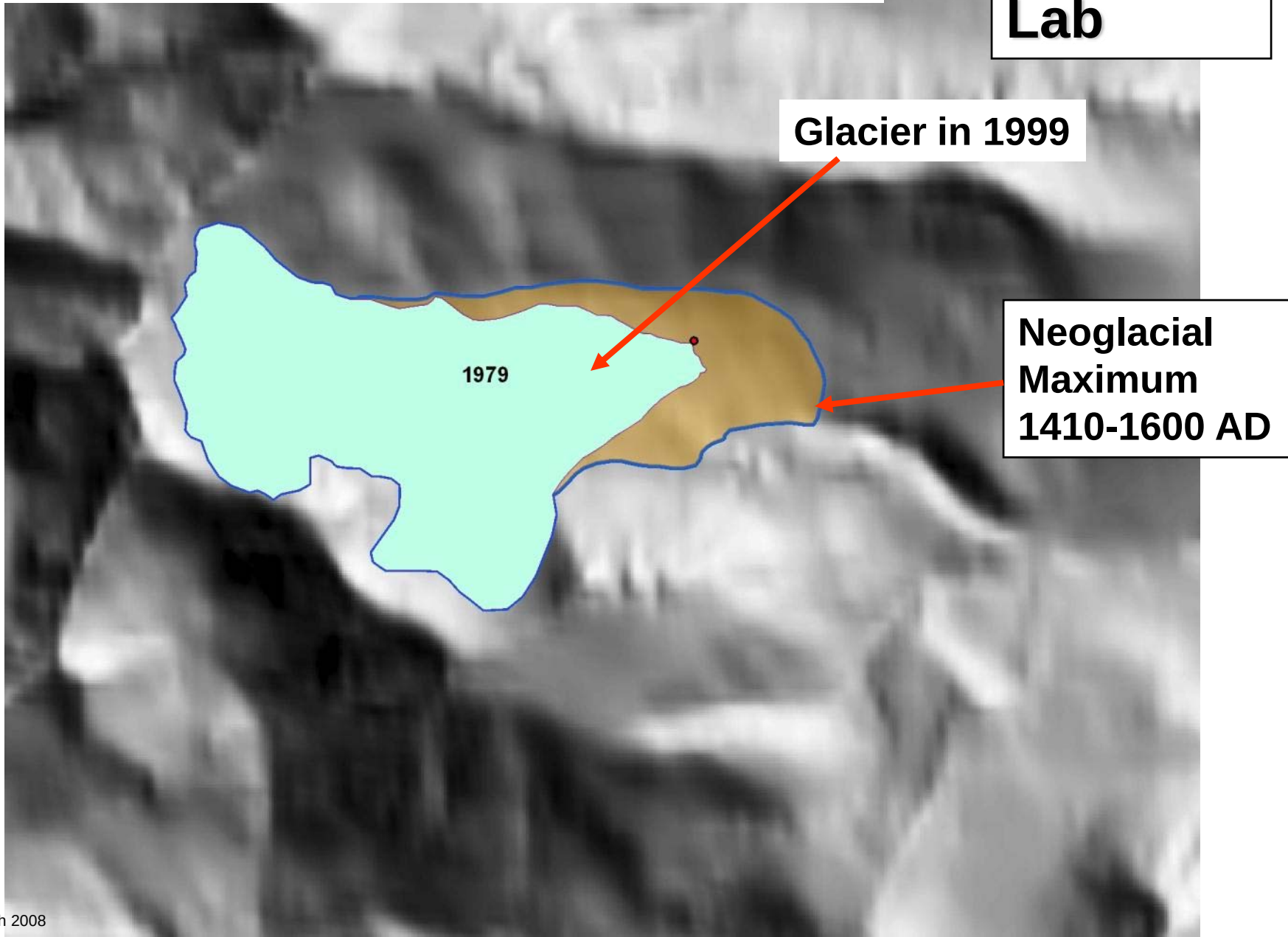


1979 CIR Aerial Photograph
2006 Quickbird Satellite Image

Interpret Post-Little Ice Age Deglaciation in GIS

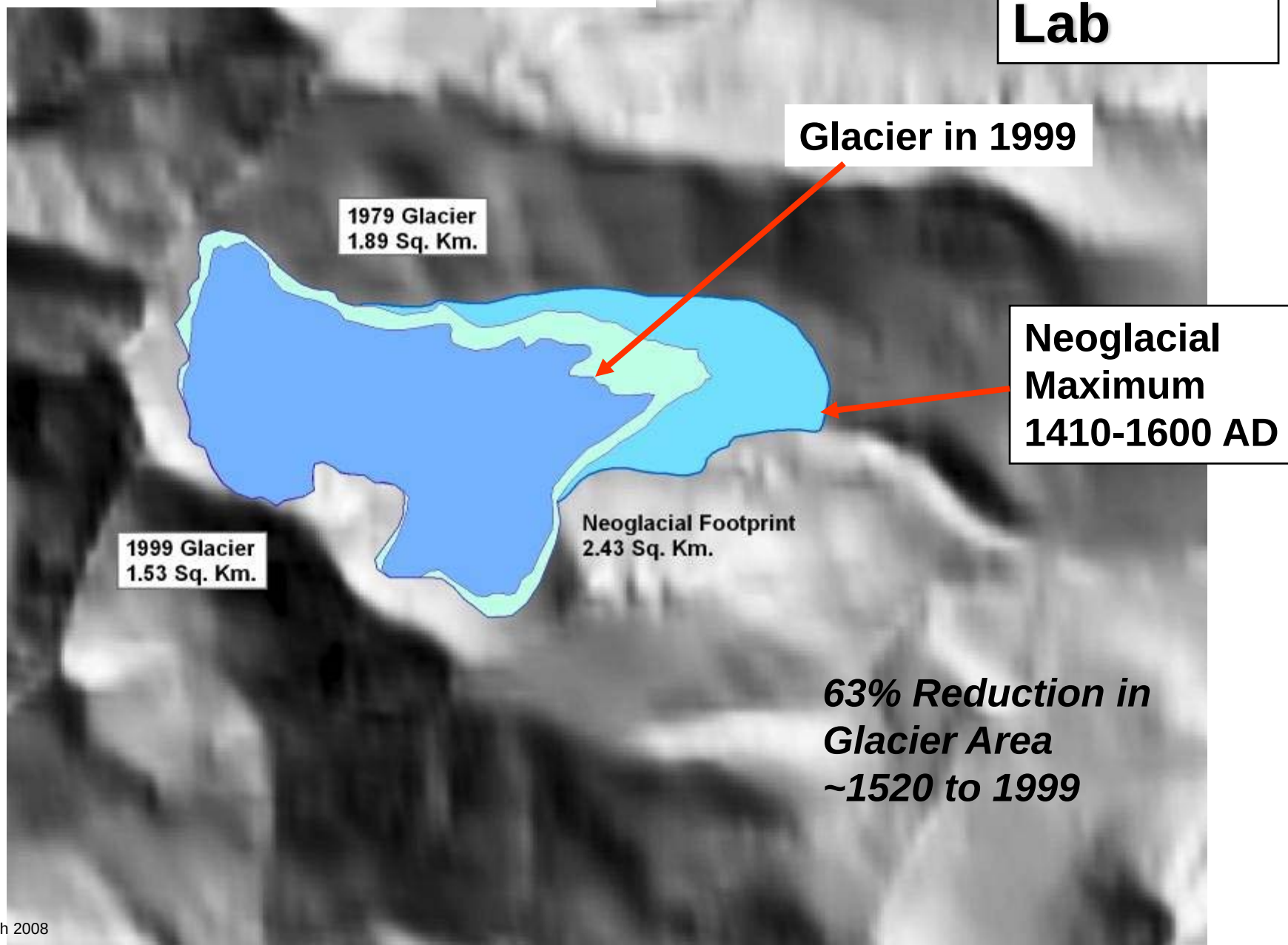
- *Buffalo Glacier*

**Research
Lab**



Measure Areas & Ice Loss from GIS - *Buffalo Glacier*

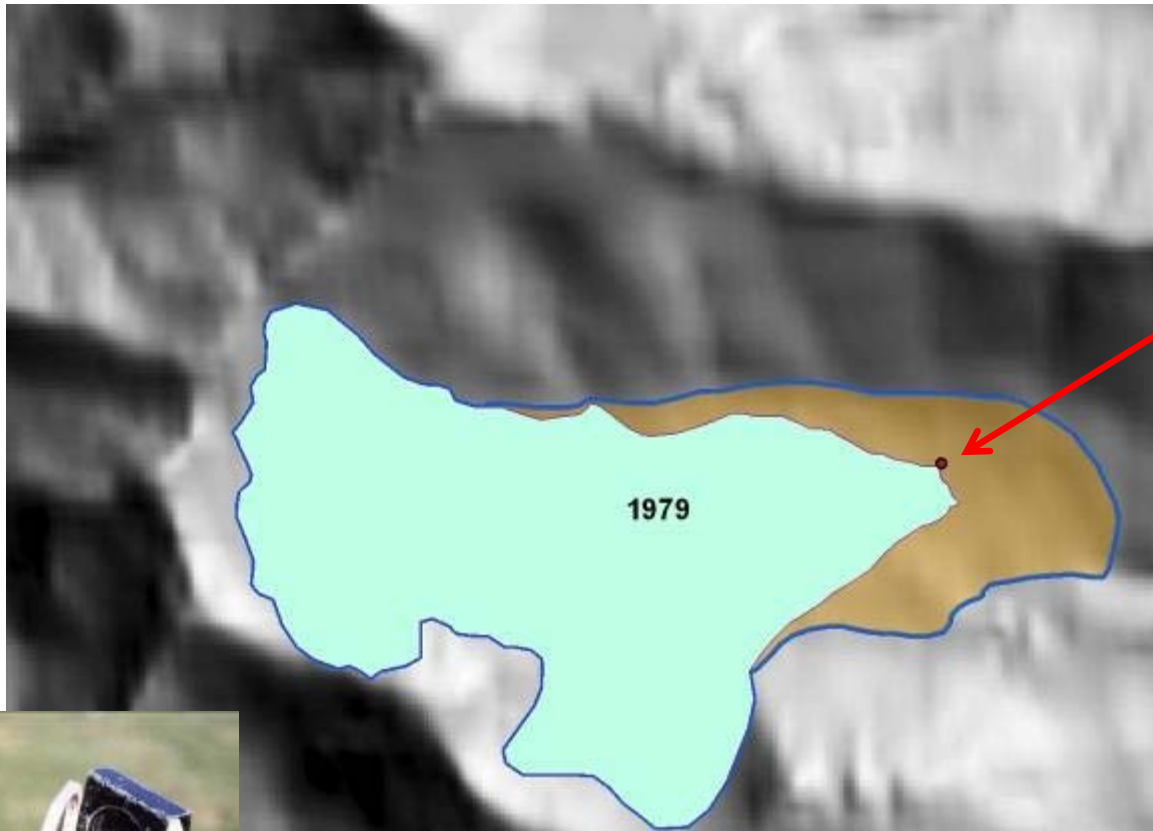
**Research
Lab**



Compile Physical Inventory in GIS as Attributes

- *Buffalo Glacier*

Research Lab

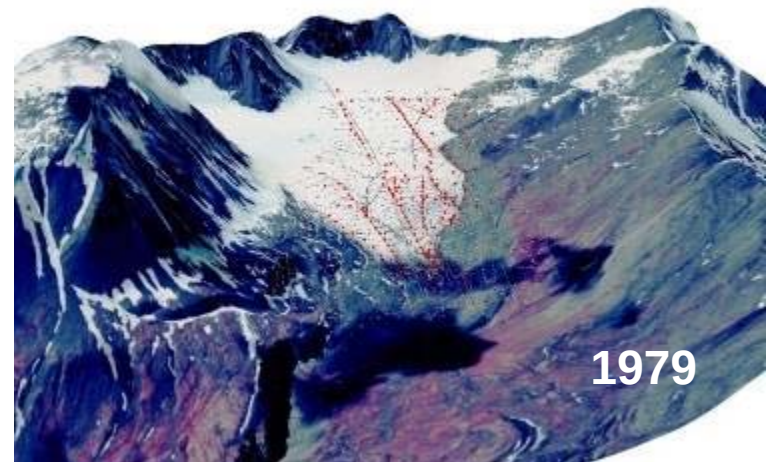
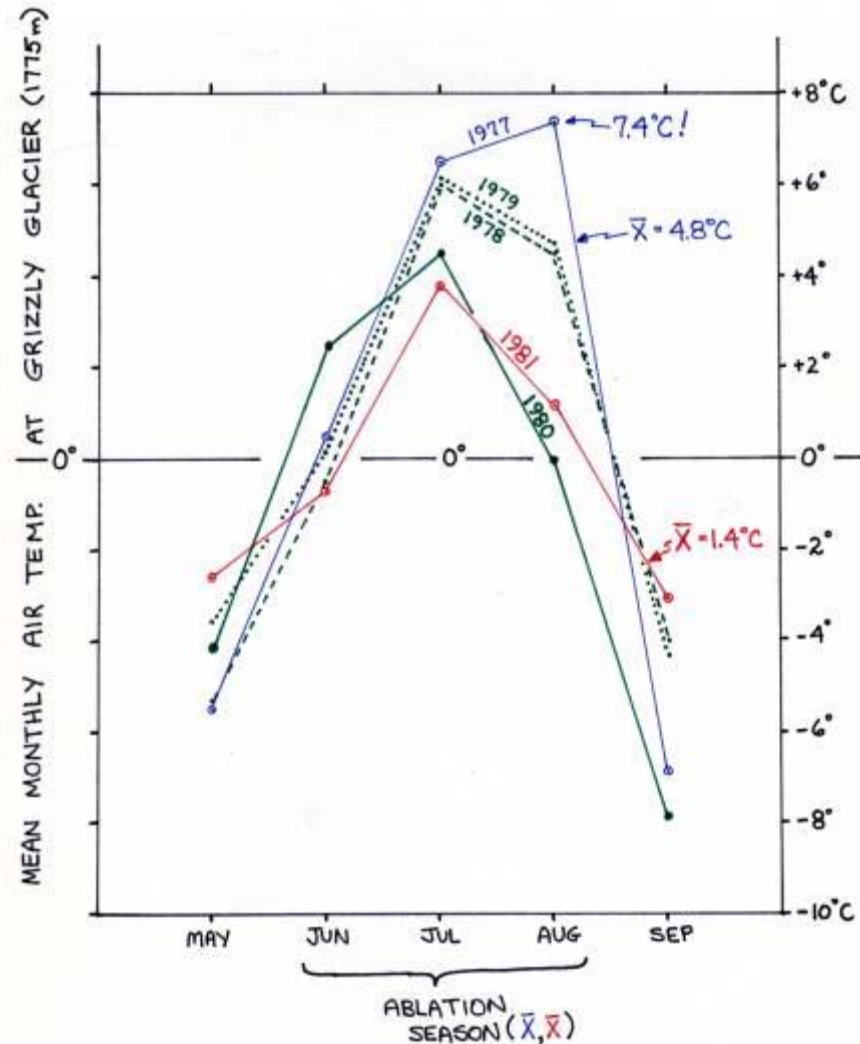


Field	Value
FID	0
Shape	Point
Id	1
Name	Buffalo
Type	Screening-AppF
Series	100
Elev	1570
Site_Type	CG-M
Duration	15.6
Blocked	-3.8
Aspect	NE
Slope	10
Slope_Exp	-1
Total_Ener	95.199997
Horiz_Mean	12.4
Horiz_SD	6
Max_Horiz	26
Bedrock1	Dkss
Bedrock2	
Series_ID	101a/1
X	383574.776677
Y	7560594.1855

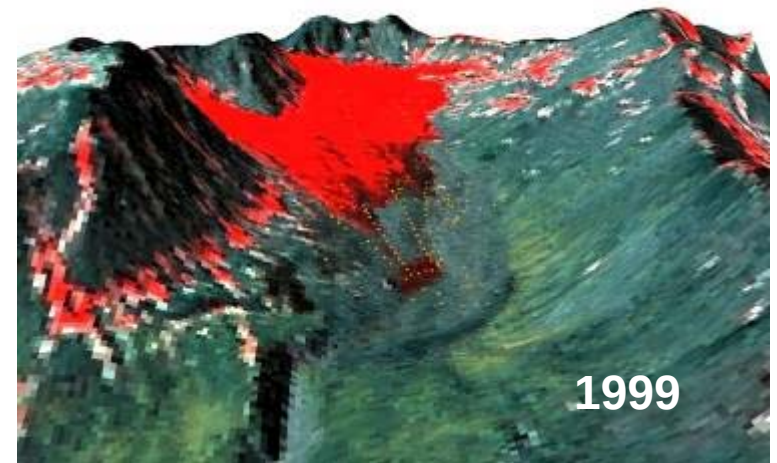


Correlate 1977 – 2009? Glacier Changes to TAPS, CRREL, & Other Weather Records

Research Lab



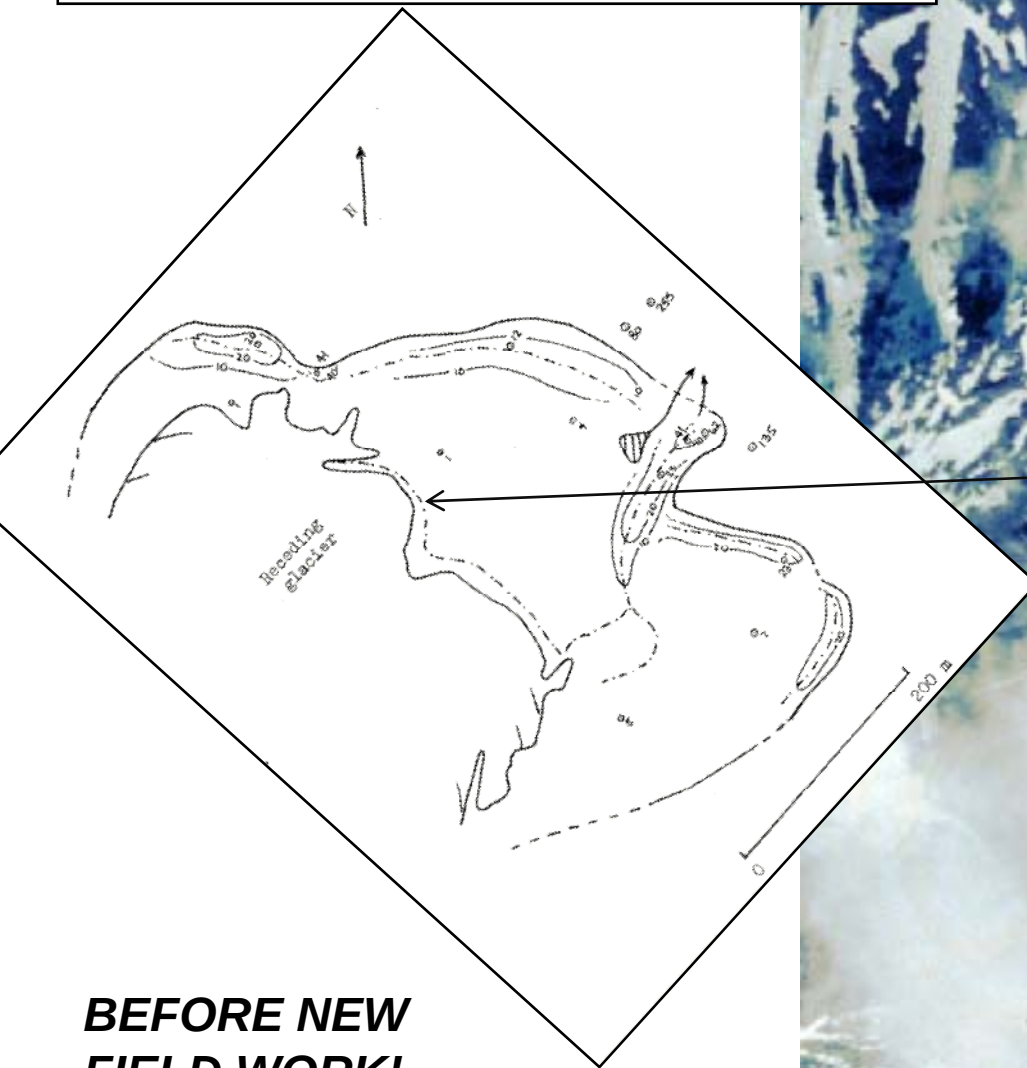
1979



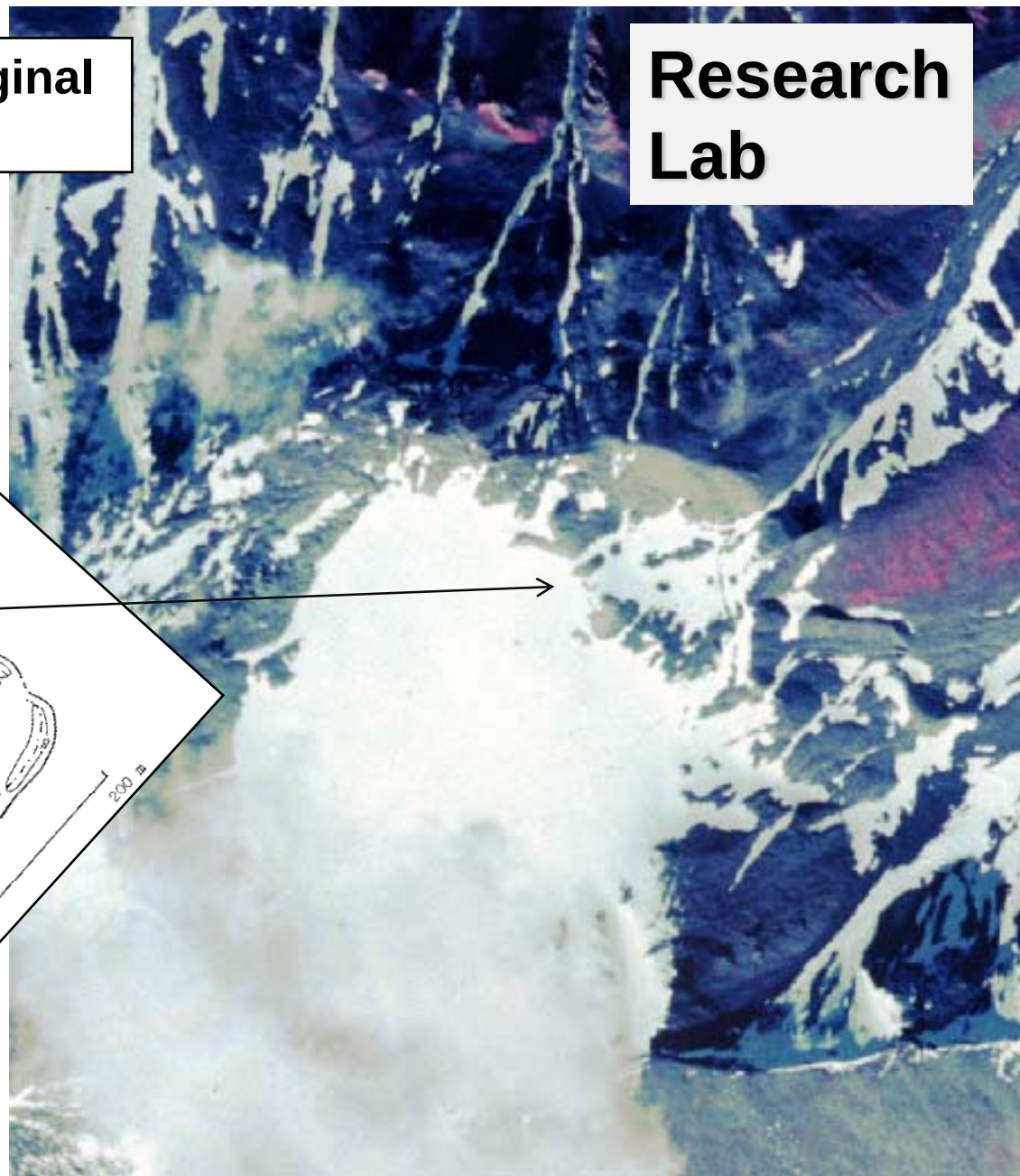
1999

**Correct & Georeference Original
(1977-1982) Maps in 2D**

**Research
Lab**

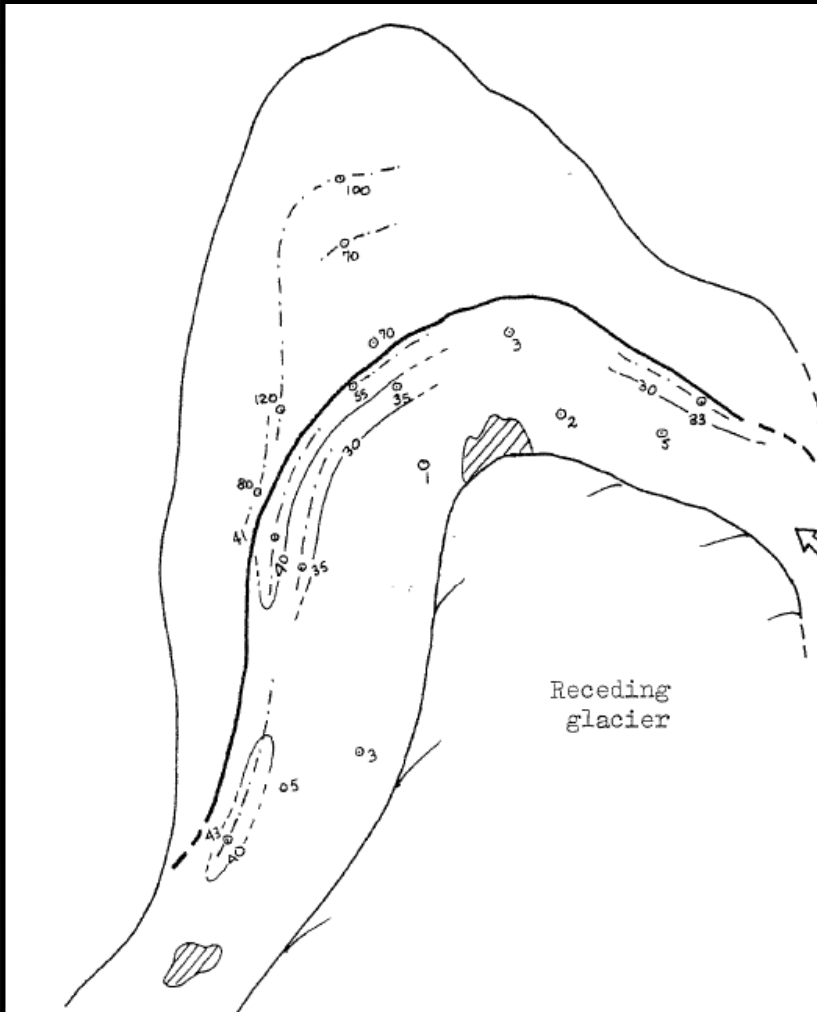
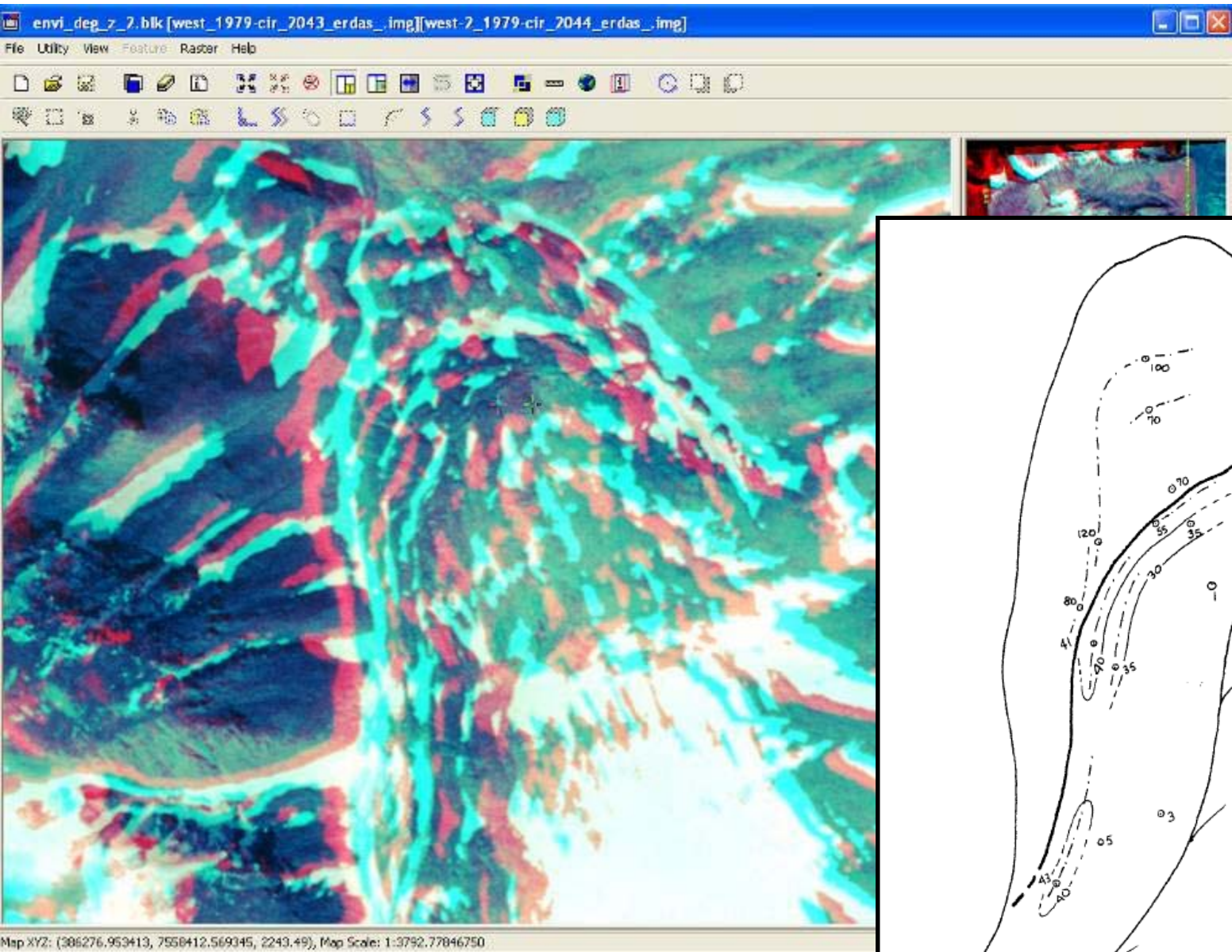
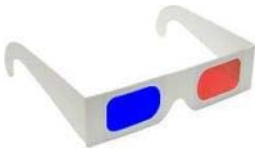


***BEFORE NEW
FIELD WORK!***



Create Detailed Morphology Maps in 3D Stereo to Improve Field Mapping Accuracy – *Softcopy Photogrammetry*

Research
Lab

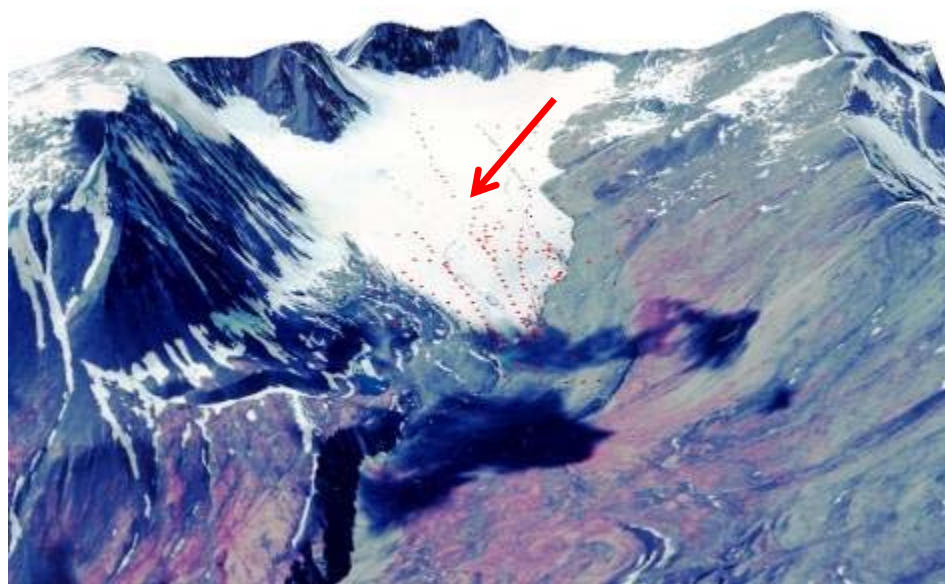


Research Lab



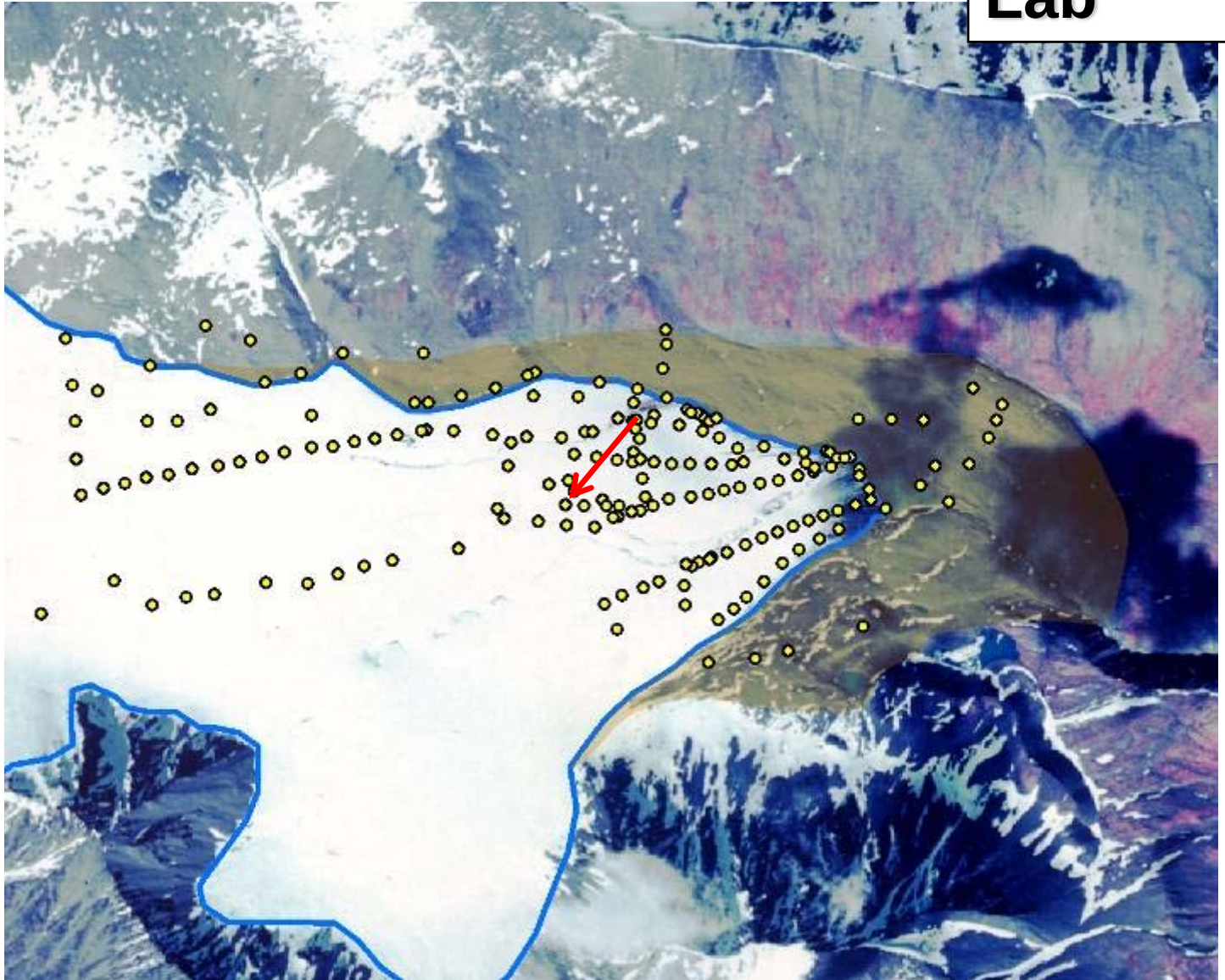
Drape 1979 Buffalo Survey Map onto 1979 Air Photo

Research
Lab



1979 Survey Points on 1979 Air Photo

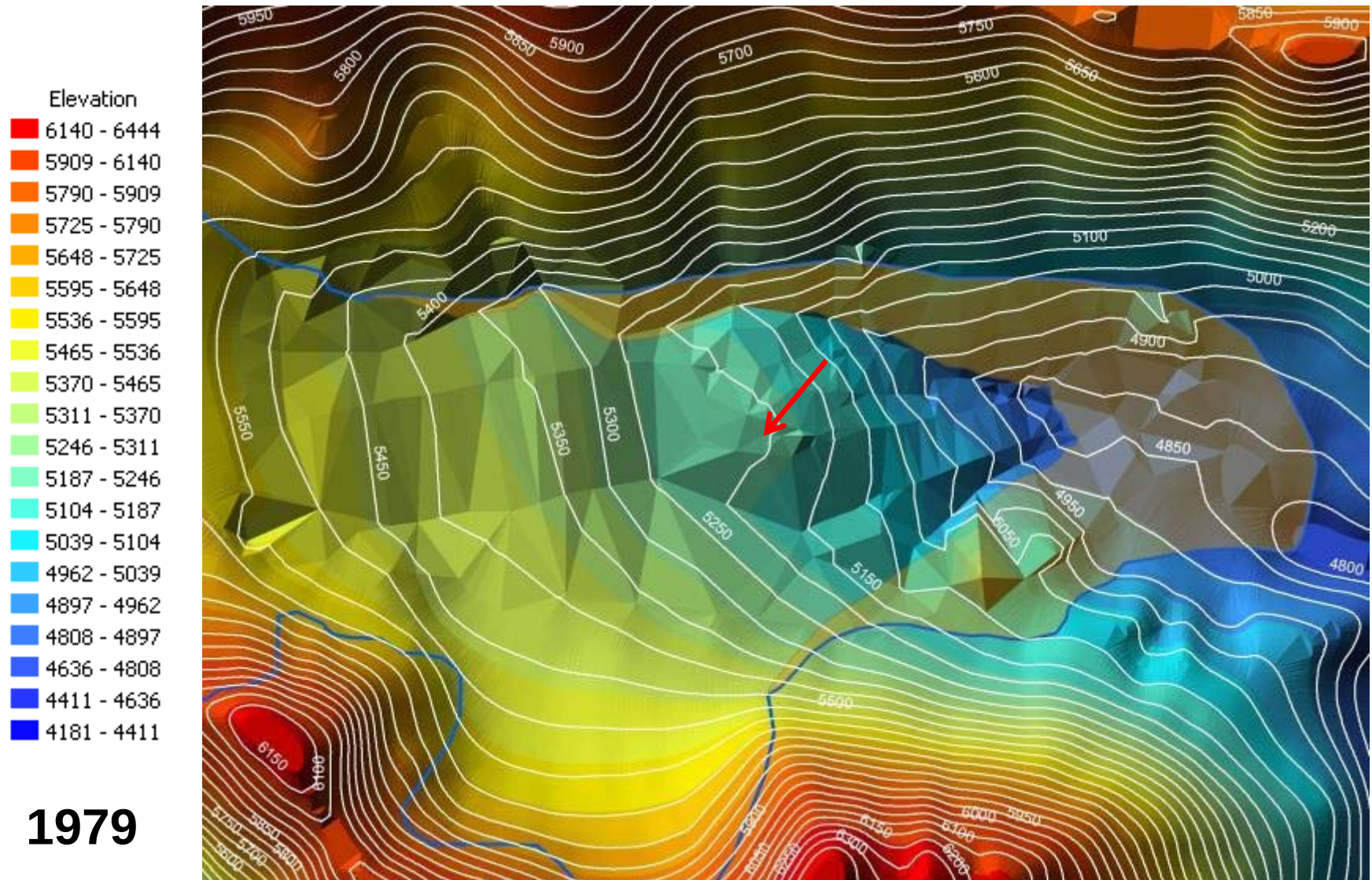
Research
Lab



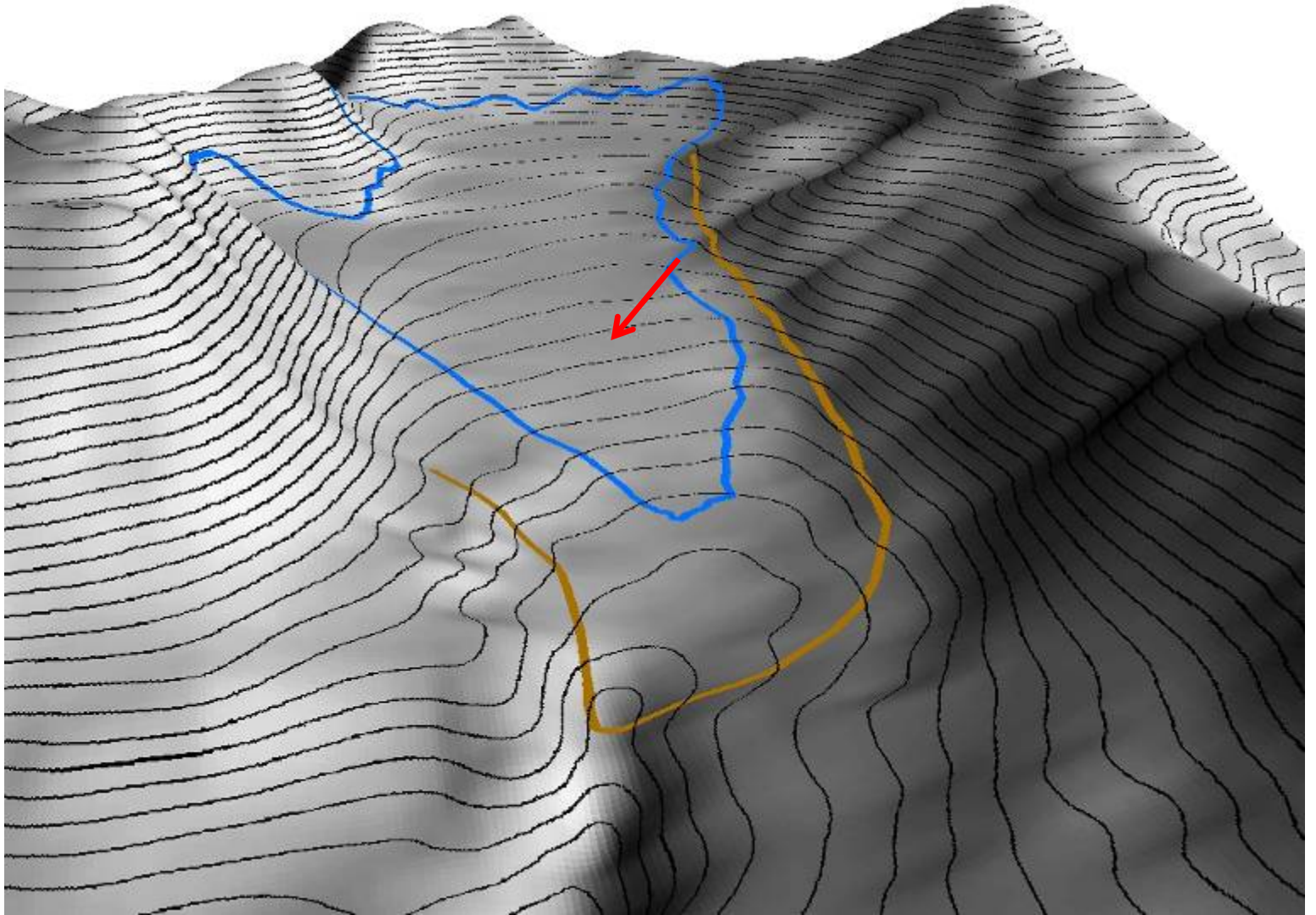
1979

Develop glacier surfaces & profiles

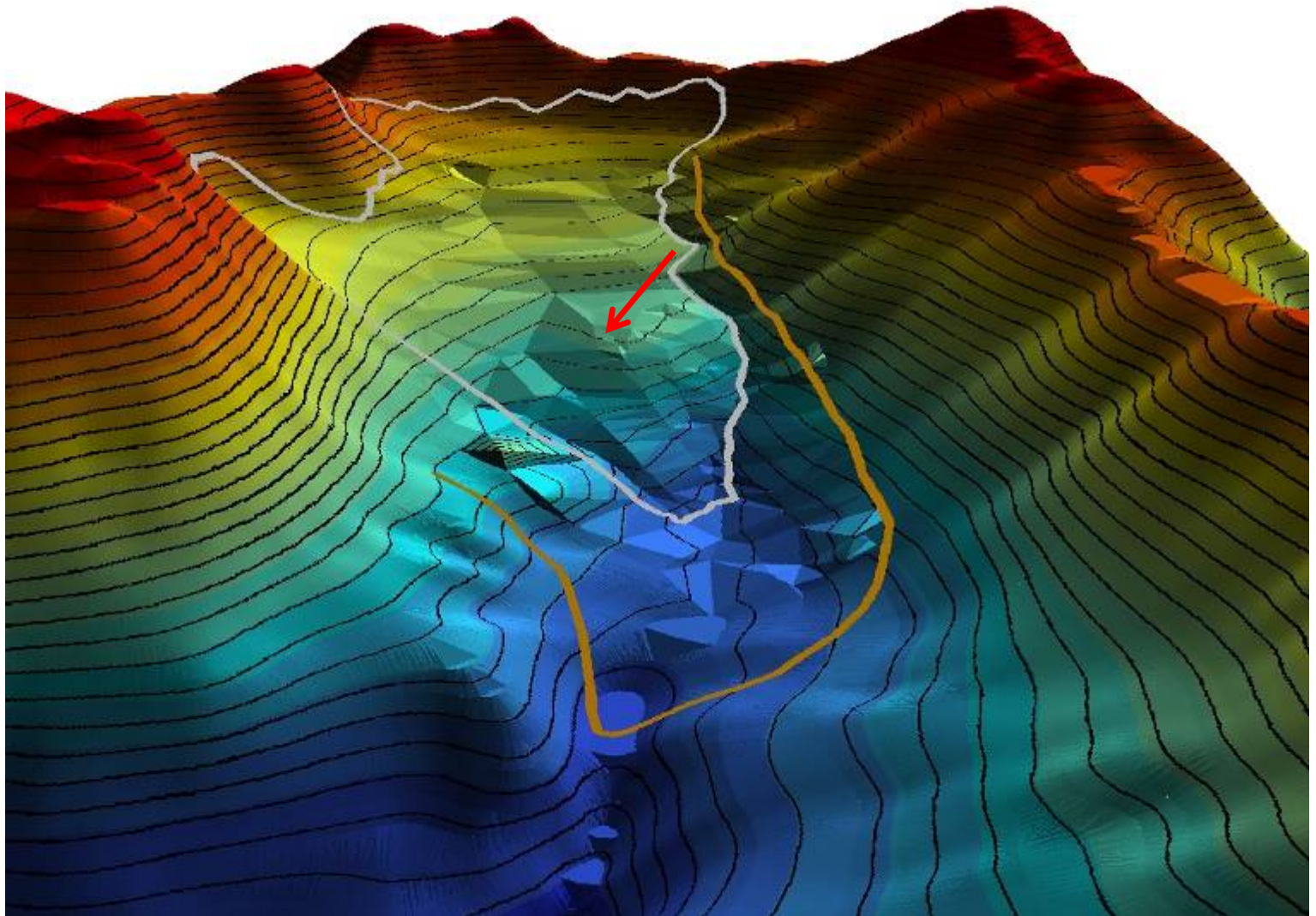
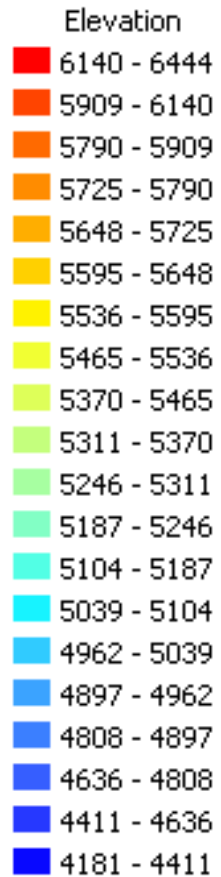
Research Lab



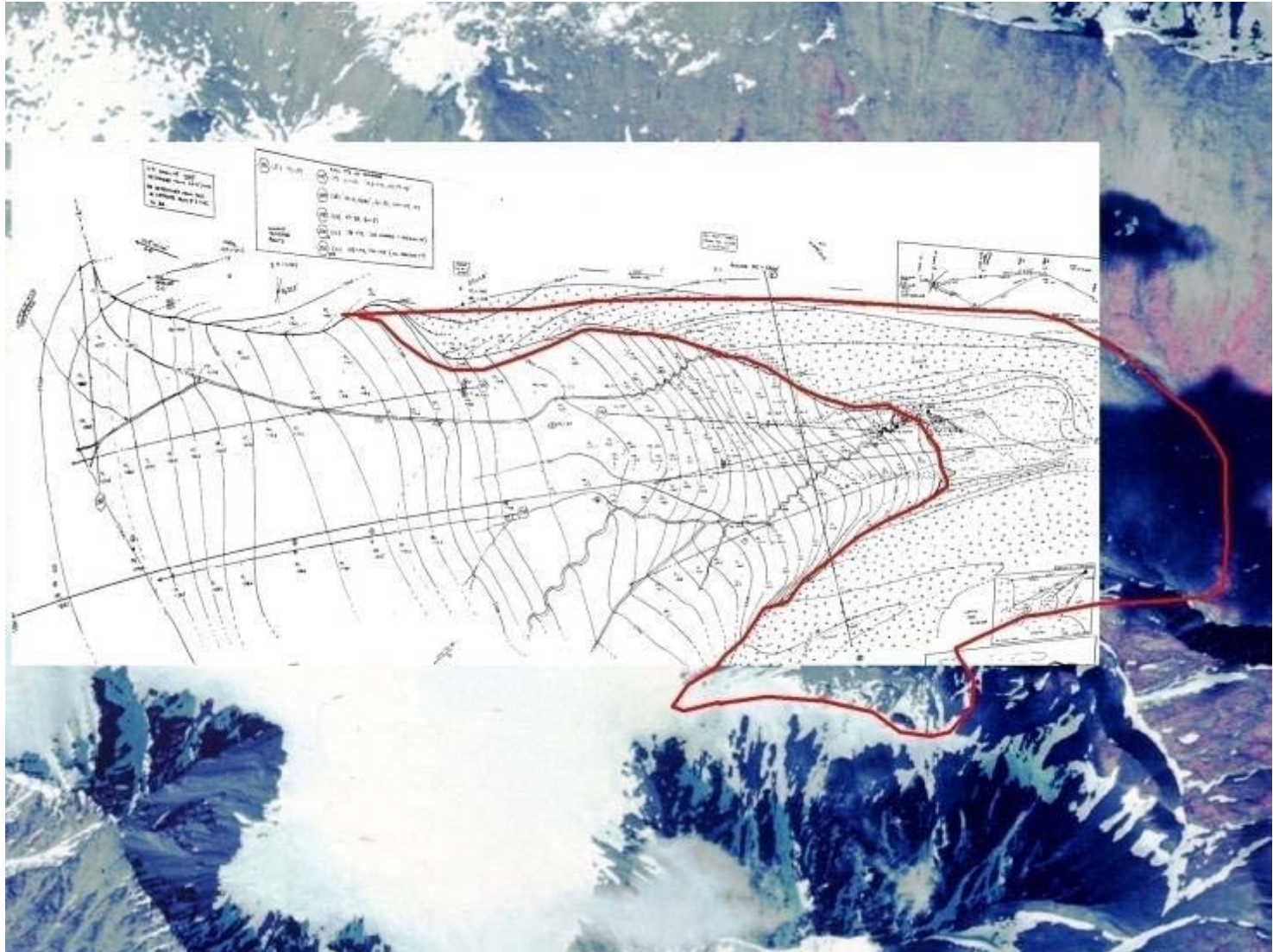
USGS 1970 Contours on Buffalo Glacier



1979 Buffalo Survey Map converted into a 3D Model



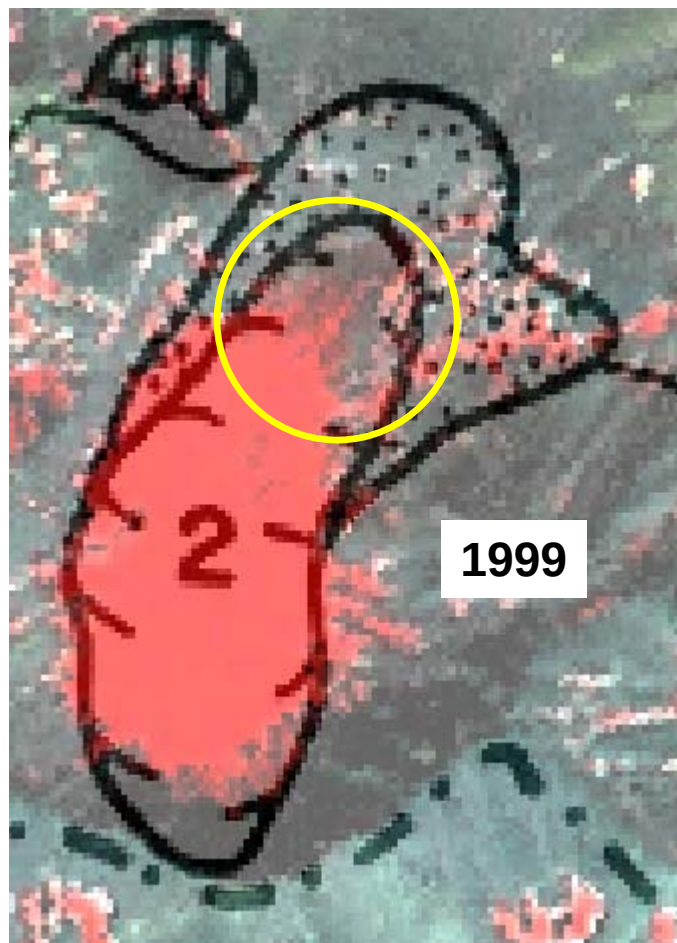
Research Field



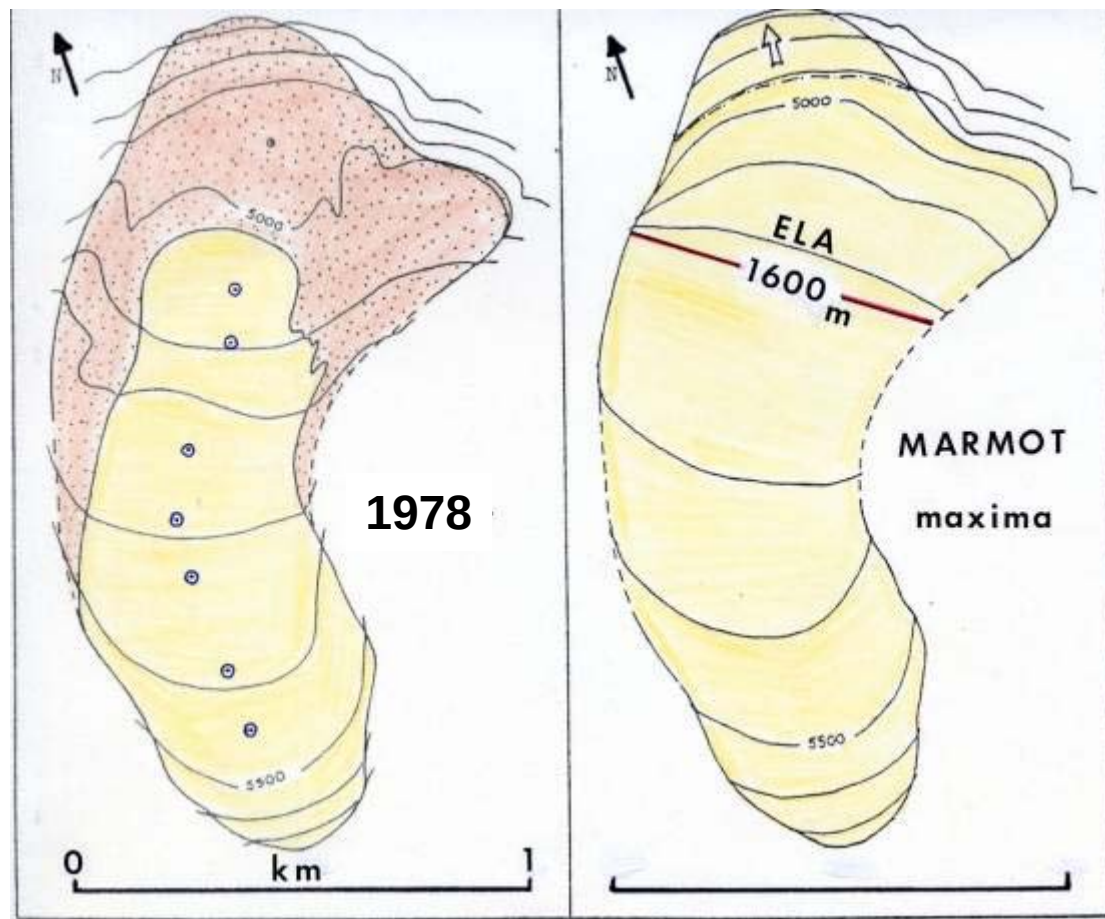
J. Ellis March 2008

Map Area Deglaciaded between ~1977/82 and 2010?

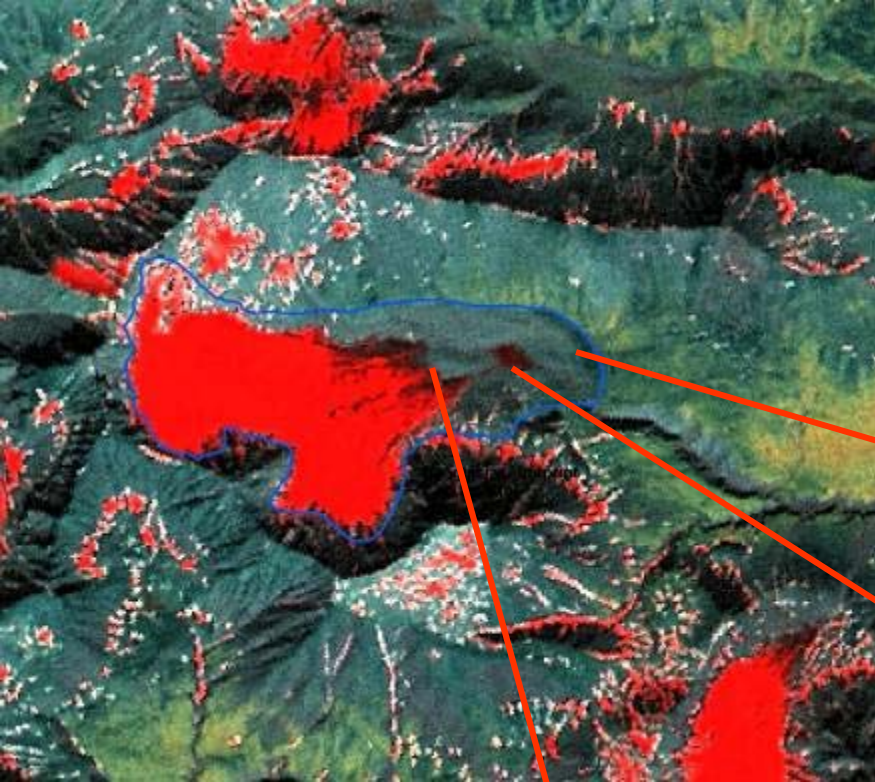
Research Field



1:62,500 Map in Dissertation

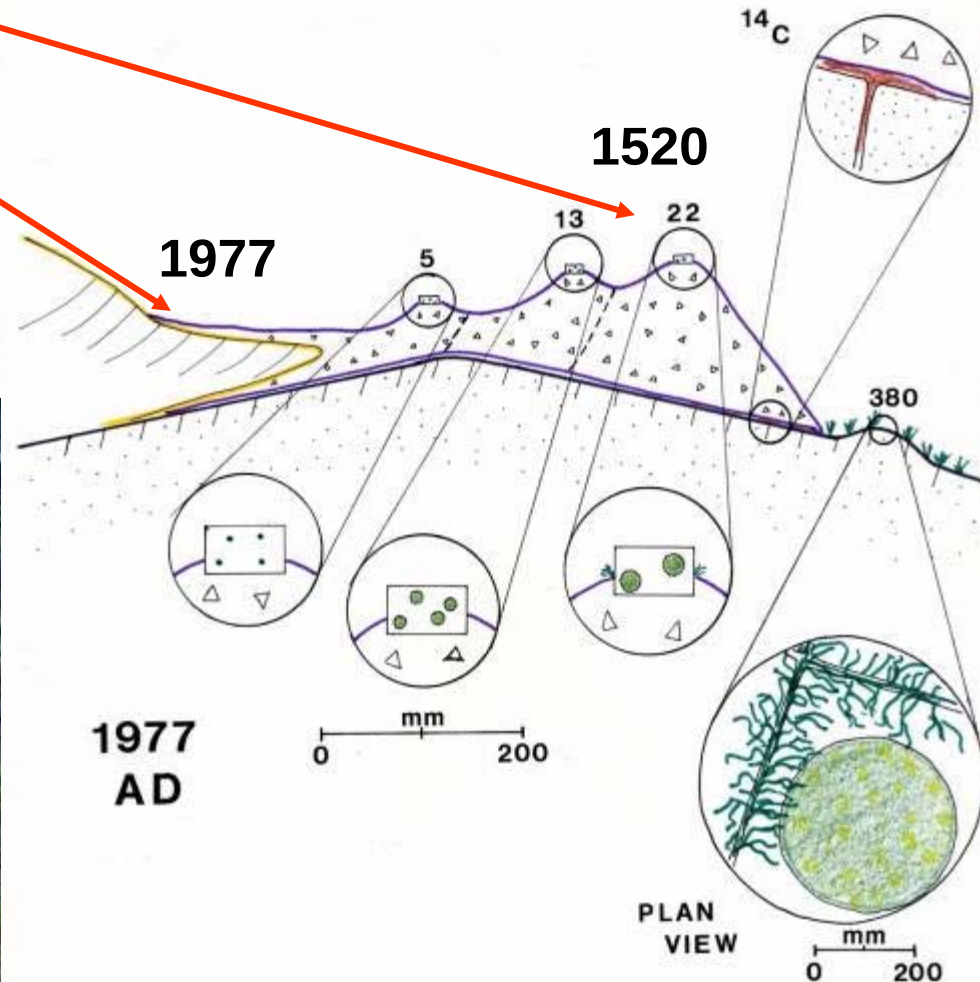


Individual Cirque Glacier/Rock Glacier
Map in Dissertation (one of fifty five....)



**Link Deglaciation
to Trees**
(G. Wiles,
College of Wooster)

**Research
Field**

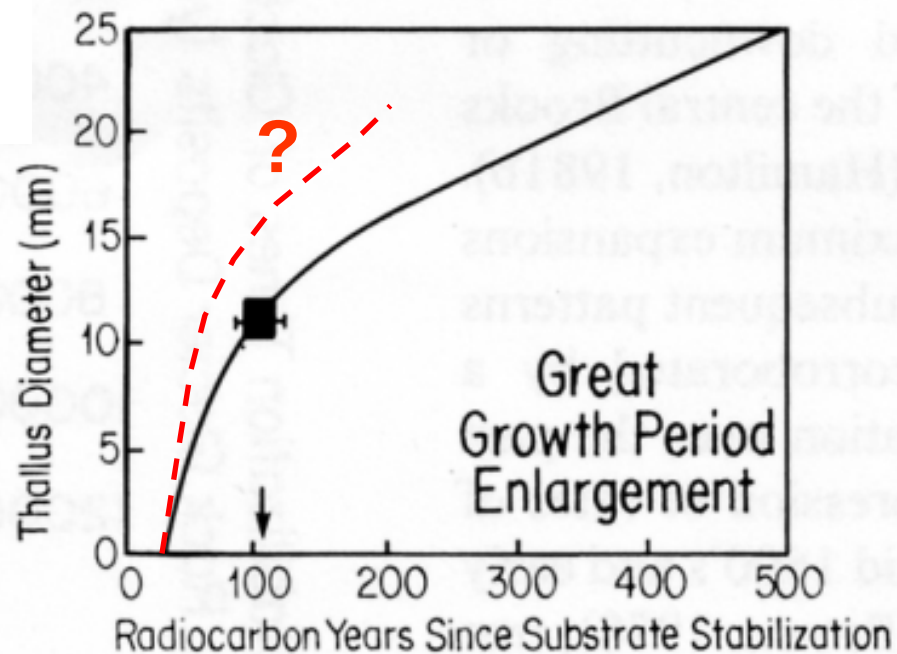


2009?



Recalibrate the Lichenometric Growth Curve

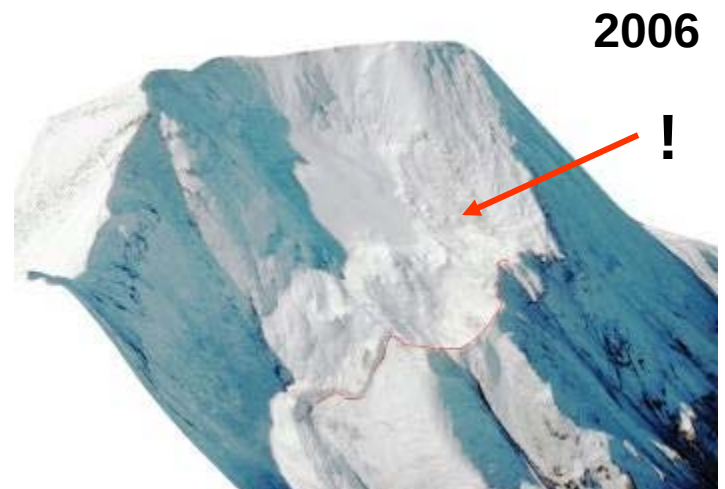
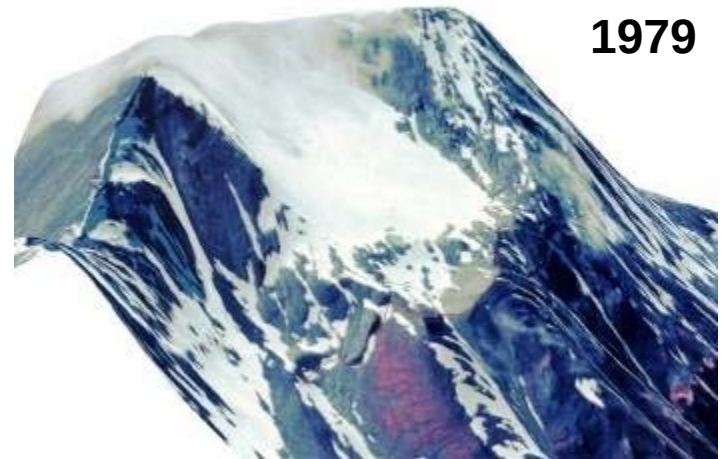
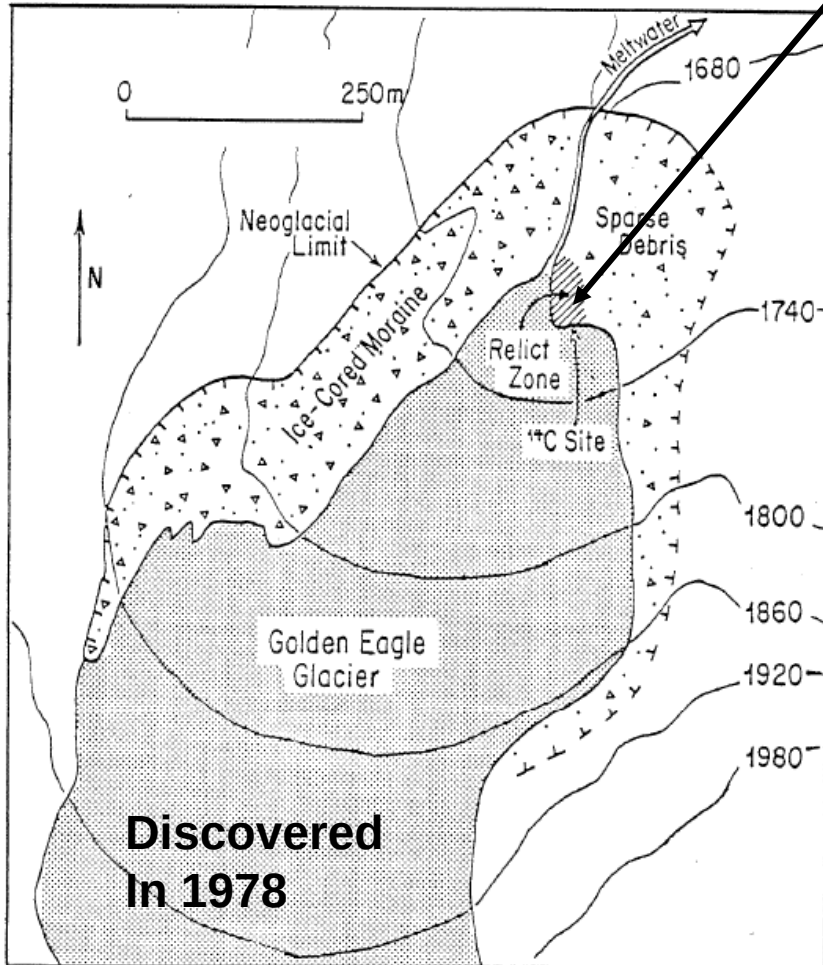
Research Field



Find & Date Relict Vegetation

Research Field

1120 +/- 180
yrs BP



SUMMARY 1

- 1. Broad Range of Baseline Work done
25-30 years ago**
- 2. Parker Calkin's work can be moved into
21st Century with GeoSpatial Technology**
- 3. There are many Education & Research
Opportunities**



Using Parker Calkin's Brooks Range work will help understand what's happening in the 21st Century





The End



*PDF available at
www.ellis-geospatial.com*



SUMMARY 2

- 1. 1977-82 Baseline Data available from James Ellis**
- 2. Visit www.ellis-geospatial.com for downloads of dissertation, images, maps, GoogleEarth kmzs, etc.**
- 3. Preliminary GIS built with imagery and scanned maps (3.6 GB)**
- 4. GIS package available upon request.**