National Park Service
U.S. Department of the Interior
Yosemite National Park

Timing and magnitude of late Pleistocene and Holocene glaciations in Yosemite National Park

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Simplified Sierra Nevada glacial history

Middle Palisade glaciers

1. Matthes
- Little Ice Age
- Relatively small in extent
- Very "fresh", sharp-crested moraines

2. Recess Peak

3. Tioga
- 18,000 yrs ago
- Most recent large glaciation
- "Fresh", relatively sharp-crested moraines

4. Tahoe
- 80,000 or 130,000 yrs ago
- Larger than Tioga Glaciation
- More weathered, diffused moraines

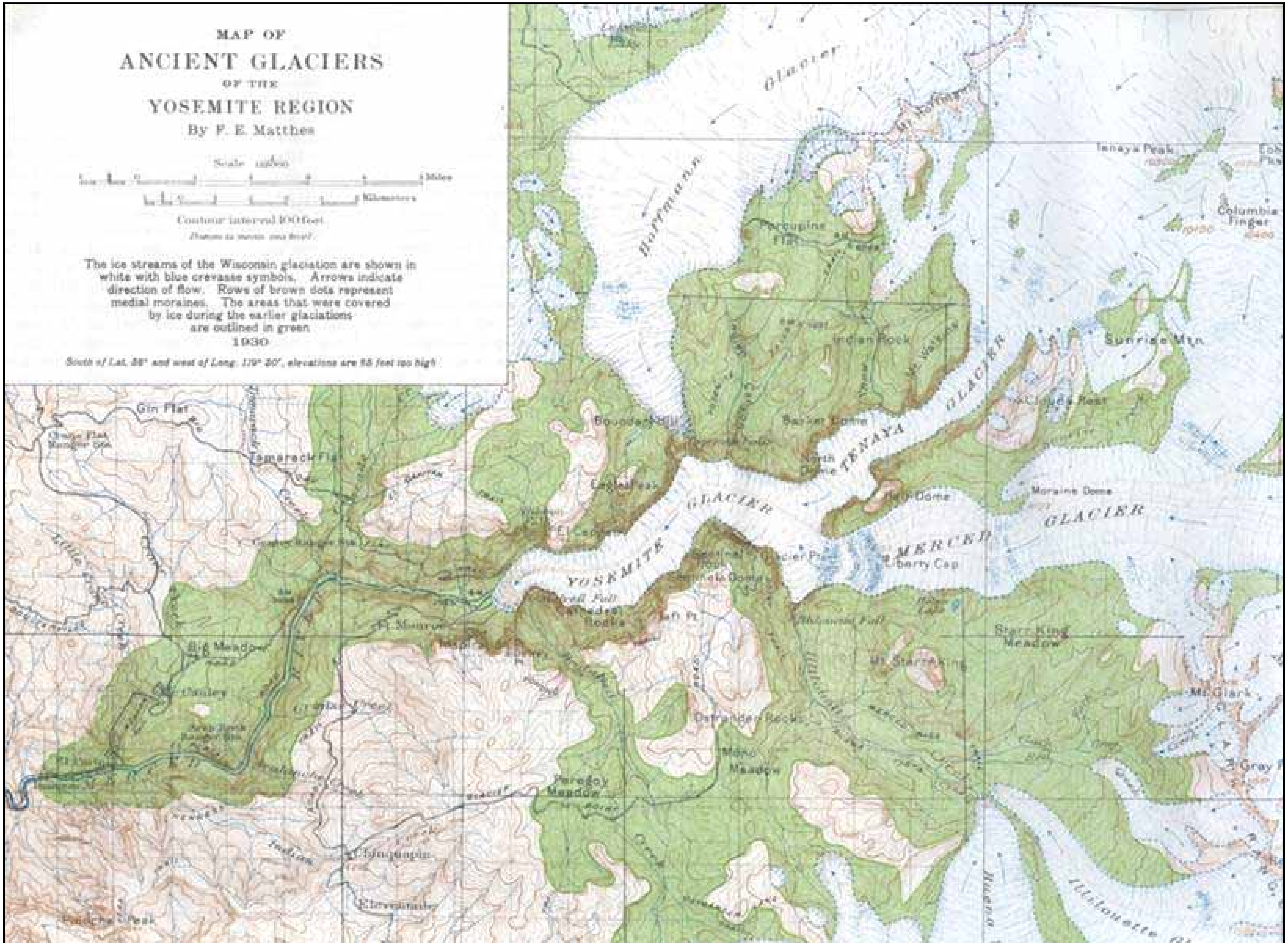
5. Mono Basin (?)

6. Sherwin
- >760,000 yrs ago
- Largest glaciation in Sierra Nevada
- Scattered till and erratics

Lee Vining Canyon

Sherwin Summit, Hwy 395

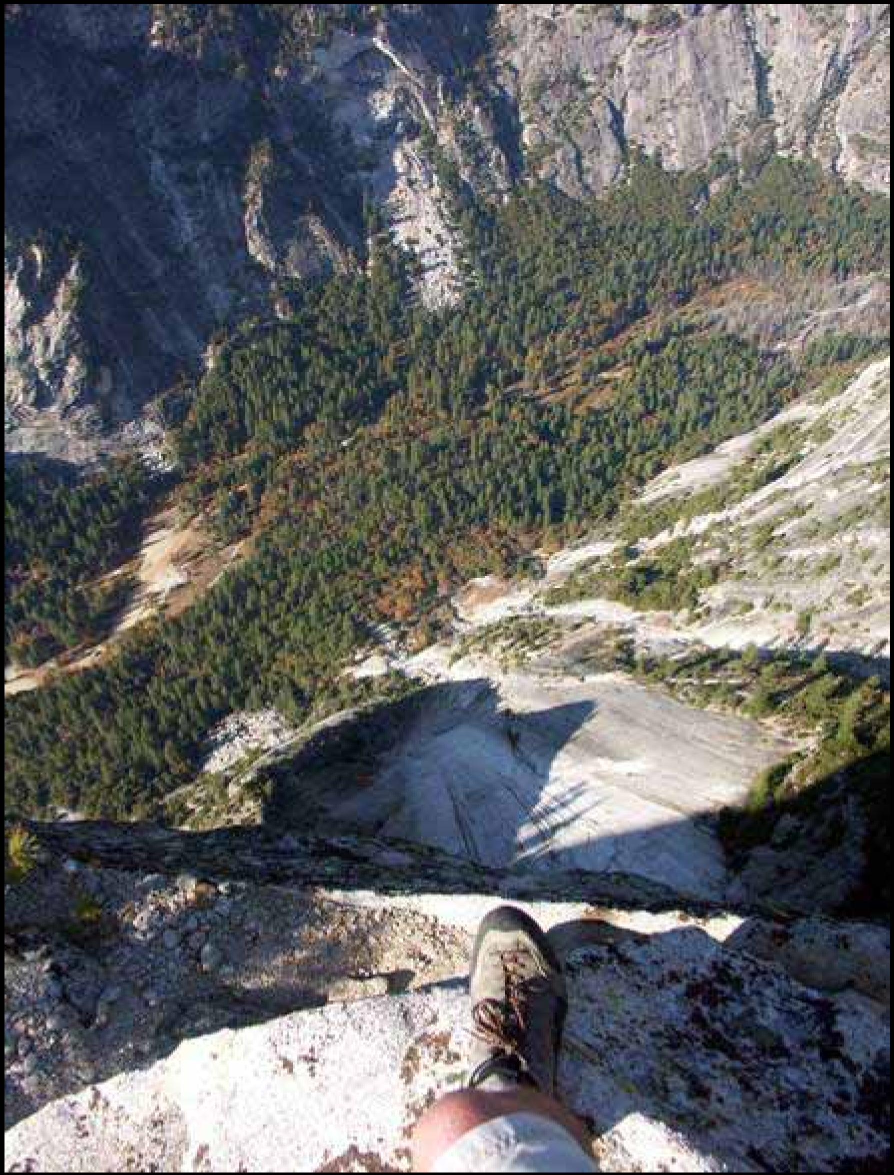
Mapping the extent of past glaciations



Yosemite Valley region glacial map of Matthes (1930)

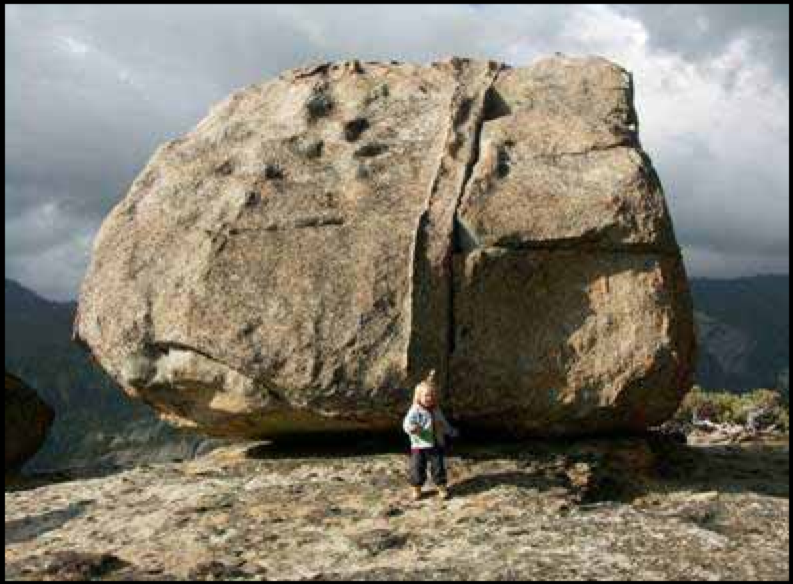
Determining the extent of pre-Tahoe glaciations

Pre-Tahoe (?) till on “Diving Board” west of Half Dome



Looking down from “Diving Board”

Determining the extent of pre-Tahoe glaciations

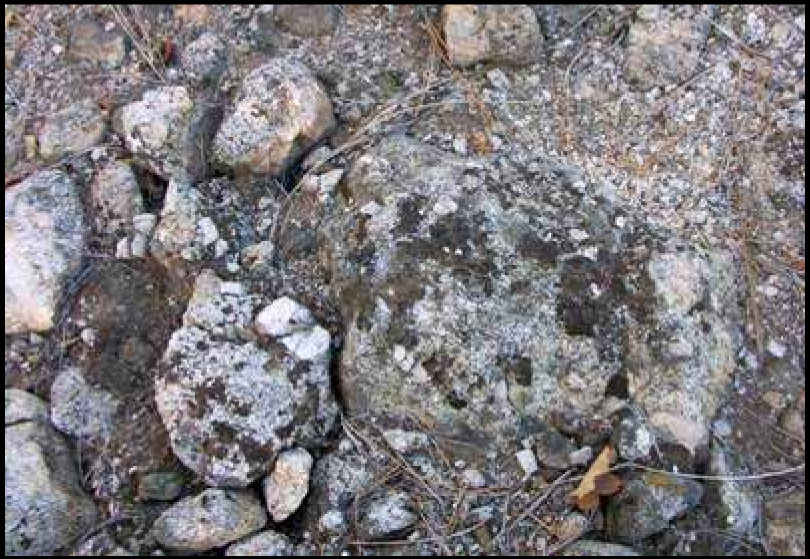


Pre-Tahoe erratic, Turtleback Dome

Several deposits appear to represent pre-Tahoe till, but how to confirm that?

- Utility of cosmogenic ^{10}Be dating limited with deposits of this age
- Quantifying till lithologies

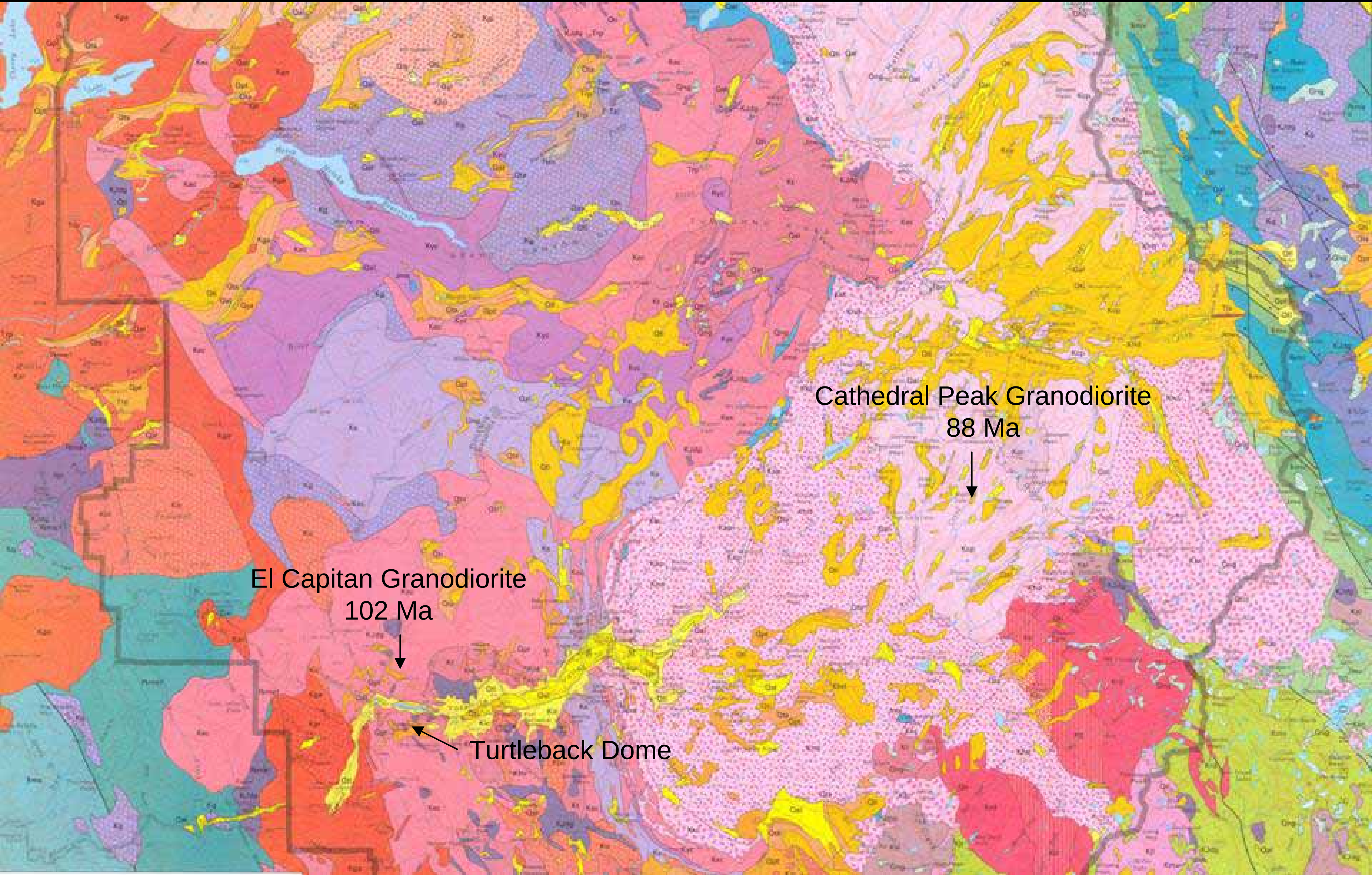
Glacial till (?) at Turtleback Dome



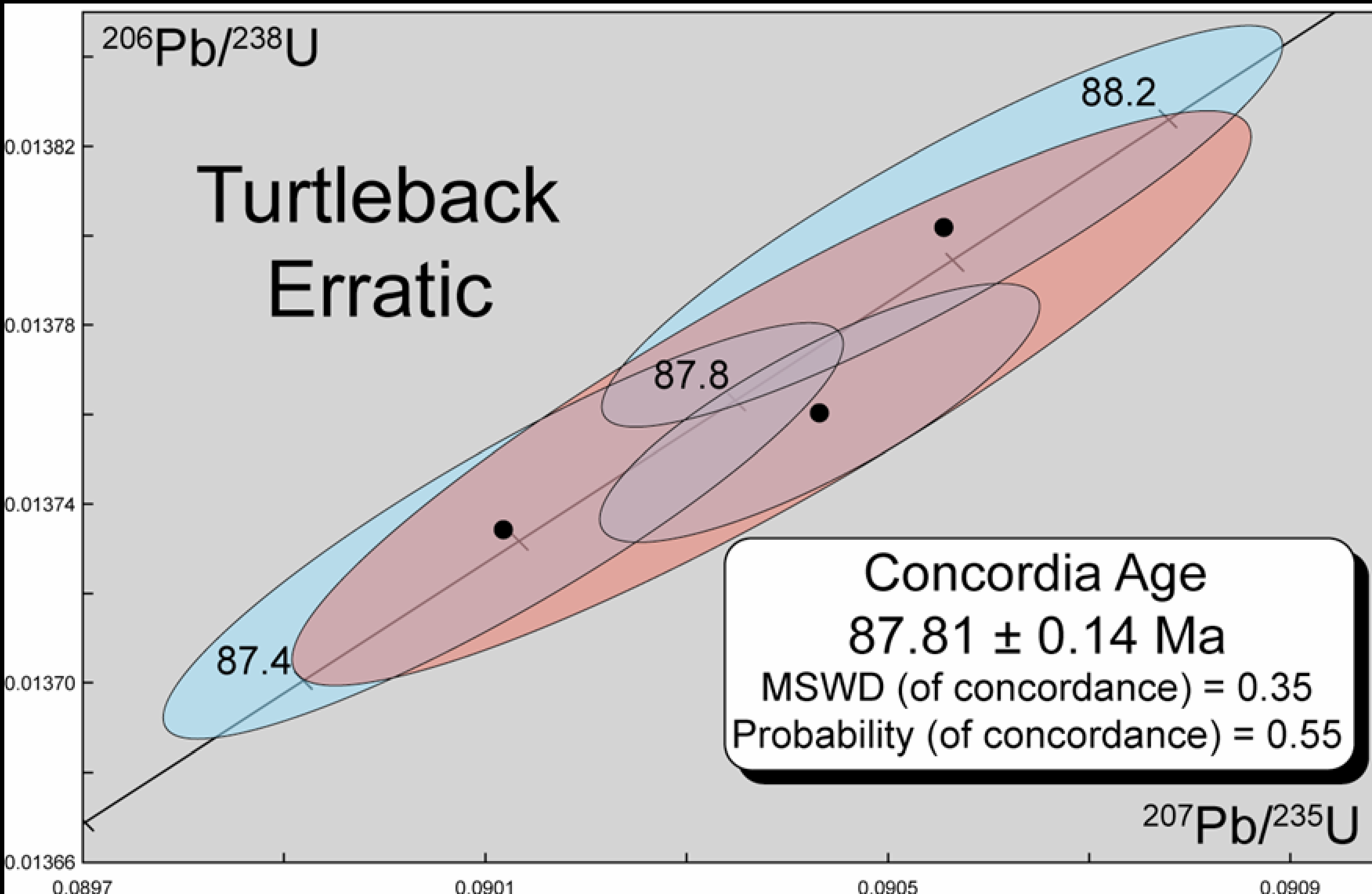
Cathedral Peak Granodiorite (?) boulder

Geologic map of Yosemite National Park

Huber et al., 1987



Determining the extent of pre-Tahoe glaciations



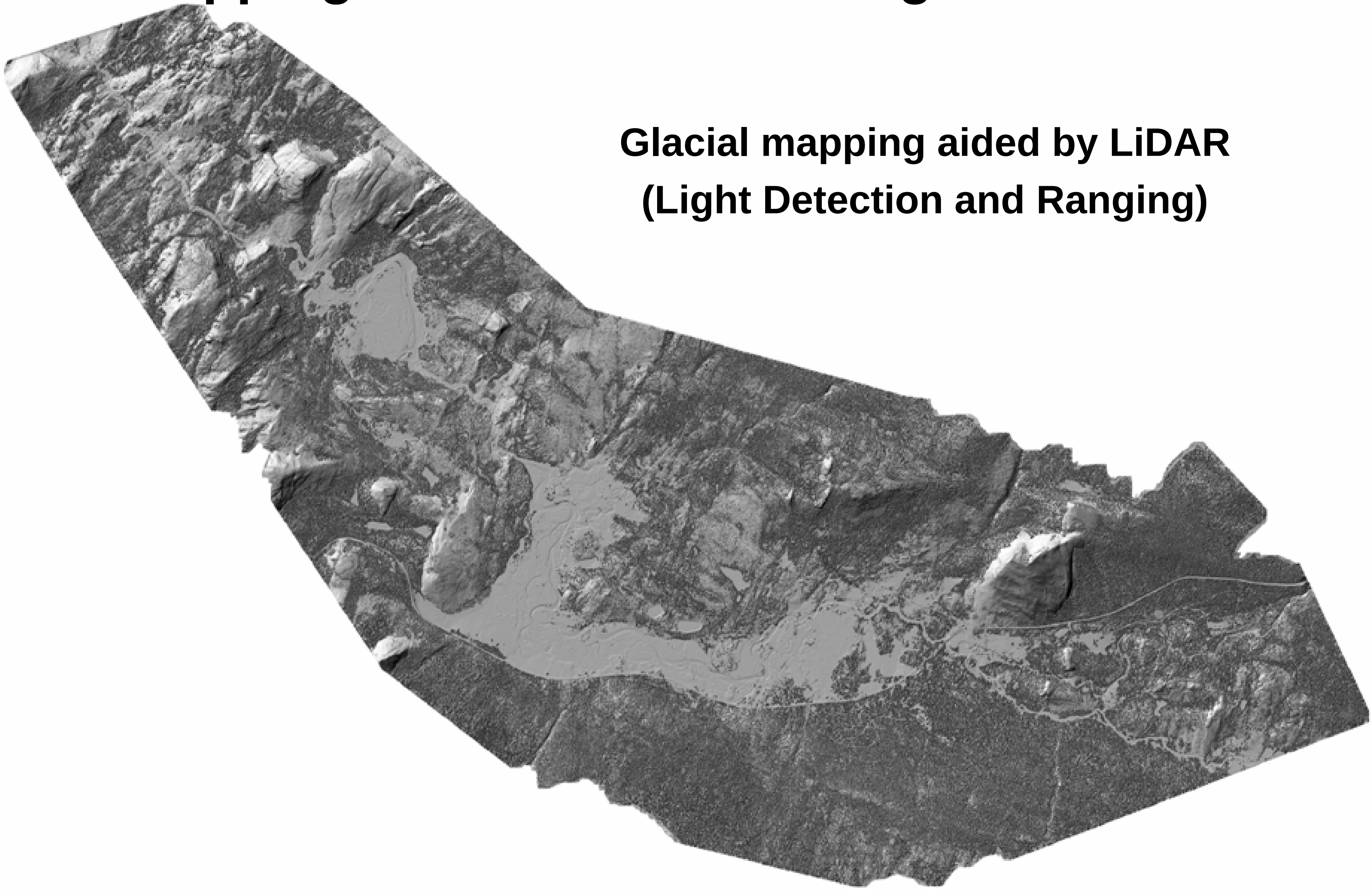
Data courtesy Drew Coleman, UNC Chapel Hill

Determining the extent of pre-Tahoe glaciations

Perched erratic, Middle Fork Tuolumne Canyon

Mapping the extent of the Tioga Glaciation

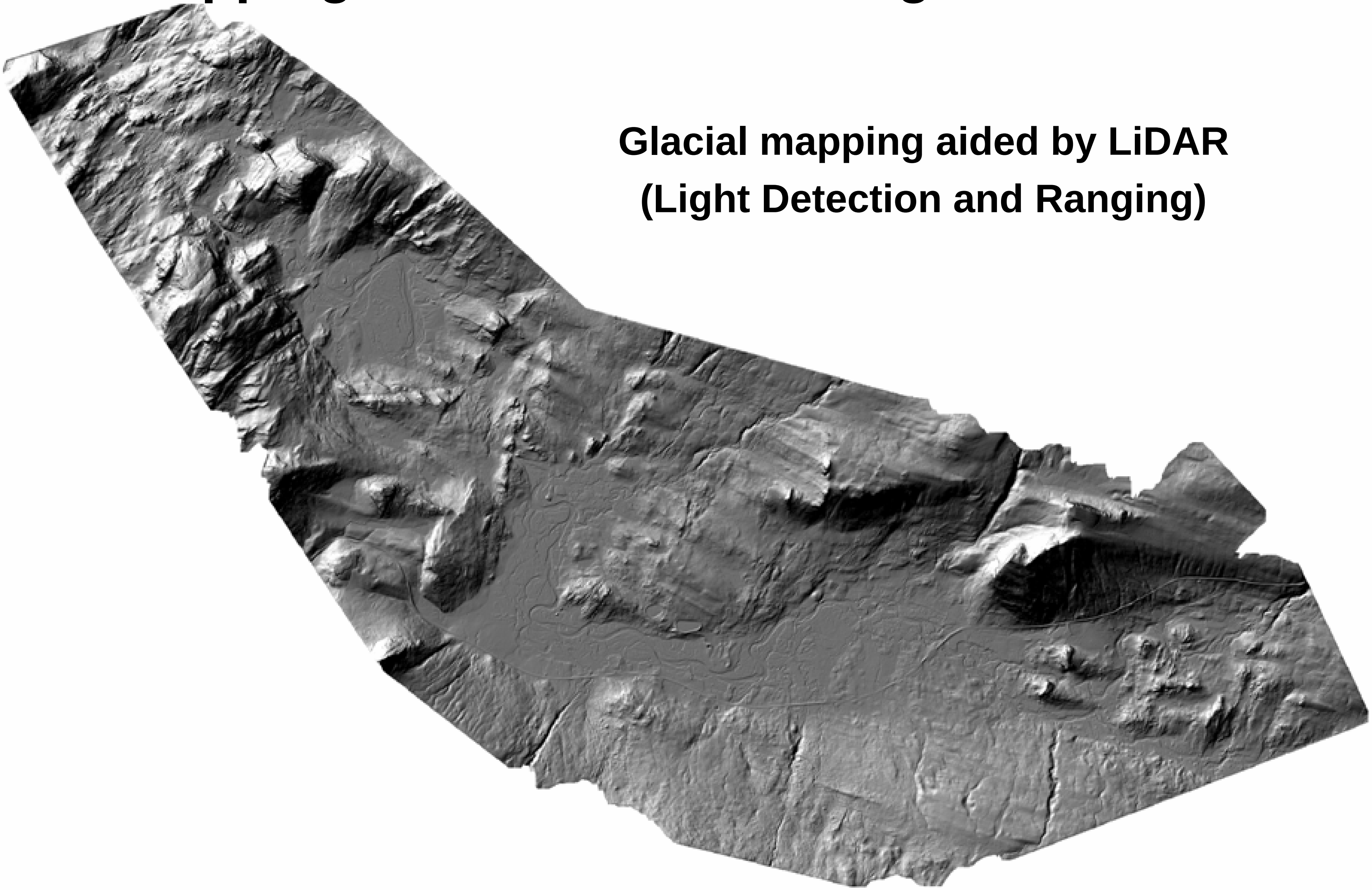
Glacial mapping aided by LiDAR (Light Detection and Ranging)



Tuolumne Meadows 1 m Digital Elevation Model (DEM) shaded relief

Mapping the extent of the Tioga Glaciation

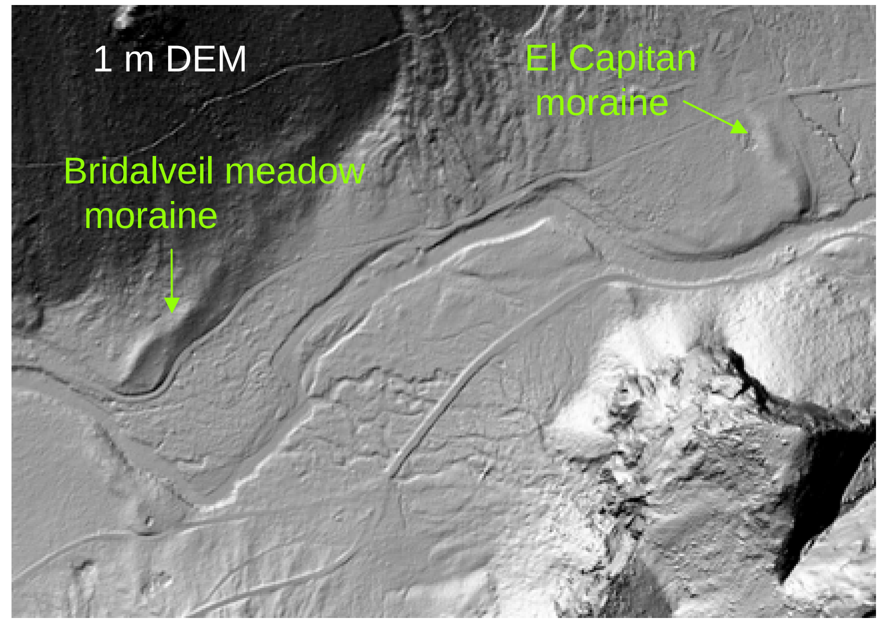
Glacial mapping aided by LiDAR
(Light Detection and Ranging)



Tuolumne Meadows 1 m Digital Elevation Model (DEM) shaded relief

Glacial mapping aided by LiDAR

10 m versus 1 m Digital Elevation Model of western Yosemite Valley



Dating the Tioga Glaciation with cosmogenic ^{10}Be

- Concentration of cosmogenic ^{10}Be (N) is a function of production rate (P), exposure time (t), and rock erosion rate (ε):

$$N = \frac{P}{\lambda + \frac{\varepsilon}{\Lambda}}\left(1 - \exp\left[-\left(\lambda + \frac{\varepsilon}{\Lambda}\right)t\right]\right)$$

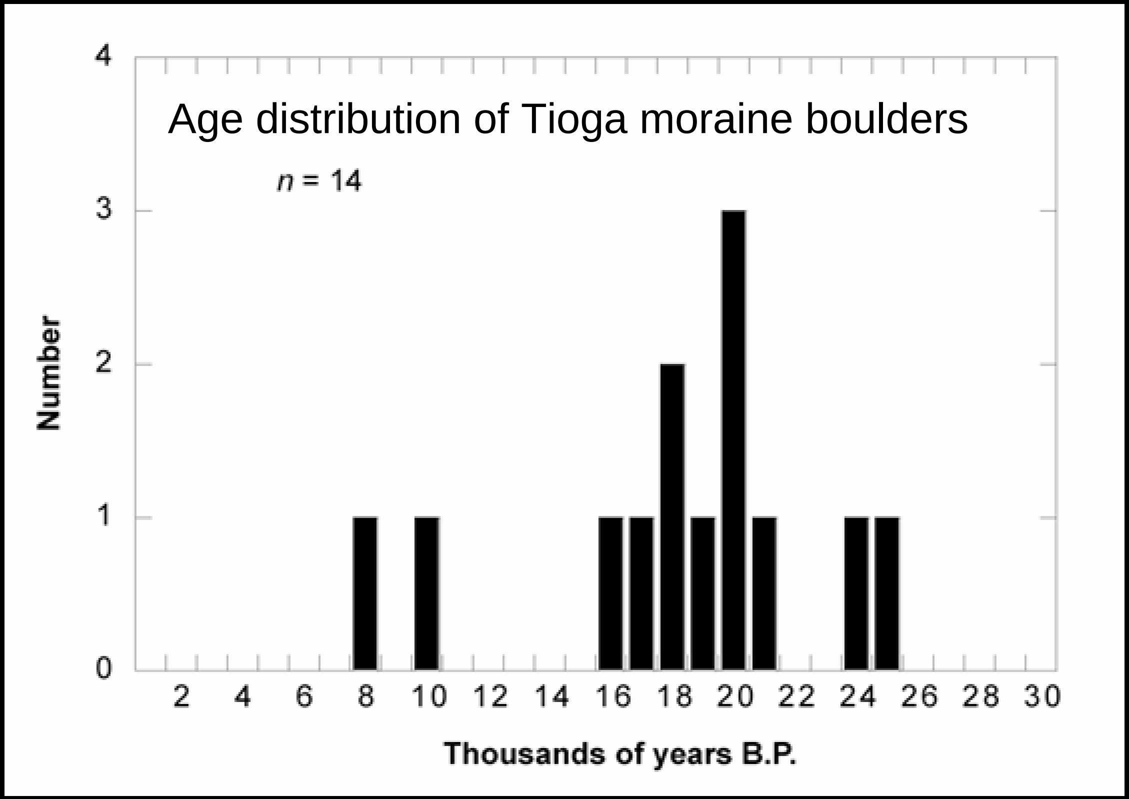
Glacial erratic on polished, striated bedrock surface, Pothole Dome

Dating the Tioga Glaciation with cosmogenic ^{10}Be

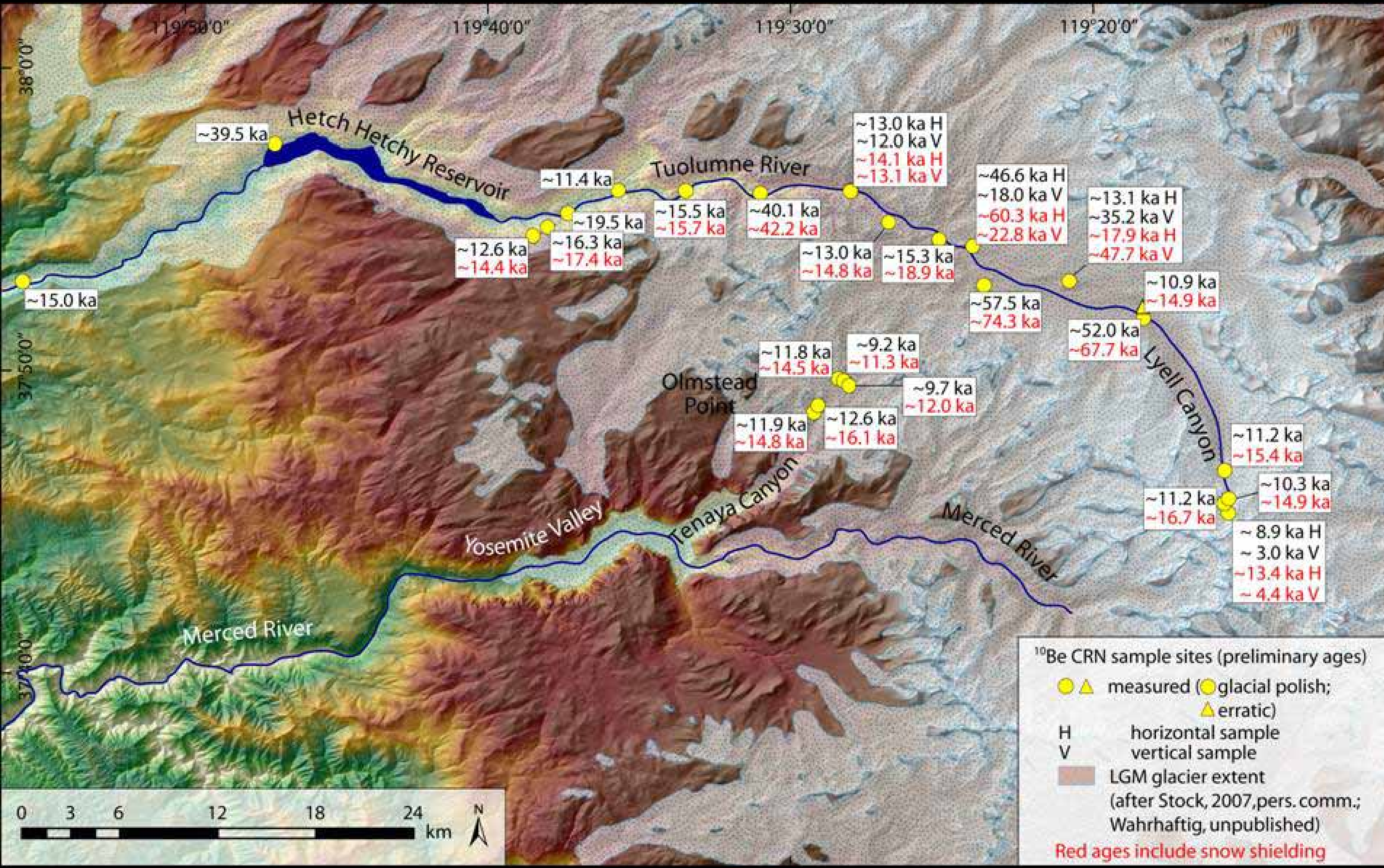
Boulder moraine in lower Yosemite Creek

Dating the Tioga Glaciation with cosmogenic ^{10}Be

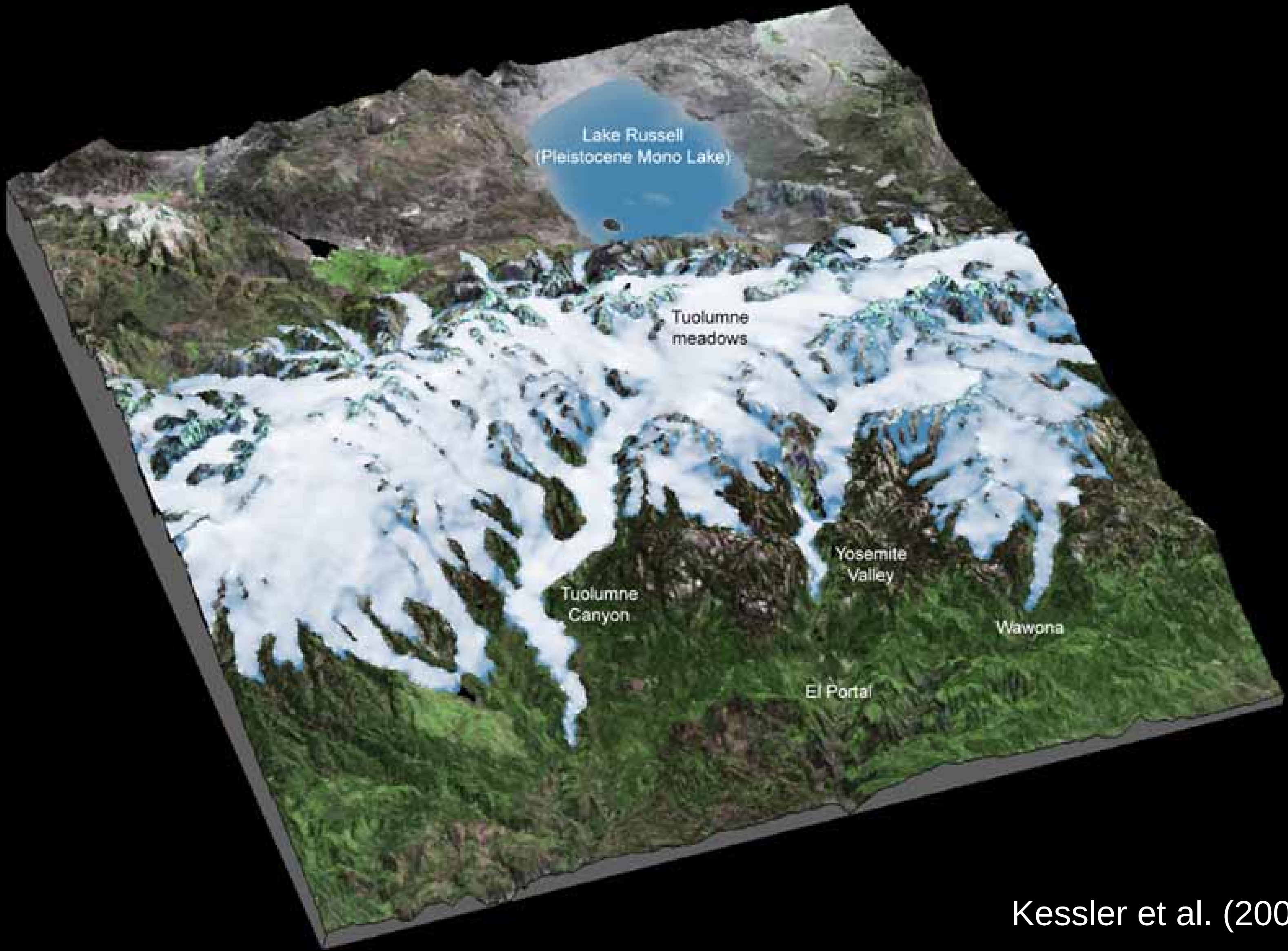
- 21 samples analyzed thus far, 8 remaining
- 3 samples from deposits mapped as pre-Tahoe are >100 kyr
- 2 samples from deposits mapped as Tahoe are >100 kyr
- 1 sample from deposit mapped as Tahoe ~20 kyr
- 14 samples from deposits mapped as Tioga are 8-25 kyr



Dating the Tioga Glaciation with cosmogenic ^{10}Be



Glacier extent in Yosemite National Park during the Last Glacial Maximum (Tioga Glaciation)

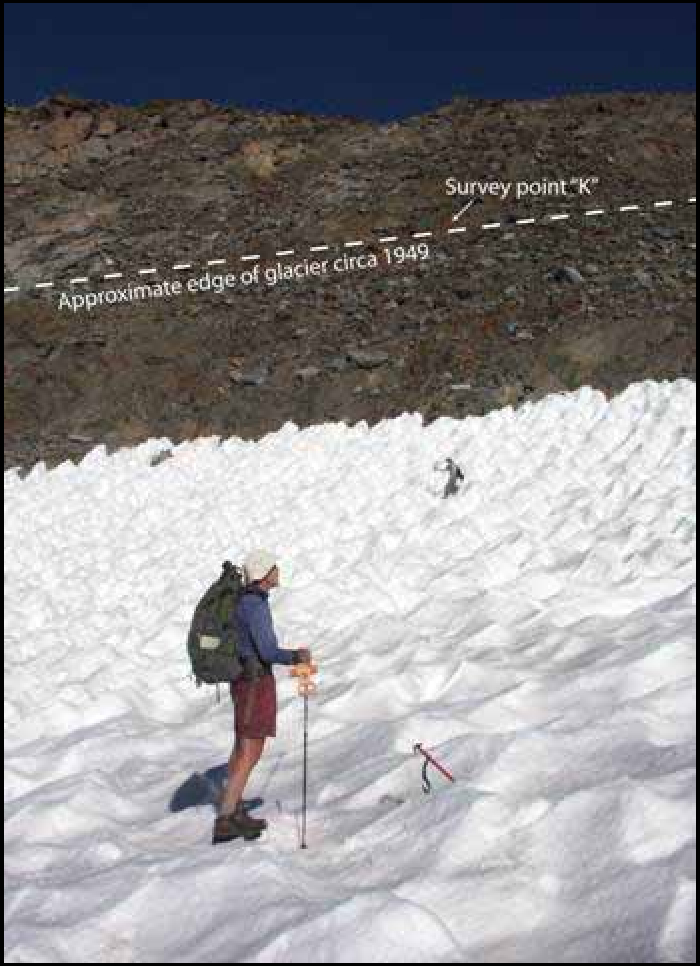


Kessler et al. (2006)

Documenting retreat of modern glaciers

- Resurvey of transects established in 1930's using standard survey methods and GPS
- Repeat photography from established photo points
- LiDAR data collection

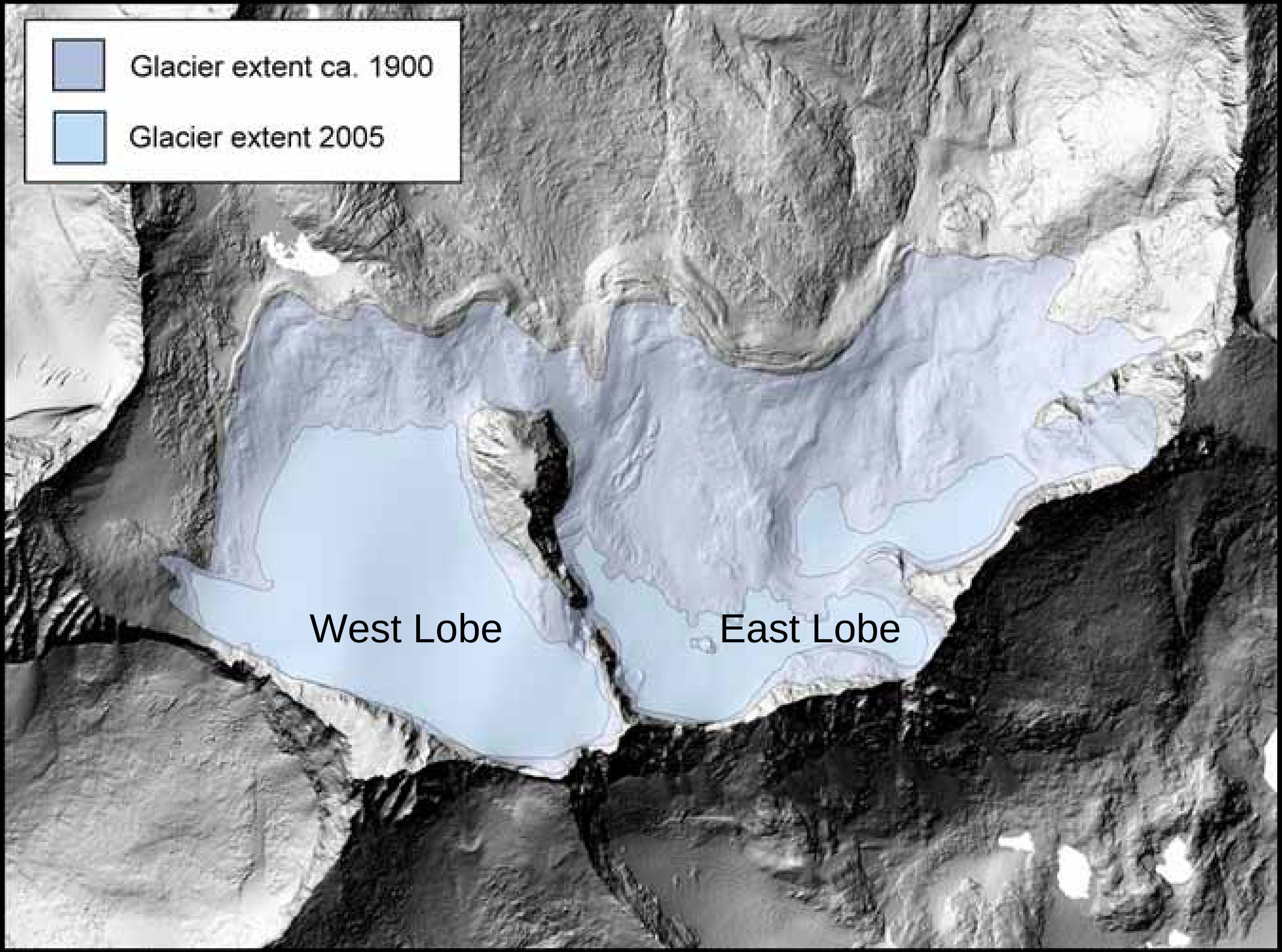
Lyell Glacier, Yosemite National Park



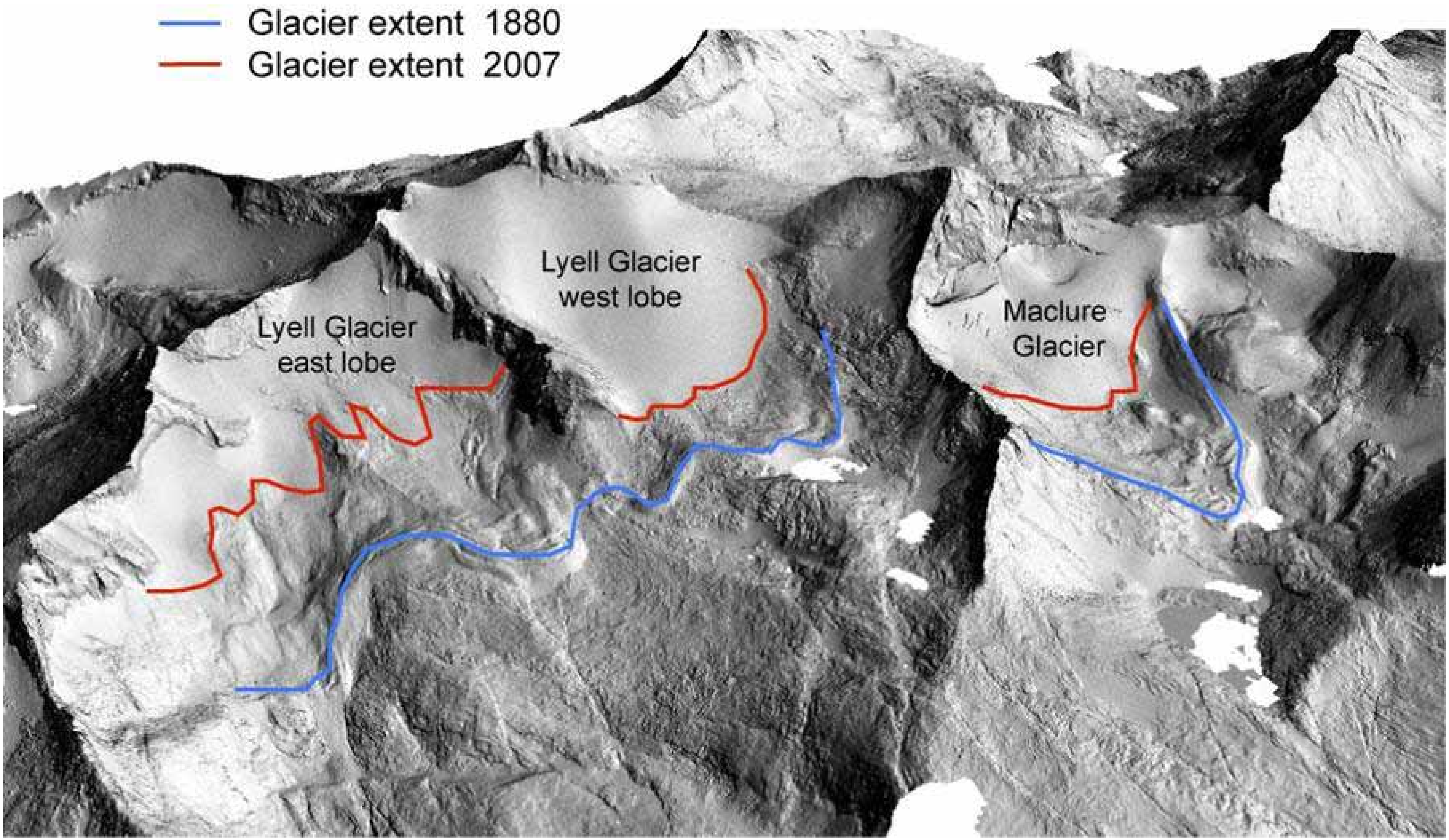
Documenting retreat of modern glaciers

Lyell Glacier surface area reduction since 1900 (Basagic, 2008):

- 35% reduction of west lobe
- 70% reduction of east lobe



1 m DEM of Lyell and Maclure glaciers from airborne LiDAR



Lyell Glacier, Yosemite National Park

August 7, 1903

Photo by G.K. Gilbert

August 14, 2004

Photo by H. Basagic

Maclure Glacier, Yosemite National Park

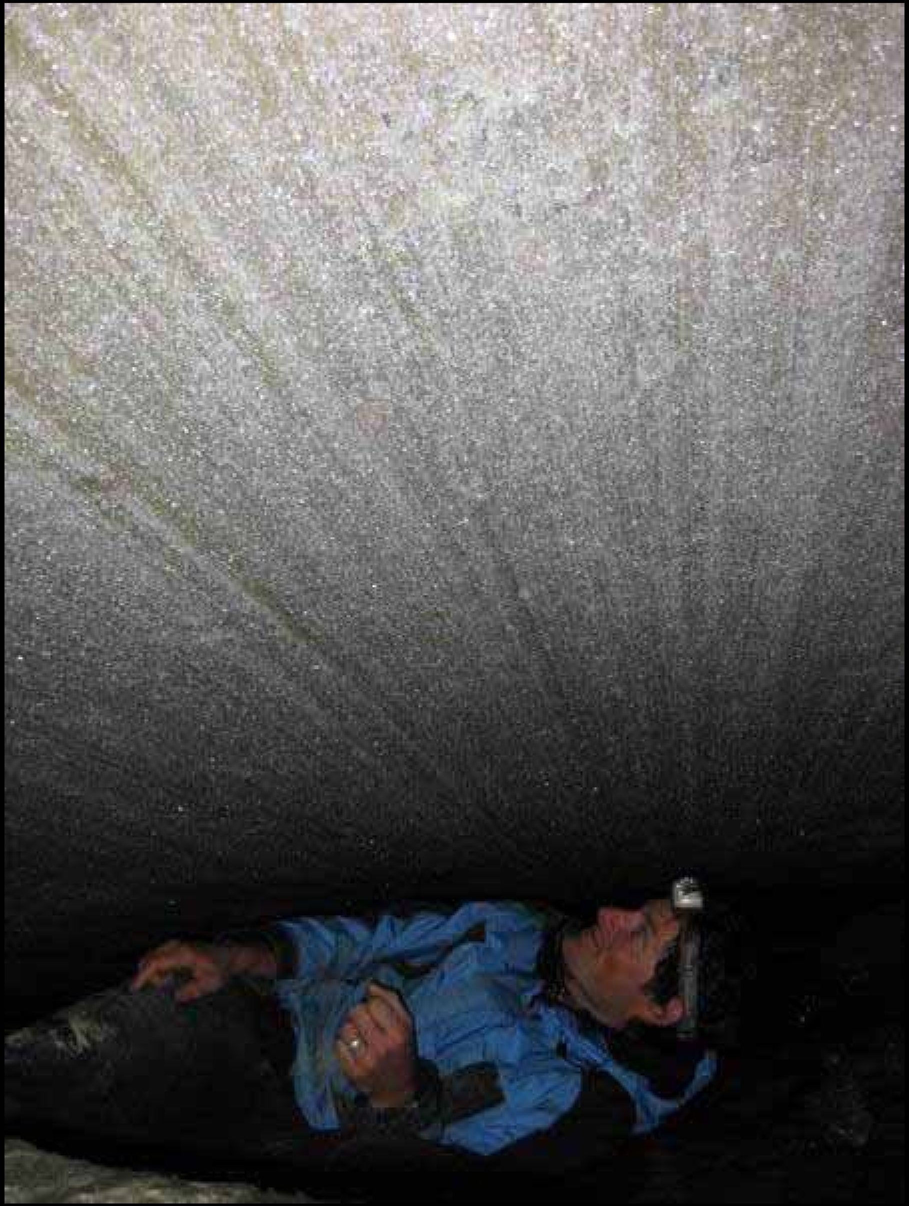
August 7, 1903

Photo by G.K. Gilbert

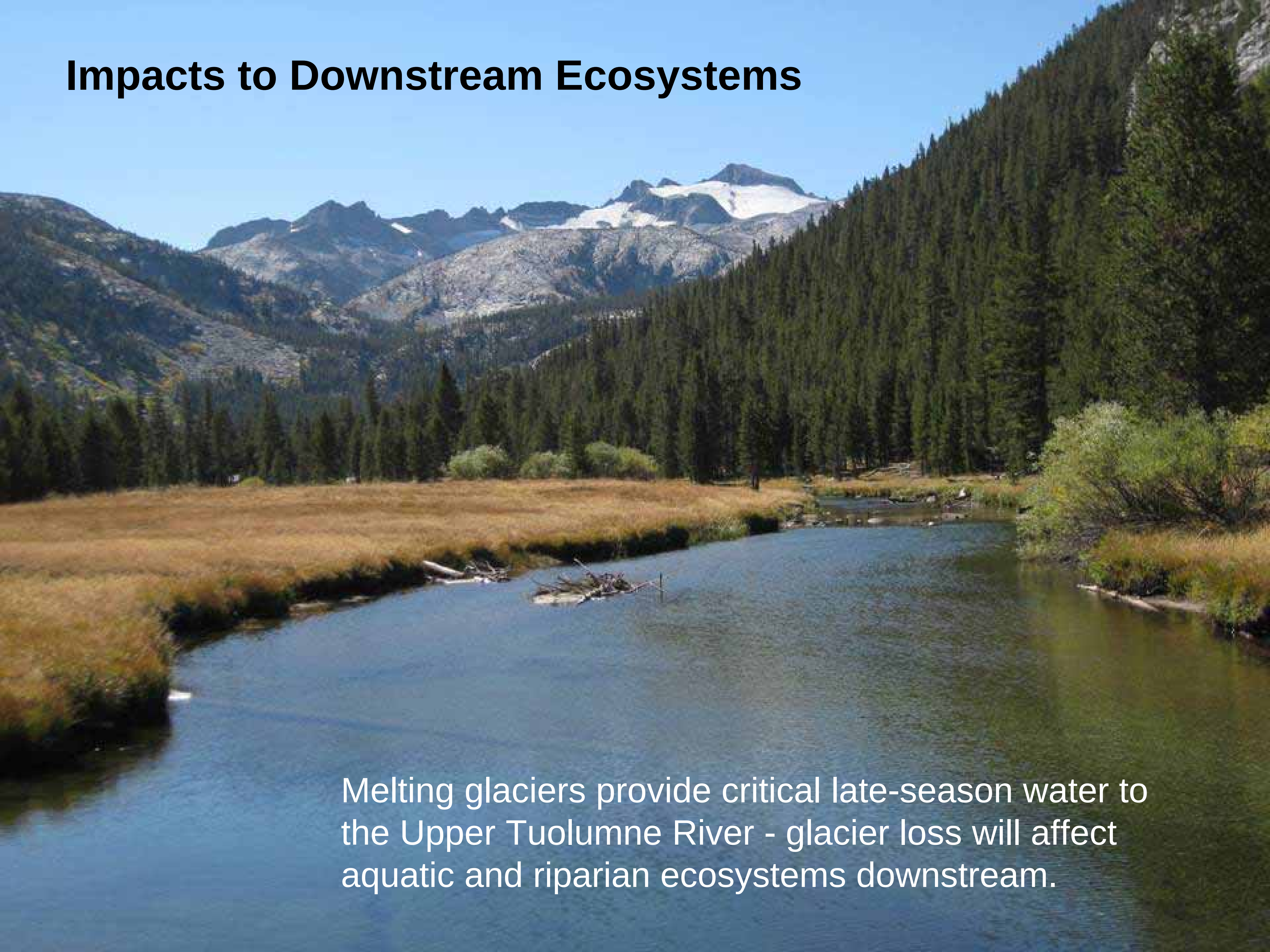
August 14, 2003

Photo by H. Basagic

Documenting retreat of modern glaciers



Impacts to Downstream Ecosystems



Melting glaciers provide critical late-season water to the Upper Tuolumne River - glacier loss will affect aquatic and riparian ecosystems downstream.