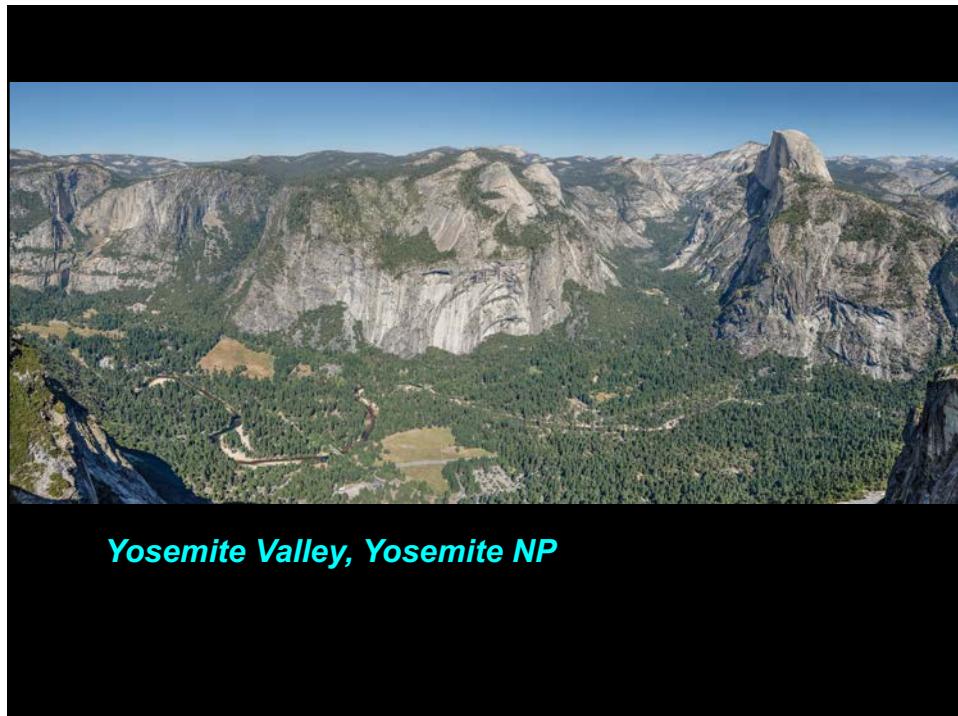
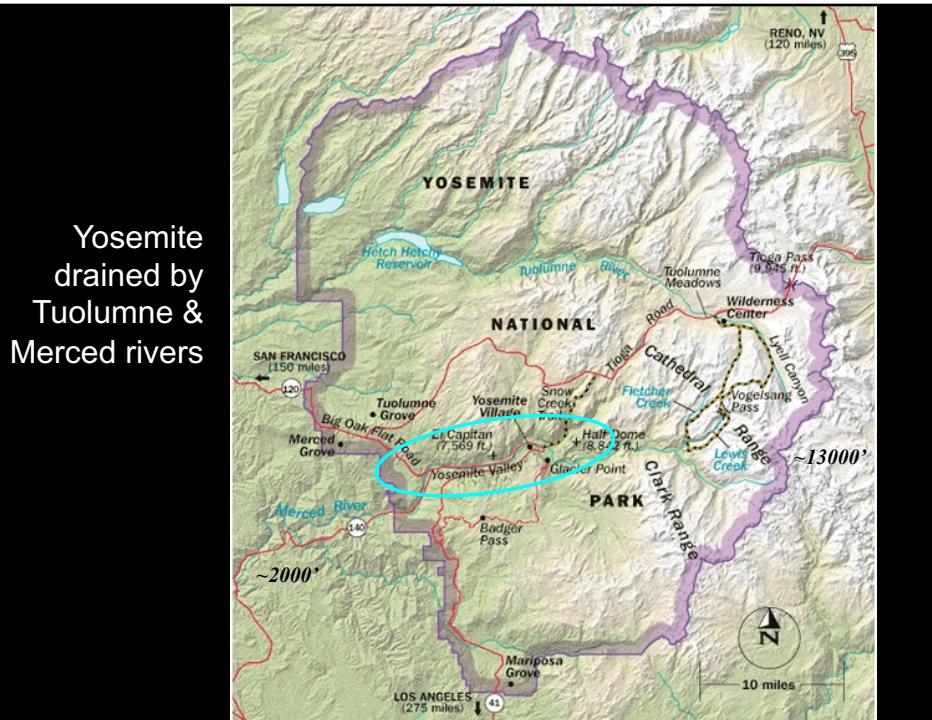




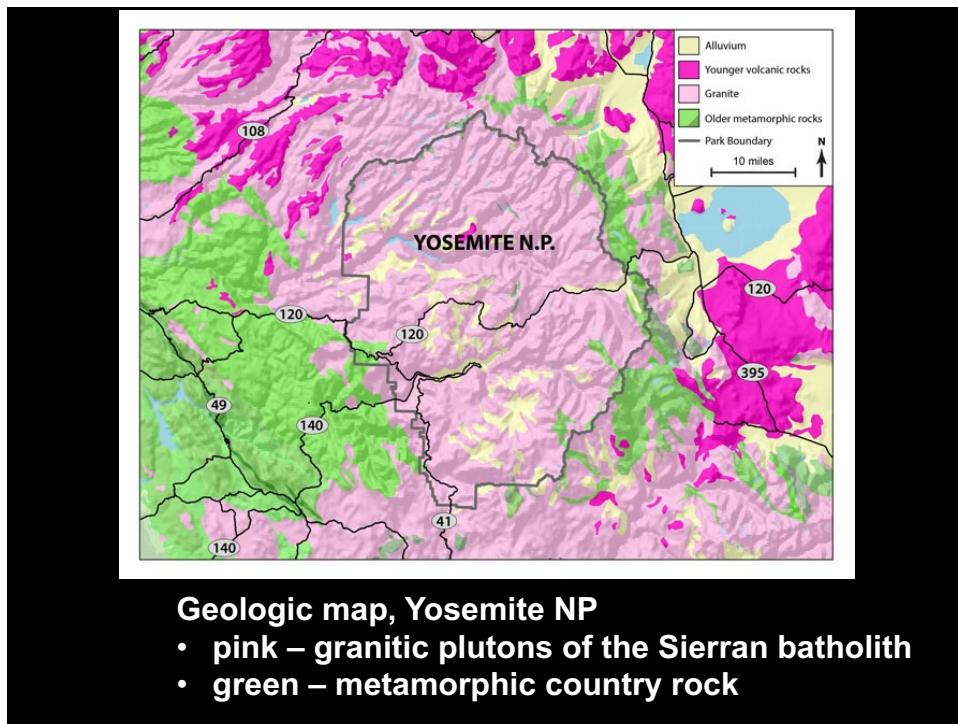
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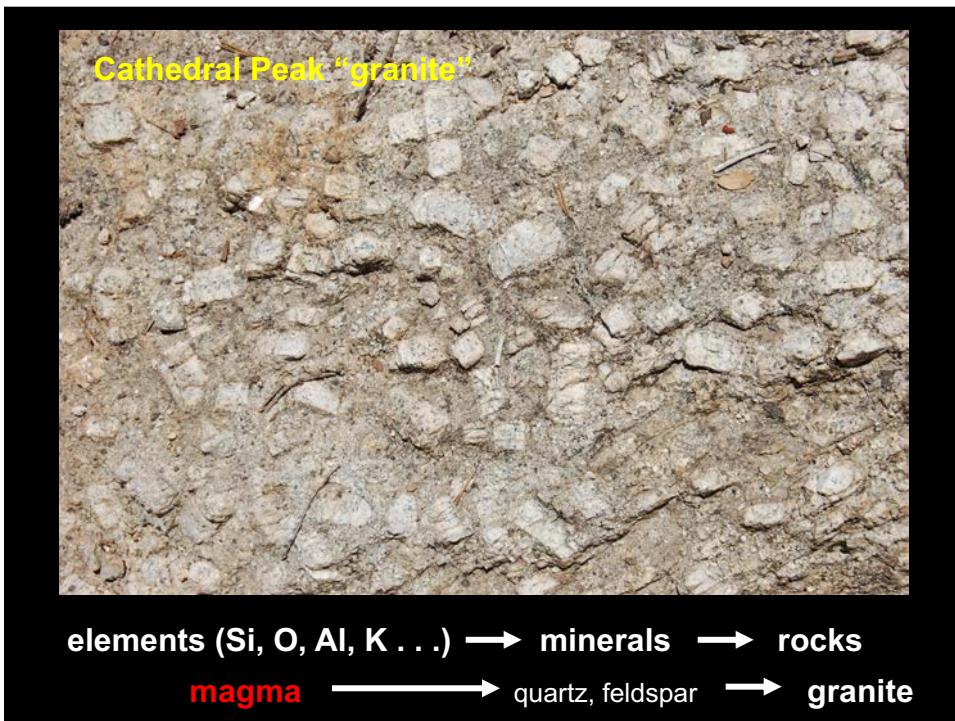
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6

**Landscape evolution: Yosemite NP**

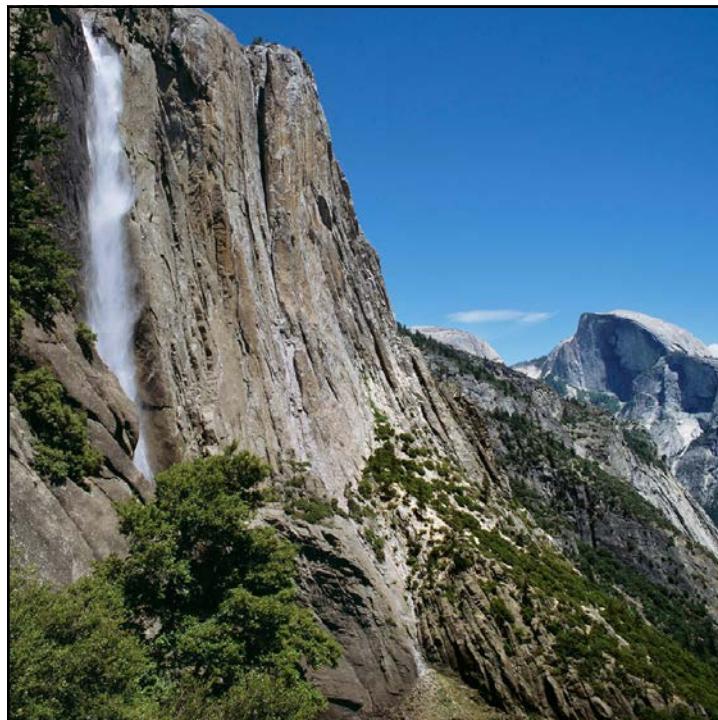


*planar jointing, exfoliation jointing, rockfalls, glaciation*

7

Vertical  
planar joints  
in rock face  
near  
Yosemite  
Falls

- developed  
during  
uplift of  
modern SN



8



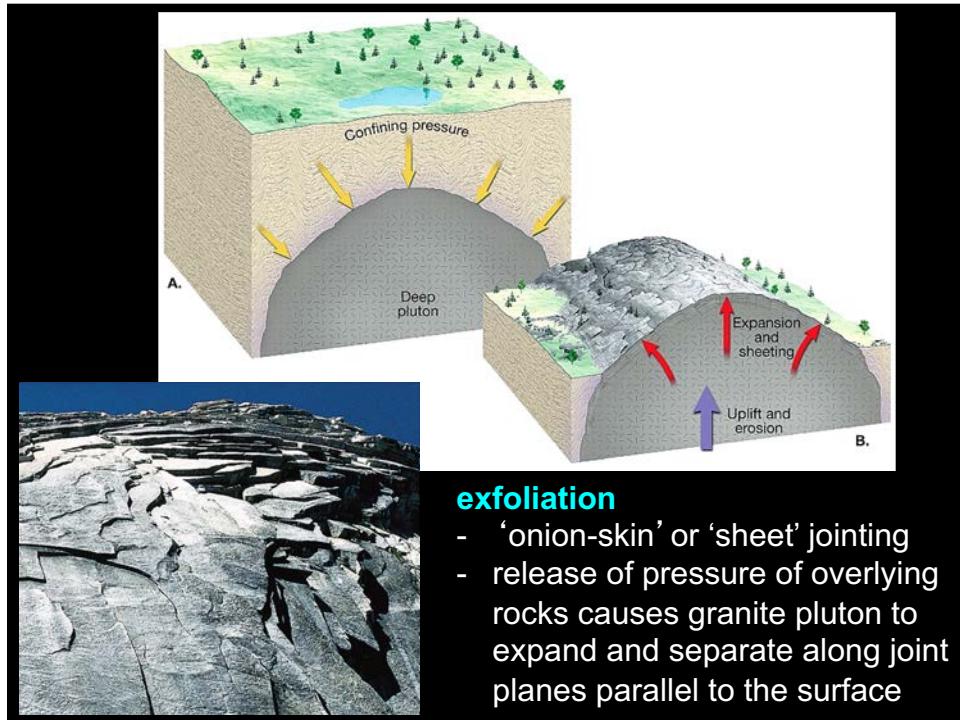
**intersecting joint planes forming Three Brothers**  
- makes the granite susceptible to weathering and erosion

9



**North & Basket Domes, Yosemite NP**  
- formed by **exfoliation jointing**

10



11



sheet-like **exfoliation joints** near Olmsted Point, Yosemite NP

12



**exfoliation jointing - Yosemite NP**  
- permits infiltration of water into the body of rock

13



**exfoliation jointing  
on Half Dome**

14

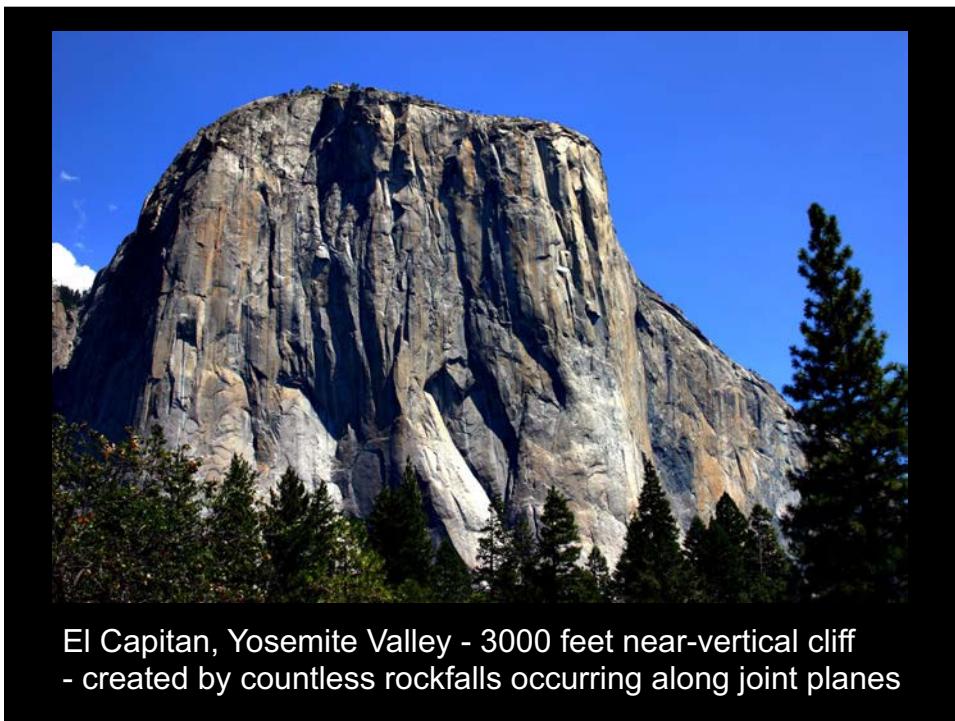
twin domes formed by exfoliation jointing



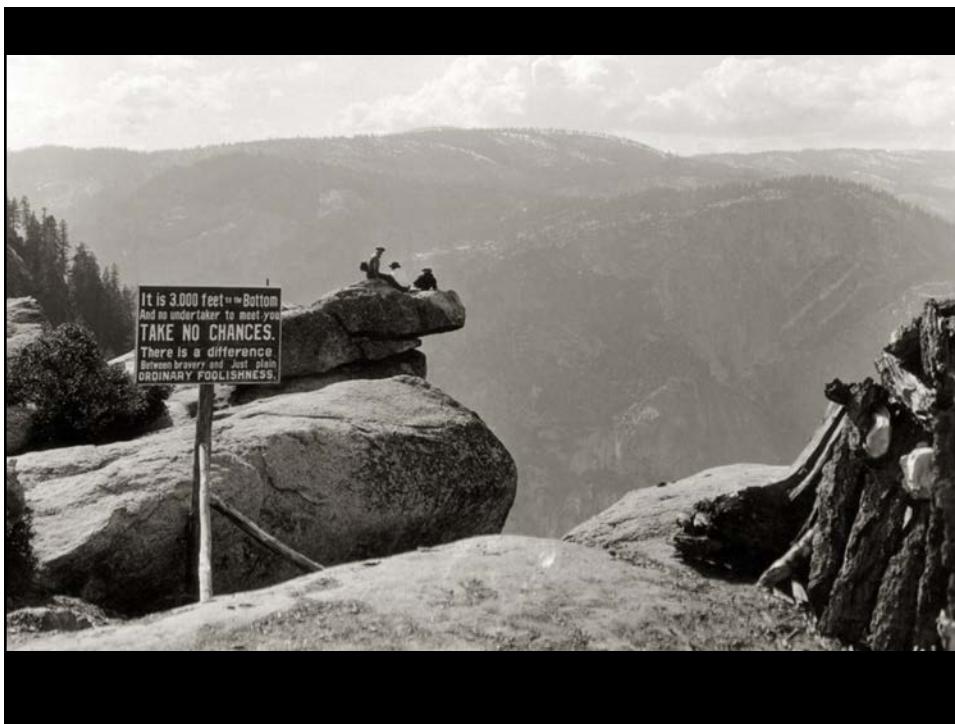
15

*How are vertical cliff faces maintained in  
Yosemite/Kings Canyon/Sequoia?*

16



17



18



**weathering and erosion along vertical joints & exfoliation joints weakens the rock, allowing slabs to separate from the main mass and ultimately to detach as rockfalls**

19



**Weakening of rock faces along joint planes generates **rockfalls**.**

- *intense rainfall*
- *small earthquakes*
- *ice wedging along joint planes*
- *temperature extremes*
- *no recognizable trigger*

20

10



**Rockfall from El Capitan  
Sept. 28, 2017**

*2 rockfalls in 2 days  
135'x65' slab, 1 killed*

21

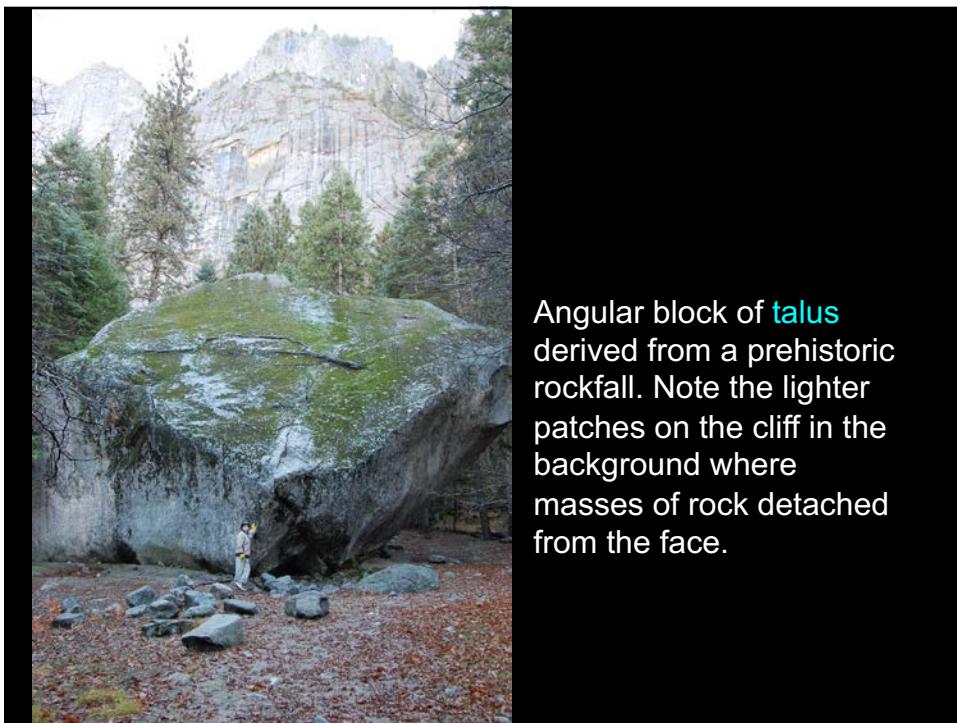


*Dust cloud from  
top of El Capitan,  
2017*

*scar on El Capitan  
where slab broke loose*

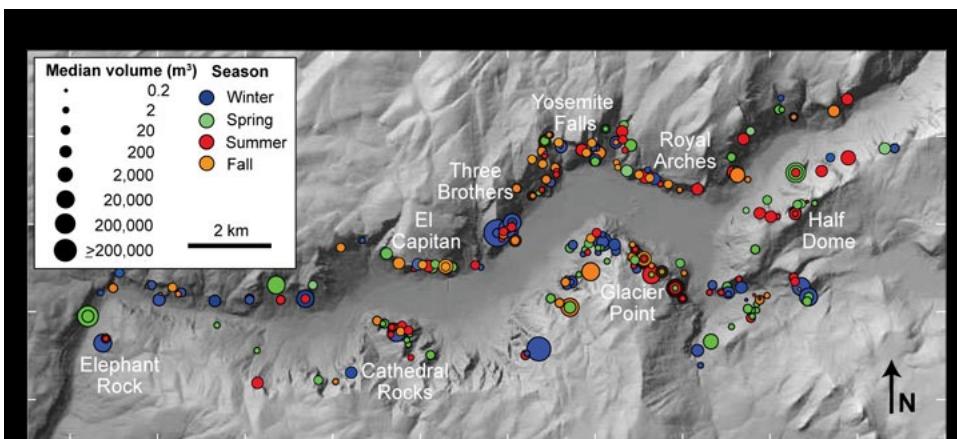


22



Angular block of talus derived from a prehistoric rockfall. Note the lighter patches on the cliff in the background where masses of rock detached from the face.

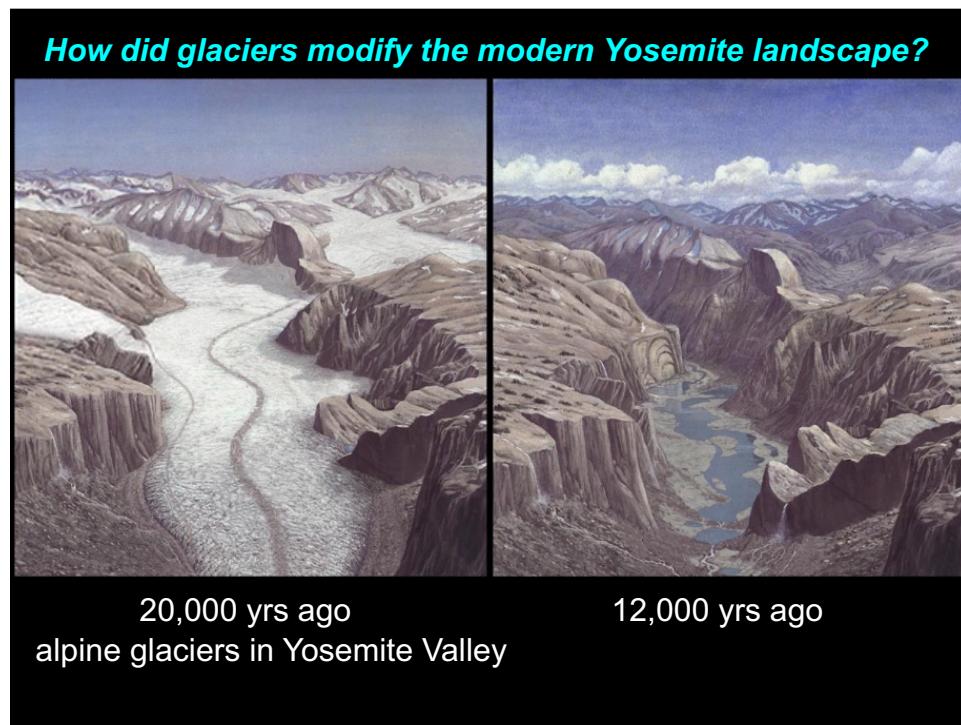
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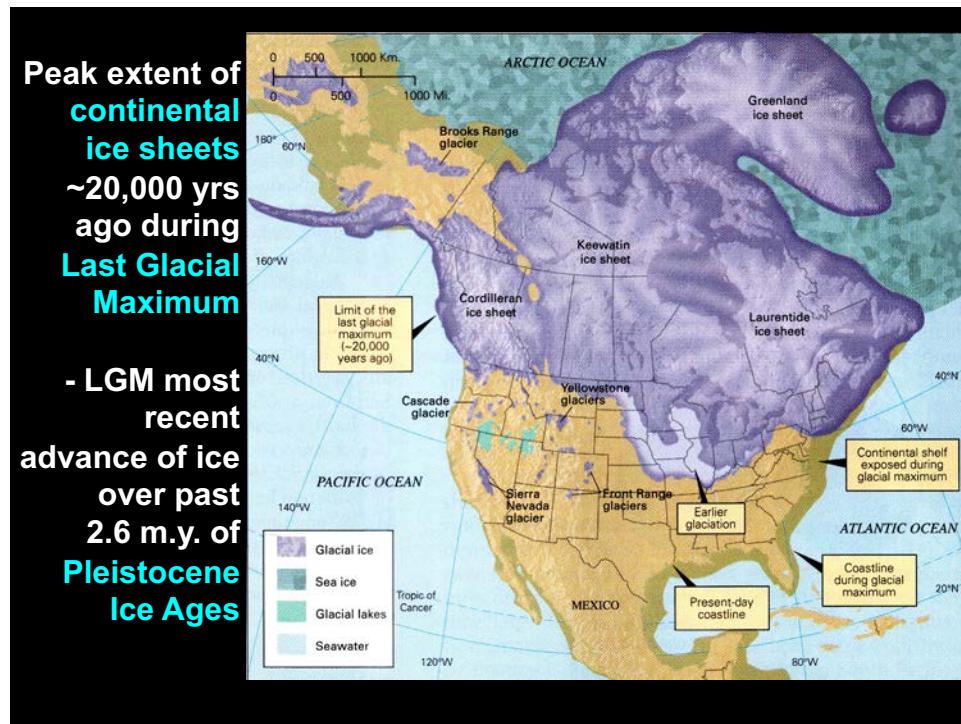
Mapped locations of documented rockfalls in Yosemite Valley from 1857 to 2011. (NPS)

On average, about 80 rockfalls happen every year in Yosemite.  
15 deaths & ~85 injuries documented over last several decades.  
- No apparent connection with season

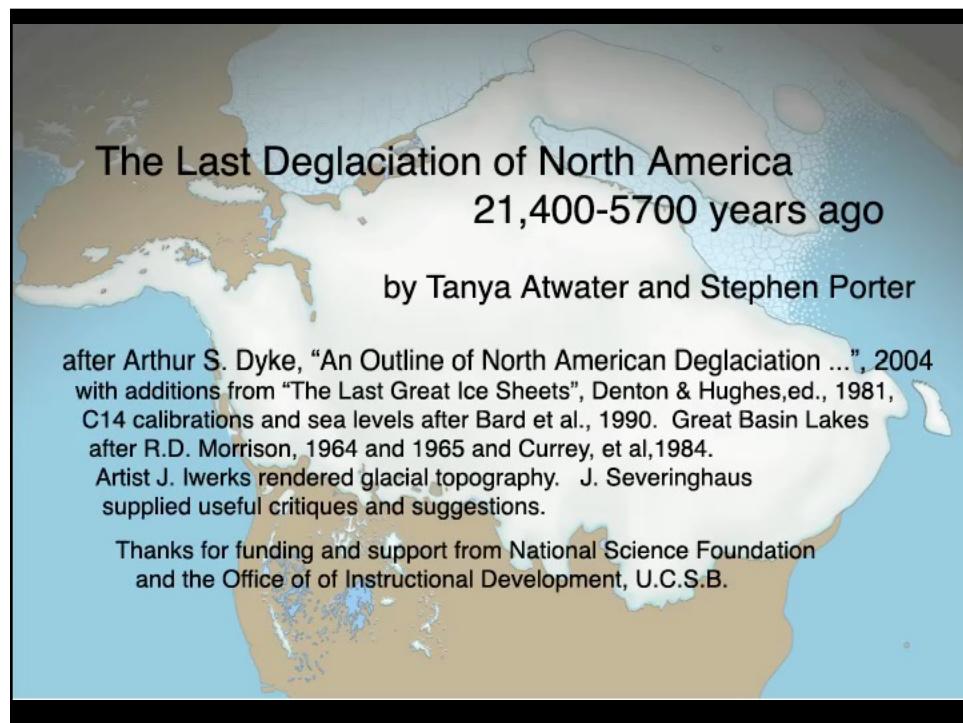
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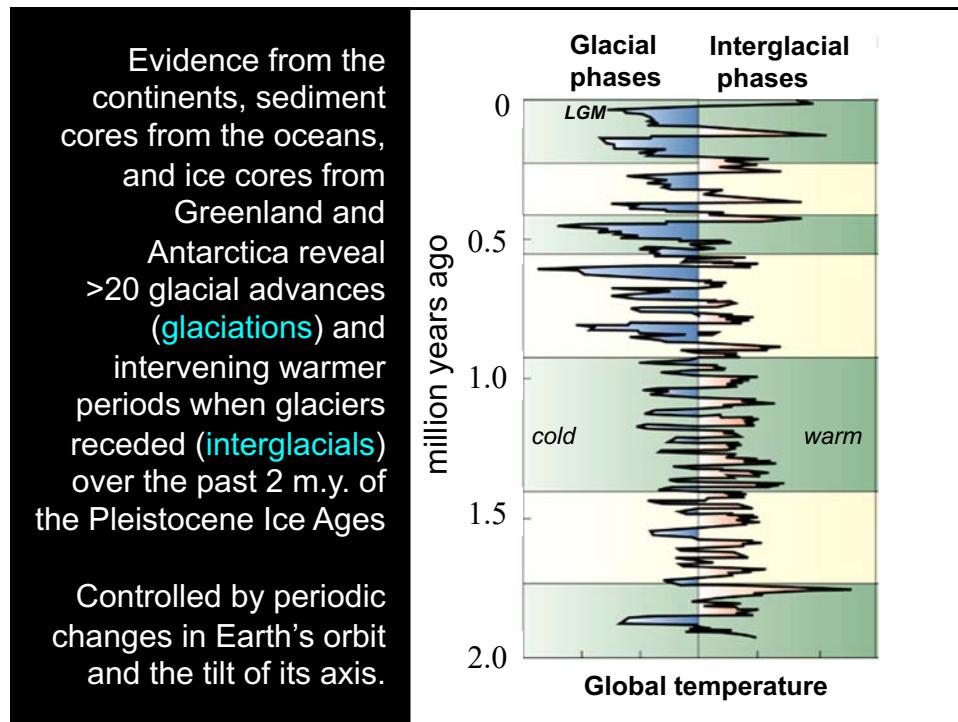
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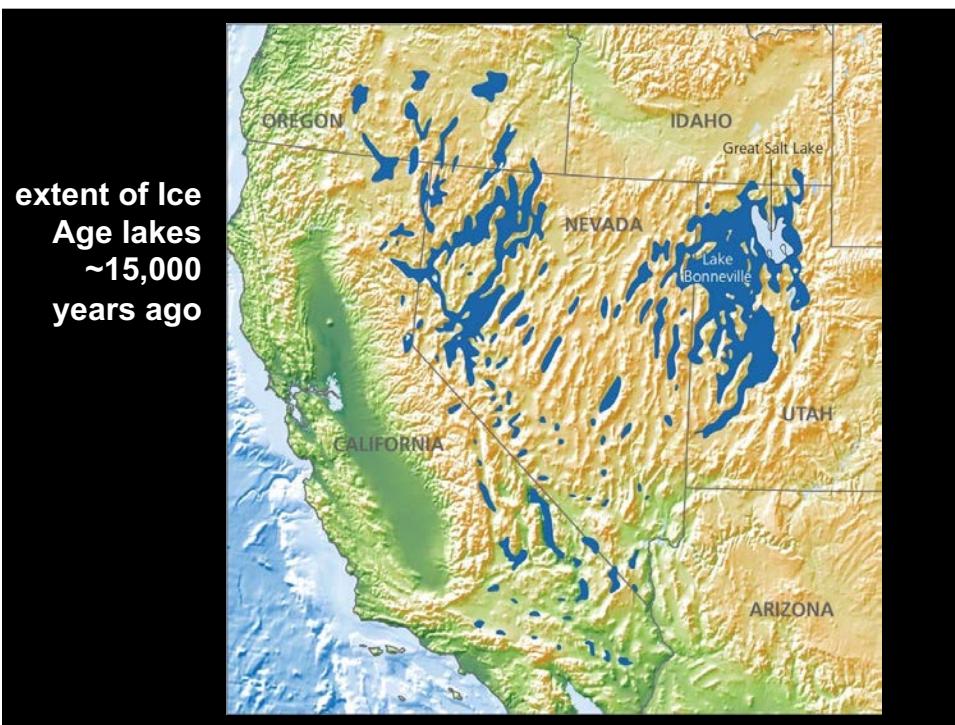
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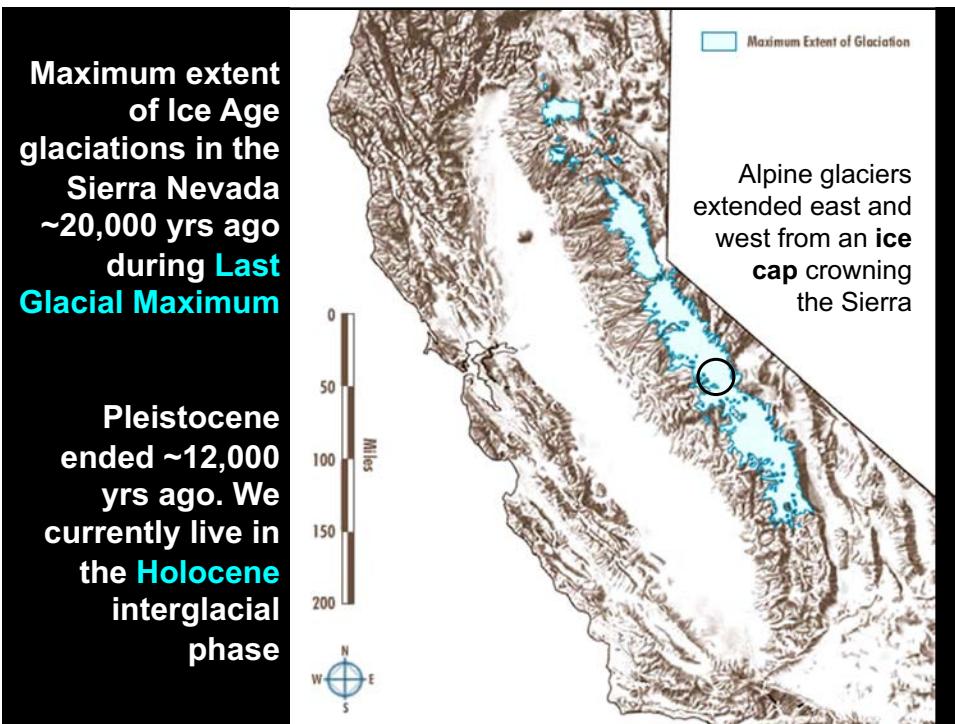
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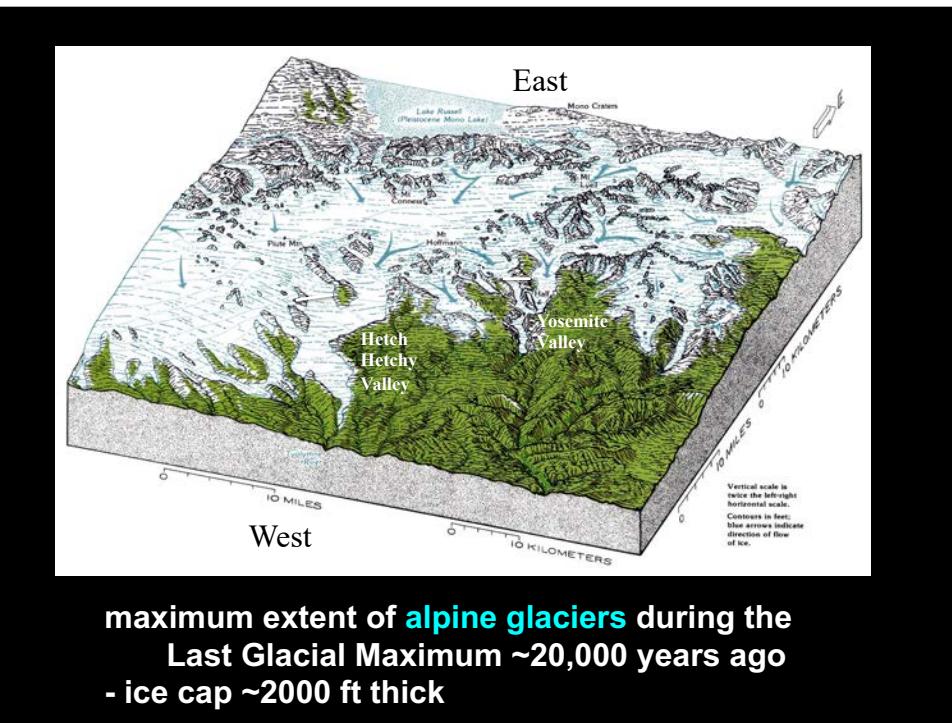
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29



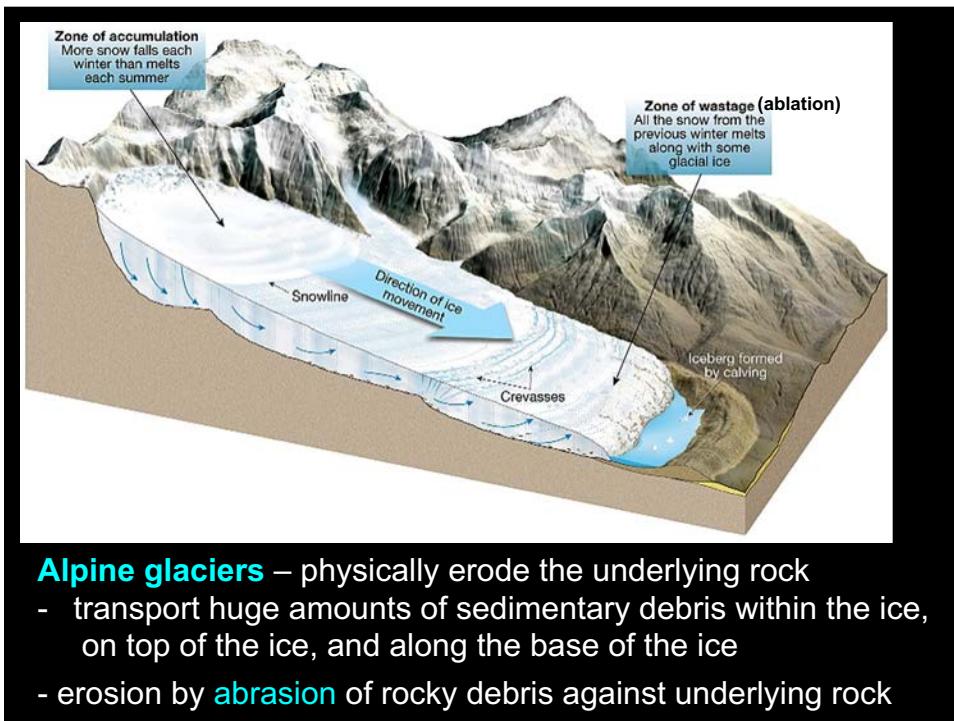
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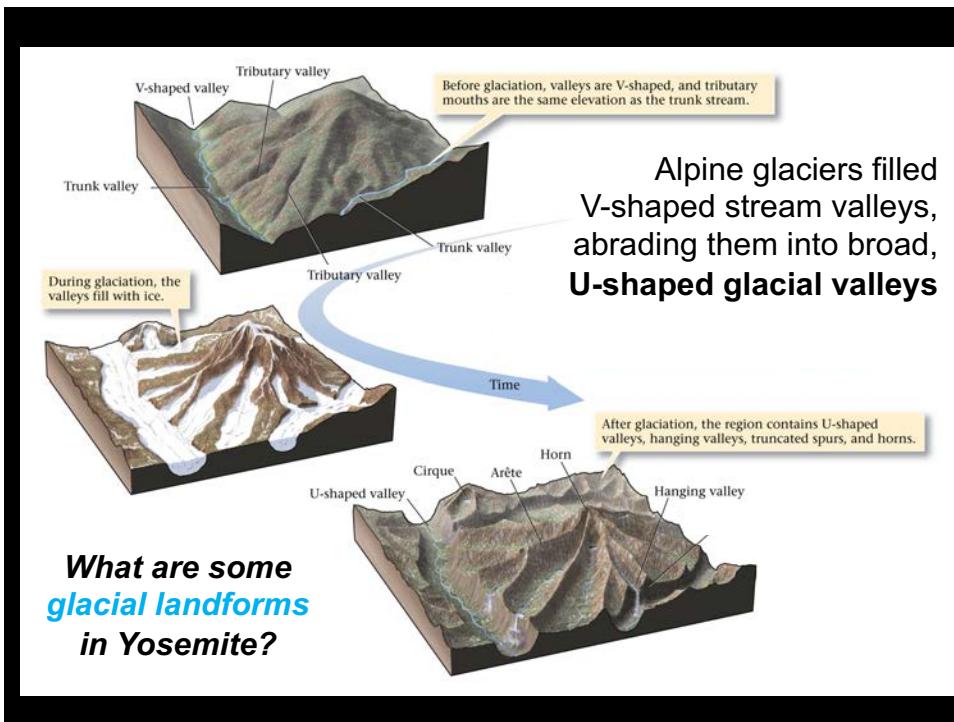
31



32



33



34



### **U-shaped Tenaya Valley, Yosemite NP**

- filled with a 2000' thick glacier, packed with sand, gravel, & large blocks of rock
- erosion by **abrasion** of rocky debris against bedrock

35

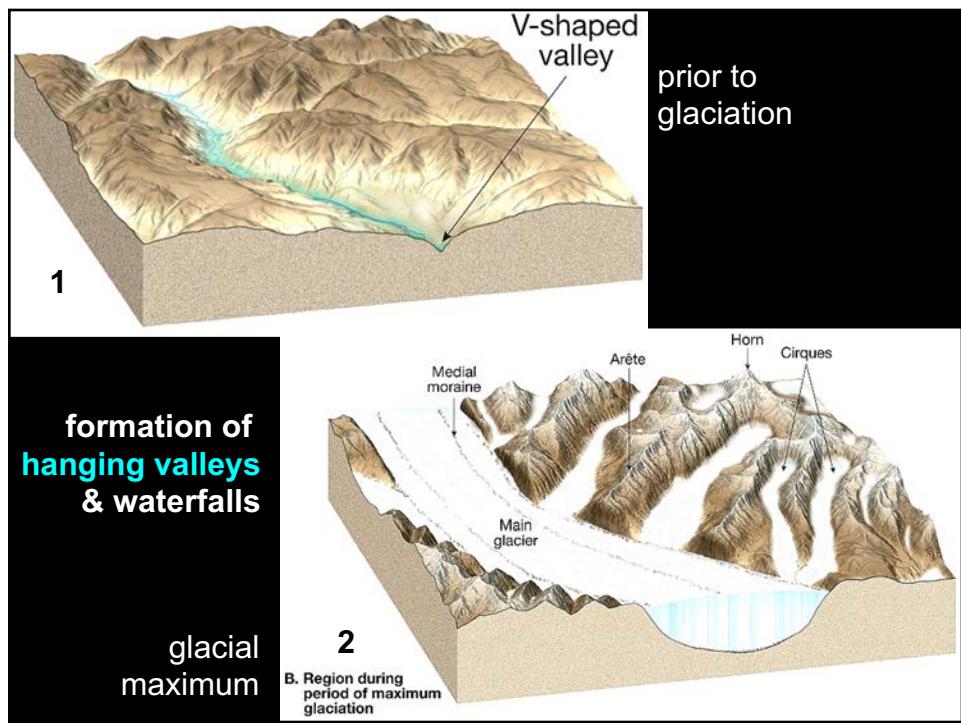
*Ice Age Panorama from Glacier Point*

Image © Eric Knight/NPS



**Yosemite 20,000 years ago during Last Glacial Maximum**  
- glacial ice was 2000' thick & full of sedimentary debris

36

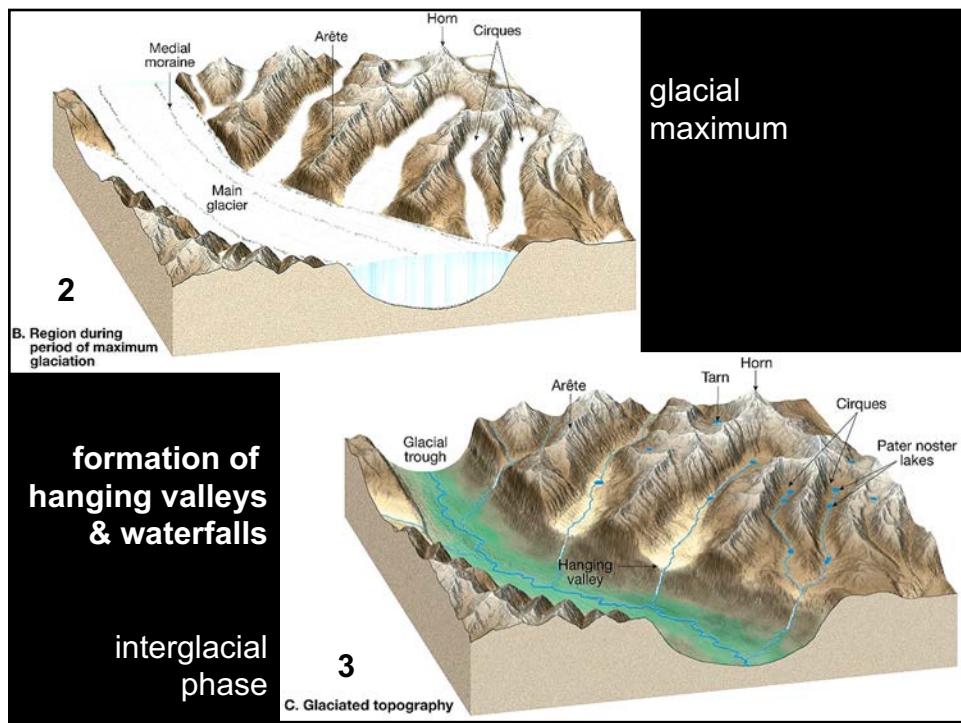


37

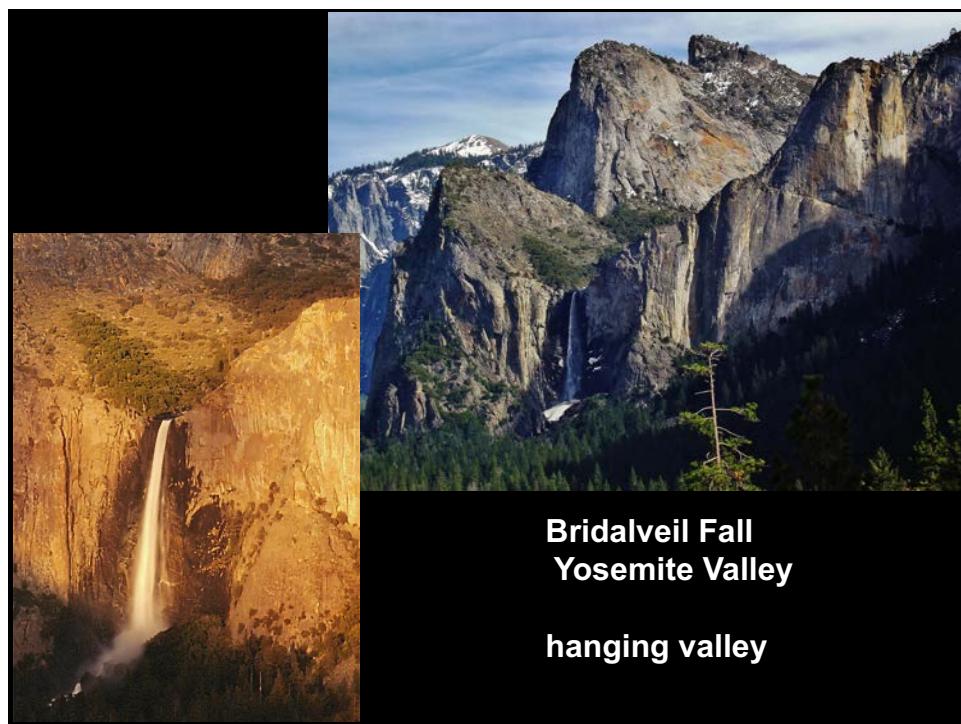


"hanging" glaciers above Athabasca Glacier - Canadian Rockies

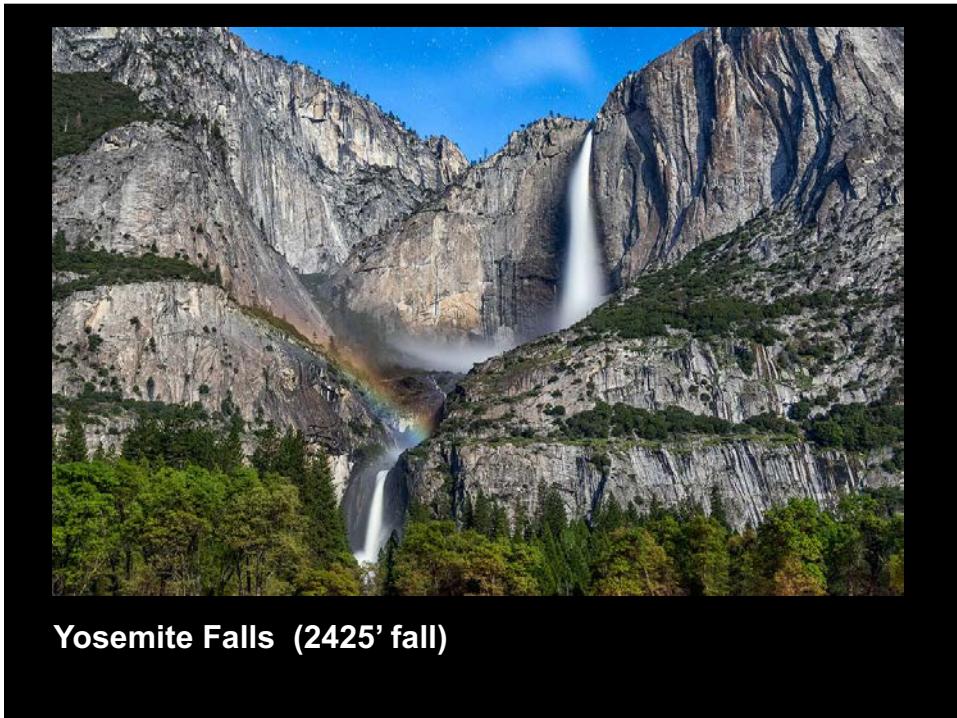
38



39



40



**Yosemite Falls (2425' fall)**

41



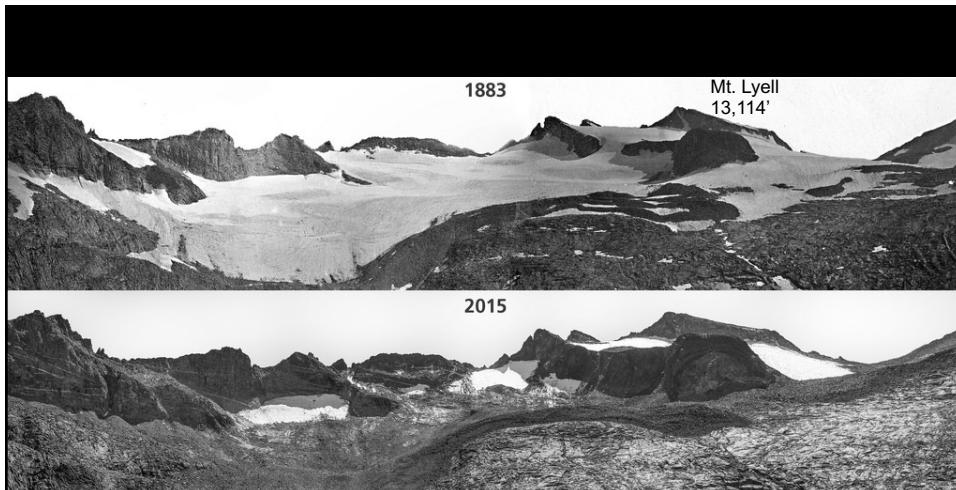
**glacial erratics - Olmsted Point, Yosemite  
- note intersecting joint planes**

42



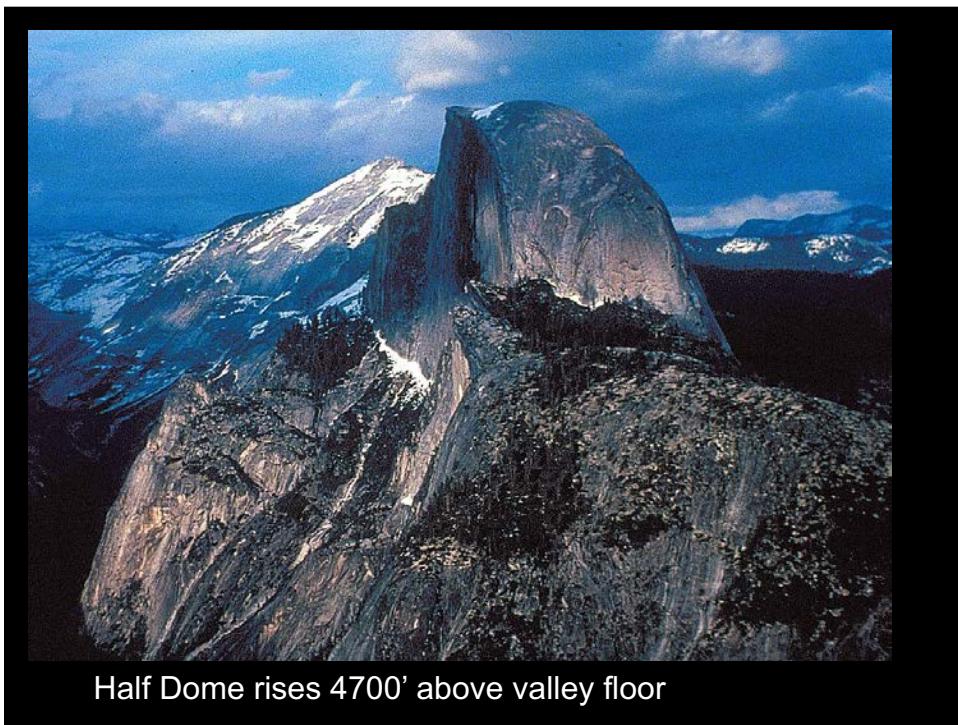
**striations & glacial polish** - Olmsted Point, Yosemite  
- abrasion of rock by particles of silt and sand  
entrained in the base of the glacier

43

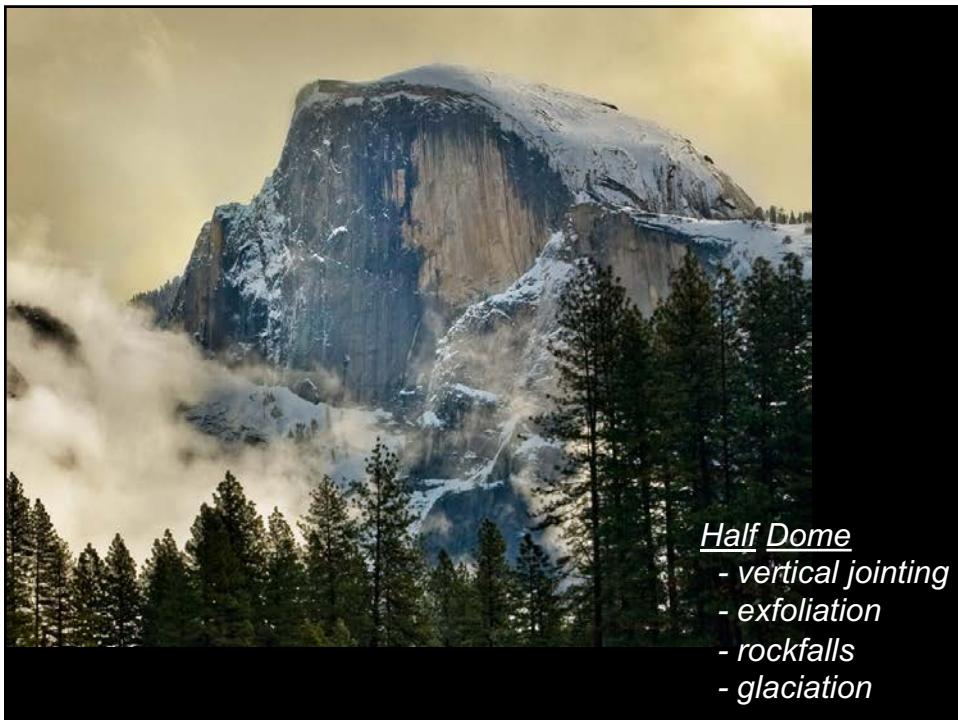


**retreat of Lyell Glacier, 1883-2015, Yosemite NP**  
- formed during Little Ice Ages (~1350-1850)  
- 78% loss of surface area in ~130 years  
- likely gone in 10-20 years

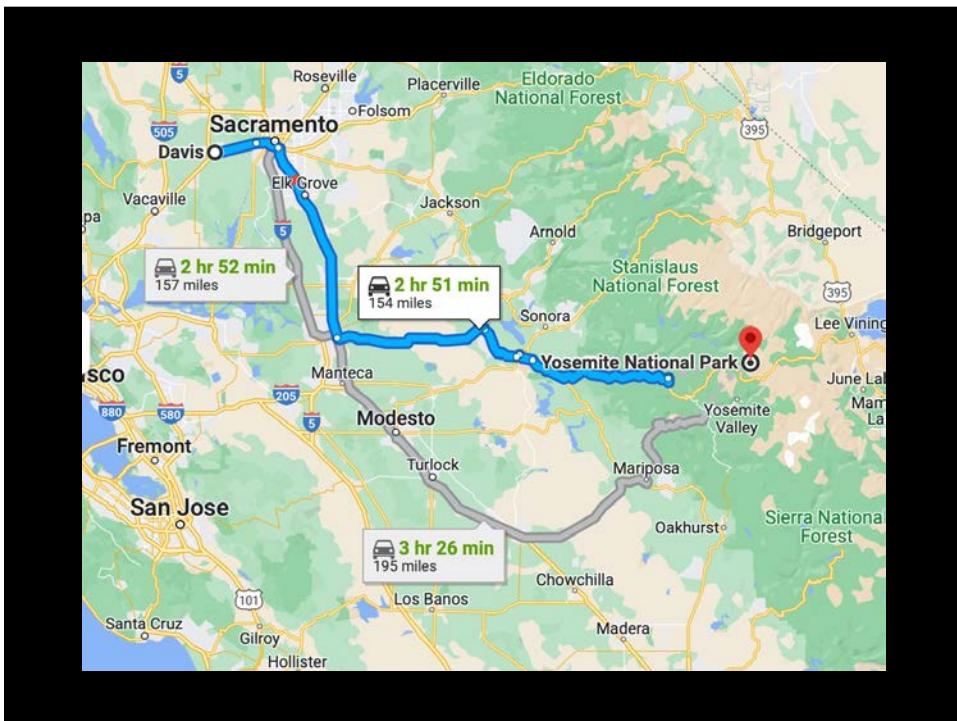
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