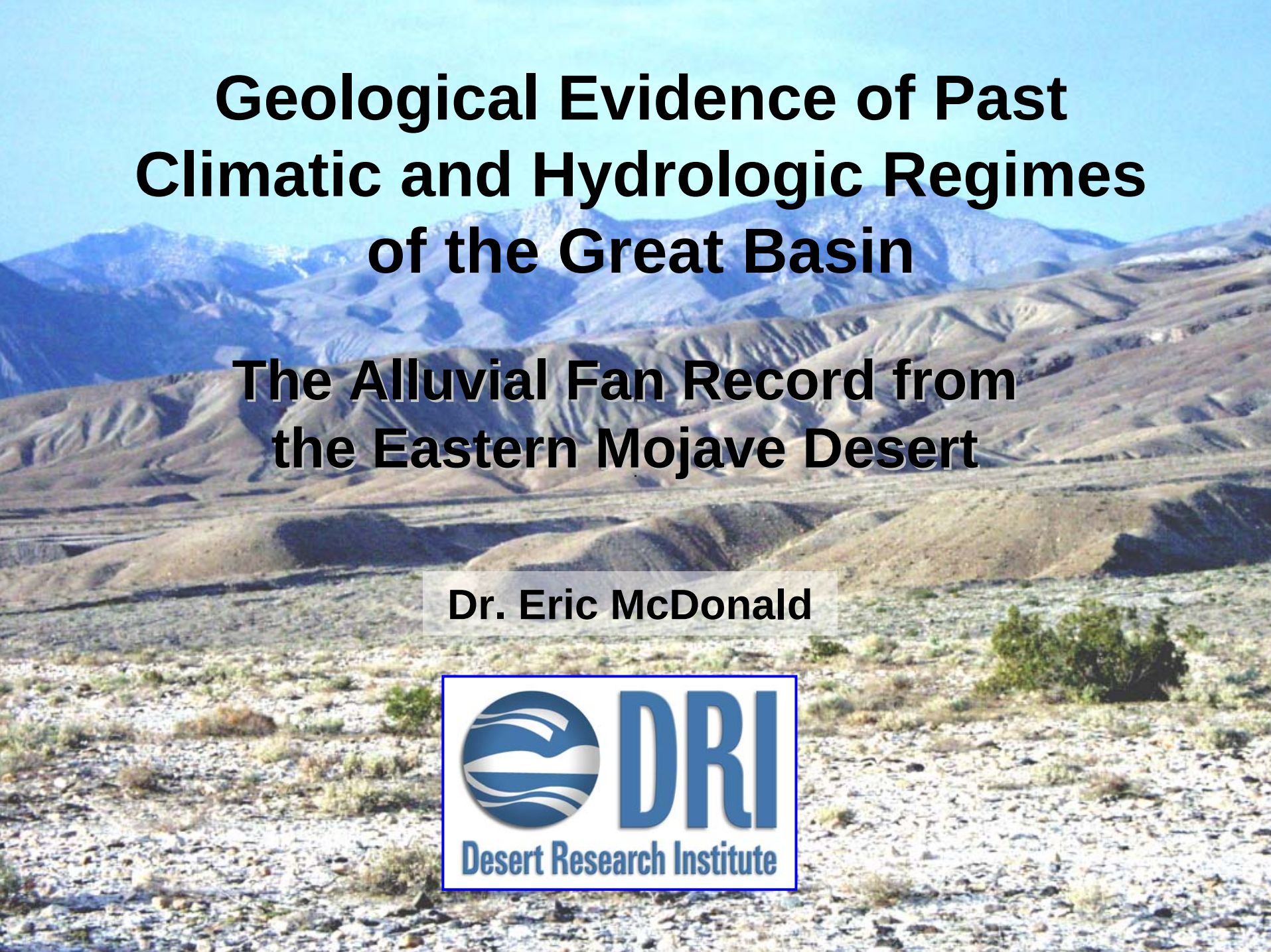

Geological Evidence of Past Climatic and Hydrologic Regimes of the Great Basin

The Alluvial Fan Record from the Eastern Mojave Desert

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DRI
Desert Research Institute

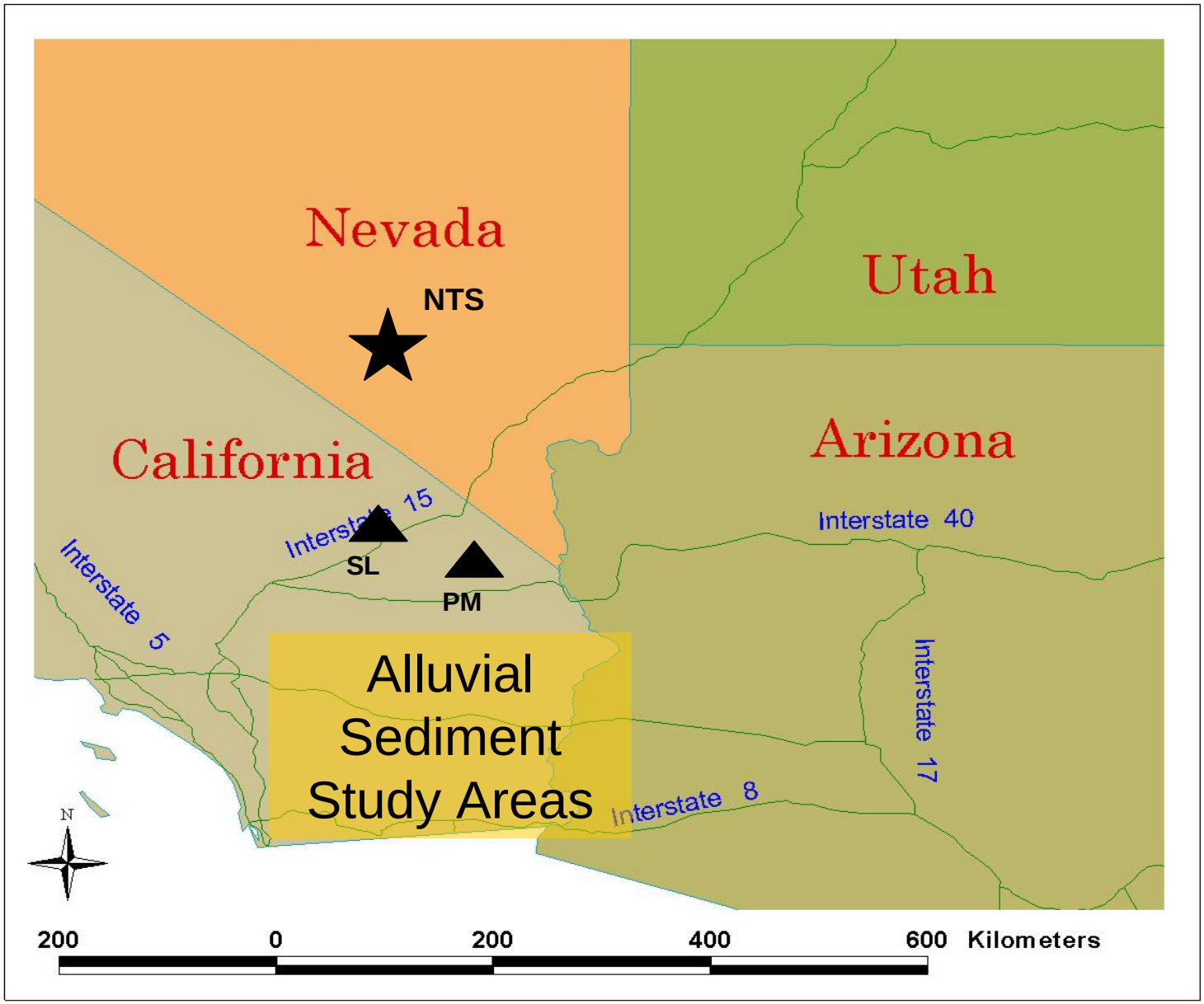
Examples of Alluvial Fans

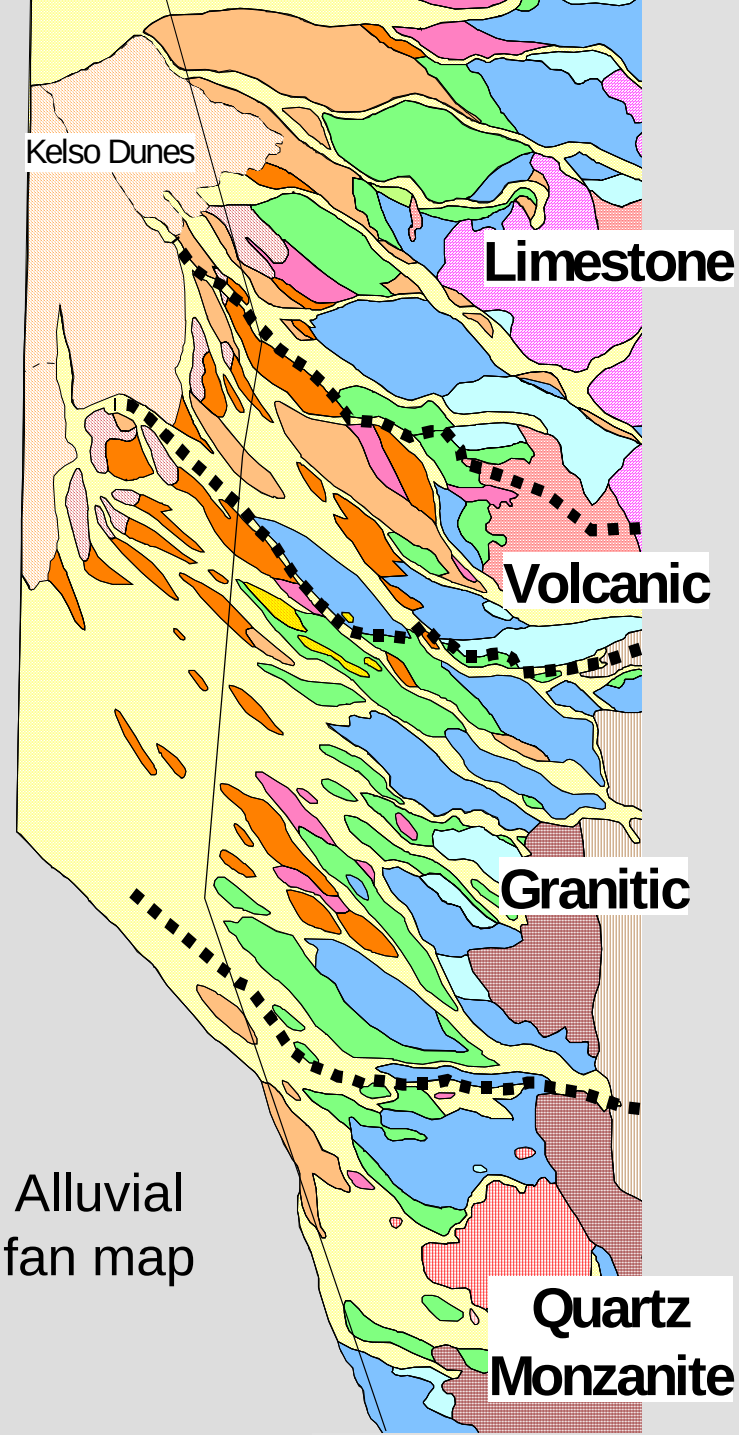
Key Points of Presentation

- Alluvial fans contain a range of sediments from cobbles to clays and are capped by soils
- Alluvial fans can be stacked on top of one another in basins
- Climate change is frequent and regularly and drives alluvial and lacustrine deposition in deserts

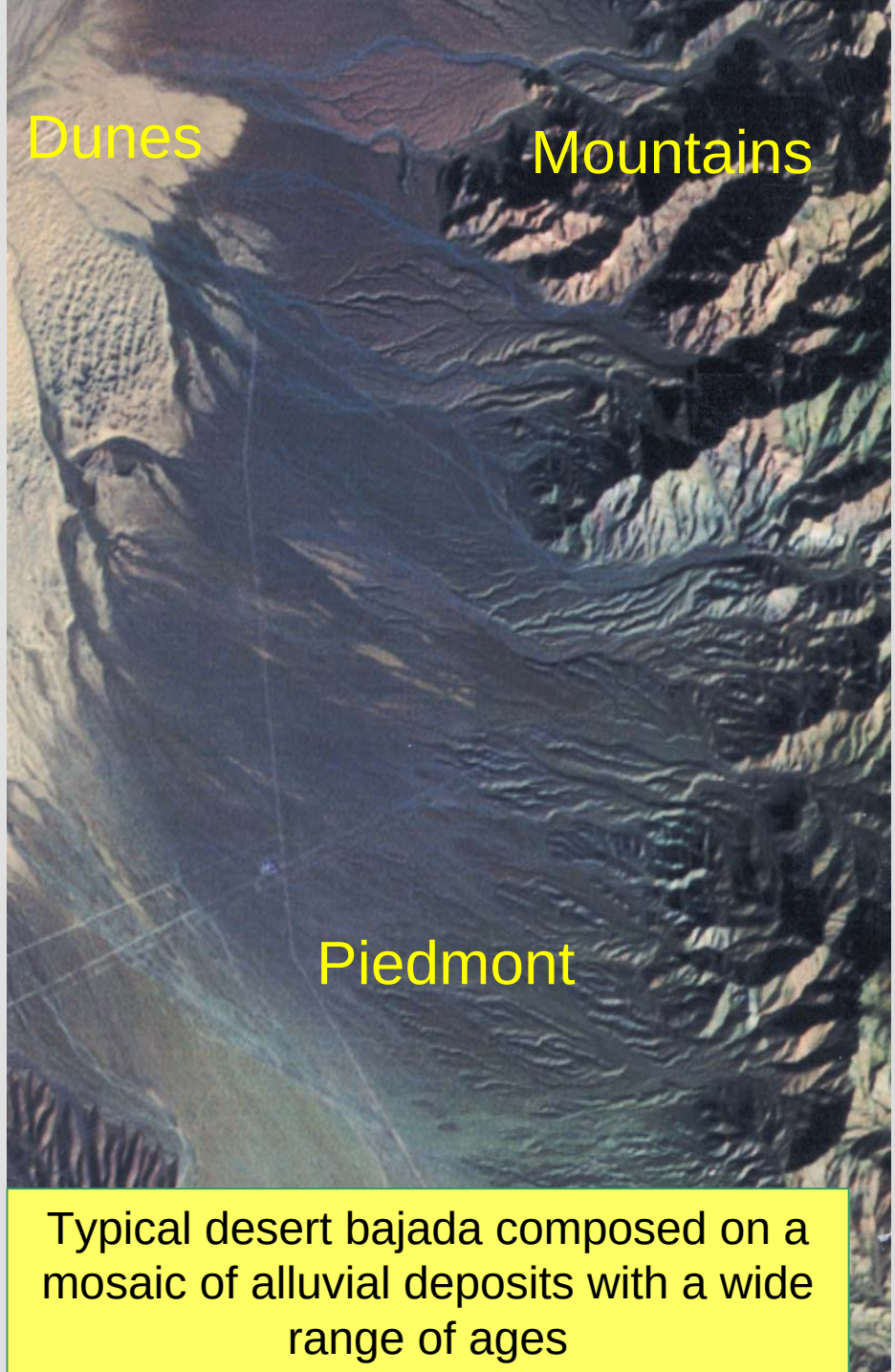
Outline

- General character of:
  - alluvial fan deposits
  - Surface and buried soils
  - Control on infiltration
- Deposition of alluvial fans are regional events:
  - Fans deposited <25 ka
  - Fans deposited <75 ka
- Fan deposition related to climate change

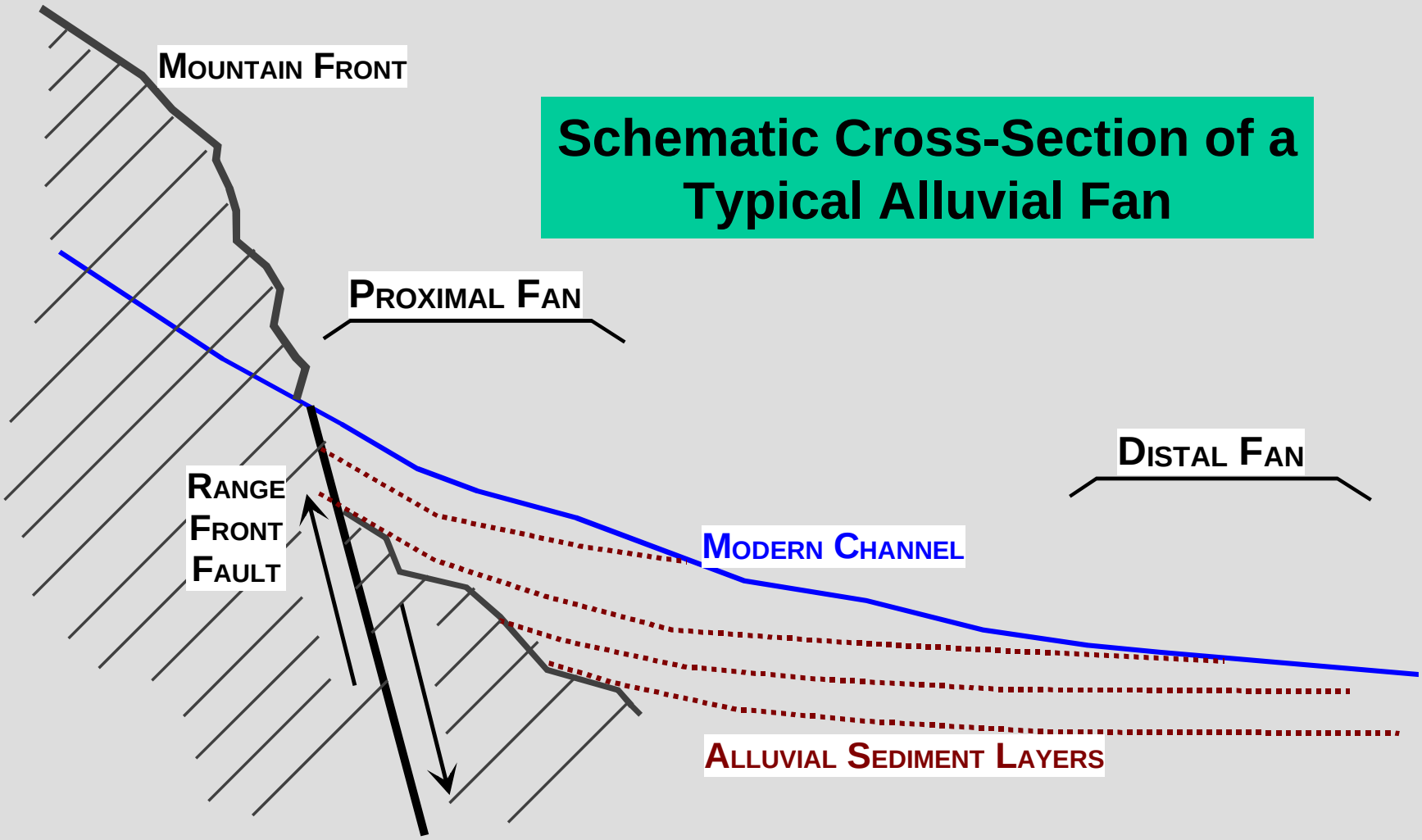

Nevada
Utah
NTS
California
Arizona
Interstate 15
Interstate 40
SL
PM
Interstate 5
Alluvial
Sediment
Study Areas
Interstate 17
Interstate 8
N
200
0
200
400
600
Kilometers



Alluvial fan map

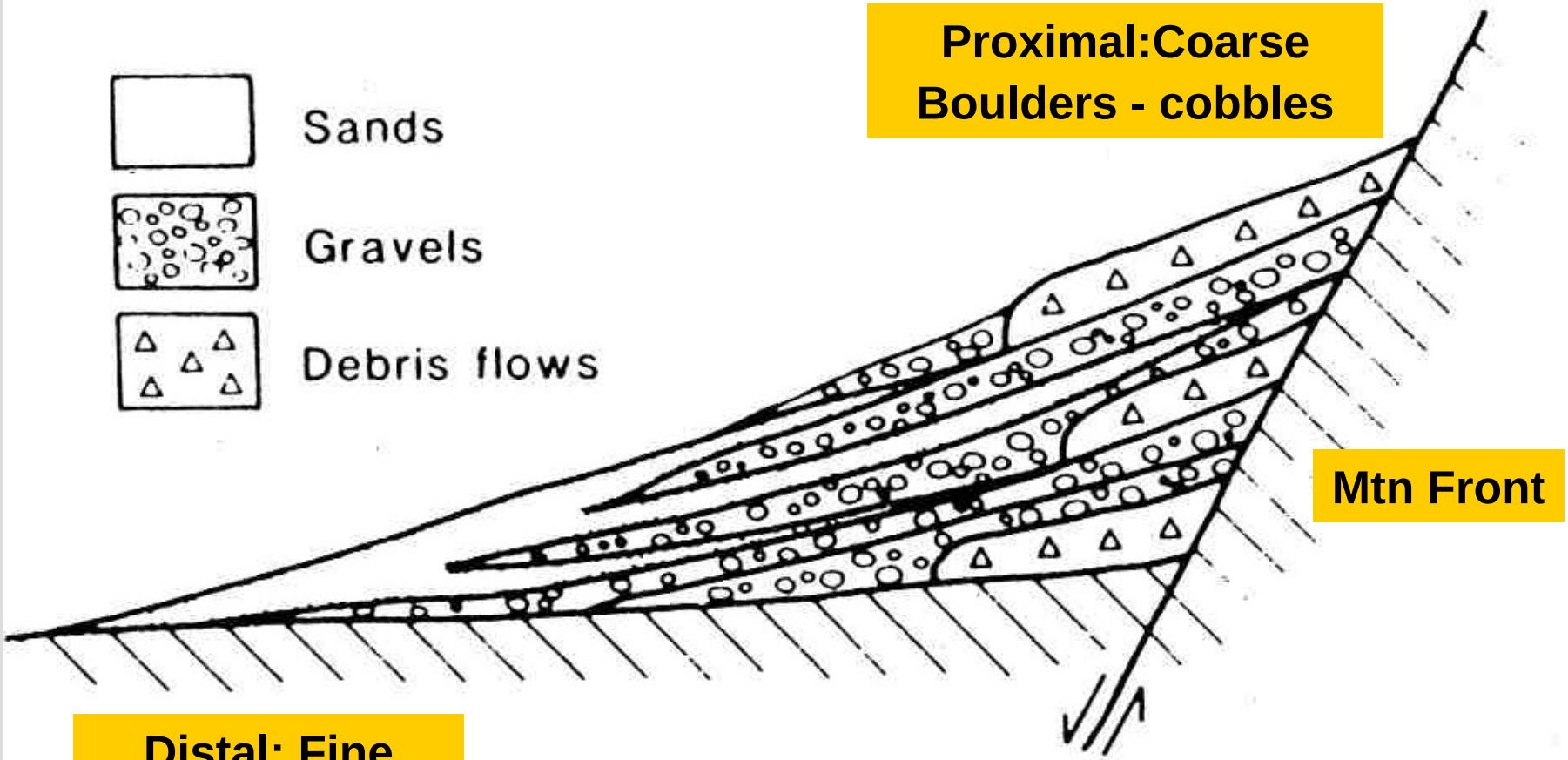


Typical desert bajada composed on a mosaic of alluvial deposits with a wide range of ages


Schematic Cross-Section of a Typical Alluvial Fan
Mountain Front
Proximal Fan
Distal Fan
Range Front Fault
Modern Channel
Alluvial Sediment Layers

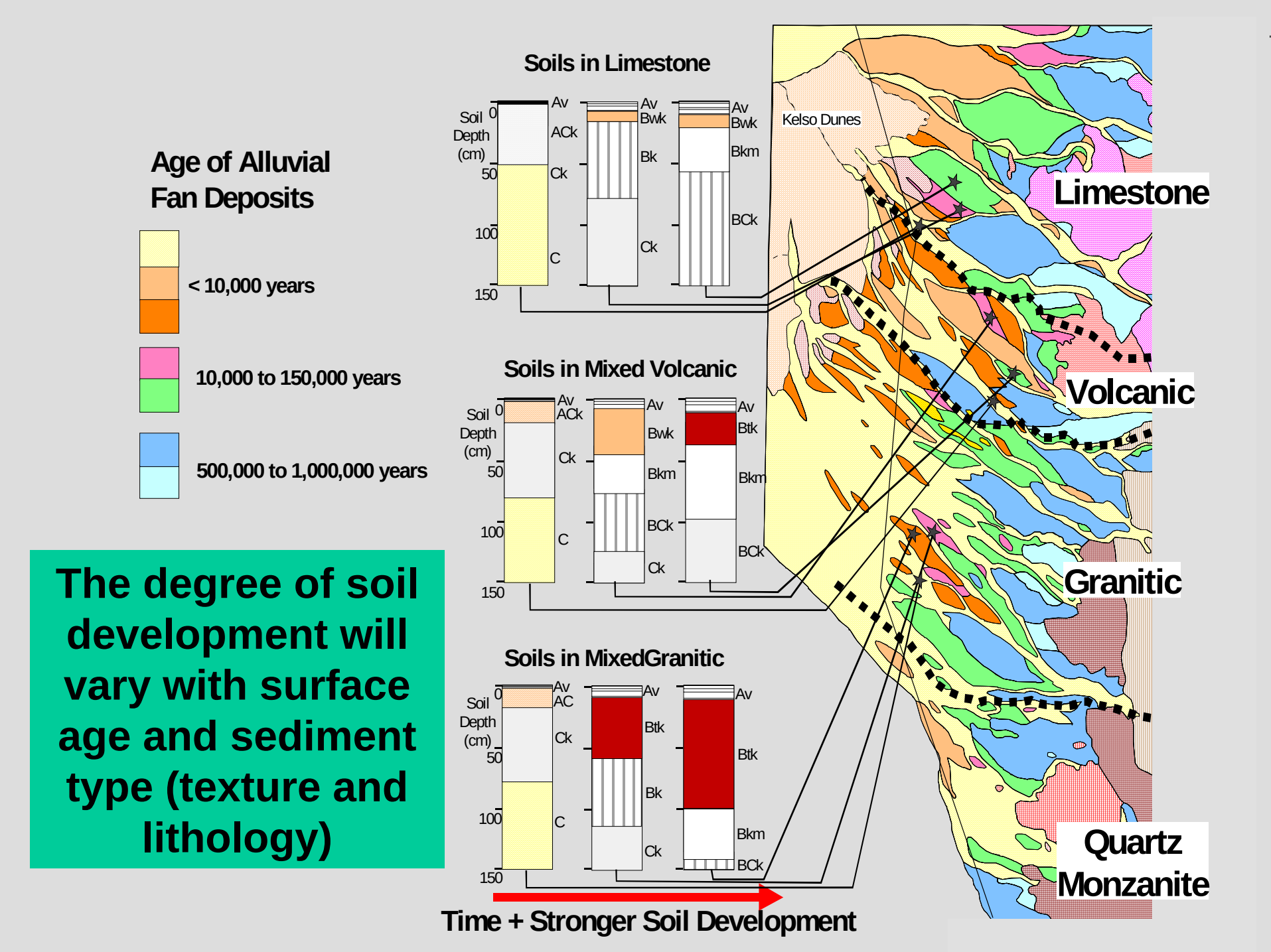
PROXIMAL-DISTAL FACIES VARIATIONS

(c) SCHEMATIC MODEL



Proximal Fan Sediment:
Coarse: boulders-cobbles
Poorly sorted

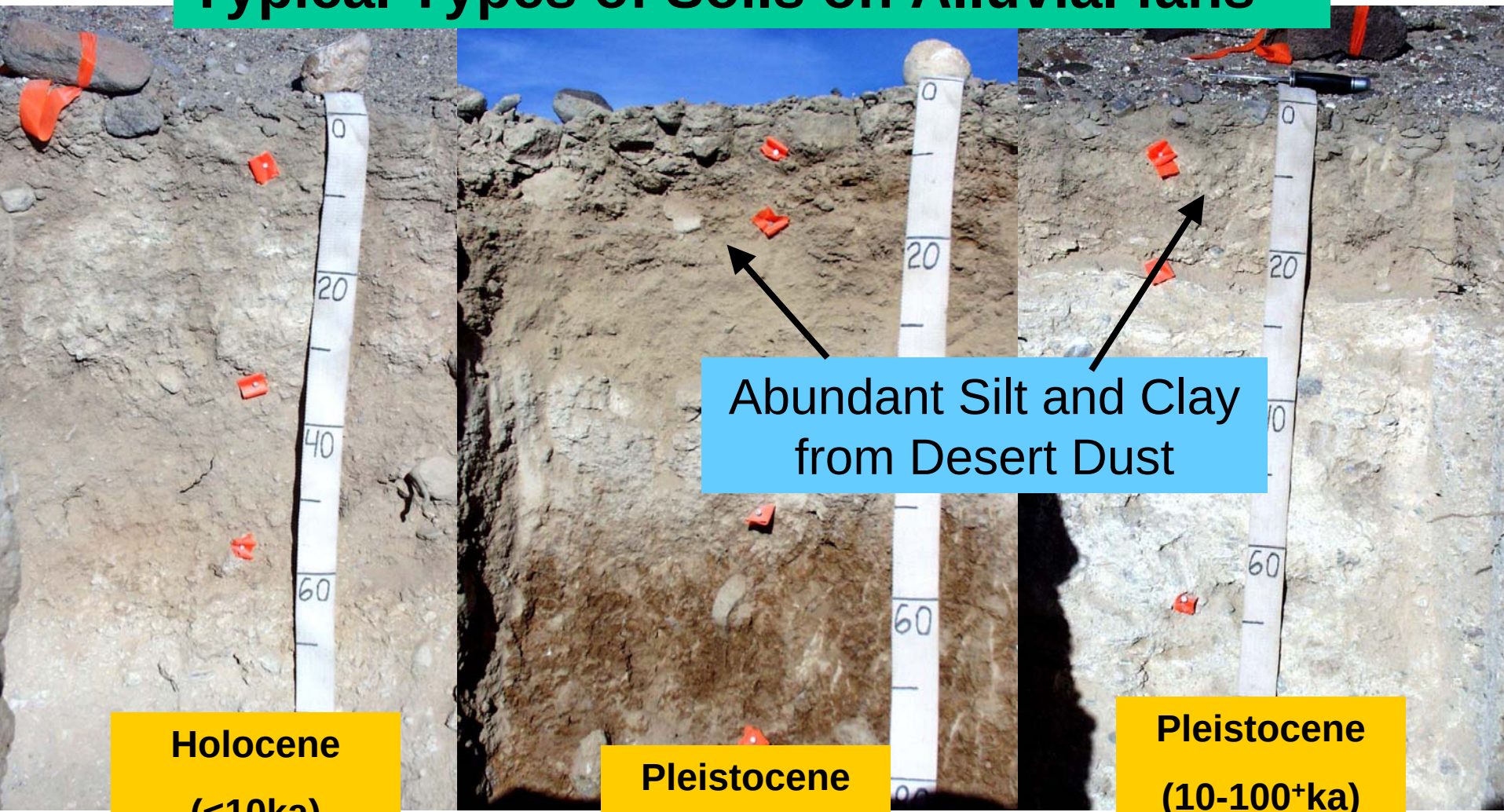
Distal Fan Sediment:
Fine: cobbles-gravel-sand
Moderately sorted


Age of Alluvial Fan Deposits
< 10,000 years
10,000 to 150,000 years
500,000 to 1,000,000 years
The degree of soil development will vary with surface age and sediment type (texture and lithology)
Soils in Limestone
Soil Depth (cm)
0
50
100
150
Av
ACk
Ck
C
Av
Bwk
Bk
Ck
Av
Bwk
Bkm
BCk
Kelso Dunes
Limestone
Soils in Mixed Volcanic
Soil Depth (cm)
0
50
100
150
Av
ACk
Ck
C
Av
Bwk
Bkm
BCk
Ck
Av
Btk
Bkm
BCk
Volcanic
Granitic
Soils in MixedGranitic
Soil Depth (cm)
0
50
100
150
Av
AC
Ck
C
Av
Btk
Bk
Ck
Av
Btk
Bkm
BCk
Quartz Monzanite
Time + Stronger Soil Development

- Young deposits
  (< 10 ka)
- Sand-rich texture
- Limited Horizonation
- Loose matrix
- High Infiltration

- Old Deposits
  (> 10 ka)
- Clay-rich texture
- Complex Horizonation
- Cemented matrix
  (Carbonate, silica)
- Low Infiltration

Typical Types of Soils on Alluvial fans



Abundant Silt and Clay from Desert Dust

Holocene

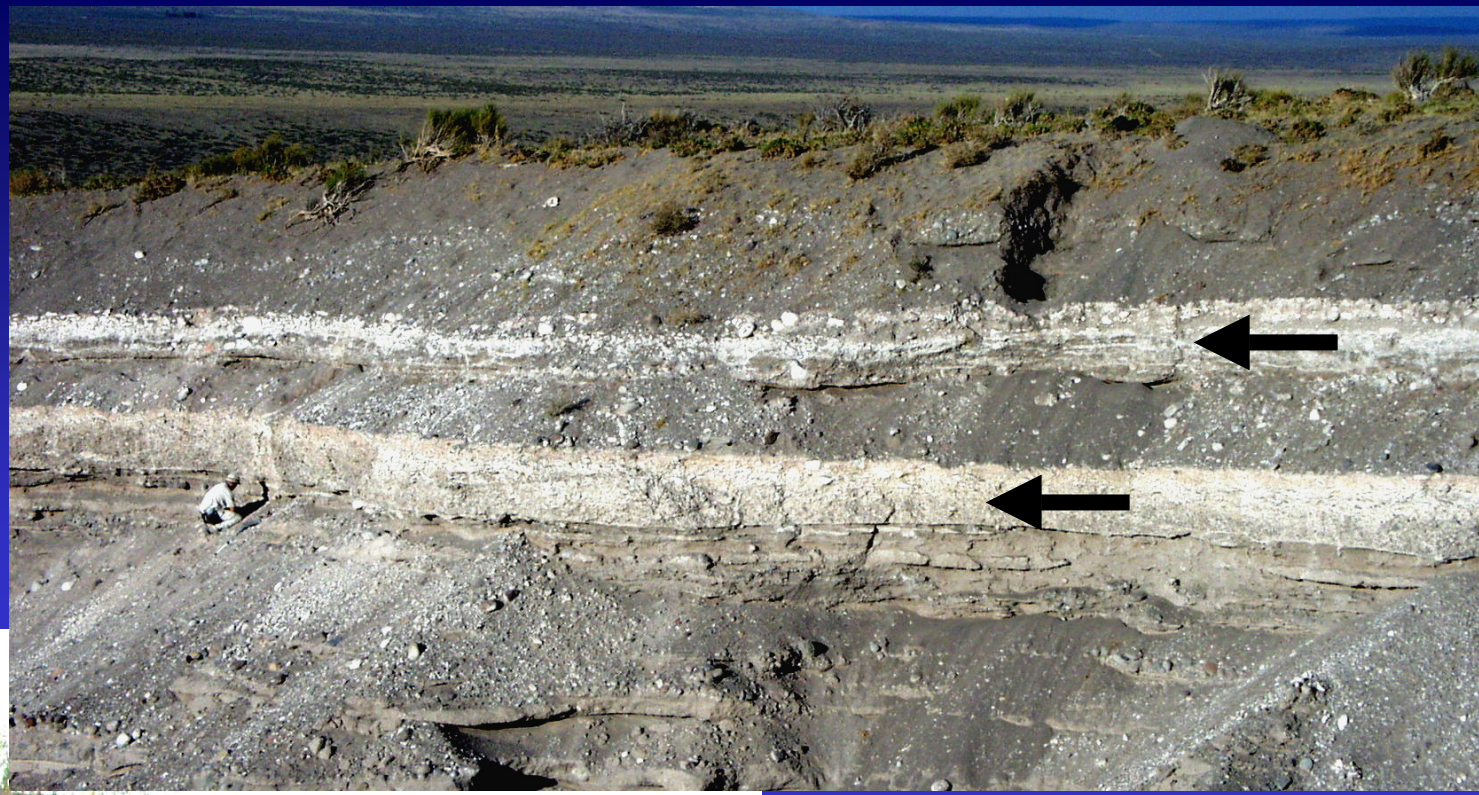
(<10ka)
Weak Carbonate Accumulation

Pleistocene

(10-100⁺ka)
Strong Clay Accumulation

Pleistocene

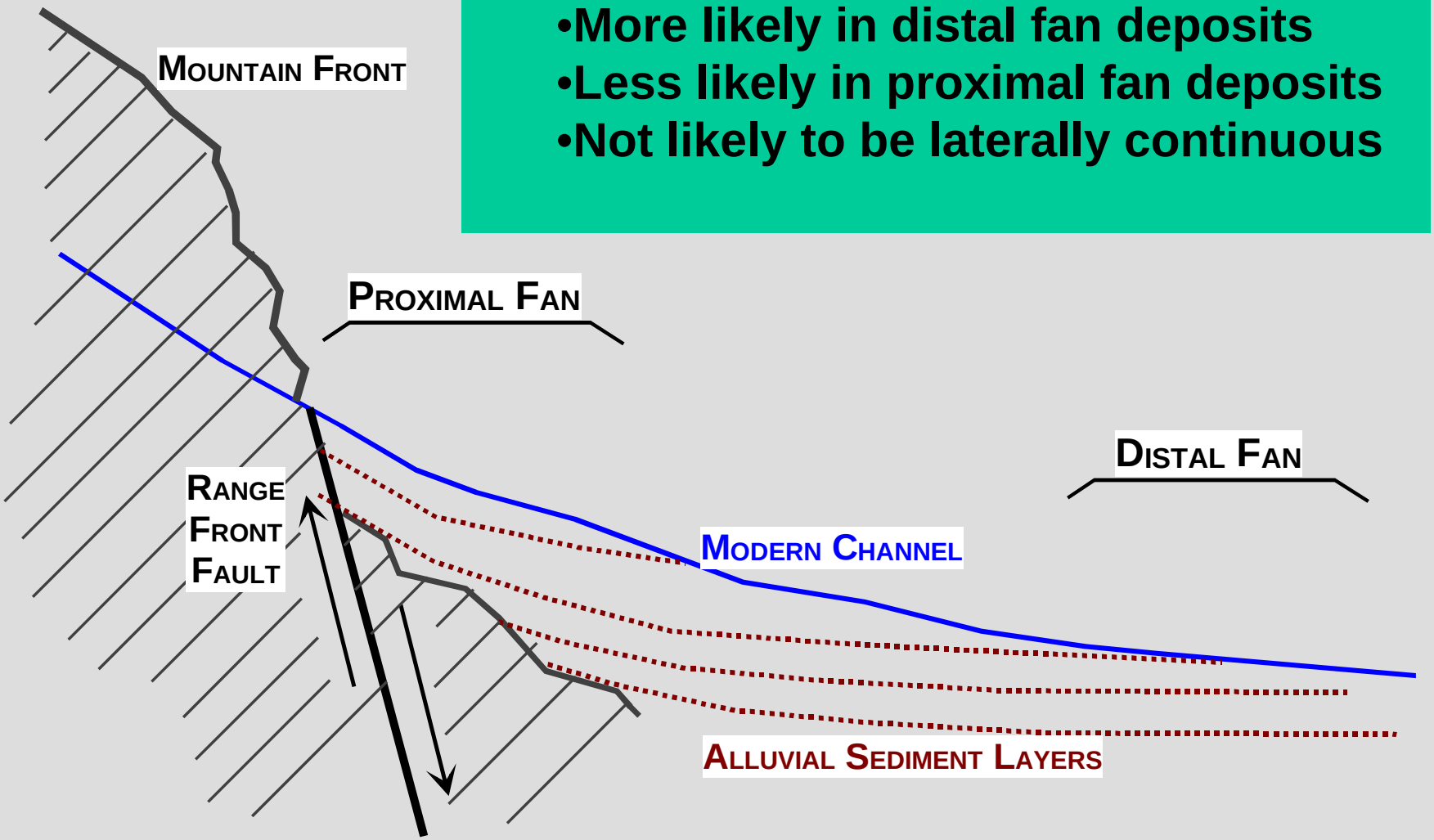
(10-100⁺ka)
Strong Carbonate Accumulation



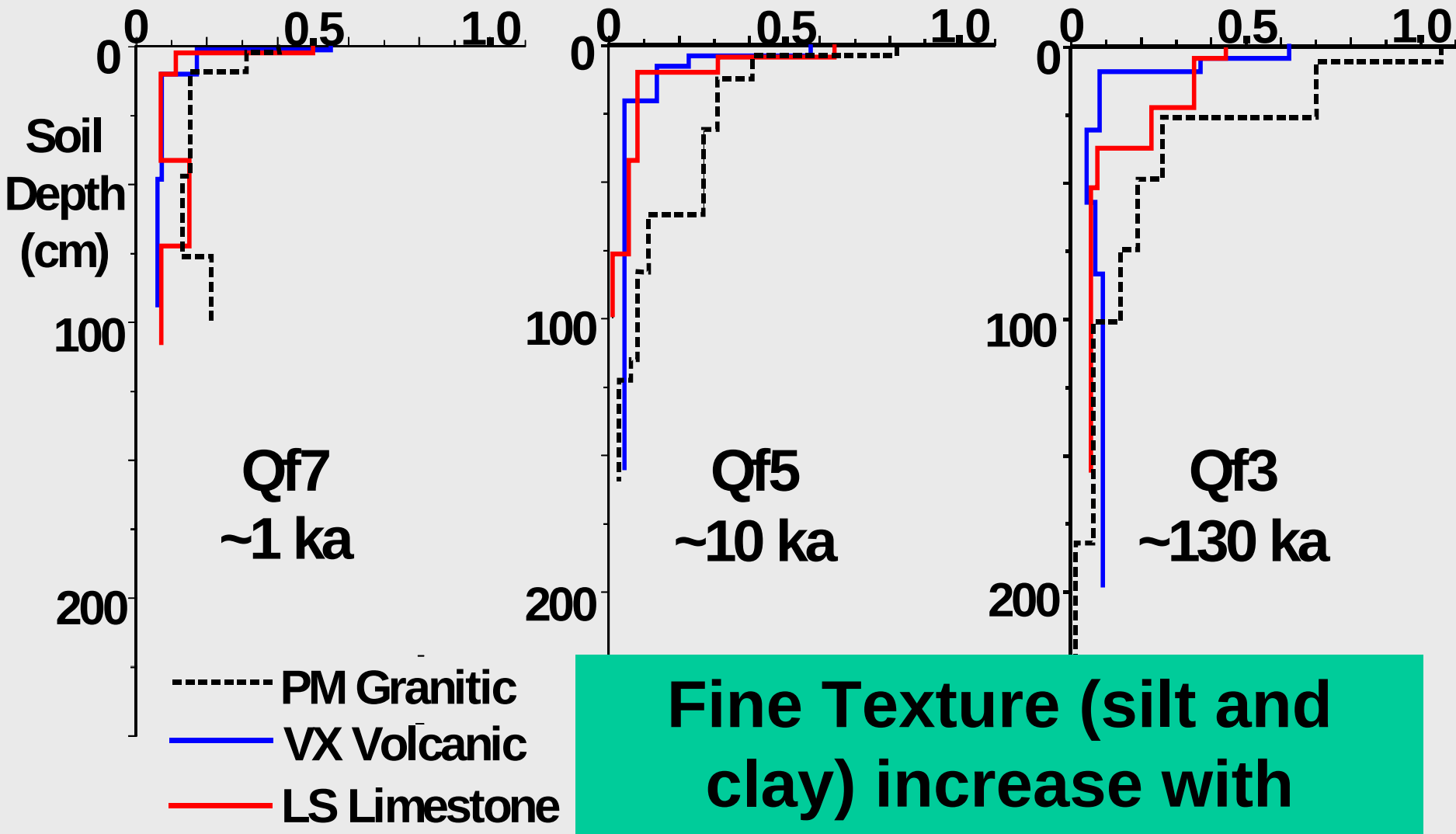
Examples of buried soils in alluvial fan deposits

Buried soils (paleosols):

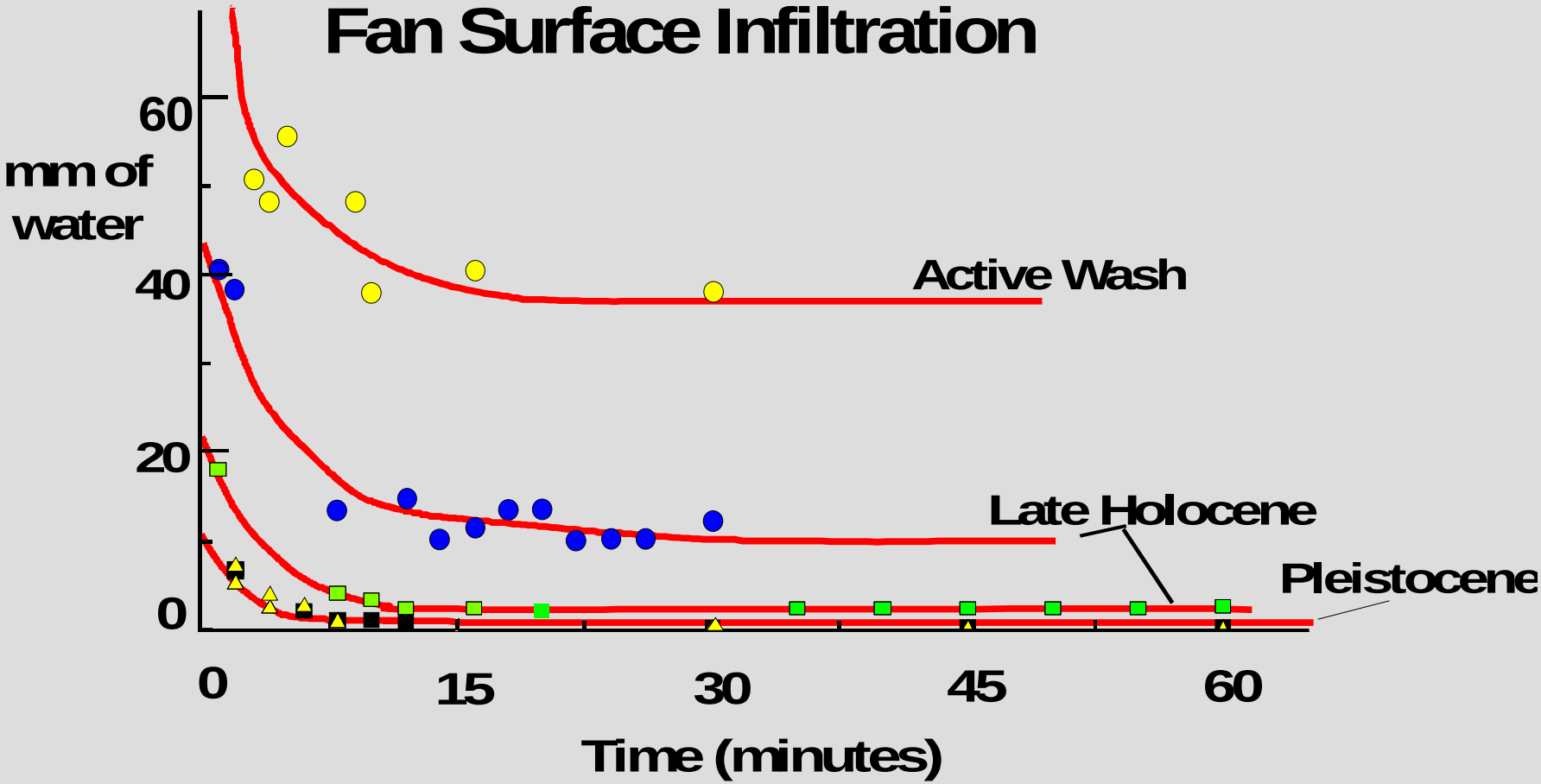
- More likely in distal fan deposits
- Less likely in proximal fan deposits
- Not likely to be laterally continuous



Depth Profiles of Soil Silt + Clay (g/cm³)



Fine Texture (silt and clay) increase with surface age



Infiltration decreases with increasing soil development

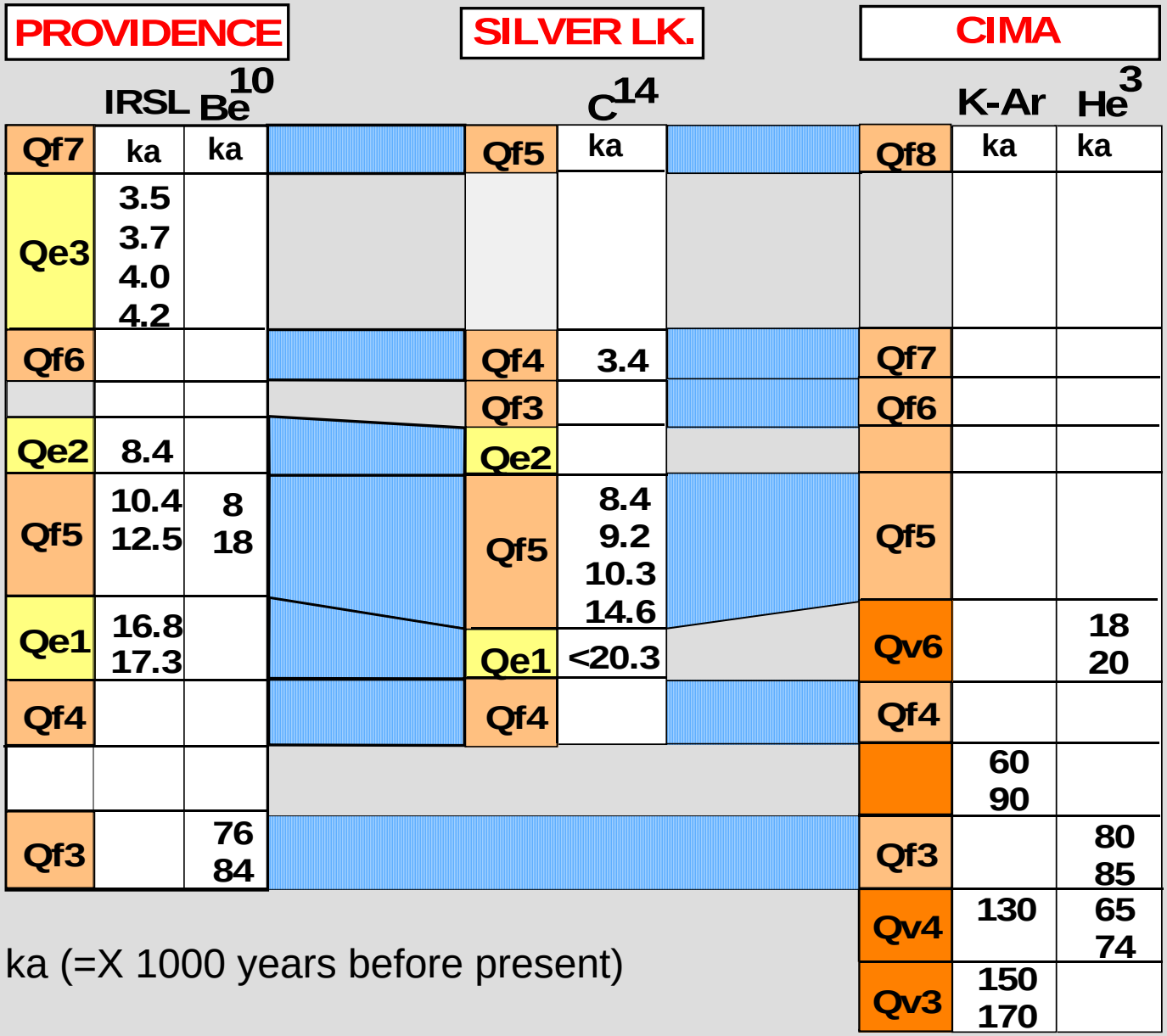
Outline

- General character of:
  - alluvial fan deposits
  - Surface and buried soils
  - Control on infiltration

- **Deposition of alluvial fans are regional events:**
  - **Fans deposited <25 ka**
  - **Fans deposited <85 ka**

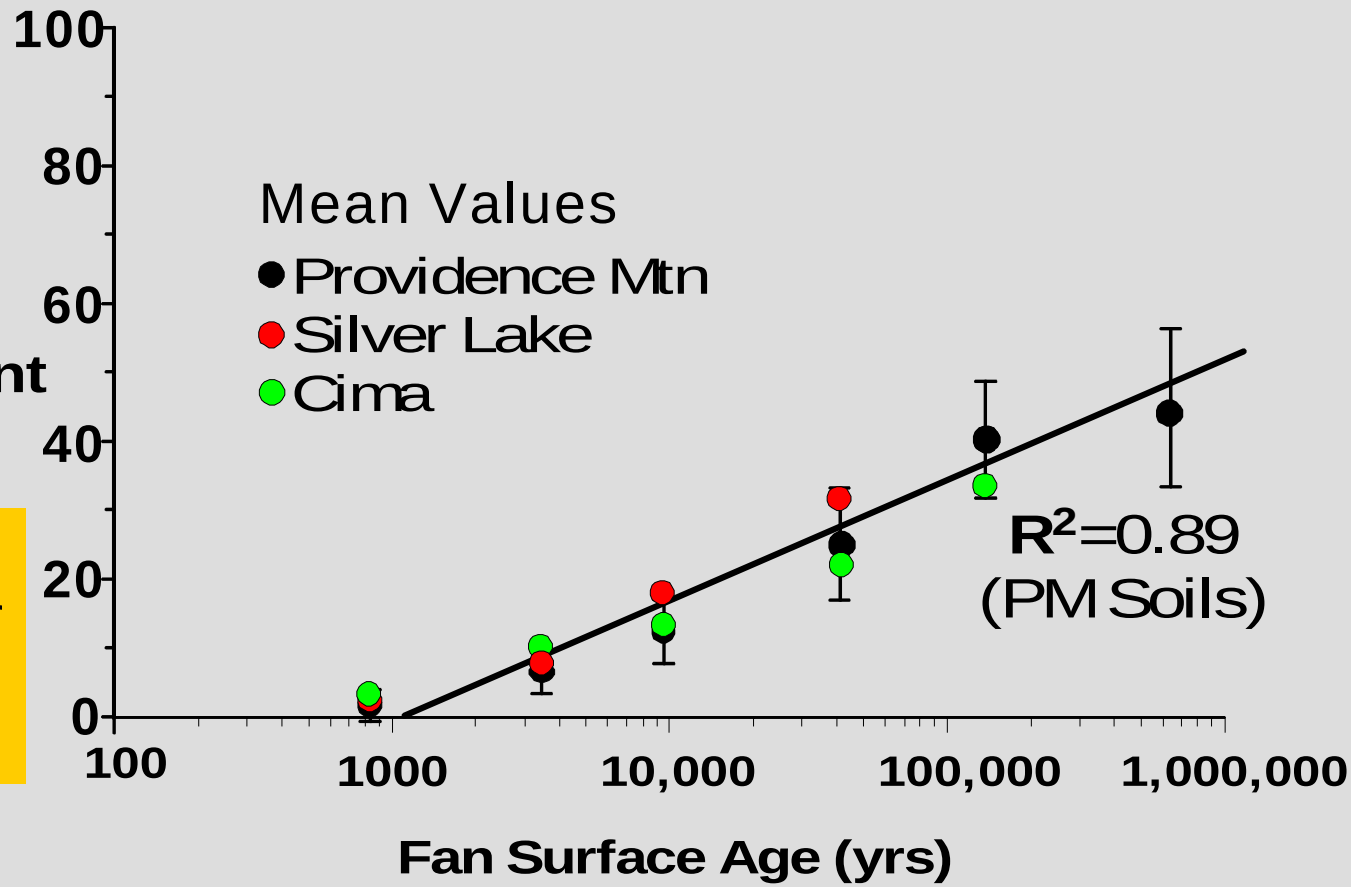
- Fan deposition related to climate change

Age Control of Quaternary Units Supports Regional Correlation



Ages in ka (=X 1000 years before present)

Regional Correlation of Alluvial fan Deposits Using Soil Development



Quantifies soil morphology for statistical comparison

Outline

- General character of:
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  - Surface and buried soils
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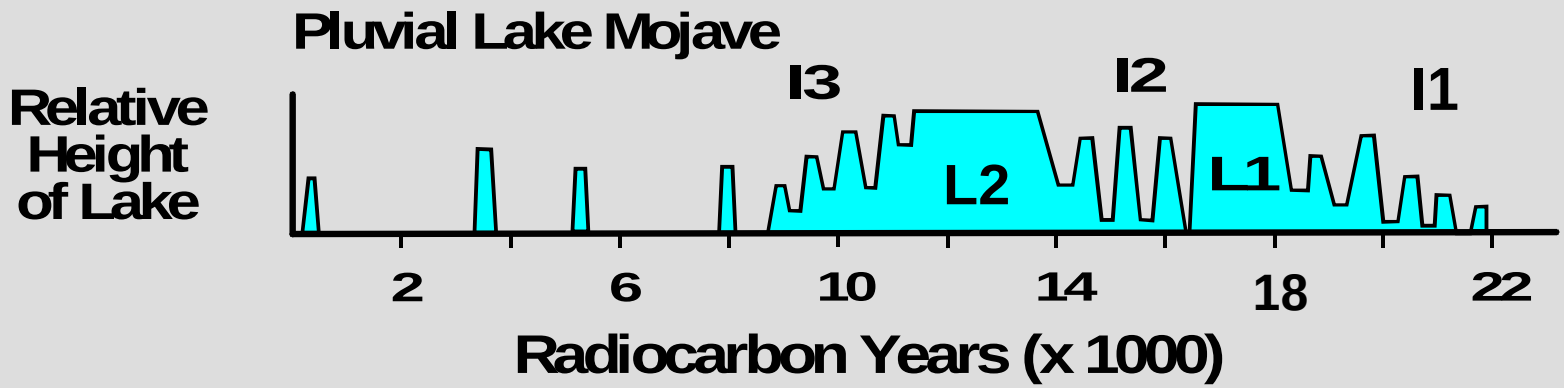
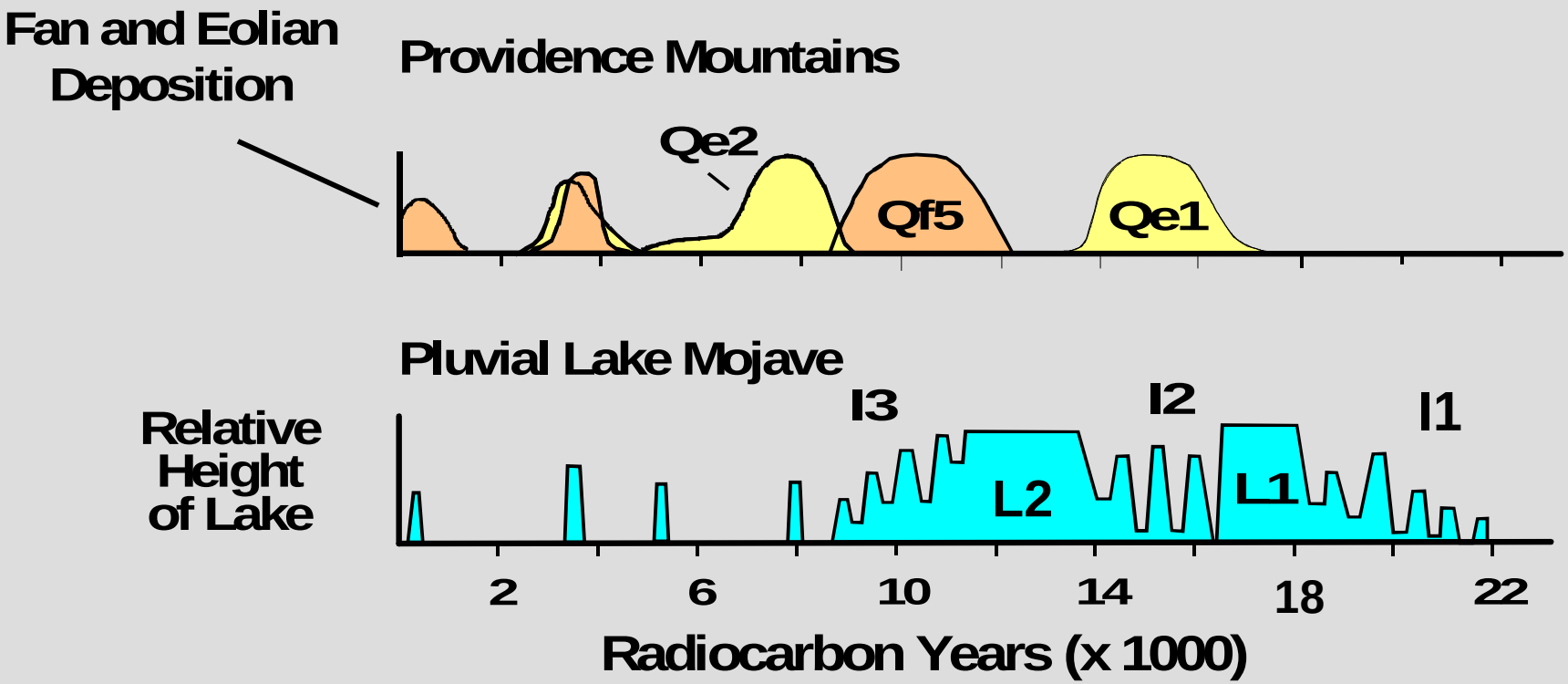
  - Fans deposited <85 ka

- **Fan deposition related to climate change**

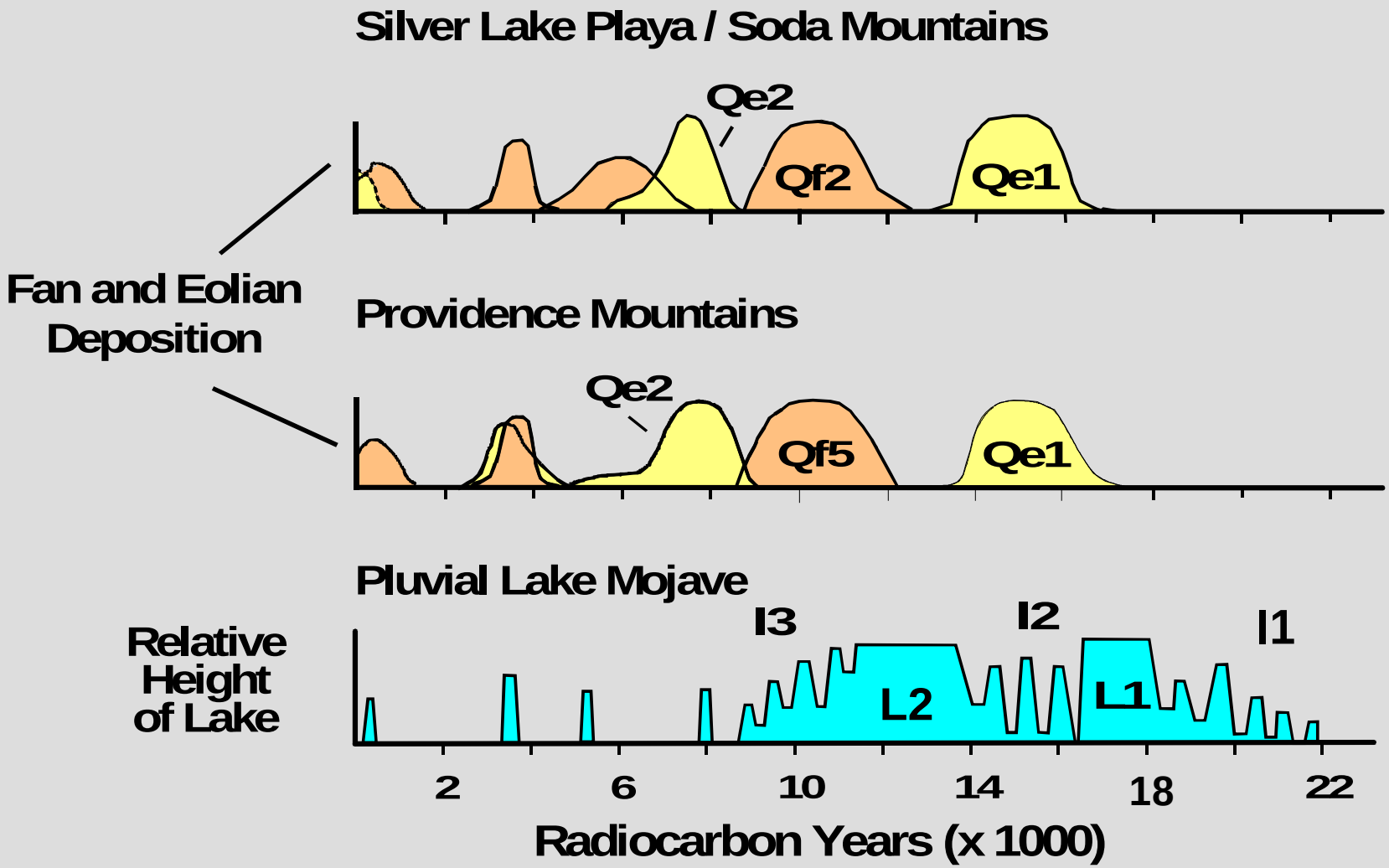
Climate Record Preserved in Pluvial Lake Sediments



Climate Record Compared with Periods of Alluvial Fan Deposition



Similar Record of Alluvial Fan Deposition Across the Region



Drainage Basin Comparison:

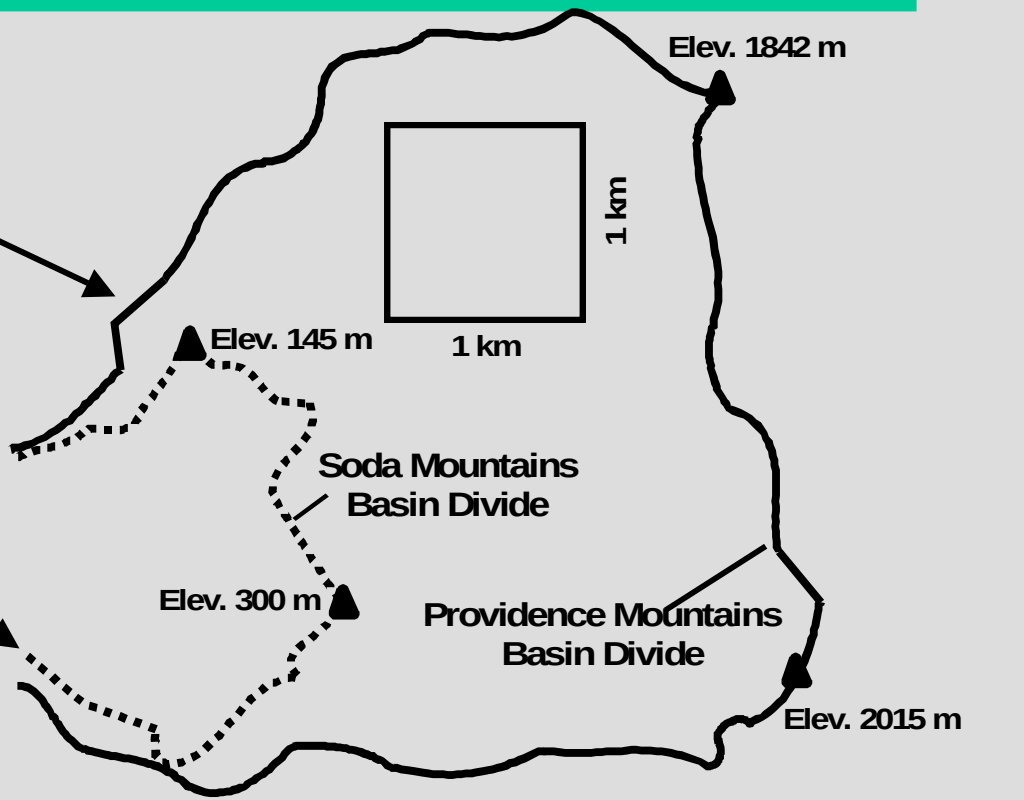
Providence:
High elevation
Semi arid - subhumid
Continuous vegetation cover

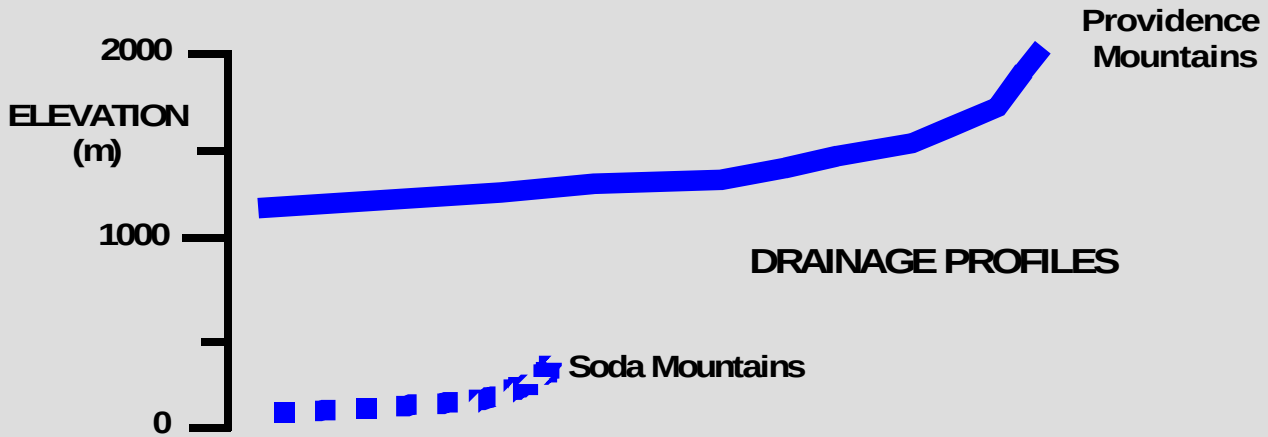
Soda:
Low elevation,
Arid
Sparse vegetation cover

Considerable Differences in Basin Environment

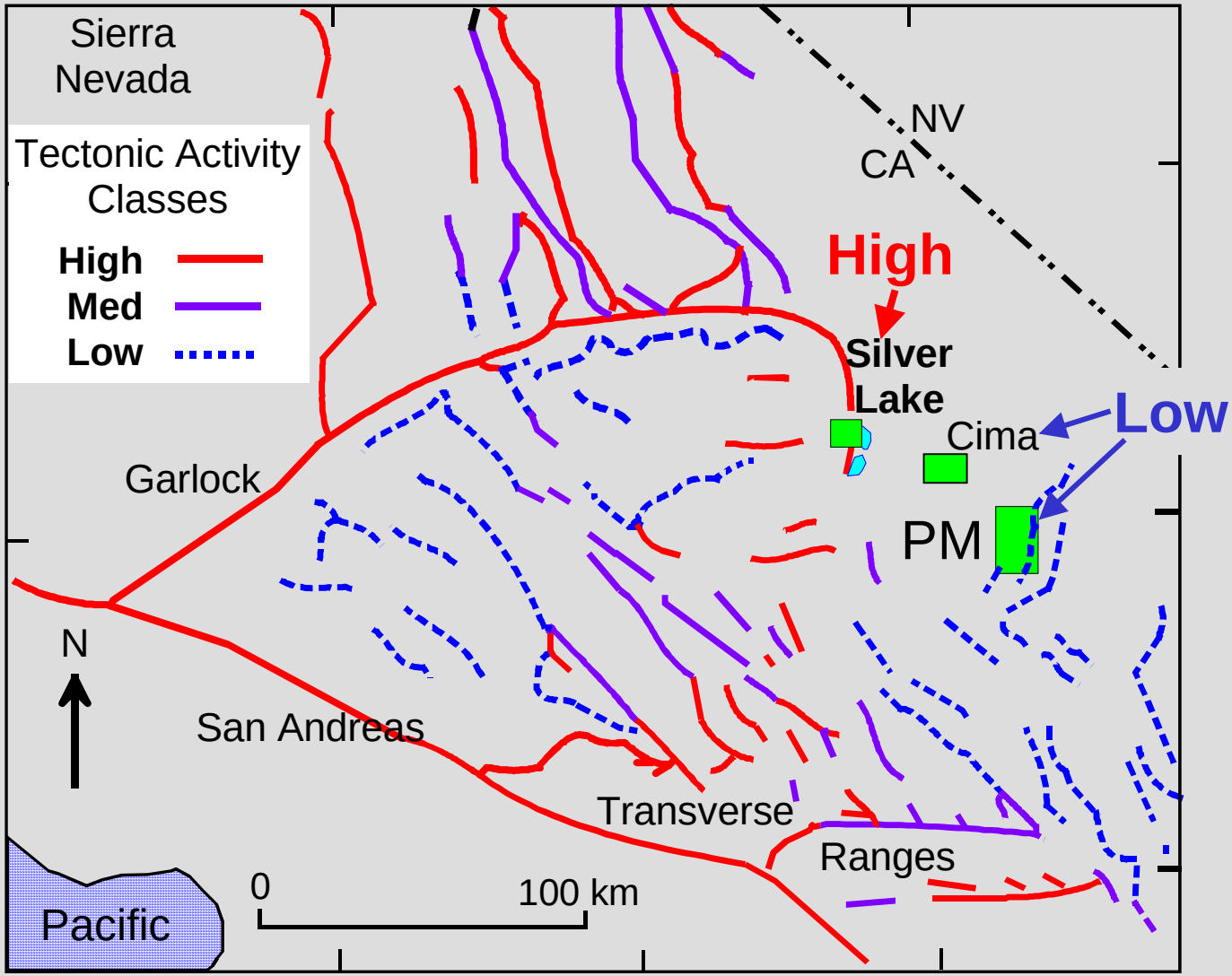
However:

Similar history of alluvial fan deposition

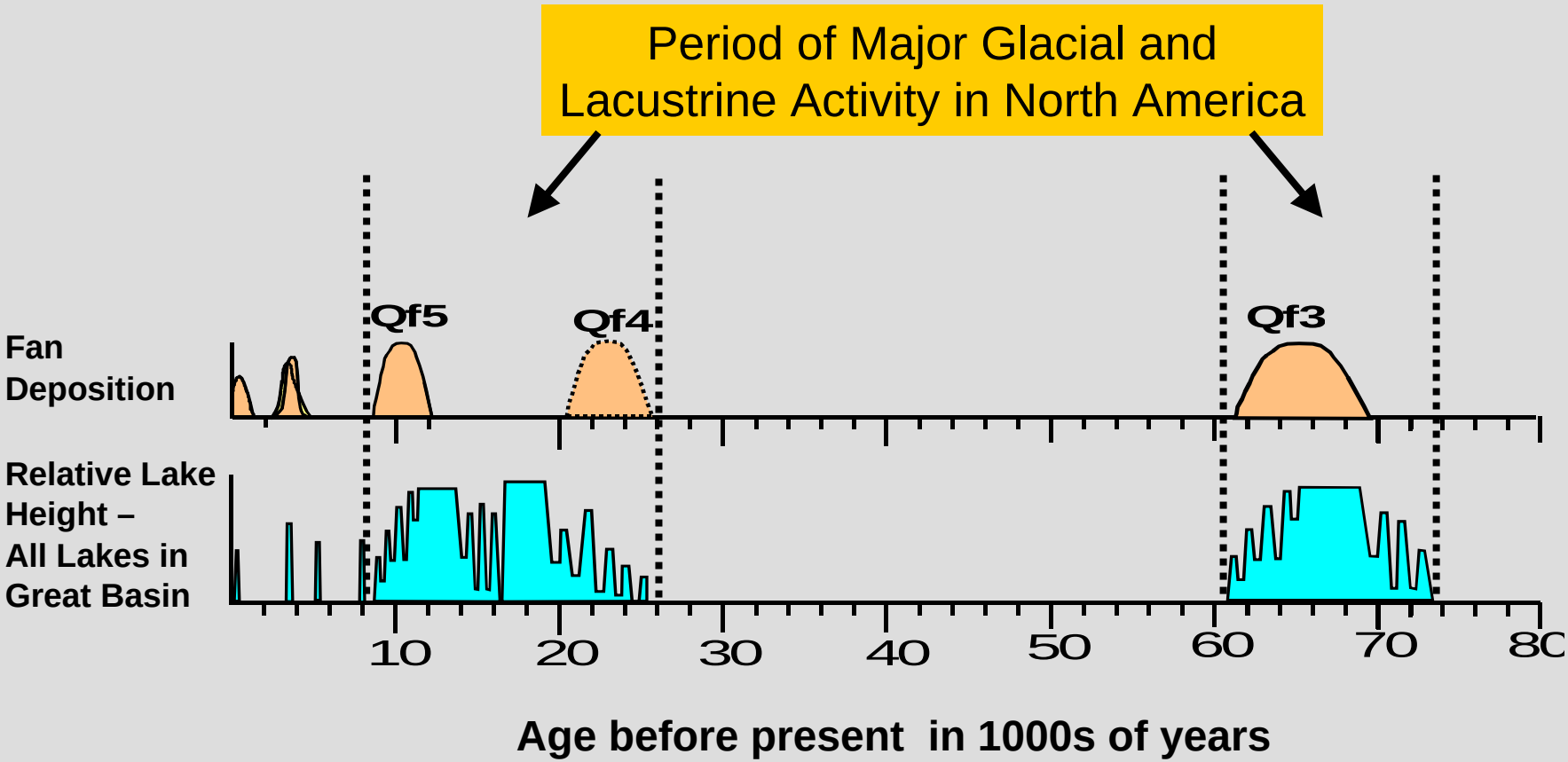


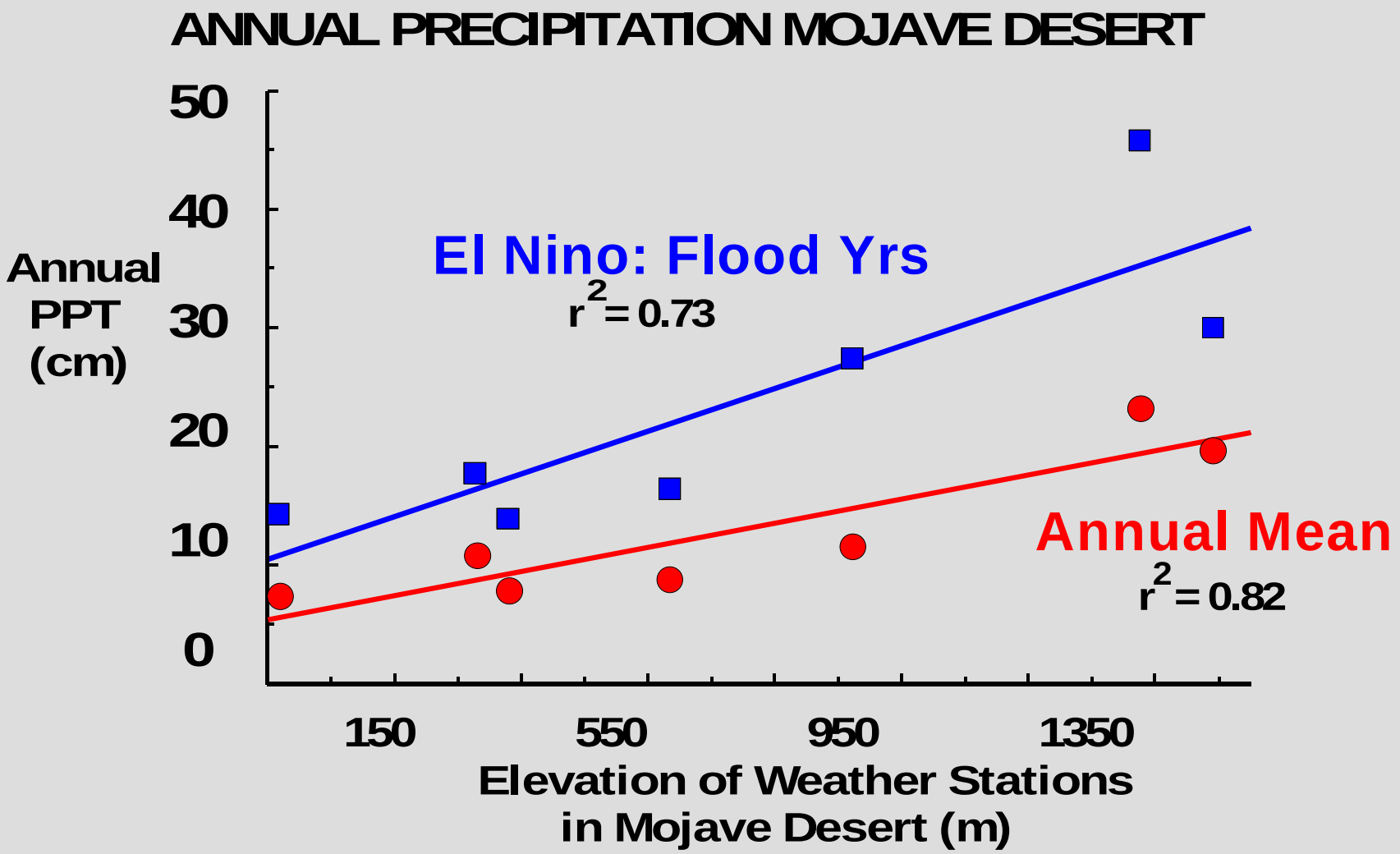


Alluvial Fan Record Similar Across All Levels of Tectonic Activity: Indicates Regional Climate Change Controlling Major Periods of Fan Deposition



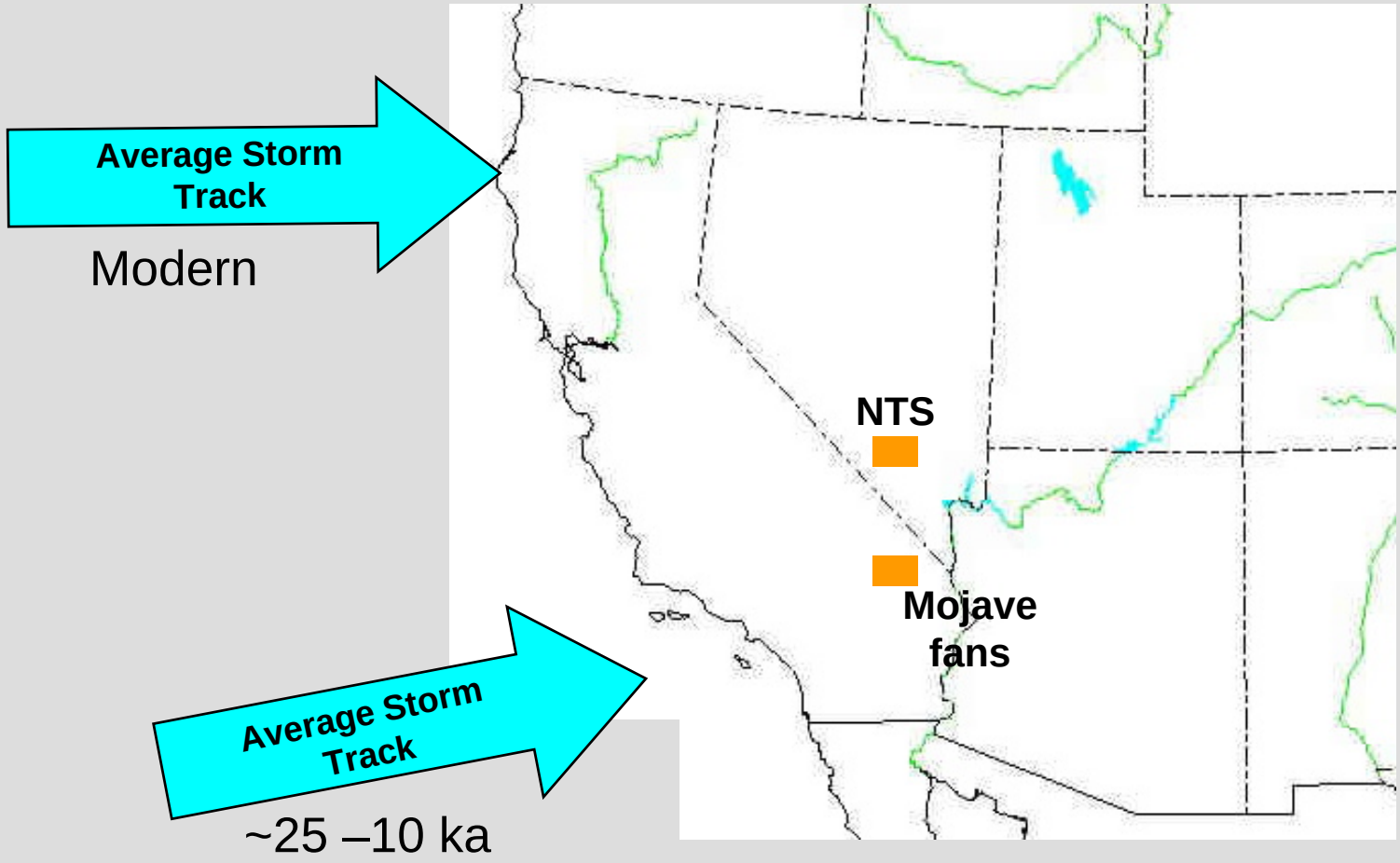
Regional Record of Lake and Alluvial Fan Activity: Last 80 ka





Regional Increase in ppt during pluvial cycles

Alluvial Fans Deposited During Intervals of Increased Storm Activity



Summary of Alluvial Fan Record

- Alluvial fans contain a range of sediments from cobbles to clays and are capped by soils
  - Soil development (silt, clay, carbonate) increases with surface age
  - Infiltration decreases with surface age
- Alluvial fans can be stacked on top of one another in basins
  - Stacked sequence of fan deposits
  - Contains buried soils, but preservation discontinuous, best in distal areas
- Climate change is frequent and regularly and drives alluvial and lacustrine deposition in deserts
  - Distinct periods of region-wide alluvial fan deposition
  - Across a wide range of environmental and tectonic settings
  - Alluvial fan deposition related to some aspect of climate change
  - At least 5 major periods of fan deposition in the last ~75 ka
  - Questions remain about how climate change drives fan deposition