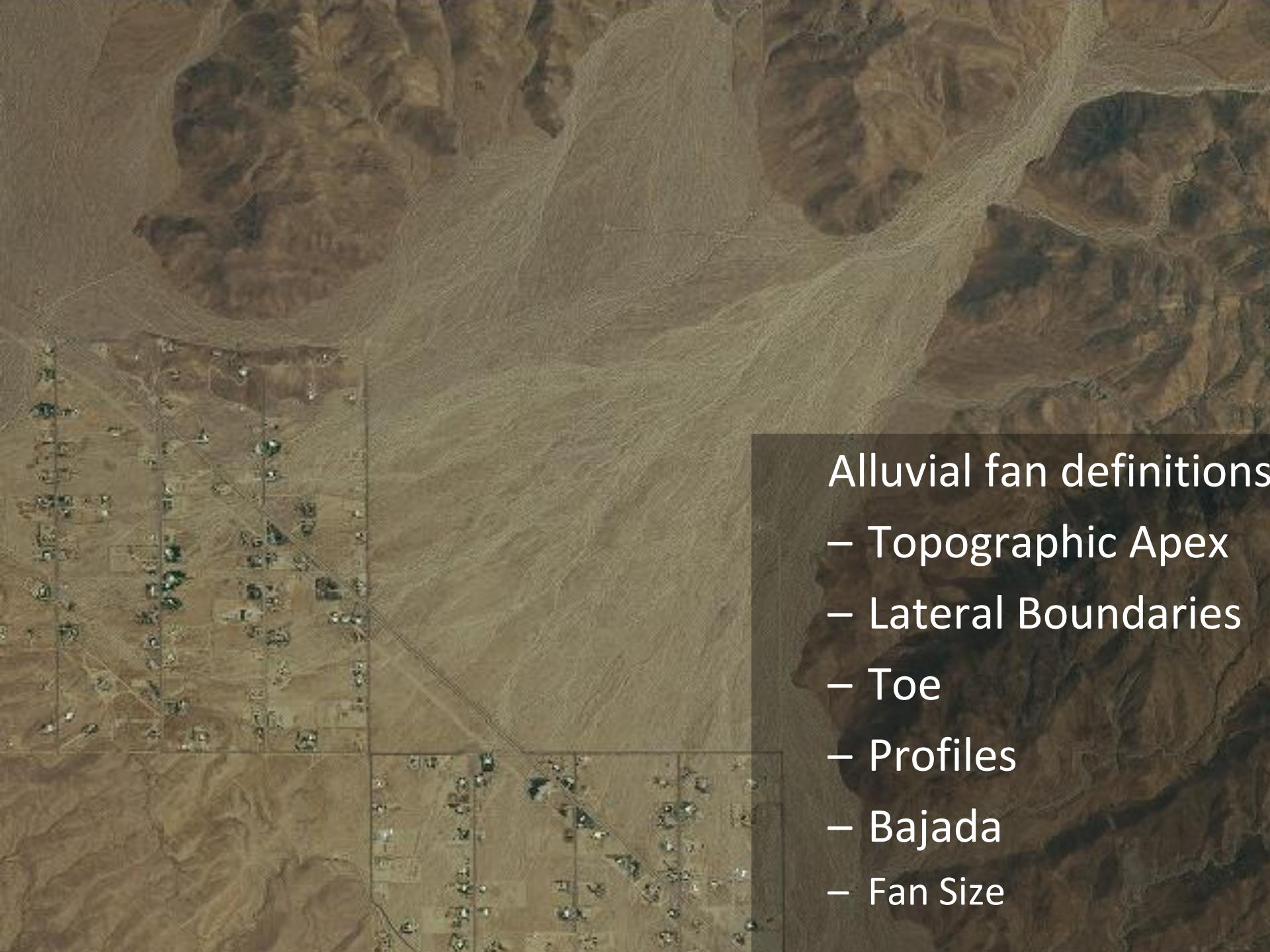
Alluvial Fans - Unique Process and Forms

Episodic Streams Workshop
November 8, 2010

Jeremy T. Lancaster
California Geological Survey

INTRODUCTION

- Geomorphology & Geology
- Deposition Types
- Geomorphic Characterization
- Channel Instability



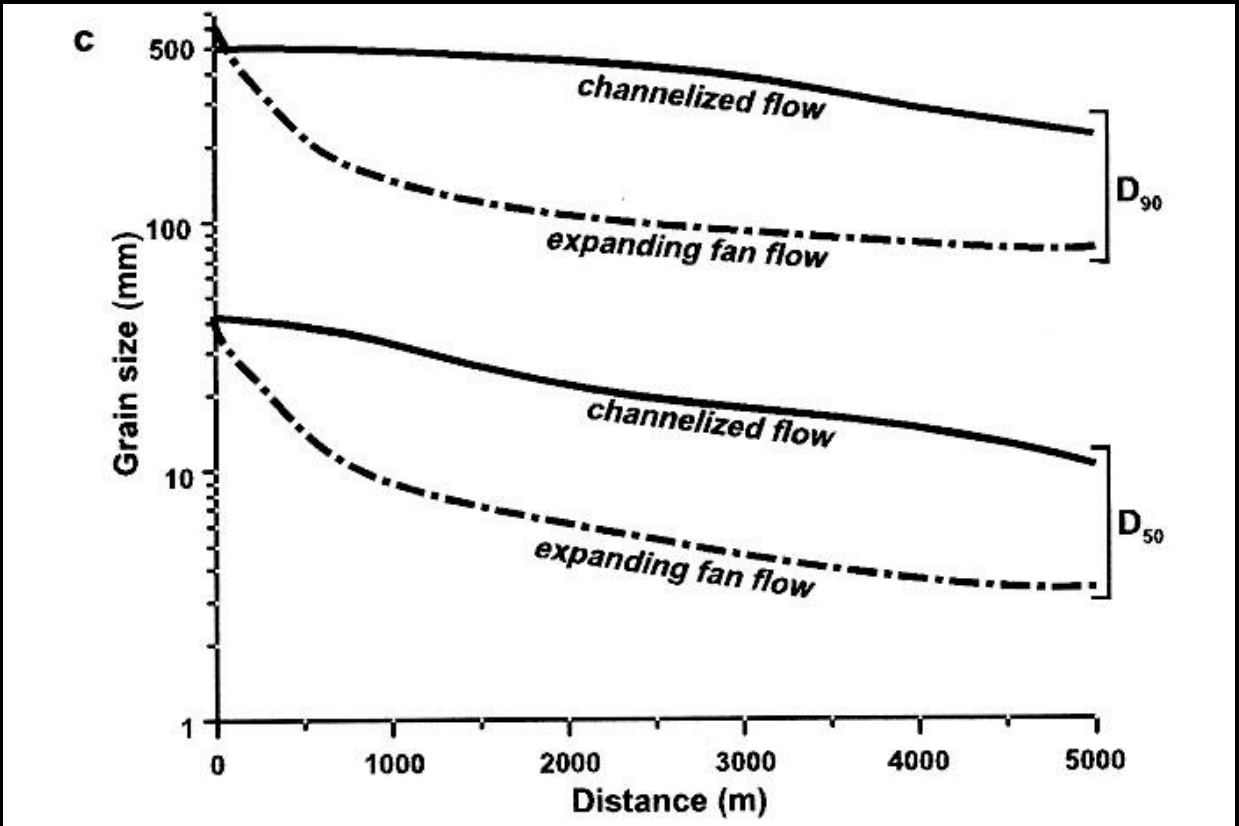
Alluvial fan definitions

- Topographic Apex
- Lateral Boundaries
- Toe
- Profiles
- Bajada
- Fan Size

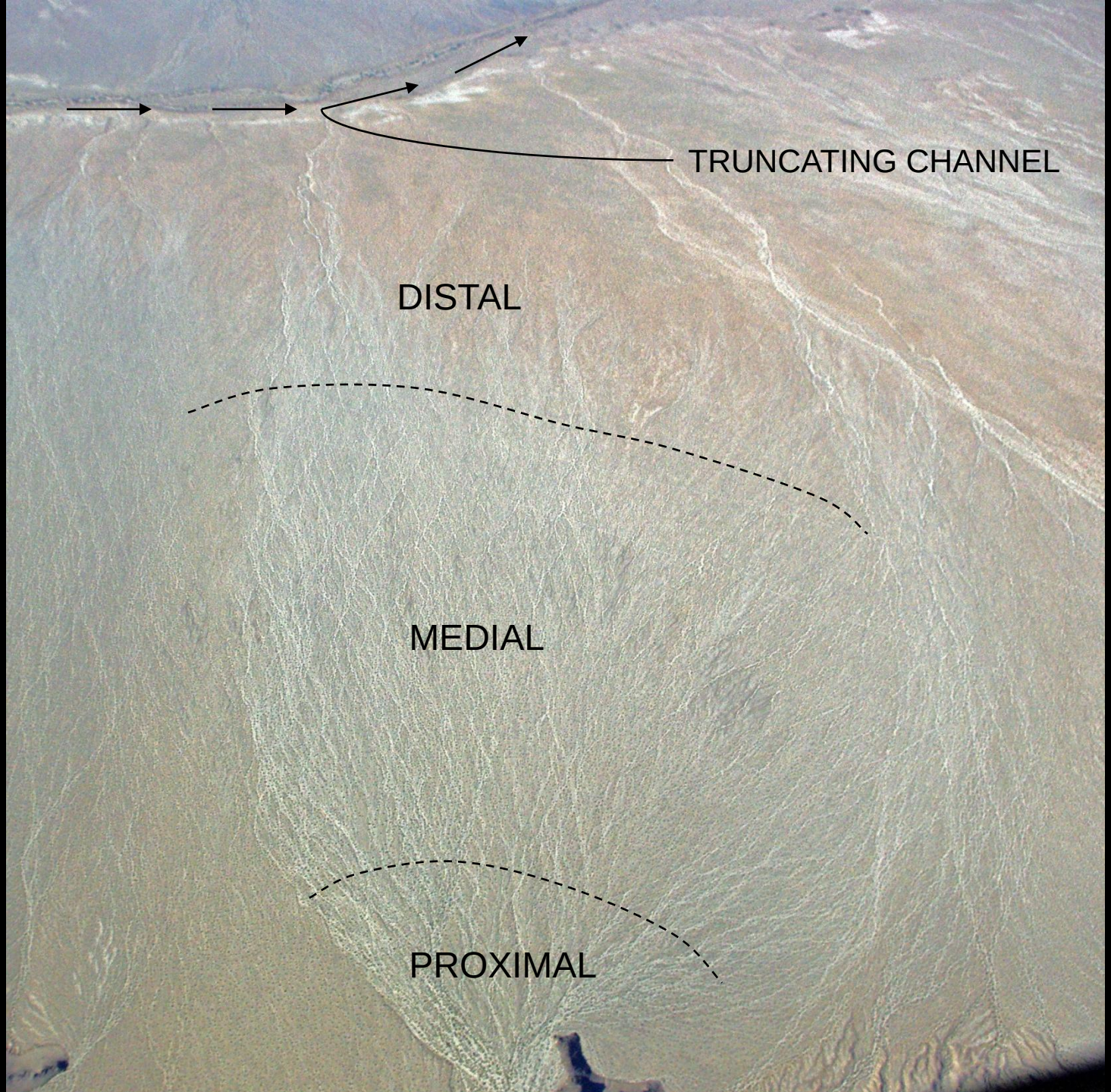
Playa Lakes
Ephemeral Streams
Bedrock Outcrops
Eolian Deposits
Relict Fans

Aggrading Fans Show Decreasing Grain Size with distance from the apex.

- Proximal
- Medial
- Distal

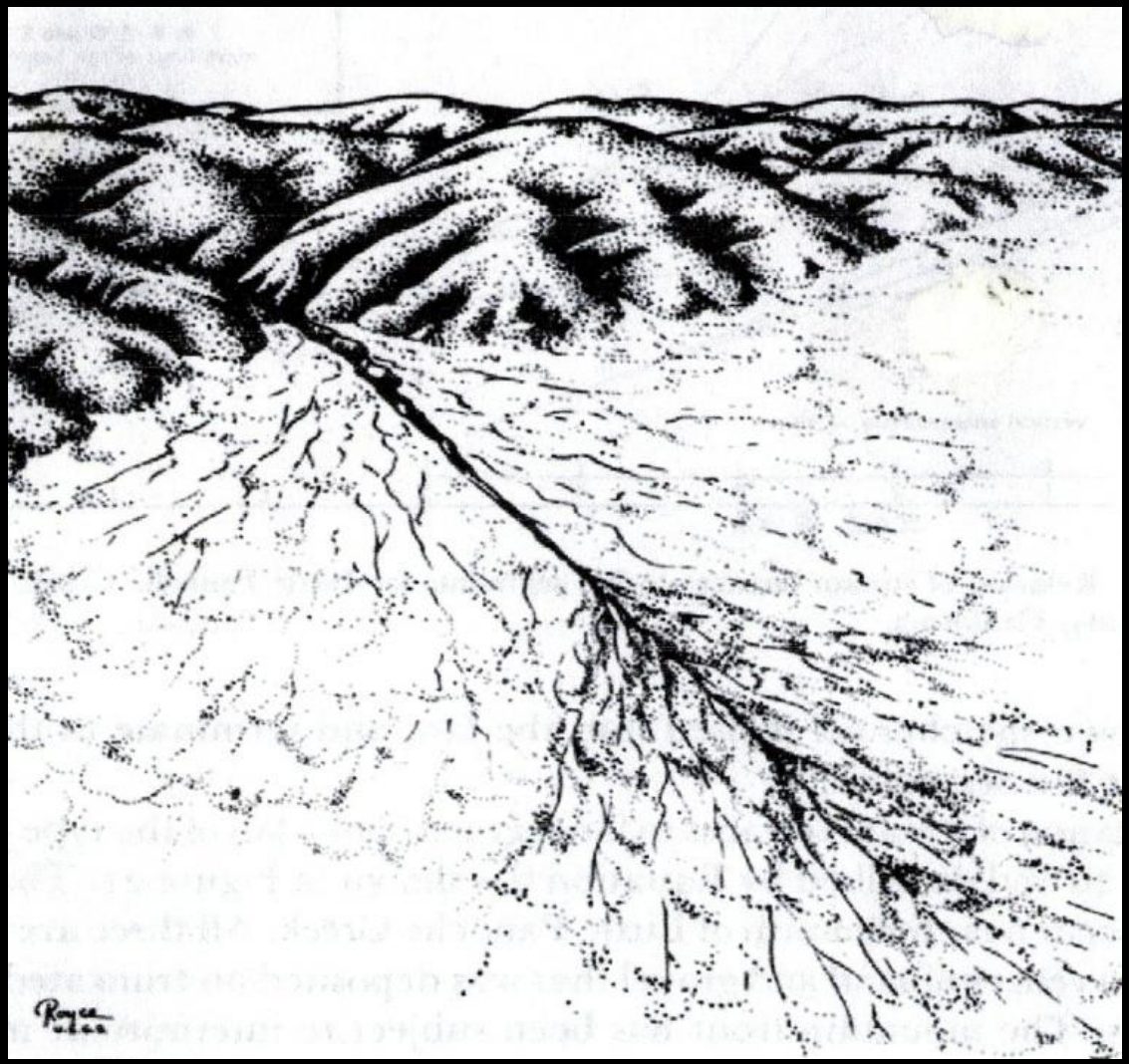


Smith, 2000


TRUNCATING CHANNEL
DISTAL
MEDIAL
PROXIMAL

Segmented

Entrenched



Primary Processes

Rainfall and runoff

Gravity induced slides

Channel derived debris flows

Sheetfloods

Incised channel floods

(Source: Blair and McPherson, 1994)

Secondary Processes

Overland flow

Soil Development

Weathering

Tectonic activity

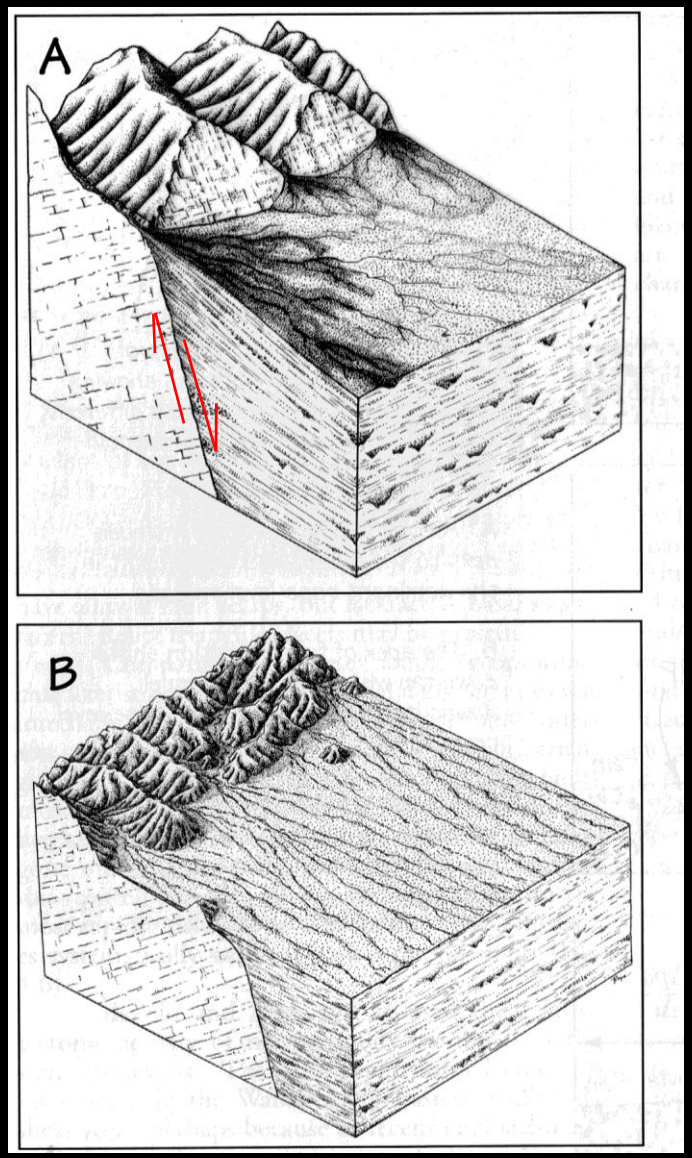
Eolian activity

Bioturbation

Controls on Fan Processes

<u>Long-term controls:</u>

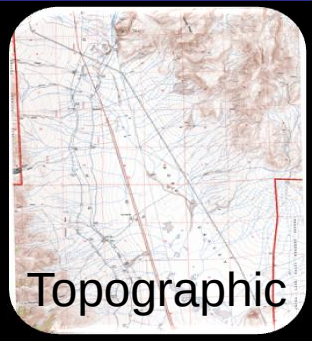
- Tectonic activity
- Uplift >Erosion
- Uplift< Erosion
- Erodible Lithology
- Basin Morphology:
  Relief Ratio and Ruggedness
- Vegetation Density and Type
- Fire History
- Climate



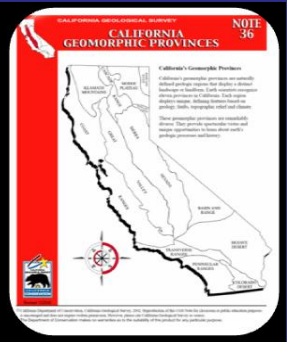
Bull, 2007

KEY DATA

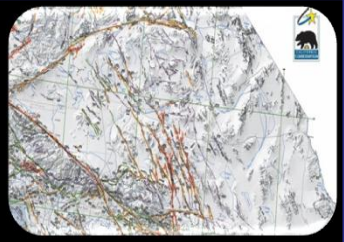
Topographic



Geomorphic

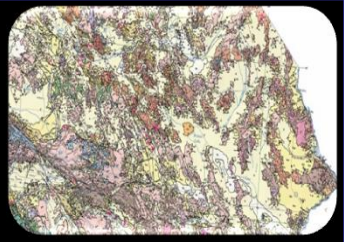


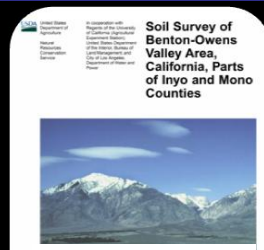
Fault Activity Maps



Fire Potential

Geologic Maps





Soils

Alluvial Fan Depositional Types

- **Streamflow Fans**
- **Debris Flow Fans**
- **Composite Fans**

(Bull, 1977)

Streamflow Fans

- Dominated by water floods
- Sediment concentrations of approx. <20%
- Slopes flatter than 7%.
- Channels are braided
- Channels migrate
- Channels have high width to depth ratios.
- Whole fans may be characterized by actively migrating flow paths or by active abandoned and relict depositional surfaces

Debris Flow Fans

- Dominated by hyper-concentrated flows and debris flows
- Sediment and debris concentrations approx. >20%
- Steep slopes approx. >7%.
- Boulder-lined levees, terminal snouts, boulder fields, and trapezoidal channels.
- Deposition is episodic, and flows easily overtax fluvial channels.
- Avulsion at the fan apex is likely during large flows.

Geomorphic Characterization of Fan Systems and Their Channels

Streamflow fans - Uplift >Erosion

Riverside County, CA

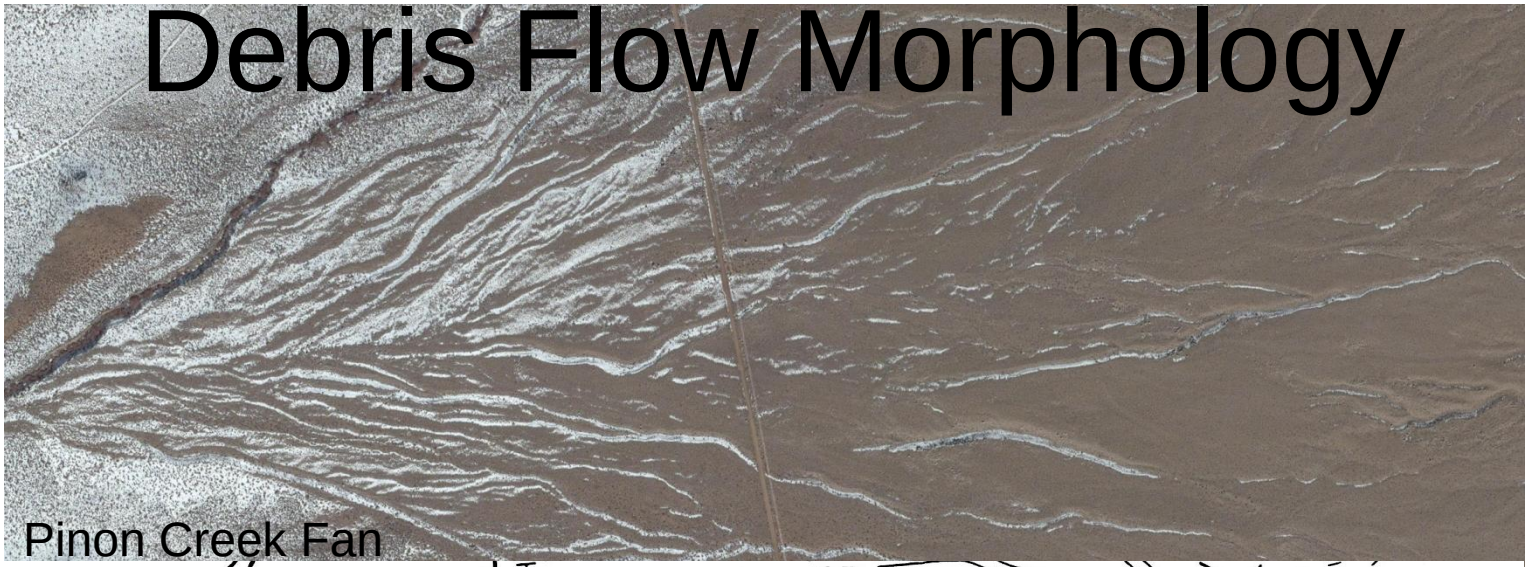
Streamflow fans - Uplift <Erosion

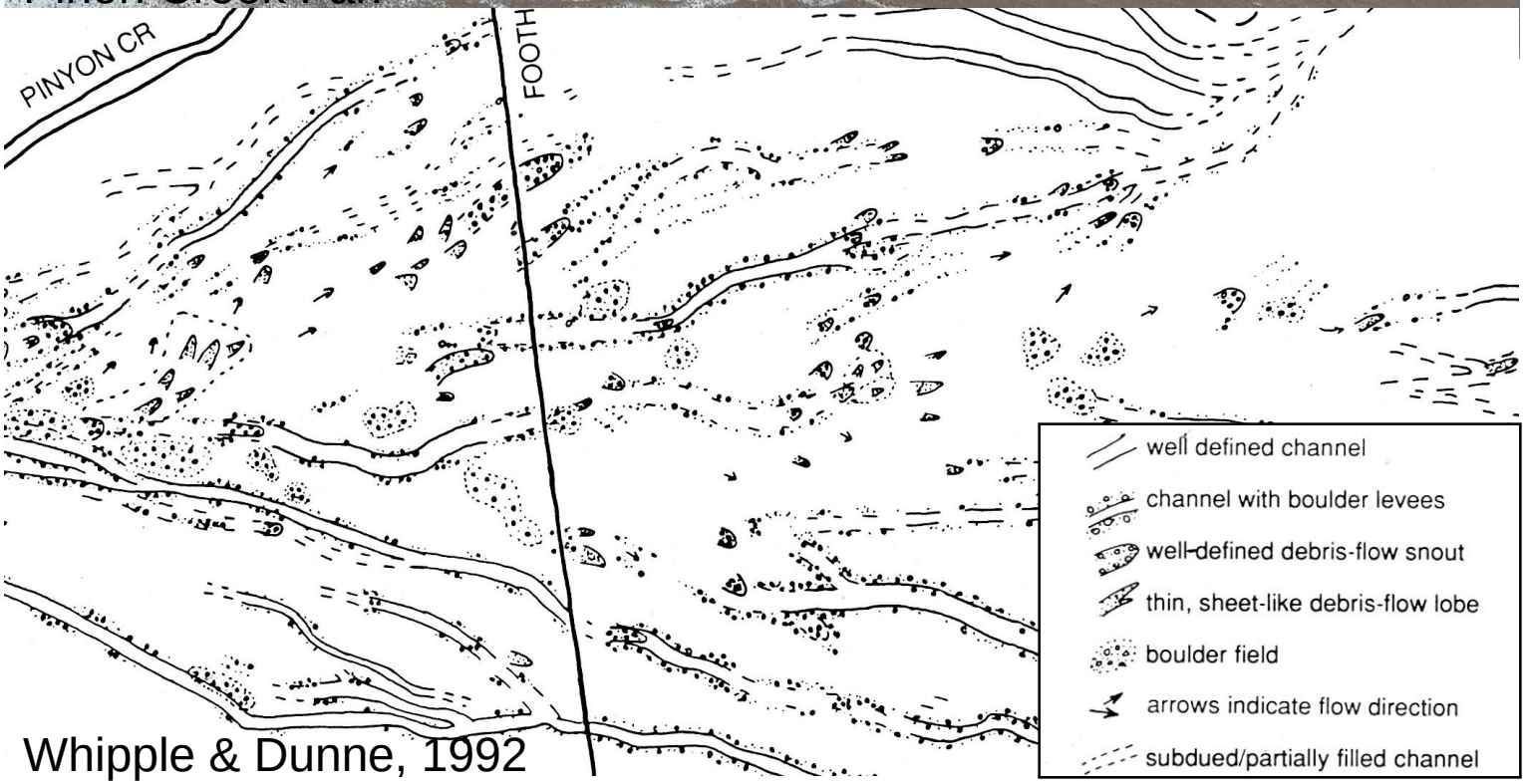
Pinto Mountains,
San Bernardino County, CA

Abandoned
Relict
Active
Relict Fan

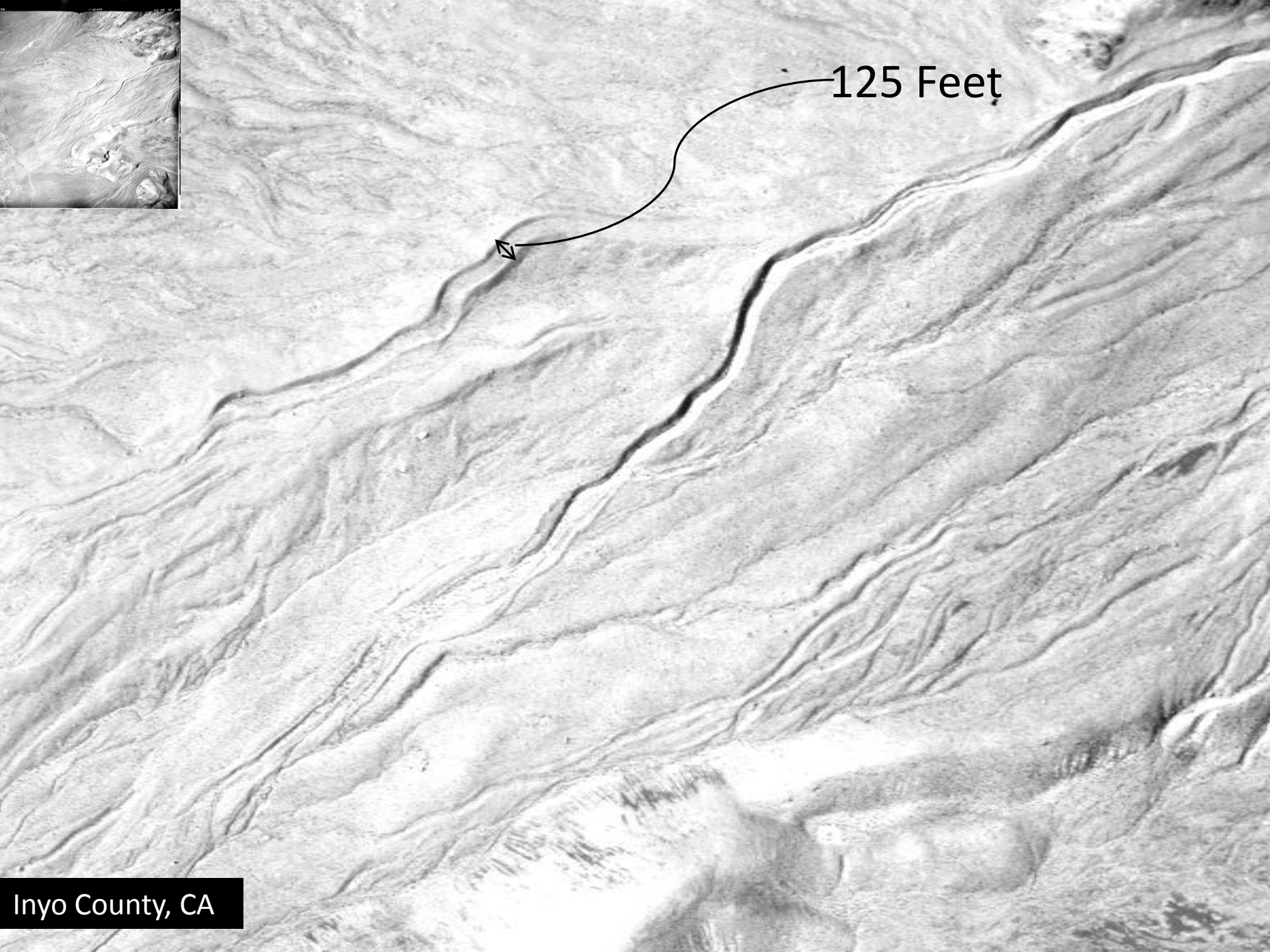
Debris Flow Fans
Uplift >>> Erosion

Debris Flow Morphology





Whipple & Dunne, 1992


125 Feet
Inyo County, CA

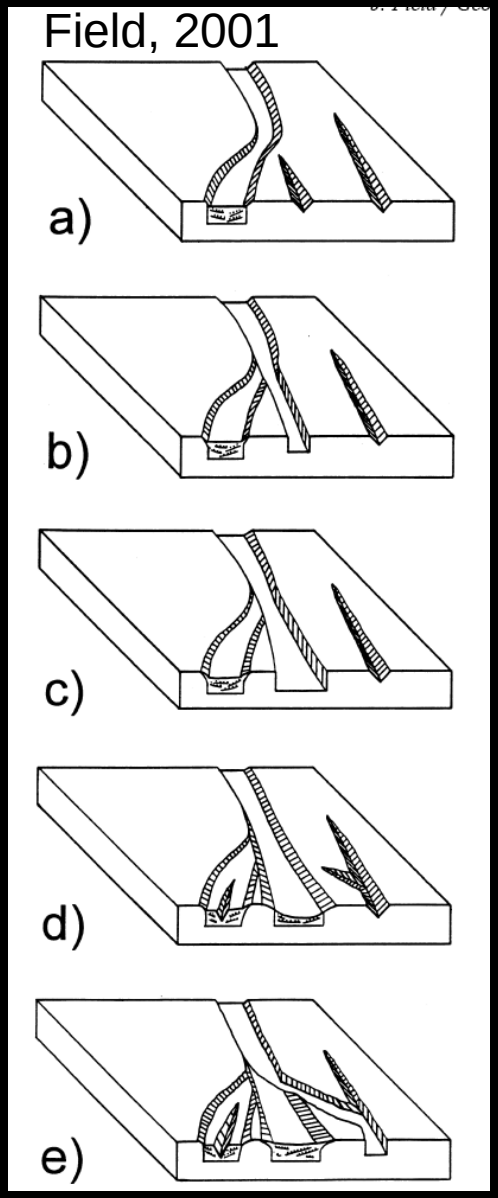
Channel Instability

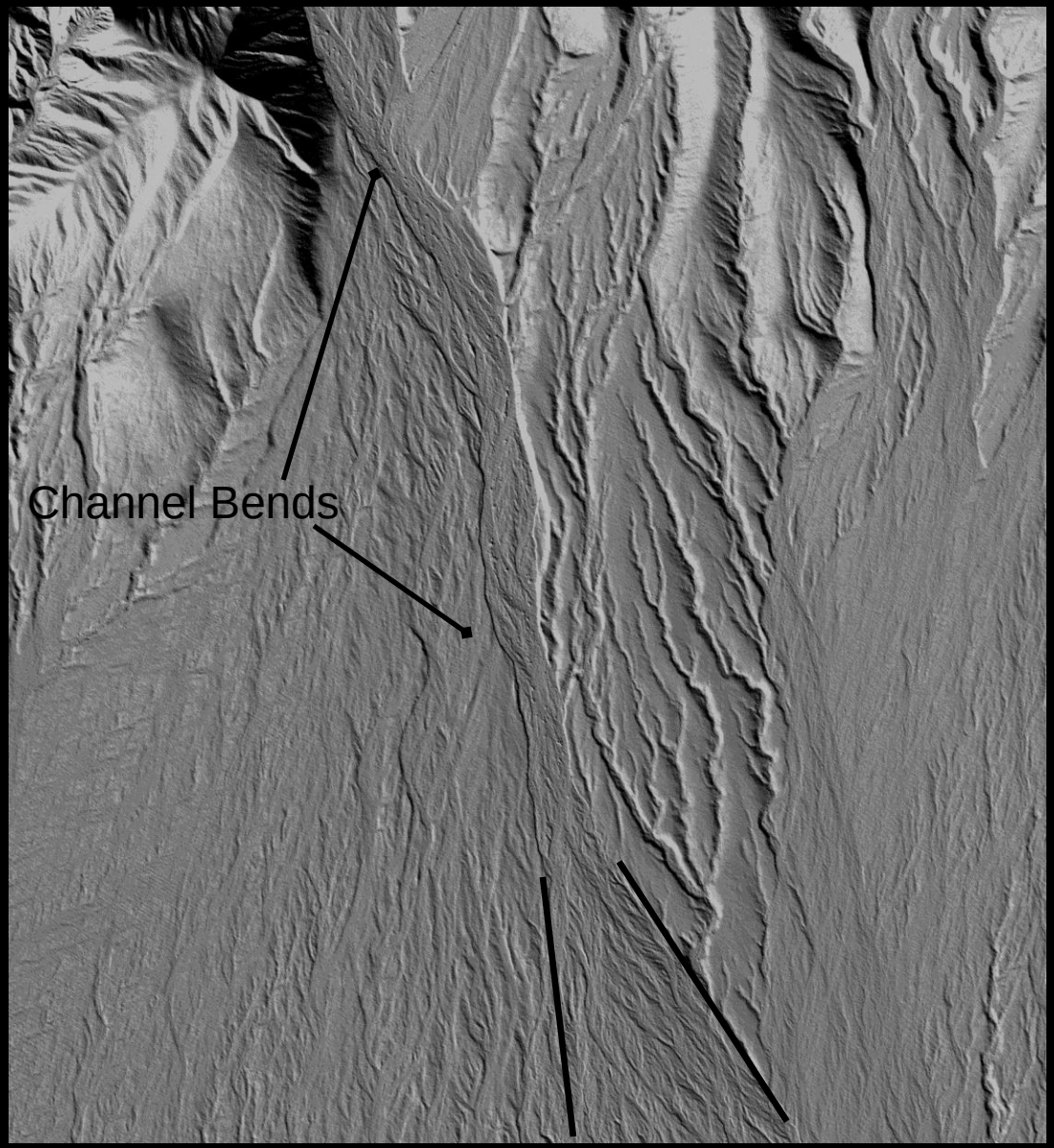
Avulsion

- Debris flow deposition areas
- Channel bends
- Stream capture sites

  - ✓Major Avulsions vs.
  - ✓Minor Avulsions

Fluvial Avulsion





Debris Flow Avulsion