Blair and McPherson, 1994 Summary
Alluvial Fan Processes and Forms

I. Introduction

A. alluvial fan defined
1. landform developed where channel emerges from mountainous uplands to an adjoining valley
a. segment of cone radiating downslope from a point or apex
b. plano-convex profile

2. Depositional Process
a. fan deposits at mouth of canyons
b. loss of power in transporting medium

3. Deposits
a. coarse-grained, poorly sorted
(1) short transport distance
(2) high-relief watersheds / mass-wasting dominated
(3) rapid loss of carrying capacity

4. Desert Settings - classic study sites
a. well-exposed
b. ease of access?

B. Fan Anatomy
1. drainage basin
a. steep
b. low order
2. feeder channel
3. apex
a. mountain front classically
4. incised channel
5. distributary channels
6. depositional lobes

II. Conditions for Fan Development

A. Topographic Setting
1. feeder channel + accommodation space
a. Fault-bounded Mountain Fronts
b. Tributary Junctions
B. Sediment Production in Watershed
1. Weathering Rates
2. Sediment Transport Rates
a. Tectonic (relief) / climate dependent
C. Meteorological Events / Effective Geomorphic Events

- D. Conditions of Fan Aggradation / Deposition
  - 1. Net Loss of Transport Power on Fan
    - a. lateral flow expansion / loss of channel confinement
    - b. decrease in slope
    - c. loss of discharge / infiltration

III. Primary Processes on Fans

- A. Transport mechanisms
  - 1. Mass Wasting Processes
    - a. fall
    - b. avalanche
    - c. slides
    - d. debris flows
      - (1) slide induced
      - (2) bulking induced ("firehose effect")
      - (3) cohesive vs. non-cohesive debris flows
  - 2. Fluvial Processes
    - a. sheet floods
      - (1) unchannelized flow
    - b. channel floods

- B. Secondary Processes (Fan Reworking)
  - 1. Fluvial Re-working
    - a. rilling / gullying
    - b. slope wash
    - c. sieve processes
      - (1) infiltration / "piping" of fine sediment fractions

  - 2. Aeolian Activity
    - a. deflation
    - b. aerosolic influx

  - 3. Bioturbation
  - 4. Groundwater activity
  - 5. Neotectonics
  - 6. Weathering / Soil Development
    - a. Desert Pavement

- C. Climatic and Tectonic Controls

  - 1. Fan-Head Trenching
    - a. incisement of channels / surface abandonment
      - (1) implies high discharge / erosive activity
        - (a) implication: moist climate / > rainfall (past climates)

  - 2. Climate Influence on Sediment Production
    - a. Weathering Limited vs. Transport Limited Slopes

IV. Controls on Fan Processes

A. Drainage Basin Bedrock Lithology
    1. Resistance to Weathering
    2. Grain size controls
    3. Fracture patterns / joint controls

    4. Process Styles
        a. Colluvial vs. Alluvial Processes

B. Drainage Basin Shape and Size

    1. Controls fan morphometry
    2. Size controls scale of geomorphic process
        a. large basins = more storage points
        b. small basins = geomorphically active
    3. Drainage Basin Slope

C. Effects of Neighboring Environments

    1. Aeolian, lacustrine, fluvial, volcanic, marine interactions
        a. control depositional environments

D. Climatic Effects
    1. Climate Influences
        a. Sediment Production Rates in Watershed
            (1) vegetation
                (a) < vegetative cover, > sediment yield
            (2) rainfall patterns
            (3) groundwater condition
        b. Style of Transport Process
            (1) style of precipitation events
                (a) intensity-duration-frequency
            (2) Debris Flow vs. Fluvial Processes

E. Tectonic Effects
    1. Tectonic Accommodation of Fan Sediments
        a. Classic: fault-bounded basins
            (1) extensional basins
            (2) strike-slip basin
        b. Mountain-Front Morphology
        c. Earthquake-induced geomorphic events
            (1) quake-induced landslides

    2. Fan Modification
        a. Fan faulting
        b. tectonic stream piracy
        c. fan tilting
            (1) fan segmentation = variable slope segments on fans

V. Fan Morphometry

A. Cross-Fan Profiles
   1. convex-up
B. Longitudinal Fan Profiles
   1. fan slope

C. Fan Area vs. Drainage Basin Area

   1. $A_f = cA_d^n$

      a. fan area > with > drainage area

      b. drainage basin lithology
         (1) weak / erodible rocks = larger fans

D. Fan Gradient vs. Drainage Basin Area
   1. general relation: > drainage area, < slope of fan

VI. Classification of Fans

A. climate classification
   1. "wet" vs. "dry" fan
   2. "humid" vs. "arid" fan

B. Process classification
   1. fluvial vs. debris flow fans
      a. fluvial vs. colluvial fans

VII. Fan Evolution (over time)

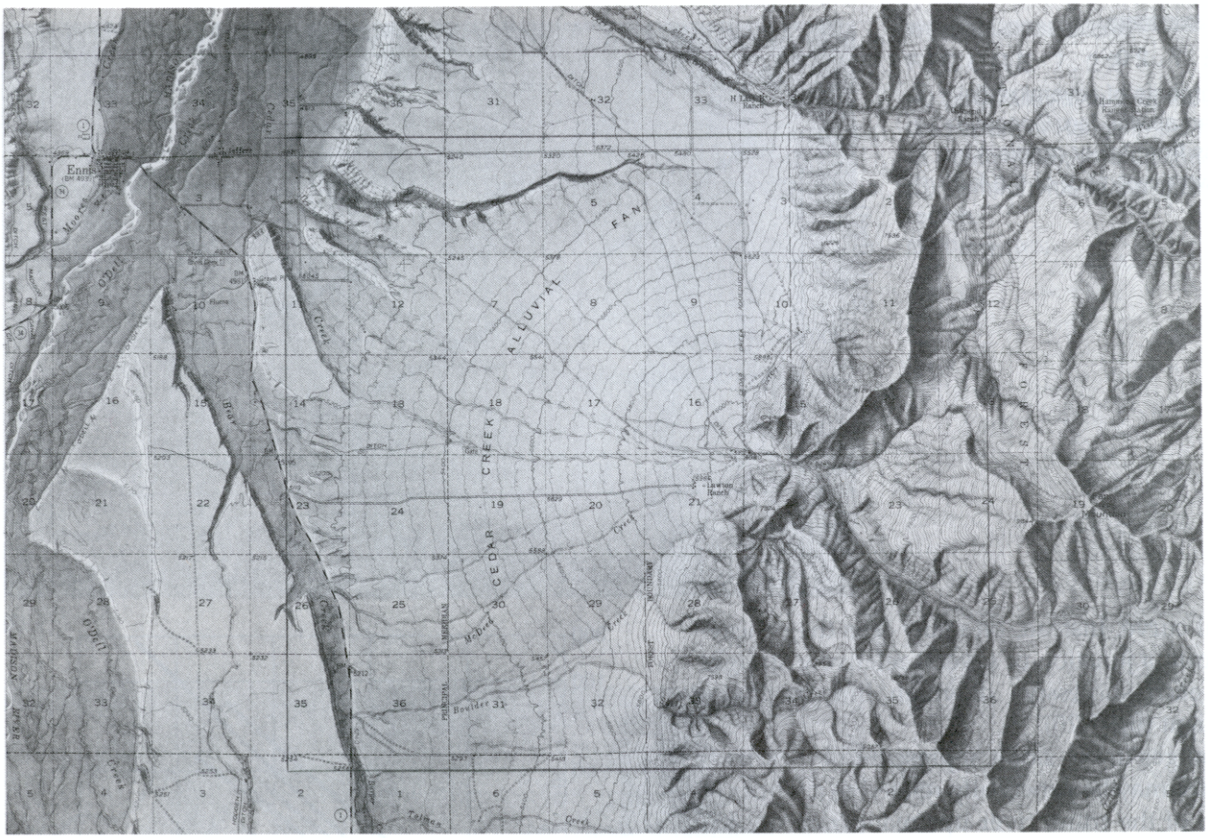
A. Incipient Stage
   1. talus cones
   2. simple fans

B. Composite Fans
   1. complex lobe shifting / surface abandonment

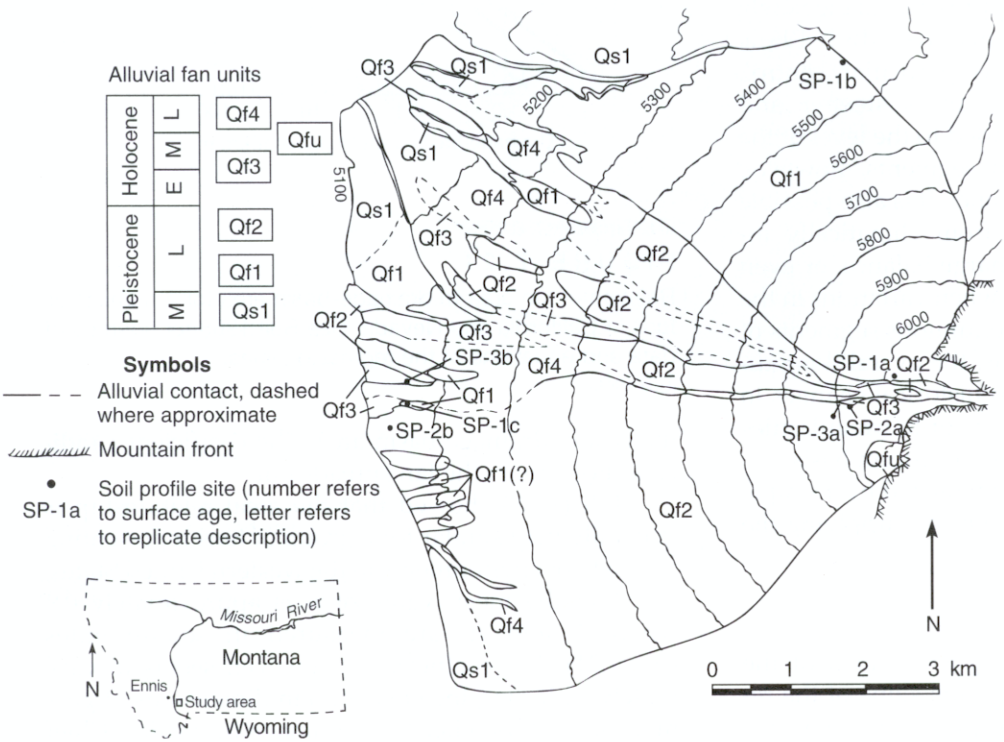
C. Fan Progradation

   1. distal fan progradation vs. proximal fan restriction

      a. tectonic subsidence / basin-fill models
         (1) slow subsidence = prograding fans
         (2) rapid subsidence = proximal fan deposition (restricted)
   2. channel vs. sheetflood fans



(A)

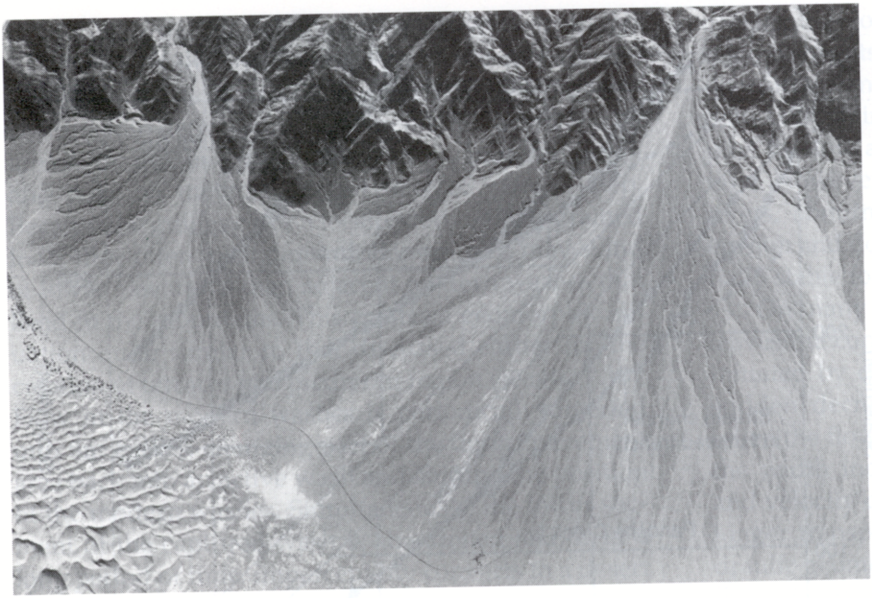


(B)

FIGURE 7.19

(A) Shaded relief edition of the Ennis, Mont., quadrangle (U.S.G.S. 15′) illustrating the classic fan morphology of Cedar Creek alluvial fan. (B) Geologic map of Cedar Creek alluvial fan illustrating spatial distribution of Quaternary alluvial fan deposits. Contours, in feet, were redrawn from the Ennis, Mont., quadrangle.

(B): (J. Ritter et al. 1993)



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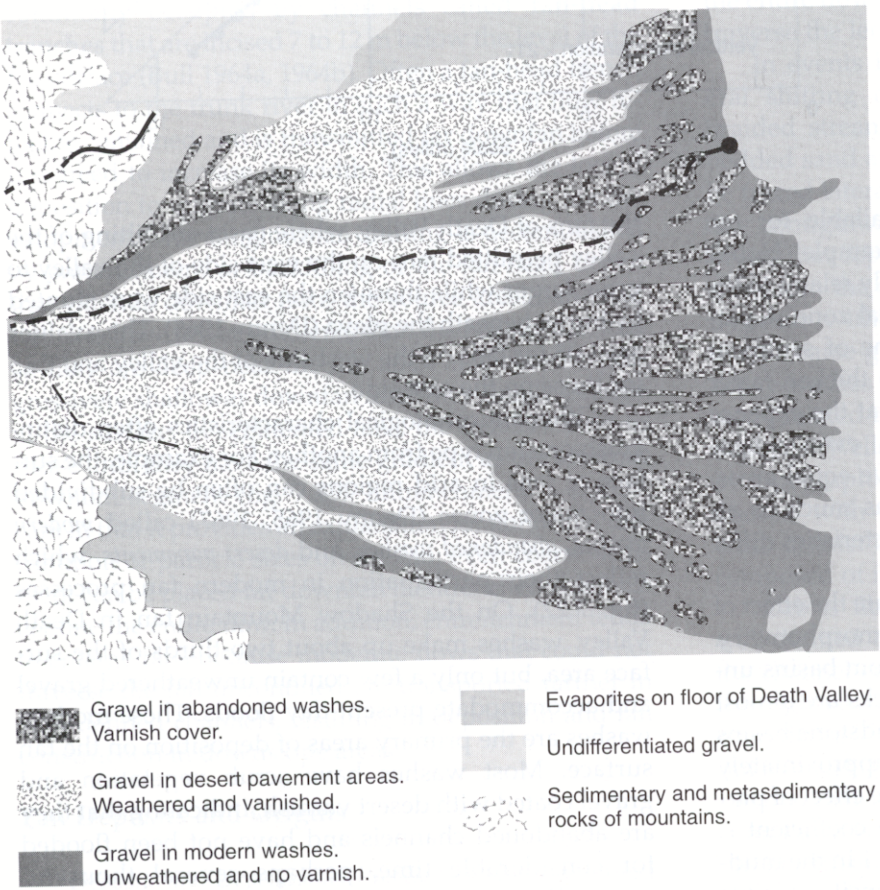

FIGURE 7.22

(A) Large alluvial fans at the base the Panamint Range in the north of Death Valley, Inyo County, Cali (B) Components of fan in Death V region.

(B): (Denny 1965)