Wells, Stephen G., and Harvey, Adrian, M., 1987, Sedimentologic and geomorphic variations in storm-generated alluvial fans, Howgill Fells, northwest England: Geological Society of America Bulletin,v. 98, p. 182-198.

I. Introduction

A. Alluvial Fan settings

1. humid regions
2. tectonic mountain fronts
3. stable footslopes and valley junctions

B. Fan Processes
1. stream flow
2. debris flow
3. hyperconcentrated flow

C. Controls on sed. processes

1. tectonic, climateic, spatial-distal relations
2. hydrologic conditions for sed. mobilization
    a. catastrophic storms

D. Sed. Facies
1. debris flow, stream flow, transitional
    a. proximal to distal relations

E. This Paper
1. high intensity short duration storm, NW England
    a. Howgill Fells, 1982
        (1) destabilized hillslopes
        (2) 13 fans activated
        (3) local debri cones
        (4) common fan dep. at trib. junctions

2. Facies Relations
    a. some not related to climate, tectonics

3. Emphasis: under constant climatic and tectonic conditions, depositional processes may vary according to intrinsic geomorphic thresholds

    a. i.e. not all facies changes are climatic or tectonic in nature

II. Strom Hydrology and Physical Setting
A. storm, 6/6/82
1. thermal convective, variable spatially
2. 2.5 hr storm, 55-80 mm; 100-500 yr storm

        3. peak trib. Q 11-30 cu. m/sec

B. Geomorphic response
   1. overland flow
   2. landslides
   3. debris flows
   4. eroded channel banks, deposition in fans at tribs.
      a. fans on old fans
      b. fans inset into old fans

C. Geology
   1. Silurian clastics, covered by Pleistocen soliflucted glacial depoists
   2. Sed. sources for 82 event
      a. fine seds. from soliflucted till in gully walls
      b. bedrock in channels
      c. older fan seds.

III. Study Sites and Methods

A. several fans for comparative sedimentology
   1. fan surveying, map work
   2. photos
   3. texture analysis
      a. clast size
      b. sieve samples
      c. strat. sections,

IV. Facies Types and Sedimentary Processes (includes some very nice maps and profiles of fans, showing facies and morphology, a good example of how to do it!)

A. Type D1 Facies: viscous debris flows

   1. lobate forms, steep snouts
   2. pressure ridges
   3. diamicts, crude coarsening up sequences
   4. breeched levee deposits
   5. clast fabric relations observed
   6. Processes
      a. laminar, non-Newtonian viscous slurry flow
      b. pulsing, surging with pressure ridges

B. Type D2 Facies: dilute debris flows

   1. thinner, broader and lack clast fabric
   2. gentler lobe fronts
   3. "runout" deposits
   4. interp.:

    a. dilute non-Newtonian flow
    b. slight > in moisture conditions

C. Type T1 Facies: transitional flow deposits

  1. stacked lobe depoist, high relief
  2. clasts dip into depressions, suggest collapse
  3. upper surface = gravel armor
  4. local stratification / fluvial deps.
  5. weak internal strat. near lobe front
  6. process interp.
    a. dilute, less viscous non-Newtonian flow (more dilute than D2)
    b. transitional between debris and stream flow
    c. late-phase cycle of debris activity
    d. hyperconcentrated flow conditions
      (1) horizontal strat.
      (2) clast support
      (3) better sorting than debris flows

D. Types S1 and S2 Facies: fluvial boulders and bars
  1. bar deposits, matrix free, imbricated
    a. long. and transverse bars
  2. long axis of clasts perp. to flow directions
  3. boulder trains behind obstacles

E. Type S3 Facies: fluvial sheet deposits
  1. planar stacked sheets of mod. sorted gravels
  2. bar and swale morphology
  3. sl. finining up relations
  4. interp.
    a. sheet flood conditions
    b. sed. conc. < debris flow, hyperconc. flow

V. Sequence of Depositional and Erosional Events

A. General
  1. no one fan displays all facies
  2. fans are characterized by particular facies
  3. late-stage modification of fans by channel reworking

B. General Seqeunce of Process observed on fans

  1. Temporal and spatial variations in facies deposition during storm
    a. variable water: sed ratio

  2. Early phase: debris flow to transitional flow
    a. large sed. input from slope failure

3. Dilute conditions
a. transition to hyperconc. flow to stream flow

b. net sequence of facies: debris flow, hyperconc. flow, stream flow

VI. Discussion

A. Alluvial Fan Classification: Facies Assemblages

1. stream flow 77% all facies i.d. from event
2. debris flow 14% of all fan facies

3. Fan classif. based on facies types
a. a: dominated by viscouse debri flow
(1) small basins, steepest slopes
b. b: fans dominated by transitional facies
(1) more dilute
(2) larger catchment basins
(3) < gradients
c. c: fluvial facies fans
(1) < area of drainage over b
d. d: sheet fluvial deposits
(1) largest basins, highest Q, lowest grad.
(2) stacked fluvial deps.

B. Conceptual Model of Fan Deposition and Erosion

1. Nice summary diagram, have seen this before from wells

a. catchment >, slope <, % area eroded during storm < = tendency towards stream-flow facies
b. catchment <, slope>, % area eroded during storm > = tendency towards debris flow facies
c. At any given fan over time (sequence of events)
(1) initiation
(2) most viscous flow
(3) gradual dilution
(4) stream flow
(5) final phase channel modification and erosion of deposits

C. Factors Controlling Facies Types (based on discriminant stat. analysis)

1. controls of facies and fan entrenchment
a. thresholds related to catchment morphology
b. type of sediment available for transport
c. position of fan within storm cell

2. NOTE: facies changes classically attributed to either climate or tectonics (extrinsic

controls)

a. In this case: those factors are constant and facies changes occur due to intrinsic factors above, not extrinsic controls
b. Sed. facies interpretations beware!!!!

VII. Conclusions
- A. Storm in NW England in 1982
  1. activated hillslopes
  2. deposition in 13 alluvial fans
  3. six facies i.d. representing debris, stream and hyperconcentrated flow
  4. localized accretion of 2m on fan surfaces
  5. local deposition of up to 10 stacked gravel layers during single dep. event
  6. strat sequenc: debris to transitional to streamflow facies
  7. late stage fan incision/reworking
  8. relative facies distribution controlled by catchment area, slope, sed. supply and precip. variations in storm cell
- B. Wolman and Miller principal of mod. freq. events more greatly mod. landscape not suggested here
  1. high mag. low freq. events doing more work