The Legacy of Massive Volcanic Sediment Input to Fluvial Systems

An Example from the Sandy River, Mount Hood, Oregon

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Key idea #1 -- Volcanic disturbance can lead to massive sediment inputs to rivers

- Sediment loading heaviest in headwaters close to volcanic source
- Loading can be “instantaneous” or prolonged

St. Helens

Pinatubo

Chaitén
At Mount Hood, massive sediment deposition occurred in the upper Sandy River during the last two eruptive periods, about 1,500 and 220 years ago. Deposition chiefly by pyroclastic flows and lahars filled up to 500 ft thick.
Key idea #2-- Much (but not all) new sediment moves quickly downstream following disturbance

- Volume, rate of sediment flux dependent on storm magnitude/frequency
- Sediment volume typically exceeds transport capacity → net storage in channel
- Geomorphic responses:
  - Channel widening
  - Bed-material fining
  - Braiding
  - Aggradation

USGS
At Mount Hood, primary geomorphic response = channel aggradation

- Channel bed aggraded 75 feet in 12 years or less (AD 1781 – 1793); aggraded 85 feet previously
- One lahar and alluvial fill buried old-growth forest
- No stratigraphic breaks in aggradational sequence
- Affected reach 37 – 52 miles downstream of volcano

Lahar deposit

Paleoterrace soil
At Mount Hood, aggradation dominated by fluvial (winter flood) deposition

- Deposits indicative of shallow, sand-bedded channels with turbulent supercritical flow

- Lewis and Clark reported (in 1805) that “the bed of this stream is formed entirely of quicksand . . . The current is swift, not more than 4 inches deep. . .”
Terrace and paleoterrace sequences at Oxbow Park

Max. tree ages give rate of river re-incision

Terraces dated to latest possible year of floodplain abandonment

Achieved between ~1870 and 1911

Deposit AD 1781-1793

Deposit AD 300-600

Deposit older than BC/AD 0 (based on tree rings)
Key idea #3: When sediment supply rate < transport rate, channels “recover”

- Braided channels return to single thread
- Sandy beds return to beds armored with gravel
- Channels re-incise to new, “stable” profiles
At Mount Hood, all three responses occurred:

- New profile stabilized in 60–70 years
- New bed at higher elevation
Key idea #4—Following initial recovery, much sediment still available for transport

• Large releases of sediment possible during large storms
• Main source is probably bank erosion
• Large pulses of remobilized sediment may destabilize downstream reaches
At Mount Hood, damaging bank erosion and channel avulsion occurred during floods in 1964, 1996, 2006, and 2011 in the upper Sandy River. Adjacent Salmon River (larger watershed) had no major damage in 2011.
Lingering question-- Do we need a new way to define and assess channel stability in volcanically disturbed drainage basins?