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Source, transport, and age of sediment from Cascade volcano watersheds to the nearshore: insights for contaminant and ecological studies

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Source, transport, and age of sediment from Cascade volcano watersheds to the nearshore: insights for monitoring studies

Renee Takesue, Kathy Conn, and Margaret Dutch
1. Background and geochemical approach

North Cascade Volcanoes

➢ YOUNG, ACTIVE volcanoes
➢ Near large population centers
➢ Volcanism + snow → lahar (ash flow)
1. Background and geochemical approach

Geochemical sourcing, aging

- Geology of watersheds
  - Rocks + weathering = Soil + transport = SEDIMENT
  - Rock types have distinct chemical compositions

- Age of sediment
  - Rates of radiometric decay of atmospheric particles delivered to the earth’s SURFACE
  - High affinity for sediment, OM
  - Erosion, transport to depositional envir.
  - $^7\text{Be}$ (up to 5 mo.)
  - $^{210}\text{Pb}$ (3 yr - 100 yr)
Mt. Rainier → Puyallup River → Commencement Bay

65 km (40 mi.) from Tacoma
2,460 sq. km (948 sq. mi.)
Puyallup River / Commencement Bay

➢ What is the fate of fluvial sediment (and contaminants) in CB?
  ○ Sediment sourcing RIVER vs. BLUFF
  ○ PAHs, wastewater ind., hormones, PCBs, PBDEs

➢ Can recent sedimentation (and contaminants) be distinguished from pre-existing?
  ○ Sediment aging ($^7\text{Be}$)

➢ What are the implications for biota?
  ○ Forage fish spawning beaches
2. Mt Rainier → Puyallup River → Commencement Bay

**Sourcing: % River v. Lowland**

Upper 0-2 cm seabed sediment
Aging: Recent deposition (winter, historical)

2. Mt Rainier → Puyallup River → Commencement Bay

$^7\text{Be}$ (last 5 months)  
$^{210}\text{Pb}$ (last 100 yr)

Upper 0-8 cm seabed sediment
Contaminant patterns in CB

- Higher in BAY than river;
- Higher in WINTER than summer;
- PAHs, waste ind., PCBs, (metals) highest at SOUTH shore/Tacoma waterfront;
- Only 1 higher on the north shore;
- Forage fish spawning beaches

Upper 0-2 cm seabed sediment
Summary (Puyallup/Comm Bay)

- River source >> Bluff source in CB
  North shore > south shore

- Sediment aging was essential:
  North shore > south shore

- Contaminants
  South shore (Tacoma) > north shore
    - Pre-existing contaminant sources predominate
  Winter > summer (Climate change?)

- Forage fish spawning site / river / fewer cont.
Mt. Baker → Nooksack River → Bellingham Bay

154 km (96 mi.) from Bellingham
230 km (143 mi.) from Vancouver
2,036 sq. km, 786 sq. mi.

© Shannon Leigh Photography

Curran and Olsen (2009)
Questions:

➢ Can NF, MF, SF sediment be distinguished?

➢ How is terrestrial (river) sediment and OM distributed in Bellingham Bay?
  ○ Sediment sourcing RIVER vs. LOWLAND

➢ Are terrestrial input and contaminants related?
  ○ Collaboration with WA ECY Urban Bays proj.
Geochemical signatures (Rare Earth Elements)

★ River = Lowland (glacial deposits)
★ Lowland = Bellingham Bay
∴ River = Bellingham Bay
★ North Fork sig. = Middle Fork sig.
≠ South Fork sig.
★ Summer runoff
Bulk $d^{13}C_{SOM}$

- Terrestrial $d^{13}C$ values closer to shore

- River influence decreases with distance offshore
Contaminant patterns in Bellingham Bay

➢ Biomass/Emission PAHs (left), summed PAHs (right), anthr. metals

➢ No association between river influence and PAHs, metals
Summary (Nooksack/Bellingham):

- River = Lowland = Bellingham Bay in summer could not be distinguished geochemically

- River discharge not a big source of PAHs, metals
  - Agricultural compounds?

- South Fork sediment was distinct from North, Middle
Implications

In the face of changing climate and human pressures, sediment sourcing and aging can:

★ Show the role of large rivers, urban centers as sources of sediment, OM, and contaminants;

★ Distinguish new inputs from pre-existing;

★ Show transport pathways

→ Improve understanding from long-term monitoring about changing processes that structure ecosystems.
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