Methods to specify and quantify sediment source contributions and transport pathways

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• Who? Source interpretations – usually qualitative
• What? Usually well defined in environmental studies
• When? )
• Where? Basin dynamics – usually speculative
• Why? Grain Size and Mineralogy
Traditional and New Methodology
Example:
San Luis Obispo Bay, Calif.
Erosion and accumulation derived from historical bathymetric charts.

GIS exercise used in Environmental Sedimentology Course
Sediment Mineralogy

MinA\text{\_deposit} = y_1\text{MinA}_{\text{source1}} + y_2\text{MinA}_{\text{source2}} + y_3\text{MinA}_{\text{source3}} + \ldots
Sediment Grain Size

- Sand
- Silt
- Clay

River sand
Beach sand
Along shoreline
W     E

Standard deviation

NW-1  PSL-1  AB-2
After McLaren 1980

Successive changes along a pathway

In Transport

Source Sediment

selective erosion

Lag

selective deposition

New Deposits

finer grained better sorted more negative skewed

coarser grained better sorted more positive skewed

increased energy
Transport vectors based upon grain-size trends between sites

Coarsening trends = storm turbulence; transport

Fining trends = normal or summer transport
Combined Results

- Storm transport (grain size)
- Net transport (mineralogy)
- Summer transport (normal grain size)

River impact mainly local but important

Harbor siltation largely from offshore sediment
Ventspils Harbor, Latvia

1898

1932

1942

$m^3/yr$
1898-1996

-1.5 to -1.25
-1.25 to -1.0
-1.0 to -0.75
-0.75 to -0.5
-0.5 to -0.25
-0.25 to 0
0
0 to 0.25
0.25 to 0.5
0.5 to 0.75
Sediment budget calculation

- Based on mineralogy (quartz/feldspars - ratio)

\[ A[Qz]_m + B[Qz]_r = 1[Qz]_h \]
GIS calculation of transport vectors

Interpolation and block kriging

Identification of trends from neighboring cells

Combination of trend directions in all three parameters

Asselman 1999
Lithuanian Coast

Fining trends: red to blue

Coareening trends: red to blue

(F,B,-) (C,B,+)
Sources

Character of supplied material

Transport mechanisms

Glacial meltwater
- Unweathered, fine-grained, abundant quartz & feldspar
- Overflow suspension transport, some density underflows

Reworked deposits
- Weathered and fresh grains relatively coarse-grained, aggregates, quartz, feldspars, clay minerals
- Bottom currents

Soil terrains
- Weathered, fine-grained, abundant clay minerals
- River discharge (mainly suspension)
Quantitative Modelling

1) *simultaneous equations with each of the three idealized sources defined using “index” compositional and size relationships.*

2) *extrapolation of values to obtain the “pure” end-member sources*
Tack!
Conclusions

Source interpretations can be quantified with mineralogy, even in the finest fractions

Usually well defined in environmental studies

Basin dynamics, at least the net effects over time, can be characterized by grain-size trends and interpreted transport pathways

A sediment perspective on source supply is a logical complement to basin studies.