Methods to specify and quantify sediment source contributions and transport pathways

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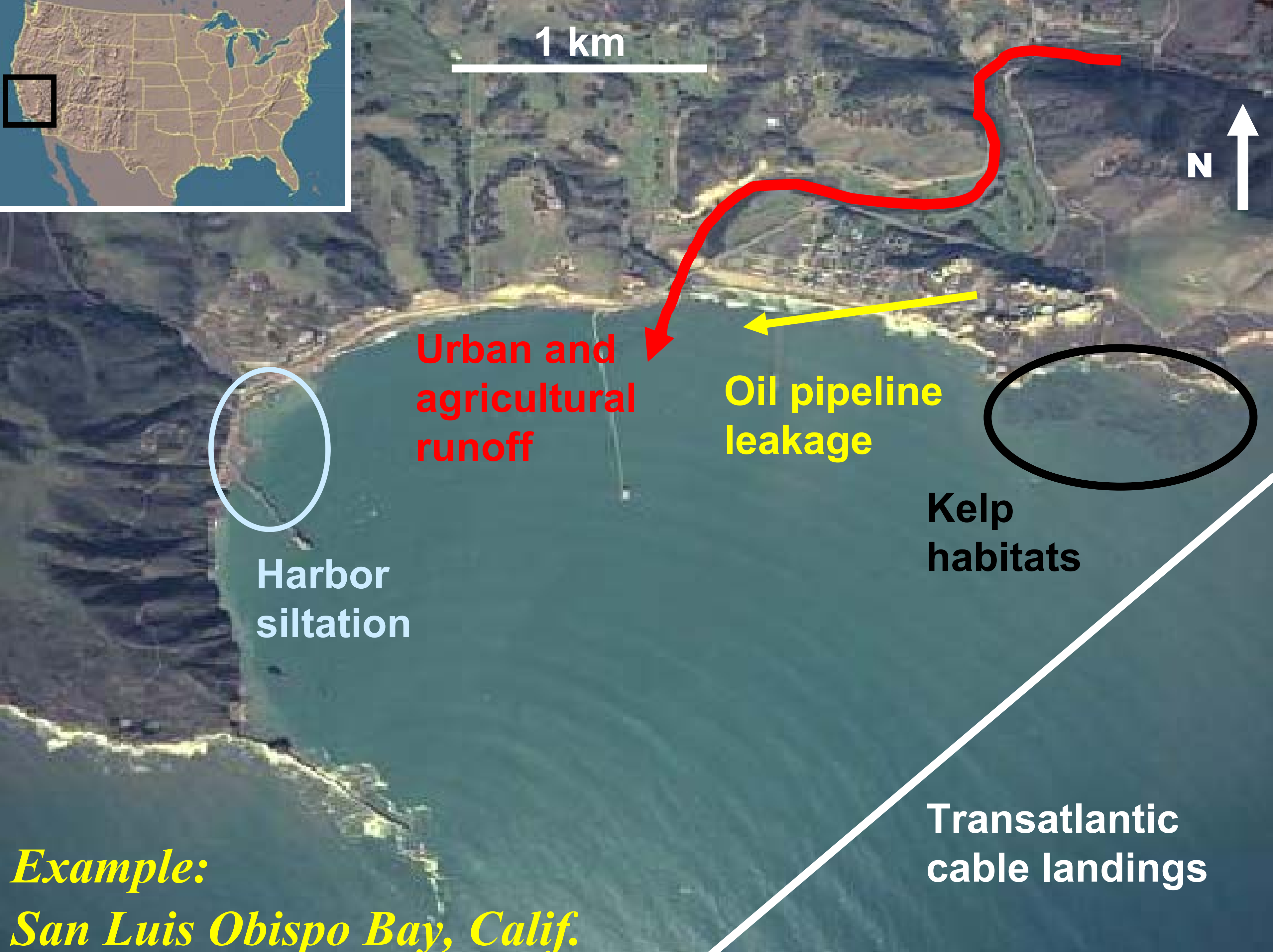
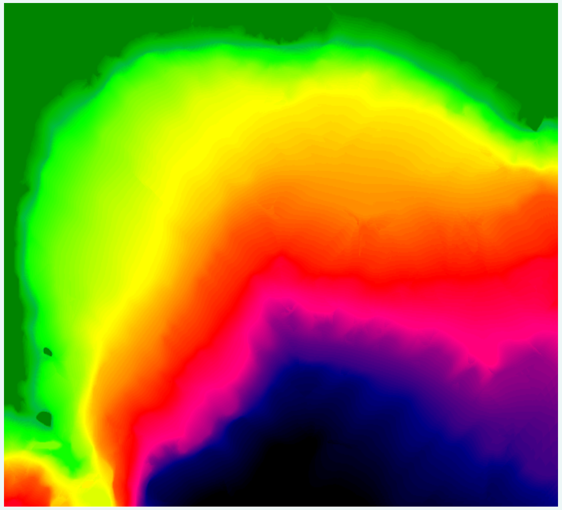
- Who? — *Source interpretations – usually qualitative*
- What?
- When?
- Where?

$\}$ *Usually well defined in environmental studies*

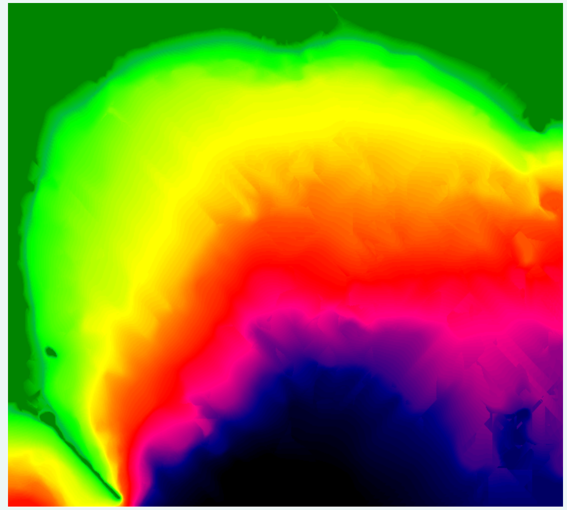
- Why? — *Basin dynamics – usually speculative*

Grain Size and Mineralogy
Traditional and New Methodology

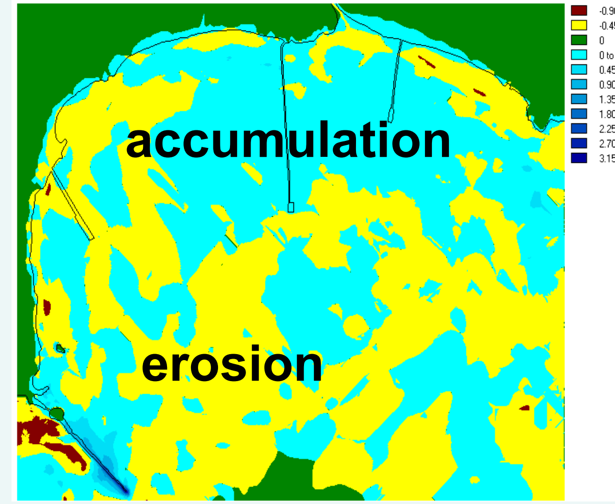

1 km
N
Urban and agricultural runoff
Oil pipeline leakage
Harbor siltation
Kelp habitats
Transatlantic cable landings
Example:
San Luis Obispo Bay, Calif.



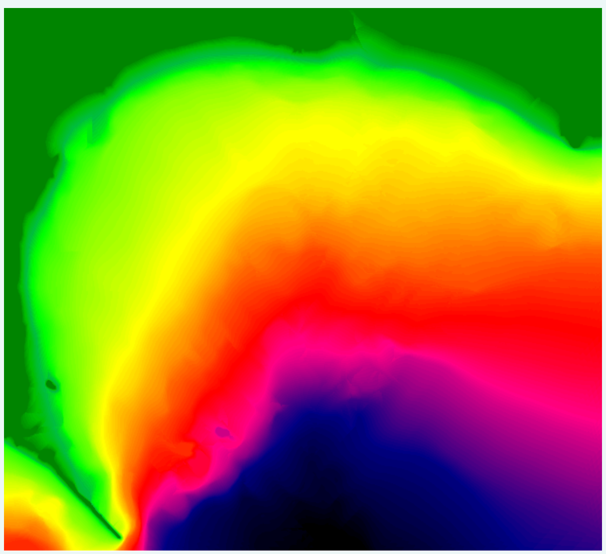
1875



1934

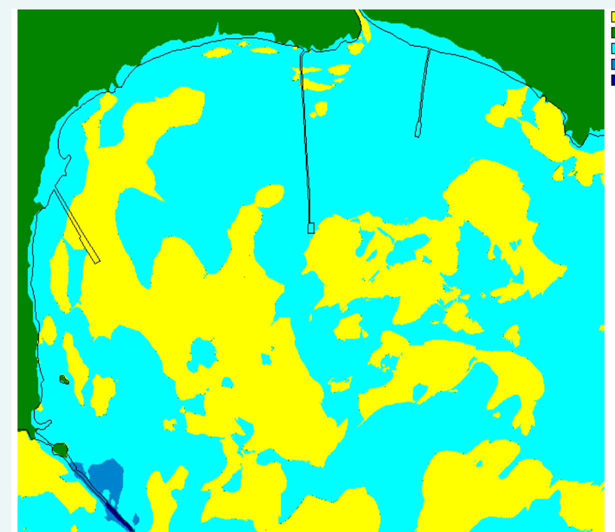


1875-1934 SEDIMENT SINKS AND SOURCES



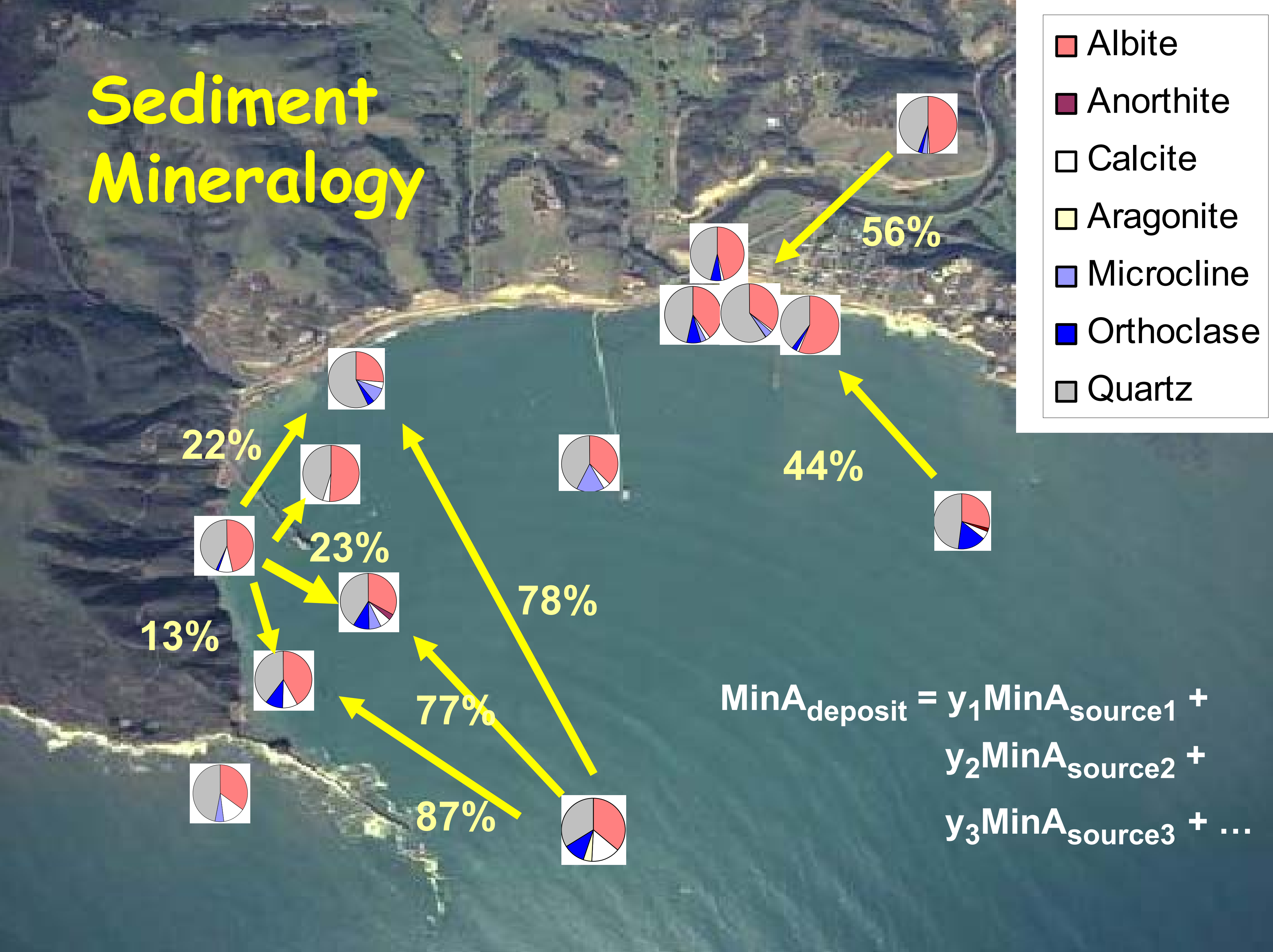
1996

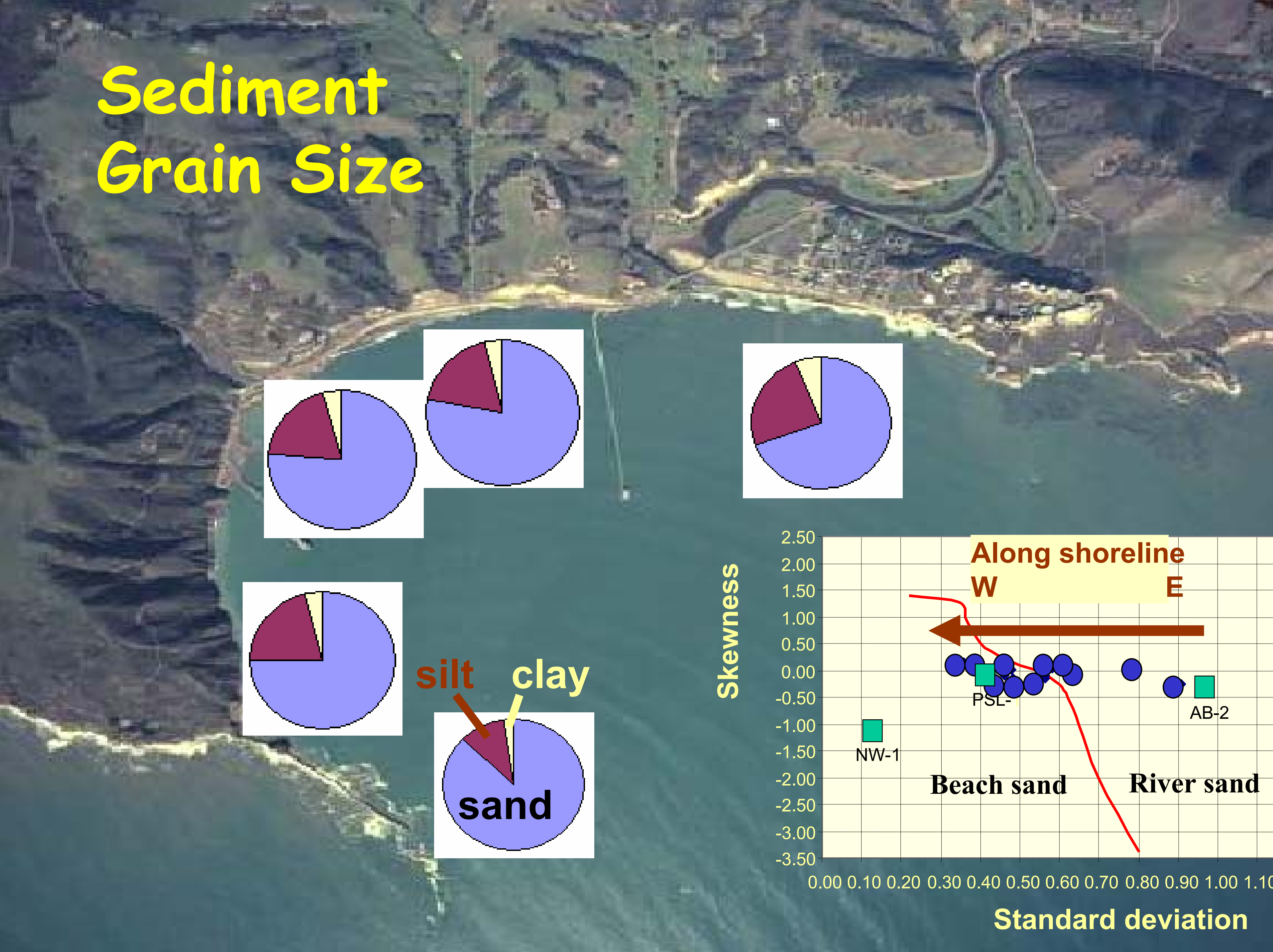
Erosion and accumulation derived from historical bathymetric charts.



1875-1996 SEDIMENT SINKS AND SOURCES

GIS exercise used in Environmental Sedimentology Course

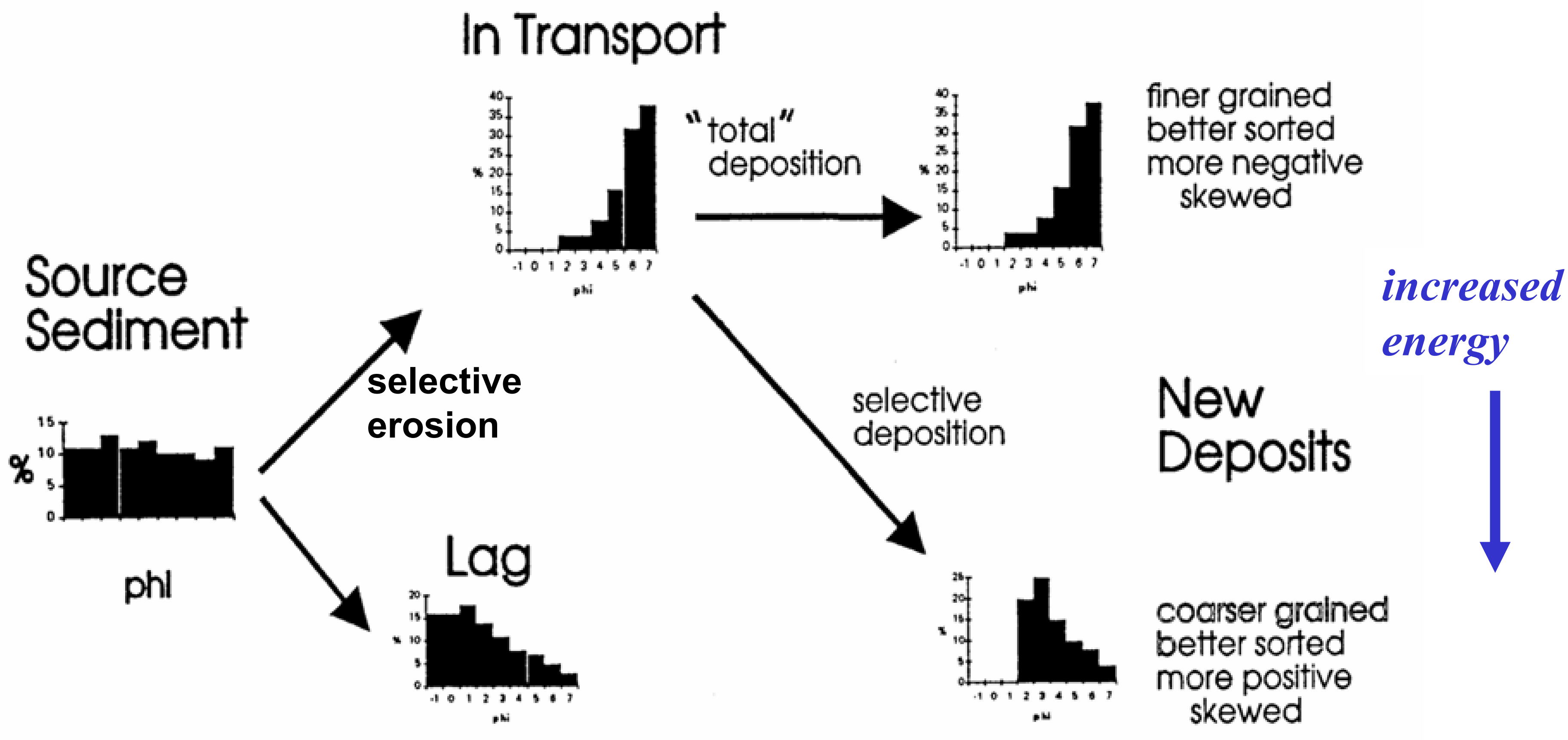

Sediment Mineralogy
Albite
Anorthite
Calcite
Aragonite
Microcline
Orthoclase
Quartz
56%
44%
22%
23%
13%
78%
77%
87%
$MinA_{deposit} = y_1 MinA_{source1} + y_2 MinA_{source2} + y_3 MinA_{source3} + \ldots$



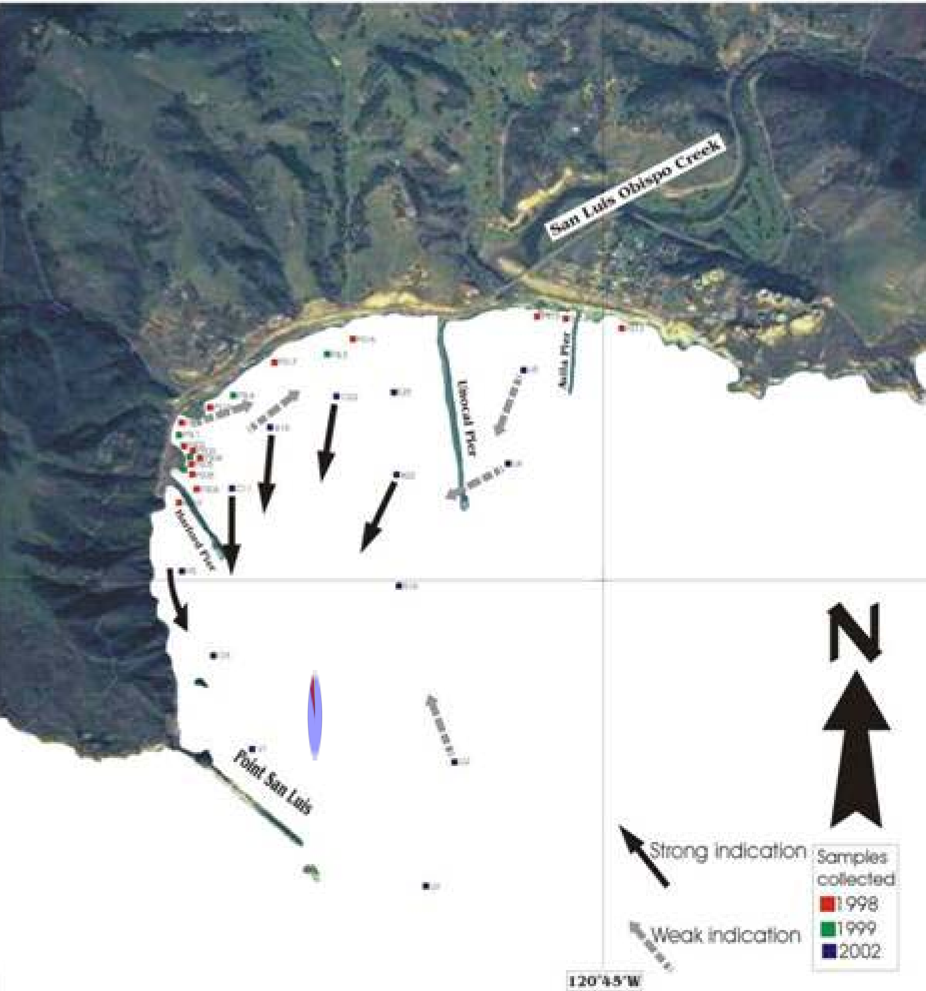
Sediment Grain Size
silt
clay
sand
Along shoreline
W
E
Skewness
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
PSL-
AB-2
NW-1
Beach sand
River sand
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Standard deviation

After McLaren 1980

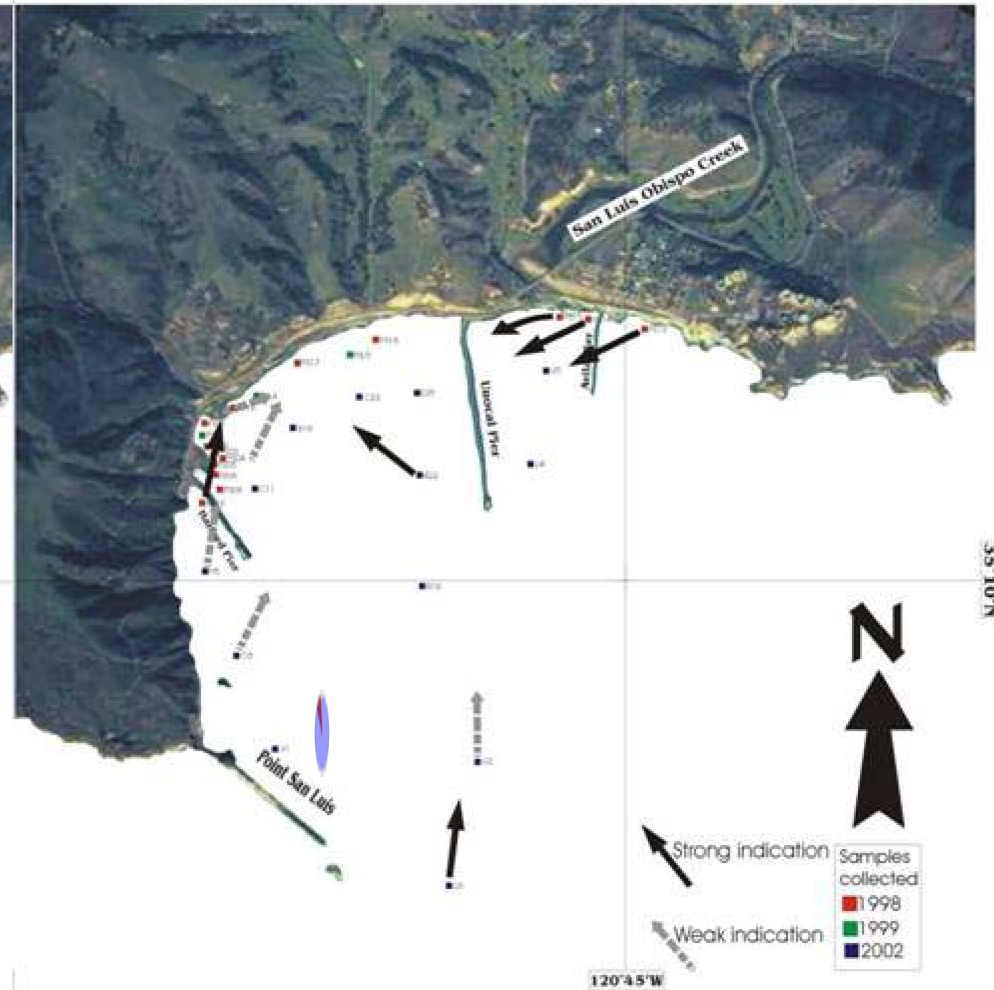
Successive changes along a pathway



Transport vectors based upon grain-size trends between sites



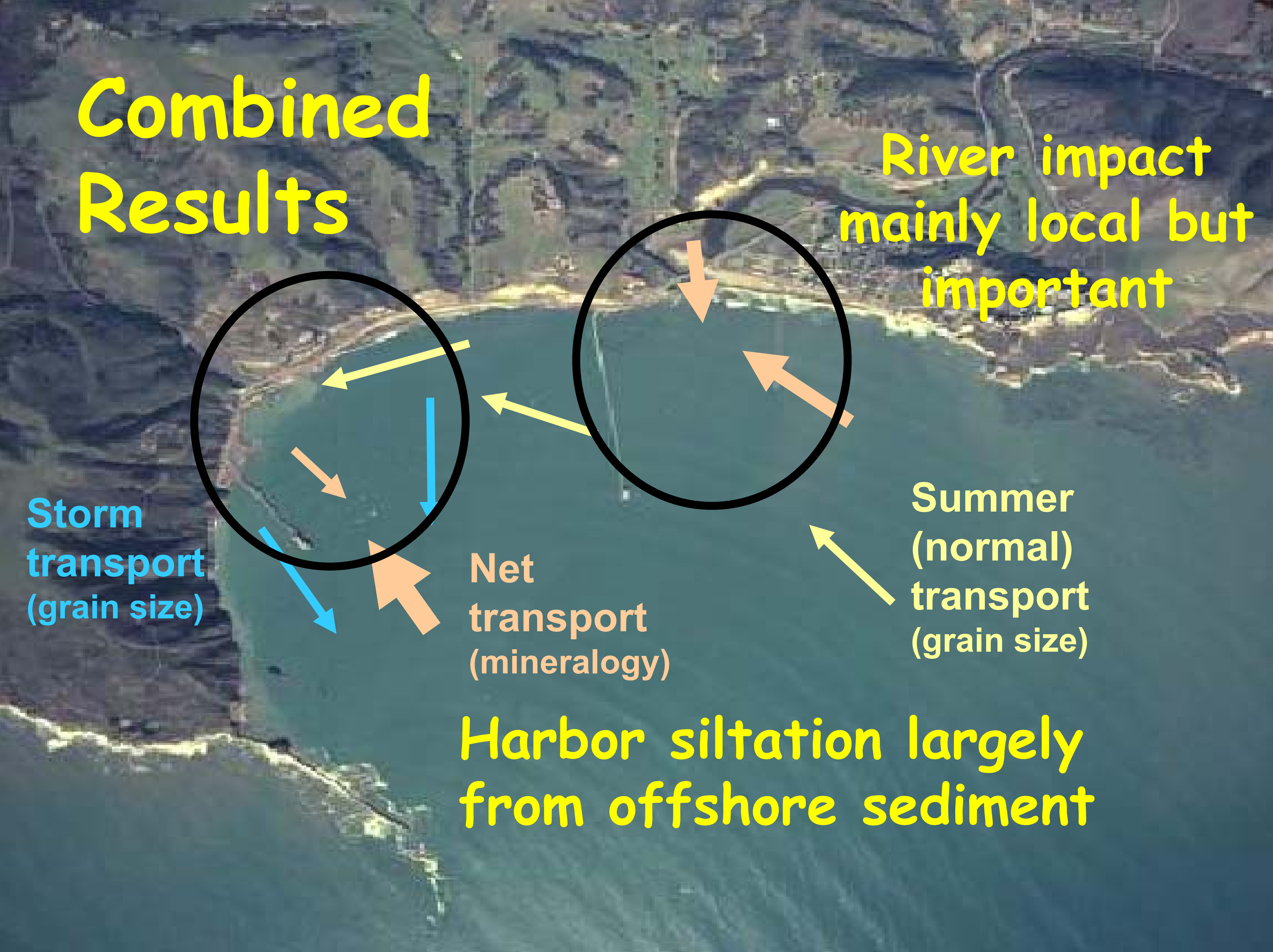
Coarser - Better sorted - Pos skewness

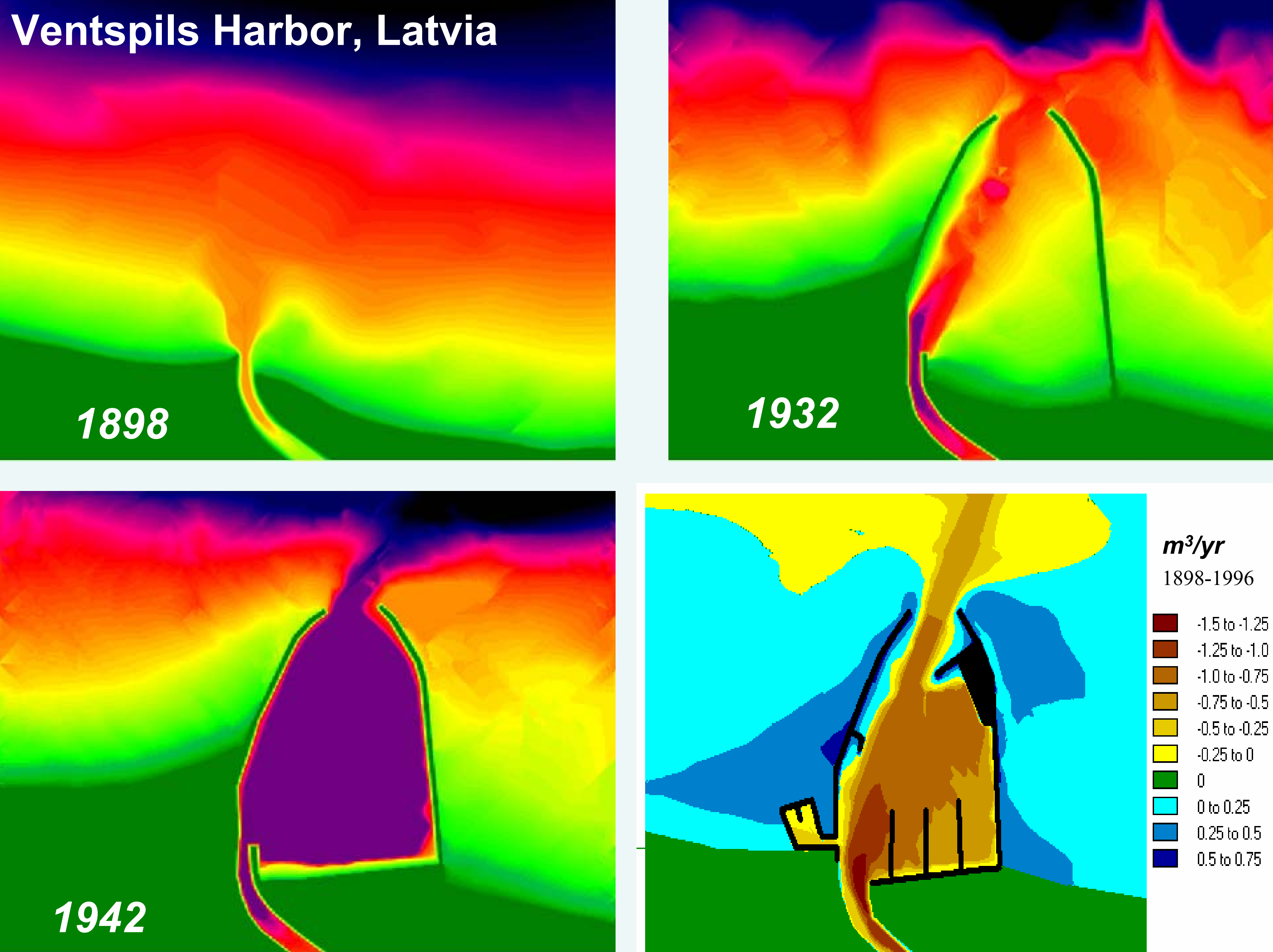


Finer - Better sorted - Neg skewness

Coarsening trends = storm turbulence; transport

Fining trends = normal or summer transport

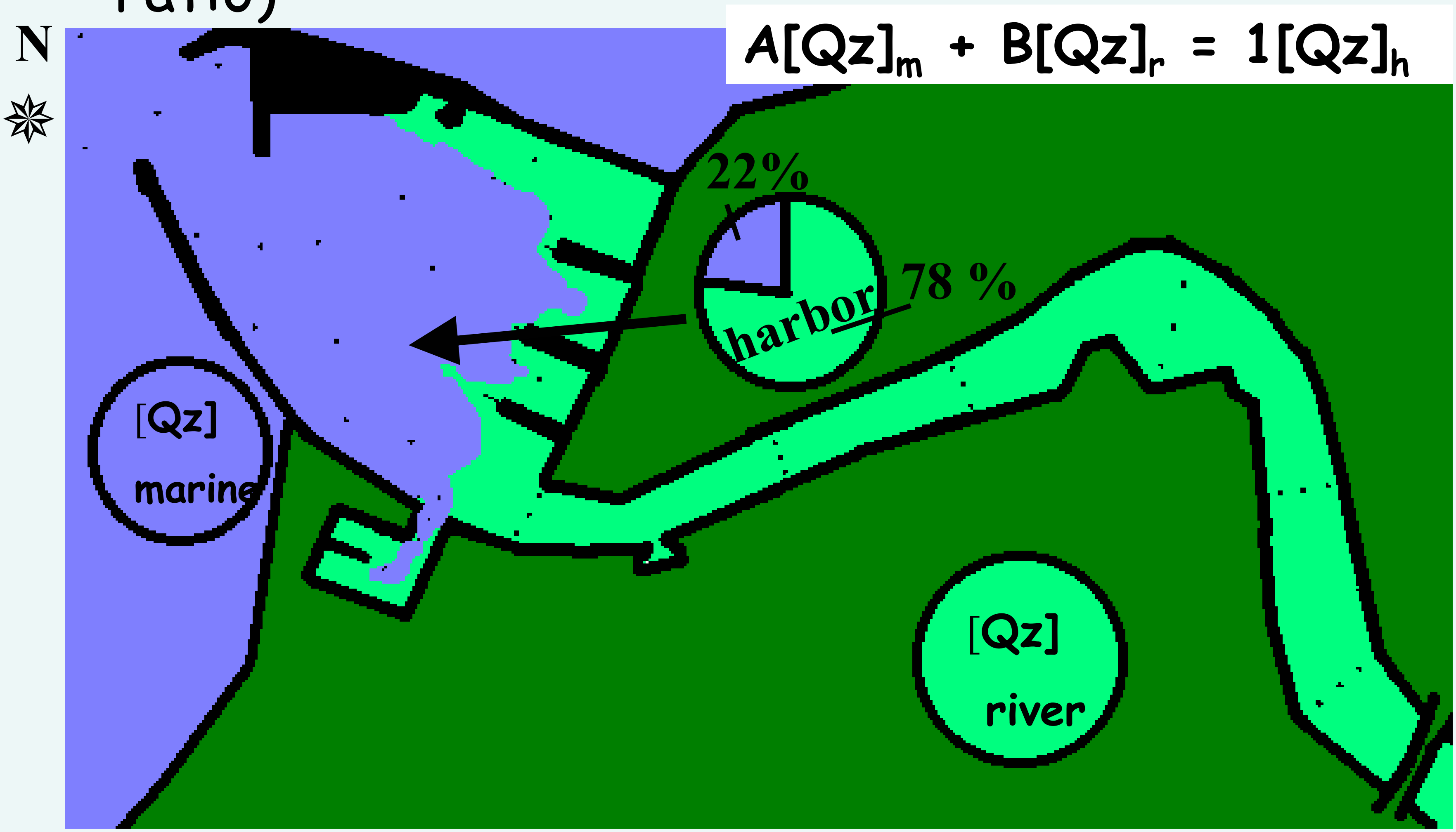

Combined Results
River impact mainly local but important
Storm transport (grain size)
Net transport (mineralogy)
Summer (normal) transport (grain size)
Harbor siltation largely from offshore sediment



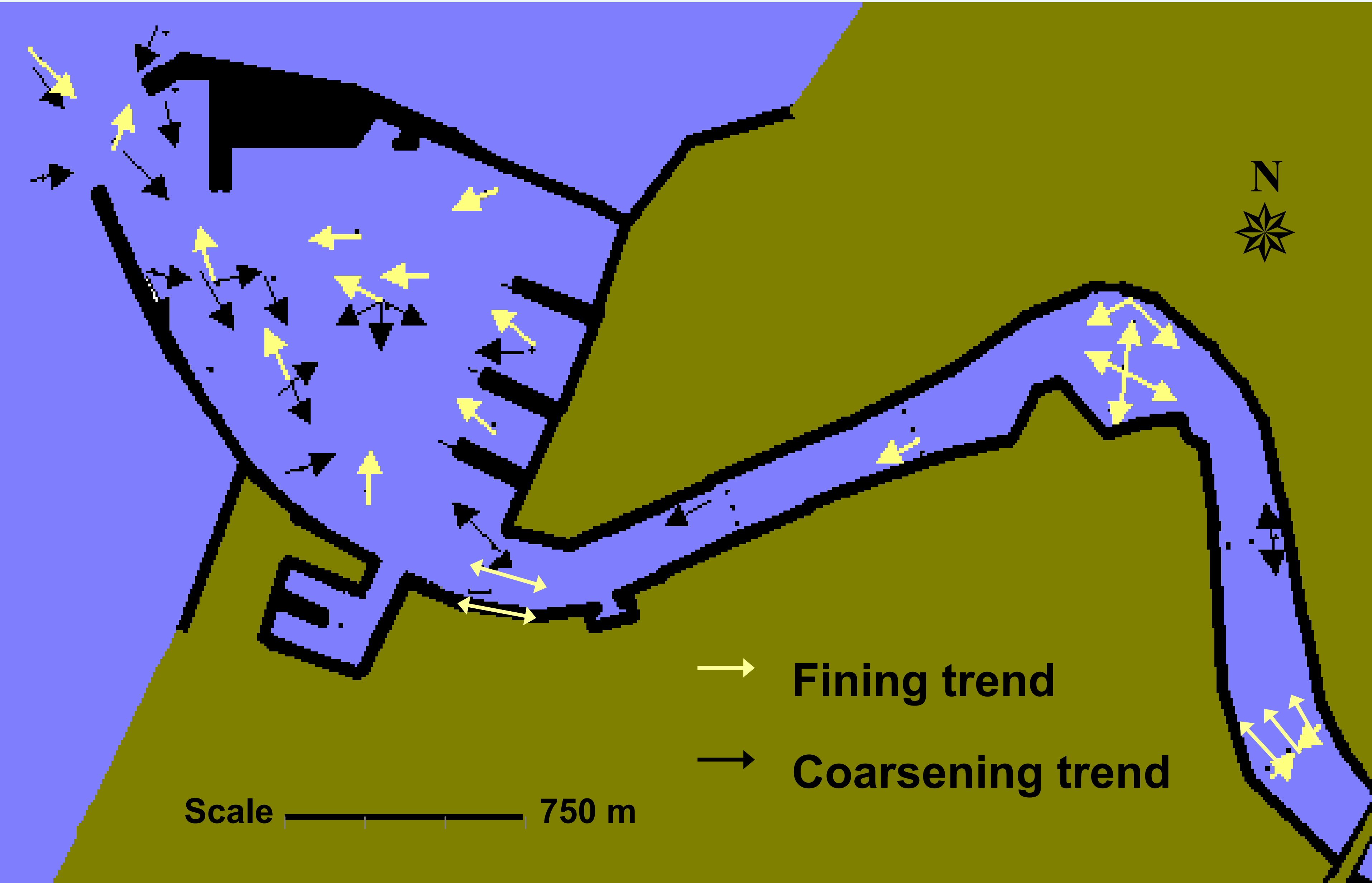
Ventspils Harbor, Latvia
1898
1932
1942
m³/yr
1898-1996
-1.5 to -1.25
-1.25 to -1.0
-1.0 to -0.75
-0.75 to -0.5
-0.5 to -0.25
-0.25 to 0
0
0 to 0.25
0.25 to 0.5
0.5 to 0.75

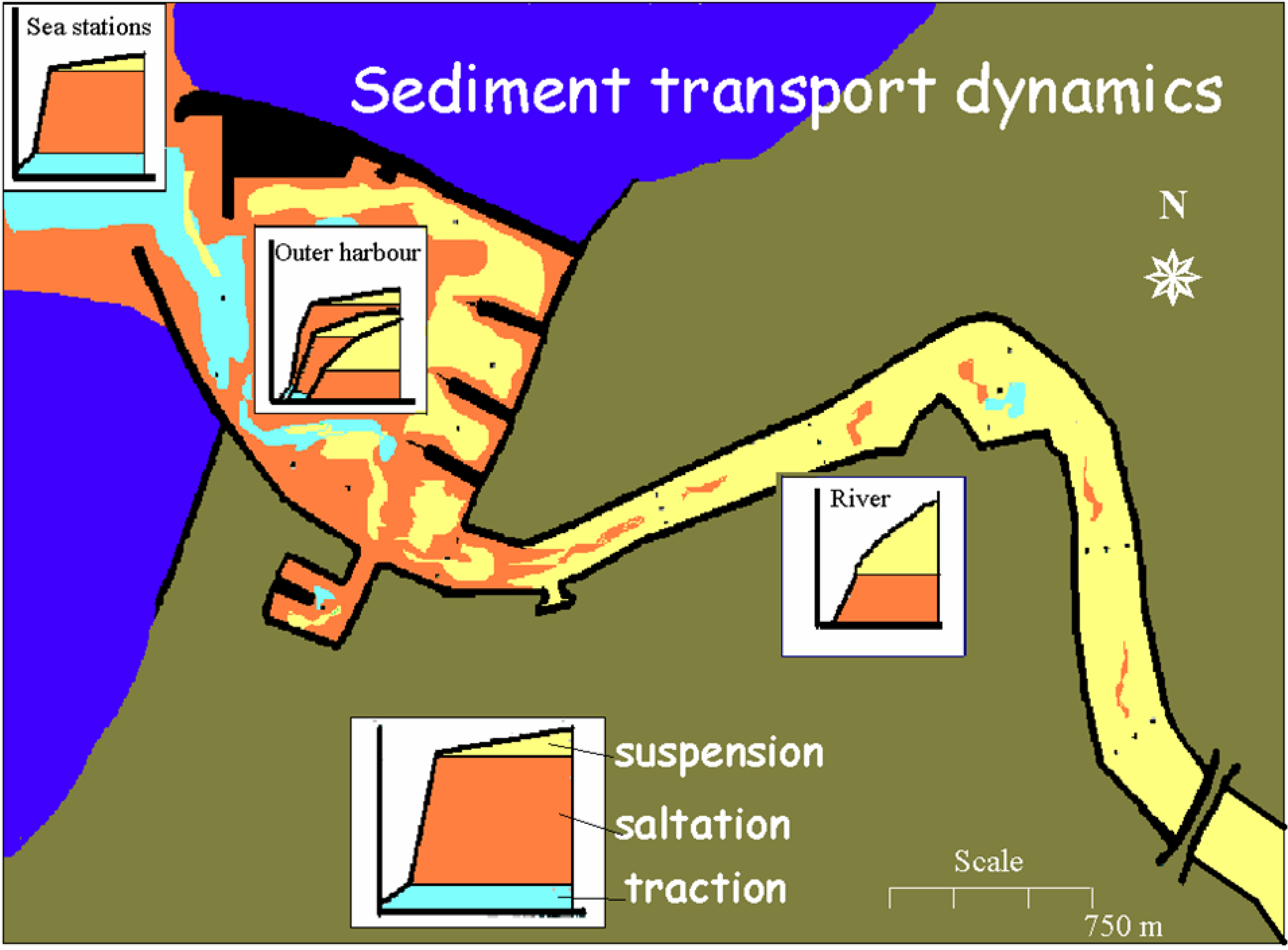
Sediment budget calculation

- Based on mineralogy (quartz/feldspars - ratio)



Transport vectors



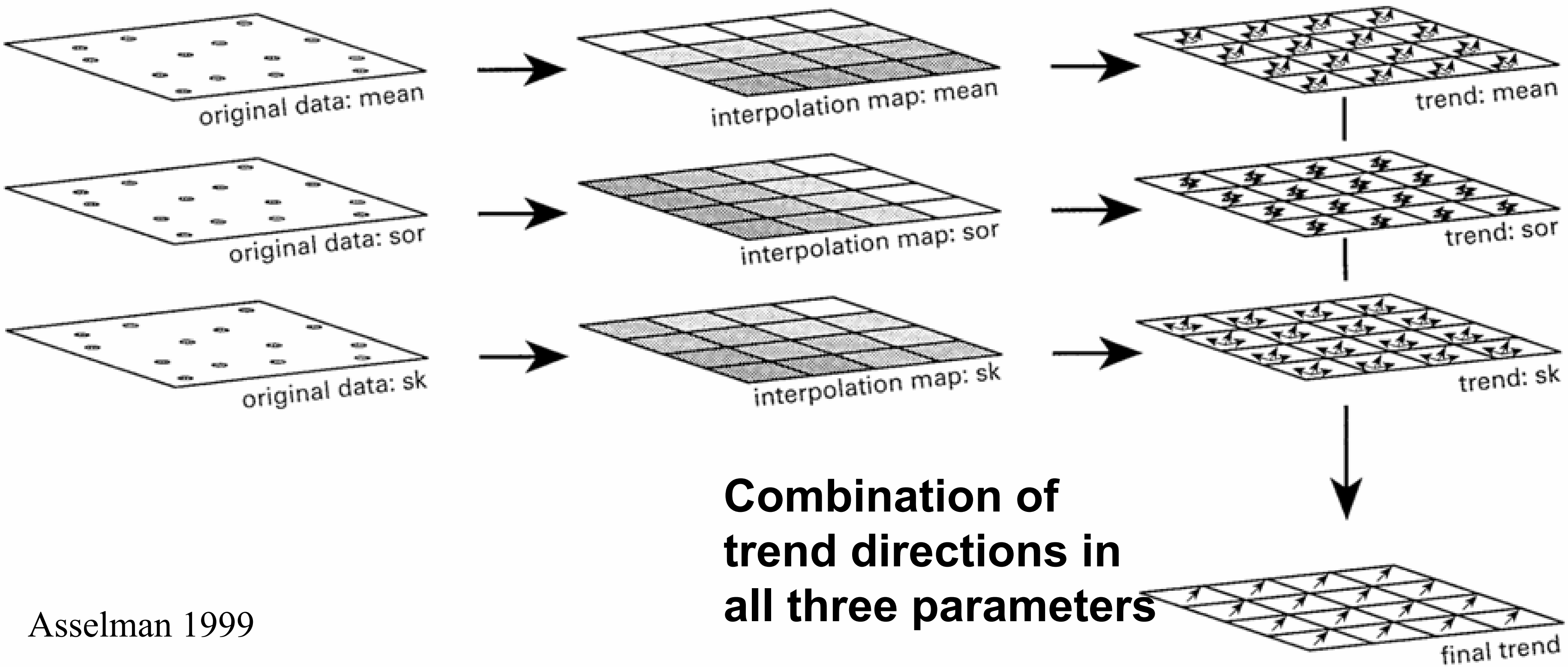


Sediment transport dynamics
Sea stations
Outer harbour
River
N
suspension
saltation
traction
Scale
750 m

GIS calculation of transport vectors

Interpolation and block kriging

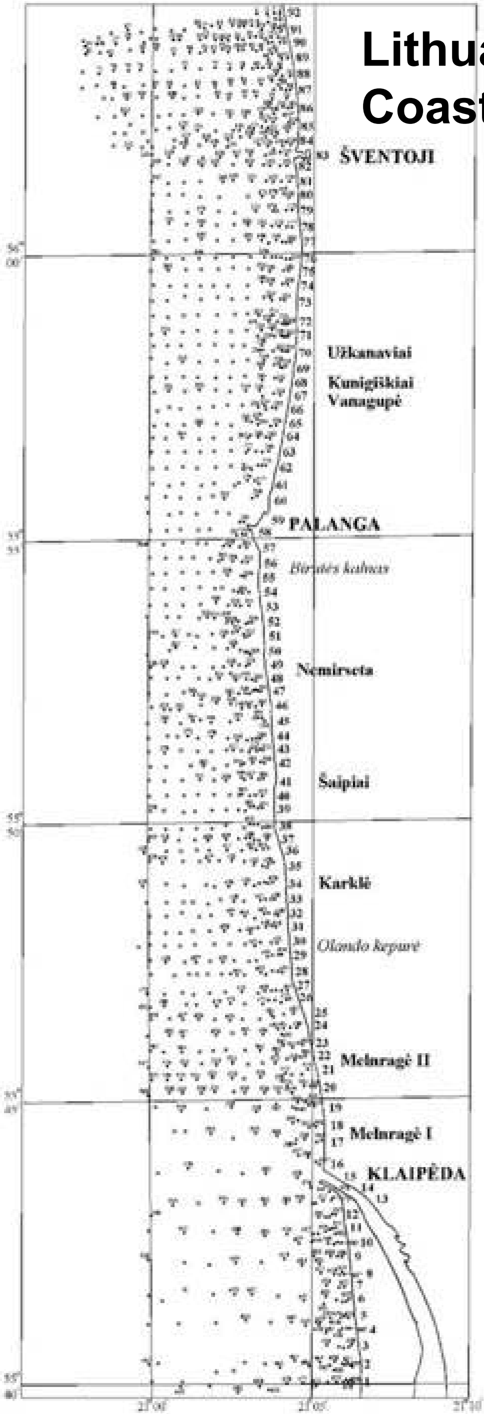
Identification of trends from neighboring cells



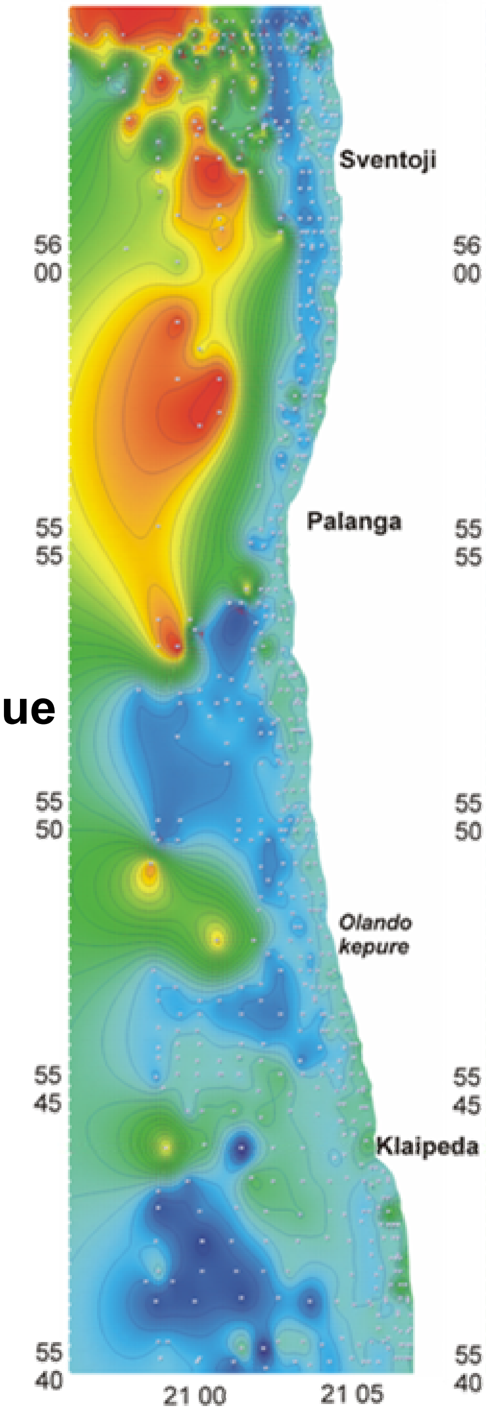
Combination of trend directions in all three parameters

Asselman 1999

Lithuanian Coast

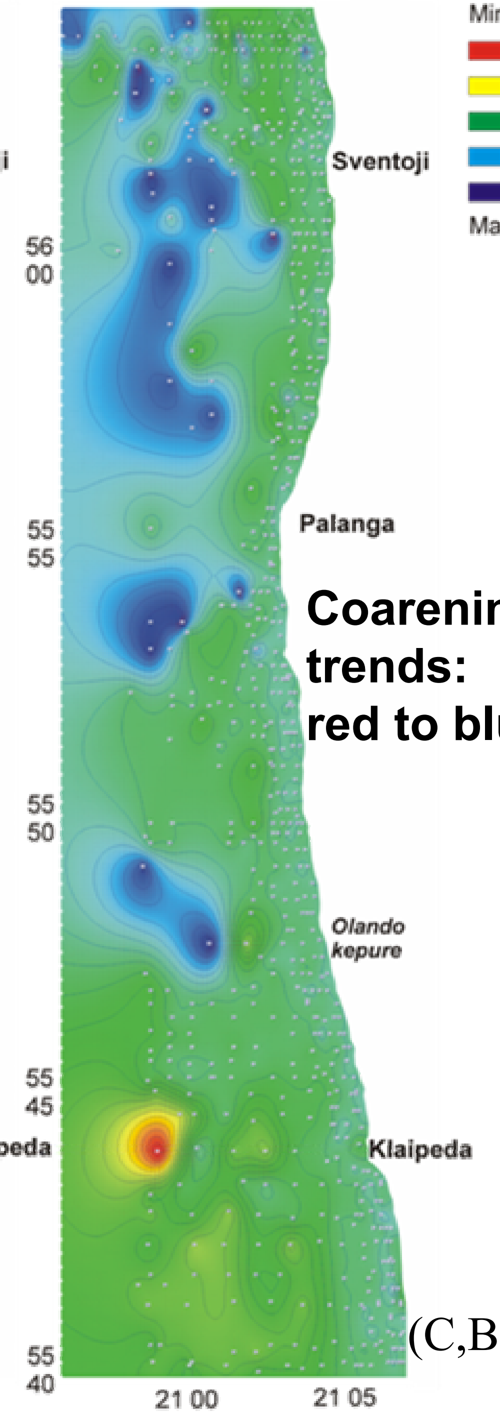


Fining trends: red to blue

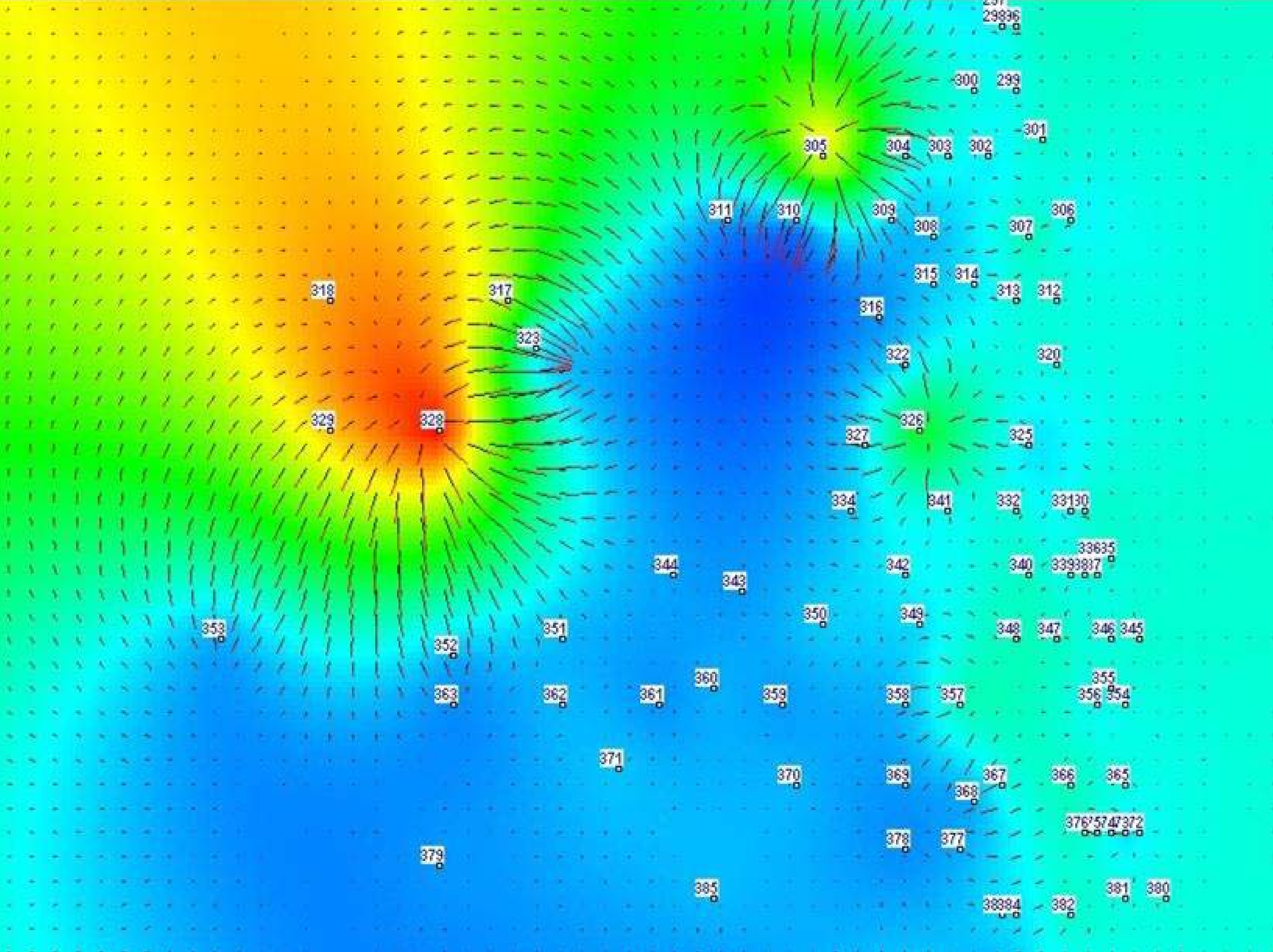


(F,B,-)

Coarening trends: red to blue



(C,B,+)



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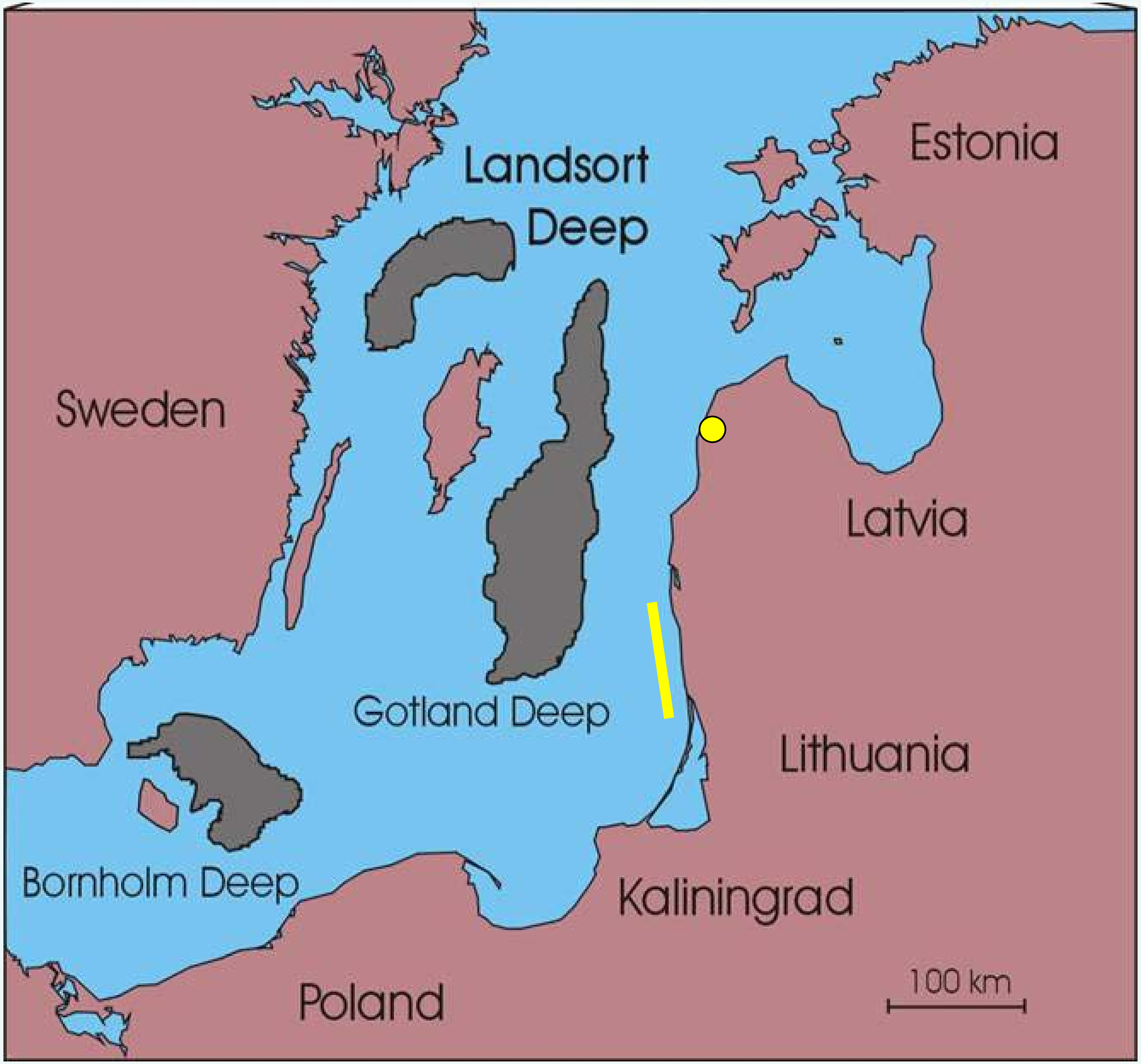
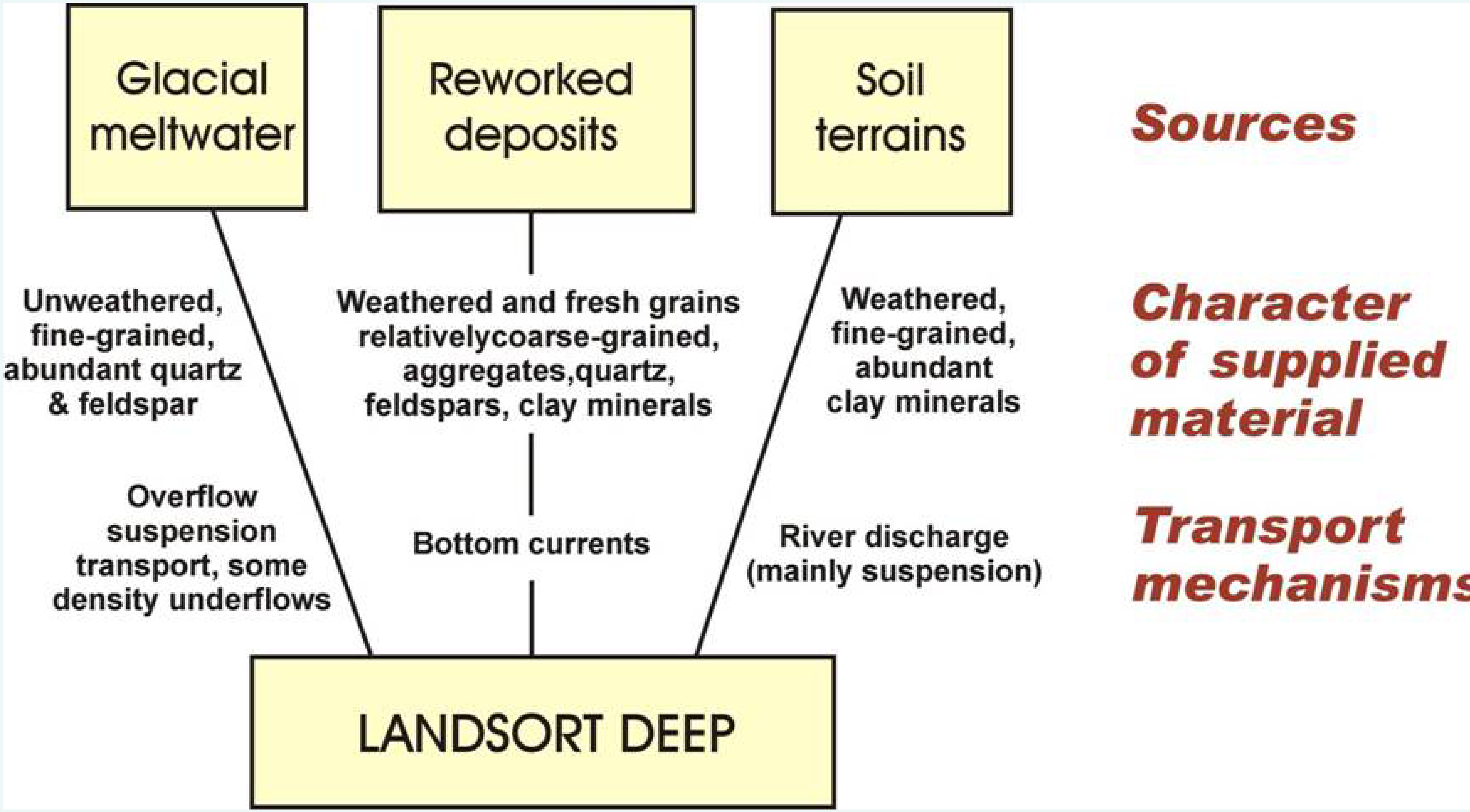
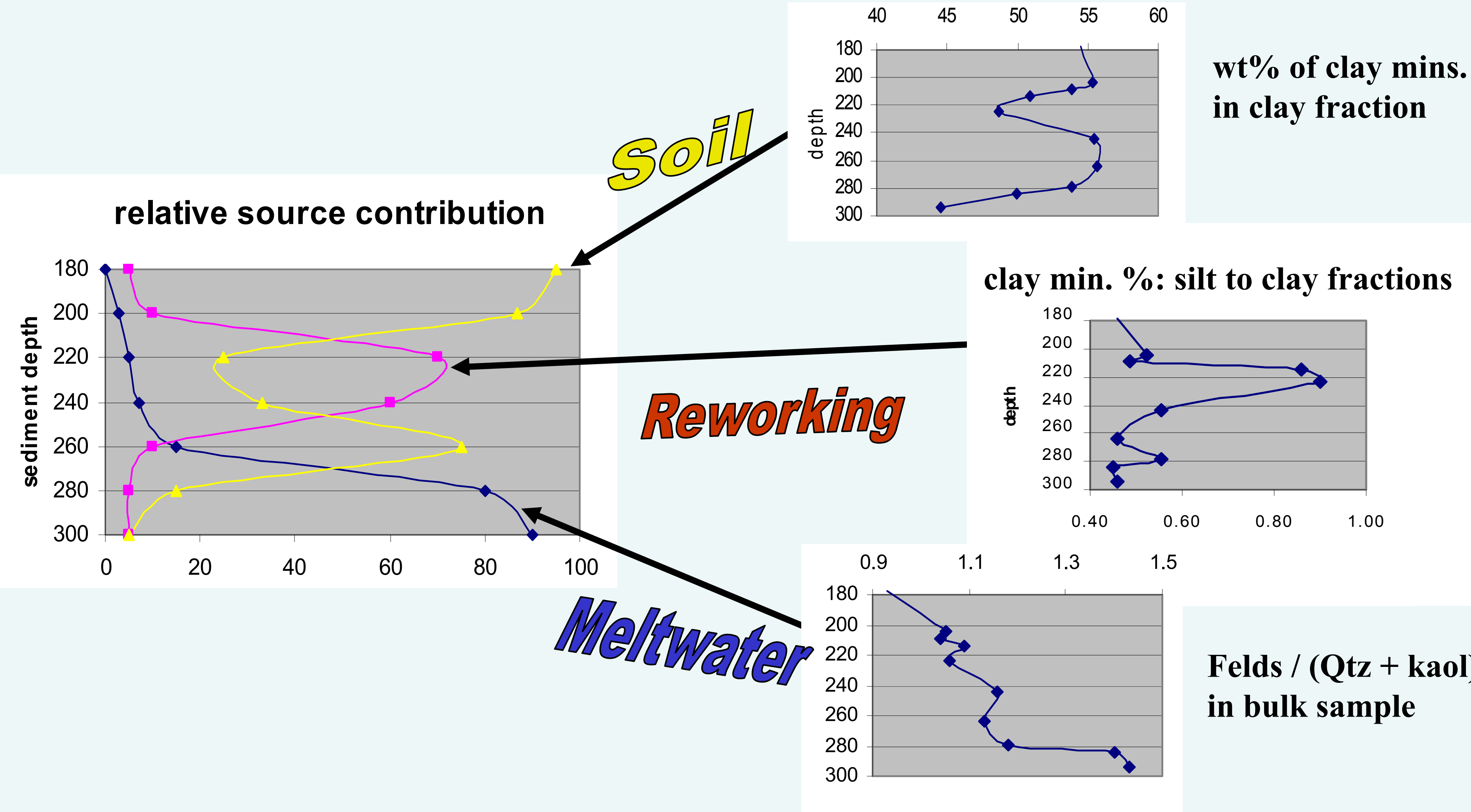


Landsort Deep
Estonia
Sweden
Latvia
Gotland Deep
Lithuania
Bornholm Deep
Kaliningrad
Poland
100 km



Glacial meltwater
Reworked deposits
Soil terrains
Sources
Unweathered, fine-grained, abundant quartz & feldspar
Weathered and fresh grains relativelycoarse-grained, aggregates,quartz, feldspars, clay minerals
Weathered, fine-grained, abundant clay minerals
Character of supplied material
Overflow suspension transport, some density underflows
Bottom currents
River discharge (mainly suspension)
Transport mechanisms
LANDSORT DEEP



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

- Who?
- What?
- When?
- Where?
- Why?

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.