Using facies models and sequence stratigraphy to model contaminant migratory pathways

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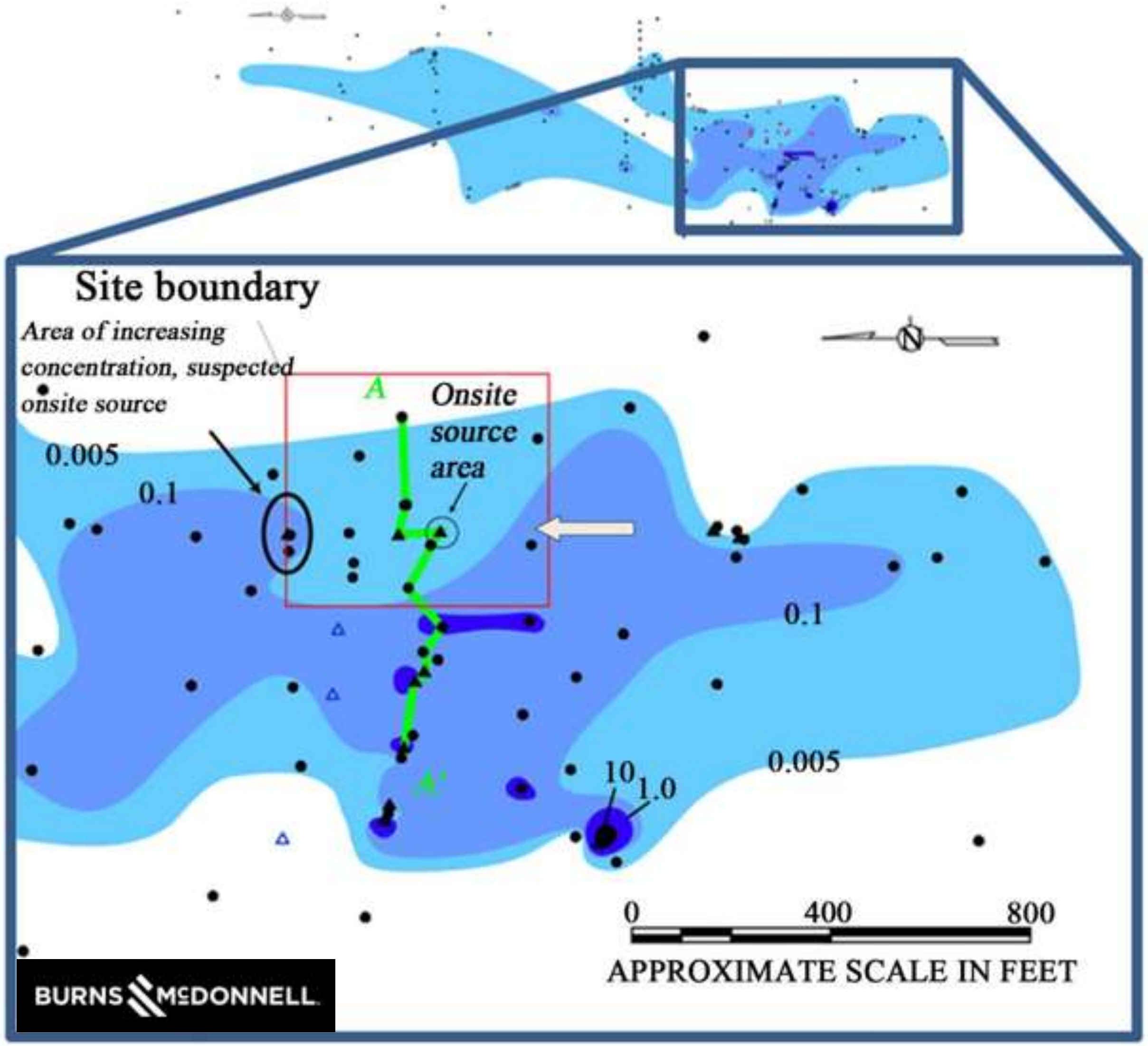
Photo by W. W. Little

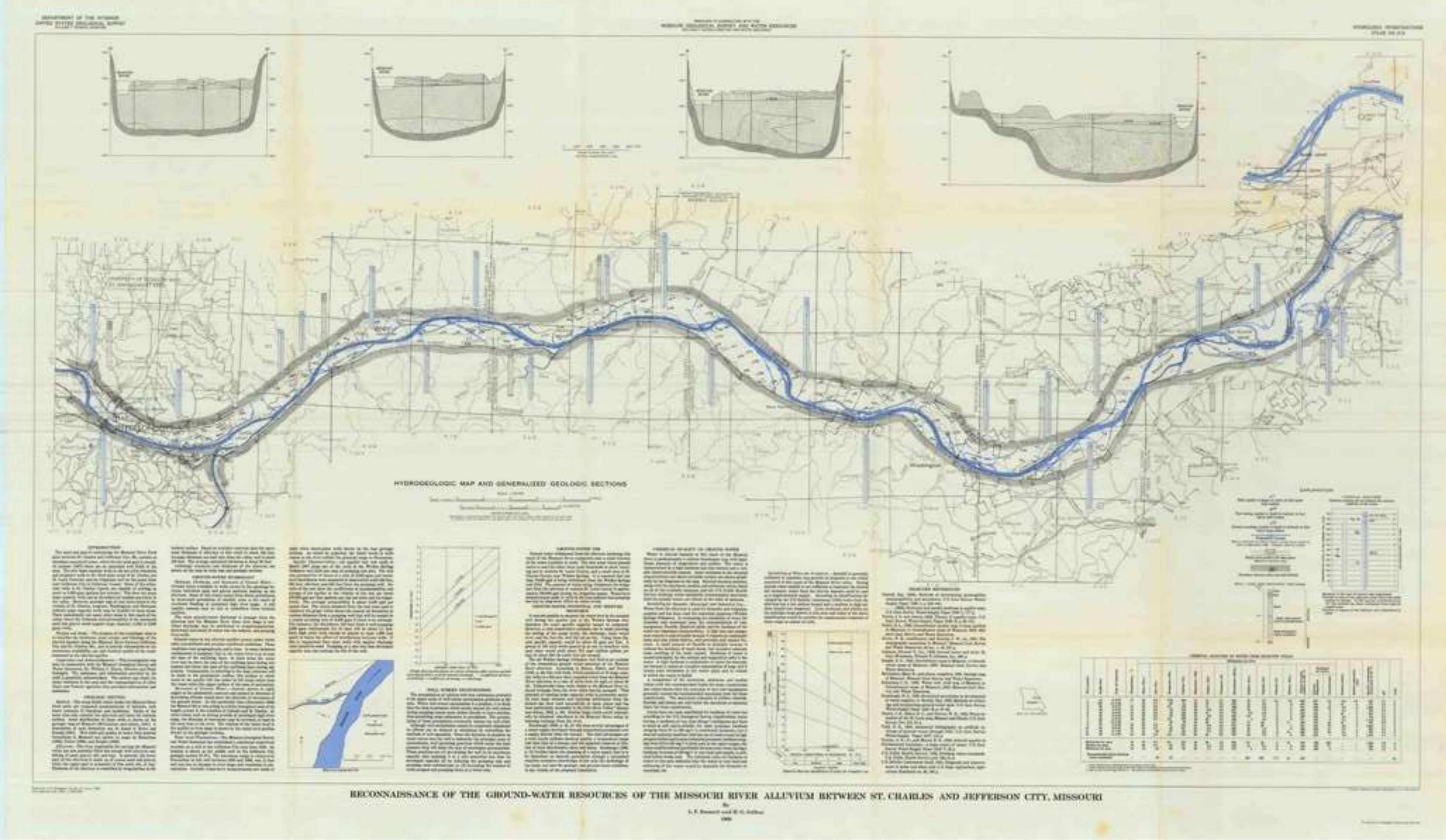
Santa Clara (Silicon) Valley, CA

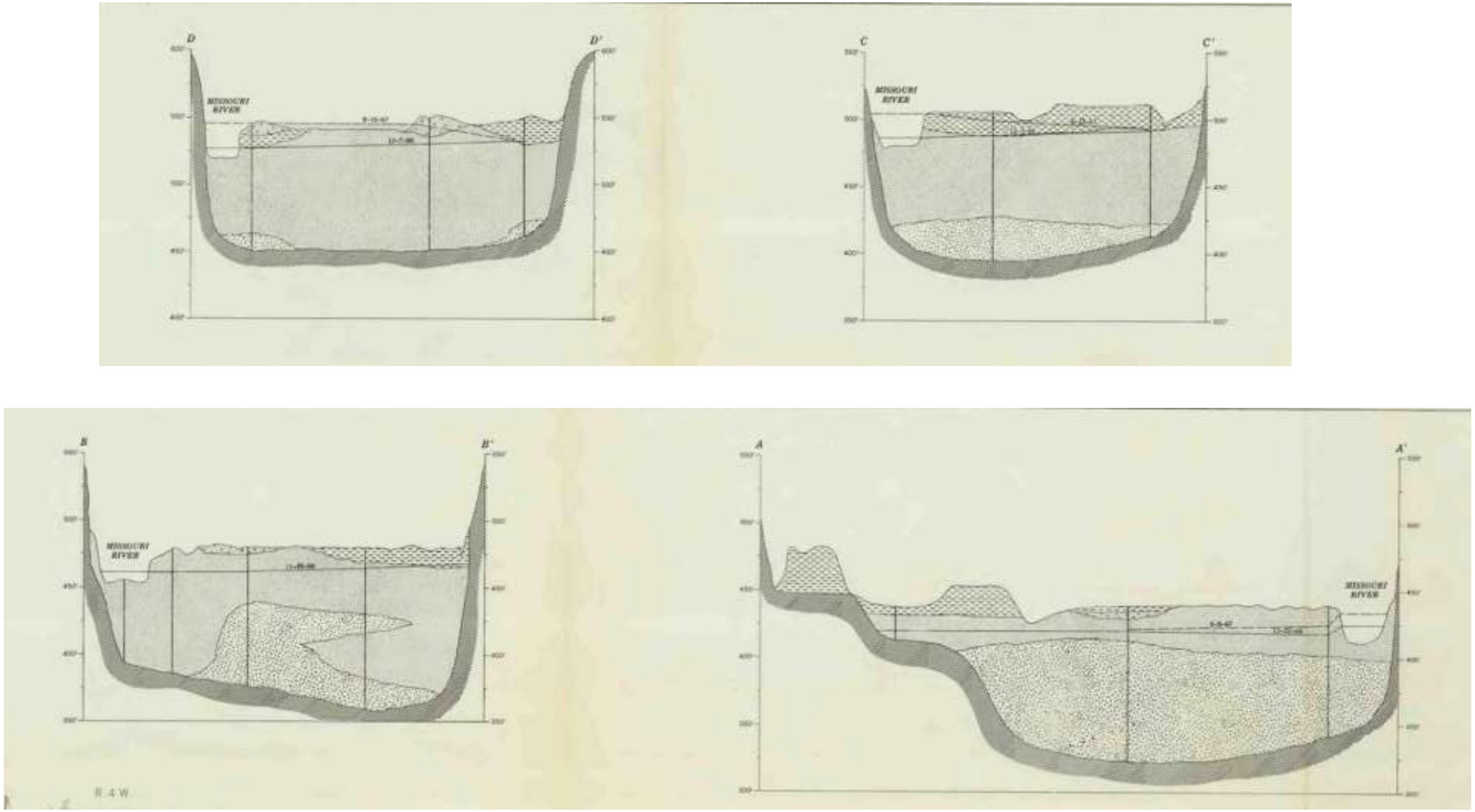


(Cramer et al. 2018)

After 20+ years of remediation, contamination had increased at some monitoring localities down gradient from the source, while decreasing at others.

Missouri River, MO





Generalized model for Missouri River aquifer assuming homogeneous subsurface conditions.

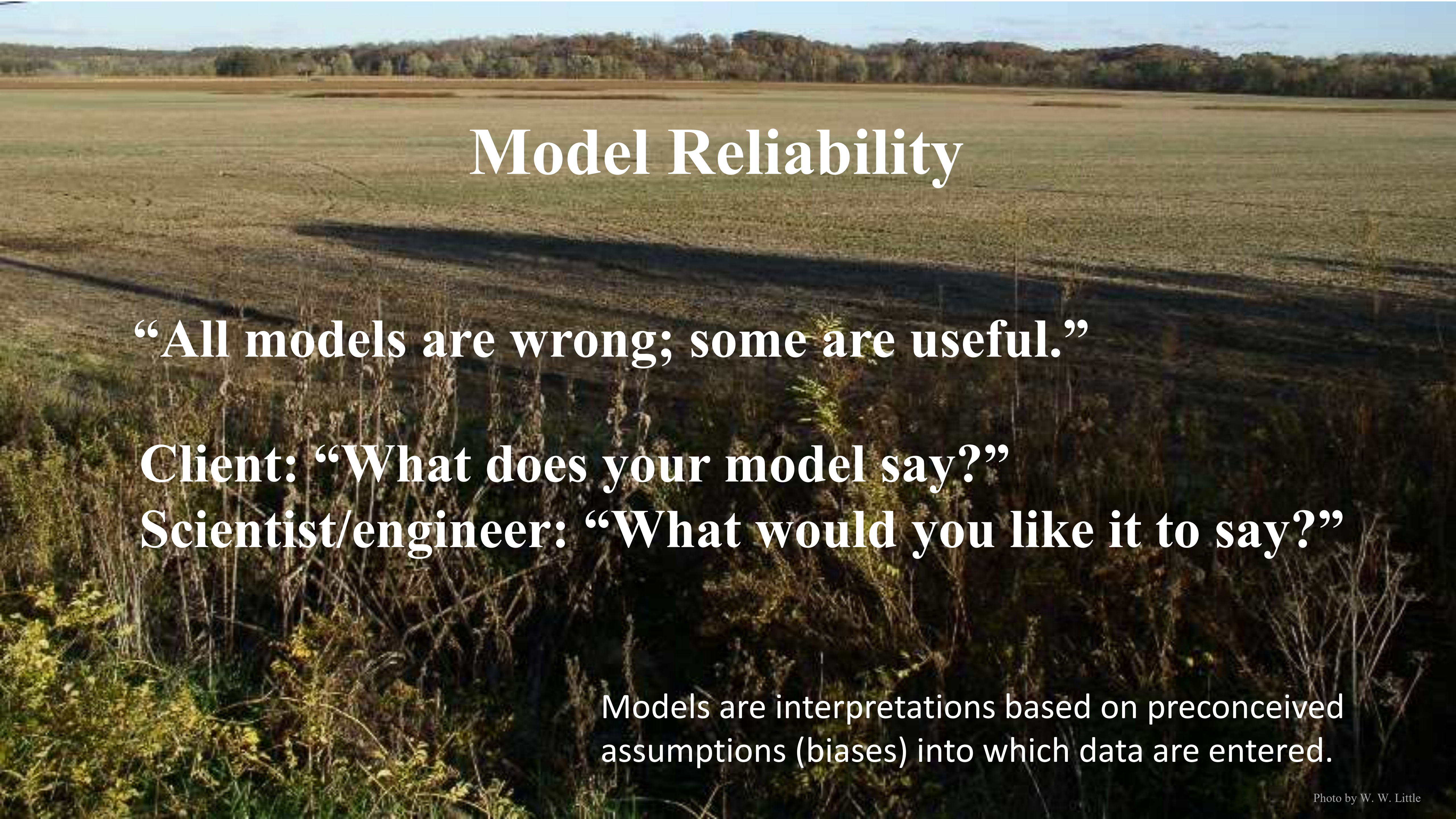
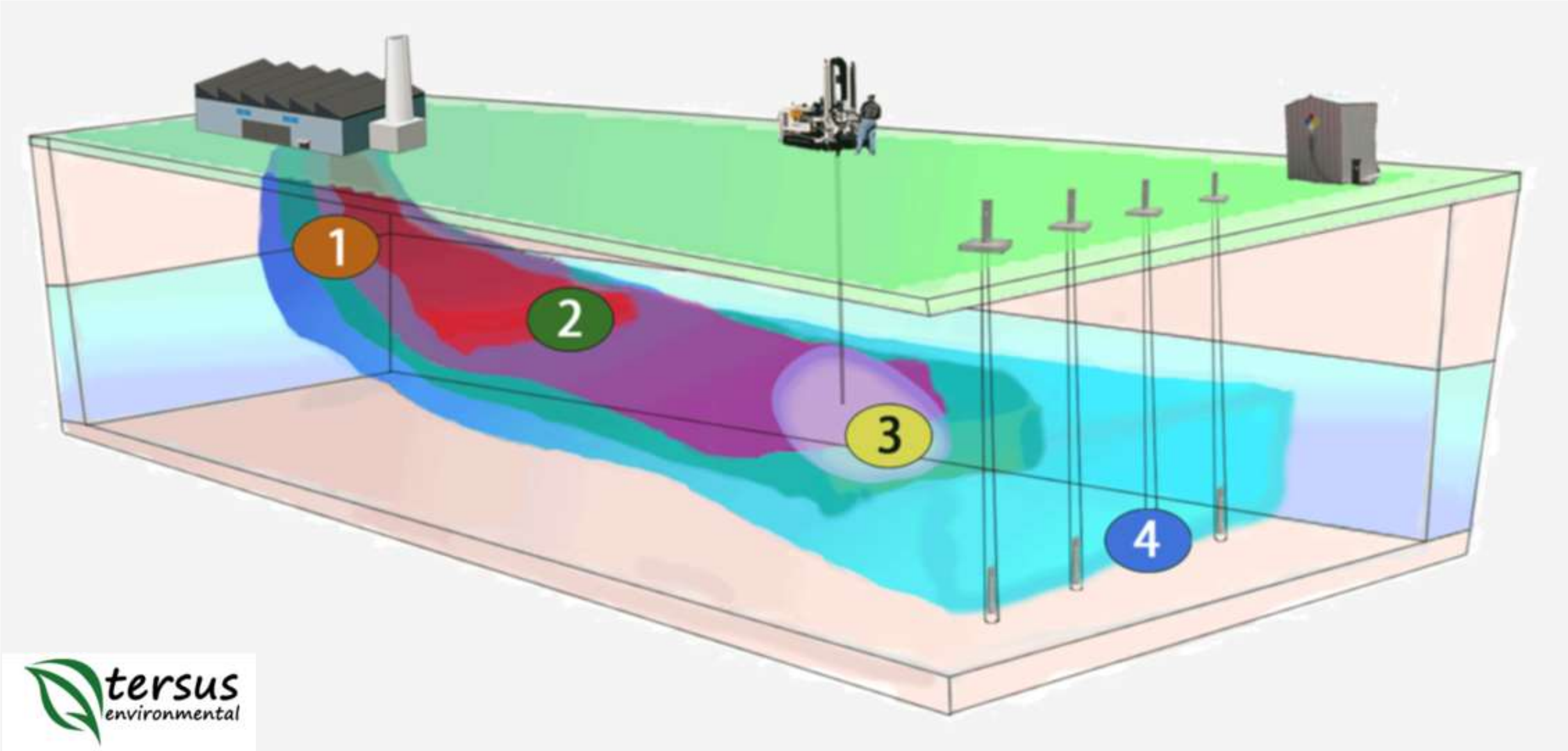


Photo by W. W. Little

Standard Groundwater Flow Model



The subsurface is assumed to be homogeneous and contaminants are predicted to disperse as a simple plume starting at a point source.

River Classification

Braided

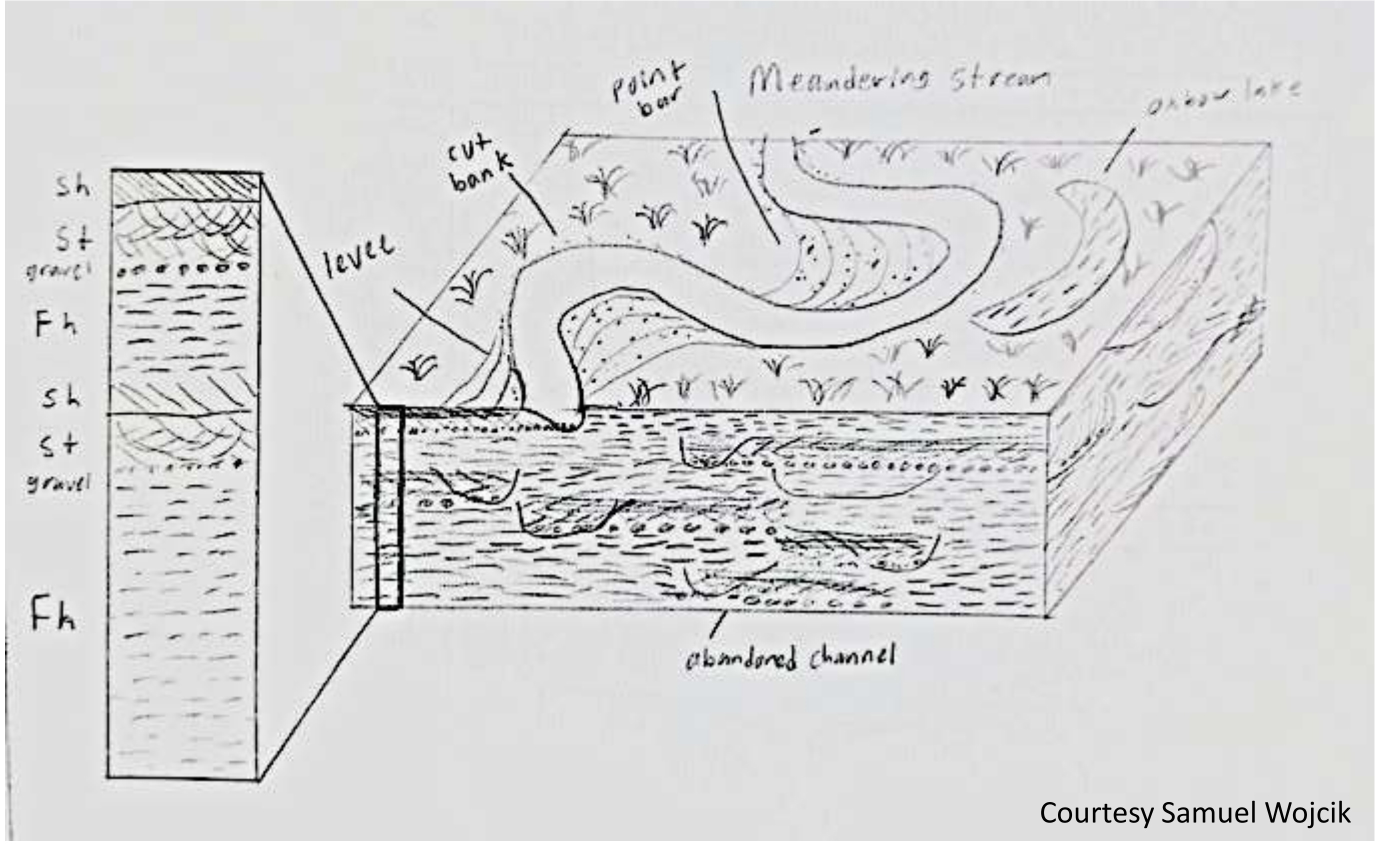
Meandering

Anastomosed

Straight

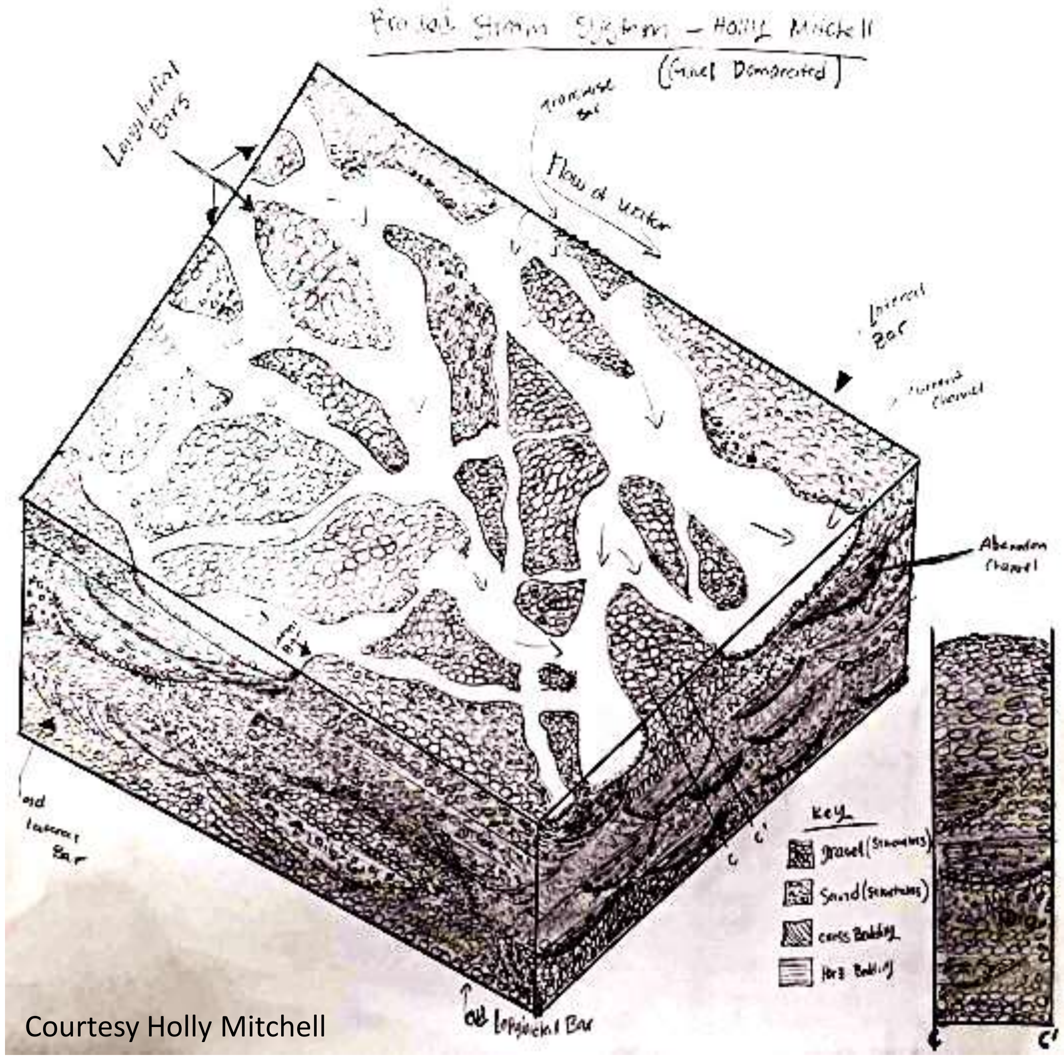
Facies Models for Fluvial Systems

Meandering Fluvial



Courtesy Samuel Wojcik

Braided Fluvial



Courtesy Holly Mitchell

There are additional models for anastomosed fluvial systems, alluvial fans, and deltaic distributary systems, as well as much variation within these models.

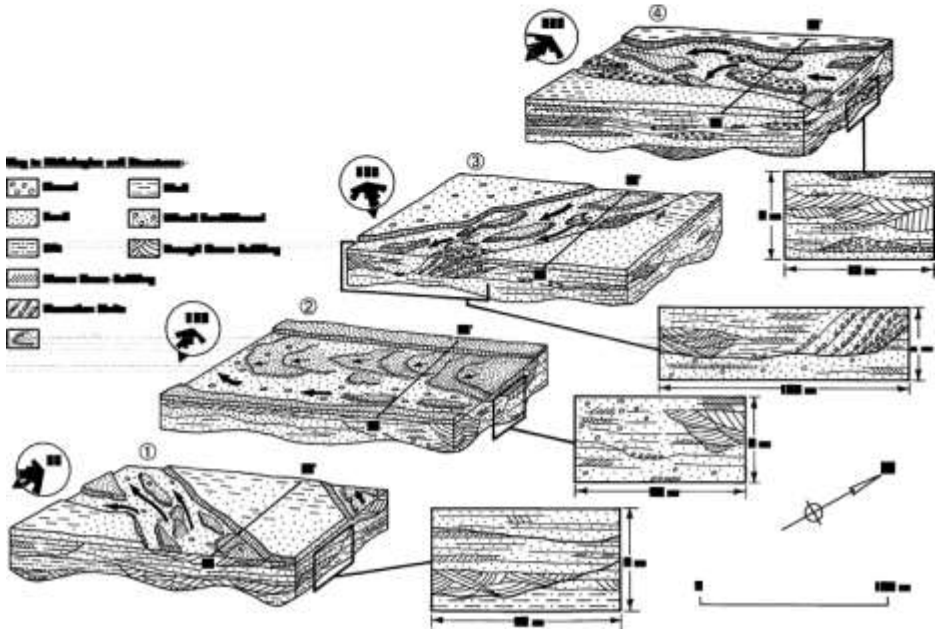
Flow Unit Connectivity

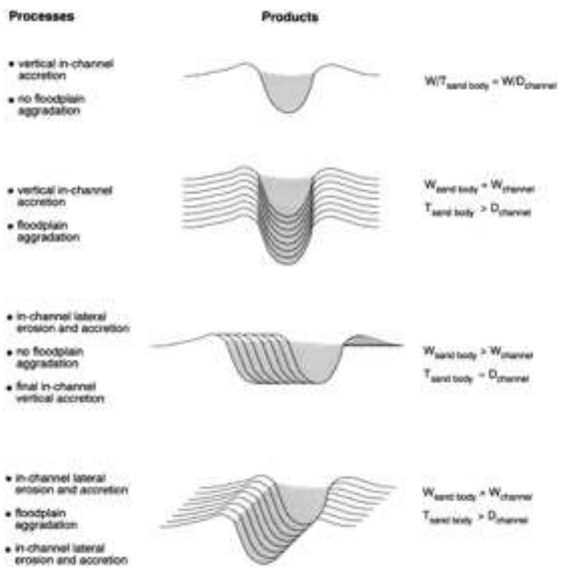
Meandering Fluvial

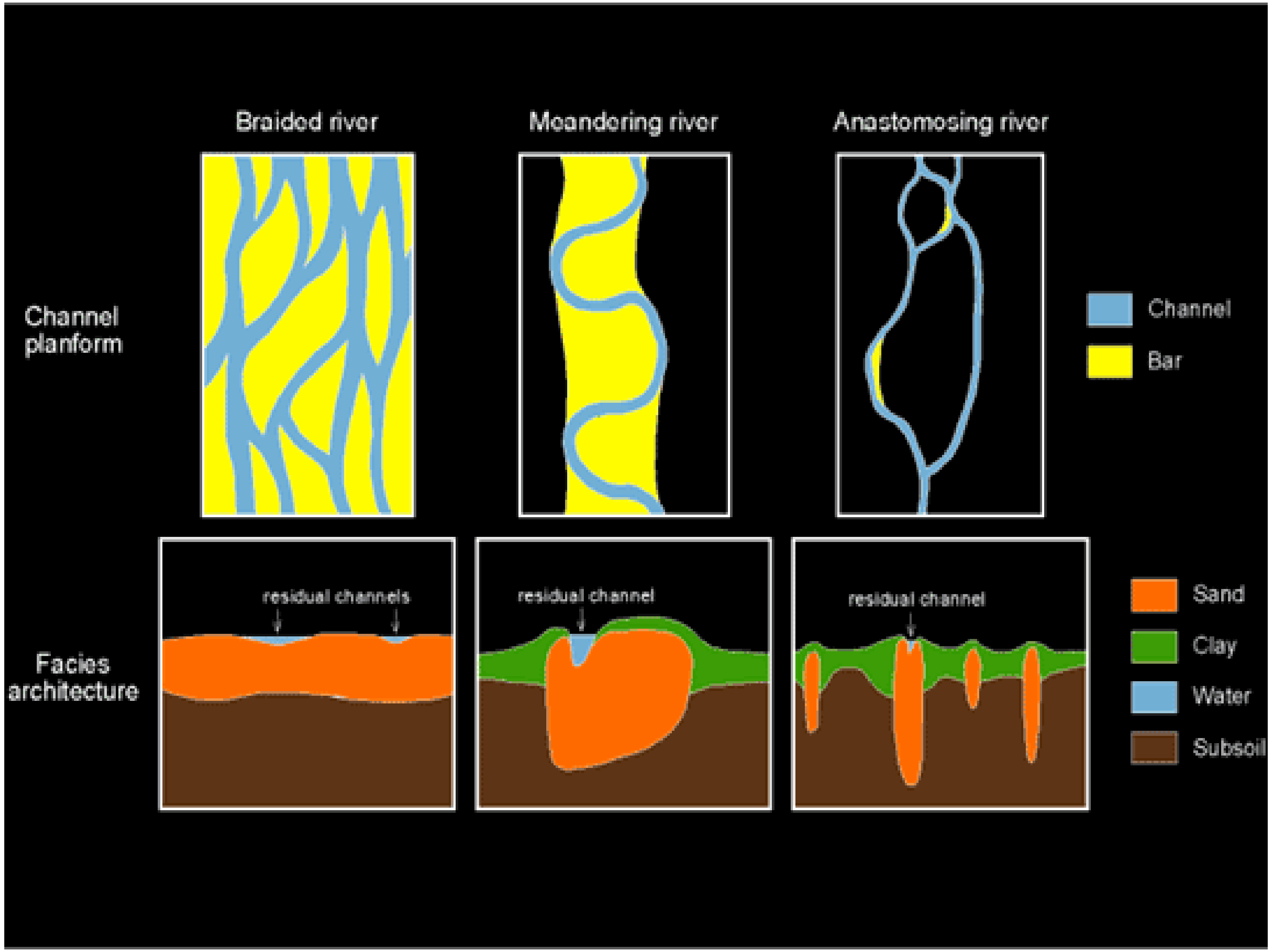
Anastomosed Fluvial

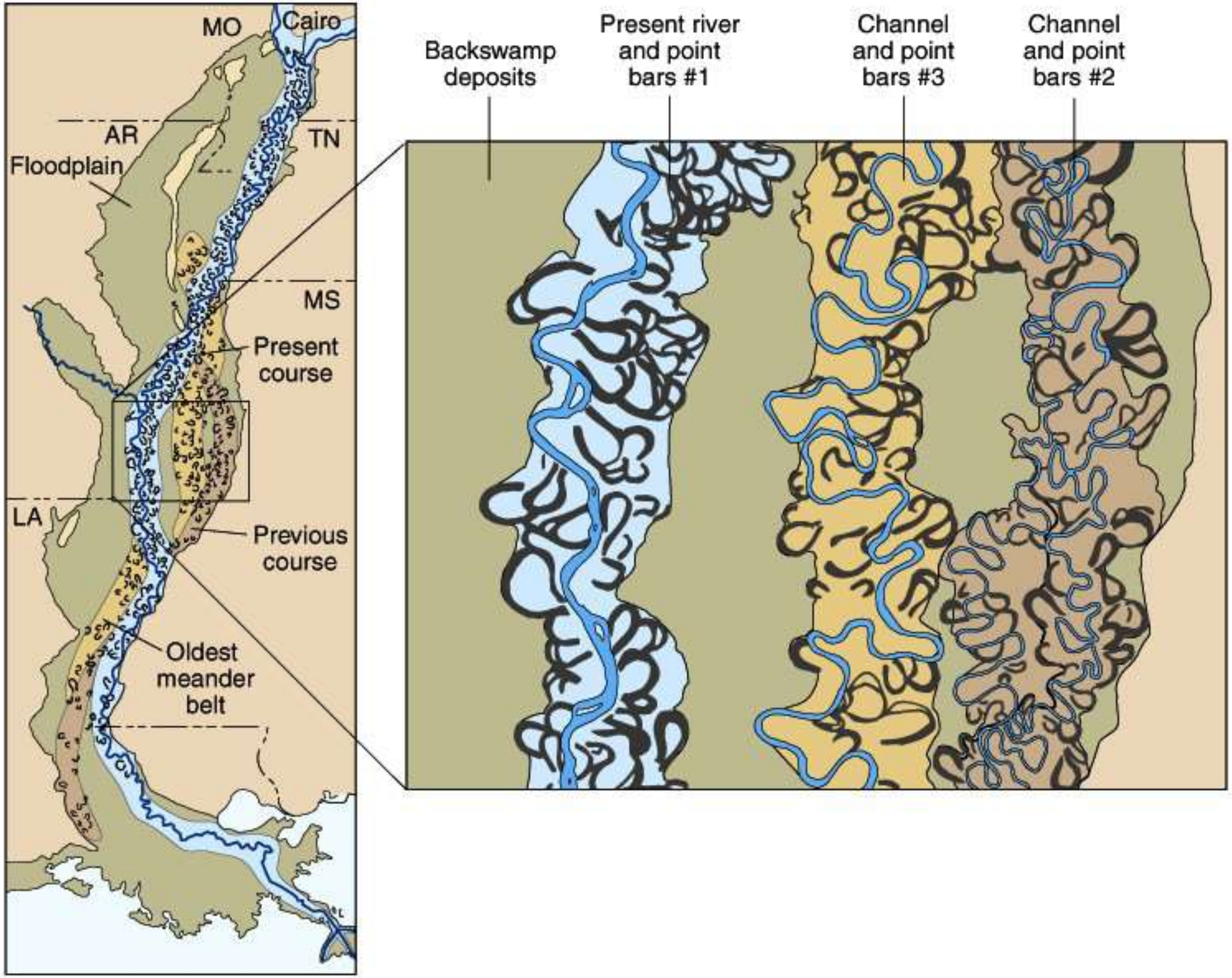
Braided Fluvial

Variations on the Theme (Models)



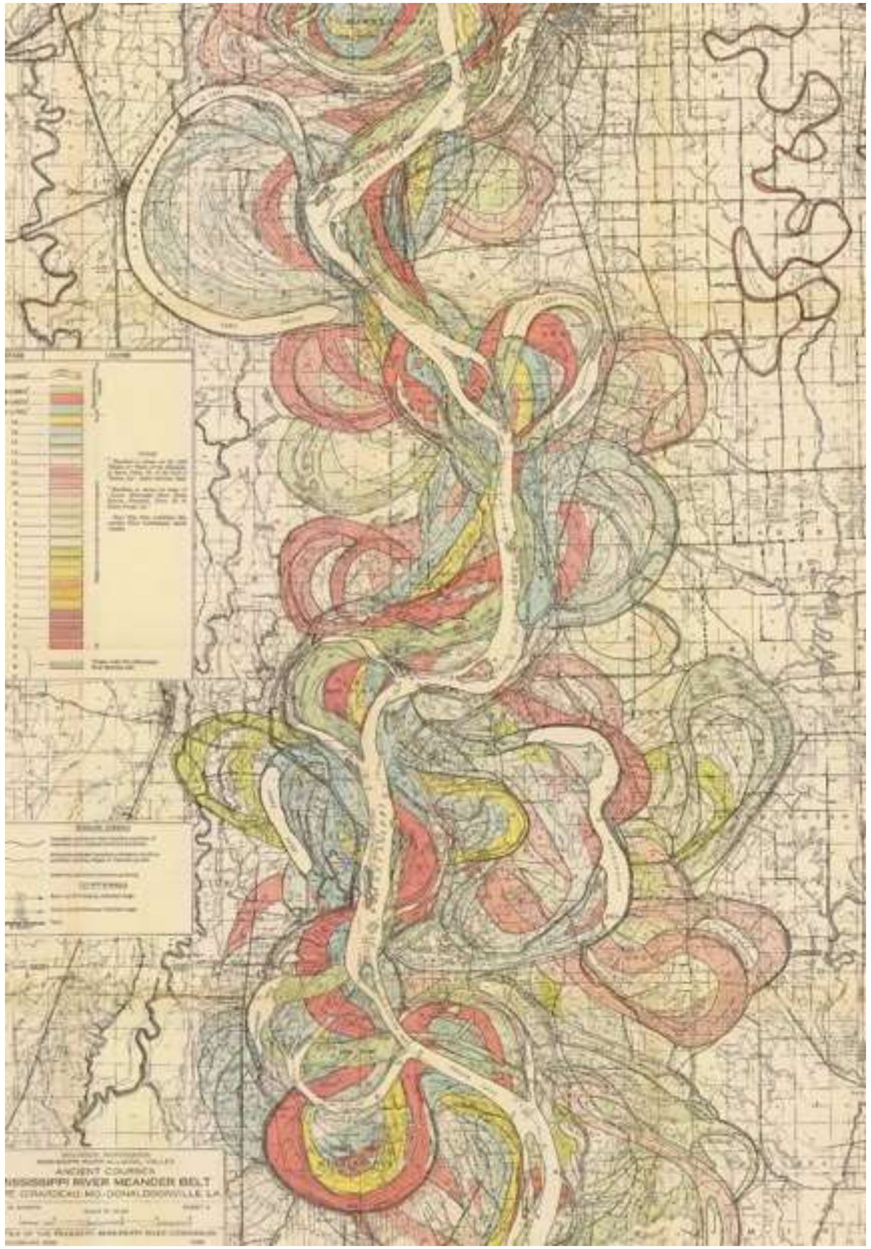






MO
Cairo
AR
TN
Floodplain
MS
Present course
LA
Previous course
Oldest meander belt
Backswamp deposits
Present river and point bars #1
Channel and point bars #3
Channel and point bars #2

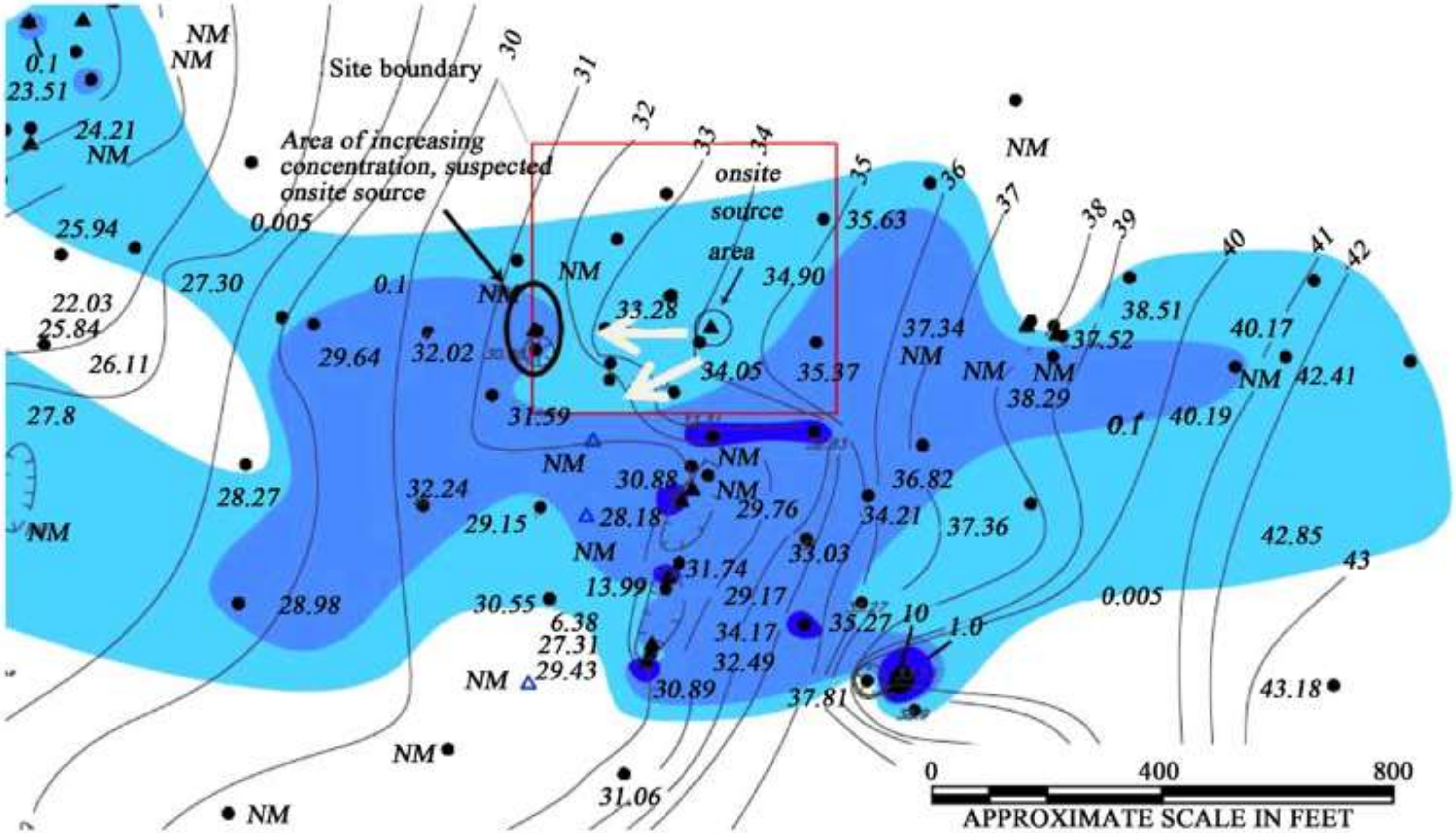
Added Complexity



Variations on the Theme (Rock Bodies)

Photo by W. W. Little

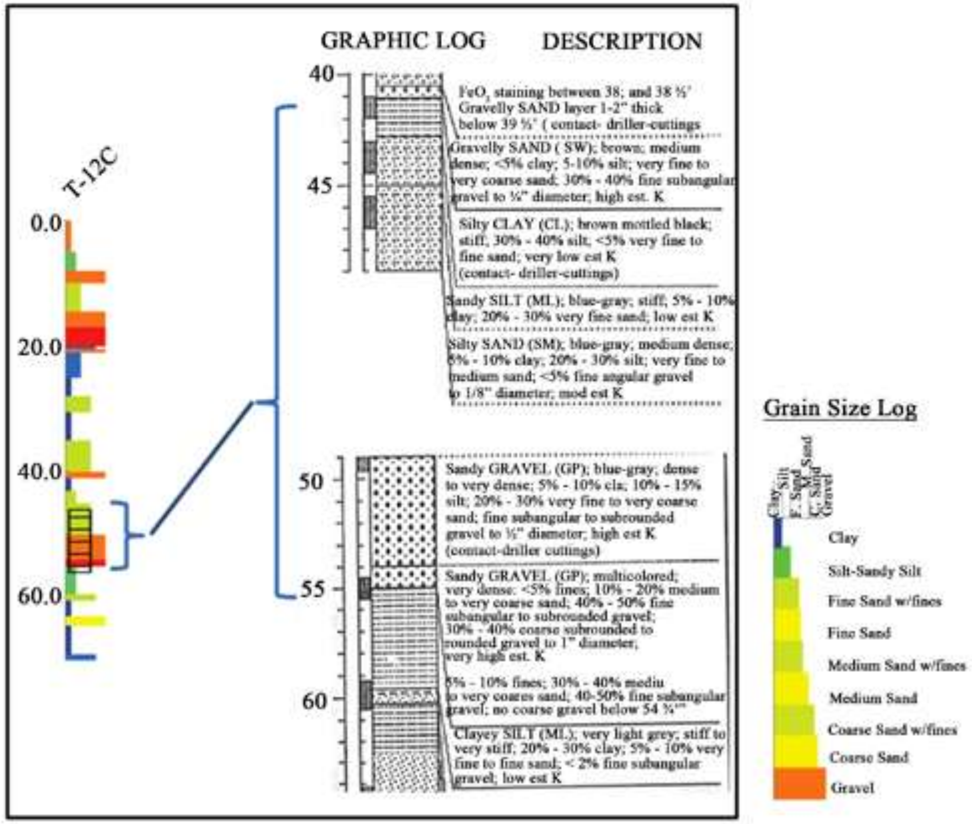
Case Study 1: Santa Clara (Silicon) Valley, CA



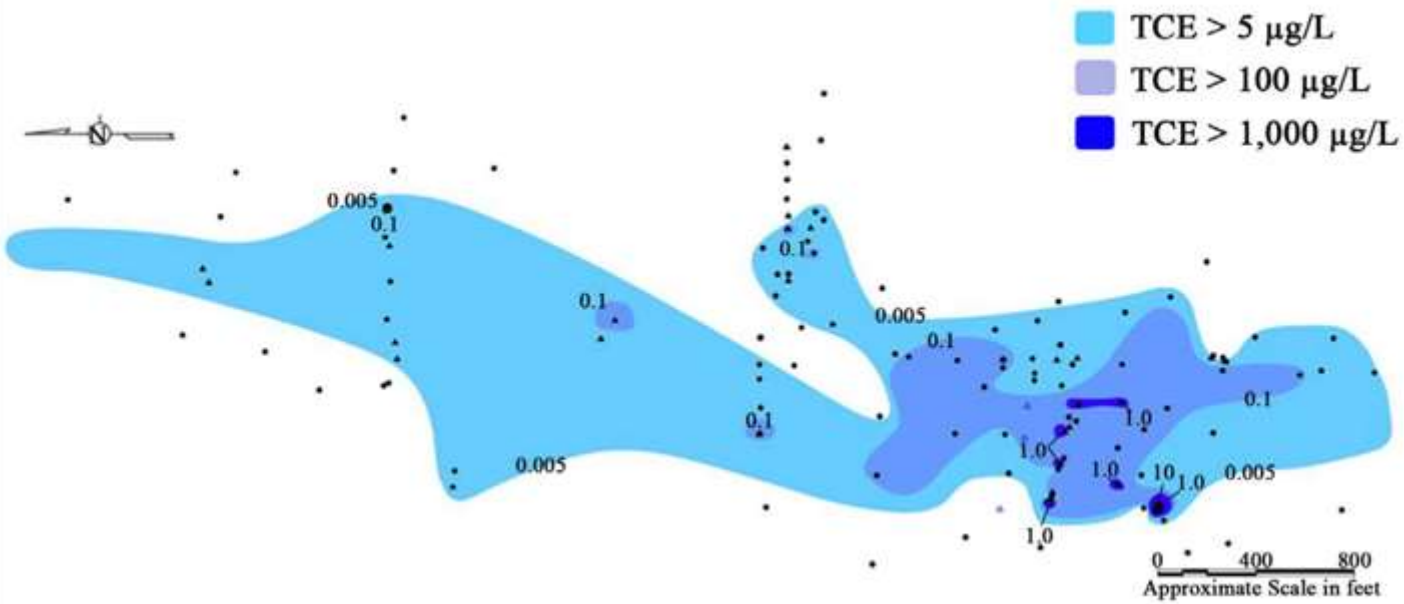
BURNS & McDONNELL

(Cramer et al. 2018)

Data



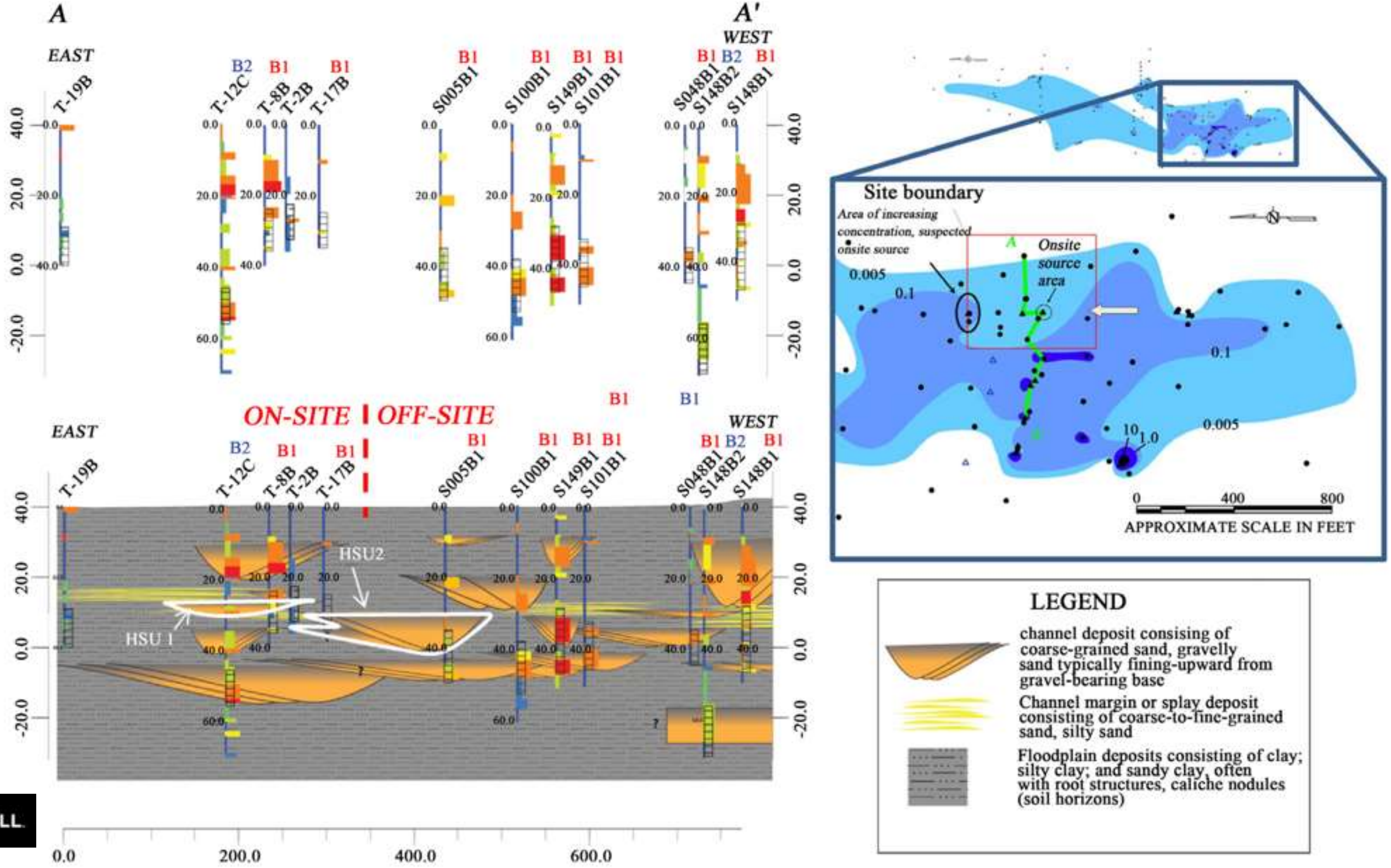
Facies Associations



Contaminant Concentrations

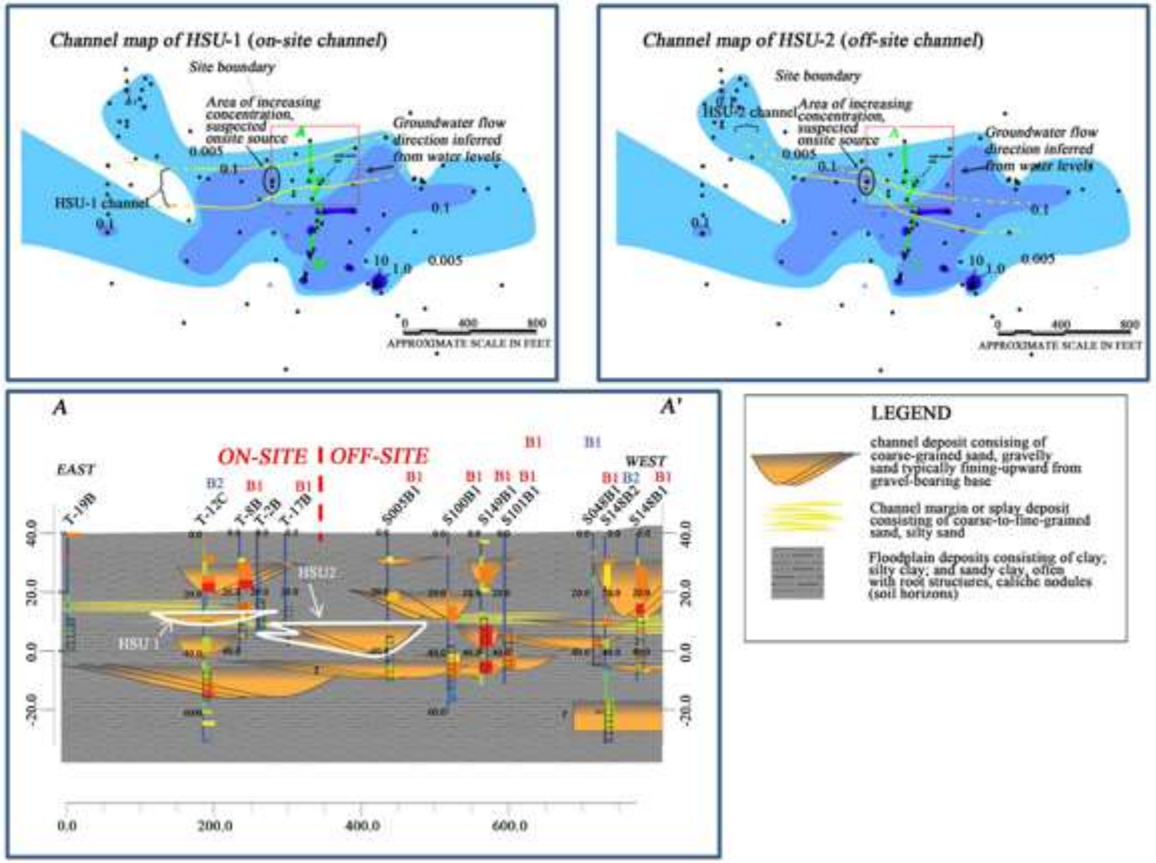
BURNS & McDONNELL

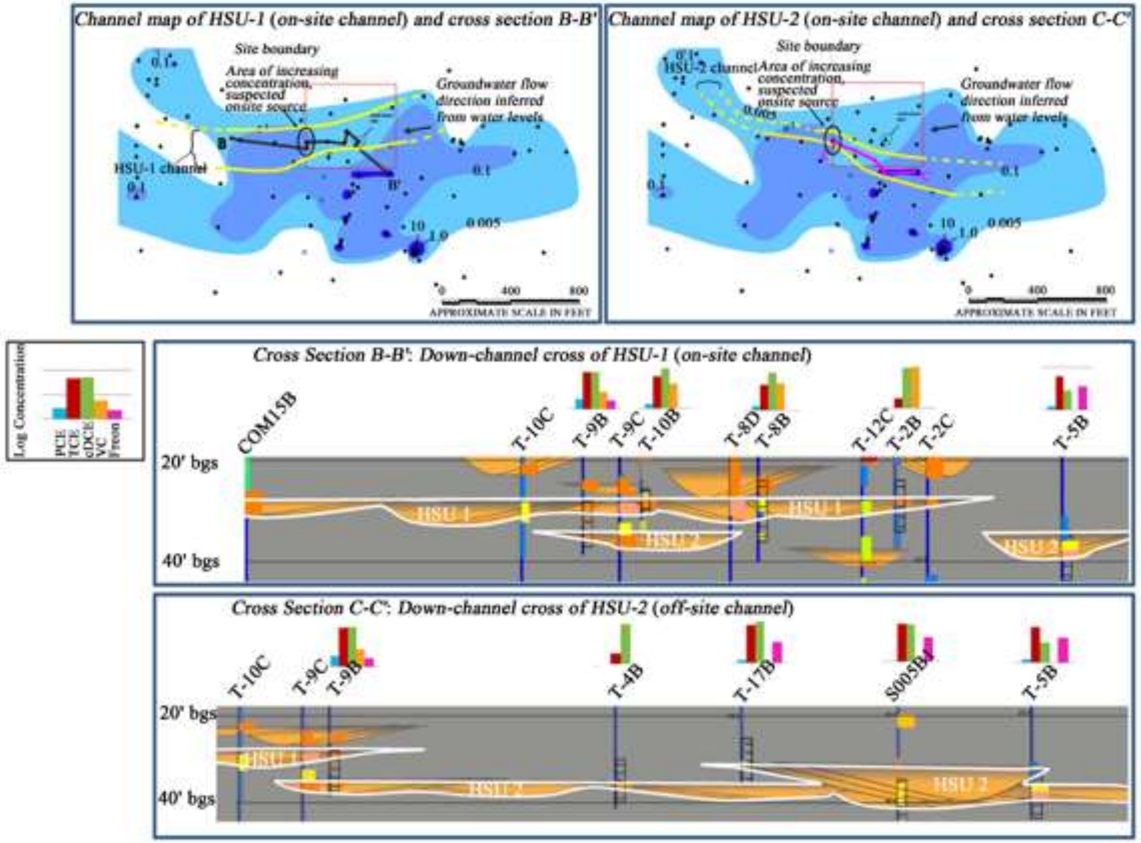
(Cramer et al. 2018)



BURNS McDONNELL

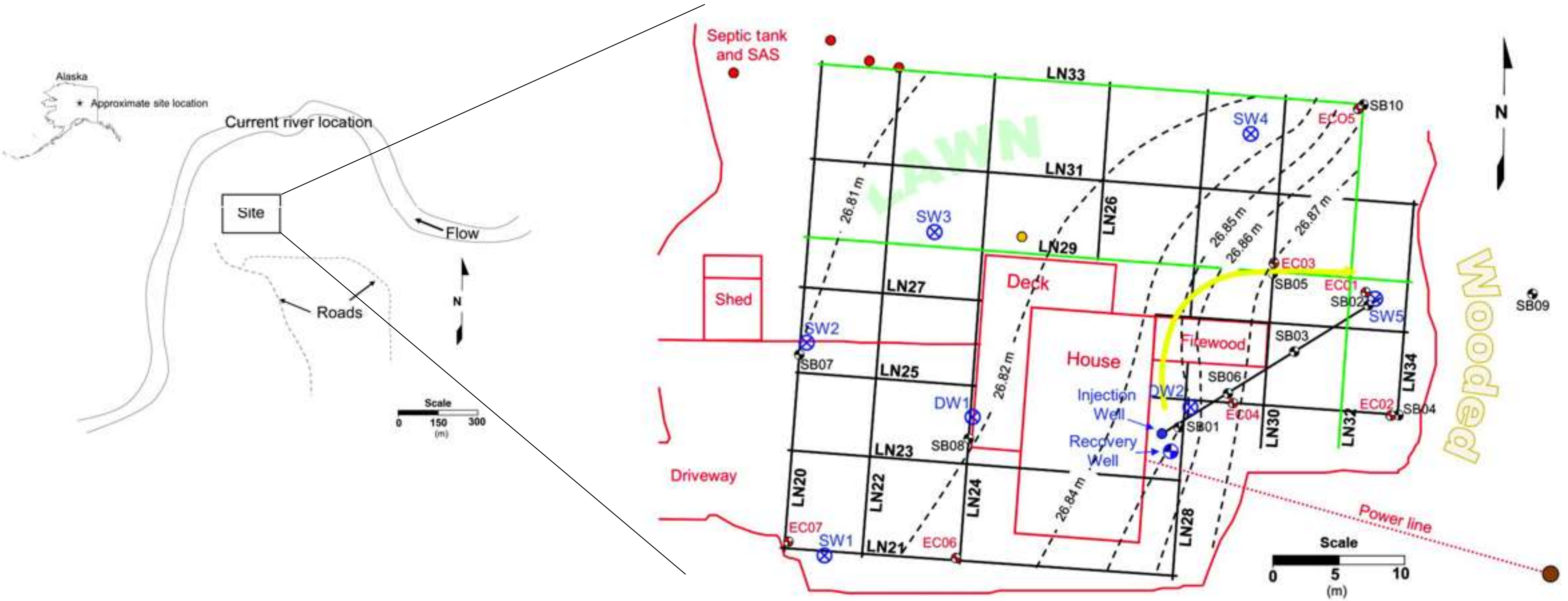
(Cramer et al. 2018)





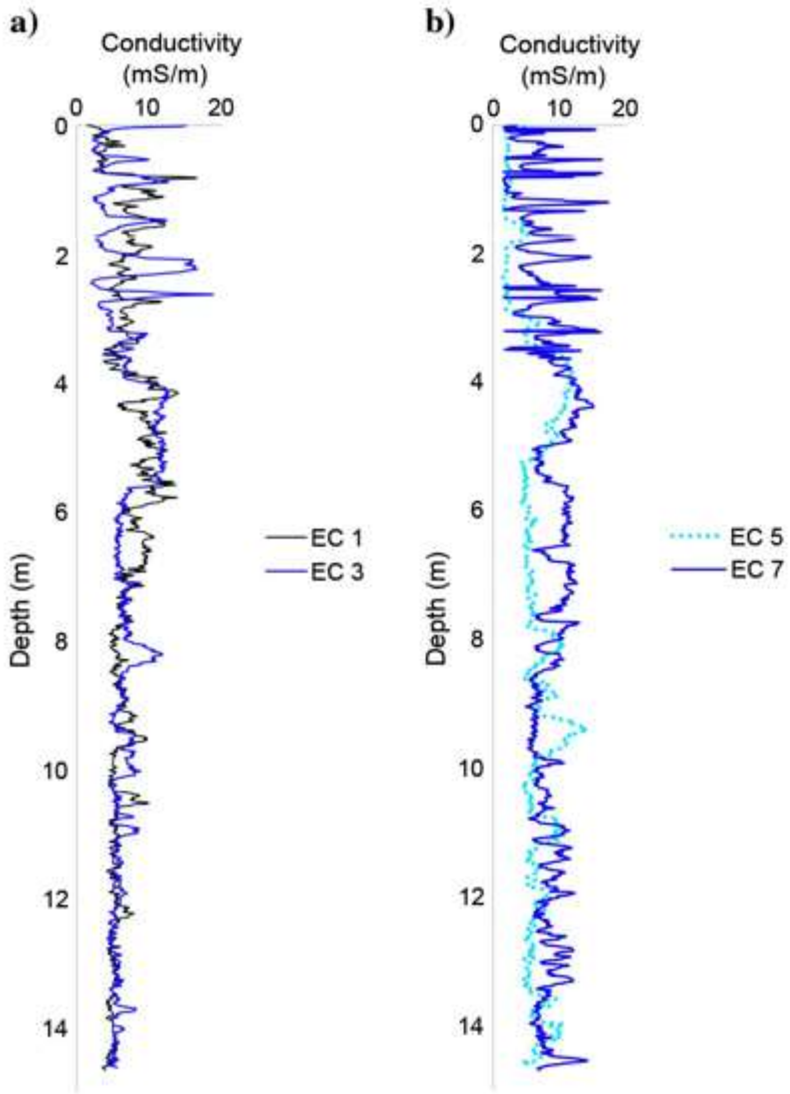
(Cramer et al. 2018)

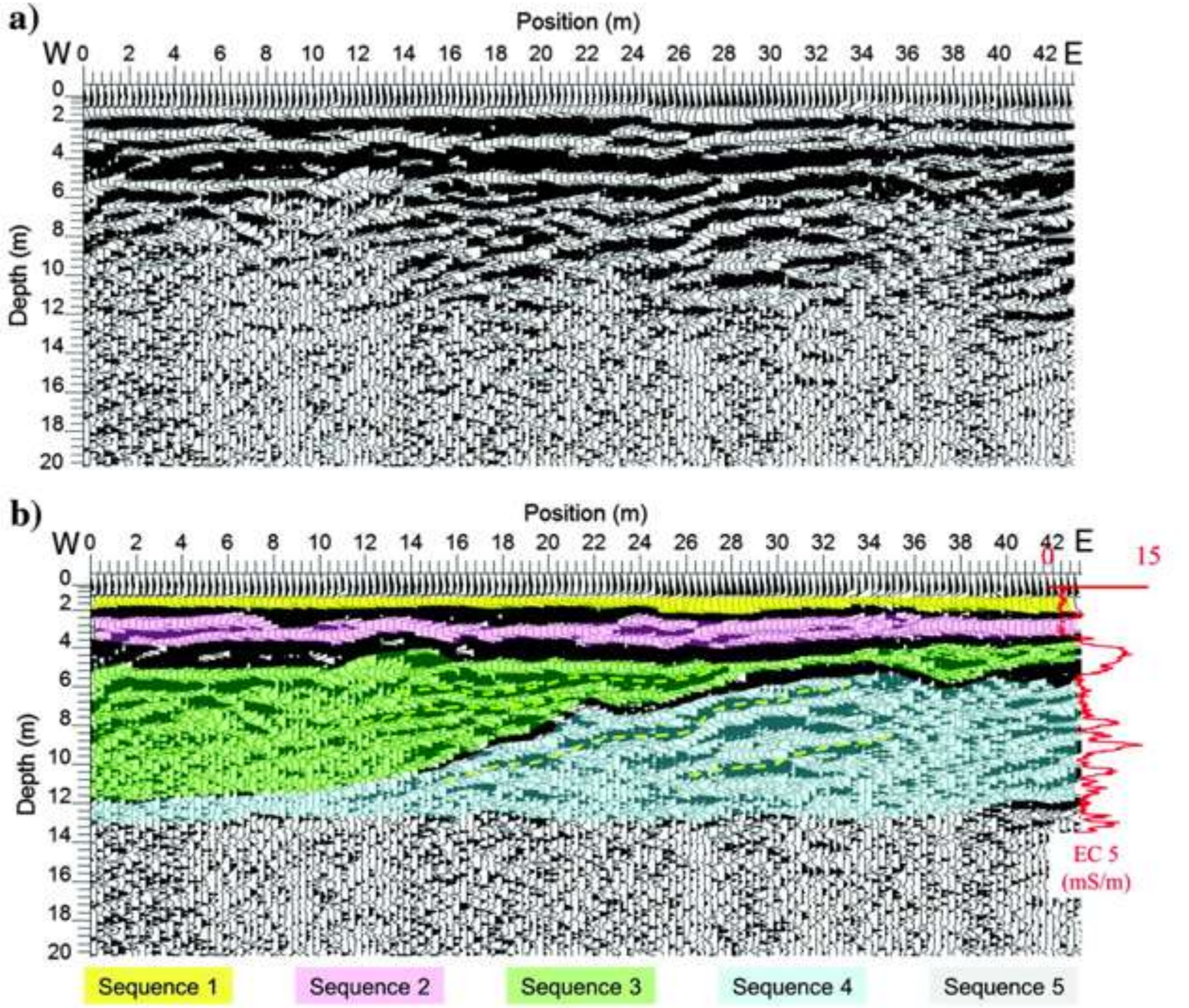
Case Study 2: Chena River (Fairbanks), AK

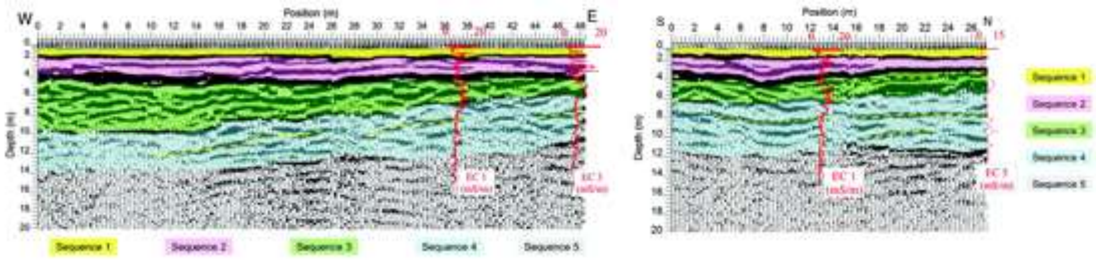


LogicGeo

Babcock, E. et al. (2015)

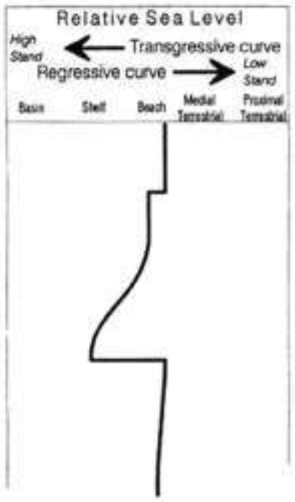


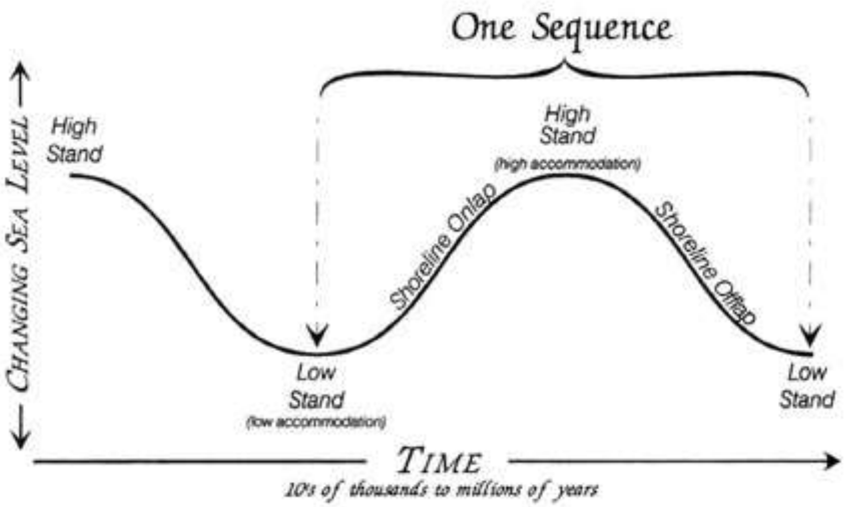


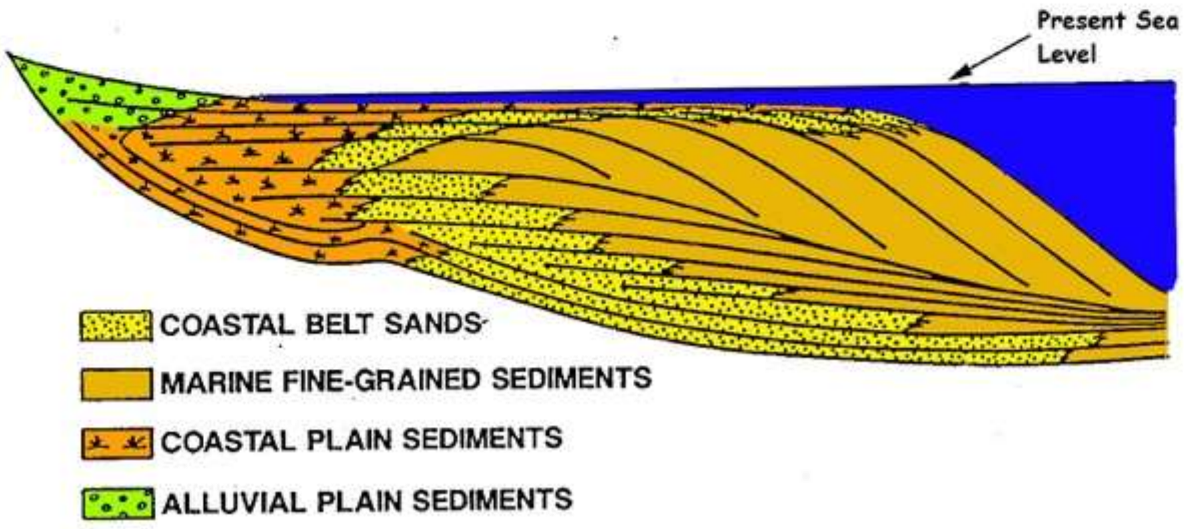


Babcock, E. et al. (2015)

Sequence Stratigraphy

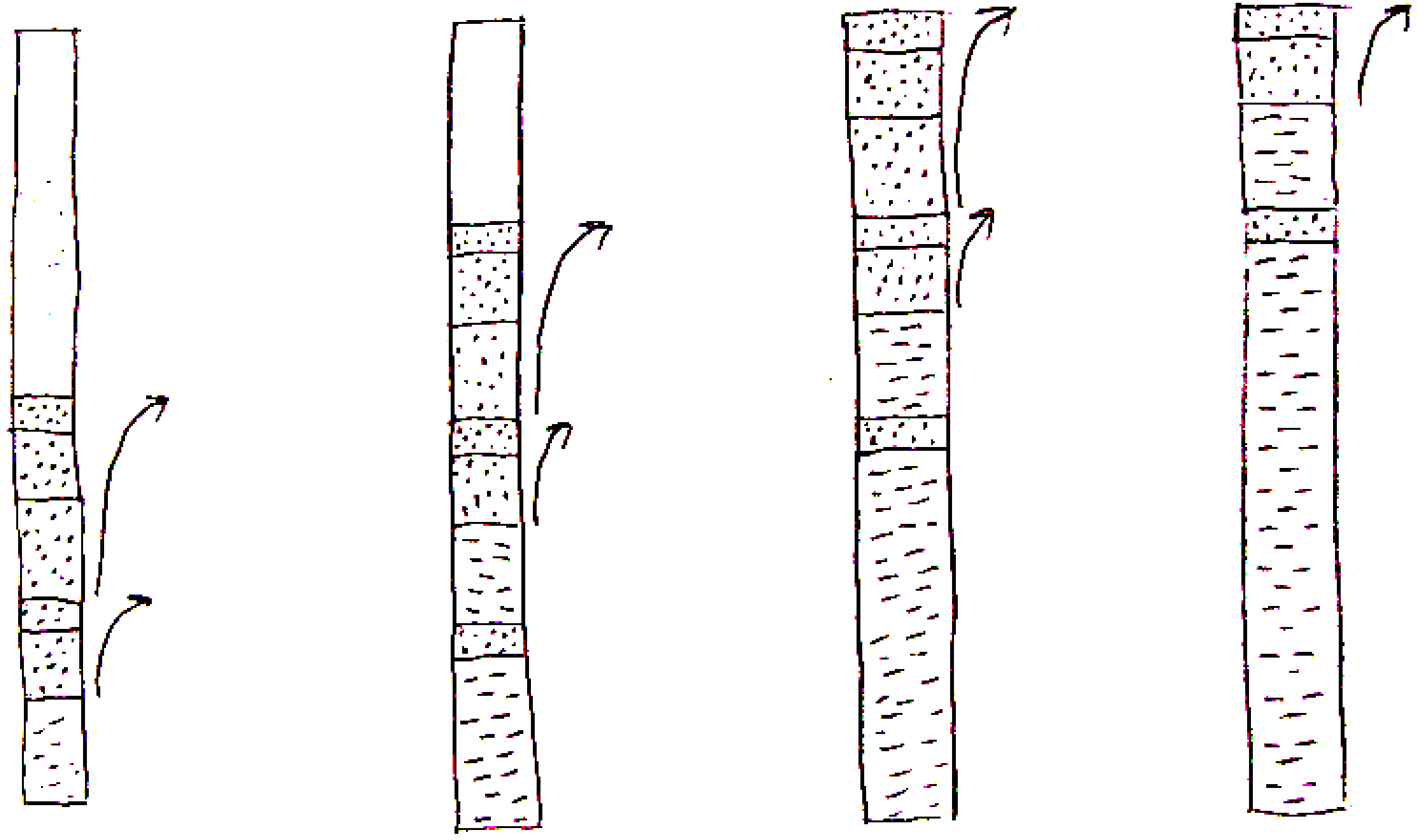






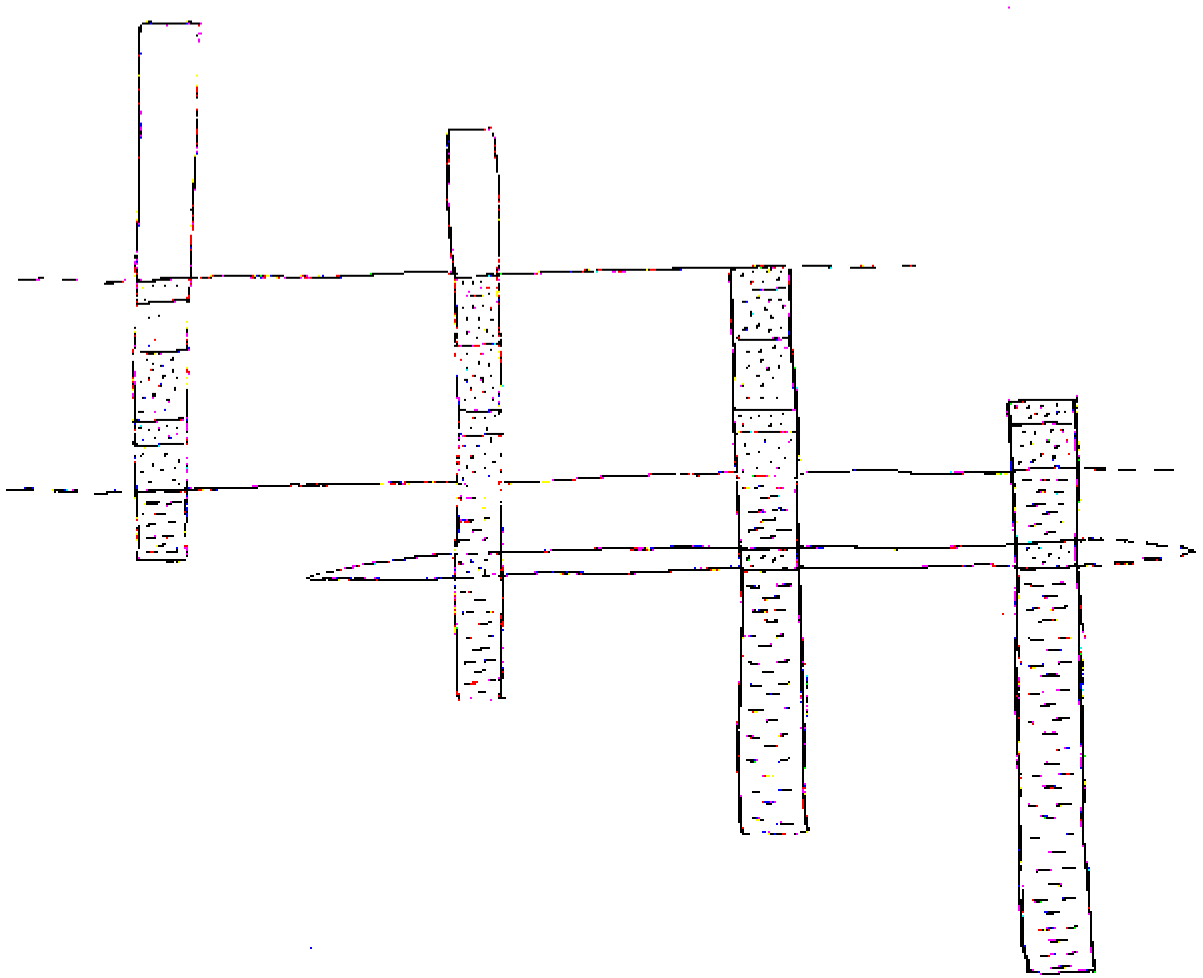
In simplest terms, sequence stratigraphy is the depositional stacking pattern that results from one full cycle of base-level change. In landward areas, the lower and upper boundaries of a sequence are typically unconformities.

Why is sequence stratigraphy important?



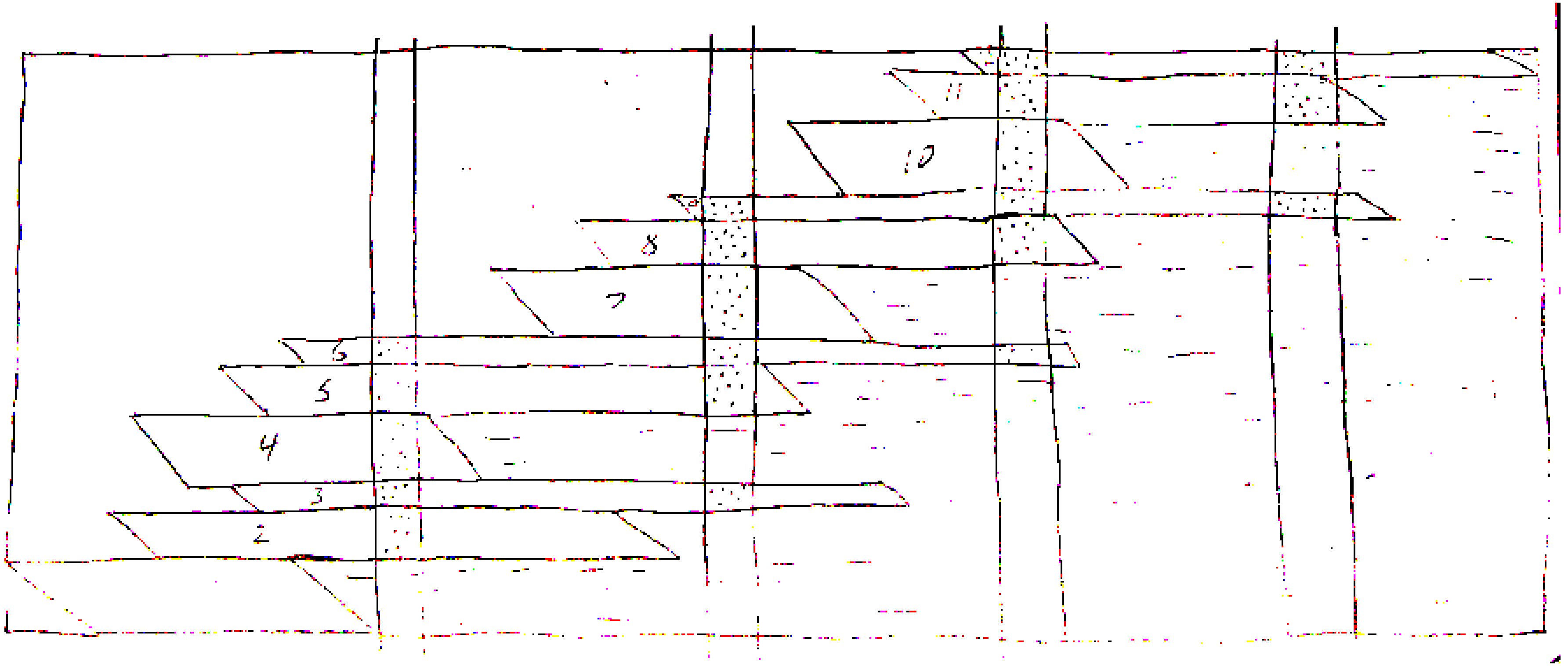
Correlate these four cores or measured sections.

Lithostratigraphic Solution



Given the similarity in physical characteristics, the most common solution would be to hang the sections at the top of the first prominent sandstone.

Sequence Stratigraphic Solution



An alternative would be to assume an overall progradational stacking pattern common to highstand systems tracts and to hang the section on the first recognizable time-correlative depositional event (parasequence), regardless of lithology.

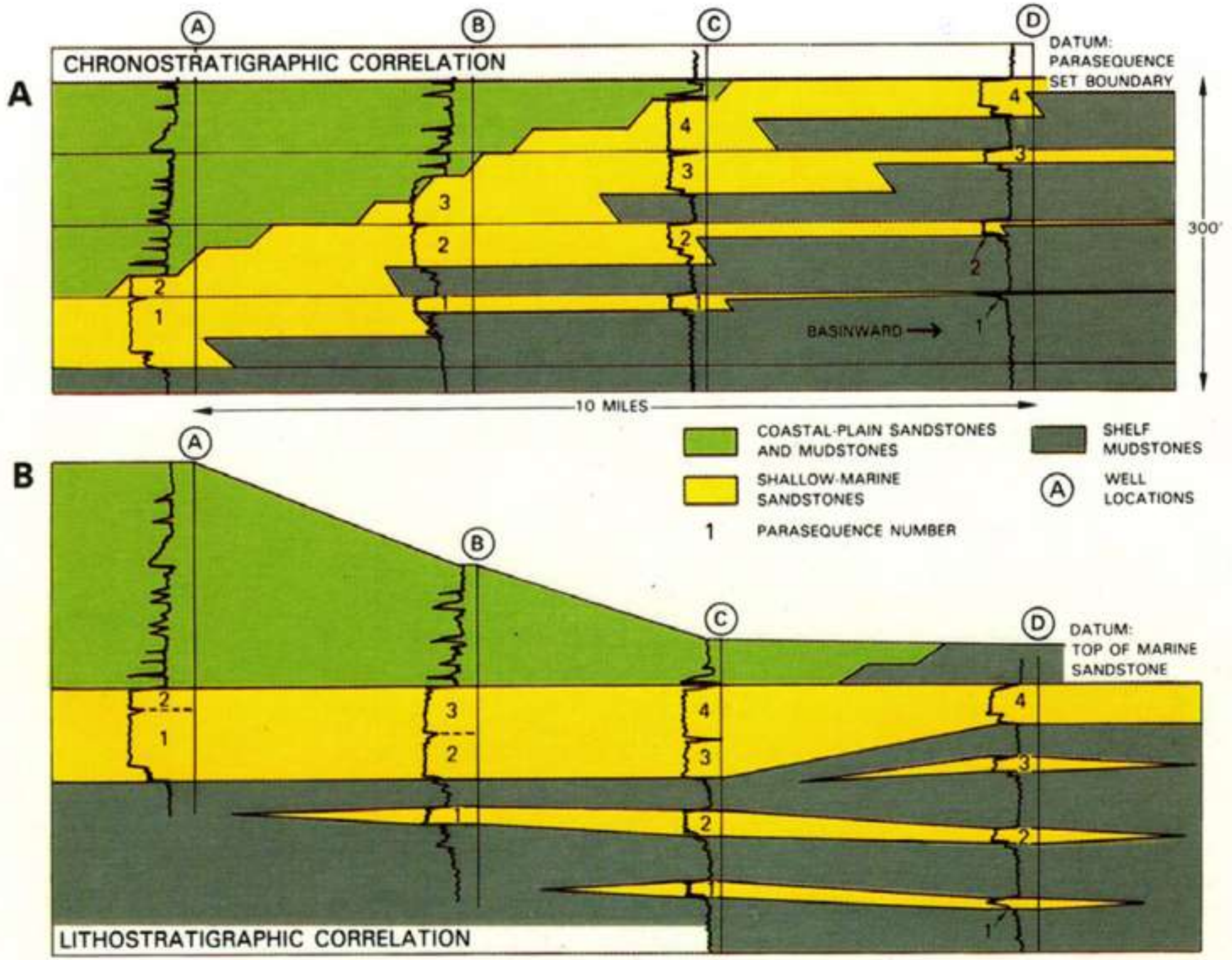
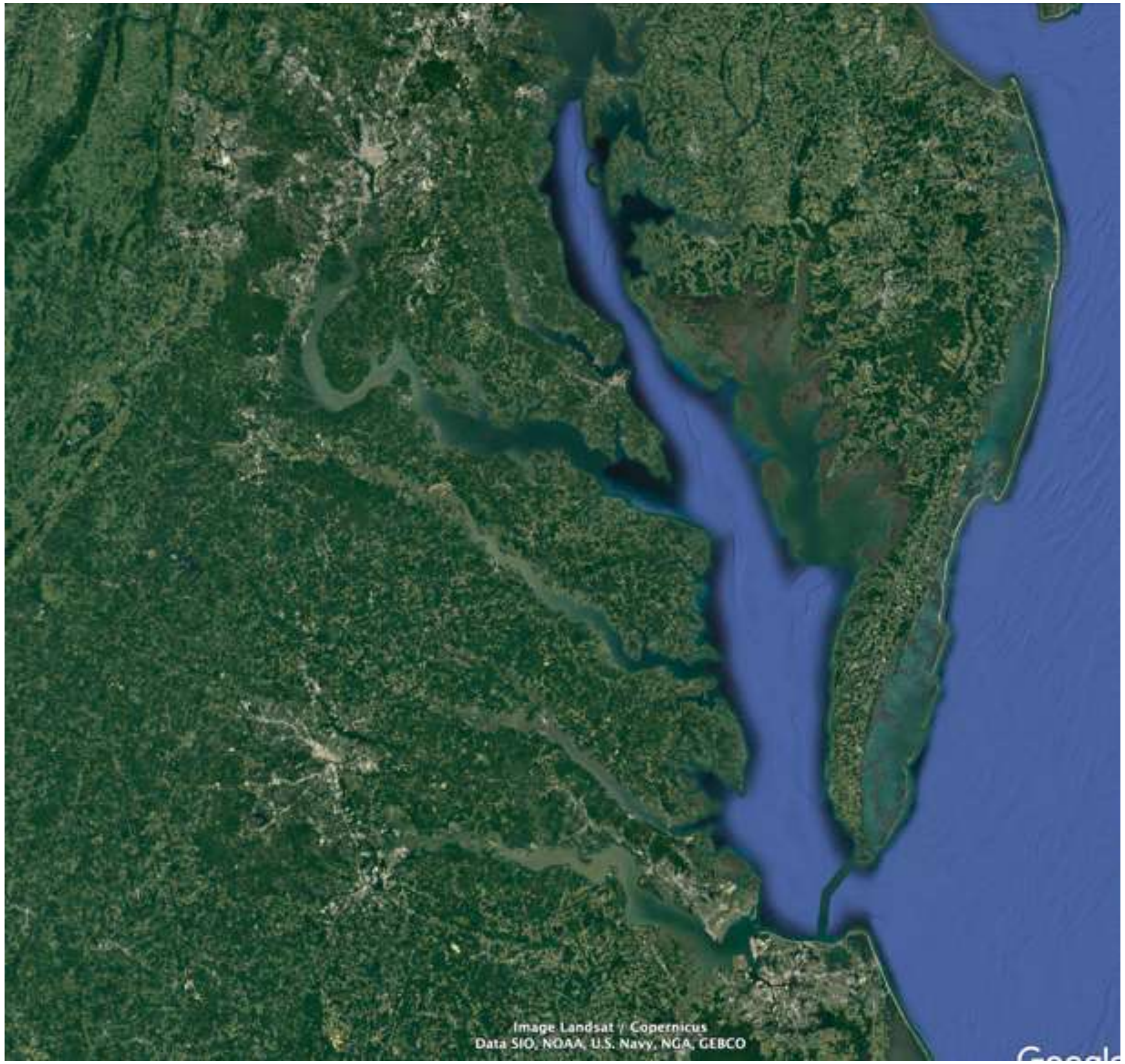
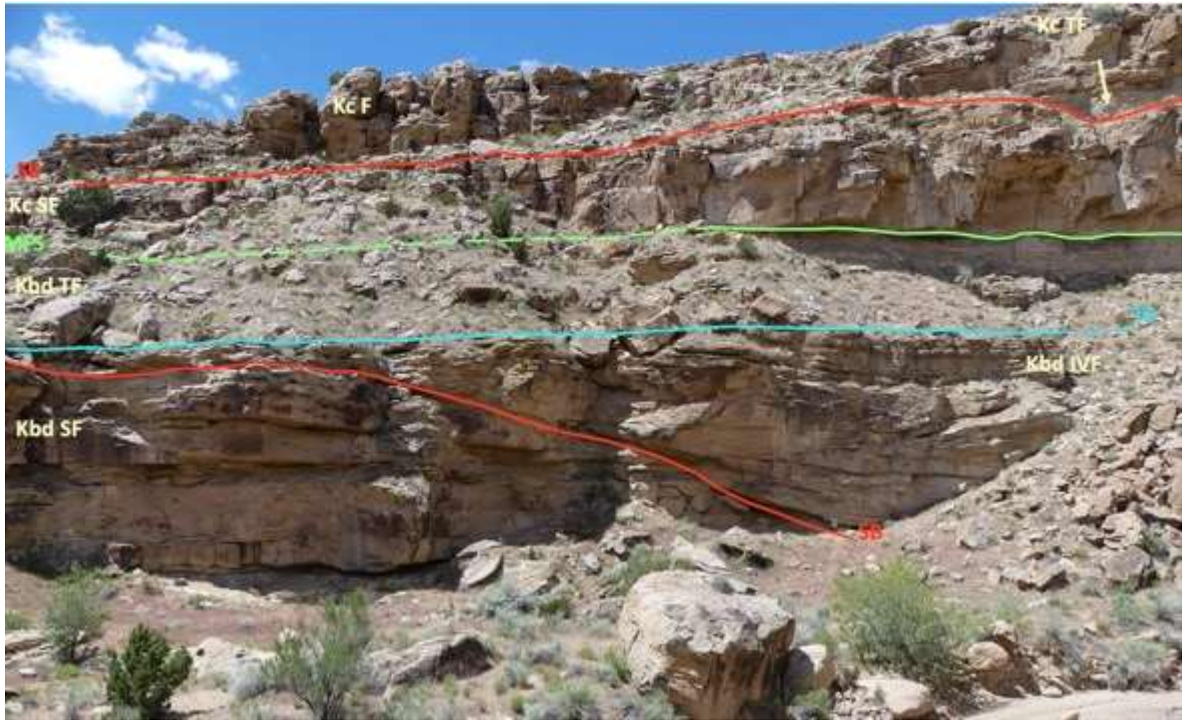


Figure 17—Comparison of (A) chronostratigraphic correlation and (B) lithostratigraphic correlation styles: progradational parasequence set.

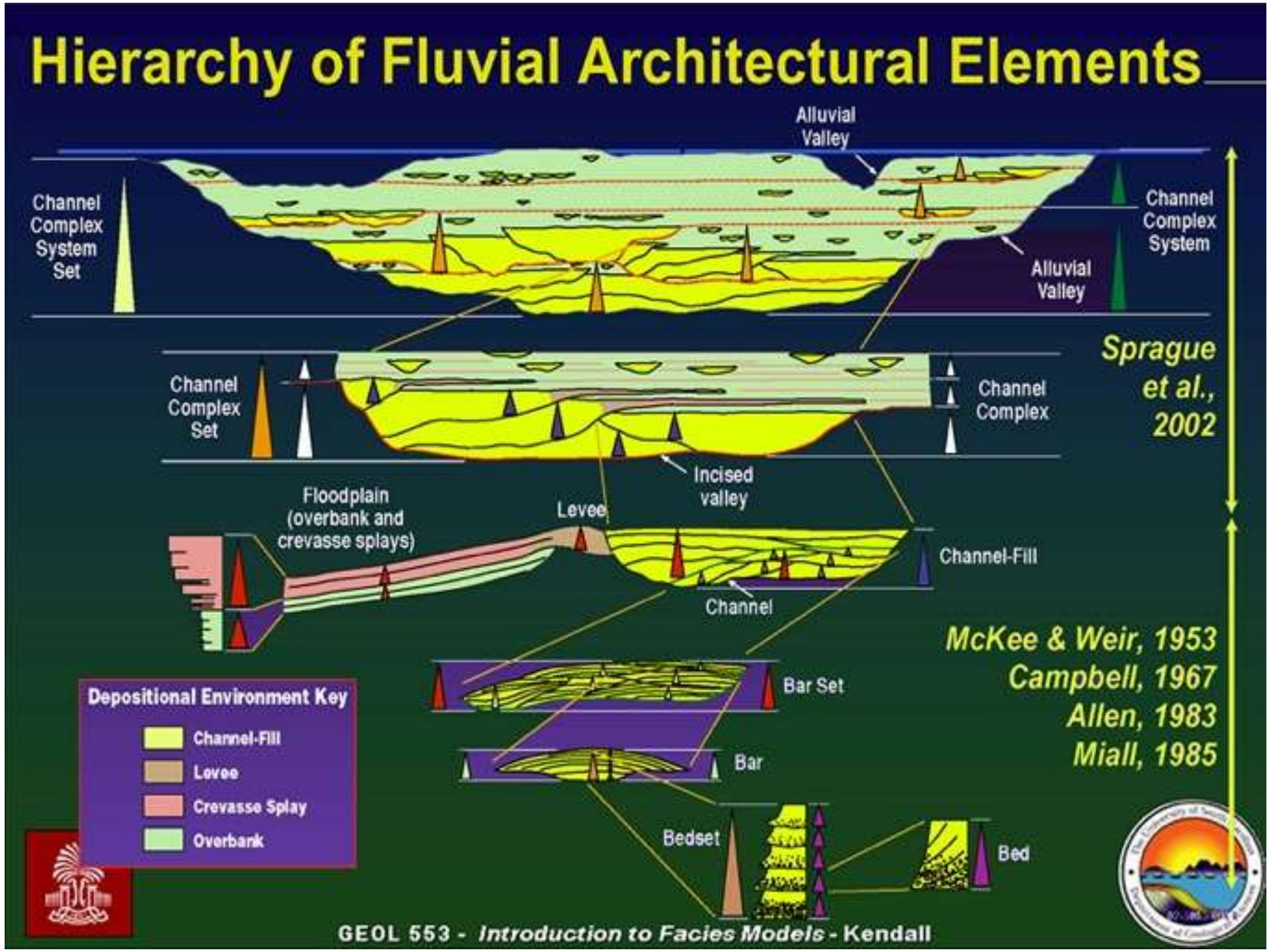
Incised Valley Fills

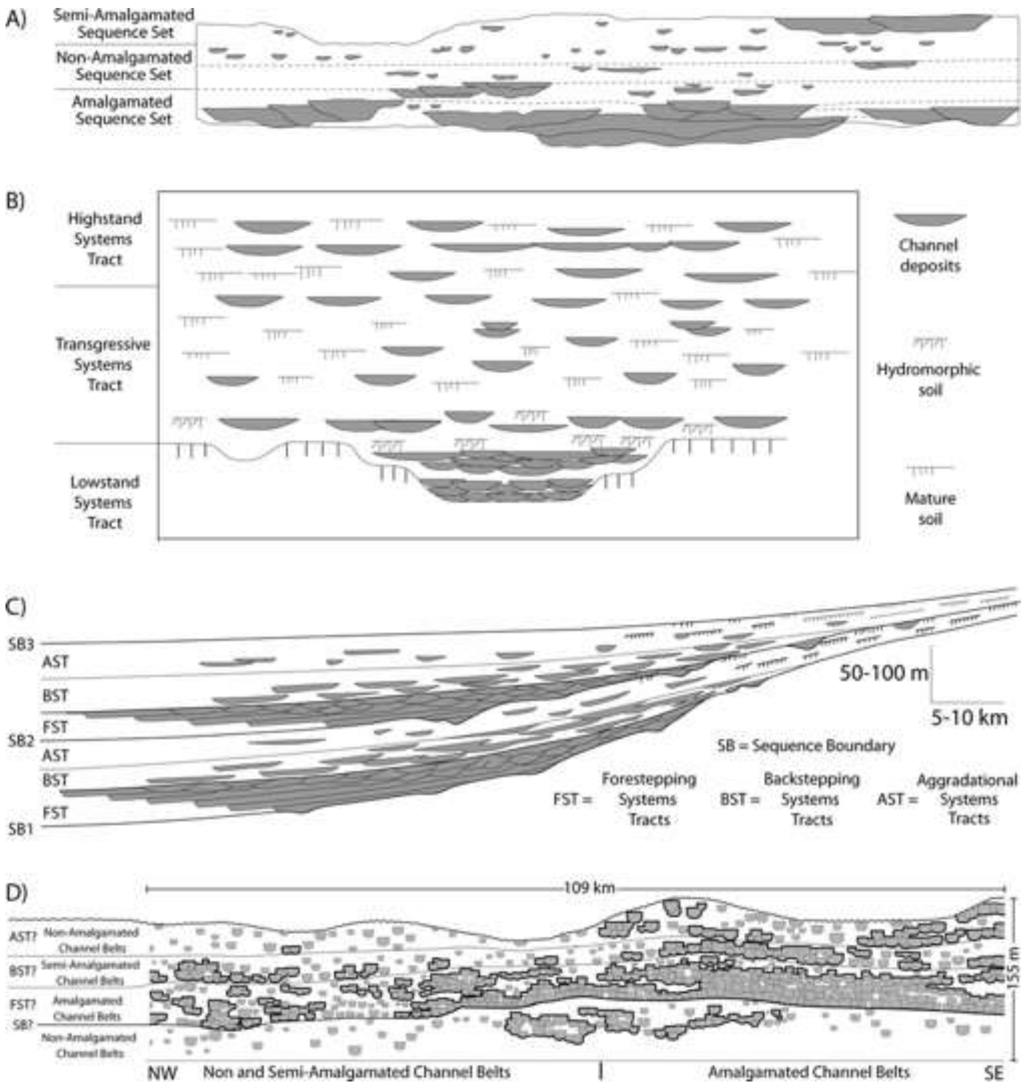




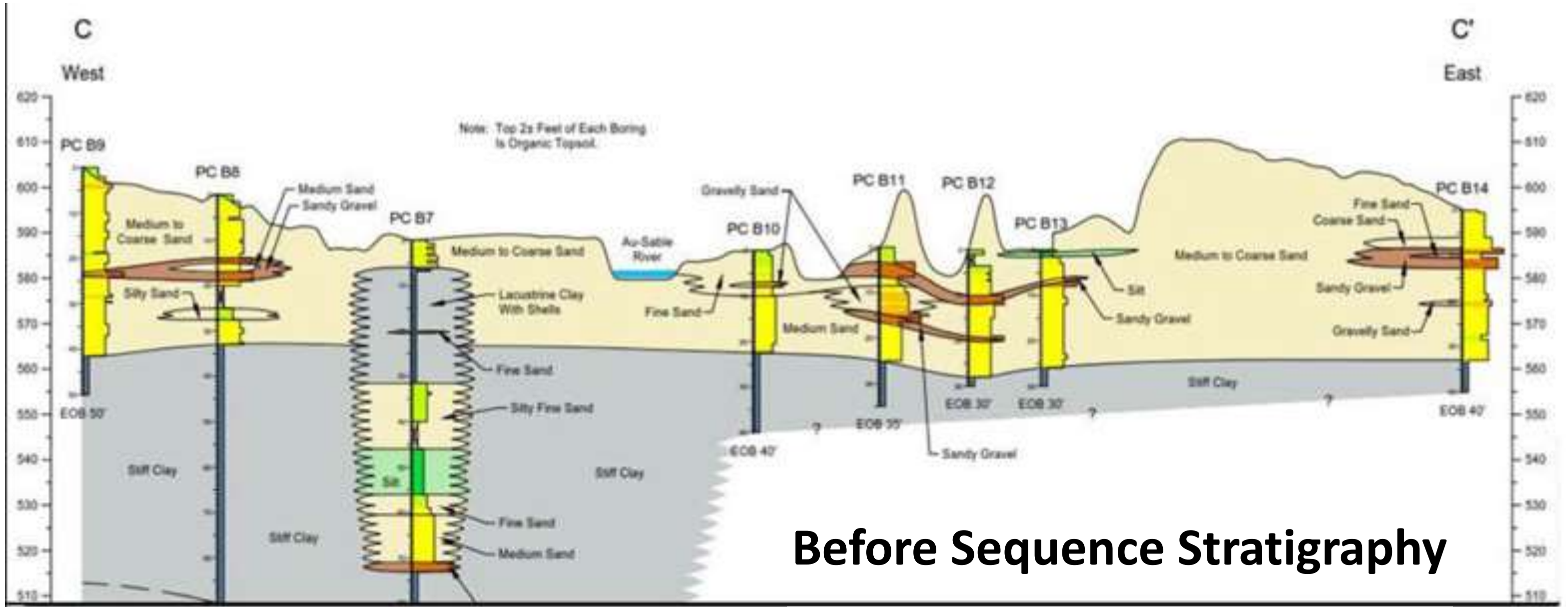

Sediment bypass
Formation of sequence boundary
Photo by W. W. Little

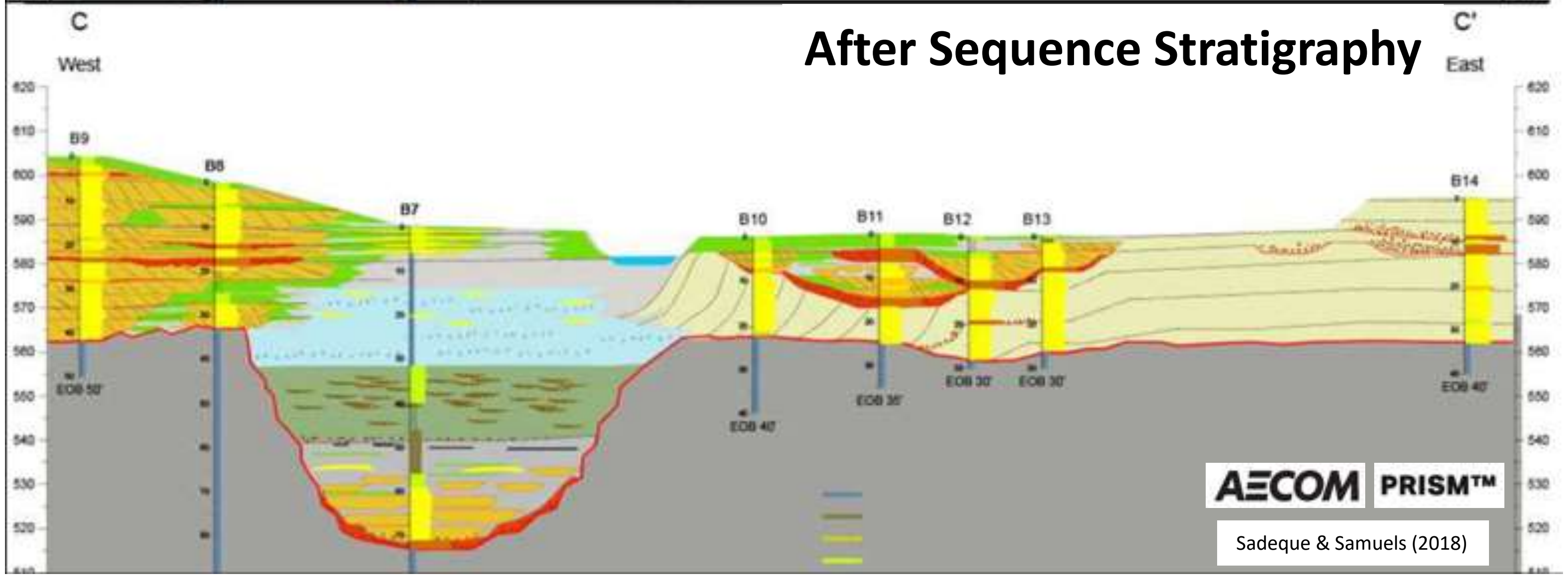

Photo by W. W. Little


Hierarchy of Fluvial Architectural Elements
Alluvial Valley
Channel Complex System Set
Channel Complex System
Alluvial Valley
Channel Complex Set
Channel Complex
Sprague et al., 2002
Incised valley
Floodplain (overbank and crevasse splays)
Levee
Channel-Fill
Channel
McKee & Weir, 1953
Campbell, 1967
Allen, 1983
Miall, 1985
Bar Set
Bar
Bedset
Bed
Depositional Environment Key
Channel-Fill
Levee
Crevasse Splay
Overbank
GEOL 553 - Introduction to Facies Models - Kendall


A)
Semi-Amalgamated Sequence Set
Non-Amalgamated Sequence Set
Amalgamated Sequence Set
B)
Highstand Systems Tract
Transgressive Systems Tract
Lowstand Systems Tract
Channel deposits
Hydromorphic soil
Mature soil
C)
SB3
AST
BST
FST
SB2
AST
BST
FST
SB1
50-100 m
5-10 km
SB = Sequence Boundary
FST = Forestepping Systems Tracts
BST = Backstepping Systems Tracts
AST = Aggradational Systems Tracts
D)
109 km
155 m
NW
Non and Semi-Amalgamated Channel Belts
Amalgamated Channel Belts
SE

Case Study 3:
"Pinnacle" Facies Associations





Sadeque & Samuels (2018)