Development of Banding in the Deposits of Experimental Transitional Flows*

Kelsi Ustipak[1], James Buttles[2], David Mohrig[2], Mauricio Perillo[2], and Benjamin Cardenas[2]

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[1]Jackson School of Geosciences, University of Texas at Austin, Austin, Texas, United States (ustipak@utexas.edu)
[2]Jackson School of Geosciences, University of Texas at Austin, Austin, Texas, United States

Abstract

Transitional flows deposits have been described in a wide range of deepwater basins such as the Agadir Basin (offshore Morocco), Britannia Formation in the North Sea, and the ultra-deepwater sub-salt Wilcox Group (USA). These types of deposits do not follow the 'classic' deepwater facies models (i.e., Bouma Sequence). One of the most enigmatic aspects of transitional flow deposits lies in an alternation between clay-rich and clean sand bands. Distinguishing between laminae and true banding in argillaceous deepwater deposits is often unclear due to uncertainty in the processes controlling the development of banding. Surging within depositing sediment gravity flows may provide a process-based explanation for why banded intervals are common in facies descriptions of transitional flow deposits. To test this hypothesis, we induced intermittent surges on clay-rich, sand-laden transitional flows in a two-dimensional experimental flume. Surging produces unsteady deposition of alternating clay-rich and clean sand bands in an overall fining upward event bed. Millimeter-scale bands are connected to fluctuating bed aggradation rates which wax and wane in response to surging. High-resolution videos taken during the experiments show that rapid bed aggradation results in clay-rich bands while lower aggradation rates deposit relatively clean sands. The character of banding differs across the tested flow compositions, from high-concentration turbidity currents to strong transitional flows. Variability in the spatial distribution of clay within banded deepwater deposits has implications for predicting both permeability structure and overall reservoir quality.

Reference Cited

Haughton, P., C. Davis, W. McCaffrey, and S. Barker, 2009, Hybrid Sediment Gravity Flow Deposits – Classification, Origin and Significance: Marine and Petroleum Geology, v. 26/10, p. 1900-1918.

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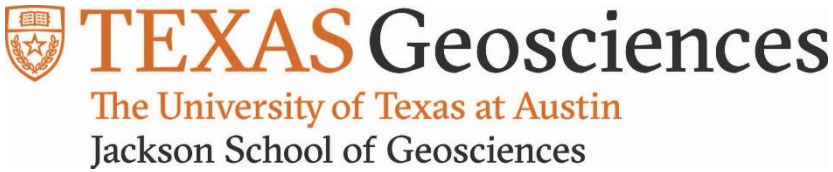
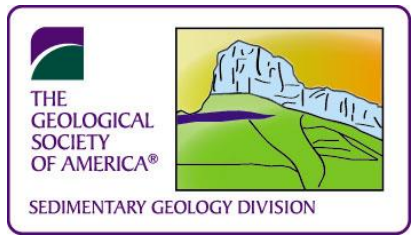
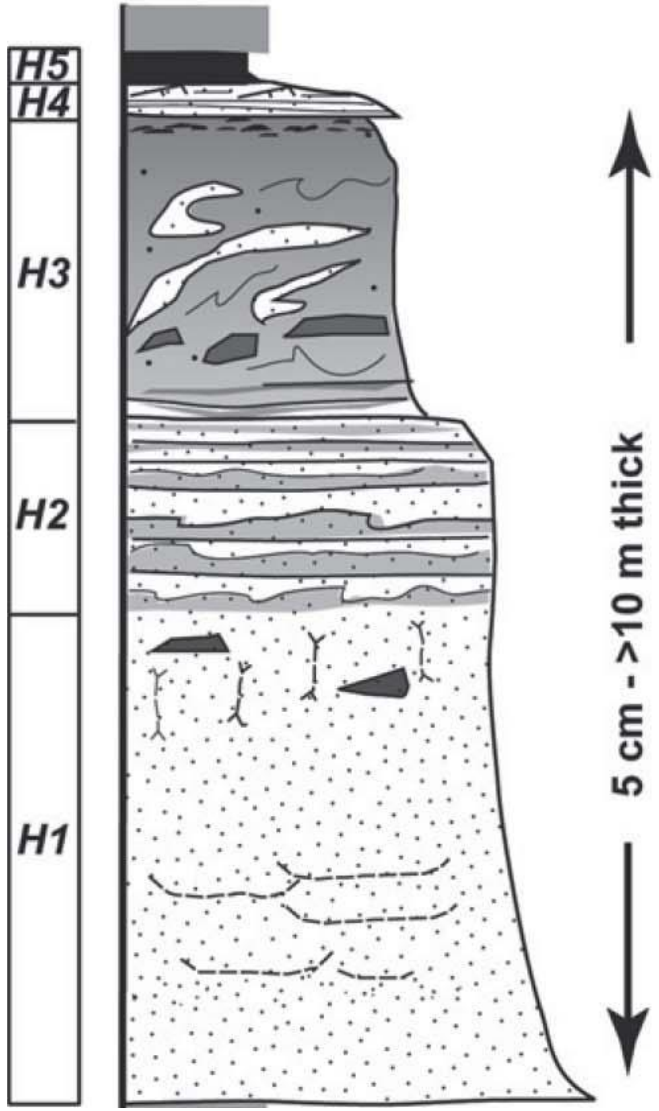


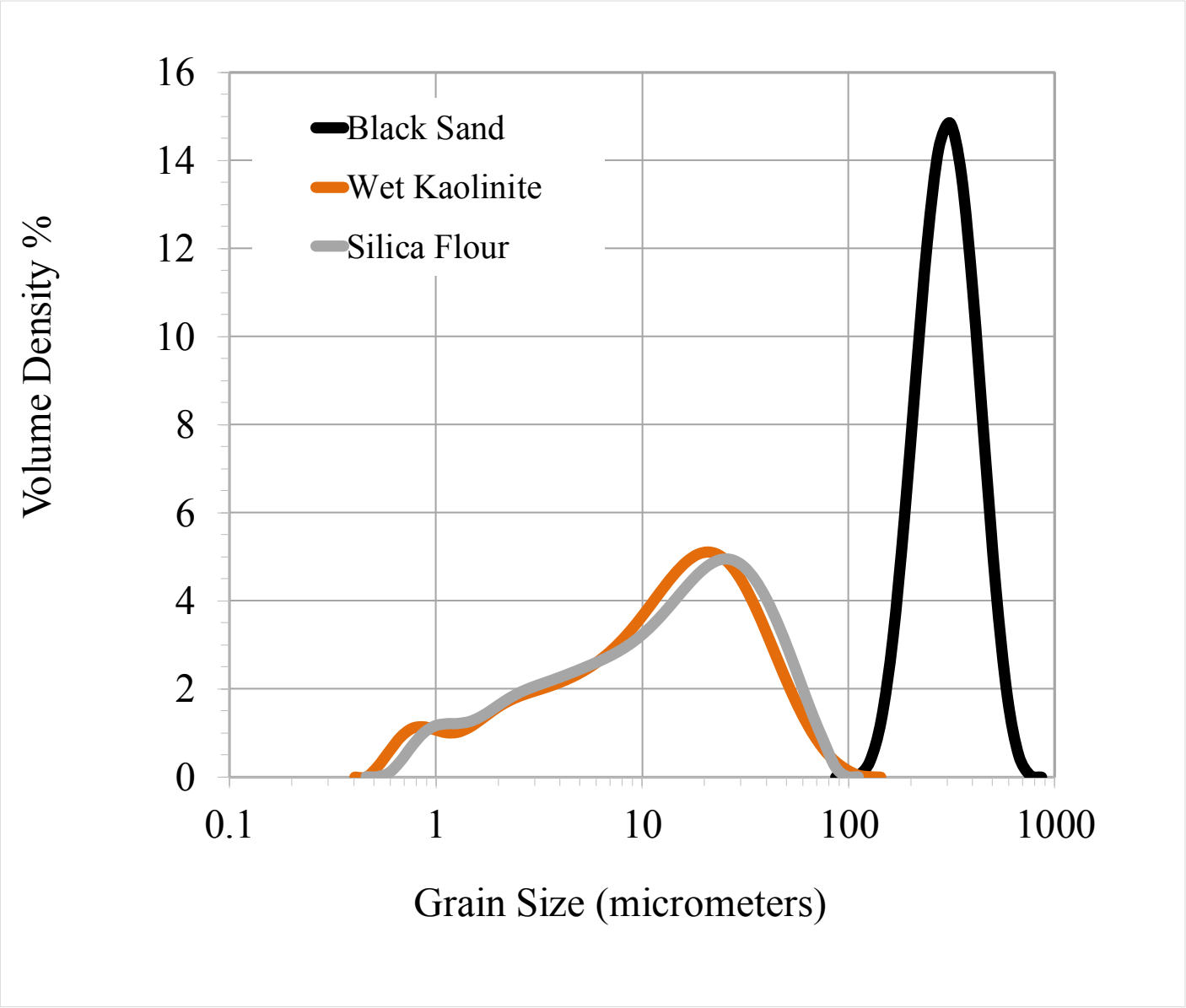




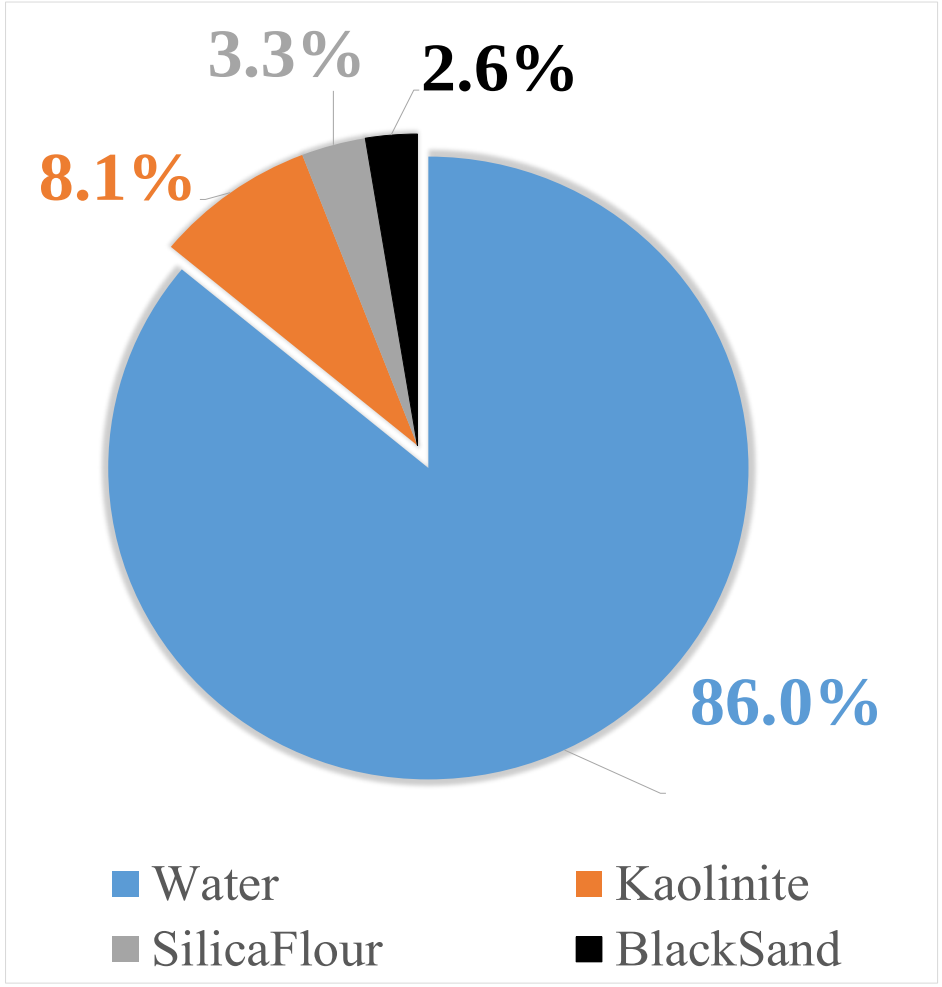
Haughton et al. (2009) *Marine and Petroleum Geology*

1. Surging of a transitional flow leads to banded deposits

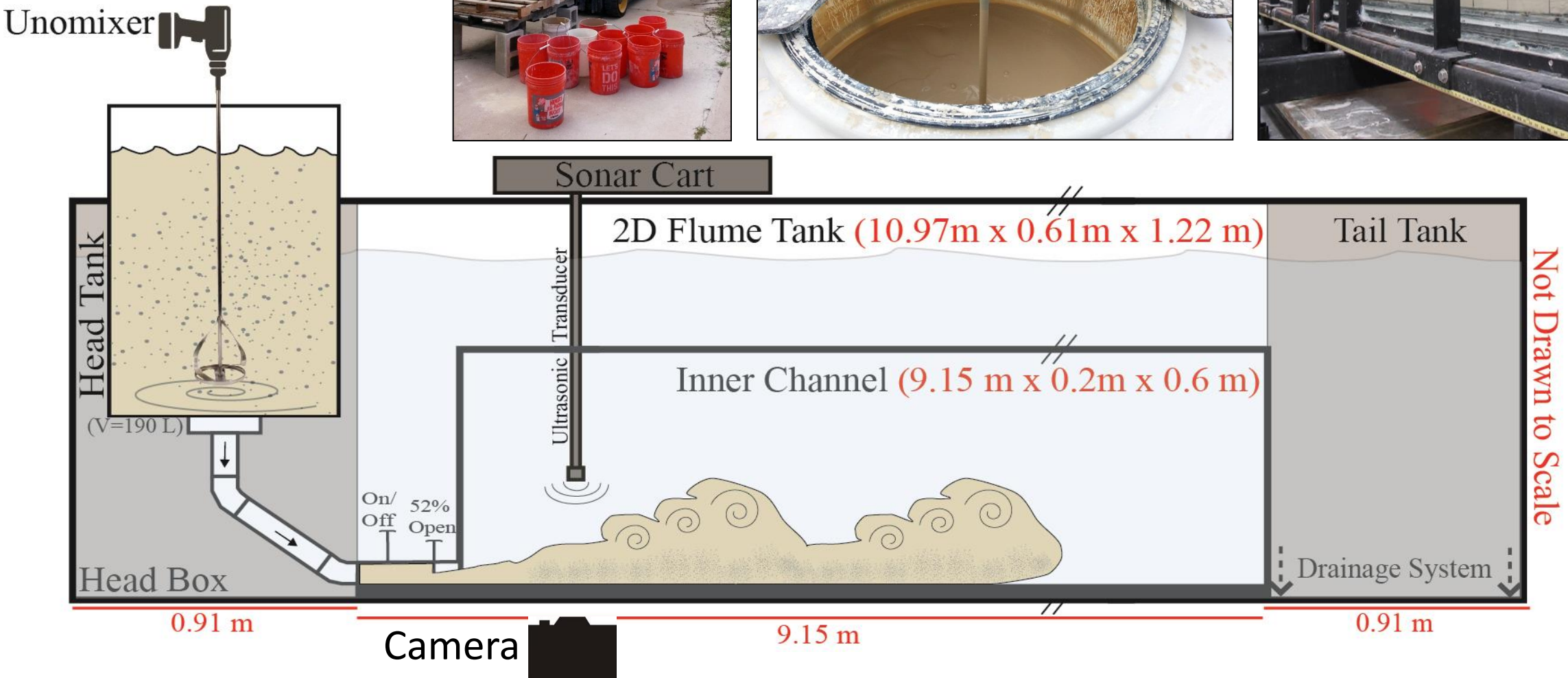
2. Clean or muddy bands directly correlate to surges in flow

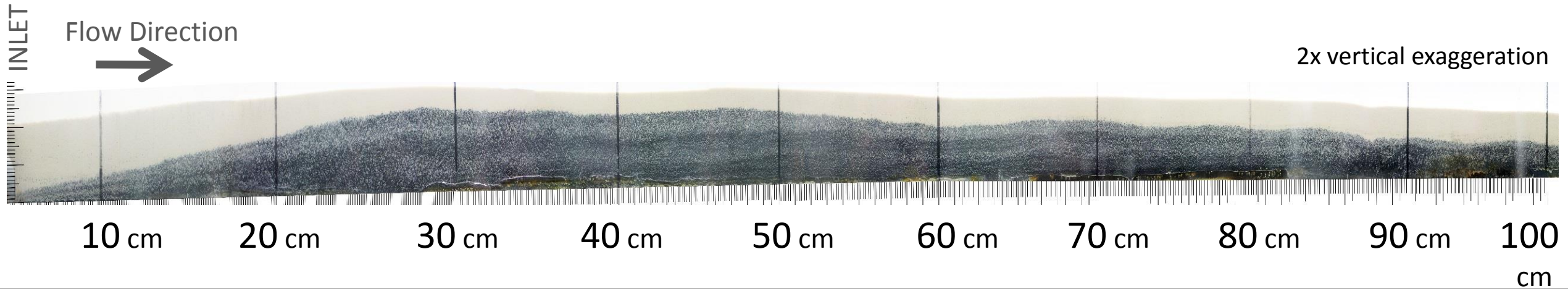


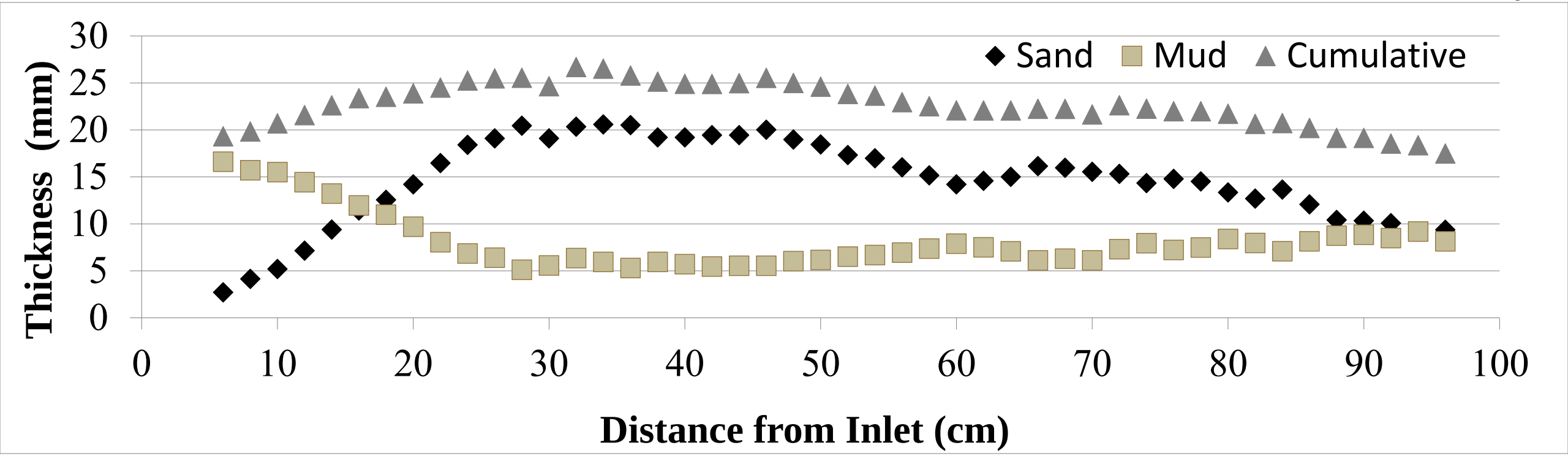
- 14% Sediment by Weight
  - 81.4% of Sediment is Mud

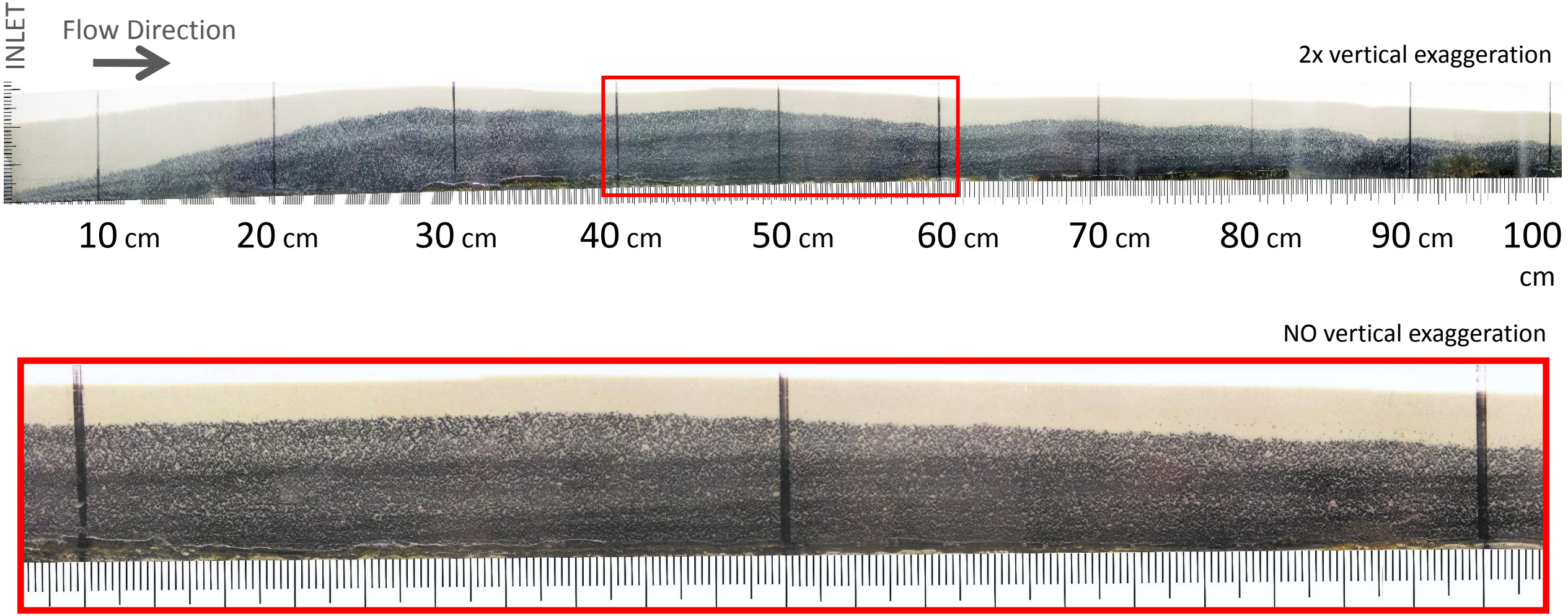


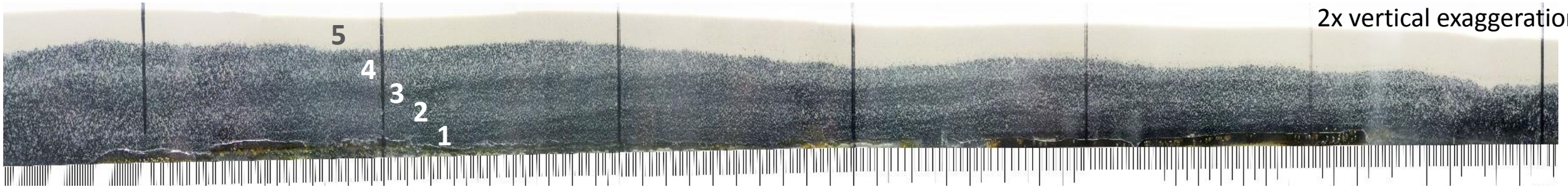

MIXING EQUIPMENT CO., INC.
LIGHTNIN
MIXERS AND AERATORS
ROCHESTER, NEW YORK

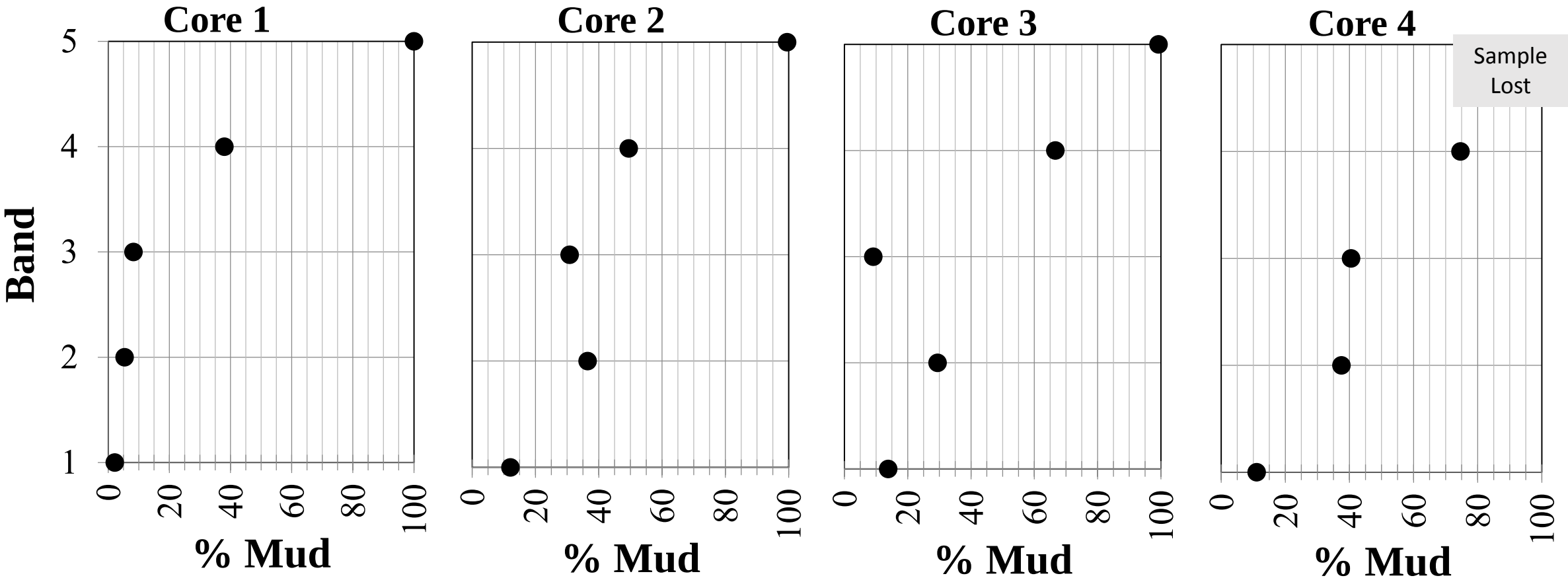

Unomixer
Sonar Cart
Head Tank
(V=190 L)
Transducer
Ultrasonic
2D Flume Tank (10.97m x 0.61m x 1.22 m)
Tail Tank
Inner Channel (9.15 m x 0.2m x 0.6 m)
On/ Off
52% Open
Head Box
Drainage System
Not Drawn to Scale
0.91 m
Camera
9.15 m
0.91 m

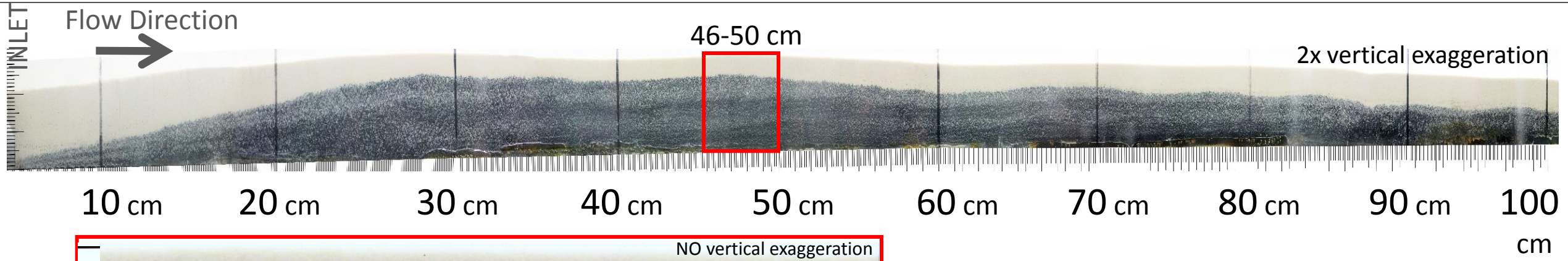

INLET
Flow Direction
2x vertical exaggeration
10 cm
20 cm
30 cm
40 cm
50 cm
60 cm
70 cm
80 cm
90 cm
100 cm

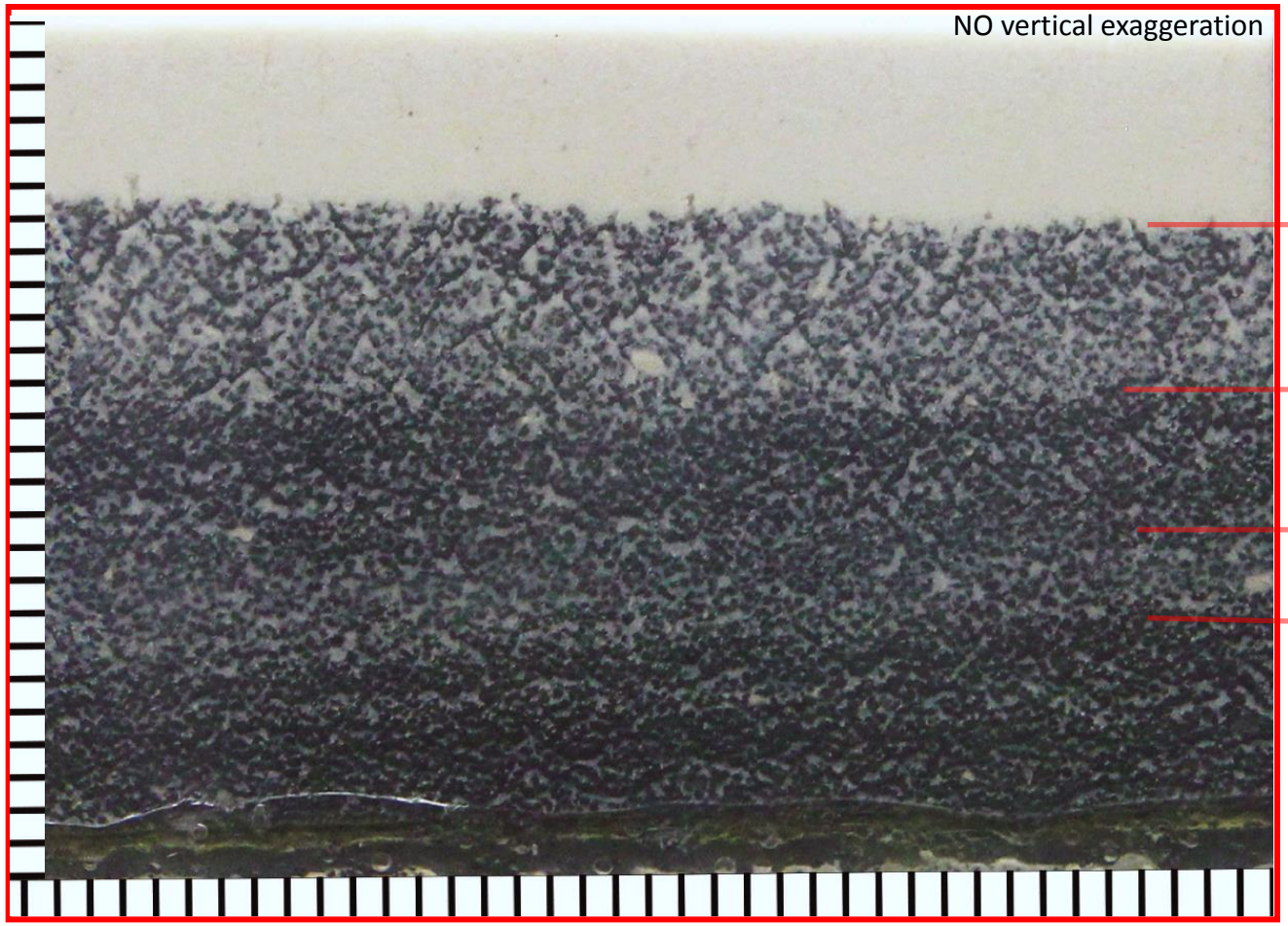

Thickness (mm)
30
25
20
15
10
5
0
Sand
Mud
Cumulative
0
10
20
30
40
50
60
70
80
90
100
Distance from Inlet (cm)


INLET
Flow Direction
2x vertical exaggeration
10 cm
20 cm
30 cm
40 cm
50 cm
60 cm
70 cm
80 cm
90 cm
100 cm
NO vertical exaggeration


2x vertical exaggeration
5
4
3
2
1
30 cm
40 cm
50 cm
60 cm
70 cm
80 cm
90 cm


Core 1
Core 2
Core 3
Core 4
Band
% Mud
Sample Lost
Avg
99.6%
57.2%
22.2%
27.2%
9.8%





5 “Muddy Cap” = 99.5 % Mud

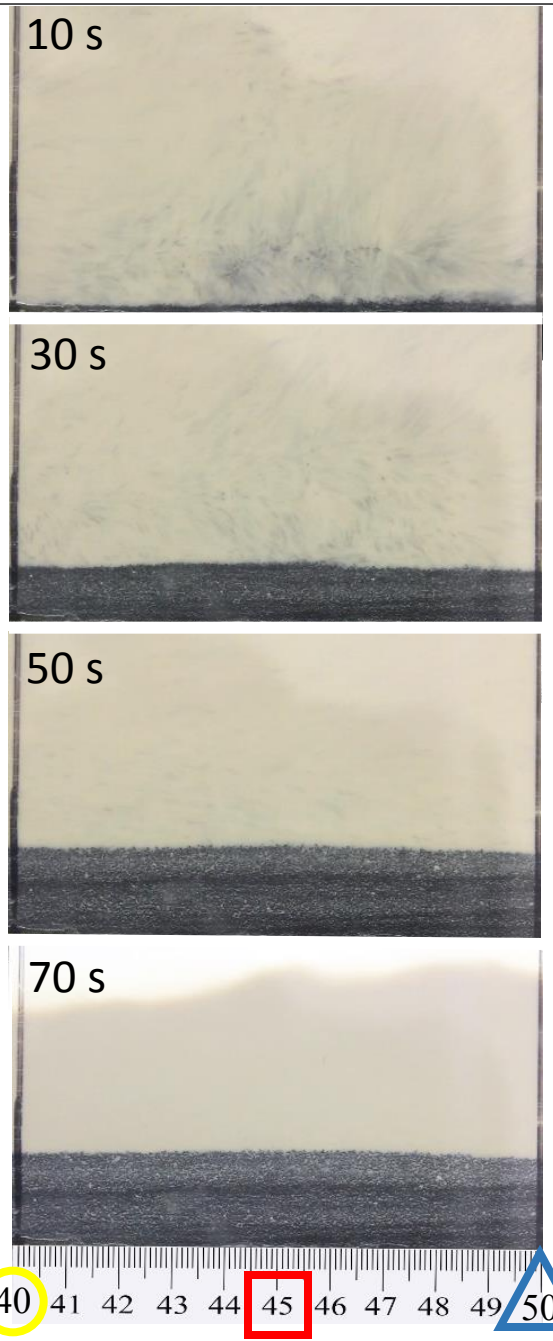
4 “Muddy Band” = 49.5 % Mud

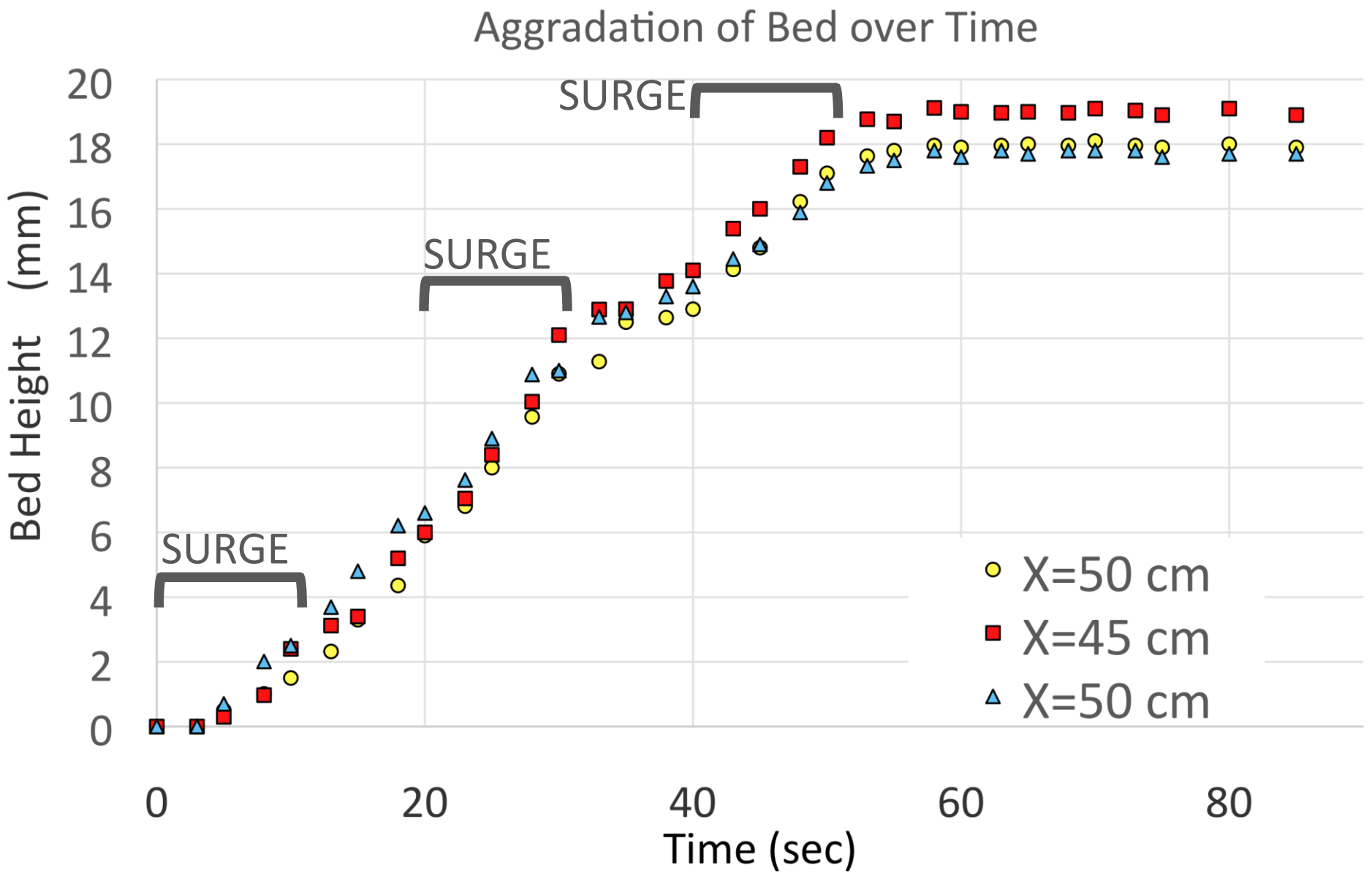
3 “Clean Band” = 30.8 % Mud

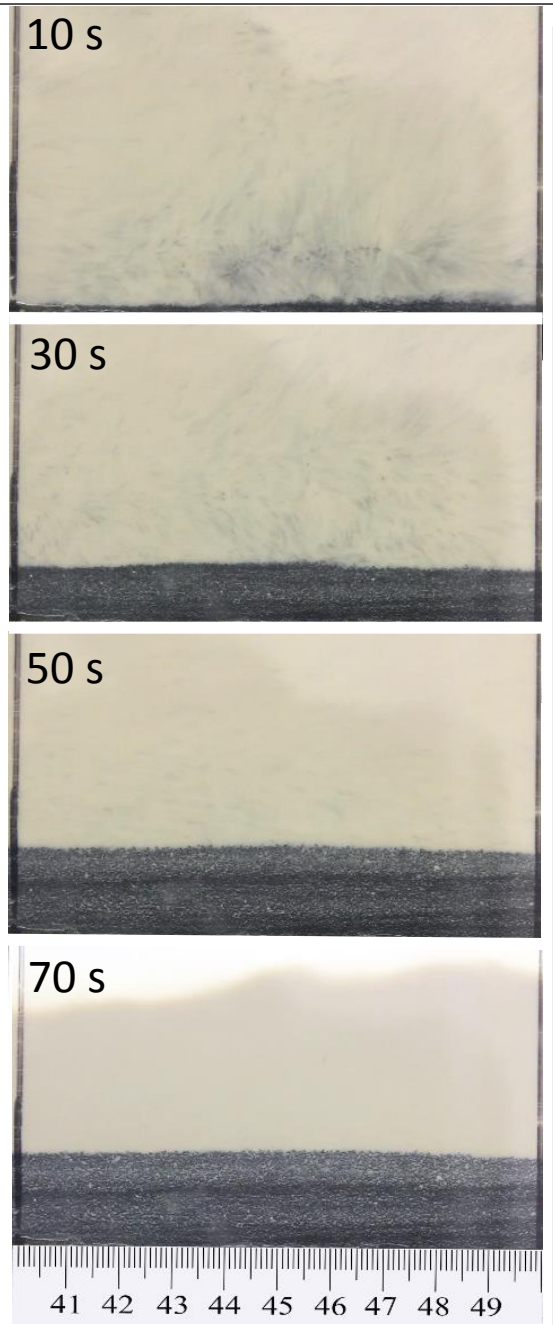
2 “Muddy Band” = 36.5% Mud

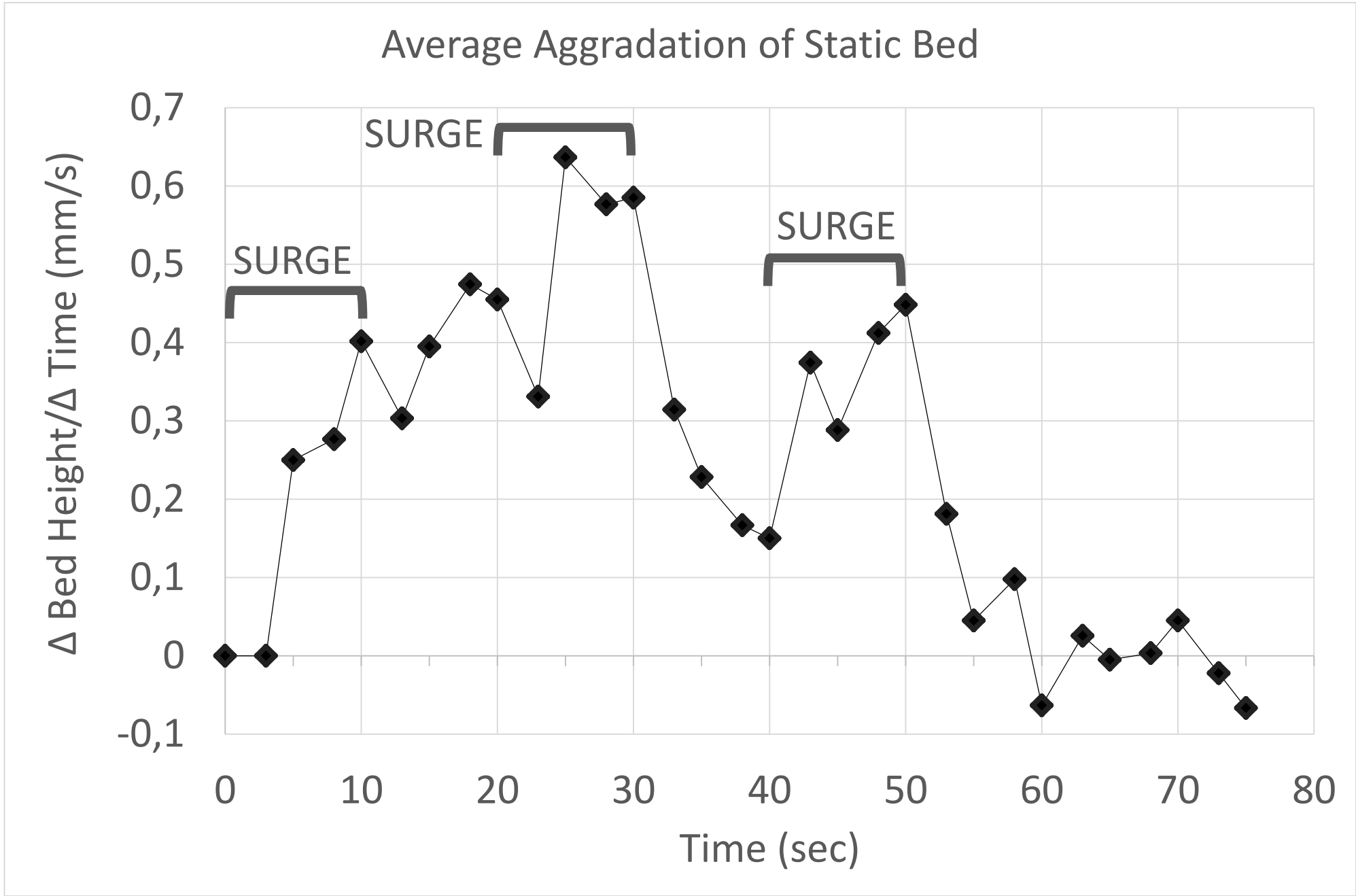
1 “Clean Band” = 12.1% Mud

Each tick is 1 mm


10 s
30 s
50 s
70 s
40 41 42 43 44 45 46 47 48 49 50


Aggradation of Bed over Time
Bed Height (mm)
0
2
4
6
8
10
12
14
16
18
20
SURGE
SURGE
SURGE
0
20
40
60
80
Time (sec)
X=50 cm
X=45 cm
X=50 cm


10 s
30 s
50 s
70 s
41 42 43 44 45 46 47 48 49


Average Aggradation of Static Bed
SURGE
SURGE
SURGE
Δ Bed Height/Δ Time (mm/s)
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
0
10
20
30
40
50
60
70
80
Time (sec)

1. Surging of a transitional flow does deposit a banded facies

2. Surging is not simply correlated to clean or muddy bands