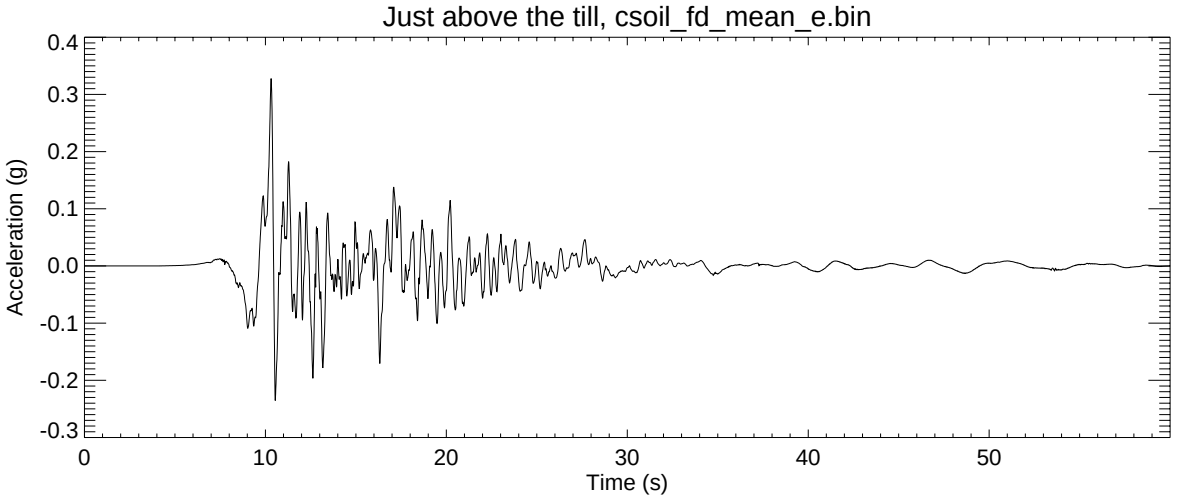
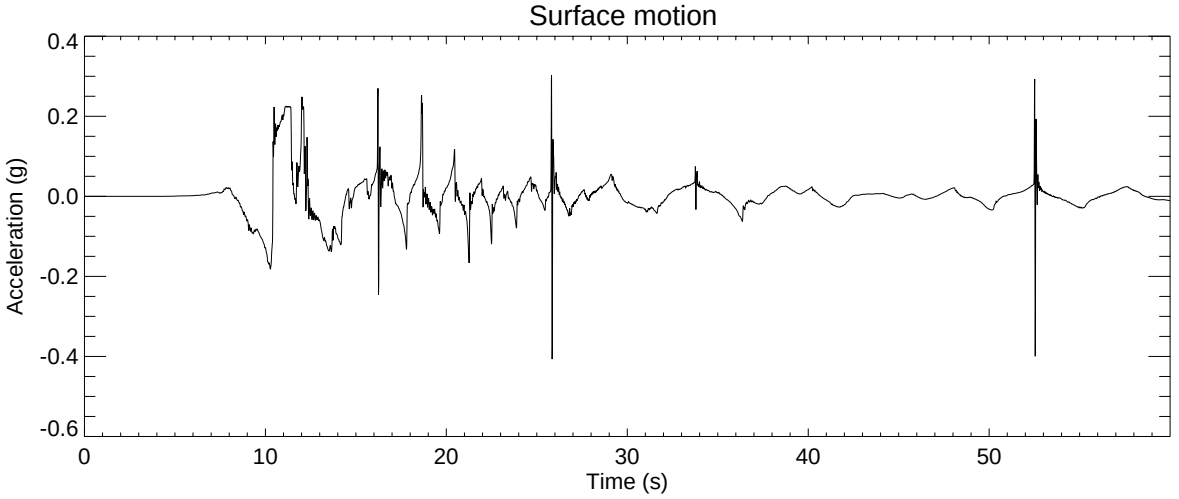
APPENDIX E: 3D NONLINEAR SOIL RESPONSE PLOTS

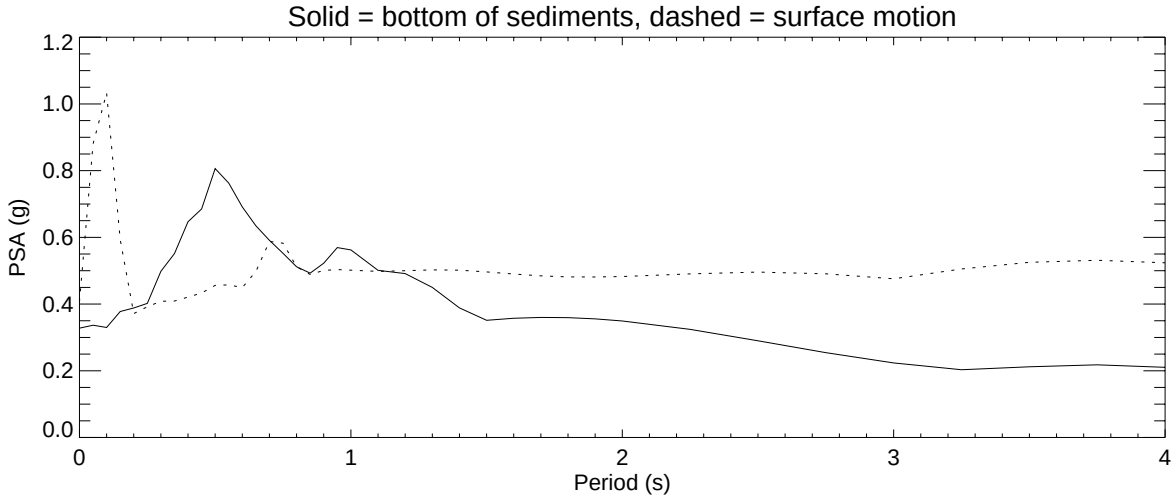
This appendix contains plots summarizing NOAH nonlinear soil calculations for the compacted soil (Figure 6-52) and soil mix wall (SMW) (Figure 6-53) 1D velocity models in Section 6. Pages E-2 to E-37 show the summary response plots from nine ground motion inputs into the compacted soil model. Pages E-38 to E-73s how the summary response plots from nine ground motion inputs into the SMW soil model. Both models are documented in Section 6.6. The nine ground motions consist of the mean, Tabas, and 84% rock input motions and the (three rock motion scenarios that are likely to significantly underestimate input durations) and two input scalings (Scenarios 2 and 3 from Table 6-5) for the JLD3 response versions of the mean, Tabas, and 84% motions that yield the remaining six input motions. The two input scalings of the JLD3 response motions ensure that the possible range of input motion scalings is bracketed. The Scenario 2 (Table 6-5) JLD3 response scaling probably underestimates input peak input motions somewhat and the Scenario 3 JDL3 responses are probably larger than expected input base motions. However, these two scenarios provide a means to investigate the sensitivity of the soil responses to a range of input peak amplitudes. The Scenario 1 rock motions are too short to even represent a lower bound end member for duration based on the results of Section 5, so they only provide a frame of reference for understanding the influence of duration on nonlinear soil responses; they are not likely to represent realistic soil response scenarios for Jackson Lake Dam.

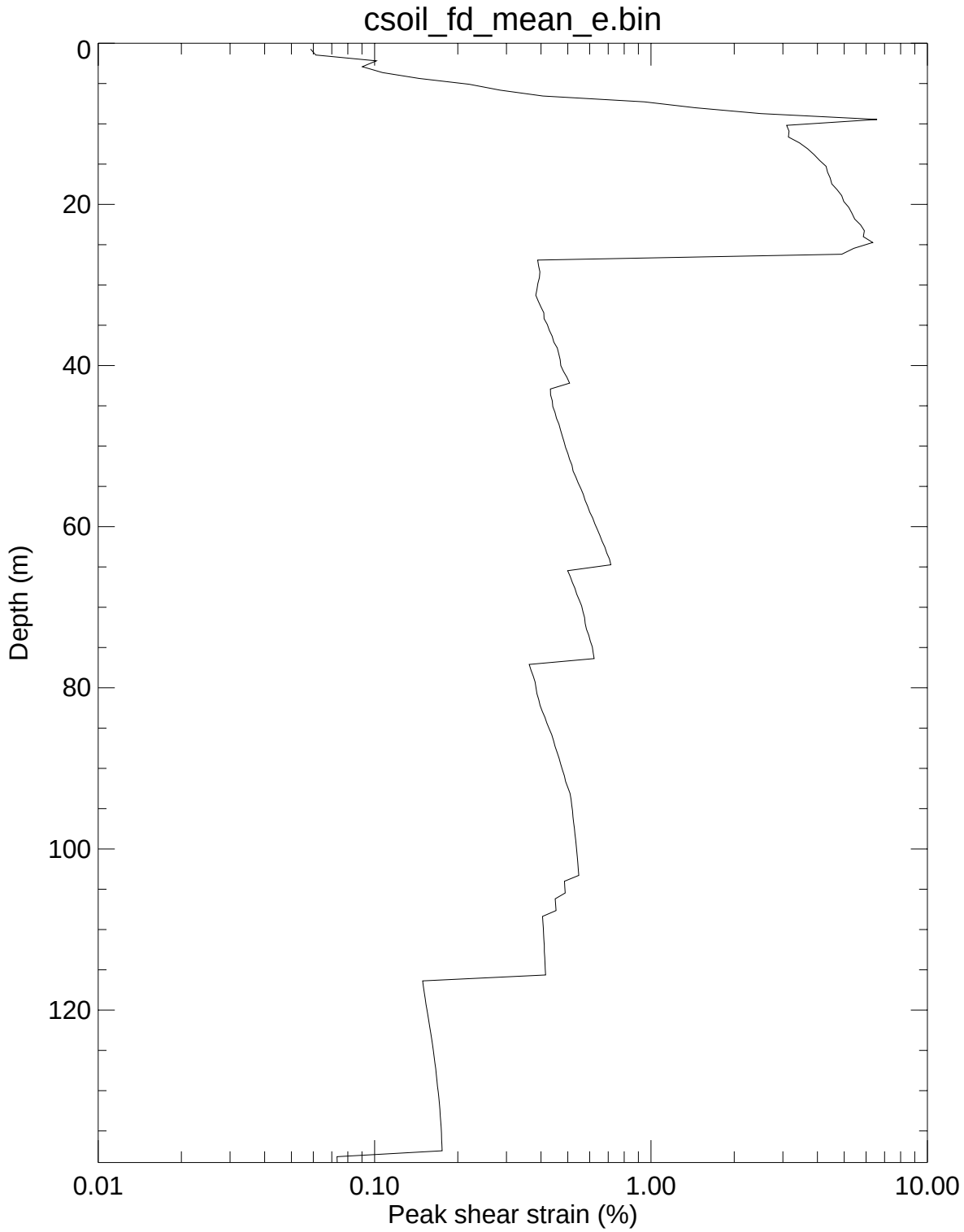
The plots are arranged in groups of four for each input ground motion. The plots are labeled by the filename containing the input velocity time history. For the compacted soils beneath the dam, the filename starts with “compact_soil”. For the SMW model, the filename starts with “SMW”. The remaining portion of the filename describes the input motion (mean, N84, Tabas) and if JLD3 is including in the filename, then the input has the JLD3 response convolved with the rock motion. Input motion Scenario 2 has “half” added to the filename. The letter “e” indicates that the east-west horizontal component was used as the input. For example, the filename SMW_jld3_n84_e.bin indicates a soil mix wall results using the 84% motion with the JLD3 response. Since there is not a “half” in the filename, this is a Scenario 3 input motion scenario. A second example: the filename compact_soil_jld3_mean_half_e.bin represents a compacted soil model result for the mean motion with JLD3 response with halved amplitude (Scenario 2).

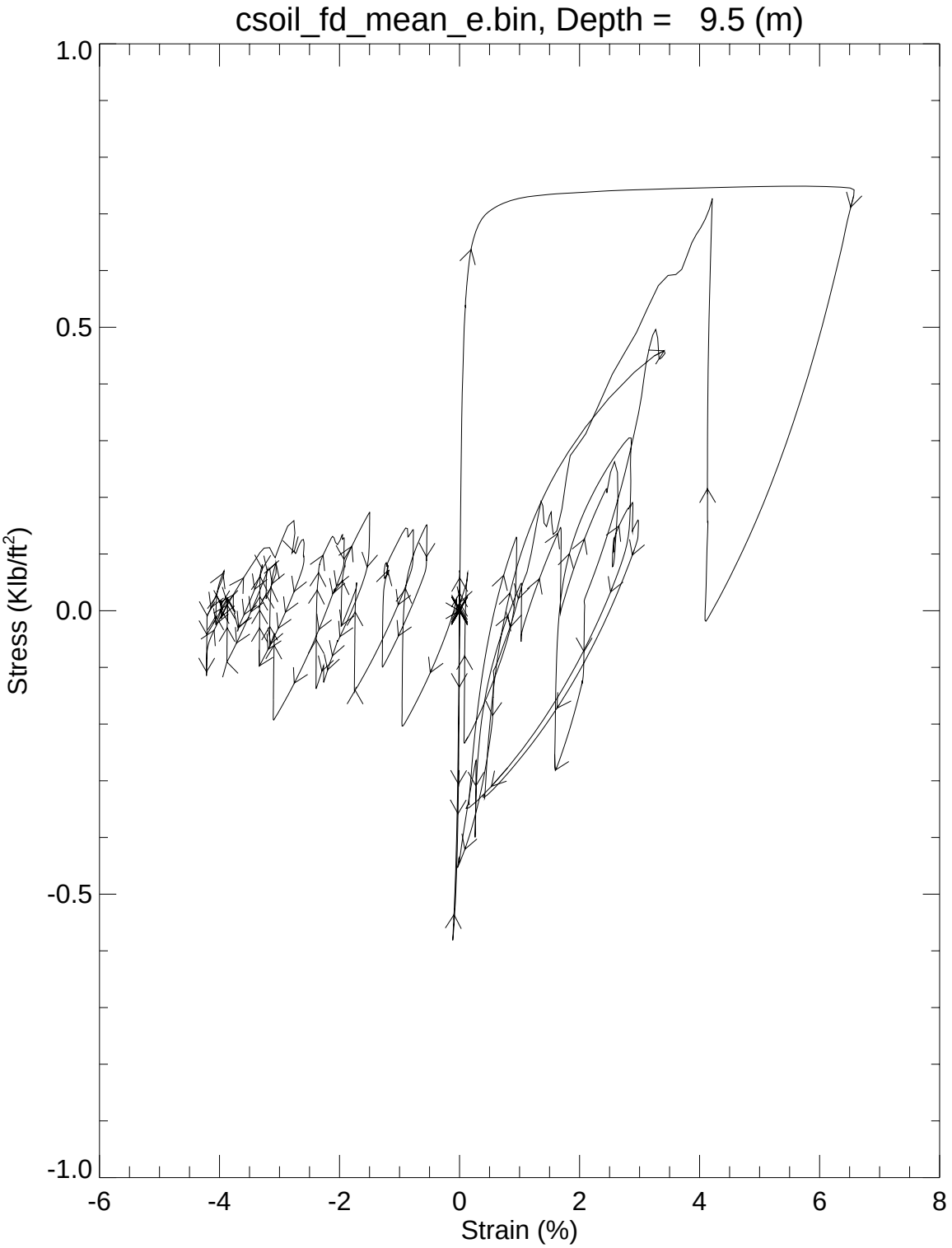
Using page E-2 as an example, the first plot in a group of four plots shows the acceleration time history at the base of the low-velocity soil column just above the bottom of the higher-velocity till half space at the top, the surface acceleration time history in the middle, and their correspond ing acceleration response spectra are shown at the bottom of the page. Using page E-3 as an example, the second plot in a group shows peak strain as a function of depth. Using page E-4 as an example, the third plot in a group shows stress-strain time histories at the depth near the base of the compacted zone or near the base of the SMW walls, as appropriate. The arrowheads point forward in time. Using page E-5 as an example, the fourth and final plot in a groups show acceleration, stress, and percent strain time histories corresponding to the depth near the base of the compacted zone or near the base of the SMW walls, as appropriate. It is interesting to note that often the subsurface peak accelerations are larger than the surface peak accelerations, similar to borehole observations (Yoshida et al., 2002). Also, acceleration durations are often strongly increased in the region above the liquefiable layer. See Section 6 for discussion.

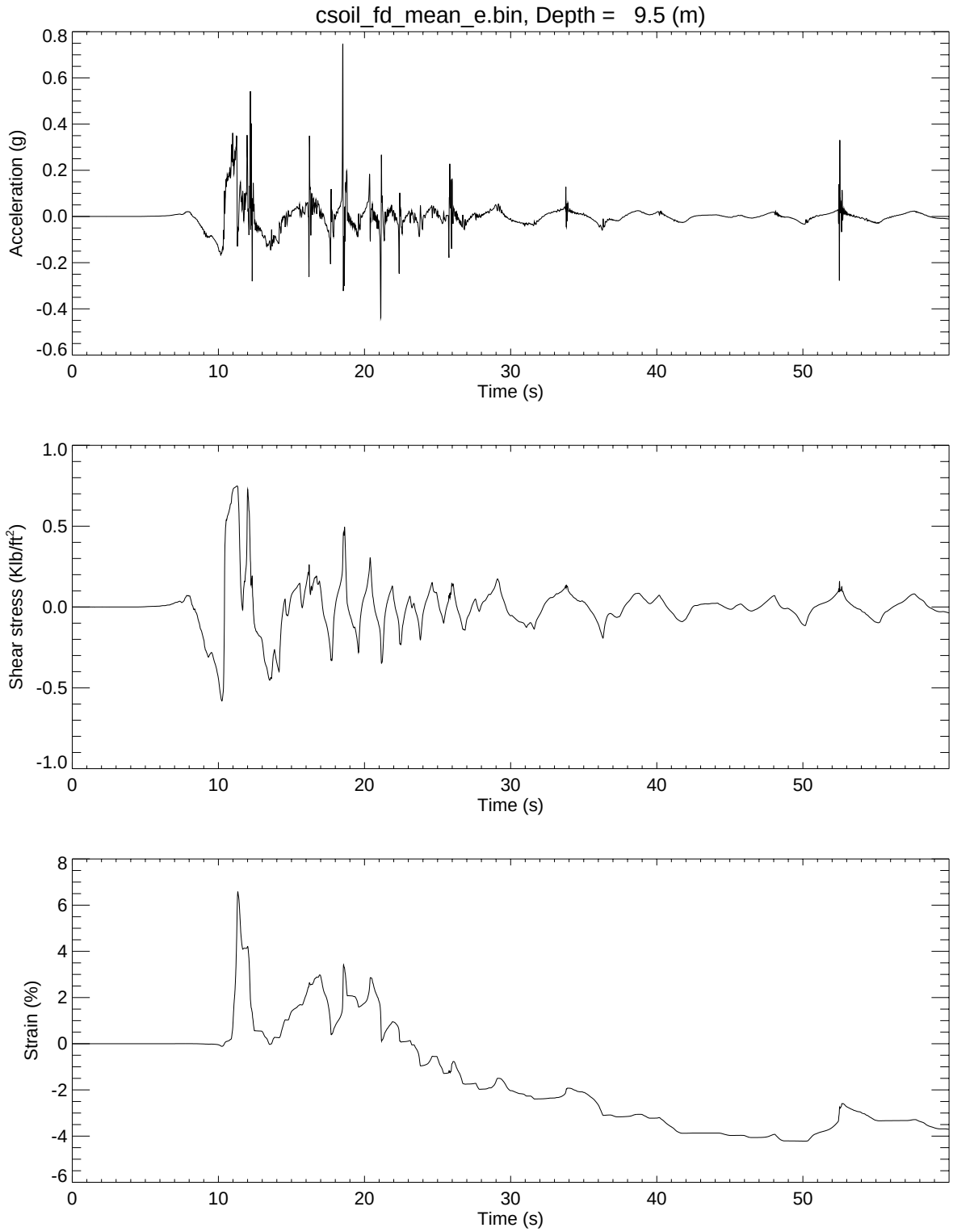

Just above the till, csoil_fd_mean_e.bin
Acceleration (g)
Time (s)

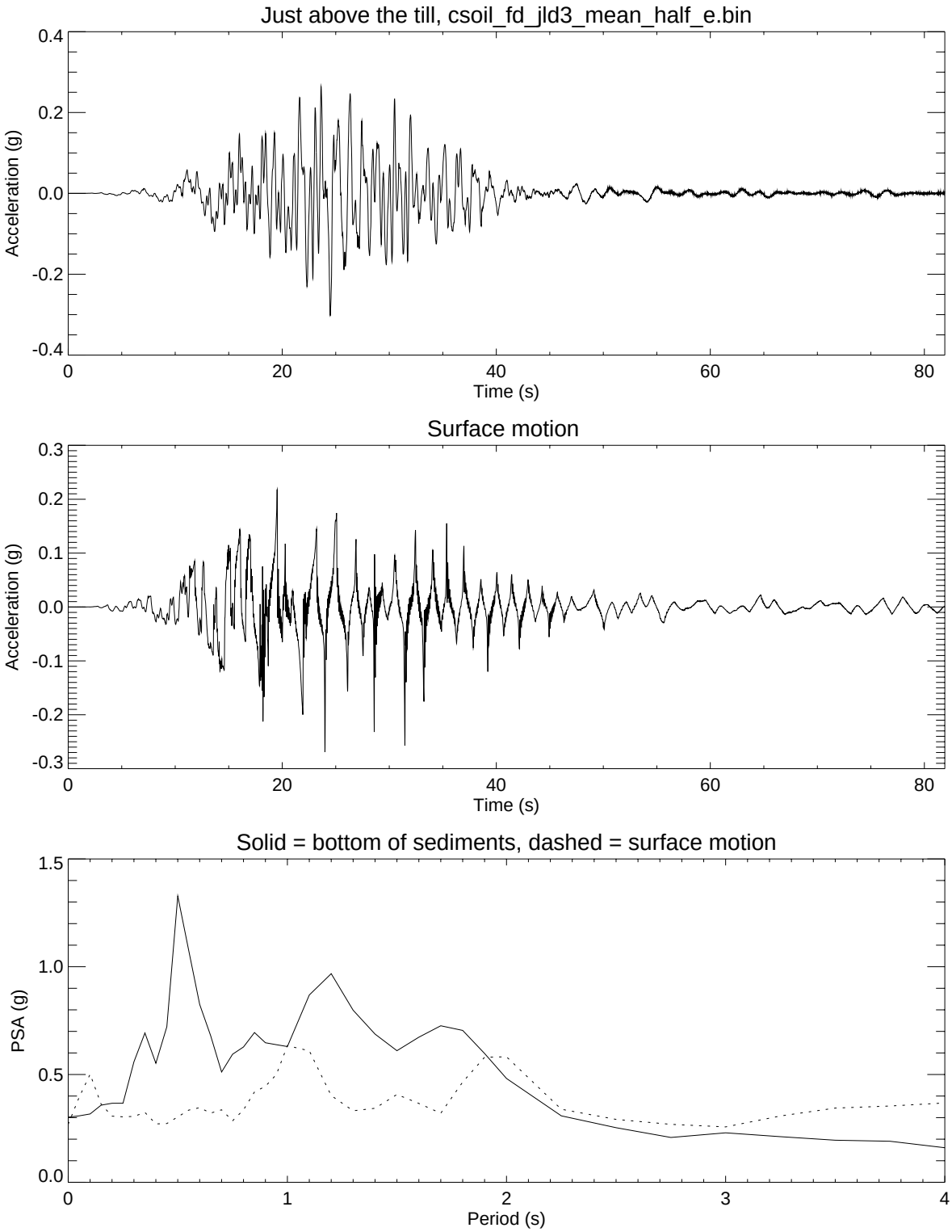

Surface motion
Acceleration (g)
Time (s)

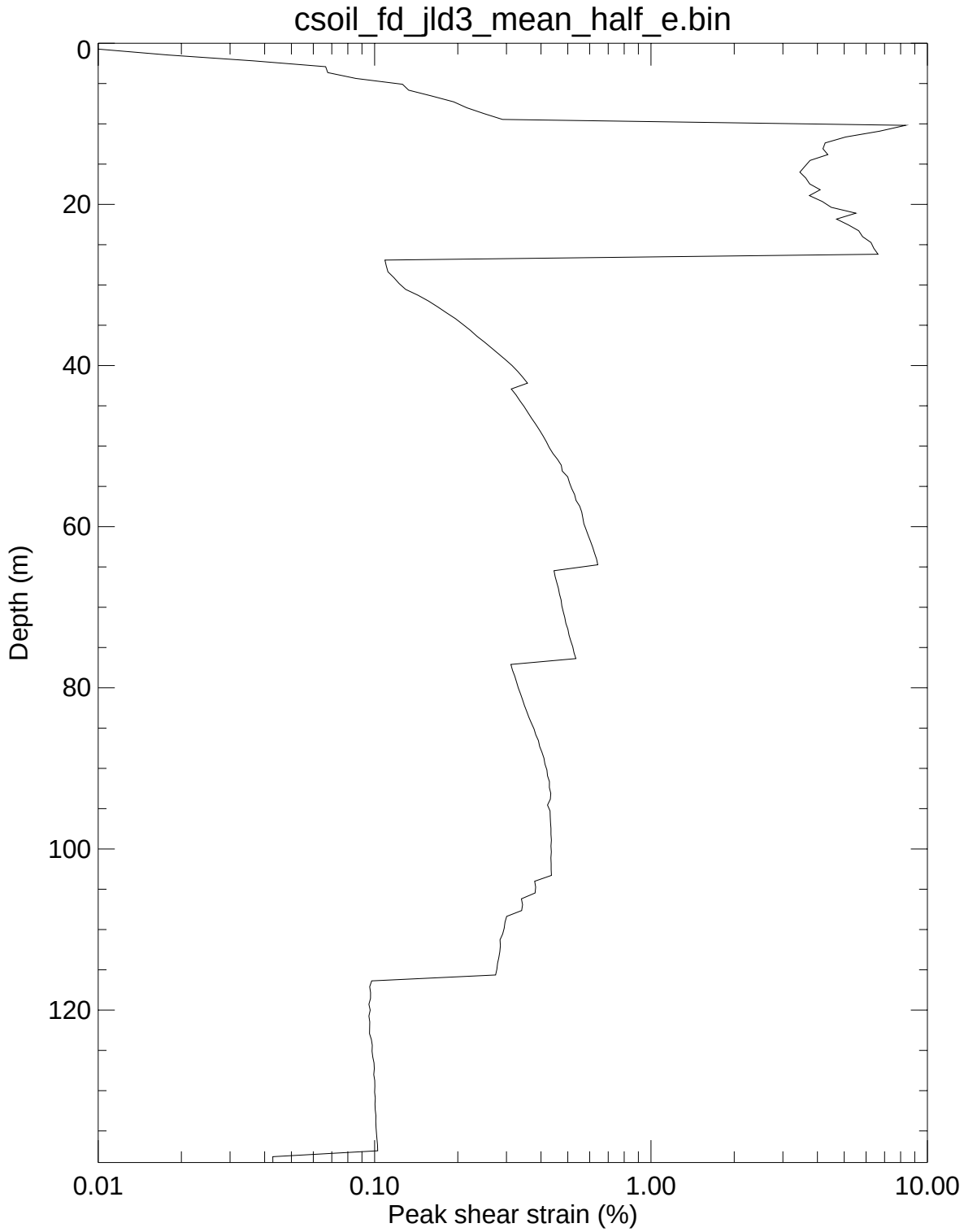

Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

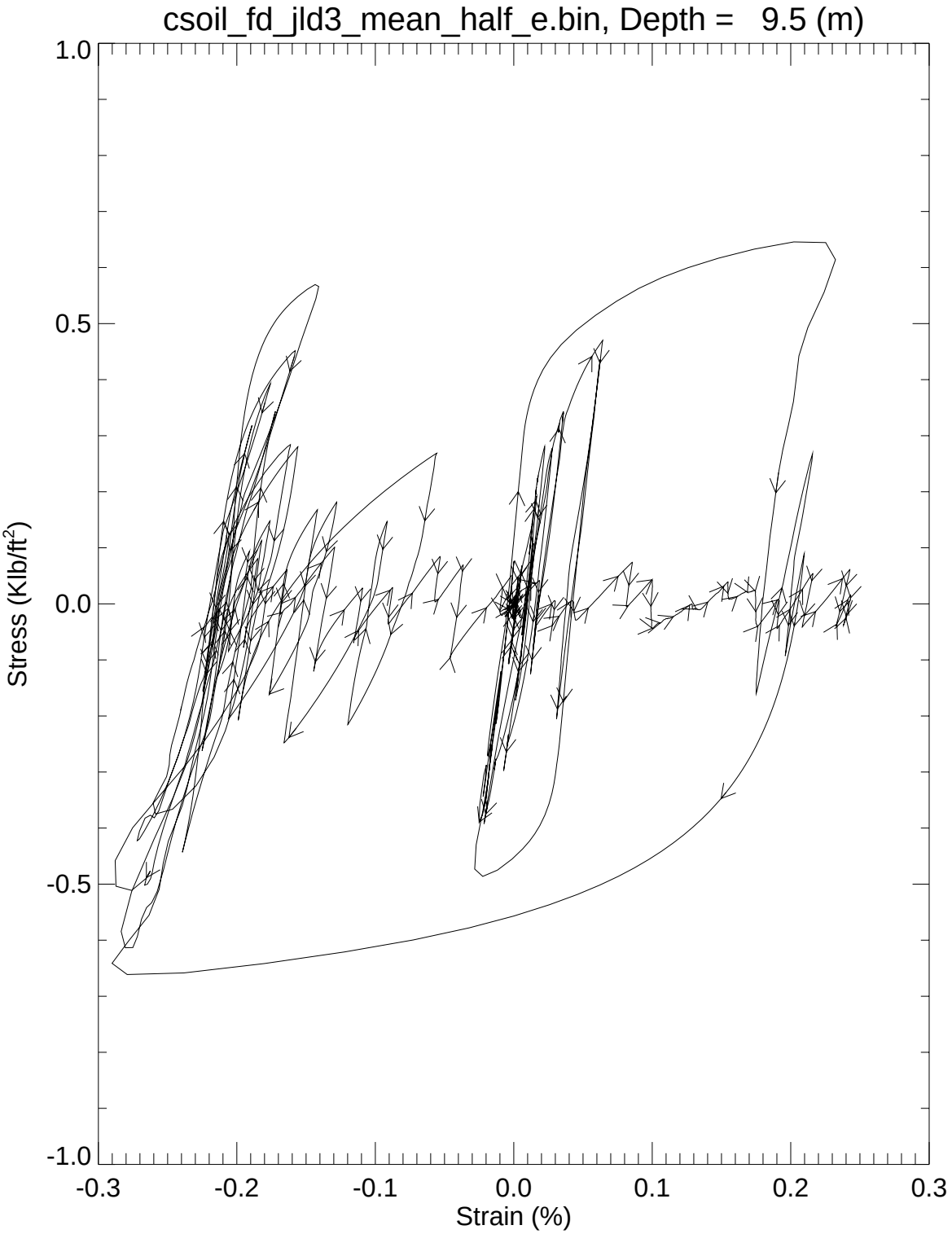

csoil_fd_mean_e.bin
0
20
40
60
80
100
120
Depth (m)
0.01
0.10
1.00
10.00
Peak shear strain (%)

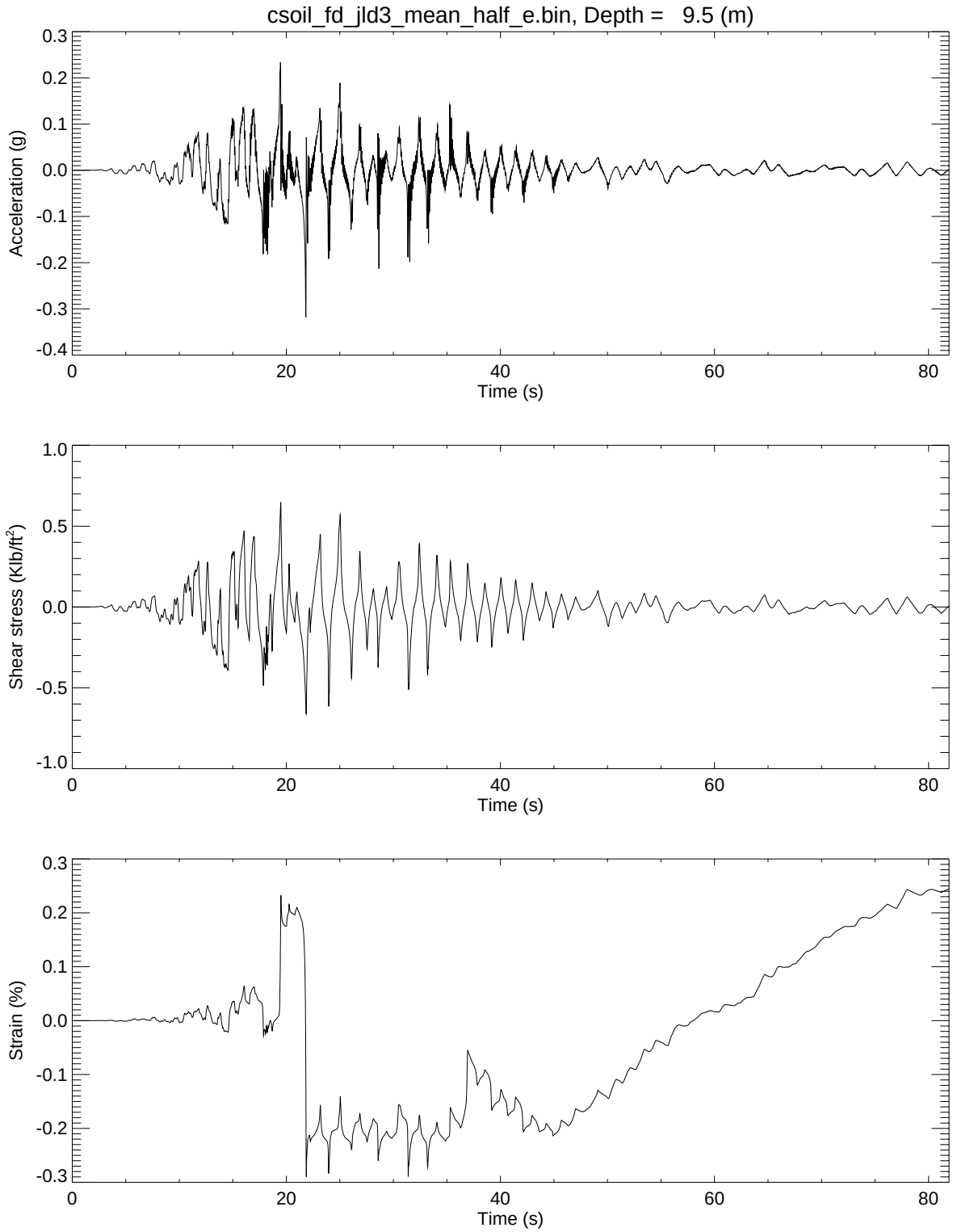

csoil_fd_mean_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft^2)
-6
-4
-2
0
2
4
6
8
Strain (%)

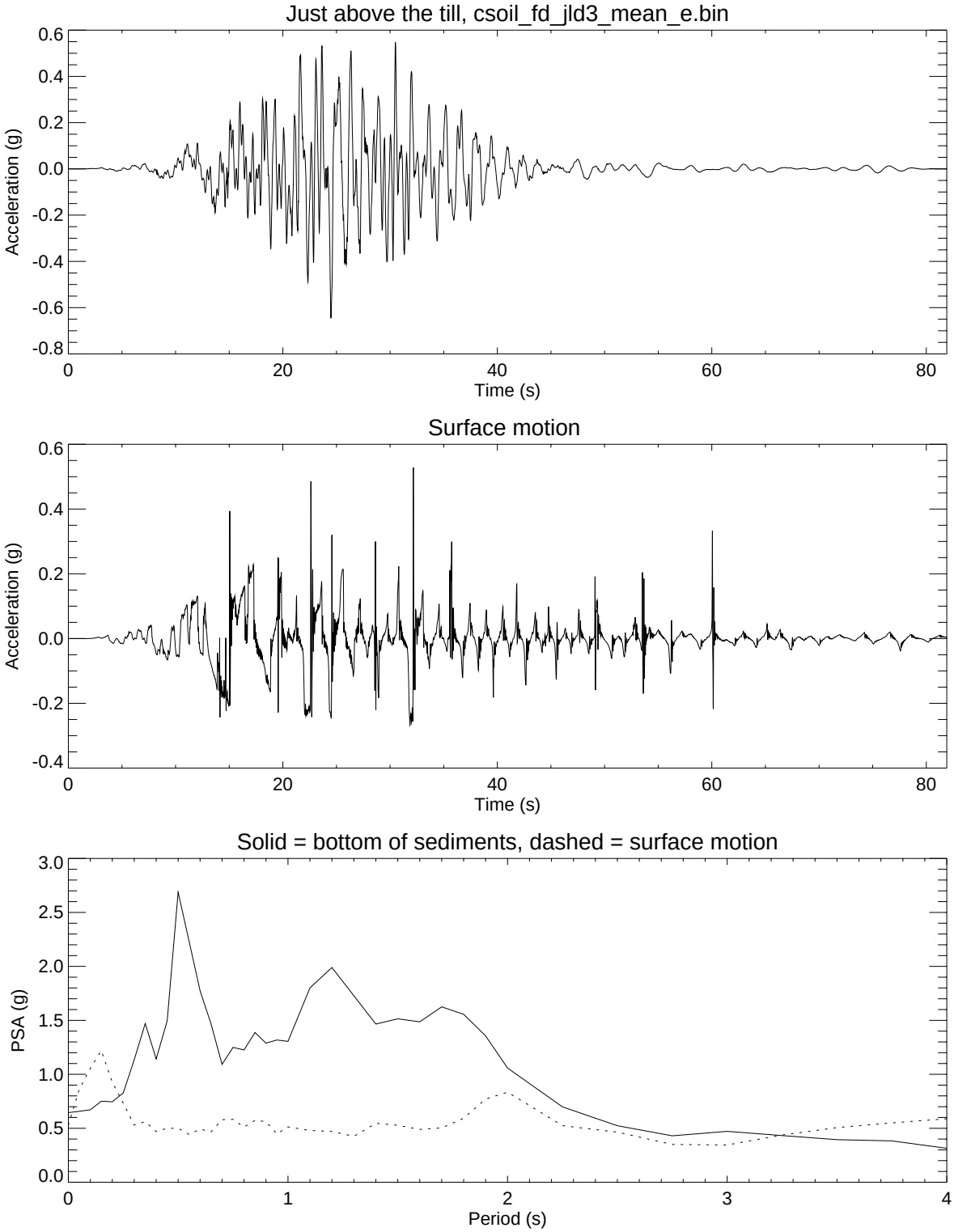

csoil_fd_mean_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

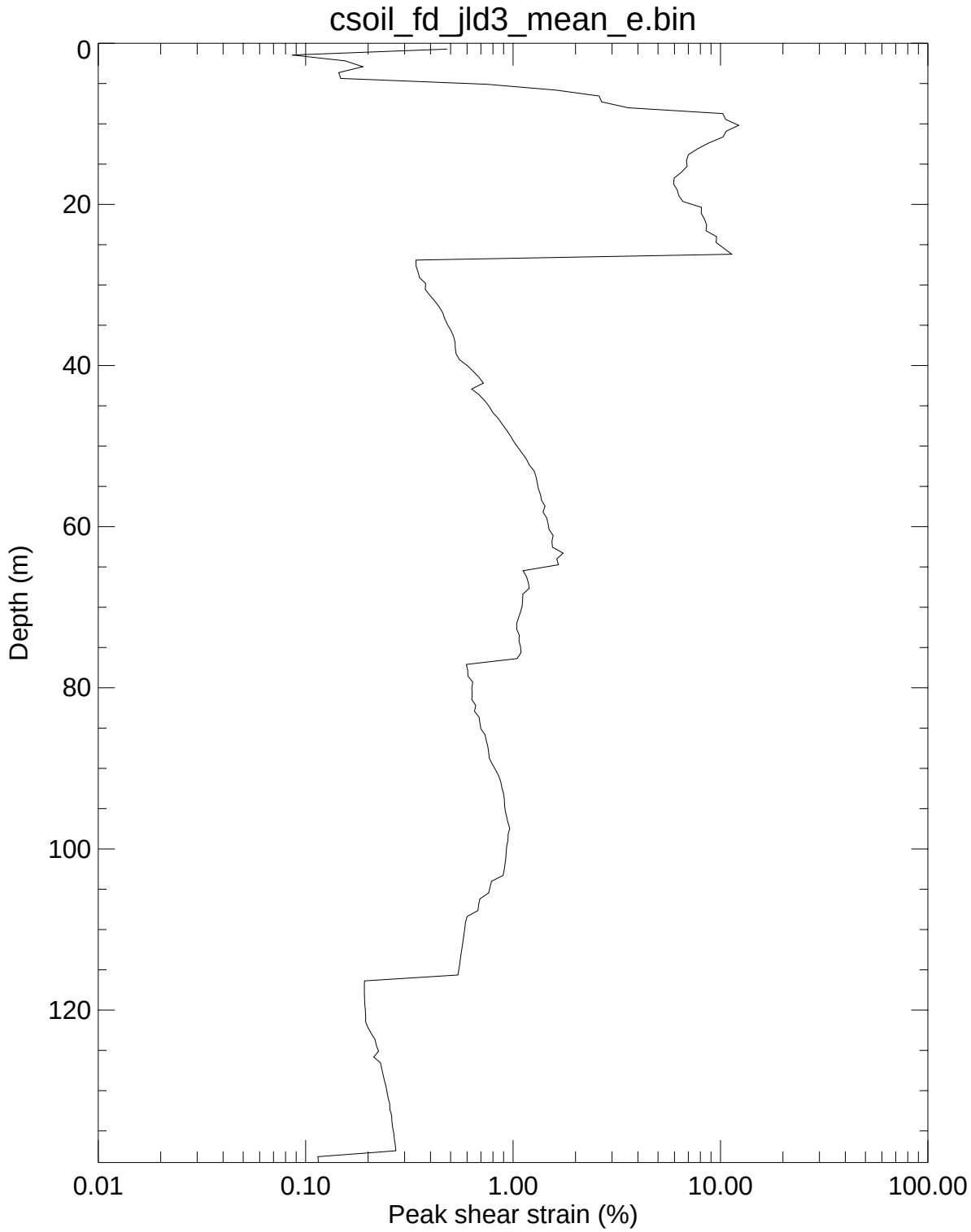

Just above the till, csoil_fd_jld3_mean_half_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

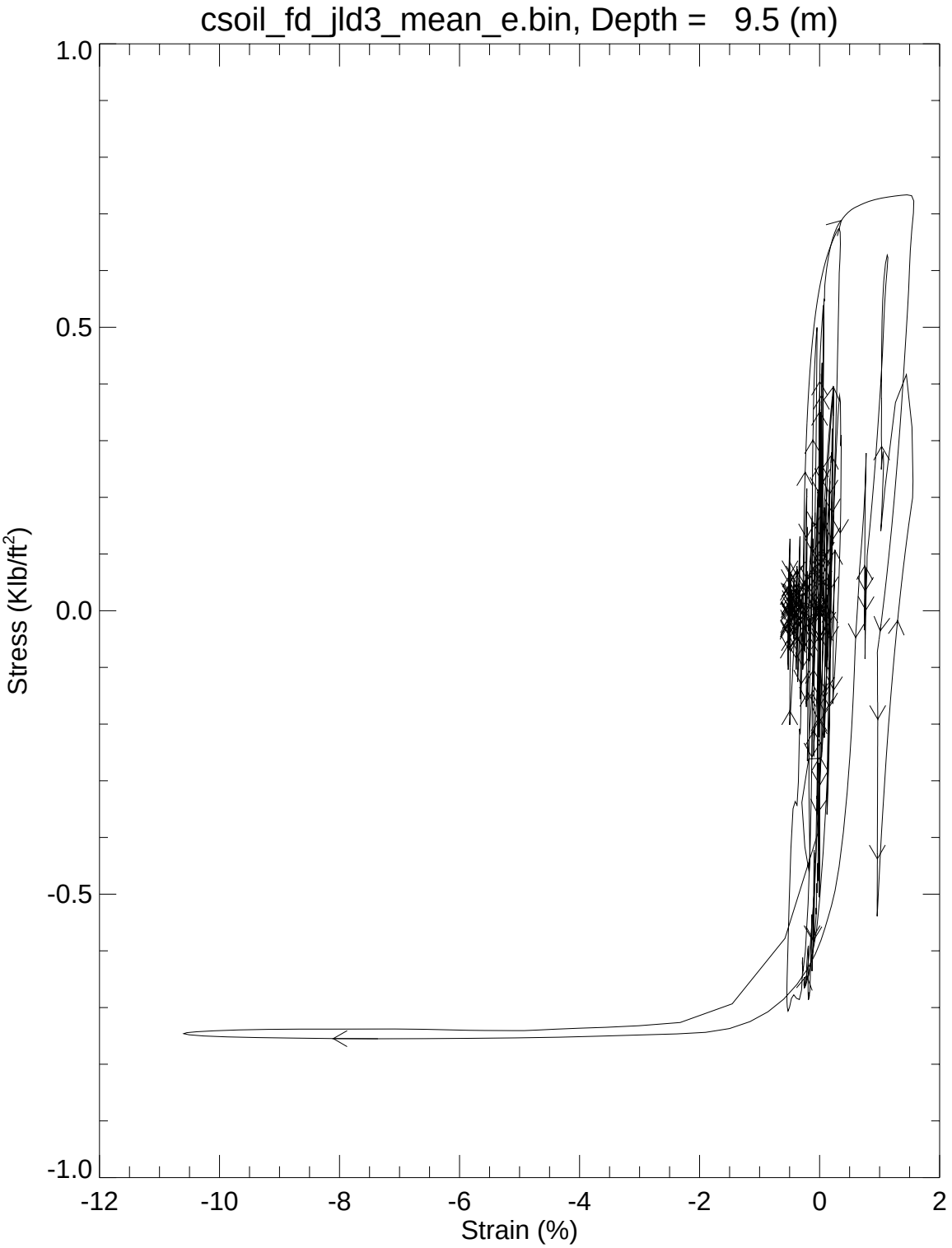

csoil_fd_jld3_mean_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
Peak shear strain (%)

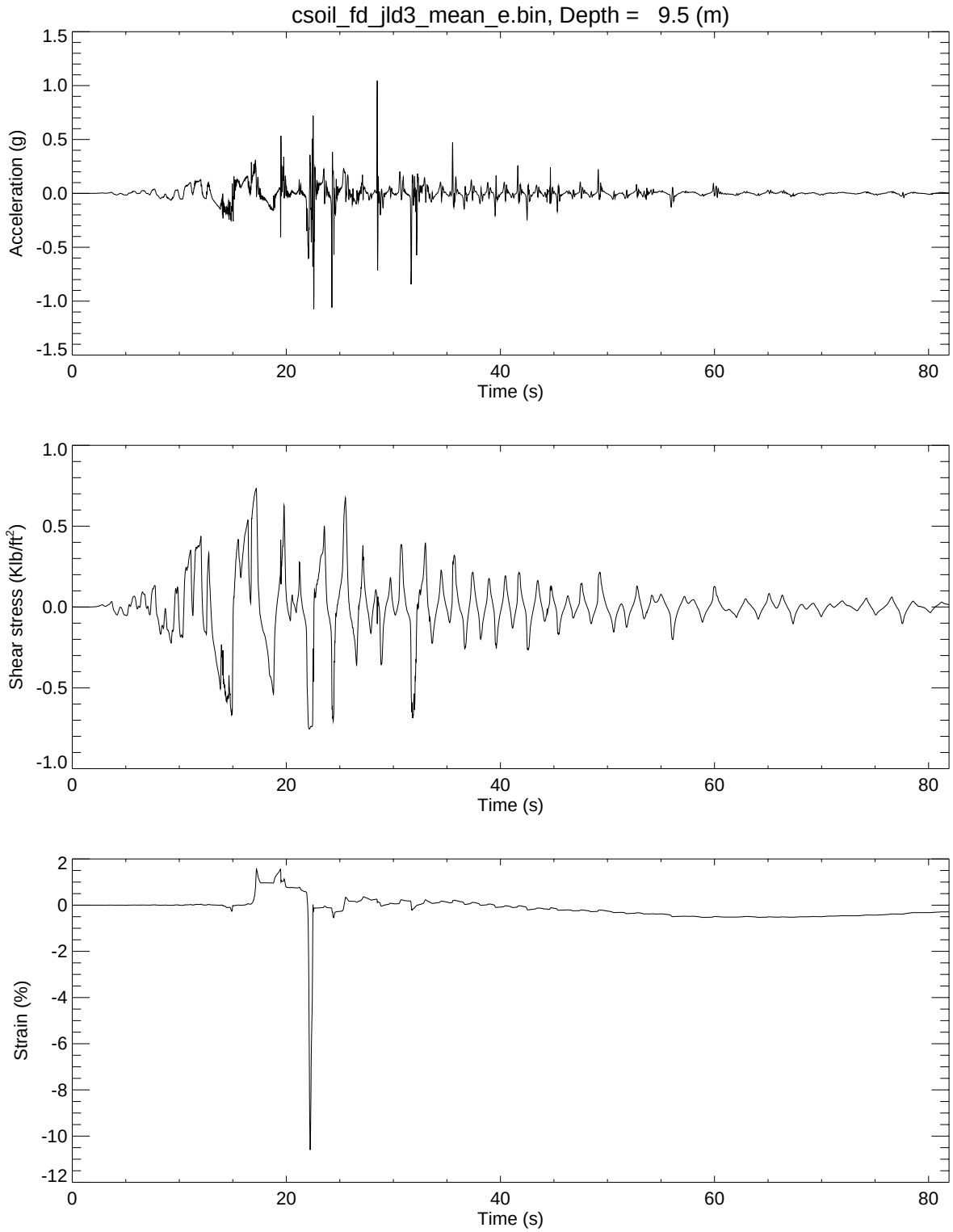

csoil_fd_jld3_mean_half_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft^2)
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
Strain (%)

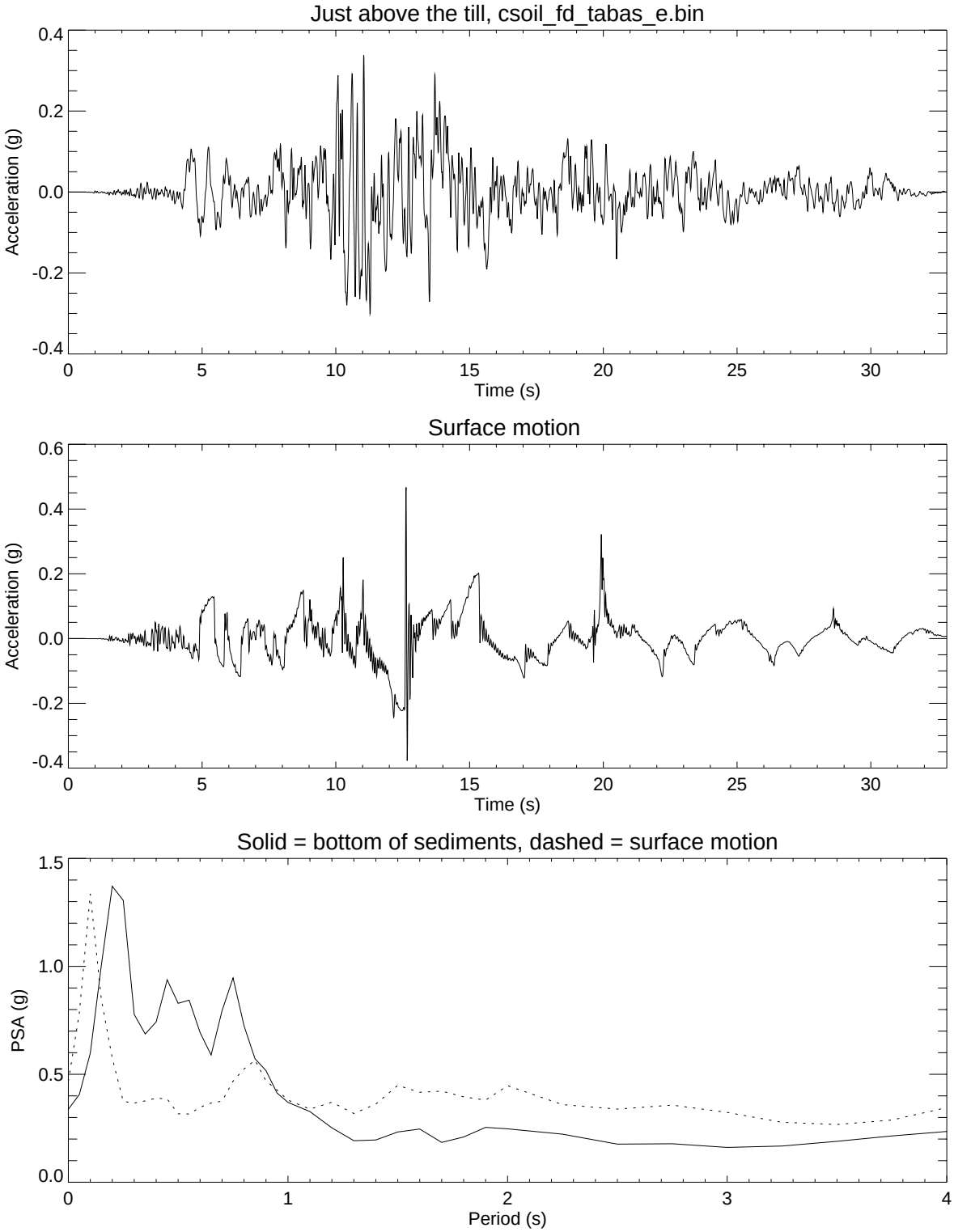

csoil_fd_jld3_mean_half_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

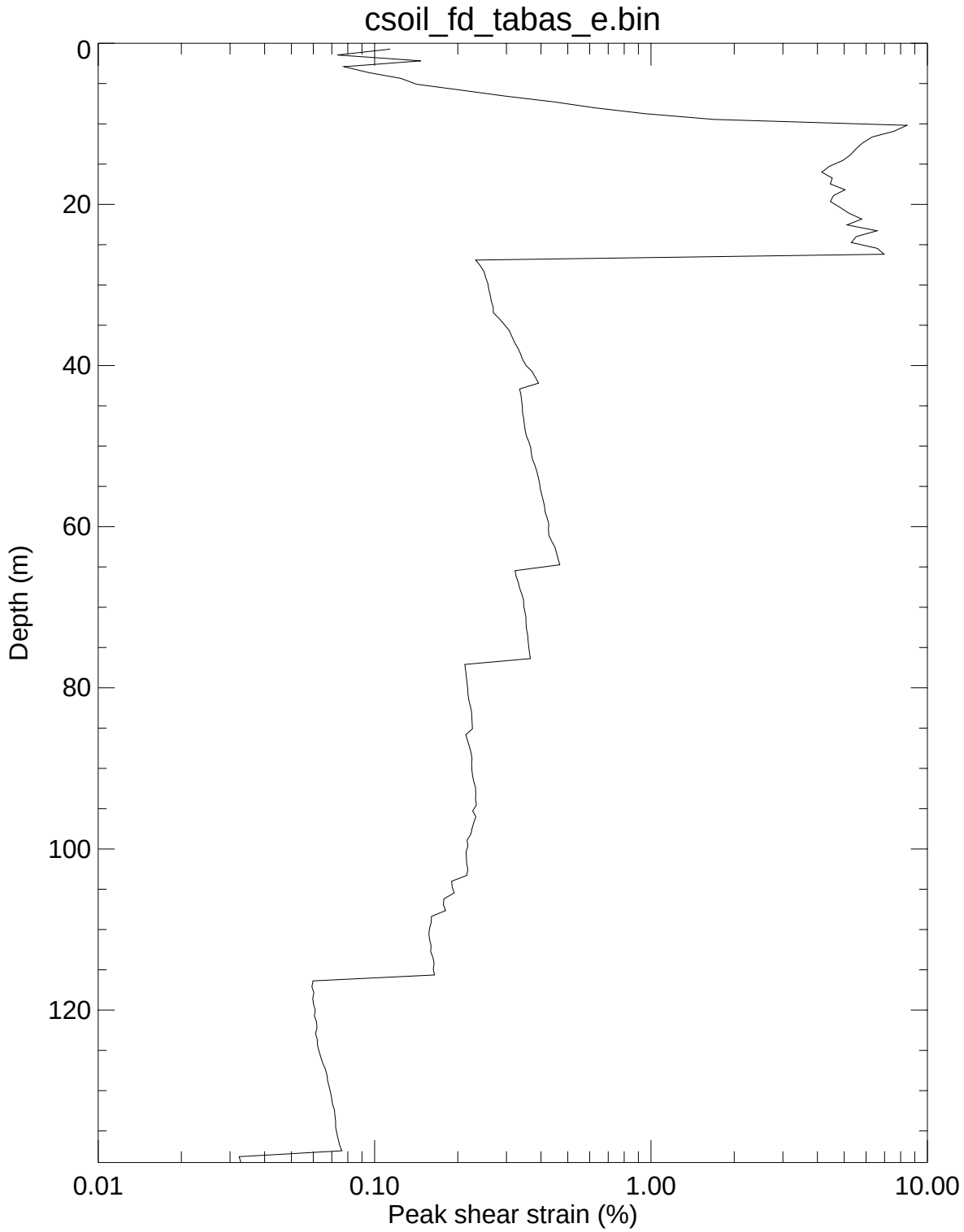

Just above the till, csoil_fd_jld3_mean_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

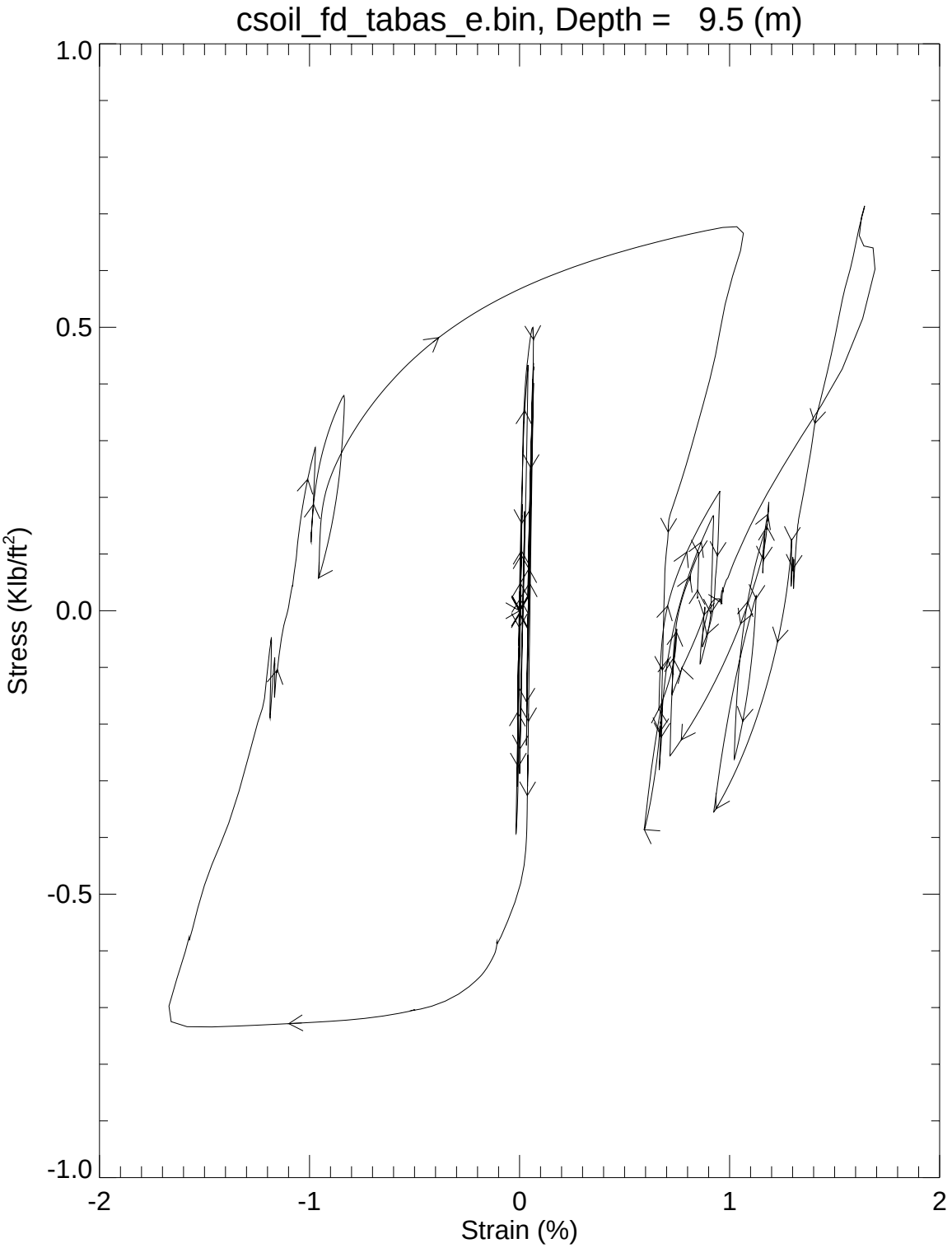

csoil_fd_jld3_mean_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
100.00
Peak shear strain (%)

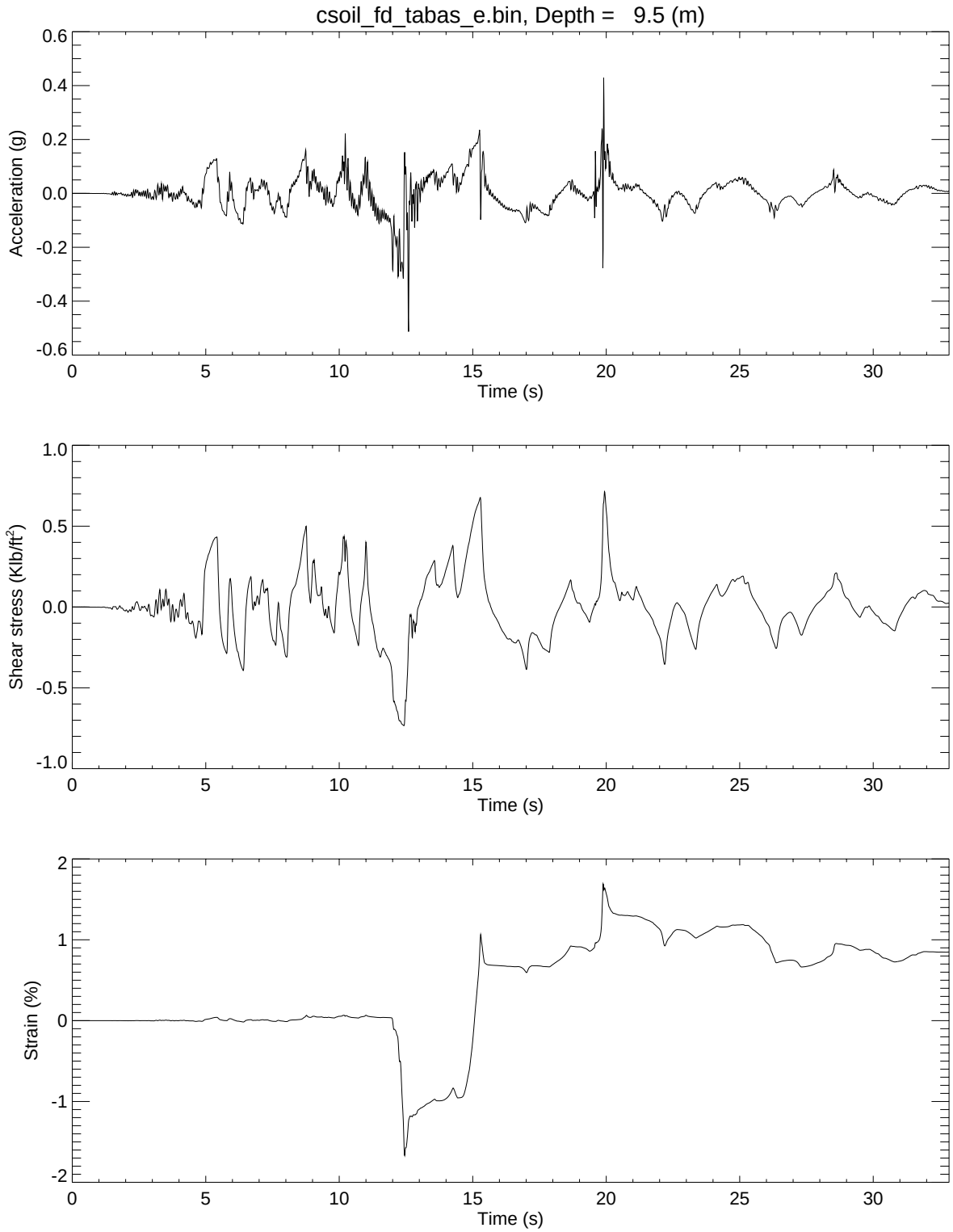

csoil_fd_jld3_mean_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft2)
-12
-10
-8
-6
-4
-2
0
2
Strain (%)

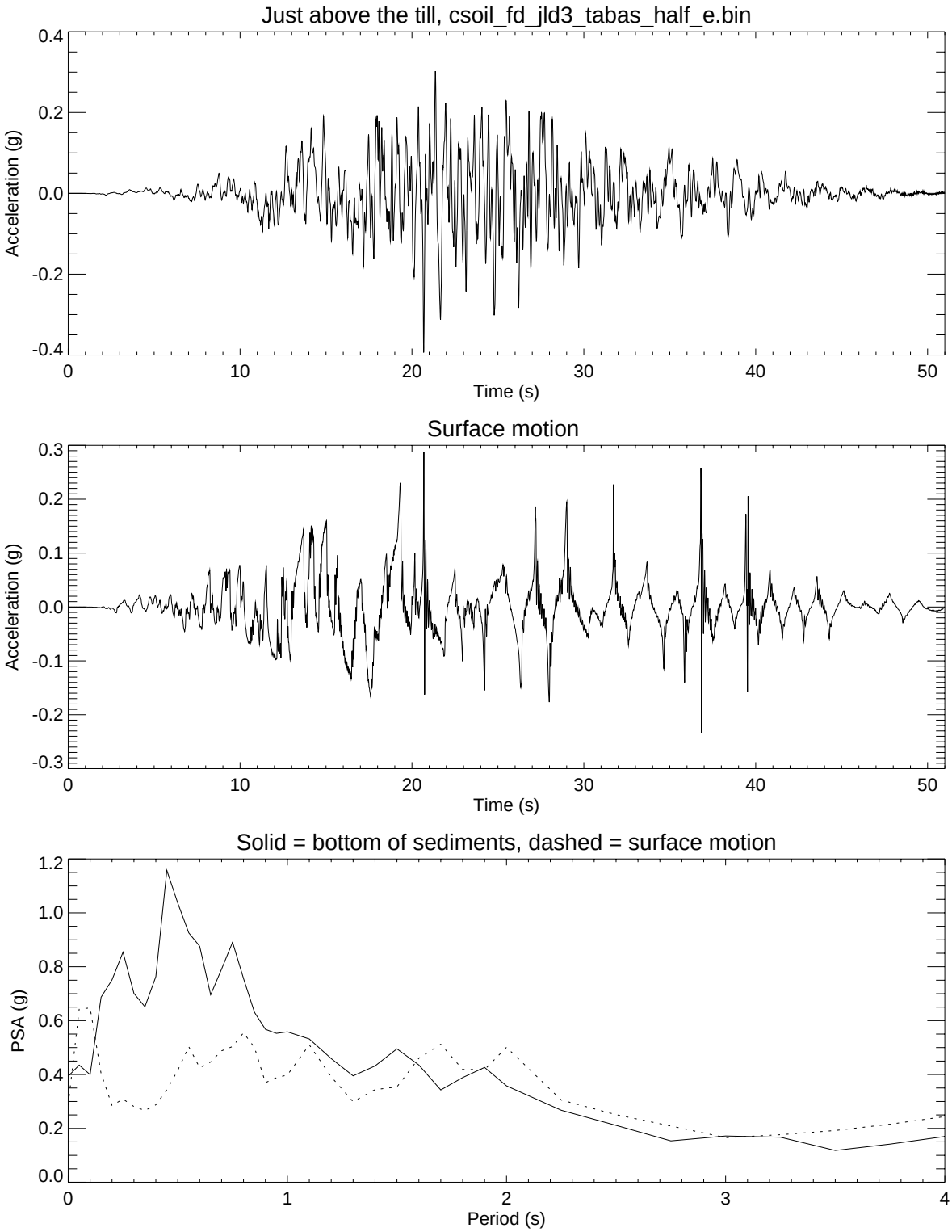

csoil_fd_jld3_mean_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

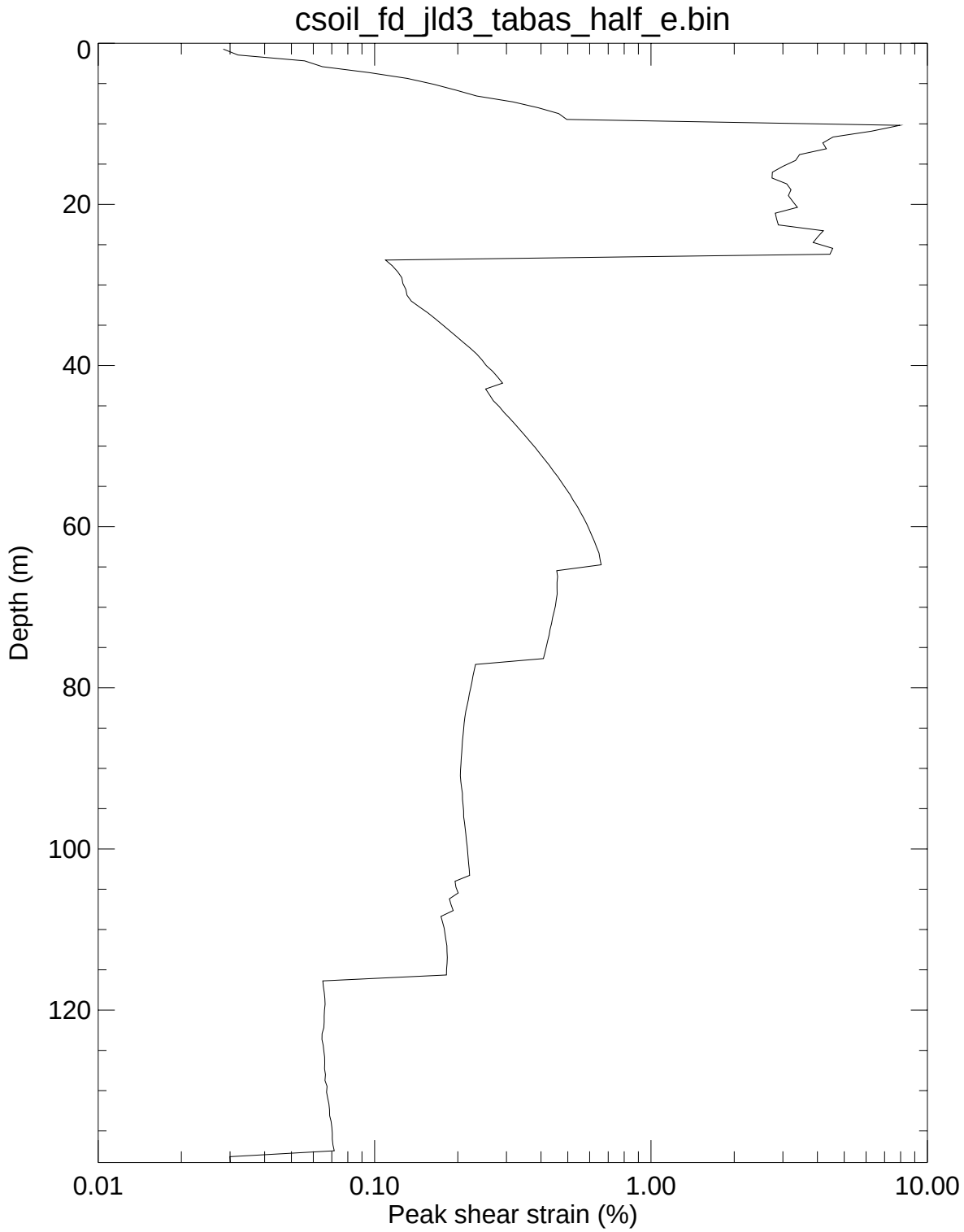

Just above the till, csoil_fd_tabas_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

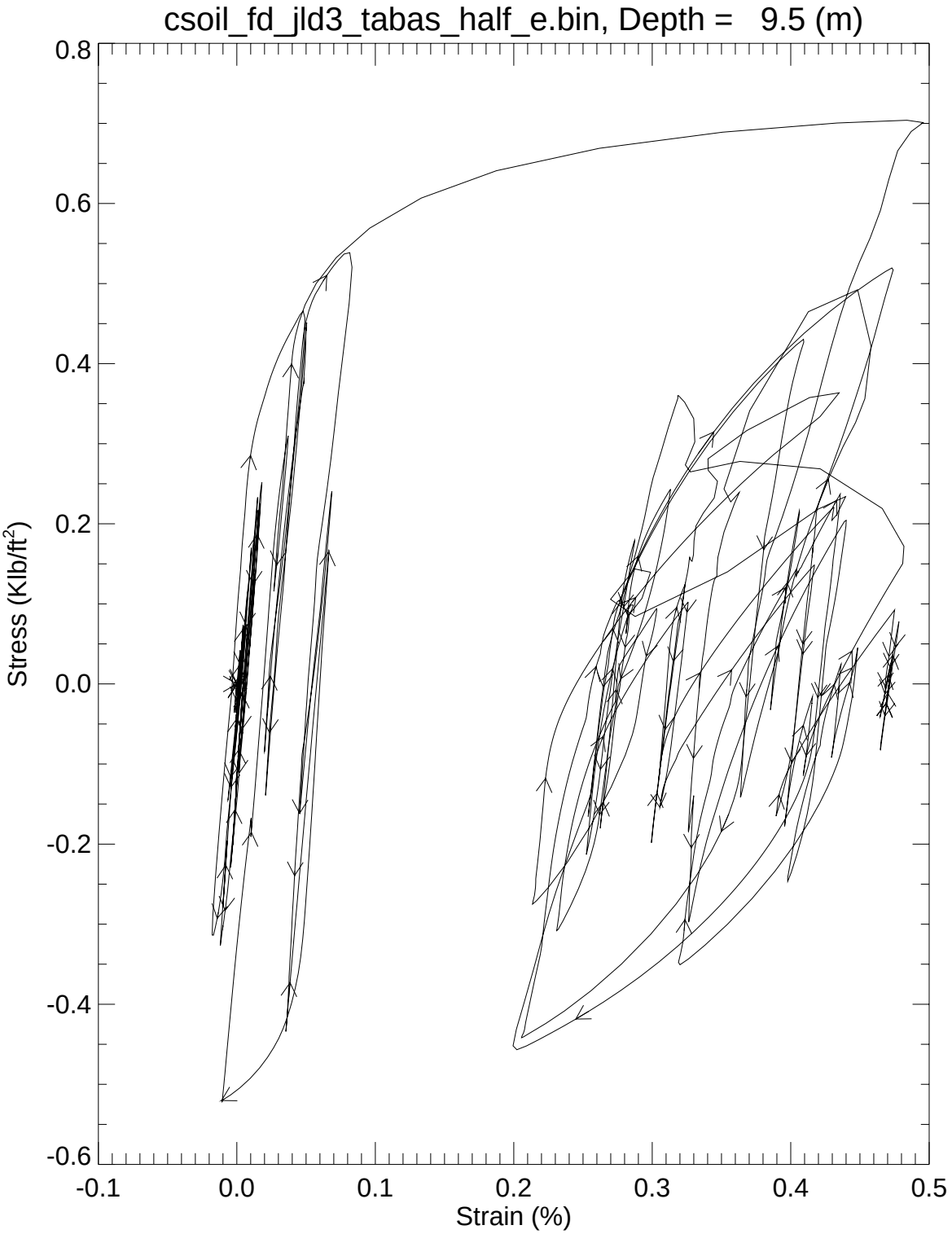

csoil_fd_tabas_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
Peak shear strain (%)

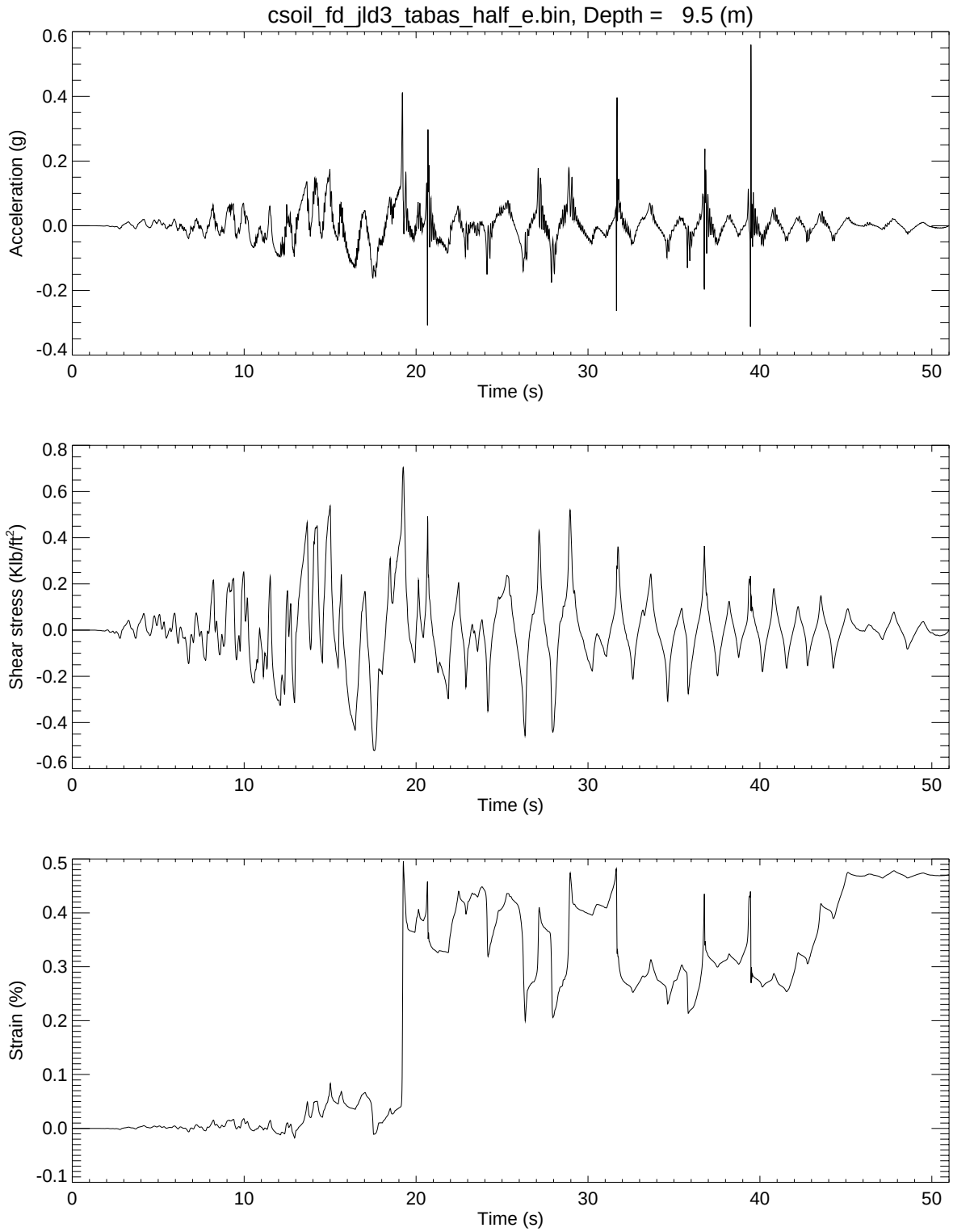

csoil_fd_tabas_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft2)
-2
-1
0
1
2
Strain (%)

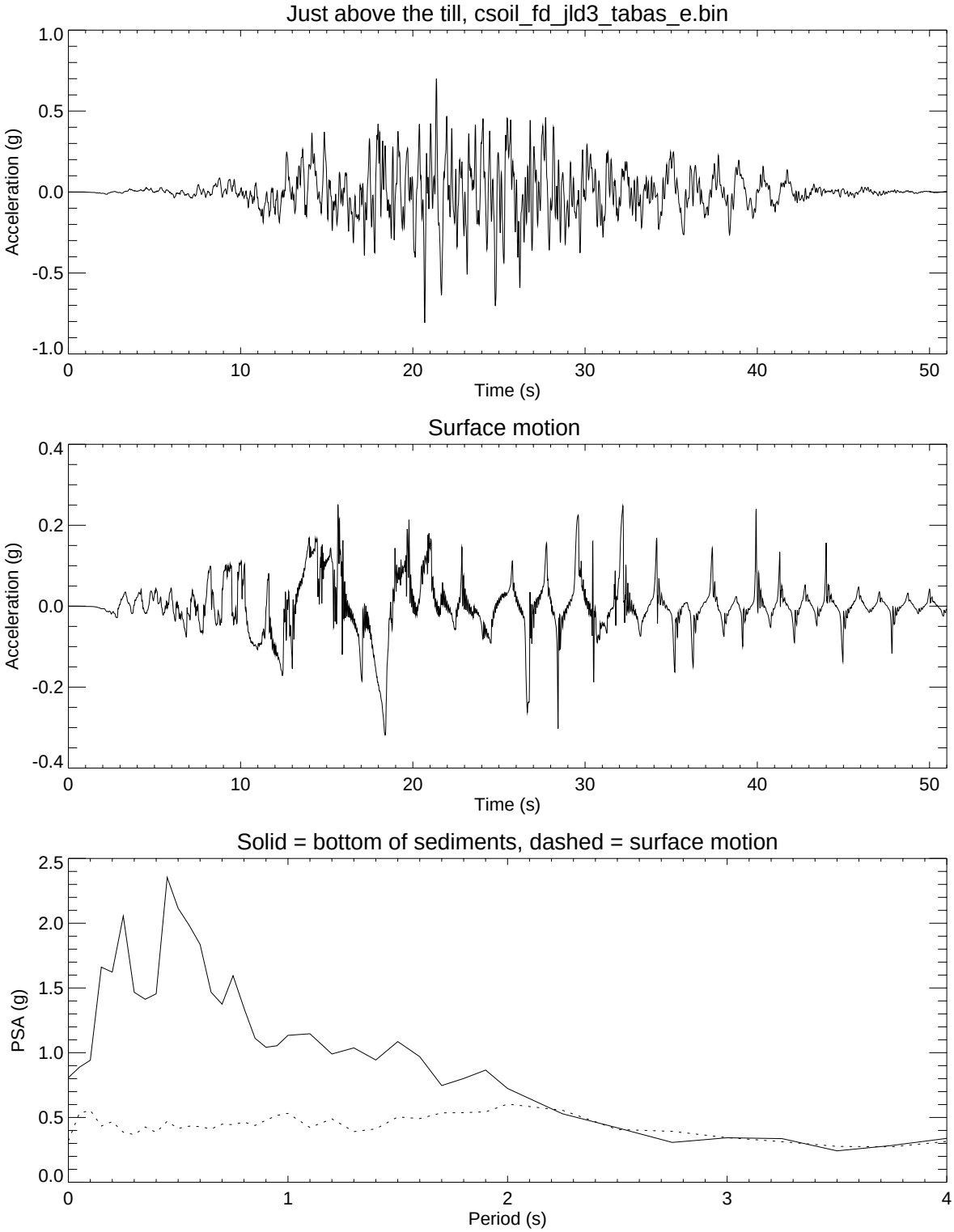

csoil_fd_tabas_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

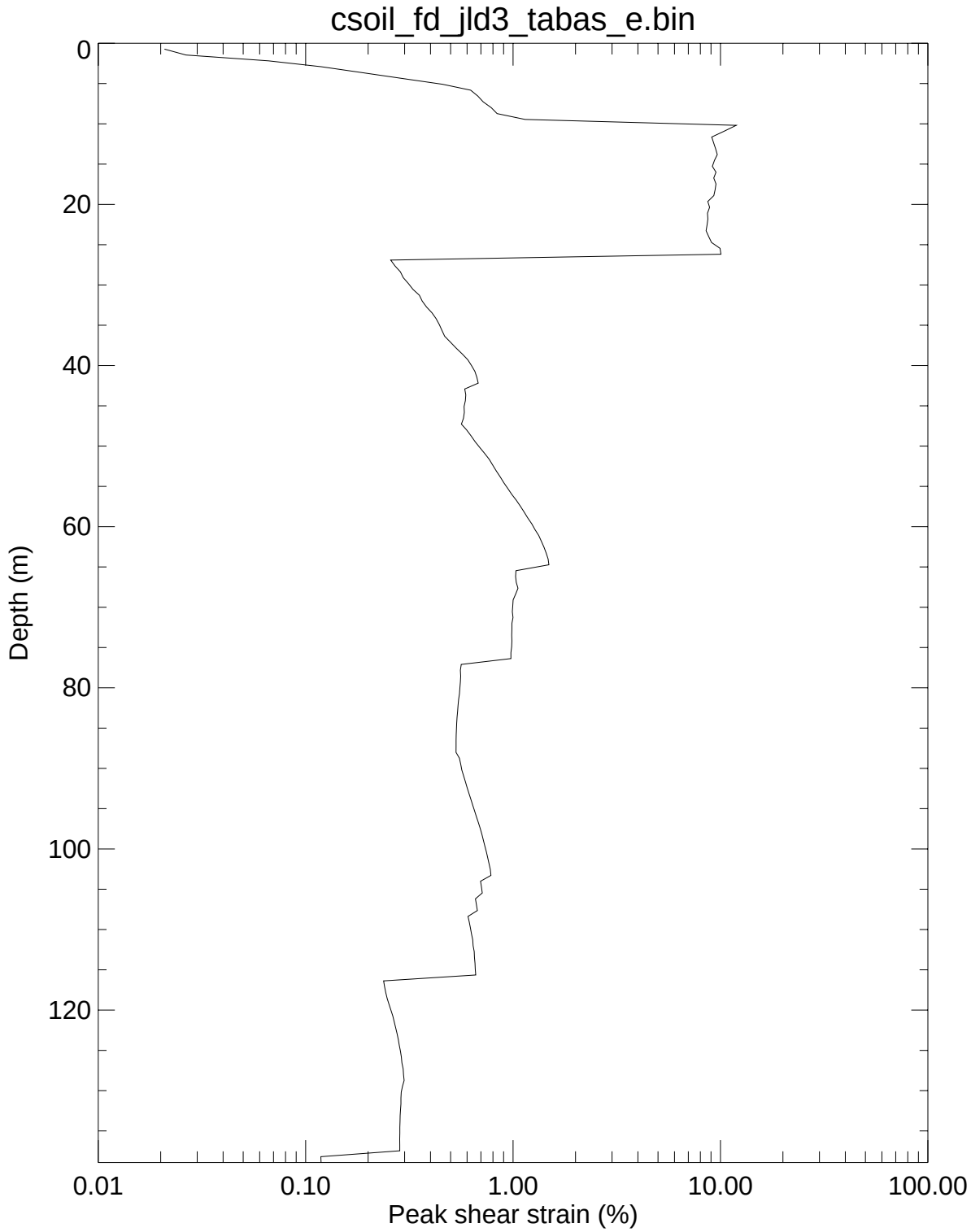

Just above the till, csoil_fd_jld3_tabas_half_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

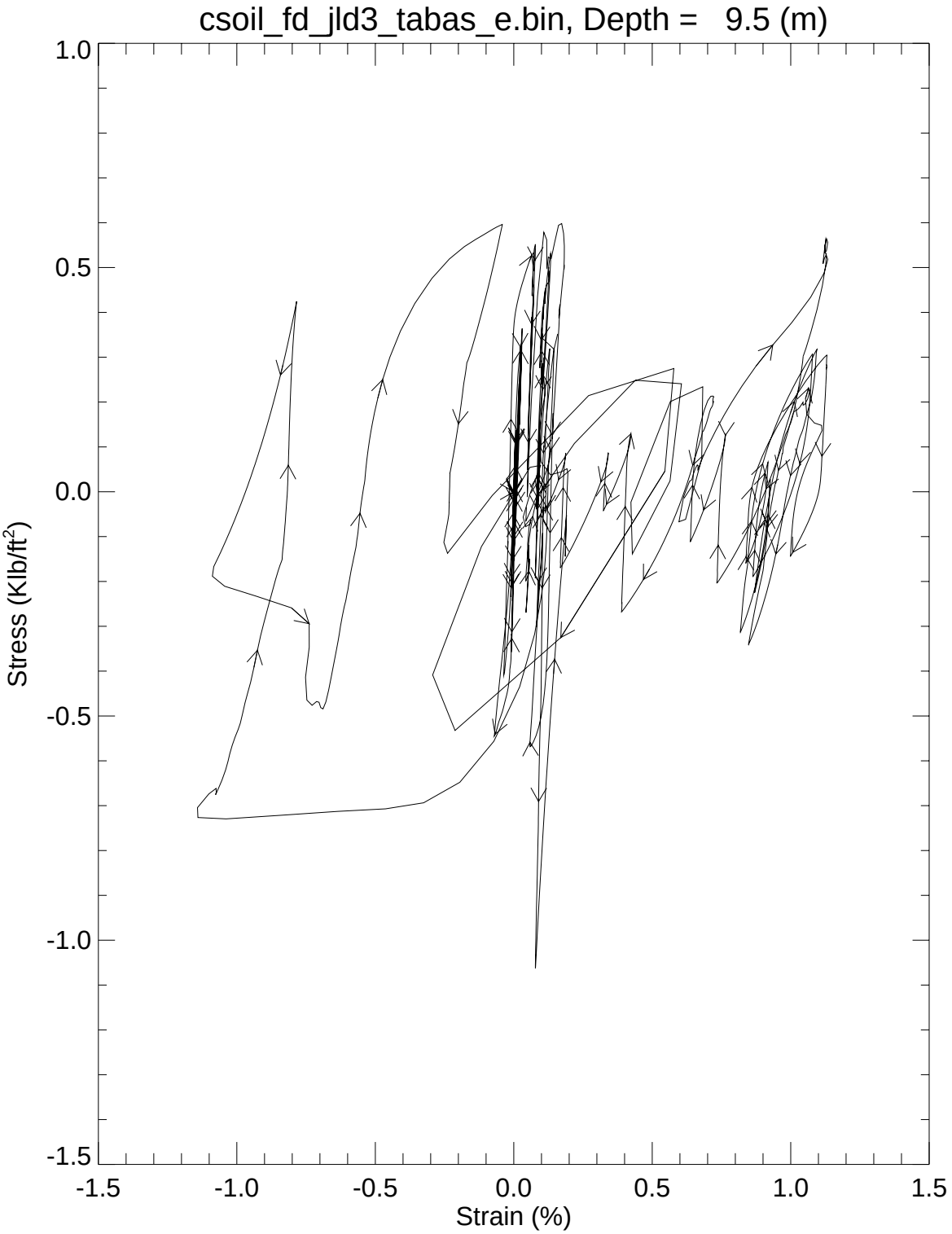

csoil_fd_jld3_tabas_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
Peak shear strain (%)

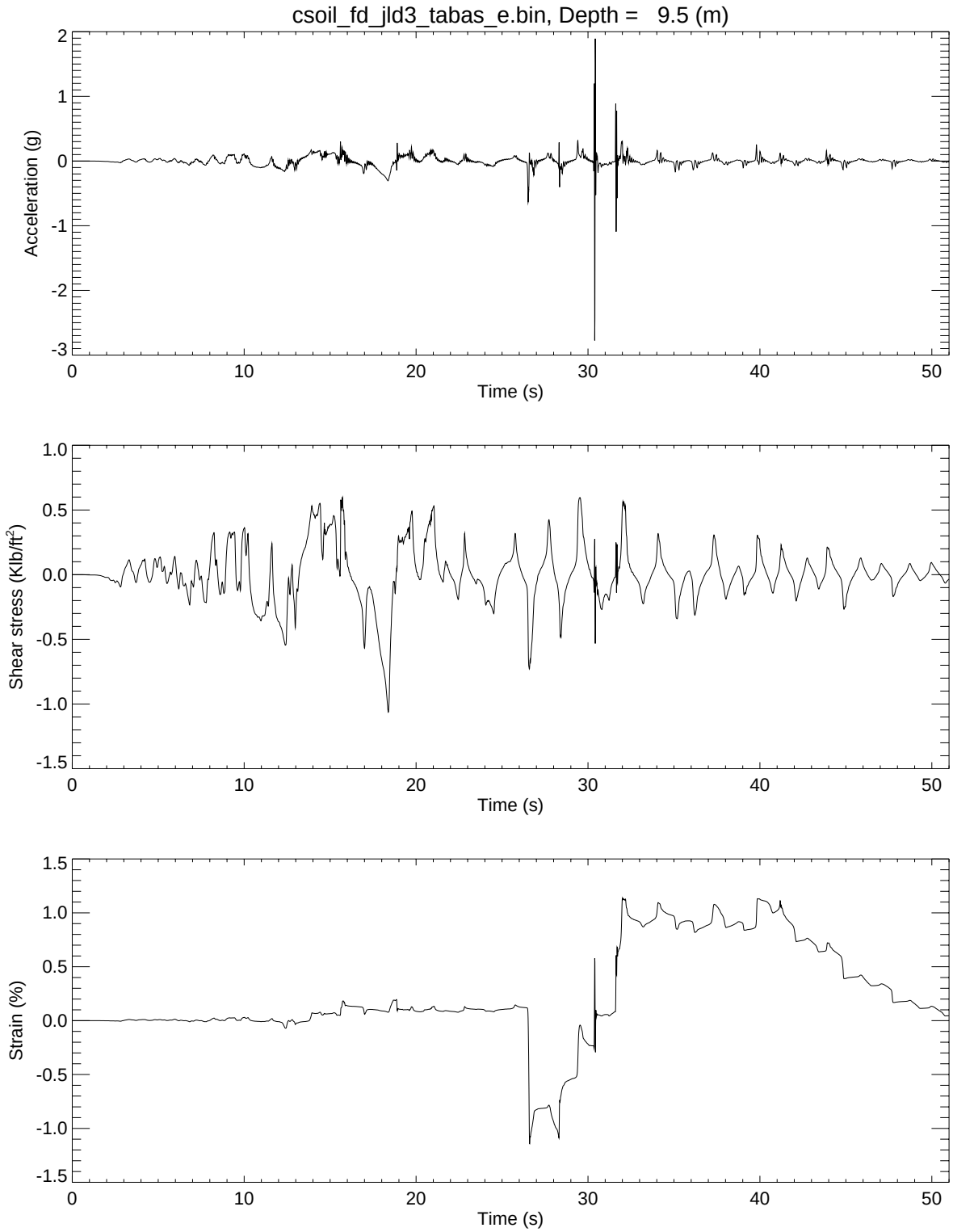

csoil_fd_jld3_tabas_half_e.bin, Depth = 9.5 (m)
Stress (Klb/ft^2)
Strain (%)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.1
0.0
0.1
0.2
0.3
0.4
0.5

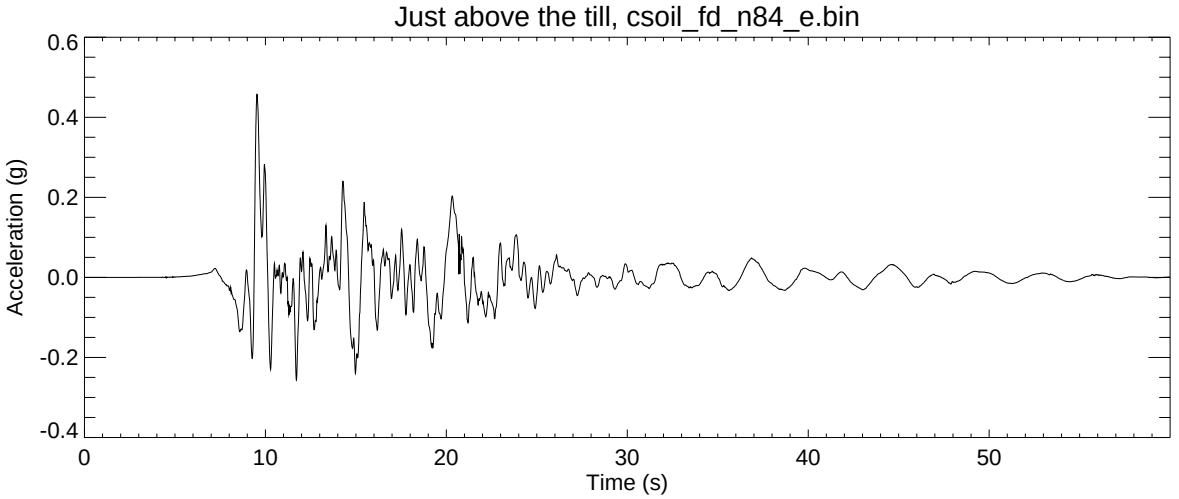

csoil_fd_jld3_tabas_half_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

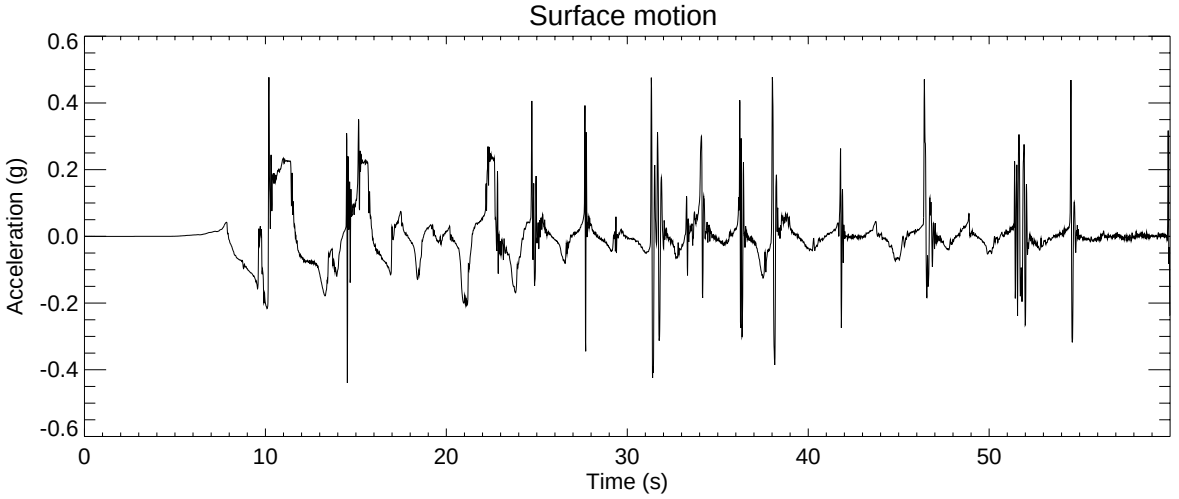

Just above the till, csoil_fd_jld3_tabas_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

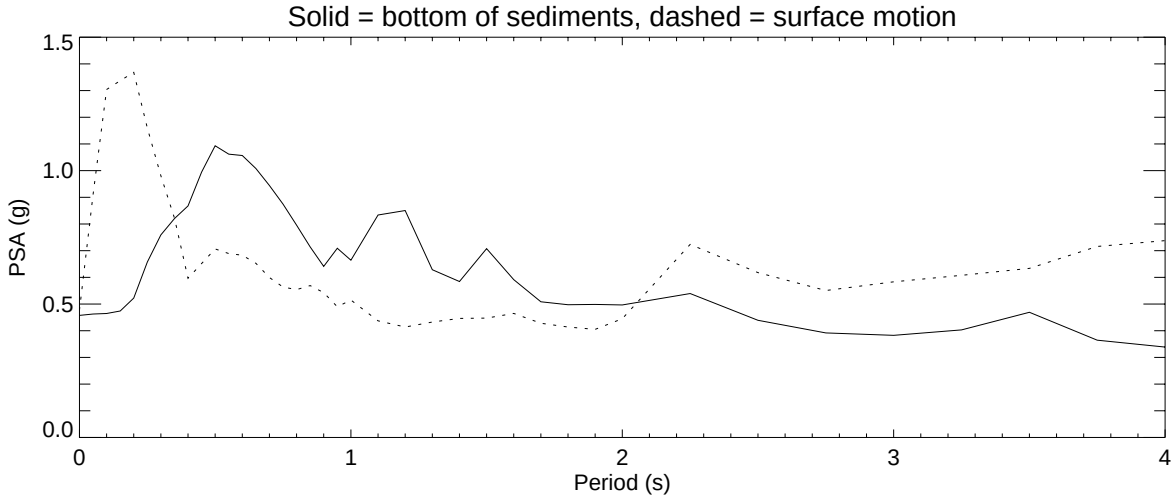

csoil_fd_jld3_tabas_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
100.00
Peak shear strain (%)

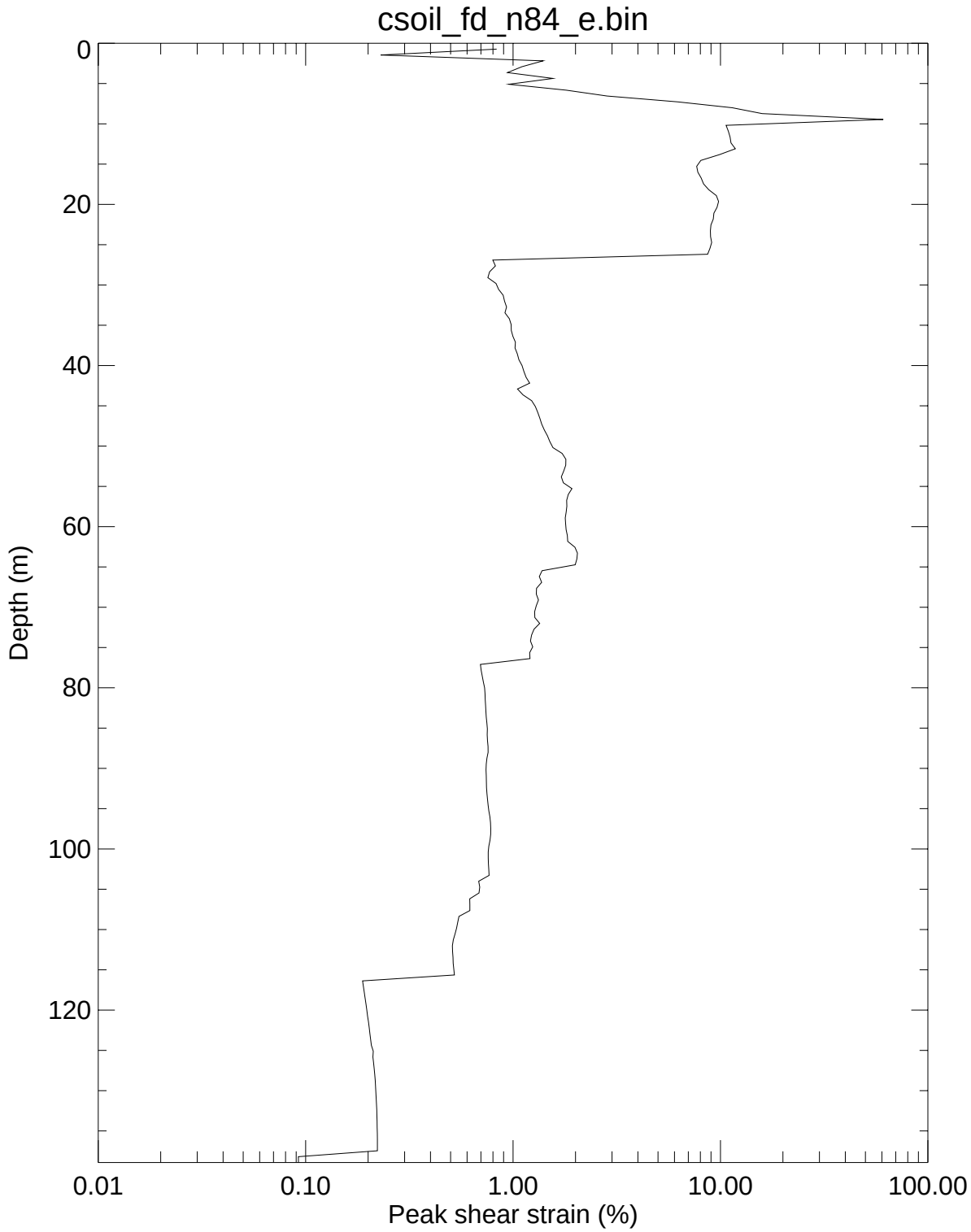

csoil_fd_jld3_tabas_e.bin, Depth = 9.5 (m)
Stress (Klb/ft^2)
Strain (%)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

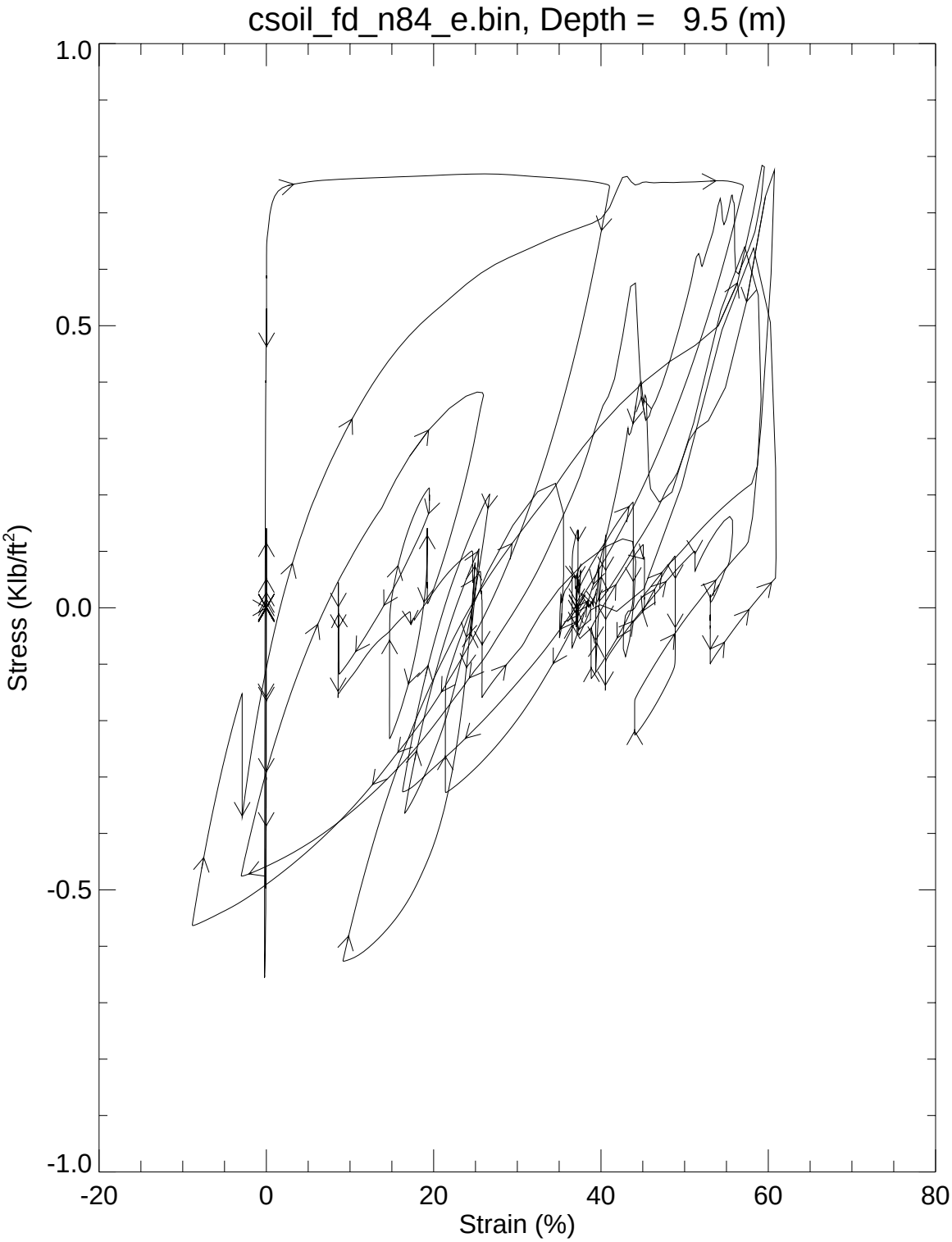

csoil_fd_jld3_tabas_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

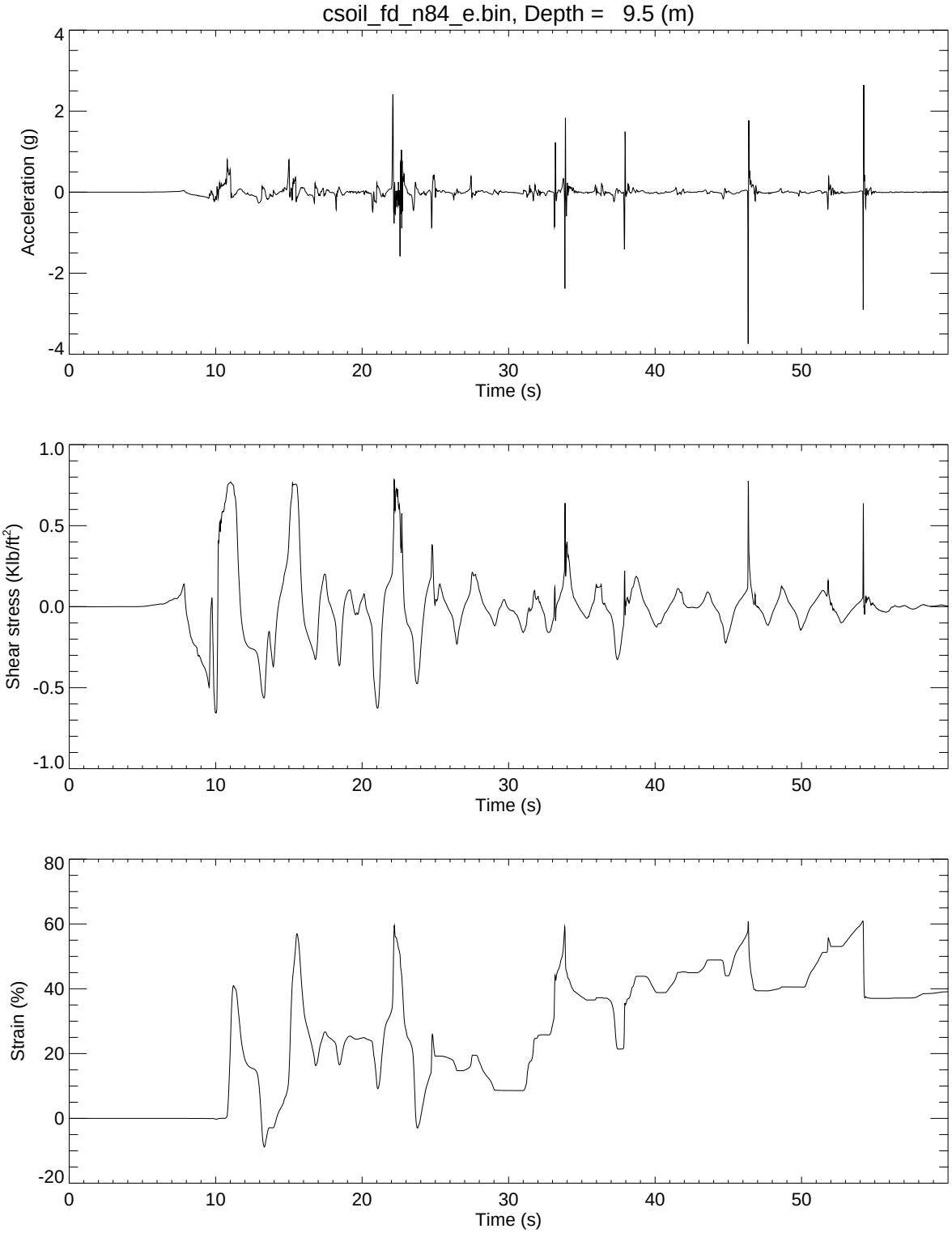

Just above the till, csoil_fd_n84_e.bin
Acceleration (g)
Time (s)

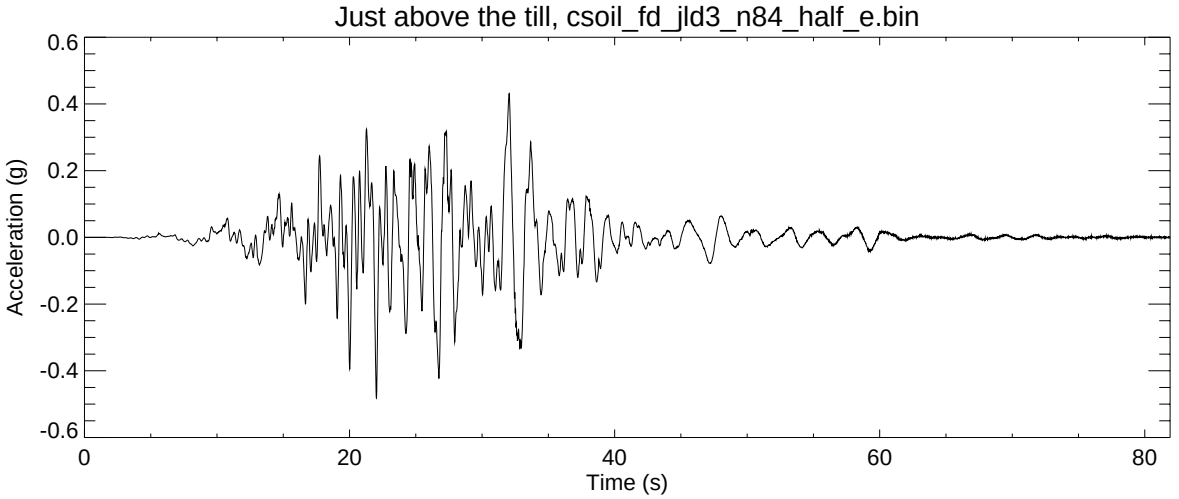

Surface motion
Acceleration (g)
Time (s)

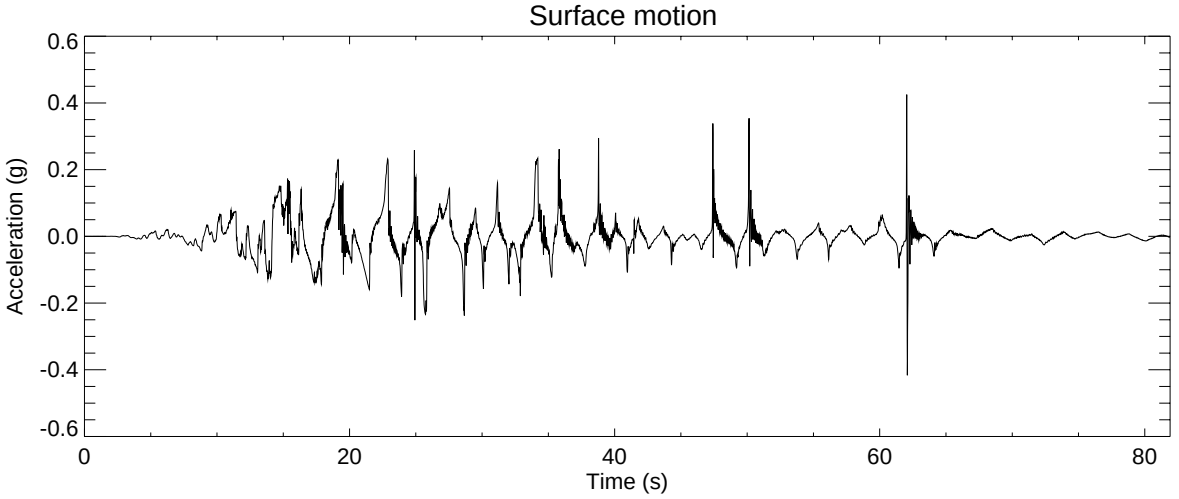

Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

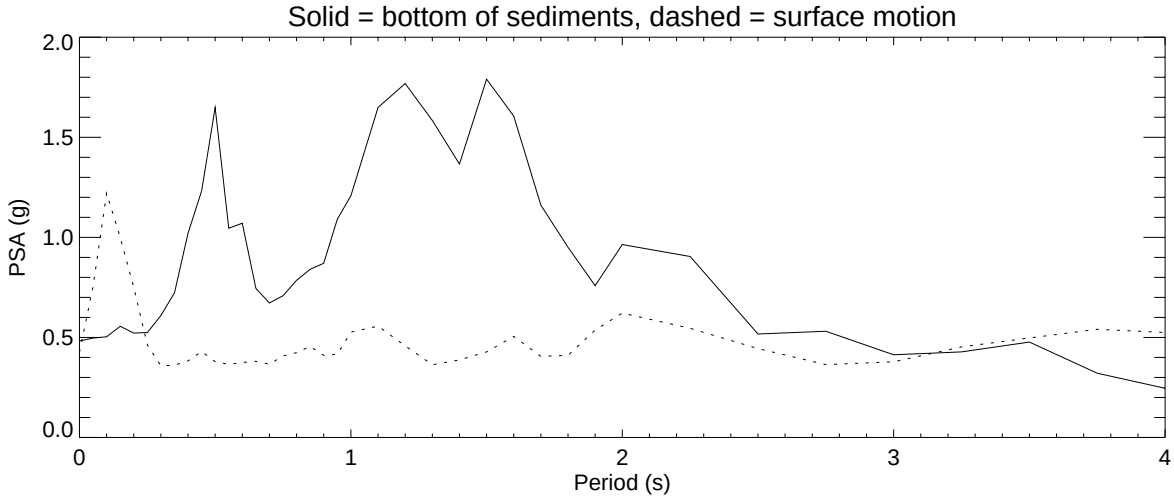

csoil_fd_n84_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
100.00
Peak shear strain (%)

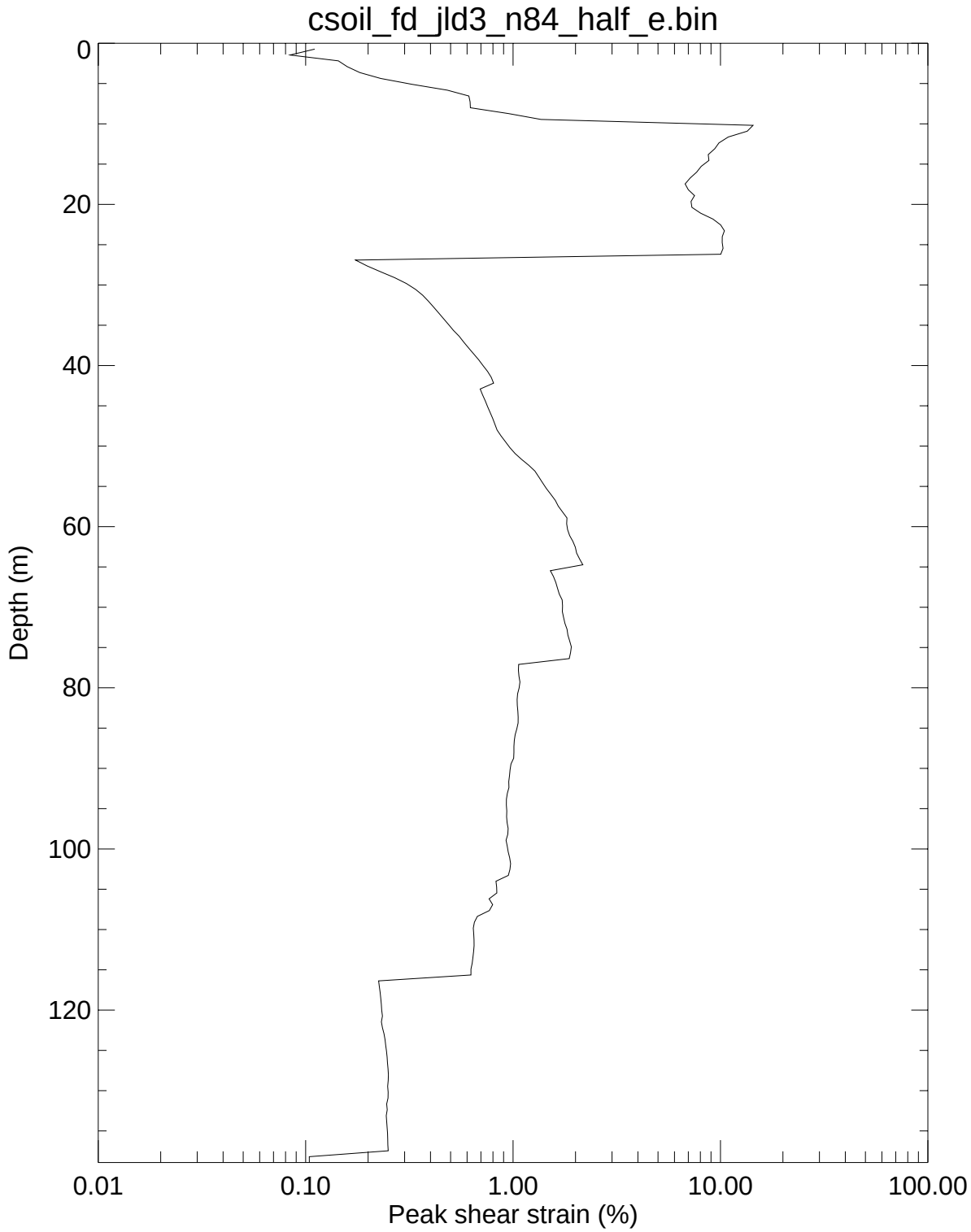

csoil_fd_n84_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft2)
-20
0
20
40
60
80
Strain (%)

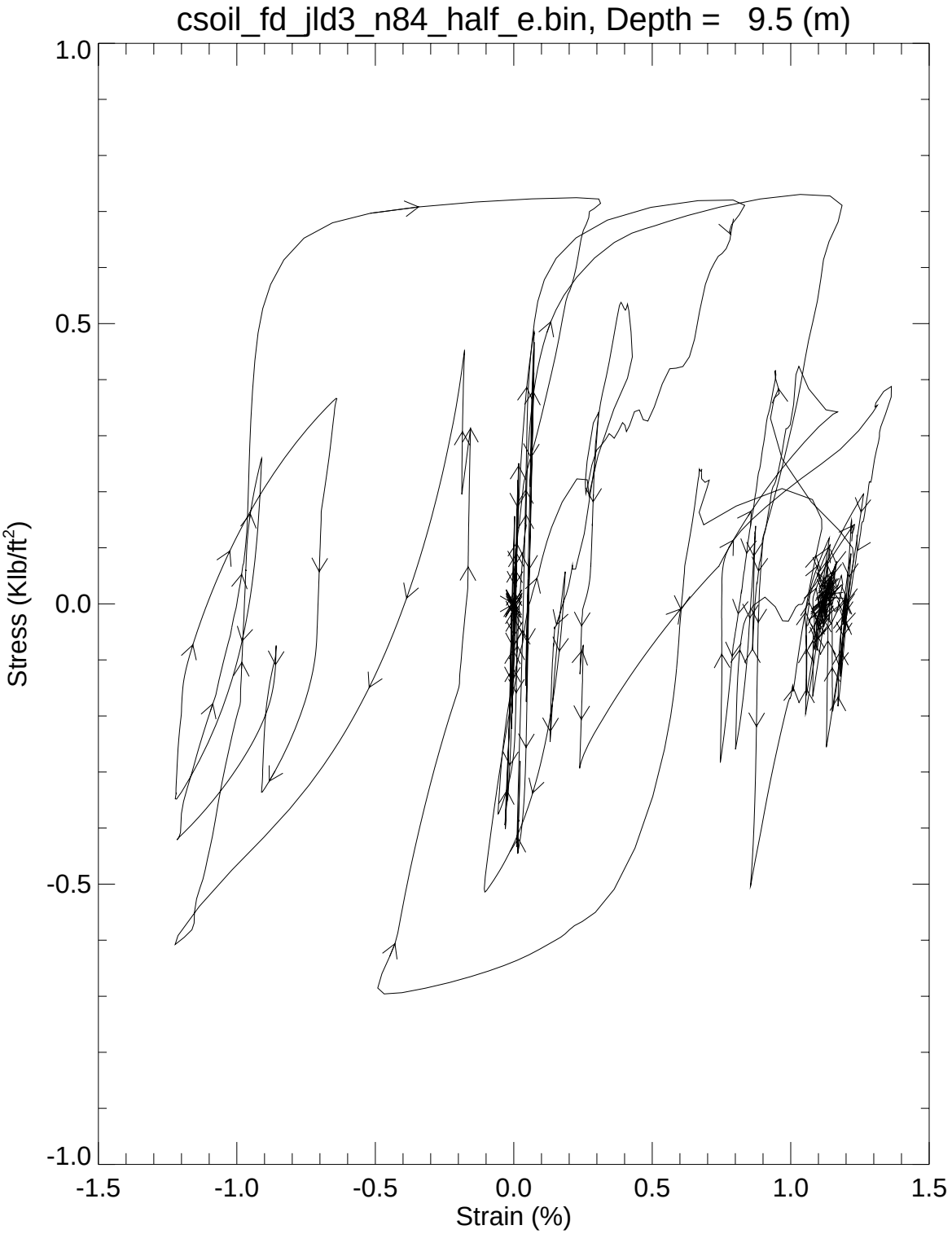

csoil_fd_n84_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

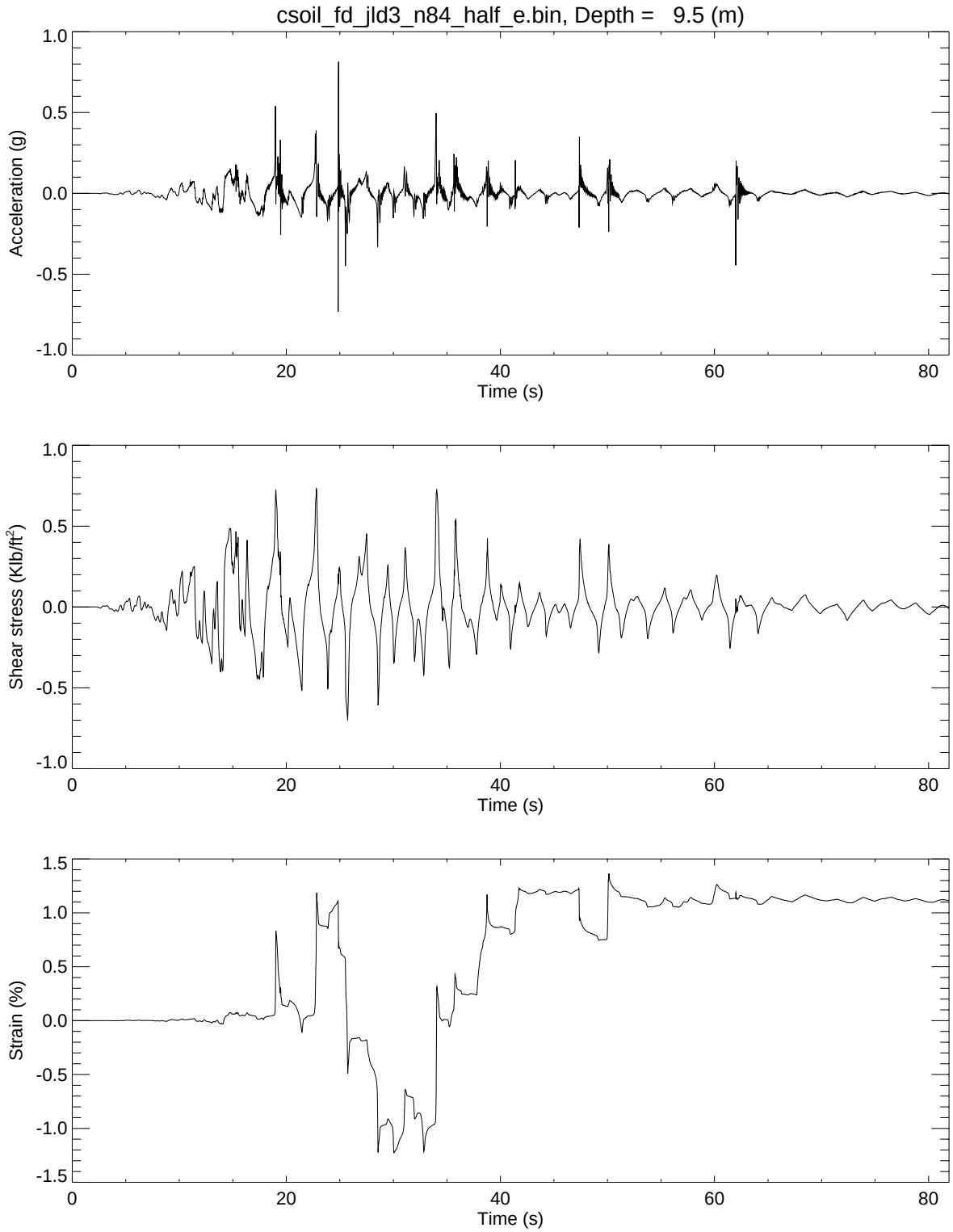

Just above the till, csoil_fd_jld3_n84_half_e.bin
Acceleration (g)
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
20
40
60
80
Time (s)

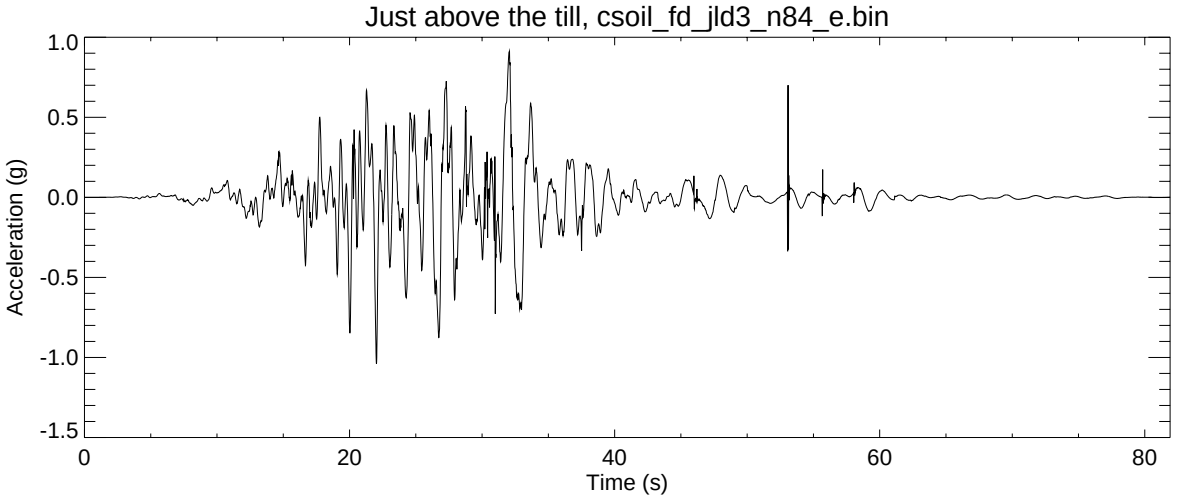

Surface motion
Acceleration (g)
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
20
40
60
80
Time (s)

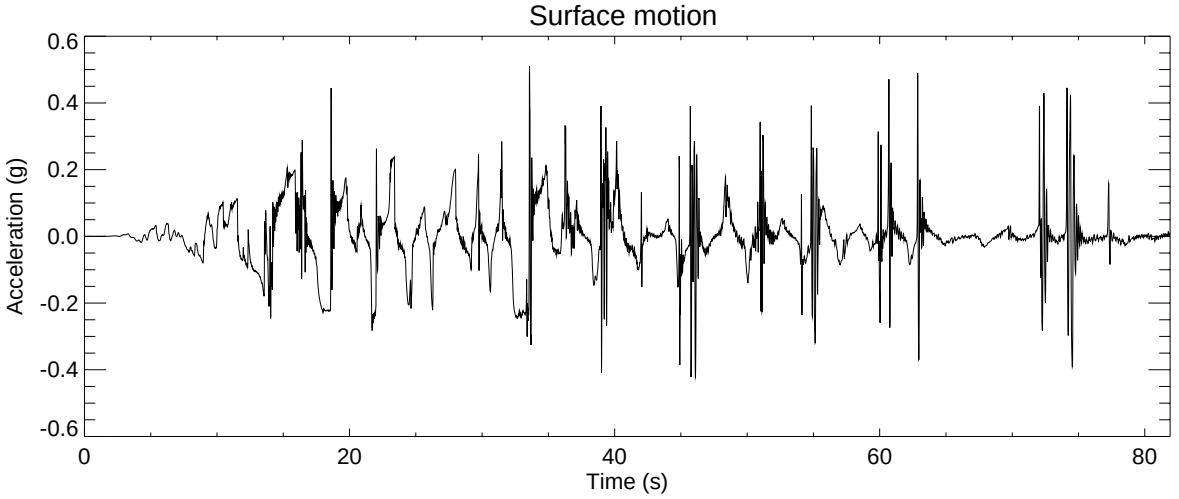

Solid = bottom of sediments, dashed = surface motion
PSA (g)
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
Period (s)

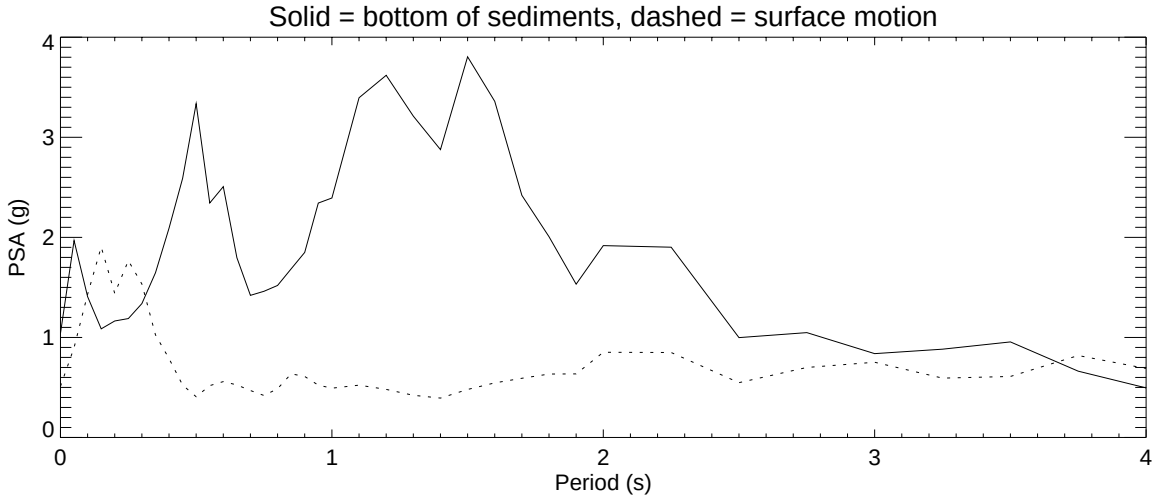

csoil_fd_jld3_n84_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.01
0.10
1.00
10.00
100.00
Peak shear strain (%)

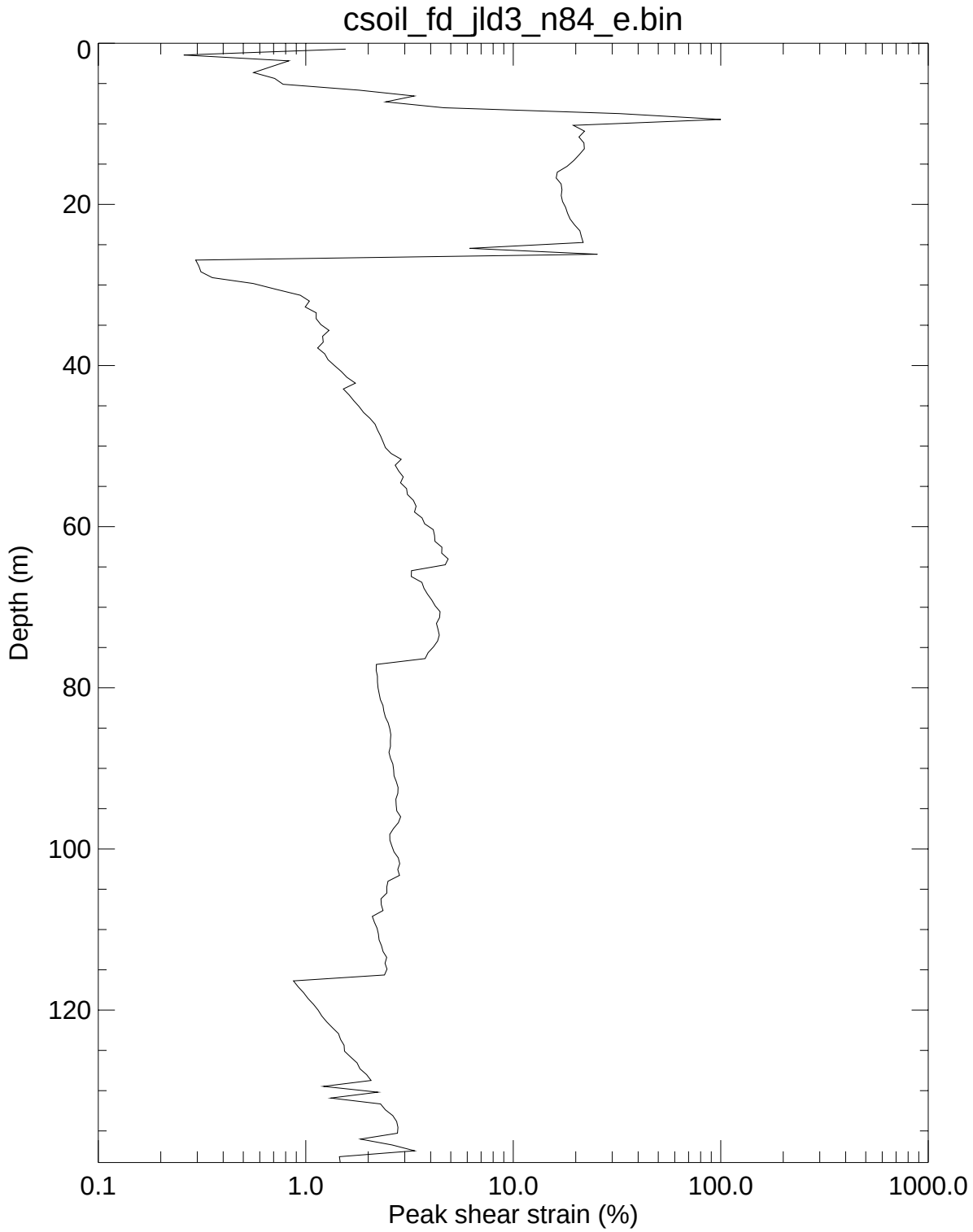

csoil_fd_jld3_n84_half_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft2)
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Strain (%)

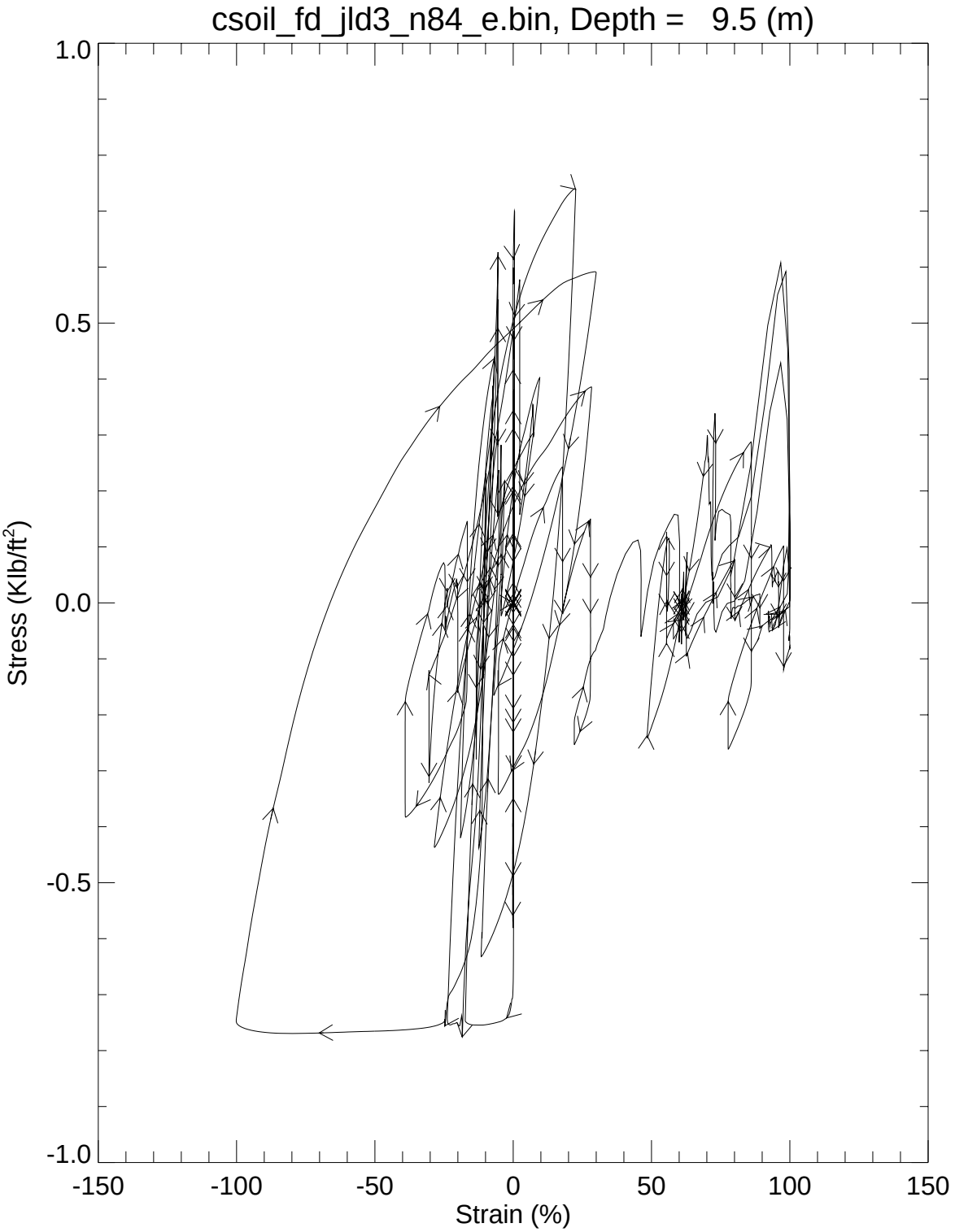

csoil_fd_jld3_n84_half_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

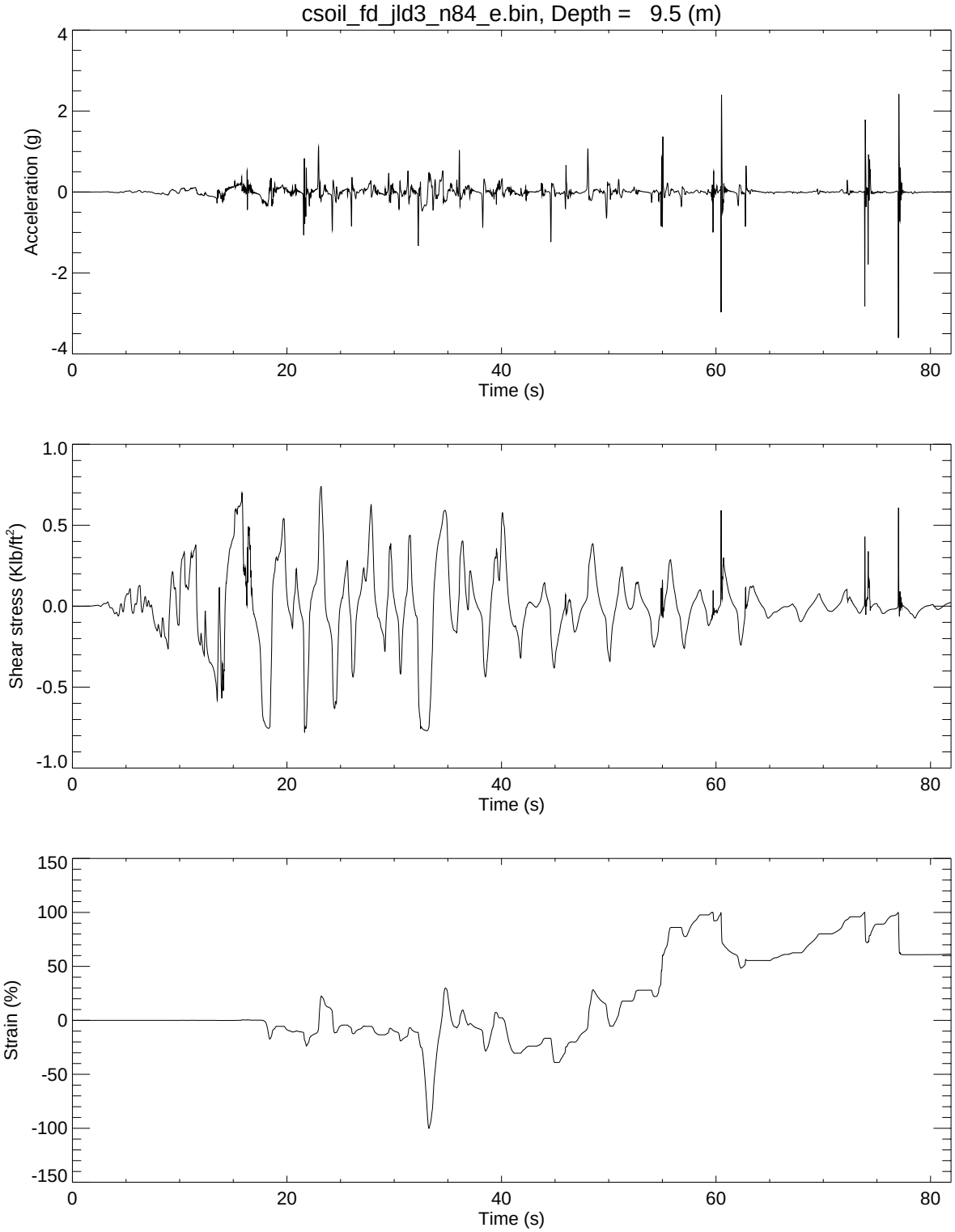

Just above the till, csoil_fd_jld3_n84_e.bin
Acceleration (g)
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
20
40
60
80
Time (s)

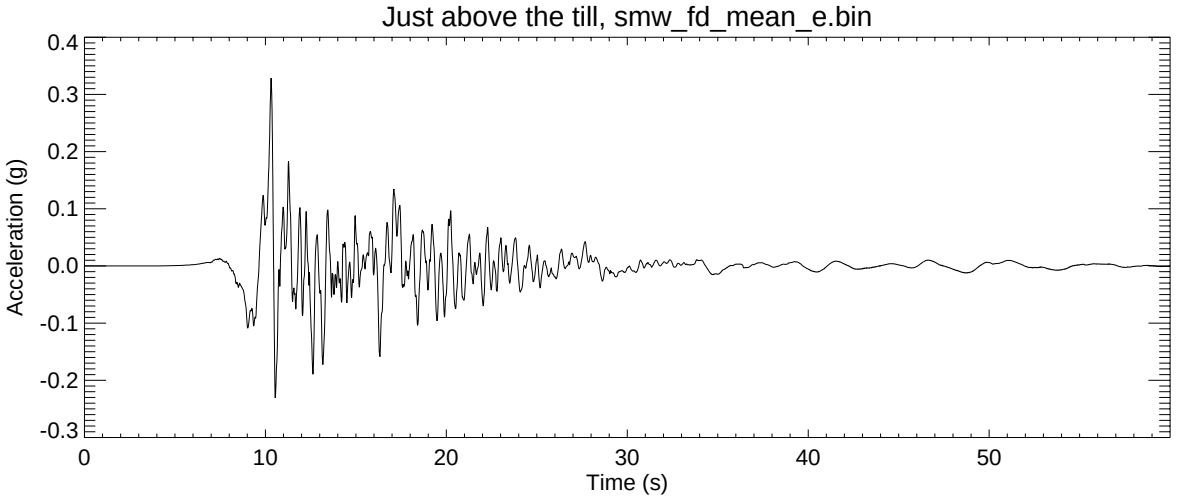

Surface motion
Acceleration (g)
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
20
40
60
80
Time (s)

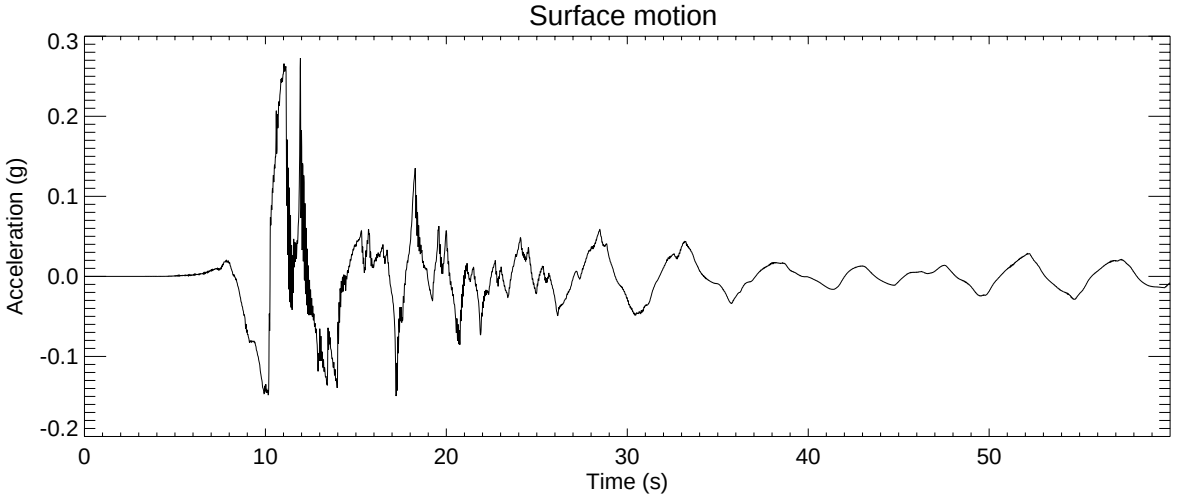

Solid = bottom of sediments, dashed = surface motion
PSA (g)
4
3
2
1
0
0
1
2
3
4
Period (s)

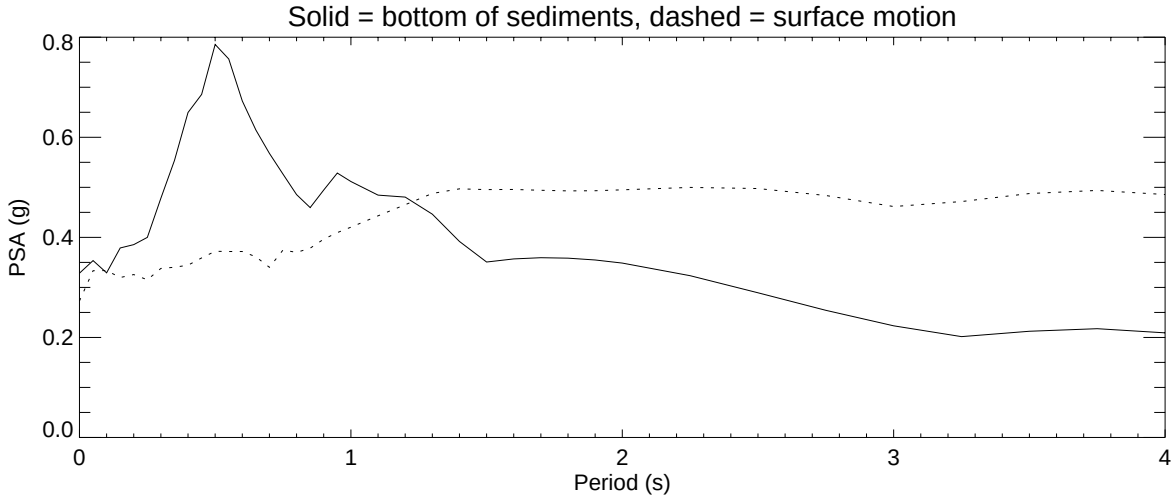

csoil_fd_jld3_n84_e.bin
Depth (m)
0
20
40
60
80
100
120
0.1
1.0
10.0
100.0
1000.0
Peak shear strain (%)

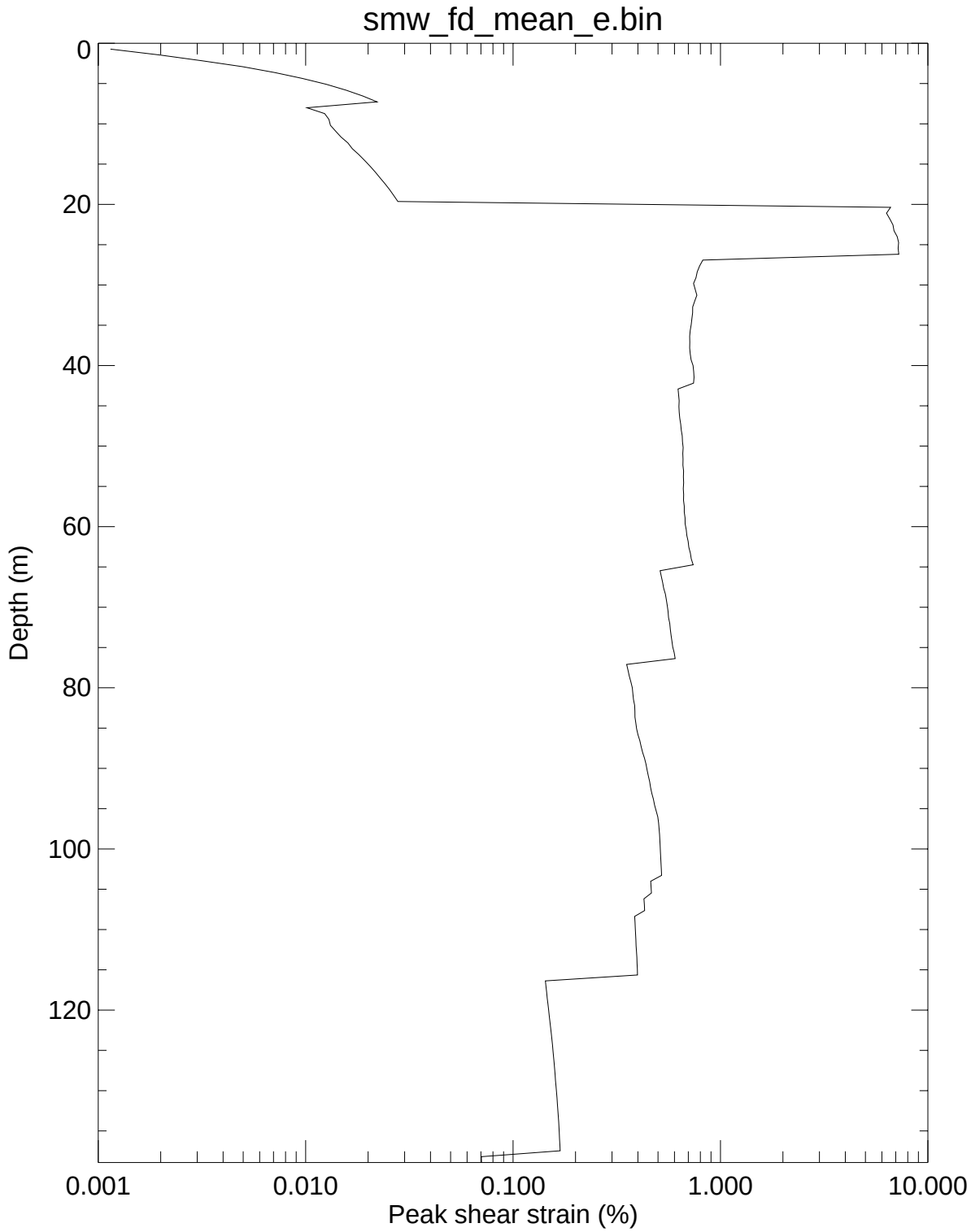

csoil_fd_jld3_n84_e.bin, Depth = 9.5 (m)
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft^2)
-150
-100
-50
0
50
100
150
Strain (%)

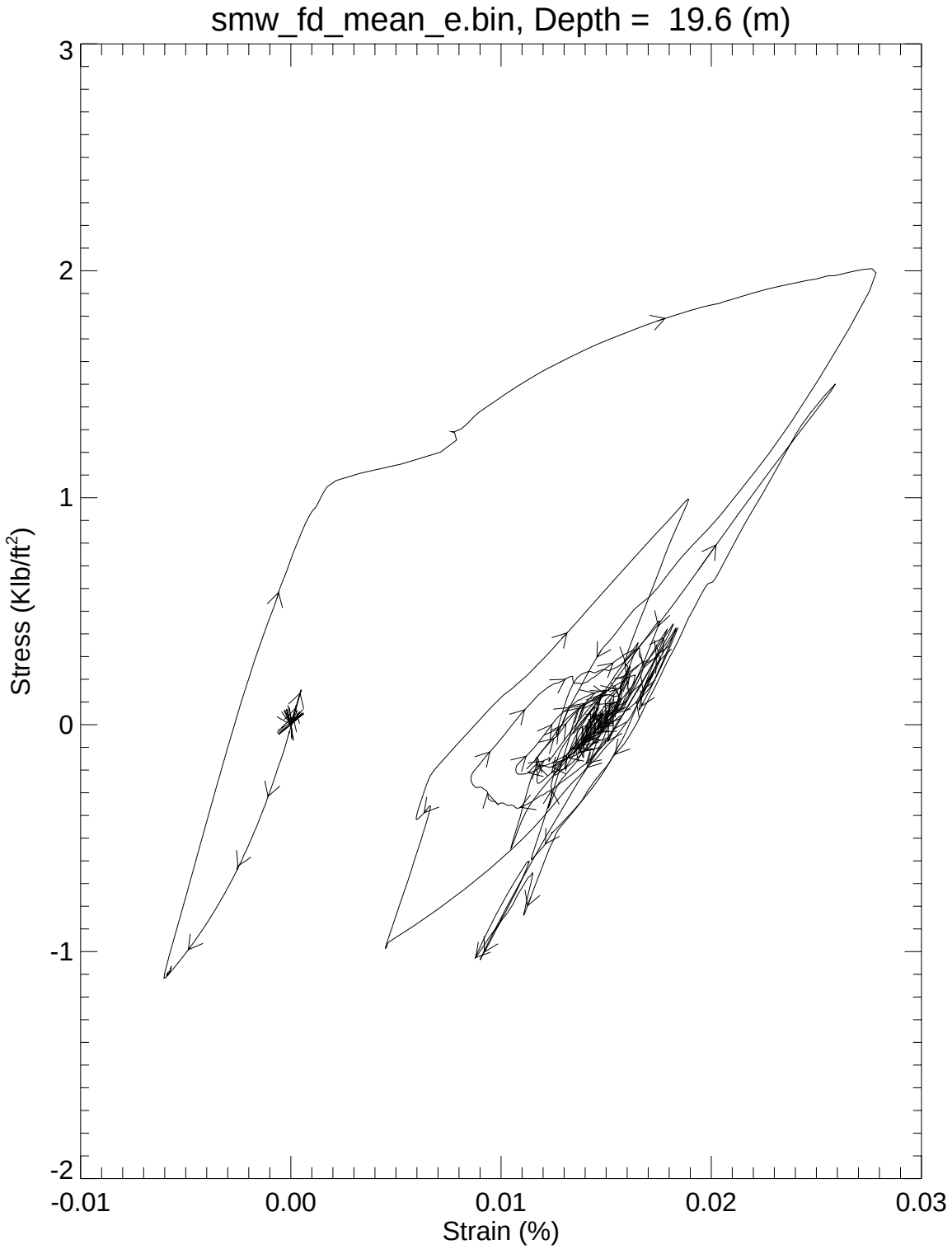

csoil_fd_jld3_n84_e.bin, Depth = 9.5 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

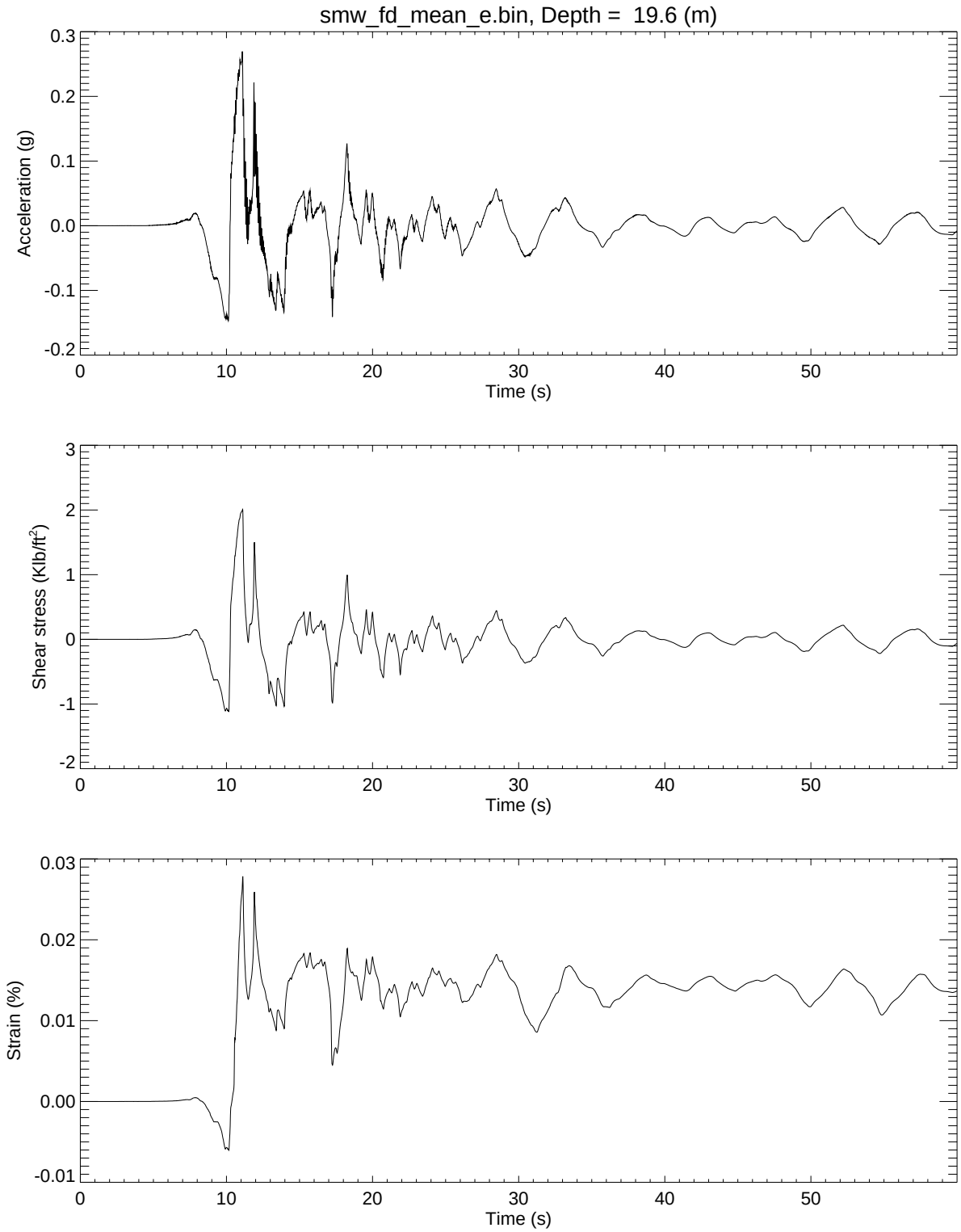

Just above the till, smw_fd_mean_e.bin
Acceleration (g)
Time (s)

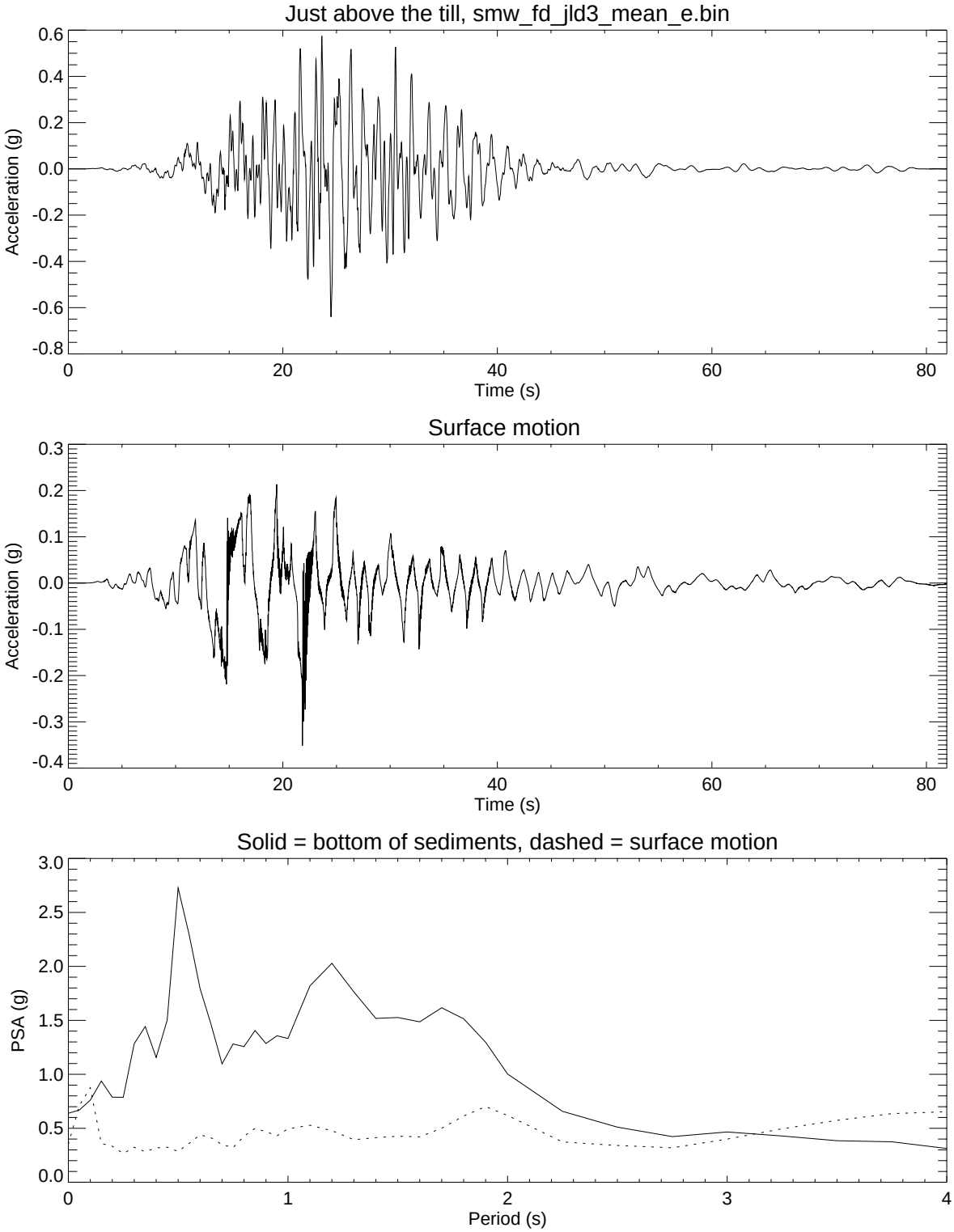

Surface motion
Acceleration (g)
Time (s)

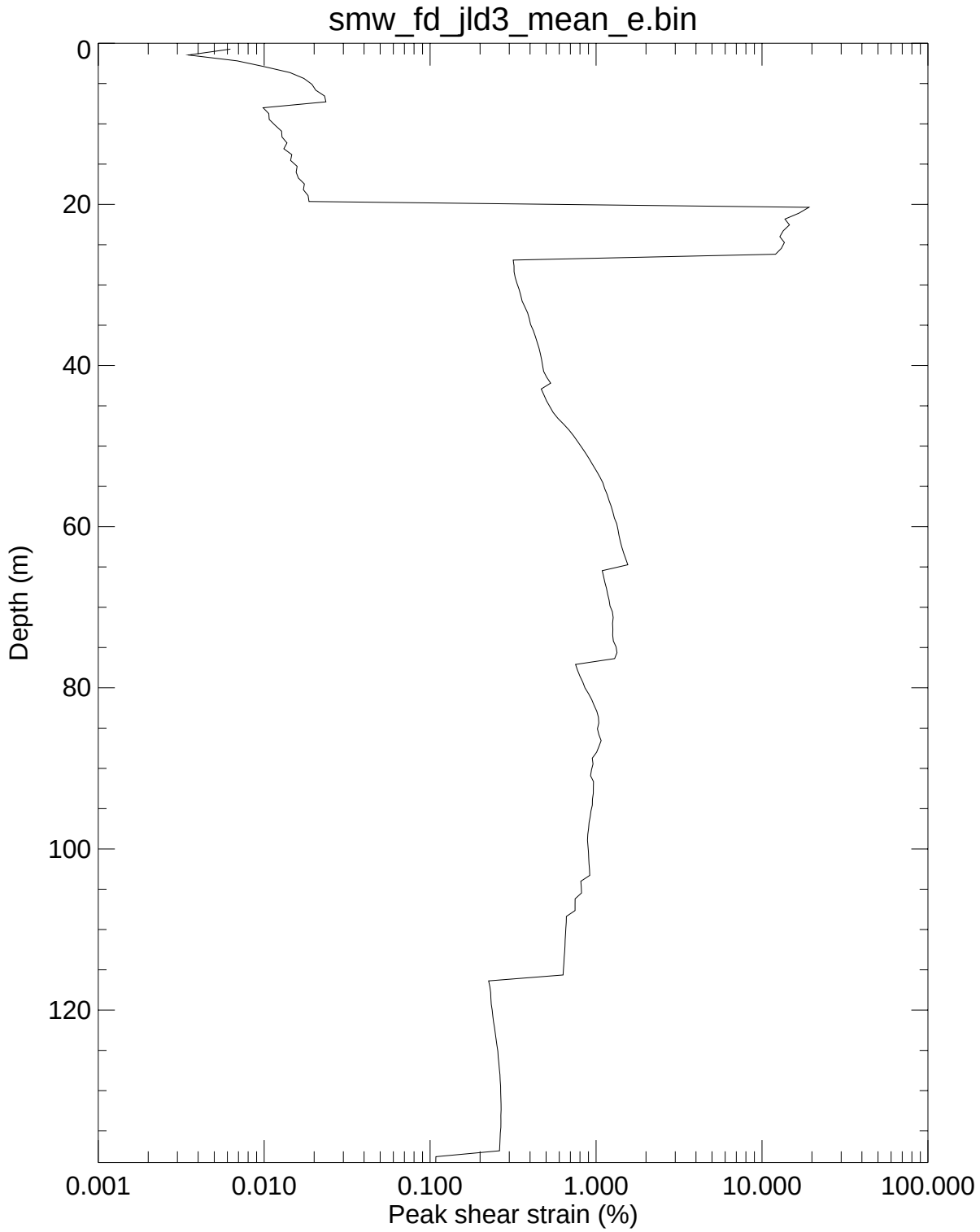

Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

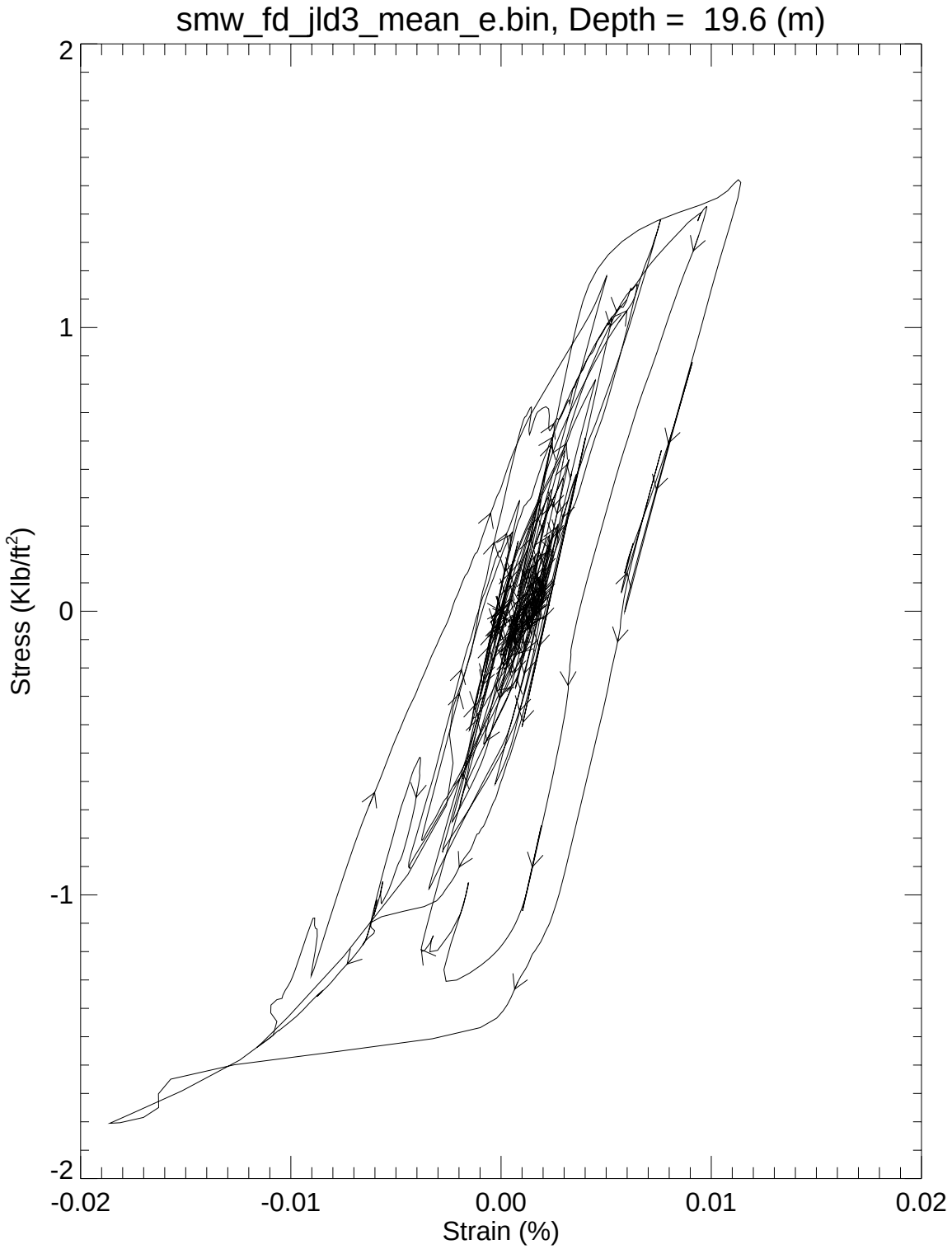

smw_fd_mean_e.bin
Depth (m)
0
20
40
60
80
100
120
0.001
0.010
0.100
1.000
10.000
Peak shear strain (%)

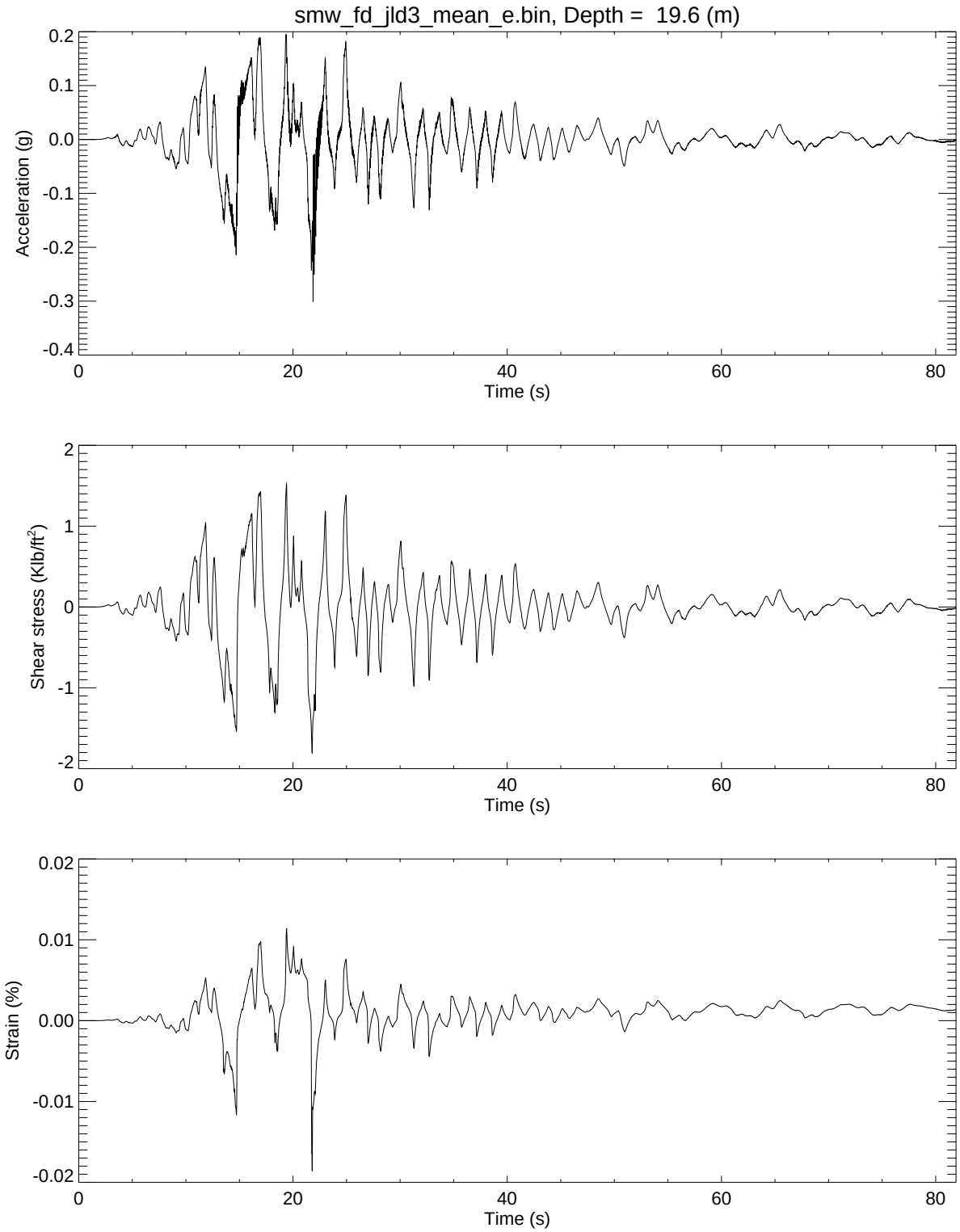

smw_fd_mean_e.bin, Depth = 19.6 (m)
Stress (Klb/ft^2)
Strain (%)
3
2
1
0
-1
-2
-0.01
0.00
0.01
0.02
0.03

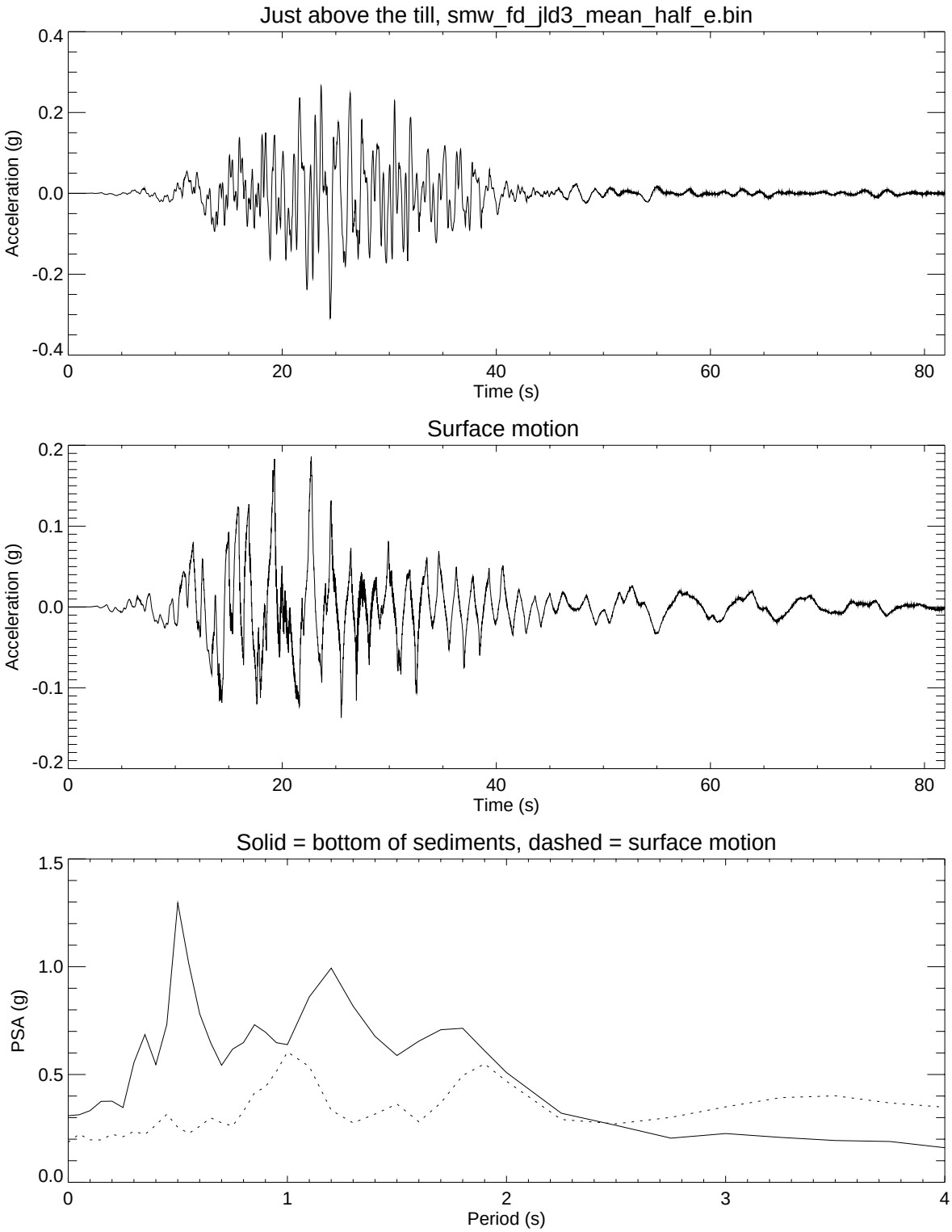

smw_fd_mean_e.bin, Depth = 19.6 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

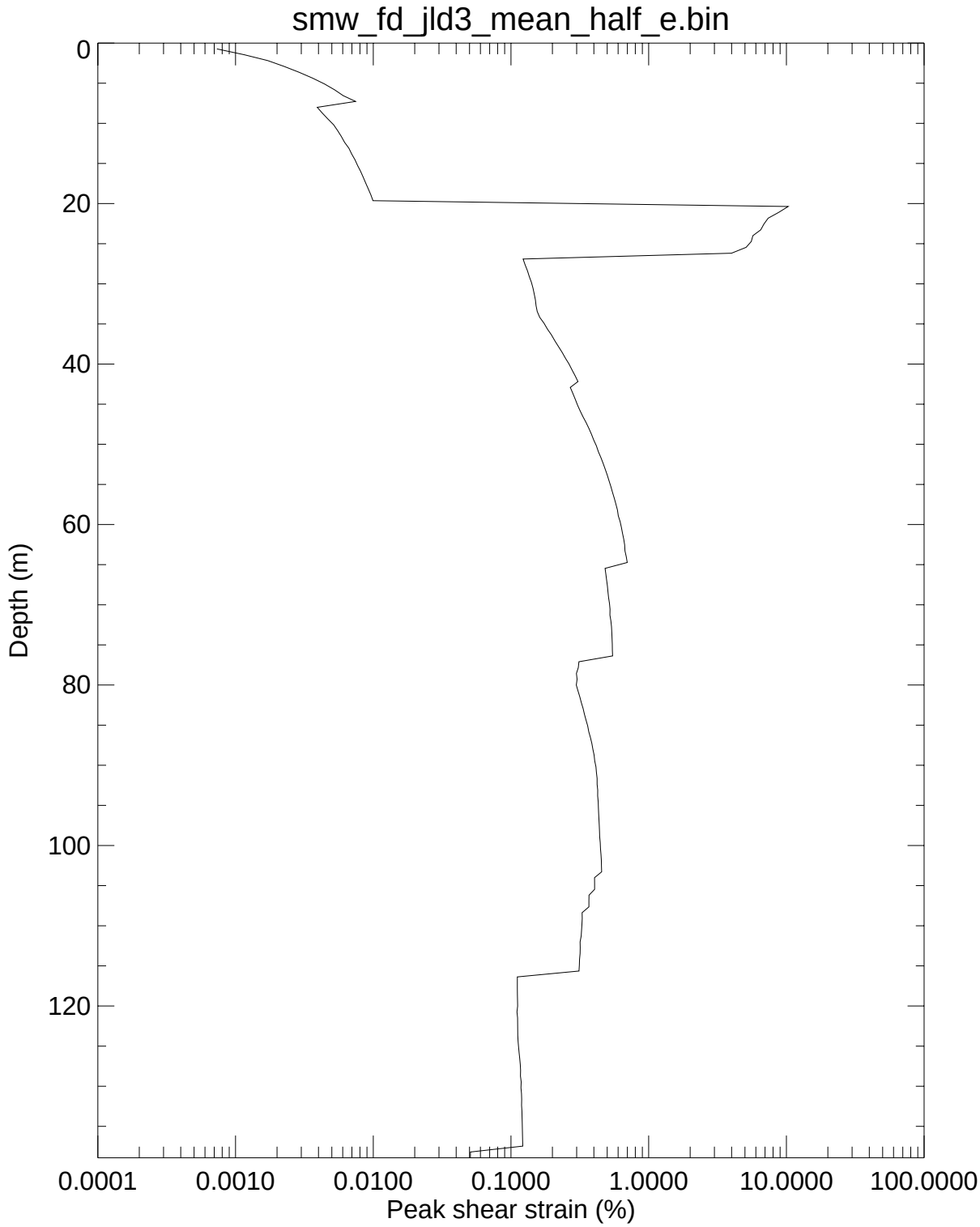

Just above the till, smw_fd_jld3_mean_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

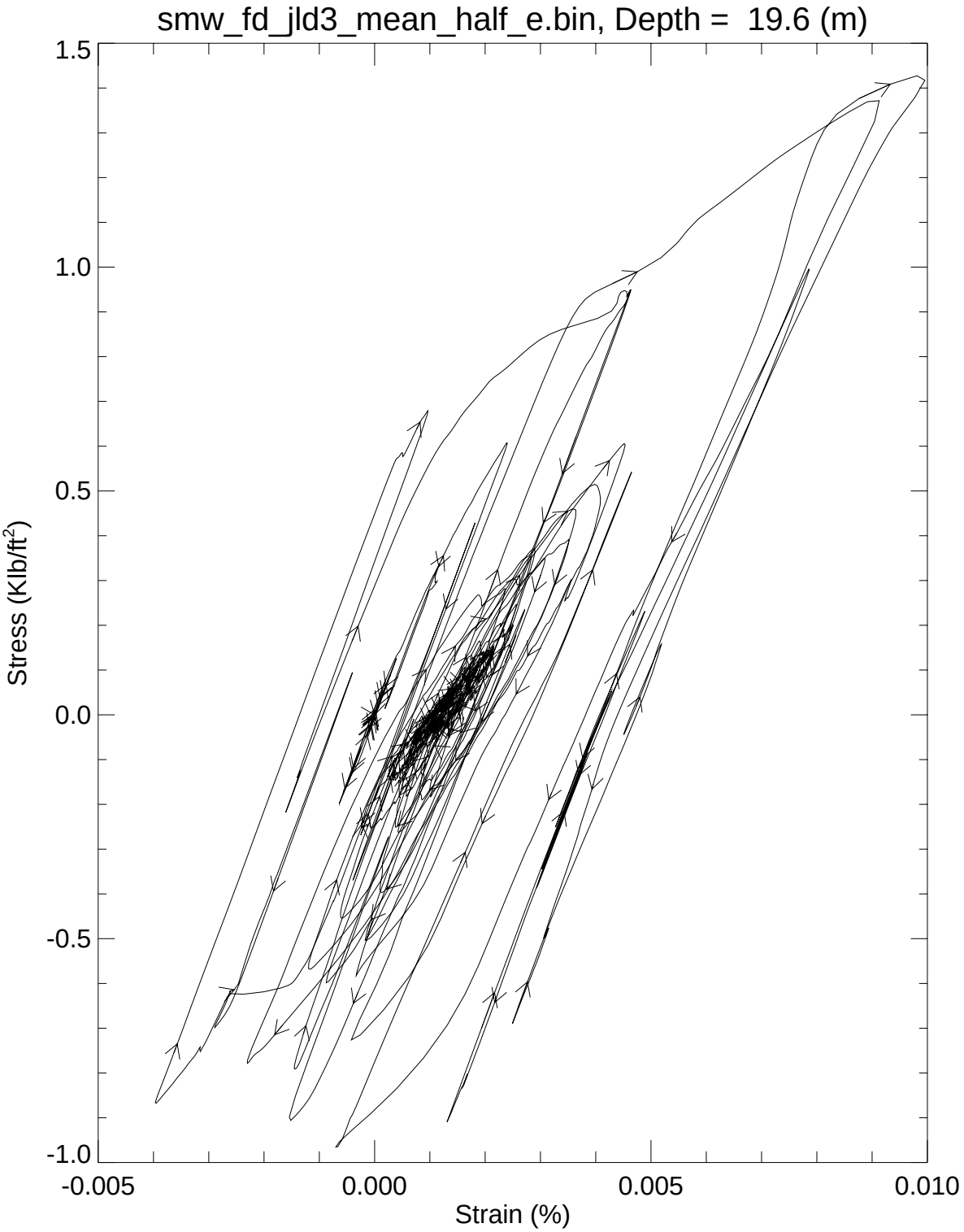

smw_fd_jld3_mean_e.bin
Depth (m)
0
20
40
60
80
100
120
0.001
0.010
0.100
1.000
10.000
100.000
Peak shear strain (%)

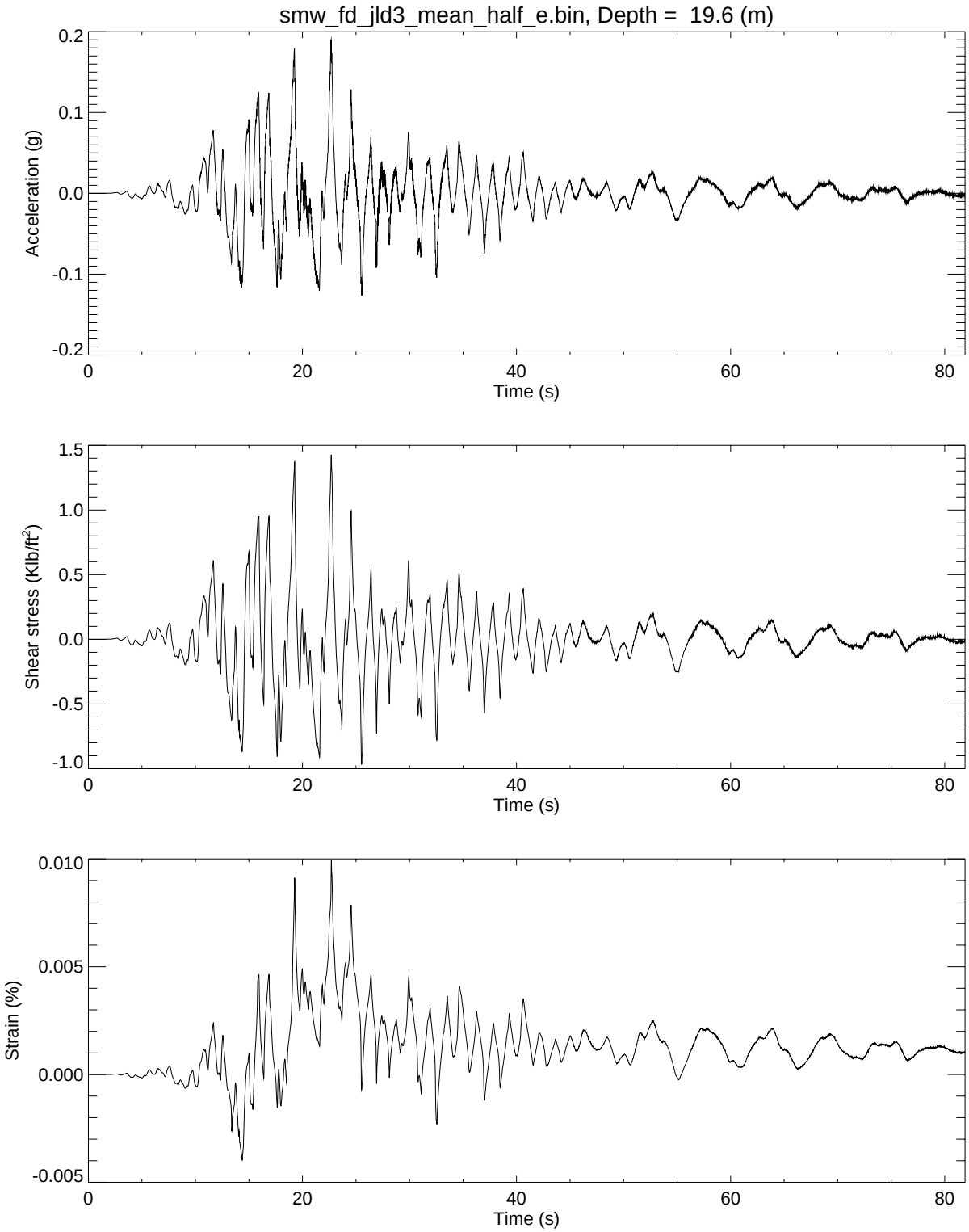

smw_fd_jld3_mean_e.bin, Depth = 19.6 (m)
Stress (Klb/ft^2)
Strain (%)
2
1
0
-1
-2
-0.02
-0.01
0.00
0.01
0.02

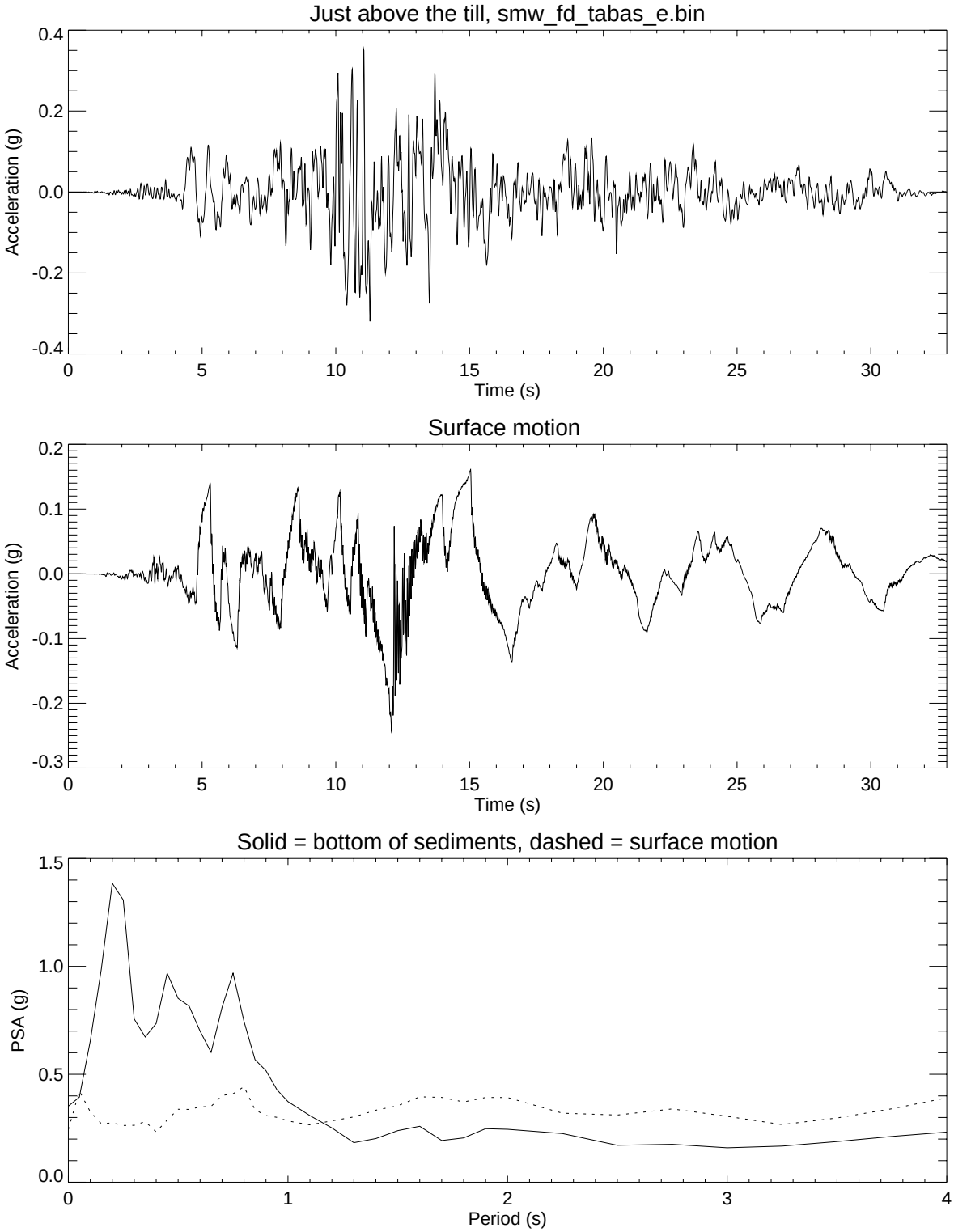

smw_fd_jld3_mean_e.bin, Depth = 19.6 (m)
Acceleration (g)
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
0
20
40
60
80
Time (s)
Shear stress (Klb/ft^2)
2
1
0
-1
-2
0
20
40
60
80
Time (s)
Strain (%)
0.02
0.01
0.00
-0.01
-0.02
0
20
40
60
80
Time (s)

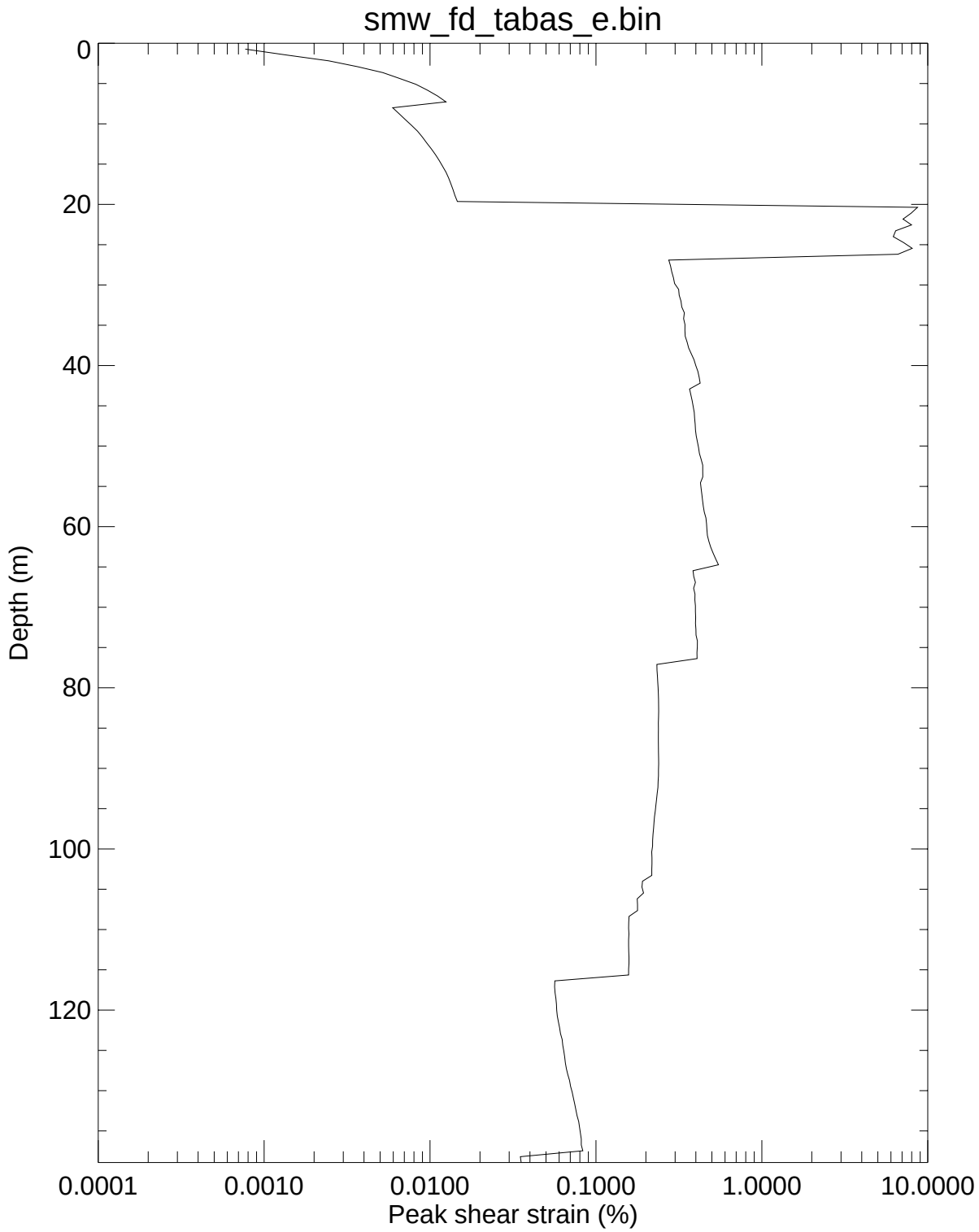

Just above the till, smw_fd_jld3_mean_half_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

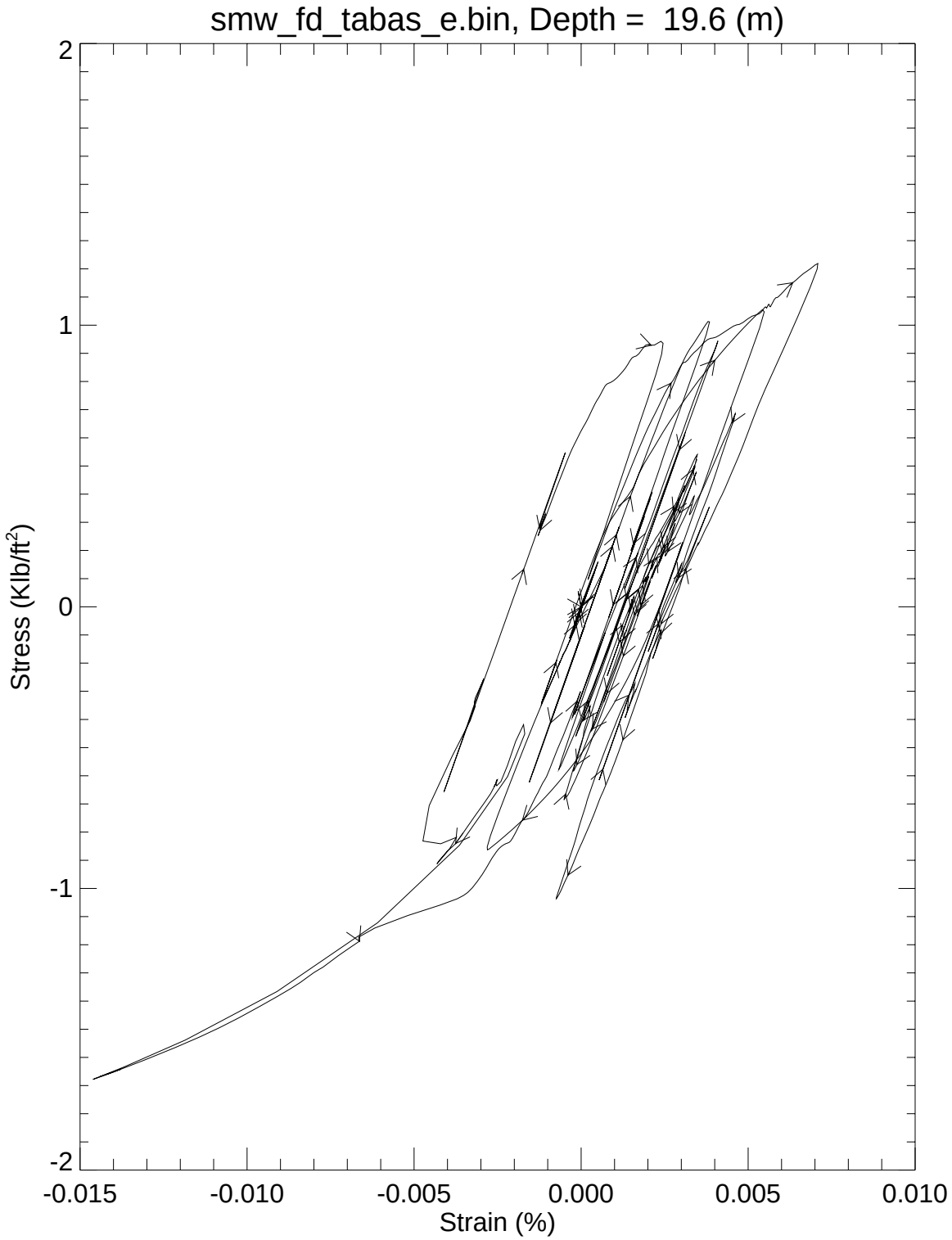

smw_fd_jld3_mean_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.0001
0.0010
0.0100
0.1000
1.0000
10.0000
100.0000
Peak shear strain (%)

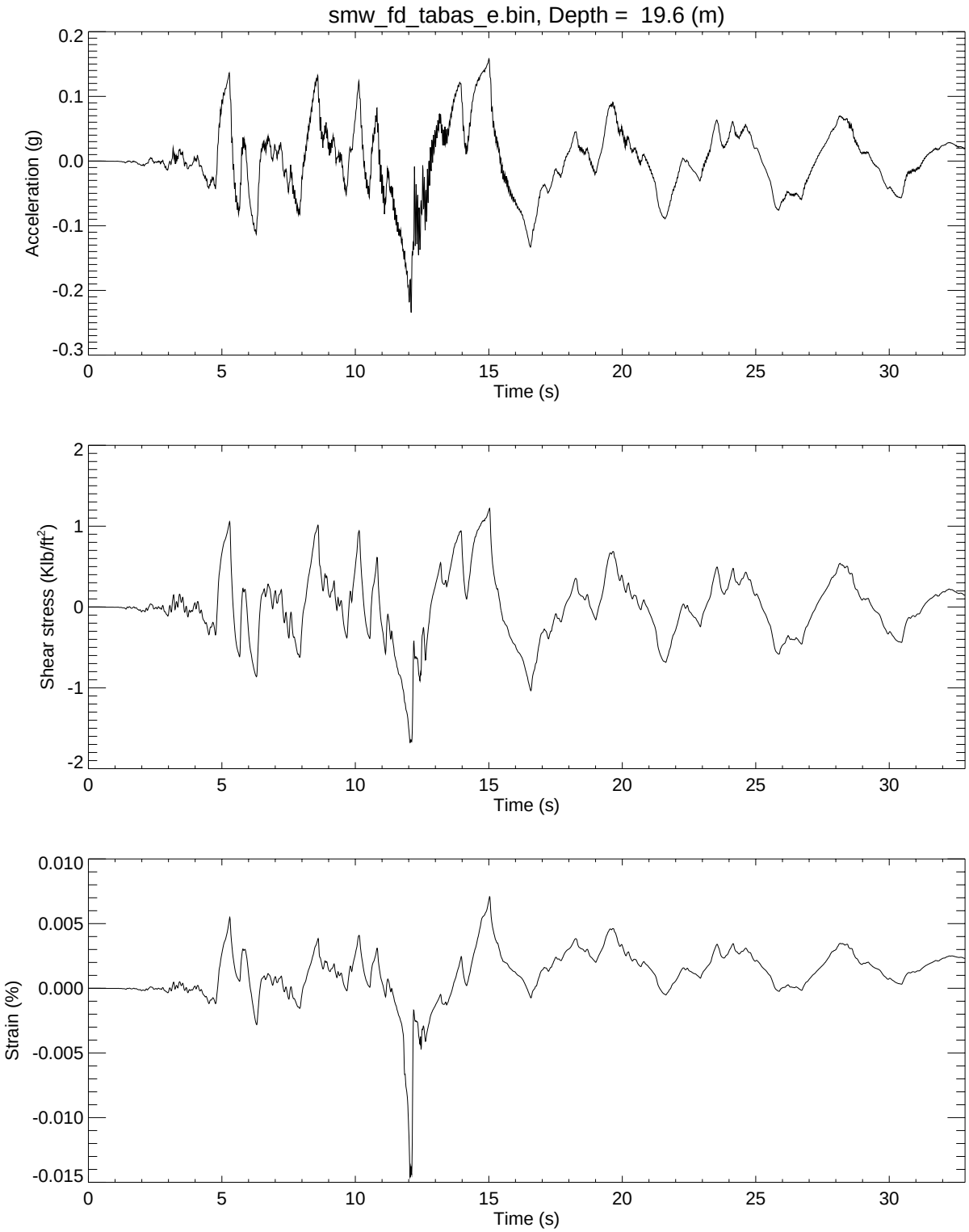

smw_fd_jld3_mean_half_e.bin, Depth = 19.6 (m)
1.5
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft^2)
-0.005
0.000
0.005
0.010
Strain (%)

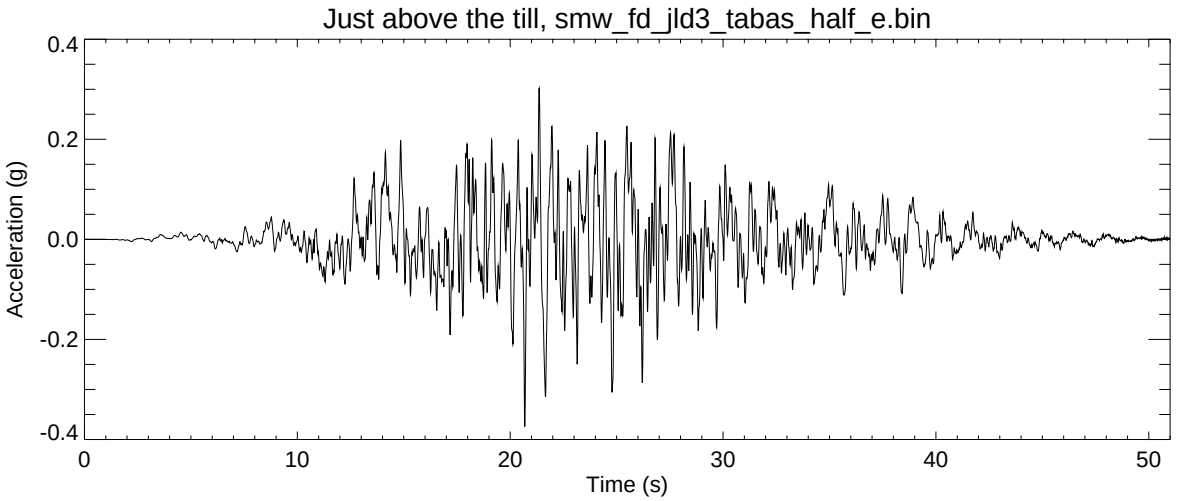

smw_fd_jld3_mean_half_e.bin, Depth = 19.6 (m)
Acceleration (g)
0.2
0.1
0.0
-0.1
-0.2
0
20
40
60
80
Time (s)
Shear stress (Klb/ft^2)
1.5
1.0
0.5
0.0
-0.5
-1.0
0
20
40
60
80
Time (s)
Strain (%)
0.010
0.005
0.000
-0.005
0
20
40
60
80
Time (s)

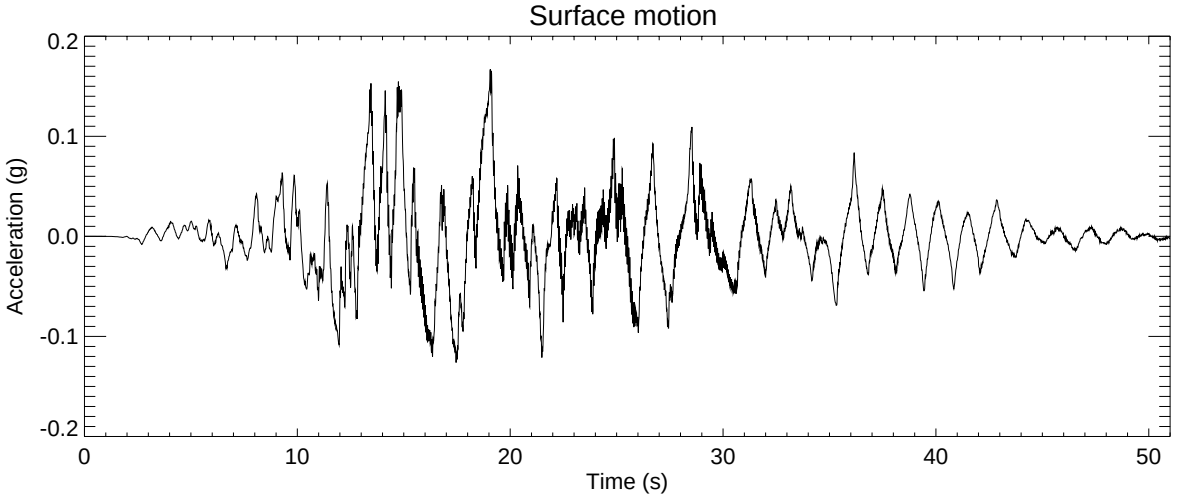

Just above the till, smw_fd_tabas_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

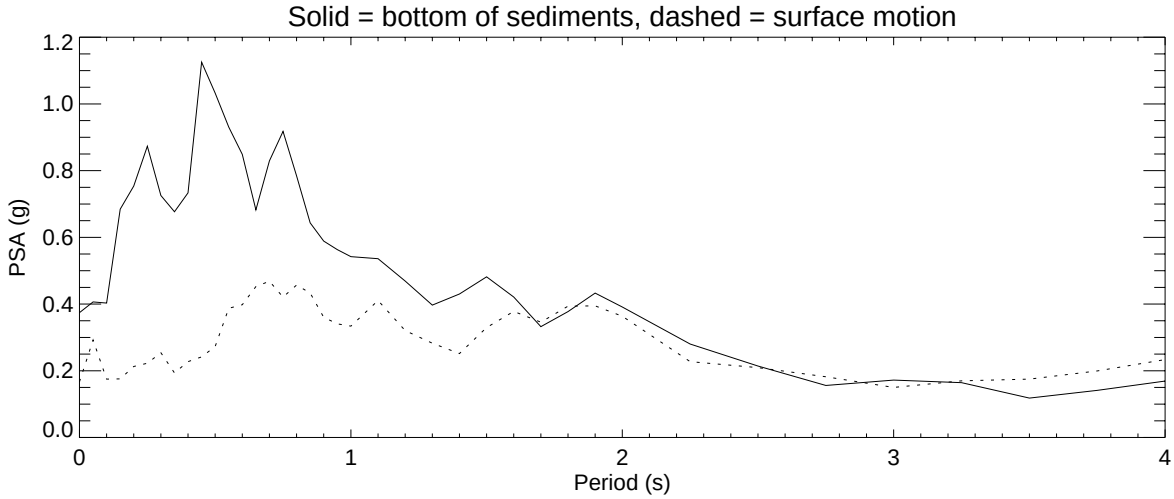

smw_fd_tabas_e.bin
Depth (m)
0
20
40
60
80
100
120
0.0001
0.0010
0.0100
0.1000
1.0000
10.0000
Peak shear strain (%)

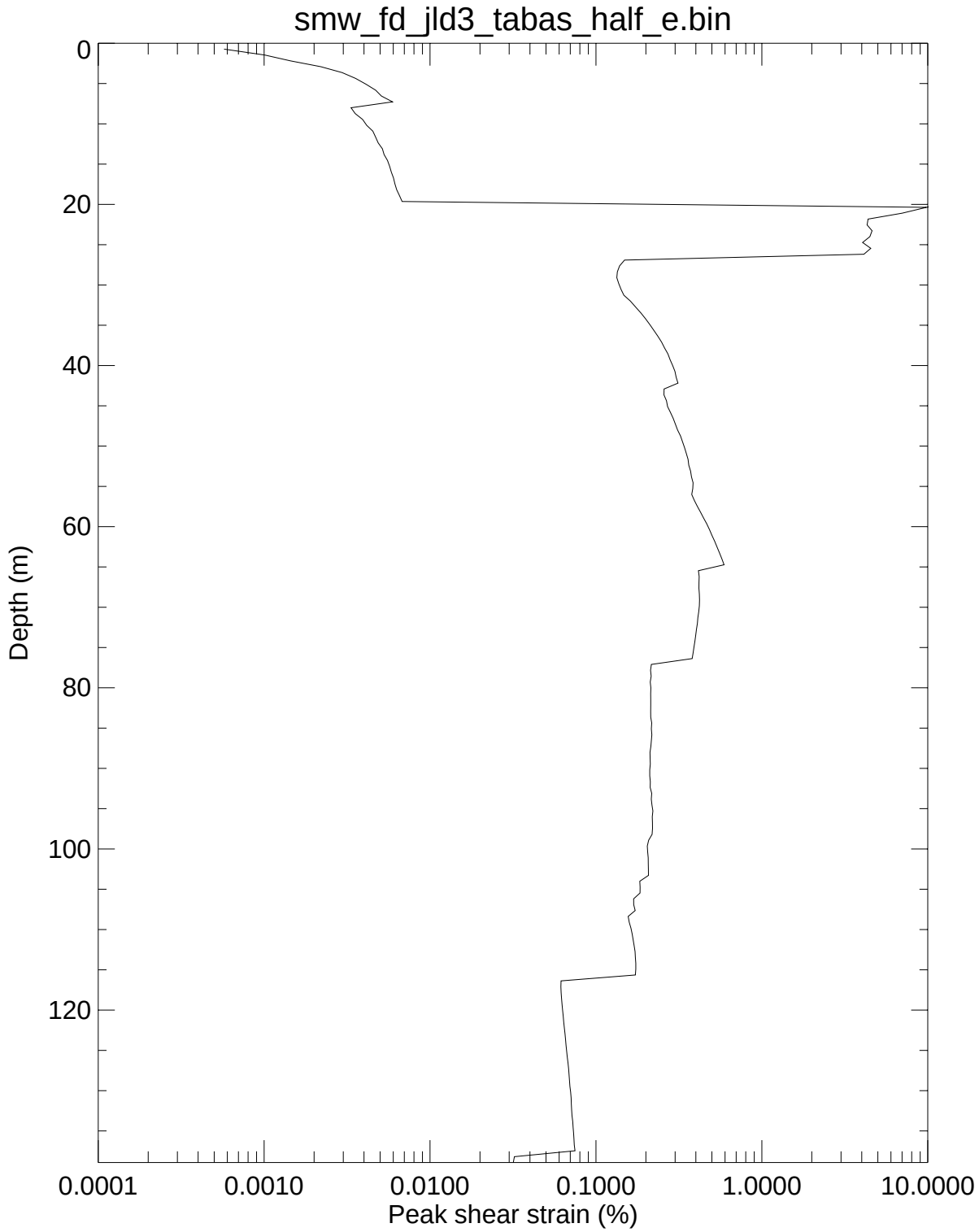

smw_fd_tabas_e.bin, Depth = 19.6 (m)
Stress (Klb/ft2)
Strain (%)
2
1
0
-1
-2
-0.015
-0.010
-0.005
0.000
0.005
0.010

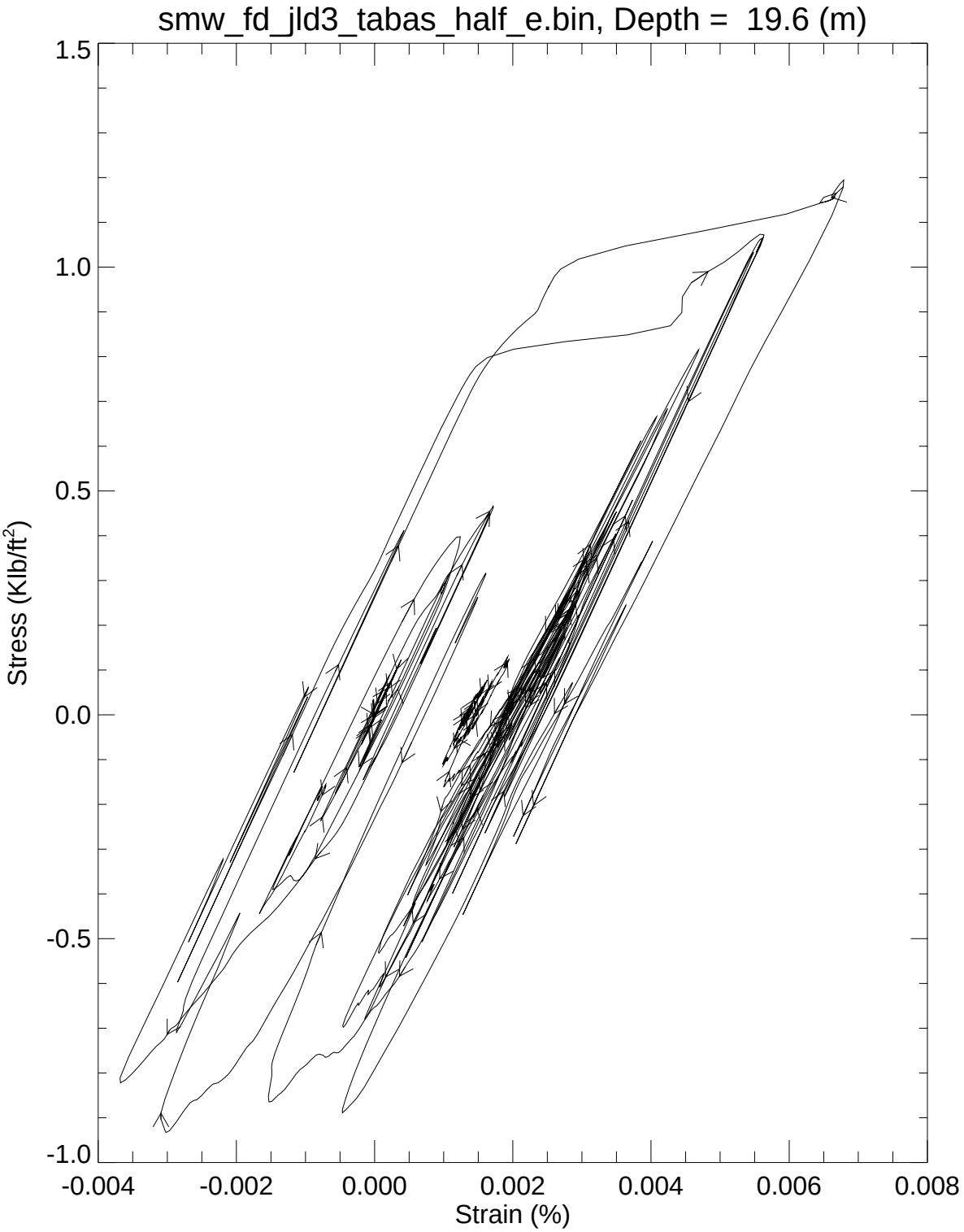

smw_fd_tabas_e.bin, Depth = 19.6 (m)
Acceleration (g)
0.2
0.1
0.0
-0.1
-0.2
-0.3
0
5
10
15
20
25
30
Time (s)
Shear stress (Klb/ft^2)
2
1
0
-1
-2
Time (s)
Strain (%)
0.010
0.005
0.000
-0.005
-0.010
-0.015
Time (s)

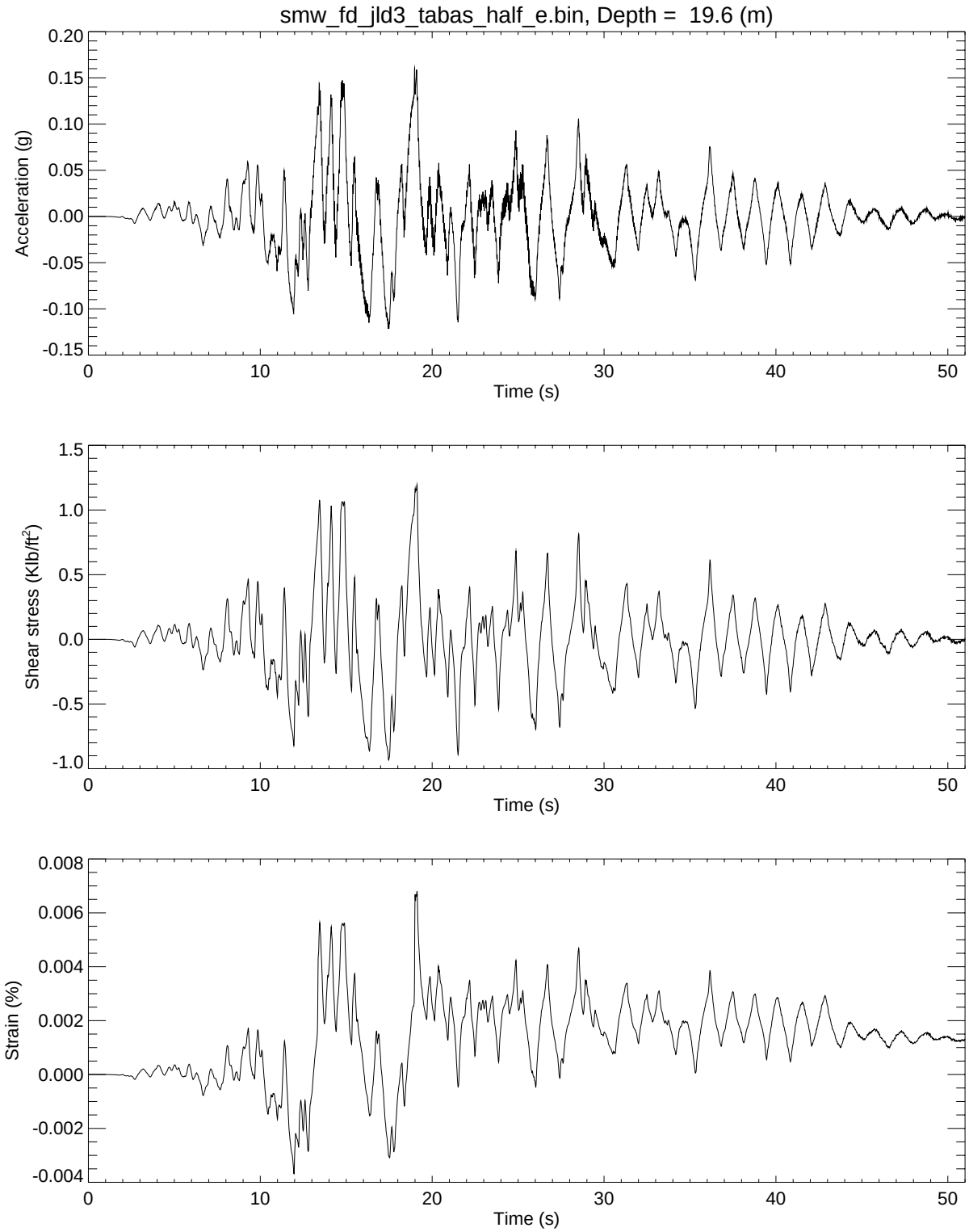

Just above the till, smw_fd_jld3_tabas_half_e.bin
Acceleration (g)
0.4
0.2
0.0
-0.2
-0.4
0
10
20
30
40
50
Time (s)

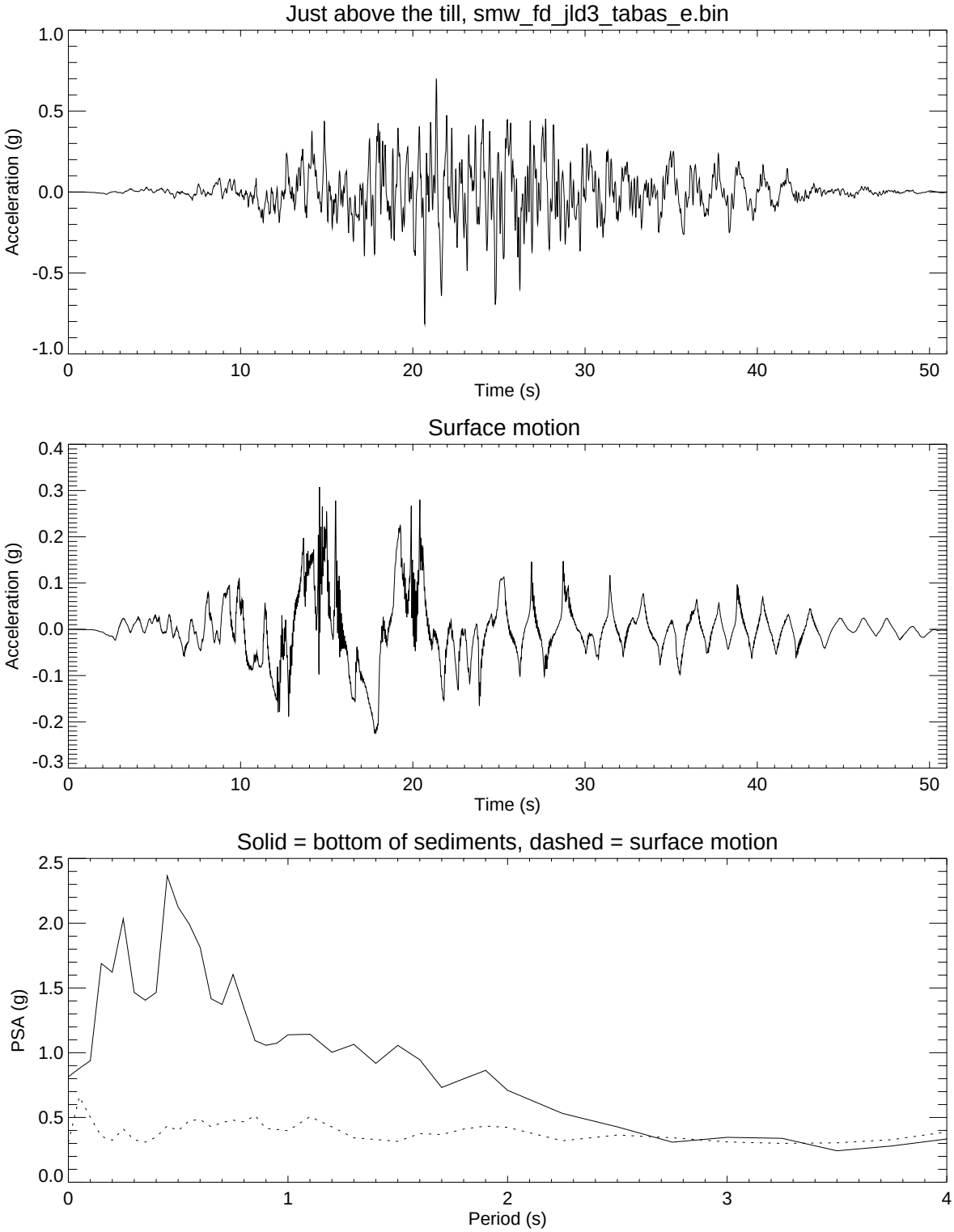

Surface motion
Acceleration (g)
0.2
0.1
0.0
-0.1
-0.2
0
10
20
30
40
50
Time (s)

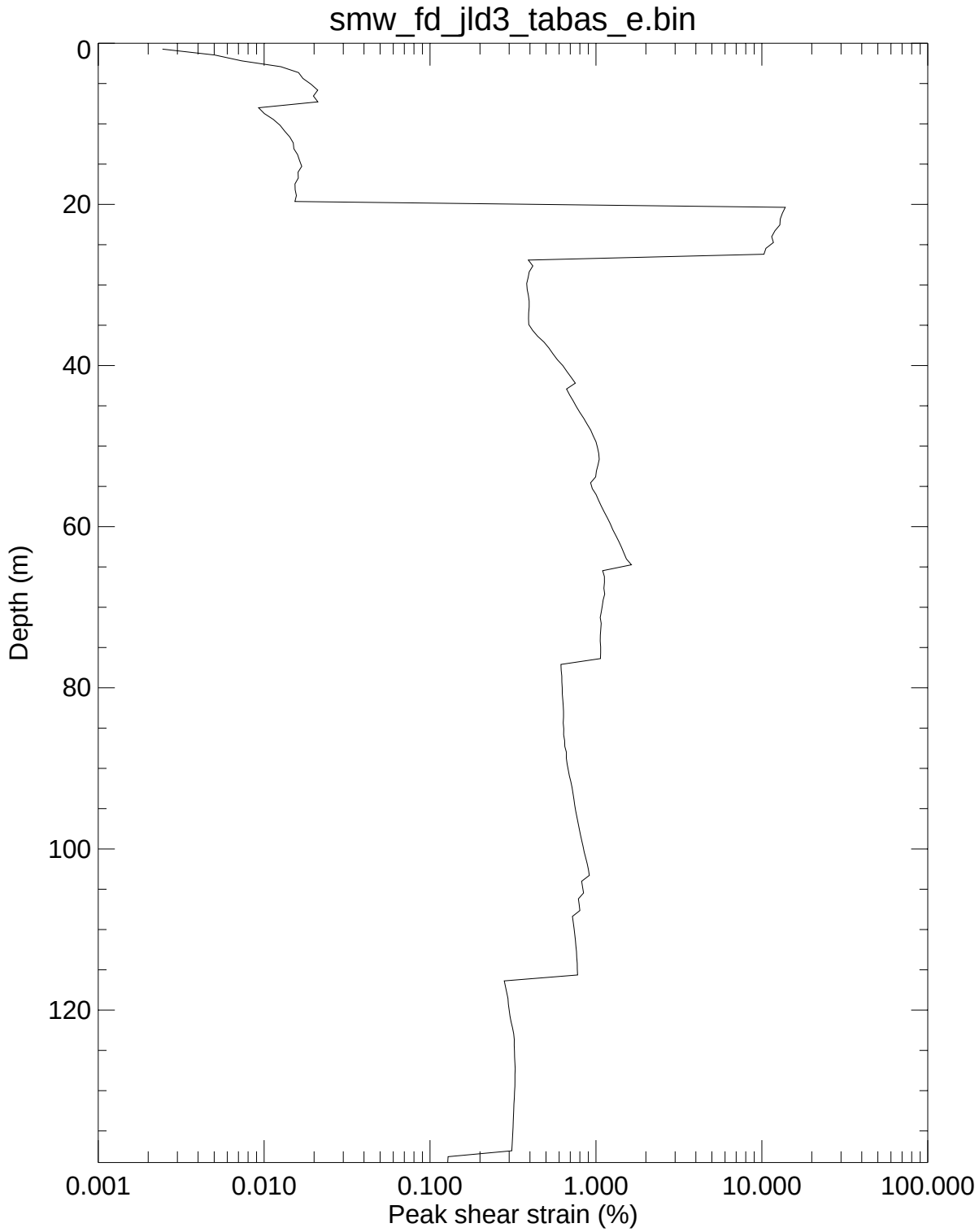

Solid = bottom of sediments, dashed = surface motion
PSA (g)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
Period (s)

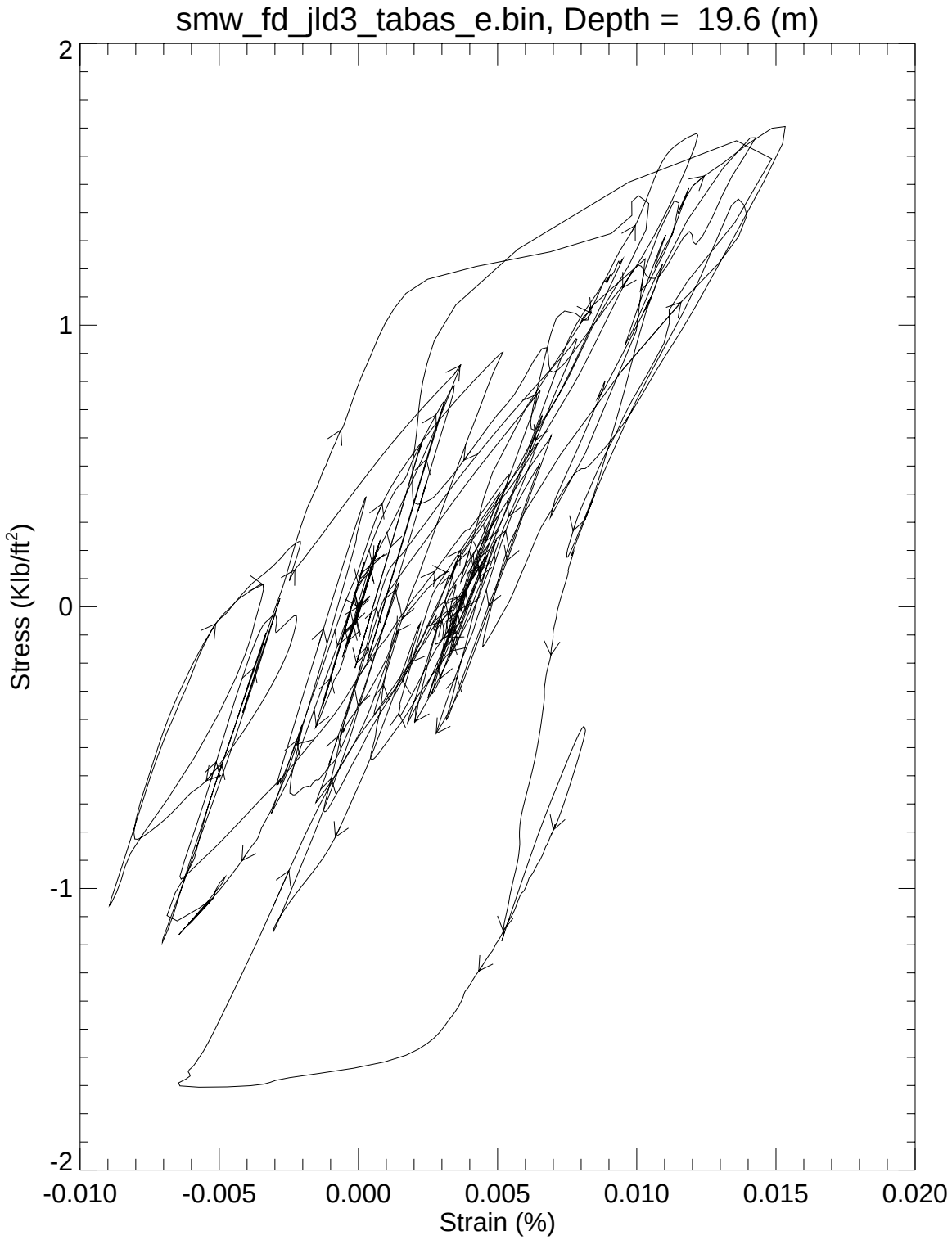

smw_fd_jld3_tabas_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.0001
0.0010
0.0100
0.1000
1.0000
10.0000
Peak shear strain (%)

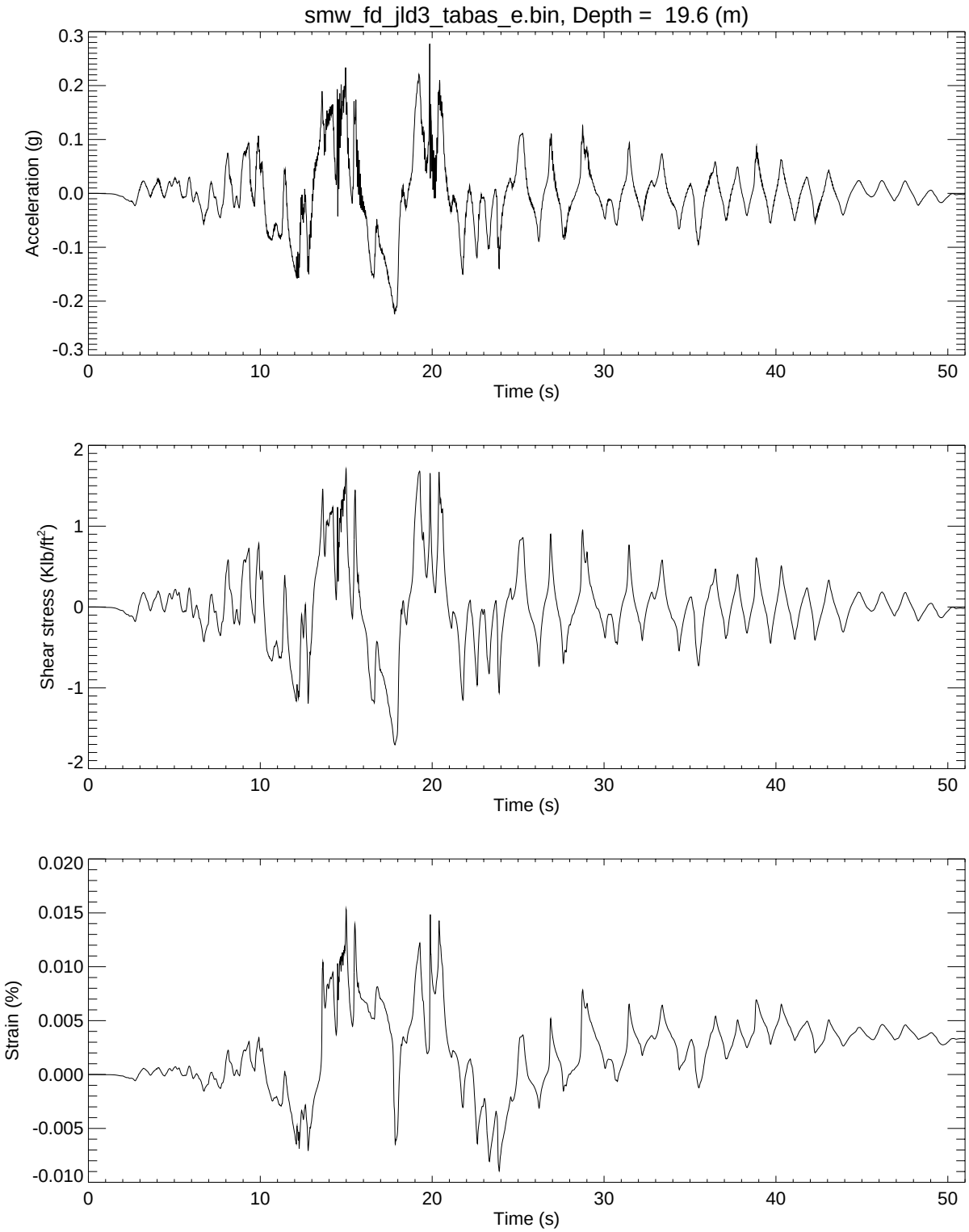

smw_fd_jld3_tabas_half_e.bin, Depth = 19.6 (m)
1.5
1.0
0.5
0.0
-0.5
-1.0
Stress (Klb/ft^2)
-0.004
-0.002
0.000
0.002
0.004
0.006
0.008
Strain (%)

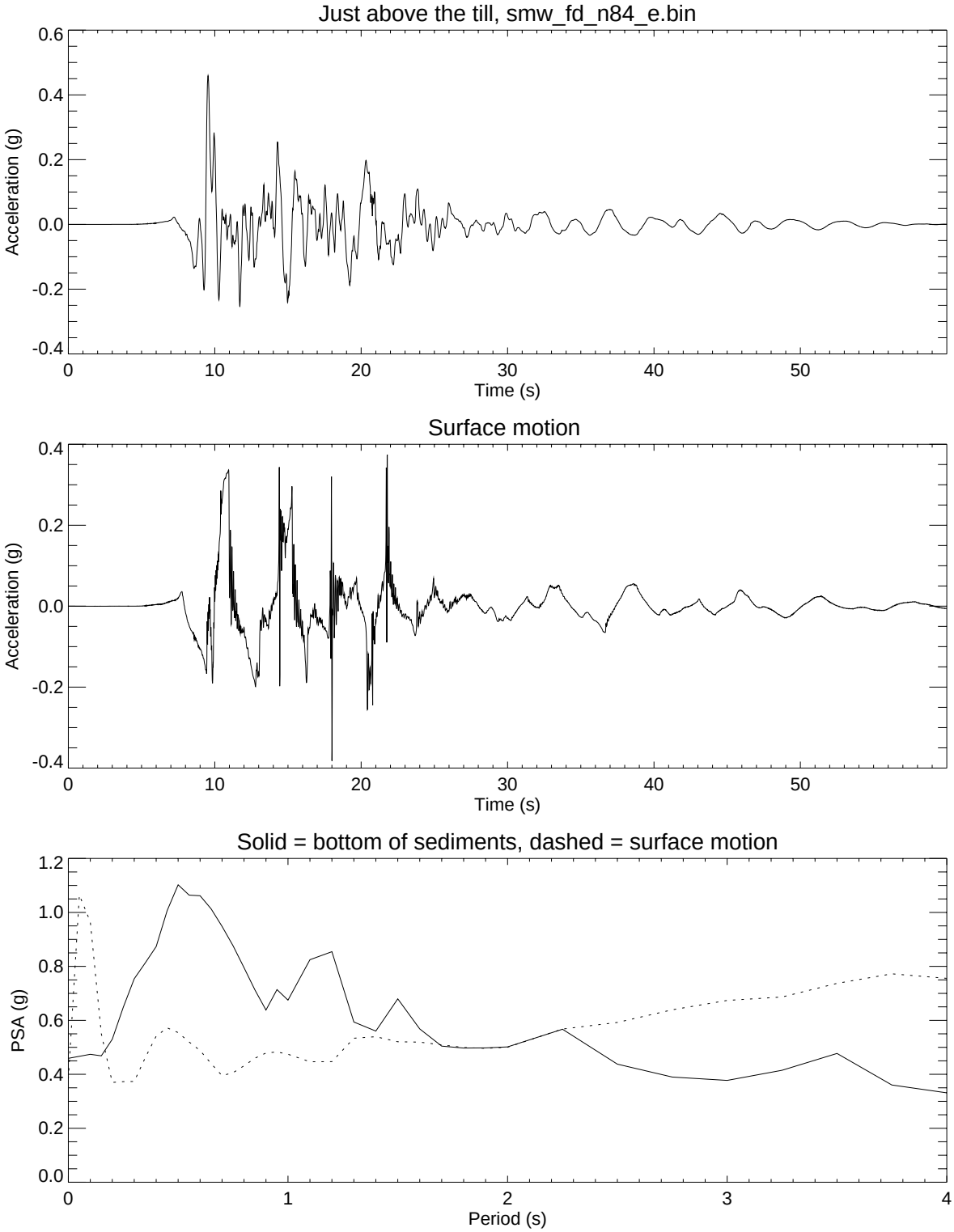

smw_fd_jld3_tabas_half_e.bin, Depth = 19.6 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

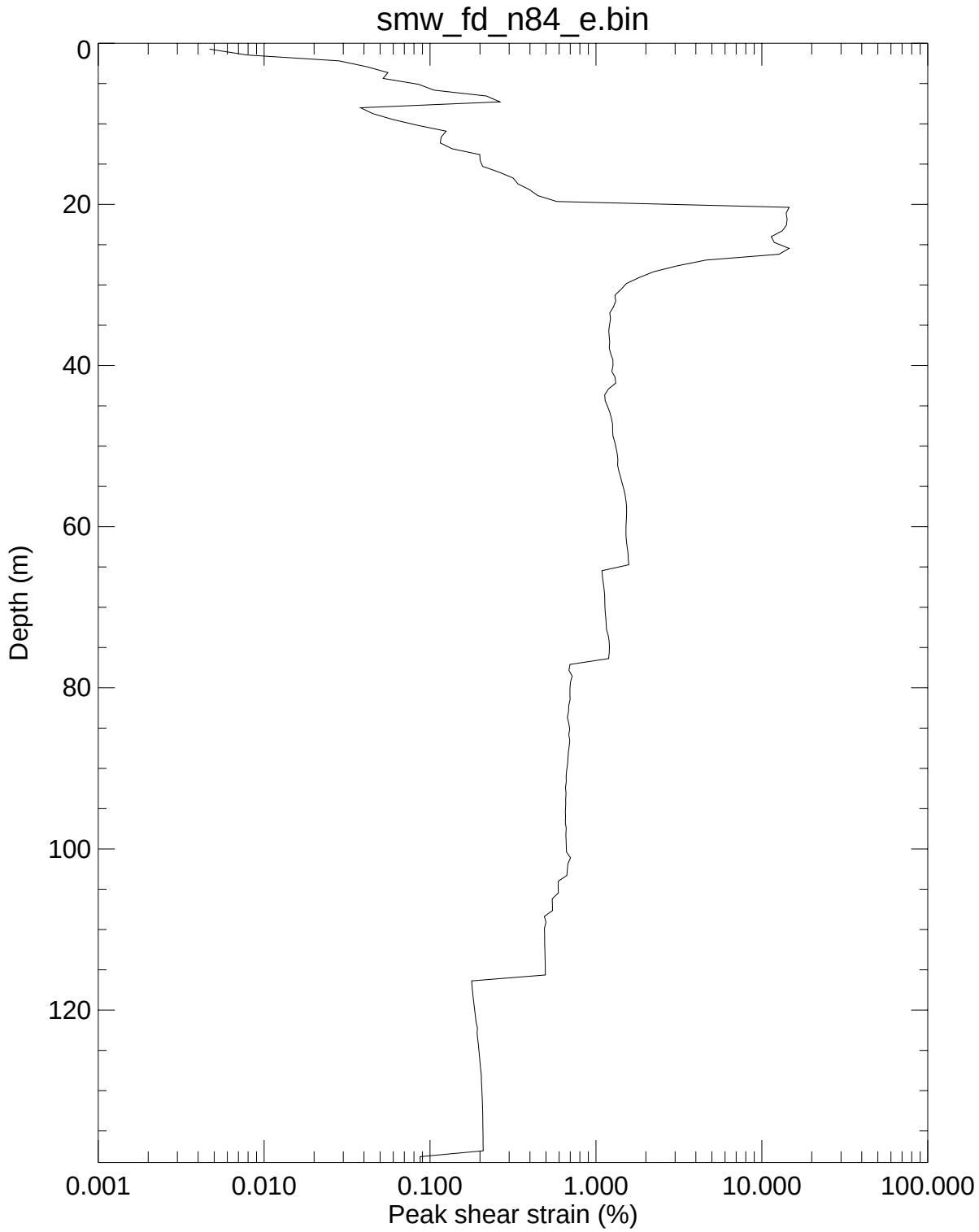

Just above the till, smw_fd_jld3_tabas_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

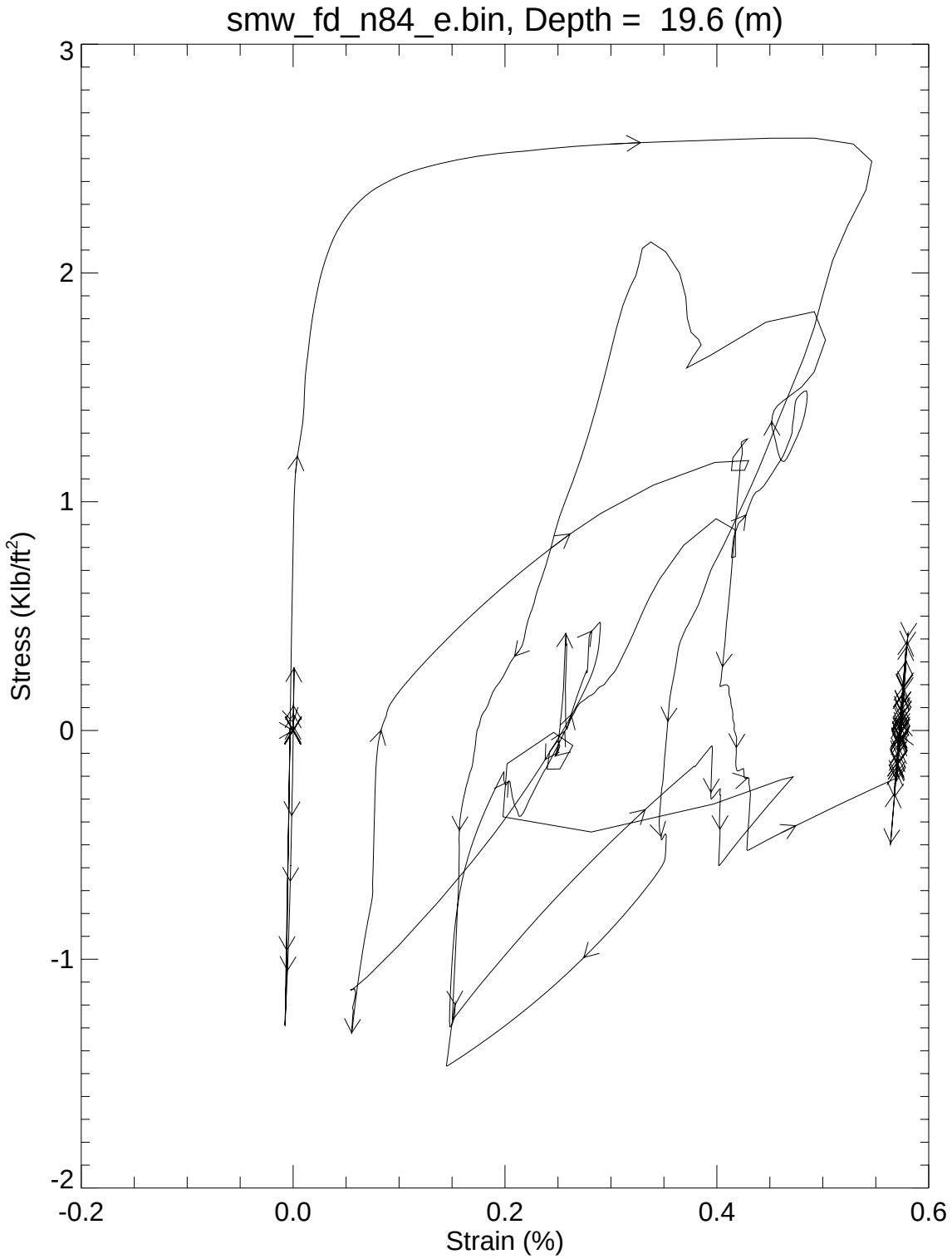

smw_fd_jld3_tabas_e.bin
Depth (m)
0
20
40
60
80
100
120
0.001
0.010
0.100
1.000
10.000
100.000
Peak shear strain (%)

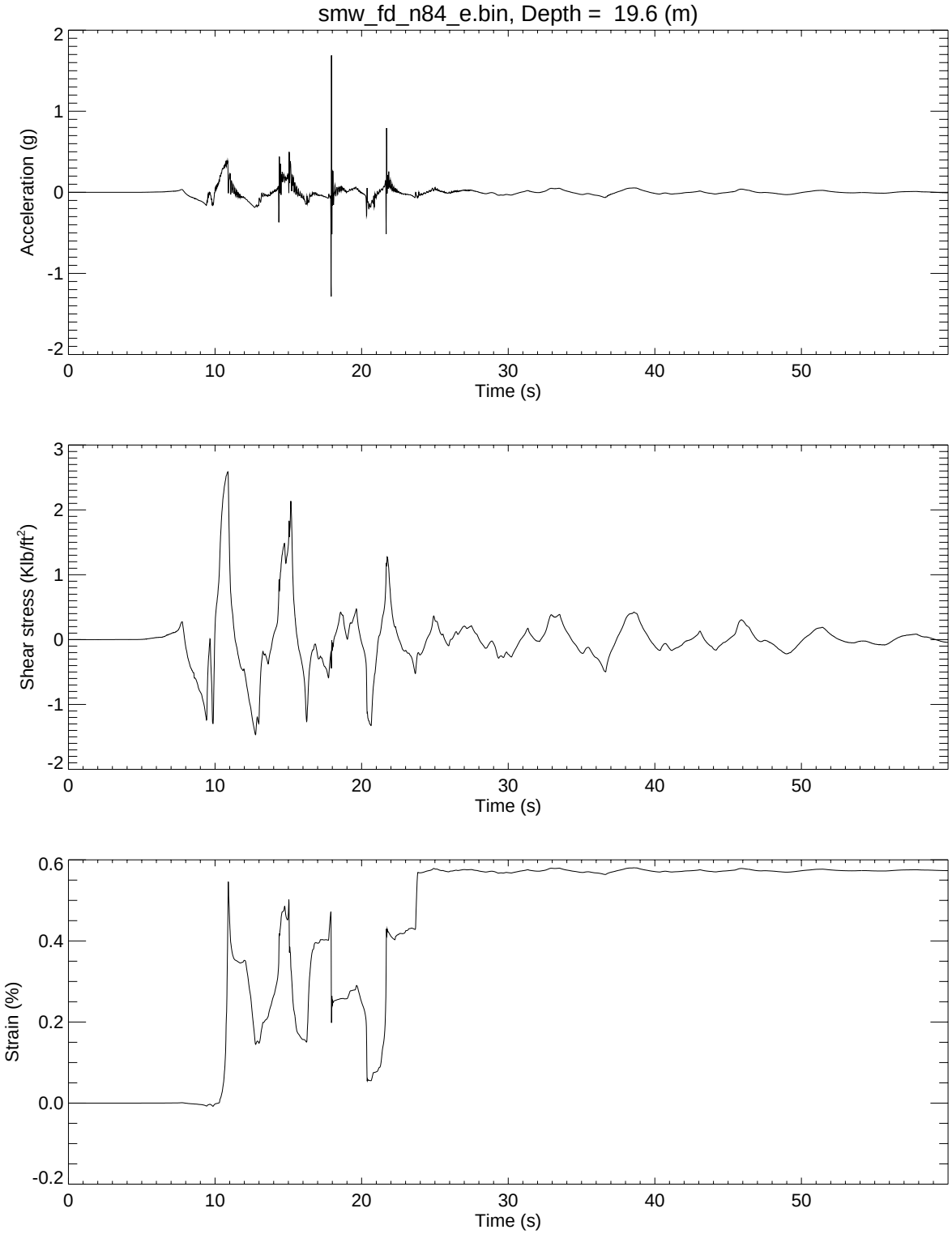

smw_fd_jld3_tabas_e.bin, Depth = 19.6 (m)
Stress (Klb/ft^2)
Strain (%)
2
1
0
-1
-2
-0.010
-0.005
0.000
0.005
0.010
0.015
0.020

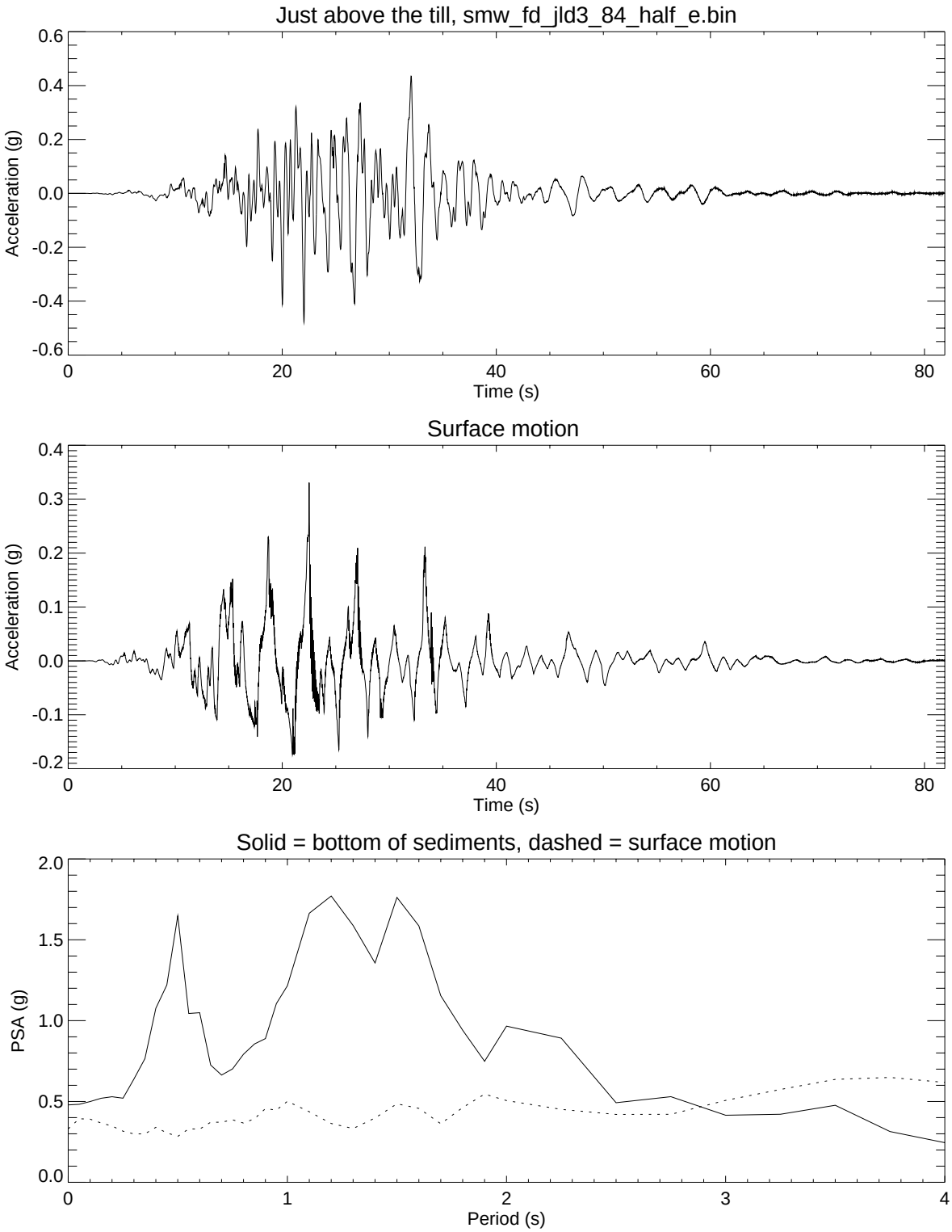

smw_fd_jld3_tabas_e.bin, Depth = 19.6 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)

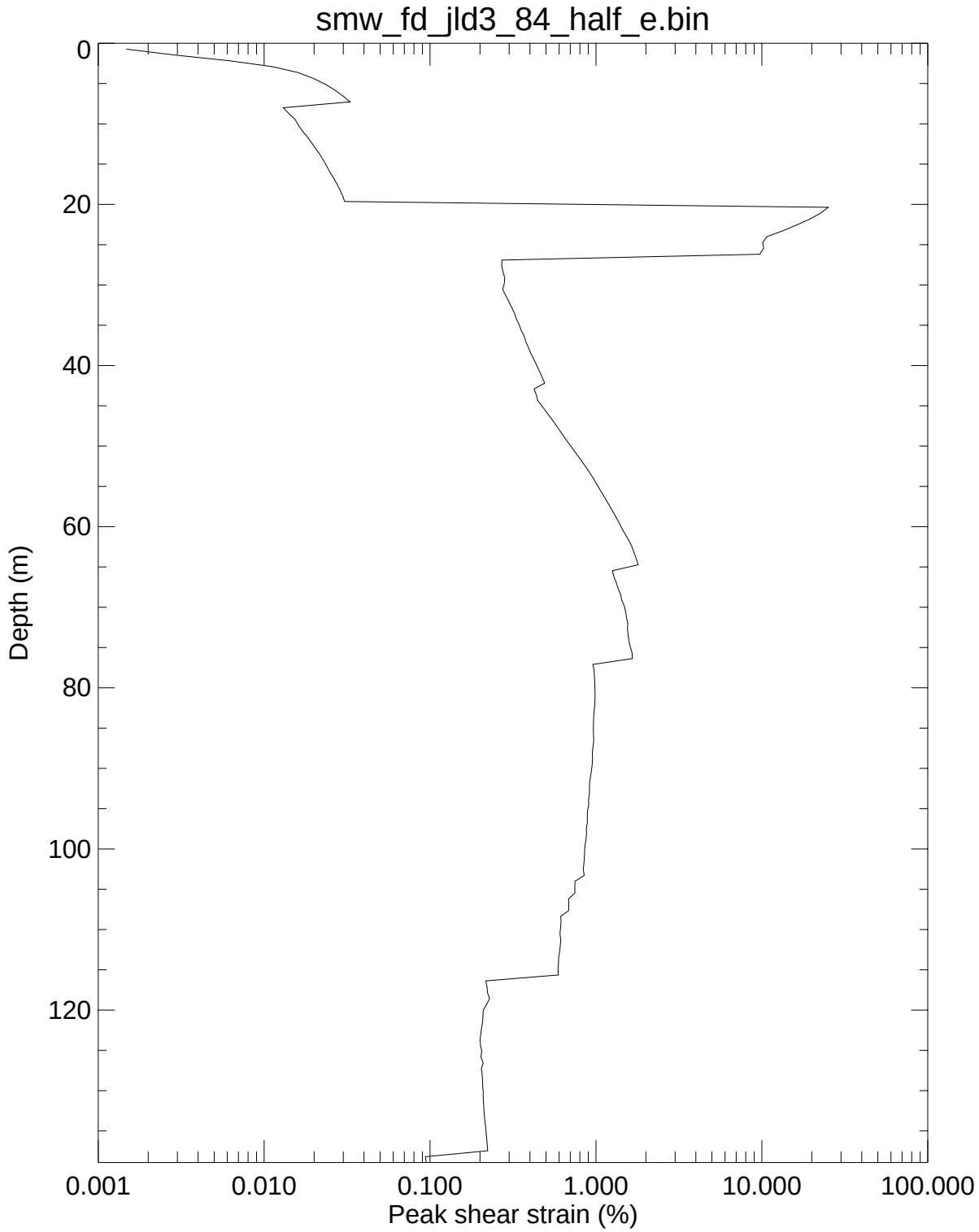

Just above the till, smw_fd_n84_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)

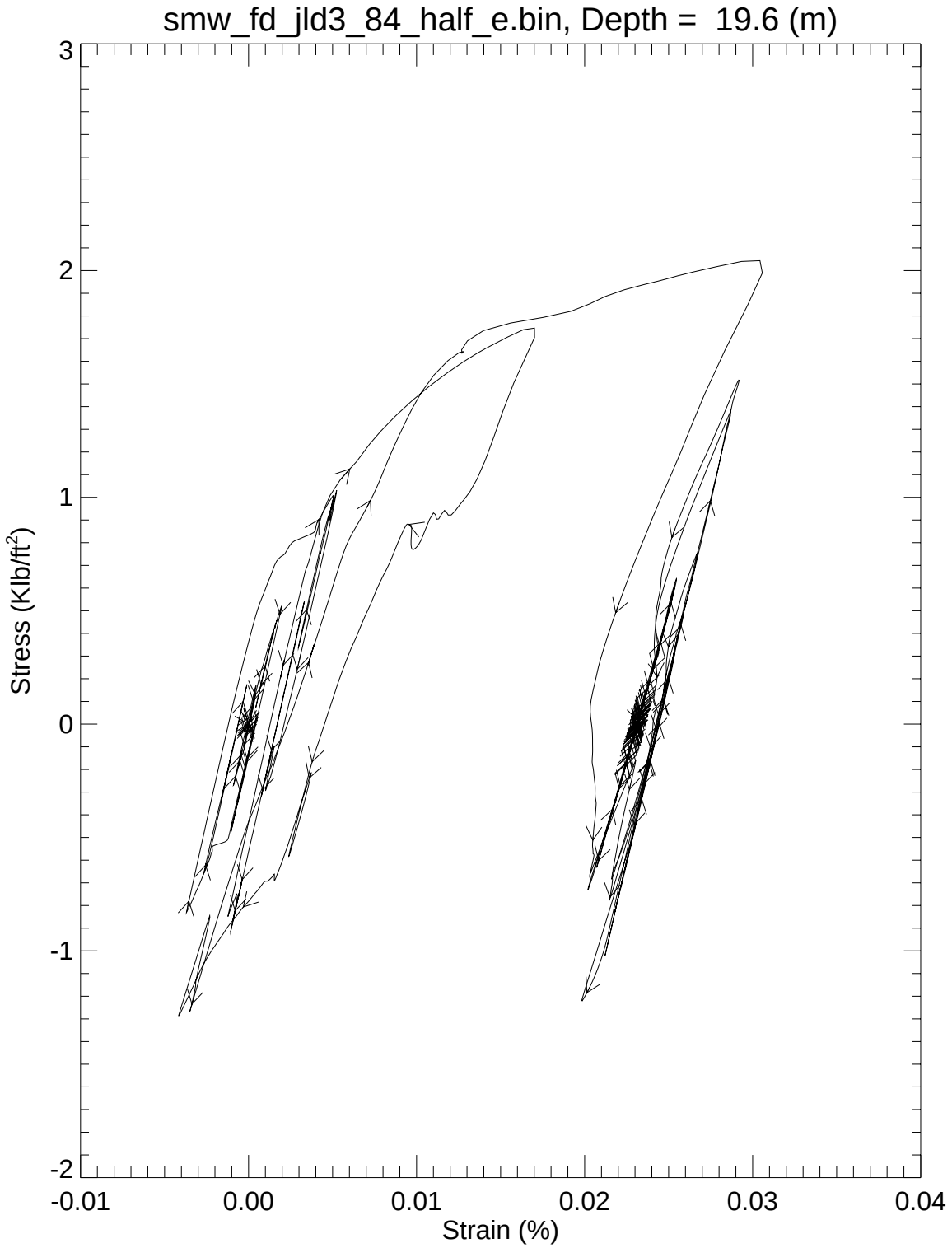

smw_fd_n84_e.bin
Depth (m)
0
20
40
60
80
100
120
0.001
0.010
0.100
1.000
10.000
100.000
Peak shear strain (%)

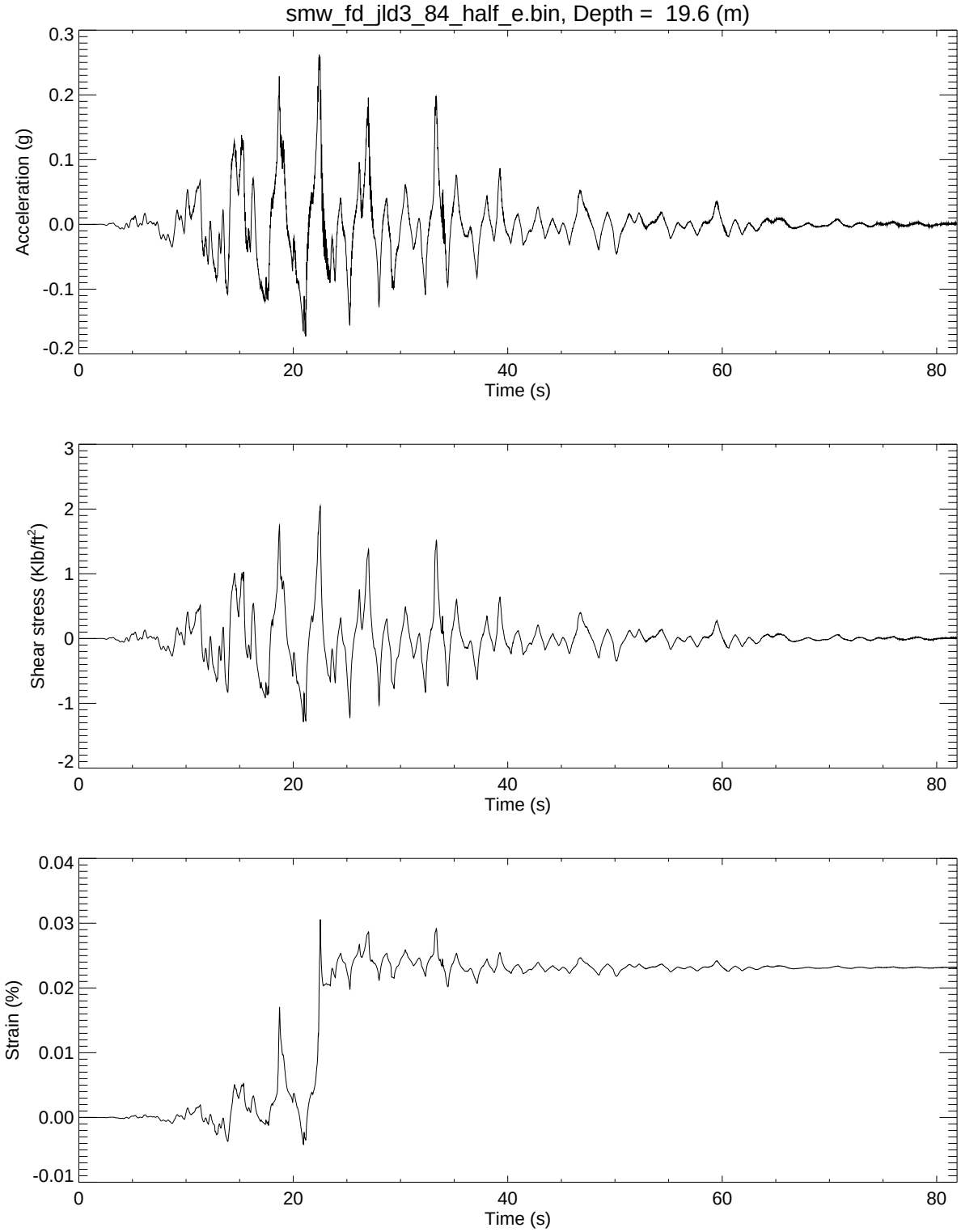

smw_fd_n84_e.bin, Depth = 19.6 (m)
Stress (Klb/ft2)
Strain (%)
3
2
1
0
-1
-2
-0.2
0.0
0.2
0.4
0.6


smw_fd_n84_e.bin, Depth = 19.6 (m)
Acceleration (g)
Time (s)
Shear stress (Klb/ft^2)
Time (s)
Strain (%)
Time (s)


Just above the till, smw_fd_jld3_84_half_e.bin
Acceleration (g)
Time (s)
Surface motion
Acceleration (g)
Time (s)
Solid = bottom of sediments, dashed = surface motion
PSA (g)
Period (s)


smw_fd_jld3_84_half_e.bin
Depth (m)
0
20
40
60
80
100
120
0.001
0.010
0.100
1.000
10.000
100.000
Peak shear strain (%)


smw_fd_jld3_84_half_e.bin, Depth = 19.6 (m)
Stress (Klb/ft^2)
Strain (%)
3
2
1
0
-1
-2
-0.01
0.00
0.01
0.02
0.03
0.04


smw_fd_jld3_84_half_e.bin, Depth = 19.6 (m)
Acceleration (g)
0.3
0.2
0.1
0.0
-0.1
-0.2
0
20
40
60
80
Time (s)
Shear stress (Klb/ft^2)
3
2
1
0
-1
-2
0
20
40
60
80
Time (s)
Strain (%)
0.04
0.03
0.02
0.01
0.00
-0.01
0
20
40
60
80
Time (s)