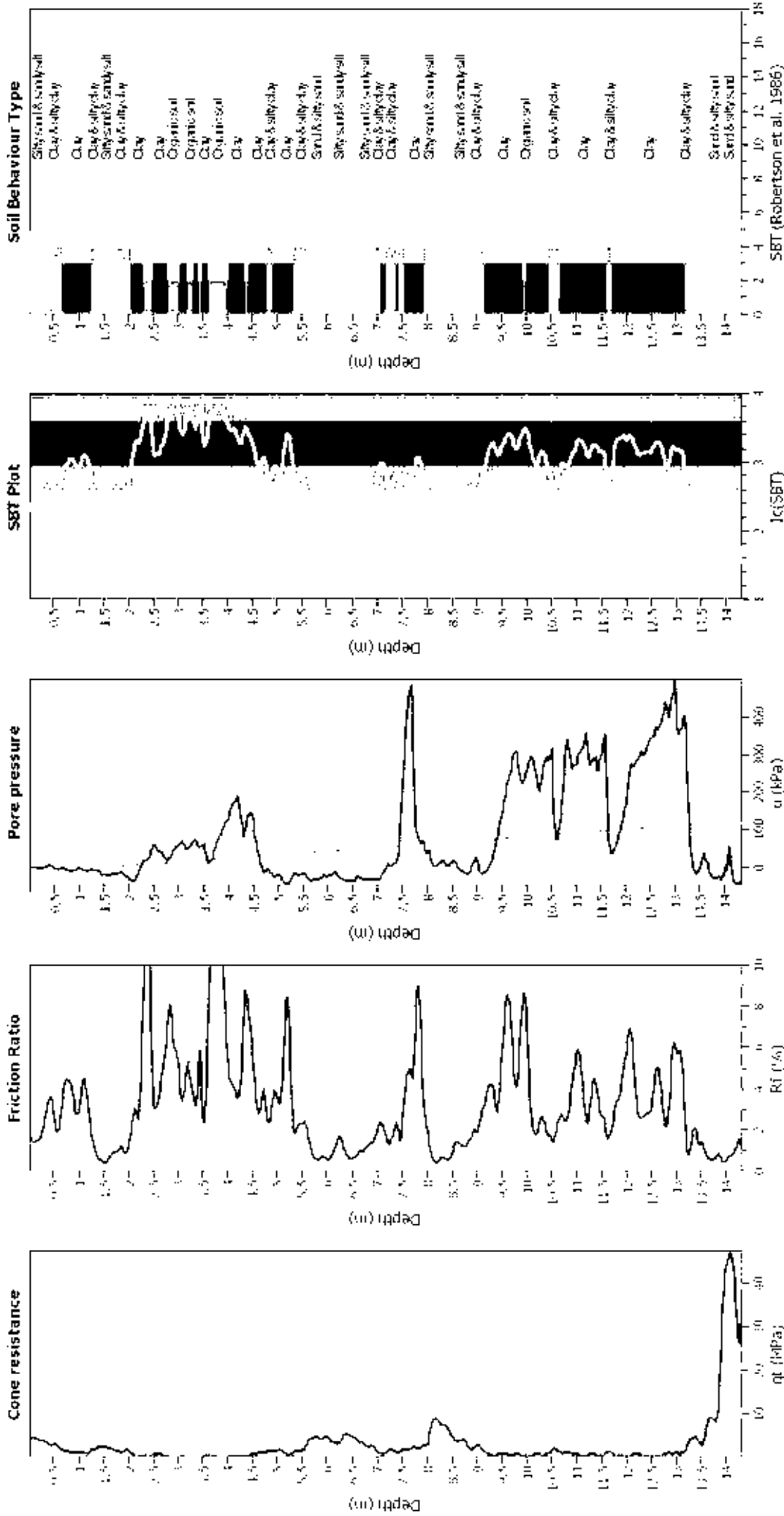


### CPT basic interpretation plots



### Input parameters and analysis data

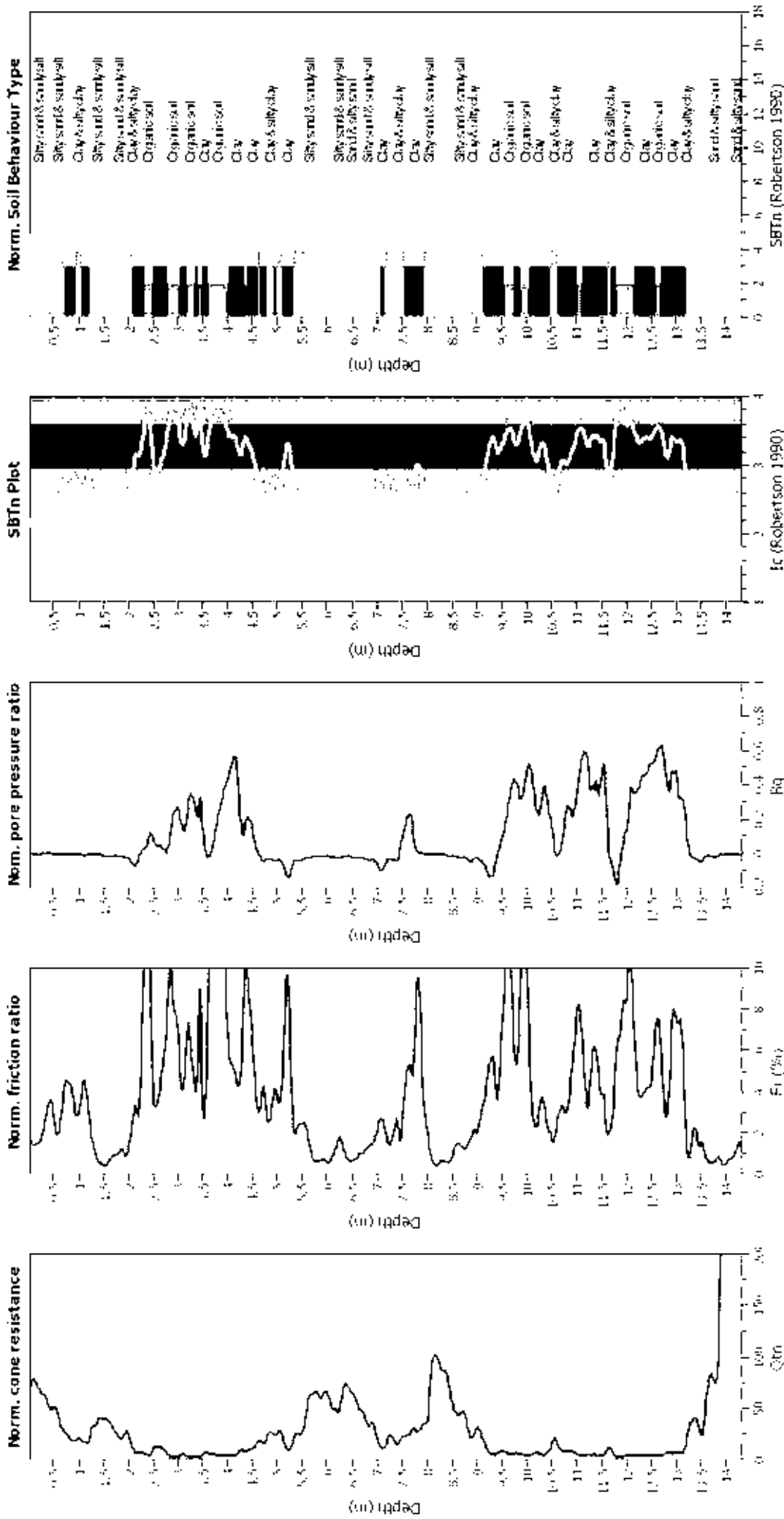
Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial magnitude $M_s$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A

Depth to GW (erthq.):	1.50 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



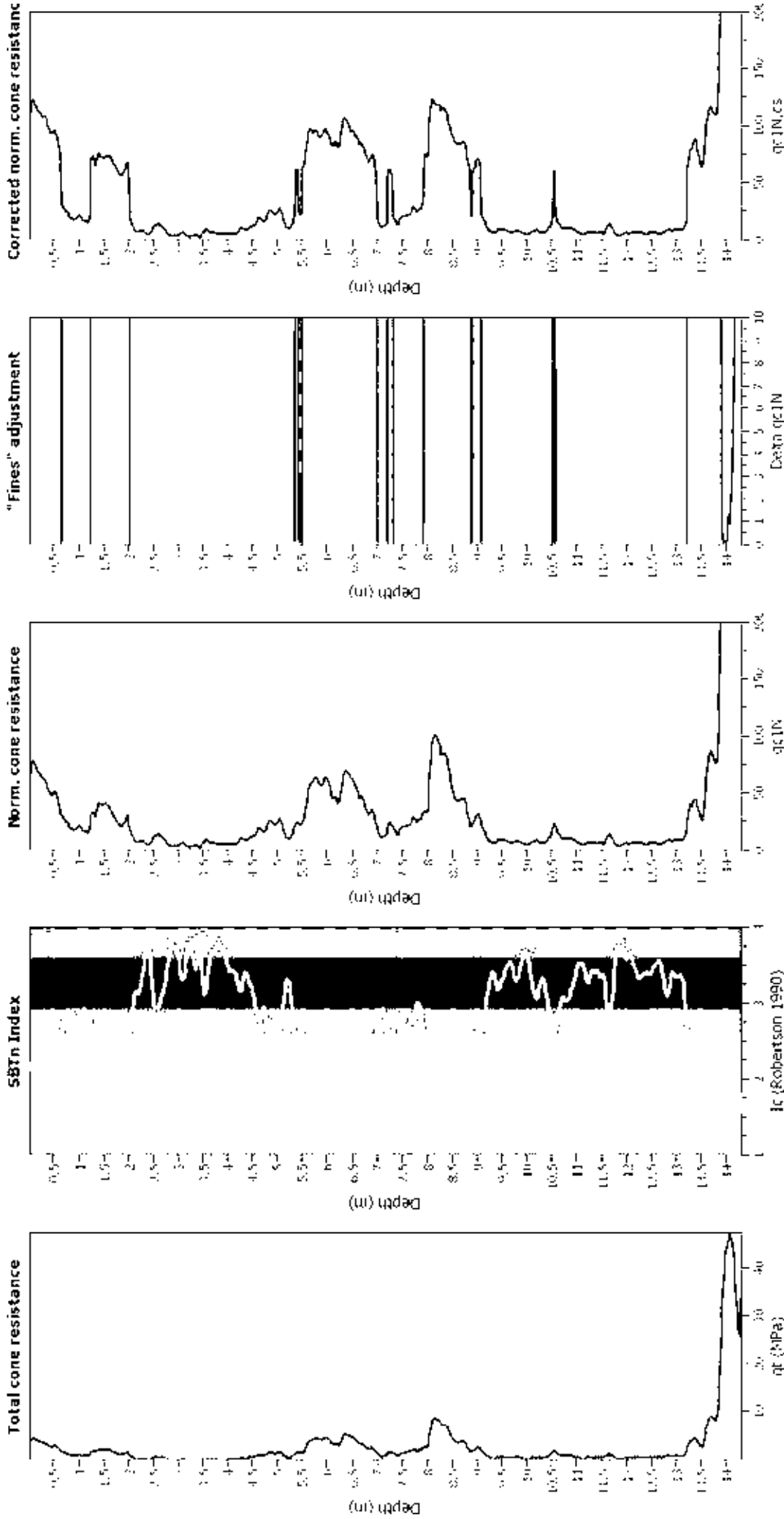
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A	Sand & Clay	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Clay like behavior applied		
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No		
Peak ground acceleration:	0.35	Use fill:	No	Unit depth:	N/A		
Depth to water table (m):	1.50 m	Fill height:	N/A				

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

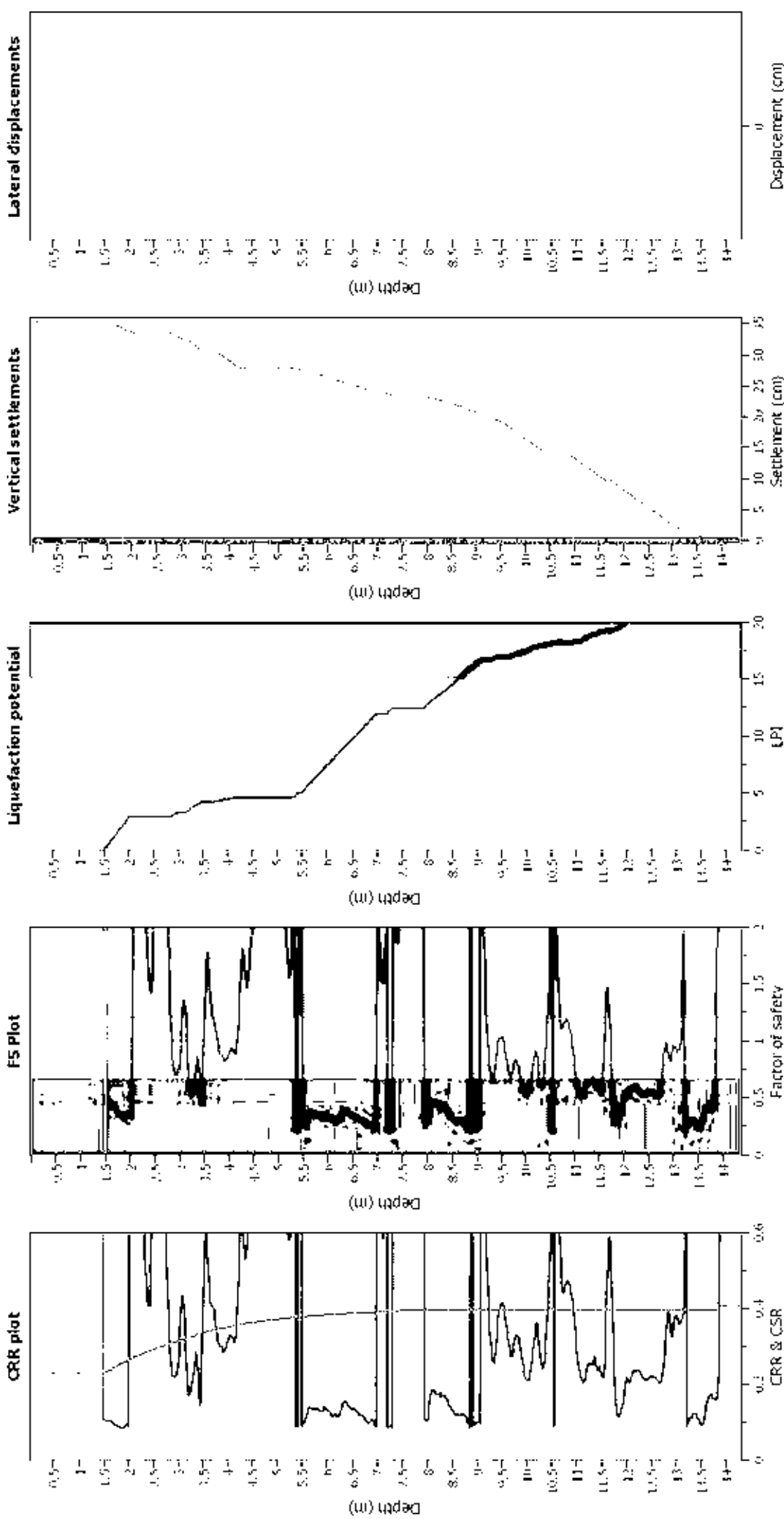
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Input correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

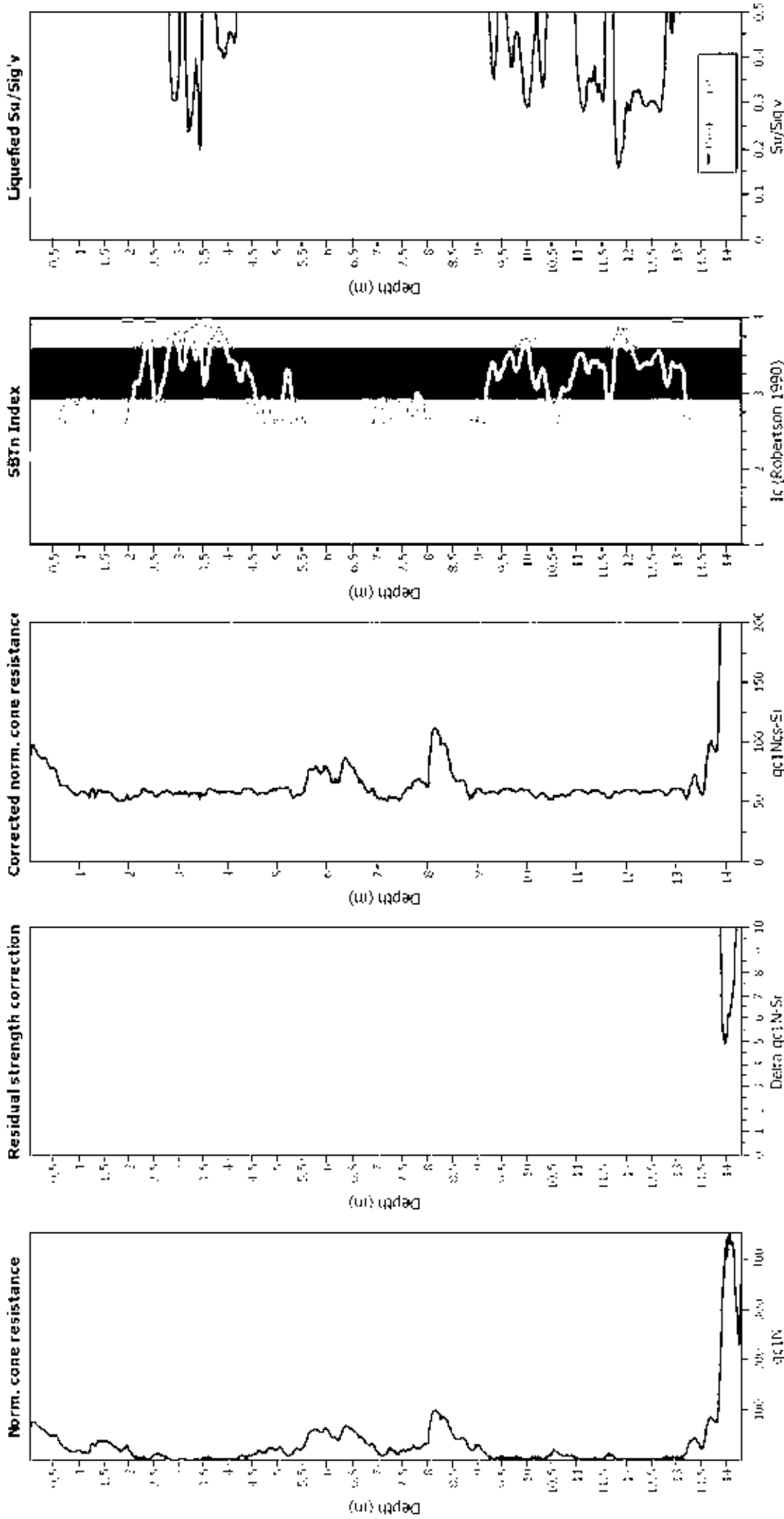
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

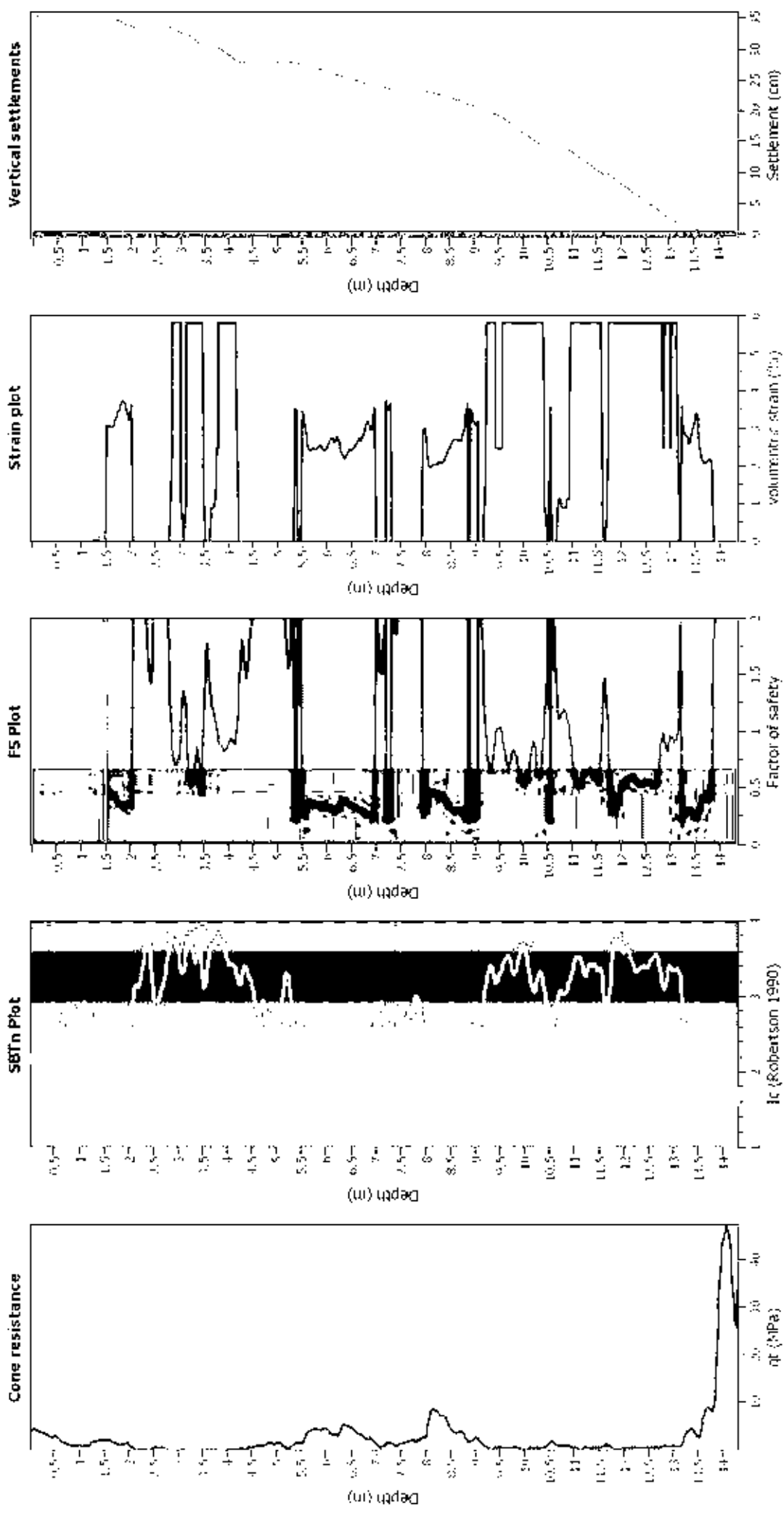
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial mag. angle $\beta_c$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (erthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- TC: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- SB: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Vol: Volumetric strain; Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT15\_101SabysRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

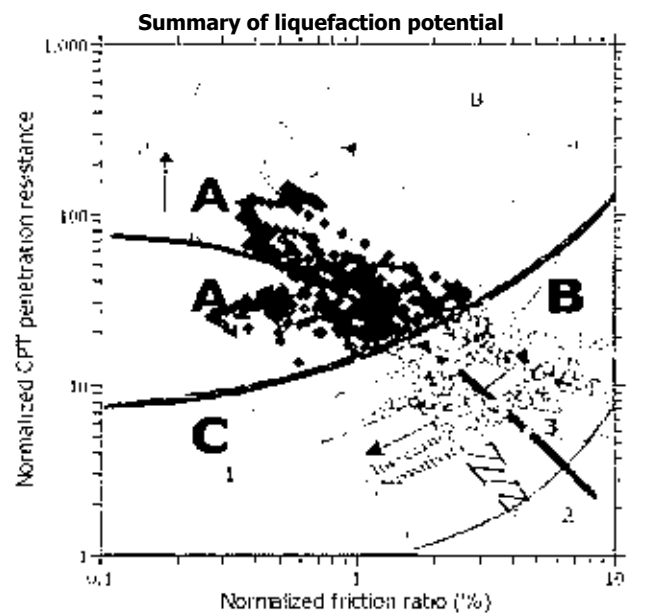
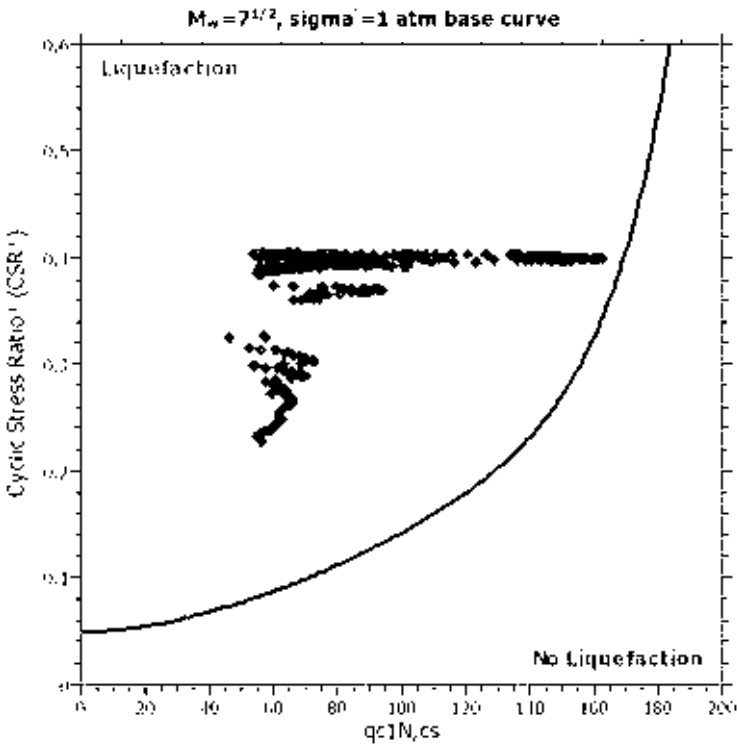
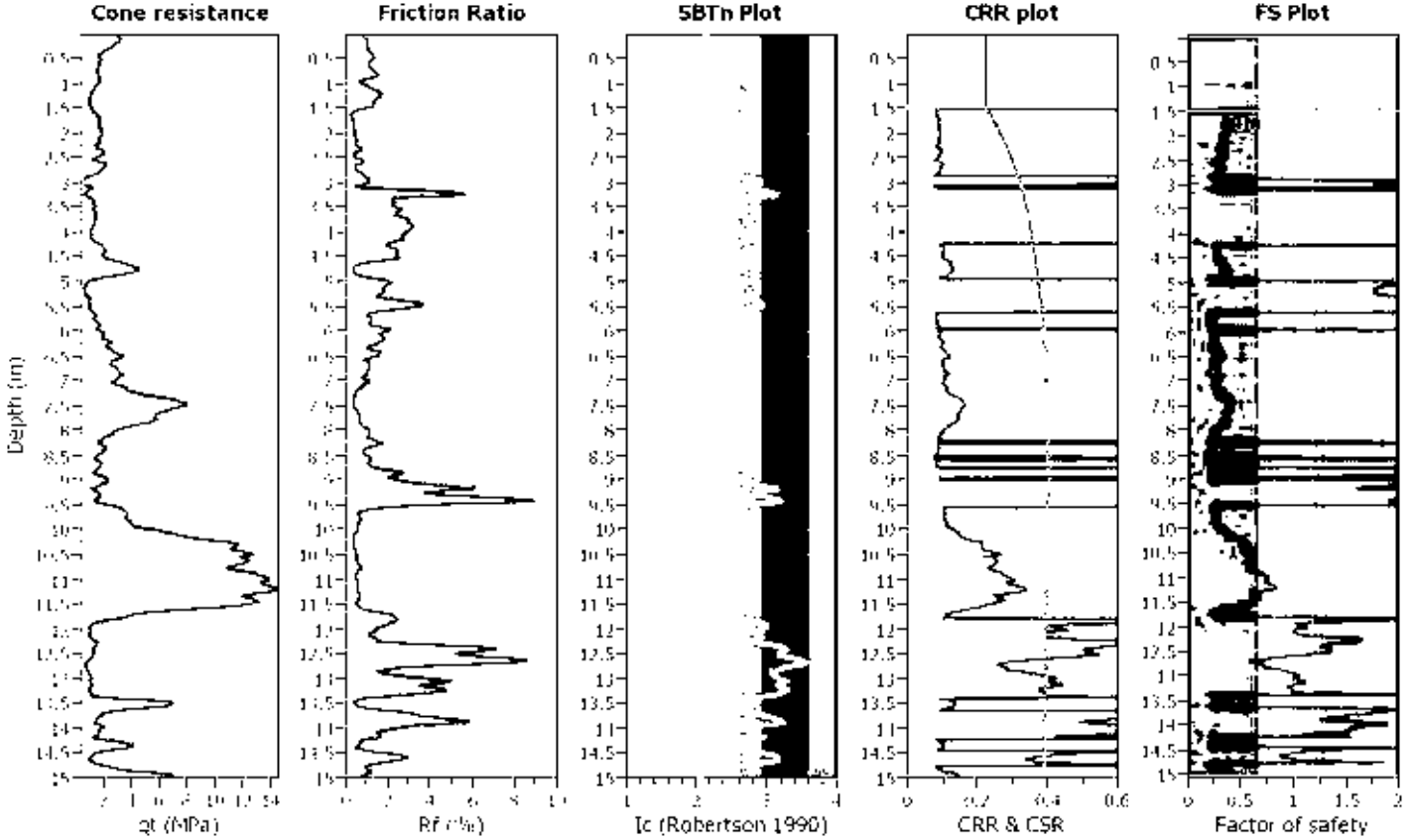
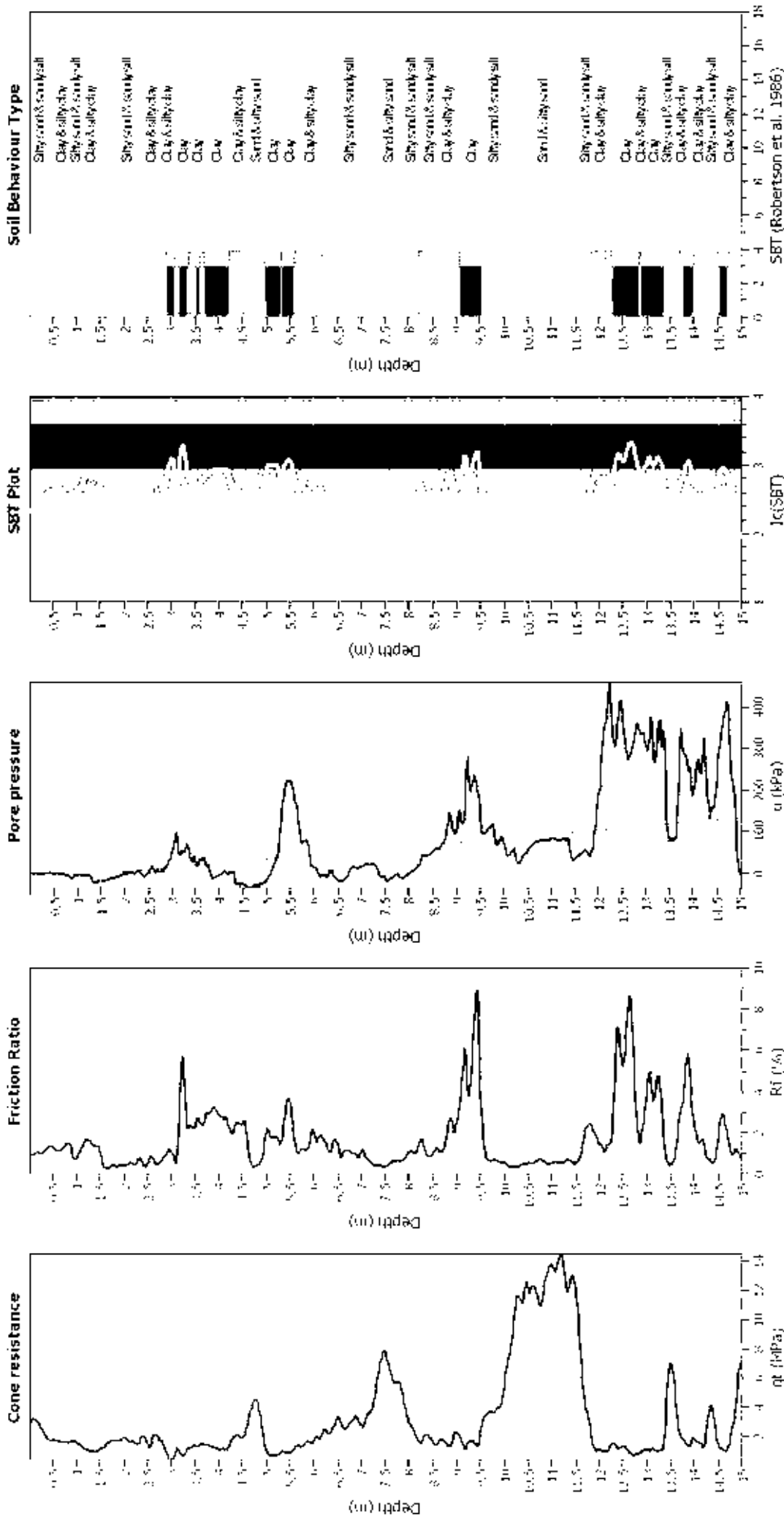


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A: Fully liquefiable; Zone B: Partially liquefiable; Zone C: Non-liquefiable. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with zones A, B, and C indicating different levels of liquefaction potential.

### CPT basic interpretation plots



### Input parameters and analysis data

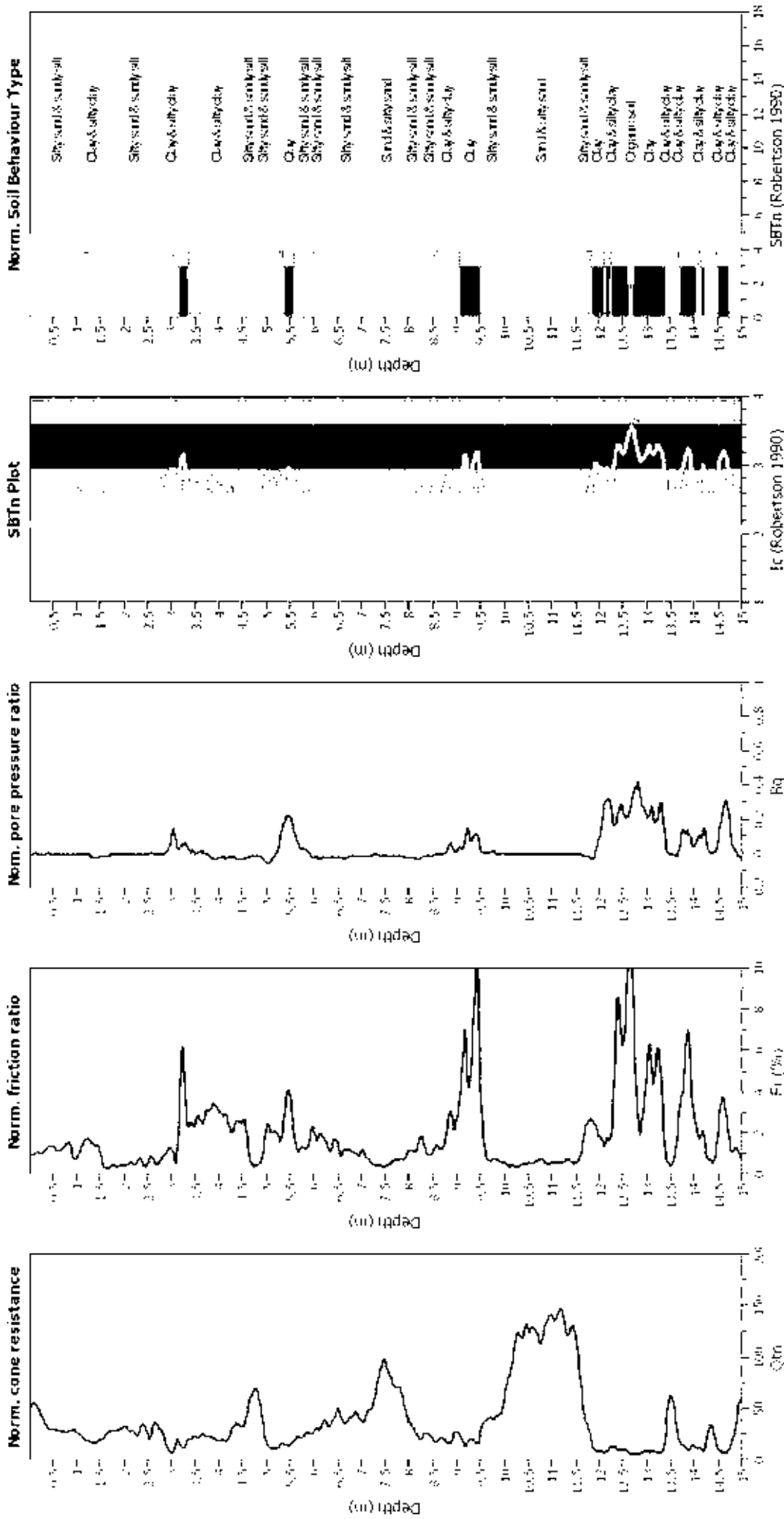
Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### CPT basic interpretation plots (normalized)



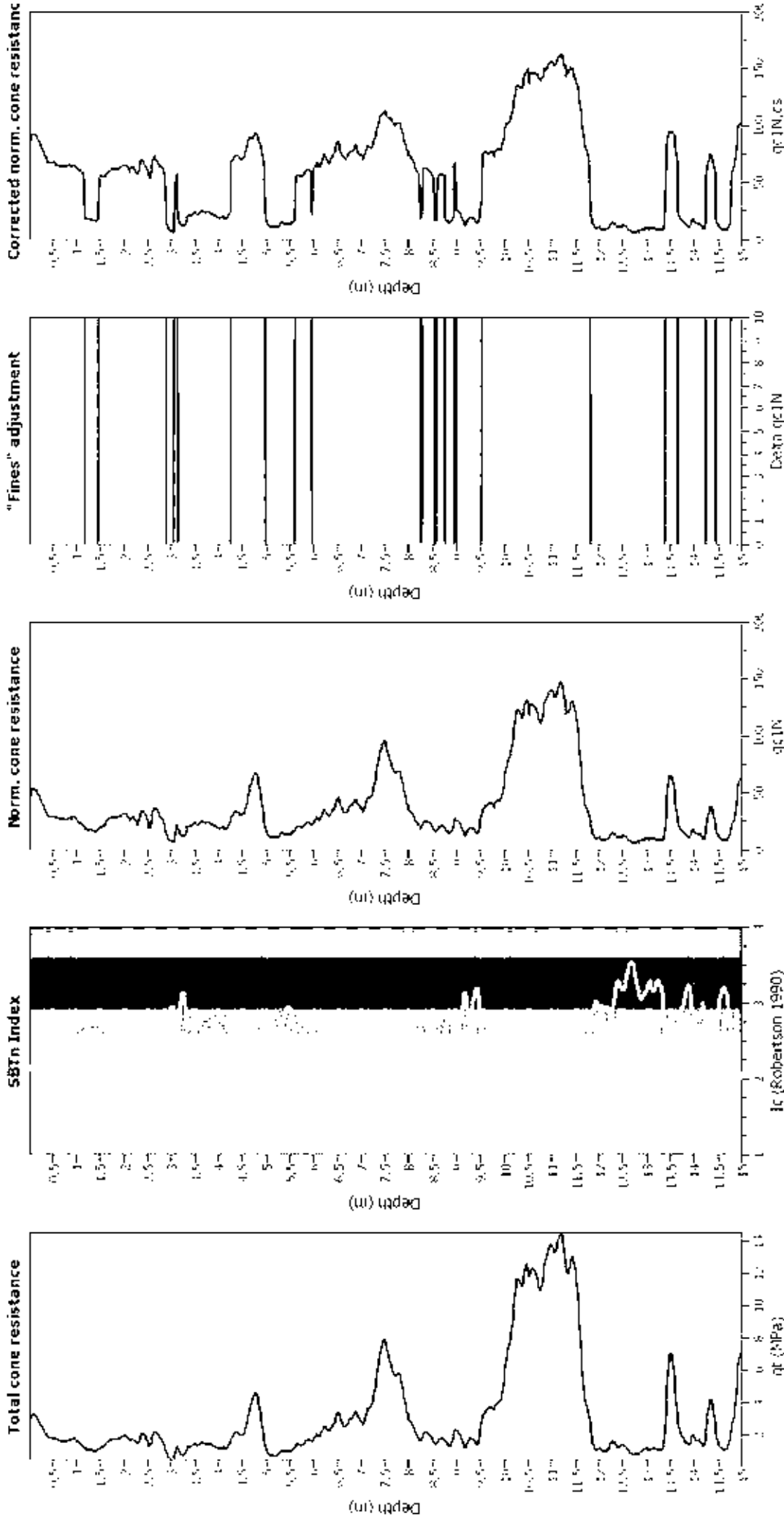
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

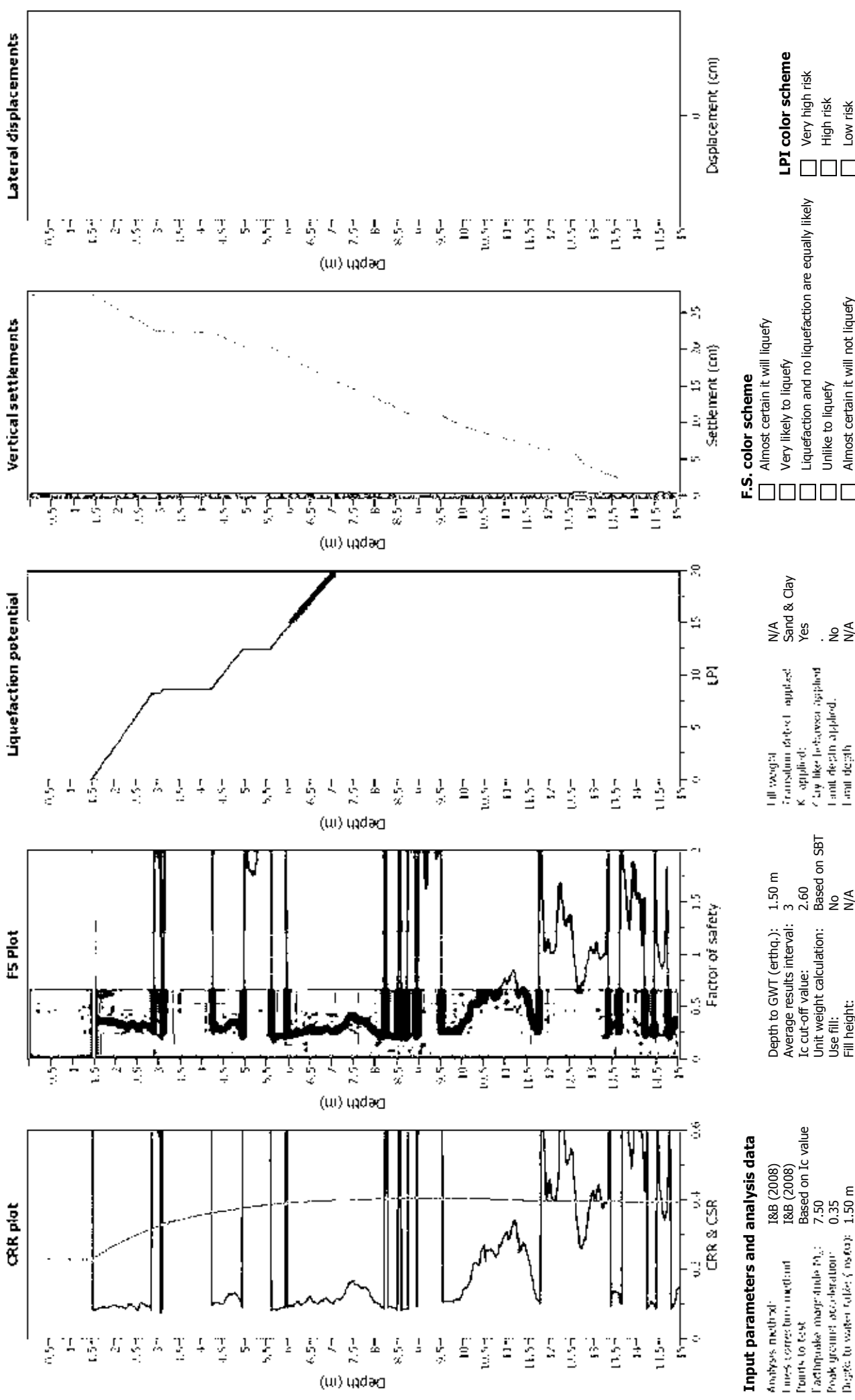
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.5  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

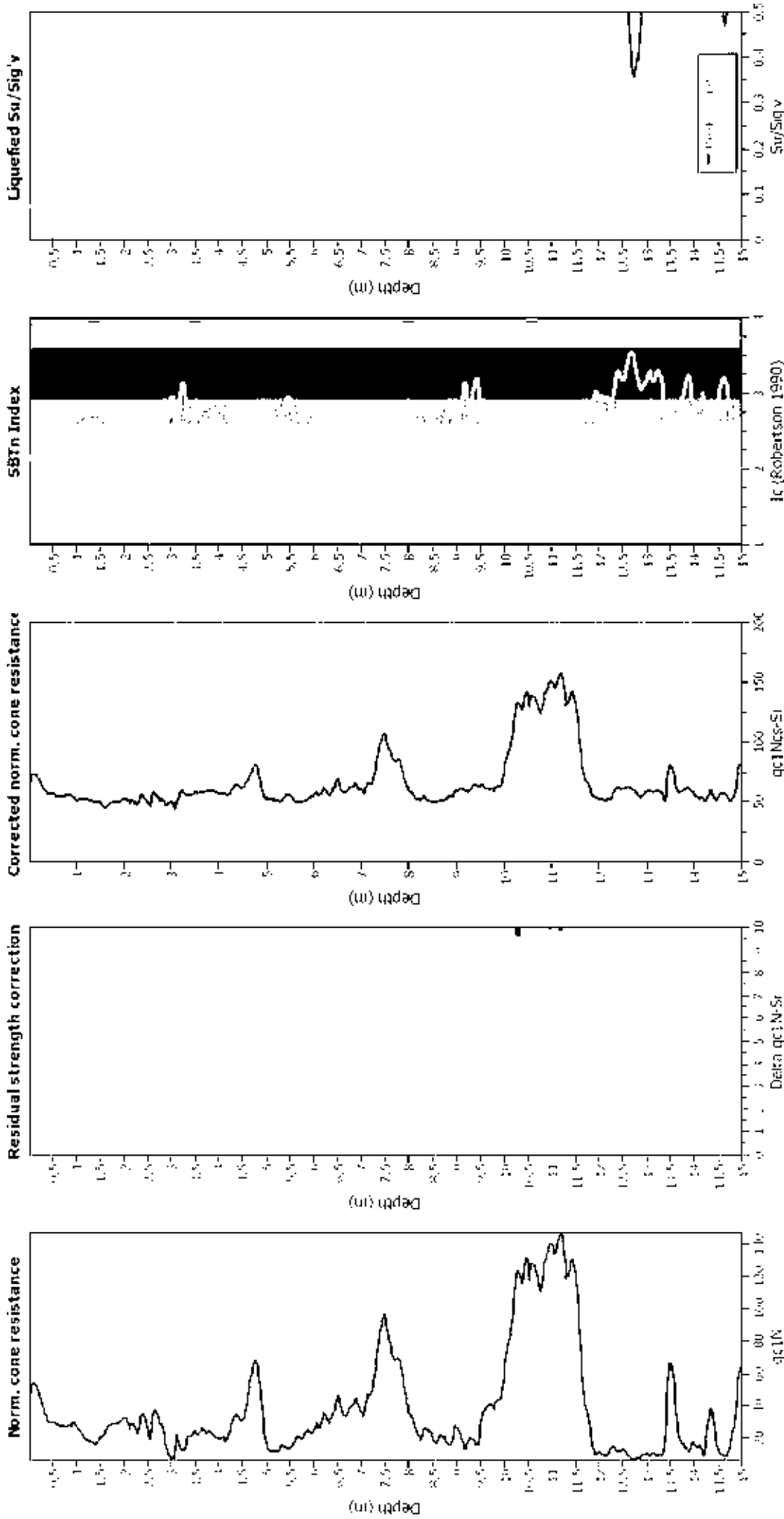
#### LPI color scheme

Very high risk  
 High risk  
 Low risk

#### F.S. color scheme

All weight transition depth applied  
 Sand & Clay  
 K applied  
 Clay like behavior applied  
 Limit depth applied  
 Limit depth

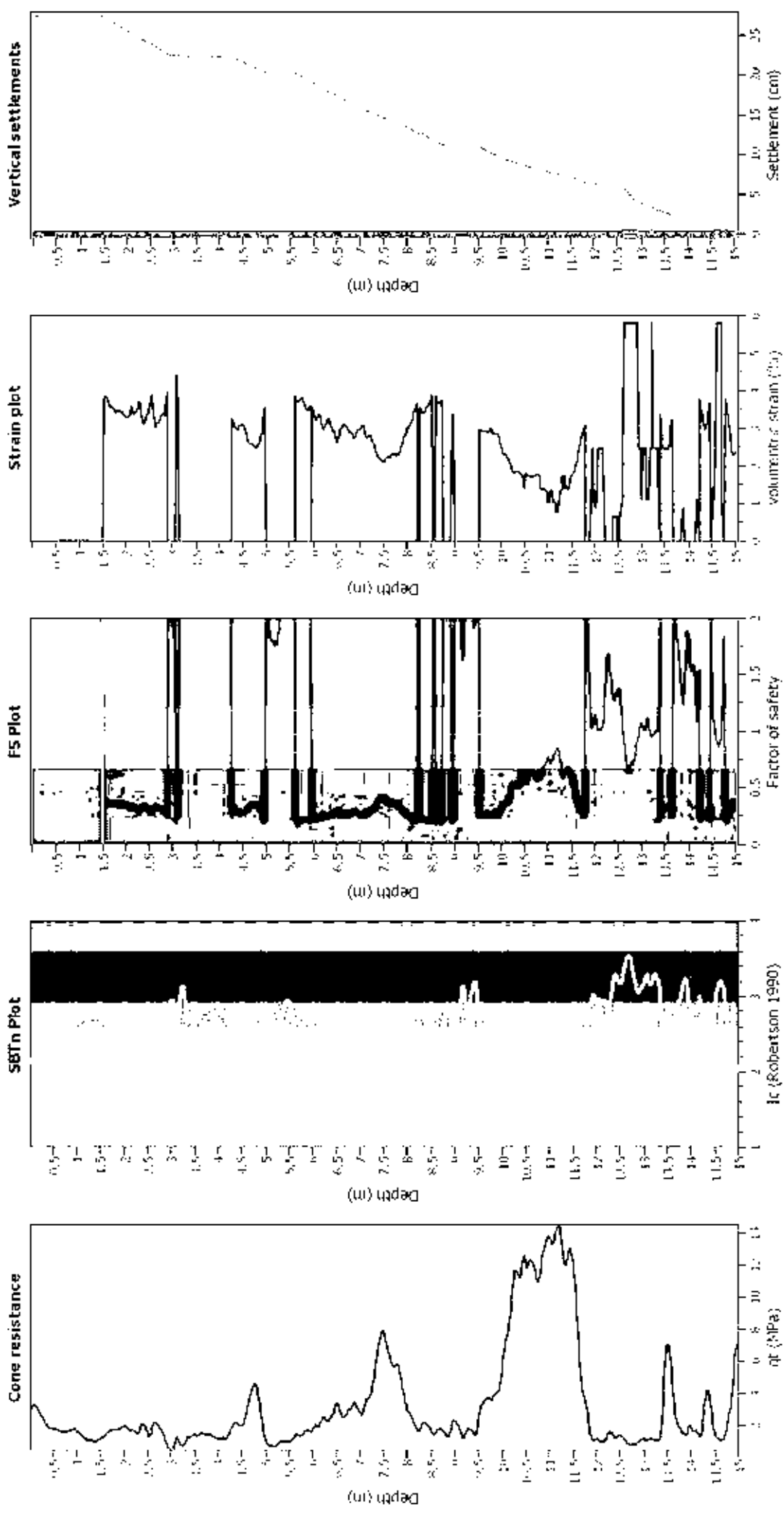
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

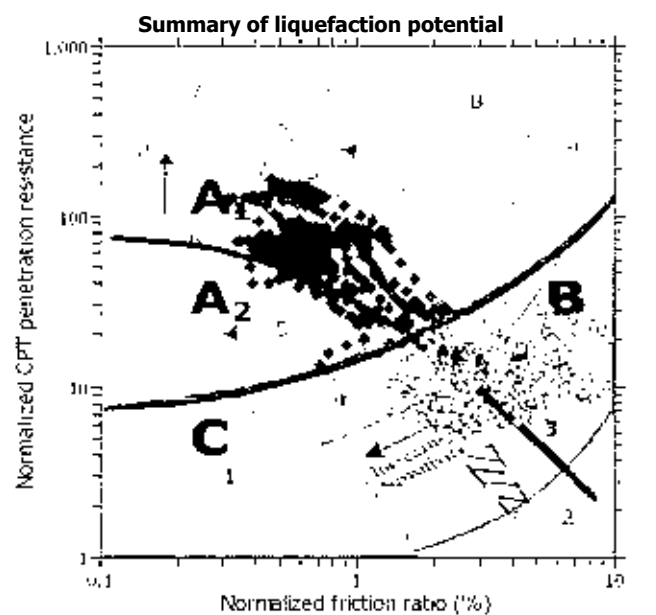
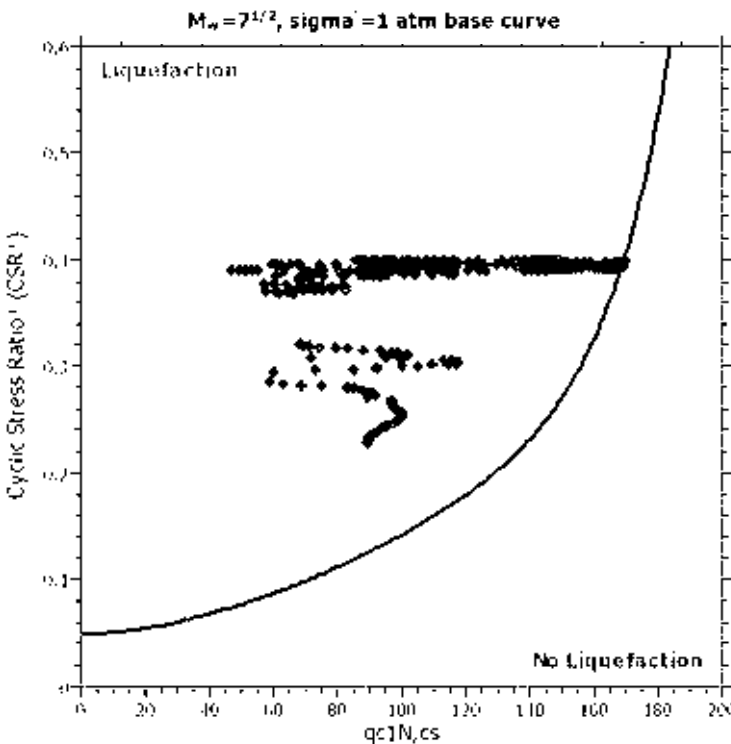
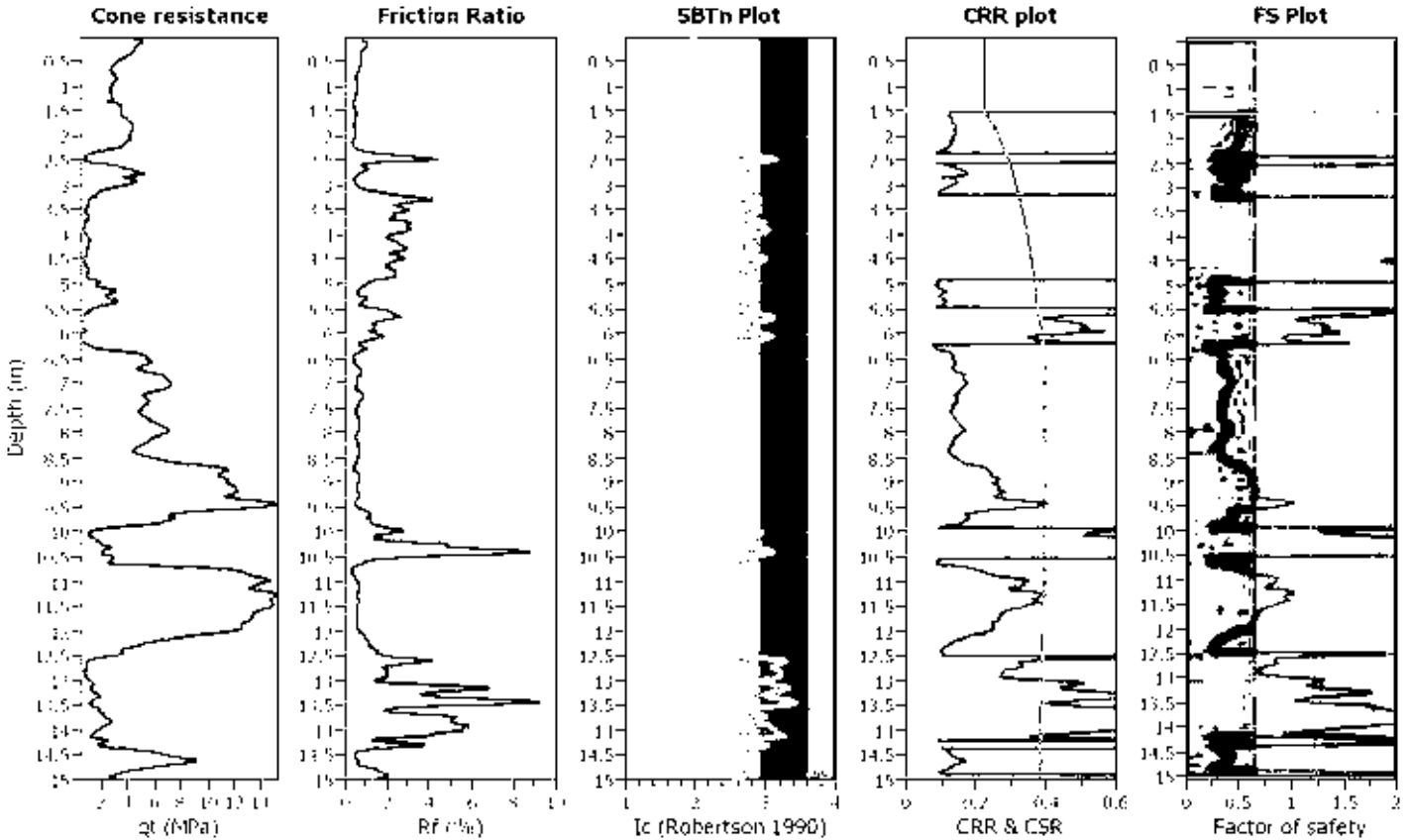
- TC: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- SB: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT16\_101SabysRd**

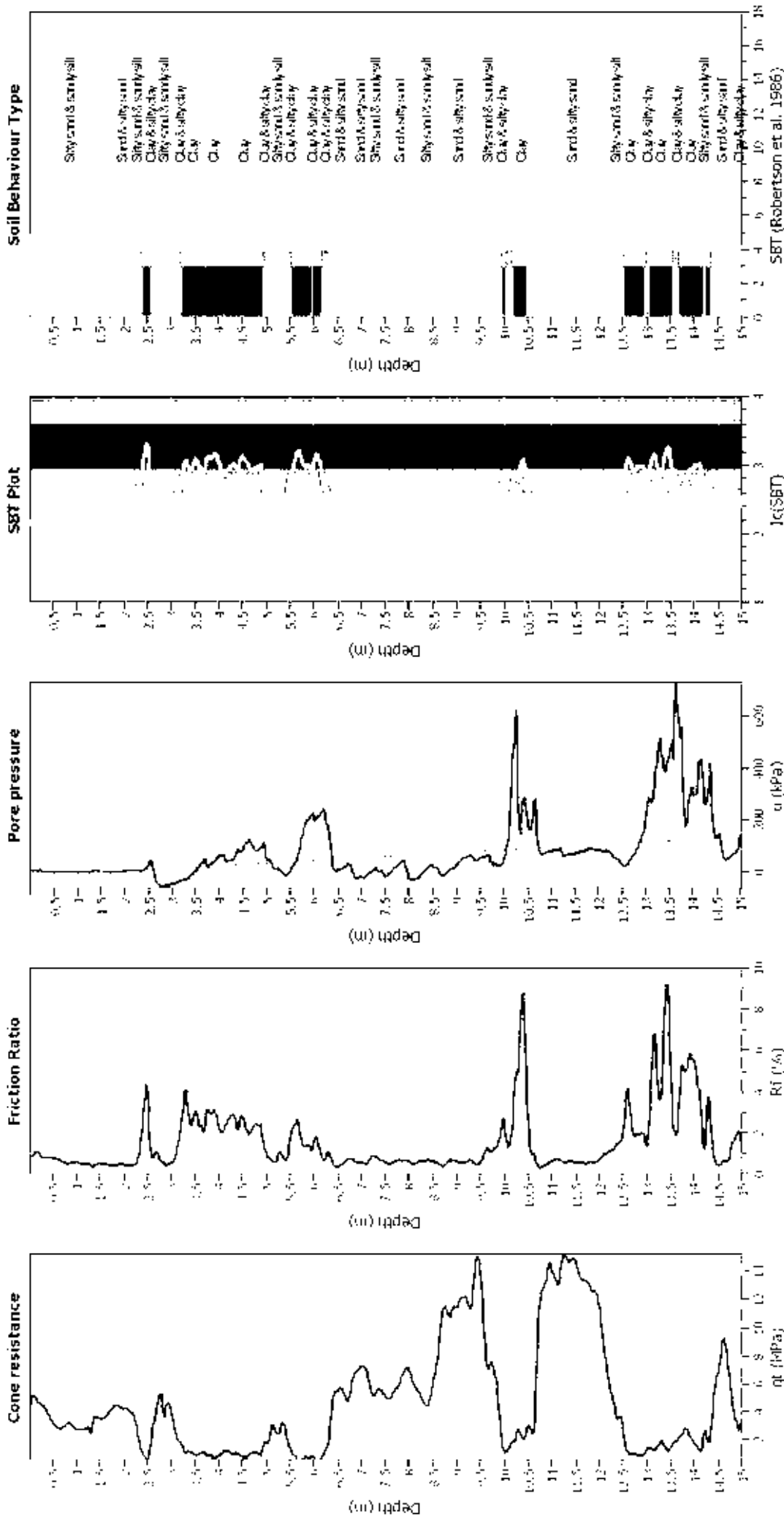
**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		



Zone A<sub>1</sub> is the area above the upper boundary curve and below the lower boundary curve. Zone A<sub>2</sub> is the area between the upper boundary curve and the transition boundary. Zone B is the area between the transition boundary and the lower boundary curve. Zone C is the area below the lower boundary curve. The transition boundary is defined by the equation:  $q_c/1N,cs = 100 \times (R_f/1\%)^{1.5}$ . The upper boundary curve is defined by the equation:  $q_c/1N,cs = 100 \times (R_f/1\%)^{1.5} \times (1 - CSR)^{-1}$ . The lower boundary curve is defined by the equation:  $q_c/1N,cs = 100 \times (R_f/1\%)^{1.5} \times (1 - CSR)^{-2}$ .

### CPT basic interpretation plots



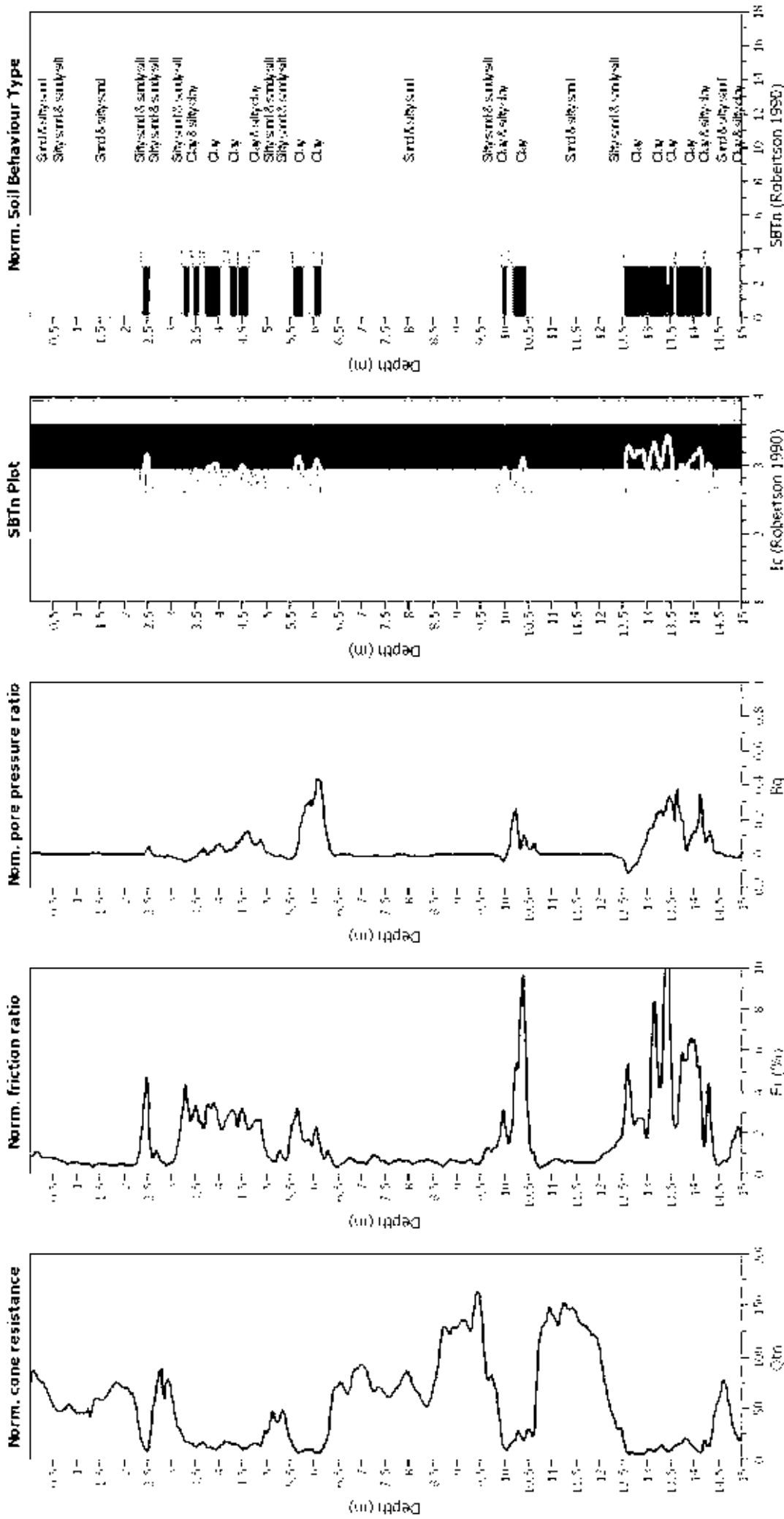
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Lamé depth applied:	No
Depth to water table (m):	1.50 m	Lamé depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)

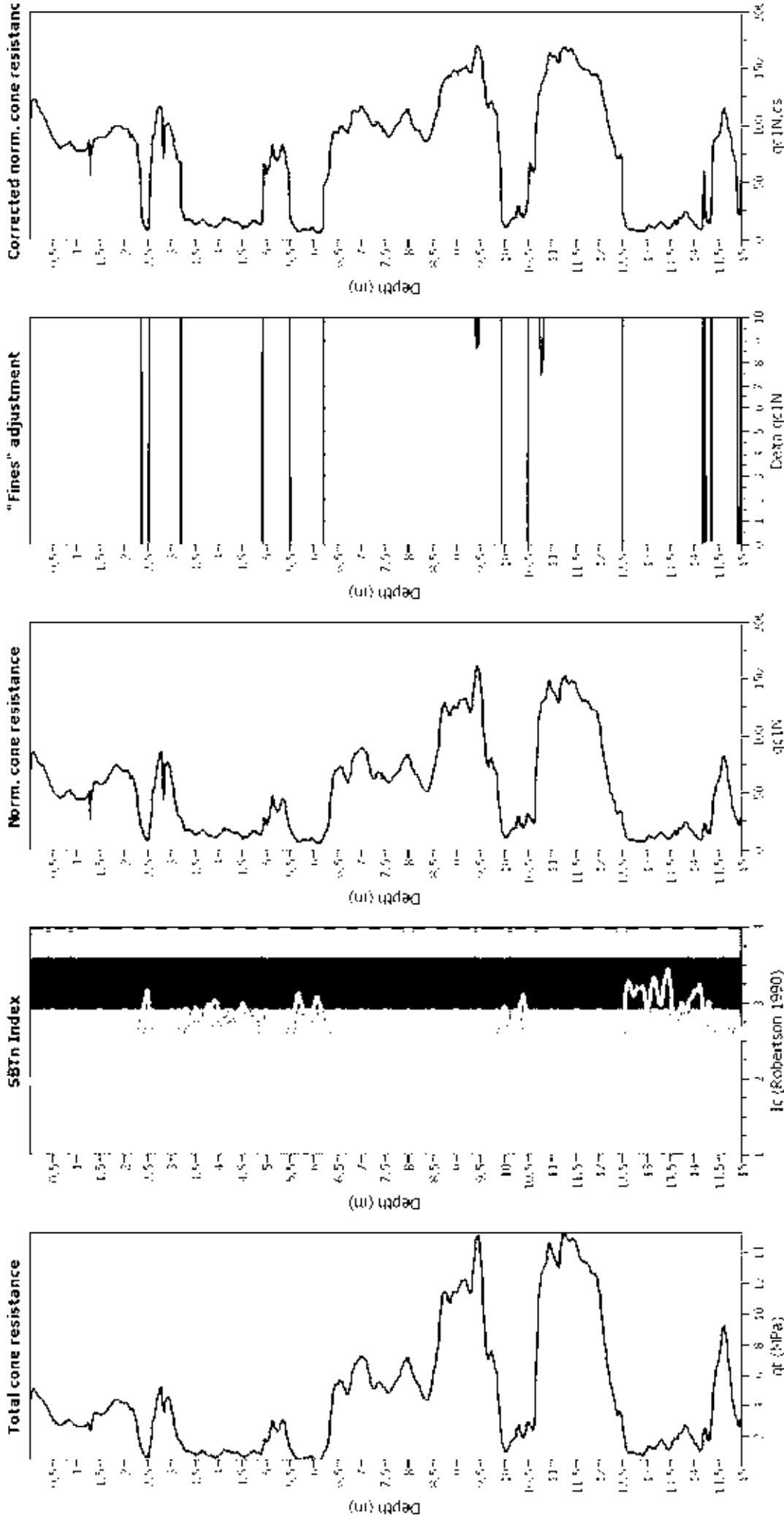


#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit height:	N/A
Depth to GW (earthq.):	1.50 m	SBTn legend:	
Average results interval:	3	1. Sensitive fine grained:	<input type="checkbox"/>
Ic cut-off value:	2.60	2. Organic material:	<input type="checkbox"/>
Unit weight calculation:	Based on SBT	3. Clay to silty clay:	<input type="checkbox"/>
Use fill:	No	4. Clayey silt to silty:	<input type="checkbox"/>
Fill height:	N/A	5. Silty sand to sandy silt:	<input type="checkbox"/>
		6. Clean sand to silty sand:	<input type="checkbox"/>
		7. Gravely sand to sand:	<input type="checkbox"/>
		8. Very stiff sand to	<input type="checkbox"/>
		9. Very stiff fine grained	<input type="checkbox"/>



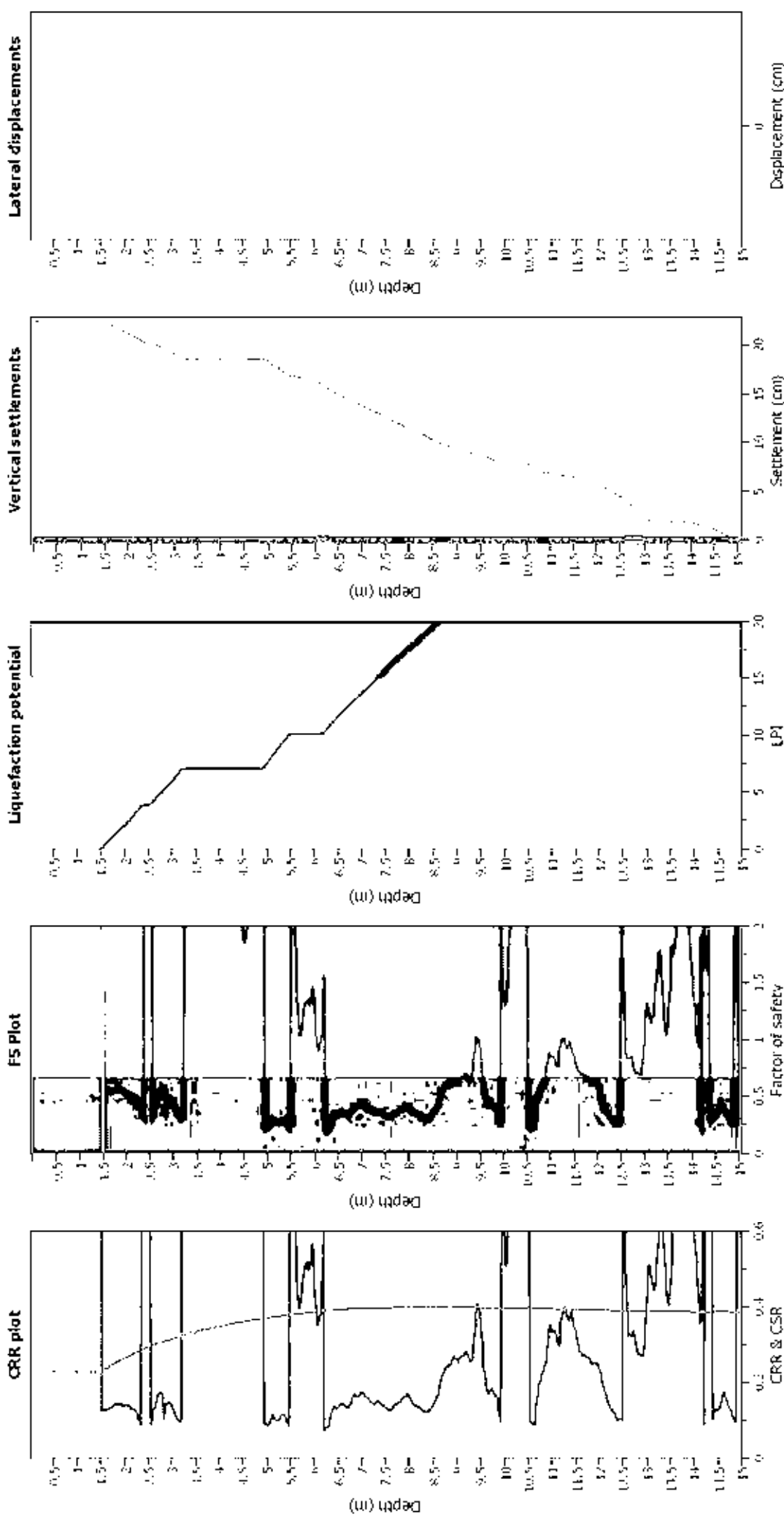
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

#### F.S. color scheme

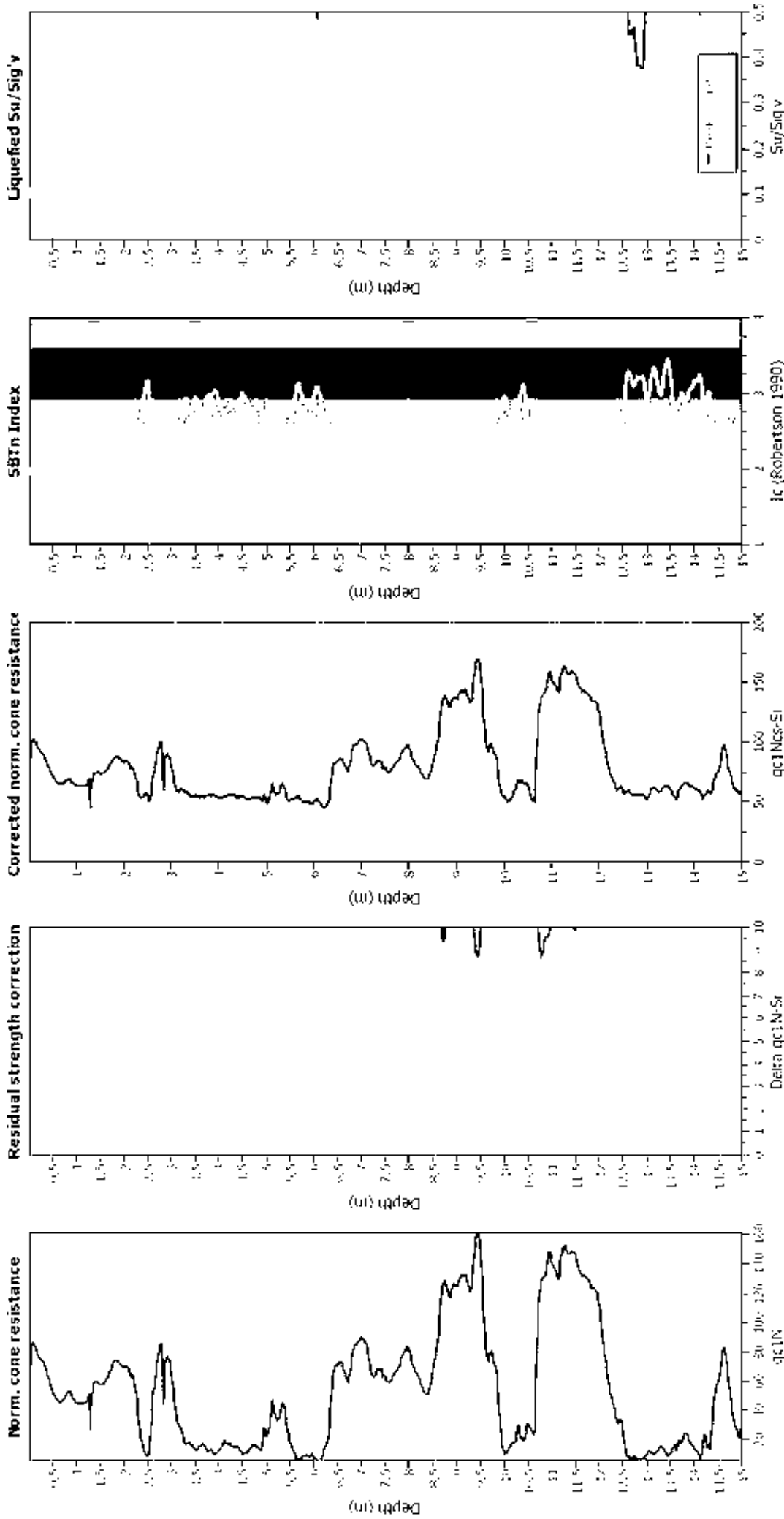
Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A  
 Fill height: N/A

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

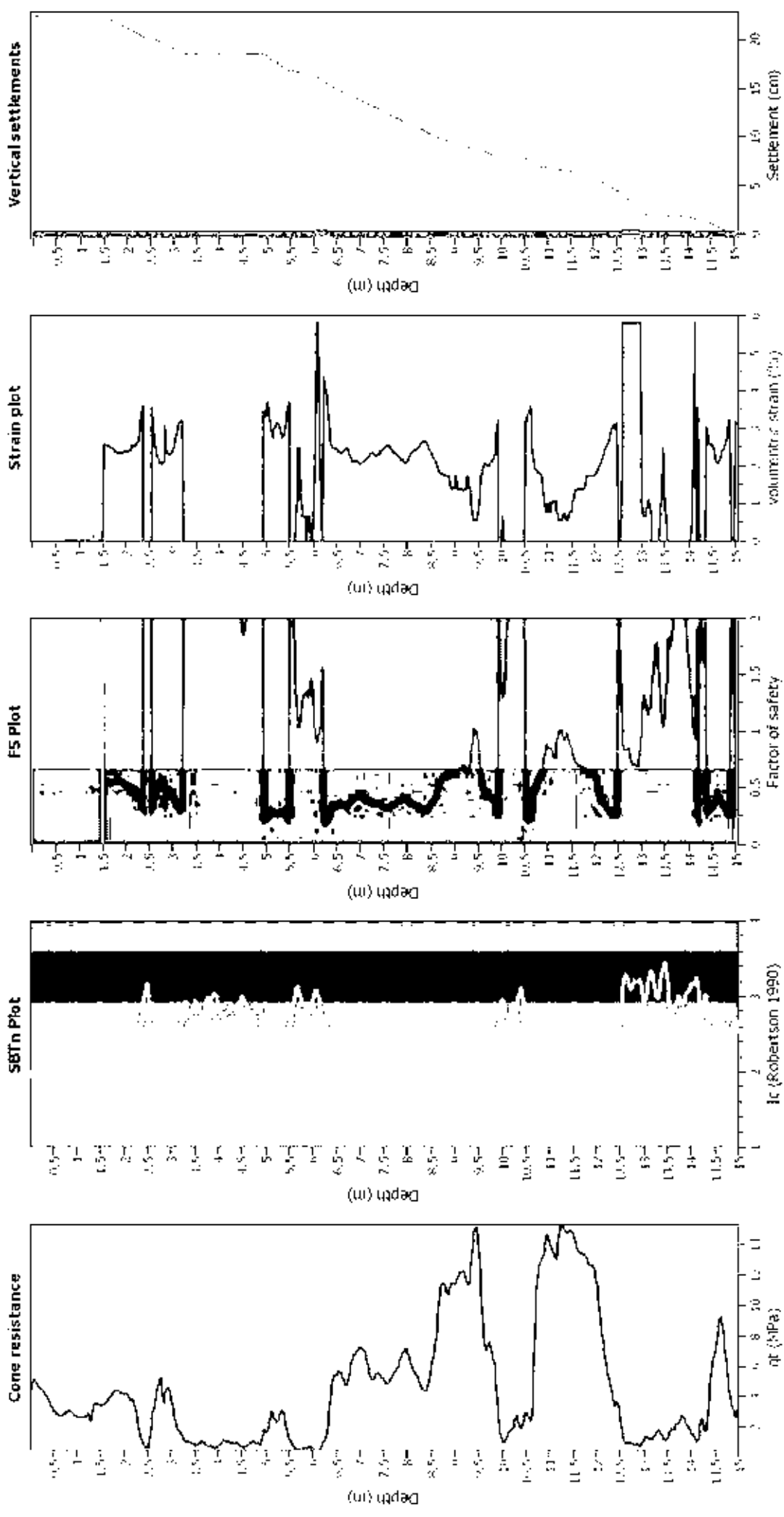
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. for method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- S<sub>b</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT17\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

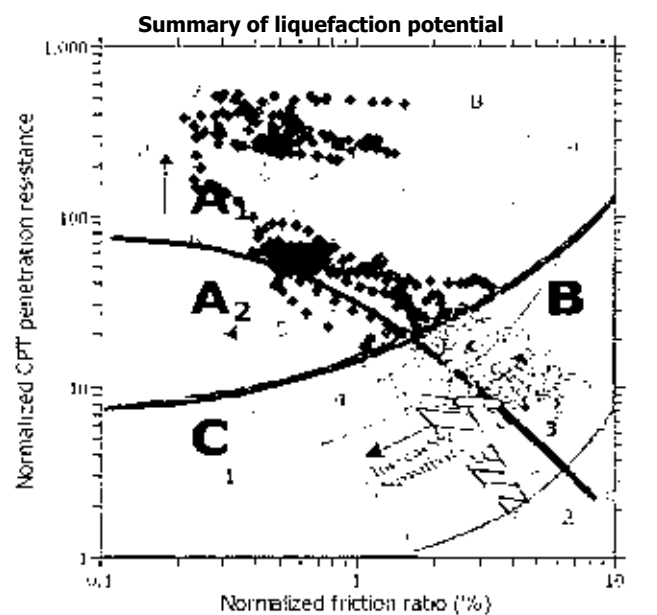
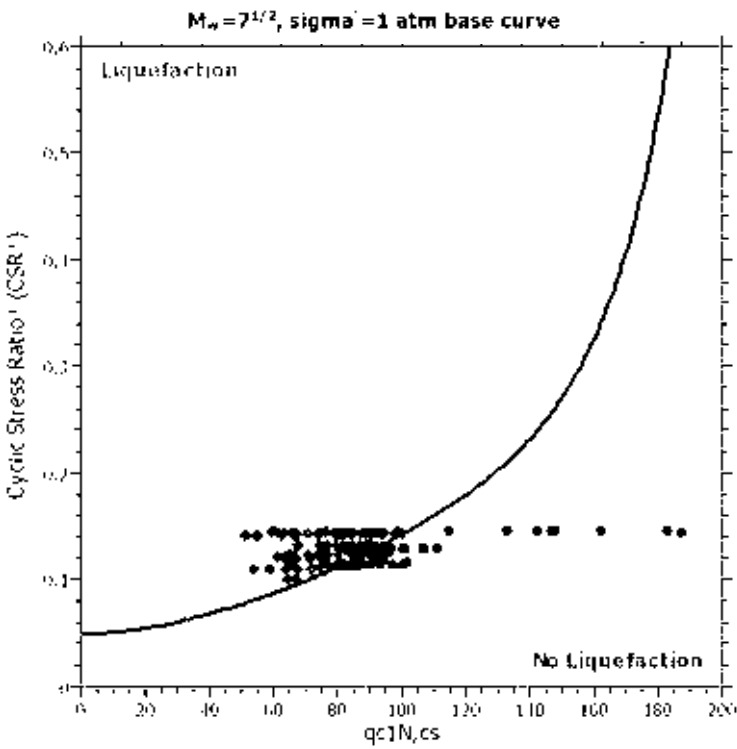
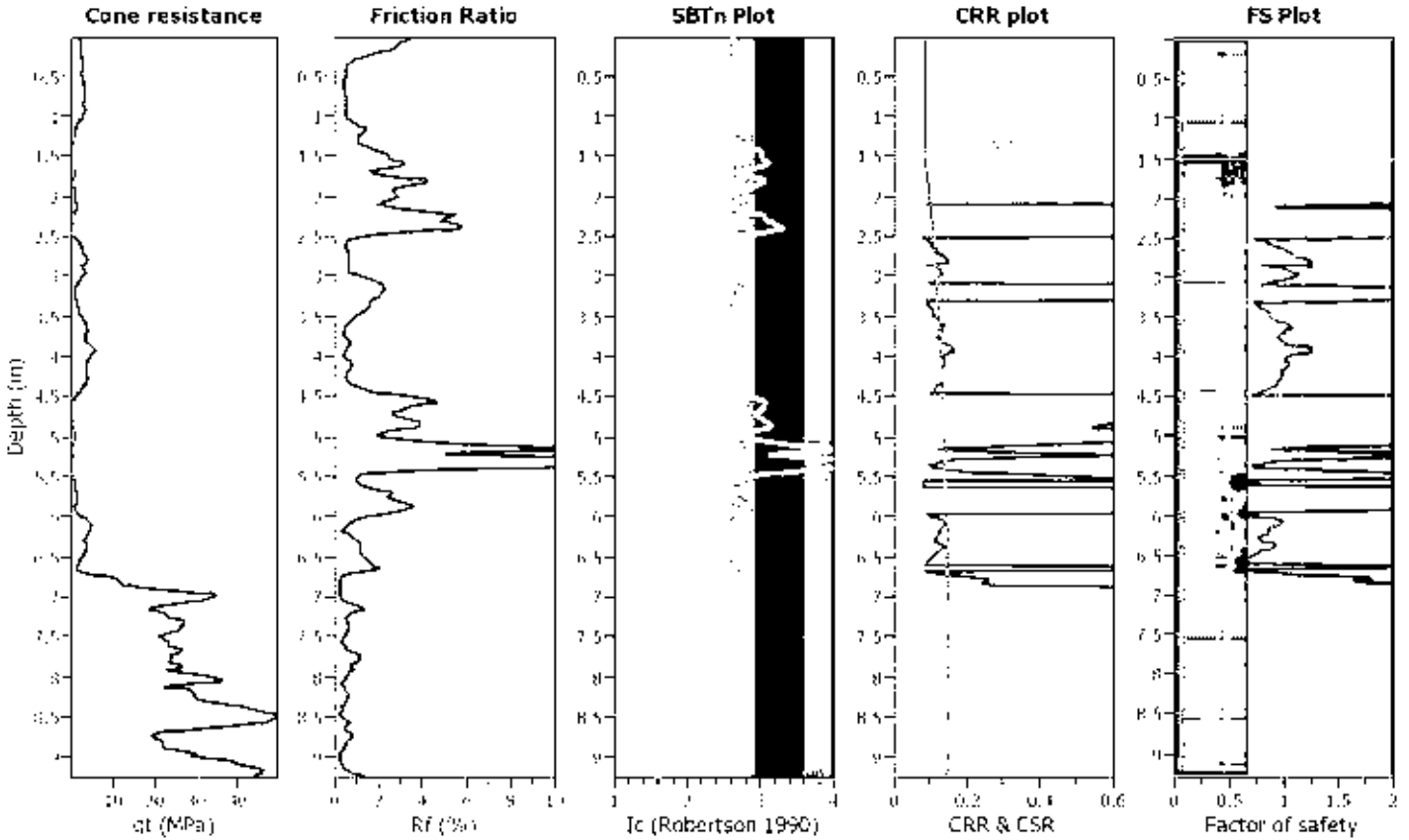
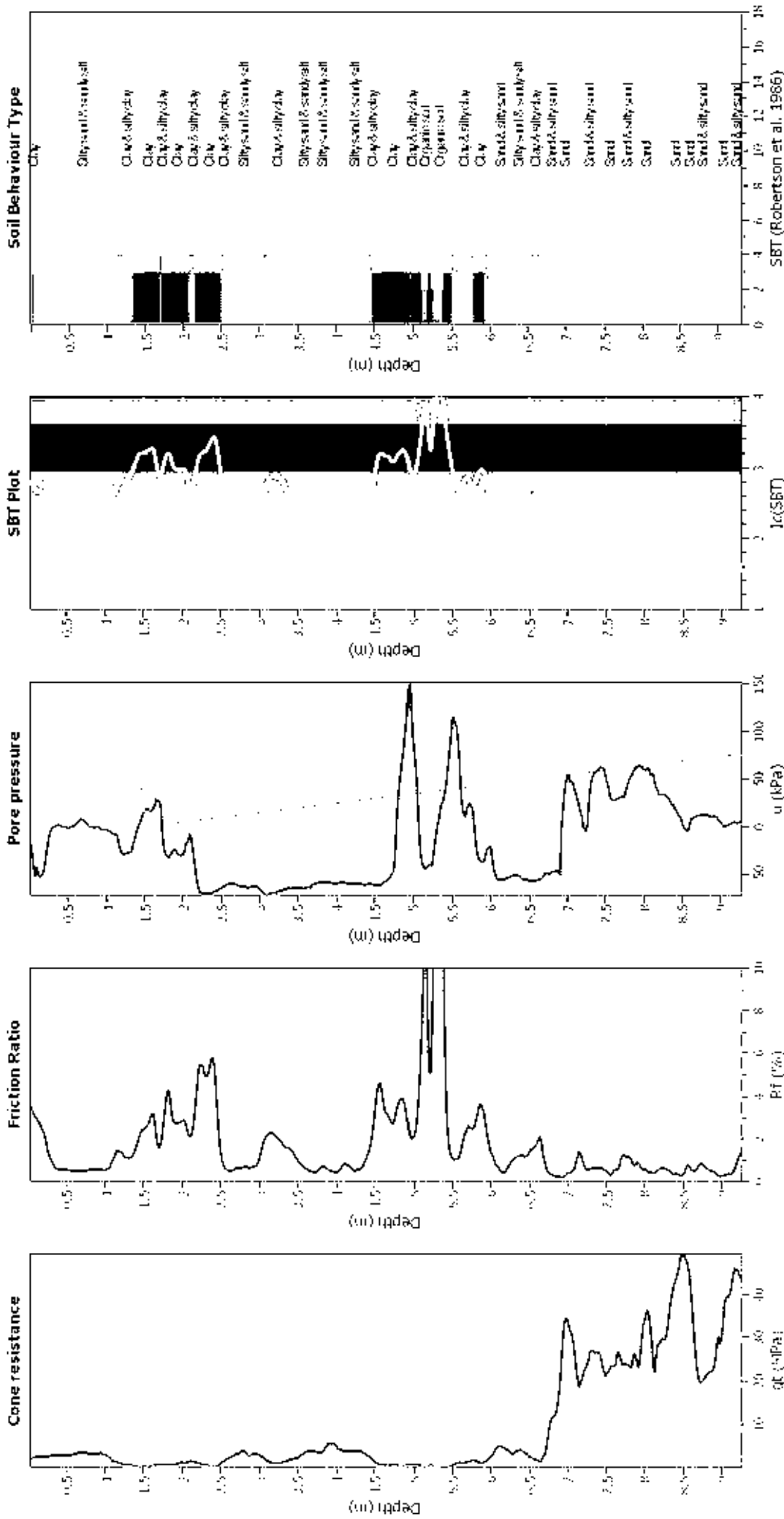


Figure 4: Summary of liquefaction potential plot and curve of cyclic stress ratio. Zone A1: Fully liquefied zone, Zone A2: Partially liquefied zone, Zone B: No liquefaction, Zone C: Fully liquefied zone. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with data points indicating the liquefaction potential of the soil.

### CPT basic interpretation plots



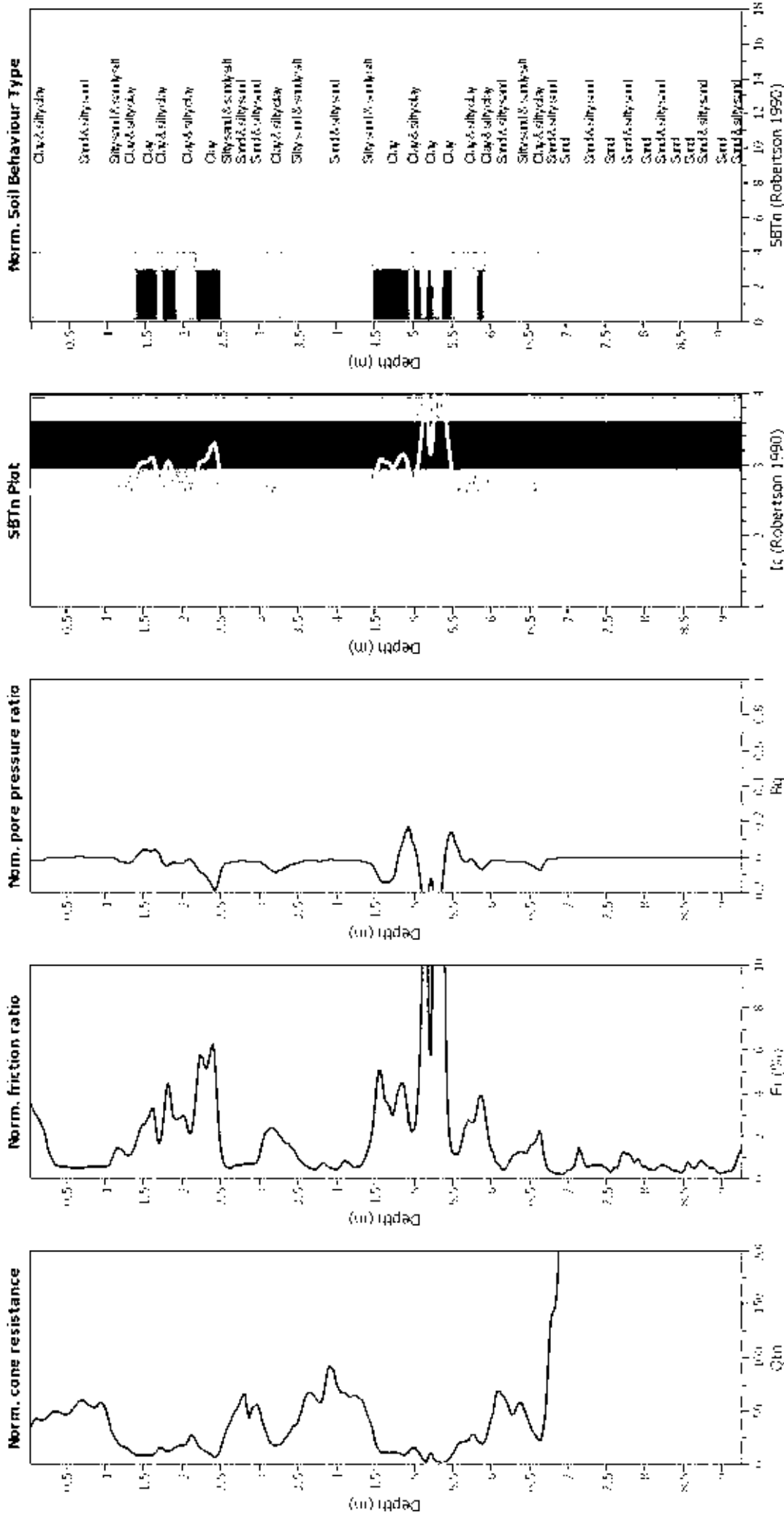
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A	Sand & Clay	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	No		
Earthquake magnitude $M_w$ :	7.5	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No		
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	N/A		
Depth to water table (m):	1.50 m	Fill height:	N/A				

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



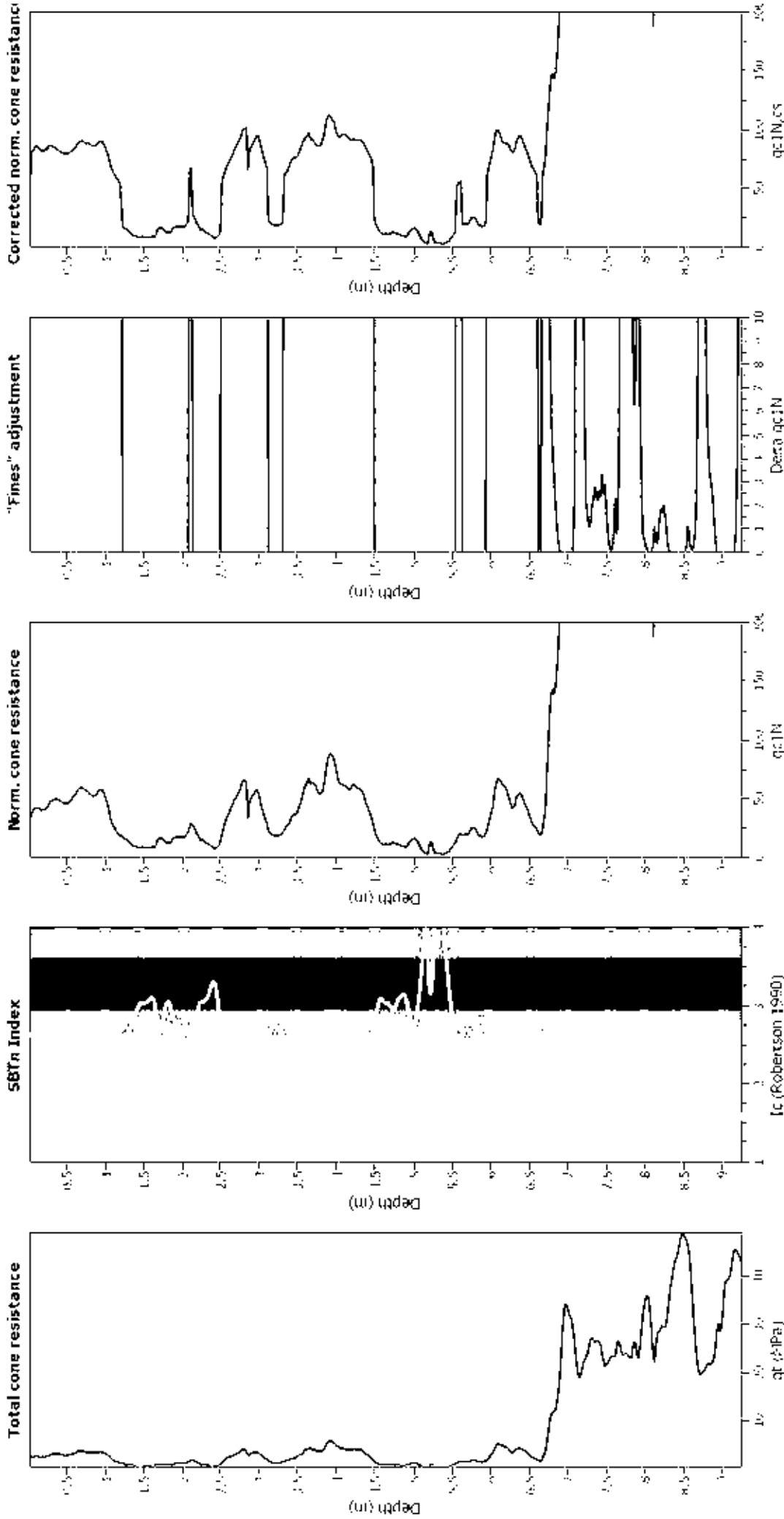
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### Liquefaction analysis overall plots (intermediate results)

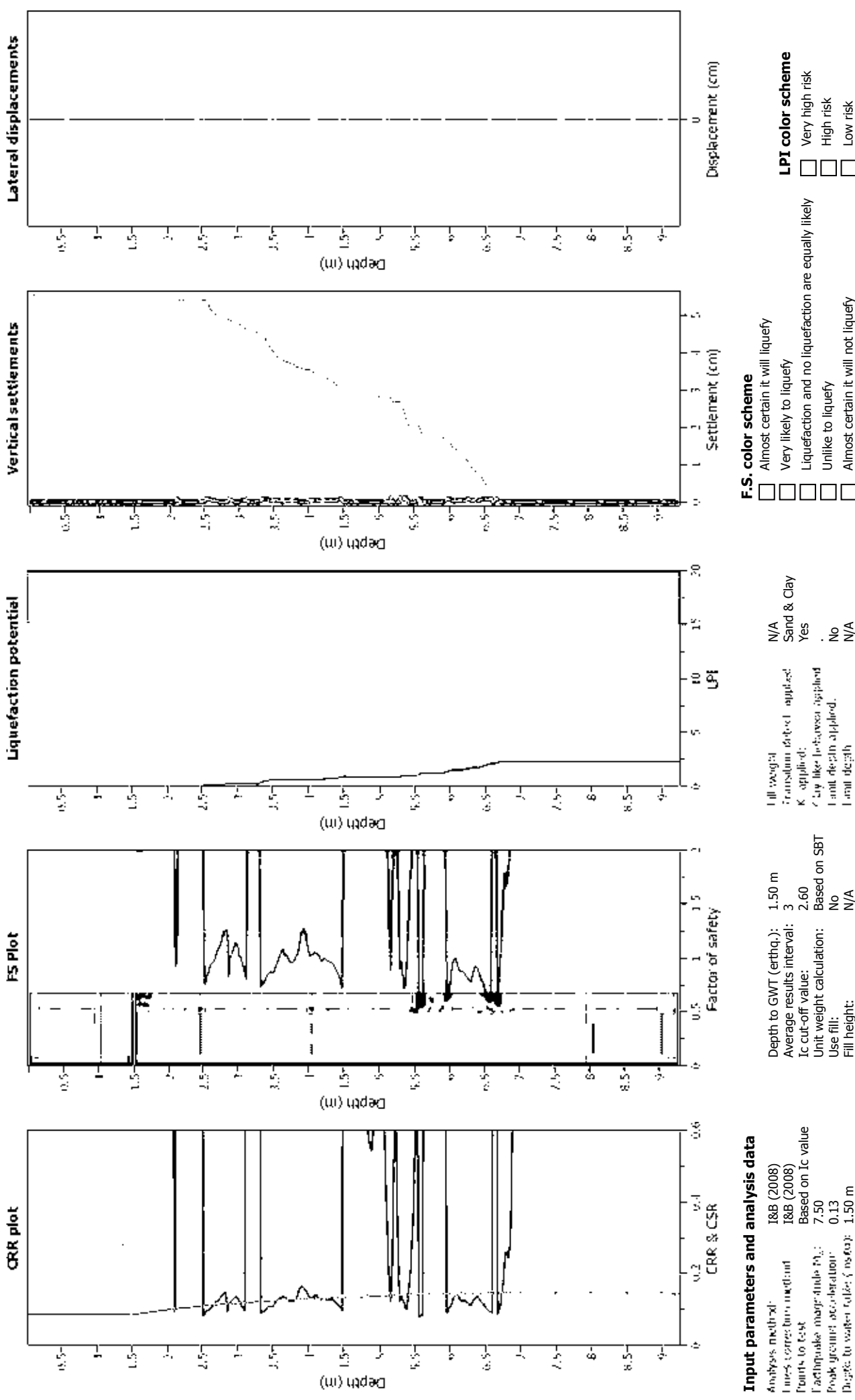


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

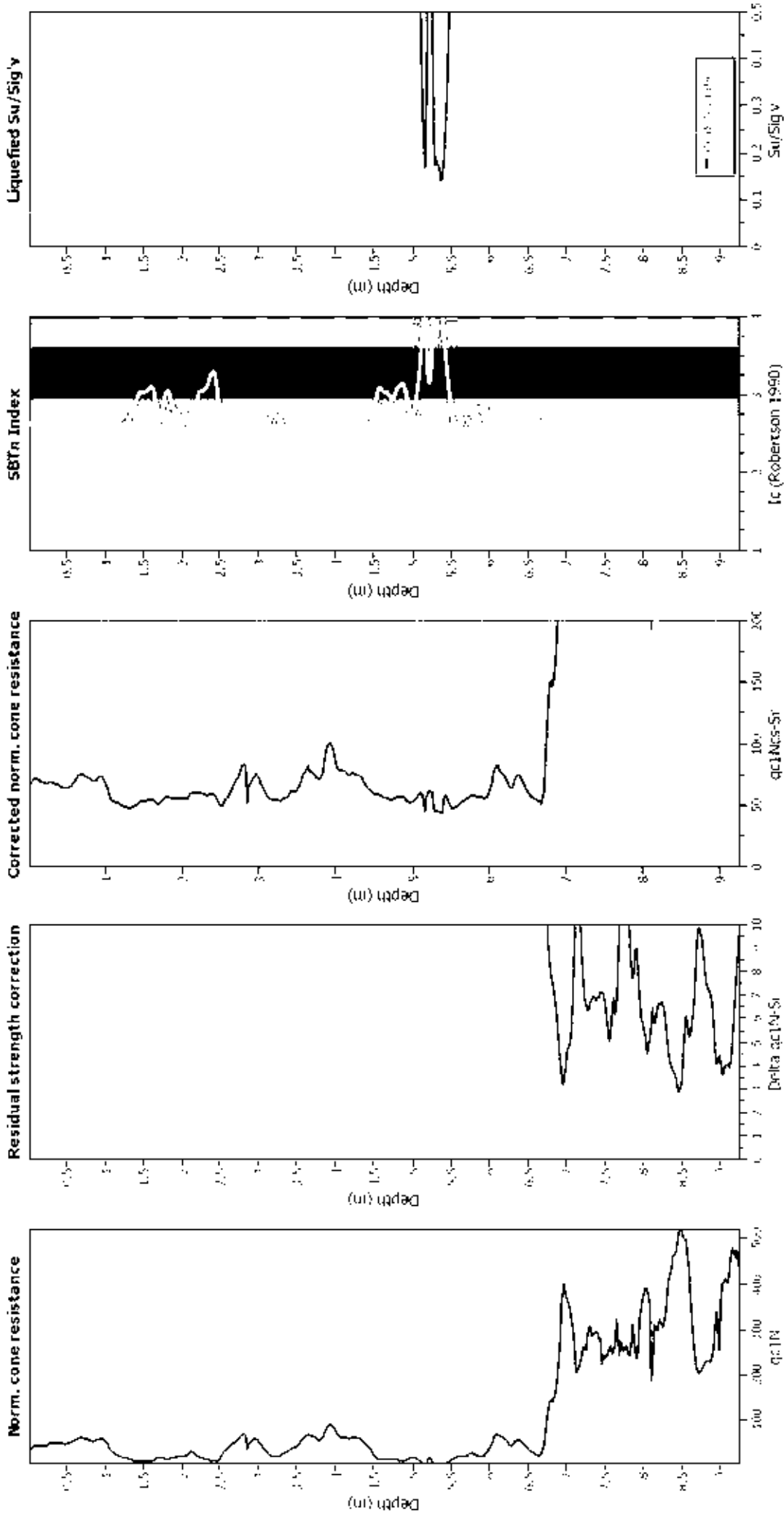
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

All weight transition method applied  
 K applied  
 Clay like behavior applied  
 Limit depth applied

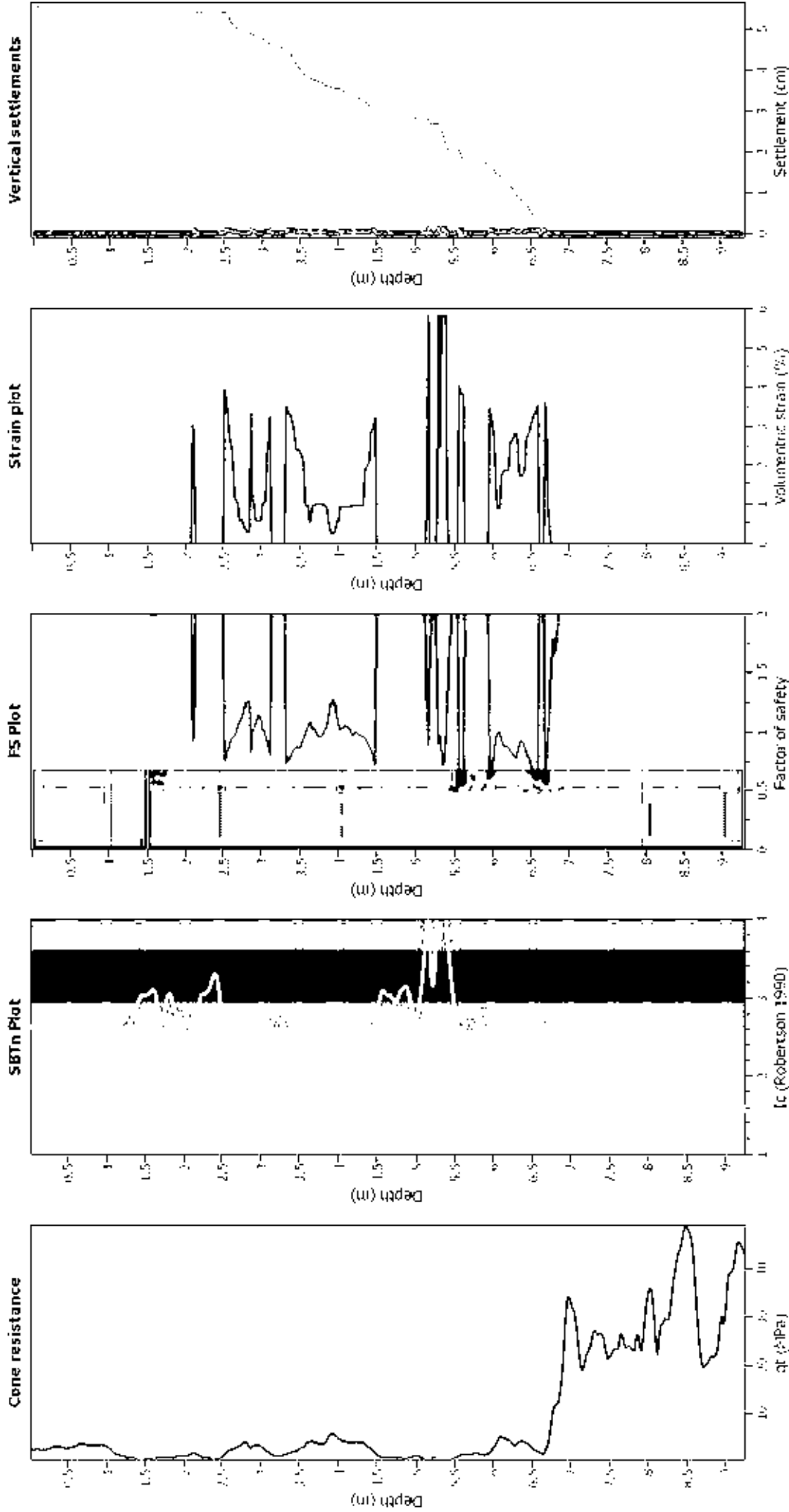
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT18\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

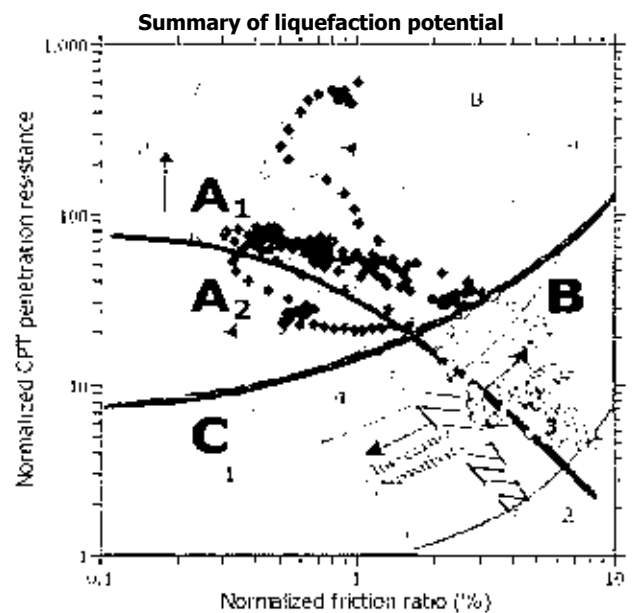
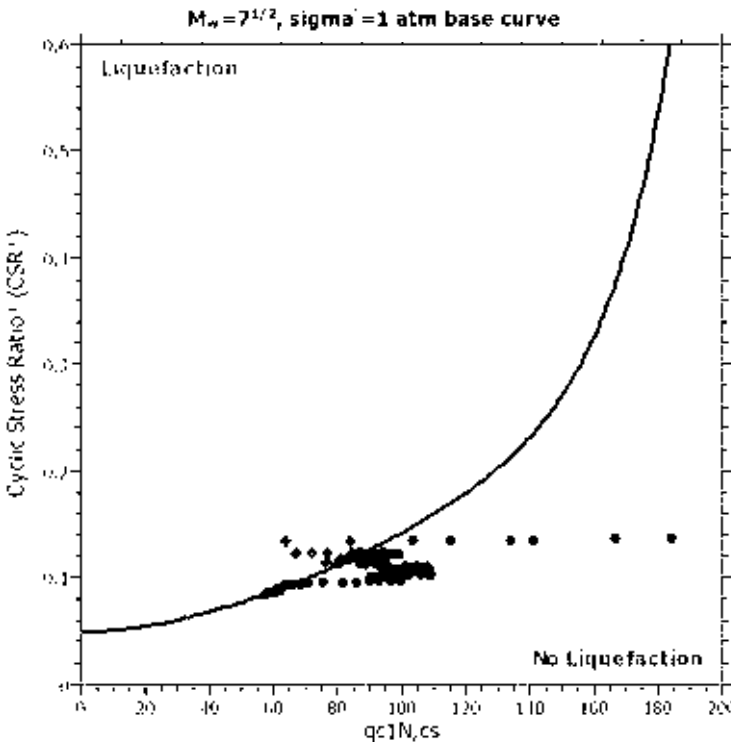
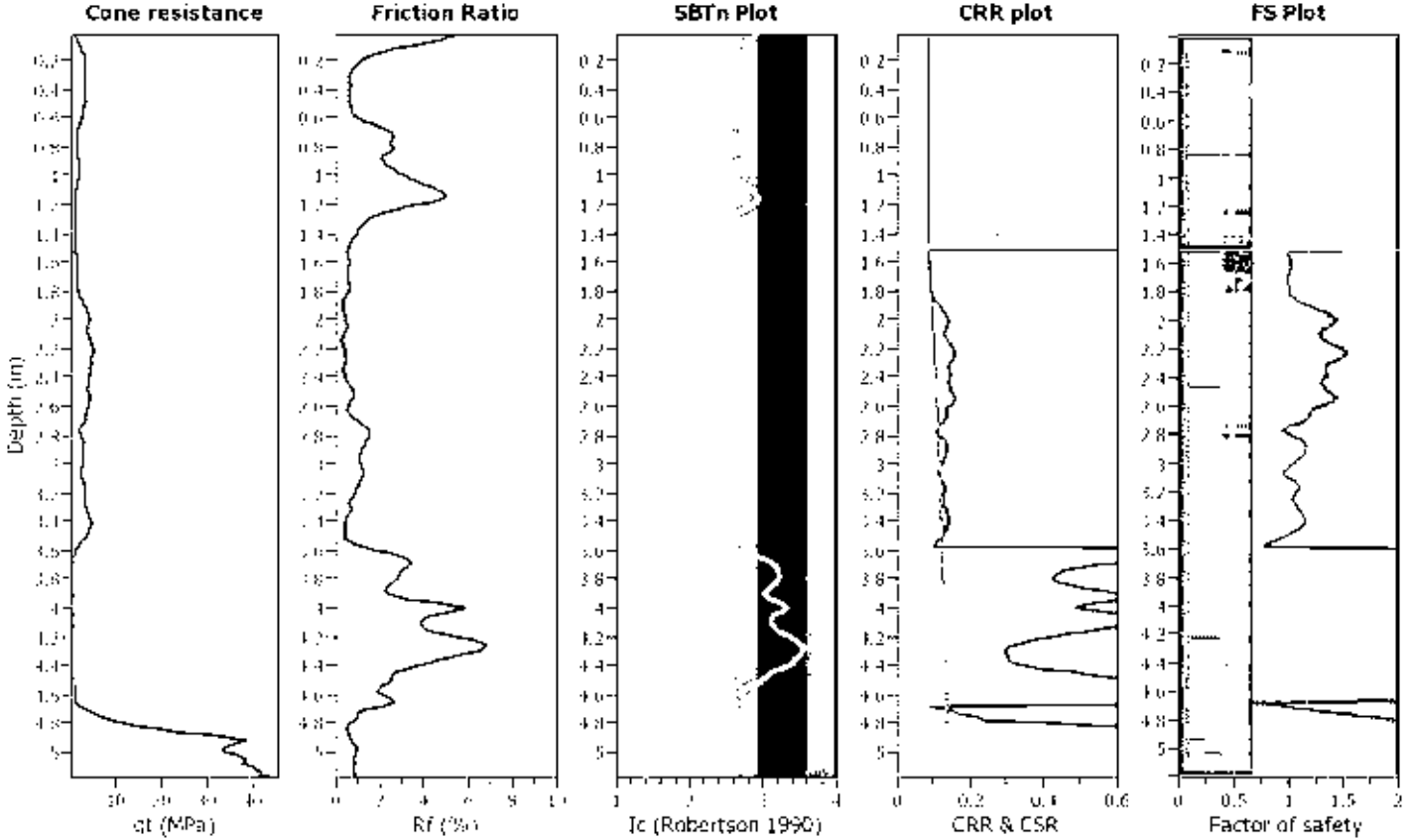
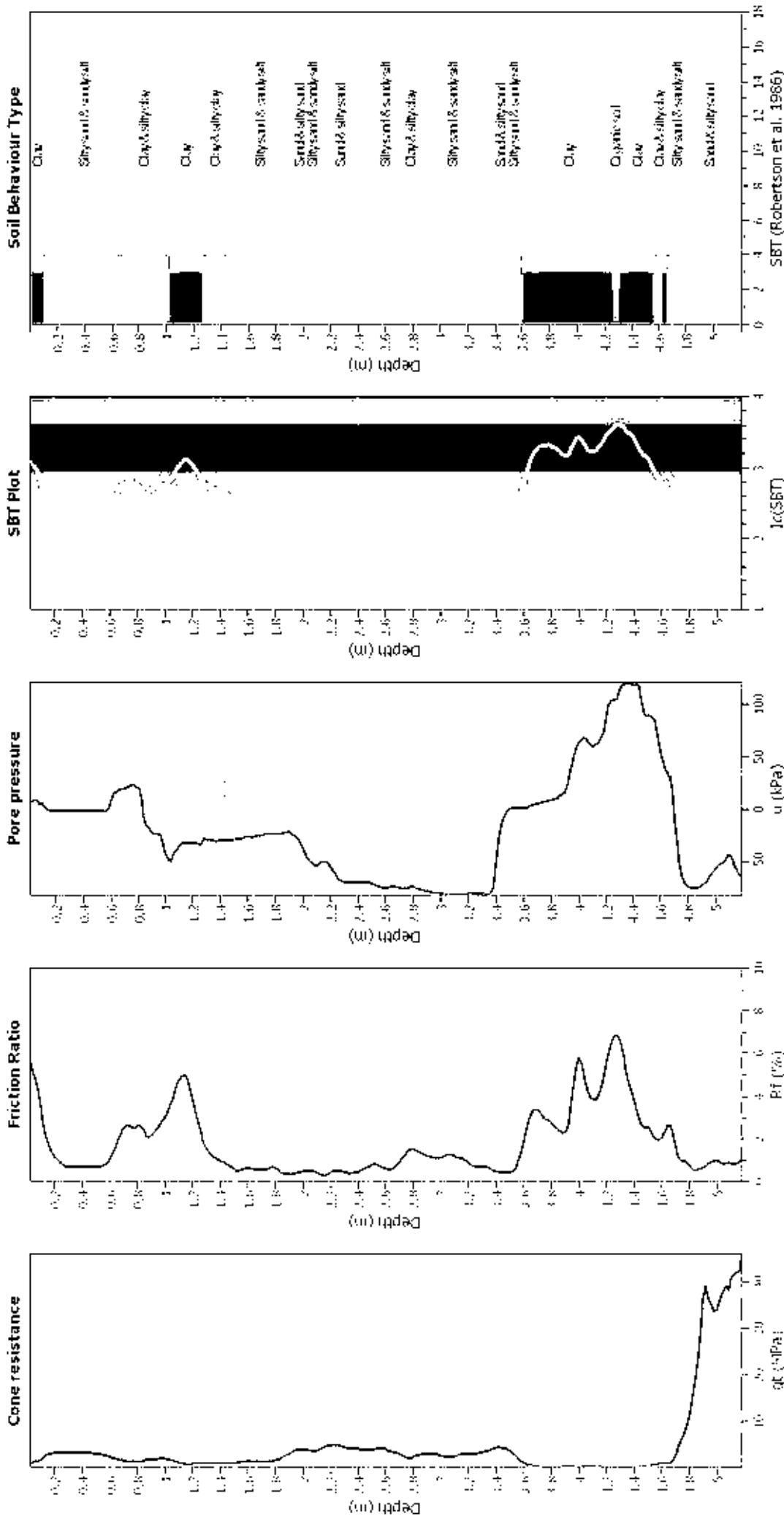


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The plot is divided into zones A1, A2, B, and C. The liquefaction boundary is indicated by a dashed line. The plot shows that the soil is generally in the 'No Liquefaction' region, with some points in the 'Liquefaction' region at higher CSR values.

### CPT basic interpretation plots



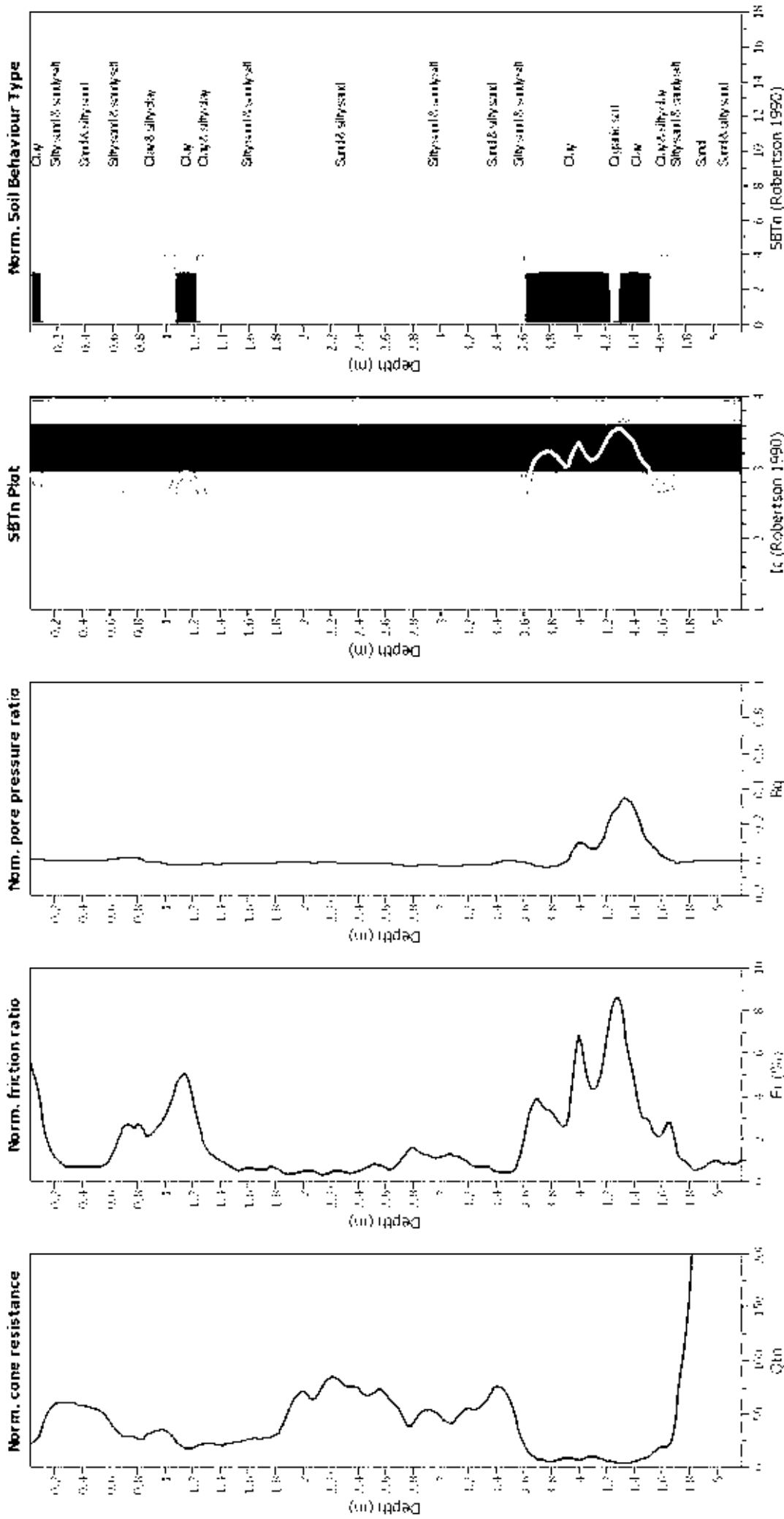
### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial analysis magnitude:	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



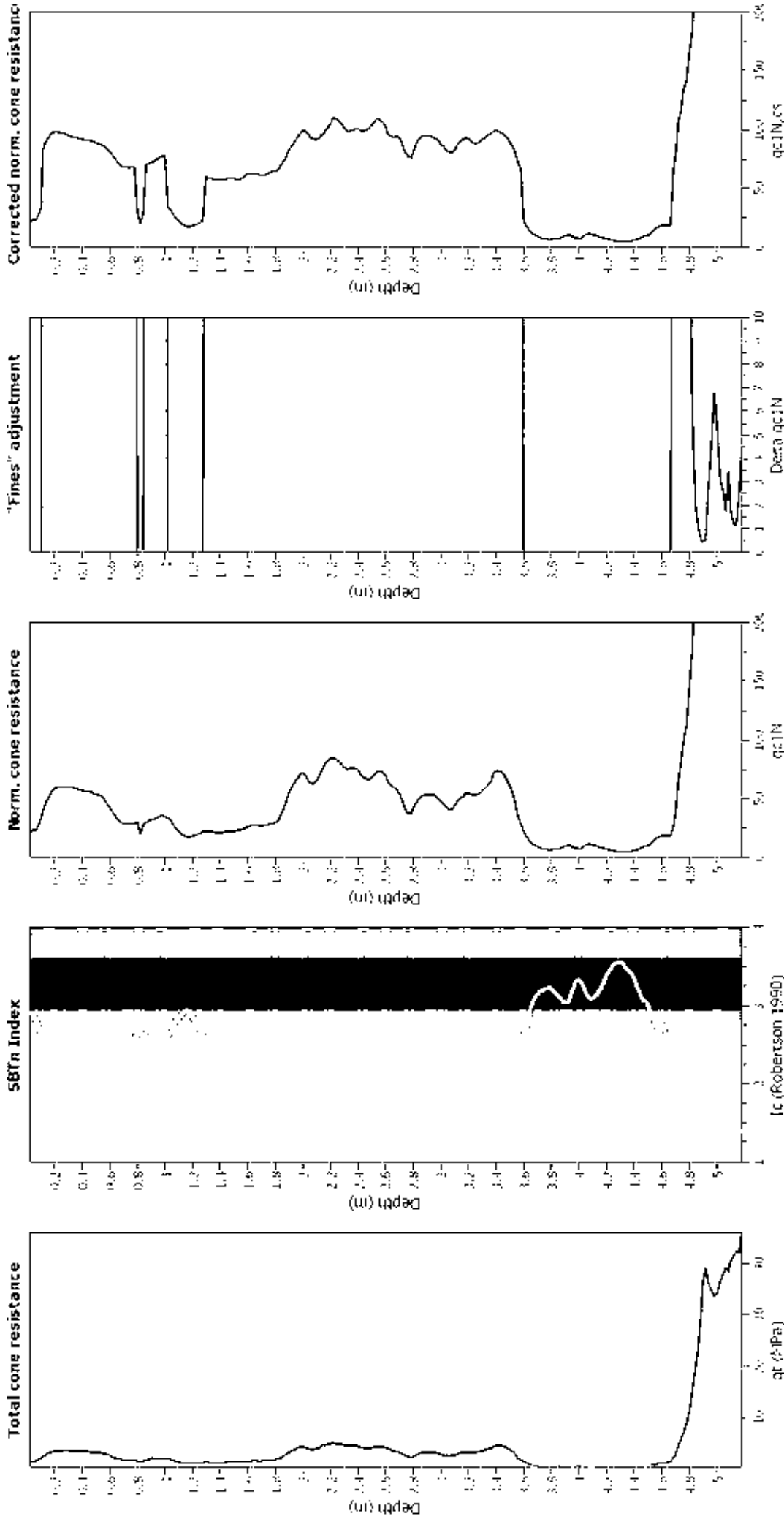
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (avg):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

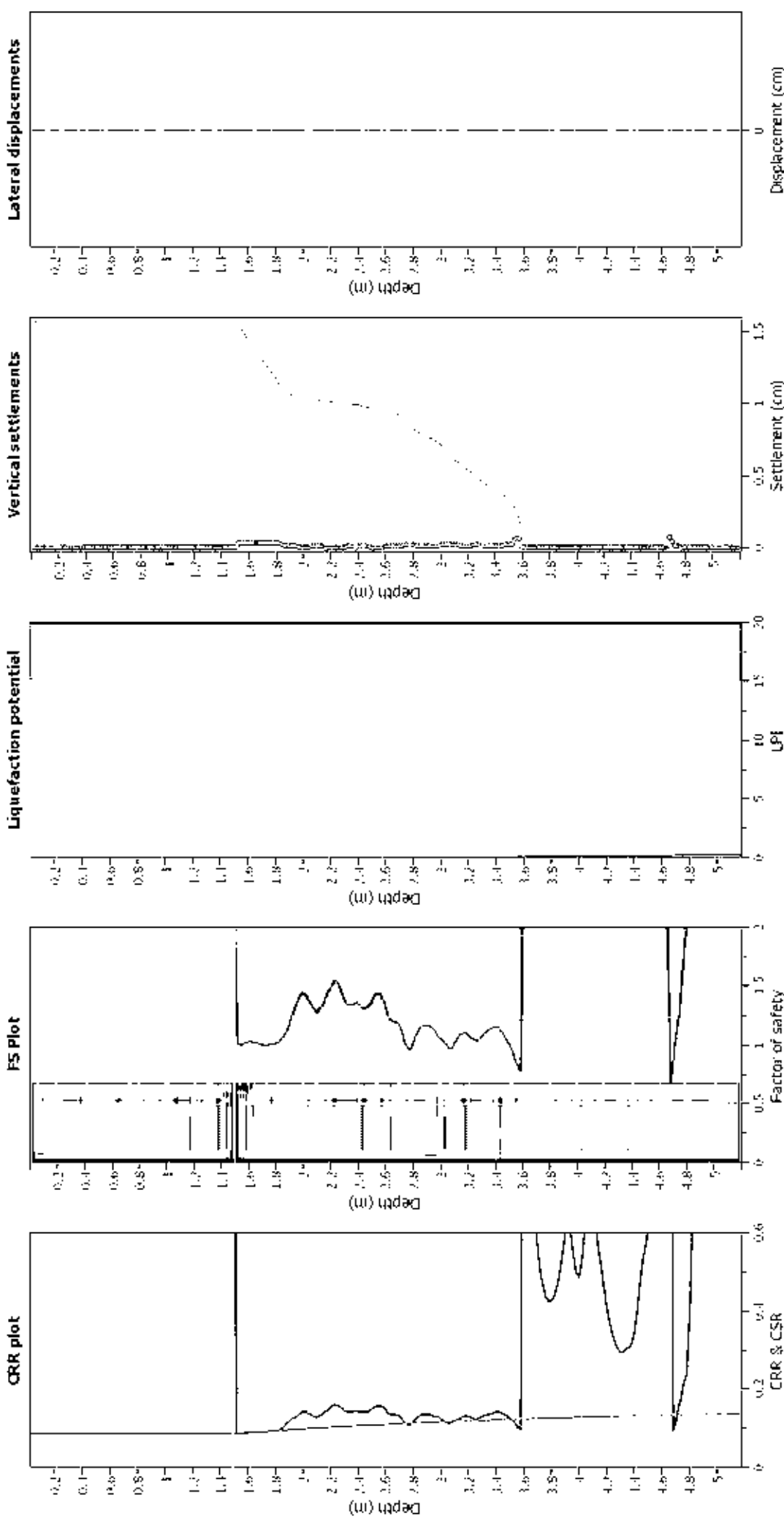
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

#### F.S. color scheme

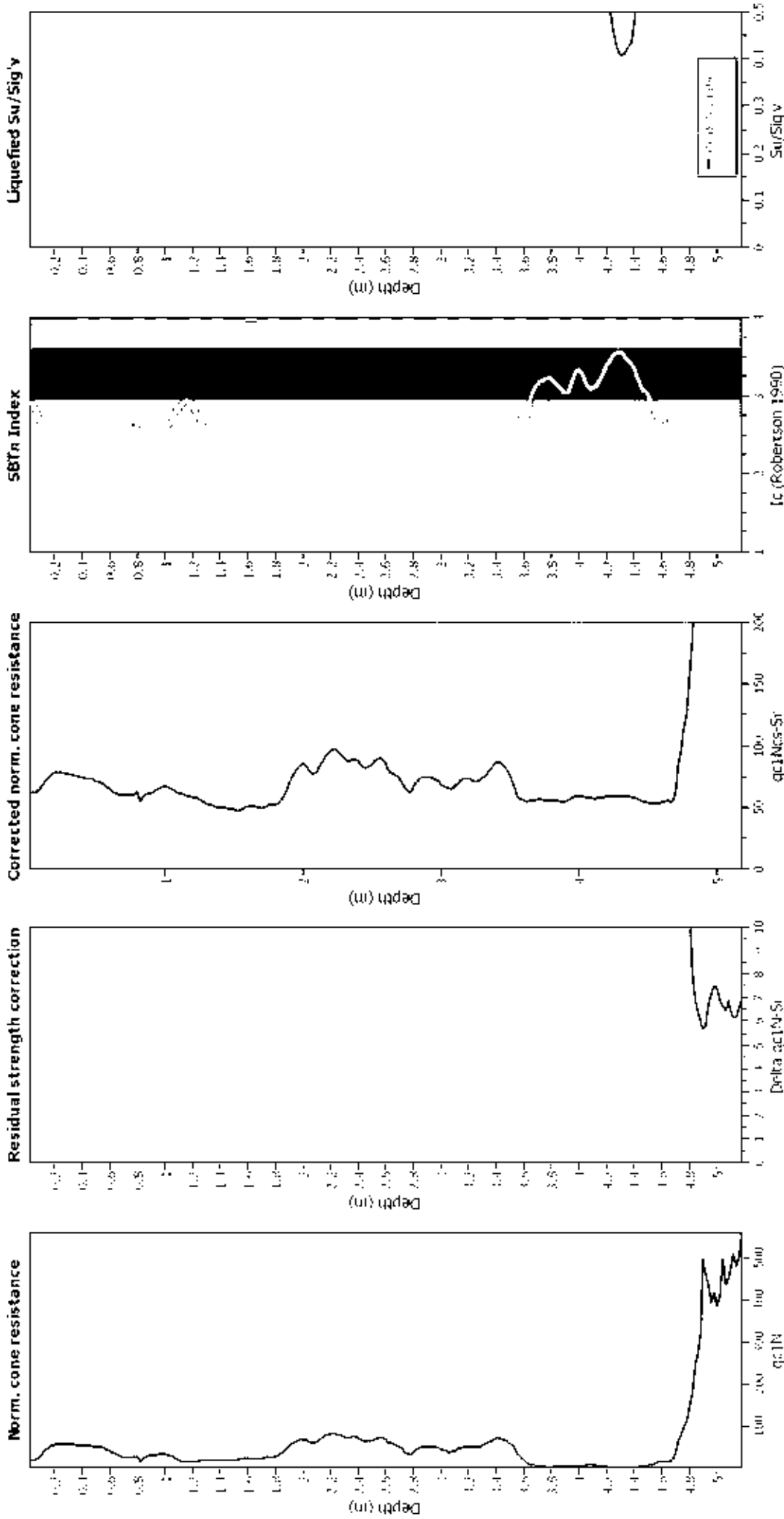
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk



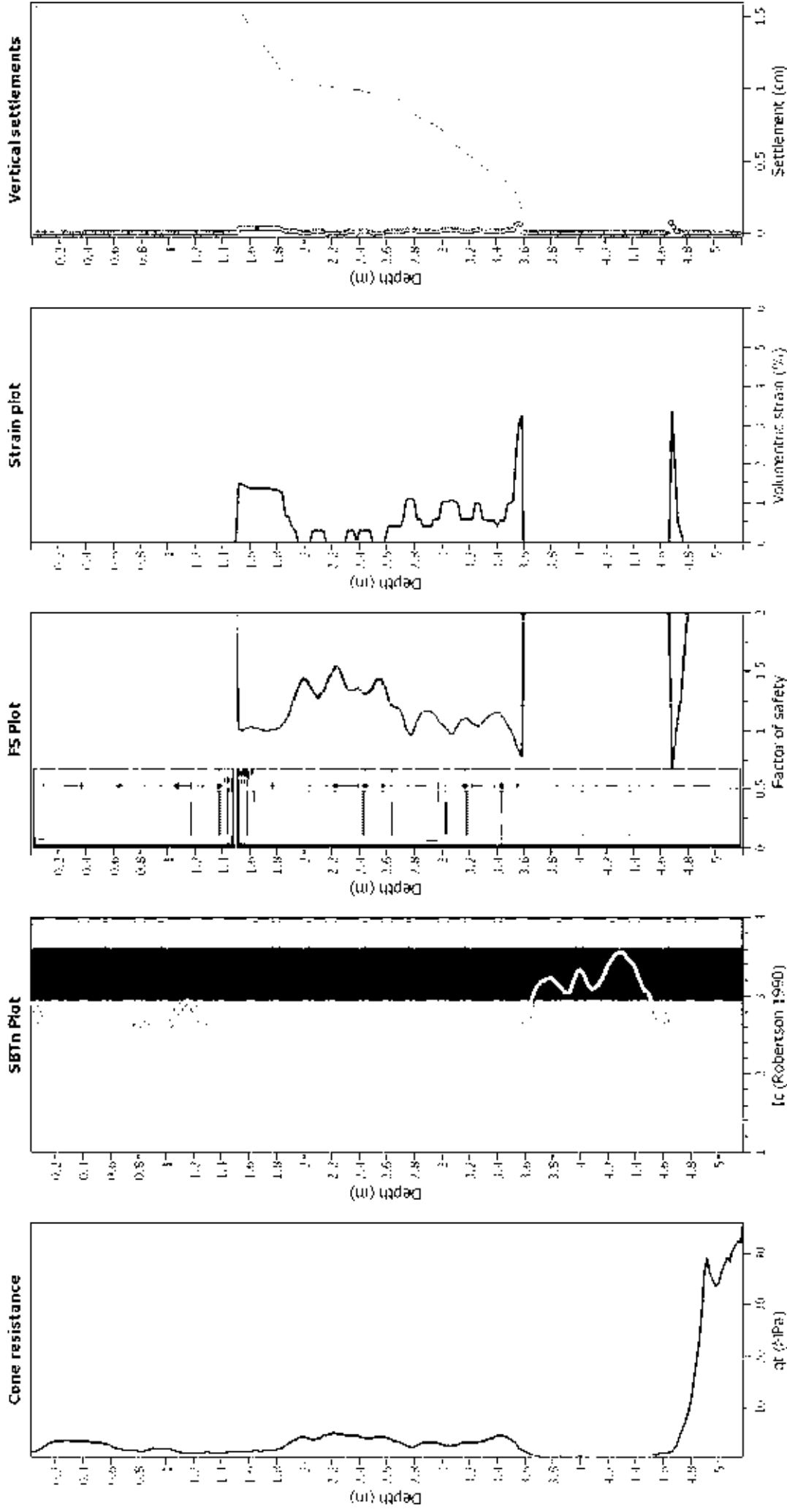
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- FS: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT19\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

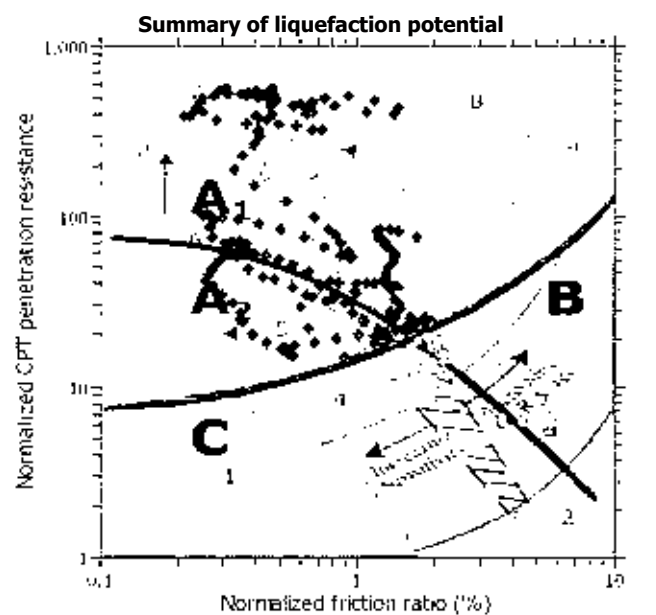
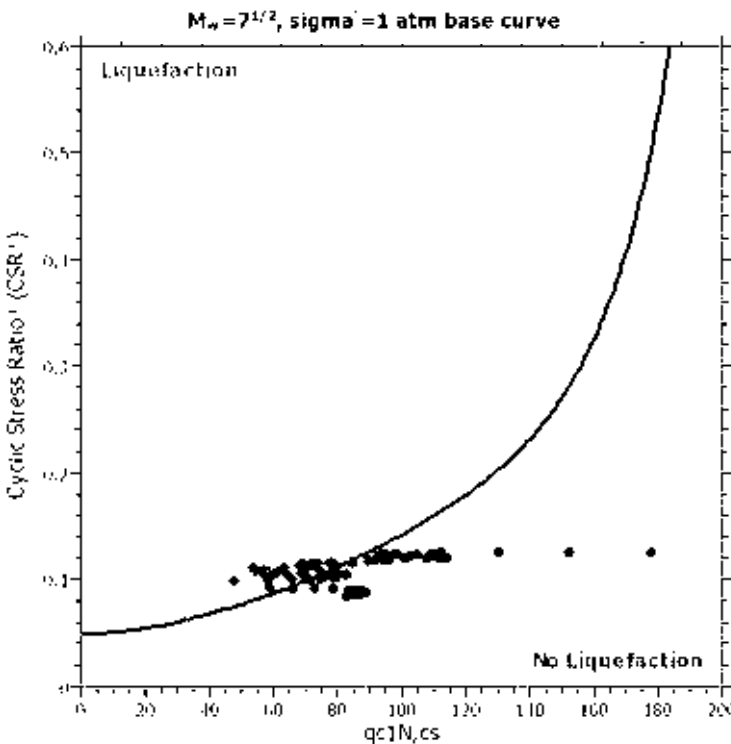
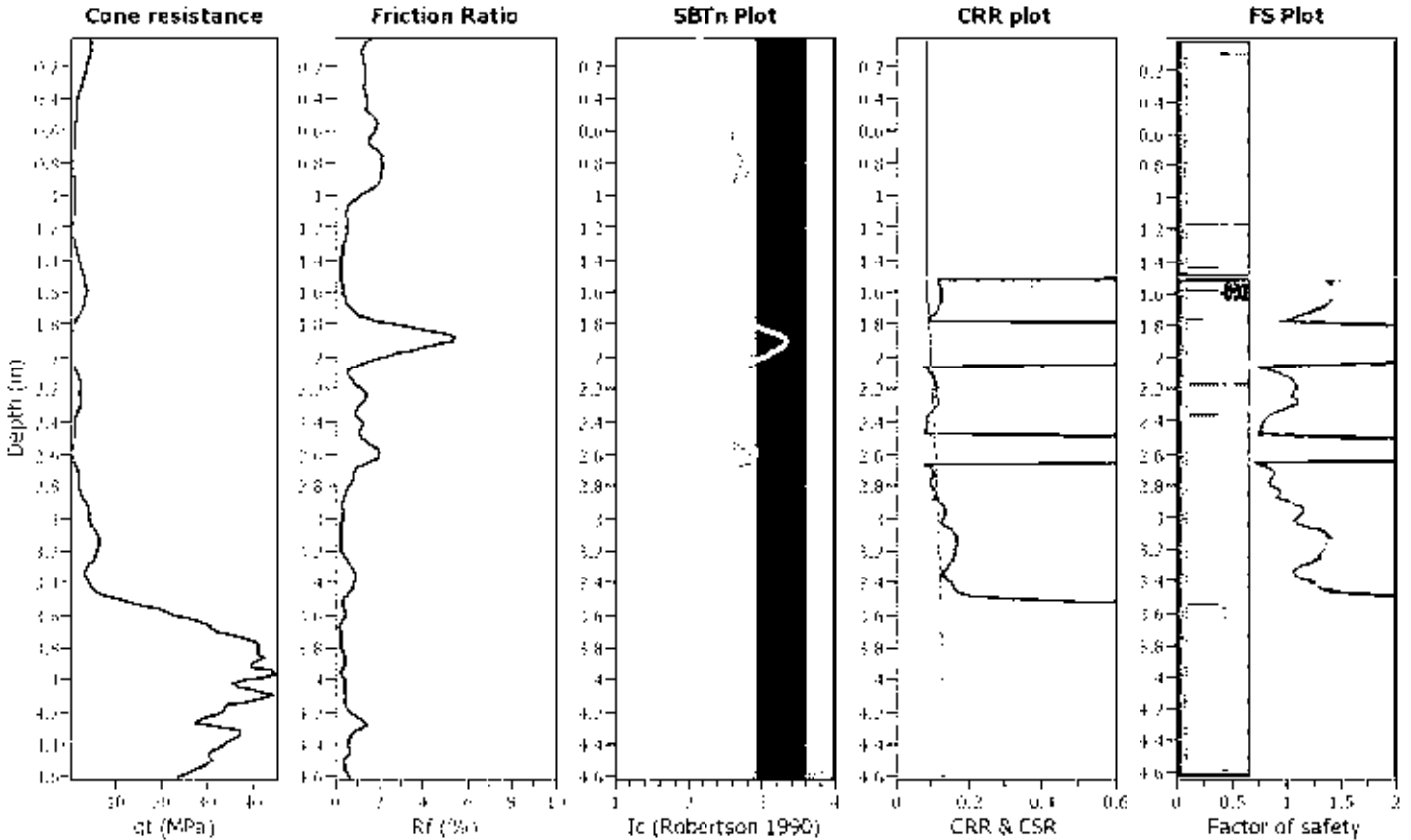
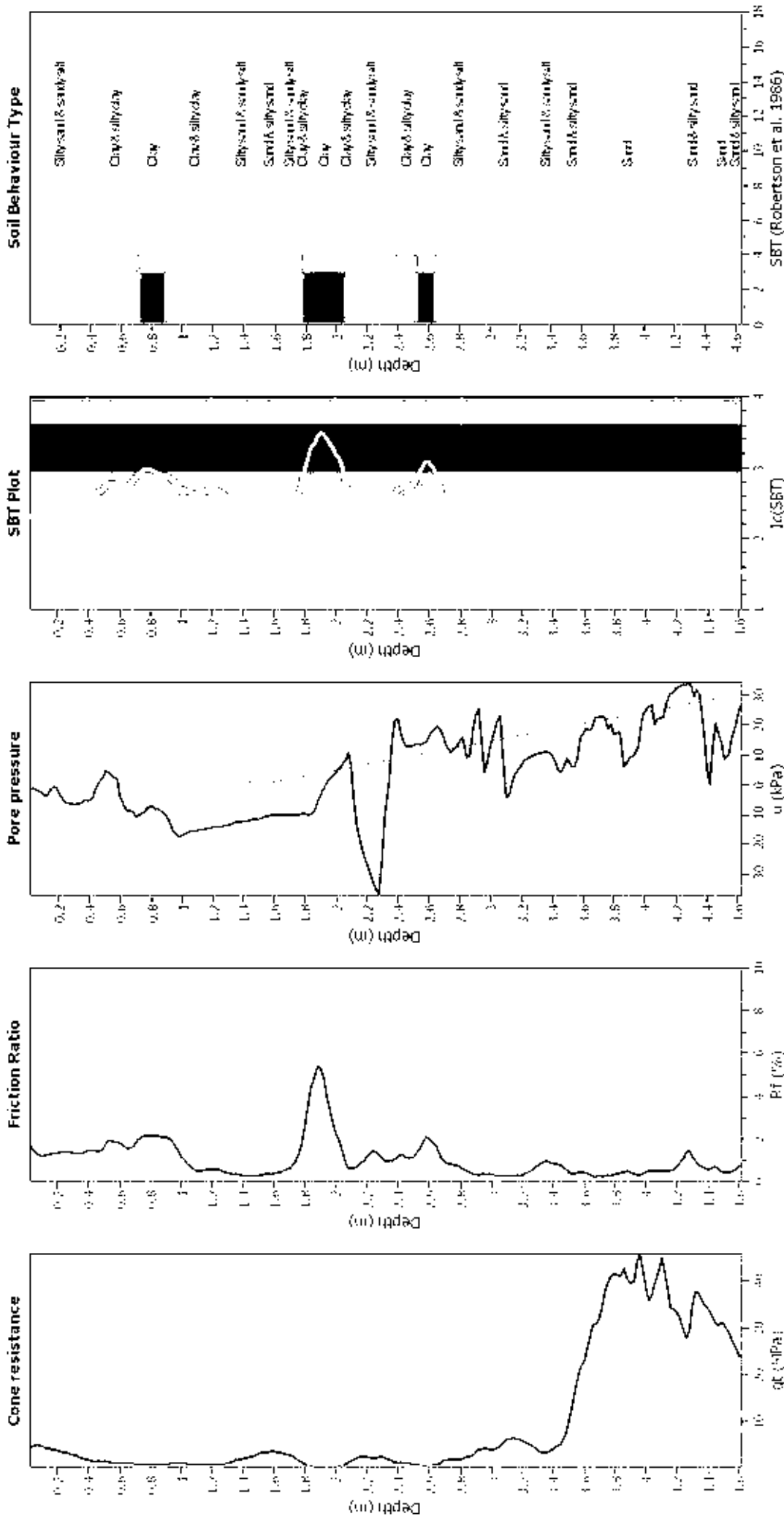


Figure 4: Summary of liquefaction potential based on penetration resistance and cyclic stress ratio. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with regions of liquefaction and no liquefaction indicated. The curves represent the boundaries between these regions.

### CPT basic interpretation plots



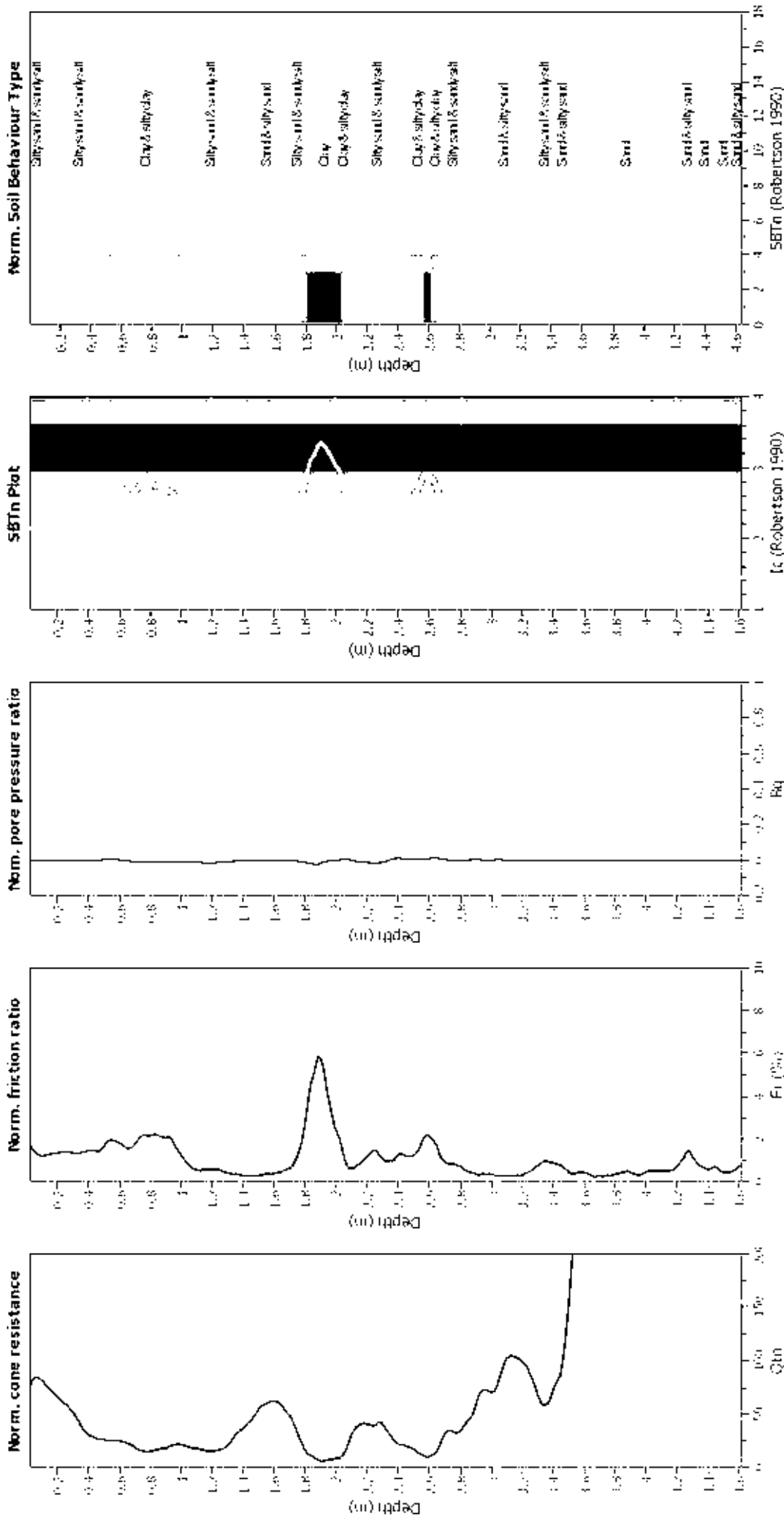
### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	N/A
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Average results interval:	3	Transition depth applied:	Sand & Clay
$I_c$ cut-off value:	2.60	K applied:	Yes
Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Use fill:	No	Unit depth applied:	N/A
Fill height:	N/A	Unit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



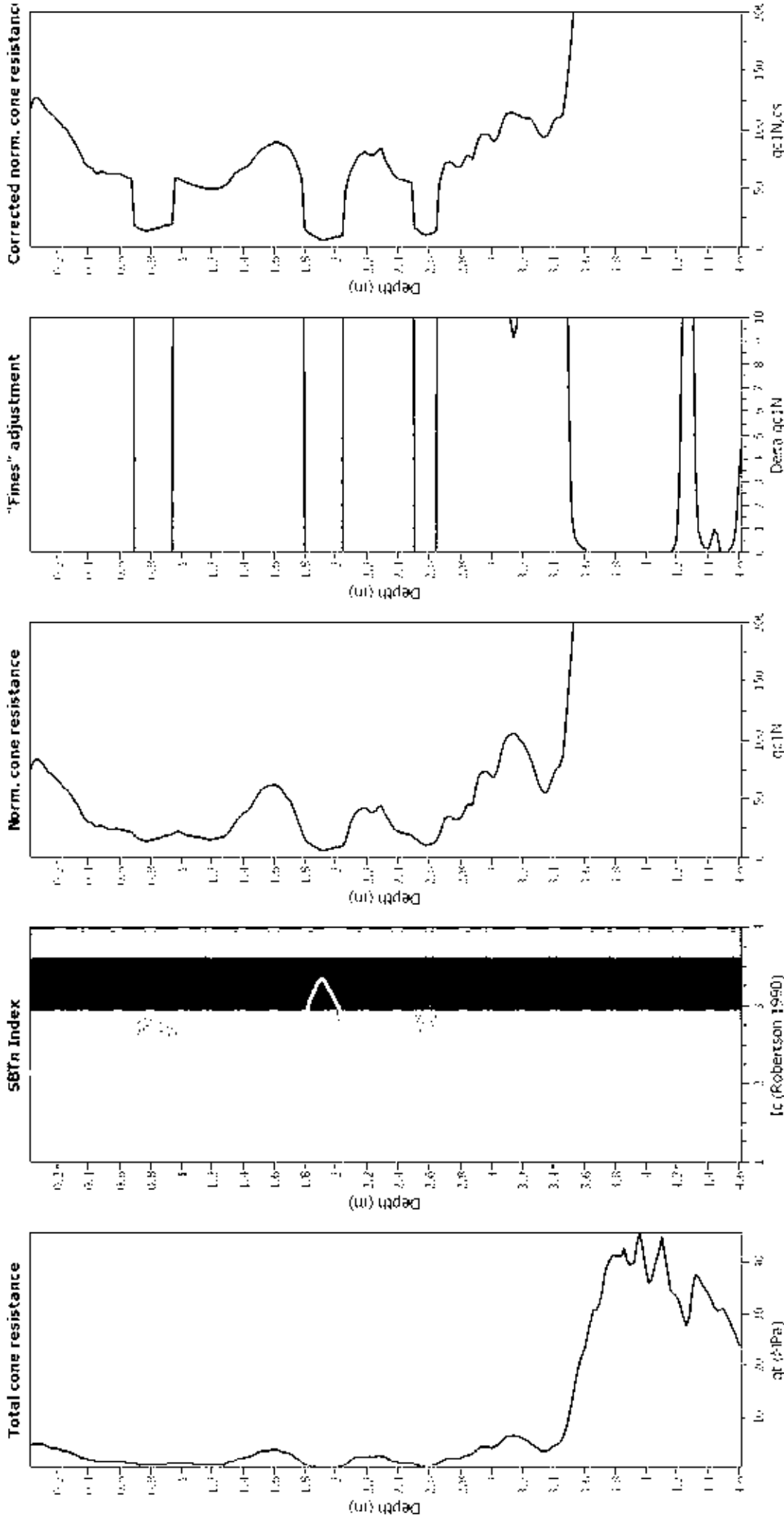
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

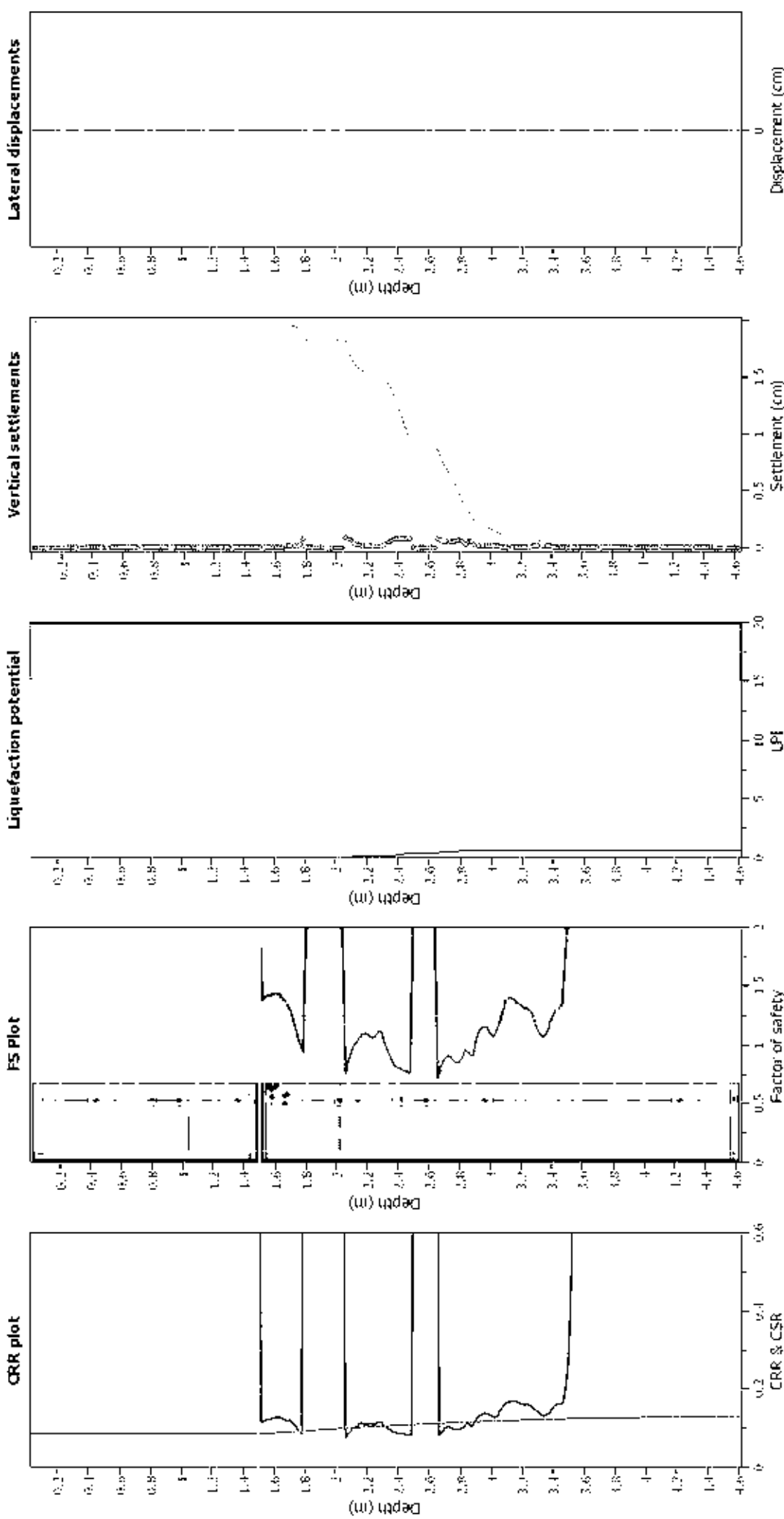
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Lines correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

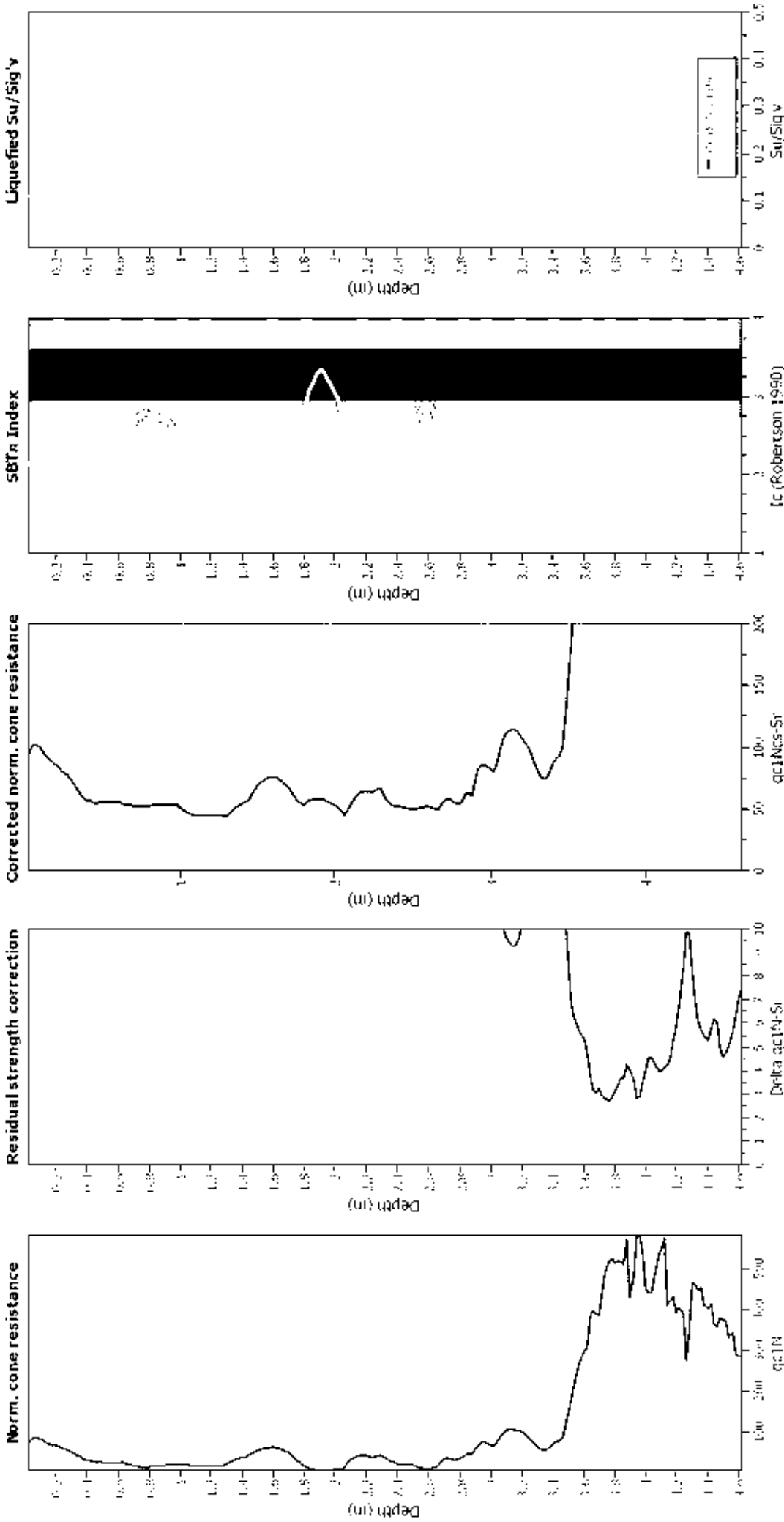
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

### Check for strength loss plots (Idriss & Boulanger (2008))

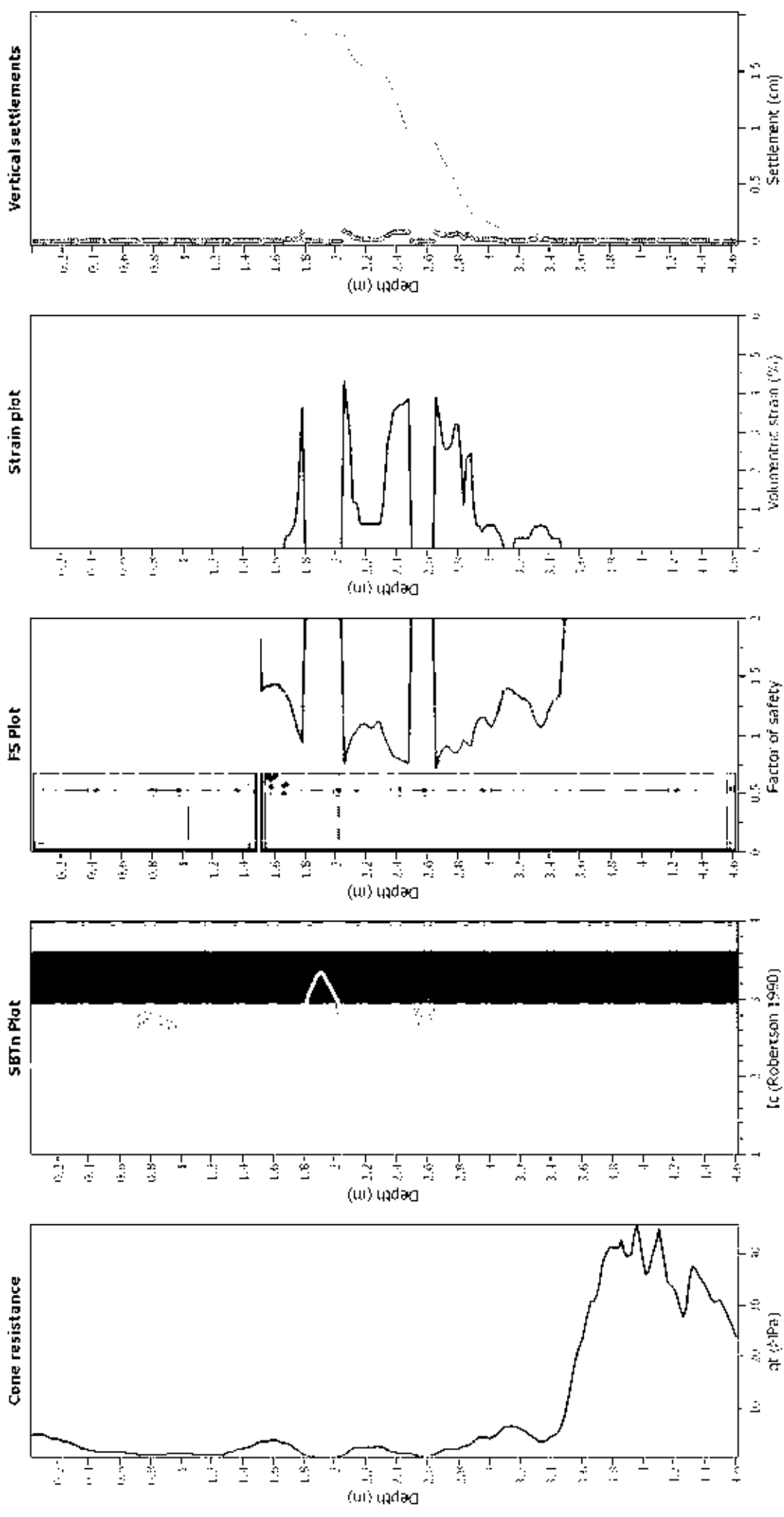


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT20\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

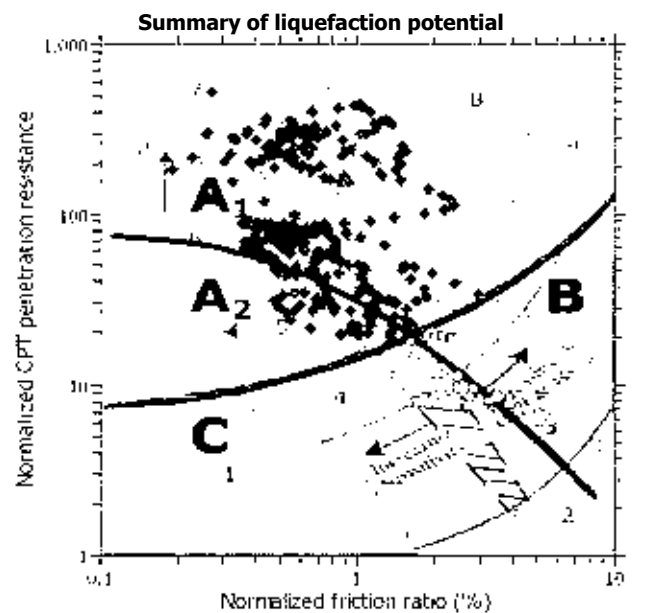
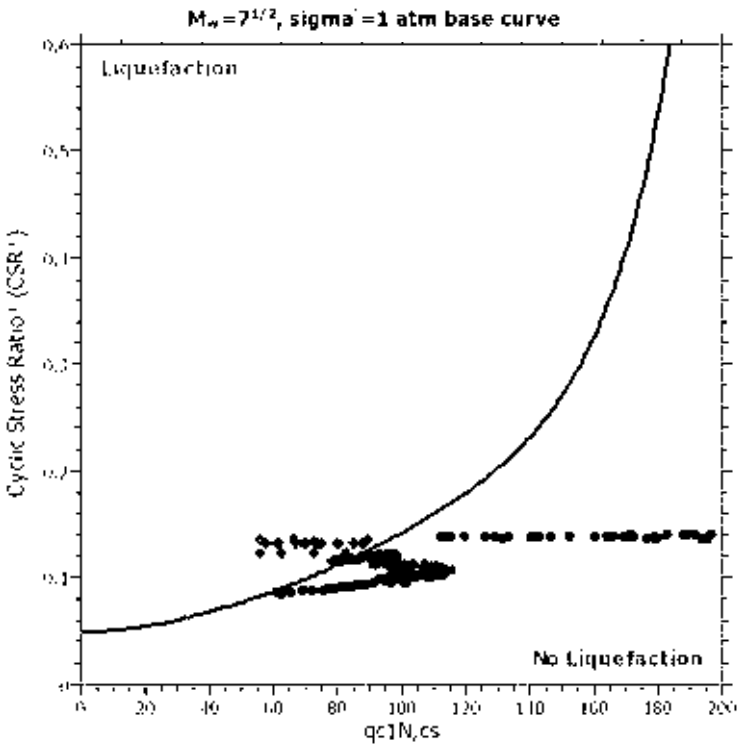
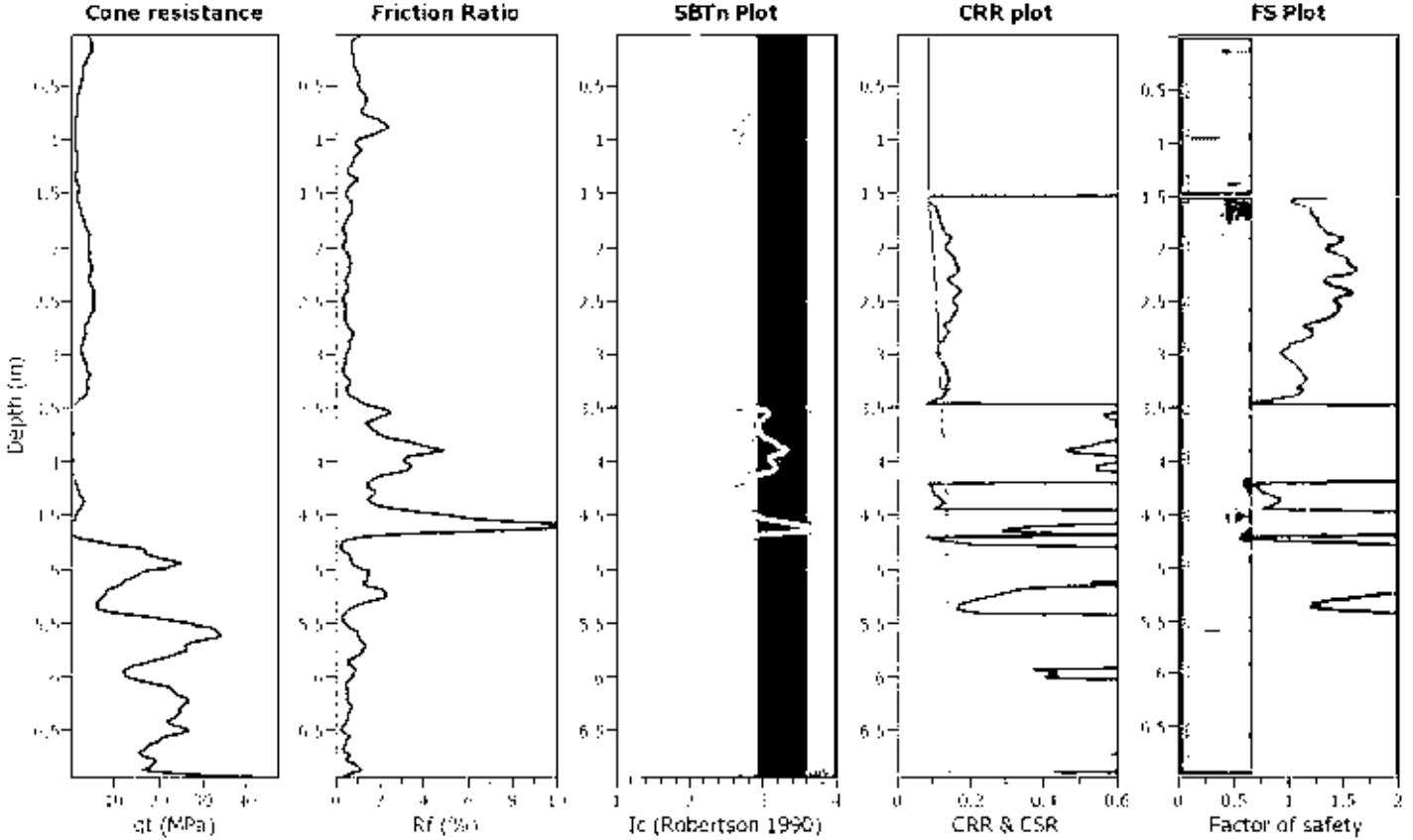
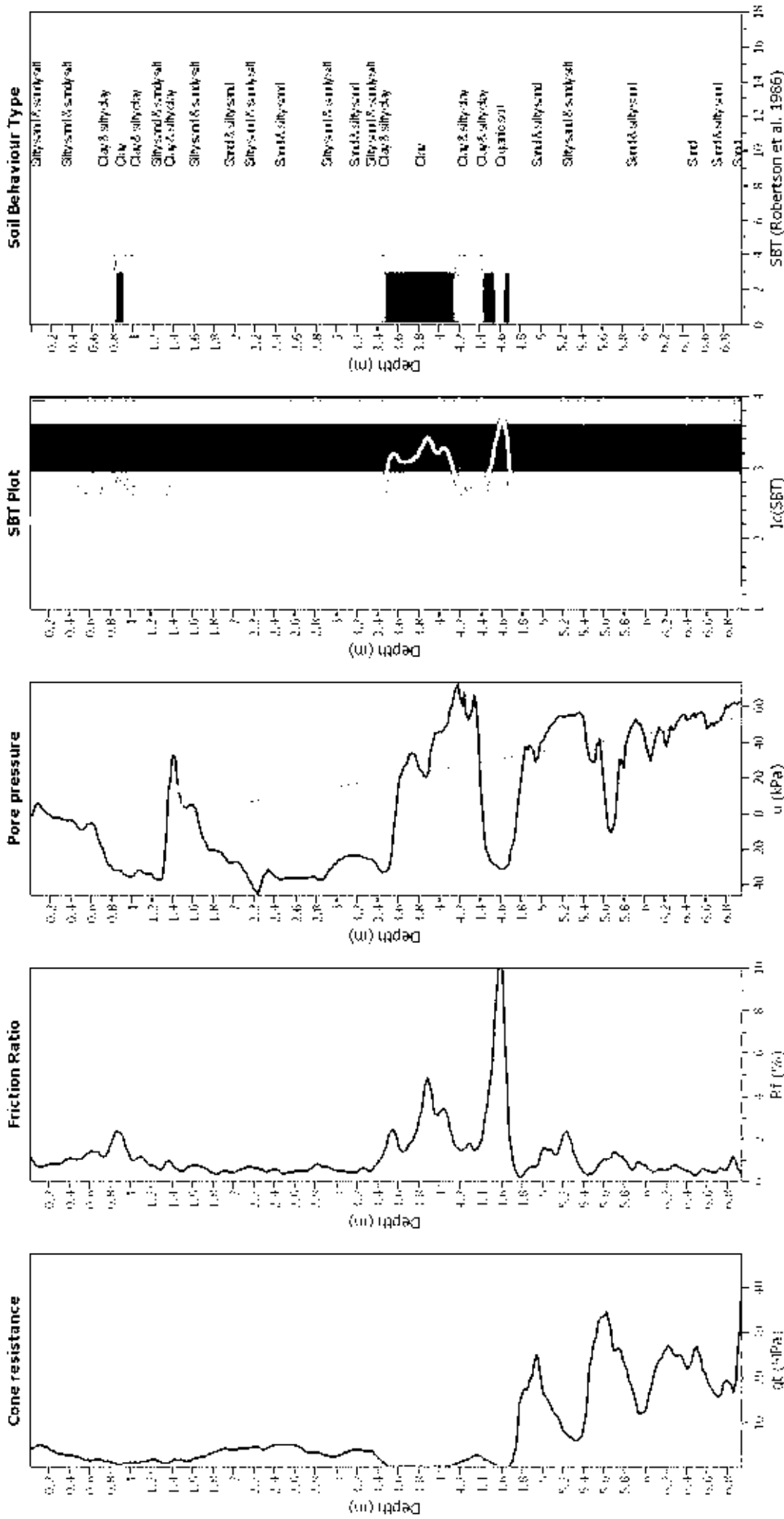


Figure 4: Summary of liquefaction potential plot and data points of cyclic test. Zone A1: Normalized CPT penetration resistance greater than 200 and normalized friction ratio greater than 1. Zone A2: Normalized CPT penetration resistance greater than 200 and normalized friction ratio less than 1. Zone B: Normalized CPT penetration resistance greater than 200 and normalized friction ratio less than 1. Zone C: Normalized CPT penetration resistance less than 200 and normalized friction ratio less than 1. The liquefaction boundary is defined by the relationship between normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



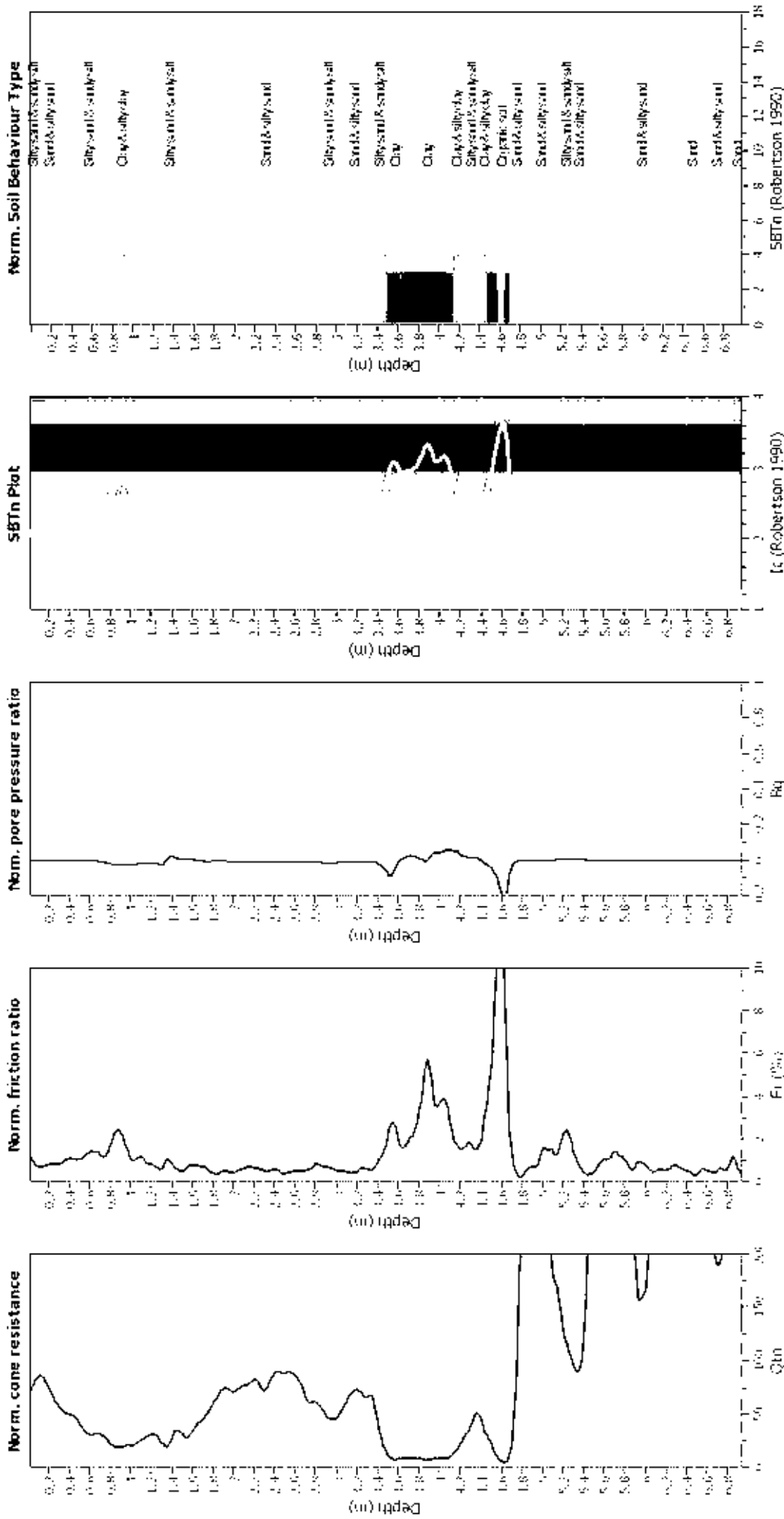
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



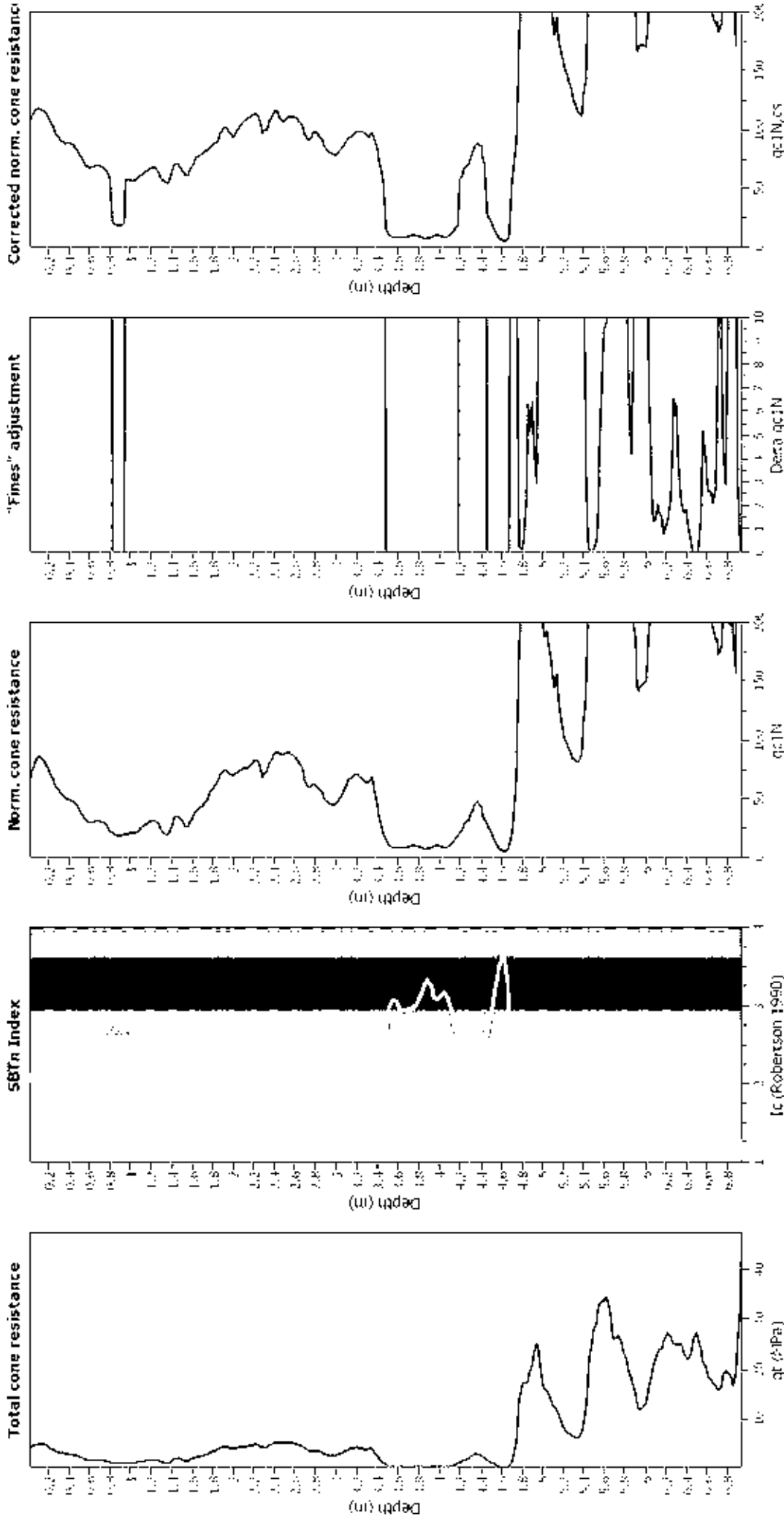
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Use fill:	No	Unit depth applied:	No
Peak ground acceleration:	0.13	Fill height:	N/A	Unit depth:	N/A
Depth to water table (m):	1.50 m				

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

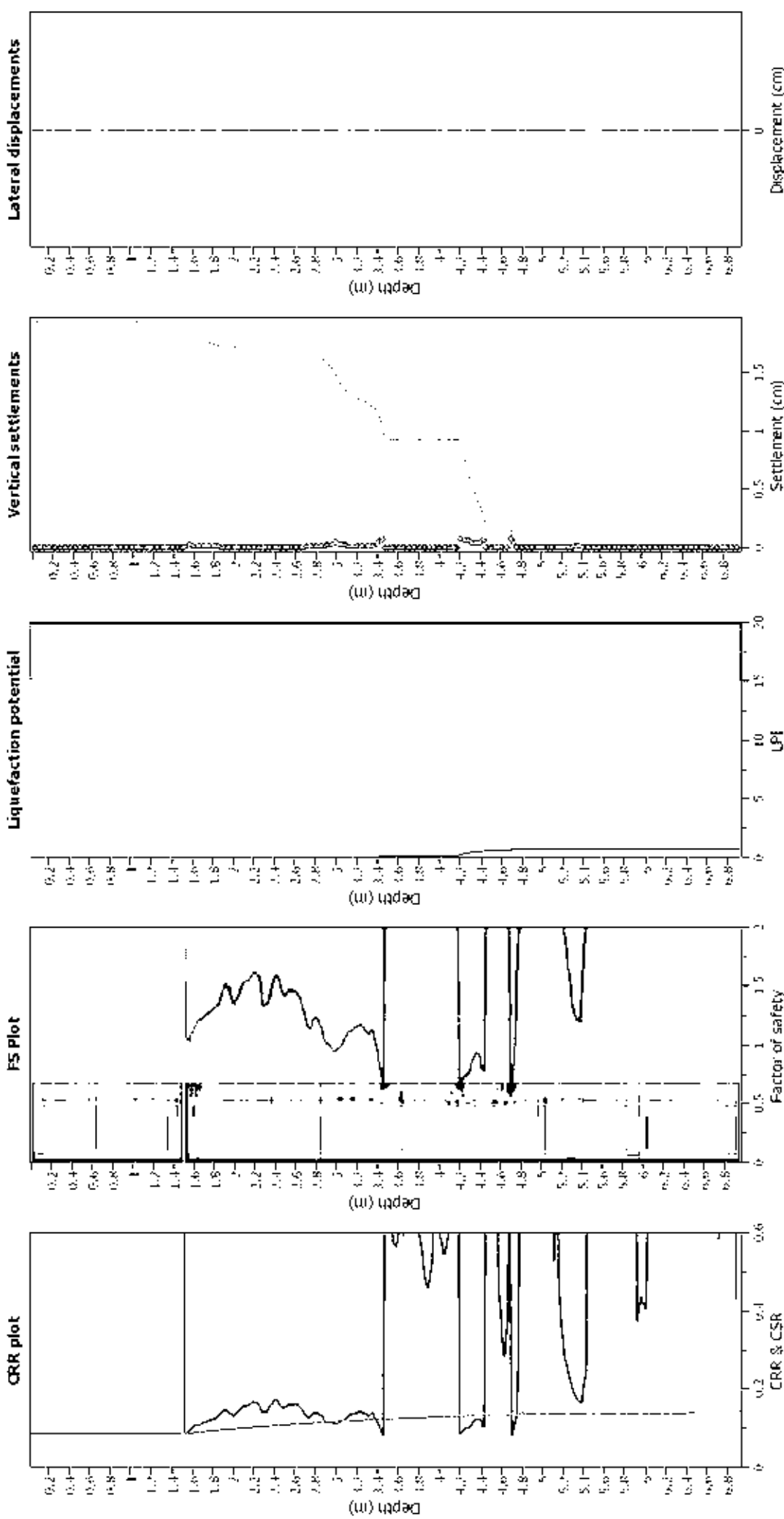
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

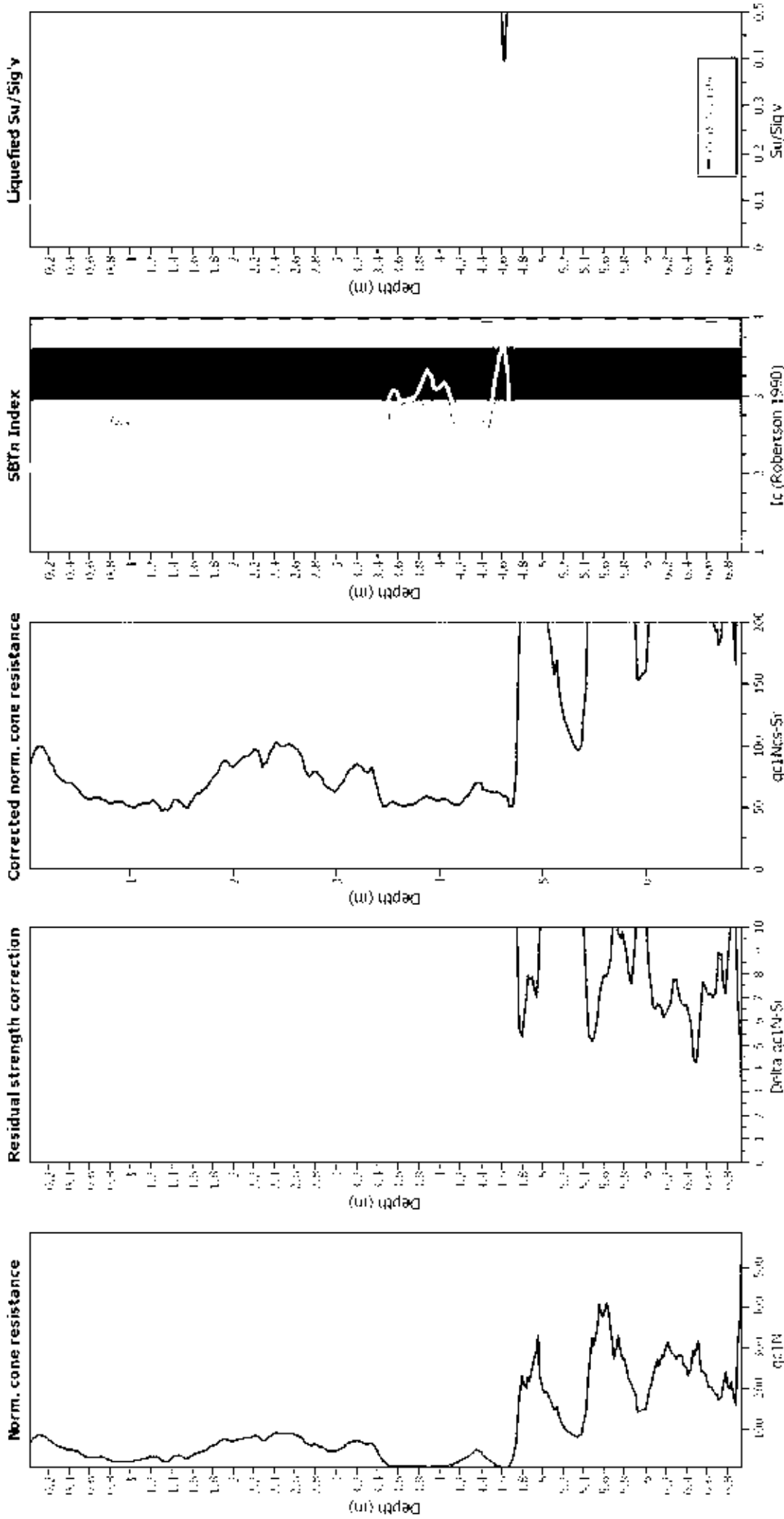
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

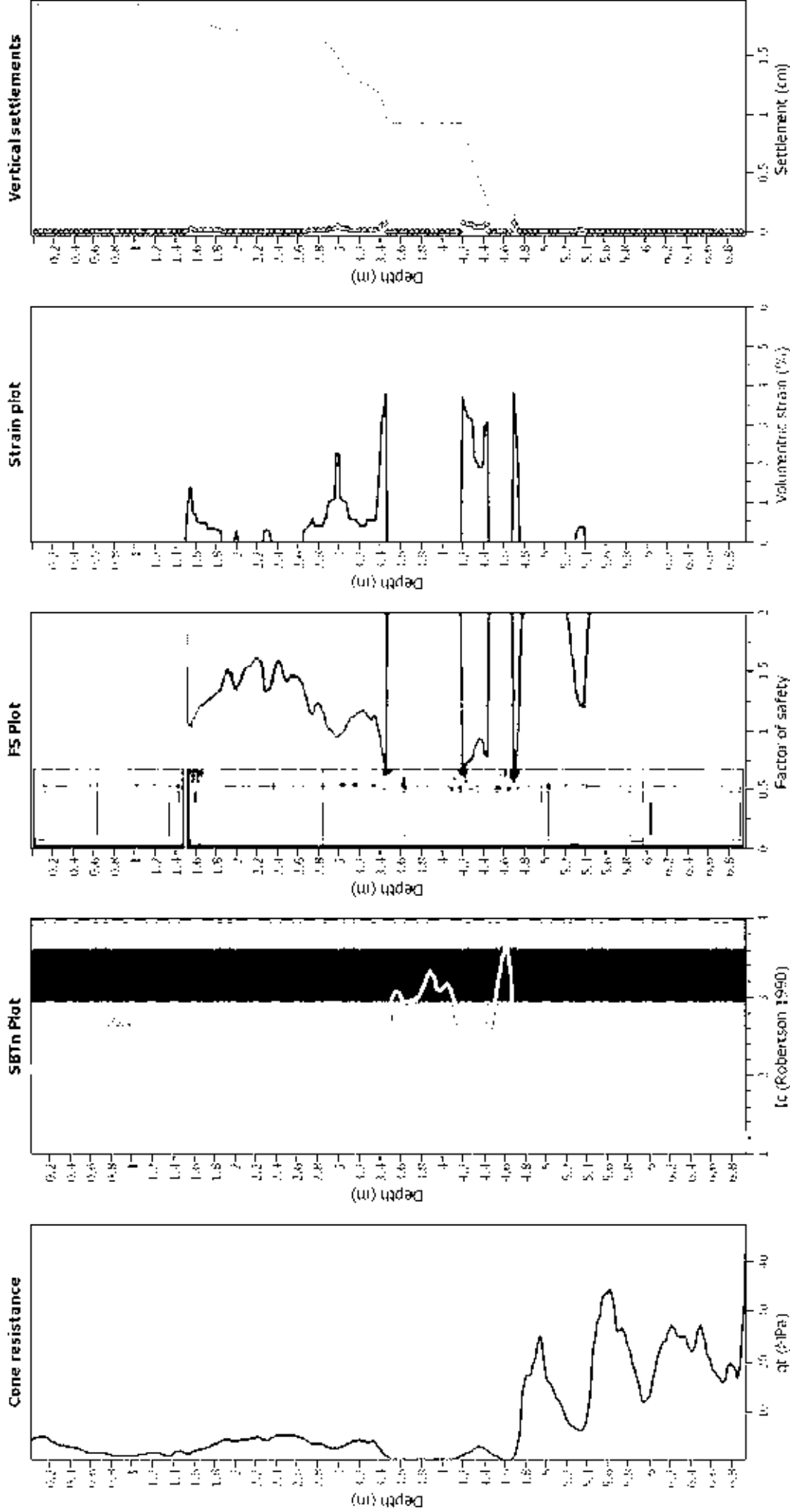
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- S<sub>b</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain



**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT21\_30GloversRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

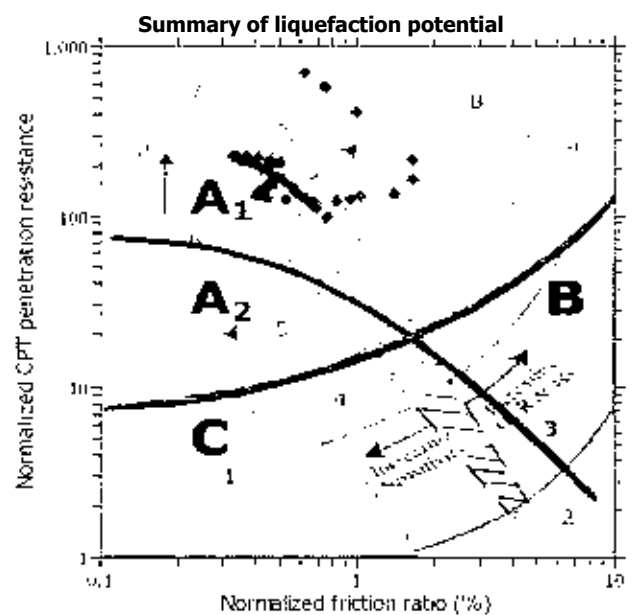
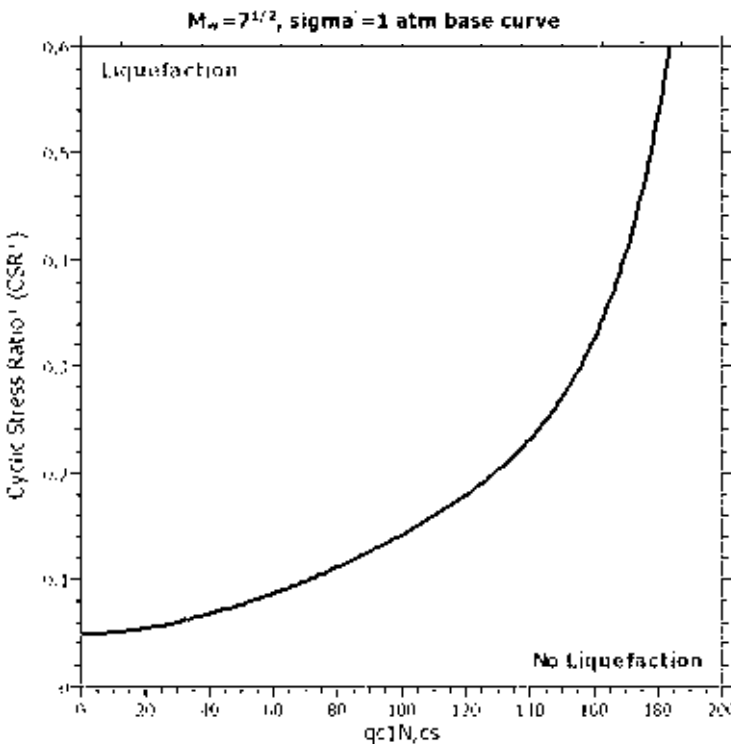
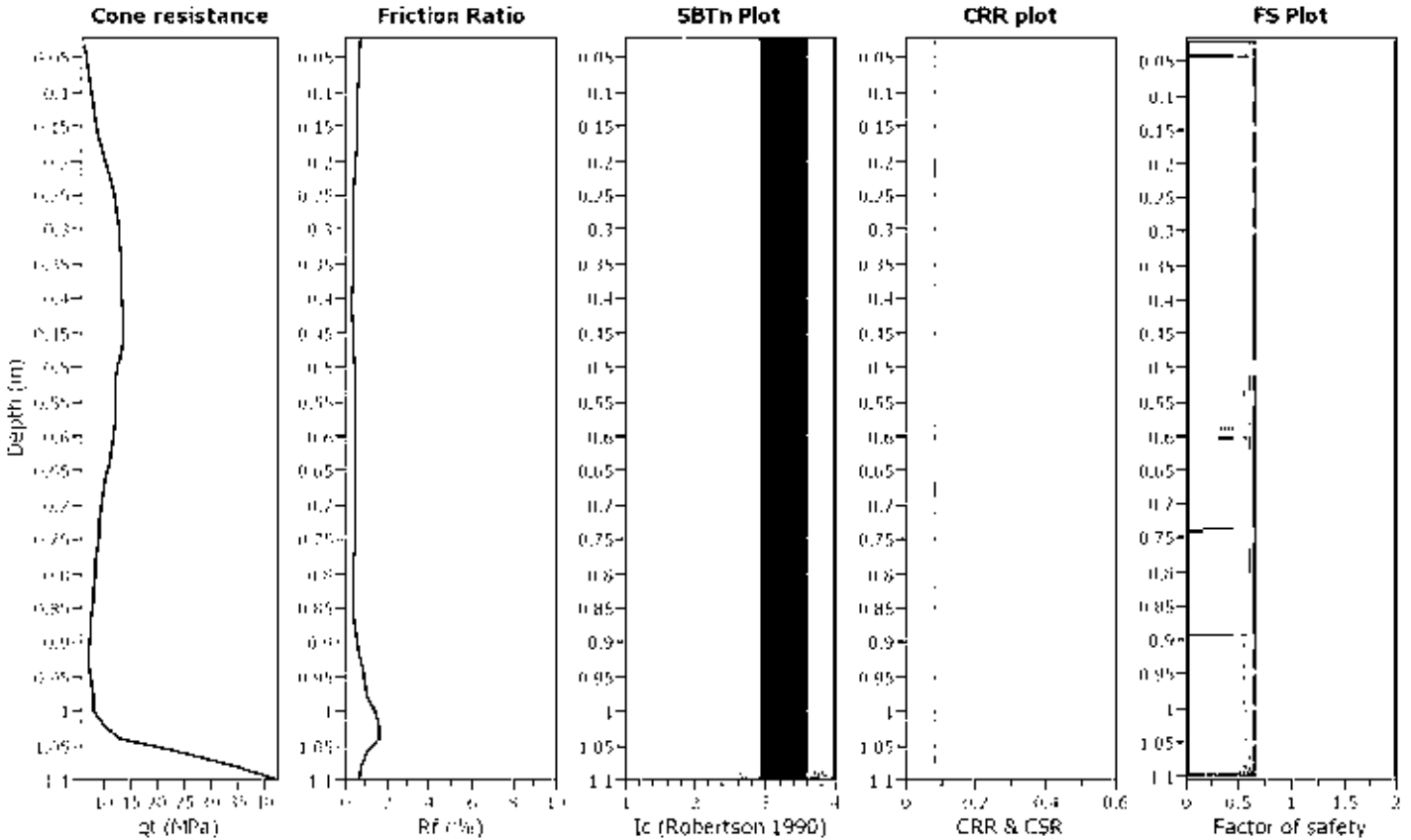
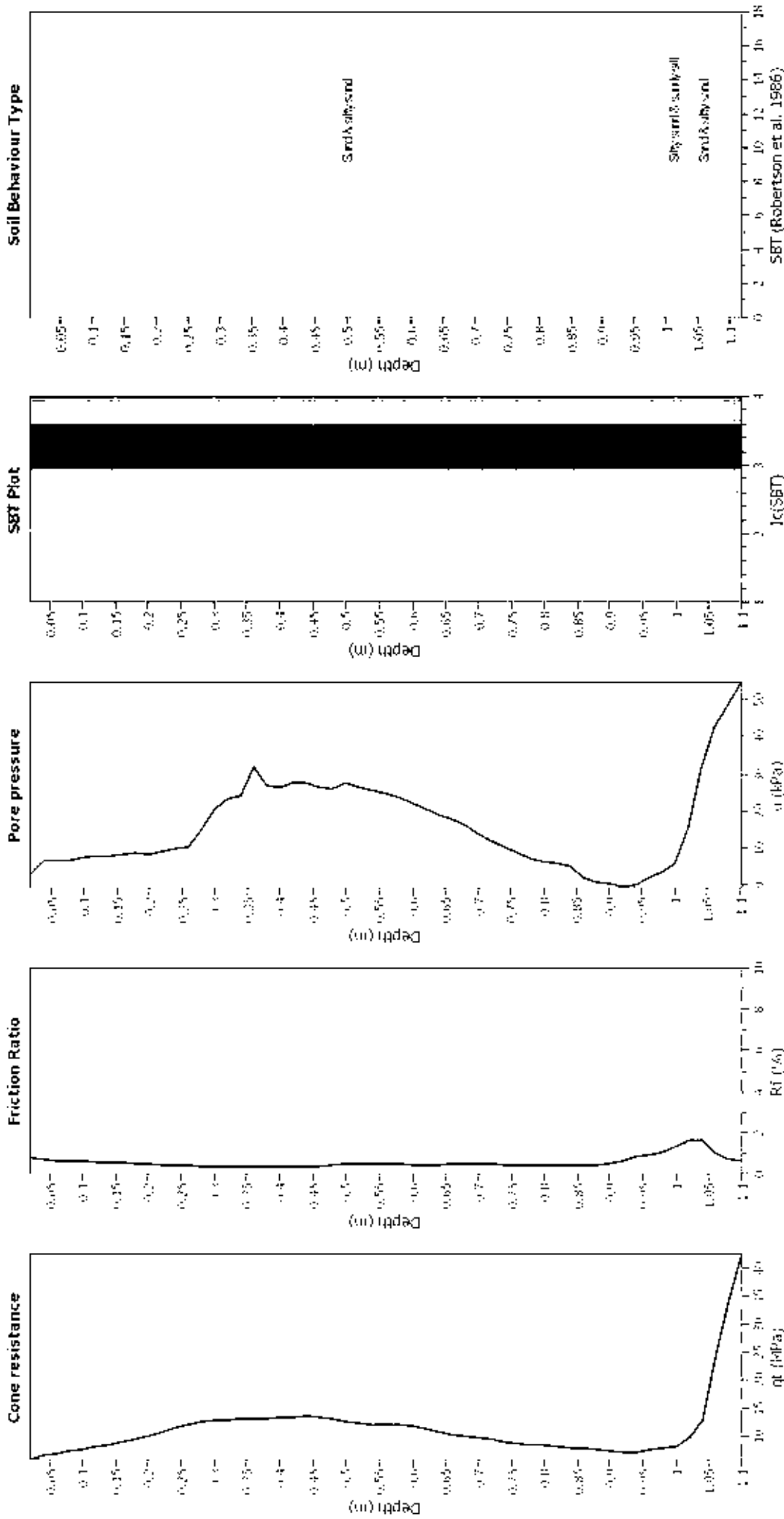


Figure 4: Summary of liquefaction potential and normalized cyclic stress ratio. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The liquefaction boundary is defined by the equation:  $CSR = 0.1 \cdot \left( \frac{R_f}{10} \right)^{1.5} \cdot \left( \frac{R_p}{100} \right)^{0.5}$ . The chart is divided into four regions: A1 (high resistance, low friction), A2 (high resistance, high friction), B (medium resistance, high friction), and C (low resistance, low friction).

### CPT basic interpretation plots



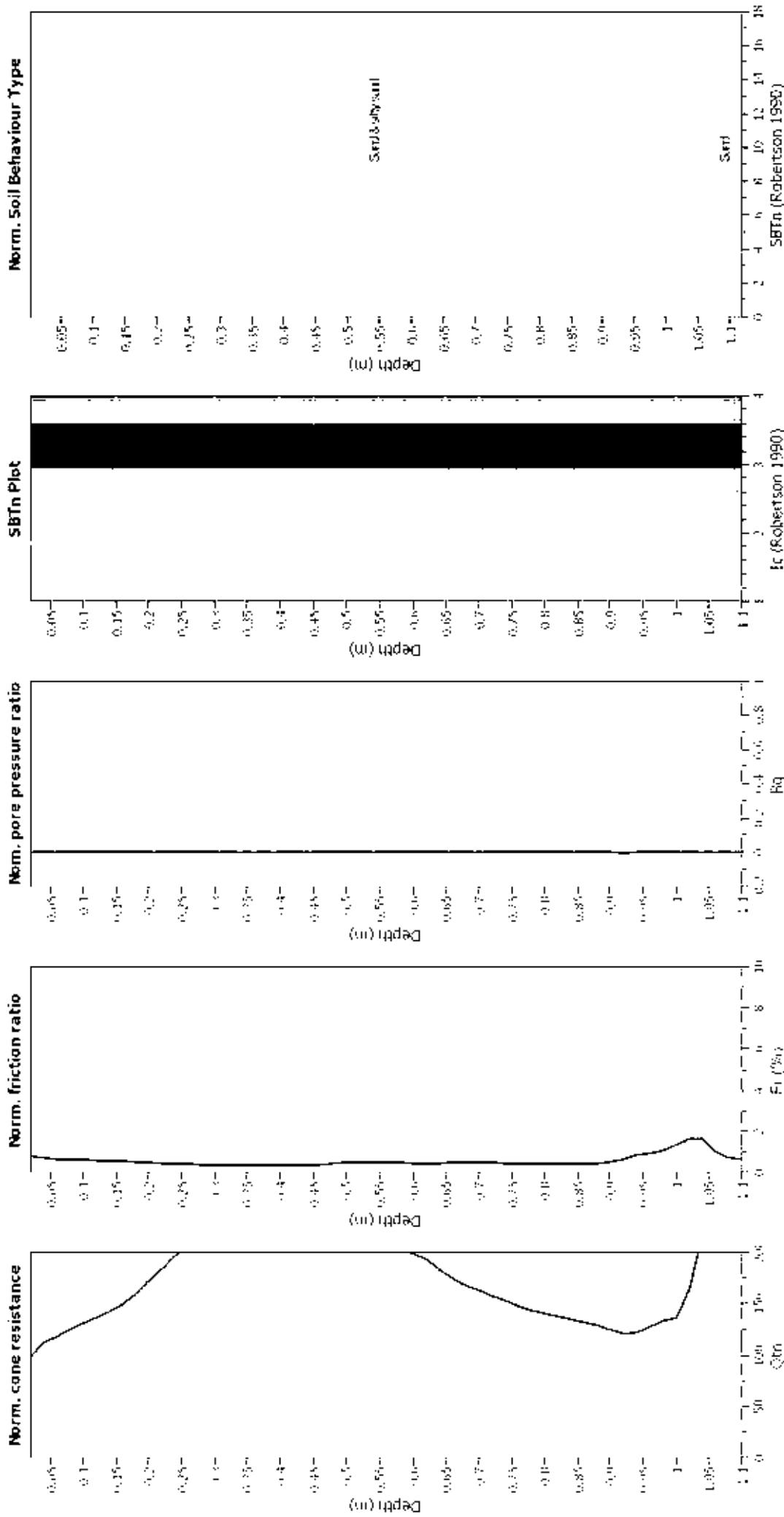
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



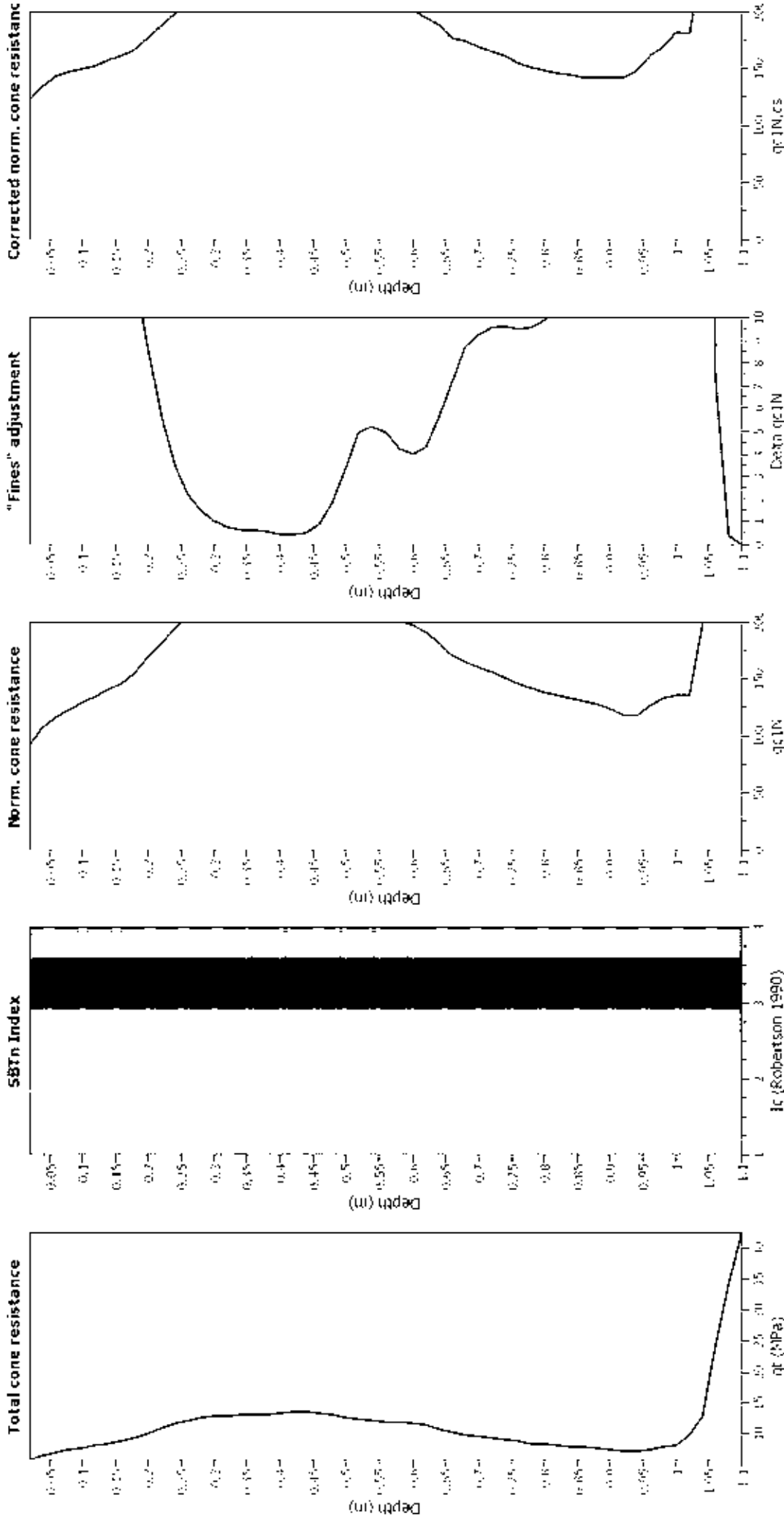
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

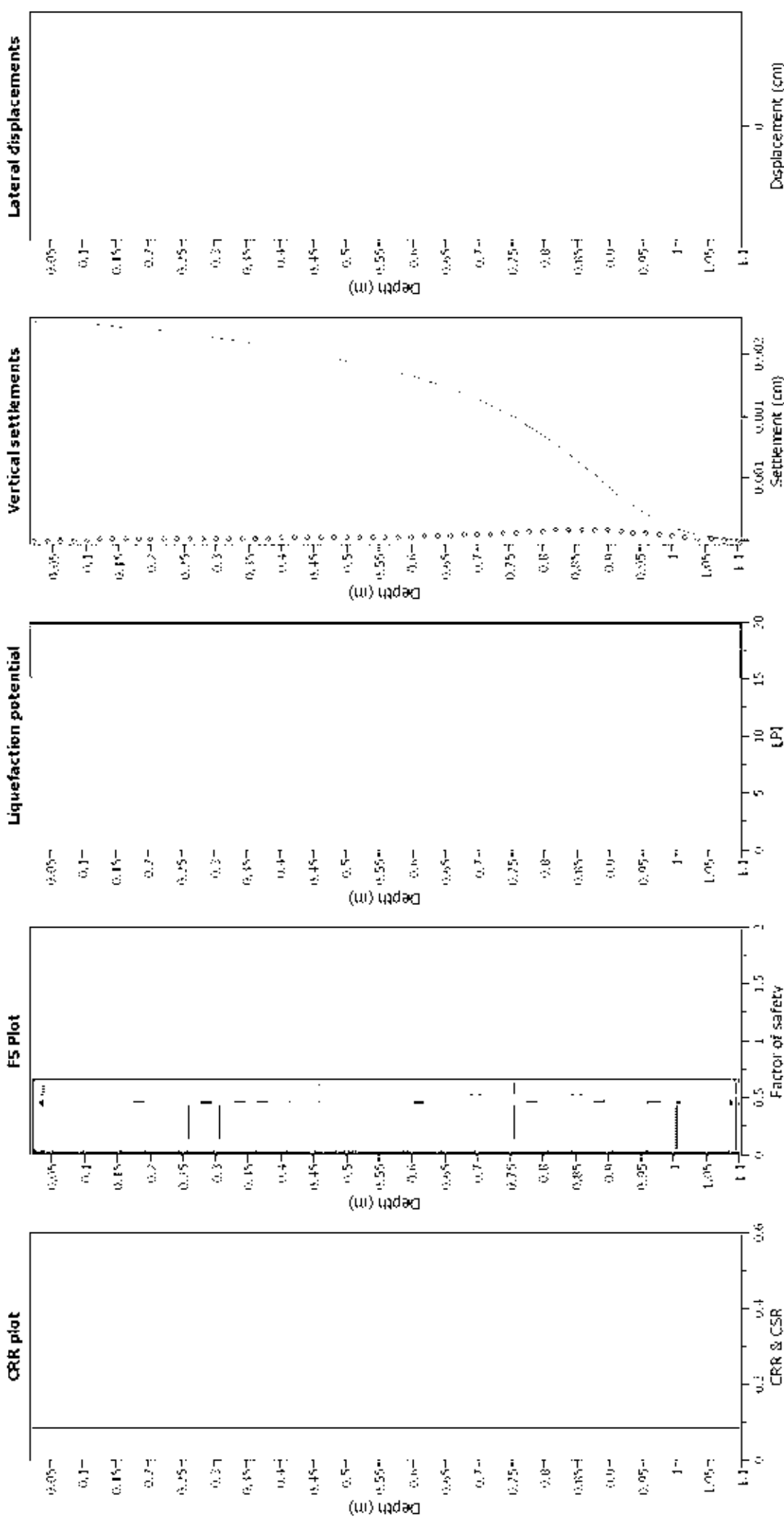
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition method applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No  
 Limit depth: N/A

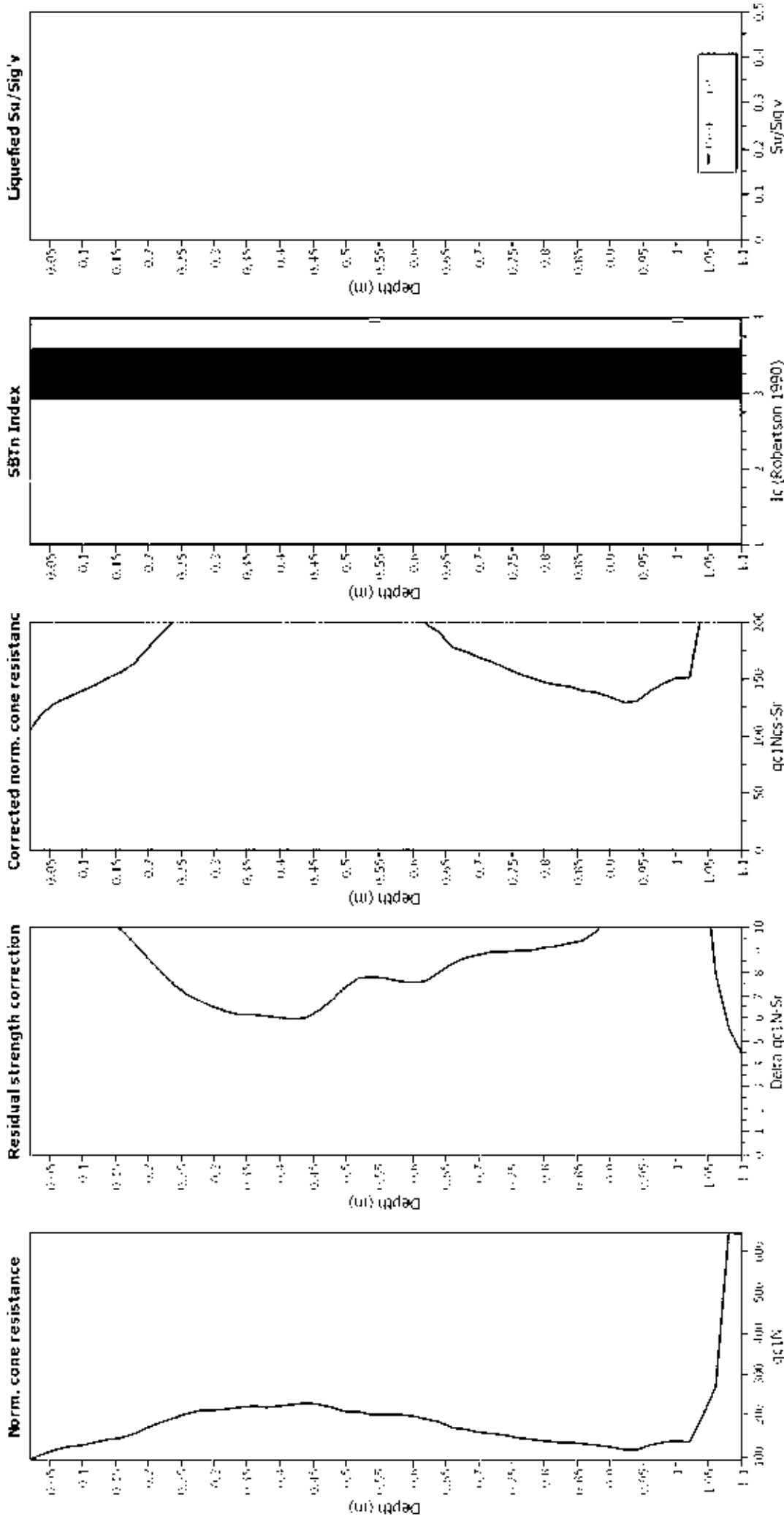
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

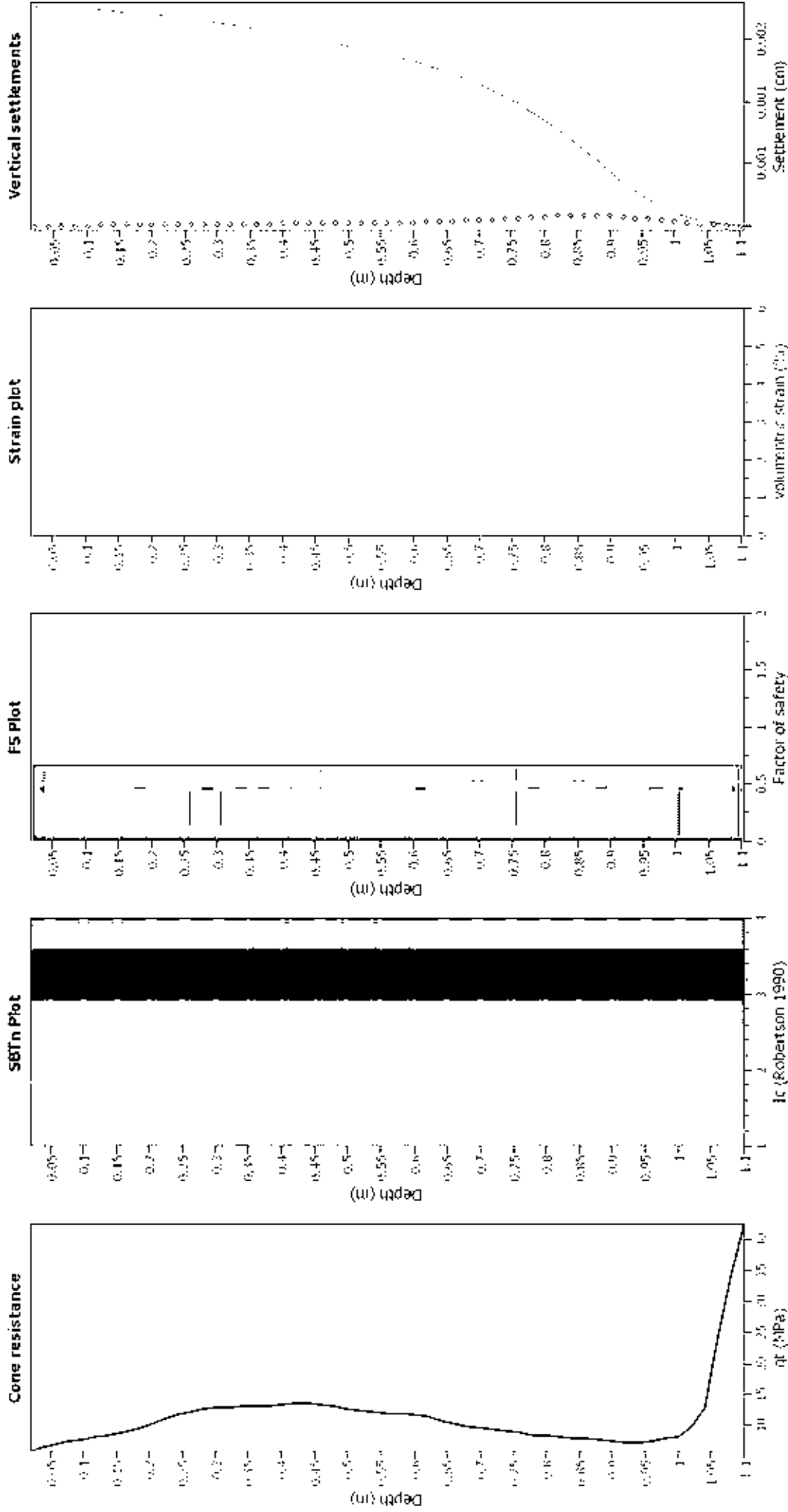
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT22\_117KennedysBushRoad**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

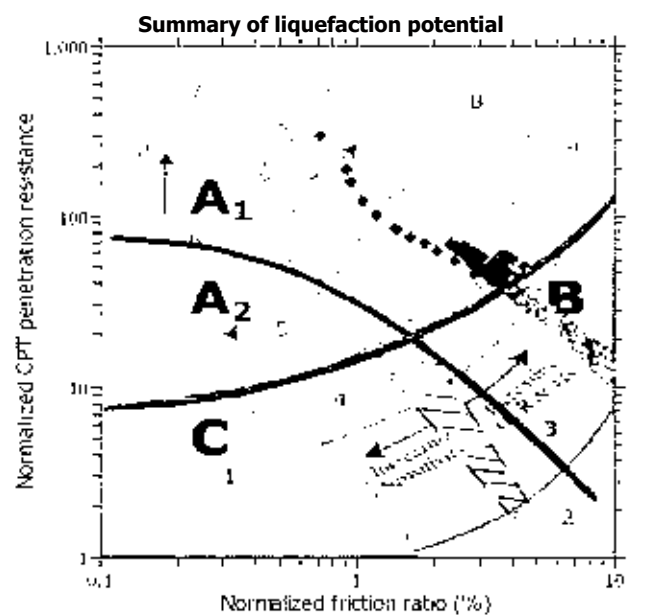
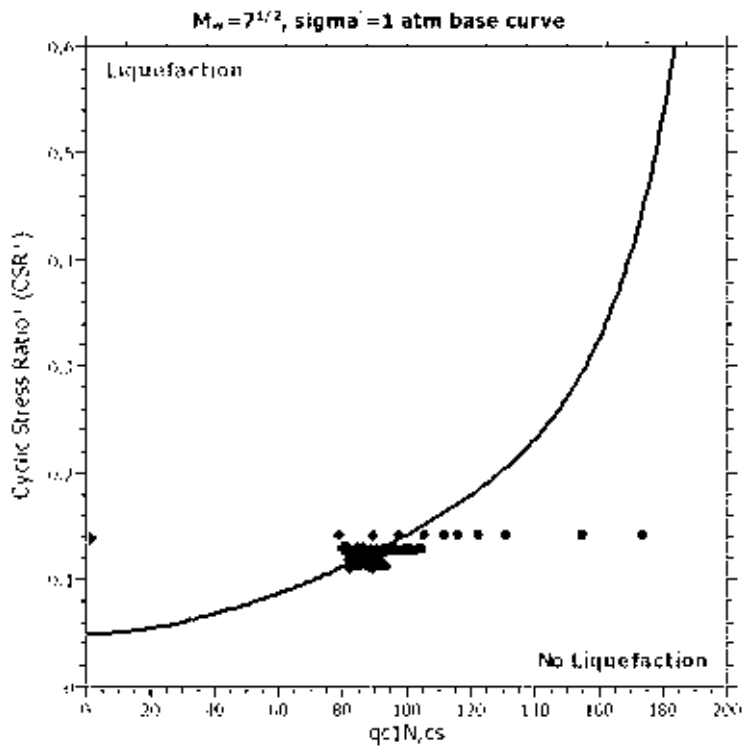
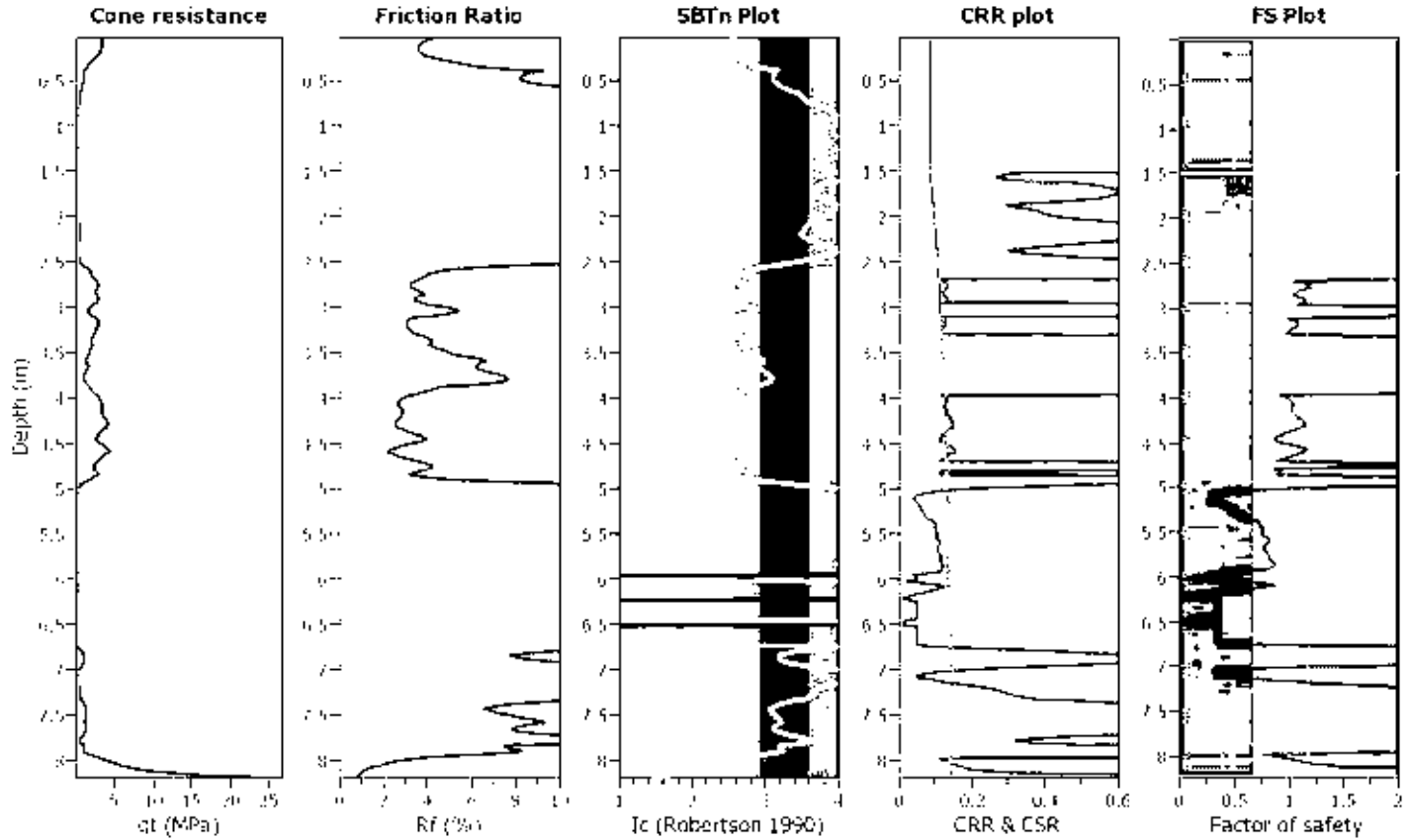
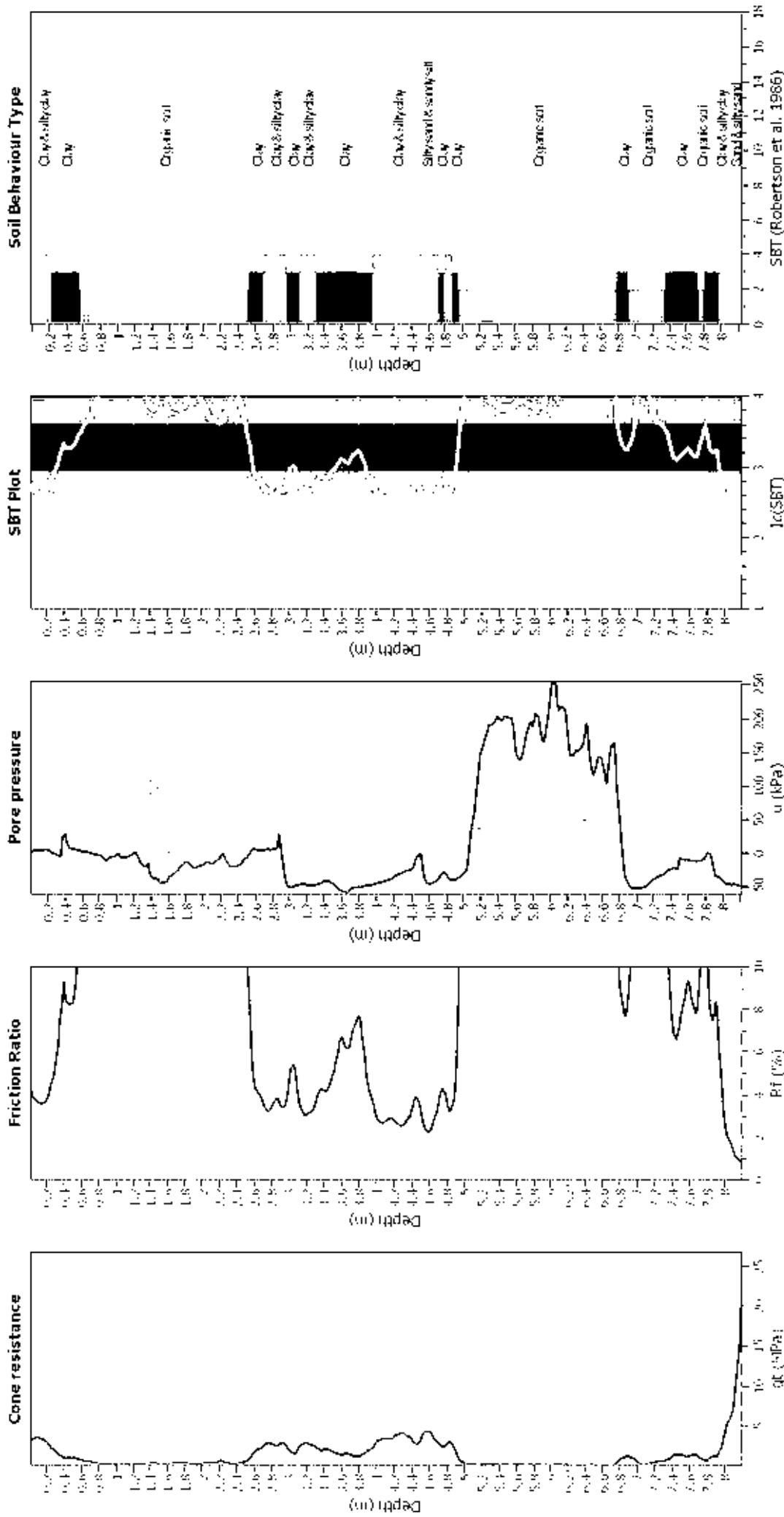


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio less than 10%. Zone A2: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 10% and 20%. Zone B: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 20% and 30%. Zone C: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 10% and 20%. The liquefaction boundary is shown as a dashed line.



### CPT basic interpretation plots



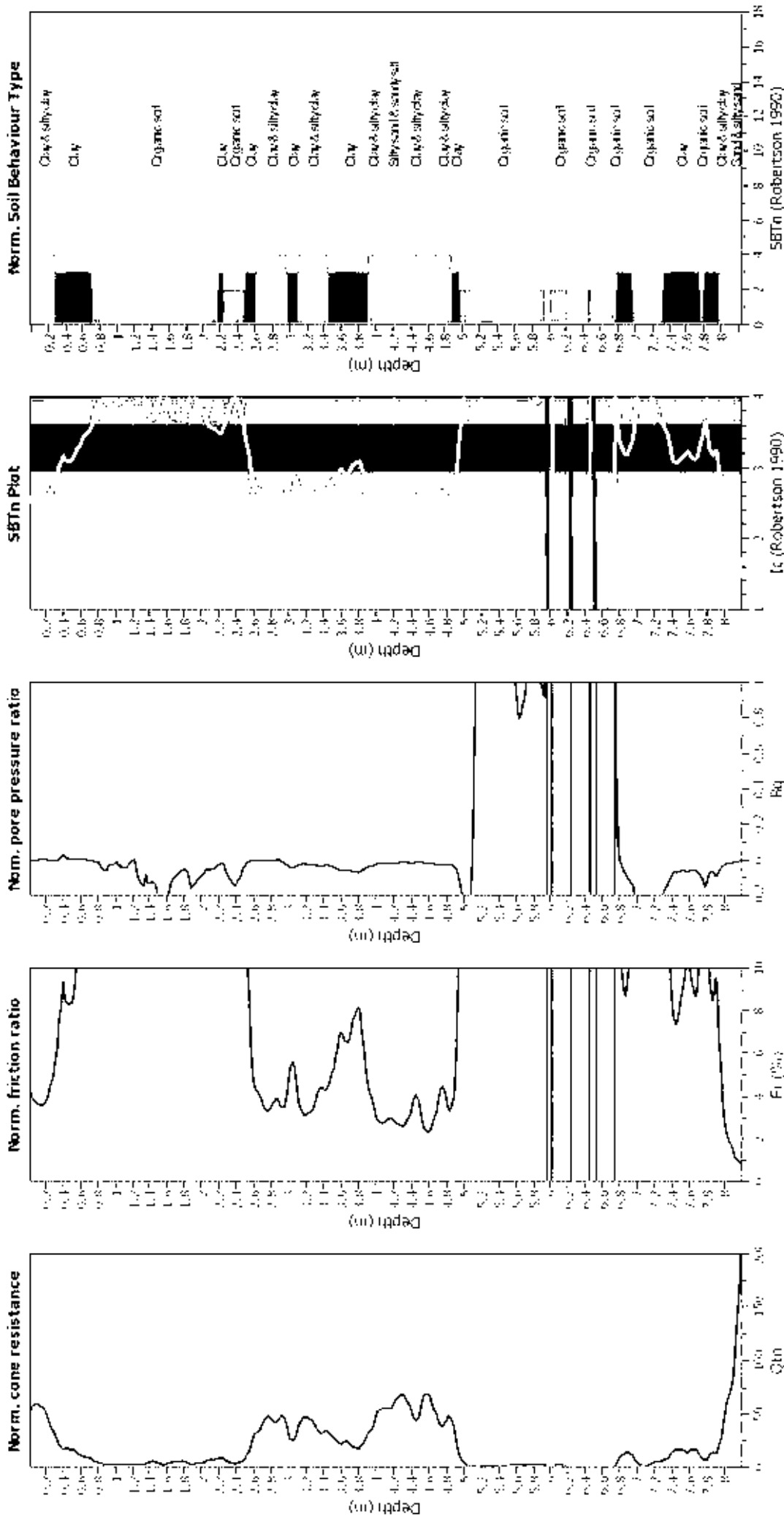
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lamé depth applied:	N/A
Depth to water table (m <sub>wt</sub> ):	1.50 m	Lamé depth:	N/A
Depth to GWL (erthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



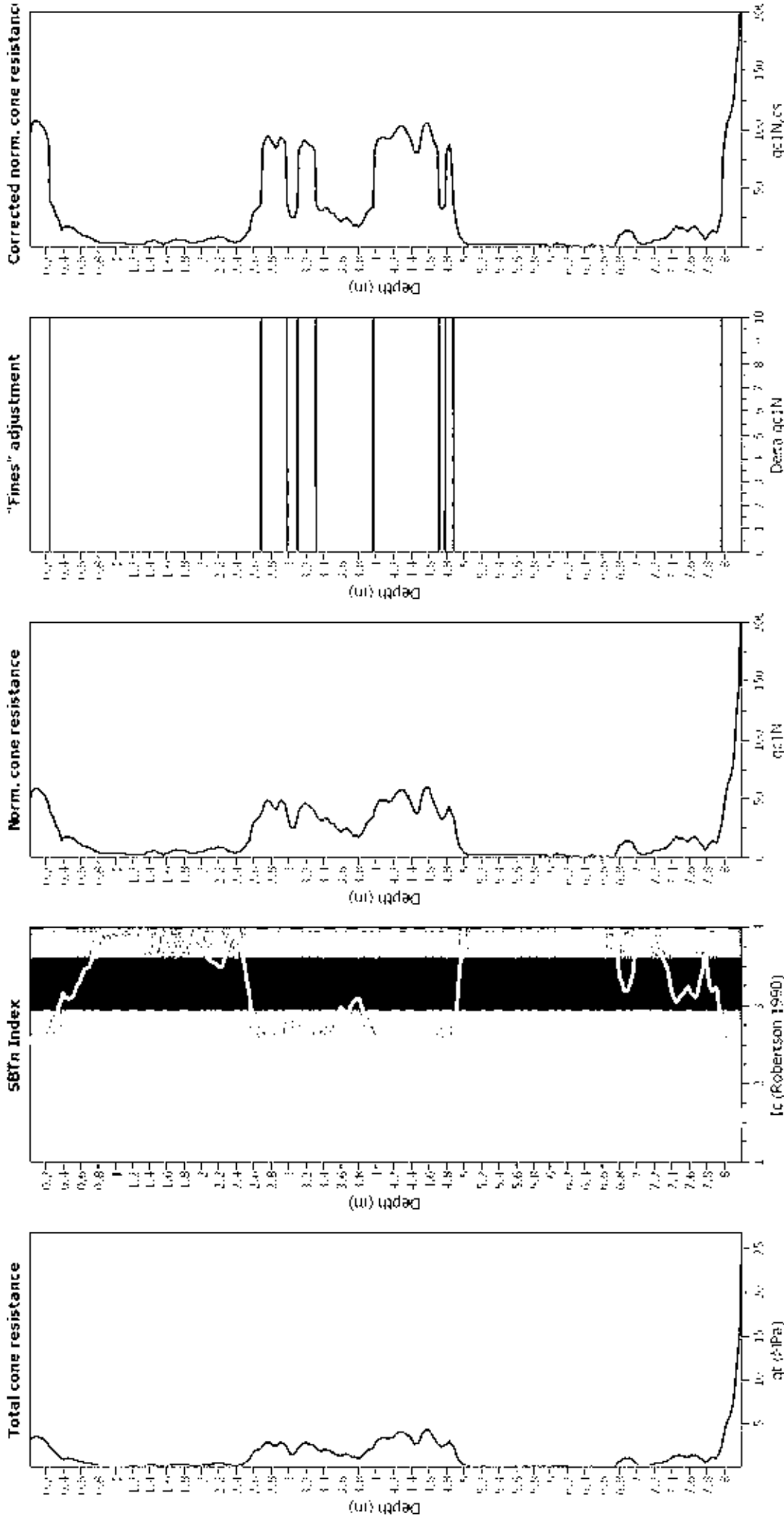
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Unit weight:	N/A
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	N/A
		Depth to GW (earthq.):	1.50 m
		Average results interval:	3
		Ic cut-off value:	2.60

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

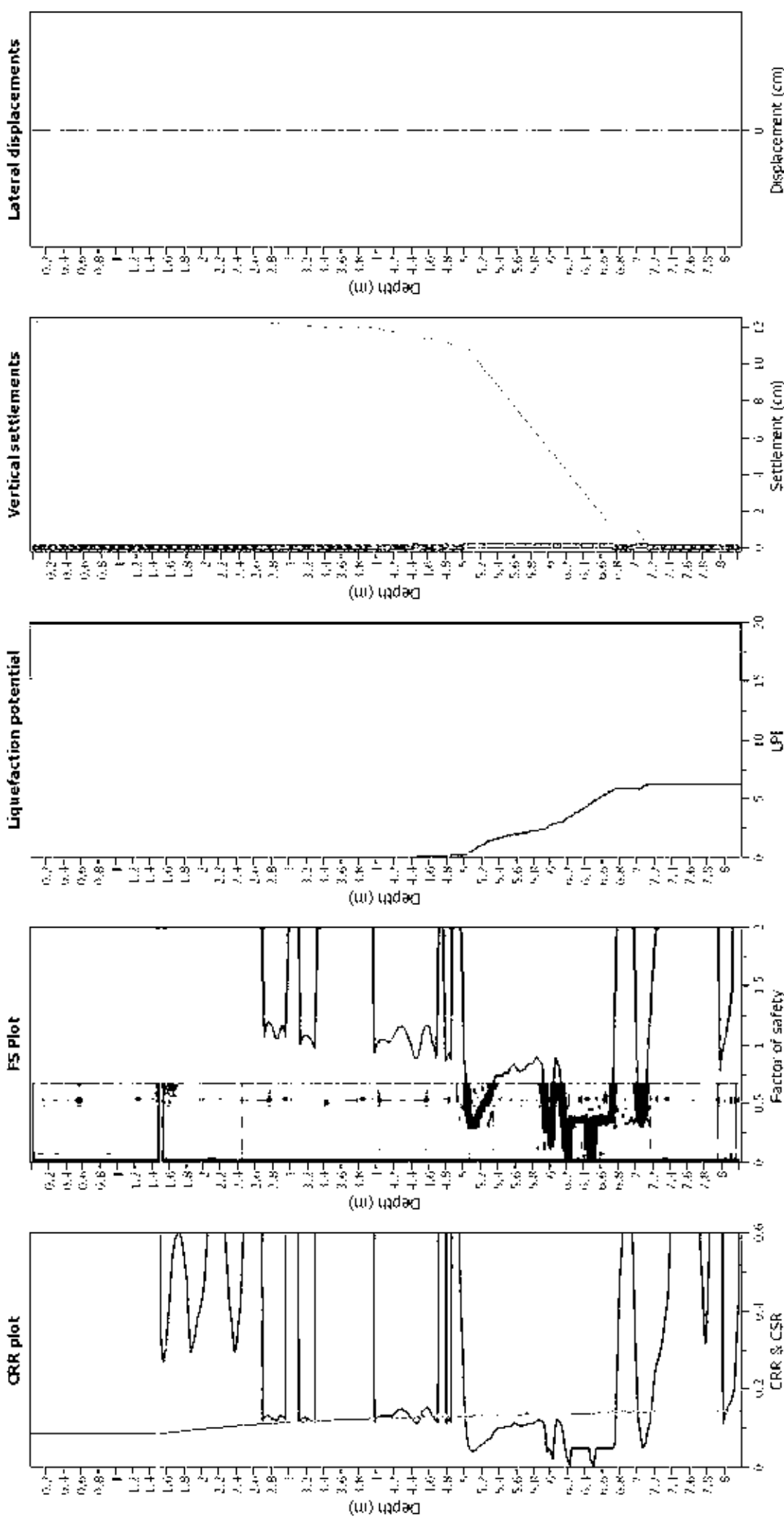
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

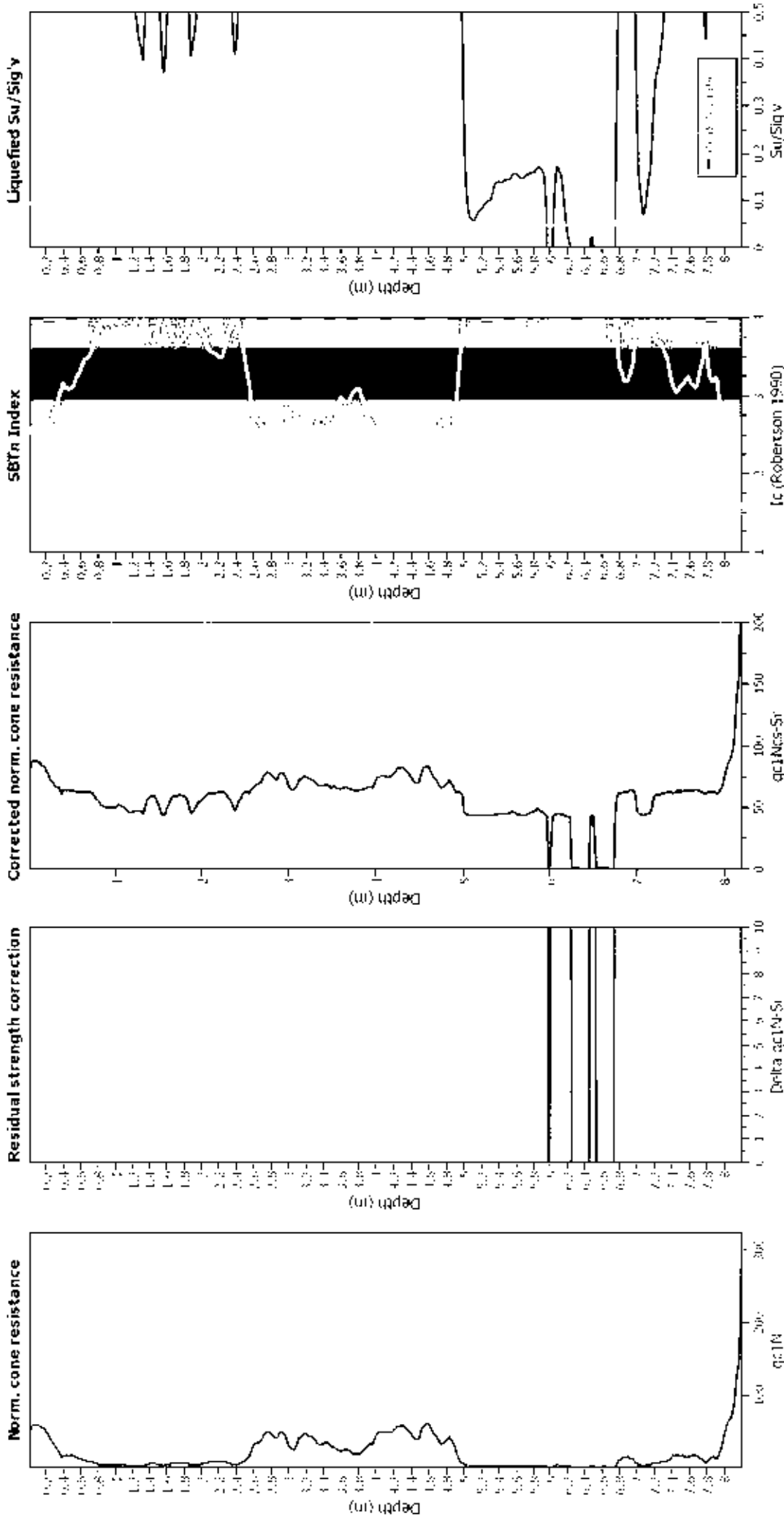
Depth to GWL (ortho.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

**F.S. color scheme**  
 Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

**LPI color scheme**  
 Very high risk  
 High risk  
 Low risk

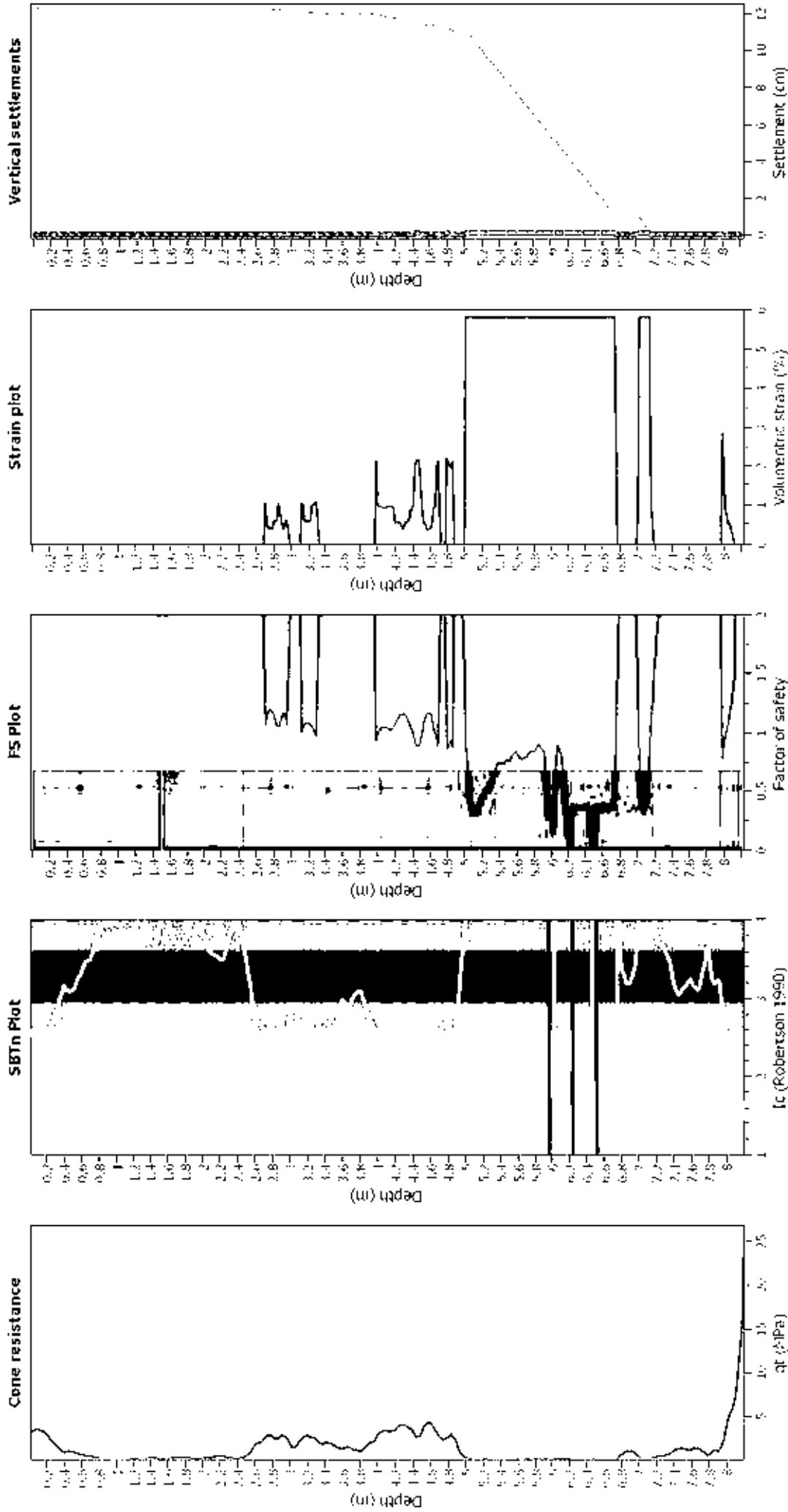
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition detect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial magnitude (M <sub>0</sub> ):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT17\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

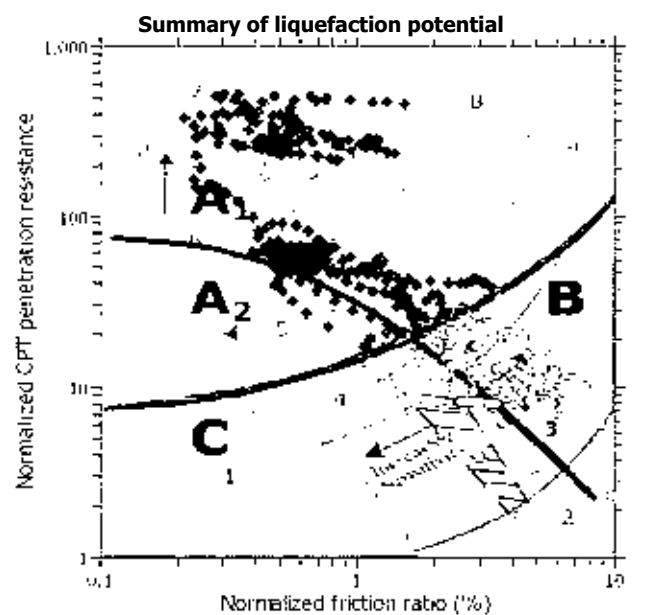
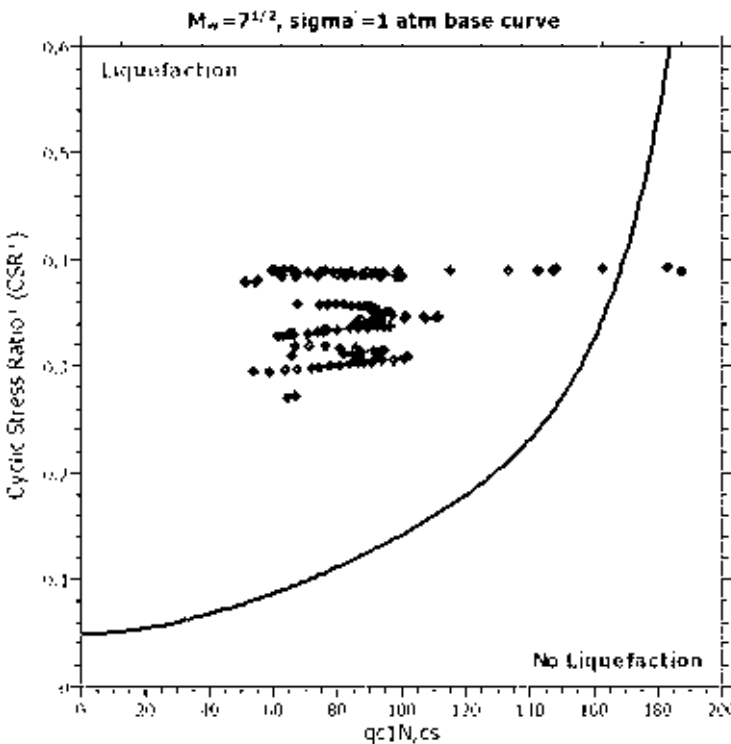
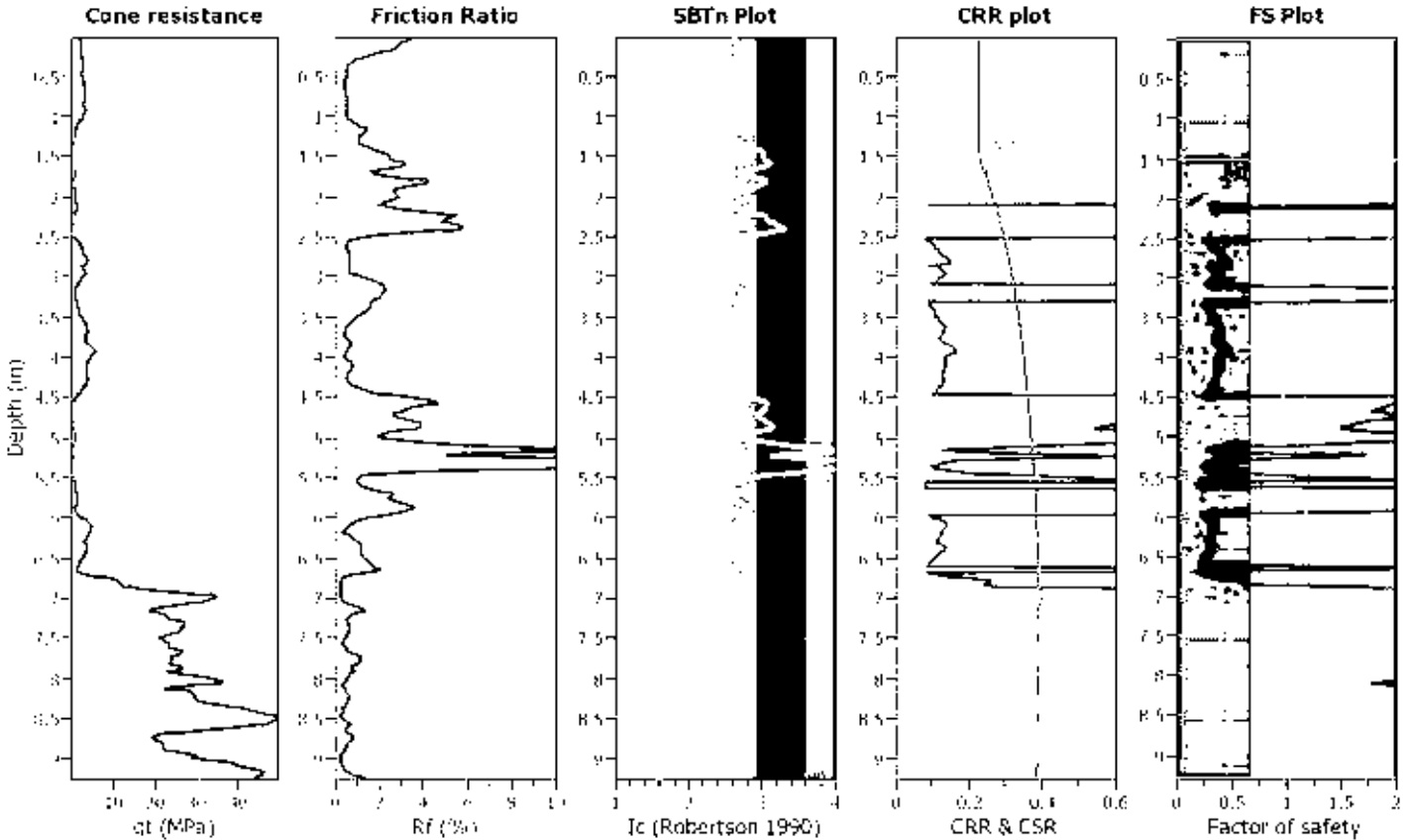
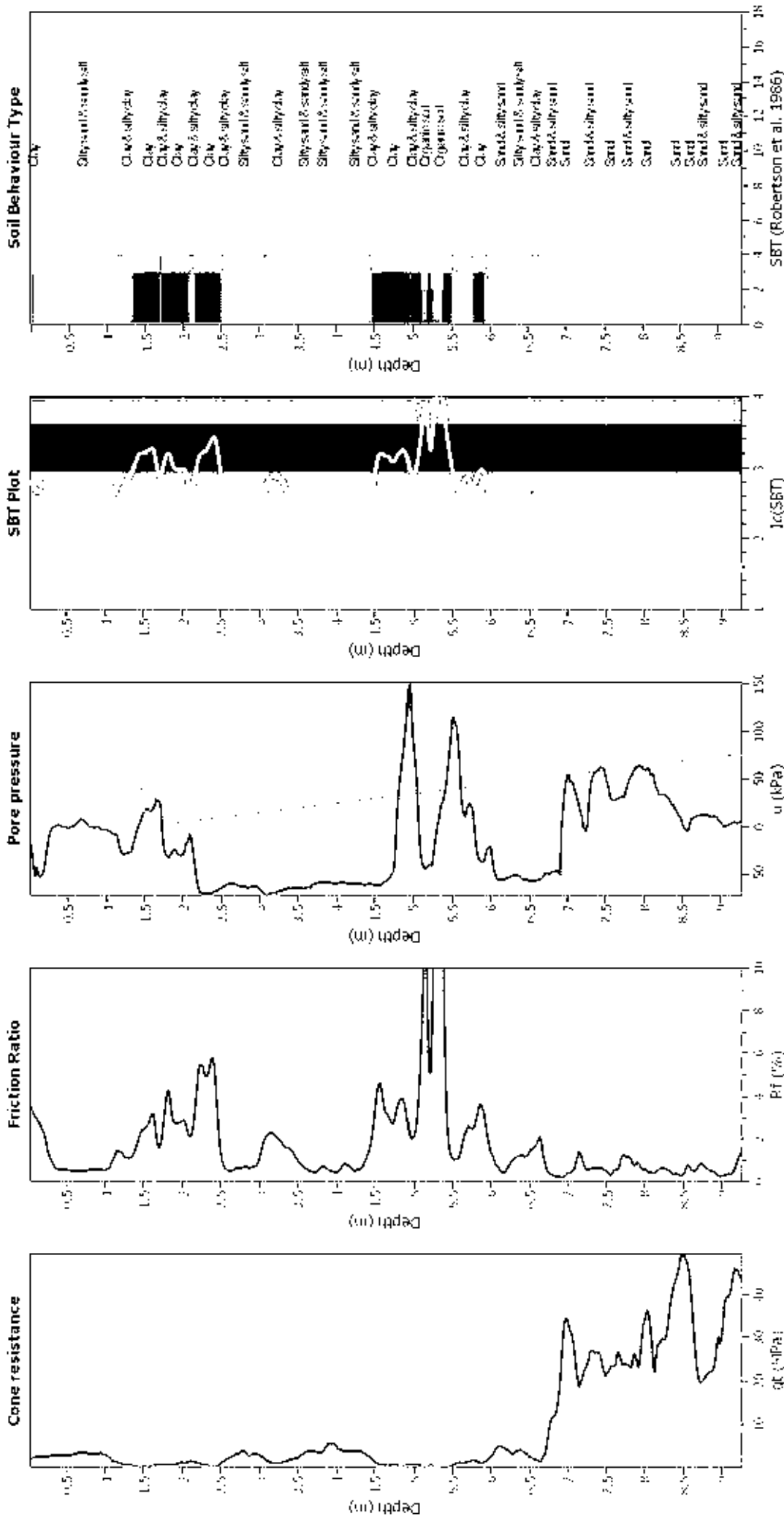


Figure 4: Summary of liquefaction potential plot and data points for test 17. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The liquefaction boundary is indicated by a dashed line. The plot is divided into regions A1, A2, B, and C. The liquefaction potential is high in regions A1 and A2, and low in regions B and C.

### CPT basic interpretation plots



#### Input parameters and analysis data

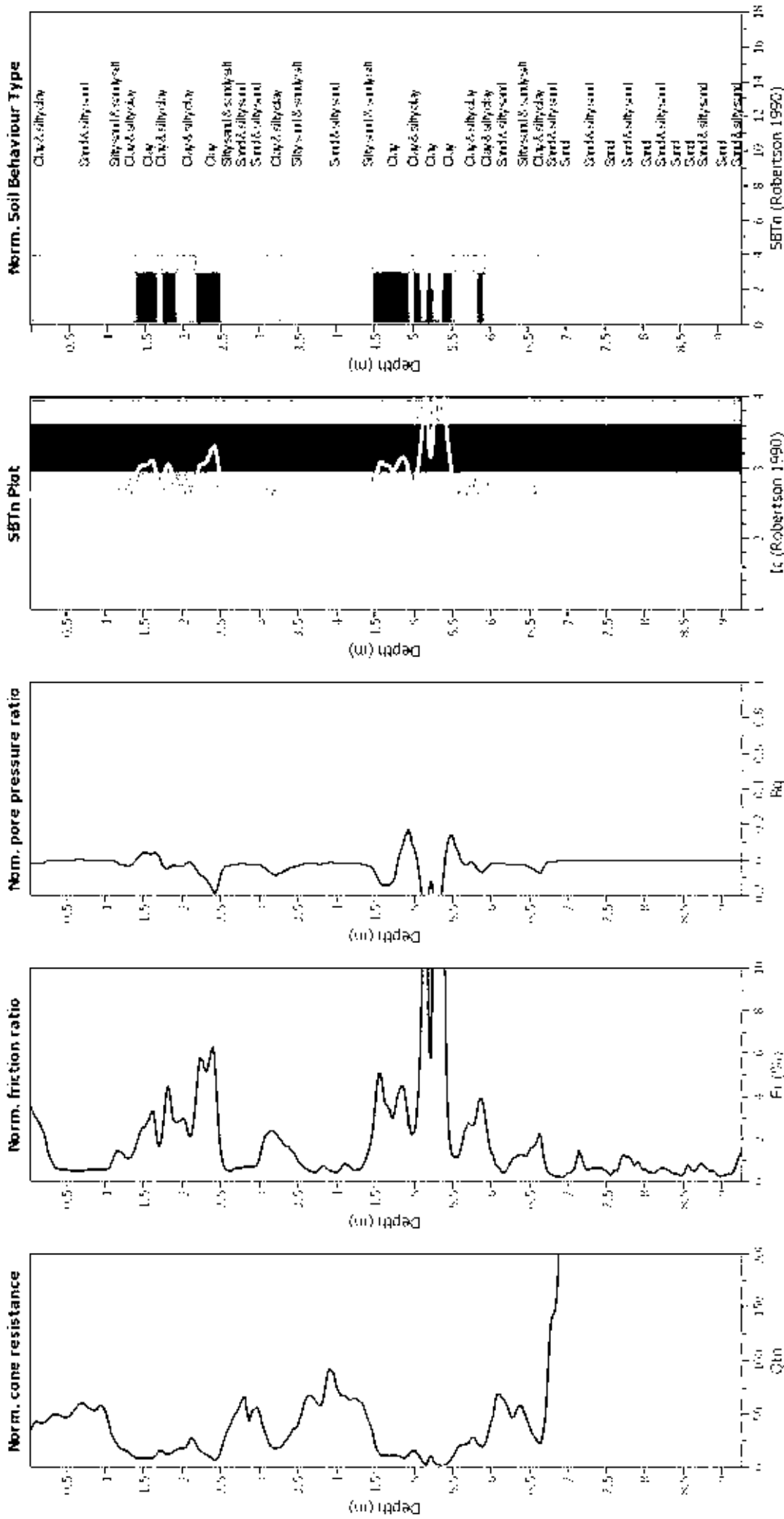
Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### CPT basic interpretation plots (normalized)



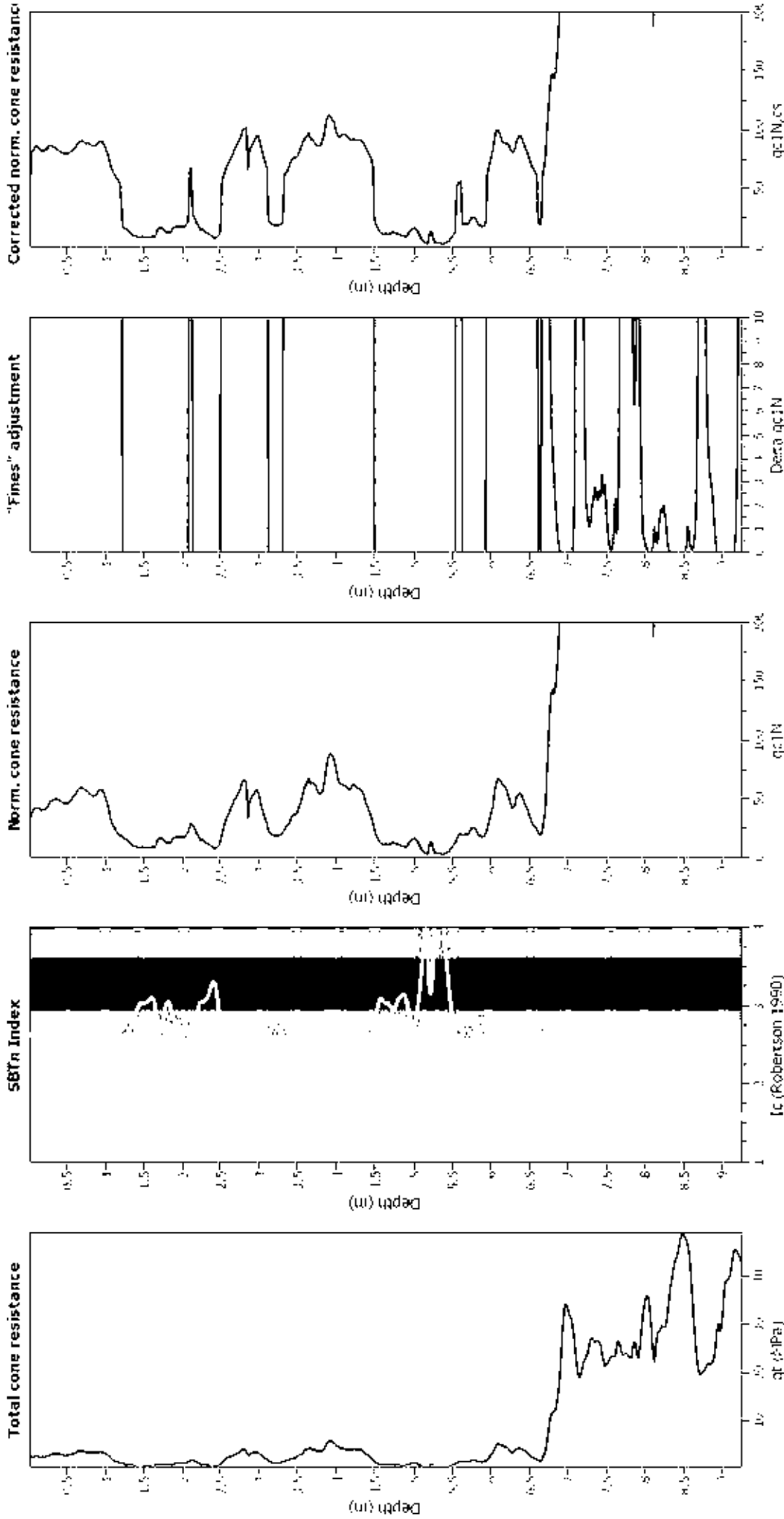
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

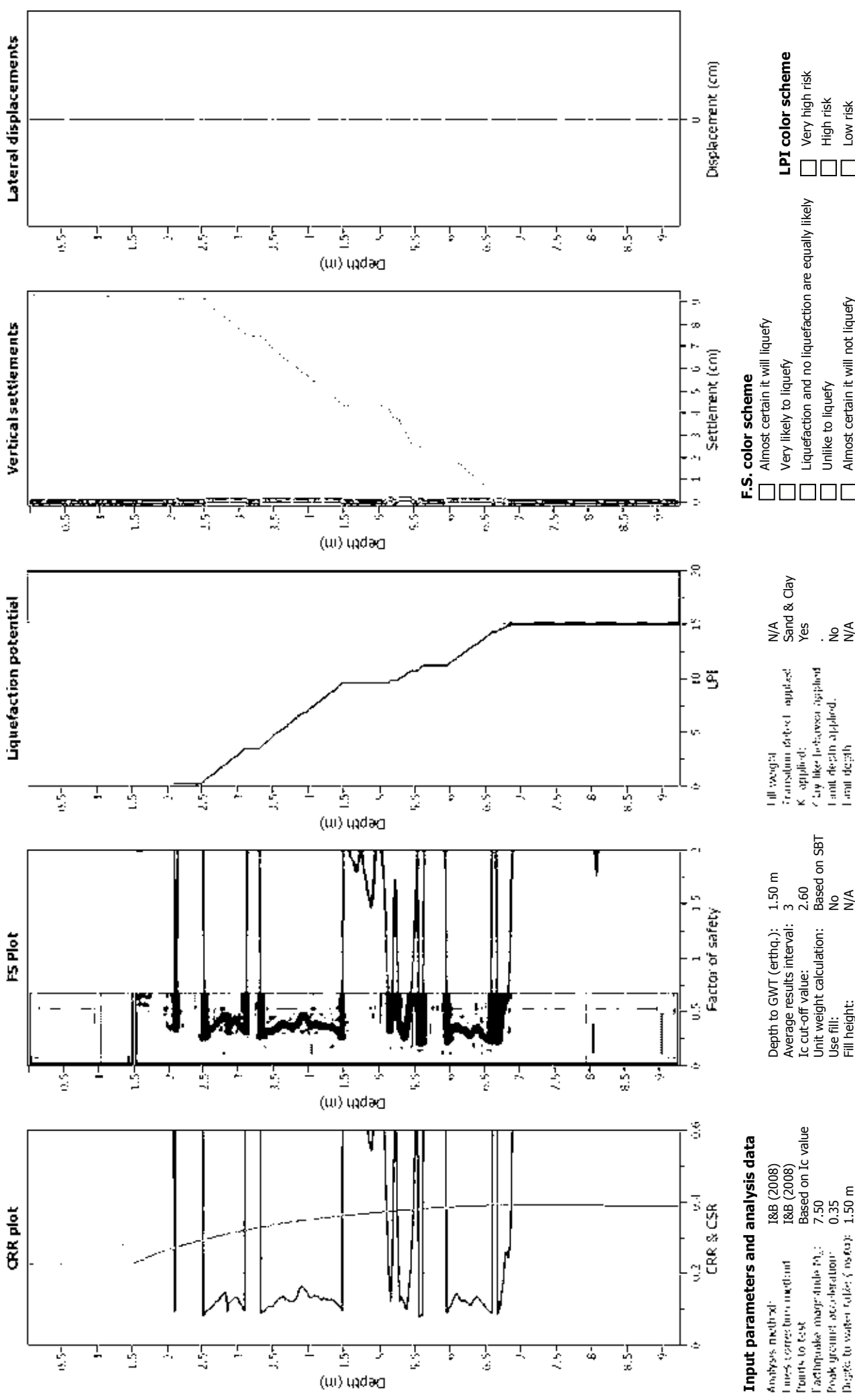
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

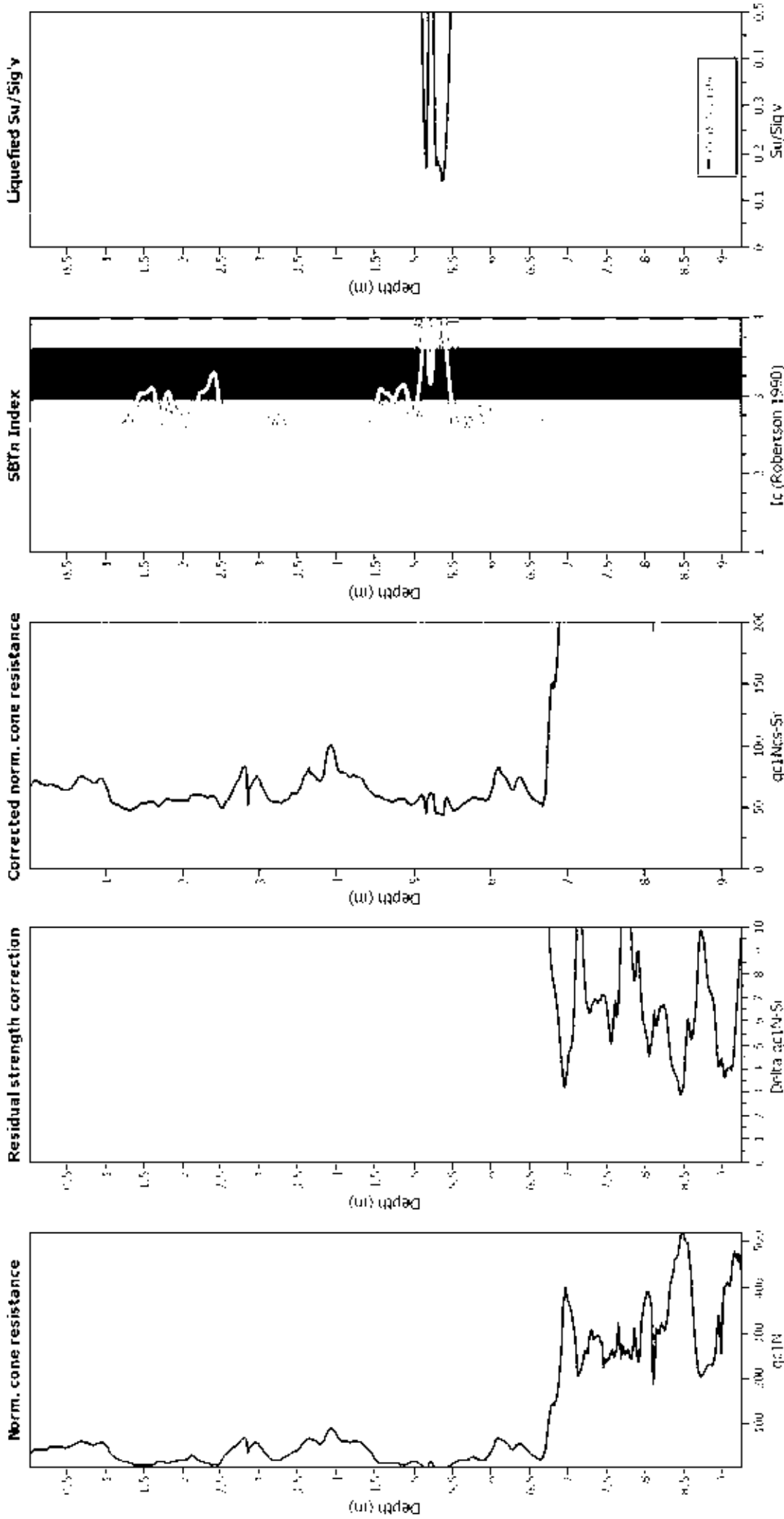
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

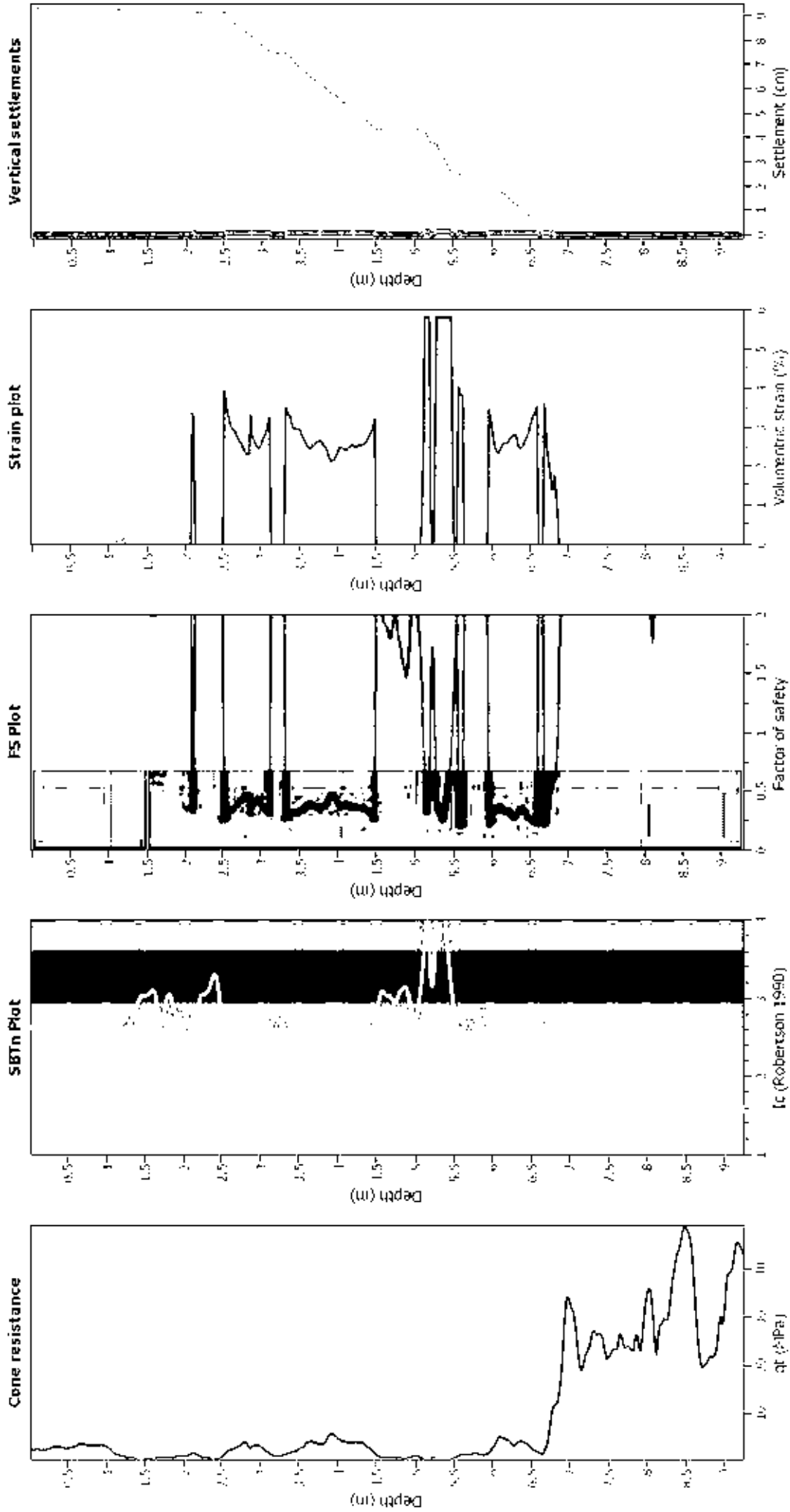
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT18\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

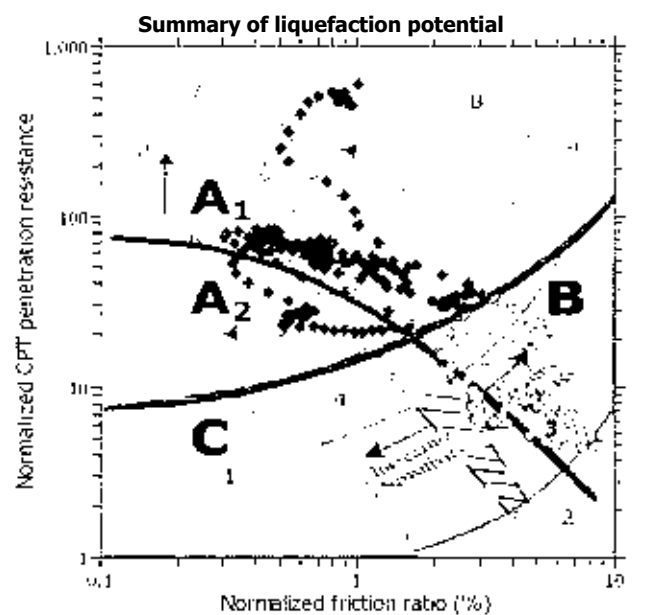
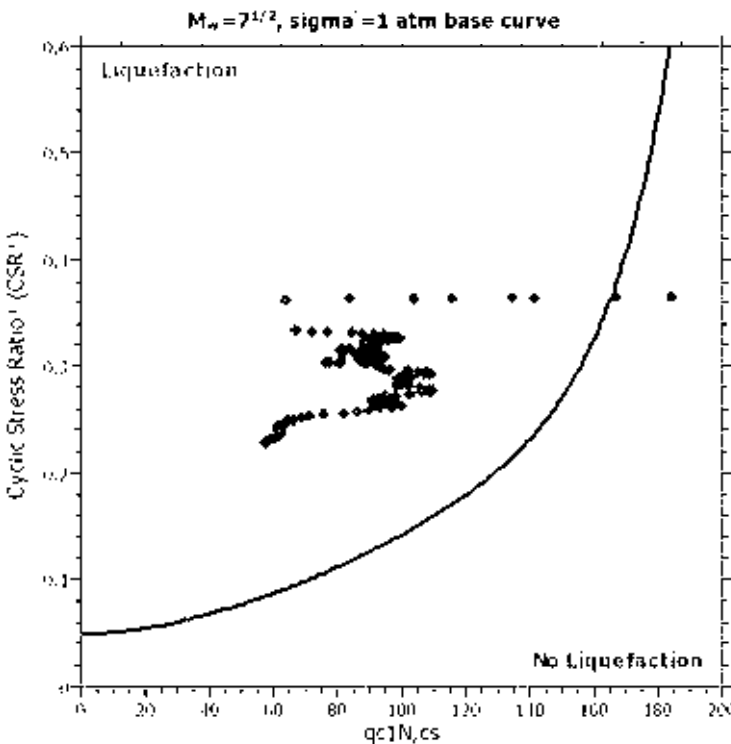
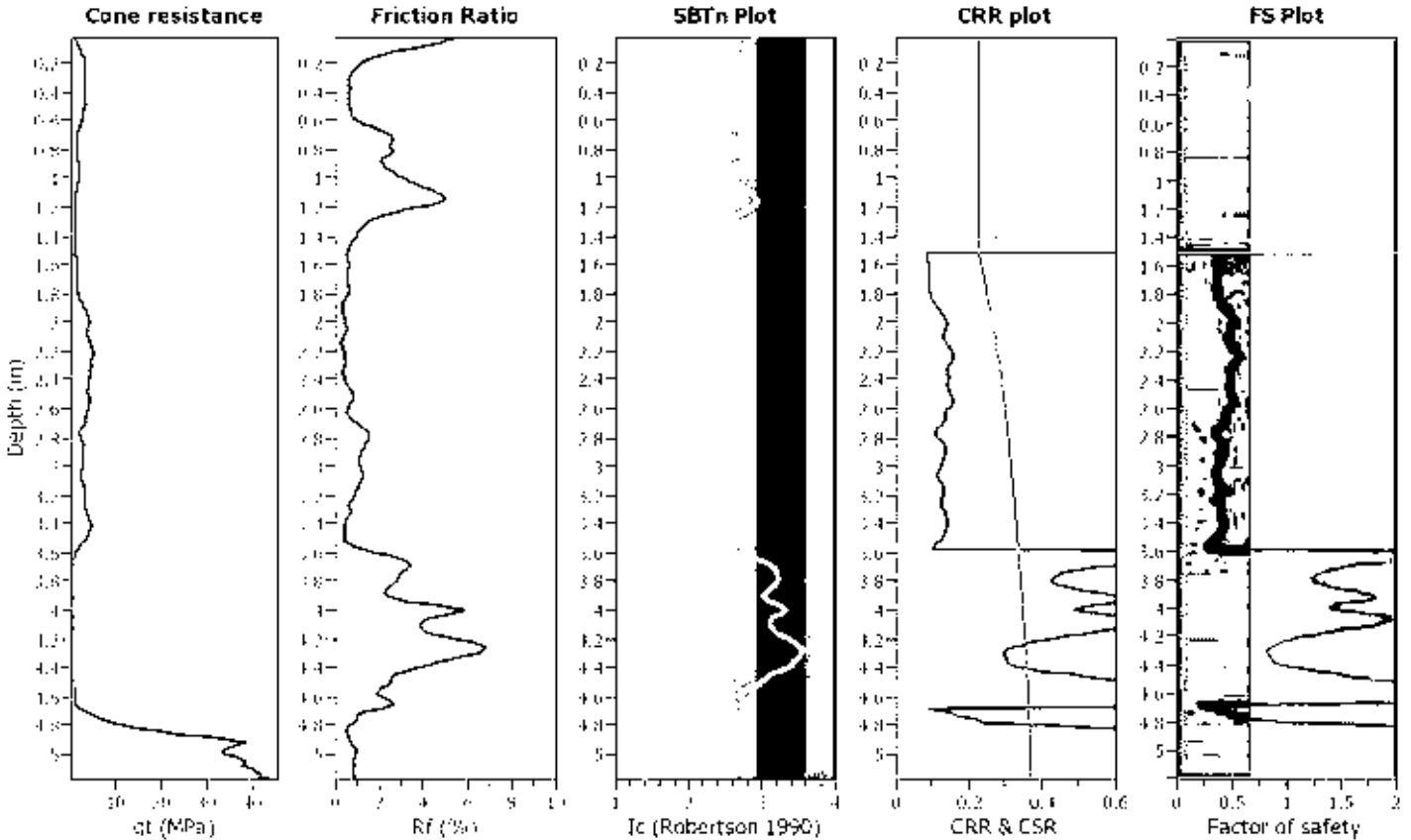
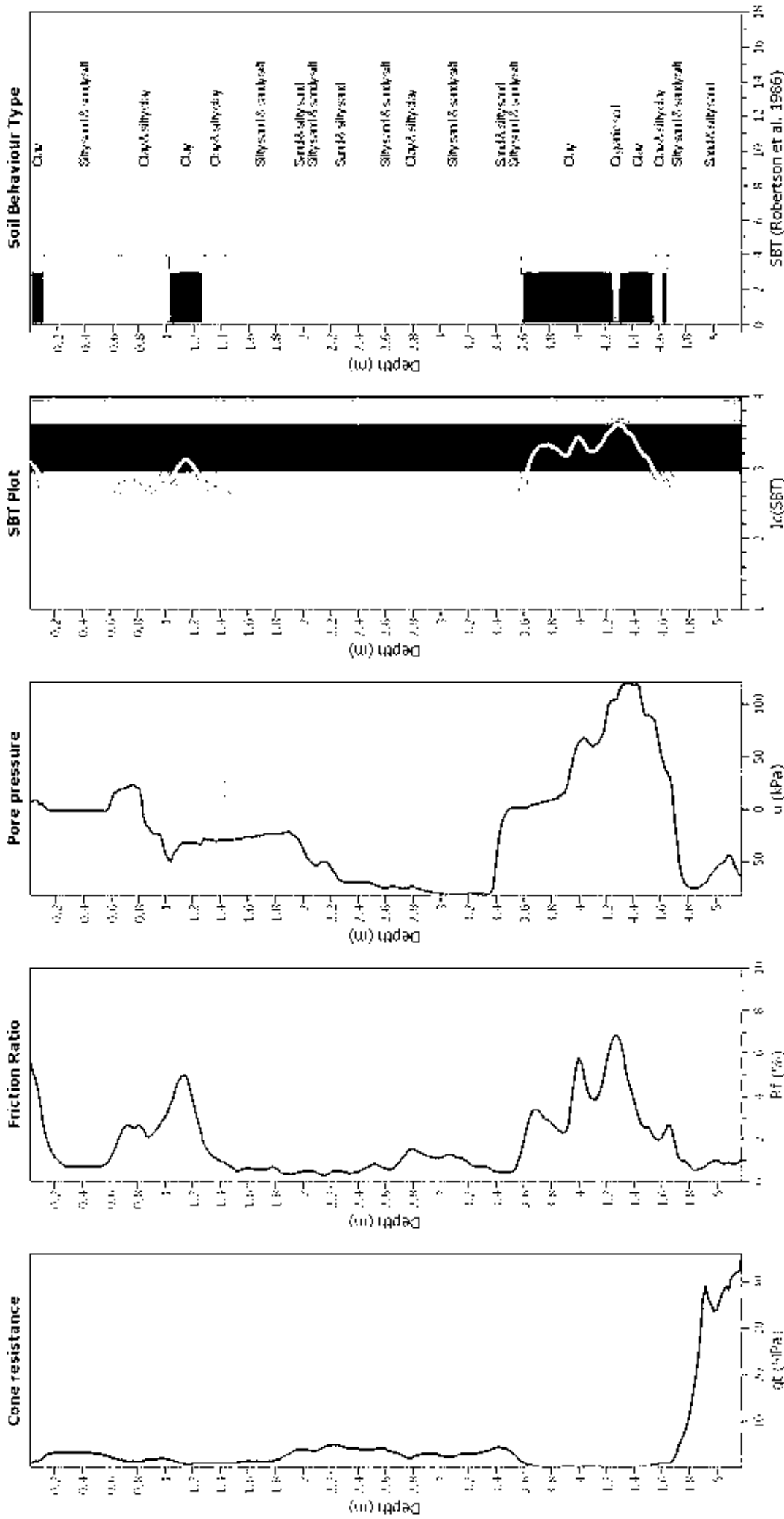


Figure 4: Summary of liquefaction potential assessment and data for the test. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The data points are categorized into regions A1, A2, B, and C. The chart also indicates the maximum and minimum penetration values.

### CPT basic interpretation plots



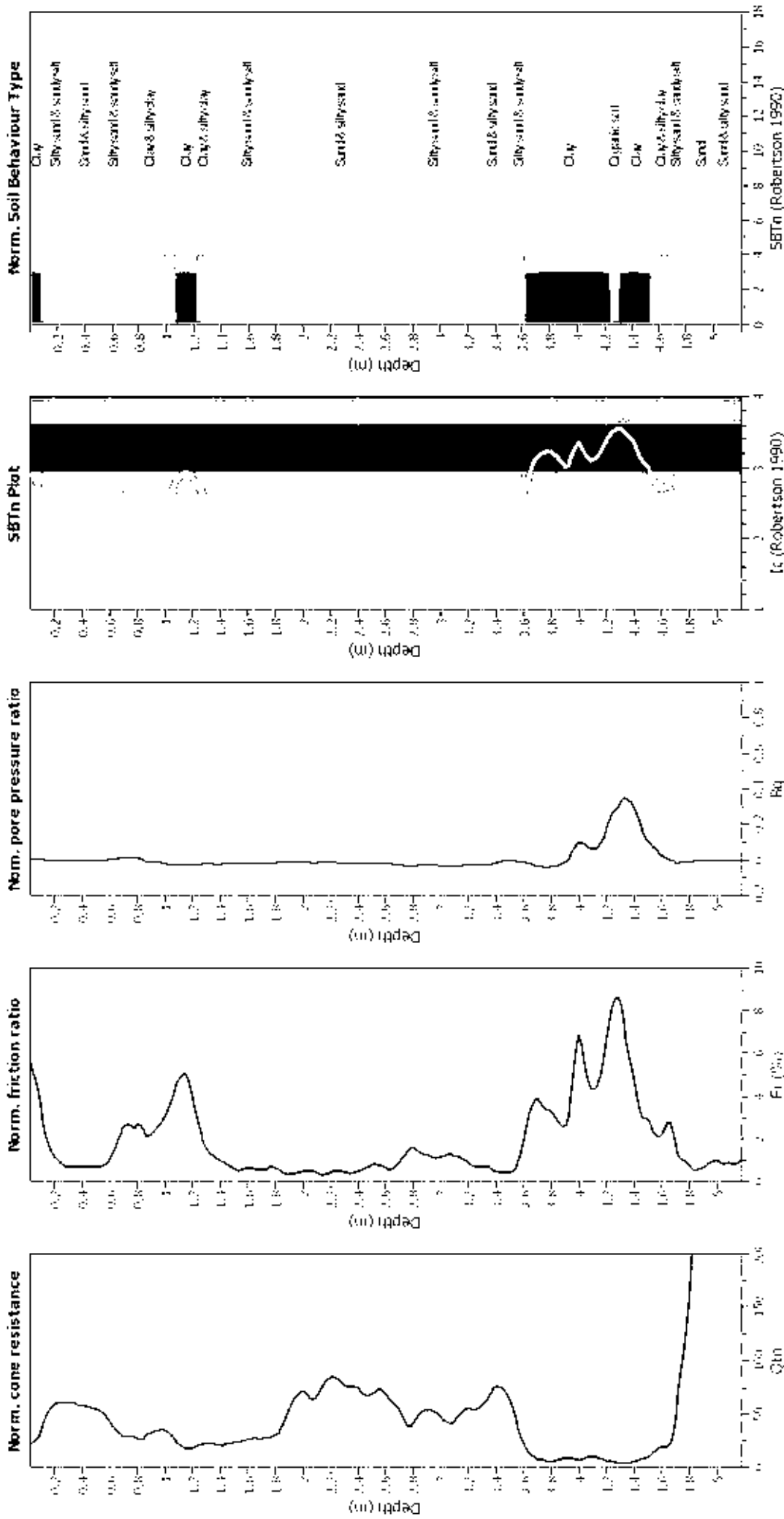
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial/make magnitude $M_v$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

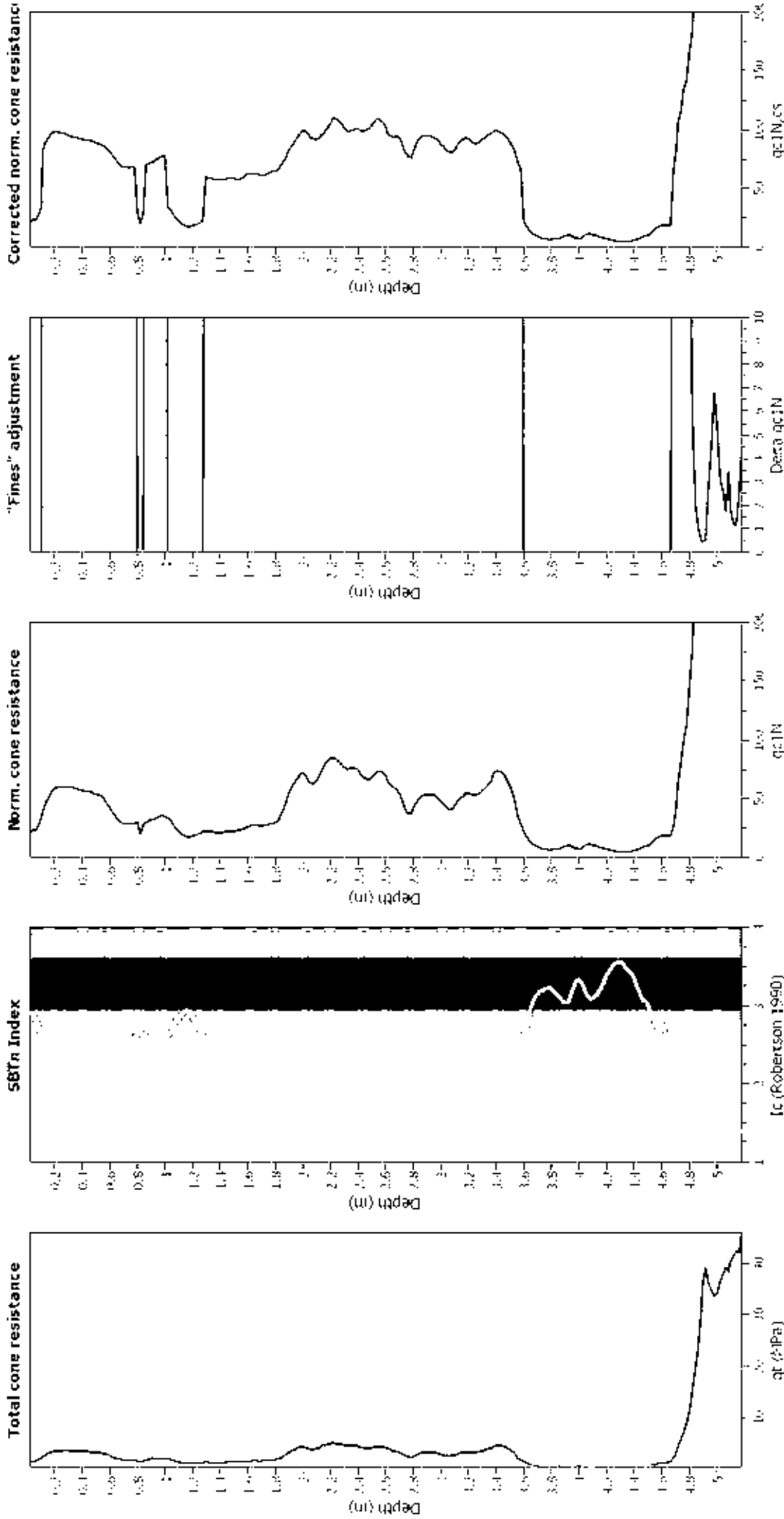
Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 4. Clayey silt to silty
- 7. Gravely sand to sand
- 2. Organic material
- 5. Silty sand to sandy silt
- 8. Very stiff sand to
- 3. Clay to silty clay
- 6. Clean sand to silty sand
- 9. Very stiff fine grained



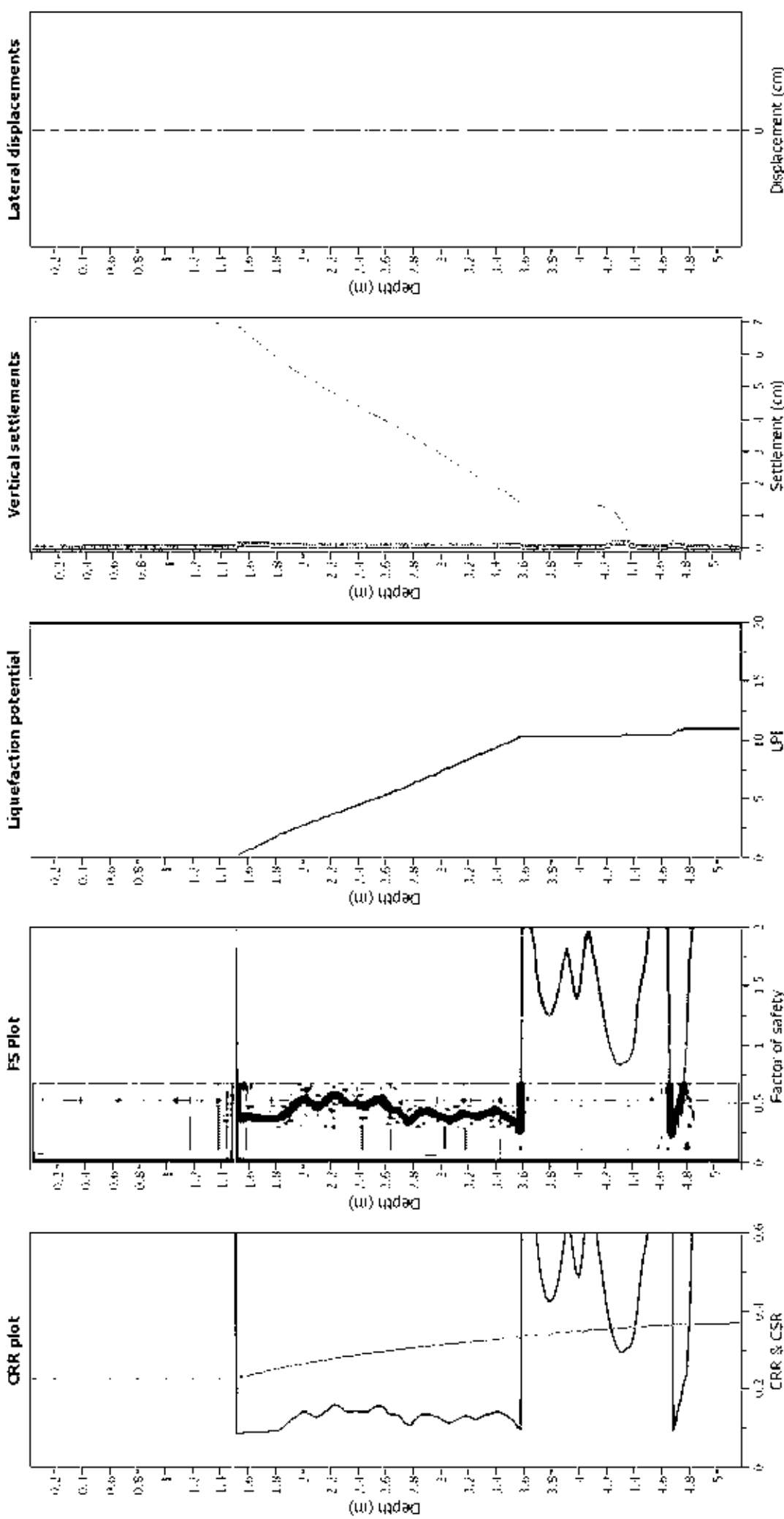
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

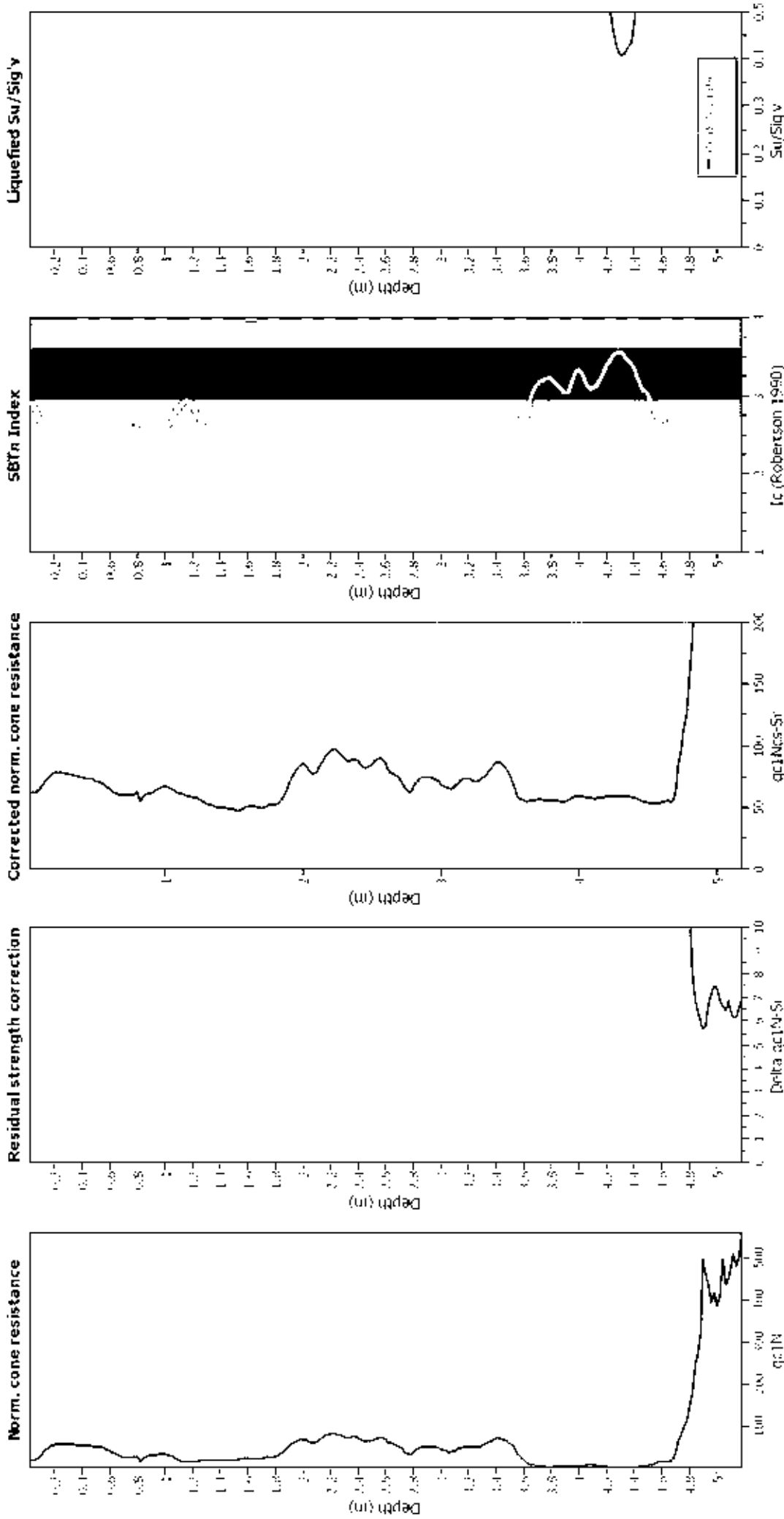
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

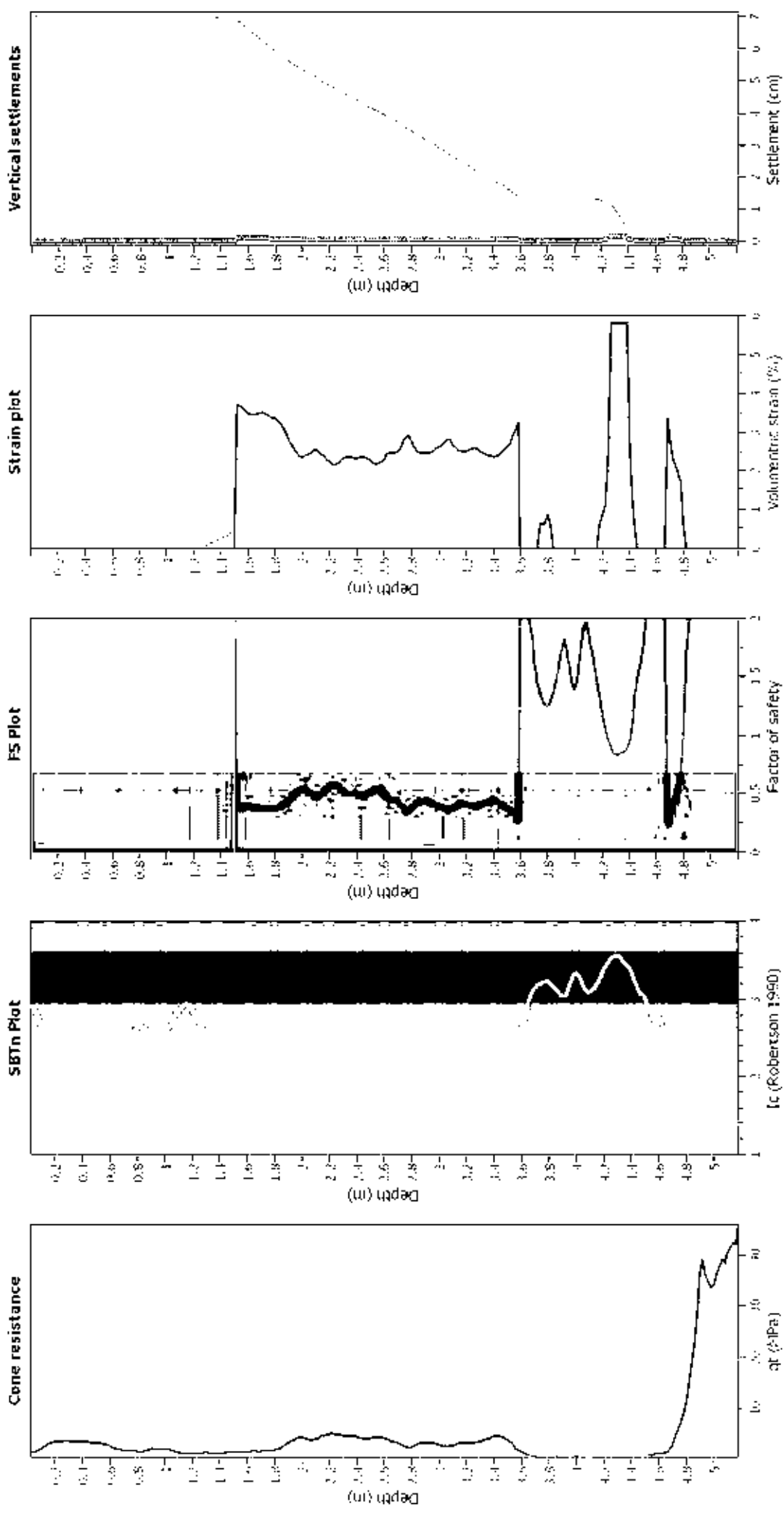
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT19\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

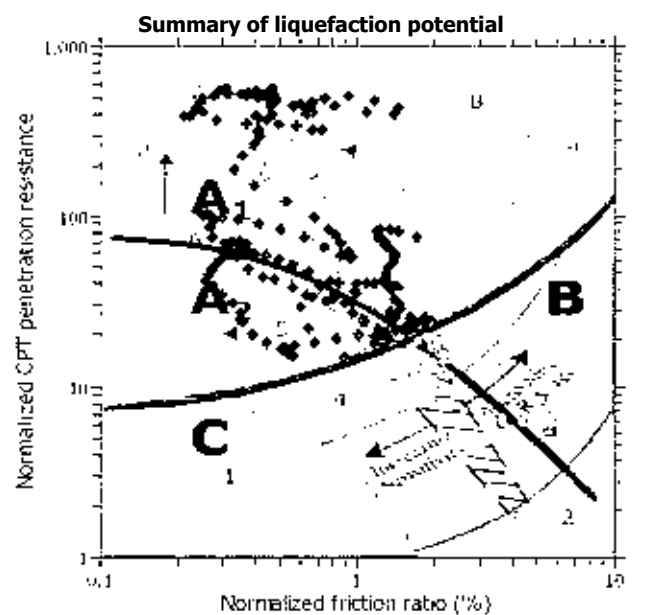
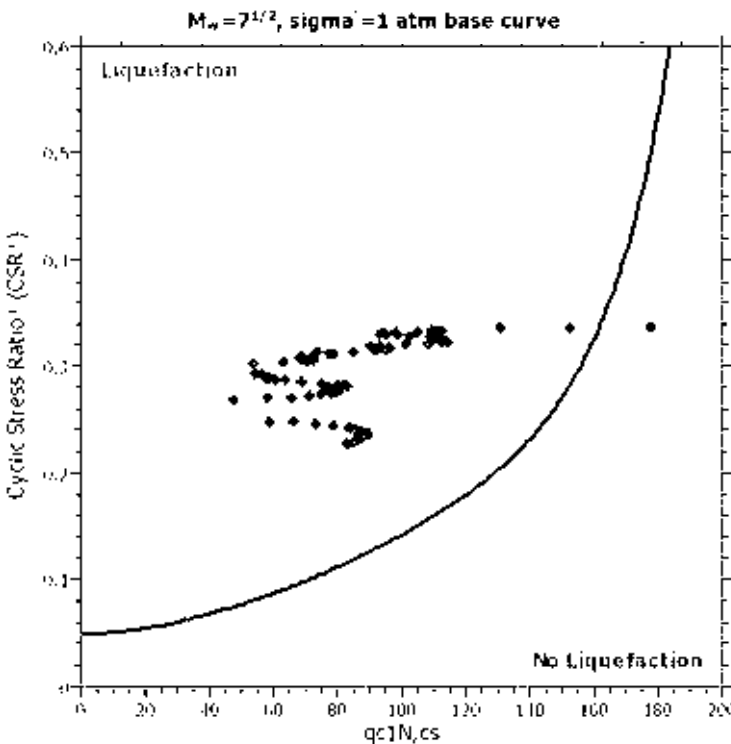
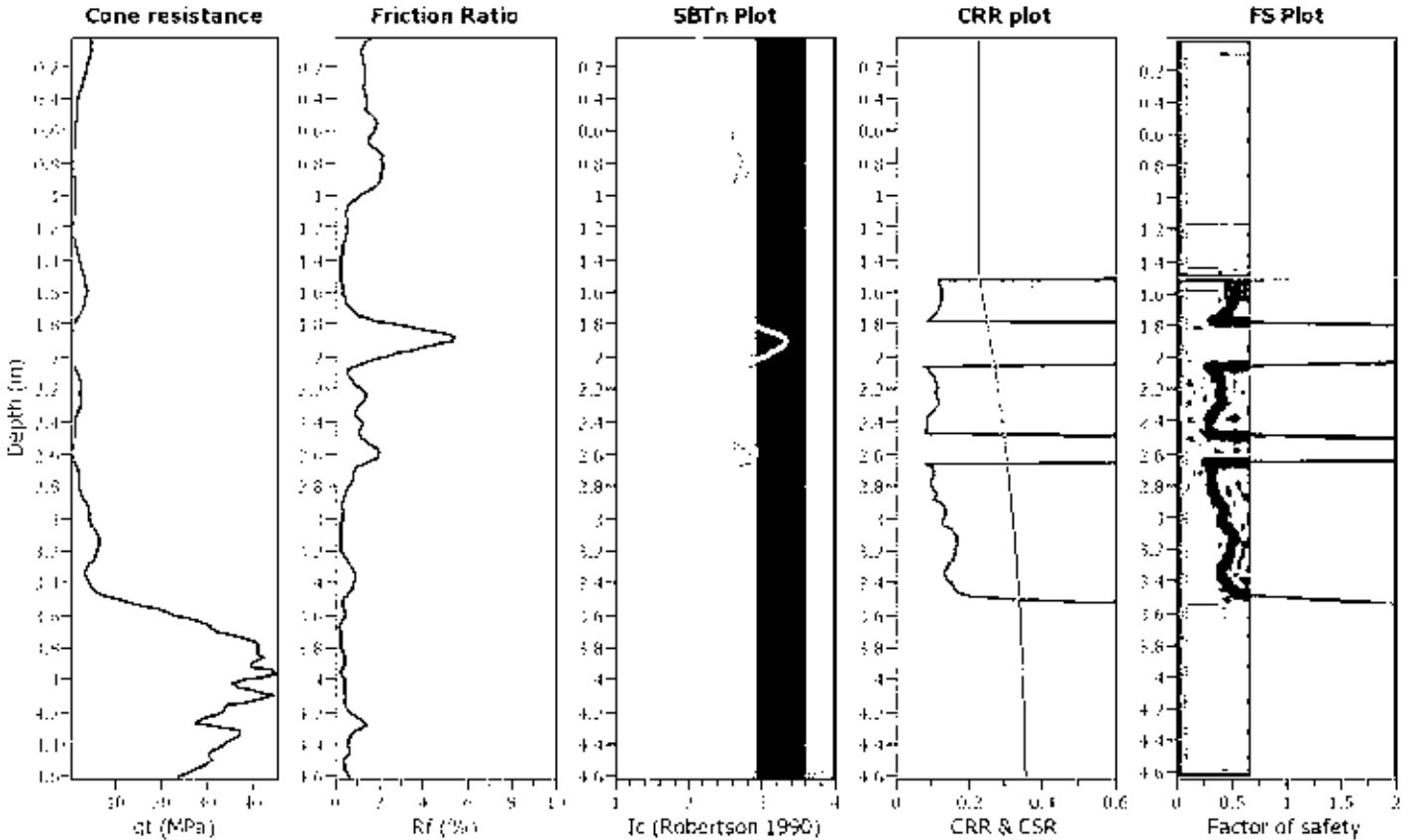
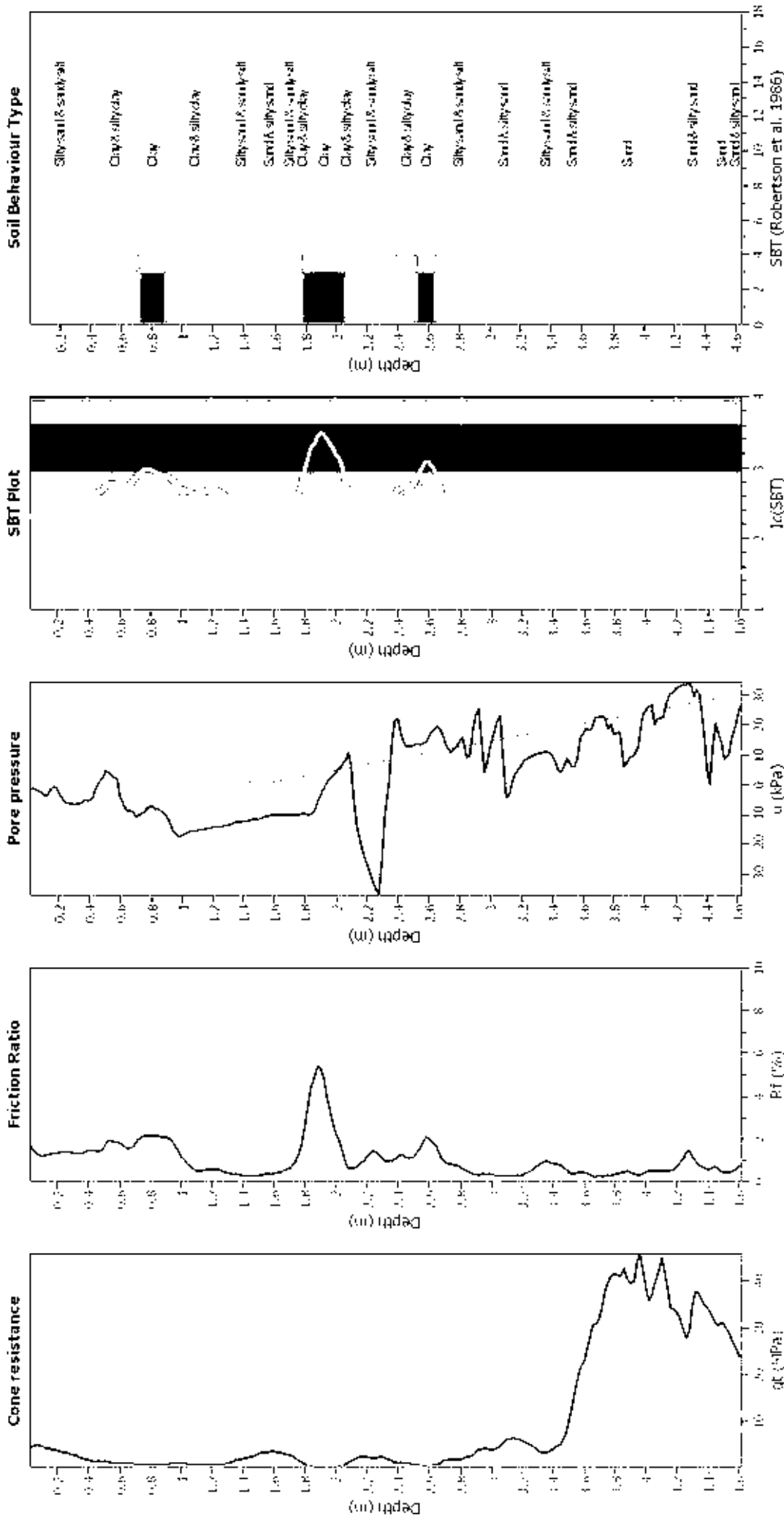


Figure 4: Summary of liquefaction potential based on normalized CPT data. Zone A: Fully susceptible to liquefaction. Zone B: Moderately susceptible to liquefaction. Zone C: Not susceptible to liquefaction. The dashed line indicates the boundary between Zone A and Zone B. The solid line indicates the boundary between Zone B and Zone C. The arrows indicate the direction of increasing resistance and decreasing friction ratio.

### CPT basic interpretation plots



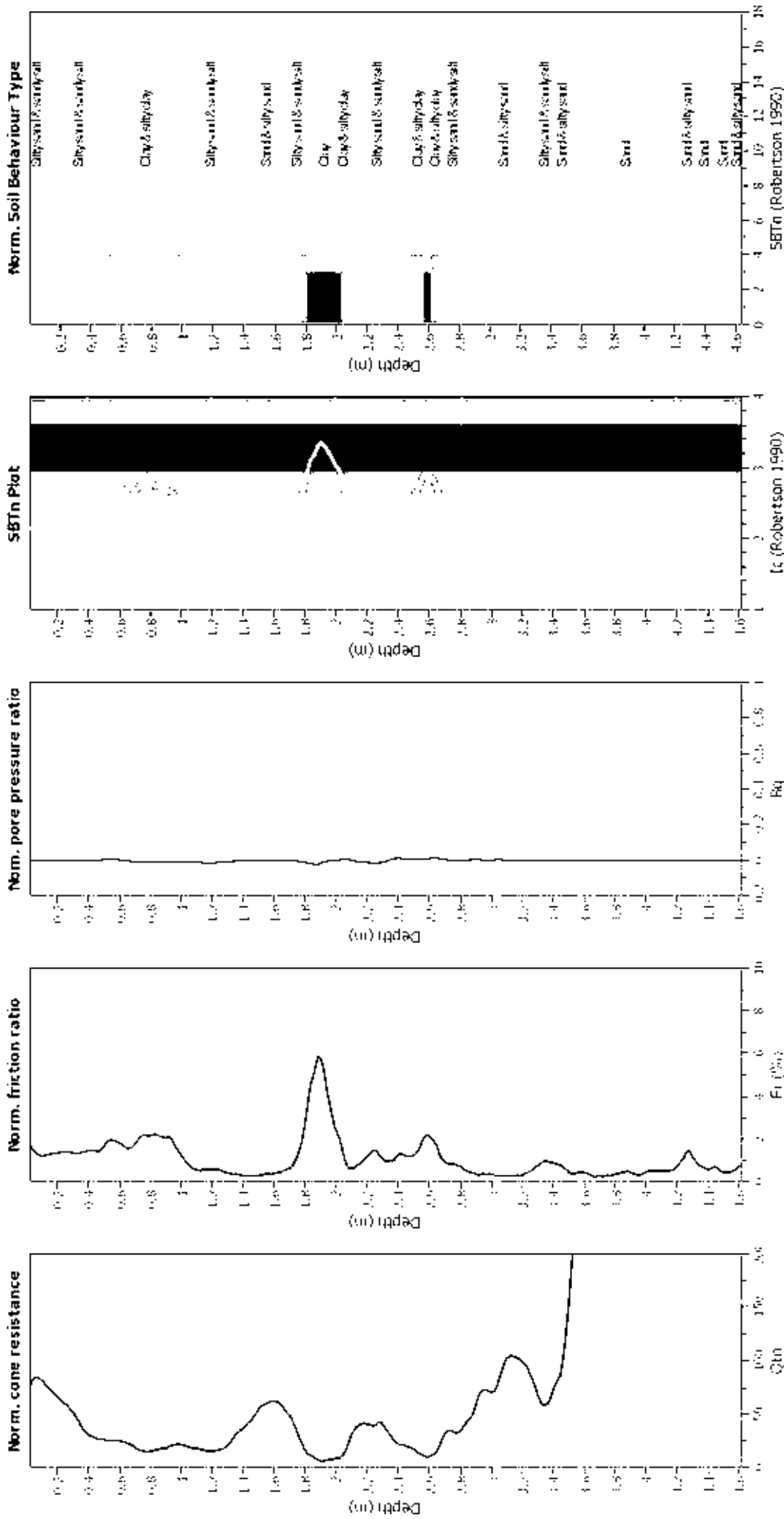
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



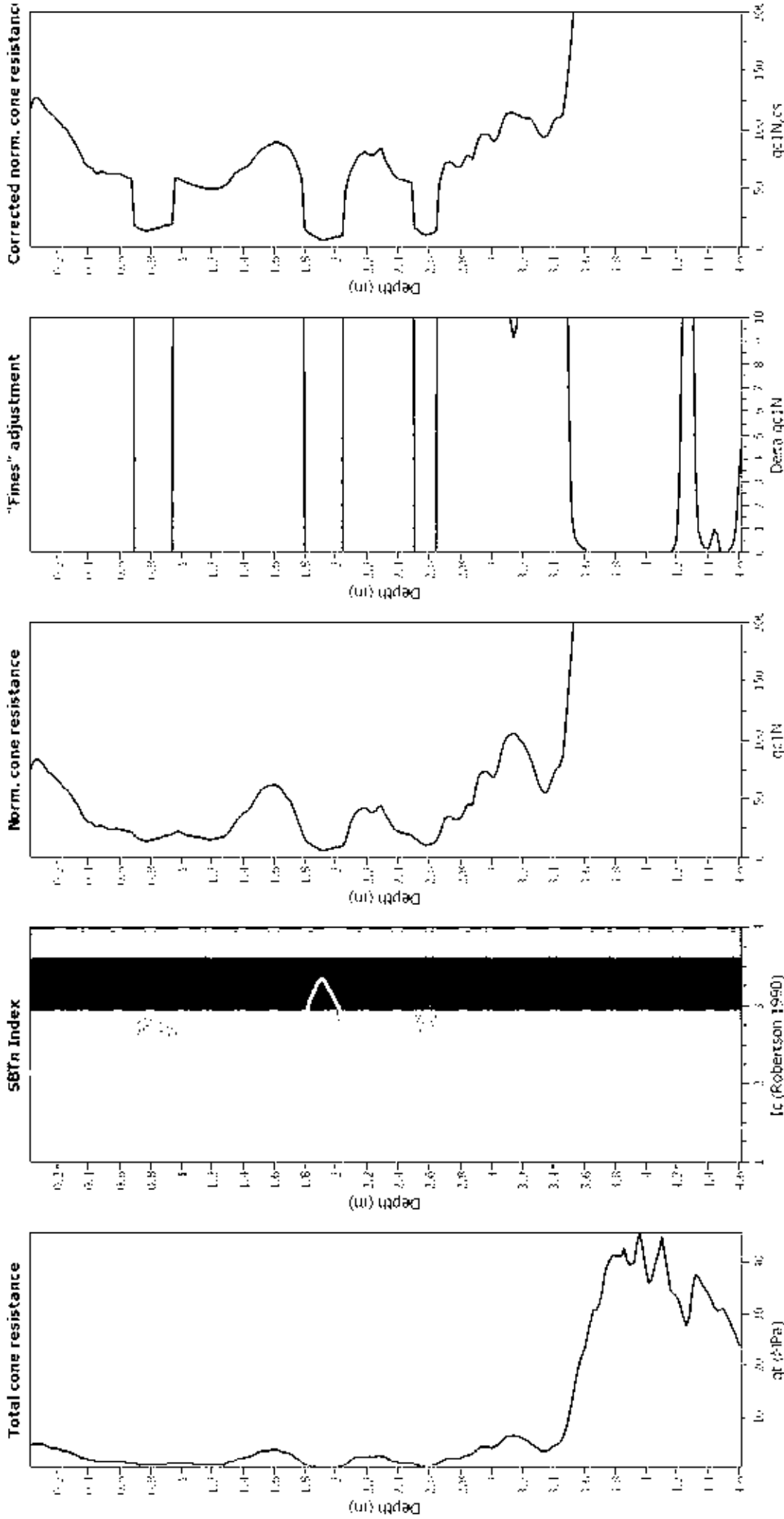
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### Liquefaction analysis overall plots (intermediate results)

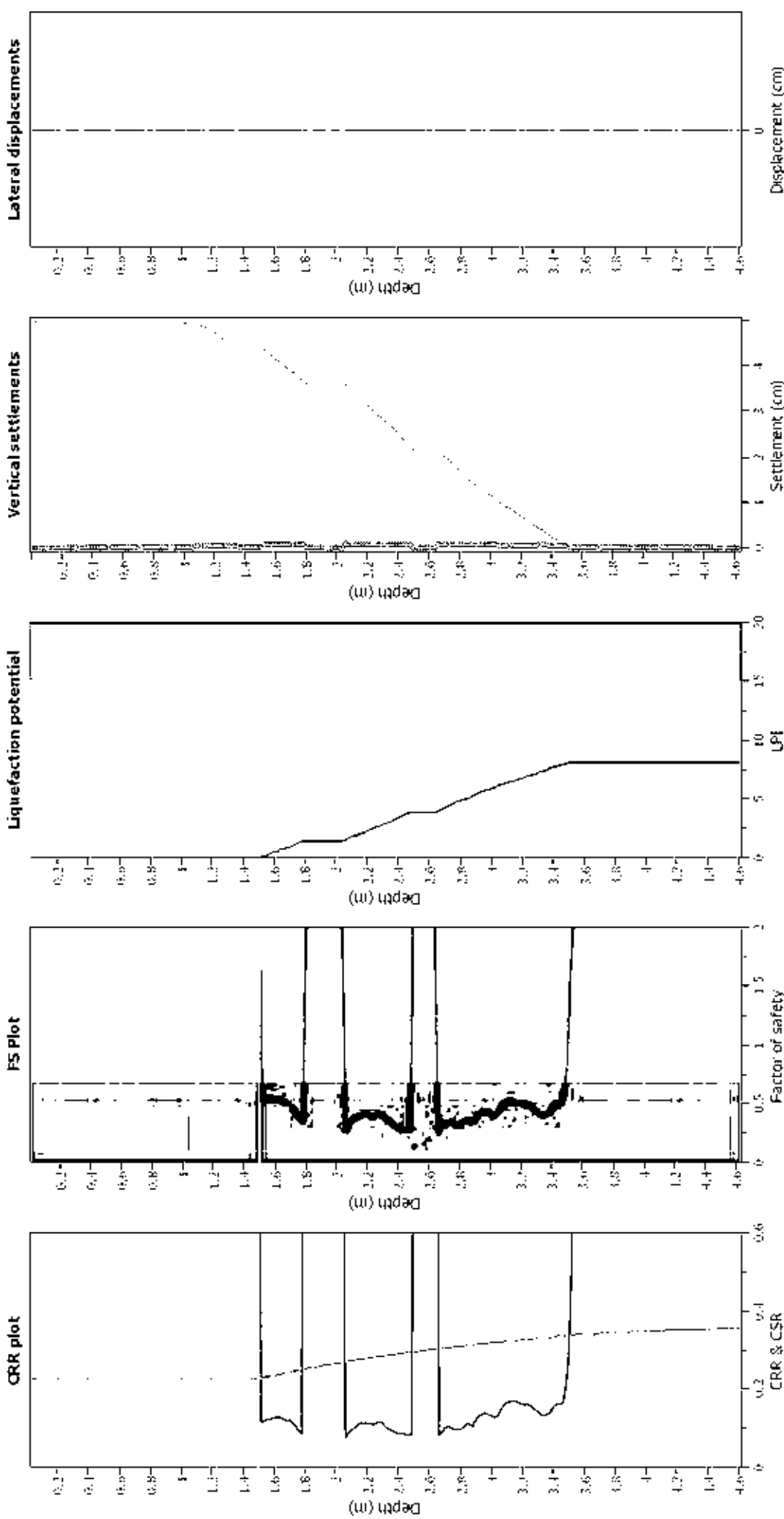


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Lines correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m  
 Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

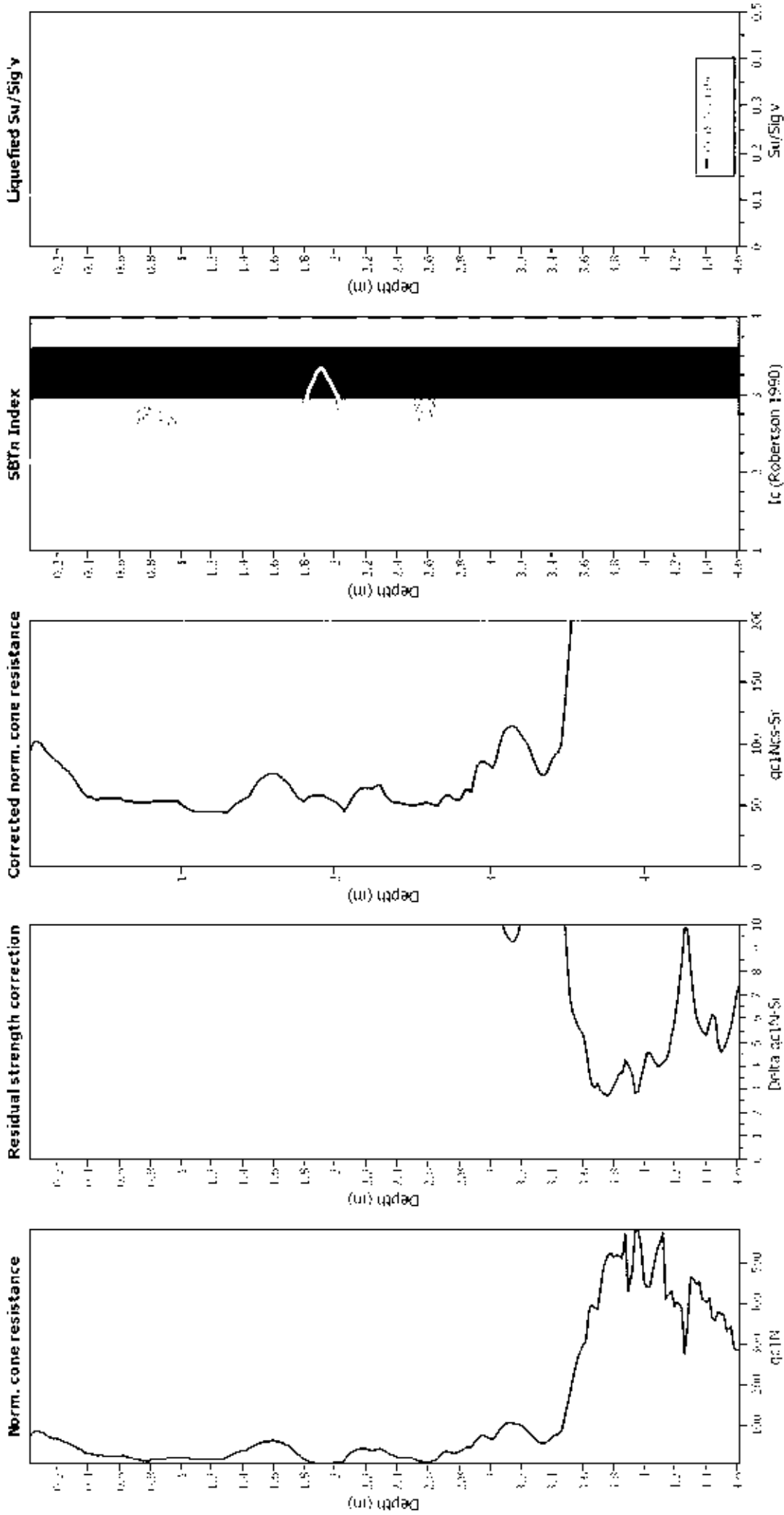
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

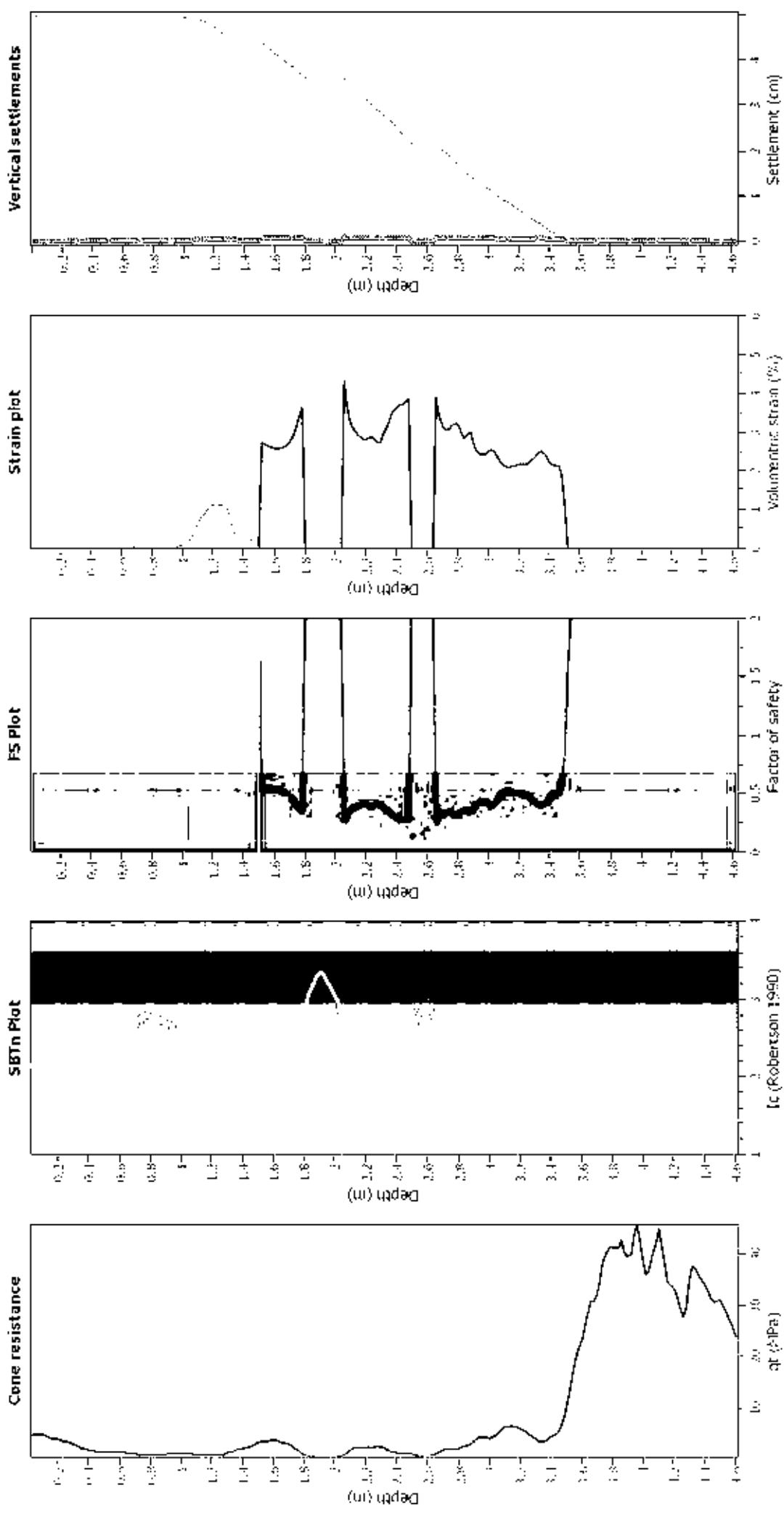
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT20\_511HalswellRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

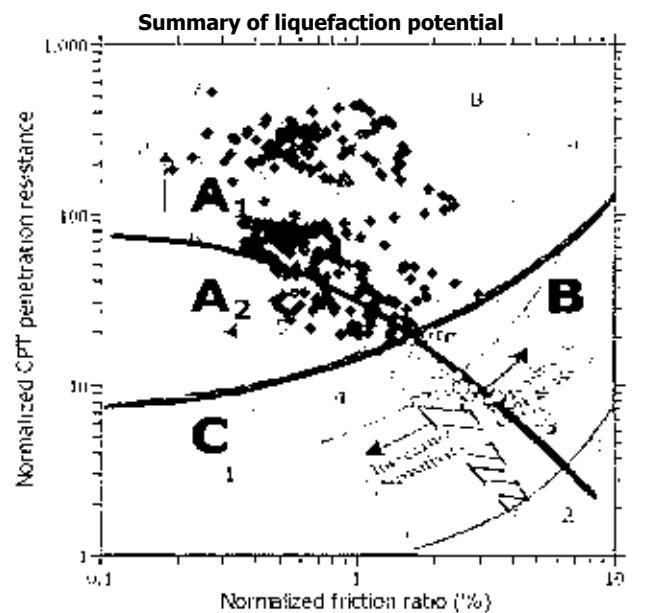
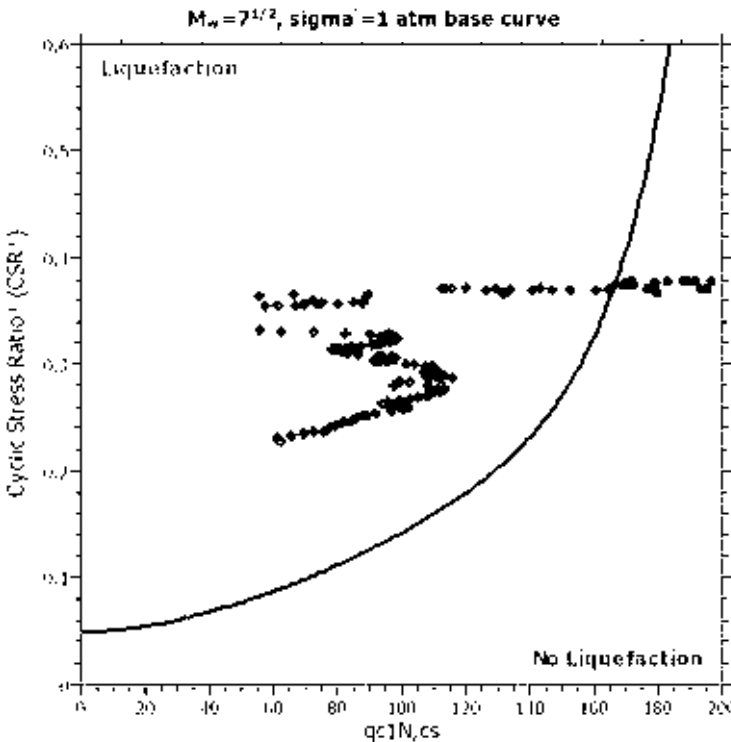
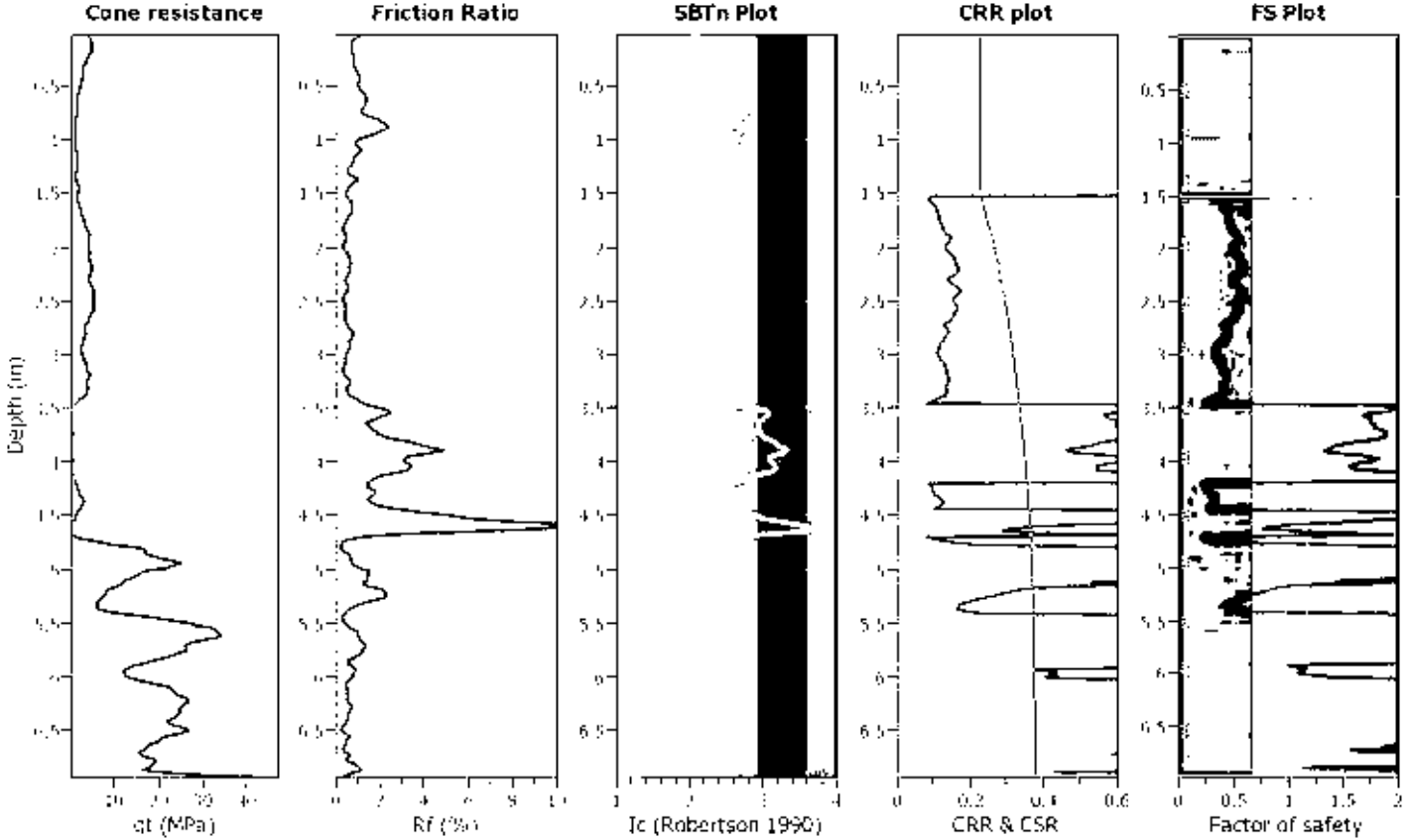
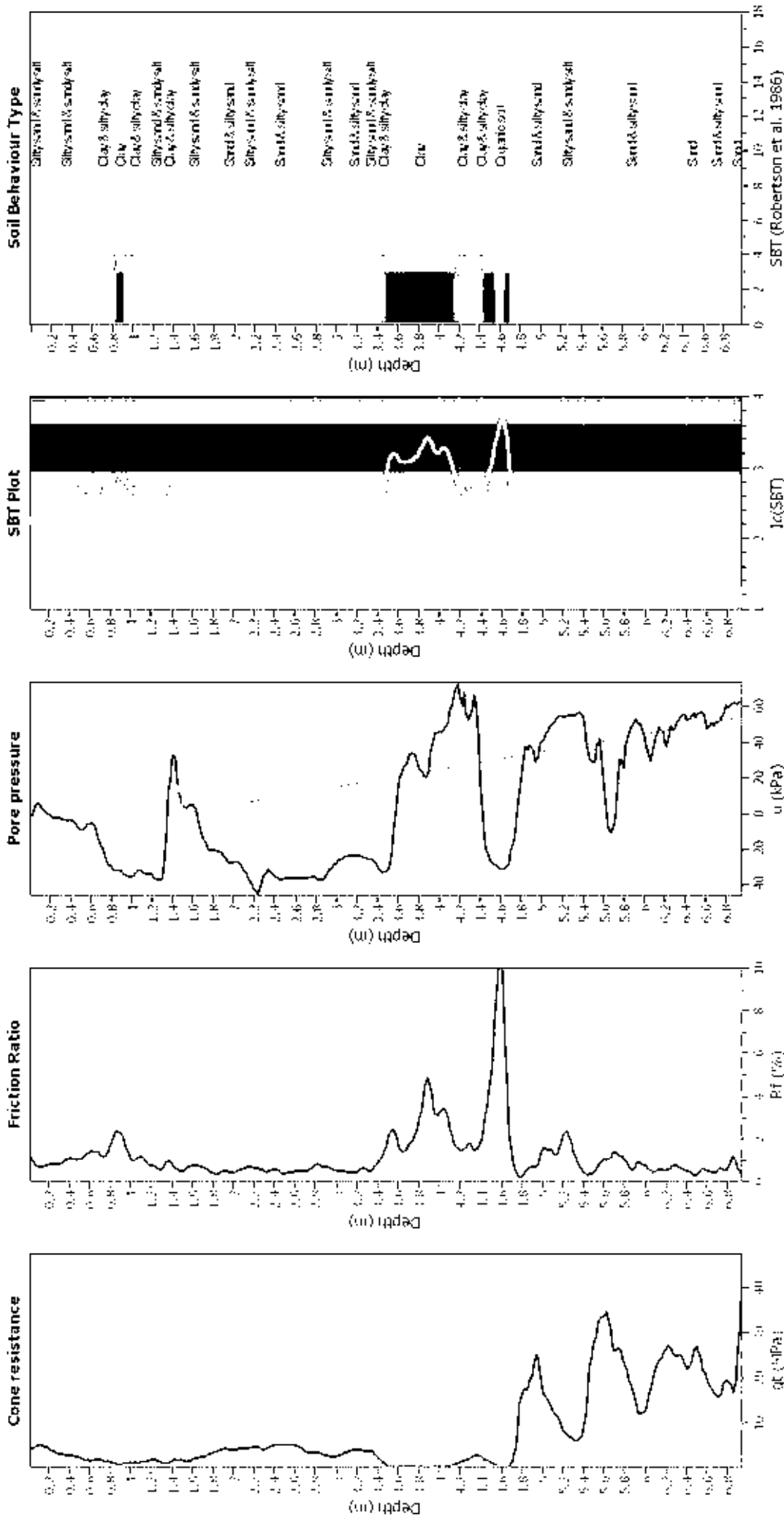


Figure 4: Summary of liquefaction potential assessment and classification of test results. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction unlikely; Zone C: No liquefaction. The dashed line indicates the liquefaction boundary. The arrows indicate the direction of increasing normalized friction ratio and increasing normalized CPT penetration resistance.

### CPT basic interpretation plots



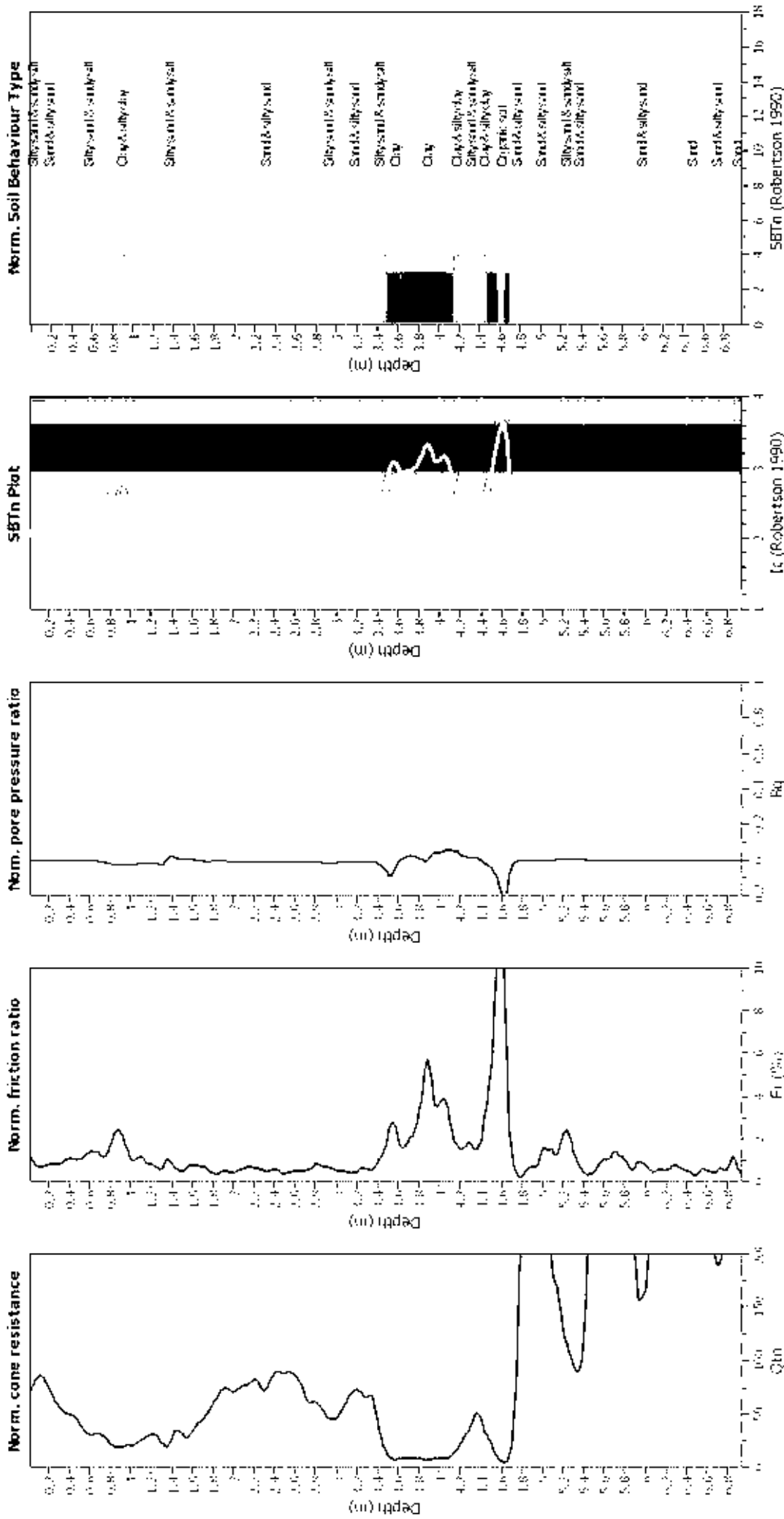
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



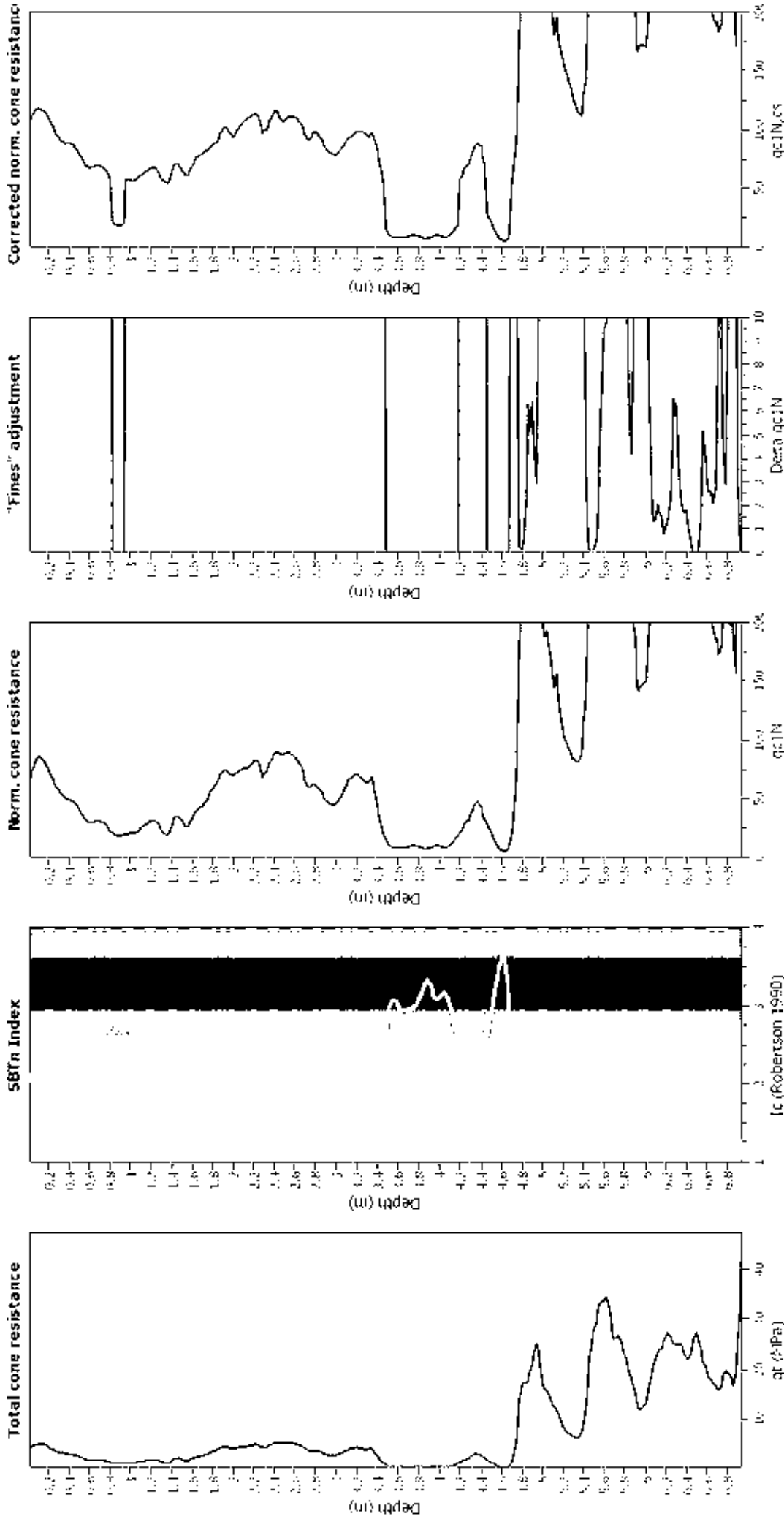
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

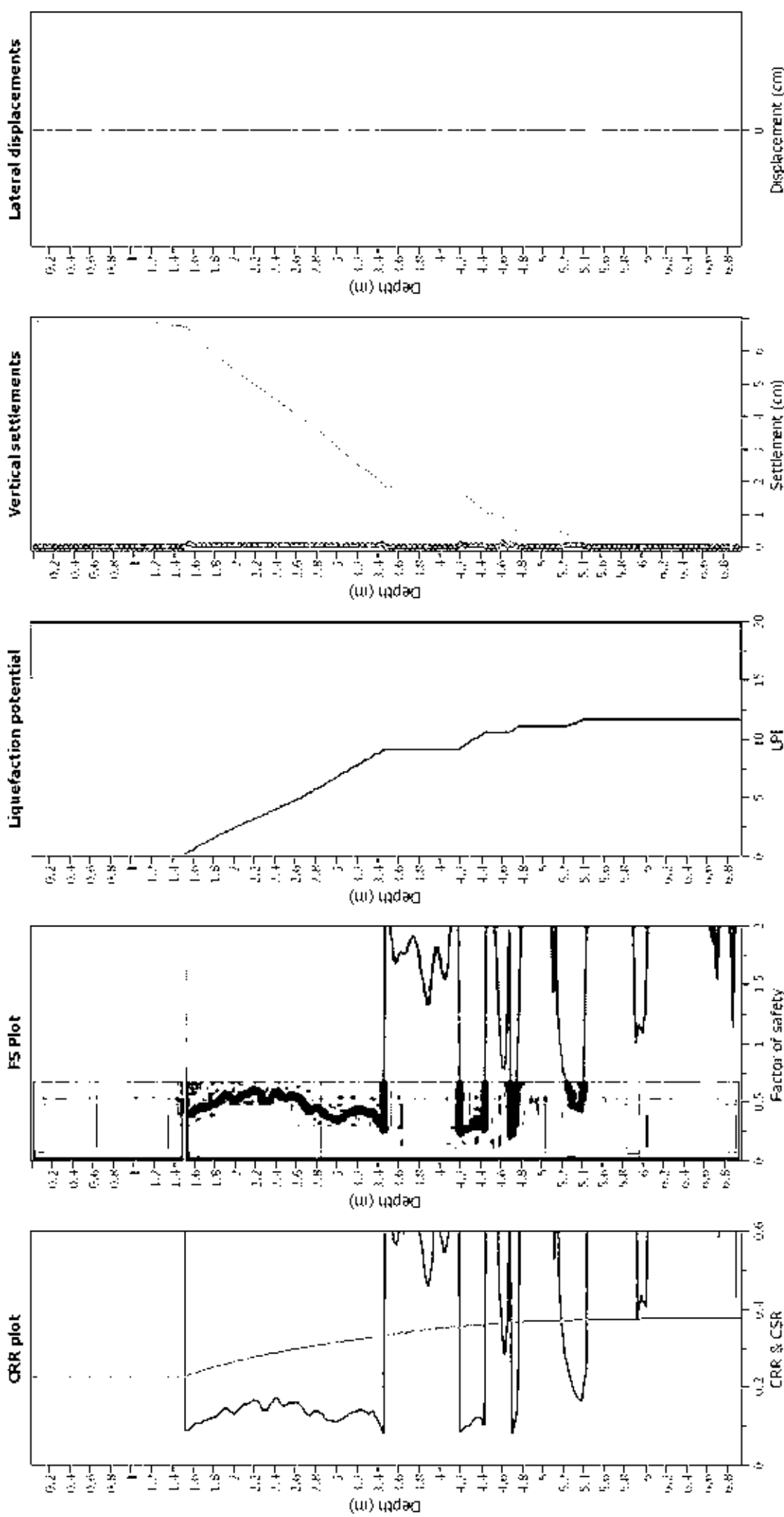
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m  
 Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

#### F.S. color scheme

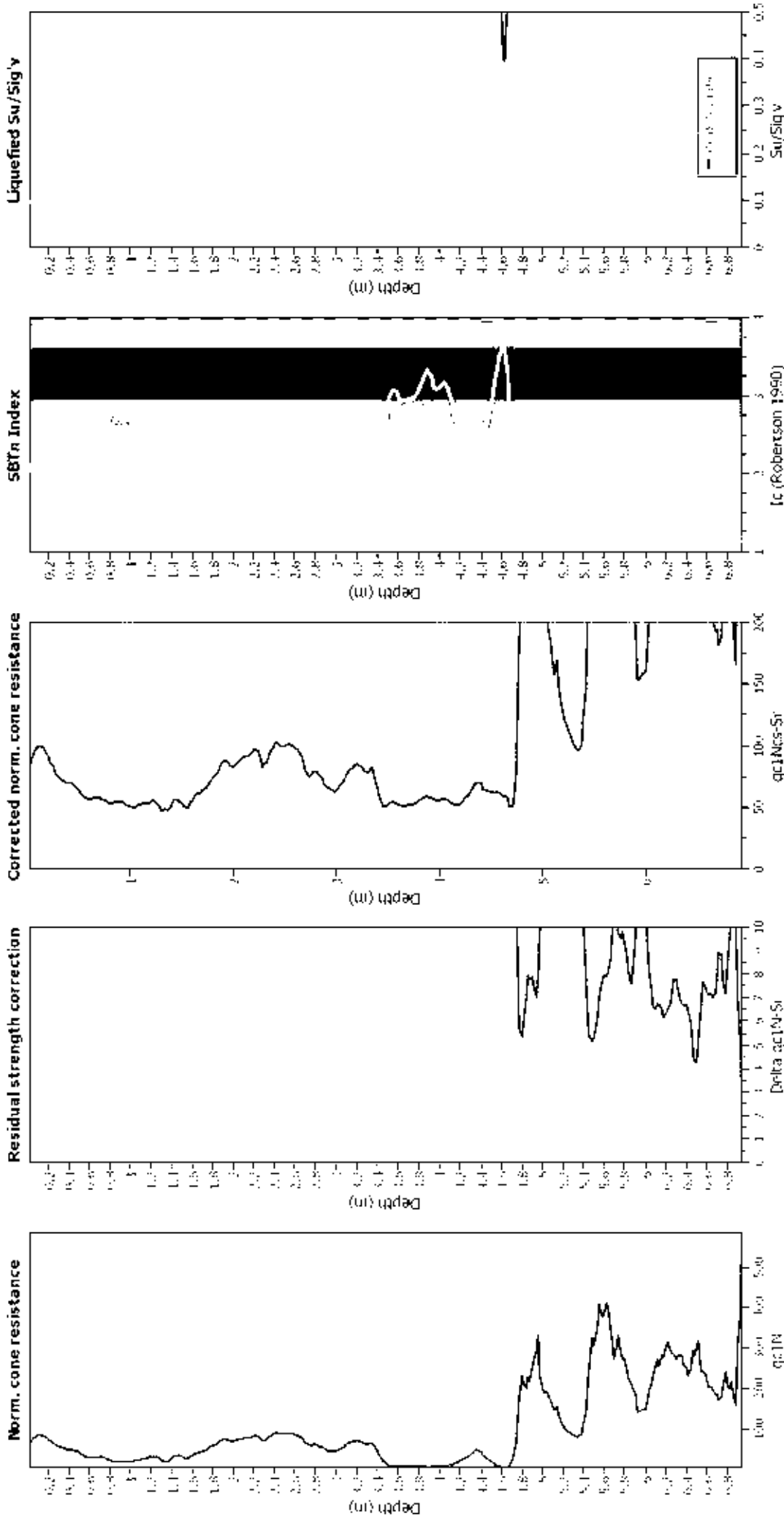
Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk



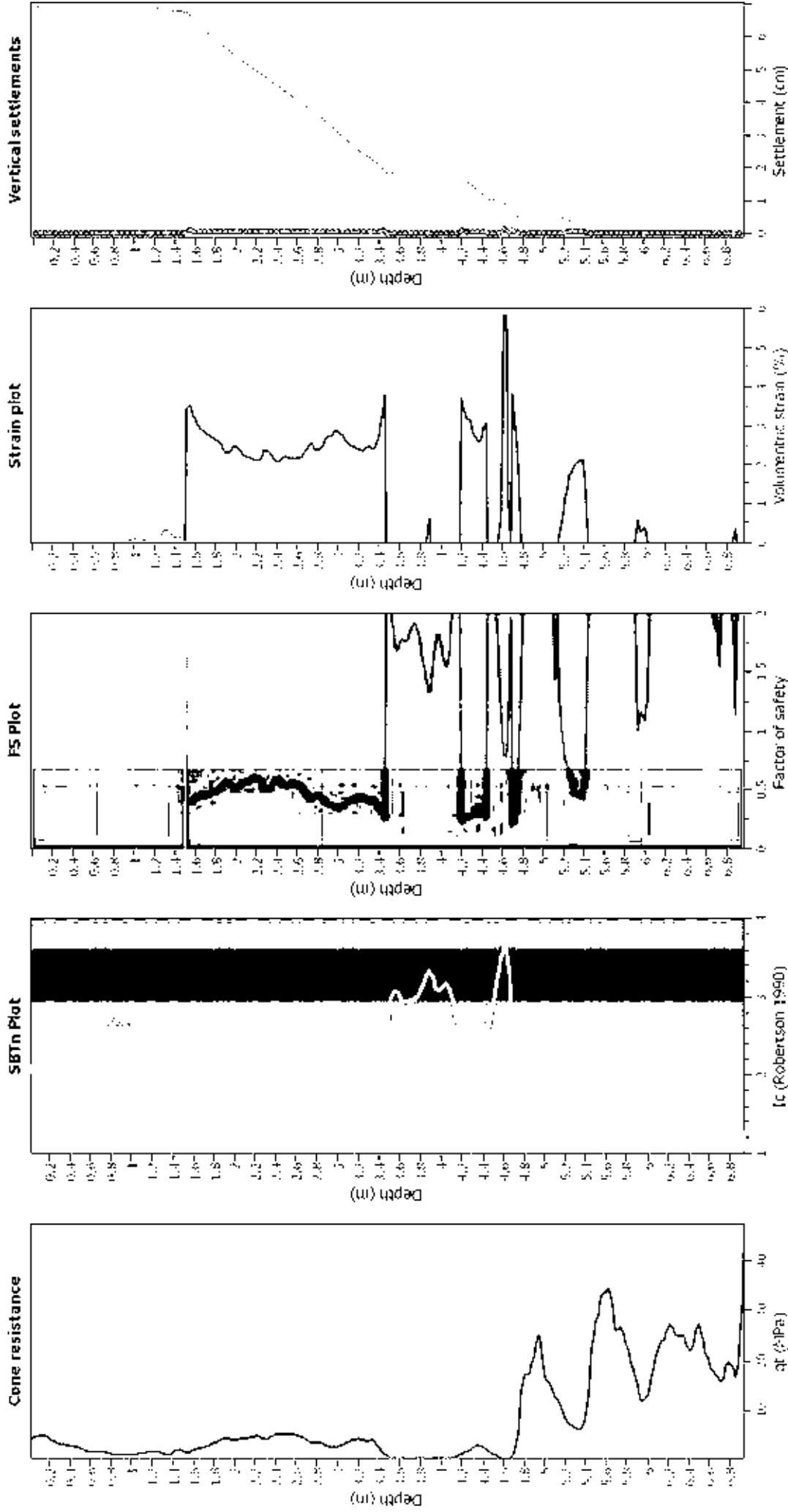
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre: (bu, m, d, m):	18B (2008)	Transition depth: applied:	Sand & Clay
Points to test:	Based on Ic value	K: applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behavior: applied:	No
Peak ground acceleration:	0.35	Limit depth: applied:	No
Depth to water table (z <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- S<sub>b</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT21\_30GloversRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

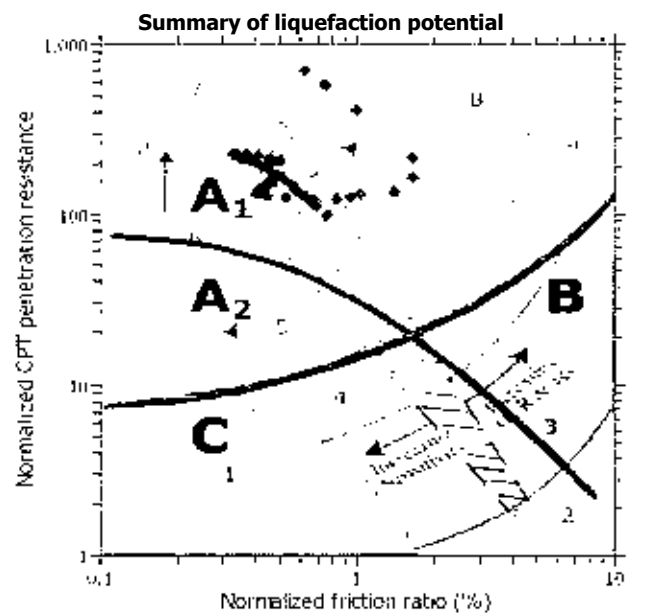
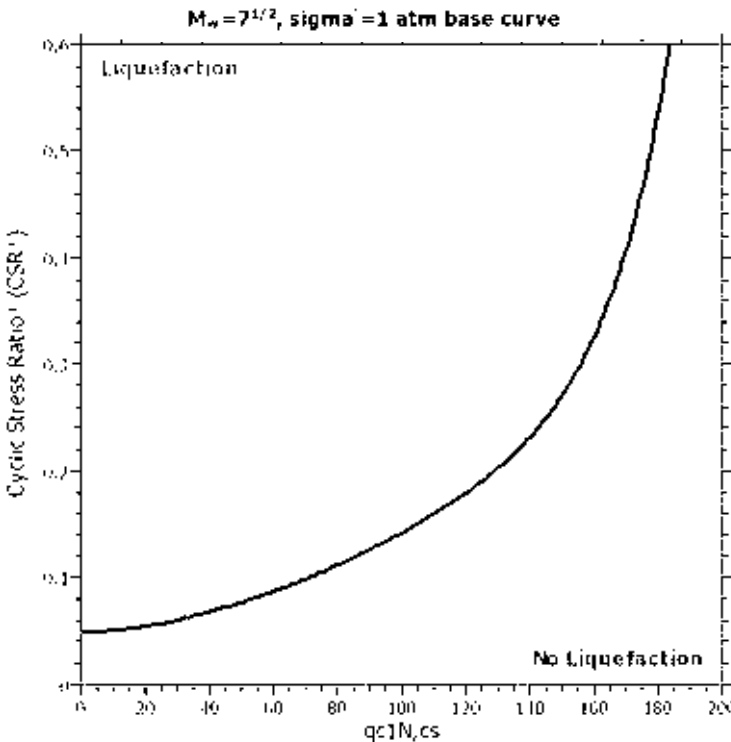
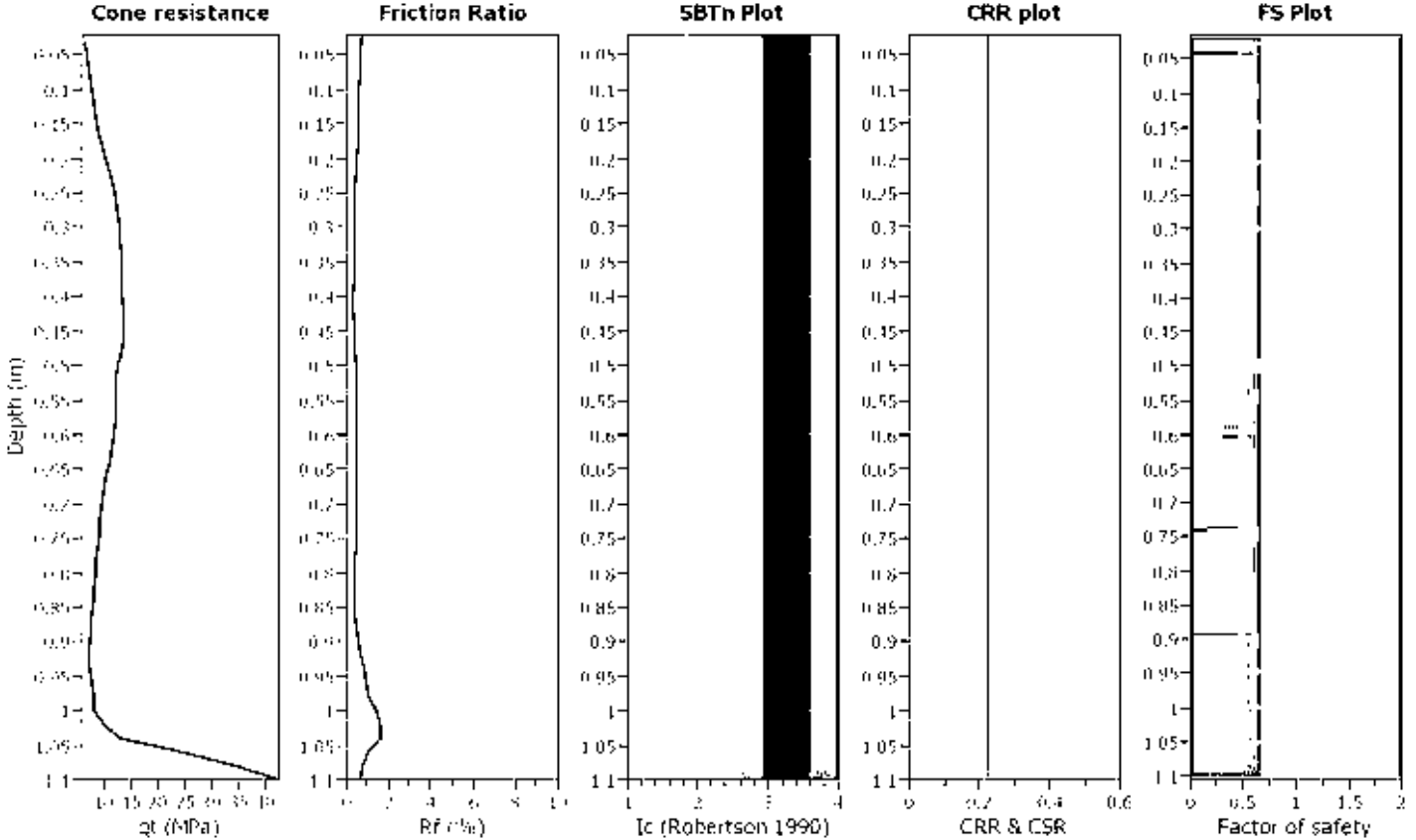
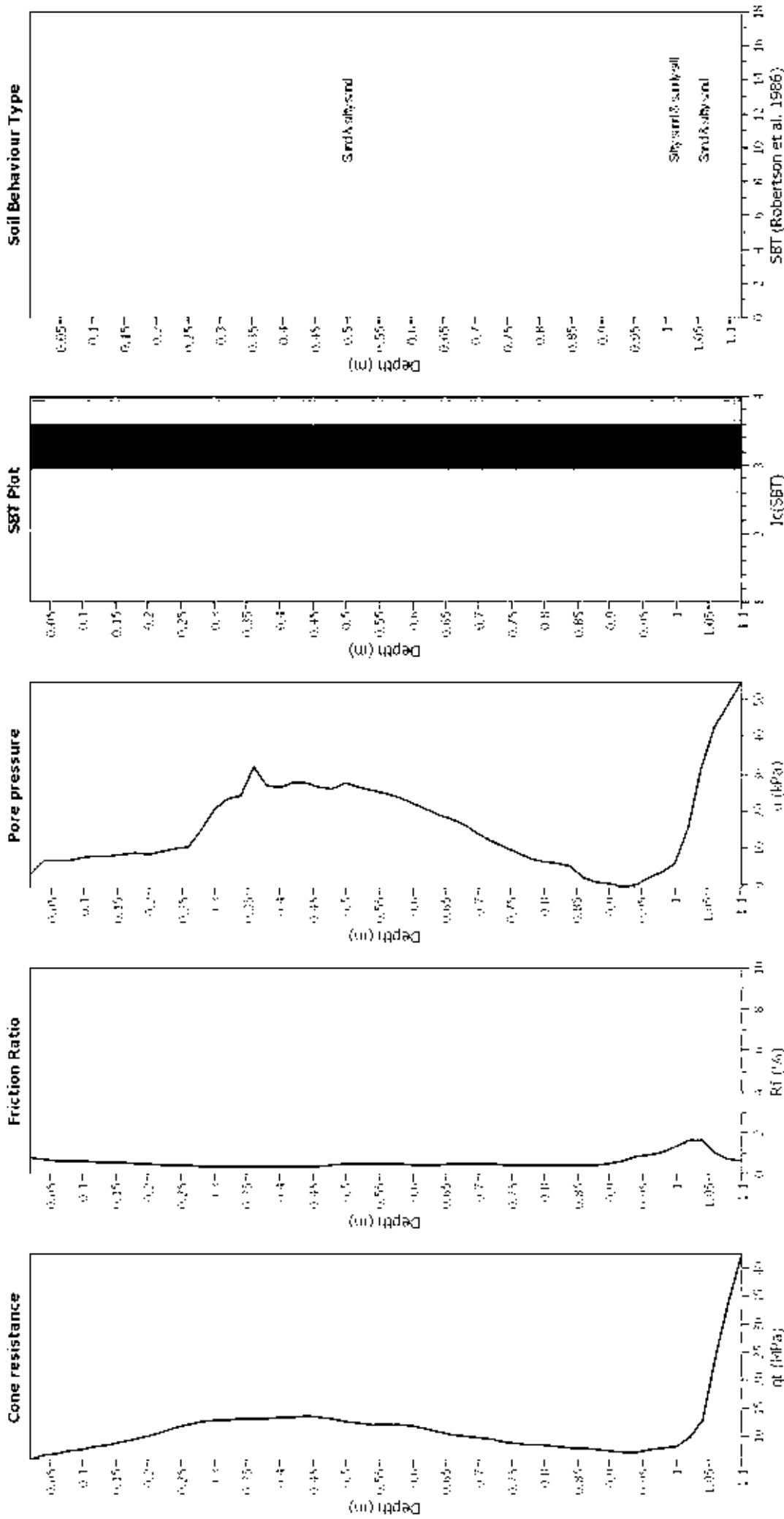


Figure 4: Summary of liquefaction potential and normalized cyclic stress ratio. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio greater than 1. Zone A2: Normalized CPT penetration resistance greater than 10 and normalized friction ratio greater than 1. Zone B: Normalized CPT penetration resistance greater than 10 and normalized friction ratio greater than 0.1. Zone C: Normalized CPT penetration resistance greater than 1 and normalized friction ratio greater than 0.1. The liquefaction boundary is defined by the relationship between normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



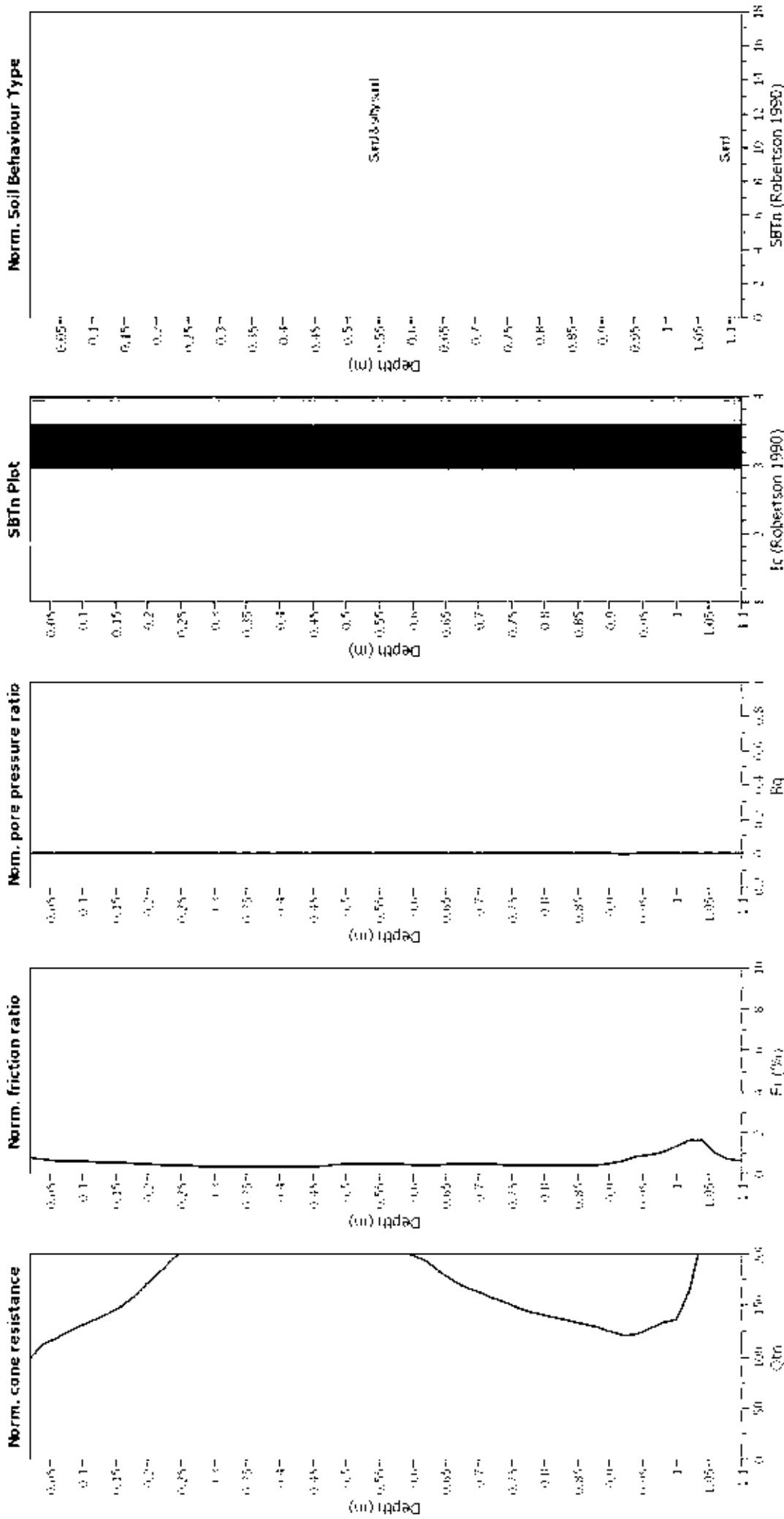
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



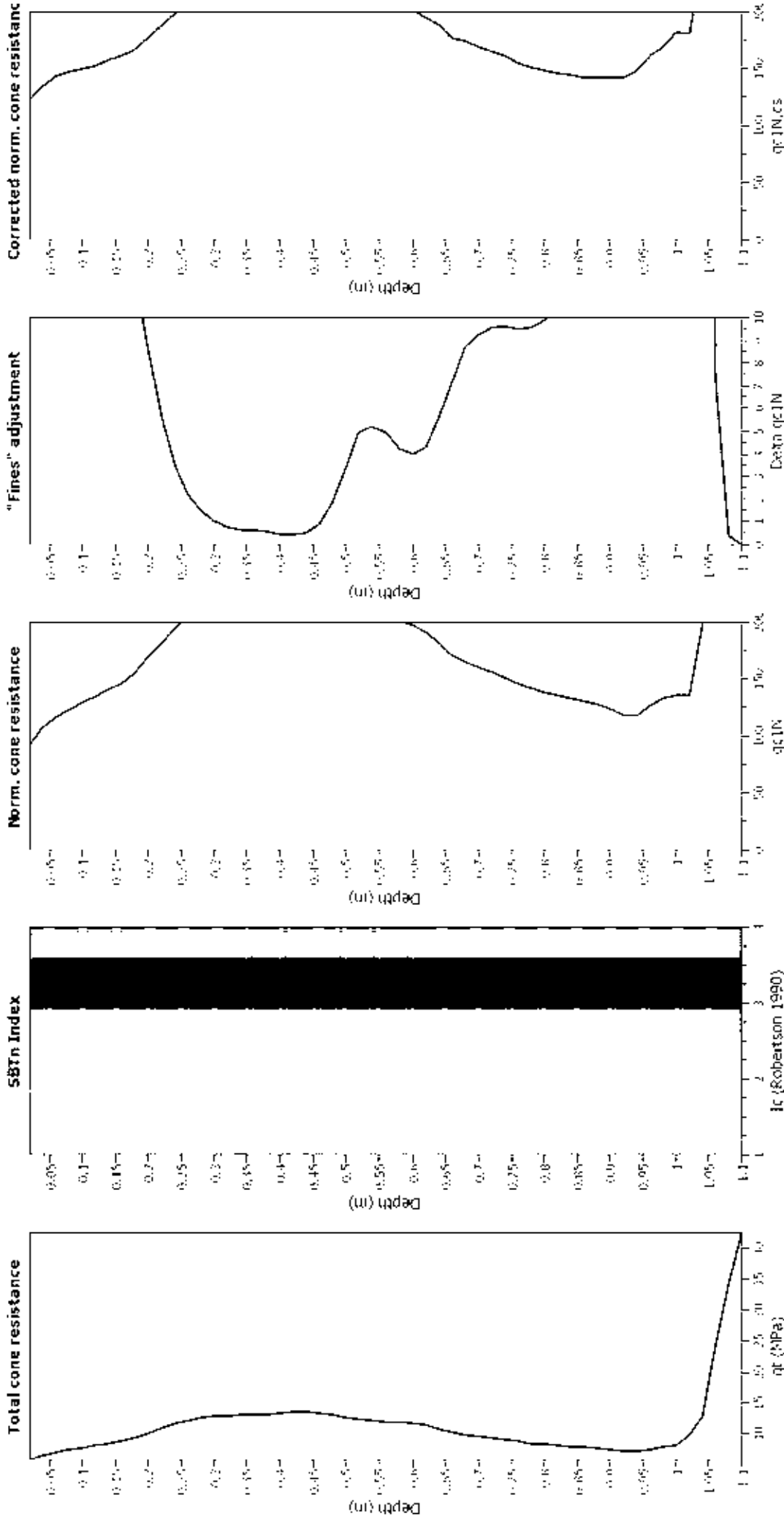
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### Liquefaction analysis overall plots (intermediate results)



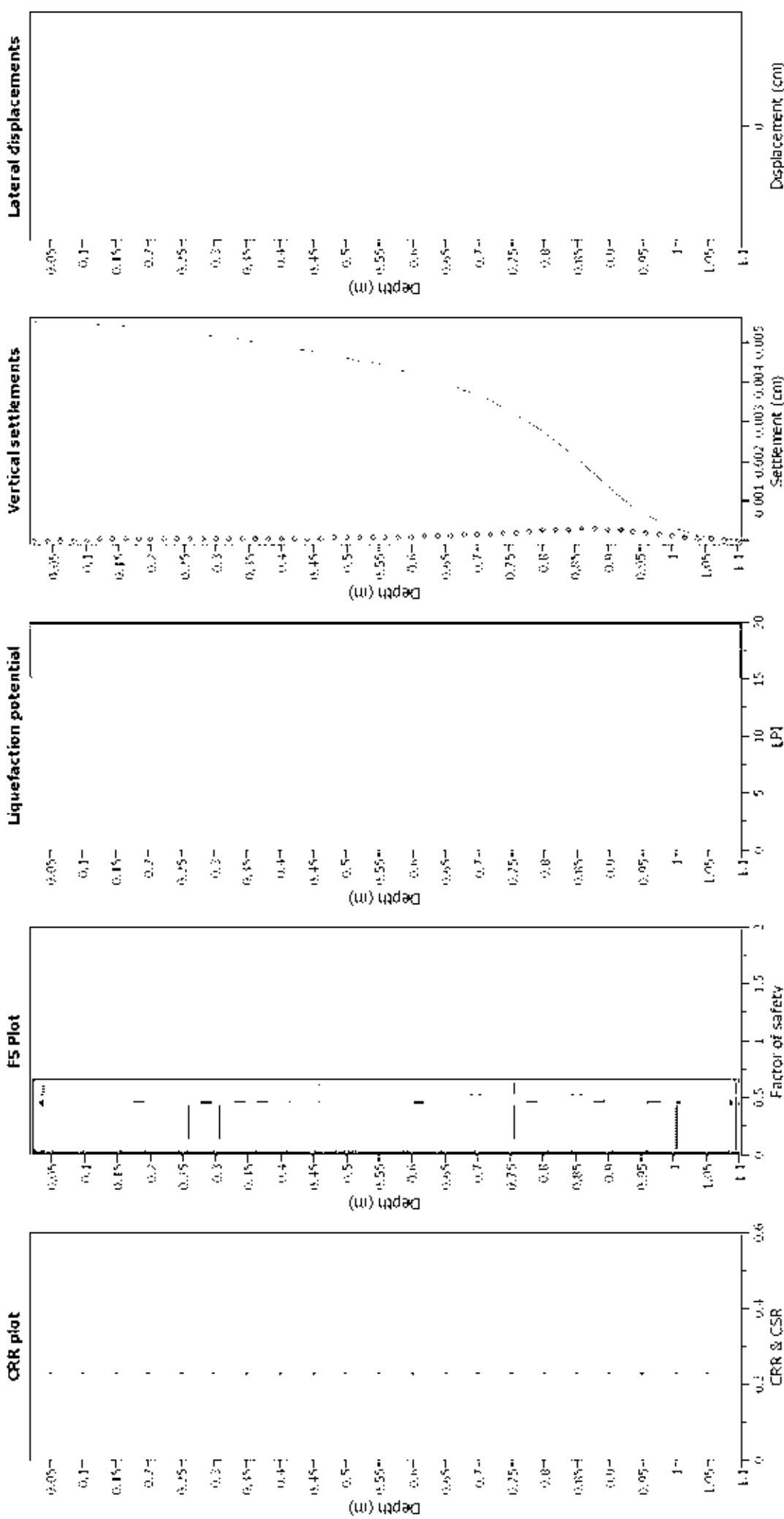
#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Lines corre. func. method: 18B (2008)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Degree to water table: 0.50  
 Fill height: 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 $I_c$  cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition detect. applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

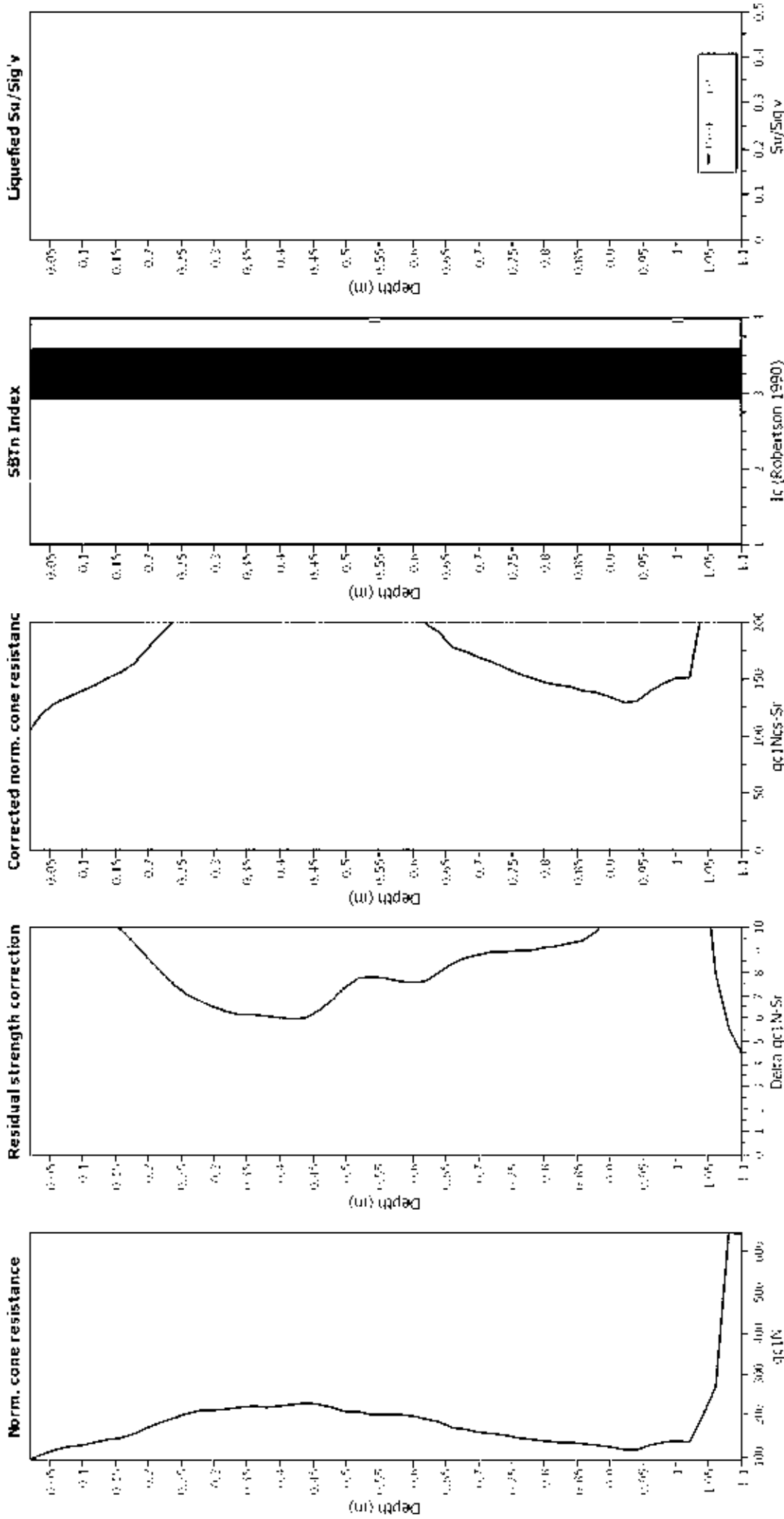
#### LPI color scheme

Very high risk  
 High risk  
 Low risk

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

### Check for strength loss plots (Idriss & Boulanger (2008))

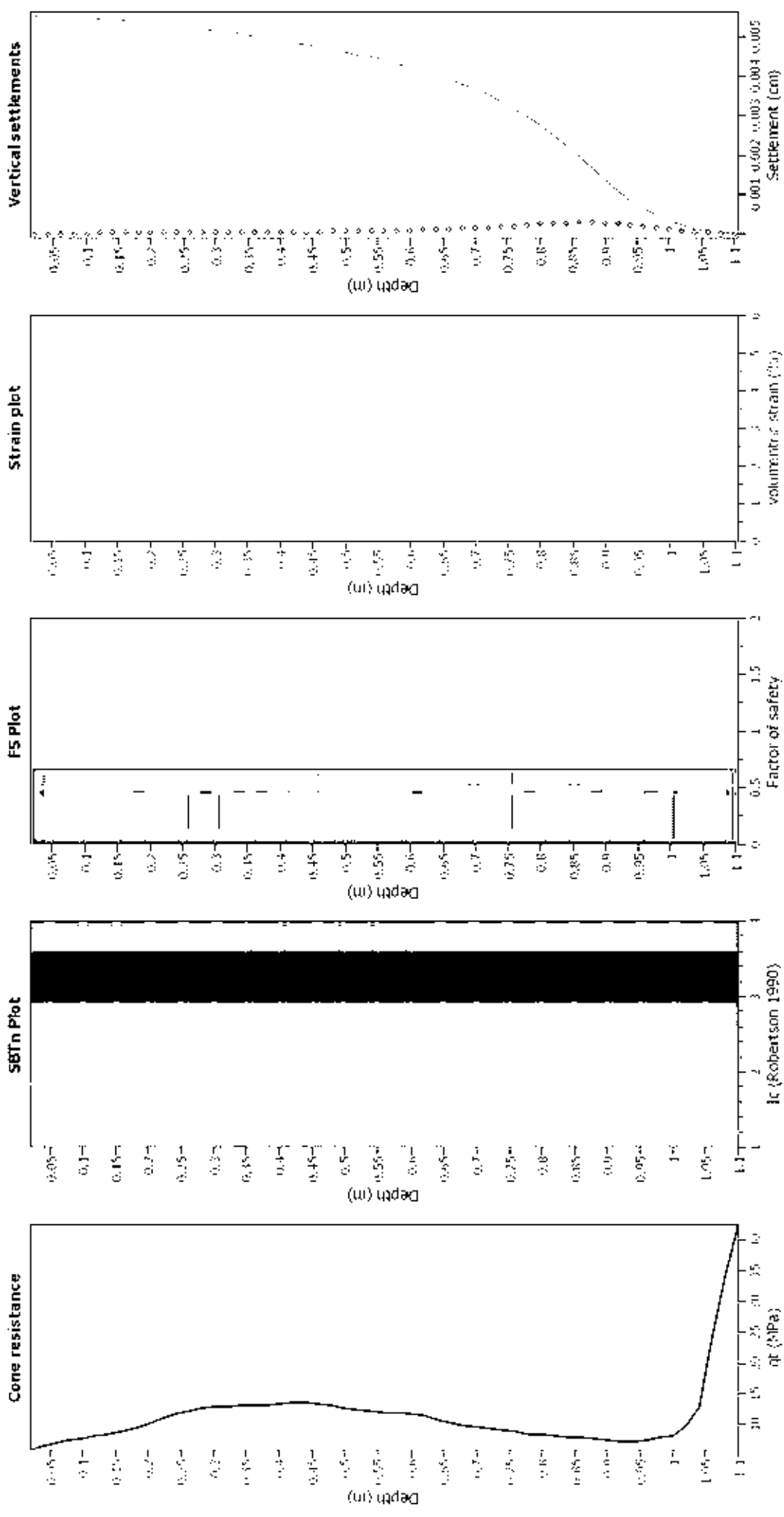


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT22\_117KennedysBushRoad**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

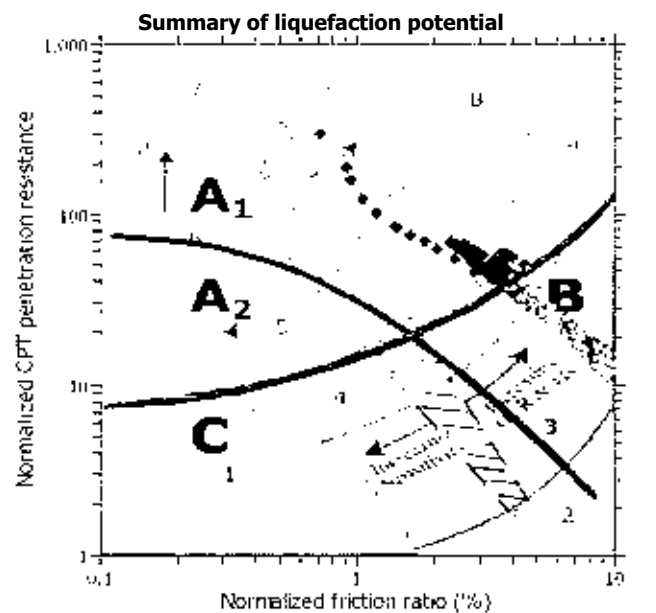
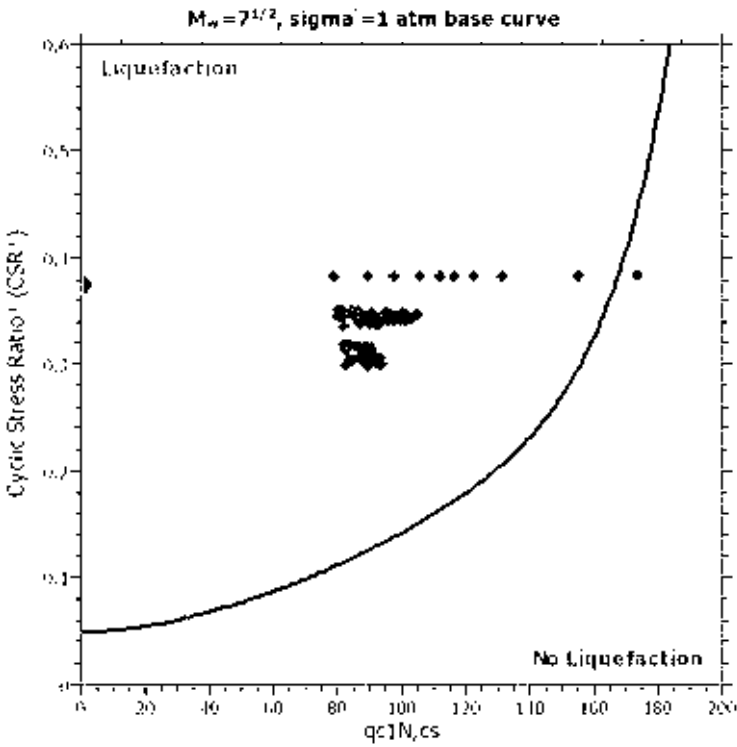
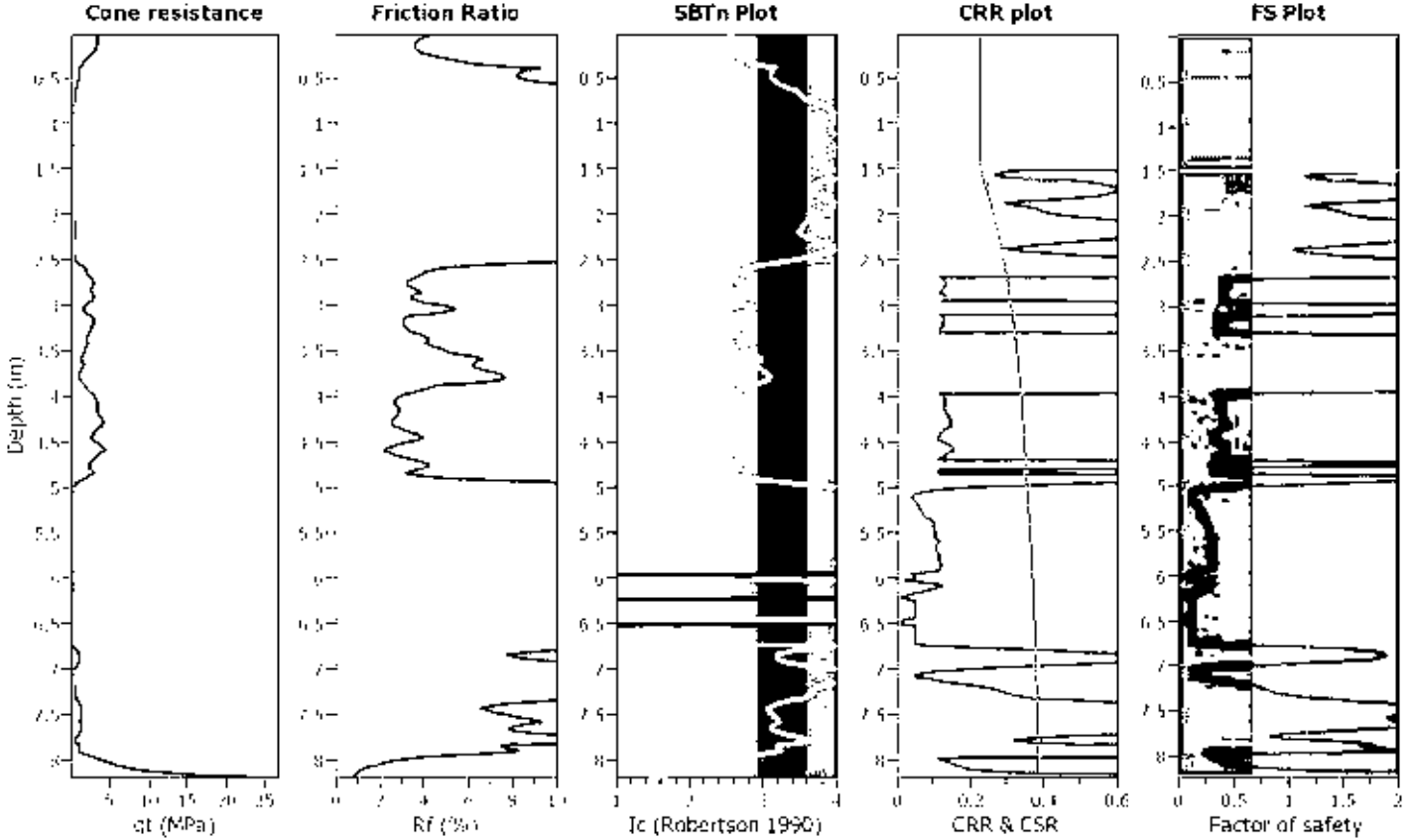
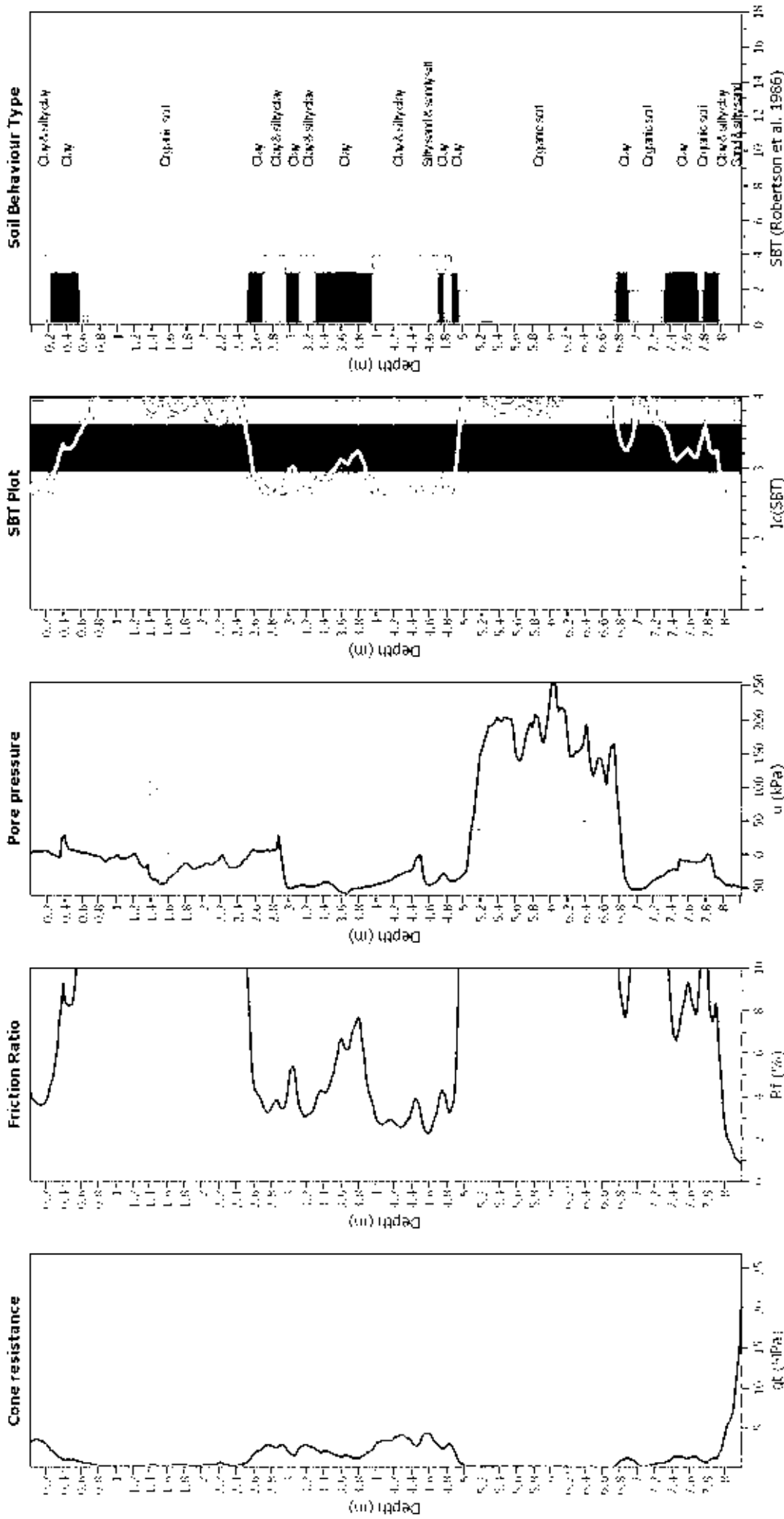


Figure 4: Summary of liquefaction potential assessment and results of cyclic test. Zone A1: Fully liquefied, Zone A2: Partially liquefied, Zone B: No liquefaction, Zone C: No liquefaction. The dashed line indicates the liquefaction boundary. The shaded area indicates the liquefaction potential. The results of the cyclic test are shown in the table below.

### CPT basic interpretation plots



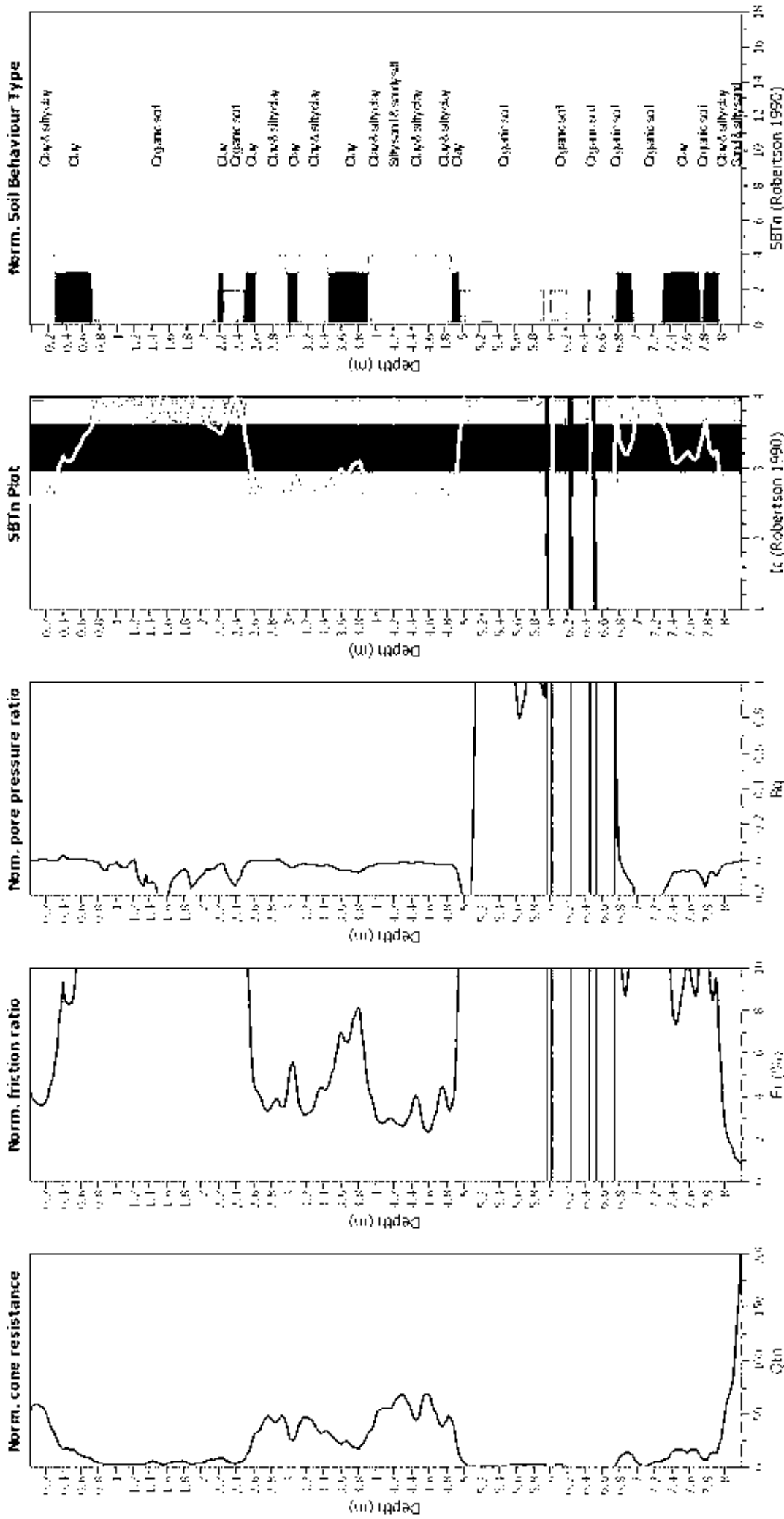
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	N/A
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



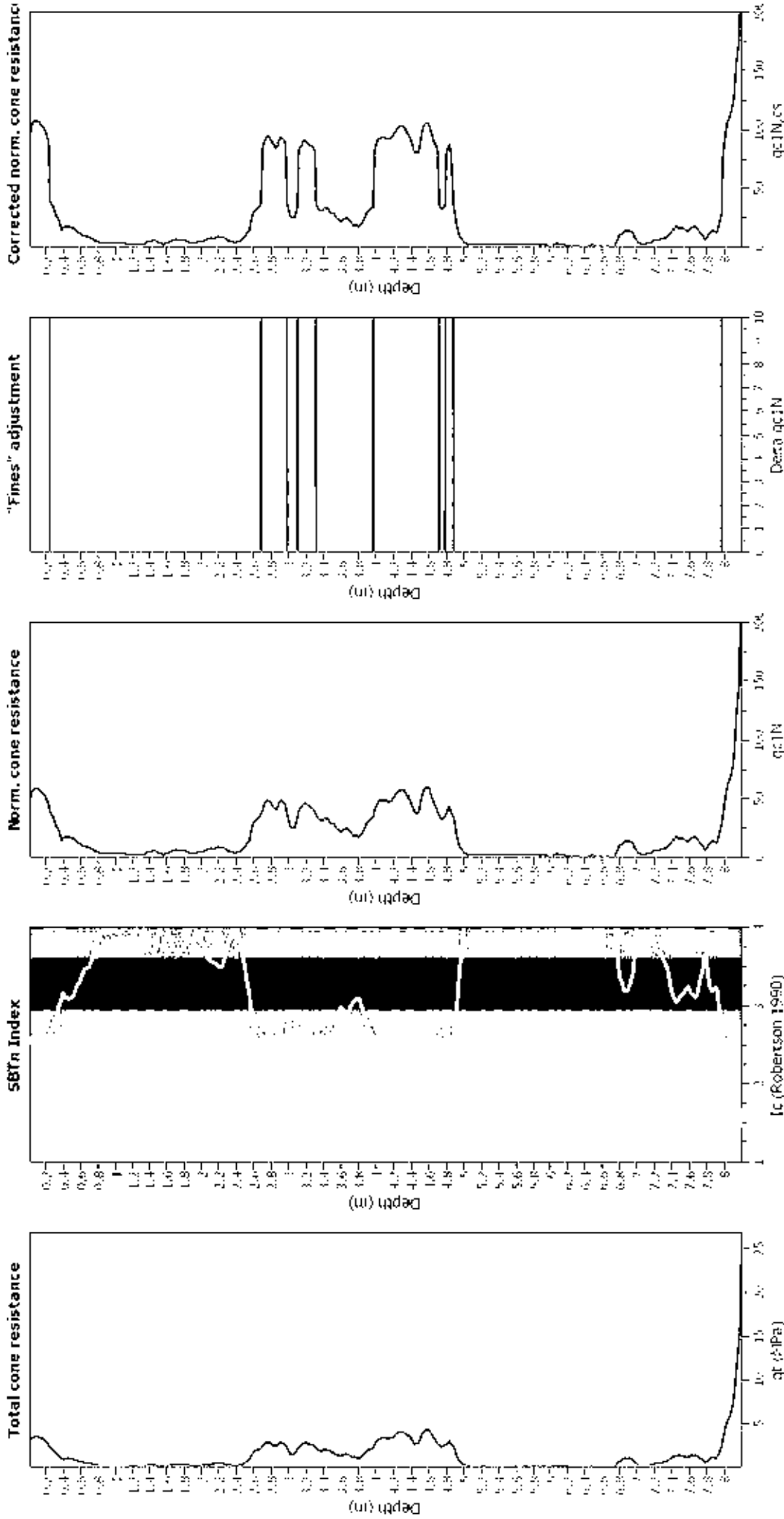
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I <sub>c</sub> value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
I <sub>c</sub> cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

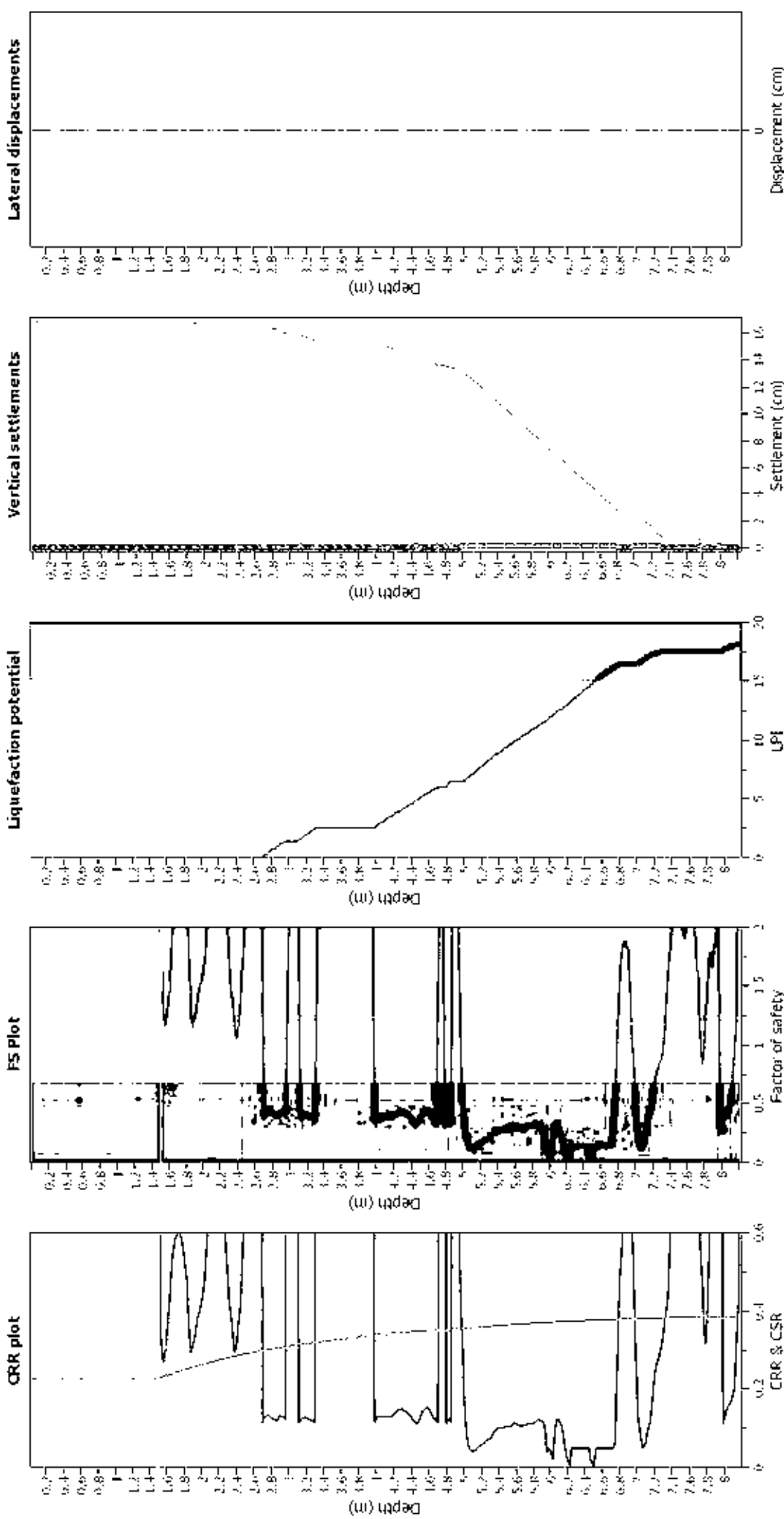
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

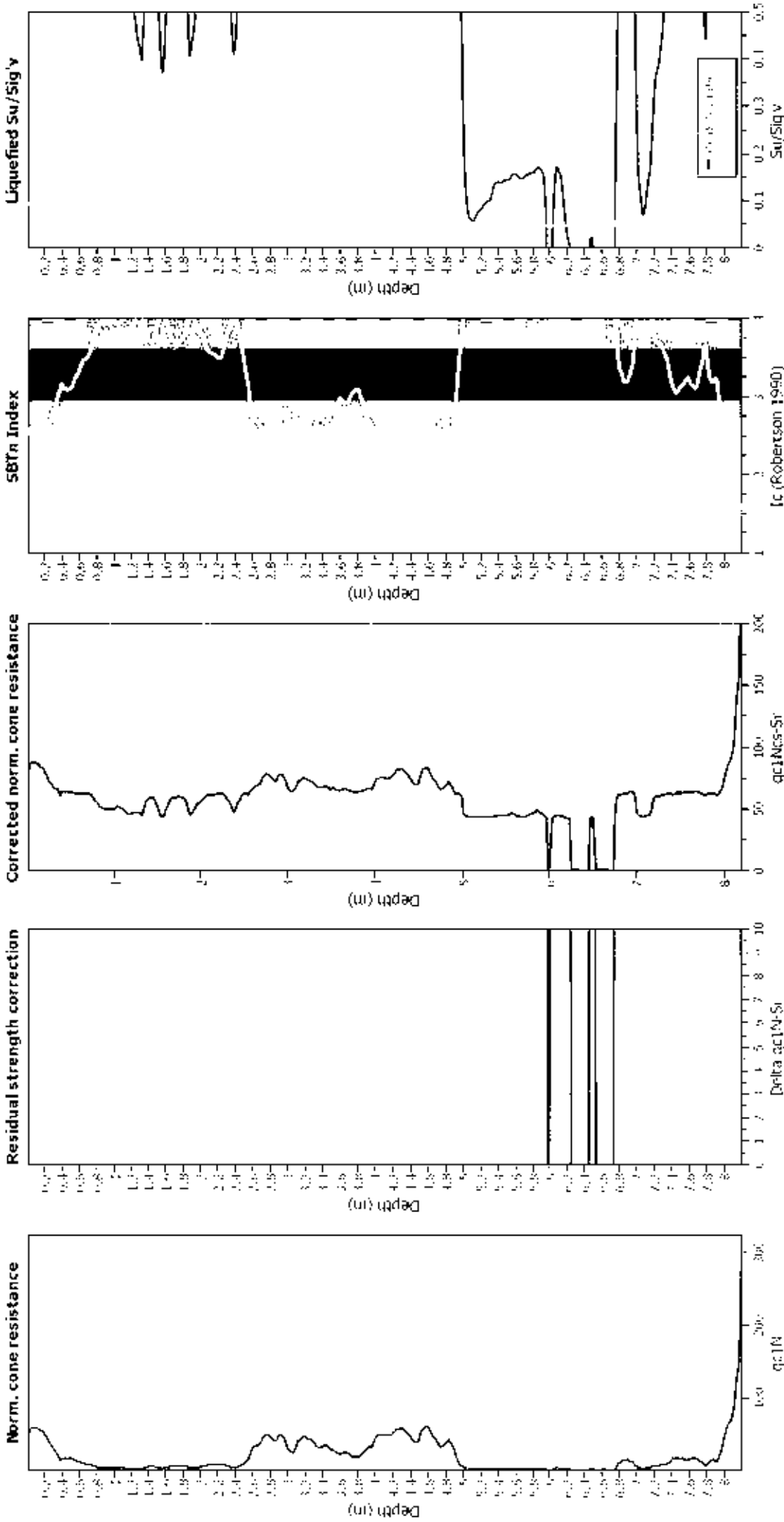
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

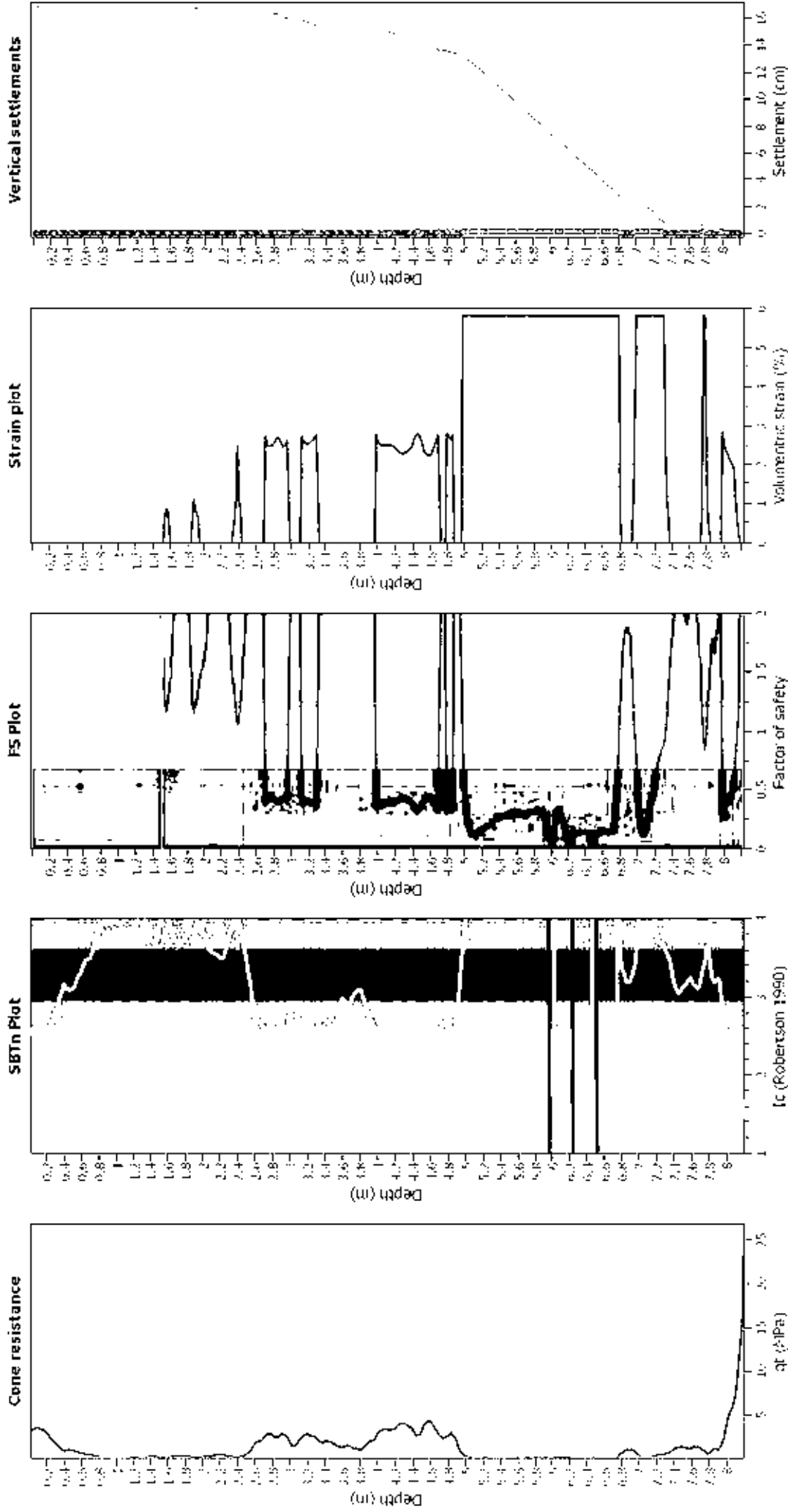
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

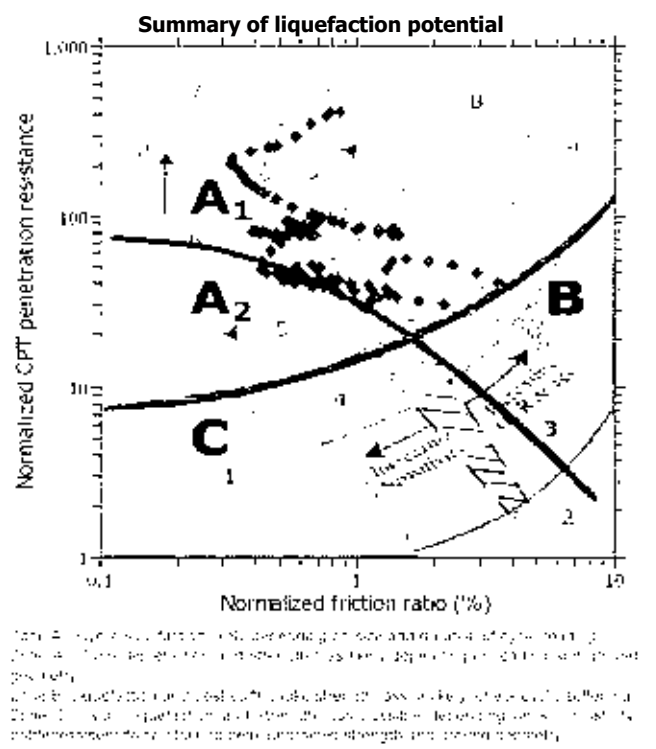
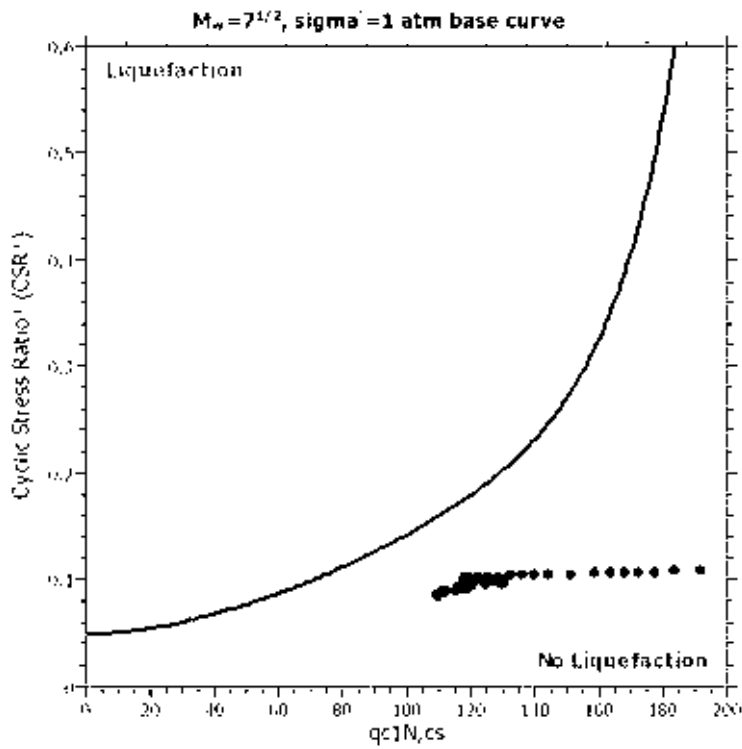
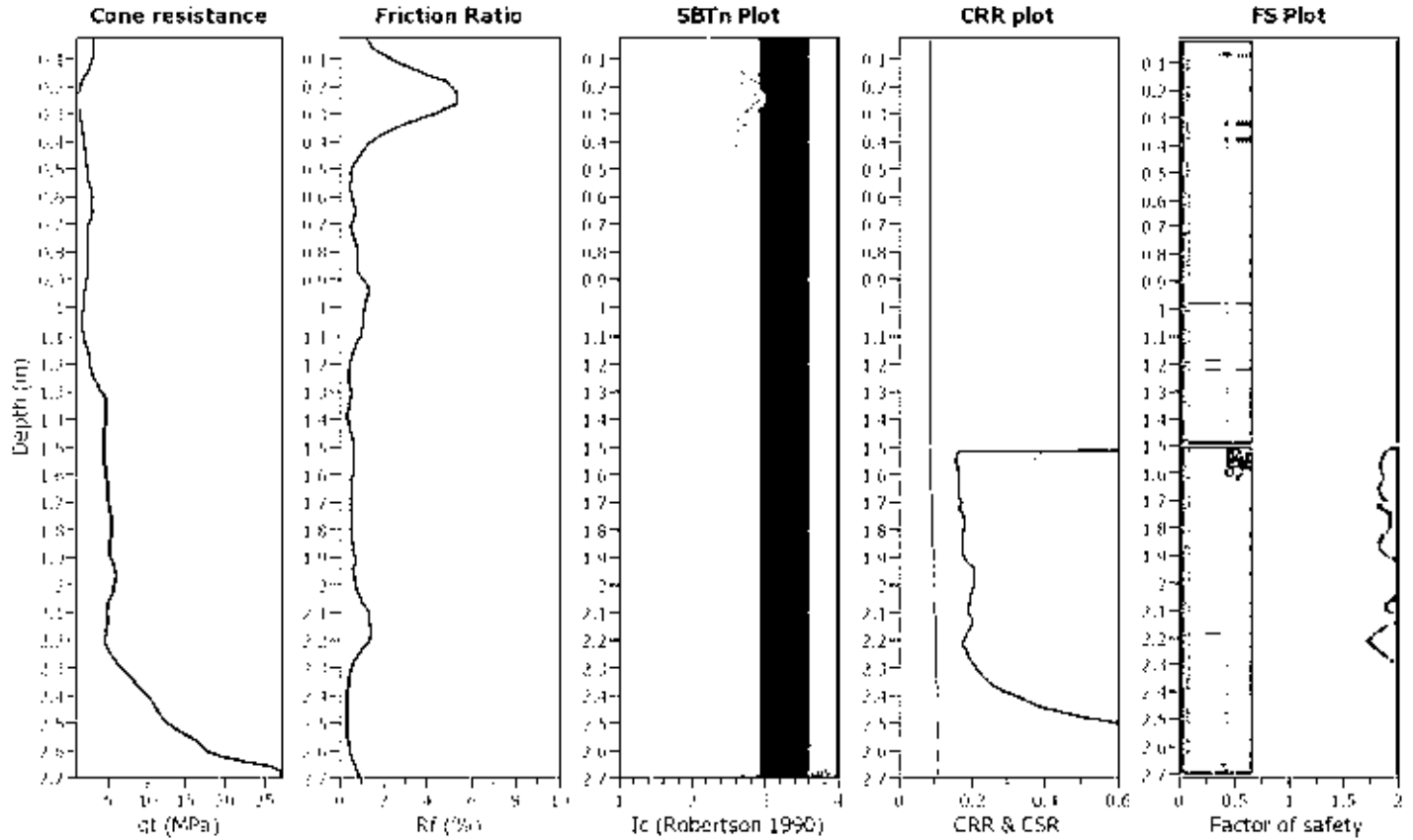


**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

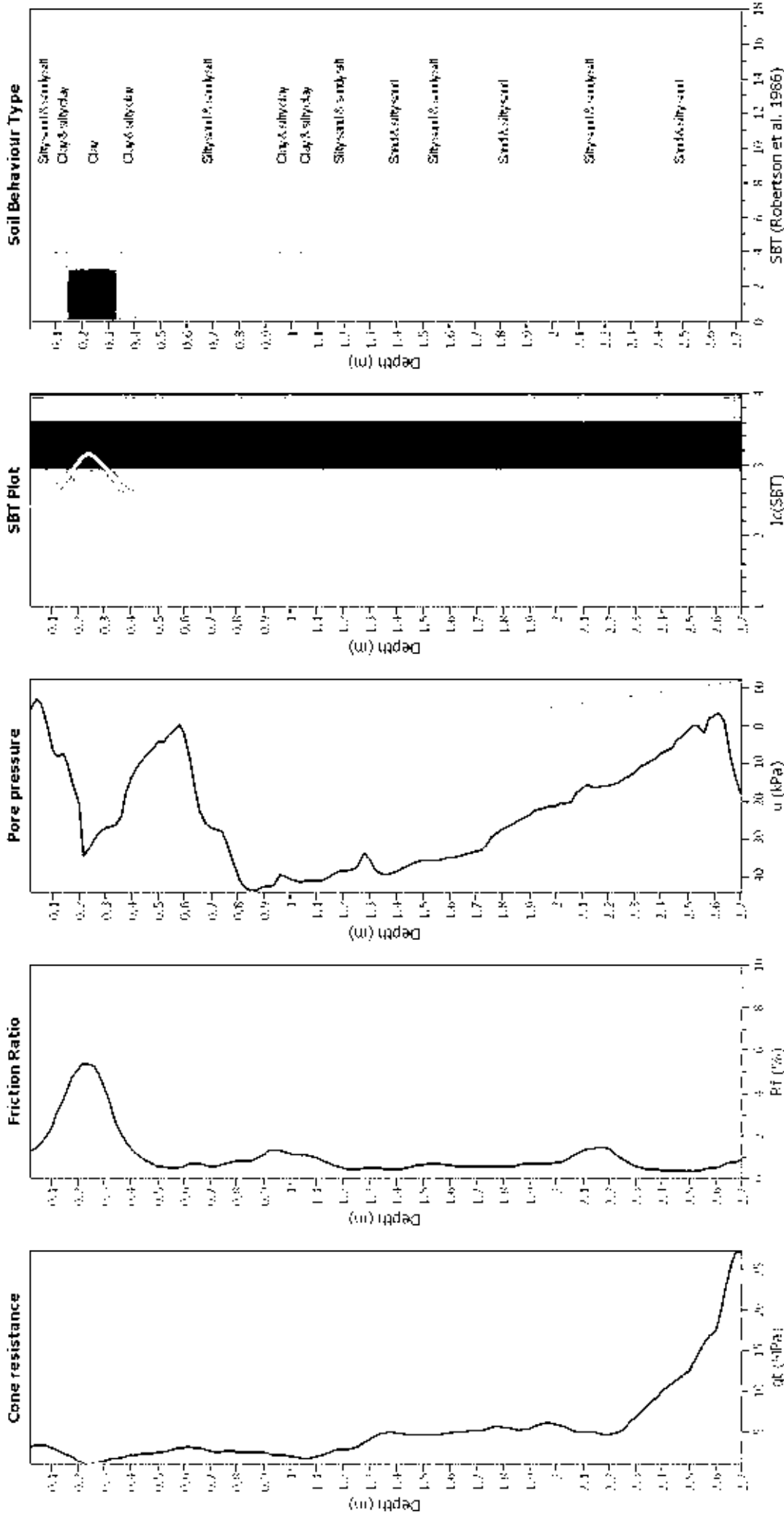
**CPT file : CPT23\_470SparksRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		



### CPT basic interpretation plots



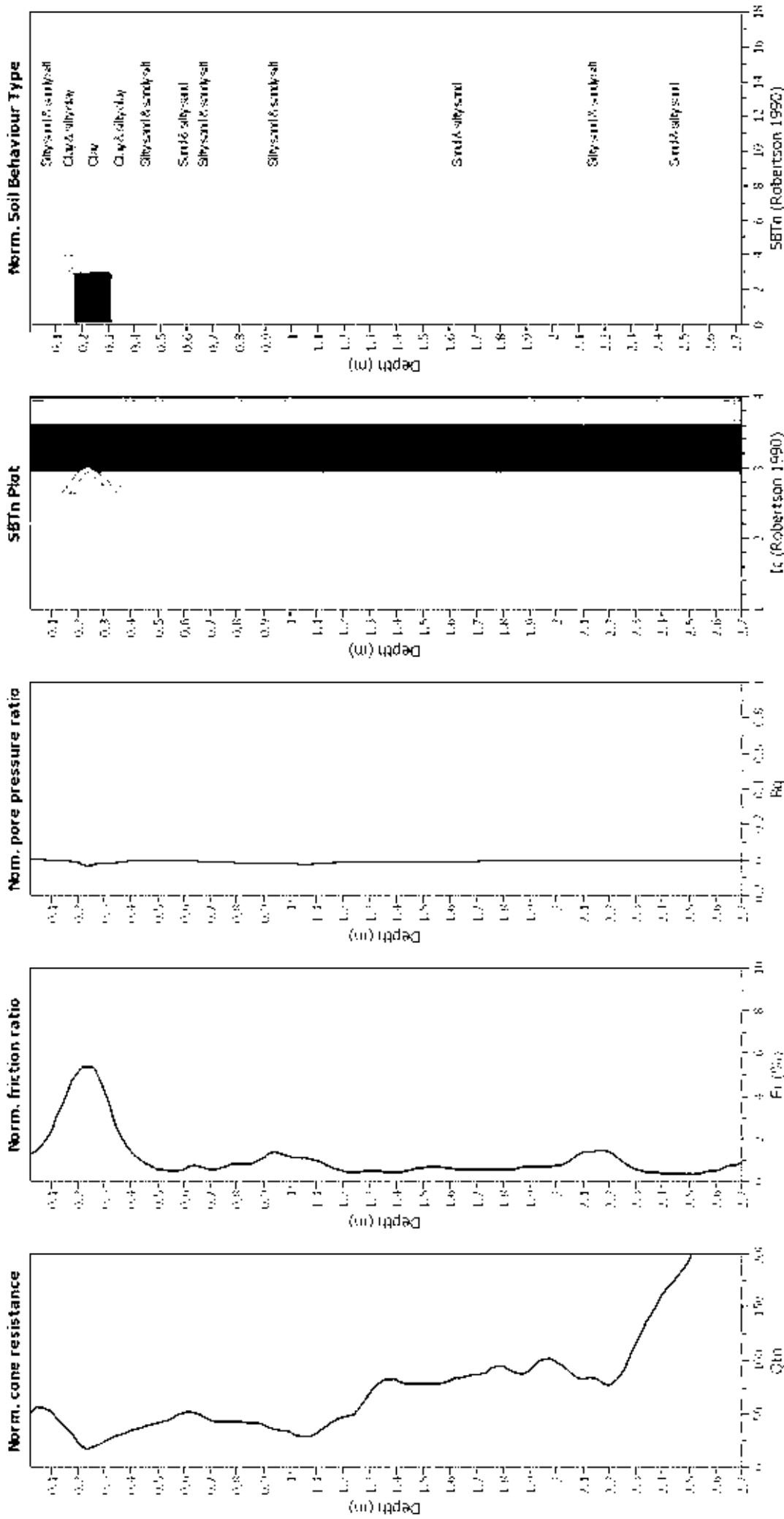
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lamé depth applied:	No
Depth to water table (m):	1.50 m	Lamé depth:	N/A
Depth to GW (ortho):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



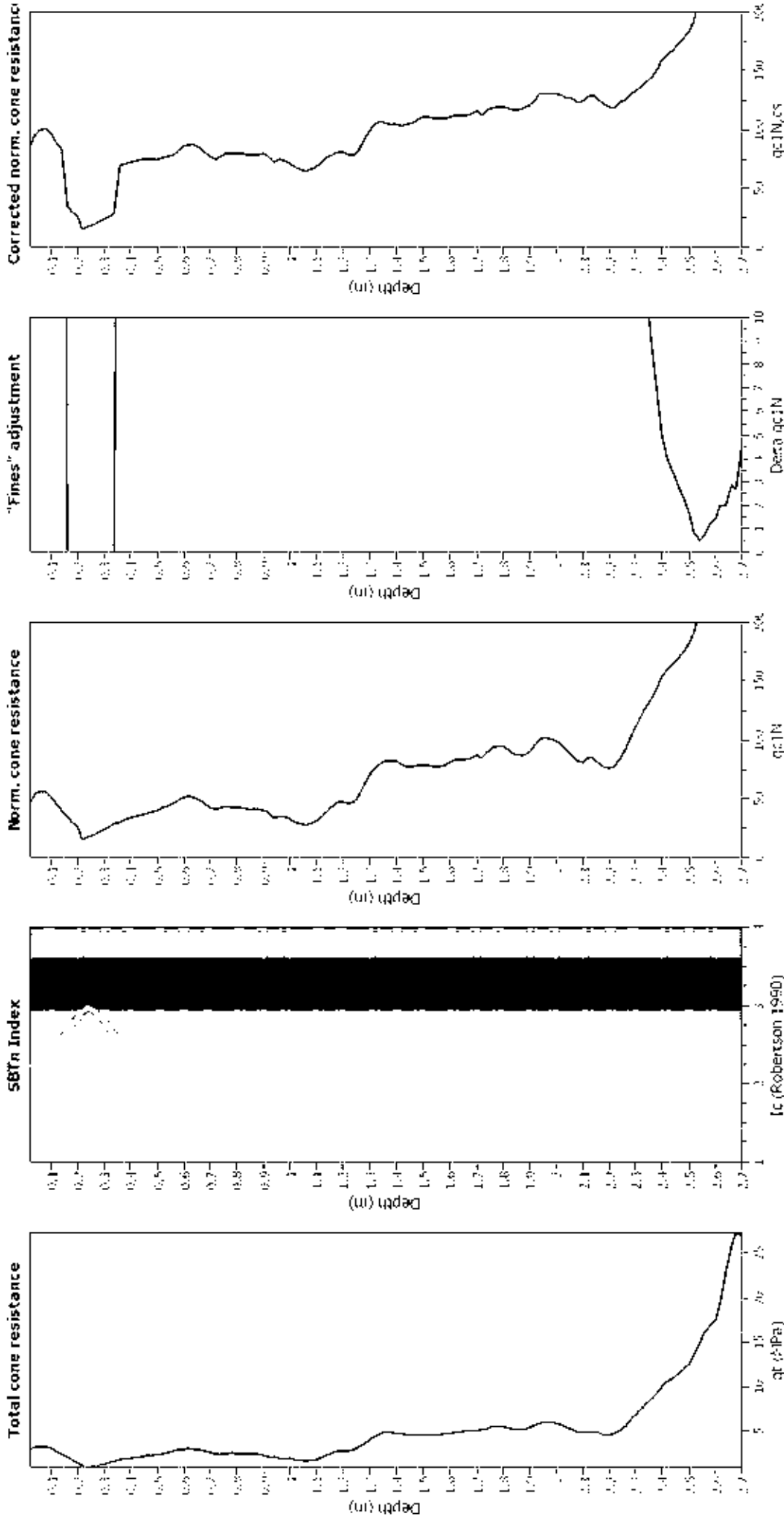
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

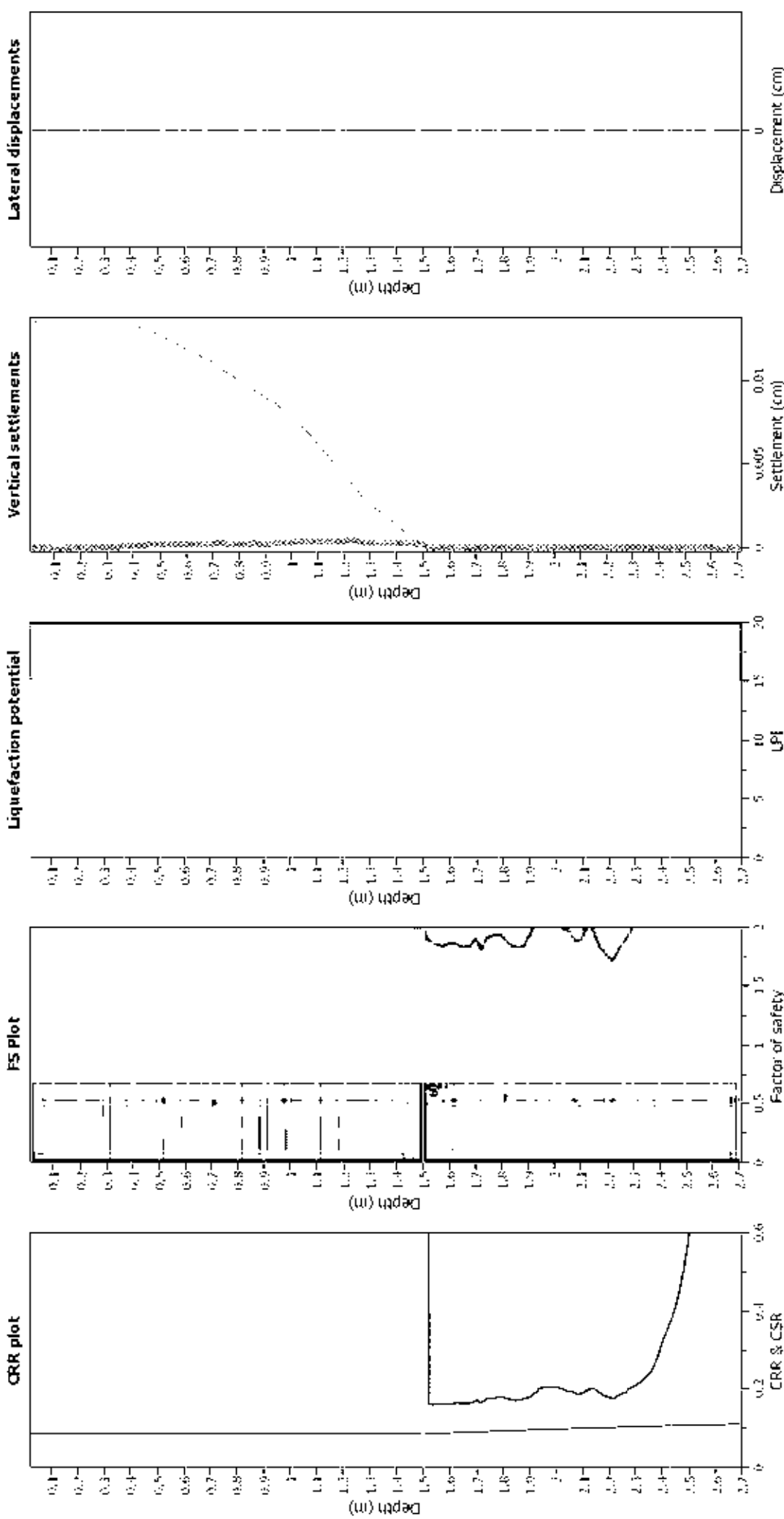
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m  
 Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

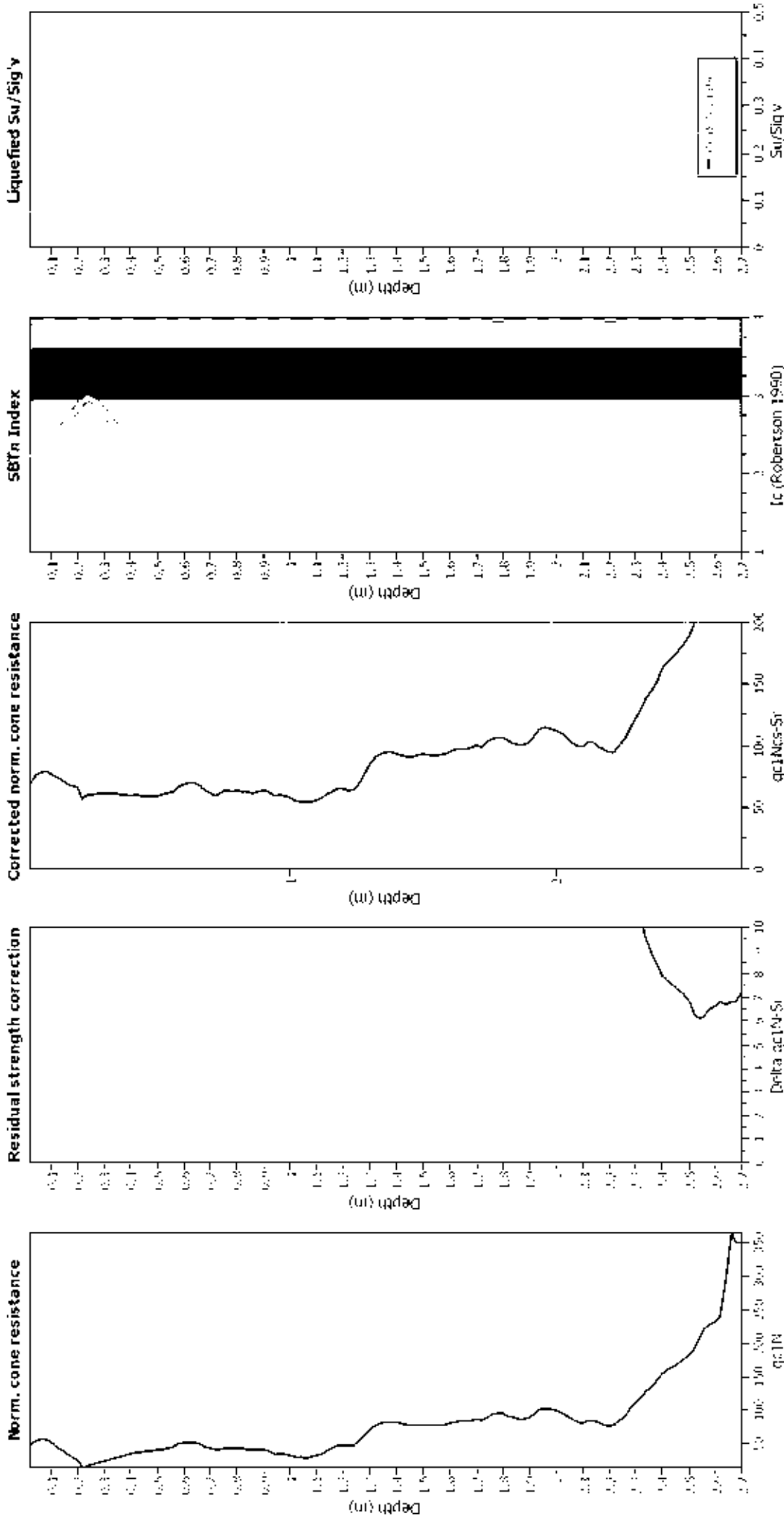
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

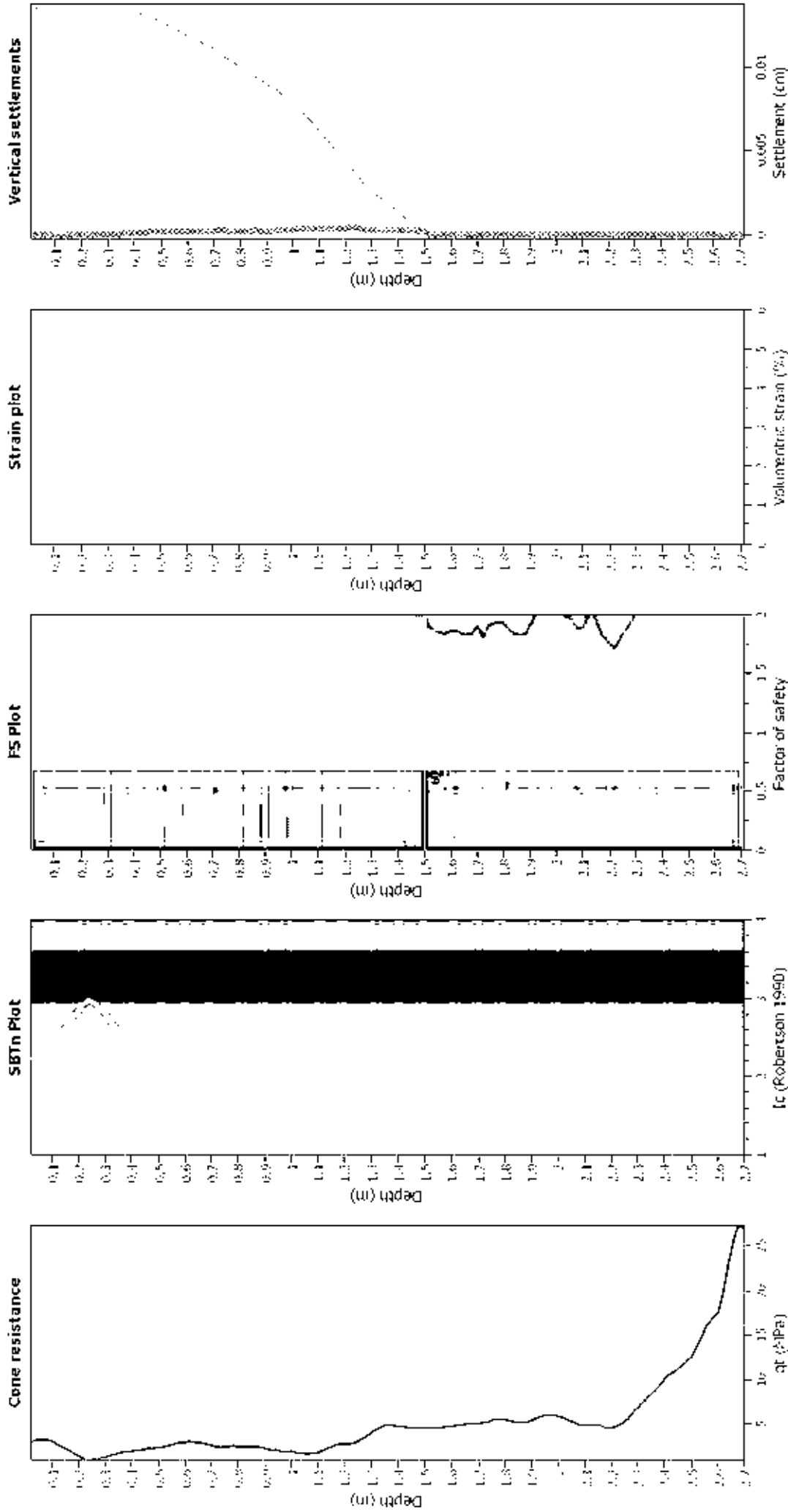
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT24\_119SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>o</sub> applied:	Yes		

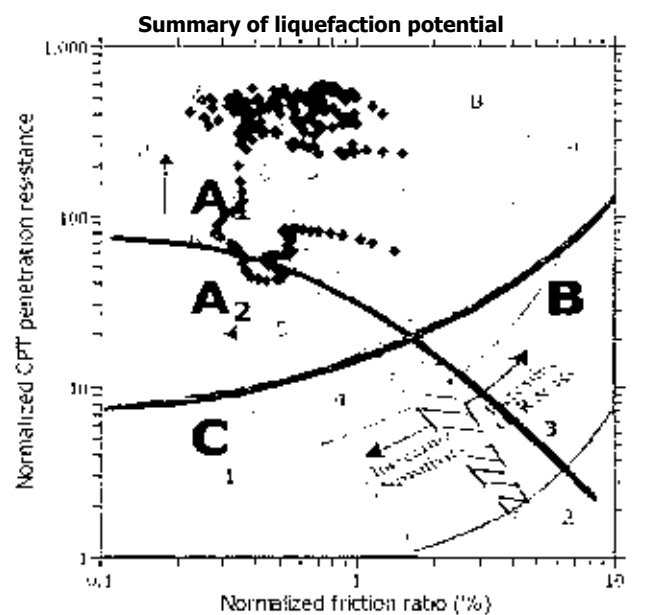
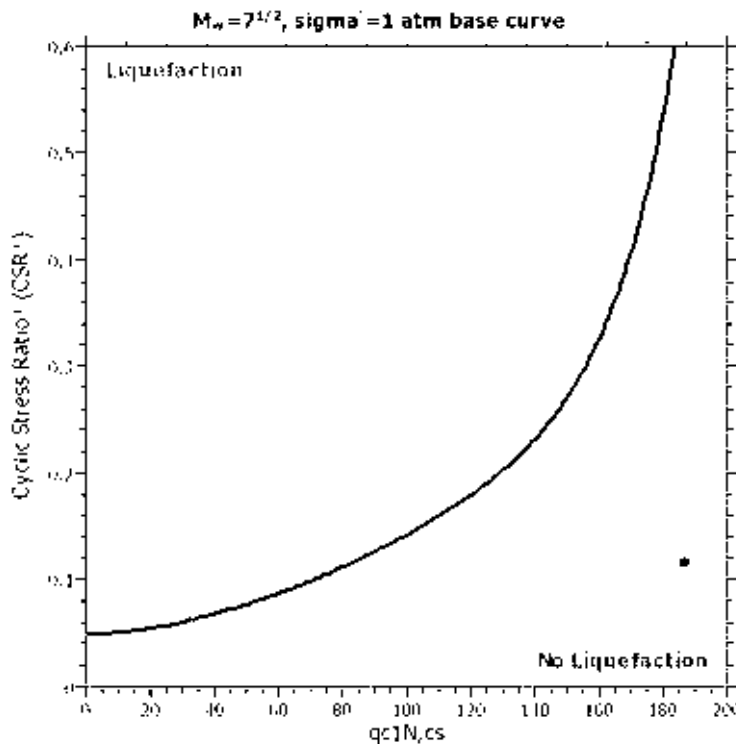
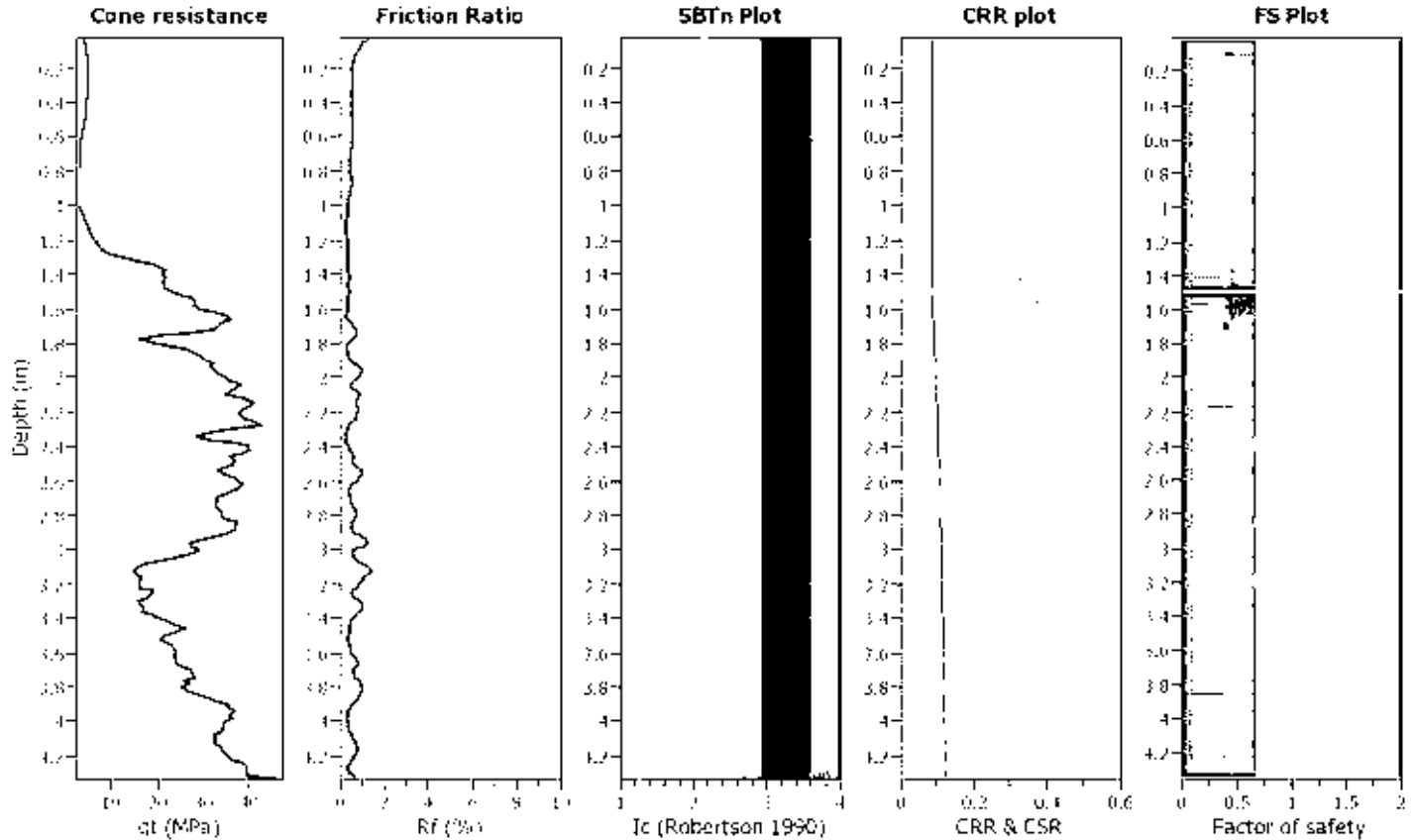
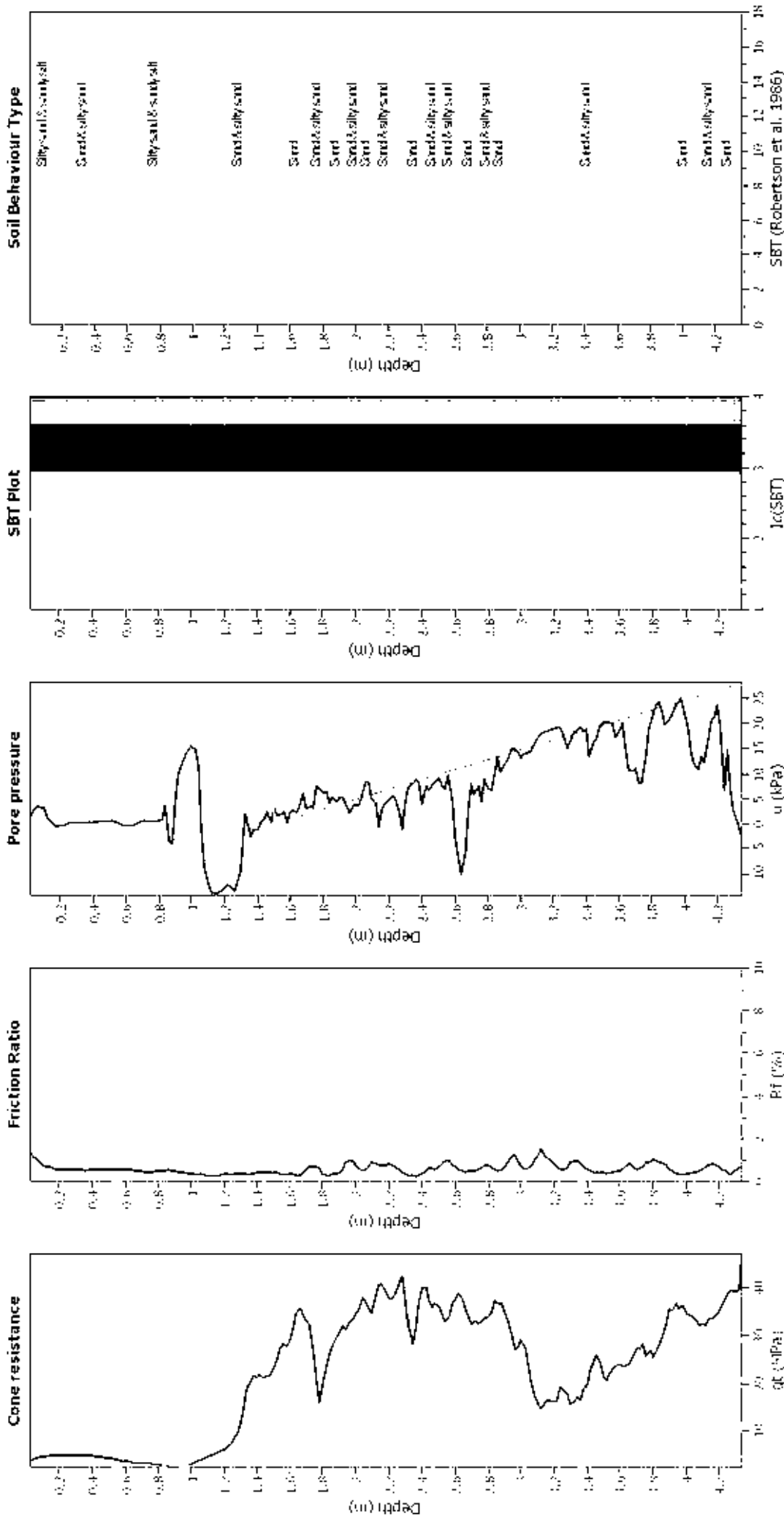


Figure 4: Summary of liquefaction potential plot and data points for test CPT24\_119. The plot shows normalized CPT penetration resistance versus normalized friction ratio. The plot is divided into regions A, A2, B, and C. Region A is the area above the A1 curve and below the A2 curve. Region A2 is the area between the A1 and A2 curves. Region B is the area above the B curve. Region C is the area below the C curve. The plot also shows the location of the test points relative to the curves.



### CPT basic interpretation plots



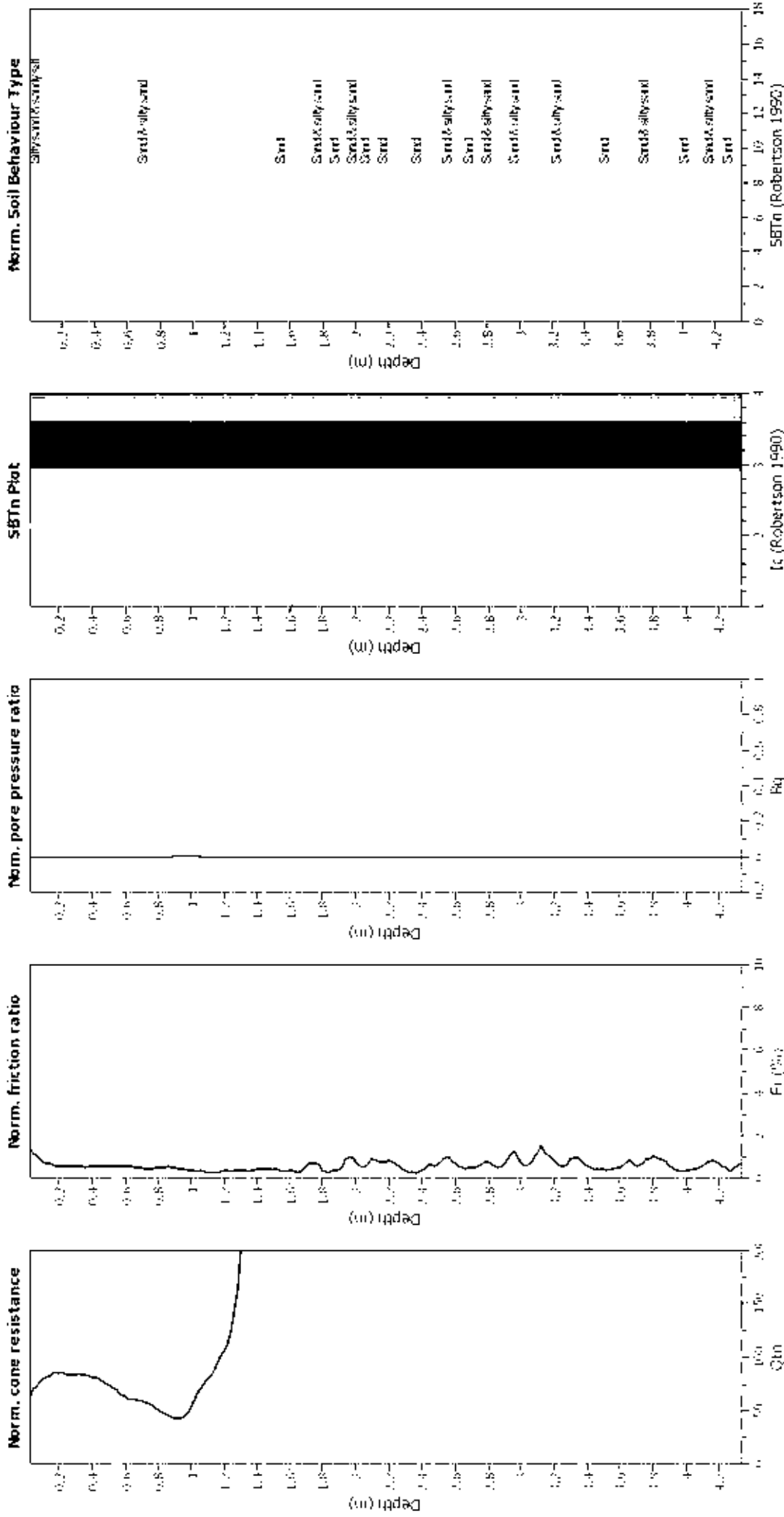
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Lamé depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A	Lamé depth:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



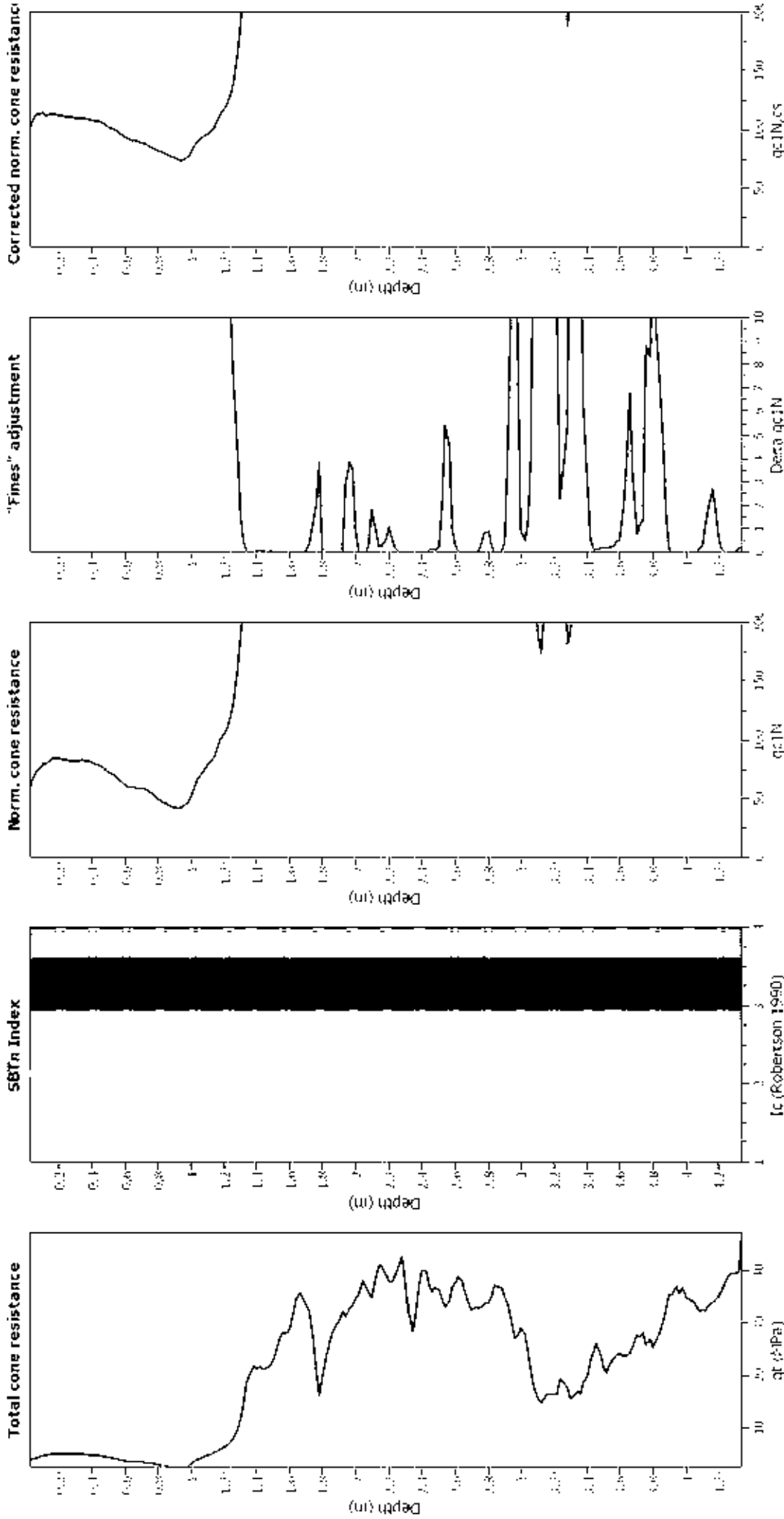
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

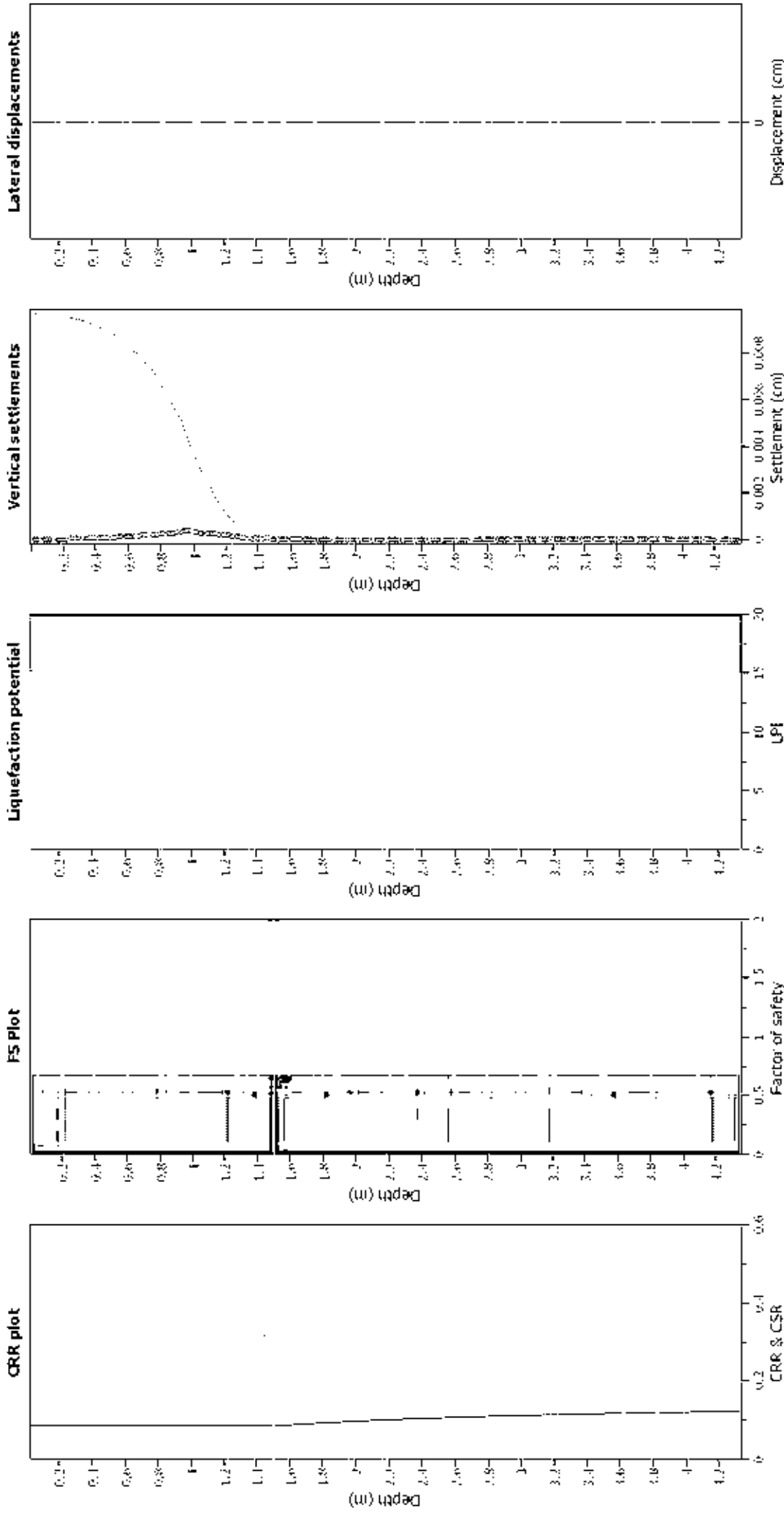
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lam. depth applied:	No
Depth to water table (m):	1.50 m	Lam. depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Degree to water table (m): 1.50 m

Depth to GW (erthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

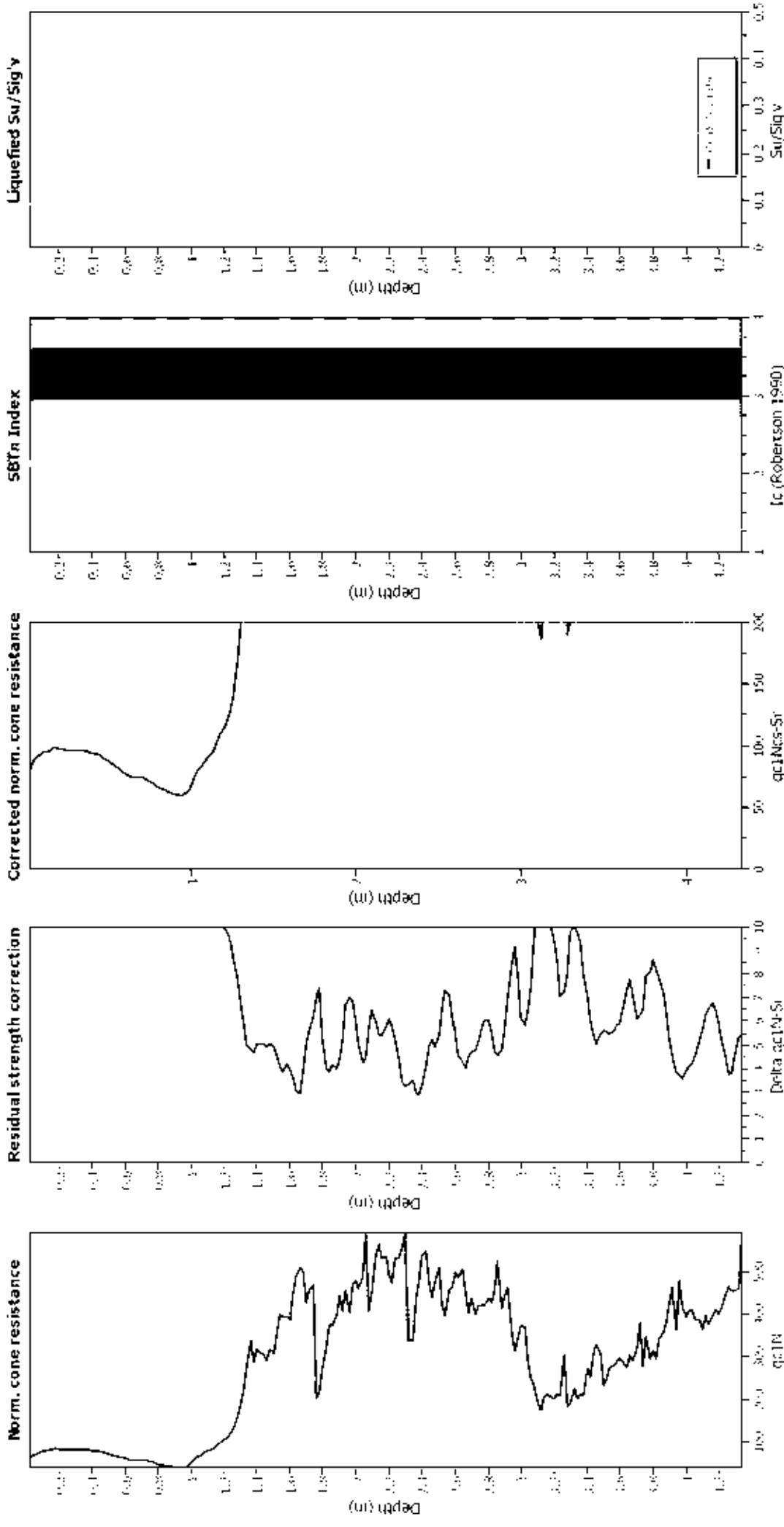
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

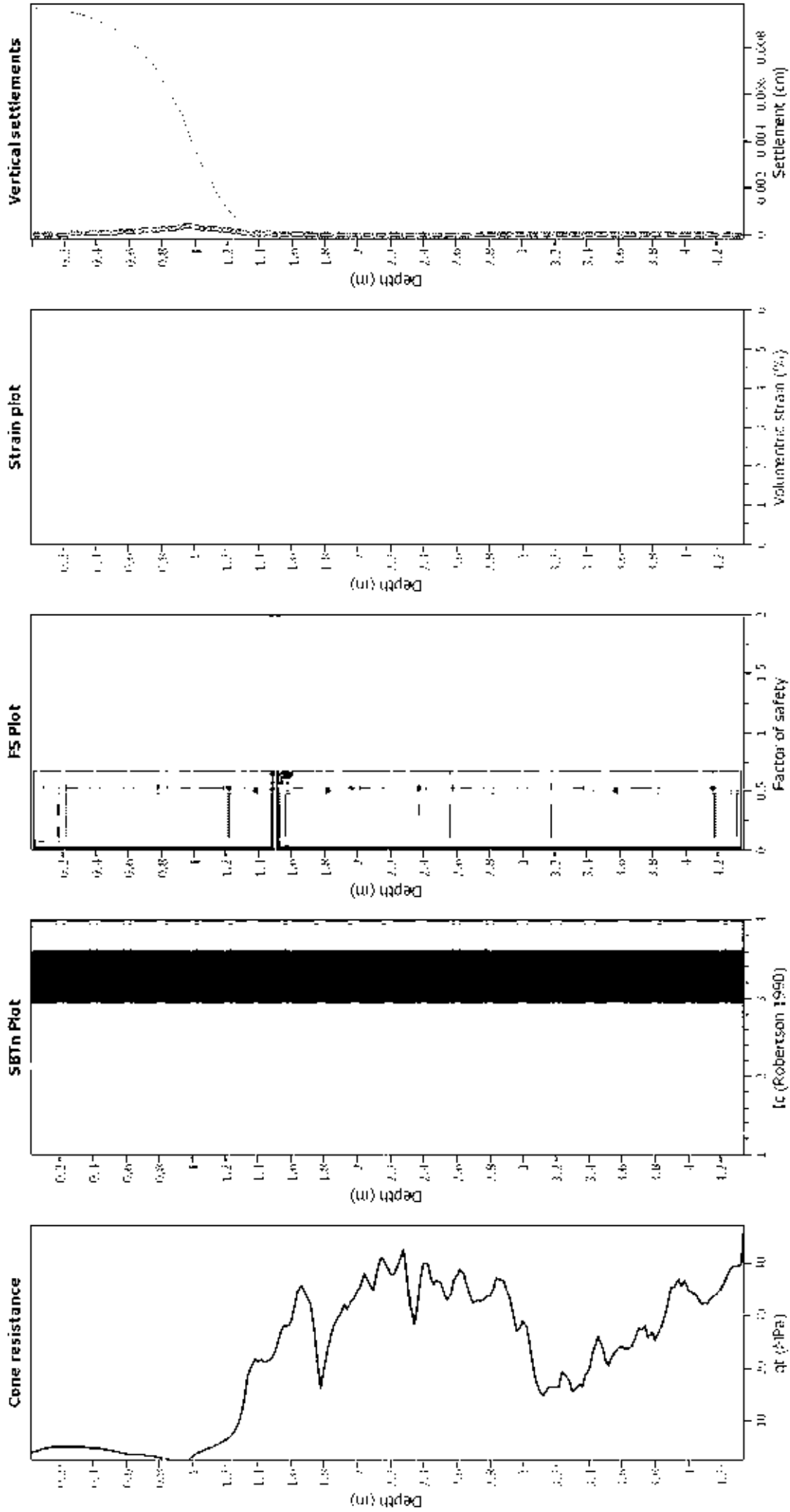
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT25\_25KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

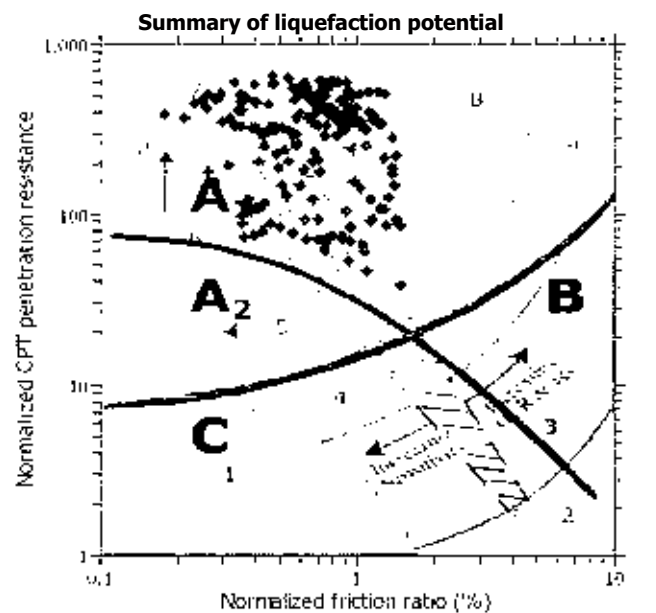
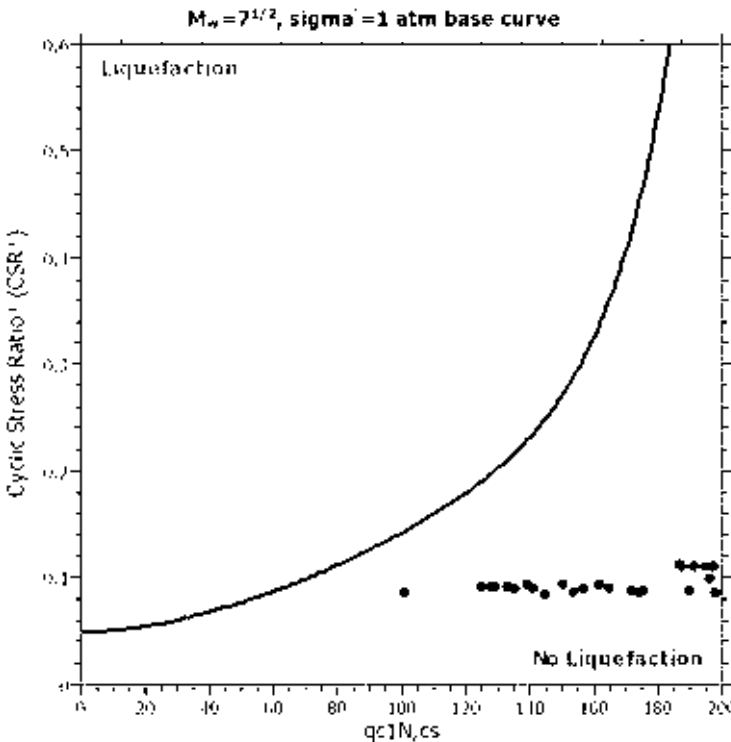
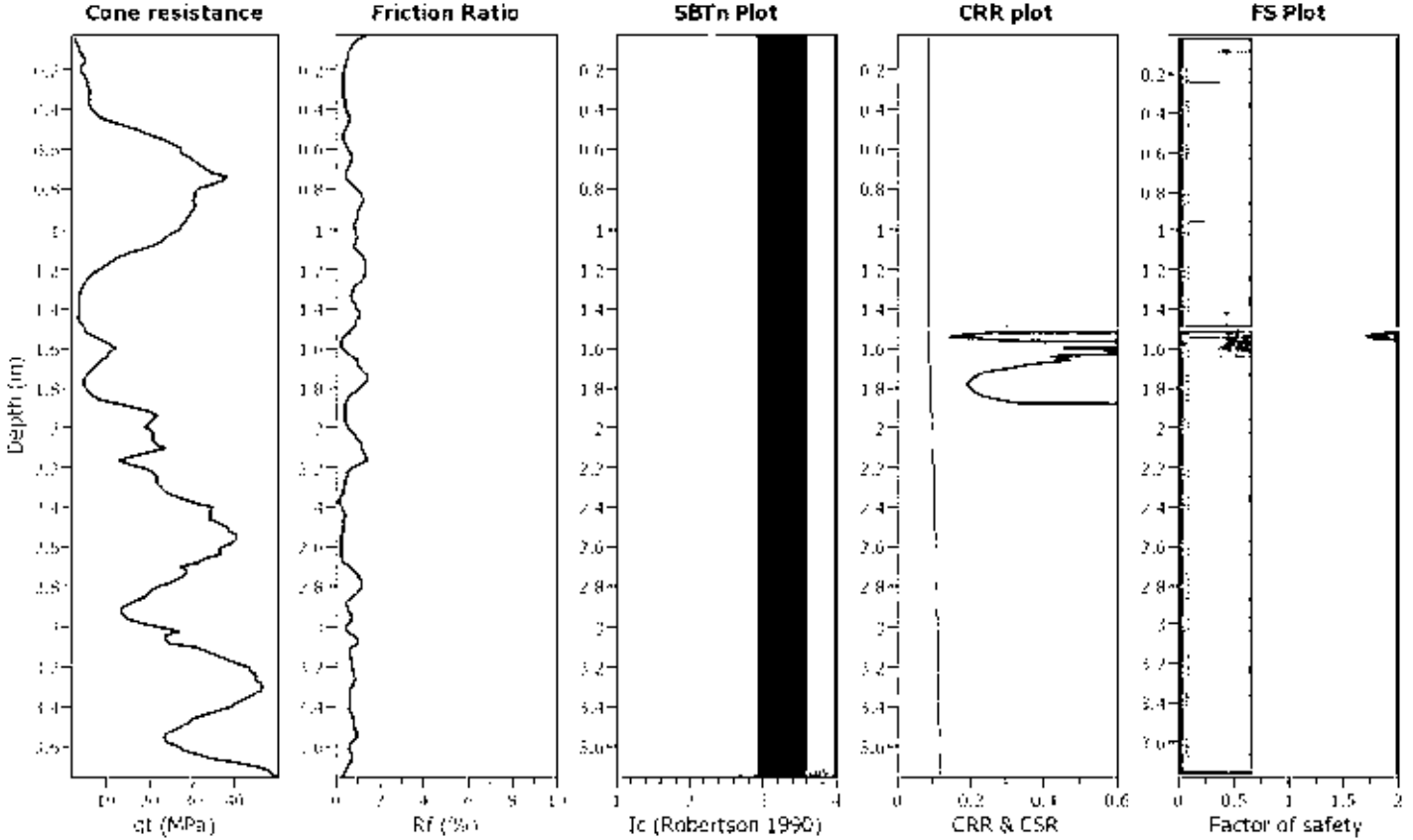
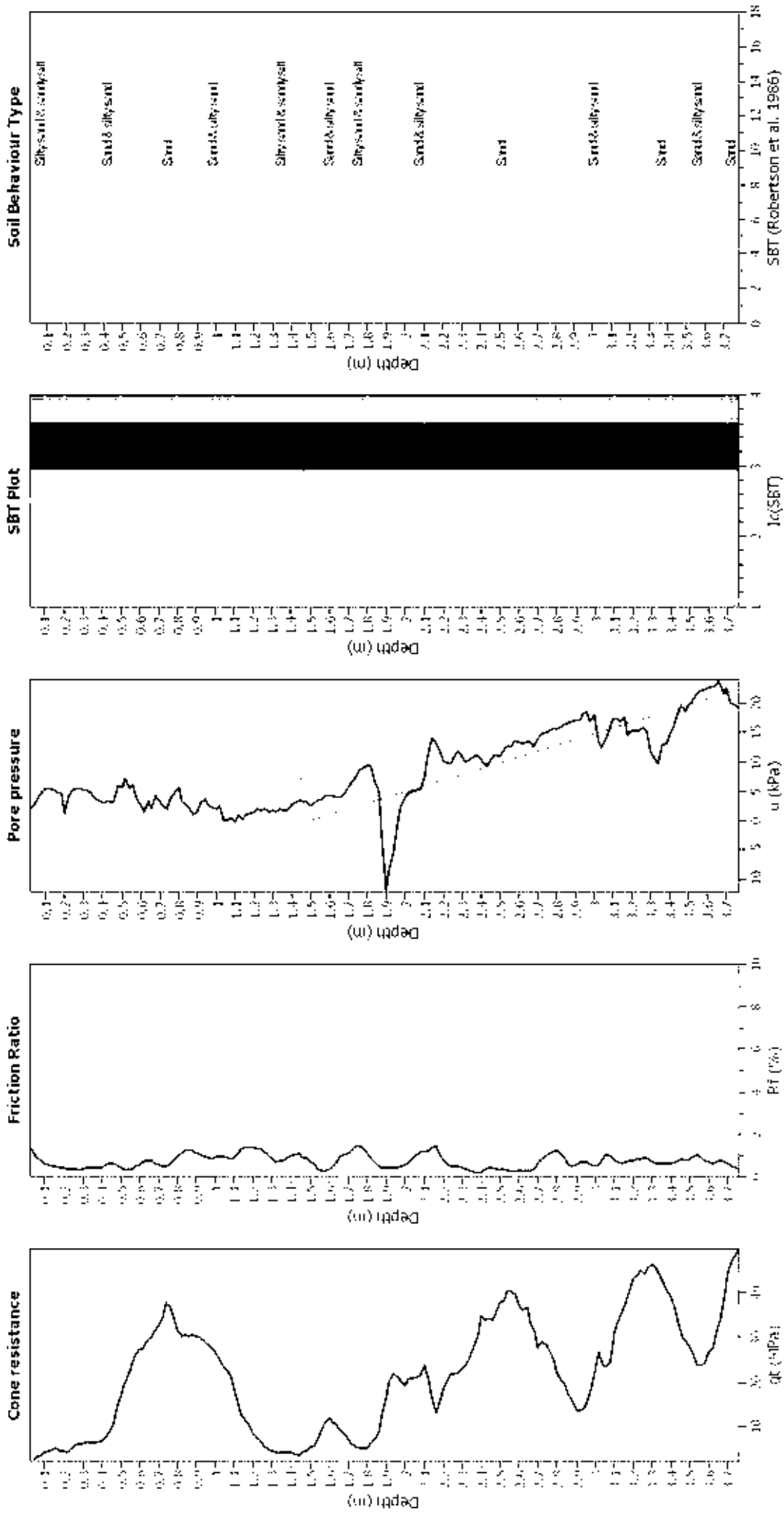


Figure 4: Summary of liquefaction potential based on cone and friction ratio data. Zone A: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Non-liquefiable; Zone C: Fully non-liquefiable. The boundary between zones A and A2 is based on the relationship between normalized CPT penetration resistance and normalized friction ratio. The boundary between zones A2 and B is based on the relationship between normalized CPT penetration resistance and normalized friction ratio. The boundary between zones B and C is based on the relationship between normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots

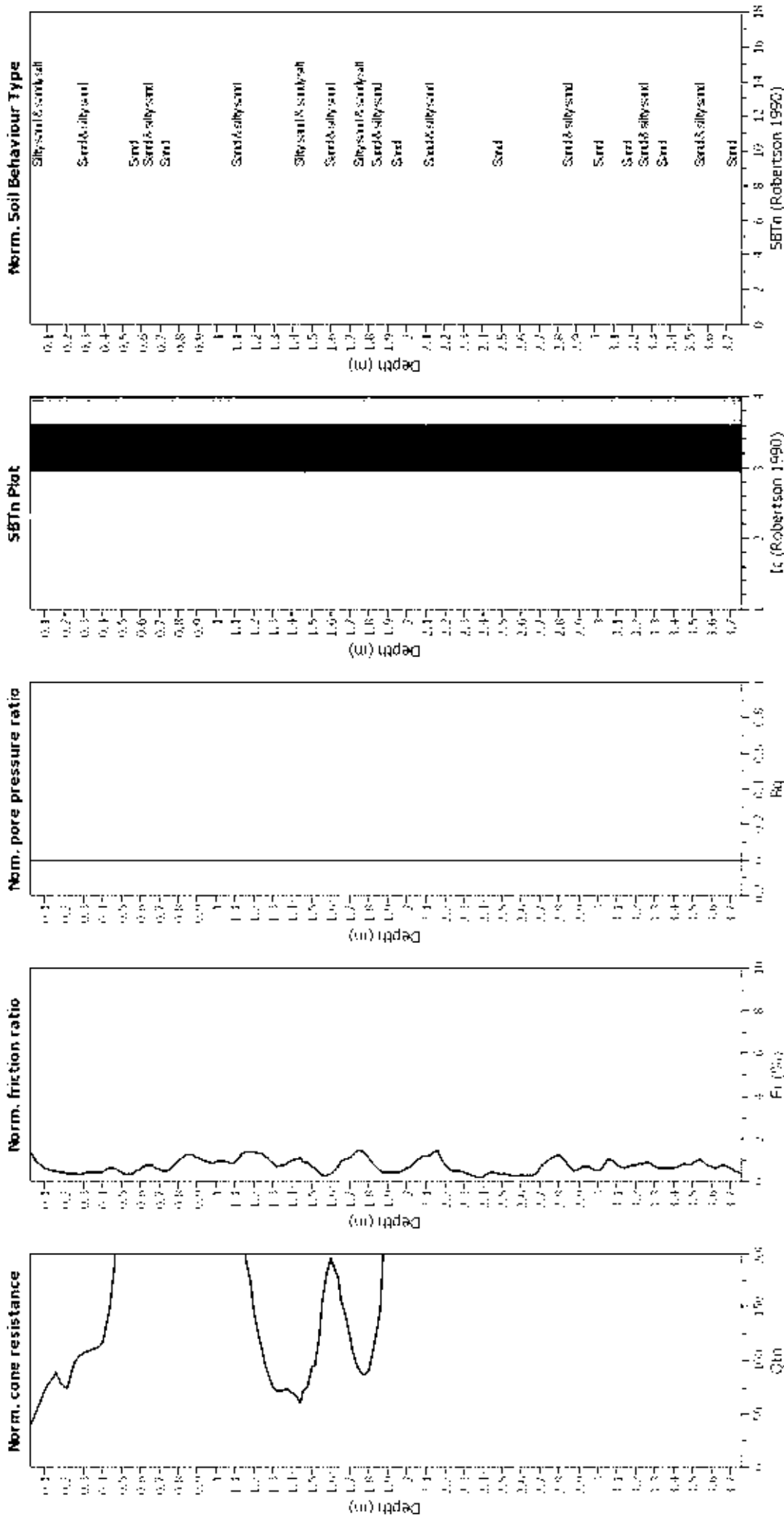


#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A	SBT legend	<input type="checkbox"/> 1. Sensitive fine grained	<input type="checkbox"/> 4. Clayey silt to silty	<input type="checkbox"/> 7. Gravely sand to sand
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay	<input type="checkbox"/> 2. Organic material	<input type="checkbox"/> 5. Silty sand to sandy silt	<input type="checkbox"/> 8. Very stiff sand to	
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes	<input type="checkbox"/> 3. Clay to silty clay	<input type="checkbox"/> 6. Clean sand to silty sand	<input type="checkbox"/> 9. Very stiff fine grained	
Earthquake magnitude M <sub>w</sub> :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No				
Peak ground acceleration:	0.13	Use fill:	No	Lamé depth applied:	No				
Depth to water table (m):	1.50 m	Fill height:	N/A	Lamé depth:	N/A				



### CPT basic interpretation plots (normalized)



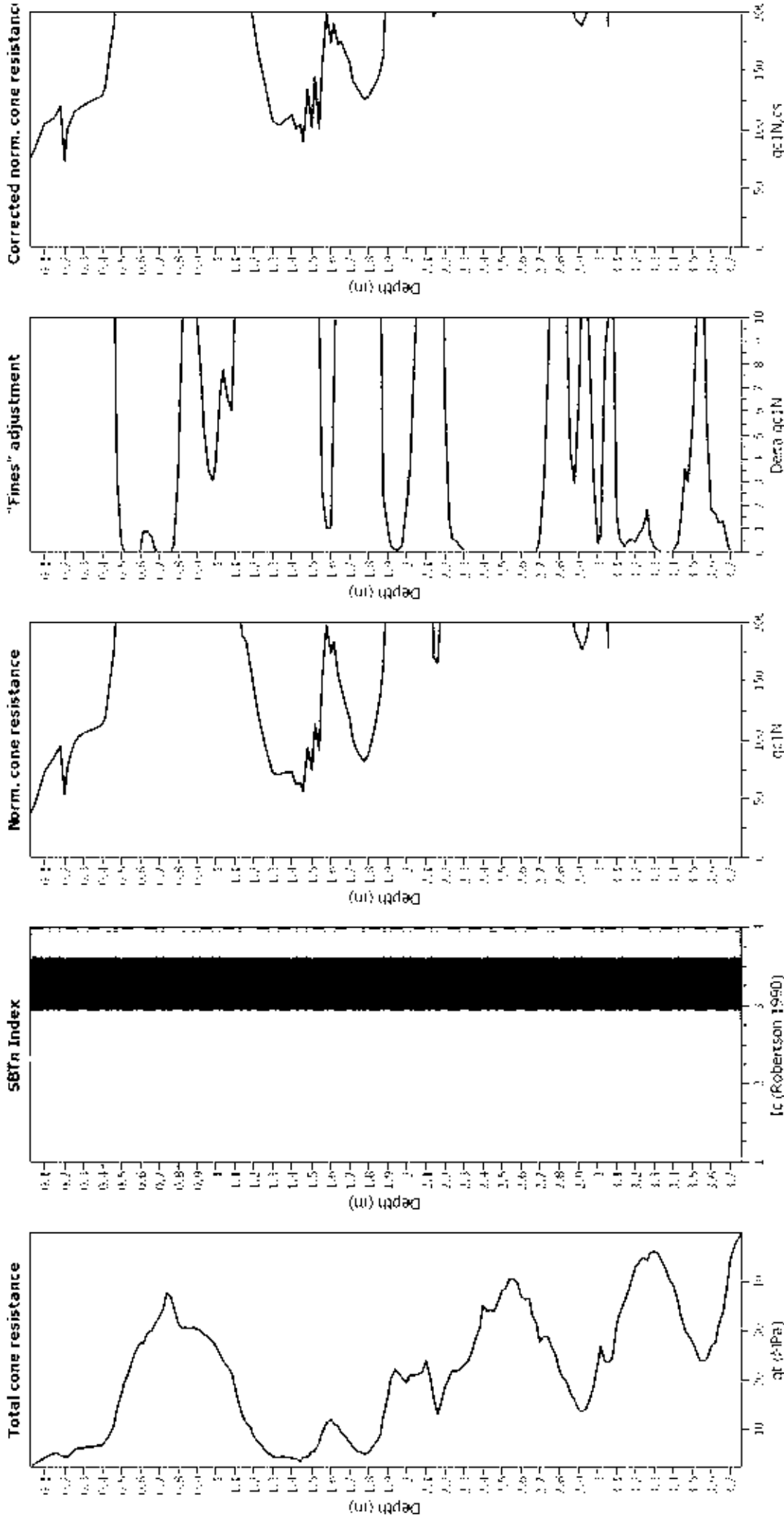
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

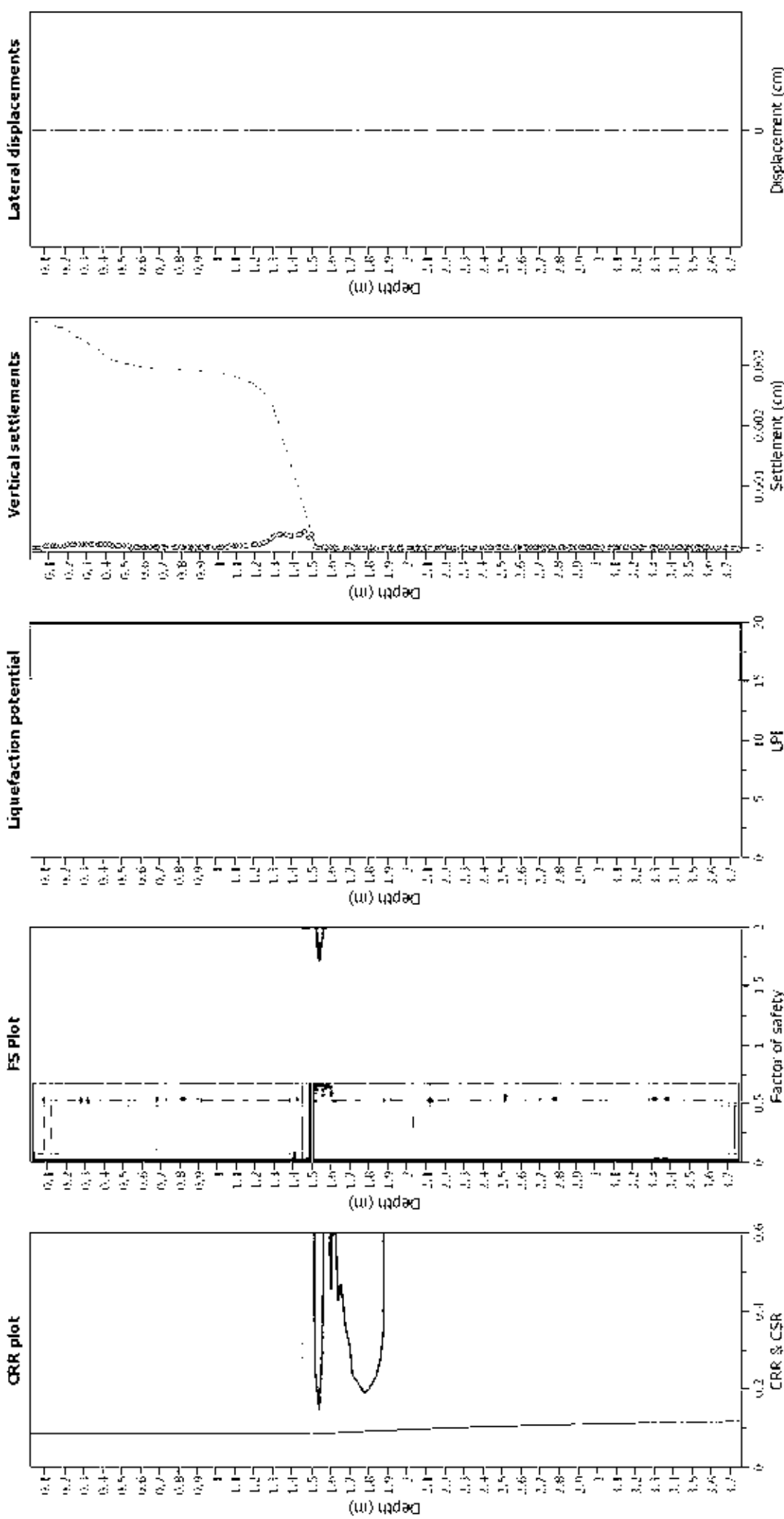
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Fines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

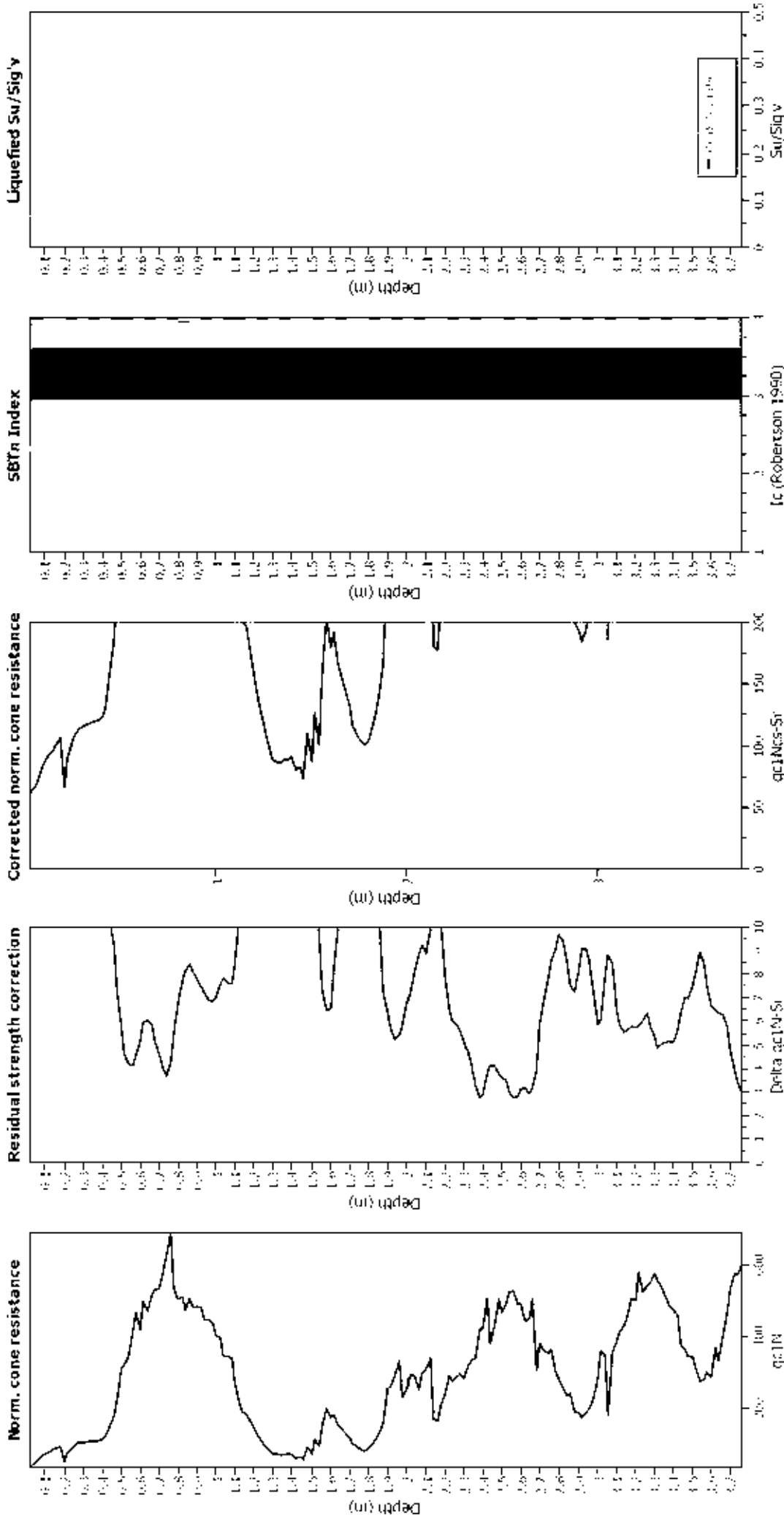
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

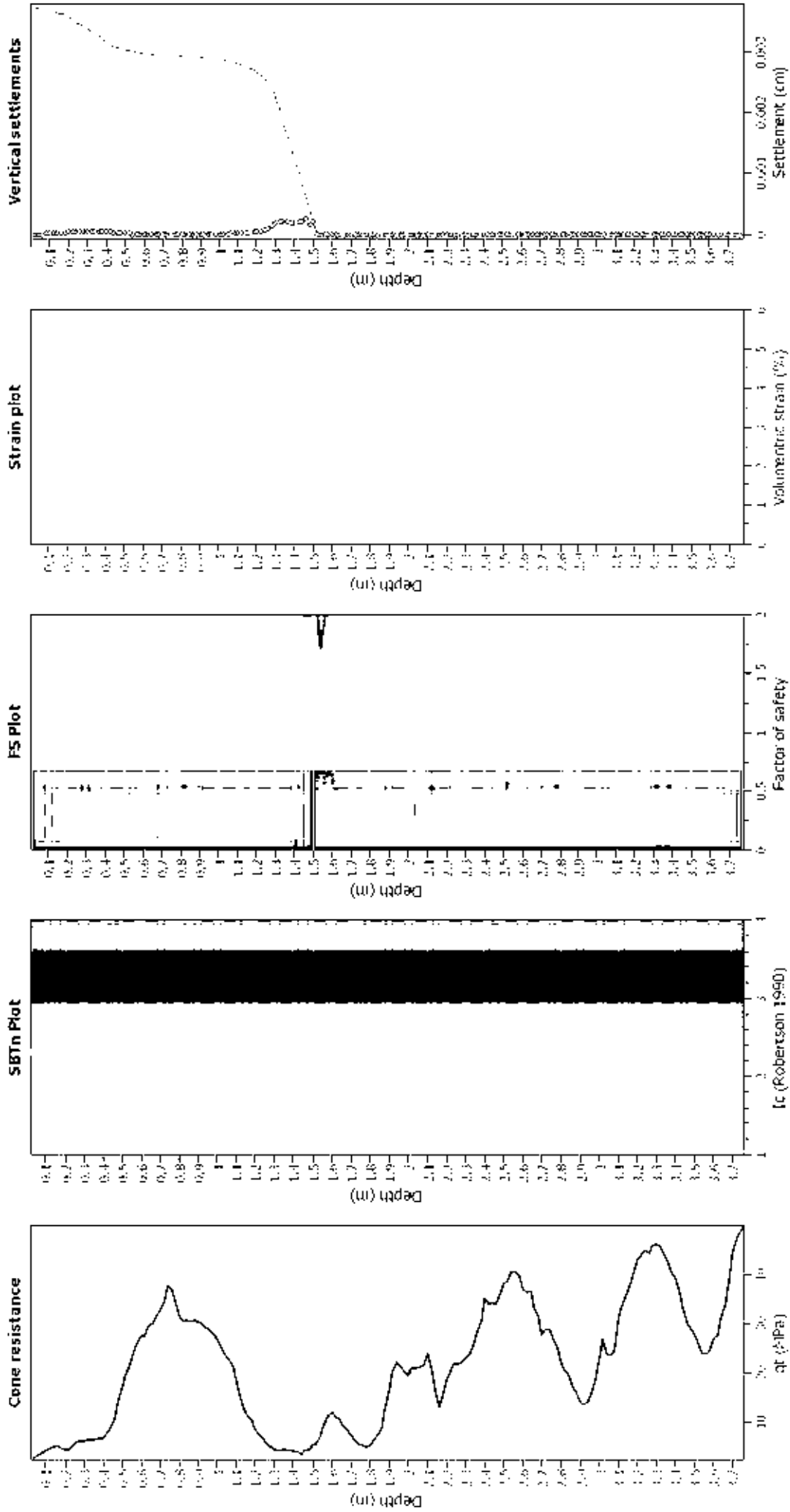
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT26\_95SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

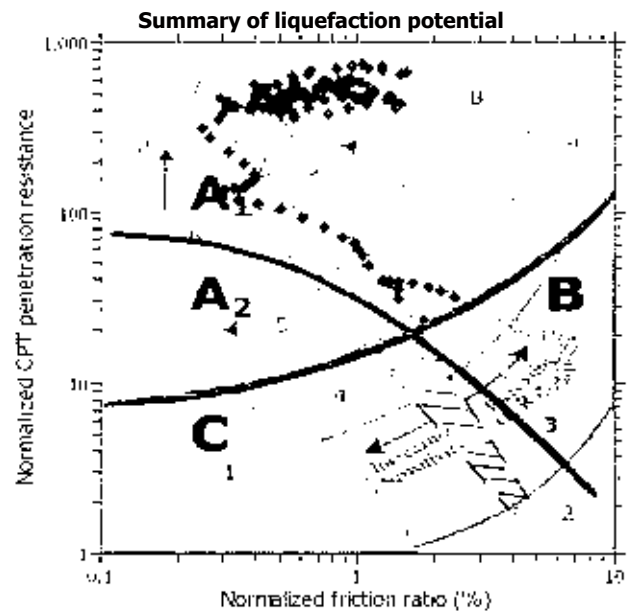
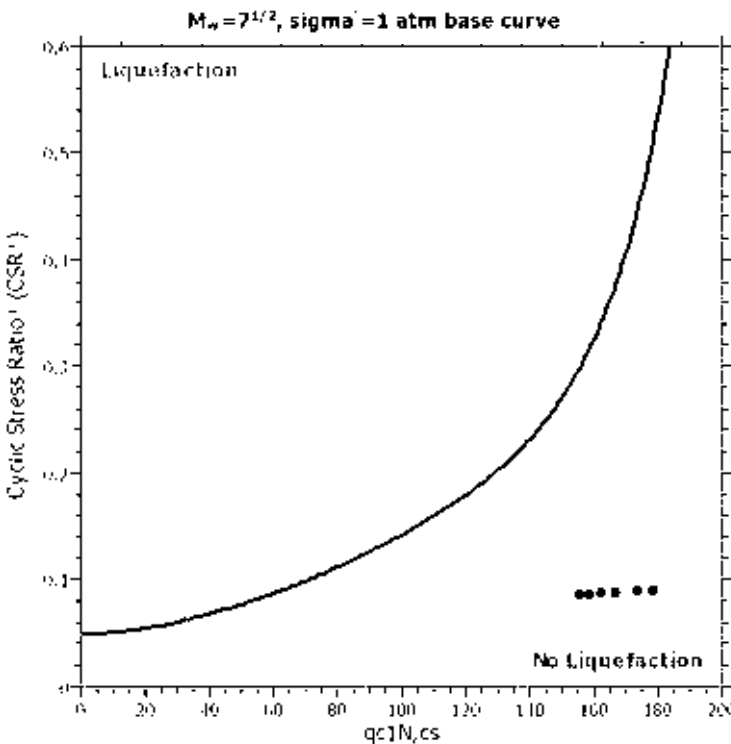
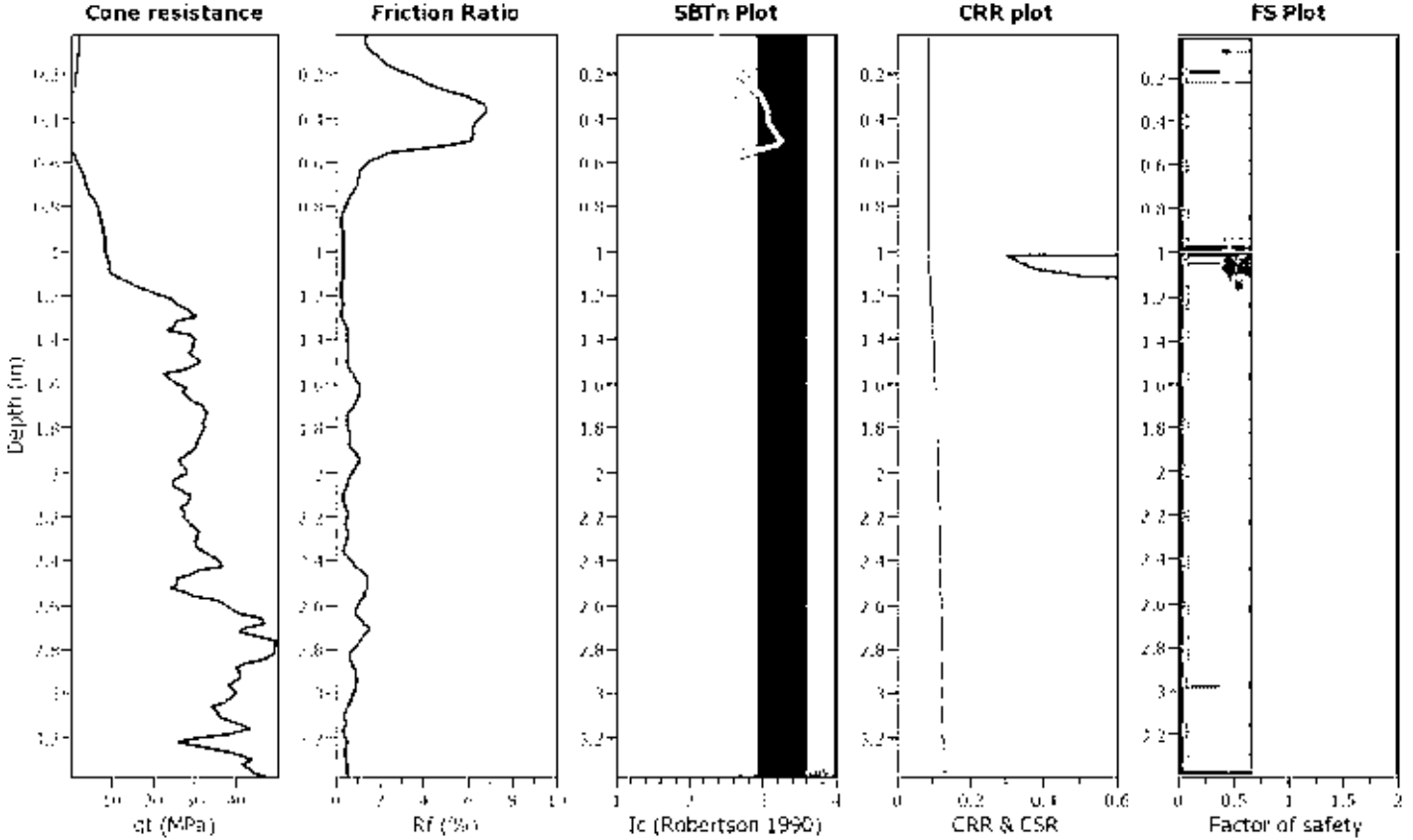
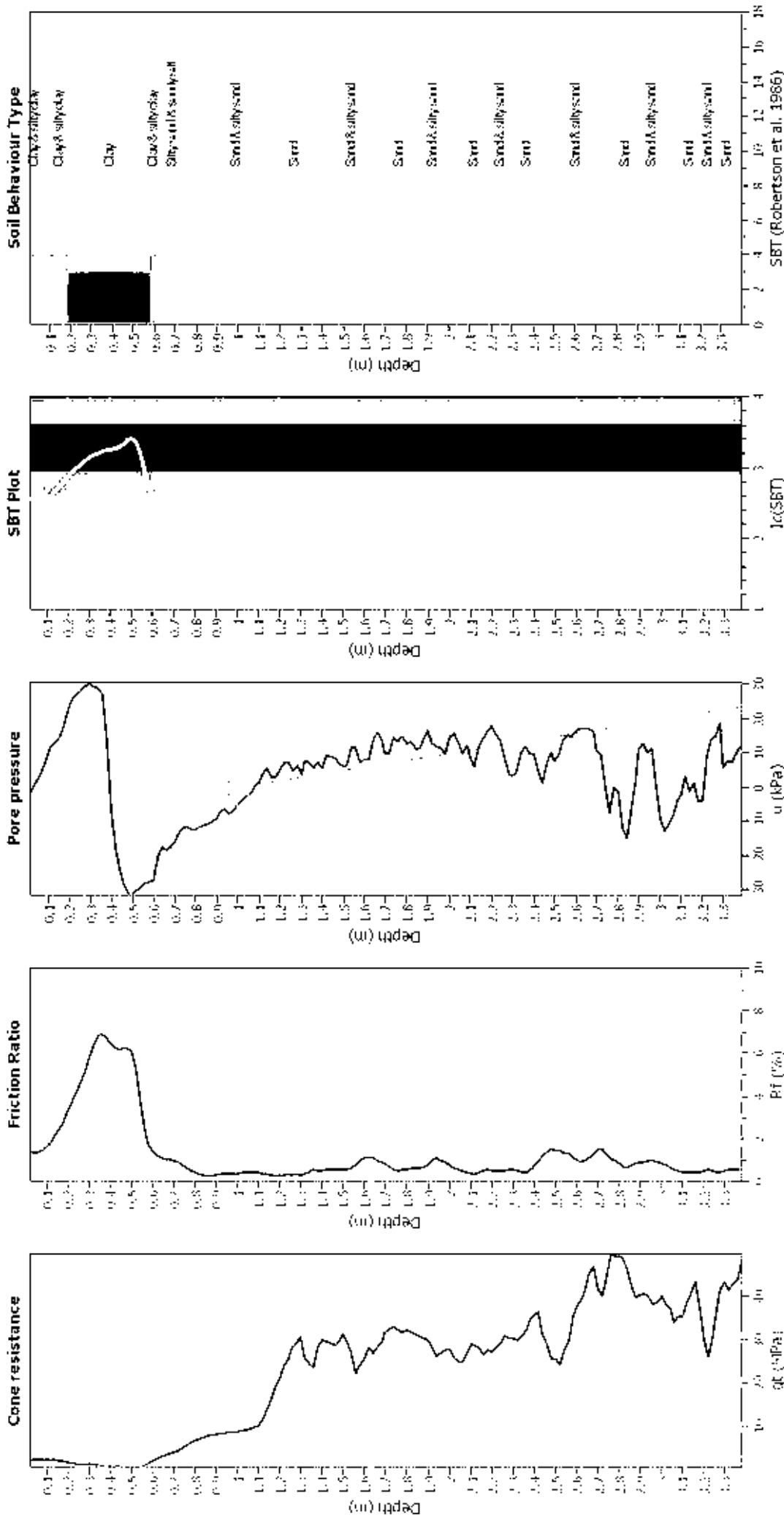


Figure 4 - Summary of liquefaction potential based on penetration resistance and normalized cyclic stress ratio. Zone A1 - Fully liquefiable (normalized friction ratio > 10% and normalized penetration resistance < 100). Zone A2 - Partially liquefiable (normalized friction ratio > 10% and normalized penetration resistance > 100). Zone B - Liquefaction potential (normalized friction ratio < 10% and normalized penetration resistance > 100). Zone C - No liquefaction (normalized friction ratio < 10% and normalized penetration resistance < 100). The chart is divided into zones A1, A2, B, and C. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio (%). The chart is divided into zones A1, A2, B, and C. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio (%).

### CPT basic interpretation plots



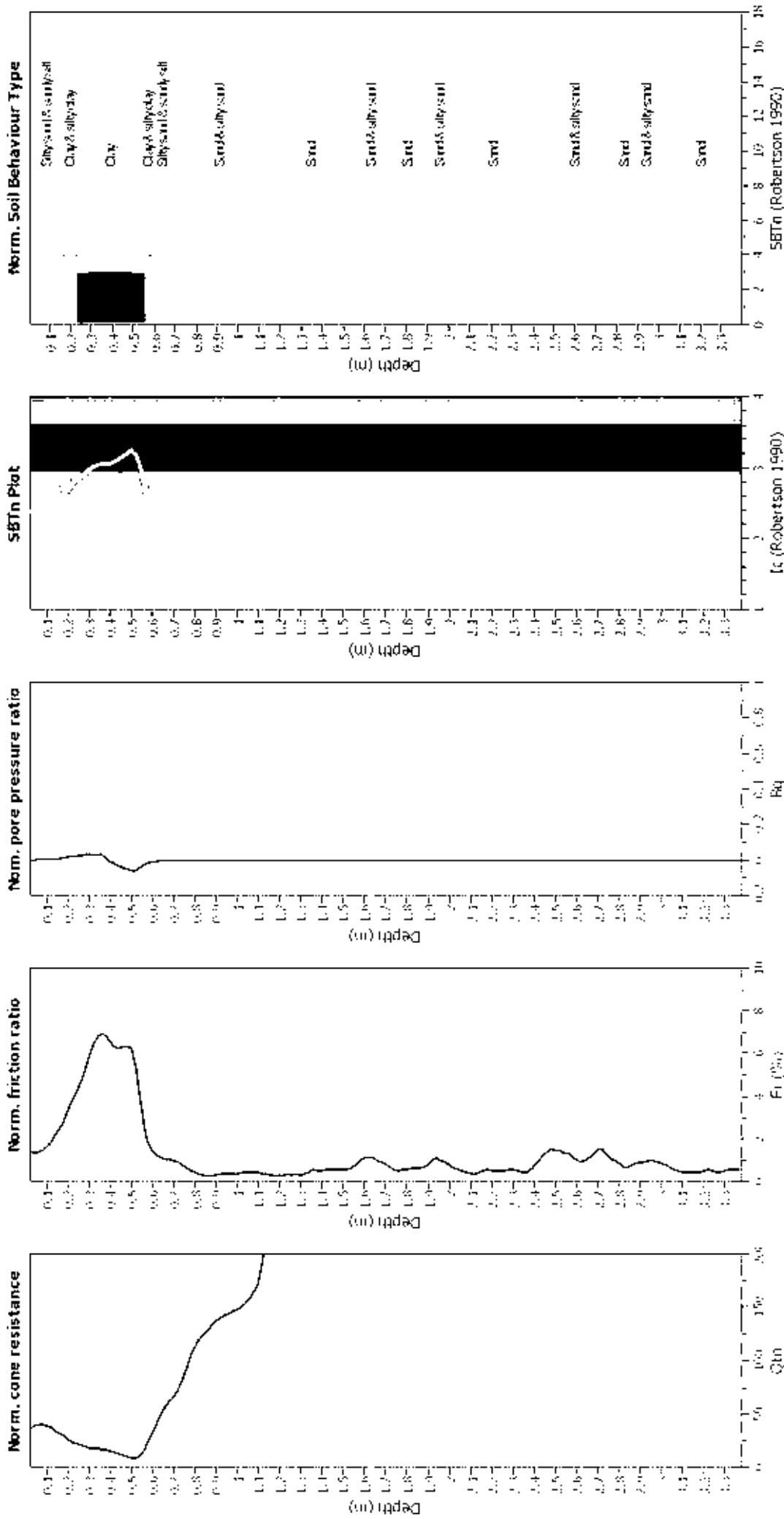
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.00 m	Fill weight:	N/A
Input correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Factorial magnitude $M_v$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

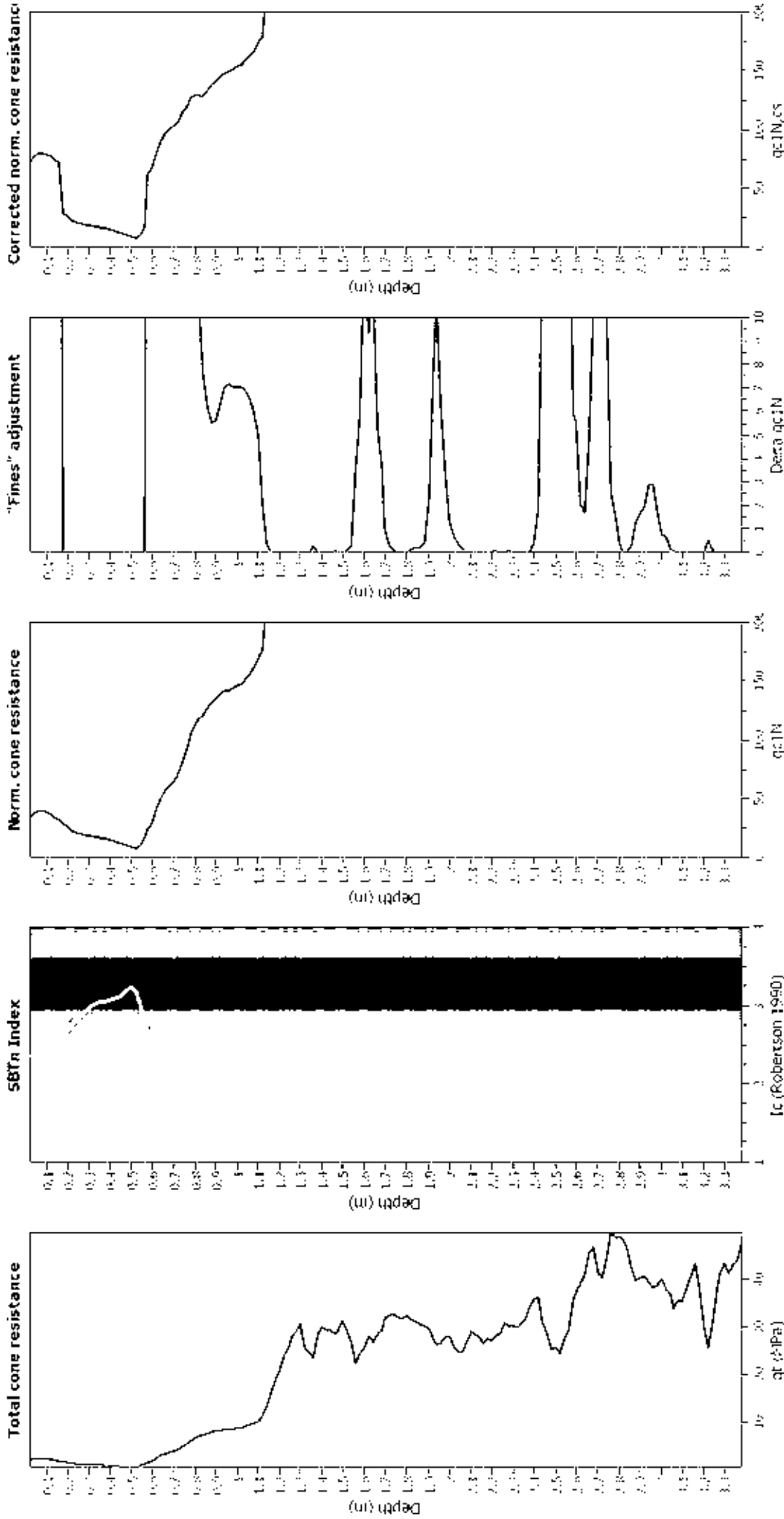
Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit weight:	N/A
		Fill height:	N/A
		Depth to GWL (ortho.):	1.00 m
		Average results interval:	3
		Ic cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



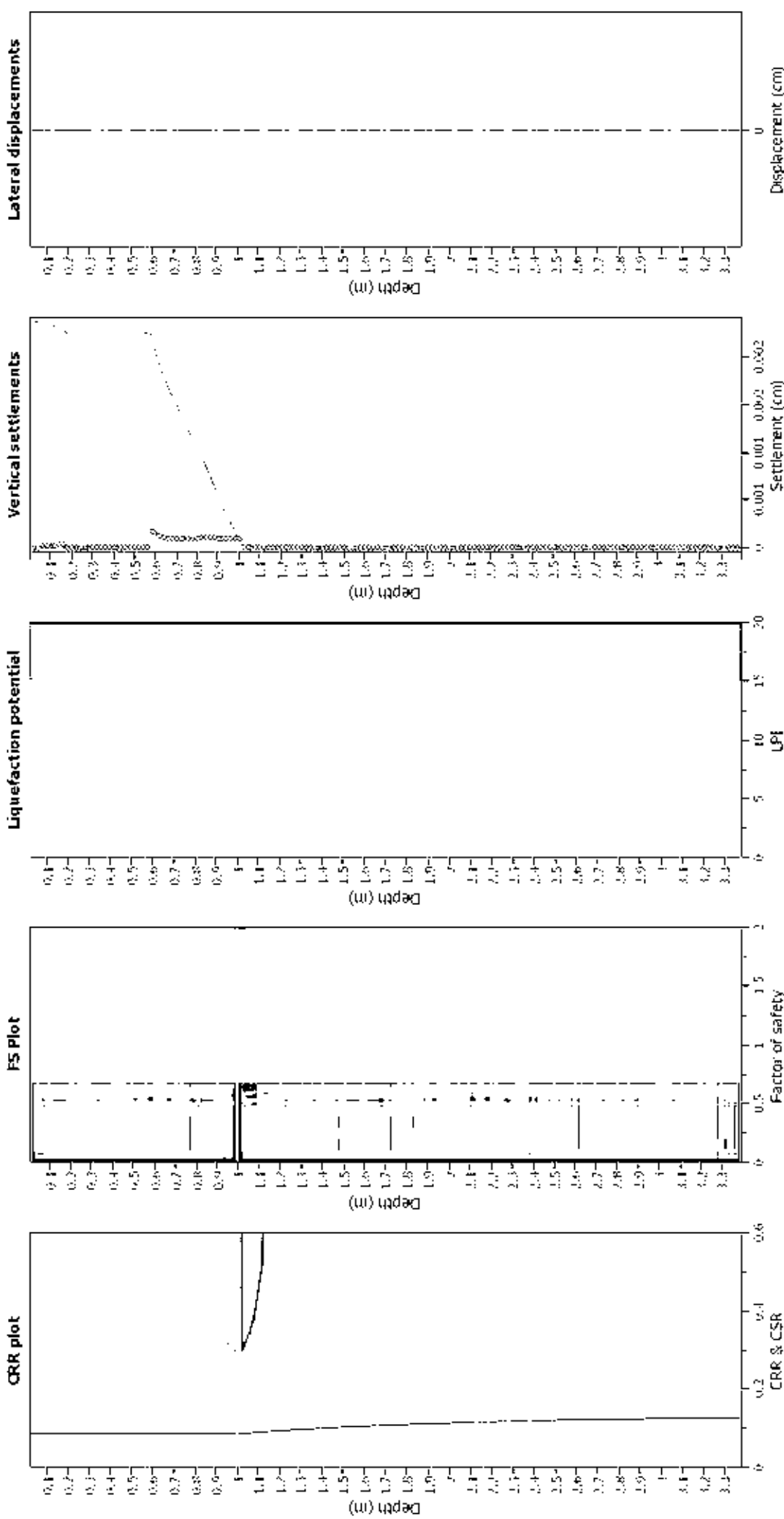
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Factorial mag. angle $M_s$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lam. depth applied:	No
Depth to water table ( $z_{w,eq}$ ):	1.00 m	Lam. depth:	N/A
Depth to GW (erthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Input correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

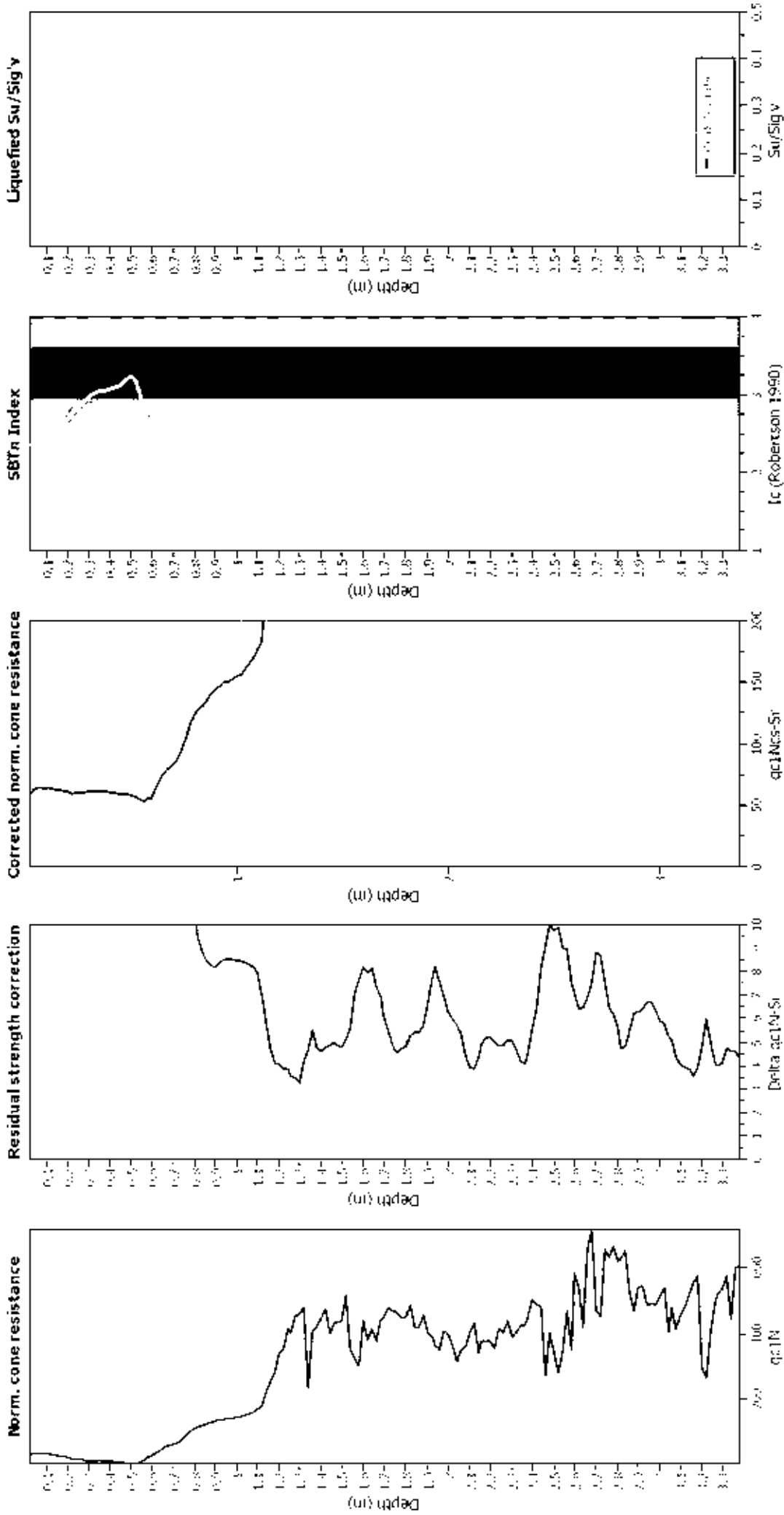
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

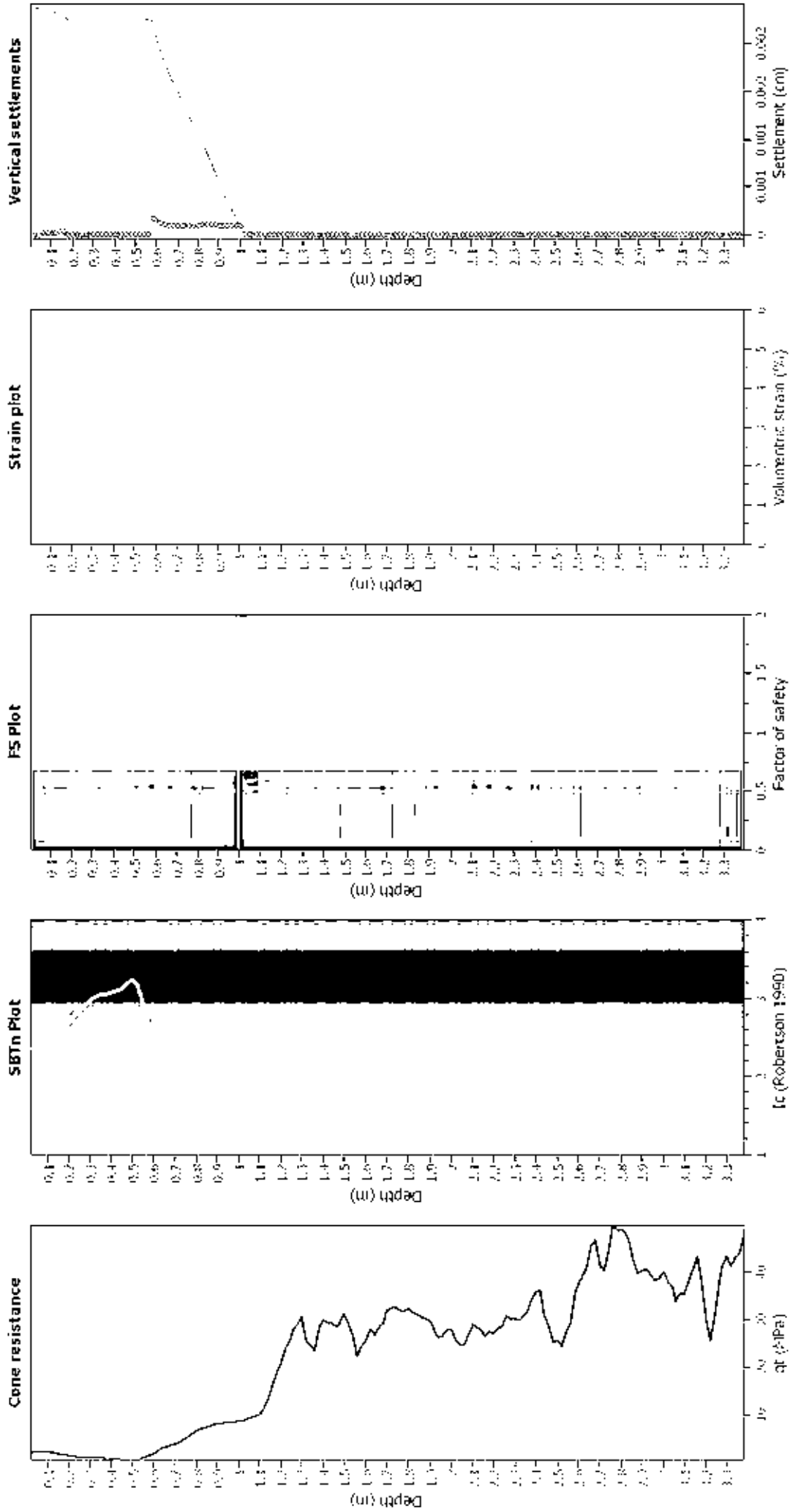
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Input correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT27\_47KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

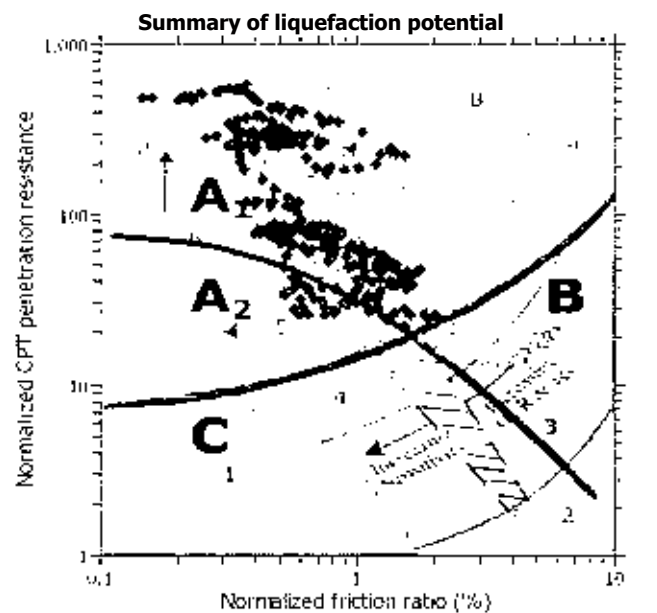
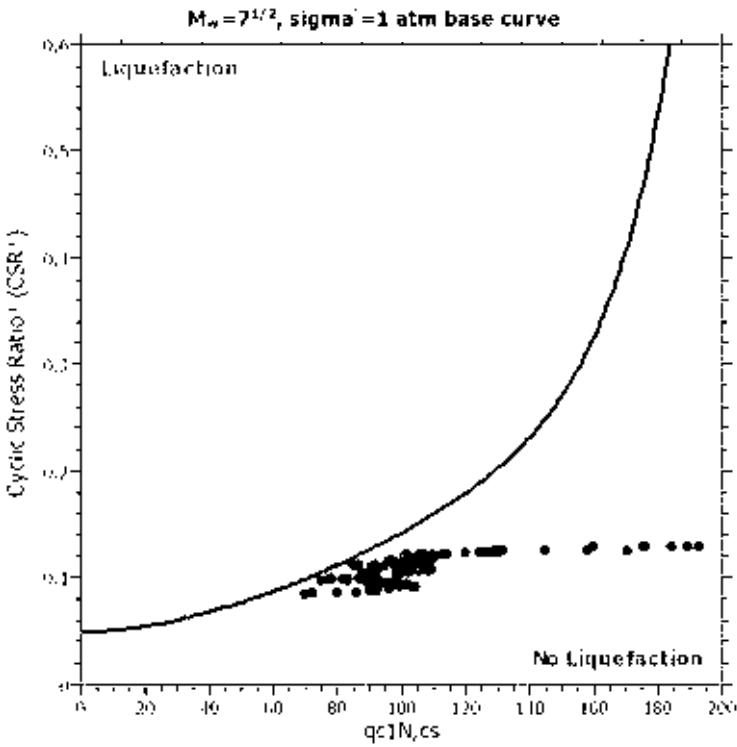
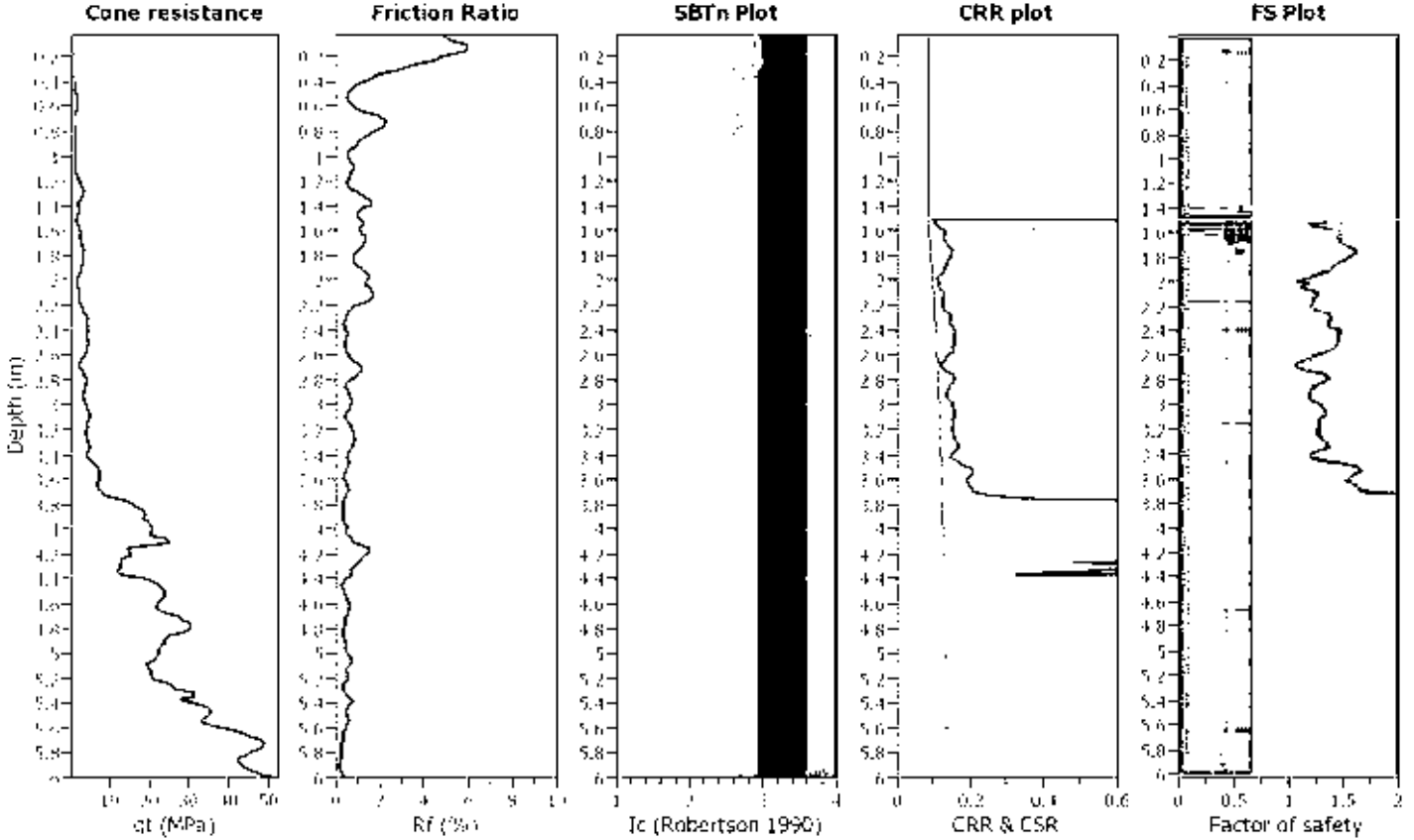
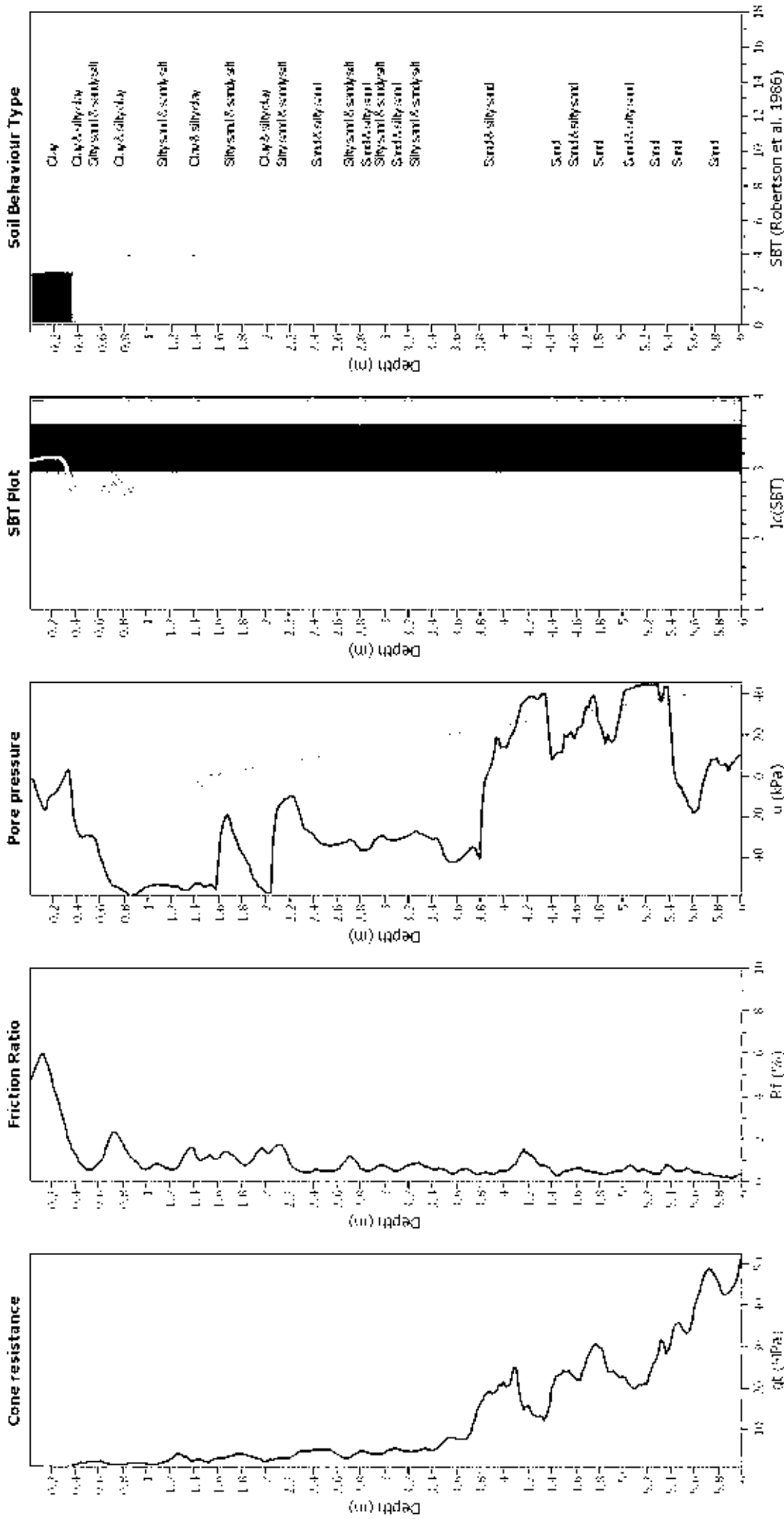


Figure 4: Summary of liquefaction potential plot and data for the test. Zone A1: Normalized CPT penetration resistance less than 100 and normalized friction ratio less than 1. Zone A2: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 1 and 2. Zone B: Normalized CPT penetration resistance between 100 and 1000 and normalized friction ratio between 2 and 10. Zone C: Normalized CPT penetration resistance between 100 and 1000 and normalized friction ratio greater than 10. The liquefaction boundary is shown as a dashed line.

### CPT basic interpretation plots



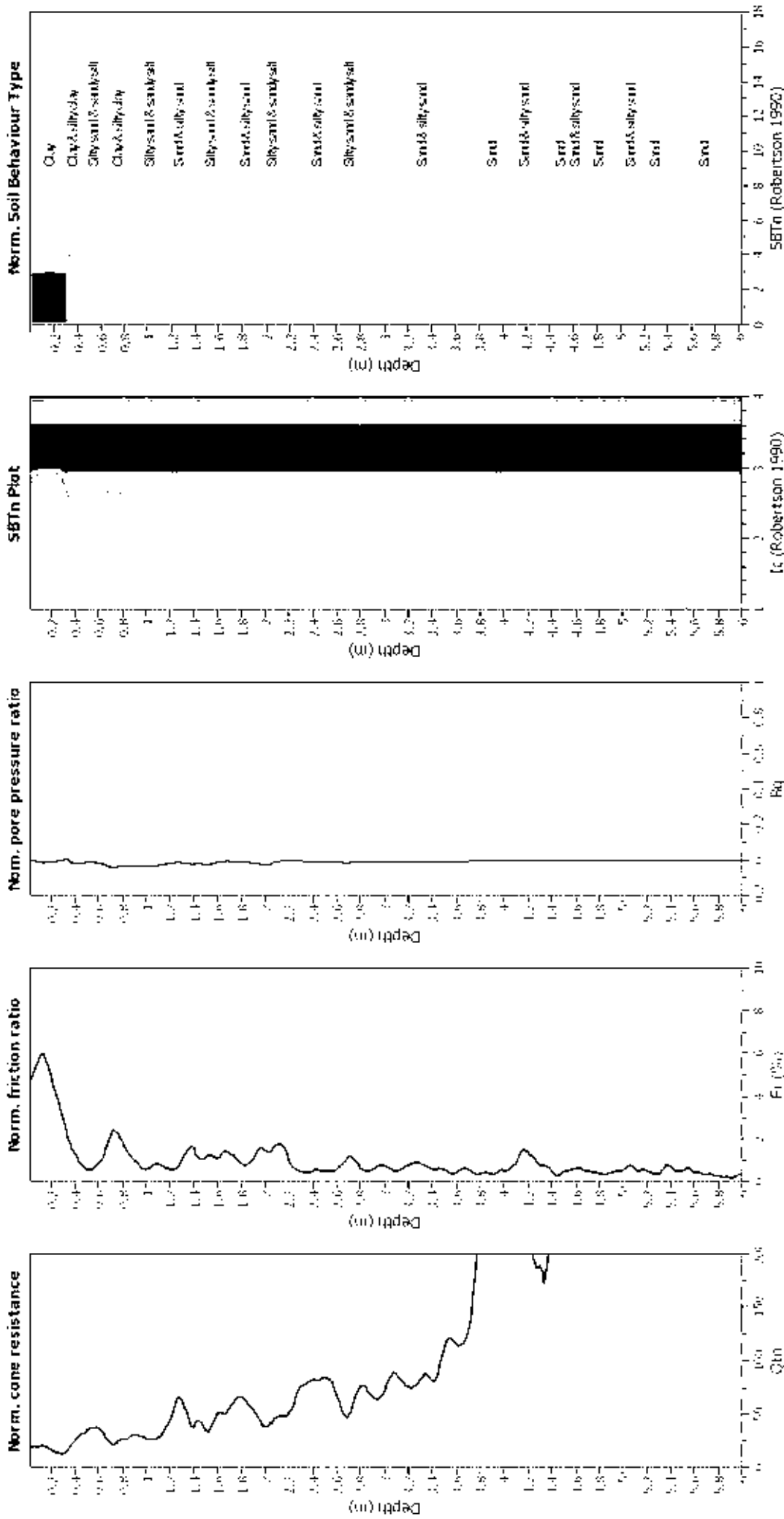
### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



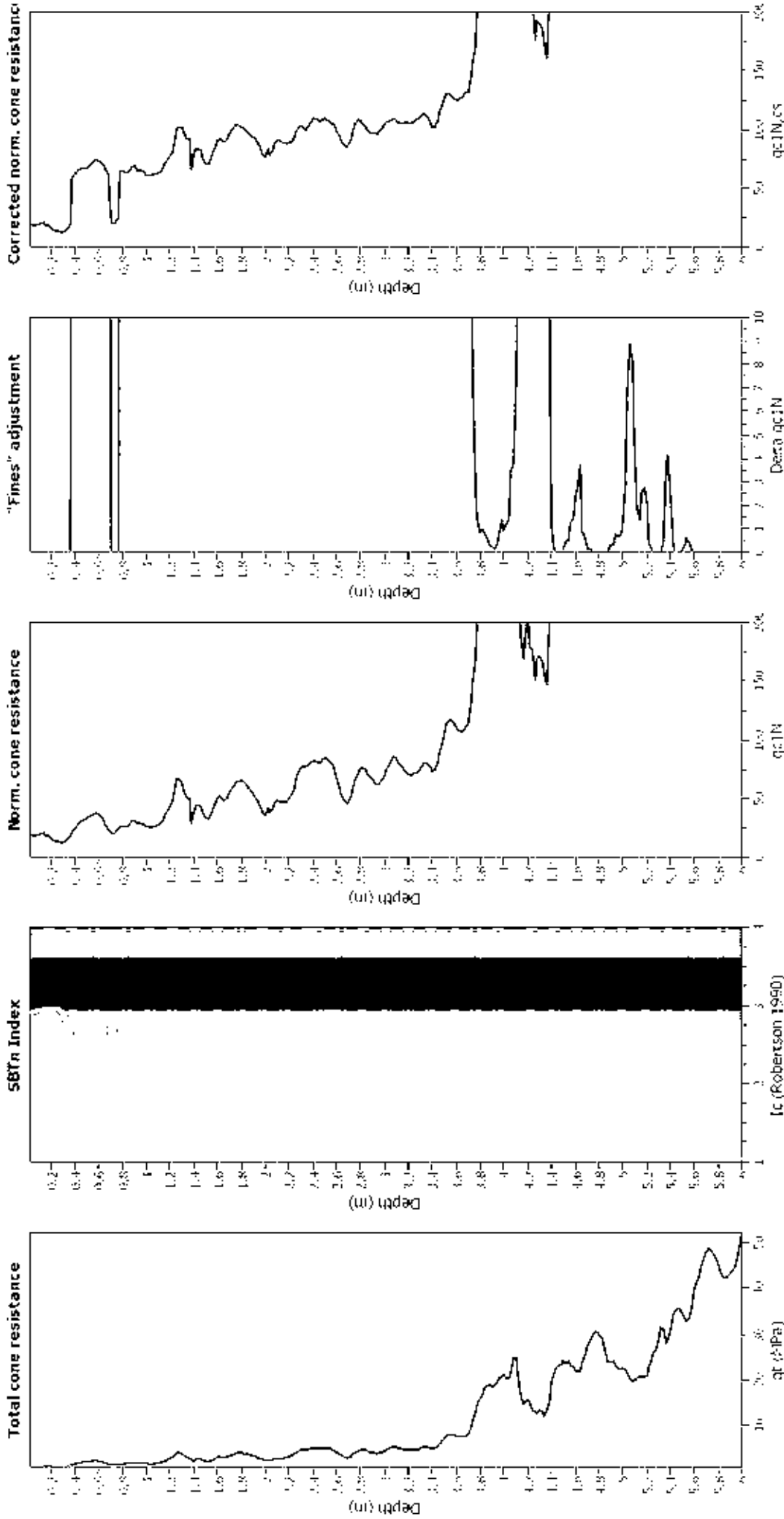
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### Liquefaction analysis overall plots (intermediate results)

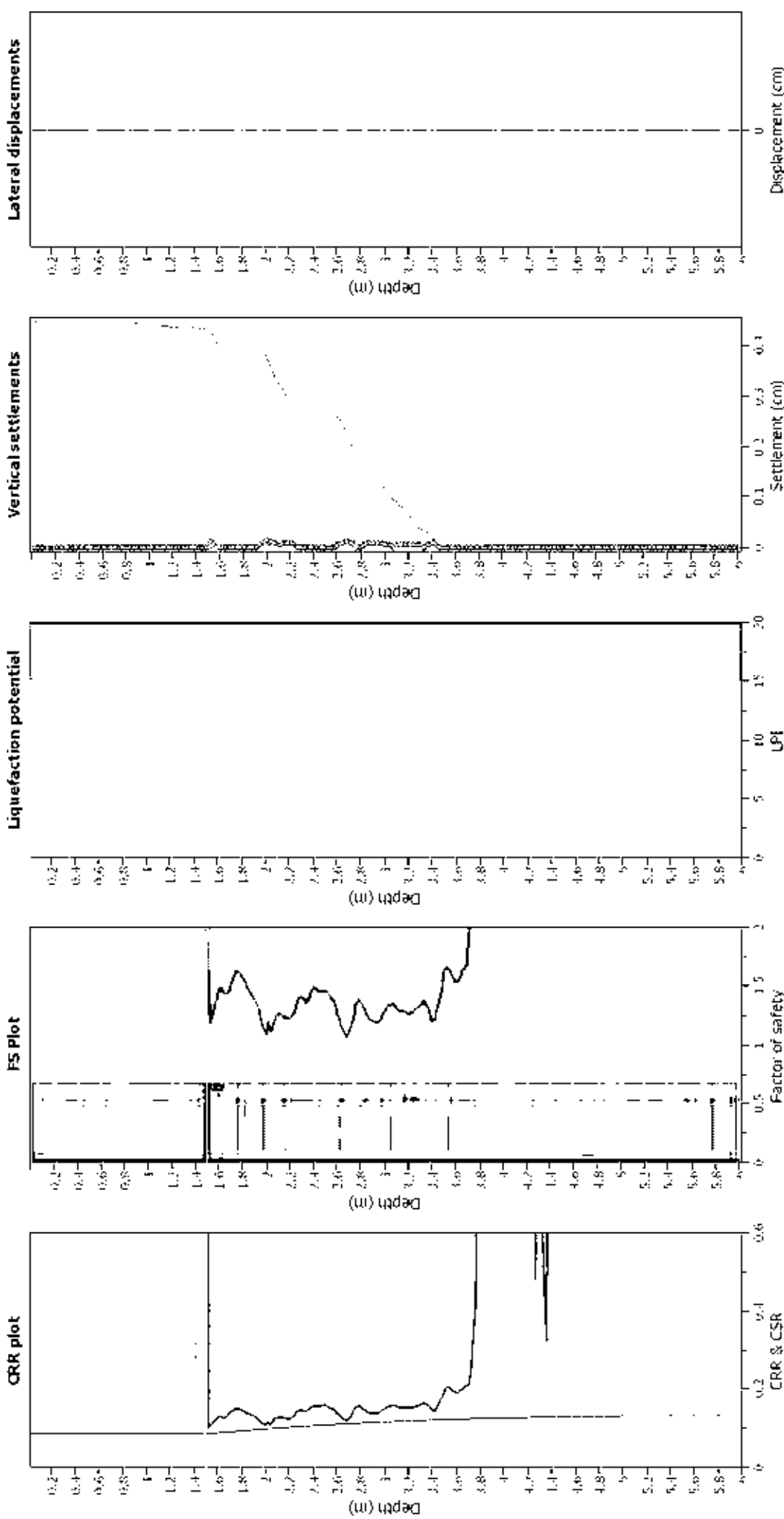


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (m): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

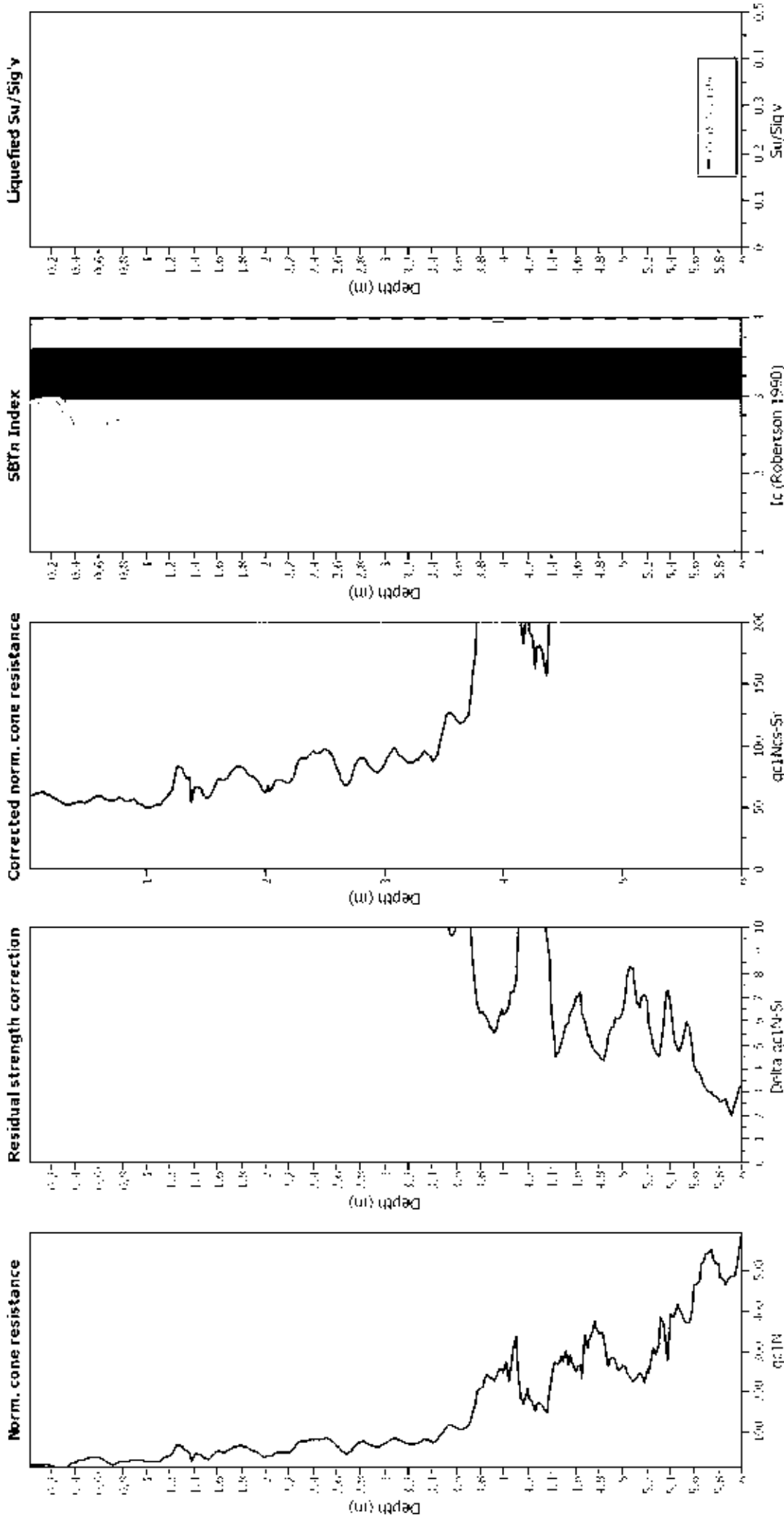
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

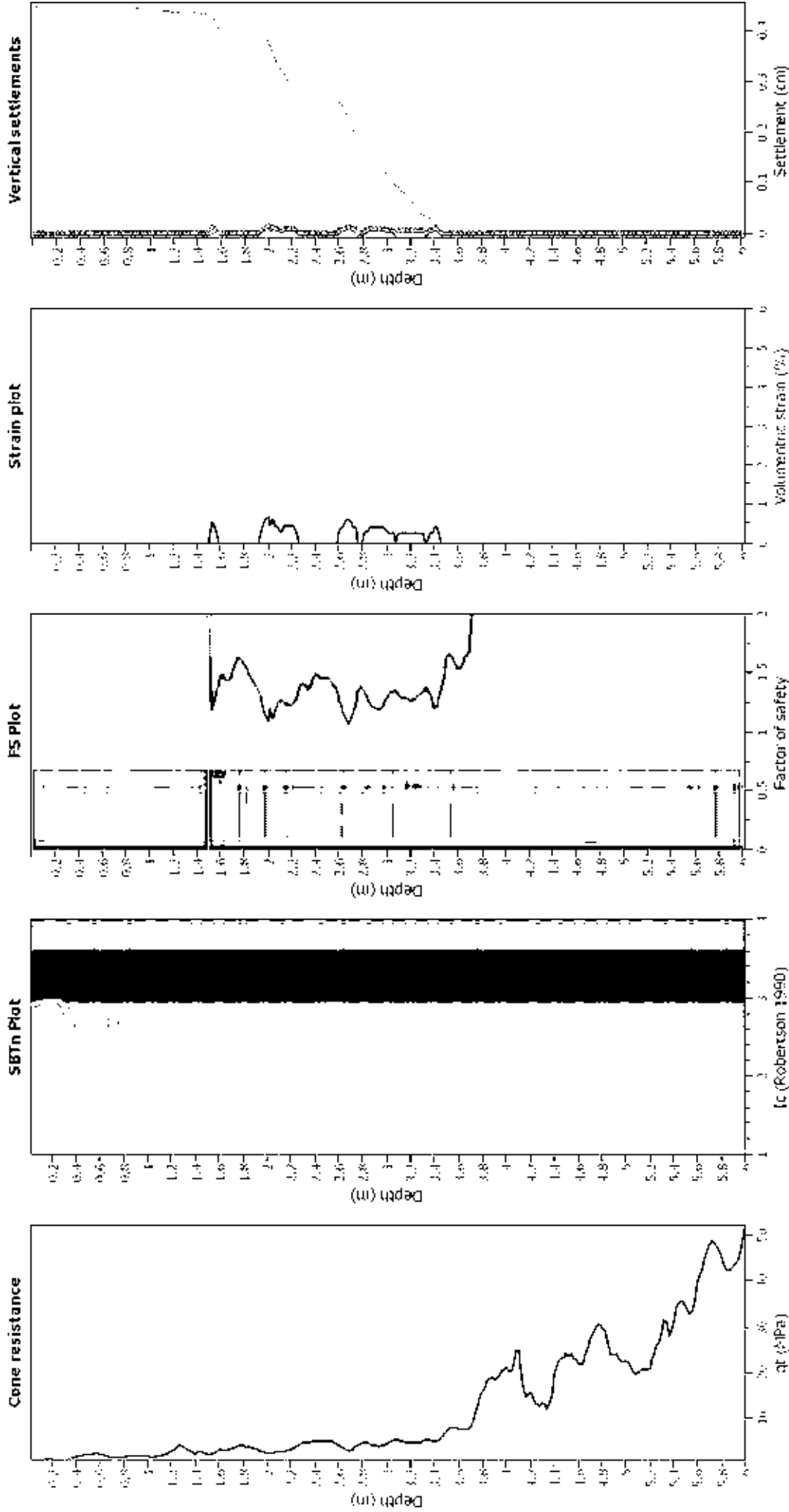
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qc Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT28\_57SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M <sub>w</sub>	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

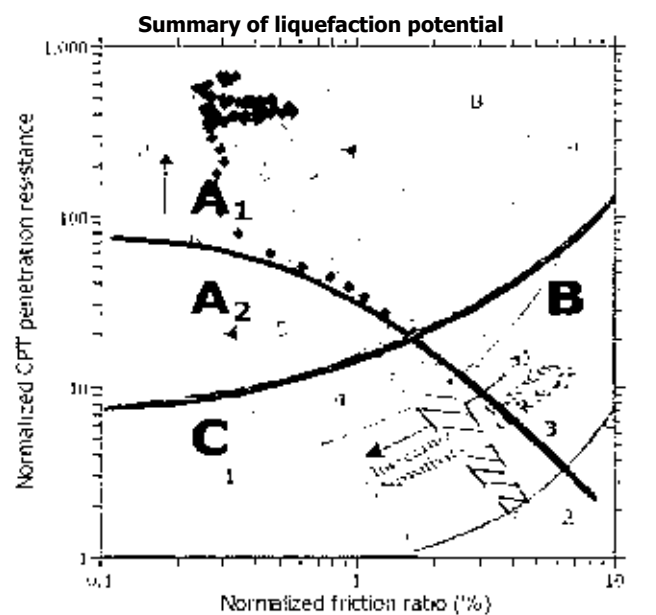
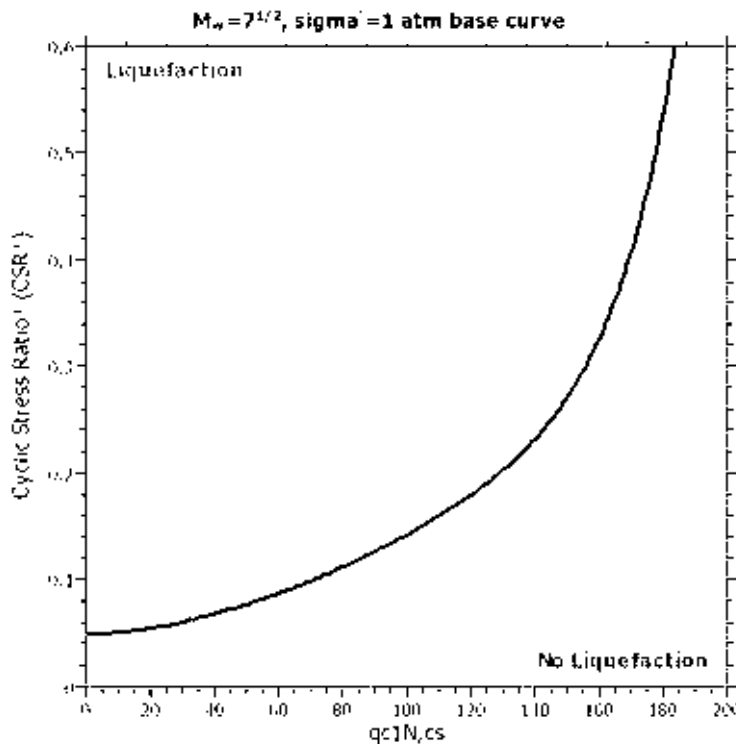
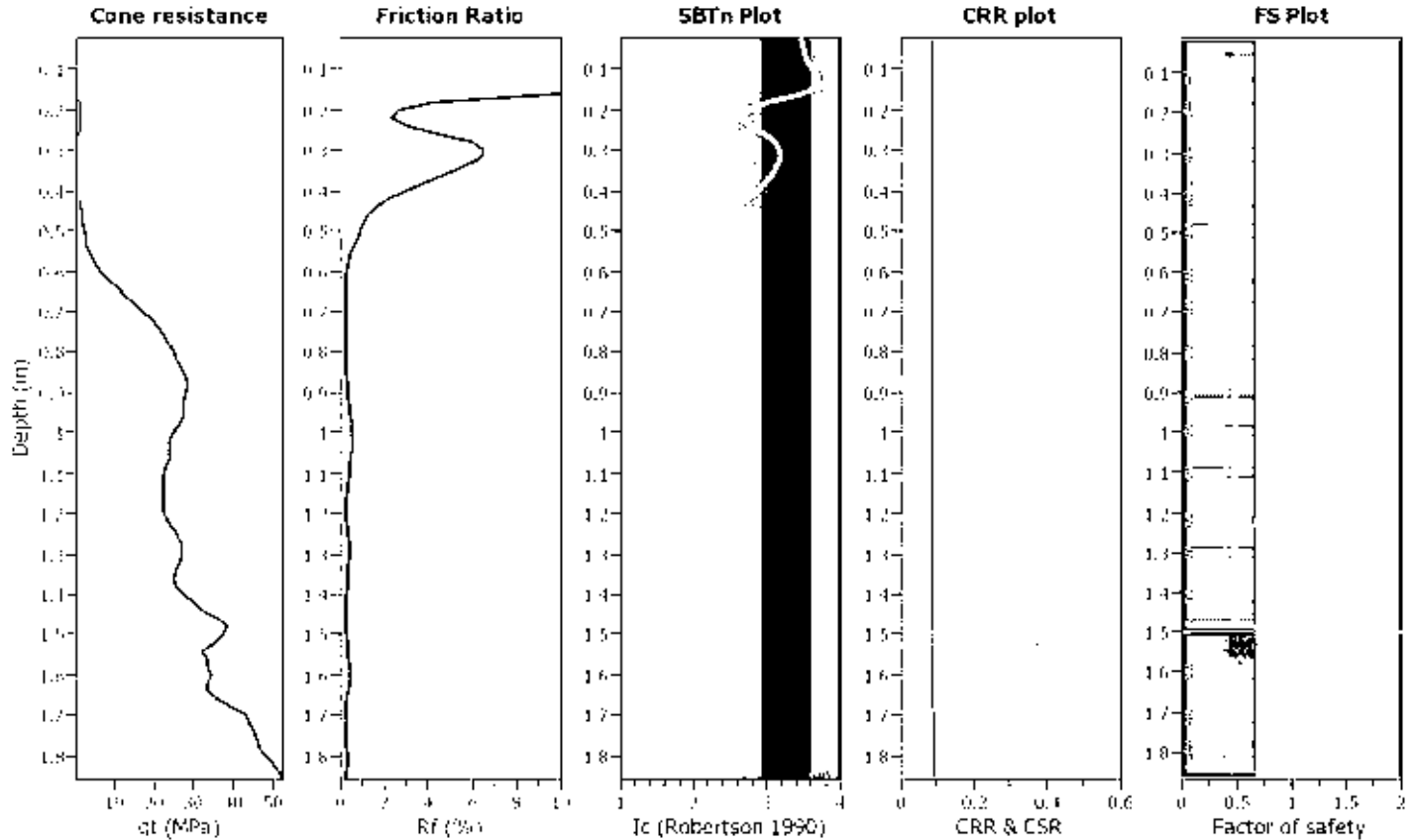
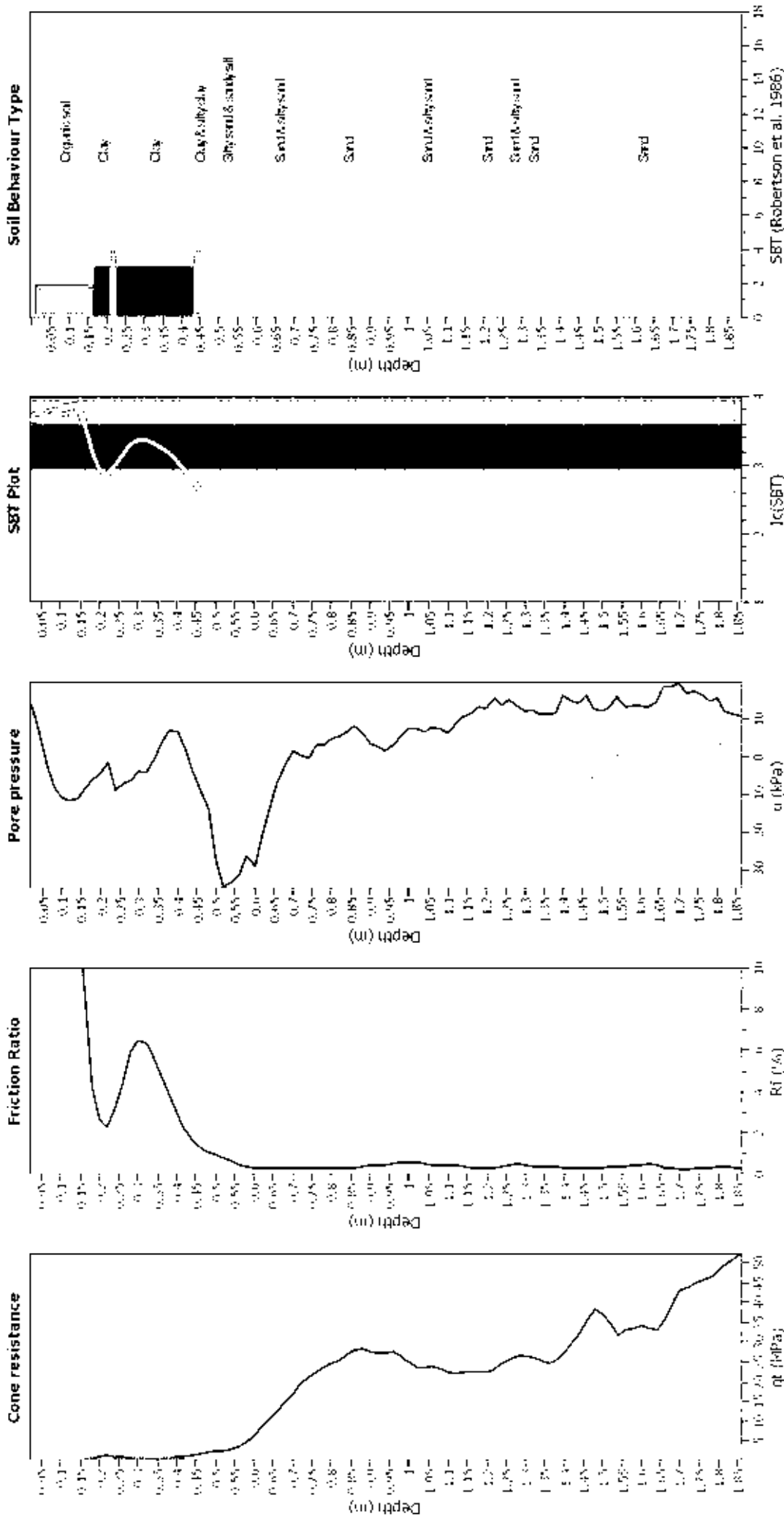


Figure 4: Summary of liquefaction potential based on penetration resistance and cyclic stress ratio. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The curves represent the boundaries between different liquefaction potential zones (A1, A2, B, C). The arrows indicate the direction of increasing penetration resistance and decreasing friction ratio.

### CPT basic interpretation plots



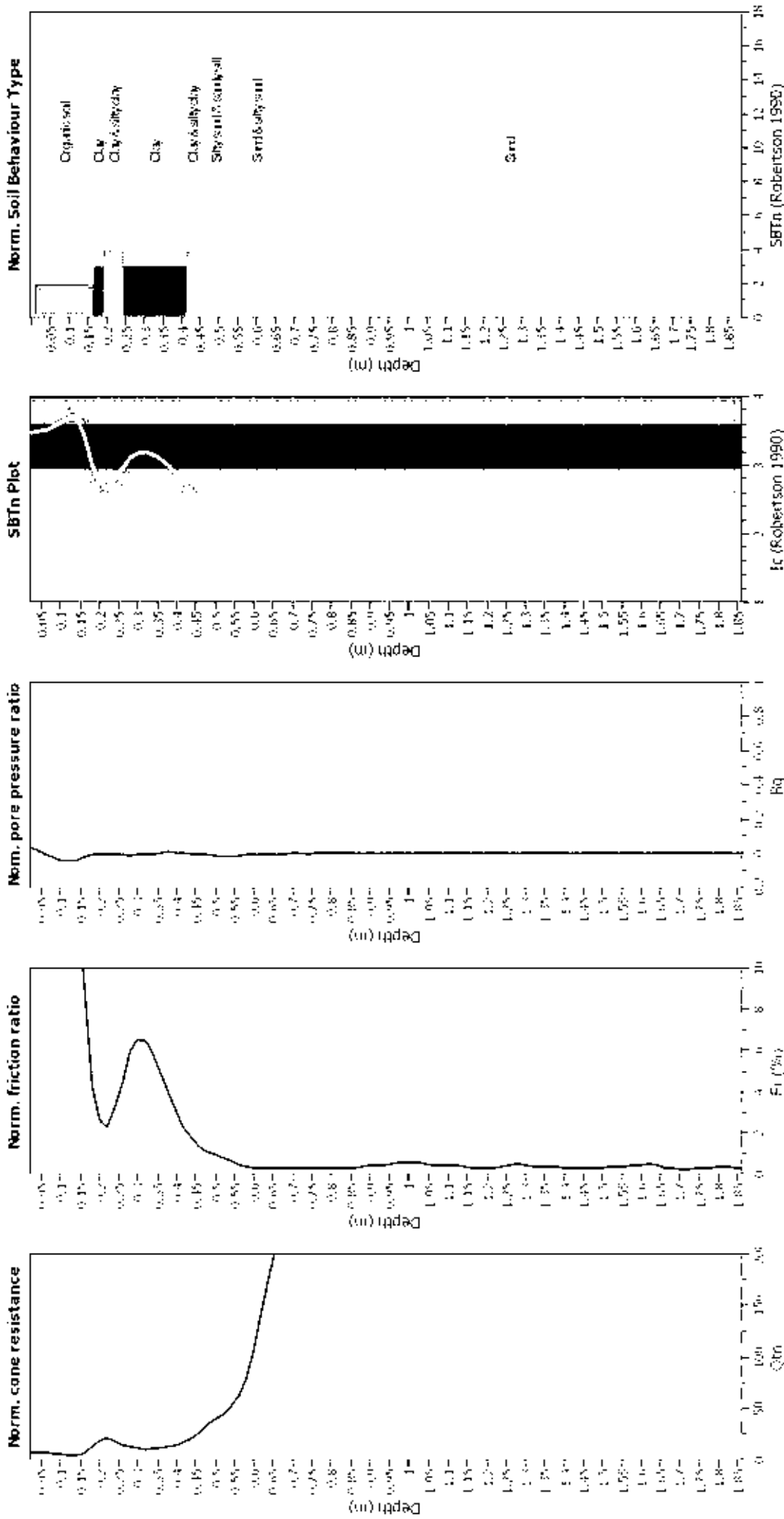
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



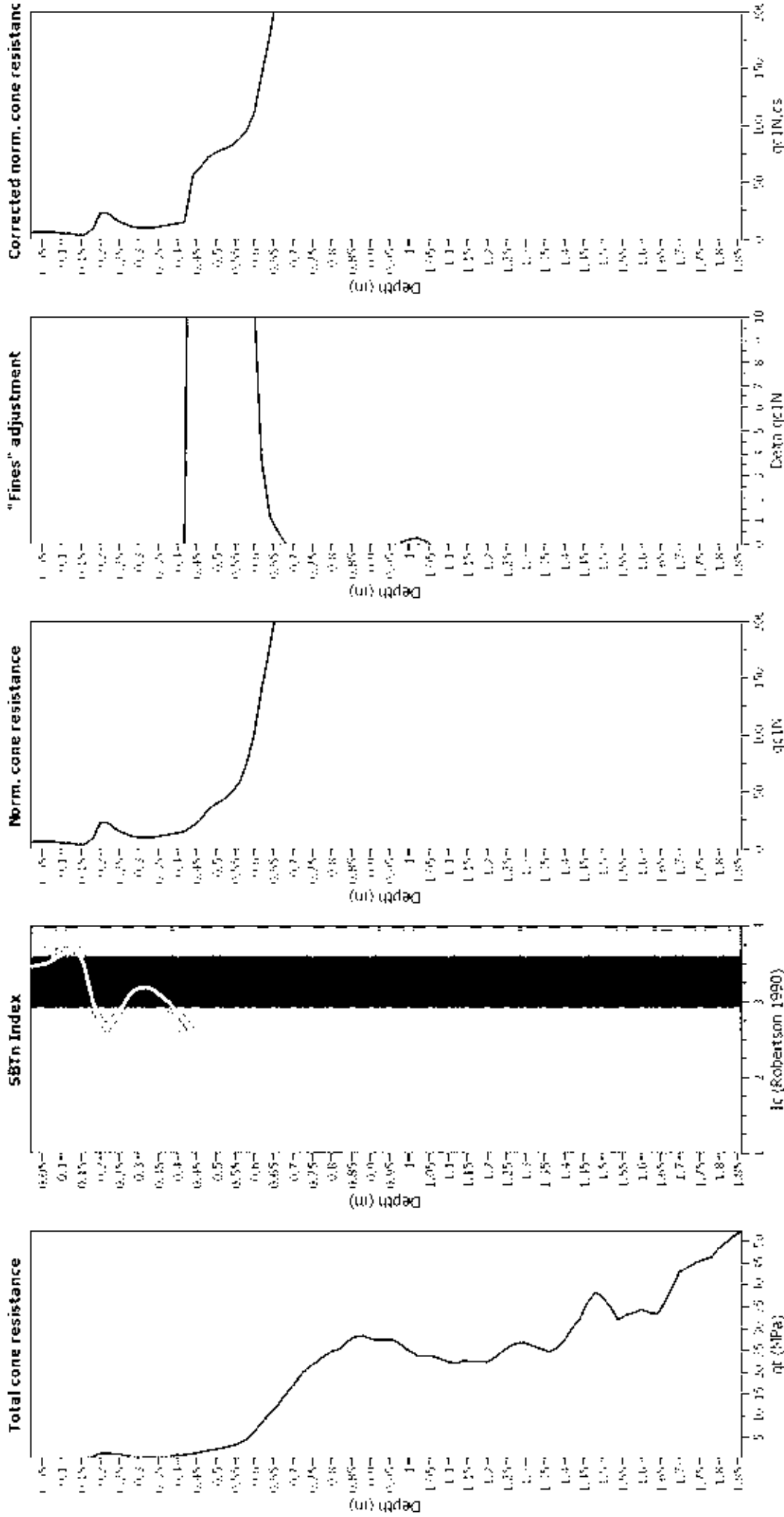
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Input correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

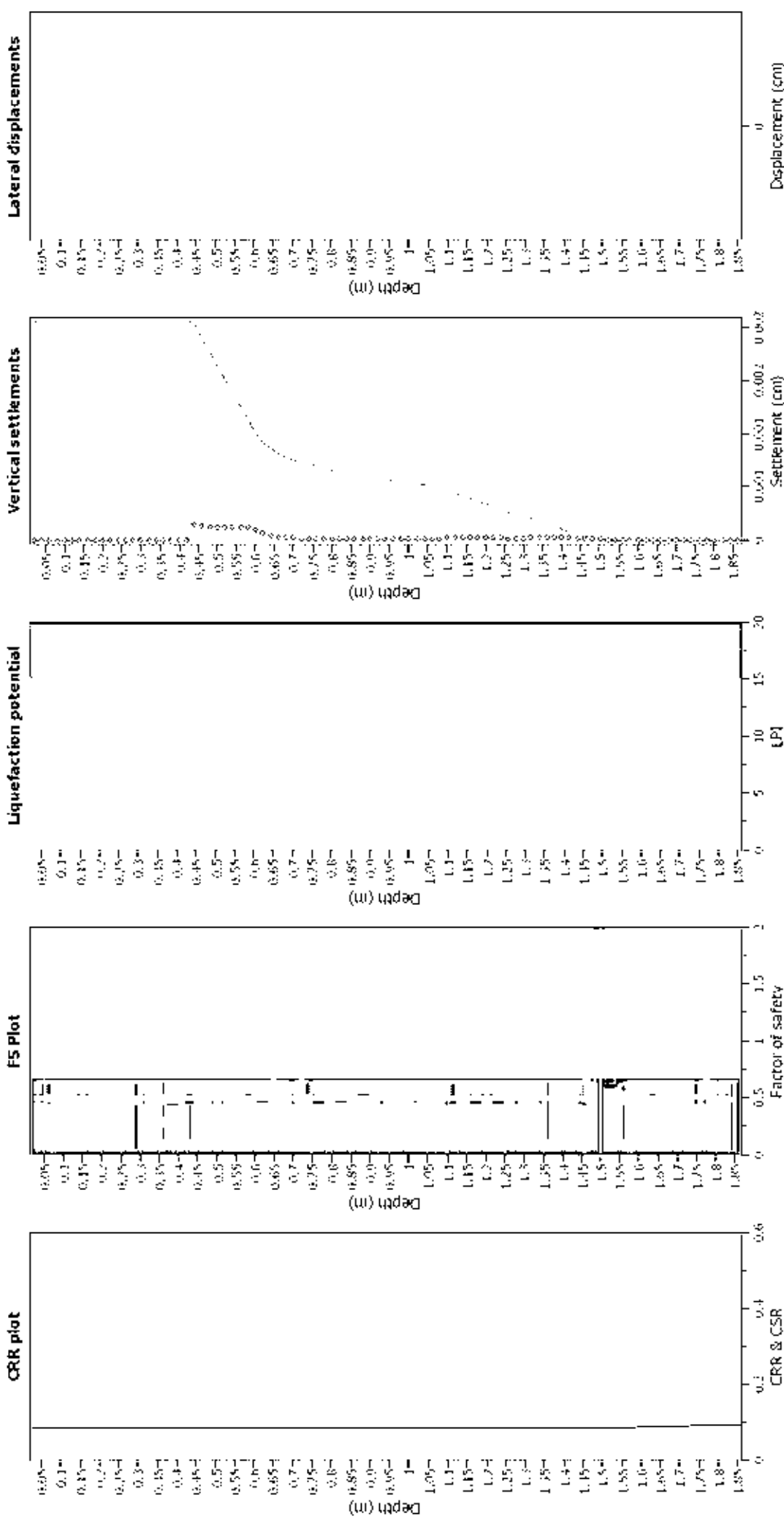
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude $M_v$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction factor: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude (M<sub>L</sub>): 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m<sub>wt</sub>): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition detected: N/A  
 K<sub>app</sub> applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No  
 Limit depth: N/A

#### F.S. color scheme

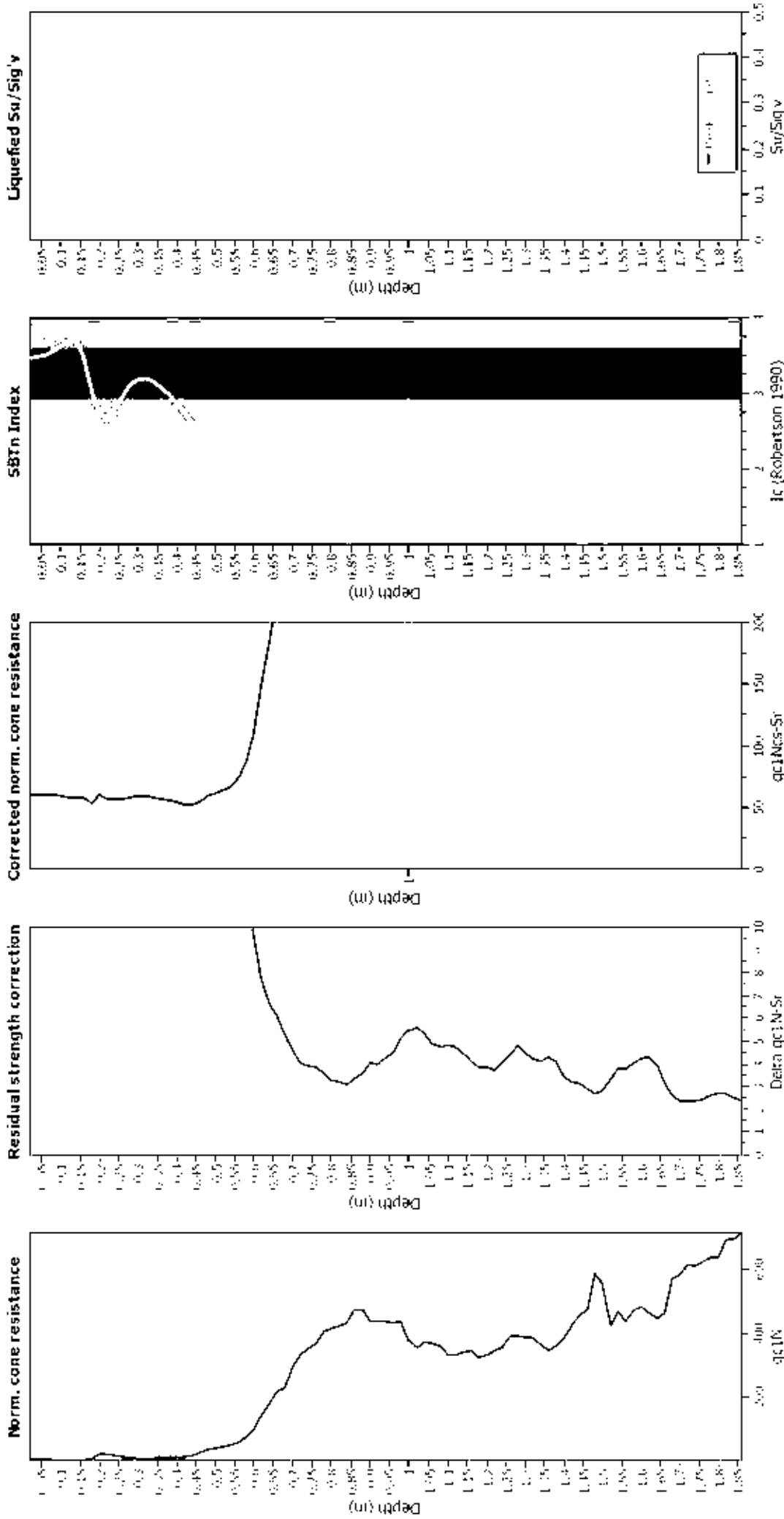
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk



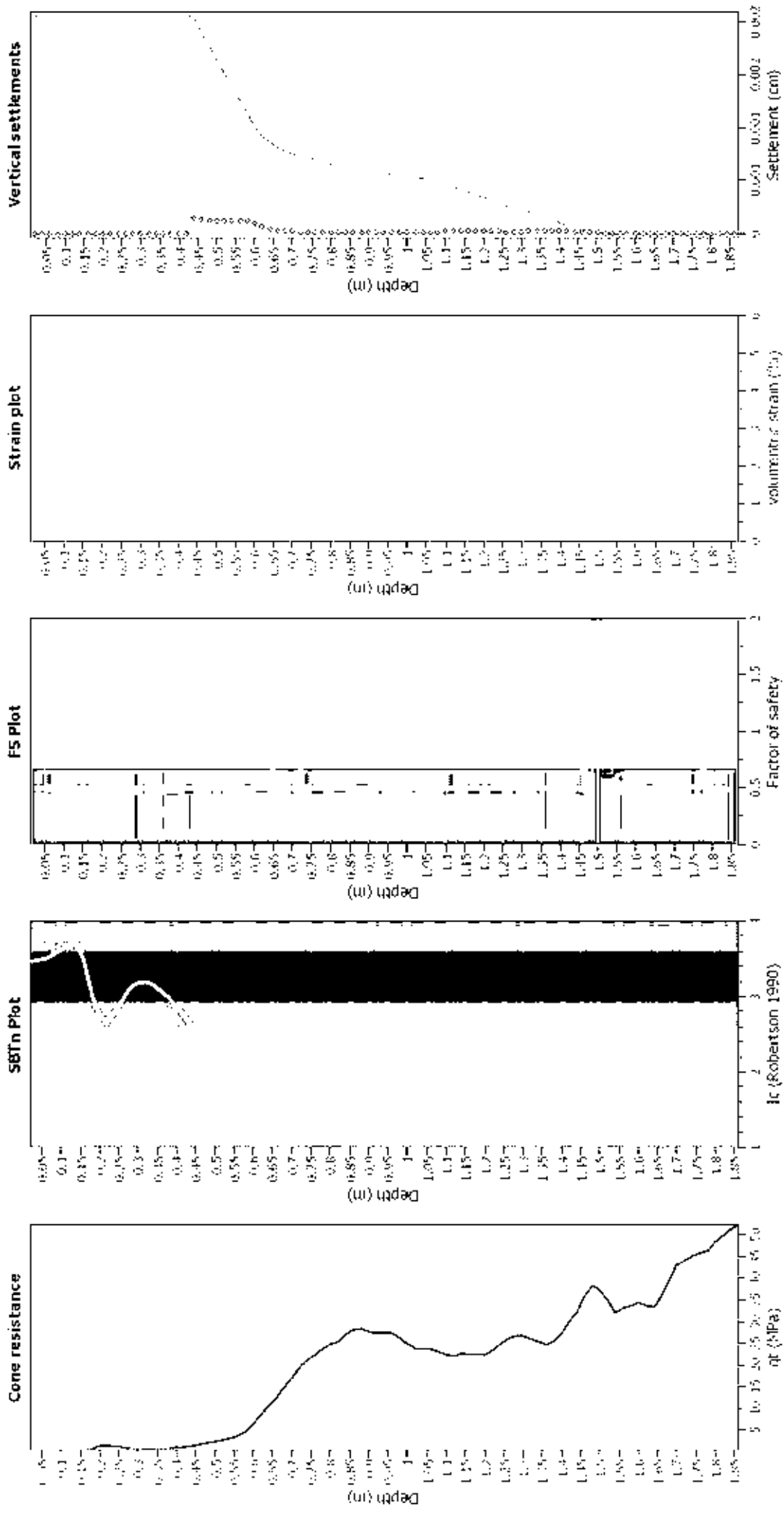
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type index
- FS Calculated Factor of Safety against liquefaction
- Volumetric strain Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT29\_57SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

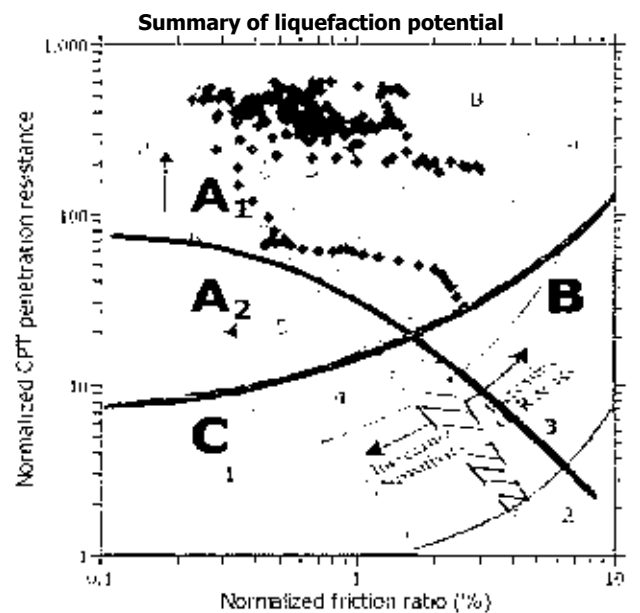
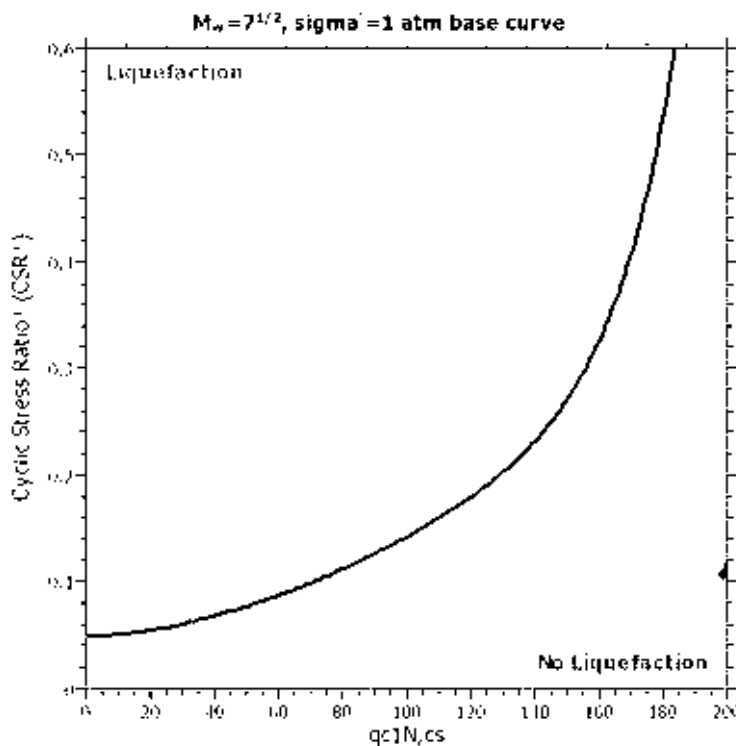
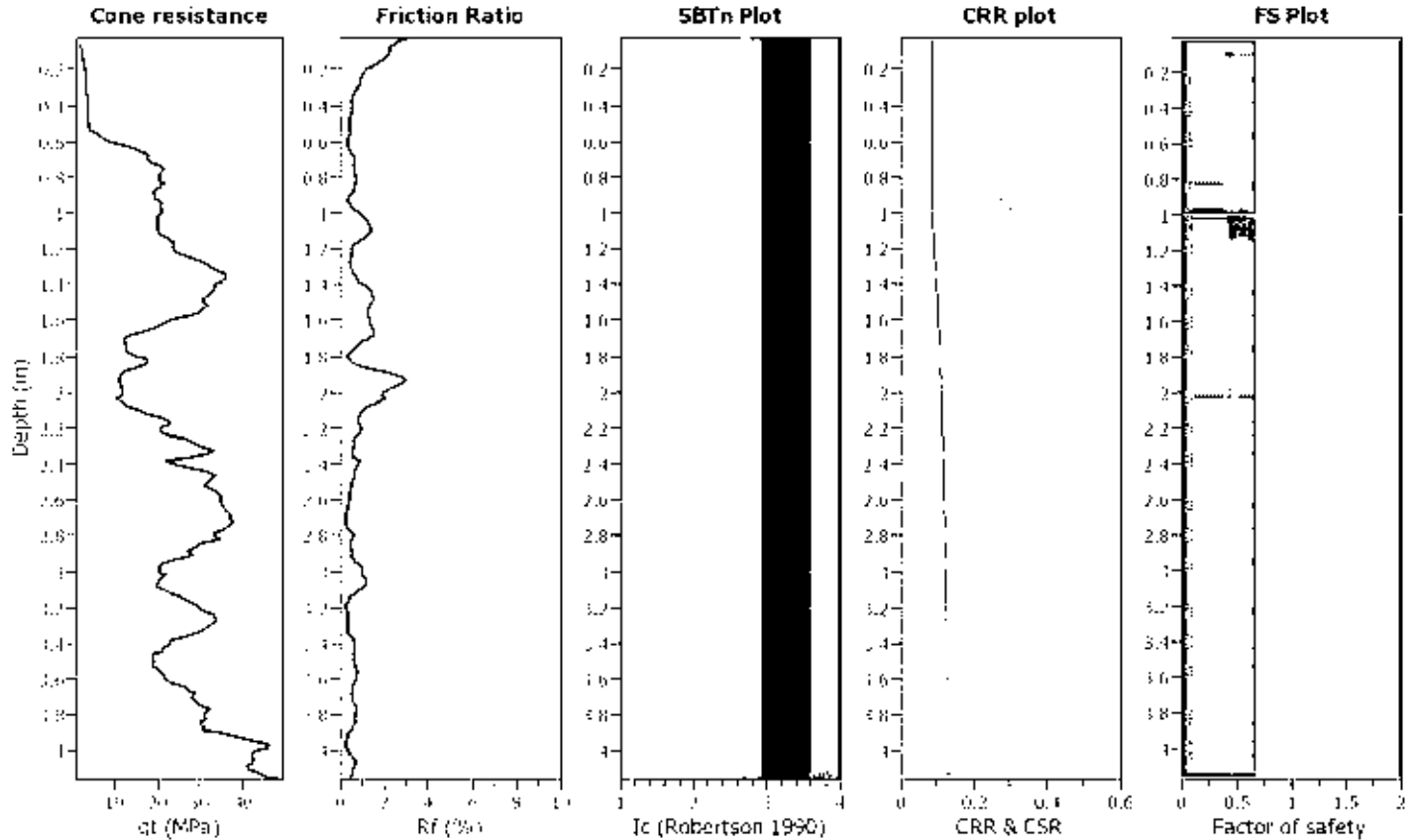
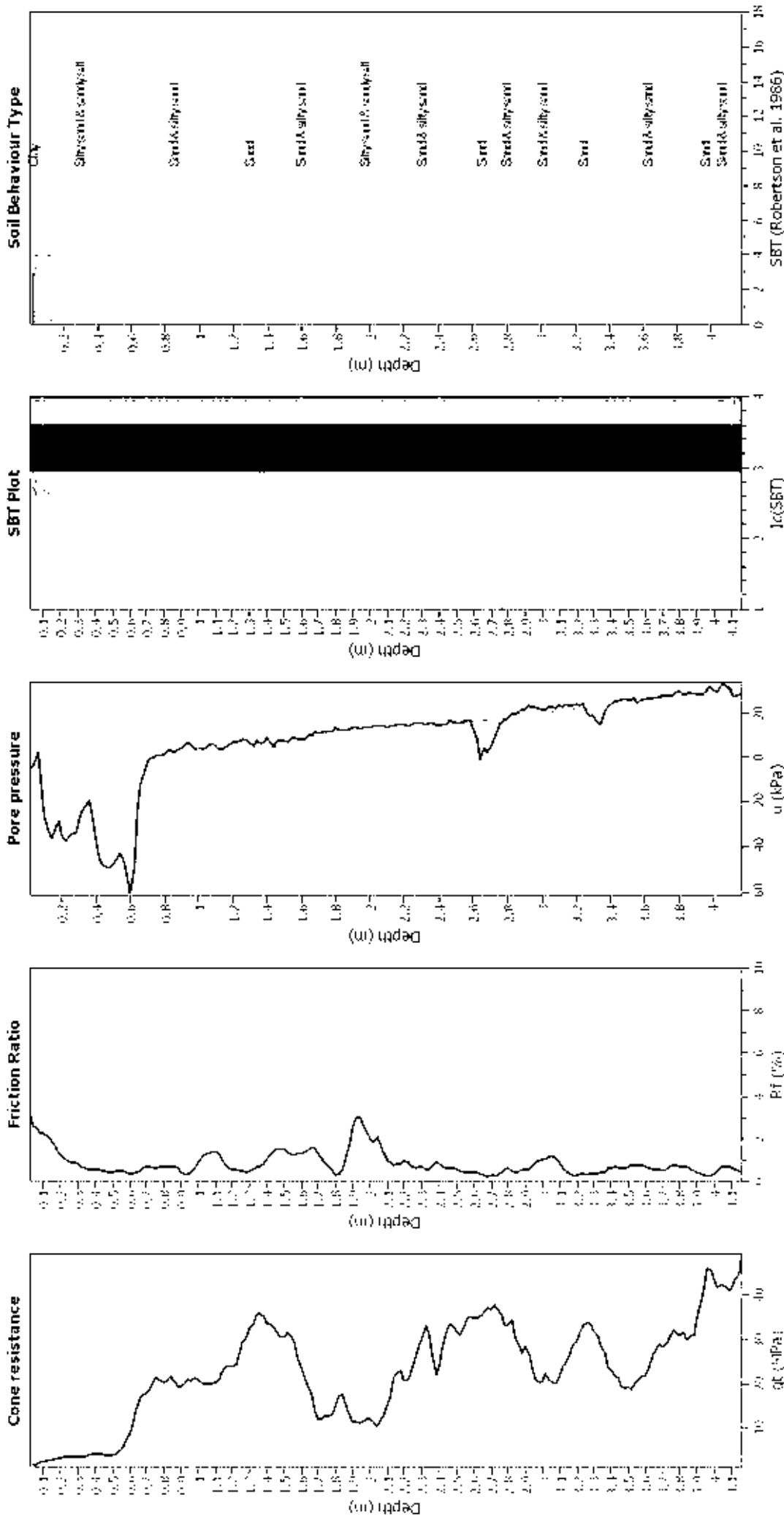


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The shaded area indicates the liquefaction zone. The curves A1, A2, B, and C represent different liquefaction potential boundaries. The shaded area is bounded by the A1 and A2 curves. The liquefaction zone is defined by the shaded area. The liquefaction zone is defined by the shaded area. The liquefaction zone is defined by the shaded area.

### CPT basic interpretation plots



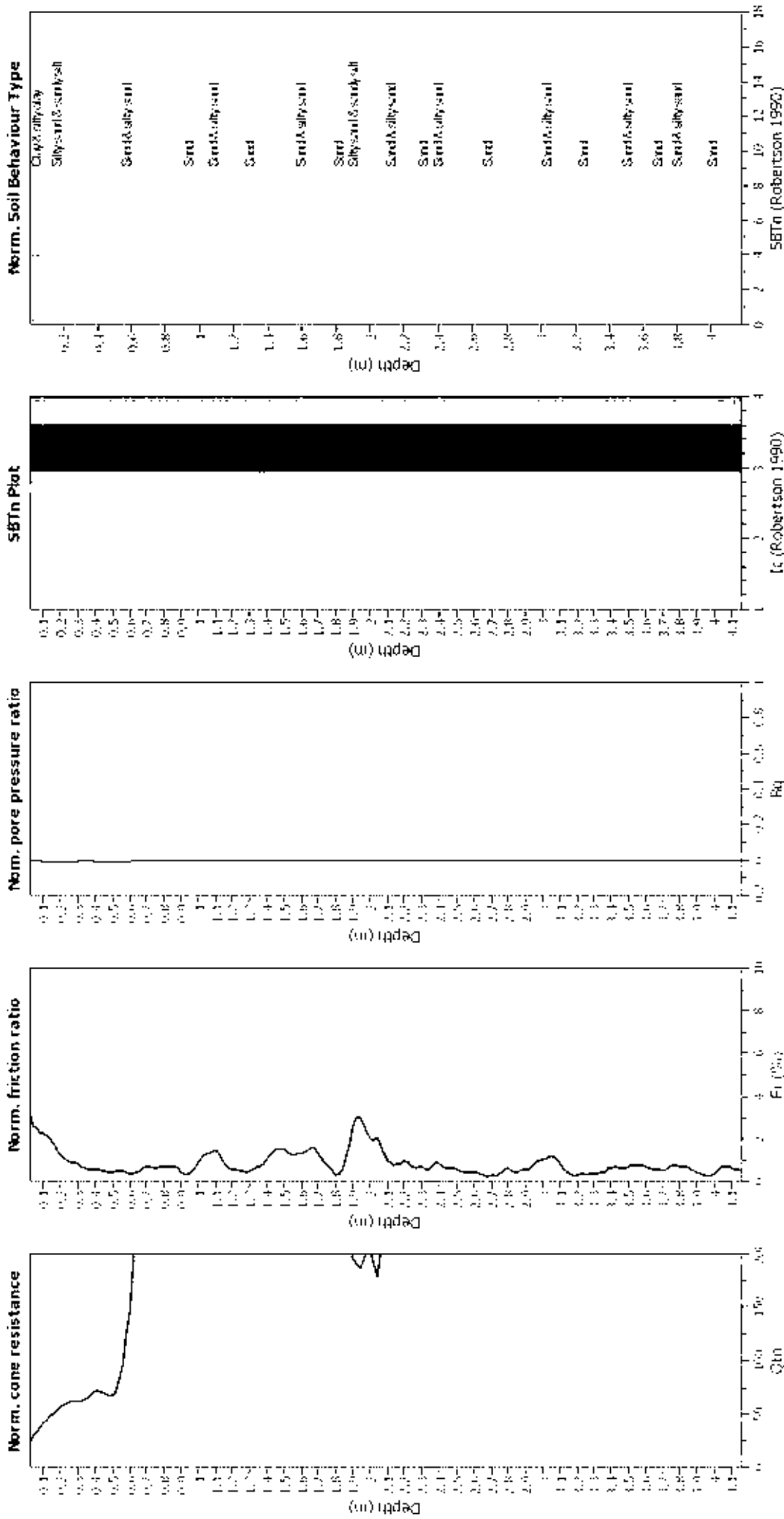
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit weight:	N/A
		Fill height:	N/A
		Depth to GW (earthq.):	1.00 m
		Average results interval:	3
		Ic cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



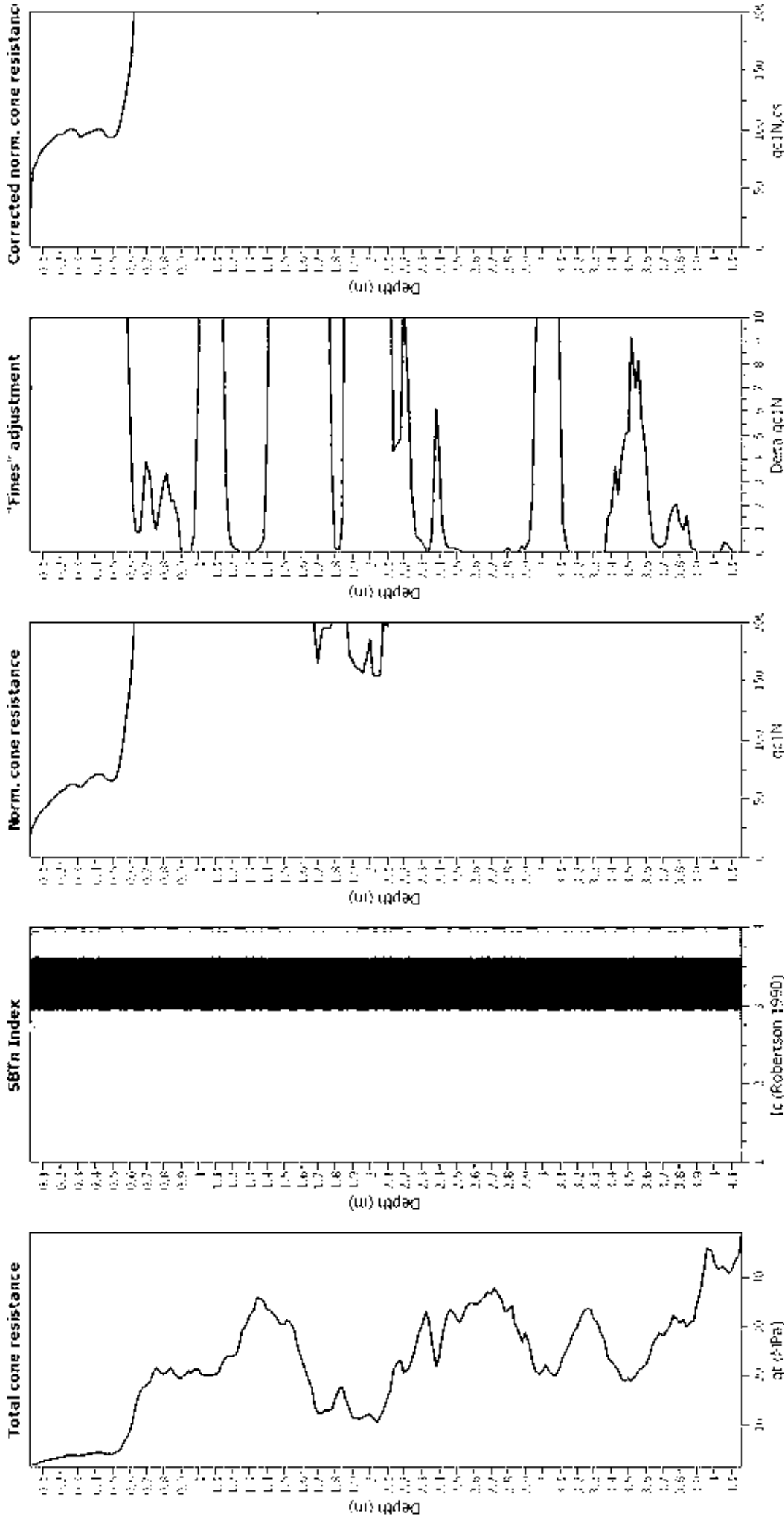
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

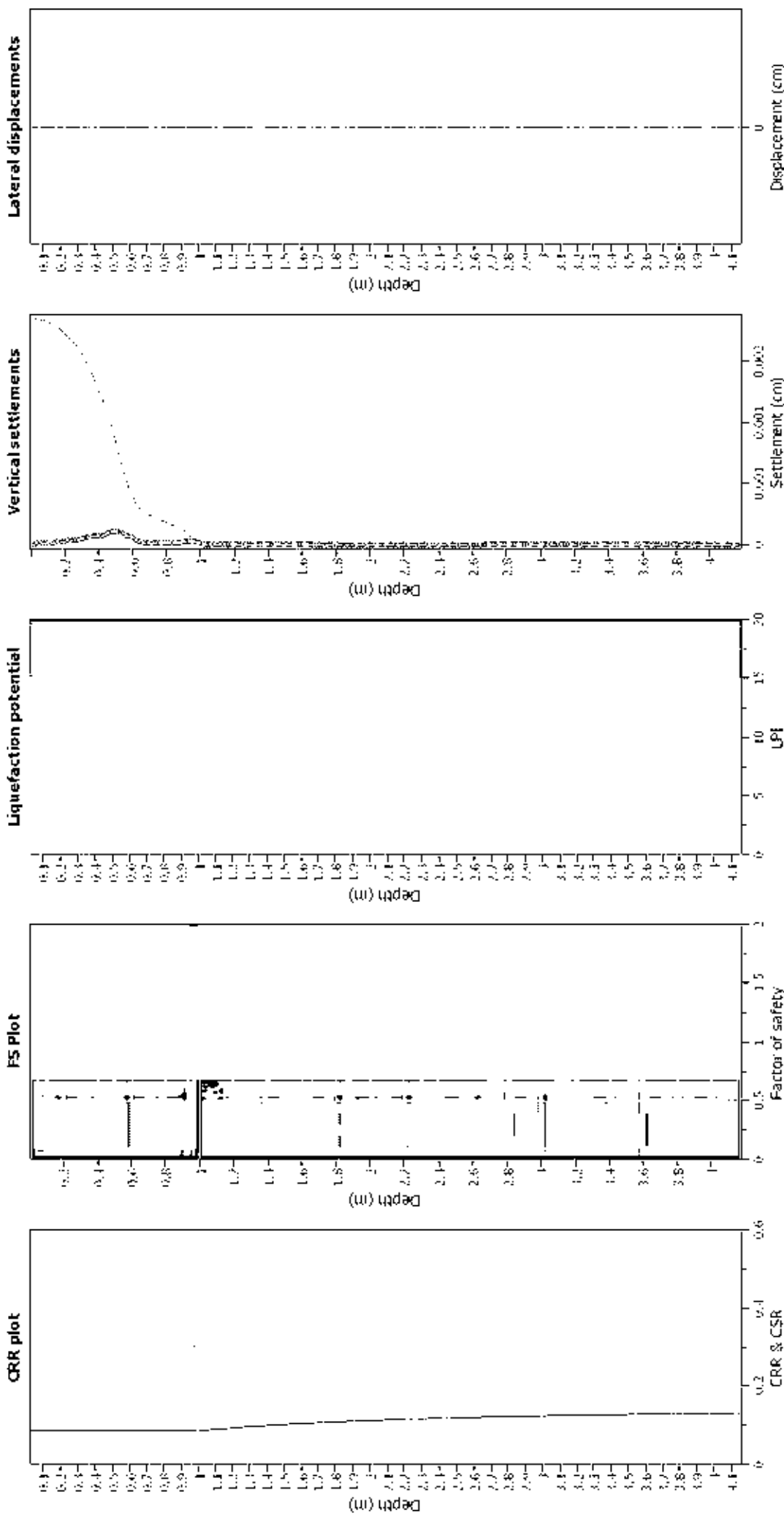
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lam. depth applied:	No
Depth to water table ( $z_{wt}$ ):	1.00 m	Lam. depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: I8B (2008)  
 Liquefaction correction method: I8B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Degree to water table: 1.00 m

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

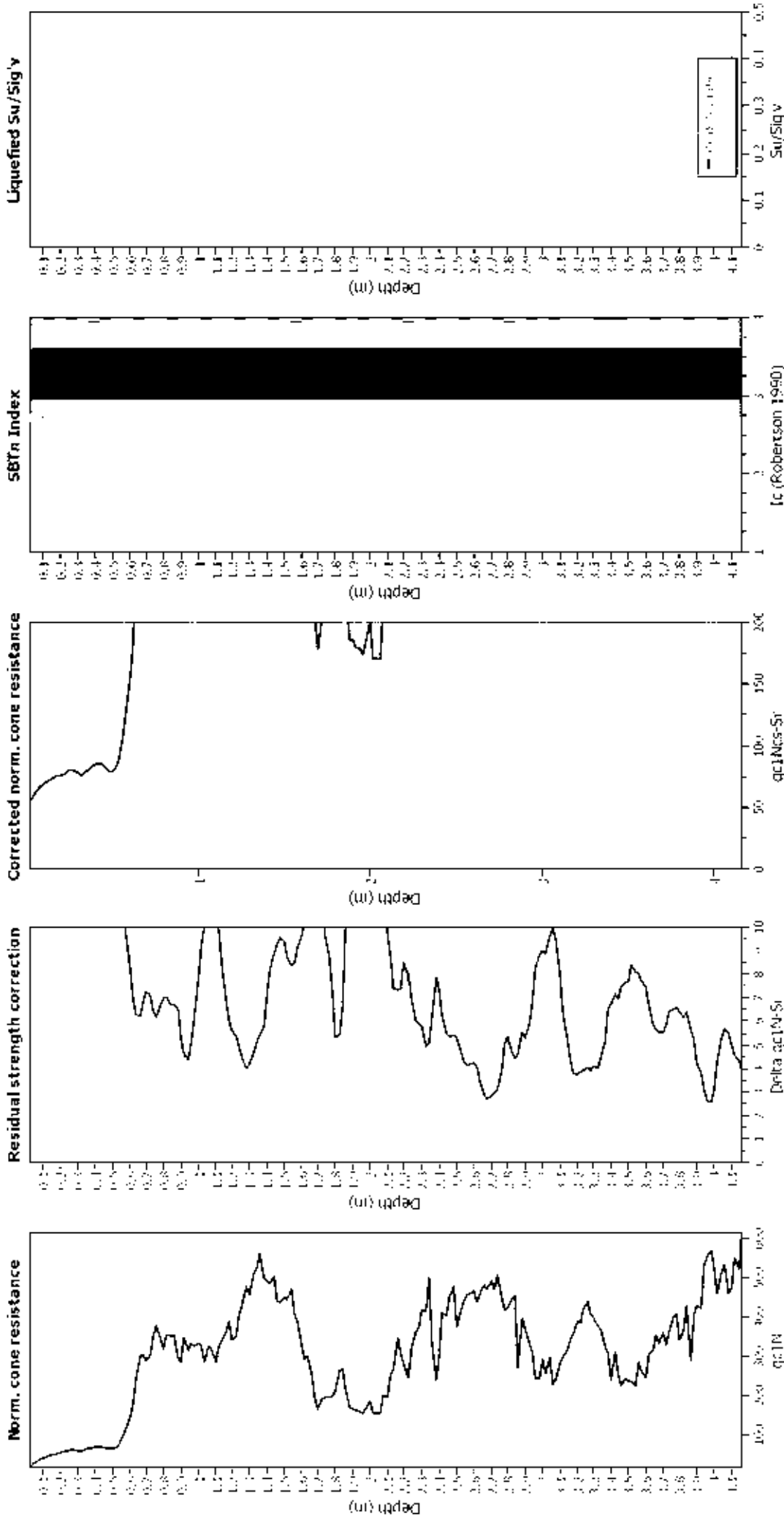
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

### Check for strength loss plots (Idriss & Boulanger (2008))

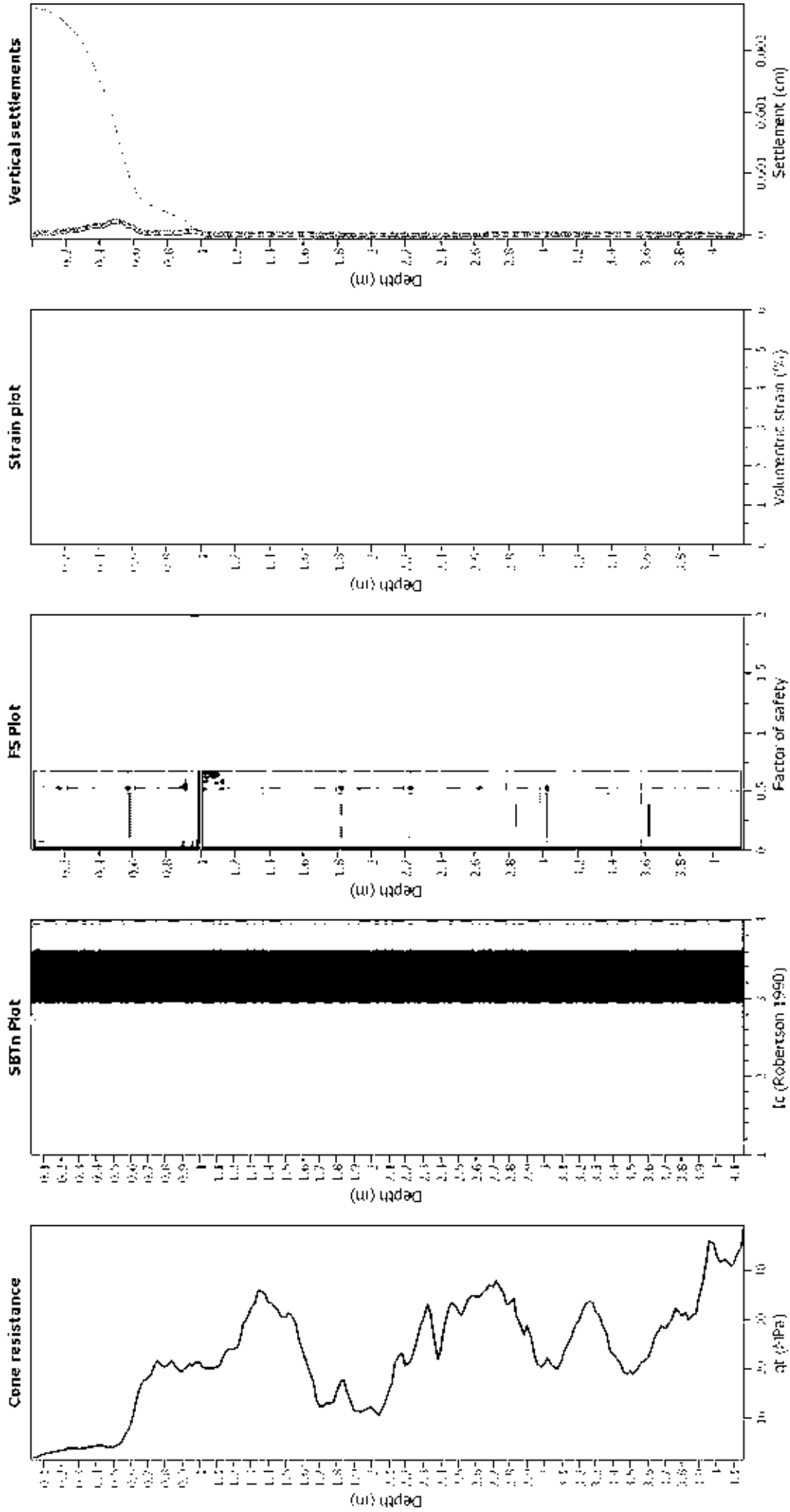


#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- S<sub>b</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT30\_29rProvincialRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

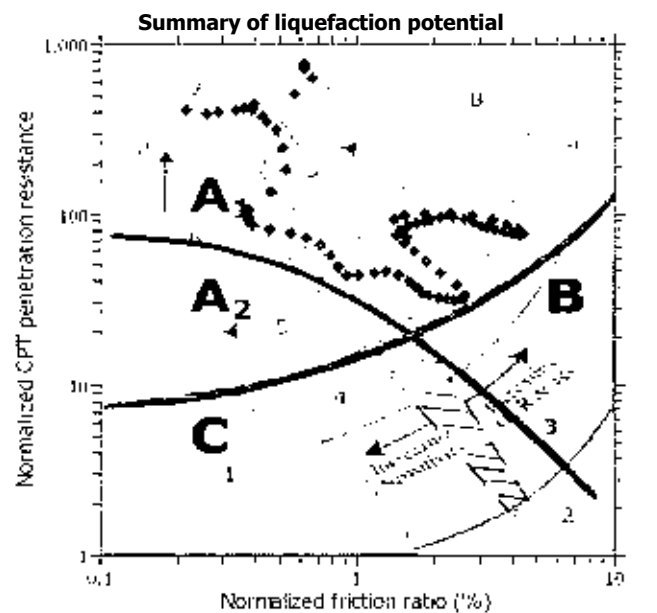
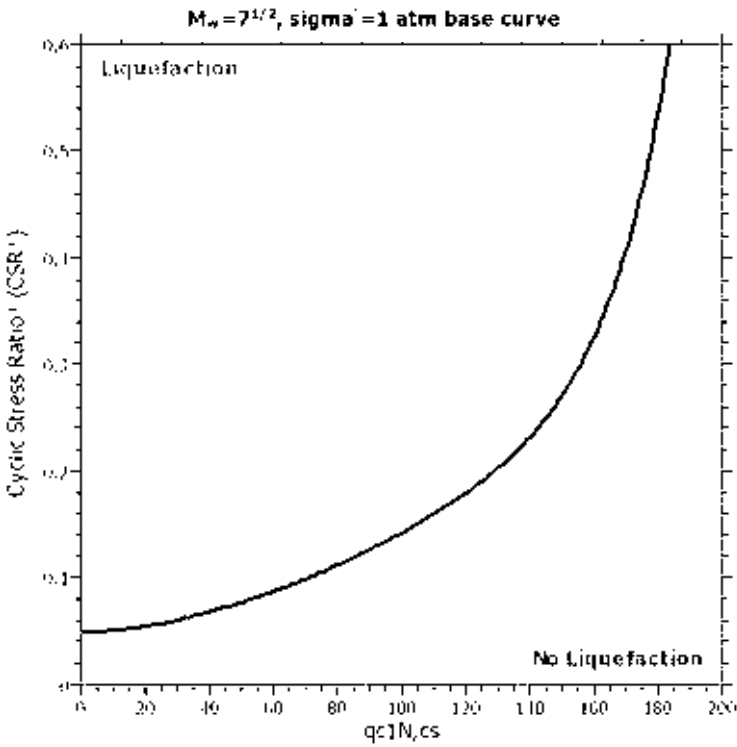
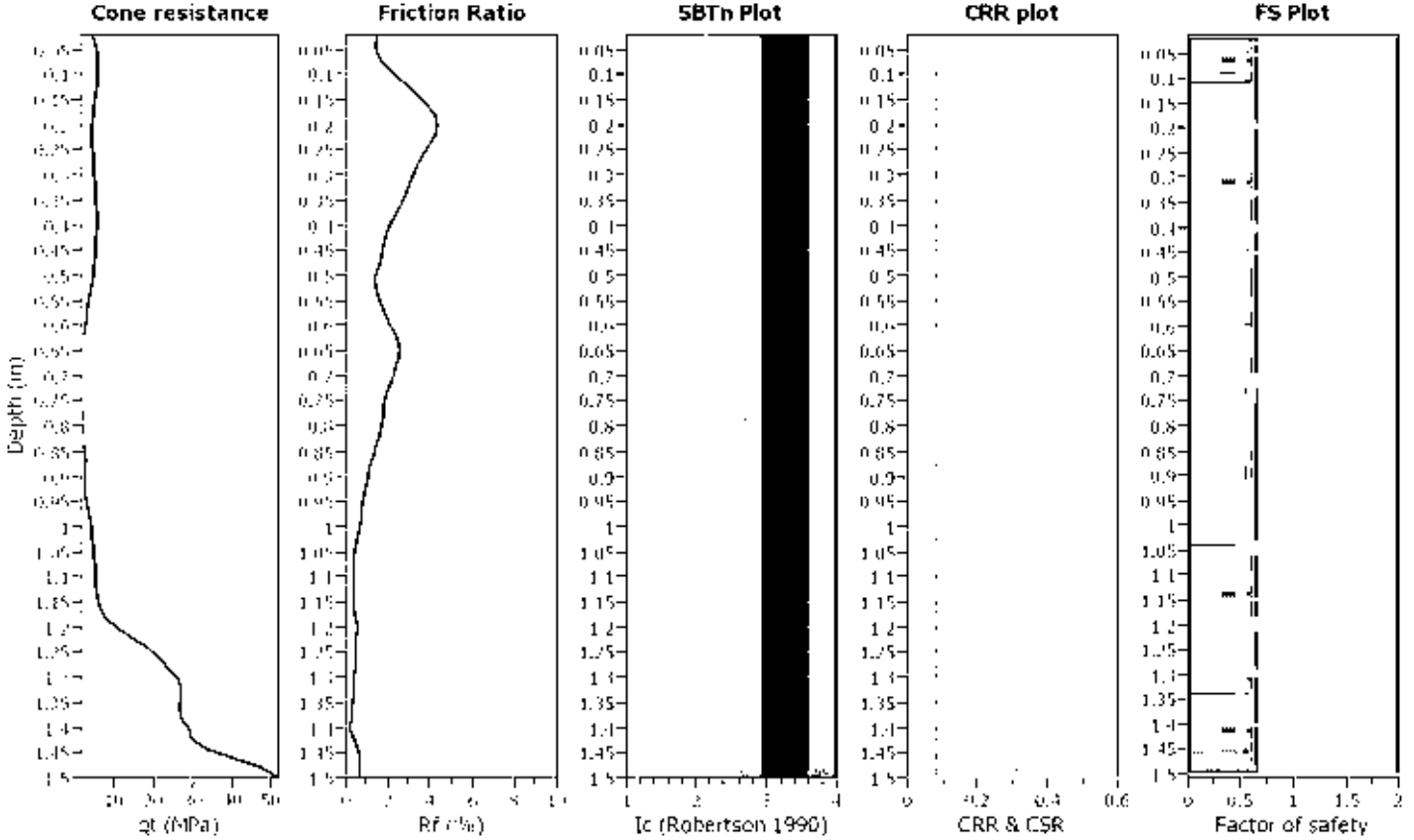
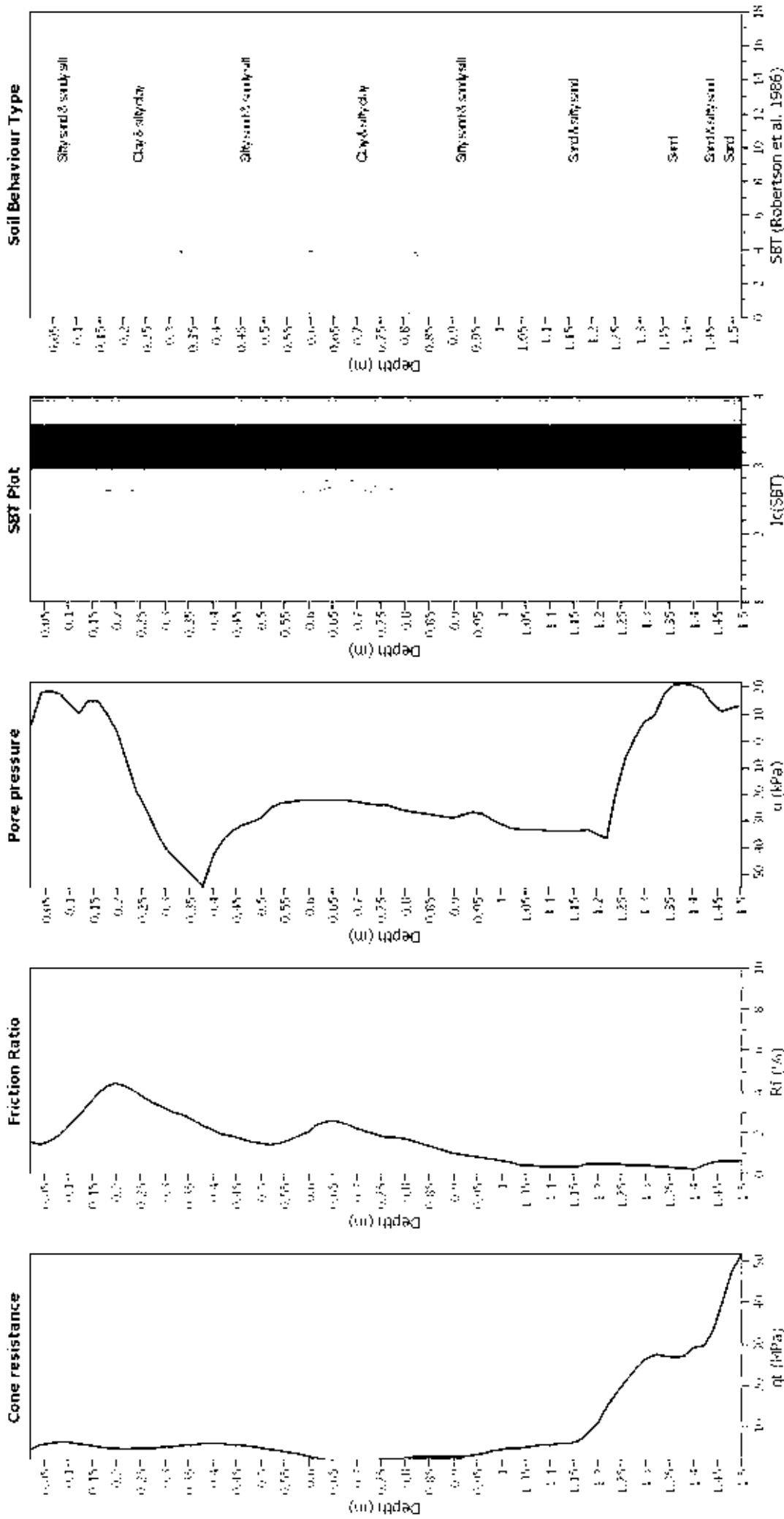


Figure 4: Summary of liquefaction potential assessment and curves of cyclic stress ratio (CSR) vs. normalized CPT penetration resistance (qc) for a 200 m high fill. The curves are based on the data from the CPT test results. The dashed line represents the seismic coefficient. The curves are based on the data from the CPT test results.

### CPT basic interpretation plots



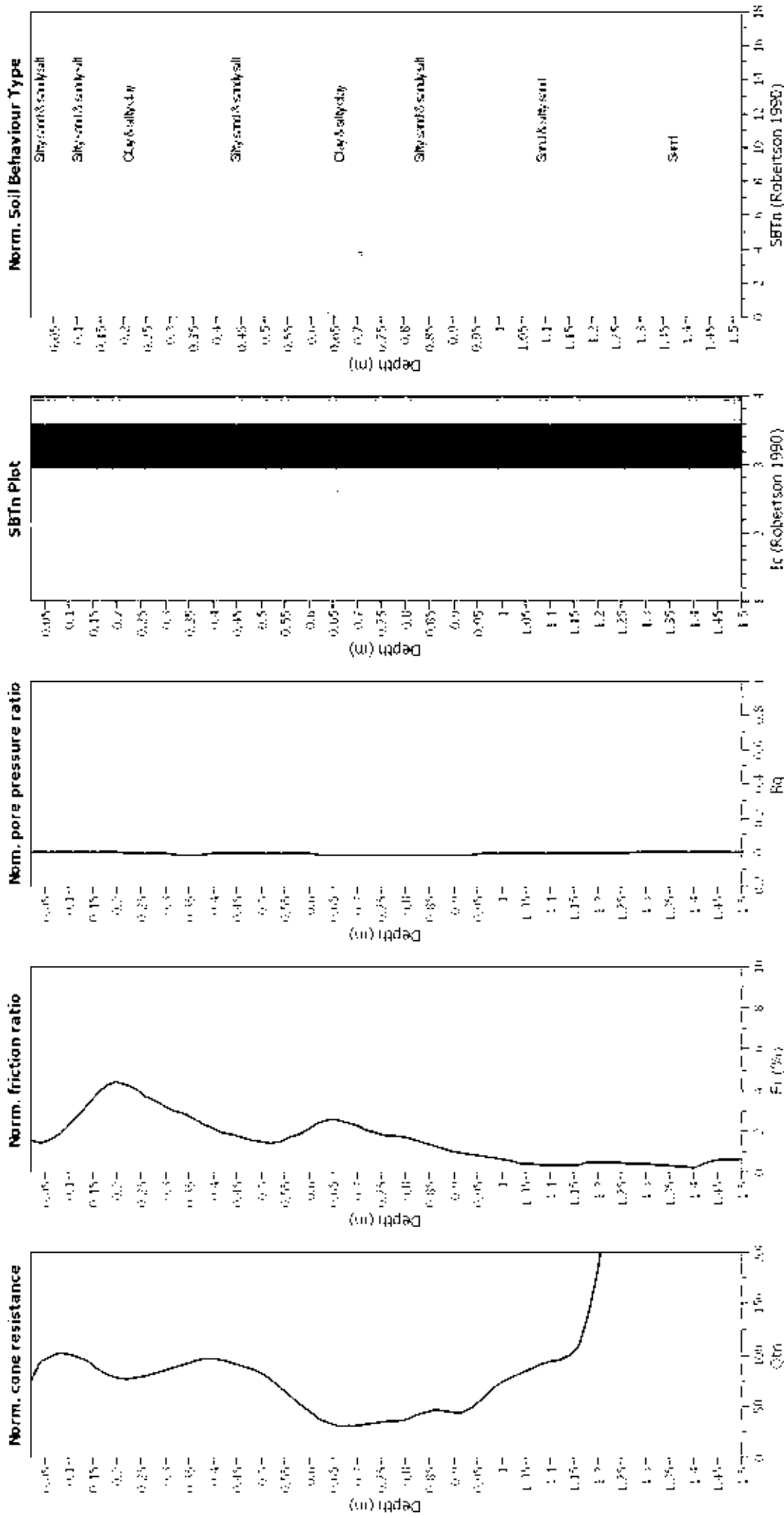
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lamé depth applied:	No
Depth to water table (m):	1.50 m	Lamé depth:	N/A
Depth to GW (earthq.):	1.50 m	Unit weight:	N/A
Average results interval:	3	Transition depth:	Sand & Clay
Ic cut-off value:	2.60	K:	Yes
Unit weight calculation:	Based on SBT	Clay like behavior:	No
Use fill:	No	Lamé depth:	No
Fill height:	N/A	Lamé depth:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



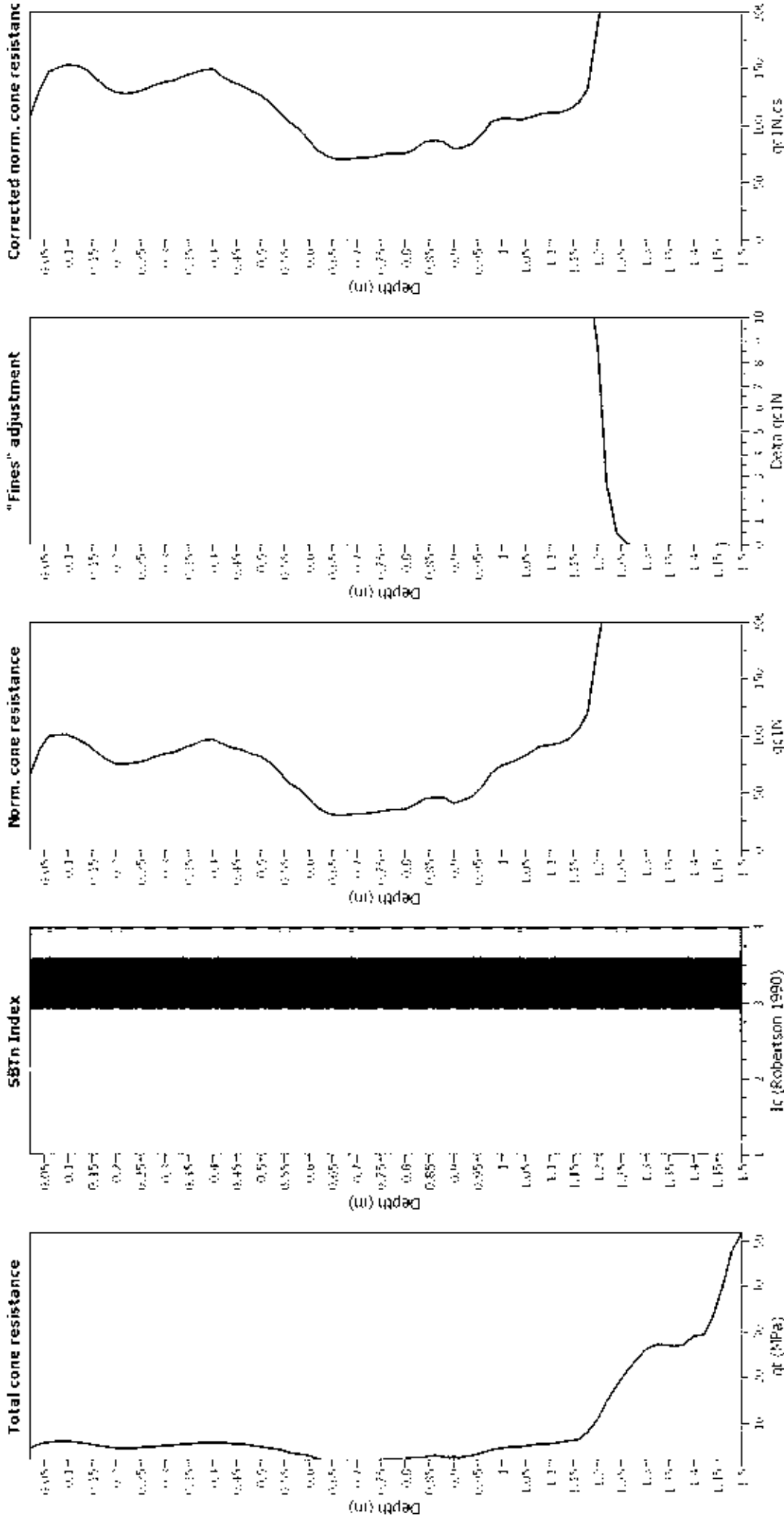
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

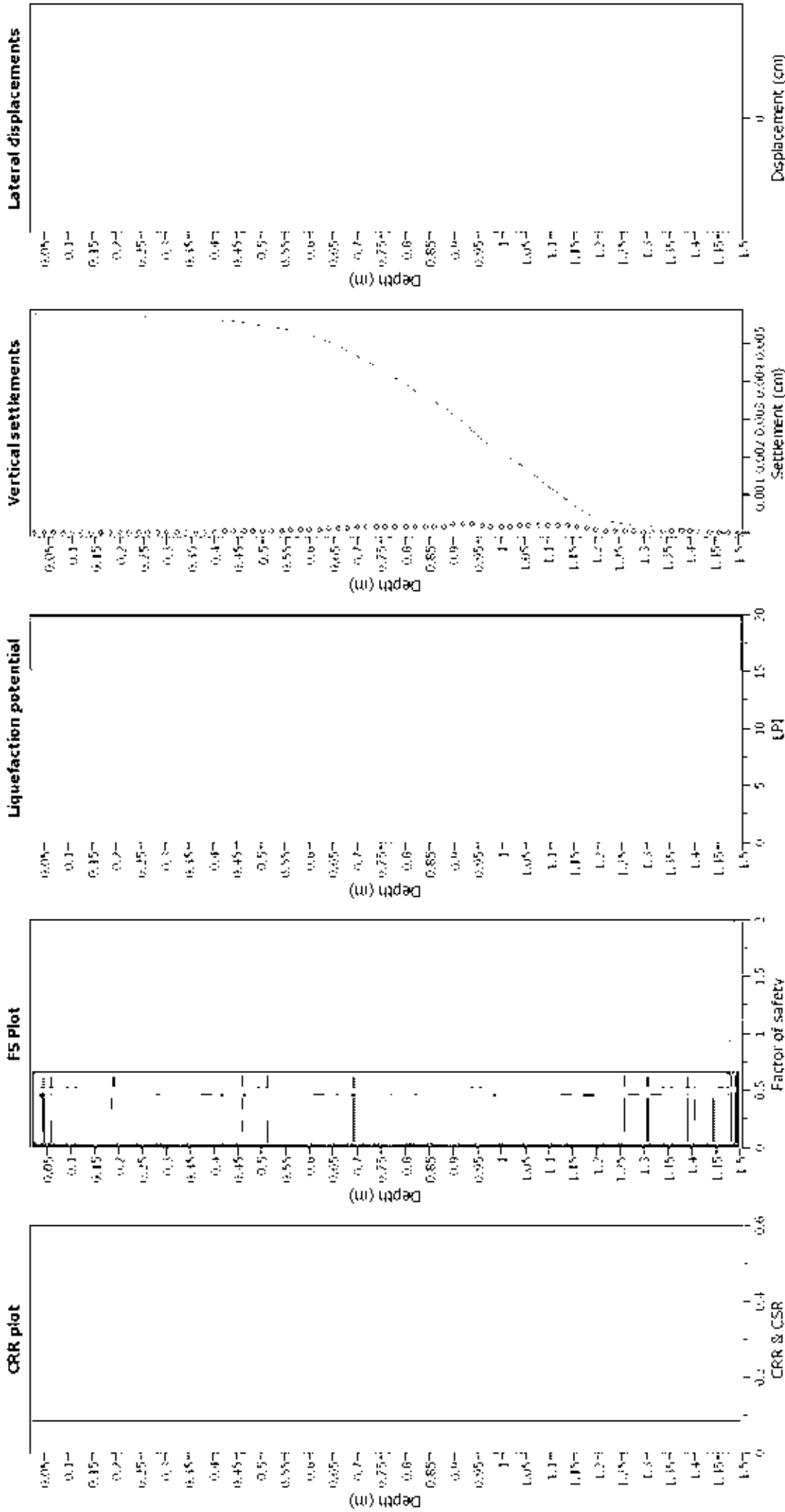
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Factor/make magnitude $M_v$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table ( $z_{w,eq}$ ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction factor: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition method applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No

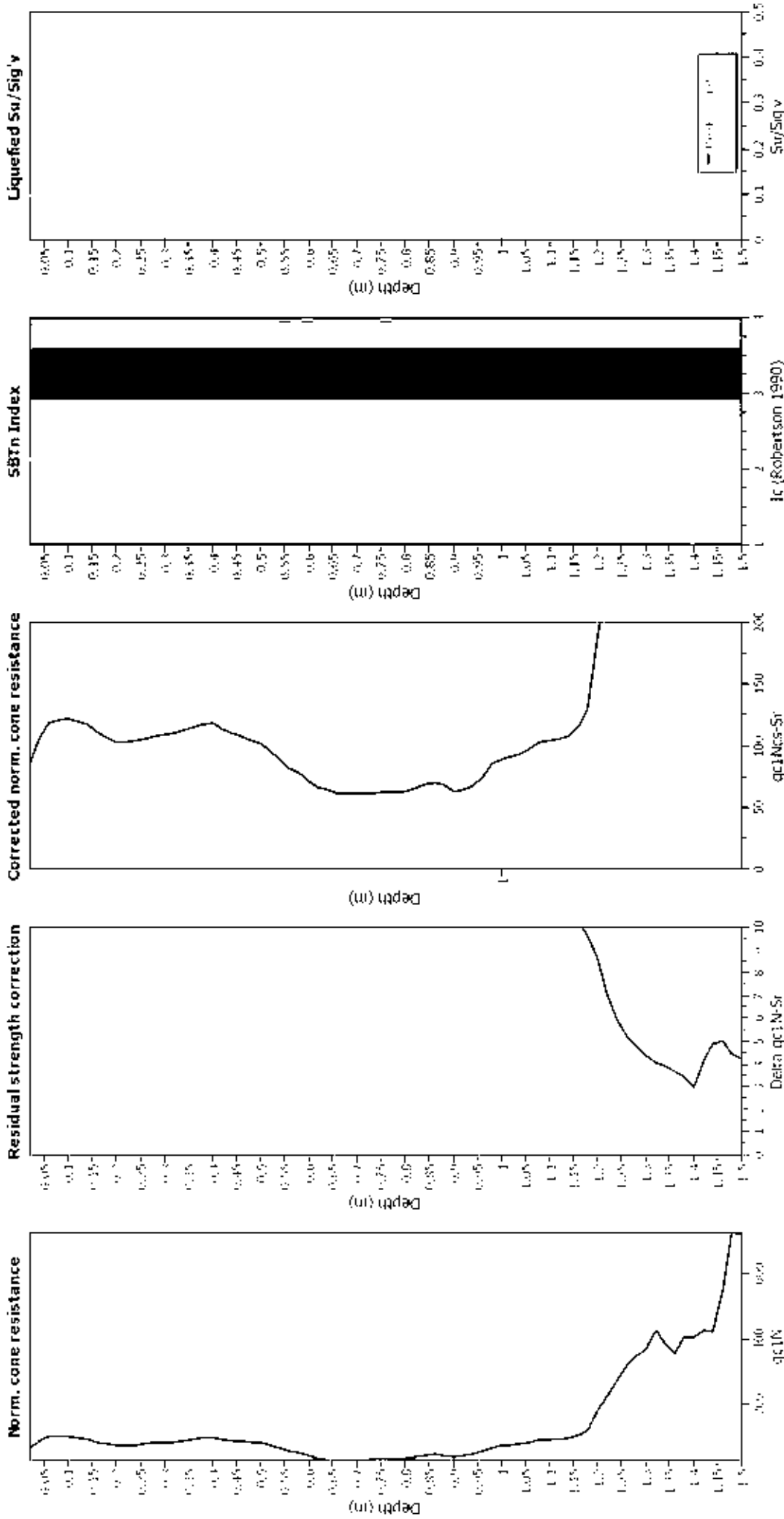
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

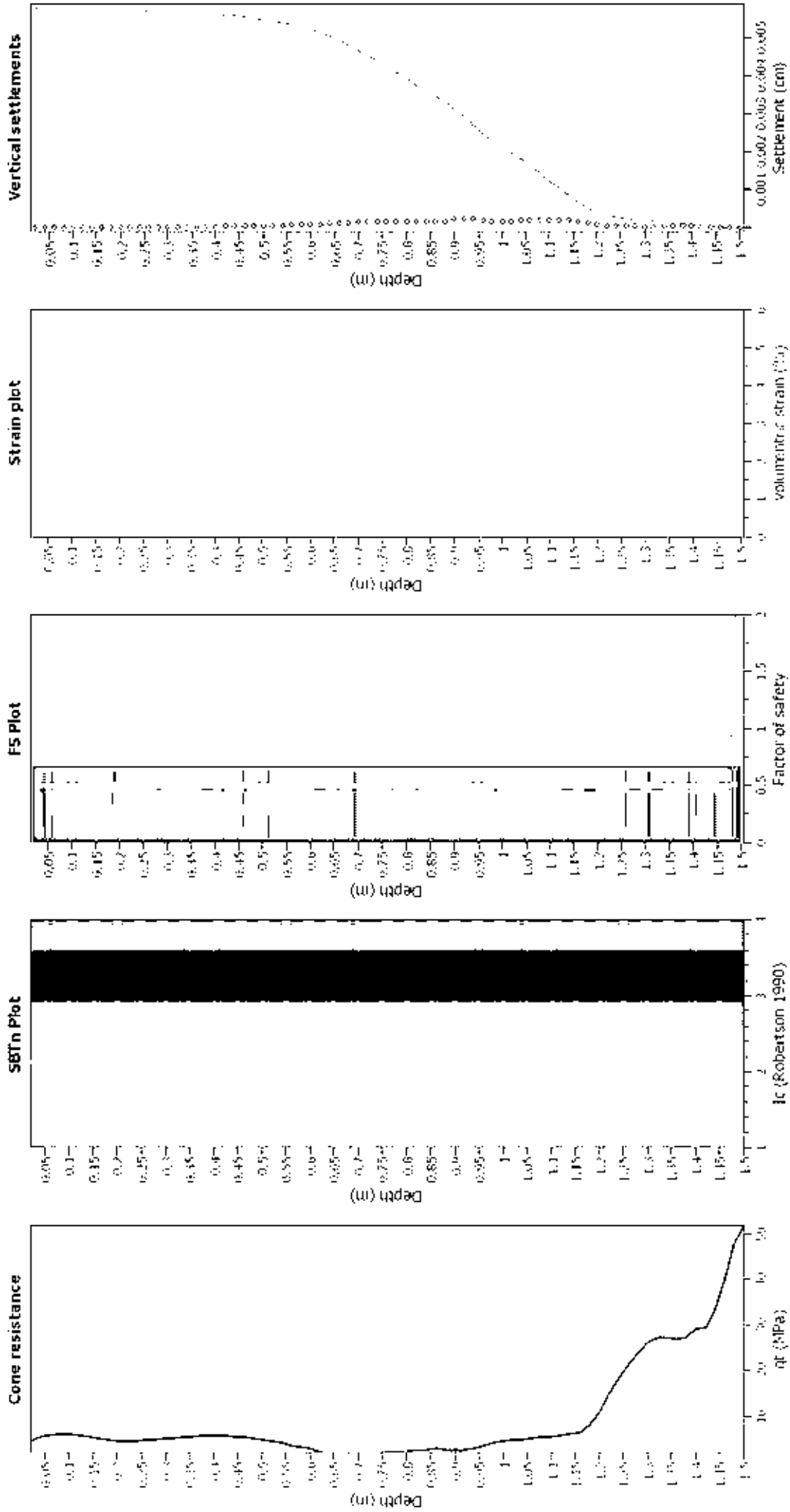
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qc Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- SI Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain



**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT31\_25KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M <sub>w</sub>	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

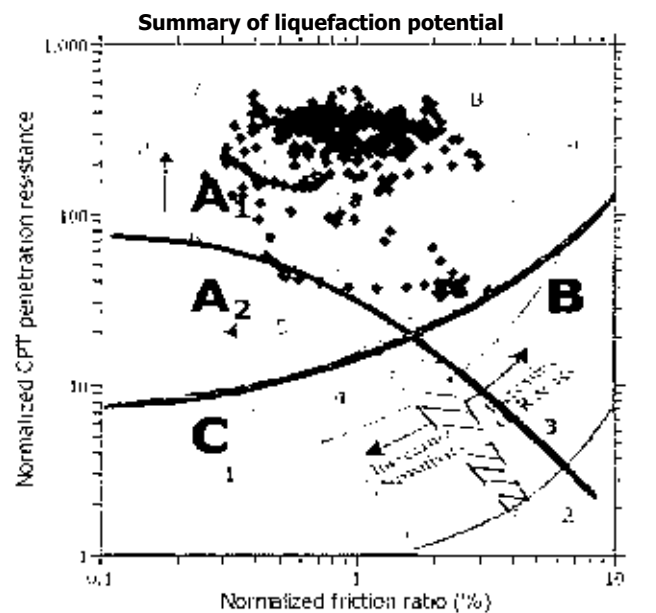
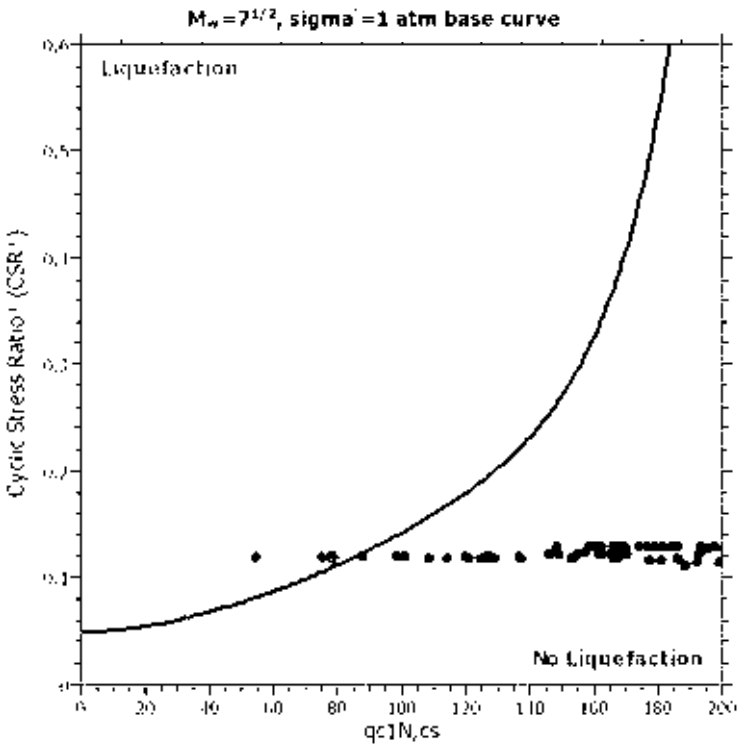
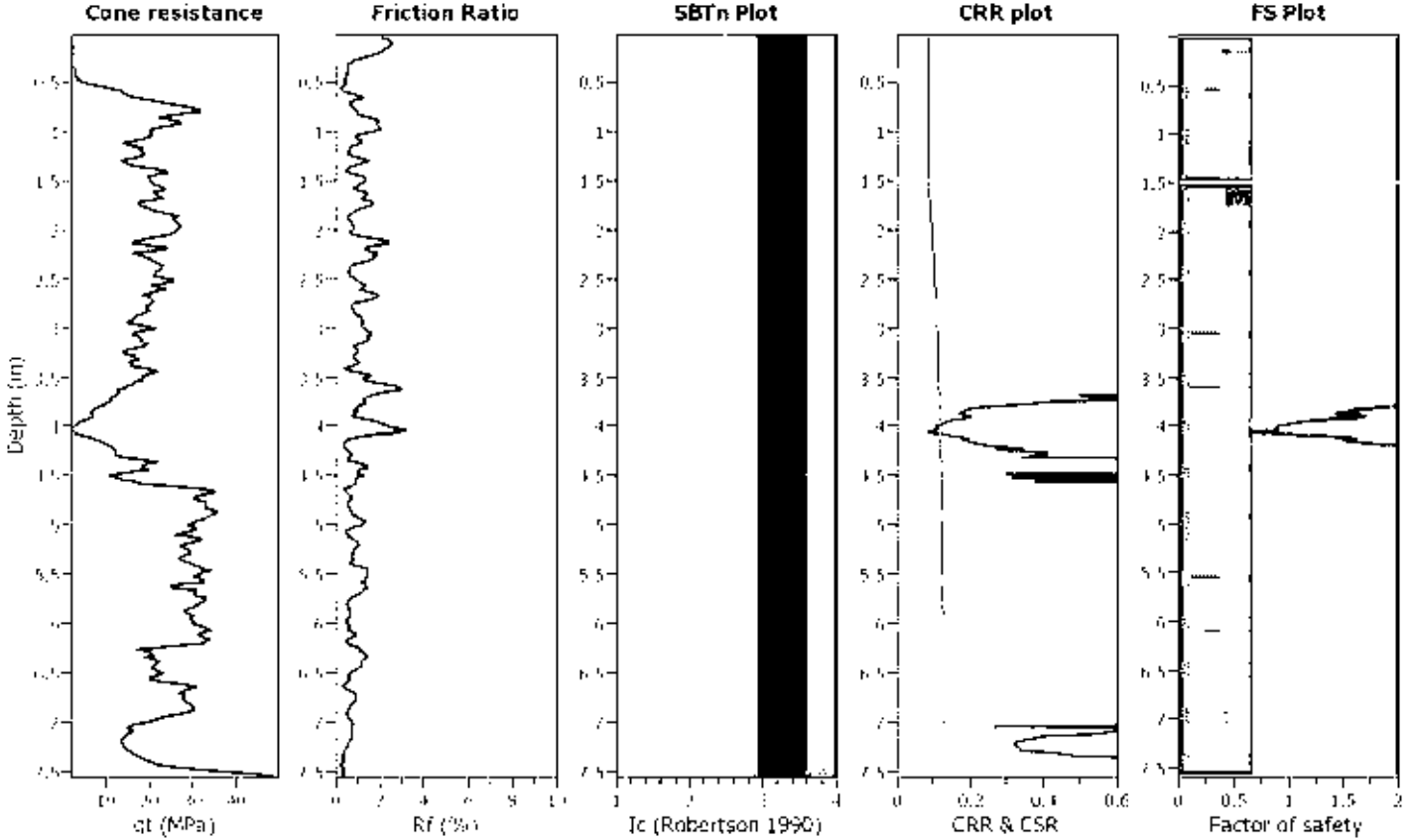
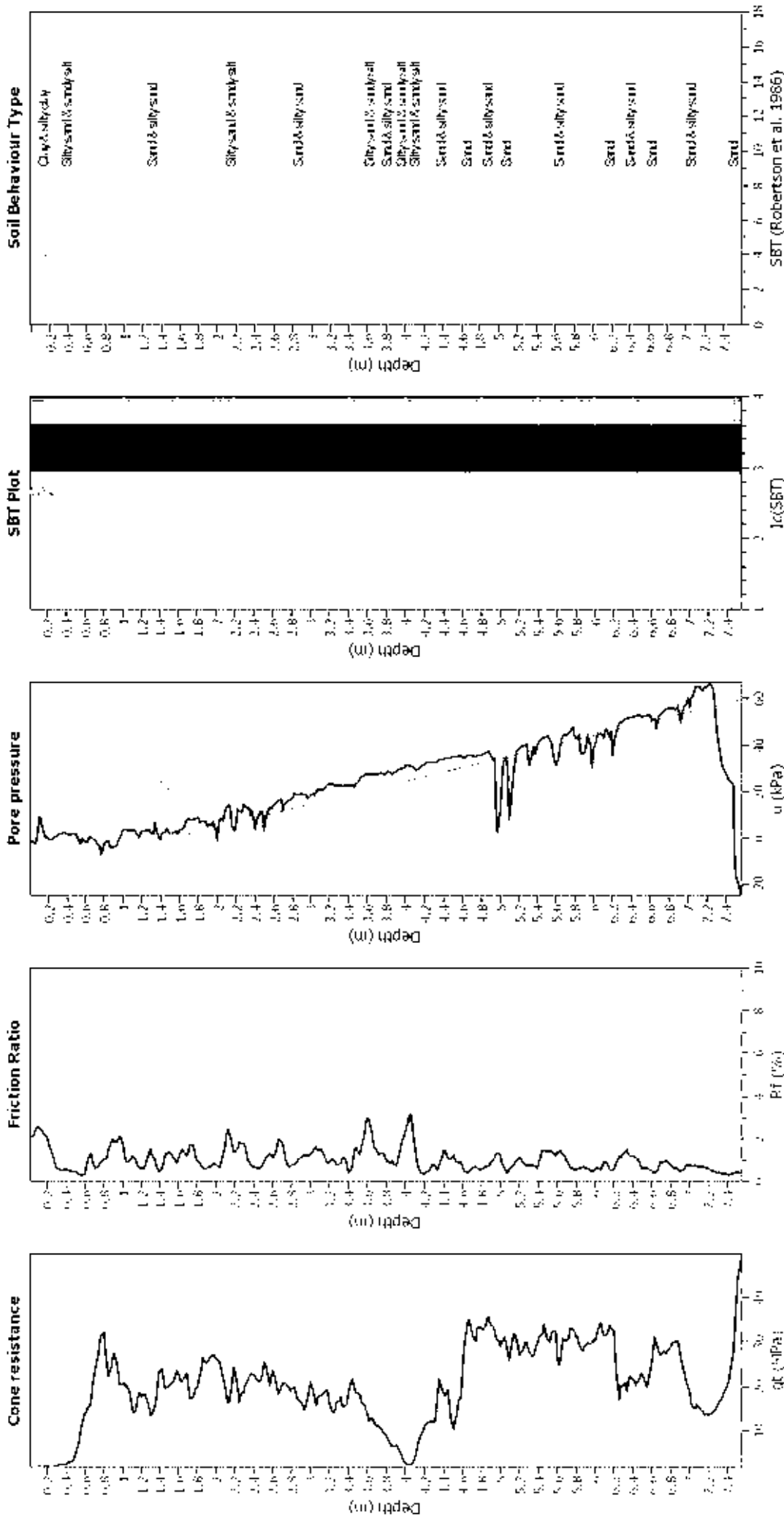


Figure 4: Summary of liquefaction potential plot and data points for test 31. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio less than 10%. Zone A2: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 10% and 20%. Zone B: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 20% and 30%. Zone C: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 10% and 20%. The liquefaction potential is determined based on the normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



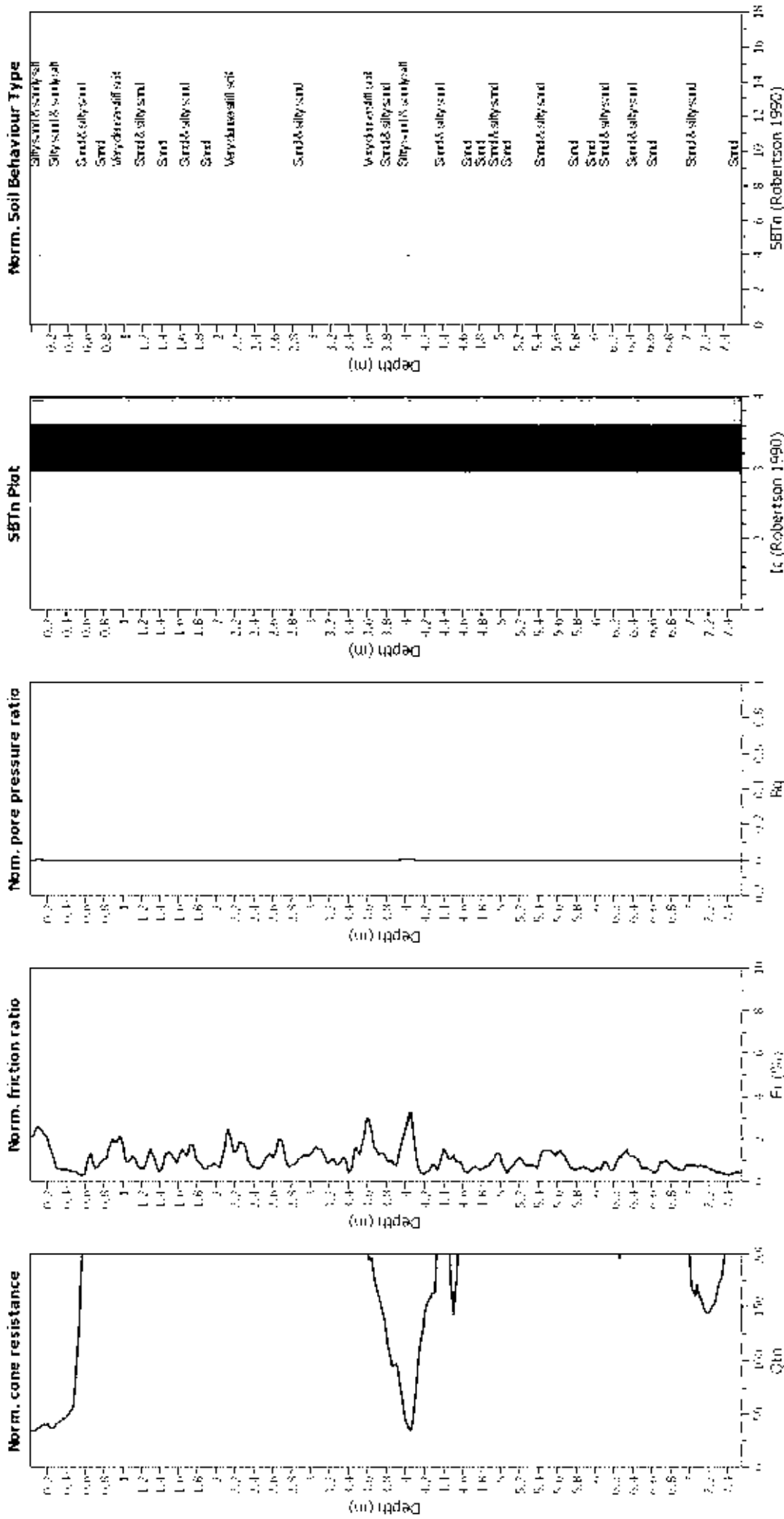
### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Unit weight:	N/A
		Fill height:	N/A
		Depth to GW (earthq.):	1.50 m
		Average results interval:	3
		Ic cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



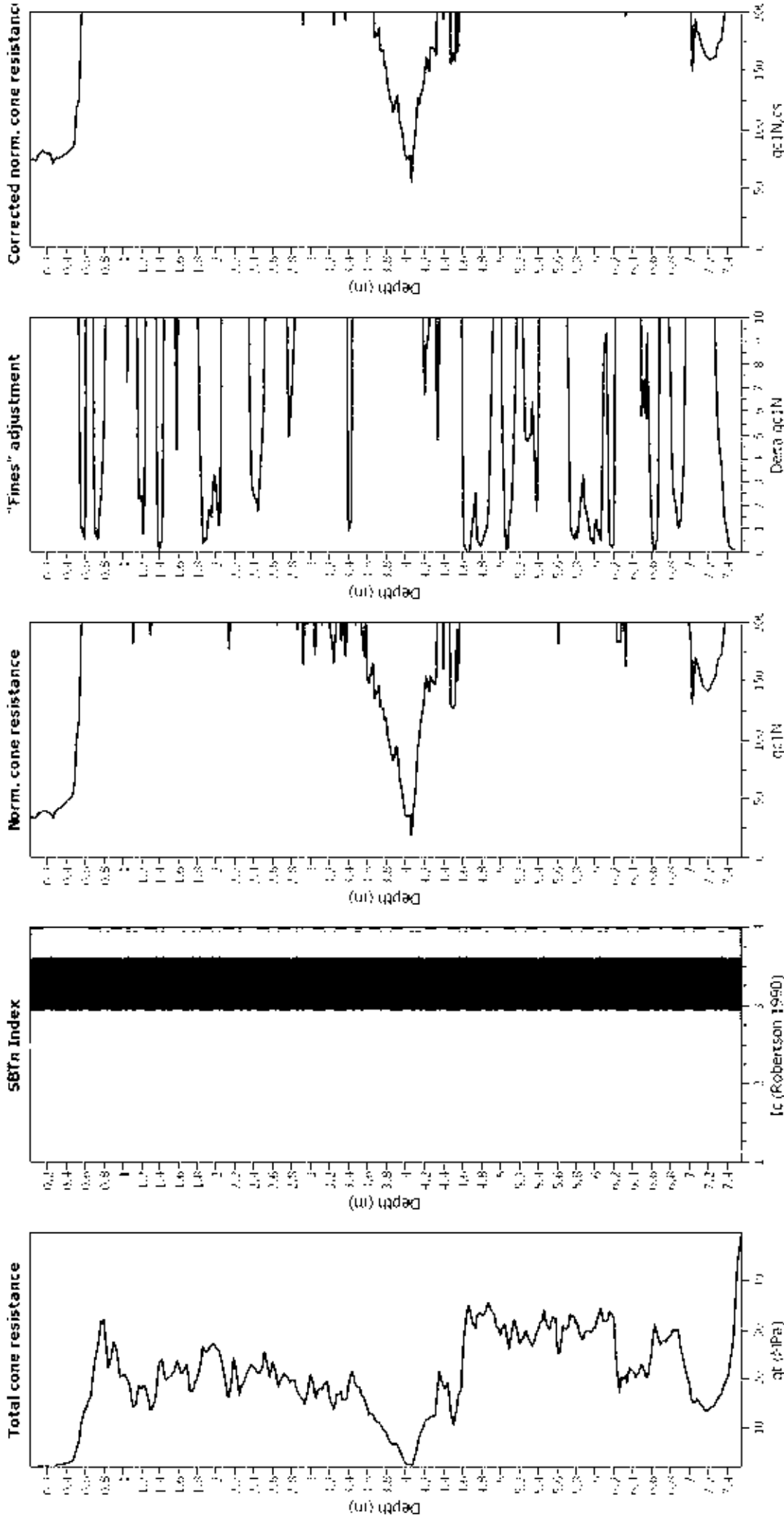
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

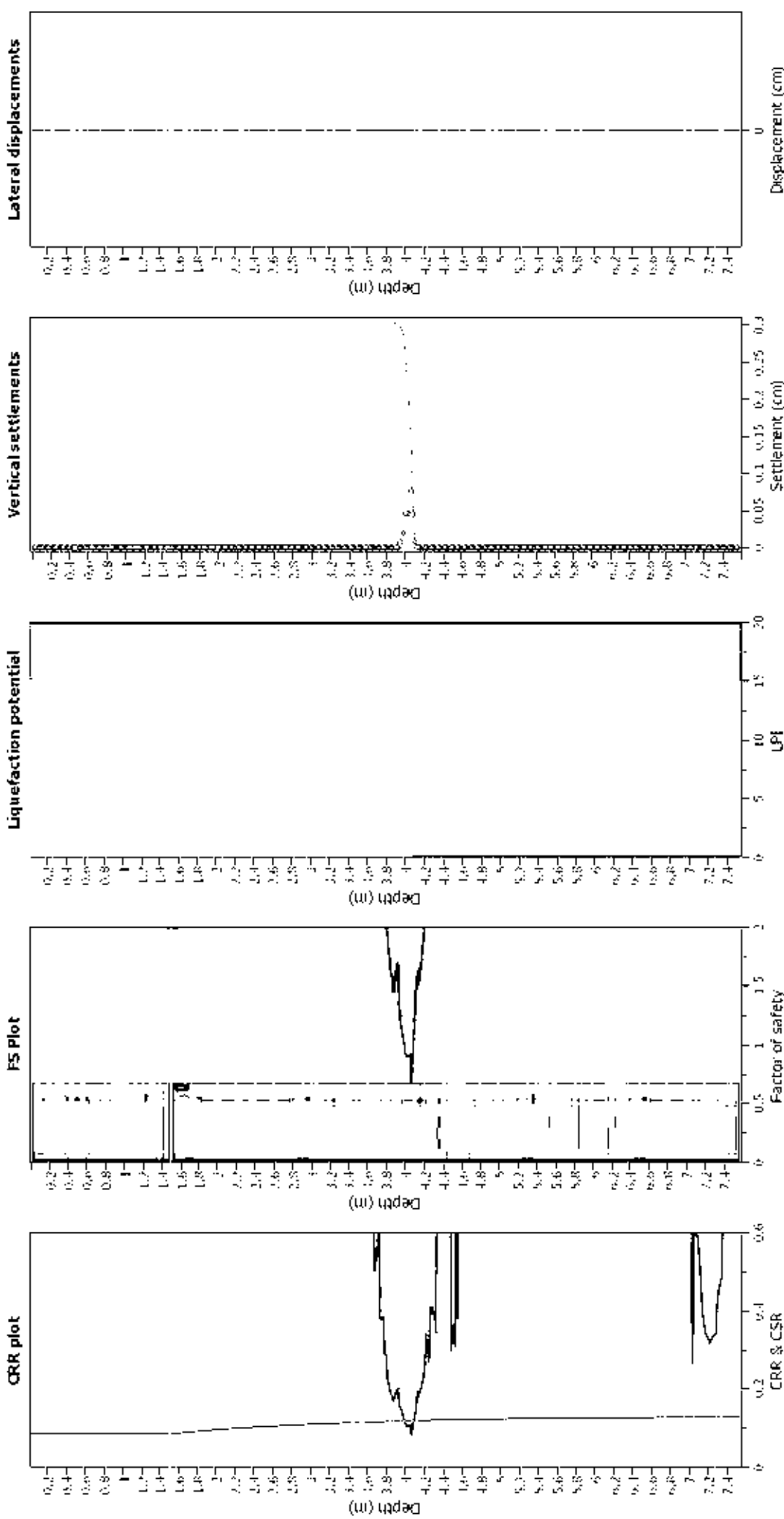
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Input correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

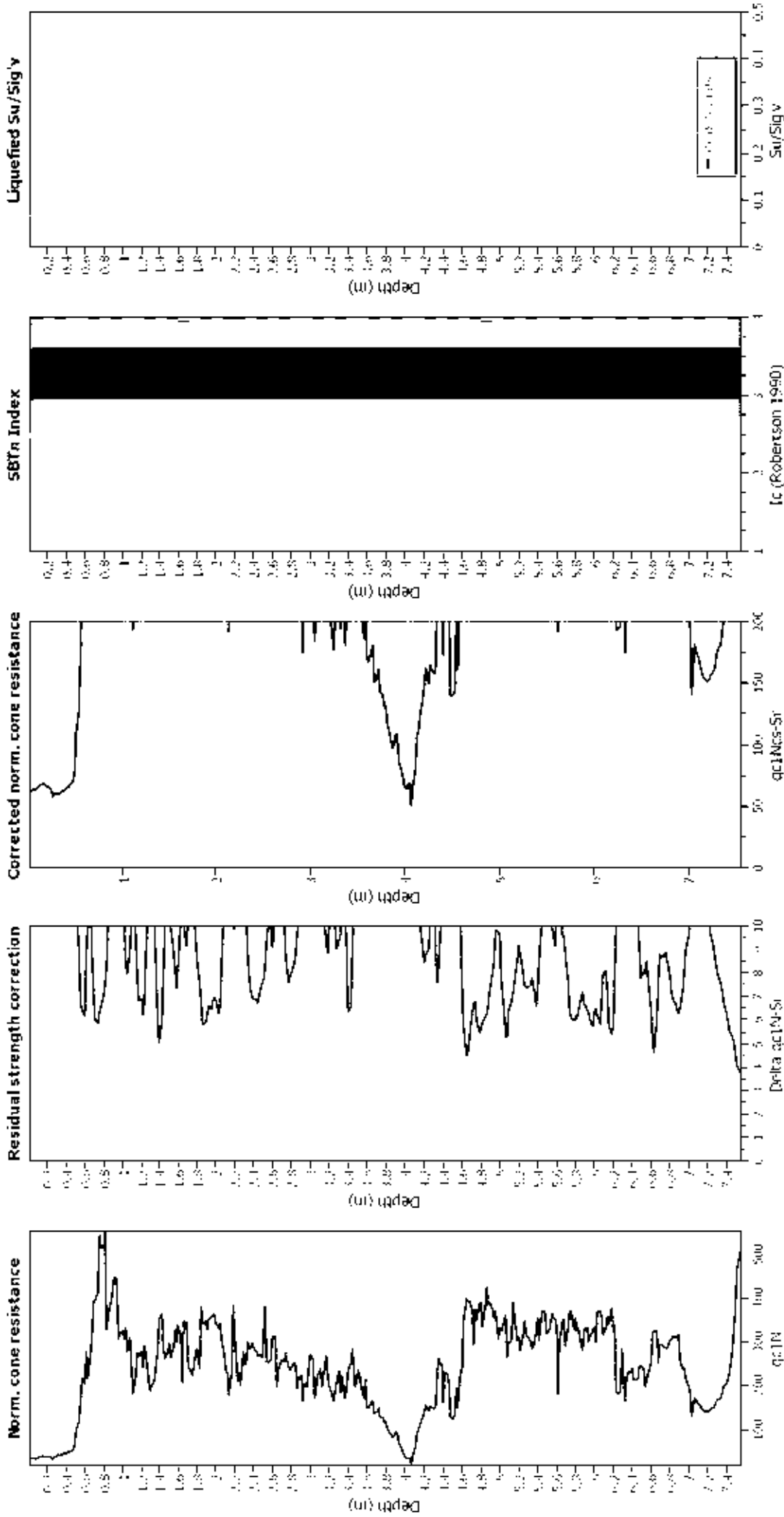
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

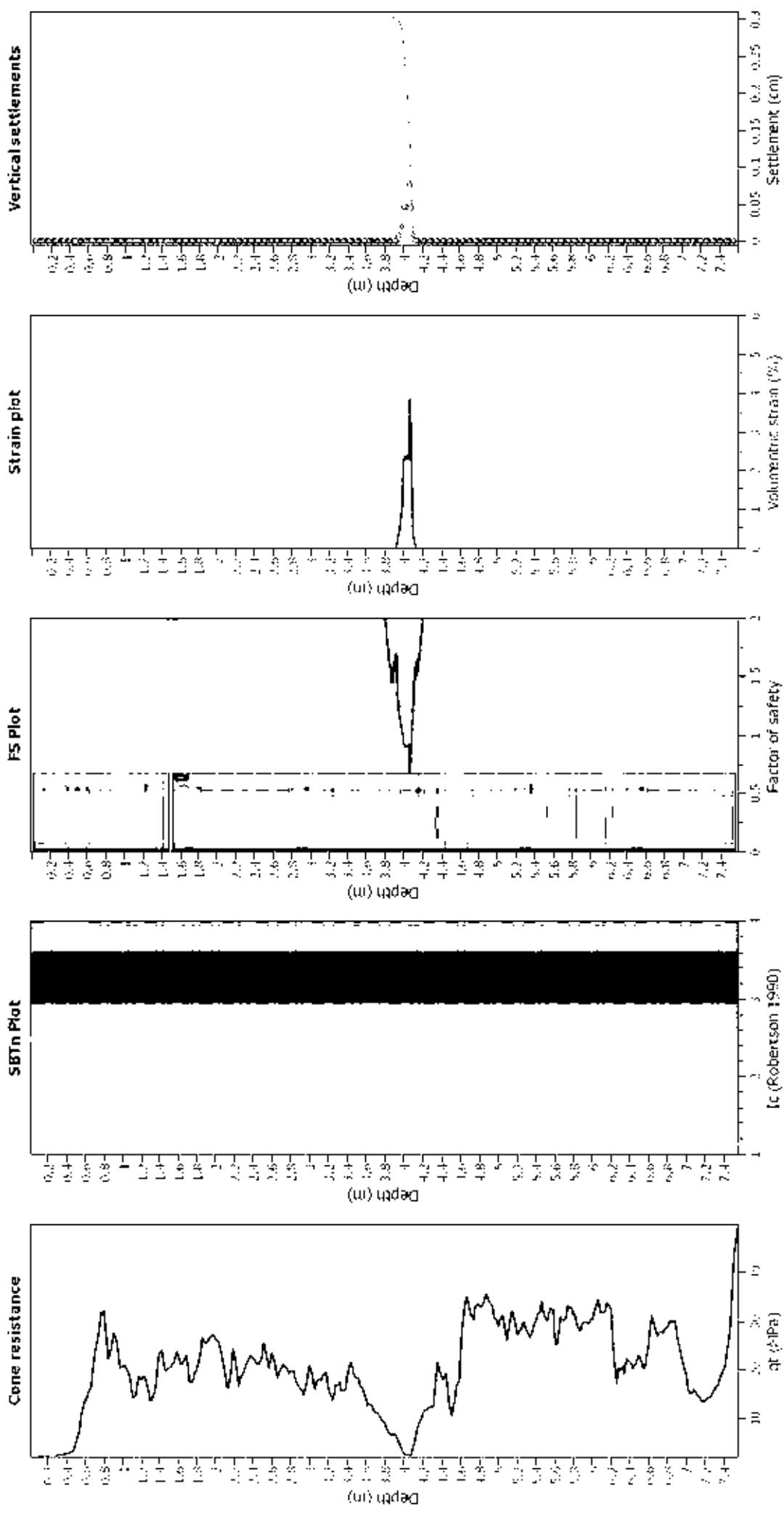
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT32\_1SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

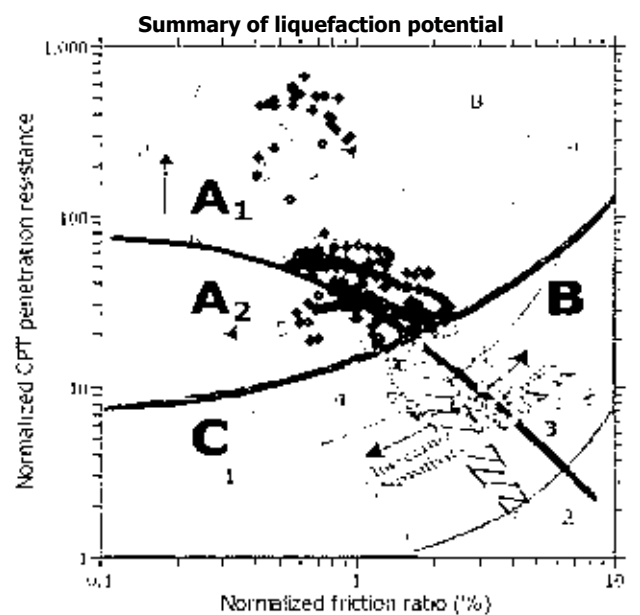
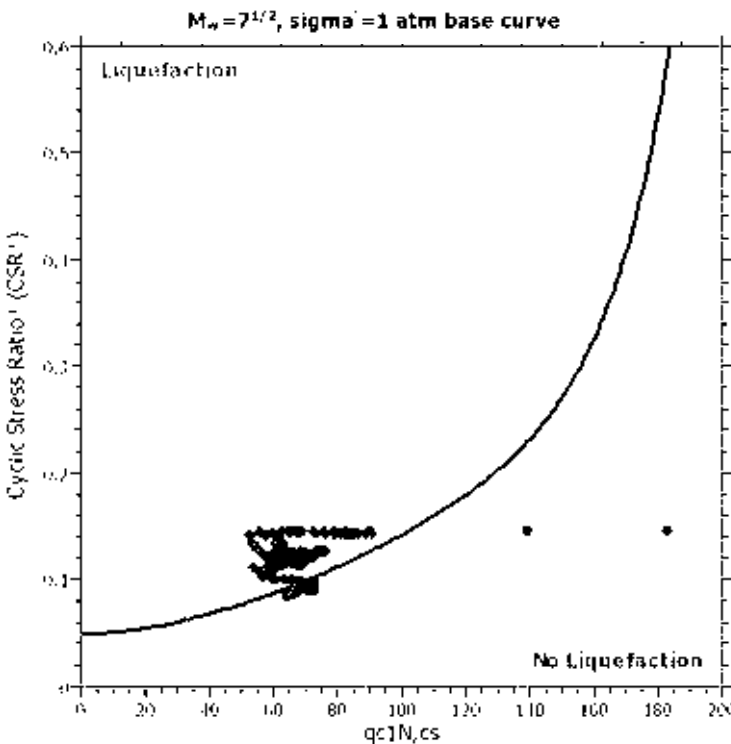
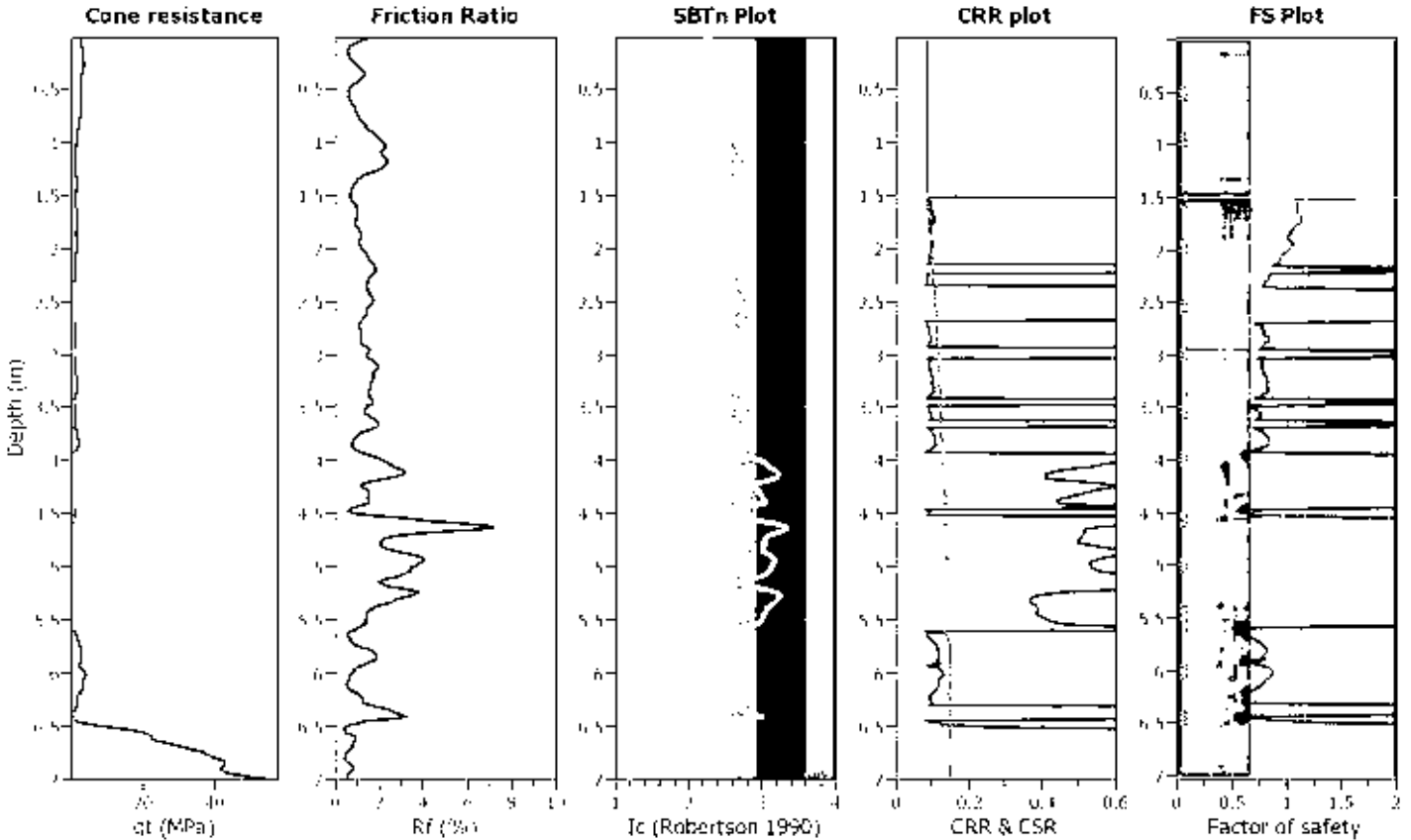
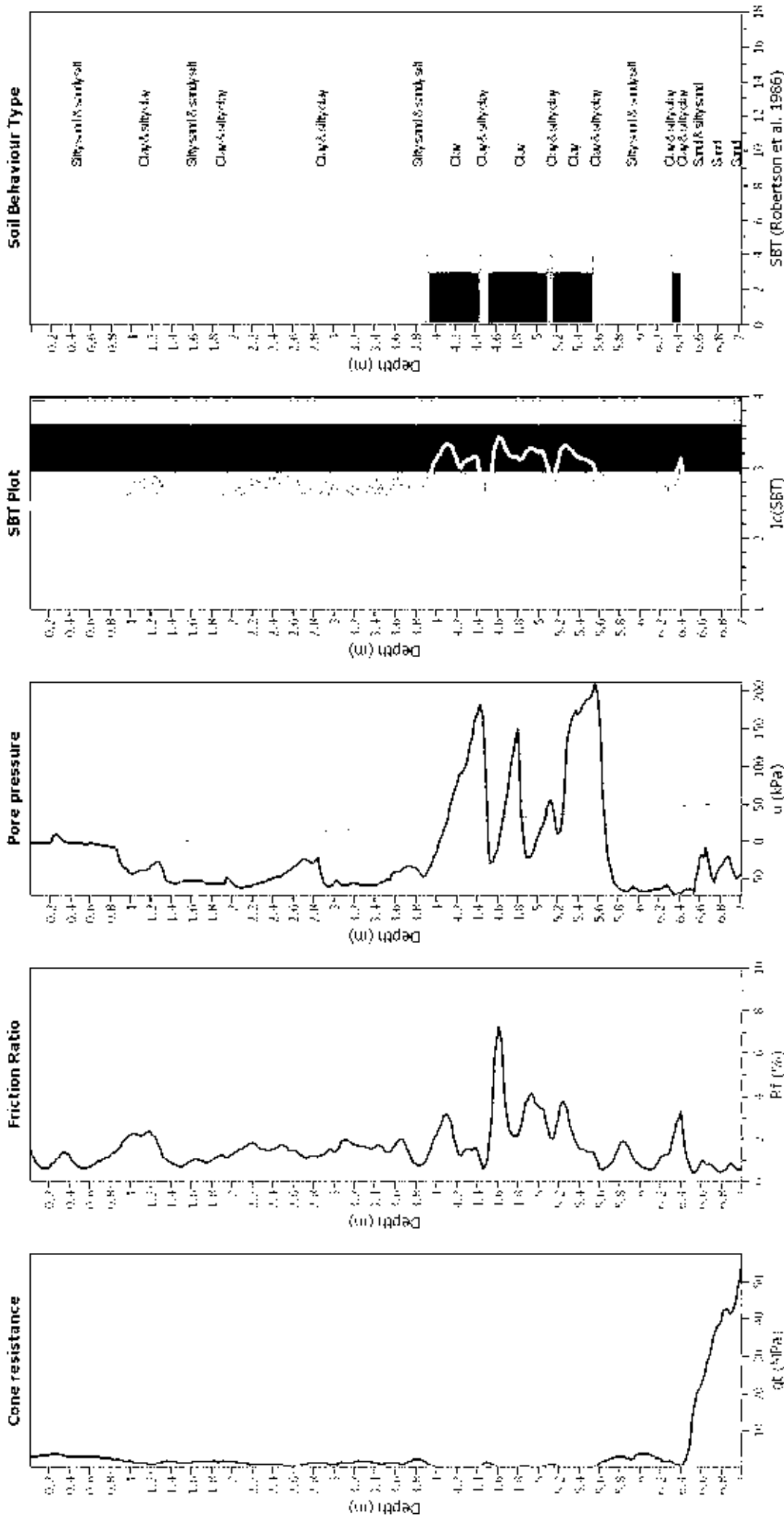


Figure 4: Summary of liquefaction potential plot and data points of cyclic test. Zone A1: Normal penetration resistance (100 to 200 kPa) and friction ratio (20 to 30%). Zone A2: Normal penetration resistance (200 to 400 kPa) and friction ratio (10 to 20%). Zone B: Normal penetration resistance (400 to 600 kPa) and friction ratio (5 to 10%). Zone C: Normal penetration resistance (600 to 1000 kPa) and friction ratio (2 to 5%).



### CPT basic interpretation plots



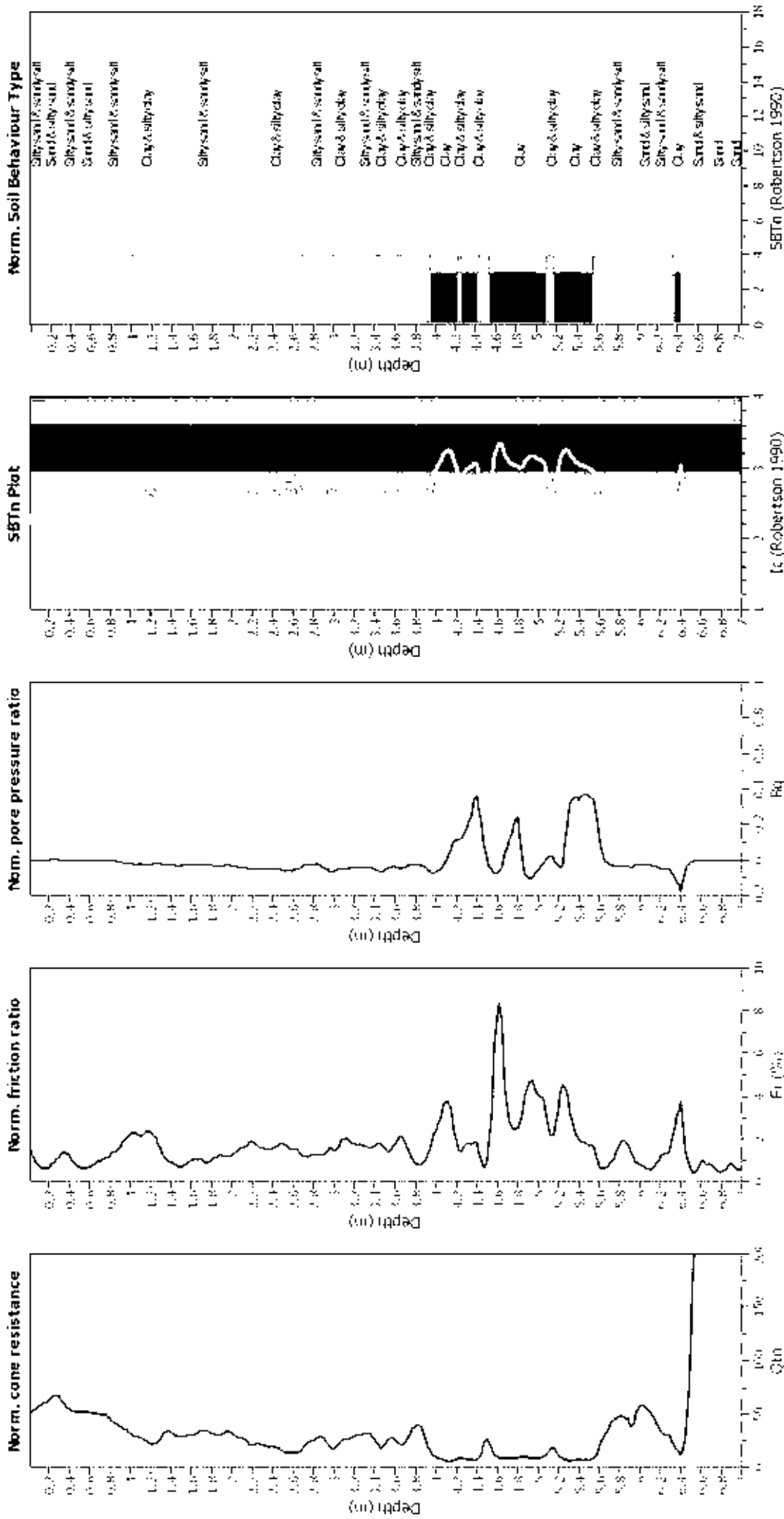
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



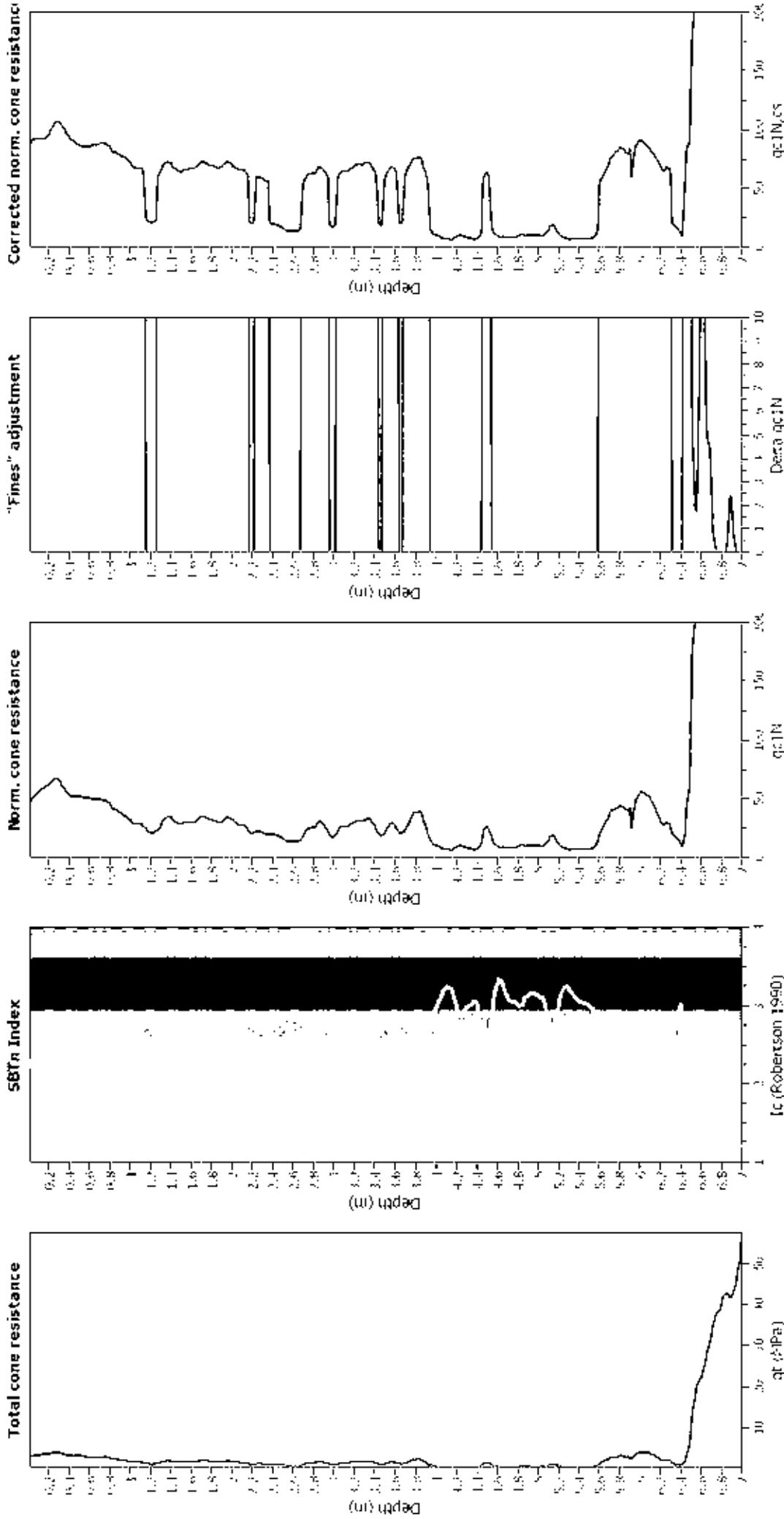
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

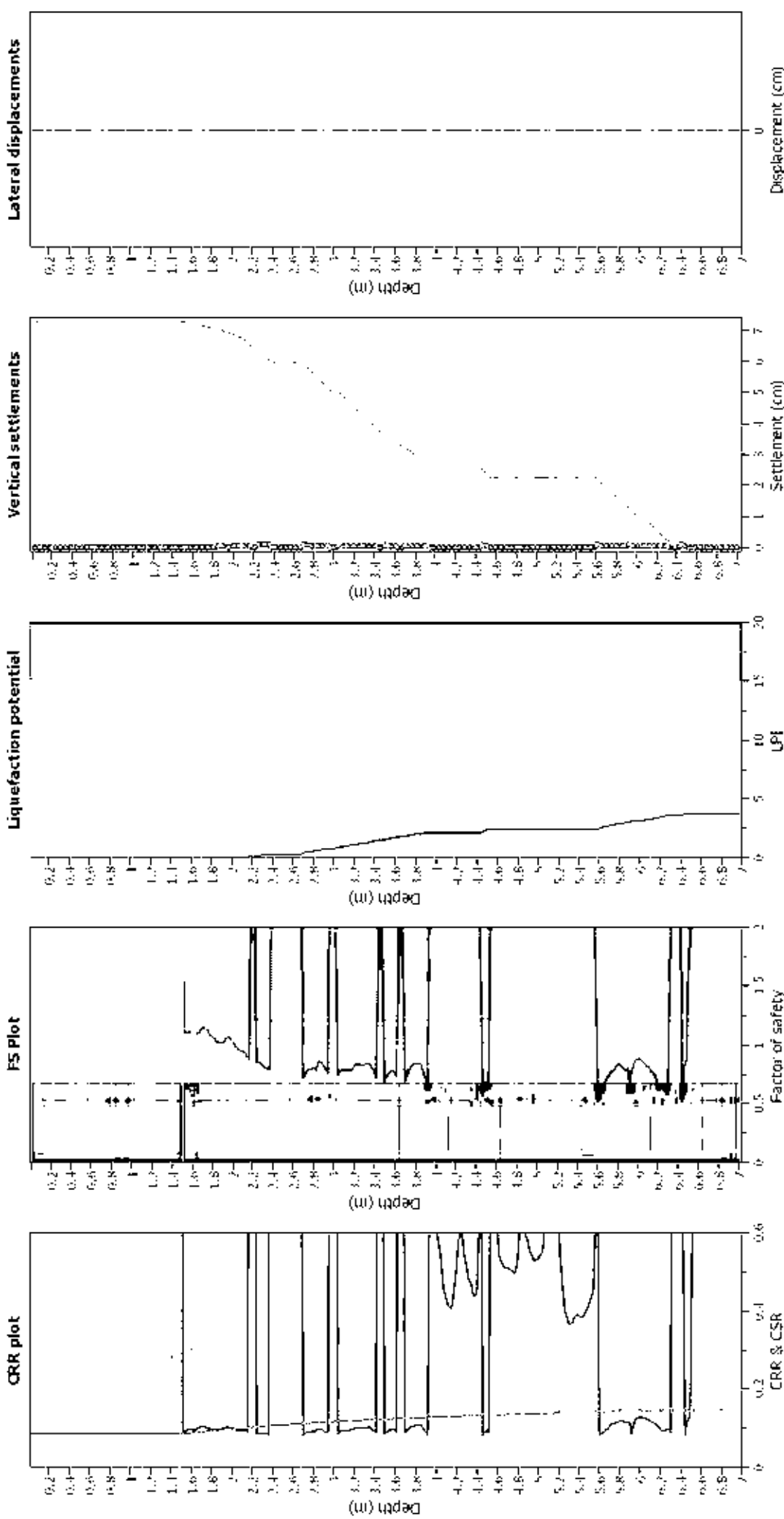
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table ( $z_{w(t)}$ ):	1.50 m	Limit depth:	N/A
Depth to GWT (erthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

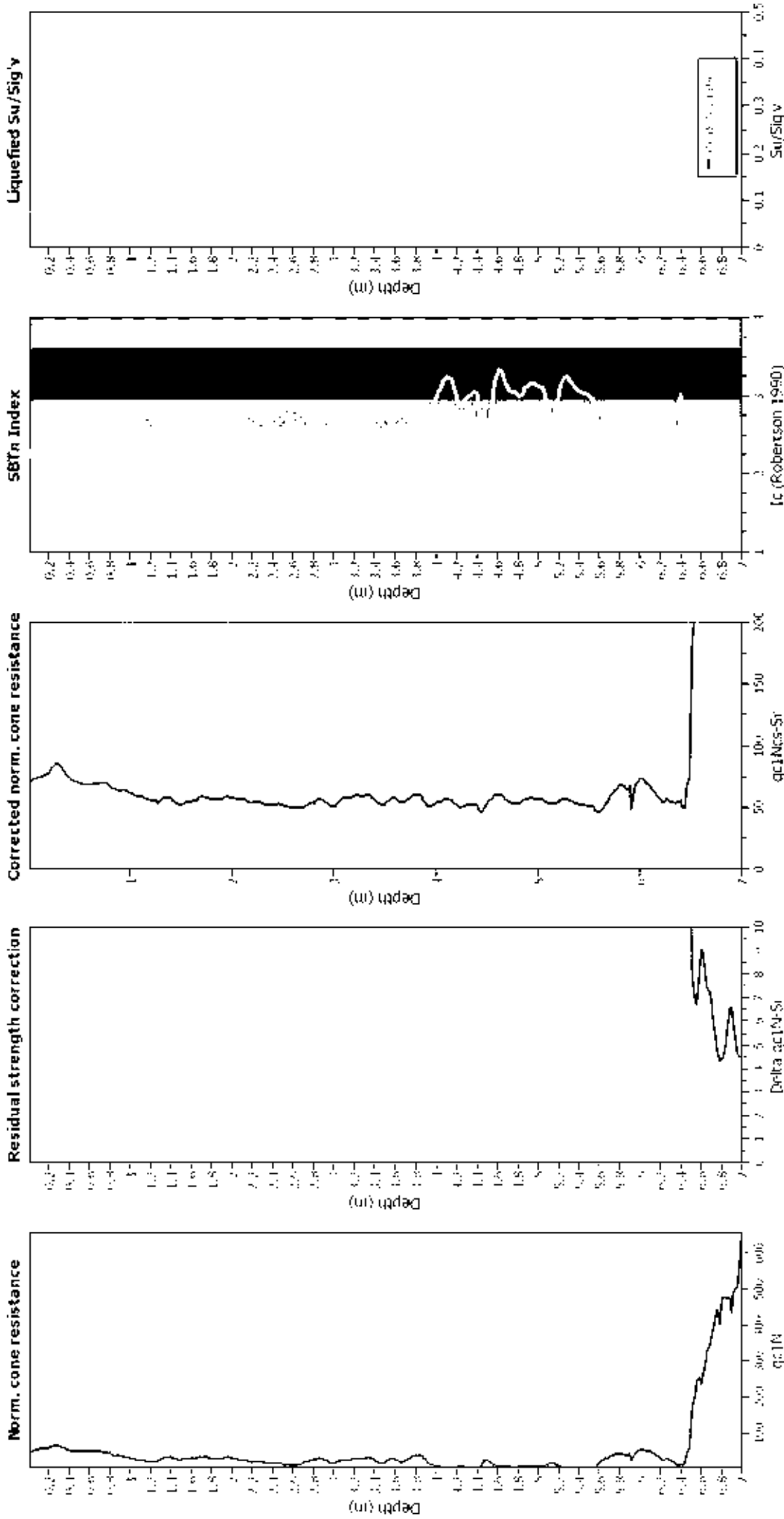
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

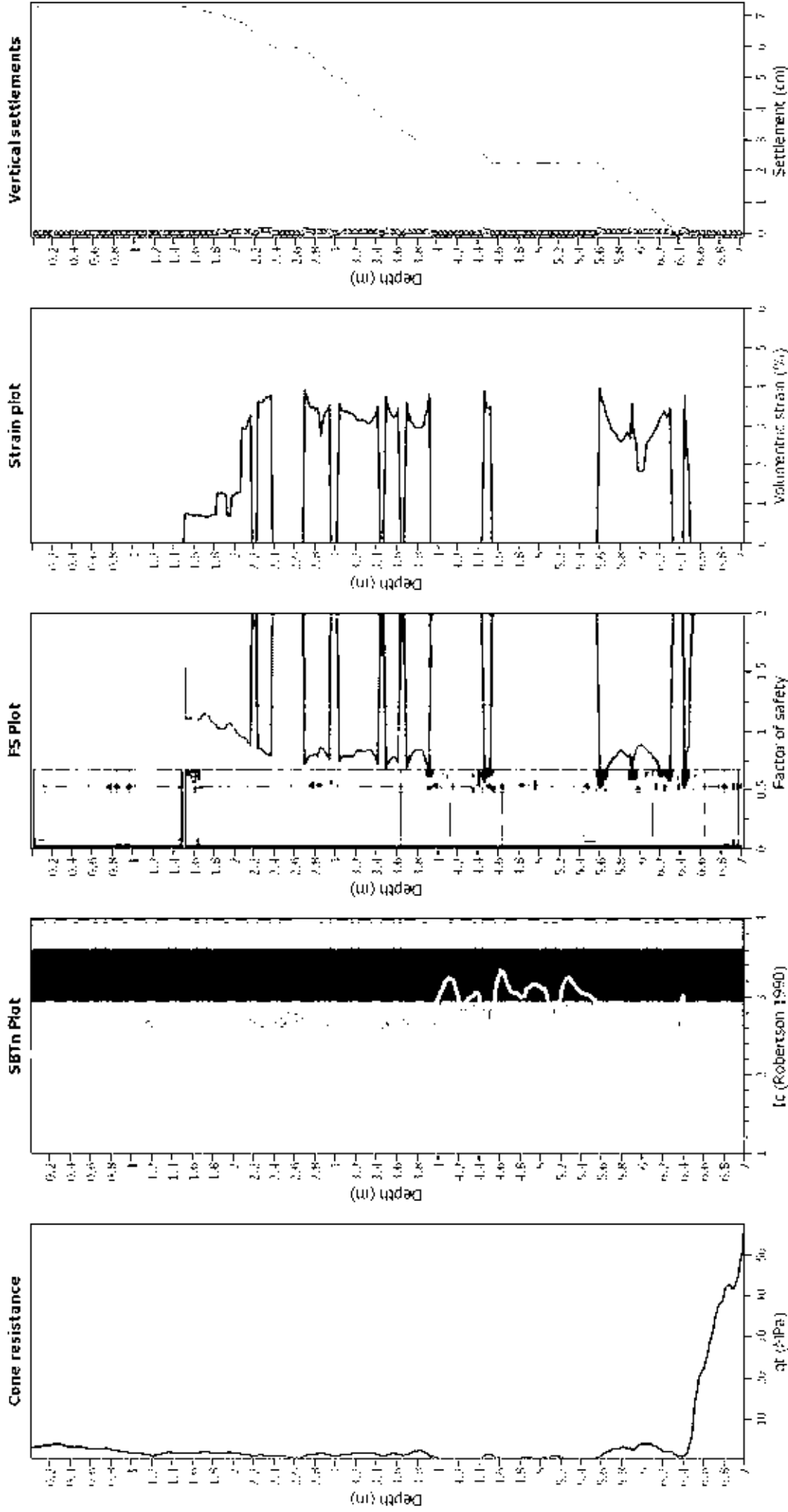
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT33\_876CashmereRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

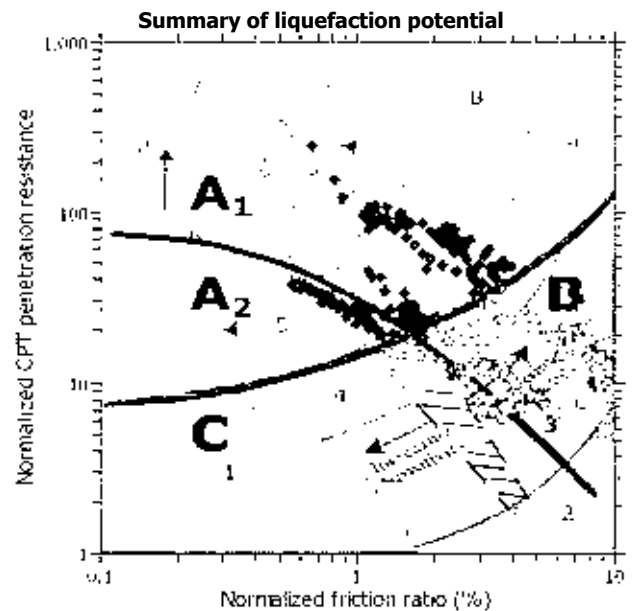
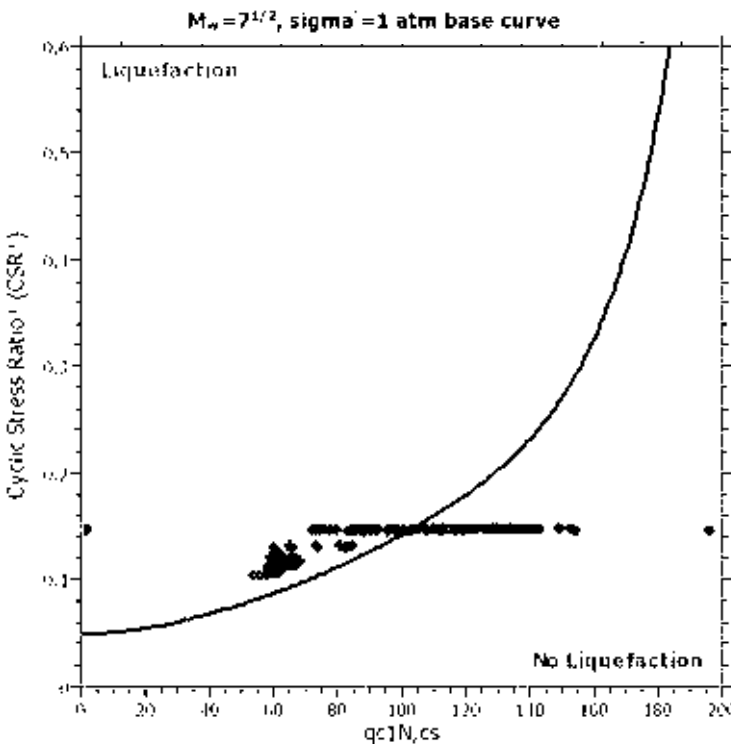
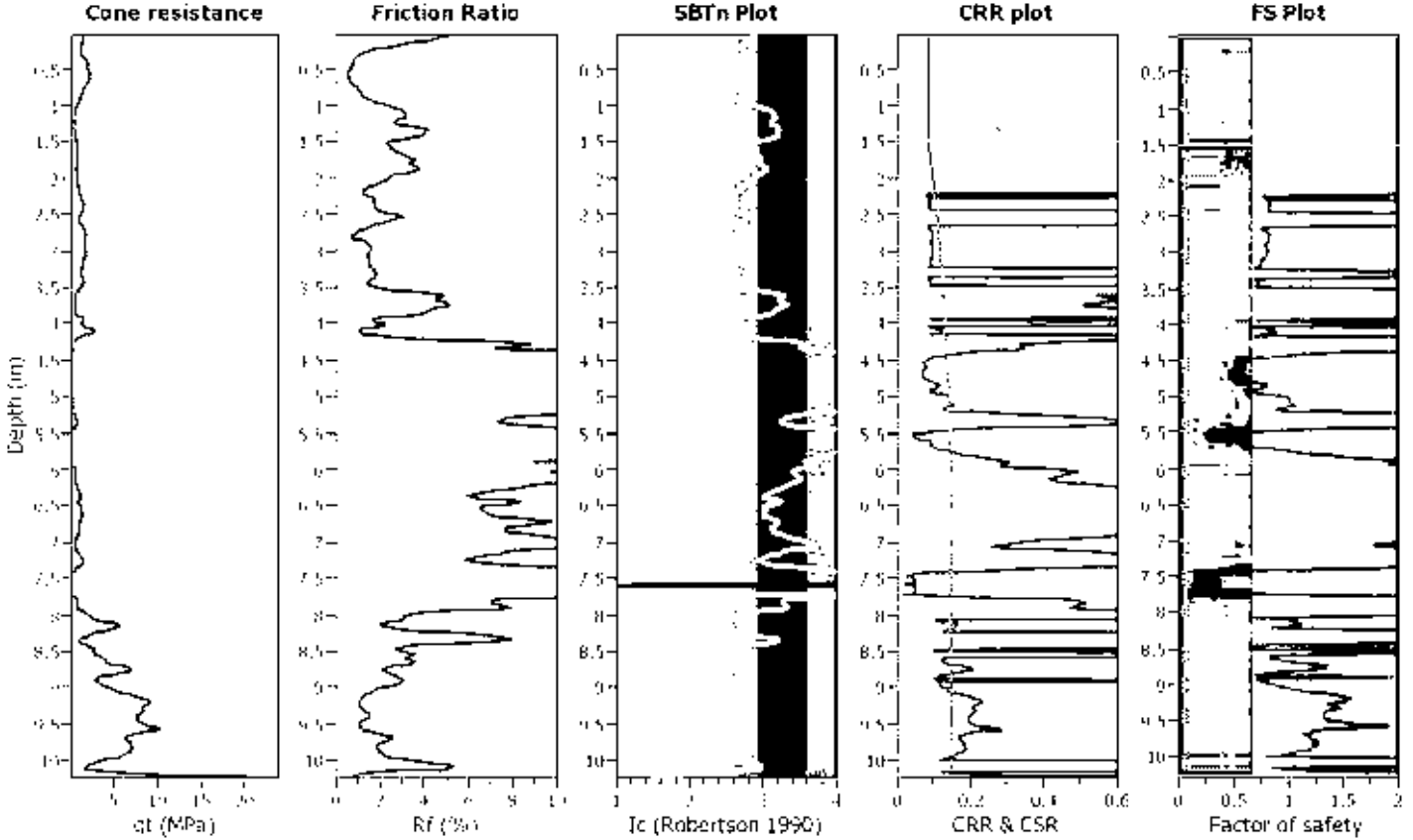
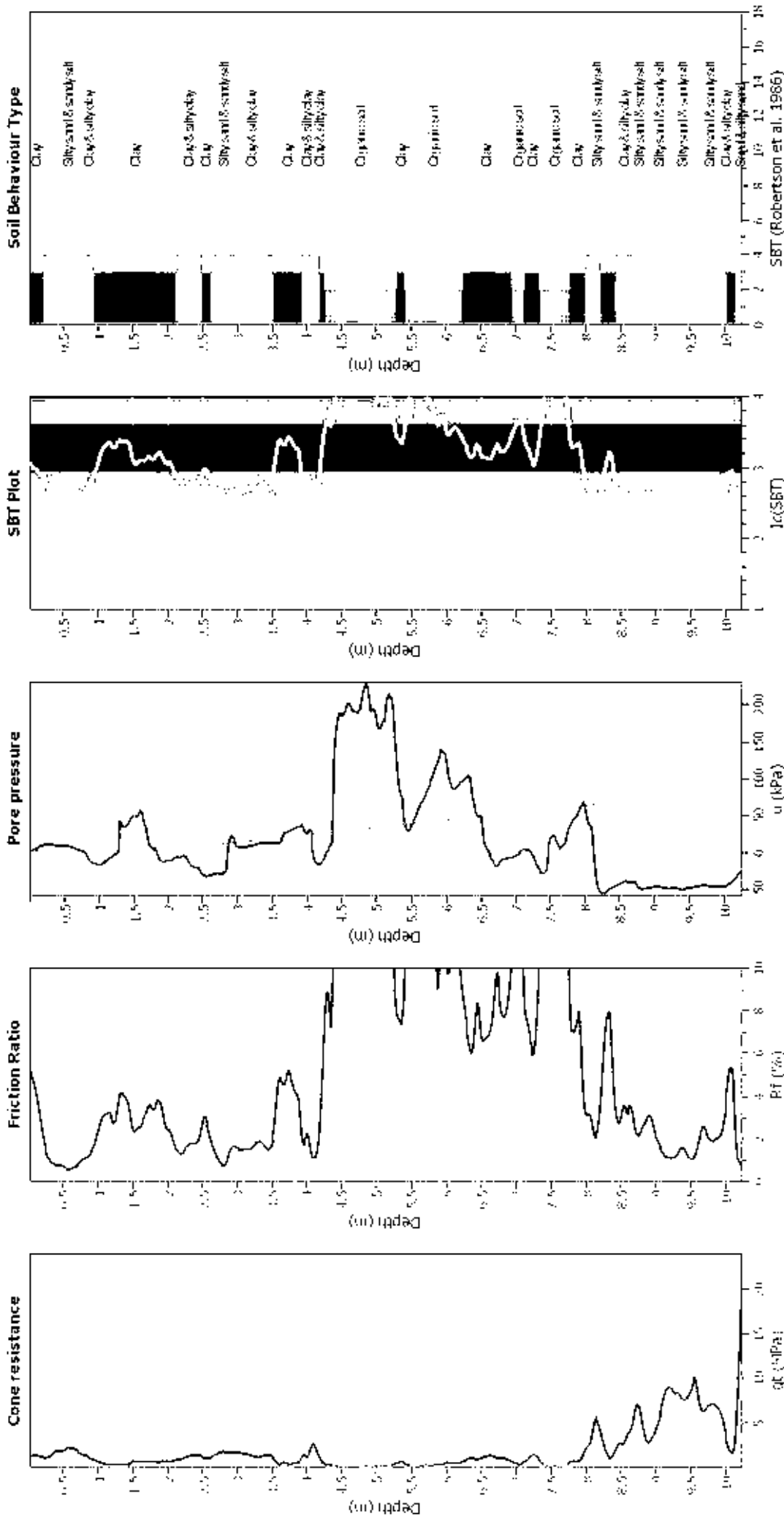


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with zones A1, A2, B, and C defined. The liquefaction potential is indicated by the diagonal line. The plot is based on the input parameters and analysis data provided in the report.

### CPT basic interpretation plots



#### Input parameters and analysis data

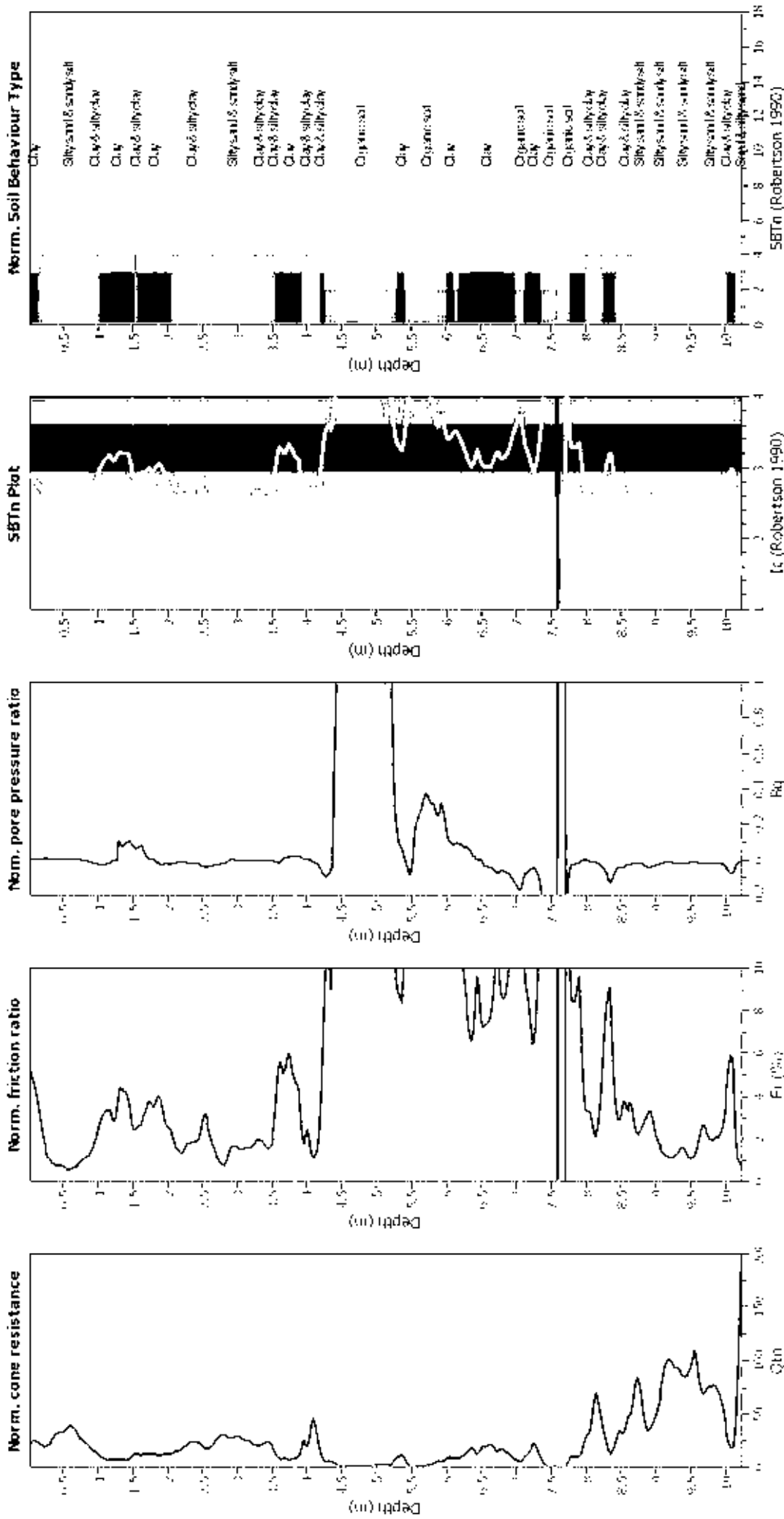
Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### CPT basic interpretation plots (normalized)



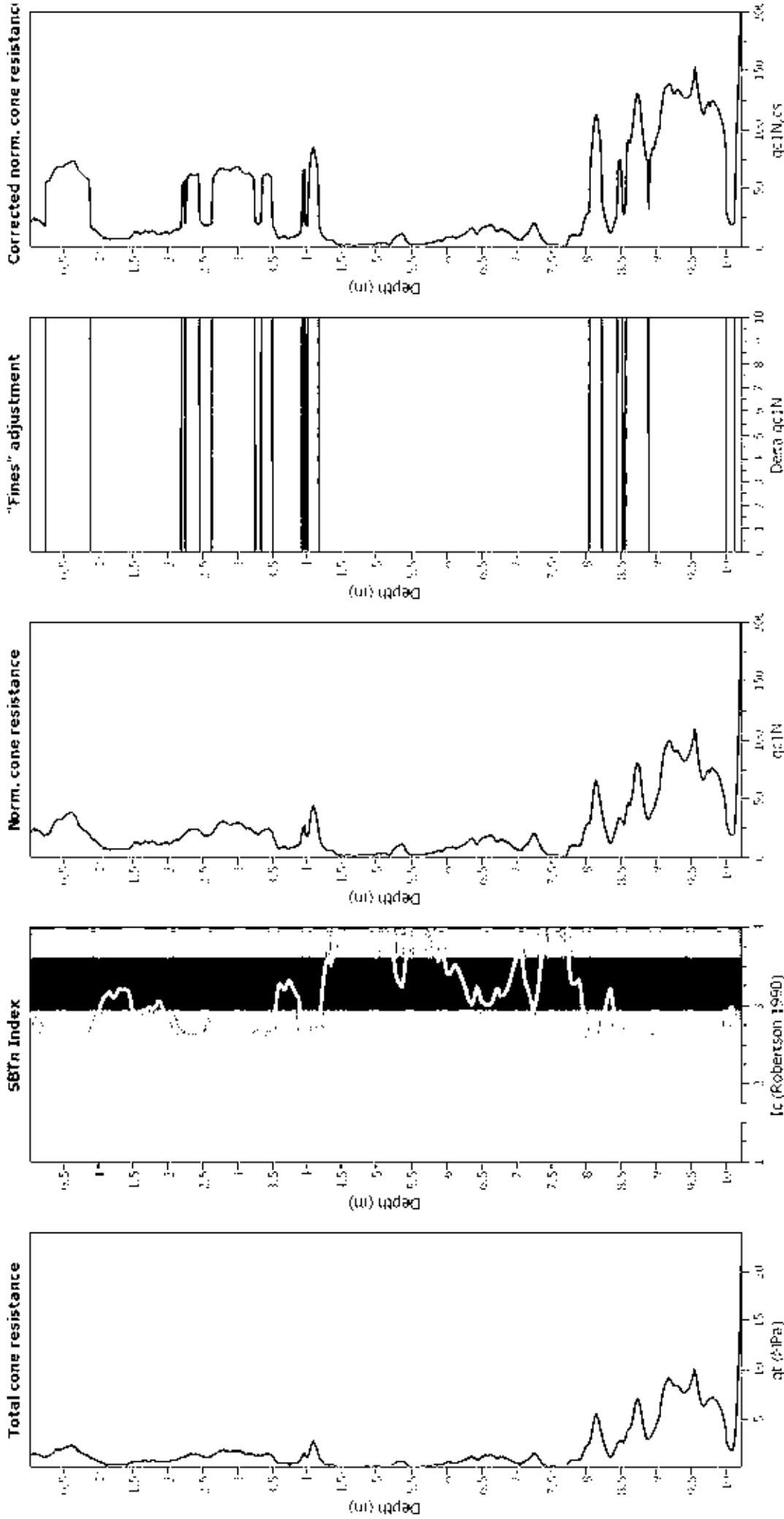
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

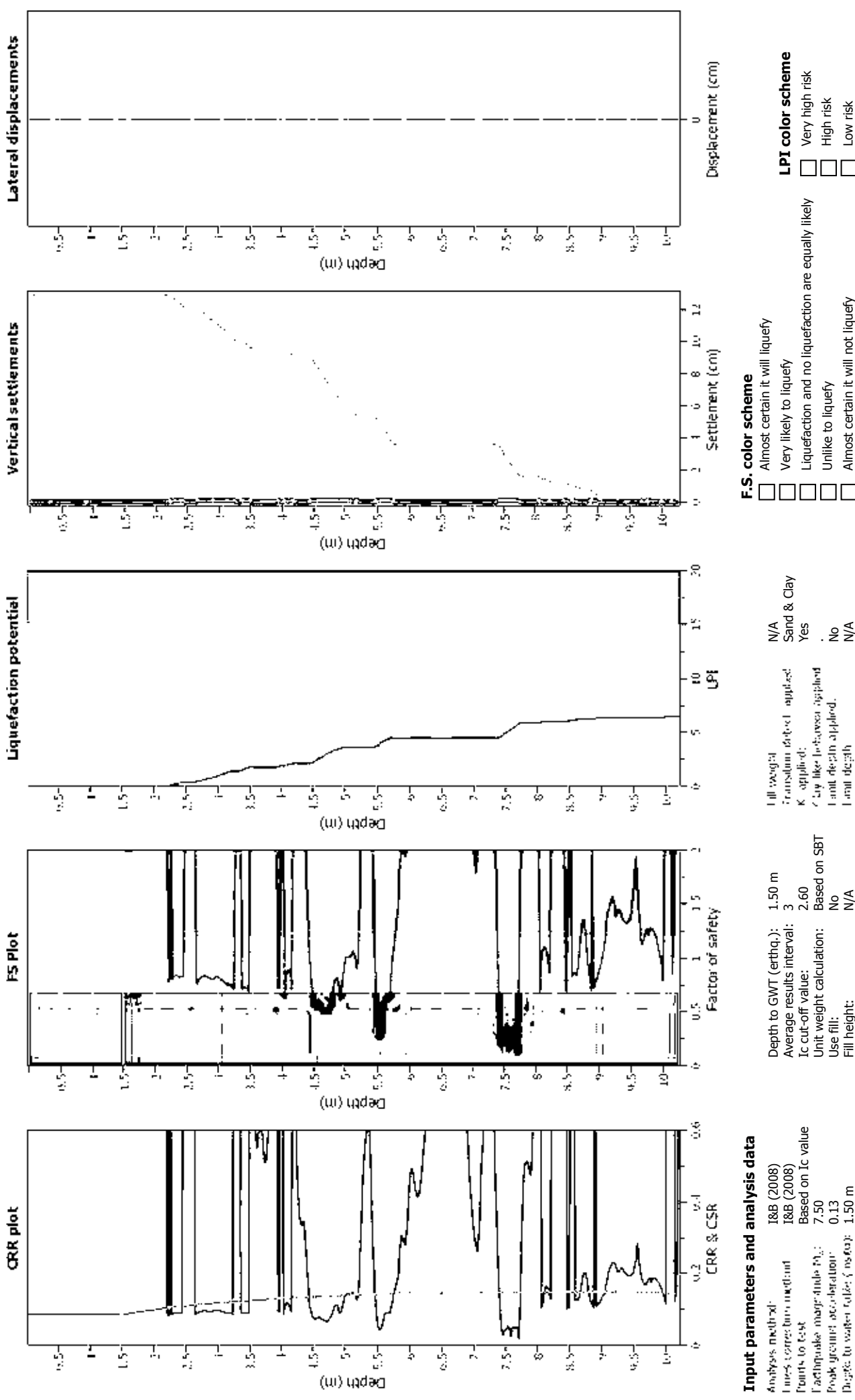
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. single P <sub>v</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.5  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition depth applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No  
 Limit depth: N/A

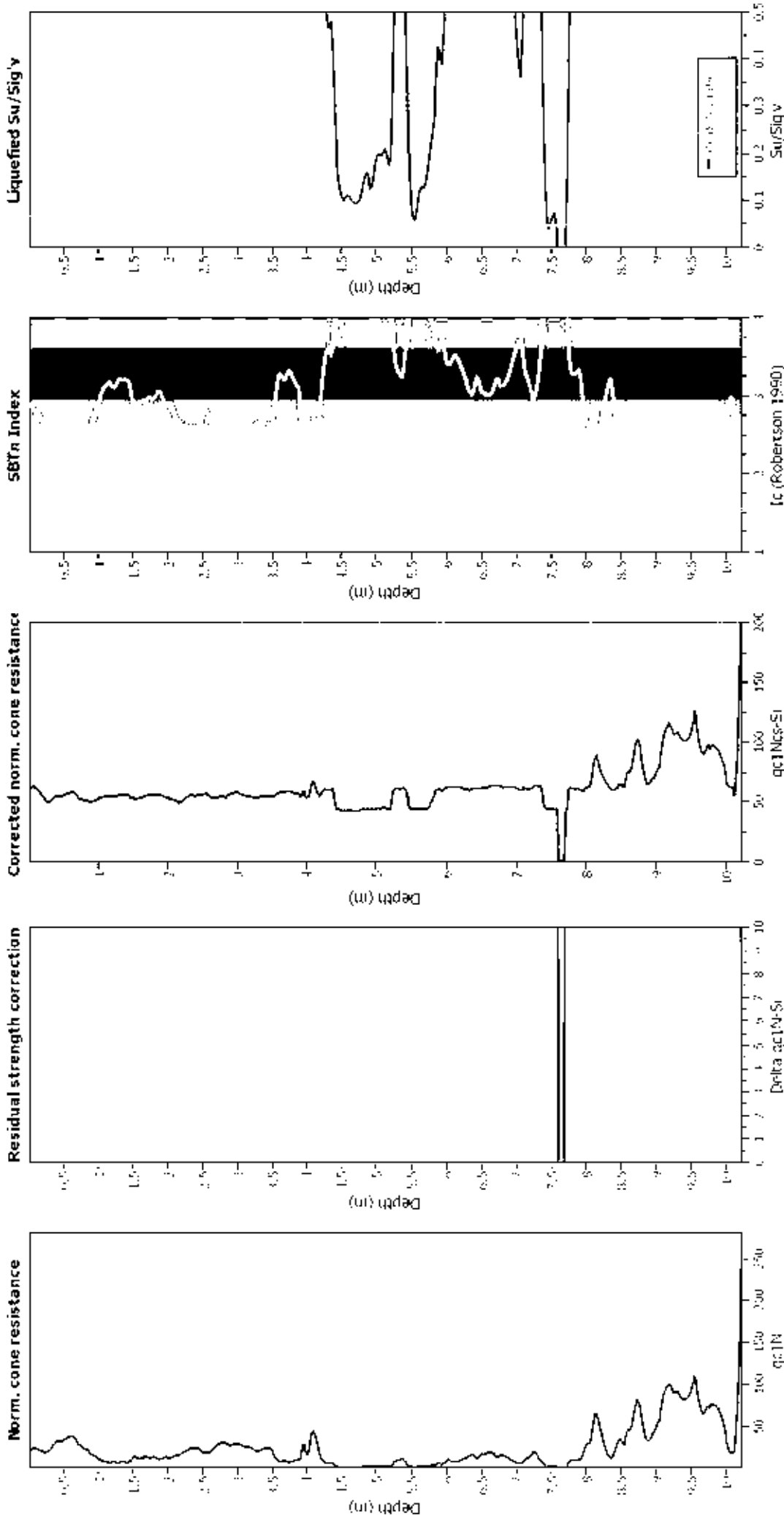
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

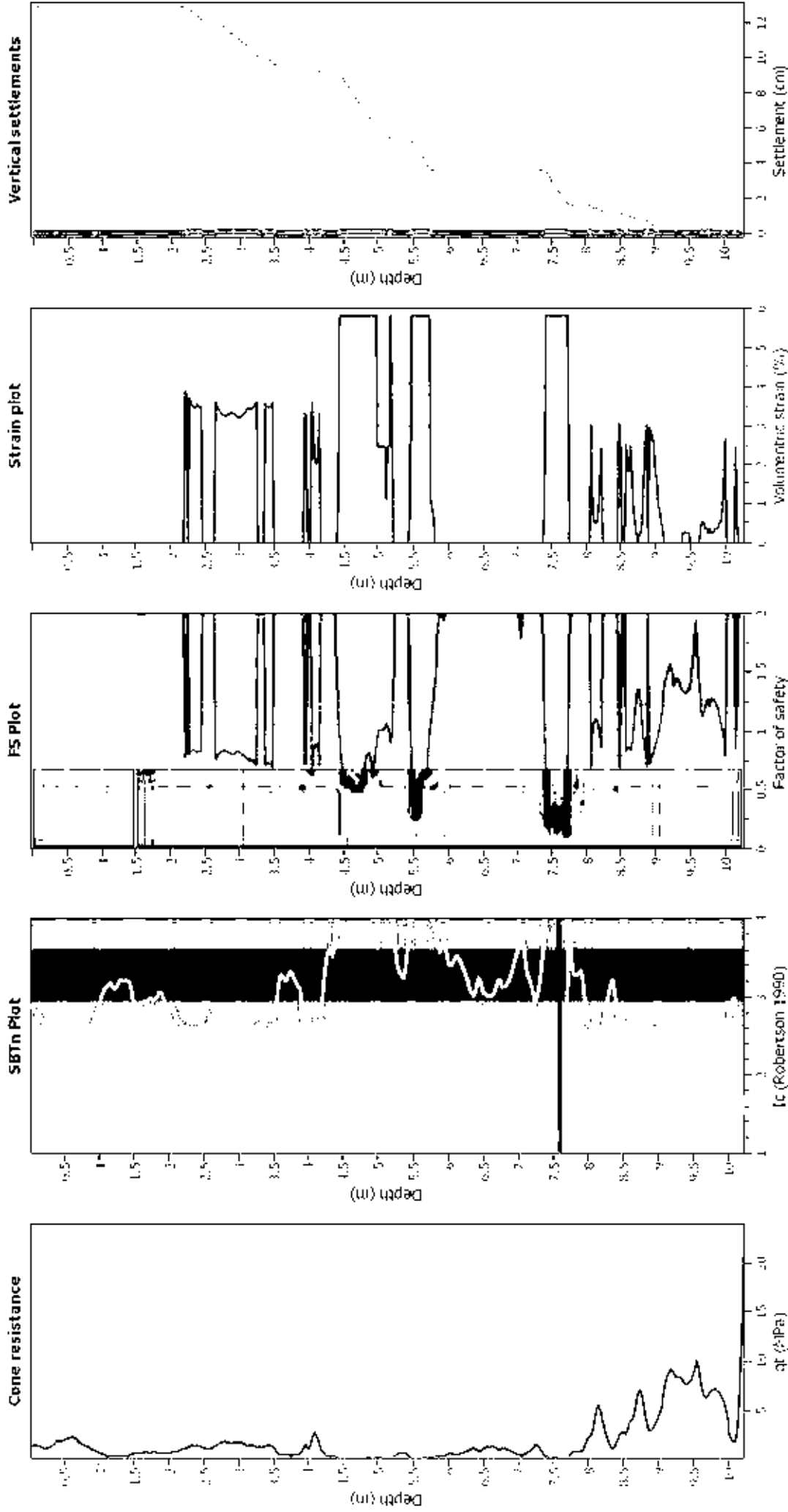
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial magnitude $M_s$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

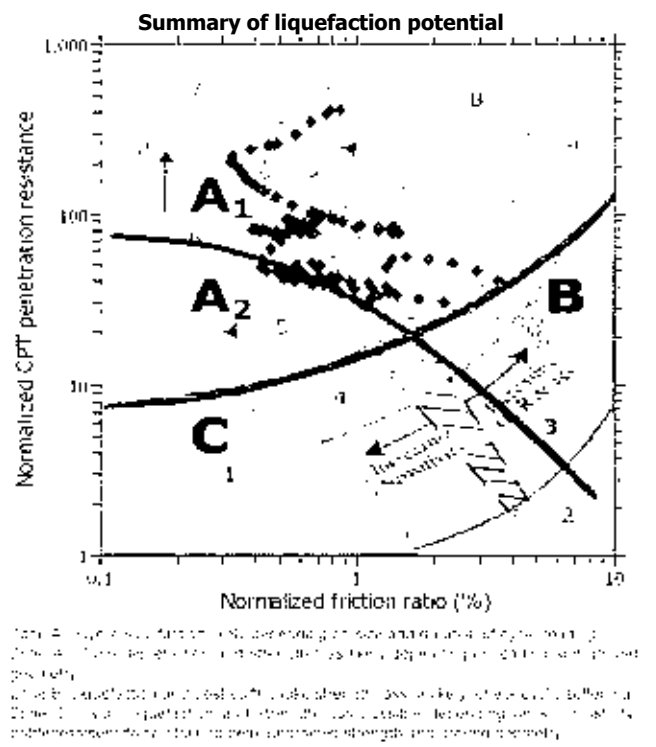
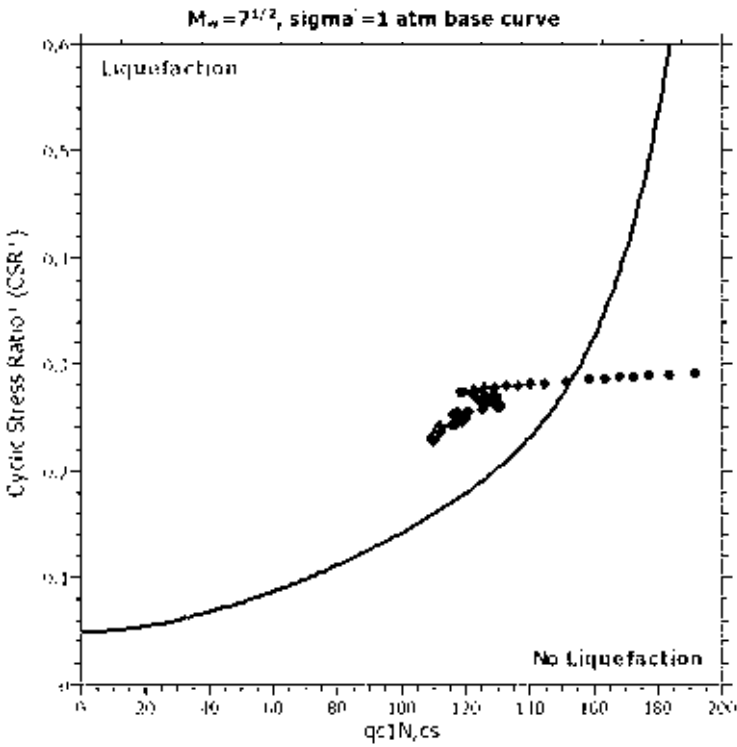
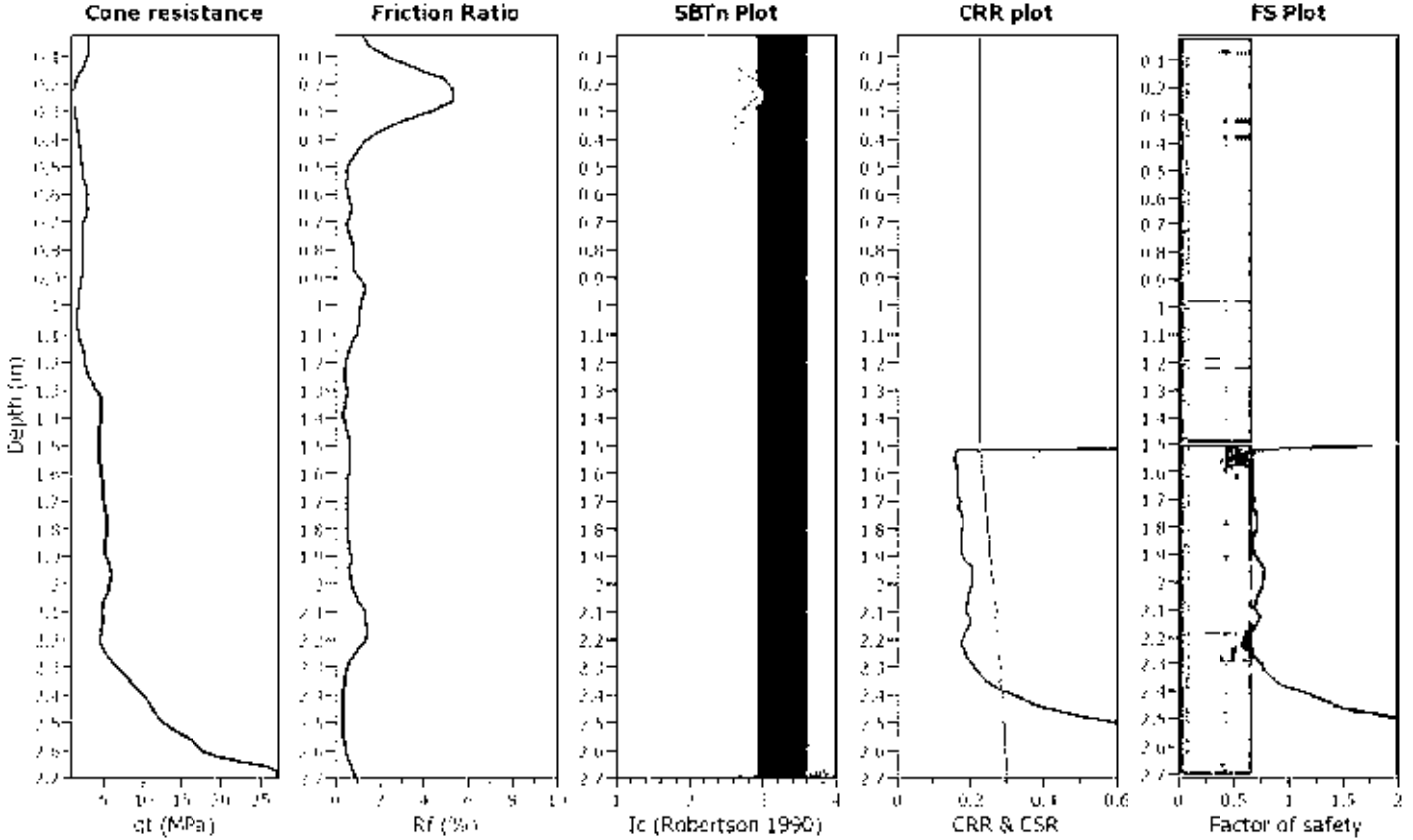
- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

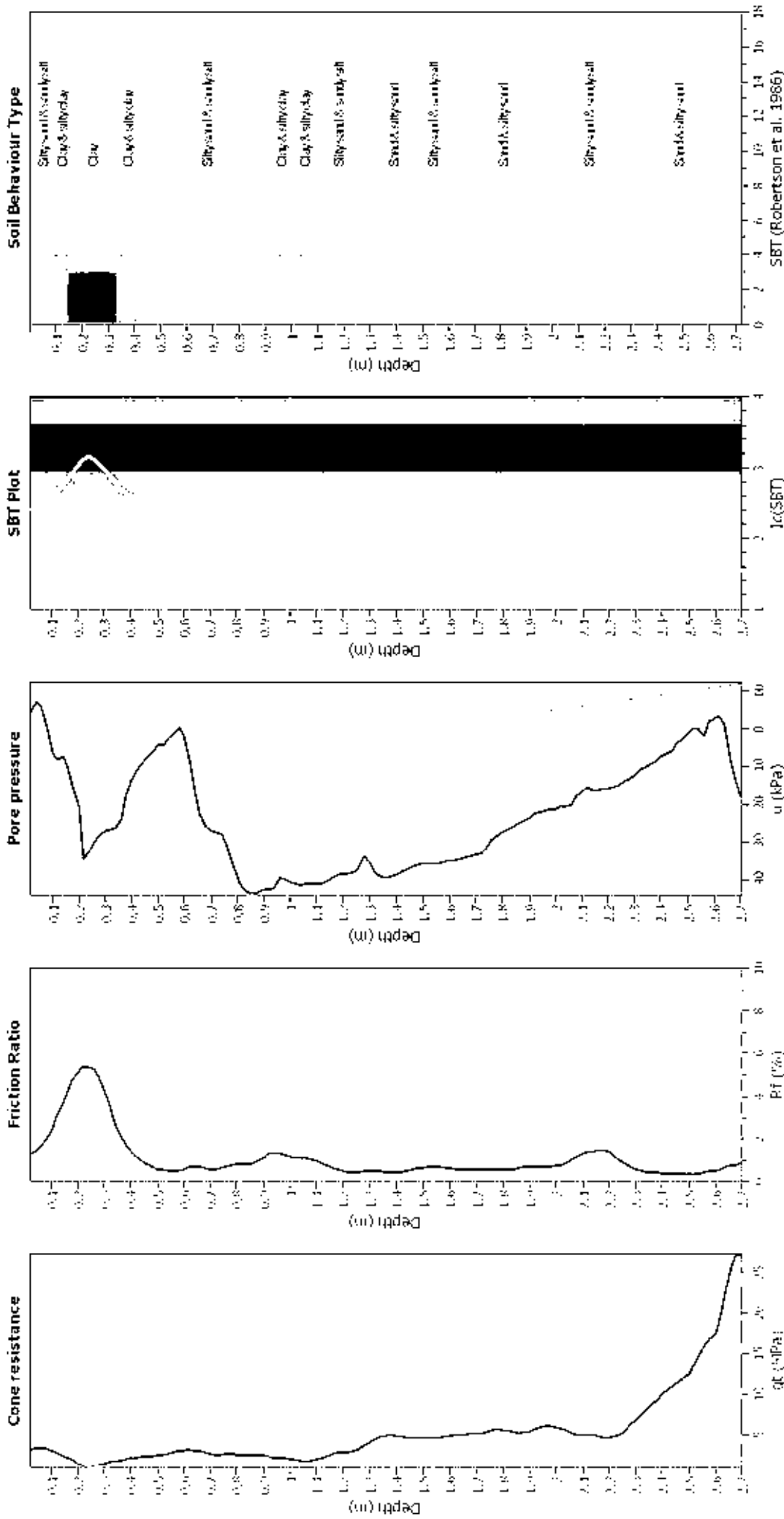
**CPT file : CPT23\_470SparksRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>o</sub> applied:	Yes		



### CPT basic interpretation plots



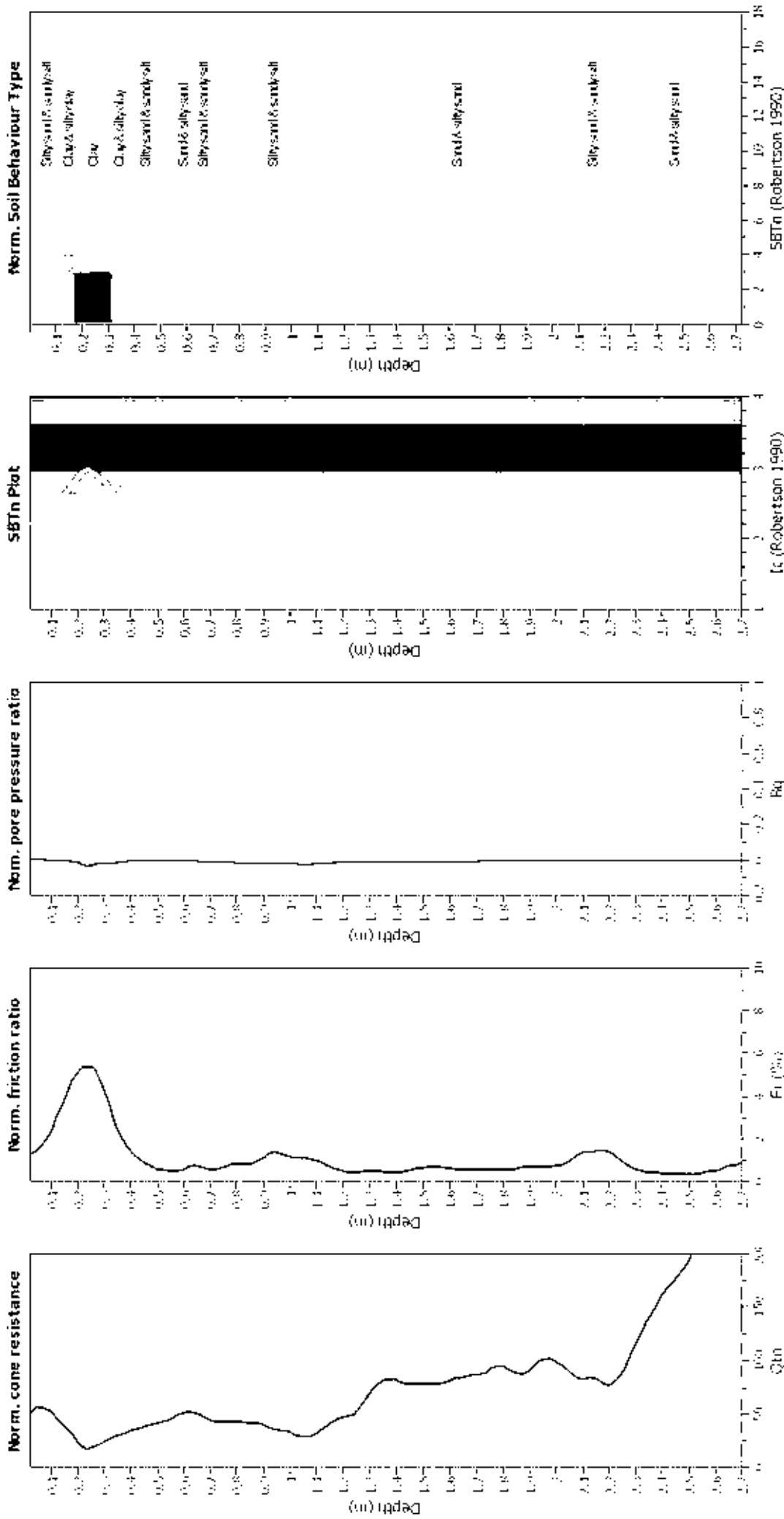
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Input correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Lamé depth applied:	No
Depth to water table (m):	1.50 m	Lamé depth:	N/A
Depth to GWL (ortho.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

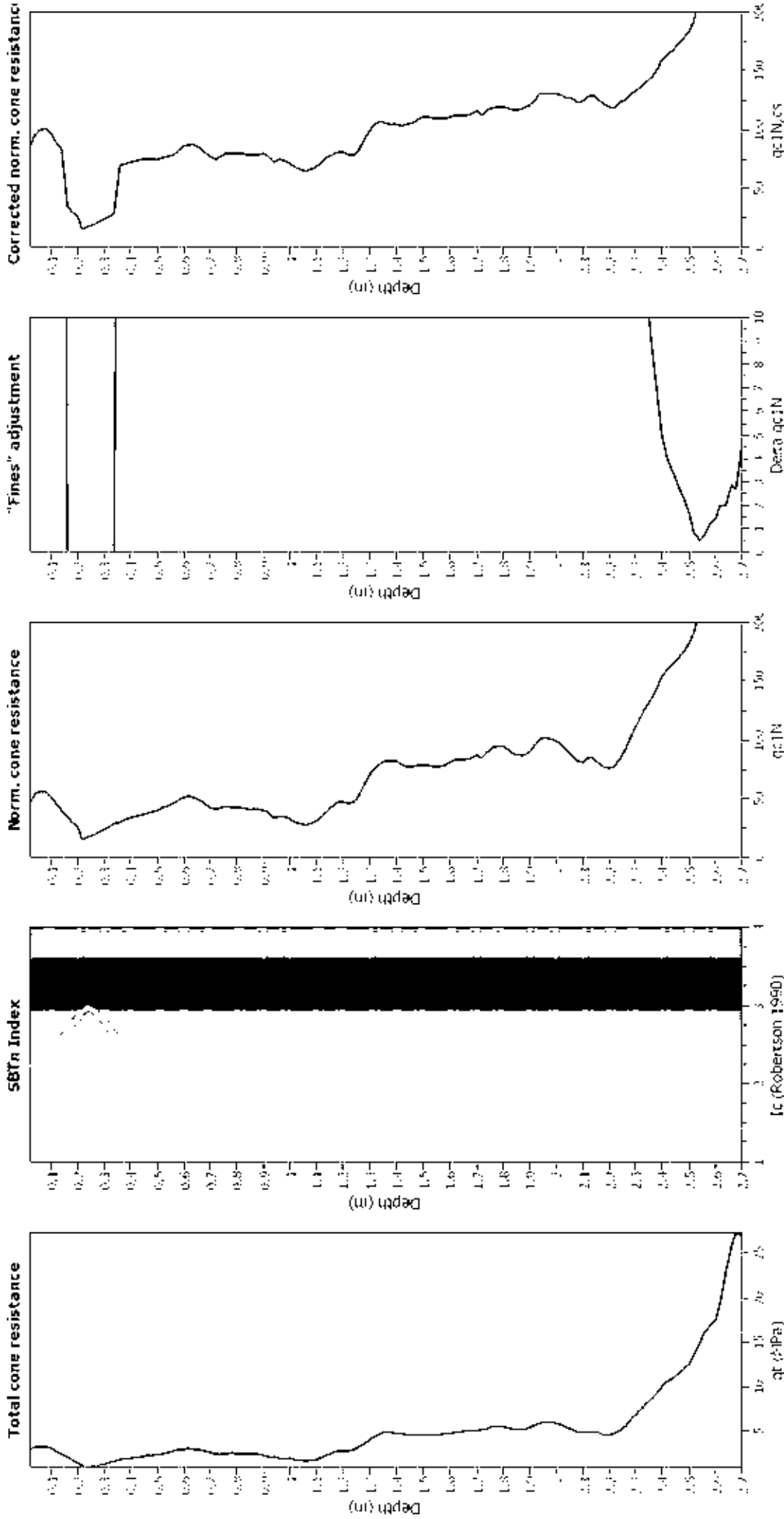
Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



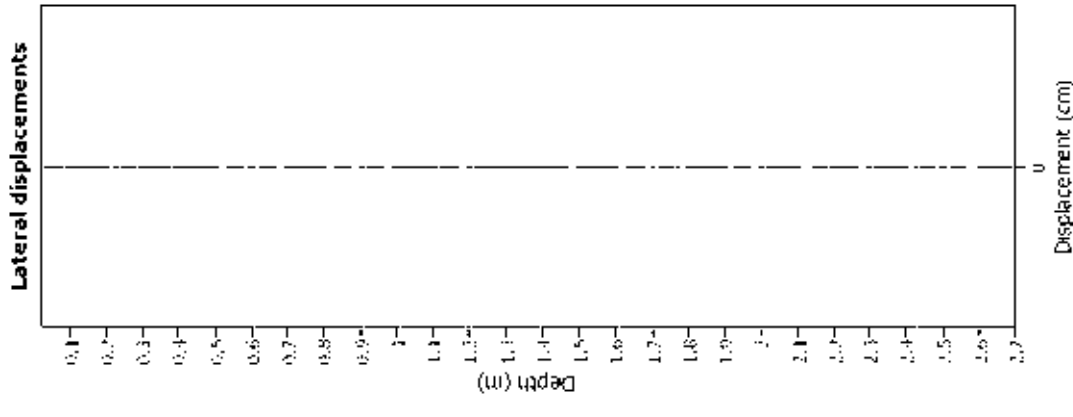
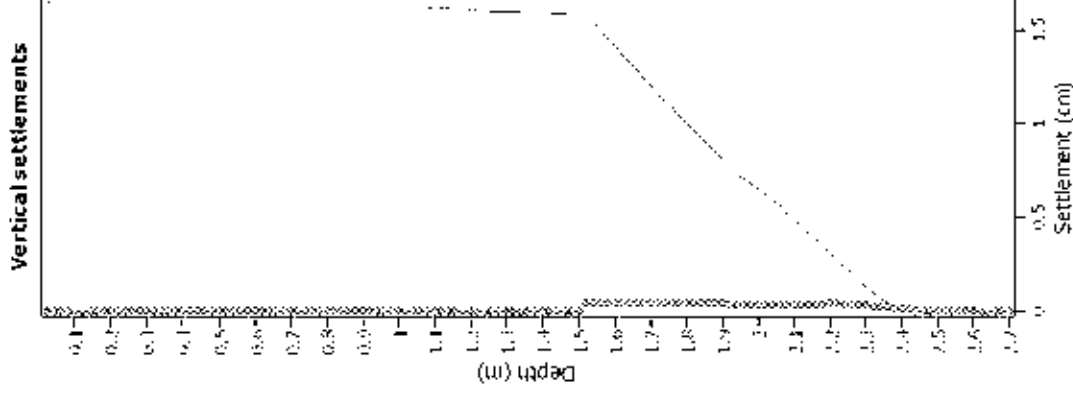
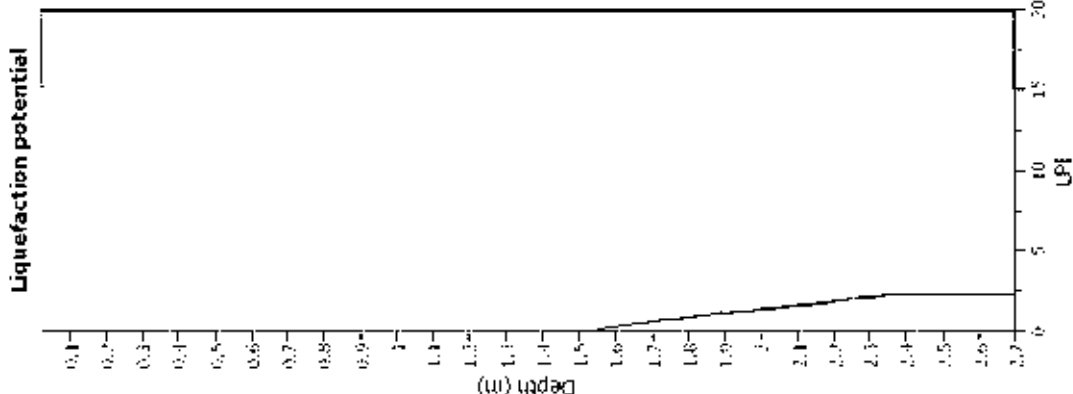
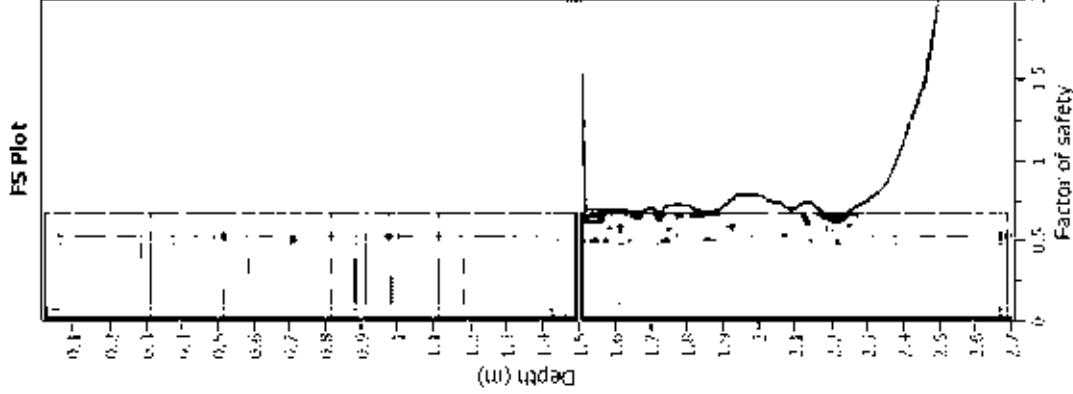
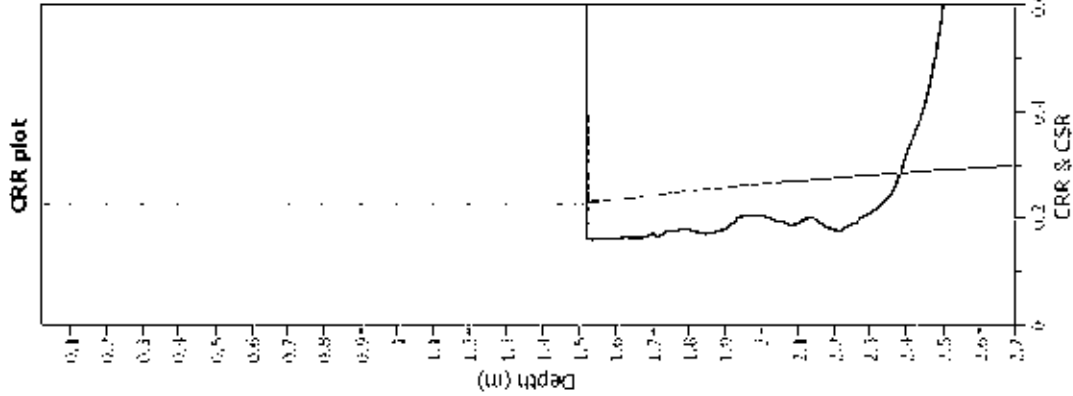
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

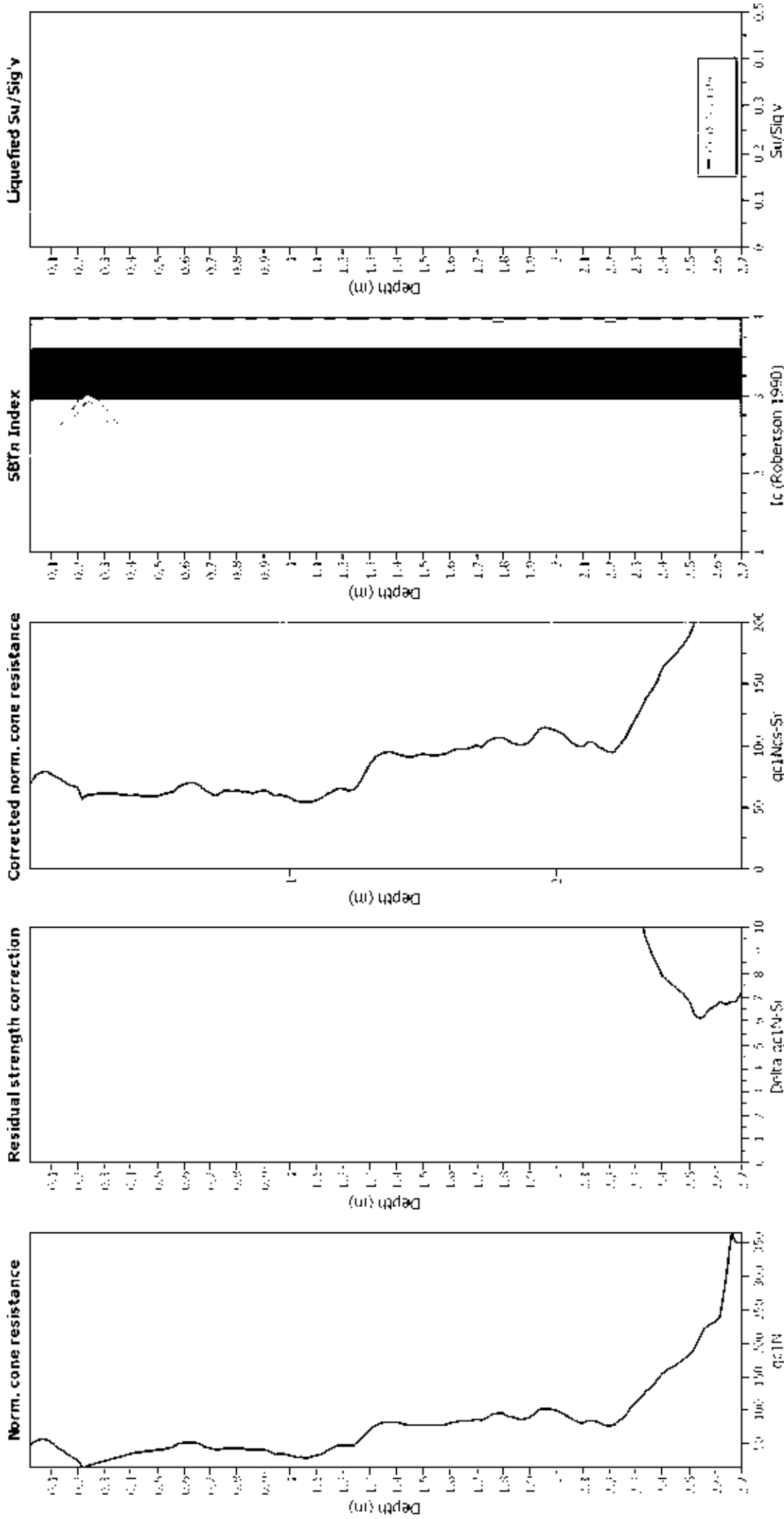
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

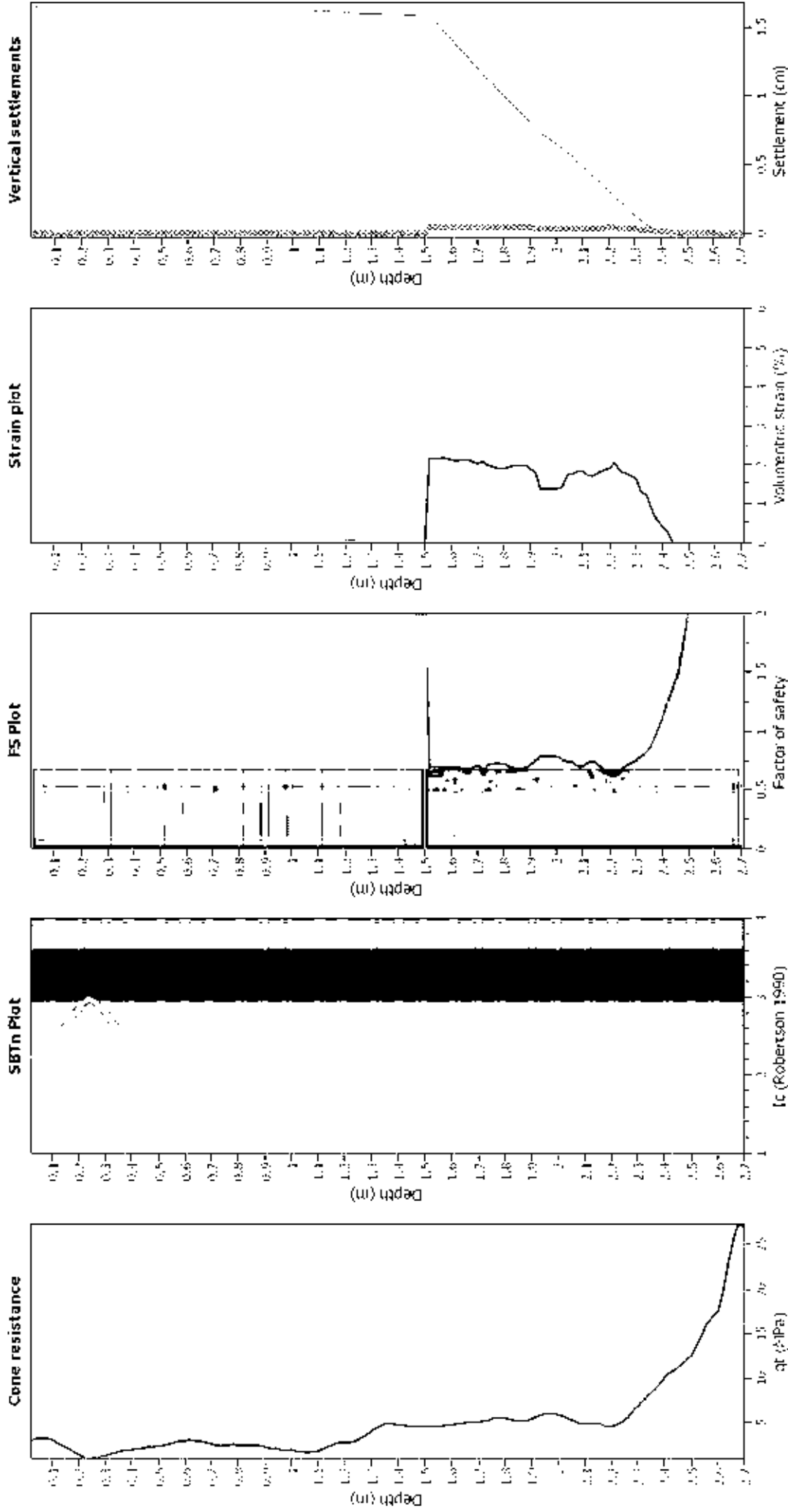
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub> Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT24\_119SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M <sub>w</sub>	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

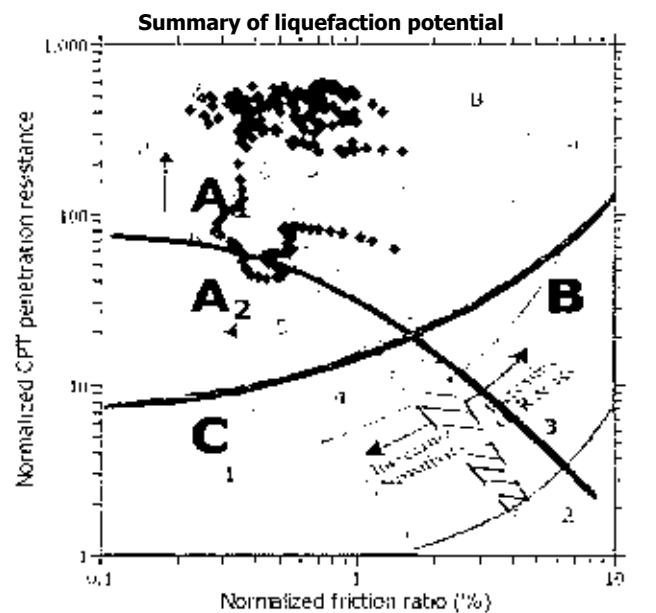
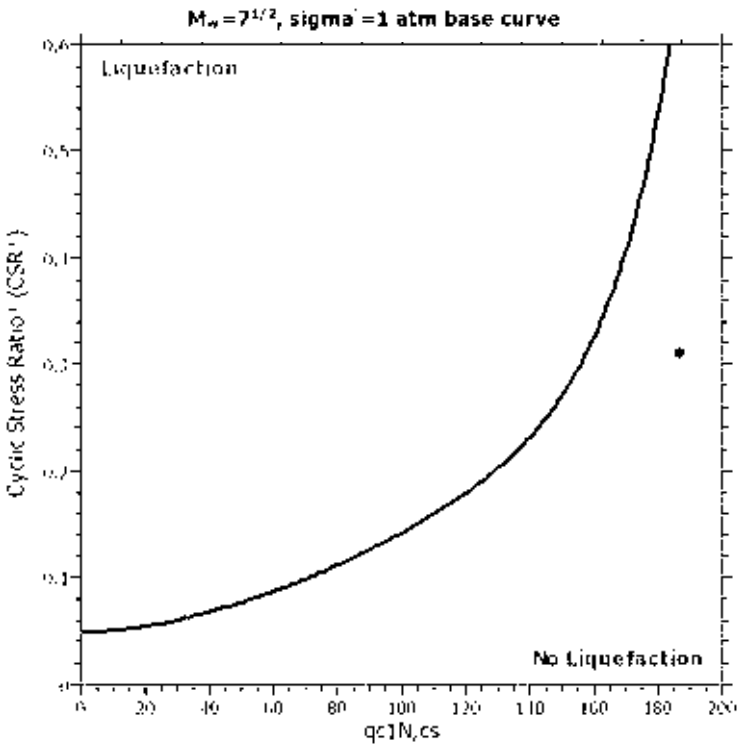
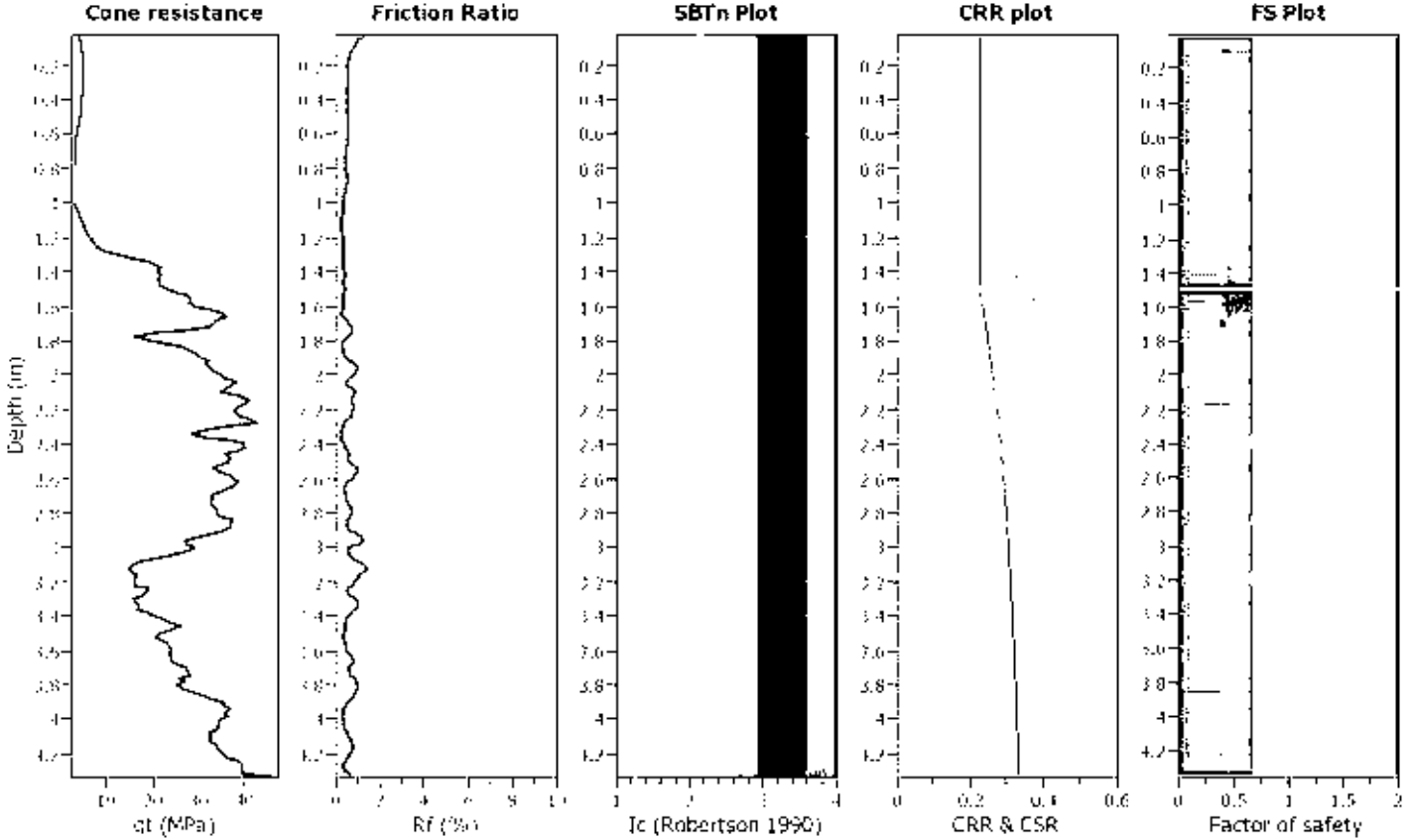
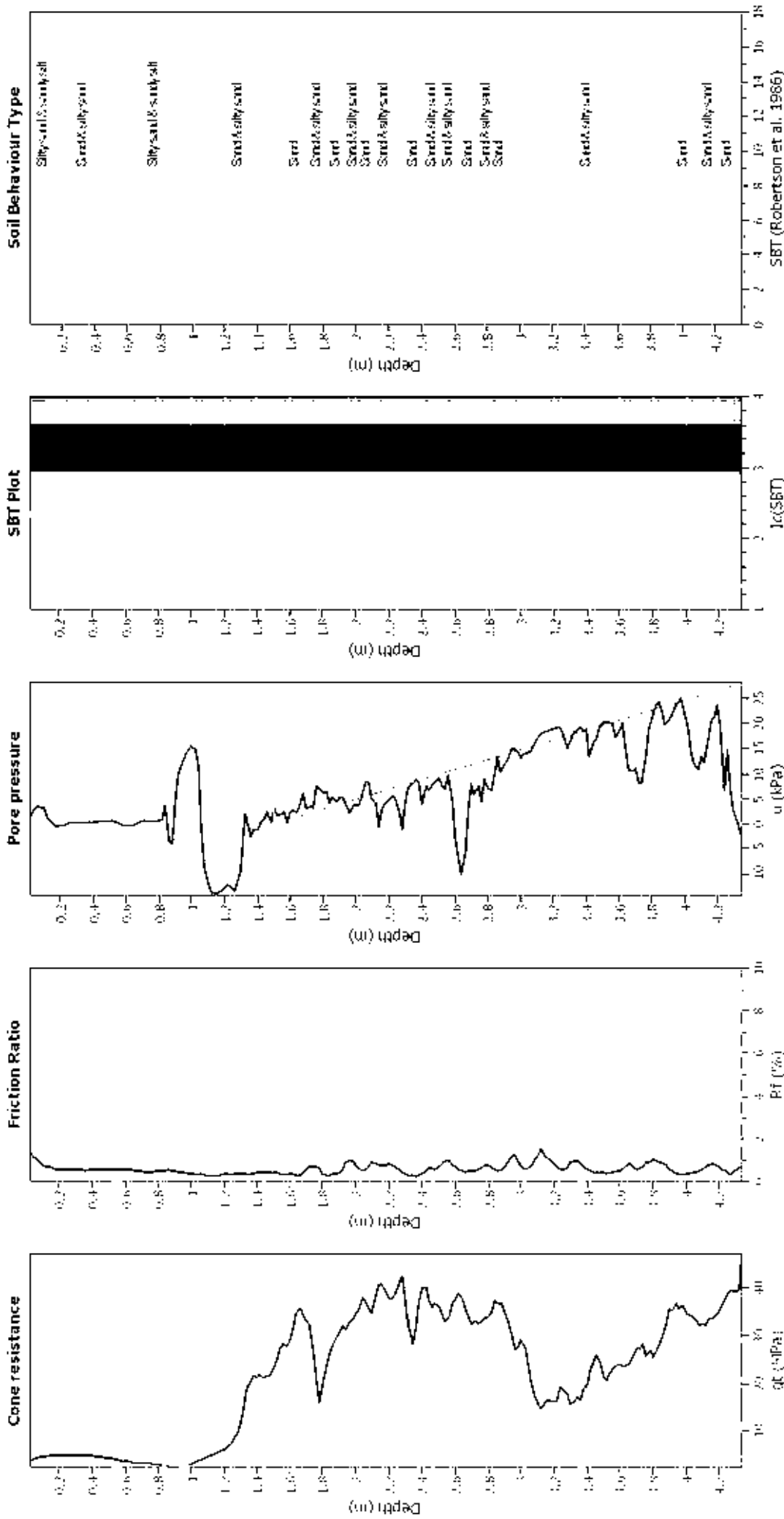


Figure 4: Summary of liquefaction potential assessment and results of cyclic test. (a) Normalized CPT penetration resistance and normalized friction ratio. (b) Normalized CPT penetration resistance and normalized friction ratio. (c) Normalized CPT penetration resistance and normalized friction ratio. (d) Normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



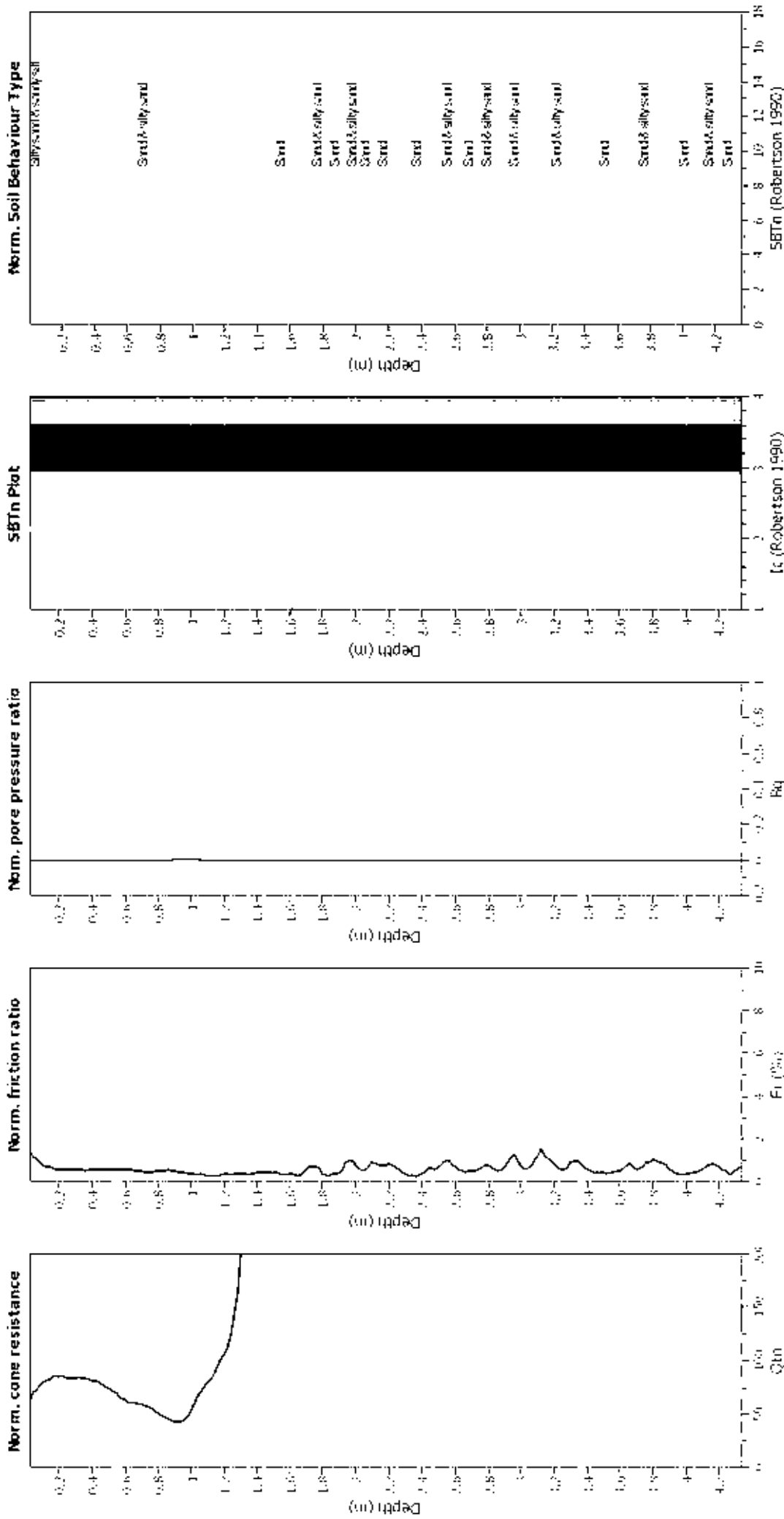
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units corre: for method:	188 (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Lamé depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A	Lamé depth:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



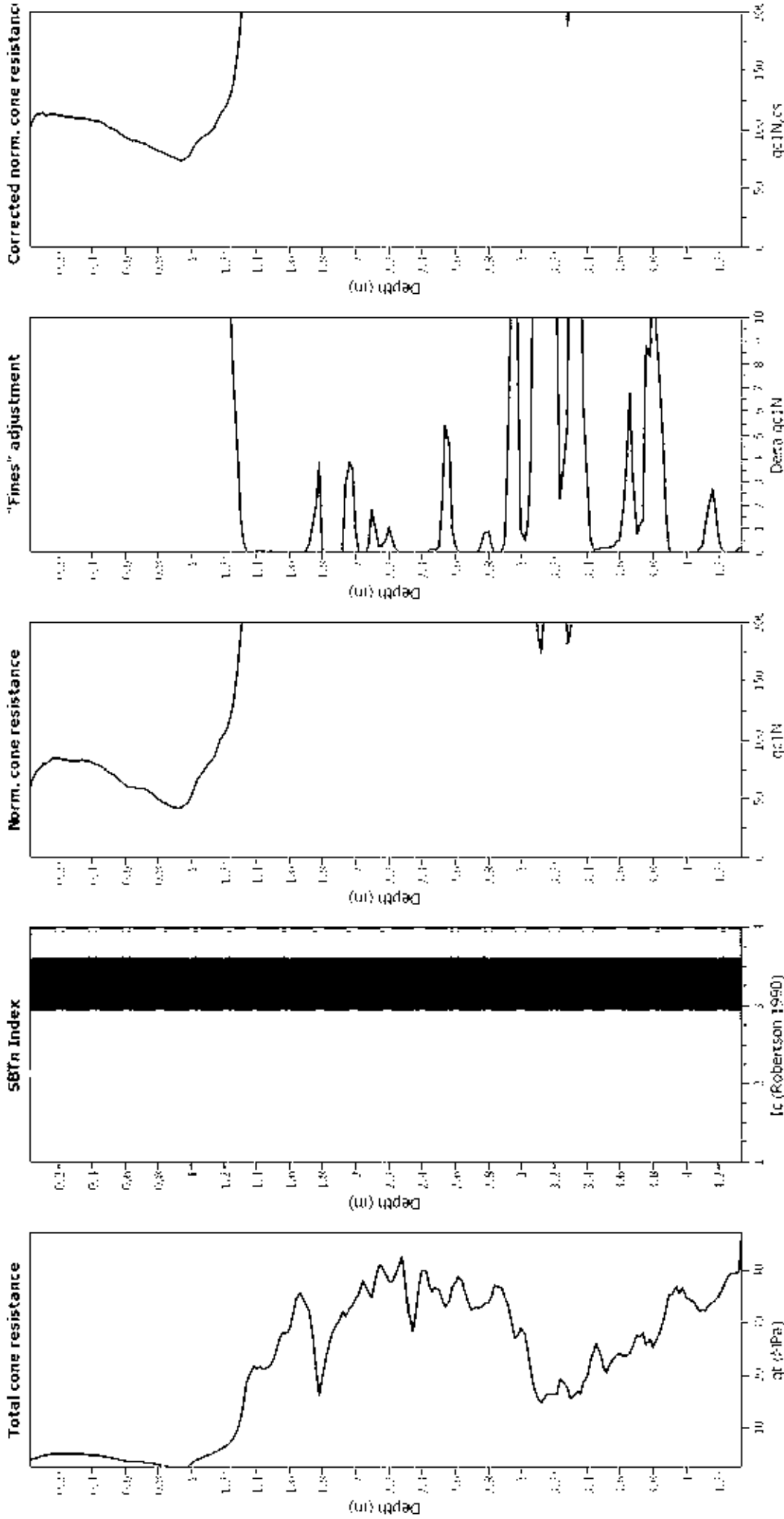
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### Liquefaction analysis overall plots (intermediate results)

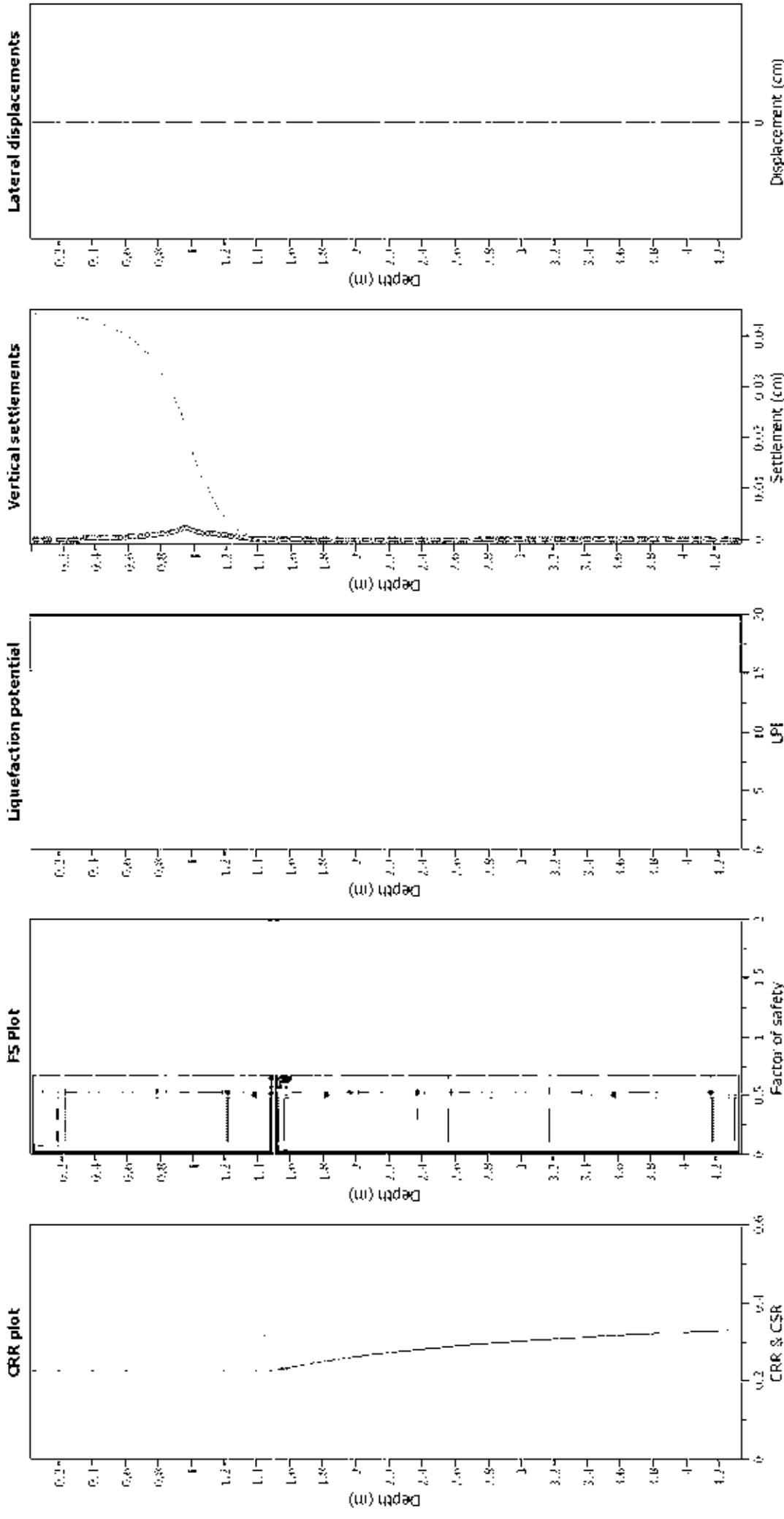


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lam. depth applied:	No
Depth to water table (m):	1.50 m	Lam. depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

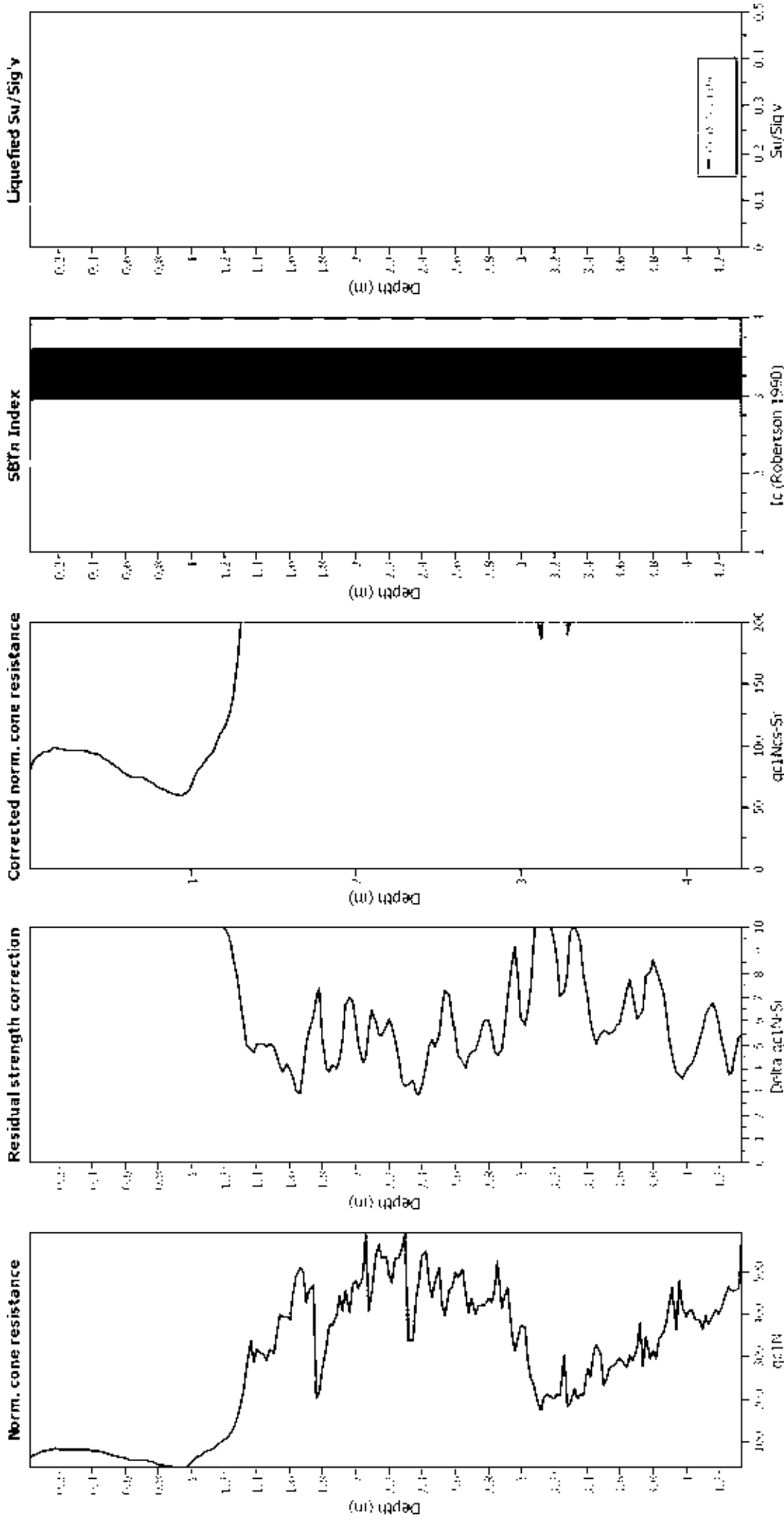
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

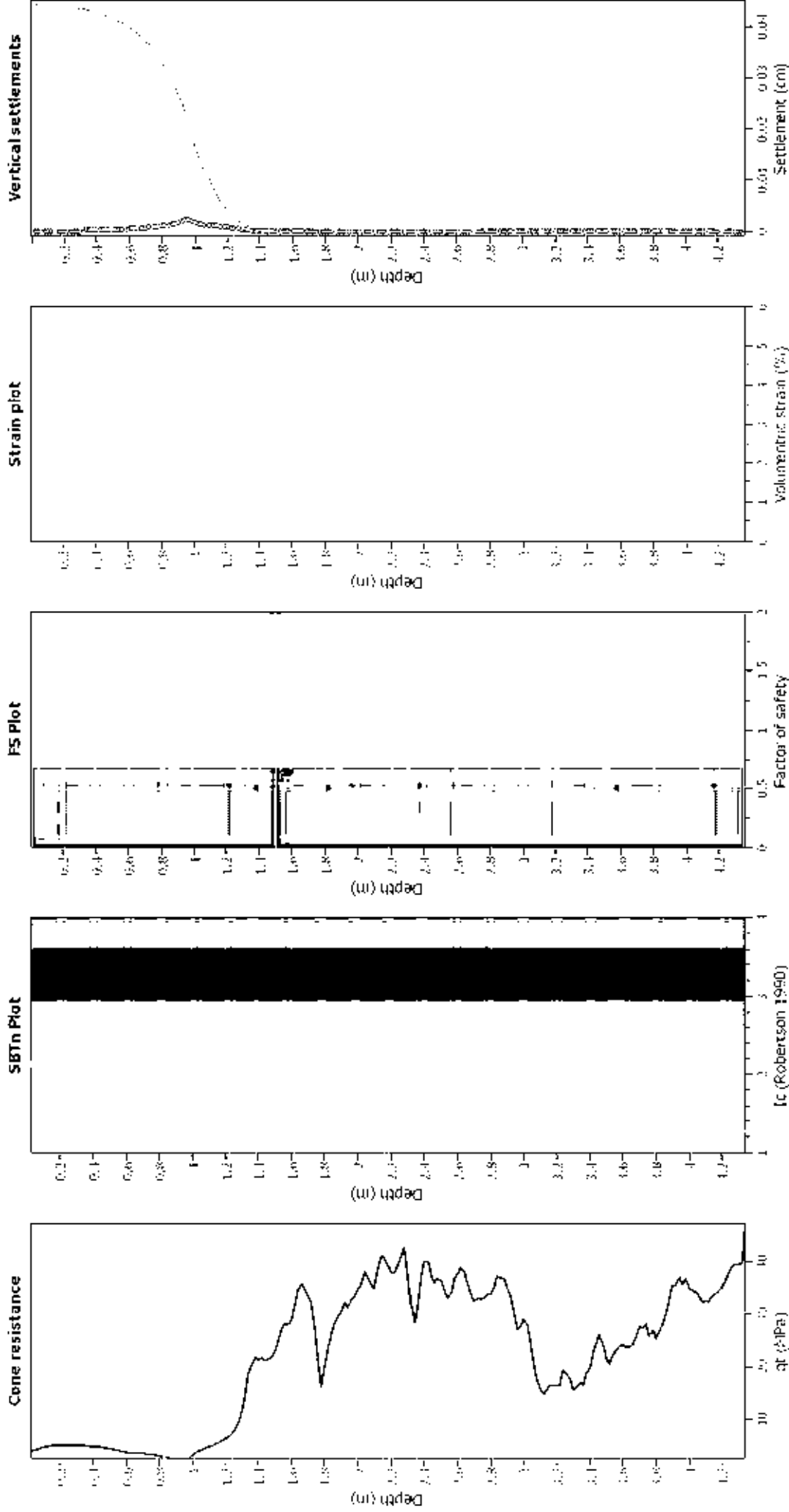
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT25\_25KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>1</sub> applied:	Yes		

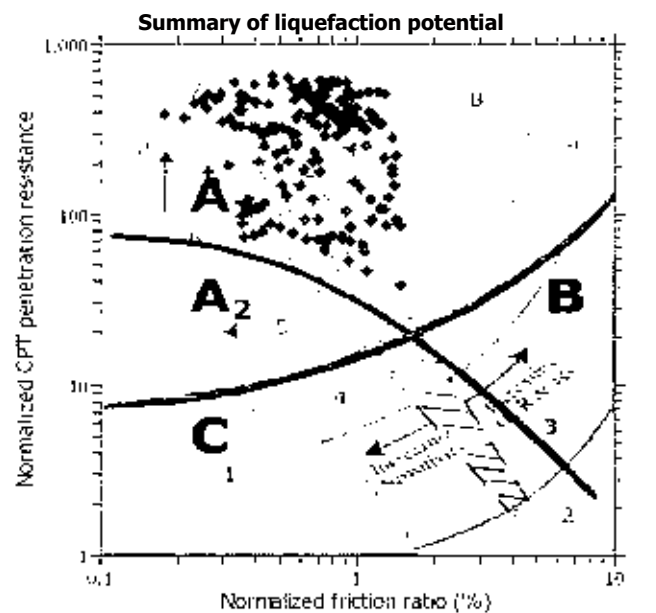
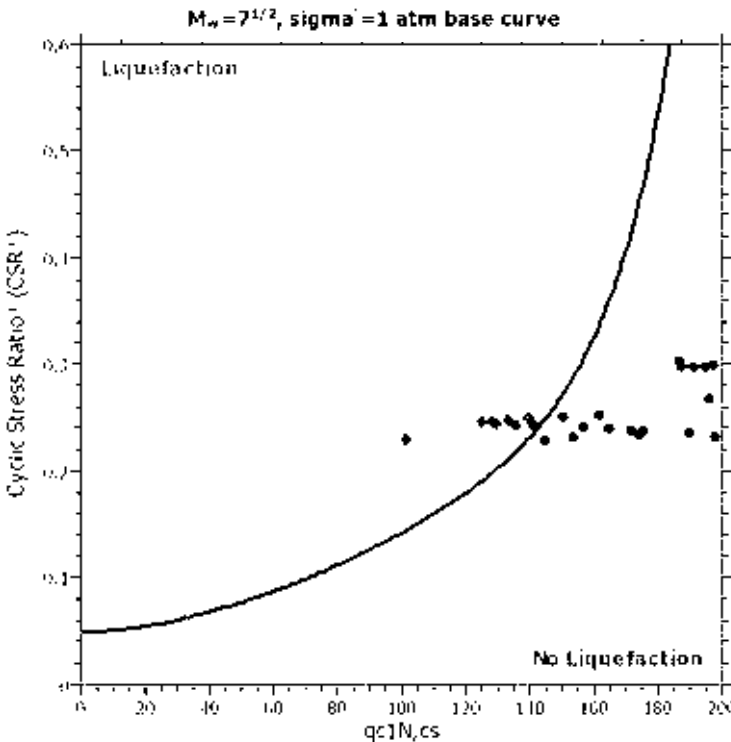
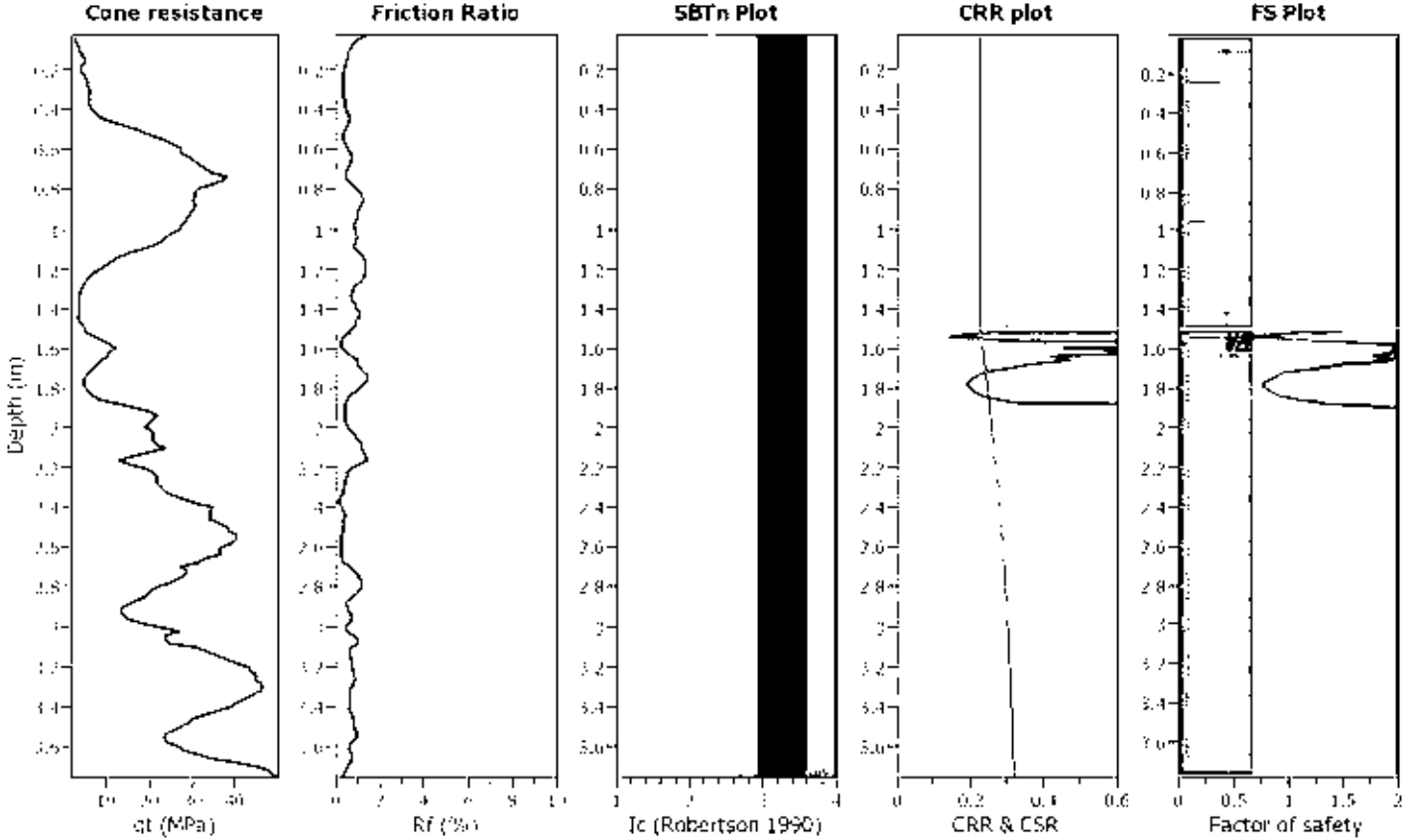
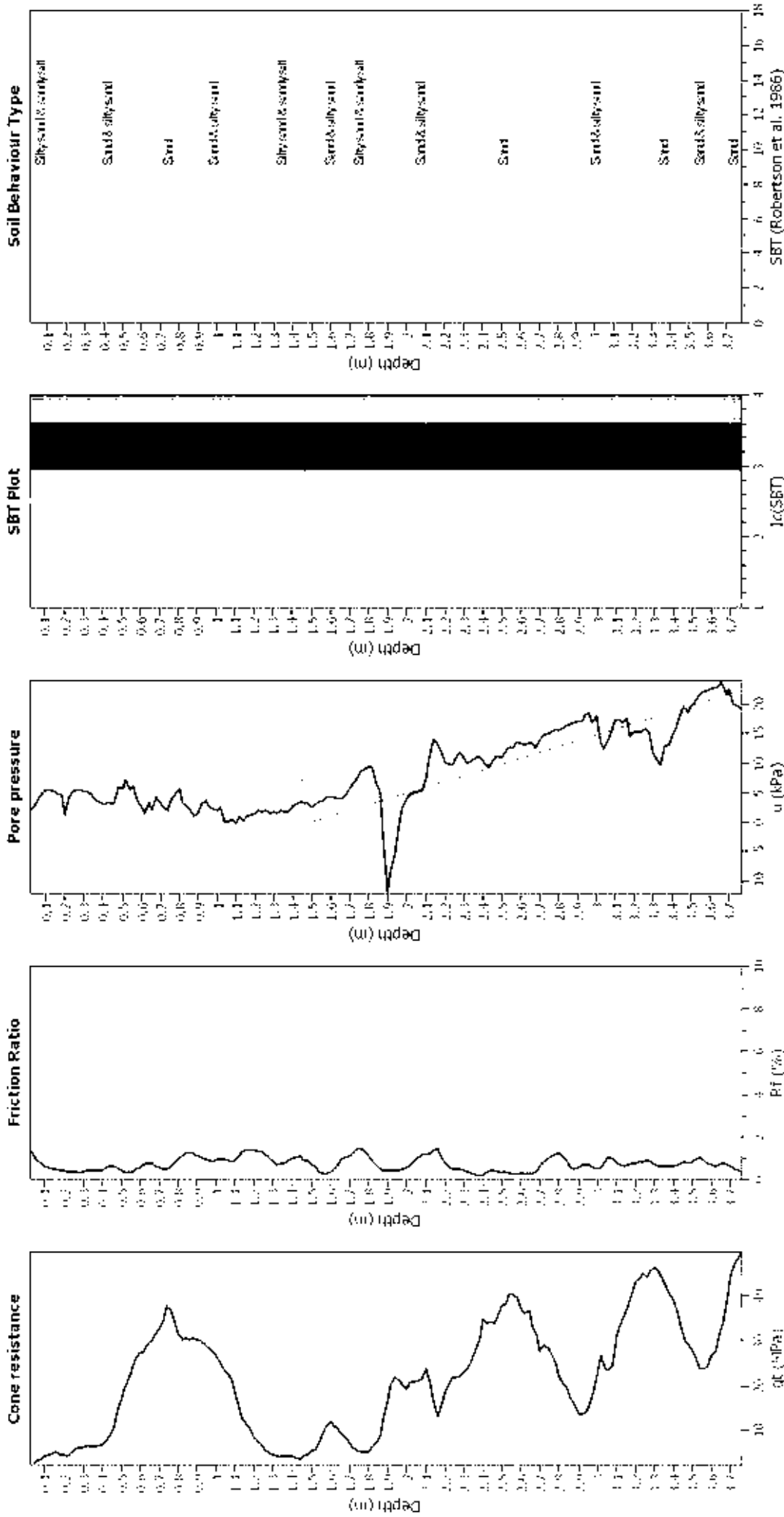


Figure 4: Summary of liquefaction potential plot and data points of cyclic test. Zone A: Fully liquefied; Zone A2: Partially liquefied; Zone B: No liquefaction; Zone C: Fully liquefied. The shaded region indicates the liquefaction potential. The plot is divided into zones A, A2, B, and C. A shaded region indicates the liquefaction potential.

### CPT basic interpretation plots



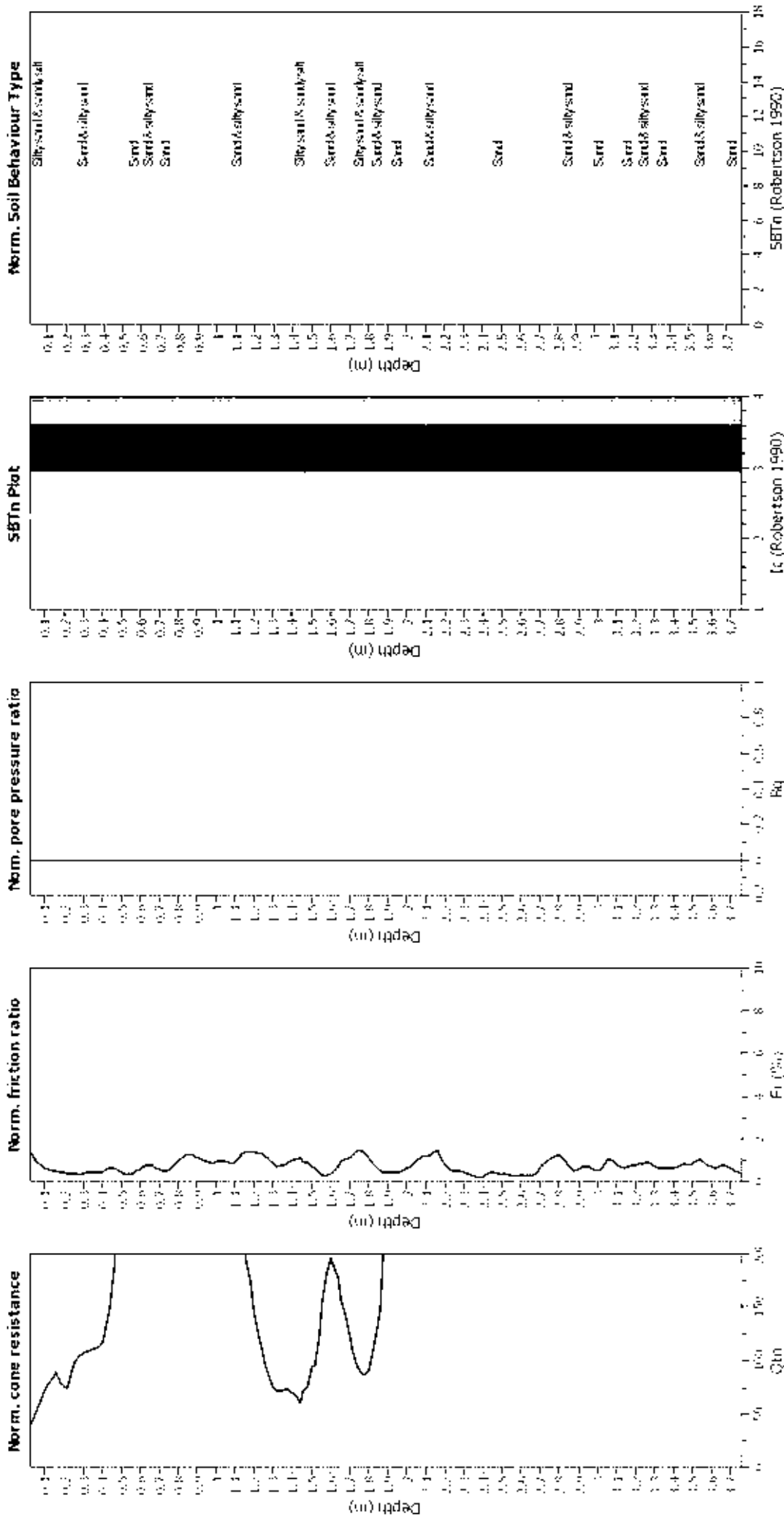
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Lines corre: true method:	18B (2008)	Average results interval:	3	Transition detect applied:	Sand & Clay
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	K applied:	Yes
Factorial: mag: angle $\theta_s$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Lam depth applied:	No
Depth to water table ( $z_{w,eq}$ ):	1.50 m	Fill height:	N/A	Lam depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



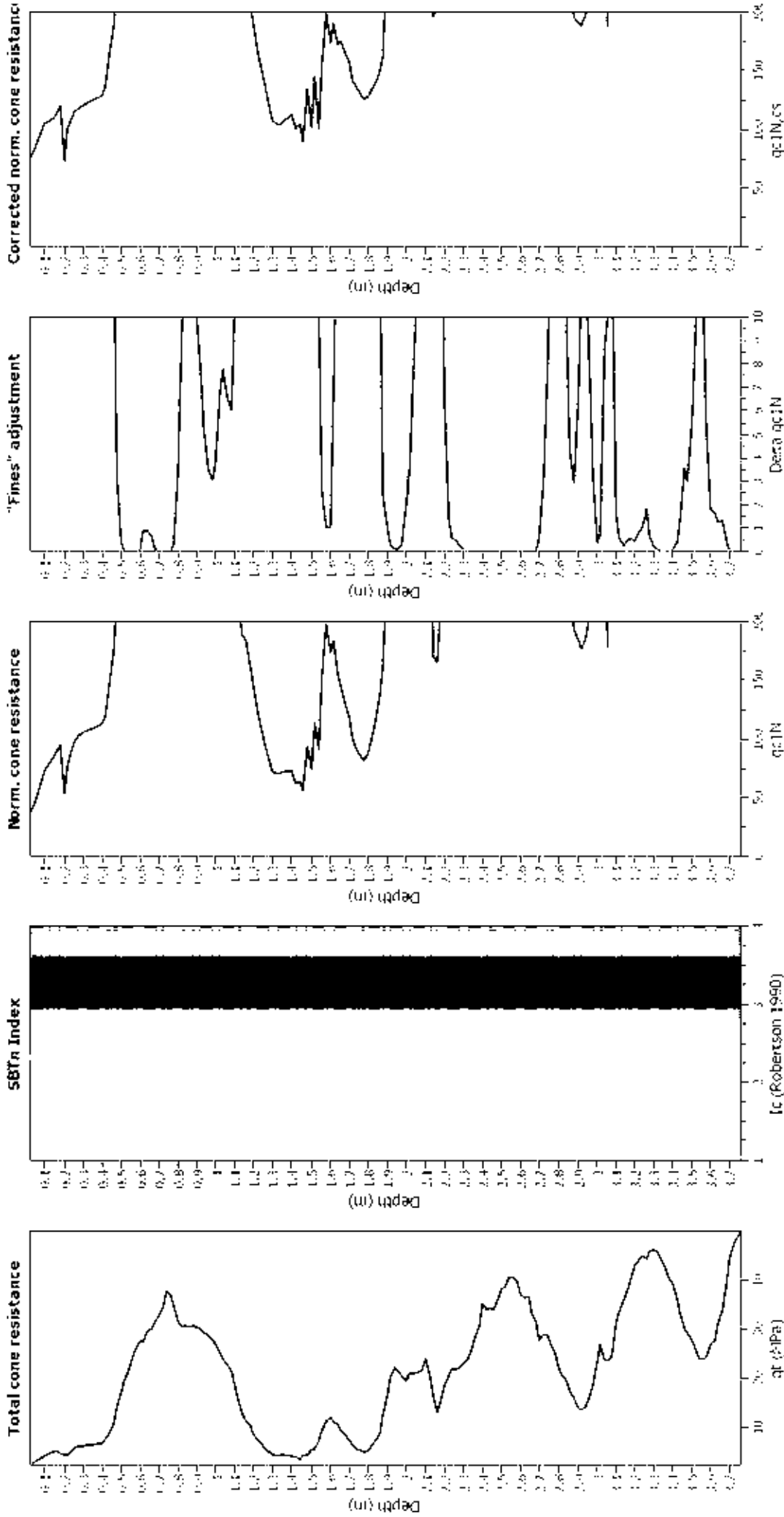
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

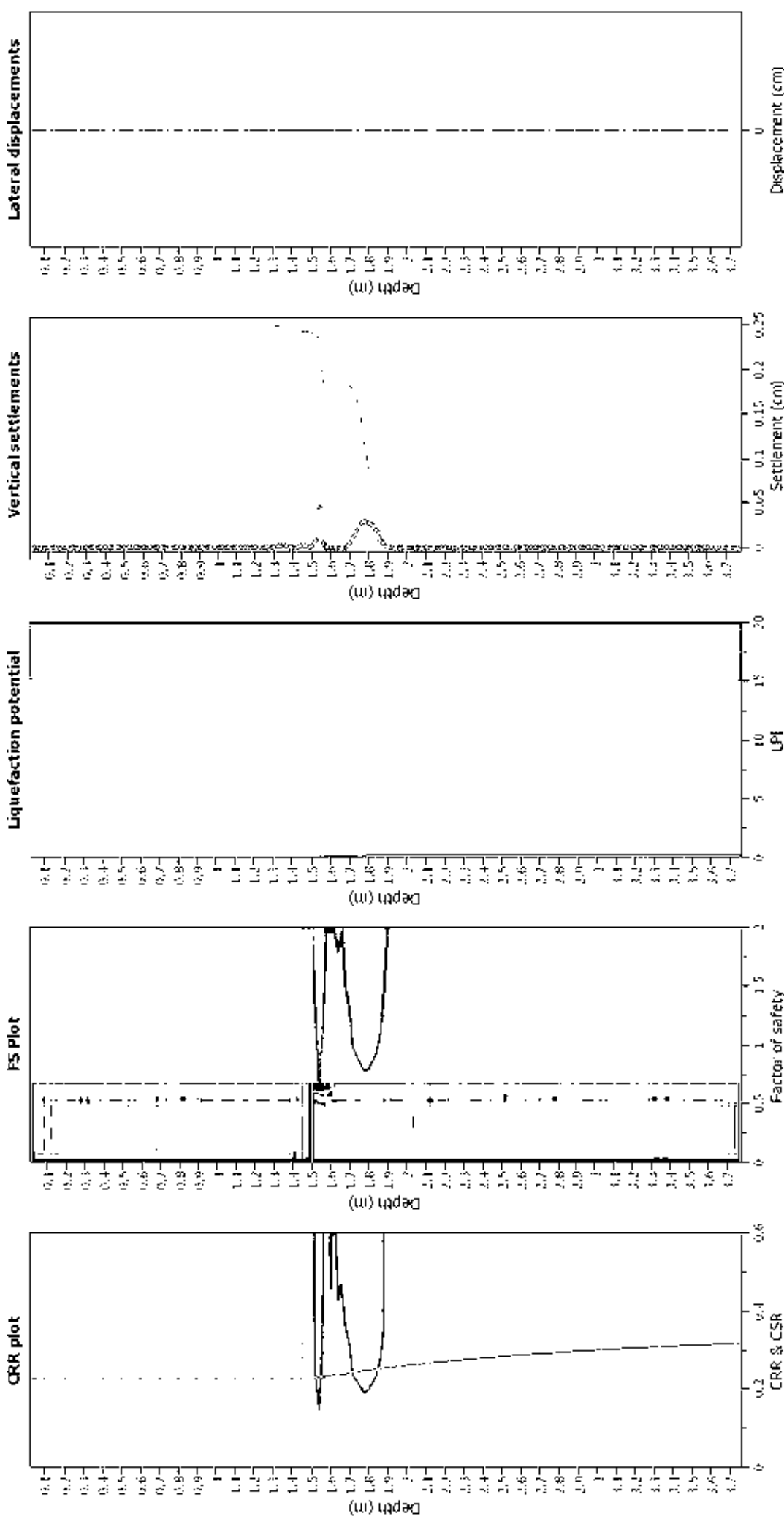
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Fines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: I8B (2008)  
 Liquefaction correction method: I8B (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude (M<sub>w</sub>): 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m<sub>wt</sub>): 1.50 m

Depth to GW (erthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

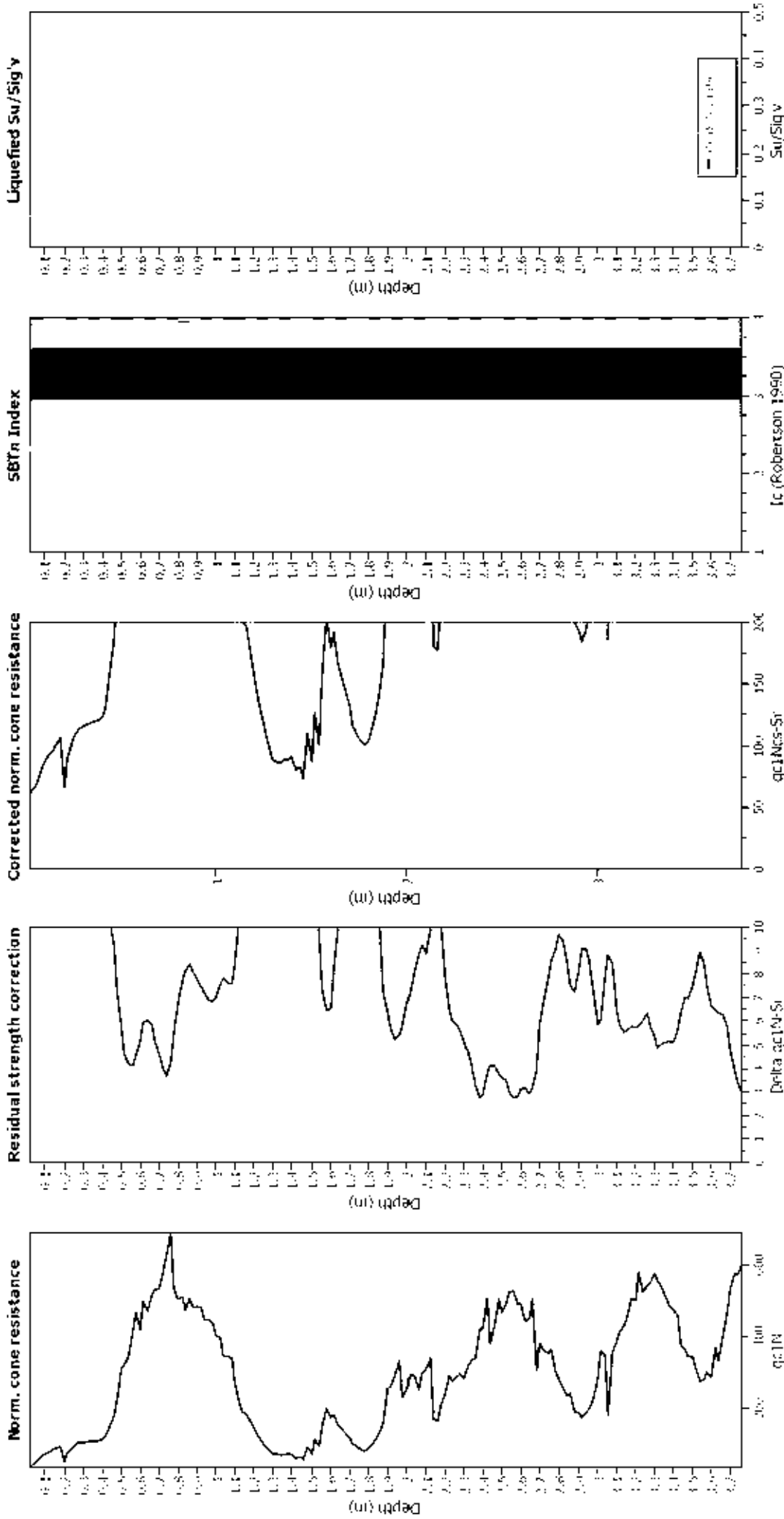
Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

**F.S. color scheme**  
 Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

**LPI color scheme**  
 Very high risk  
 High risk  
 Low risk



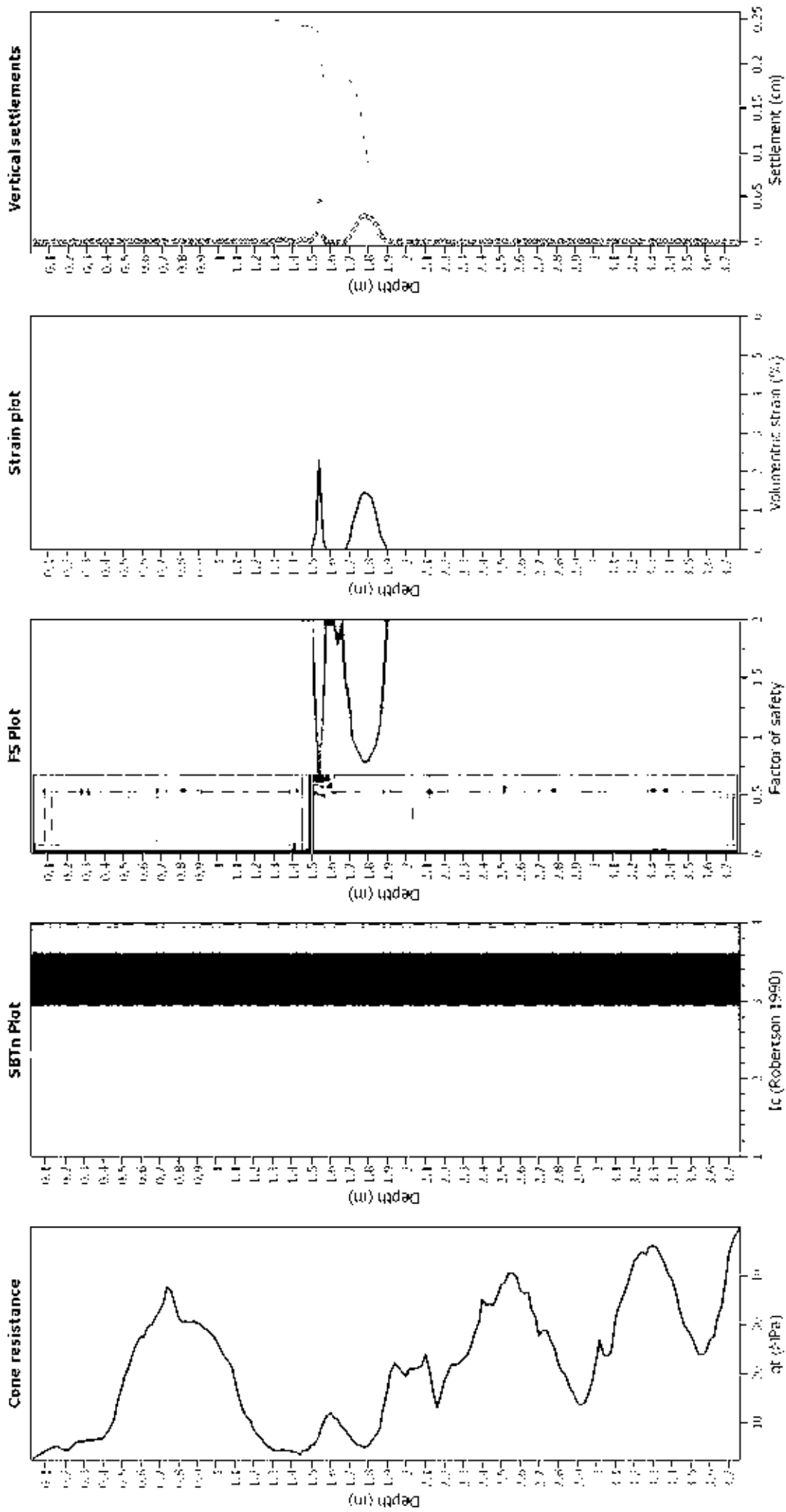
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- S<sub>b</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT26\_95SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

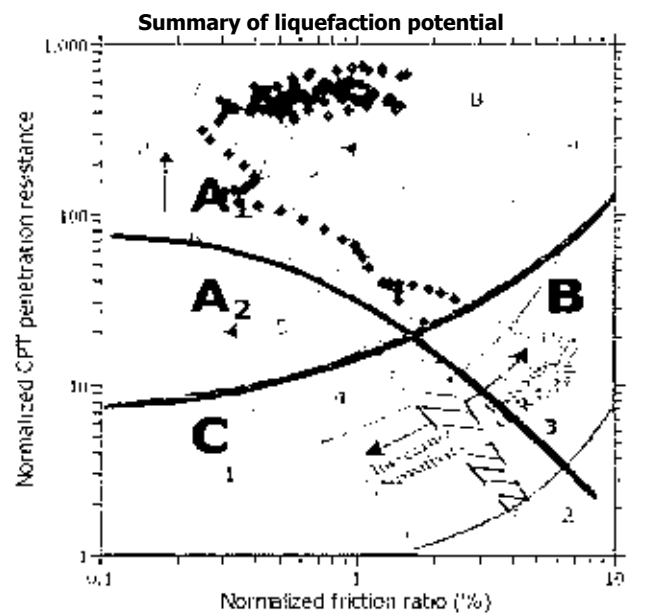
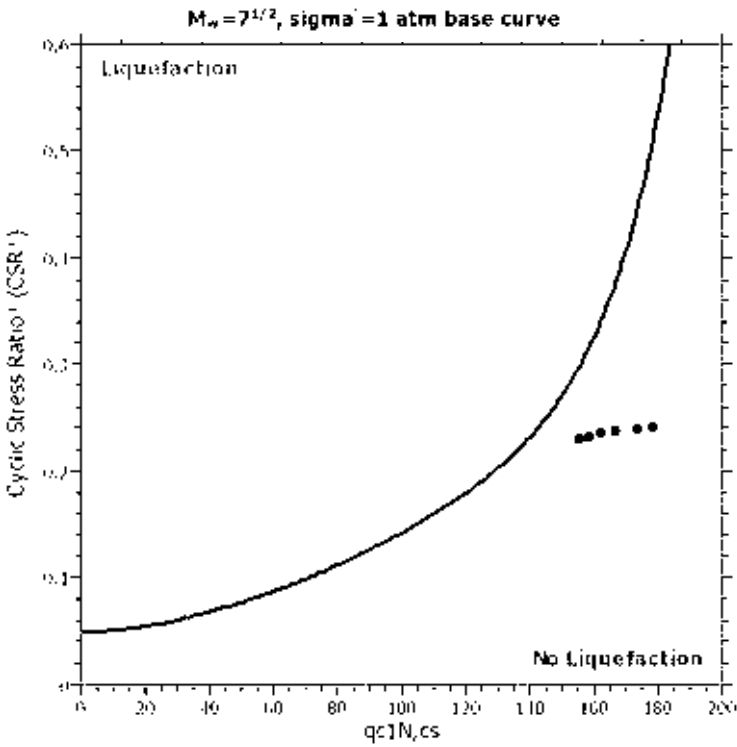
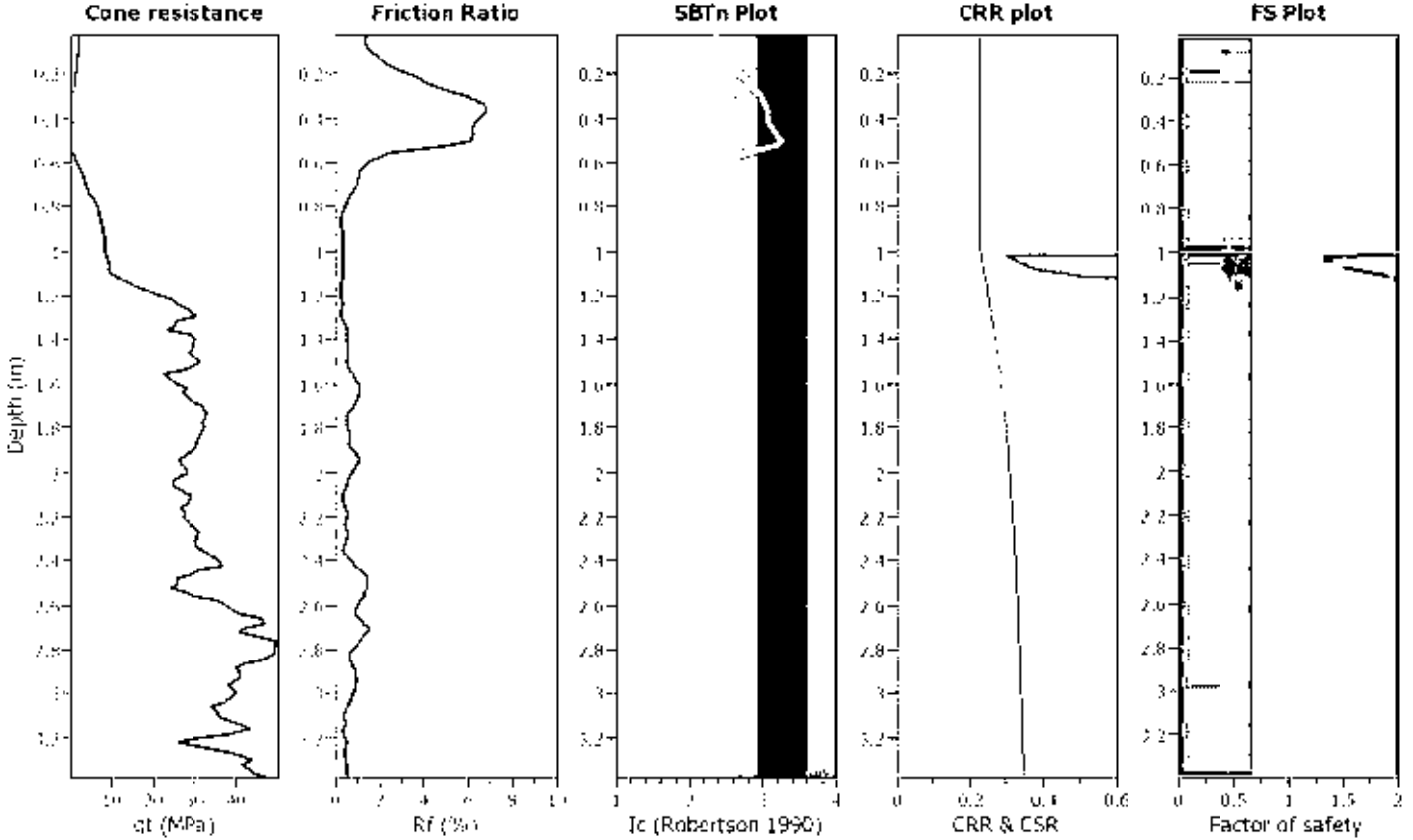
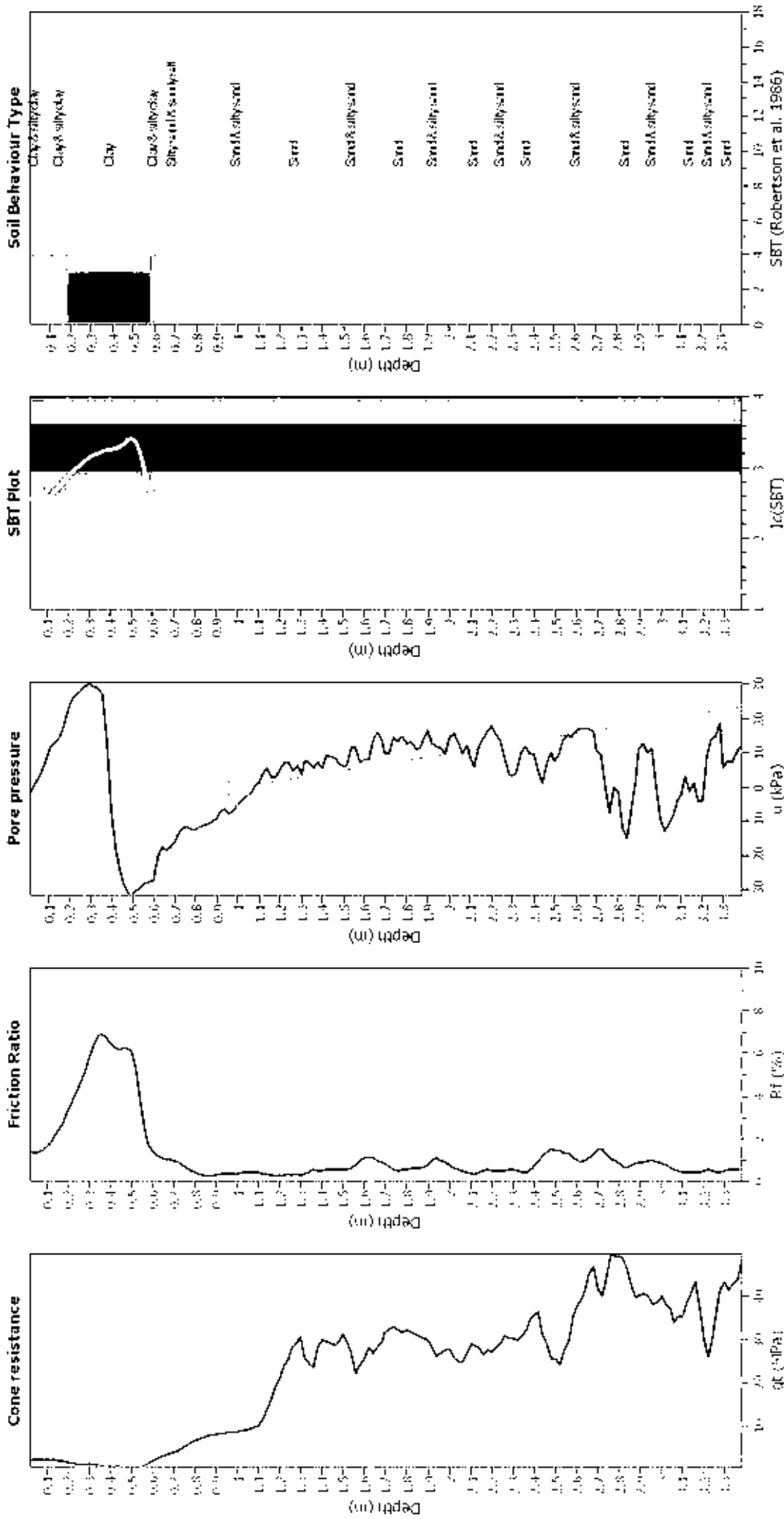


Figure 4. Summary of liquefaction potential based on penetration resistance and normalized cyclic stress ratio. Zone A<sub>1</sub> is the region where liquefaction is likely to occur during a design earthquake. Zone A<sub>2</sub> is the region where liquefaction is possible during a design earthquake. Zone B is the region where liquefaction is unlikely to occur during a design earthquake. Zone C is the region where liquefaction is not expected to occur during a design earthquake. The chart is based on the data from the CPT logs and the input parameters.

### CPT basic interpretation plots



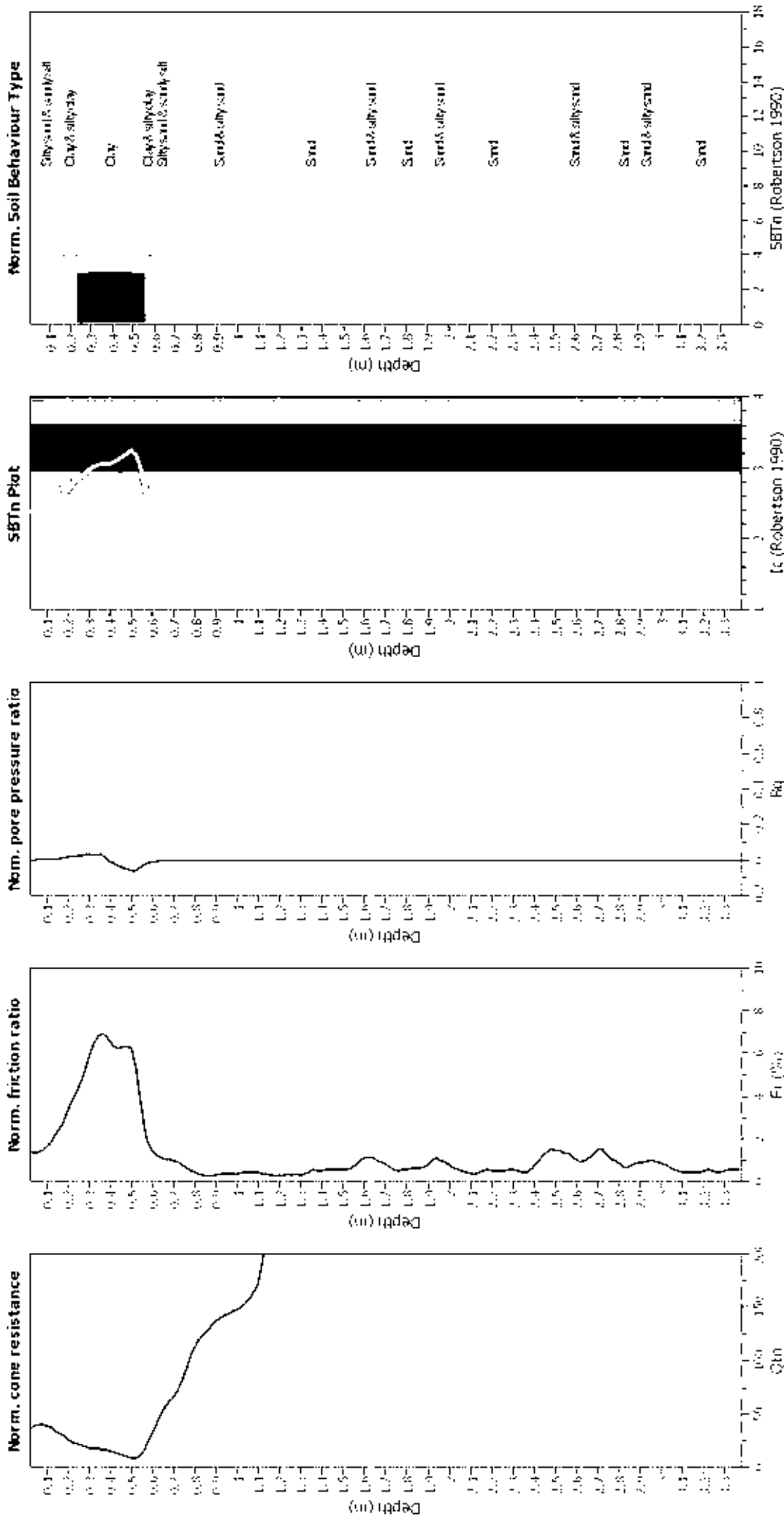
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Input correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m <sub>wt</sub> ):	1.00 m		
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



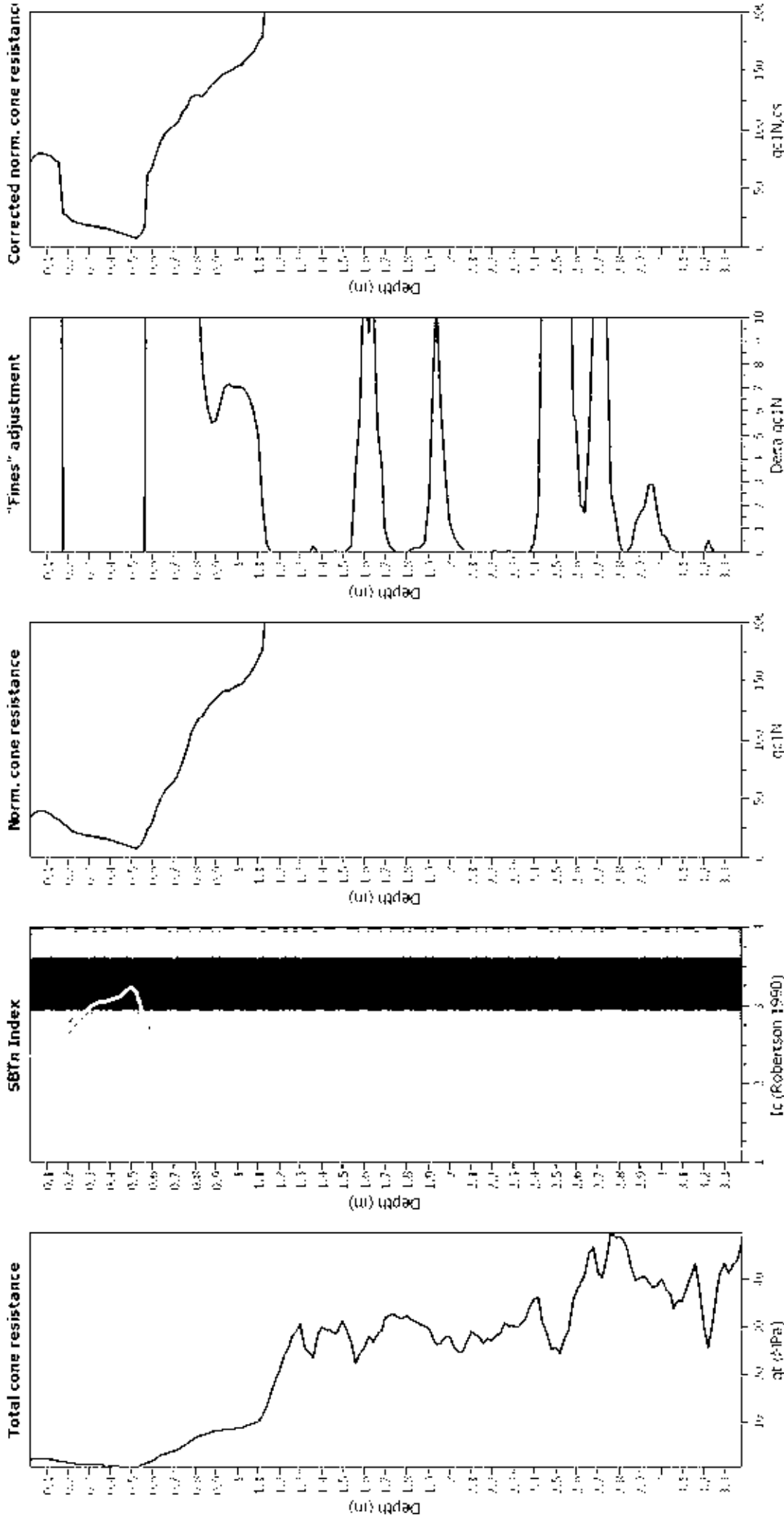
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

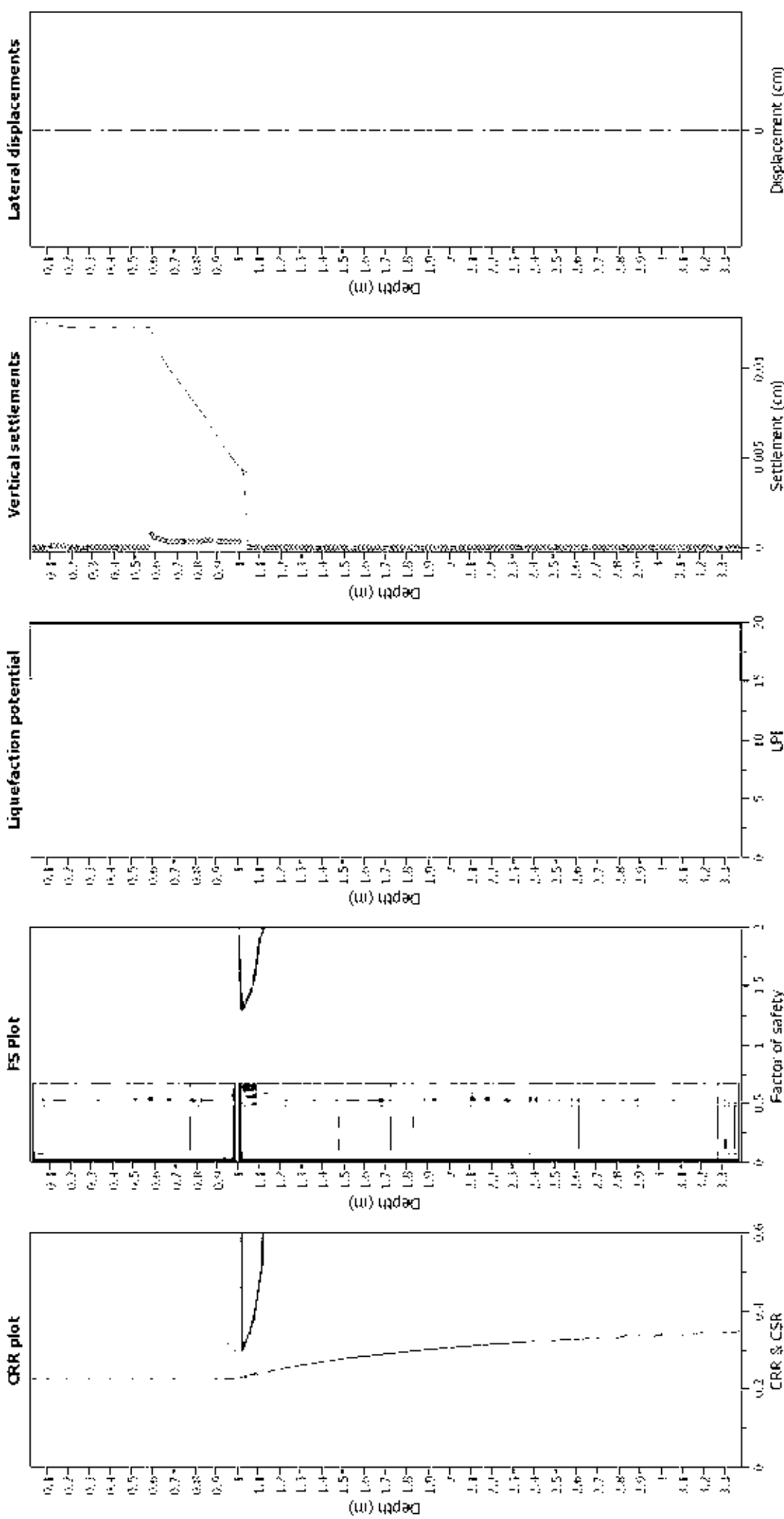
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial mag. angle $\beta_s$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table ( $z_{wt}$ ):	1.00 m	Limit depth:	N/A
Depth to GW (erthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Factorial safety margin (M<sub>f</sub>): 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m<sub>wt</sub>): 1.00 m

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

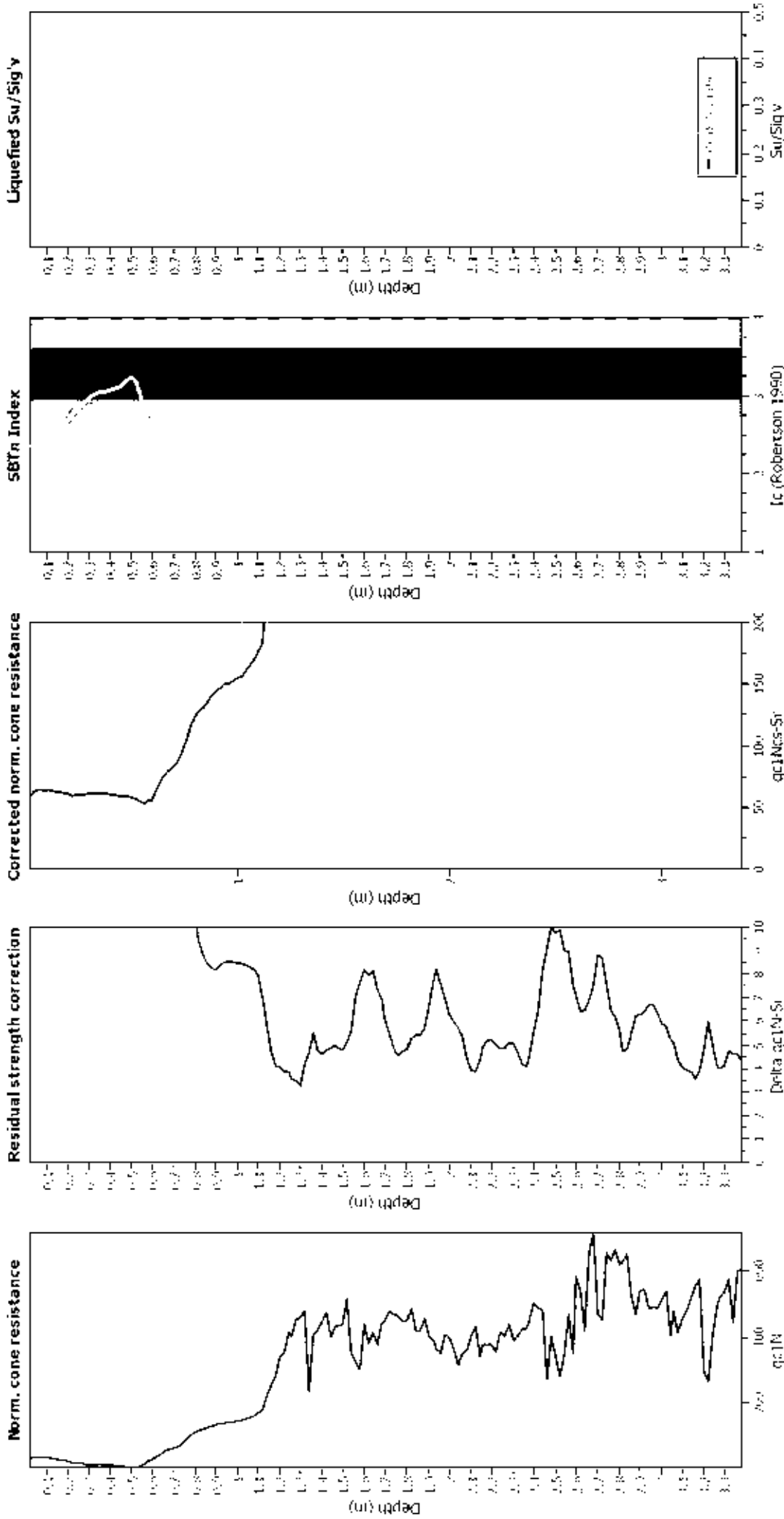
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

### Check for strength loss plots (Idriss & Boulanger (2008))

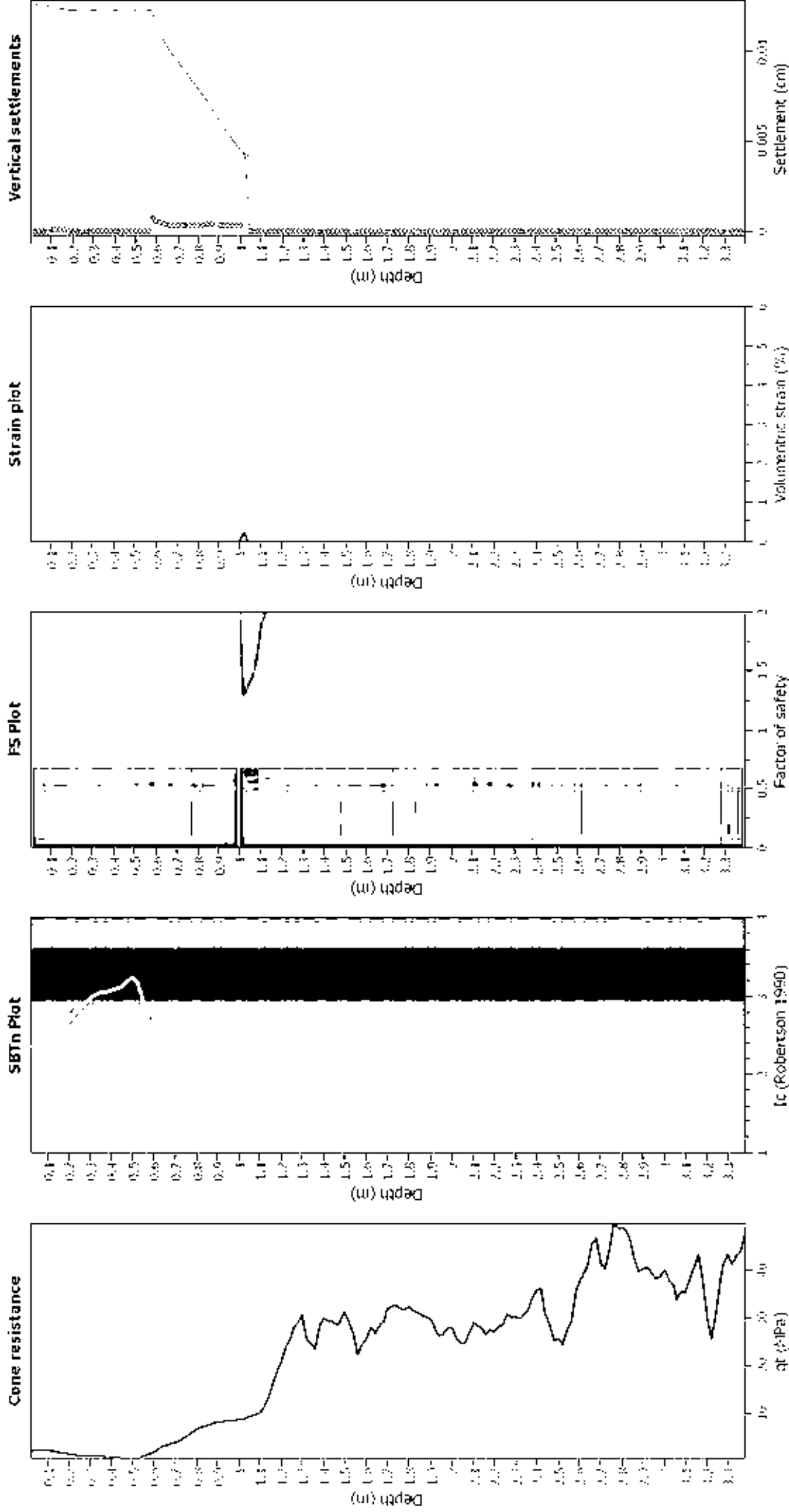


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT27\_47KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

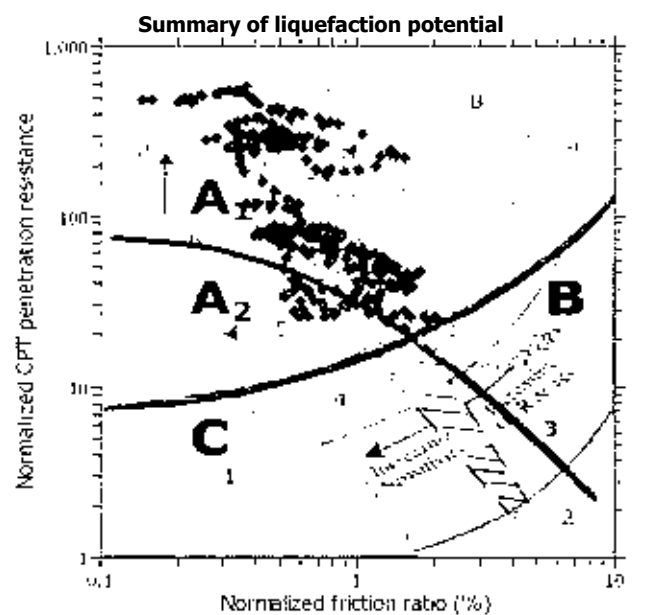
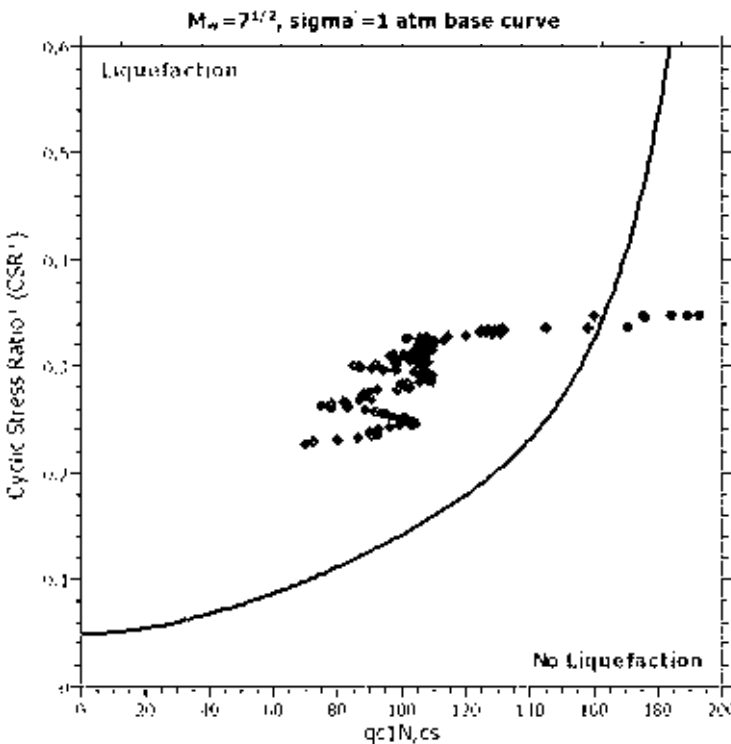
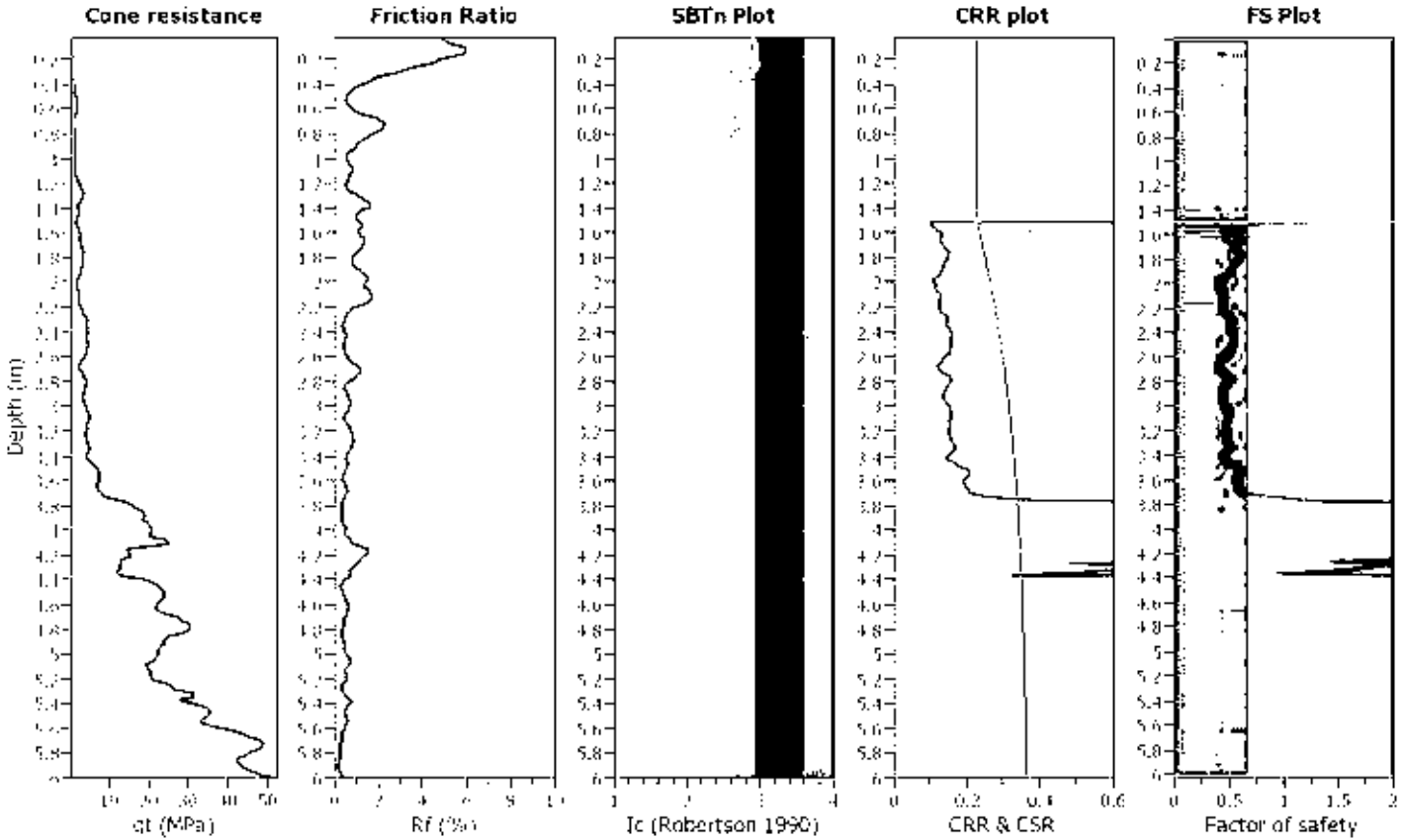
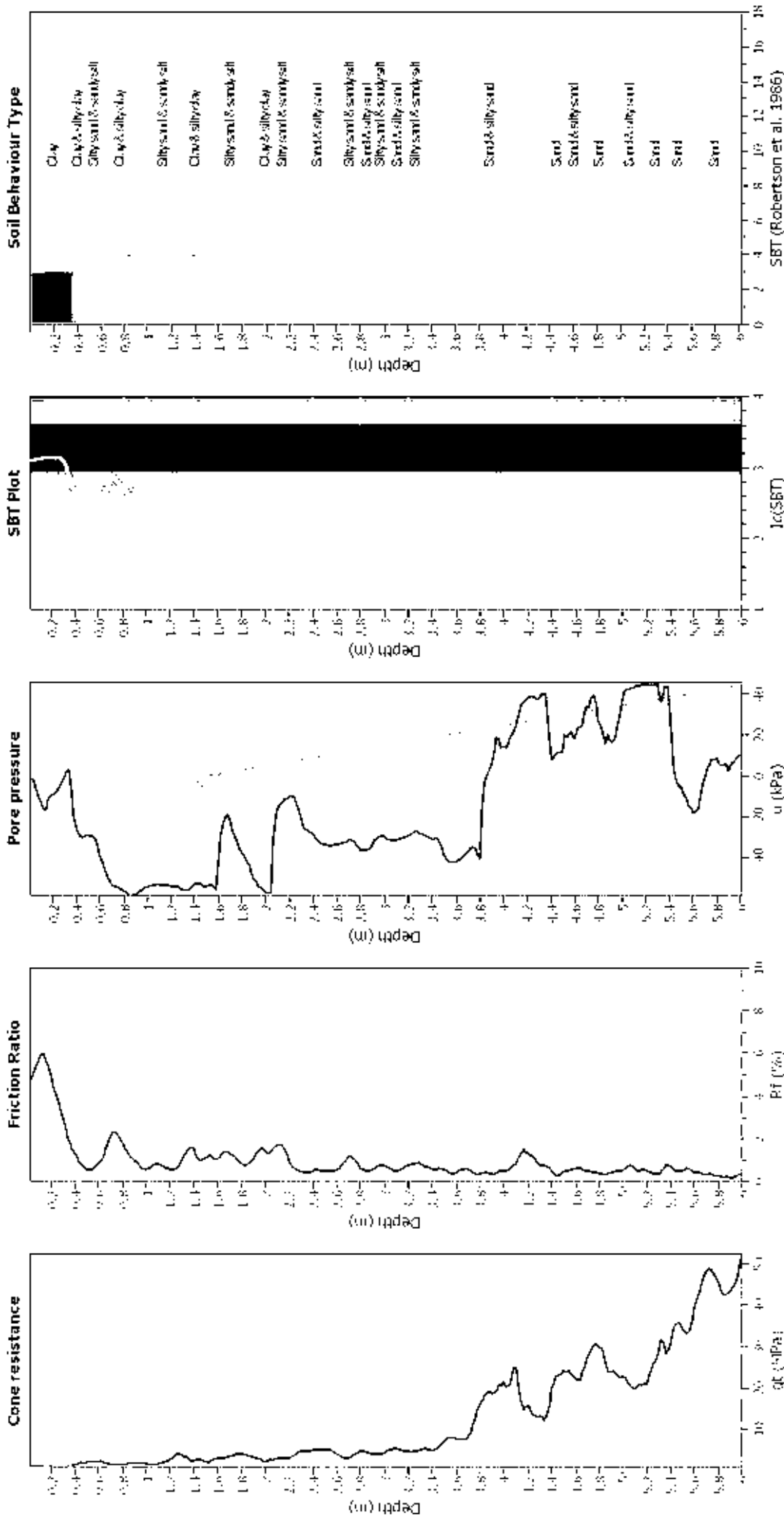


Figure 4: Summary of liquefaction potential plot and data for the test. Zone A1 is the liquefaction zone, Zone A2 is the zone of partial liquefaction, Zone B is the zone of partial liquefaction, and Zone C is the zone of no liquefaction. The liquefaction boundary is shown as a dashed line.

### CPT basic interpretation plots



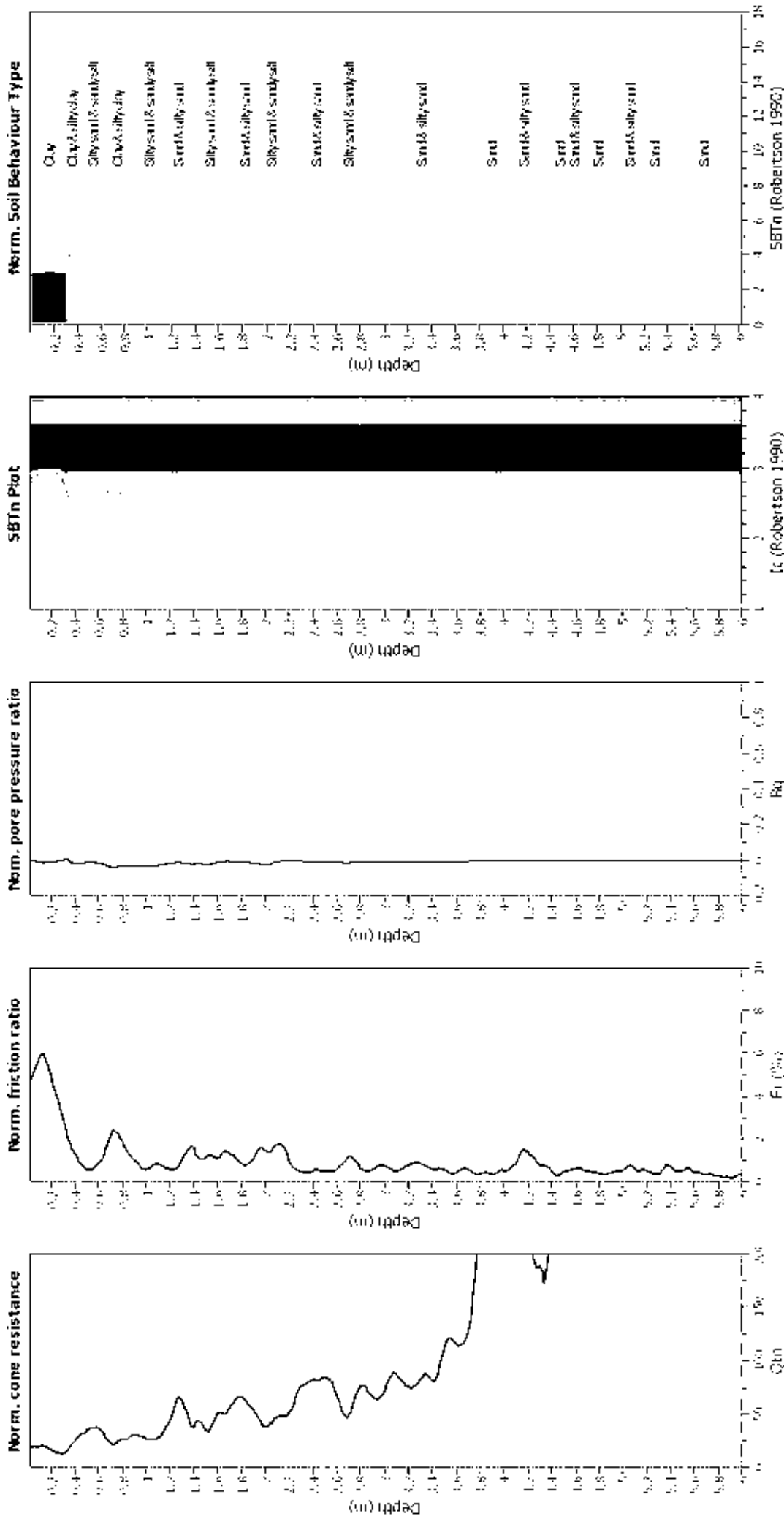
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



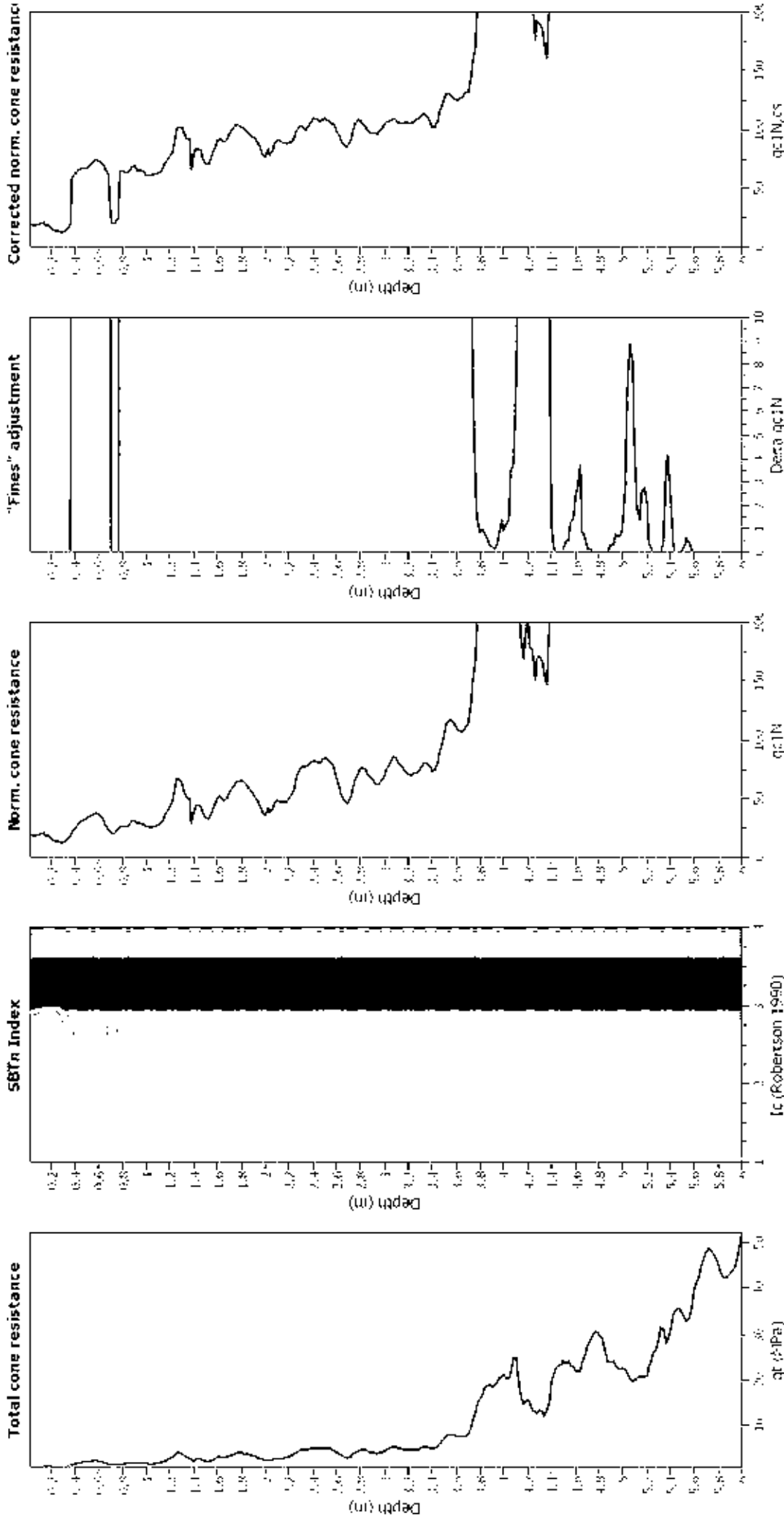
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

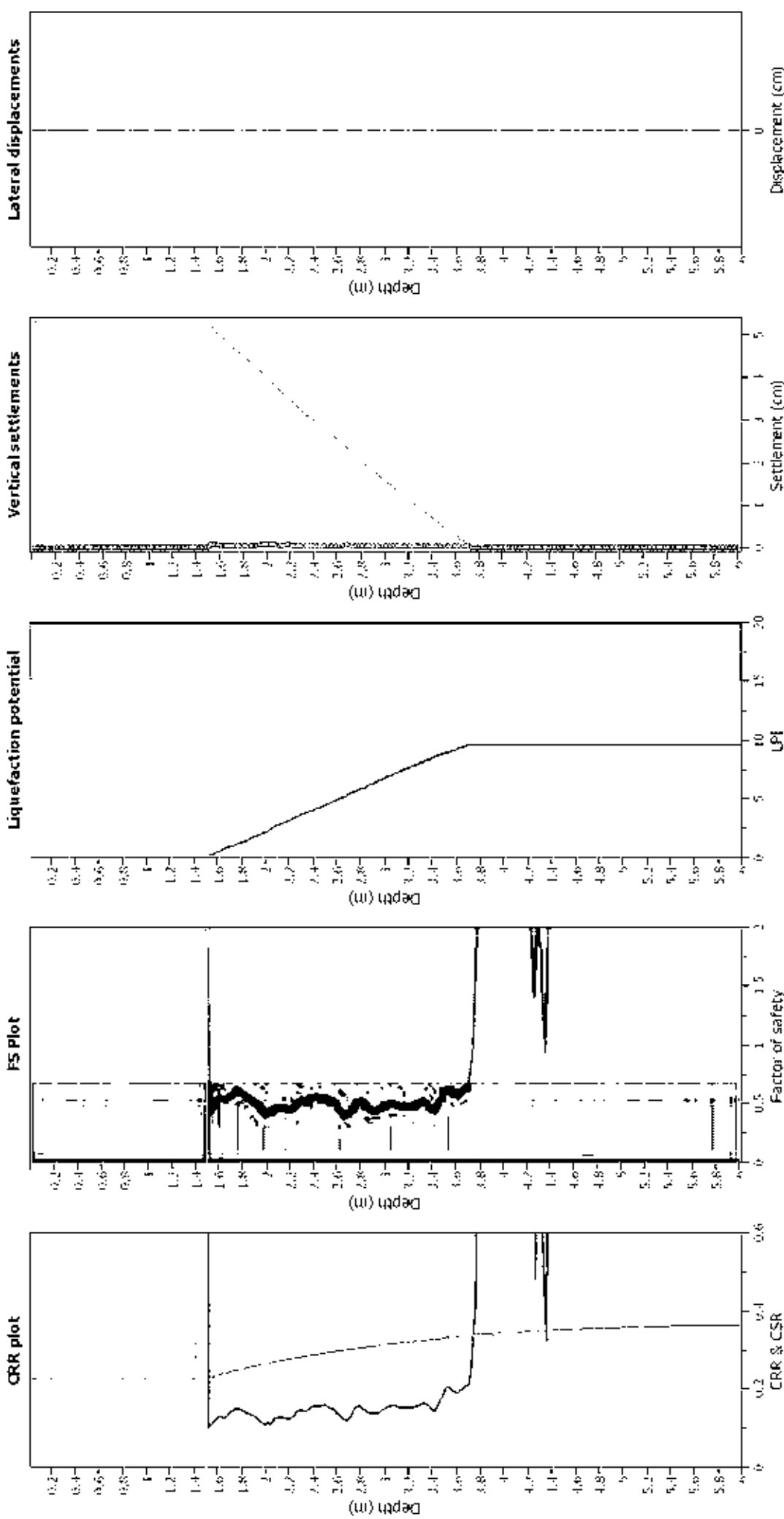
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

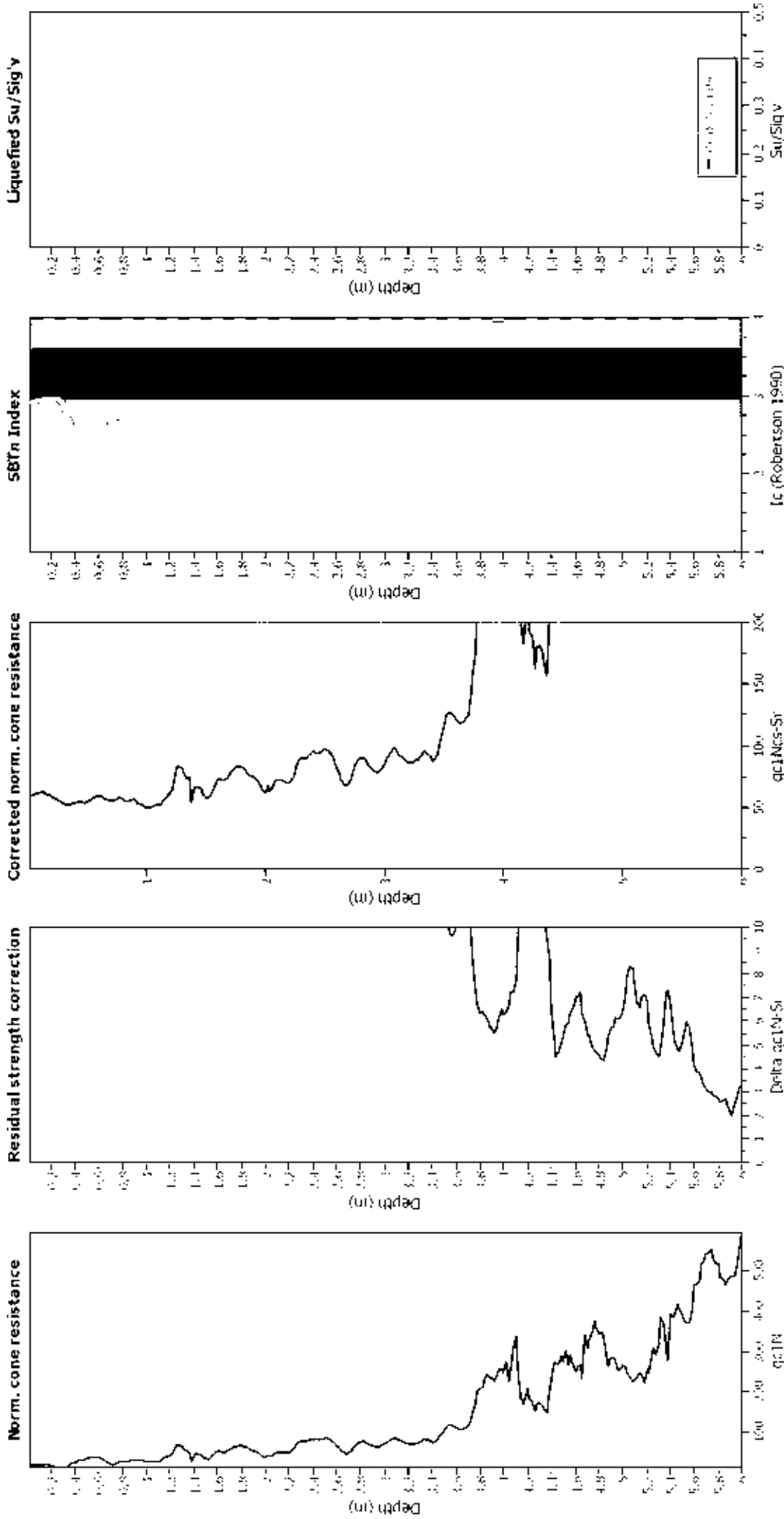
Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

**F.S. color scheme**  
 Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

**LPI color scheme**  
 Very high risk  
 High risk  
 Low risk

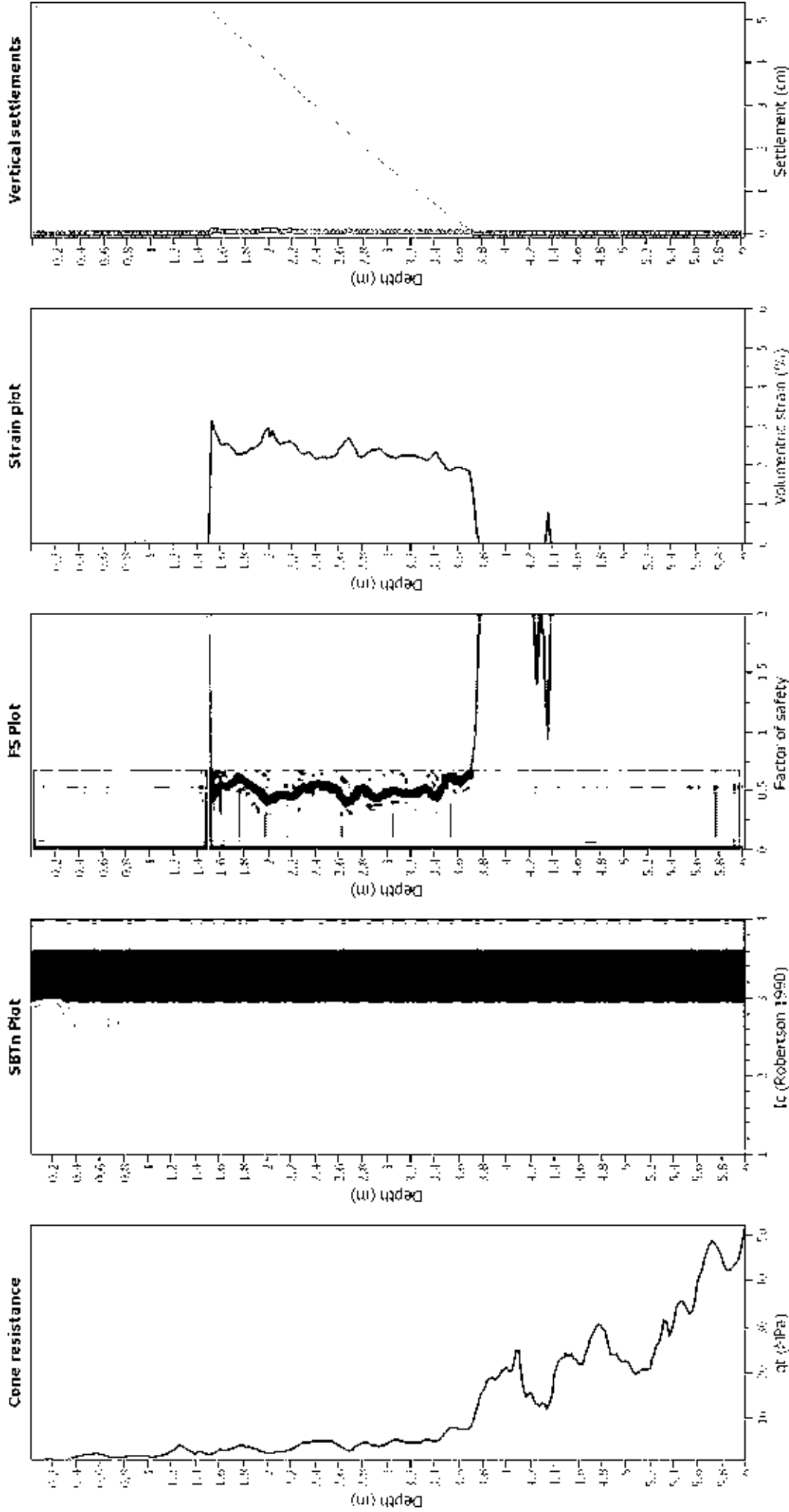
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain



**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT28\_57SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>o</sub> applied:	Yes		

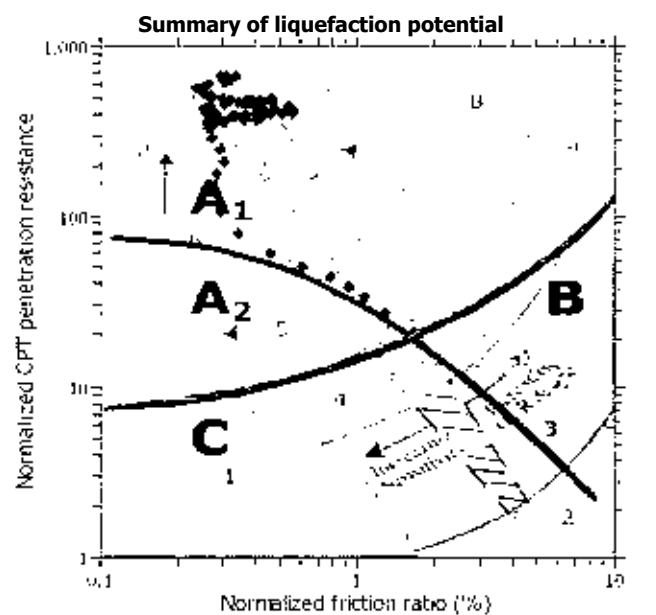
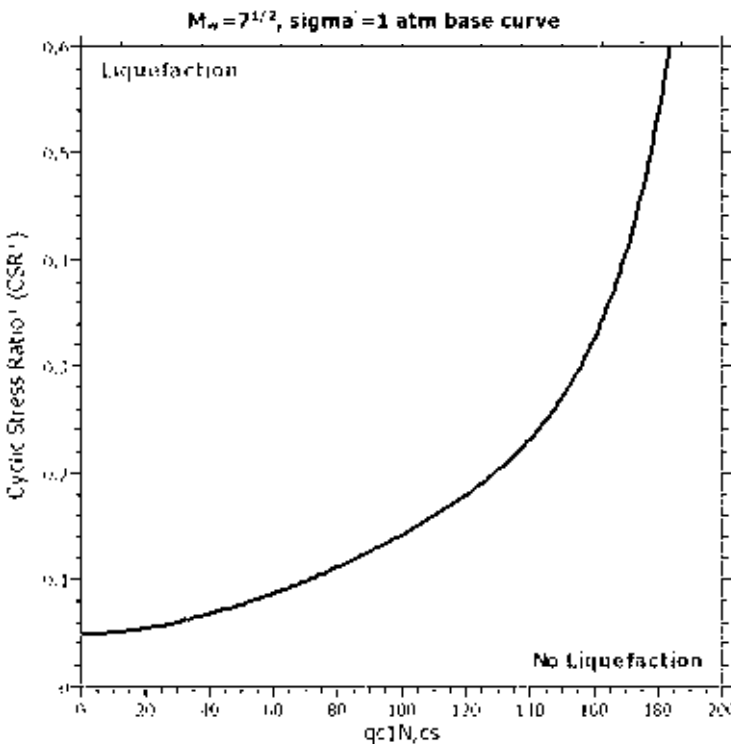
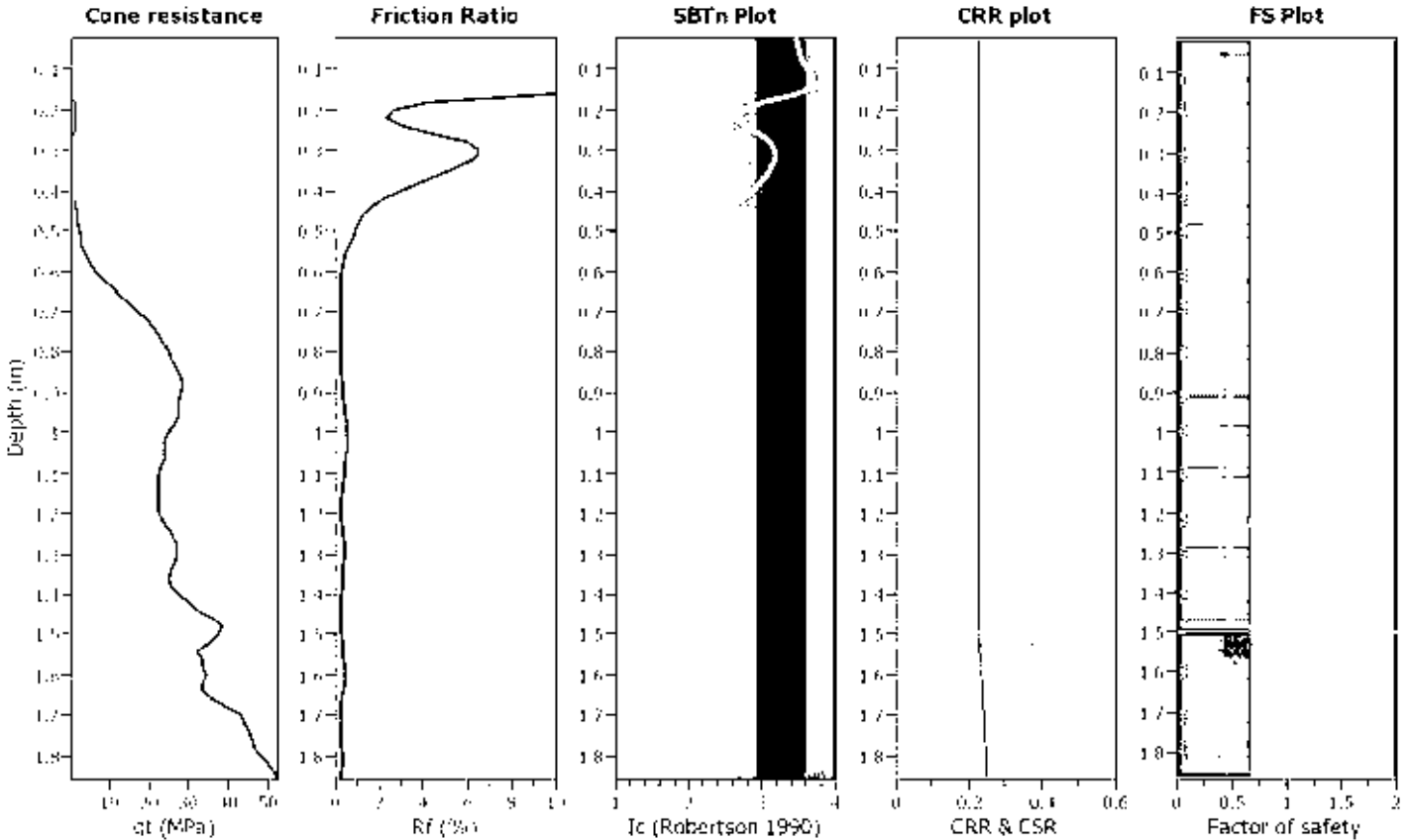
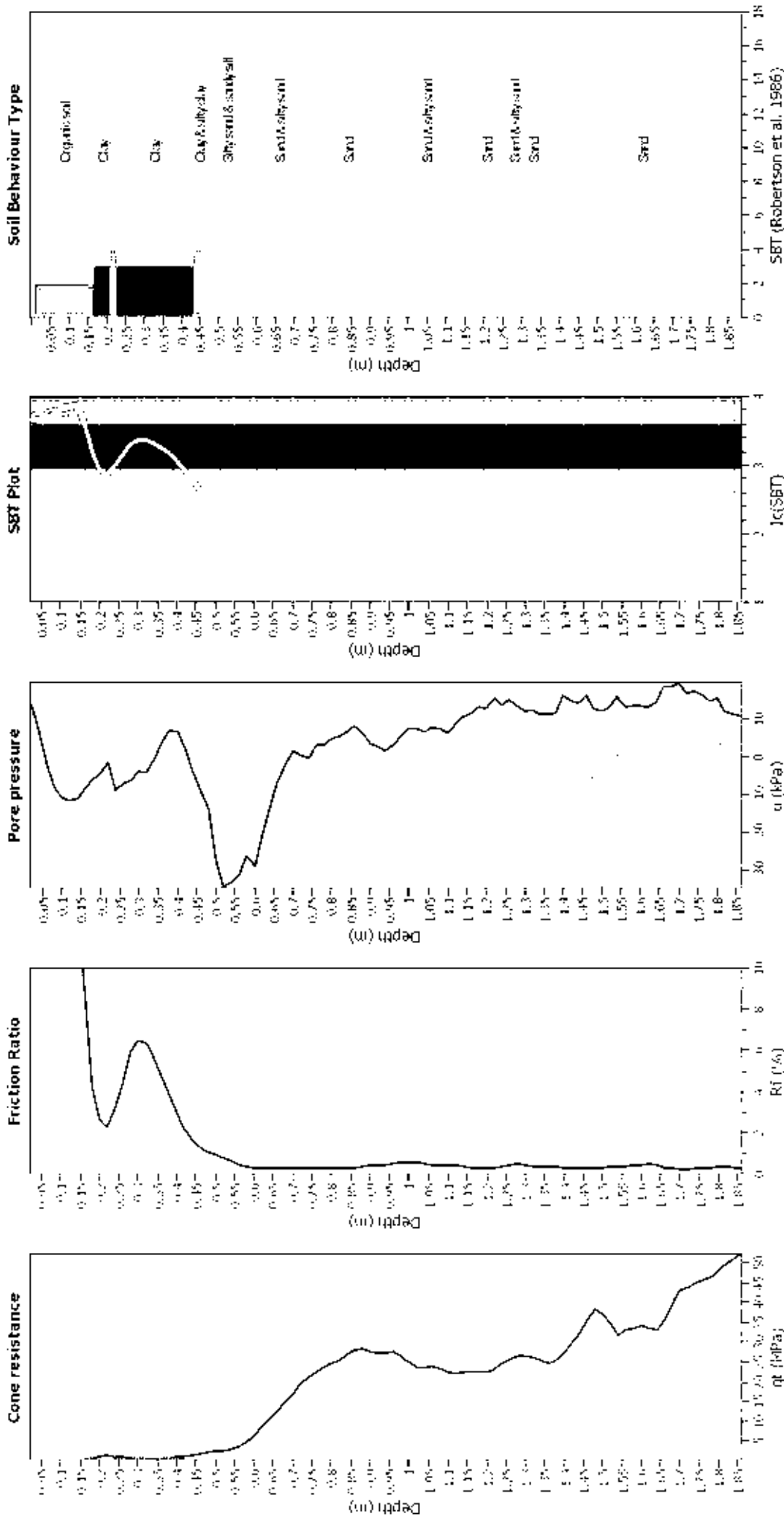


Figure 4: Summary of liquefaction potential plot and a curve of cyclic stress ratio. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The plot is divided into regions A1, A2, B, and C. The plot is titled 'Summary of liquefaction potential'.

### CPT basic interpretation plots



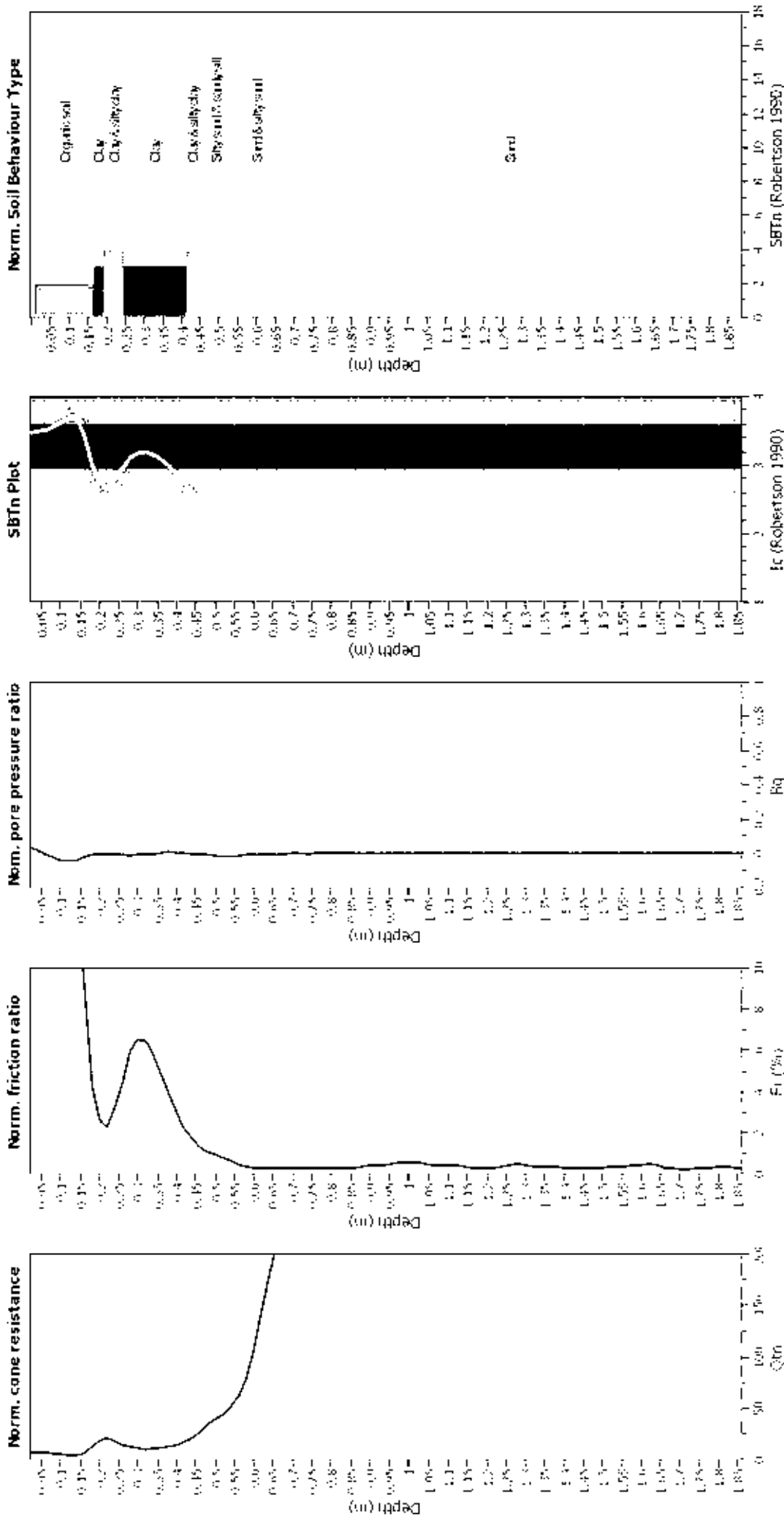
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Average results interval:	3	Transition depth applied:	Sand & Clay
Ic cut-off value:	2.60	K applied:	Yes
Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Use fill:	No	Unit depth applied:	No
Fill height:	N/A	Unit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

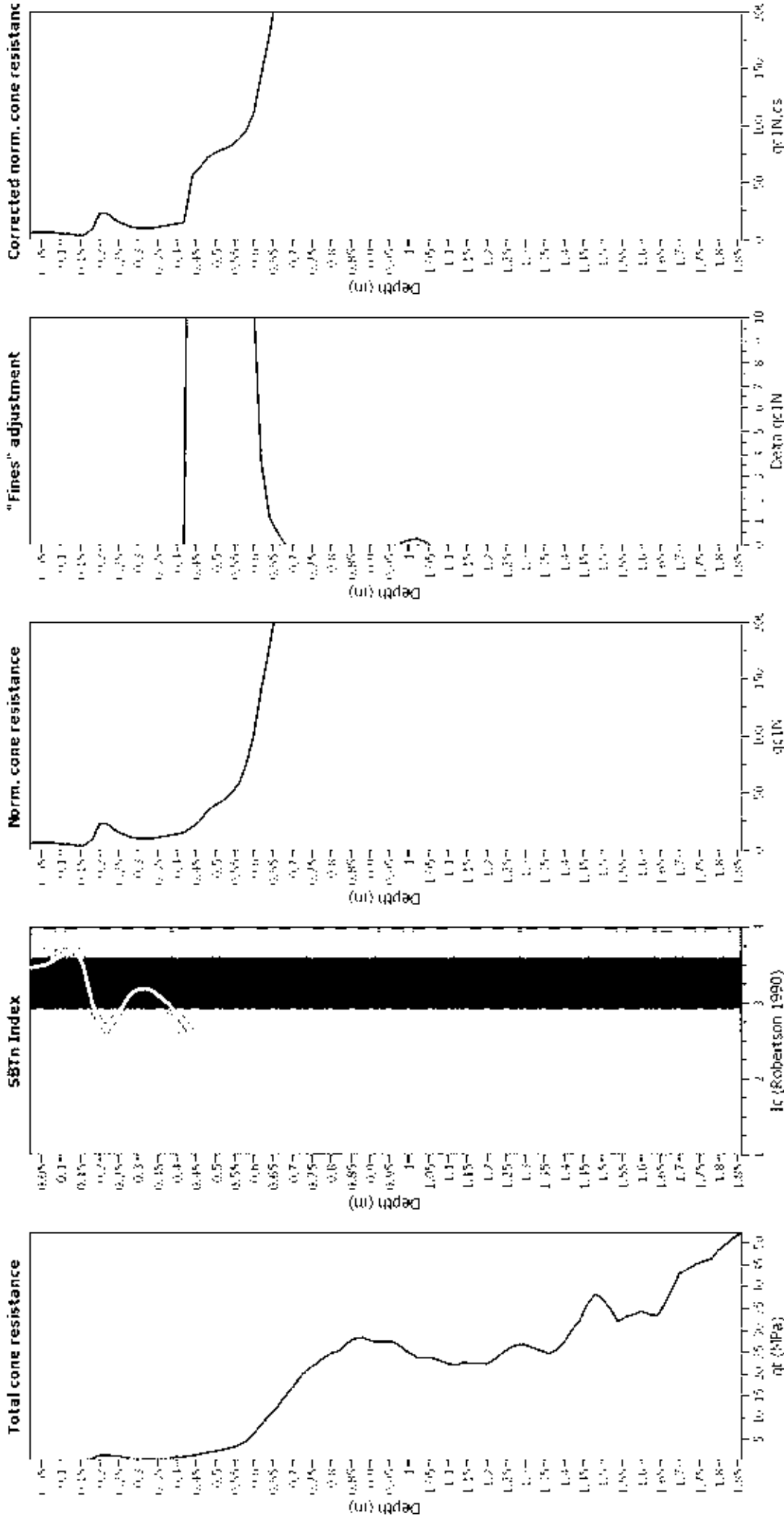
### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GWL (erthq.):	1.50 m	SBTn legend:	
Average results interval:	3	1. Sensitive fine grained:	<input type="checkbox"/>
Ic cut-off value:	2.60	2. Organic material:	<input type="checkbox"/>
Unit weight calculation:	Based on SBT	3. Clay to silty clay:	<input type="checkbox"/>
Use fill:	No	4. Clayey silt to silty:	<input type="checkbox"/>
Fill height:	N/A	5. Silty sand to sandy silt:	<input type="checkbox"/>
		6. Clean sand to silty sand:	<input type="checkbox"/>
		7. Gravely sand to sand:	<input type="checkbox"/>
		8. Very stiff sand to	<input type="checkbox"/>
		9. Very stiff fine grained	<input type="checkbox"/>

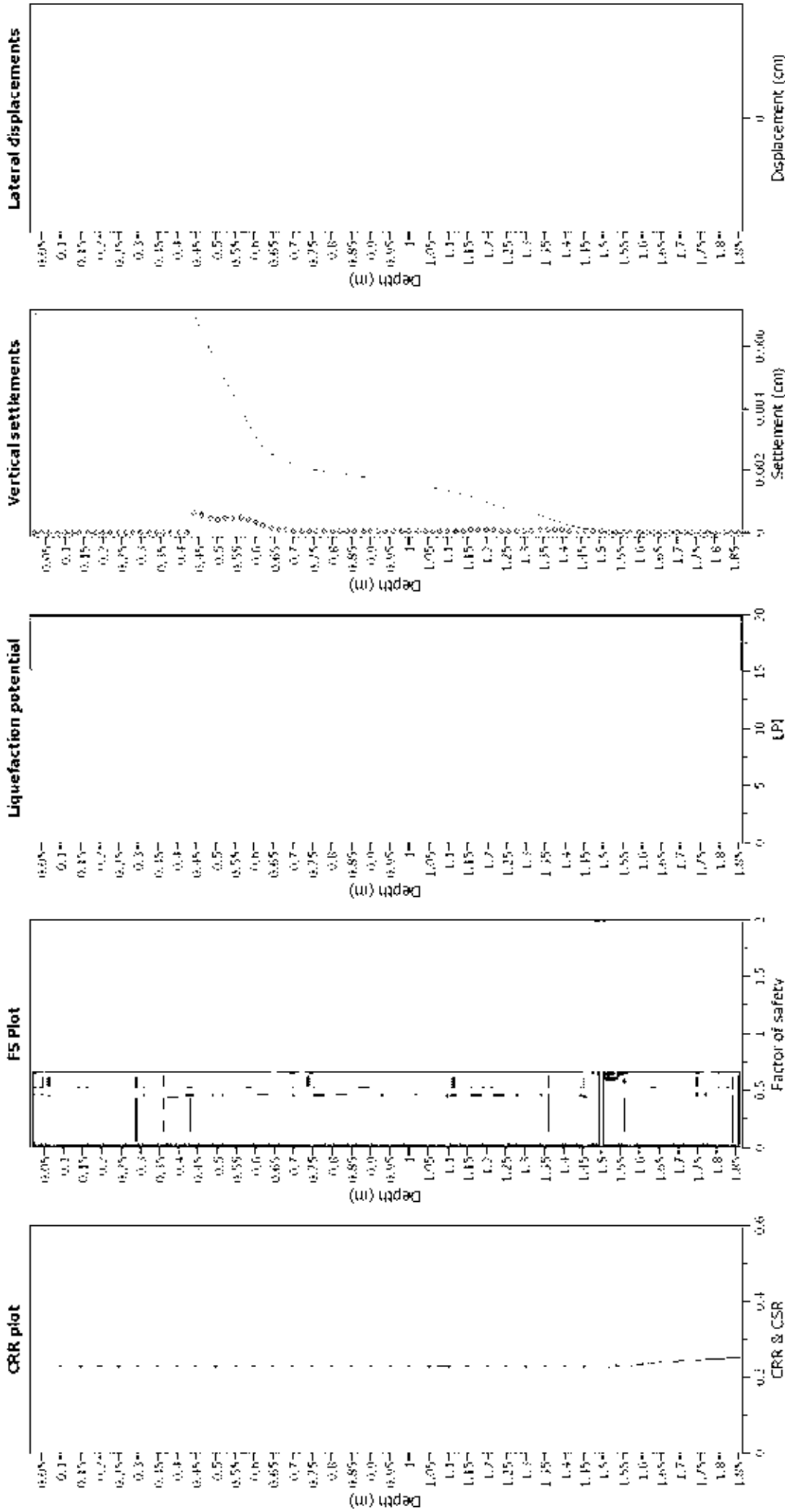
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude $M_v$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Lines correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition defect applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No

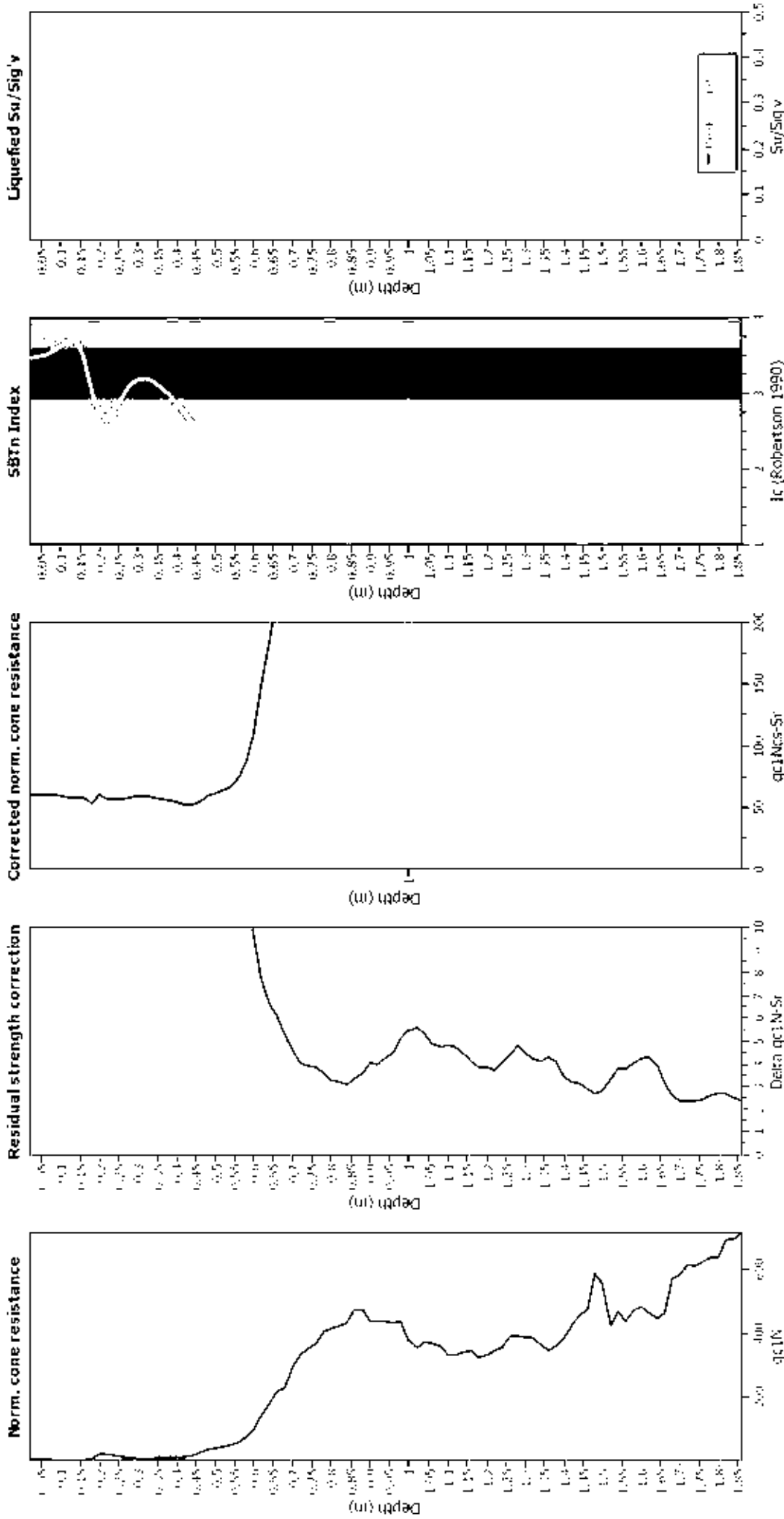
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

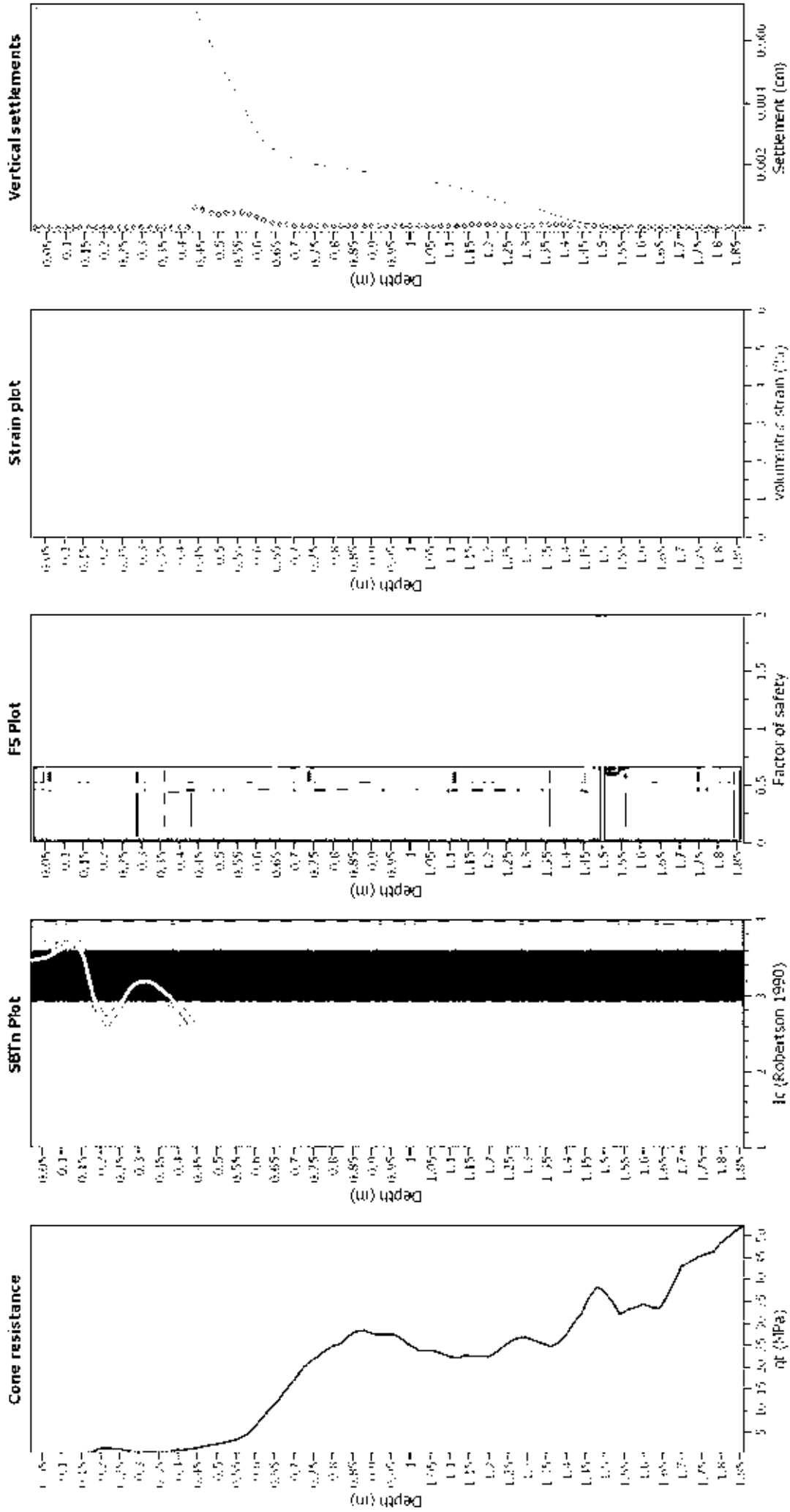
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. angle $\theta_c$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT29\_57SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M <sub>w</sub>	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

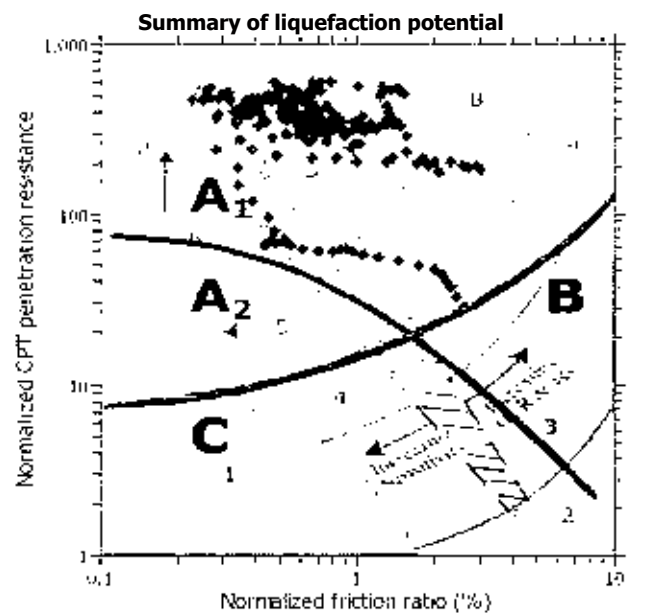
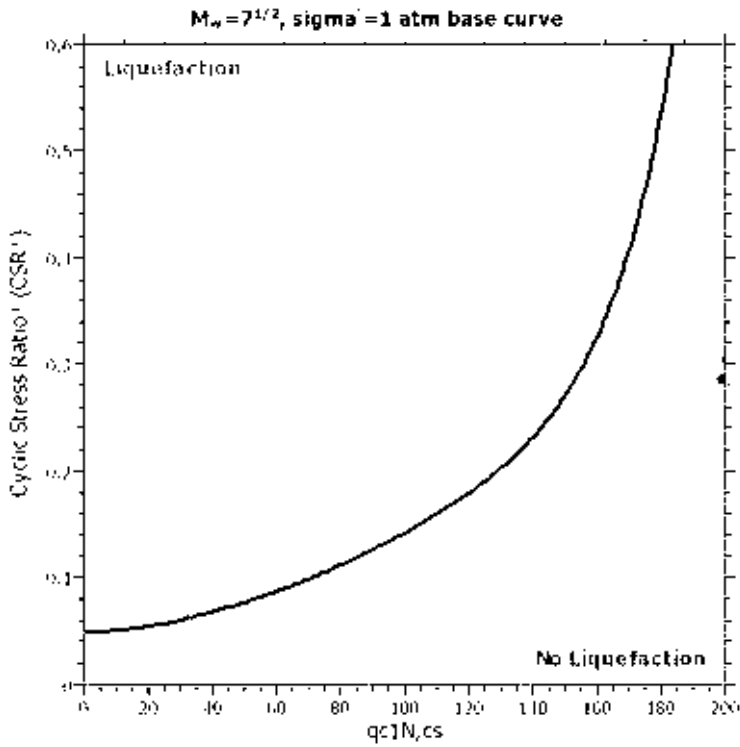
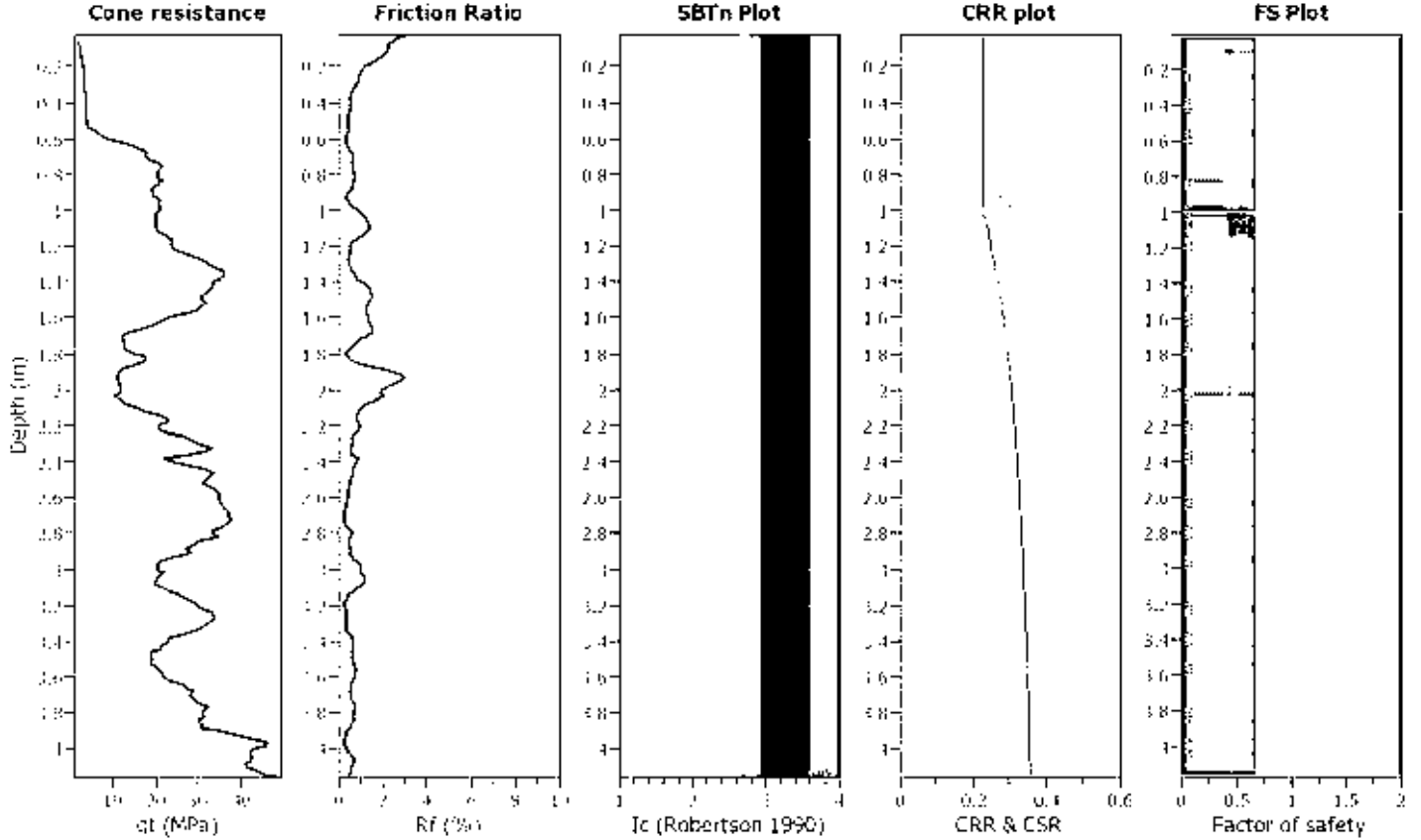
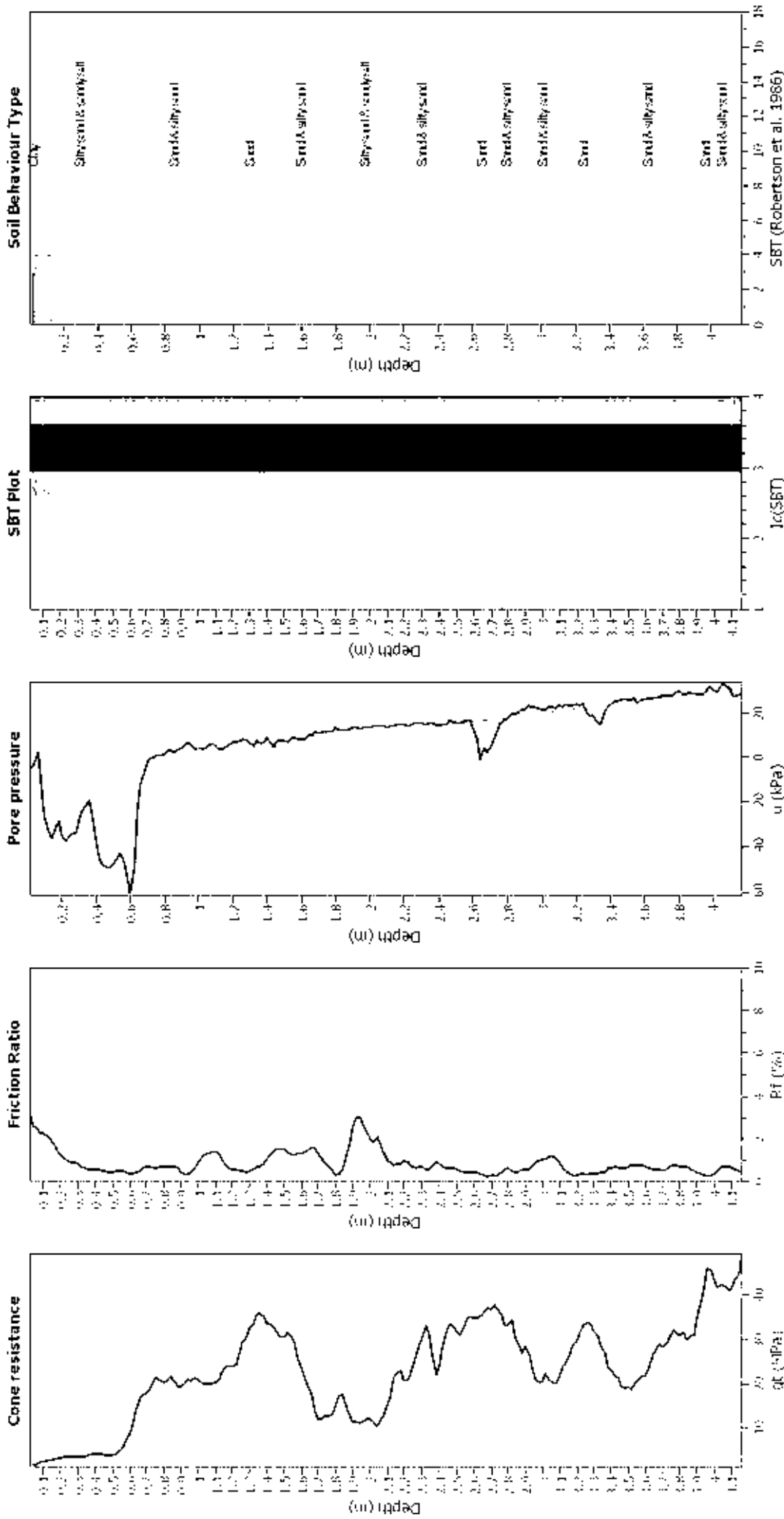


Figure 4. Summary of liquefaction potential based on penetration resistance and normalized cyclic stress ratio. Zone A1 is the liquefaction zone, Zone A2 is the zone of marginal liquefaction, Zone B is the zone of no liquefaction, and Zone C is the zone of no liquefaction. The liquefaction boundary is shown as a dashed line. The liquefaction boundary is shown as a dashed line.



### CPT basic interpretation plots



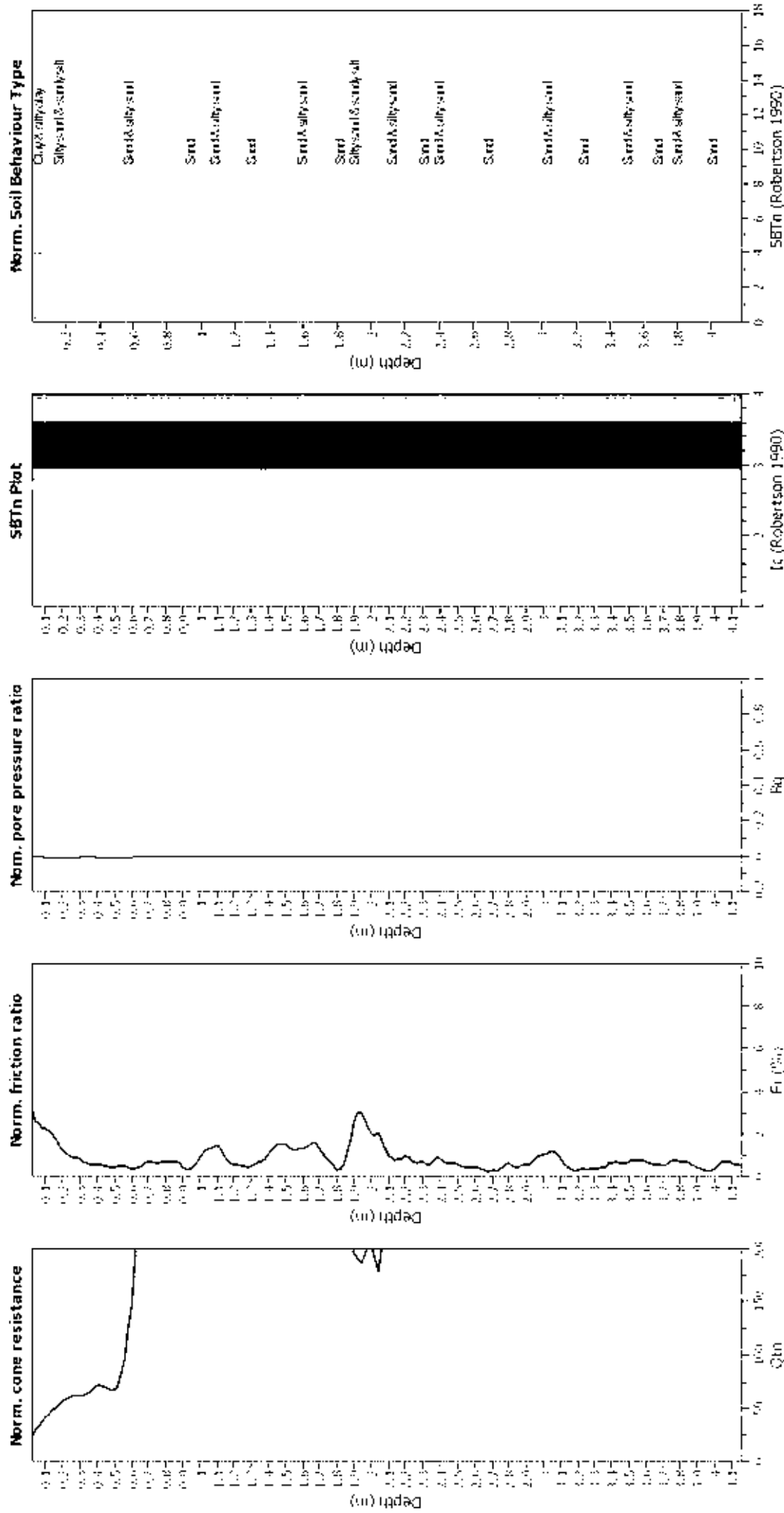
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

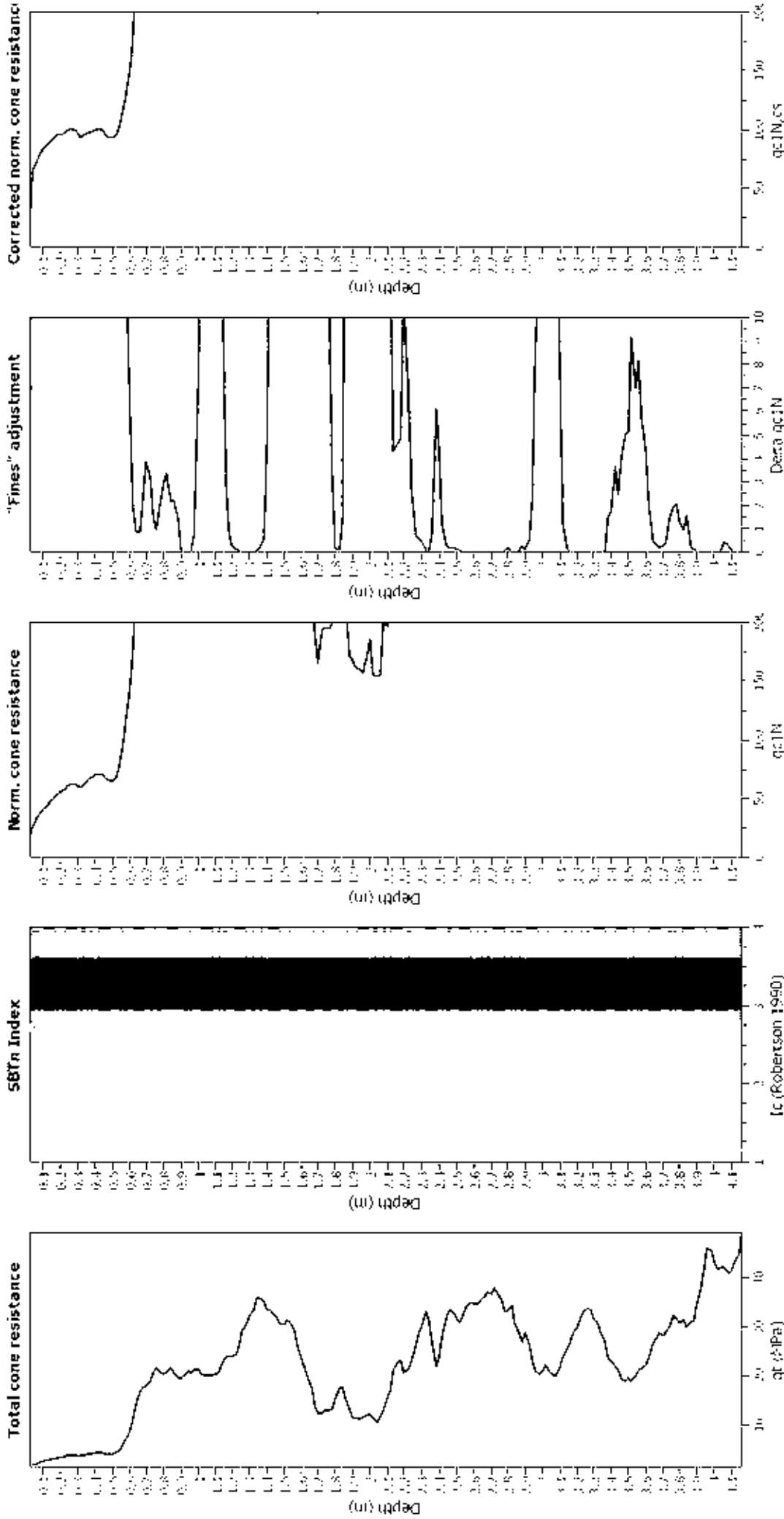
### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A	SBTn legend	<input type="checkbox"/> 1. Sensitive fine grained	<input type="checkbox"/> 7. Gravely sand to sand
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay	<input type="checkbox"/> 2. Organic material	<input type="checkbox"/> 4. Clayey silt to silty	<input type="checkbox"/> 8. Very stiff sand to
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes	<input type="checkbox"/> 3. Clay to silty clay	<input type="checkbox"/> 5. Silty sand to sandy silt	<input type="checkbox"/> 9. Very stiff fine grained
Earthquake magnitude M <sub>w</sub> :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No			
Peak ground acceleration:	0.35	Use fill:	No	Lamé depth applied:	No			
Depth to water table (m):	1.00 m	Fill height:	N/A	Lamé depth:	N/A			

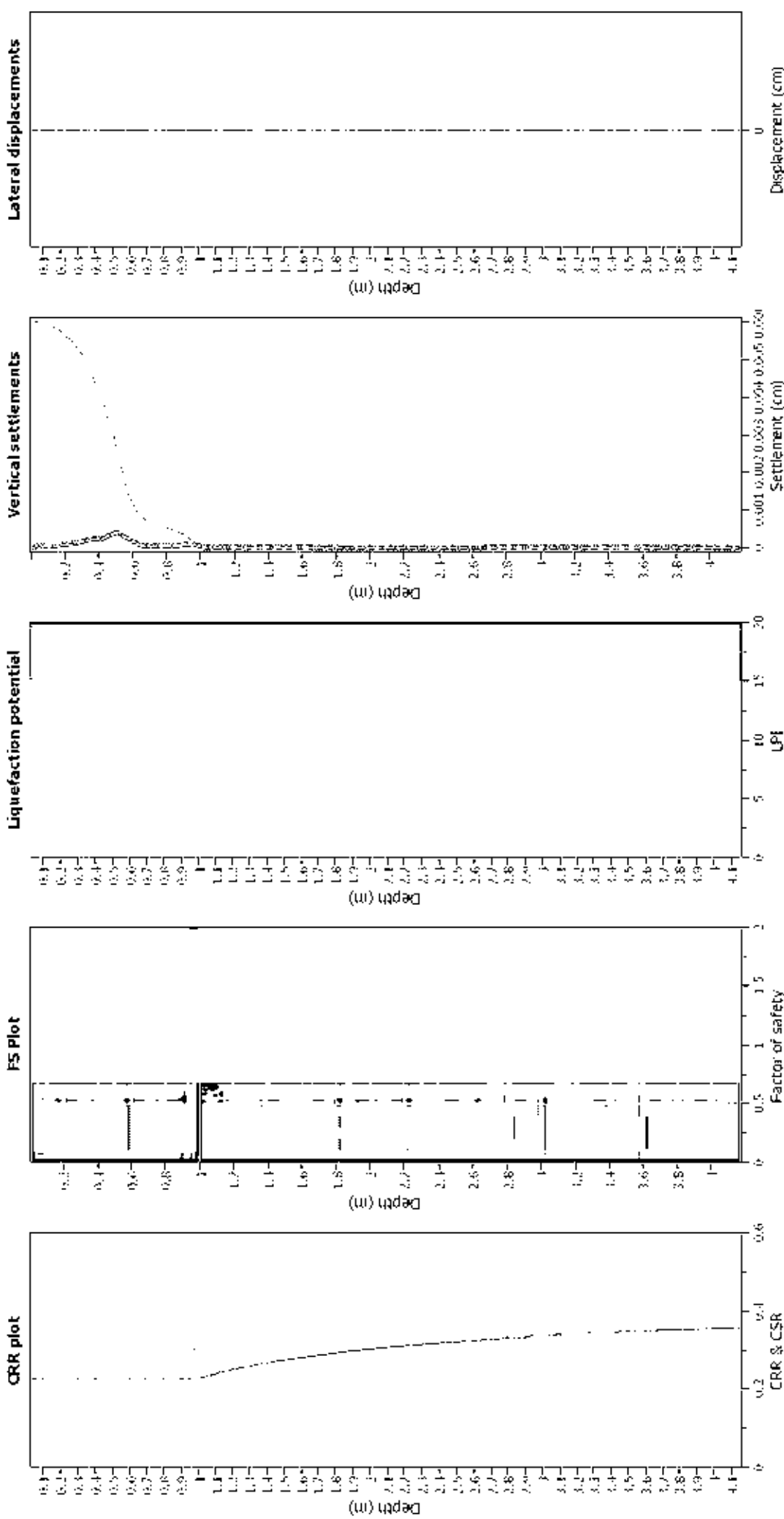
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lam. depth applied:	No
Depth to water table (m):	1.00 m	Lam. depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: I8B (2008)  
 Liquefaction correction method: I8B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Degree to water table: 1.00 m

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

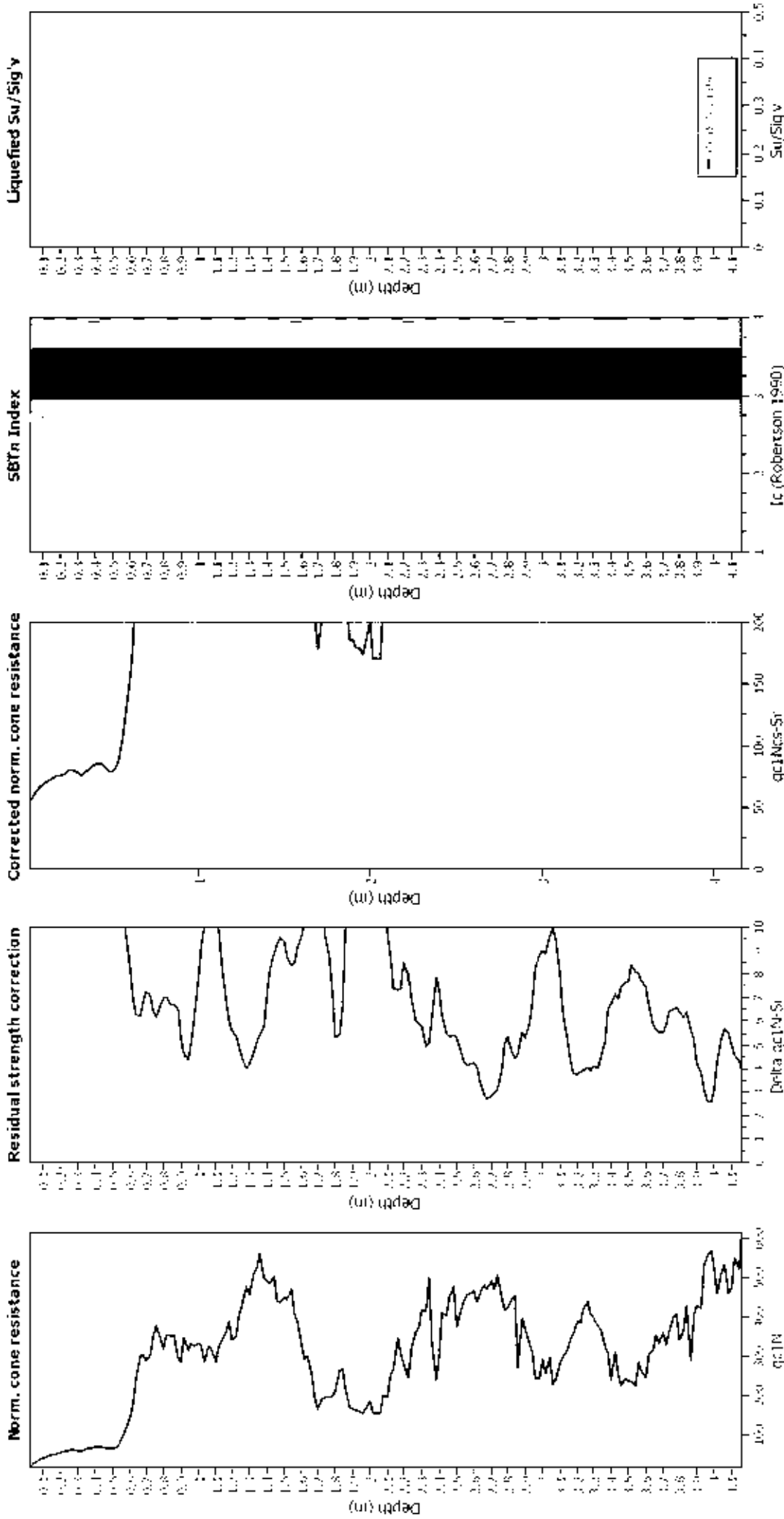
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

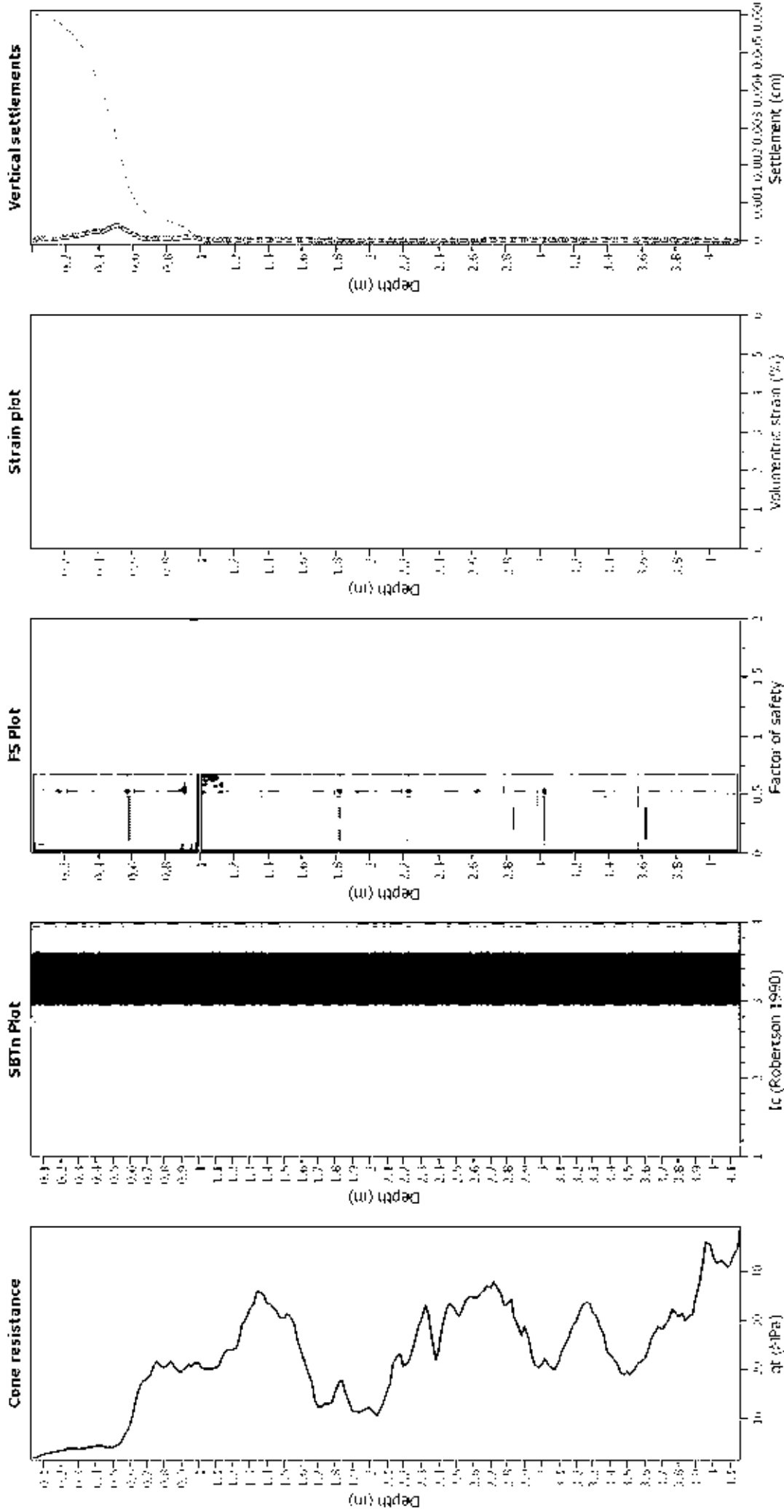
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT30\_29rProvincialRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M <sub>w</sub>	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

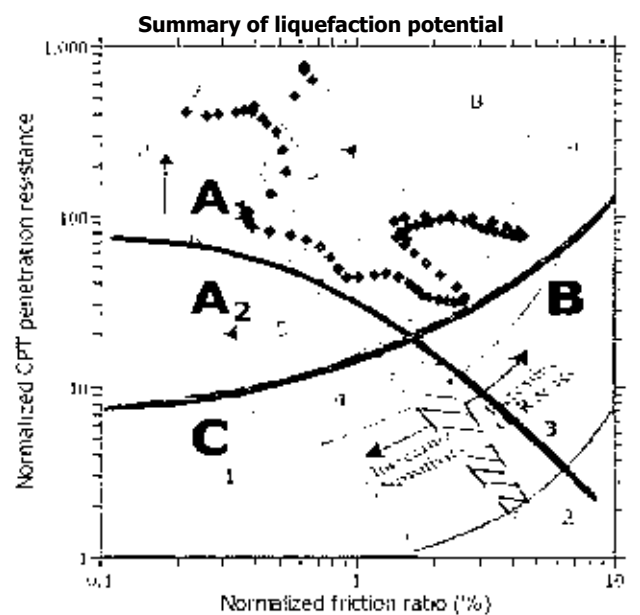
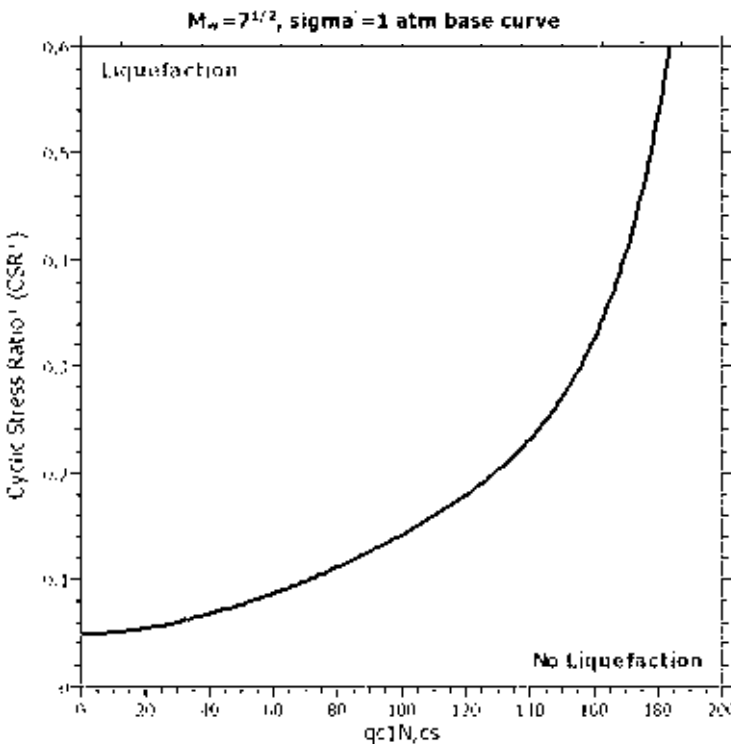
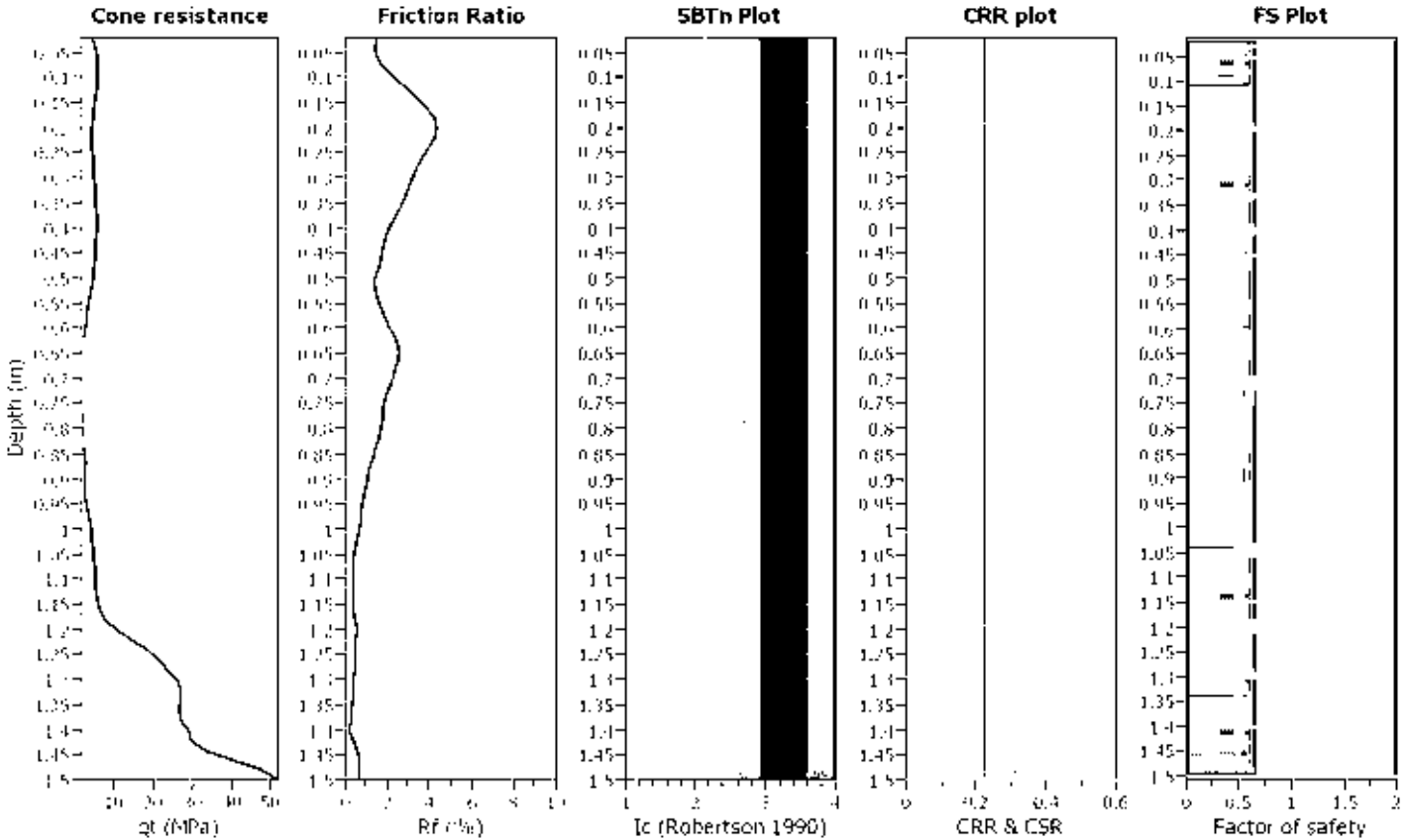
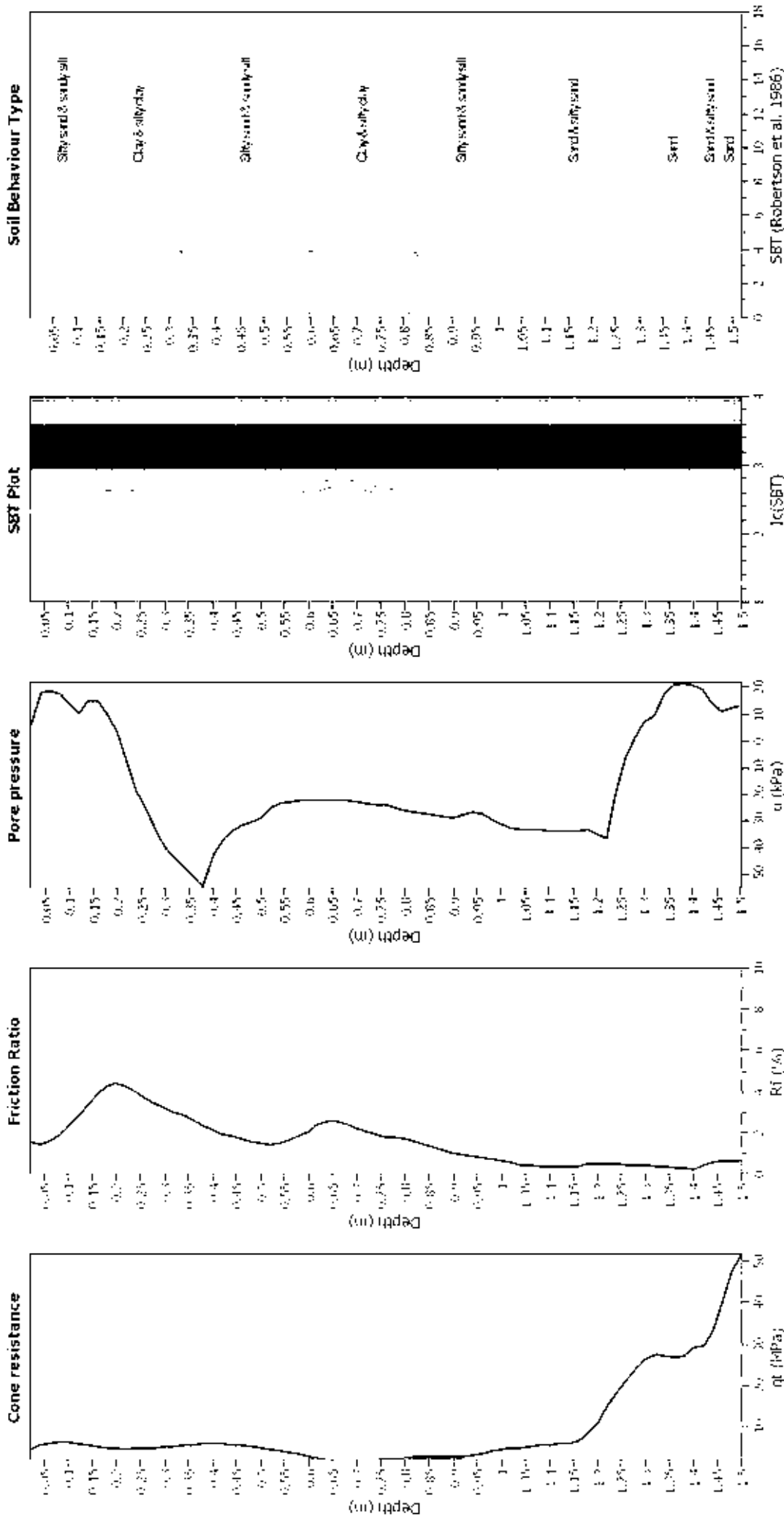


Figure 4: Summary of liquefaction potential plot and curves of cyclic stress ratio. The shaded area represents the liquefaction zone. The curves A, A2, B, and C represent different soil types. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



### Input parameters and analysis data

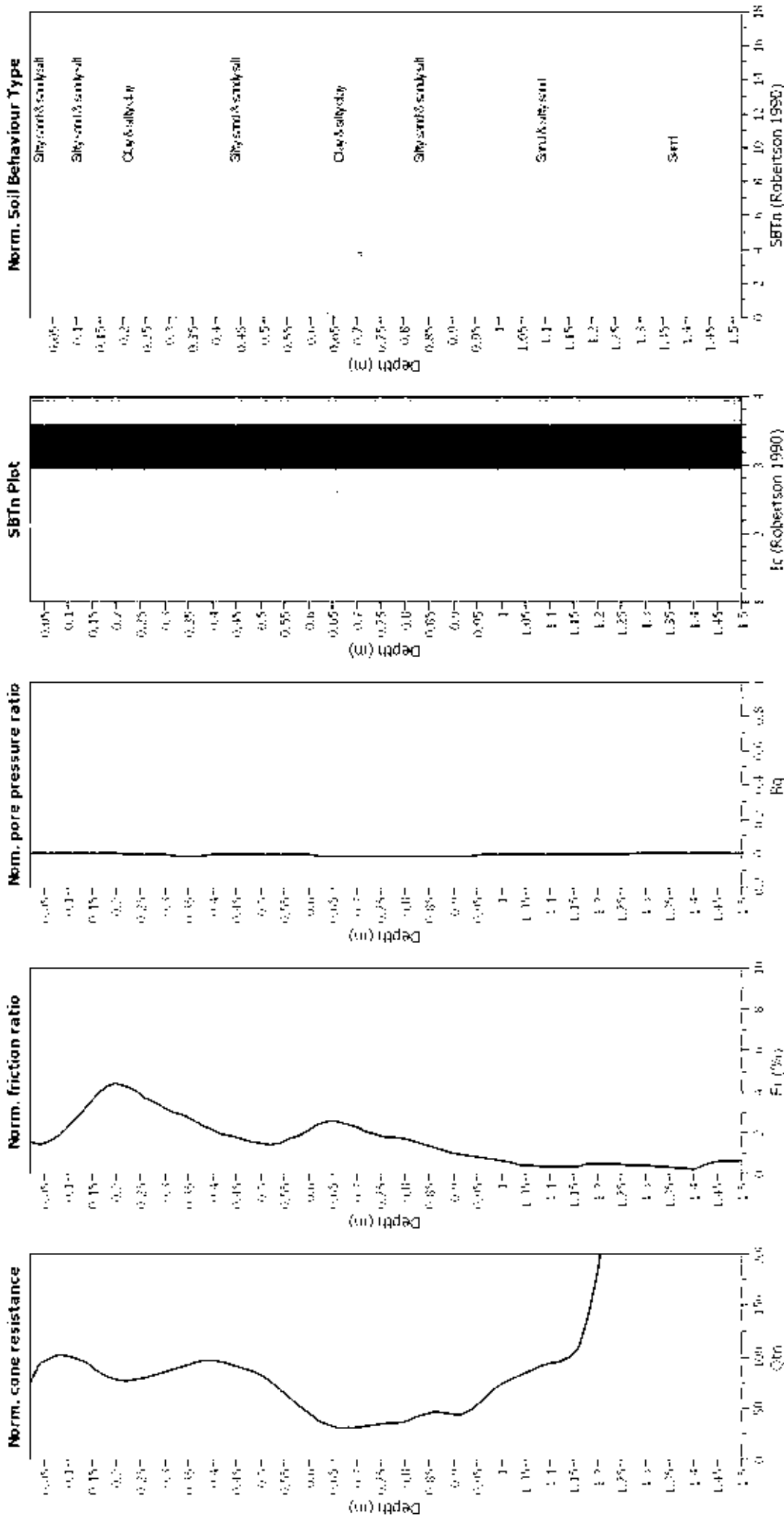
Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.5	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Lamé depth applied:	No
Depth to water table (m):	1.50 m	Lamé depth:	N/A
Depth to GW (earthq.):	1.50 m	Unit weight:	N/A
Average results interval:	3	Transition depth:	Sand & Clay
$I_c$ cut-off value:	2.60	Use fill:	No
Unit weight calculation:	Based on SBT	Fill height:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### CPT basic interpretation plots (normalized)



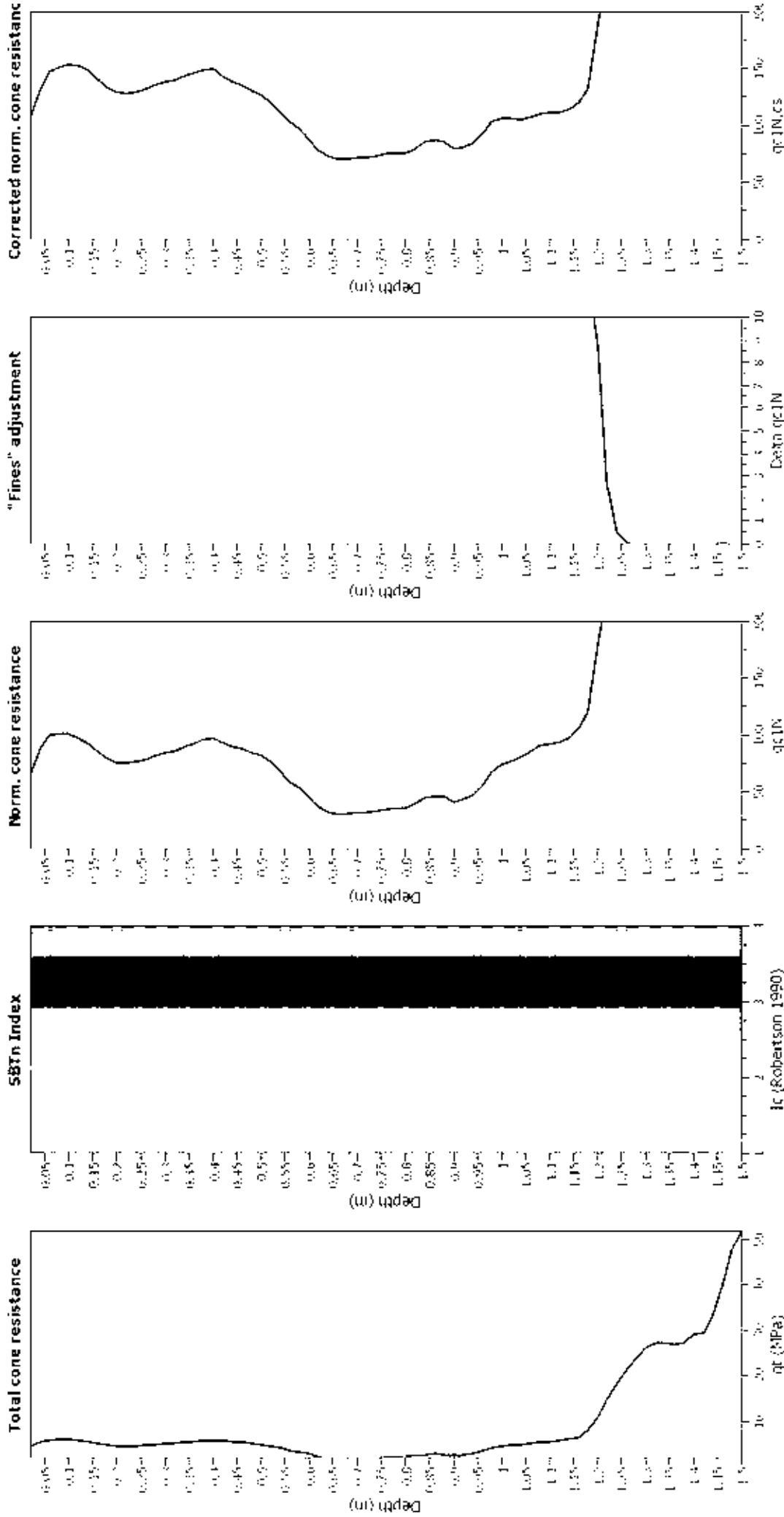
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition detected:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

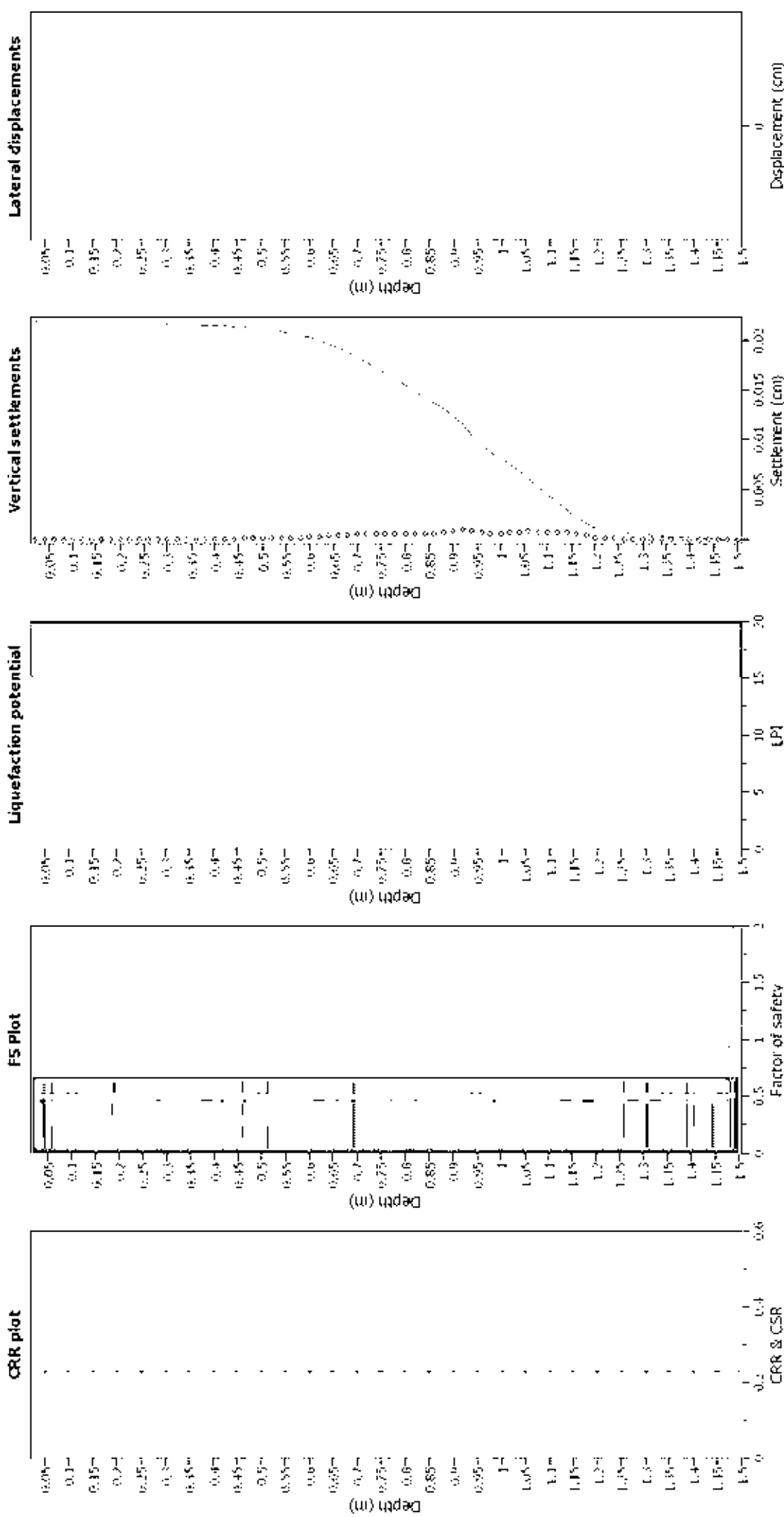
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Factor/make magnitude $M_v$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table ( $z_{w,eq}$ ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction factor: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (erthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

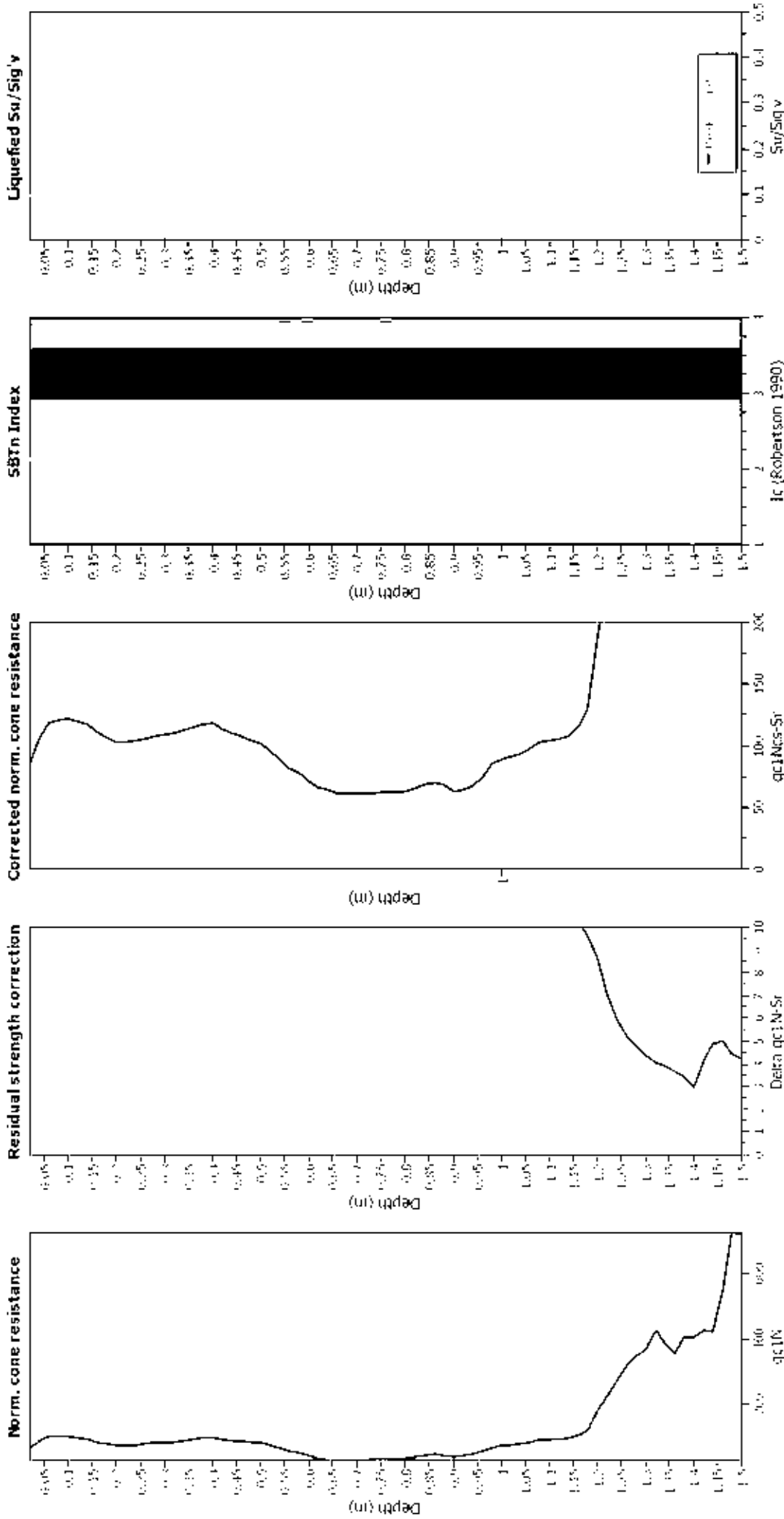
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

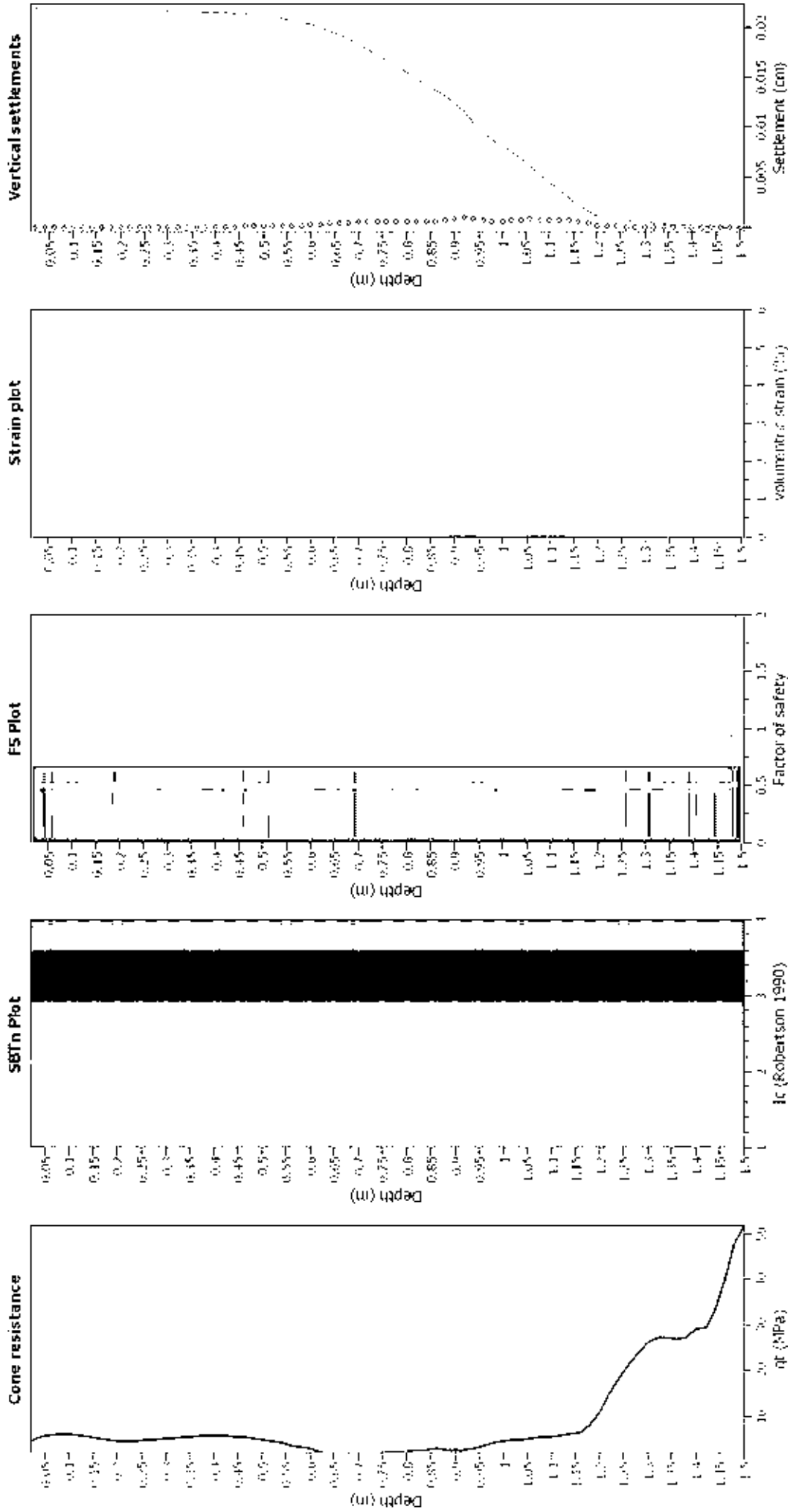
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- SC: Total cone resistance (cone resistance q corrected for pore water effects)
- SBT: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT31\_25KennedysBushRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

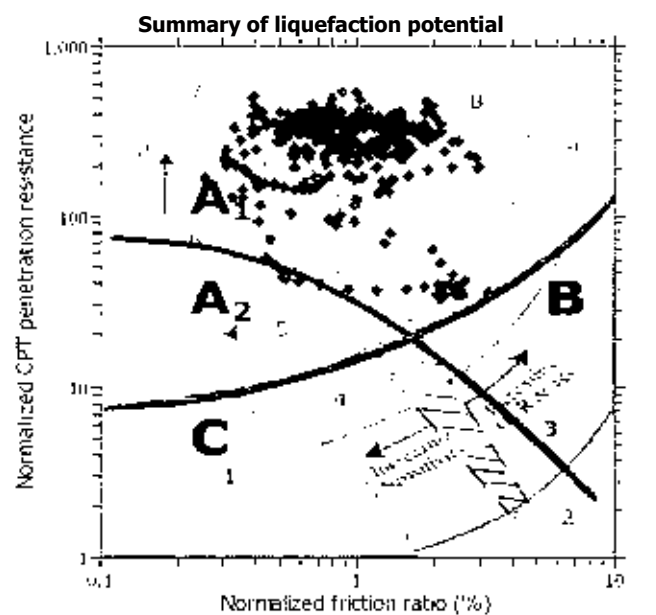
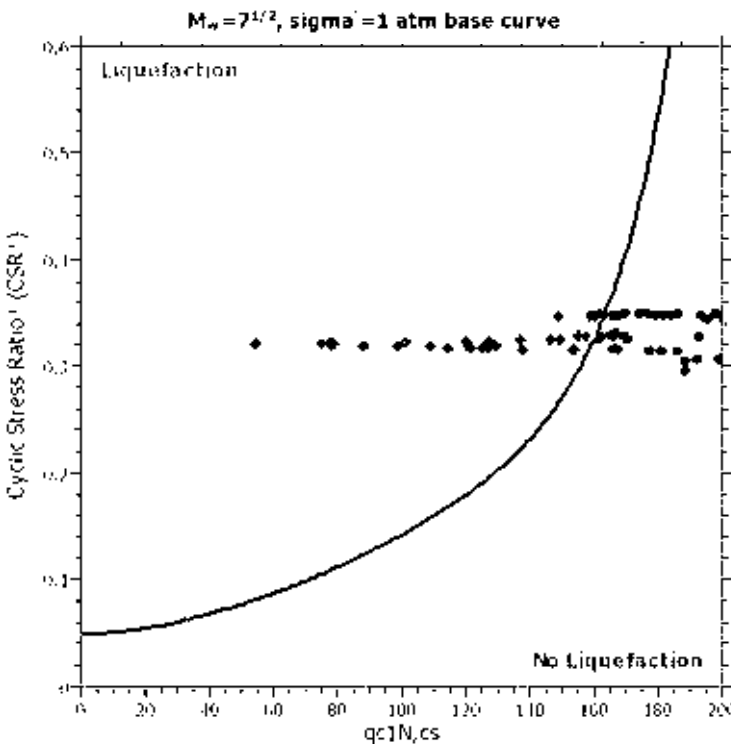
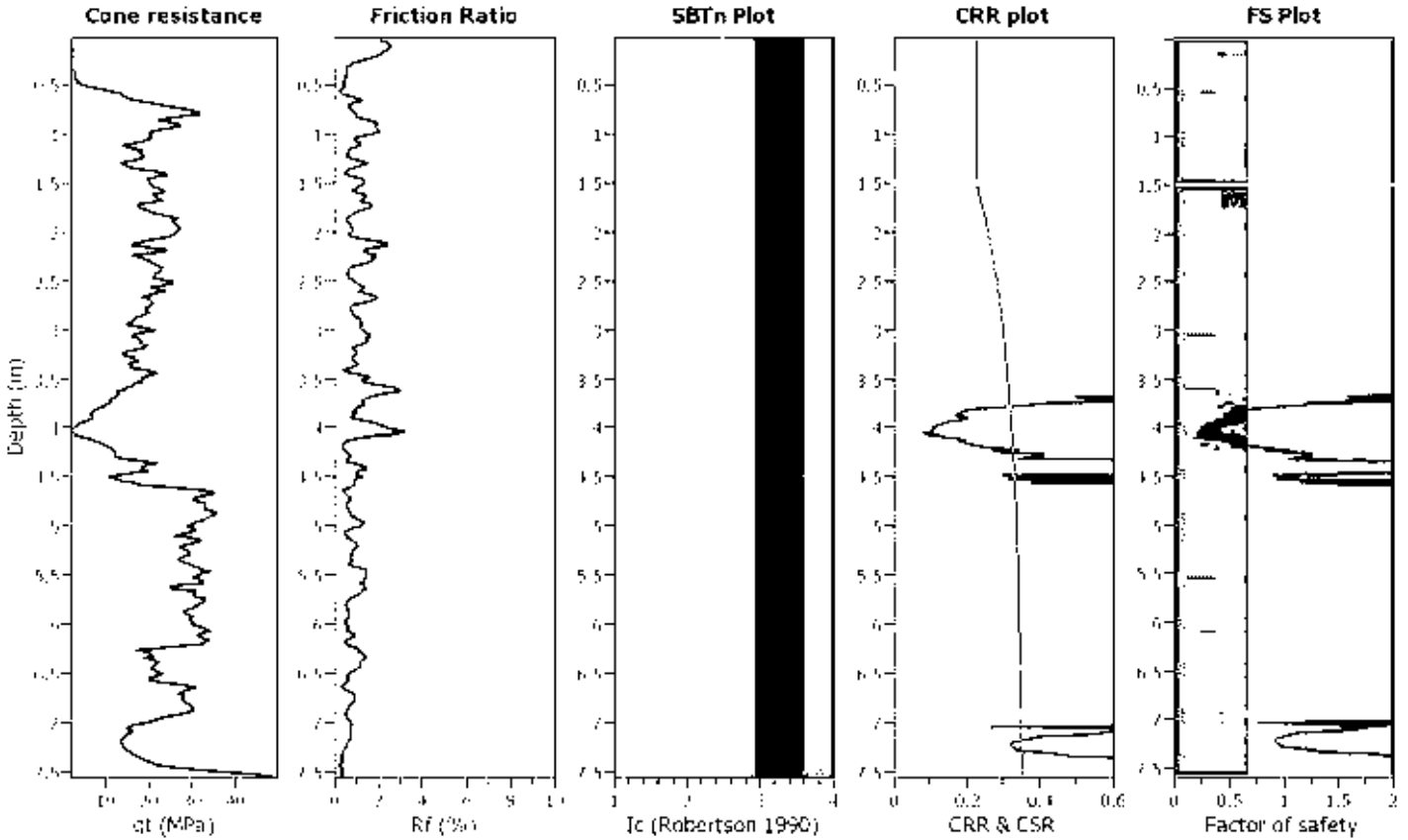
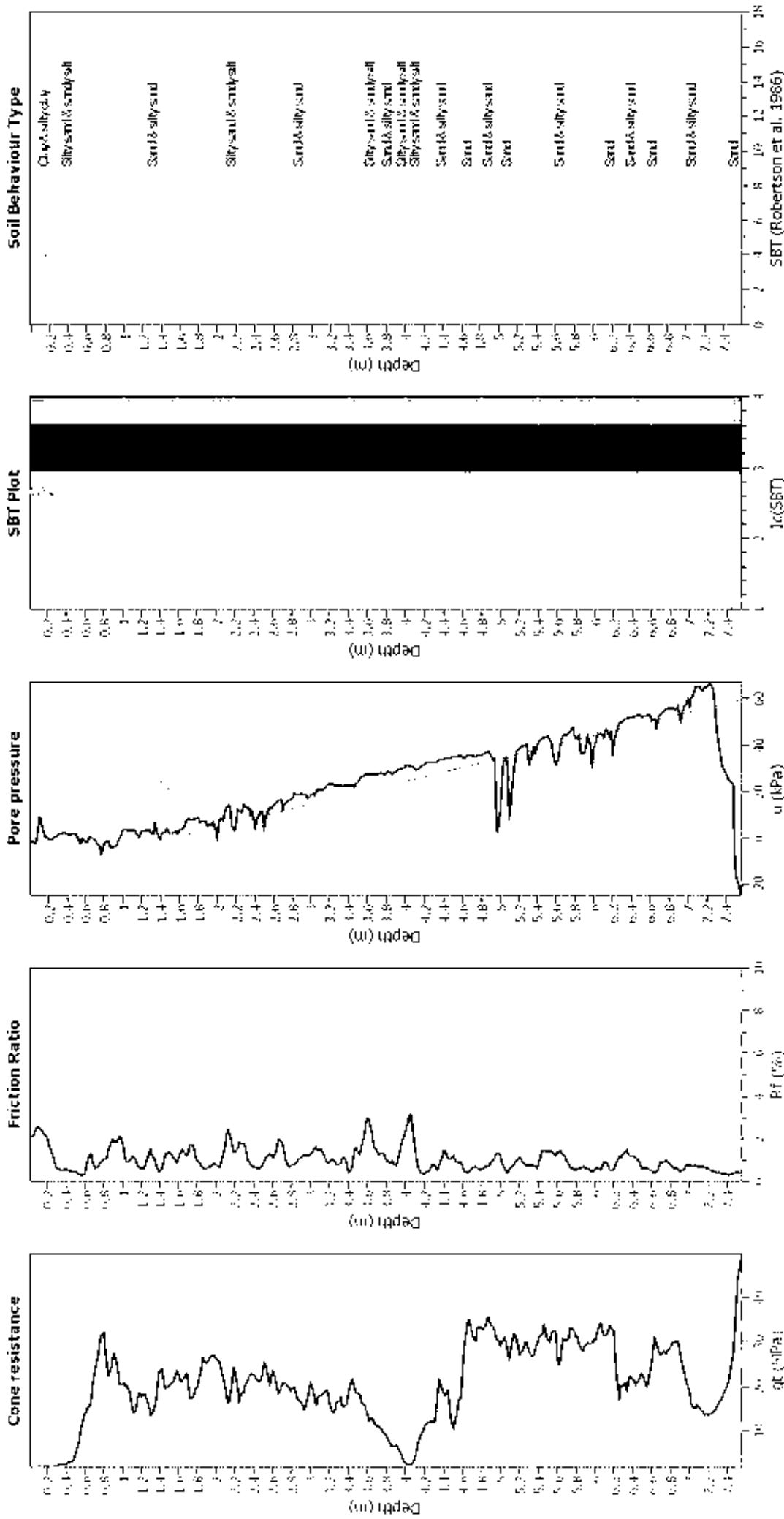


Figure 4: Summary of liquefaction potential plot and data for the test. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio less than 10%. Zone A2: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 10% and 20%. Zone B: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 20% and 30%. Zone C: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 10% and 20%. The liquefaction boundary is shown as a dashed line.

### CPT basic interpretation plots



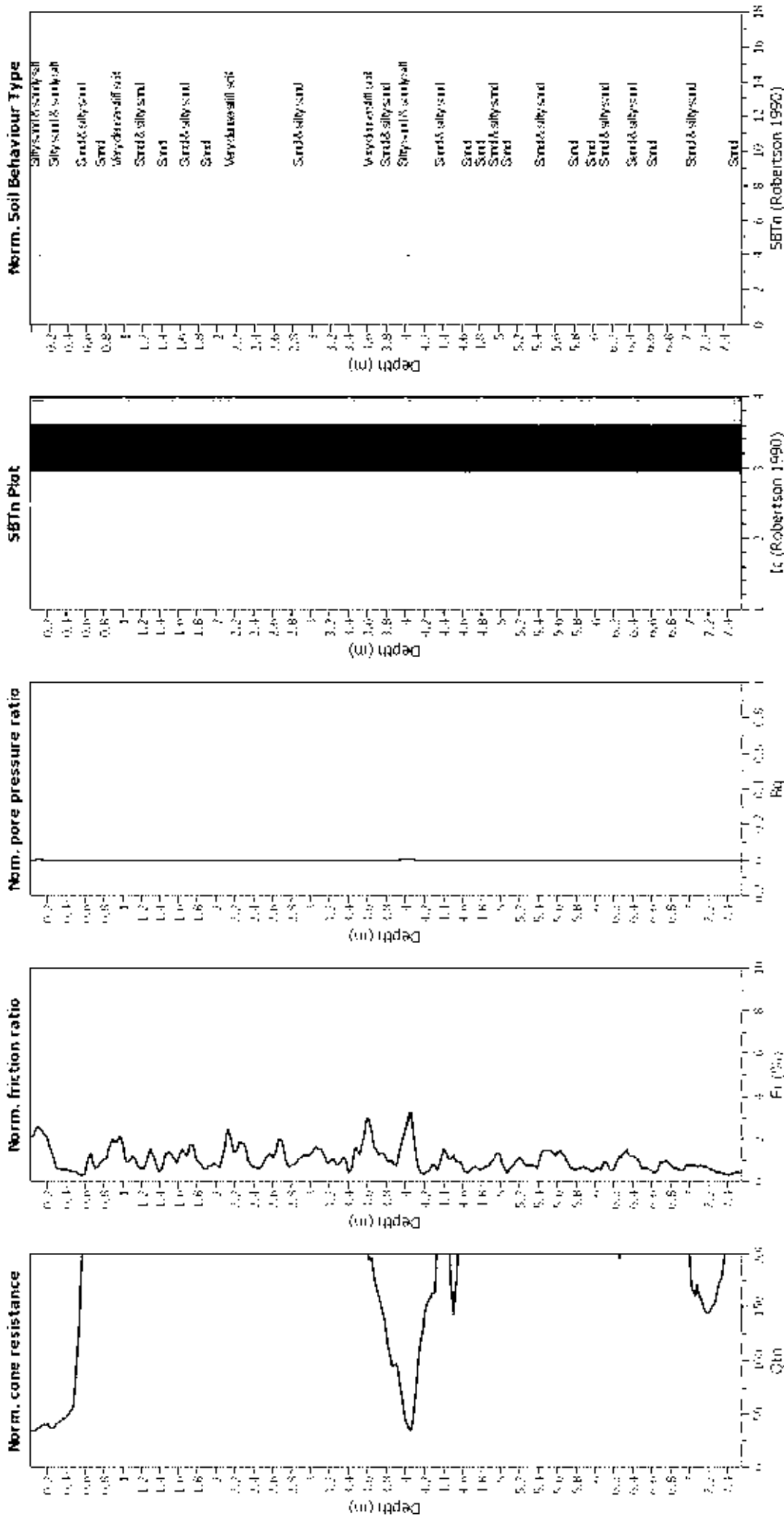
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 4. Clayey silt to silty
- 7. Gravely sand to sand
- 2. Organic material
- 5. Silty sand to sandy silt
- 8. Very stiff sand to
- 3. Clay to silty clay
- 6. Clean sand to silty sand
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

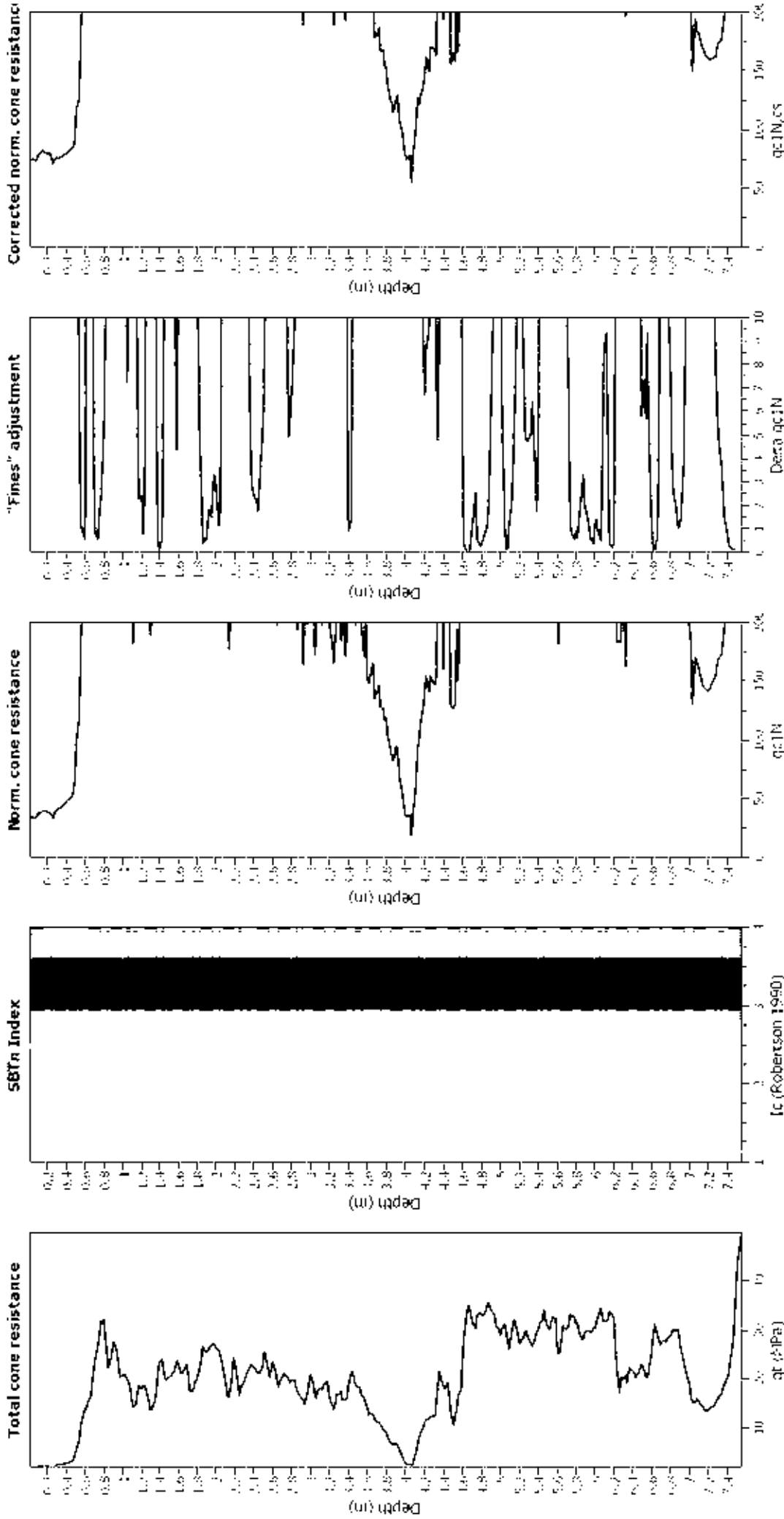
Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (erthq.):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



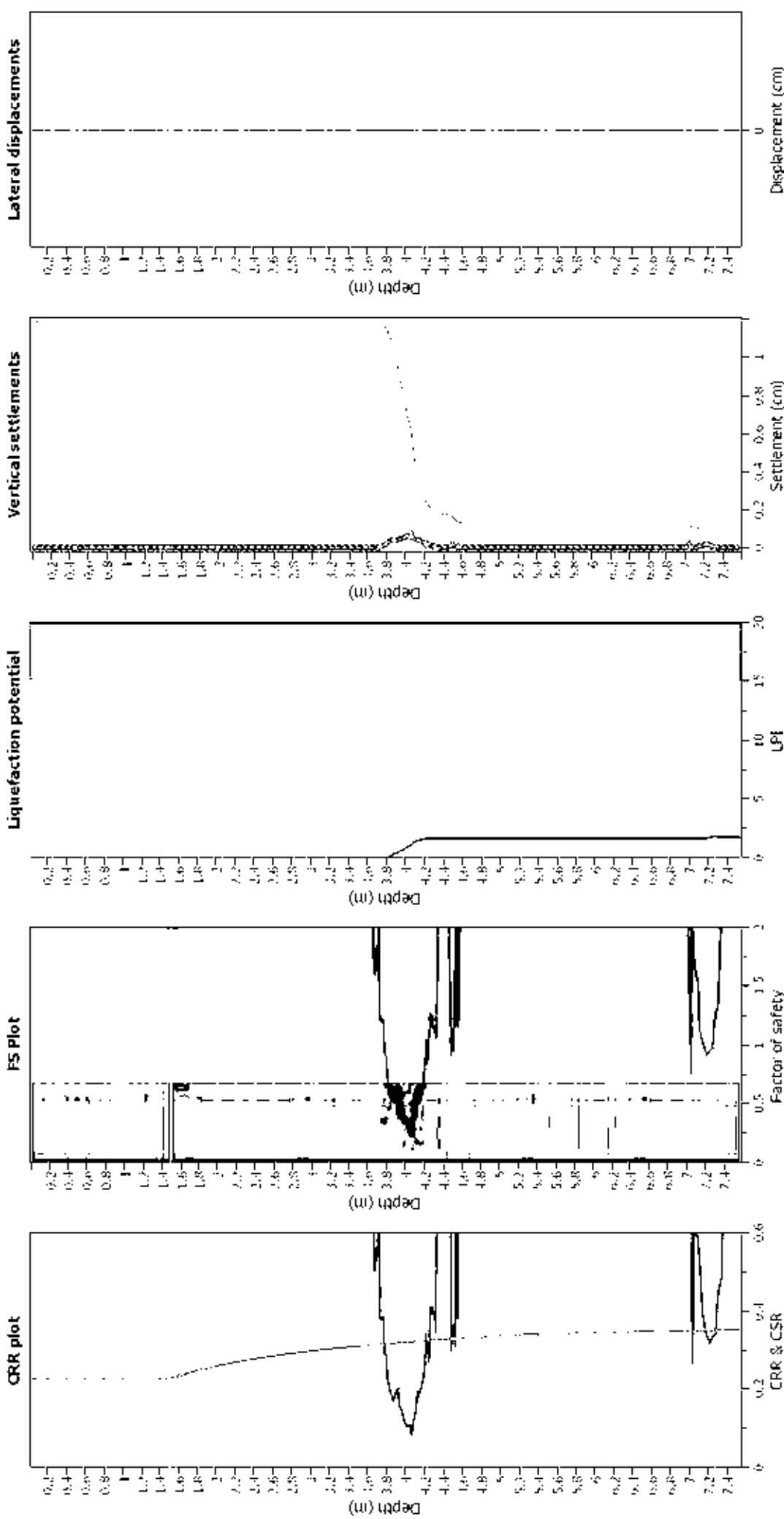
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

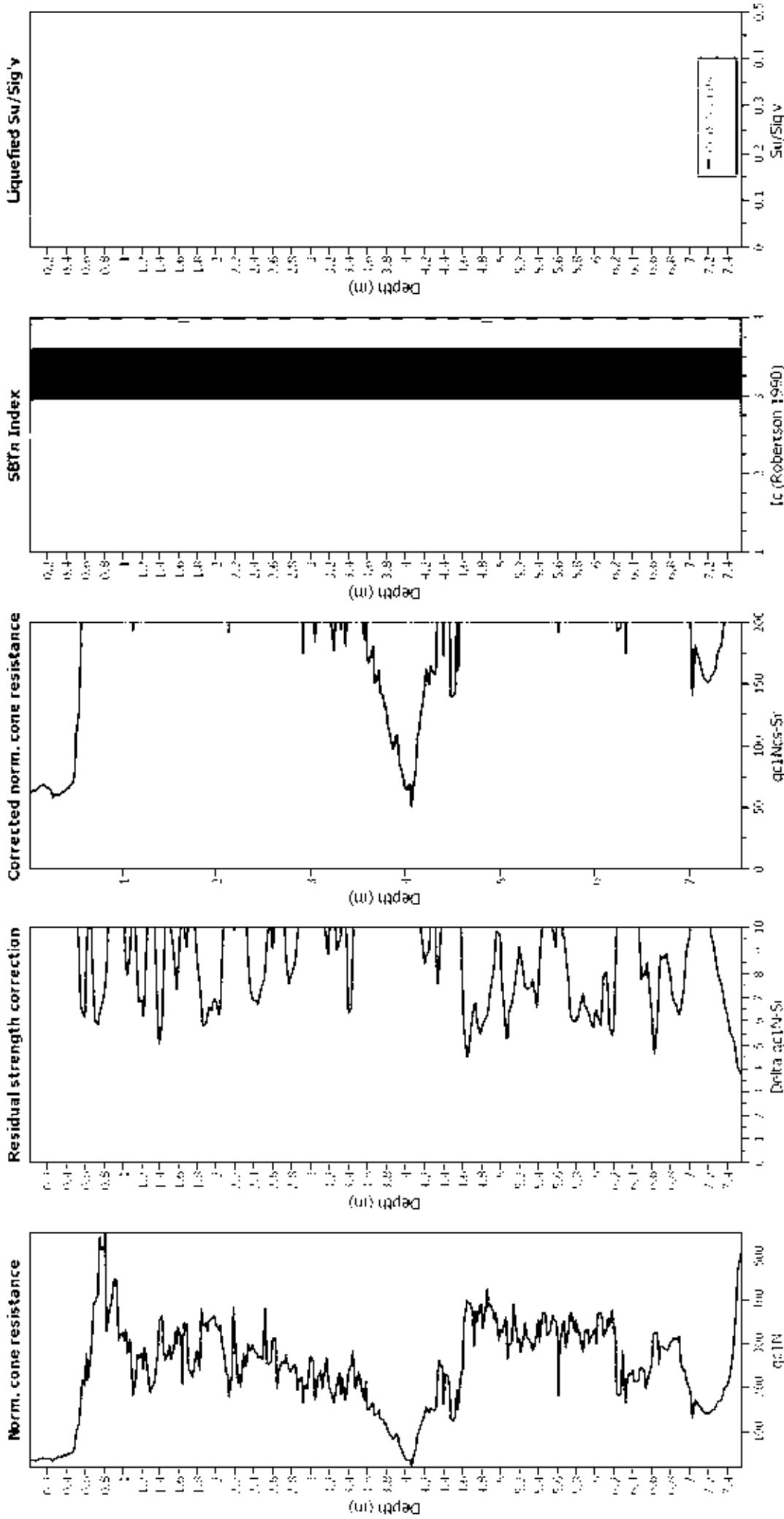
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

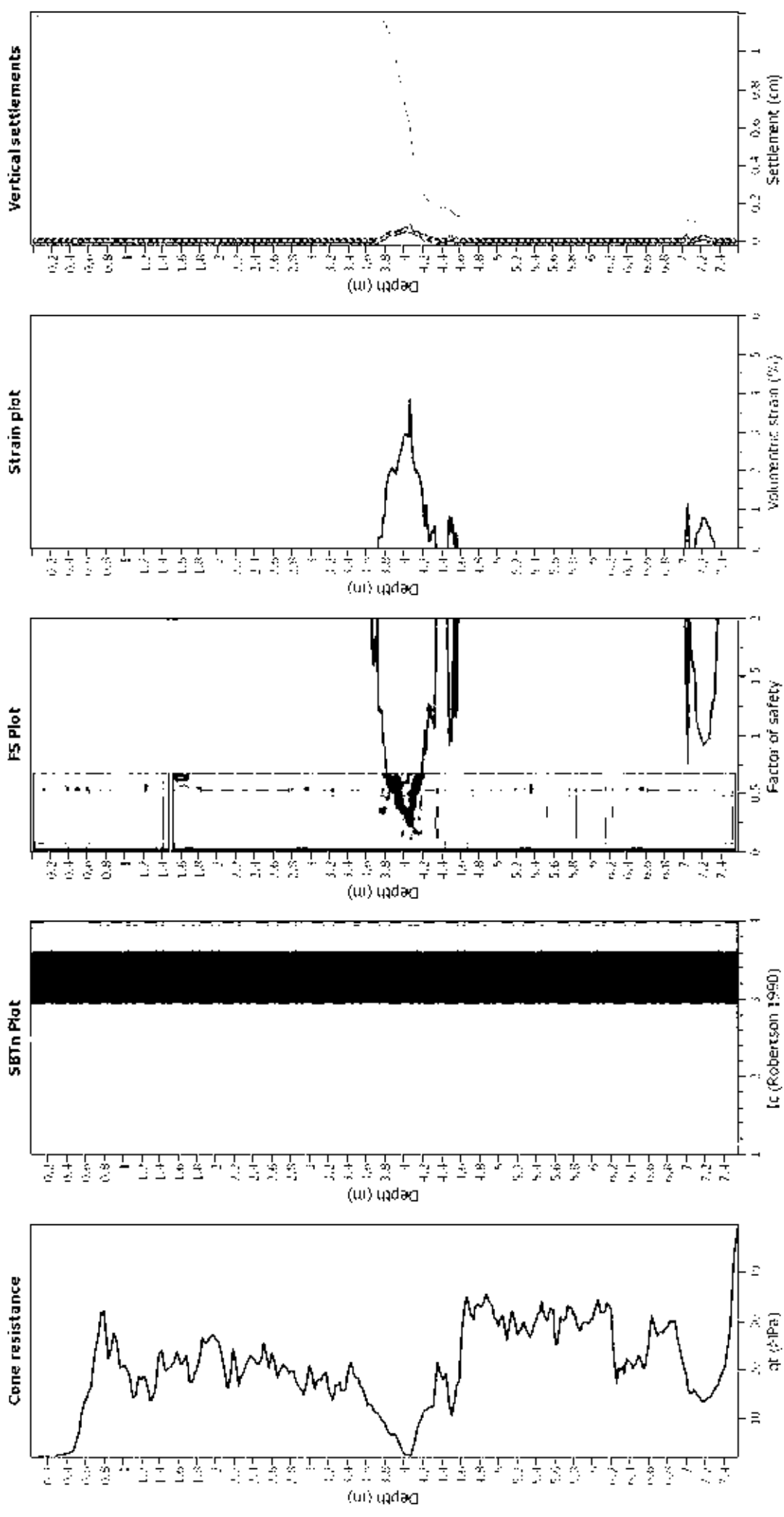
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT32\_1SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

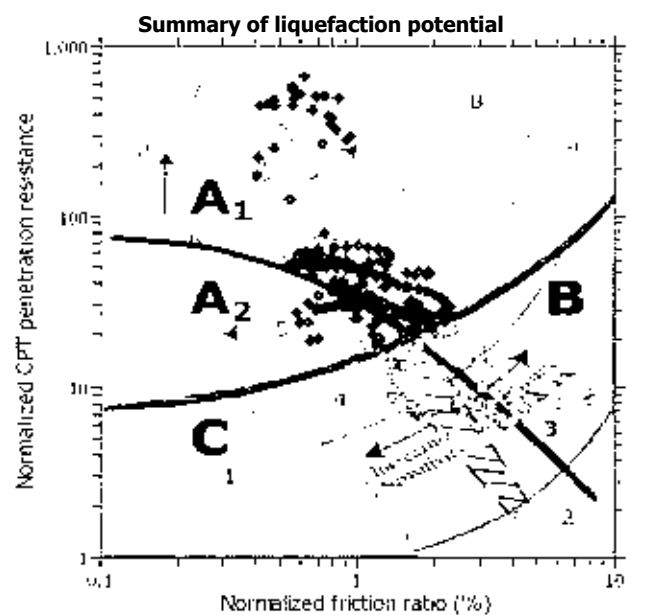
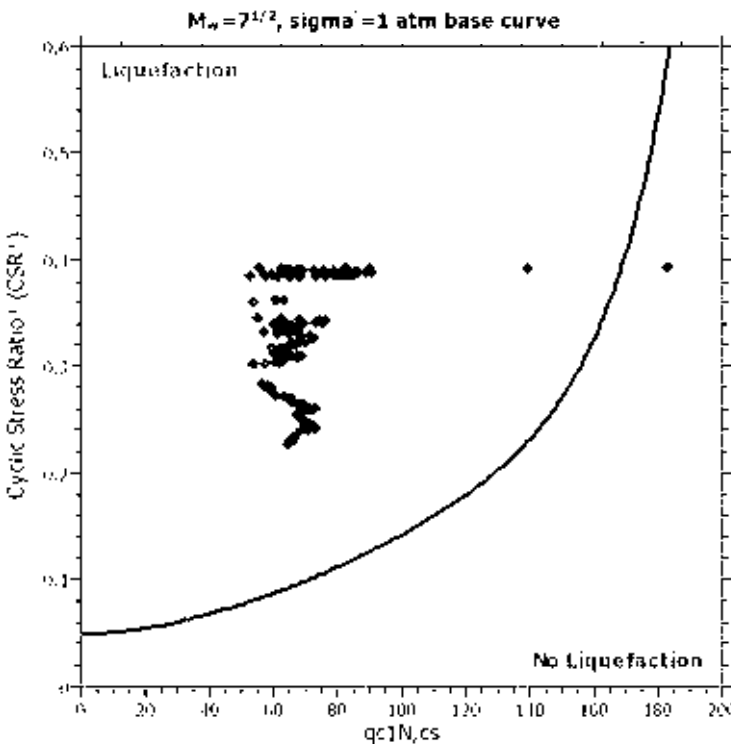
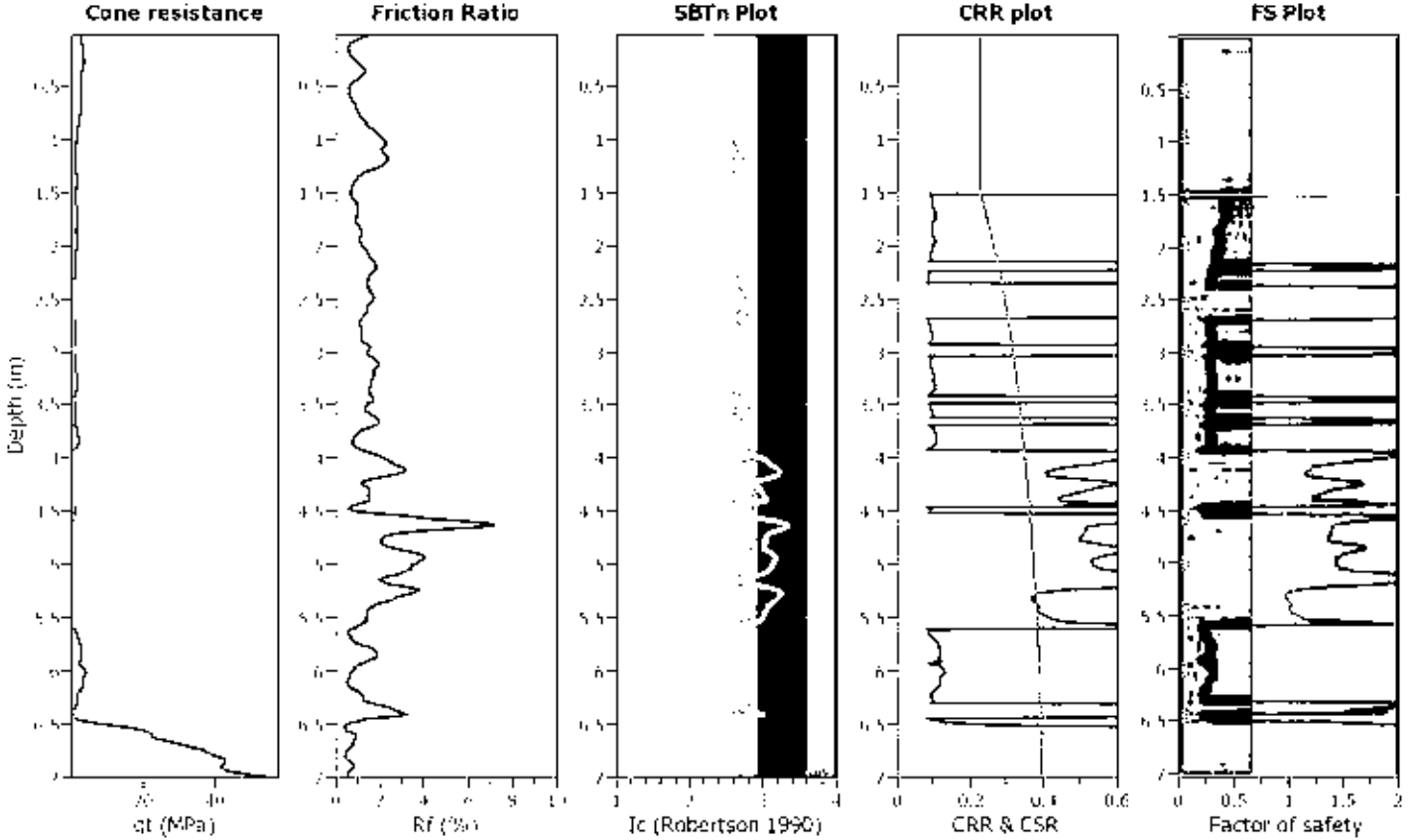
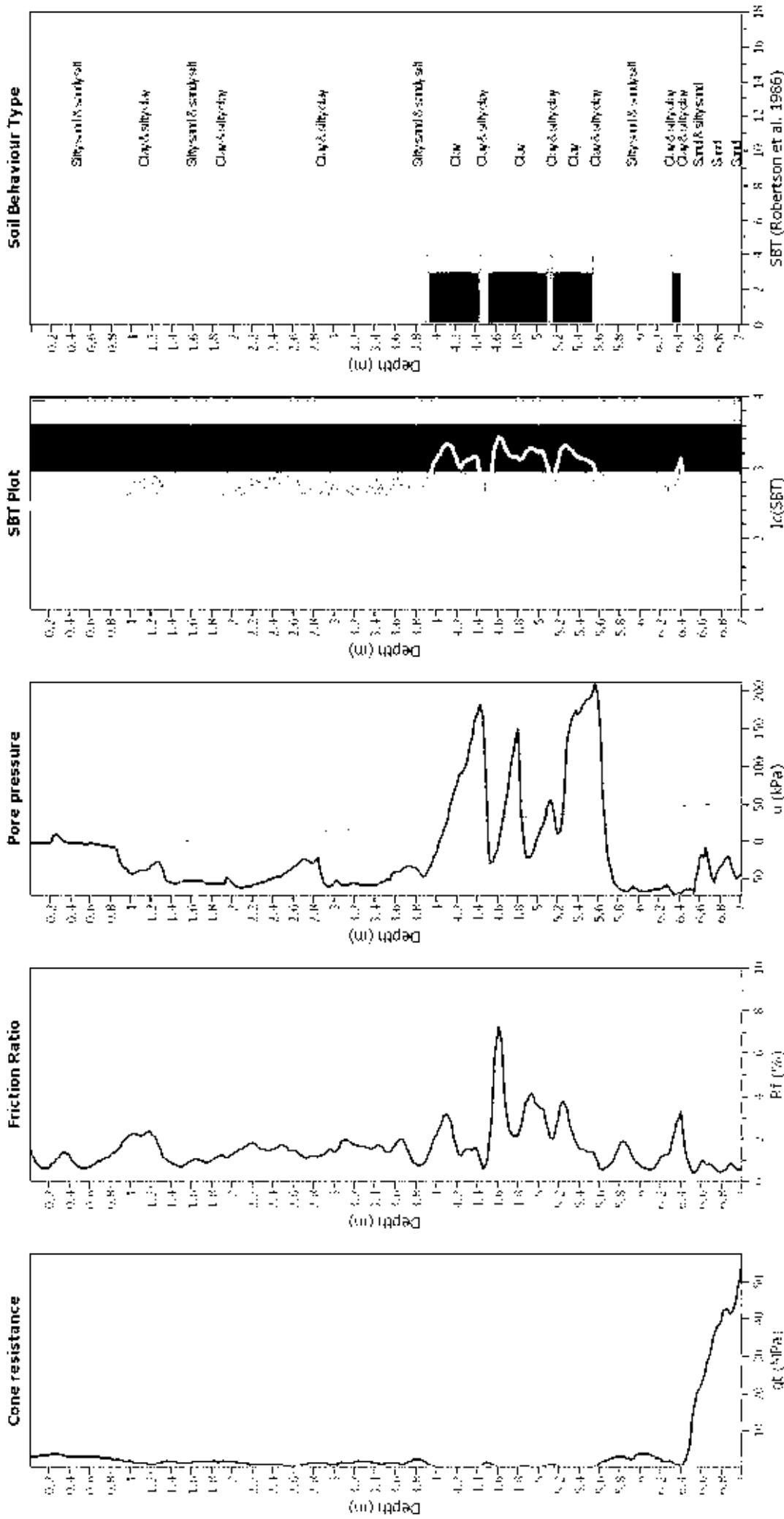


Figure 4: Summary of liquefaction potential assessment and classification of test results. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction potential; Zone C: No liquefaction. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with data points indicating the liquefaction potential of the soil.

### CPT basic interpretation plots



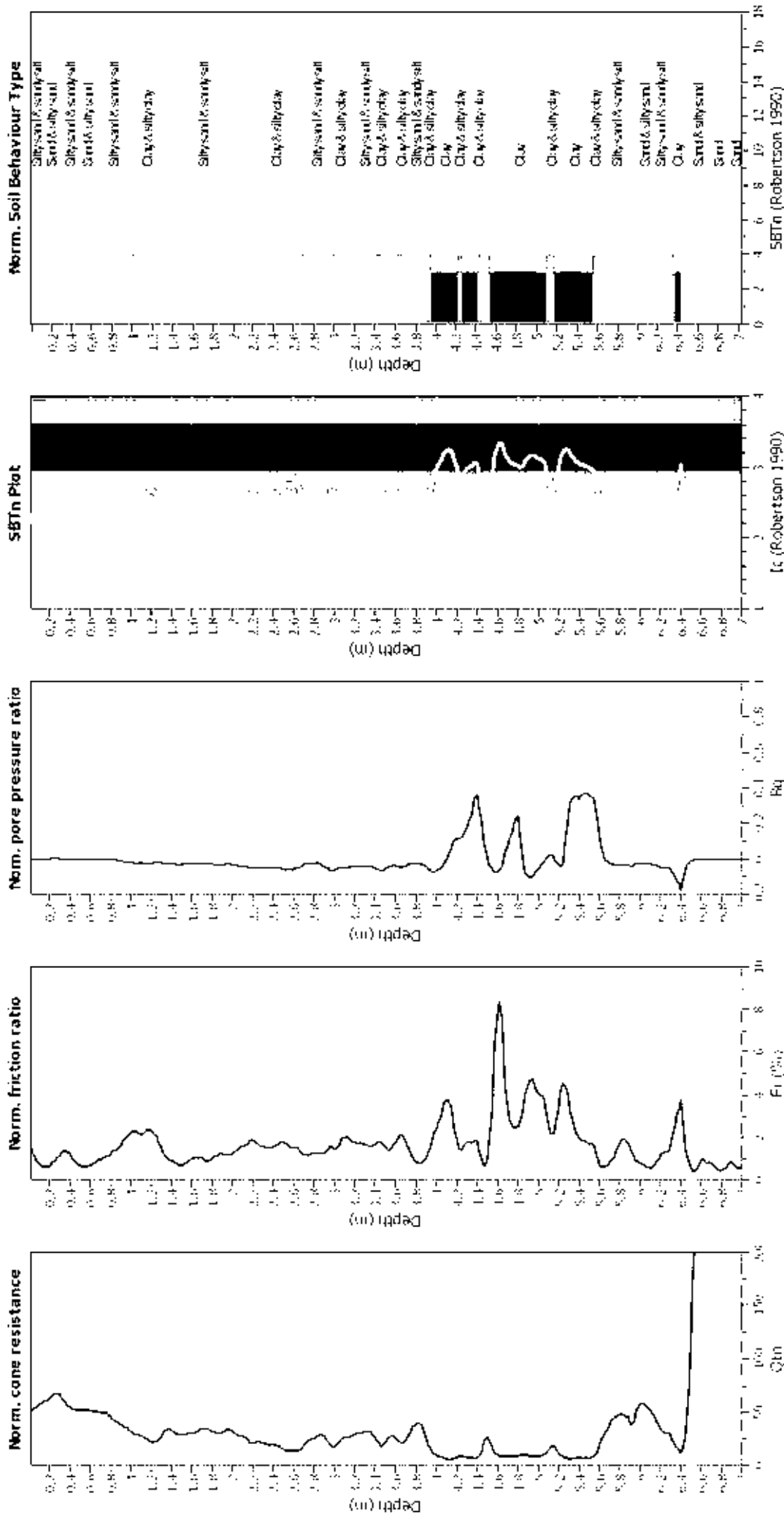
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

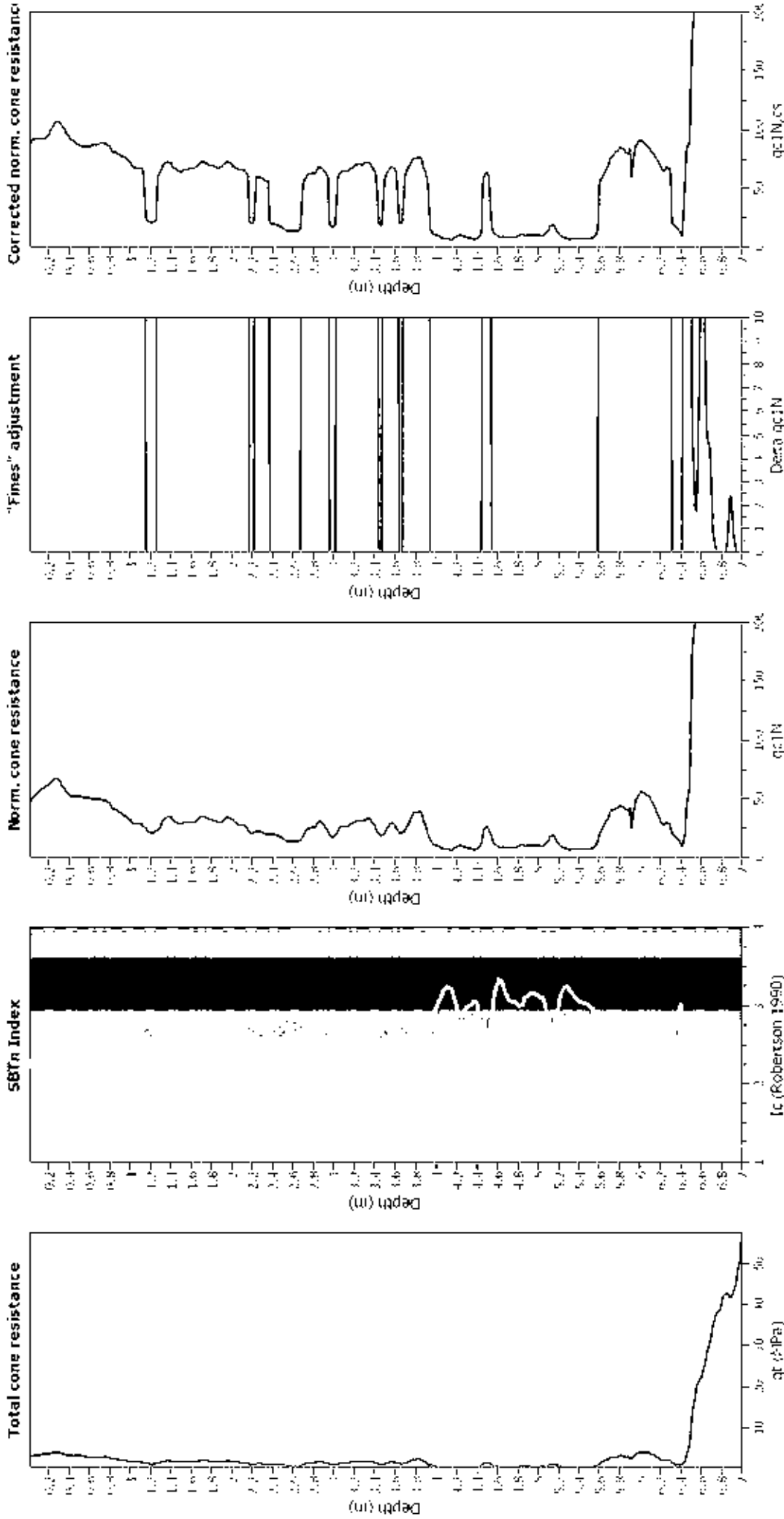
### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.50 m	Unit depth:	N/A
Depth to GW (earthq.):	1.50 m	SBTn legend:	
Average results interval:	3	1. Sensitive fine grained	<input type="checkbox"/>
Ic cut-off value:	2.60	2. Organic material	<input type="checkbox"/>
Unit weight calculation:	Based on SBT	3. Clay to silty clay	<input type="checkbox"/>
Use fill:	No	4. Clayey silt to silty	<input type="checkbox"/>
Fill height:	N/A	5. Silty sand to sandy silt	<input type="checkbox"/>
		6. Clean sand to silty sand	<input type="checkbox"/>
		7. Gravely sand to sand	<input type="checkbox"/>
		8. Very stiff sand to	<input type="checkbox"/>
		9. Very stiff fine grained	<input type="checkbox"/>

### Liquefaction analysis overall plots (intermediate results)

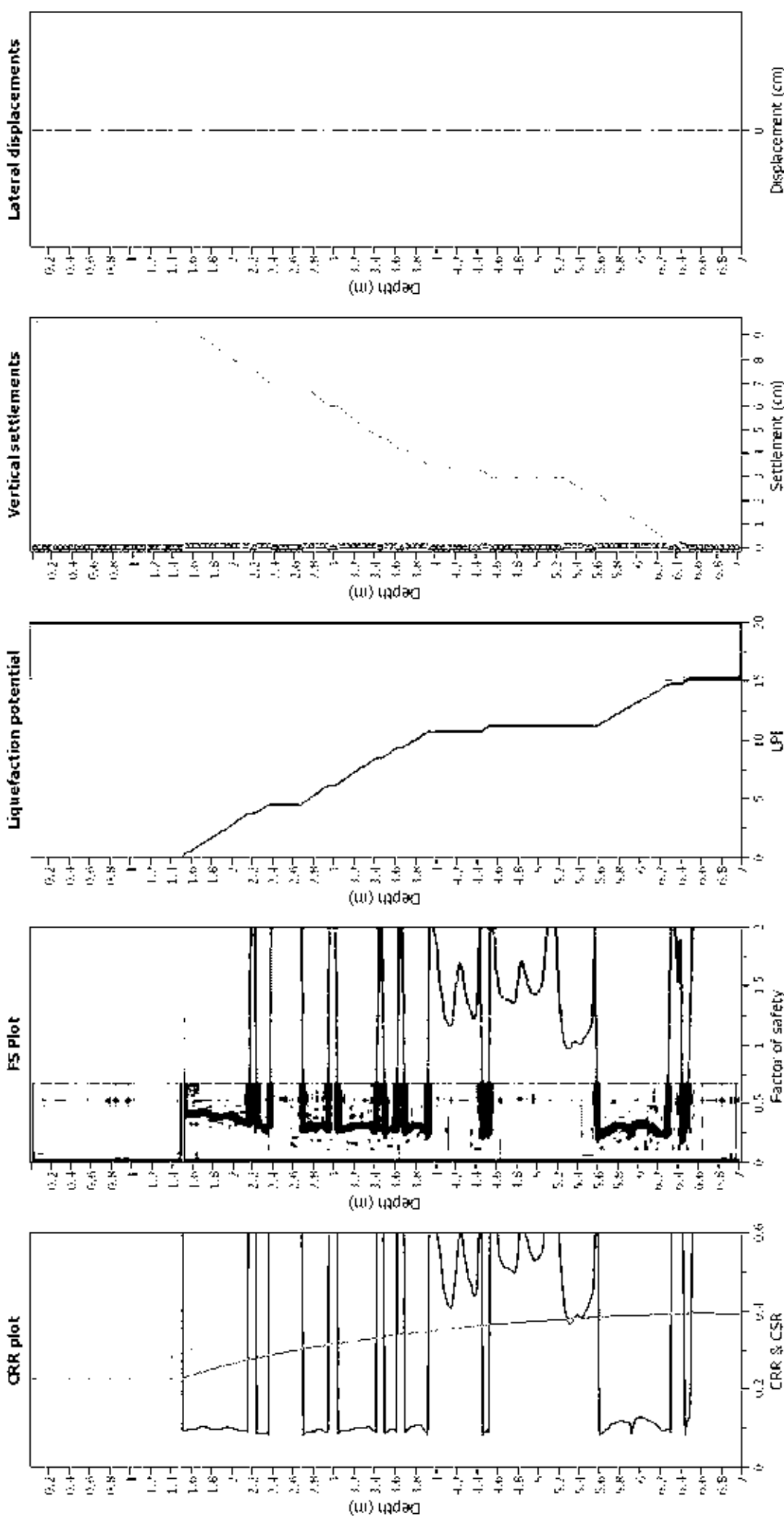


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Input correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

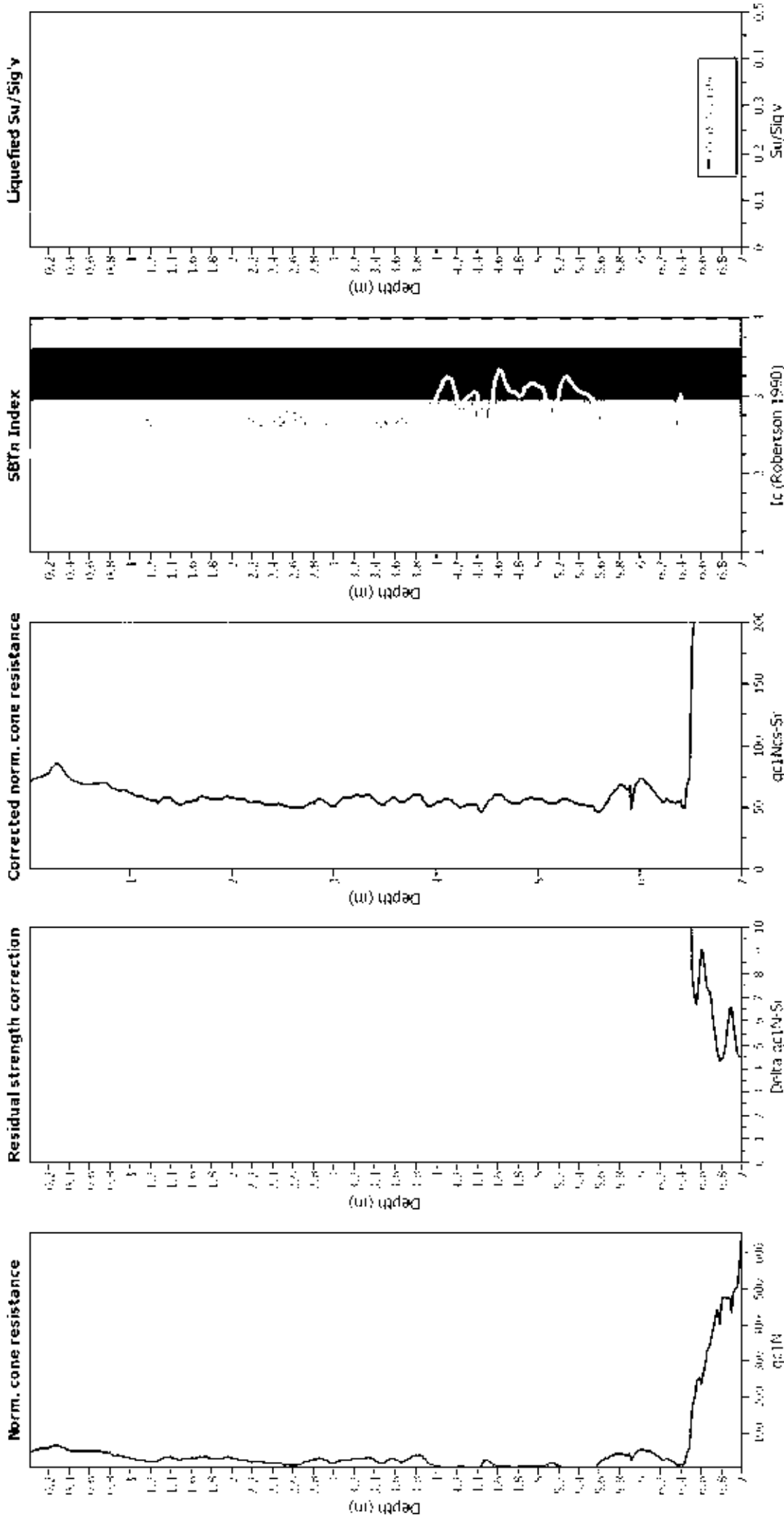
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

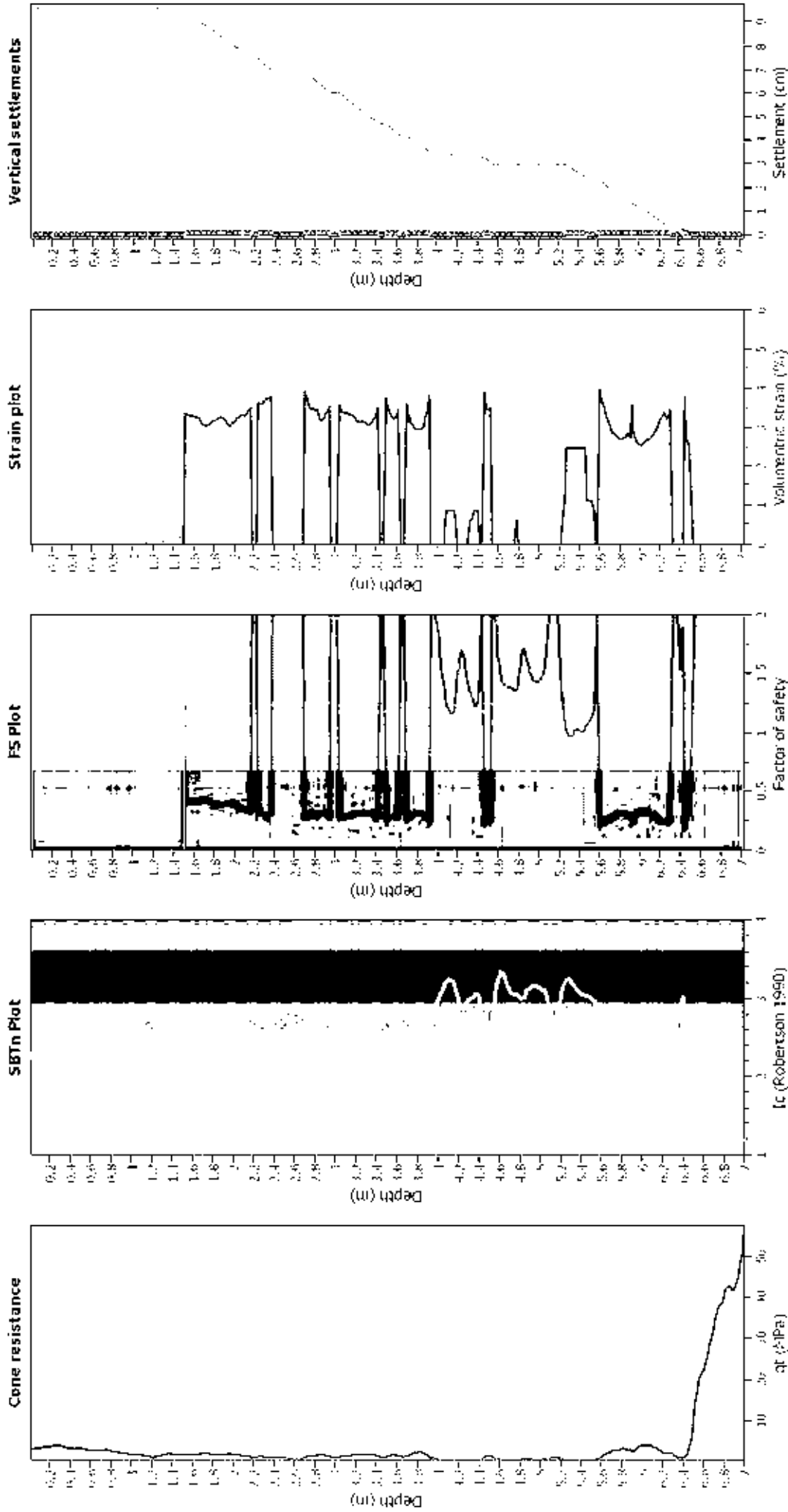
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT33\_876CashmereRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

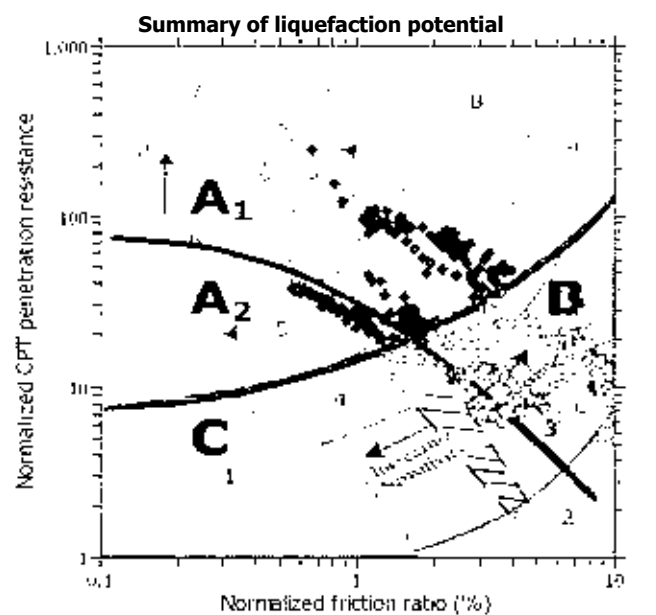
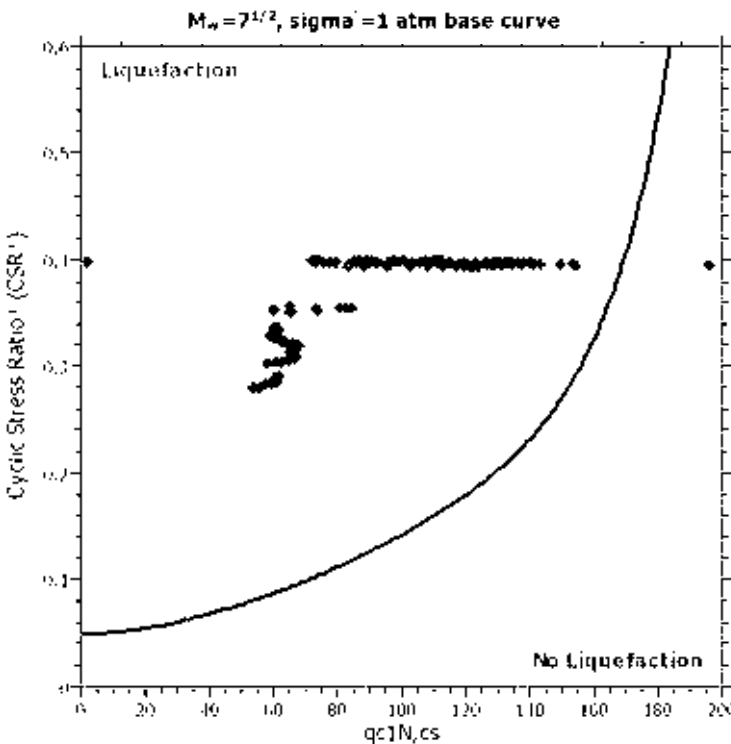
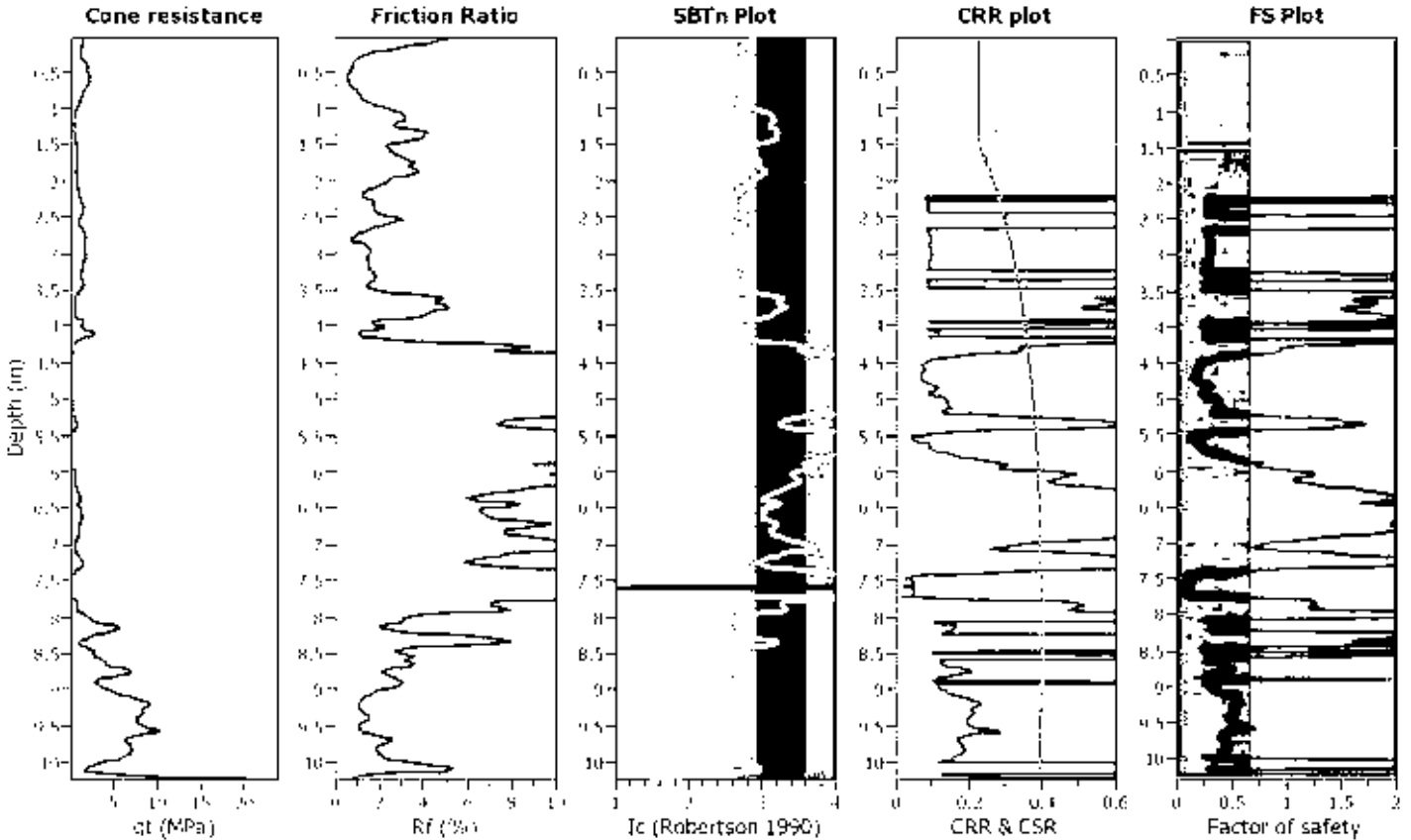
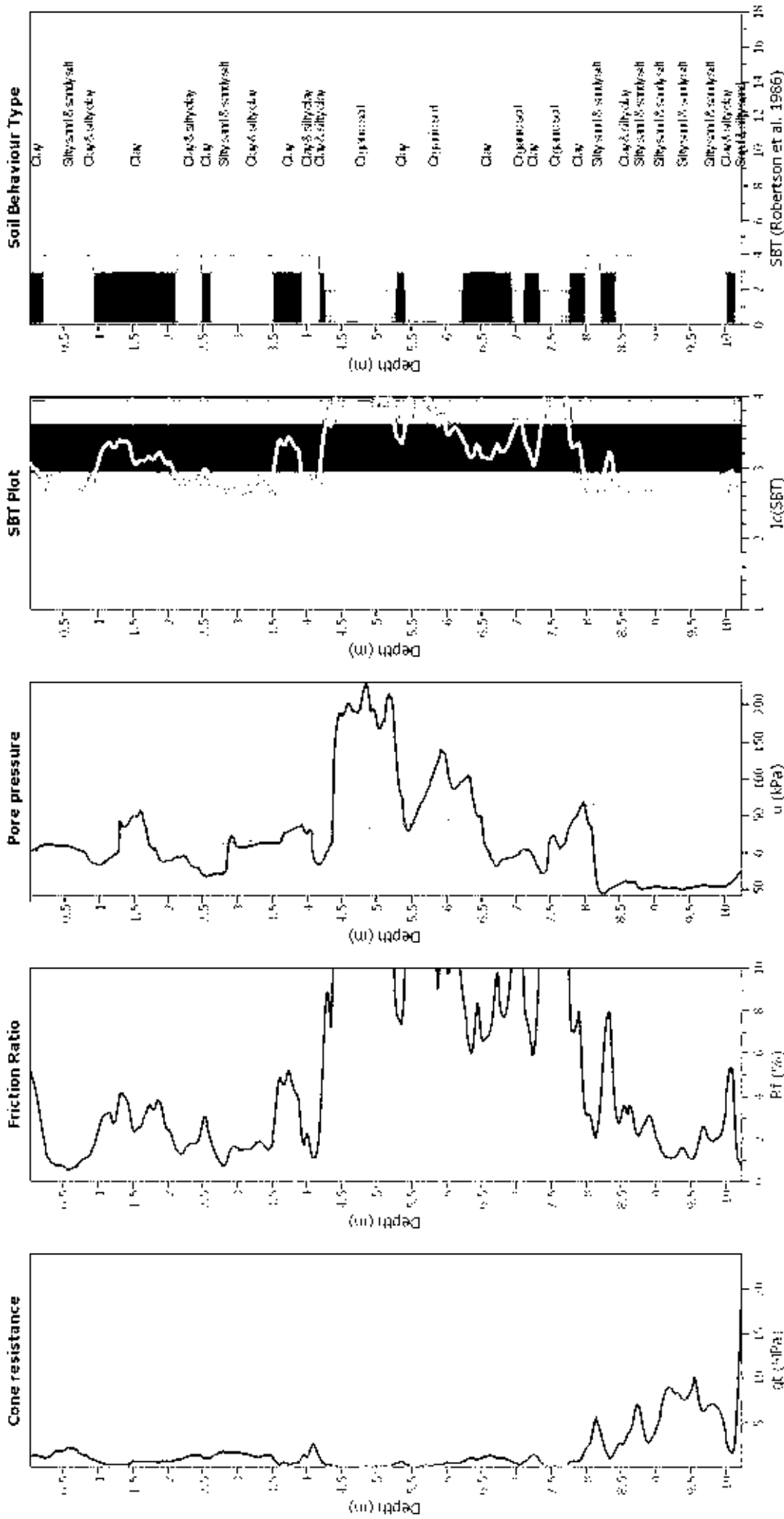


Figure 4: Summary of liquefaction potential plot and data points for test 33. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio less than 10%. Zone A2: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 10% and 20%. Zone B: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 20% and 30%. Zone C: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 20% and 30%. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio.

### CPT basic interpretation plots



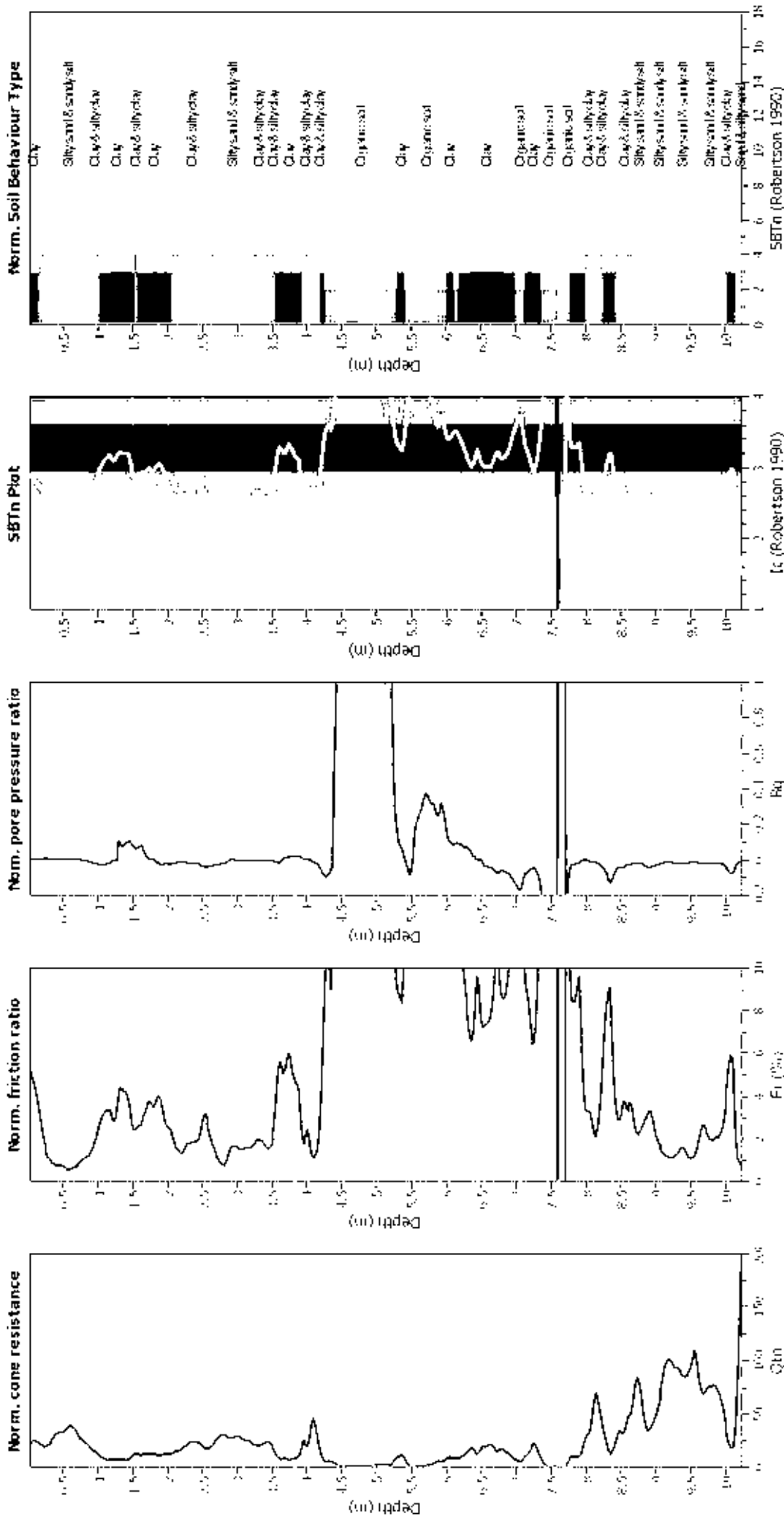
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (earthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Fill height:	N/A	Unit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



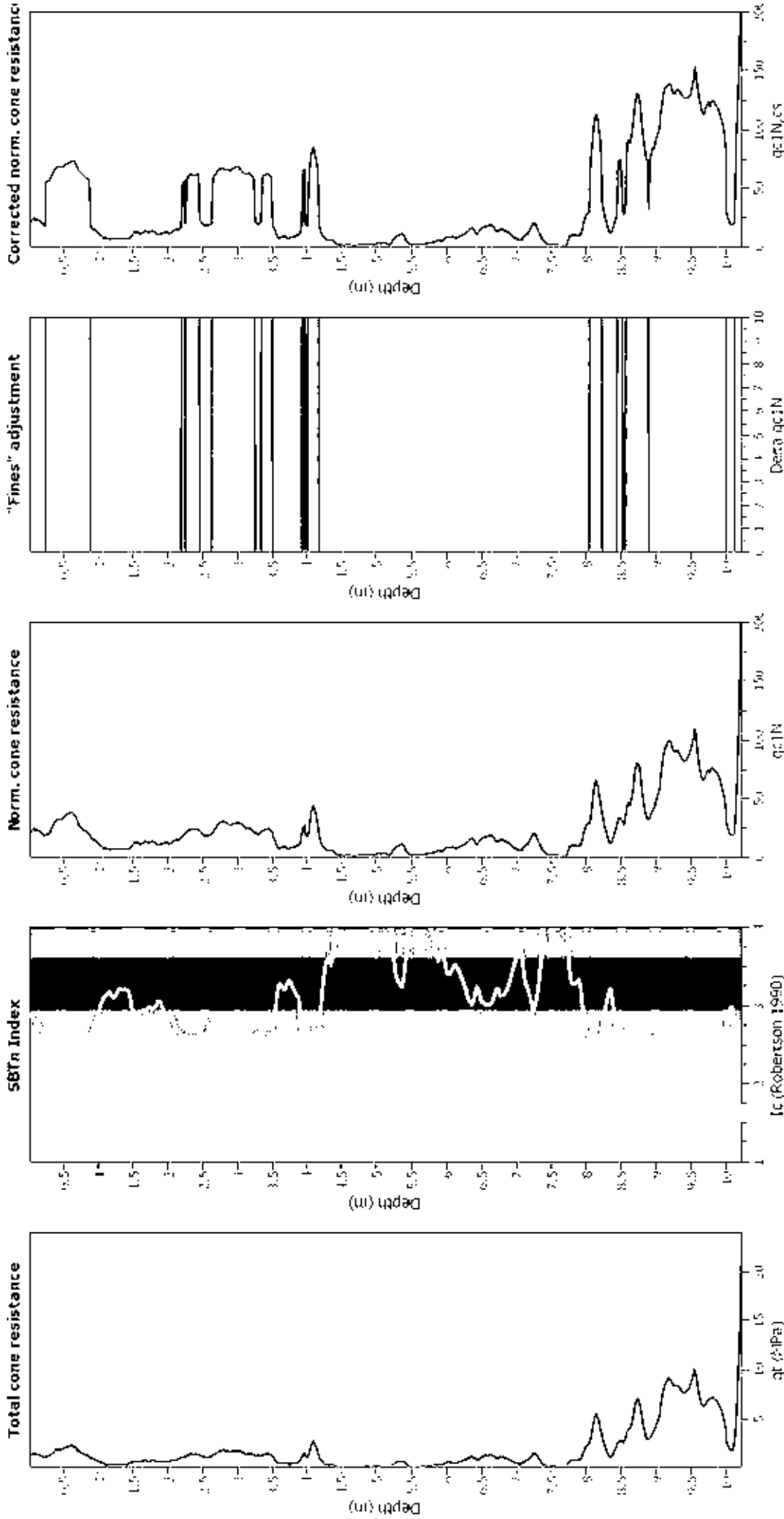
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

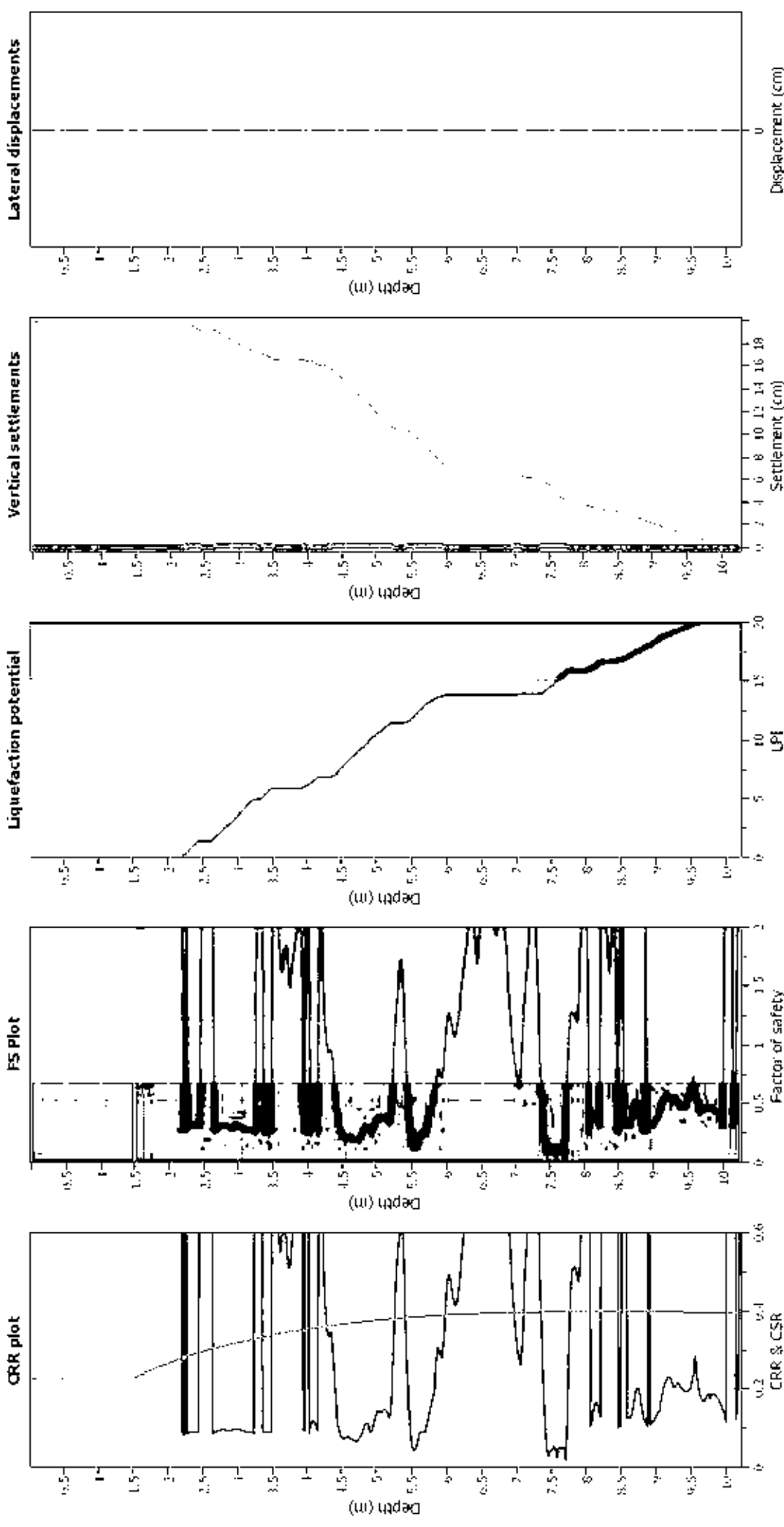
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. single N <sub>60</sub> :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction factor: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude: 7.50  
 Peak ground acceleration: 0.35  
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition defect applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No  
 Limit depth: N/A

#### F.S. color scheme

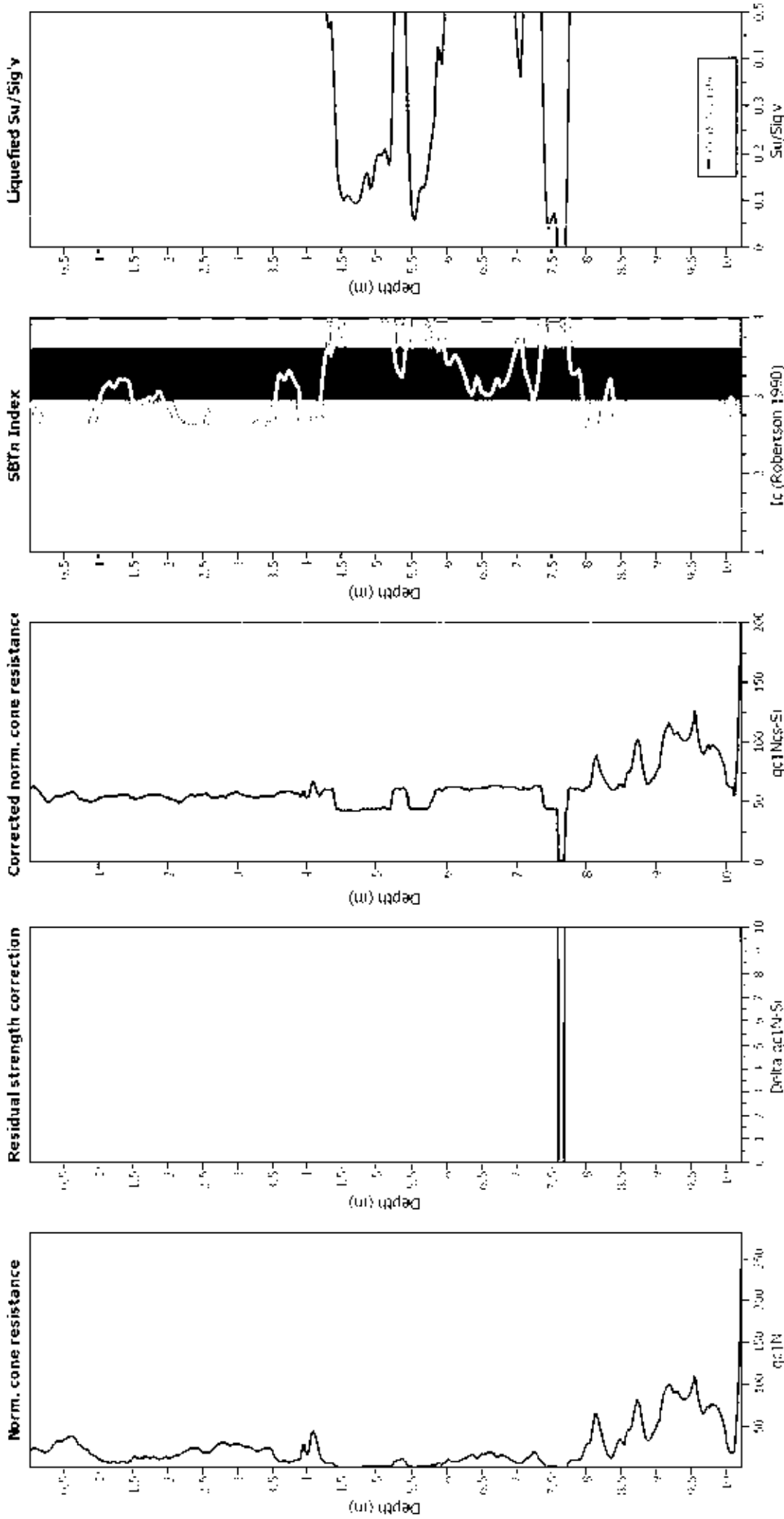
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk



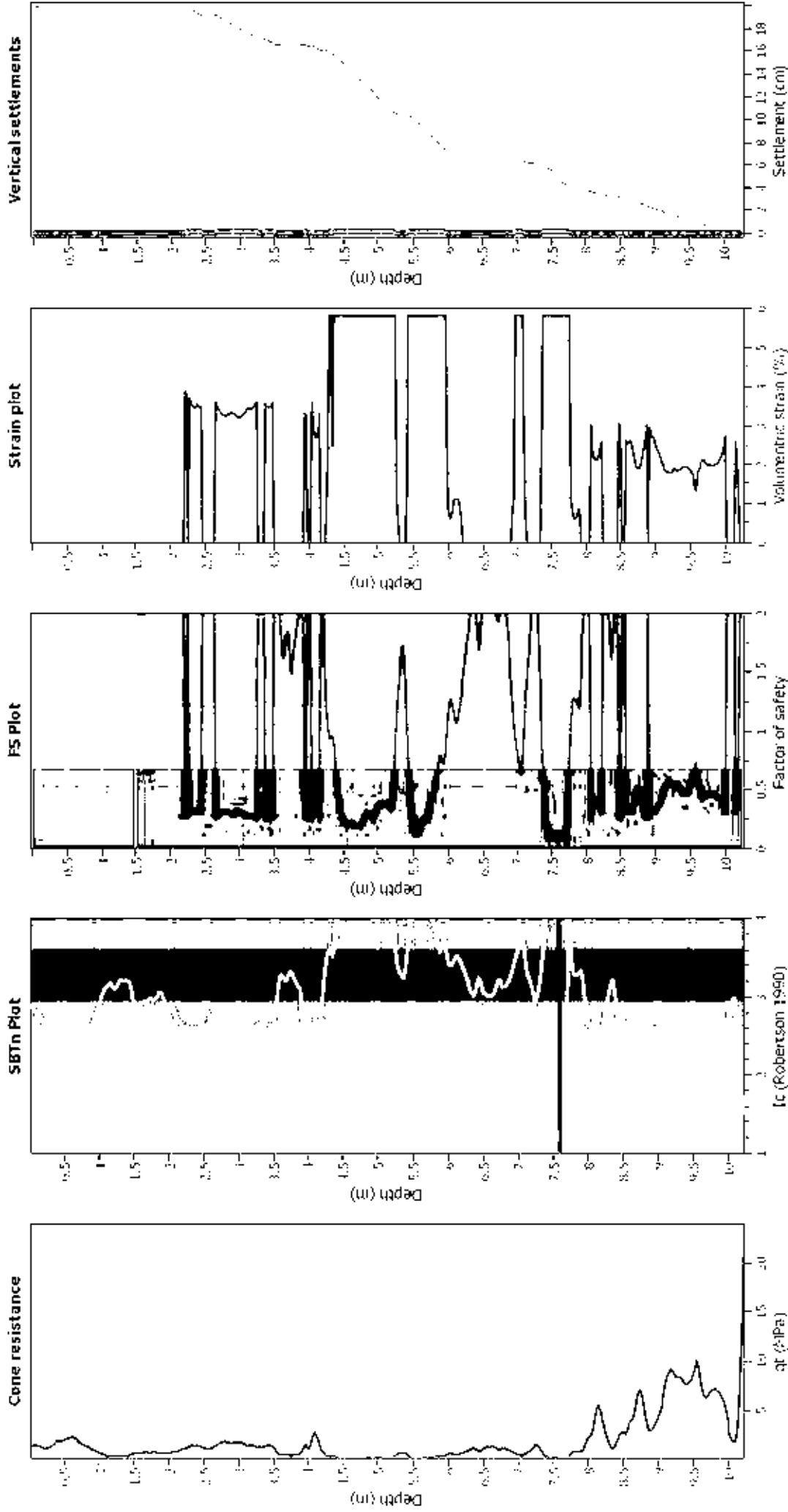
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Factorial magnitude $M_s$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table ( $z_{water}$ ):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT34\_396SparksRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

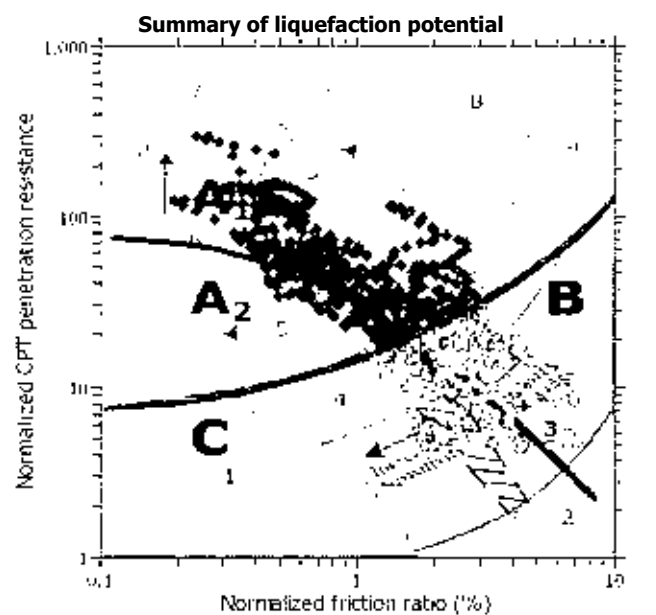
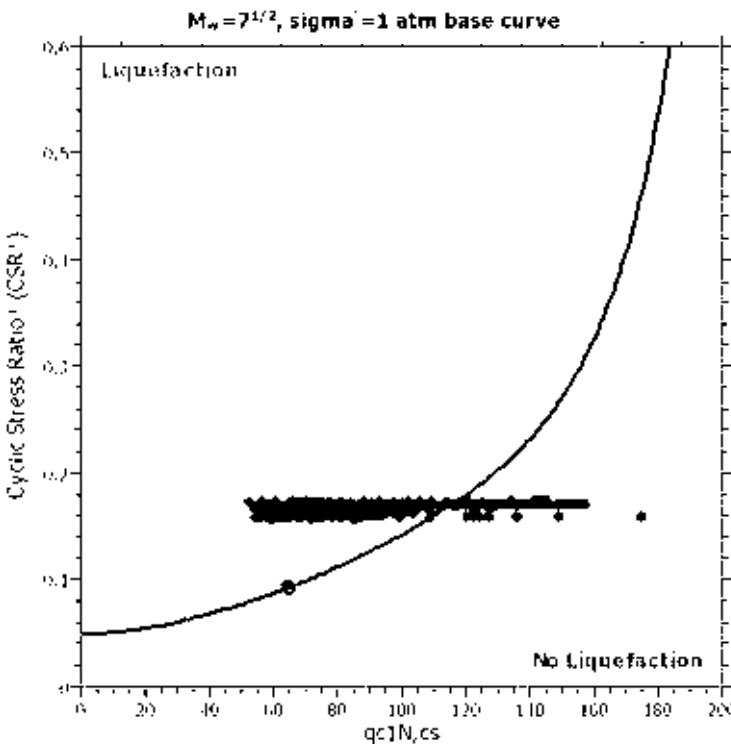
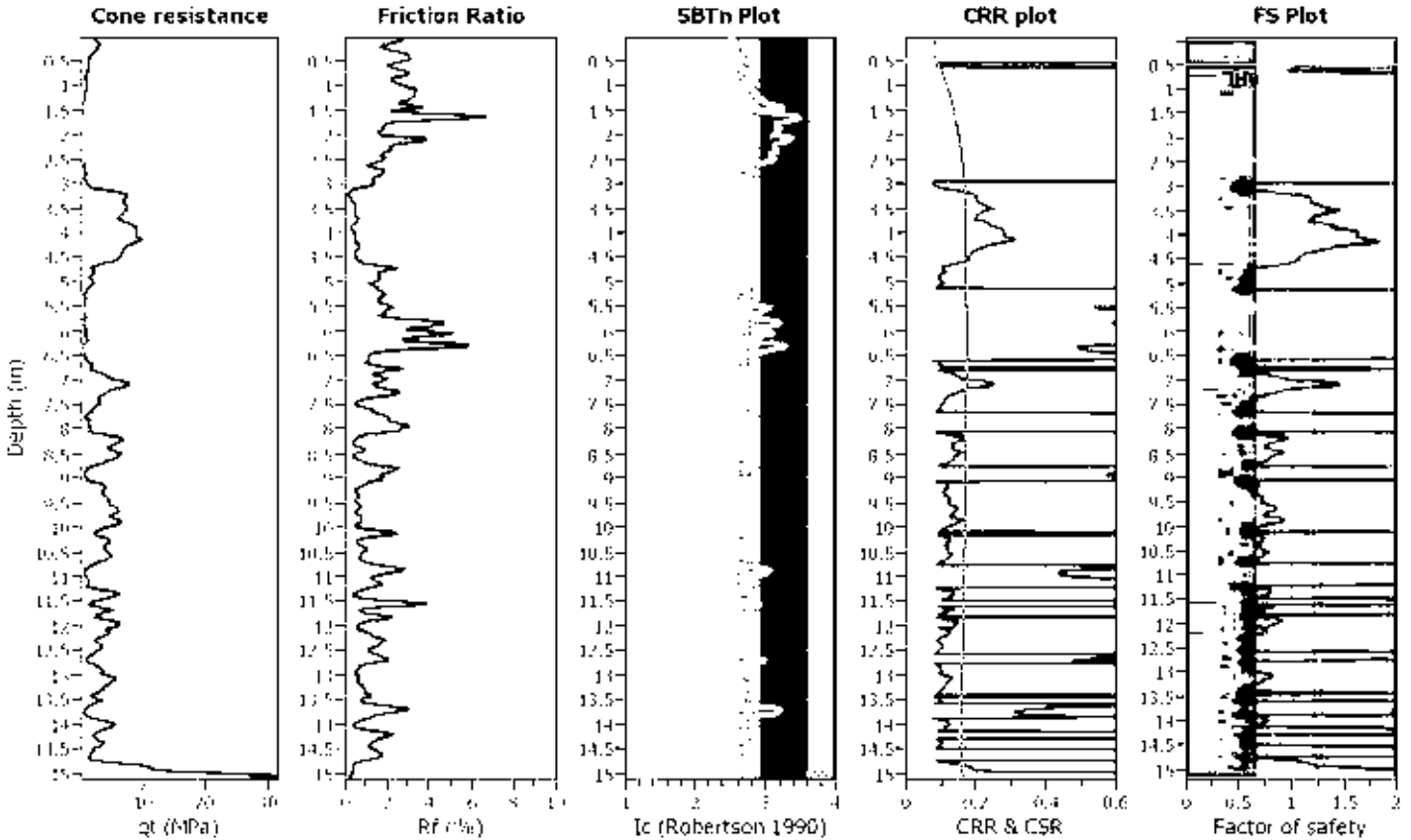
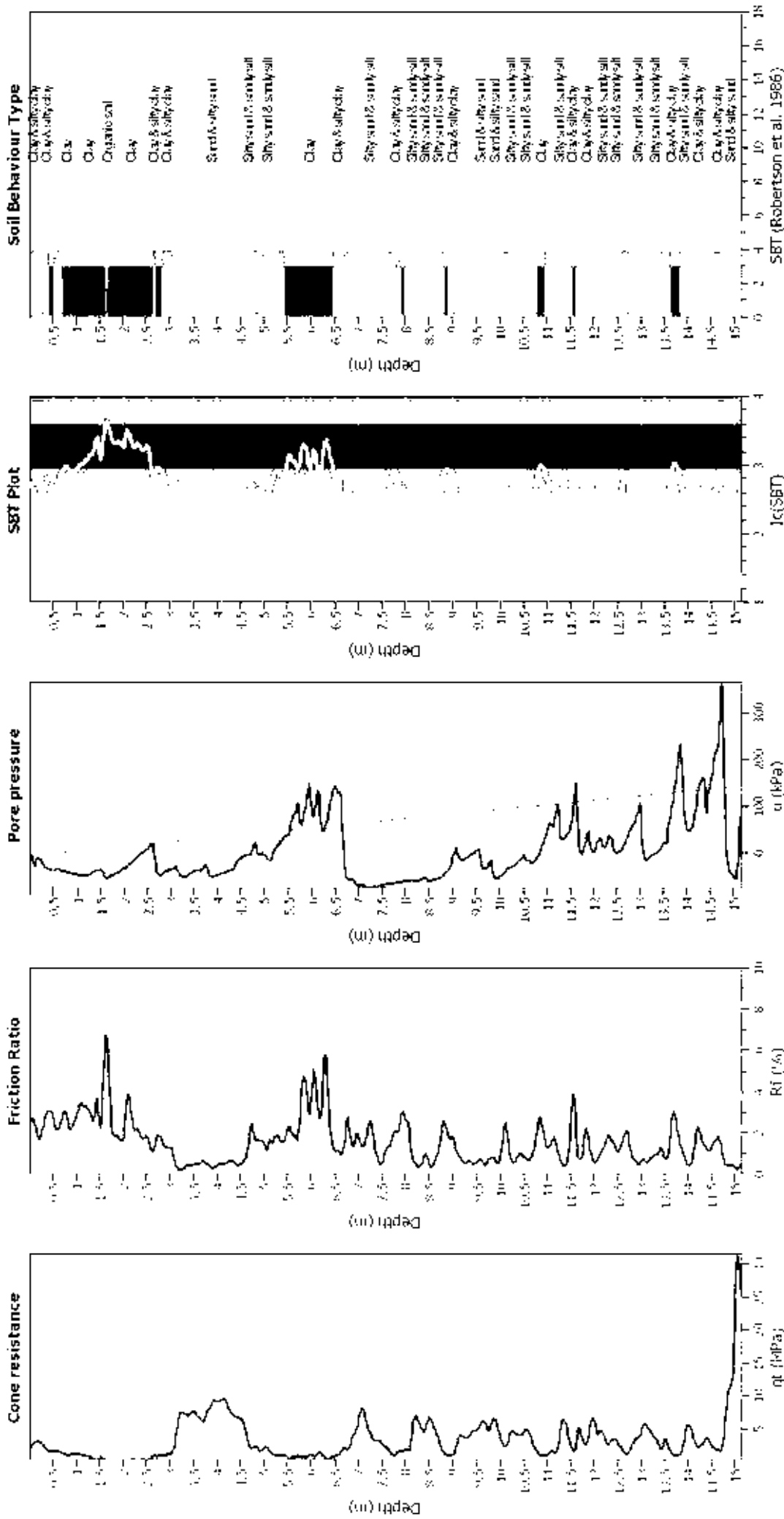


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A1: Fully liquefiable soils; Zone A2: Partially liquefiable soils; Zone B: Non-liquefiable soils; Zone C: Fully liquefiable soils. The dashed line indicates the liquefaction boundary. The plot is divided into zones A1, A2, B, and C. A dashed line indicates the 'Liquefaction boundary'.

### CPT basic interpretation plots



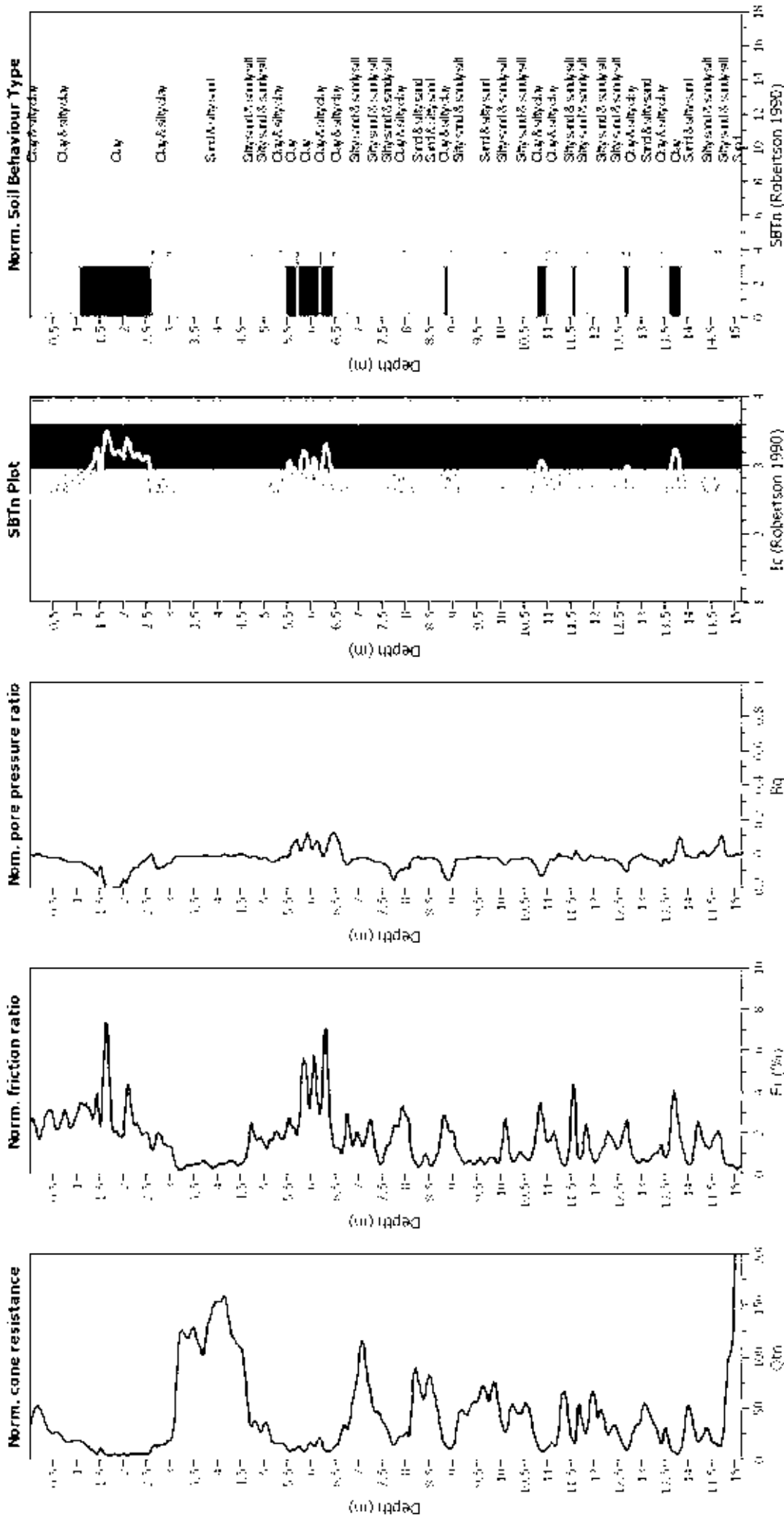
### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



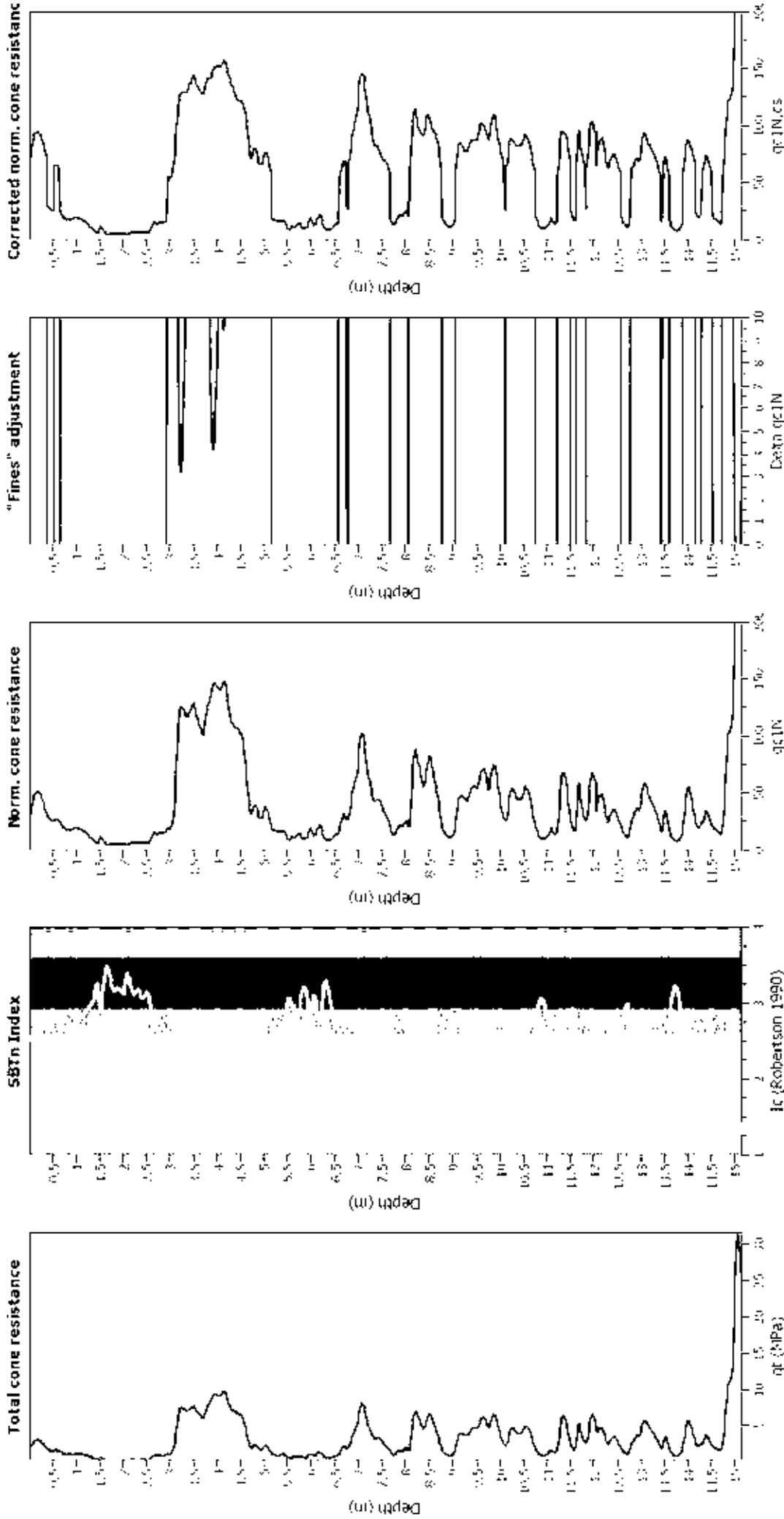
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	0.50 m	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Average results interval:	3	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	0.50 m	Fill height:	N/A		N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

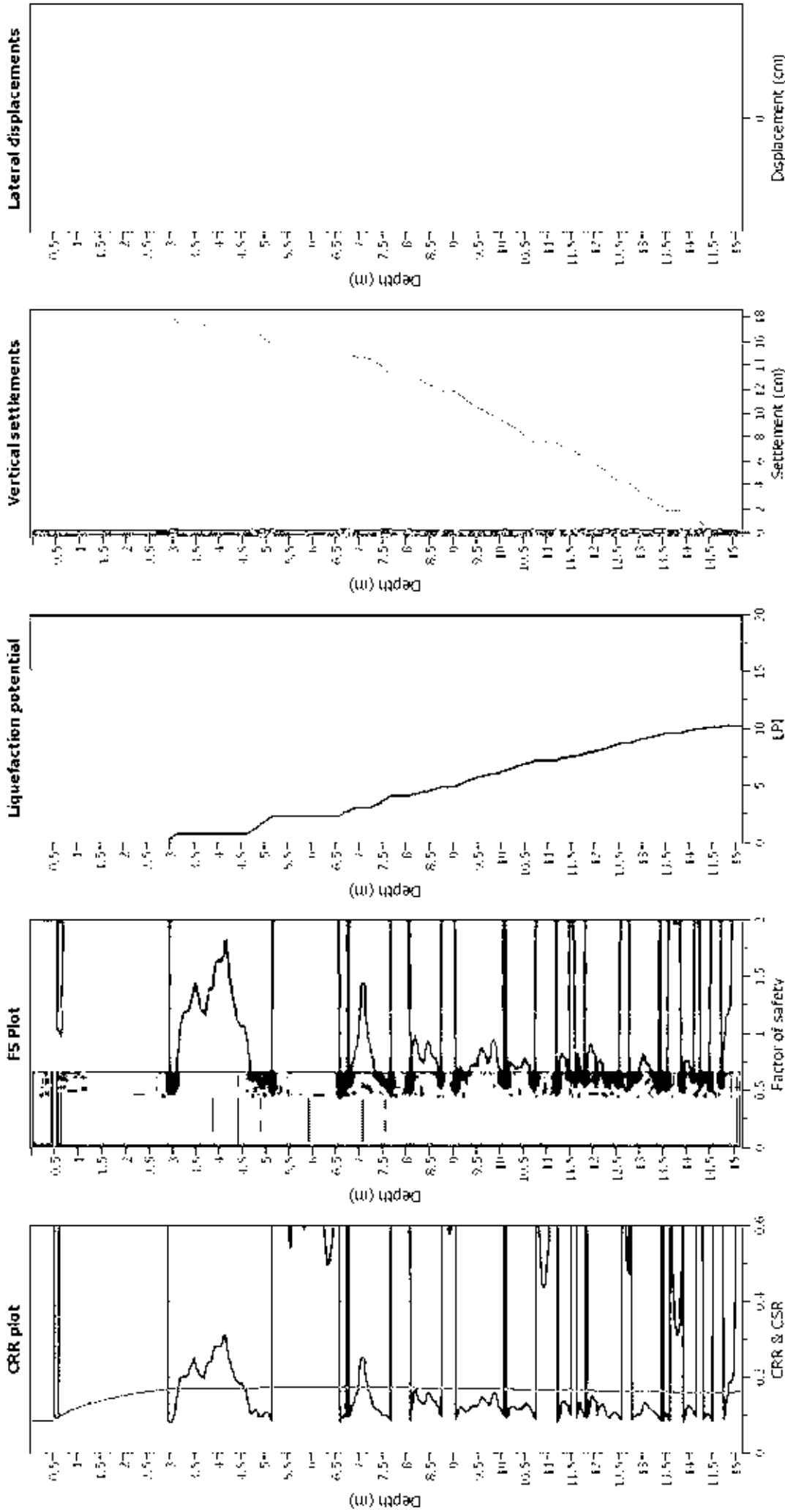
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude $M_v$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction method: 18B (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 0.50 m

#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

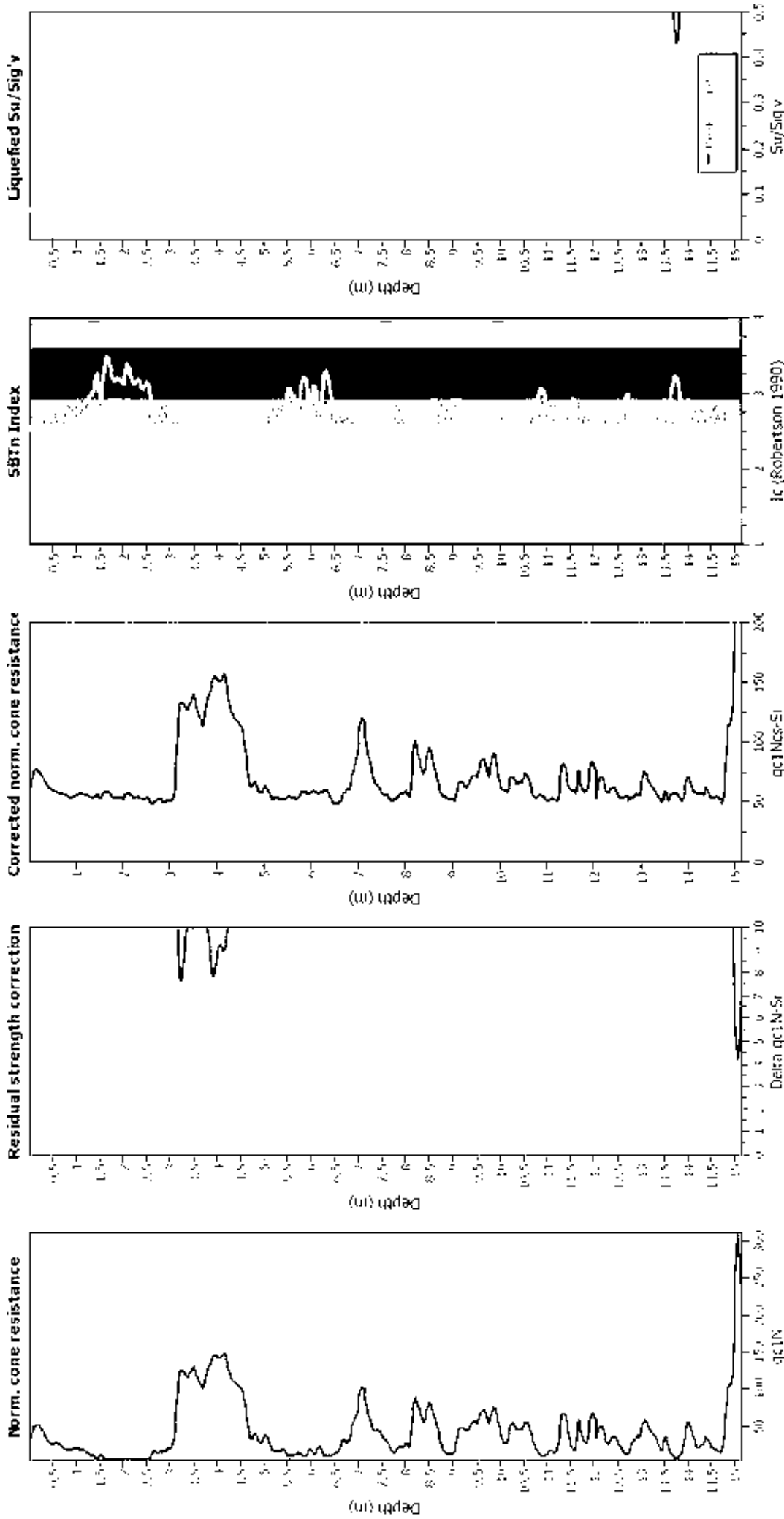
#### LPI color scheme

- Very high risk
- High risk
- Low risk

Depth to GW (earthq.): 0.50 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Full weight transition method applied: N/A  
 K applied: Sand & Clay  
 Clay like behavior applied: Yes  
 Limit depth applied: No  
 Limit depth: N/A

### Check for strength loss plots (Idriss & Boulanger (2008))

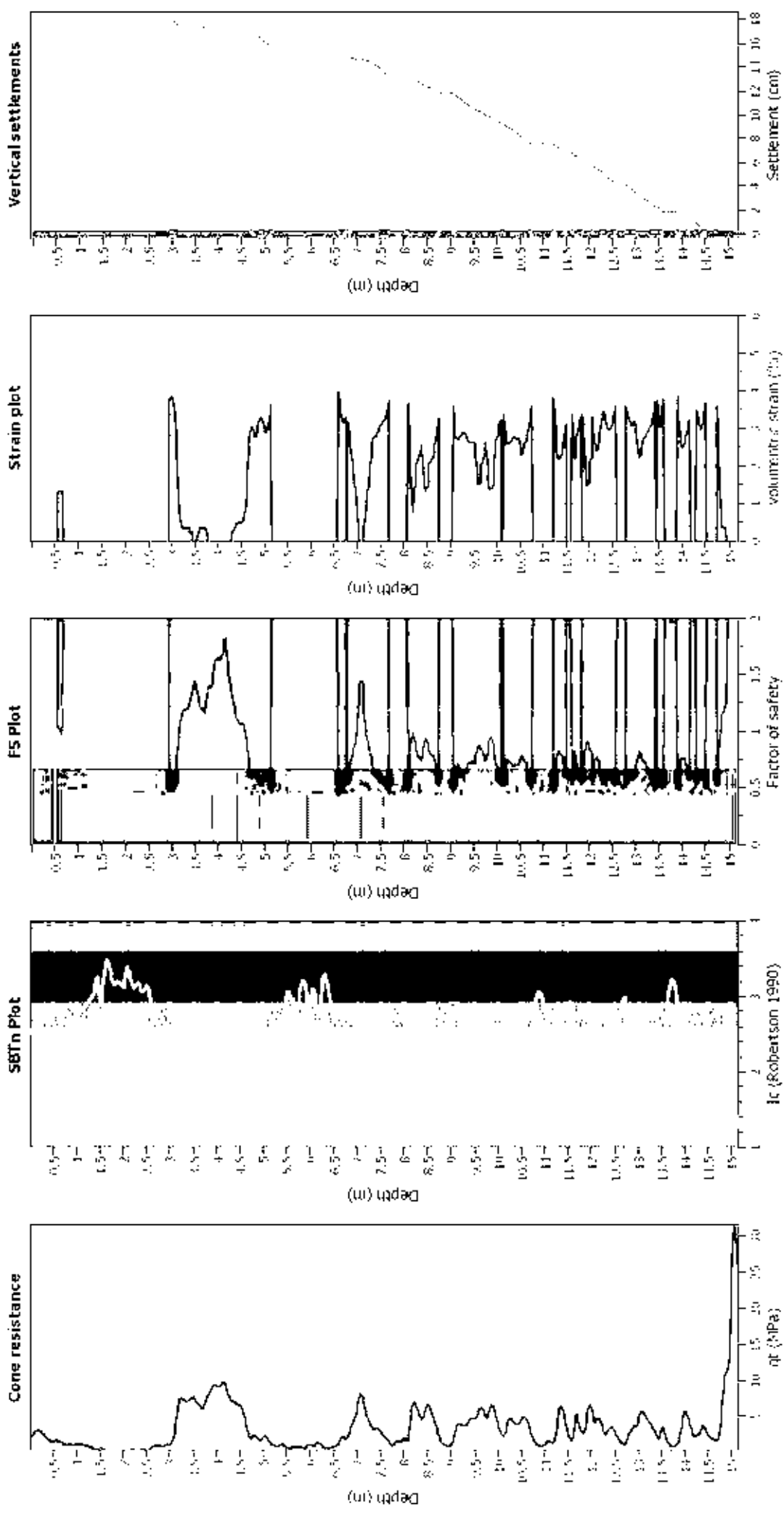


#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		



### Estimation of post-earthquake settlements



#### Abbreviations

- TC: Total cone resistance (cone resistance q corrected for pore water effects)
- SB: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Vol: Volumetric strain; Post-liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT35\_32SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

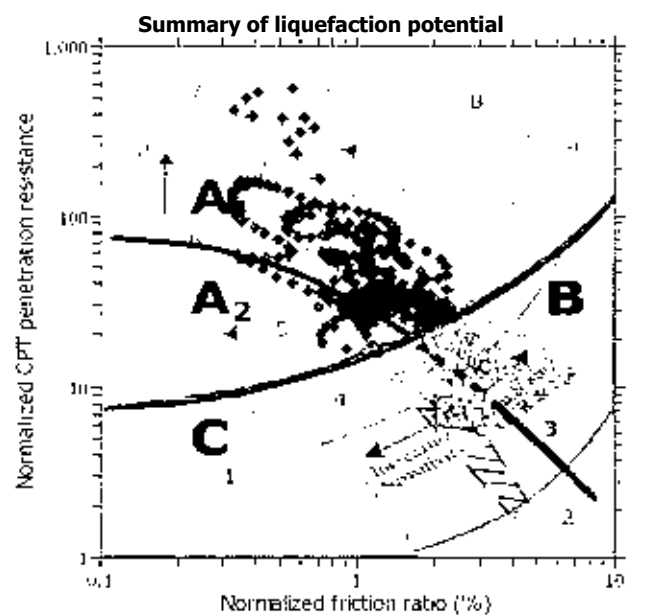
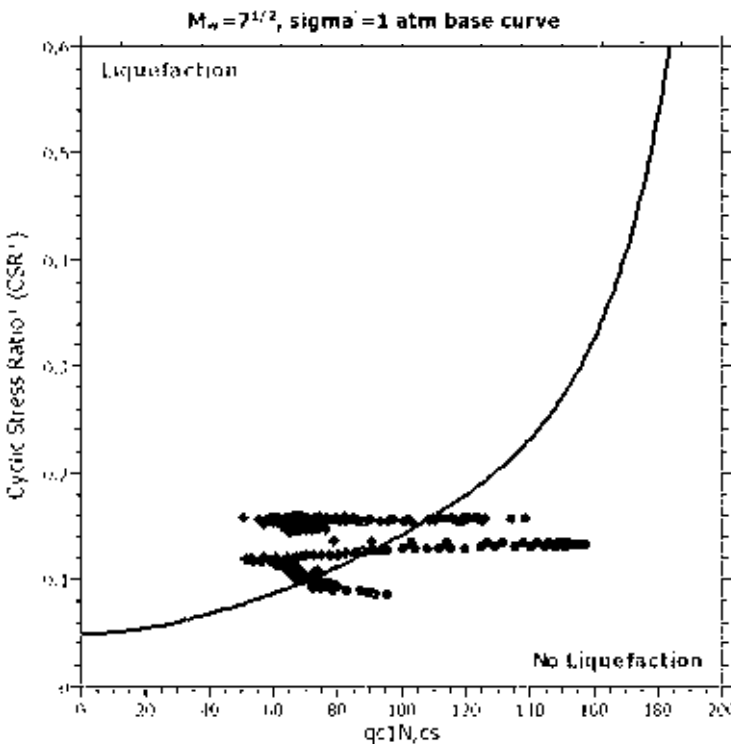
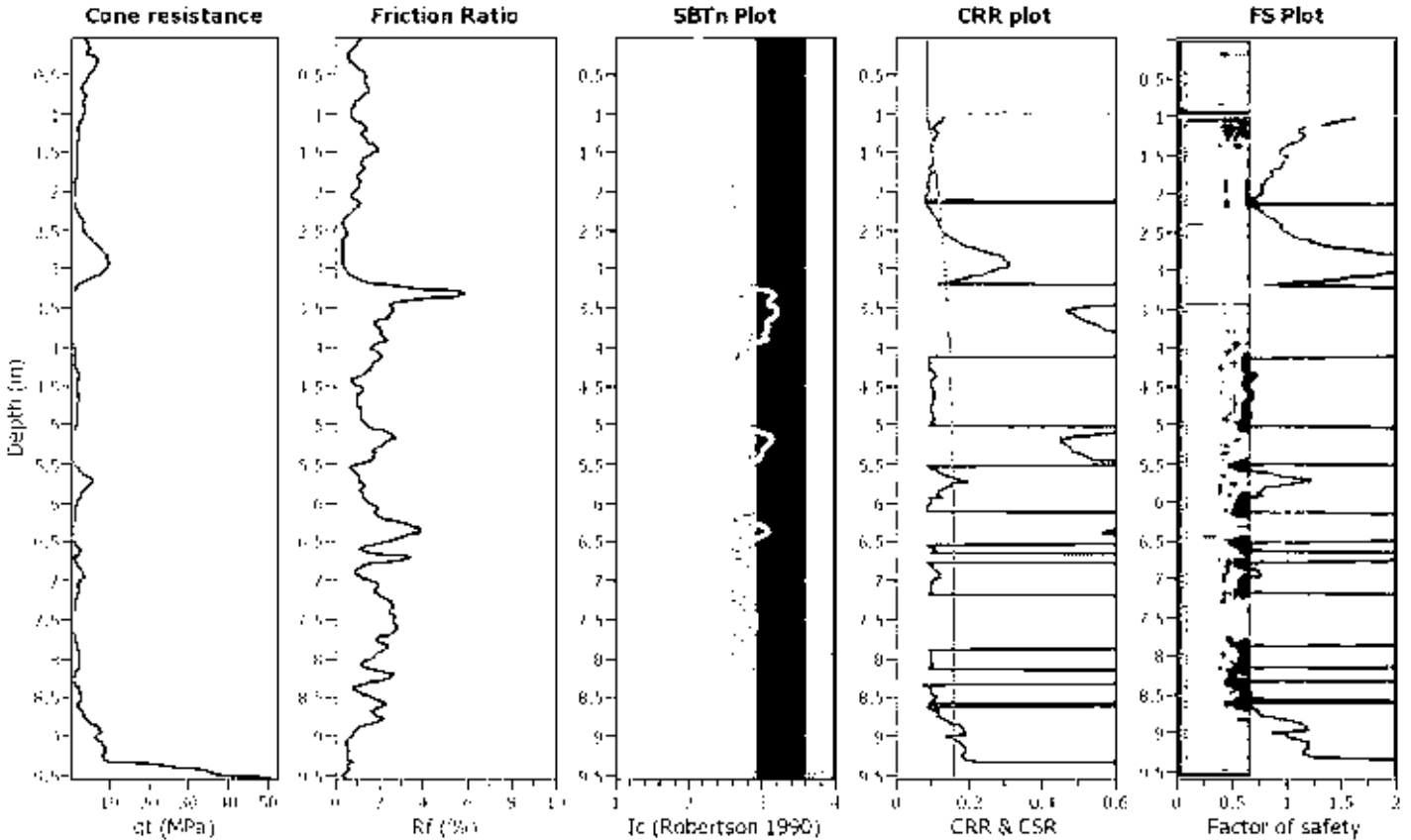
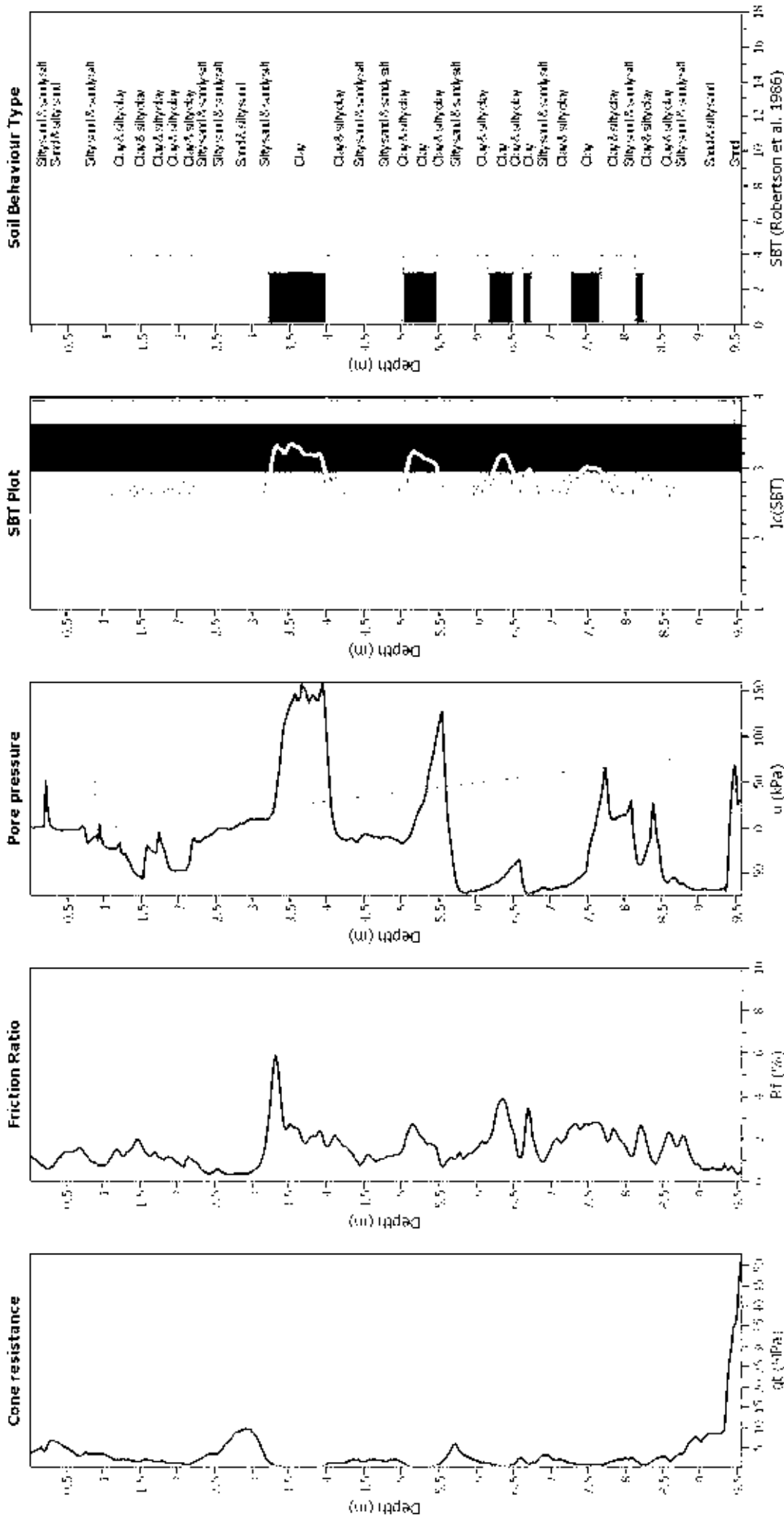


Figure 4: Summary of liquefaction potential plot and data points of cyclic test. (a) Zone A1: Normalized CPT penetration resistance  $> 100$  and normalized friction ratio  $> 1$  (b) Zone A2: Normalized CPT penetration resistance  $> 100$  and normalized friction ratio  $< 1$  (c) Zone B: Normalized CPT penetration resistance  $< 100$  and normalized friction ratio  $> 1$  (d) Zone C: Normalized CPT penetration resistance  $< 100$  and normalized friction ratio  $< 1$ . The liquefaction boundary is shown as a dashed line.

### CPT basic interpretation plots



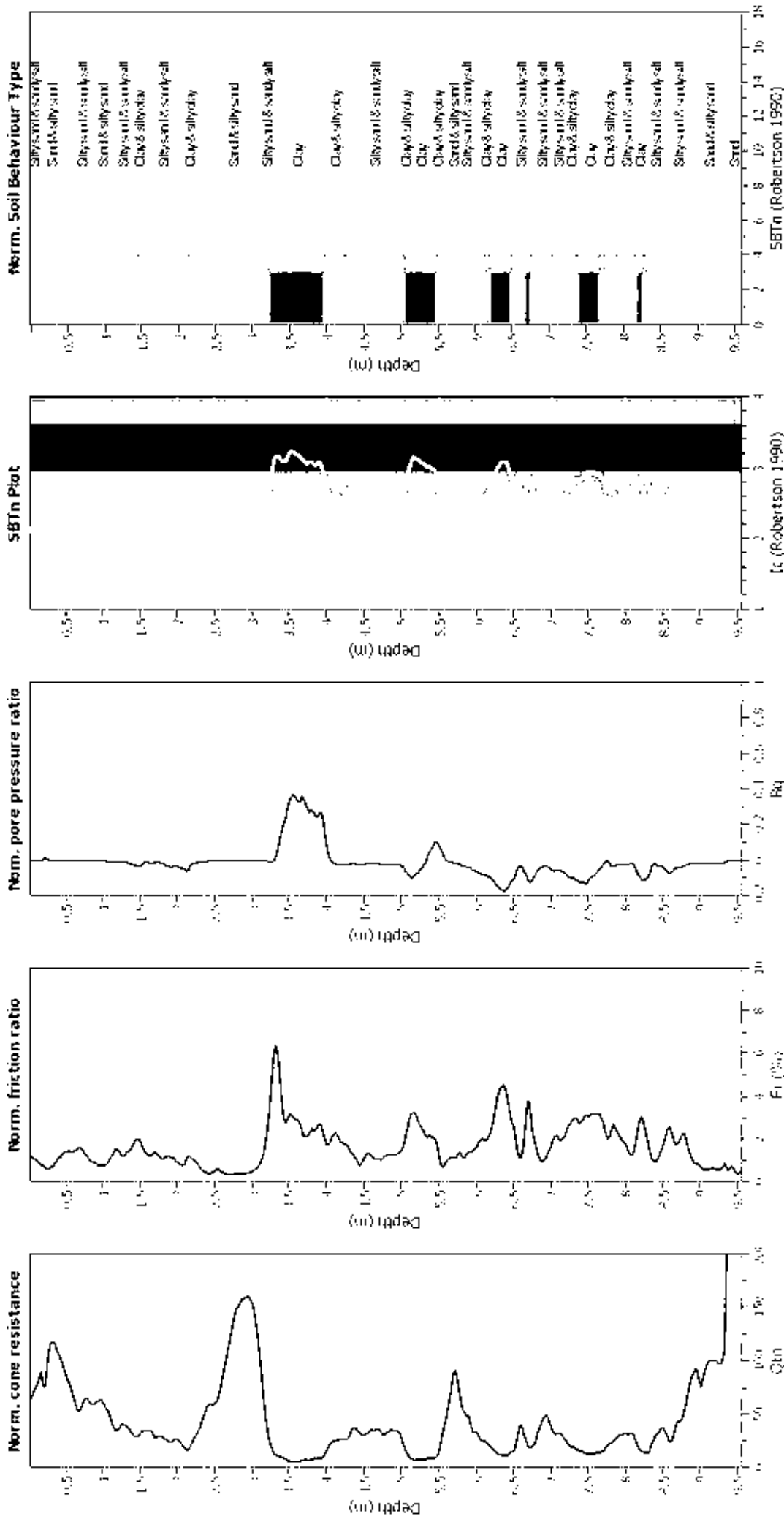
#### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Fill depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



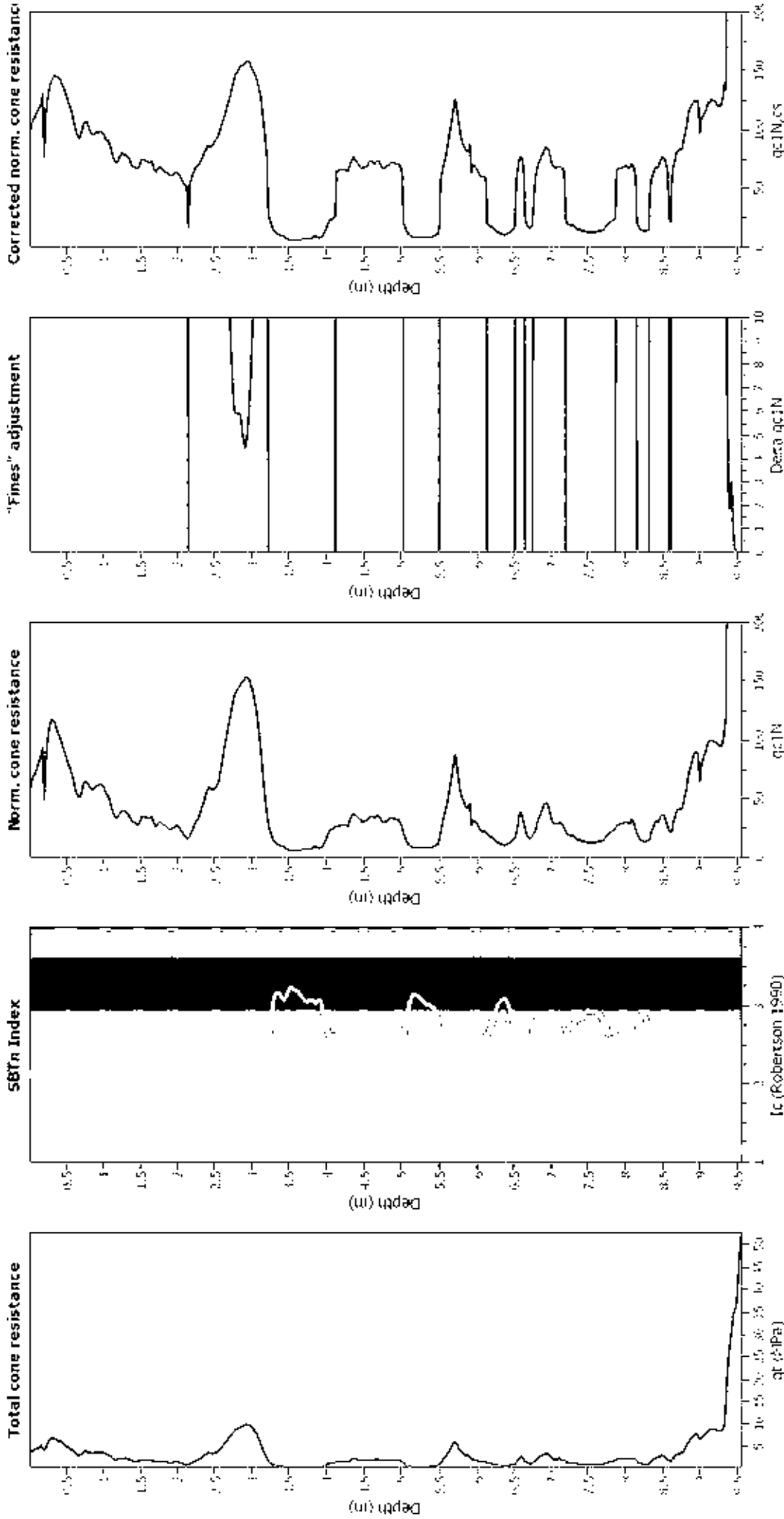
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

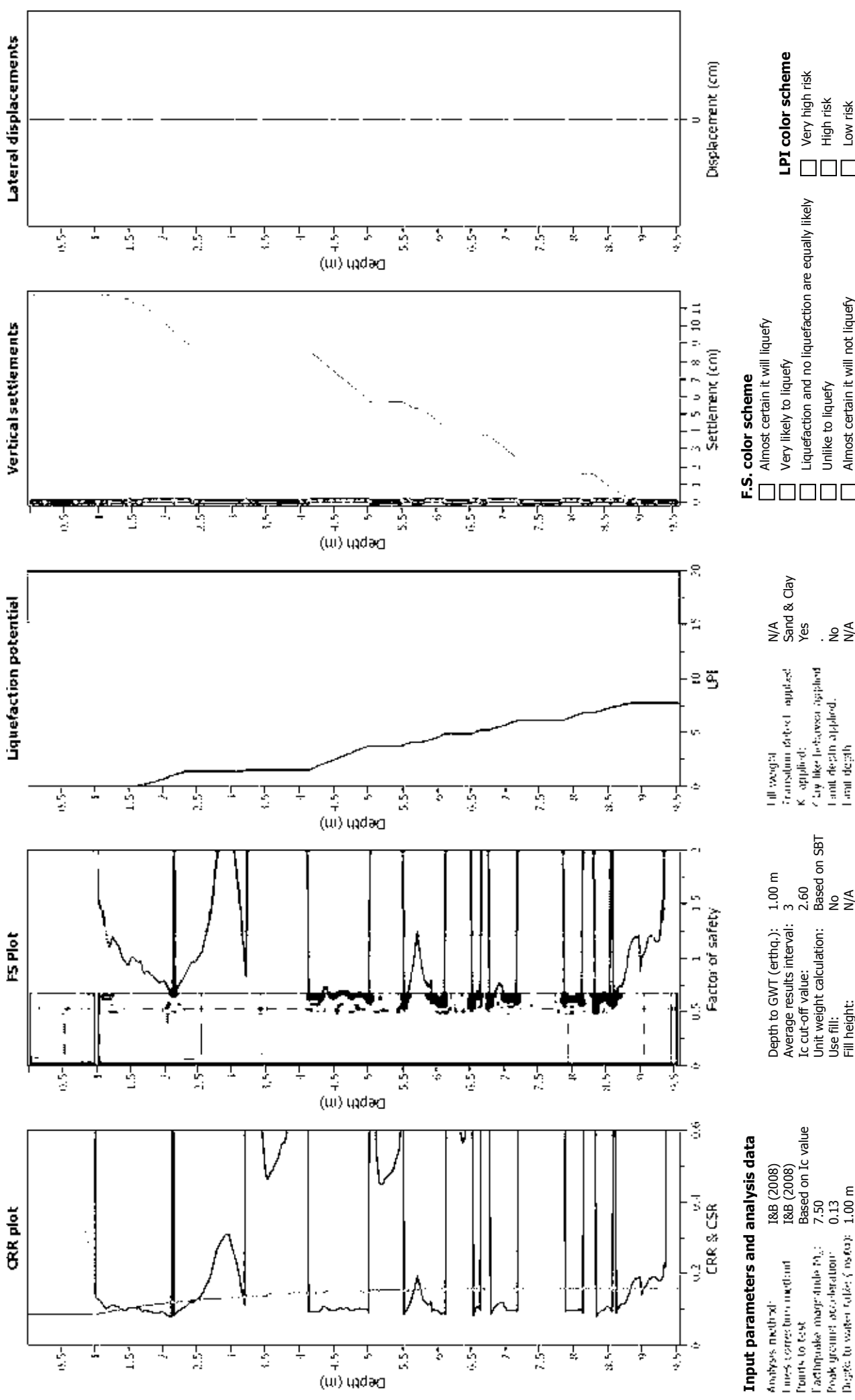
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction method: 188 (2008)  
 Points to test: Based on Ic value  
 Liquefaction magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.00 m

#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Sand & Clay  
 Yes  
 No  
 N/A

#### Input parameters and analysis data

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

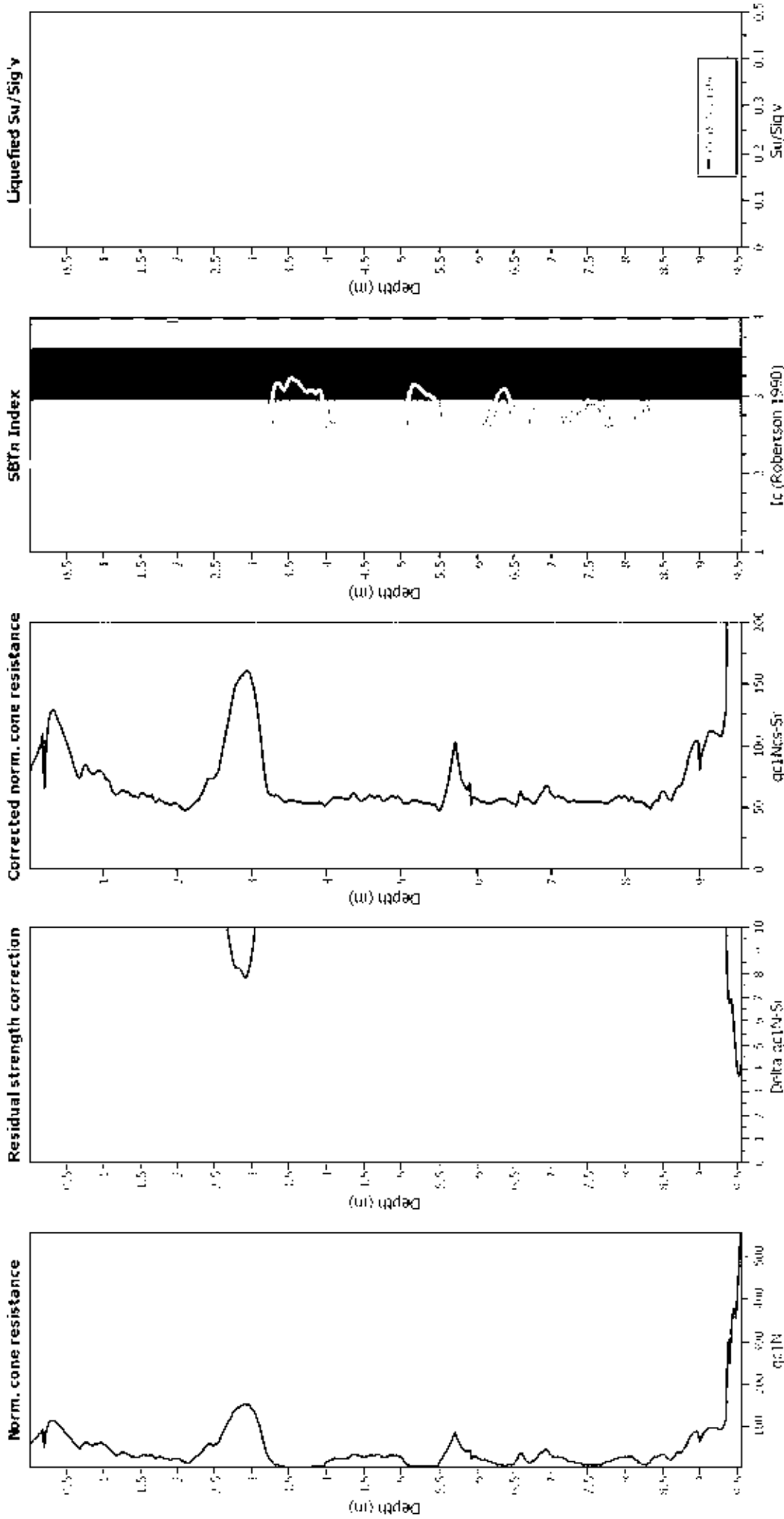
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

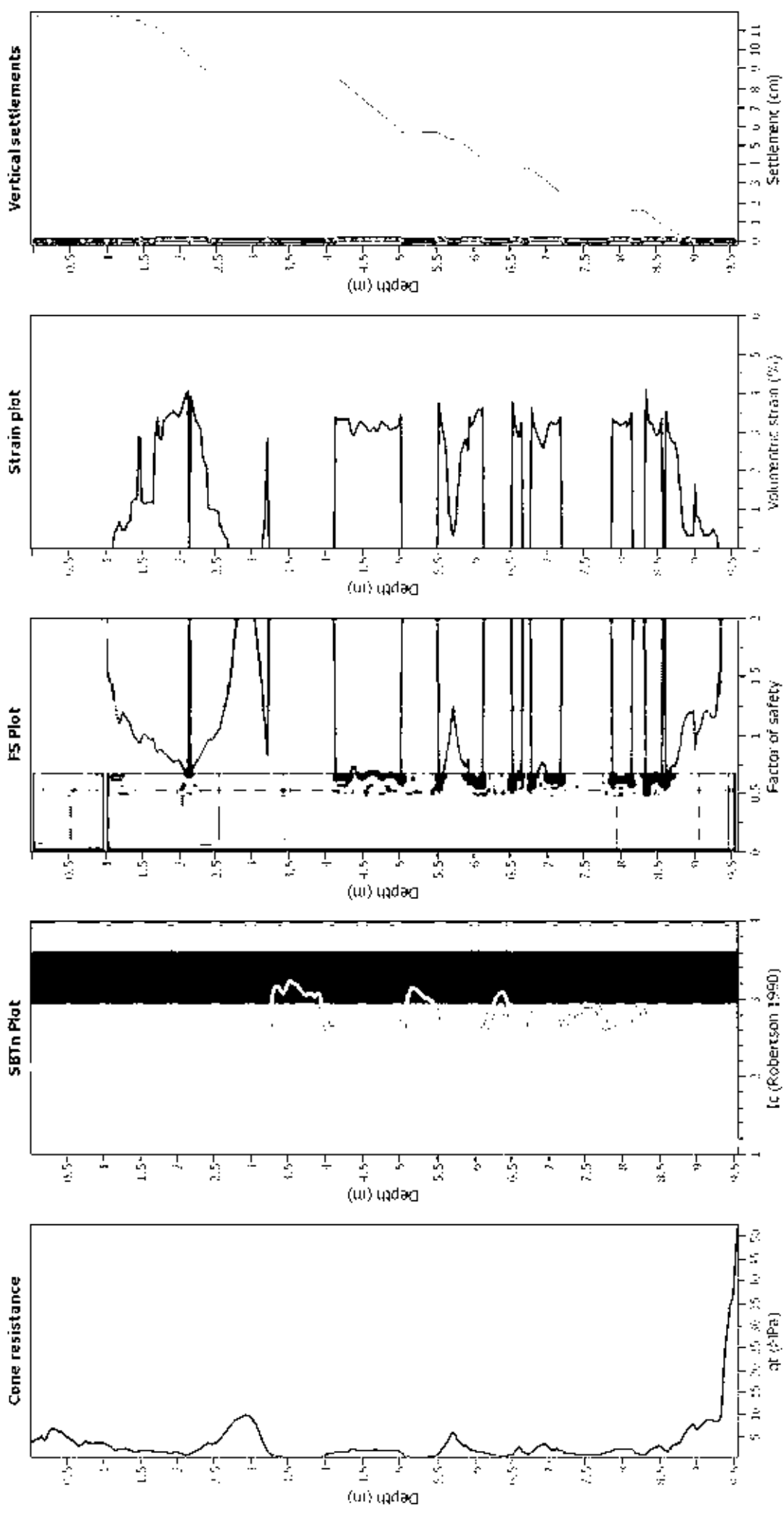
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.5	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

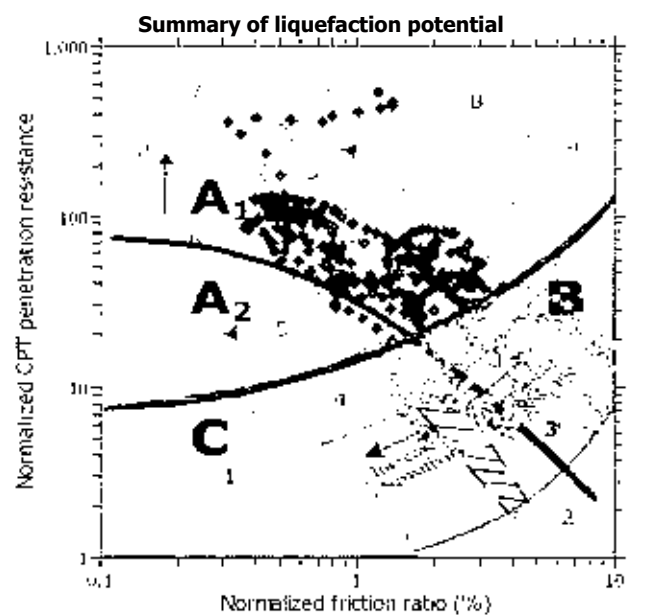
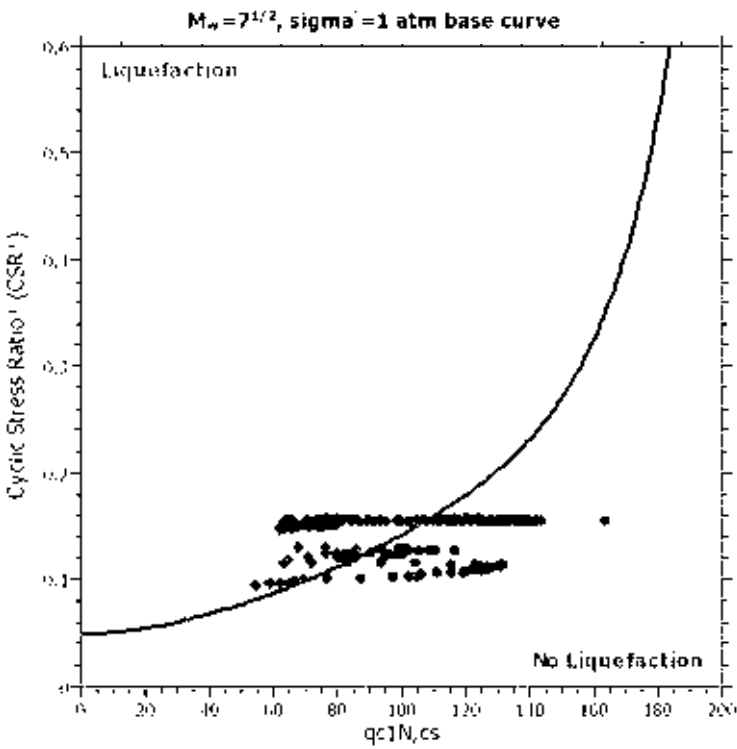
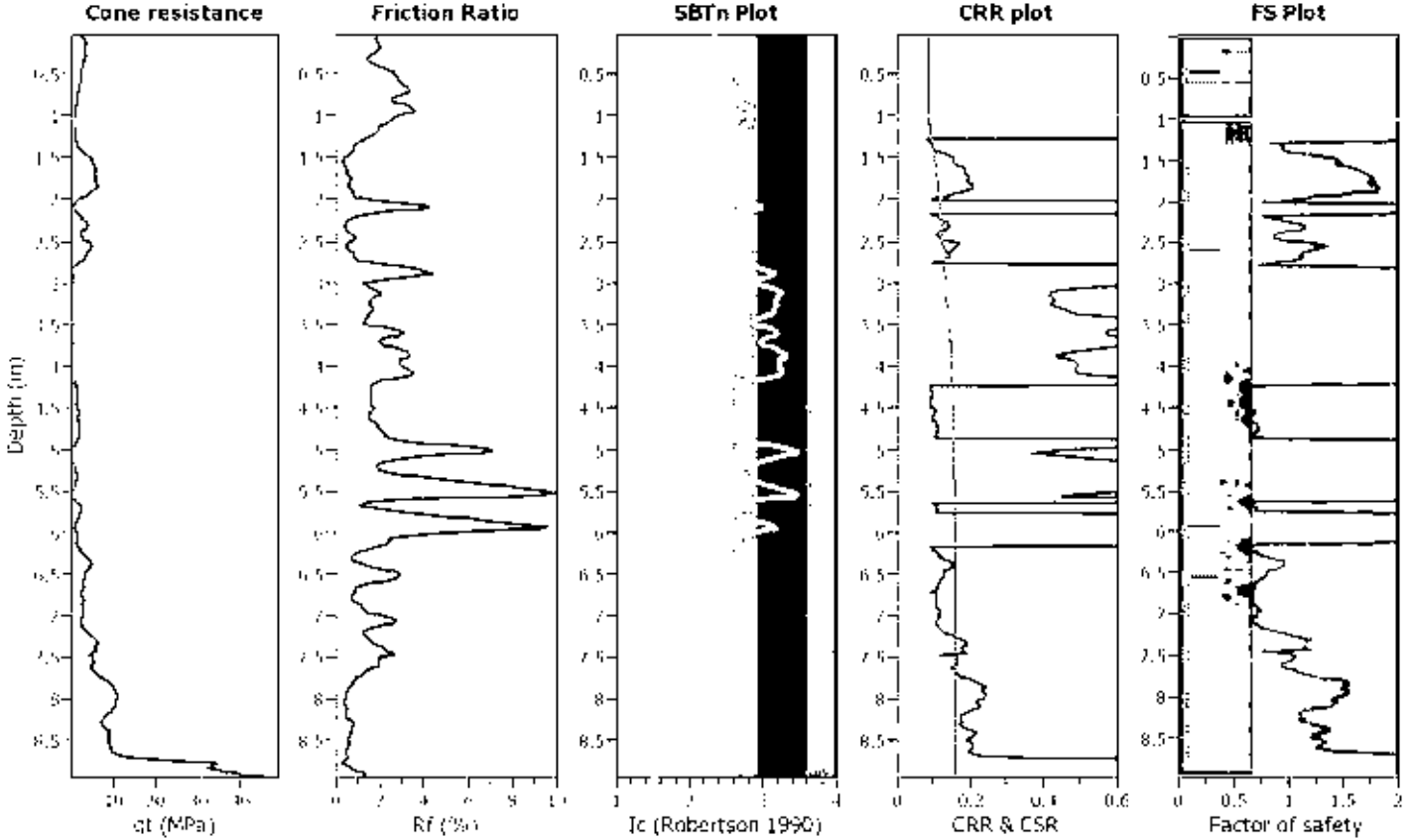


**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT36\_32SutherlandsRd**

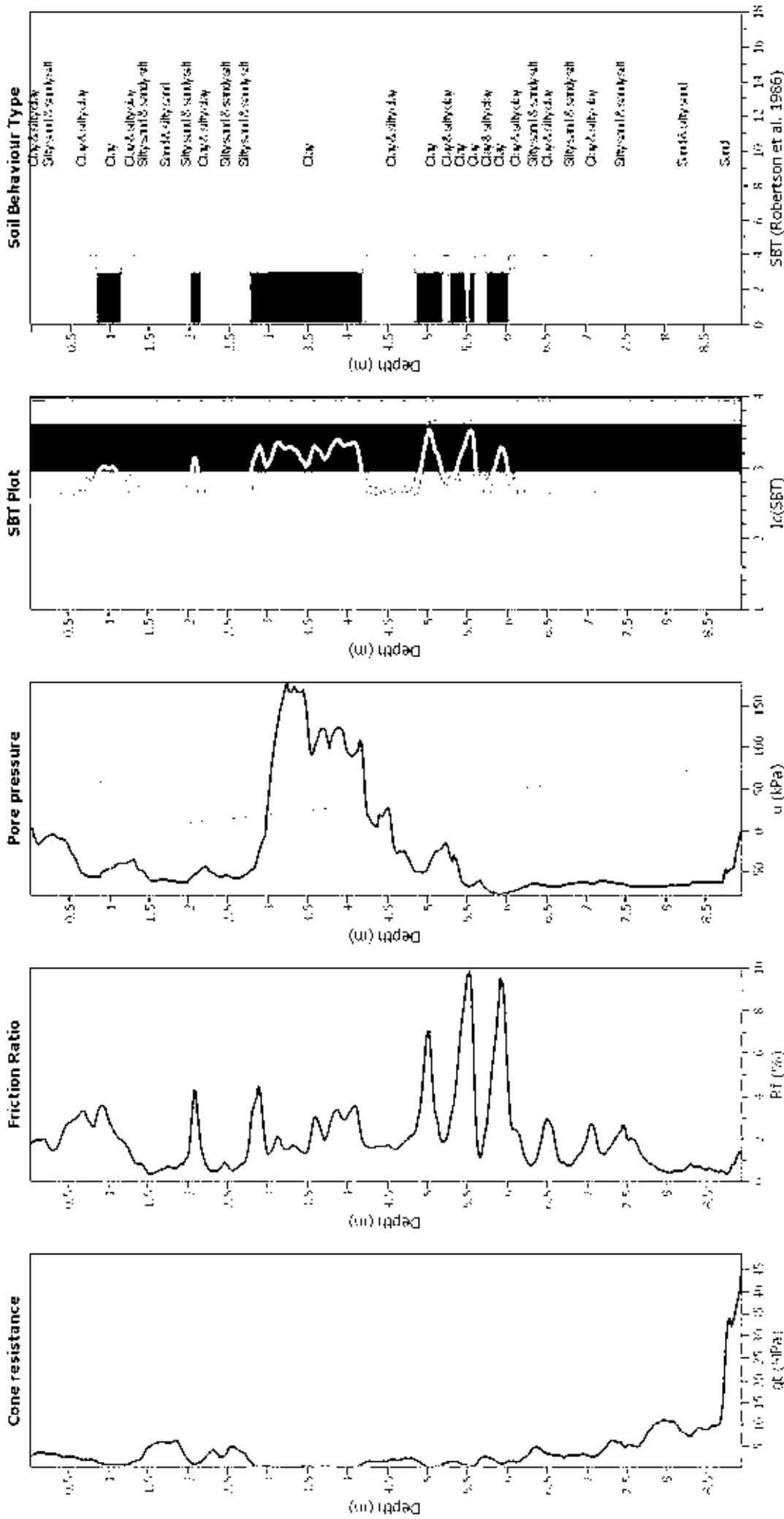
**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		



Zone A<sub>1</sub> is the area of high penetration resistance and low cyclic stress ratio. Zone A<sub>2</sub> is the area of low penetration resistance and low cyclic stress ratio. Zone B is the area of low penetration resistance and high cyclic stress ratio. Zone C is the area of high penetration resistance and high cyclic stress ratio. The liquefaction boundary is the boundary between the liquefied and non-liquefied zones.

### CPT basic interpretation plots



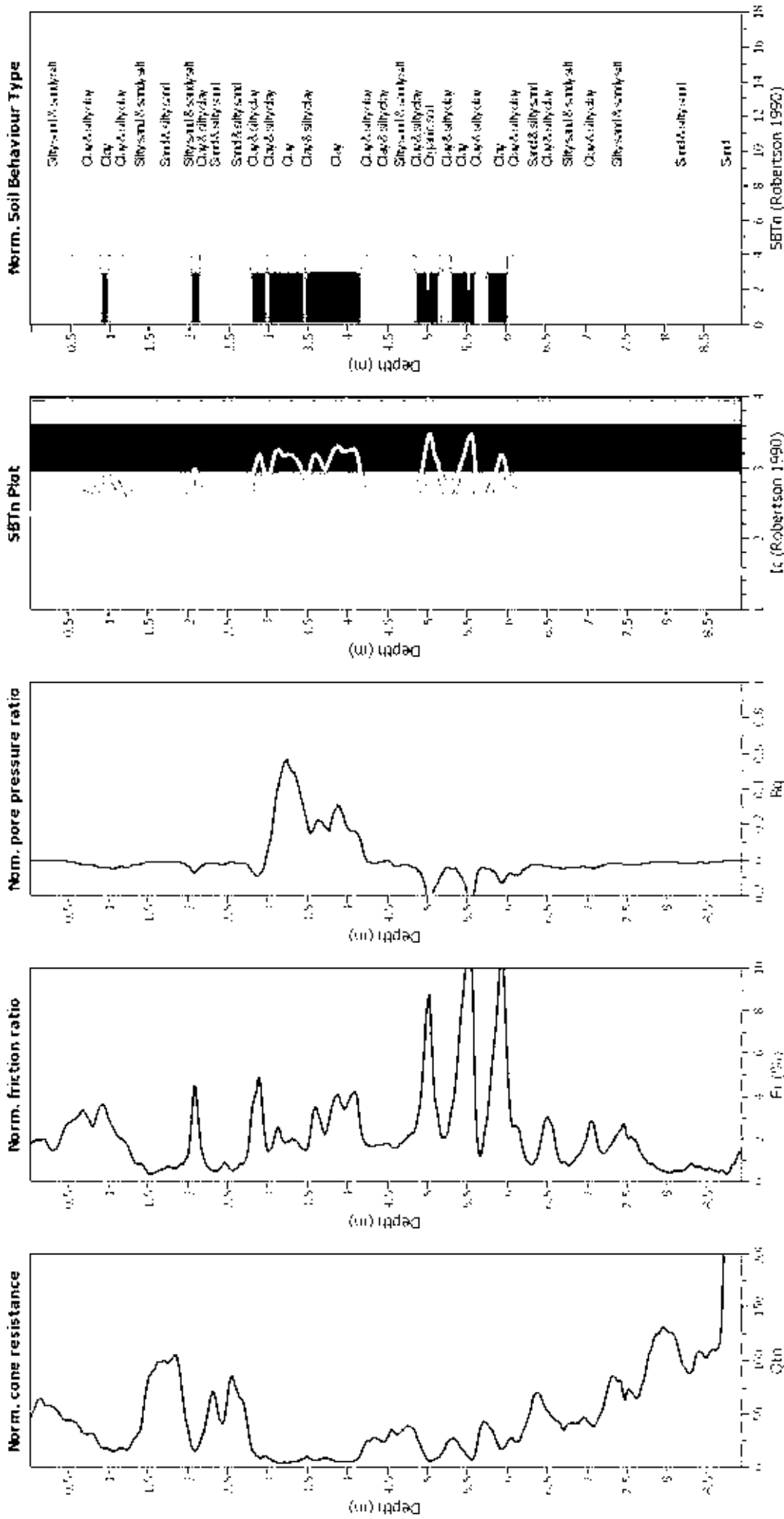
#### Input parameters and analysis data

Analysis method:	18B (2008)	Full weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit weight:	N/A
		Fill height:	N/A
		Depth to GW (earthq.):	1.00 m
		Average results interval:	3
		$I_c$ cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	N/A

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



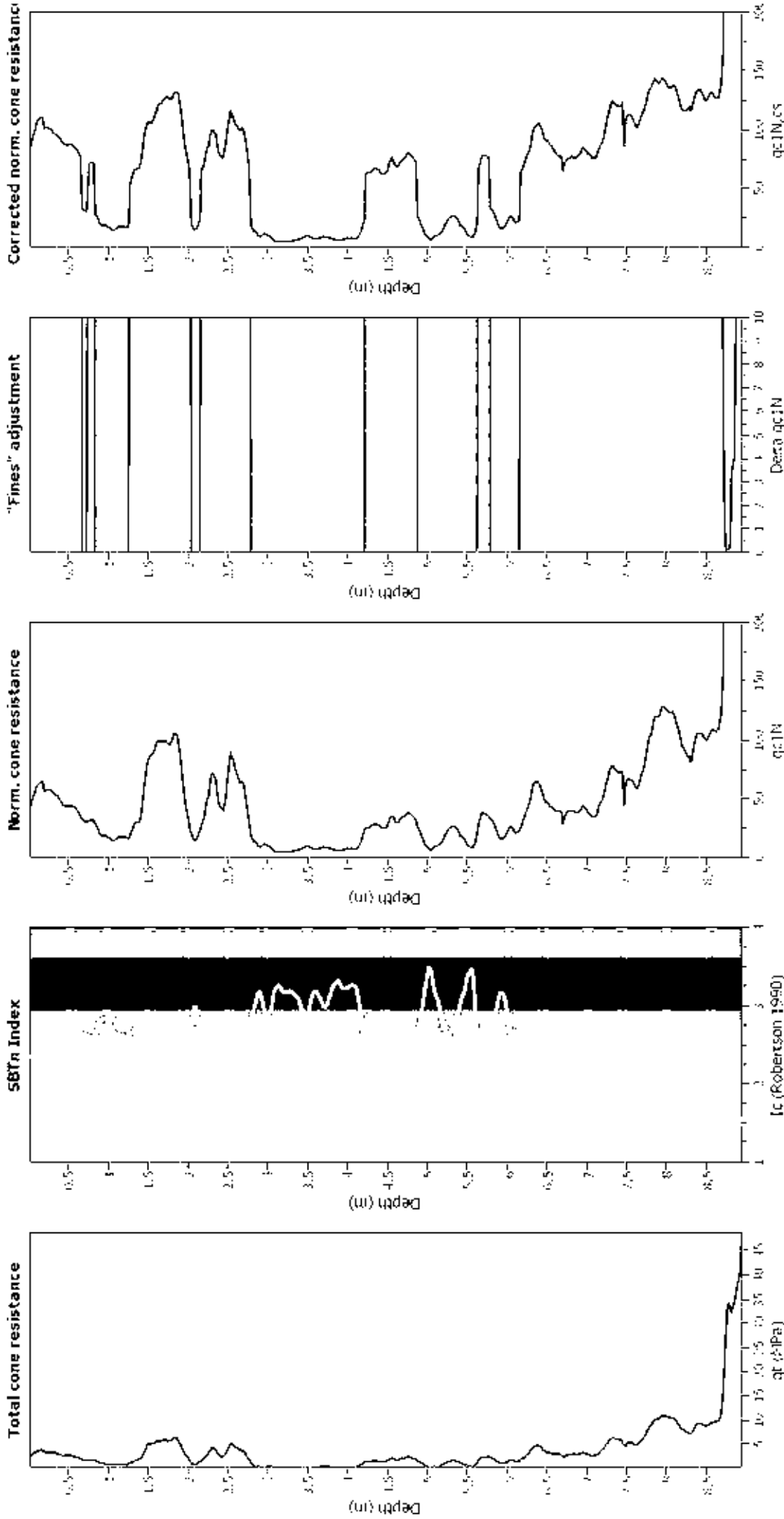
#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth:	N/A
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m	Fill weight:	N/A
Average results interval:	3	Transition depth applied:	Sand & Clay
Ic cut-off value:	2.60	K applied:	Yes
Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Use fill:	No	Unit depth:	N/A
Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

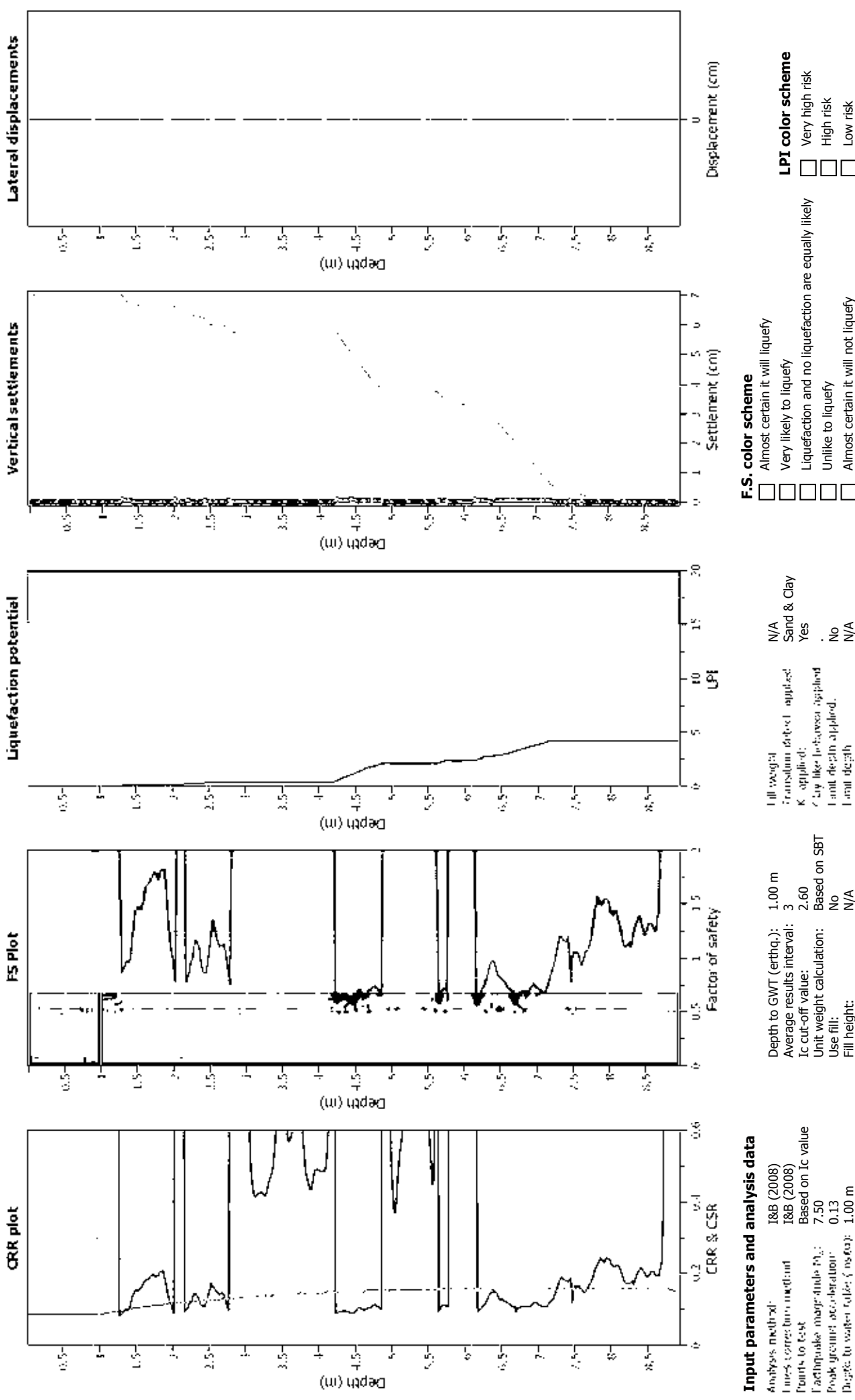
### Liquefaction analysis overall plots (intermediate results)



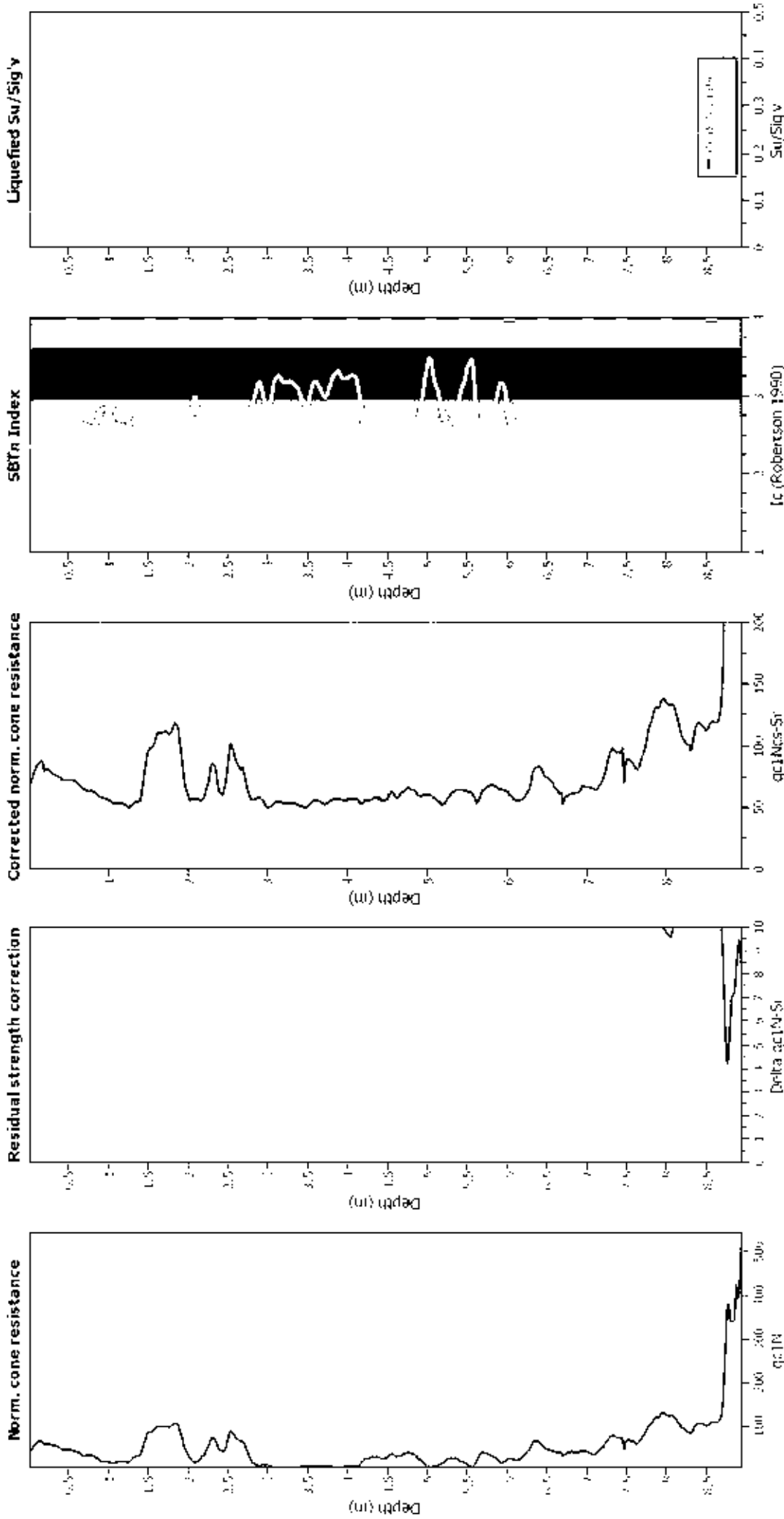
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Fines correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



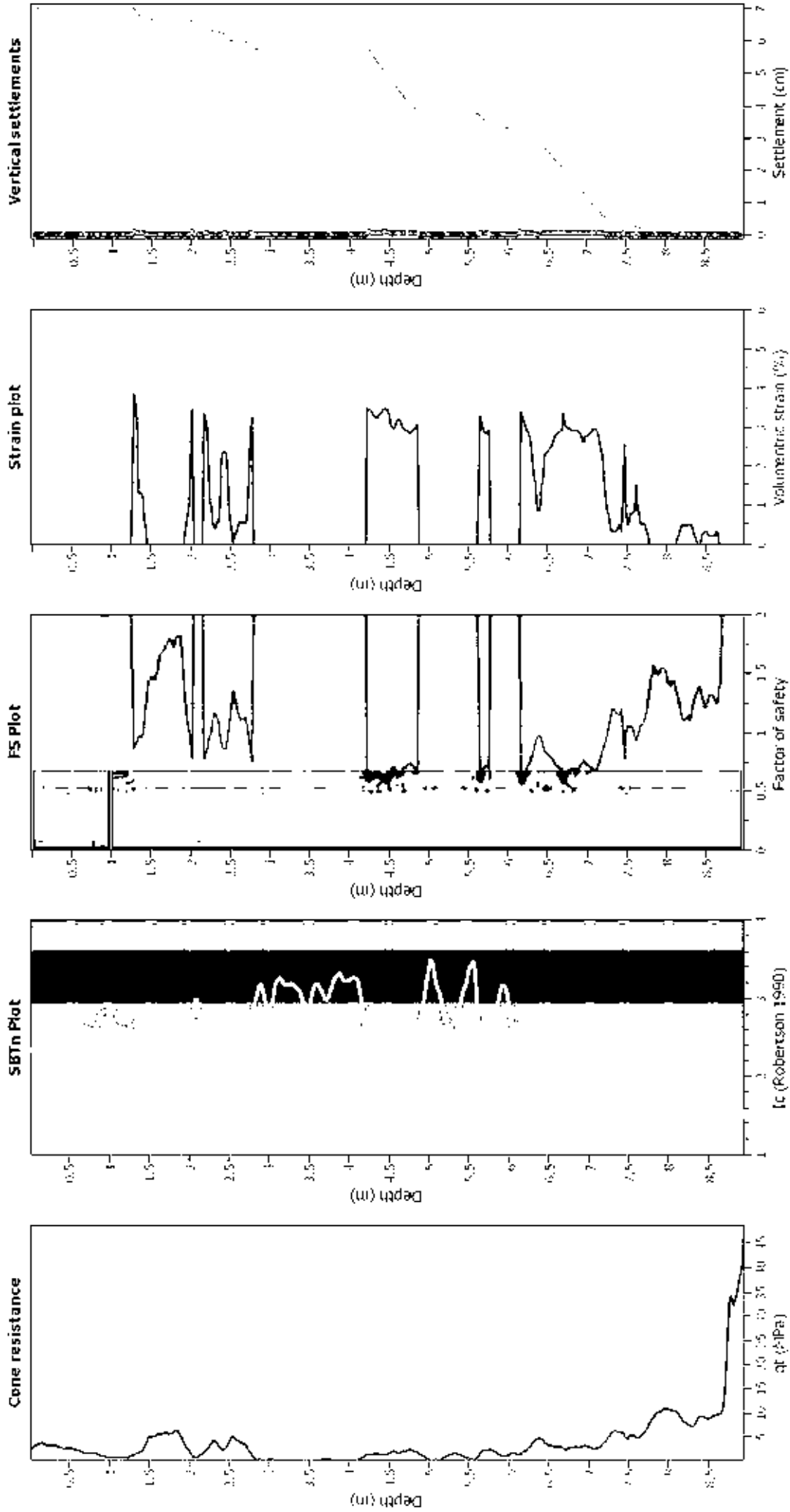
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT37\_32SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

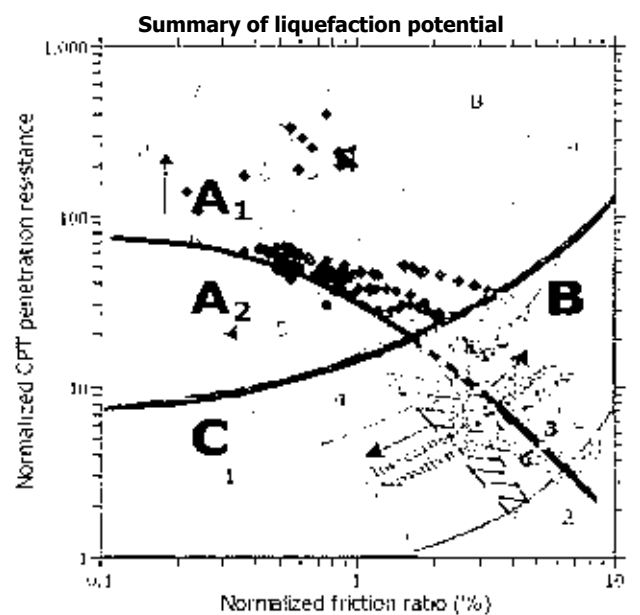
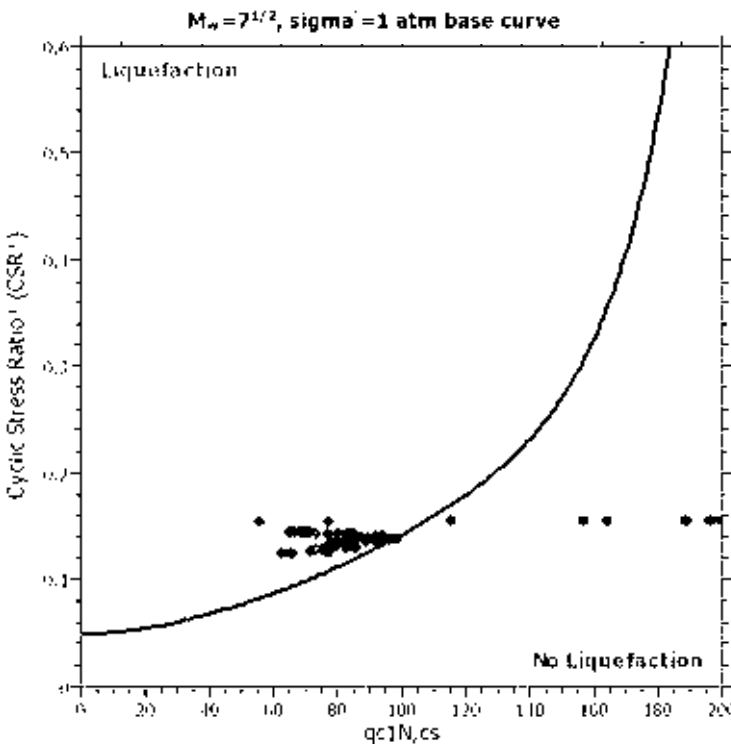
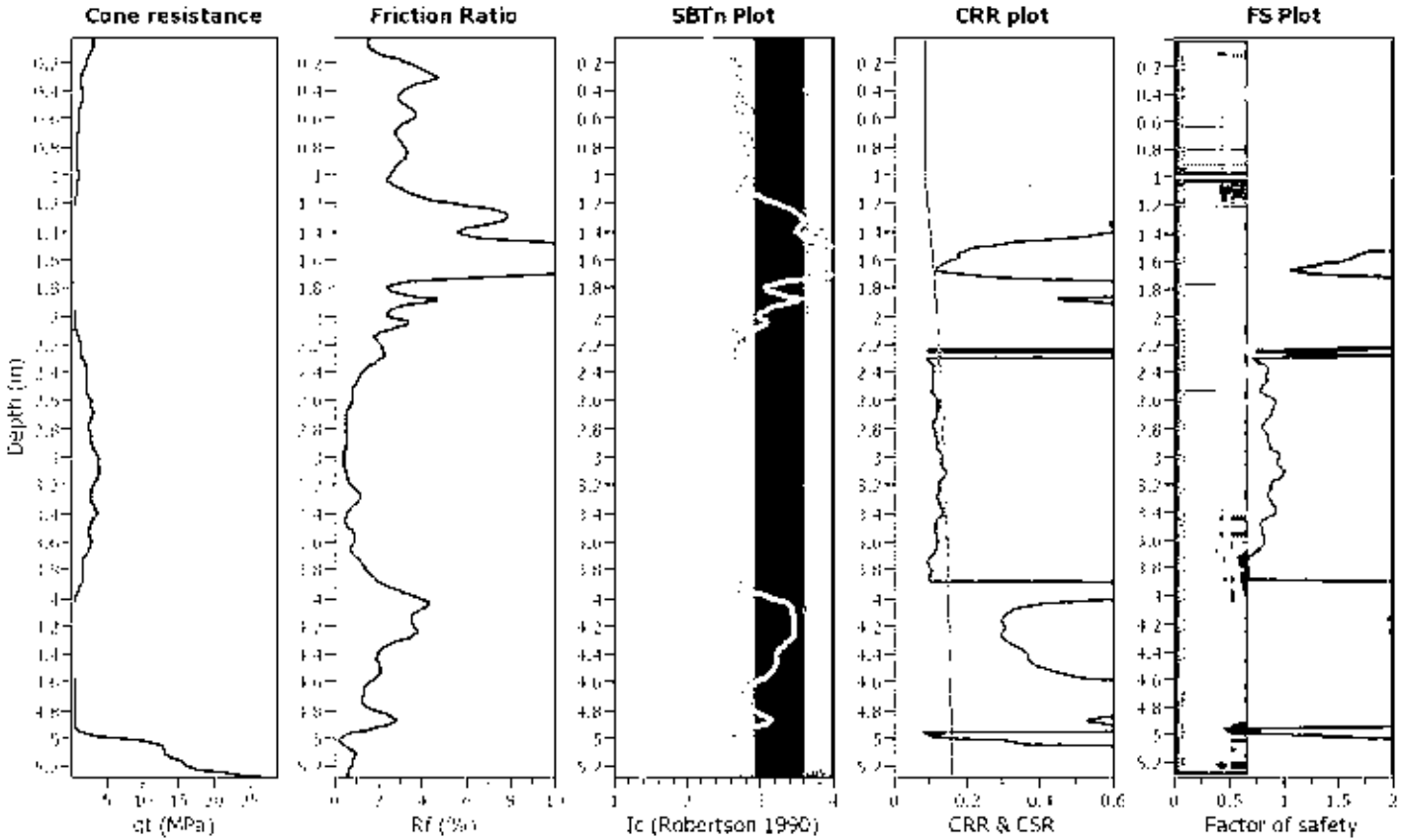
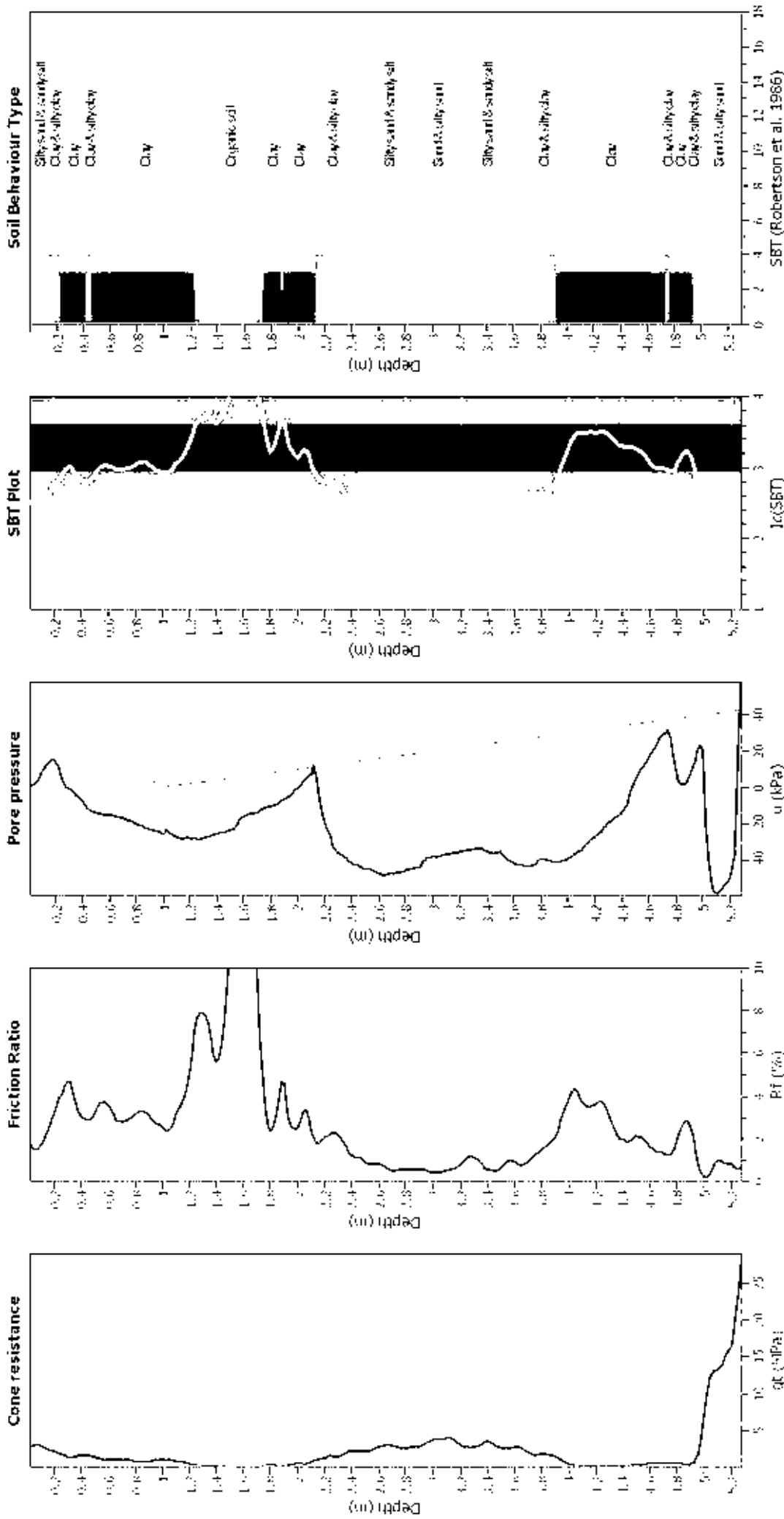


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A1: Fully liquefiable, Zone A2: Partially liquefiable, Zone B: Non-liquefiable, Zone C: Fully liquefiable. The liquefaction boundary is shown as a dashed line.



### CPT basic interpretation plots



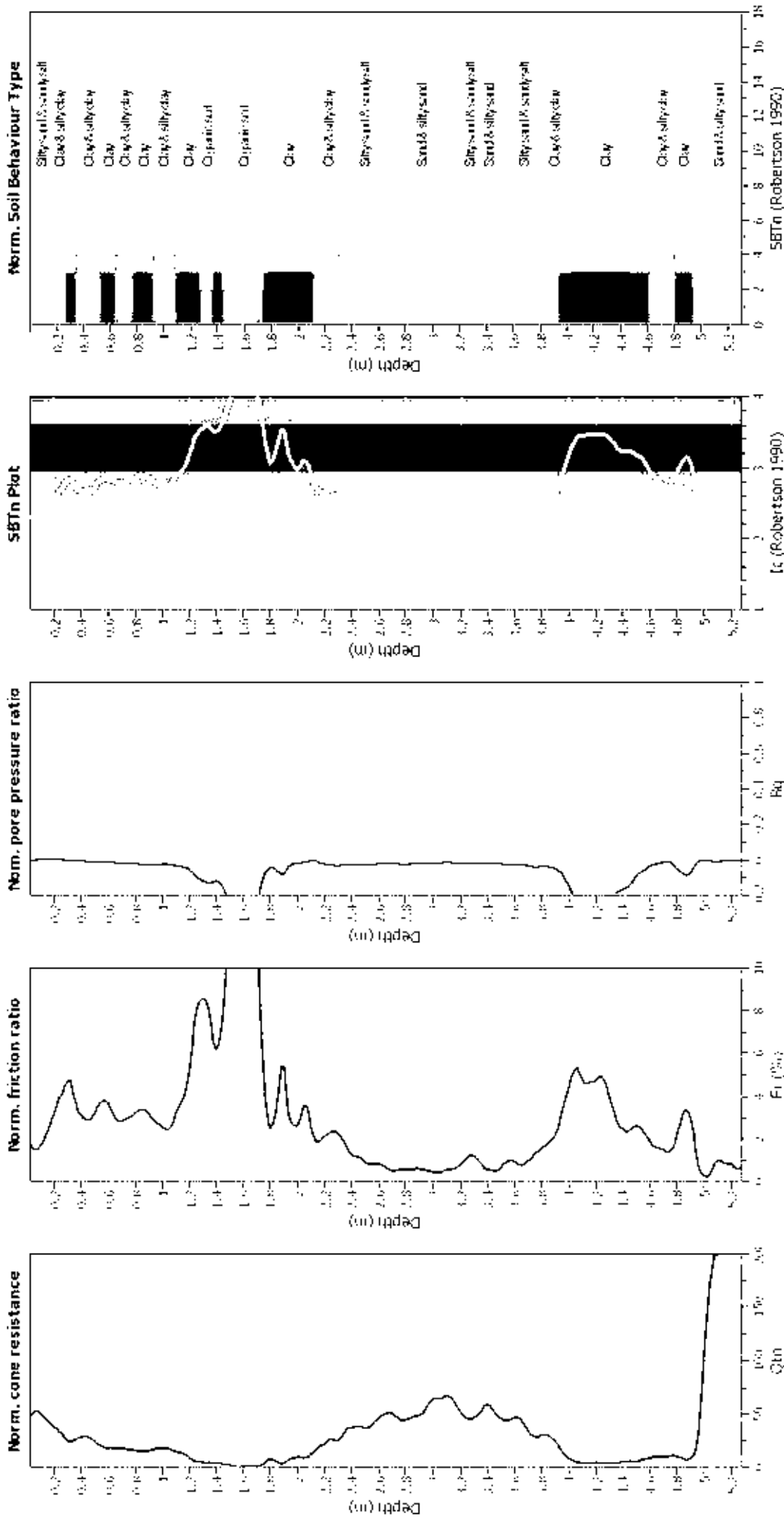
### Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (earthq.):	1.00 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude (M <sub>w</sub> ):	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.00 m	Fill height:	N/A	Unit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



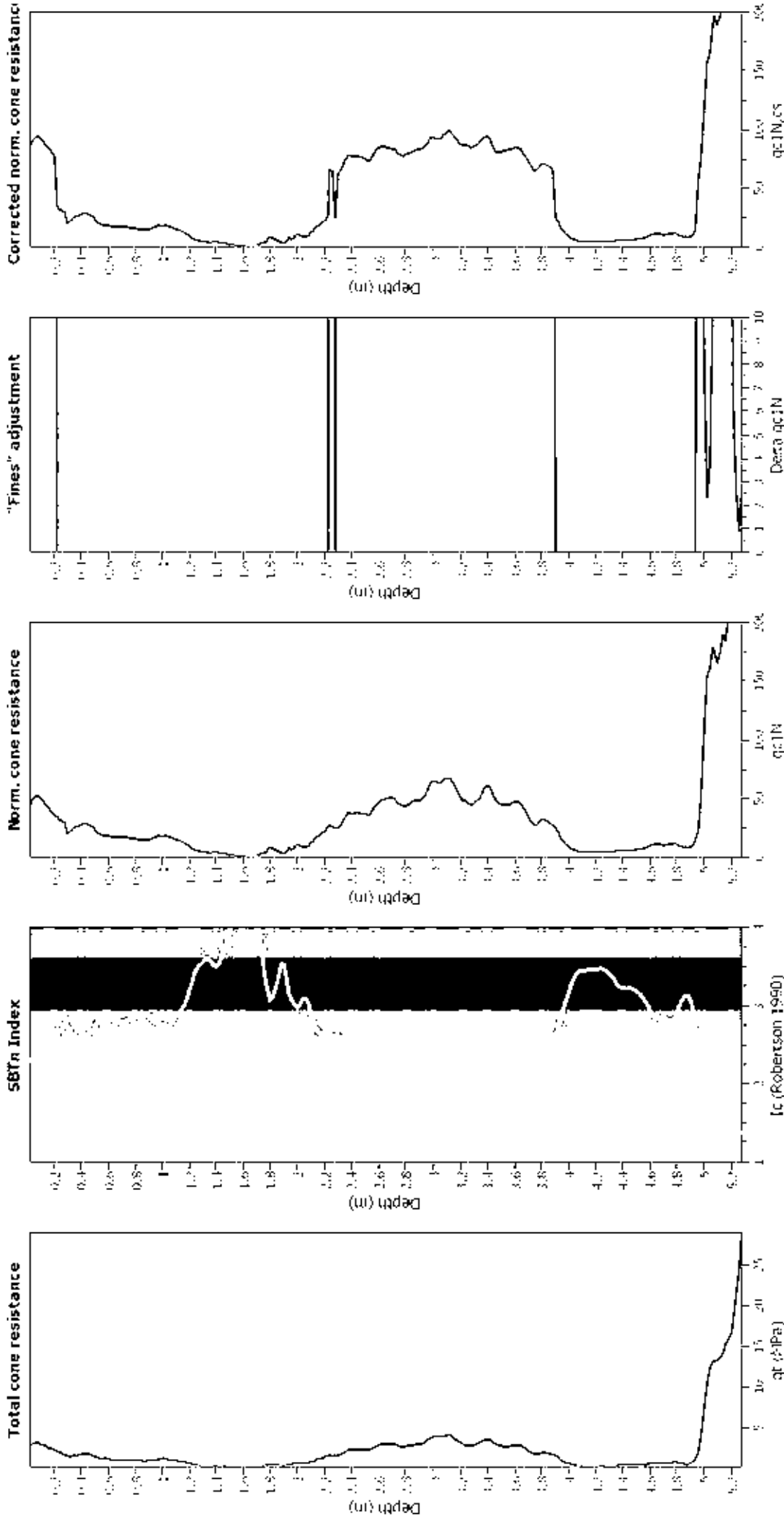
#### Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
$I_c$ cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

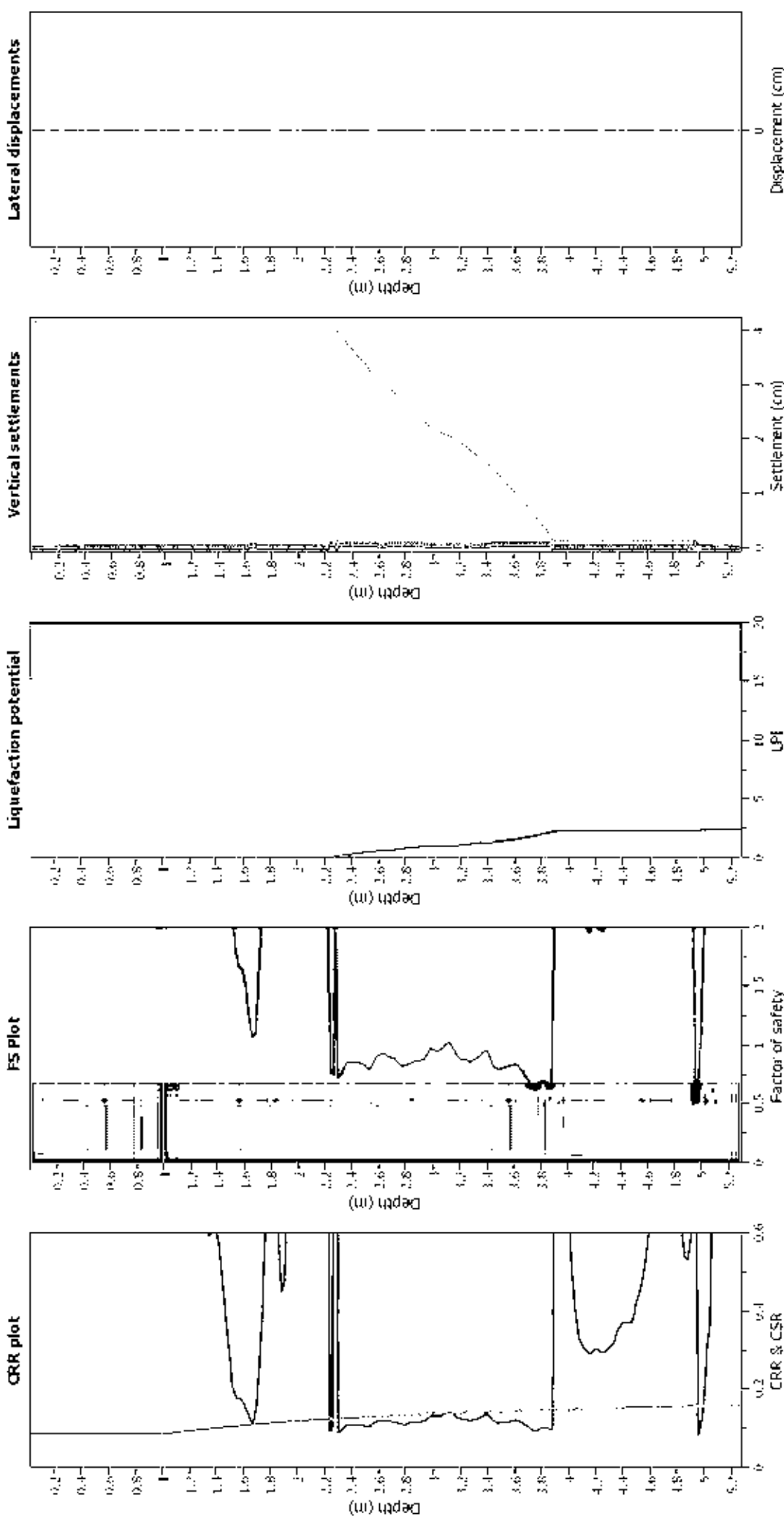
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 188 (2008)  
 Liquefaction correction method: 188 (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

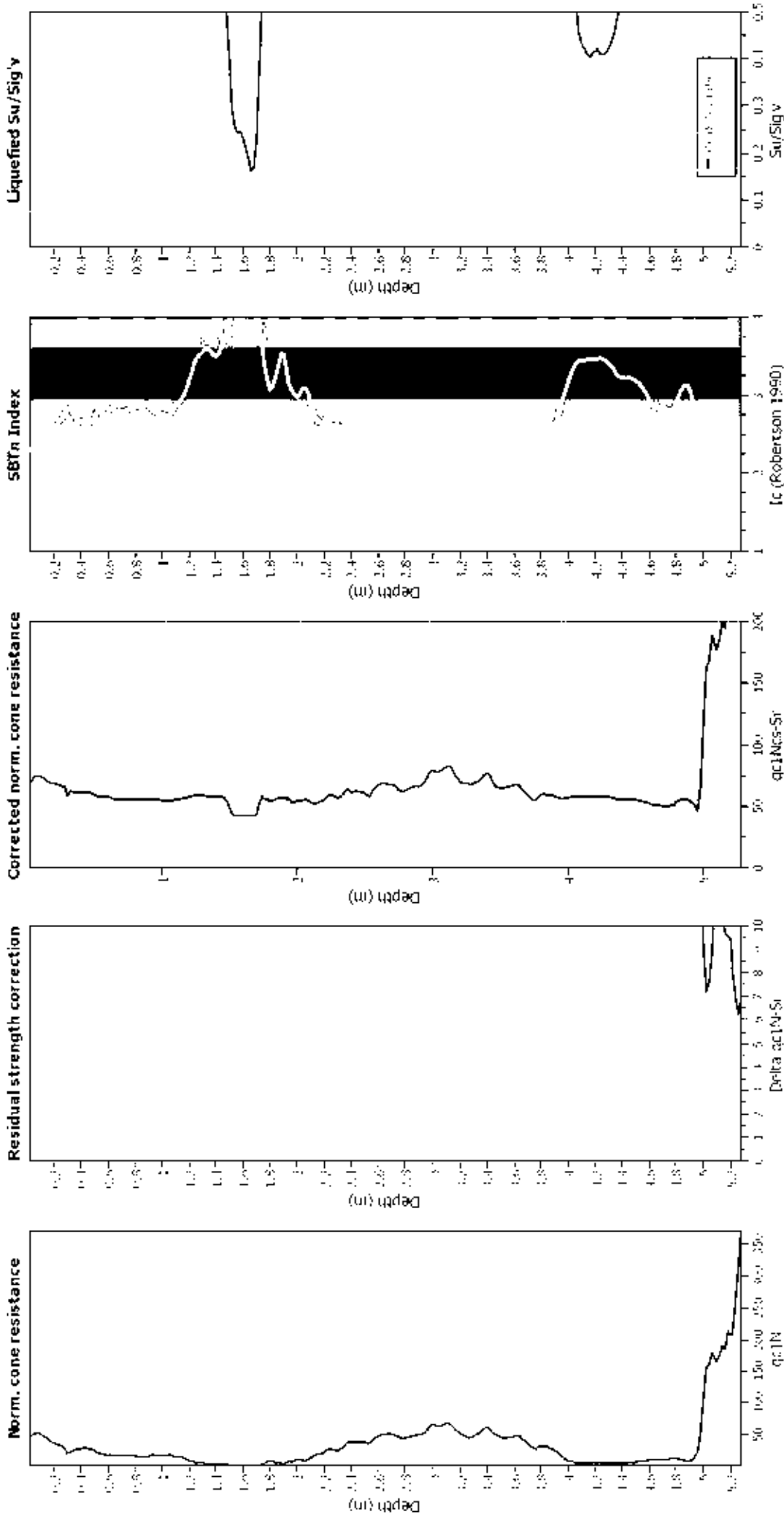
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

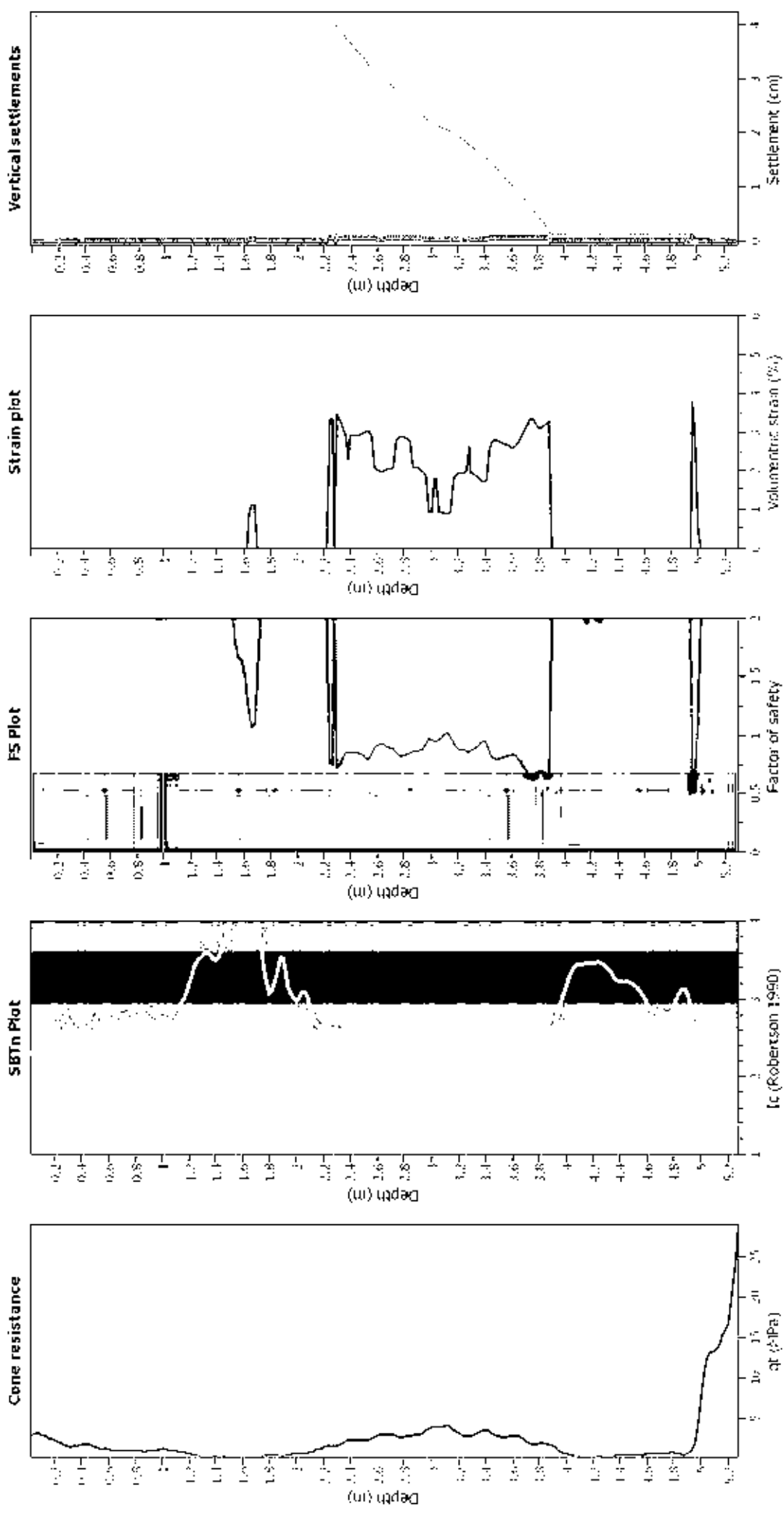
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m <sub>wt</sub> ):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT38\_32SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.25 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.25 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

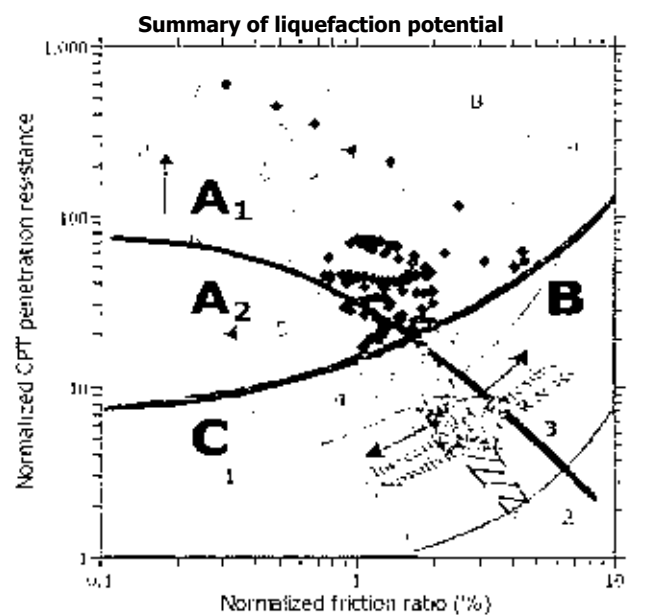
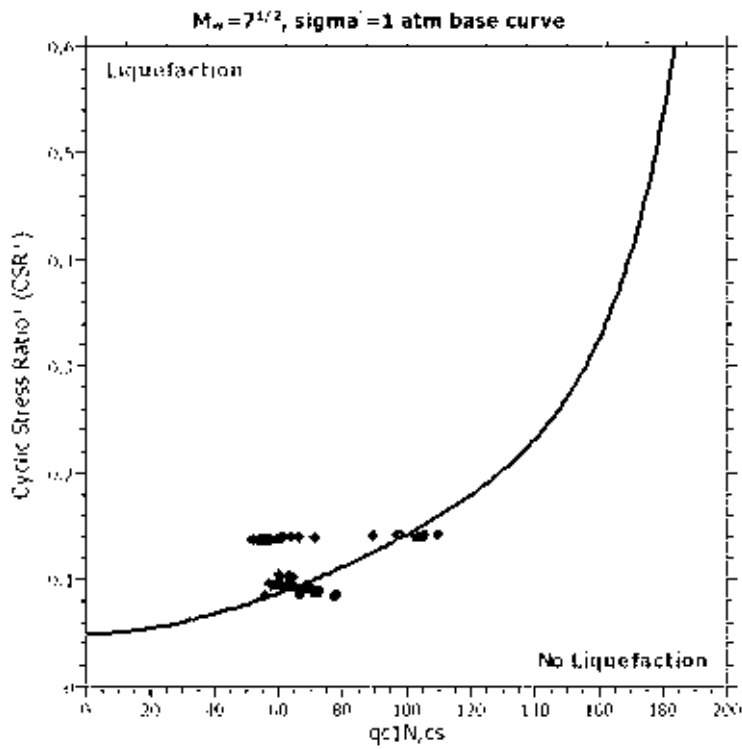
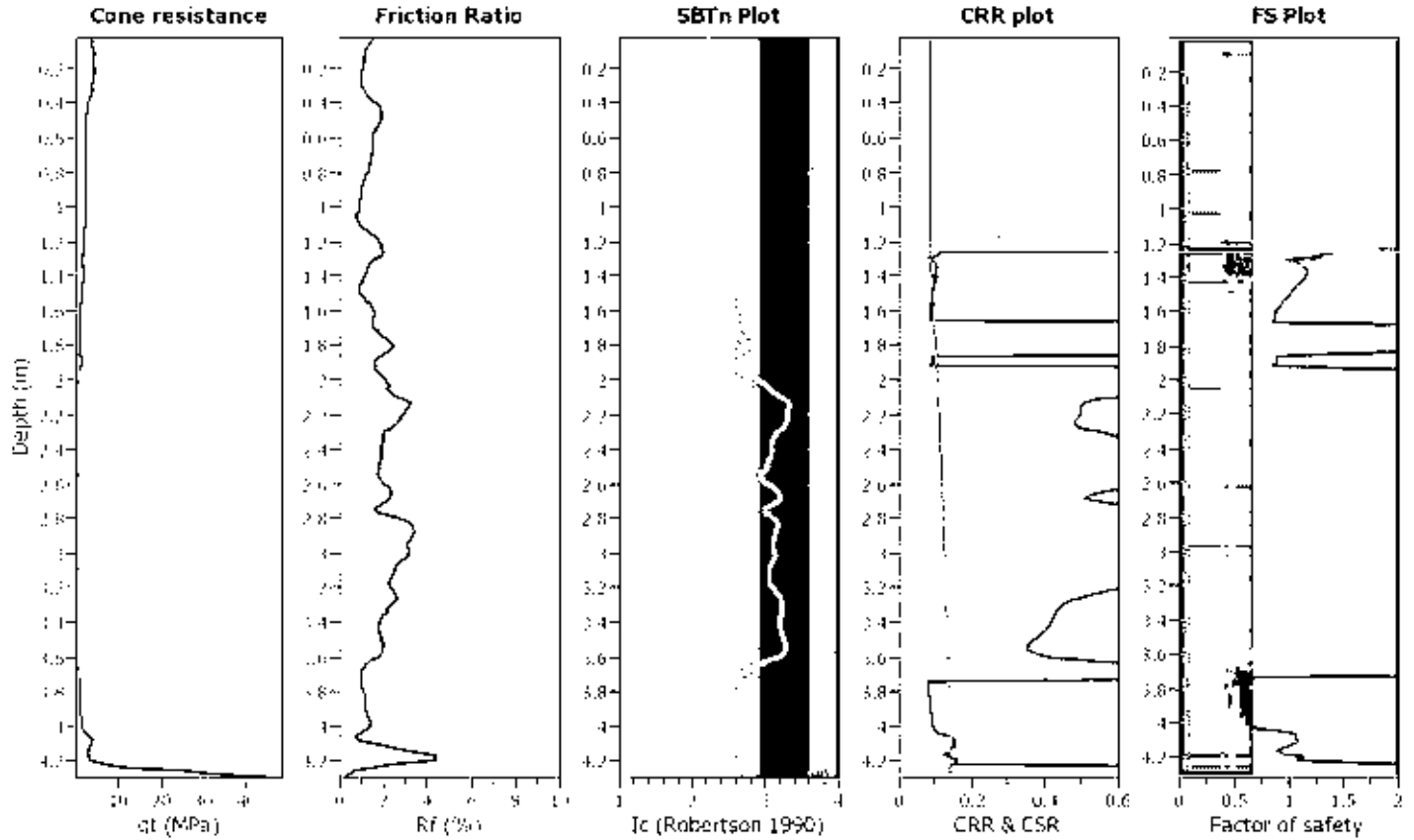
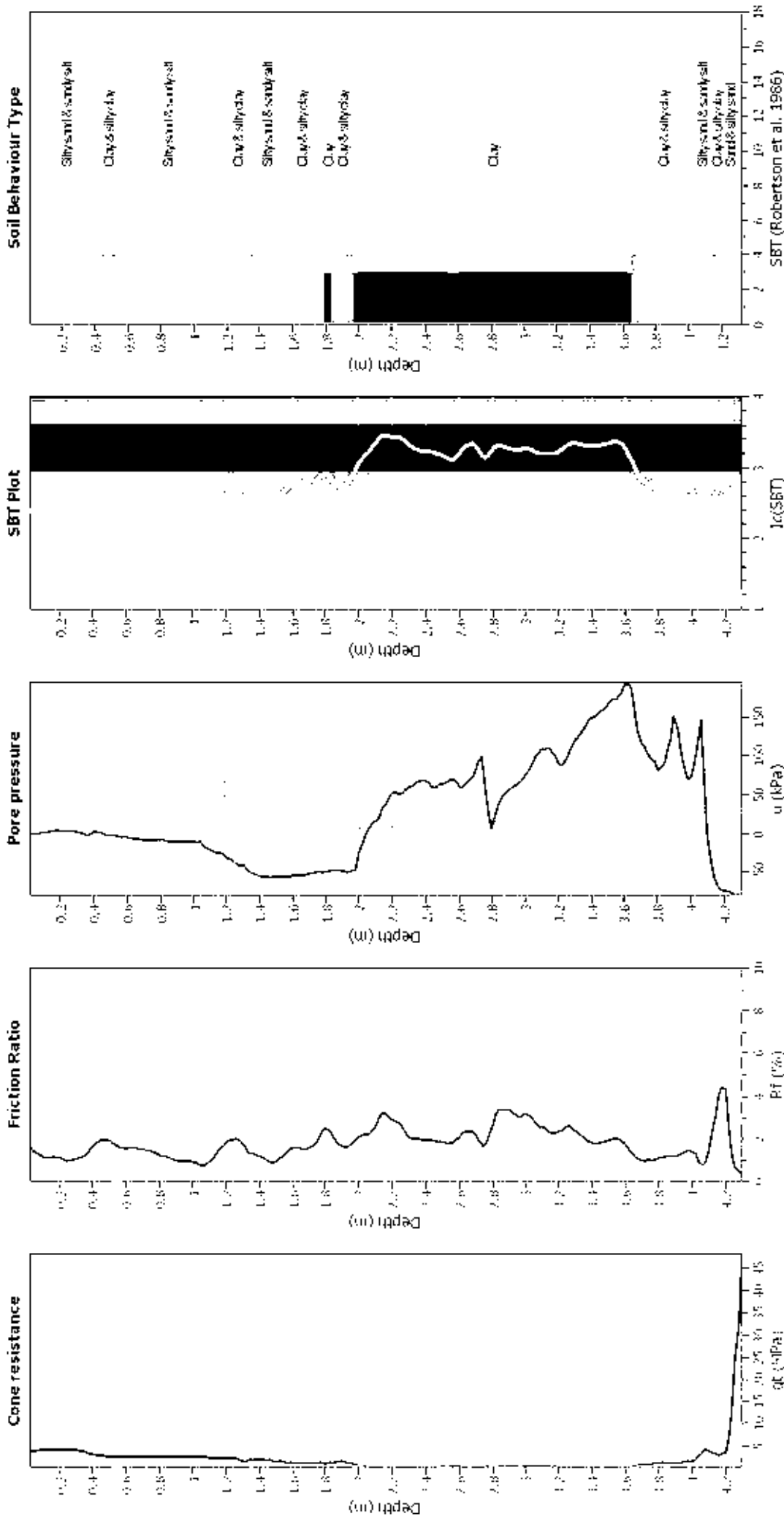


Figure 4: Summary of liquefaction potential assessment and classification of test results. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The plot is divided into regions A1, A2, B, and C, which correspond to different levels of liquefaction potential. The data points are clustered in the A1 and A2 regions, indicating a high potential for liquefaction. The plot also shows the relationship between normalized CPT penetration resistance and normalized friction ratio, which is a key parameter in the liquefaction assessment.

### CPT basic interpretation plots



#### Input parameters and analysis data

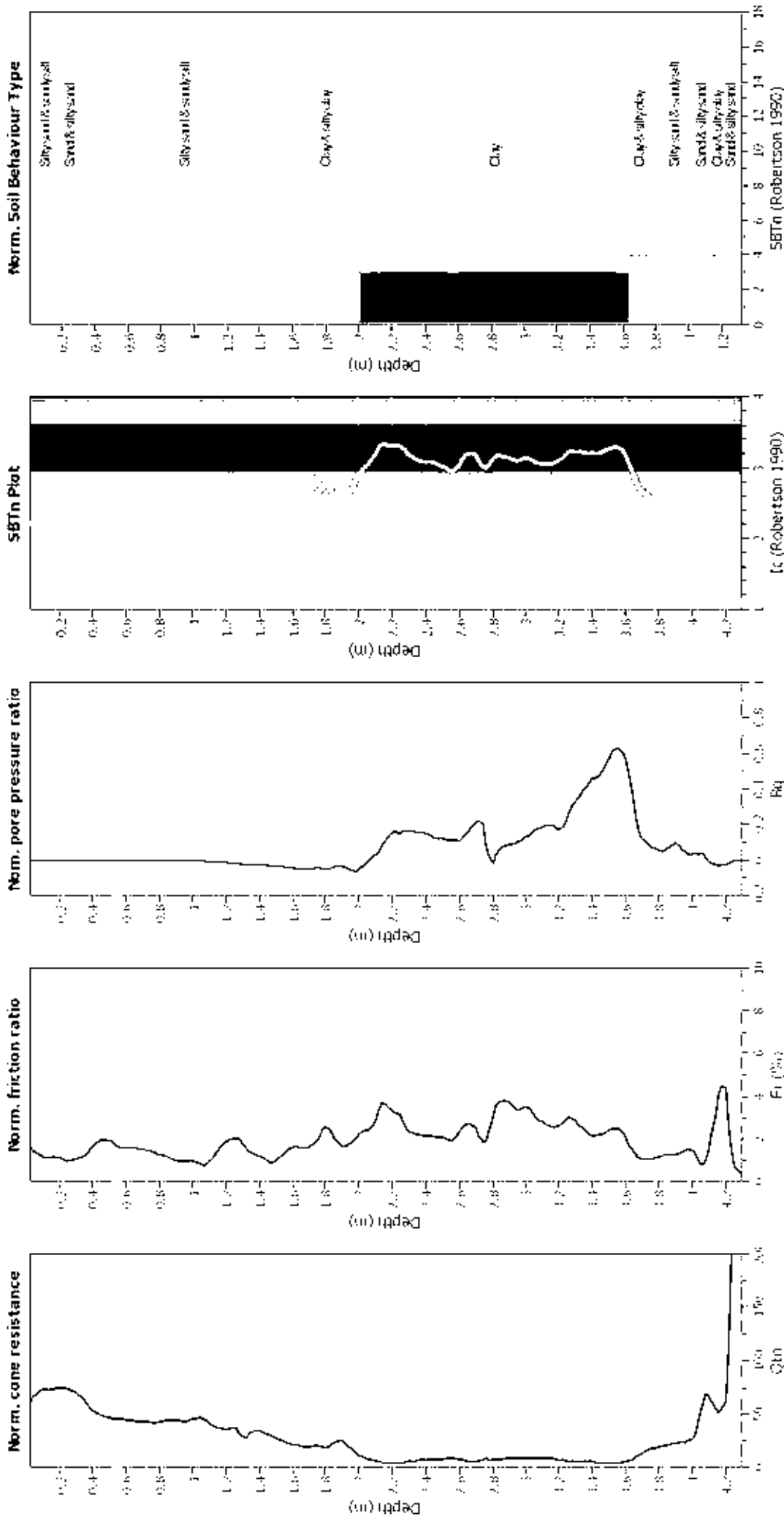
Analysis method:	188 (2008)	Depth to GW (erthq.):	1.25 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on $I_c$ value	Unit weight calculation:	Based on SBT	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Use fill:	No	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Fill height:	N/A	Unit depth applied:	N/A
Depth to water table (m):	1.25 m				

#### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### CPT basic interpretation plots (normalized)



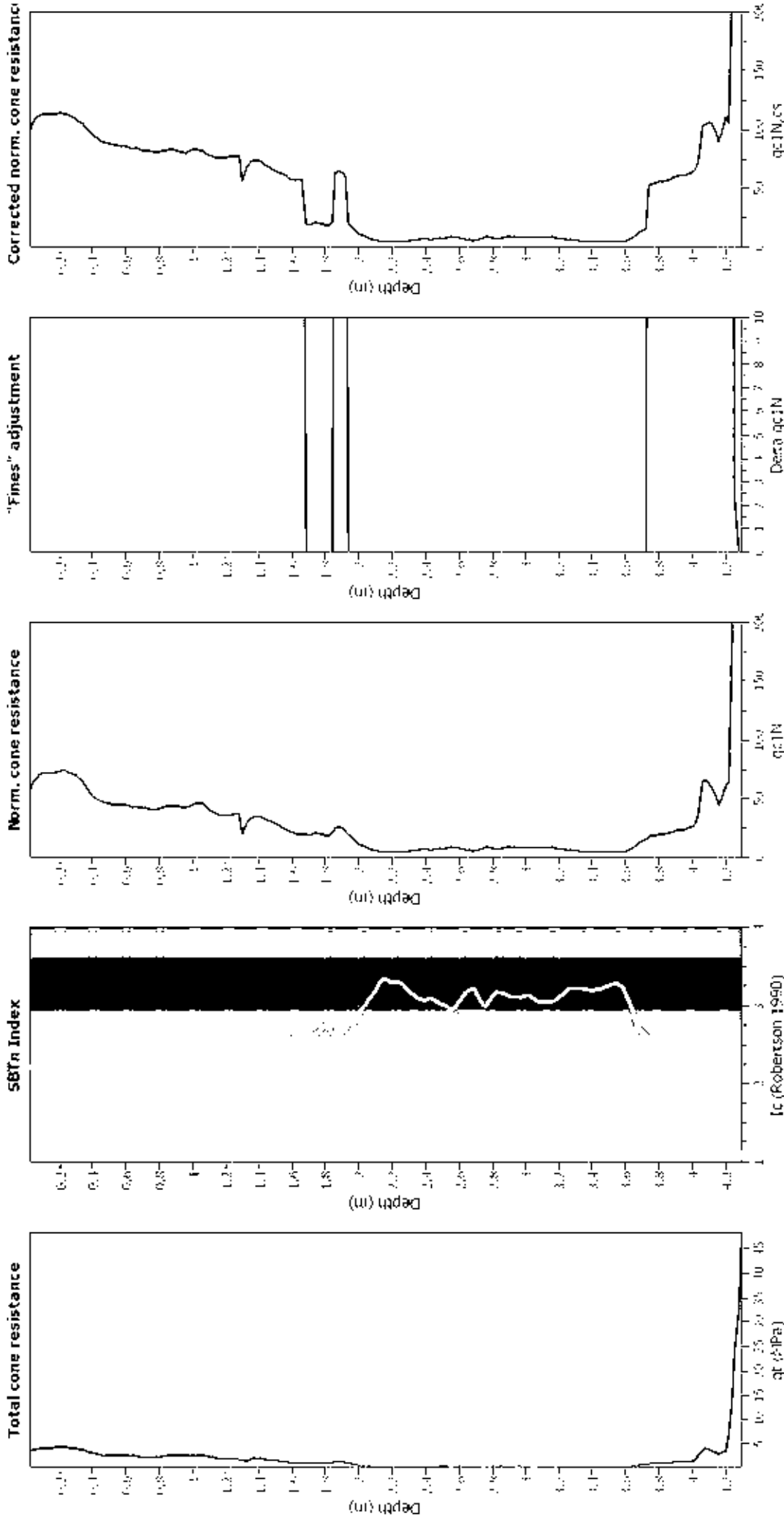
#### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.25 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.25 m	Fill height:	N/A	Unit depth:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

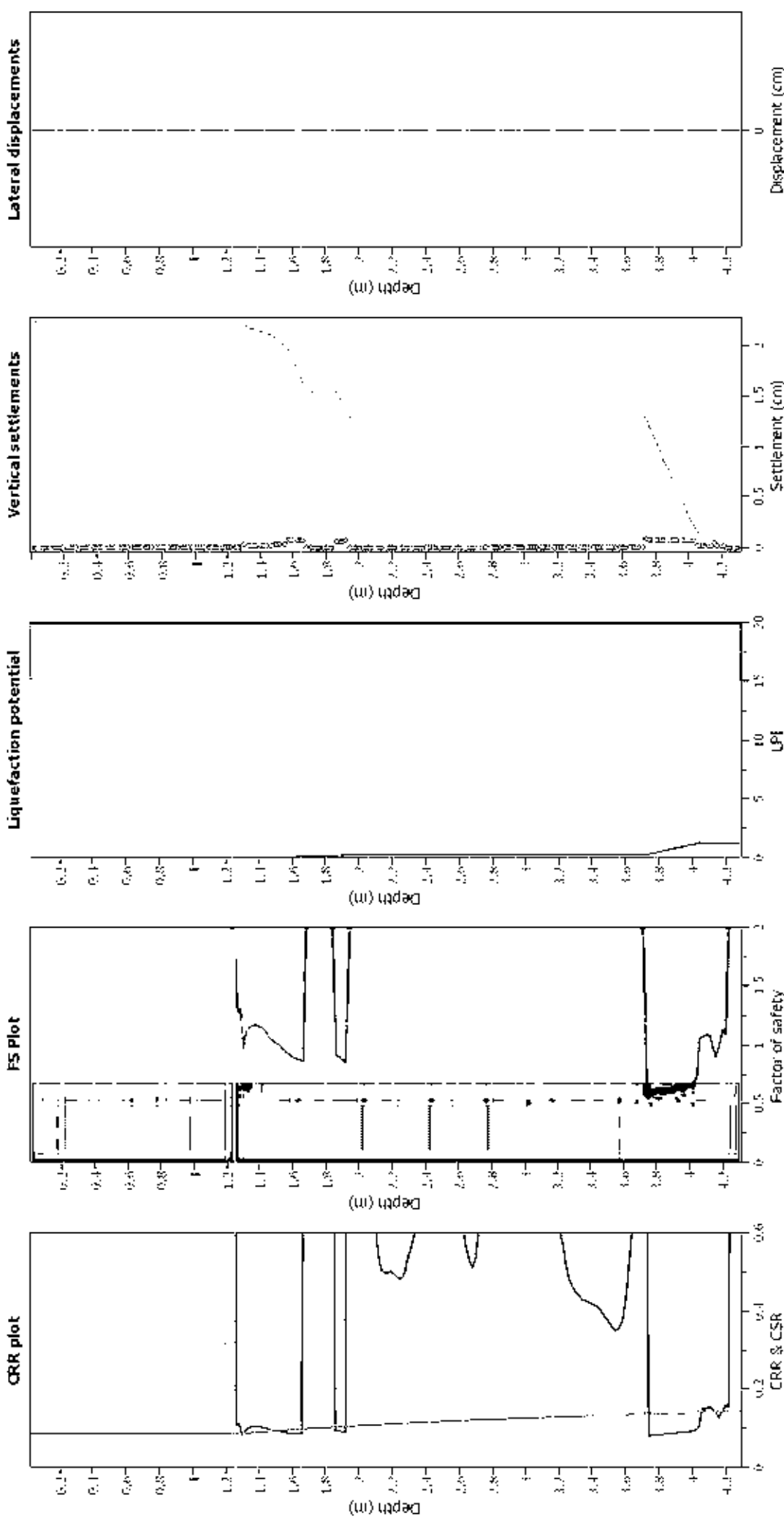
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GW (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: 18B (2008)  
 Liquefaction correction method: 18B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.25 m

Depth to GW (earthq.): 1.25 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

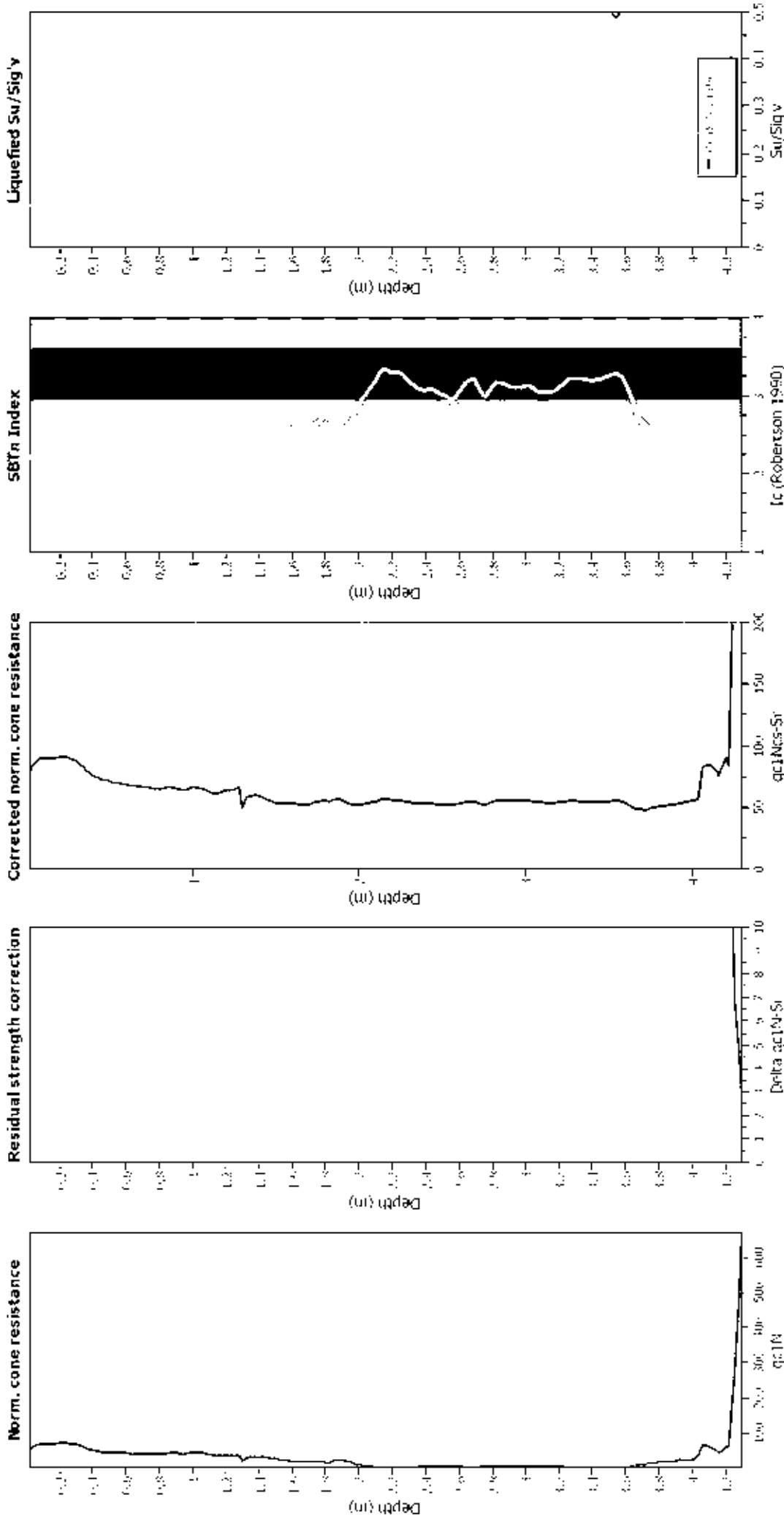
#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk

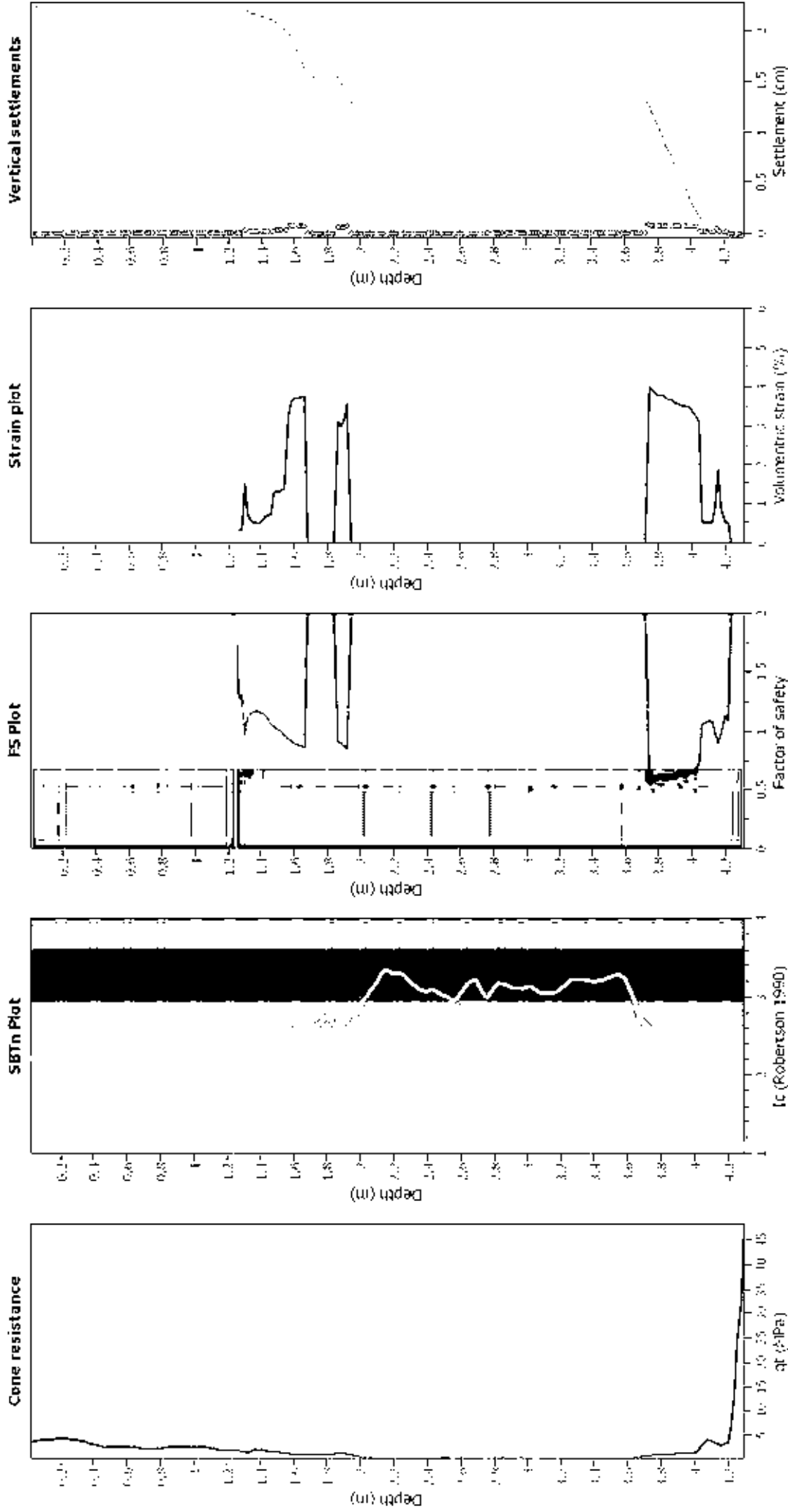
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GW (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



#### Abbreviations

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- S<sub>BTn</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

**Project title : CCC Halswell ODP Geotechnical Investigation      Location : Halswell, Christchurch**

**CPT file : CPT39\_32SutherlandsRd**

**Input parameters and analysis data**

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.25 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.25 m	Fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K <sub>v</sub> applied:	Yes		

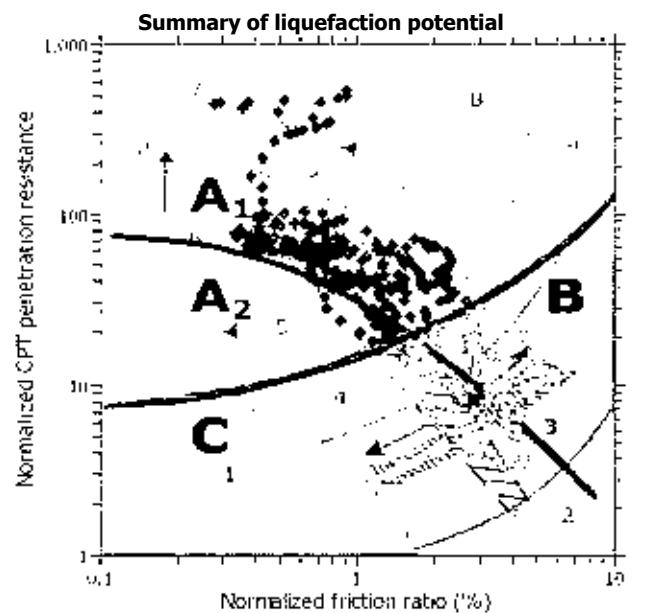
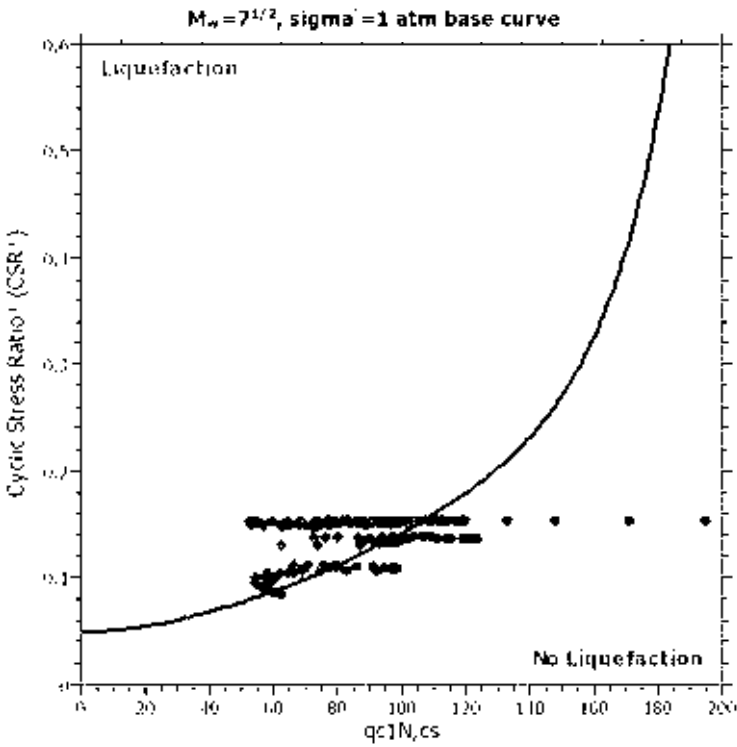
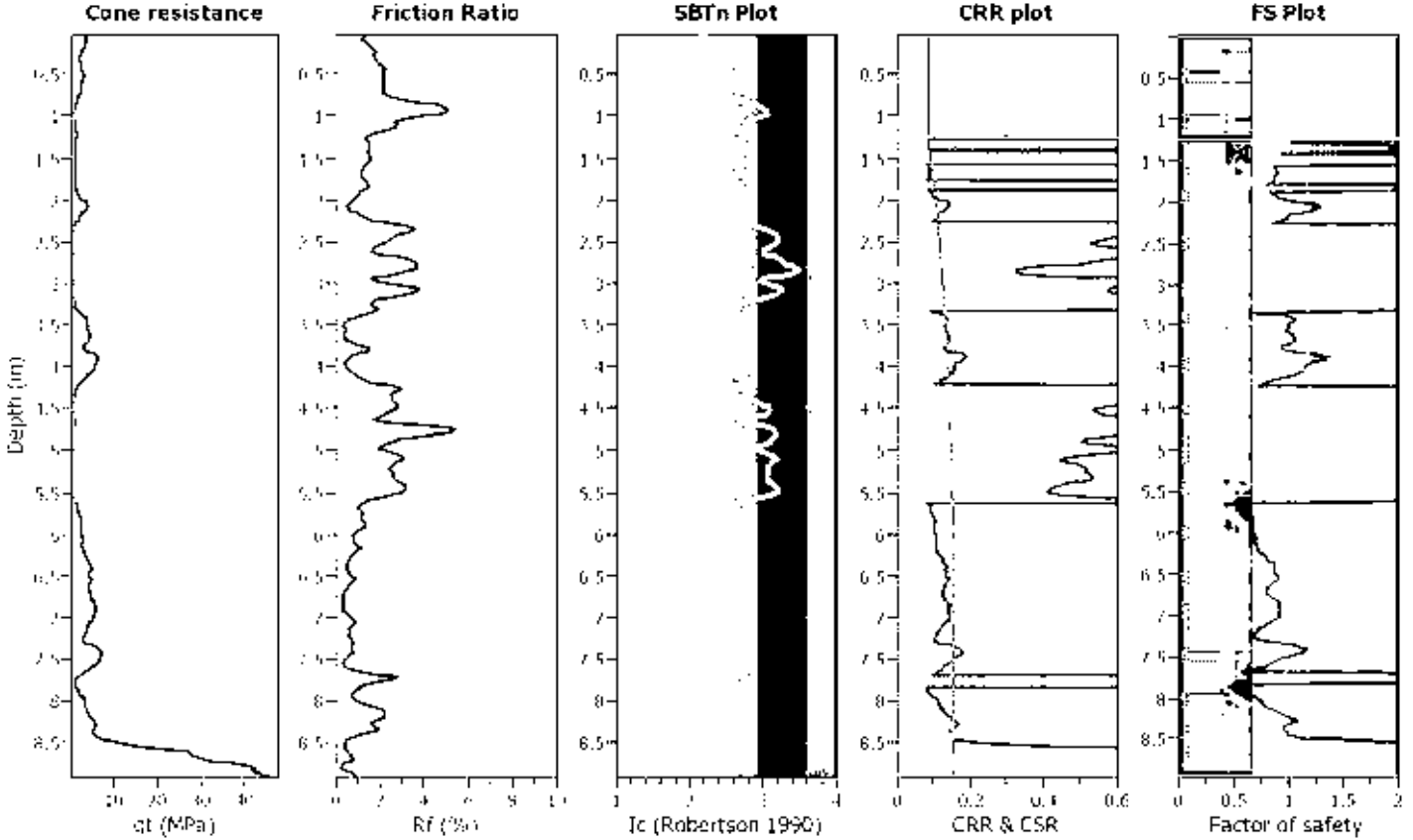
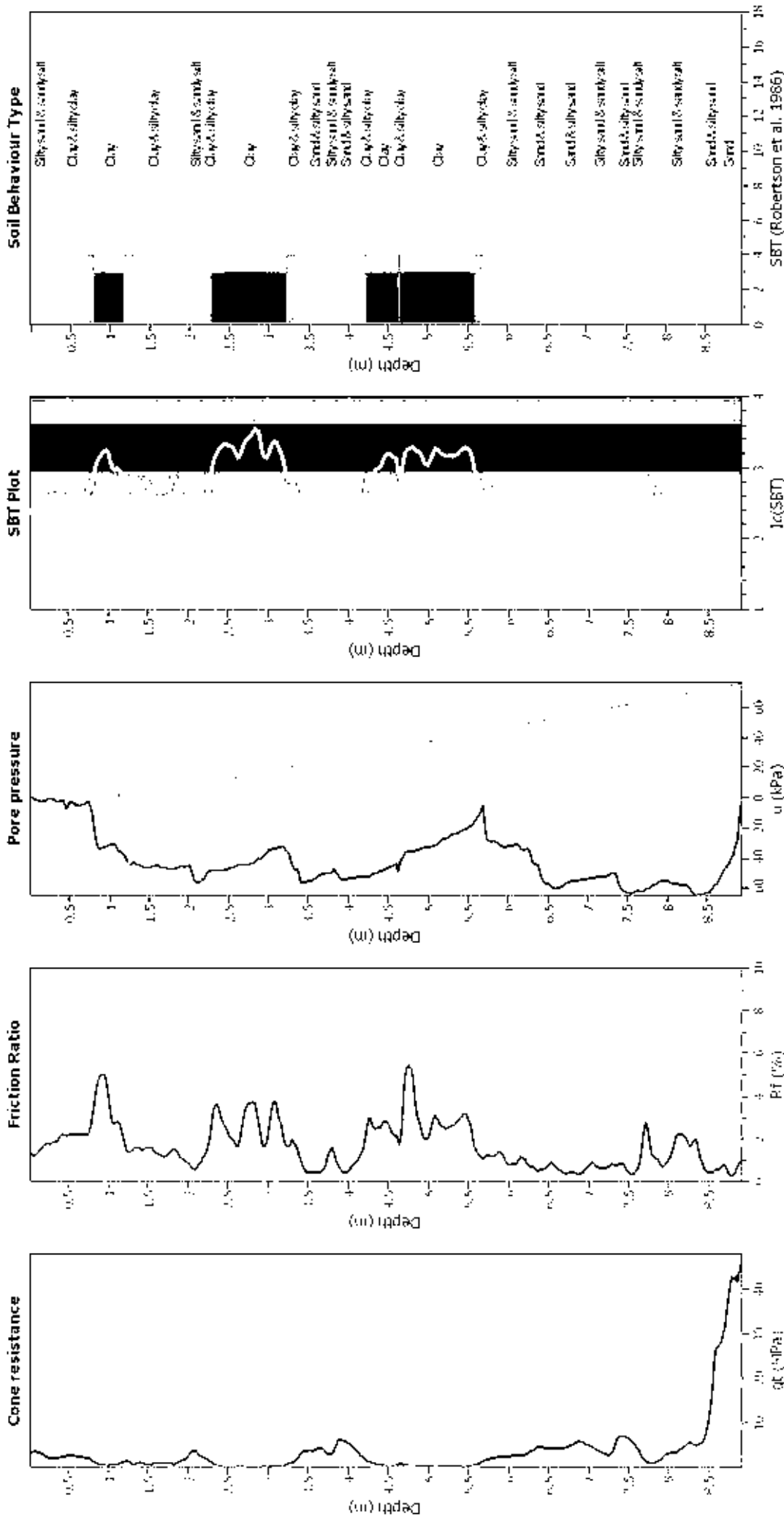


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The plot is divided into zones A1, A2, B, and C. A dashed line indicates the liquefaction threshold. The plot is titled 'Summary of liquefaction potential'.

### CPT basic interpretation plots



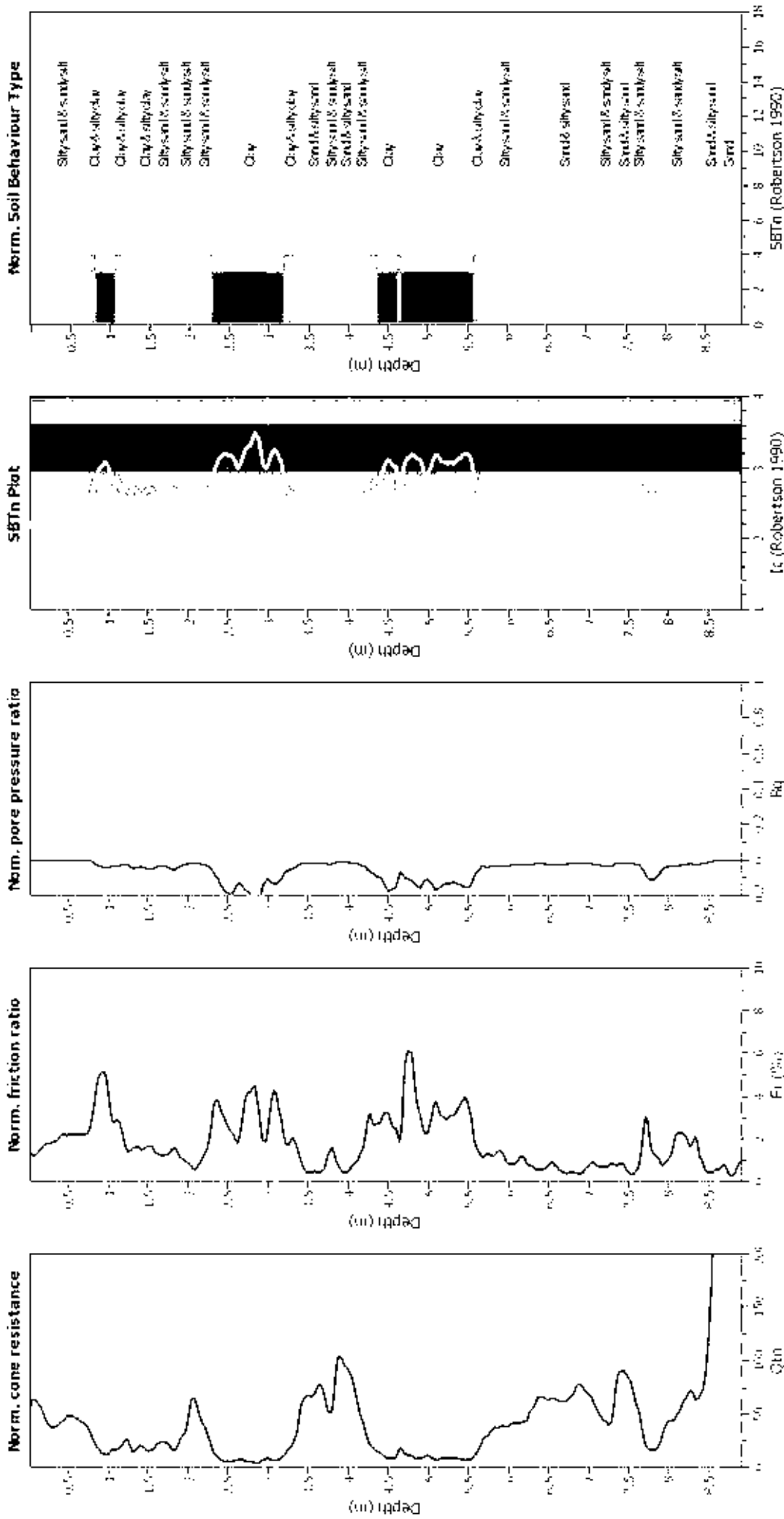
### Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	1.25 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.25 m	Fill height:	N/A	Unit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

### CPT basic interpretation plots (normalized)



#### Input parameters and analysis data

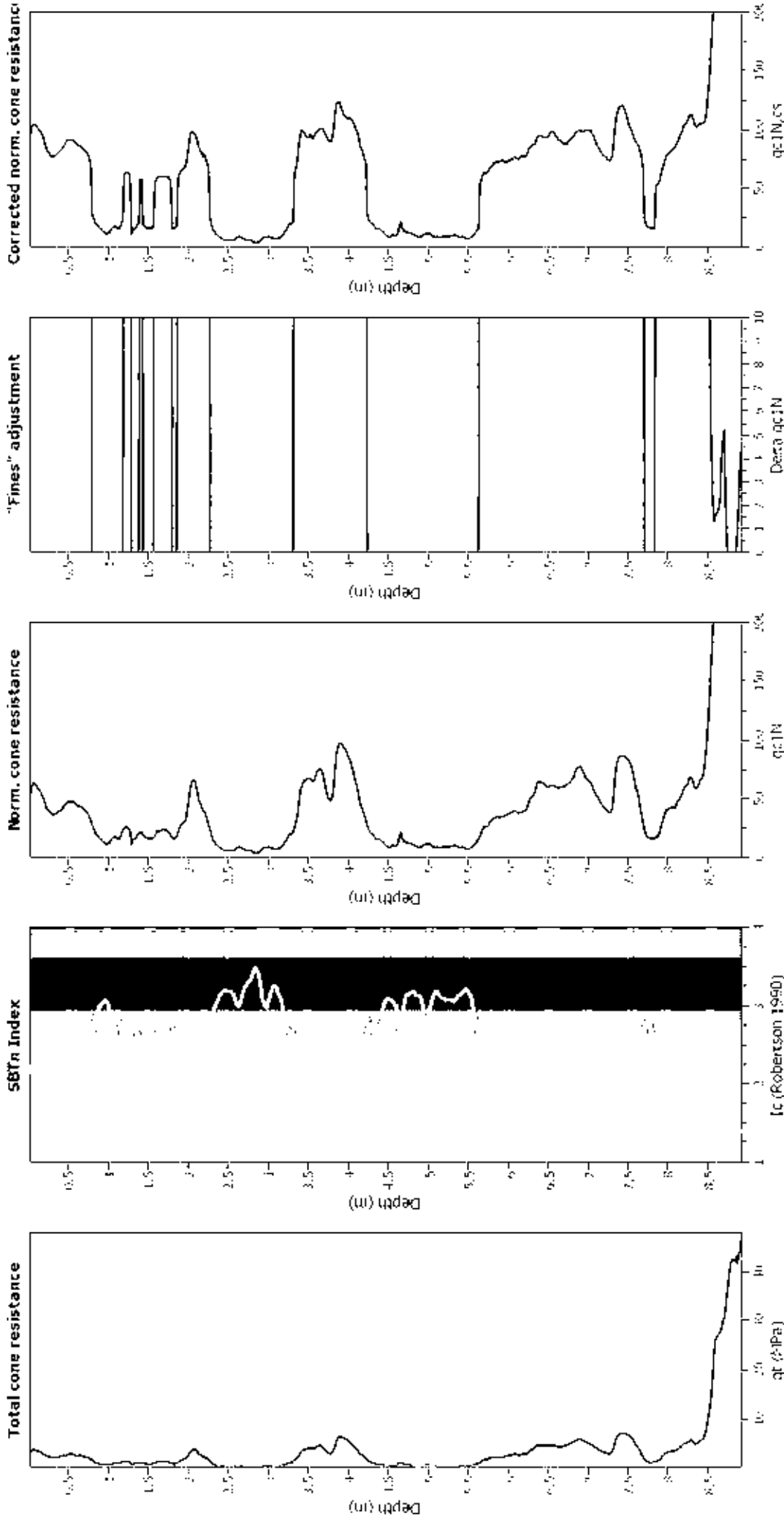
Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.25 m	Fill height:	N/A
Depth to GW (earthq.):	1.25 m	Unit weight calculation:	Based on SBT
Average results interval:	3	Use fill:	No
Ic cut-off value:	2.60	Fill height:	N/A

#### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



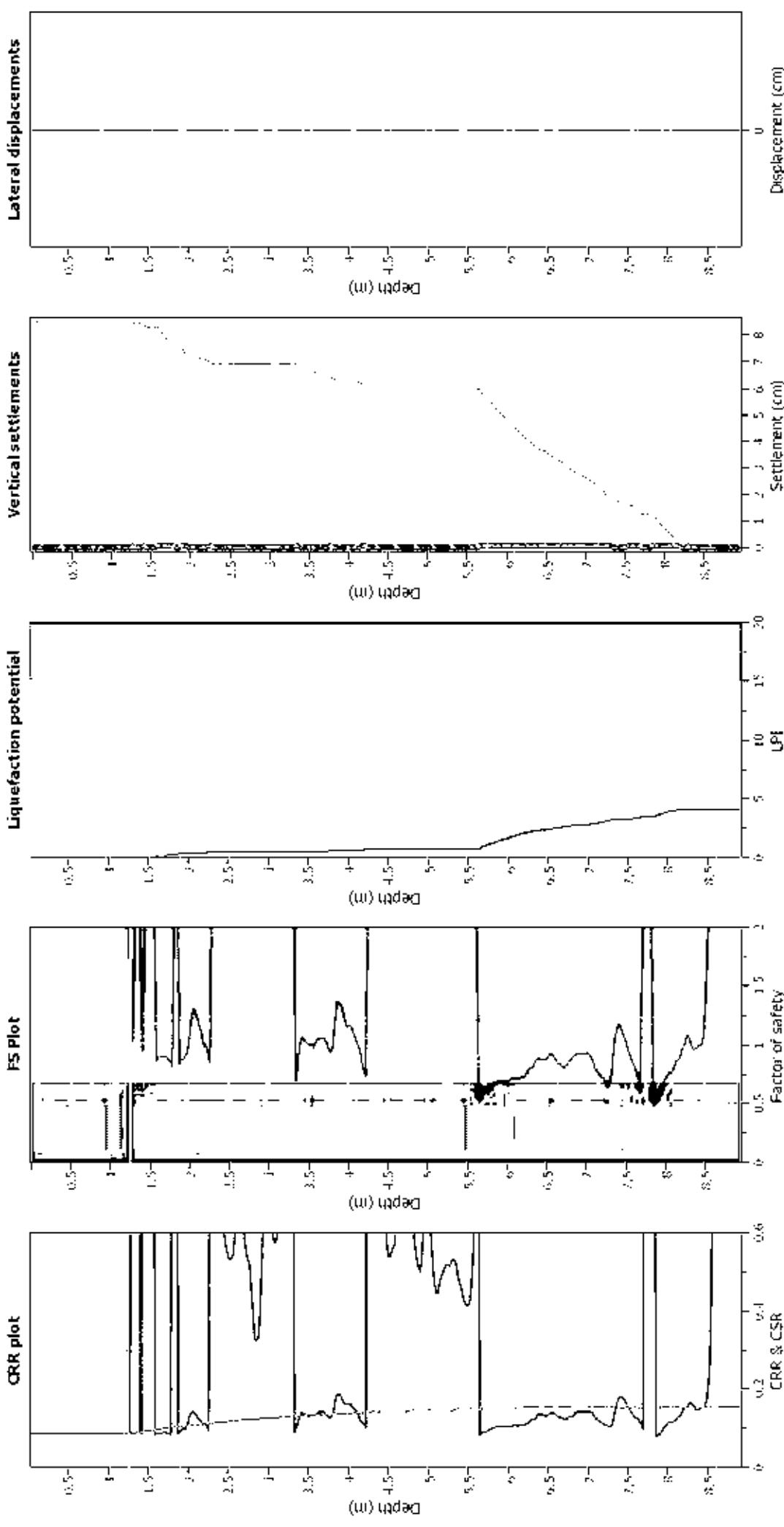
### Liquefaction analysis overall plots (intermediate results)



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Liquefaction analysis overall plots



#### Input parameters and analysis data

Analysis method: I8B (2008)  
 Lines correction method: I8B (2008)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 7.5  
 Peak ground acceleration: 0.13  
 Depth to water table (m): 1.25 m

Depth to GW (earthq.): 1.25 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition depth applied: Sand & Clay  
 K applied: Yes  
 Clay like behavior applied: No  
 Limit depth applied: N/A

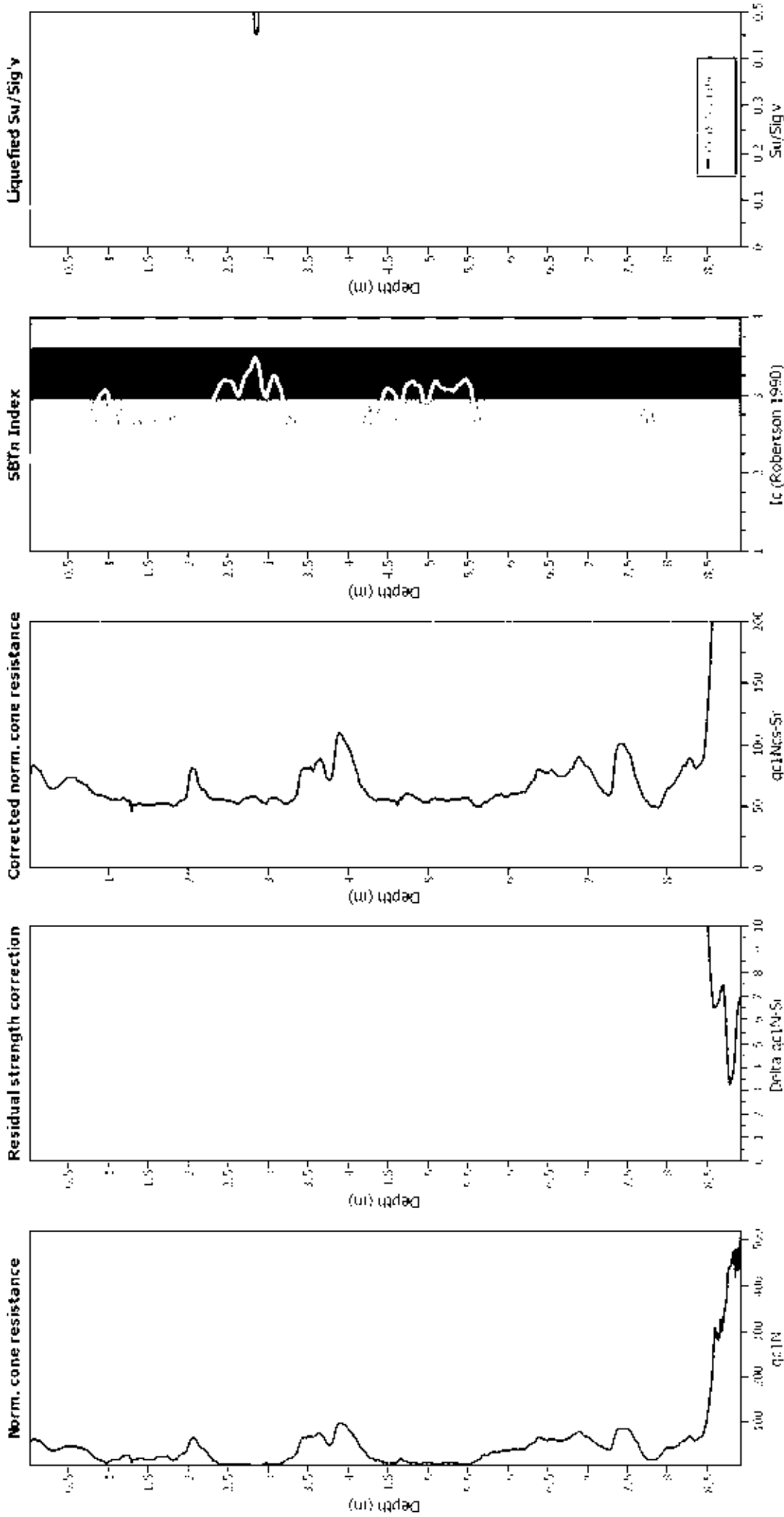
#### F.S. color scheme

Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liquefaction are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk

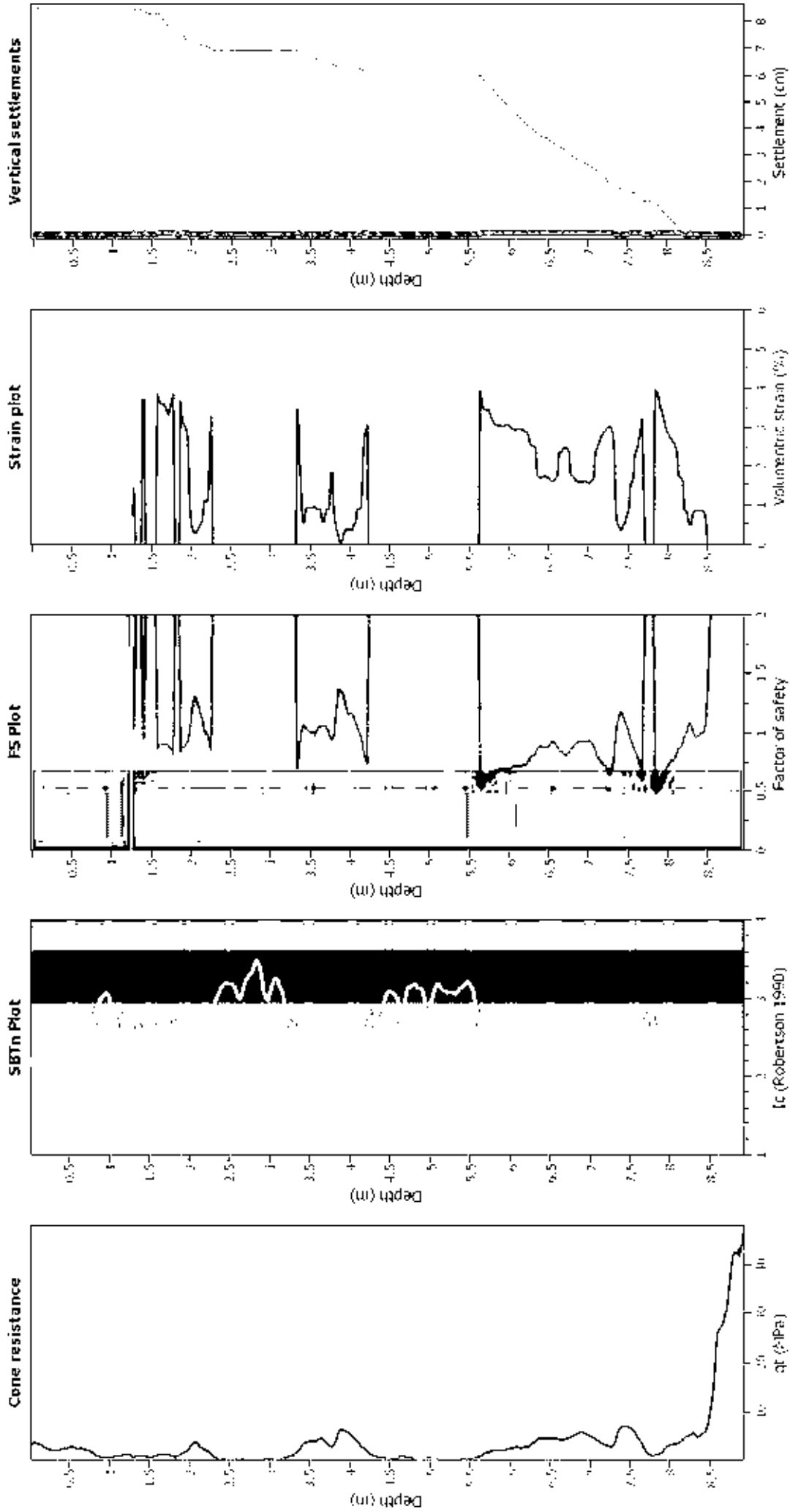
### Check for strength loss plots (Idriss & Boulanger (2008))



#### Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### Estimation of post-earthquake settlements



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