Comune

Comune di Ravarino
Provincia di Modena

Committente

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Amm: Via Albareto n.211 – 41122 Modena

Oggetto

Procedimento Unico ai sensi dell'Art. 53 L.R. 24/2017

Ampliamento stabilimento Fini Group Spa

Titolo Documento

Relazione geologica geotecnica e modellazione sismica

Numero Documento

GE 01

Progettista

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Via Adige 1, 22079 Villa Guardia (CO)
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Data | 04/03/2026	Rev | 00
Redatto | GV	Verifica | PD
Scala | -	Formato | A4

COMUNE DI RAVARINO
PROVINCIA DI MODENA

CRELAZIONE GEOLOGICA GEOTECNICA E SISMICA A SUPPORTO PERMESSO DI COSTRUIRE RELATIVO AD INTERVENTO DI NUOVA COSTRUZIONE DI FABBRICATO AD USO MAGAZZINO PER STOCCAGGIO MASSIVO, PROCEDIMENTO UNICO IN VARIANTE AI VIGENTI STRUMENTI URBANISTICI AI SENSI DELL'ART. 53 DELLA L.R.24/2017 SITO IN VIA MUZZA SUD, NEL COMUNE DI RAVARINO (MO).

RELAZIONE GEOLOGICA

Sulle indagini, caratterizzazione e modellazione geologica del sito
(NTC 2018; DGR RER 1373/2011);

RELAZIONE GEOTECNICA

Sulle indagini, caratterizzazione e modellazione del volume significativo di terreno
(NTC 2018; DGR RER 1373/2011);

RELAZIONE SULLA MODELLAZIONE SISMICA

Concernente la "pericolosità sismica di base" del sito di costruzione
(NTC 2018; DGR RER 1373/2011)

Dott. Geol [redacted]

[redacted]

CODICE	DATA
RIF.878/25	MARZO 2026

N. REV.	DATA	DESCRIZIONE	REDATTO	CONTROLLATO	APPROVATO
1	*11/03/2026*	*RELAZIONE GEOLOGICA GEOTECNICA E SISMICA*			

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AZIENDA CON SISTEMA DI GESTIONE QUALITÀ CERTIFICATO DA DNV

GEO GROUP
GEOLOGIA E AMBIENTE

COMUNE DI RAVARINO
Provincia di Modena

CONTENUTI

RELAZIONE GEOLOGICA

Sulle indagini, caratterizzazione e modellazione geologica del sito
(NTC 2018; DGR RER 1373/2011);

RELAZIONE GEOTECNICA

Sulle indagini, caratterizzazione e modellazione del volume significativo di terreno
(NTC 2018; DGR RER 1373/2011);

RELAZIONE SULLA MODELLAZIONE SISMICA

Concernente la "pericolosità sismica di base" del sito di costruzione
(NTC 2018; DGR RER 1373/2011)

OGGETTO

RELAZIONE GEOLOGICA GEOTECNICA E SISMICA A SUPPORTO PERMESSO DI COSTRUIRE RELATIVO AD INTERVENTO DI NUOVA COSTRUZIONE DI FABBRICATO AD USO MAGAZZINO PER STOCCAGGIO MASSIVO, PROCEDIMENTO UNICO IN VARIANTE AI VIGENTI STRUMENTI URBANISTICI AI SENSI DELL'ART. 53 DELLA L.R.24/2017 SITO IN VIA MUZZA SUD, NEL COMUNE DI RAVARINO (MO).

REV.1

Rif. n. 878/2025

GEO GROUP
GEOLOGIA E AMBIENTE

CERTIFICAZIONE SISTEMA DI GESTIONE
DNV
ISO 9001
ISO 14001

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TAVOLE

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Tav. n. 2: "Ripresa Satellitare" scala 1: 5.000;
Tav. n. 3: "Ubicazione indagini" scala 1: 1.000

ALLEGATI

ALL. n. 1 Prove penetrometriche statiche CPTU;
ALL. n. 2 Indagini sismiche;
ALL. n. 3 Verifica alla liquefazione.

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1 PREMESSE

Nel mese di Novembre 2025 è stato eseguito il presente studio geologico, geotecnico e sismico a supporto del progetto di nuova costruzione di un fabbricato ad uso magazzino per stoccaggio massivo (art. 53 L.R 24/17) posto in Via Muzza Sud nel Comune di Ravarino (MO).

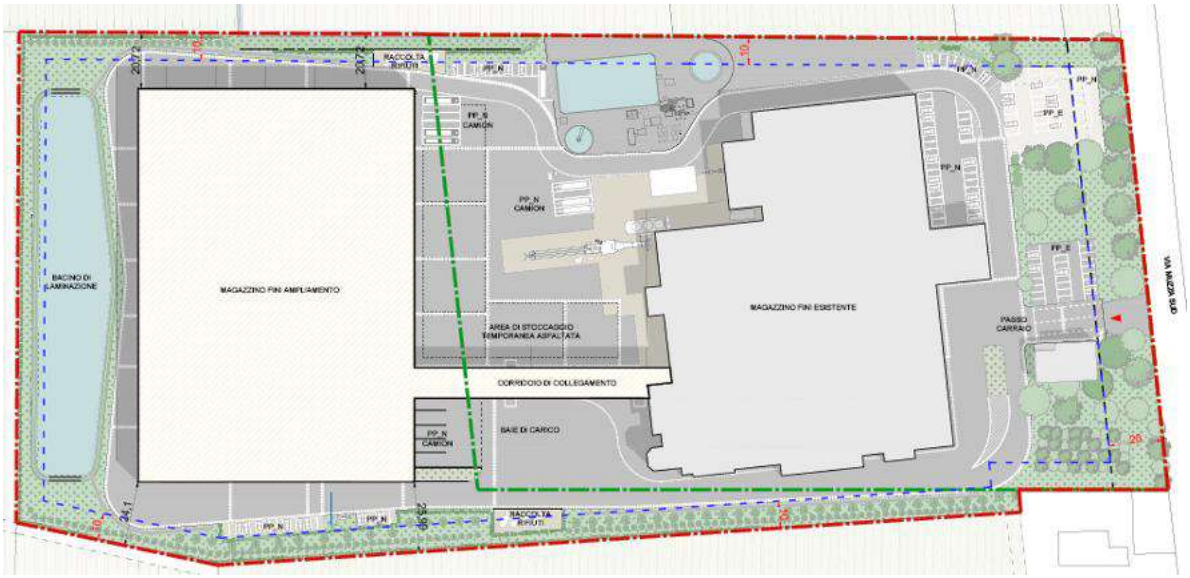

Fig.1.1 – Intervento in progetto

L'elaborato contiene la modellazione geologica, geotecnica e sismica derivante dalla sintesi dei risultati delle analisi e delle indagini eseguite nell'area di interesse a supporto della progettazione ingegneristica delle opere in progetto, in conformità alla normativa nazionale NTC 2018 e relative normative regionali DGR 630/19 e DGR 476/21.

In particolare, il progetto si muove nell'ambito dell'Art. 53 della Legge 24/2017, (procedimento unico), si è pertanto suddivisa la relazione in due parti.
Nella prima parte viene eseguito uno studio di microzonazione sismica secondo la DGR 630/2019 e successiva DGR 476/2021 e nella seconda parte, a supporto del progetto esecutivo, la caratterizzazione sismica del sito avviene secondo le NTC18.

1.1 Riferimenti normativi

Il presente studio è stato condotto secondo la seguente Normativa Tecnica e documentazione di riferimento:

- **OPCM 3274/2003 -** Primi elementi in materia di criteri generali per la classificazione sismica del territorio nazionale e normative tecniche per le costruzioni in zona sismica;
- **D.M. 17.01.2018** - Norme Tecniche per le Costruzioni 2018;
- **Circolare 21 gennaio 2019 n. 7/C.S.LL.PP. -** Circolare esplicativa delle NTC 2018;

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- **D.G.R. 476/2021**– Aggiornamento dell'"Atto di coordinamento tecnico sugli studi di microzonazione sismica per la pianificazione territoriale e urbanistica (artt. 22 e 49, L.R. n. 24/2017)" di cui alla deliberazione della Giunta regionale 29 aprile 2019 n. 630.

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2 INQUADRAMENTO GENERALE

2.1 Inquadramento geografico

L'area in esame è collocata in ambiente di pianura, a Nord del Comune di Ravarino (Fig.2.1). Le coordinate specifiche dell'area sono le seguenti:

SITO IN ESAME	
COORDINATE GEOGRAFICHE ED50	
LATITUDINE	LONGITUDINE
44.521066	**11.177374**

Tali coordinate sono state stimate grossomodo al centro del sedime di intervento, e successivamente utilizzate per il calcolo dei parametri dell'azione sismica di base in relazione al reticolo sismico da INGV.

Fig.2.1 – Ubicazione geografica del sito in studio.

Per un completo inquadramento geografico dell'area si rimanda alla cartografia allegata alla presente relazione, in particolare alla "Carta topografica" alla scala 1: 5.000 (tav. n. 1) e alla "Ripresa satellitare" alla scala 1: 5.000 (tav. n. 2).

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2.2 Elementi geologici e geomorfologici

Dalla consultazione della carta delle coperture, si evidenzia come l'area in studio sia caratterizzata da **argilla**, tipico di un ambiente alluvionale di piana inondabile.

In particolare l'area in studio è caratterizzata da: **Unità di Modena AES8a**, caratterizzata da depositi ghiaiosi passanti a sabbie e limi di terrazzo alluvionale. Limi prevalenti nelle fasce pedecollinari di interconoide. Unità definita dalla presenza di un suolo a bassissimo grado di alterazione, con profilo potente meno di 100 cm, calcareo, grigio-giallastro o bruno grigiastro. Nella pianura ricopre resti archeologici di età romana del VI secolo d.C.. Potenza massima di alcuni metri (< 10 m) (Fig. 2.2).

Fig.2.2 – Estratto della carta di litologia di superficie.

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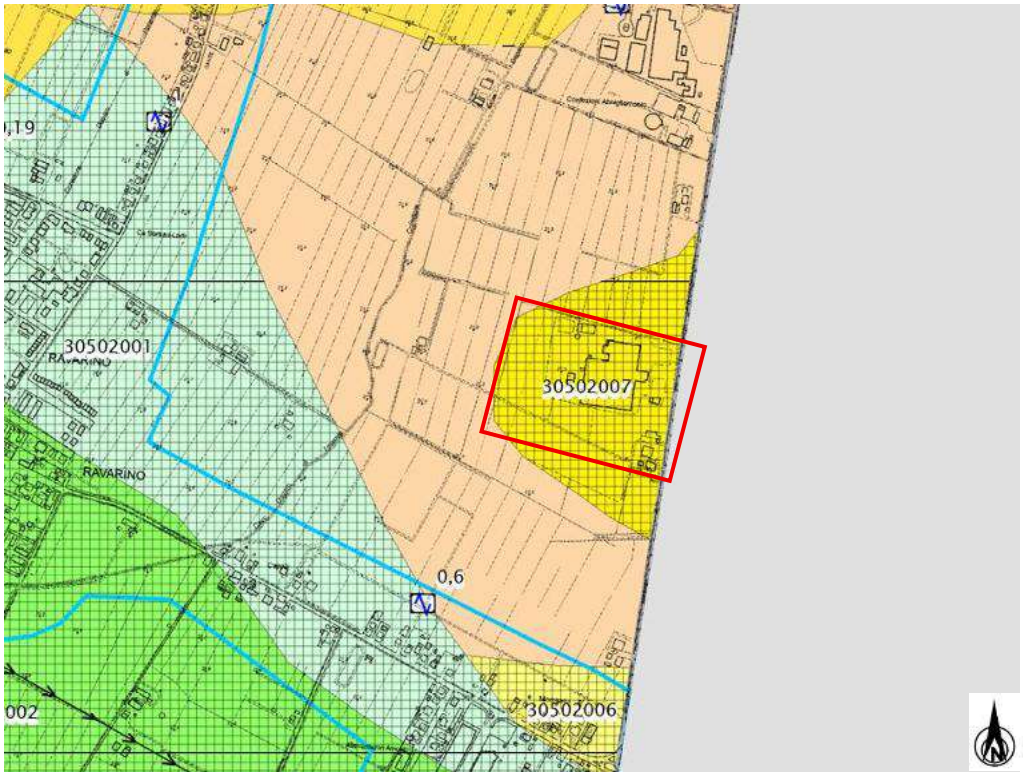
2.3 Inquadramento sismico

A supporto dell'analisi sismica e della valutazione della stabilità del sito, successivamente descritta nei paragrafi seguenti, per quel che concerne i fenomeni co-sismici è stata preliminarmente consultata la cartografia relativa allo studio di Microzonazione Sismica del Comune di Ravarino (MO), ed in particolare dalla "***Carta di microzonazione mops***", un cui estratto è riportato in figura (Fig. 2.3), si nota come l'area in studio ricada in zona di attenzione per instabilità.



Zone di attenzione per instabilità

30502001 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 1
Successione stratigrafica con sabbie limose, miscela di sabbia e limo in superficie, con prevalente argilla sottostante entro i primi 20 metri dal piano campagna

30502002 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 2
Successione stratigrafica con sabbie limose, miscela di sabbia e limo in superficie, con lenti di sabbia sottostante con spessore cumulativo > 0,5 m entro i primi 20 metri dal piano campagna

30502003 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 3
Successione stratigrafica con miscele di sabbie ed argille organiche di media-alta plasticità e limi organici in superficie, con prevalente argilla sottostante entro i primi 20 metri dal piano campagna

30502004 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 4
Successione stratigrafica con argille organiche di media-alta plasticità e limi organici in superficie, con lenti di sabbia sottostante con spessore cumulativo > 0,5 m entro i primi 20 metri dal piano campagna

30502005 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 5
Successione stratigrafica con miscele di sabbie e limi organici e argille limose organiche di bassa plasticità in superficie, con prevalente argilla sottostante entro i primi 20 metri dal piano campagna

30502006 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 6
Successione stratigrafica con limi organici e argille limose organiche di bassa plasticità in superficie, con prevalente argilla sottostante entro i primi 20 metri dal piano campagna e lenti di sabbia con spessore cumulativo minore di 0,5 m dal piano campagna

30502007 – ZA_{LQ} – Zona di Attenzione per liquefazione – Zona 7
Successione stratigrafica con limi organici e argille limose organiche di bassa plasticità in superficie, con lenti di sabbia sottostante con spessore cumulativo > 0,5 m entro i primi 20 metri dal piano campagna

Fig.2.3 – Estratto della "Carta delle microzonazione sismica mops" – Microzonazione Sismica del Comune di Ravarino (MO).

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3 INDAGINI GEOGNOSTICHE

3.1 Indagini Geotecniche

In relazione alla litologia presente nell'area e in base alla tipologia di intervento in progetto, sono state eseguite le seguenti indagini geognostiche, in particolare:

- ***n. 12 prove penetrometriche statiche con punta elettrica CPTu.***

I risultati delle suddette indagini sono riportati nell'**allegato n. 1**.

3.1.1 Prove penetrometriche statiche CPTU

La prova penetrometrica statica con punta elettrica (CPTE/U), consiste essenzialmente nella misura della resistenza alla penetrazione di una punta conica standard, connessa all'estremità inferiore di una batteria di aste cave, che viene infissa a pressione e velocità costante nel terreno tramite un dispositivo di spinta idraulico che agisce alla sommità delle aste. La punta elettrica è strumentata con sensori elettrici e un sistema di trasmissione dei dati in superficie via cavo, che permette l'acquisizione e la registrazione dei dati quasi in continuo, ogni centimetro. I dati misurati durante la prova sono la resistenza totale alla penetrazione Qt, la resistenza alla penetrazione della punta Qc e la resistenza laterale del manicotto Fs; è possibile inoltre monitorare, durante l'esecuzione della prova, alcuni parametri di controllo quali l'inclinazione rispetto alla verticalità e la velocità di penetrazione del cono. Una punta elettrica particolare, detta "piezocono", è dotata anche di un dispositivo di misura della pressione, attraverso il quale viene misurata la pressione dell'acqua nei pori del terreno u (CPTU). La pressione che viene misurata è la pressione $u = u_0 + \Delta u$, dove u_0 è la pressione dovuta al livello idrostatico e Δu quella generata dallo sforzo alla penetrazione nel terreno.
Il piezocono da Noi utilizzato è un Pagani, con sistema di acquisizione TGAS07 ed è dotato di un dispositivo di misura della pressione costituito da un cilindro metallico saturato con grasso, situato poco al di sopra della punta conica. I dati acquisiti sono stati elaborati con software CPeT – IT v. 1.7.4.13 prodotto da GeoLogisMiki – Geotechnical Software.

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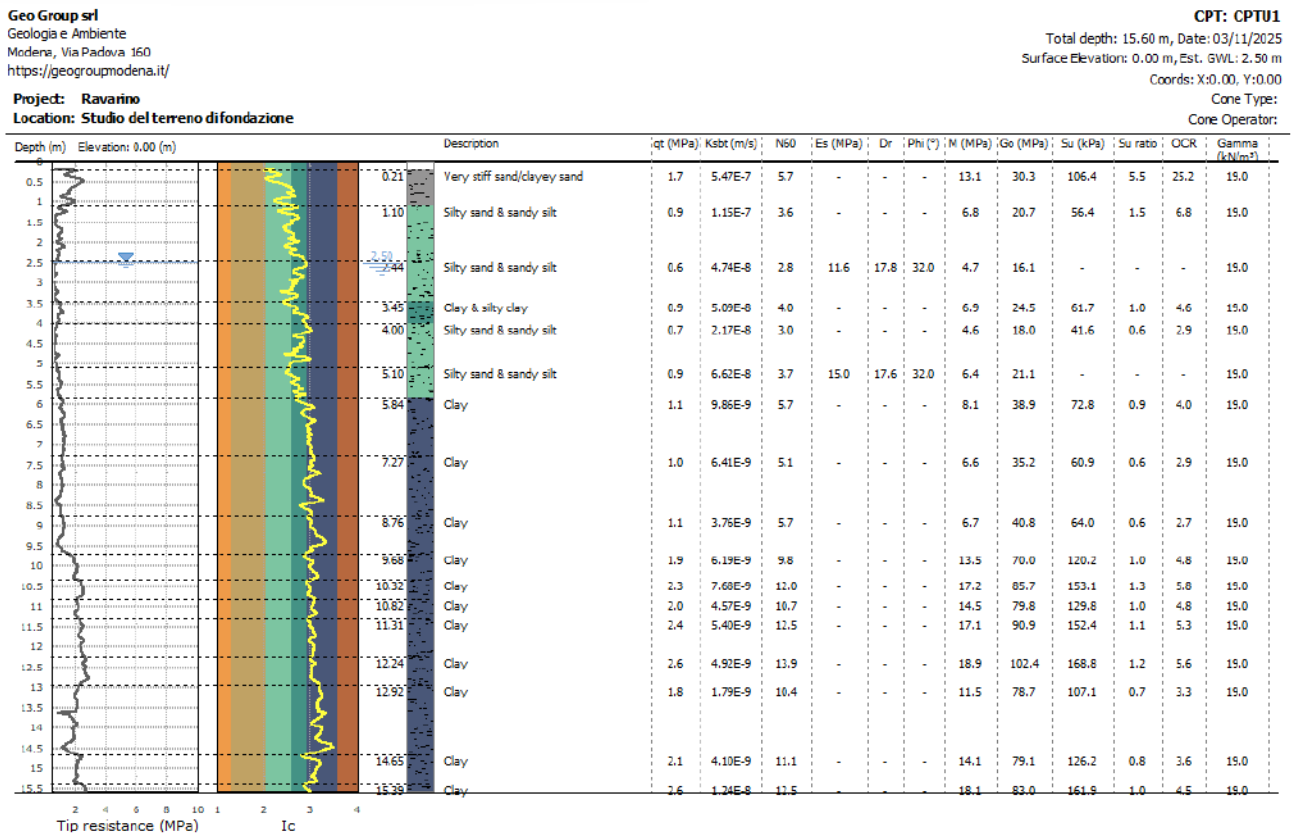
Di seguito si riporta la sezione stratigrafica delle prove penetrometriche CPTu.

INDAGINE	*LATITUDINE*	*LONGITUDINE*
CPTU1	4954554.5	667549.8
CPTU2	4954539.3	667509.5
CPTU3	4954556.1	667448.4
CPTU4	4954575.7	667536.8
CPTU5	4954585.0	667496.8
CPTU6	4954612.4	667542.2
CPTU7	4954617.3	667502.6
CPTU8	4954630.1	667463.2
CPTU9	4954653.8	667511.8
CPTU10	4954664.5	667471.2
CPTU11	4954694.2	667477.5
CPTU12	4954680.4	667552.4



Stratigrafica CPTU1

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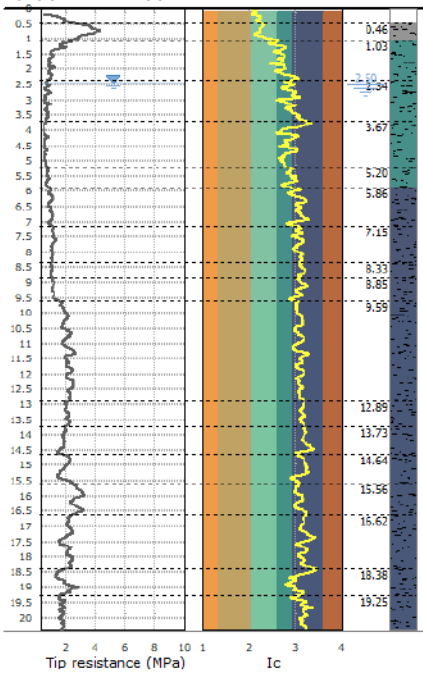
Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



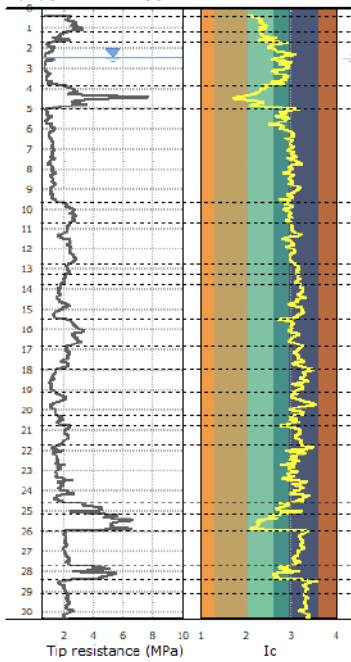
Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff sand/clayey sand	3.3	1.78E-6	10.2	34.8	58.1	41.0	26.4	49.2	-	-	-	19.0
Clay & silty clay	1.1	8.79E-8	4.5	-	-	-	8.5	27.4	72.3	2.0	9.1	19.0
Clay & silty clay	0.7	1.38E-8	3.2	-	-	-	4.9	22.1	44.0	0.8	3.8	19.0
Clay & silty clay	0.5	1.44E-8	2.6	-	-	-	3.1	16.3	32.5	0.5	2.3	19.0
Clay & silty clay	0.7	1.56E-8	3.4	-	-	-	4.8	21.8	44.3	0.6	2.7	19.0
Clay	0.9	5.32E-9	4.9	-	-	-	6.5	34.8	58.2	0.7	3.2	19.0
Clay	1.1	4.85E-9	5.9	-	-	-	7.5	40.8	67.1	0.7	3.2	19.0
Clay	1.0	2.51E-9	5.6	-	-	-	6.3	39.7	58.0	0.6	2.6	19.0
Clay	1.1	3.51E-9	6.1	-	-	-	7.6	44.3	68.7	0.6	2.9	19.0
Clay	2.1	4.02E-9	11.2	-	-	-	14.9	83.5	132.8	1.0	4.8	19.0
Clay	2.1	2.49E-9	11.6	-	-	-	14.5	88.9	129.6	0.9	4.1	19.0
Clay	1.8	1.56E-9	10.8	-	-	-	12.2	82.2	109.2	0.7	3.3	19.0
Clay	1.9	2.55E-9	10.8	-	-	-	12.6	78.5	114.9	0.7	3.3	19.0
Clay	2.7	4.70E-9	14.6	-	-	-	19.4	106.1	173.5	1.0	4.6	19.0
Clay	2.1	1.98E-9	12.2	-	-	-	14.0	91.4	127.1	0.7	3.2	19.0
Clay	1.8	3.81E-9	10.1	-	-	-	10.1	67.7	104.6	0.5	2.4	19.0
Clay	1.7	2.41E-9	9.8	-	-	-	8.7	66.3	95.9	0.5	2.1	19.0

Stratigrafica CPTU2

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff sand/clayey sand	2.6	8.18E-7	8.5	30.9	54.6	41.1	20.4	43.8	-	-	-	19.0
Silty sand & sandy silt	1.7	4.42E-7	6.1	26.1	38.2	37.4	13.8	33.1	-	-	-	19.0
Clay & silty clay	0.8	3.82E-8	3.6	-	-	-	6.1	22.9	53.7	1.1	4.9	19.0
Silty sand & sandy silt	2.8	1.54E-6	8.8	32.9	33.2	34.2	21.6	41.5	-	-	-	19.0
Clay	1.1	9.32E-9	5.3	-	-	-	7.3	35.2	65.1	0.7	3.3	19.0
Clay	2.4	1.12E-8	12.0	-	-	-	17.9	83.6	159.8	1.4	6.3	19.0
Clay	2.2	6.48E-9	11.5	-	-	-	16.0	82.6	143.2	1.1	5.0	19.0
Clay	2.2	2.96E-9	12.1	-	-	-	15.5	91.7	138.0	1.0	4.4	19.0
Clay	2.0	2.67E-9	11.1	-	-	-	13.7	83.0	122.5	0.8	3.8	19.0
Clay	1.6	2.24E-9	9.7	-	-	-	9.9	66.2	94.7	0.6	2.8	19.0
Clay	2.7	6.32E-9	14.2	-	-	-	19.5	100.8	173.9	1.0	4.7	19.0
Clay	2.1	2.21E-9	11.9	-	-	-	14.0	88.1	125.3	0.7	3.1	19.0
Clay	1.1	1.36E-9	6.9	-	-	-	7.2	43.8	56.1	0.3	1.3	19.0
Clay	1.4	2.25E-9	8.1	-	-	-	5.1	52.1	73.0	0.4	1.6	19.0
Clay	1.6	6.00E-9	8.5	-	-	-	7.1	51.5	87.9	0.4	1.9	19.0
Clay	2.1	3.06E-9	11.4	-	-	-	12.2	77.9	117.9	0.5	2.5	19.0
Clay	1.6	3.38E-9	8.7	-	-	-	5.5	53.3	81.6	0.3	1.6	19.0
Clay & silty clay	3.6	2.01E-8	16.9	-	-	-	25.0	105.3	224.0	0.9	4.1	19.0
Silty sand & sandy silt	5.4	5.15E-7	18.8	65.7	25.4	32.3	39.6	92.5	-	-	-	19.0
Clay	2.1	2.25E-9	11.9	-	-	-	9.1	78.7	112.3	0.4	1.9	19.0
Clay & silty clay	4.3	3.39E-8	19.3	-	-	-	30.4	116.3	271.9	1.0	4.5	19.0
Clay	1.9	8.37E-10	12.4	-	-	-	6.4	85.4	97.3	0.3	1.6	19.0
Clay	2.2	9.34E-10	13.6	-	-	-	8.5	96.0	114.0	0.4	1.8	19.0

Stratigrafica CPTU3

GEO GROUP GEOLOGIA E AMBIENTE
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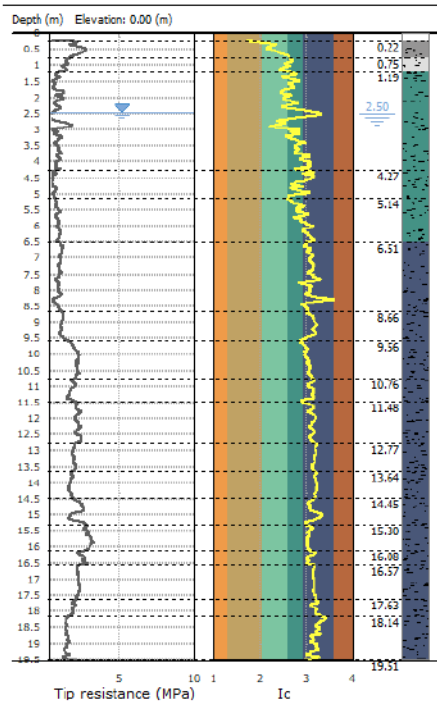
Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Ravarino
Location: Studio del terreno difondazione



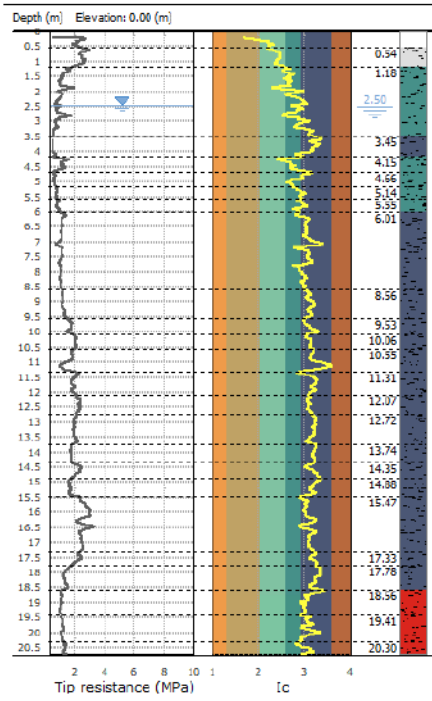
Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff sand/clayey sand	2.2	1.10E-6	7.1	22.3	59.5	40.9	17.4	35.4	-	-	-	19.0
Very stiff fine grained	1.4	1.15E-7	5.5	-	-	-	10.9	33.4	96.9	4.2	19.2	19.0
Clay & silty clay	0.8	4.05E-8	3.5	-	-	-	5.9	22.0	48.5	1.0	4.6	19.0
Clay & silty clay	0.6	1.05E-8	2.8	-	-	-	3.4	17.6	35.2	0.5	2.4	19.0
Clay & silty clay	0.8	1.17E-8	4.1	-	-	-	5.9	27.2	52.6	0.7	3.1	19.0
Clay	0.9	3.74E-9	4.9	-	-	-	5.5	34.8	54.2	0.6	2.7	19.0
Clay	1.1	2.96E-9	6.2	-	-	-	7.4	44.4	66.7	0.6	2.8	19.0
Clay	2.1	6.38E-9	10.8	-	-	-	15.1	78.0	134.9	1.1	5.3	19.0
Clay	1.8	3.62E-9	9.9	-	-	-	12.7	72.6	113.2	0.9	4.1	19.0
Clay	2.2	3.10E-9	12.2	-	-	-	15.8	93.0	141.0	1.0	4.8	19.0
Clay	2.0	2.02E-9	11.3	-	-	-	13.7	87.4	122.6	0.8	3.9	19.0
Clay	1.7	1.60E-9	10.2	-	-	-	11.8	78.4	105.5	0.7	3.2	19.0
Clay	2.2	2.73E-9	12.1	-	-	-	15.0	90.6	133.7	0.8	3.8	19.0
Clay	2.9	5.20E-9	15.5	-	-	-	21.1	113.0	180.3	1.1	5.2	19.0
Clay	2.5	4.19E-9	13.7	-	-	-	17.8	99.2	158.8	0.9	4.2	19.0
Clay	2.2	2.25E-9	12.7	-	-	-	15.2	94.7	135.6	0.7	3.4	19.0
Clay	1.9	1.75E-9	11.1	-	-	-	12.4	82.0	112.1	0.6	2.7	19.0
Clay	1.5	1.59E-9	8.7	-	-	-	6.0	58.6	78.0	0.4	1.8	19.0
Clay	2.0	6.44E-9	10.5	-	-	-	12.7	67.4	116.6	0.6	2.6	19.0

Stratigrafica CPTU4

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Ravarino
Location: Studio del terreno difondazione



Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff fine grained	2.5	4.38E-7	8.7	-	-	-	19.6	47.2	173.2	7.1	32.6	19.0
Clay & silty clay	0.9	3.13E-8	4.1	-	-	-	7.1	27.4	61.6	1.4	6.4	19.0
Clay	0.5	2.37E-9	2.7	-	-	-	2.4	19.1	27.4	0.5	2.1	19.0
Clay & silty clay	1.0	5.08E-8	4.4	-	-	-	7.3	26.3	61.6	0.9	4.2	19.0
Clay & silty clay	0.6	1.55E-8	2.8	-	-	-	3.3	16.6	34.5	0.5	2.3	19.0
Clay & silty clay	0.7	1.64E-8	3.2	-	-	-	4.8	21.2	43.5	0.6	2.7	19.0
Clay & silty clay	0.8	1.30E-8	4.0	-	-	-	5.5	25.5	50.1	0.6	3.0	19.0
Clay	1.0	6.13E-9	5.5	-	-	-	7.1	37.6	64.3	0.7	3.3	19.0
Clay	1.2	3.23E-9	6.6	-	-	-	8.2	47.9	73.2	0.7	3.1	19.0
Clay	1.7	3.48E-9	9.0	-	-	-	11.7	67.6	104.6	0.9	4.2	19.0
Clay	2.0	3.38E-9	10.8	-	-	-	14.4	83.4	128.6	1.1	5.0	19.0
Clay	1.5	1.47E-9	9.1	-	-	-	10.0	72.9	92.7	0.7	3.4	19.0
Clay	1.9	2.57E-9	10.8	-	-	-	13.5	82.1	120.3	0.9	4.2	19.0
Clay	2.2	3.54E-9	12.1	-	-	-	15.7	90.4	140.4	1.0	4.7	19.0
Clay	2.0	2.04E-9	11.3	-	-	-	13.8	87.3	122.8	0.8	3.9	19.0
Clay	1.8	1.64E-9	10.2	-	-	-	11.9	78.4	106.0	0.7	3.2	19.0
Clay	2.1	1.98E-9	12.2	-	-	-	14.6	93.4	130.4	0.8	3.8	19.0
Clay	1.7	1.96E-9	9.5	-	-	-	11.0	70.9	98.5	0.6	2.8	19.0
Clay	2.5	4.11E-9	13.7	-	-	-	17.9	99.9	159.4	0.9	4.2	19.0
Clay	2.1	1.68E-9	12.4	-	-	-	14.3	94.2	127.9	0.7	3.2	19.0
Clay	1.4	1.30E-9	8.4	-	-	-	5.7	58.3	74.6	0.4	1.8	19.0
Sensitive fine grained	1.0	2.82E-9	5.5	-	-	-	2.3	30.0	50.3	0.3	1.2	19.0
Sensitive fine grained	1.1	3.90E-9	6.1	-	-	-	2.8	33.0	54.3	0.3	1.2	19.0
Sensitive fine grained	1.3	6.39E-9	6.6	-	-	-	3.9	36.7	65.6	0.3	1.4	19.0

Stratigrafica CPTU5

GEO GROUP GEOLOGIA E AMBIENTE
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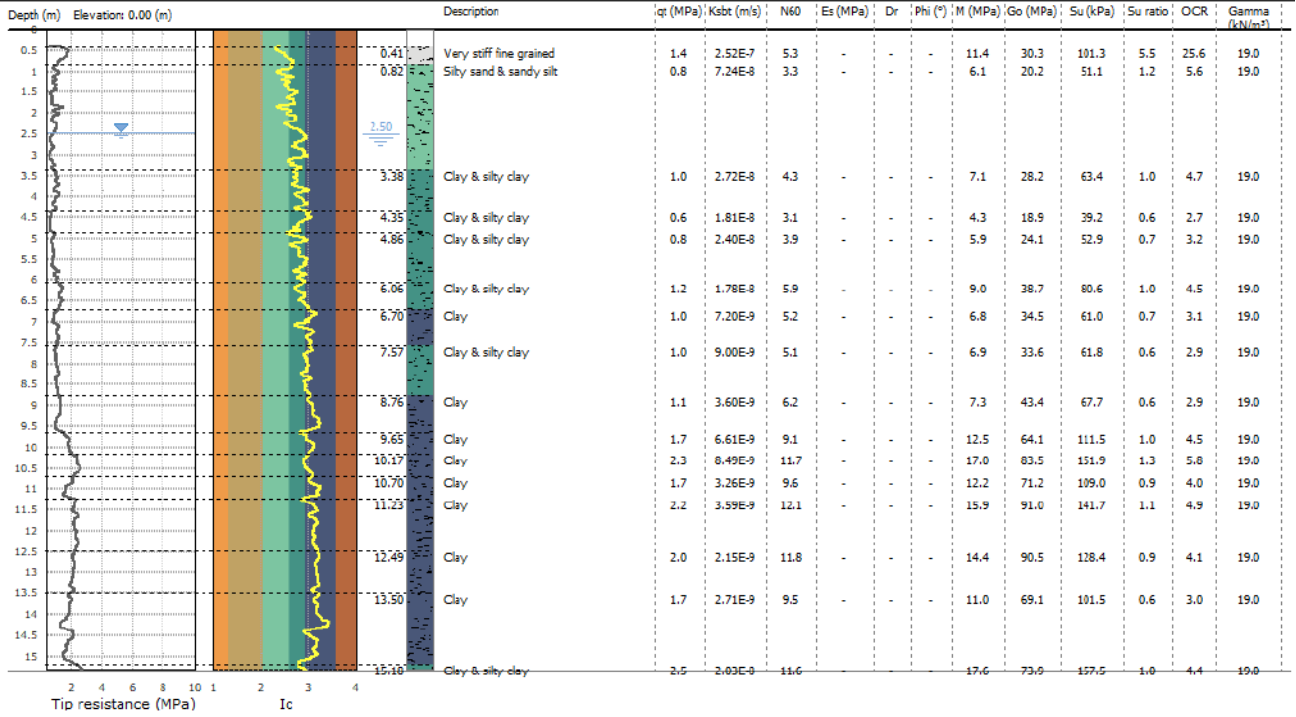
Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Ravarino
Location: Studio del terreno di fondazione



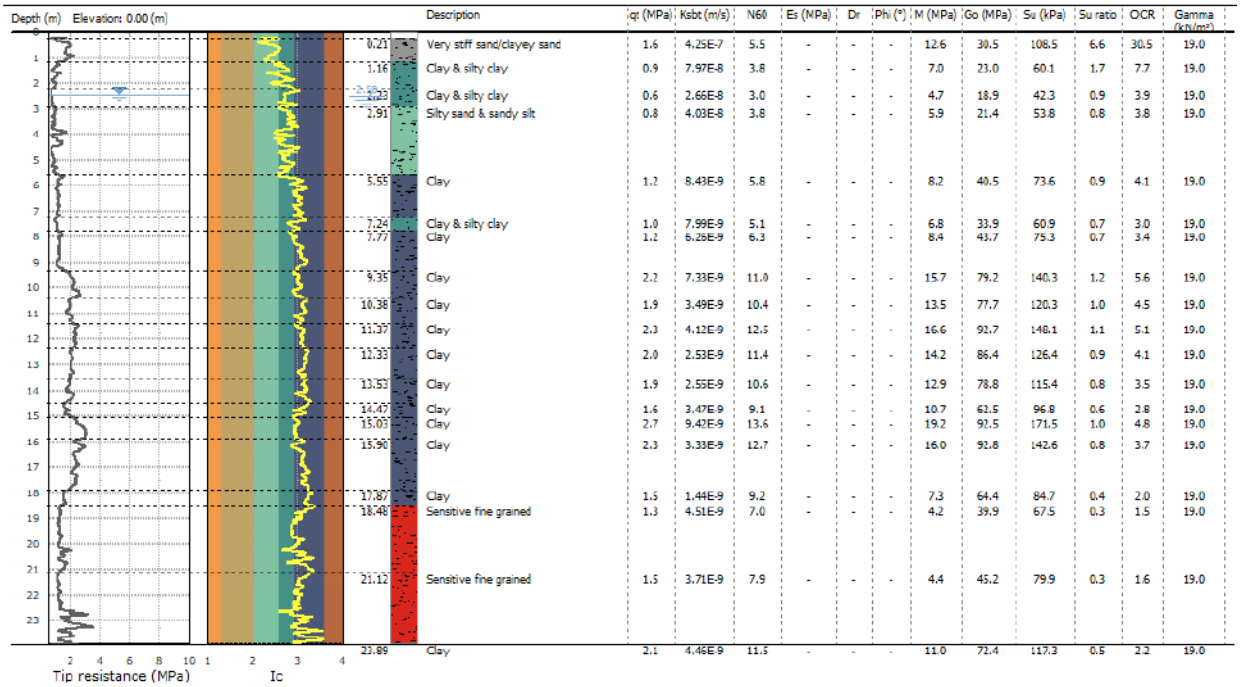
Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.41	Very stiff fine grained	1.4	2.52E-7	5.3	-	-	-	11.4	30.3	101.3	5.5	25.6	19.0
0.82	Silty sand & sandy silt	0.8	7.24E-8	3.3	-	-	-	6.1	20.2	51.1	1.2	5.6	19.0
3.38	Clay & silty clay	1.0	2.72E-8	4.3	-	-	-	7.1	28.2	63.4	1.0	4.7	19.0
4.35	Clay & silty clay	0.6	1.81E-8	3.1	-	-	-	4.3	18.9	39.2	0.6	2.7	19.0
4.86	Clay & silty clay	0.8	2.40E-8	3.9	-	-	-	5.9	24.1	52.9	0.7	3.2	19.0
6.06	Clay & silty clay	1.2	1.78E-8	5.9	-	-	-	9.0	38.7	80.6	1.0	4.5	19.0
6.70	Clay	1.0	7.20E-9	5.2	-	-	-	6.8	34.5	61.0	0.7	3.1	19.0
7.57	Clay & silty clay	1.0	9.00E-9	5.1	-	-	-	6.9	33.6	61.8	0.6	2.9	19.0
8.76	Clay	1.1	3.60E-9	6.2	-	-	-	7.3	43.4	67.7	0.6	2.9	19.0
9.65	Clay	1.7	6.61E-9	9.1	-	-	-	12.5	64.1	111.5	1.0	4.5	19.0
10.17	Clay	2.3	8.49E-9	11.7	-	-	-	17.0	83.5	151.9	1.3	5.8	19.0
10.70	Clay	1.7	3.26E-9	9.6	-	-	-	12.2	71.2	109.0	0.9	4.0	19.0
11.23	Clay	2.2	3.59E-9	12.1	-	-	-	15.9	91.0	141.7	1.1	4.9	19.0
12.49	Clay	2.0	2.15E-9	11.8	-	-	-	14.4	90.5	128.4	0.9	4.1	19.0
13.50	Clay	1.7	2.71E-9	9.5	-	-	-	11.0	69.1	101.5	0.6	3.0	19.0
15.18	Clay & silty clay	2.5	2.03E-9	11.6	-	-	-	17.6	73.9	157.5	1.0	4.4	19.0

Stratigrafica CPTU6

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Ravarino
Location: Studio del terreno di fondazione



Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.21	Very stiff sand/clayey sand	1.6	4.25E-7	5.5	-	-	-	12.6	30.5	108.5	6.6	30.5	19.0
1.16	Clay & silty clay	0.9	7.97E-8	3.8	-	-	-	7.0	23.0	60.1	1.7	7.7	19.0
2.23	Clay & silty clay	0.6	2.66E-8	3.0	-	-	-	4.7	18.9	42.3	0.9	3.9	19.0
1.91	Silty sand & sandy silt	0.8	4.03E-8	3.8	-	-	-	5.9	21.4	53.8	0.8	3.8	19.0
5.55	Clay	1.2	8.43E-9	5.8	-	-	-	8.2	40.5	73.6	0.9	4.1	19.0
7.24	Clay & silty clay	1.0	7.99E-9	5.1	-	-	-	6.8	33.9	60.9	0.7	3.0	19.0
7.77	Clay	1.2	6.25E-9	6.3	-	-	-	8.4	43.7	75.3	0.7	3.4	19.0
9.35	Clay	2.2	7.33E-9	11.0	-	-	-	15.7	79.2	140.3	1.2	5.6	19.0
10.38	Clay	1.9	3.49E-9	10.4	-	-	-	13.5	77.7	120.3	1.0	4.5	19.0
11.37	Clay	2.3	4.12E-9	12.5	-	-	-	16.6	92.7	148.1	1.1	5.1	19.0
12.33	Clay	2.0	2.53E-9	11.4	-	-	-	14.2	86.4	126.4	0.9	4.1	19.0
13.53	Clay	1.9	2.55E-9	10.6	-	-	-	12.9	78.8	115.4	0.8	3.5	19.0
14.47	Clay	1.6	3.47E-9	9.1	-	-	-	10.7	62.5	96.8	0.6	2.8	19.0
15.03	Clay	2.7	9.42E-9	13.6	-	-	-	19.2	92.5	171.5	1.0	4.8	19.0
15.90	Clay	2.3	3.33E-9	12.7	-	-	-	16.0	92.8	142.6	0.8	3.7	19.0
17.87	Clay	1.5	1.44E-9	9.2	-	-	-	7.3	64.4	84.7	0.4	2.0	19.0
18.48	Sensitive fine grained	1.3	4.51E-9	7.0	-	-	-	4.2	39.9	67.5	0.3	1.5	19.0
21.12	Sensitive fine grained	1.5	3.71E-9	7.9	-	-	-	4.4	45.2	79.9	0.3	1.6	19.0
23.89	Clay	2.1	4.46E-9	11.5	-	-	-	11.0	72.4	117.3	0.5	2.2	19.0

Stratigrafica CPTU7

GEO GROUP GEOLOGIA E AMBIENTE
UFFICI: via Per Modena, 12 - 41051 Castelnuovo R. (MO)
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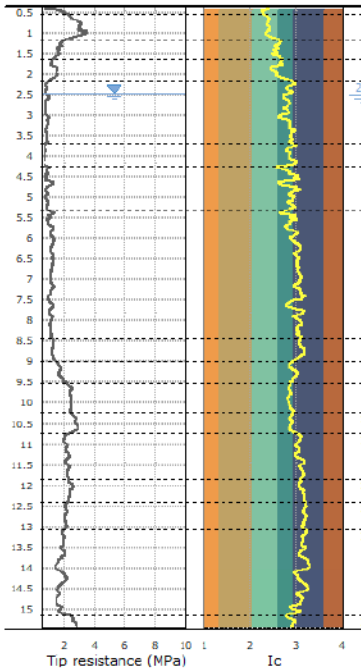
Email: info@geogroupmodena.it Pec: geo.group@winpec.it Sito: www.geogroupmodena.it

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



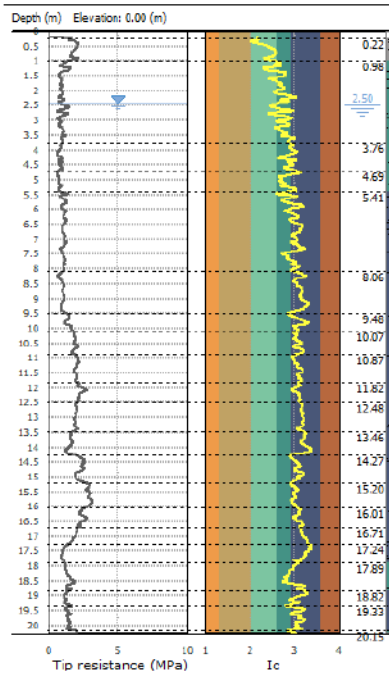
Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff fine grained	2.8	4.95E-7	9.8	-	-	-	22.3	52.3	201.3	8.3	38.2	19.0
Very stiff fine grained	1.6	1.25E-7	6.4	-	-	-	12.7	38.4	113.5	3.5	16.4	19.0
Clay & silty clay	1.2	1.08E-7	4.9	-	-	-	9.7	29.9	83.2	2.1	9.5	19.0
Clay & silty clay	0.8	2.16E-8	3.5	-	-	-	5.7	23.4	50.5	1.0	4.5	19.0
Clay & silty clay	0.6	1.54E-8	3.0	-	-	-	4.2	18.5	37.6	0.6	2.8	19.0
Clay & silty clay	0.8	1.81E-8	3.9	-	-	-	5.7	24.4	50.7	0.7	3.4	19.0
Clay	1.1	7.20E-9	5.4	-	-	-	7.3	37.2	65.7	0.8	3.5	19.0
Clay	1.2	3.87E-9	6.2	-	-	-	8.1	45.7	72.2	0.7	3.2	19.0
Clay	1.7	1.10E-8	8.4	-	-	-	12.2	57.0	108.8	1.0	4.6	19.0
Clay	2.3	1.90E-8	10.9	-	-	-	17.2	73.1	153.8	1.3	6.2	19.0
Clay	2.6	1.41E-8	12.8	-	-	-	19.6	87.5	174.6	1.4	6.7	19.0
Clay	2.1	4.18E-9	11.4	-	-	-	15.2	84.9	136.0	1.1	4.9	19.0
Clay	2.3	3.07E-9	12.8	-	-	-	16.7	98.4	149.0	1.1	5.1	19.0
Clay	2.0	2.16E-9	11.8	-	-	-	14.4	90.6	128.8	0.9	4.2	19.0
Clay	1.7	3.08E-9	9.6	-	-	-	11.3	68.2	103.3	0.7	3.1	19.0
Clay	2.5	1.45E-8	12.1	-	-	-	17.9	79.9	160.2	1.0	4.5	19.0

Stratigrafica CPTU8

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU9
Total depth: 20.28 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Very stiff sand/clayey sand	1.8	5.53E-7	6.1	-	-	-	14.2	32.7	125.3	6.5	30.0	19.0
Clay & silty clay	0.9	5.76E-8	3.8	-	-	-	7.0	24.2	59.7	1.3	6.2	19.0
Clay & silty clay	0.8	1.46E-8	3.7	-	-	-	5.6	24.9	50.0	0.8	3.6	19.0
Clay & silty clay	0.7	1.55E-8	3.3	-	-	-	4.6	19.9	42.1	0.6	2.7	19.0
Clay	1.0	0.16E-9	5.3	-	-	-	7.3	36.4	65.6	0.8	3.5	19.0
Clay	0.9	2.66E-9	5.2	-	-	-	5.4	36.9	54.4	0.5	2.4	19.0
Clay	1.4	4.25E-9	7.4	-	-	-	9.6	53.2	85.4	0.7	3.5	19.0
Clay	1.8	4.27E-9	9.9	-	-	-	13.1	72.7	116.8	1.0	4.5	19.0
Clay	2.0	4.22E-9	10.7	-	-	-	14.1	78.7	126.3	1.0	4.5	19.0
Clay	2.3	4.18E-9	12.2	-	-	-	16.2	90.6	145.0	1.1	4.9	19.0
Clay	1.9	2.25E-9	11.0	-	-	-	13.5	84.3	120.7	0.8	3.9	19.0
Clay	1.5	1.51E-9	8.9	-	-	-	9.5	67.5	89.0	0.6	2.7	19.0
Clay	2.3	5.03E-9	11.9	-	-	-	15.8	85.1	140.8	0.9	4.1	19.0
Clay	2.9	7.35E-9	14.9	-	-	-	20.9	105.4	186.8	1.1	5.1	19.0
Clay	2.4	3.61E-9	13.0	-	-	-	16.5	94.7	147.6	0.8	3.9	19.0
Clay	1.8	1.62E-9	10.8	-	-	-	11.7	80.9	108.8	0.6	2.8	19.0
Clay	1.0	1.30E-9	6.3	-	-	-	2.7	39.5	50.3	0.3	1.2	19.0
Clay & silty clay	1.4	9.46E-9	6.8	-	-	-	5.3	39.0	72.4	0.4	1.7	19.0
Clay	1.2	4.18E-9	6.7	-	-	-	3.7	38.6	61.7	0.3	1.4	19.0
Clay	1.4	4.22E-9	7.5	-	-	-	5.1	45.9	73.6	0.4	1.7	19.0
Clay & silty clay	1.9	1.20E-8	9.4	-	-	-	11.4	57.0	110.5	0.5	2.4	19.0

Stratigrafica CPTU9

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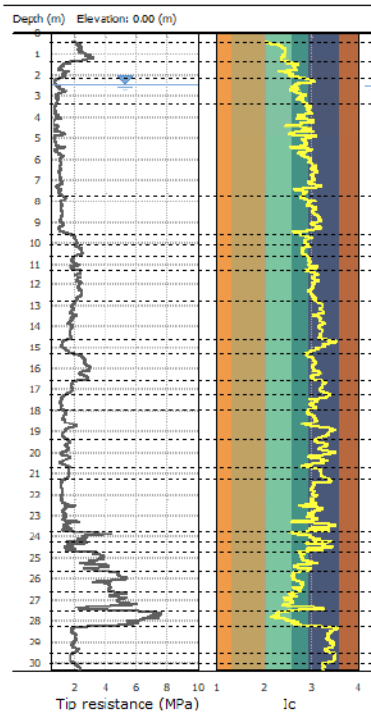
Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



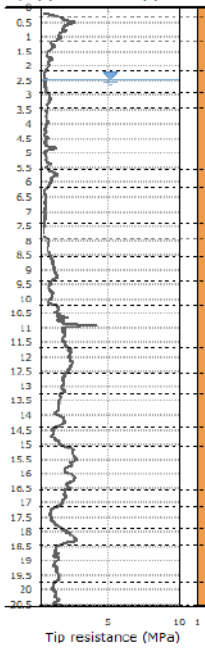
Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.44	Very stiff sand/clayey sand	2.5	6.17E-7	8.5	-	-	-	19.8	44.8	180.2	7.2	33.1	19.0
1.36	Silty sand & sandy silt	1.2	1.26E-7	4.9	-	-	-	9.4	28.3	81.4	2.1	9.8	19.0
2.12	Clay & silty clay	0.8	3.52E-8	3.8	-	-	-	6.3	23.8	56.0	1.1	5.0	19.0
3.38	Clay & silty clay	0.8	1.32E-8	3.9	-	-	-	5.7	26.2	51.7	0.7	3.2	19.0
7.71	Clay	1.1	6.98E-9	5.7	-	-	-	7.2	37.5	65.8	0.6	2.9	19.0
9.55	Clay & silty clay	2.0	1.64E-8	9.5	-	-	-	14.4	62.6	128.4	1.1	5.2	19.0
10.10	Clay & silty clay	2.3	1.92E-8	10.6	-	-	-	16.6	70.1	147.9	1.2	5.7	19.0
10.64	Clay	1.9	8.36E-9	9.5	-	-	-	13.5	66.5	120.6	1.0	4.5	19.0
11.24	Clay	2.3	6.05E-9	11.7	-	-	-	16.2	84.5	144.7	1.1	5.0	19.0
12.71	Clay	1.8	1.89E-9	10.3	-	-	-	12.2	78.4	108.7	0.7	3.4	19.0
14.59	Clay	1.3	2.00E-9	7.6	-	-	-	6.0	52.2	70.6	0.4	2.0	19.0
15.30	Clay	2.6	5.45E-9	13.5	-	-	-	18.2	96.9	162.7	1.0	4.4	19.0
16.54	Clay	1.8	1.37E-9	10.9	-	-	-	11.6	81.0	105.5	0.6	2.7	19.0
17.20	Clay	1.1	3.11E-9	6.3	-	-	-	3.1	36.5	54.6	0.3	1.4	19.0
17.93	Clay	1.3	3.36E-9	7.4	-	-	-	4.8	46.3	69.7	0.4	1.6	19.0
19.37	Clay	1.4	2.03E-9	7.9	-	-	-	4.5	49.9	68.8	0.3	1.5	19.0
20.67	Clay	1.6	2.16E-9	8.8	-	-	-	6.3	58.7	83.3	0.4	1.8	19.0
21.23	Sensitive fine grained	1.2	3.67E-9	6.7	-	-	-	2.7	36.0	57.5	0.2	1.1	19.0
23.72	Clay & silty clay	2.8	1.58E-8	13.5	-	-	-	18.1	82.1	165.0	0.7	3.1	19.0
24.20	Clay	1.7	2.47E-9	10.0	-	-	-	6.4	63.3	90.6	0.4	1.7	19.0
24.70	Clay & silty clay	3.3	2.22E-8	15.4	-	-	-	22.8	94.3	204.1	0.8	3.7	19.0
25.64	Clay & silty clay	4.4	5.42E-8	18.6	-	-	-	31.1	109.2	277.9	1.1	4.9	19.0
26.62	Clay & silty clay	4.3	7.27E-8	17.7	-	-	-	29.1	99.4	232.1	0.9	4.0	19.0
27.53	Silty sand & sandy silt	6.3	3.43E-7	22.7	85.7	27.2	32.6	46.2	116.2	-	-	-	19.0
28.24	Clay	2.0	7.09E-10	13.2	-	-	-	7.1	96.1	102.7	0.4	1.6	19.0
29.51	Clay	1.7	5.55E-10	12.2	-	-	-	4.7	86.1	84.3	0.3	1.3	19.0
30.37	Clay	2.2	1.22E-9	13.4	-	-	-	8.9	91.5	117.3	0.4	1.8	19.0

Stratigrafica CPTU10

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.29	Very stiff fine grained	1.8	3.41E-7	6.5	-	-	-	14.6	36.6	131.3	6.3	28.9	19.0
1.14	Clay & silty clay	0.9	5.25E-8	3.9	-	-	-	7.0	24.8	62.4	1.8	8.3	19.0
2.17	Clay & silty clay	0.6	1.55E-8	2.8	-	-	-	4.3	18.7	38.0	0.8	3.6	19.0
2.93	Clay & silty clay	0.9	4.26E-8	3.9	-	-	-	6.5	24.0	57.8	1.0	4.7	19.0
3.43	Clay & silty clay	0.7	1.51E-8	3.3	-	-	-	4.8	21.6	43.6	0.7	3.0	19.0
5.55	Clay	1.1	8.51E-9	5.4	-	-	-	7.8	38.0	69.2	0.9	4.1	19.0
6.13	Clay	0.6	1.07E-9	3.8	-	-	-	2.4	26.8	32.7	0.4	1.7	19.0
7.36	Clay	0.5	5.94E-10	3.1	-	-	-	1.1	22.6	22.5	0.2	1.1	19.0
7.89	Clay	0.8	2.58E-9	4.9	-	-	-	4.7	33.4	49.0	0.5	2.3	19.0
8.55	Clay	1.2	2.64E-9	6.9	-	-	-	8.4	51.0	75.2	0.7	3.3	19.0
9.37	Clay	1.0	3.97E-9	5.4	-	-	-	5.5	35.8	56.7	0.5	2.3	19.0
10.21	Clay	1.8	1.34E-8	9.0	-	-	-	13.1	59.1	112.3	0.9	4.2	19.0
11.63	Clay	2.3	3.42E-9	12.9	-	-	-	16.8	97.0	145.7	1.1	5.1	19.0
12.52	Clay	1.9	1.60E-9	11.2	-	-	-	13.3	88.2	118.7	0.8	3.8	19.0
13.25	Clay	1.6	1.33E-9	9.7	-	-	-	10.6	75.2	96.5	0.6	2.9	19.0
14.40	Clay	1.3	2.01E-9	7.6	-	-	-	6.5	53.8	73.2	0.5	2.1	19.0
15.05	Clay	2.4	4.47E-9	12.8	-	-	-	16.7	92.1	145.2	0.9	4.1	19.0
16.55	Clay	1.9	1.53E-9	11.3	-	-	-	12.6	85.8	114.0	0.6	2.9	19.0
17.11	Clay	1.2	1.38E-9	7.1	-	-	-	3.8	47.5	60.3	0.3	1.5	19.0
17.88	Clay	2.3	3.93E-9	12.5	-	-	-	15.6	88.7	140.0	0.7	3.4	19.0
18.42	Clay	1.4	1.19E-9	8.6	-	-	-	5.4	60.2	74.5	0.4	1.7	19.0
19.71	Clay	1.3	4.14E-9	7.0	-	-	-	4.0	40.8	65.1	0.3	1.4	19.0
20.51	Clay	1.6	7.55E-9	8.0	-	-	-	7.2	45.8	88.6	0.4	1.9	19.0

Stratigrafica CPTU11

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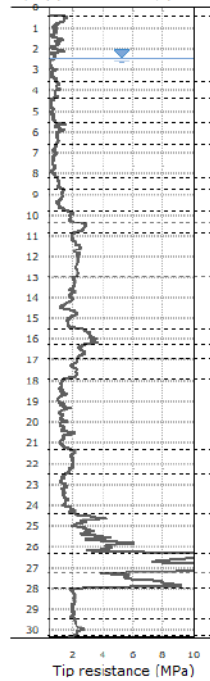
Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

Project: Ravarino
Location: Studio del terreno di fondazione

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.41 Clay & silty clay	0.8	5.64E-8	3.5	-	-	-	6.3	21.9	53.1	1.4	6.5	19.0
3.64 Clay & silty clay	1.0	1.66E-8	4.6	-	-	-	7.1	31.0	63.6	1.0	4.8	19.0
4.38 Clay & silty clay	0.7	9.46E-9	3.4	-	-	-	4.6	22.9	42.5	0.6	2.8	19.0
5.57 Clay	1.1	9.15E-9	5.2	-	-	-	7.6	36.7	67.7	0.8	3.9	19.0
6.62 Clay	0.8	2.55E-9	4.5	-	-	-	4.5	31.8	46.5	0.5	2.3	19.0
8.18 Clay	1.1	6.03E-9	5.5	-	-	-	7.2	37.5	64.2	0.6	2.9	19.0
8.70 Clay	1.2	3.85E-9	6.7	-	-	-	8.3	47.7	75.3	0.7	3.2	19.0
9.77 Clay	1.8	9.67E-9	9.1	-	-	-	13.0	62.2	116.0	1.0	4.6	19.0
10.34 Clay	2.6	1.90E-8	12.2	-	-	-	19.5	82.8	174.2	1.4	6.6	19.0
10.85 Clay	2.2	4.20E-9	12.1	-	-	-	16.0	89.3	143.1	1.1	4.9	19.0
12.95 Clay	1.8	2.13E-9	10.6	-	-	-	12.3	79.1	111.5	0.7	3.3	19.0
15.42 Clay	3.1	8.55E-9	15.6	-	-	-	22.3	109.2	199.0	1.2	5.4	19.0
16.22 Clay	2.6	3.25E-9	14.3	-	-	-	18.2	106.1	162.3	0.9	4.2	19.0
16.90 Clay	2.2	3.06E-9	12.0	-	-	-	14.6	86.3	130.6	0.7	3.3	19.0
17.84 Clay	1.3	3.33E-9	7.3	-	-	-	4.3	43.8	67.2	0.3	1.5	19.0
21.26 Clay	1.9	2.18E-9	10.9	-	-	-	10.0	75.4	107.3	0.5	2.2	19.0
22.44 Clay	1.5	2.87E-9	8.3	-	-	-	4.5	49.8	74.4	0.3	1.4	19.0
24.37 Clay	3.4	1.13E-8	16.6	-	-	-	22.5	107.3	204.6	0.8	3.7	19.0
26.27 Sand & silty sand	10.2	6.29E-6	28.1	90.6	36.2	33.6	77.8	115.5	-	-	-	19.0
27.17 Silty sand & sandy silt	6.2	3.37E-7	22.4	83.5	29.4	32.4	45.6	114.8	-	-	-	19.0
27.94 Clay	2.0	7.96E-10	13.2	-	-	-	7.8	96.2	107.1	0.4	1.7	19.0
29.39 Clay	2.3	1.71E-9	13.4	-	-	-	9.8	89.7	121.1	0.4	1.9	19.0
30.27 Clay	1.9	8.02E-10	12.2	-	-	-	5.7	82.4	93.6	0.3	1.4	19.0

Stratigrafica CPTU12

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3.4 *Indagini Geofisiche*

Per la caratterizzazione sismica dell'area in studio, sono state eseguite le seguenti indagini geofisiche:

- ***n. 2 indagini sismica passiva HVSR***
- ***n.2 indagine sismica attiva MASW***

I risultati delle indagini sismiche sopra citate sono riportati integralmente nell'**allegato n. 2**.

3.4.1 Indagine sismica passiva a stazione singola (*analisi HVSR*)

La misura sismica passiva a stazione singola è stata eseguita mediante un tomografo digitale dotato di tre canali velocimetrici, modello Tromino® prodotto da Moho srl (Marghera (VE), Italia). Per l'acquisizione è stata adottata una frequenza di campionamento di 128 Hz per una durata totale di 20 minuti.
Lo scopo dell'indagine è la misura della frequenza di risonanza del terreno, la quale è legata alla velocità delle onde di taglio Vs nel terreno dalla formula:

$$f = \frac{Vs}{4h}$$

dove *h* è lo spessore dello strato.

3.4.2 Indagine sismica attiva con metodo MASW

Per misurare le velocità delle onde di taglio si possono eseguire prospezioni sismiche mediante stendimenti superficiali, utilizzando geofoni verticali da 4,5 Hz ed acquisendo attivamente i segnali delle onde rifratte alla superficie mediante una sorgente artificialmente provocata. Questa tecnica, nota con la sigla **MASW** (Multichannel Analysis of Surface Waves), permette di ricostruire il profilo verticale delle Vs con procedimenti di modellazione diretta delle velocità di fase delle onde, rifratte alla superficie. Partendo dal sismogramma registrato mediante sorgente energizzante in asse con lo stendimento, viene eseguita un'analisi spettrale che ha consentito di elaborare un'immagine della distribuzione del segnale di velocità sismica in funzione delle diverse frequenze che lo compongono. Da tale elaborazione, tramite una fase di "picking" del segnale ad elevata intensità è stata ottenuta la **"curva di dispersione"**, dalla cui inversione è stato calcolato il **modello sismo-stratigrafico** espresso in termini di velocità delle onde di taglio (Vs). I dati sono stati registrati mediante un sismografo *Geode Geometrics 24* bit con filtri disinseriti, velocità di campionamento (sample rate) di 0.25 millisecondi e lunghezza delle acquisizioni di 2 secondi. Si effettuano battute poste ad offset diversi (10 m e 15 m di distanza dal primo geofono) mediante grave da 8,0 kg di massa. Il calcolo del profilo delle velocità delle onde di Rayleigh, V(fase)/freq., può essere convertito nel profilo Vs/profondità. Tale metodo non è univoco e quindi il modello che ne scaturisce è un modello teorico; per questo motivo è preferibile operare in presenza di dati di taratura (come nel caso specifico) onde ricavare il modello reale.

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4 STUDI DI MICROZONAZIONE SISMICA – DGR 476/21

4.1 Primo livello di approfondimento

La presente fase di analisi, in accordo con le linee guida della Protezione Civile Italiana e le normative regionali DGR2193/15, DGR 630/19 e successiva DGR 476/21 della Regione Emilia-Romagna, costituisce lo studio preliminare nel quale vengono definite le caratteristiche geologiche, idrogeologiche e sismiche del sito sulla scorta delle indagini eseguite e dei dati bibliografici precedentemente illustrati. Lo studio di primo livello di approfondimento risulta propedeutico alla seconda fase di analisi, in questo caso eseguita secondo il II livello di approfondimento data la presenza di zone stabili suscettibili di amplificazione locale. Attraverso l'interpretazione stratigrafica delle indagini eseguite si è reso possibile definire l'assetto stratigrafico medio del primo sottosuolo.

Sulla scorta della velocità derivata dall'elaborazione congiunta delle indagini sismiche HVSR e MASW e in riferimento a quanto illustrato nel paragrafo 3.2.2 delle NTC 2018 è possibile definire come le indagini riconducano il terreno a una categoria di **sottosuolo C**. Facendo riferimento al profilo S delle indagini sismiche è stato ottenuto un valore di Vs30 pari a 192 m/s. **Dall'analisi della curva HVSR è emersa una frequenza fondamentale di sito pari a 0.75 Hz.**

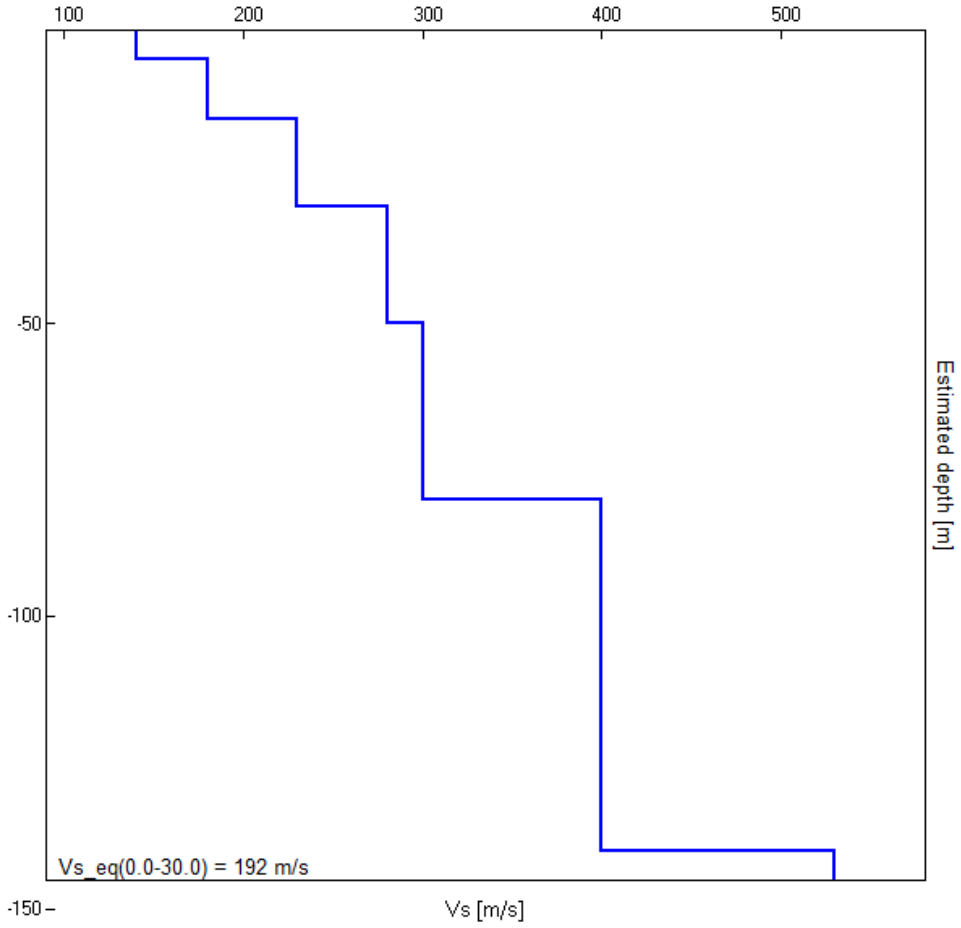

Fig.4.2 – Sintesi del modello di velocità ottenuto dall'elaborazione congiunta dell'indagine sismica HVSR-MASW.

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Il modello di velocità ricavato è il seguente:

Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
5.00	5.00	140	0.42
15.00	10.00	180	0.42
30.00	15.00	230	0.42
50.00	20.00	280	0.42
80.00	30.00	300	0.42
140.00	60.00	400	0.42
inf.	inf.	530	0.42

Tab.4.2 – Modello geofisico ottenuto dall'elaborazione congiunta dell'indagine sismica HVSR-MASW.

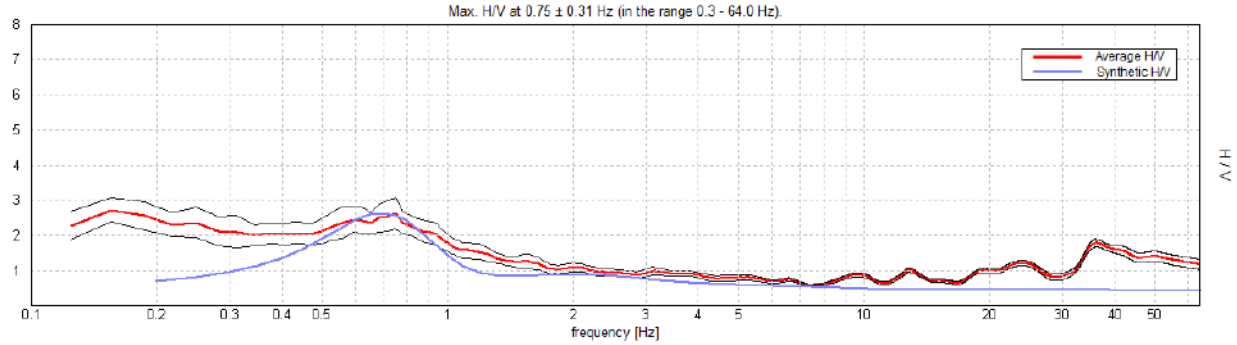

Fig.4.3 - Curva HVSR che identifica un picco a 0.75Hz.

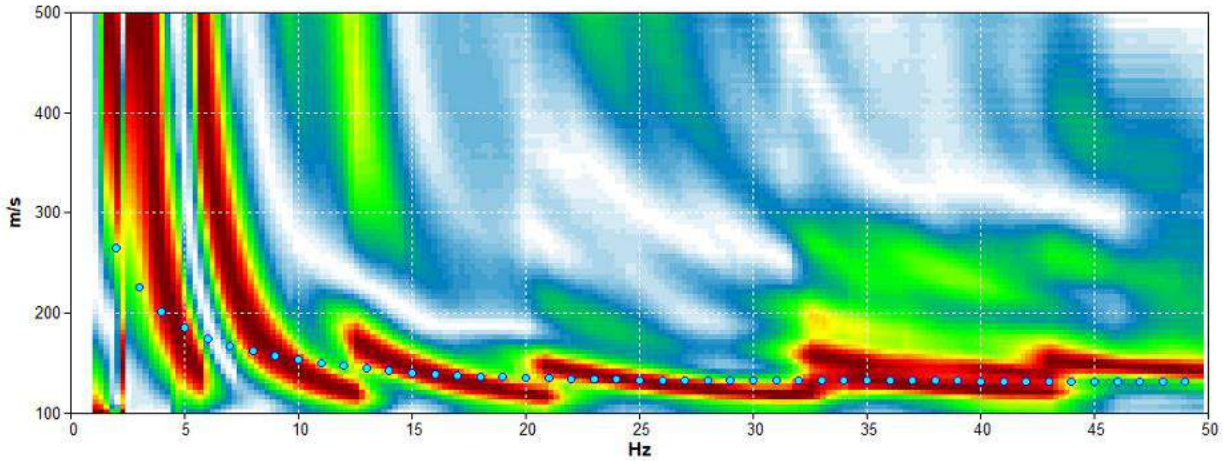

Fig.4.4 - Curva dispersione MASW.

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4.2 Terzo livello di approfondimento – DGR.476/21

Per ottemperare ai riferimenti normativi citati l'analisi è stata svolta secondo quanto indicato nella DGR 476/21, attraverso analisi numerica monodimensionale in campo lineare equivalente. Per fare ciò è stato utilizzato come strumento di lavoro il software di calcolo STRATA (University of Texas - Austin).

Ai fini della restituzione degli spettri di accelerazione, relativi allo stato limite SLV, è stata svolta la verifica dell'amplificazione del sito mediante l'utilizzo di un modello simulato in campo lineare equivalente.

Utilizzando un modello lineare equivalente è possibile ottenere una soluzione di un modello non lineare, attraverso analisi lineari complete nelle quali al termine di ogni interazione vengono aggiornati i parametri di **rigidezza** e **smorzamento** che sono dipendenti dallo stato di deformazione del terreno. Attraverso un'iterazione di calcoli si raggiunge una convergenza prefissata a monte della fase di computazione.

Il software STRATA è in grado di valutare la risposta sismica di un deposito di terreno, considerando un profilo monodimensionale in cui si propagano linearmente le onde sismiche, in funzione dei parametri dinamici attribuiti al terreno. Il terreno viene schematizzato come un sistema di N strati orizzontali omogenei, isotropi e visco-elastici, sovrastanti un semispazio uniforme, attraversati da un treno di onde di taglio che incidono verticalmente le superfici. Ogni strato è descritto per mezzo dello spessore *H*, del modulo di taglio massimo G_{max} o dalla corrispondente velocità massima V_{max}, dal valore dello smorzamento *D*, dal peso dell'unità di volume γ e dalle curve di decadimento del modulo di rigidezza a taglio normalizzato (G / G_0 -γ) e le corrispondenti curve dello smorzamento (*D* -γ) con la deformazione di taglio γ. Il modello lineare visco-elastico fa riferimento al modello reologico di Kelvin-Voigt, costituito da una molla e uno smorzatore viscoso in parallelo. Tale modello è descritto quindi dalla rigidezza (**G)** e dallo smorzamento (**D**). L'onda monodimensionale viene descritta dall'equazione in cui lo spostamento provocato (*u*) è funzione della profondità (*z)* e del tempo (*t):*

$$u(z,t) = A\exp[i(\omega t + k^* z)] + B\exp[i(\omega t - k^* z)]$$

Nell'equazione appena presentata A e B rappresentano le corrispettive amplificazioni del tetto e della base dello strato considerato. Il fattore *k** risulta dipendente dal modulo di taglio (*G*), dal grado di smorzamento (*D*) e dalla densità del terreno (*ρ*). Le relazioni sono le seguenti:

$$k^* = \frac{\omega}{v_s^*}$$

$$v_s^* = \sqrt{\frac{G^*}{\rho}}$$

$$G^* = G\left(1 - 2D^2 + i2D\sqrt{1 - D^2}\right) \simeq G(1 + i2D)$$

Dove G* e v^*_s rappresentano il modulo di taglio e la velocità di taglio.

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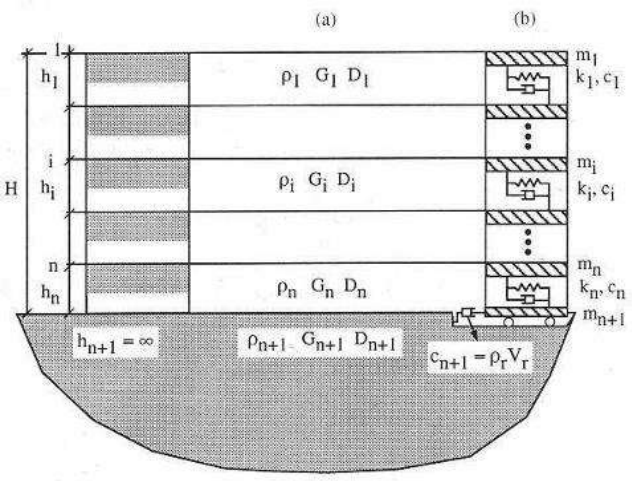

Fig.4.4 - Modello a strati continui adottato per la simulazione con il codice di calcolo STRATA.

MODELLO SIMULATO

Il modello simulato deriva dai dati ottenuti dalle prove geofisiche che compongono la campagna geognostica eseguita in sito. Tale profilo approssima il comportamento del sottosuolo, dal punto di vista sismico, in corrispondenza dell'area studiata. Il profilo considerato deriva dall'interpolazione dei dati provenienti dalle indagini geofisiche eseguite e i dati, di natura bibliografica, disponibili per il sito di riferimento.
Il profilo sismico del sottosuolo utilizzato per la modellazione della RSL deriva dall'elaborazione congiunta dell'indagine HVSR e MASW eseguite in sito, integrate con dati di bibliografia. Si illustra successivamente il modello utilizzato:

Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
5.00	5.00	140	0.42
15.00	10.00	180	0.42
30.00	15.00	230	0.42
50.00	20.00	280	0.42
80.00	30.00	300	0.42
140.00	60.00	400	0.42
inf.	inf.	530	0.42

Tab.4.2 – Modello ottenuto dall'elaborazione congiunta delle indagini sismiche HVSR e MASW.

Per descrivere il comportamento dinamico dei terreni costituenti il modello sono state considerate curve di decadimento dei moduli di rigidezza e smorzamento, al variare della deformazione percentuale γ(%). Si riporta successivamente la curva di decadimento considerata per l'esecuzione del calcolo di risposta sismica locale:

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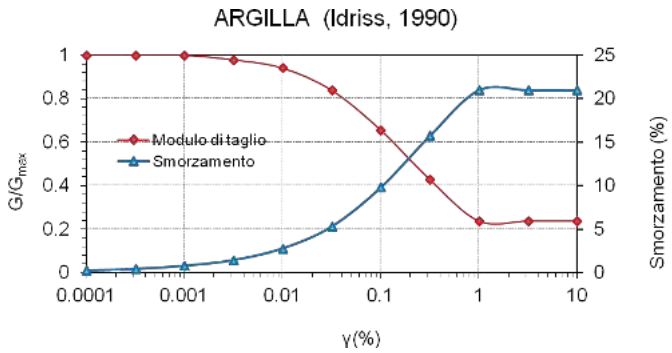

Fig.4.5 - Curva di decadimento dei moduli G/Gmax e smorzamento D, utilizzati per descrivere il comportamento dei materiali coesivi che compongono il sottosuolo in oggetto.

In accordo con quanto esposto nella D.G.R. 476/21, l'analisi RSL in oggetto è stata svolta adottando come input sismico 7 accelerogrammi, corrispondenti allo stato limite SLV. I segnali di riferimento sono stati successivamente scalati per il valore di PGA_0 atteso al suolo rigido in corrispondenza dell'areale oggetto di analisi. Per fare ciò è stata considerata l'interpolazione spaziale dei valori di PGA_0 proposta da INGV per il territorio nazionale e resi disponibili per il territorio regionale sui punti di una griglia con passo 0.05 gradi.

Per il sito in oggetto tale valore è pari a **0.157g** considerando un valore di **Cu = 1.00** (Classe d'uso II) e **Vn = 50 anni** per ottenere un tempo di ritorno pari a 475 anni.

RISULTATI OTTENUTI

Sulla scorta delle verifiche svolte mediante software STRATA, è possibile definire il campo di frequenze entro il quale il sottosuolo, in corrispondenza del sito in oggetto, amplifica il segnale sismico, oltre che a quantificare l'amplificazione stessa.

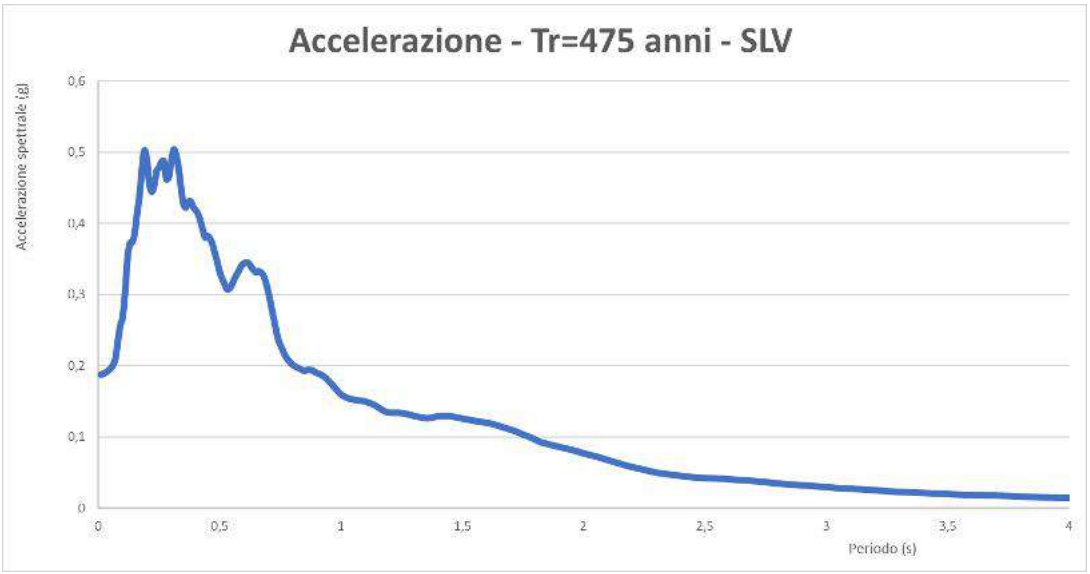

Fig.4.6 - Spettro accelerazione RSL terzo livello di approfondimento

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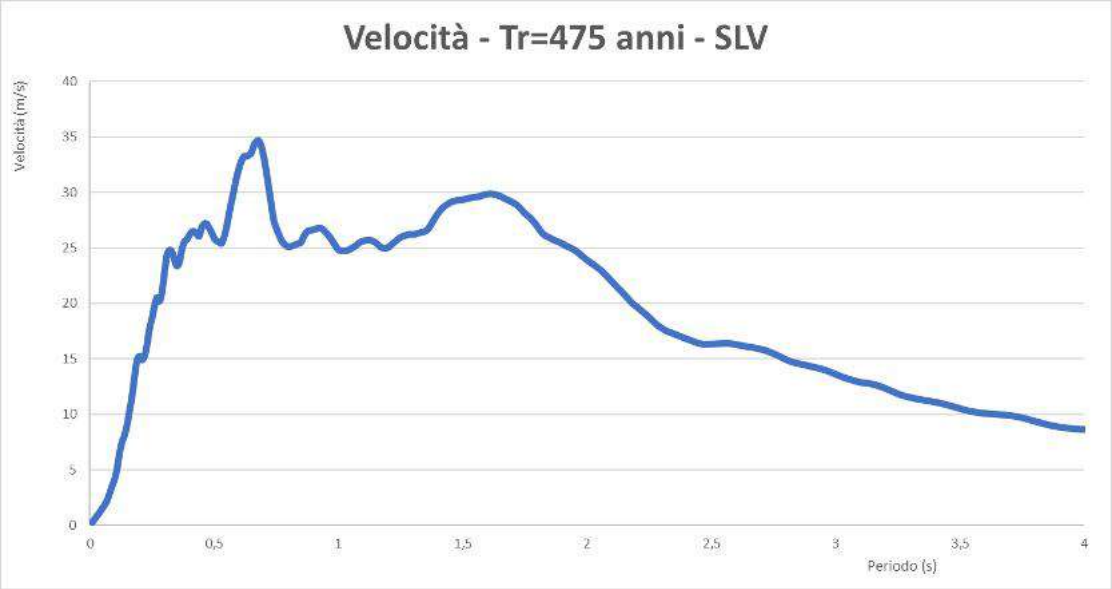

Fig.4.7 - Spettro velocità RSL terzo livello di approfondimento

Come descritto nell'all.2 della DGR 476/2021, la stima del fattore di amplificazione **FA** è stata calcolata considerando un tempo di ritorno TR=475 anni, con uno smorzamento ζ=5%, e relativi parametri rappresentativi dello scuotimento sismico, in particolare:

- accelerazione di picco orizzontale (PGA);
- intensità spettrale SA

$$SA = \int_{T_1}^{T_2} A(T,\zeta)dT$$

dove A è lo spettro di risposta in accelerazione, T è il periodo proprio e ζ è lo smorzamento; sono stati considerati quattro intervalli di periodo proprio T ottenendo quattro valori di intensità spettrale:

	T_1	T_2
SA1	0,1 s	0,5 s
SA2	0,4 s	0,8 s
SA3	0,7 s	1,1 s
SA4*	0,5 s	1,5 s

- intensità spettrale SI

$$SI = \int_{T_1}^{T_2} V(T,\zeta)dT$$

dove V è lo spettro di risposta in velocità, T è il periodo proprio e ζ è lo smorzamento3; sono stati considerati tre intervalli di periodo proprio T ottenendo tre valori di intensità

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	T_1	T_2
SI1	0,1 s	0,5 s
SI2	0,5 s	1,0 s
SI3*	0,5 s	1,5 s

Di seguito si riportano in tabella i valori di FA:

Fattore di amplificazione	Periodo T (s)	FA
Fattore di Amplificazione SA1	*0.1s≤T≤0.5s*	*1.31*
Fattore di Amplificazione SA2	*0.4s≤T≤0.8s*	*1.70*
Fattore di Amplificazione SA3	*0.7s≤T≤1.1s*	*1.68*
Fattore di Amplificazione SA4	*0.5s≤T≤1.5s*	*1.72*

Tab.4.4 – Fattori di amplificazione SA1 –SA2 –SA3 – SA4.

Fattore di amplificazione	Periodo T (s)	FA
Fattore di Amplificazione SI1	*0.1s≤T≤0.5s*	*1.31*
Fattore di Amplificazione SI2	*0.5s≤T≤1.0s*	*1.70*
Fattore di Amplificazione SI3	*0.5s≤T≤1.5s*	*1.72*

Tab.4.5 – Fattori di amplificazione SI1 –SI2 –SI3.

Infine si è calcolato il valore di $\mathbf{H_{SM}}$, ovvero il parametro che esprime lo scuotimento atteso al sito in valore assoluto, dato dal prodotto del parametro Acceleration Spectrum Intensity (ASI_{UHS}), valore integrale dello spettro di riferimento in accelerazione calcolato per l'intervallo di periodi 0.1≤ T ≤ 0.5 s e moltiplicato per il fattore di amplificazione in accelerazione (FA) calcolato per lo stesso intervallo di periodi:

$$H_{SM} = \frac{ASI_{UHS}}{\Delta T} \times FA$$

I valori di ASIUHS/ΔT, calcolati per ogni punto della griglia INGV, sono riportati nel file all_4_coord.kmz disponibili nella pagina web dedicata agli indirizzi per gli studi di microzonazione sismica a cura del Servizio Geologico, Sismico e dei Suoli, di seguito si riportano i valori della griglia INGV dell'area in studio.

La zona in studio presenta un valore di **$\mathbf{ASIU_{HS}/\Delta T}$** pari a **347.**

Di seguito si riportano i valori di H_{SM} e H_{0408}, H_{0711}, H_{0515} ricavati, ovvero lo scuotimento in accelerazione (cm/s^2) atteso al sito per gli intervalli di periodi 0,4s≤T≤0,8s, 0,7s≤T≤1,1s e 0,5s≤T≤1,5s.

H_{SM}	Periodo T (s)
H_{SM} = 455	0,1 s ≤T ≤ 0,5s
H_{0408}= 589	0,4 s ≤ T ≤ 0,8s
H_{0711}= 583	0,7 s ≤ T ≤ 1,1s
H_{0515}= 598	0,5 s ≤ T≤ 1,5s

Tab.4.6 – Valori Hsm ottenuti per i diversi periodi.

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Dai risultati sopra esposti dell'analisi di risposta sismica locale si ottiene un valore di accelerazione massima attesa al suolo del valore **PGA_{max}=A_{max}=0.**207g (per T=0 s).

4.2.1 Stabilità nei confronti della liquefazione (§ A2.2. DGR 476/2021)

In accordo con la normativa regionale DGR 476/21 si è proceduto alla verifica della liquefazione per le verticali di prova CPTU.

La valutazione del fenomeno della liquefazione viene svolta attraverso il calcolo del fattore di sicurezza di ciascun livello che compone il sottosuolo analizzato nei confronti del fenomeno stesso. Il fattore di sicurezza è derivato secondo la seguente formulazione:

$$F_L(z) = \frac{CRR_{M=7.5;\sigma'_v=1atm}}{CSR} \cdot MSF \cdot K_\sigma$$

Dove:

CRR è rappresentato dal rapporto di resistenza ciclica

MSF rappresenta il fattore di scala della magnitudo che è funzione della magnitudo stessa, della PGA e del valore di CRR

K_σ è il fattore di correzione che tiene conto della pressione efficace alla profondità a cui la resistenza viene valutata

CSR è il rapporto di tensione ciclica, ovvero la tensione di taglio indotta dall'azione sismica, normalizzata rispetto alla tensione verticale efficace. Tale parametro è derivabile secondo la seguente formulazione:

$$CSR = \frac{\tau_{media}}{\sigma'_{v0}} = 0.65 \cdot \frac{a_{max\,s}}{g} \cdot \frac{\sigma_{v0}}{\sigma'_{v0}} \cdot r_d$$

I termini che compongono la seguente relazione sono rappresentati da a_{max}/g che descrive il valore dell'accelerazione orizzontale a T = 0.00 s, il rapporto della tensione litostatica totale ed efficace, e il coefficiente riduttivo r_d. Quest'ultimo, in accordo con la predetta normativa è stato stimato secondo la seguente formulazione:

$$r_d = \exp[\alpha(z) + \beta(z) \cdot M]$$
$$\alpha(z) = -1.012 - 1.126 \cdot \operatorname{sen}\left(\frac{z}{11.73} + 5.133\right)$$
$$\beta(z) = 0.106 + 0.118 \cdot \operatorname{sen}\left(\frac{z}{11.28} + 5.142\right)$$

dove M rappresenta il valore di magnitudo di riferimento per il sito in analisi.

Il valore **CRR** è stato ricavato attraverso la metodologia di calcolo proposta da ***Boulanger&Idriss* 2014**. Per le specifiche della procedura di calcolo adottata si faccia riferimento all'allegato **A2.2** della DGR 476/2021 della

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Regione Emilia Romagna. L'analisi di liquefazione è stata eseguita entro i -20.00 m rispetto al piano campagna come prescritto dalla normativa di riferimento.

A seguito dell'identificazione del fattore di sicurezza F_L è stato determinato l'indice potenziale di liquefazione IL (LPI) attraverso il quale è possibile definire l'esposizione del sito al rischio di liquefazione. Il potenziale di liquefazione LPI è stato determinato secondo la seguente formulazione:

$$I_L = \int_0^{z_{crit}} F(z) \cdot w(z) \cdot dz \qquad \text{in cui} \qquad w(z) = \frac{200}{z_{crit}} \cdot \left(1 - \frac{z}{z_{crit}}\right)$$

Dove F(z) viene determinato secondo le formulazioni proposte da Somnez (2003)

$$\begin{aligned} F(z) &= 0 && \text{per} && F_L \geq 1.2 \\ F(z) &= 2 \cdot 10^6 \cdot \exp(-18.427 \cdot F_L) && \text{per} && 1.2 > F_L \geq 0.95 \\ F(z) &= 1 - F_L && \text{per} && F_L \leq 0.95 \end{aligned}$$

In base al valore di LPI ottenuto è possibile fornire un'indicazione del rischio di liquefazione. In considerazione delle linee guida emesse dalla Regione Emilia Romagna, a seguito degli eventi sismici di Maggio e Giugno 2012, si considera la classificazione di rischio definita da **Sonmez 2003**:

INDICE DI LIQUEFAZIONE	Rischio di liquefazione
LPI=0	Nullo
0<LPI≤2	Basso
2<LPI≤5	Moderato
5<LPI≤15	Alto
15>LPI	Molto alto

Si illustra successivamente il valore di LPI derivato dalle verticali di prova CPTU, considerando un'accelerazione massima al suolo pari **a 0.20 g** (calcolata secondo RSL – secondo terzo livello di approfondimento), una magnitudo di riferimento pari a M=**6.14 e la falda a D=-2.50 m da p.c.**.

A seguito della verifica, in riferimento alle verticali di prova, sono stati ottenuti i seguenti valori di LPI:

INDAGINE	INDICE DI LIQUEFAZIONE	RISCHIO
CPTu1	1.801	BASSO
CPTu2	0.272	BASSO
CPTu3	0.846	BASSO
CPTu4	0.533	BASSO
CPTu5	0.211	BASSO
CPTu6	0.099	BASSO
CPTu7	0.792	BASSO
CPTu8	0.184	BASSO

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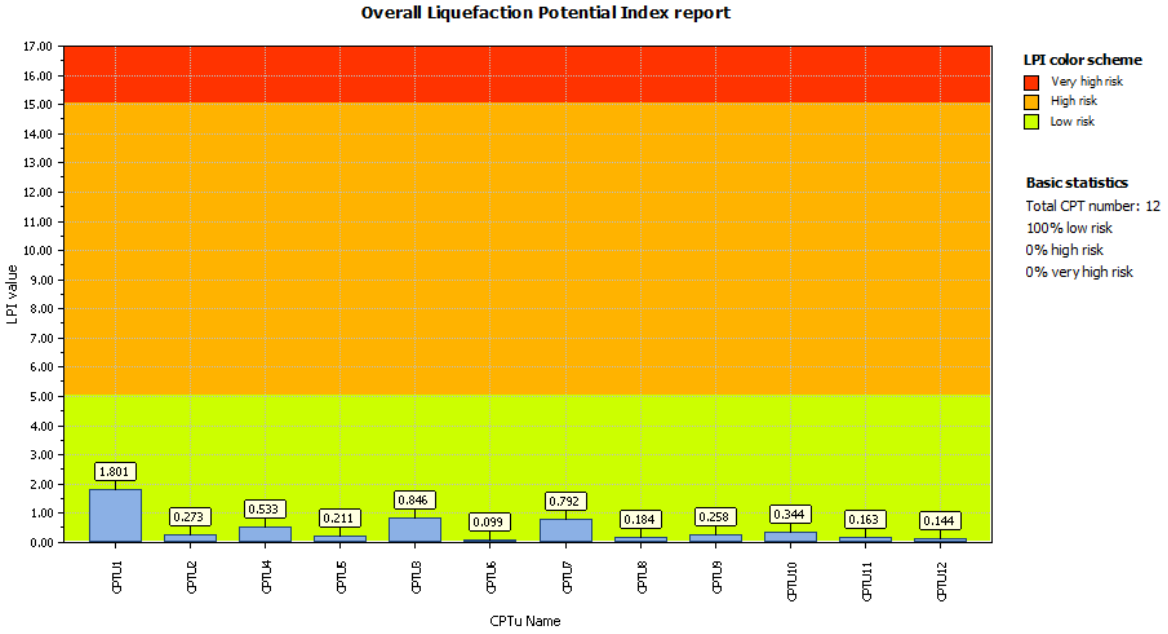
CPTu9	0.258	BASSO
CPTu10	0.344	BASSO
CPTu11	0.163	BASSO
CPTu12	0.144	BASSO

Project title : Ravarino, Conserve della Nonna
Location : Verifica alla liquefazione



Indice di liquefazione.

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4.2.2 Cedimenti post-sismici (§ A2.2. DGR 476/2021)

La stima dei cedimenti indotti dall'azione sismica si ottiene applicando le procedure descritte nell'allegato A3.B della DGR 476/2021. Si ricorda che, come cita la norma DGR 476/21, la stima dei cedimenti indotti dall'azione sismica è affetta da notevoli incertezze e che i valori che si ottengono devono intendersi solo orientativi.
Il cedimento permanente indotto dall'azione sismica in corrispondenza di una verticale di esplorazione si ottiene dalla somma dei contributi al cedimento stimati per i diversi strati del sottosuolo, fino alla profondità alla quale tali contributi non sono più significativi. Il cedimento permanente post-sismico può dunque essere stimato con l'equazione:

$$s = \sum_{i=1}^{n} \varepsilon_{vi} \cdot \Delta z_i$$

in cui ε_{vi} è la deformazione volumetrica (e verticale) dello strato i-esimo e Δz_i il suo spessore.
I cedimenti permanenti indotti dall'azione sismica possono essere dovuti alle deformazioni volumetriche (e quindi verticali) di:

- terreni granulari saturi,
- terreni granulari insaturi,
- terreni coesivi soffici.

I cedimenti conseguenti a liquefazione di terreni granulari saturi hanno luogo immediatamente dopo il terremoto o comunque in un tempo non superiore a un giorno, i cedimenti per densificazione di terreni granulari insaturi avvengono durante lo scuotimento sismico, mentre i cedimenti per consolidazione di terreni coesivi soffici possono richiedere tempi anche molto lunghi in funzione delle condizioni stratigrafiche e geotecniche.
Il calcolo dei cedimenti post-sismici in terreni incoerenti (*vertical settlements*) in condizioni sature (*liquefaction vertical settlements*) e insature (*dry sand vertical settlements*), eseguito per la verticale CPTU ha evidenziato quanto segue:

CPTU	Dry Seattle (cm)	Liq Seattle (cm)
CPTU1	0	3.7
CPTU2	0	0.6
CPTU3	0	5.2
CPTU4	0	1
CPTU5	0	0.56
CPTU6	0	0.25
CPTU7	0	2.02
CPTU8	0	0.43
CPTU9	0	0.6

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CPTU10	0	3.52
CPTU11	0	0.36
CPTU12	0	2.4

Per la stima della portata del danneggiamento dovuto al verificarsi dei cedimenti post-sismici è possibile fare riferimento agli autori Ishihara & Yoshimine (Soils and Foundations Vol.32, No. 1, 173-188, Mar 1992 Japanese Society of Soil Mechanics and Foundation Engineering) (Fig. n. 10.2).

Table 1. Relation between damage extent and approximate settlements

Extent of damage	Settlements (cm)	Phenomena on the ground surface
Light to no damage	0~10	Minor cracks
Medium damage	10~30	Small cracks, oozing of sand
Extensive damage	30~70	Large cracks, spouting of sands, large offsets, lateral movement

Relazione tra la portata del danneggiamento e il valore di cedimento post-sismico Ishihara & Yoshimine 1992

Considerando la classificazione indicata, il valore di cedimento ottenuto si riferisce a una classe di danneggiamento bassa. I fenomeni attesi in superficie sono relativi a piccole crepe.

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5 CARATTERIZZAZIONE SISMICA DEL SITO

5.1 Pericolosità sismica di base

Secondo la classificazione sismica del territorio nazionale proposta a partire dall'O.P.C.M. n. 3274/2003 e successive modifiche, il **Comune di Ravarino (MO)** risulta appartenente alla **classe di sismicità 3** (Fig. 4.1).

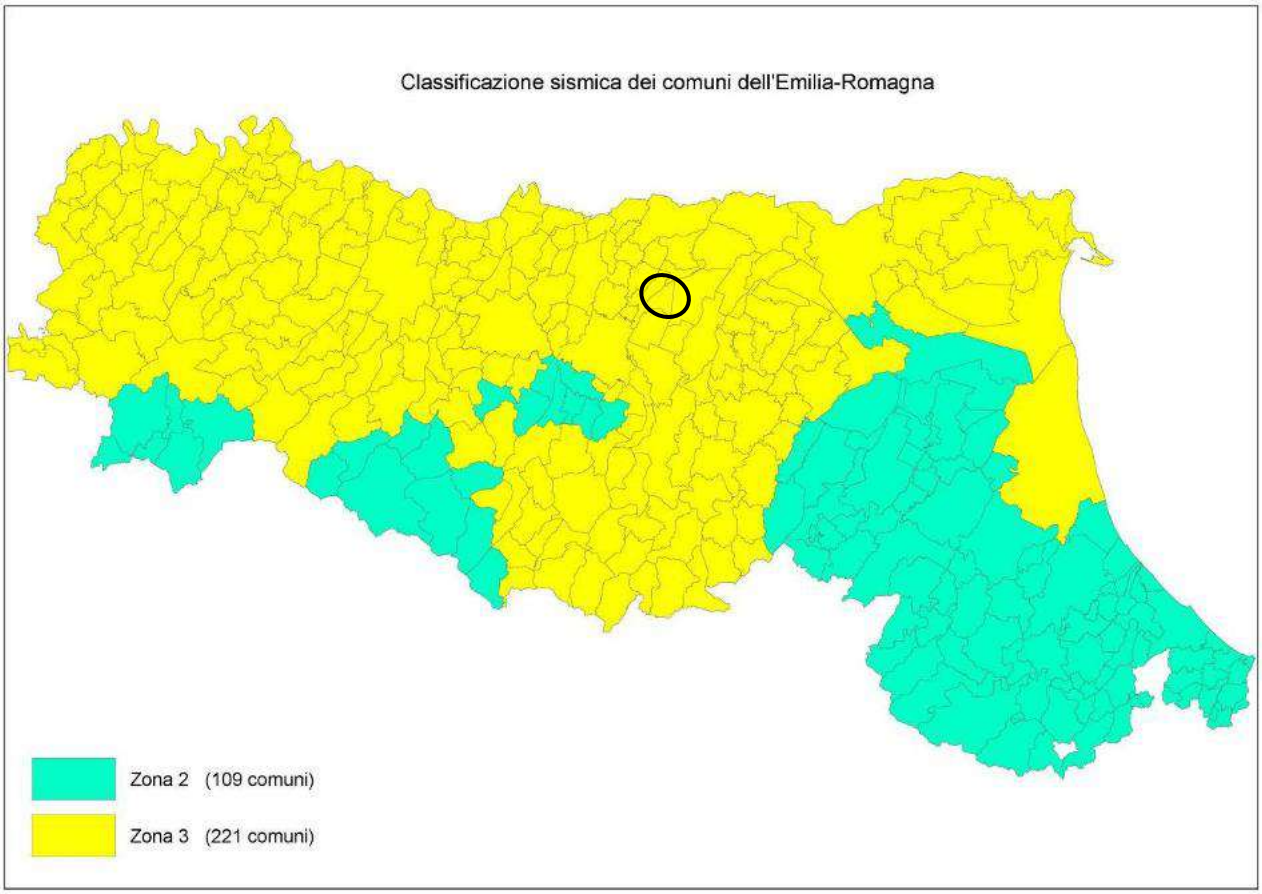

Fig.4.1 - Classificazione sismica dei comuni della Regione Emilia-Romagna (DGR 146/23).

La suddivisione del territorio nazionale in zone a diversa classe di sismicità, caratterizzate da un valore di accelerazione di picco ed un corrispondente spettro di risposta elastico da utilizzare nella progettazione, risulta in realtà superata dall'entrata in vigore del D.M. 14/01/2008. Sulla base dei contenuti delle NNTC 2008 e delle successive NTC 2018, per ogni costruzione deve essere definita un'accelerazione di riferimento propria, in funzione delle coordinate geografiche dell'area e della vita nominale dell'opera.

Per ciascuna area in oggetto, in relazione a un periodo di riferimento $\mathbf{T_R}$ stimato di 712 anni, è stato definito un parametro di accelerazione massima attesa $\mathbf{a_g}$ definita in condizioni di campo libero su sito di riferimento rigido e con superficie topografica orizzontale. L'accelerazione $\mathbf{a_g}$ rappresenta uno dei parametri principali che definisce la **pericolosità sismica di base**, insieme ai parametri $\mathbf{F_0}$ e **Tc*** dello spettro di risposta elastico, desumibili nelle tabelle riportate sotto (Tab. 4.1).

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Stati limite

Classe Edificio

II. Affollamento normale. Assenza di funz. pubbliche e sociali...

Vita Nominale 50

Interpolazione Media ponderata

CU = 1

Stato Limite	Tr [anni]	a_g [g]	Fo	Tc^* [s]
Operatività (SLO)	30	0.044	2.499	0.254
Danno (SLD)	50	0.056	2.497	0.269
Salvaguardia vita (SLV)	475	0.157	2.591	0.272
Prevenzione collasso (SLC)	975	0.209	2.529	0.279
Periodo di riferimento per l'azione sismica:	50			

Coefficienti sismici

Tipo: Stabilità dei pendii e fondazioni

☐ Muri di sostegno che non sono in grado di subire spostamenti

H (m): 1 — us (m): 0.1

Cat. Sottosuolo: C

Cat. Topografica: T1

	SLO	SLD	SLV	SLC
SS Amplificazione stratigrafica	1,50	1,50	1,46	1,38
CC Coeff. funz categoria	1,65	1,62	1,61	1,60
ST Amplificazione topografica	1,00	1,00	1,00	1,00

☐ Acc.ne massima attesa al sito [m/s²] 0.6

Coefficienti	SLO	SLD	SLV	SLC
kh	0.013	0.017	0.055	0.081
kv	0.007	0.008	0.027	0.040
Amax [m/s²]	0.652	0.823	2.246	2.832
Beta	0.200	0.200	0.240	0.280

Tab.5.1 - Parametri sismici del sito in esame secondo NTC18.

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5.2 Azione sismica e risposta sismica del sito – Approccio semplificato

Per la definizione dell'azione sismica, sulla base di quanto previsto dalle NTC si può fare riferimento ad un approccio semplificato che **si basa sull'individuazione della categoria di sottosuolo e le condizioni topografiche del sito**, in funzione delle quali si definiscono l'entità dell'amplificazione stratigrafica e topografica. Sulla base delle NTC 2018, e tenendo conto dei dati ottenuti **dalle indagini geofisiche eseguite in sito**, si **classifica** il terreno di fondazione in oggetto, come appartenente alla **categoria C**.

Si ricava quindi il **fattore stratigrafico S_s**, mediante la seguente relazione, valida suoli in classe C:

$$\mathbf{1.00 \leq S_s = 1.70 - (0.60 \bullet F_o \bullet a_g/g) \leq 1.50} \qquad (4.1.1)$$

dove:

- **F_o** = fattore che quantifica l'amplificazione spettrale massima, su sito di riferimento rigido orizzontale, ed ha valore minimo pari a 2.2;
- **a_g/g** = accelerazione orizzontale del sito, con tempo di ritorno pari a **475 anni**/accelerazione di gravità;
- **S_S** = coefficiente di amplificazione stratigrafica o fattore stratigrafico, calcolato tramite la relazione sopra riportata**.**

Successivamente, sulla base delle condizioni topografiche del sito studiato, si considera un valore di un fattore topografico **S_T** sulla base della seguente tabella:

Categoria topografica	Ubicazione opera/intervento	ST
T1	Superficie pianeggiante, pendii e rilievi isolati con inclinazione media ≤ 15°	**1.0**
T2	Pendii con inclinazione media > 15°	**1.2**
T3	Rilievi con larghezza in cresta molto minore che alla base e inclinazione media 15°≤ i ≤ 30°	**1.2**
T4	Rilievi con larghezza in cresta molto minore che alla base e inclinazione media > 30°	**1.4**

Per l'area studiata si riportano in tabella i parametri della pericolosità di base.

PARAMETRI PERICOLOSITÀ DI BASE			
Tr (anni)	**ag(g)**	**Fo**	**Tc*(s)**
475	0.157	2.591	0.272

PARAMETRI PERICOLOSITÀ DI SITO	
S_s	**S_T**
1.46	1.00

Si calcola infine per ciascuna area l'accelerazione massima orizzontale **A_{max}** con la seguente formula:

$$\mathbf{A_{max} = S_S \bullet S_T \bullet a_g = 1.57 \bullet 1.0 \bullet 0.146 = 0.229g}$$

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5.3 Azione sismica e risposta sismica del sito – Analisi di risposta sismica locale

Per ottemperare ai riferimenti normativi citati l'analisi è stata svolta secondo quanto indicato al § 7.11.3 delle NTC 2018, attraverso analisi numerica monodimensionale in campo lineare equivalente. Per fare ciò è stato utilizzato come strumento di lavoro il software di calcolo STRATA (University of Texas - Austin).

Ai fini della restituzione degli spettri di accelerazione, relativi allo stato limite SLV, è stata svolta la verifica dell'amplificazione del sito mediante l'utilizzo di un modello simulato in campo lineare equivalente.

Utilizzando un modello lineare equivalente è possibile ottenere una soluzione di un modello non lineare, attraverso analisi lineari complete nelle quali al termine di ogni interazione vengono aggiornati i parametri di **rigidezza** e **smorzamento** che sono dipendenti dallo stato di deformazione del terreno. Attraverso un'iterazione di calcoli si raggiunge una convergenza prefissata a monte della fase di computazione.

Il software STRATA è in grado di valutare la risposta sismica di un deposito di terreno, considerando un profilo monodimensionale in cui si propagano linearmente le onde sismiche, in funzione dei parametri dinamici attribuiti al terreno. Il terreno viene schematizzato come un sistema di N strati orizzontali omogenei, isotropi e visco-elastici, sovrastanti un semispazio uniforme, attraversati da un treno di onde di taglio che incidono verticalmente le superfici. Ogni strato è descritto per mezzo dello spessore *H*, del modulo di taglio massimo G_{max} o dalla corrispondente velocità massima V_{max}, dal valore dello smorzamento *D*, dal peso dell'unità di volume γ e dalle curve di decadimento del modulo di rigidezza a taglio normalizzato (G / G_0-γ) e le corrispondenti curve dello smorzamento (D -γ) con la deformazione di taglio γ. Il modello lineare visco-elastico fa riferimento al modello reologico di Kelvin-Voigt, costituito da una molla e uno smorzatore viscoso in parallelo. Tale modello è descritto quindi dalla rigidezza (**G)** e dallo smorzamento (**D**). L'onda monodimensionale viene descritta dall'equazione in cui lo spostamento provocato (*u*) è funzione della profondità (*z)* e del tempo (*t):*

$$u(z,t)=A\exp[i(\omega t+k^* z)]+B\exp[i(\omega t-k^* z)]$$

Nell'equazione appena presentata A e B rappresentano le corrispettive amplificazioni del tetto e della base dello strato considerato. Il fattore *k** risulta dipendente dal modulo di taglio (*G*), dal grado di smorzamento (*D*) e dalla densità del terreno (*ρ*). Le relazioni sono le seguenti:

$$k^* = \frac{\omega}{v_s^*}$$

$$v_s^* = \sqrt{\frac{G^*}{\rho}} \qquad G^* = G\left(1 - 2D^2 + i2D\sqrt{1 - D^2}\right) \simeq G(1 + i2D)$$

Dove G* e v^*_s rappresentano il modulo di taglio e la velocità di taglio.

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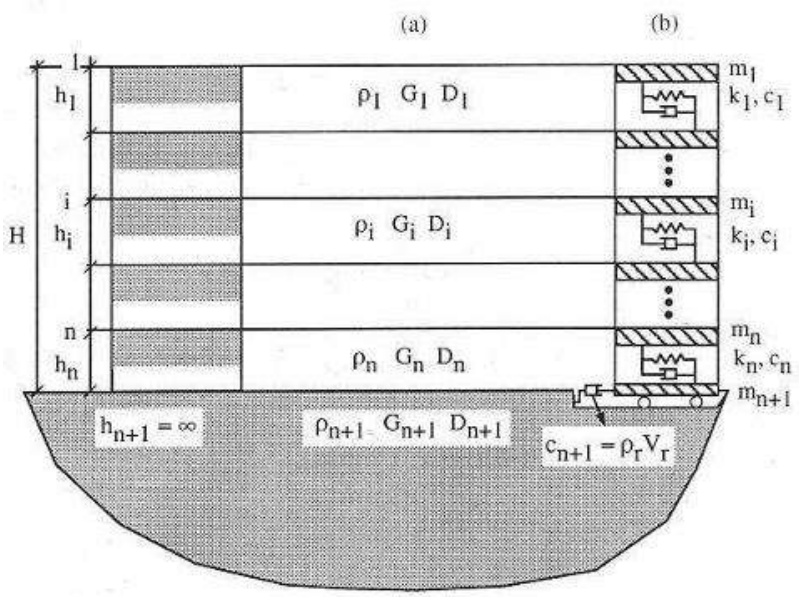

Fig.4.2 - Modello a strati continui adottato per la simulazione con il codice di calcolo STRATA.

MODELLO SIMULATO

Il modello simulato deriva dai dati ottenuti dalle prove che compongono la campagna geognostica eseguita in sito. Tale profilo approssima il comportamento del sottosuolo, dal punto di vista sismico, in corrispondenza dell'area studiata. Il profilo considerato deriva dall'interpolazione dei dati provenienti dalle indagini geofisiche eseguite, e i dati, di natura bibliografica, disponibili per il sito di riferimento**.**
Il profilo sismico del sottosuolo utilizzato per la modellazione della RSL deriva dall'elaborazione congiunta delle indagini HVSR e MASW eseguite in sito, integrato con dati di bibliografici. Si illustra successivamente il modello utilizzato:

Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
5.00	5.00	140	0.42
15.00	10.00	180	0.42
30.00	15.00	230	0.42
50.00	20.00	280	0.42
80.00	30.00	300	0.42
140.00	60.00	400	0.42
inf.	inf.	530	0.42

Per descrivere il comportamento dinamico dei terreni costituenti il modello sono state considerate curve di decadimento dei moduli di rigidezza e smorzamento, al variare della deformazione percentuale γ(%). Si riportano successivamente le curve di decadimento considerate per l'esecuzione del calcolo di risposta sismica locale:

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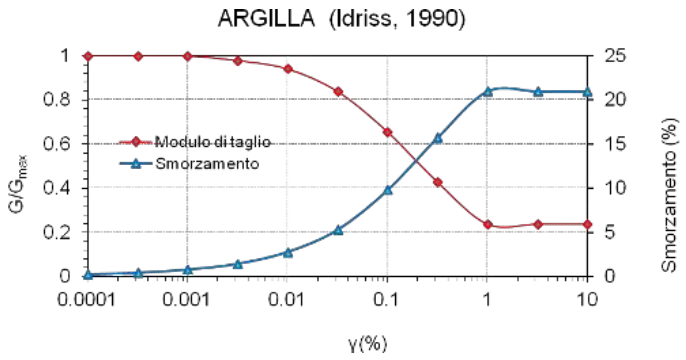

Fig.4.4 - Curve di decadimento dei moduli G/Gmax e D, utilizzate per descrivere il comportamento dei materiali coesivi che compongono il sottosuolo in oggetto.

Trattandosi di una verifica diretta ai fini progettuali, in accordo con quanto esposto nel § 7.3 delle NTC 2018, l'analisi RSL in oggetto è stata svolta adottando come input sismico 30 accelerogrammi, corrispondenti allo stato limite SLV. Gli accelerogrammi reali e misurati, sono stati individuati mediante l'utilizzo del software REXEL v. 3.5 (Computer aided code-basedreal record selection for seismicanalysis of structures) realizzato dal Dipartimento di Strutture per l'ingegneria e l'architettura dell'Università degli Studi di Napoli Federico II. Utilizzando le coordinate relative al sito di riferimento, considerando una categoria di sottosuolo A e una classe d'uso pari a II e una vita nominale pari a 50 anni, sono stati definiti n. 30 accelerogrammi per lo stato limite SLV. Gli accelerogrammi sono stati prelevati dal "European Strong-motion Database".

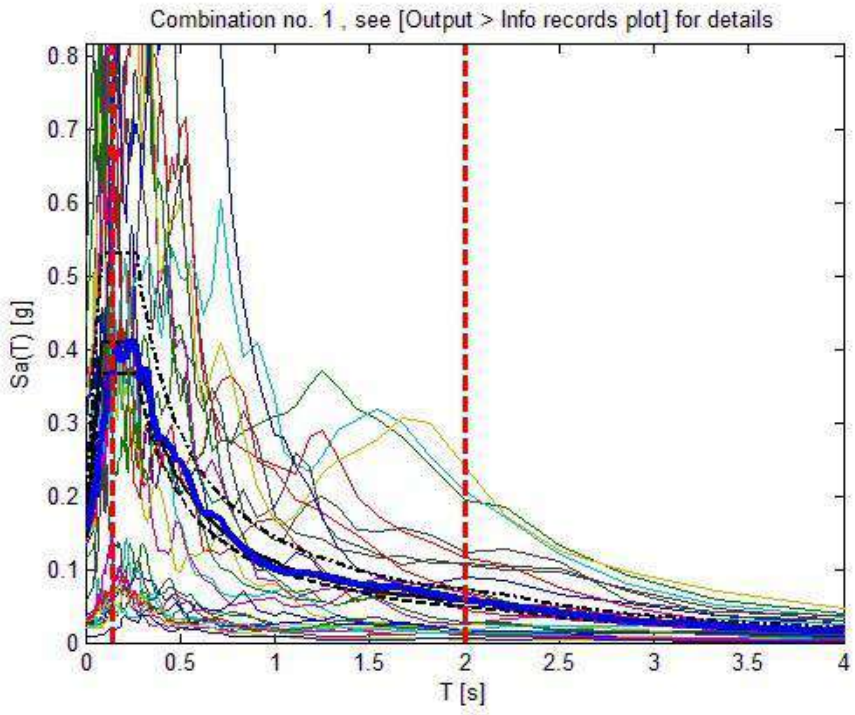

Fig.4.5 - Forme spettrali relative agli accelerogrammi considerati.

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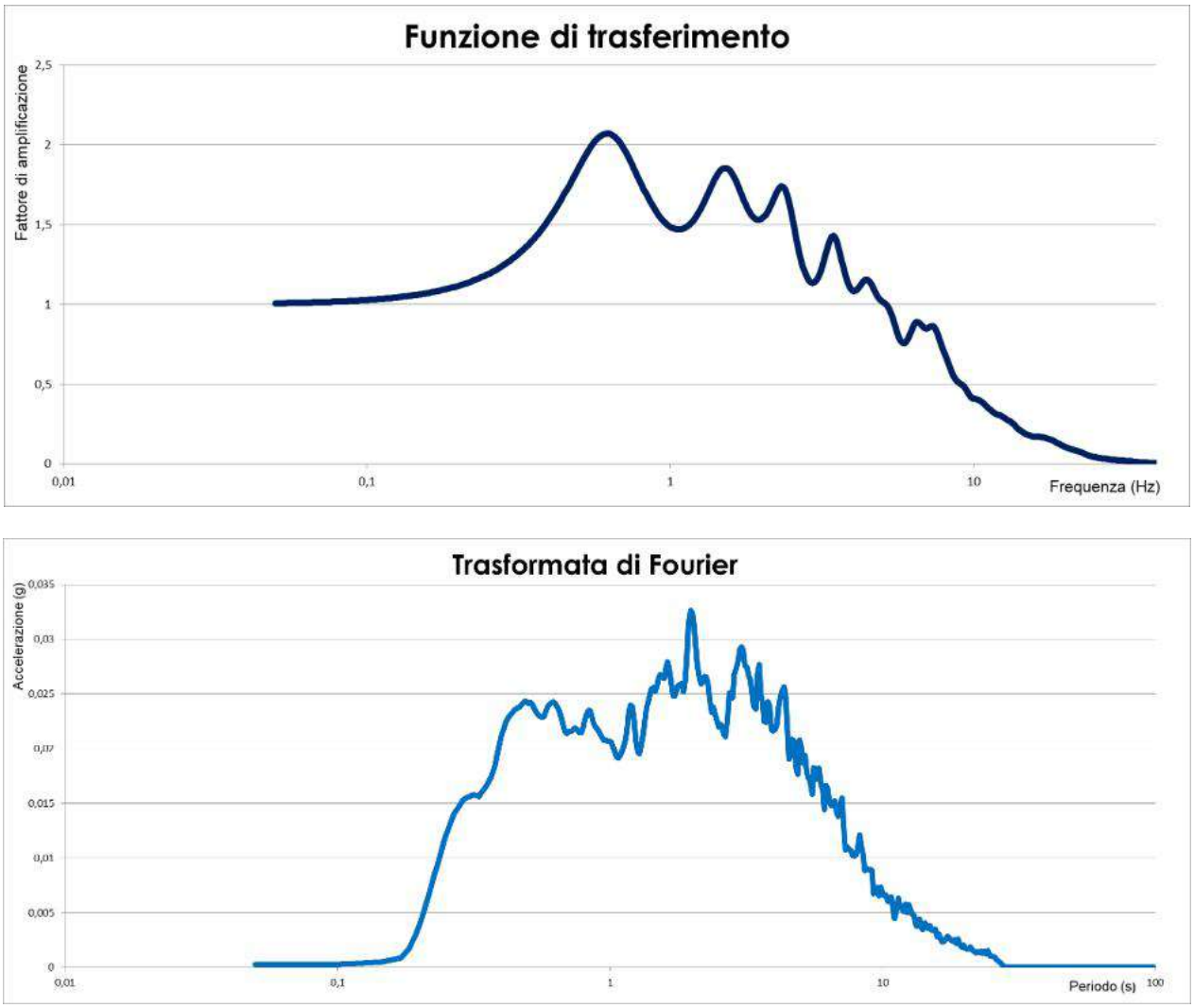
RISULTATI OTTENUTI

Sulla scorta delle verifiche svolte mediante software STRATA, in riferimento al modello considerato, è stato possibile definire, nel dominio delle frequenze, la funzione TF (Funzione di trasferimento) e rapporto spettrale di amplificazione associato. Per via grafica si inserisce successivamente la funzione di trasferimento TF ottenuta a seguito dell'analisi RSL in oggetto. Attraverso tale funzione è possibile definire il campo di frequenze entro il quale il sottosuolo, in corrispondenza del sito in oggetto, amplifica il segnale sismico, oltre che a quantificare l'amplificazione stessa.



In alto Funzione di Trasferimento e in basso funzione FT.

Definiti i parametri che descrivono il comportamento del sottosuolo nel campo elastico lineare equivalente e descritti gli accelerogrammi su suolo rigido validi per il sito in oggetto, attraverso il software STRATA sono state definite le seguenti forme spettrali, in termini accelerazione e velocità alla superficie:

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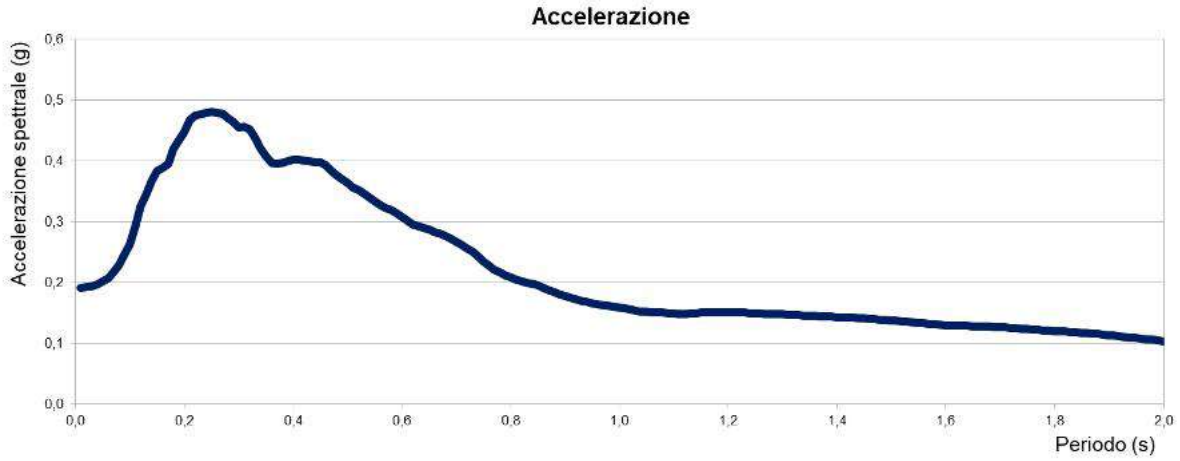
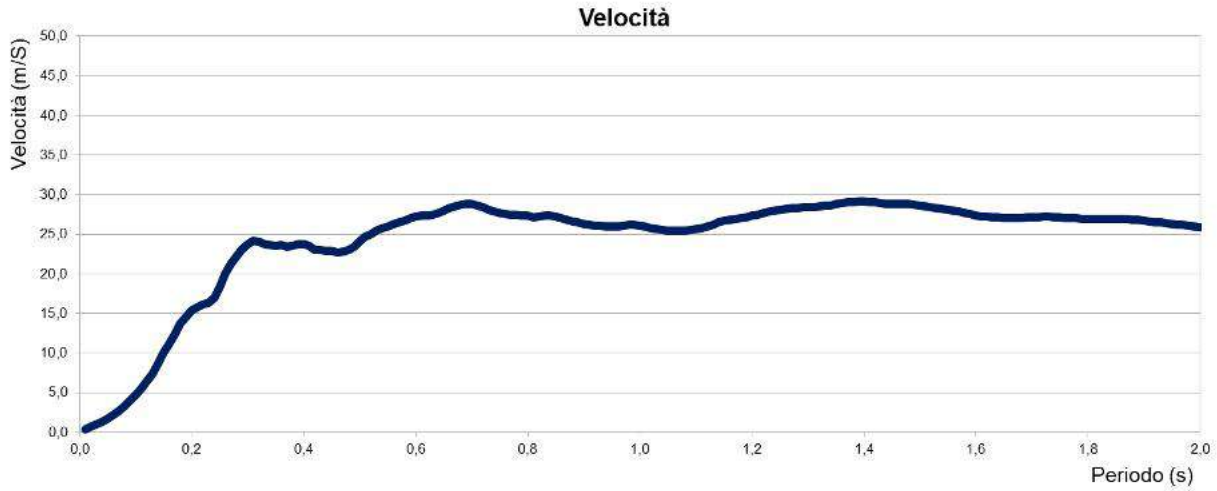


Accelerazioni spettrali relative a un periodo di ritorno pari a 475 anni (SLV)



Velocità spettrali relative a un periodo di ritorno pari a 475 anni (SLV).

Dati i valori di accelerazione ottenuti dal calcolo eseguito, è stato definito lo spettro normalizzato per lo stato limite considerato. Così facendo è stato ottenuto lo spettro a probabilità uniforme, sulla base dei risultati ottenuti mediante il software STRATA. Lo spettro normalizzato RSL è stato derivato attraverso le indicazioni contenute nell'ordinanza n.55 del 24 aprile 2018 "Disciplina per la delocalizzazione temporanea delle attività economiche o produttive e dei servizi pubblici danneggiati dal sisma eseguiti e conclusi in data anteriore a quella di entrata in vigore del decreto legge n. 189 del 2016".

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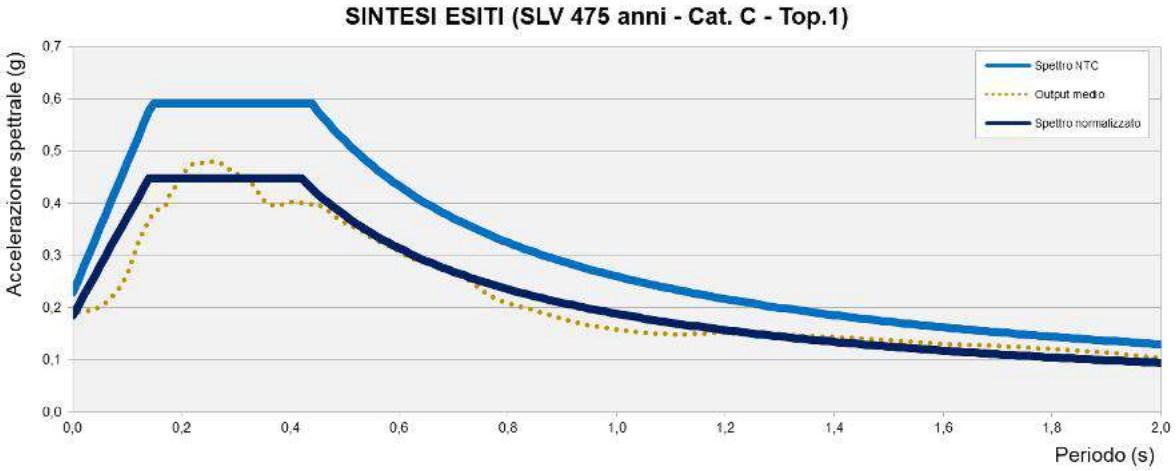

Sintesi esiti RSL e confronto con spettro NTC2018 (SLV) derivato secondo approccio semplificato

Lo spettro RSL, sia nella forma per punti, sia nella forma normalizzata, definito sulla base di 30 simulazioni definisce un'azione sismica **inferiore** rispetto a quanto derivabile secondo approccio semplificato NTC2018 per una categoria di sottosuolo di tipo C. Si illustra successivamente, in forma tabellare, lo spettro RSL per punti e il suo corrispettivo normalizzato.

SLV – PARAMETRI SPETTRO NORMALIZZATO - RSL						
ag (g)	**Fo**	**Tc***	**TB(s)**	**TC(s)**	**Ss**	**Amax (g)**
0.157	2.420	0.272	0.14	0.42	1.18	**0.185**

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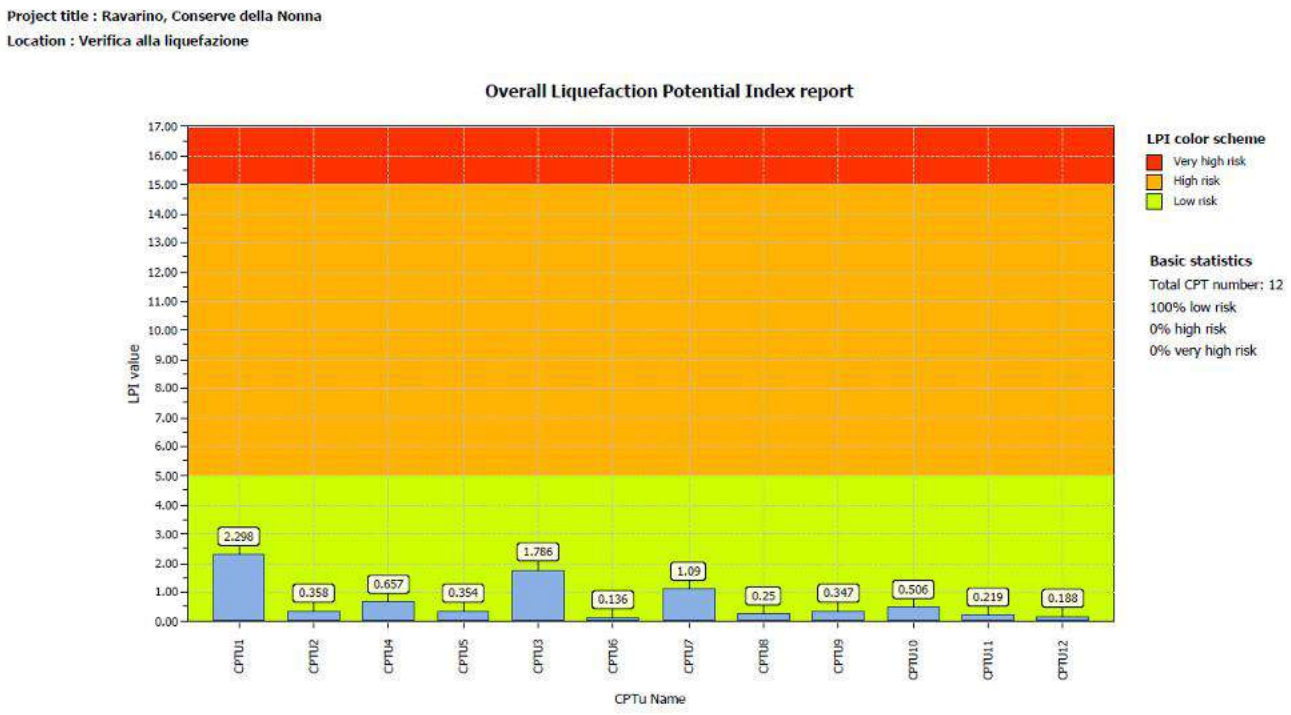
5.3.1 Stabilità nei confronti della liquefazione (§ A2.2. DGR 476/2021)

In accordo con la normativa regionale DGR 476/21 si è proceduto alla verifica della liquefazione per le verticali di prova CPTU, come descritto nel paragrafo §4.2.1.

Si illustra successivamente il valore di LPI derivato dalle verticali di prova considerando un'accelerazione massima al suolo A_{max}= **0.229g approssimata a 0.23g** (calcolata secondo l'approccio semplificato NTC18), la soggiacenza **della falda freatica è stata considerata alla quota D= -2.50 m da p.c.** e una magnitudo di riferimento pari a M=**6.14**.

A seguito della verifica, in riferimento alle verticali CPTu, sono stati ottenuti i seguenti valori di LPI:

INDAGINE	INDICE DI LIQUEFAZIONE	RISCHIO
CPTu1	2.298	MODERATO
CPTu2	0.358	BASSO
CPTu3	1.786	BASSO
CPTu4	0.657	BASSO
CPTu5	0.354	BASSO
CPTu6	0.136	BASSO
CPTu7	1.09	BASSO
CPTu8	0.25	BASSO
CPTu9	0.347	BASSO
CPTu10	0.506	BASSO
CPTu11	0.219	BASSO
CPTu12	0.188	BASSO



Valore di LPI

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6 MODELLAZIONE GEOLOGICA E GEOTECNICA DEL SITO

6.1 Modello geotecnico del sottosuolo

Sulla base dei dati emersi dall'elaborazione delle indagini geotecniche e litostratigrafiche, si può riassumere il seguente modello geotecnico schematico del terreno investigato.

Modello geotecnico medio

	Profondità	Spessore	Deposito	γ_{NAT} /γ_{SAT}	c'	Cu	Dr	φ'	Es	M	ρ	Dw
A	0.0 – 6.0	6.0	Argilla limosa limo argilloso a media scarsa consistenza	18.0/20.0	4.5	45.0	/	22	6300	4000	0.4	-2.50
B	6.0 – 8.0	2.0	Argilla limosa limo argilloso a scarsa consistenza	18.0/20.0	3.0	30.0	/	20	4200	2000	0.5	
C	8.0 – 10.0	2.0	Argilla limosa limo argilloso a media consistenza	18.0/20.0	6.0	60.0	/	23	8400	5000	0.38	
D	10.0 – 14.0	4.0	Argilla limosa limo argilloso a elevata consistenza	18.5/20.5	9.0	90.0	/	25	12600	10000	0.35	
E	14.0 – 15.0	1.0	Argilla limosa limo argilloso a elevata consistenza	18.5/20.5	7.0	70.0	/	23	9800	6000	0.38	
F	15.0 – 17.0	2.0	Argilla limosa limo argilloso a elevata consistenza	18.5/20.5	10.0	100.0	/	25	14000	12000	0.35	/
G	17.0 – 21.0	4.0	Argilla limosa limo argilloso a elevata consistenza	18.5/20.5	7.0	70.0	/	23	9800	4000	0.38	
H	21.0 – 24.0	3.0	Argilla limosa limo argilloso a media consistenza	18.0/20.0	5.0	50.0	/	22	7000	3000	0.4	/
I	24.0 - 30.0	6.0	Argilla limosa limo argilloso a elevata consistenza	18.5/20.5	10.0	100.0	/	25	14000	12000	0.35	
			Descrizione litologica	Peso di volume naturale e saturo	Coesione efficace	Coesione non drenata	Densità relativa	Angolo d'attrito efficace di picco	Modulo di Young	Modulo edometrico	Modulo di poisson	Soggiacenza
	M da p.c.	m		(kN/m3)	(kN/m2)	(kN/m²)	(%)	(°)	(kN/m²)	(kN/m²)		(m da p.c.)

La quota zero del presente modello corrisponde al piano campagna, dove sono state eseguite le prove penetrometriche CPTu.

Durante l'esecuzione delle indagini, è stato monitorato il livello piezometrico. In data 10/11/2025, la quota della falda è stata misurata a D=-2,50 m dal piano campagna per le prove CPTu. Si ricorda che il livello della falda può subire variazioni stagionali o essere influenzato da eventi meteorici intensi.

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6 CONSIDERAZIONI CONCLUSIVE

Il presente elaborato contiene la modellazione geologica, geotecnica e sismica derivante dalla sintesi dai risultati delle analisi e delle indagini eseguite nell'area di interesse a supporto della progettazione ingegneristica delle opere in progetto, in conformità alla normativa nazionale NTC 2018 e relative normative regionali DGR 630/19 e DGR 476/21.

Il progetto si muove nell'ambito dell'Art. 53 della Legge 24/2017, (accordi operativi e piani attuativi di iniziativa pubblica), si è pertanto suddivisa la relazione in due parti.
Nella prima parte viene eseguito uno studio di microzonazione sismica secondo la DGR 630/2019 e successiva DGR 476/2021 e nella seconda parte, a supporto del progetto esecutivo, la caratterizzazione sismica del sito avviene secondo le NTC18.

Per quel che concerne la caratterizzazione geofisica del sottosuolo si è fatto riferimento alla campagna indagini espletata. In ottemperanza della normativa tecnica nazionale (NTC 2018) e in accordo con i risultati ottenuti a seguito delle indagini geofisiche espletate è possibile classificare il terreno di fondazione come appartenente alla **categoria C**.

Per la definizione dell'azione sismica del sito, in riferimento alla **DGR 476/2021,** è stato eseguito l'approfondimento di **III livello,** dato che l'area in studio risulta essere instabile suscettibile di amplificazione. Da tale analisi ottiene un valore di accelerazione massima attesa al suolo del valore **$PGA_{max}=A_{max}=0.20g$** (per T=0 s).

Di seguito si riportano in tabella i valori di FA e HSM:

Fattore di amplificazione	Periodo T (s)	FA
Fattore di Amplificazione SA1	*0.1s≤T≤0.5s*	*1.31*
Fattore di Amplificazione SA2	*0.4s≤T≤0.8s*	*1.70*
Fattore di Amplificazione SA3	*0.7s≤T≤1.1s*	*1.68*
Fattore di Amplificazione SA4	*0.5s≤T≤1.5s*	*1.72*
Fattore di amplificazione	**Periodo T (s)**	**FA**
Fattore di Amplificazione SI1	*0.1s≤T≤0.5s*	*1.31*
Fattore di Amplificazione SI2	*0.5s≤T≤1.0s*	*1.70*
Fattore di Amplificazione SI3	*0.5s≤T≤1.5s*	*1.68*

H_{SM}	Periodo T (s)
H_{SM} = 455	0,1 s ≤T ≤ 0,5s
H_{0408}= 589	0,4 s ≤ T ≤ 0,8s
H_{0711}= 583	0,7 s ≤ T ≤ 1,1s
H_{0515}= 598	0,5 s ≤ T≤ 1,5s

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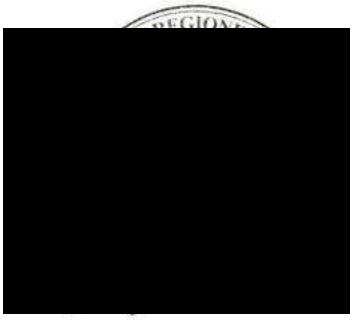
Per la definizione dell'azione sismica, a supporto del progetto esecutivo, è stato eseguito lo studio di pericolosità sismica utilizzando **l'approccio semplificato delle NTC 2018**. Dall'analisi così eseguita si sono ottenuti i seguenti risultati:

	Approccio semplificato NTC18		Approccio RSL	
ag	FA	Amax (g)	FA	Amax (g)
0.157	1.46	0.229	1.18	0.185

È stata eseguita la verifica della suscettibilità al fenomeno della liquefazione sulla base delle prove penetrometriche CPTU, considerando una accelerazione massima al suolo **A_{max} = 0.20g (secondo lo studio di risposta sismica locale di terzo livello) e una A_{max} = 0.23g (secondo l'approccio semplificato NTC18)**, e una **magnitudo di riferimento** pari a **M=6.14.** Dalle analisi delle suscettibilità nei confronti del fenomeno della liquefazione così eseguita si sono ottenuti valori di LPI corrispondenti a un **rischio di liquefazione basso e moderato** (§4.2.1 e §5.2.1).

Modena, 23 dicembre 2025



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TAVOLE

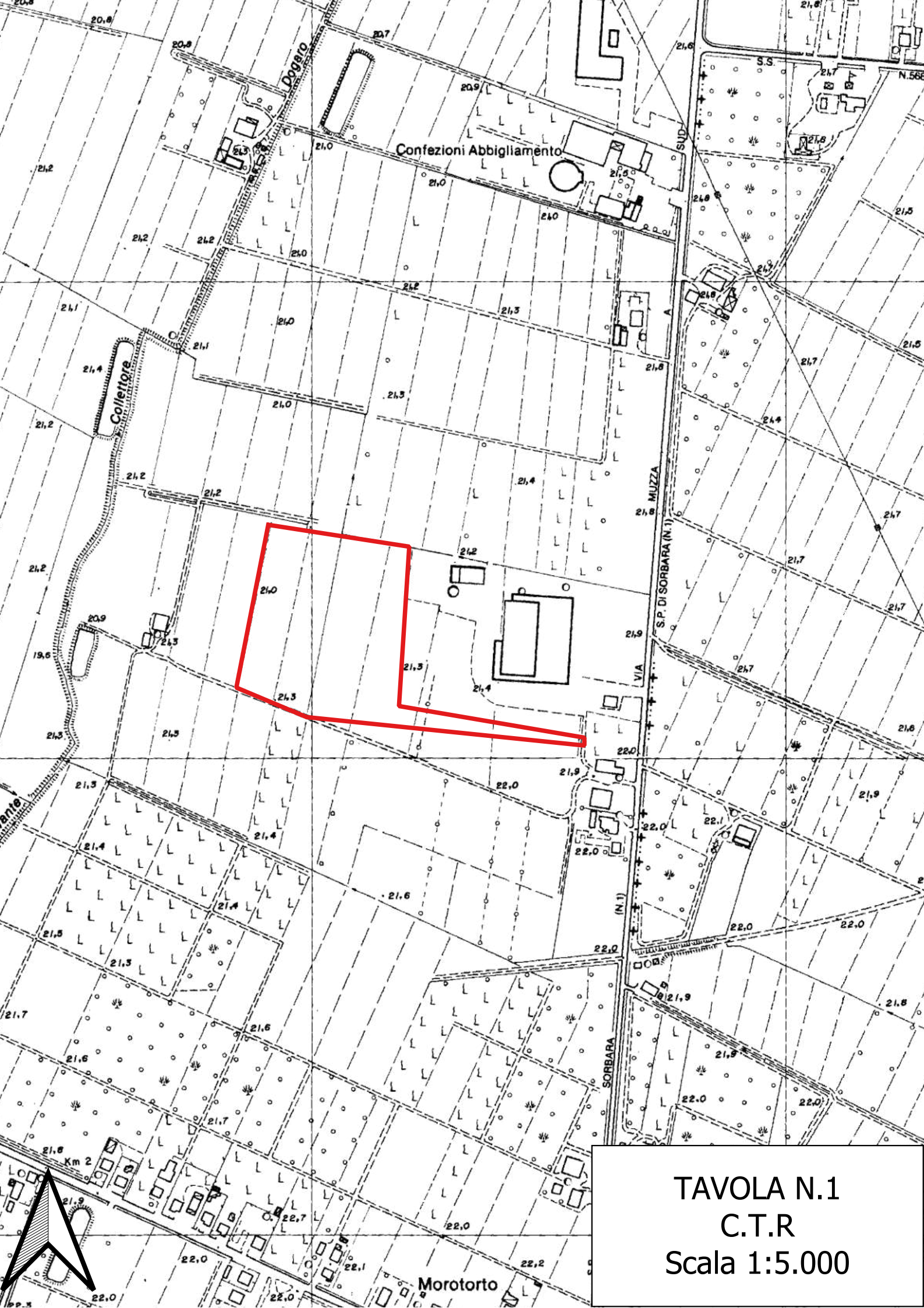

TAVOLA N.1
C.T.R
Scala 1:5.000

TAVOLA N.2
ripresa satellitare
Scala 1:5.000

TAVOLA N.3
UBICAZIONE INDAGINI
Scala 1:1.000

ALLEGATO 1

PROVE PENETROMETRICHE STATICHE CPTE/U

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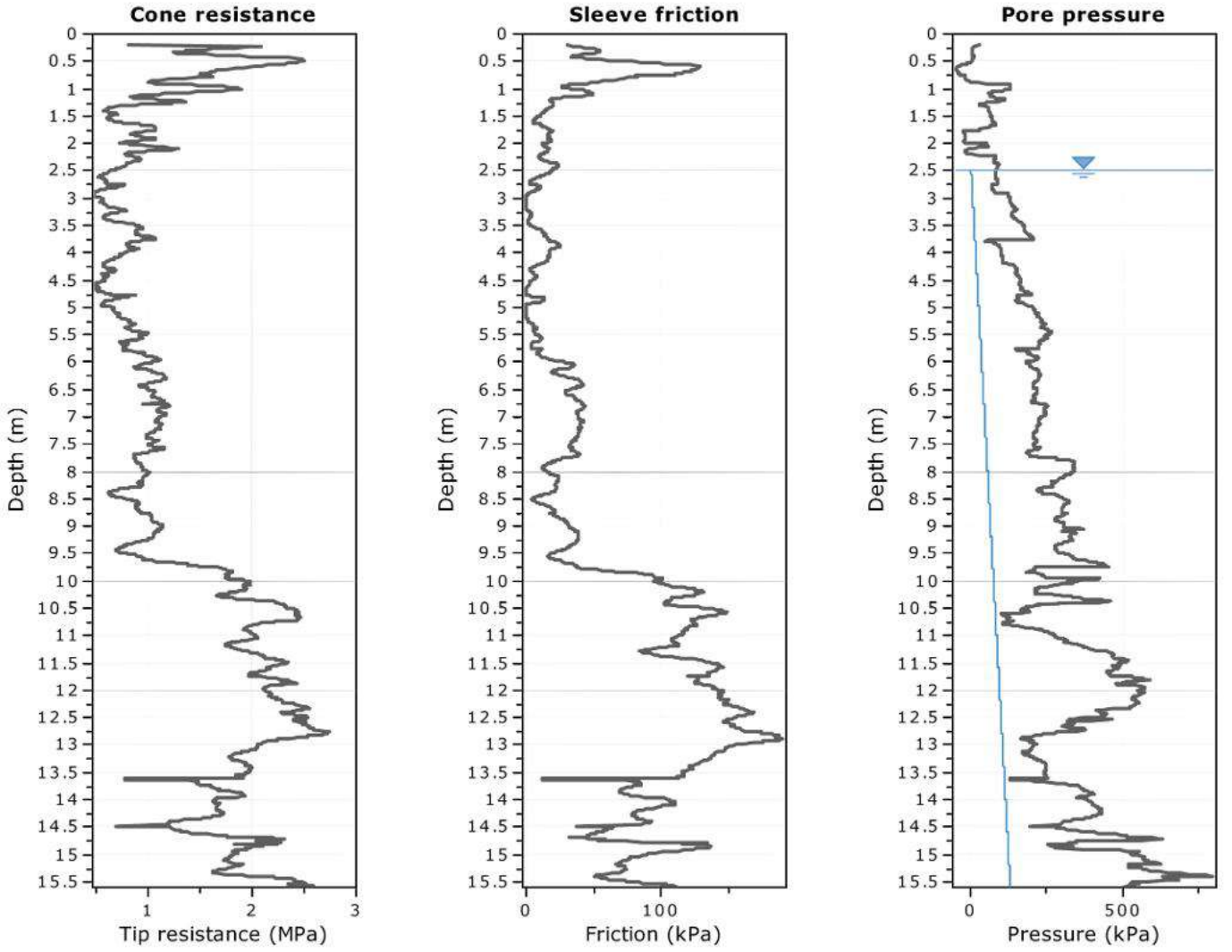
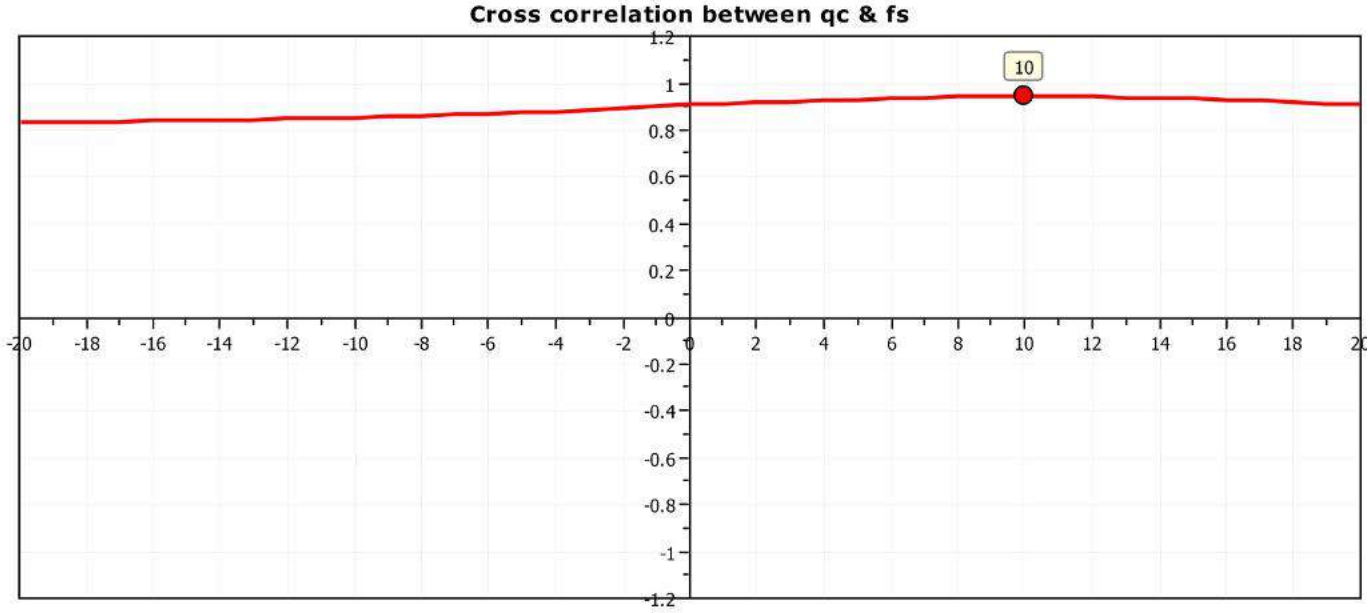
CPT: CPTU1
Total depth: 15.60 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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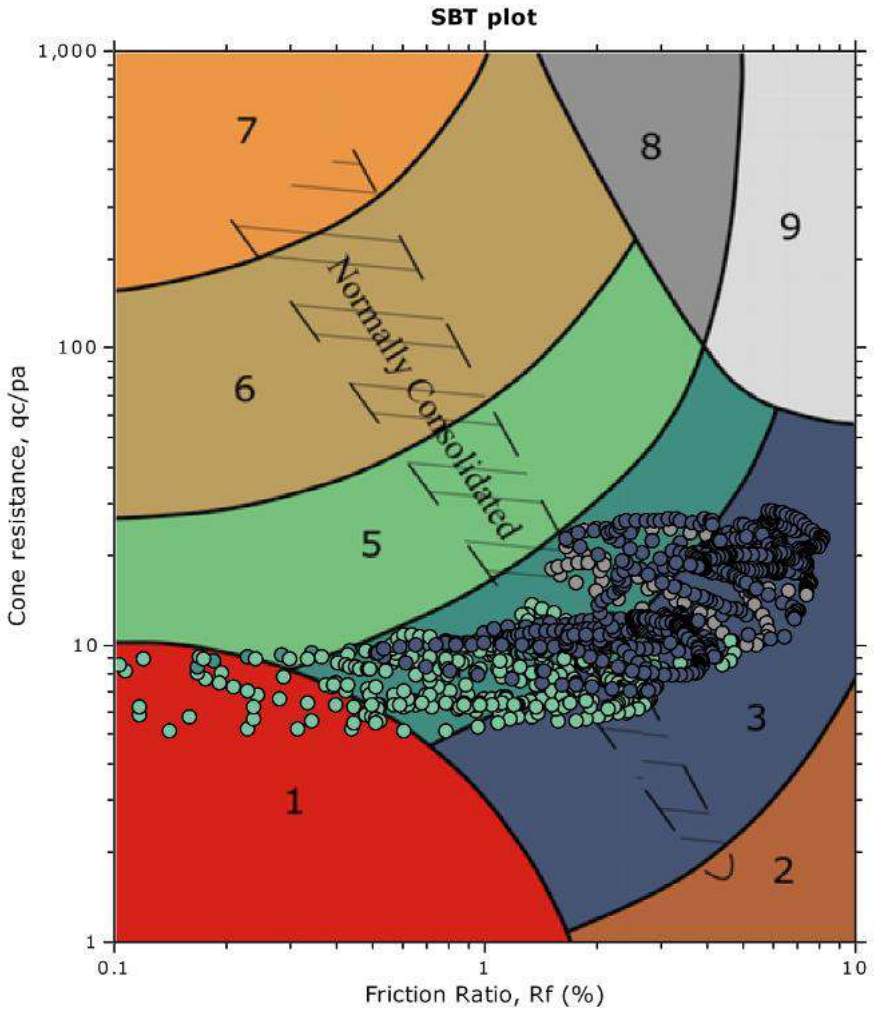
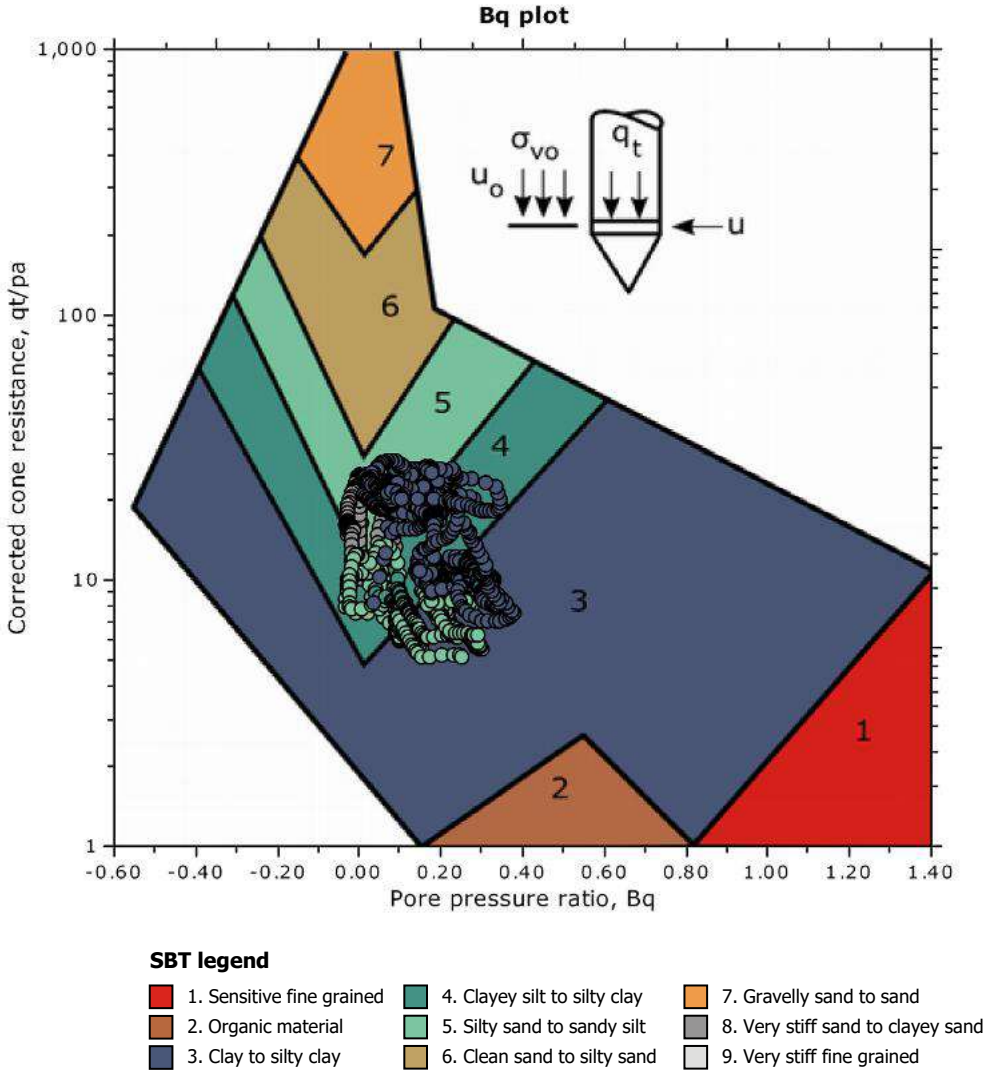
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU1
Total depth: 15.60 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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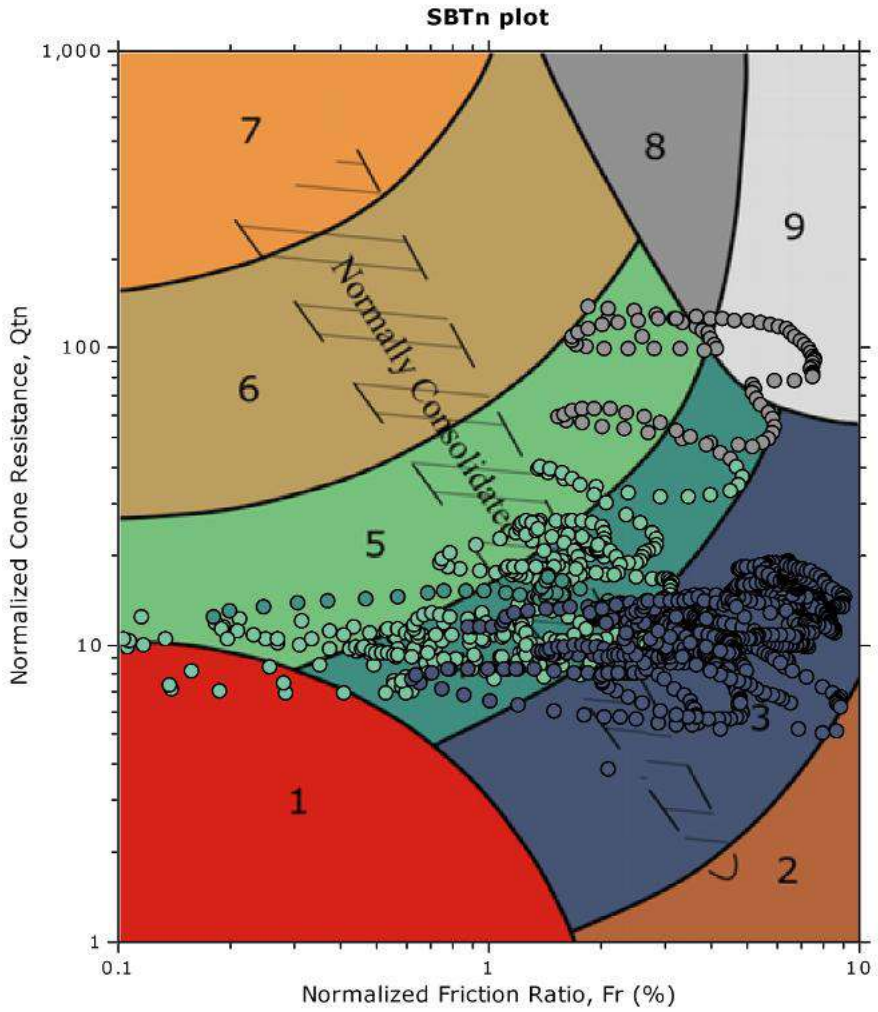
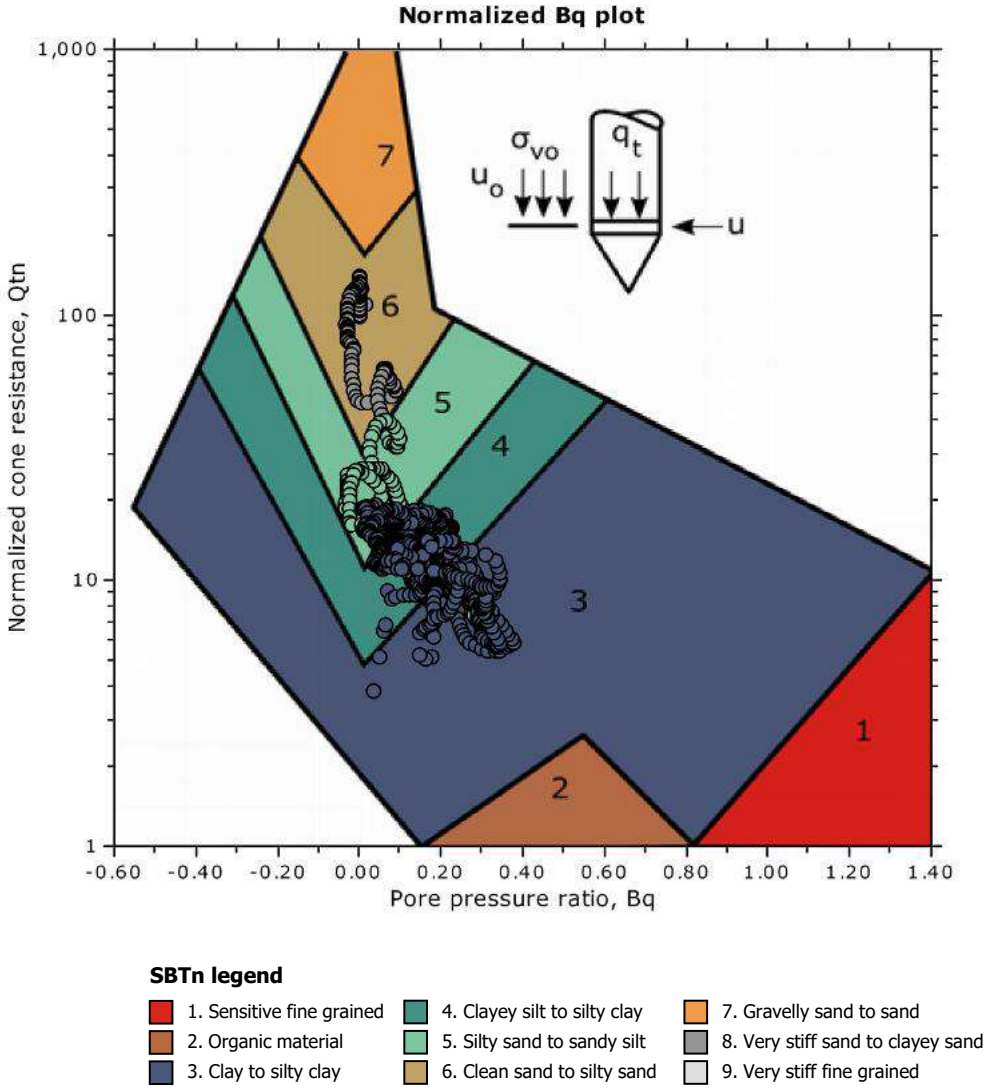
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU1
Total depth: 15.60 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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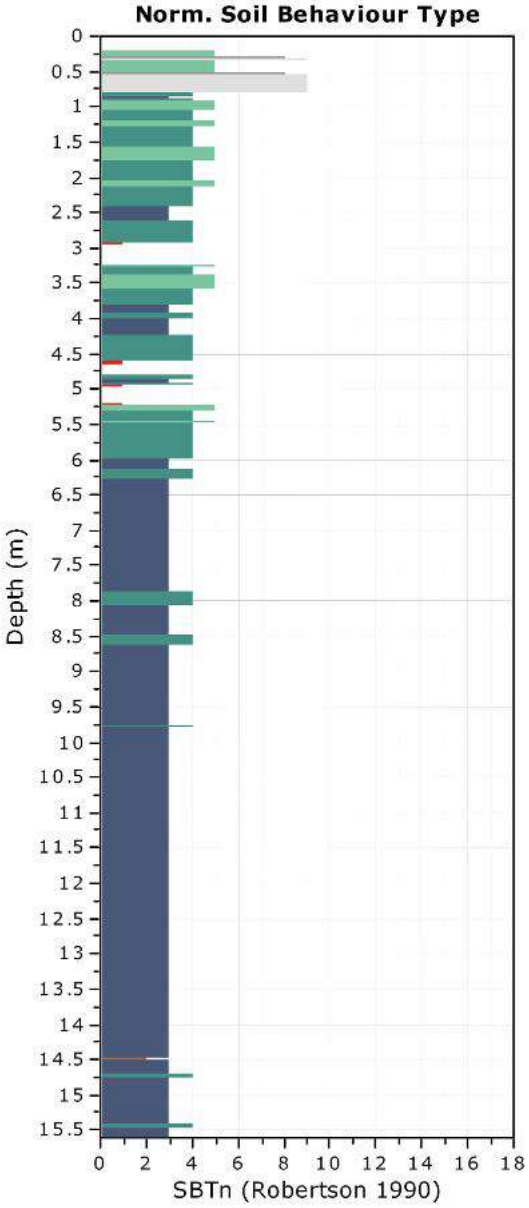
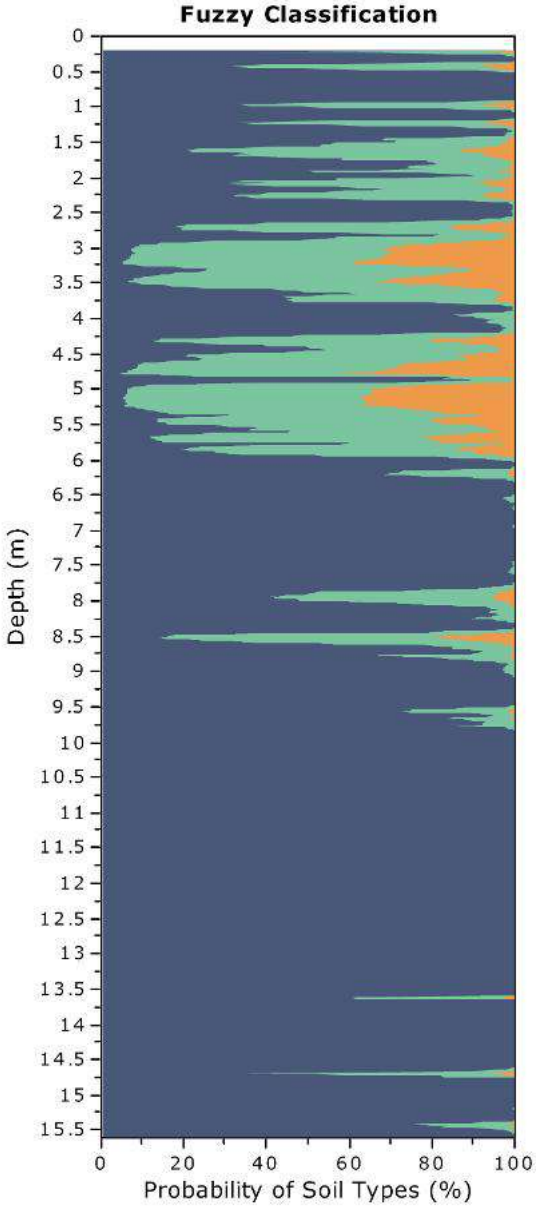
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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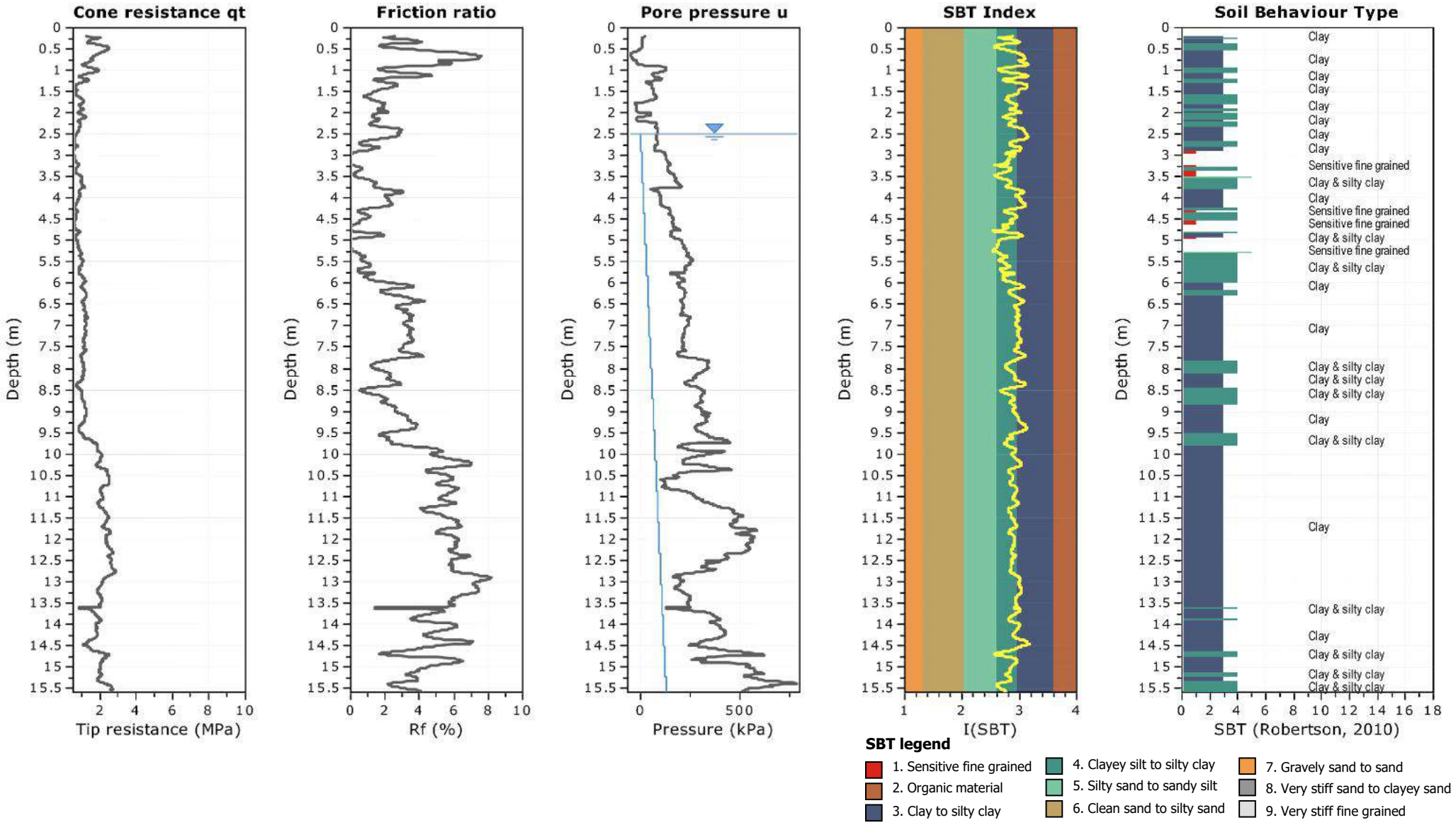
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU1
Total depth: 15.60 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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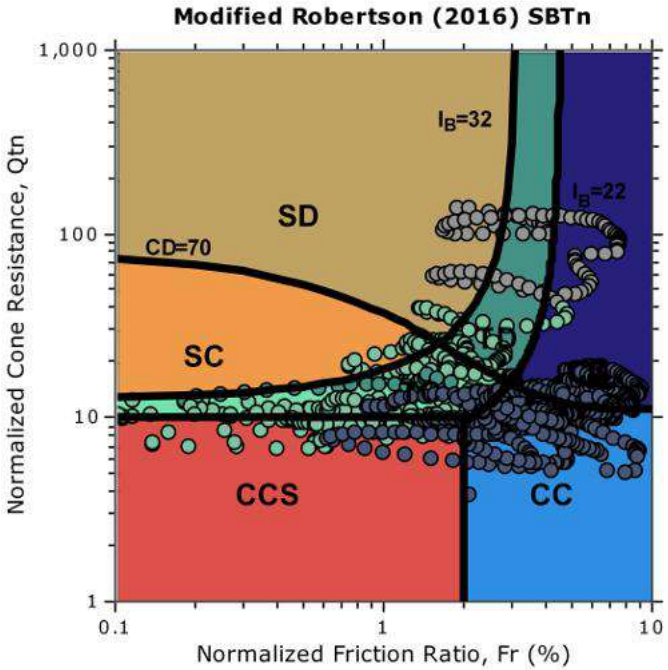
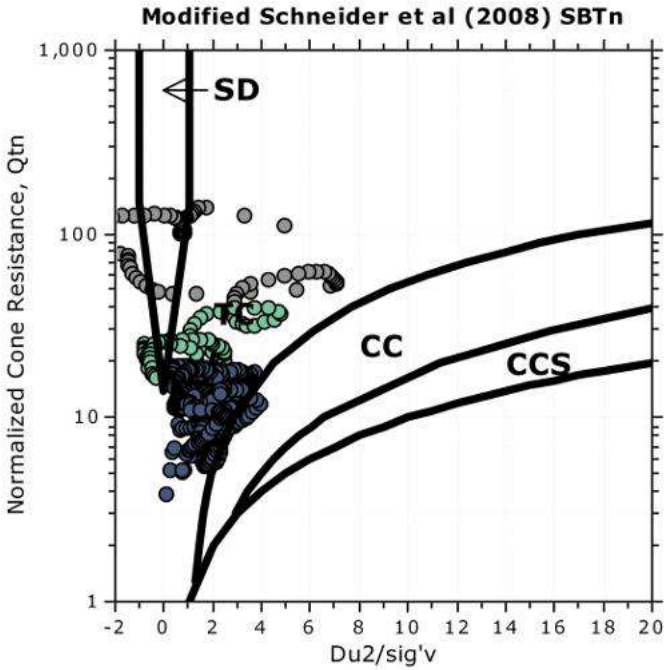
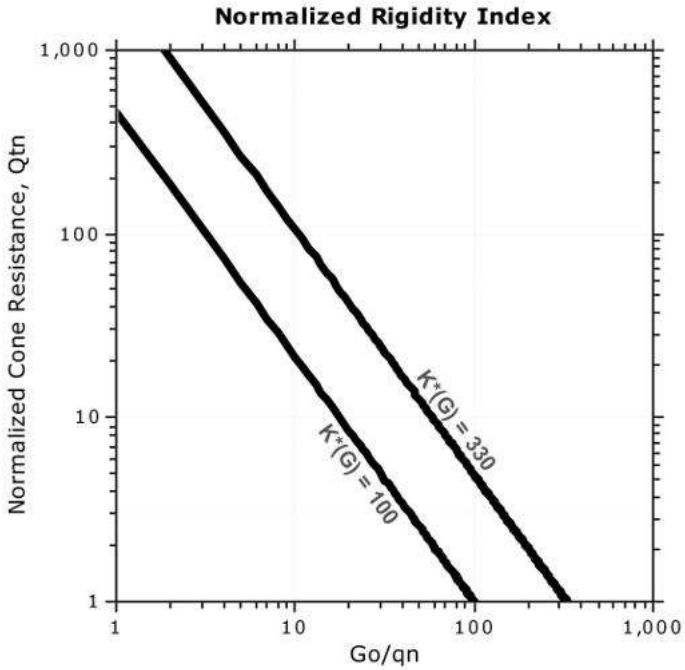
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU1
Total depth: 15.60 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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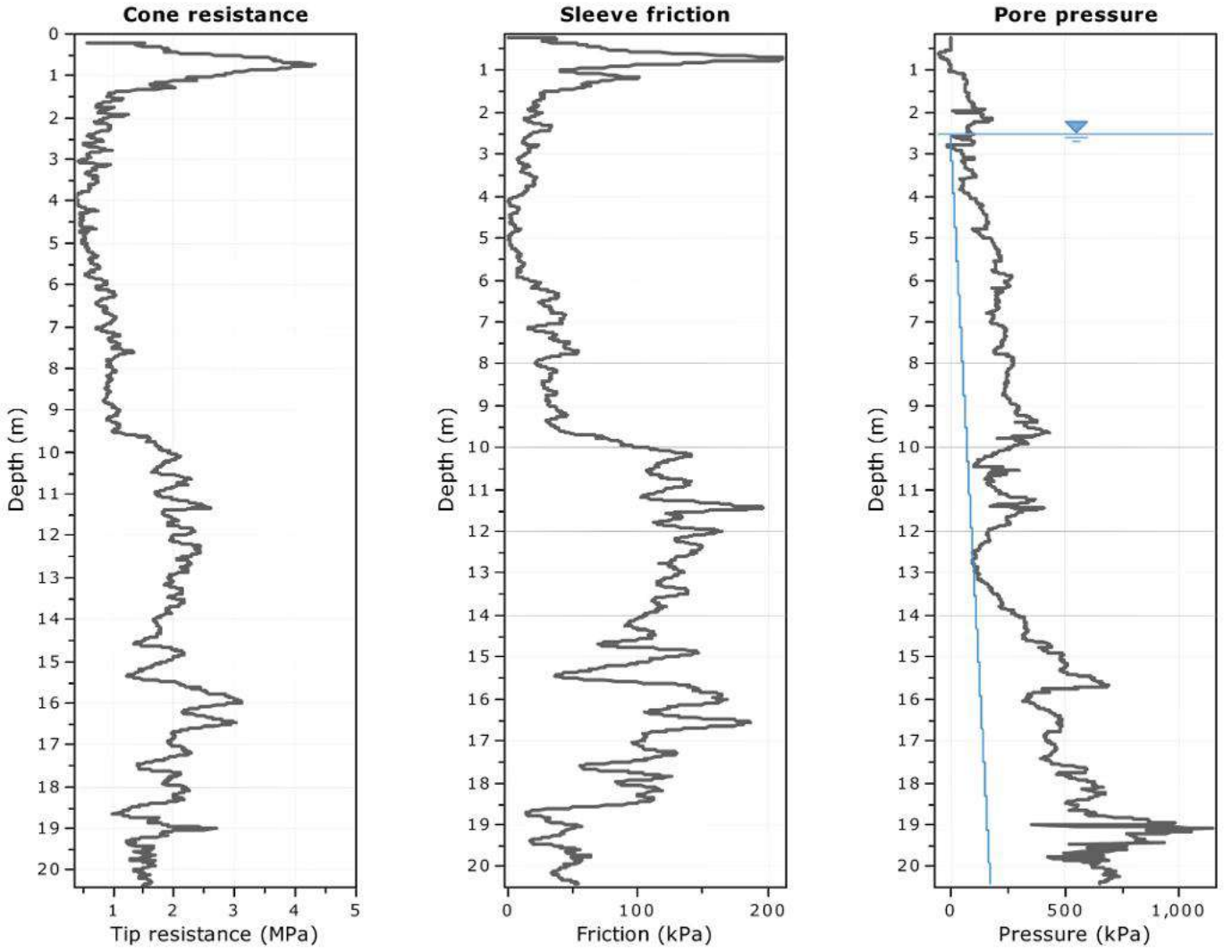
CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



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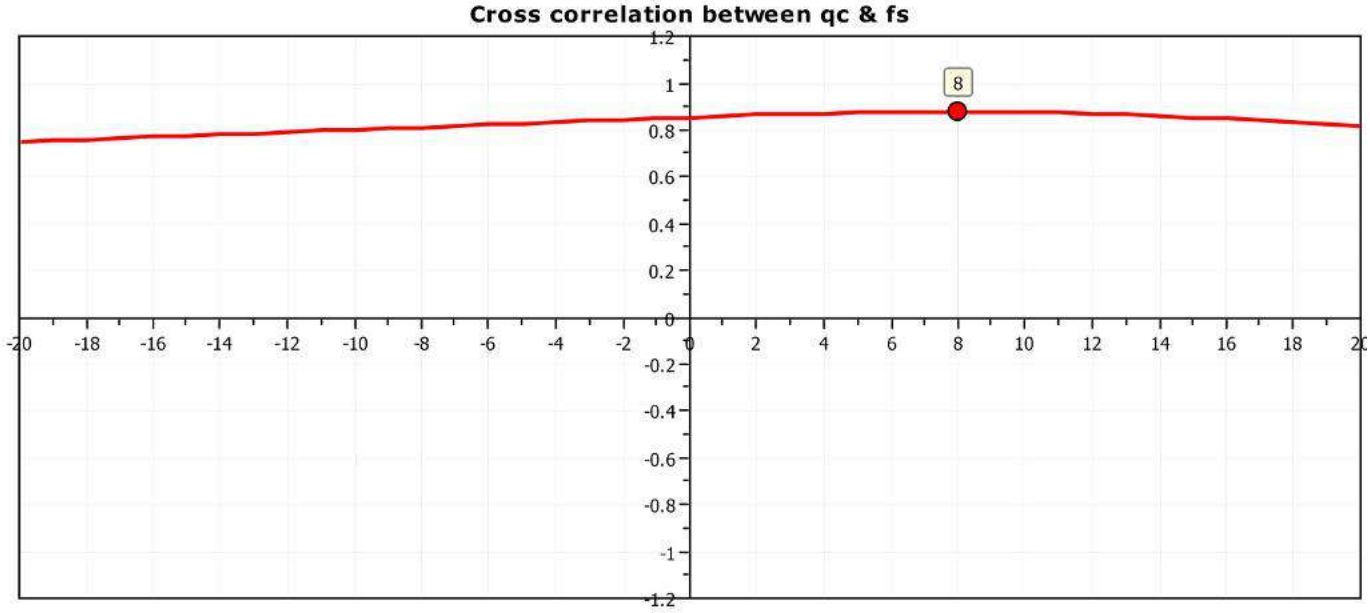

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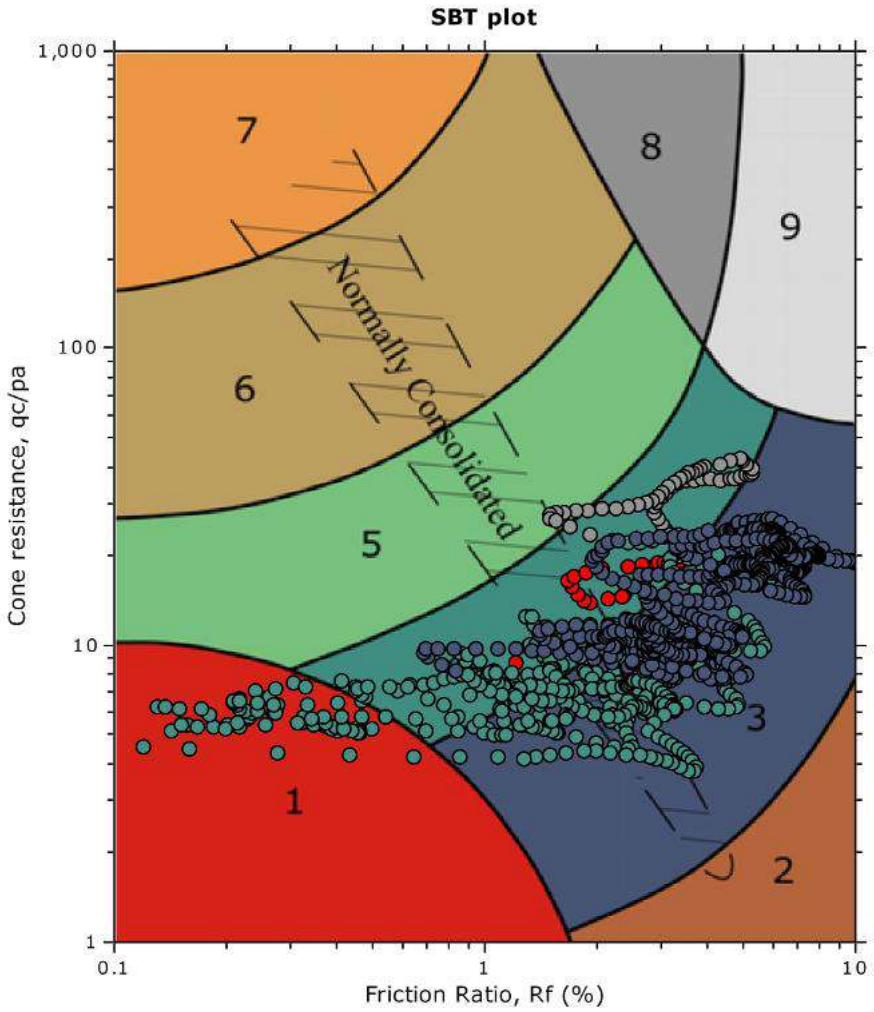
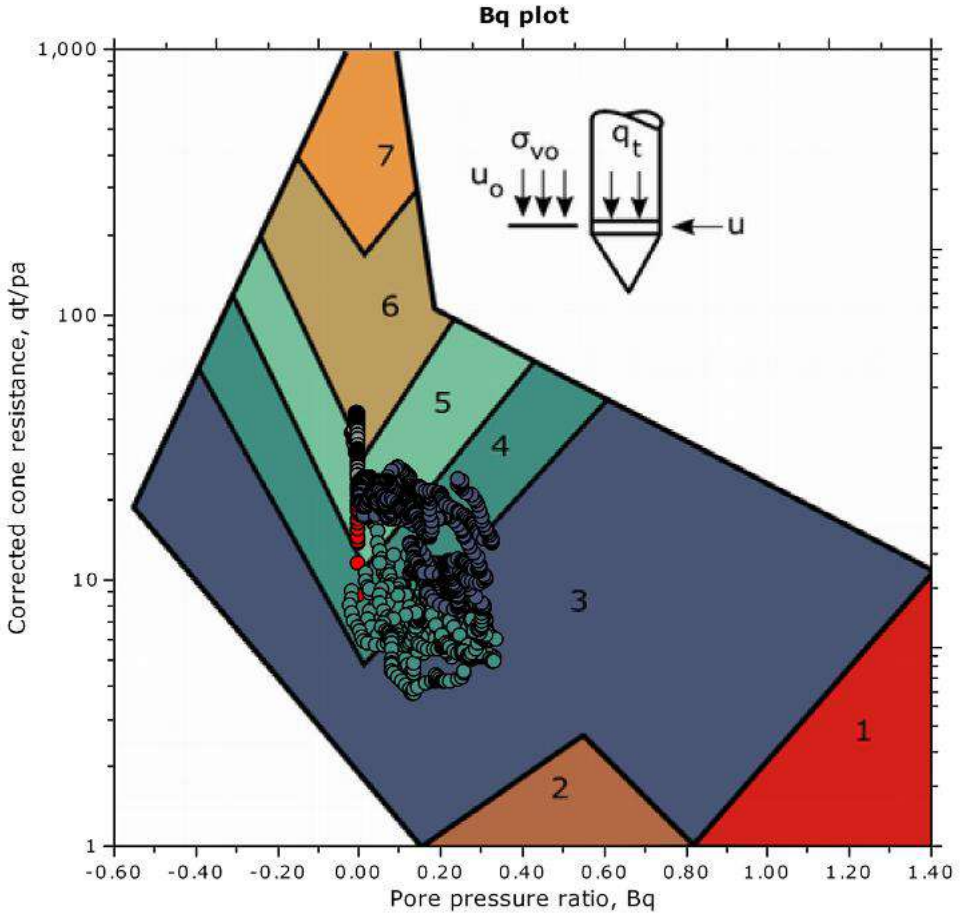
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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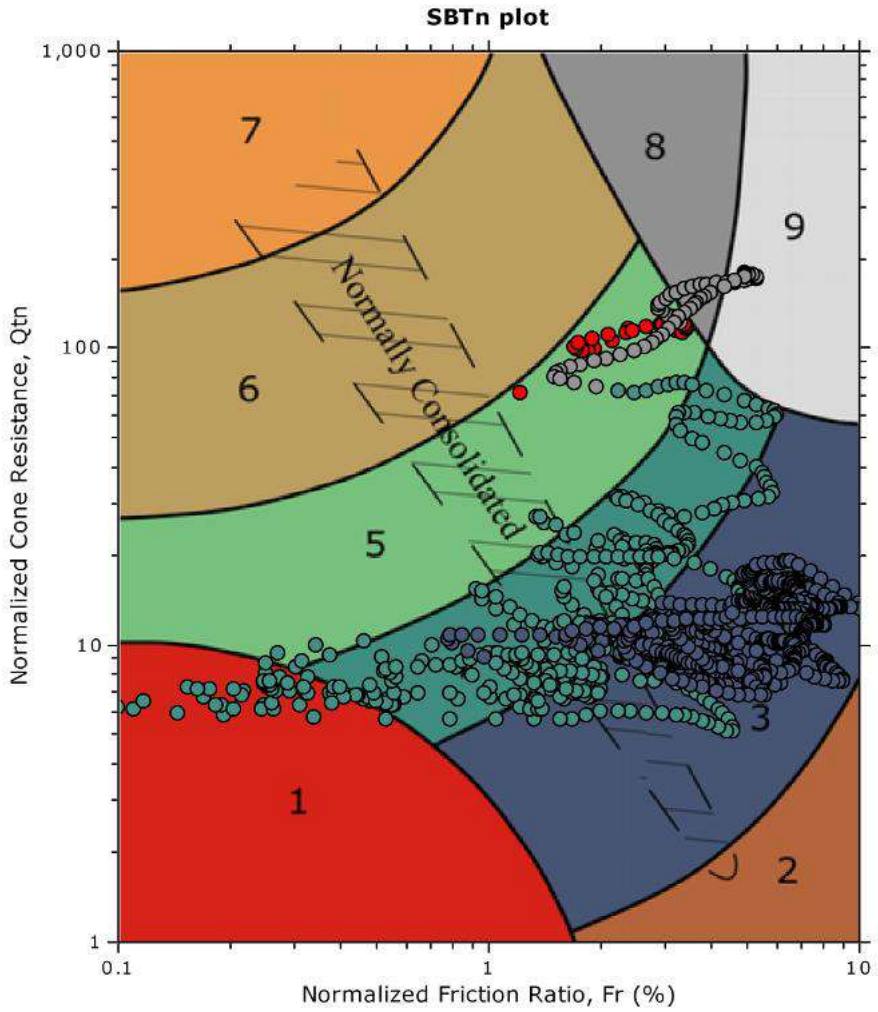
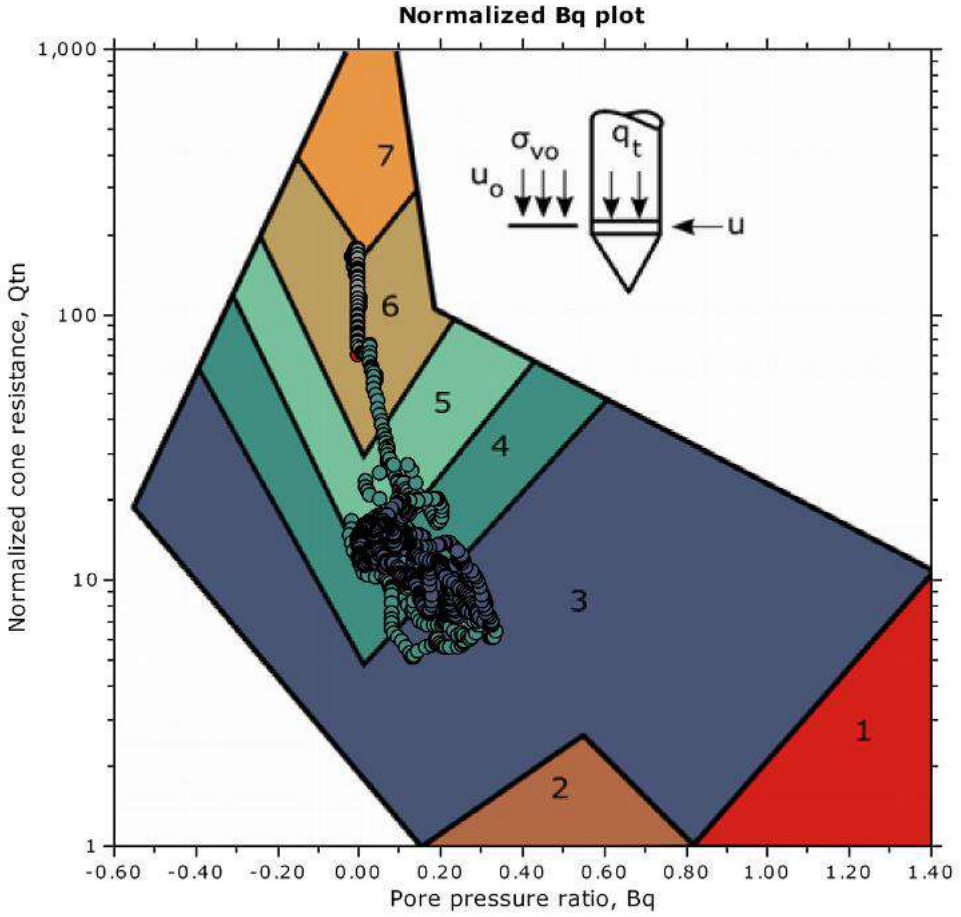
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





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Project: **Ravarino**
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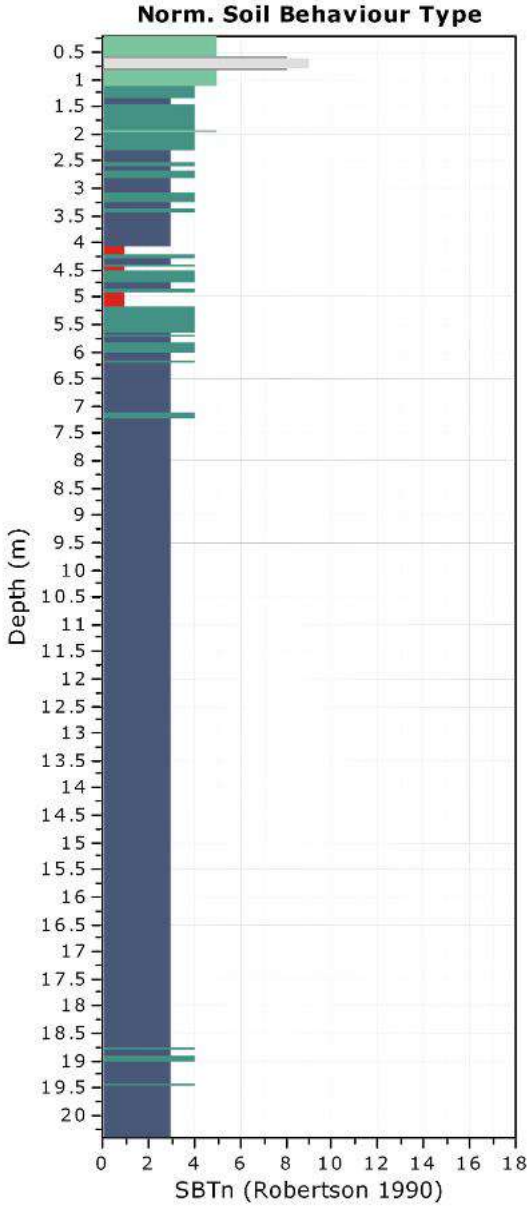
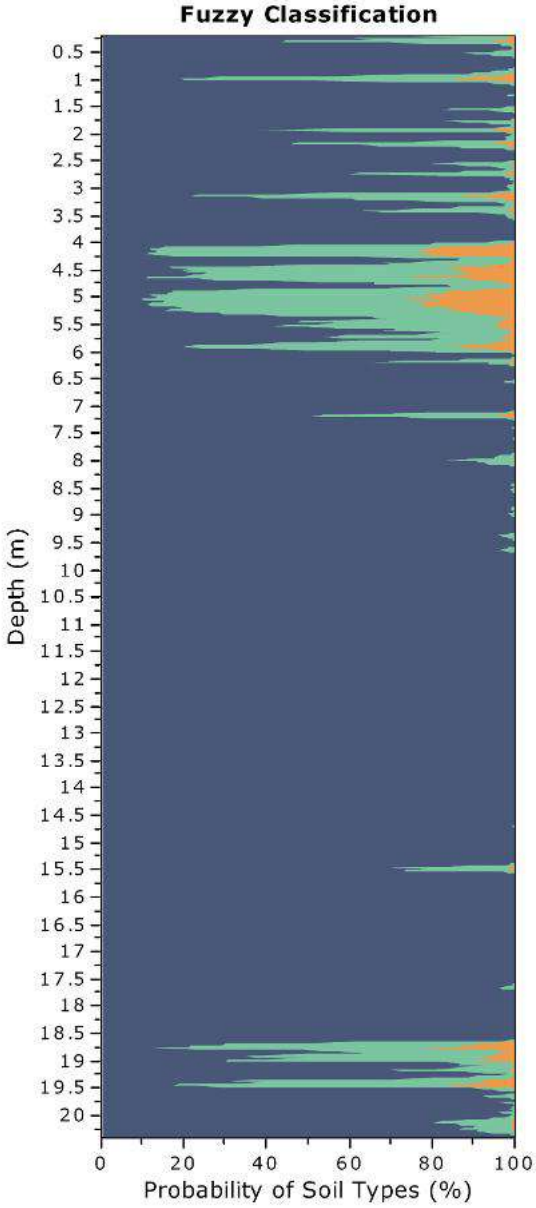
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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Project: **Ravarino**
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CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
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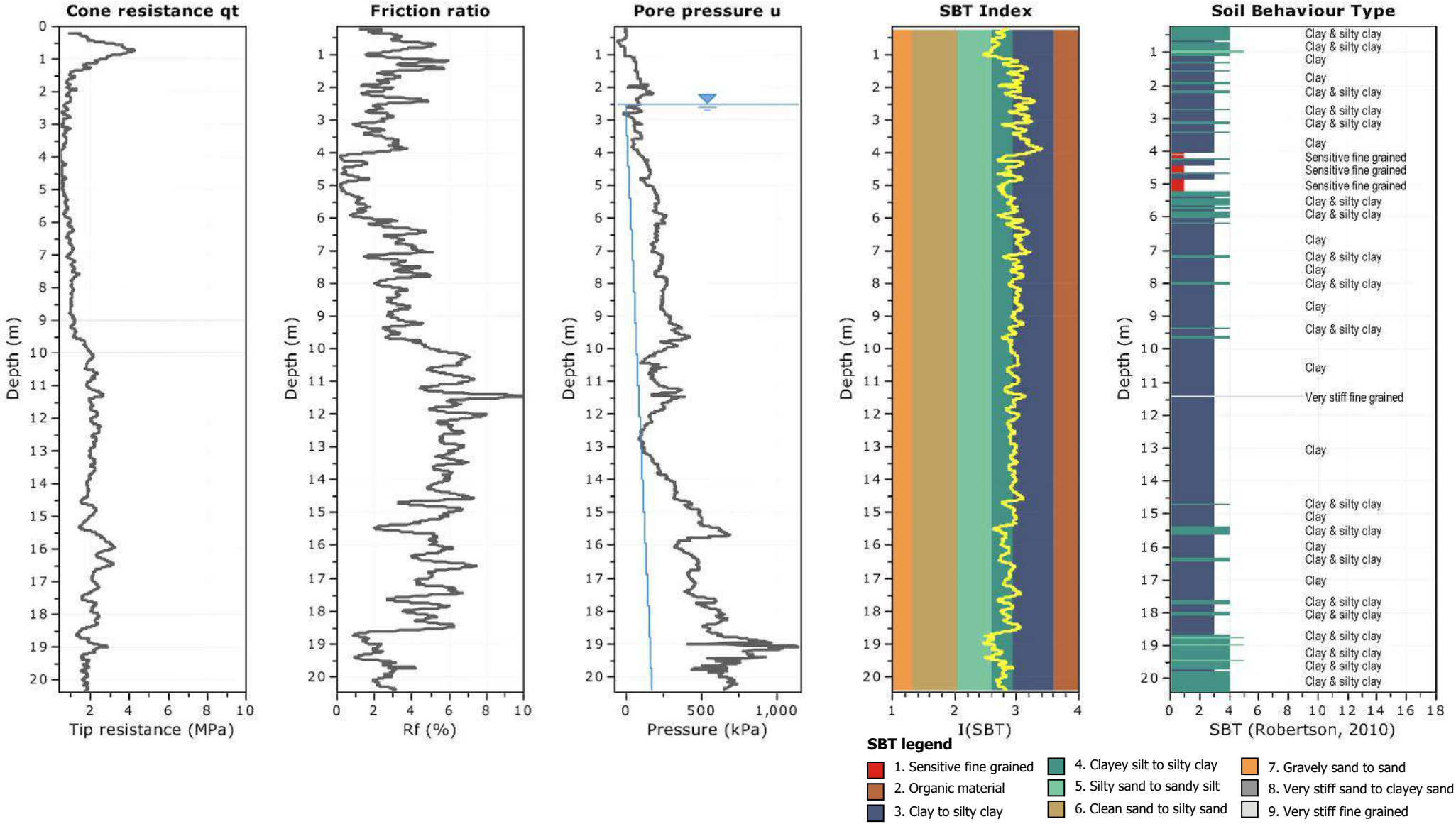

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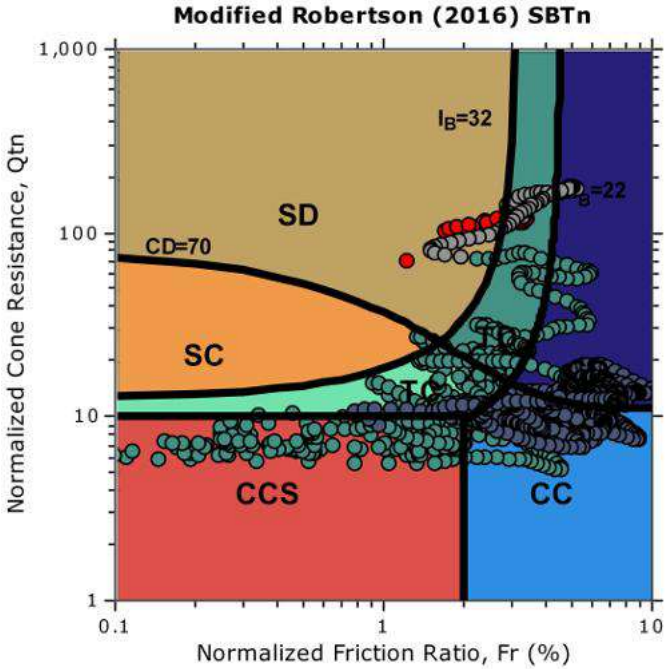
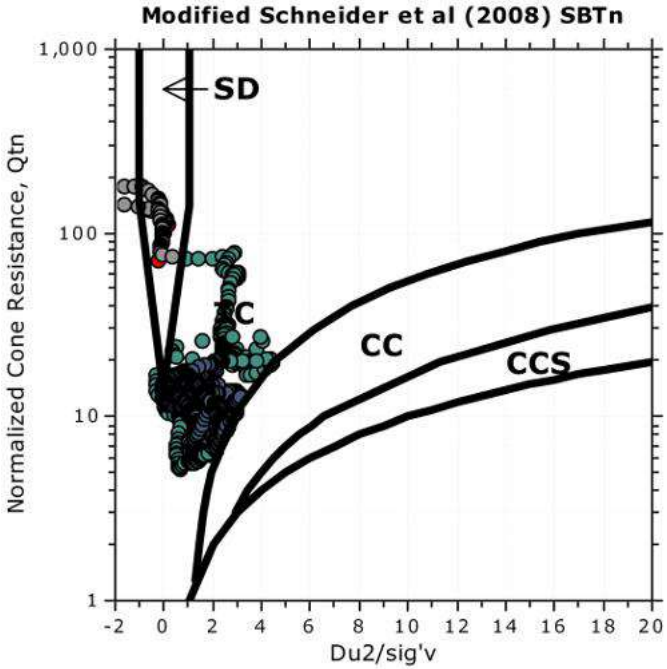
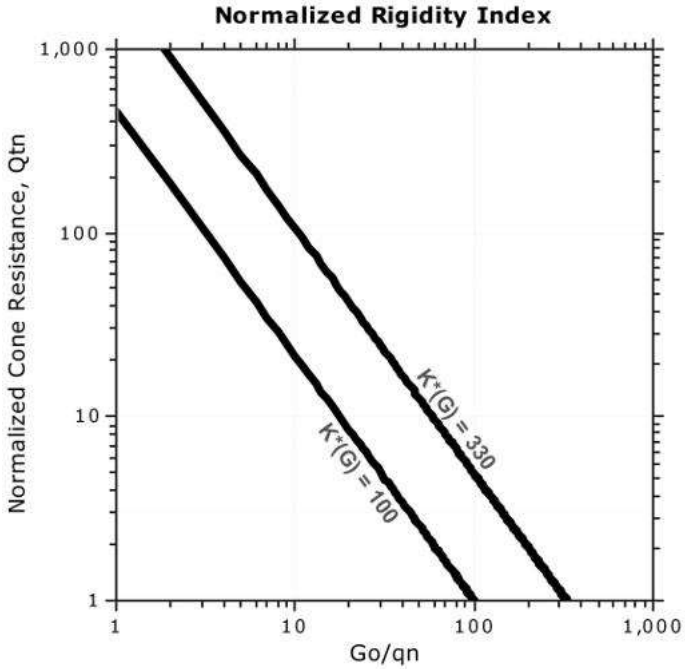
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU2
Total depth: 20.41 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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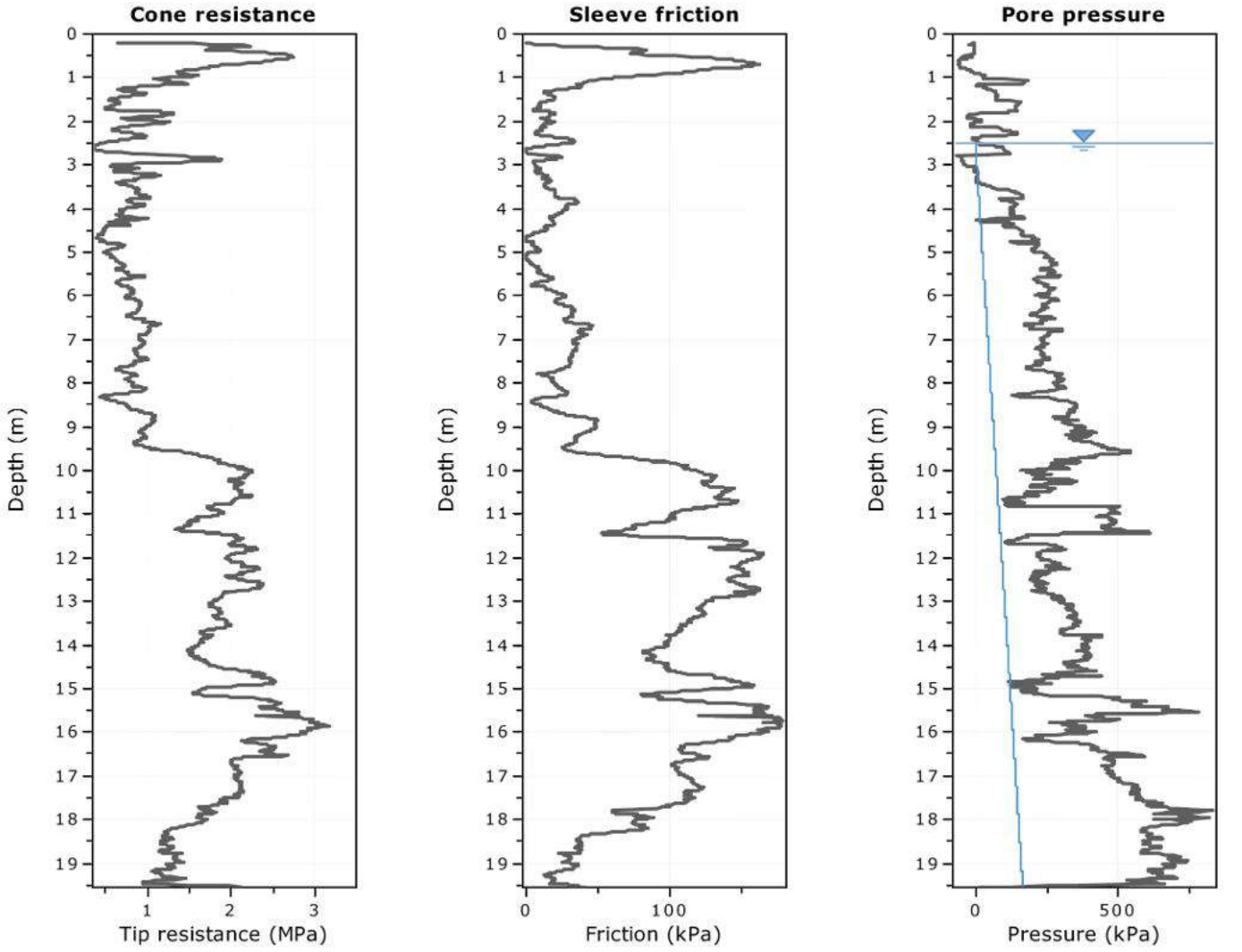
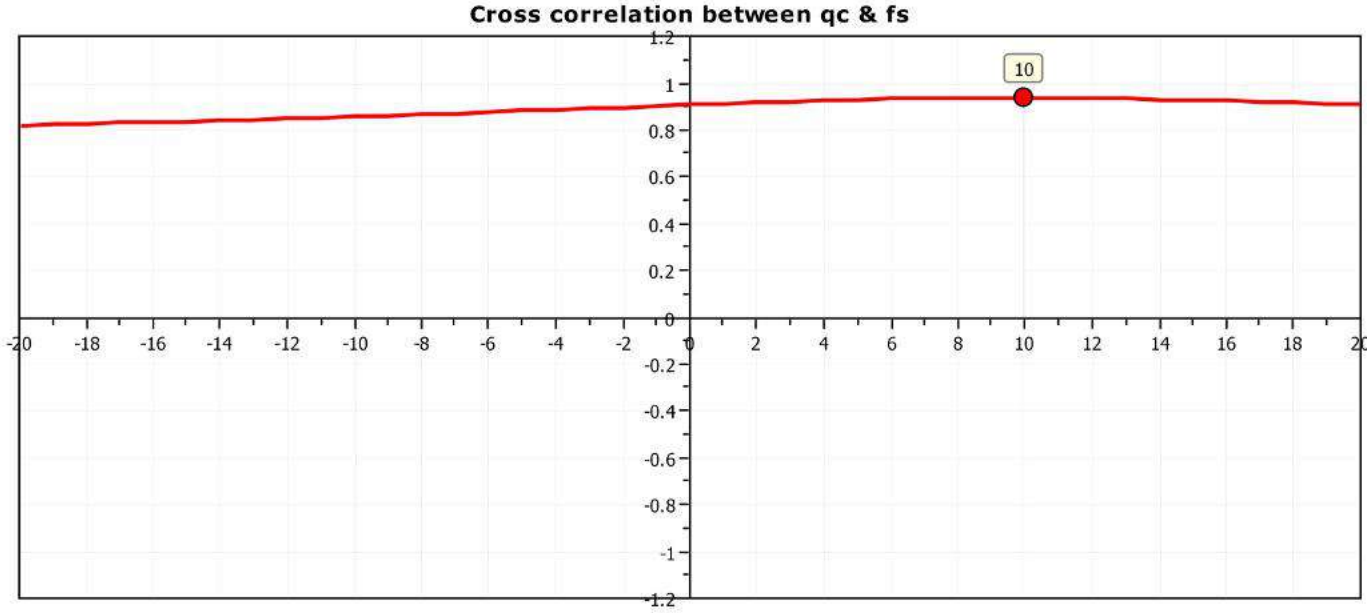
CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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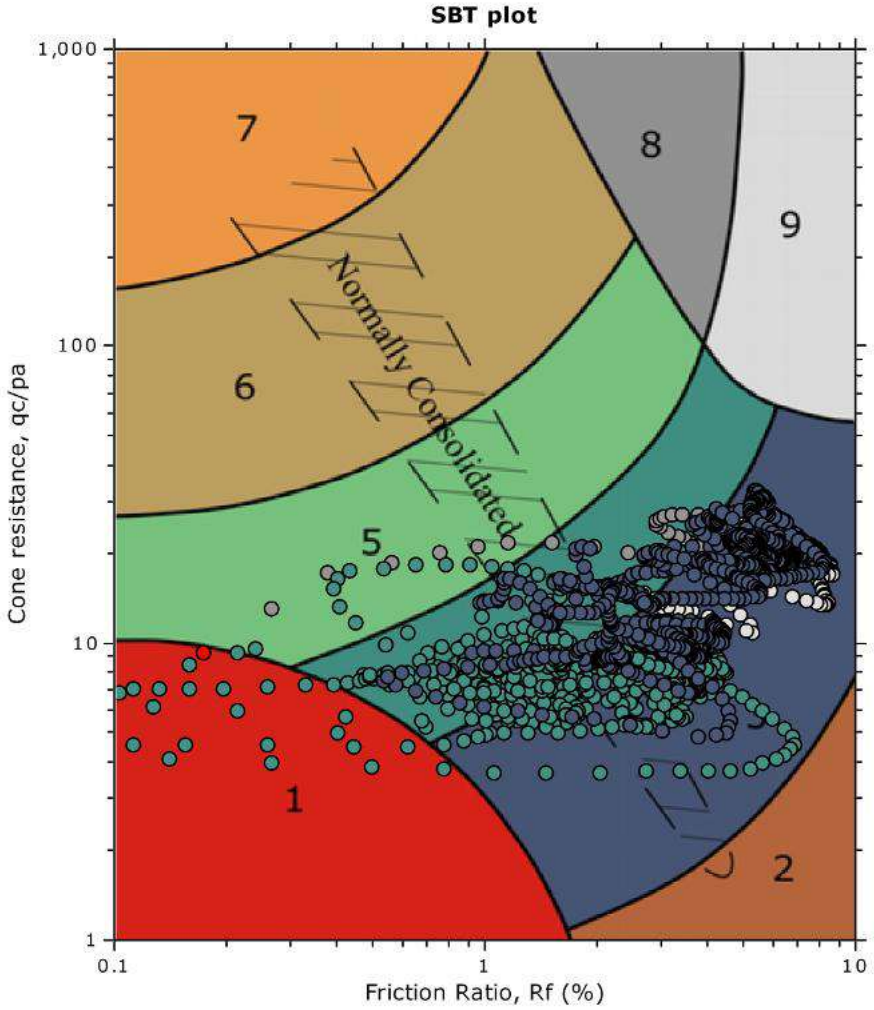
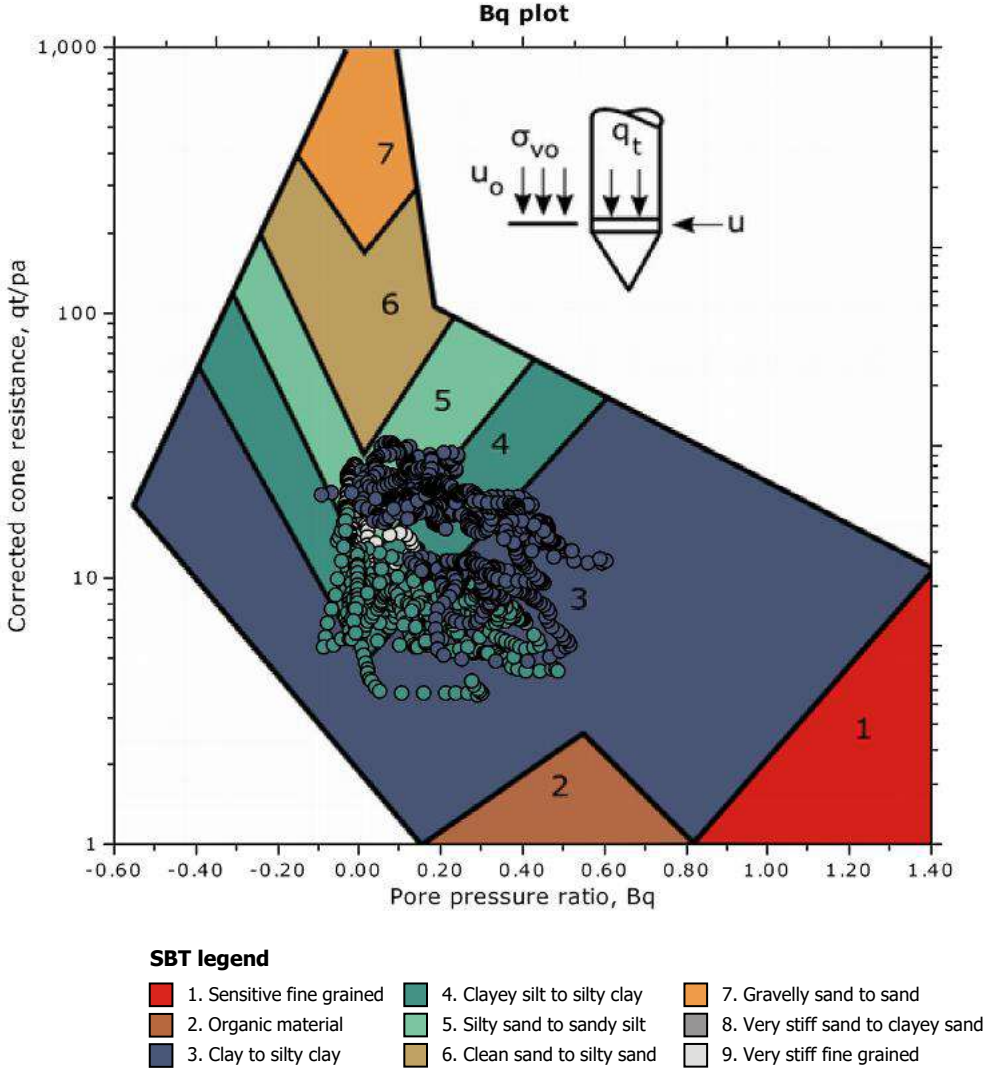
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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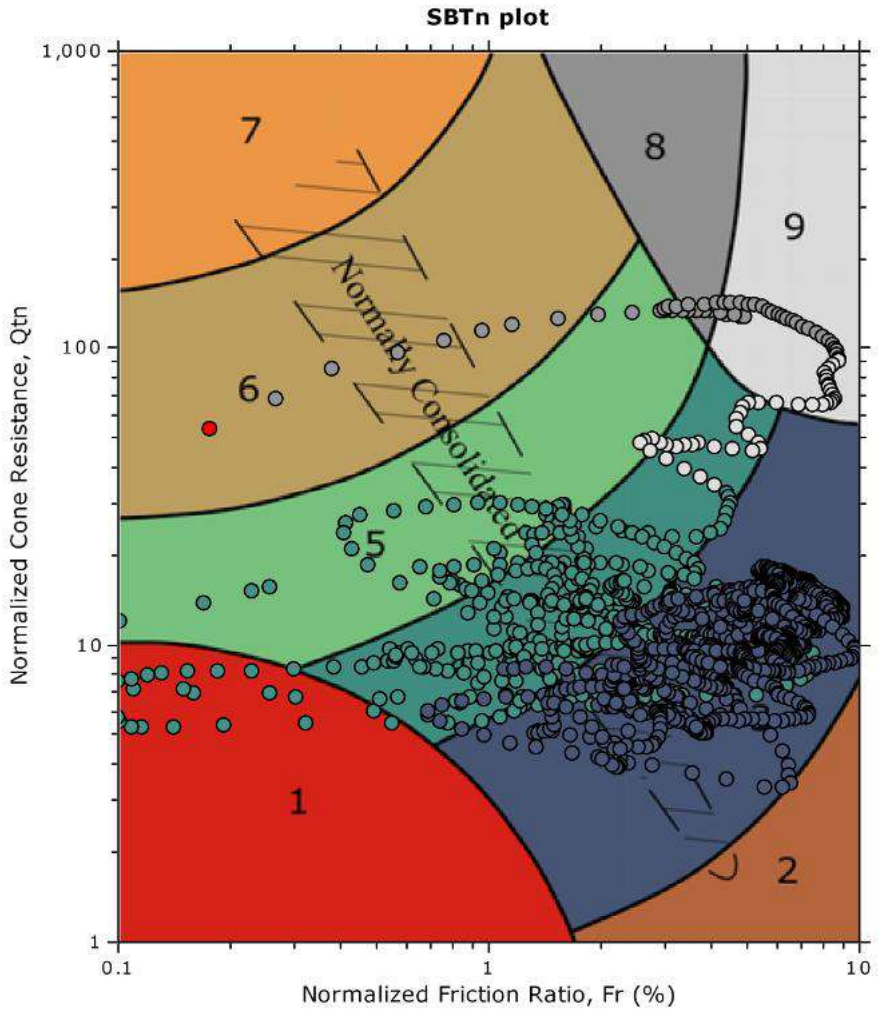
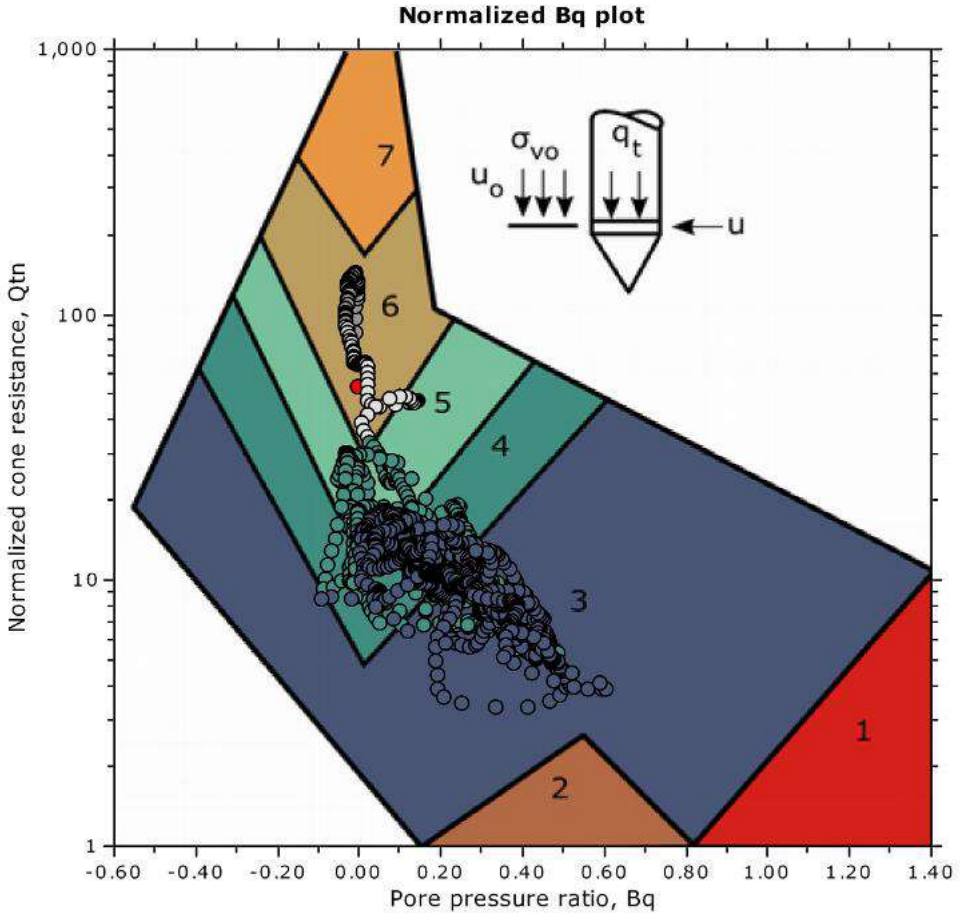
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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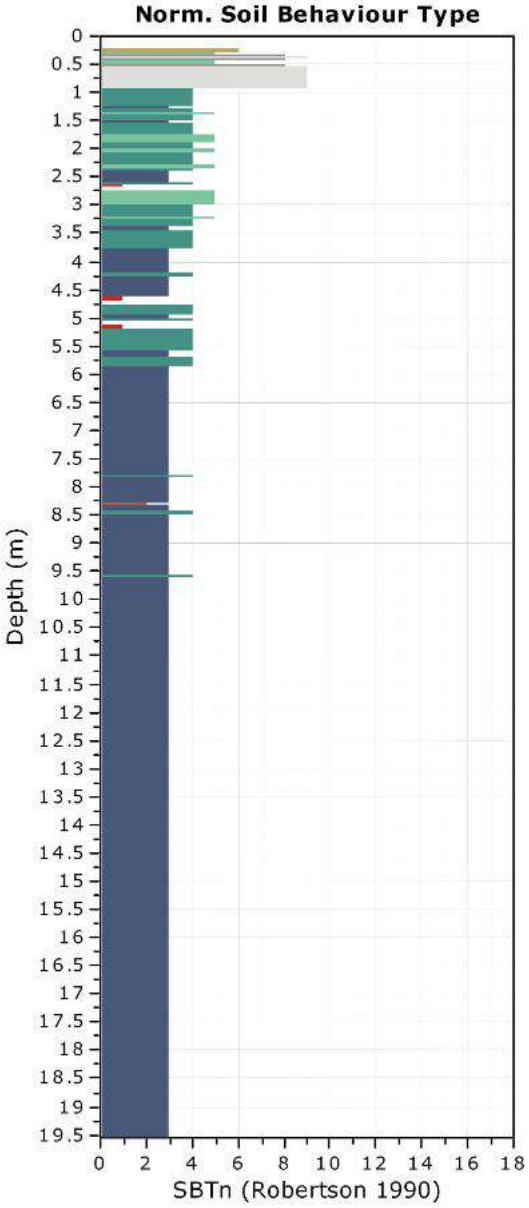
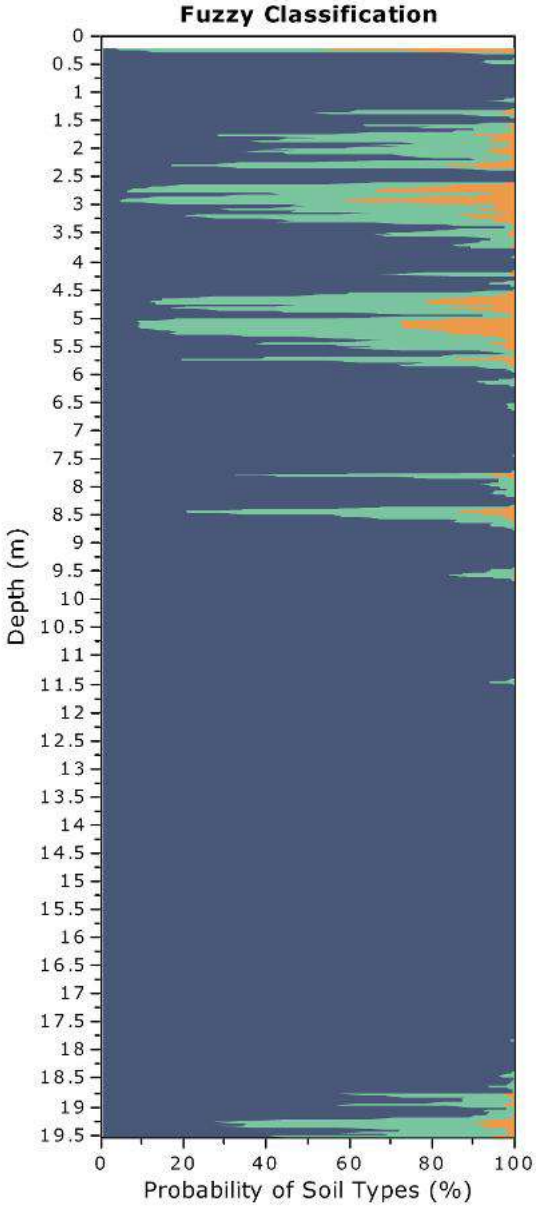
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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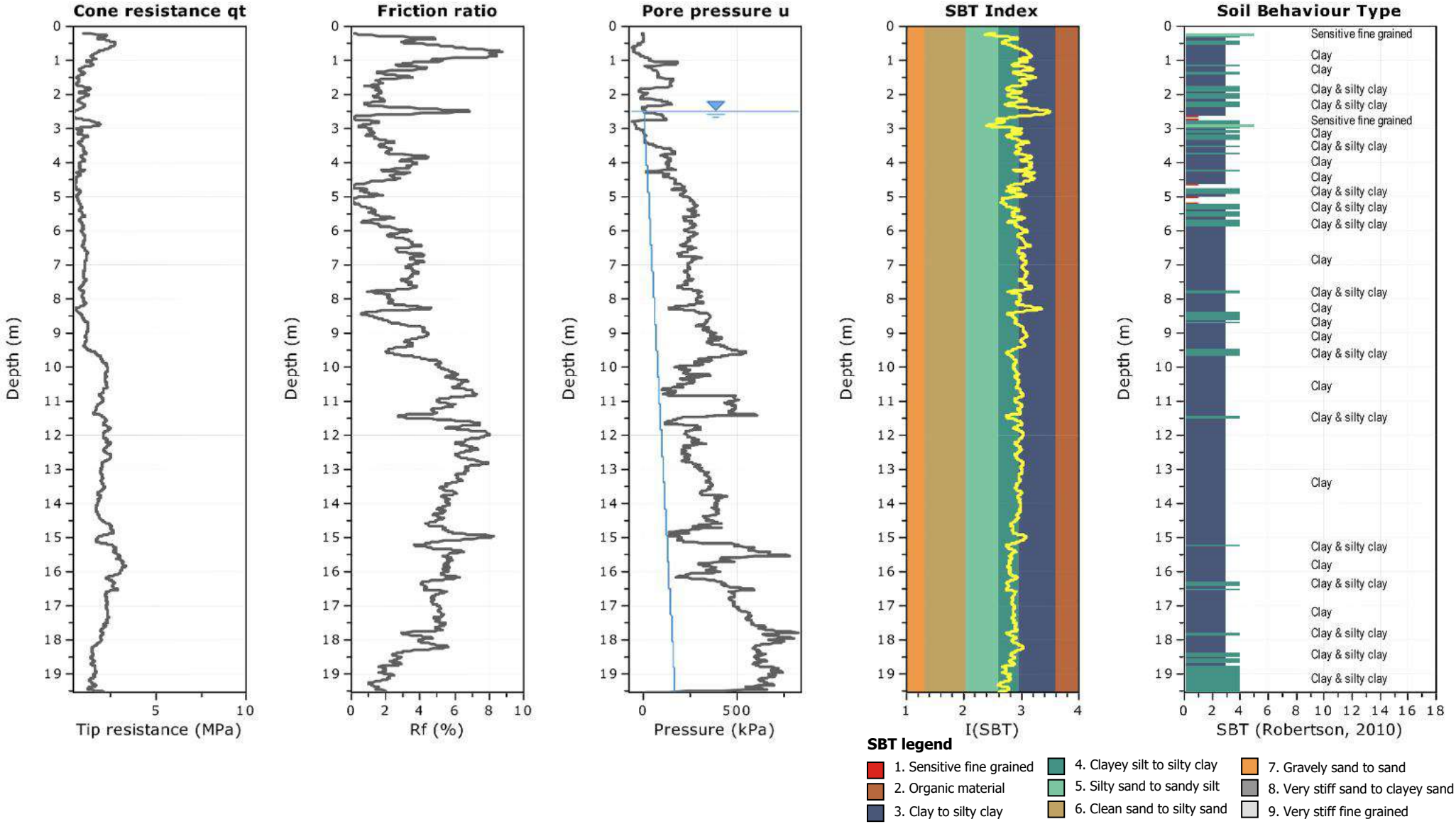
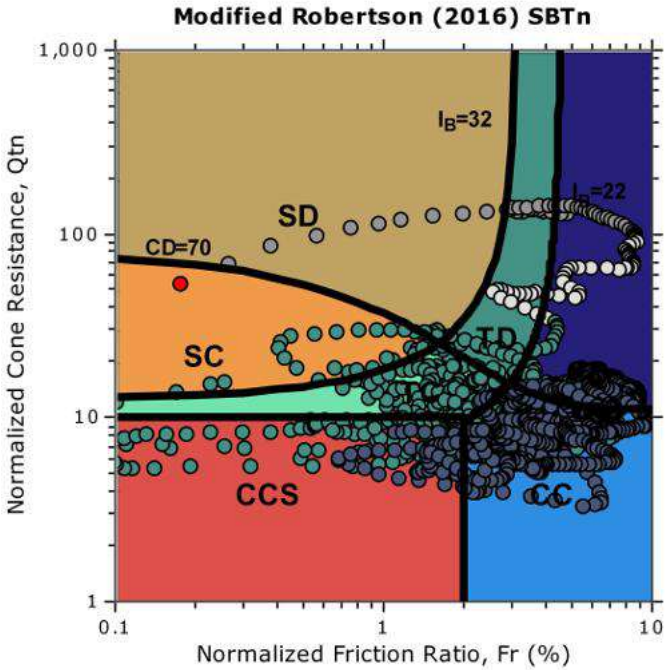
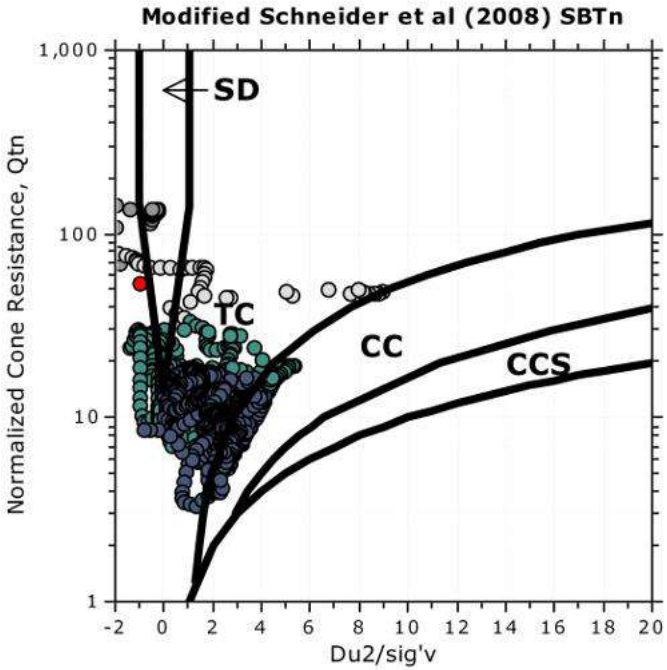
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

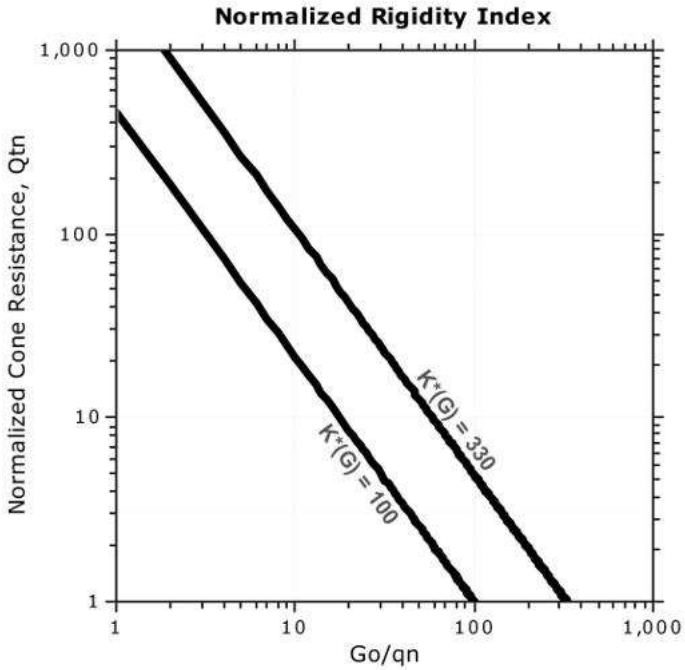
CPT: CPTU4
Total depth: 19.55 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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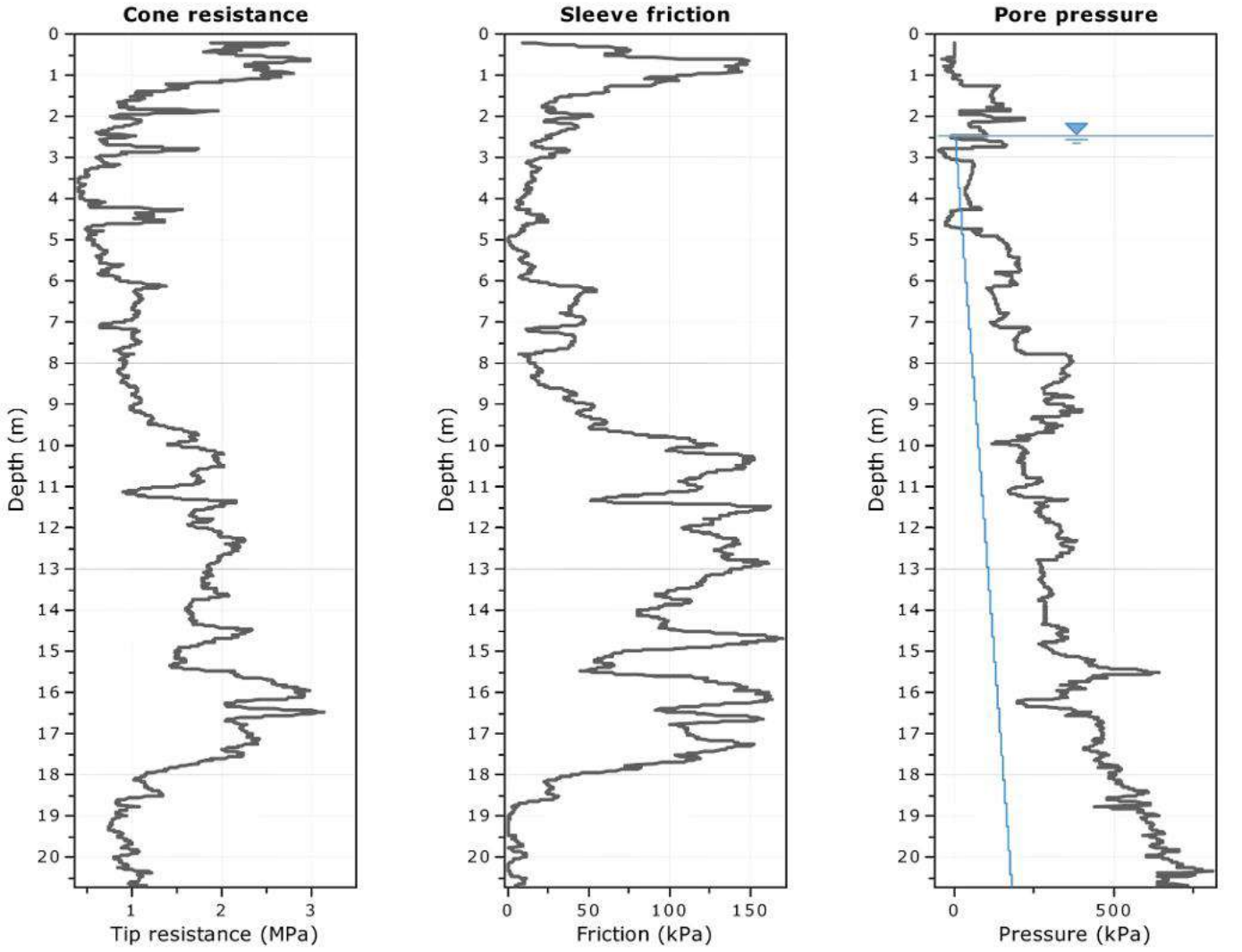
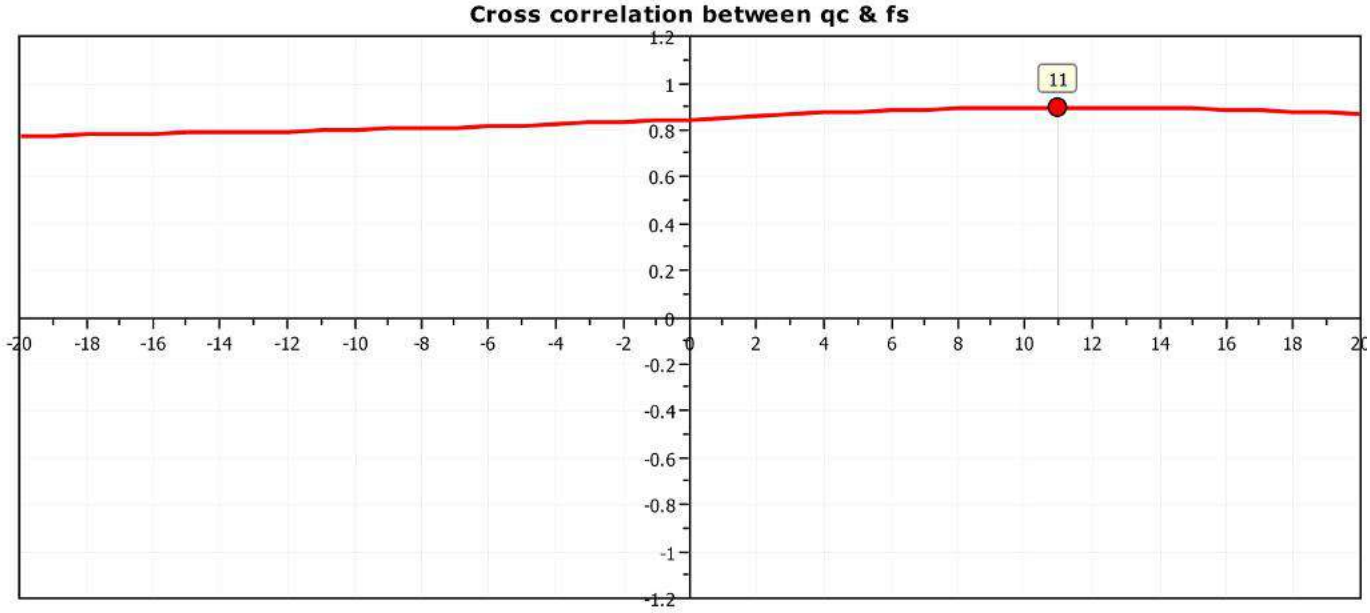
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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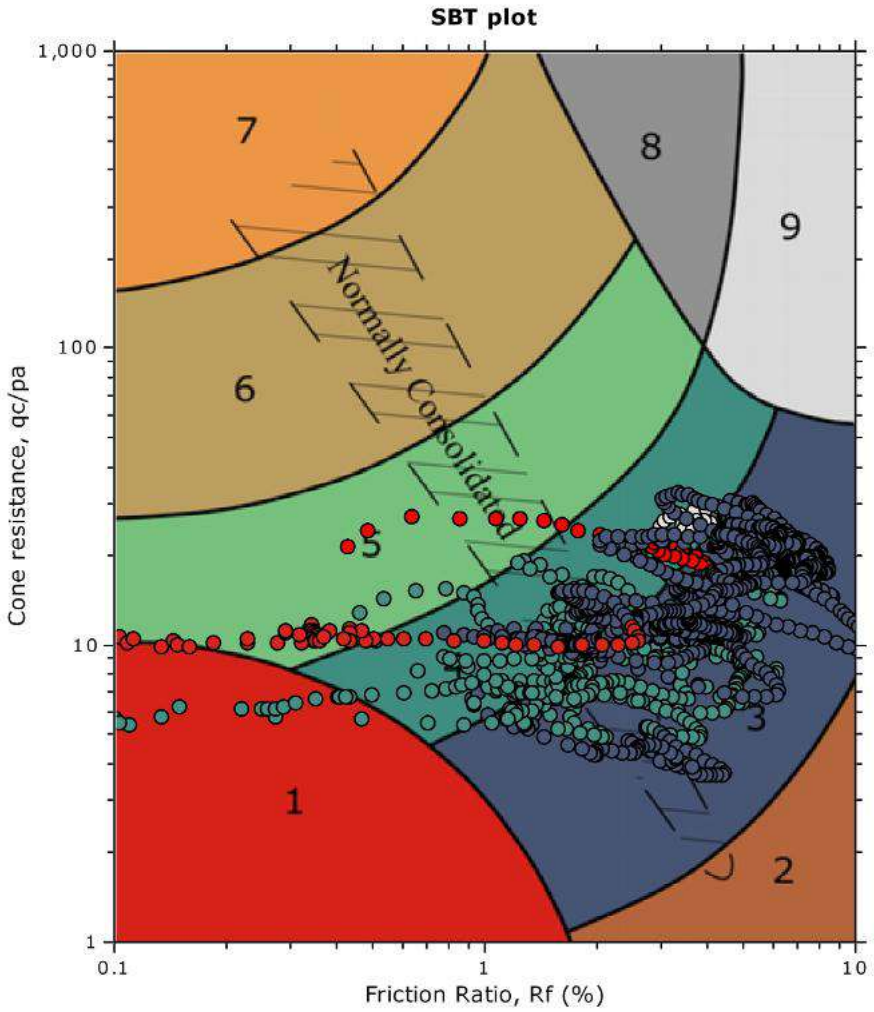
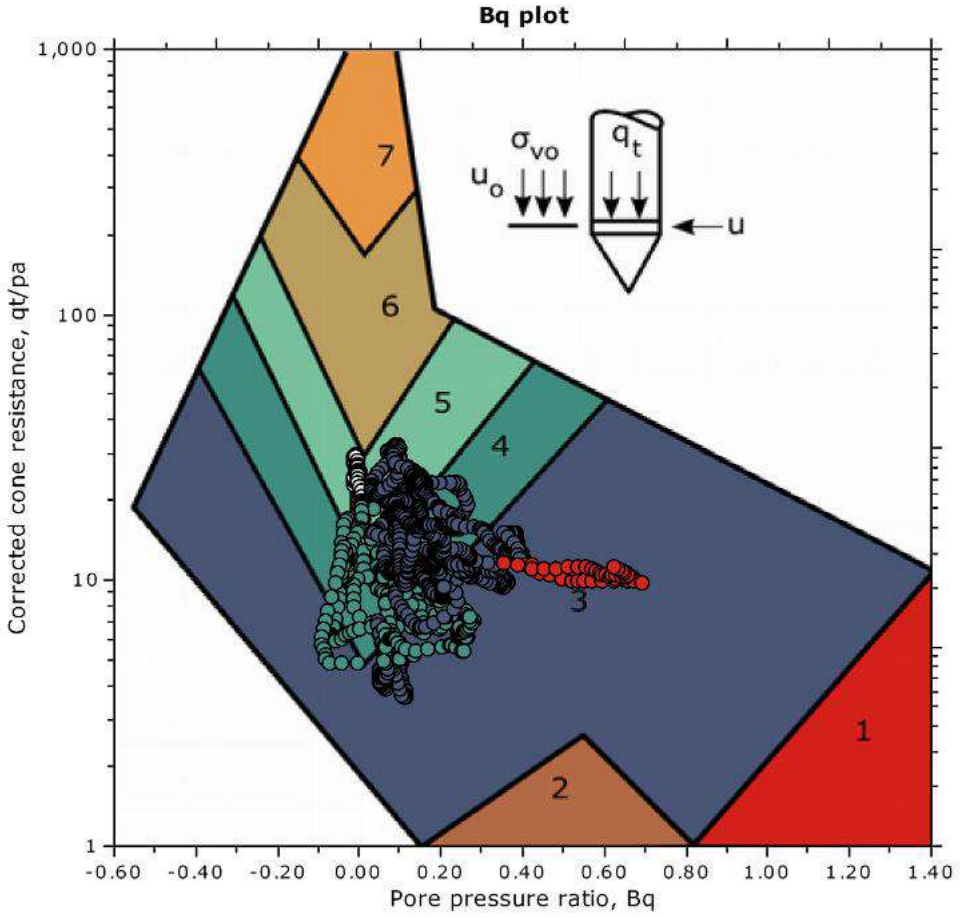
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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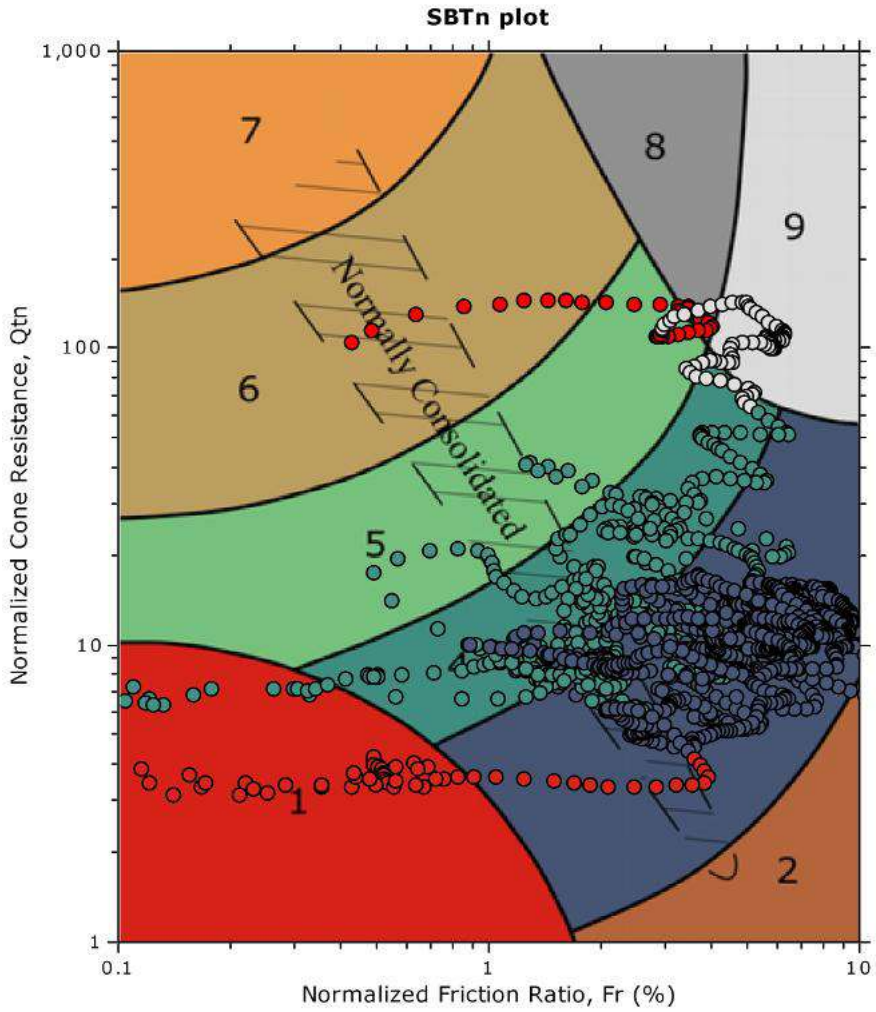
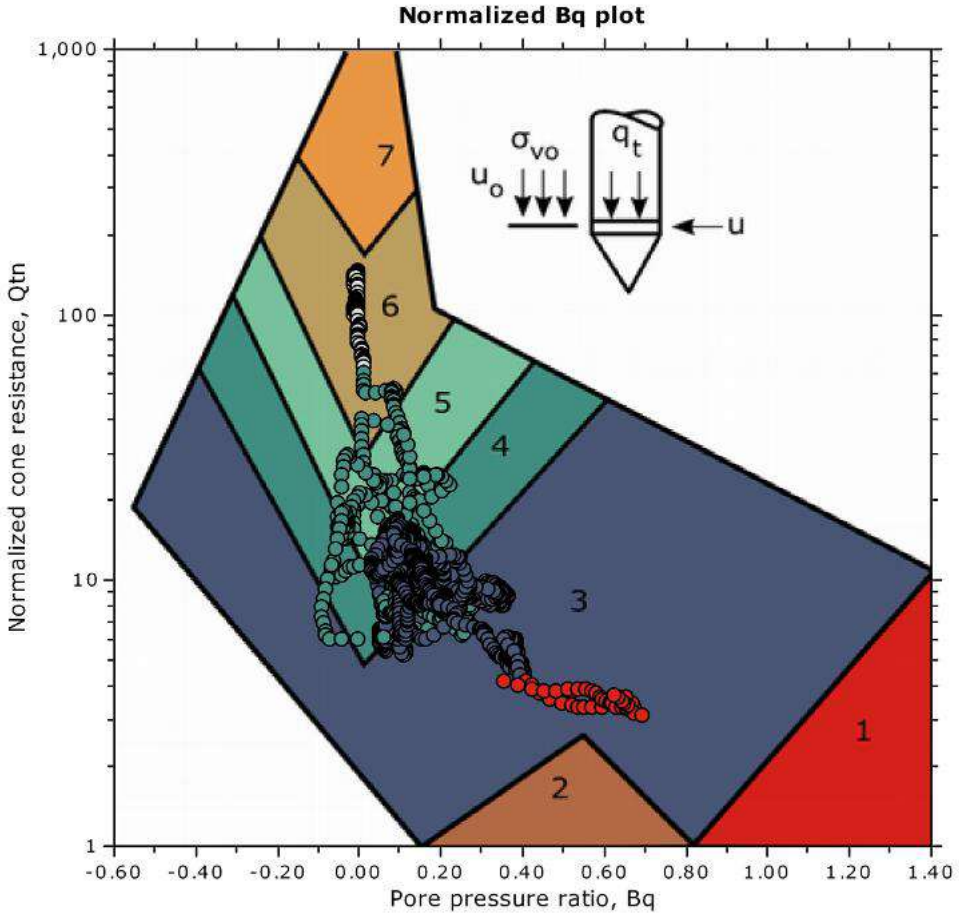
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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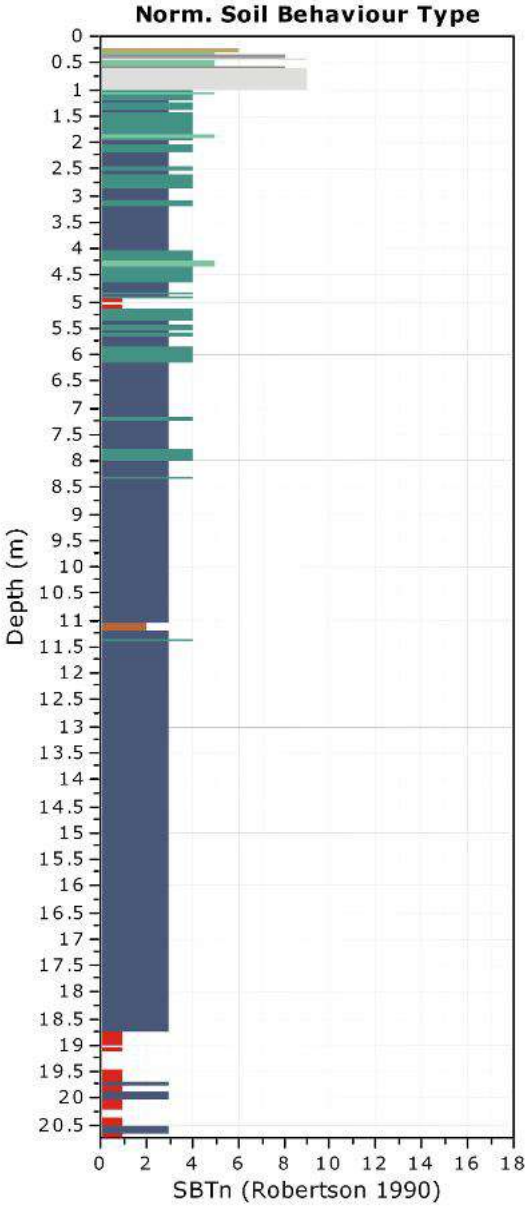
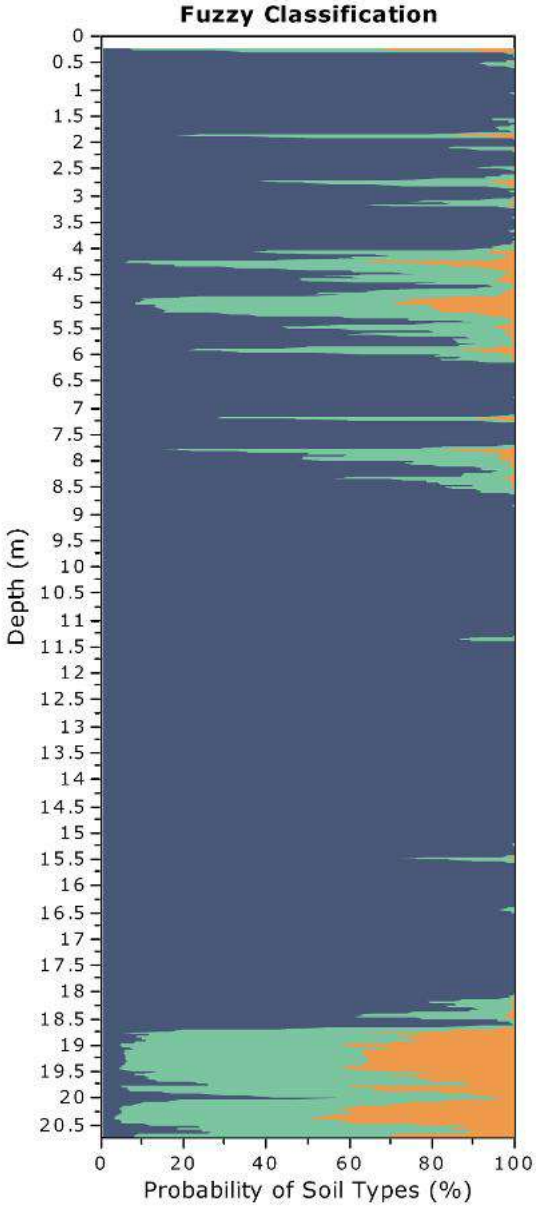
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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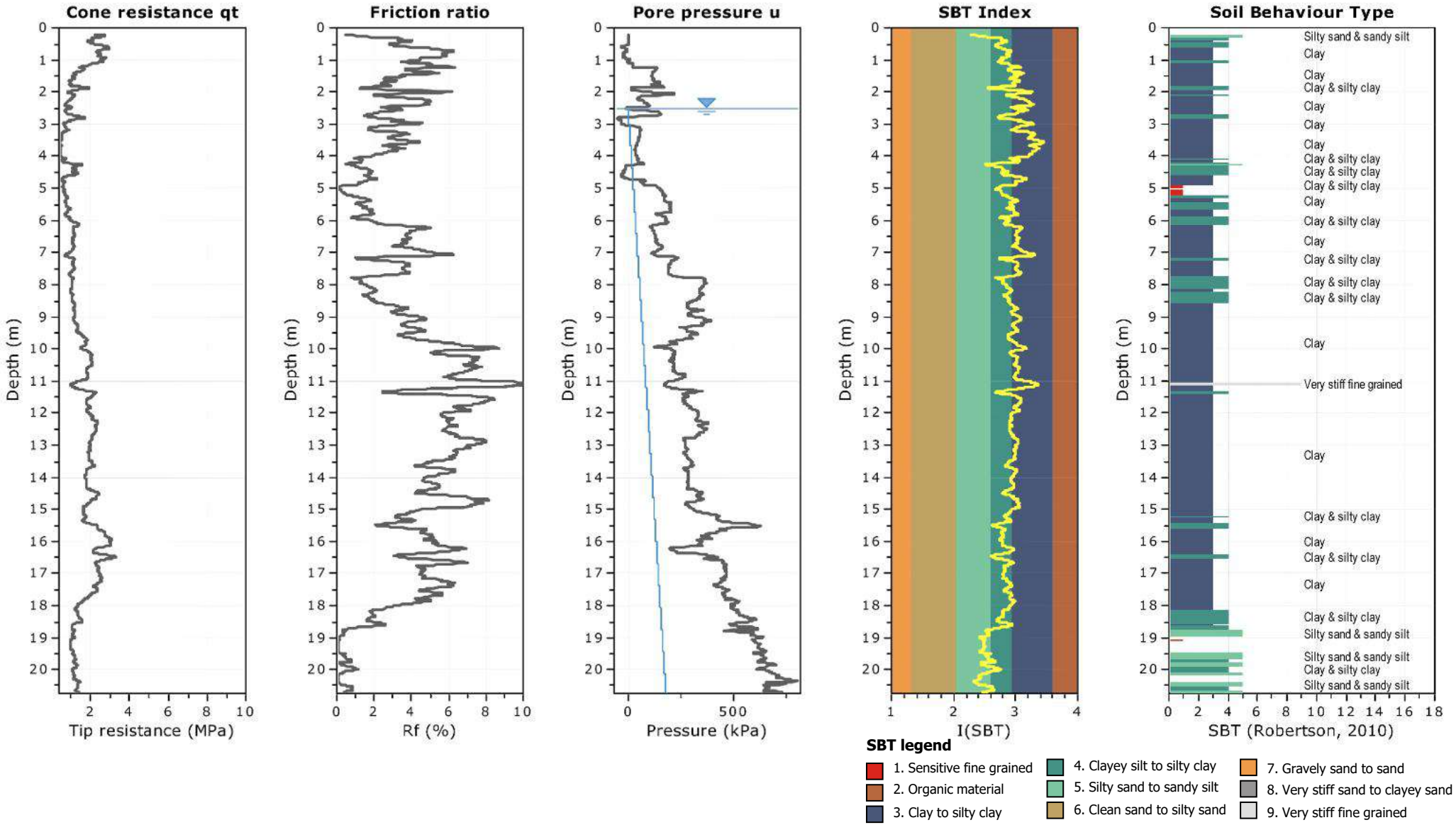
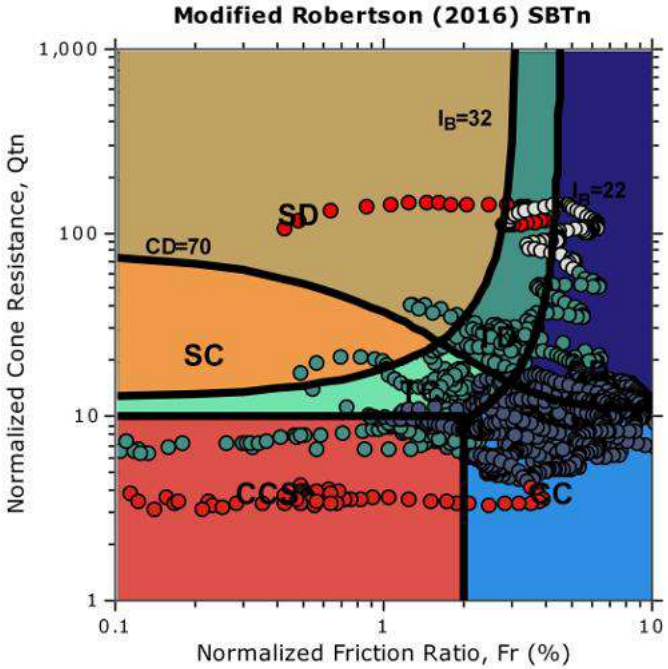
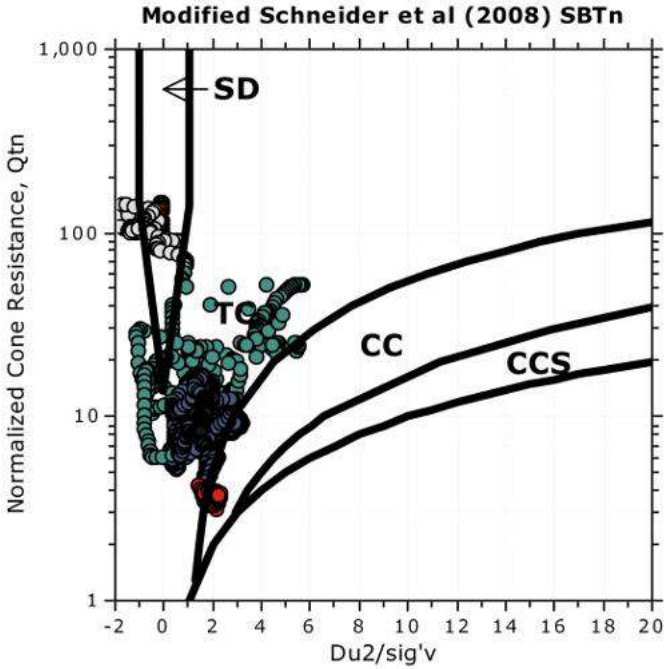
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

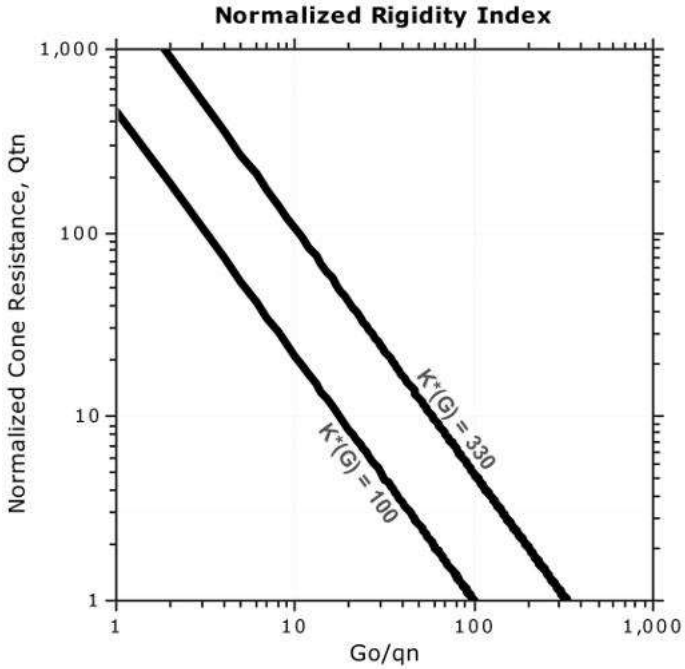
CPT: CPTU5
Total depth: 20.74 m, Date: 03/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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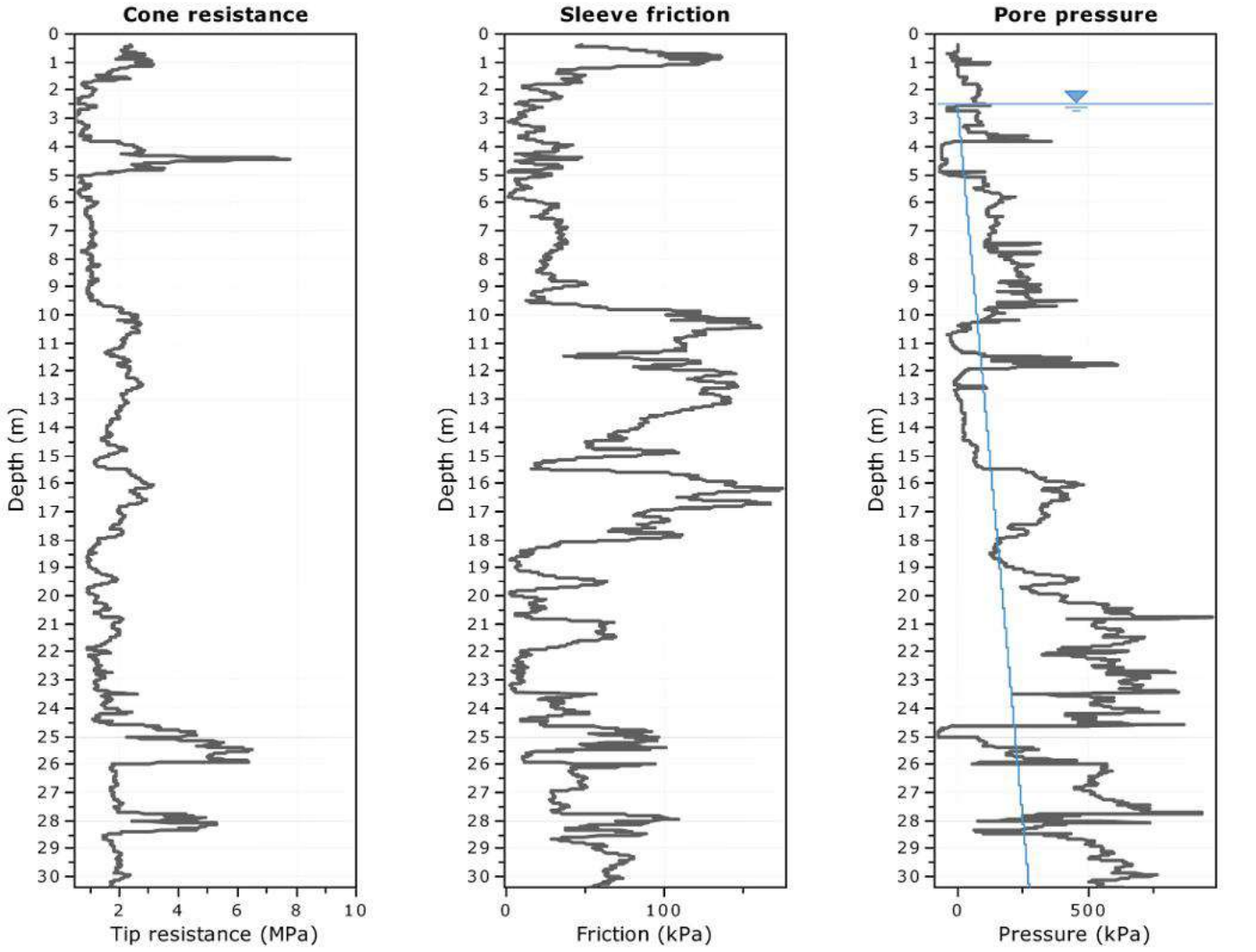
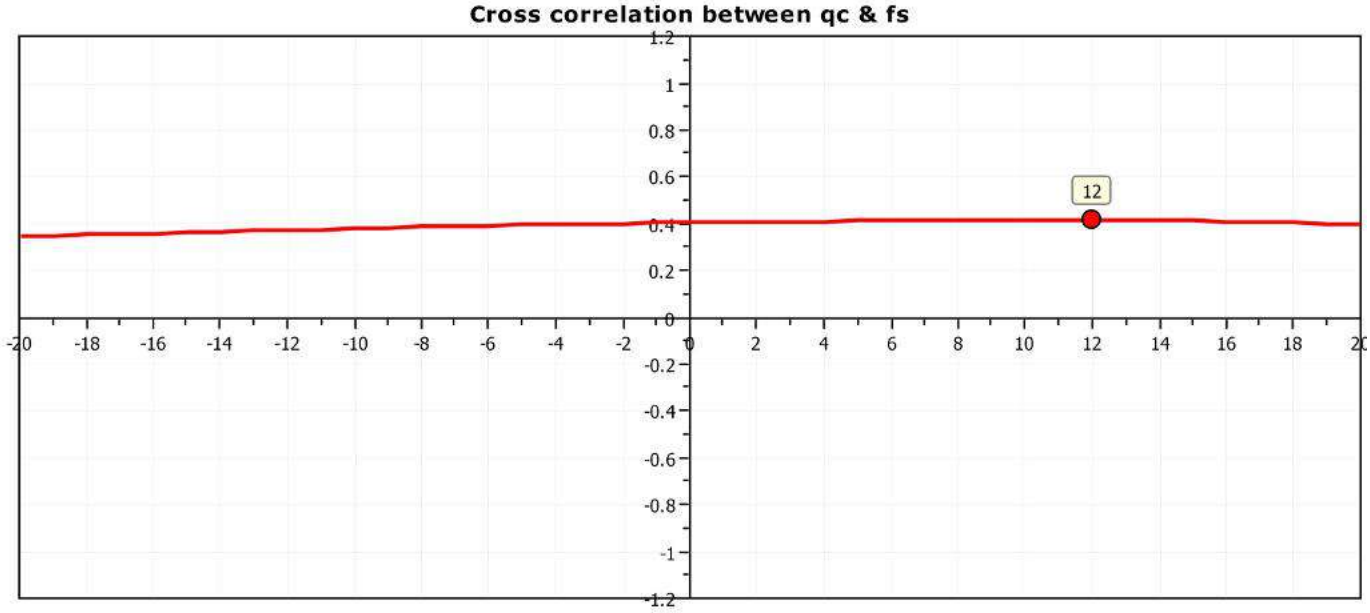
CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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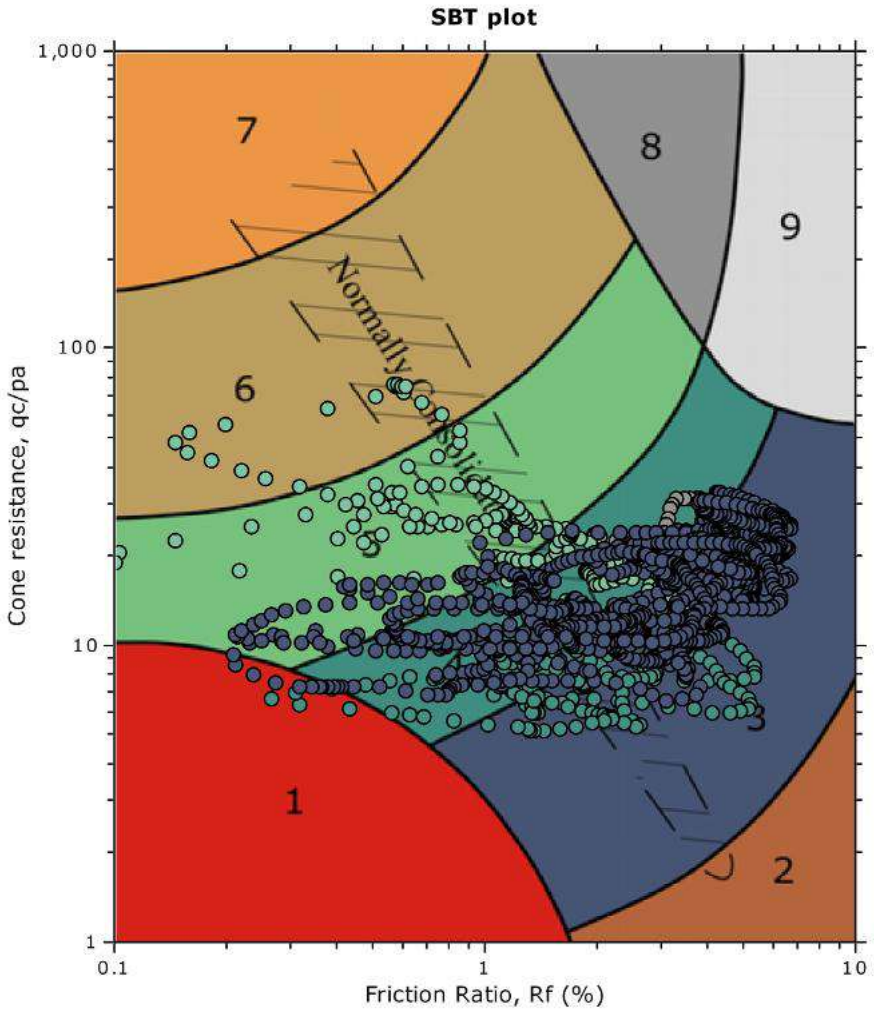
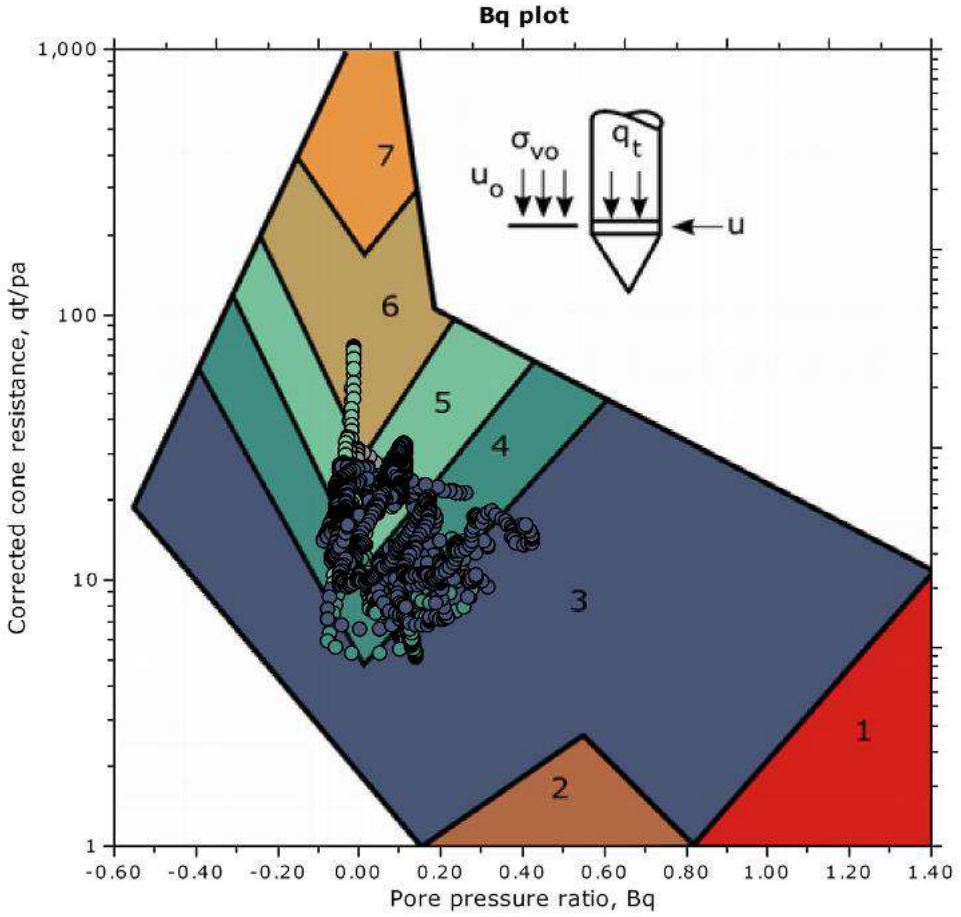
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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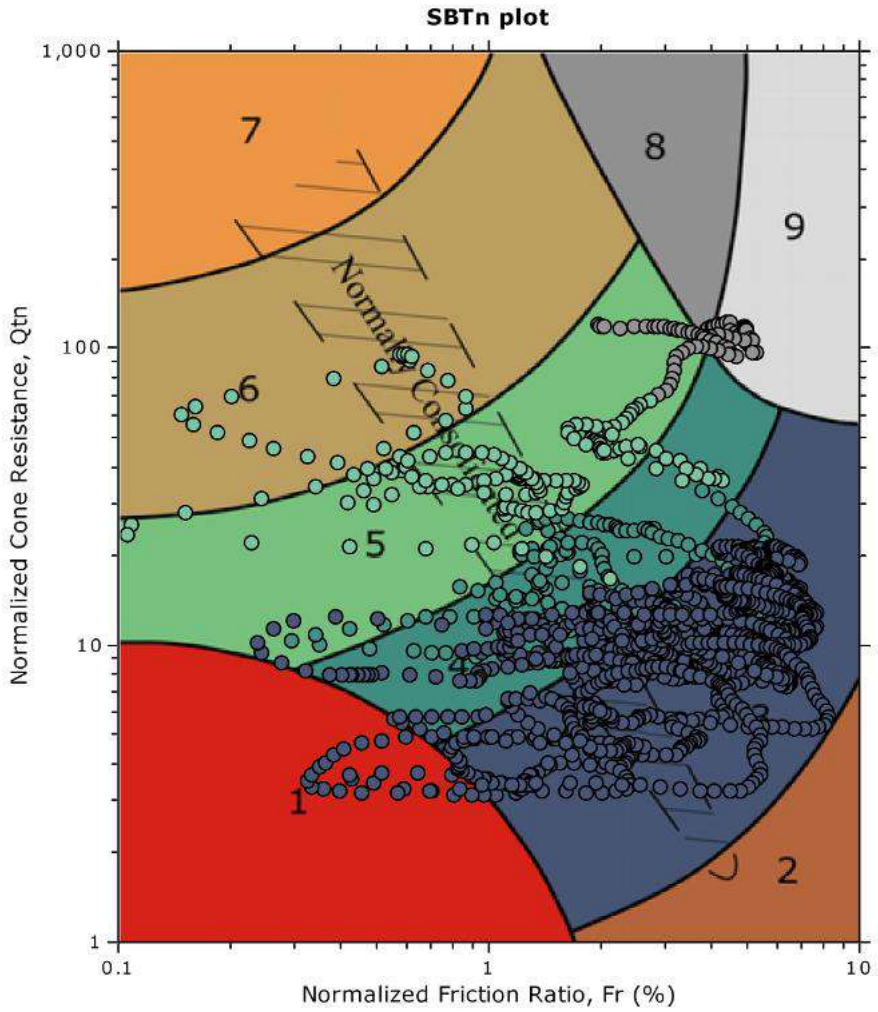
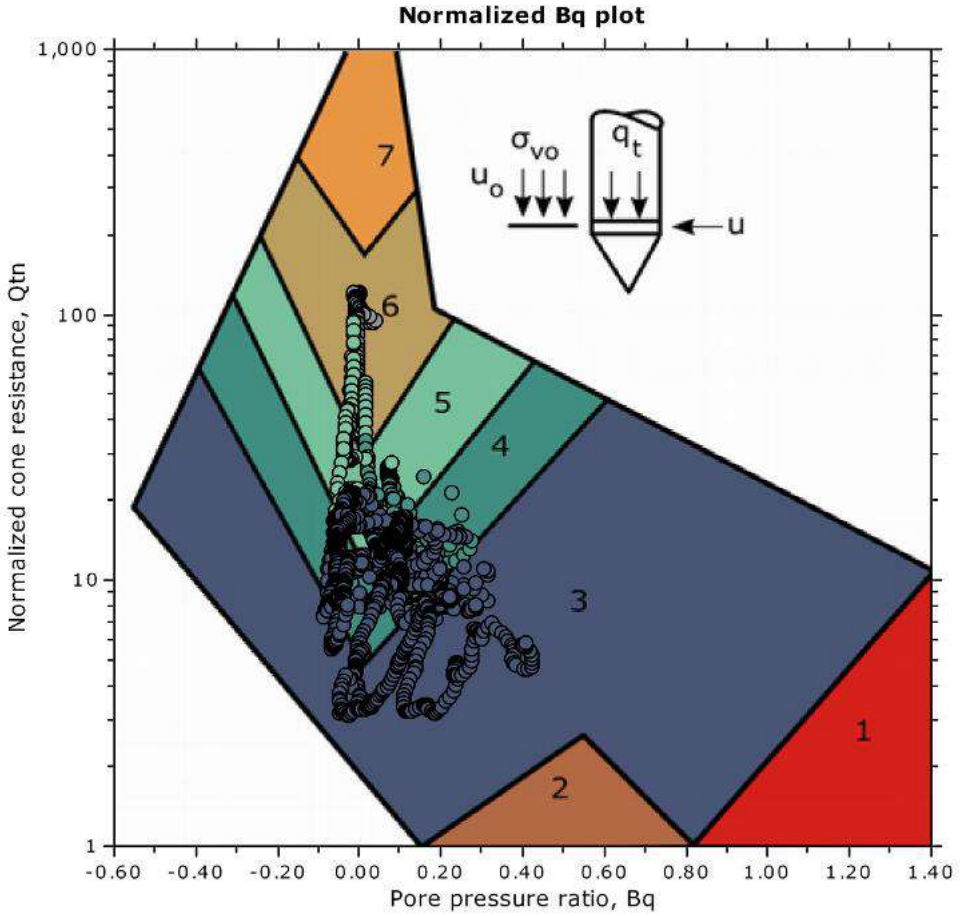
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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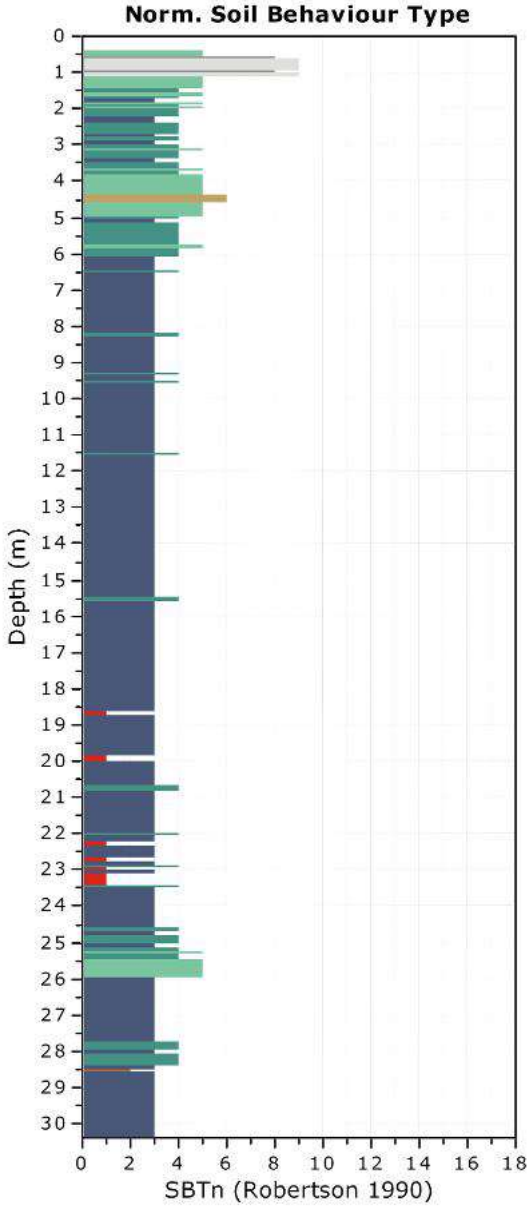
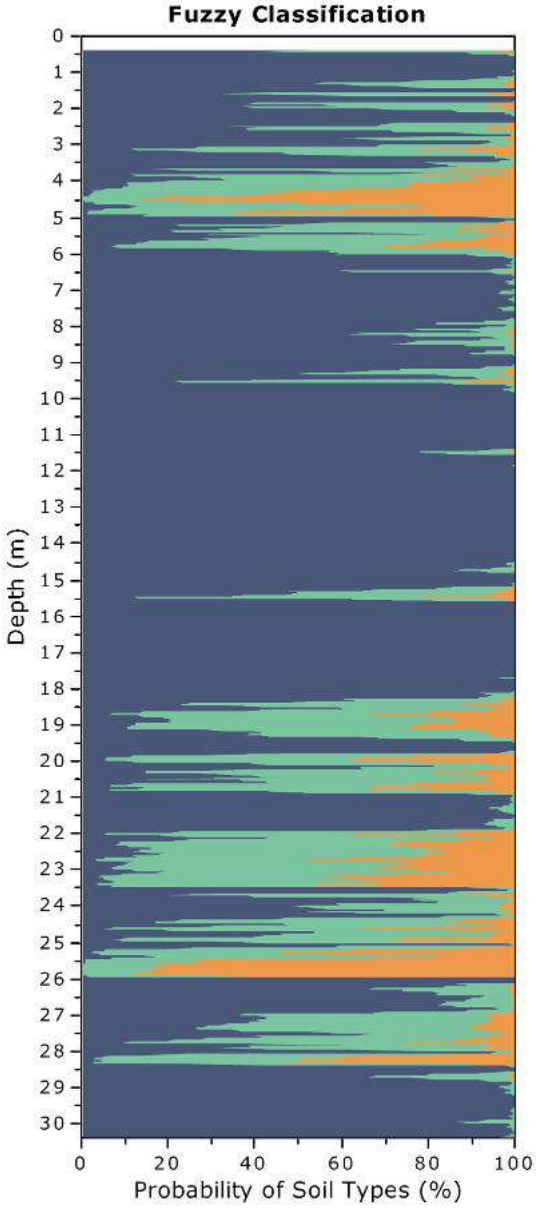
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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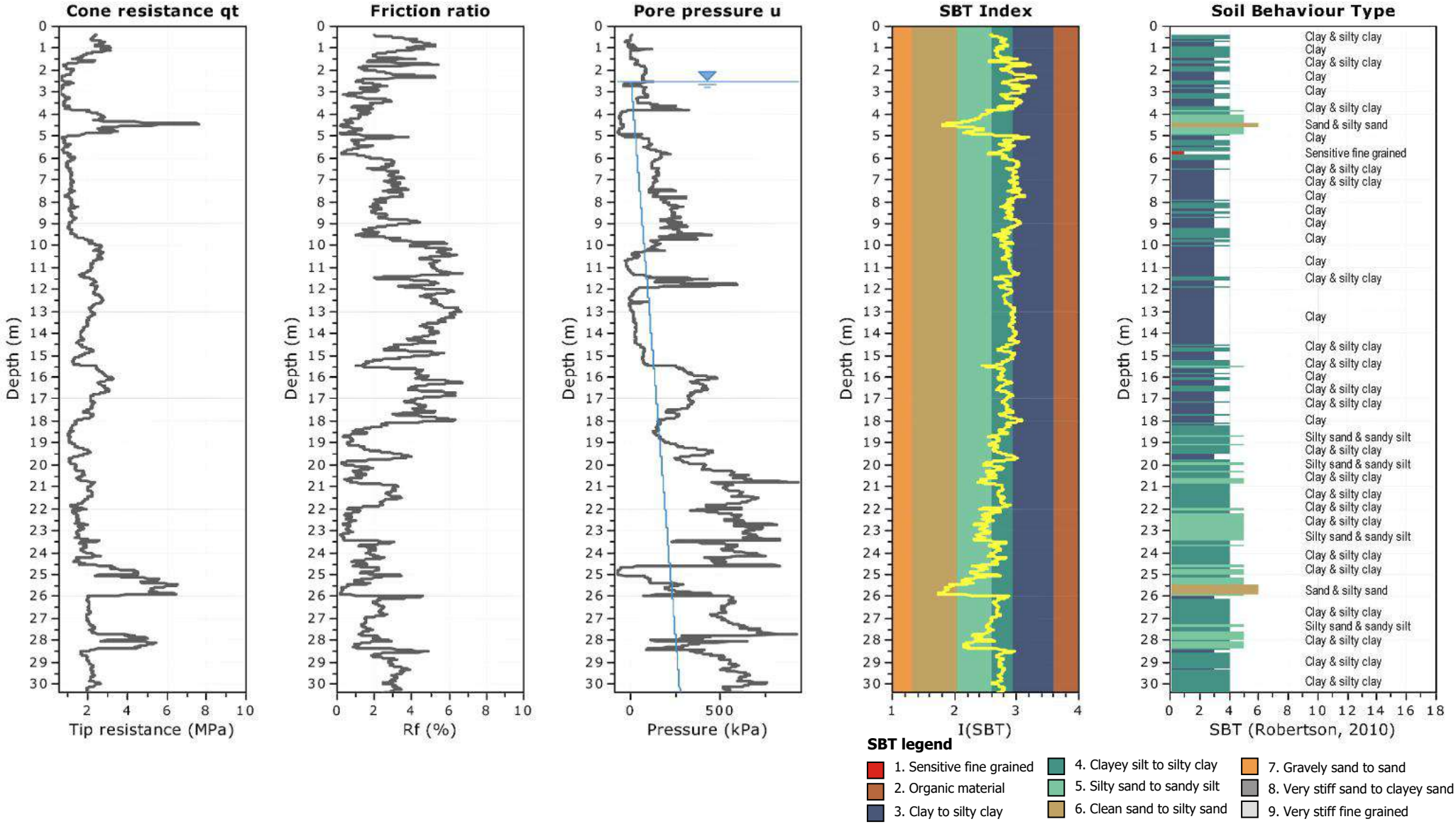
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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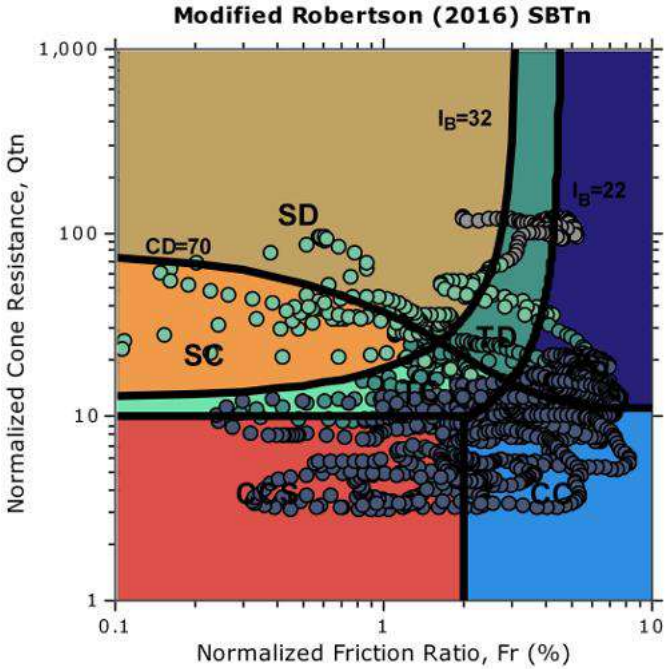
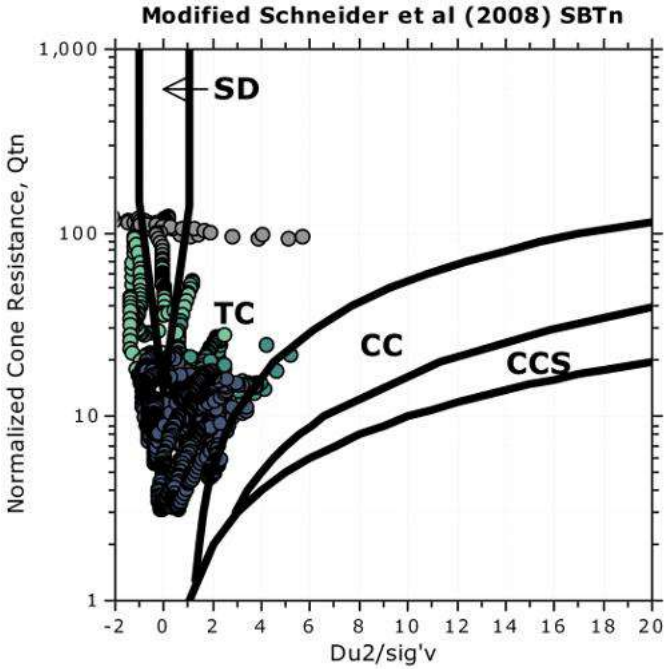
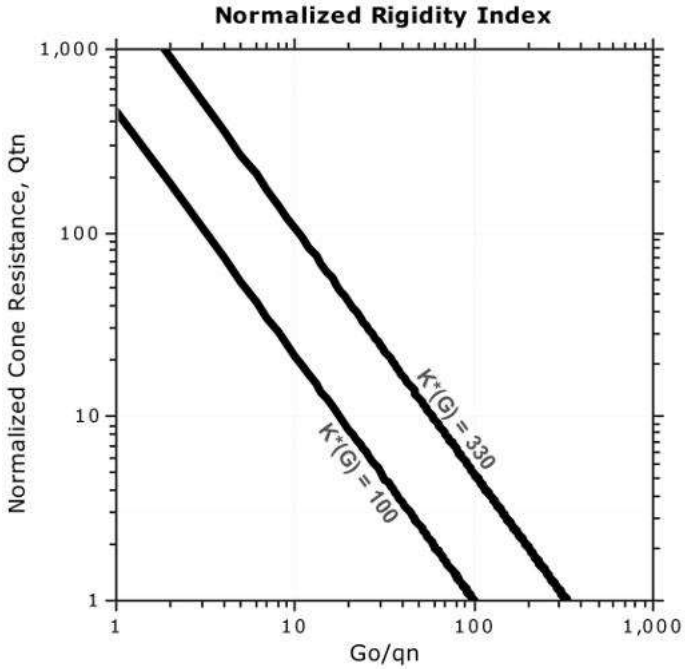
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU3
Total depth: 30.38 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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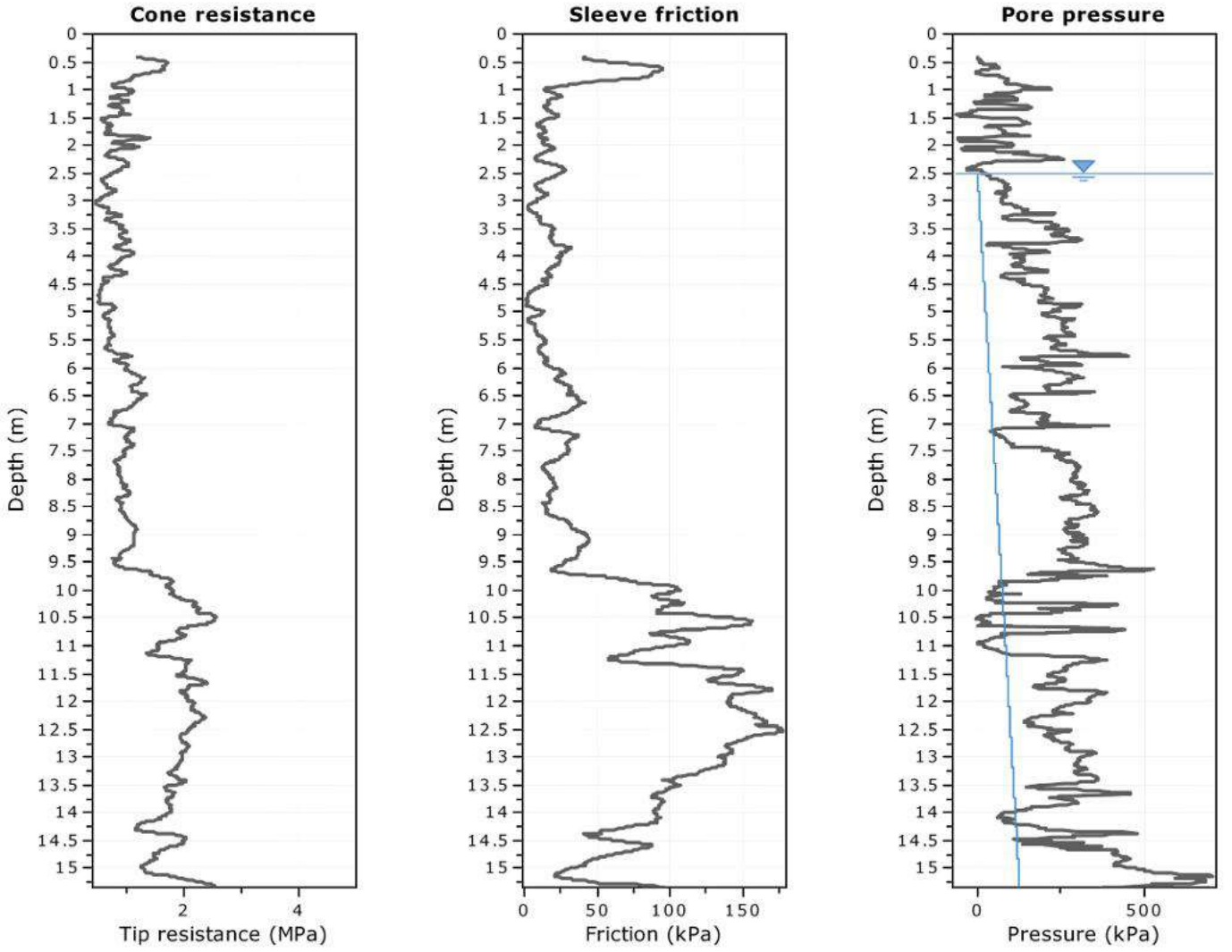
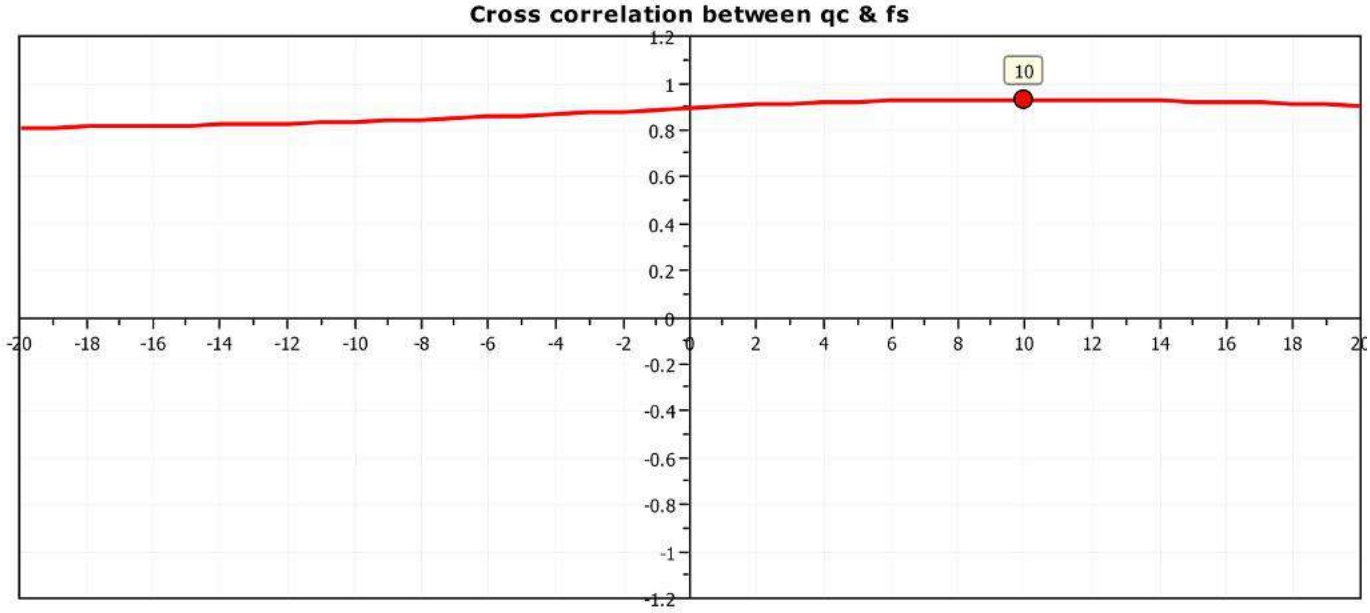
CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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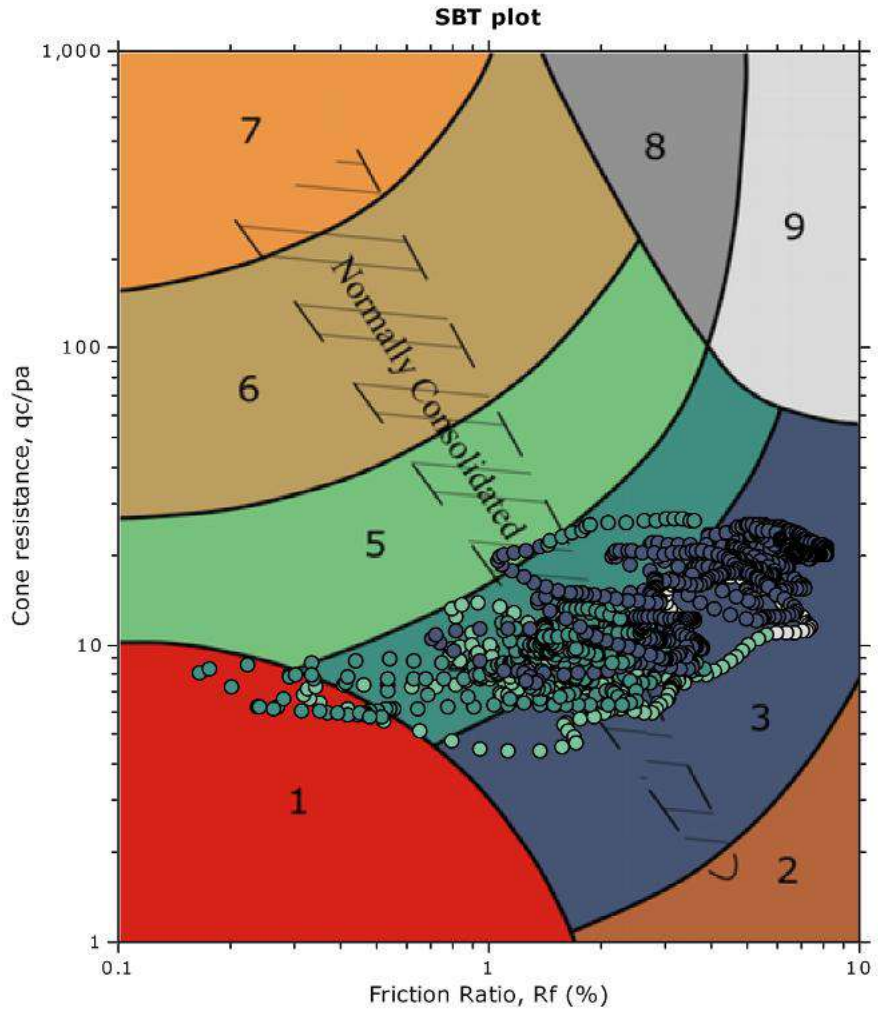
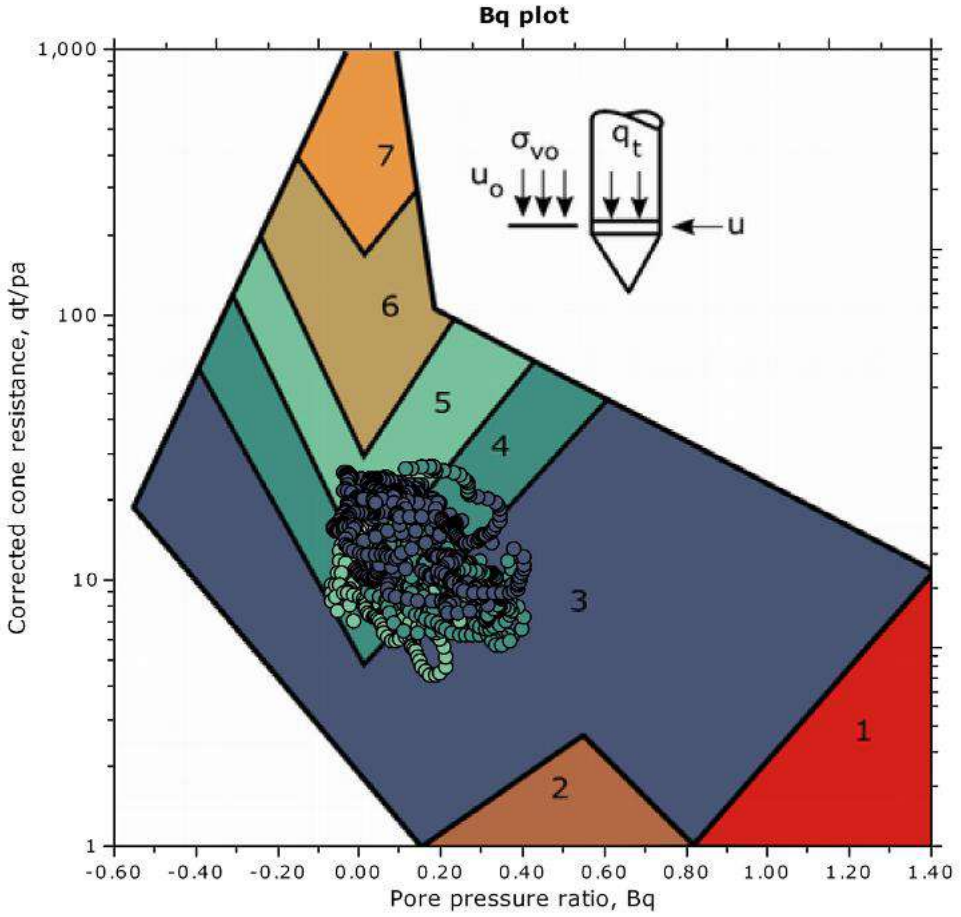
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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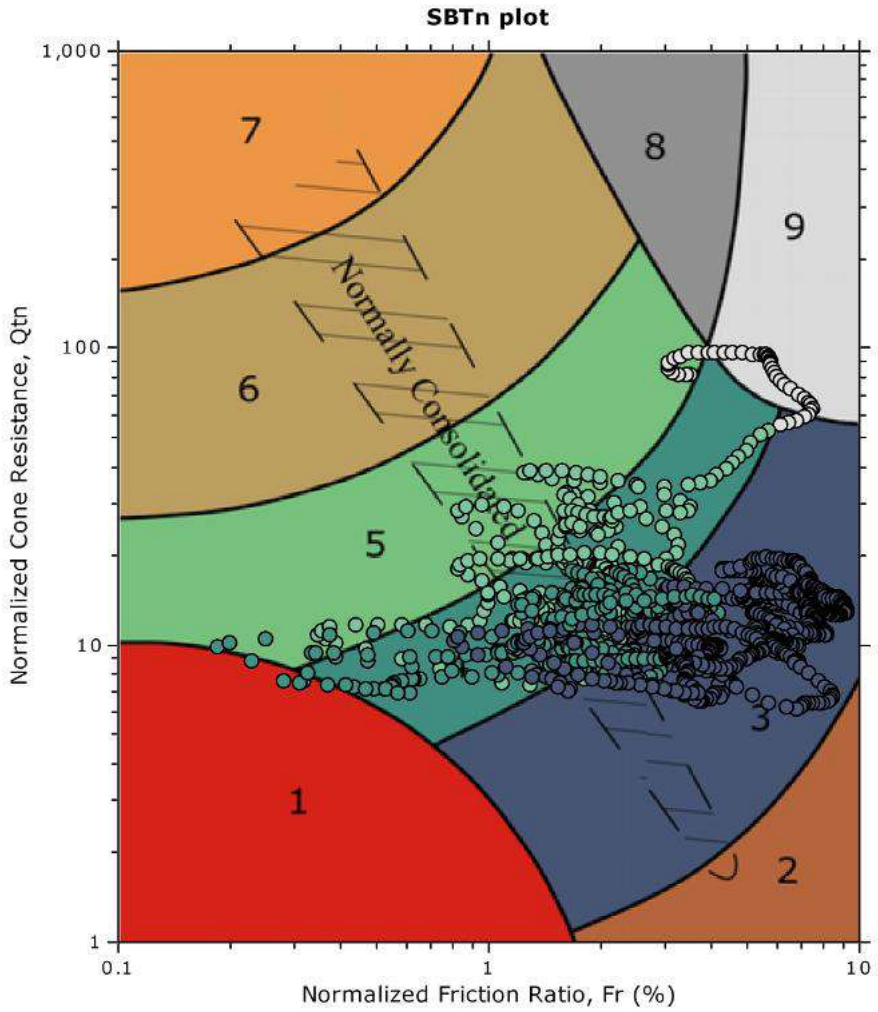
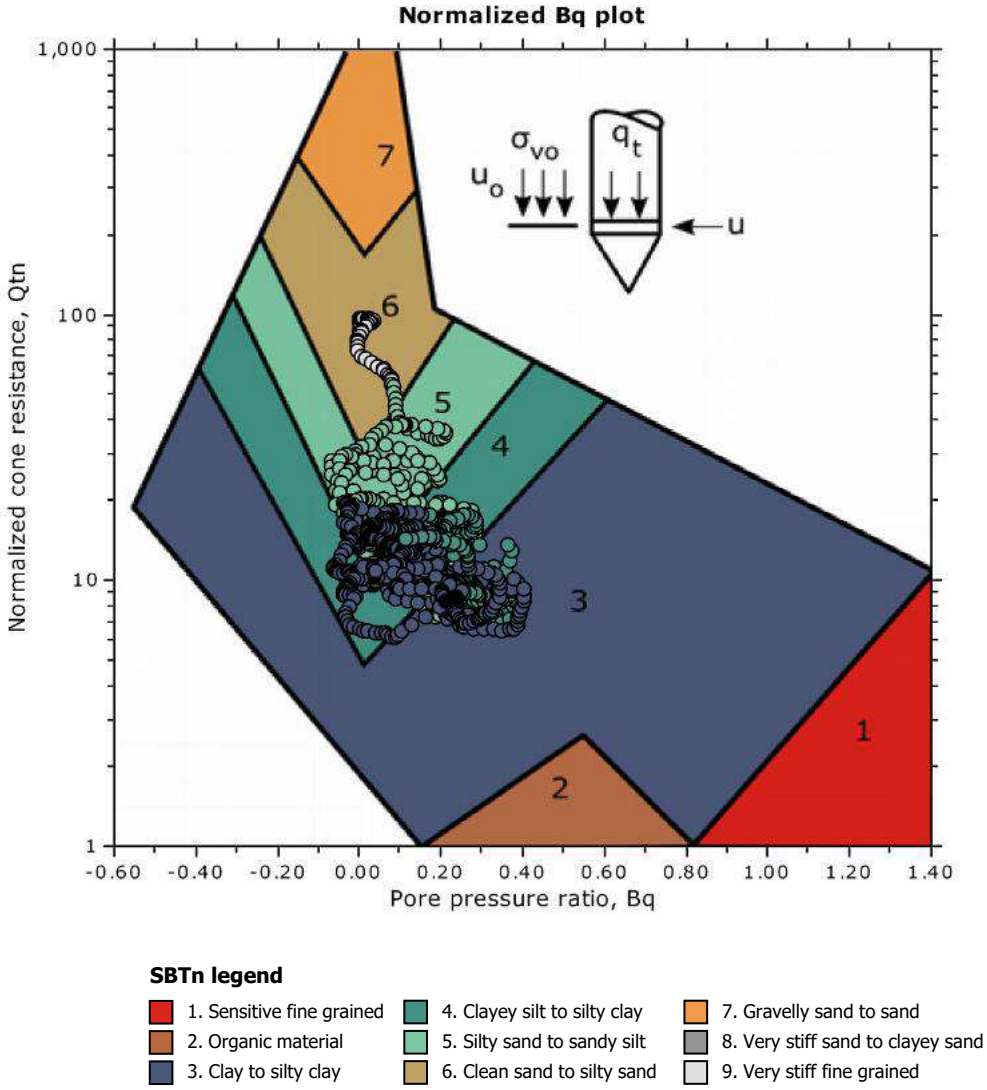
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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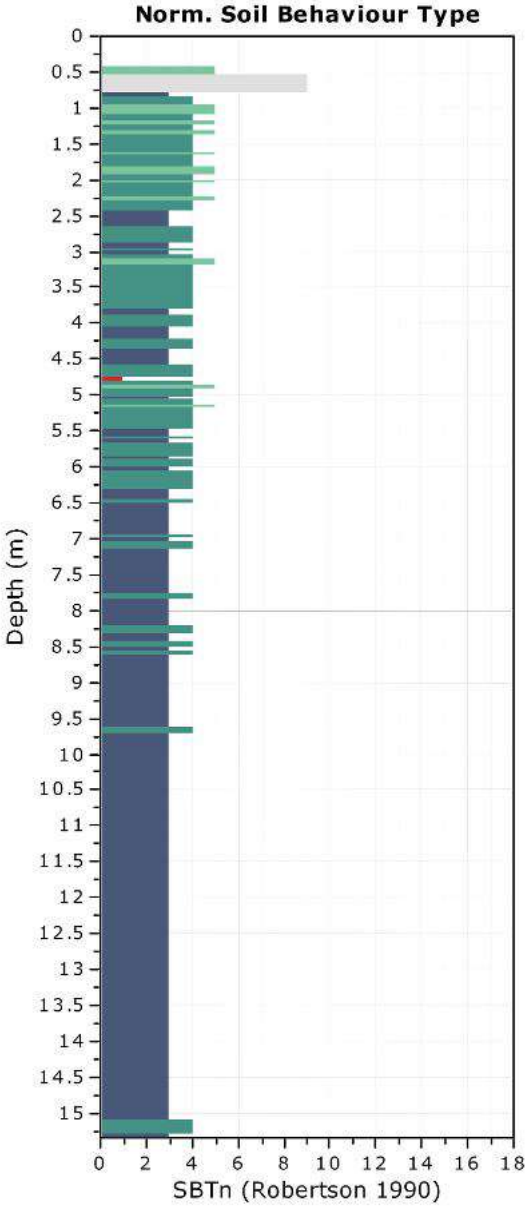
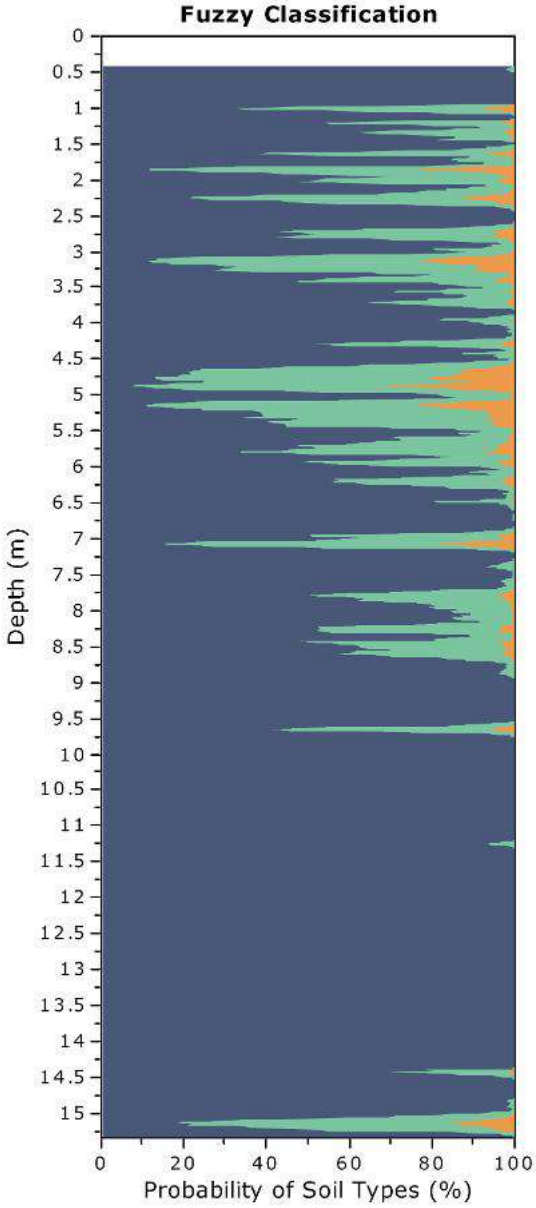
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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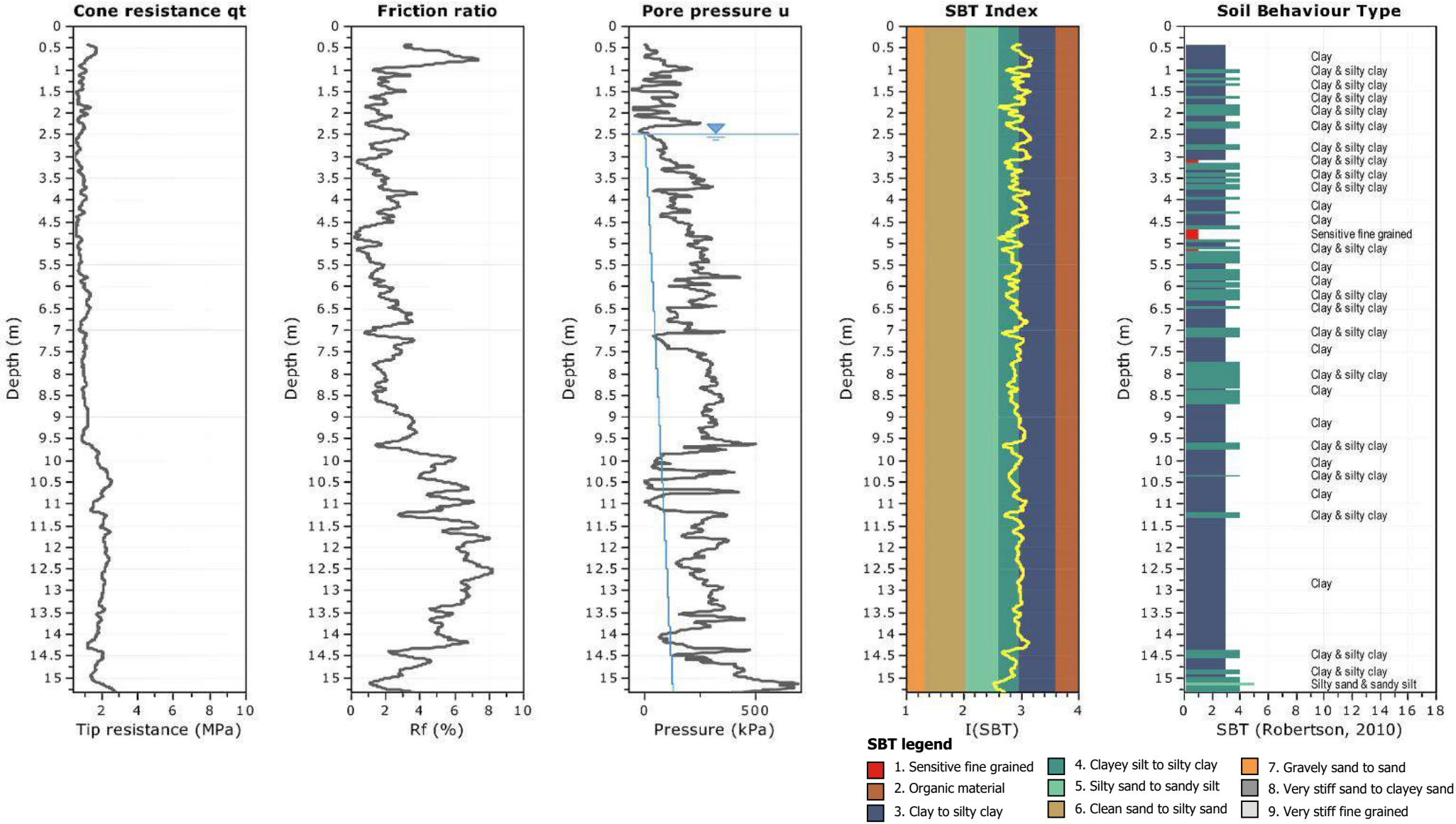
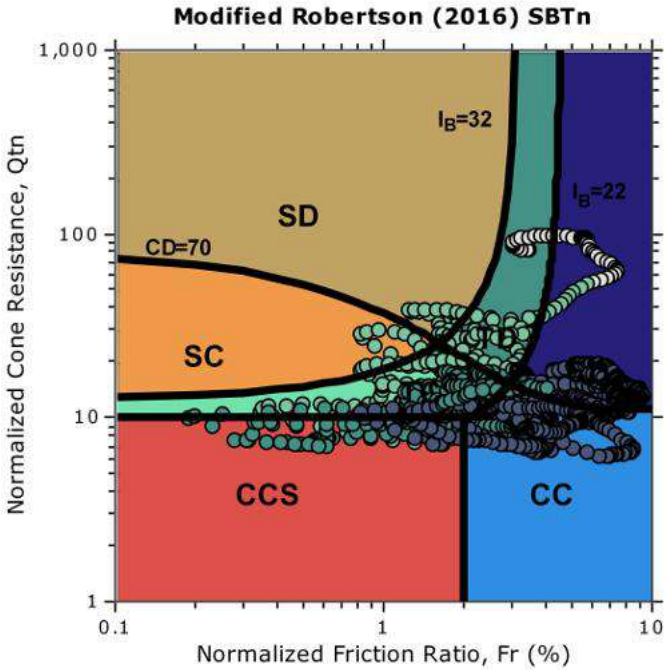
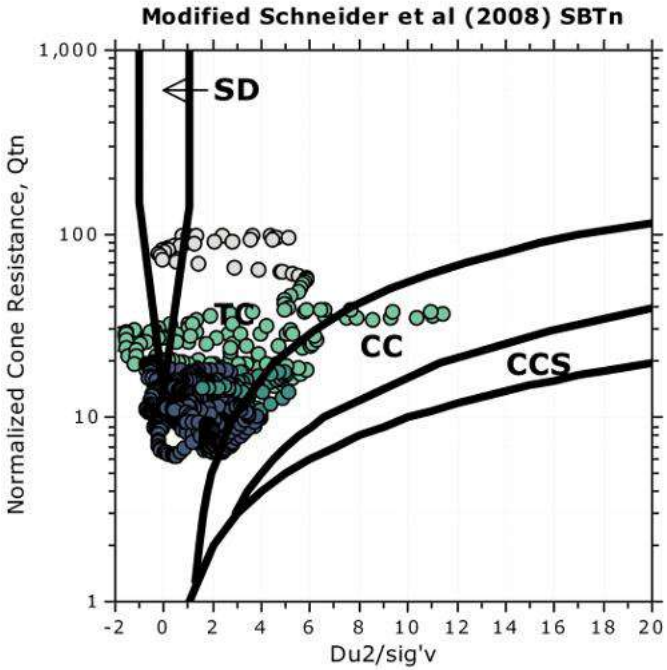
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

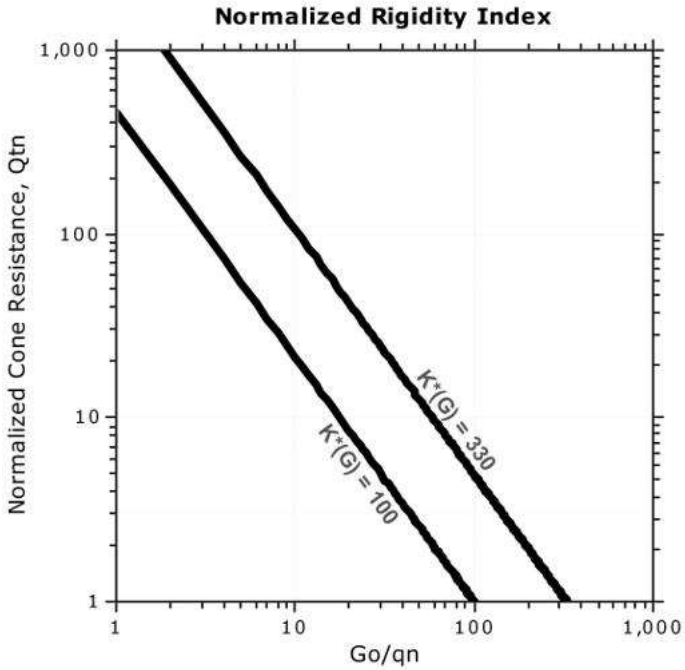
CPT: CPTU6
Total depth: 15.34 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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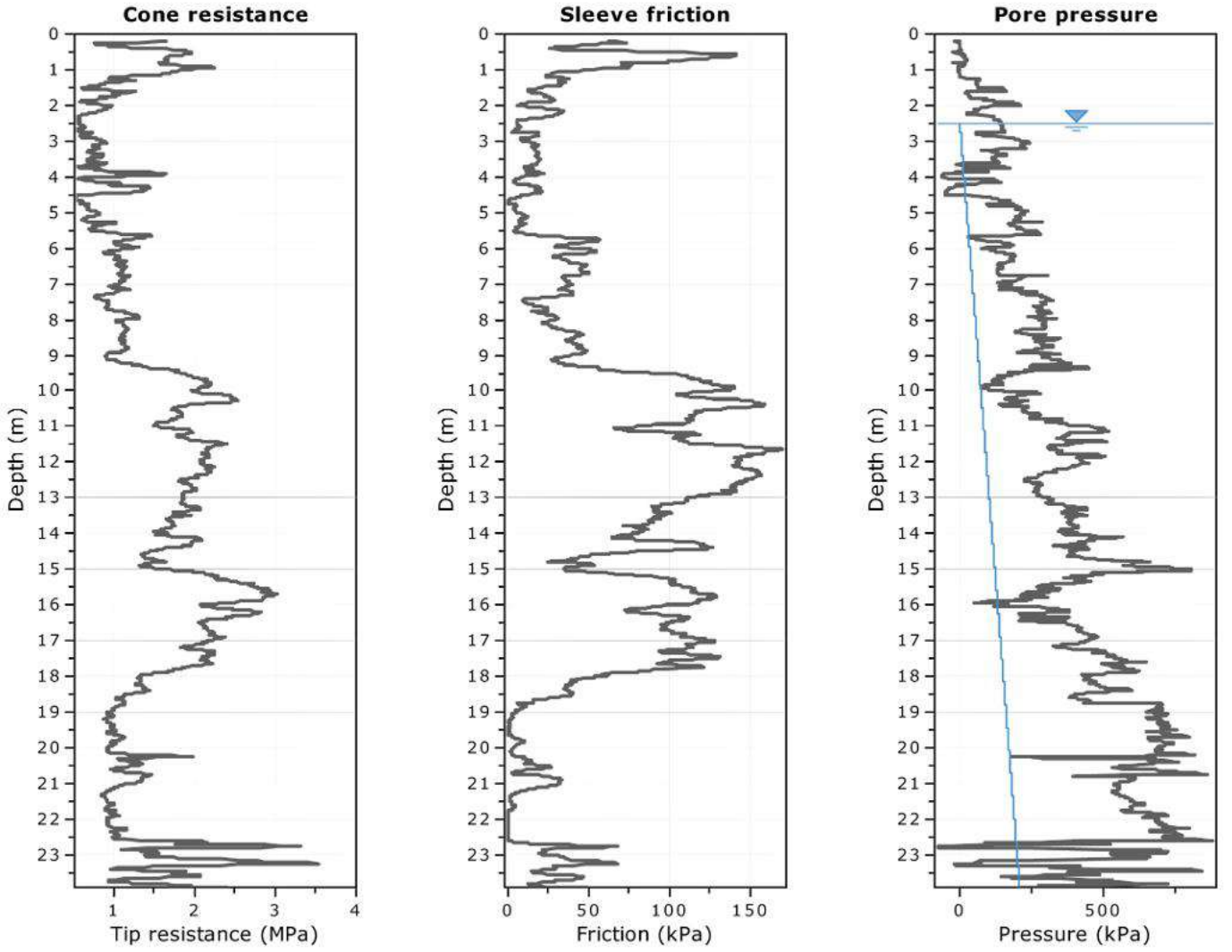
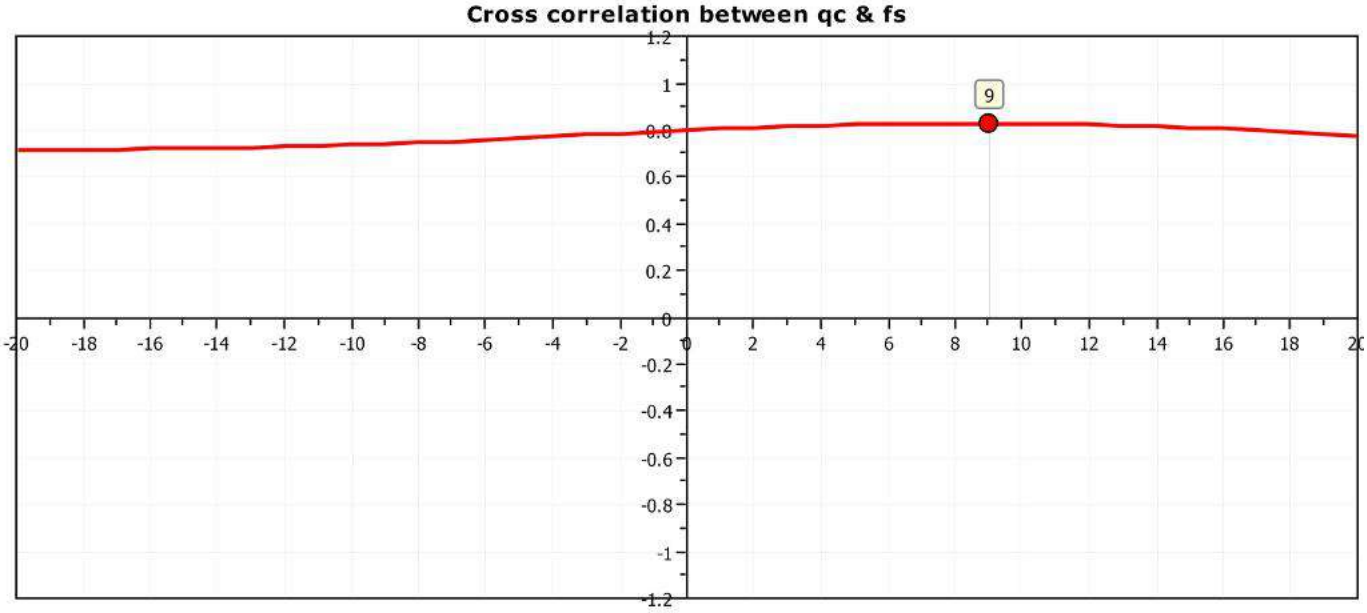
CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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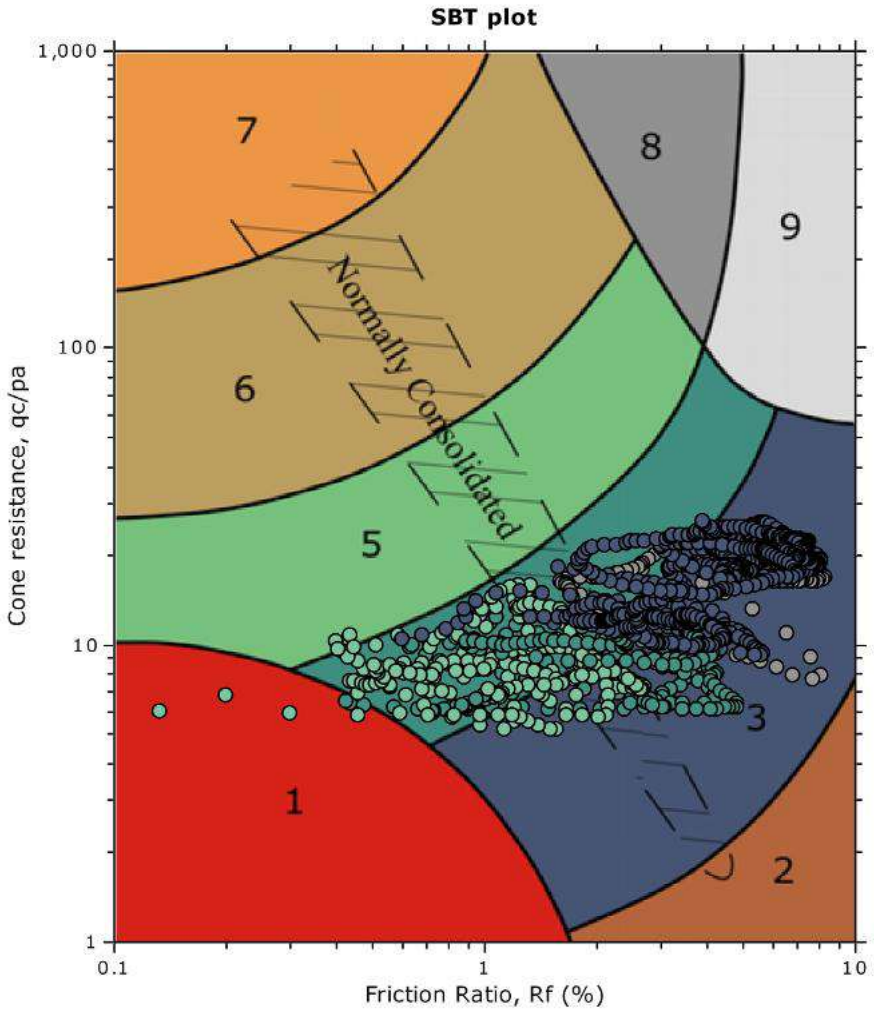
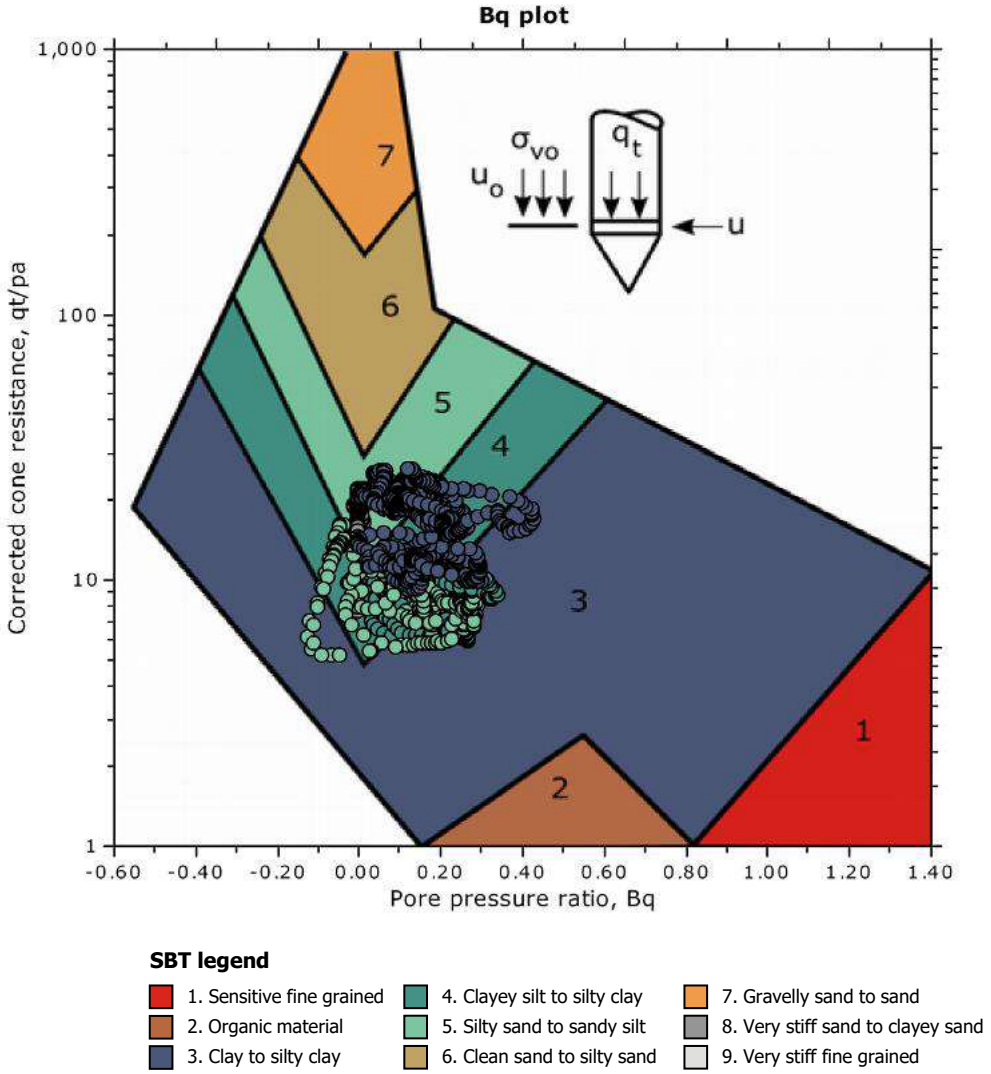
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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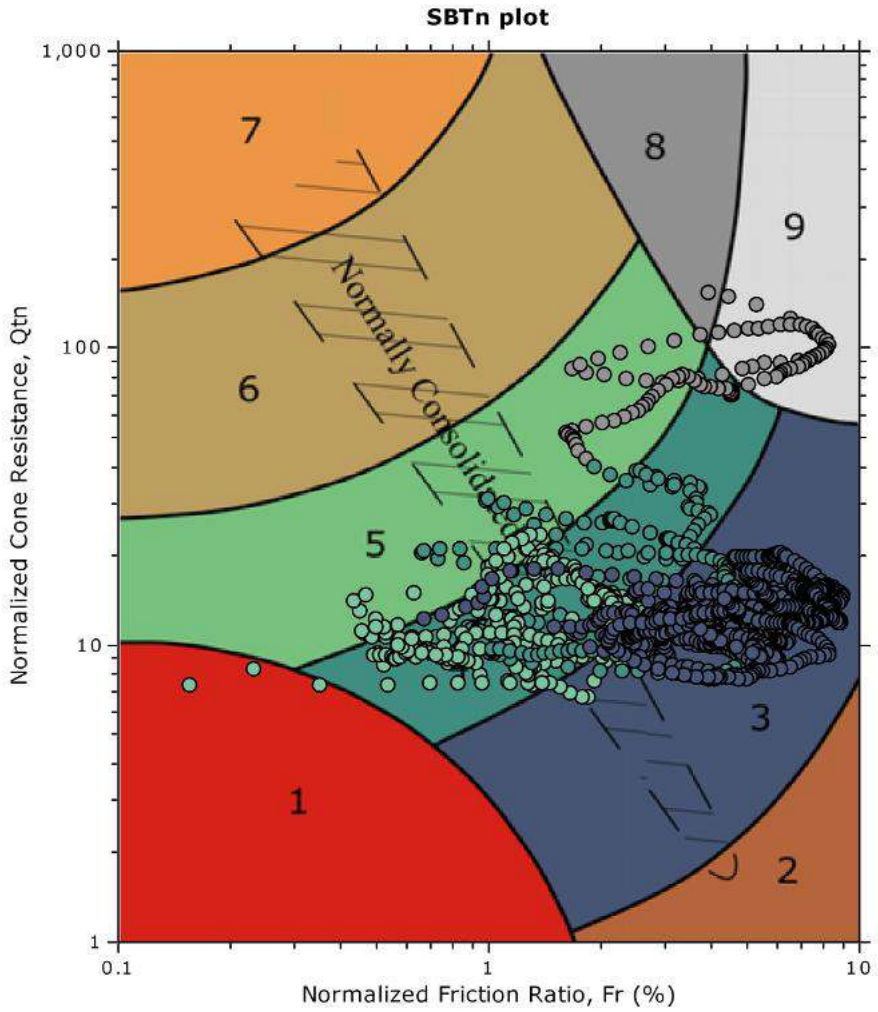
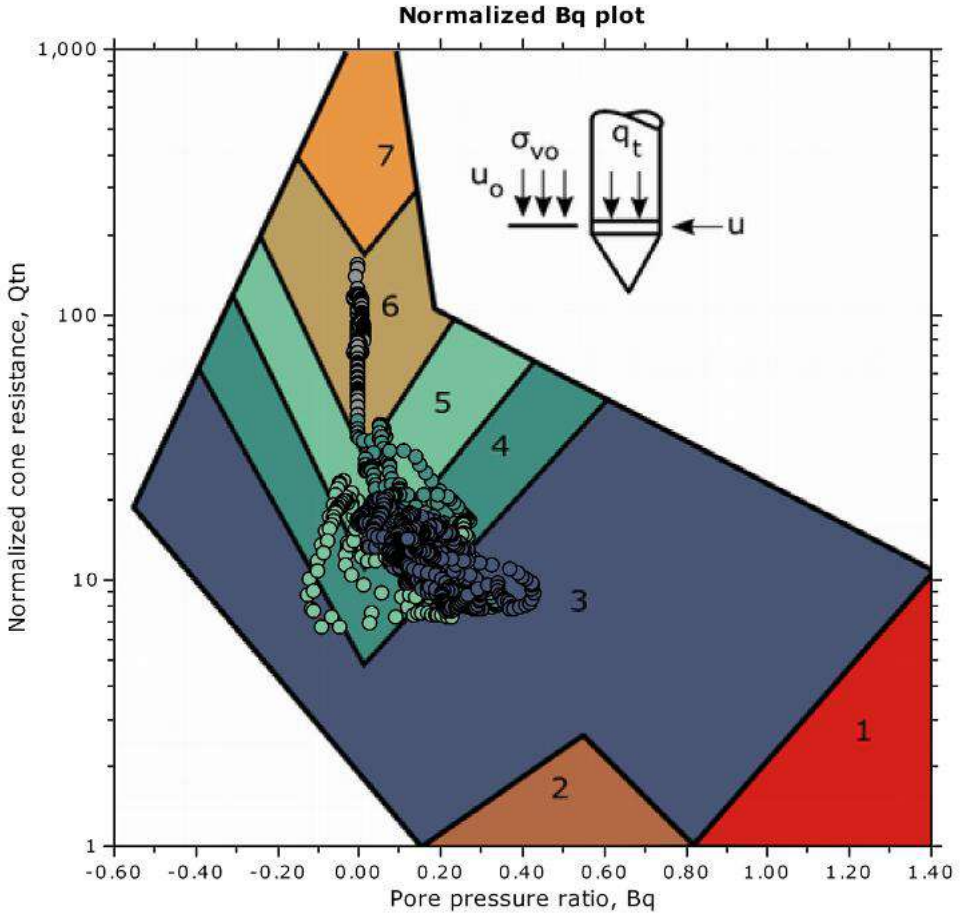
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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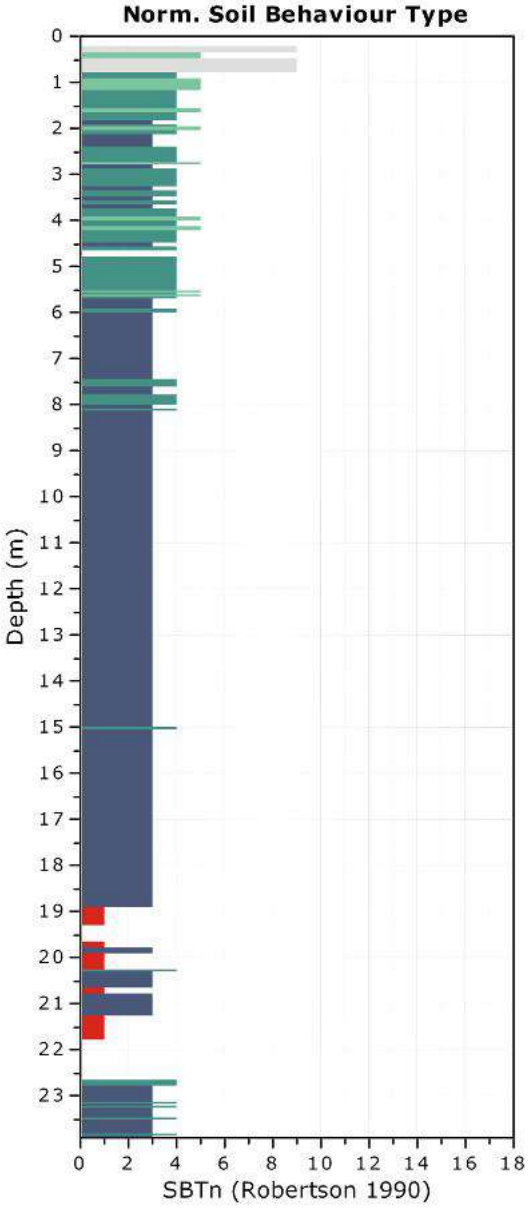
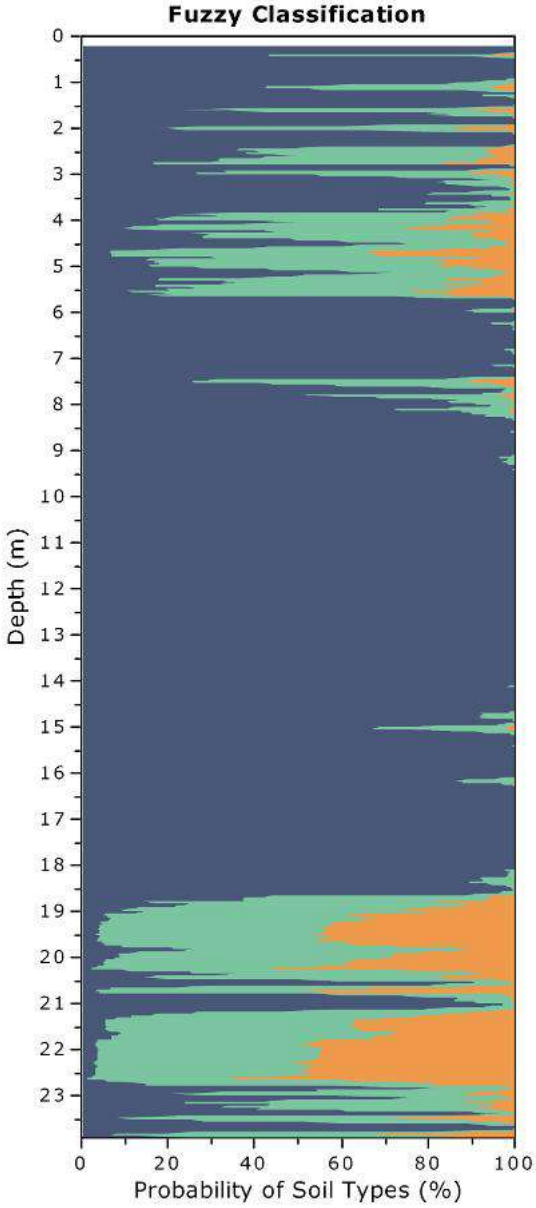
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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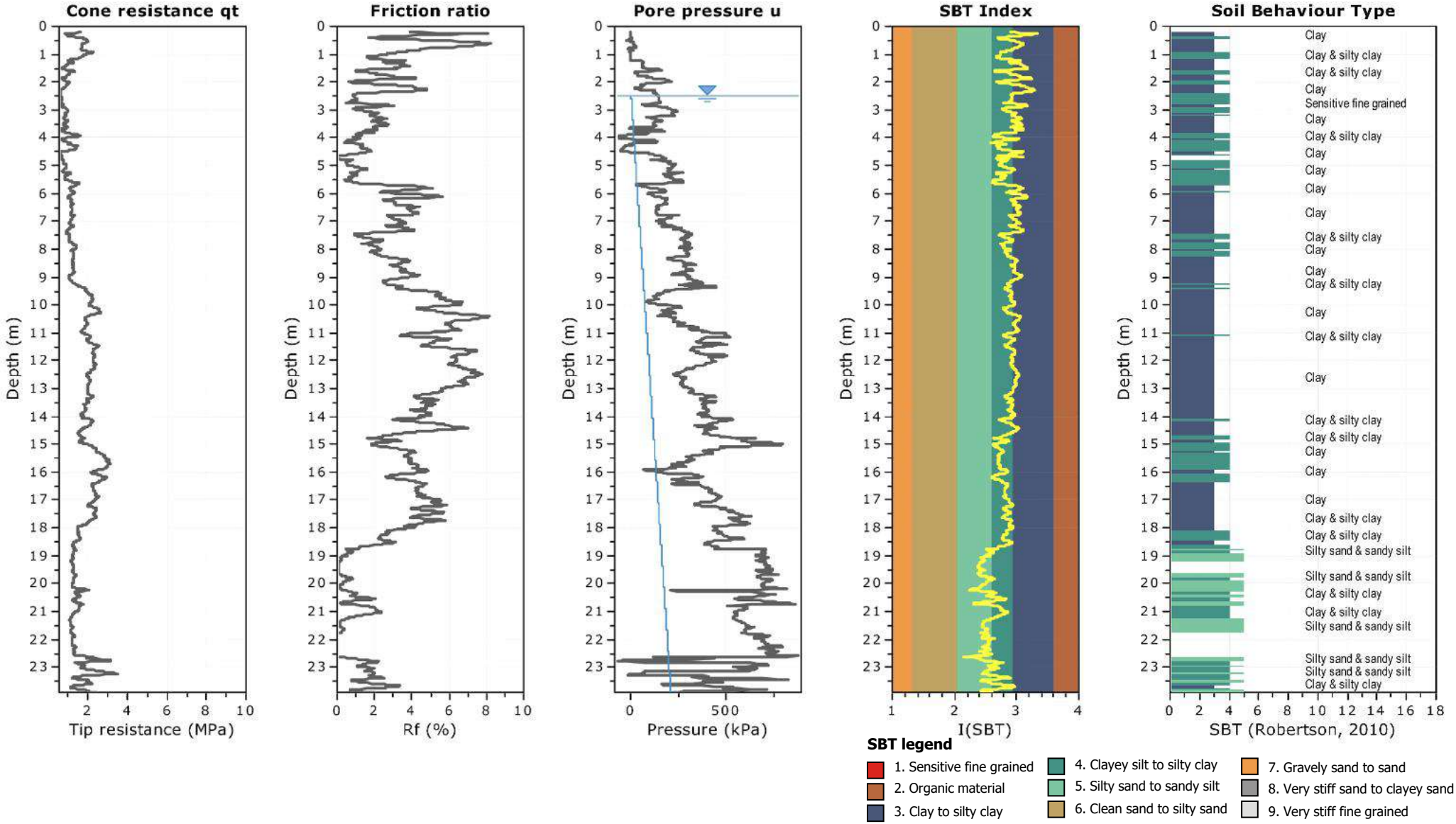
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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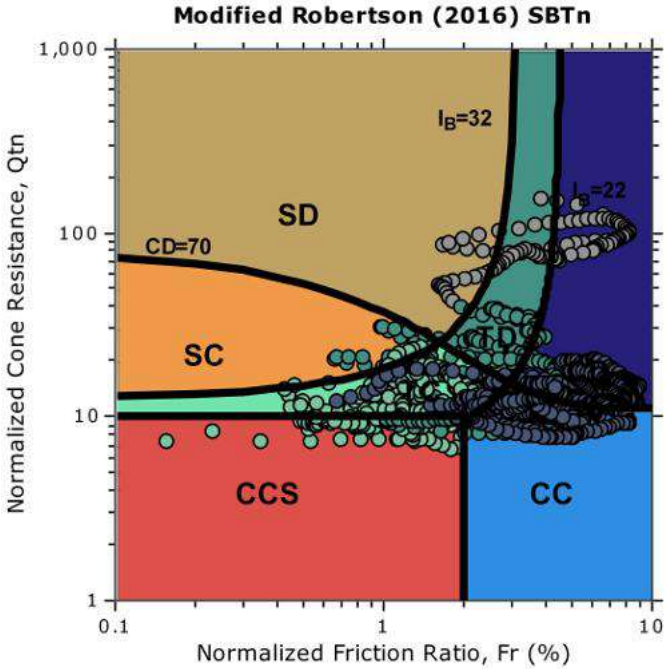
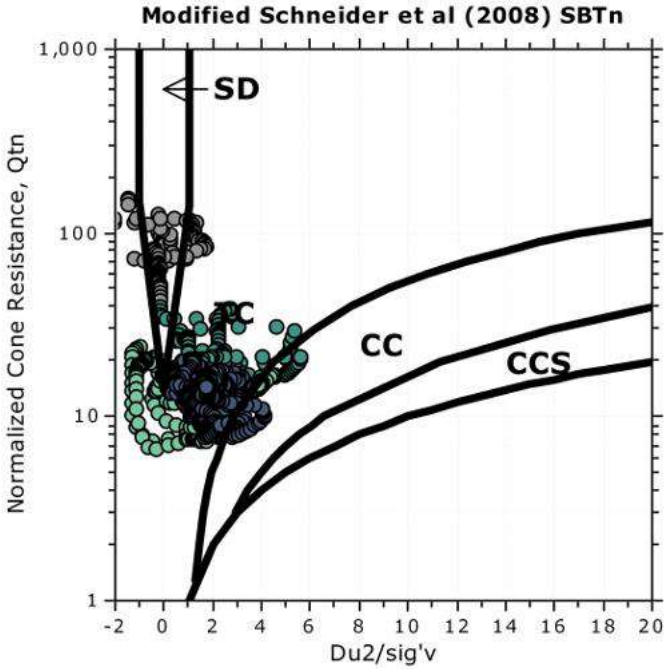
https://geogroupmodena.it/

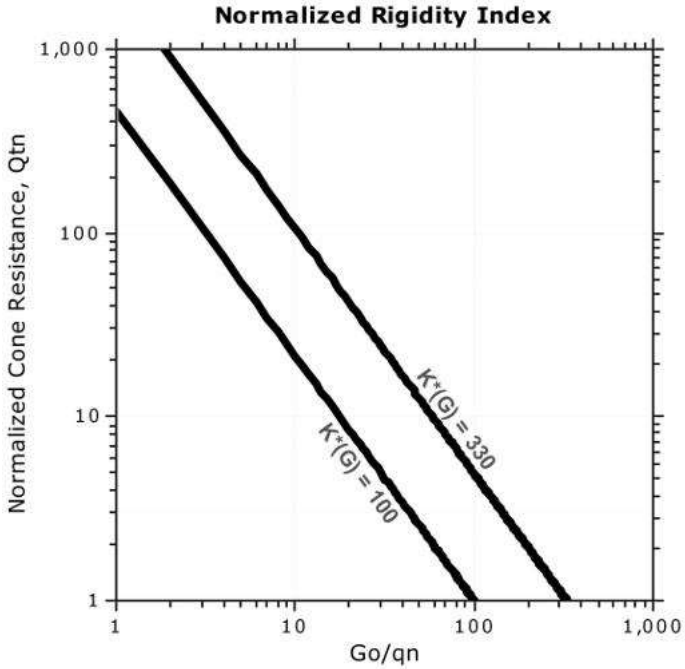
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU7
Total depth: 23.91 m, Date: 13/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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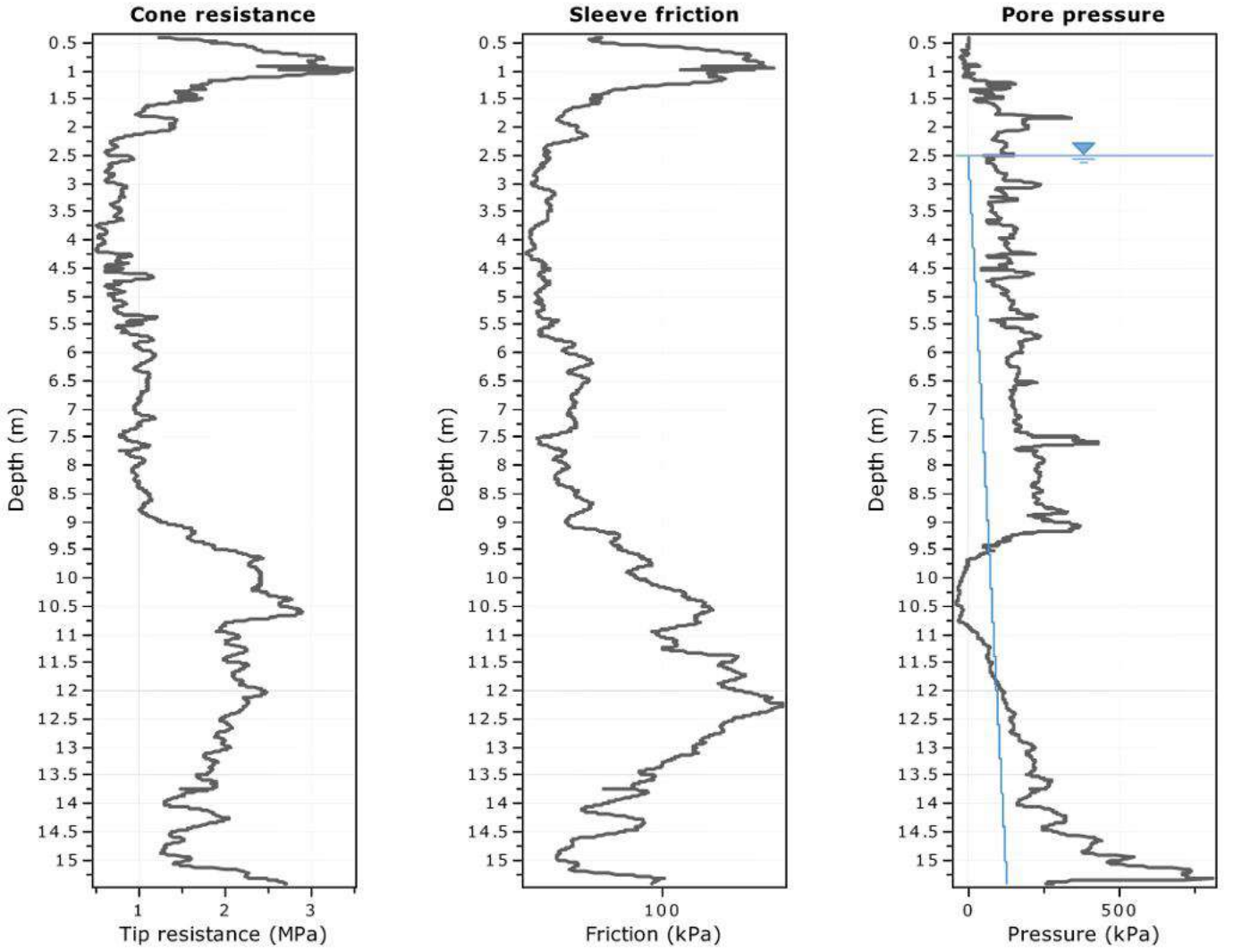
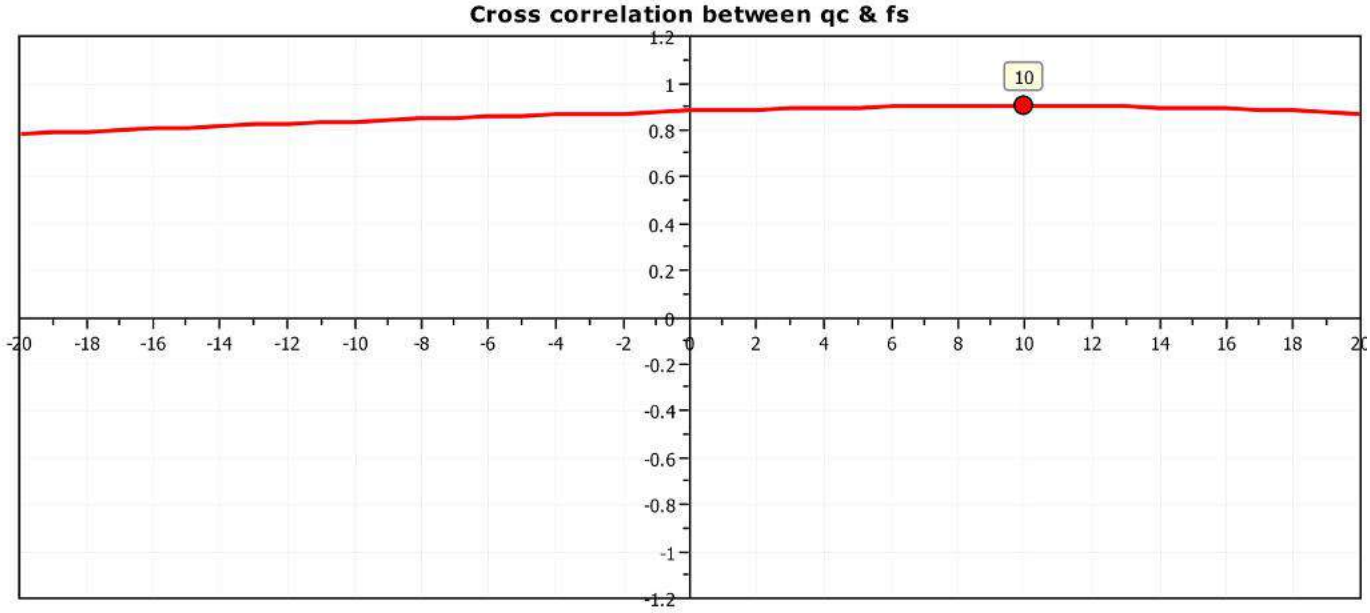
CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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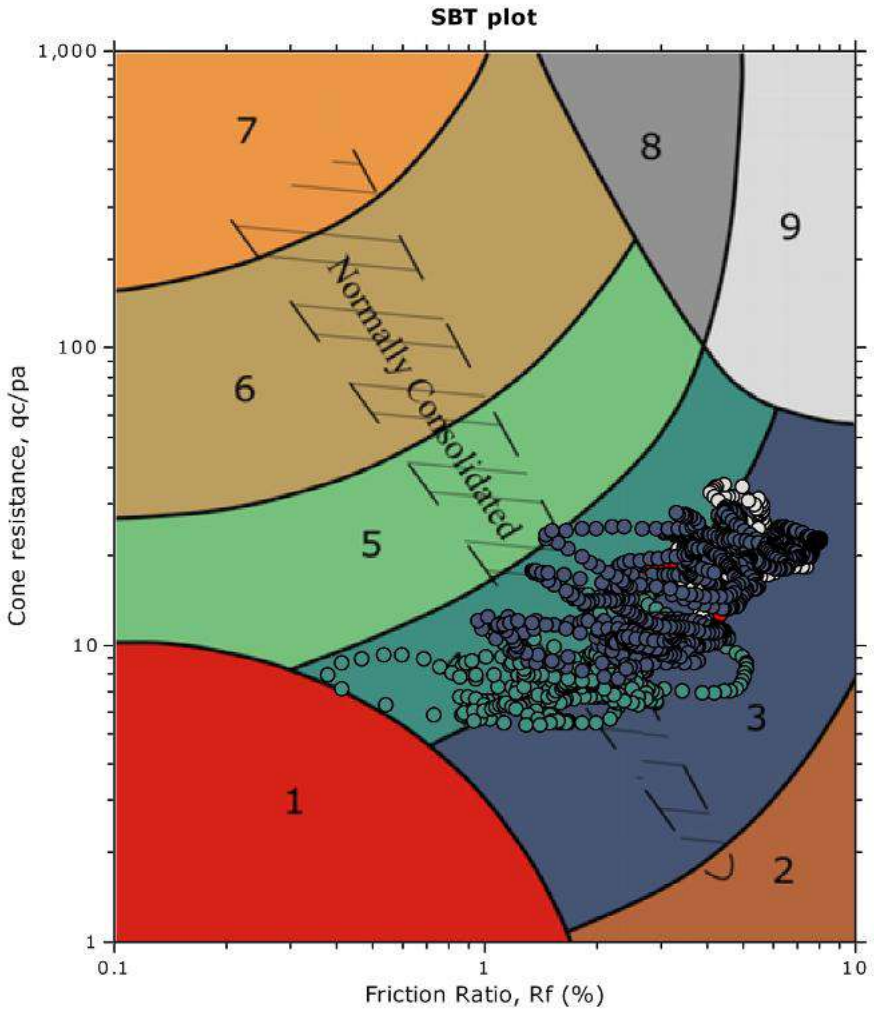
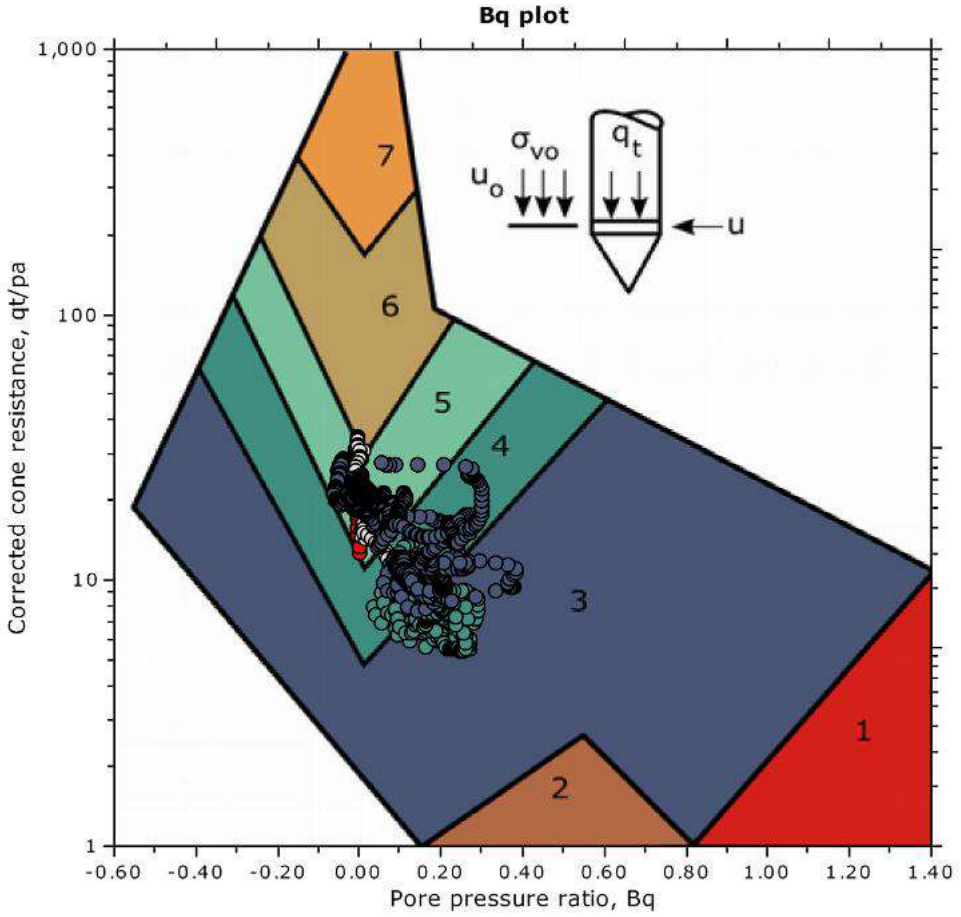
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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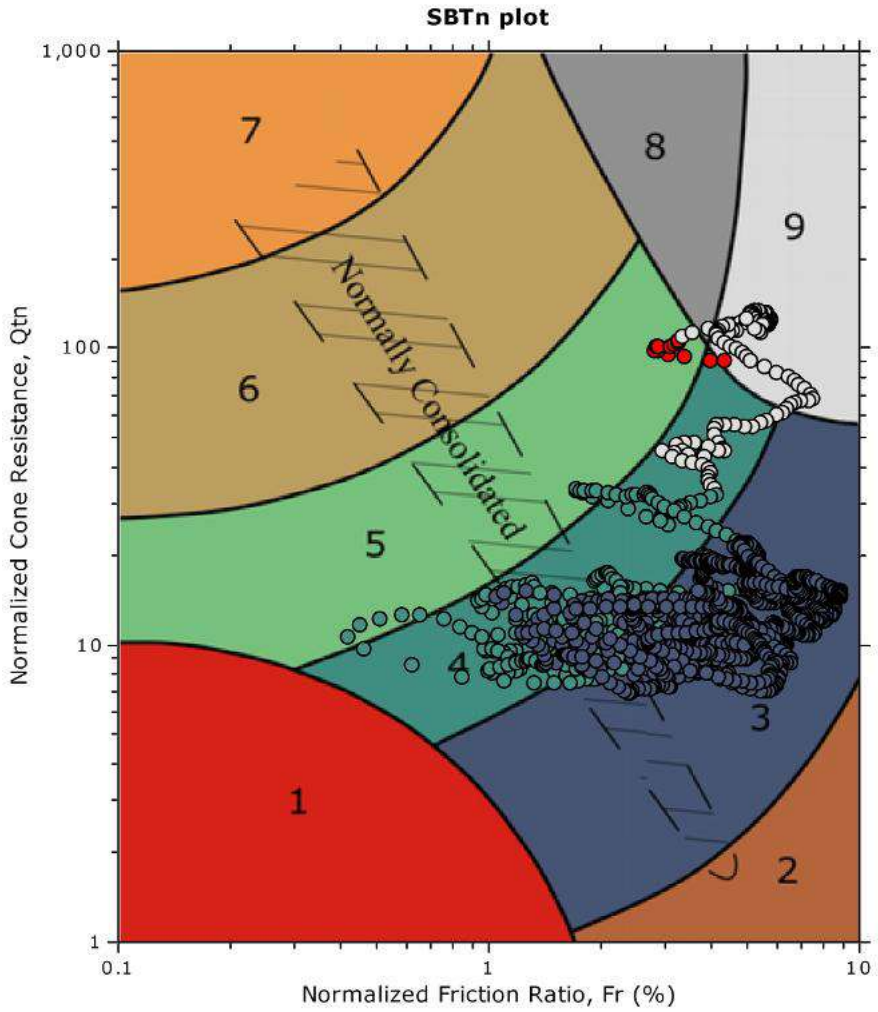
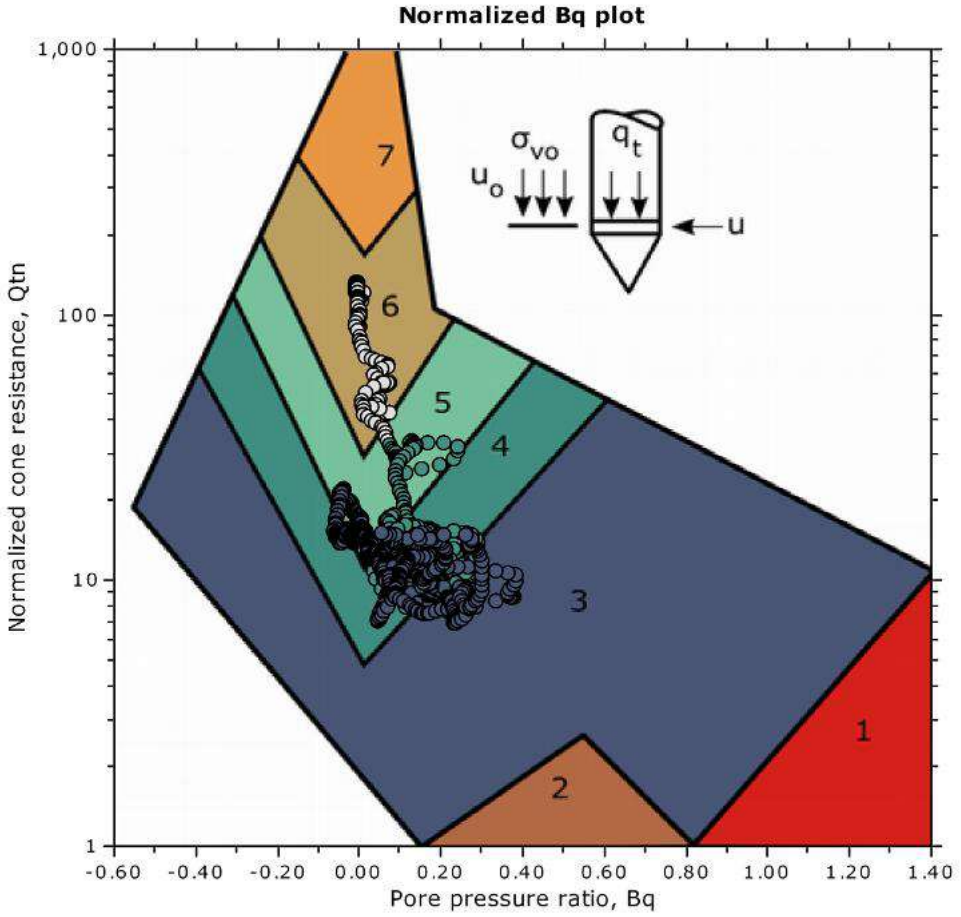
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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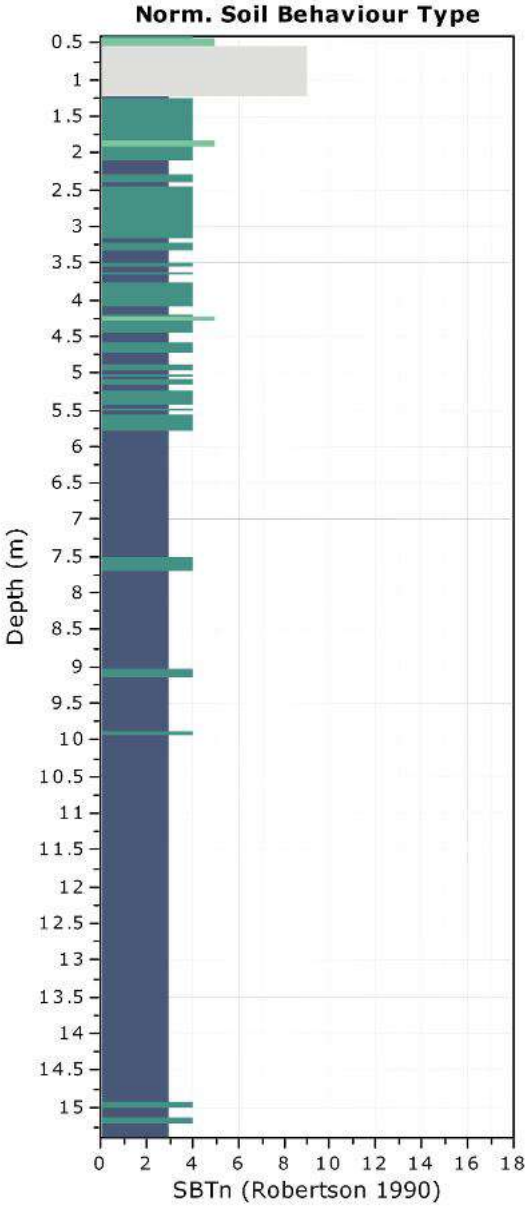
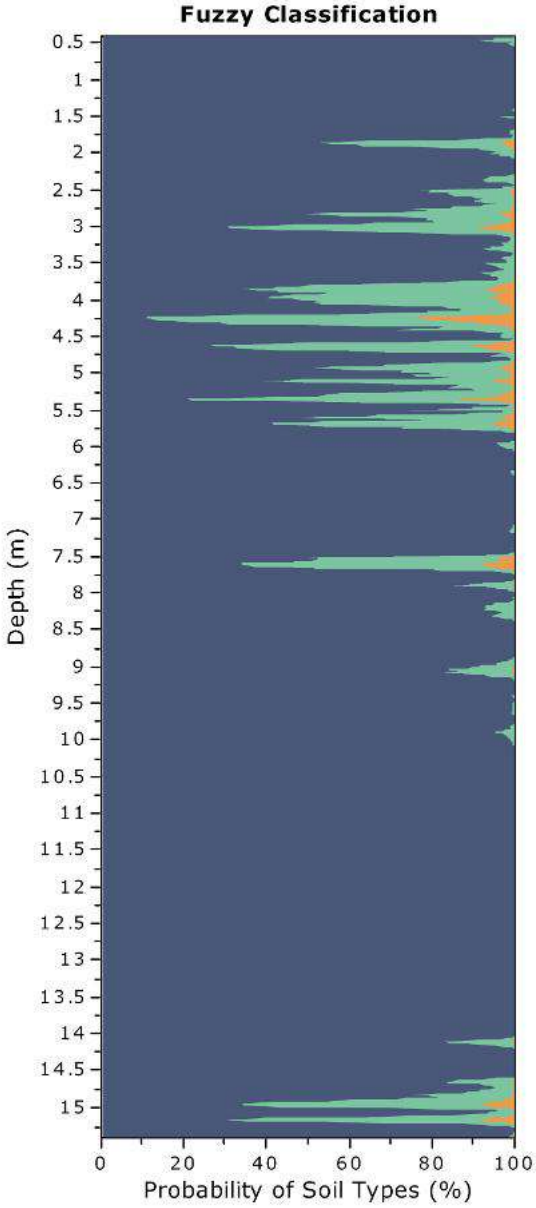
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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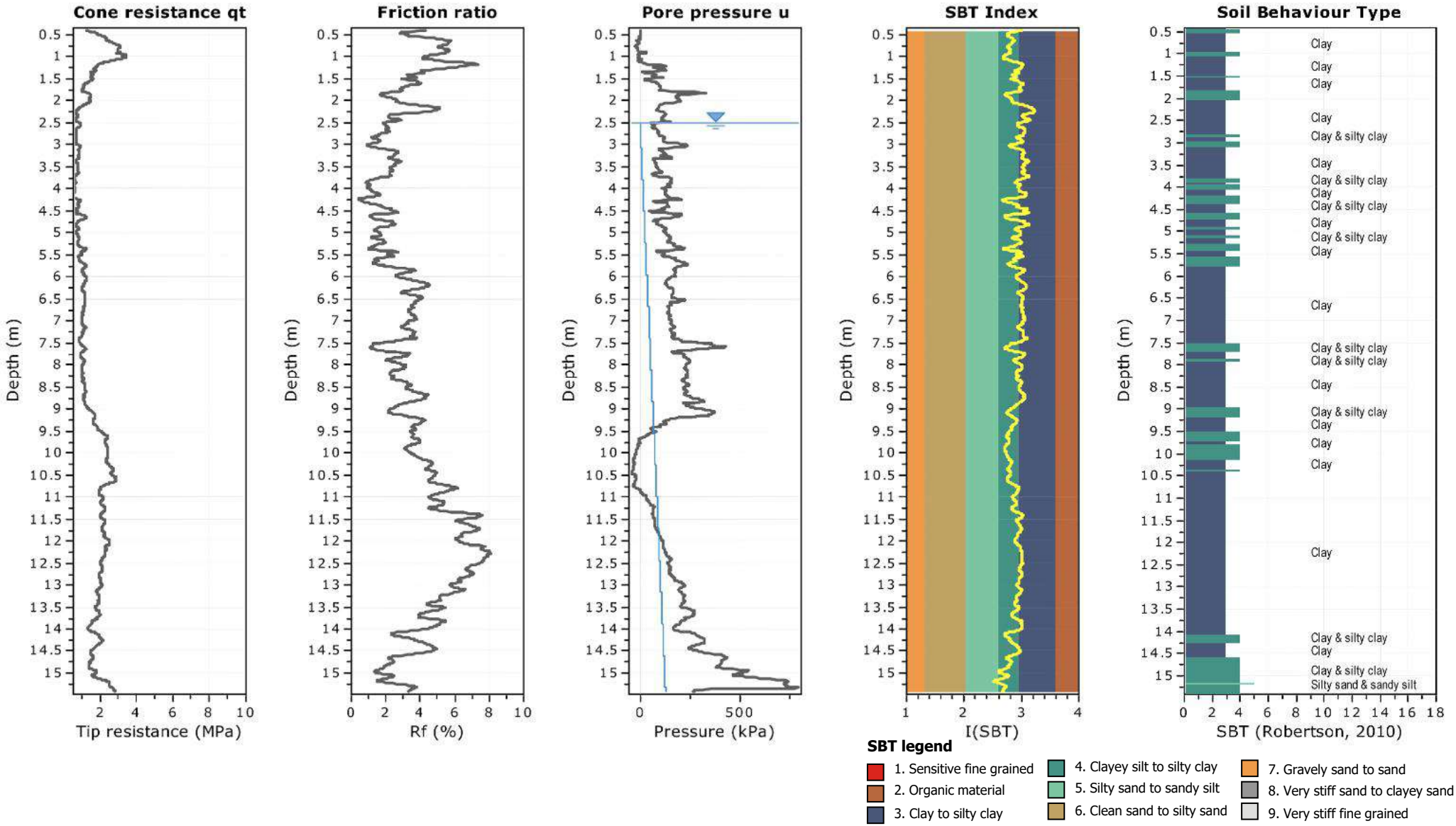
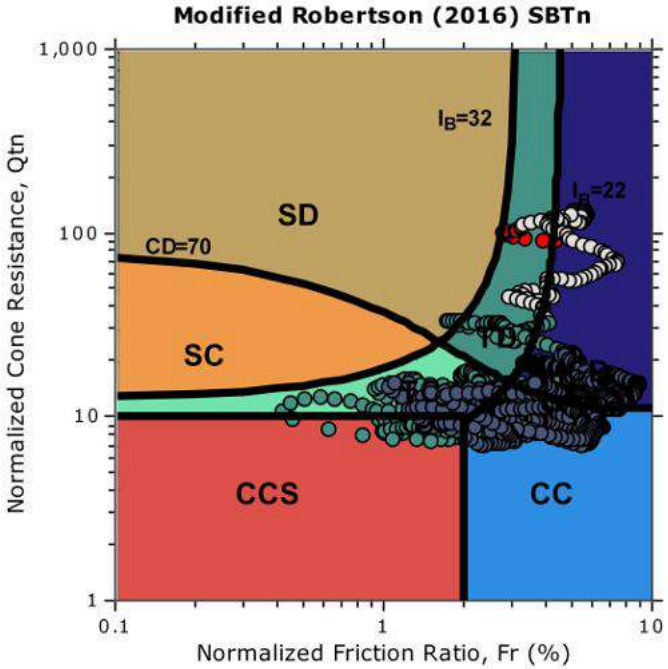
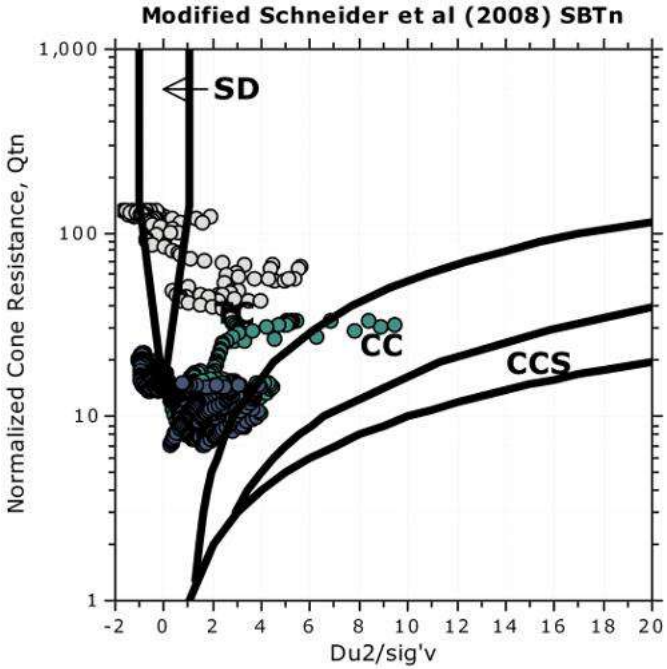
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

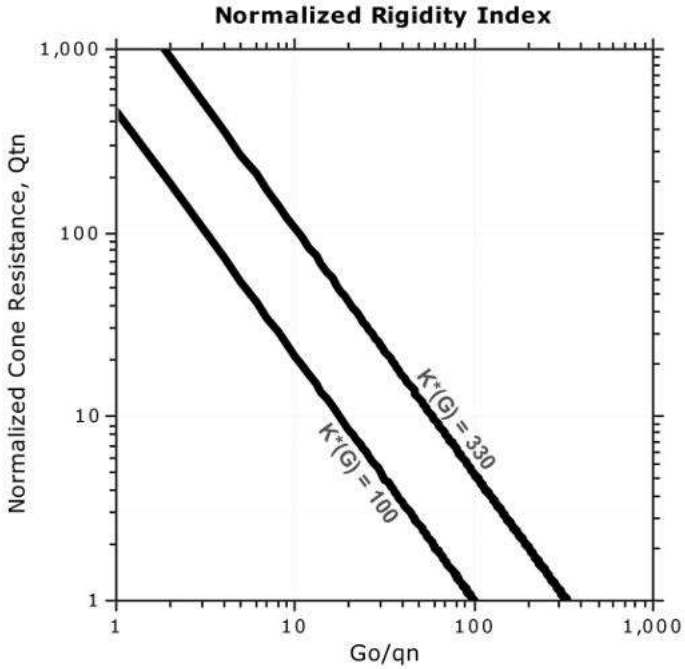
CPT: CPTU8
Total depth: 15.42 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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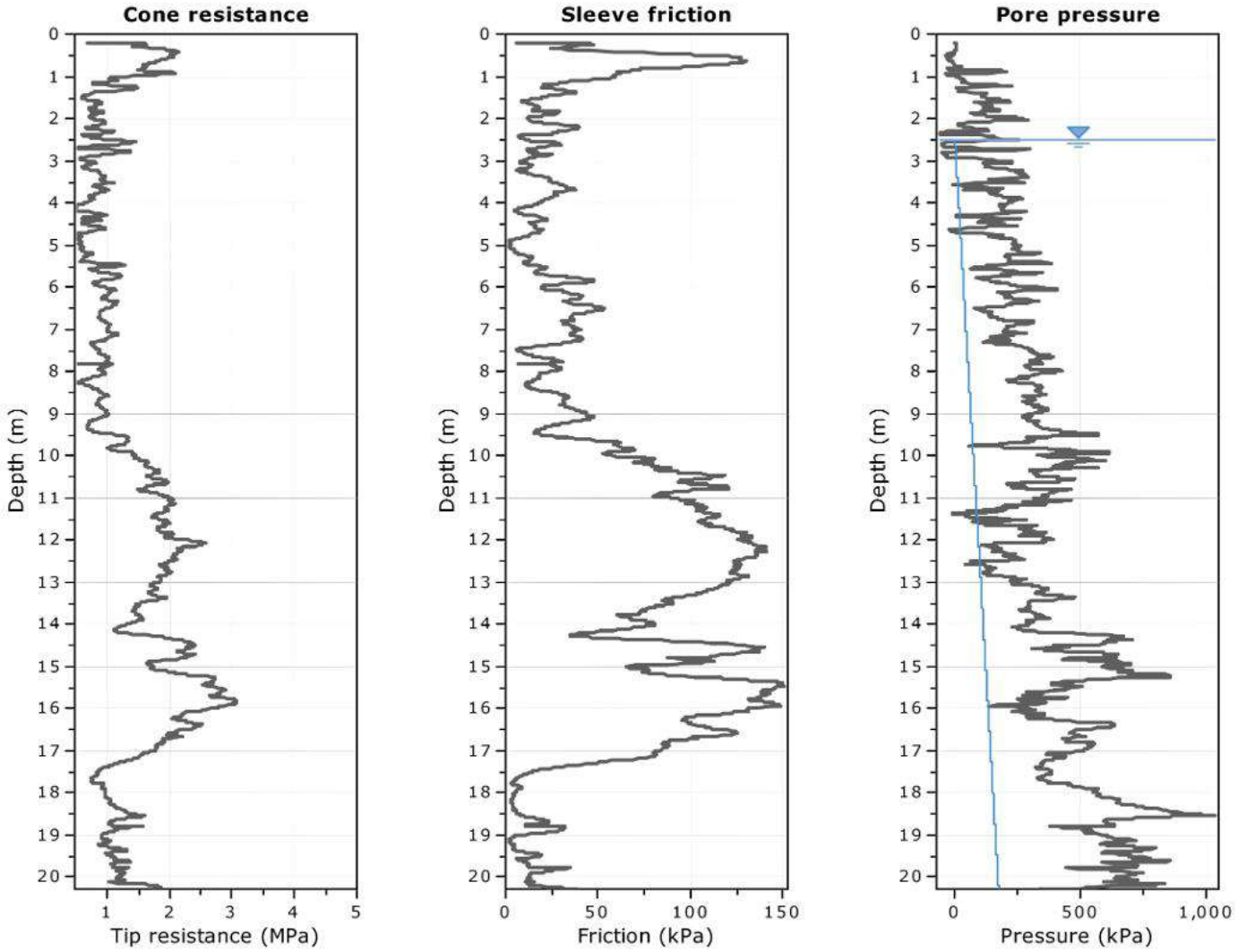
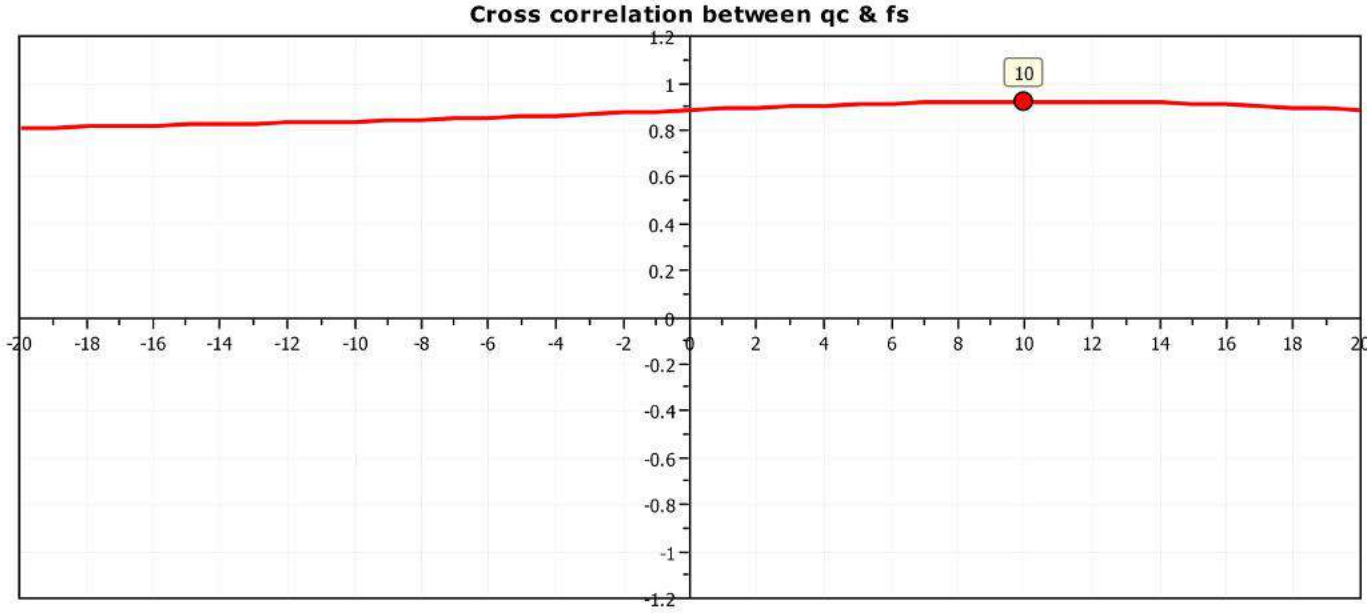
CPT: CPTU9
Total depth: 20.28 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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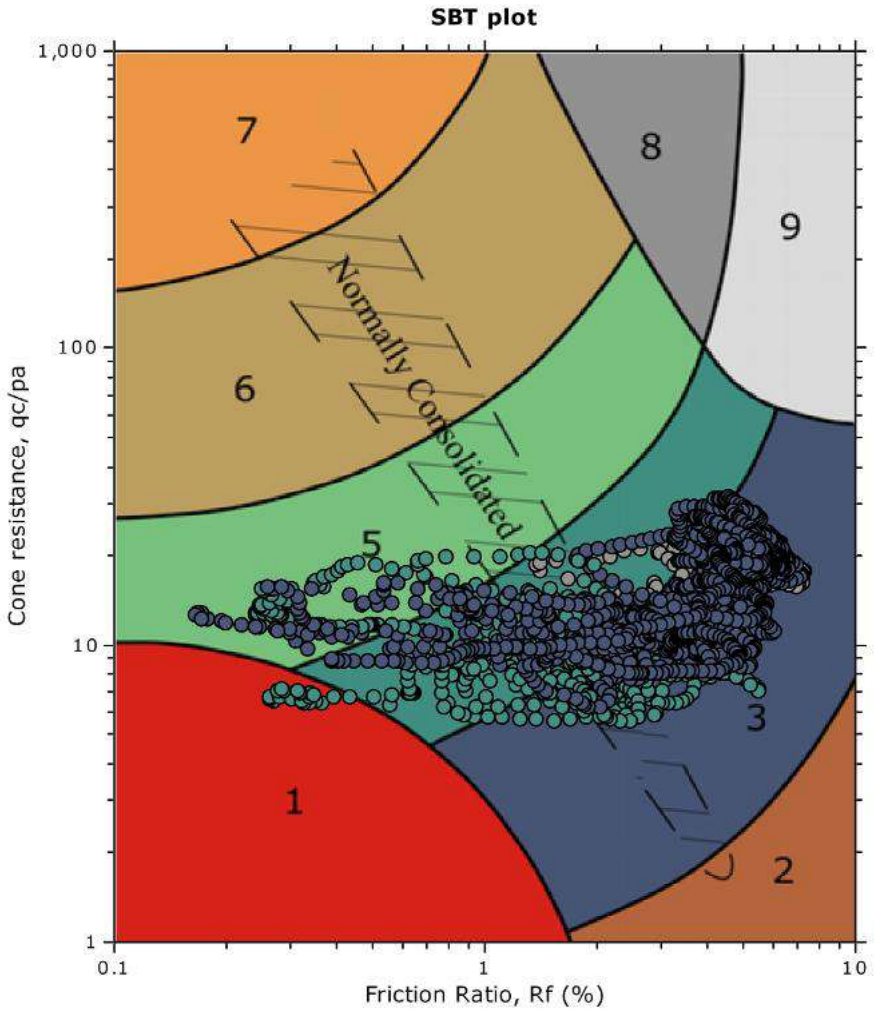
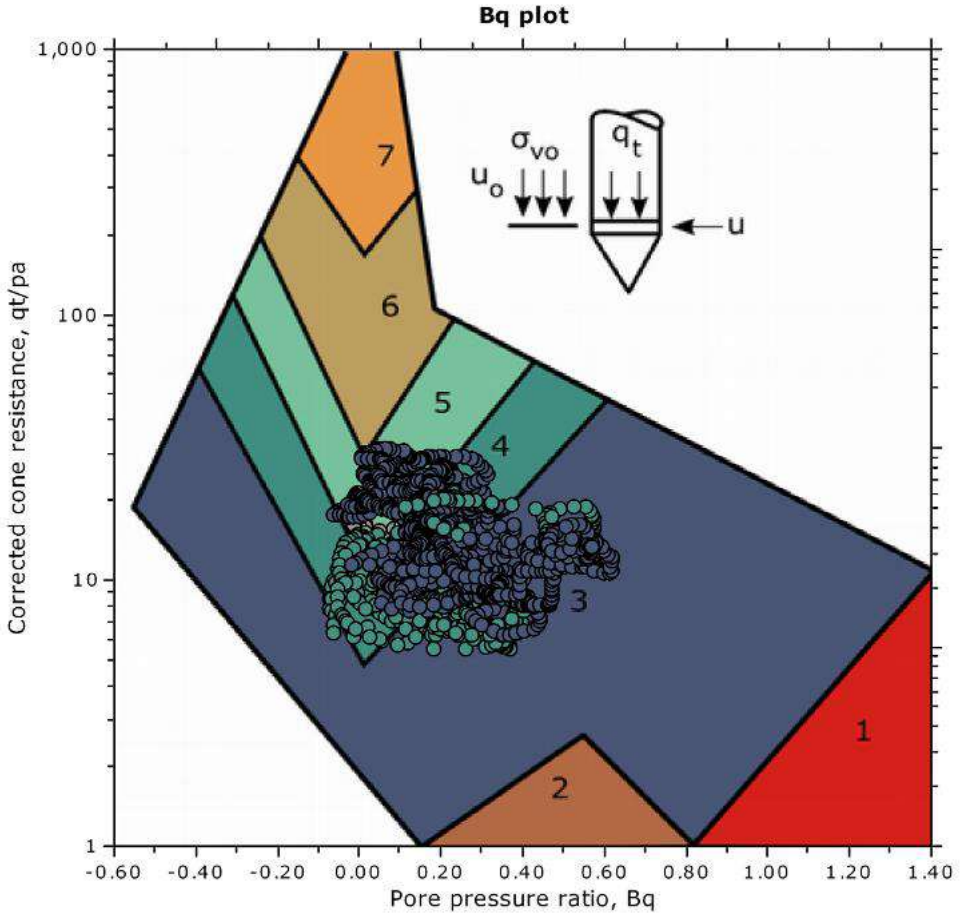
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU9
Total depth: 20.28 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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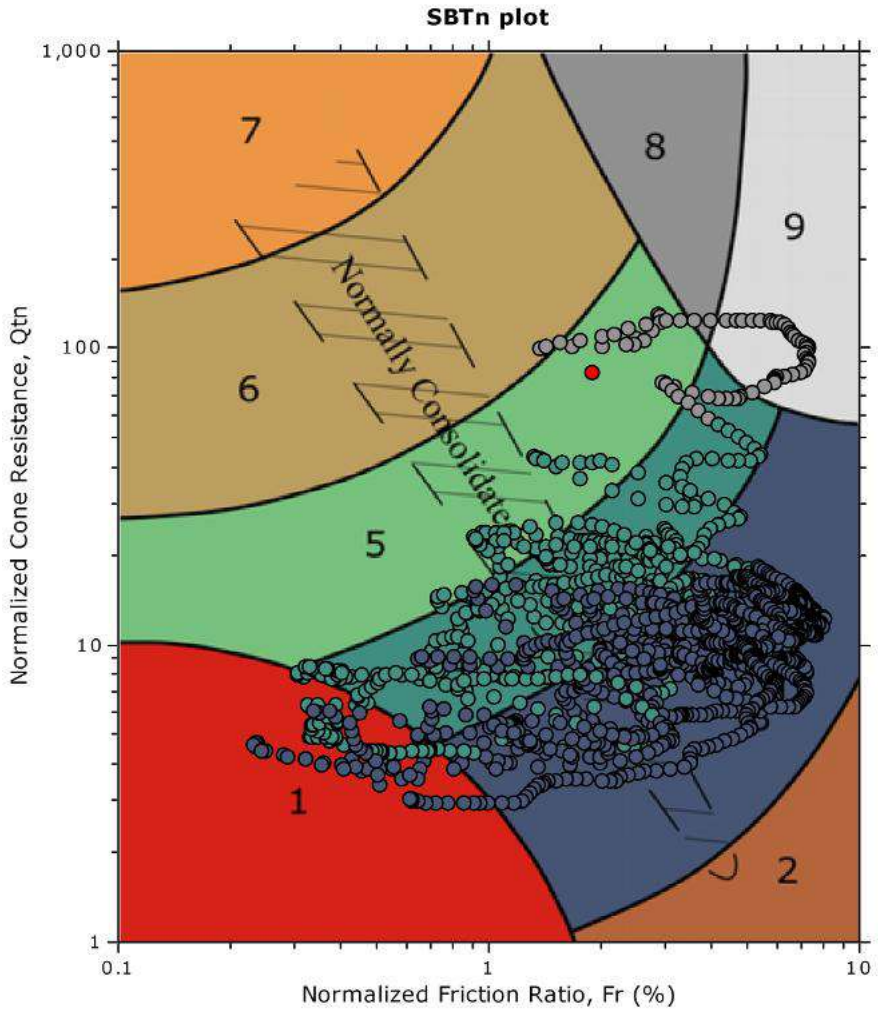
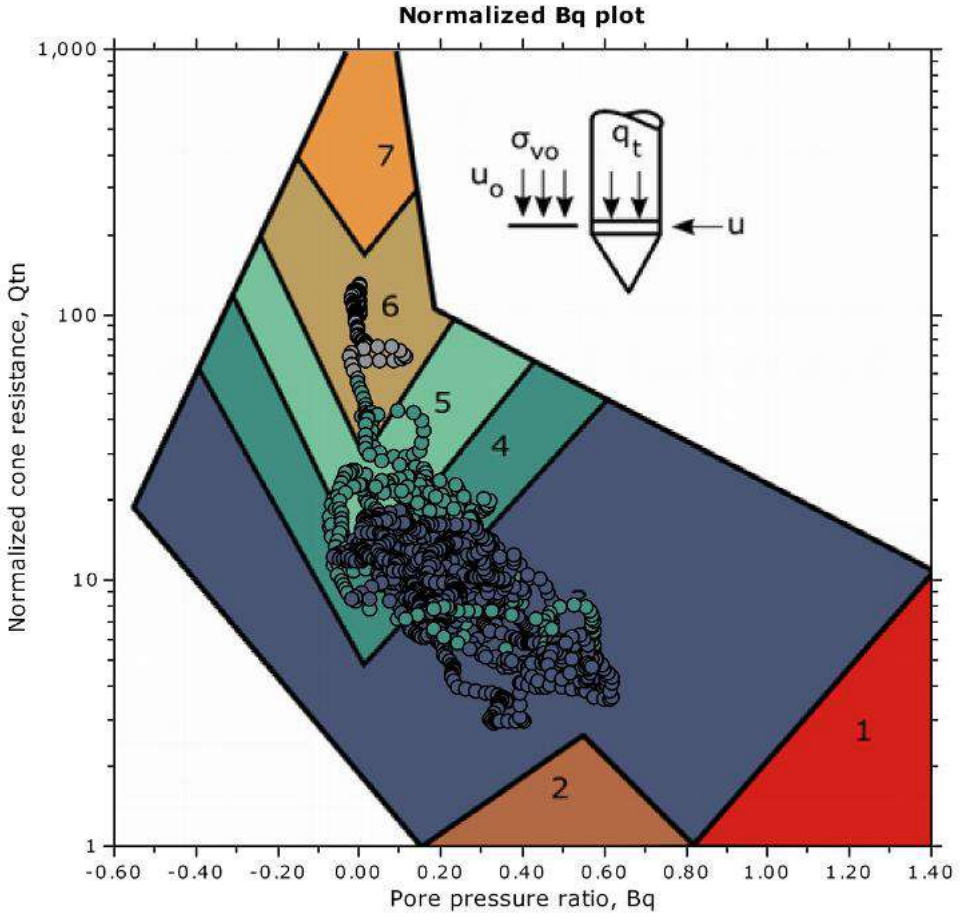
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU9
Total depth: 20.28 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

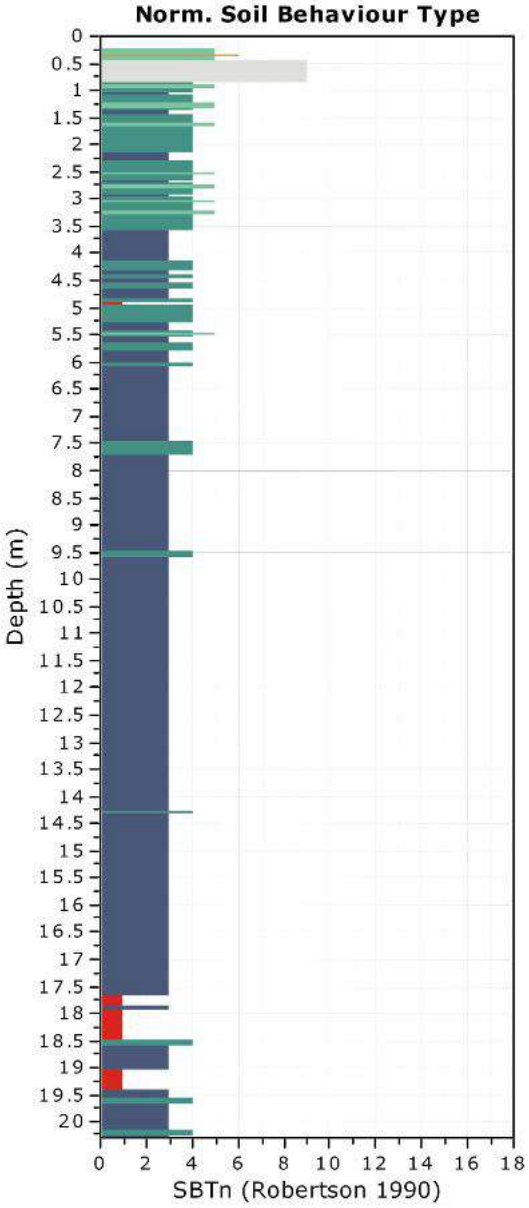
SBT - Bq plots (normalized)

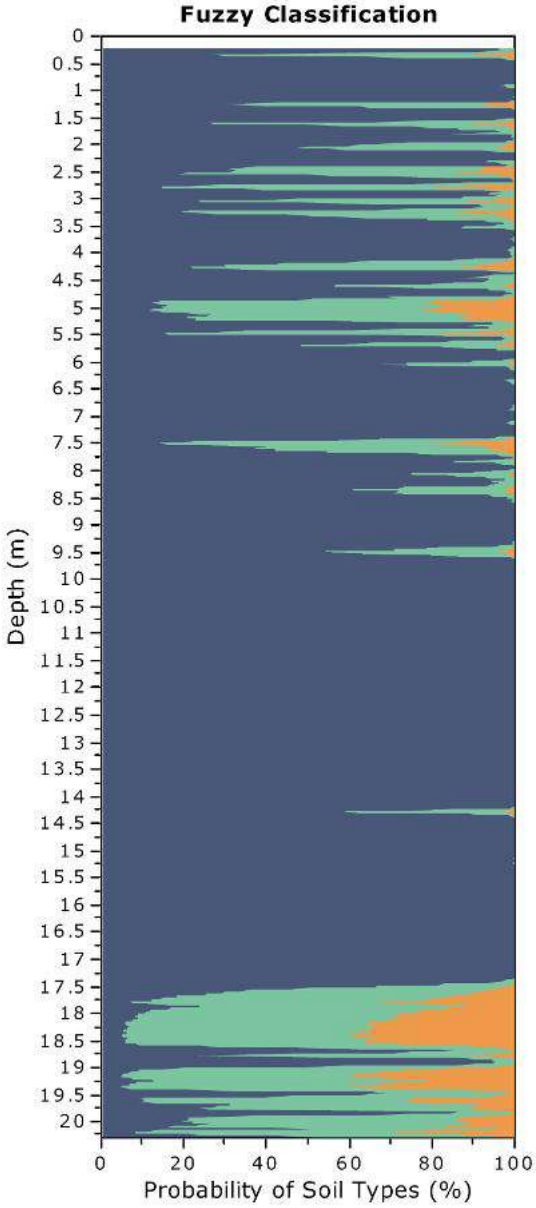




SBTn legend

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





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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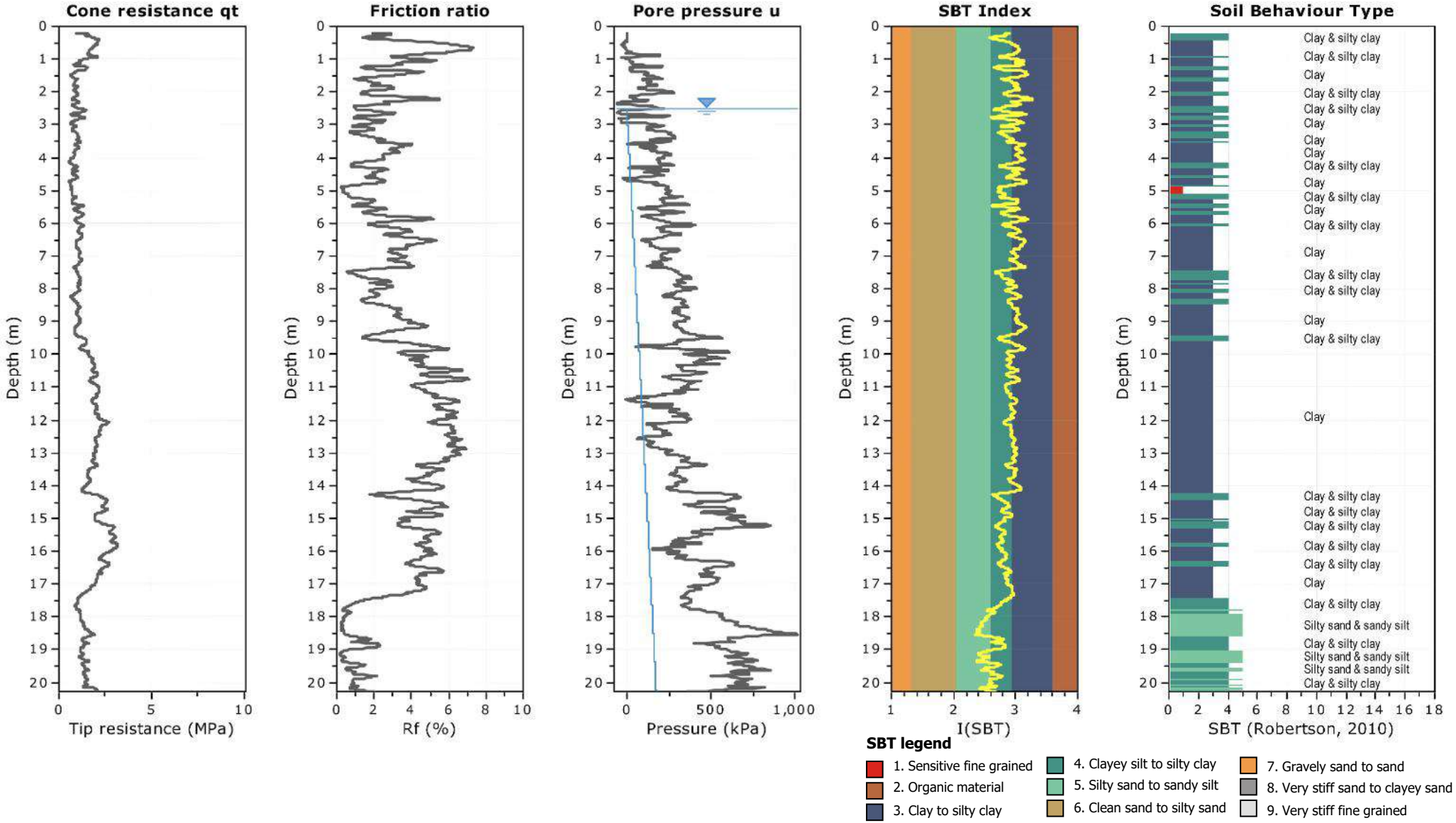
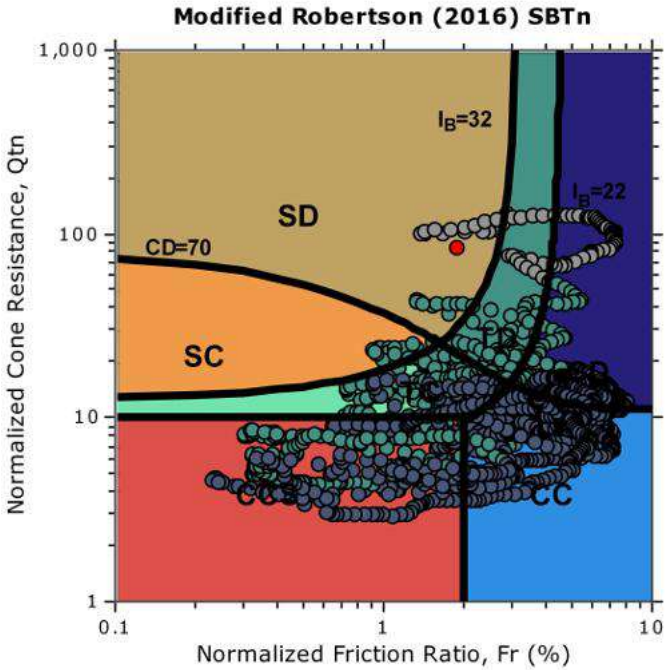
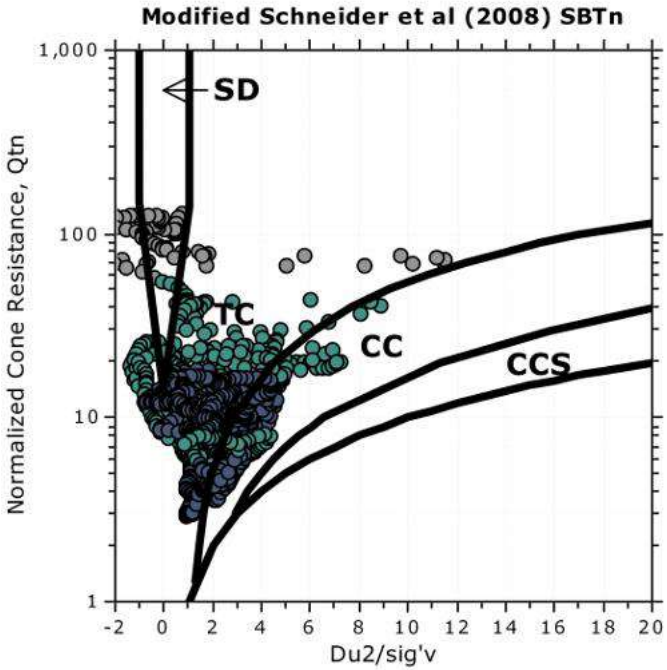
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

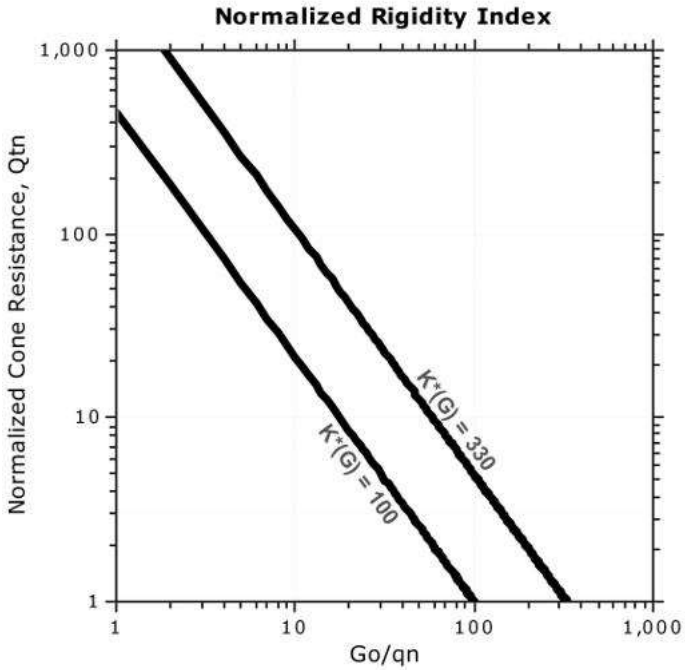
CPT: CPTU9
Total depth: 20.28 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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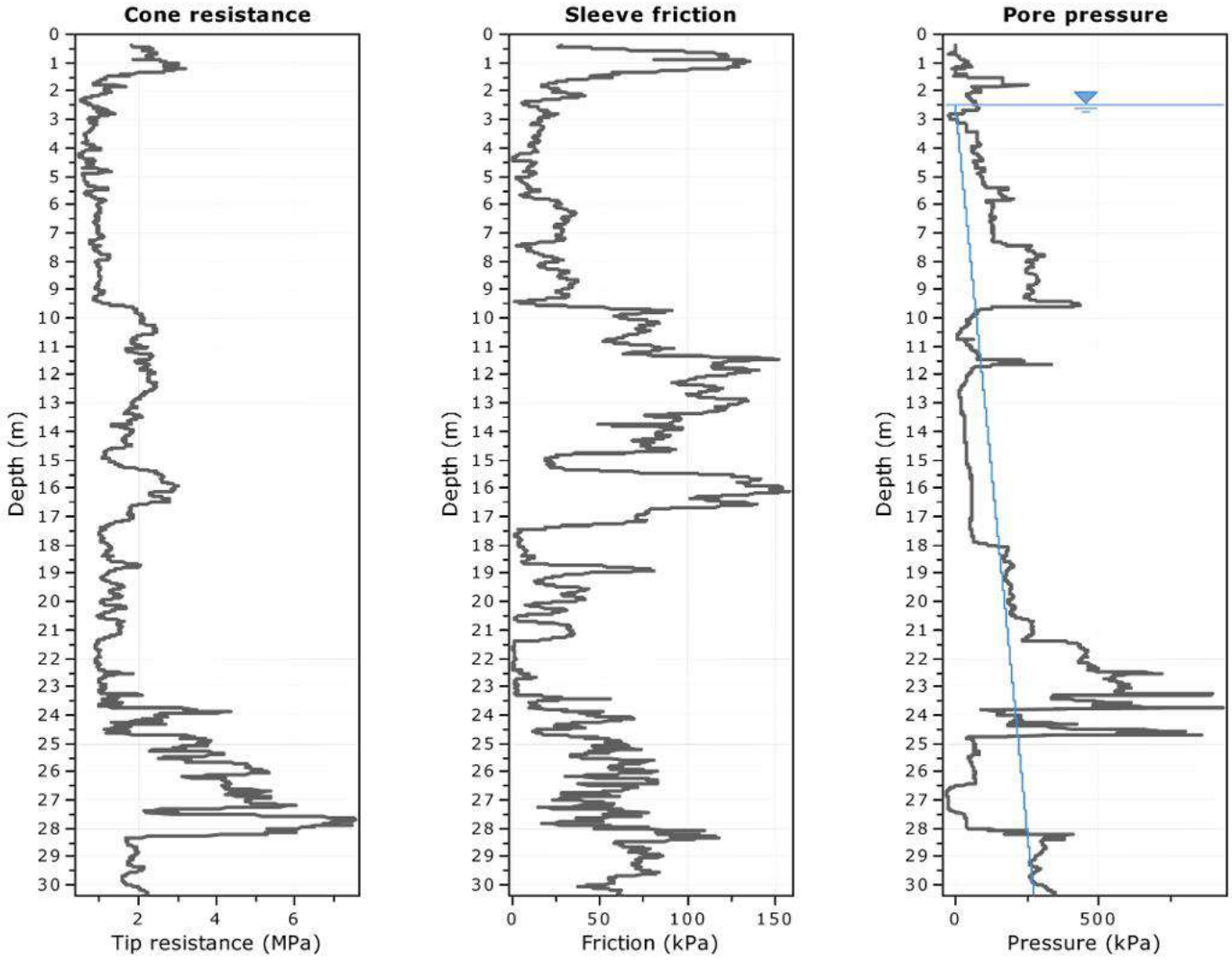
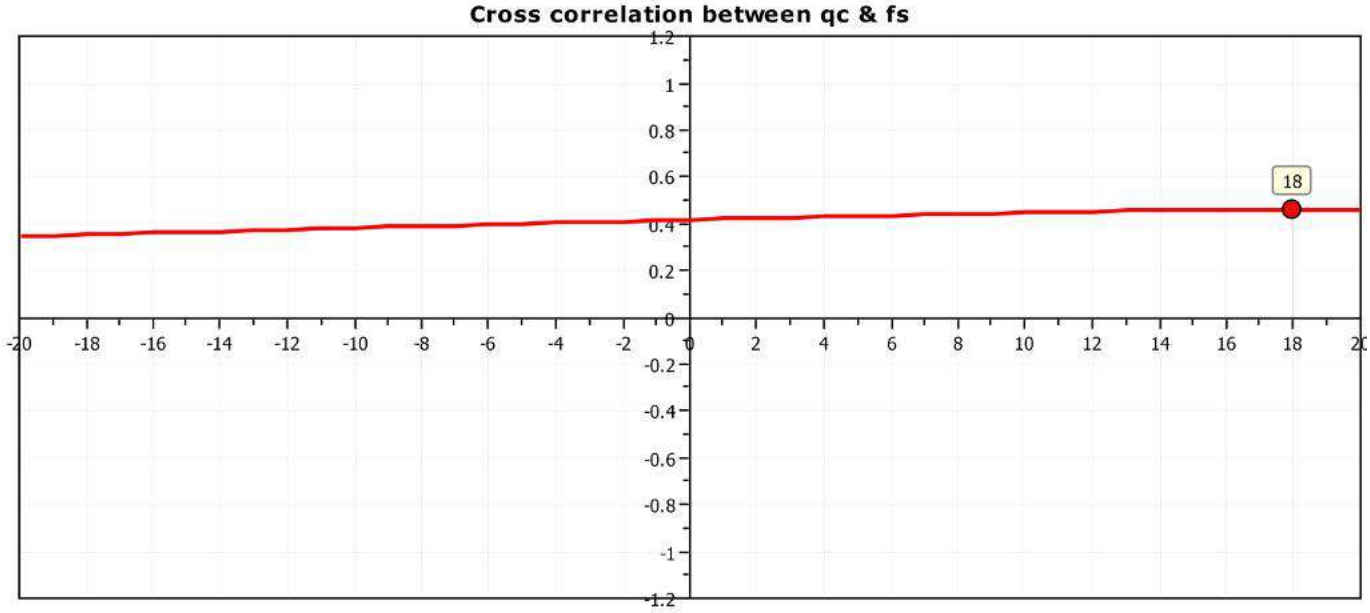
CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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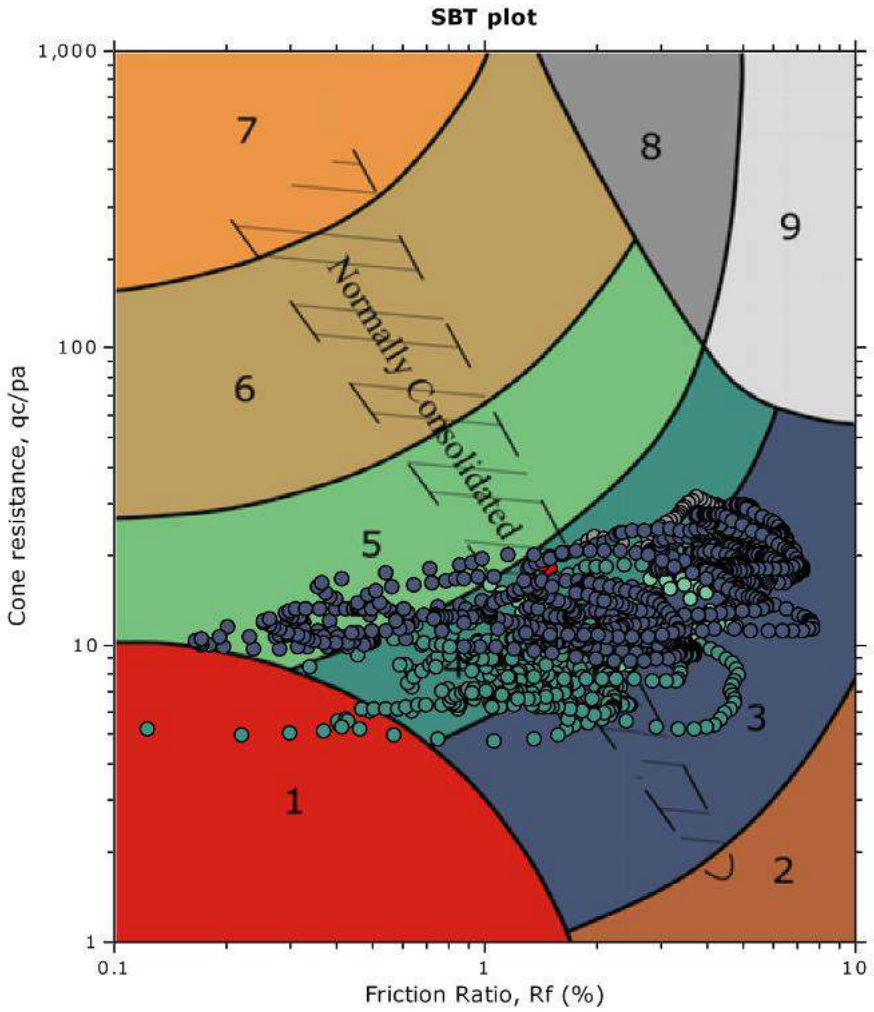
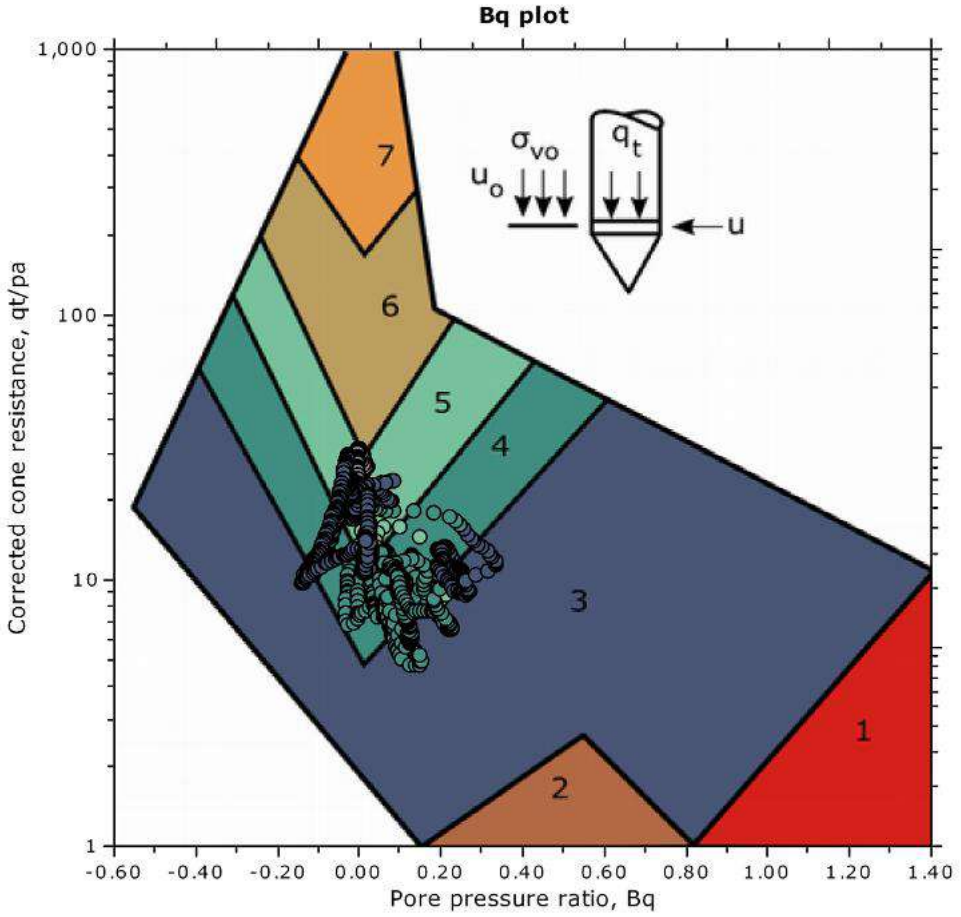
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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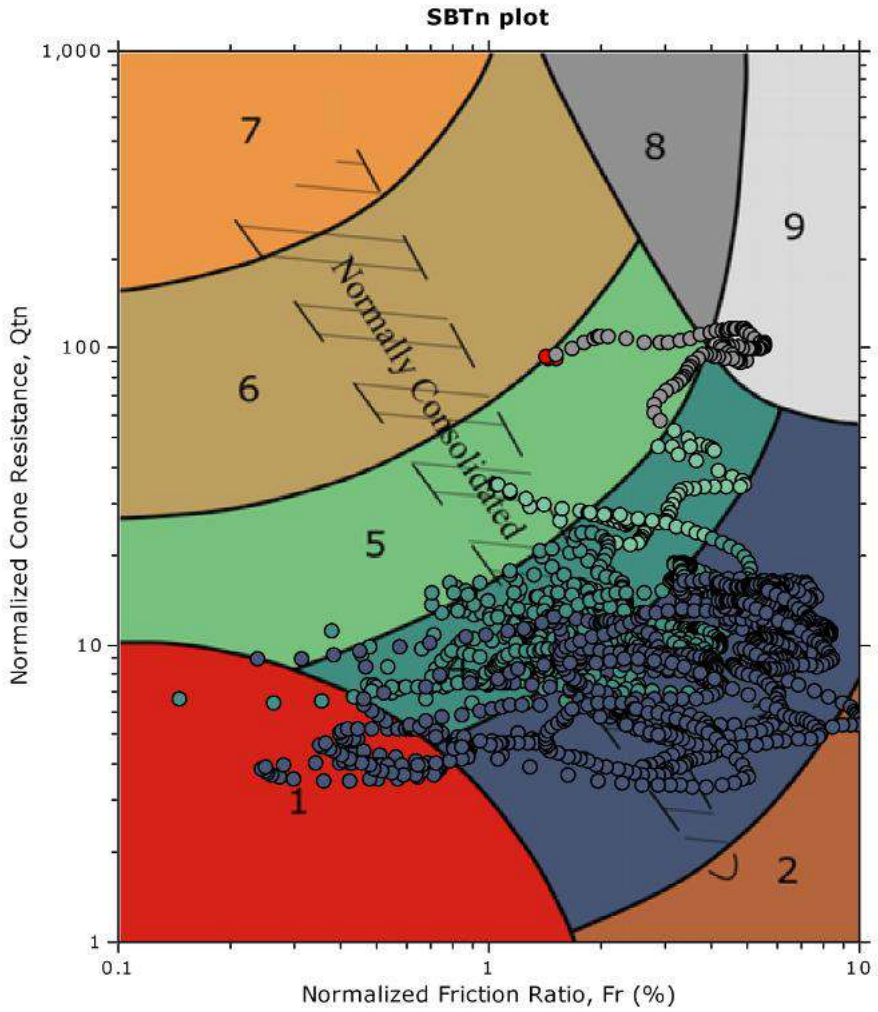
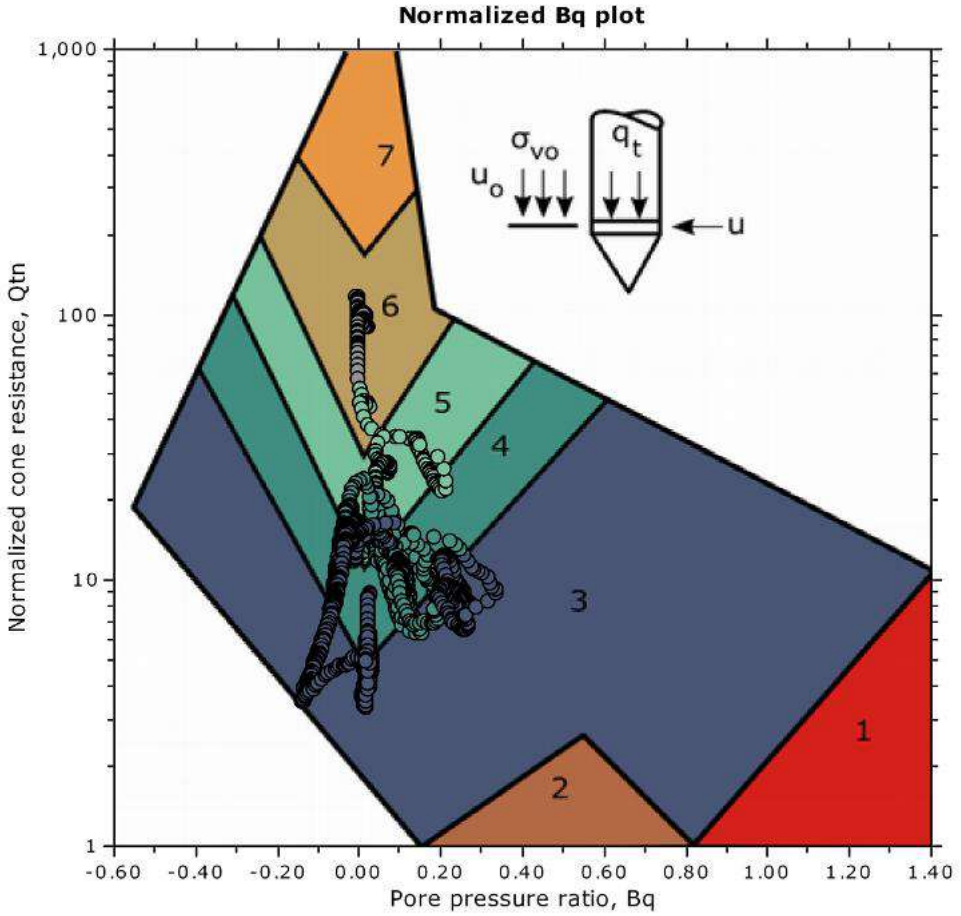
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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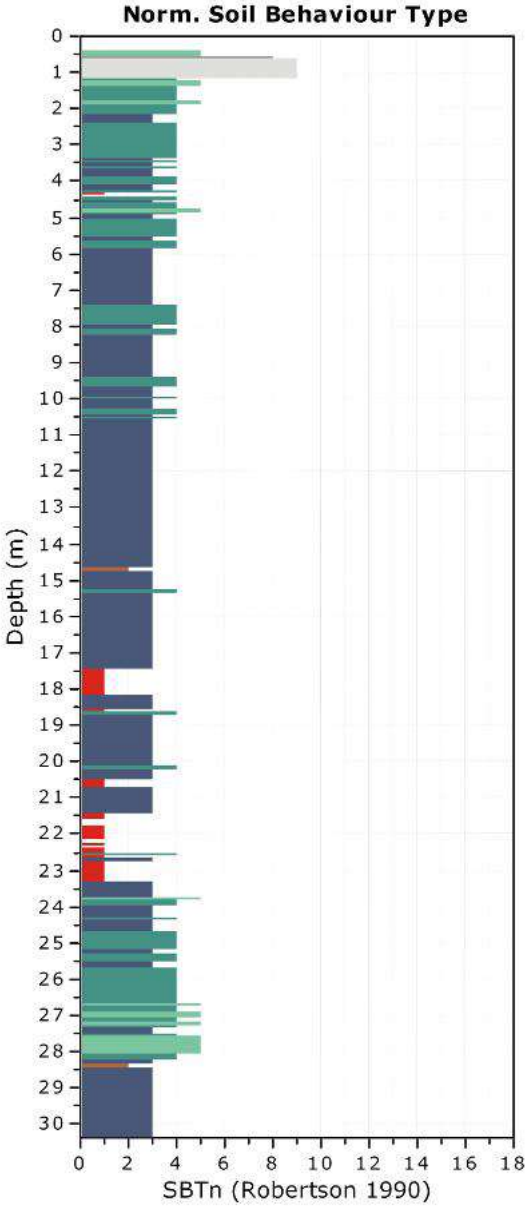
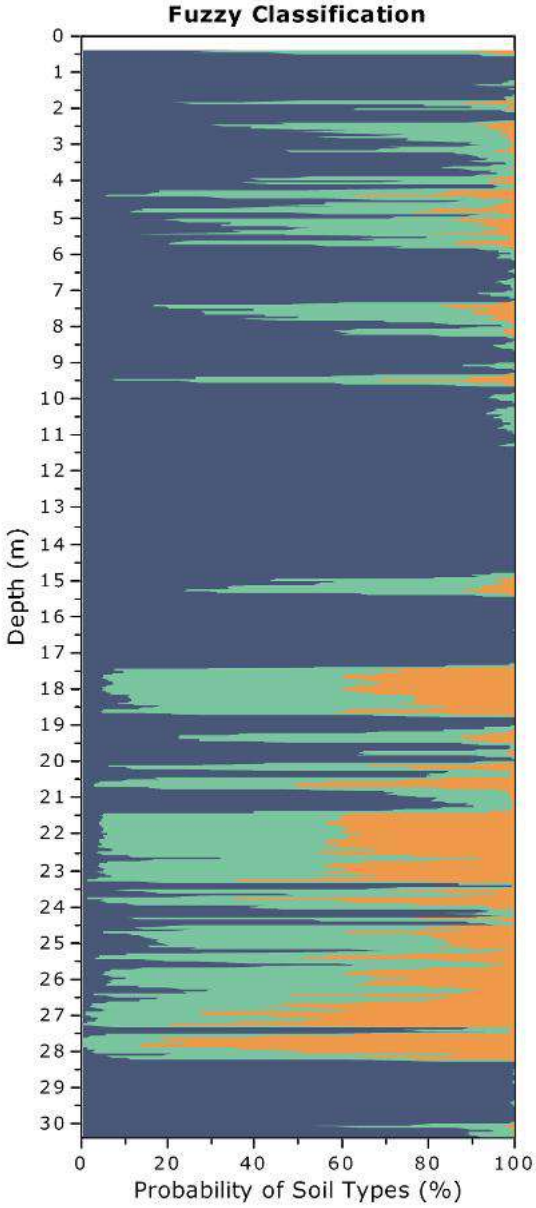
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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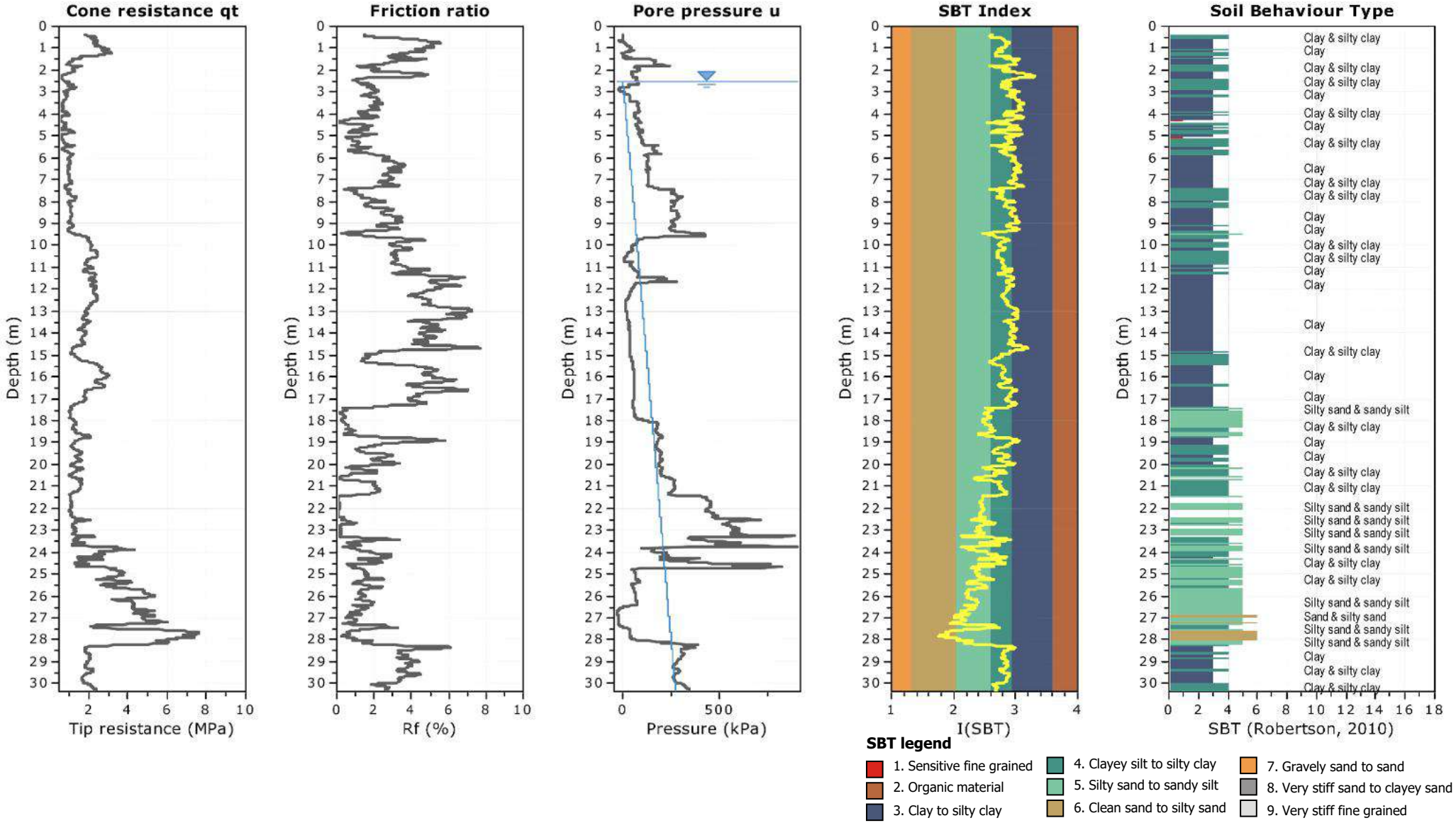
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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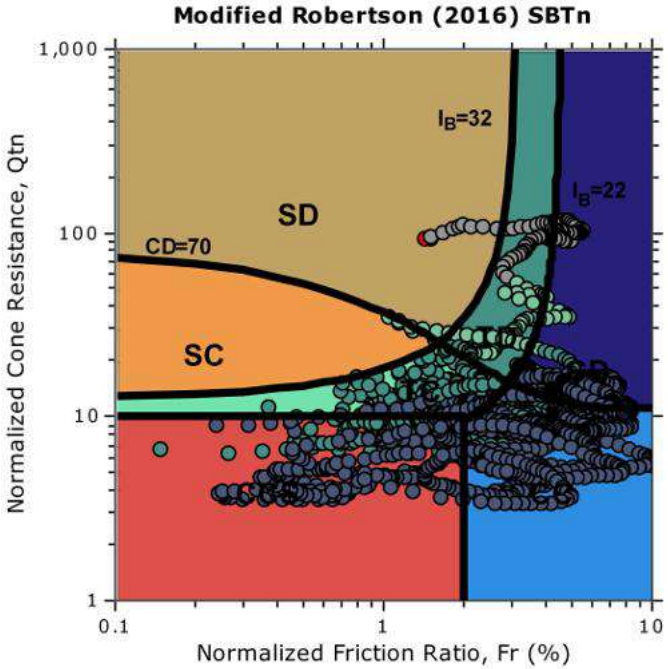
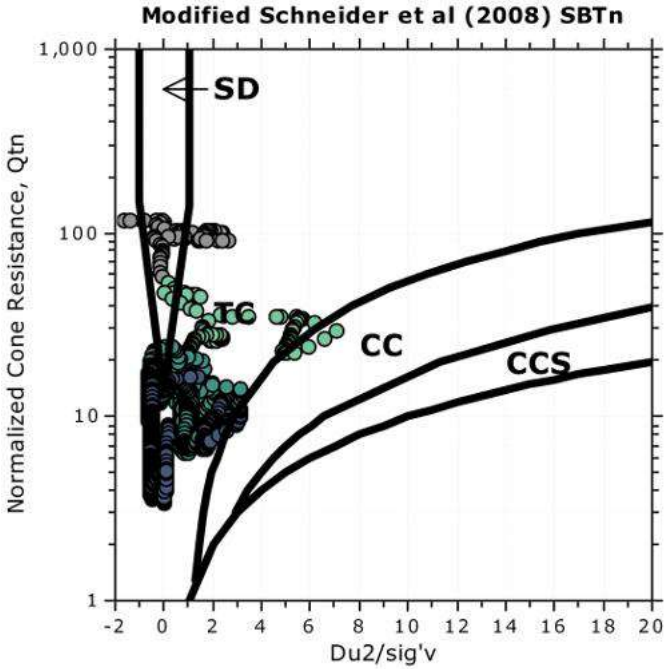
https://geogroupmodena.it/

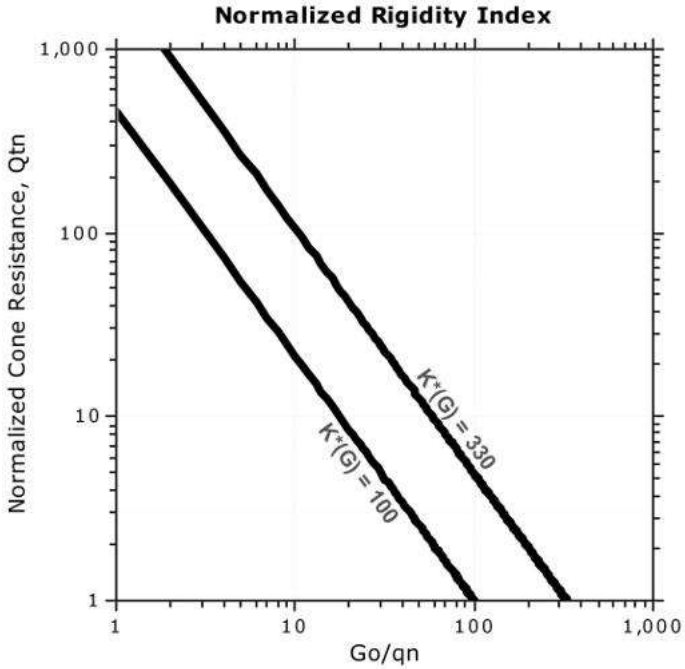
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU10
Total depth: 30.37 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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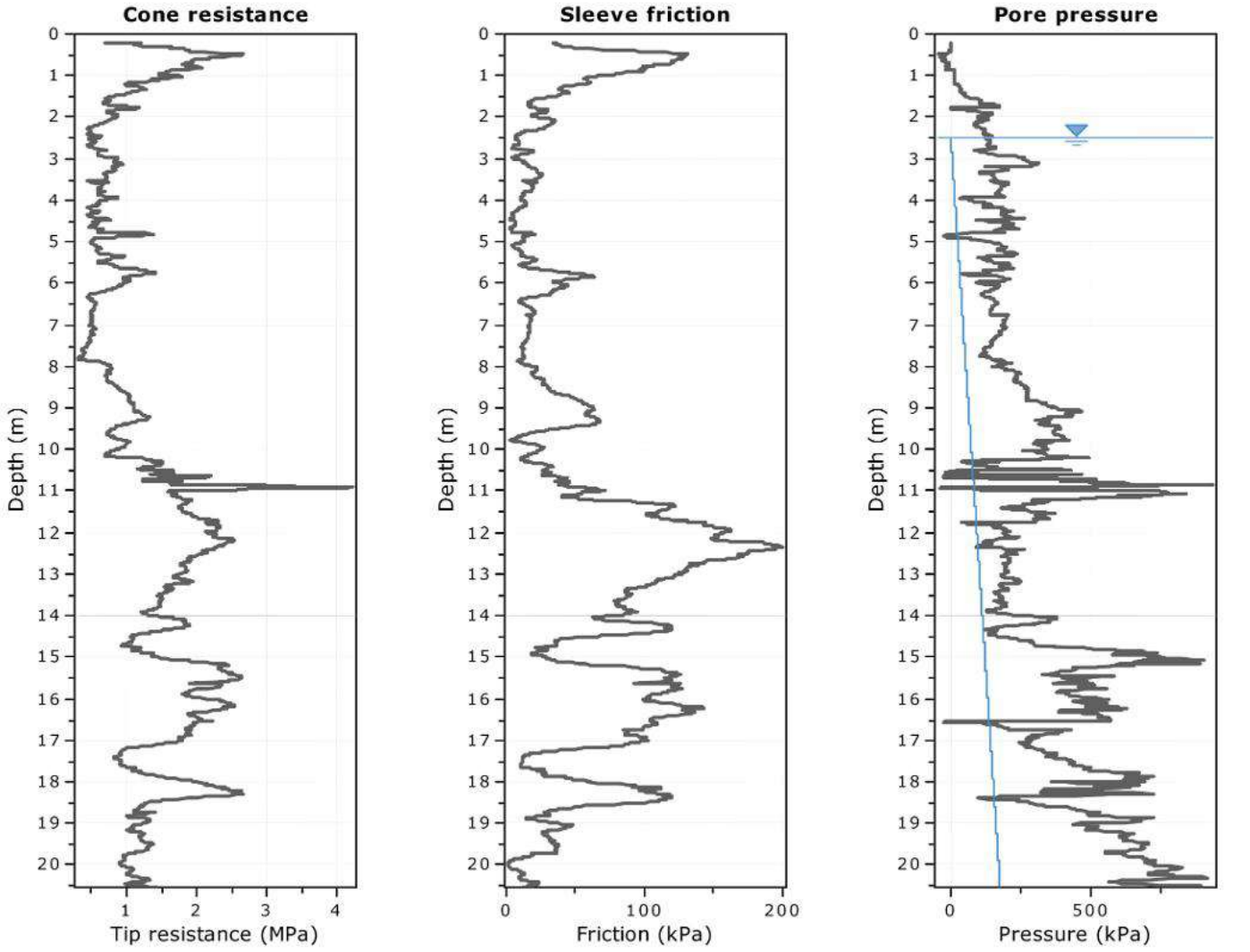
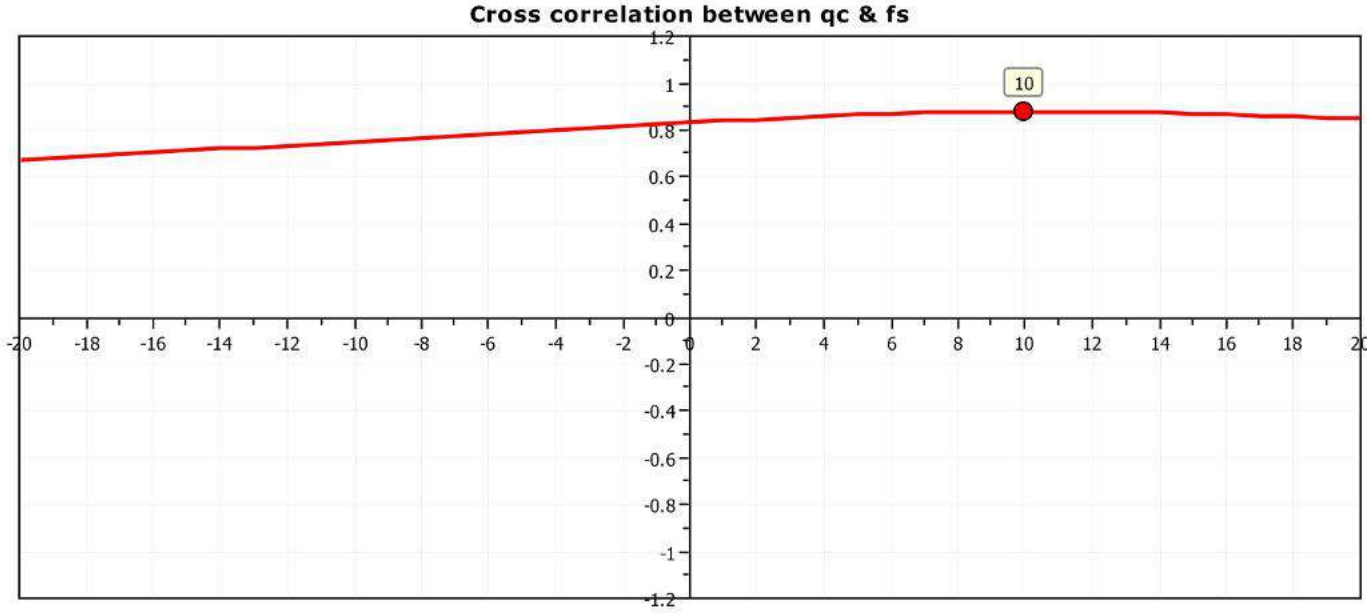
CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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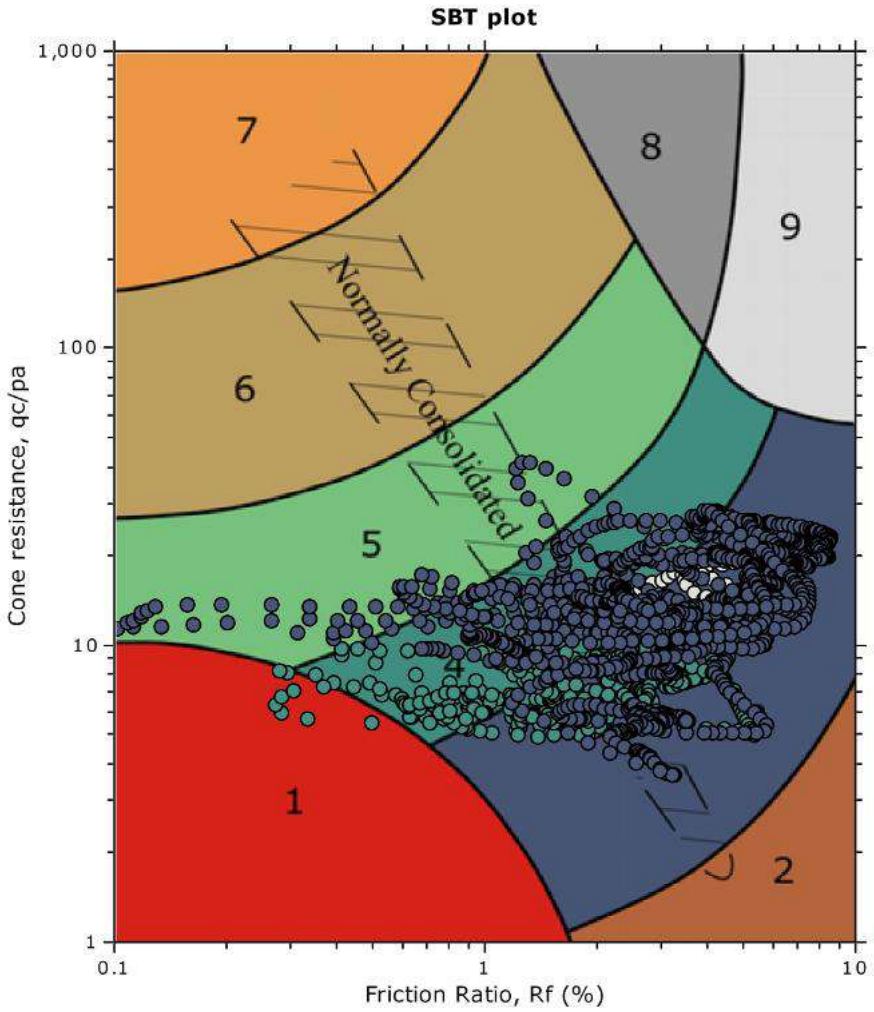
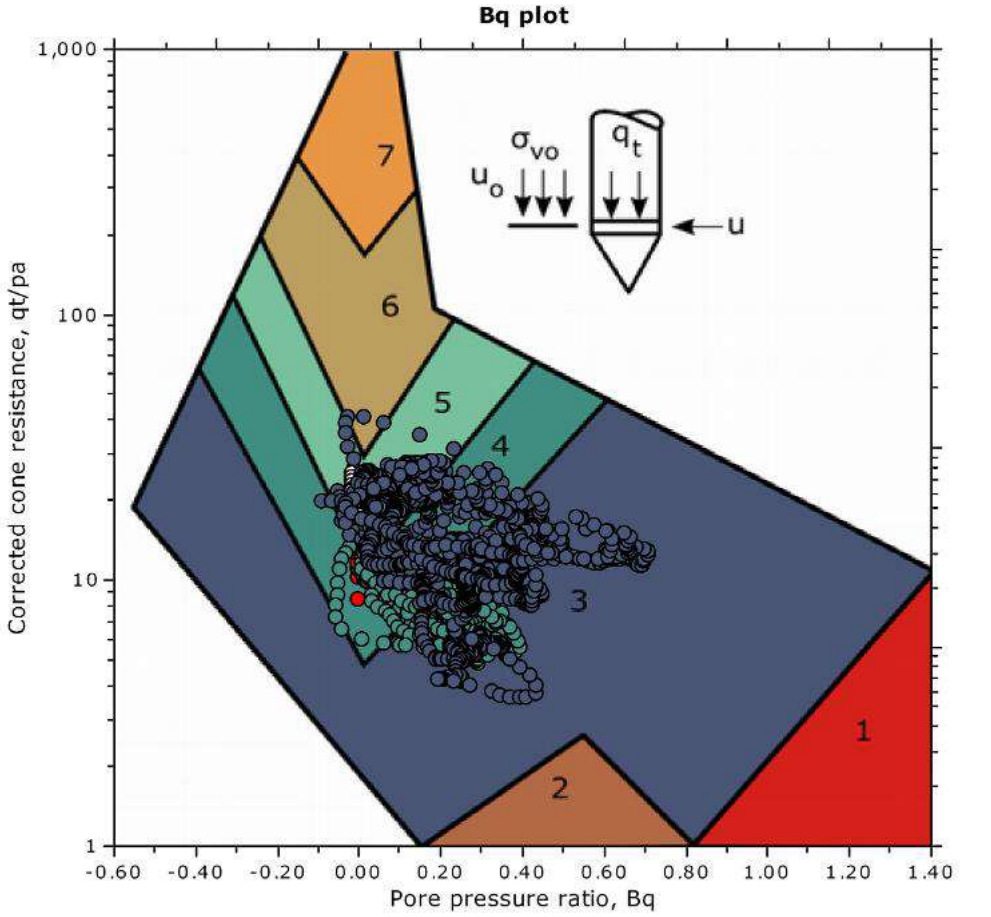
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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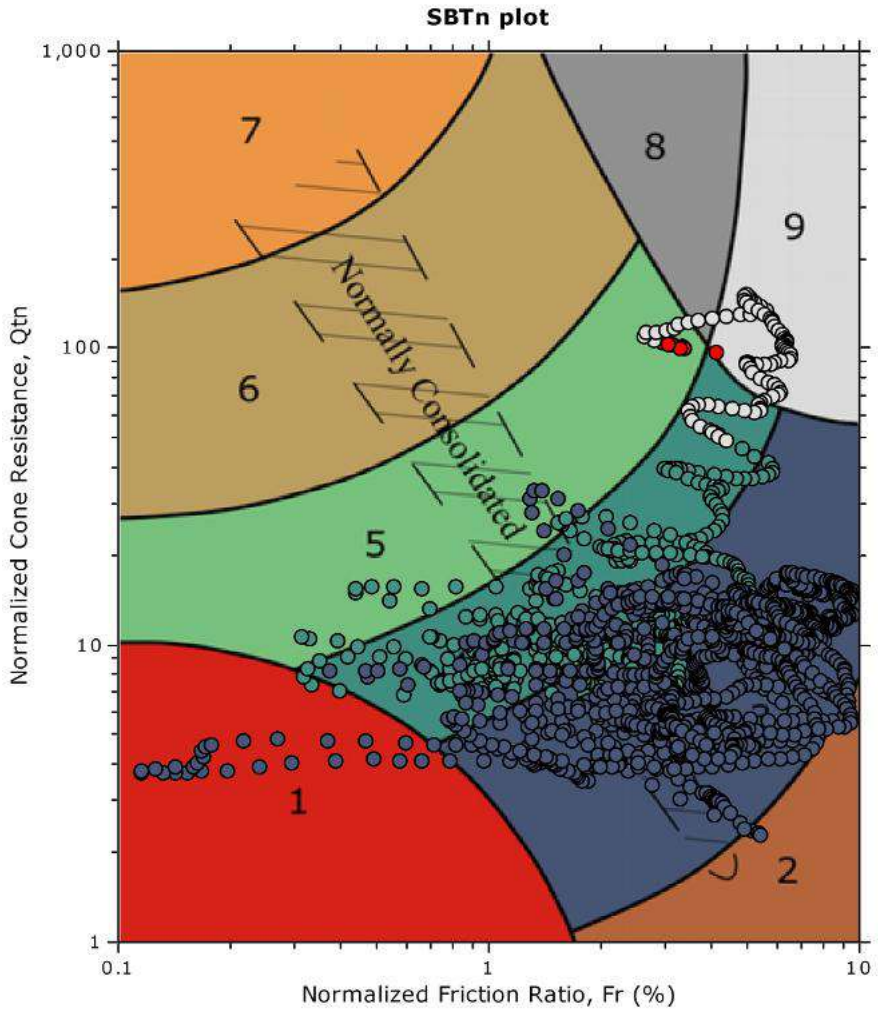
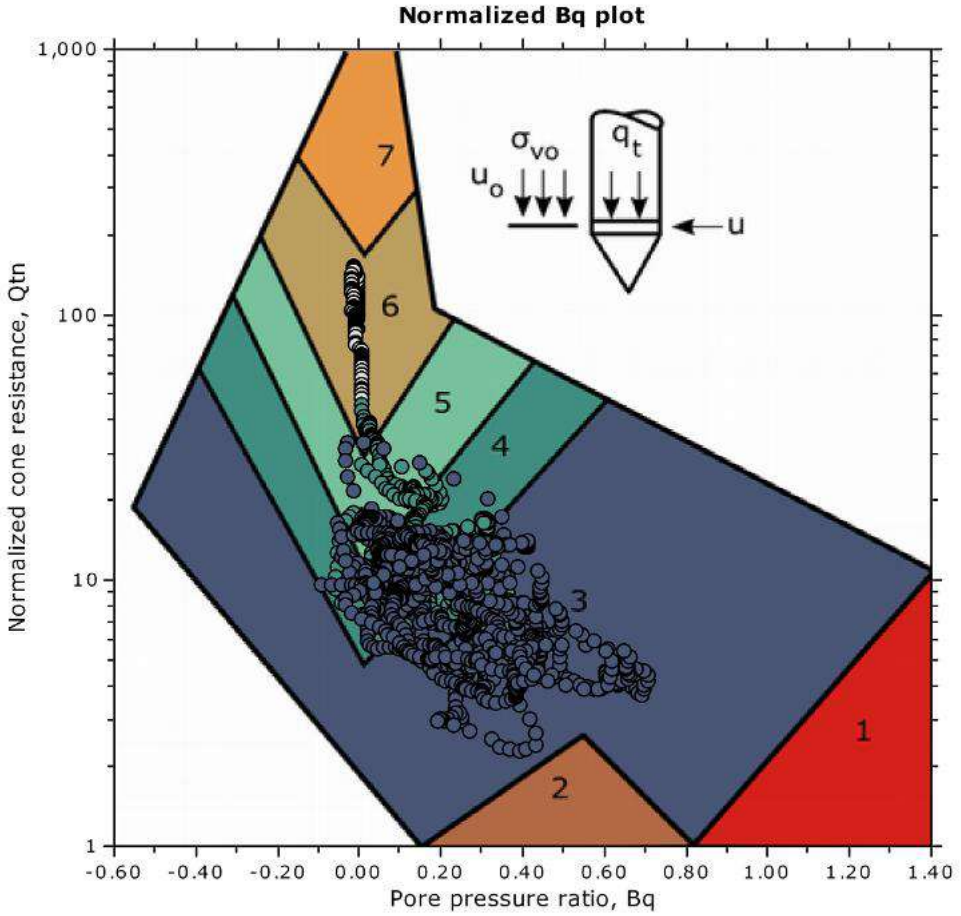
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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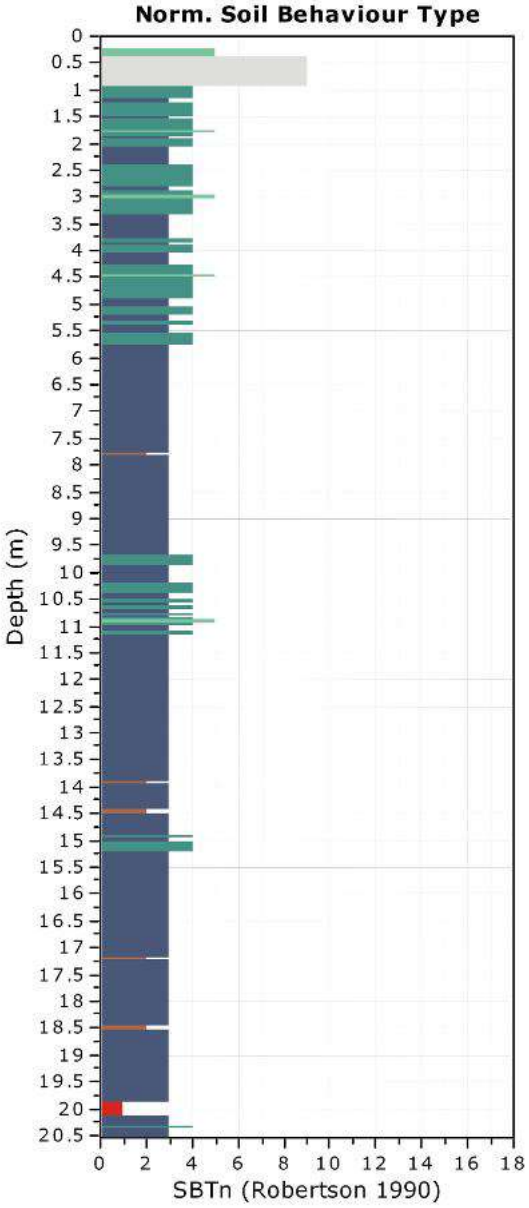
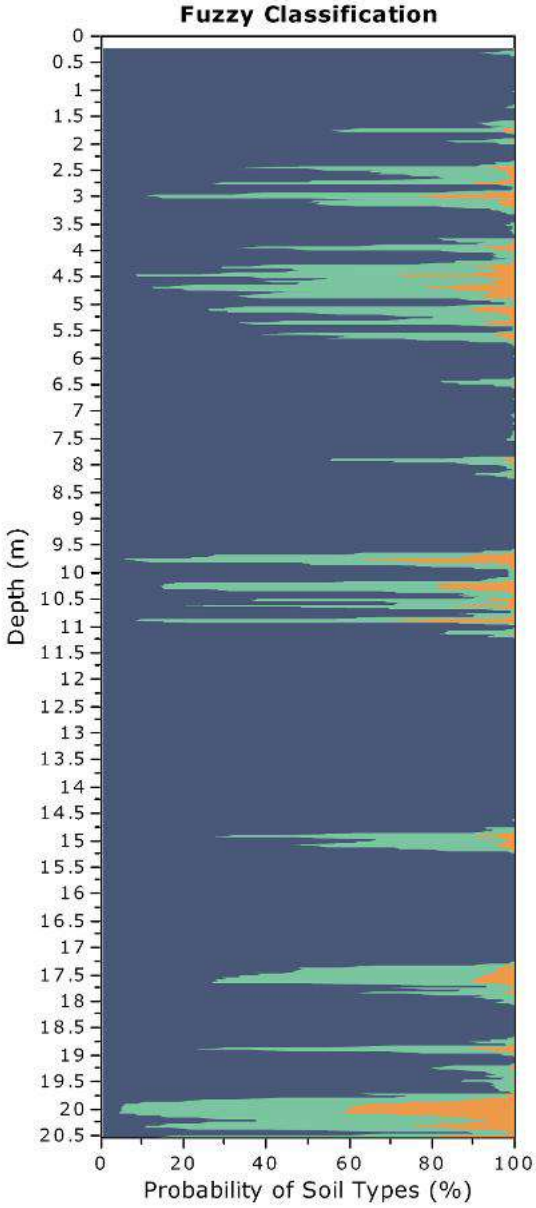
https://geogroupmodena.it/

Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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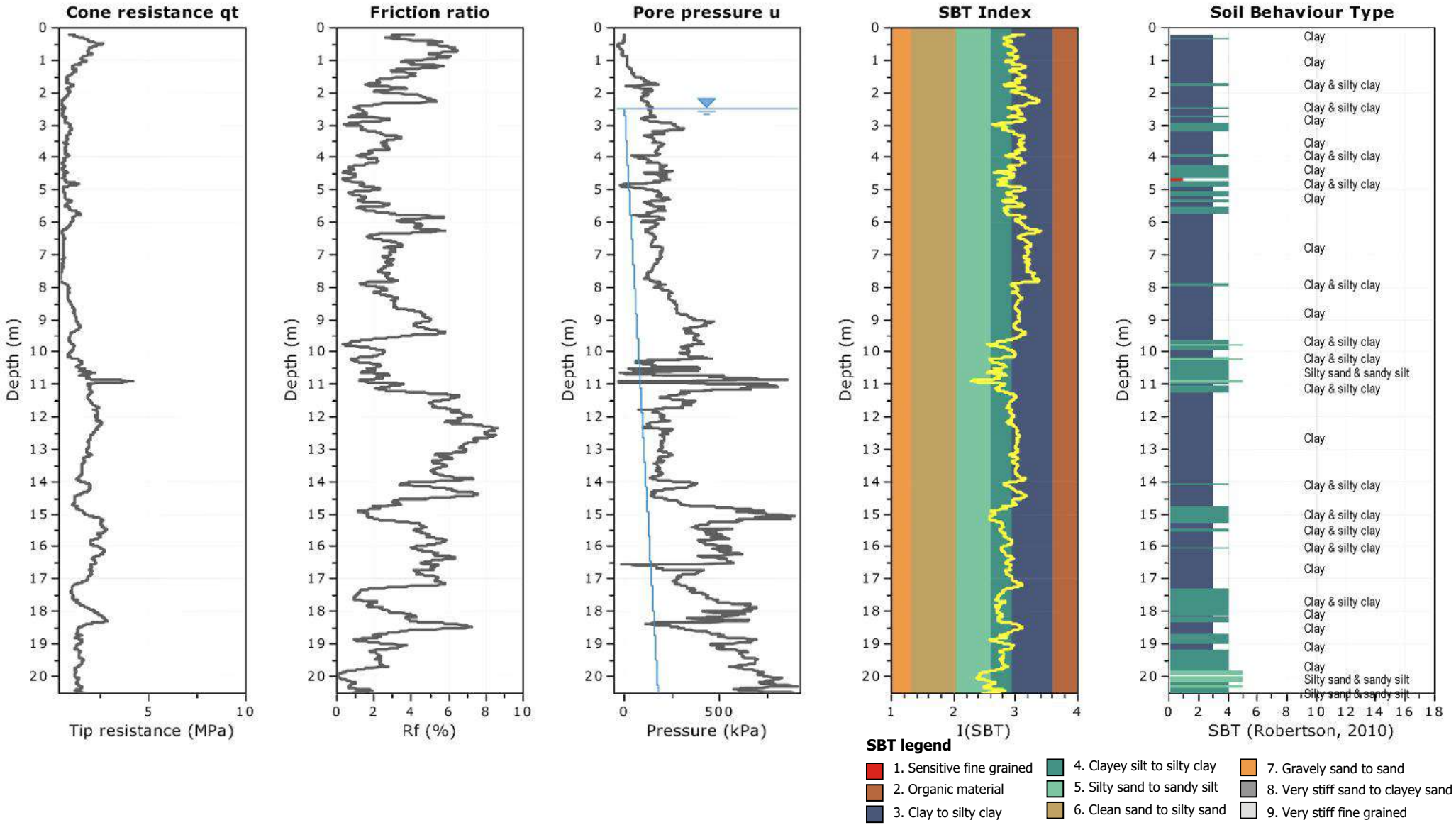
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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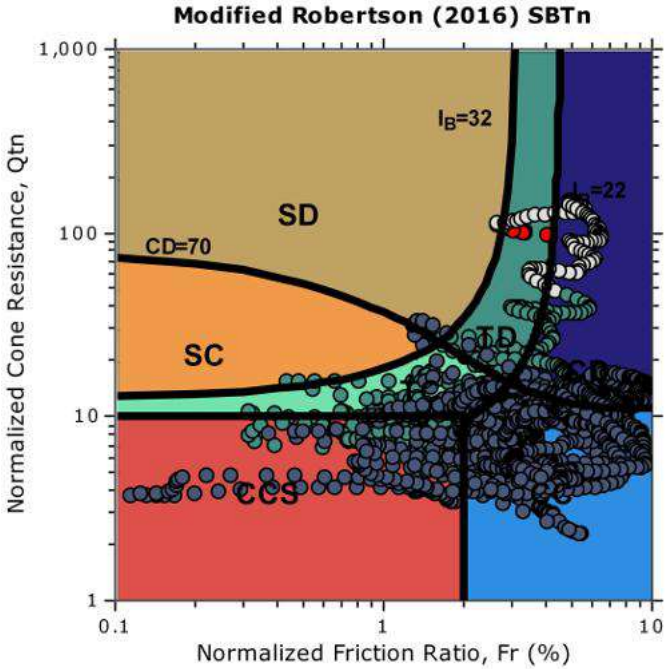
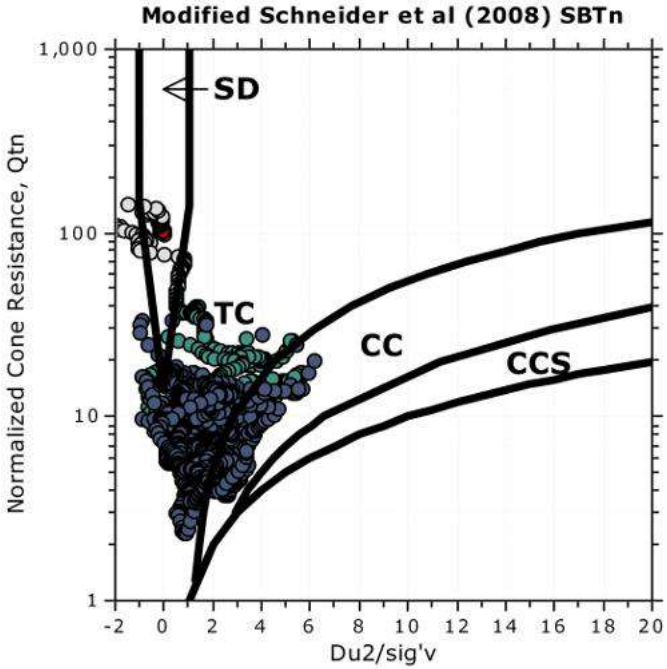
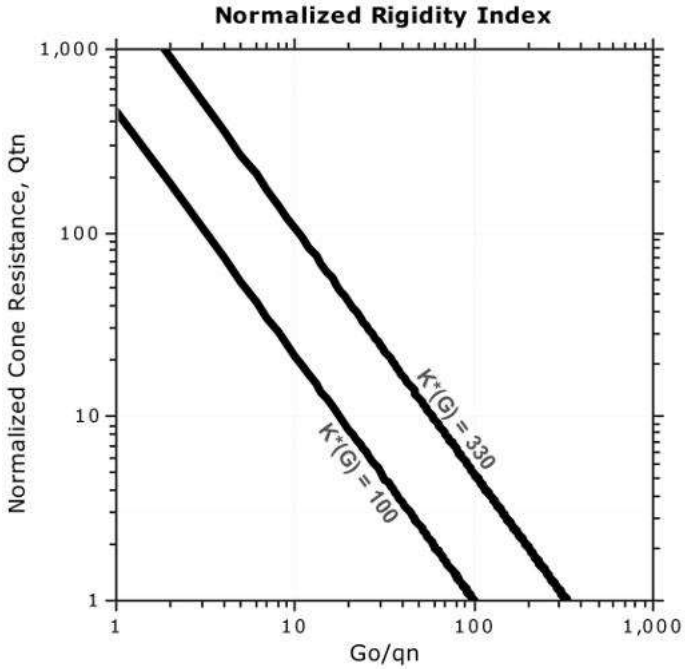
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU11
Total depth: 20.54 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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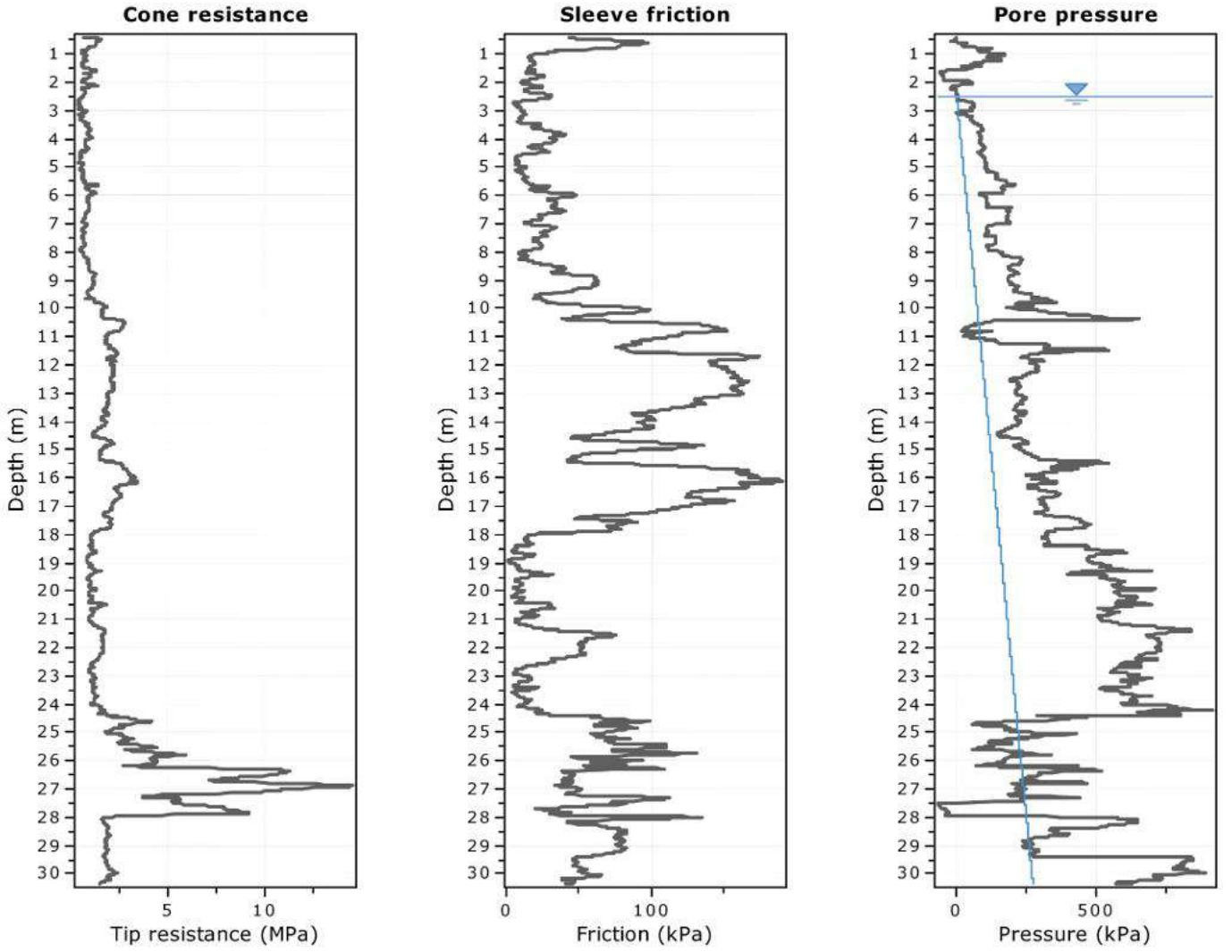
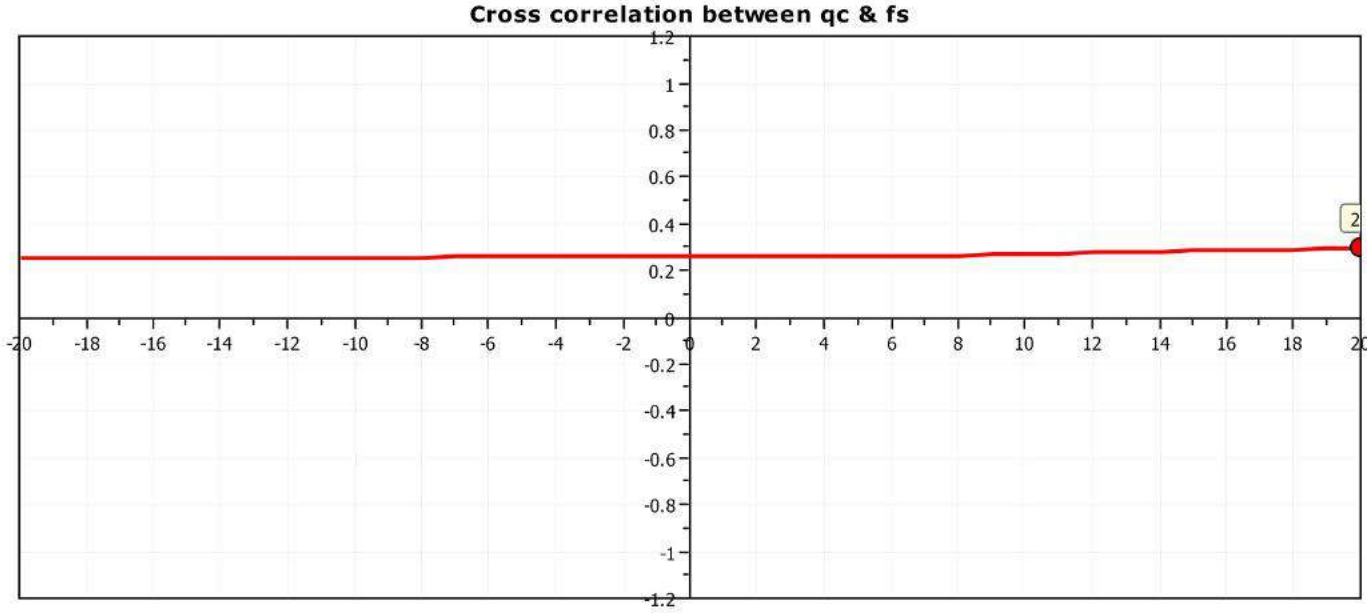
CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Ravarino**
Location: **Studio del terreno di fondazione**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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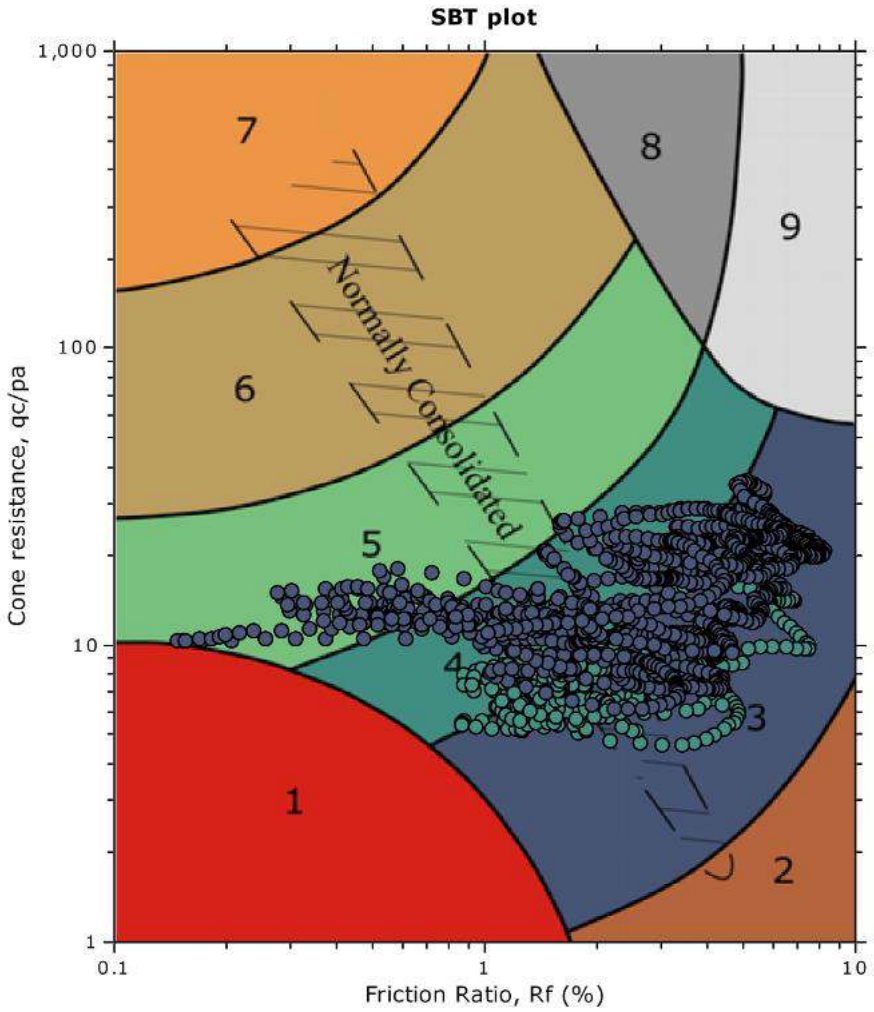
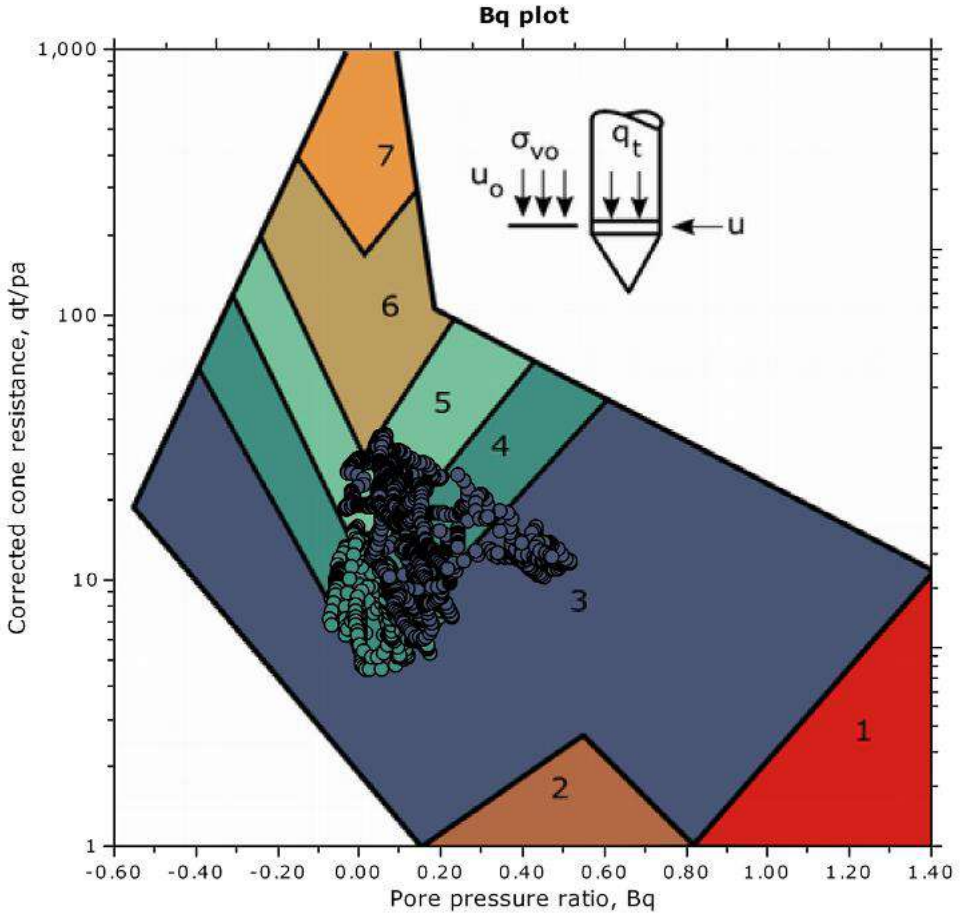
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots





SBT legend

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

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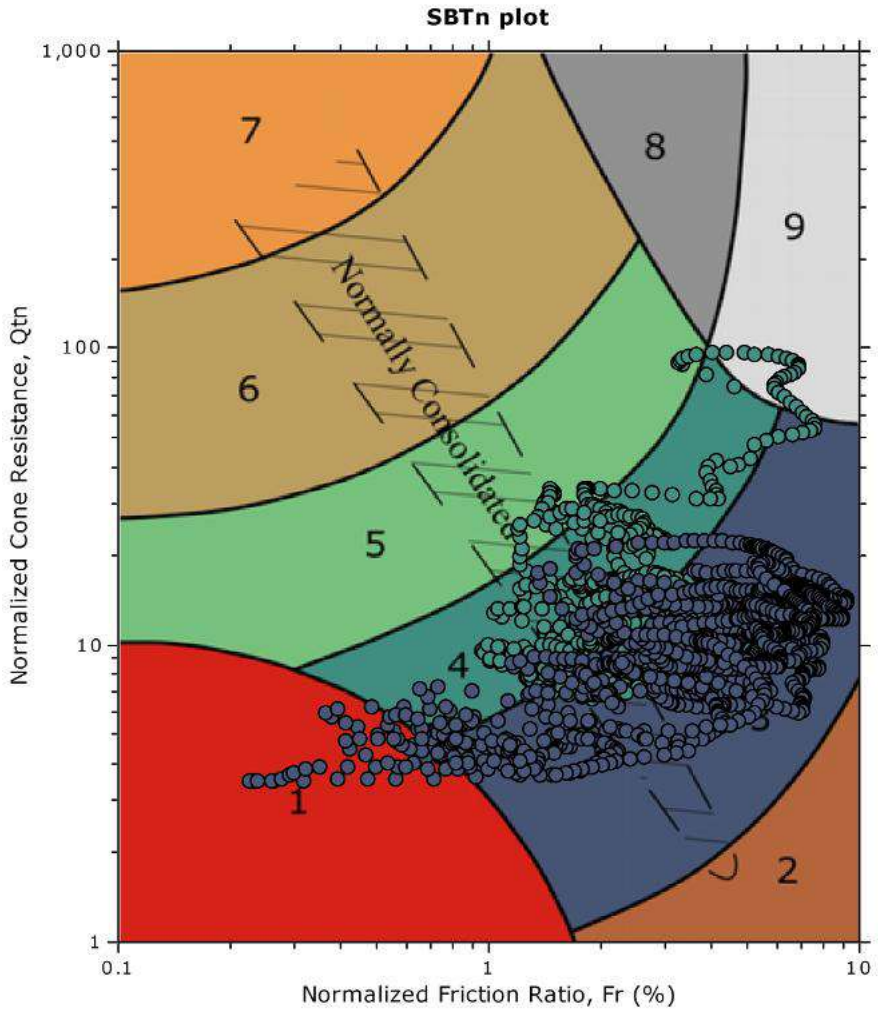
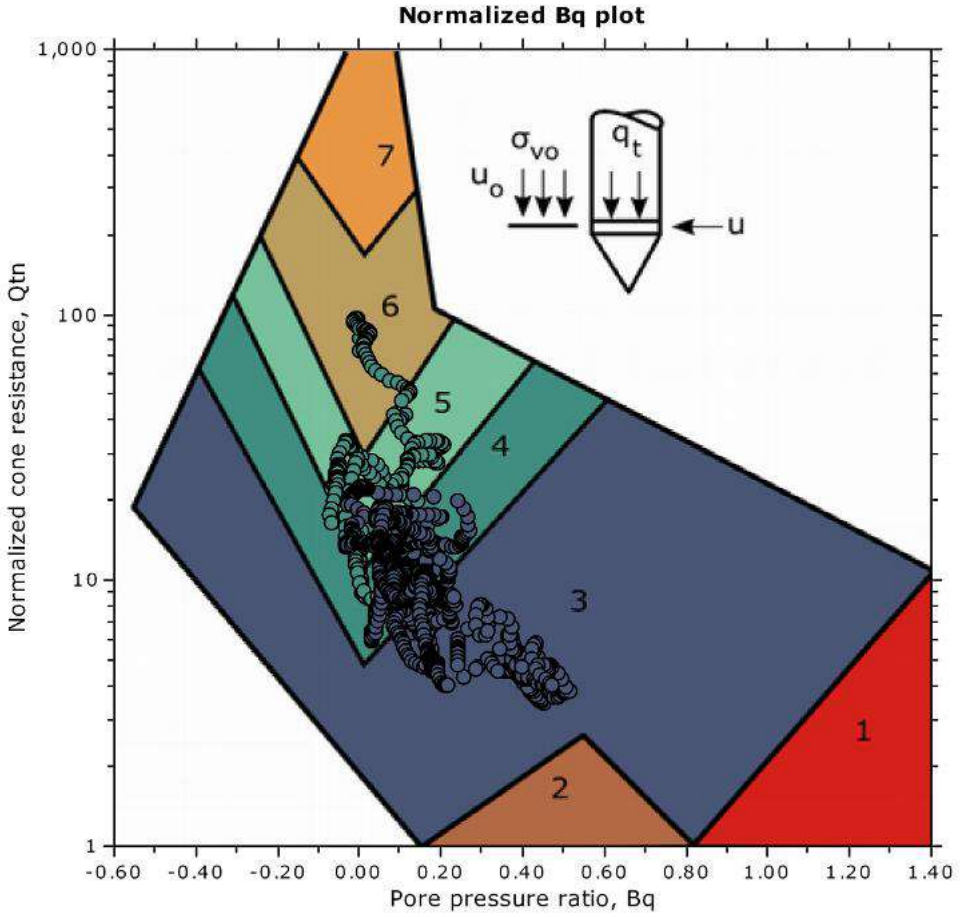
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

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

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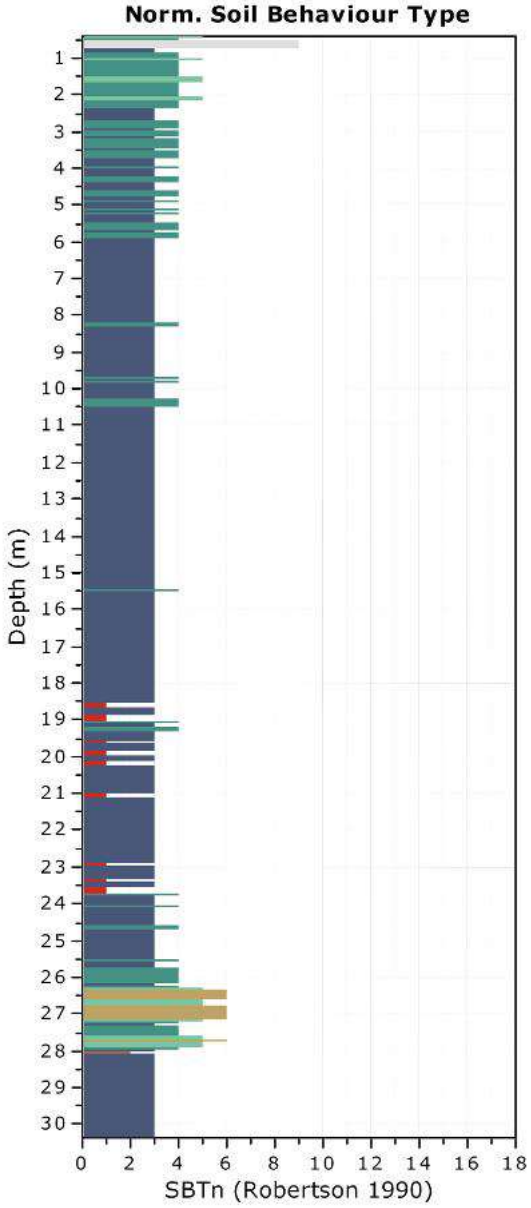
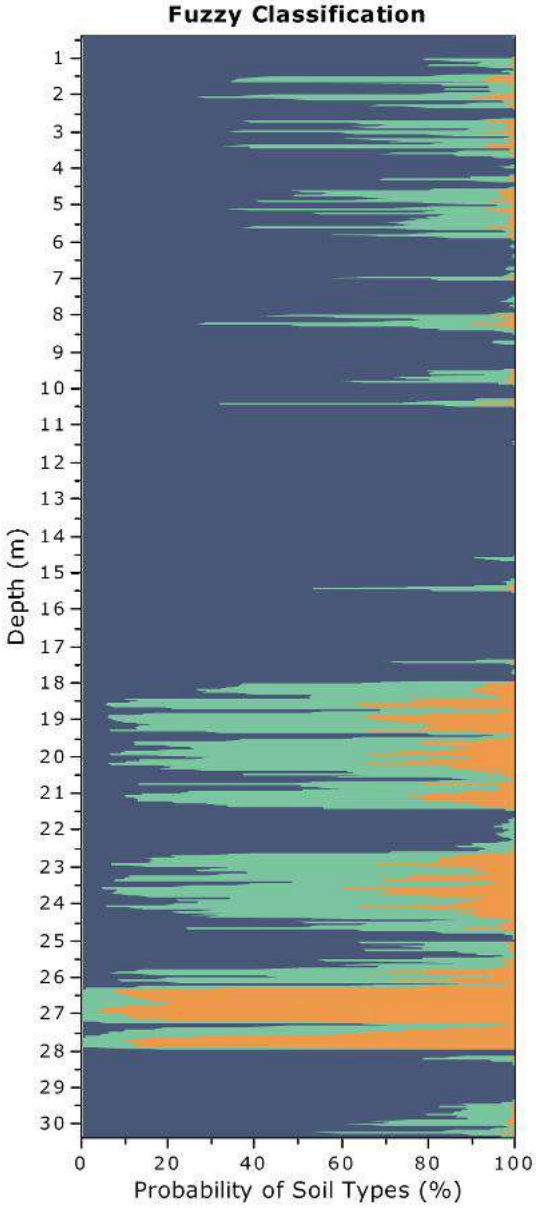
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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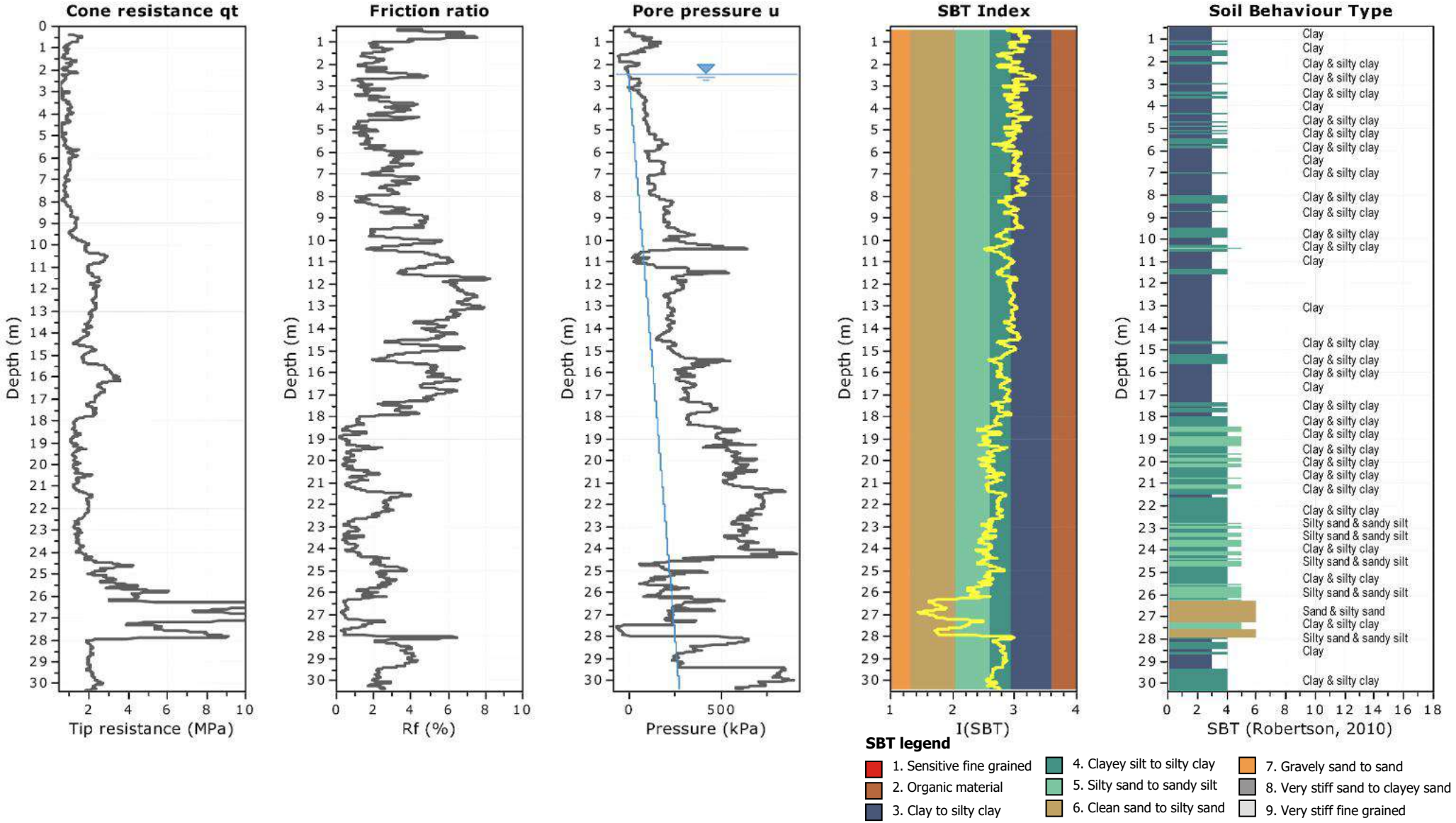
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



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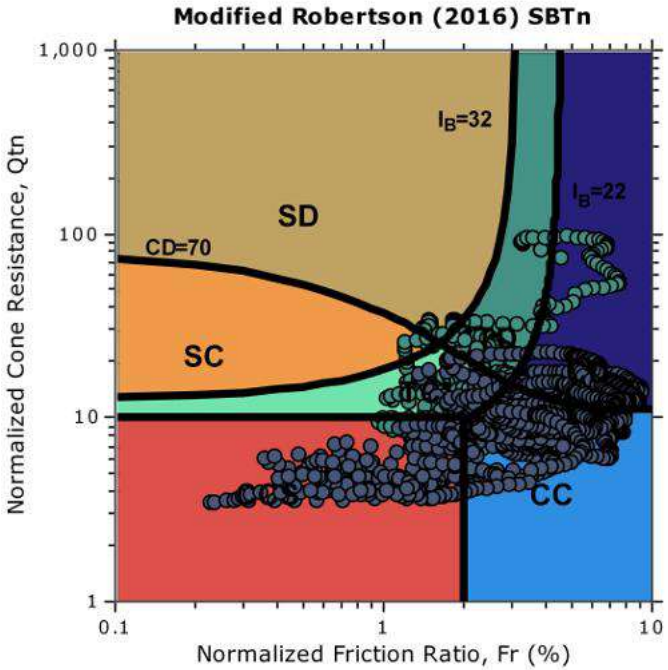
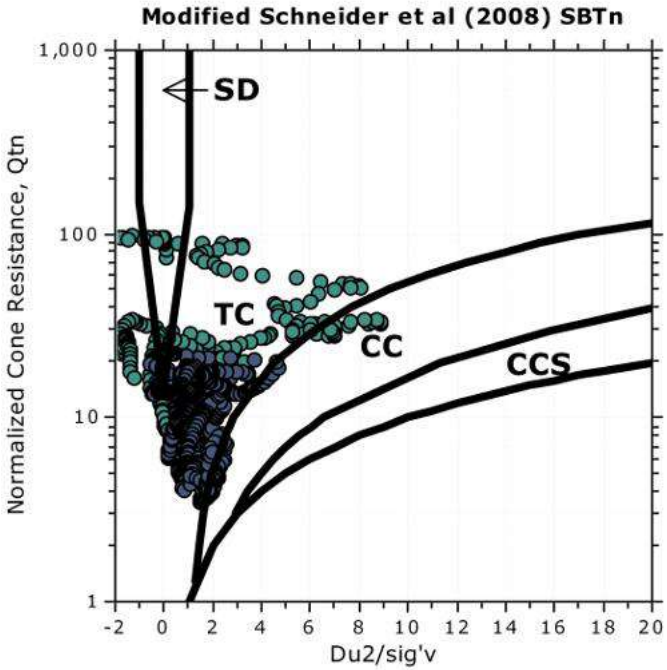
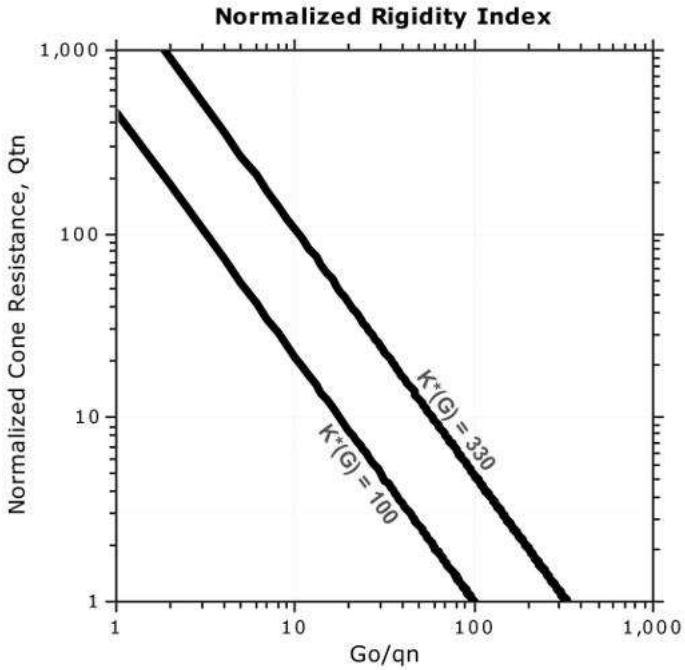
Project: **Ravarino**
Location: **Studio del terreno di fondazione**

CPT: CPTU12
Total depth: 30.36 m, Date: 10/11/2025
Surface Elevation: 0.00 m, Est. GWL: 2.50 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

ALLEGATO 2

INDAGINI SISMICHE

TROMINO
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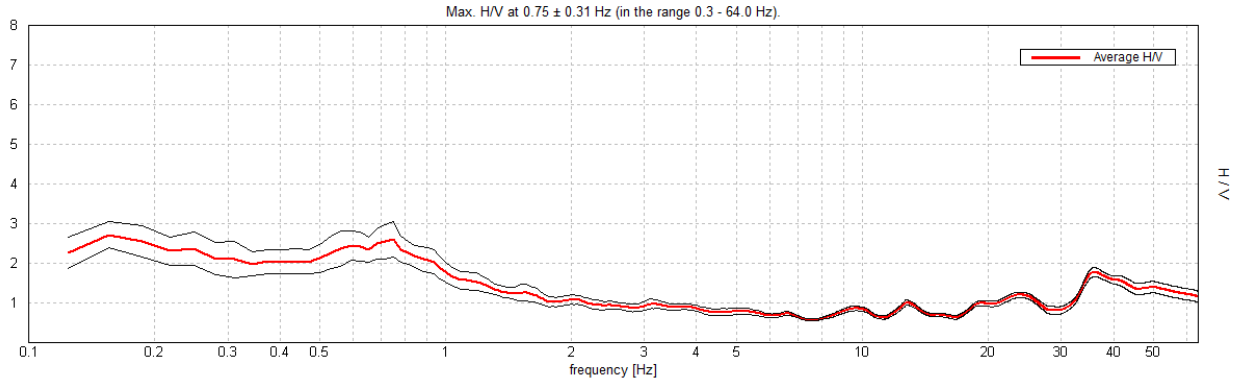
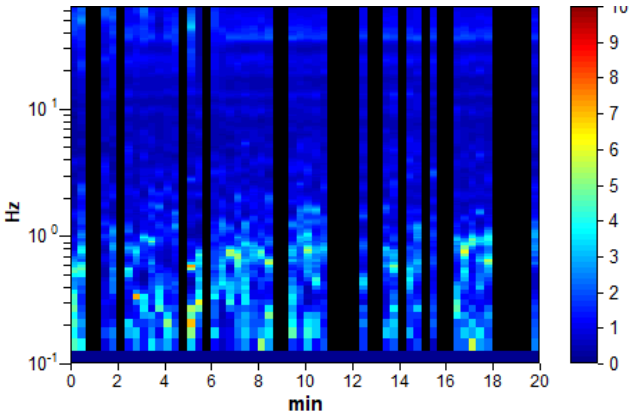
RAVARINO, CONSERVE DELLA NONNA
Instrument: TZB-0123/01-20
Data format: 32 bit
Full scale [mV]: 179
Start recording: 28/10/2025 16:58:58 End recording: 28/10/2025 17:18:58
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h20'00". Analyzed 63% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

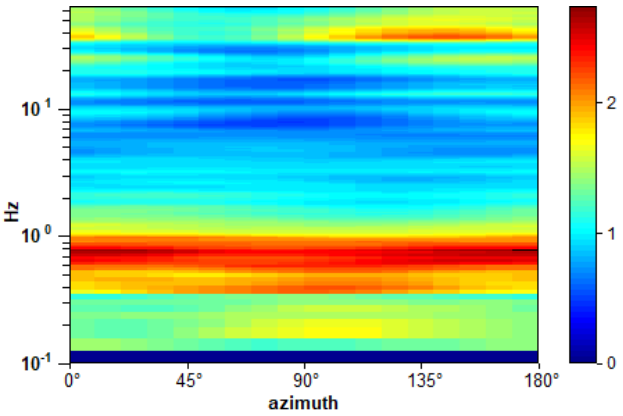
HORIZONTAL TO VERTICAL SPECTRAL RATIO



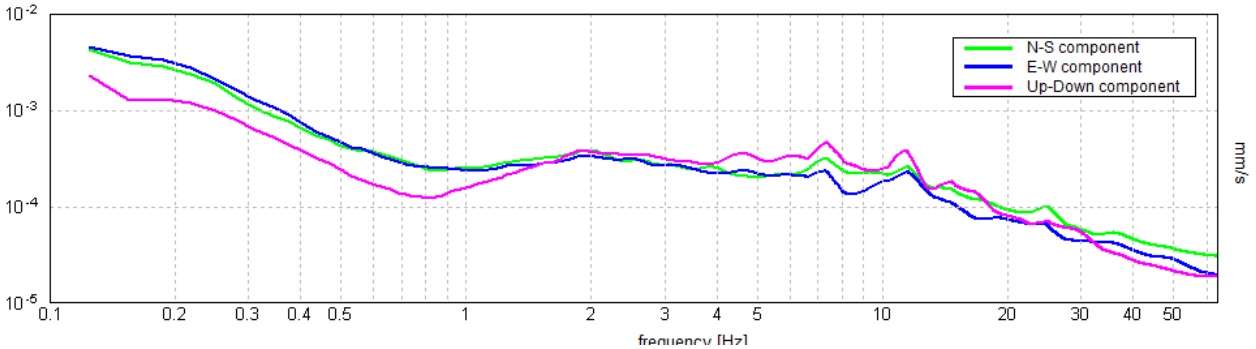
H/V TIME HISTORY



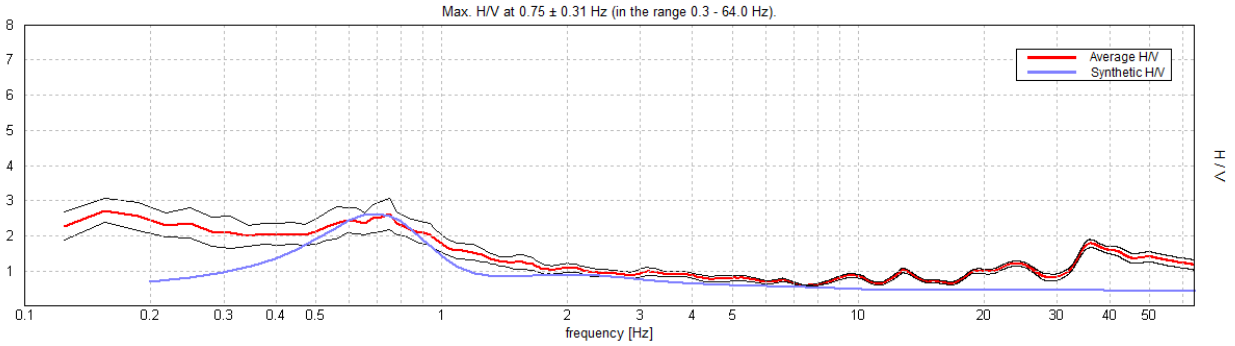
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

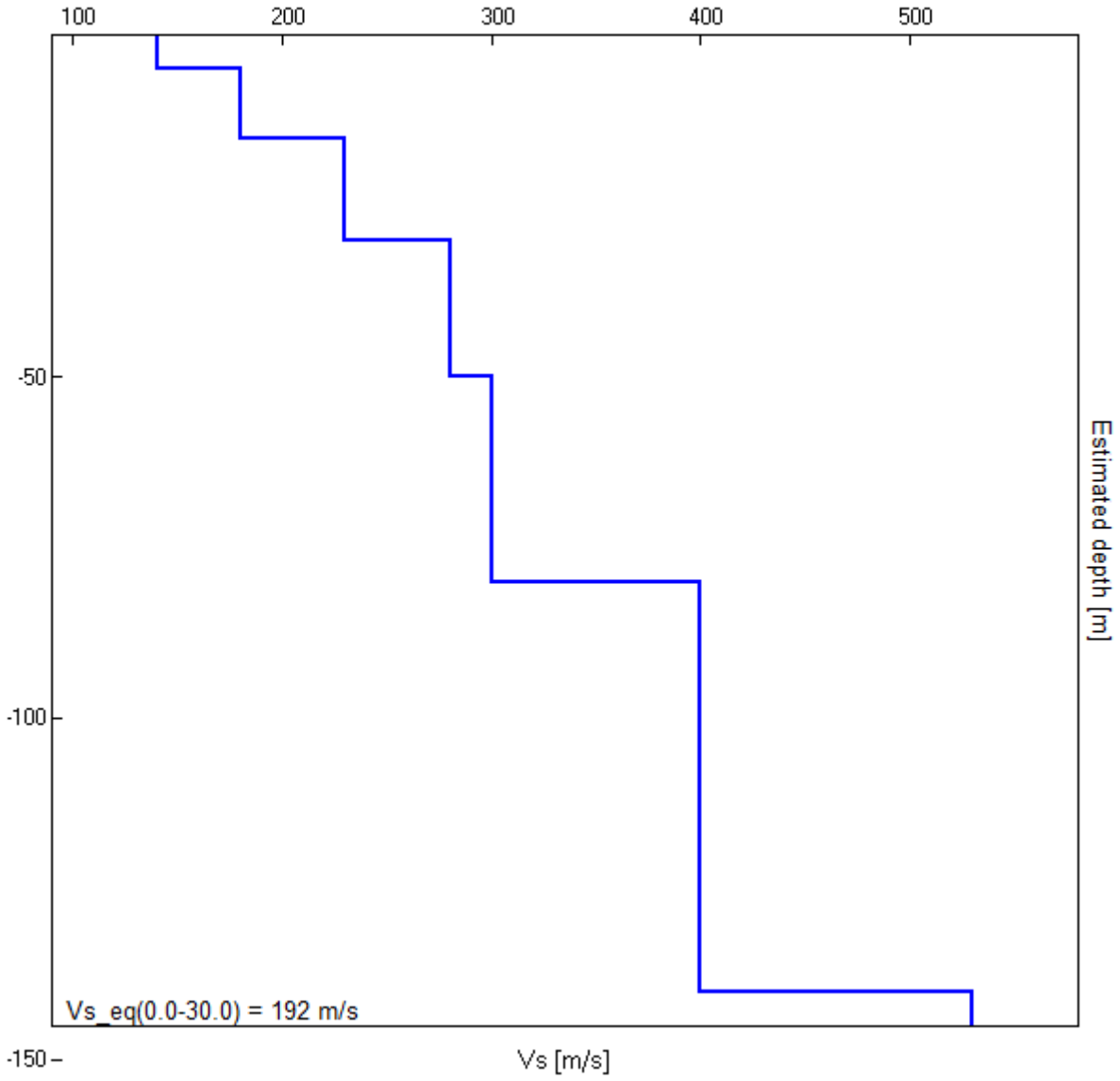


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
5.00	5.00	140	0.42
15.00	10.00	180	0.42
30.00	15.00	230	0.42
50.00	20.00	280	0.42
80.00	30.00	300	0.42
140.00	60.00	400	0.42
inf.	inf.	530	0.42

Vs_eq(0.0-30.0) = 192 m/s


100
200
300
400
500
-50
-100
-150
Estimated depth [m]
Vs_eq(0.0-30.0) = 192 m/s
Vs [m/s]

[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 0.75 ± 0.31 Hz (in the range 0.3 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	0.75 > 0.50	OK	
$n_c(f_0) > 200$	570.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 37 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1.375 Hz	OK	
$A_0 > 2$	2.61 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.40786| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	0.30589 < 0.1125		NO
$\sigma_A(f_0) < \theta(f_0)$	0.448 < 2.0	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

TROMINO
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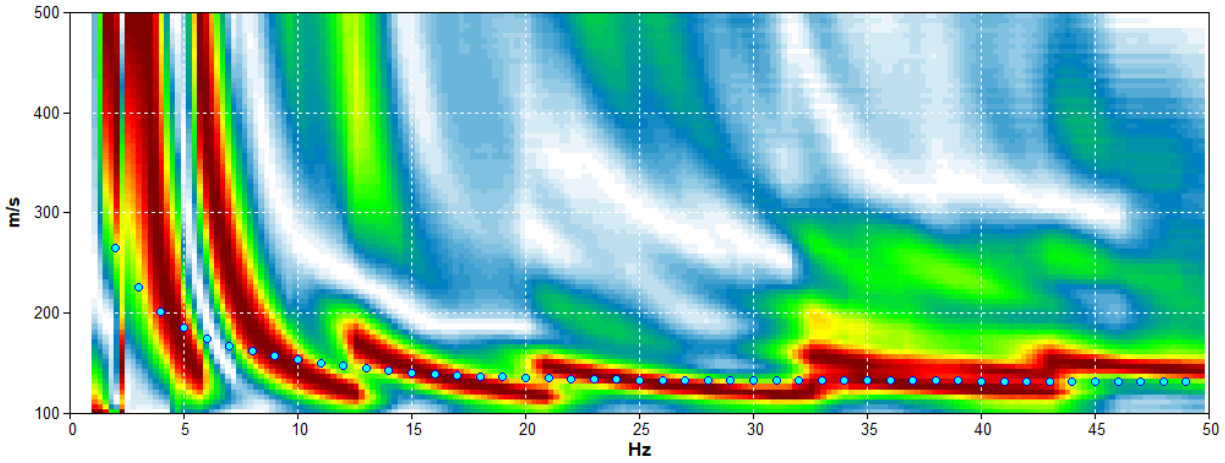
RAVARINO CONSERVE DELLA NONNA

Start recording: 28/10/2025 16:58:58 End recording: 28/10/2025 17:18:58
Trace length: 0h20'00''. Analyzed 63% trace (manual window selection)
Sampling rate: 128 Hz

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

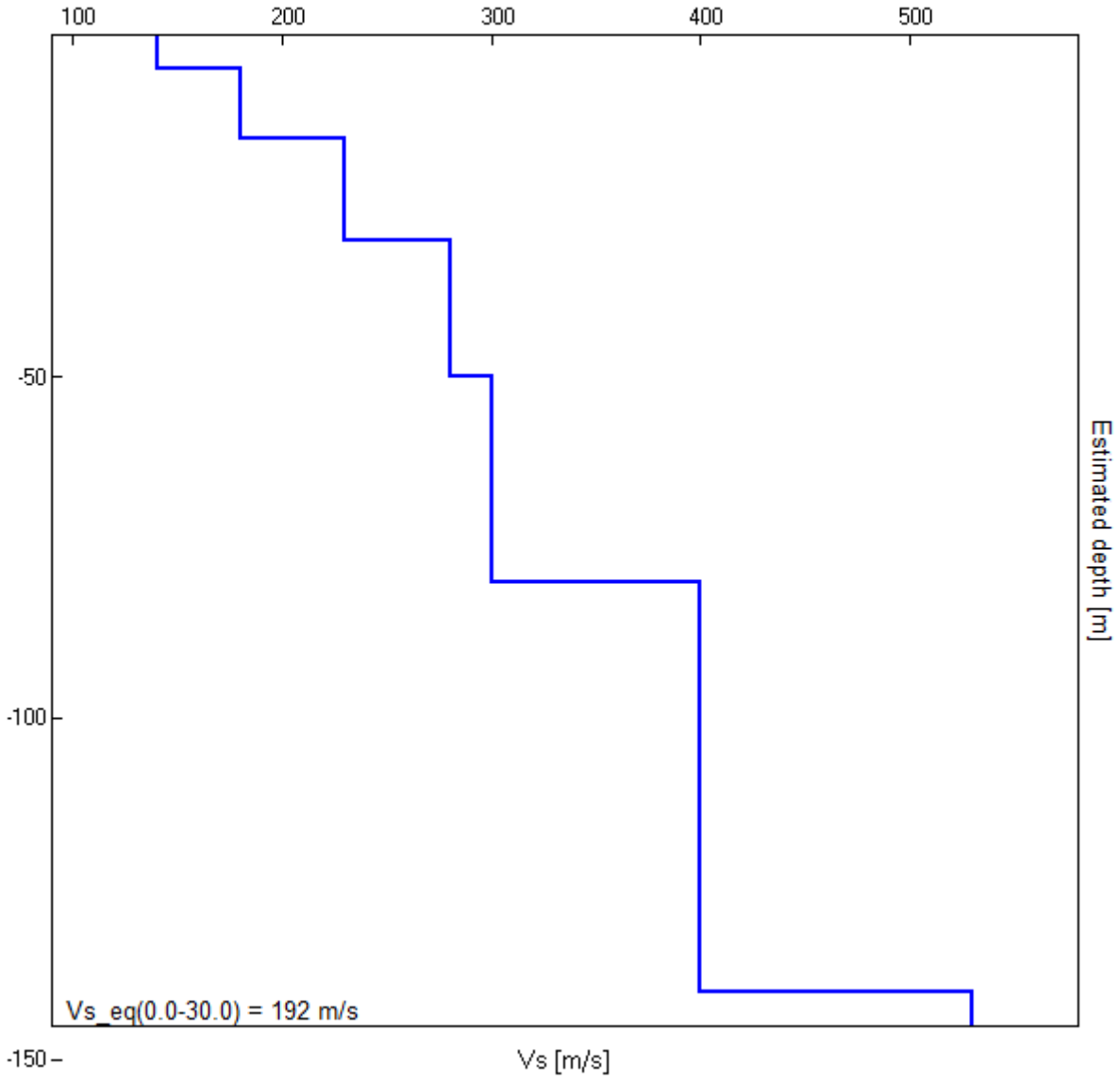
Array geometry (x): 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 m.

MODELLED RAYLEIGH WAVE PHASE VELOCITY DISPERSION CURVE



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
5.00	5.00	140	0.42
15.00	10.00	180	0.42
30.00	15.00	230	0.42
50.00	20.00	280	0.42
80.00	30.00	300	0.42
140.00	60.00	400	0.42
inf.	inf.	530	0.42

Vs_eq(0.0-30.0) = 192 m/s


100
200
300
400
500
-50
-100
-150
Estimated depth [m]
Vs_eq(0.0-30.0) = 192 m/s
Vs [m/s]

ALLEGATO 3

VERIFICA ALLA LIQUEFAZIONE

Geo Group srl
Geologia e Ambiente
Modena, Via Padova 160
https://geogroupmodena.it/

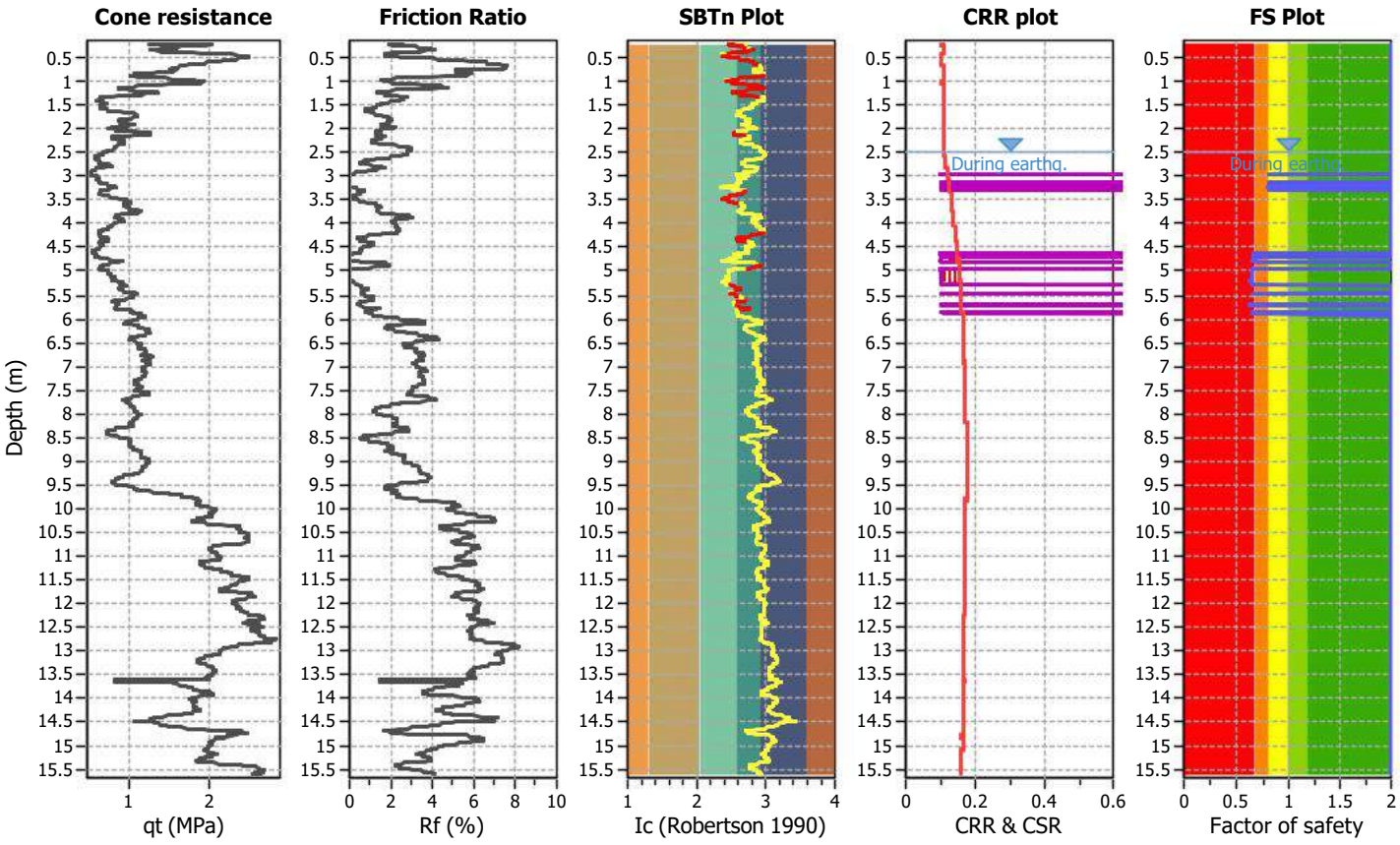
LIQUEFACTION ANALYSIS REPORT

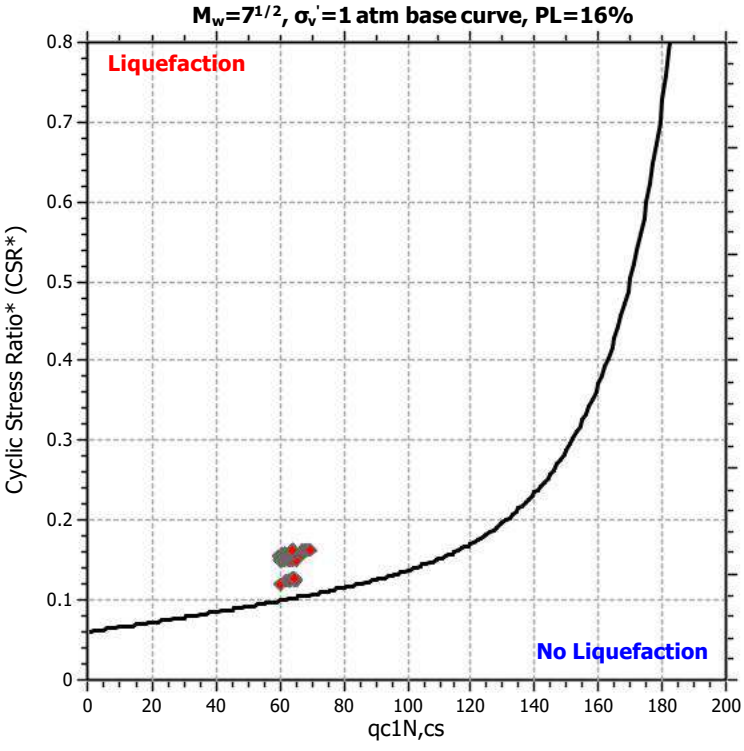
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

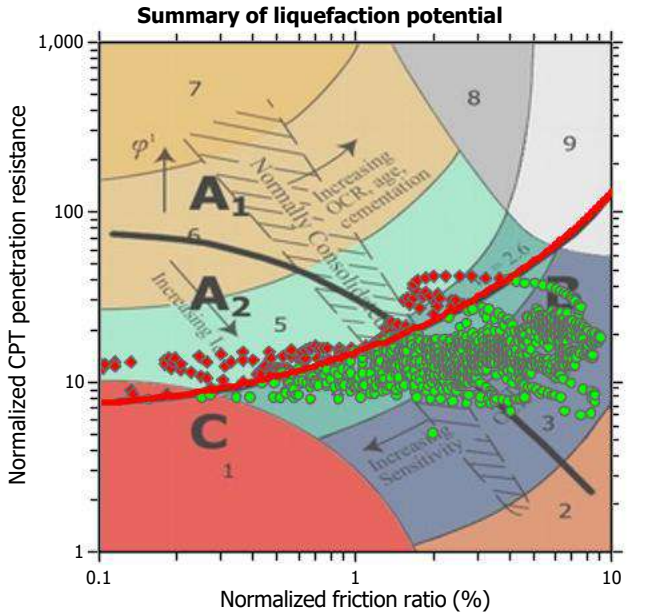
CPT file : CPTU1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

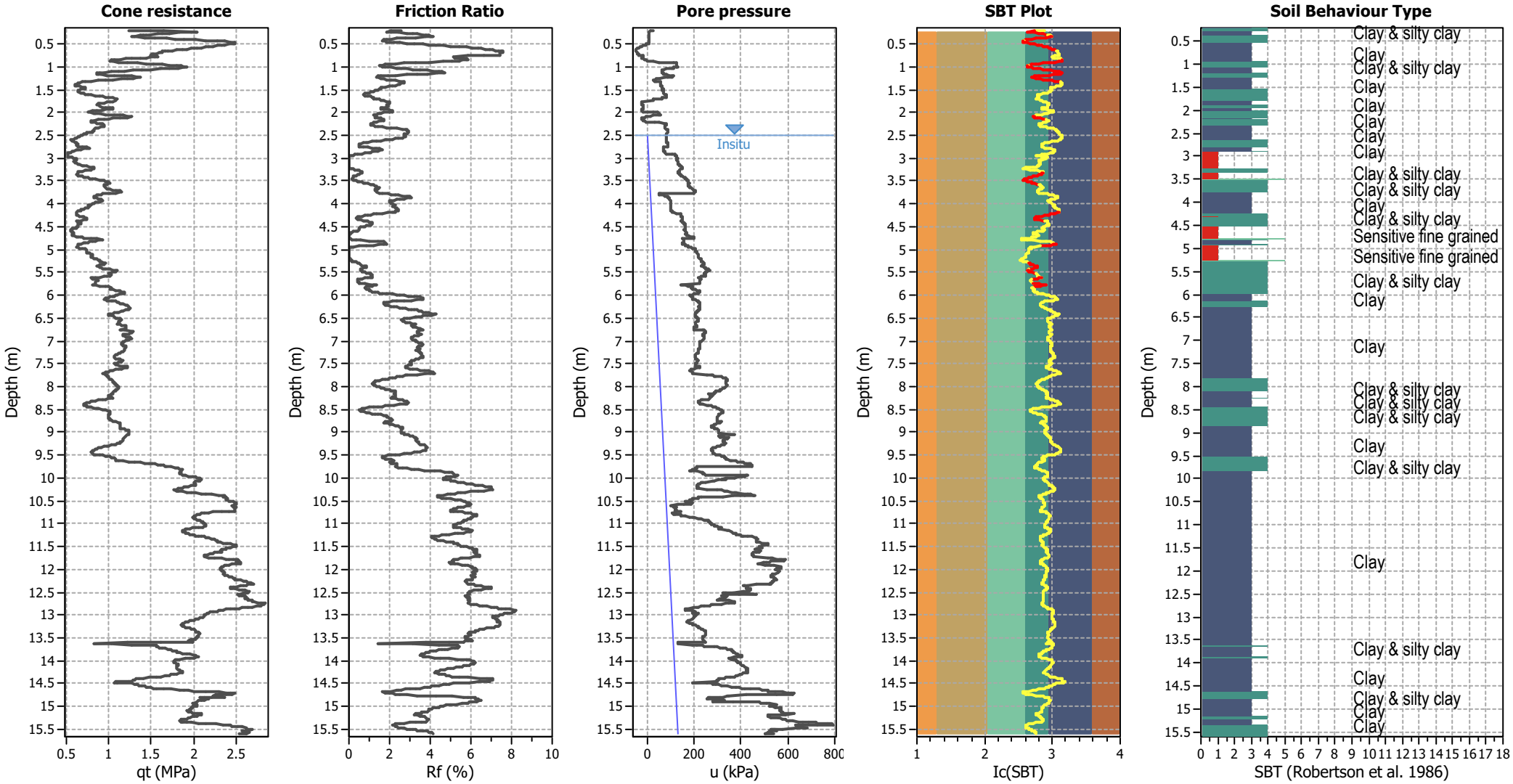






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



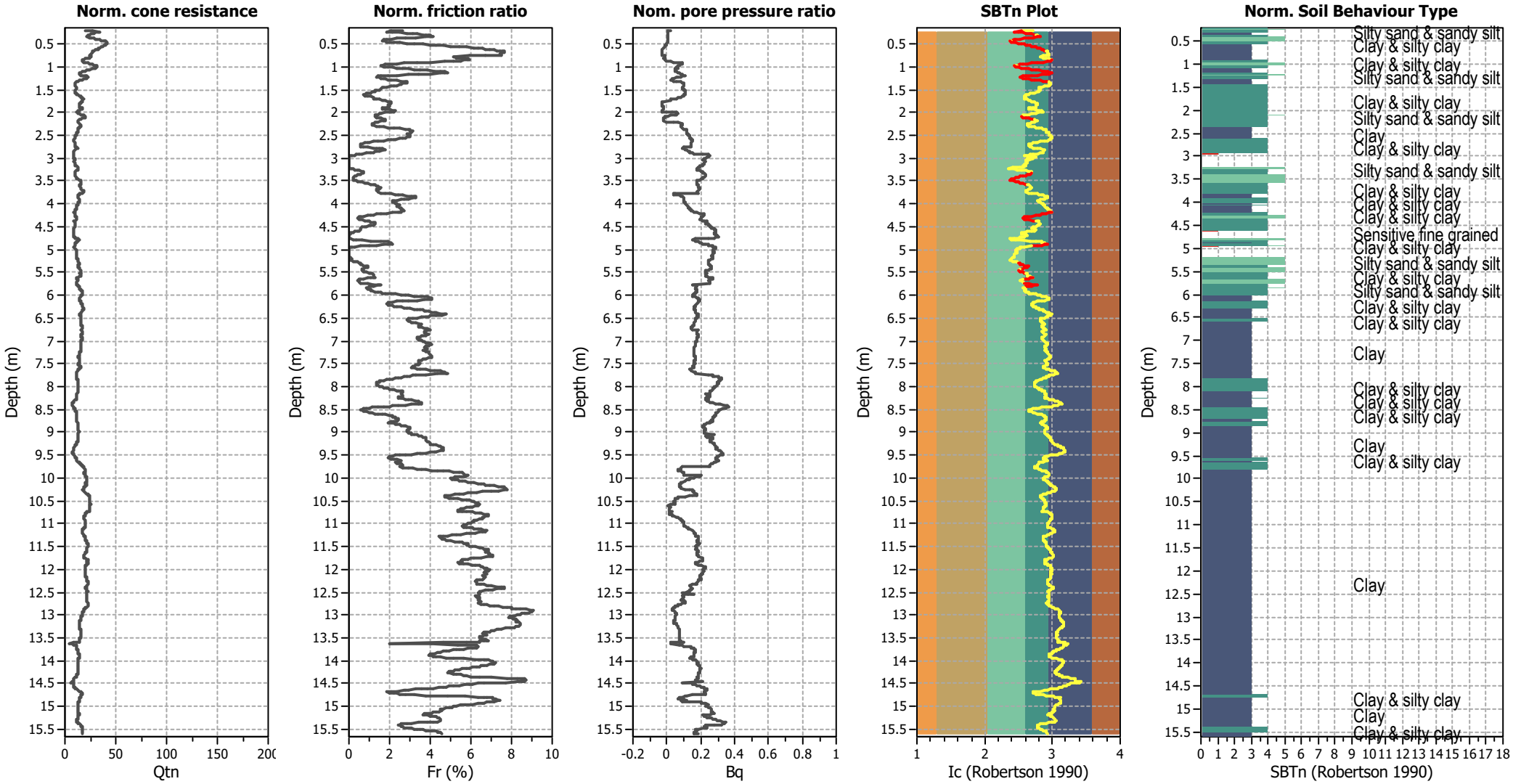
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



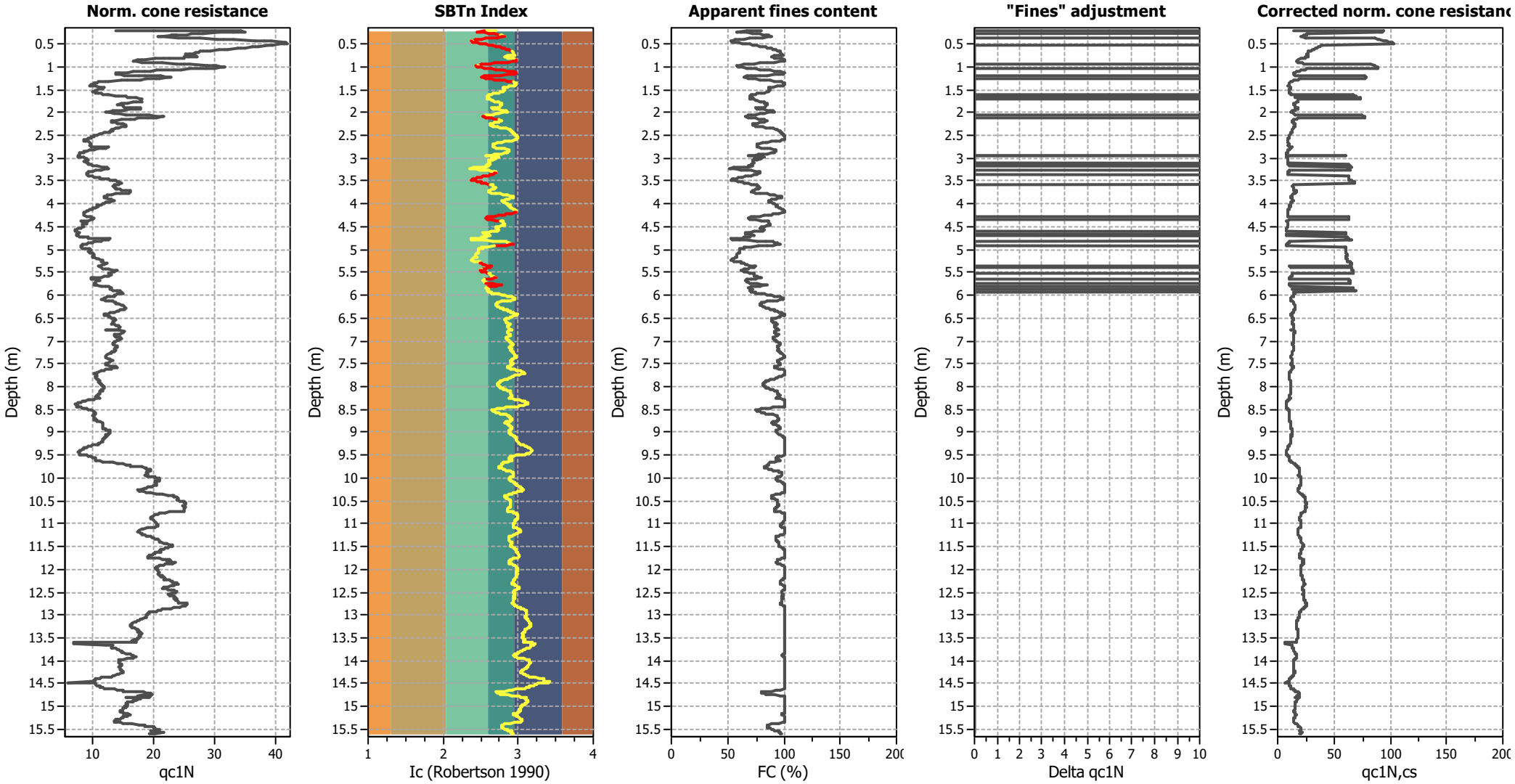
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

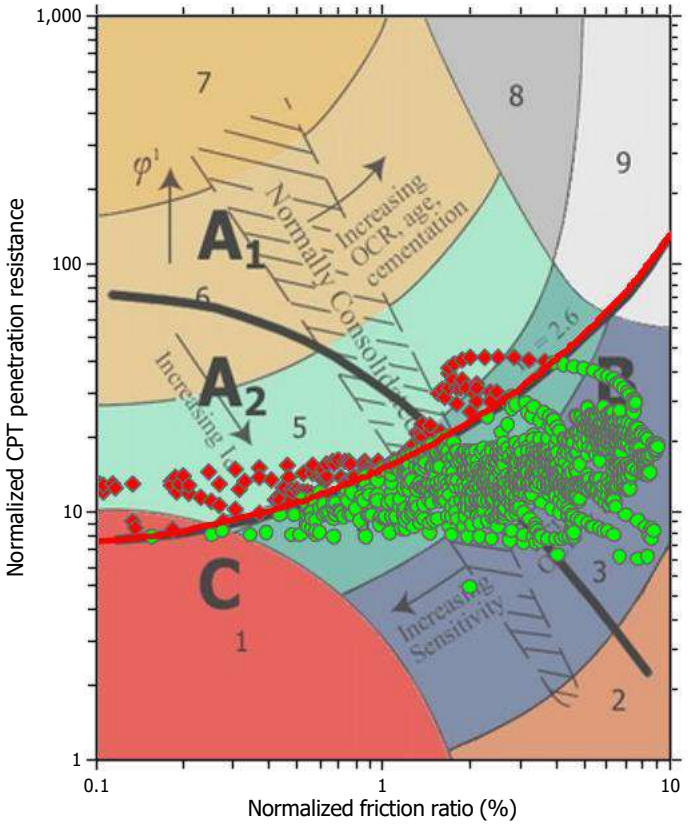
Liquefaction analysis overall plots (intermediate results)

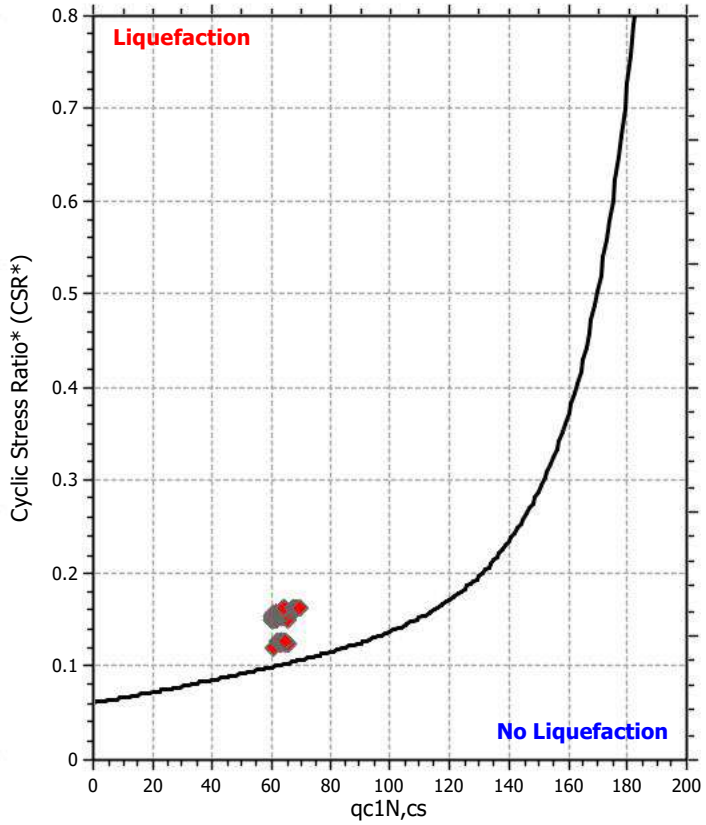


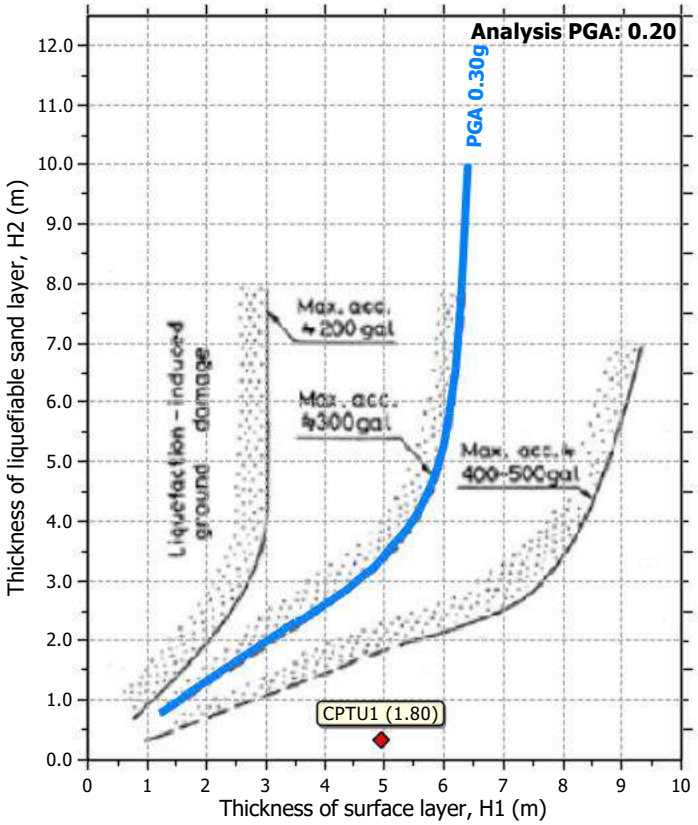
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



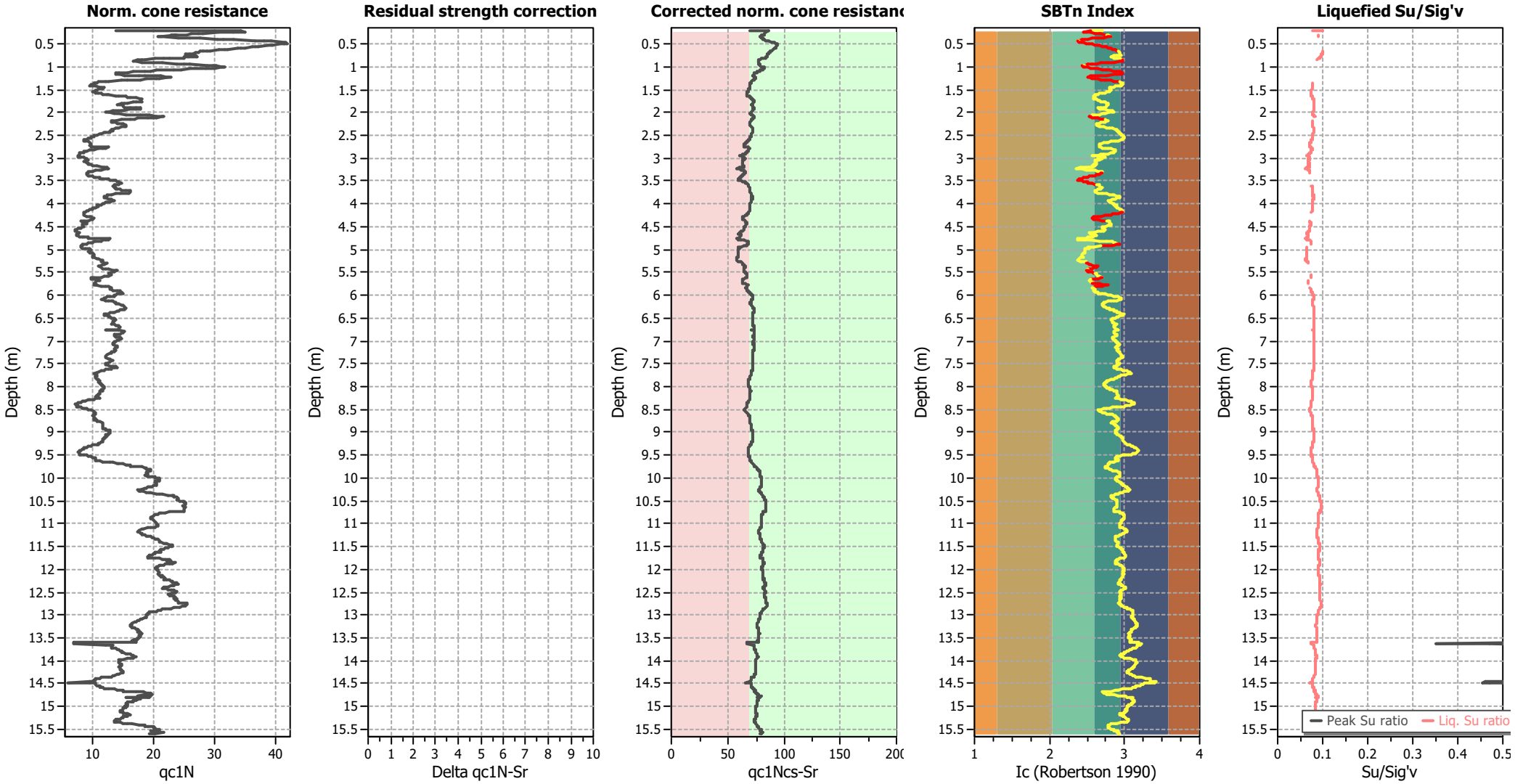




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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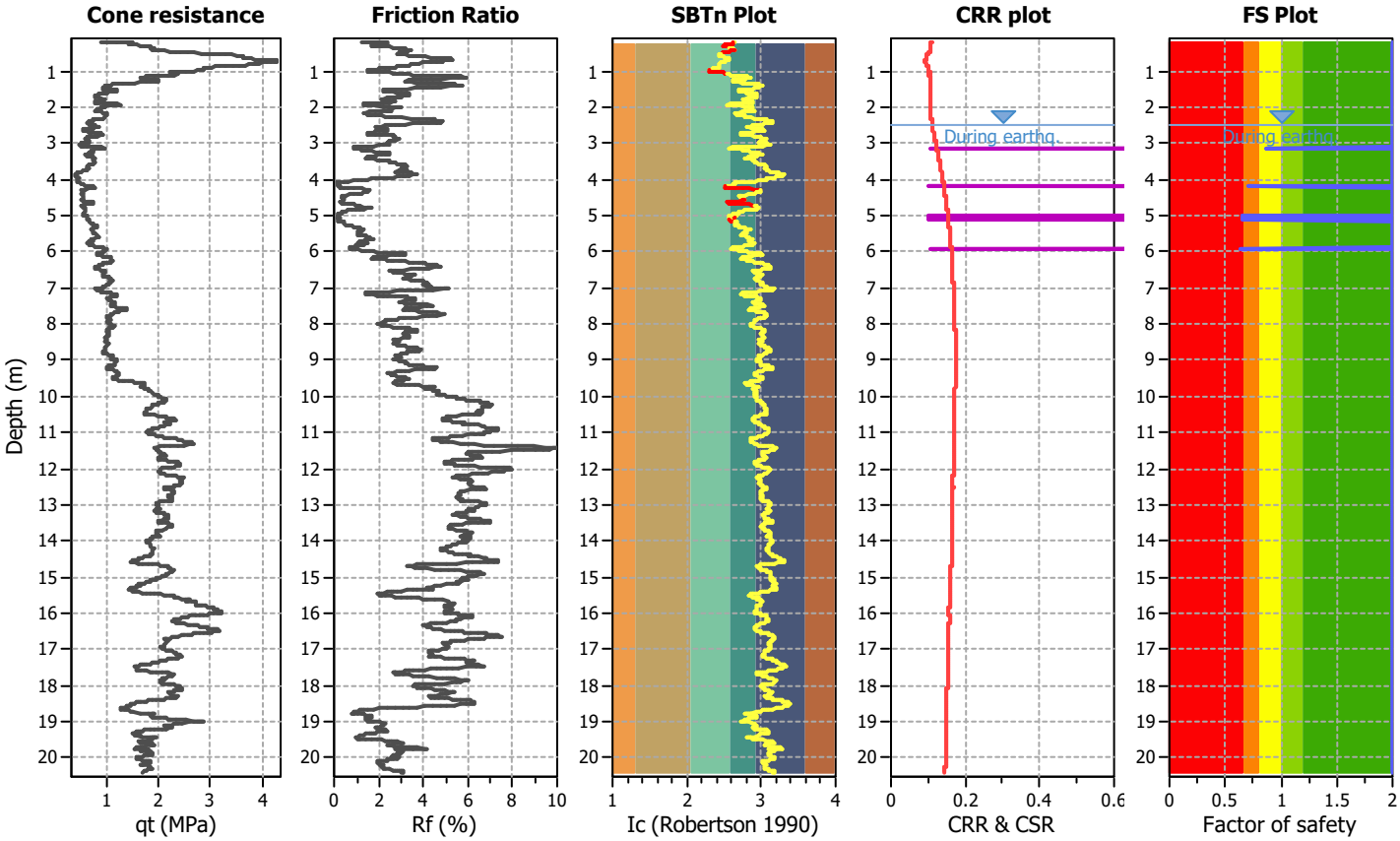
LIQUEFACTION ANALYSIS REPORT

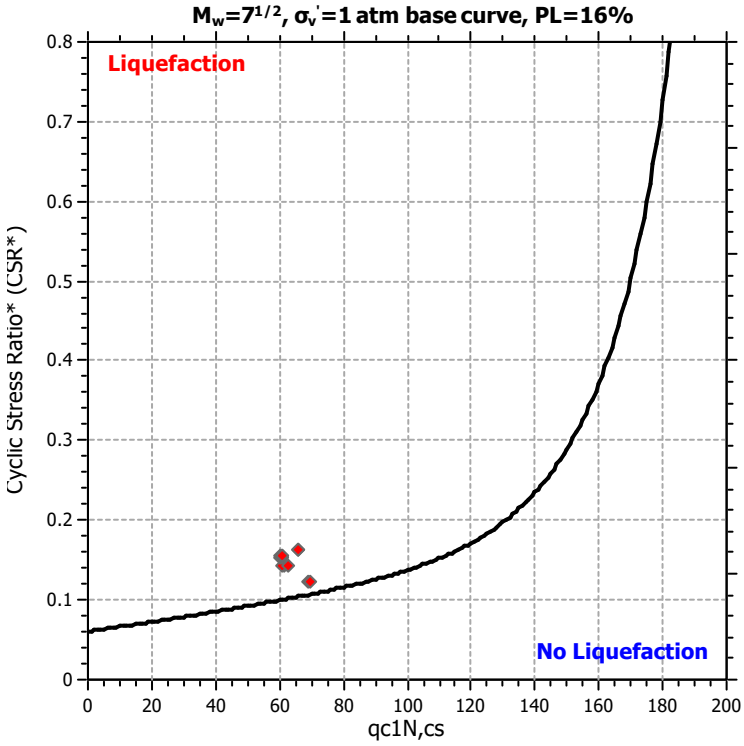
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

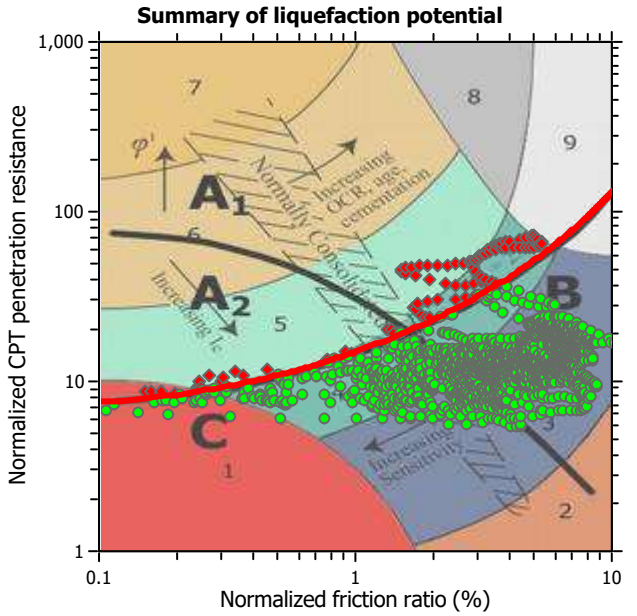
CPT file : CPTU2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

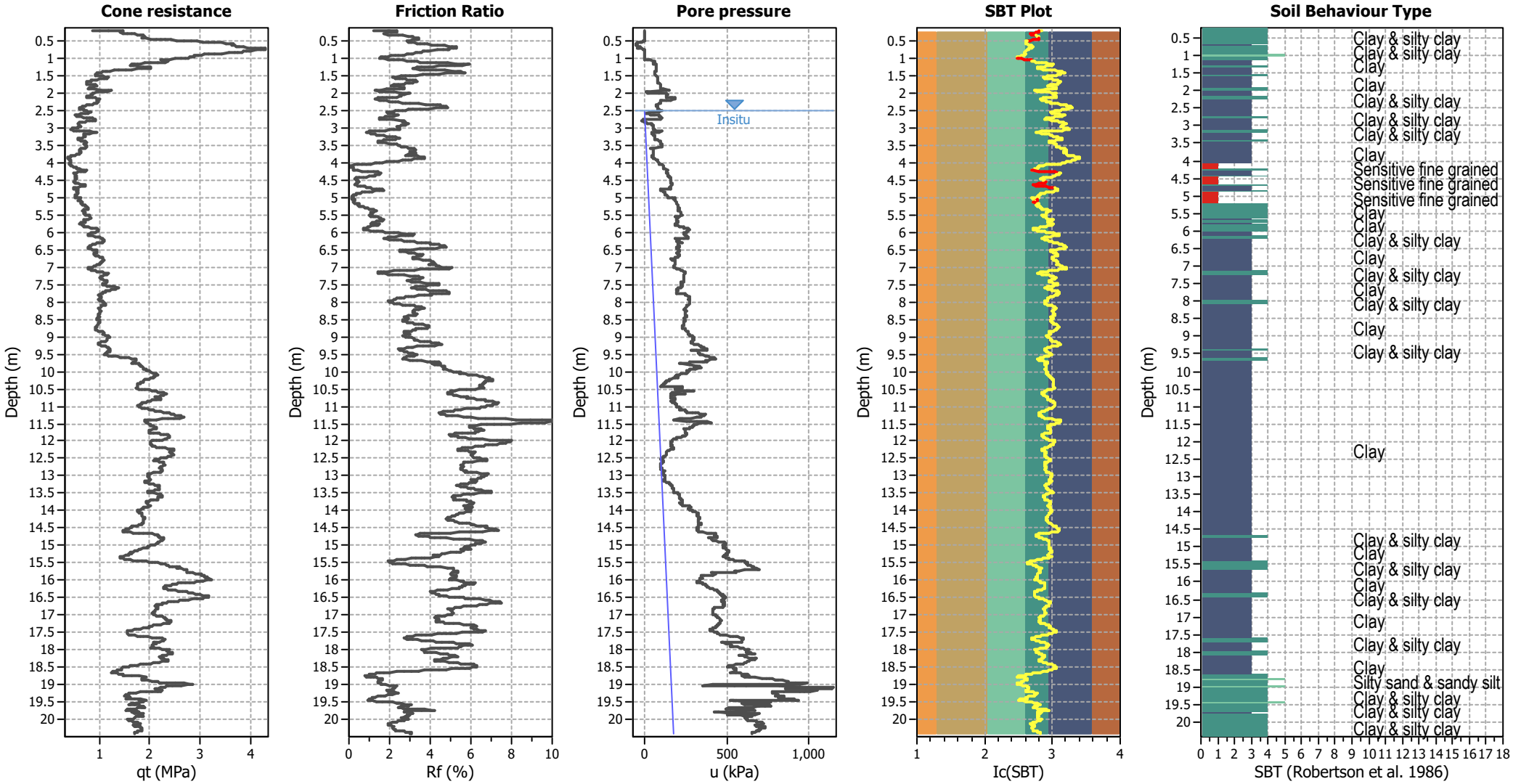






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



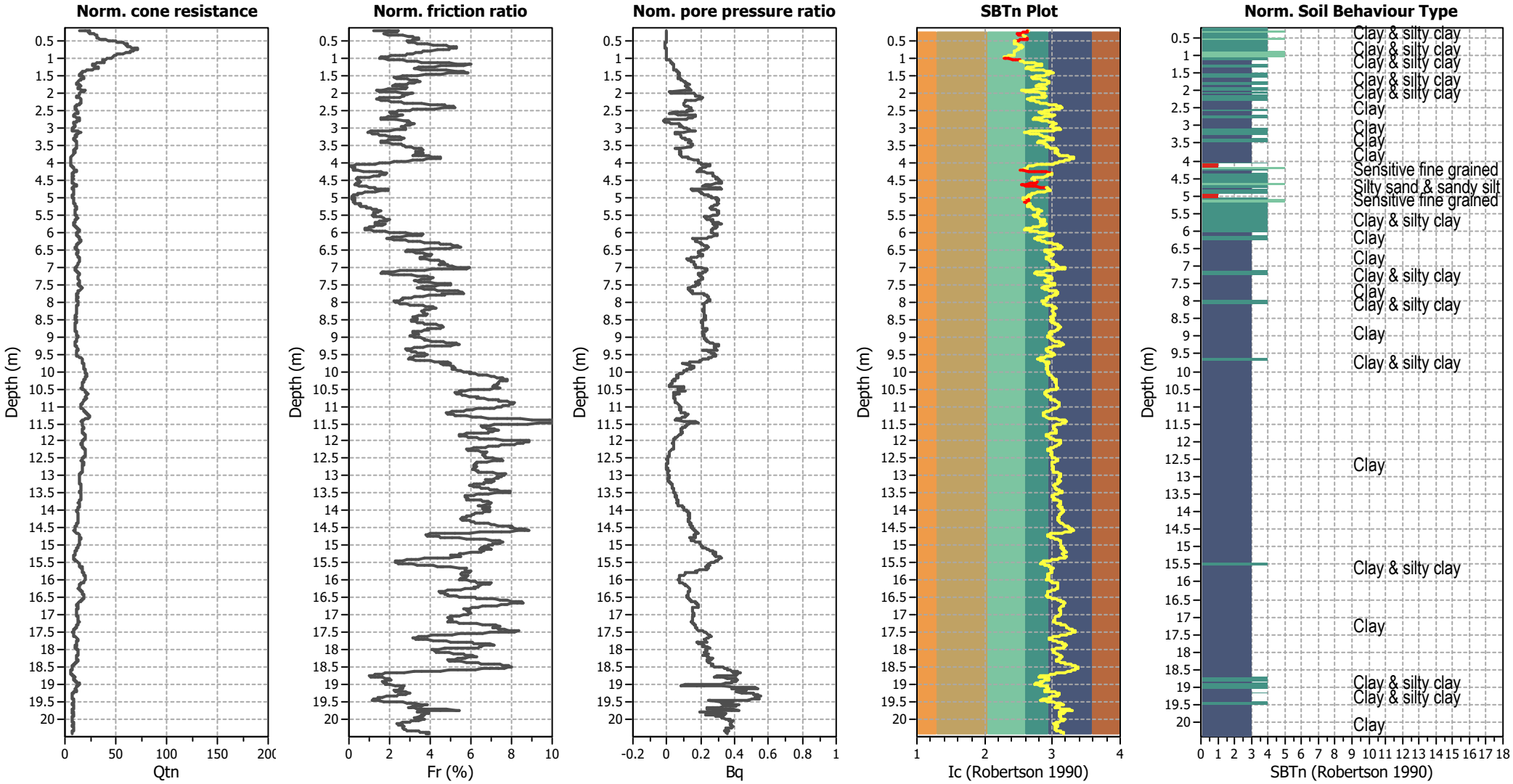
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



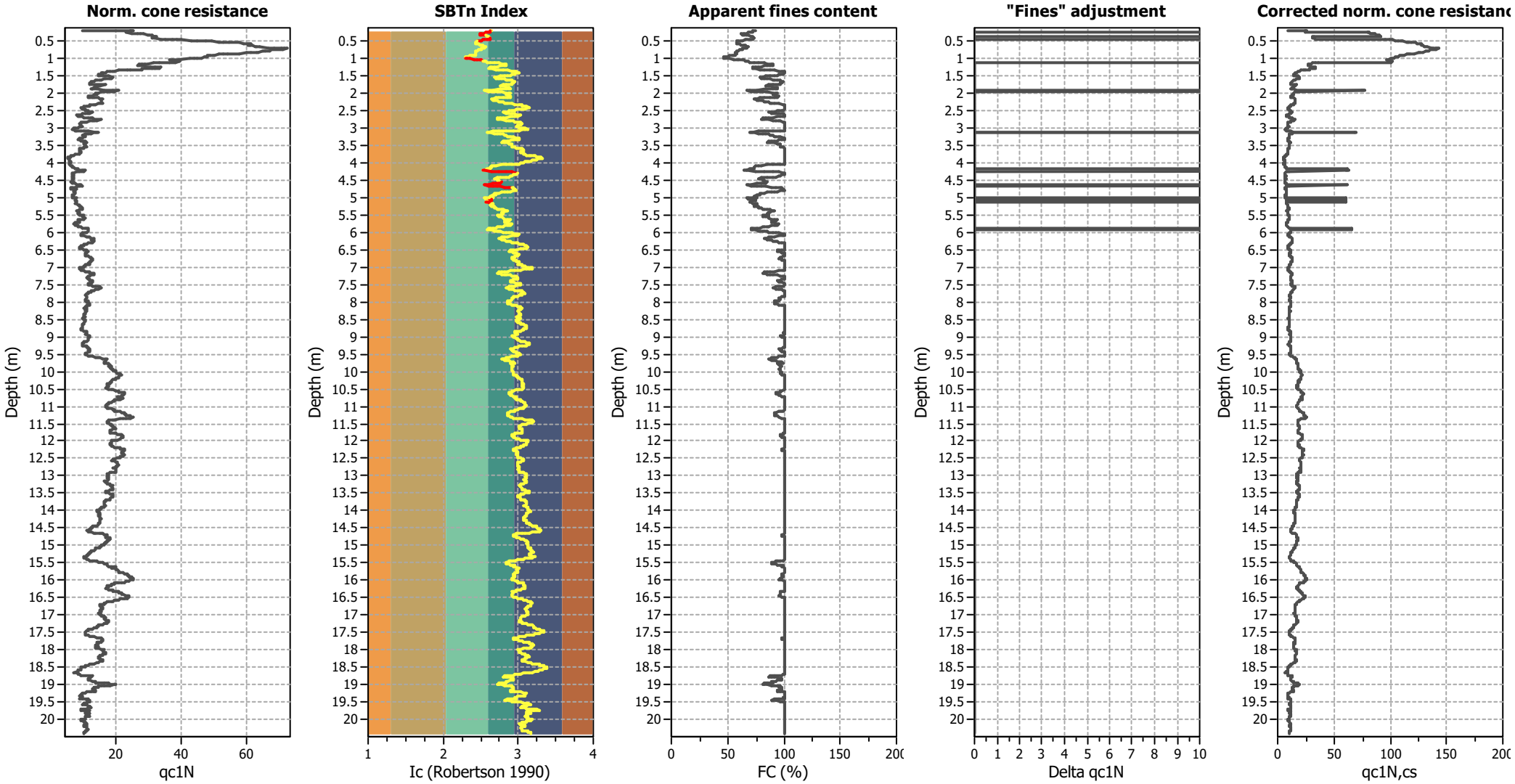
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

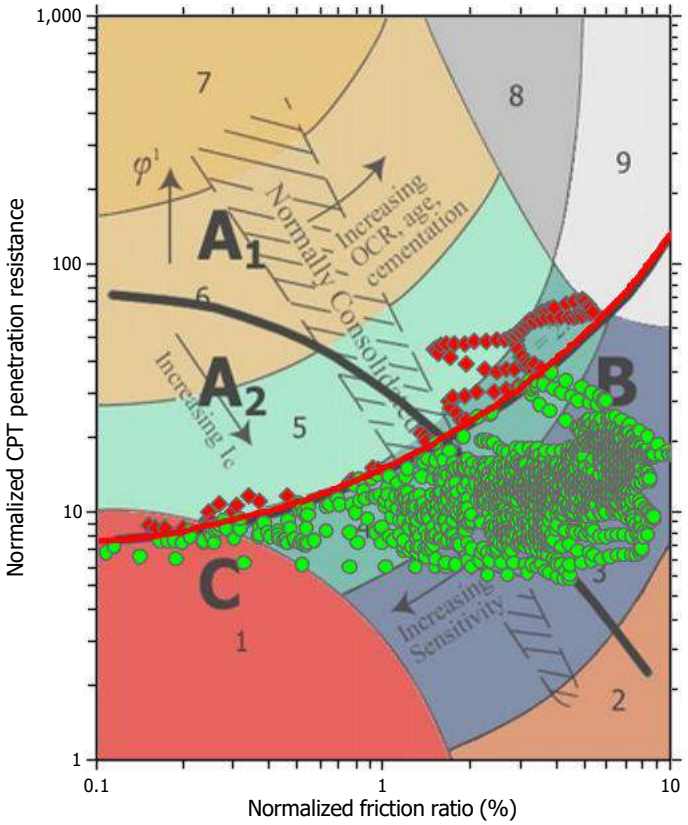
Liquefaction analysis overall plots (intermediate results)

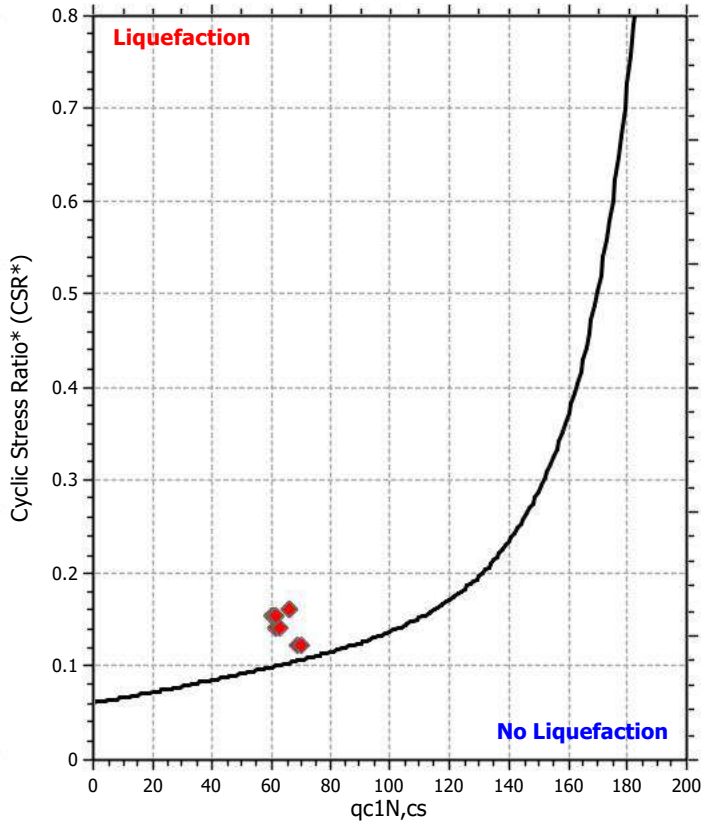


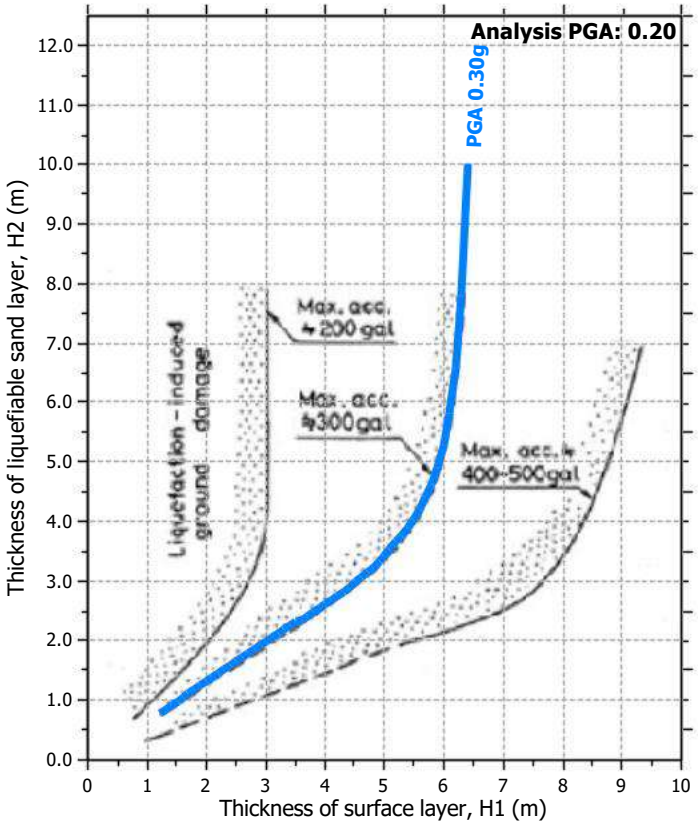
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



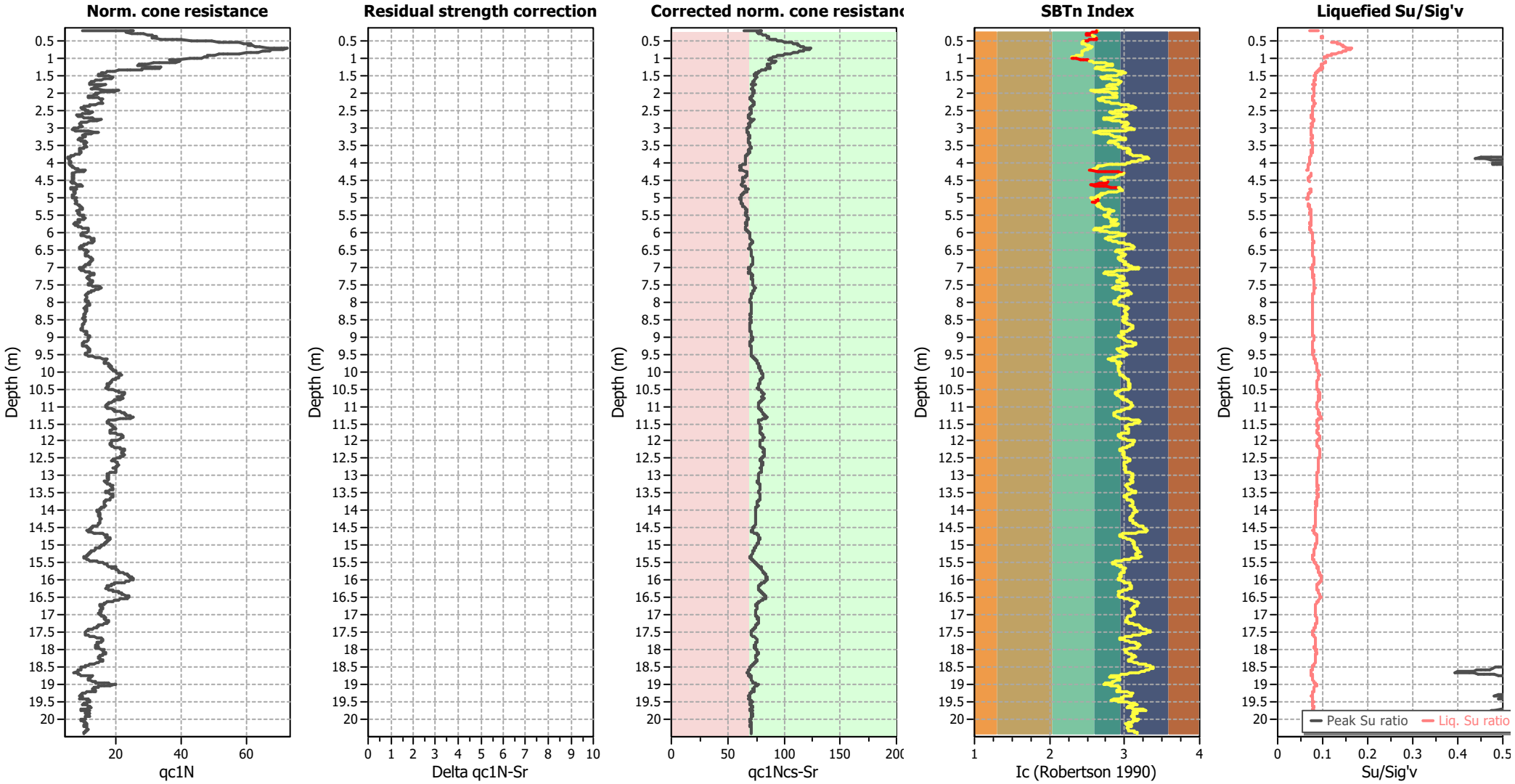




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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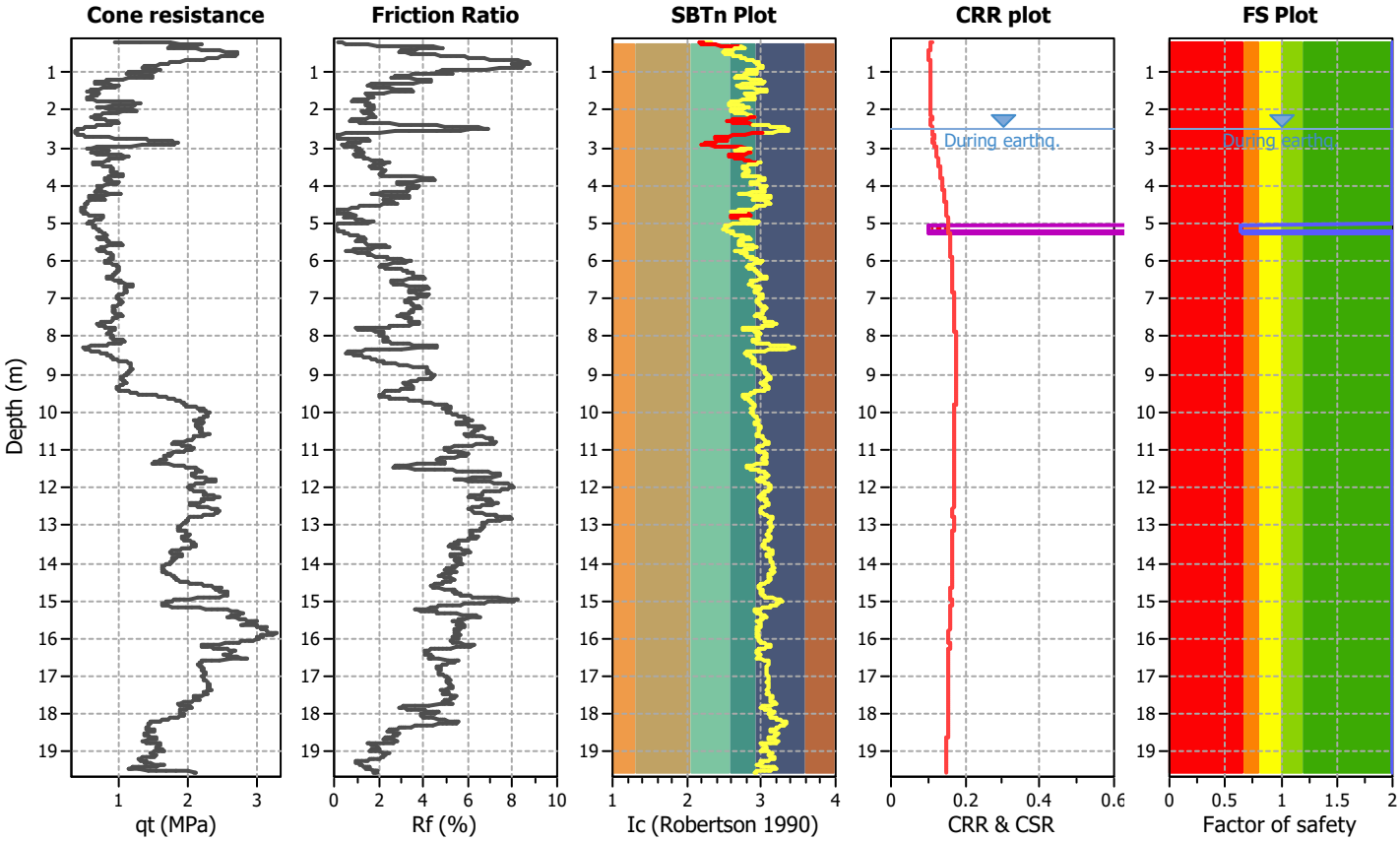
LIQUEFACTION ANALYSIS REPORT

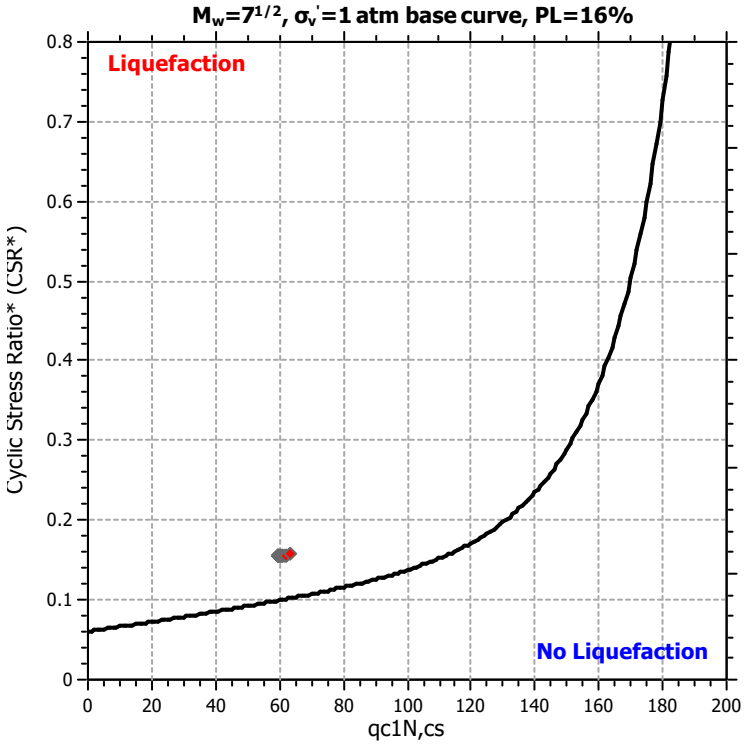
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

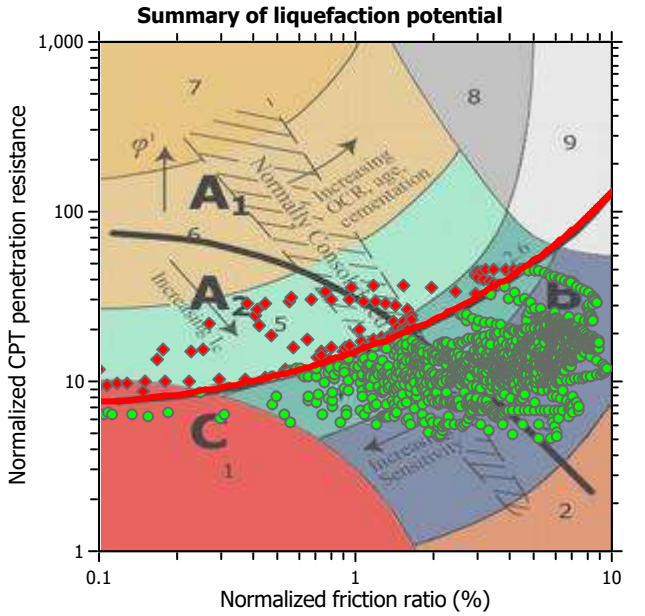
CPT file : CPTU4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

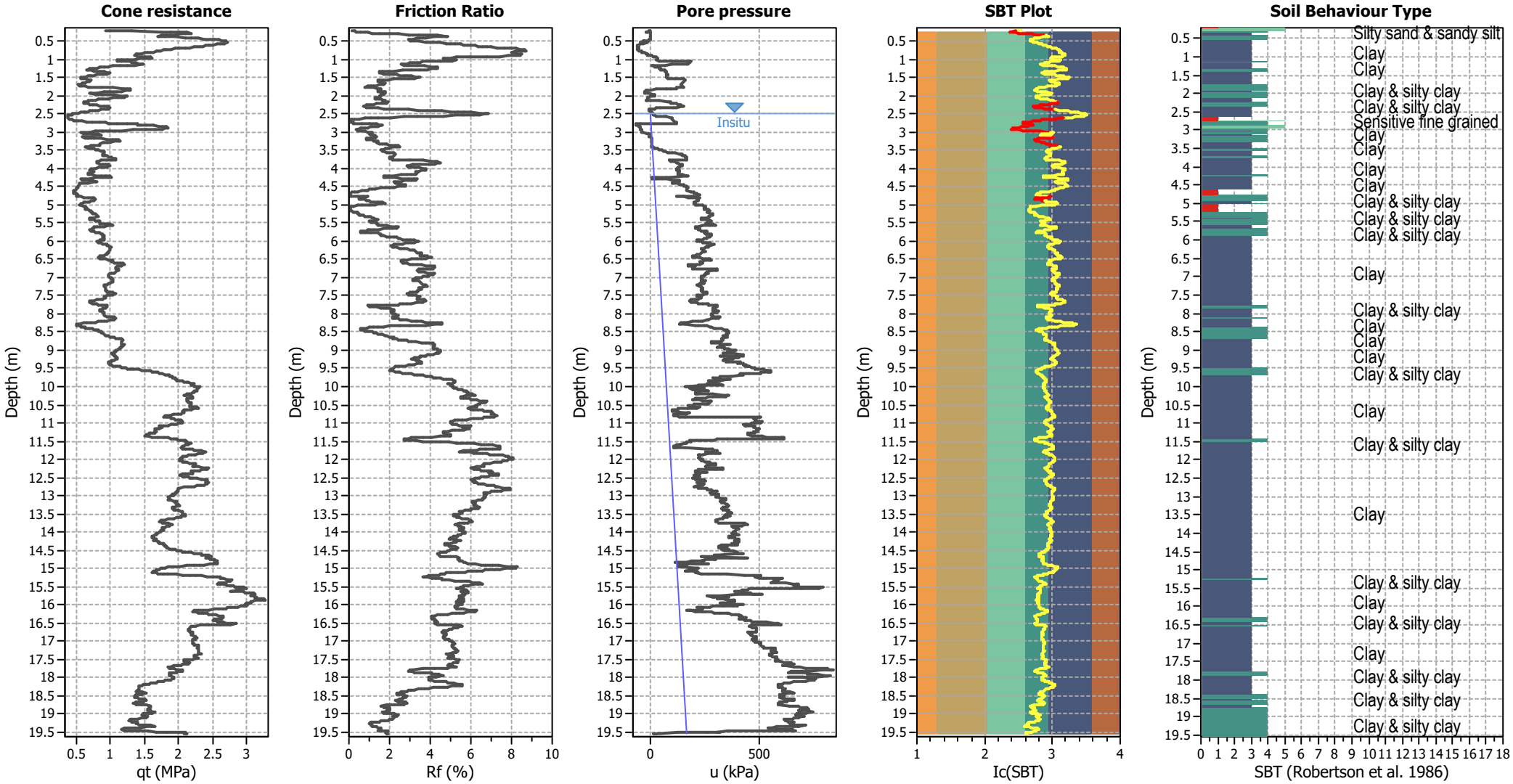






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



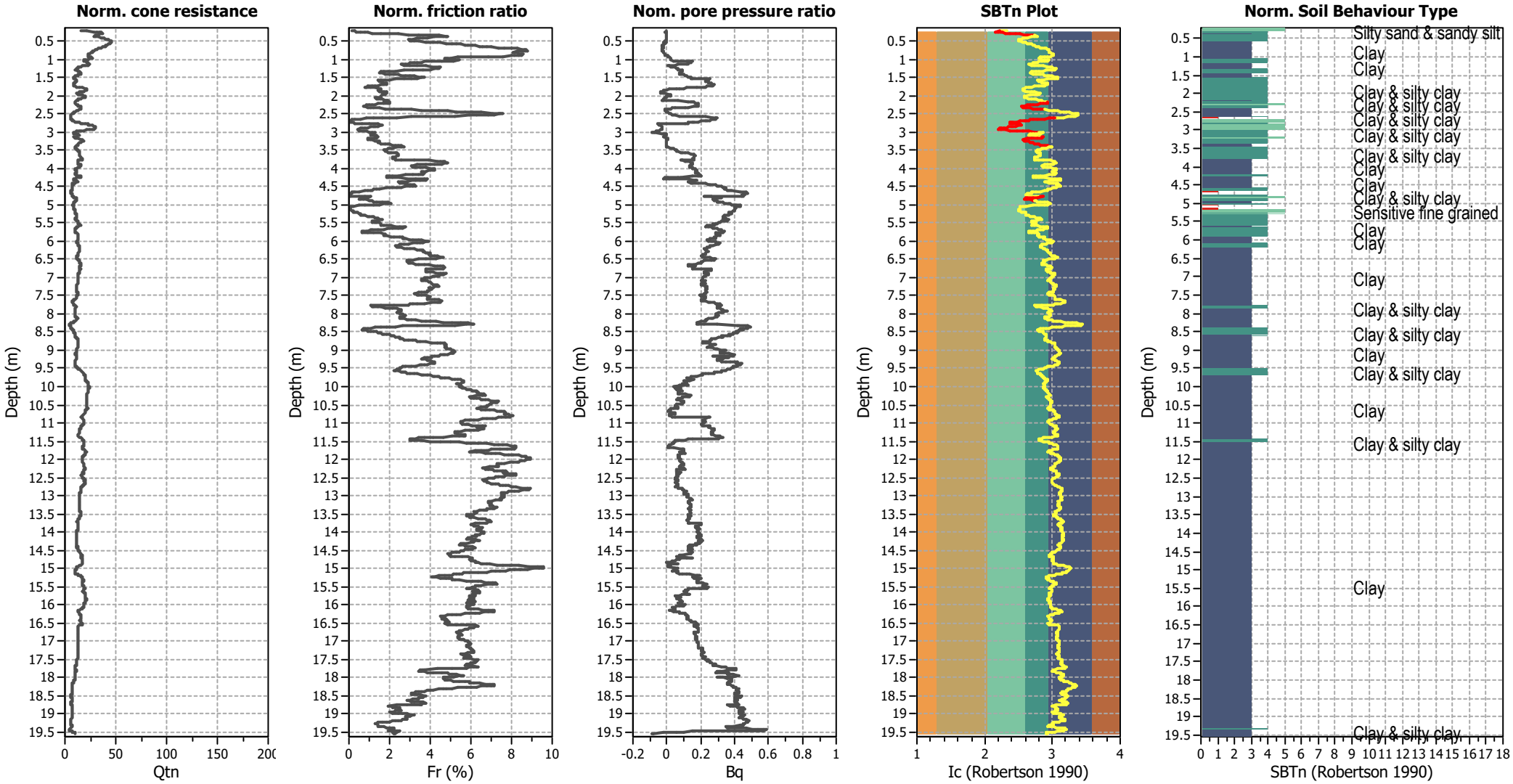
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



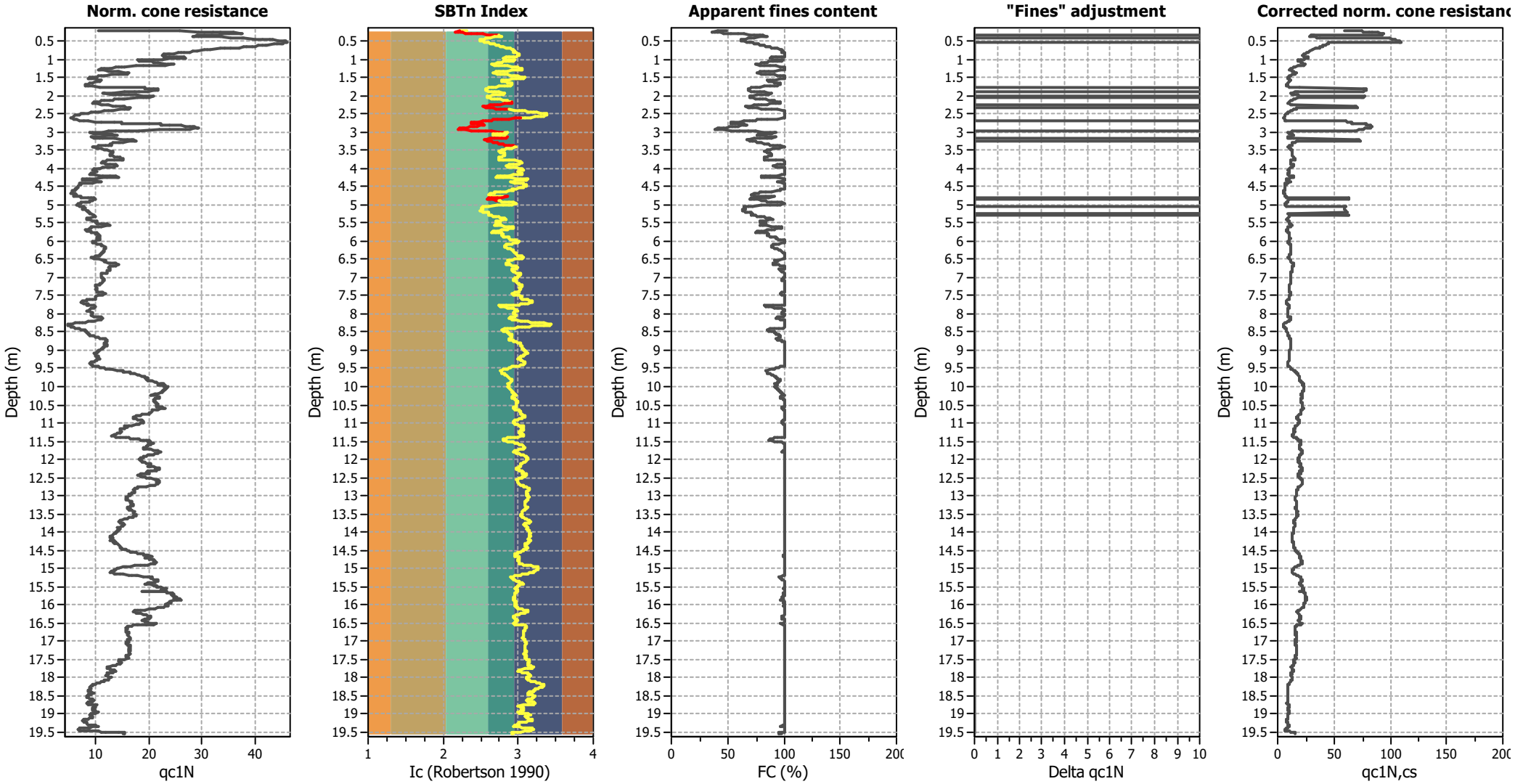
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

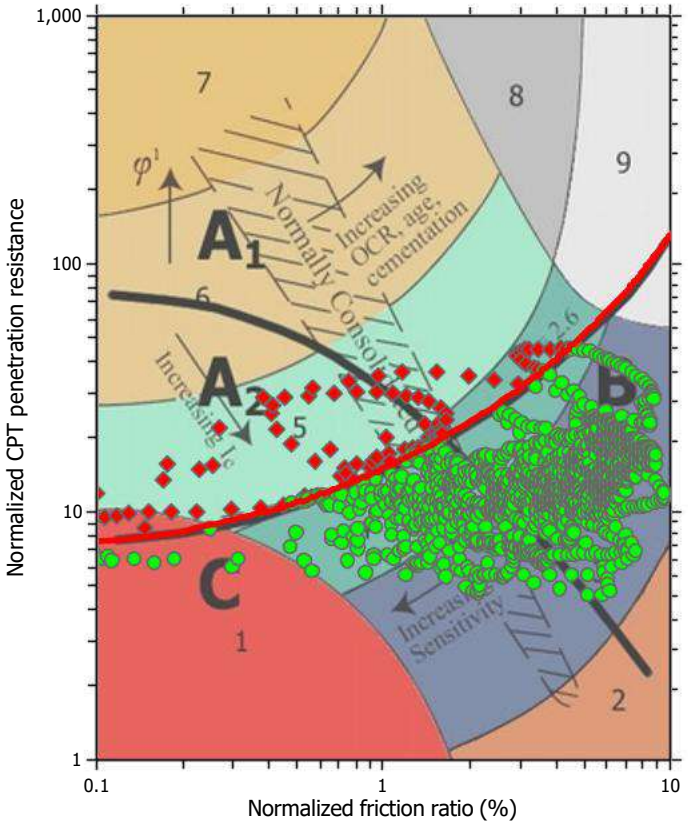
Liquefaction analysis overall plots (intermediate results)

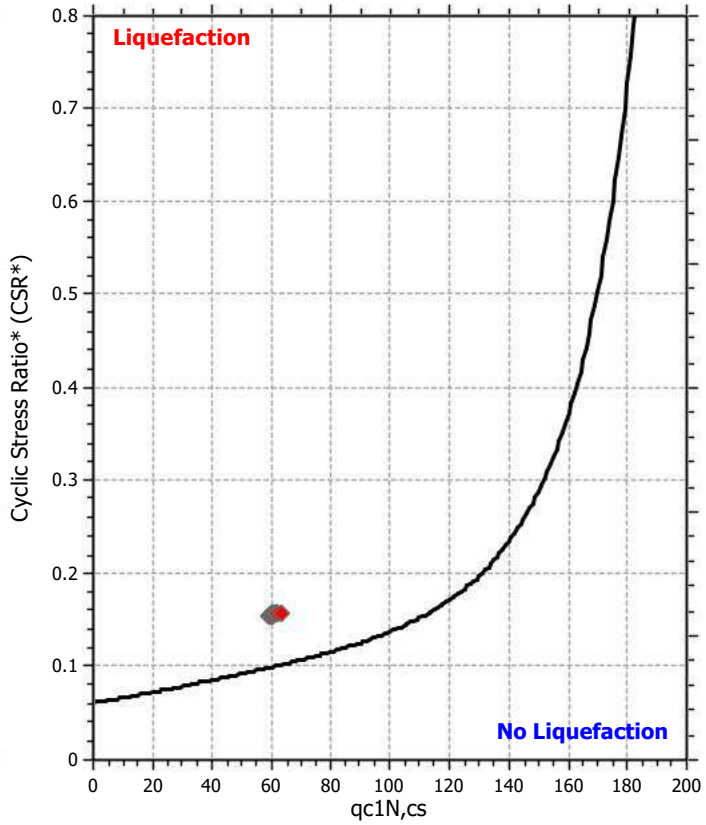


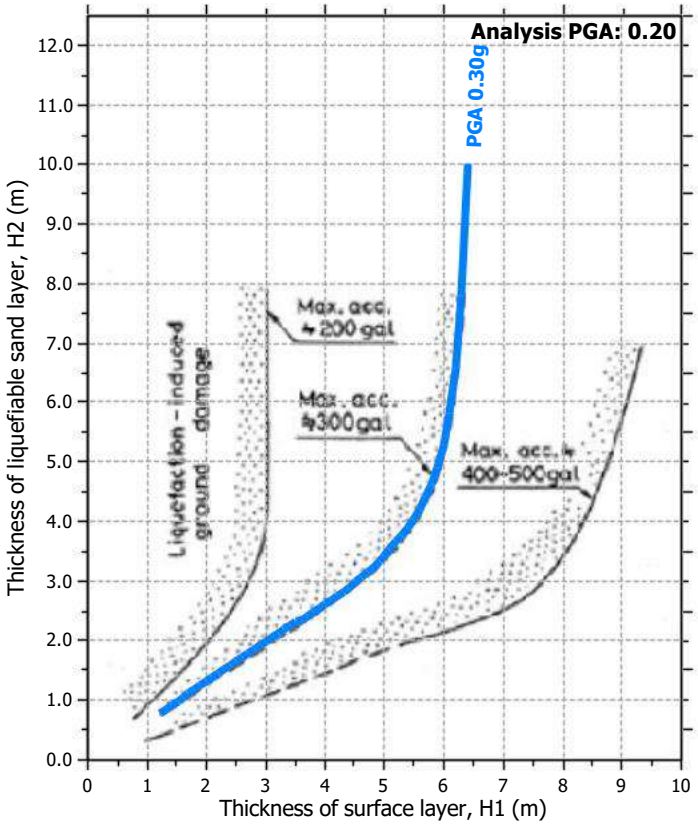
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



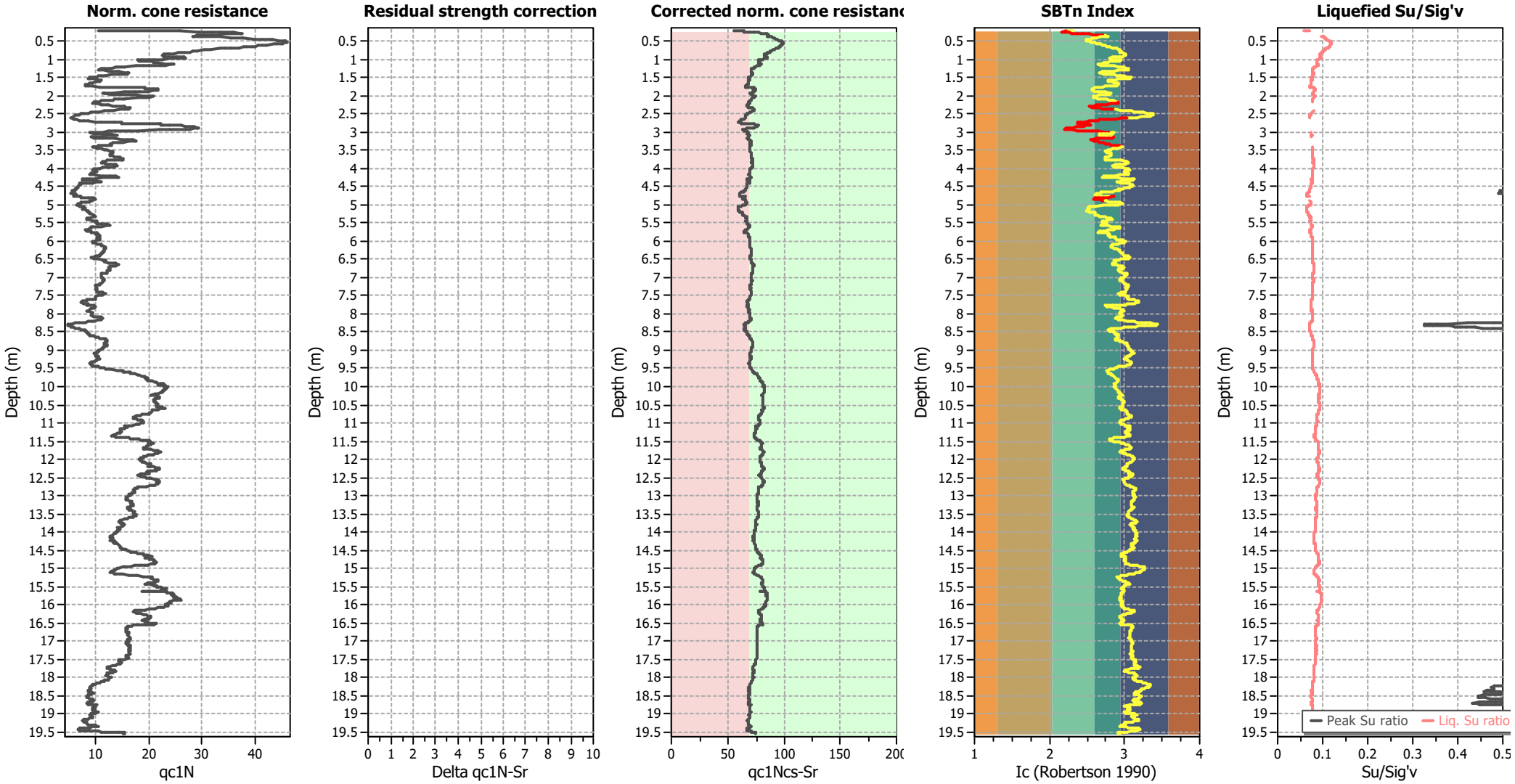




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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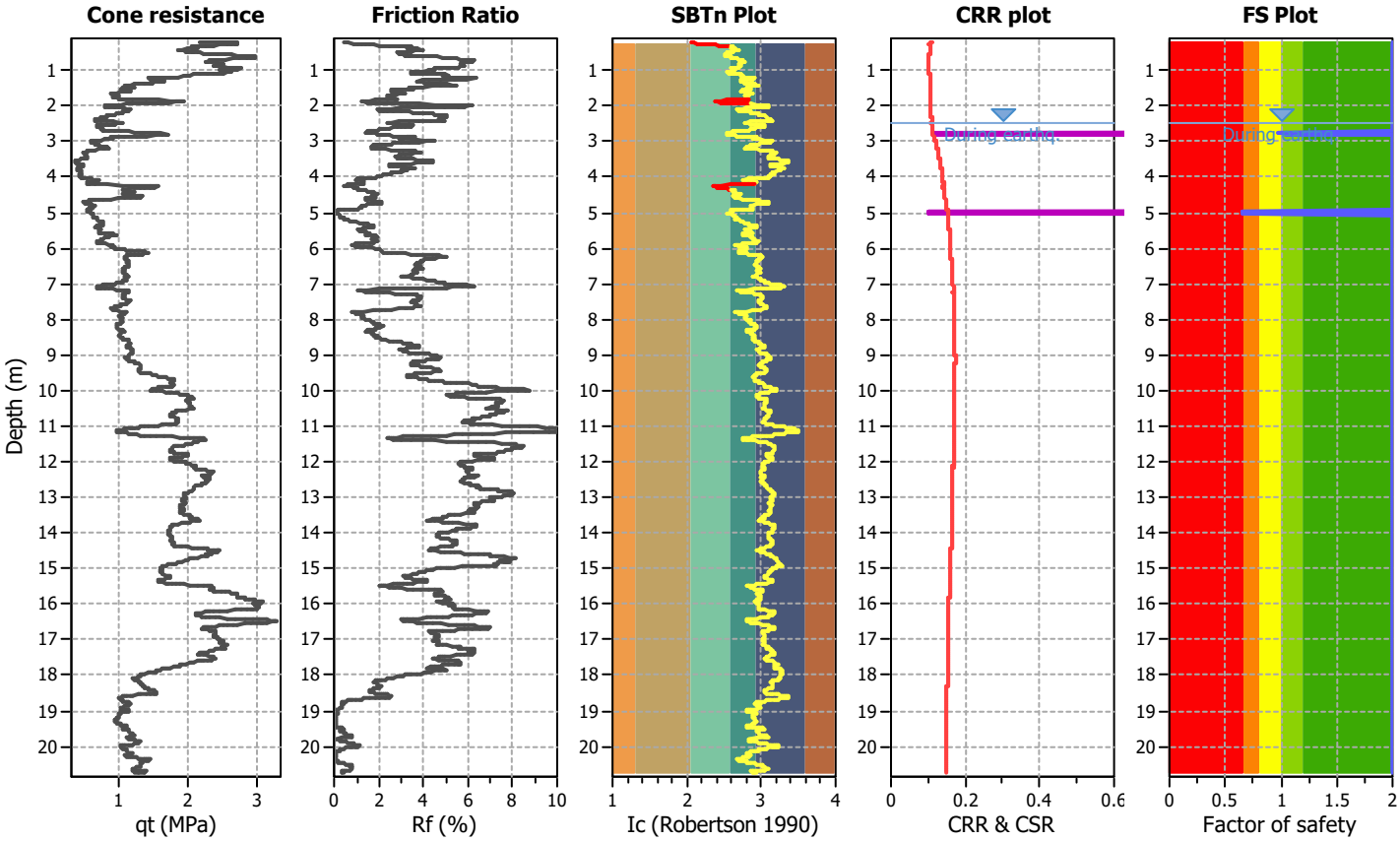
LIQUEFACTION ANALYSIS REPORT

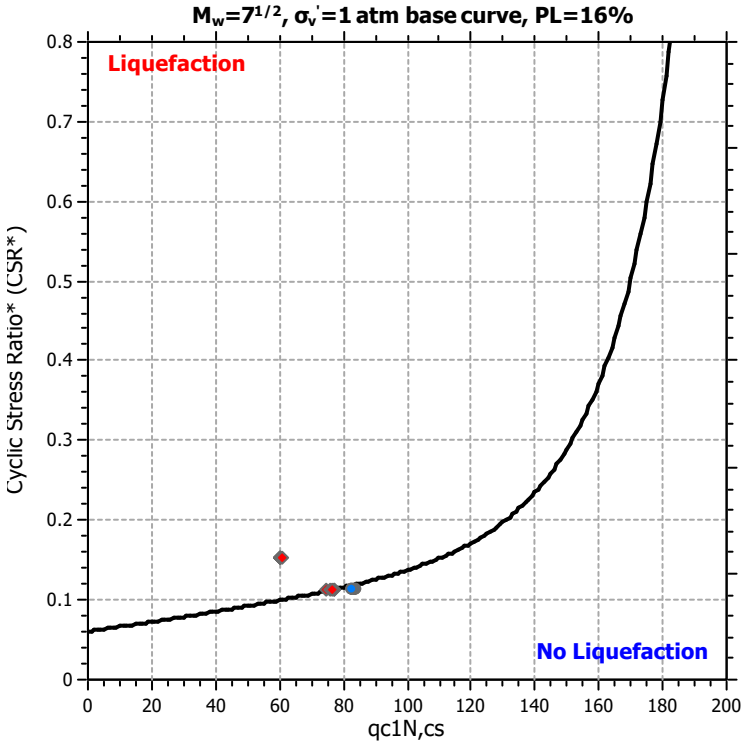
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

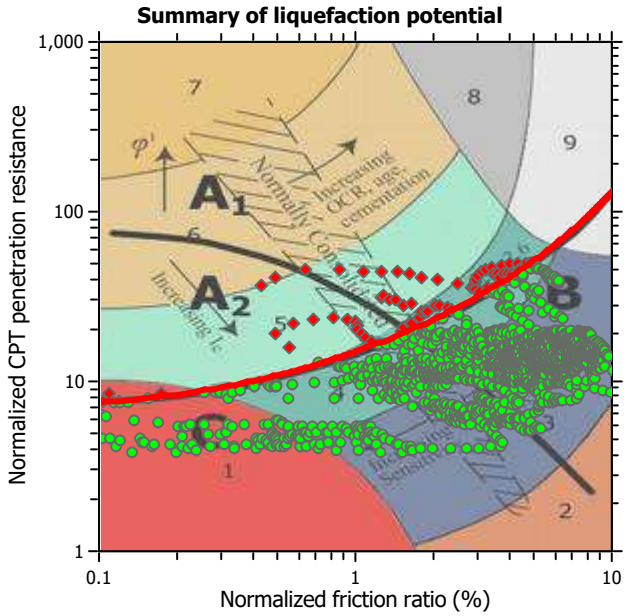
CPT file : CPTU5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

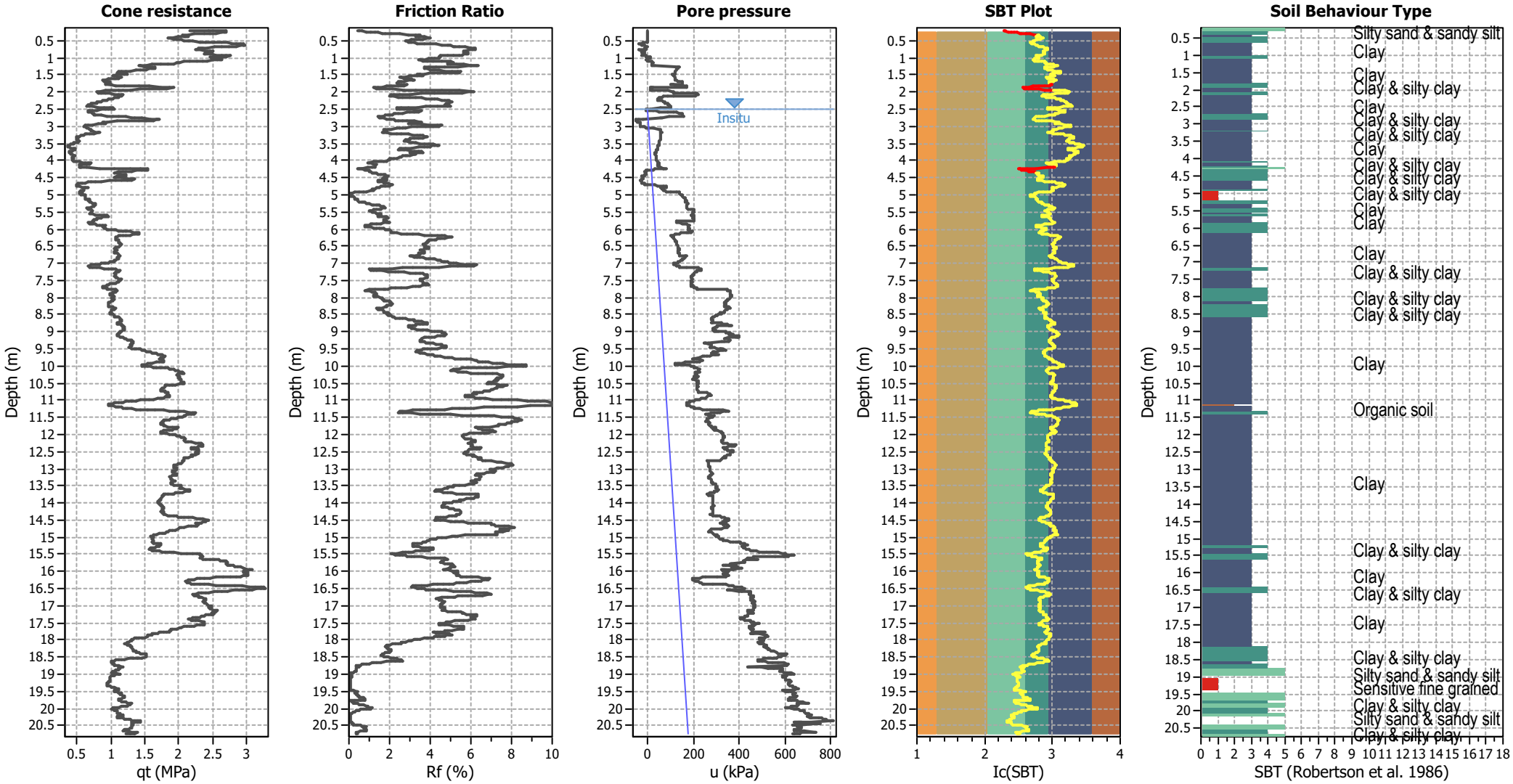






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



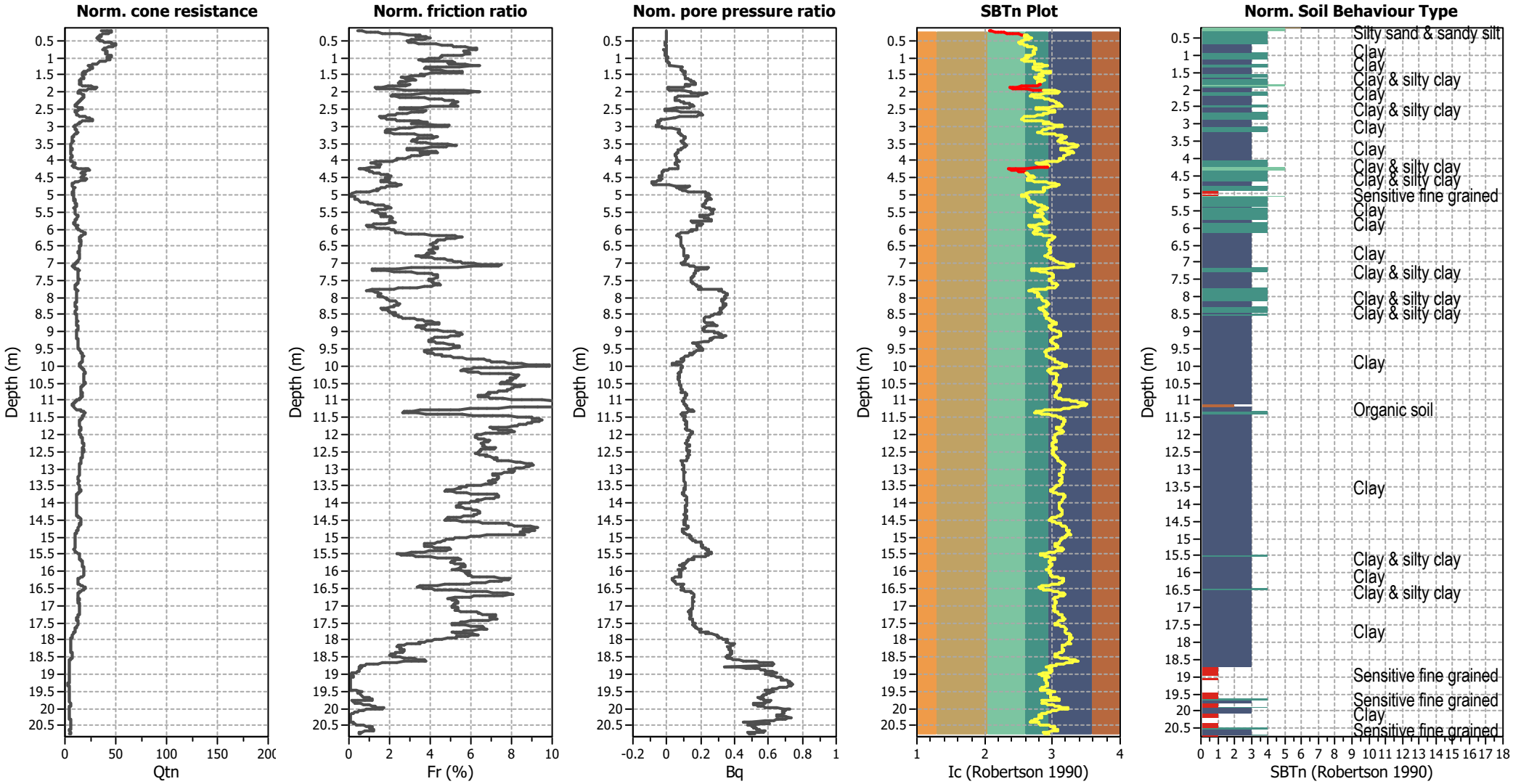
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



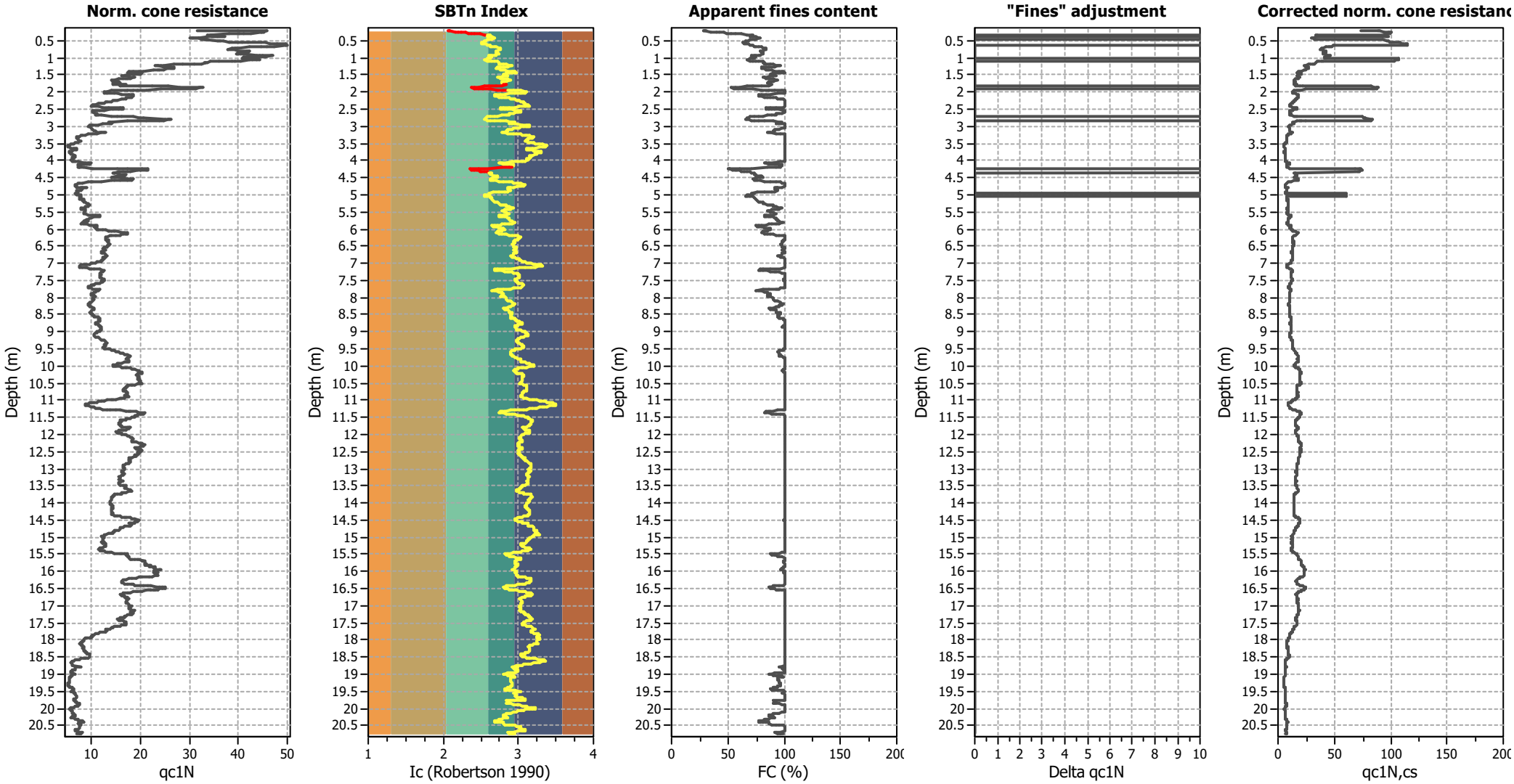
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

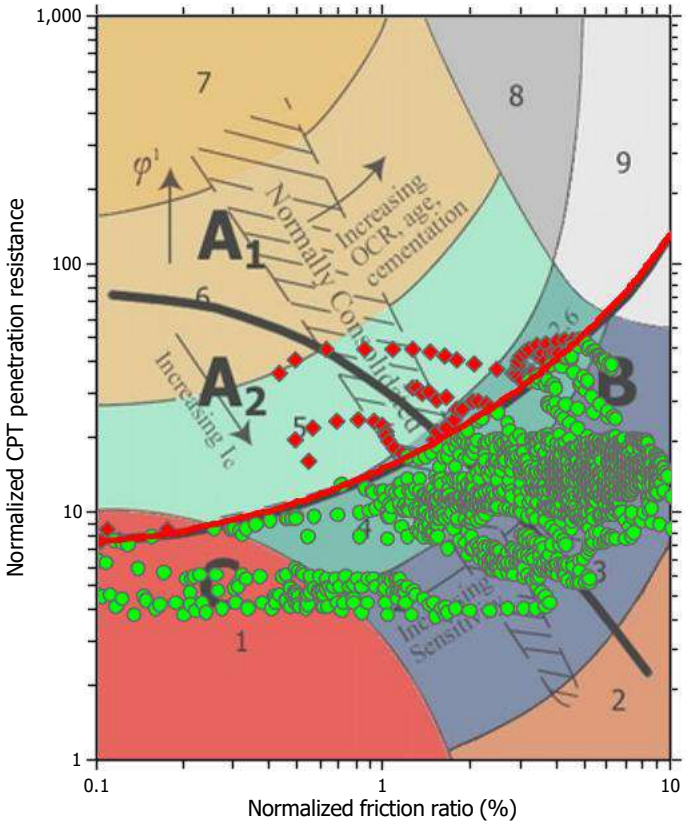
Liquefaction analysis overall plots (intermediate results)

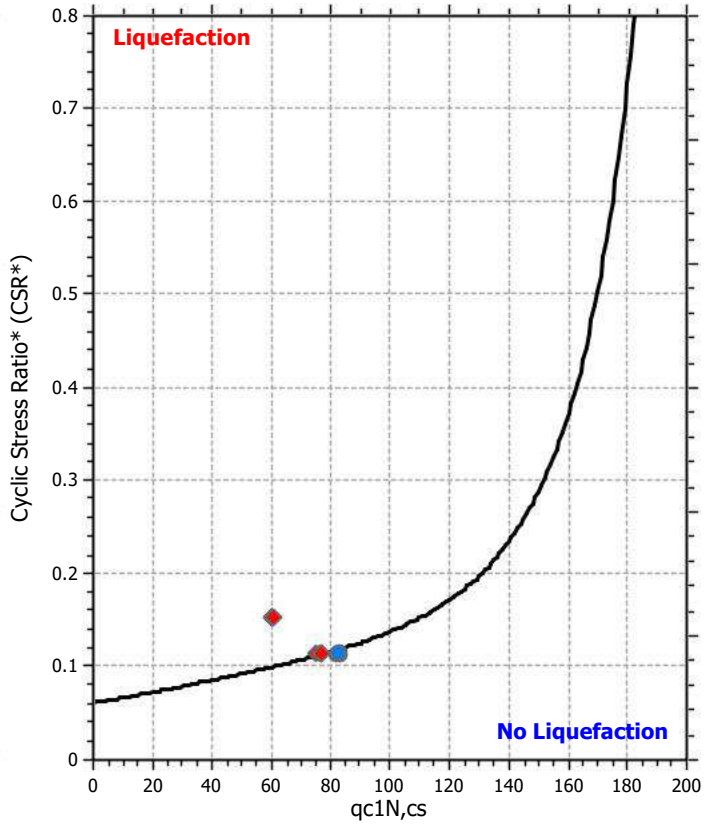


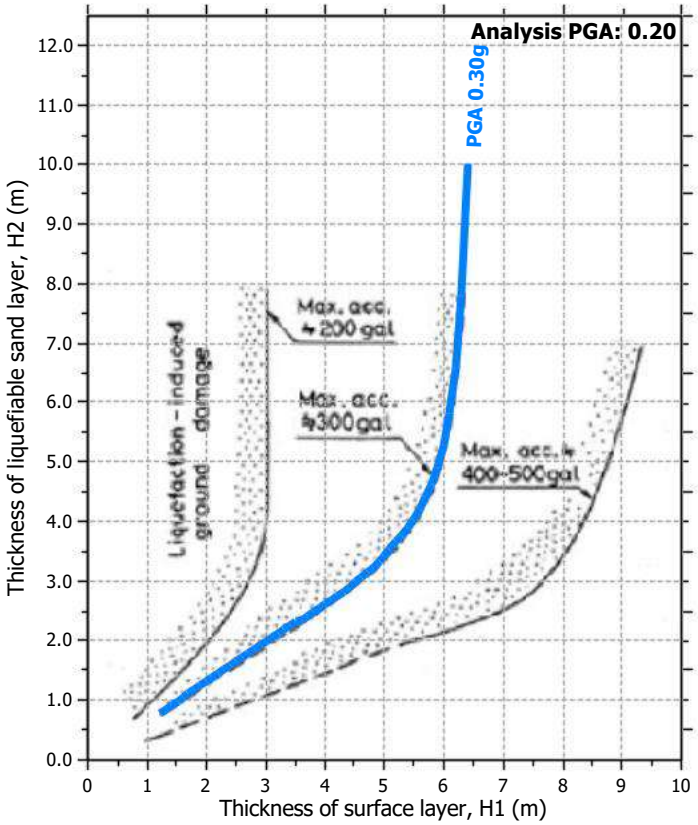
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



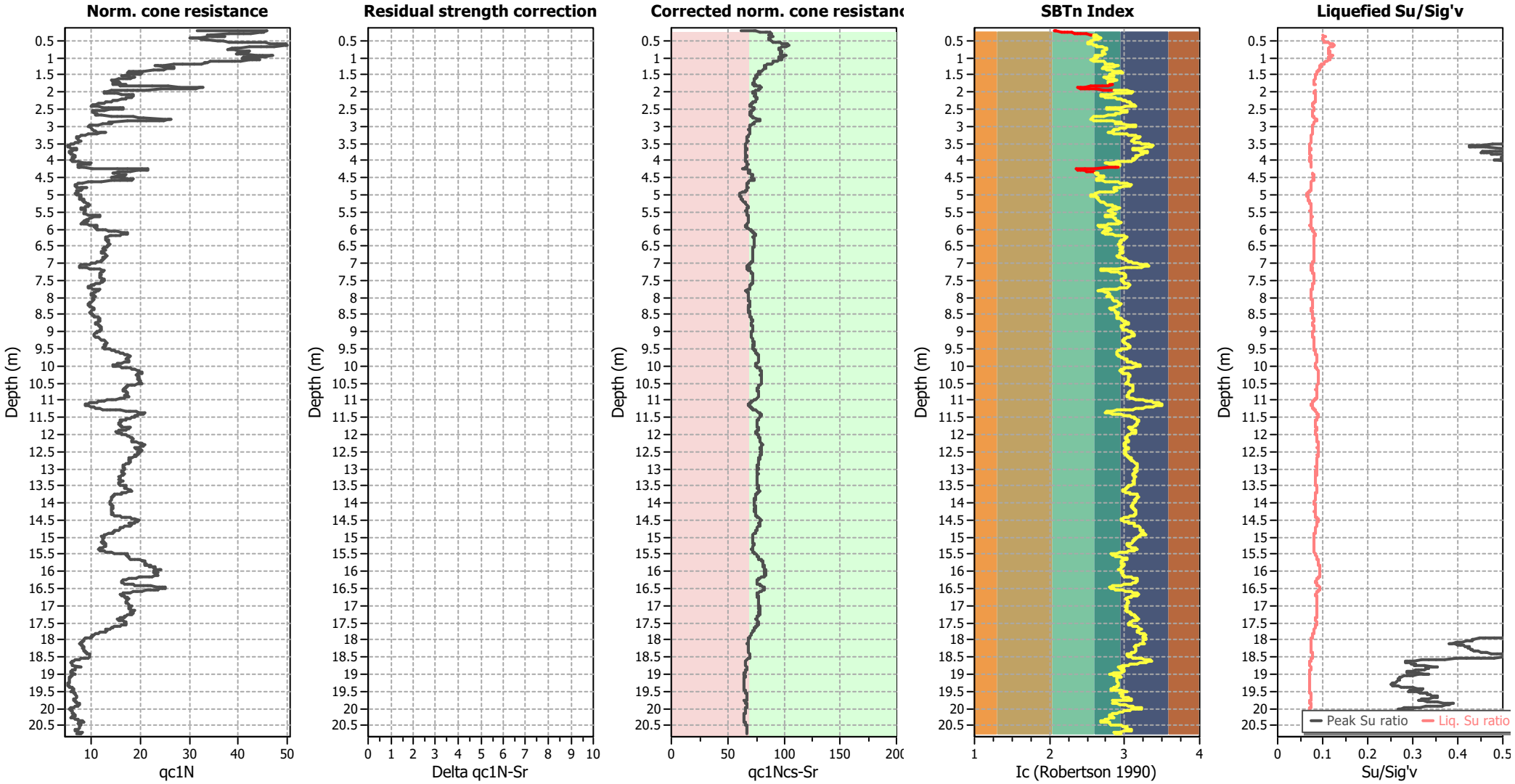




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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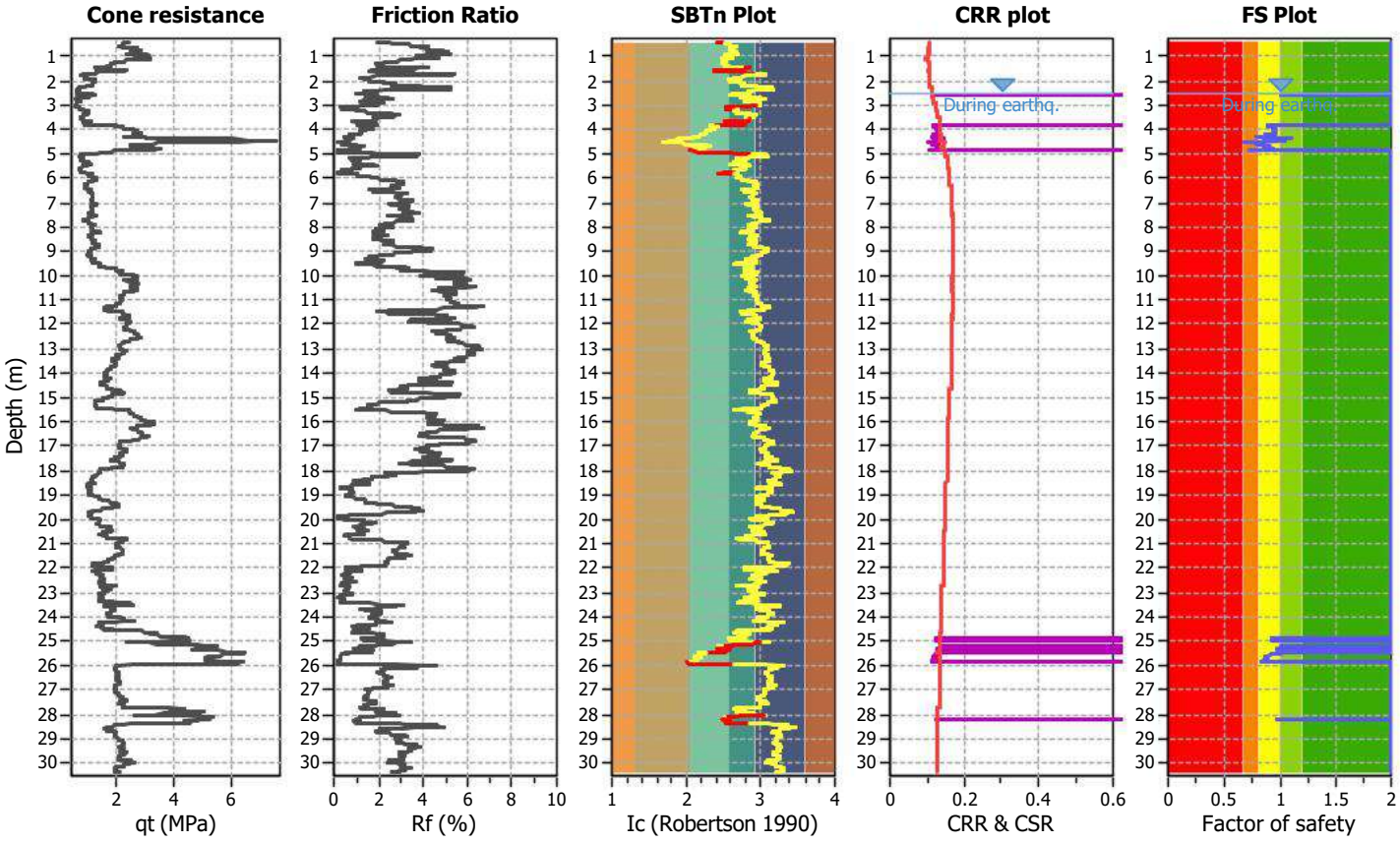
LIQUEFACTION ANALYSIS REPORT

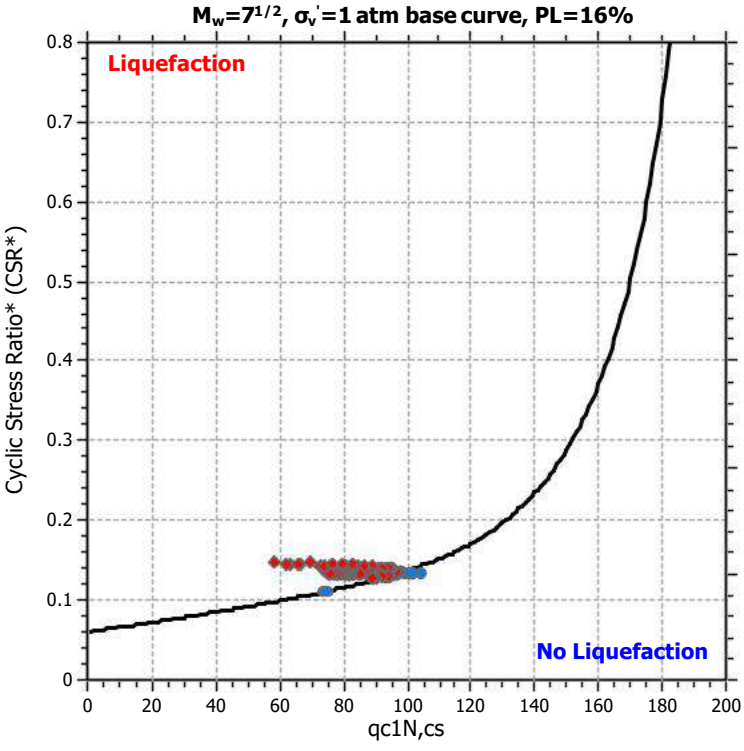
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

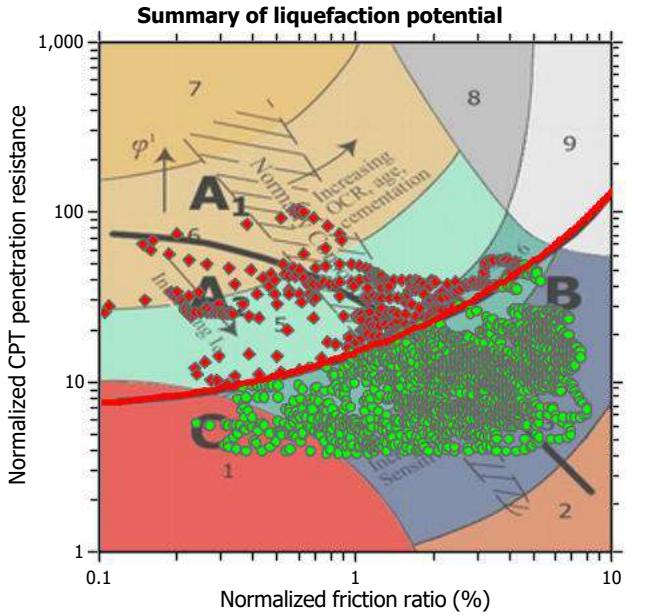
CPT file : CPTU3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

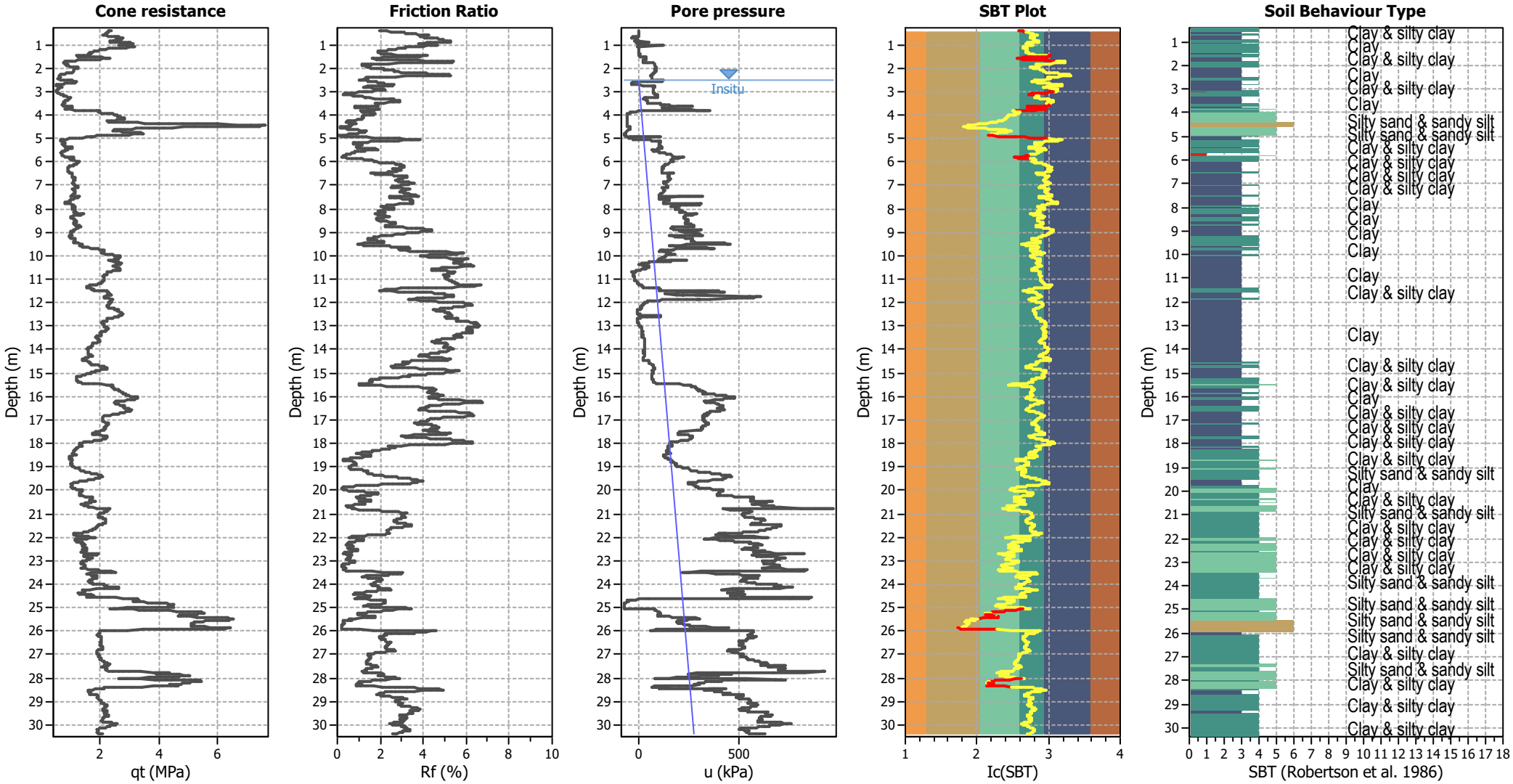






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



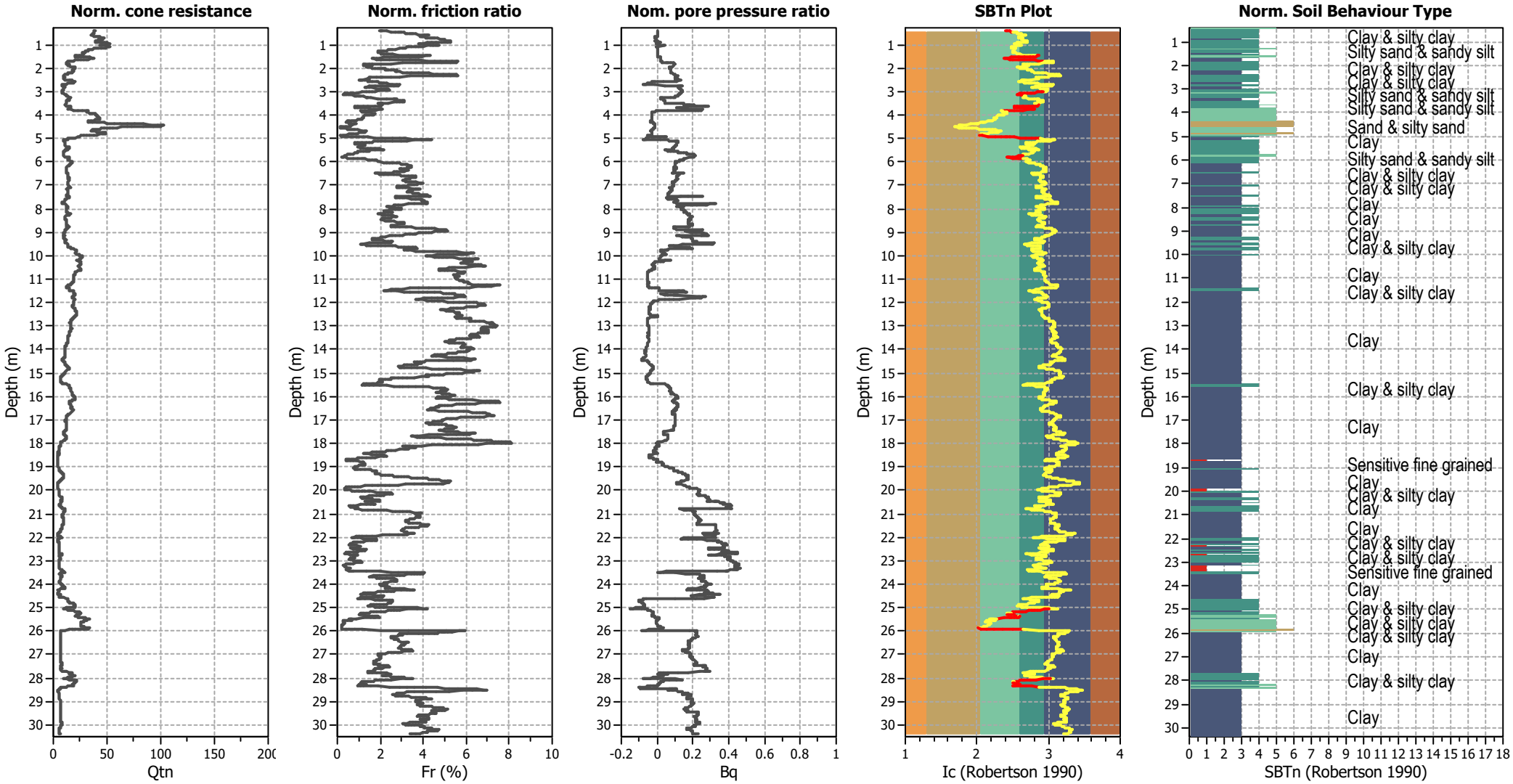
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



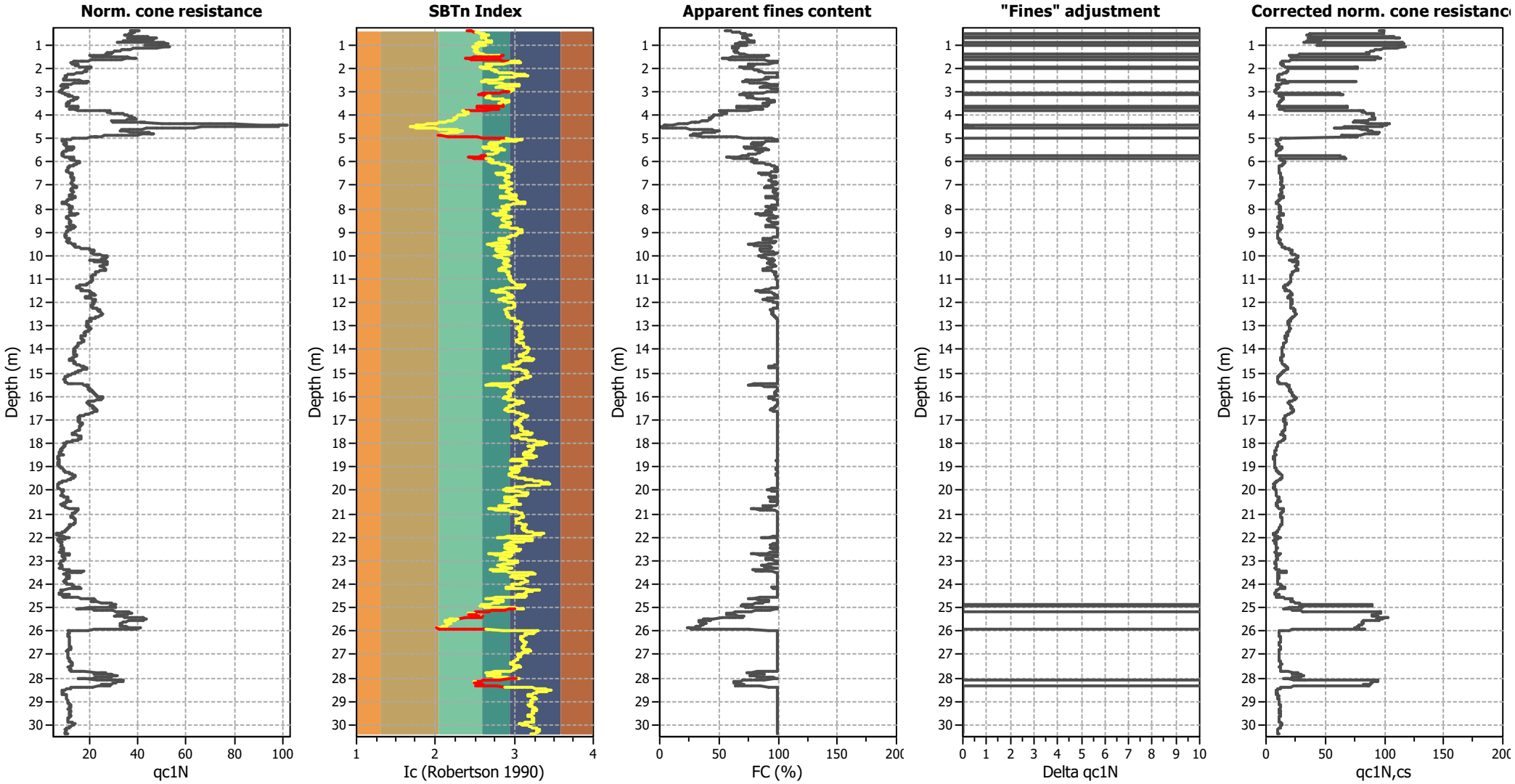
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

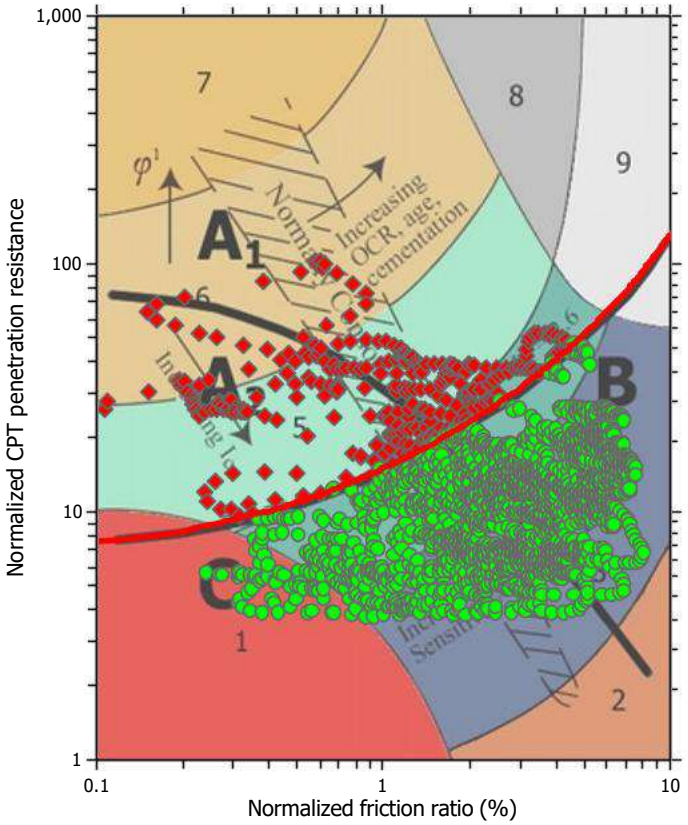
Liquefaction analysis overall plots (intermediate results)

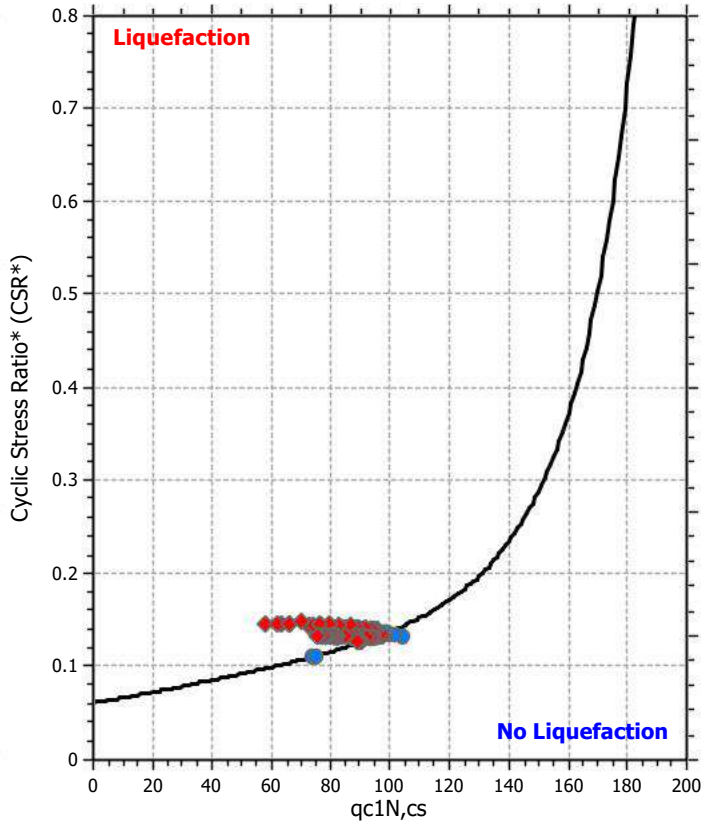


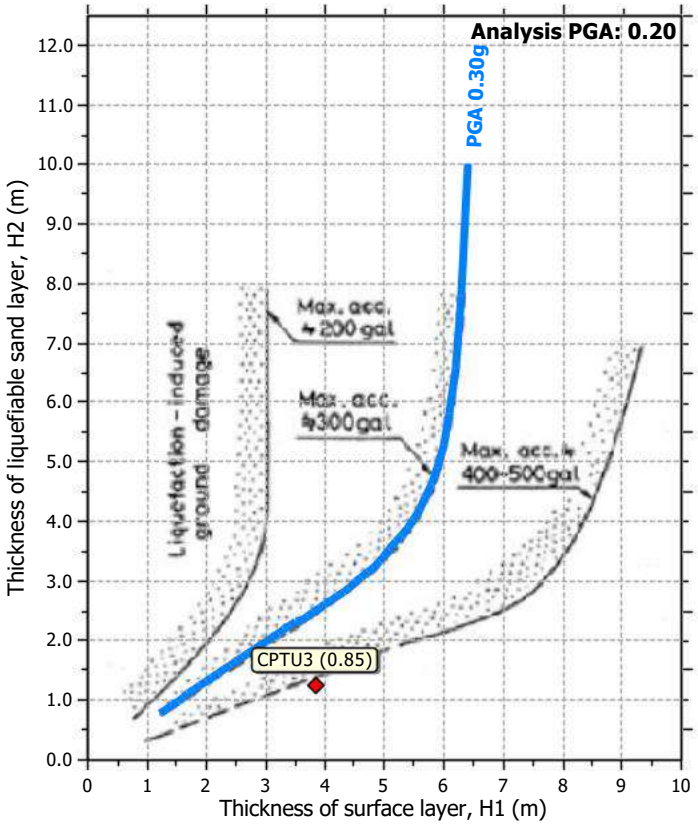
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



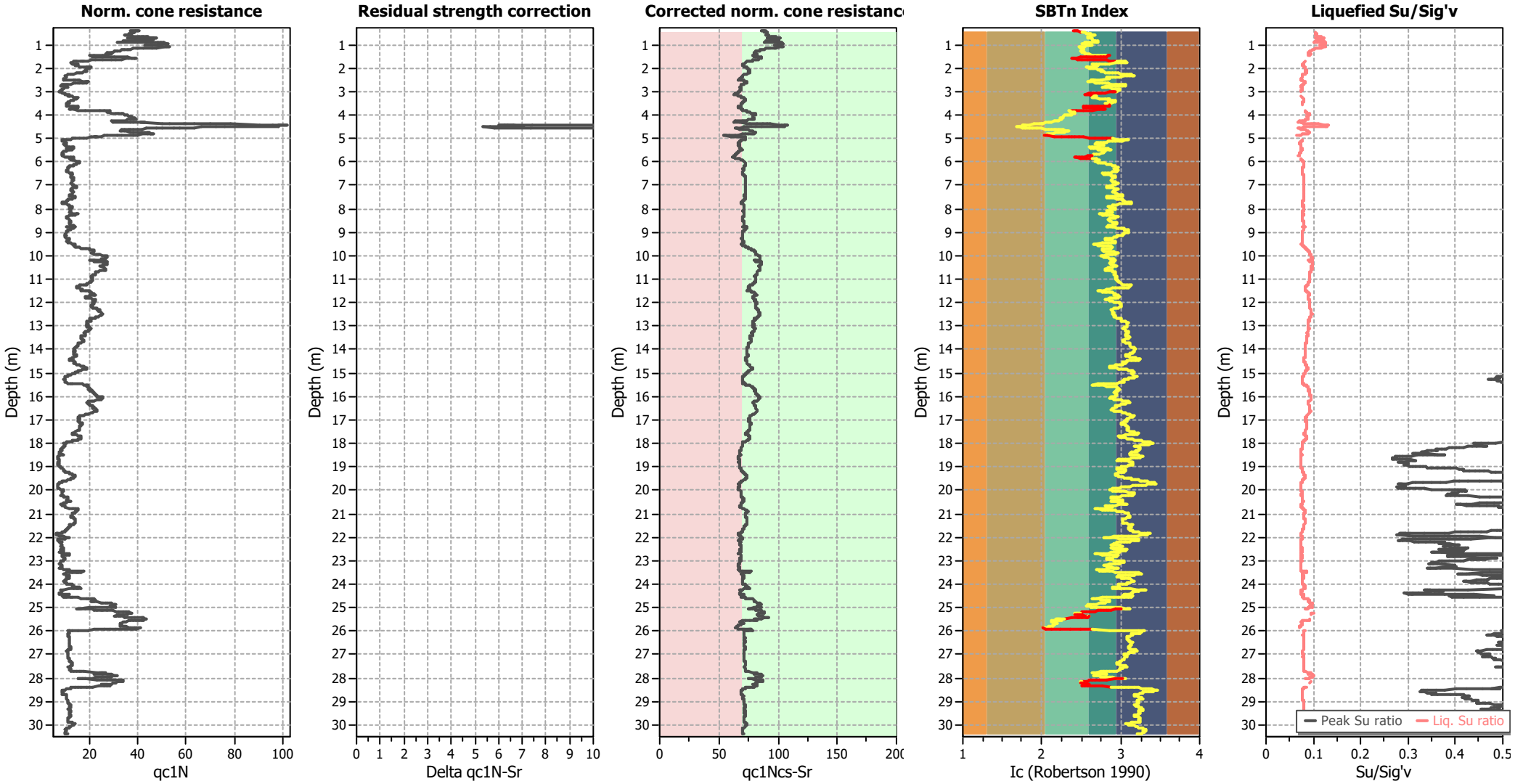




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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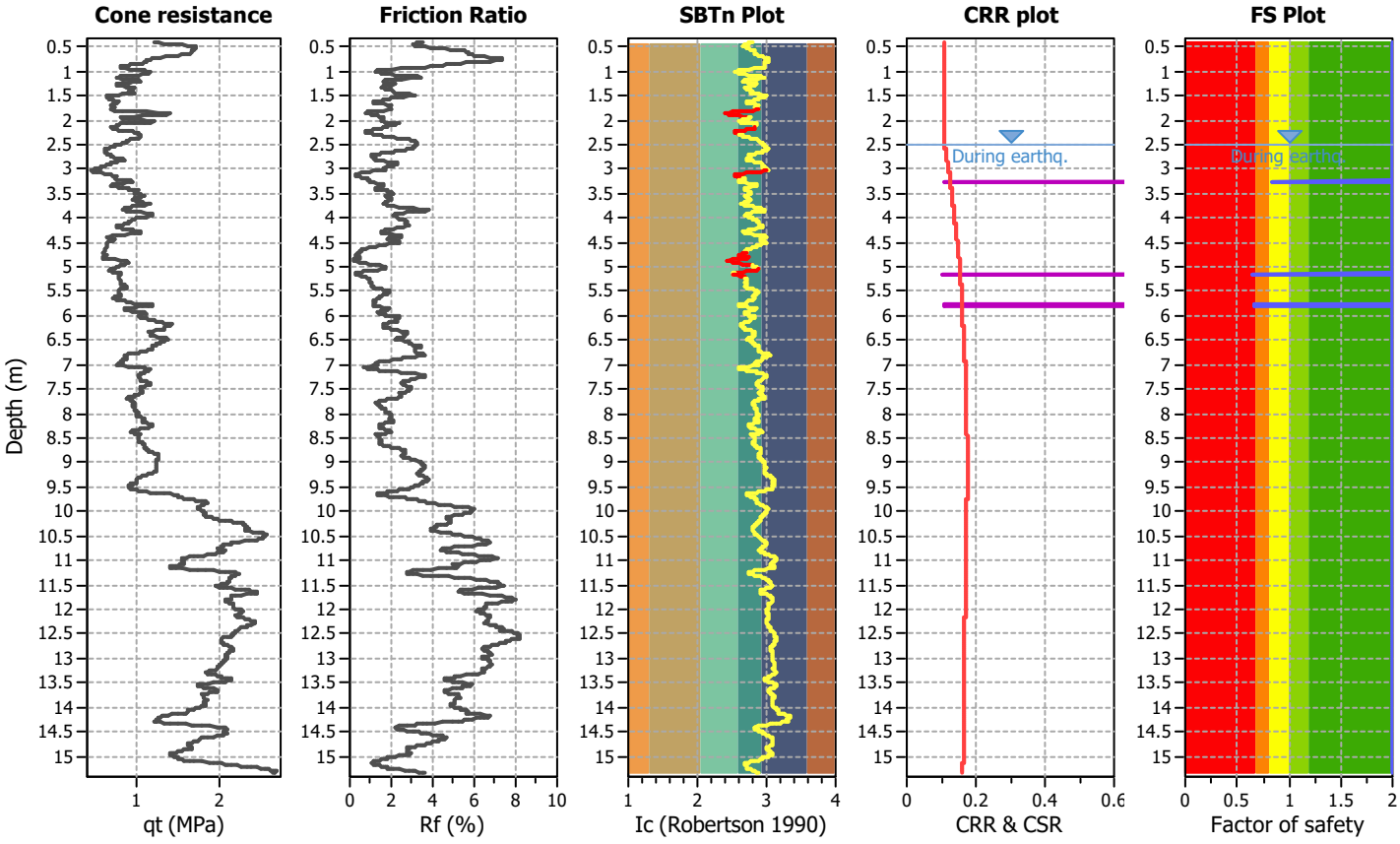
LIQUEFACTION ANALYSIS REPORT

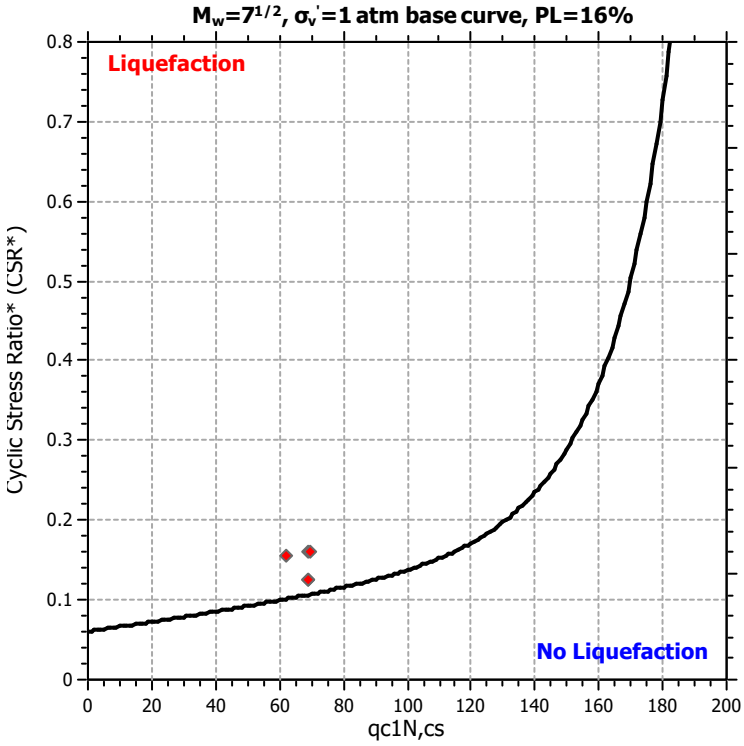
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

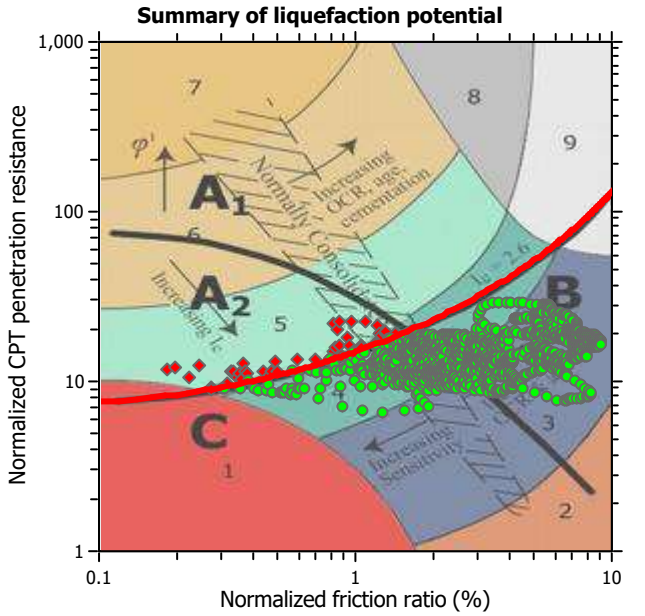
CPT file : CPTU6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

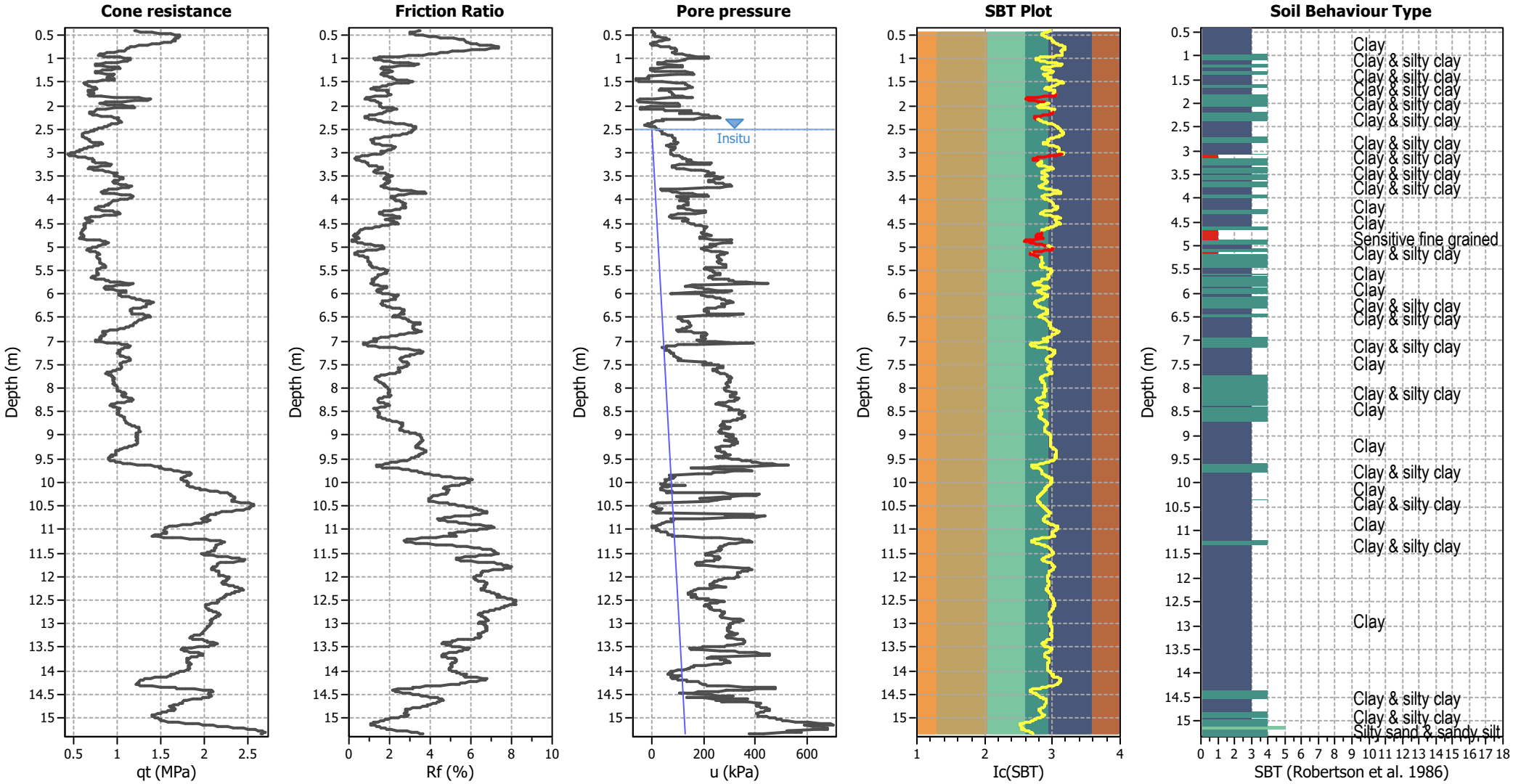






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



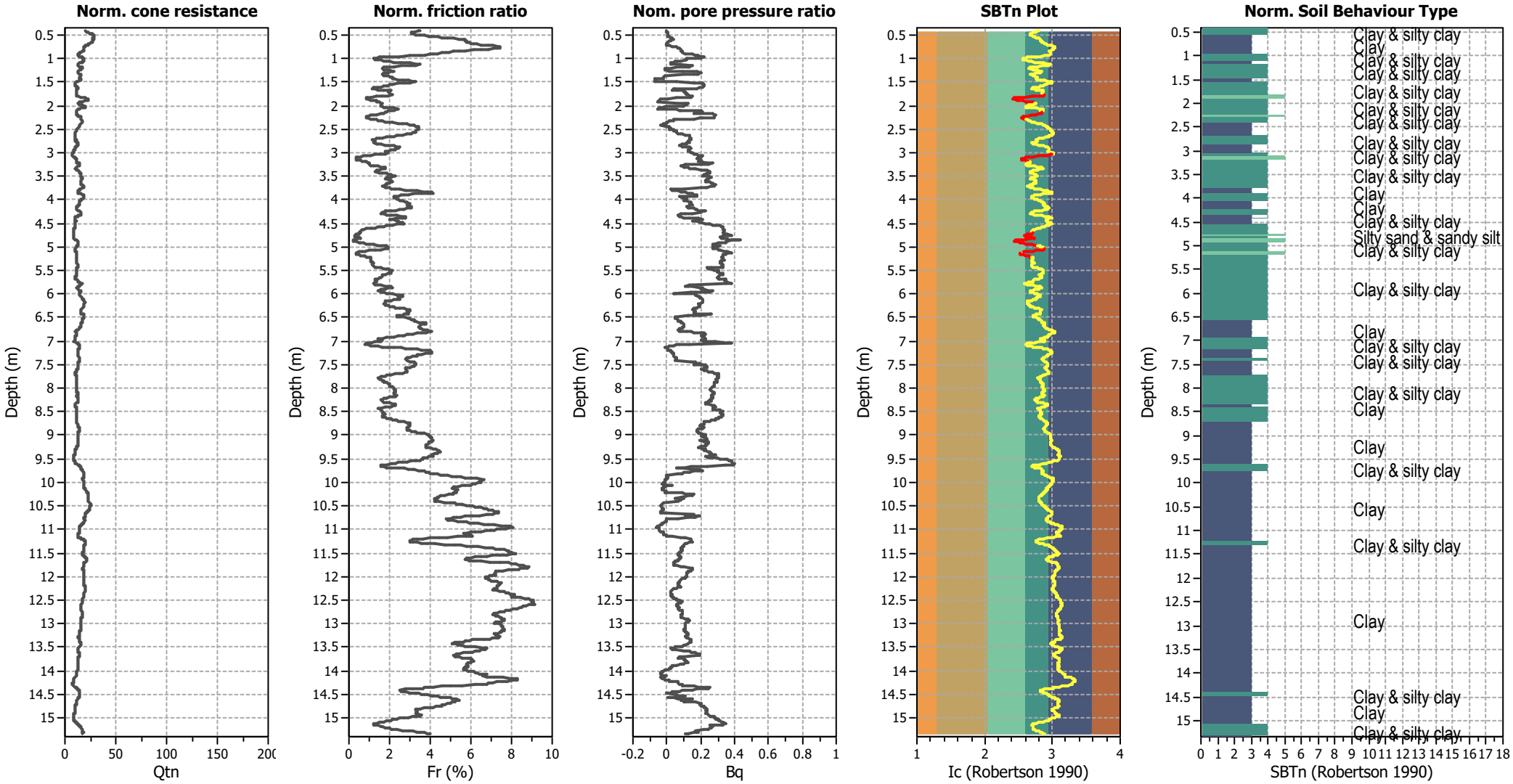
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



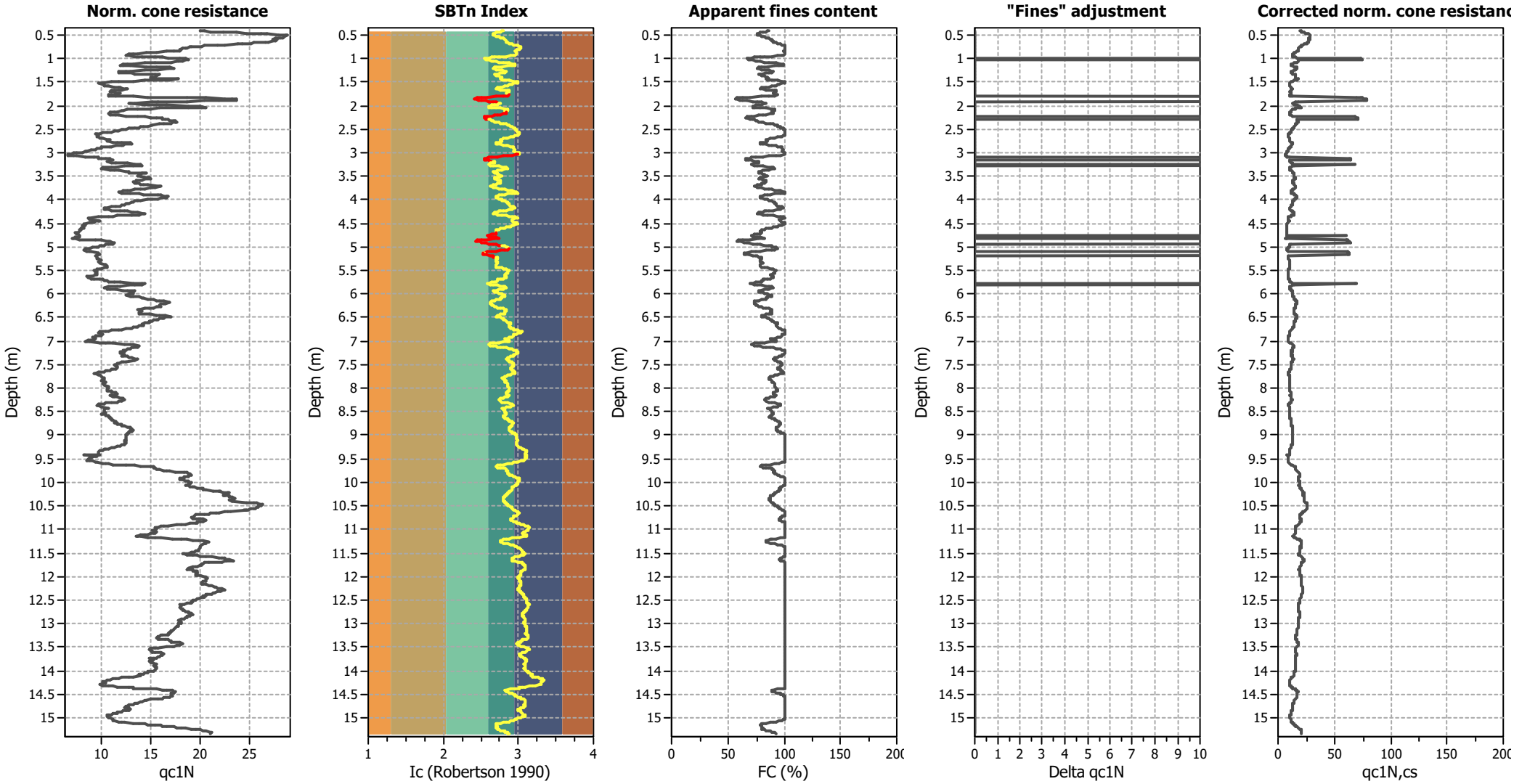
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

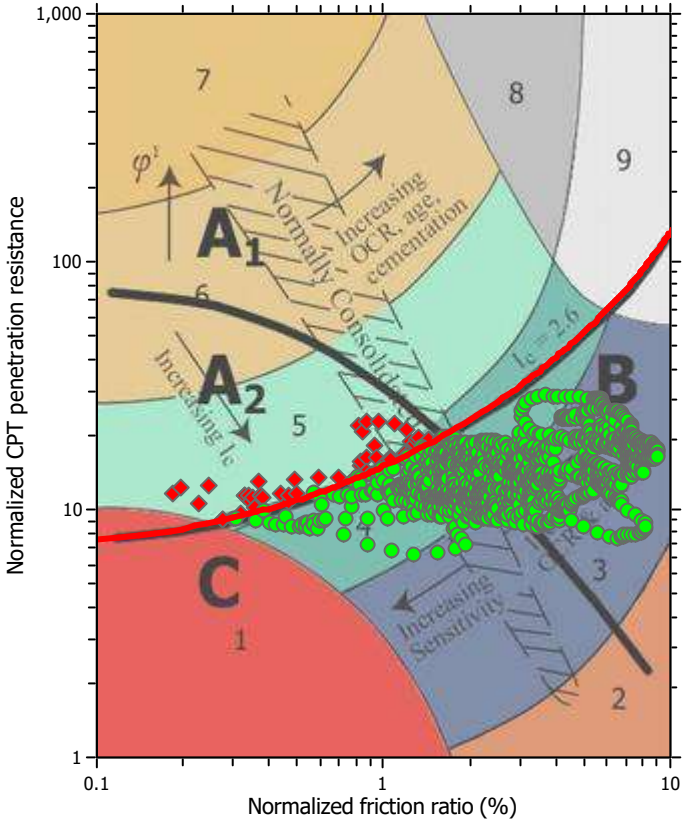
Liquefaction analysis overall plots (intermediate results)

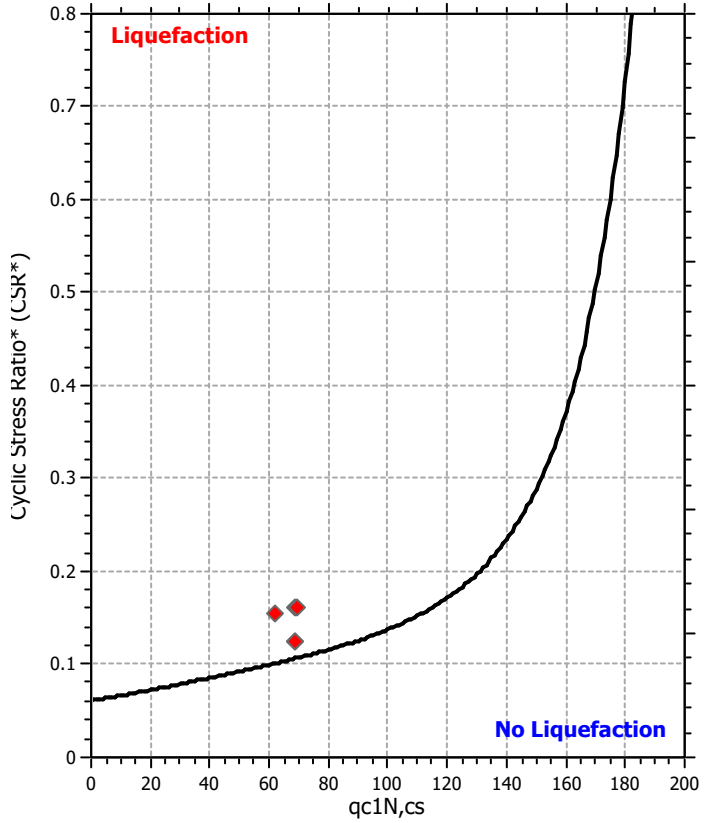


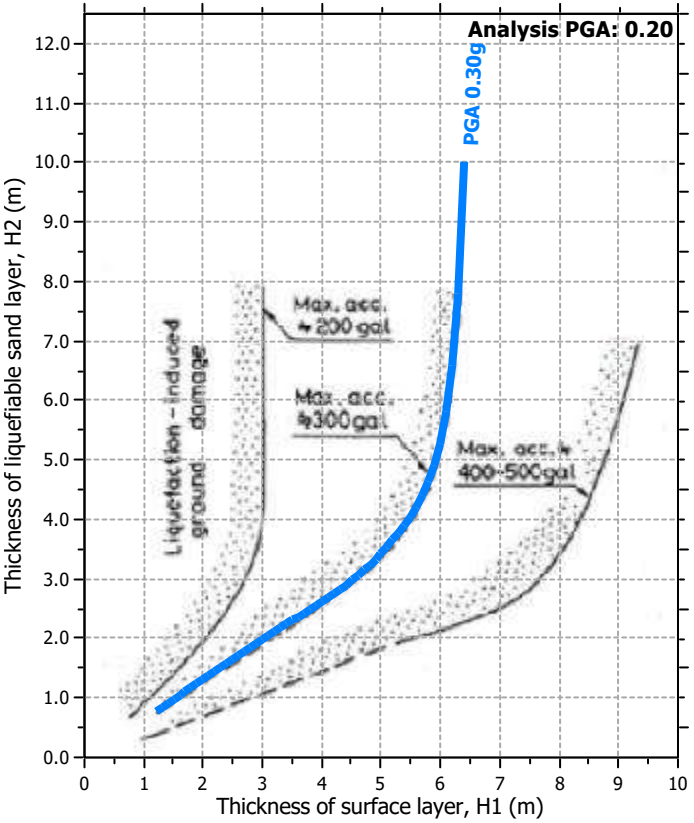
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



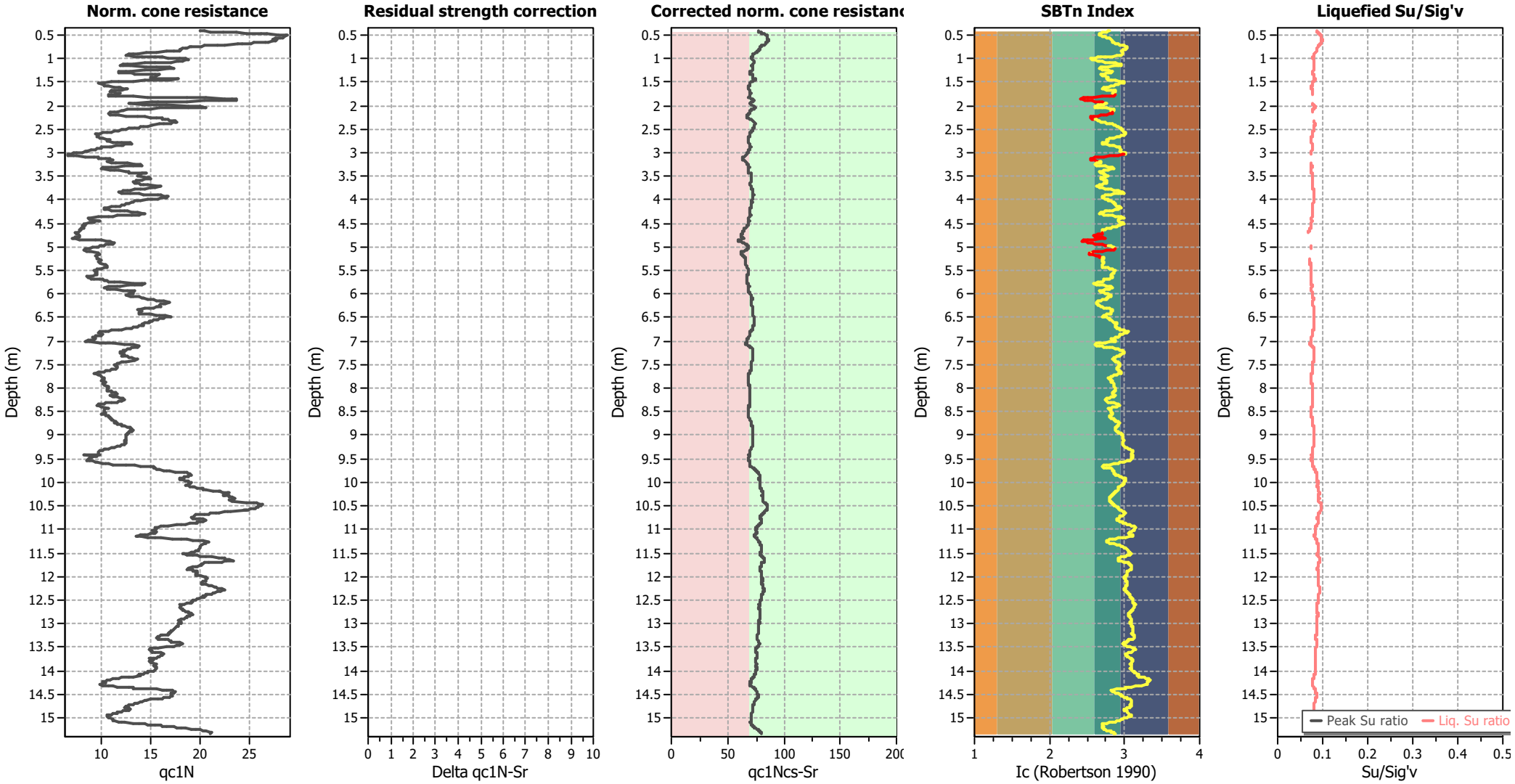




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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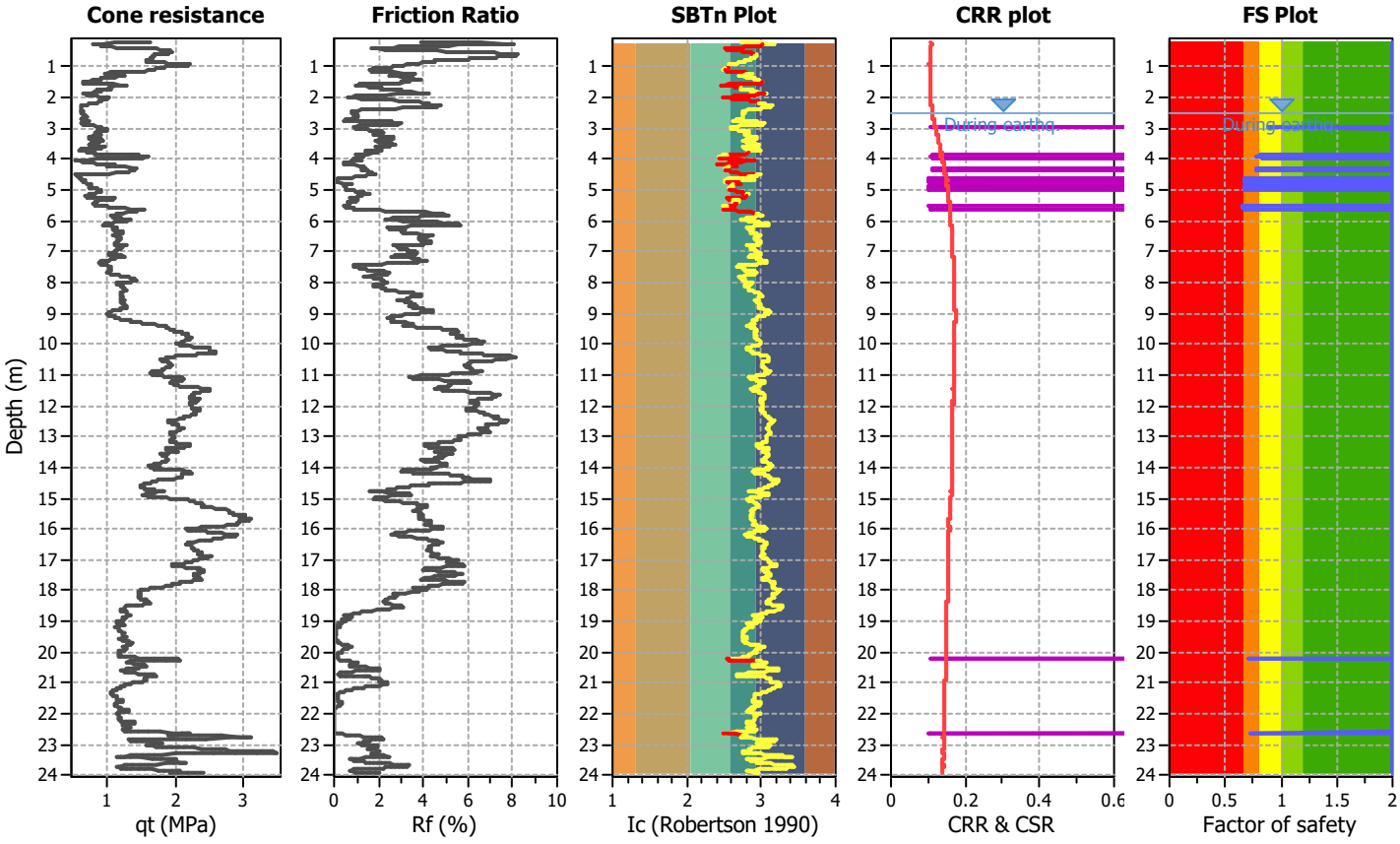
LIQUEFACTION ANALYSIS REPORT

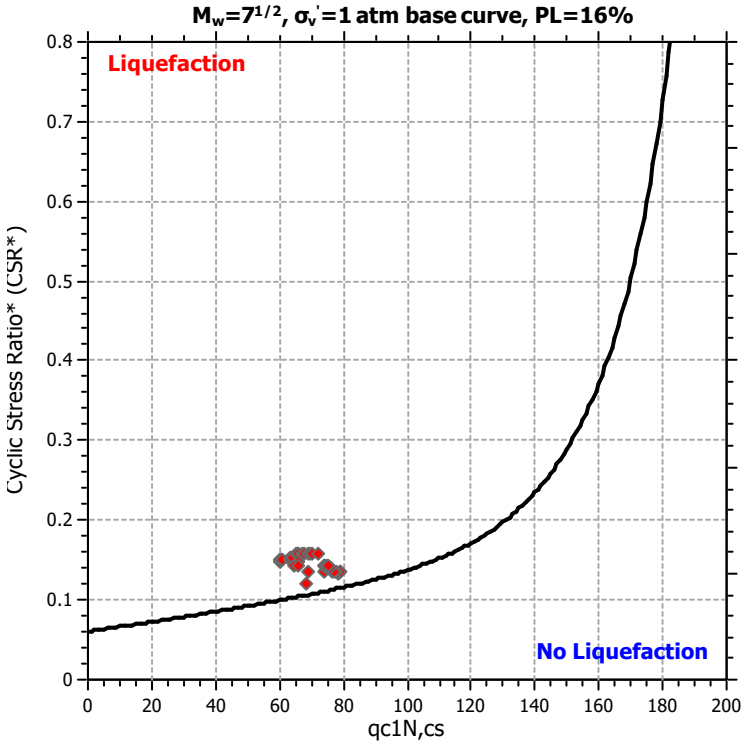
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

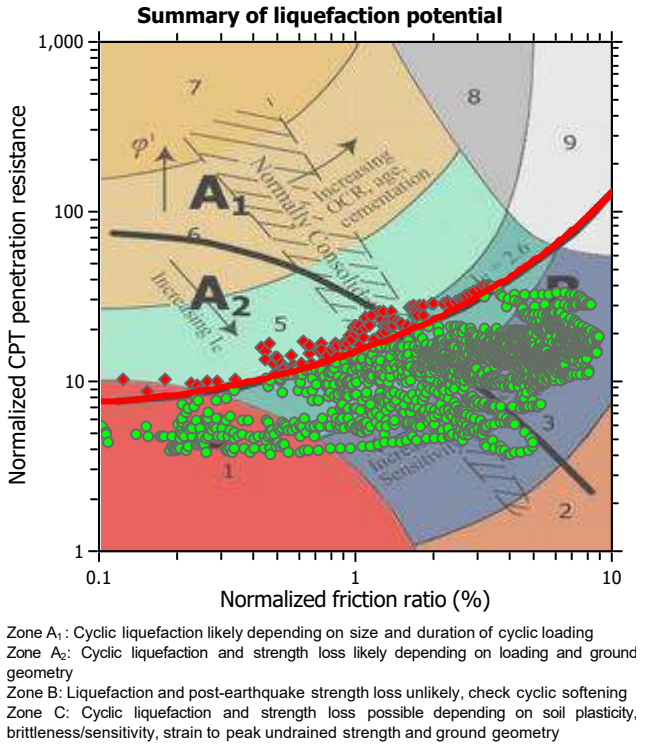
CPT file : CPTU7

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

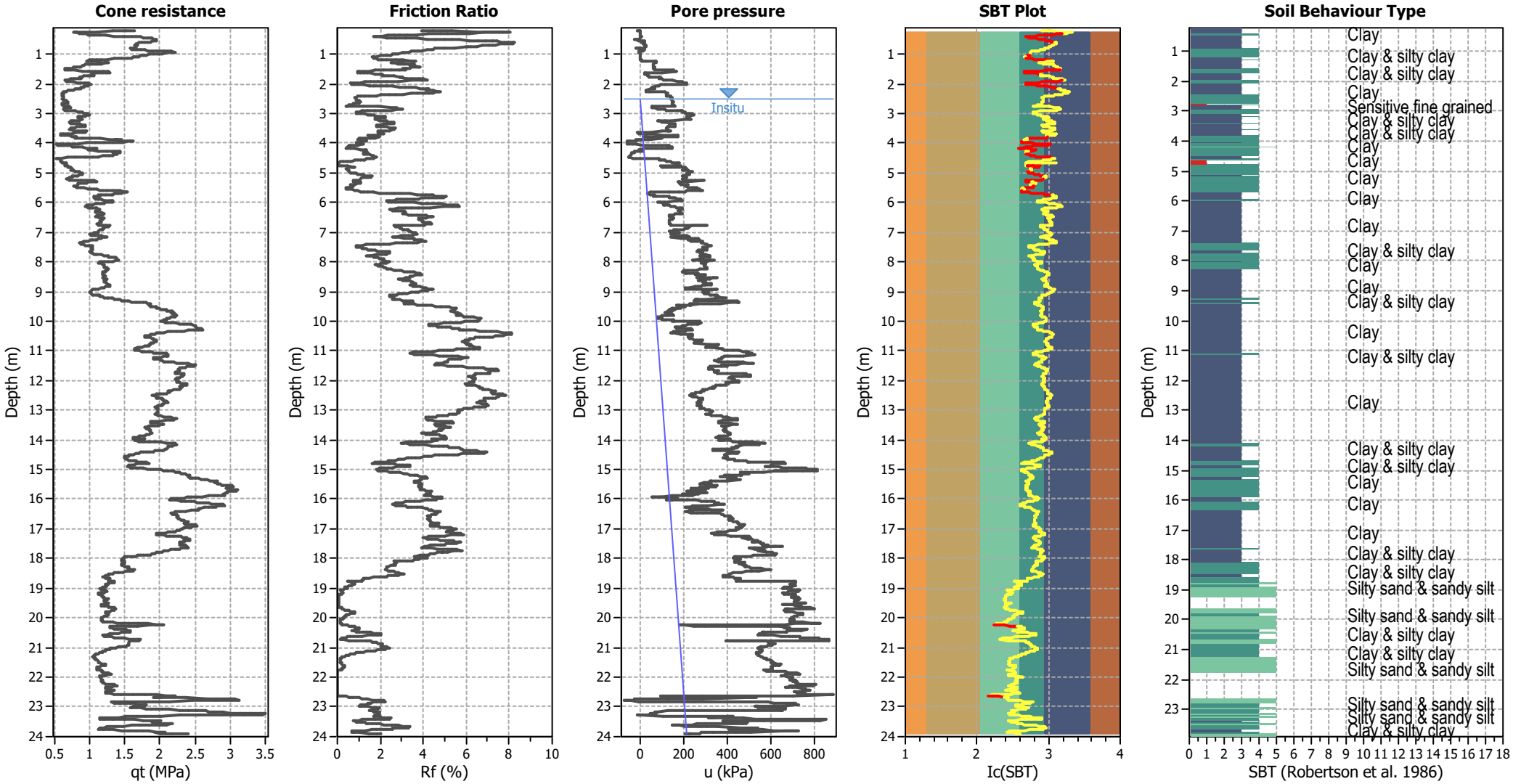






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



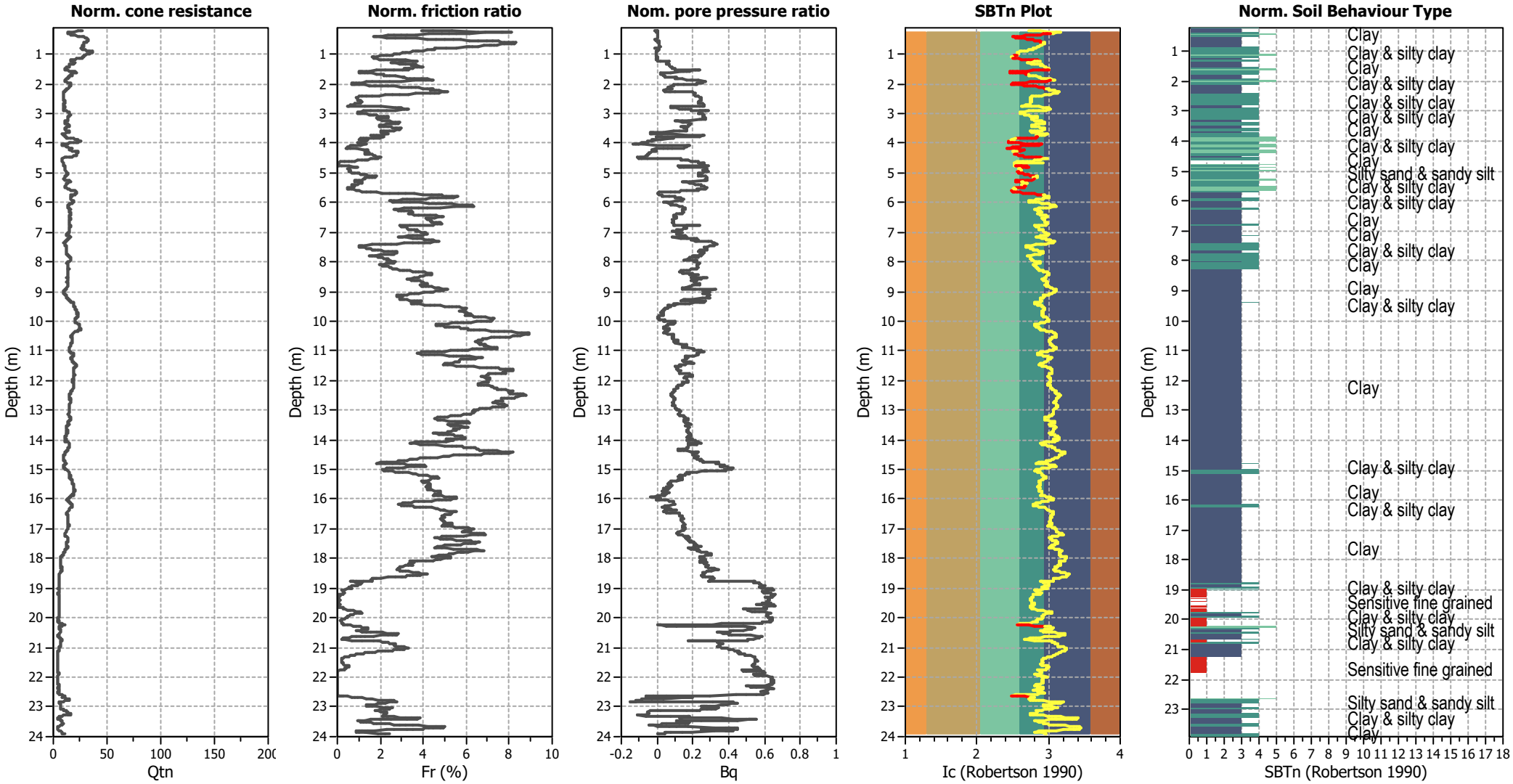
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



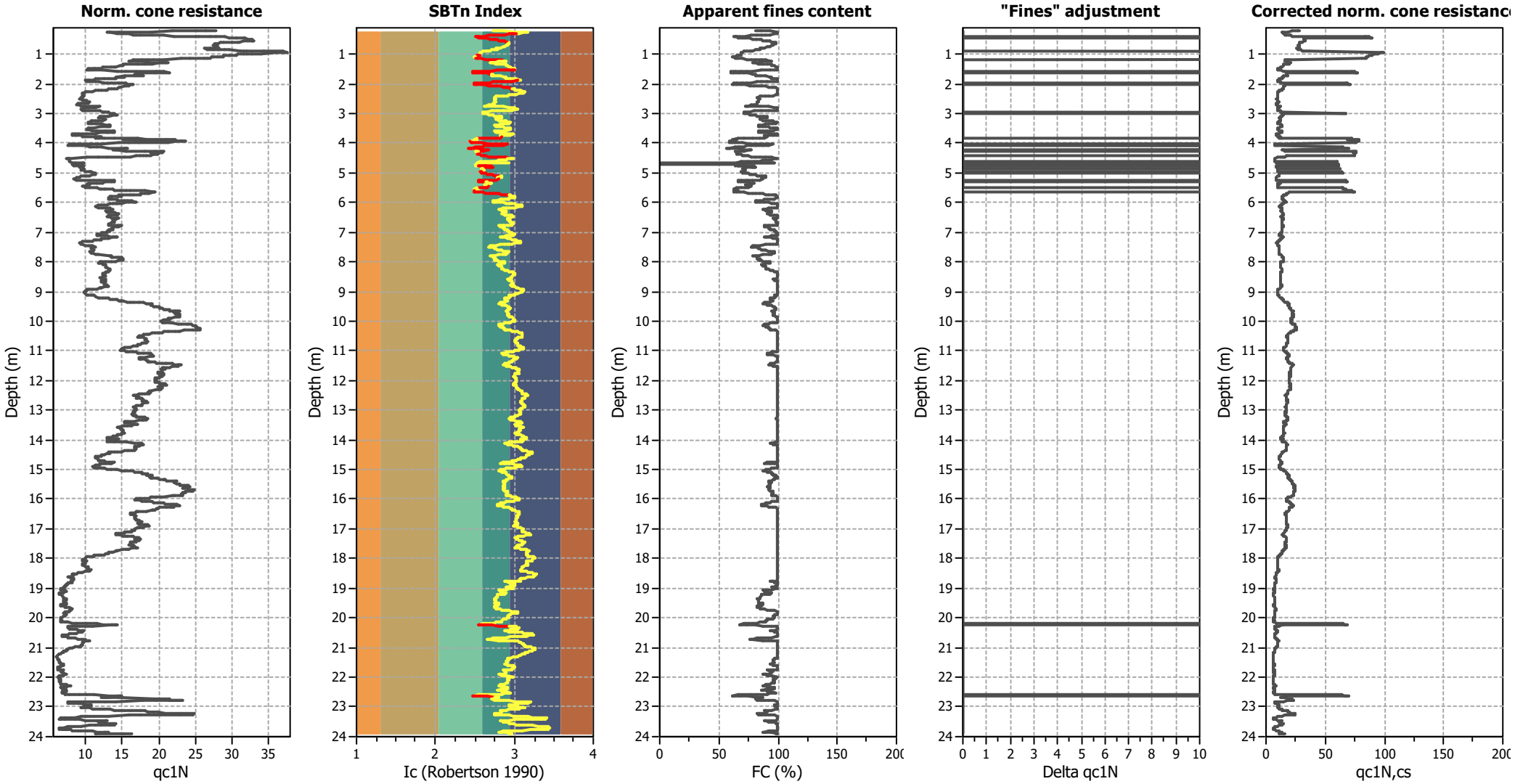
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

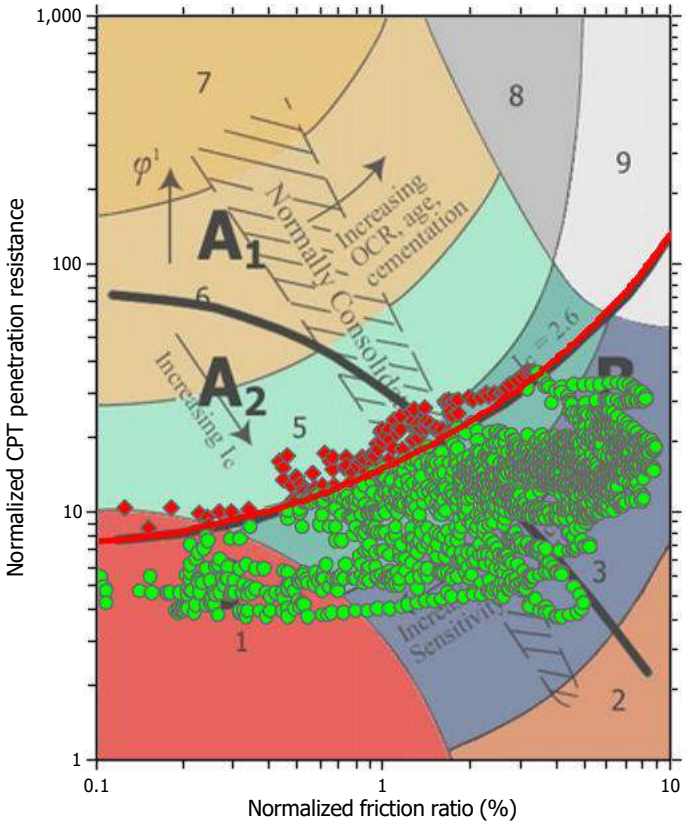
Liquefaction analysis overall plots (intermediate results)

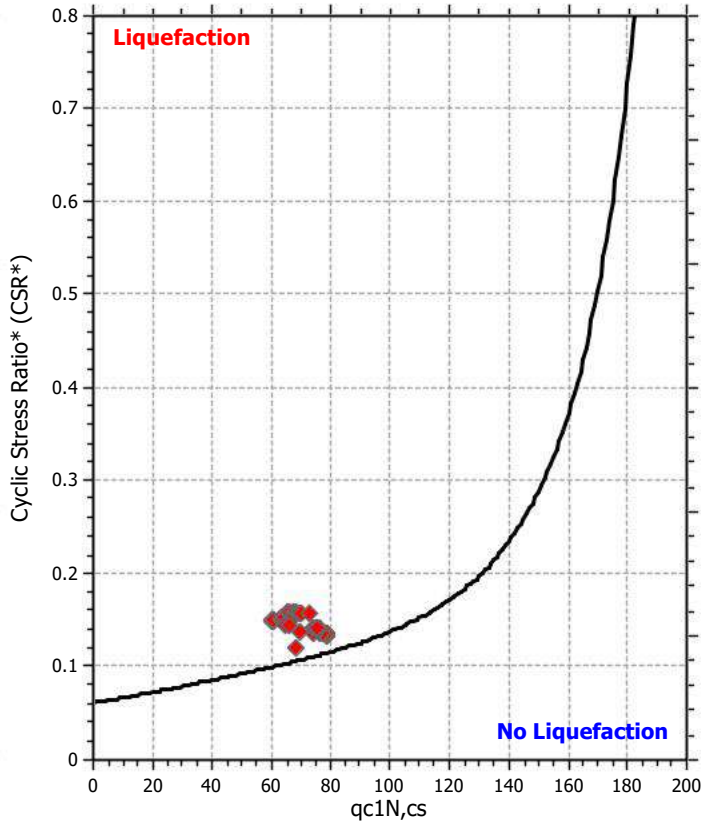


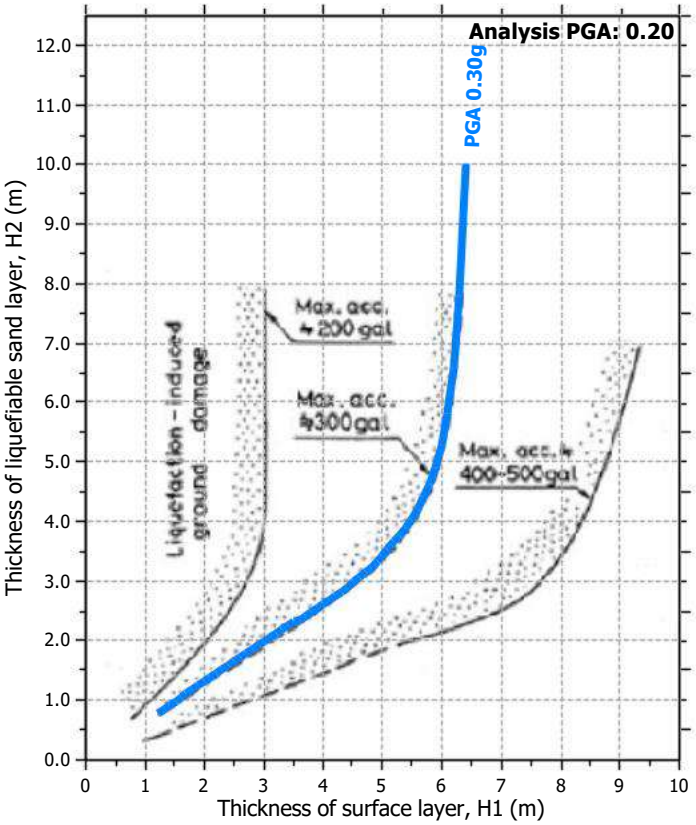
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



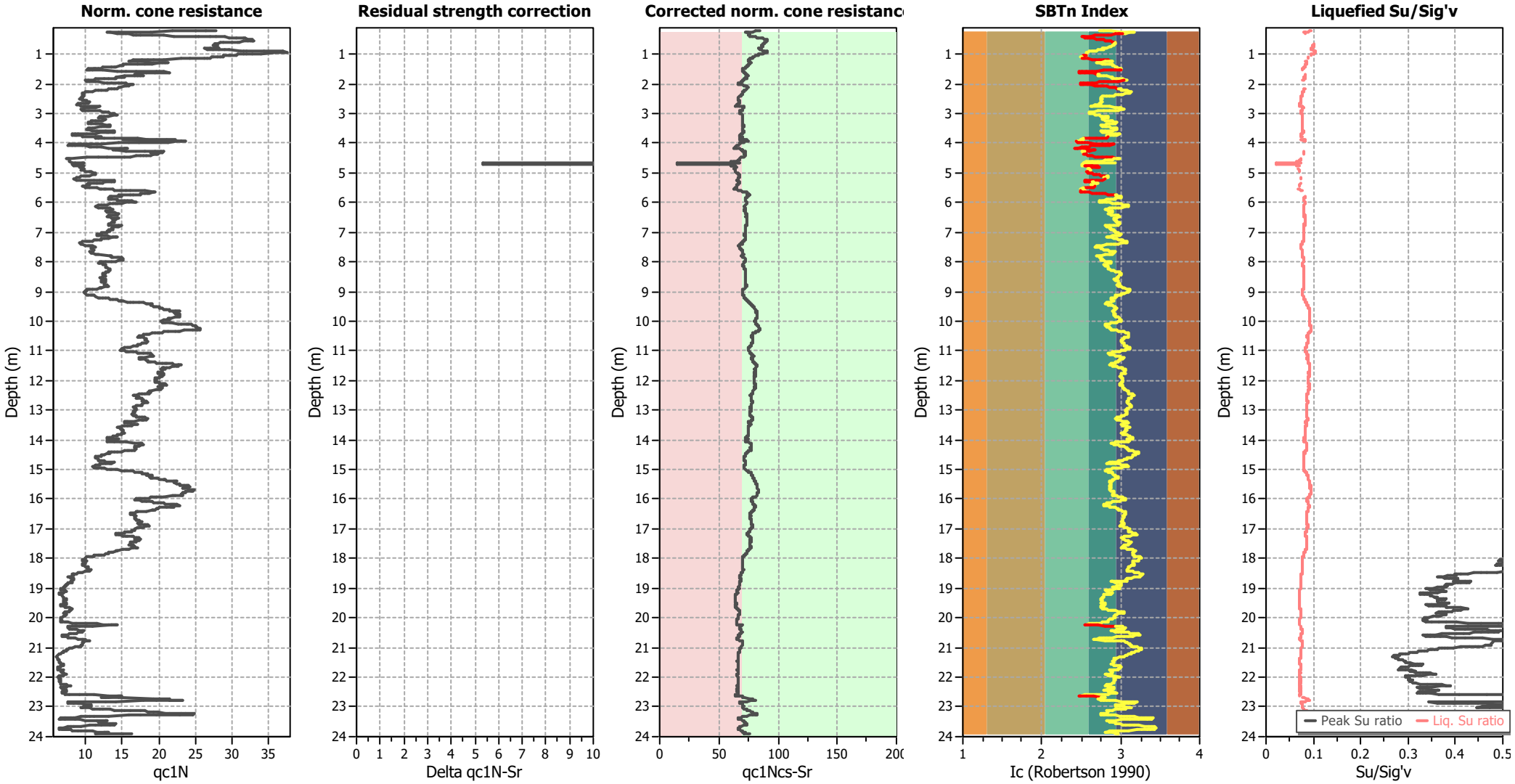




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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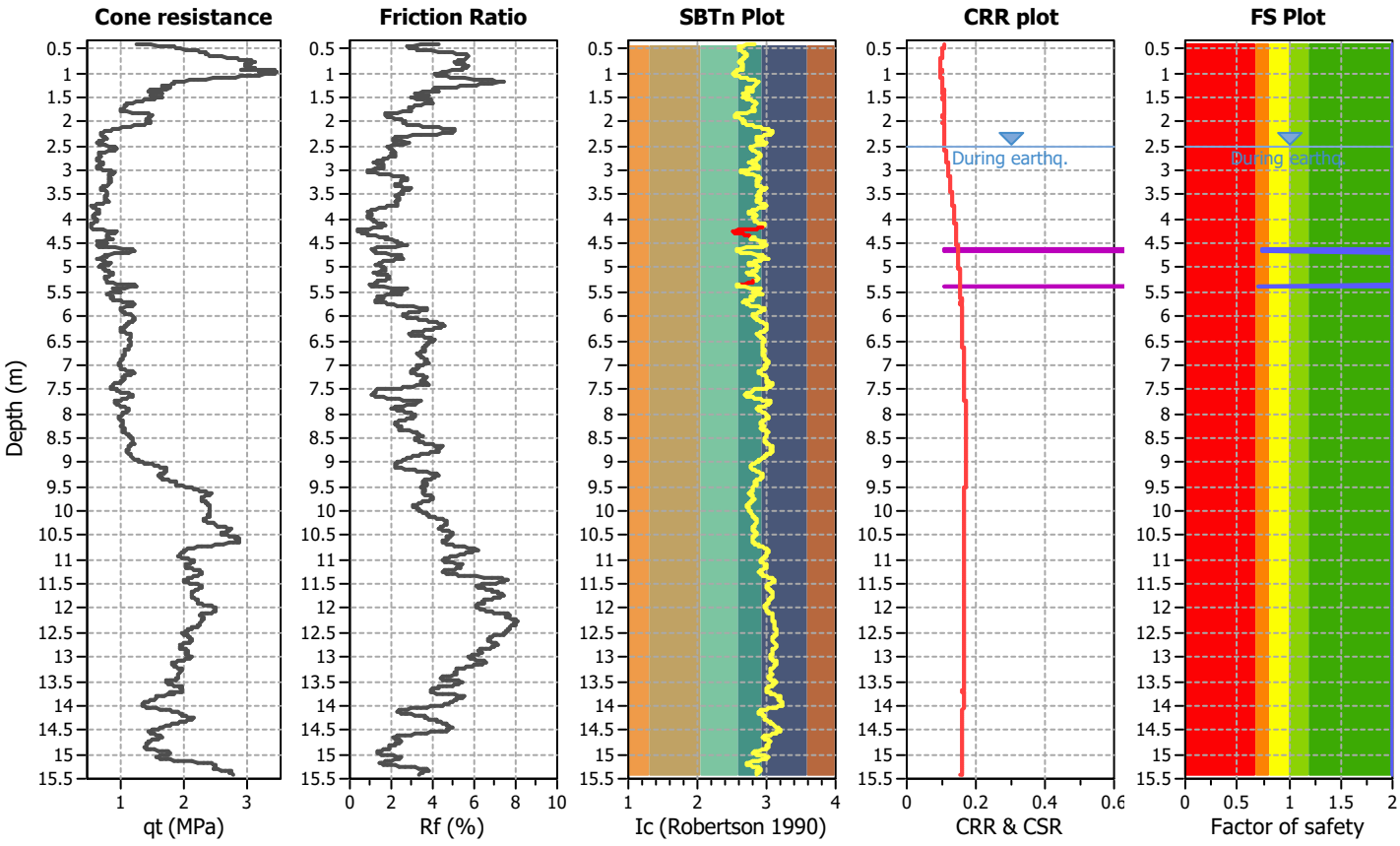
LIQUEFACTION ANALYSIS REPORT

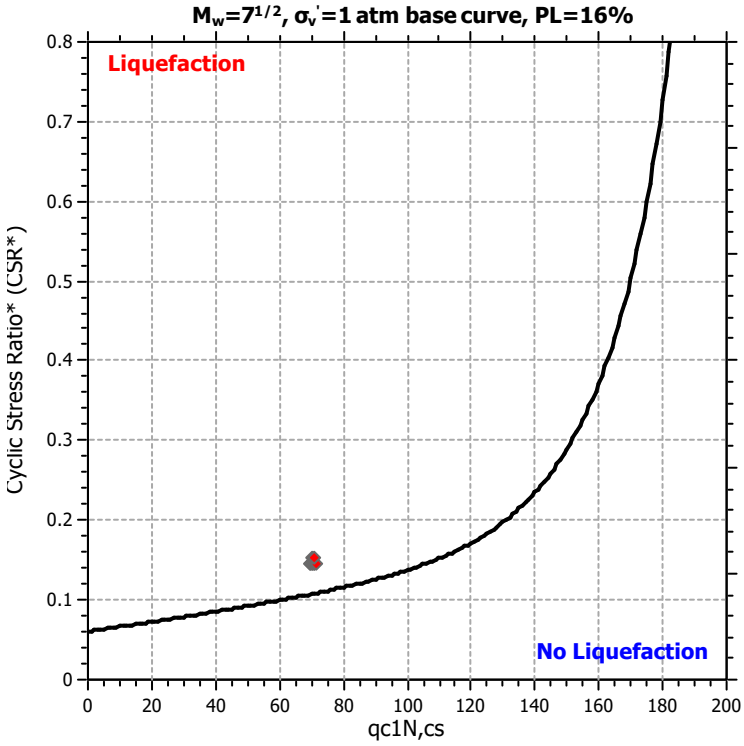
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

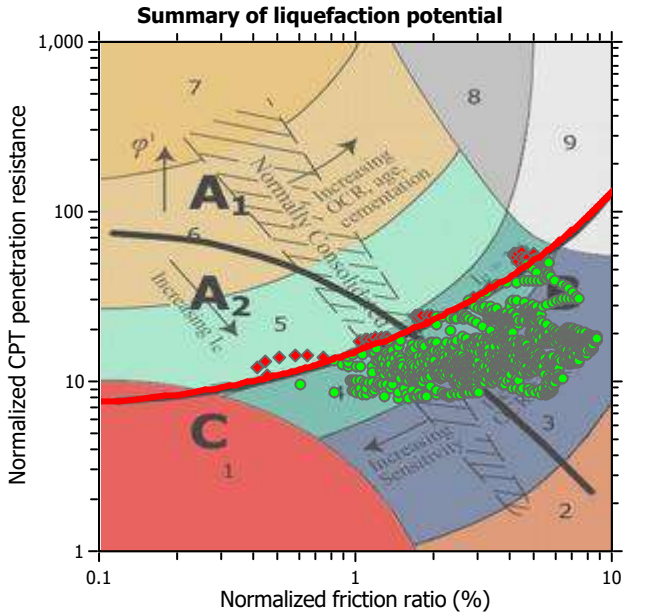
CPT file : CPTU8

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

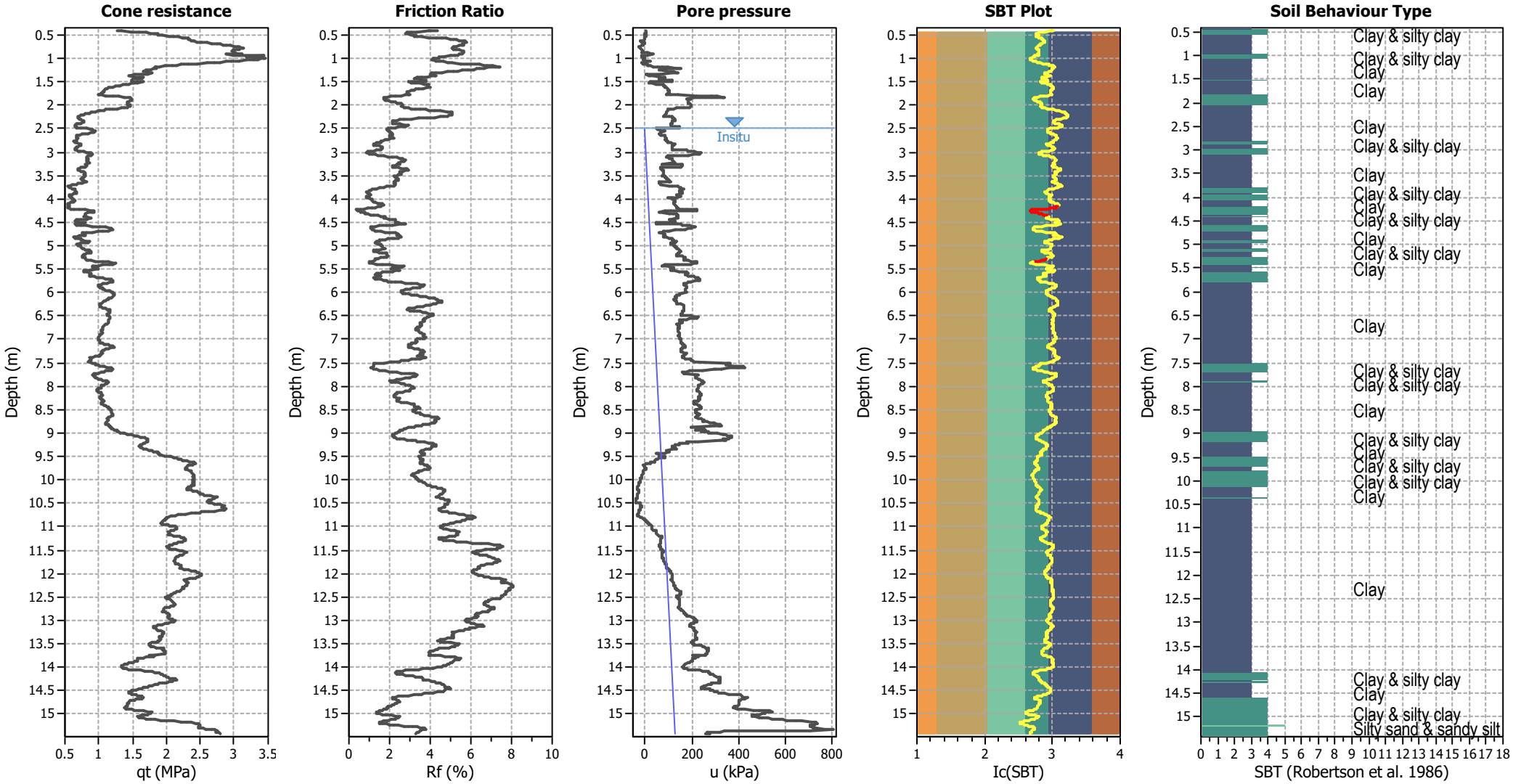






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



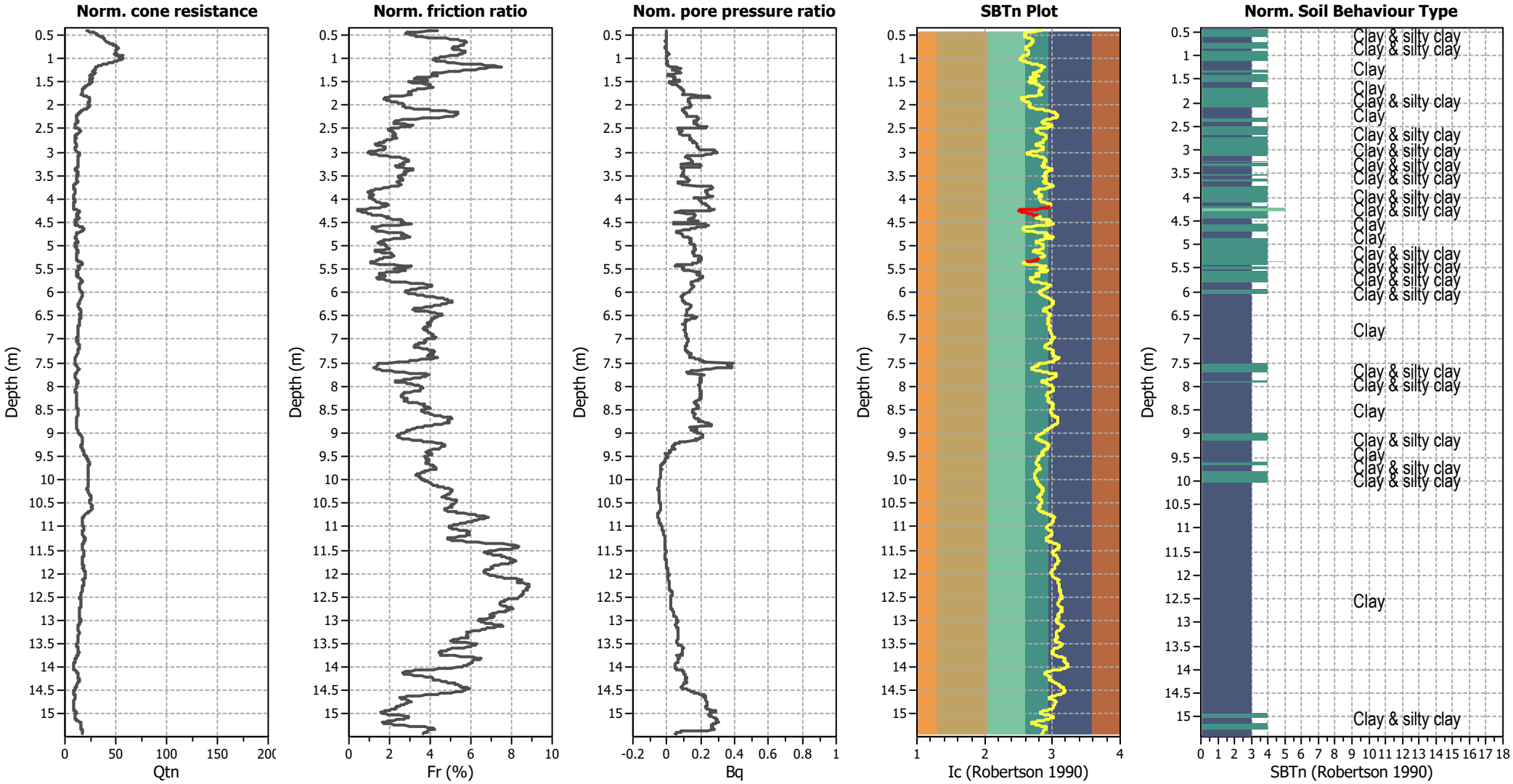
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



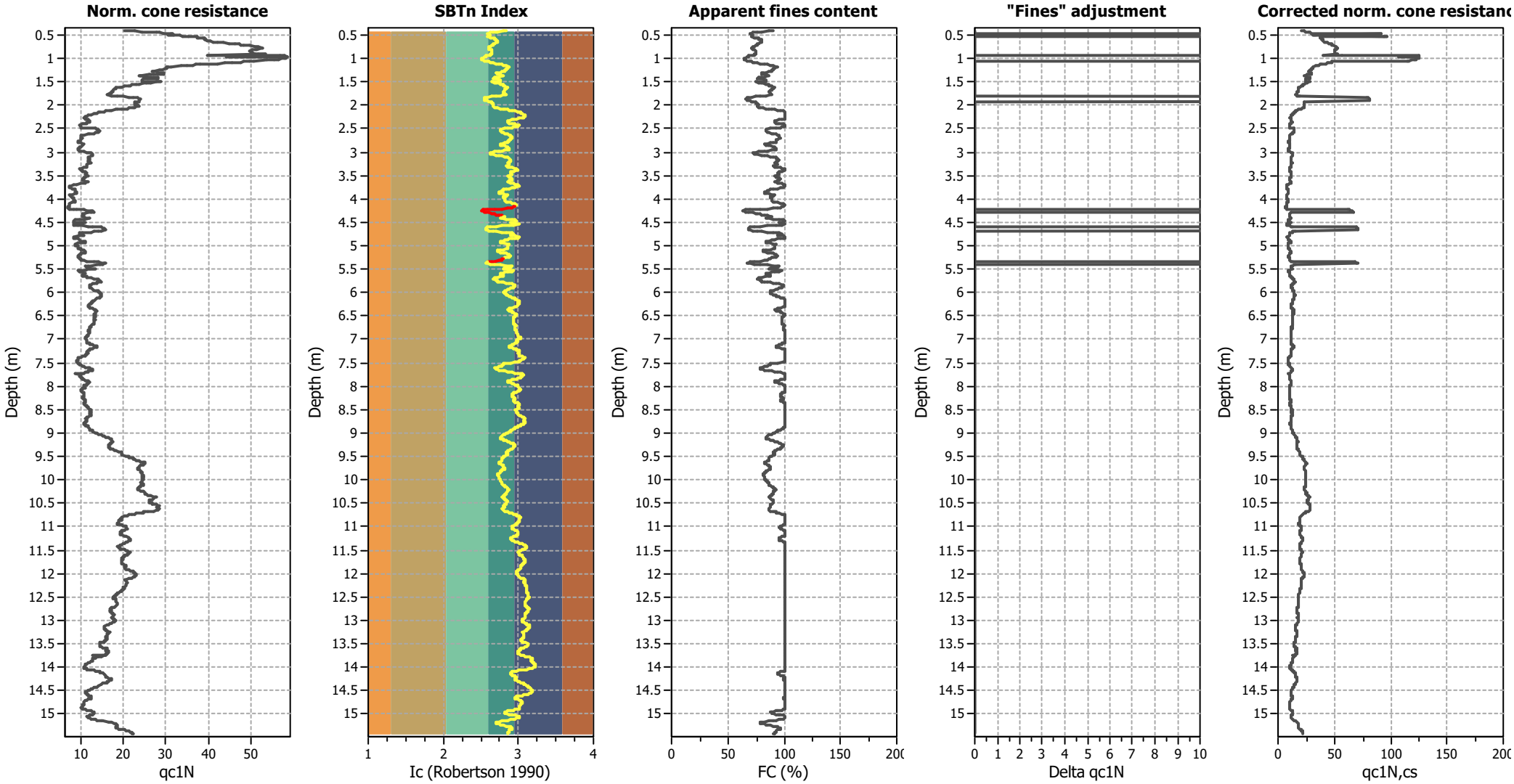
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

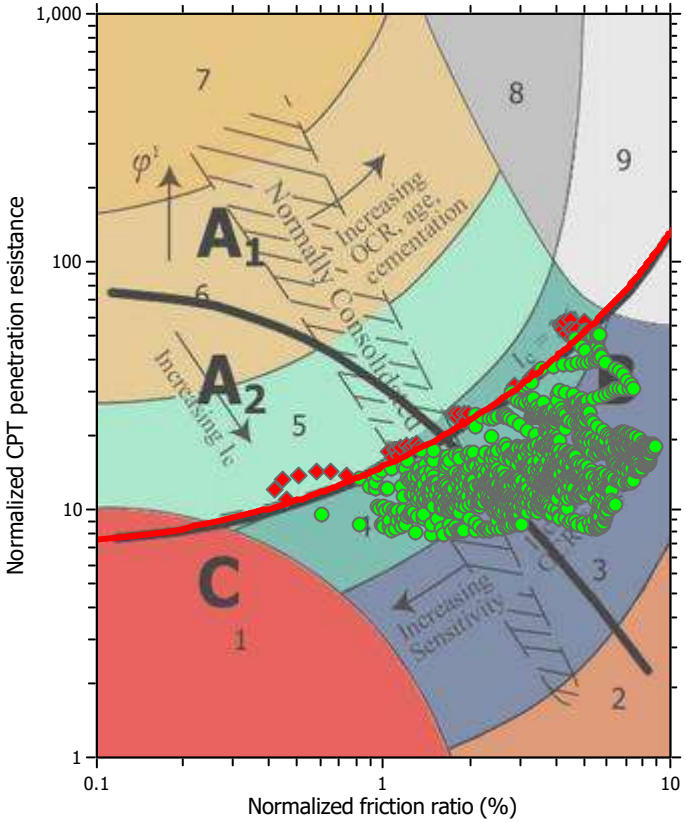
Liquefaction analysis overall plots (intermediate results)

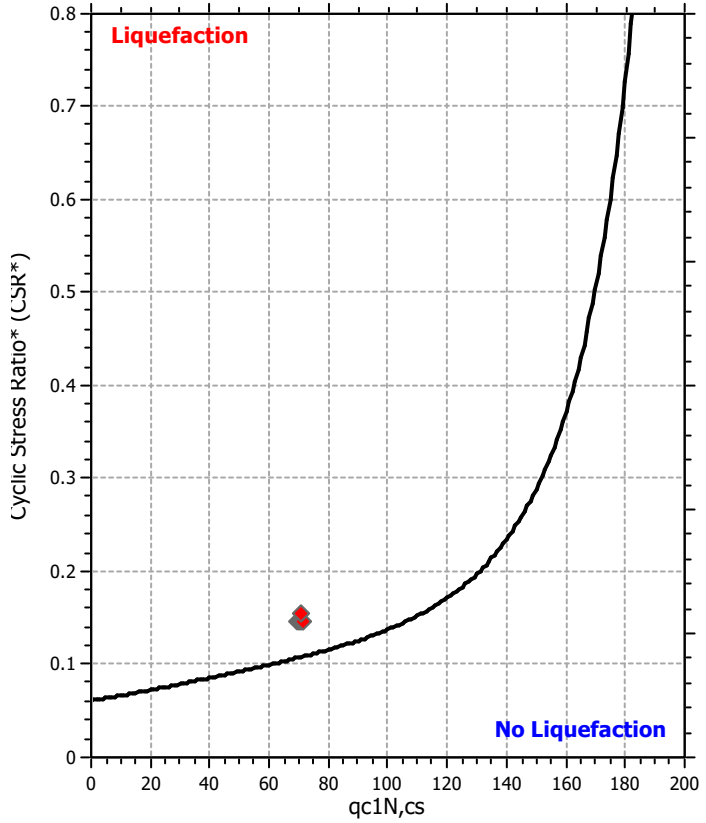


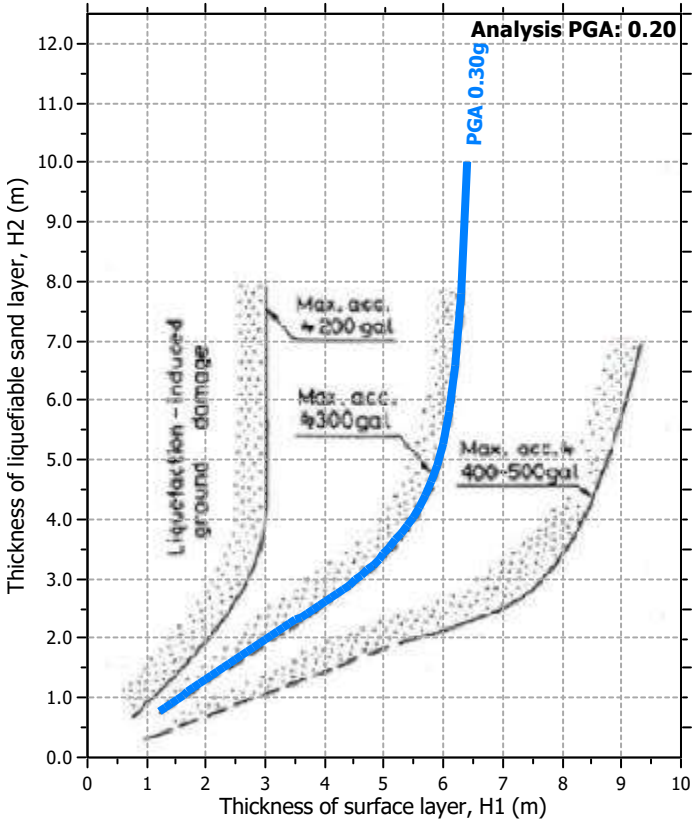
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



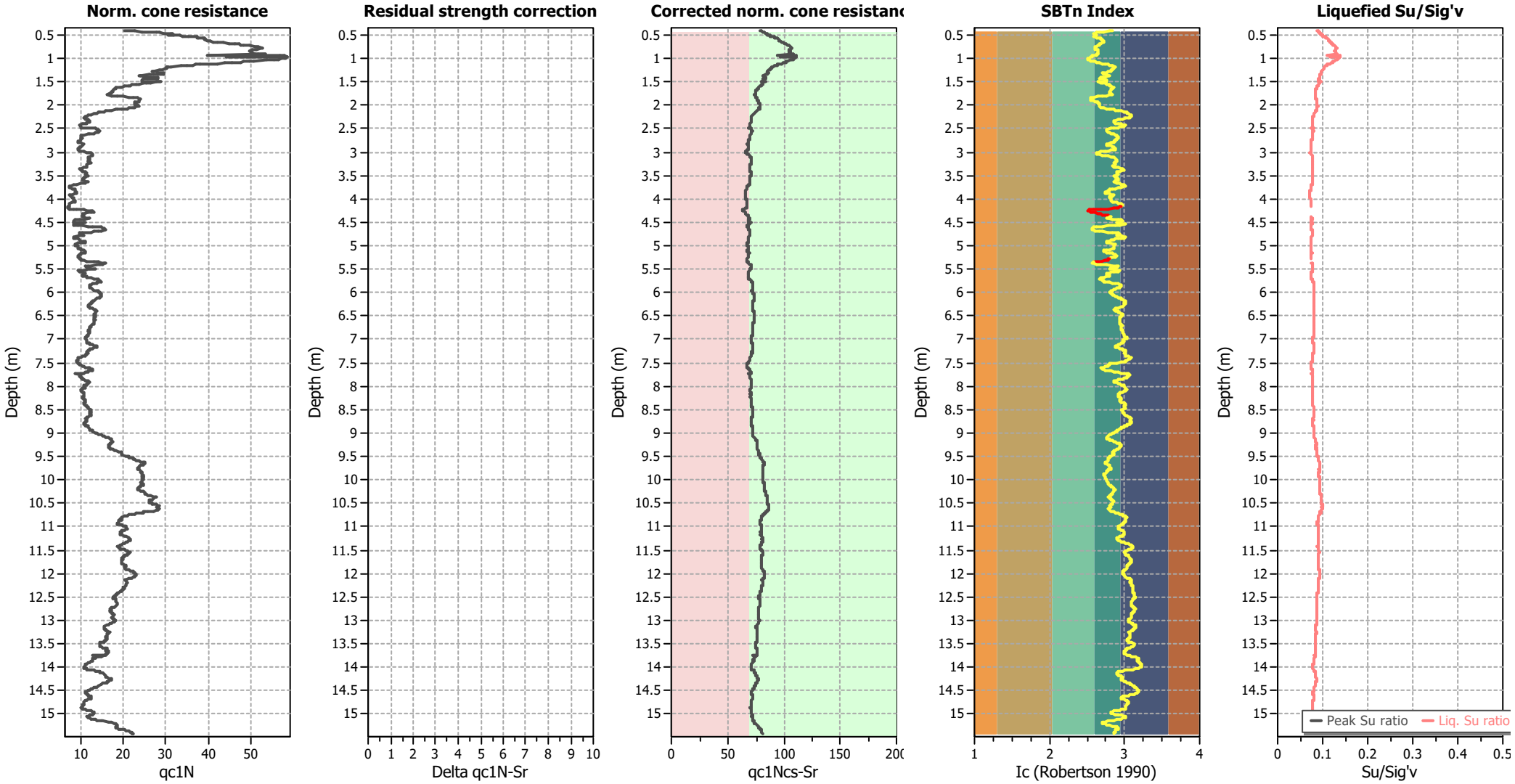




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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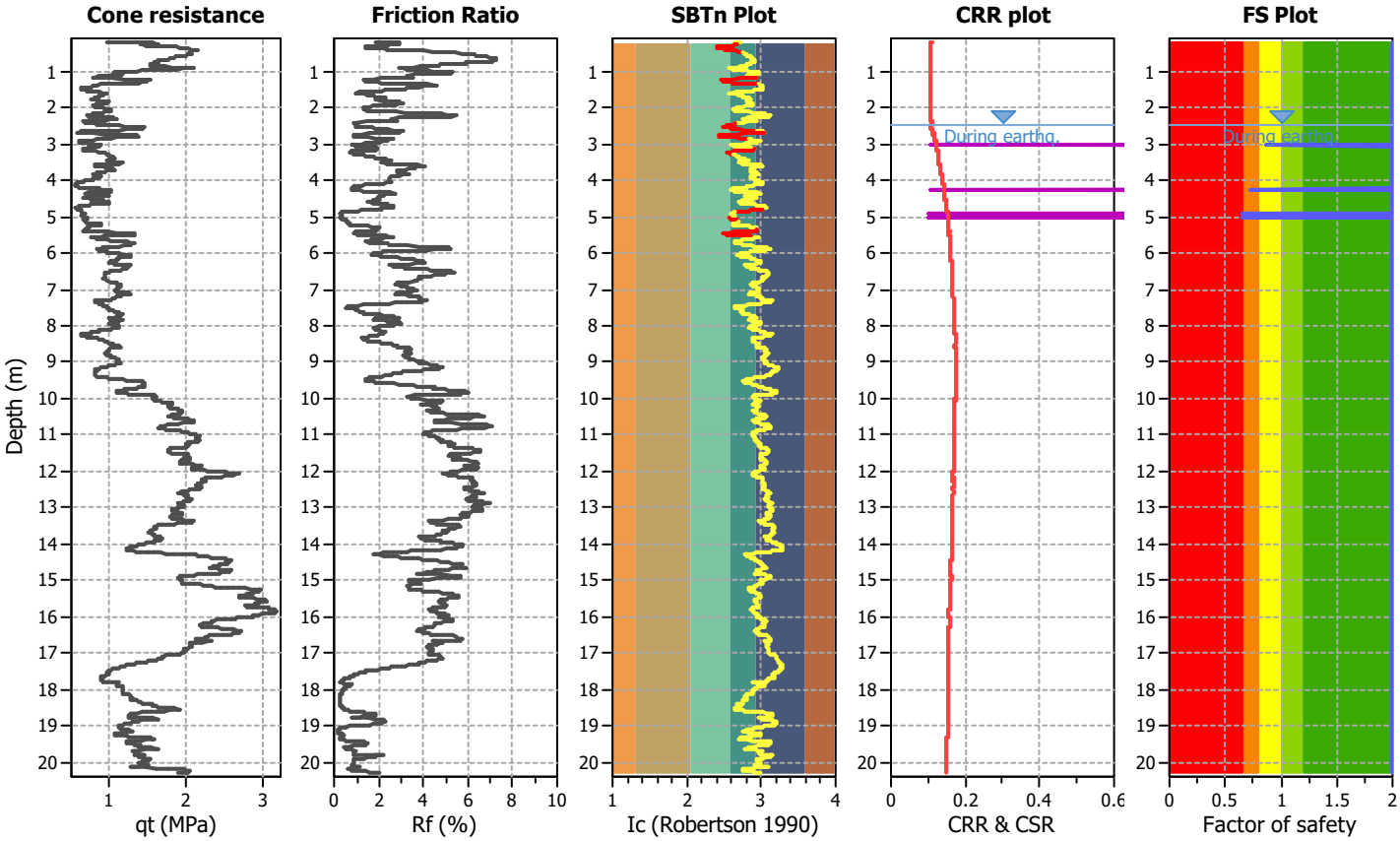
LIQUEFACTION ANALYSIS REPORT

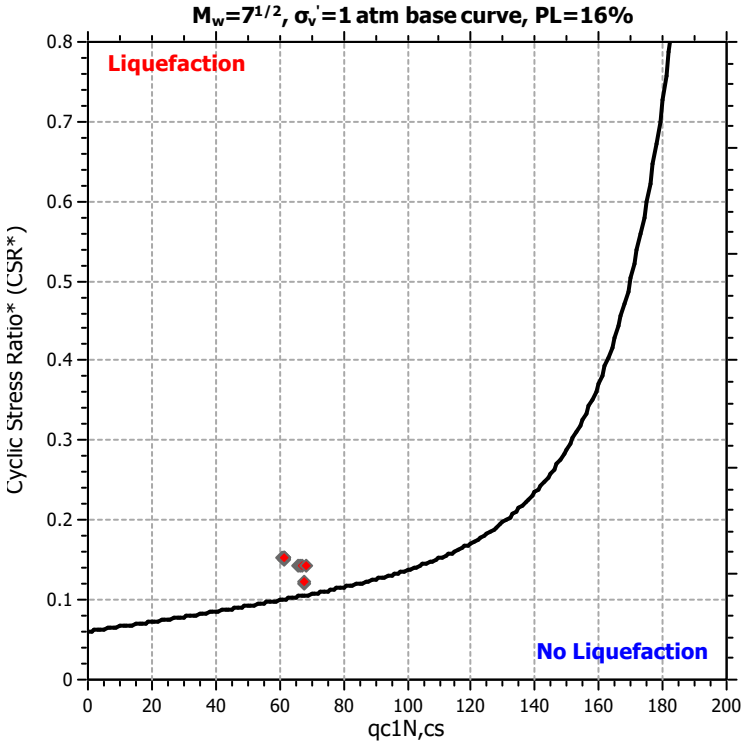
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

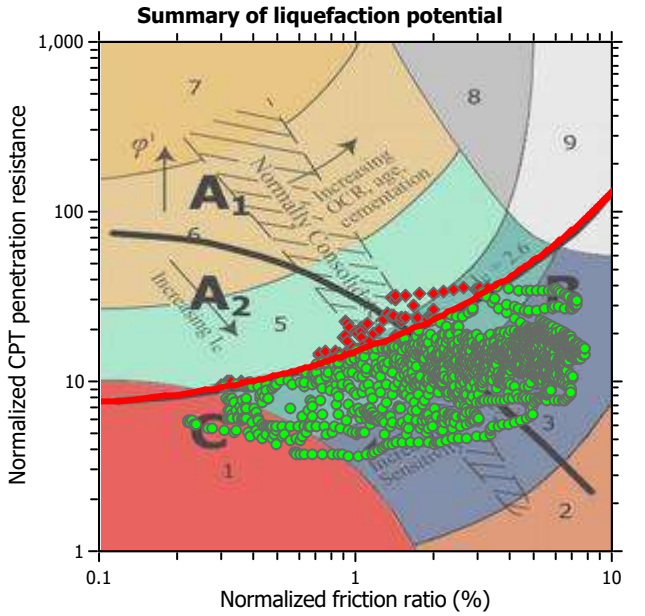
CPT file : CPTU9

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

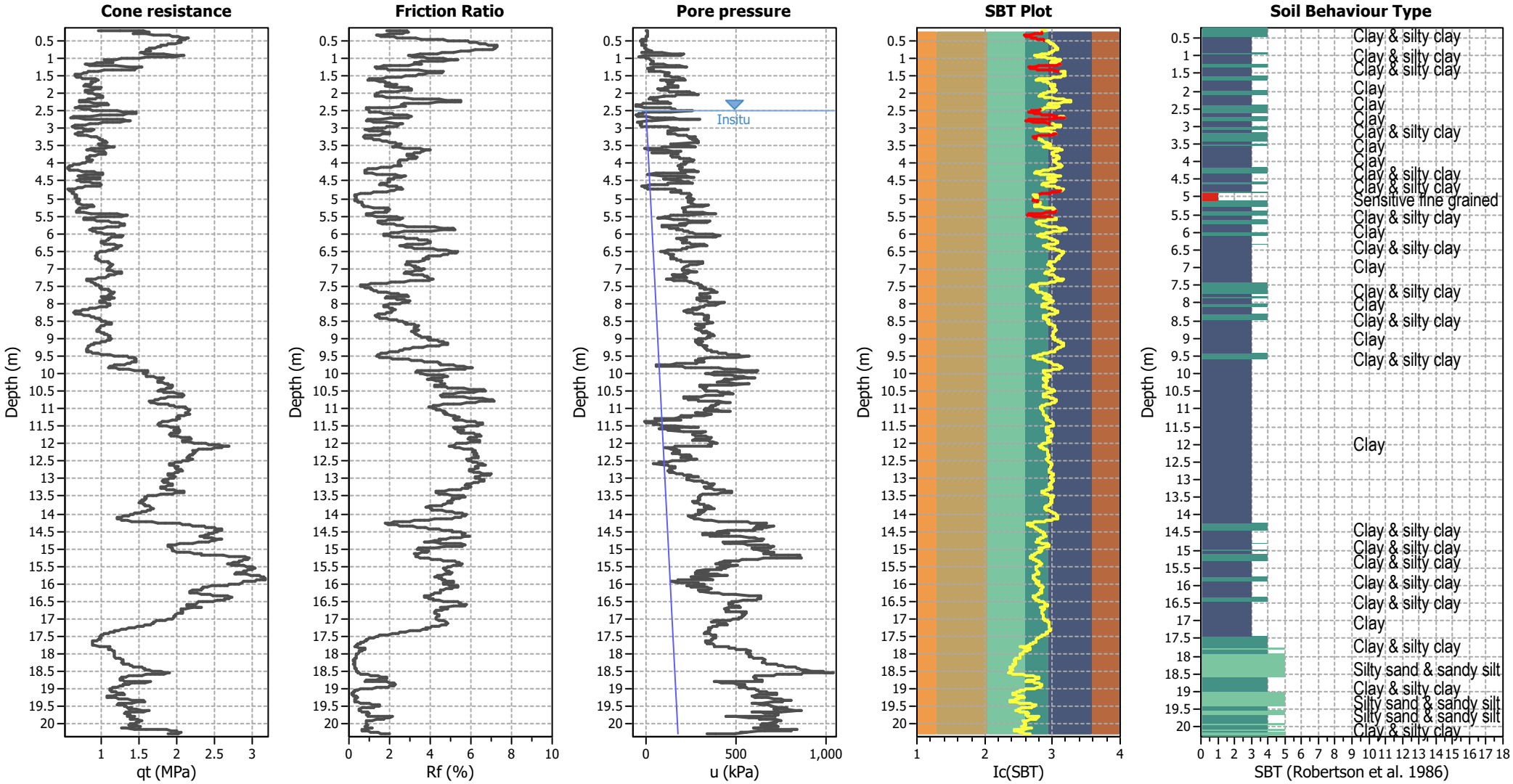






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



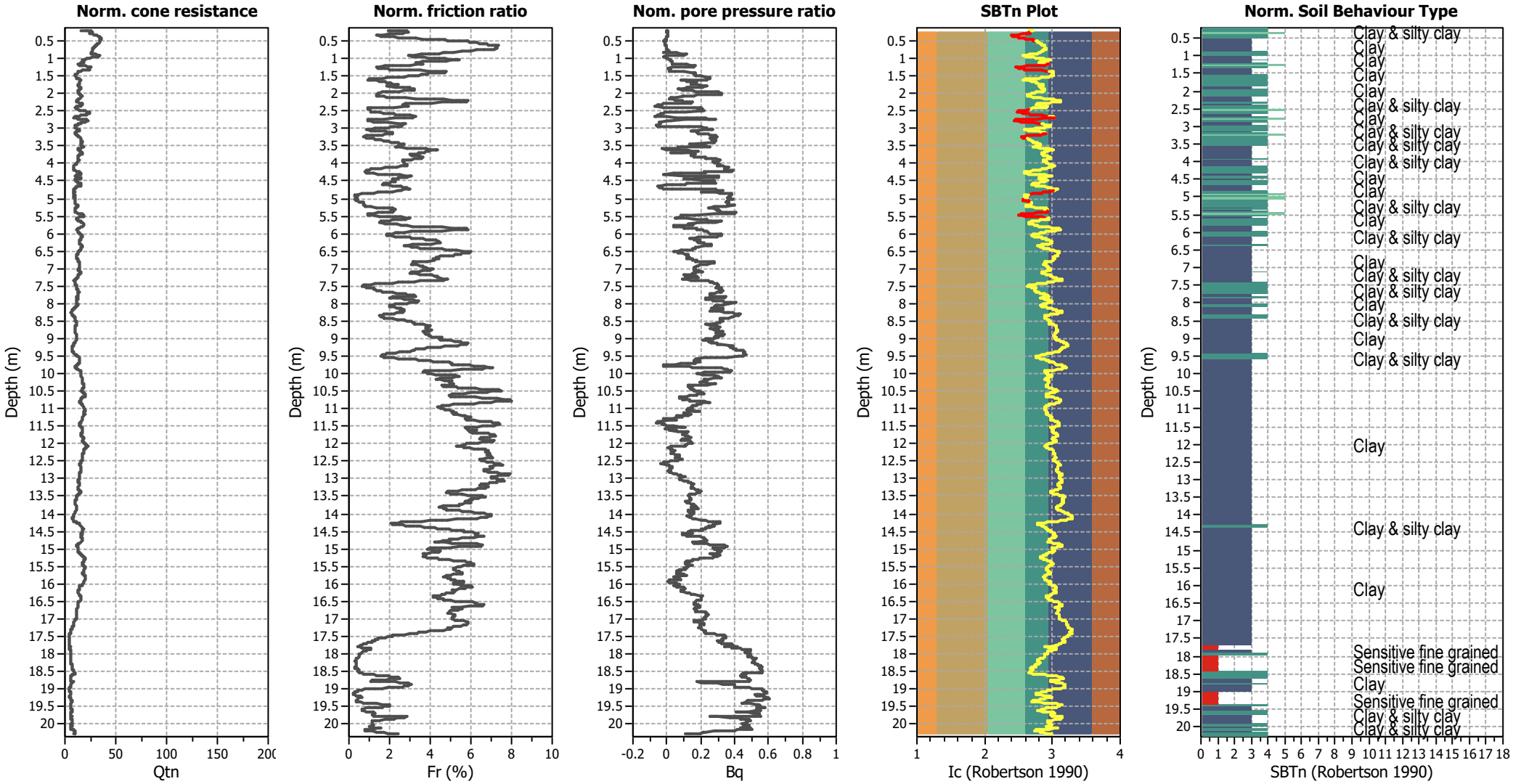
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



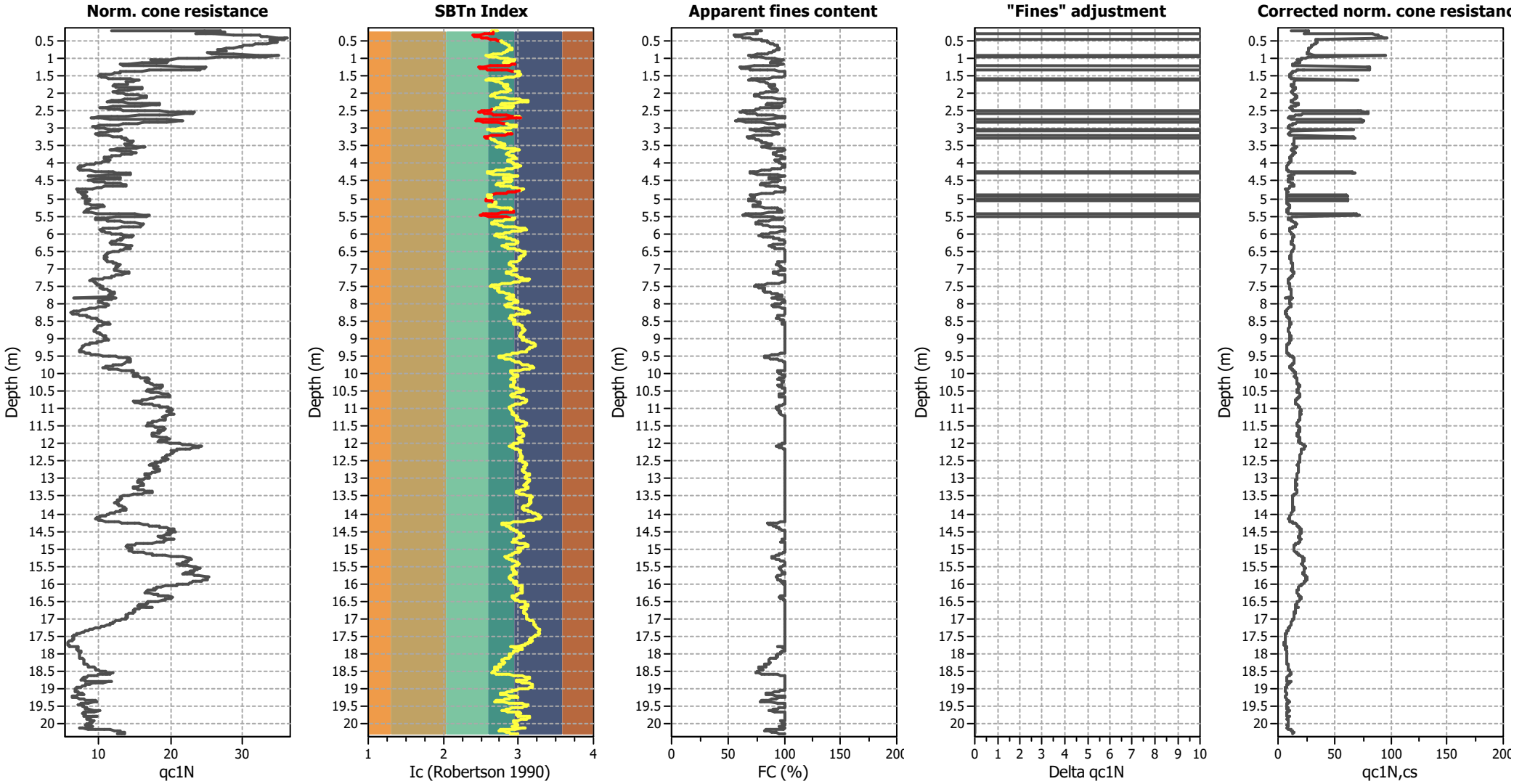
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

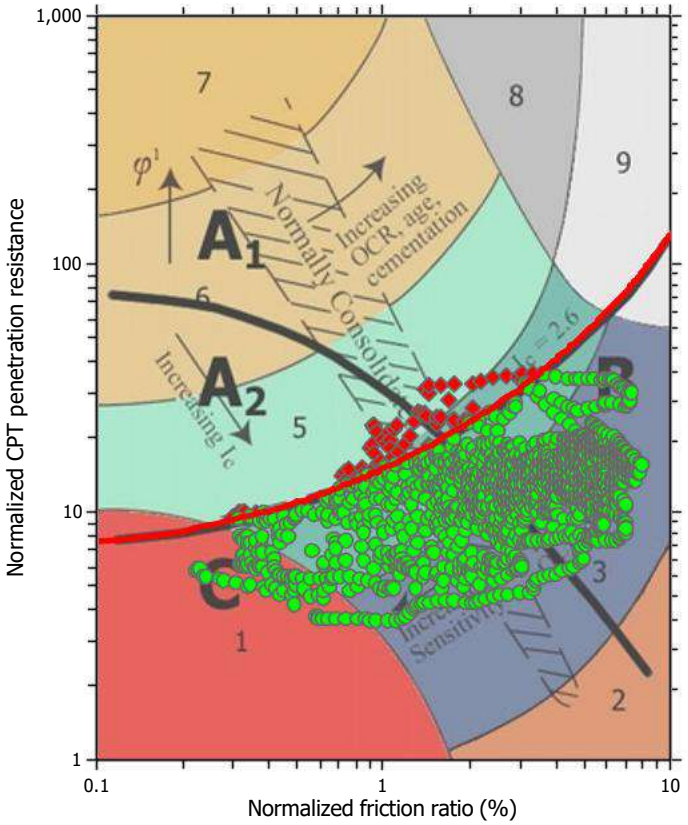
Liquefaction analysis overall plots (intermediate results)

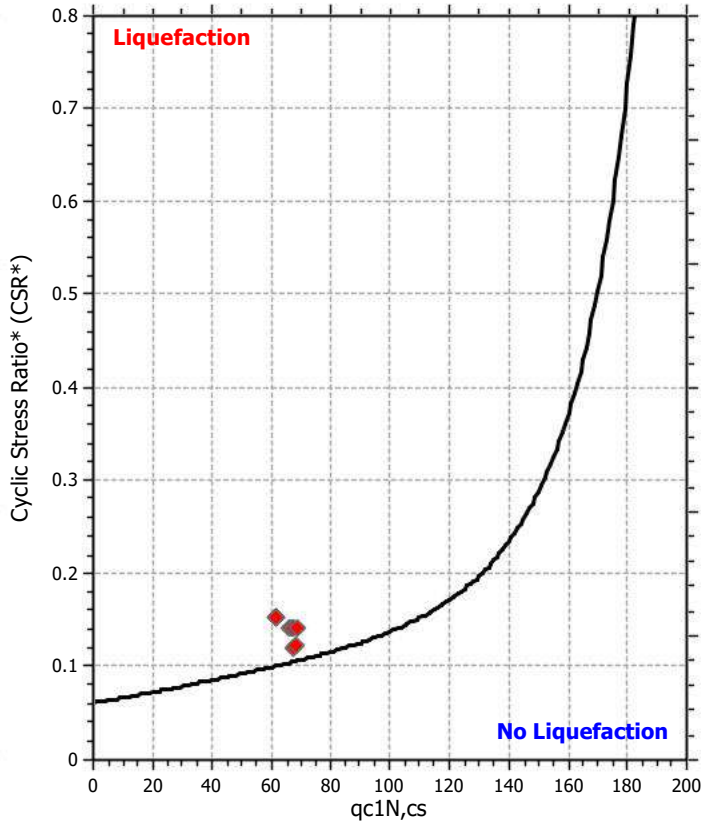


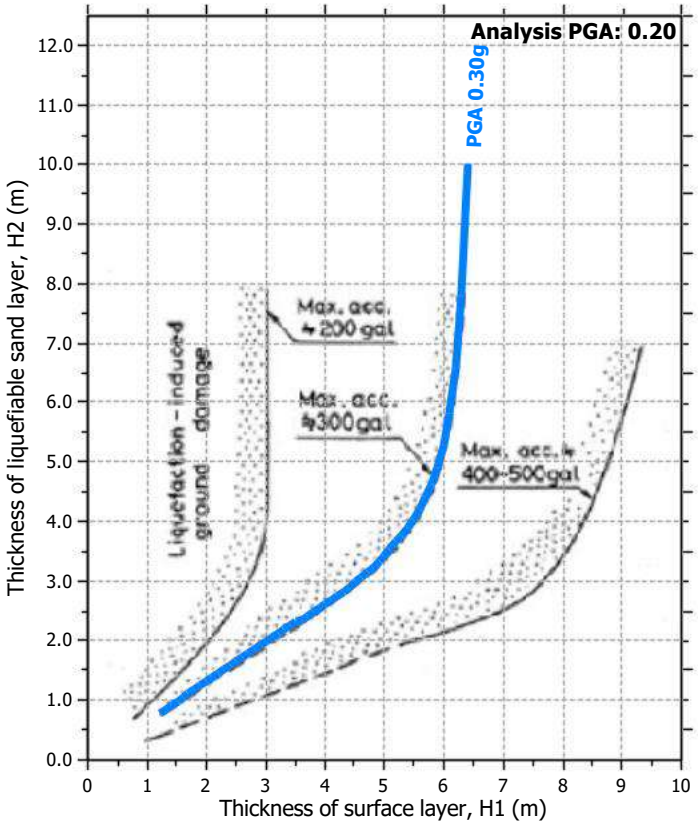
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



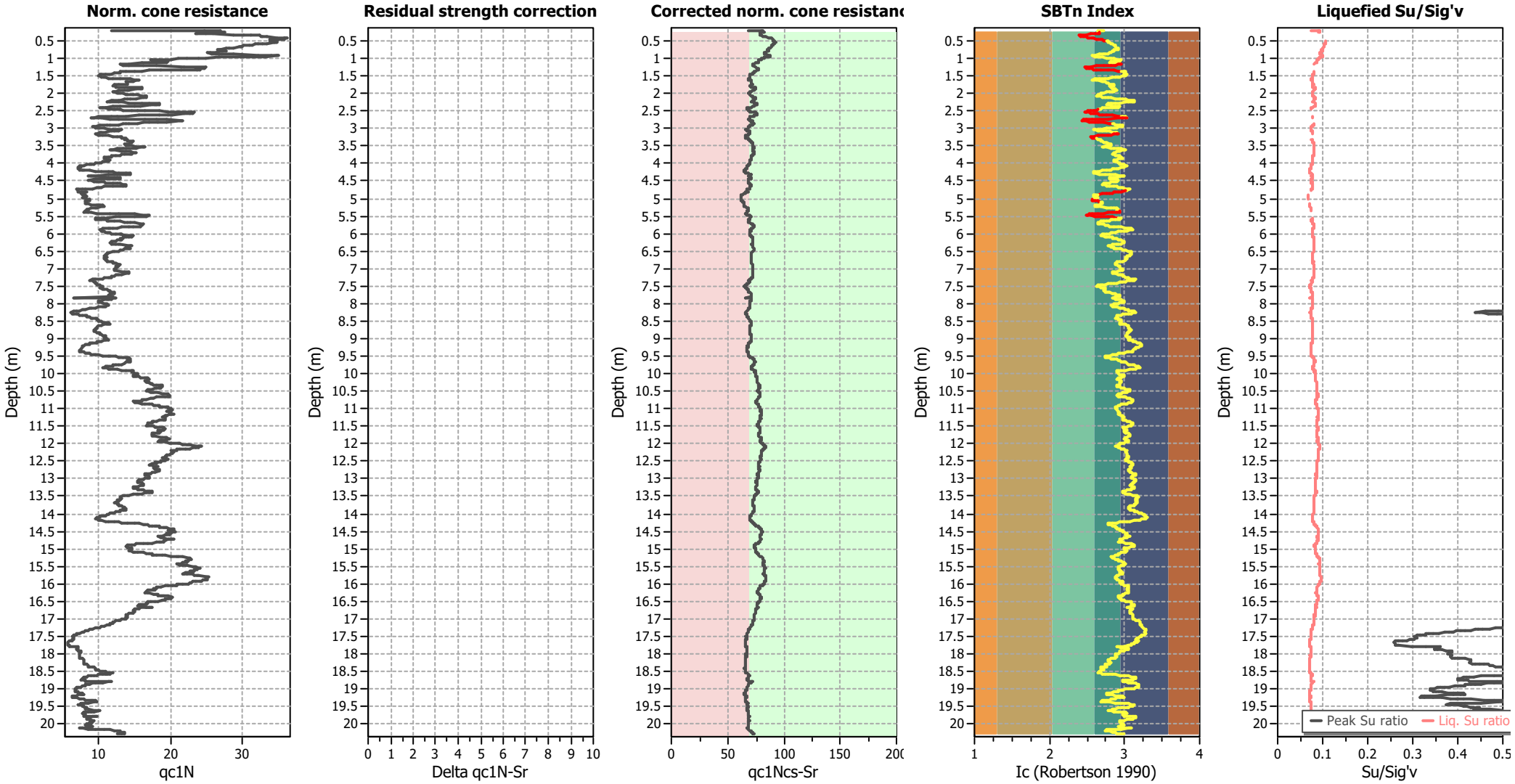




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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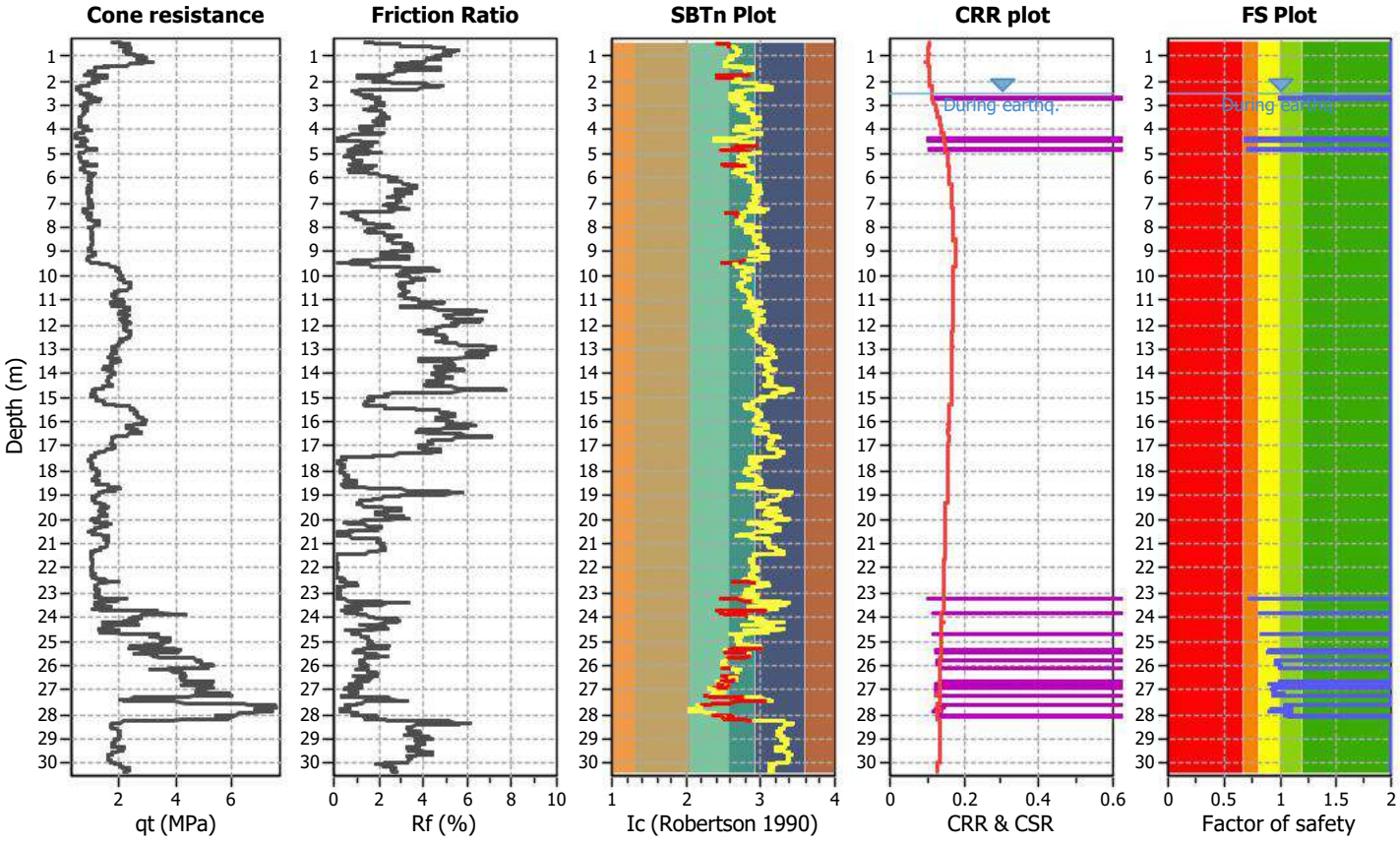
LIQUEFACTION ANALYSIS REPORT

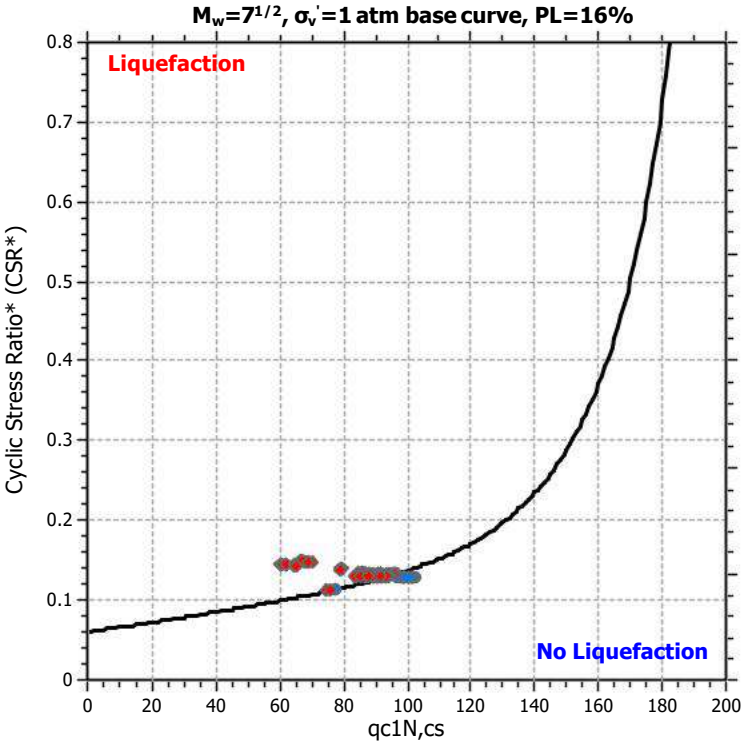
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

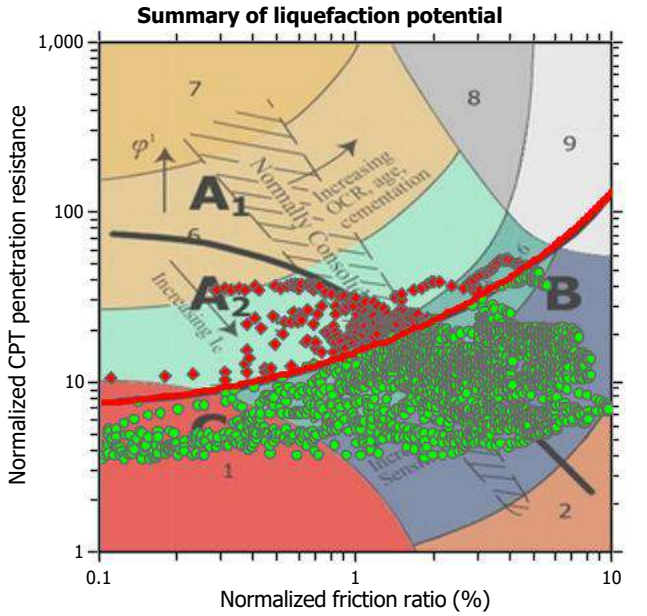
CPT file : CPTU10

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

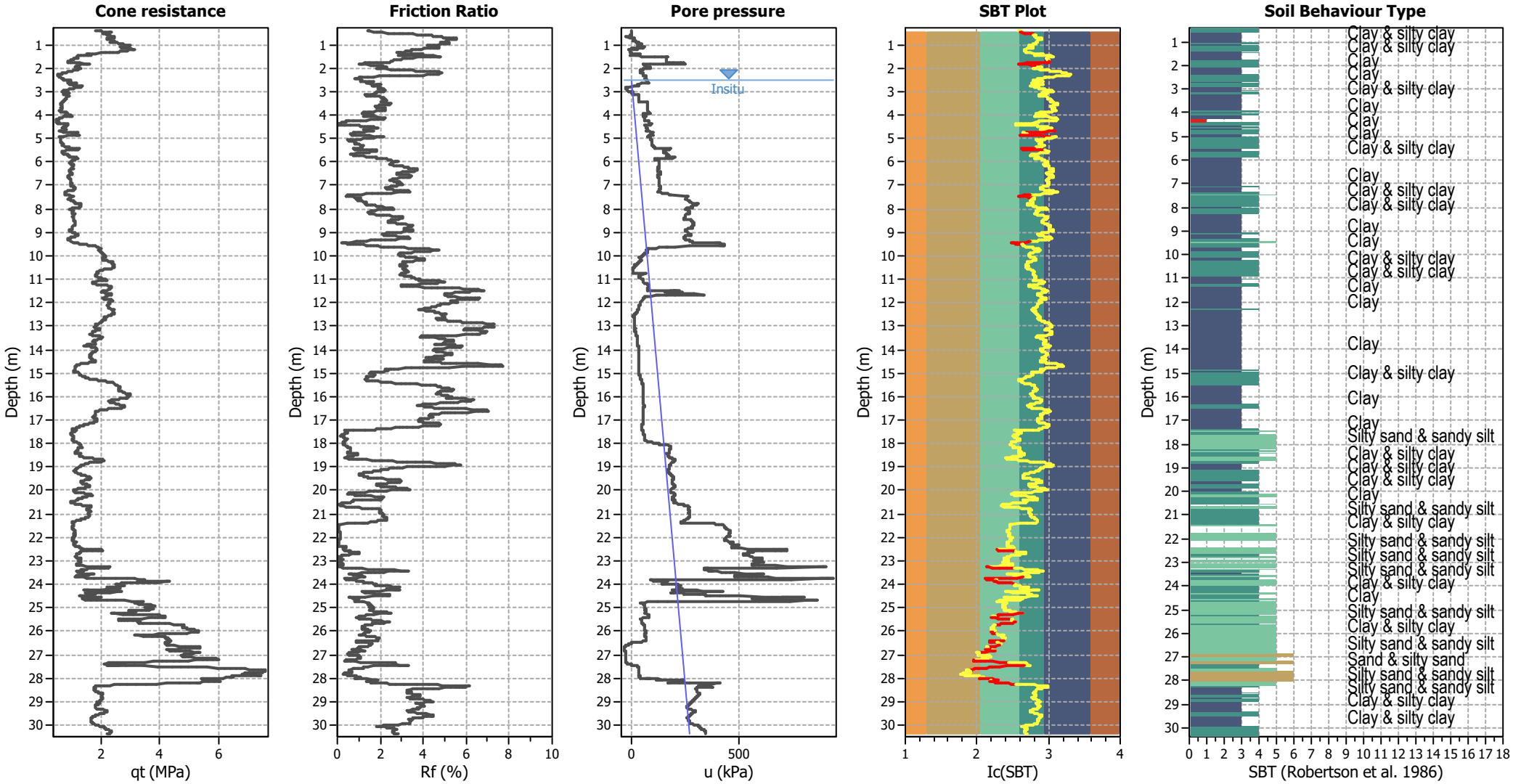






Zone A_1 : Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



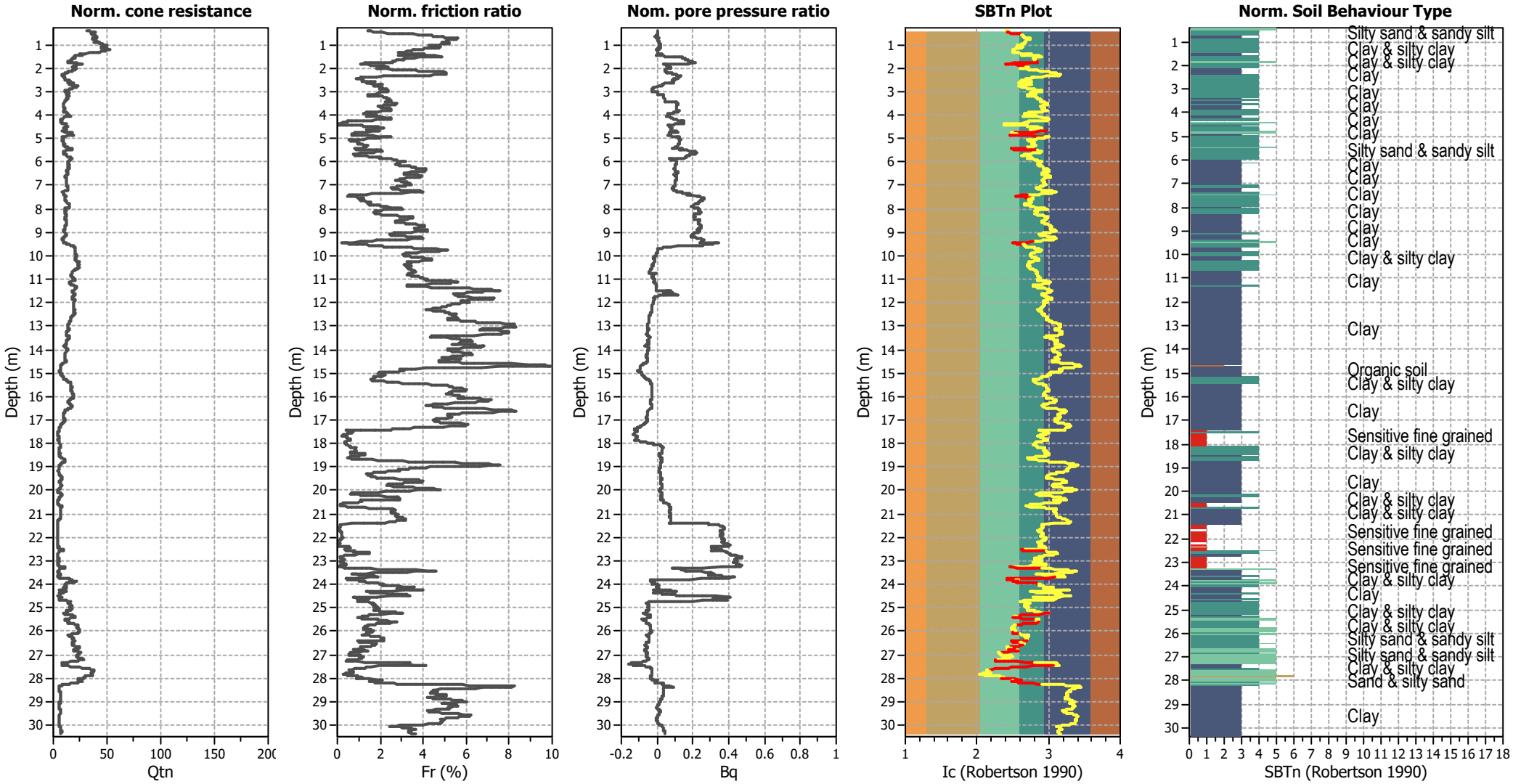
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



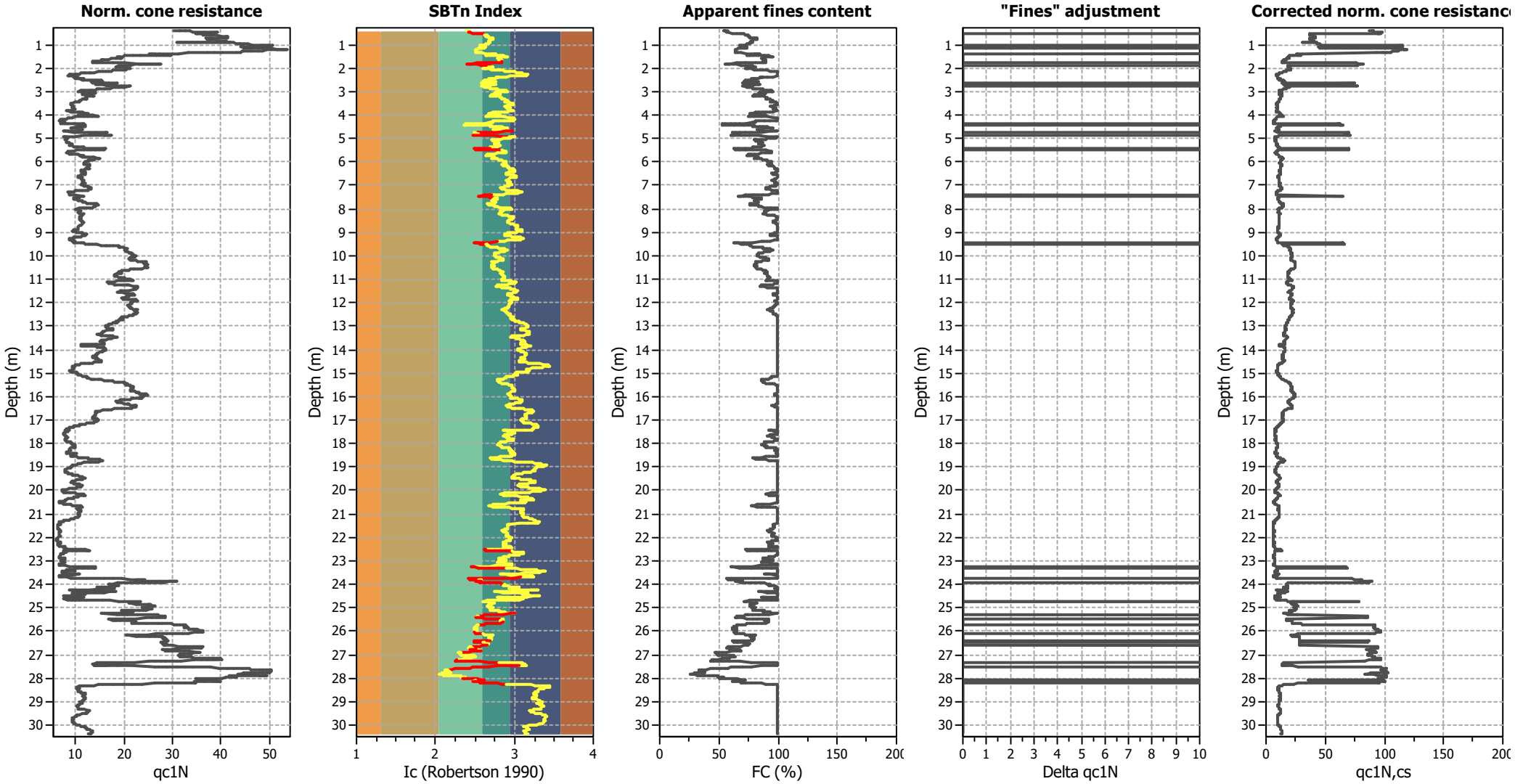
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

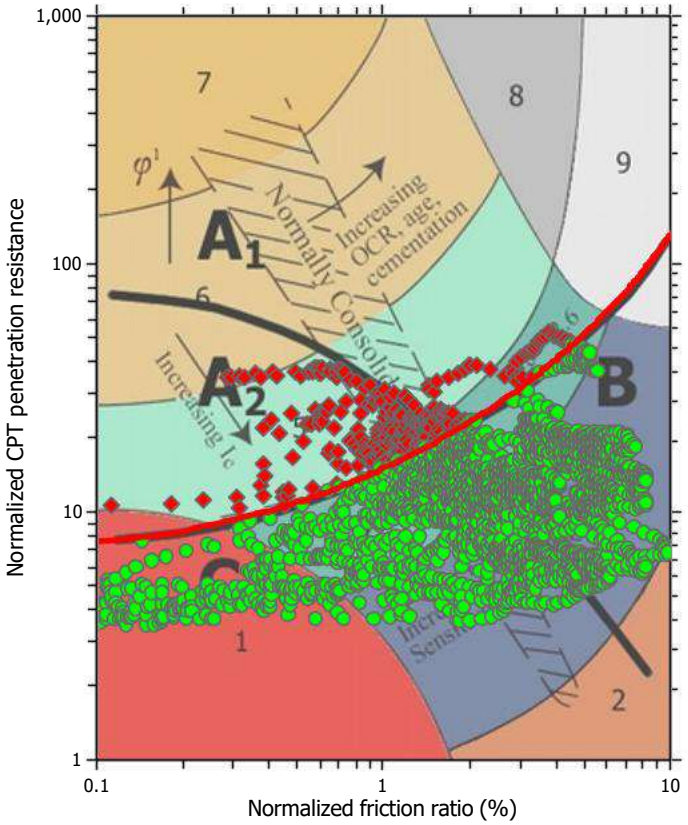
Liquefaction analysis overall plots (intermediate results)

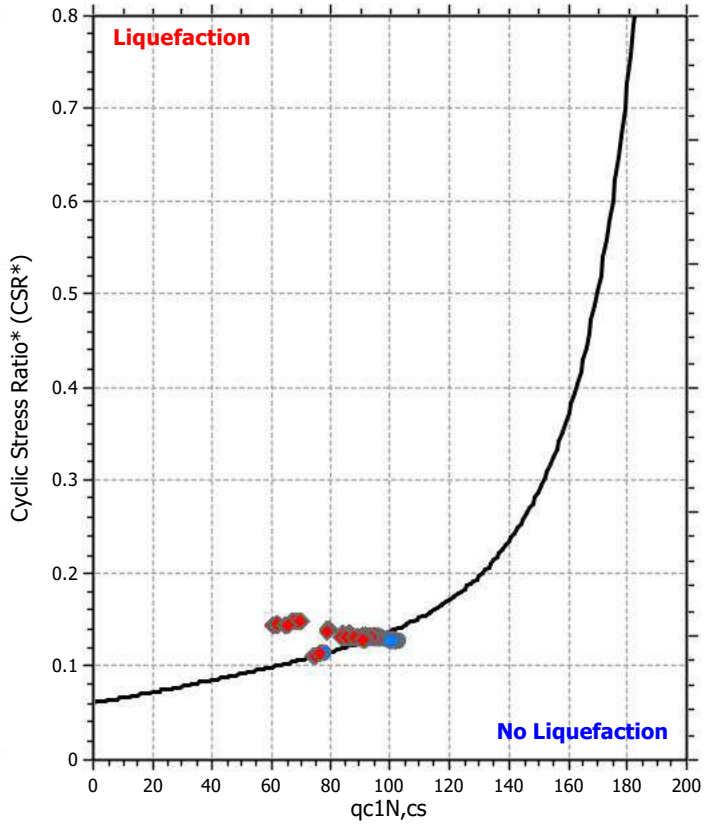


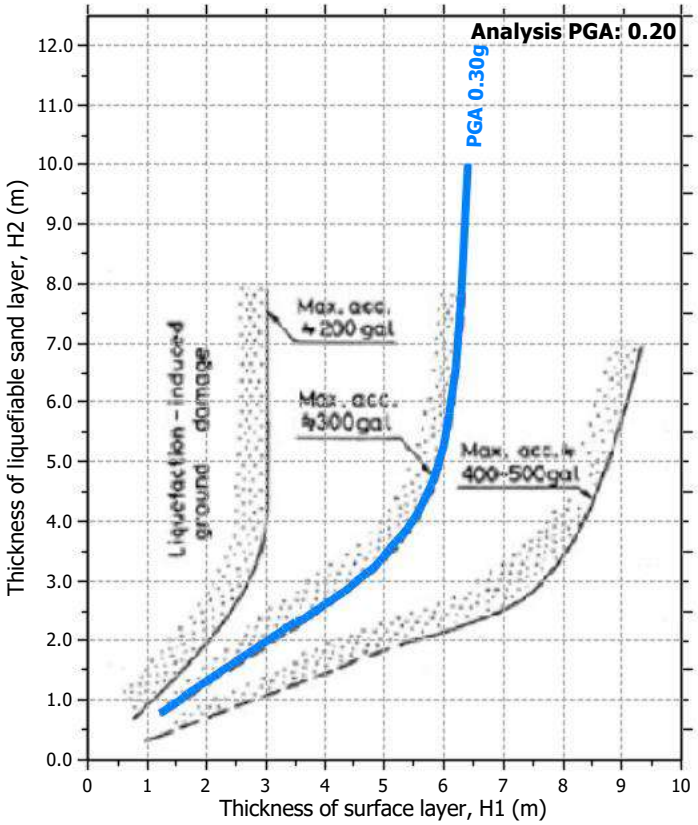
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



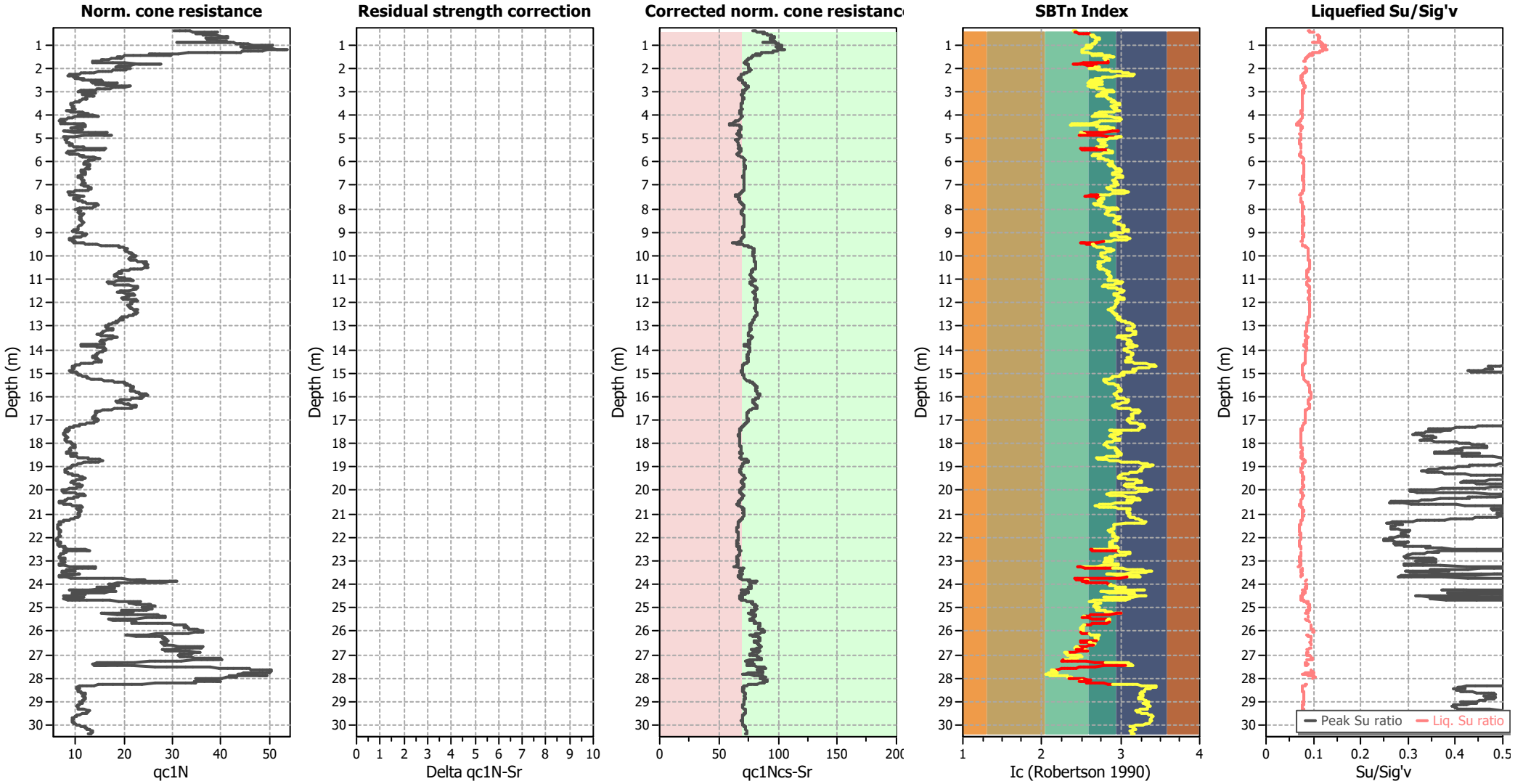




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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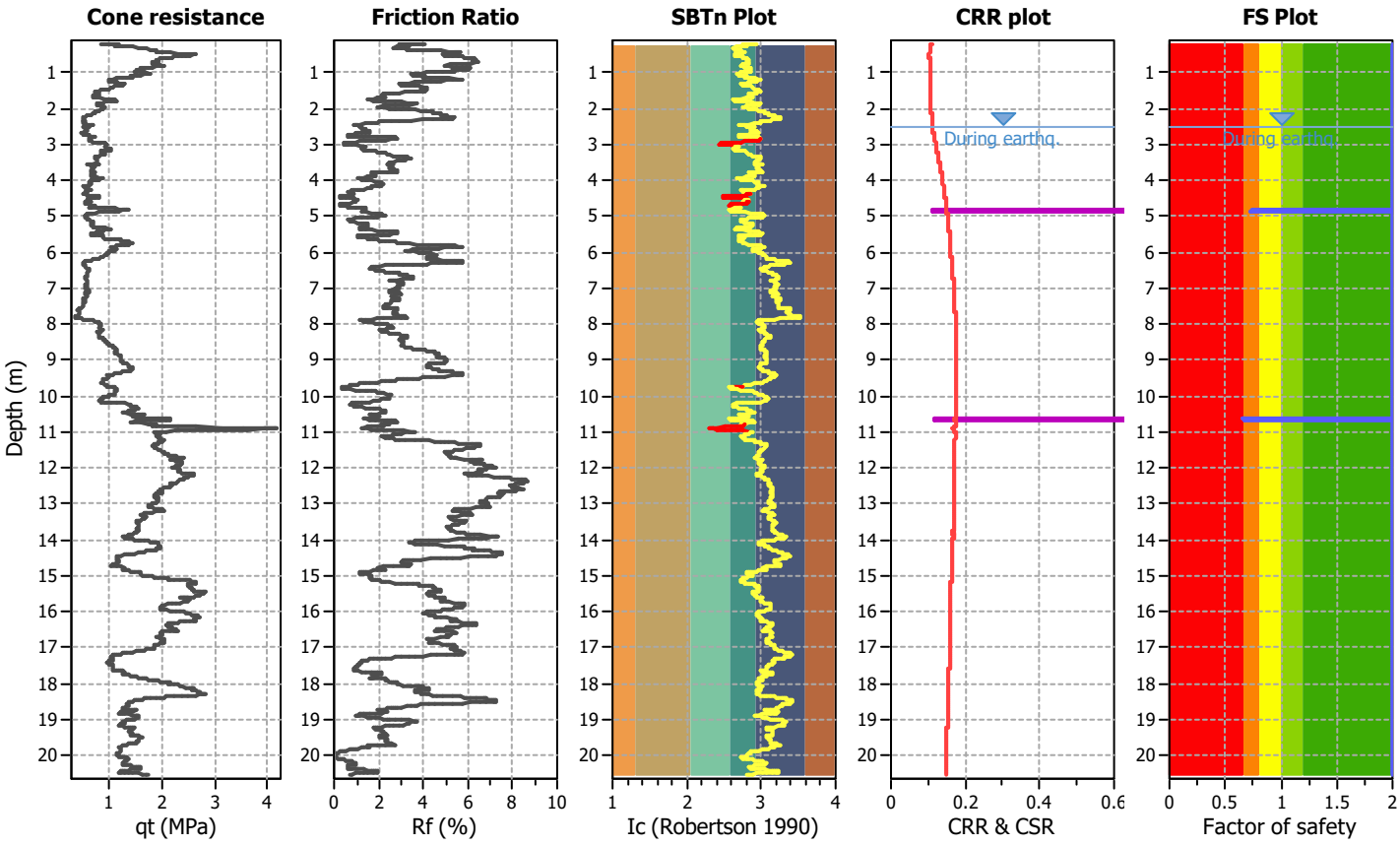
LIQUEFACTION ANALYSIS REPORT

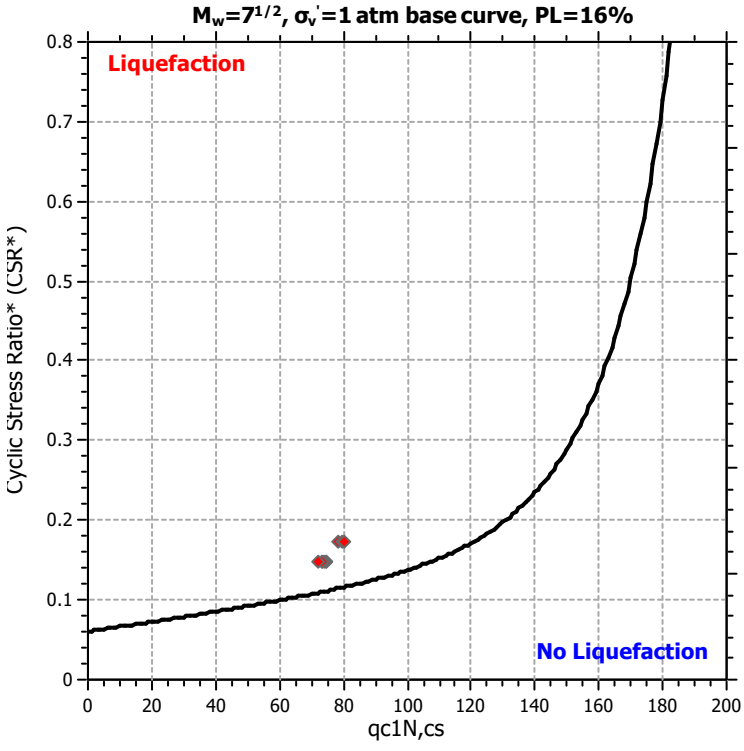
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

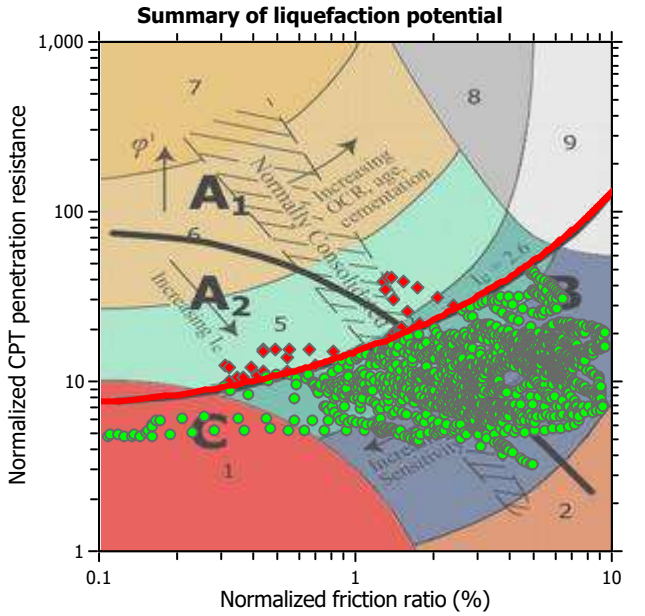
CPT file : CPTU11

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

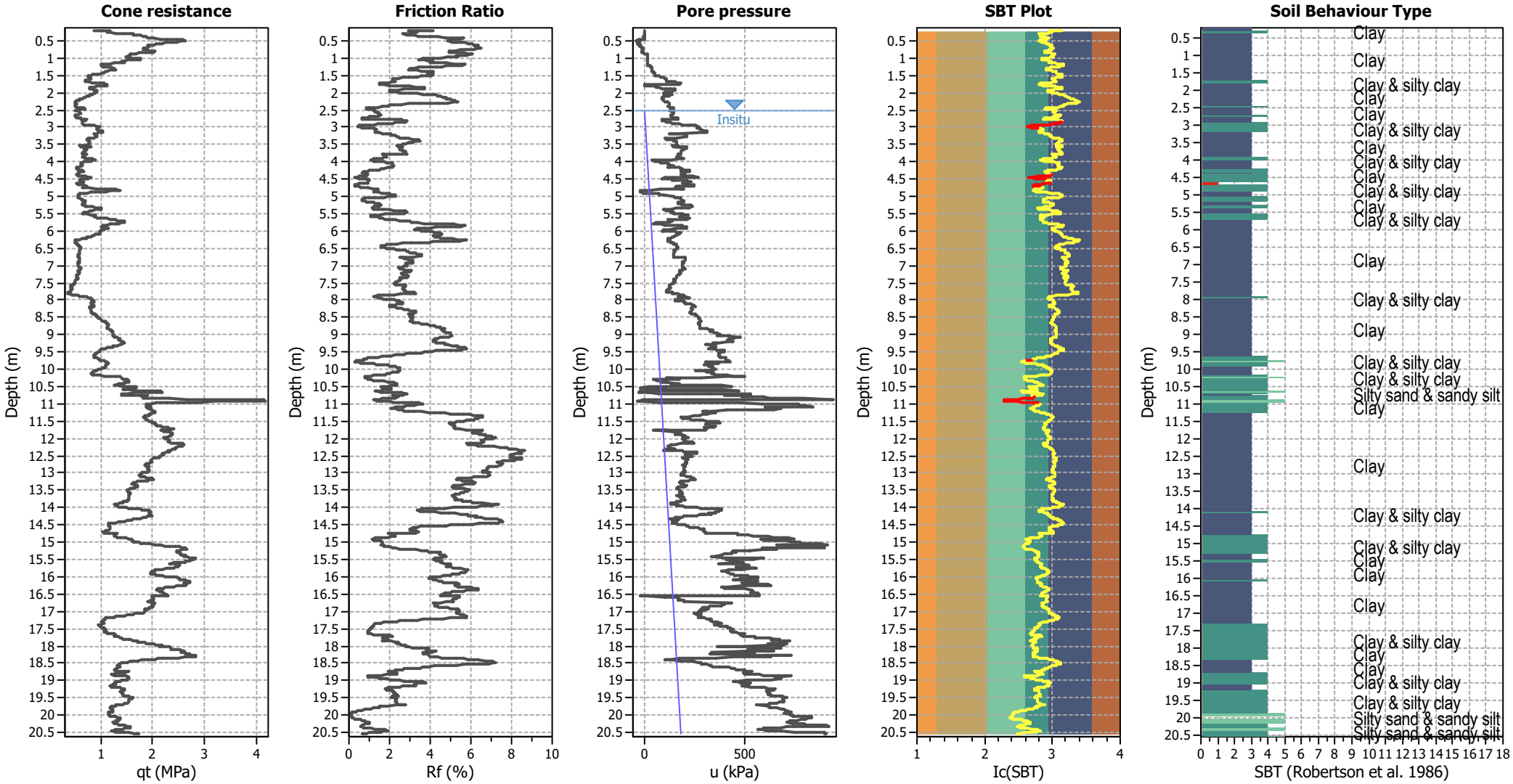






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



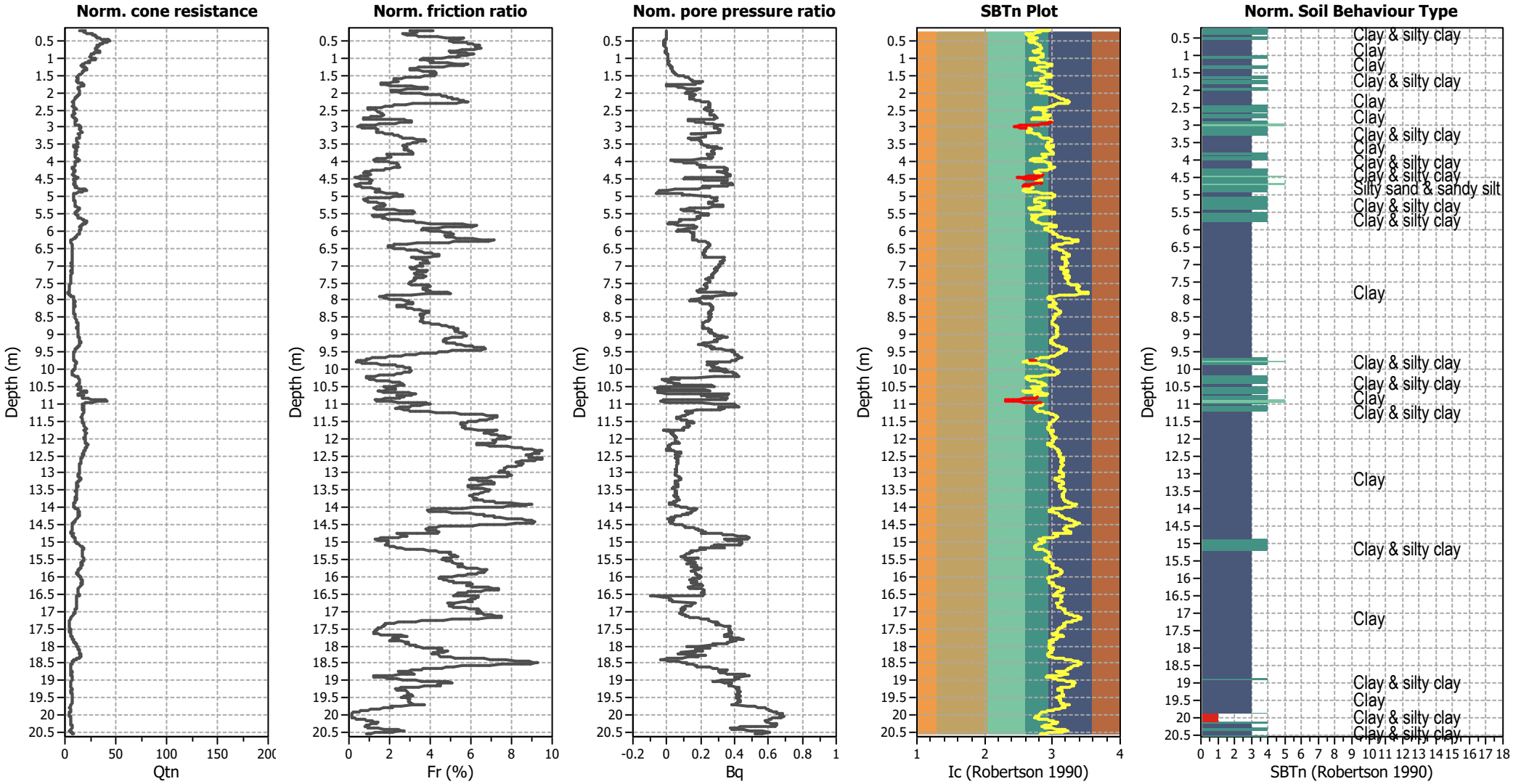
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



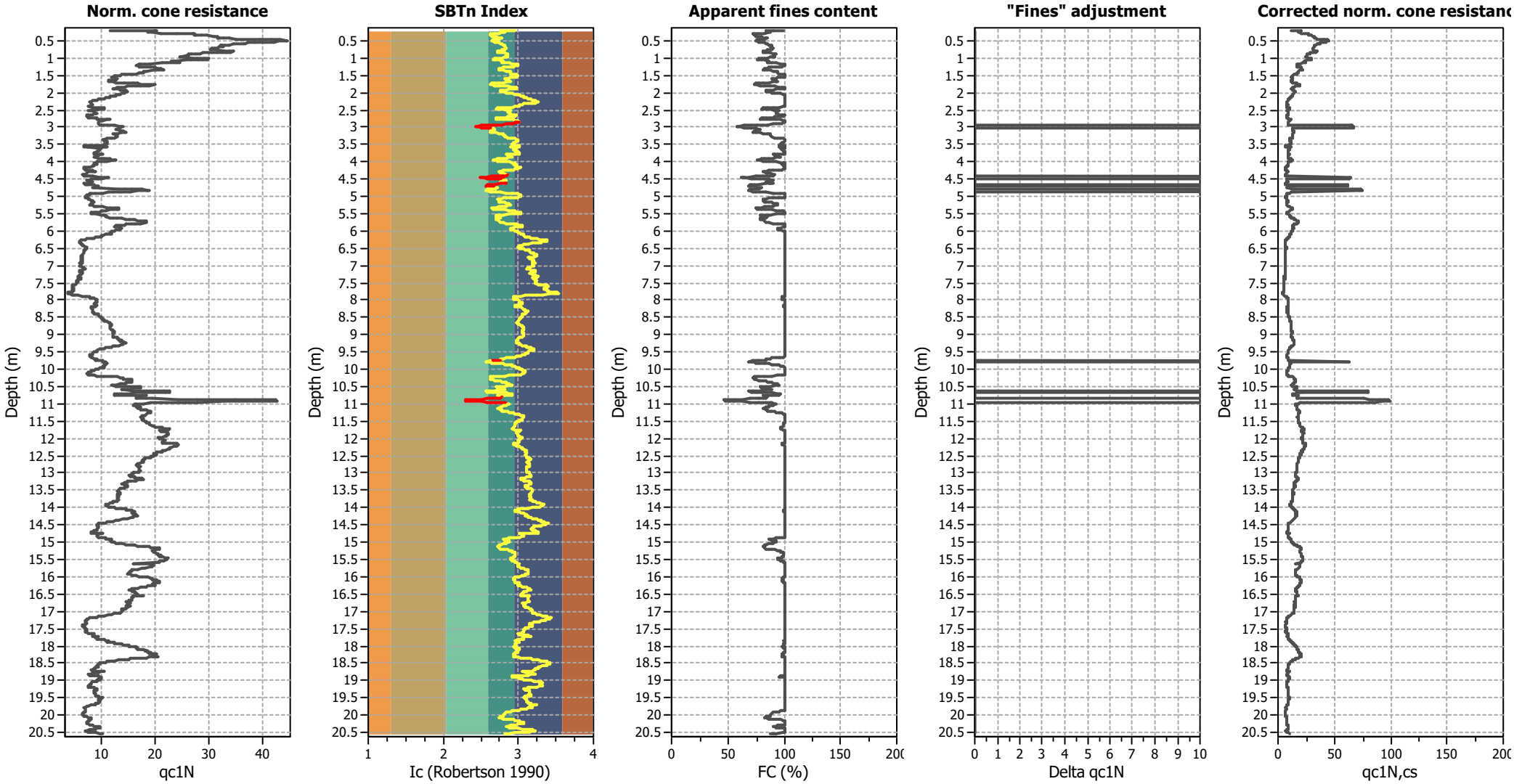
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

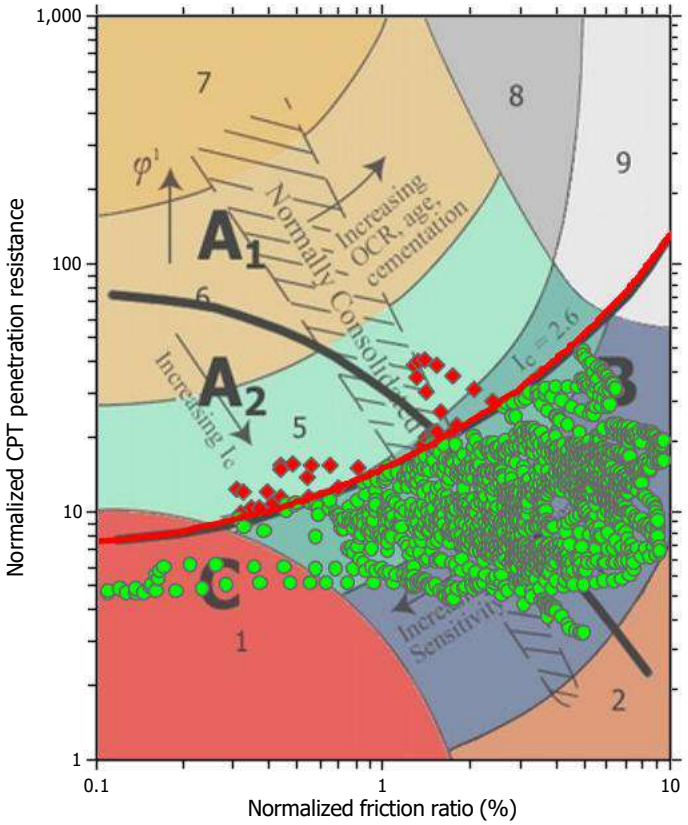
Liquefaction analysis overall plots (intermediate results)

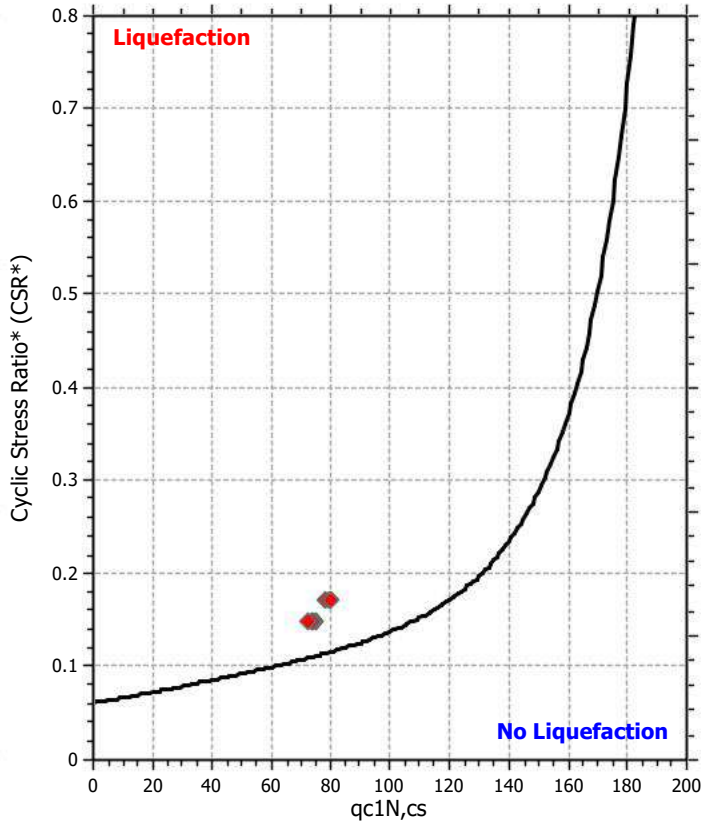


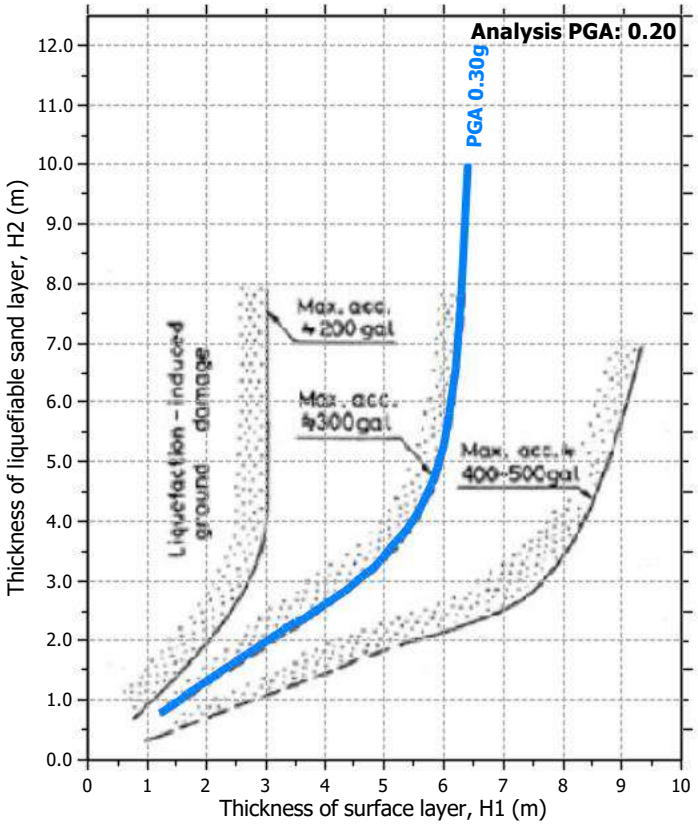
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



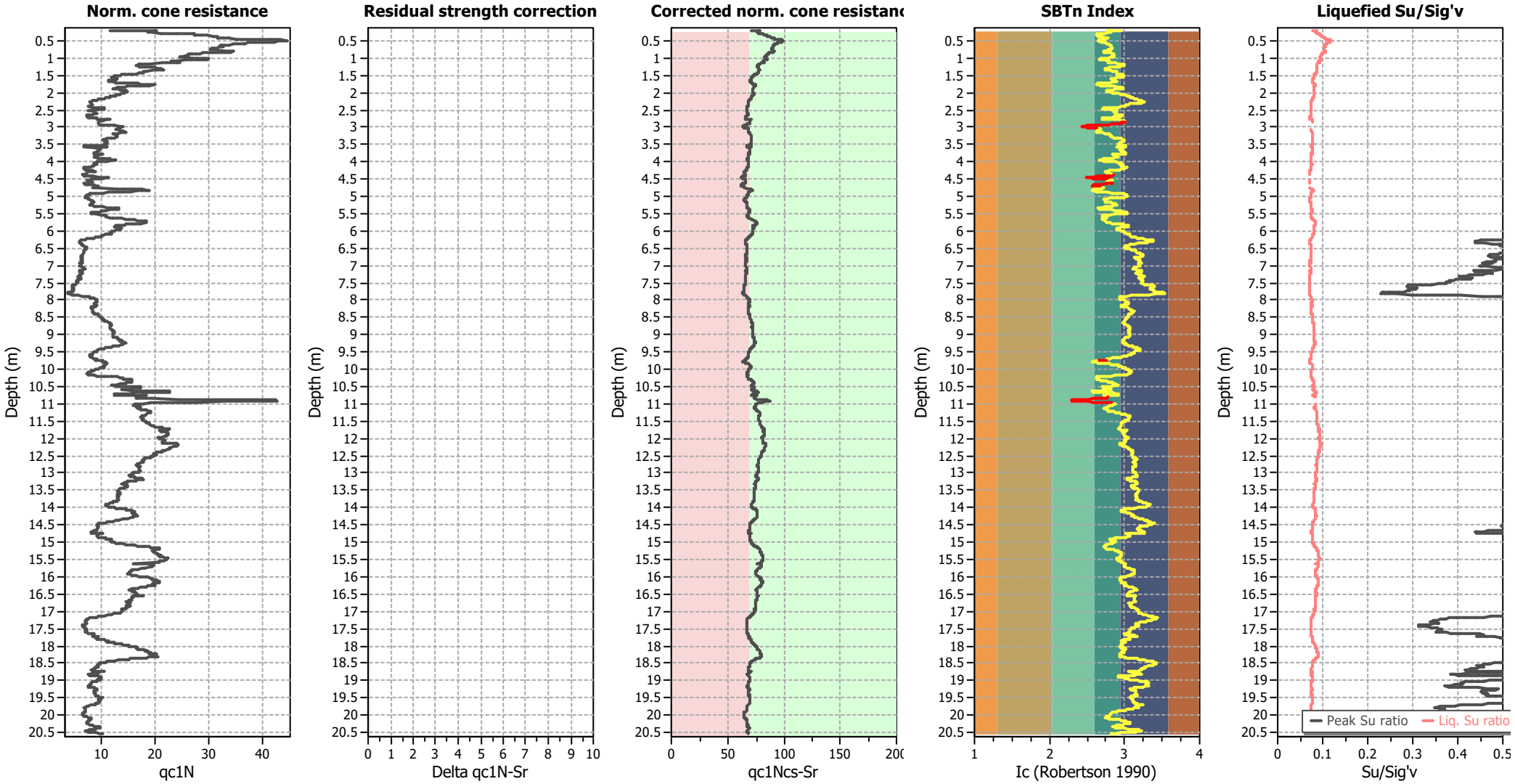




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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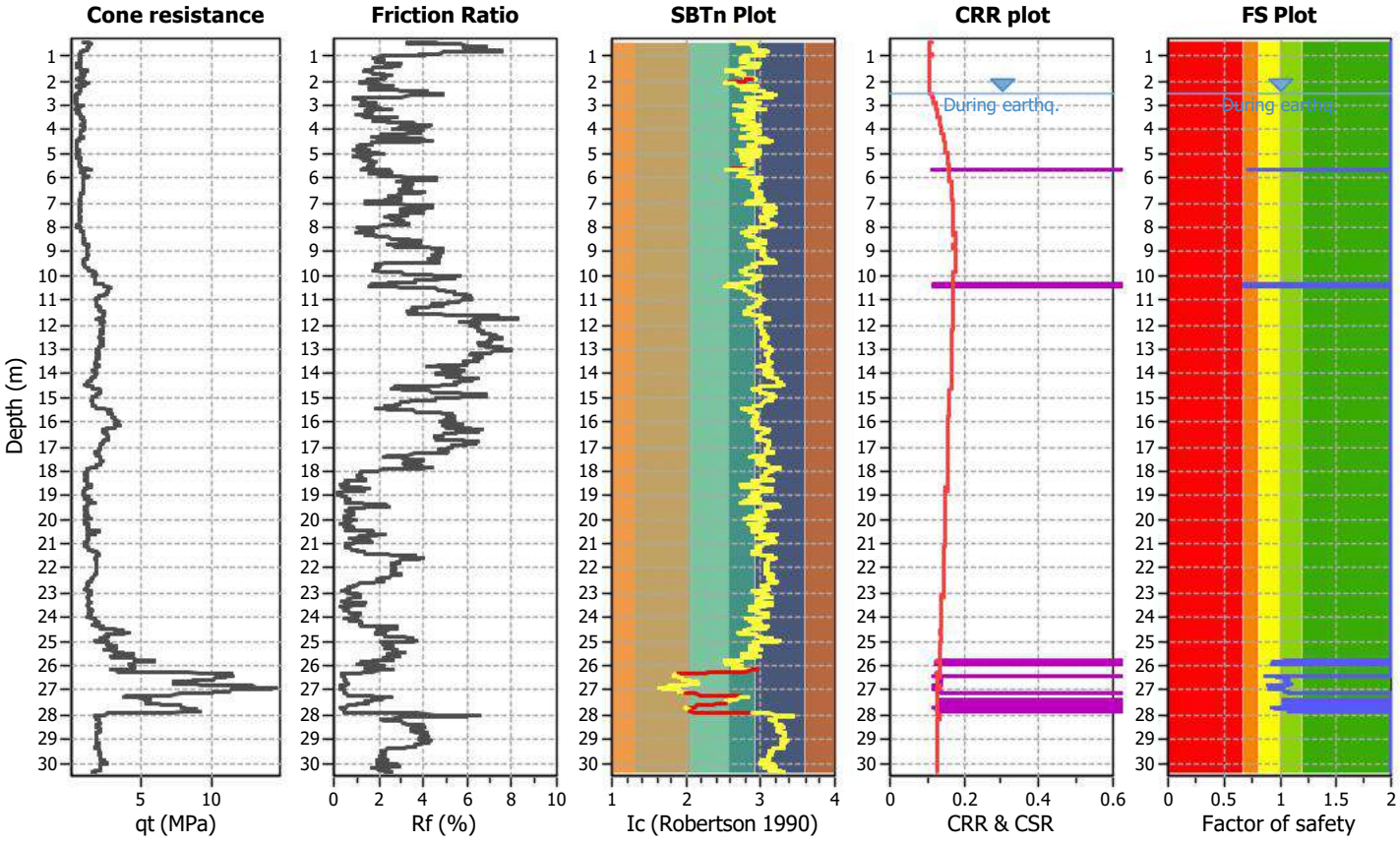
LIQUEFACTION ANALYSIS REPORT

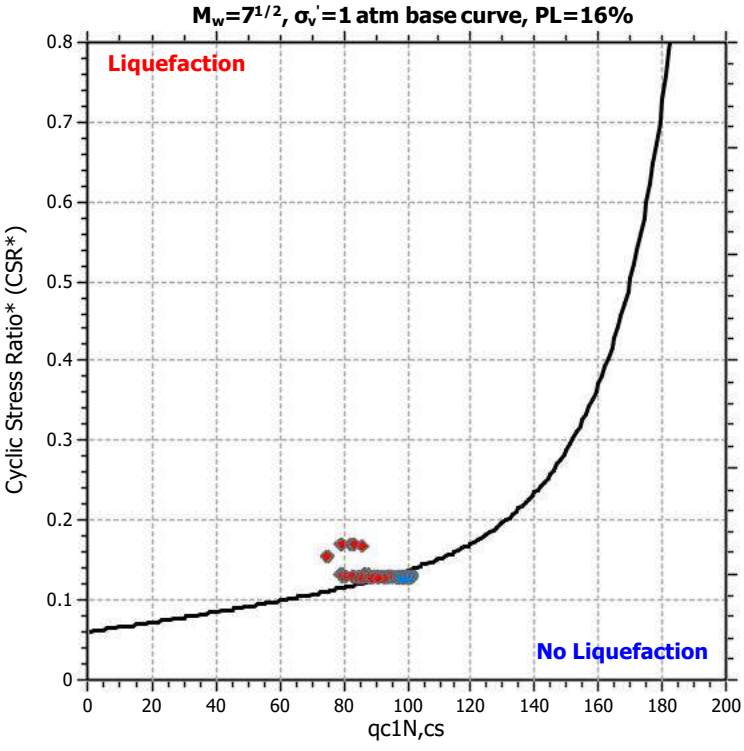
Project title : Ravarino, Conserve della Nonna **Location : Verifica alla liquefazione**

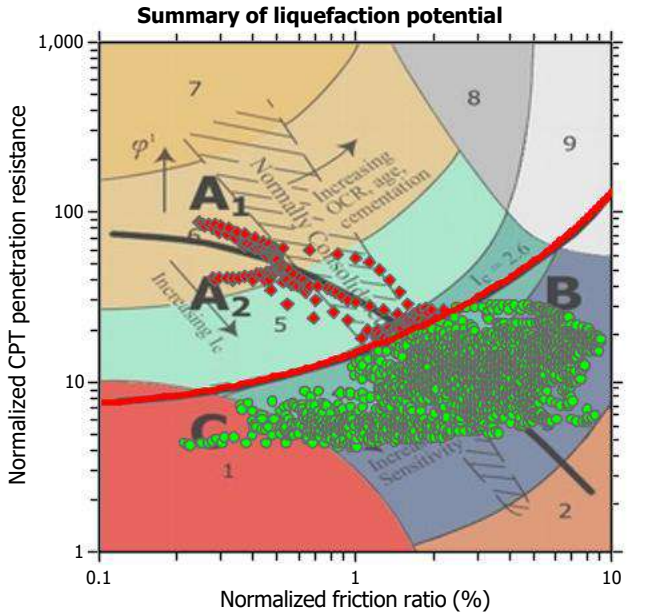
CPT file : CPTU12

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

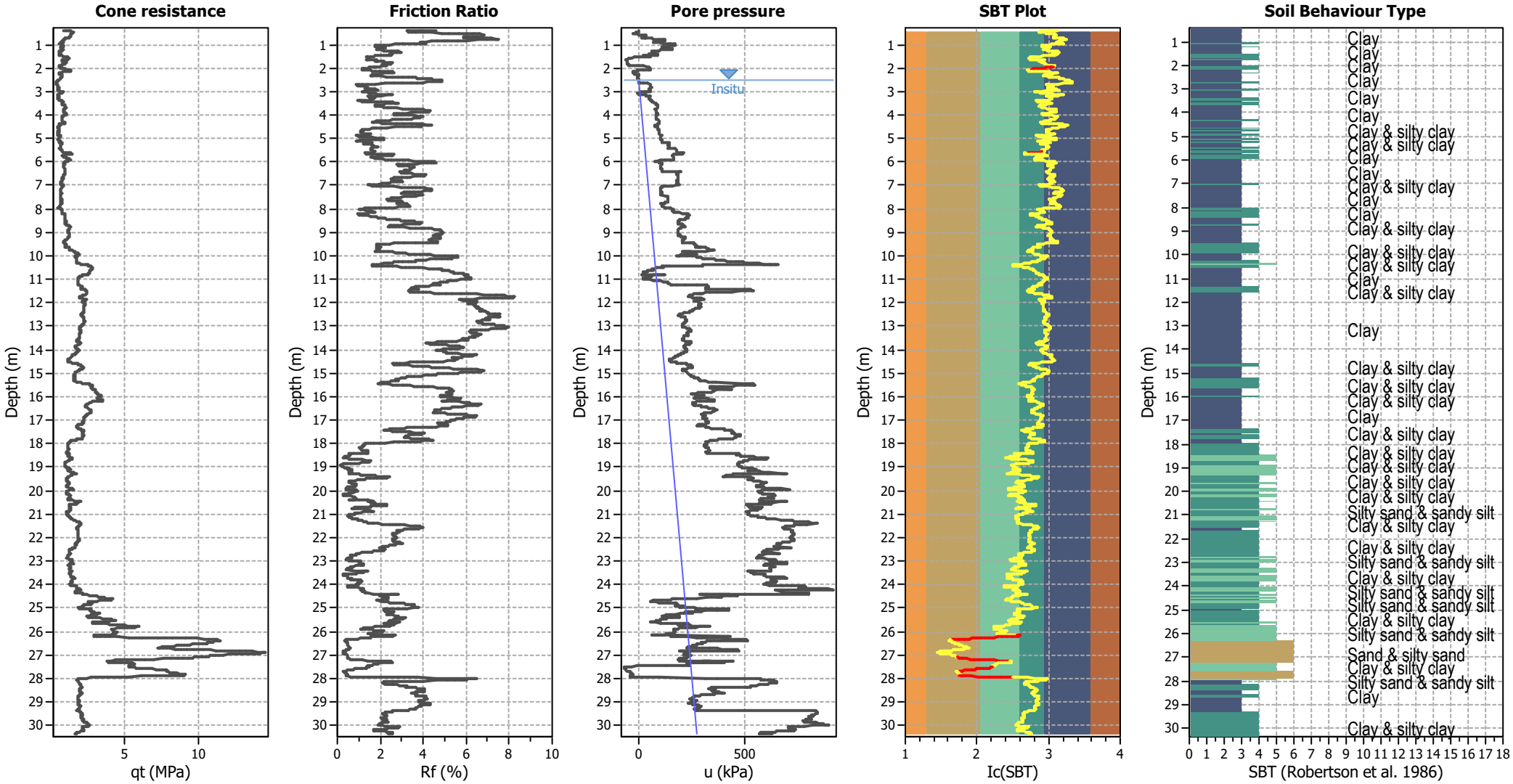






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



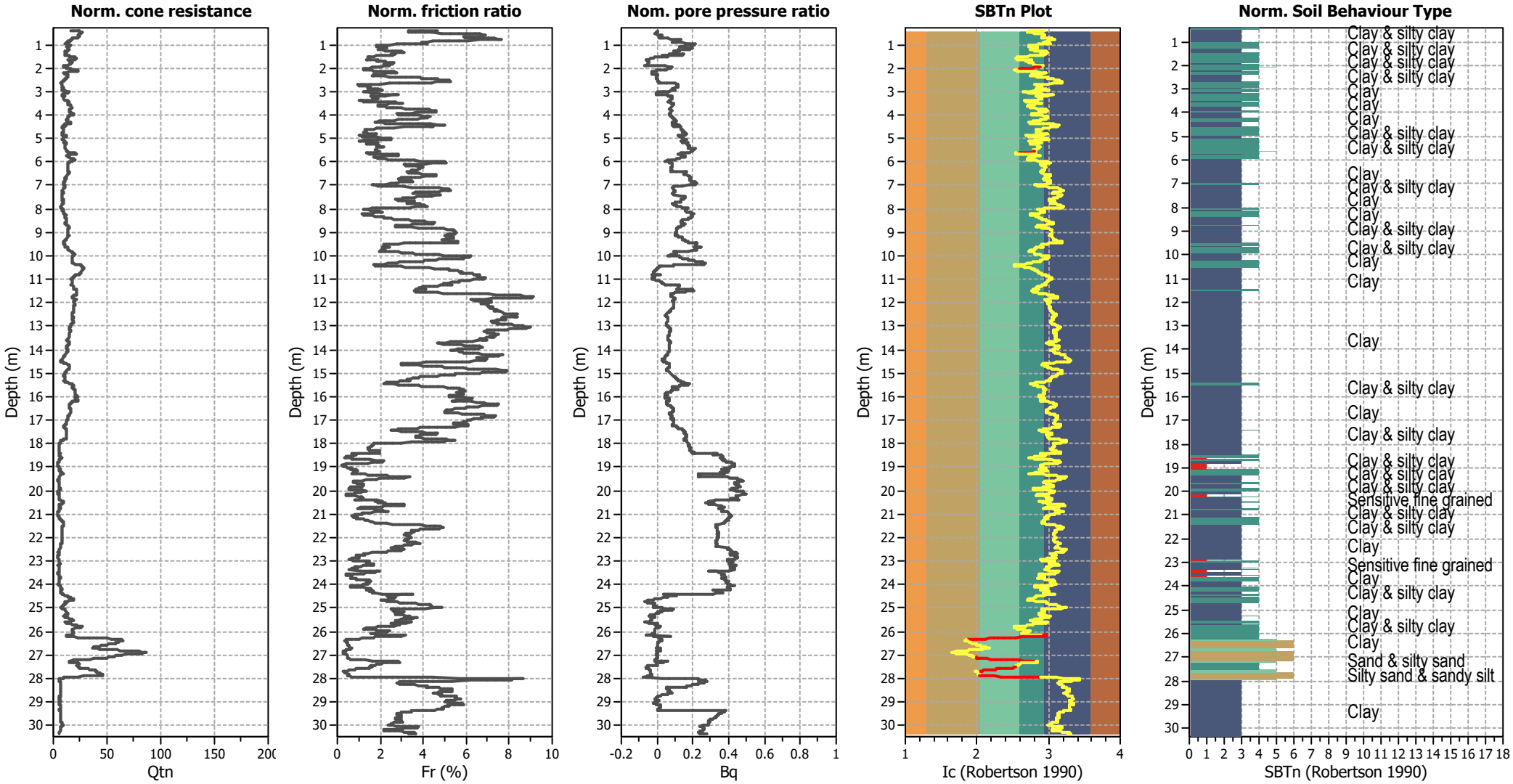
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



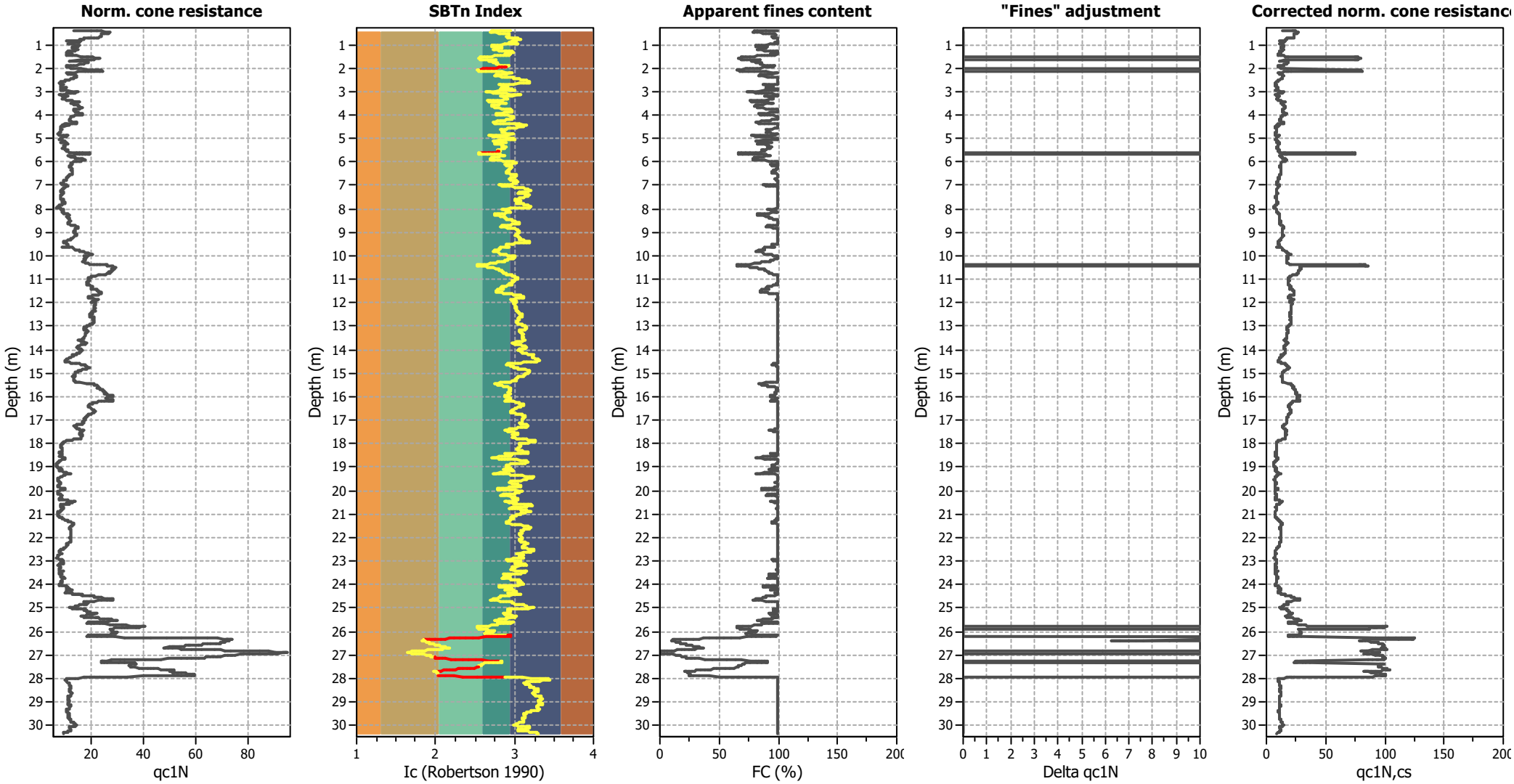
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

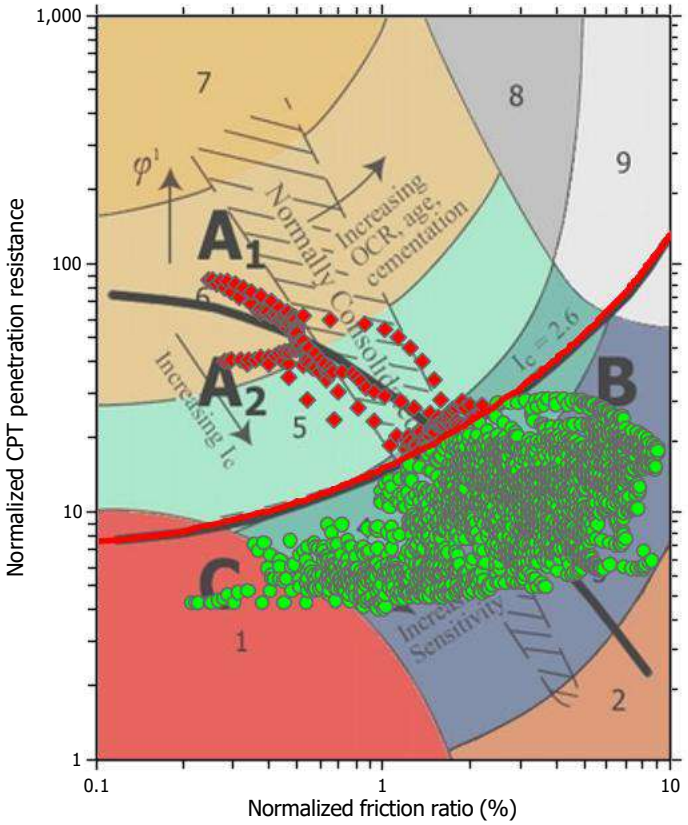
Liquefaction analysis overall plots (intermediate results)

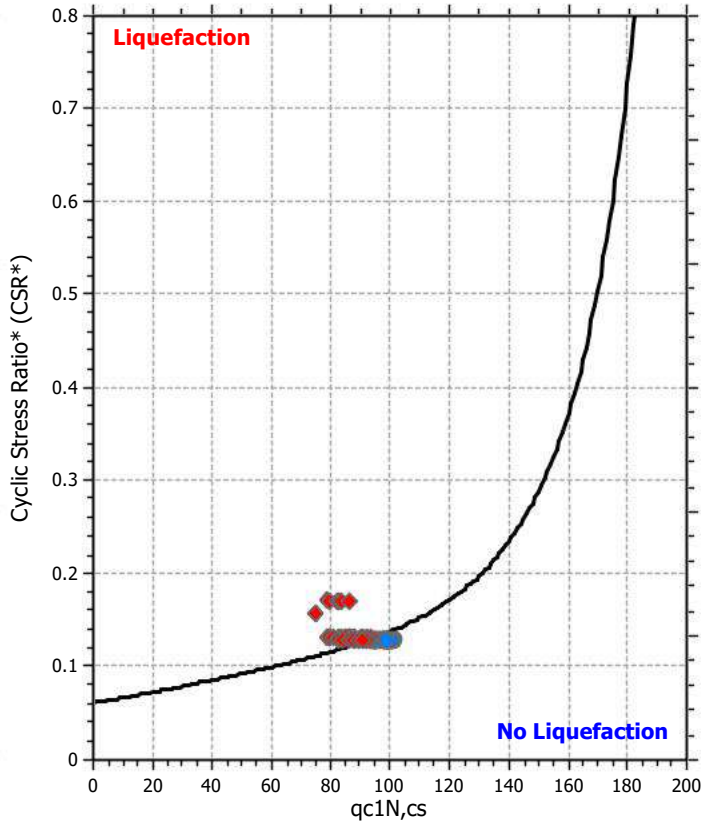


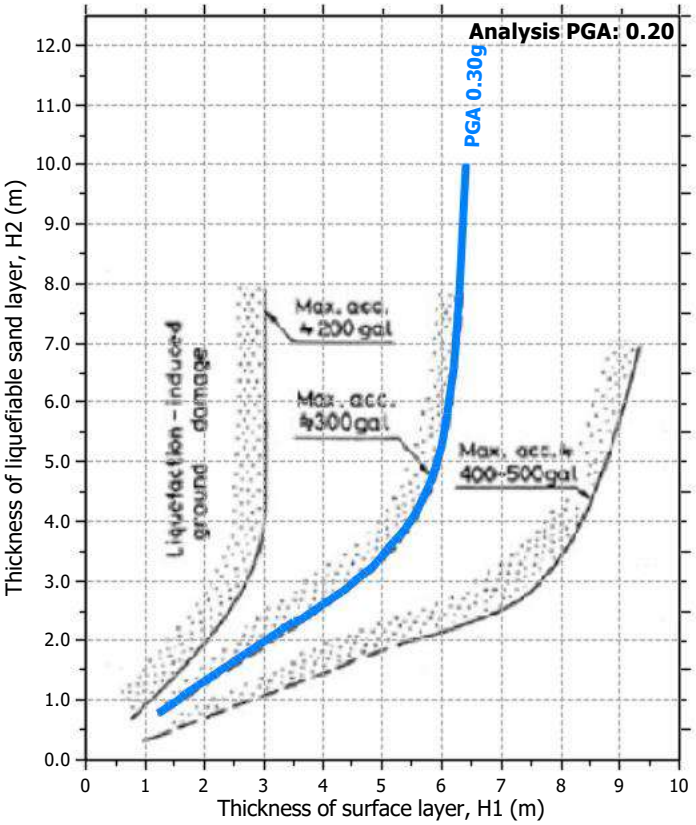
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



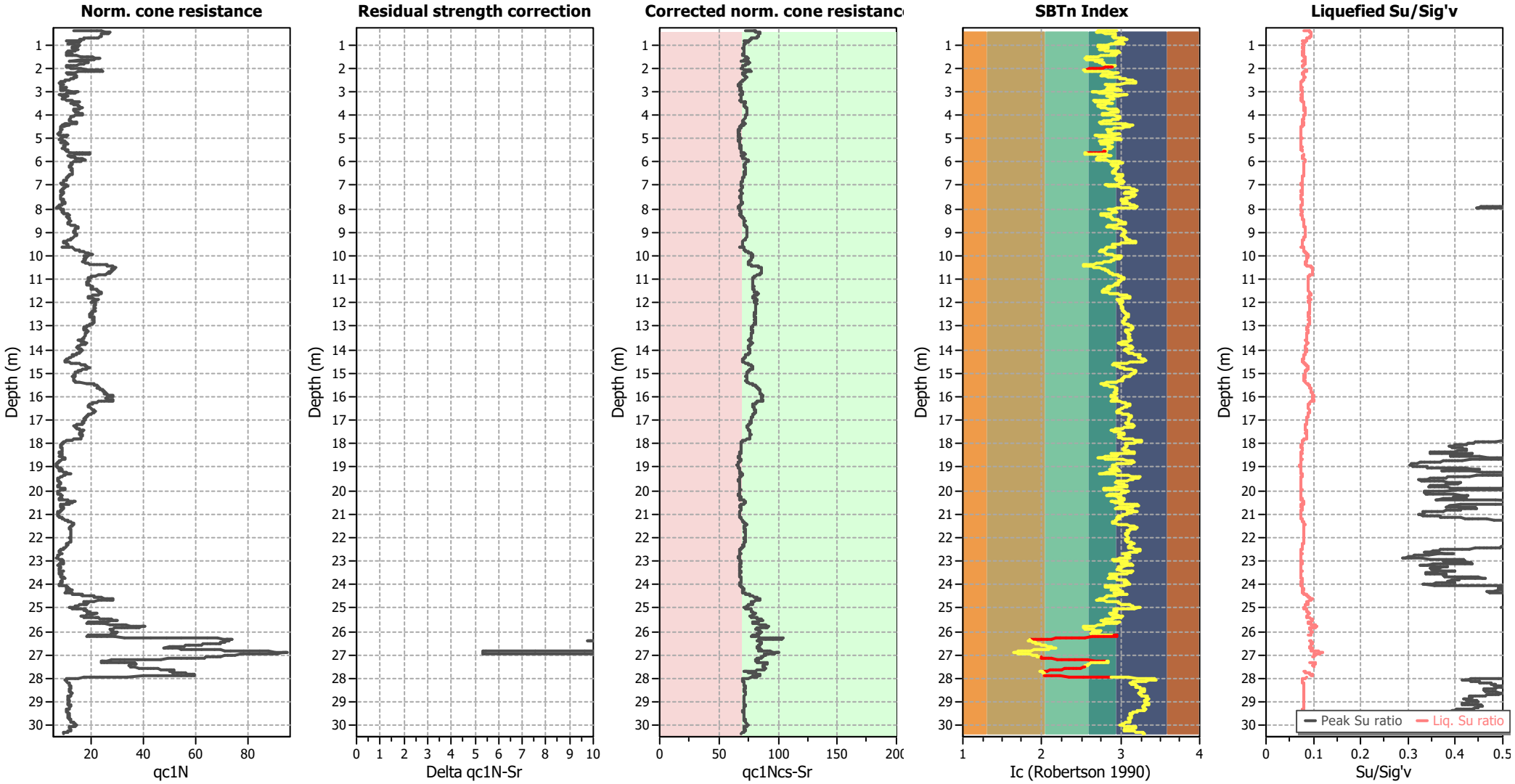




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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LIQUEFACTION ANALYSIS REPORT

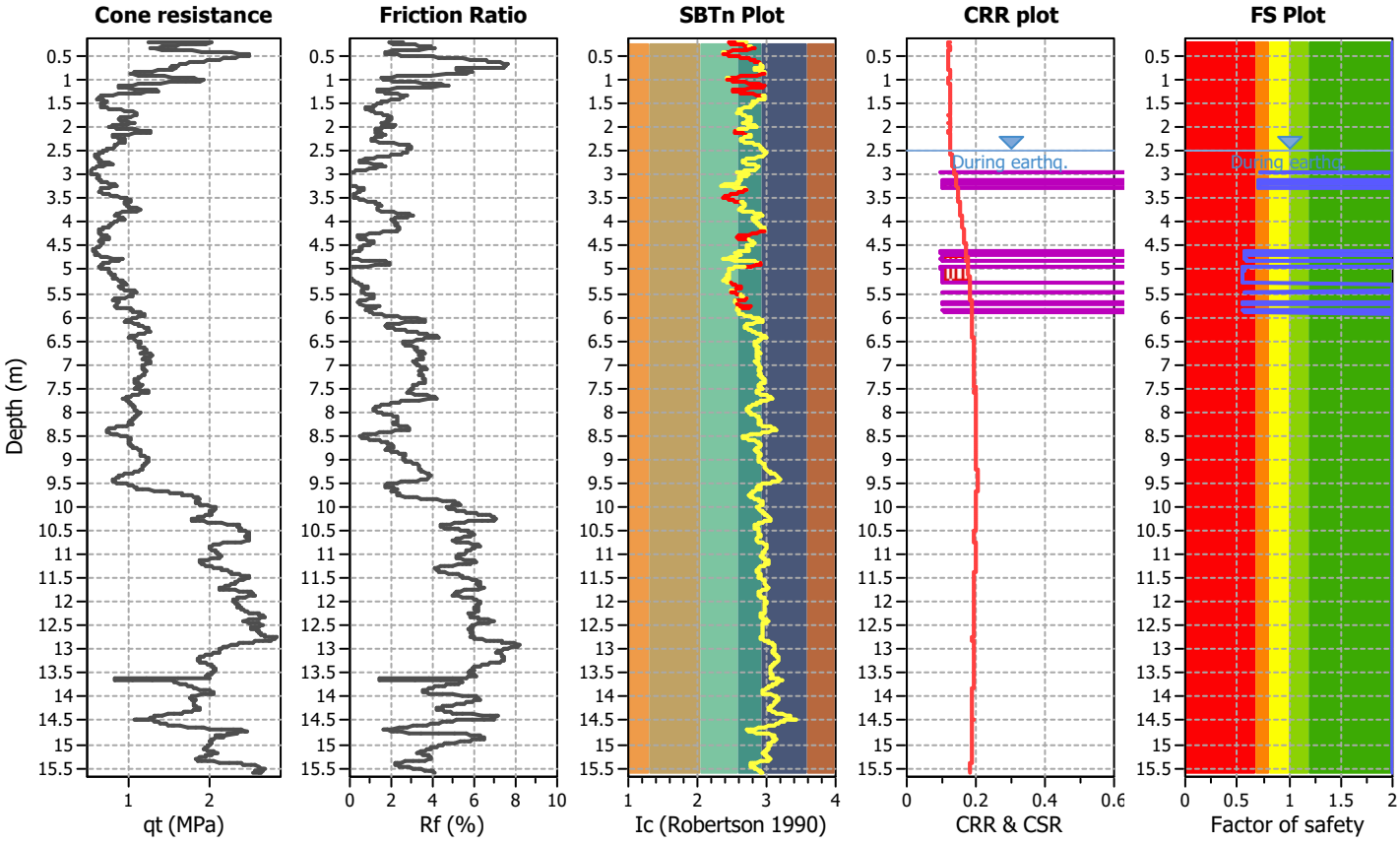
Project title : Ravarino

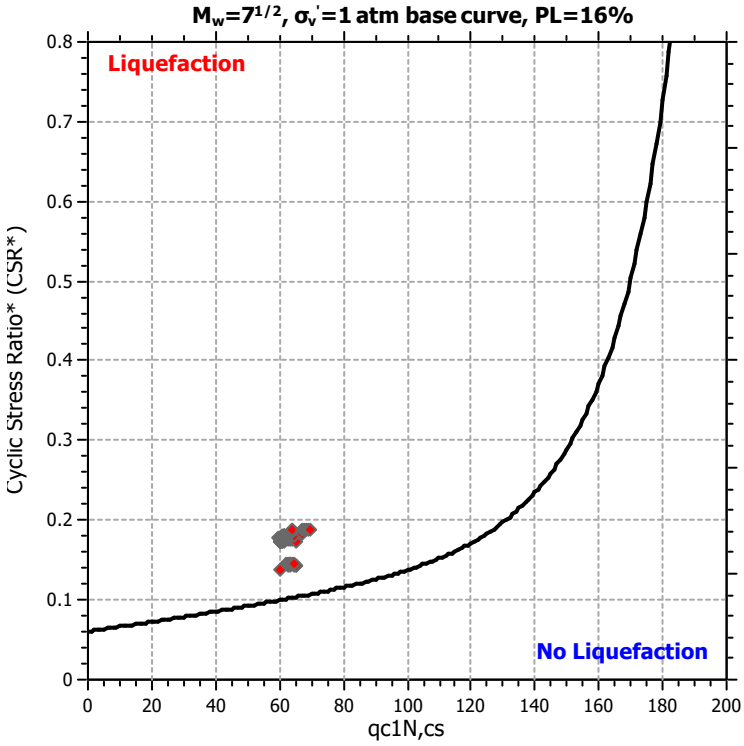
Location : Studio del terreno di fondazione

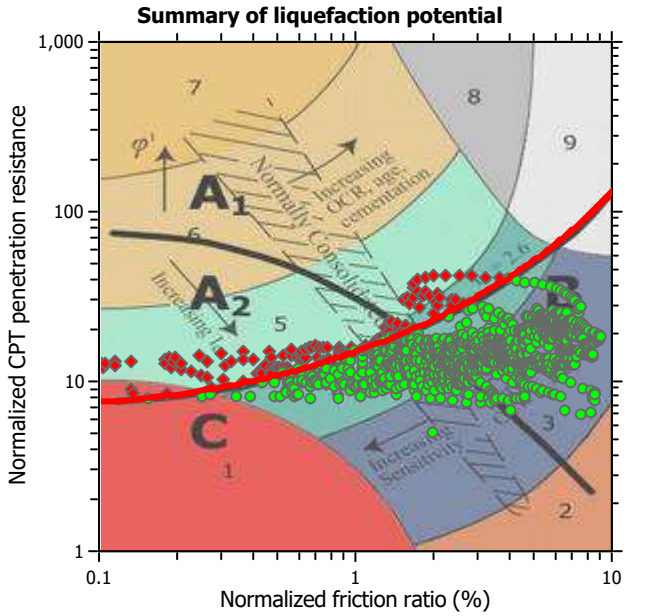
CPT file : CPTU1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

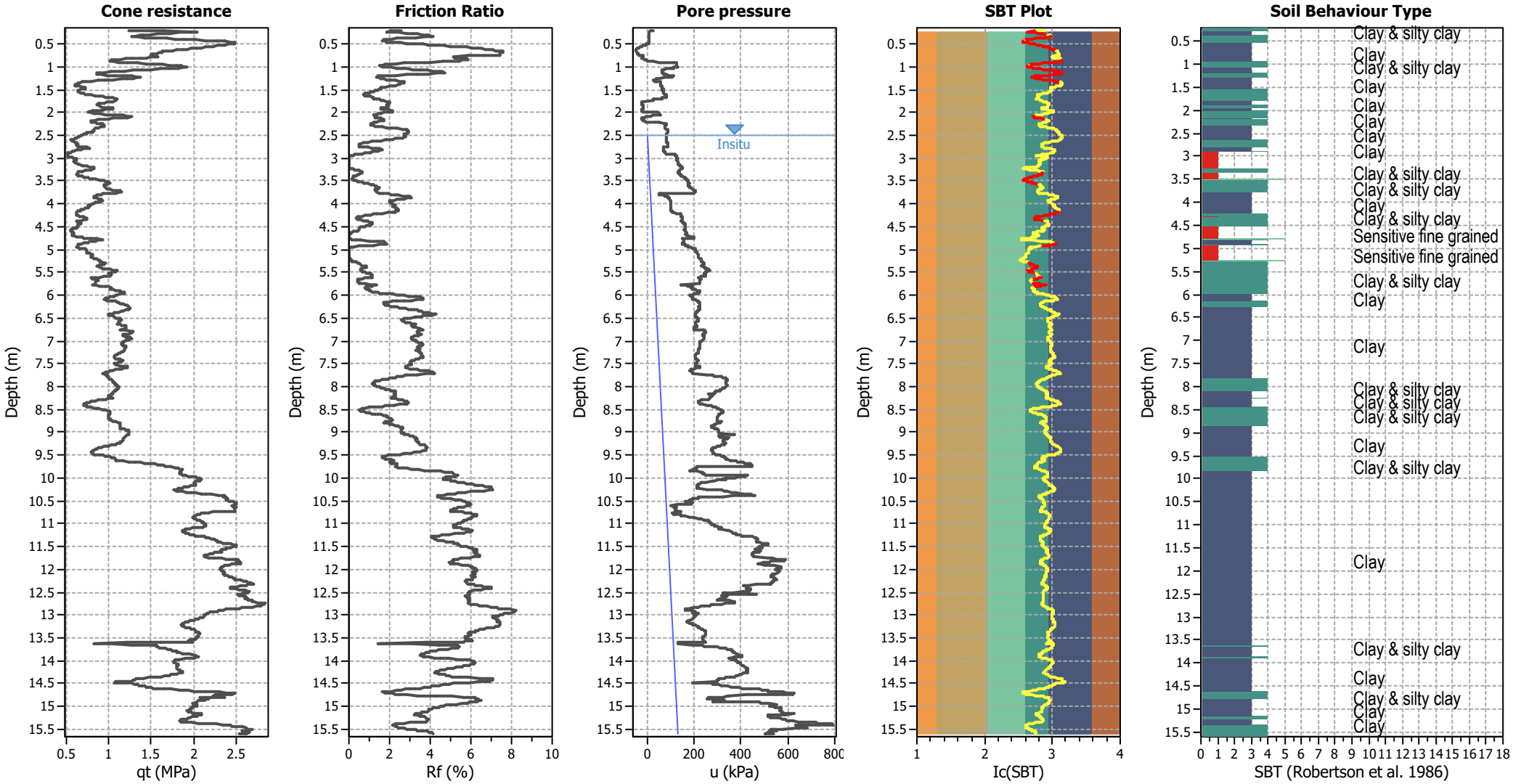






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



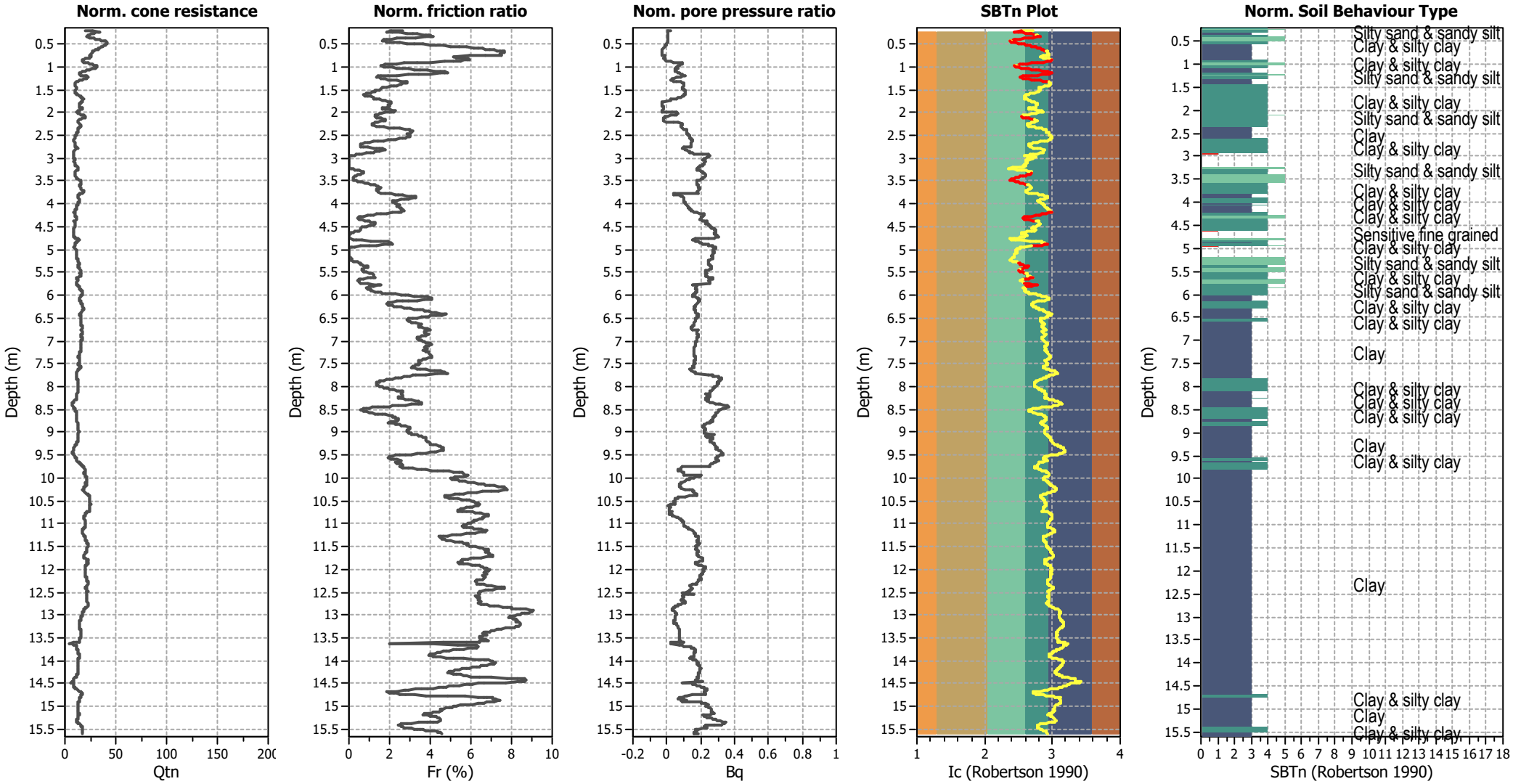
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



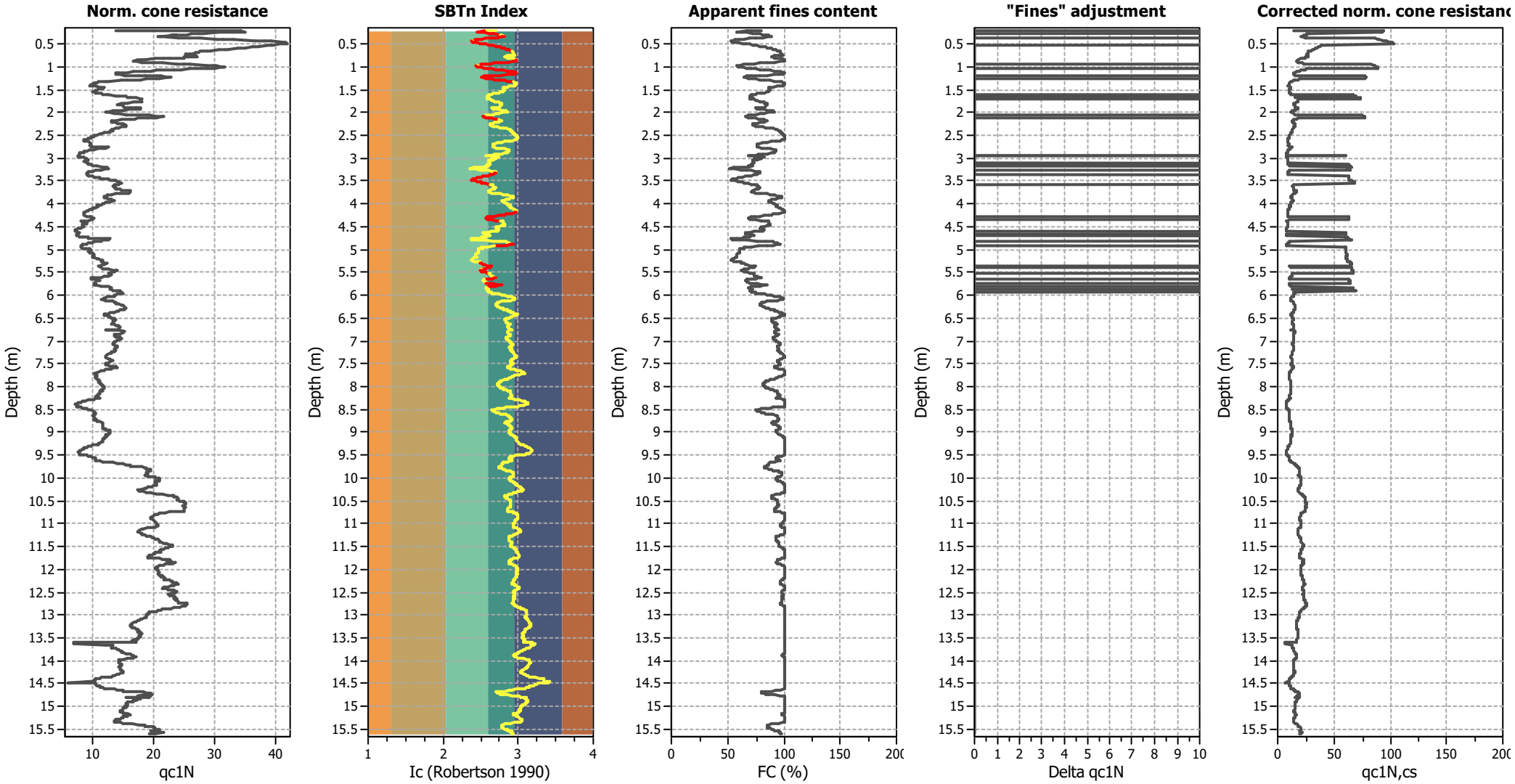
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

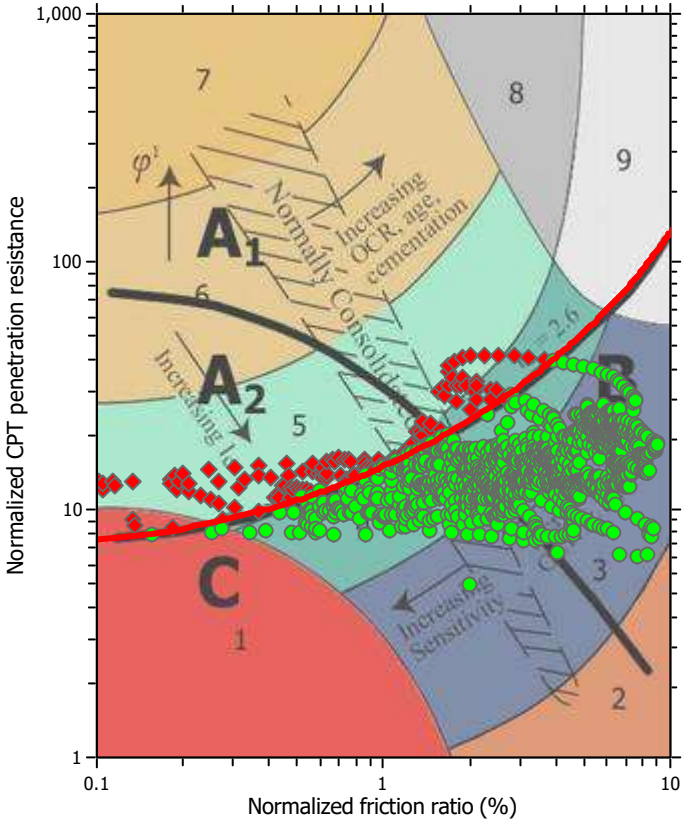
Liquefaction analysis overall plots (intermediate results)

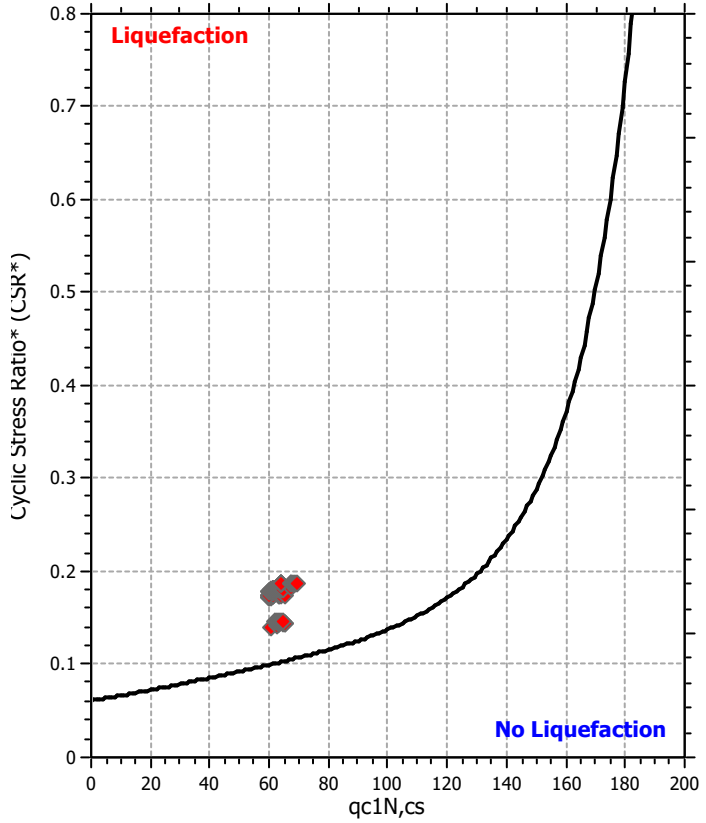


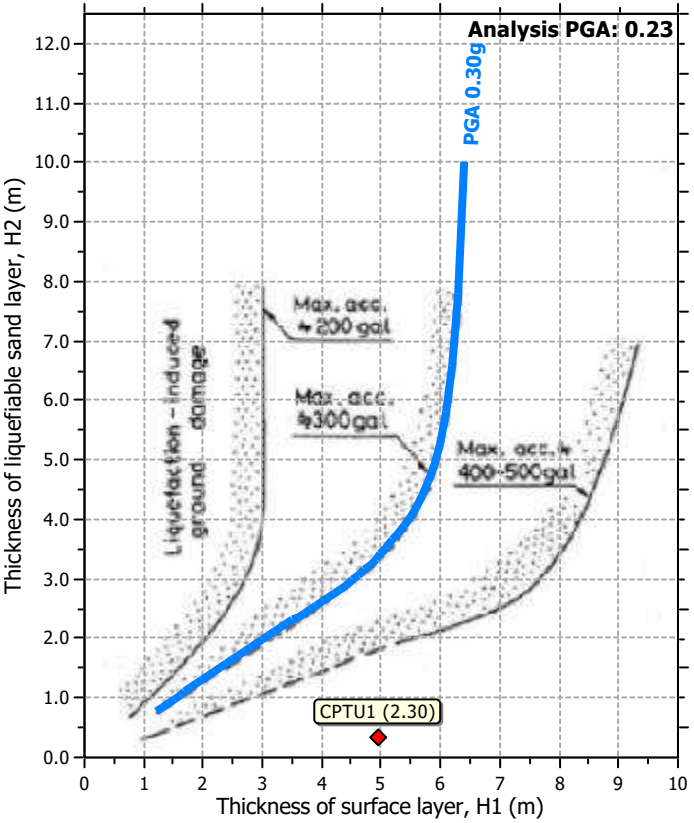
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



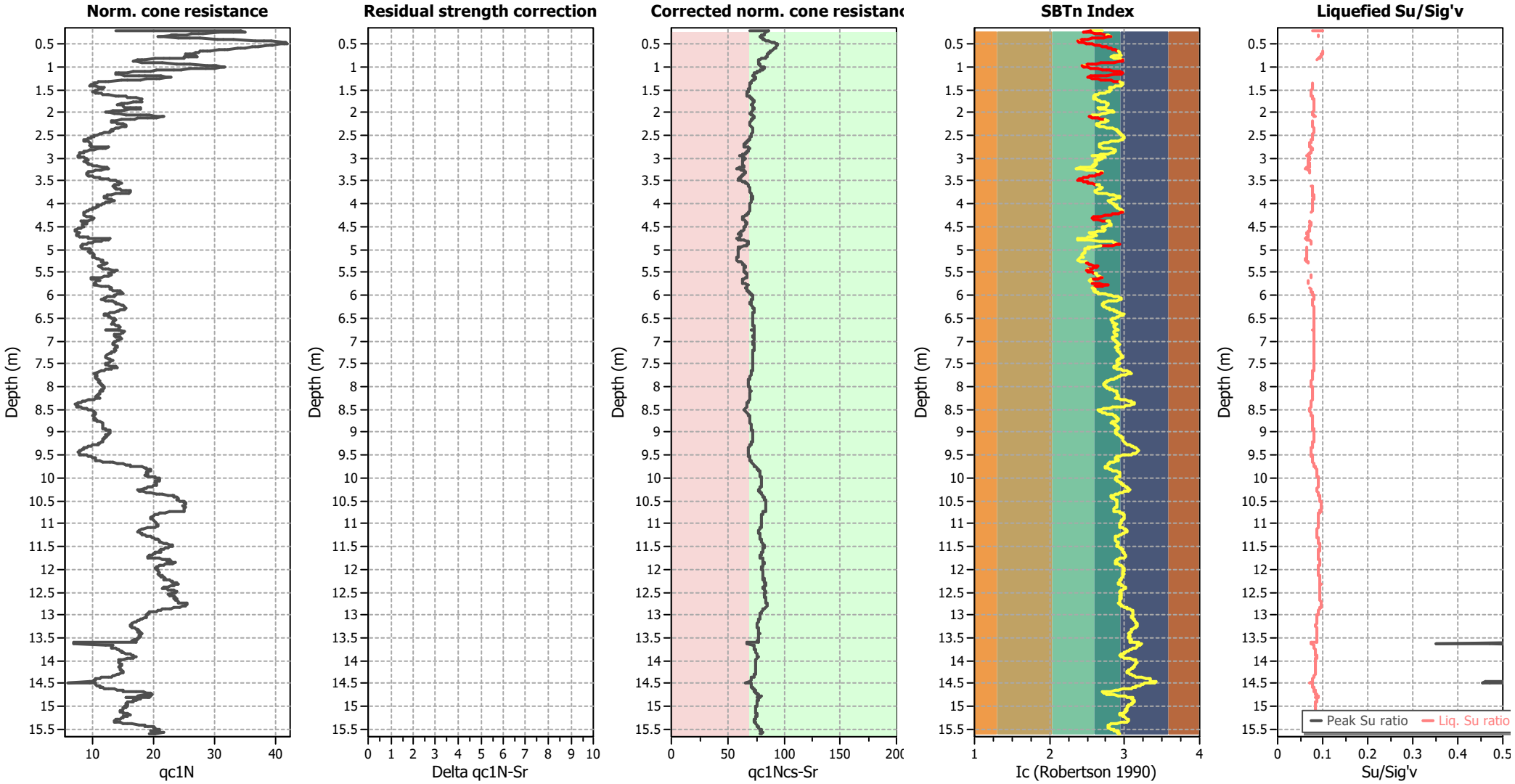




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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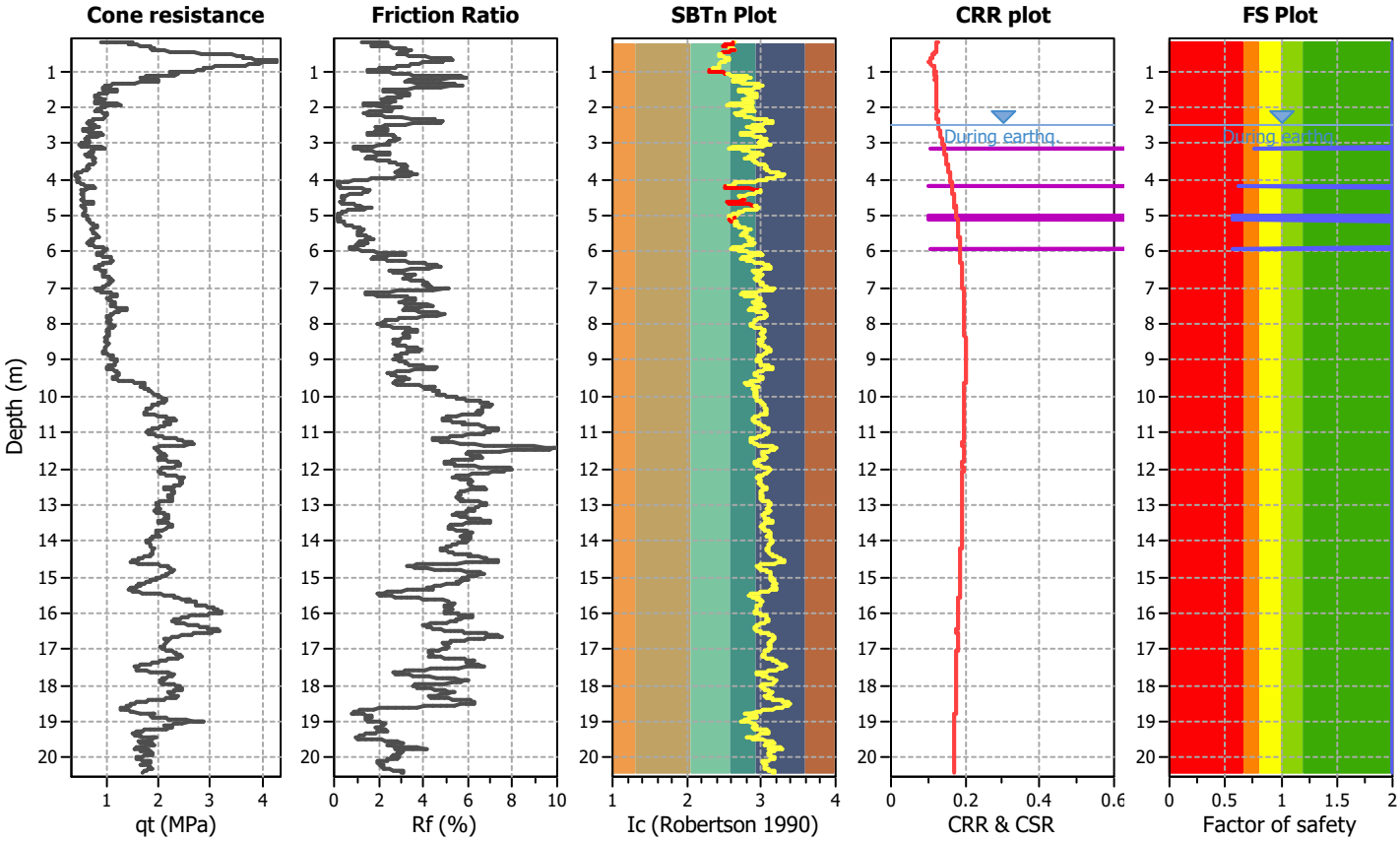
LIQUEFACTION ANALYSIS REPORT

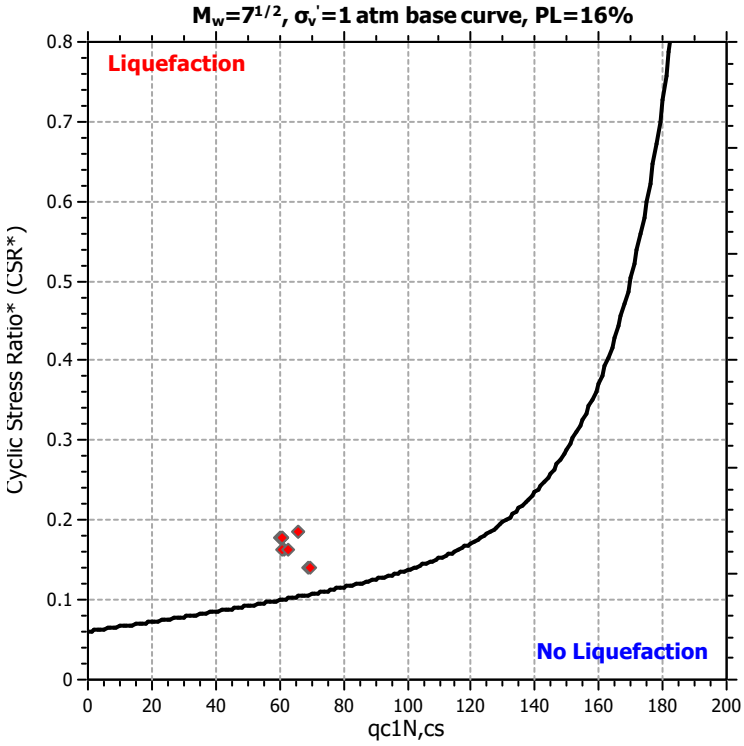
Project title : Ravarino **Location : Studio del terreno di fondazione**

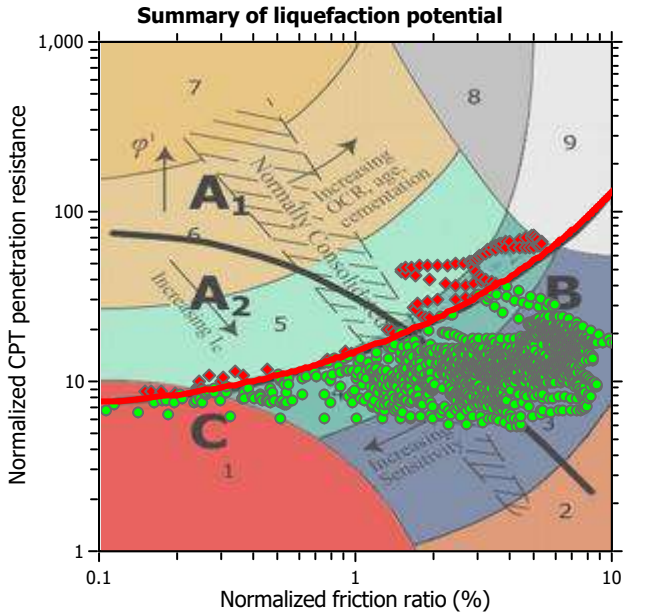
CPT file : CPTU2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

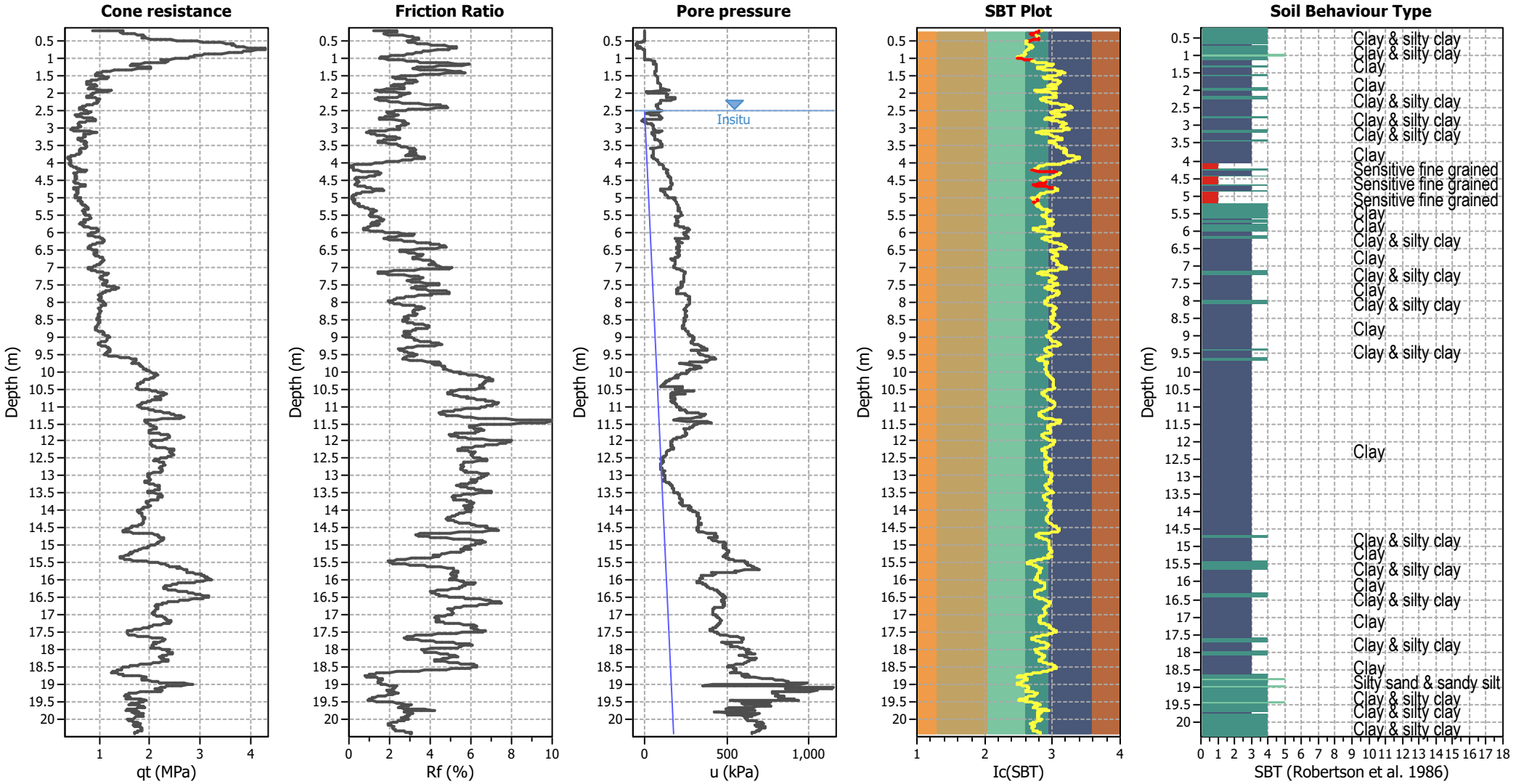






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



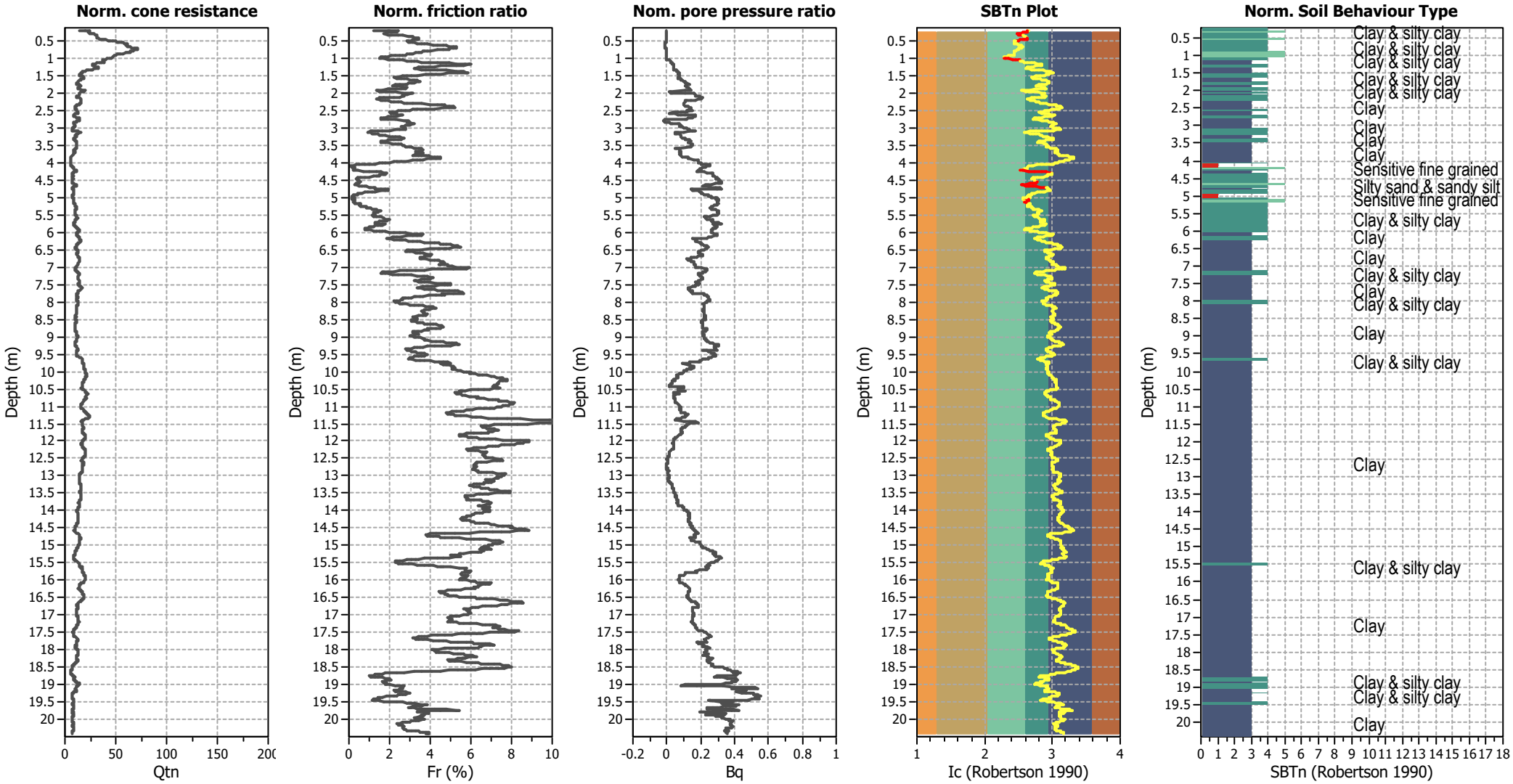
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



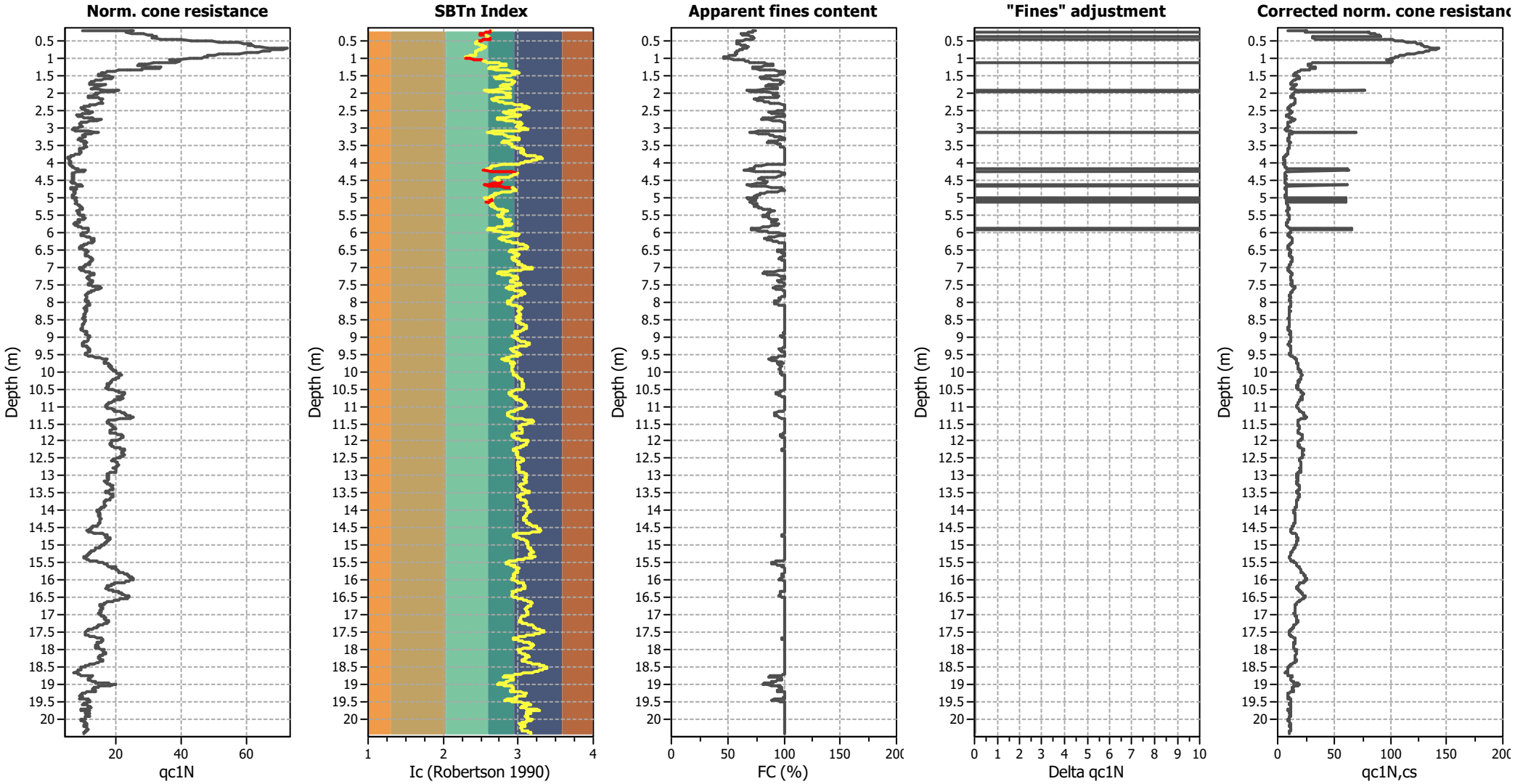
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

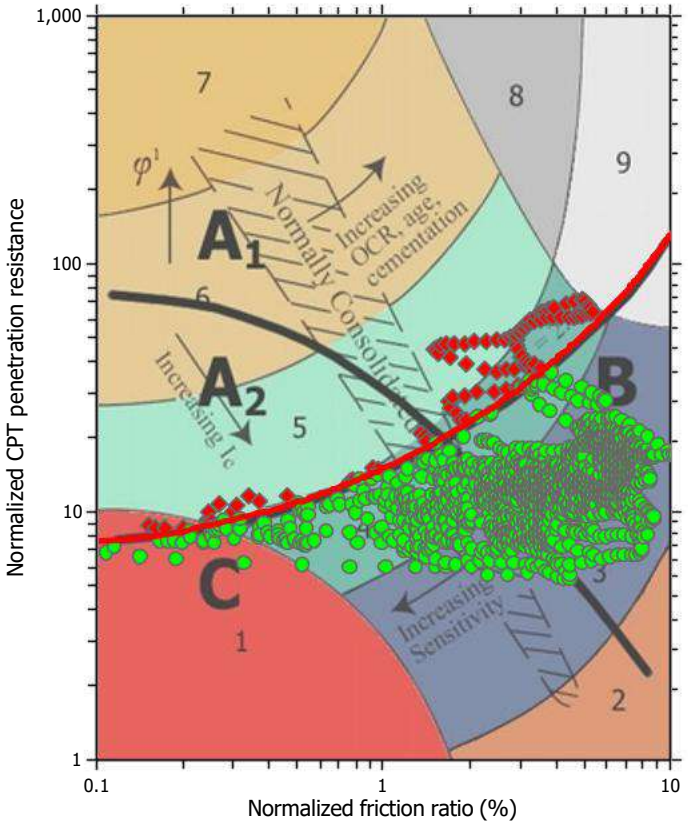
Liquefaction analysis overall plots (intermediate results)

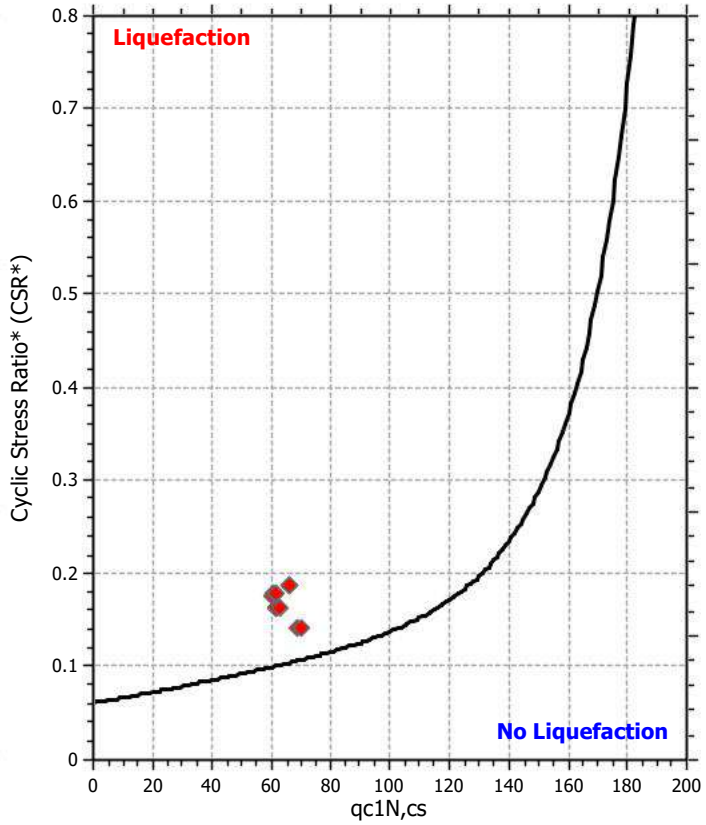


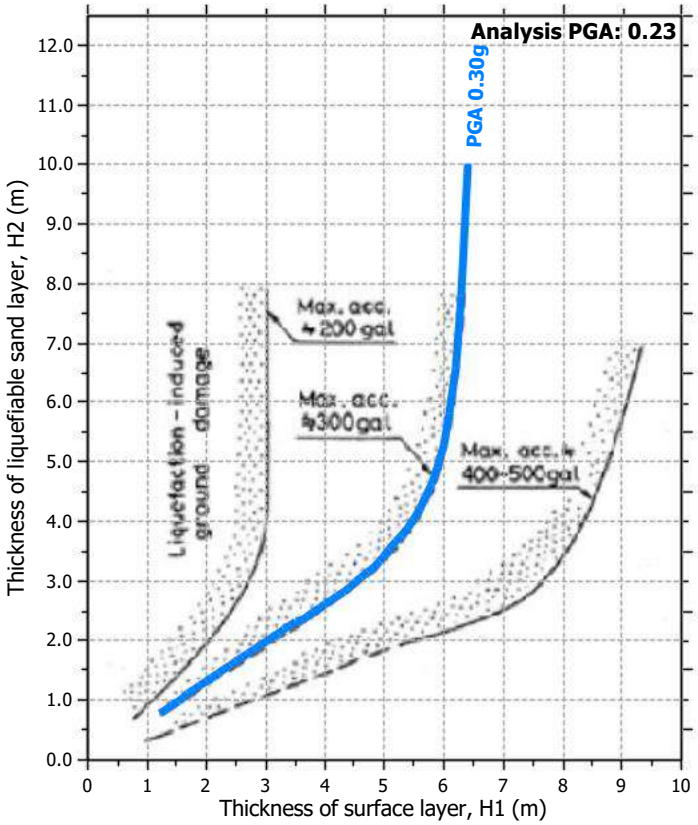
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



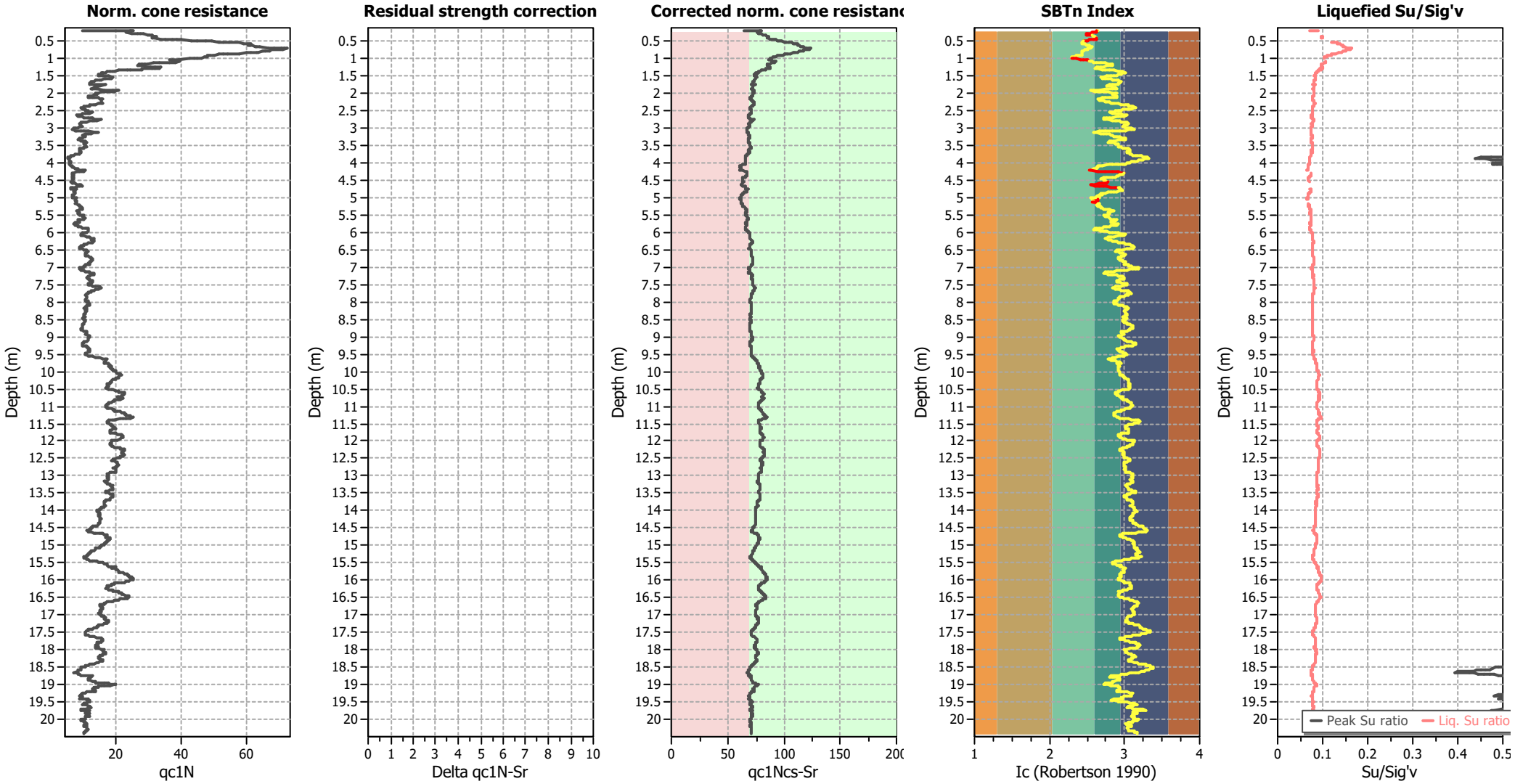




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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LIQUEFACTION ANALYSIS REPORT

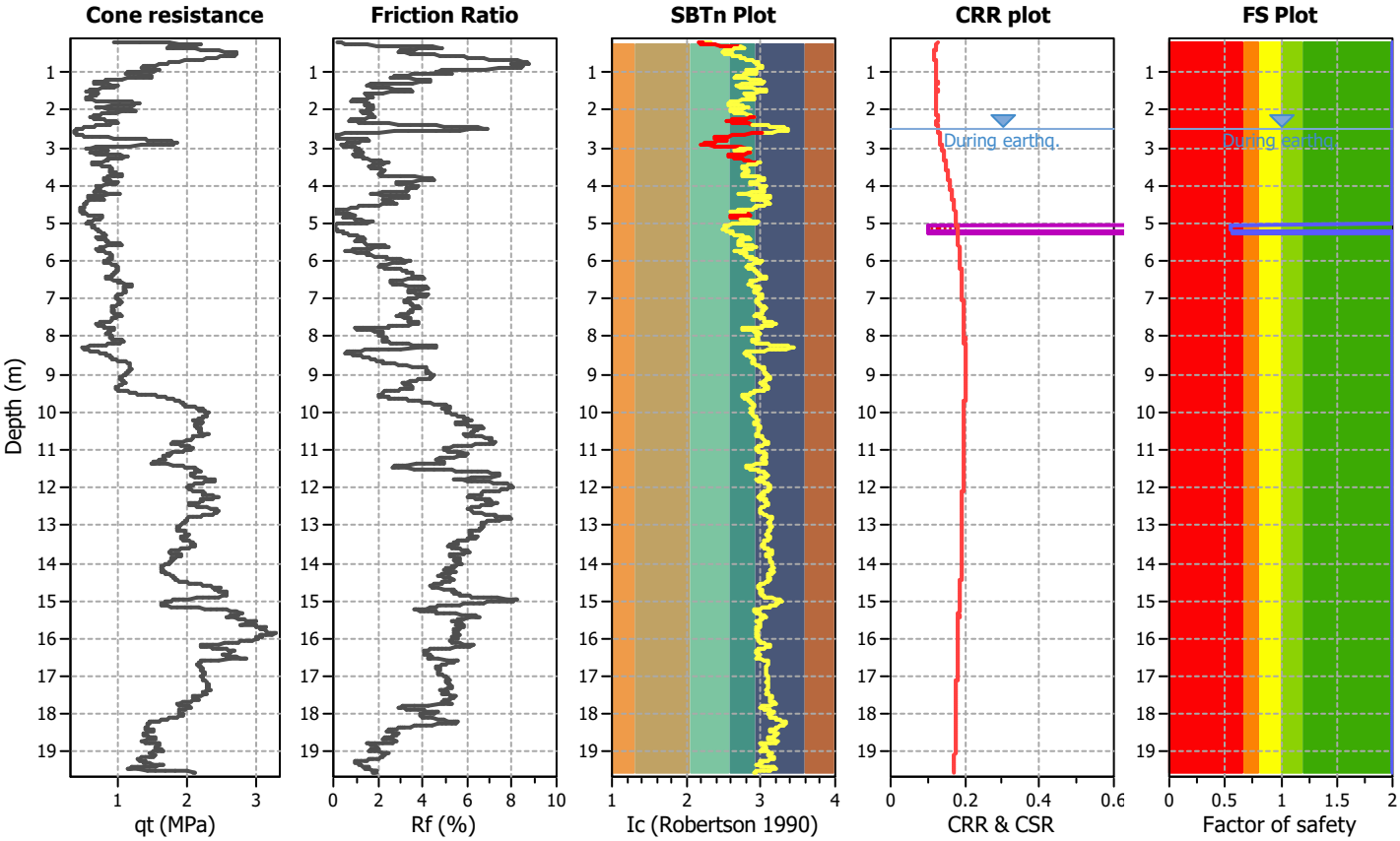
Project title : Ravarino

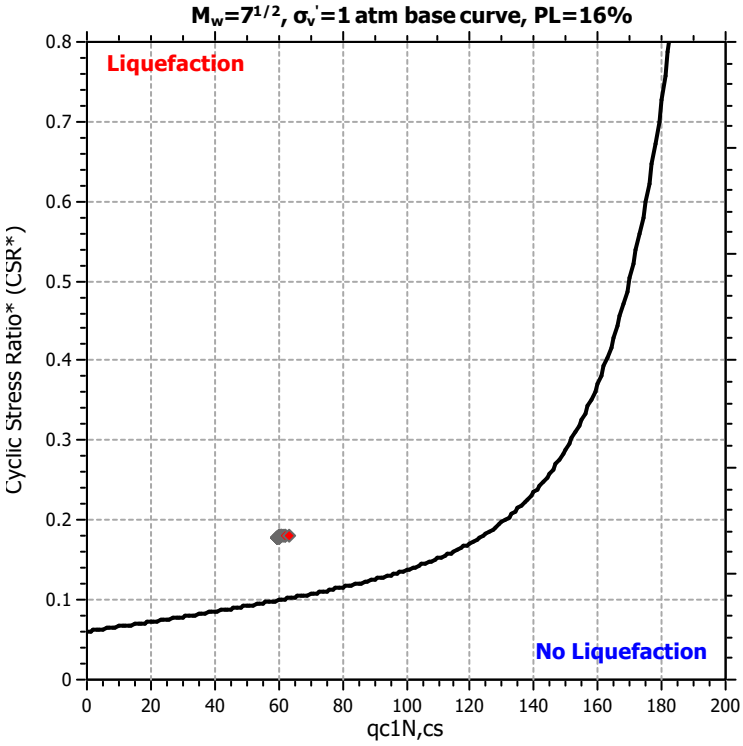
Location : Studio del terreno di fondazione

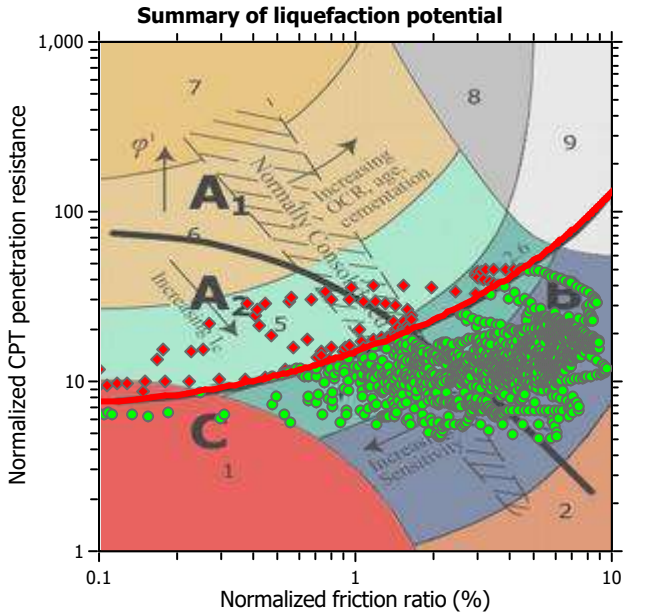
CPT file : CPTU4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

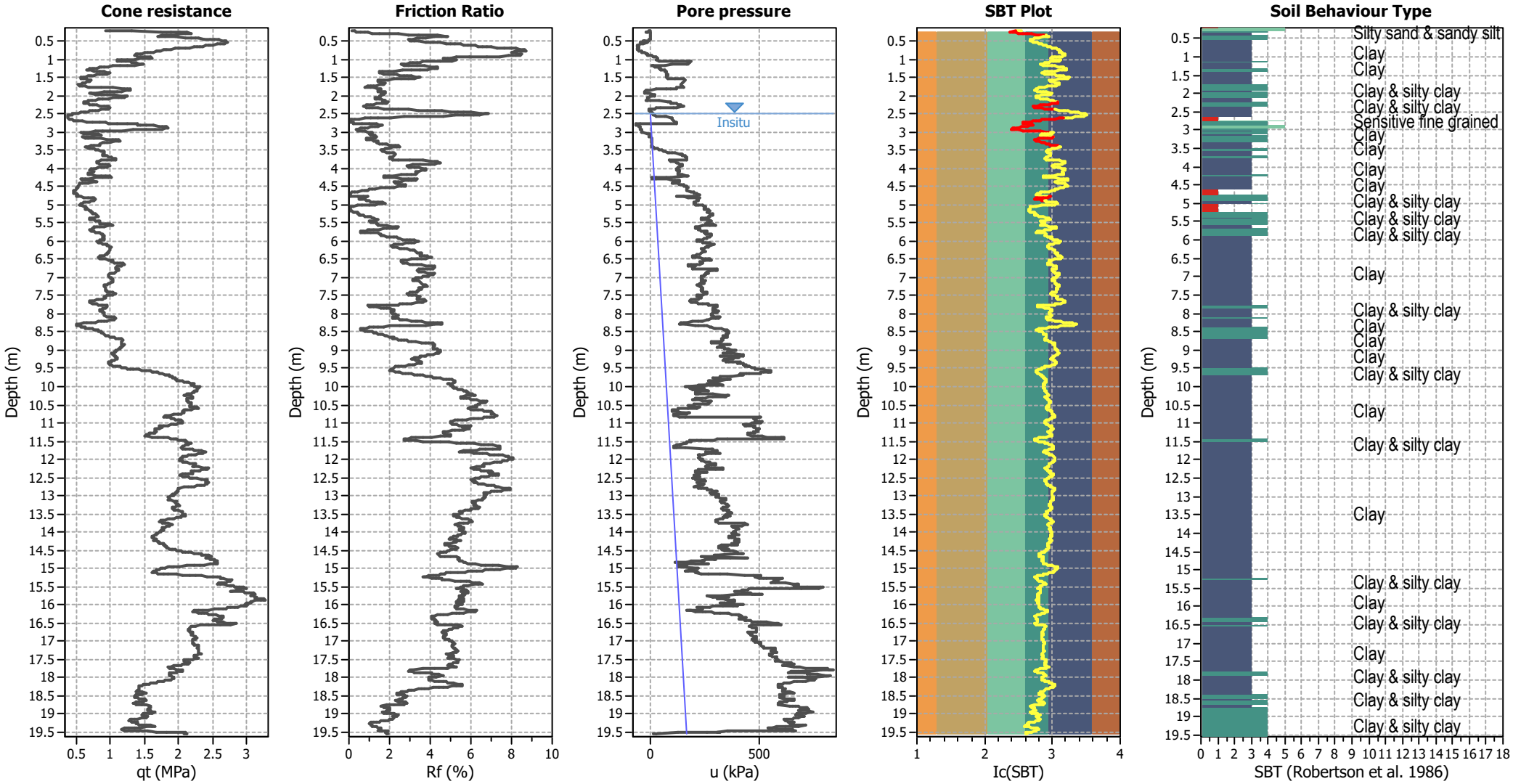






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



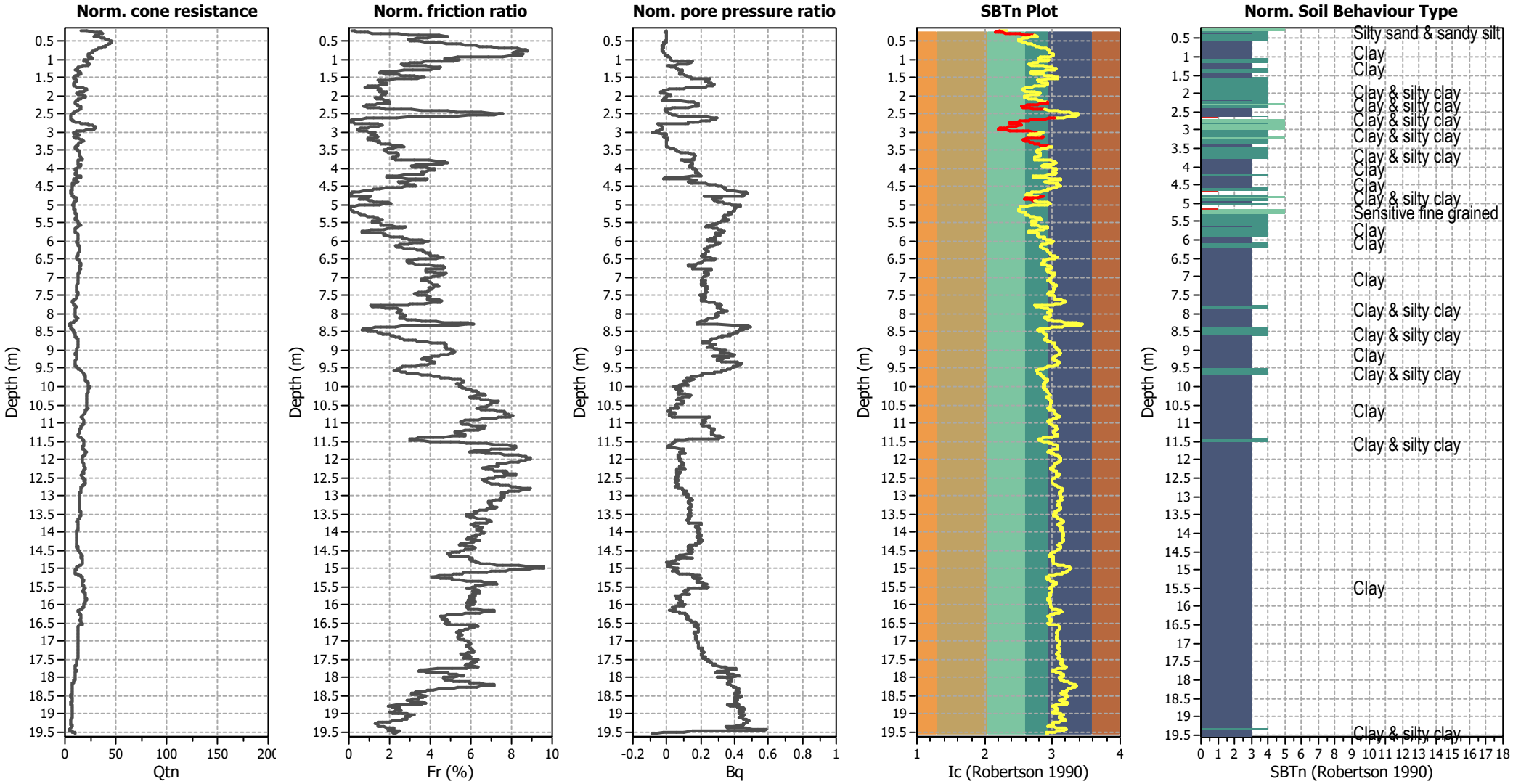
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



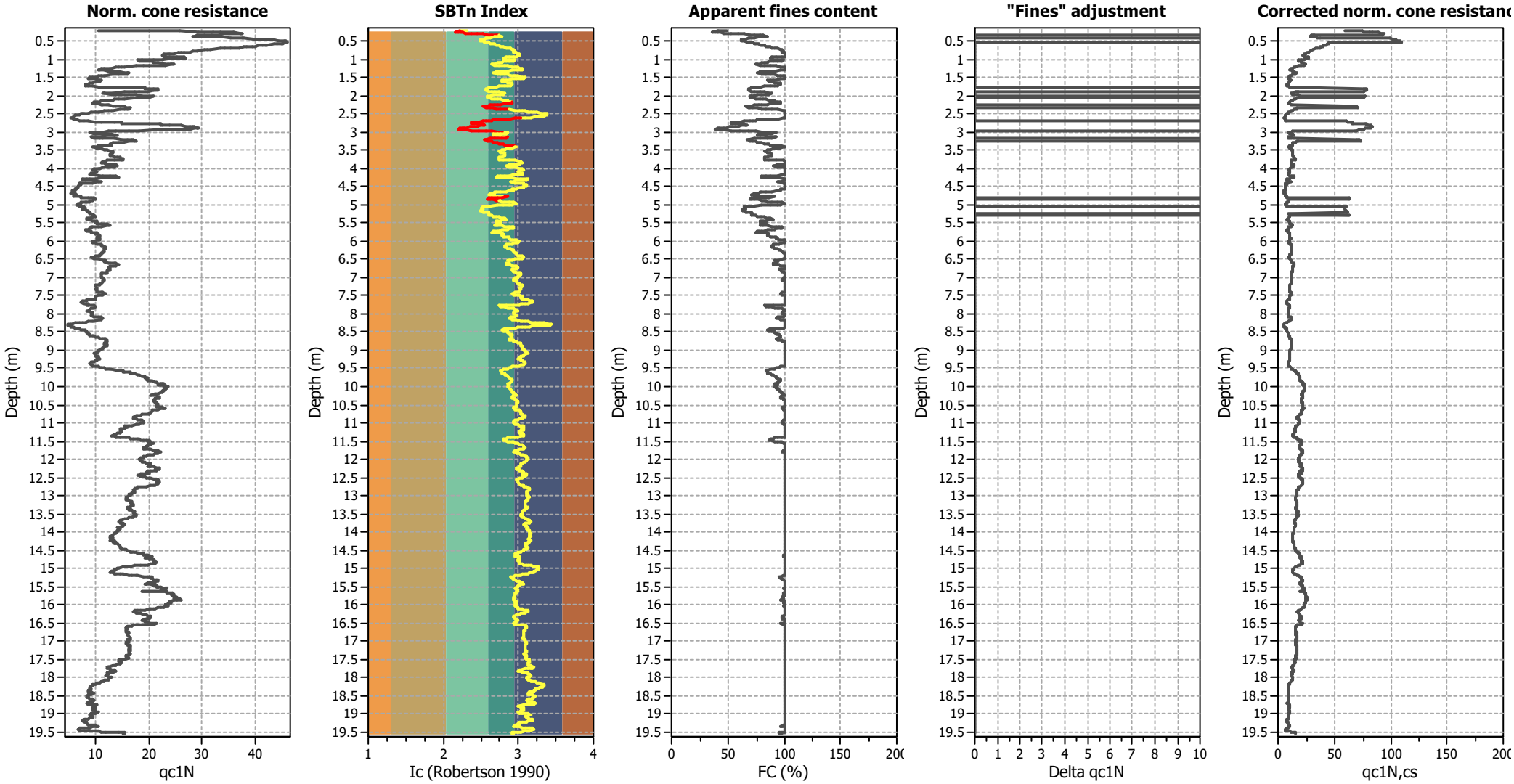
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

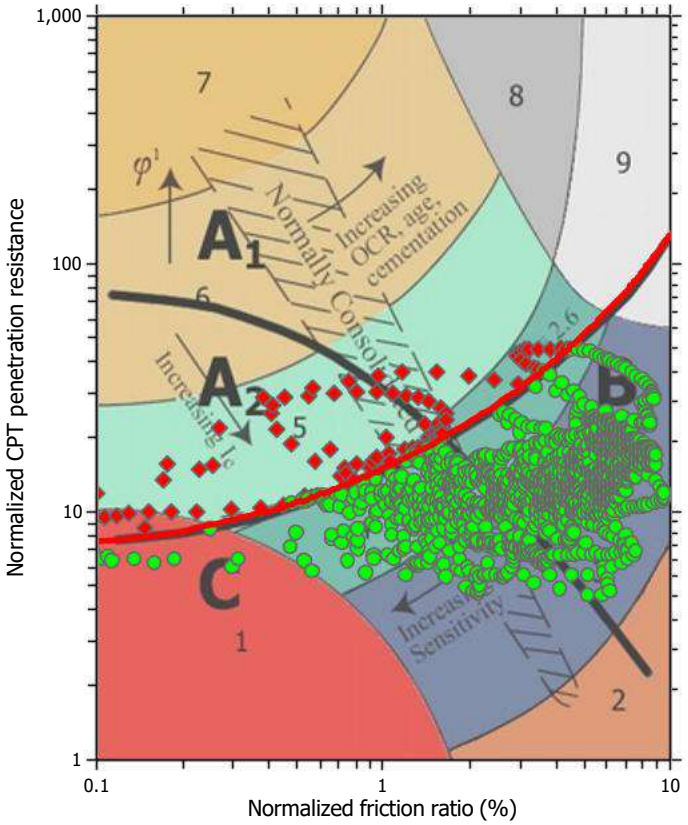
Liquefaction analysis overall plots (intermediate results)

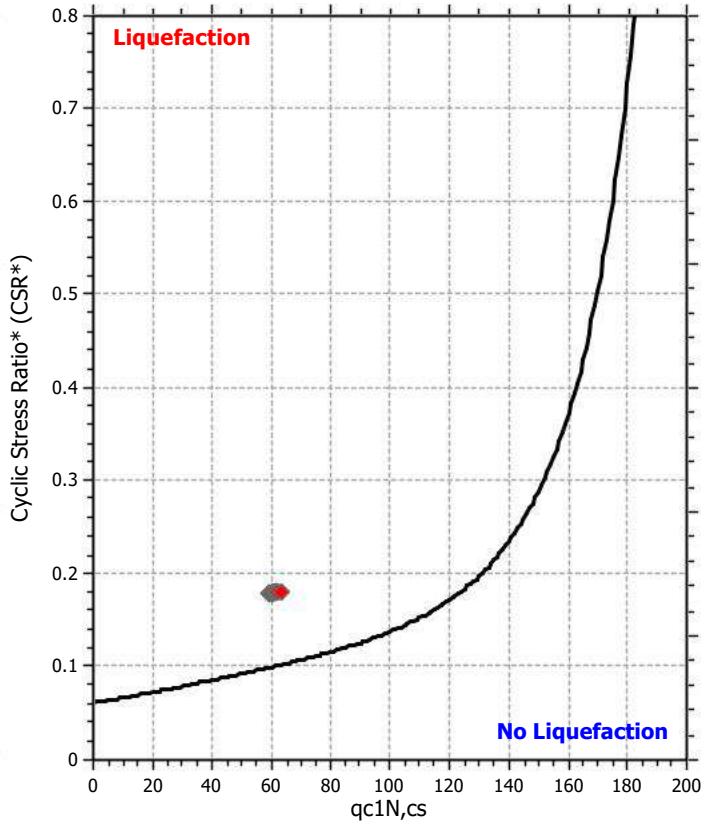


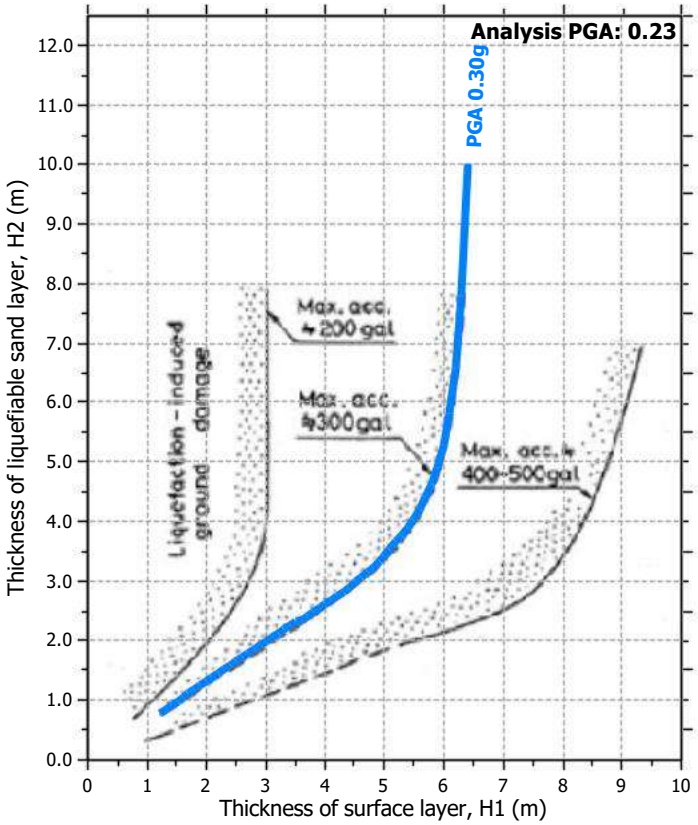
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



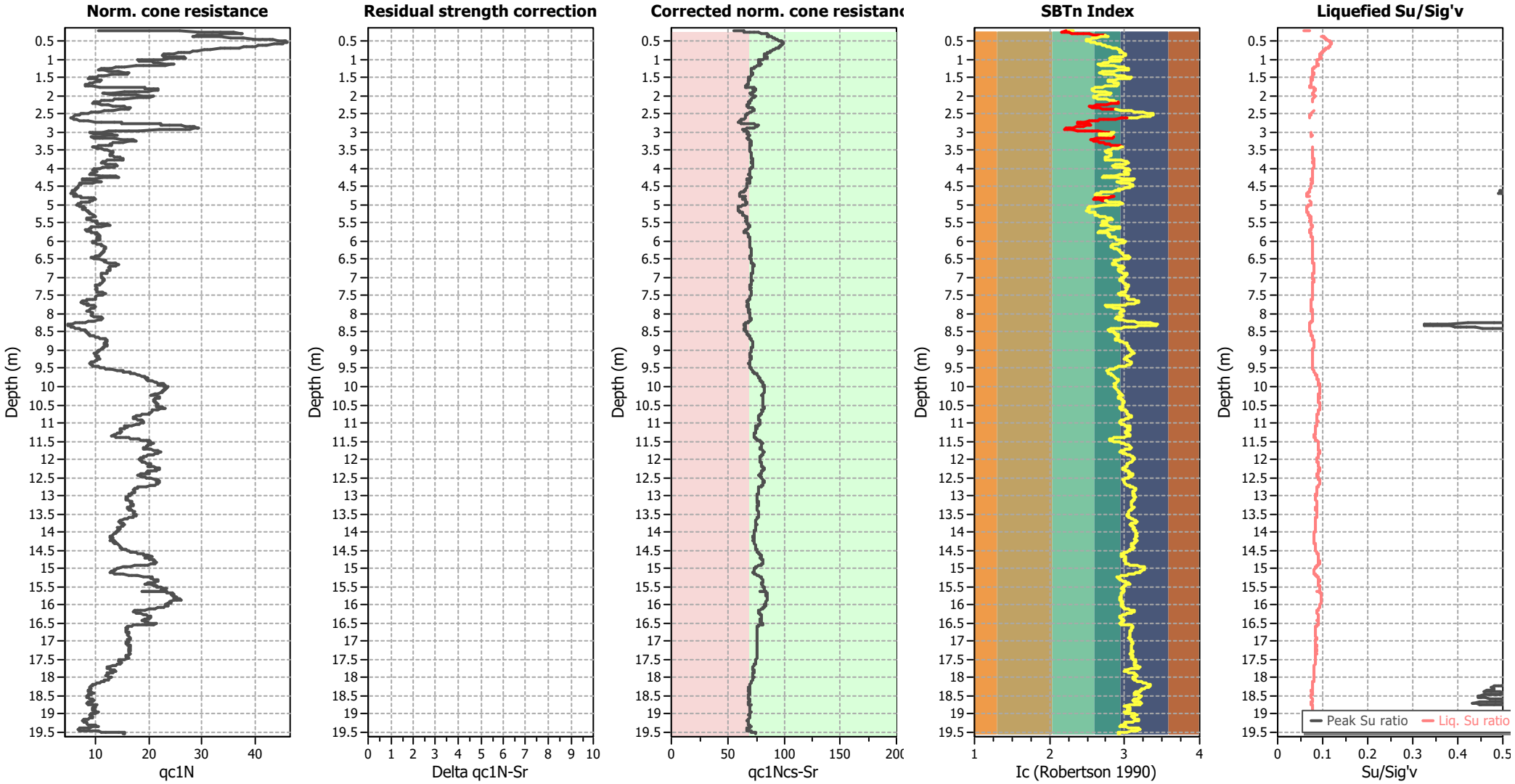




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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LIQUEFACTION ANALYSIS REPORT

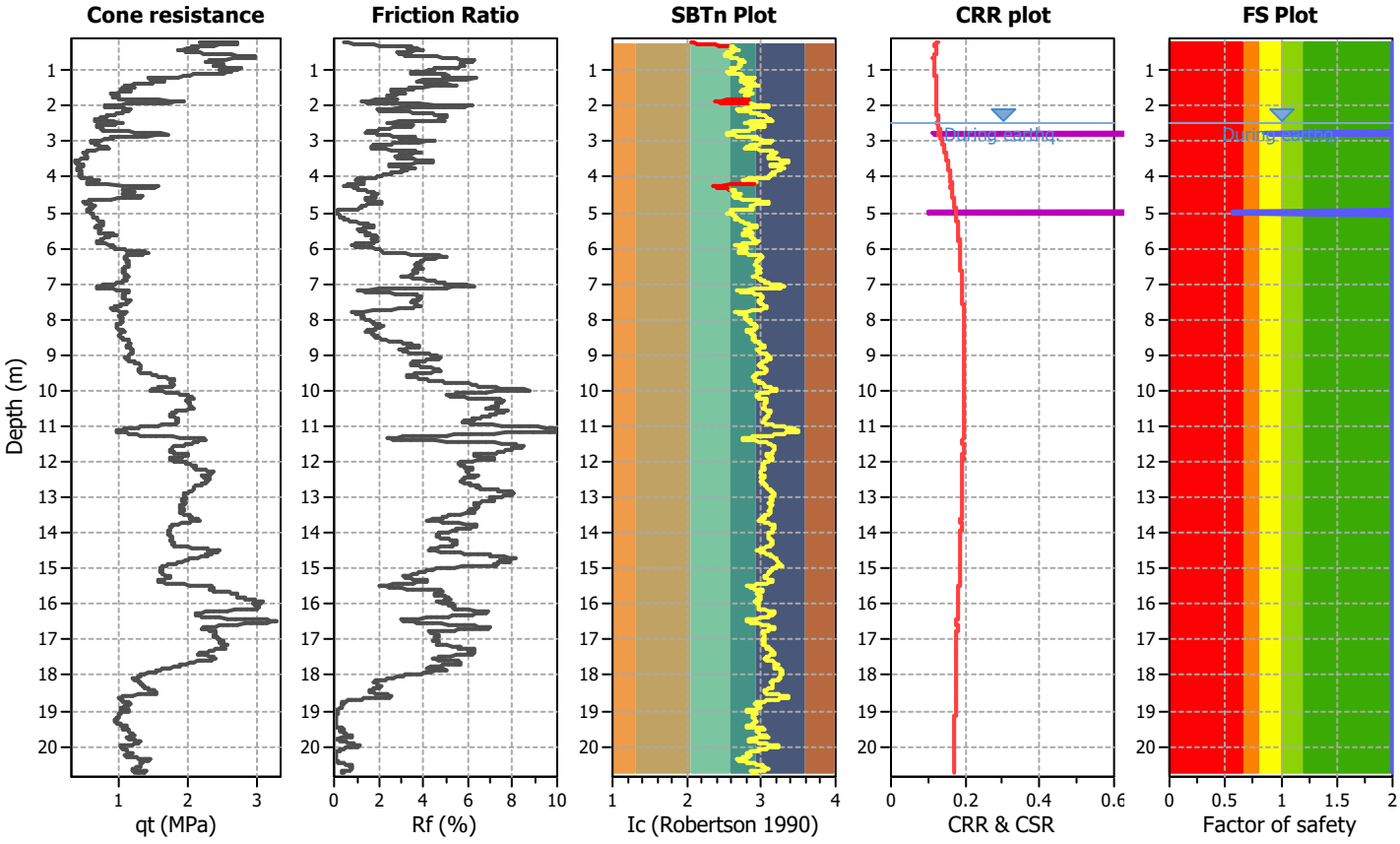
Project title : Ravarino

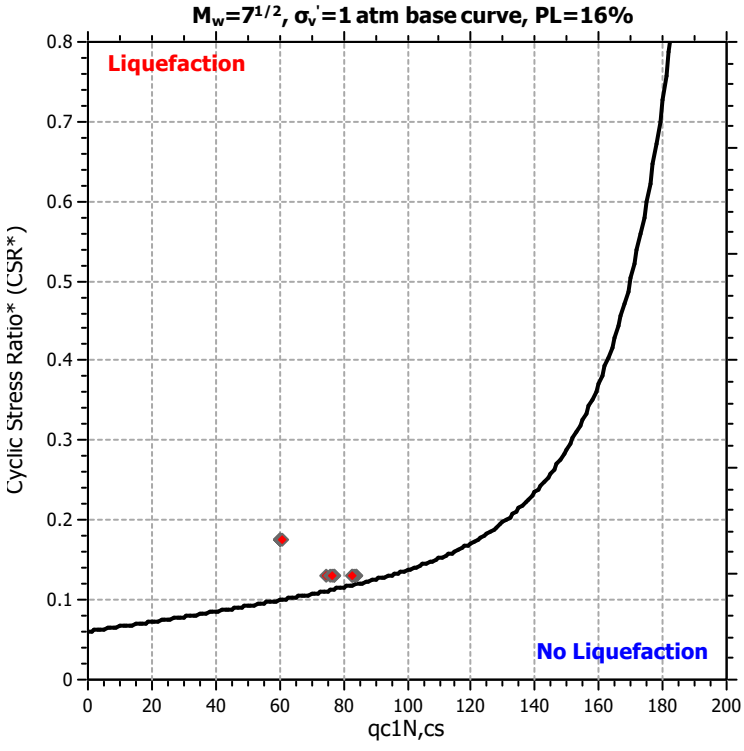
Location : Studio del terreno di fondazione

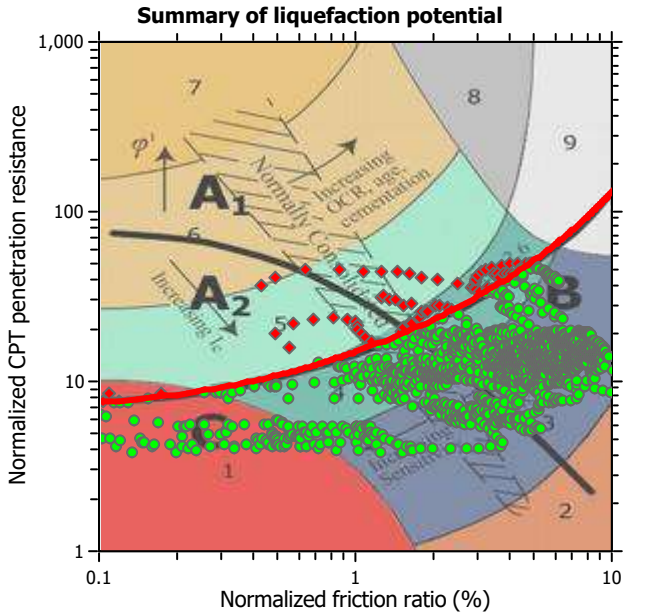
CPT file : CPTU5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

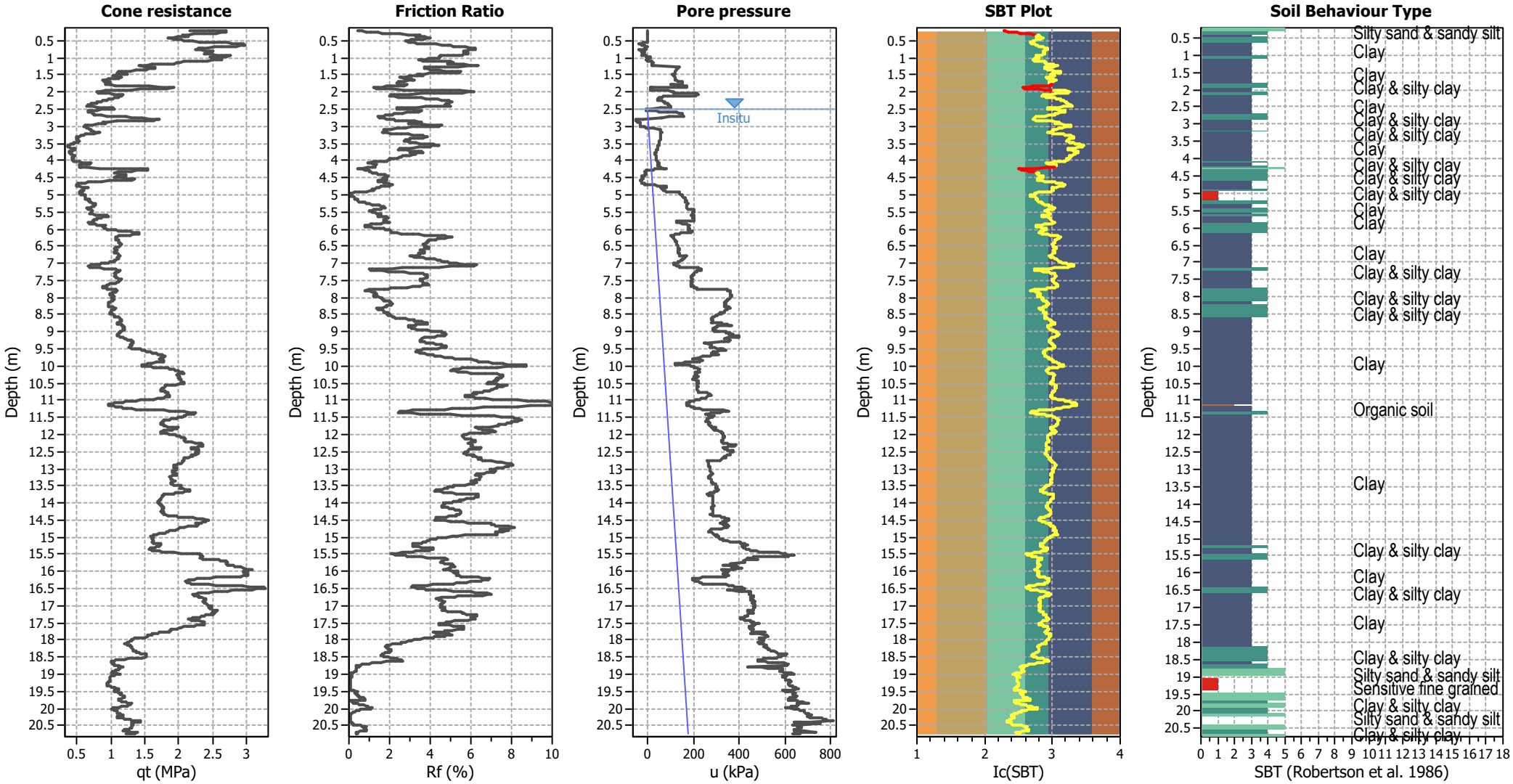






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



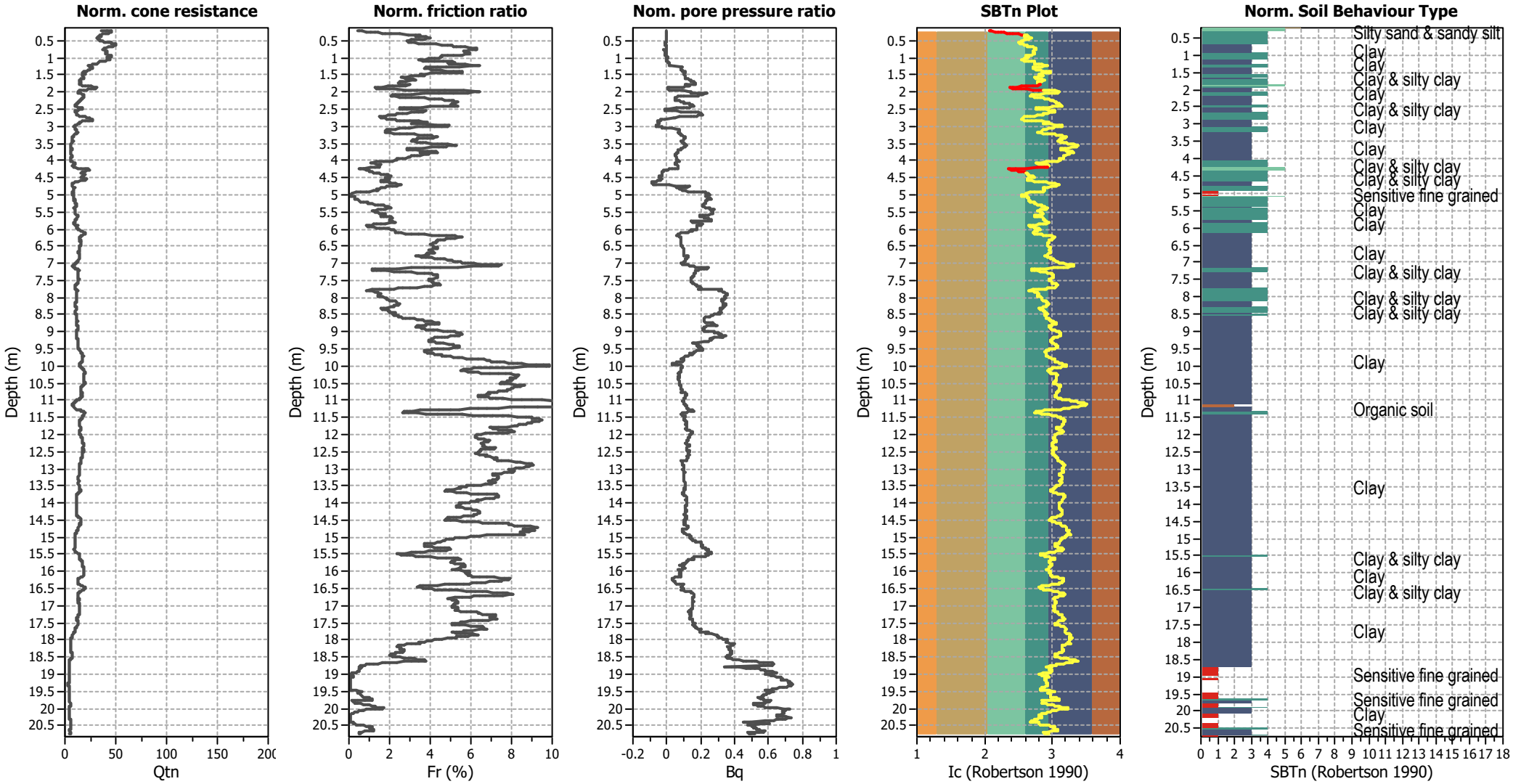
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



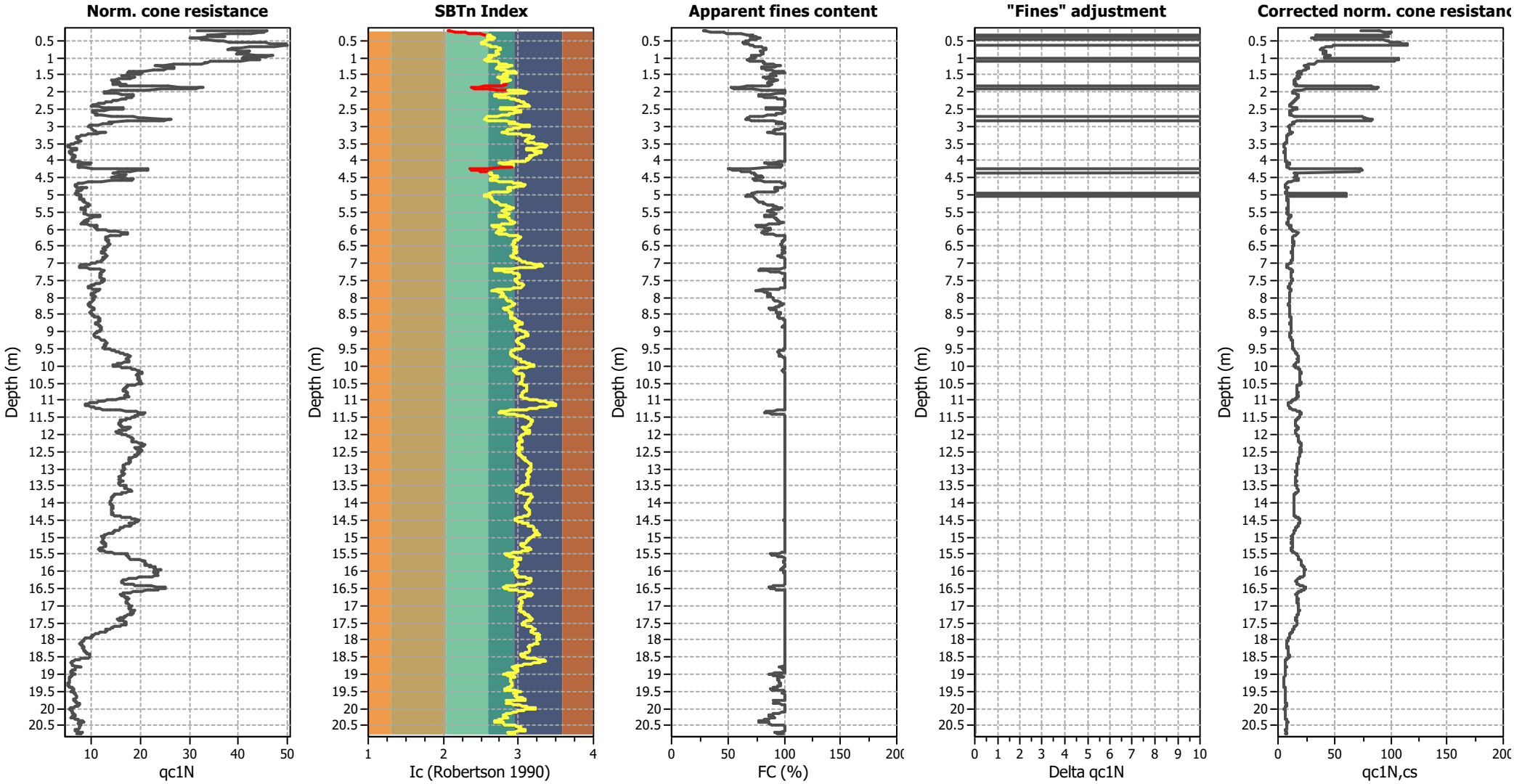
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

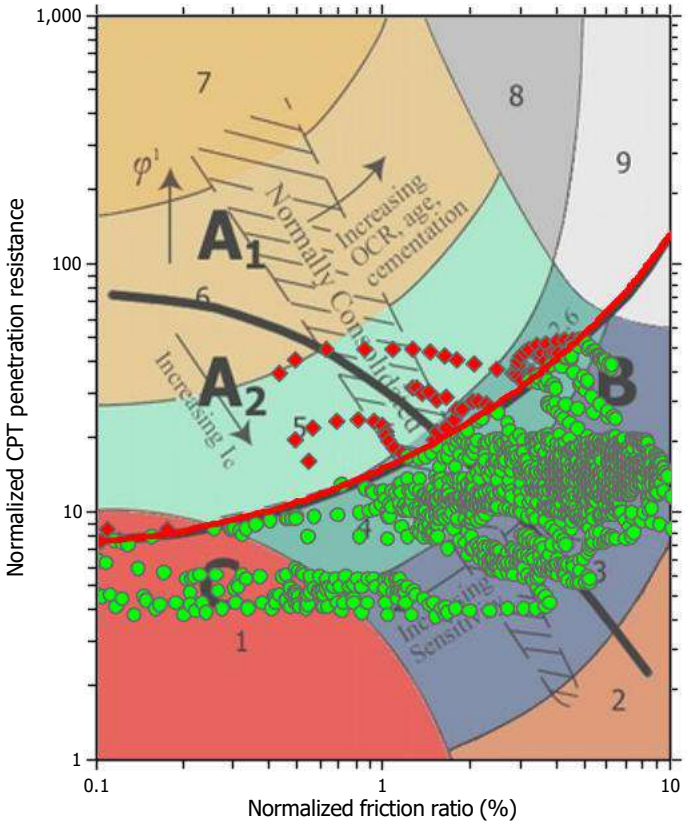
Liquefaction analysis overall plots (intermediate results)

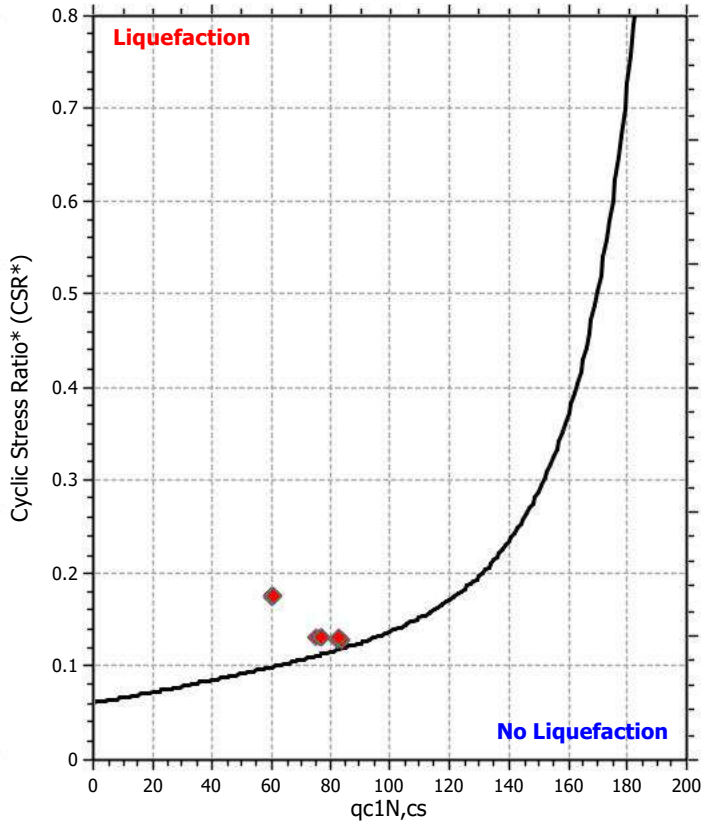


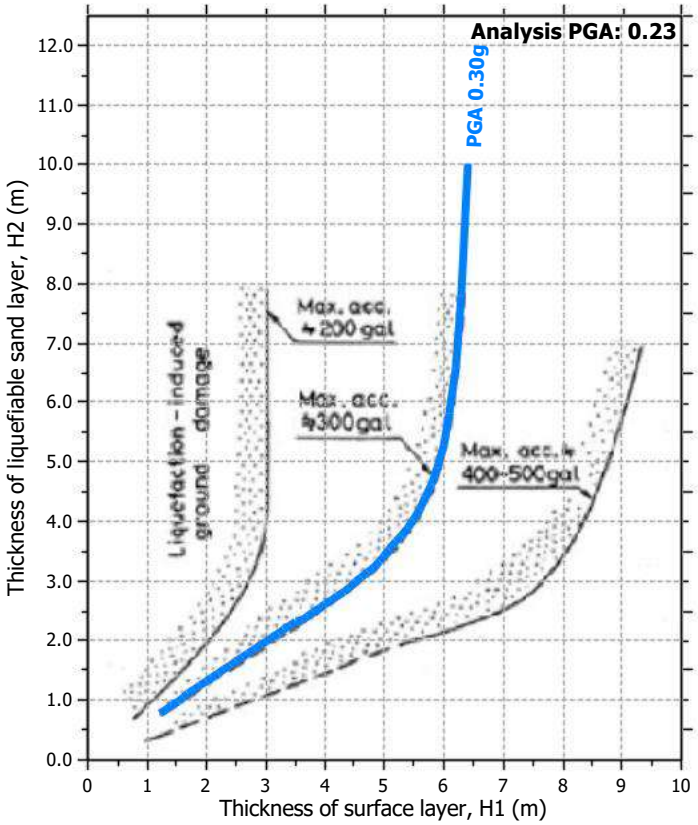
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



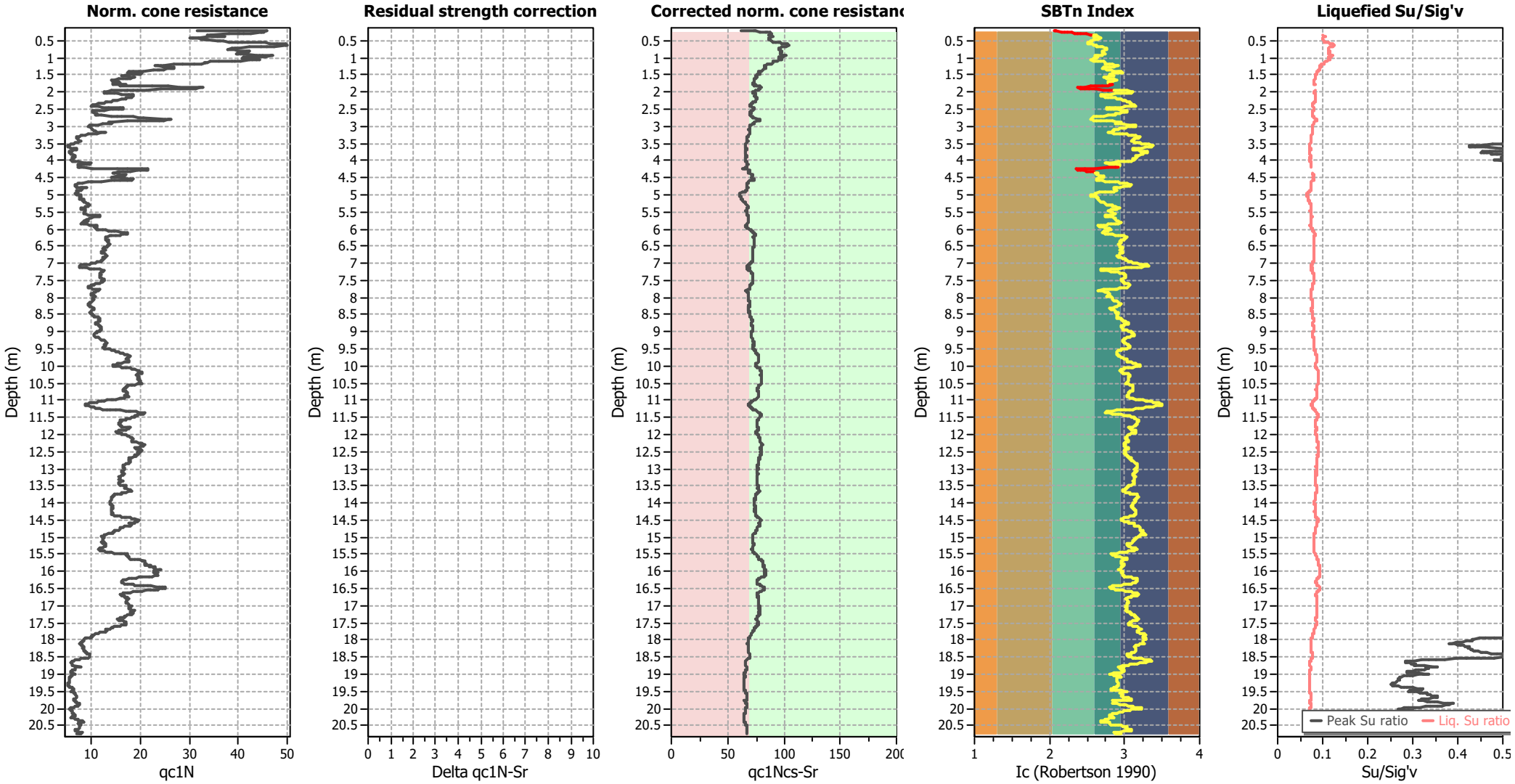




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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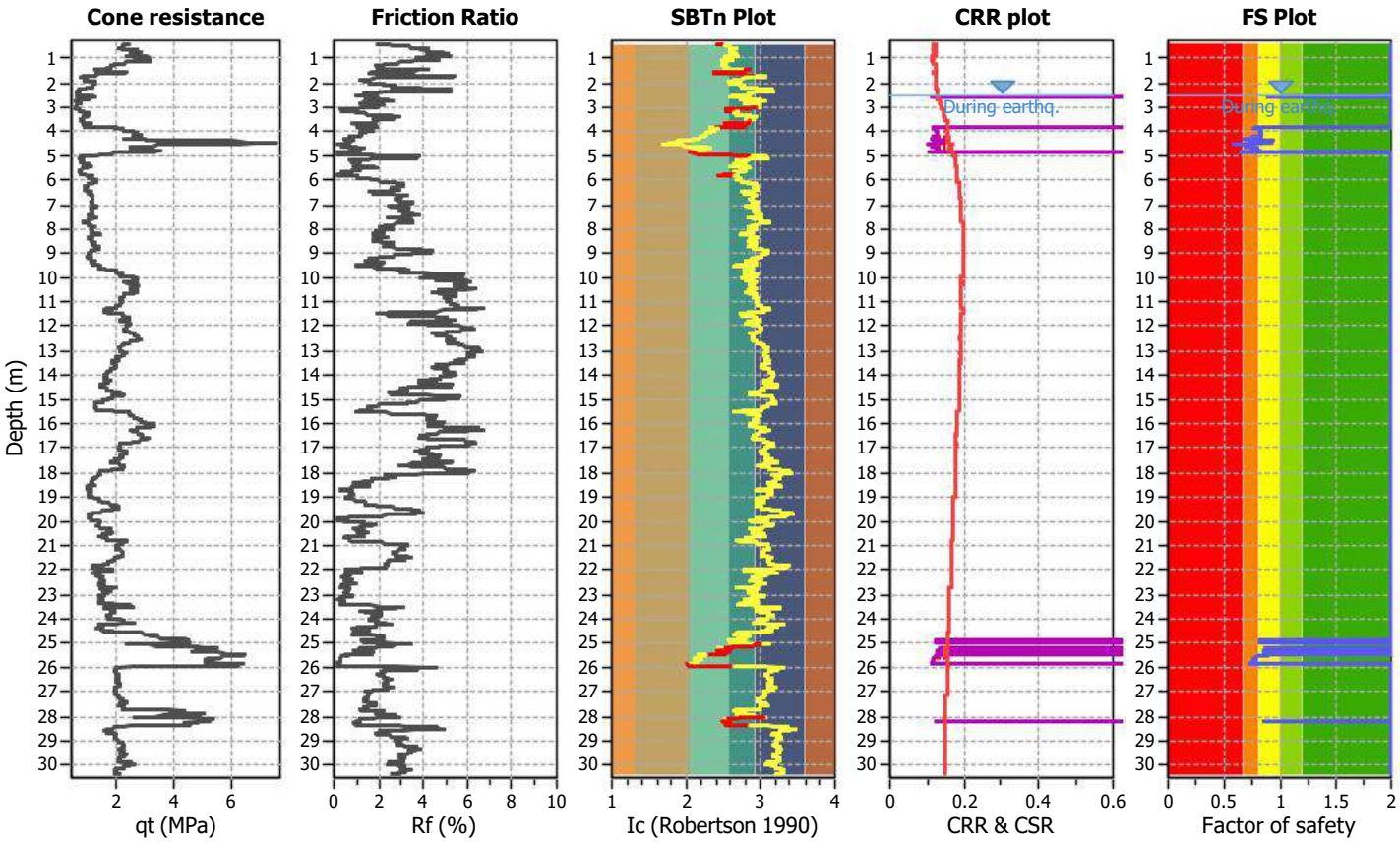
LIQUEFACTION ANALYSIS REPORT

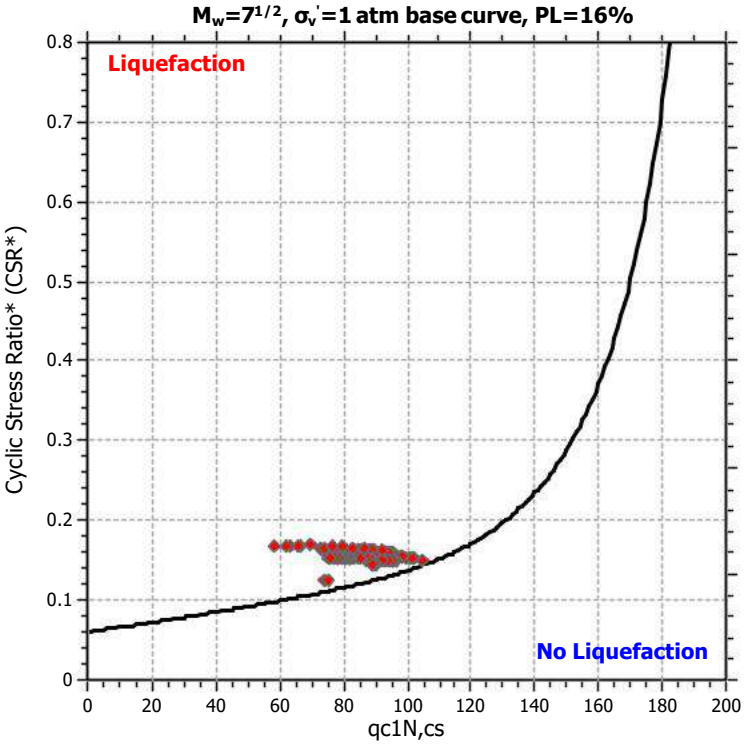
Project title : Ravarino **Location : Studio del terreno di fondazione**

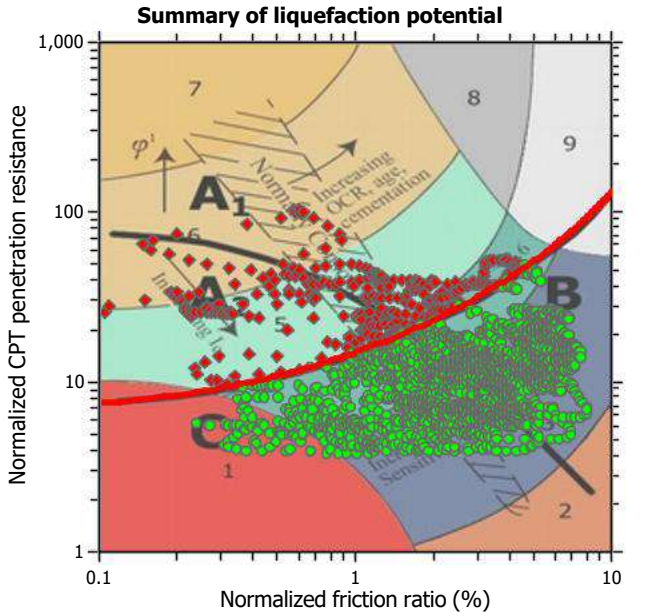
CPT file : CPTU3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

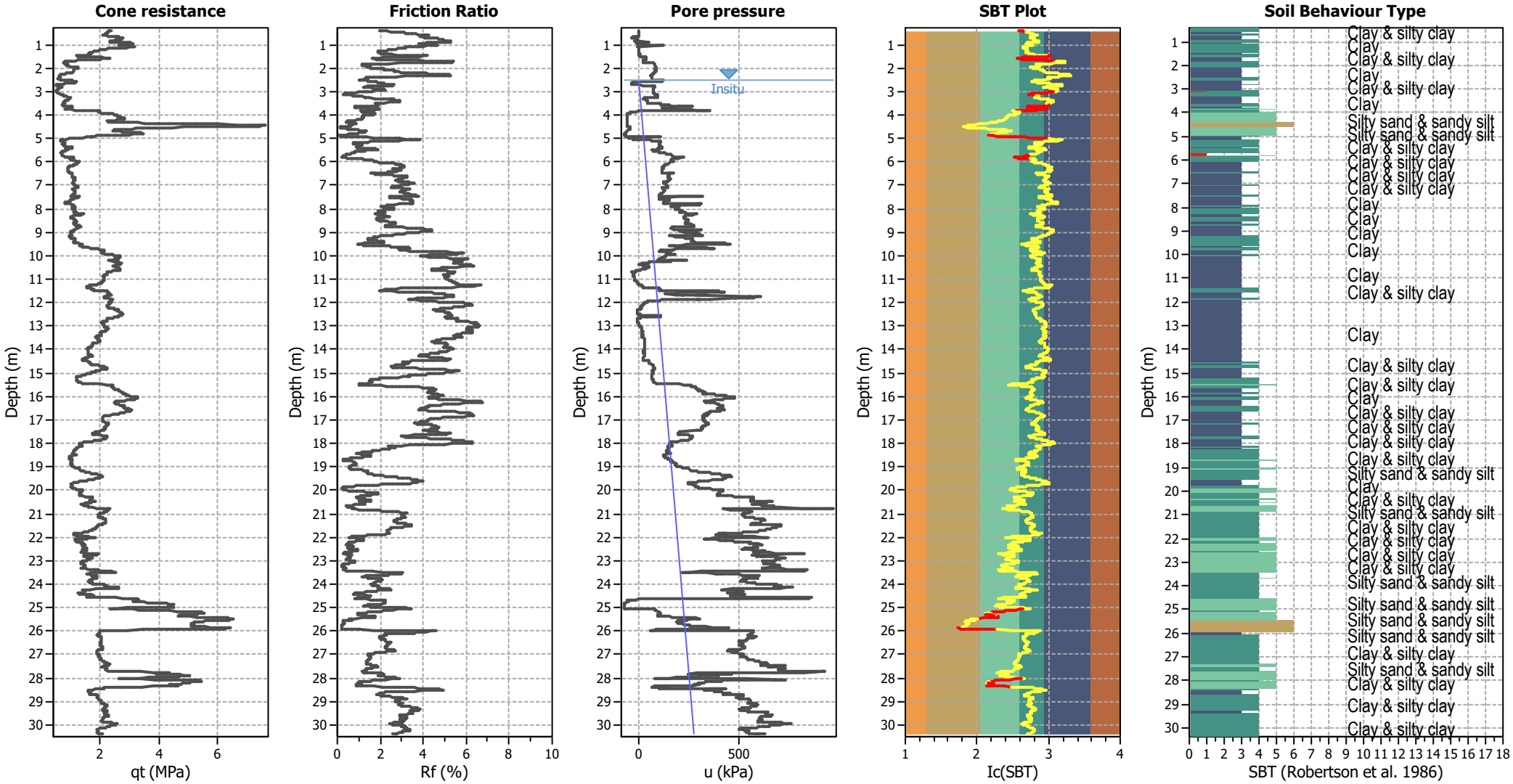






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



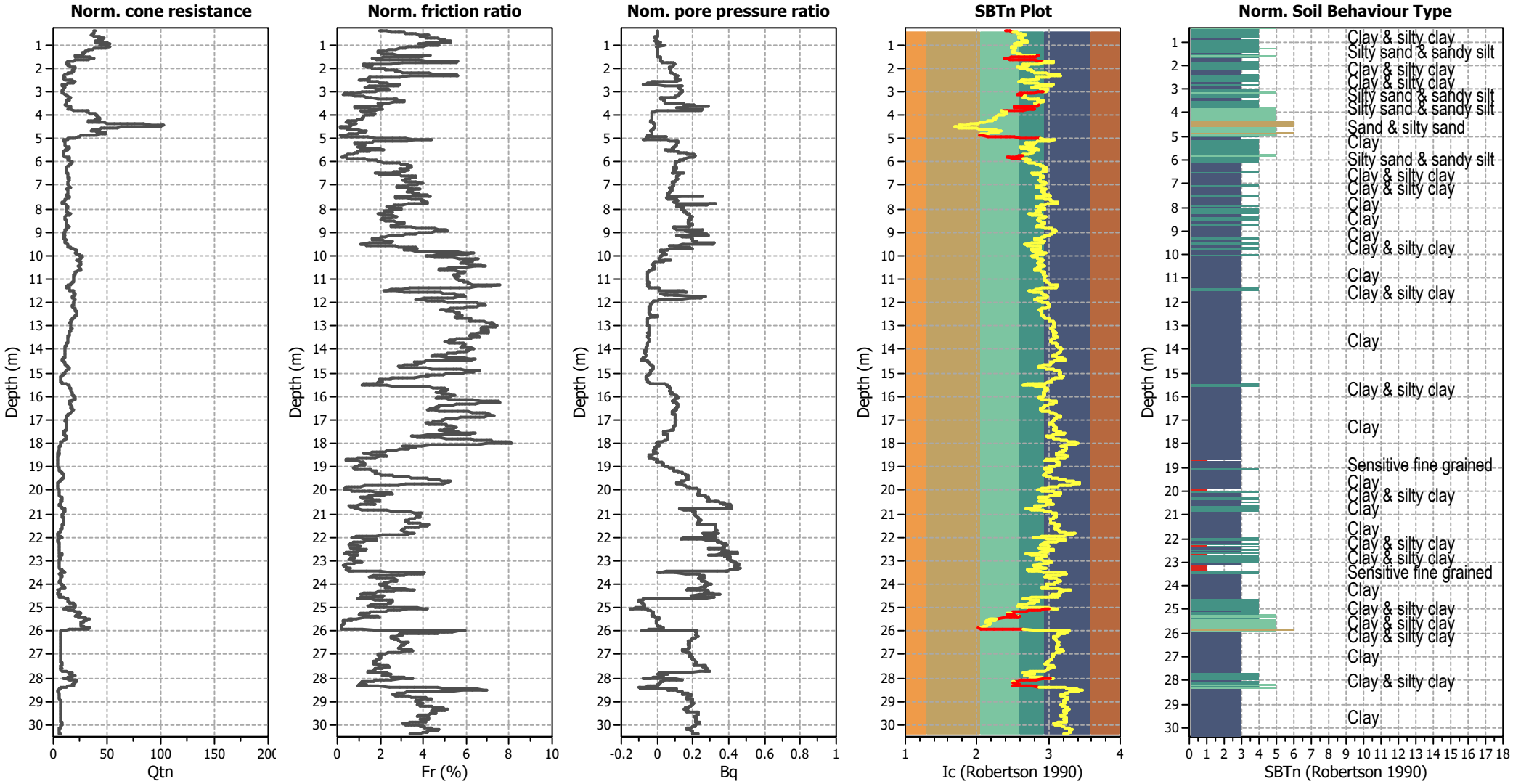
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



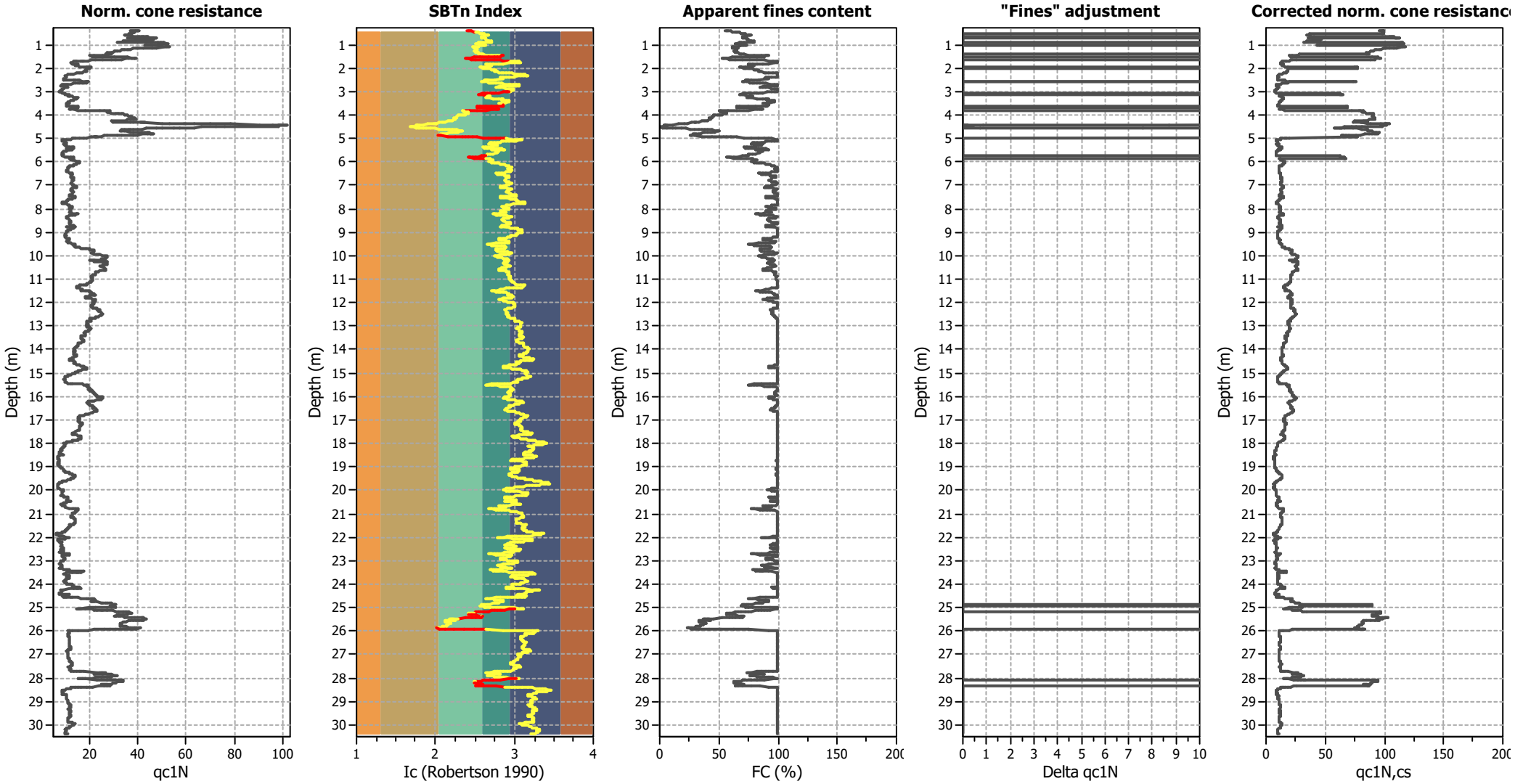
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

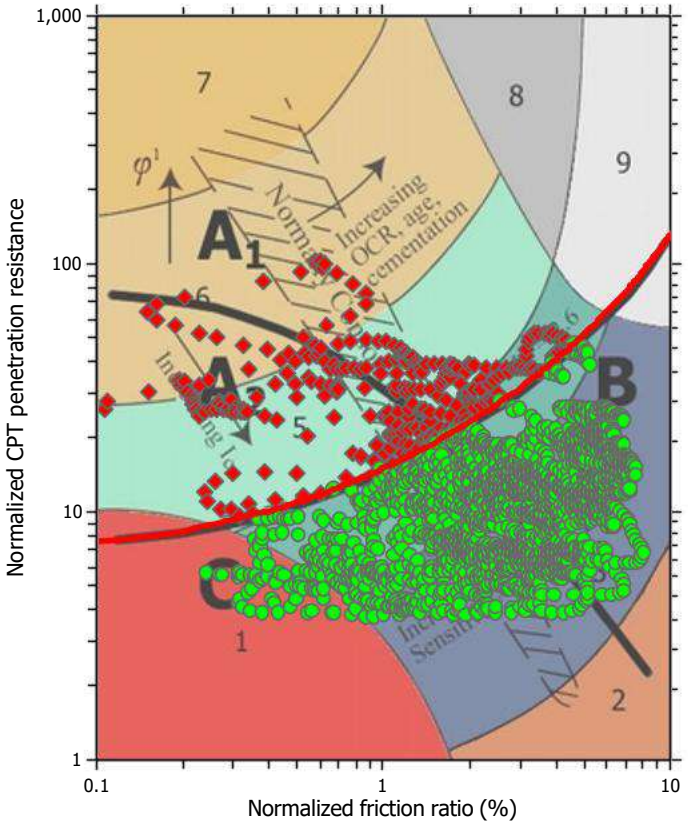
Liquefaction analysis overall plots (intermediate results)

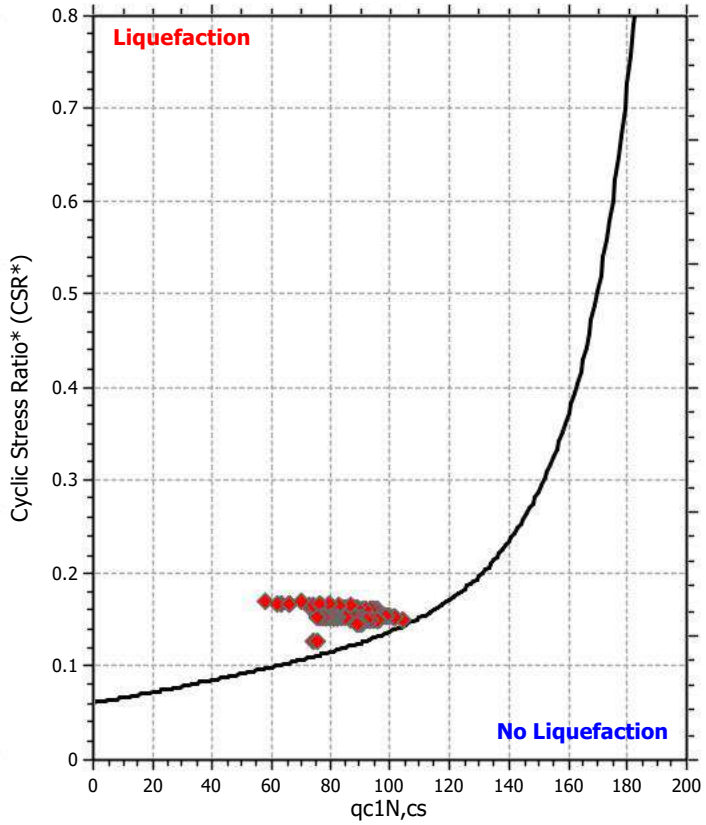


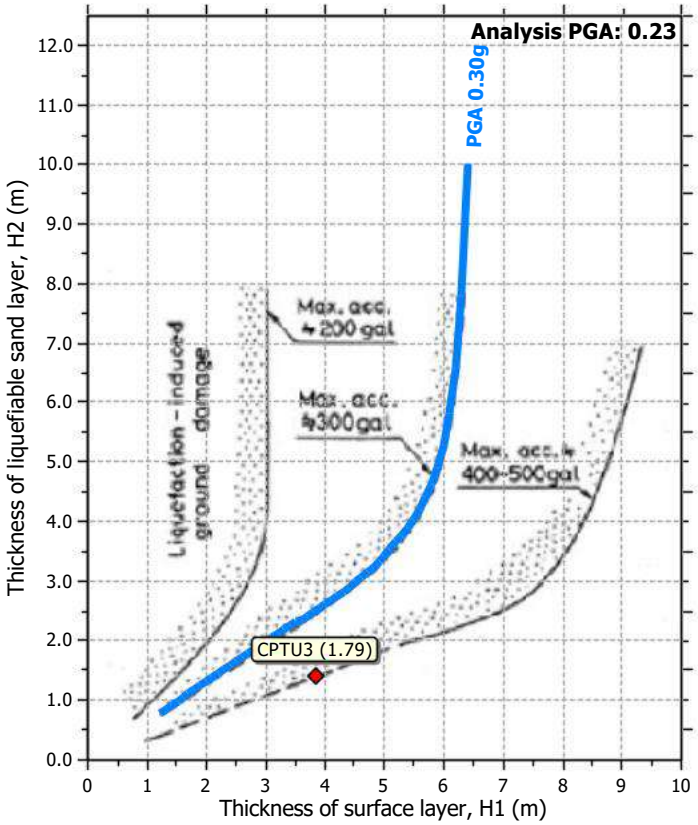
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



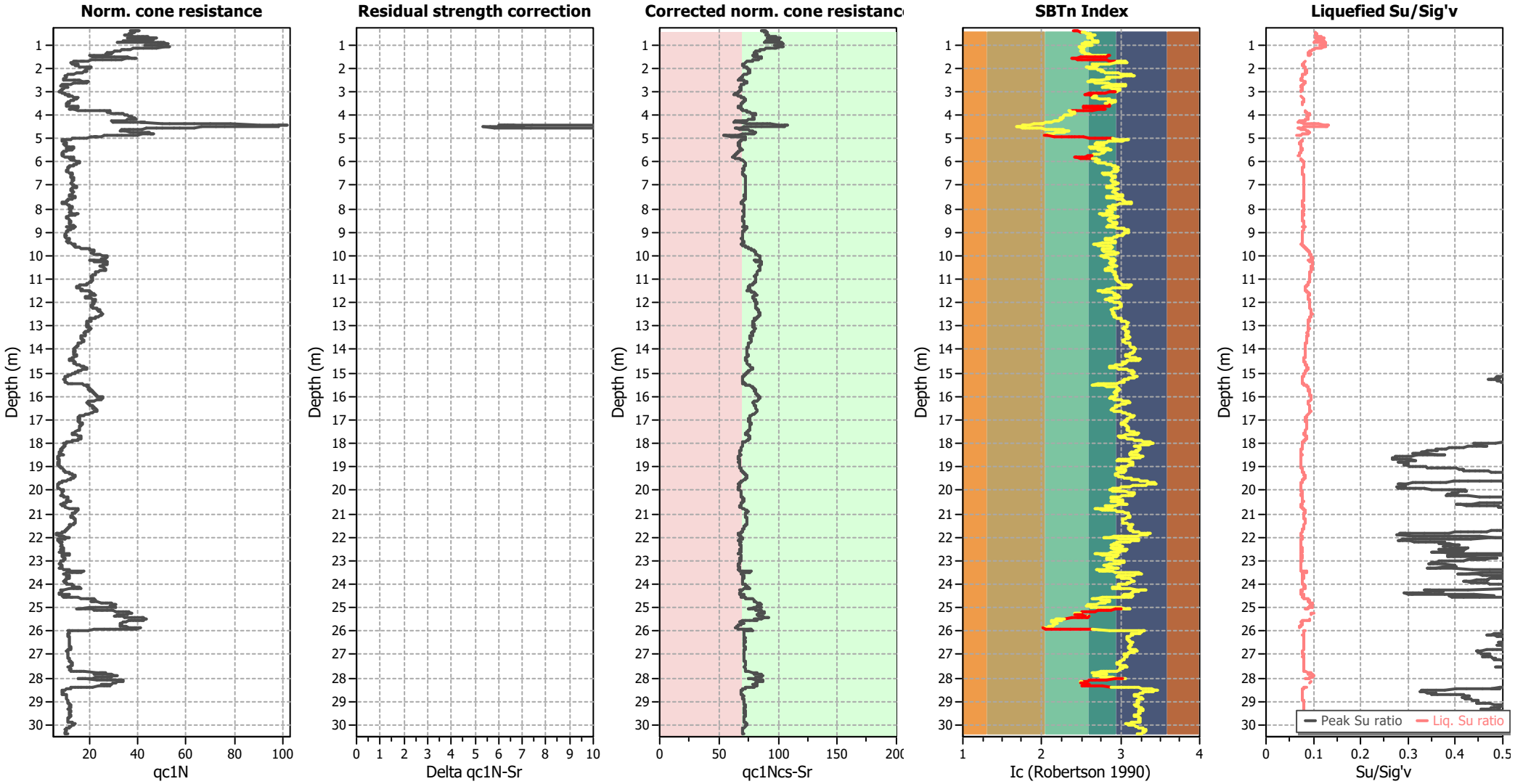




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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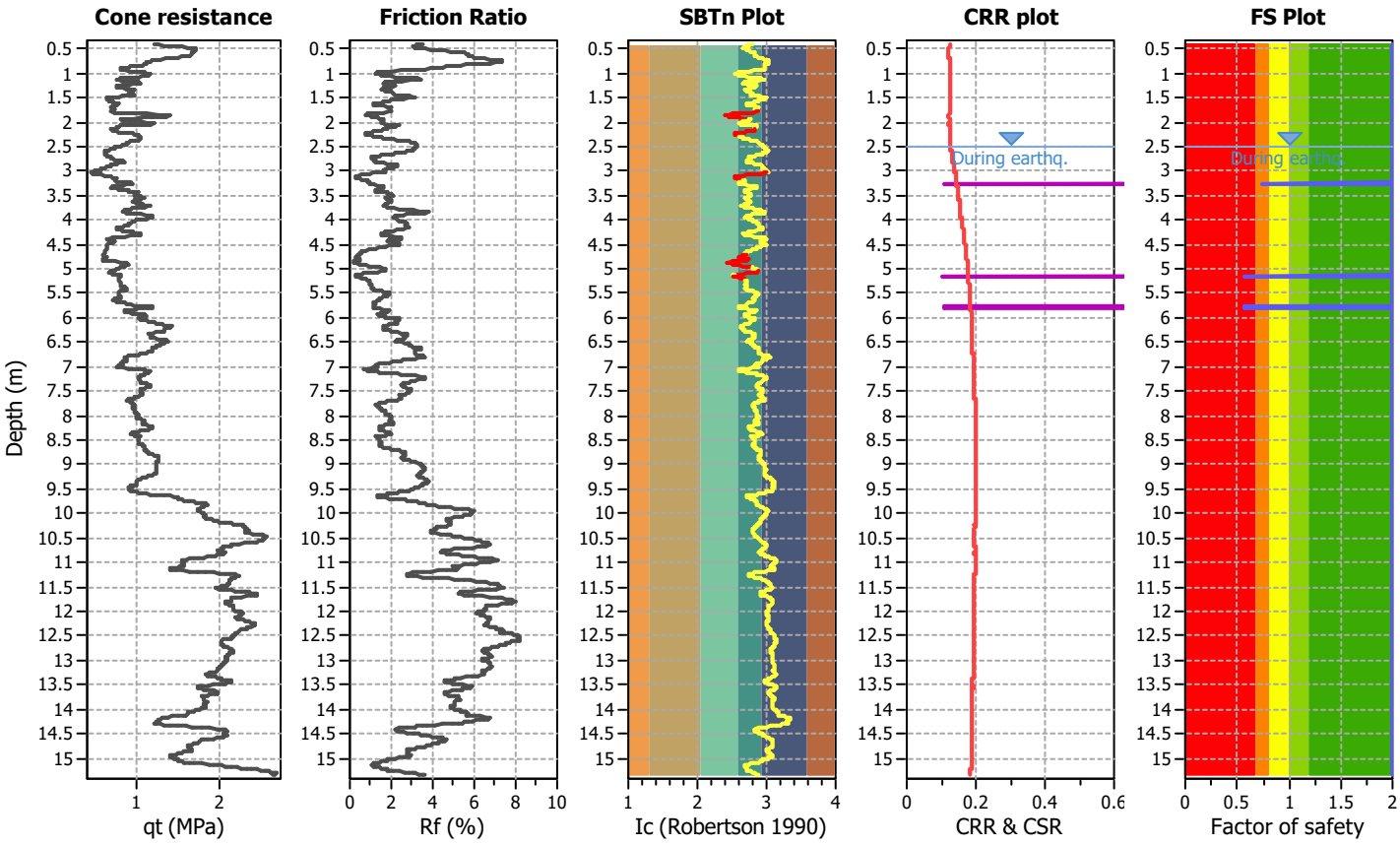
LIQUEFACTION ANALYSIS REPORT

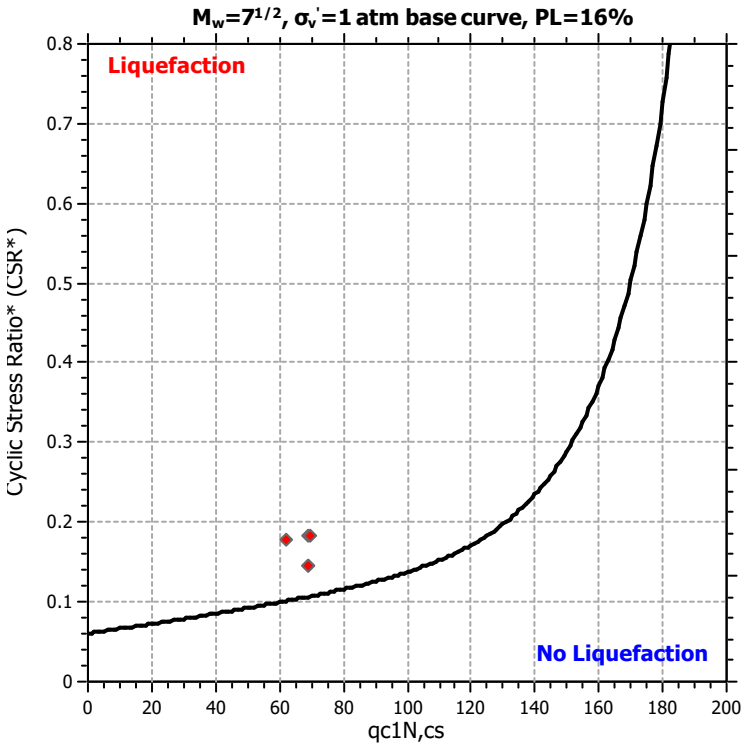
Project title : Ravarino **Location : Studio del terreno di fondazione**

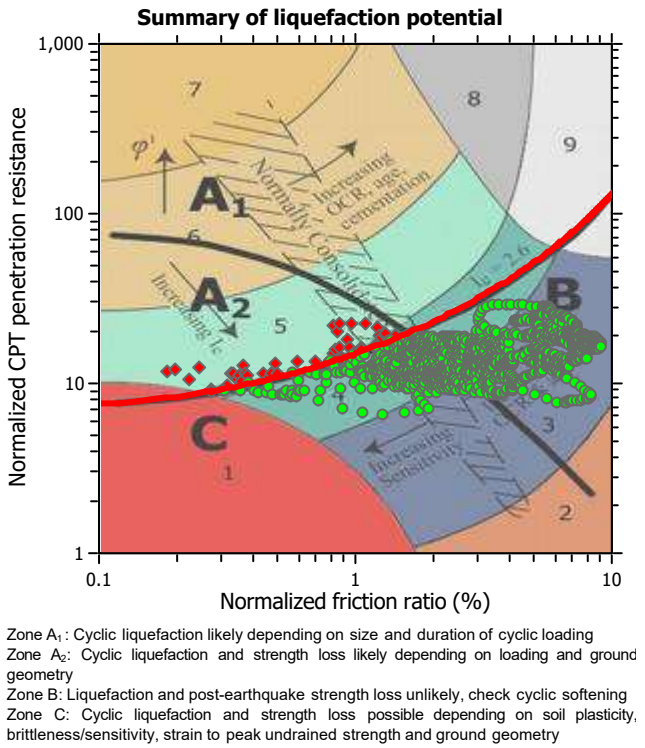
CPT file : CPTU6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

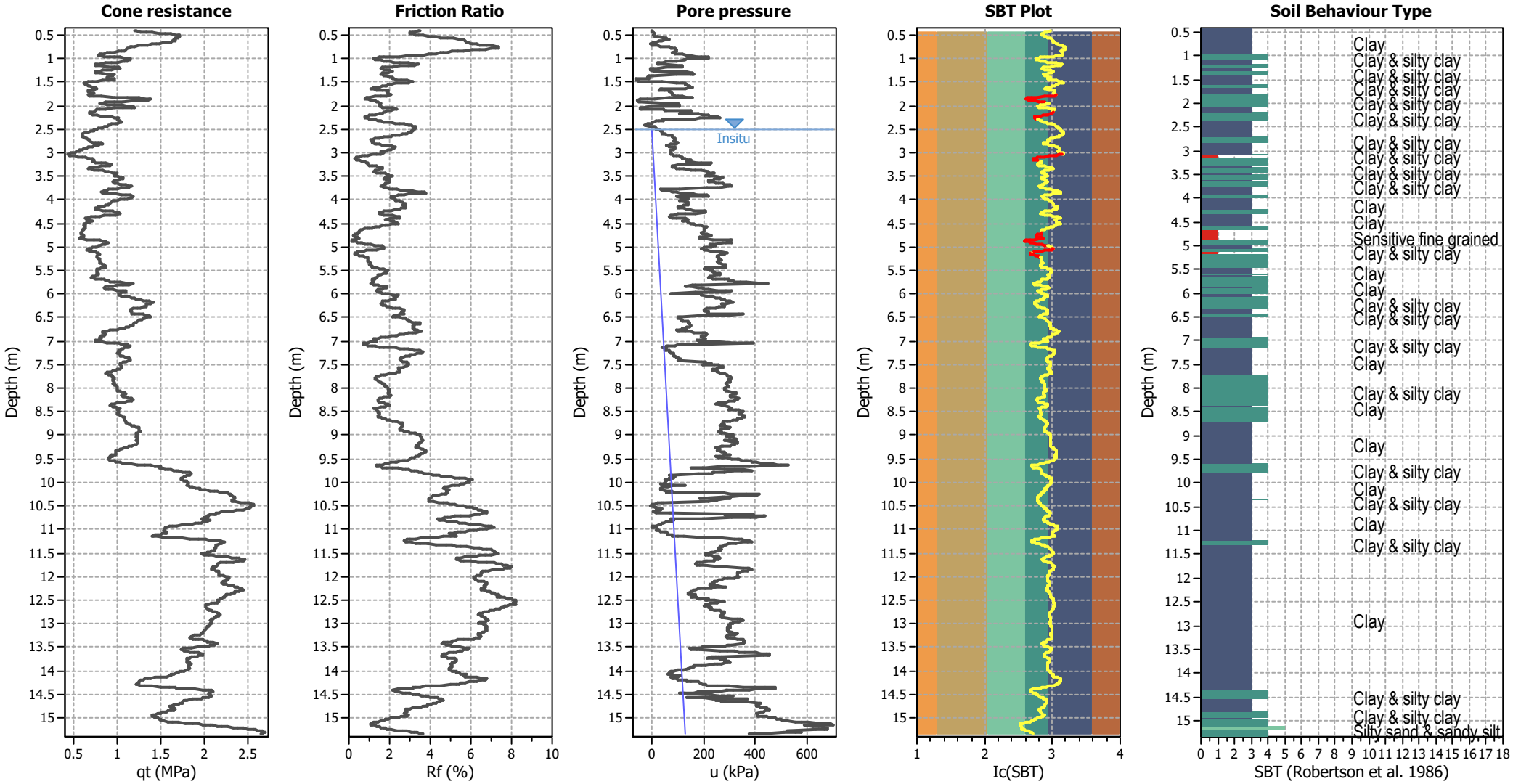






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



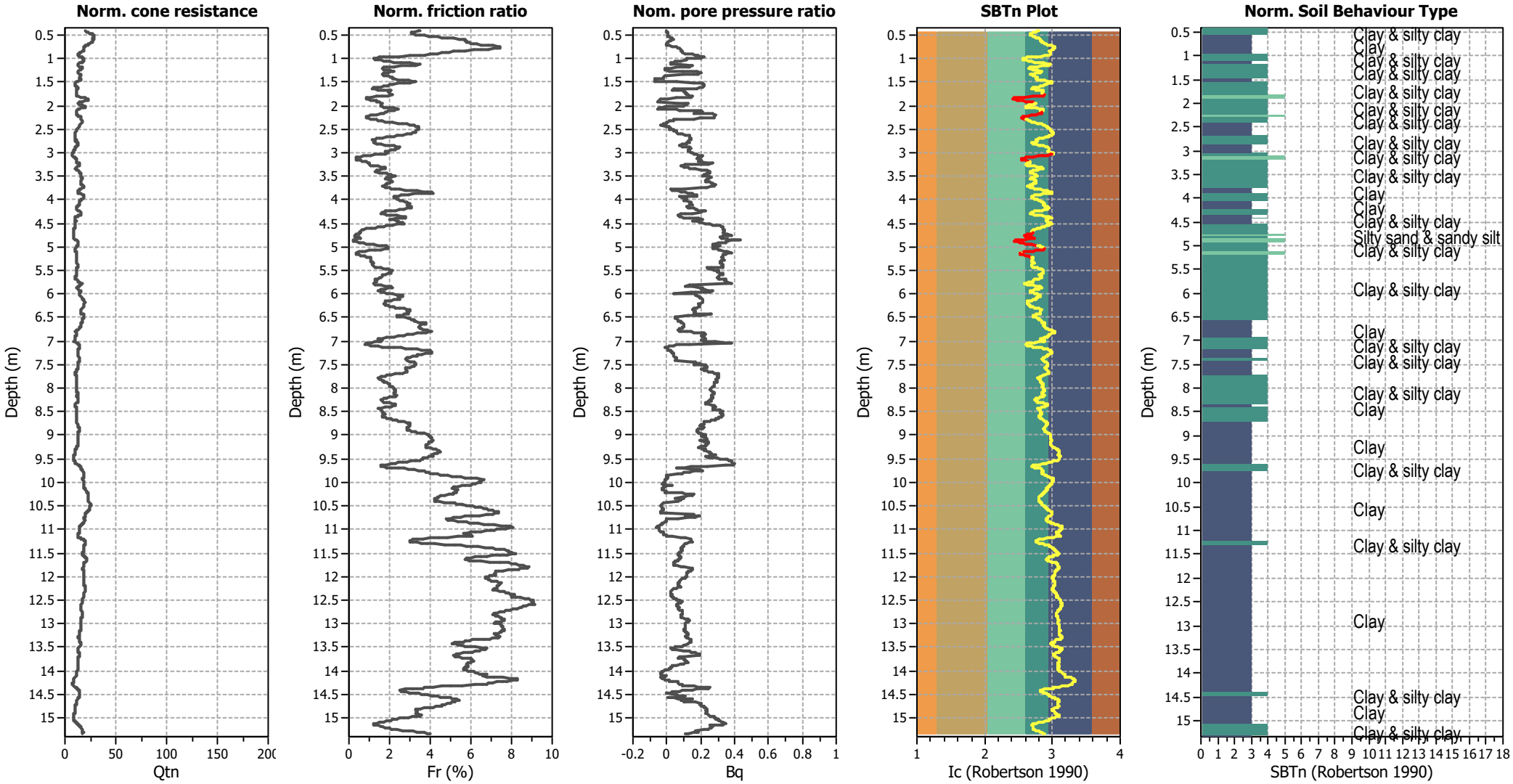
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



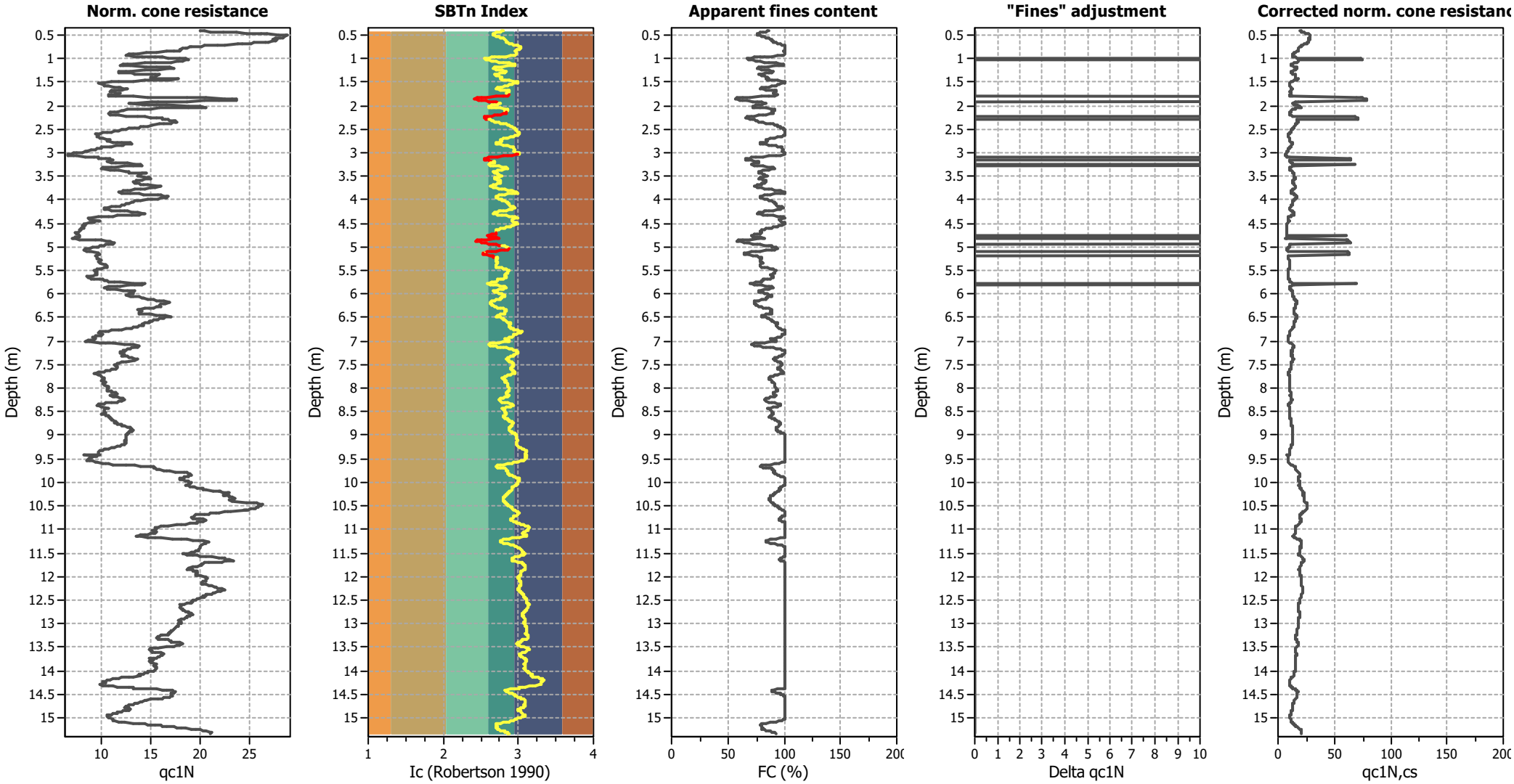
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

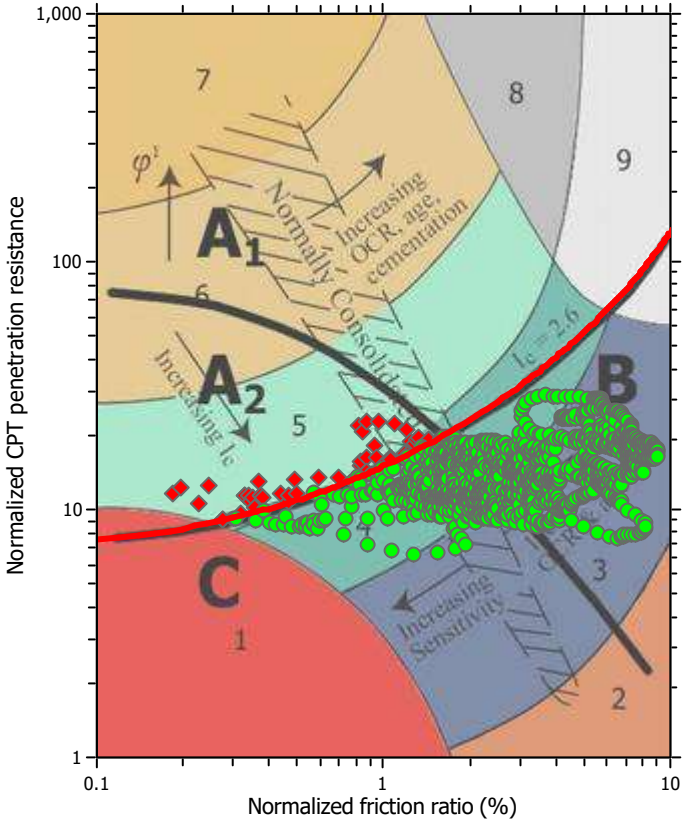
Liquefaction analysis overall plots (intermediate results)

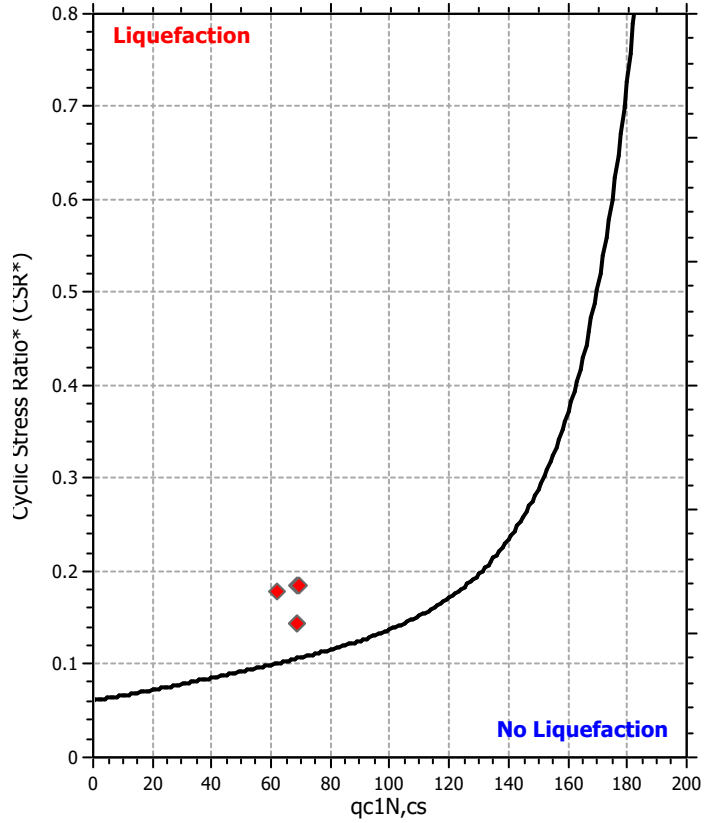


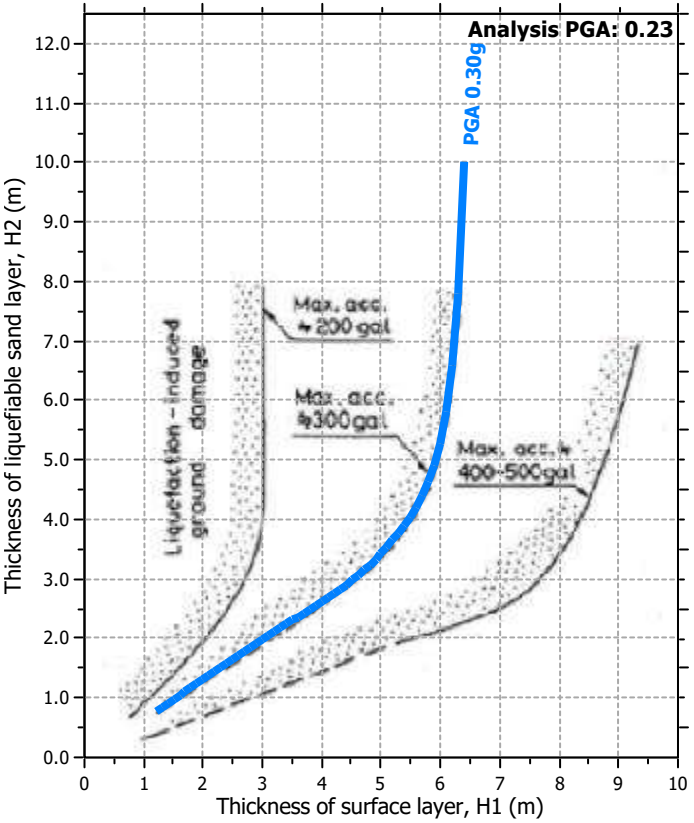
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



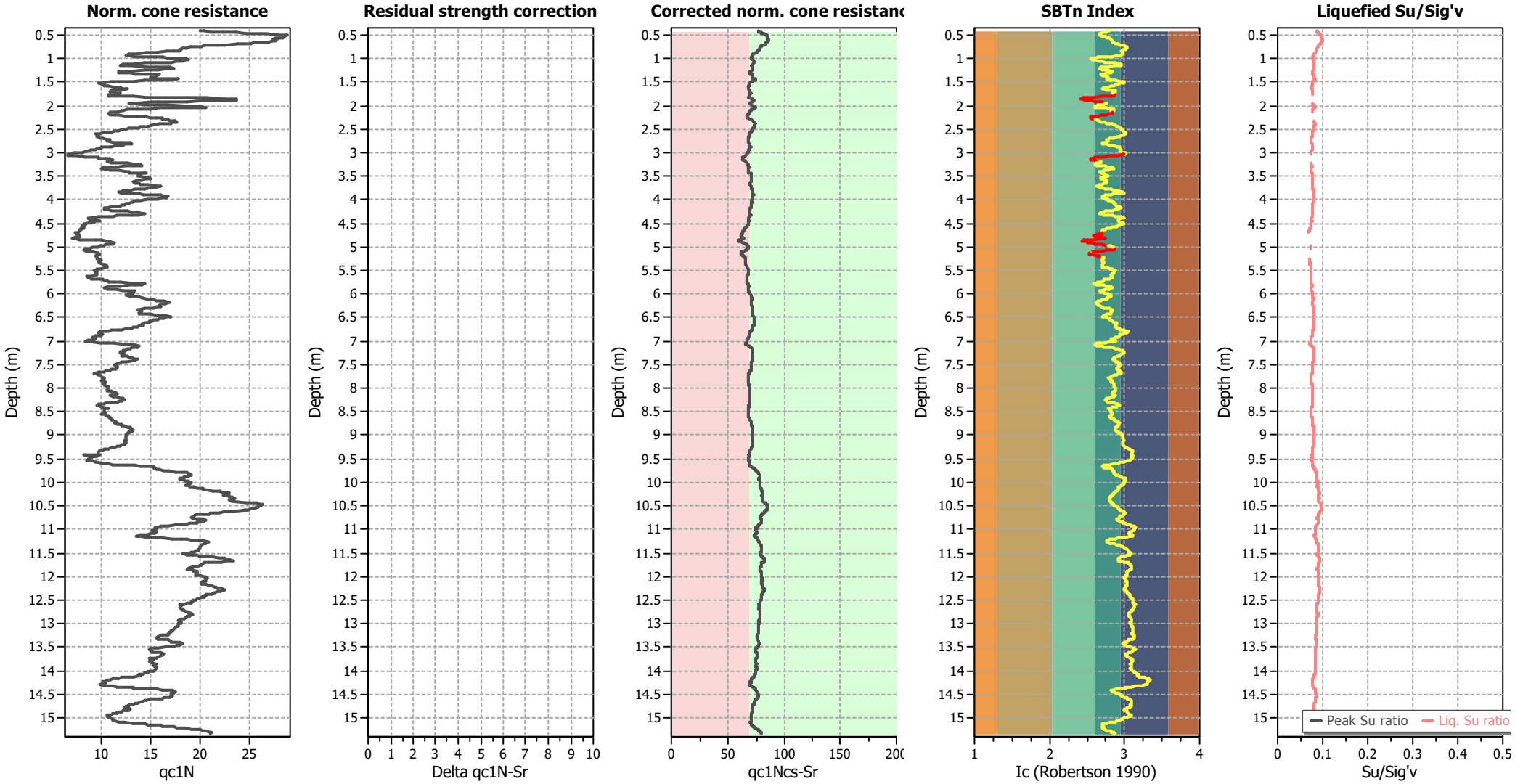




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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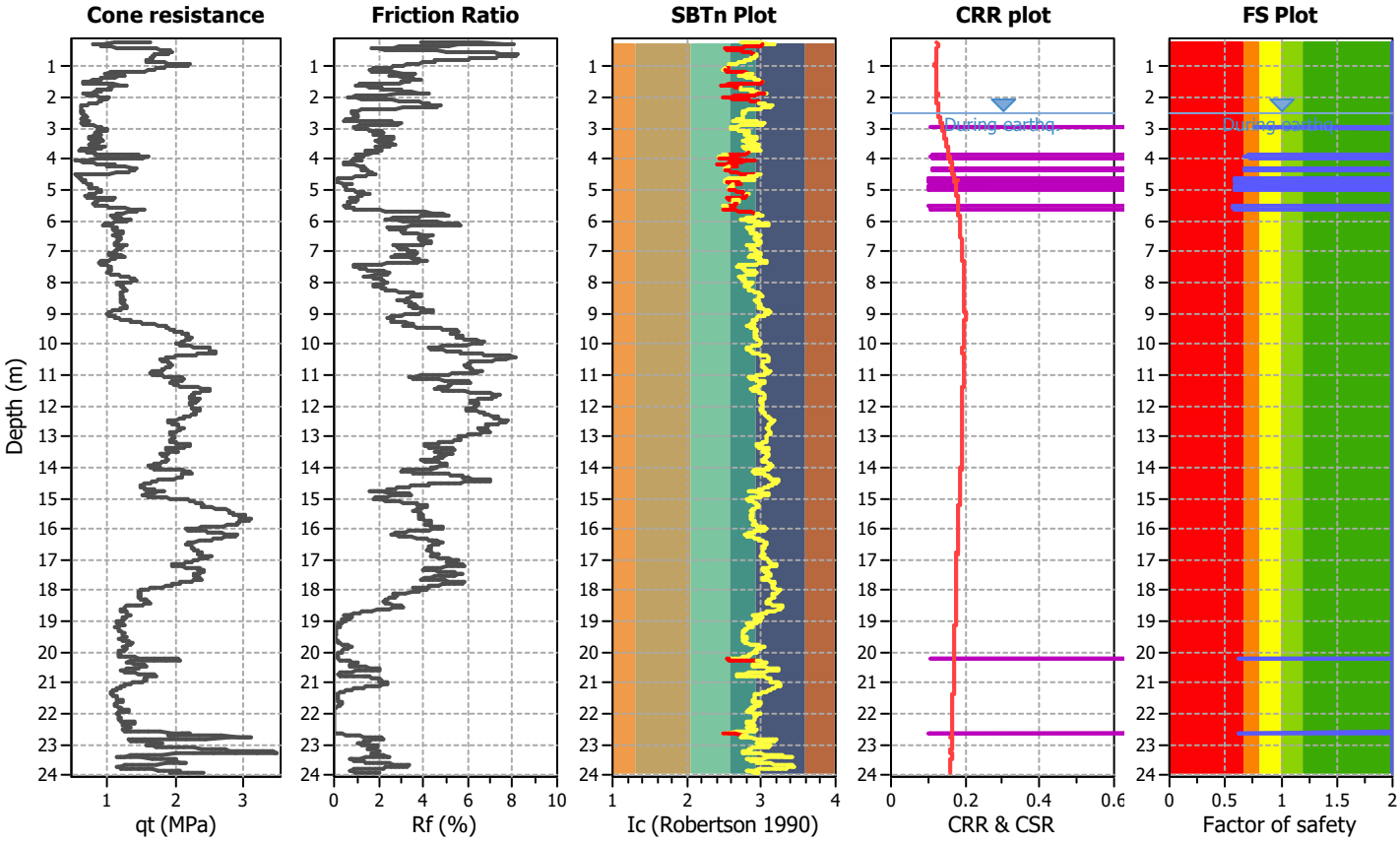
LIQUEFACTION ANALYSIS REPORT

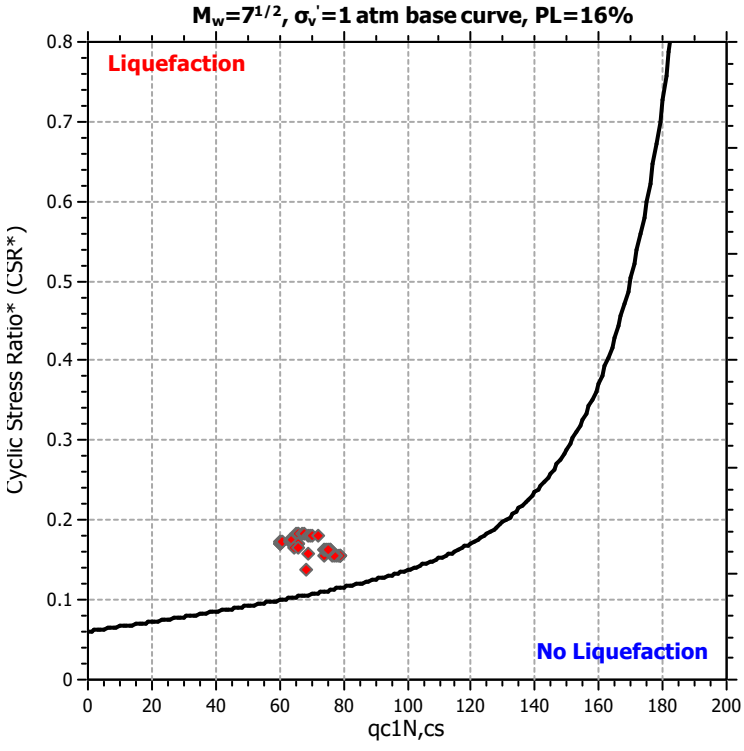
Project title : Ravarino **Location : Studio del terreno di fondazione**

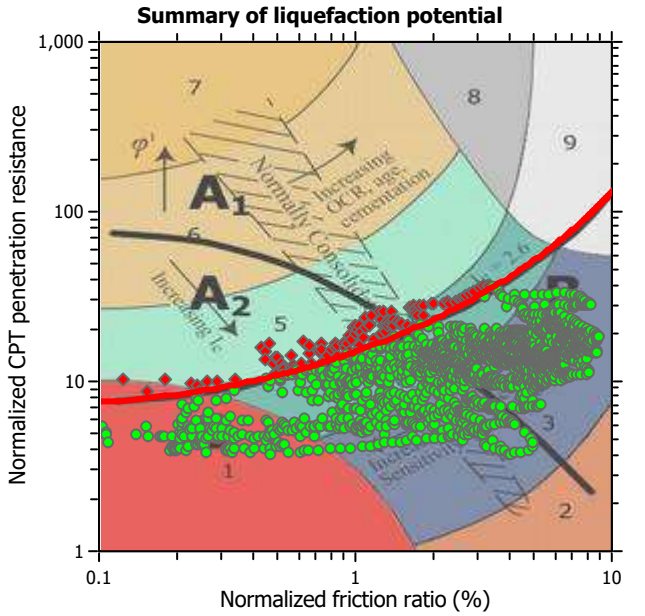
CPT file : CPTU7

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

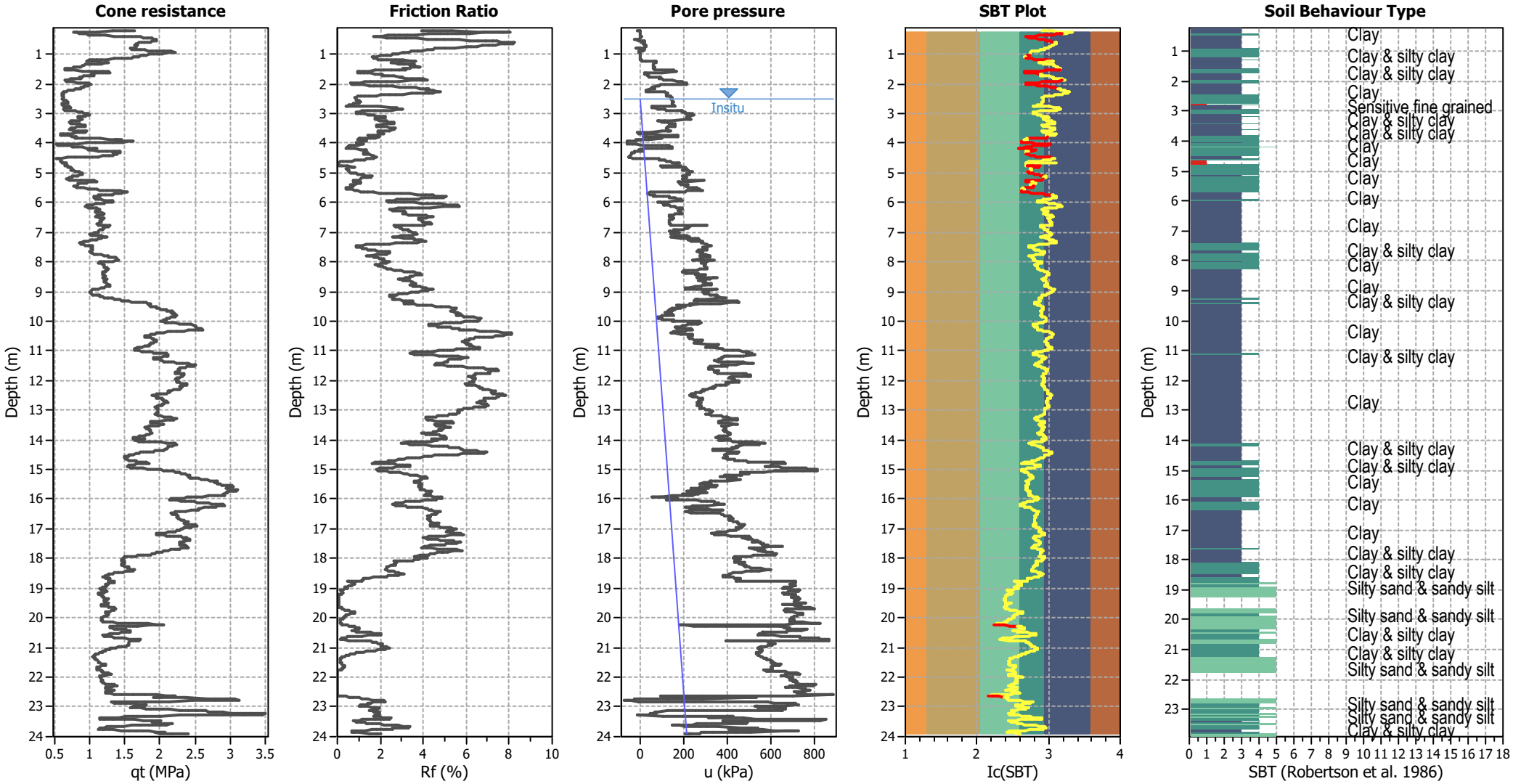






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



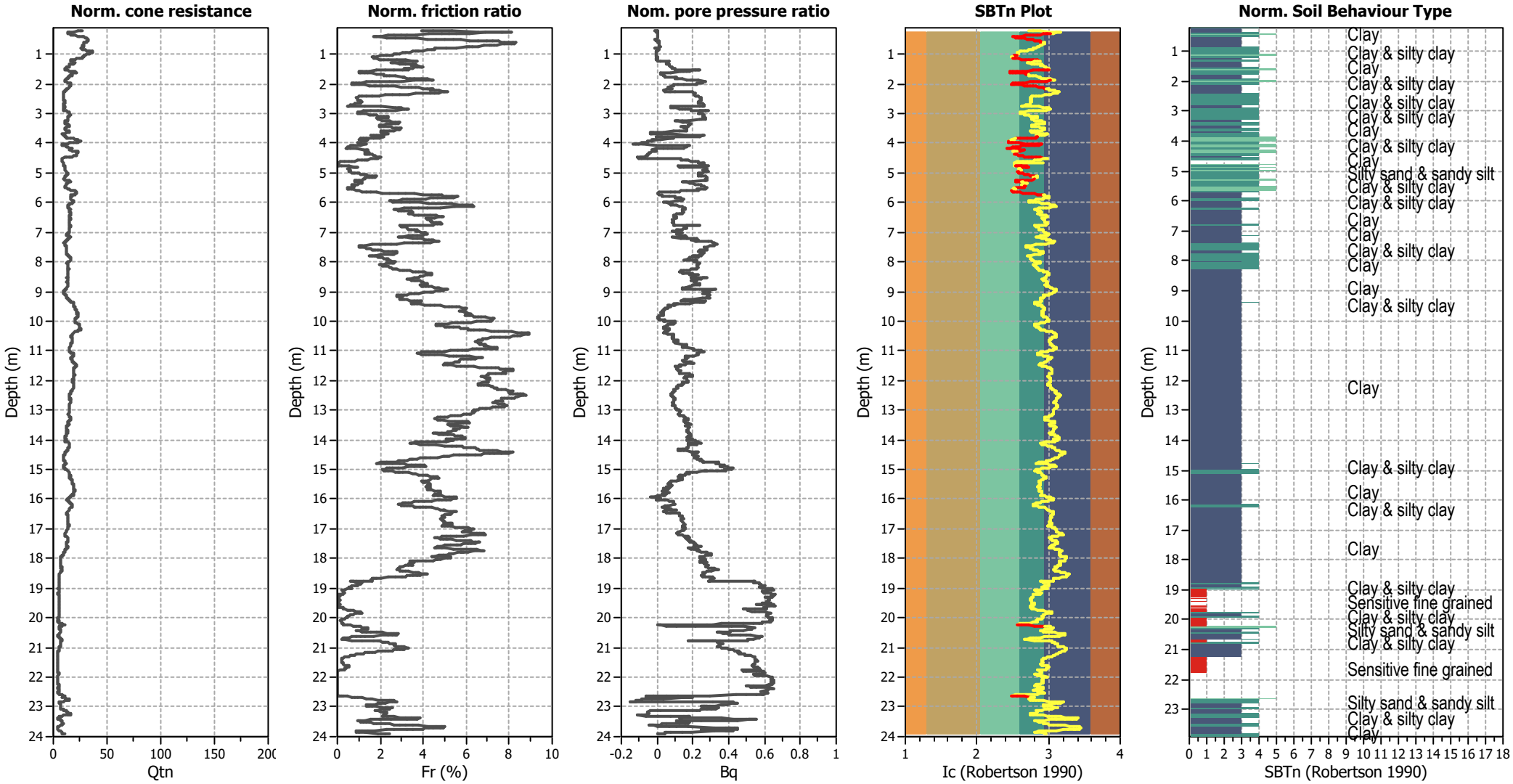
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



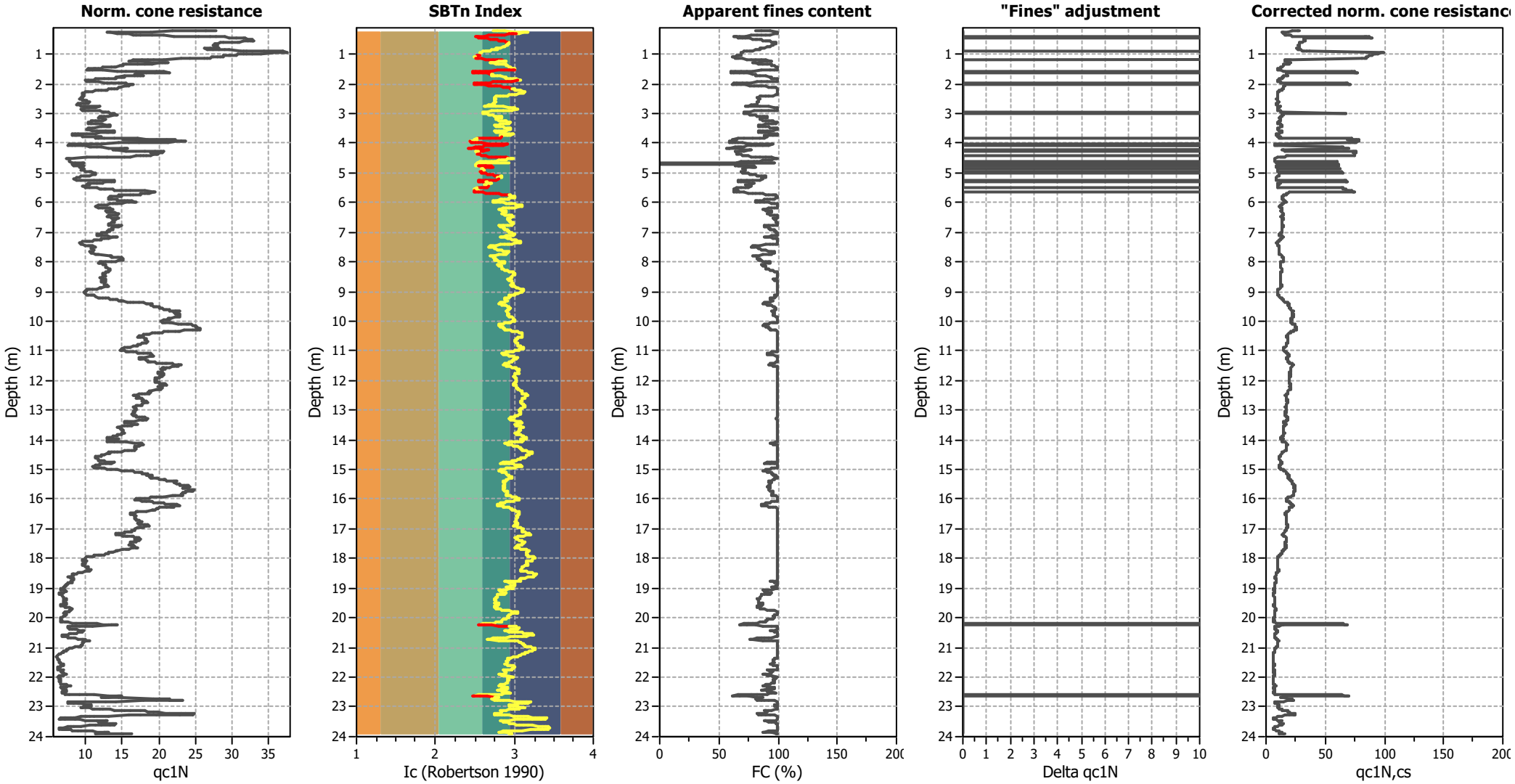
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

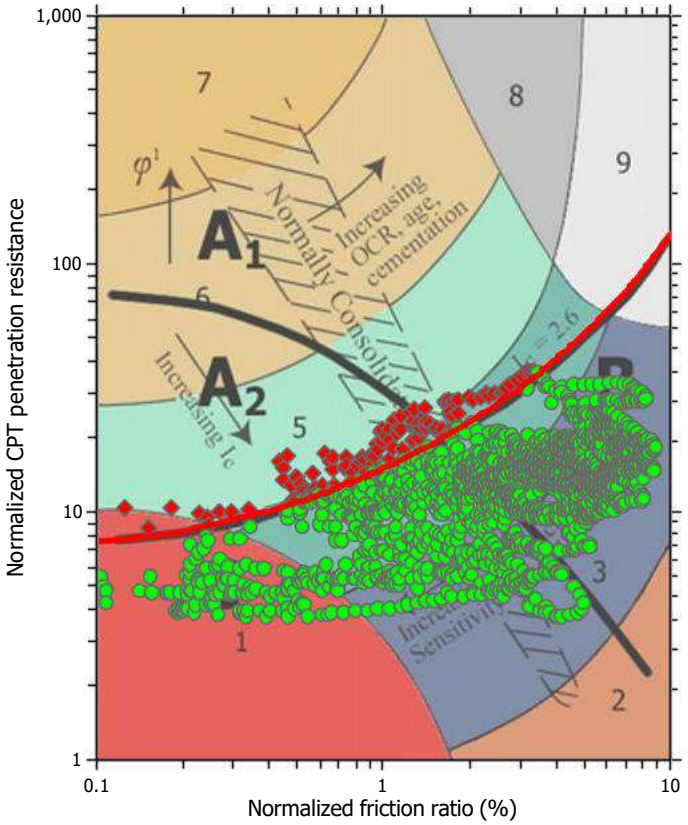
Liquefaction analysis overall plots (intermediate results)

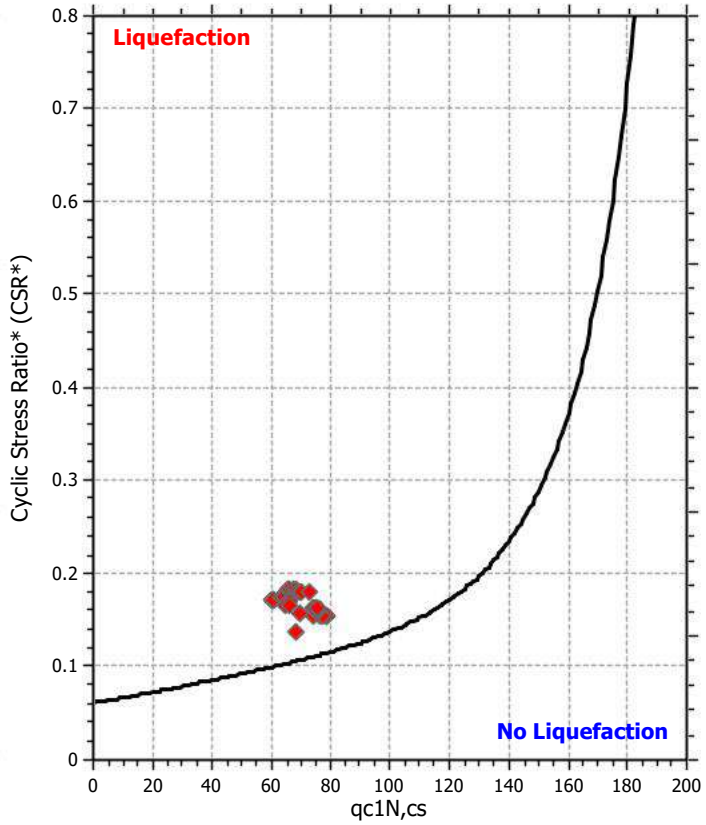


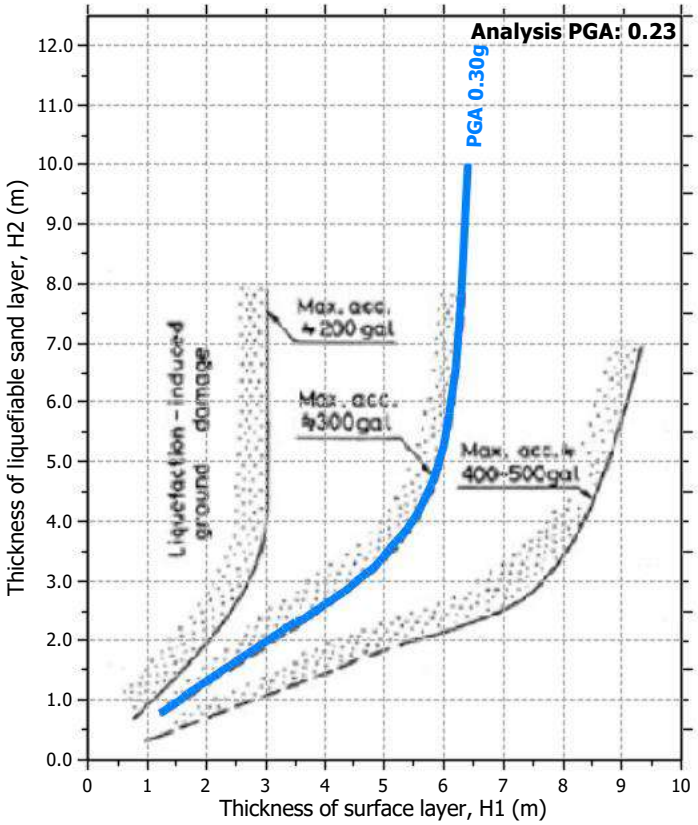
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



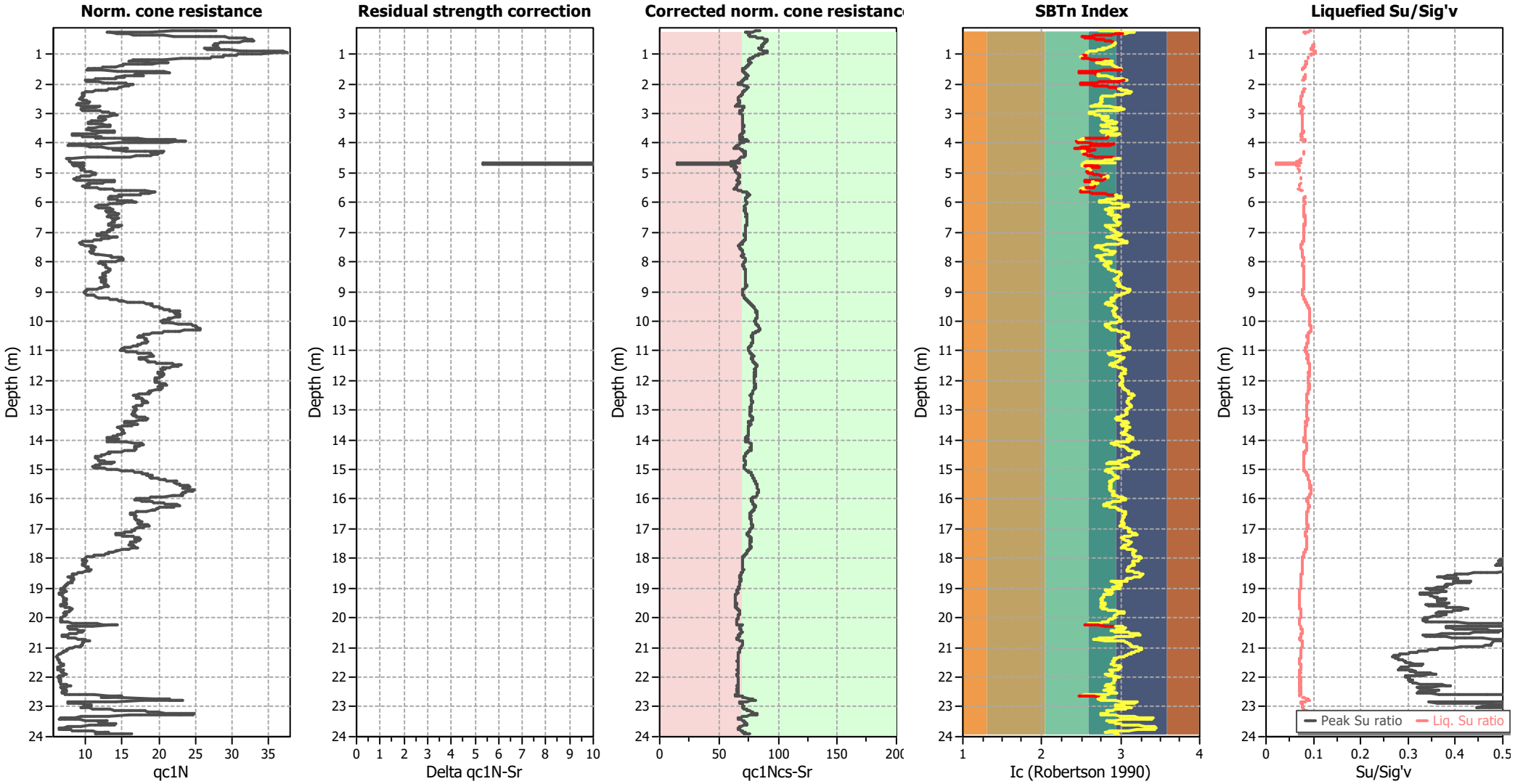




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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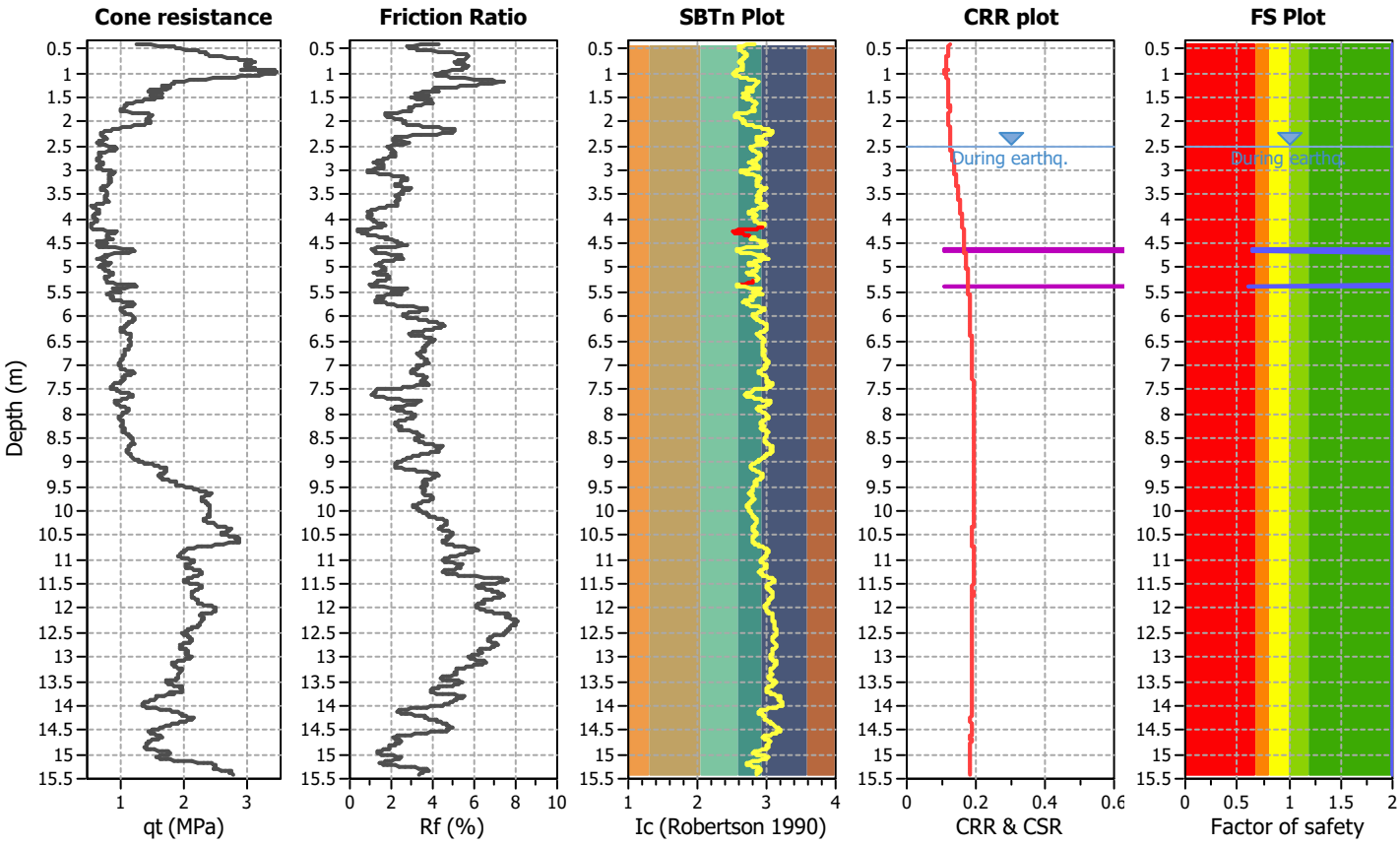
LIQUEFACTION ANALYSIS REPORT

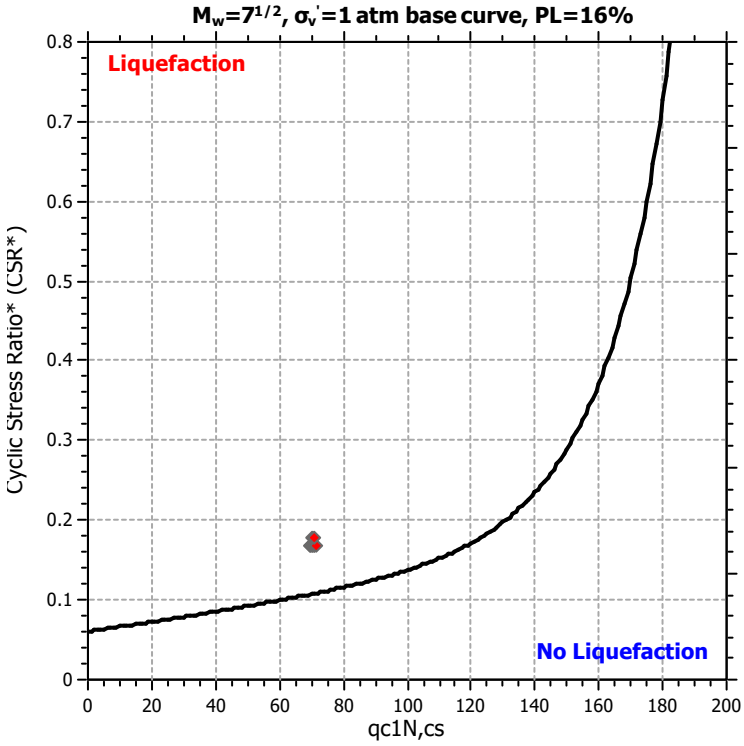
Project title : Ravarino **Location : Studio del terreno di fondazione**

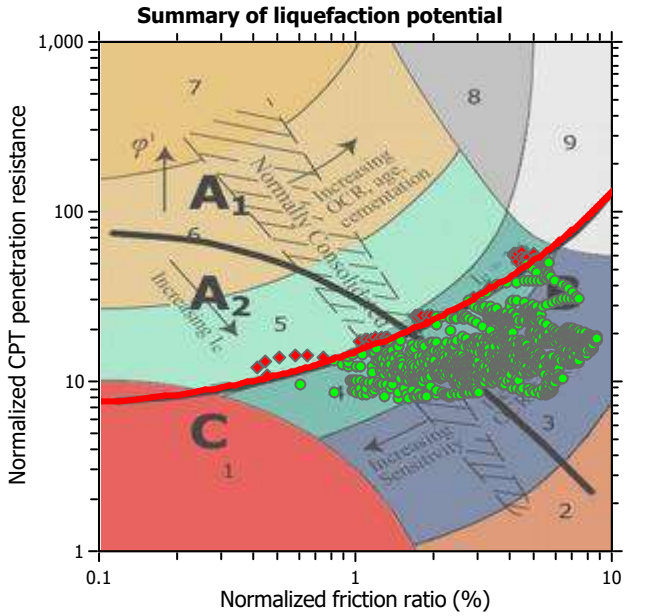
CPT file : CPTU8

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

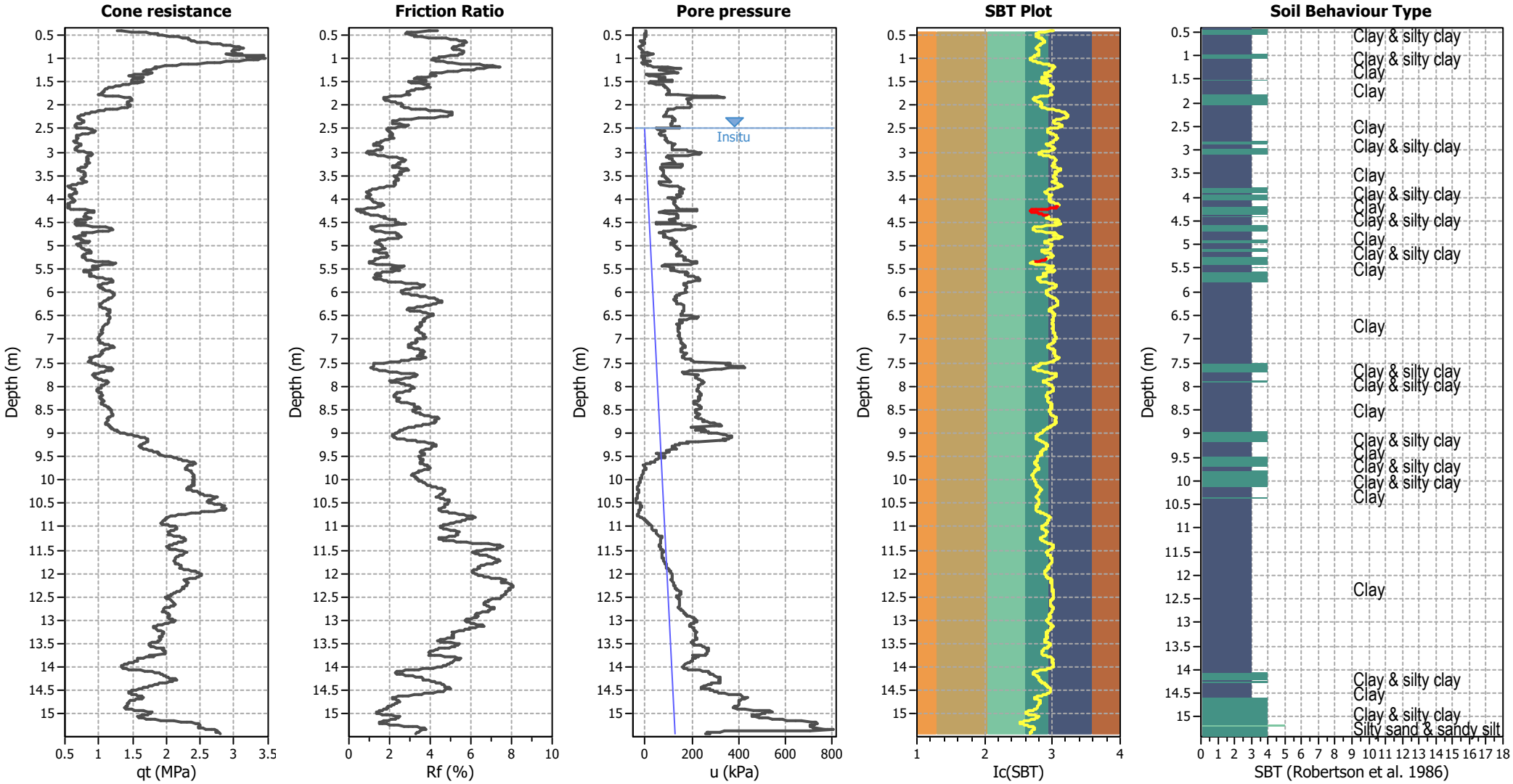






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



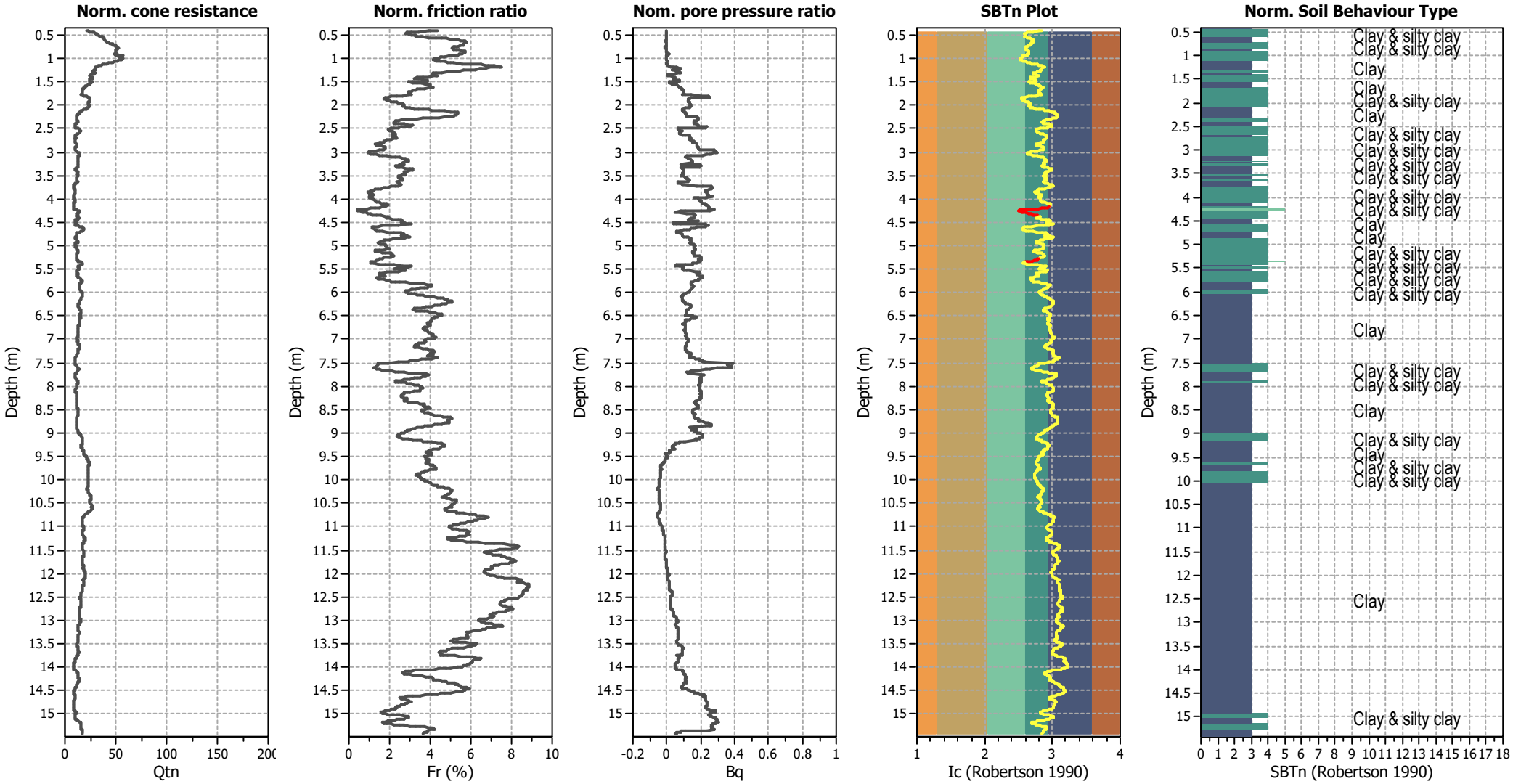
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



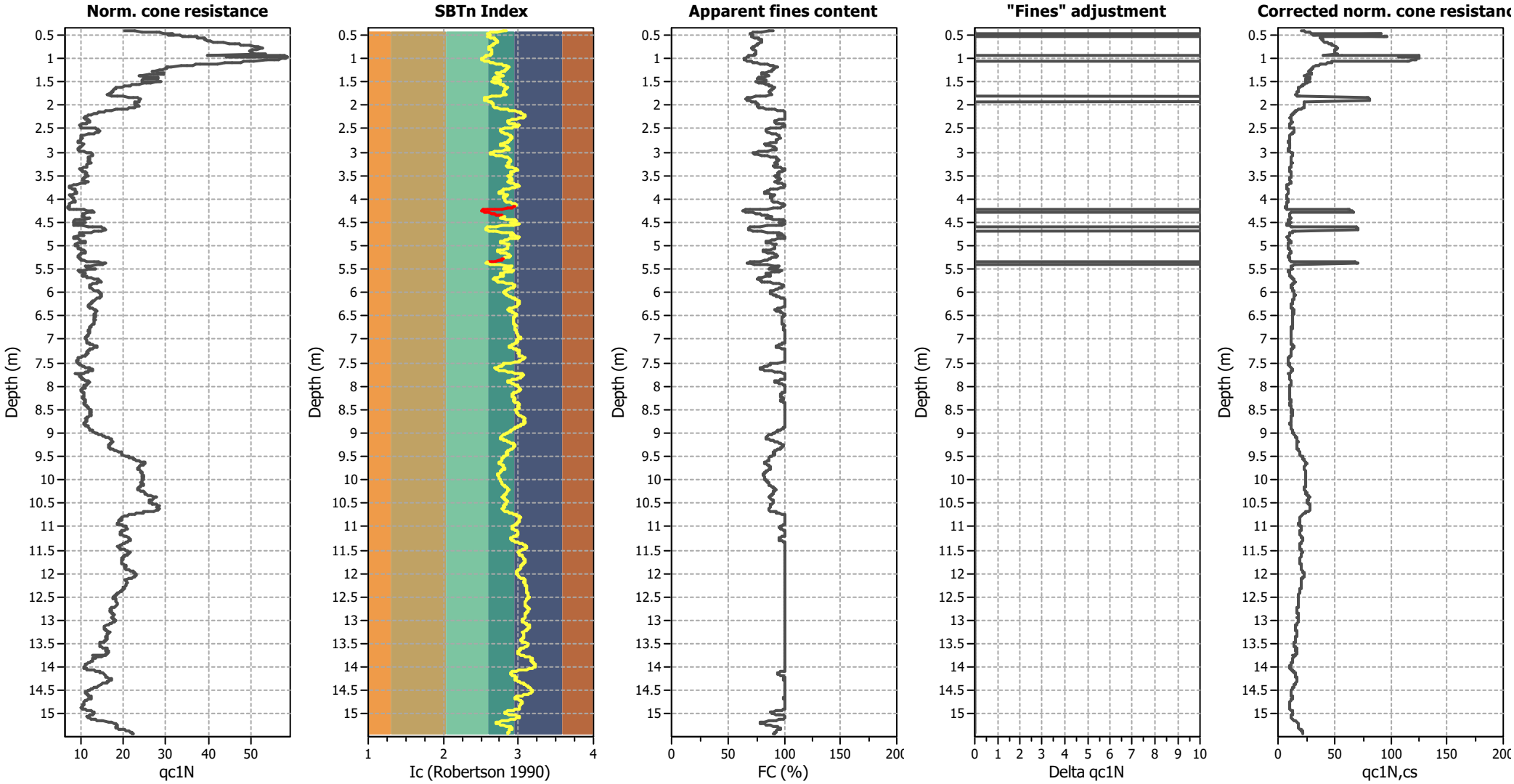
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

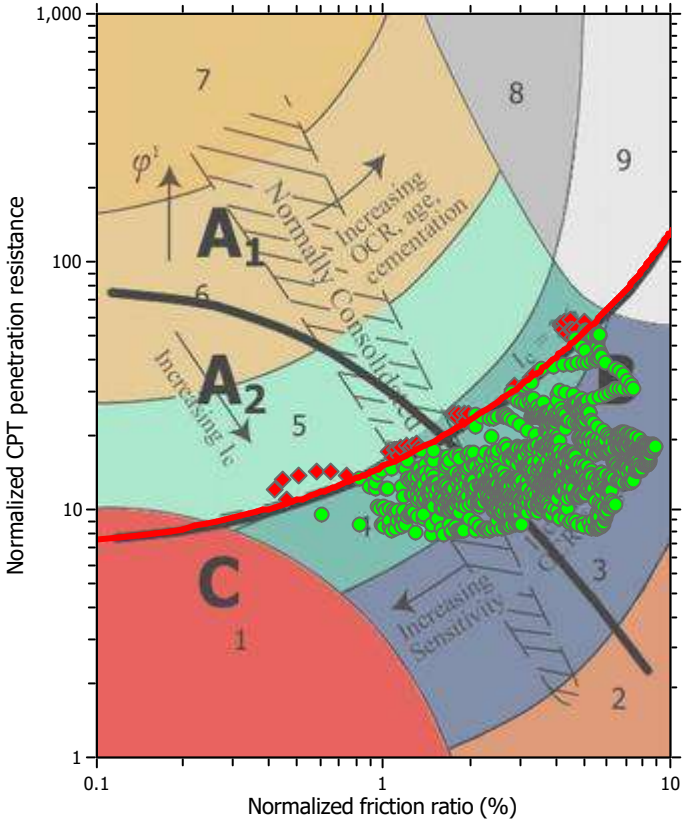
Liquefaction analysis overall plots (intermediate results)

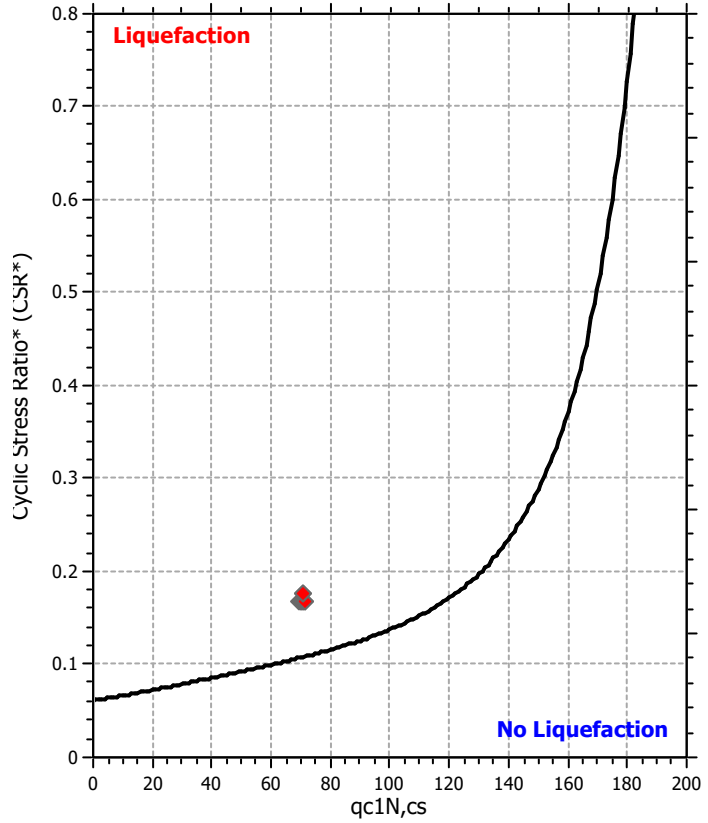


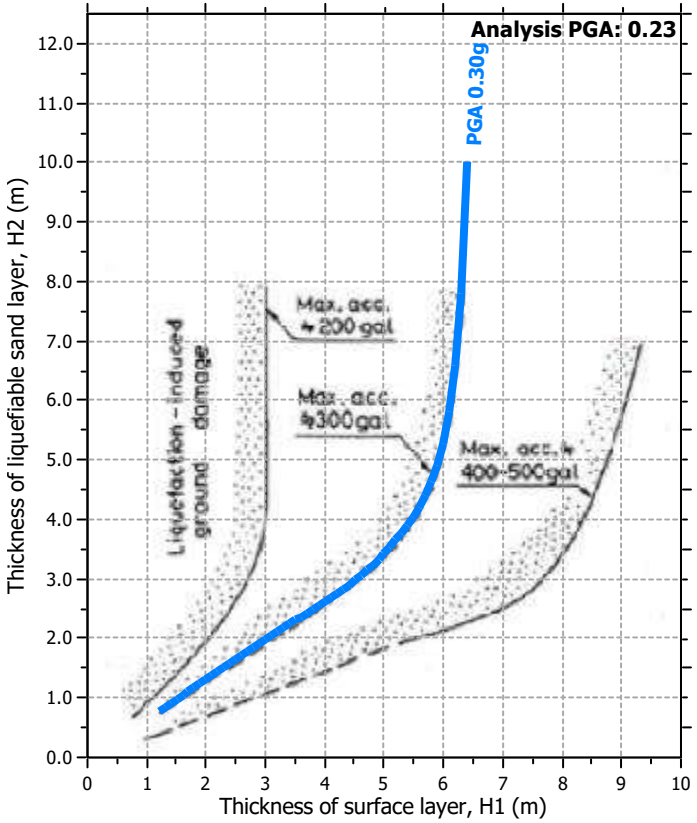
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



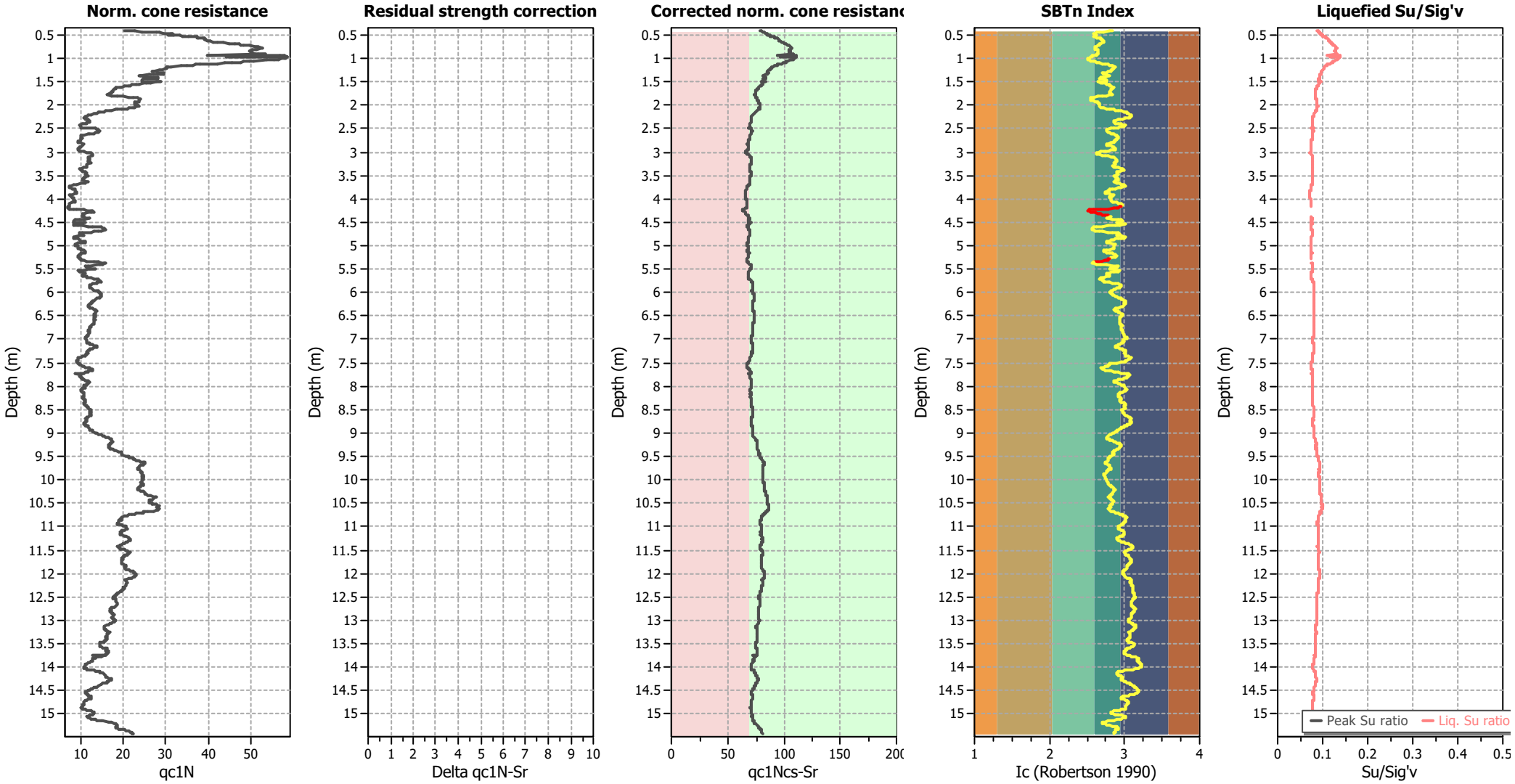




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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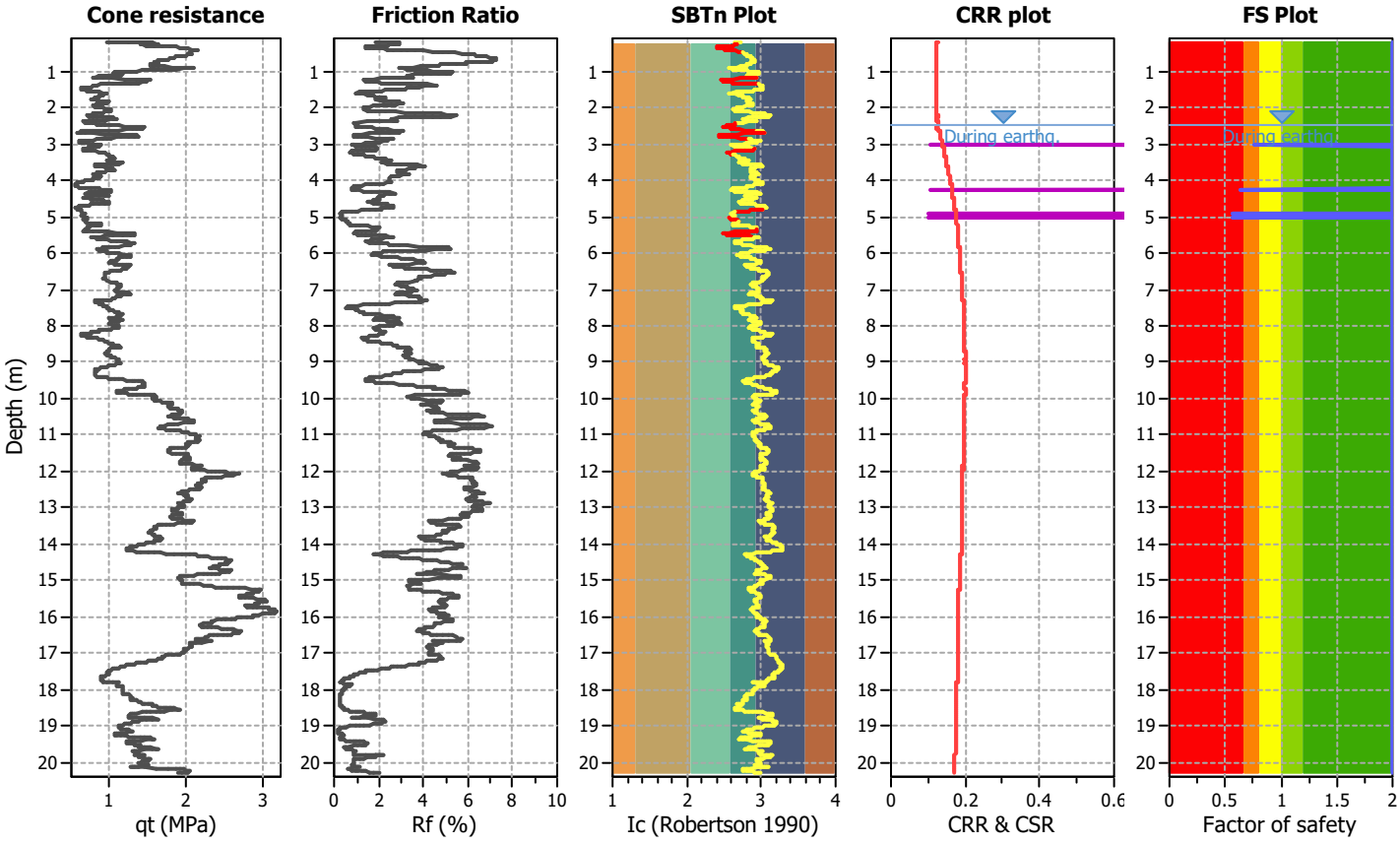
LIQUEFACTION ANALYSIS REPORT

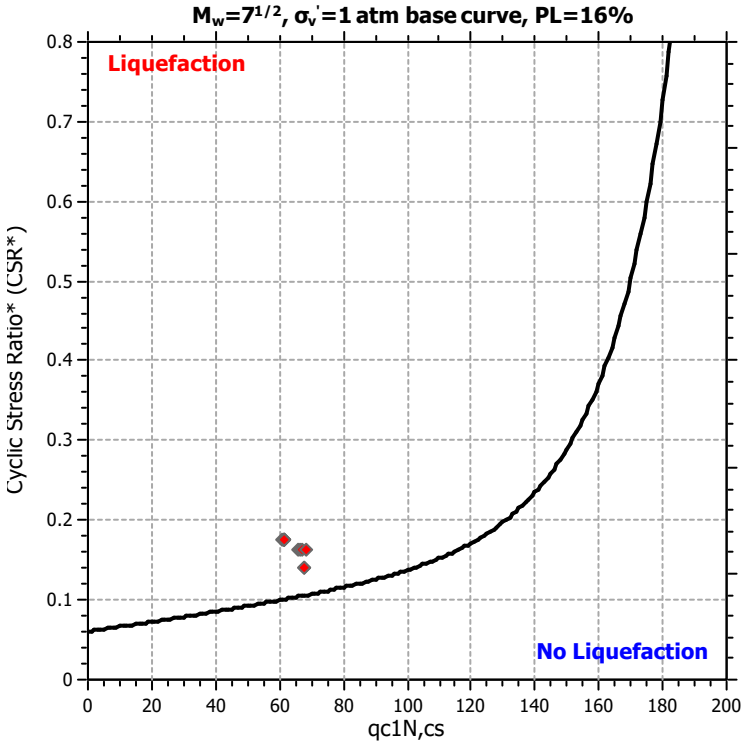
Project title : Ravarino **Location : Studio del terreno di fondazione**

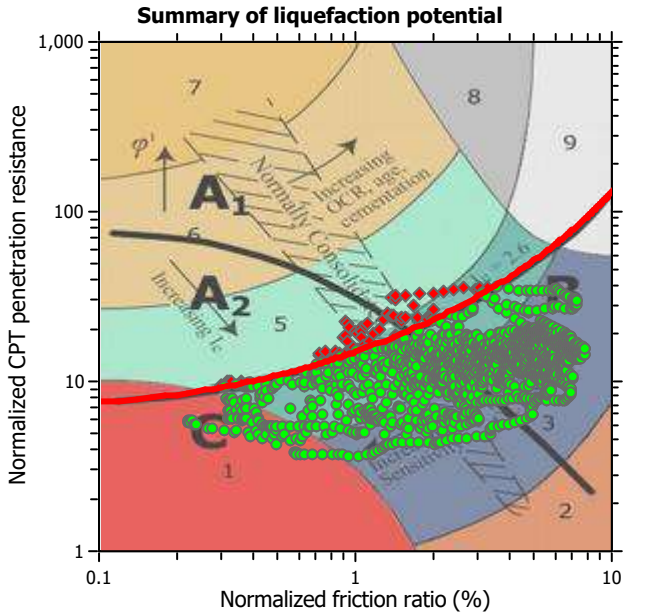
CPT file : CPTU9

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

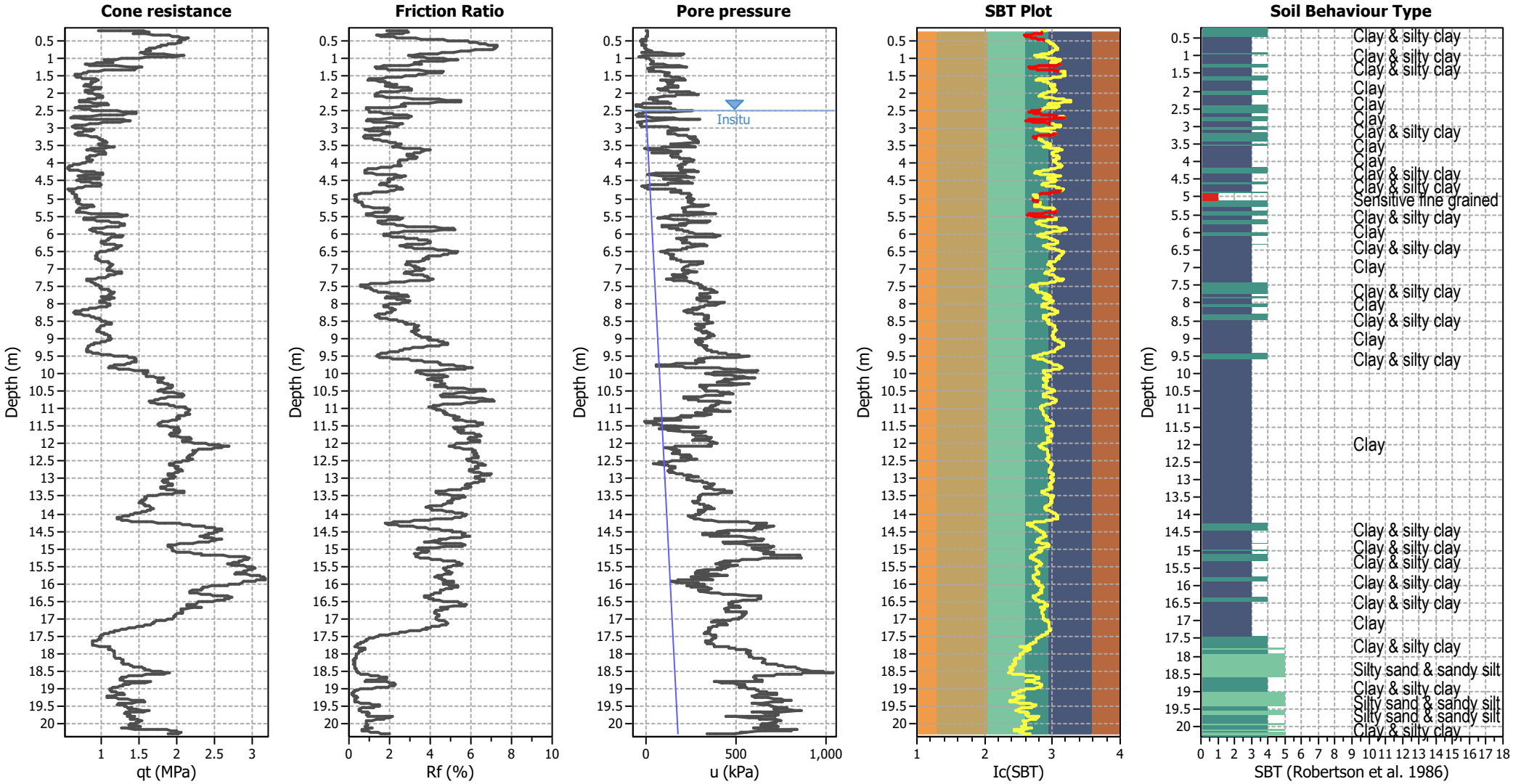






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



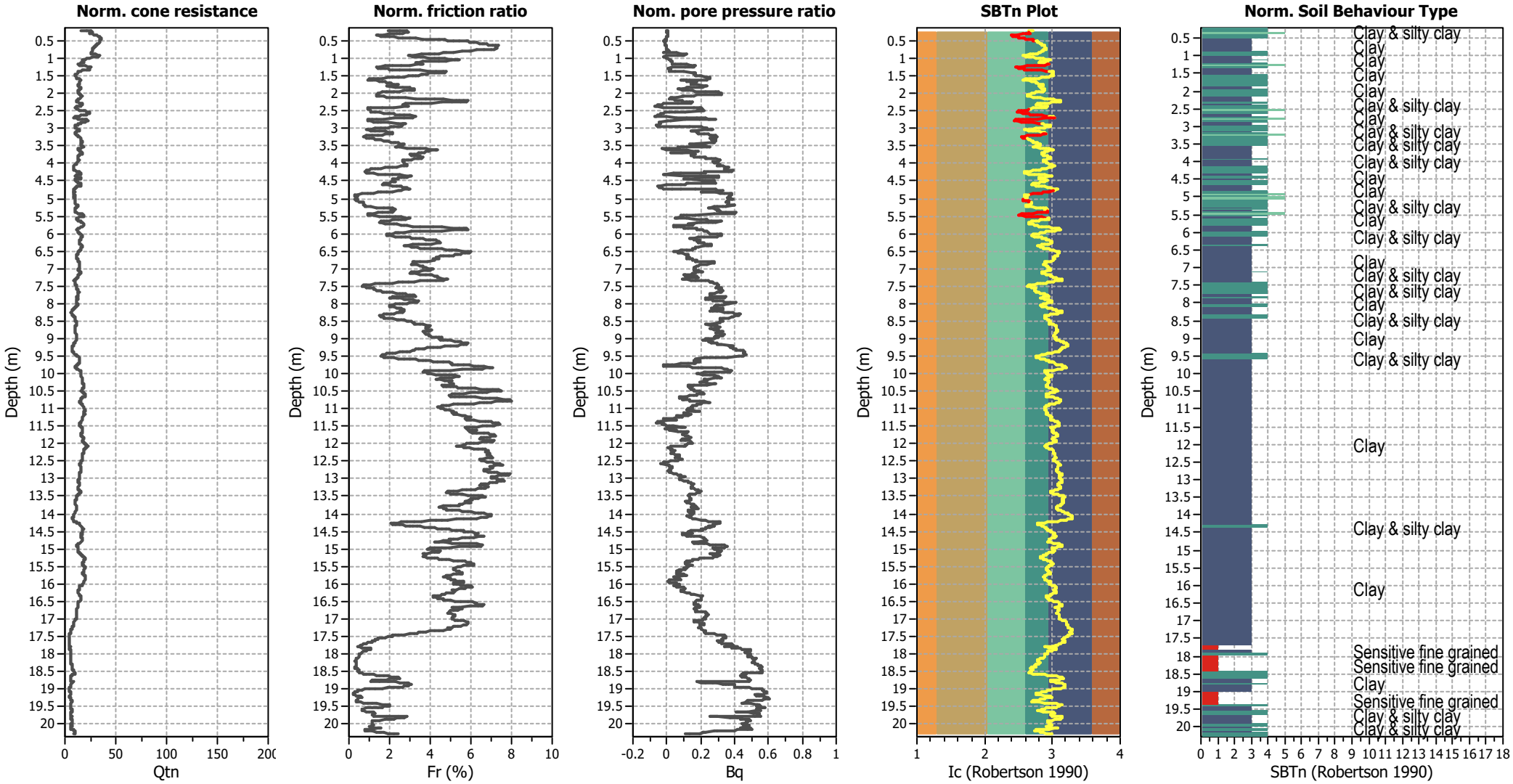
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



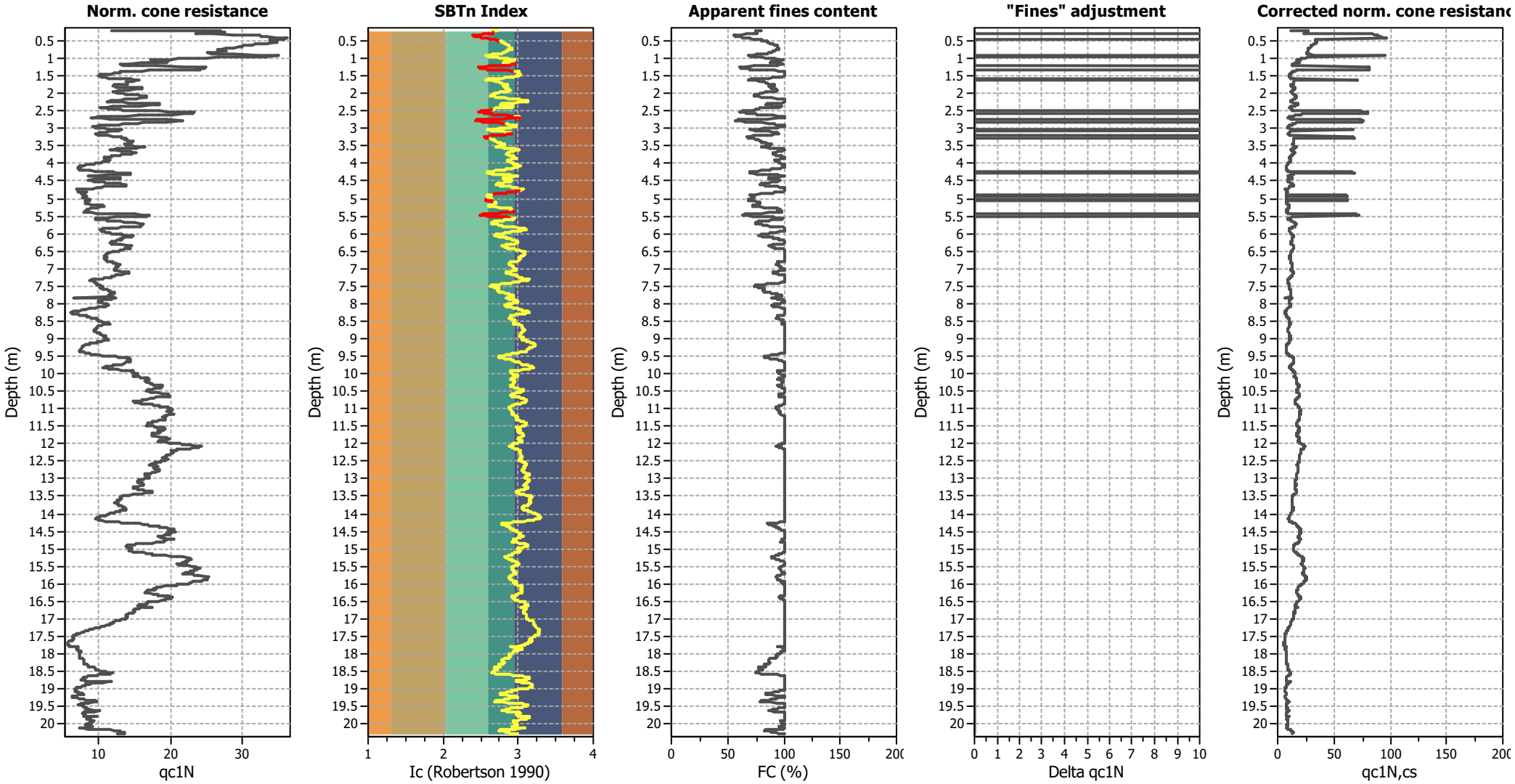
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

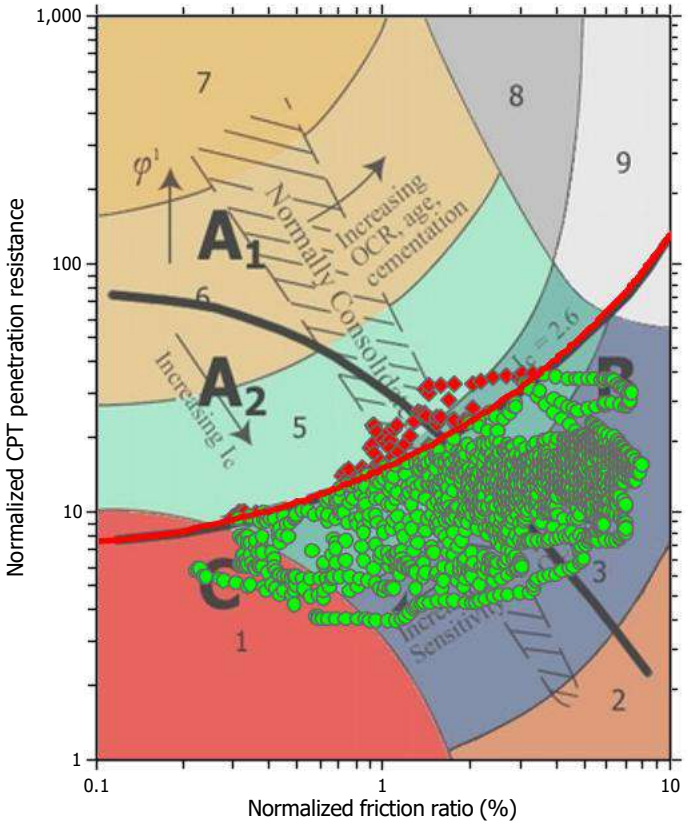
Liquefaction analysis overall plots (intermediate results)

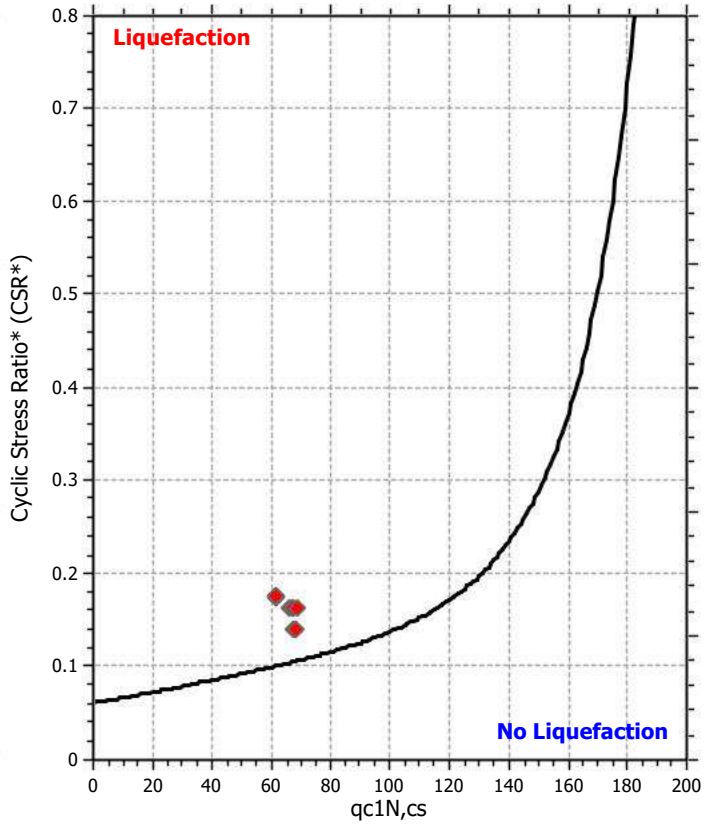


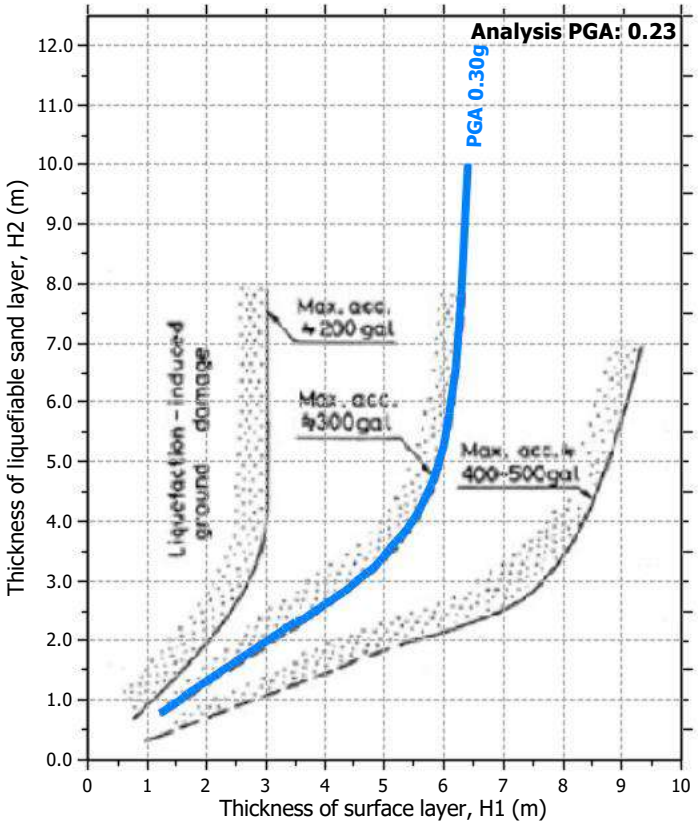
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



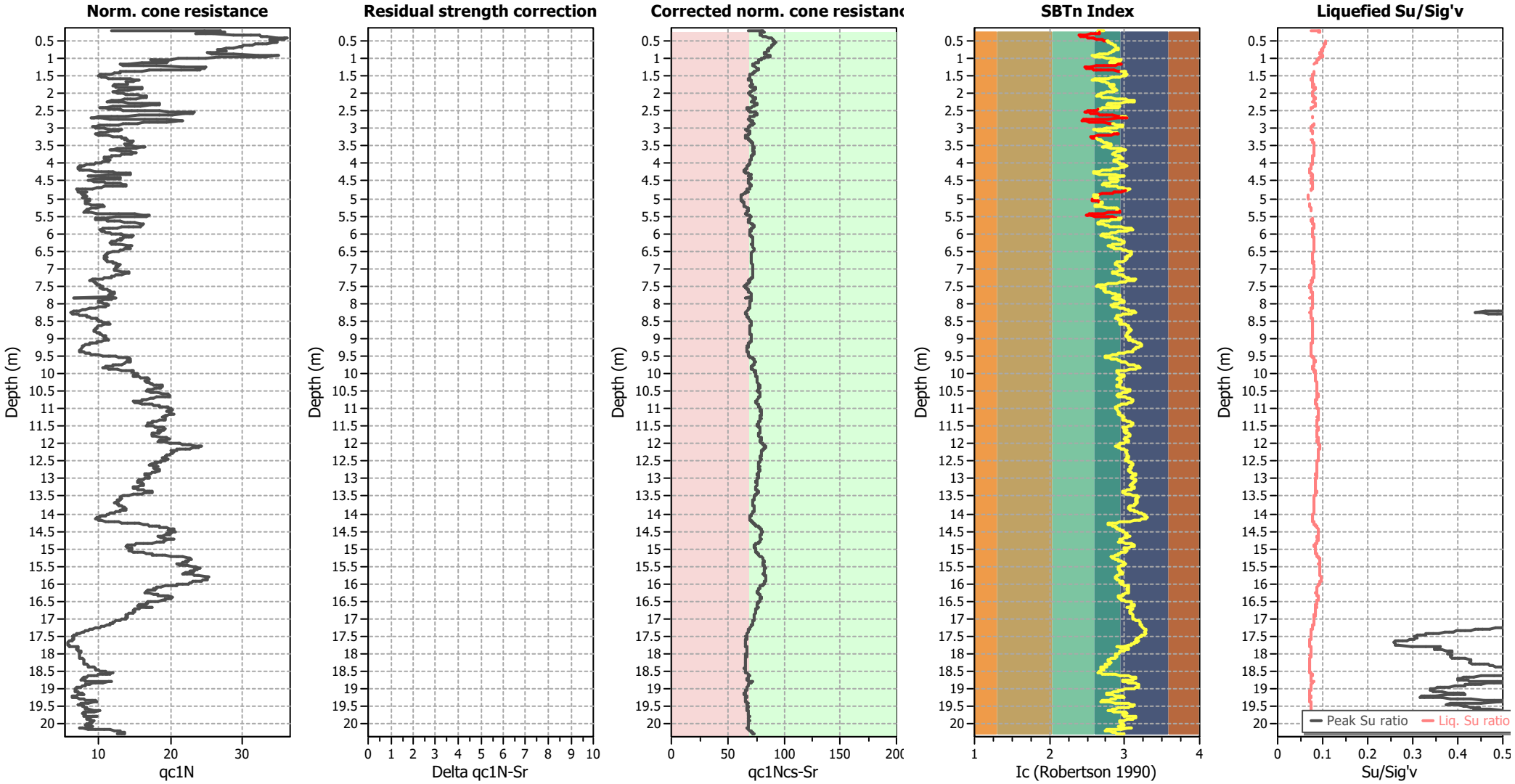




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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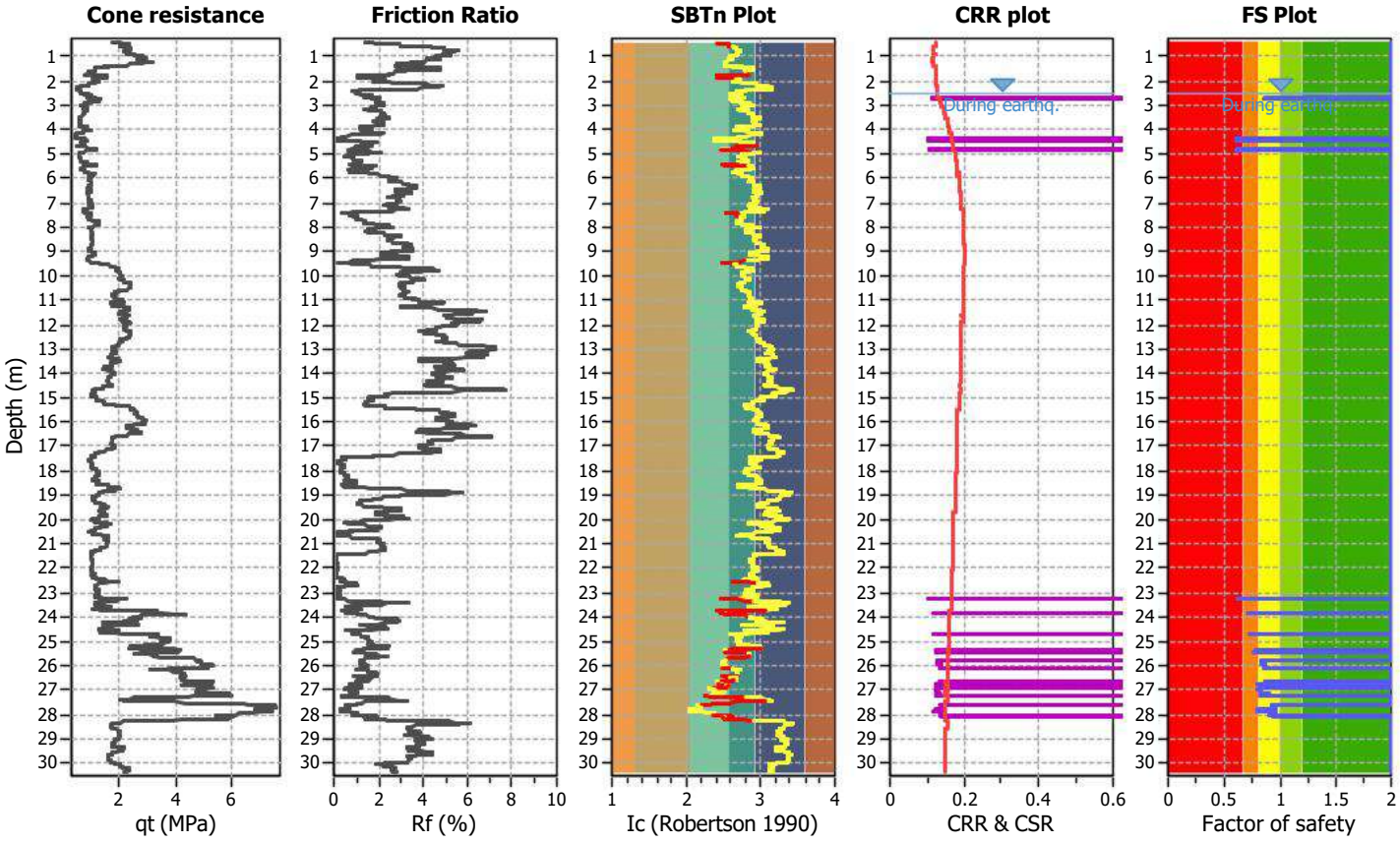
LIQUEFACTION ANALYSIS REPORT

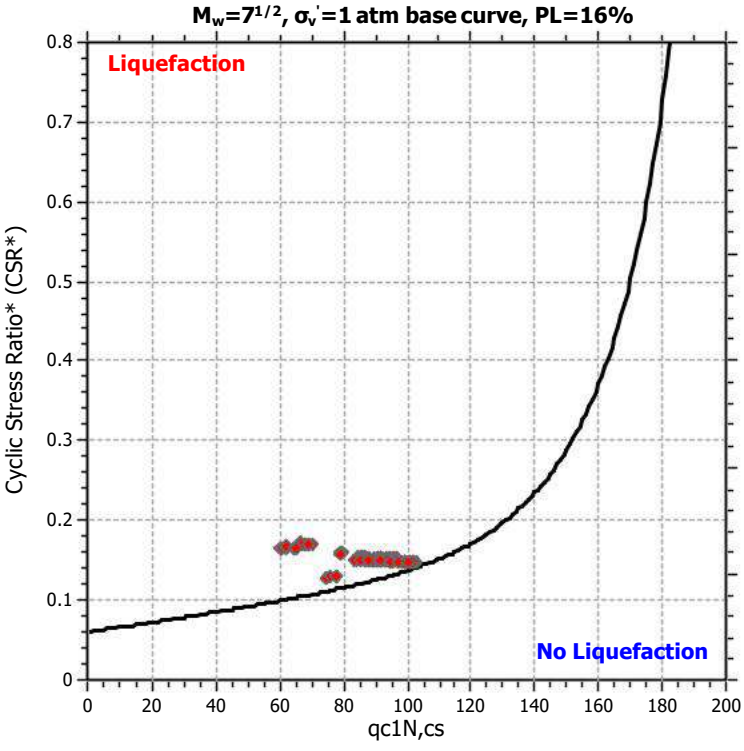
Project title : Ravarino **Location : Studio del terreno di fondazione**

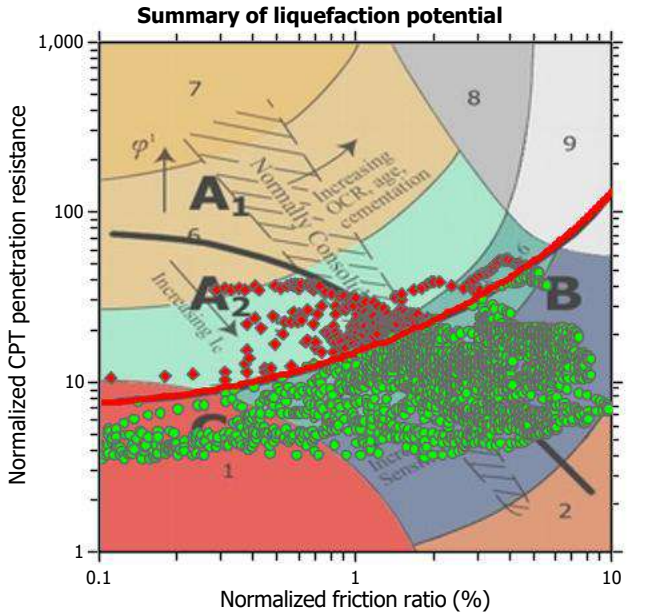
CPT file : CPTU10

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

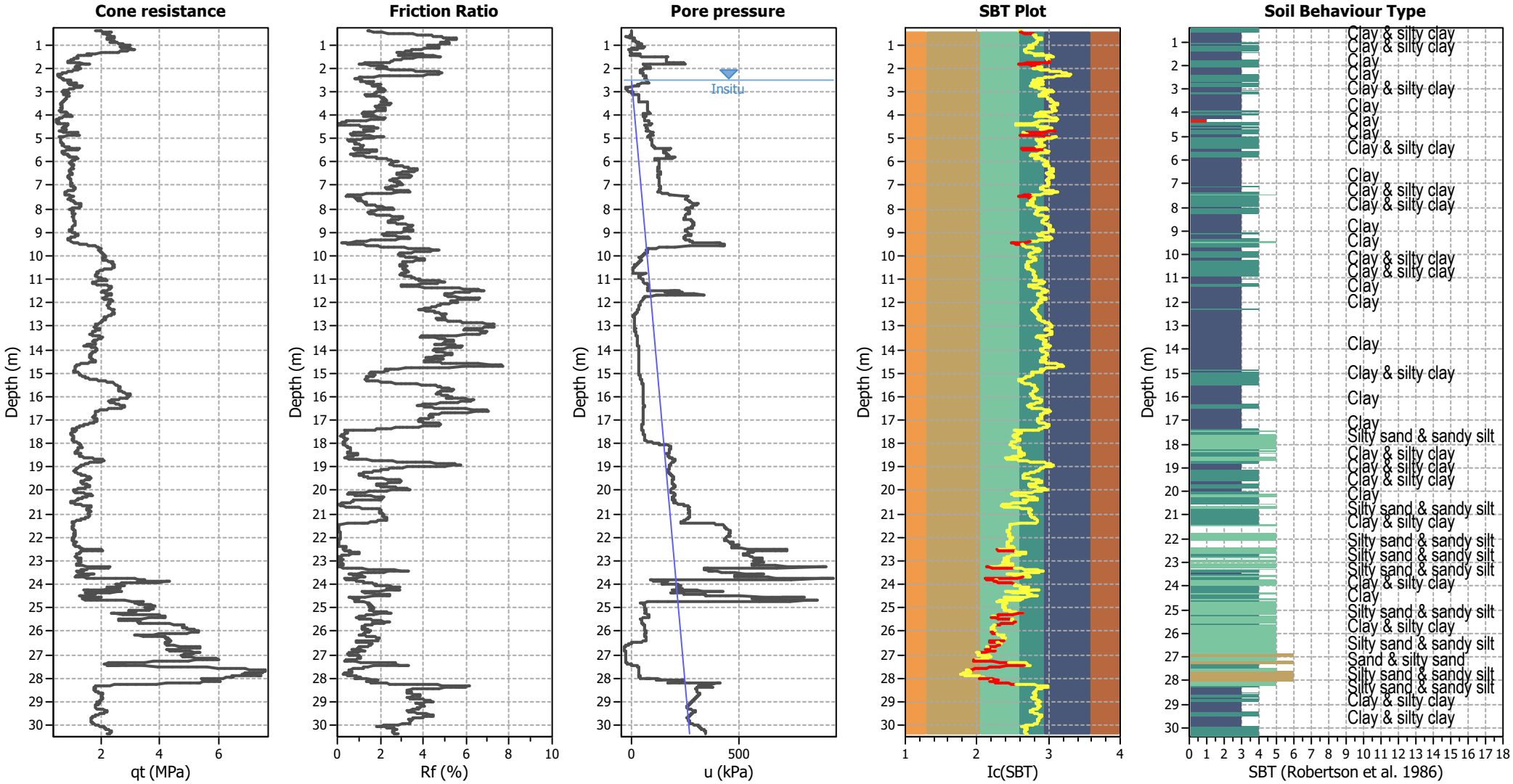






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



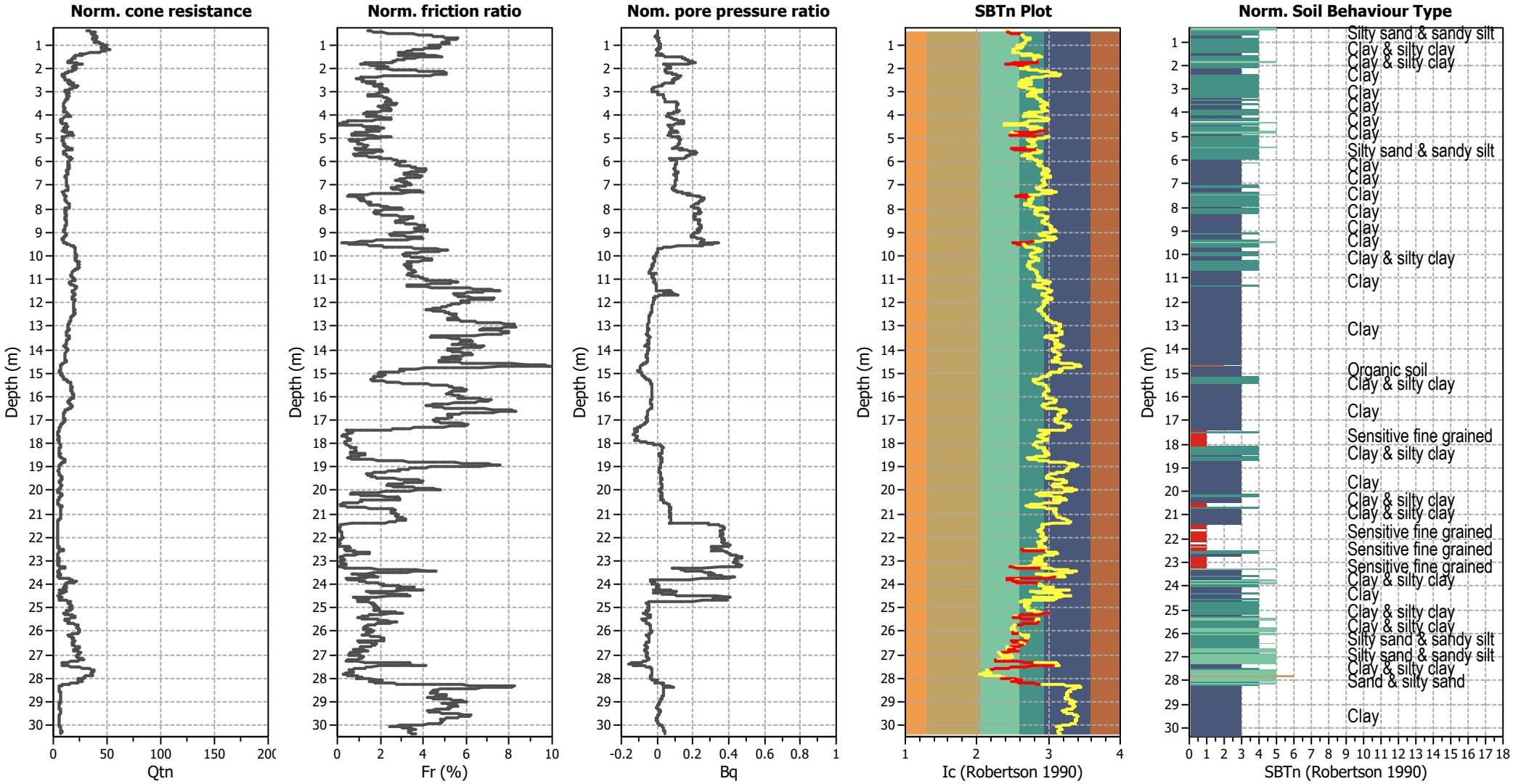
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



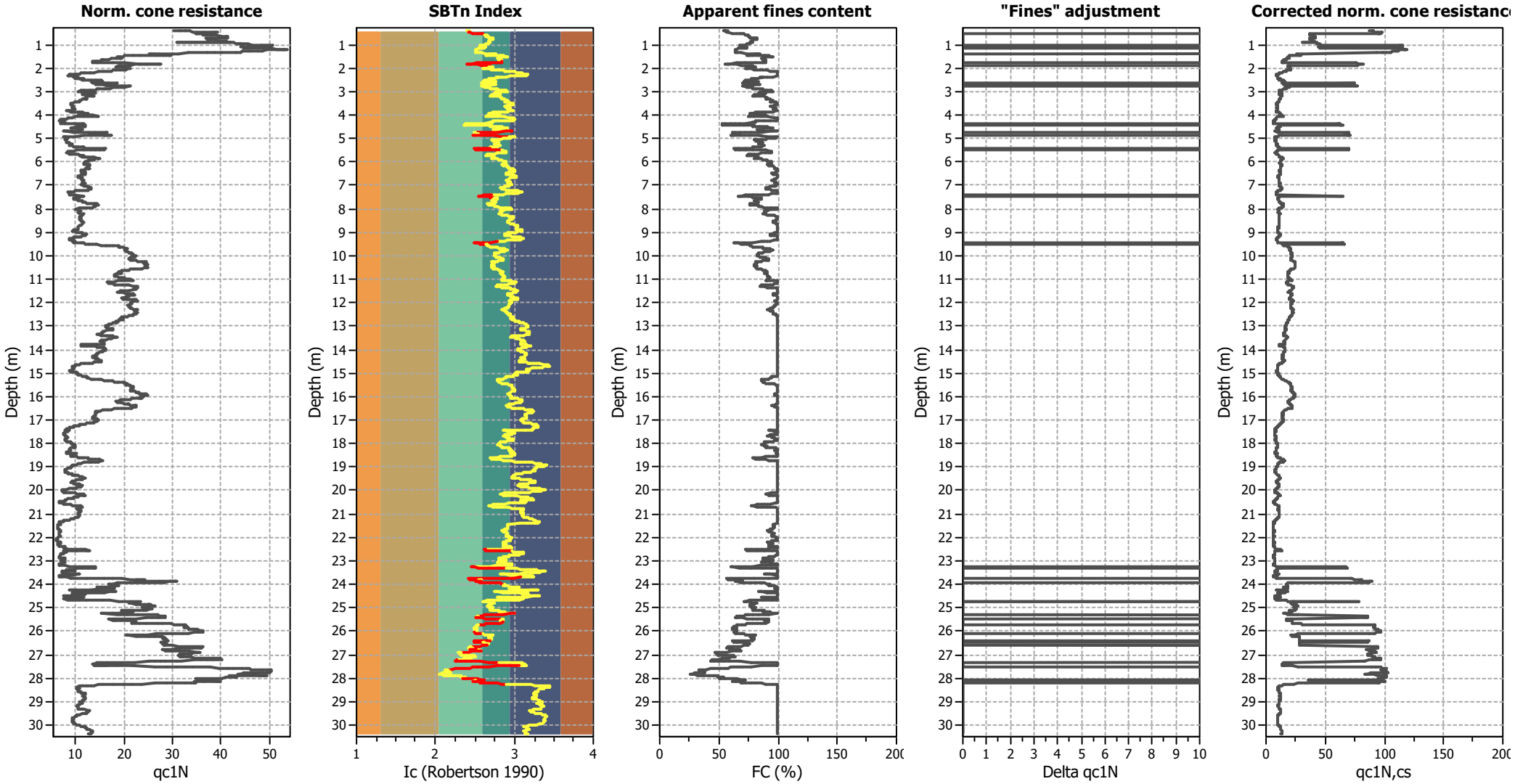
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

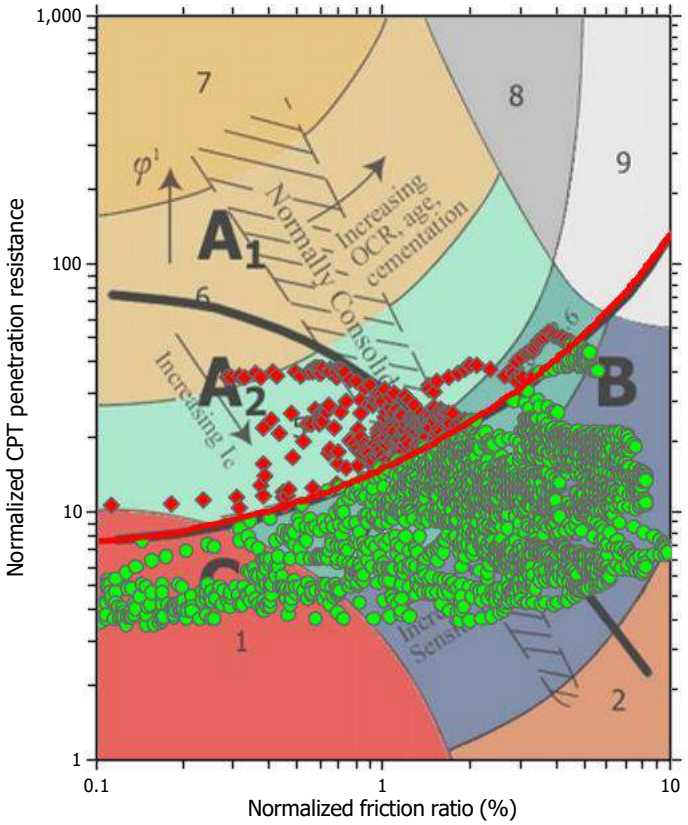
Liquefaction analysis overall plots (intermediate results)

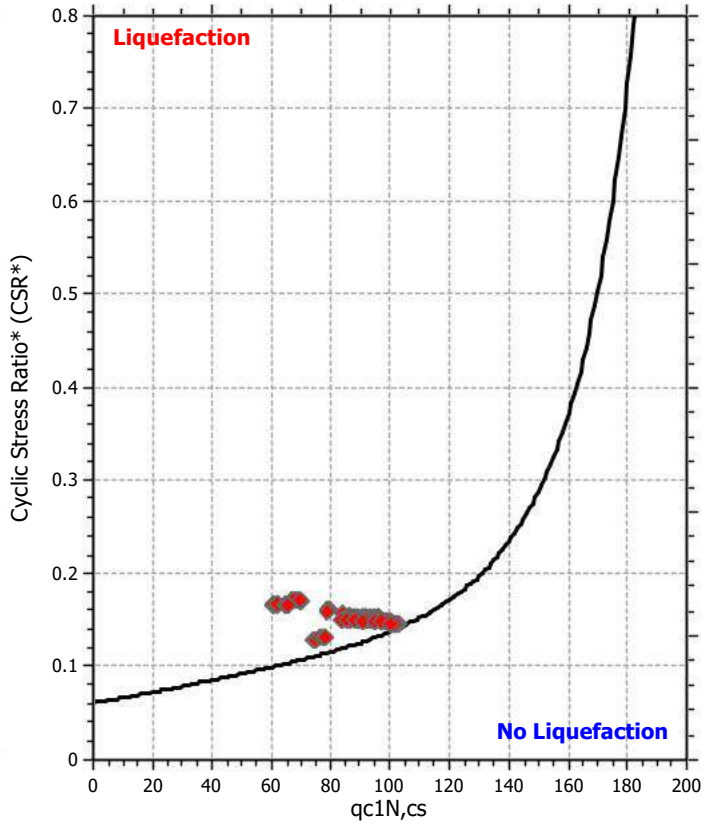


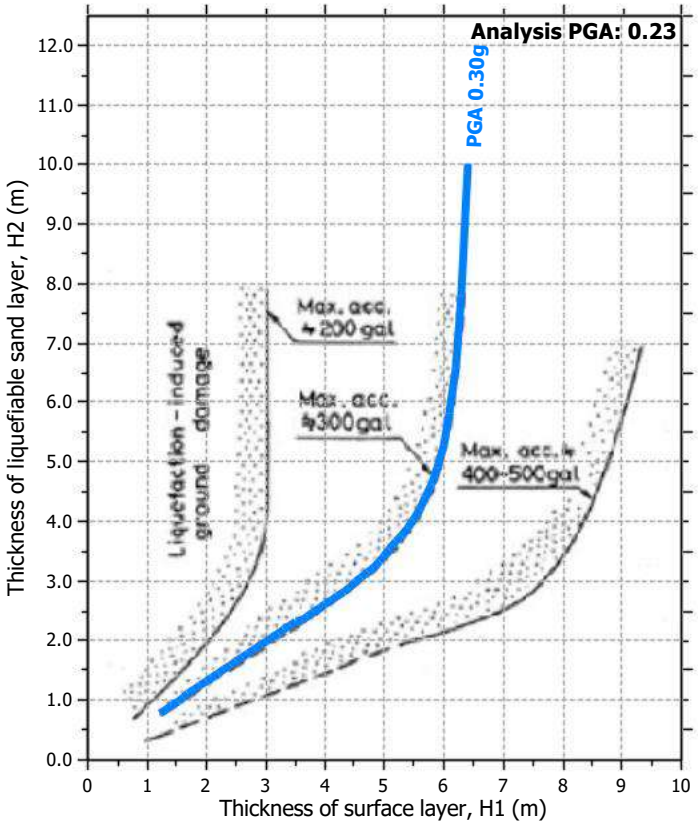
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



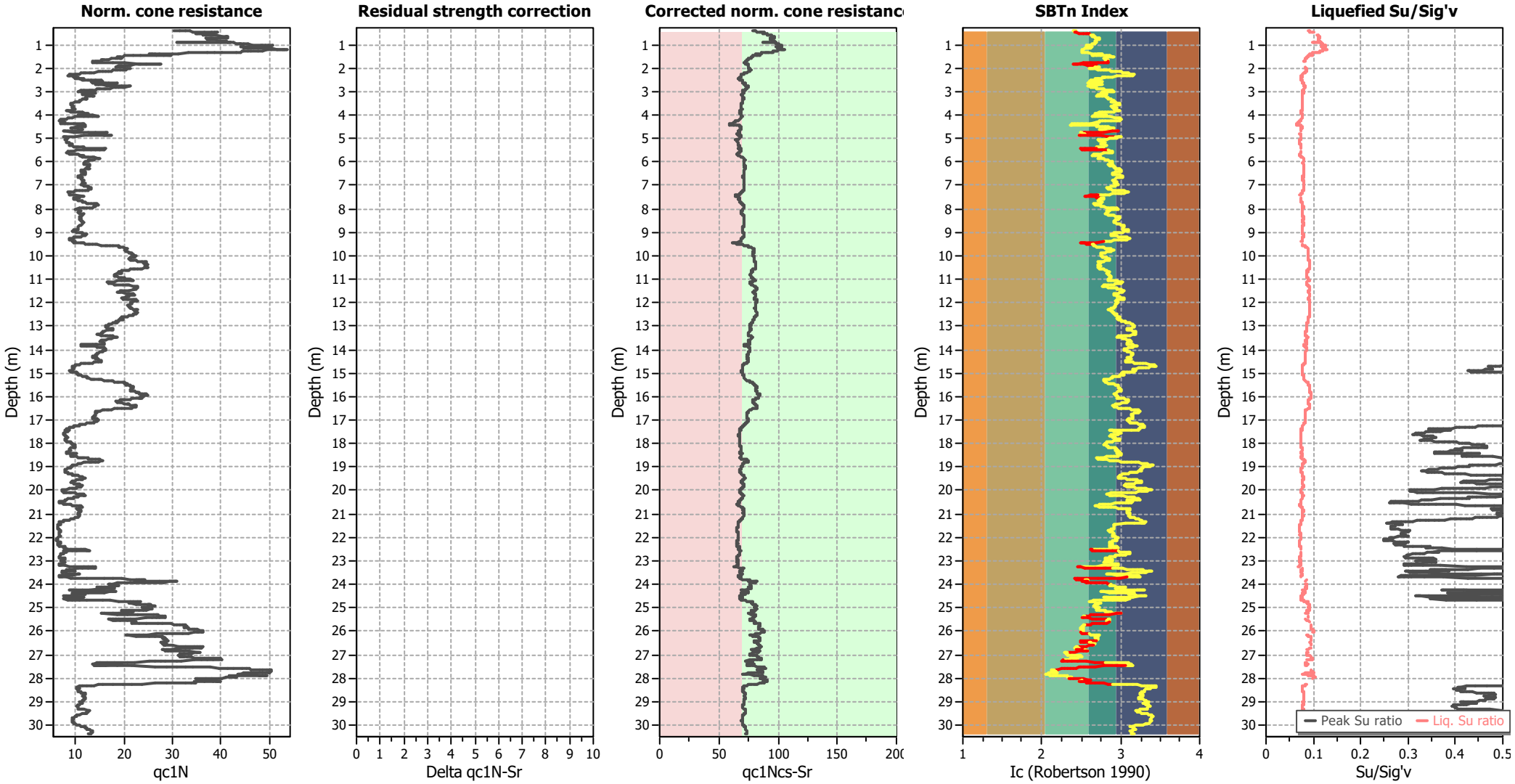




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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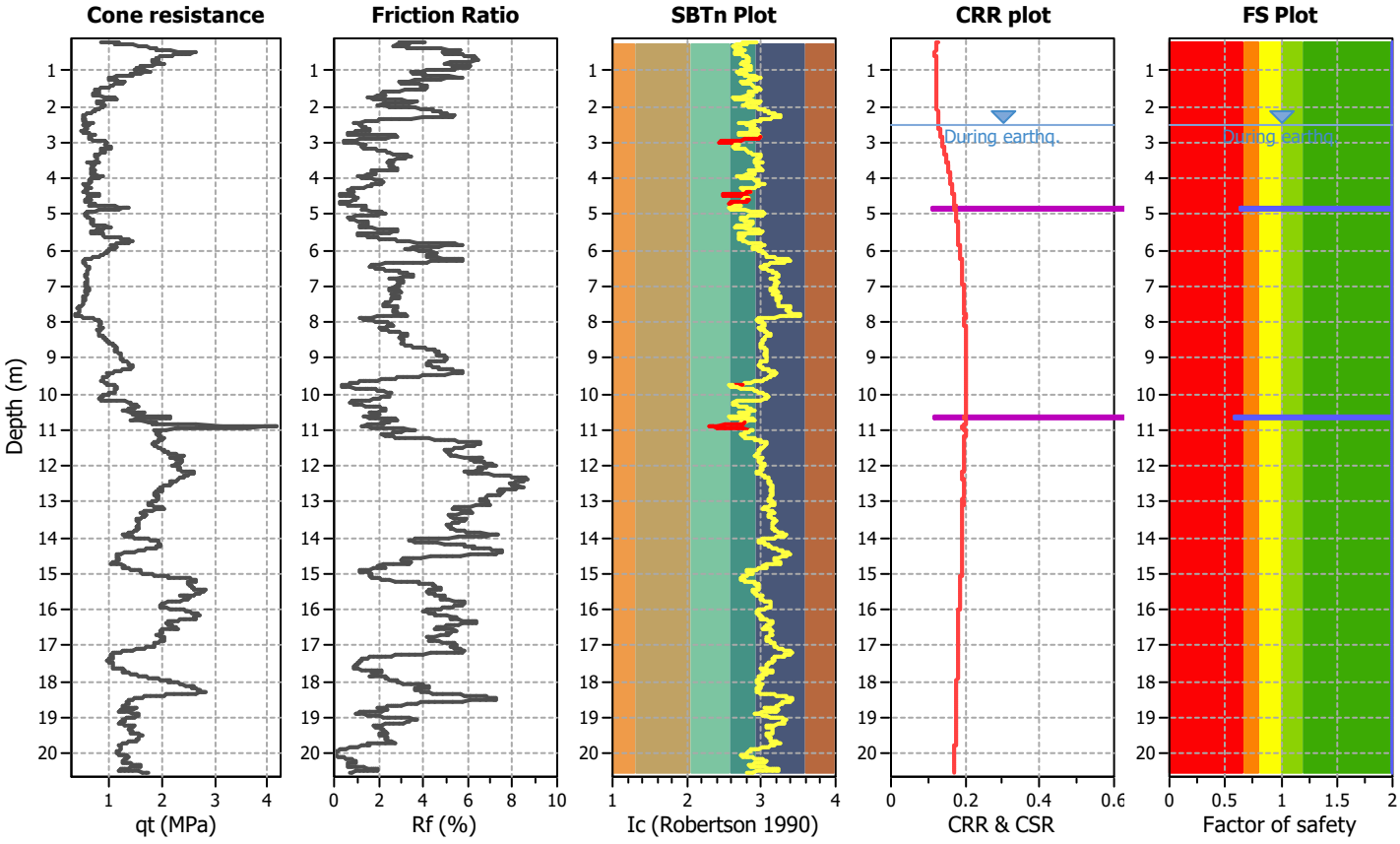
LIQUEFACTION ANALYSIS REPORT

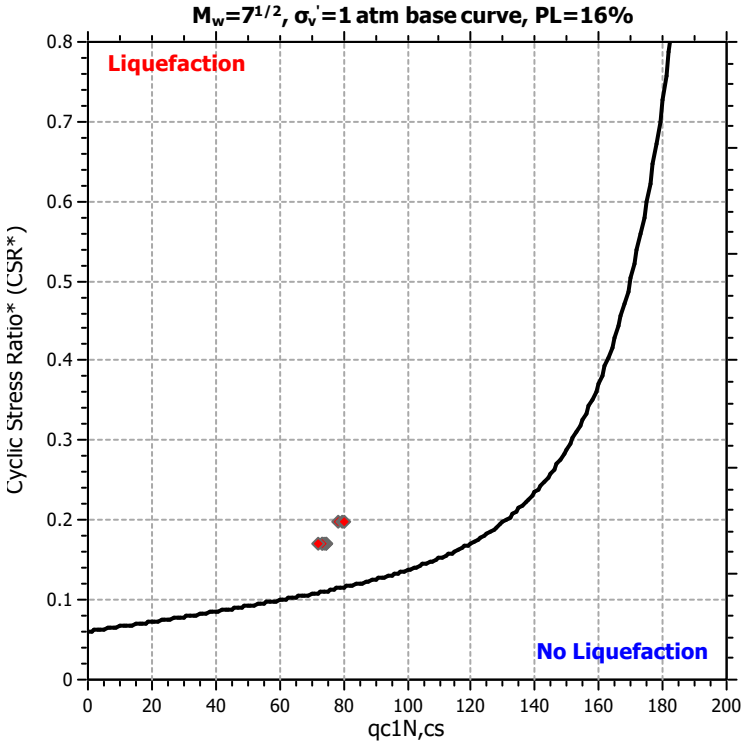
Project title : Ravarino **Location : Studio del terreno di fondazione**

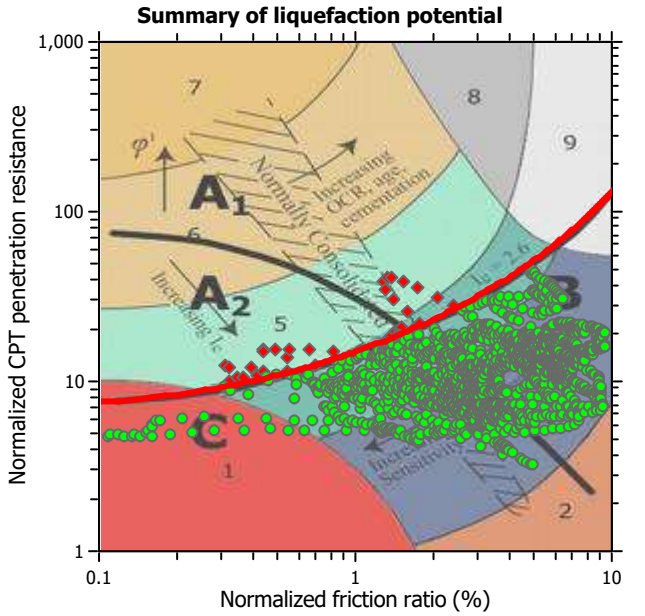
CPT file : CPTU11

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

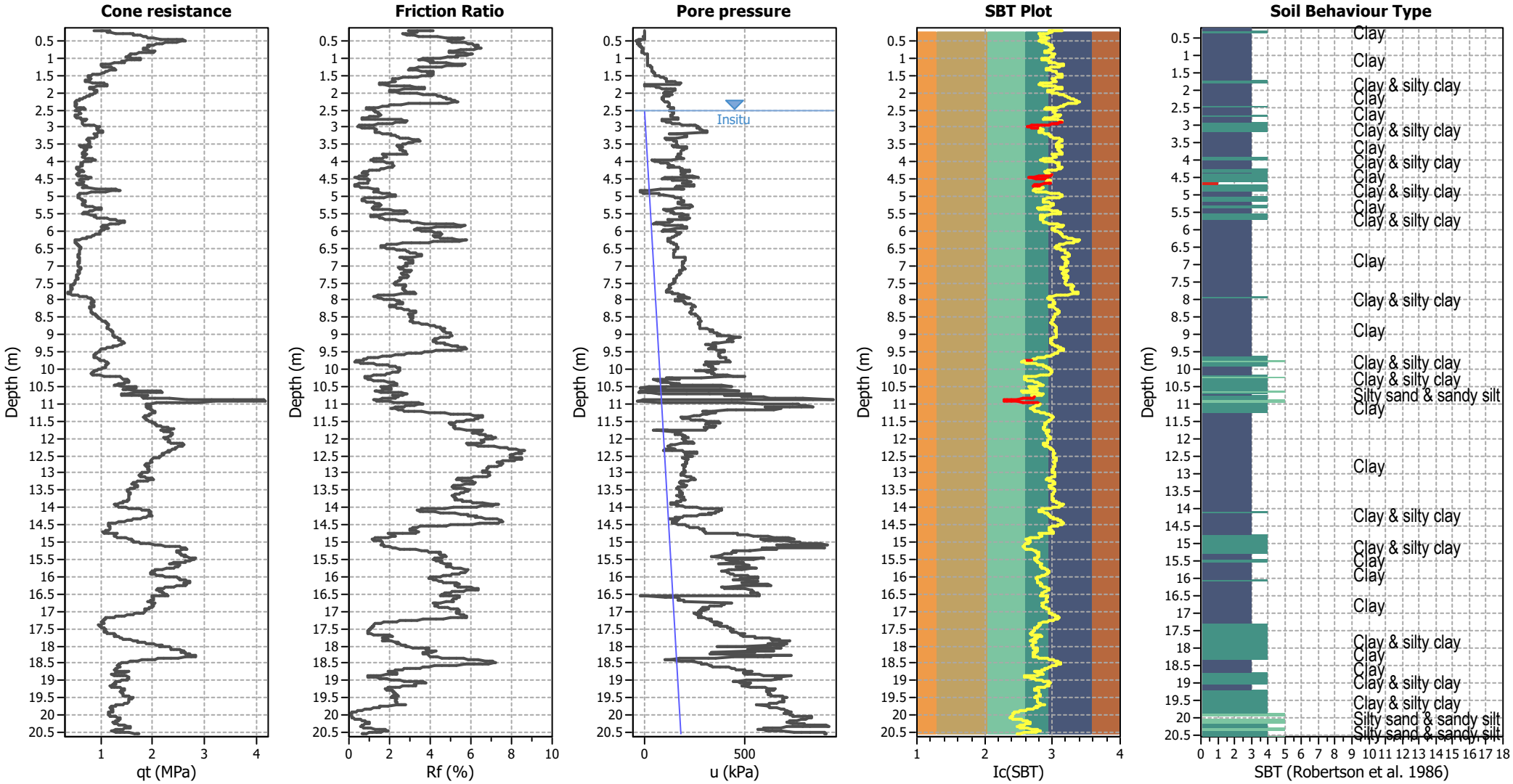






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



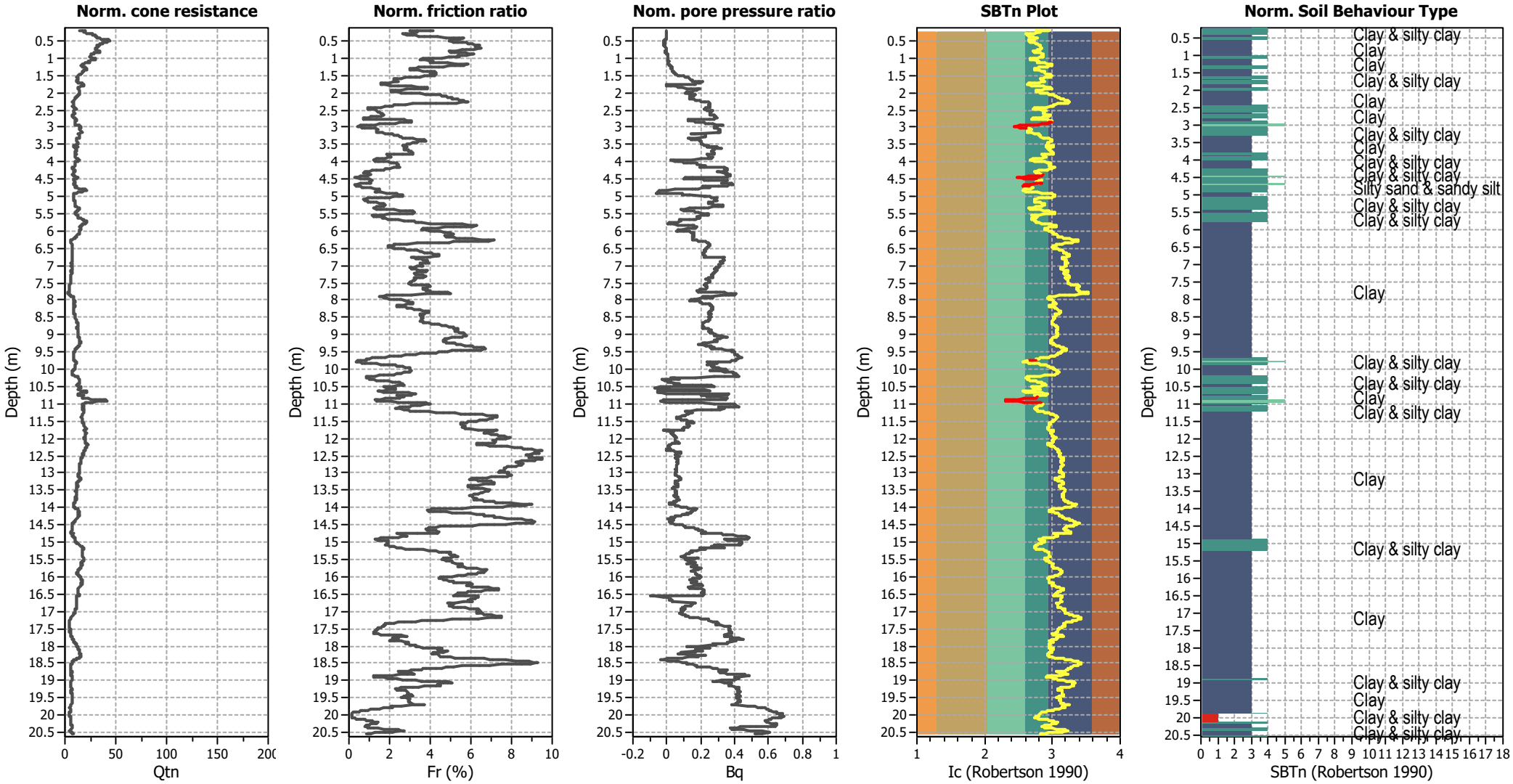
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



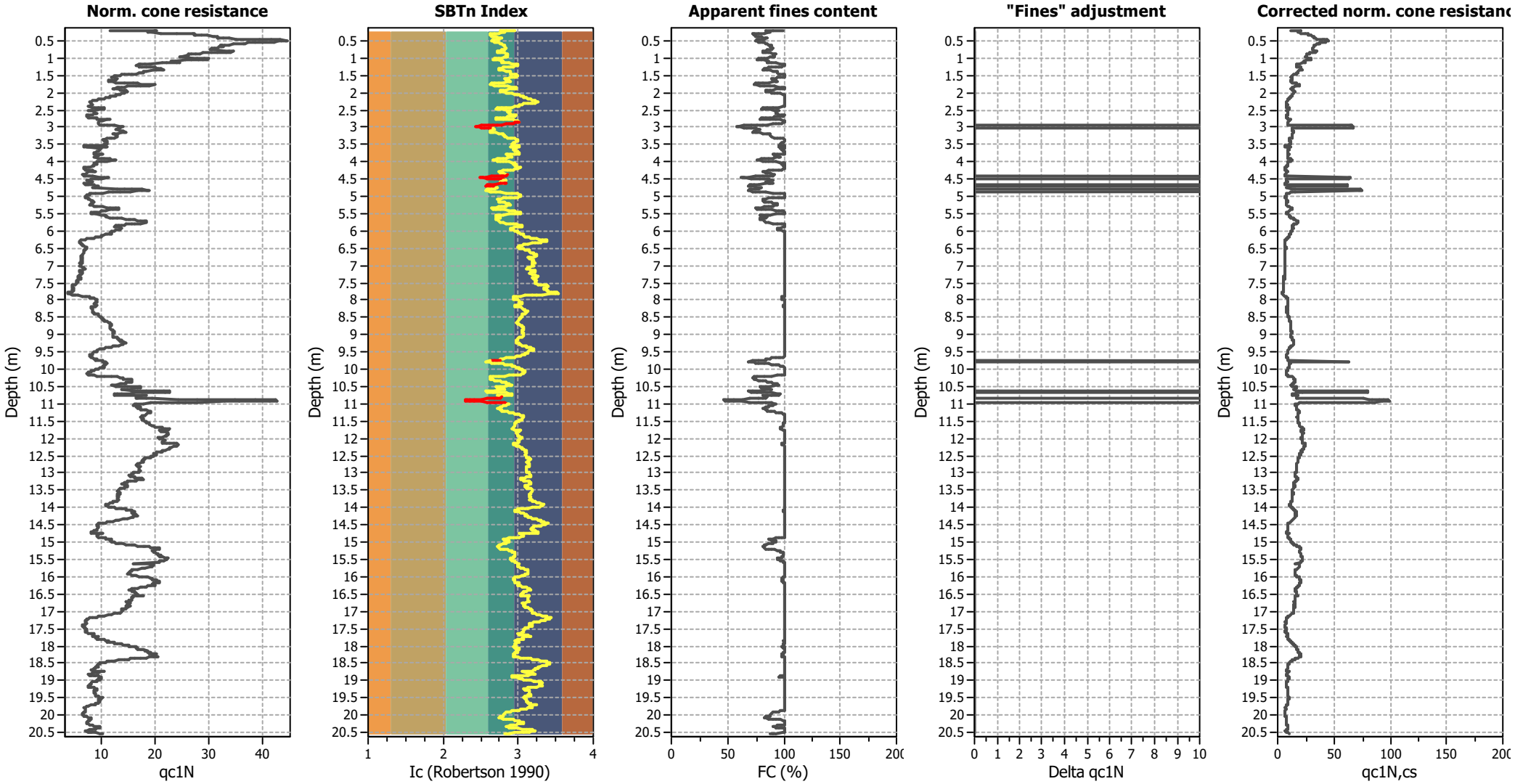
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

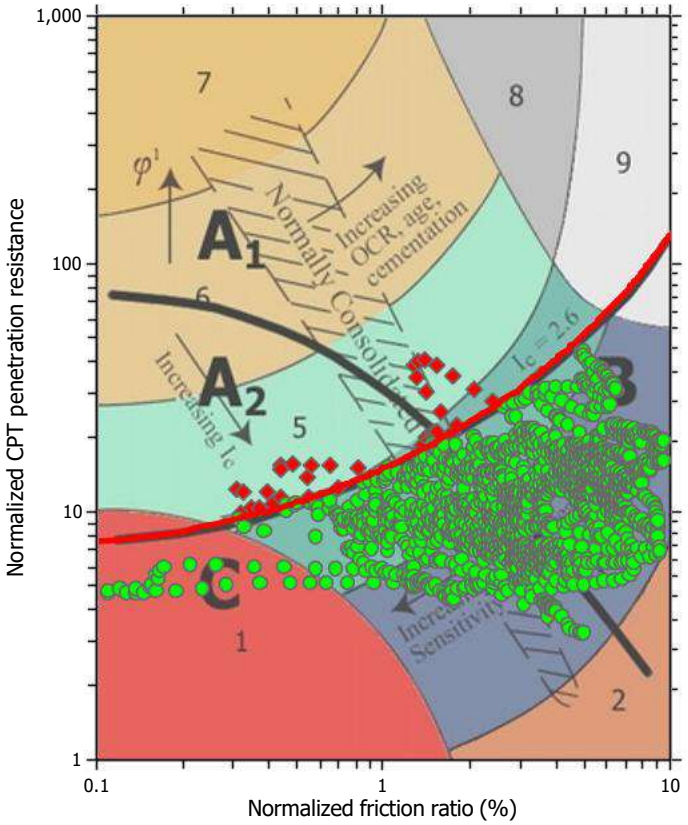
Liquefaction analysis overall plots (intermediate results)

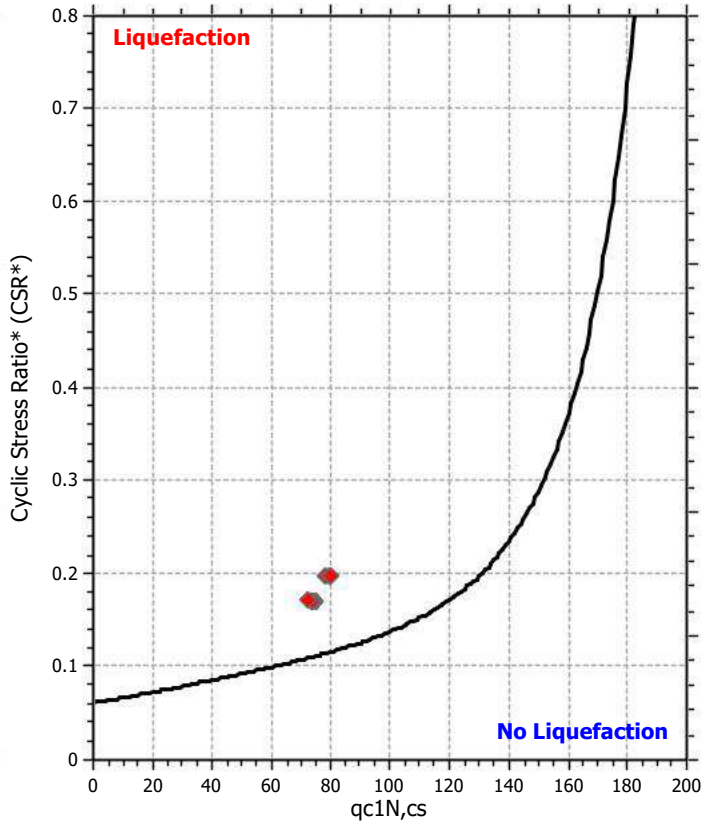


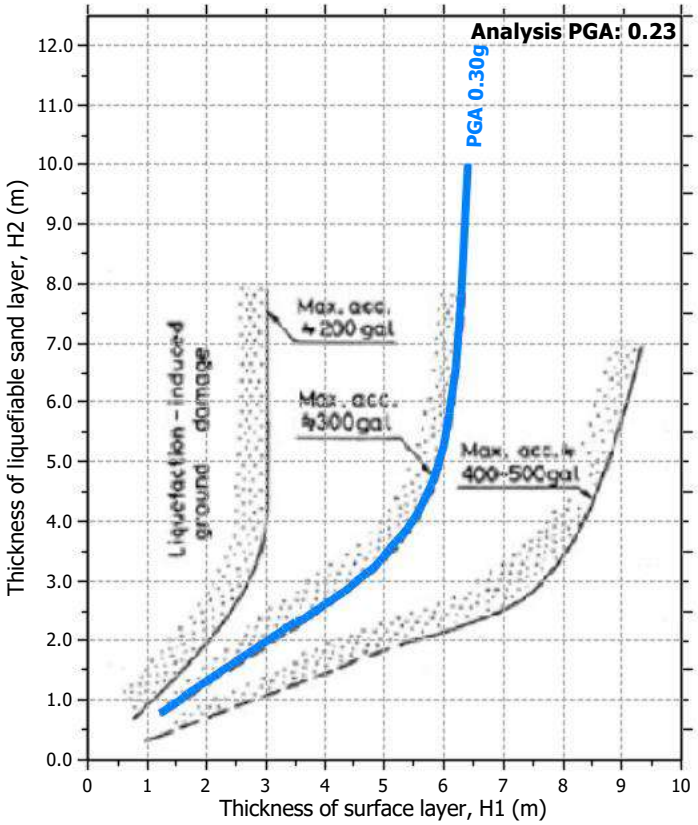
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



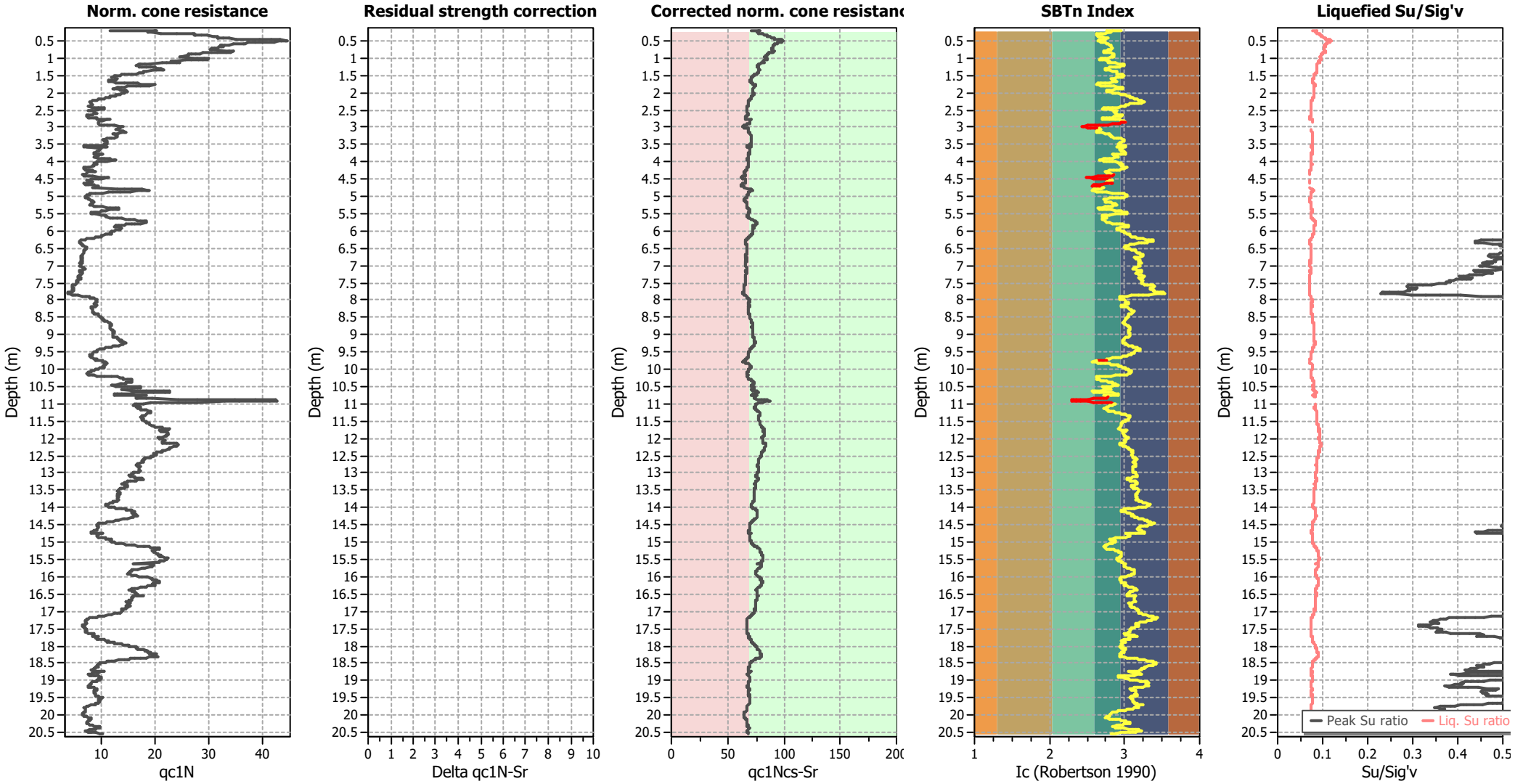




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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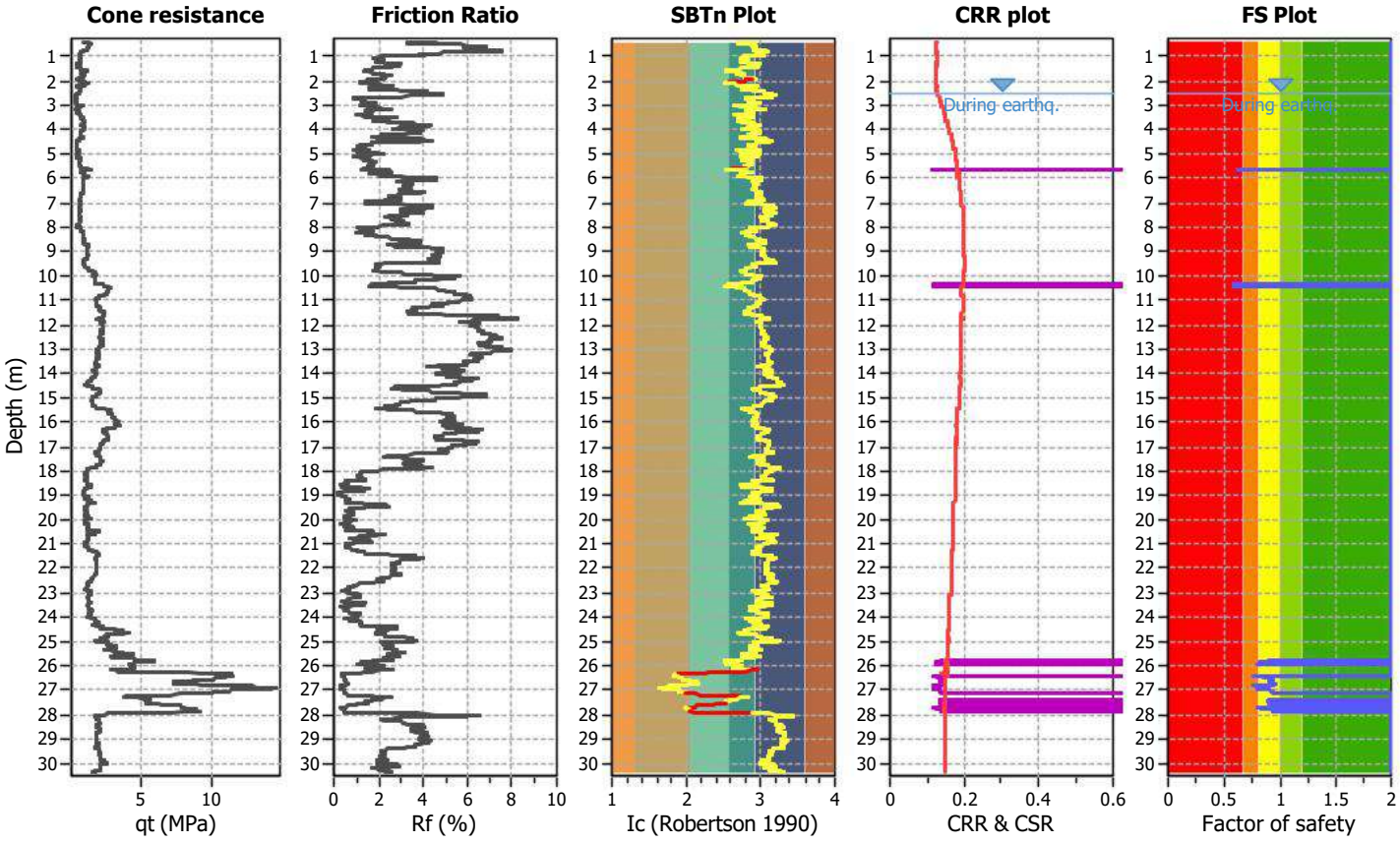
LIQUEFACTION ANALYSIS REPORT

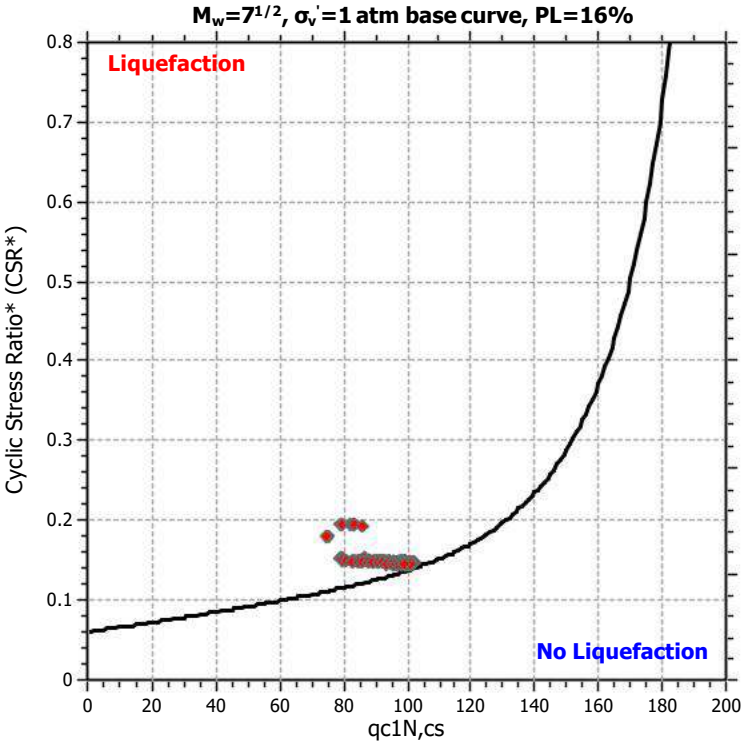
Project title : Ravarino **Location : Studio del terreno di fondazione**

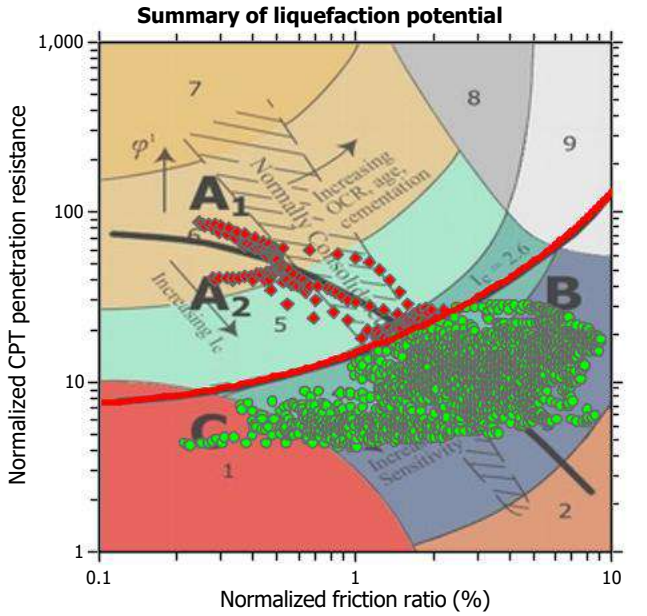
CPT file : CPTU12

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.14	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.23	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

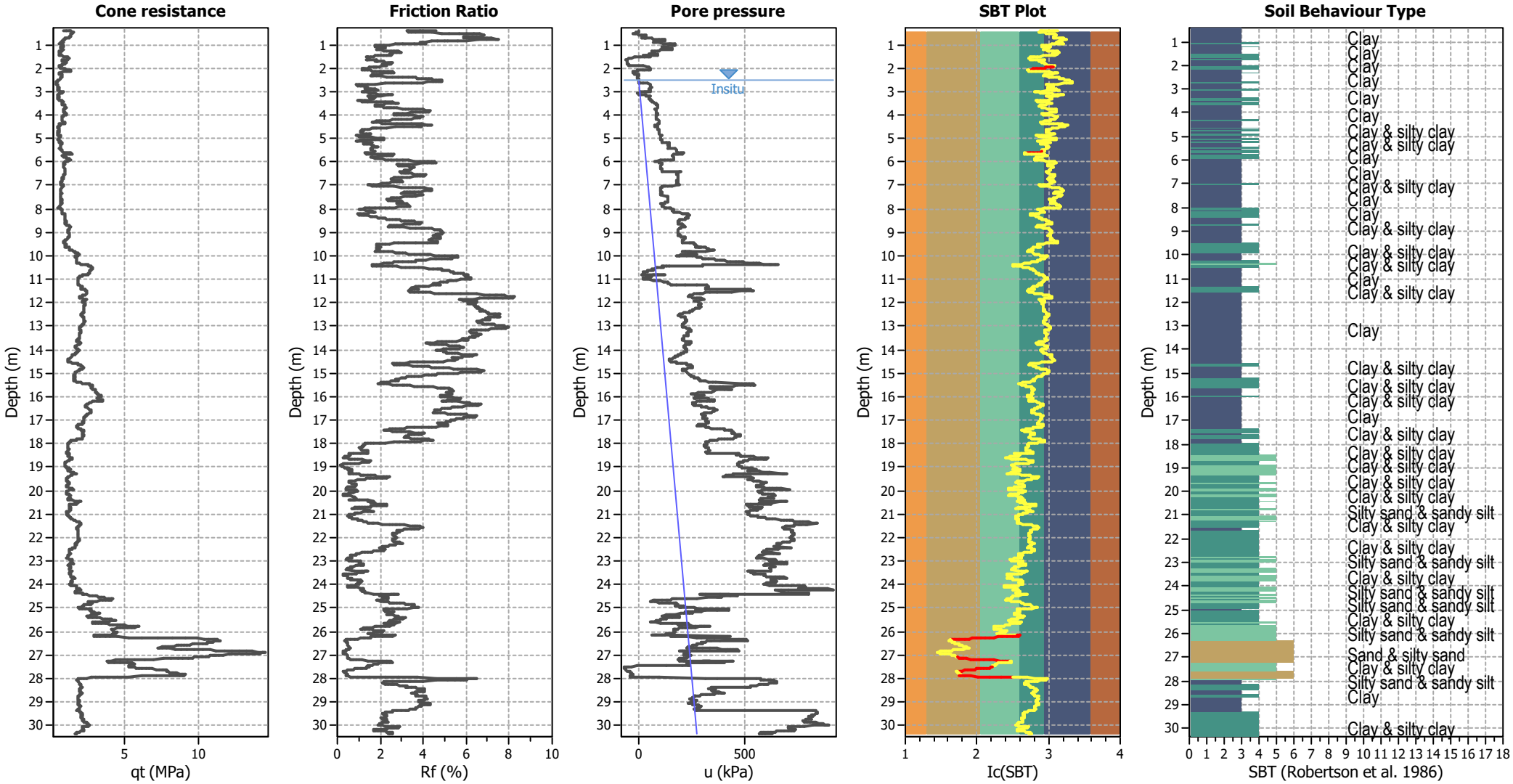






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



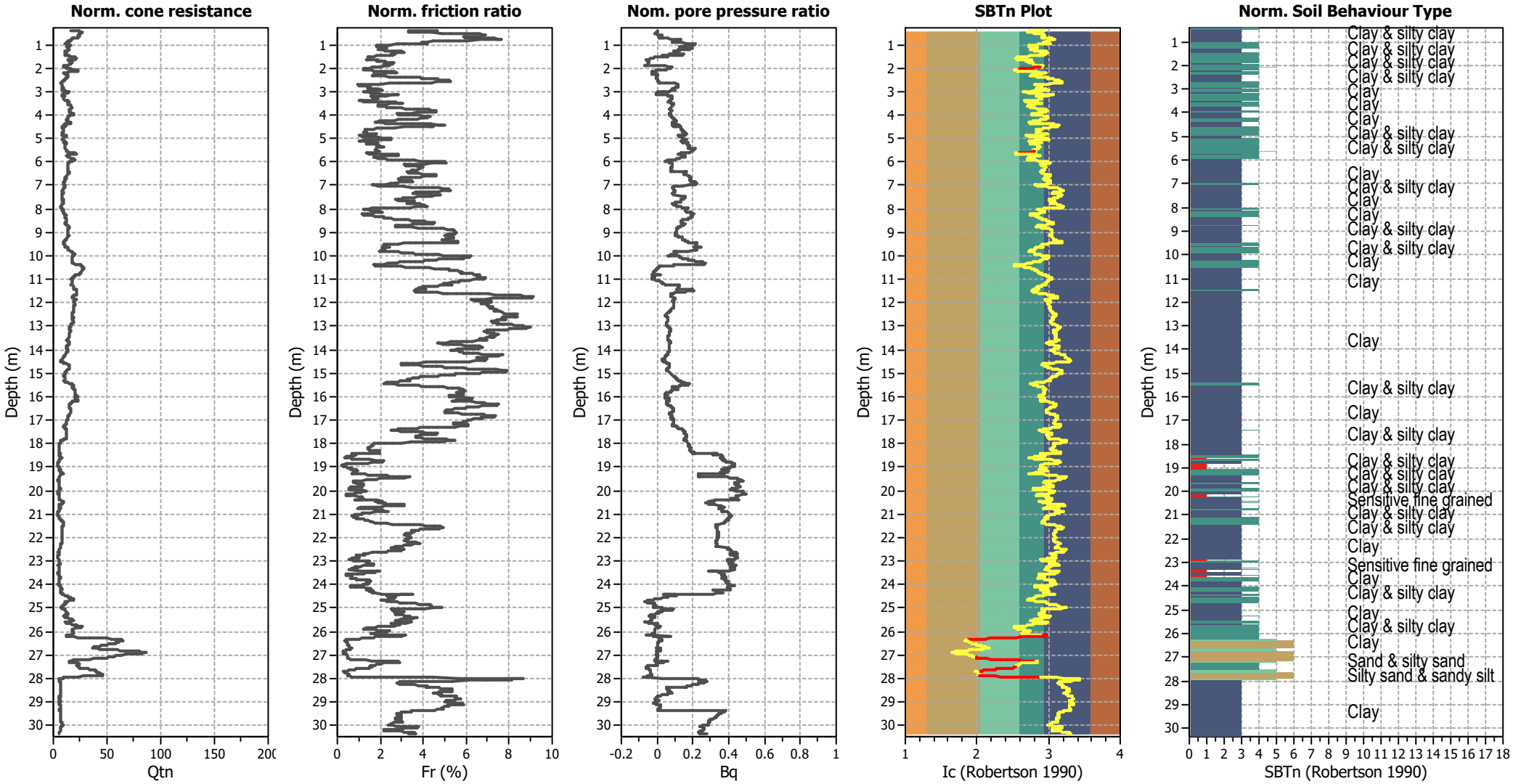
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit 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)



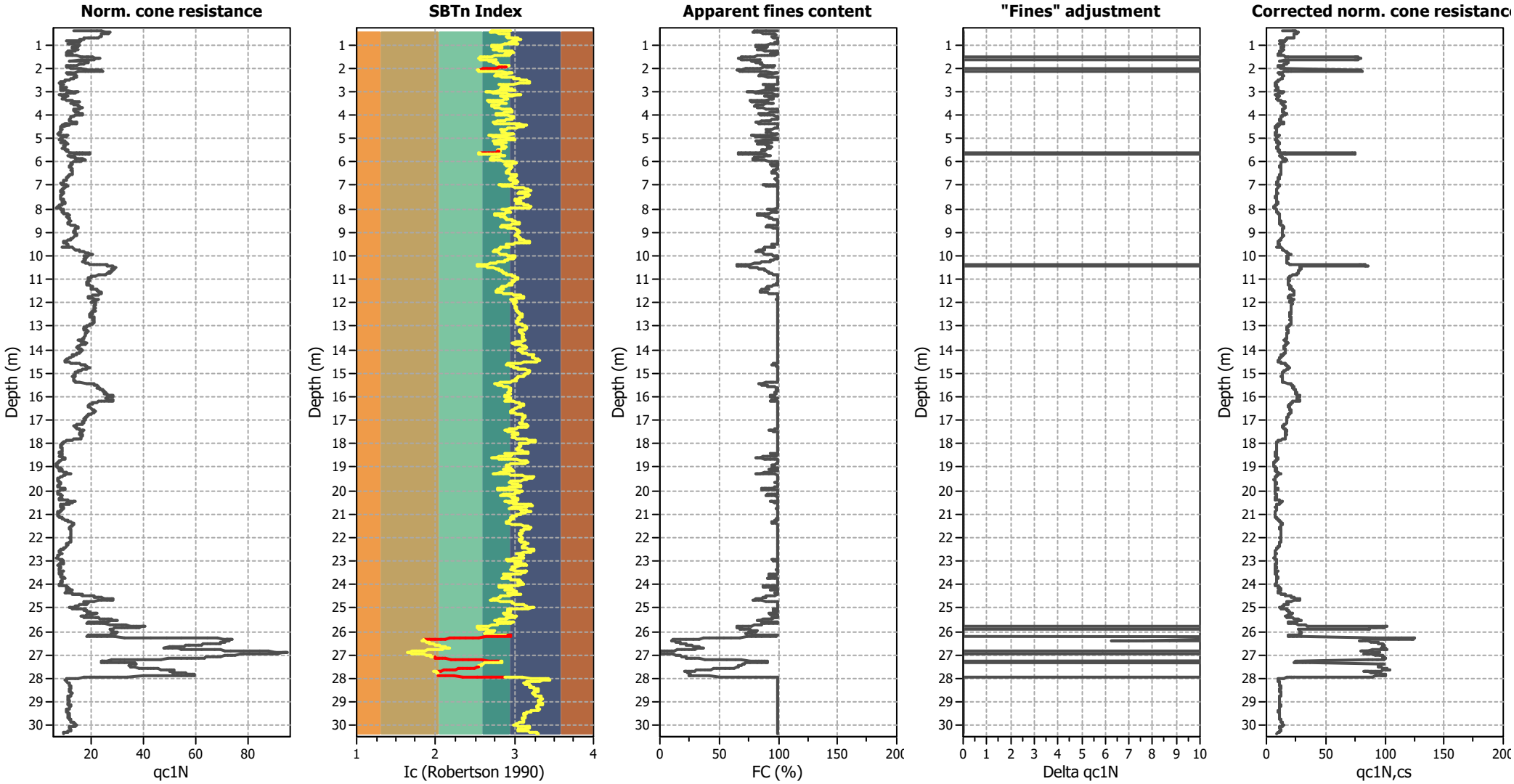
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 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

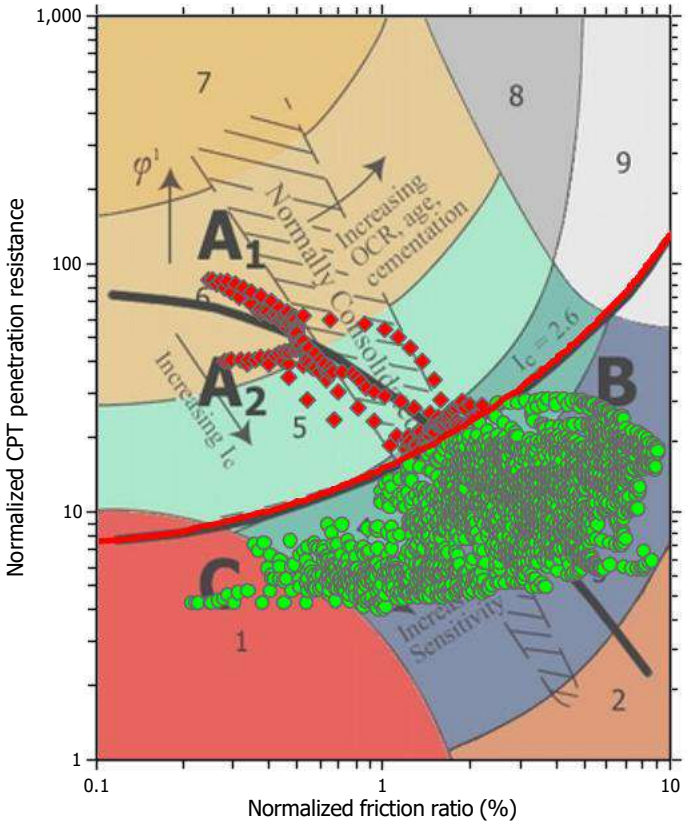
Liquefaction analysis overall plots (intermediate results)

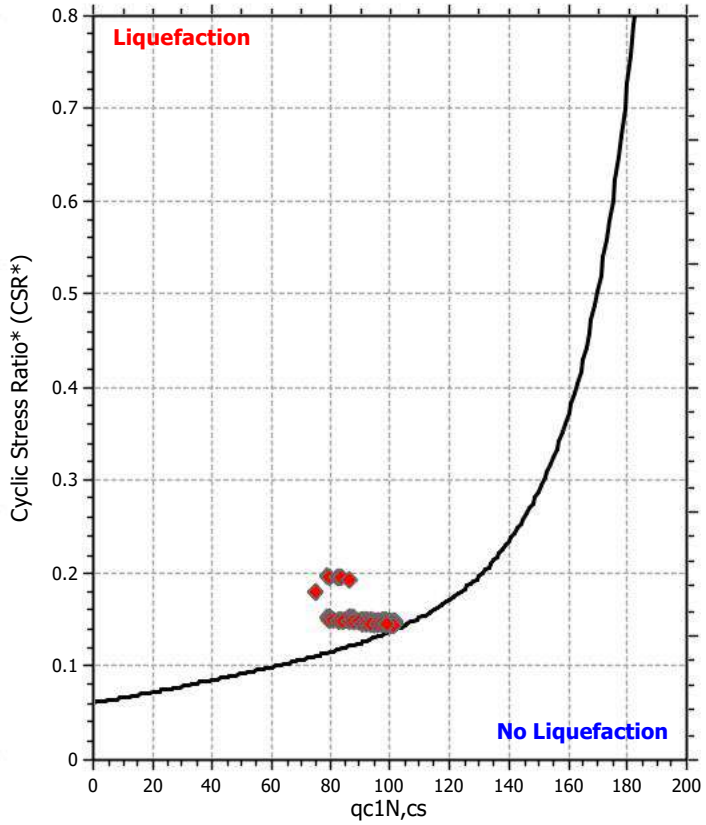


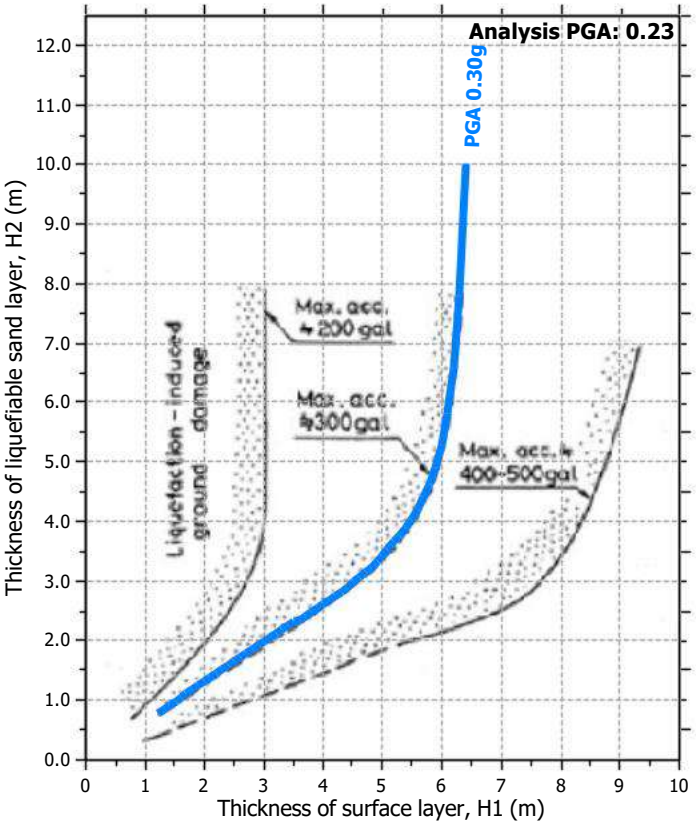
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis summary plots



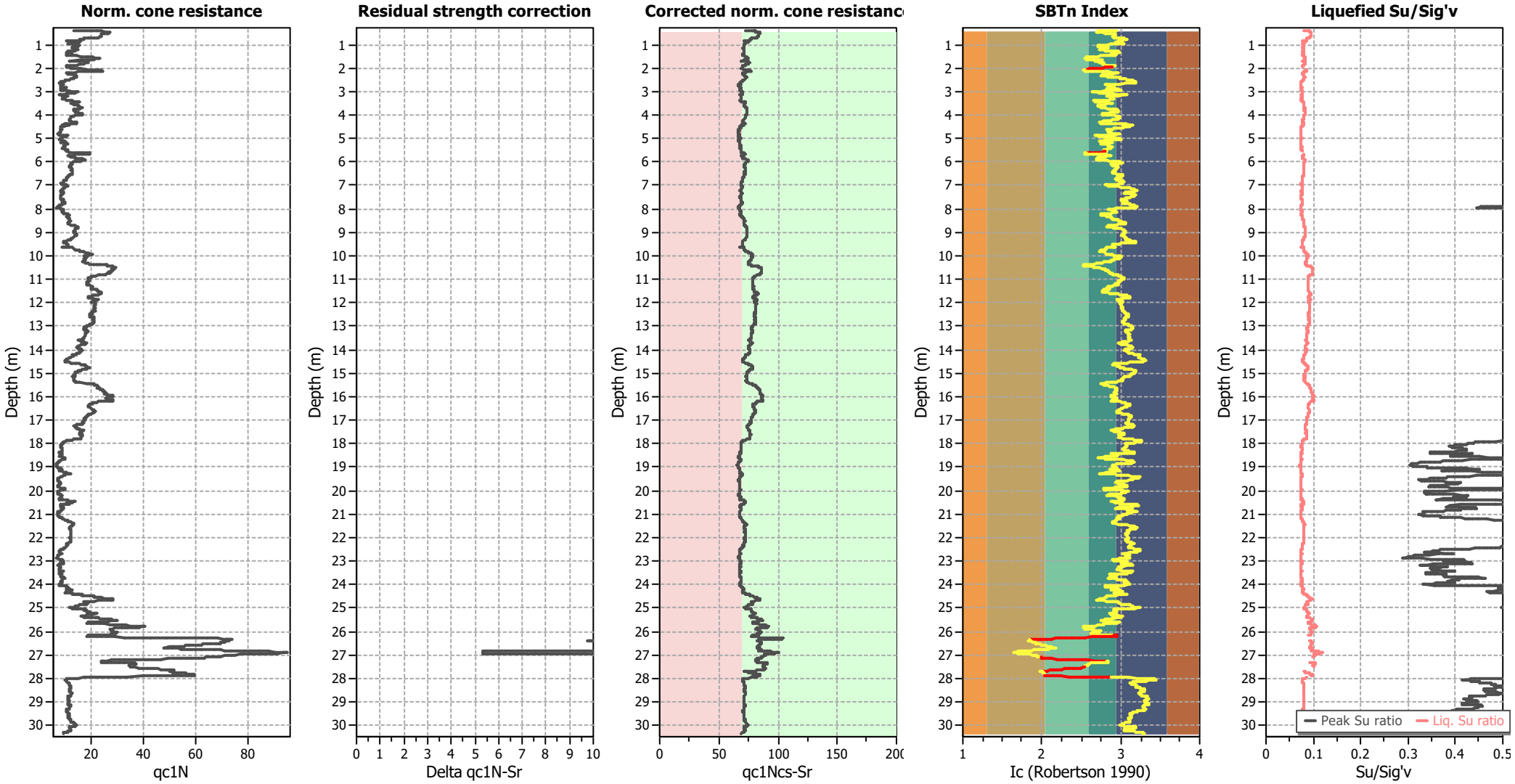




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.14	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.23	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A