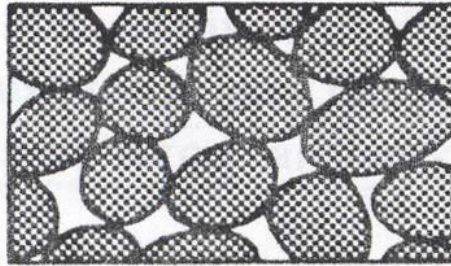


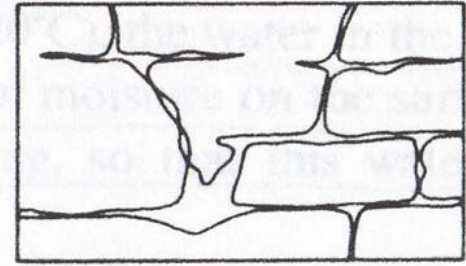
MEZZI POROSI



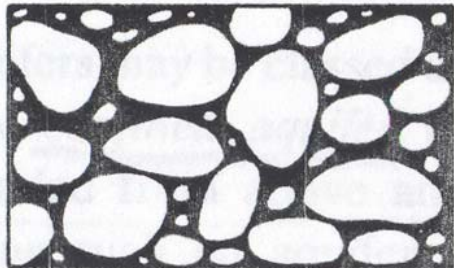
A



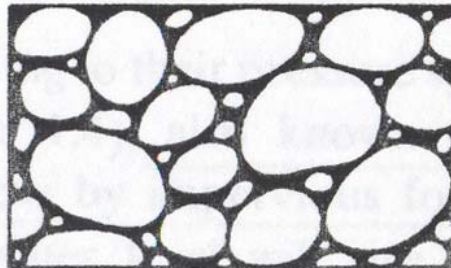
C



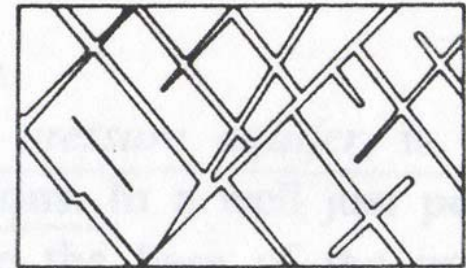
E



B

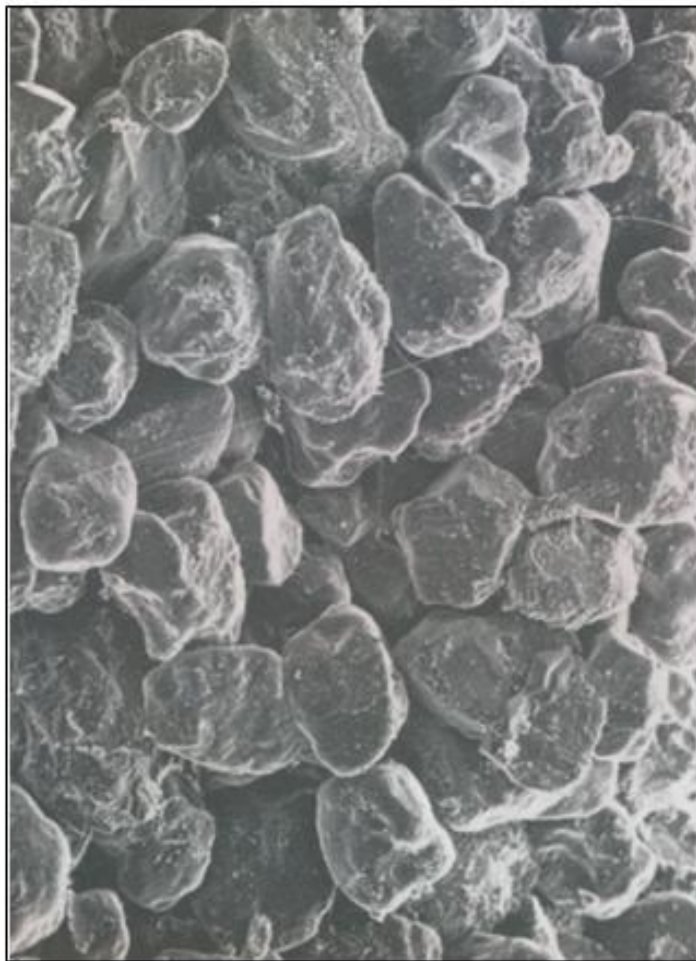


D



F

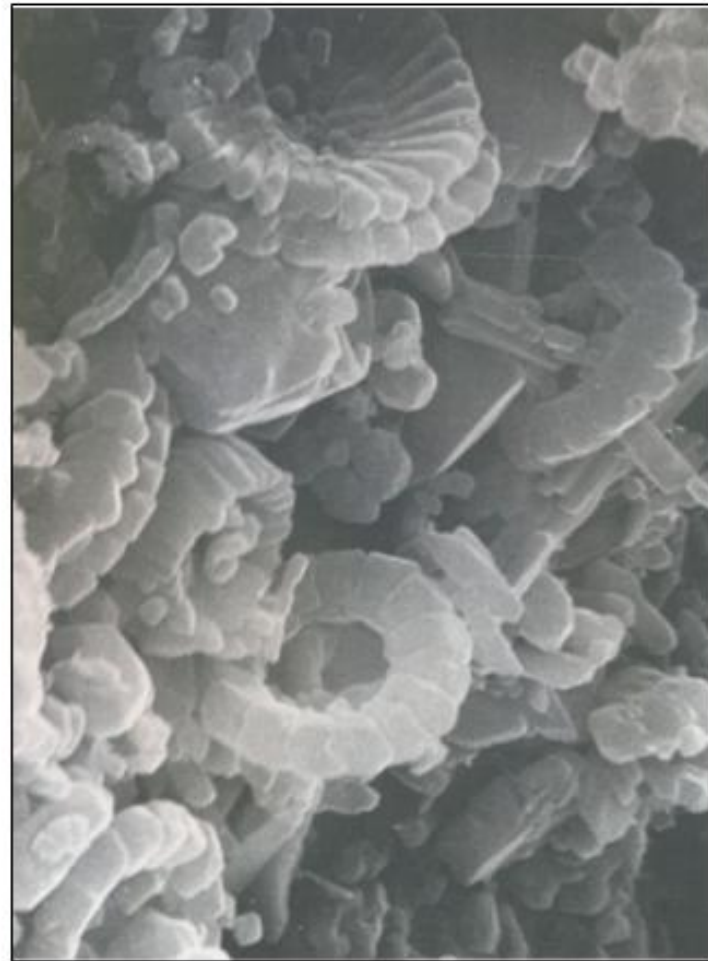
[M.Price, 1995 - perm.BGS]



1 mm

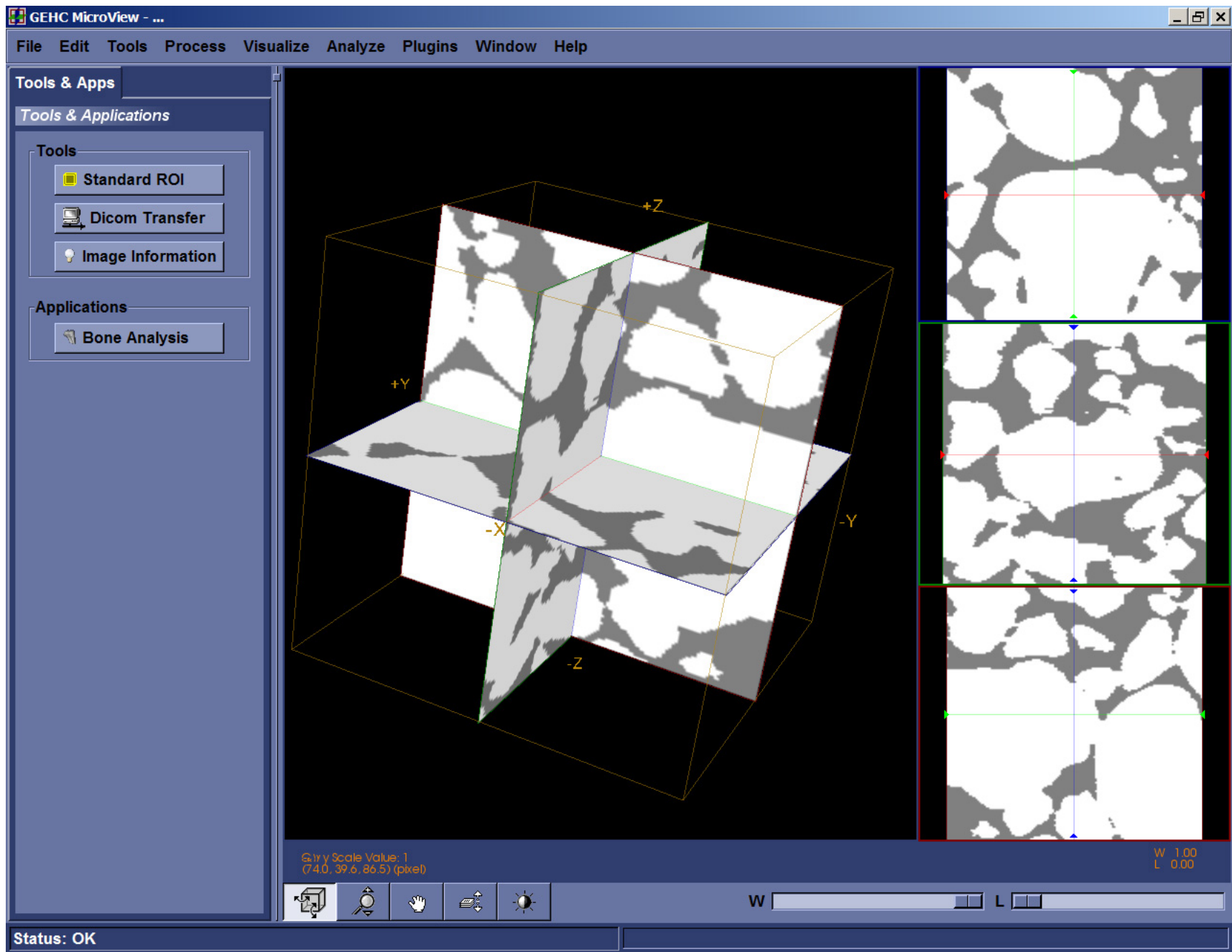
sandstone

[M.Price, 1995 - perm.BGS]



5 μm

chalk

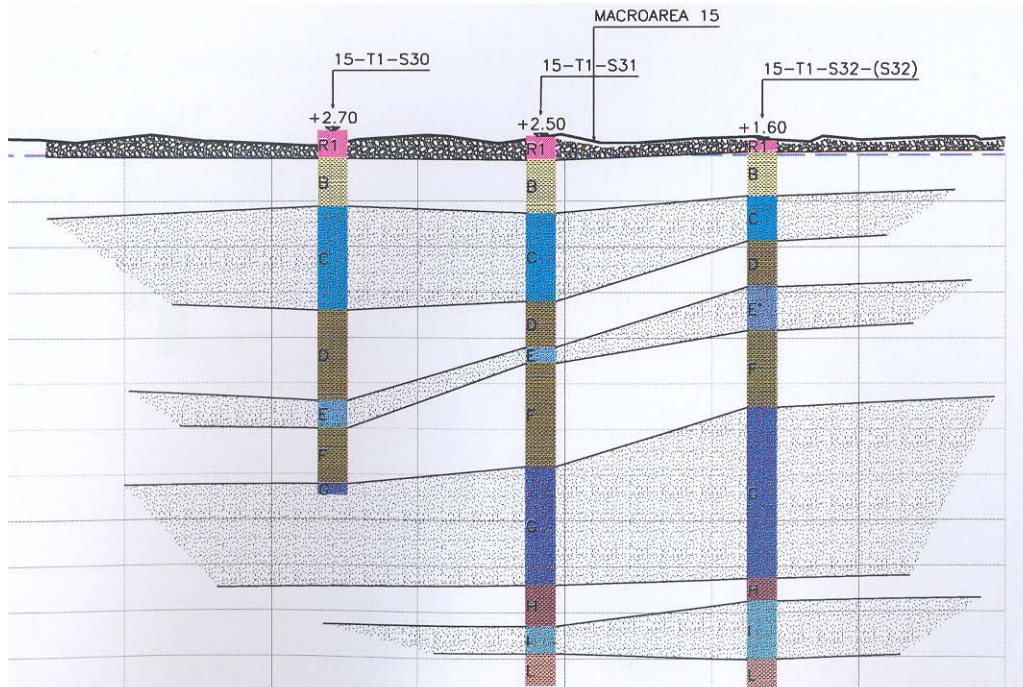


METODI CLASSICI DI INDAGINE STRATIGRAFICA

ricostruzione “soggettiva” a partire dall’analisi di carote prelevate in pozzo +



+ correlazione a sentimento delle stratigrafie fornite dai diversi pozzi



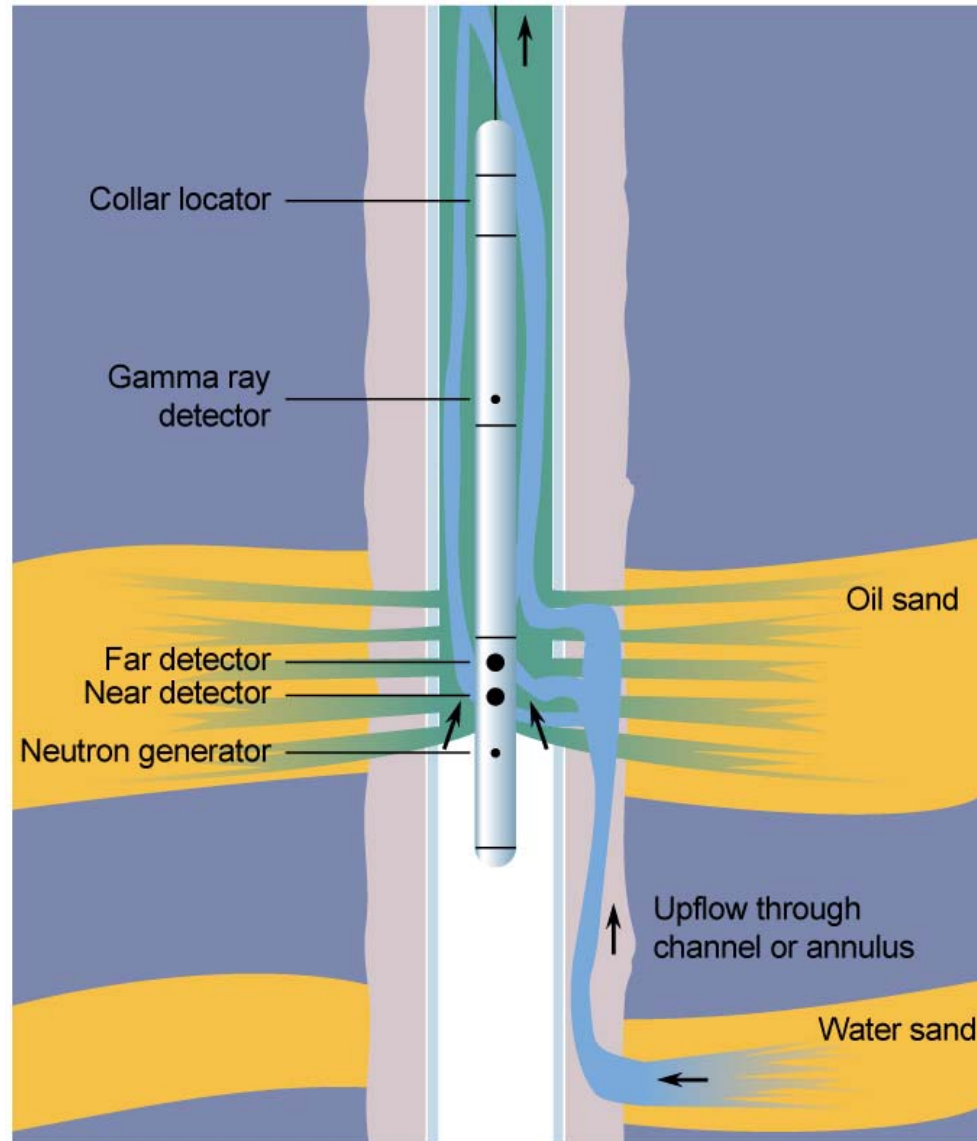
Livelli Deposizionali		Deposizioni Alluvionali	
R1	Riparto - tout venant - materiale non contaminante	DG	Deposito prevalentemente ghiaioso-sabbioso
R2	Riparto - materiale contaminante	DS	Deposito prevalentemente sabbioso
A	Sabbia fine limosa	DL	Deposito prevalentemente limoso-argilloso
B	Argilla compatta - Corante	LEGENDA 	
B	Limo argilloso - argilla limosa con presenza di livelli sabbiosi		
C	Sabbia fine localmente limosa		
D	Limo argilloso - Limo Sabbioso		
E	Torba mescolata a sabbia fine limo e argilla	2-T1-S1 SONDAGGI DISTANTI DAL PROFILO DA 200 m A 500 m 5-C1-S2 SONDAGGI DISTANTI DAL PROFILO DA 80 m A 200 m 8-A3-S3 SONDAGGI DISTANTI DAL PROFILO FINO A 80 m 	
F	Sabbia media fine localmente limosa		
F	Limo argilloso-sabbioso		
G	Limo argilloso-sabbioso		
H	Sabbia fine limosa		
I	Limo argilloso, argilla limosa		
I	Sabbie		
L	Argilla con limo		

METODI NON INTRUSIVI DI INDAGINE STRATIGRAFICA

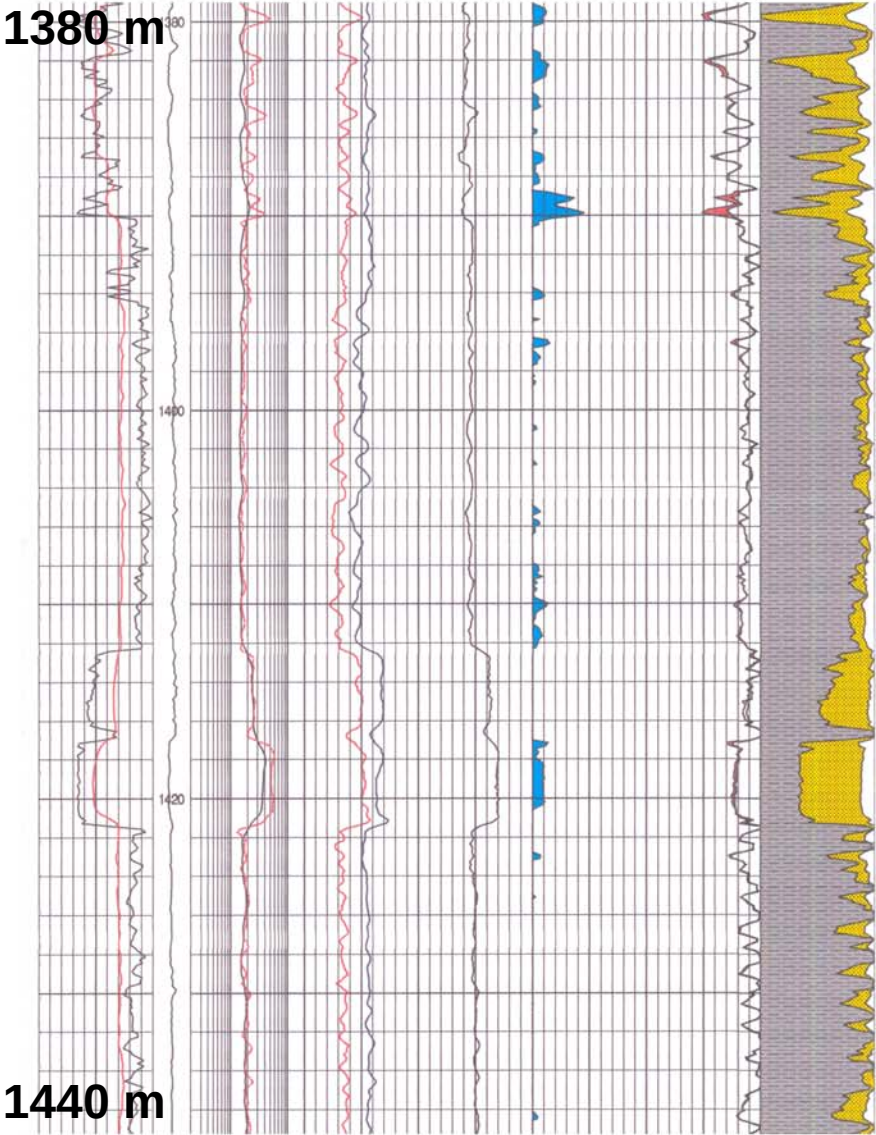
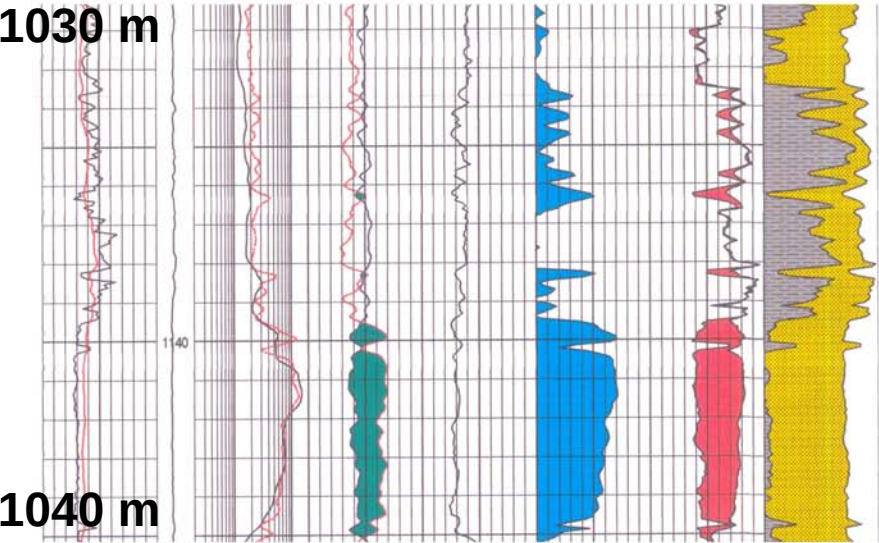
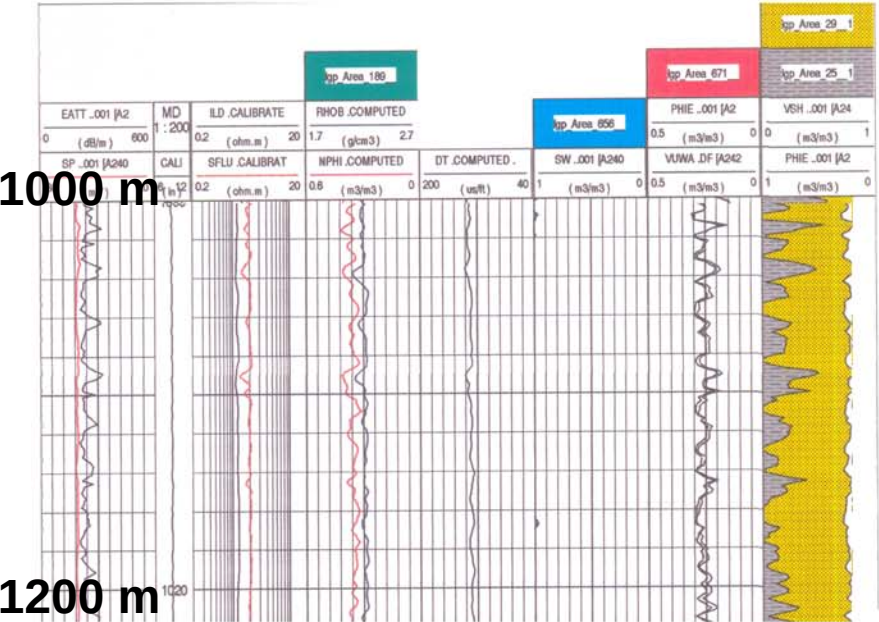
I RILIEVI GEOFISICI

- logs in pozzo - georadar(GPR) $\Rightarrow$ onde elettromagnetiche
- geosismica $\Rightarrow$ onde di pressione
- geoelettrica $\Rightarrow$ potenziale elettrico

logs in pozzo



EATT (Electromagnetic Attenuation Propagation Tool): fluido di formazione



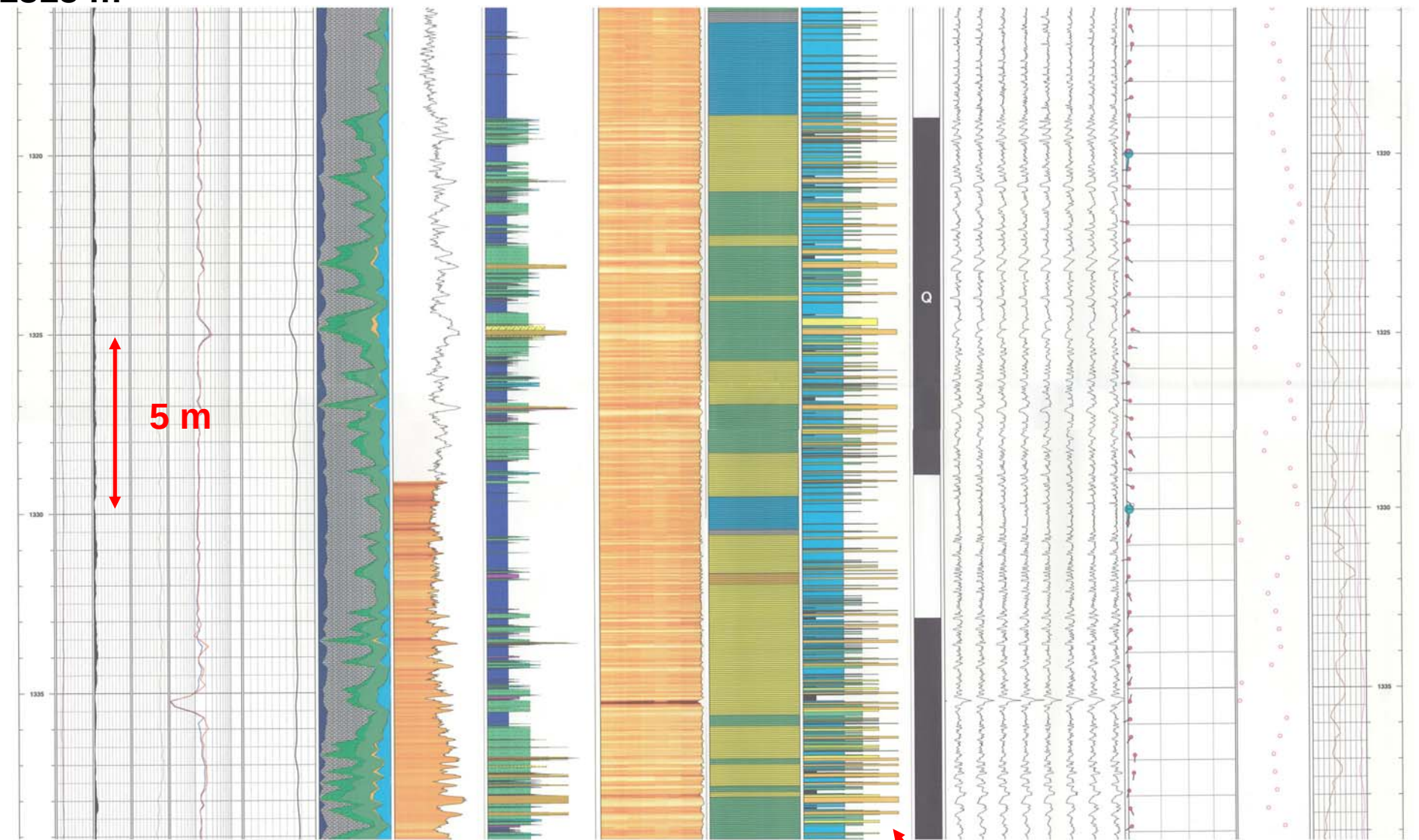
CPI ELAN RESULTS			
		VXBW	
0	BOUND WATER	1	
V/V			
VXBW		VILL	
0	ILLITE	1	
VILL		VSIL	
0	SILT	1	
VSIL		VQUA	
0	QUARTZ	1	
VQUA		VUGA	
0	CALCITE	1	
VUGA		VUWA	
0	SAND	1	

LITHOFACIES	
COMPACTED SILTY SHALE	
PHI RANGE: 0-10 %	
PHI MEAN: 5 %	
KH MODE: 0.30 mD	
LOW COMP. SILTY SHALE	
PHI RANGE: 0-10 %	
PHI MEAN: 5 %	
KH MODE: 0.30 mD	
COMP. SHALY SLST	
PHI RANGE: 10-20 %	
PHI MEAN: 13.9 %	
0.30 < KH < 2.0 mD	
LOW COMP. SHALY SLST	
PHI RANGE: 5-20 %	
PHI MEAN: 13.3 %	
0.30 < KH < 2.0 mD	

SANDY SLST	
PHI RANGE: 15-25 %	
PHI MEAN: 19.7 %	
2.0 < KH < 50.0 mD	
KH MODE: 2.0 mD	
SILTY SAND	
PHI RANGE: 24-32 %	
PHI MEAN: 28.6 %	
2.0 < KH < 500 mD	
KH MODE: 50 mD	
V.FINE SILTY SAND	
PHI RANGE: 24-30 %	
PHI MEAN: 27.1 %	
2.0 < KH < 500 mD	
KH MODE: 50 mD	
GAS EFFECT SANDY SLST	
PHI RANGE: 10-20 %	
PHI MEAN: 14.9 %	
0.30 < KH < 50.0	
KH MODE: 2.0	
GAS EFFECT SILTY SAND	
PHI RANGE: 22-32 %	
PHI MEAN: 28.2 %	
50.0 < KH < 500.0 mD	
KH MODE: 50.0 mD	

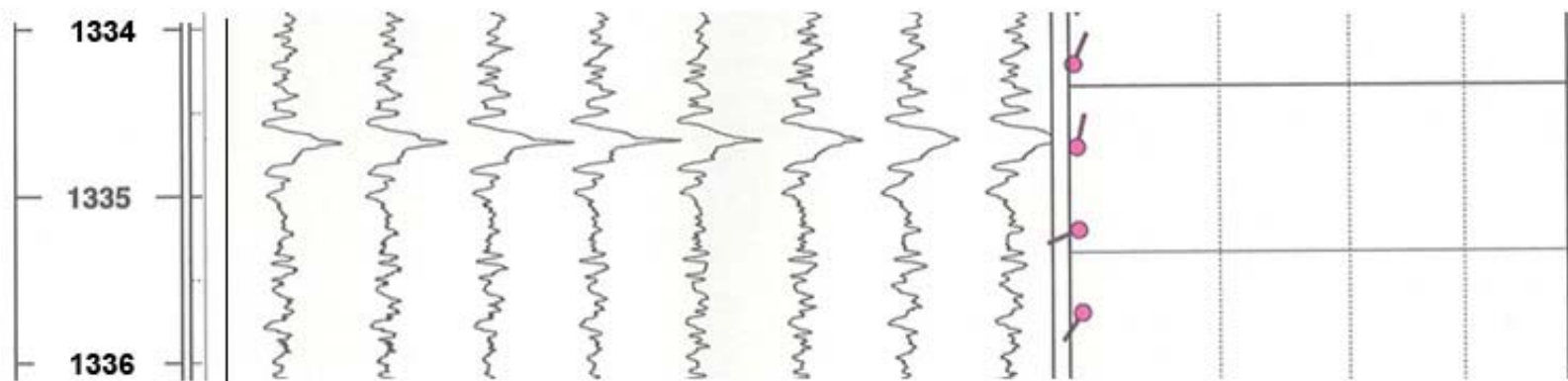
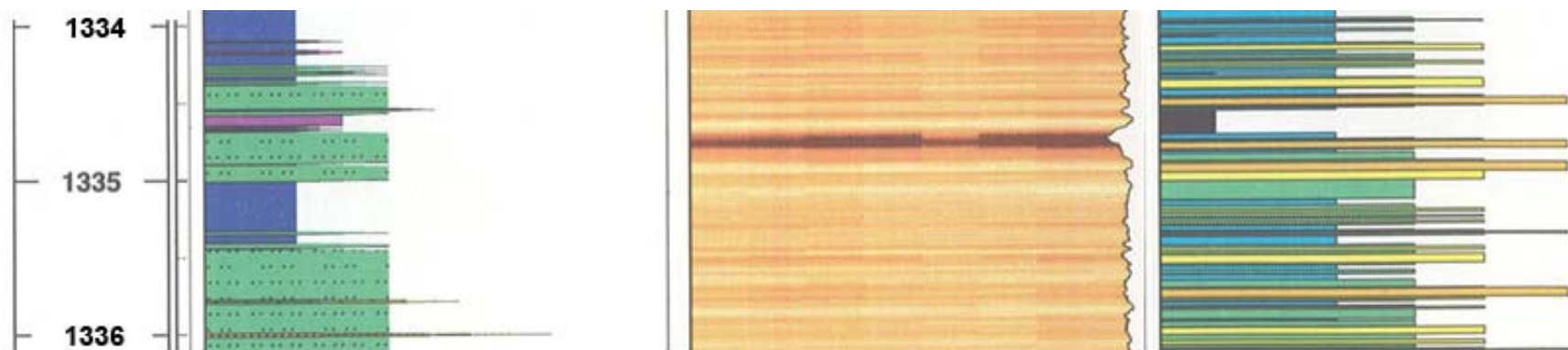
LITHOLOGY	
UNCONSOLIDATED SAND	
MEAN PHI: 27 %	
MEAN KH: 500 mD	
COMPACTED SILTY SAND	
MEAN PHI: 24.6 %	
MEAN KH: 50 mD	
SILT	
MEAN PHI: 18.3 %	
MEAN KH: 2 mD	
SILTY SHALE	
MEAN PHI: 5.6 %	
MEAN KH: 0.3 mD	
SHALE	
MEAN PHI = 5.6 %	
MEAN KH: 0.3 mD	

1315 m

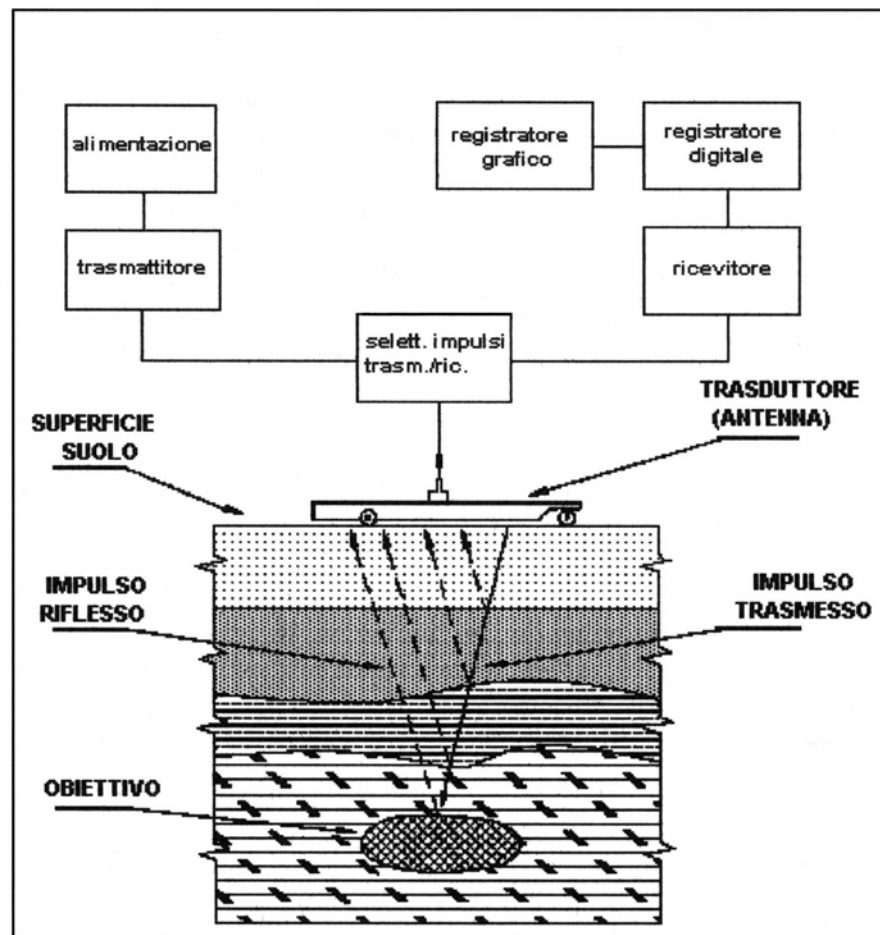


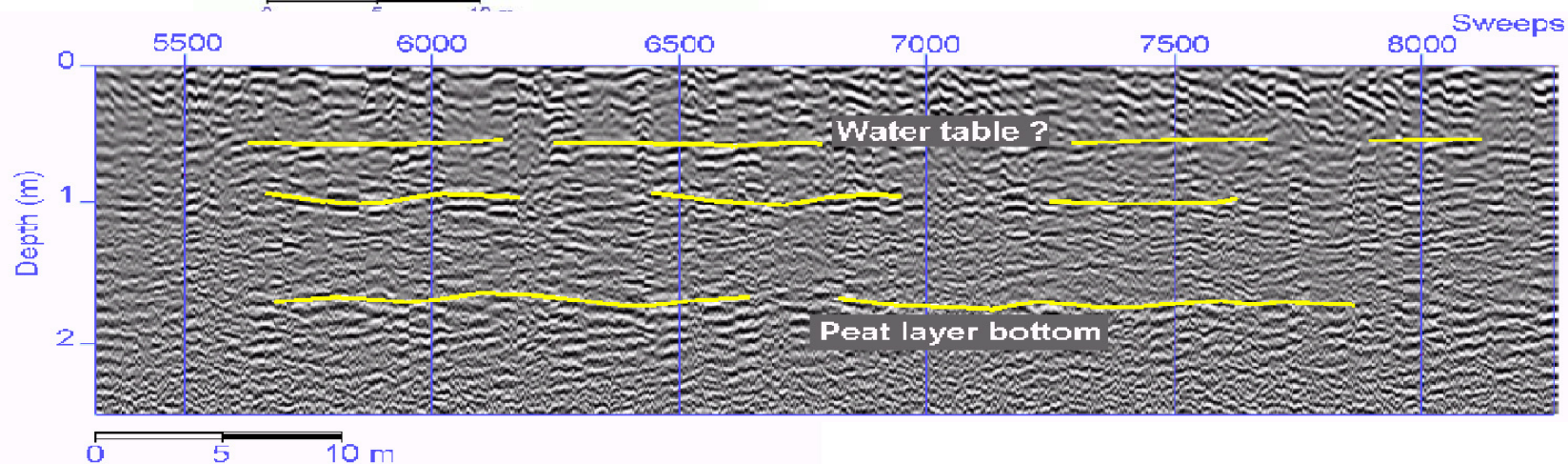
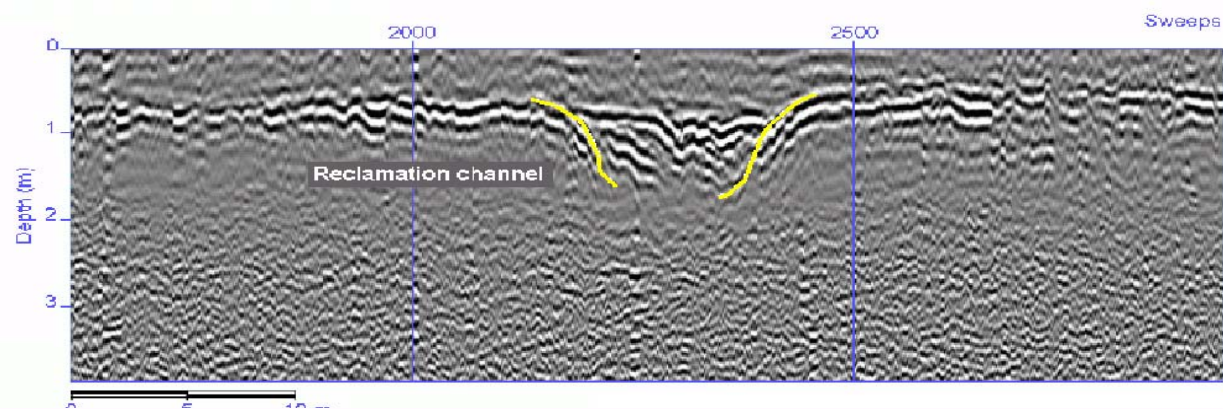
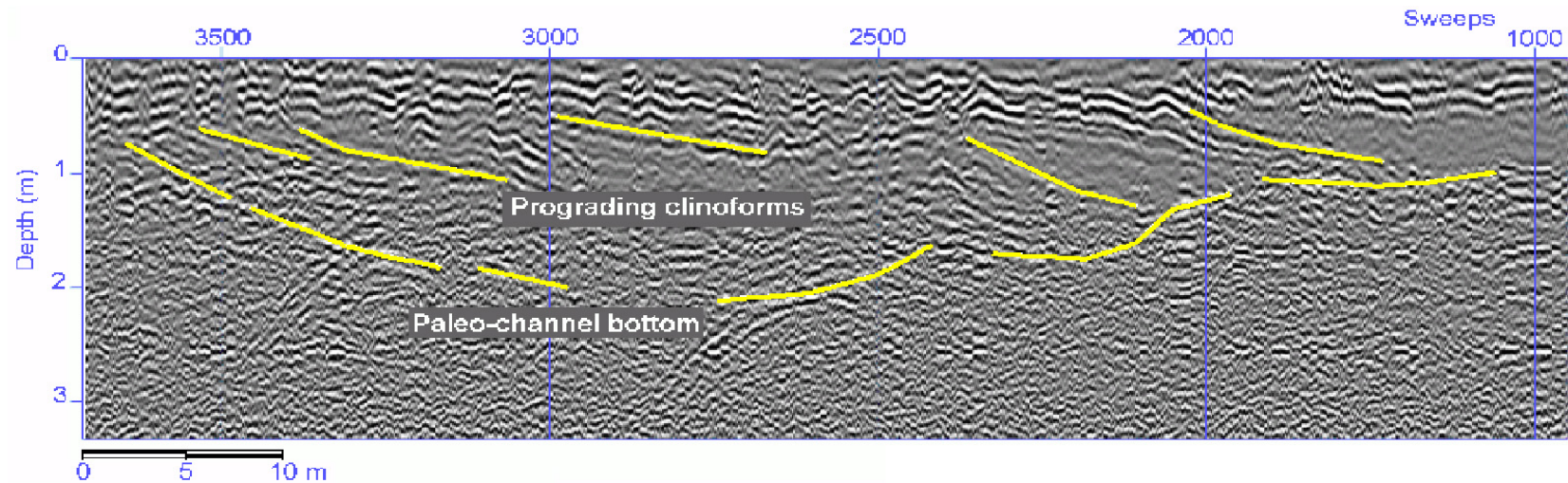
1340 m

1 cm



georadar (ground penetrating radar)

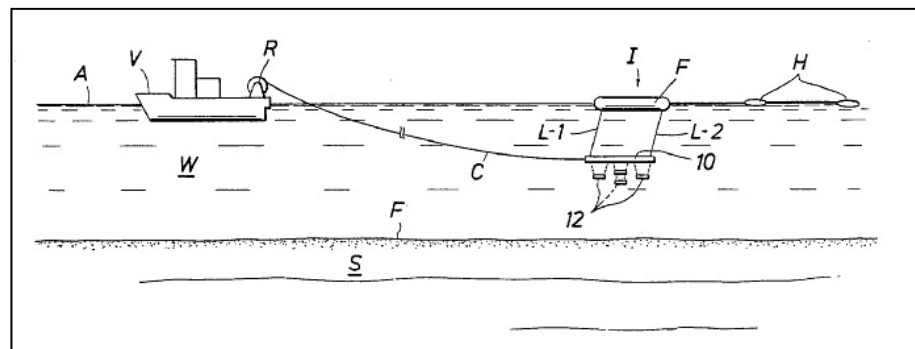




geosismica



a terra

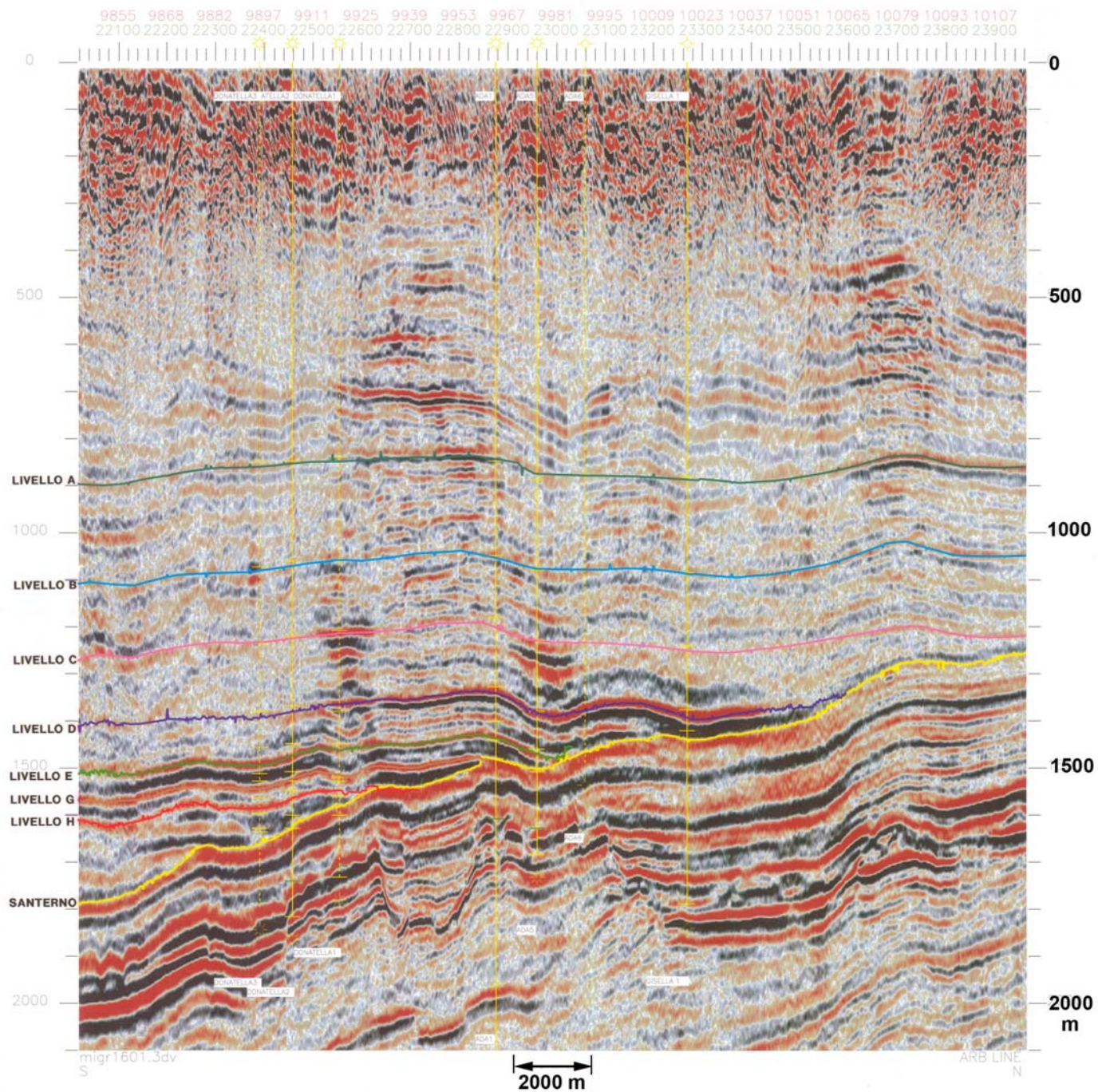


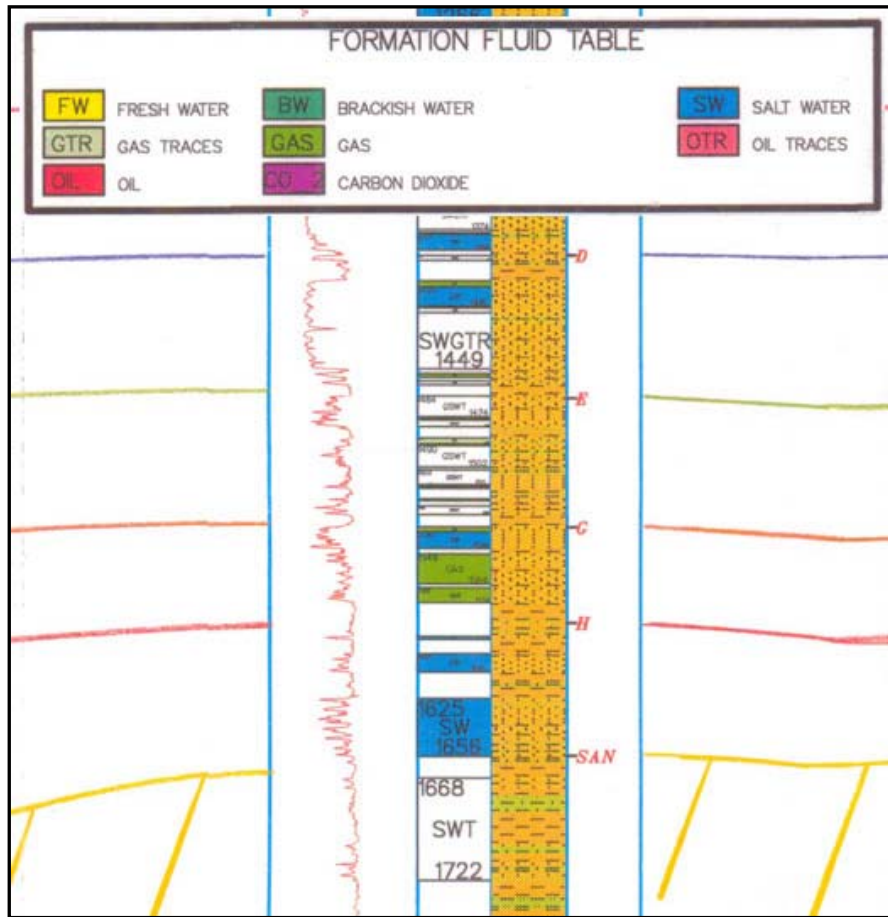
a mare



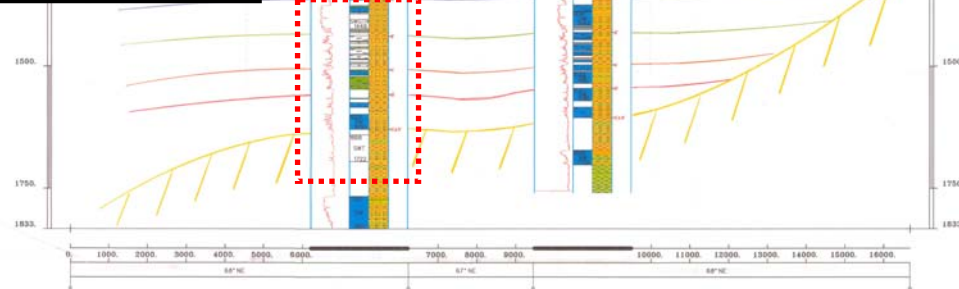
diversi metodi di esecuzione

**sezione sismica
profonda
(risoluzione
3-5 m)**

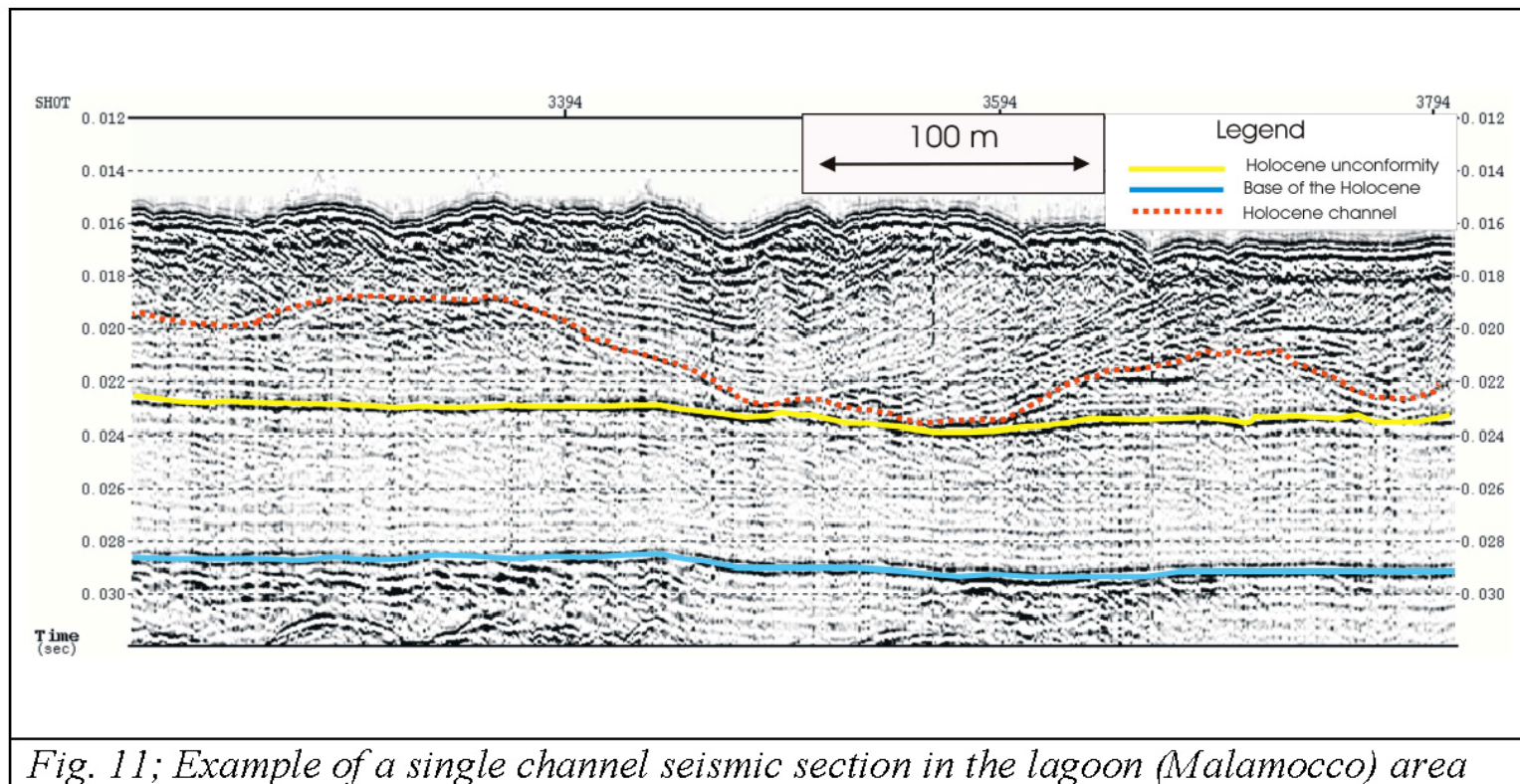




- GAS AND CONDENSATE SHOWS
- GAS AND OIL SHOWS
- OIL
- OIL AND CONDENSATE
- OIL AND WATER
- OIL/GAS AND CONDENSATE
- OIL SHOWS
- OIL SHOWS AND GAS SHOWS
- OIL SHOWS AND WATER
- OIL AND GAS SHOWS
- CONDENSATE
- CONDENSATE SHOWS
- CONDENSATE AND GAS SHOWS
- TEST/PROBING, DRY
- DRILLING
- PLATFORM OR VESSEL
- DIRECTIONAL OR VESSEL
- PROPOSED LOCATION
- DEPLETED AND ABANDONED
- DEPLETED AND JAMMED
- JAMMED AND ABANDONED
- PLUGGED AND ABANDONED
- STORAGE
- SUPERCHARGED
- EXHAUSTED
- PRODUCTION

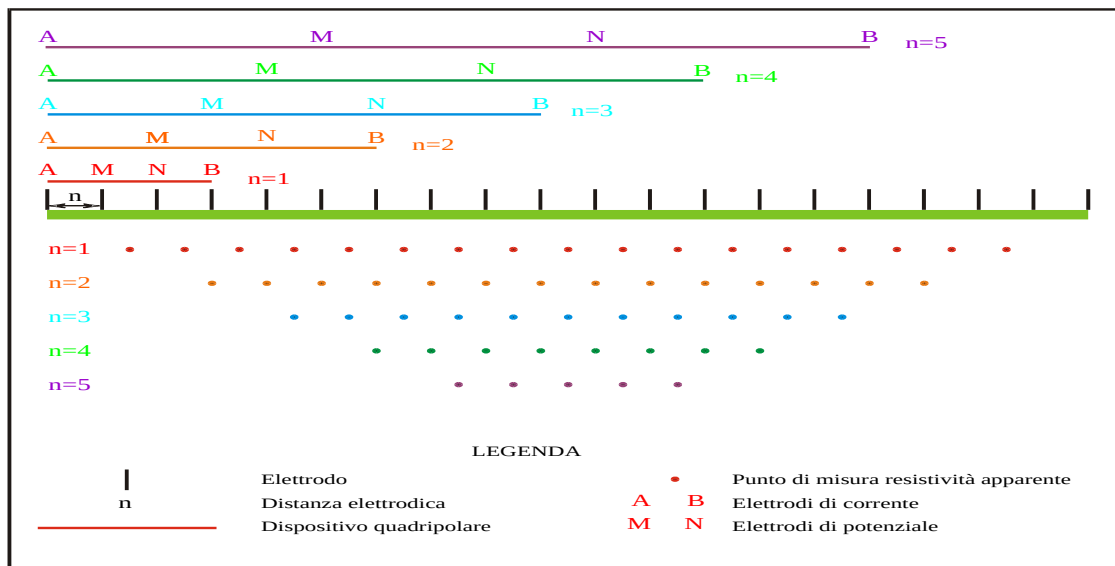
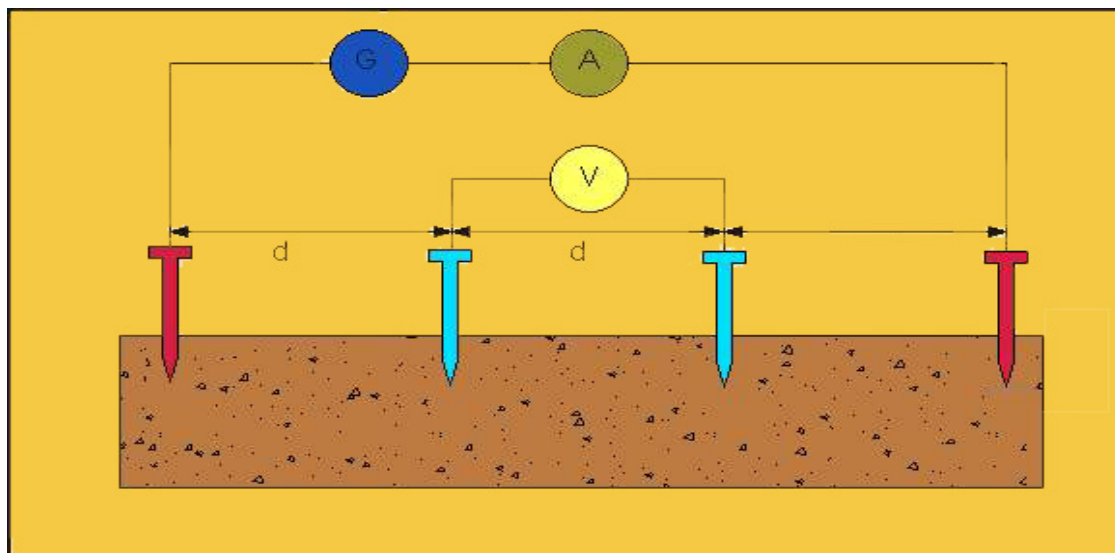


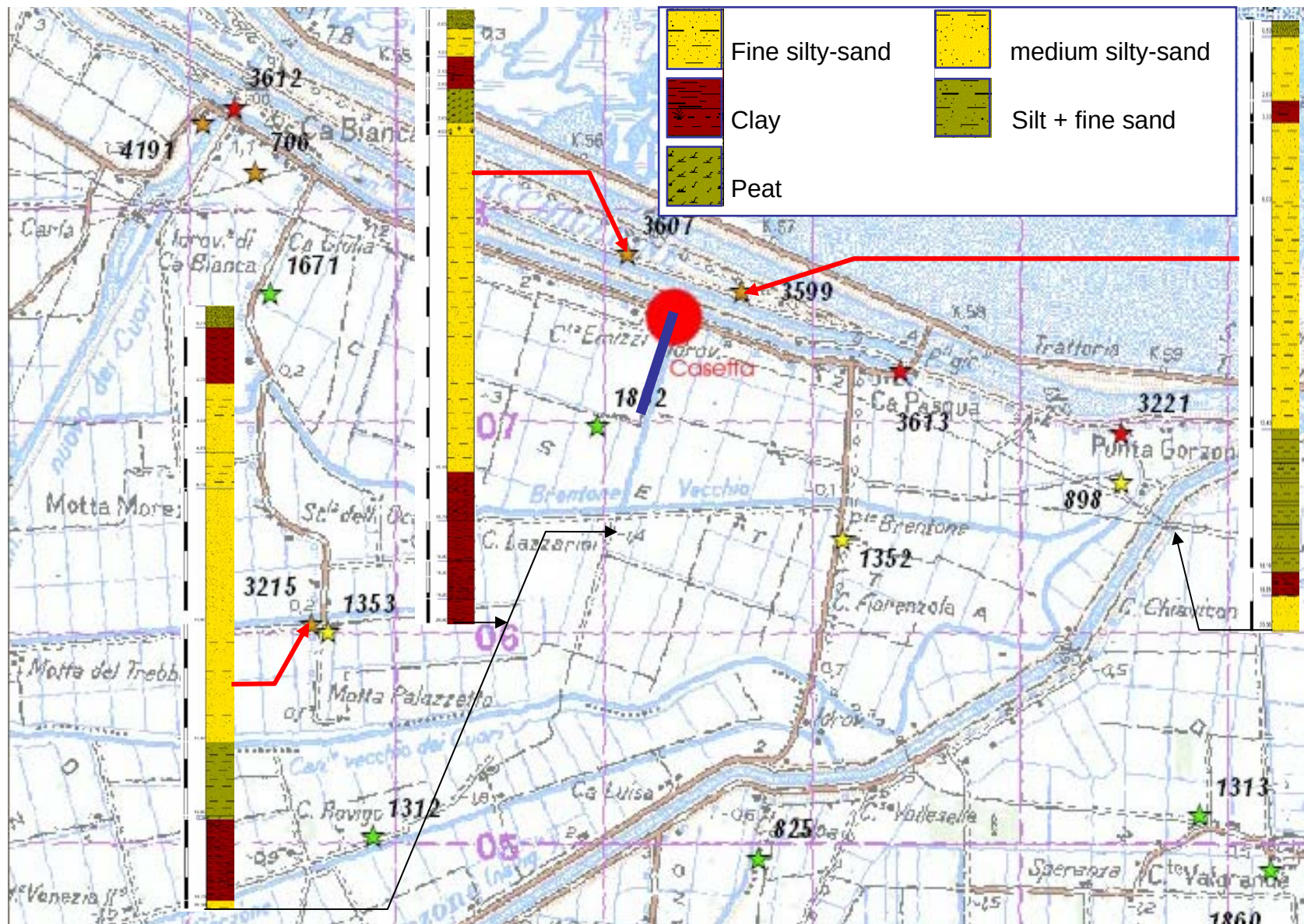
le sezioni sismiche sono calibrate su dati da pozzo che vengono quindi correlati in modo univoco utilizzando i risultati geosismici



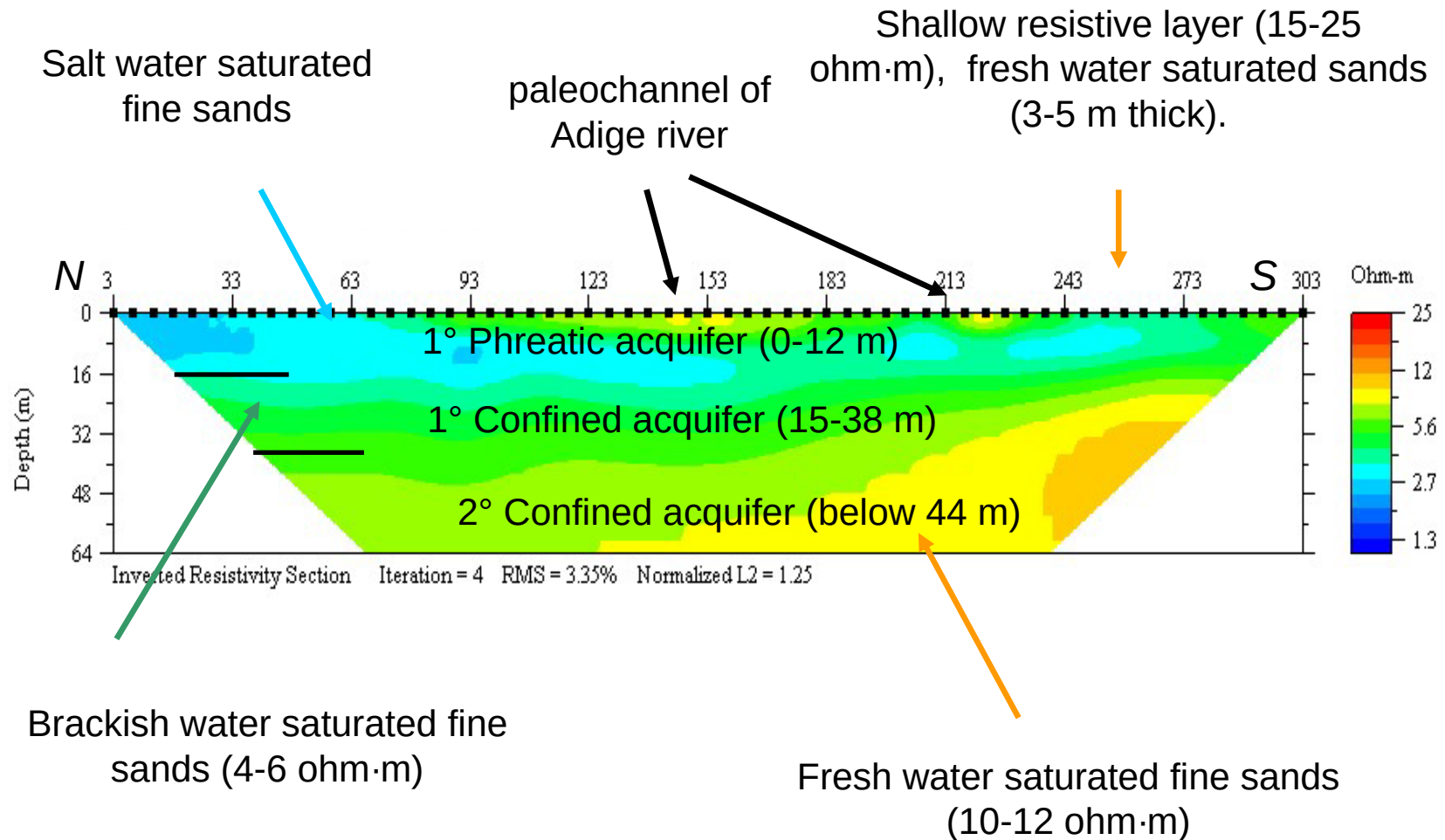
**sezione sismica
superficiale ad altissima (10 cm) risoluzione**

geoelettrica



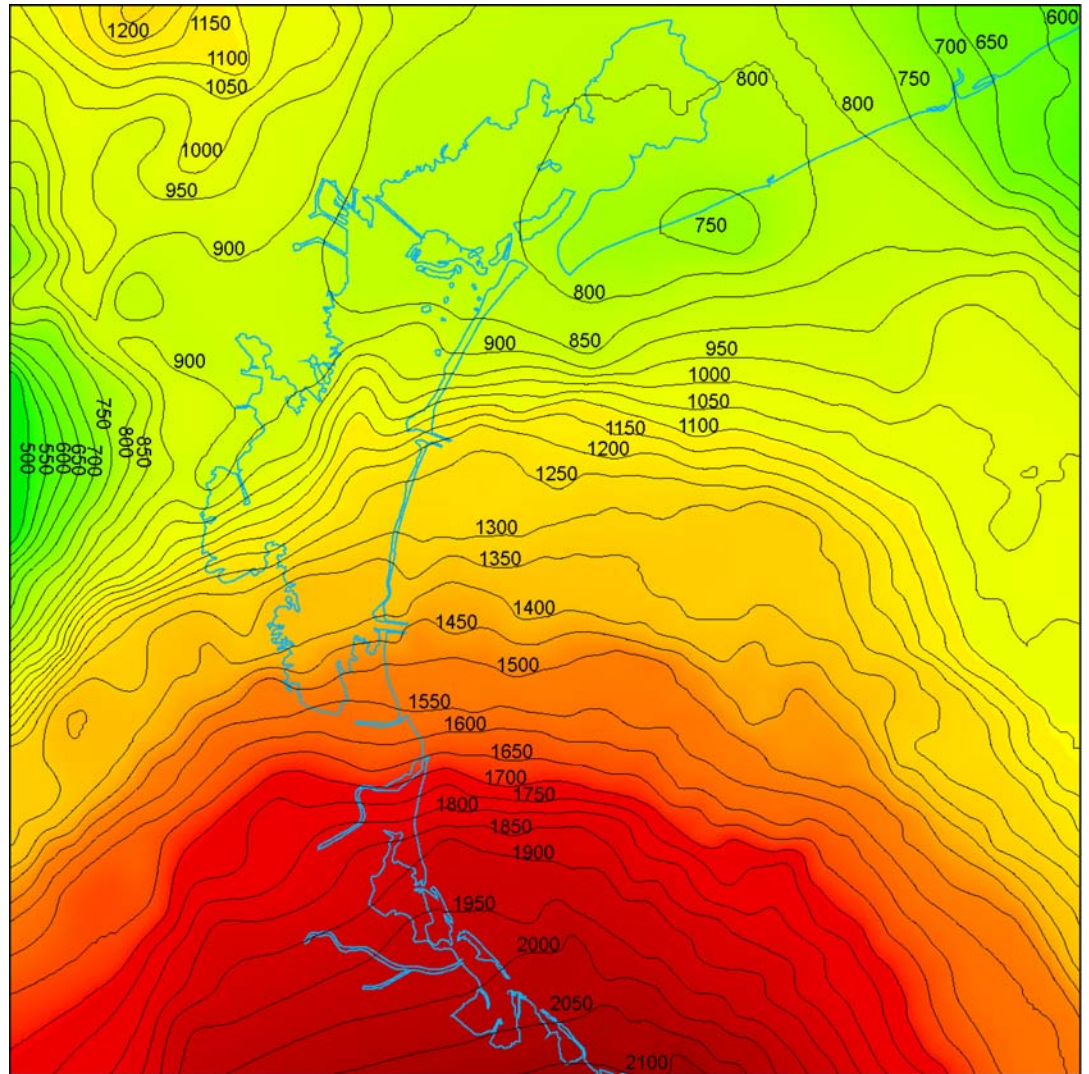


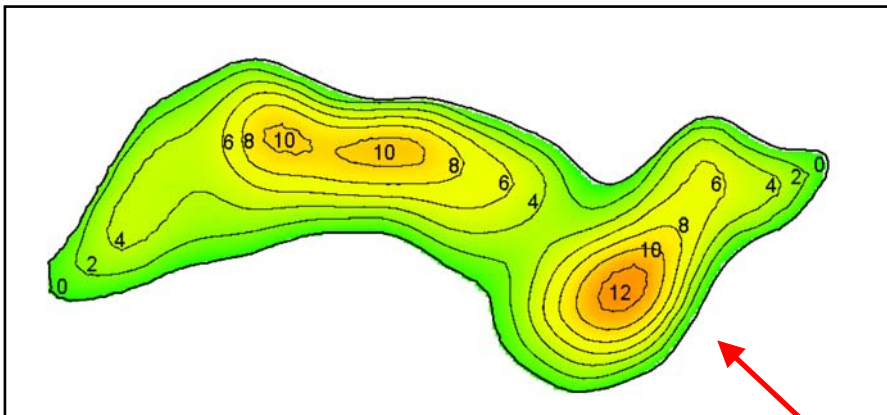
Low resolution tomography: geo-electro-stratigraphy



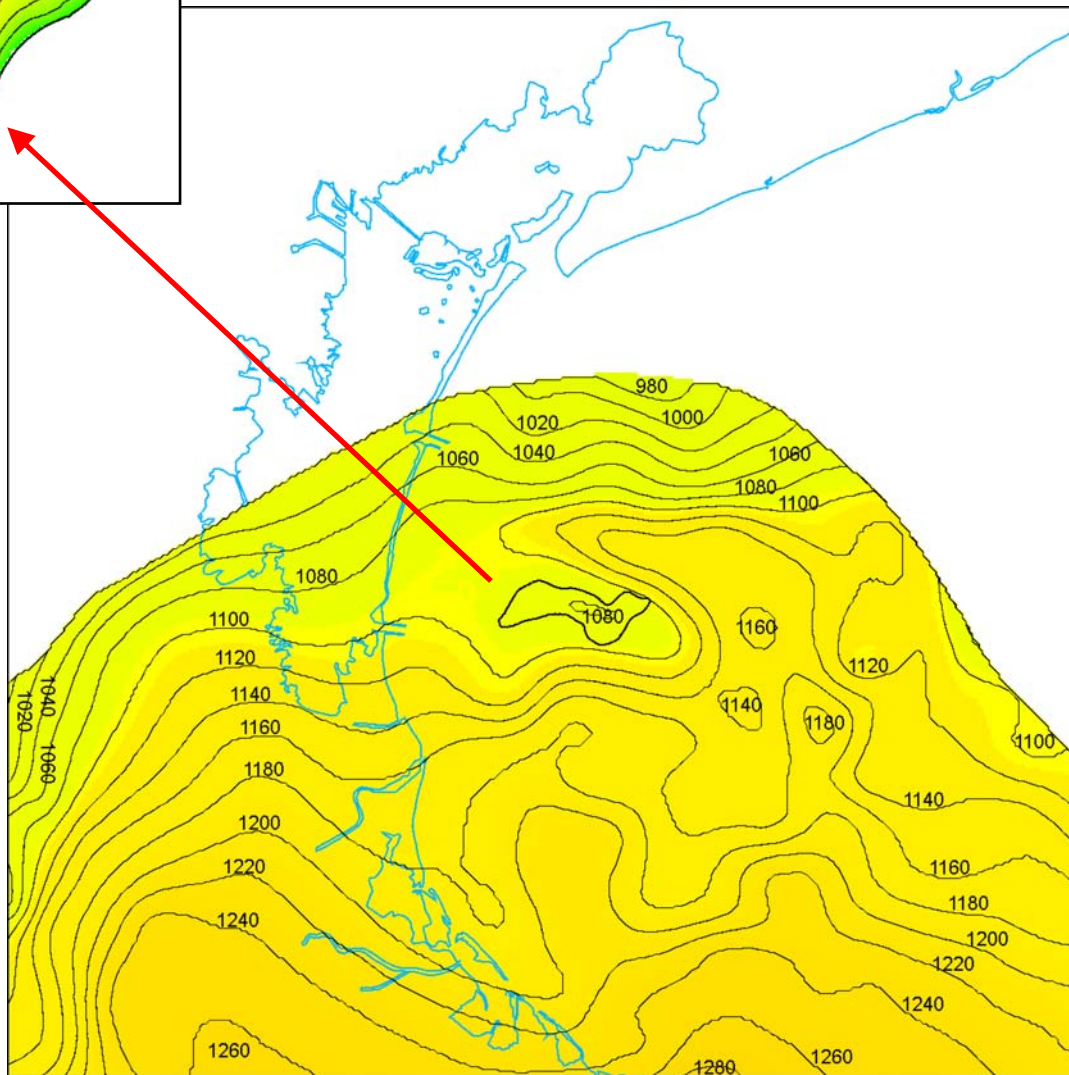
INTEGRAZIONE DI TUTTE LE METODOLOGIE DI INDAGINE

**mappa di
profondita'
della Santerno**





**mapa di spessore
di una zona del
livello C**

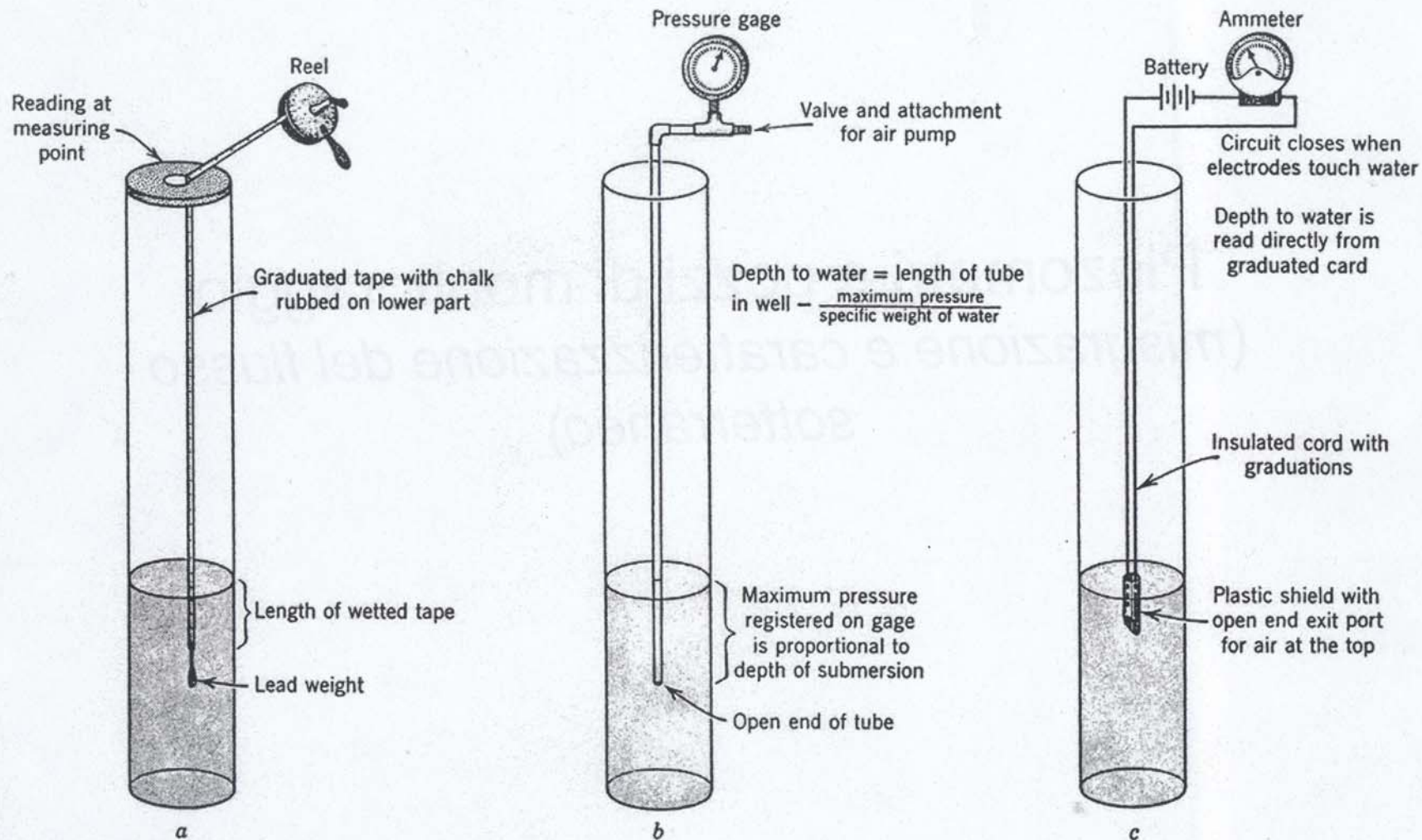


**mapa di
profondita'
livello C**

STRUMENTAZIONE PER LA MISURA DI GRANDEZZE IDROLOGICHE

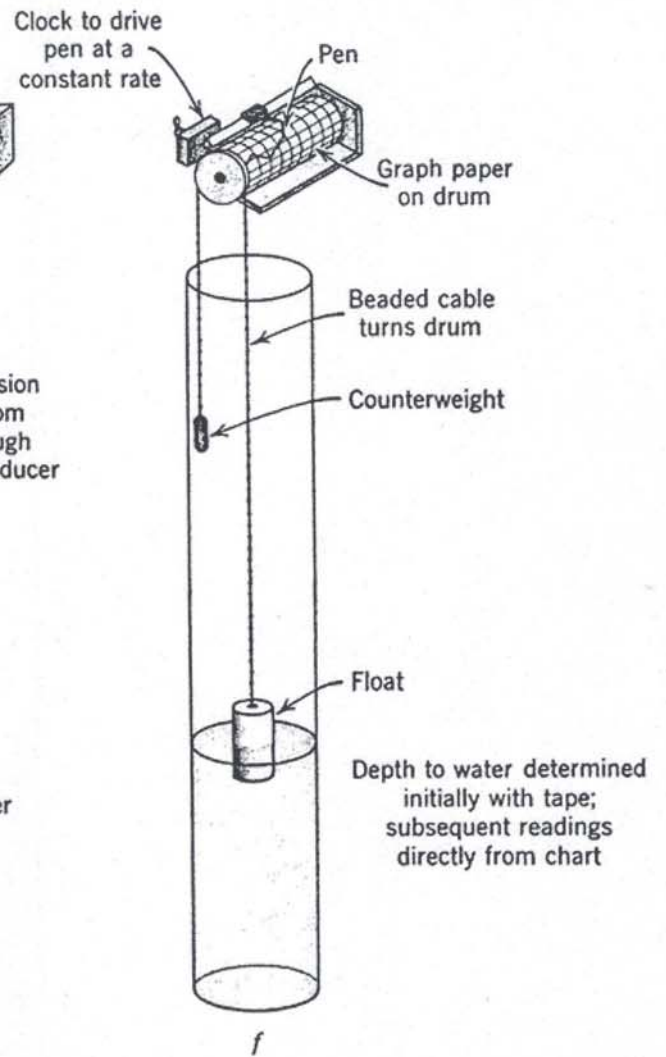
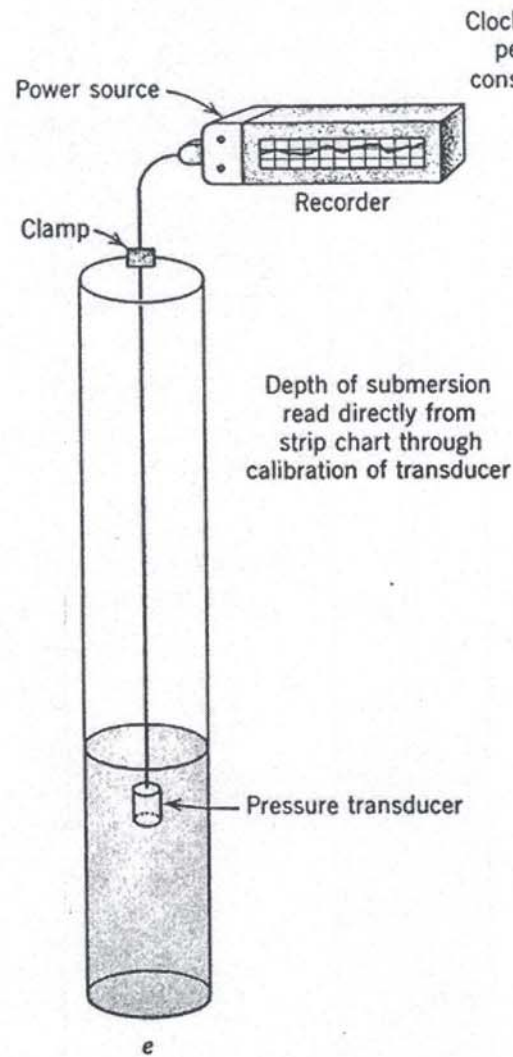
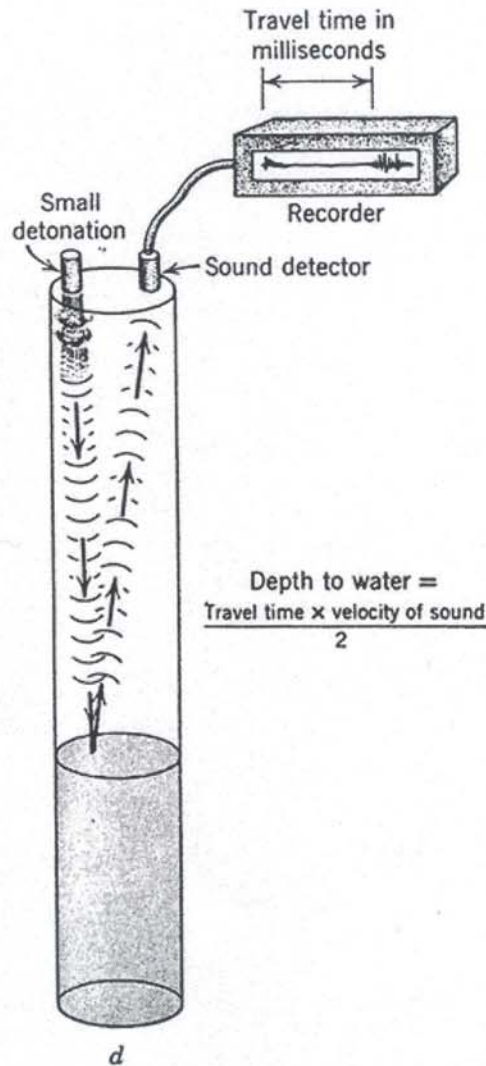
- **livello di falda / piezometria $\Rightarrow$ “piezometri”**
- **pressione capillare $\Rightarrow$ tensiometri**
- **contenuto d'acqua $\Rightarrow$ TDR**

Strumenti per la misura di livello in pozzo

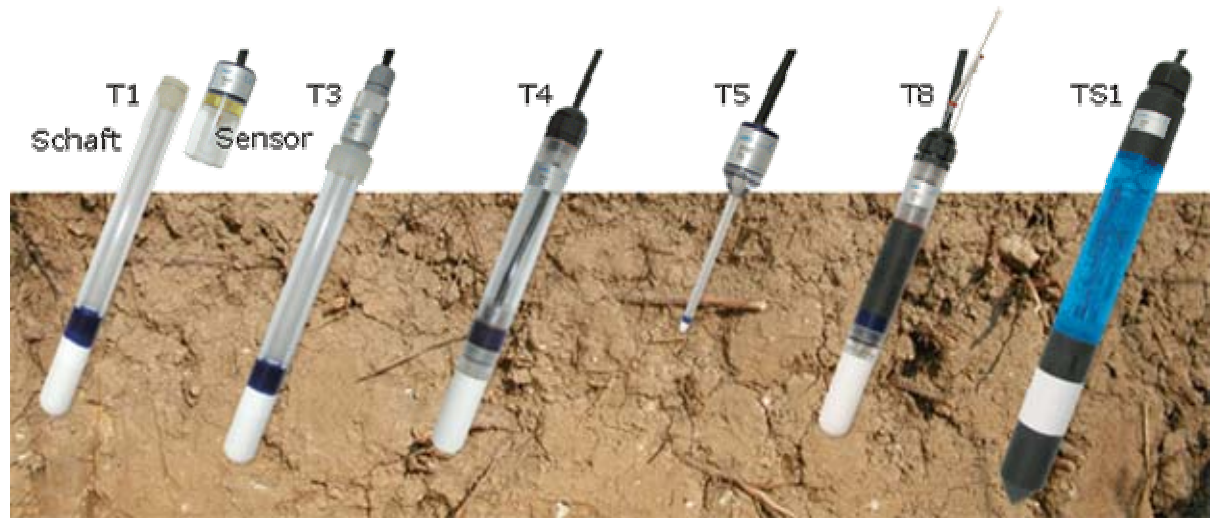


Depth to water = Reading at measuring point - wetted length

Strumenti per la misura di livello in pozzo



pressione capillare



tensiometri



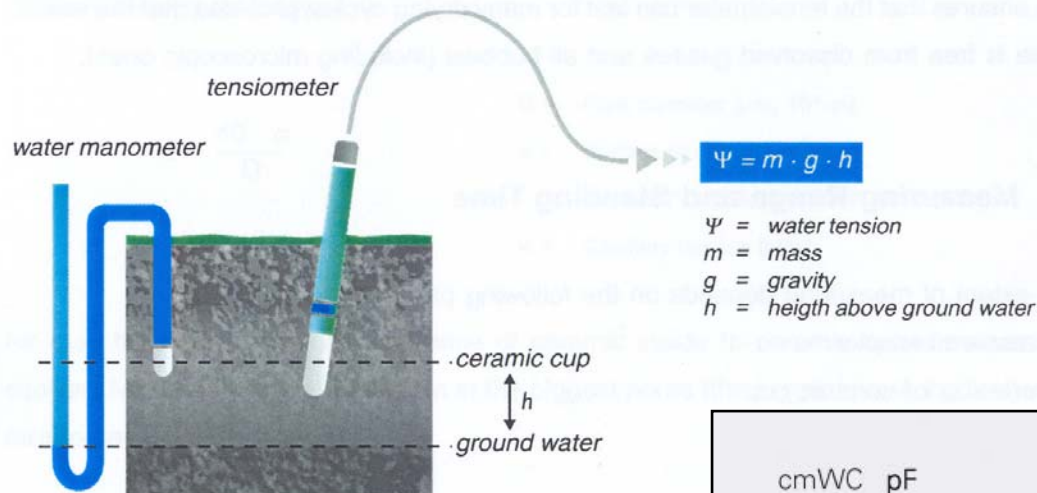
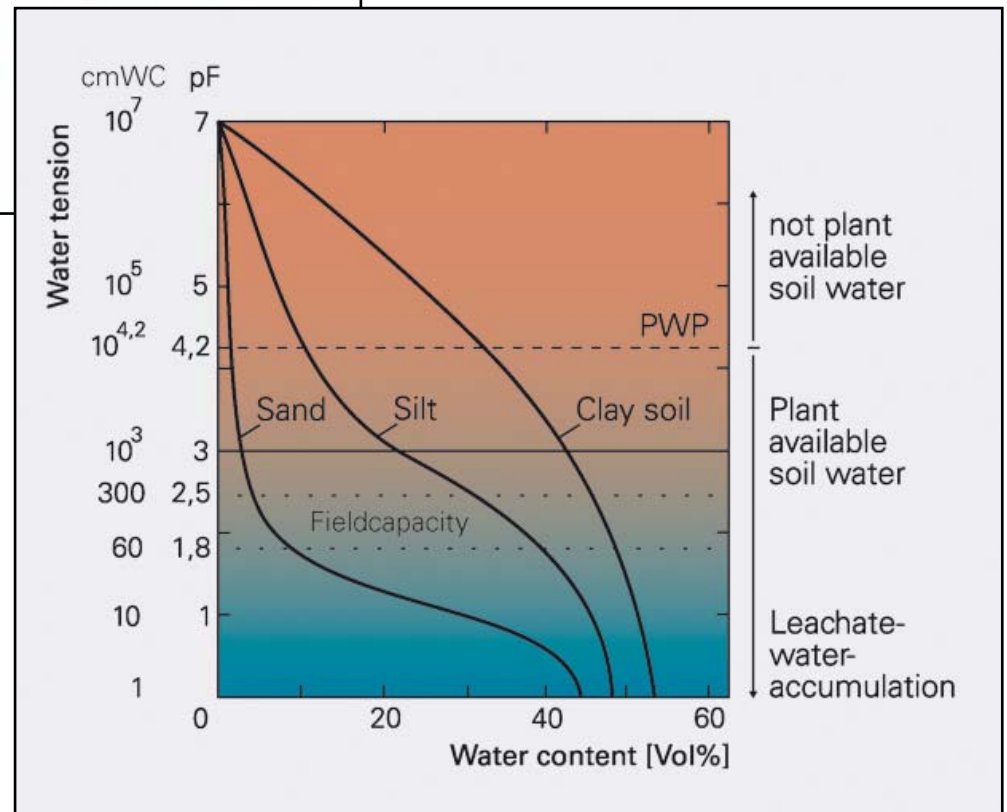
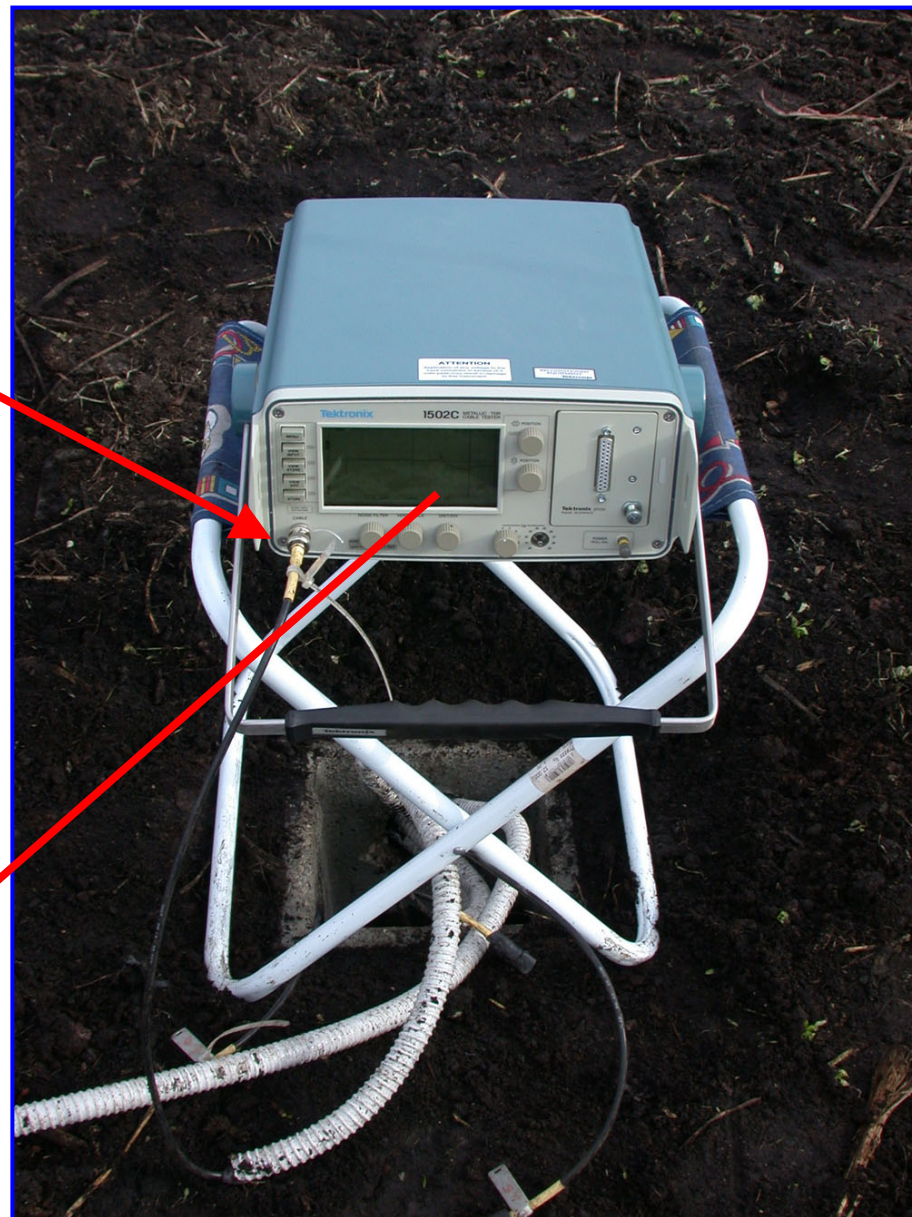
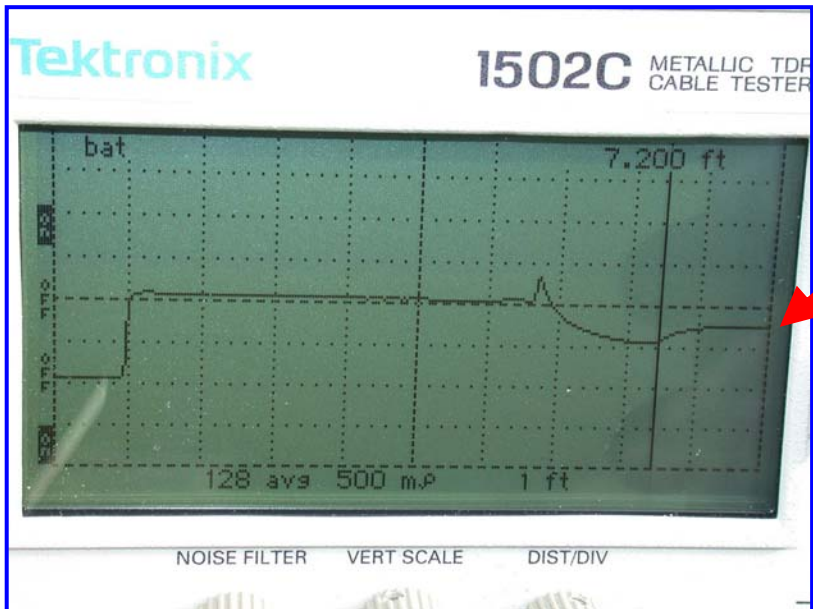
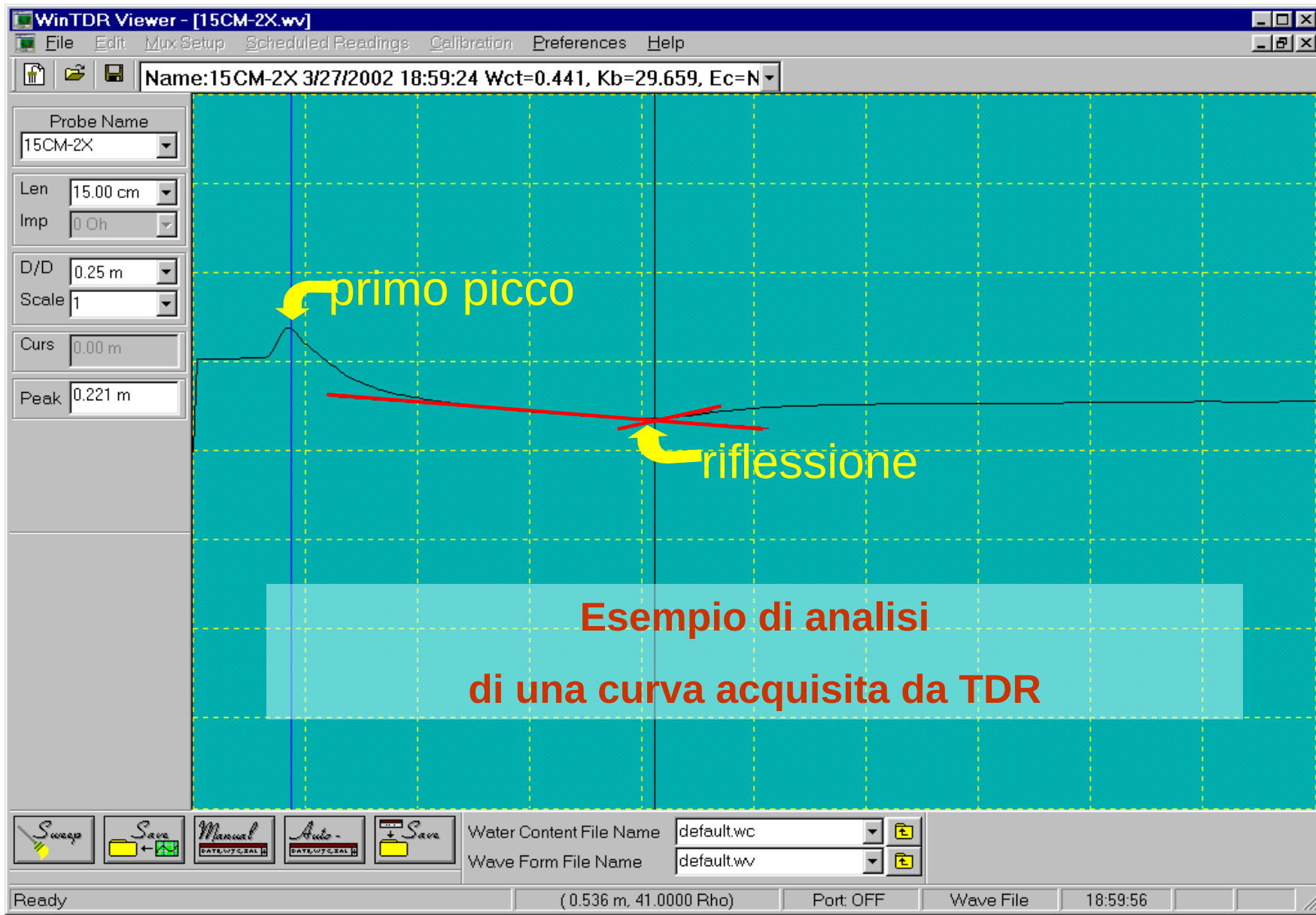


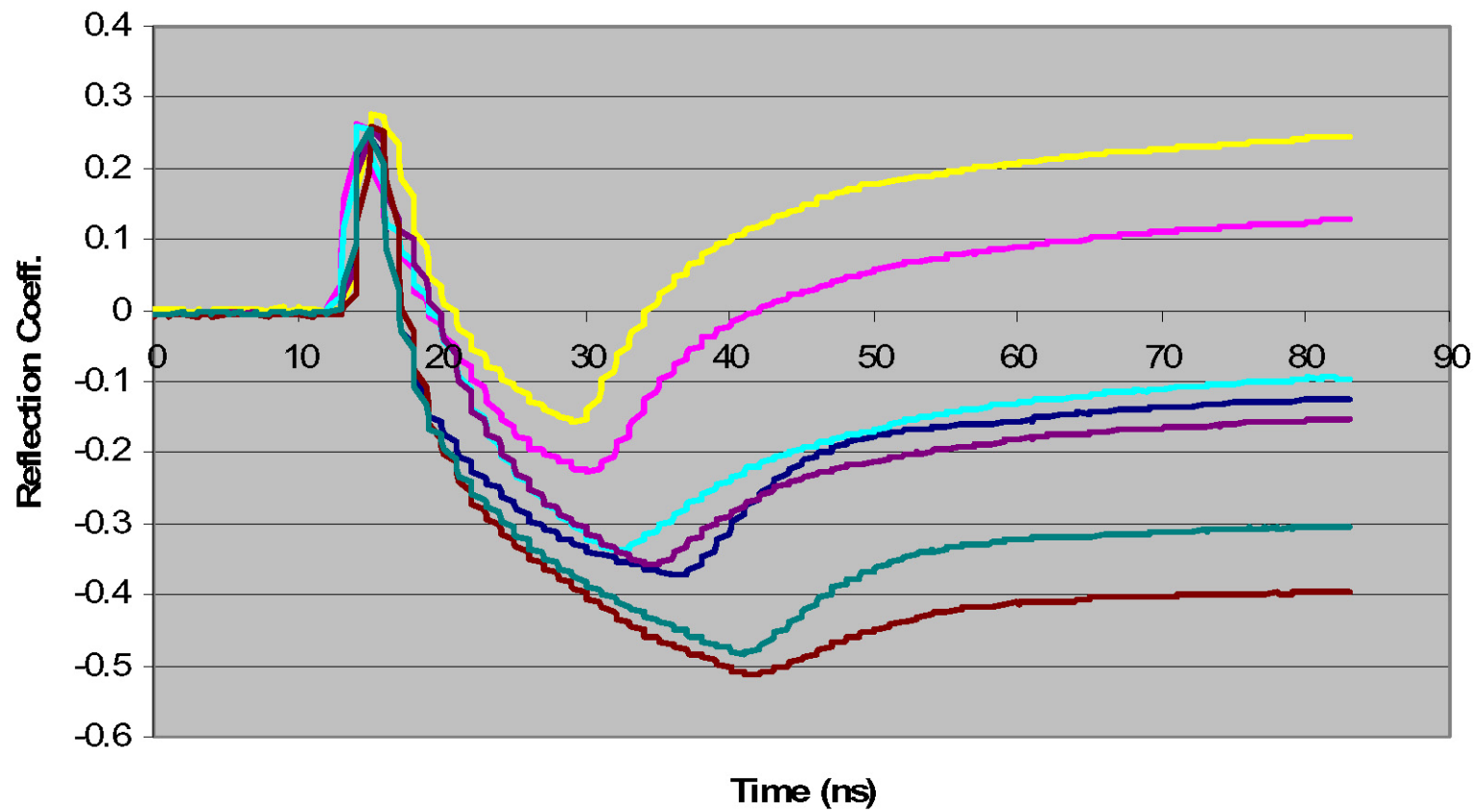
Fig. 4b: Measuring Principle



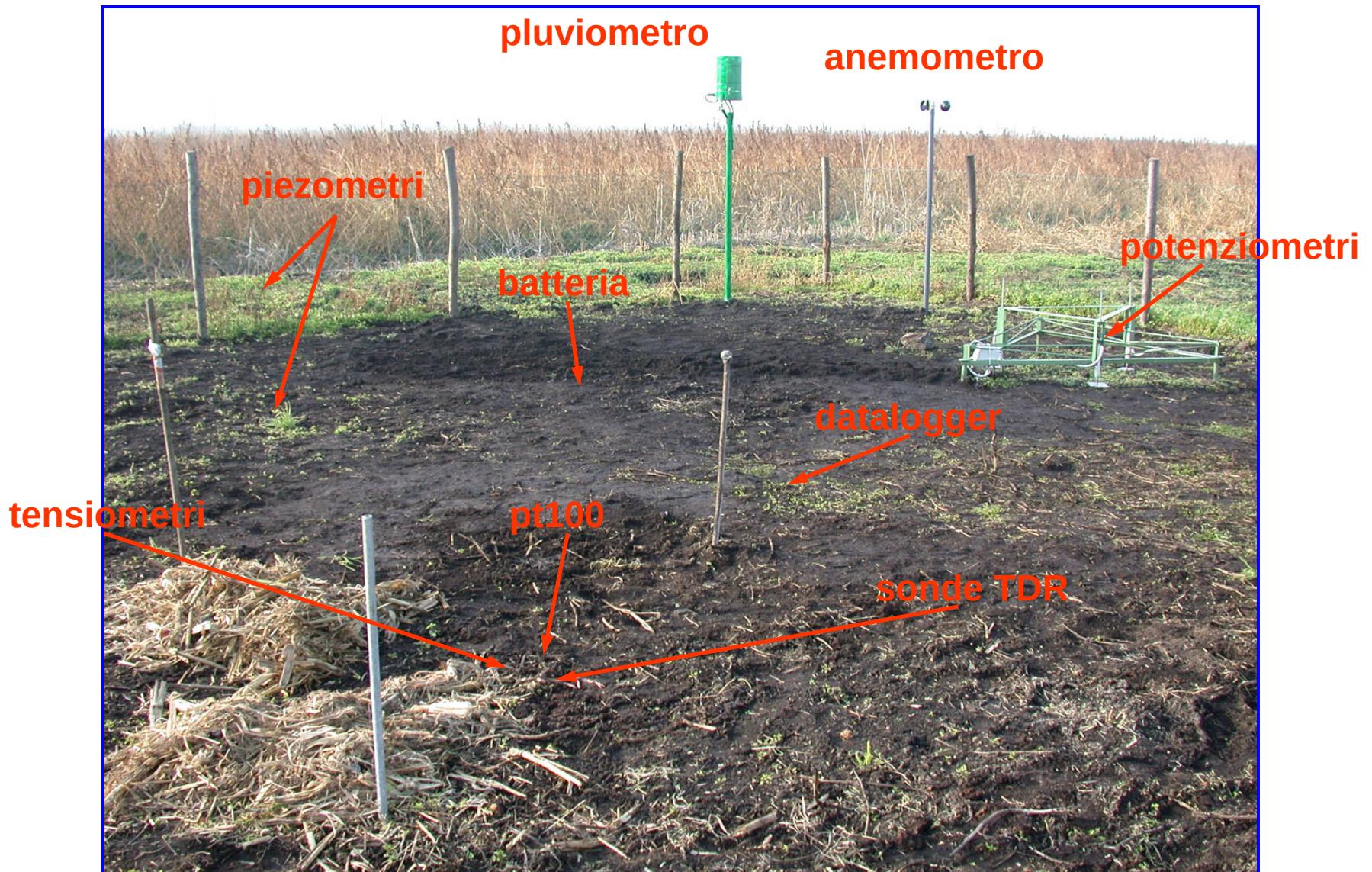
contenuto d'acqua







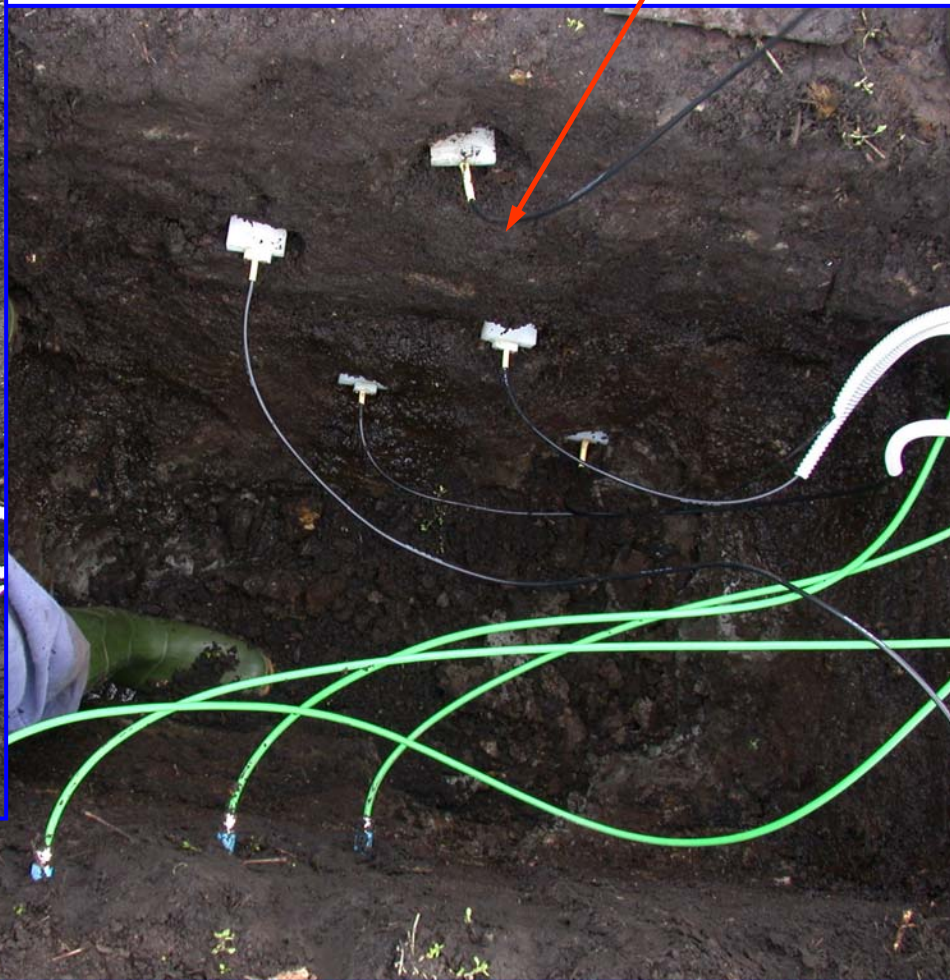
ESEMPIO DI UN SITO SPERIMENTALE DI MONITORAGGIO IDROLOGICO





tensiometri

sonde TDR



pt100