0			Fresia	Cacciatori	Venturini
Revisione	Data	Oggetto revisione	Redatto	Verificato	Approvato

REGIONE LIGURIA PROVINCIA DI GENOVA COMUNE DI GENOVA

PROTOCOLLO D'INTESA PER GLI INTERVENTI STRUTTURALI VOLTI ALLA MITIGAZIONE DELL'EMERGENZA IDRAULICA DEL BACINO DEL TORRENTE BISAGNO, ALLA RIDEFINIZIONE URBANISTICA DEL TRATTO TERMINALE ED ALLA RIQUALIFICAZIONE AMBIENTALE DELL'ALVEO E DELLE AREE CIRCOSTANTI

COMUNE DI GENOVA

AREA TECNICA - DIREZIONE MANUTENZIONE INFRASTRUTTURE E VERDE PUBBLICO

Dirigente **Ing. Stefano PINASCO**

PROGETTISTI:

A.T.I.

TECHNITAL S.p.A. (Capogruppo mandataria)
STUDIO MAIONE INGEGNERI ASSOCIATI
SGI STUDIO GALLI INGEGNERIA S.p.A.
ARTELIA GROUP S.A.

RESPONSABILE UNICO PROCEDIMENTO **Ing. Stefano PINASCO**

Staff tecnico

TECHNITAL S.p.A. (Capogruppo mandataria)
Ing. A.Scotti - Ing. S. Venturini
STUDIO MAIONE INGEGNERI ASSOCIATI
Ing. D Cerlini - Ing. M. Ferrari
SGI STUDIO GALLI INGEGNERIA S.p.A.
Ing. A.Galli - Ing. U. Galli
ARTELIA GROUP S.A.
Mr. O. Cazaillet

Intervento/Opera

SCOLMATORE DEL TORRENTE BISAGNO IN COMUNE DI GENOVA
PRIMO LOTTO: REALIZZAZIONE DELLE OPERE PER LA MESSA IN SICUREZZA IDRAULICA DEL TORRENTE FEREGGIANO (E RIVI ROVARE E NOCE)

Elaborato
TECHNITAL S.p.A.

Dott. Ing. Simone Venturini

Oggetto della tavola

CAMPAGNA DI INDAGINI GEOLOGICO GEOTECNICHE
Sismica a mare

Scala

Data
Agosto 2013

Progetto Definitivo

Tavola N° PD1.DS.590

Codice GULP	Codice Commessa Precedente	Revisione
12383	DSU100	0

I DISEGNI E LE INFORMAZIONI IN ESSI CONTENUTE SONO PROPRIETA' ESCLUSIVA DEL COMUNE DI GENOVA E NON POSSONO ESSERE MODIFICATI, RIPRODOTTI, RESI PUBBLICI O UTILIZZATI PER USI DIFFERENTI DA QUELLI PER CUI SONO STATI REDATTI, SALVO AUTORIZZAZIONE SCRITTA.

1. INTRODUZIONE

Per richiesta della **TECHNITAL Spa**, è stata eseguita un'indagine geofisica marina mediante sismica a riflessione, finalizzata alla ricerca della coltre sedimentaria superficiale e del sottostante substrato roccioso, presenti nei fondali marini antistanti l'area interessata dal nuovo progetto dell'opera di sbocco a mare dello scolmatore T. Bisagno in prossimità della foce del Rio Fereggiano in loc. San Nazaro (GE). I rilievi sono stati suddivisi in n°2 fasi: la prima di controllo dell'inquadramento planimetrico della zona, la seconda di sismica marina mediante sistema Boomer Plate a 100 Joule. Questo rapporto contiene le procedure adottate, ed i risultati dei tracciati sottoforma di immagini JPEG georeferenziate in Coordinate Cartesiane piane Gauss Boaga.

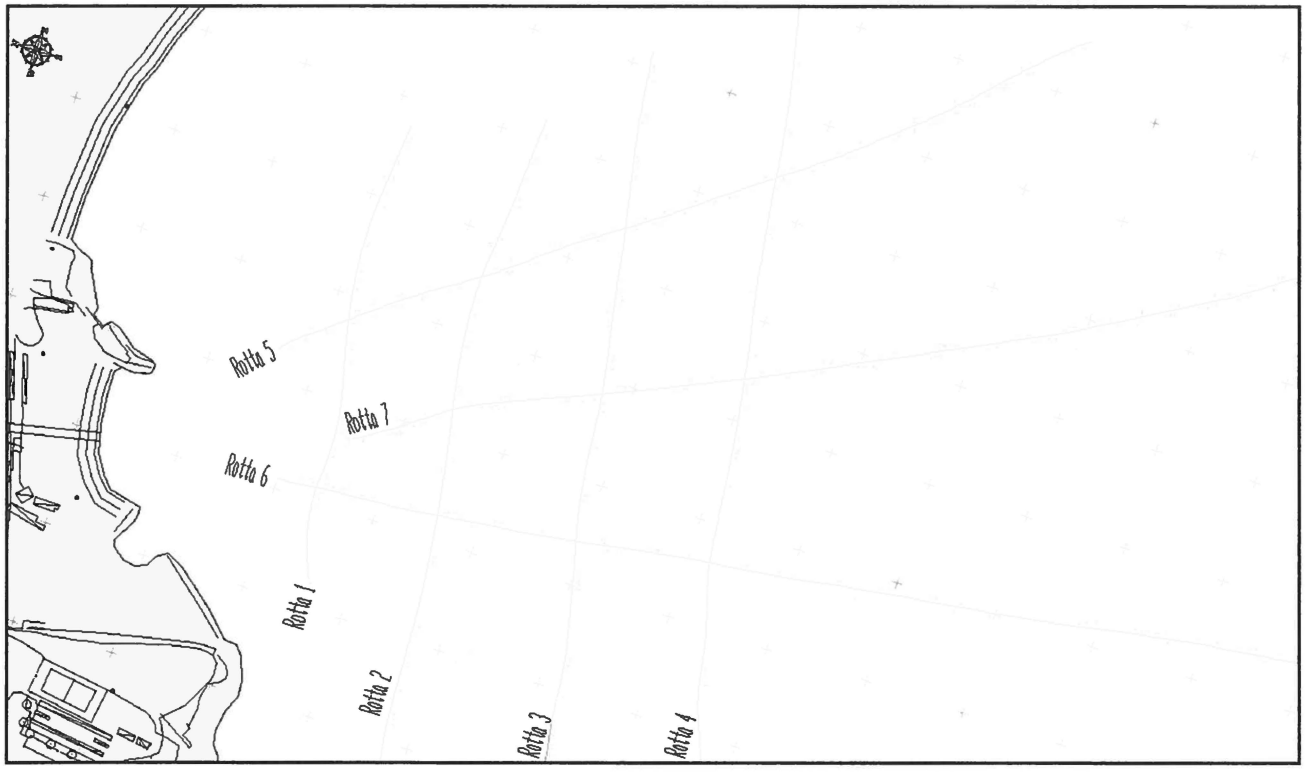
1.1 Termini

Appaltatrice - **TECHNITAL Spa**
Ordine - del 21/09/04
Contratto - del 21/09/04.

1.2 Caratteristiche generali delle indagini.

L'obiettivo dei rilievi è stato quello di indagare i fondali mediante penetrazione degli stessi facendo uso di strumentazione per la sismica ad ultrasuoni in bassa frequenza. A tale scopo, la committente ha richiesto:

- Controllo sui caposaldi della rete IGM95, affinché sia le posizioni di navigazione che i dati acquisiti durante l'attività di survey siano coerenti all'inquadramento planimetrico esistente sull'area di approdo.
- Indagine con SBP tipo Boomer Plate su n°7 profili sismici di cui 3 lungo la direttrice dell'opera di sbocco a mare scolmatore T.Bisagno e 4 paralleli alla linea di costa intersecanti con i primi in modo da avere dei crossing di controllo (come rappresentato nella figura di seguito riportata).



Rotte navigate nella campagna di sismica a mare del 30 Maggio 2005

1.3 Pianificazione, tempistica di esecuzione e risultati delle indagini.

Il lavoro è stato eseguito nella giornata del 30 maggio 2005.
Le attività svolte sono state così ripartite:

- Mattina del 30/05/2005 attività di controllo dell'inquadramento planimetrico.
- Pomeriggio del 30/05/2005 mobilitazione del personale ed apparecchiature dal Porto di Genova, ed esecuzione delle indagini richieste, lungo 7 rotte equidistanti circa 60m, di cui, le 3 sull'asse della lunghezza di circa 600m circa e le 4 perpendicolari a queste navigate quindi parallellamente alla linea di costa della lunghezza di circa 350-400m.

I risultati della ricerca sono stati così restituiti:

- Carta delle rotte navigate durante l'indagine sismica effettuata con Boomer Plate AAE200, Scala di restituzione 1:500 su A0 e riduzione su A3.
- N°7 tracciati sismici inerenti le sezioni acquisite con SBP, restituite su supporto cartaceo in formato A4 e A3, e digitale sia come documento *.pdf di Acrobat che *.dwg di ACAD2000, Asse Z reale in ms, asse orizzontale in metri scala 1:1.
- CD-Rom contenente i formati digitali di: tavola planimetrica e immagini JPEG in overlay su DWG inerenti i tracciati sismici.

1.4 Scopo del lavoro

Lo scopo del lavoro è specificato nel seguente documento contrattuale:

- Offerta Commerciale (prot. 2004.047)

1.5 Acronimi usati nella relazione

SBP	-	Sub Bottom Profiler
SOL	-	Start of Line
EOL	-	End of Line
XTF	-	eXtended Tritonelics Format
SEG-Y	-	Formato dei file di acquisizione sismica
KP	-	Kilometer Post

2. LOGISTICA OPERATIVA

2.1 Mobilitazione

Mobilitazione del personale e della strumentazione dal Porto di Genova a San Nazaro (GE) ed esecuzione indagini nel giorno 30 Maggio 2005.

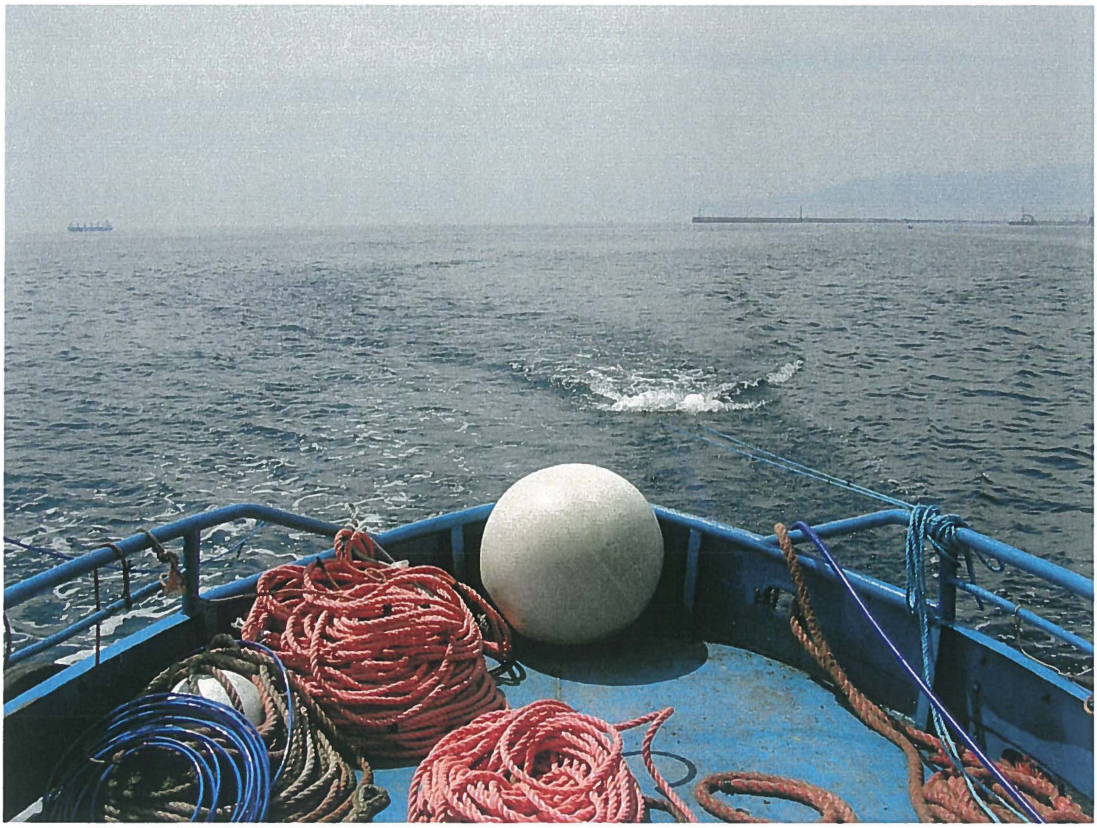
2.2 Attrezzature usate per l'esecuzione delle indagini

Durante la mobilitazione è stata allestita, in diverse fasi, la seguente strumentazione:

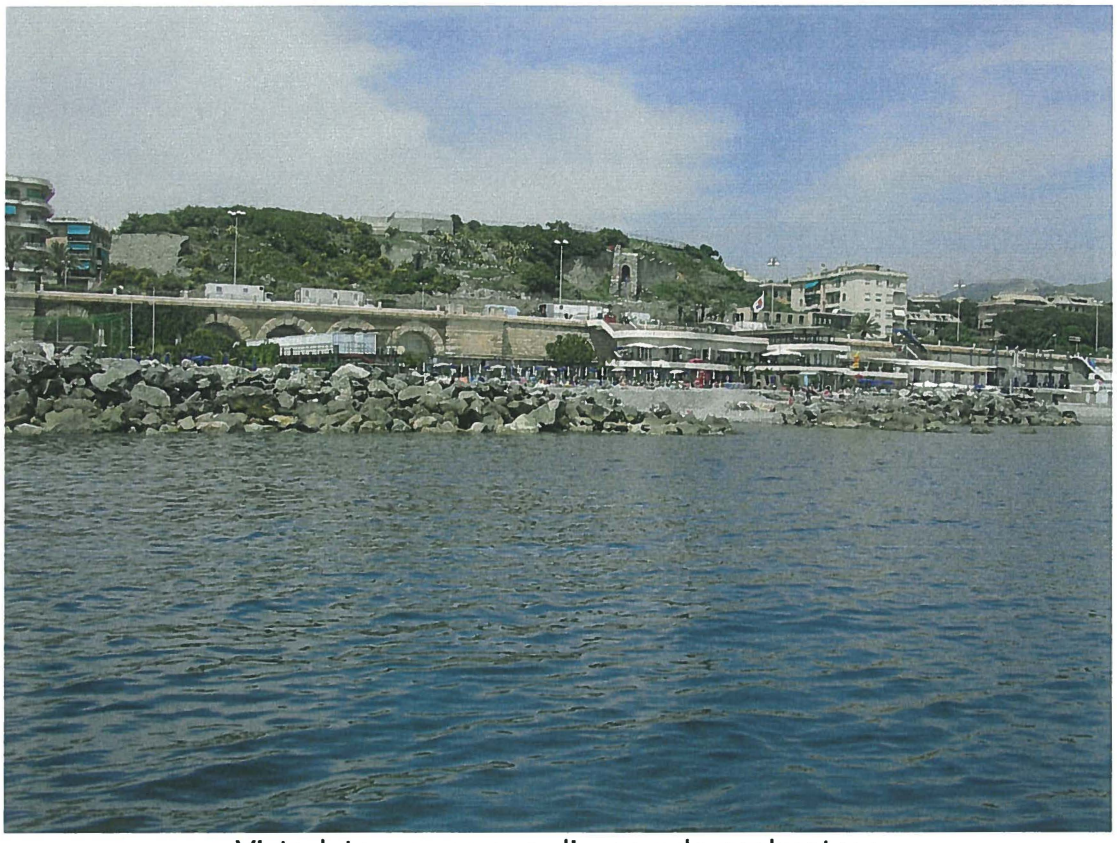
- M/B Fausto della lunghezza di 14m.
- Computer e programma di navigazione TRIMBLE HYDROPro 1.50 product 37967 s/n 142651 + dongle key.
- Ricevitore GPS-TRIMBLE 5700, correzioni differenziali da satellite Egnoss.
- Giro bussola e sensore pitch & roll KVH industries AZIMUTH GYROTRAC P/N 01-0226 99110015.
- Applied Acoustics Engineering (AAE) Sub Bottom Profiling System, composto da:
    - CSP 1500 Seismic Energy Source completa di HV Junction Box e Hardigg Transit Case, S/N 2030337.
    - Cavo alta tensione HV4000 da 10m, S/N 562/10
    - Hydrophone streamer a 1 elemento, mod. AH1, S/N 2040672
    - Hydrophone streamer a 8 elementi, mod AH3 60/8, S/N 2030671
    - Catamarano di supporto x Boomer Plate mod. CAT200, S/N 2030741.
    - Trasduttore Boomer Plate mod. AA200, S/N 2030773.
    - Seismic energy source Spare Kit, S/N 163
- N°1 Unità di acquisizione SwanPro 1.52 su portatile Laptop industriale BSI-LCDV9T12-15.4, S/N 1020542.
- N°2 Computer portatili Panasoni cf29 Intel Centrino.
- Software Tritoelics DelphMap utilizzato per il processing delle passate SBP + dongle key.
- 3 x Digiboard PCMCIA - QUATECH.
- 2 x Alimentatore stabilizzato 24V.
- 2 x Alimentatore 12V.
- 2 x UPS.
- 1 x Generatore Inverter da 3KW - HONDA mod.EU30is.
- N° 2 PC Pentium 4 + 2 Monitor SVGA x processing dei dati di navigazione e sismici.
- Stampanti a colori formato A3 EPSON Stylus color 1520, HP DeskJet 1220C ed elettrografica OKI C5400.
- Plotter a colori HP DeskJet 450C.



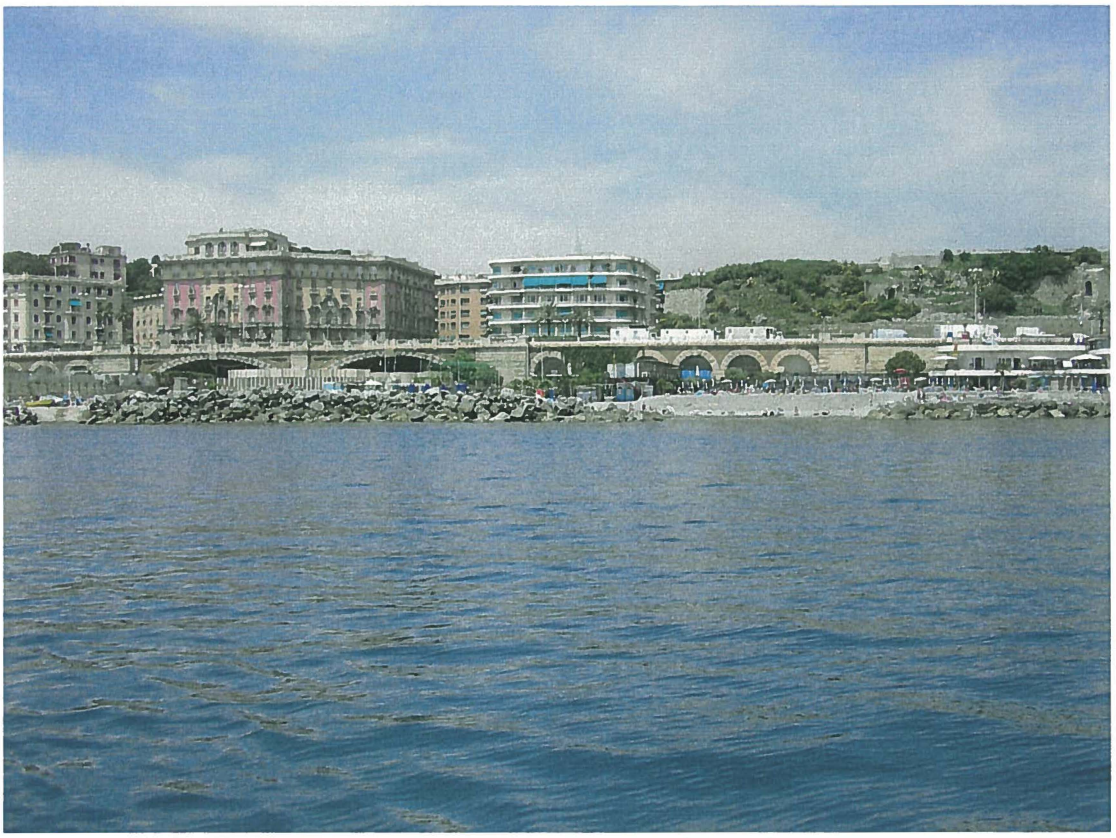
Attrezzatura software e hardware montata su imbarcazione FAUSTO



Configurazione della geometria a mare del trasduttore e idrofoni visti dalla imbarcazione FAUSTO



Vista lato mare zona di approdo scolmatore



Vista lato mare zona di approdo scolmatore



Vista lato mare zona di approdo scolmatore



Sbocco opere a mare scolmatore T. Bisagno

2.3 Calibrazioni eseguite in sito e nelle area interessata

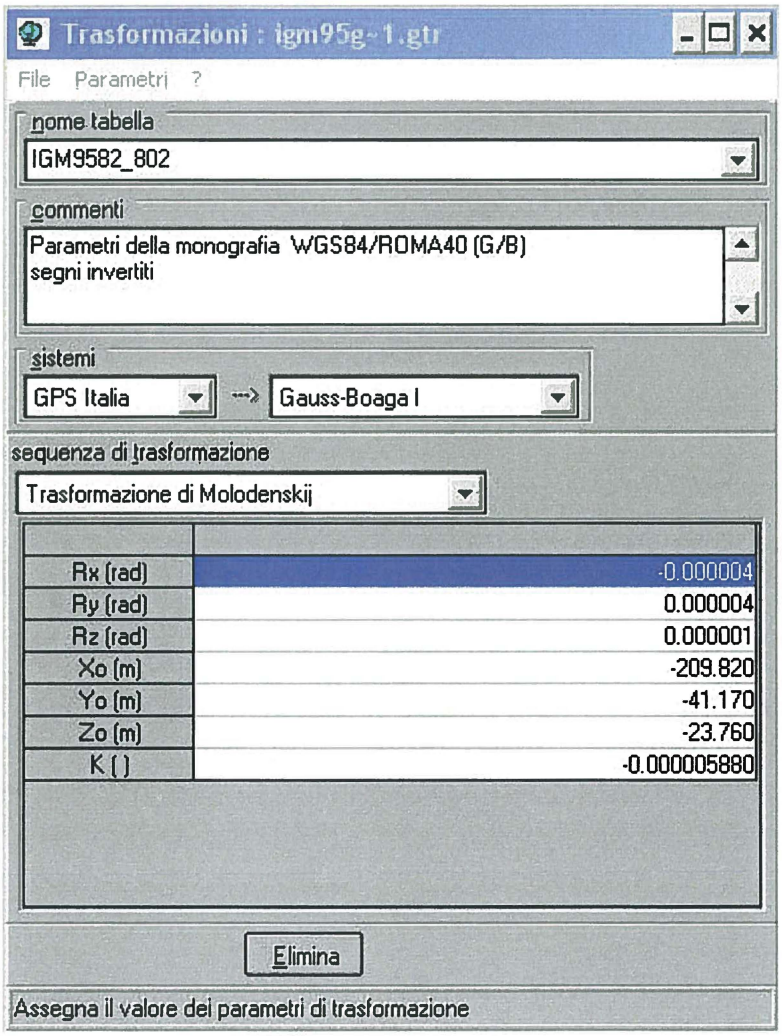
Prima dell'inizio delle operazioni, sono state eseguite, in prossimità dell'area da indagare le seguenti calibrazioni strumentali:

- Controllo dell'Inquadramento GPS dell'area d'indagine.
- Montaggio e taratura del sistema SBP.
- Test d'isolamento delle apparecchiature elettroniche collegate al motogeneratore elettrico Inverter.
- Test funzionali a secco, in acqua e sintonizzazione del sistema SBP.

3. PARAMETRI ADOTTATI

3.1 Rete d'inquadramento, osservazioni GPS e parametri geodetici

Durante l'esecuzione della geofisica marina, è stato usato come software di navigazione il TRIMBLE HYDROPro 1.50, collegato al sistema di posizionamento GPS-RTK in differenziale – TRIMBLE 5700 con correzioni differenziali satellitari.



3.2 Unità di misura

- Tutte le Unità di Misura utilizzate in questo rapporto sono conformi al Sistema Internazionale (SI).
- I tempi per il campionamento di: software, computer per la navigazione, Hydro Pro 1.5, SwanPro sono espressi in UTC.

4. POSIZIONAMENTO E SISTEMA DI NAVIGAZIONE

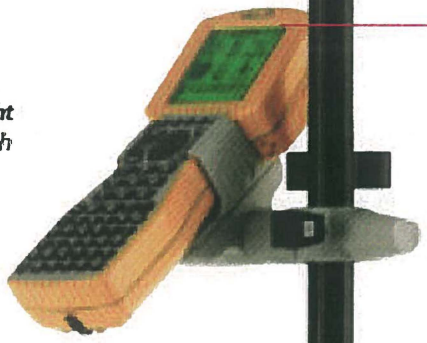
4.1 Sistema di posizionamento utilizzato sull'imbarcazione FAUSTO

4.1.1 Coppia di ricevitori RTK-OTF TRIMBLE 5700





A comfortable, lightweight belt pouch is included with the instrument.



VERSATILE CONTROLLER

Lightweight and rugged, the TSC1 controller has a graphic display that's capable of operating in extreme temperatures and easy to read in direct sunlight. Full keyboard and an intuitive interface that simplifies all survey tasks.

POWERFUL INTEGRATED SOFTWARE

Trimble Survey Controller software handles a wide variety of conventional and GPS instruments, all in a single environment. Its powerful computer and large memory capacity allow complete 3D designs to be uploaded and carried into the field.

BALANCED FEATHERWEIGHT POLE

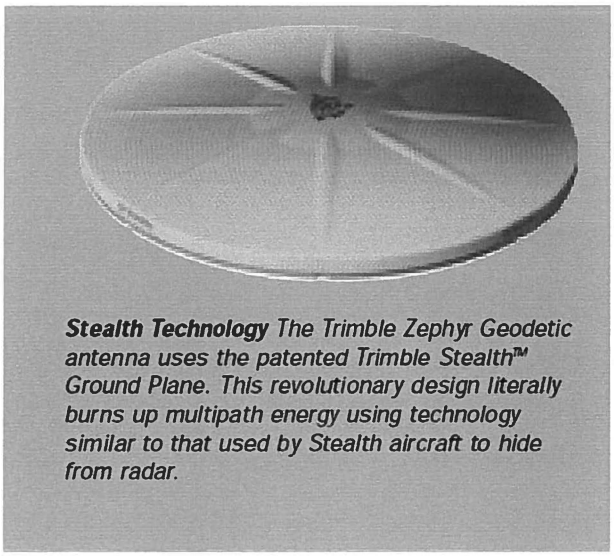
Carbon-fiber construction with center of gravity at handgrip for easy handling and comfort all day. Entire pole is balanced and weighs less than 4kg (8.8lb) including batteries for a day's work.



LIGHTWEIGHT RECEIVER

The 5700 receiver is not only the most powerful RTK receiver we've ever built it's also the lightest, fastest, and least power hungry. RTK systems come with eRTK technology, a USB interface, road and slope staking, DTM staking, GIS support, and WAAS/EGNOS, all standard.

Configurazione sistema RTK-OTF



Antenna della Stazione totale

4.2 Software di Navigazione

La navigazione è stata gestita usando il TRIMBLE HYDROPro V1.5; questo software consente di acquisire, in tempo reale, i dati fondamentali per un rilievo idrografico di precisione. L'HYDROPro, è un software che può essere configurato in modo da visualizzare un indicatore di rotta a monitor (helmsman monitor) e gestire diversi dispositivi in input e output, tramite porte addizionali (multi-seriali e multi-parallele PCMCIA o slot 16 bit ISA e PCI).

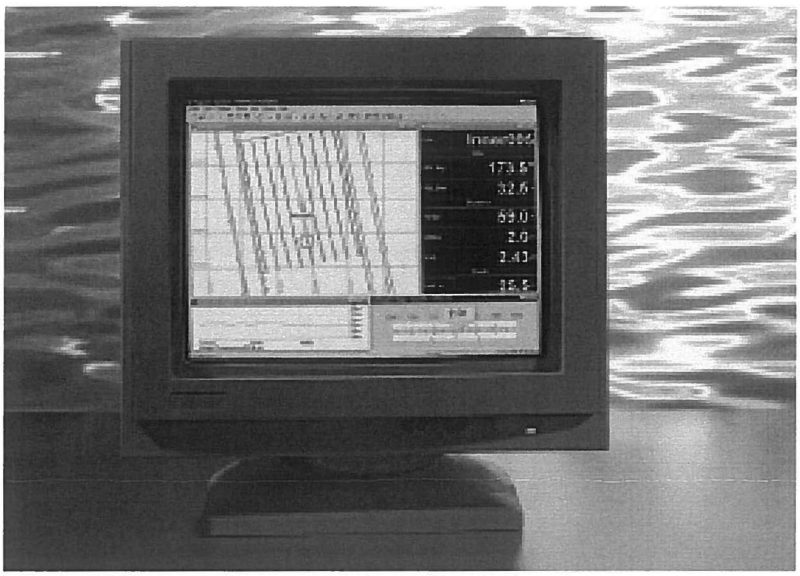
Durante le varie fasi d'indagine, al computer con HYDROPro in linea sono stati collegati i seguenti dispositivi :
Sistema di posizionamento RTK OTF.
Giro bussola – KVH Azimuth GyroTrac.
Unità acquisizione dati da SBP AA200 – CSP1500 con software SwanPro 1.52.

La navigazione è stata replicata su di un secondo monitor per permettere al pilota dell'imbarcazione di seguire le rotte pre-impostate.

Le Caratteristiche del software di navigazione sono:
Video plotter sul quale sono visualizzate tutte le informazioni necessarie per una Corretta navigazione delle rotte d'indagine.
Interfacce per il collegamento tra i vari sistemi di bordo.
Calcolo in tempo reale del punto nave ed indicazione dello stesso sul video
Calcolo in tempo reale della posizione nelle coordinate cartografiche richieste dalla committente.
Controllo della qualità del punto nave (deviazione standard, PDOP etc.).
Calibrazione dei sensori.
Calcolo della marea.
Visualizzazione delle rotte da navigare.
Memorizzazione di tutti i dati acquisiti.
Confronto tra rotta impostata e rotta vera.
Cartografia CAD in overlay.
Elaborazione dei dati acquisiti.

Al termine delle indagini i dati della navigazione sono stati estratti dai files di registrazione dell'unità di acquisizione SwanPro e convertiti in ASCII chiaro - file estensione *.TXT. Successivamente sono stati filtrati (smooth) allo scopo di eliminare eventuali punti spuri; il risultato è ottenere un ASCII - file con estensione *.CSV da utilizzare nei vari passaggi di post-processing dei dati dal Sw DelphSeismic.

Quì di seguito vengono riportate le caratteristiche del SW HYDROPro1.5 di TRIMBLE.



HYDRO*pro* Navigation Software

THE NEXT GENERATION HYDROGRAPHIC SURVEY SOFTWARE

Faster, more accurate surveys in the marine environment are what today's hydrographic surveyors strive for. Taking advantage of new technologies that increase quality and productivity is essential to provide the competitive edge. Trimble's HYDRO*pro*™ software suite is a comprehensive hydrographic survey package designed for today's diverse hydrographic industry.

WHAT IS HYDRO*pro* SOFTWARE? The HYDRO*pro* software suite is Trimble's Windows-based hydrographic software. It includes a complete range of data processing components that complement its real-time navigation and data acquisition software. Built on over a decade of development and industry based experience, HYDRO*pro* software offers a total field-to-finish solution and represents a powerful new generation in hydrographic survey software.

MAIN COMPONENTS OF HYDRO*pro*

Navigation is the real-time survey module of HYDRO*pro* software, and is used for survey preparation, guidance, and data acquisition. It provides the elements required for real-time navigation/guidance and data logging in the field. This includes configuring vessel shape and offsets, equipment, coordinate systems, Guidance Objects, Events, and data logging.

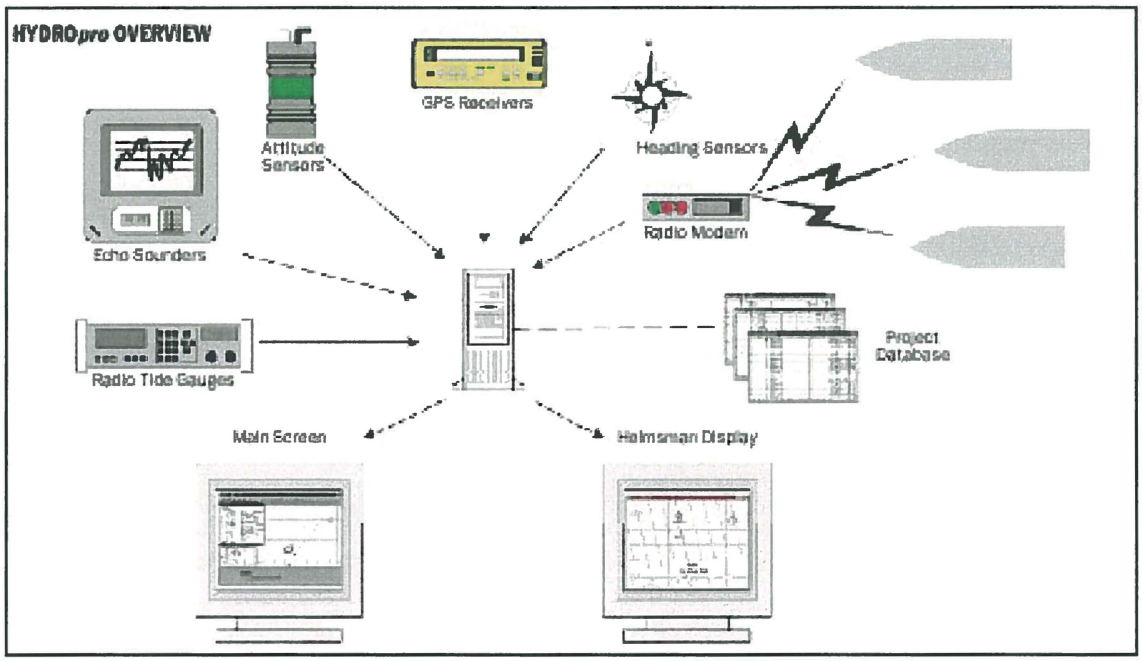
NavEdit is the graphical depth data visualization and cleaning tool that allows you to edit depth-related data such a recorded depth, heave, and tide. It is also the link between the Navigation and Processing software components.

Processing is the data presentation and analysis tool. This provides standard editing as well as specialized data processing, reporting, and plotting. Further information on the NavEdit and Processing software components can be found in the HYDRO*pro* NavEdit and Processing Technical Notes.

NAVIGATION SOFTWARE

A survey project can be treated as a number of interlocking pieces, each with its own function and properties. Components such as the vessel, GPS receiver, and echo sounder are all part of this project. With the HYDRO*pro* Navigation software concept, fulfilling a project's requirements is limited only by your PC hardware. Components of HYDRO*pro* Navigation software are:

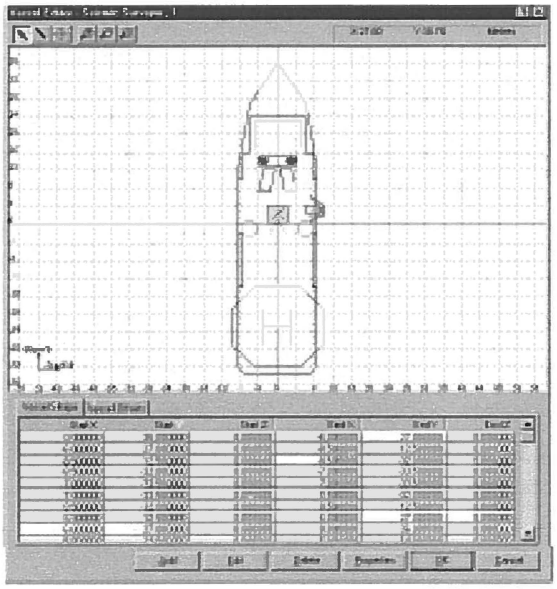
Services: Services are what drive the Navigation software. They are data streams provided by each piece of equipment connected to your system.



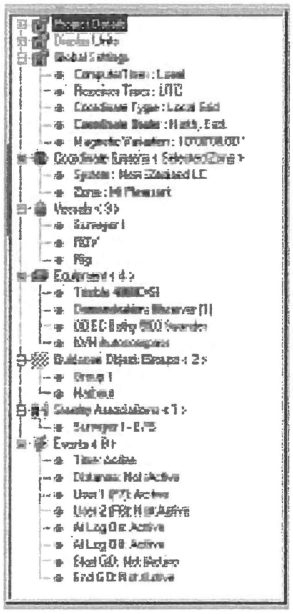
Vessels: Your project can have any number of vessels. These can be boats, towed sensors, ROVs, or any other objects you wish to assign services to. Each vessel has its own shape, offsets, and display properties such as color and offset symbol.

Equipment: The concept of equipment services brings enormous flexibility to the Navigation software. When equipment is added to your project, the software makes a set of services available. The services such as GPS Position or Heading can be assigned to any Vessel Offset within the Project. This concept allows you to use data (services) from remote equipment, such as Tide from a radio tide gauge or GPS Time from a remote GPS receiver for data synchronization. It also makes it easy to configure complex equipment, such as data multiplexers, that provide services from several sources in a single data stream.

Guidance Objects: (GOs) – Using points, run-lines, and routes to guide you through a survey is something every hydrographic surveyor is familiar with. The Navigation software concept treats these Guidance Objects in a simple yet very efficient way. The simplest form of a Guidance Object is a point. Points may be connected with lines to form run-lines or routes. Any number of Guidance Objects, such as a series of run-lines for a harbor survey, can be stored together in a group. All GOs are configured in the Guidance Object Editor, so all guidance information is in one place and can be easily manipulated.



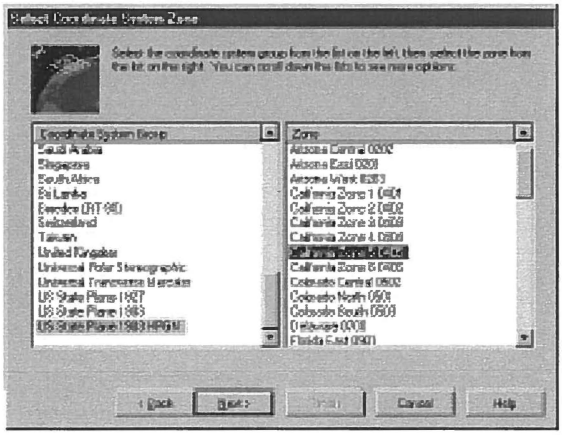
Project Set-up



The Project Outline provides a total overview of the project configuration in a single graphical display. Graphical icons provide immediate recognition of specific areas of configuration, such as equipment and vessels. The expanding tree provides additional levels of detail as, and when, you require them. Using this graphical display, you can directly edit any specific configuration in your project. A simple double click on an item in the Project Outline brings up the correct configuration dialog. Setting up vessel and equipment offsets in the new Graphical Vessel Editor is quick and simple. It enables you to customize many things—such as the way the vessel is displayed during the survey.

Coordinate System Configuration

Navigation software uses Trimble's extensive database of coordinate systems worldwide. The same database

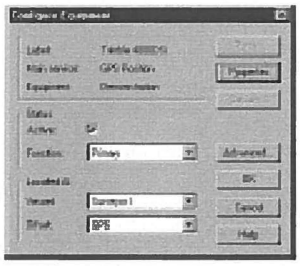


is used in many other Trimble products, such as the mapping and land survey products. All you have to do to configure your Geodetic parameters is select a zone. All local ellipsoid, transformation and projection parameters are loaded for you. You can use the View option to check the loaded details, or use Edit if you wish to use a modification of this zone.

Equipment Configuration

Equipment configuration can be as simple as selecting a service and the serial port it's connected to, and the Navigation software will do the rest. However, if there are more complex requirements, the advanced configuration can be used. Some possible applications for this powerful and extensive option are:

- To receive and use multiplexed data (e.g. position, depth, heading etc.) via a single serial port
- To receive observations to multiple ROVs from a single device
- To use specific information from a device, such as Time from a GPS receiver



The concept of equipment services brings enormous flexibility to the Navigation software. Data packets received from equipment are time tagged and decoded into separate streams (services) which are made available to the system for use in displays, computations, logging, output, etc. This technique not only improves performance but also provides you with total flexibility—you choose what services are used and how they are used. Navigation software uses independent equipment drivers (DLL's) to support specific equipment. The drivers can be developed quickly and added to your system by simply installing a file.

Guidance Object Editor

In their simplest form, Guidance Objects (GOs) are single points, lines, or routes. In their complex form, they can be almost anything: a rectangle, disjointed lines, or a combination of points lines and routes. GOs are used for guidance during navigation and data acquisition. They can also be used as background on the Plan View Map to display coastlines, cables, pipelines, or any other feature. The unique all in one design developed for GO handling means that, no matter what form the GO takes, its definition and use are the same. When used for guidance, the system automatically provides guidance details in the form expected. Each GO has unique properties, such as symbol type. These can be arranged in order of use when setting up each survey.

For laying mooring buoys, or for transition zone seismic operations, a GO containing a set of unconnected points (targets) could be used. The Navigation software provides guidance, not only as bearing and distances to the next point, but also as *along line* and *offline* distances between the current and next point.

Event Configuration

Navigation Events are unique occurrences whereby actions (such as recording positions, updating event names, and selecting new lines) are performed. Standard Events are automatically generated based on time or distance. Other Events can be manually generated using either of two User Event buttons, or at start and end of GO at Log On or at Log Off.

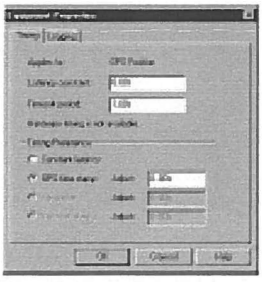
A simple dialog is used to configure Events and their actions. As with all Navigation configurations, the default Event dialog is designed for standard operations, so that you generally do not need to make any changes. However, a high degree of flexibility is provided for specialized event configurations such as:

- Alpha numeric event names of any form e.g. T.00234A
- Definable numeric increment and decrement intervals
- Automatic line selection at Log Off or end of GO
- Automatic Log On and Off at start and end of GO

Data Storage

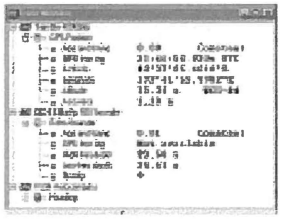
Too many files, too difficult to find, and cryptic filenames, are some of the comments associated with survey data management. However, the Navigation software uses a single database file for each project, so managing your files couldn't be easier. The relational database is the heart of the data acquisition system that records all decoded observation data, timing offsets, vessel dynamics, vessel-offset relationships, equipment configurations, guidance information, geodetic information, and general system parameters. Each item within the database has been accurately time stamped for future reference.

Timing



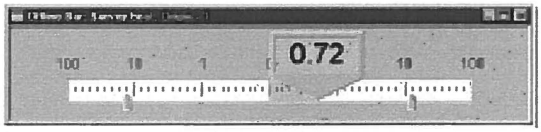
One of the factors affecting the quality of your survey is data synchronization, (i.e., determining at what point in time the data from any sensor, such as an echo sounder or GPS receiver, originated). Unknown latencies and differences in timing sources can cause serious inaccuracies in your processed survey. The Navigation software uses advanced timing techniques to time stamp the data it receives to a 1ms precision. If you have equipment providing a GPS time service such as NMEA ZDA, you can use this for time synchronization between vessels. For precise time-stamping, the Navigation software also supports 1PPS hardware and variable latency timing methods.

Real-Time Displays

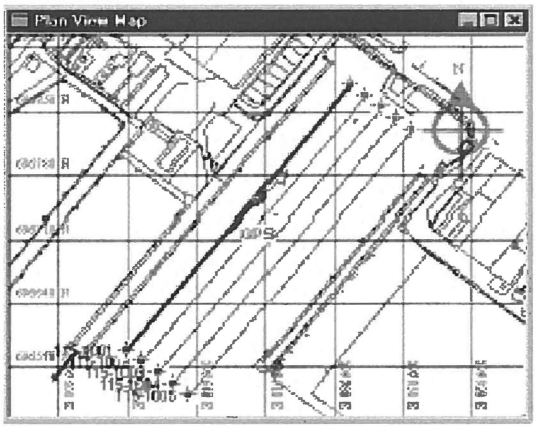


Prior to and during your survey, the Equipment Monitor displays the services being received from your equipment. Red and green traffic lights tell you if the service has failed or is functioning normally. Each Equipment Monitor display can be configured to display the services chosen and the tree structure can be expanded or collapsed.

The Offline Bar offers graphical guidance information for runline or route navigation. Its combined logarithmic and linear scale and auto-adjusting resolution means the same display can be used for navigating to the start of line (coarse resolution) as for your along line navigation (fine resolution).



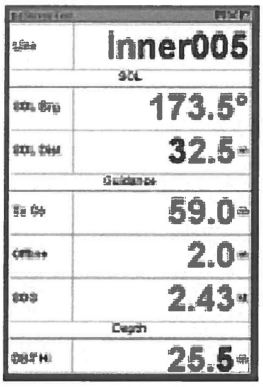
The Plan View Map (PVM) is the real-time graphical display of all (or any) of the vessels, lines, and background files you choose to include. DXF background files are supported, which can be used to display coastline or other features on a PVM display. Multiple PVM displays can be open, and each can be uniquely configured to show only relevant information.



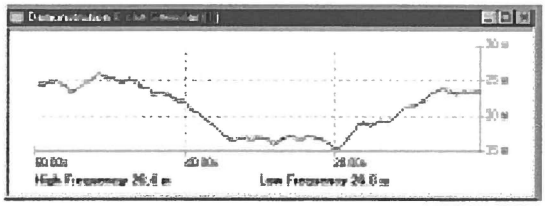
Survey Text displays enable you to view any information associated with your project. The display can be customized, so you only view the data required. With the Survey Text display, you can also view non-vessel information, such as environmental data. You can configure any number of Survey Text displays with any combination of information within them. You can also select the font type, size, and color of each display.

The information you choose to include in your Survey Text display may include:

- Position for each offset point
- Heading and velocity
- Adjusted or raw depths
- Guidance information to the start and end of a line or target
- Guidance information along the line or route
- Magnetometer readings, and much more



Many modern echo sounders use digital technology, a move away from the older paper trace equipment. Displaying the depth data directly onto your survey PC has obvious advantages. With HYDRO*pro* Navigation software, you can open echo sounder trace displays to monitor dual frequency depths and echo sounder annotations for each device. Either decoded depths, or depths adjusted for tide and heave, can be displayed in real-time—adding a further level of confidence for the surveyor who is often working in demanding situations.



CONCLUSION

The Navigation software is an integral part of the HYDRO*pro* software suite. Backed by over a decade of research and development, it has been designed to meet the requirements of many different hydrographic survey applications.

This easy-to-use Windows software comes with extensive on-line help and all standard Windows features. HYDRO*pro* software provides you with fast, efficient data acquisition, and a simple file structure for easy data management. Automatic swapping to backup equipment for continuous survey operation and advanced data synchronization techniques enhances final data quality. GPS receivers, and some other hardware products used in conjunction with HYDRO*pro* software, can all be supplied by Trimble and are backed by Trimble's worldwide service and support.

HYDRO*pro* software–the next generation of hydrographic survey software.

TECHNICAL SPECIFICATIONS

Software Requirements

- Windows 95/98 or Windows NT Version 4.0 or later.
- HYDRO*pro* software uses the ODBC driver manager and Microsoft Access ODBC driver. For version compatibility with Microsoft products, check with your local Trimble dealer or see our web site:
  http://www.trimble.com/marine/survey

Hardware Requirements

Minimum Configuration

CPU	Pentium 100 MHz
RAM	32MB
Hard drive	1GB (< 12 ms access)
Monitor	SVGA (800 x 600)
Ports	1 x RS232 port 16550 UART 1 x parallel port
Input devices	Keyboard with mouse or trackball CD ROM

Recommended Configuration

CPU	Pentium 166 MHz
RAM	64MB
Hard drive	2GB (< 12 ms access)
Monitor	SVGA (1024 x 768)
Ports	2 or more RS232 port 16550 UART 1 x parallel port
Input devices	Keyboard with mouse or trackball CD ROM

The technical specifications are recommended at time of printing and are subject to change without notice.

4.3 Giro Bussola

Sull'imbarcazione è stata installata una bussola elettronica Azimuth GyroTrac - KVH Industries; questa ha fornito le indicazioni di rotta da inserire nel computer di navigazione.

Le rotte derivate dalla bussola sono usate per il computo delle posizioni dei sensori utilizzati, riferite al reticolo cartografico in uso; essi sono stati installati con un offset fisso rispetto al punto comune di riferimento opportunamente scelto a bordo (CRP = common reference point).
La precisione della misura di bussola ha un grande effetto nel computo della posizione relativa dai sensori.
Per esempio: se la bussola ha un'accuratezza di 0.695°, con 250m di cavo filato a mare, l'errore laterale nella posizione del sensore (X-direction) sarà di $\pm$3m.

Il giorno 24 maggio 2004 è stata eseguita la calibrazione del modulo sensore bussola. Anche se il sensore è calibrato in fabbrica, la distorsione locale del campo magnetico terrestre introdotta dalla presenza di masse ferrose nei pressi del modulo può causare errori nelle rotte indicate. Questi errori sono minimizzati con un'accurata installazione e sono ulteriormente ridotti dal "GyroTrac's autocompensation features", il quale misura le distorsioni del campo magnetico circostante e le compensa. Rimuovendo questi errori il sistema fornisce un'accuratezza di rotta migliore di $\pm$ 0.05°.
Quindi è di fondamentale importanza che sia eseguita la procedura di calibrazione e che sia ottenuto un buon valore; il risultato finale ottenuto è stato:

ACC (Calibration Accuracy) <1°

MAGENV (Magnetic Environment) GOOD

CAL # (Calibration Update Number) 2

Appendix A
System Specifications

La seguente tabella presenta le specifiche del sistema ed i parametri operativi della Azimuth Gyrotrac:

Performance Data

Accuracy	±3.0' peak; ±1.0' typical *
Repeatability	±0.25'
Resolution	±0.l' (gyro ±0.01)
Tilt Angle/Pitch & Roll Range	±45'
Rate Gyro Drift	0°/minute (auto-corrected)
Maximum Angular Velocity	45°/second
Bandwidth **	10 Hz
Power/Consumption	12-32VDC/330 mA (stand-alone) TracVísíon component. 11-16VDC 3.5 amps nominal, 4.5 amps peak

Data I/O Format RS-422 (NMEA 0183 Version 2.2)
Zero Point Stability +/- 0.8°

* After calibration, free magnetic field to tilt angles of ±20°; accuracy ±5.0 RMS to ±45° tilt or roll.

** Gyros are internally sampled at 300 Hz; data is integrated and output at a user-selected data rate.

Environmental Data

Operating Temperature	-25°C to +75°C
Storage Temperature	-40°C to +85°C
Altitude	50,000 feet MSL
Maximum Shock (Performance)	20G, 11 msec
EMI/RFI	IEC 945; FCC Part 15J, Class B



- 3-axis gyro-stabilization for rock-steady heading in all conditions
- Improves autopilot performance
- Provides stable heading for North-up/ARPA radars
- Auto-calibration
- Easily interfaces to all electronics – one central heading device
- Provides true or magnetic north
- Drives all KVH TracVision

The compact GyroTrac combines two leading-edge concepts: a digital magnetic compass (technology pioneered by KVH) together with a patented three-axis gyro sensor. The integration of these systems results in the world's finest magnetic compass, offering the precision and versatility of digital technology with the stability and accuracy of gyro-stabilization, all for less than 25% of the price of the lowest cost mechanical gyro. The GyroTrac's control unit provides an outstanding user interface and incorporates a wide selection of digital and analog outputs.
GyroTrac is the successor to KVH's popular Azimuth Digital Gyro Compass (ADGC), winner of the 1998 National Marine Electronics Association "Best Gyro Compass" Product Award and installed on more than 1,000 vessels worldwide.

SYSTEM SPECIFICATIONS
Physical

Sensor Box Dimensions 7.8"l x 5.0"w x 5.1"h
(198 mm x 127 mm x 129 mm)
Control Unit Dimensions 7.3"d x 8.2"w x 2.6"h
(185 mm x 208 mm x 66 mm)
Weight 8 lbs (3.63 kg)
Power Input 12-32 VDC Nominal
Consumption 330 mA
Performance

Reference Magnetic and True North *
Warm-up Time Milliseconds
Deviation Compensation Automatic

Accuracy ±1.0° typical
Repeatability/Resolution ±0.25°/0.1°
Recovery Time Milliseconds
Gyro Drift None (auto-corrected)
Pitch & Roll Range ±45°
Max. Ang. Velocity 45°/sec.
Linearity 1% of full scale
Max. Acceleration 0.5° G
Zero Point Stability ±0.8°
Max. Shock/Performance 20G, 11 msec.
* Requires input from GPS

Environmental

Operating Temperature -13°F to +167°F (-25°C to +75°C)
Storage Temperature -40°F to +185°F (-40°C to +85°C)
EMI/RFI (CE Approved) IEC 945
Warranty 1 Year Labor, 2 Years Parts

Standard Outputs

Choice of 5 simultaneous outputs:
3 Digital from: NMEA1: $HCHDM, 1Hz - 20Hz
NMEA2: $HCHDG, 1Hz - 20Hz
NMEA3: $HCHDT, 1Hz - 20Hz
3-Axis Proprietary, RS232
Cetrek
1 Analog from: Sin/Cos, field configurable
B&G Sin/Cos
1 Proprietary from: Furuno AD10S

5. DESCRIZIONE DELLE INDAGINI

5.1 Relazione Tecnica

Le indagini di sismica marina a 100 Joule, sono state eseguite su n°7 rotte navigate sia normalmente alla foce del Rio Fereggiano che parallelamente alla linea di costa con una equidistanza di 60m una dall'altra, partendo dal limite più prossimo a costa (fattore dettato dalla quantità di cavo traino Boomer Plate e idrofoni usata durante i rilievi e dal pescaggio dell'imbarcazione usata) sino a superare il limite a mare dell'area.

Come da richiesta della Committente, la profilatura sismica ha interessato lo studio dell'andamento del bedrock.
Le indagini strumentali SBP hanno permesso di evidenziare l'andamento dei livelli di sedimentazione post-glaciale o Olocenica s.s. che si appoggiano sul substrato roccioso, in una zona poco conosciuta sotto questo aspetto sia per la sua notevole vicinanza a costa che per il dettaglio richiesto.
Il substarto roccioso mostra un andamento uniformemente degradante verso batimetrie maggiori nella zona di interesse con non meno di 2.5 ms di pelite sabbiosa soprastante, mentre a batimetrie maggiori e quindi all'esterno dell'area di intervento è morfologicamente interessato da alti e bassi strutturali come mostrato dalla tavola delle isocronopache allegata (Vedere profili sismici allegati).

Da tali prospezioni, sono stati identificati due principali riflettori acustici, come riportato nelle tabelle e nei profili sismici:

- Nelle prime sono riportati i valori di Z in msec e corrispondenti coordinate piane cartesiane Gauss Boaga, estrapolati dalla digitalizzazione degli strati a diversa impedenza acustica.
- Nei secondi sono rappresentati sia l'andamento strutturale dell'area indagata che la morfologia dei riflettori che sono stati evidenziati con riempimenti colorati e trasparenti (giallo e rosso mattone) sulle immagini post-processate del SBP.

Nota: Le posizioni dei riflettori estrapolati dalle passate sismiche, sono già corretti dal layback orizzontale, in quanto i dati di navigazione trasmessi all'unità di acquisizione digitale del SBP sono depurati in tempo reale perché tengono conto della distanza idrofoni piezoelettrici-antenna D-GPS (in questo caso pari a 14m).

5.1.1 Cenni sui metodi di interpretazione della sismica a riflessione

- Z in metri calcolata sulla base della Velocità media del suono in acqua di mare, la cui profilatura ha dato un valore pari a 1520 m/s.
- Z in metri calcolata per differenza tra il valore medio della velocità del suono in acqua di mare ed il valore di 1650 m/s, correlato alla presenza di sedimento sabbioso nell'area in esame.
- Z con scala in ms (millisecondi), valore più comunemente usato dai geologi per stimare con buona approssimazione in fase di post-elaborazione dei dati, le diverse quote dei sedimenti a seconda della loro natura (tale calcolo necessita obbligatoriamente di: taratura eseguita su carota indisturbata e specifica analisi della velocità del suono nel campione).

5.1.2 Caratteristiche del Sistema Sub Bottom Profiling e dell'unità di acquisizione

La strumentazione utilizzata per tale indagine è costituita da:

- Un'unità computer portatile di registrazione tipo industriale mod. LCDV9T12-15.4, interfacciato mediante convertitore A/D multicanale:
  - CH1 preposto alla ricezione delle riflessioni dalla catena idroponica.
  - CH2 per il segnale di trigger selezionabile da modulo separato, quest'ultimo preposto sia alla scelta del fondo scala di acquisizione (ms) che alla sincronizzazione degli impulsi generati dalla sorgente sismica di emissione CSP 1500.
- Trasduttore subacqueo Boomer Plate AA200 (Spettro delle frequenze di emissione compreso tra 400Hz e 4KHz) montato su catamarano CAT200 e trainato mediante cavo di potenza in Kevlar dall'imbarcazione di supporto.

Parametri di acquisizione usati:
249.7m corrispondente a 333ms
Samples 25616/0.97cm/13 micro sec, Vel suono=1520m/s
Trigger rate - 333 msec

EdgeTech DF-1000
Dual frequency digital Side Scan Sonar.
Odom Echoscan
Multibeam and analogue Side Scan Sonar.
Analogue Instruments
Virtually every analogue system can be interfaced for real time data acquisition.
"If it can print on an analogue graphic recorder (like an EPC), we can acquire it".
Benthos Bubble Pulser
EG&G Sparker
Sub Bottom Profilers by Datasonics, AAE, ORE or Geoacoustics

SwanPro: Software Specifications

Operating System
Windows Microsoft Windows 95, Windows 98 or Windows NT
Image/signal processing
Automatic, manual or telemetry-based bottom tracking.
Ground-range correction and water column removal.
Speed correction.
Selectable down-sampling methods to fit application.
Time Varying Gain.
Fixed or variable range scale settings, both graphical & numerical.
Spatial filters.
Prints on 2 different printers simultaneously.
Data Logging
Q-MIPS, XTF, SEG-Y data formats
Any number of samples per channel per ping (or shot) saved
True 16 bits/sample data sampling and recording
Geo-referencing
Each data pixel has a geographic position according to the position of the source central pixel, the heading and the across-track coverage.
Display Control
Target for interactive object analysis.
Coverage Map for real time coverage data.
Dual monitor operations.
Virtual resolution up to 3200 x 1200 pixels.
User-definable scale lines image annotation.
User-definable file output.
Image analysis
Measurement of object width, length, altitude & height
Object geographical position from cursor location

SwanPro: Interface Specifications

Digital Inputs
2 RS-232 serial ports
1 standard parallel & 1 high speed parallel ports
Up to 32 intelligent serial ports, optional
Analog Inputs
Up to 8 channels per A/D board

Caratteristiche del Real Time
Geophysical Data Acquisition & Processing
Software SwanPro 1.52





SwanPro™ is the innovative software for real time data acquisition of sea floor imaging systems, seismic systems and multibeam echo sounders. Sonar, Seismic & Bathymetry in one software package.
SwanPro™ digitizes in real time, records and processes true 16 bits/sample signals and combines the imagery with the navigation inputs to geo-reference the data in real-time.
SwanPro™ interfaces with most analog and digital side scan sonars, sub bottom profilers, seismic systems and multibeam in the industry. It runs under any 32 bit Microsoft Windows operating system. SwanPro™ is very flexible and user friendly.
With SwanPro™ you can playback your data without buying it. The unregistered version can be installed in as many computer as you wish.

The ideal solution for Industry, Academia and the Navy
Sonar, Seismic & Bathymetry in one software package.
Small Object Detection/Site Clearance
Cable/Pipeline Route Survey

SwanPro: Interfaced Systems

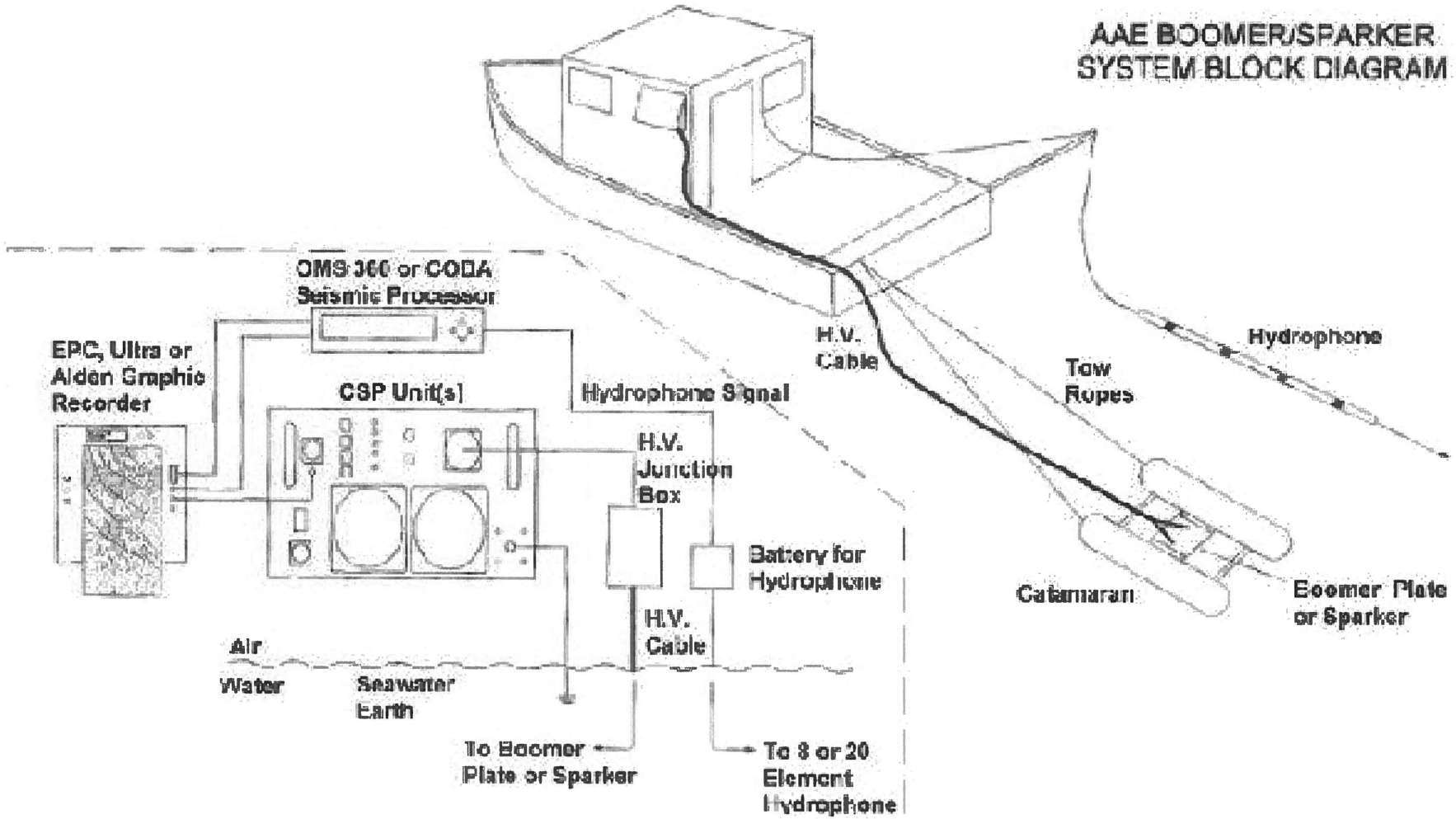
Benthos SIS-1000
Combined chirp digital Side Scan Sonar, Sub Bottom Profiler & Magnetometer, for depth up to 1000 m.

Benthos SIS-3000
Combined chirp digital Side Scan Sonar, Sub Bottom Profiler & Magnetometer, for depth up to 3000 m.

Benthos SIS-1500
Single frequency chirp digital Side Scan Sonar.

IMAGENEX 858-855
Single frequency 330KHz Side Scan sonar

AAE BOOMER/SPARKER SYSTEM BLOCK DIAGRAM



REV. 0

Sub Bottom Profiling

CSP 1500 Seismic Energy Source



- Cutting edge power supply technology evolved from years of field use.
- All CSP units contain our new, proprietary Variable Input Power Circuitry (AVIP) enabling the new breed of CSPs to operate from the smallest of generators.
- Reliability and security with global after sales service and support from the world's leading seismic power source manufacturer.
- All CSP units contain our proprietary pulse shaping circuitry for optimisation of high resolution data.
- All CSP units meet current EC emissions regulations enabling interference-free field and laboratory use.
- Additional safety/protection features in all semiconductor discharge CSP units.
- Higher rated charger for better 'overhead' or more energy compared with CSP1000.
- All settings externally selectable including voltage output power increments of 100, 200, 300, 400, 500, 600, 800, 1000, 1200 & 1500 Joules.
- LED Fault Indicators display Overtemperature, Low Input Voltage and Capacitor Fault warnings.
- Solid state (semiconductor) discharge method.
- All CSP units come complete with Hardigg case and HV cable junction box as standard.
- Fully upgradeable 300 and 600 Joule variants also available.
  The CSP1500's small volume and lightweight make it the operators' unit of choice.

Dimensions	: 31 cms (7U) high x 48.25 cms wide x 62 cms depth (including handles).
Weight	: 48 kg plus Hardigg Case.
Mains Input	: 200-240 VAC. 115V Units available to order. 45-65Hz @ 3.0kVA. 3 pin connector, Contains AVIP soft start circuitry to reduce generator requirements.
Voltage Output	: 3550 volts DC, 4 pin interlocked connector, Solid state semi-conductor discharge method.
Output Energy	: Externally selectable in increments of 100, 200, 300, 400, 500, 600, 800, 1000, 1200 & 1500J
Charging Rate	: 1500J/second for continuous operation at 0 - 50°c ambient.
Capacitance	: 240µf , 10^8 shot life.
Trigger	: +ve key opto isolated or closure set by front panel switch. BNC connector on front panel and remote.
Repetition Rate	: 6 pps maximum. To 5 pps @ 300 Joules (or 1 pps at 1500 Joules).
Earth	: M8 stainless steel stud on front panel.
Internal Design	: A Modular approach allows for easy servicing and capacitor replacement. (However, for safety reasons, only factory trained technicians should attempt a repair)
Safety Features	: Main electronic control circuits and secondary layer of safety circuitry. Specially designed HV connector. High speed dump resistors for high voltage components. Capacitor bleed resistors, Open circuit shutdown. Short circuit protected. Cover and connector interlocks. Remote control available for triggering and operation.

CSP UNITS ARE PART OF OUR INTERGRATED RANGE OF BOOMER AND SPARKER SYSTEMS



THE COMPLETE CSP 1500 SPARKER SYSTEM WITH CODA DA50 PROCESSOR AND EPC1086 PRINTER

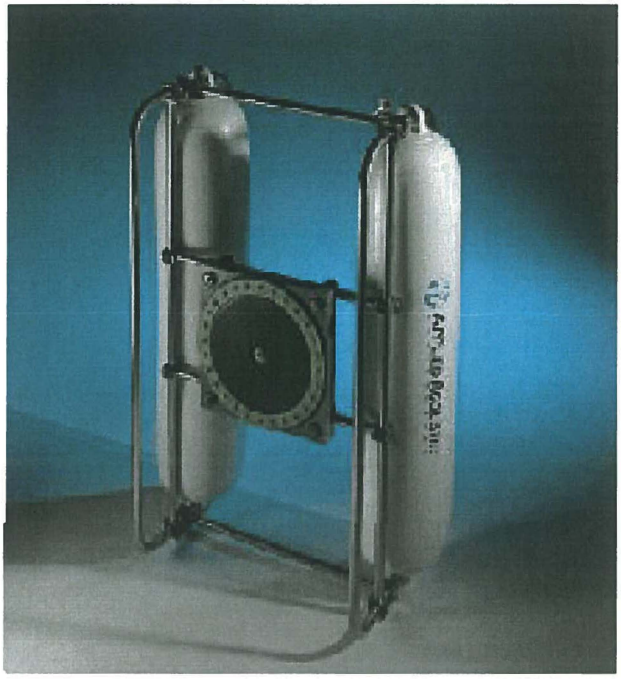


THE COMPLETE CSP 1500 SPARKER SYSTEM WITH CODA DA200 PROCESSOR AND ALDEN 9315 CTP PRINTER

December 2001

Sub Bottom Profiling

AA200 Boomer Plate and CAT200 catamaran



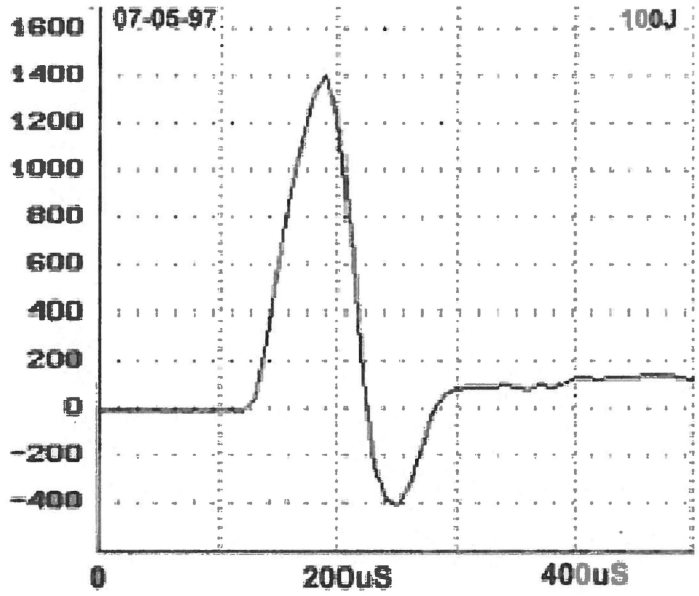
The Model AA200 is a proven design in boomer plates which encompasses precision moulding techniques to give a rugged design with a stable and repeatable signature. Designed specifically for use with our CSP range of energy sources, (although others can be used) the efficiency of the AA200 transducer ensures high output with an excellent pulse shape.

Designed for ease of use in the real world offshore, we have ensured that the flying lead connectors can be replaced in the field in case of damage. Diaphragm replacement is also straightforward. The lightweight design allows easy transportation. The unit is shown fitted to our 'CAT200' small sized catamaran which has been praised for its towing characteristics. Spectral content information is available.

- **Small Size and weight**
- **Repeatable high output pulse**
- **Rugged mechanical design**
- **Proven Performance**

Size	: 38cm x 38 cm x 5cm thick 9cm including connectors.
Weight in air / water	: 18 / 10 kg.
Fixing centres	: 31.5cm square.
Recommended use	: 100-200J / shot.
Maximum energy input	: 300J / shot.
Source Level	: 215dB re 1uPa @1m at 200J.
Pulse Length	: See graph below.
Reverberation	: <1/10 x initial pulse.
Connector type	: Joy plug male & female.

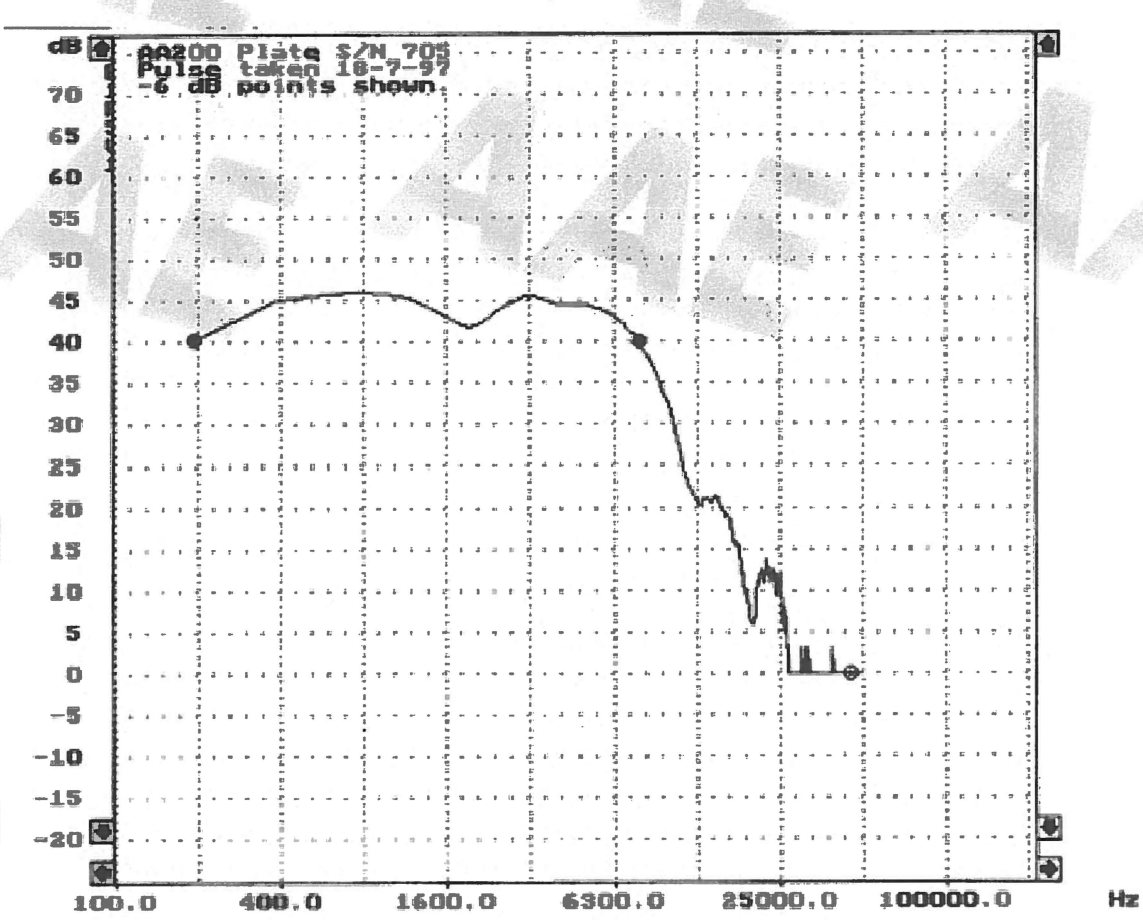
AA200 Pulse Shape



Part of our integrated Sub-bottom Profiler system. Sample data is available upon request.

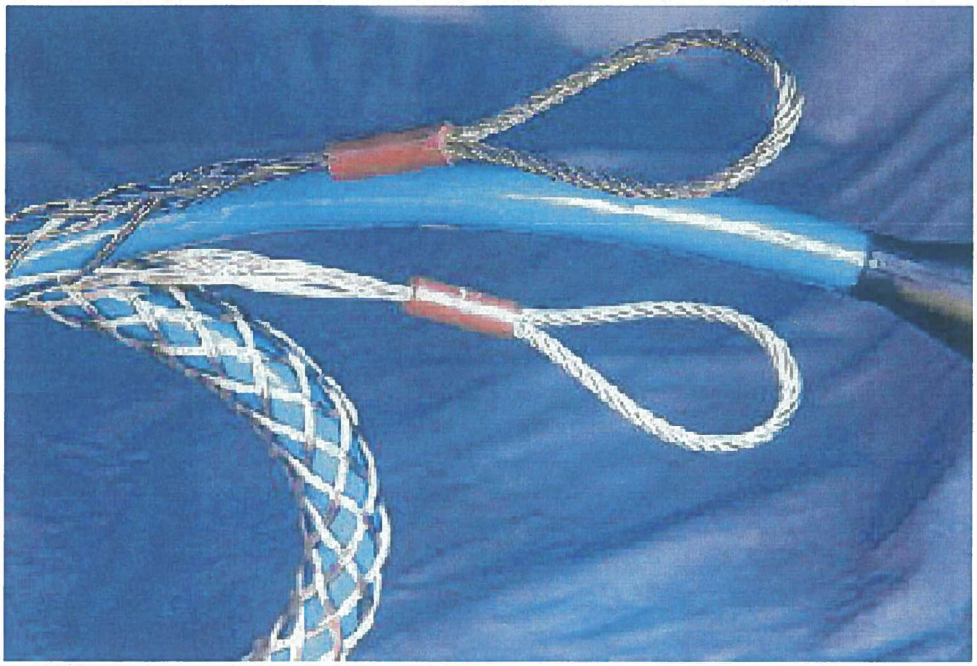
December 2001

AA200 Boomer Plate
Spectral Content Graph



Sub Bottom Profiling

High Voltage Boomer or Sparker Cables



- **Very high quality, high strength HV Cable for use with AAE integrated Boomer/Sparker systems and other sources.**
- **Terminated with robust connectors at both ends. (Joy-Plugs & Solder Tags for use with AAE Junction Box).**
- **Complete with Kellums Grip for strain-free connection to towed sound source.**
- **Comes with heavy duty Polyurethane Jacket for protection, insulation and durability.**
- **Available for Boomer/Squid 500 or Squid 2000 sound sources.**

Terminated cable 50m long with 4 x 10mm SQ conductors.

Terminated with robust Joyplugs and Kellums Grip for connection to sound source and Solder Tags for connection to an AAE Junction Box.

25mm diameter cable.

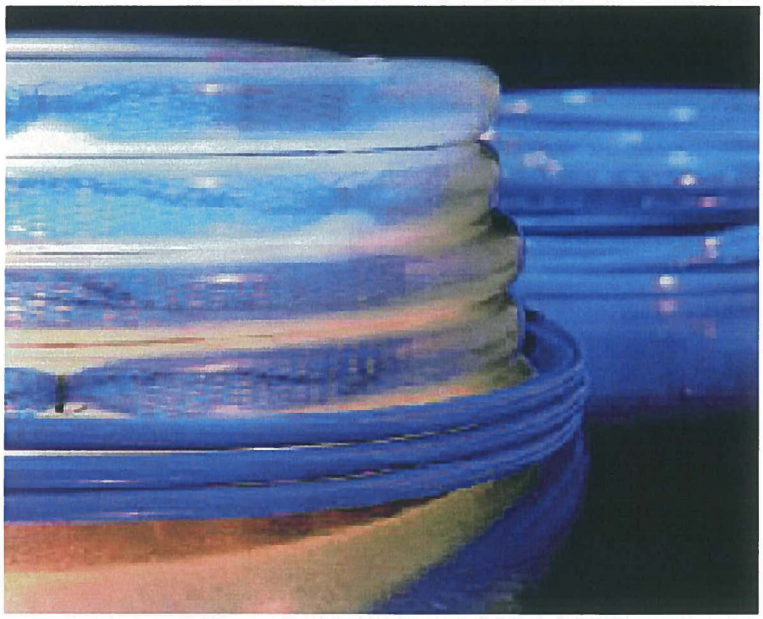
Specially designed with polyurethane jacket.

Available in standard 50m length or in length of choice.

Weight in air: 33kg.

Sub Bottom Profiling

AAE 8 & 20 Element Hydrophone Streamers



- **High quality, complete 8 & 20 Element Hydrophone Streamers.**
- **Kerosene filled for neutral buoyancy.**
- **Supplied with a robust 50-metre tow-leader as standard.**
- **Comes complete with pre-amp and easily replaceable alkaline battery.**
- **Extensively field proven to offer consistently high quality results.**

HYDROPHONE LENGTH (8 & 20 EL' VARIANTS)	:4.5 METRES
HYDROPHONE ELEMENT SPACING ON	:8 ELEMENT VARIANT = 365mm 20 ELEMENT = 150mm
FREQUENCY RESPONSE	:20Hz – 10kHz (-3dB)
OVERALL HYDROPHONE SENSITIVITY (8 ELEMENT)	:MINUS 176dB REF 1v PER MICRO PASCAL
OVERALL HYDROPHONE SENSITIVITY (20 ELEMENT)	:MINUS 167dB REF 1v PER MICRO PASCAL
COMES WITH ROBUST TOW LEADER – STANDARD LENGTH (50 METRES) OR LENGTH OF CHOICE	
WEIGHT IN AIR	:5KG (8 ELEMENT)
WEIGHT IN AIR	:7.5 KG (20 ELEMENT)
COMES WITH USER REPLACEABLE 9v ALKALINE BATTERY (DURACELL TYPE MN 1604)	

Bipolar input signal, +/- 5V range

Printers

EPC and Alden models and all standard Windows printers

SwanPro: System Specifications

Chassis

19" industrial rack mount with rack case.

Anti-shock mounting optional.

Processor

Industrial grade 933+ MHz Pentium III, 128 MB RAM; 2 serial ports, 1 standard parallel port & 1 high speed parallel port.

Dual processor industrial grade processor boards optional.

Graphics Processor

Dual head G-400 Matrox 128-bit 16 MB SDRAM

Display Resolution

1280 x 1024

Mass Storage

LS-120 Floppy Drive

Standard 3.5" 1.44 MB diskette/LS-120 120 MB diskette

Hard disk drive

Standard 40 GB

DVD - CD drive

DVD-CD Recorder

6. CARTOGRAFIA e DATA PROCESSING

6.1 N°1 Tavola complessiva dell'area indagata in f.to A0.

6.2 N°7 tavole contenenti le sezioni acquisite con il boomer plate, in f.to A4 per le prime 5 e per le rotte 6 e 7 in f.to A3.

6.3 Post-Processing dei dati digitali relativi all'indagine sismica

Per la restituzione delle sezioni acquisite con il Boomer Plate SBP è stato usato il pacchetto software di Tritonelics dotato del modulo Delph Seismic processing and interpretation; relativo all'analisi di dati sismici registarti mediante sorgenti analogiche e digitali.
Tale sistema è abilitato a processare dati sismici di diverso formato (tra i più importanti:XTF tritonelics, SEG-Y standard e Benthos) acquisiti da un singolo canale a bassa frequenza (Sub bottom profiler/Sparker/Air Gun).

7. PERSONALE

Il personale specializzato che ha partecipato alle indagini in questione, è stato:

Nome		**Funzione**
Lelio **De Laurentiis**	-	Marine surveyor
Mirko **Zaquini**	-	Geologo e Seismic surveyor

Processing finale e relazione:

Nome		**Funzione**
Lelio **De Laurentiis**	-	Navigation processing
Antonio **Lucarelli e** Mirko **Zaquini**	-	SBP post-processing

8. APPENDICE

8.1 Tabella dei files di acquisizione raw data da SBP in formato .XTF

- Rotta1 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta2 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta3 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta4 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta5 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta6 – file: 30mag2005_100J.XTF acquisito il 30/05/05
- Rotta7 – file: 30mag2005_100J.XTF acquisito il 30/05/05

Convertiti successivamente per il post-processing in formato SEG-Y:

Rotta1 – file: 30mag2005_100J1.SEG
Rotta2 – file: 30mag2005_100J2.SEG
Rotta3 – file: 30mag2005_100J3.SEG
Rotta4 – file: 30mag2005_100J4.SEG
Rotta5 – file: 30mag2005_100J5.SEG
Rotta6 – file: 30mag2005_100J6.SEG
Rotta7 – file: 30mag2005_100J7.SEG

8.2 Elenco dei files tracciato SBP (formato *.JPEG) in overlay su DWG di ACAD2002

Sezioni in formato dwg:		Rif. file immagine dei tracciati SBP:
- Rotta 01	-	Rotta 01color ft.jpg
- Rotta 02	-	Rotta 02color ft.jpg
- Rotta 03	-	Rotta 03color ft.jpg
- Rotta 04	-	Rotta 04color ft.jpg
- Rotta 05	-	Rotta 05color ft.jpg
- Rotta 06	-	Rotta 06color ft.jpg
- Rotta 07	-	Rotta 07color ft.jpg

Raggruppate nei disegni CAD dwg sotto la directory:
D:\Scolmatore T.Bisagno\Dwg\

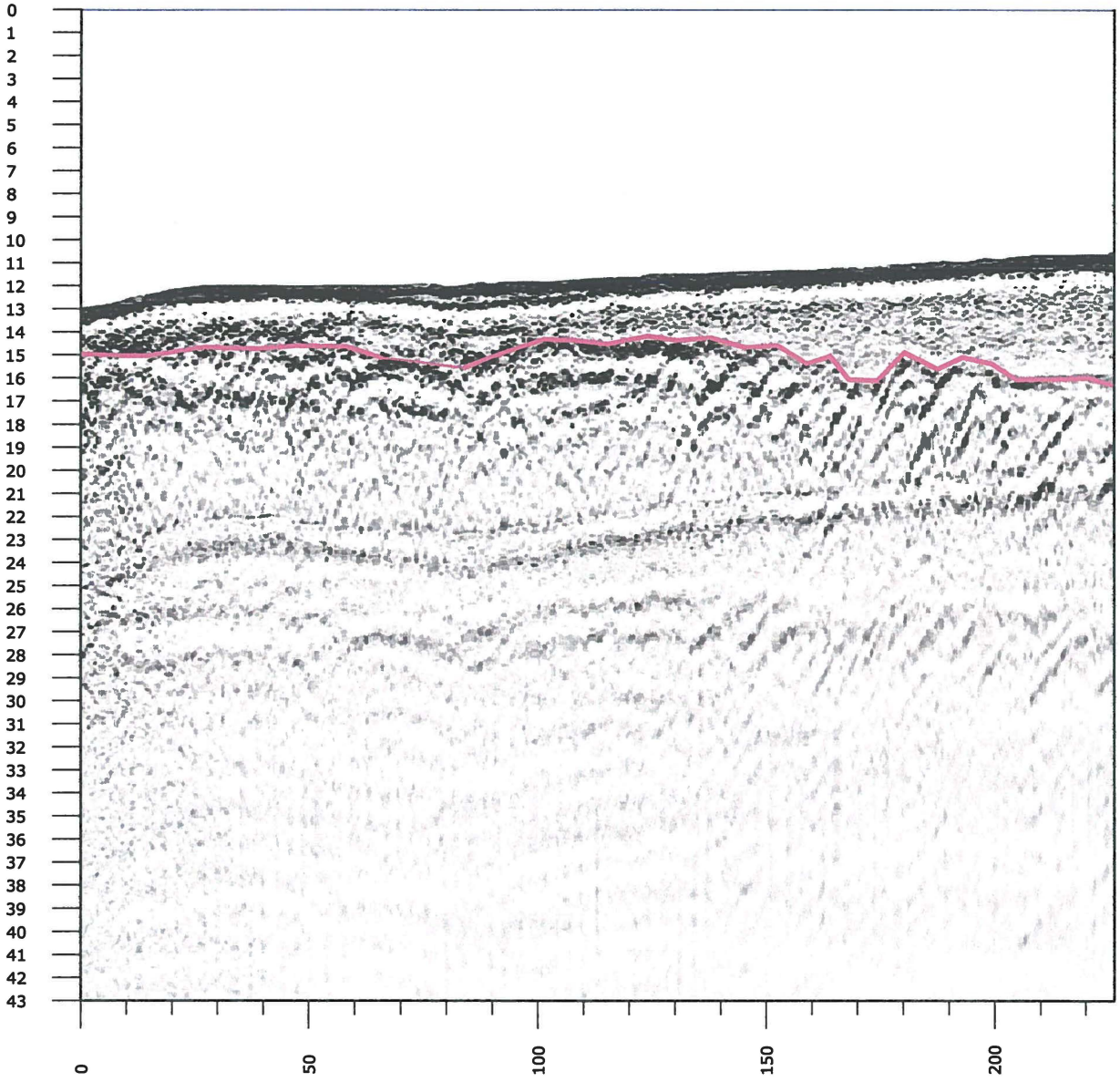
ed in pdf di Acrobat sotto la directory:
D:\ Scolmatore T.Bisagno\Relazione\Passate Sub Bottom Profiler\

INDAGINE SISMICA - Sezione n°01 (Ponente - Levante)

TECHNITAL S.p.a

DISEGNATO da: Data: 01.06.2005 Scala: Z=1:300–X= 1:1500

Z in ms dal l.m.m.
per Vs=1500 m/s



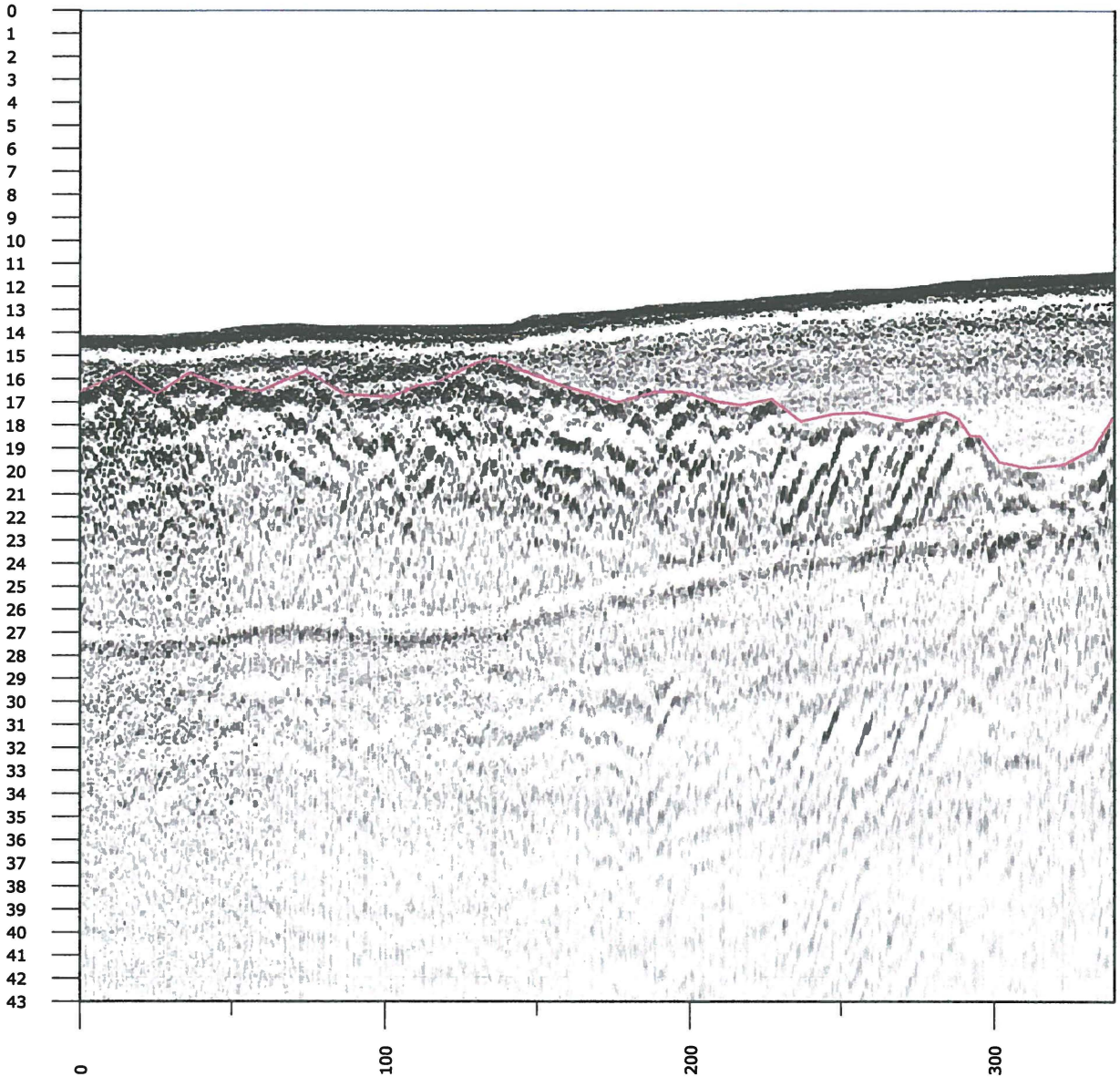
Legenda: Riflettore calcare marnoso

Distanza in metri percorsa da Ponente a Levante, lungo la sezione sismica R01

INDAGINE SISMICA - Sezione n°02 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s



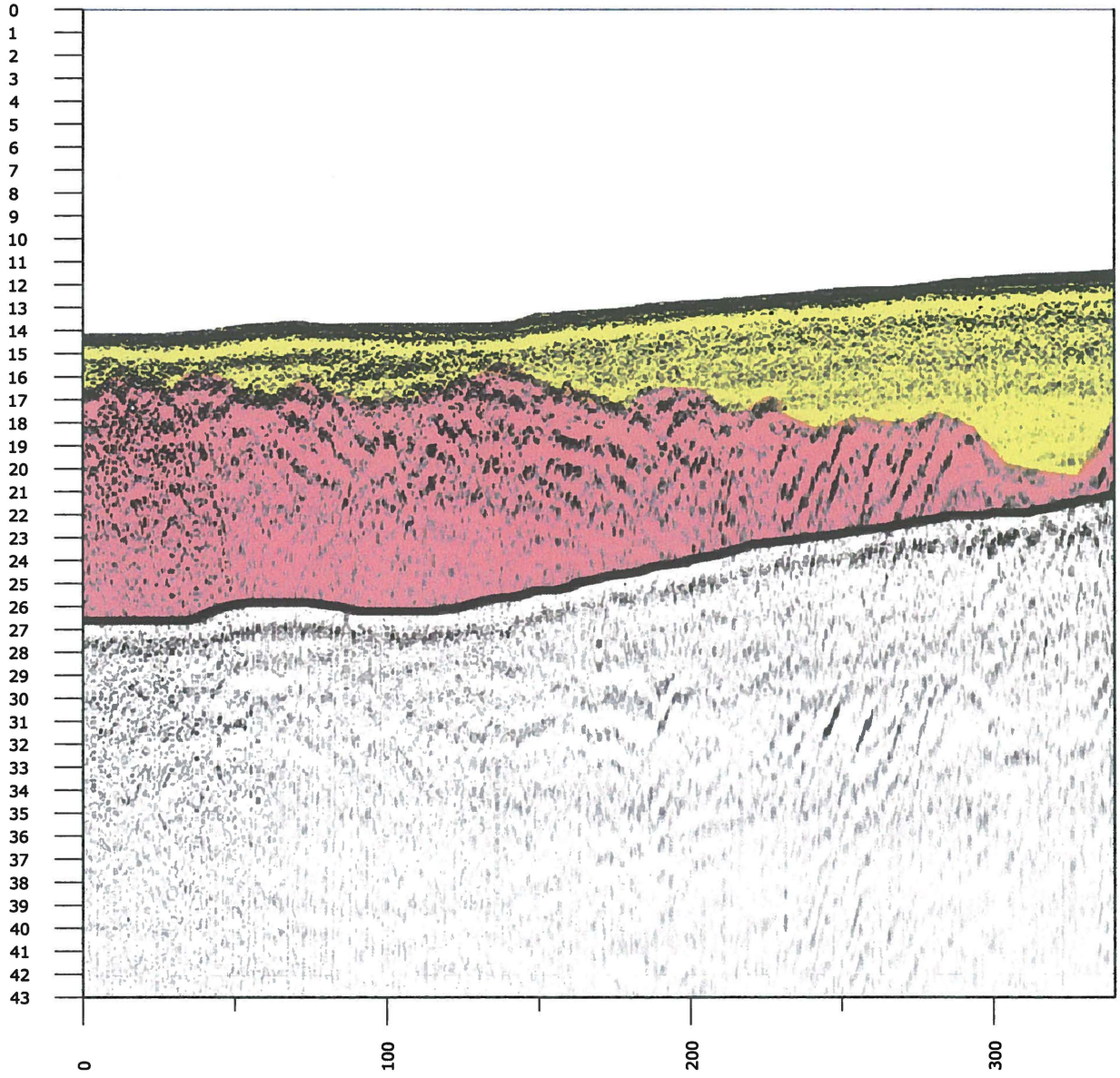
Legenda: Riflettore calcare marnoso

Distanza in metri percorsa da Ponente a Levante, lungo la sezione sismica R02

INDAGINE SISMICA - Sezione n°02 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s



Legenda:

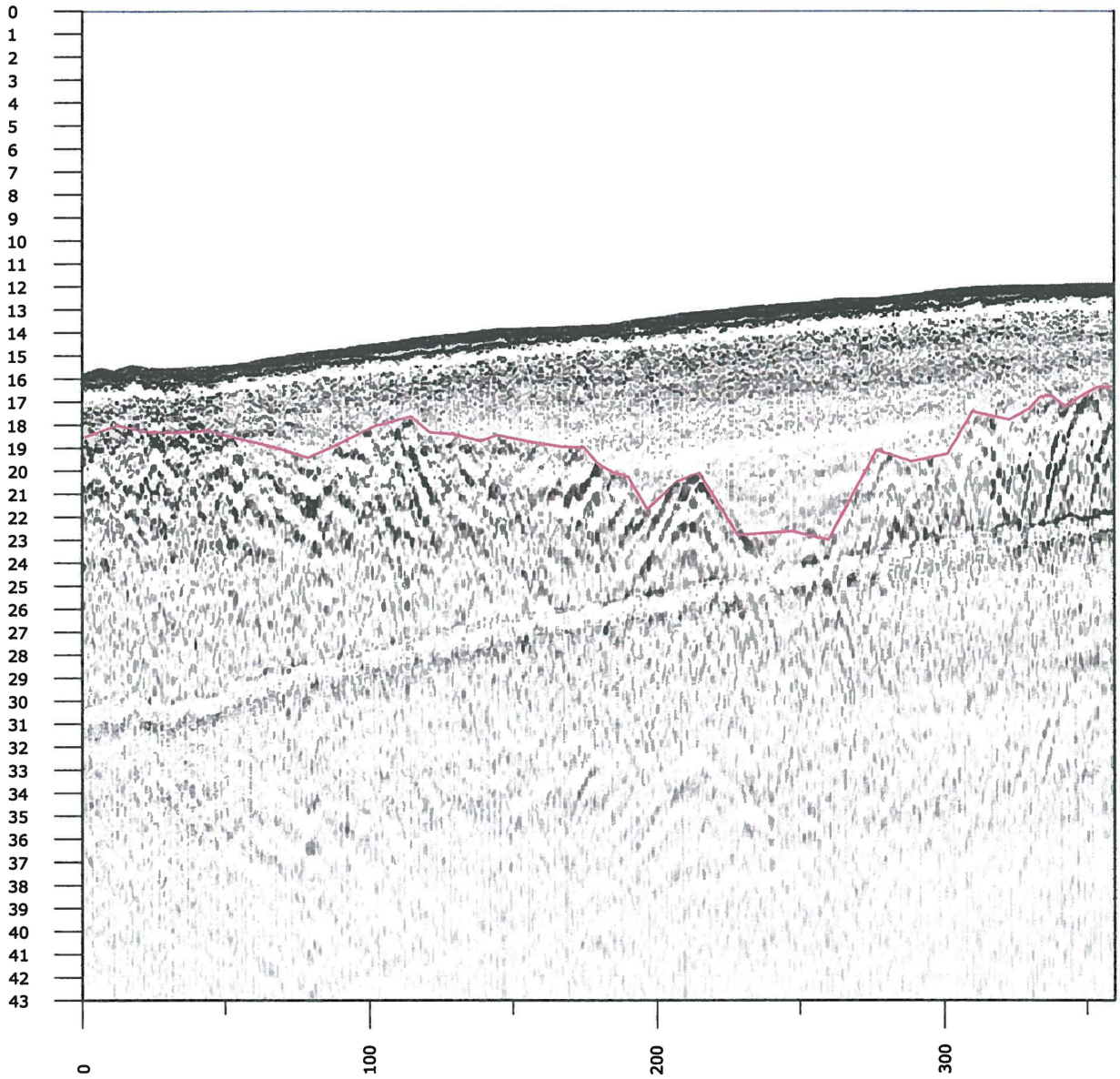
- Riflessione multipla
- Riflettore calcare marnoso
- Riflettore layer sabbioso-ghiaioso

Distanza in metri percorsa da Ponente a Levante, lungo la sezione sismica R02

INDAGINE SISMICA - Sezione n°03 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s

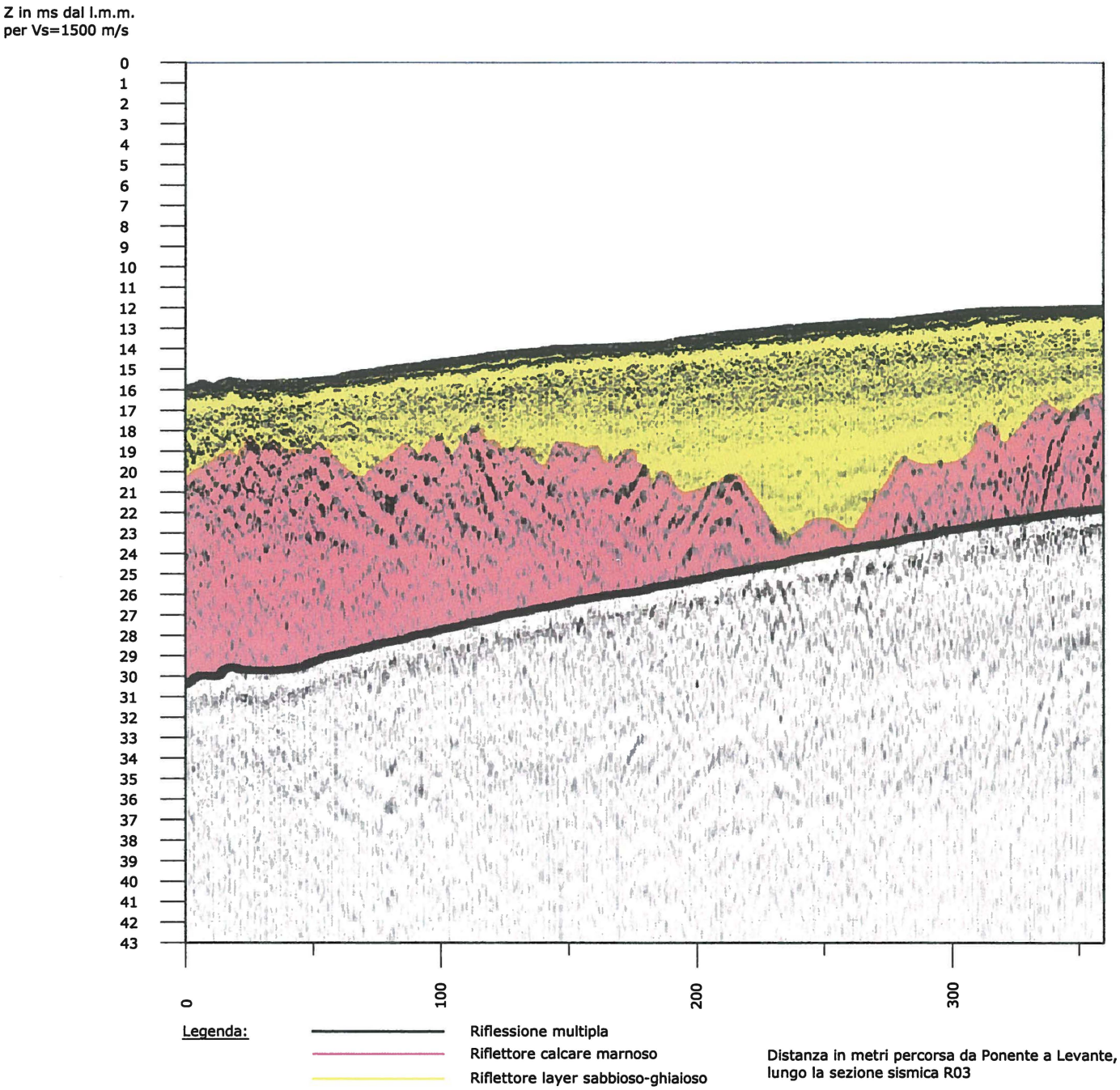


Legenda: Riflettore calcare marnoso

Distanza in metri percorsa da Ponente a Levante, lungo la sezione sismica R03

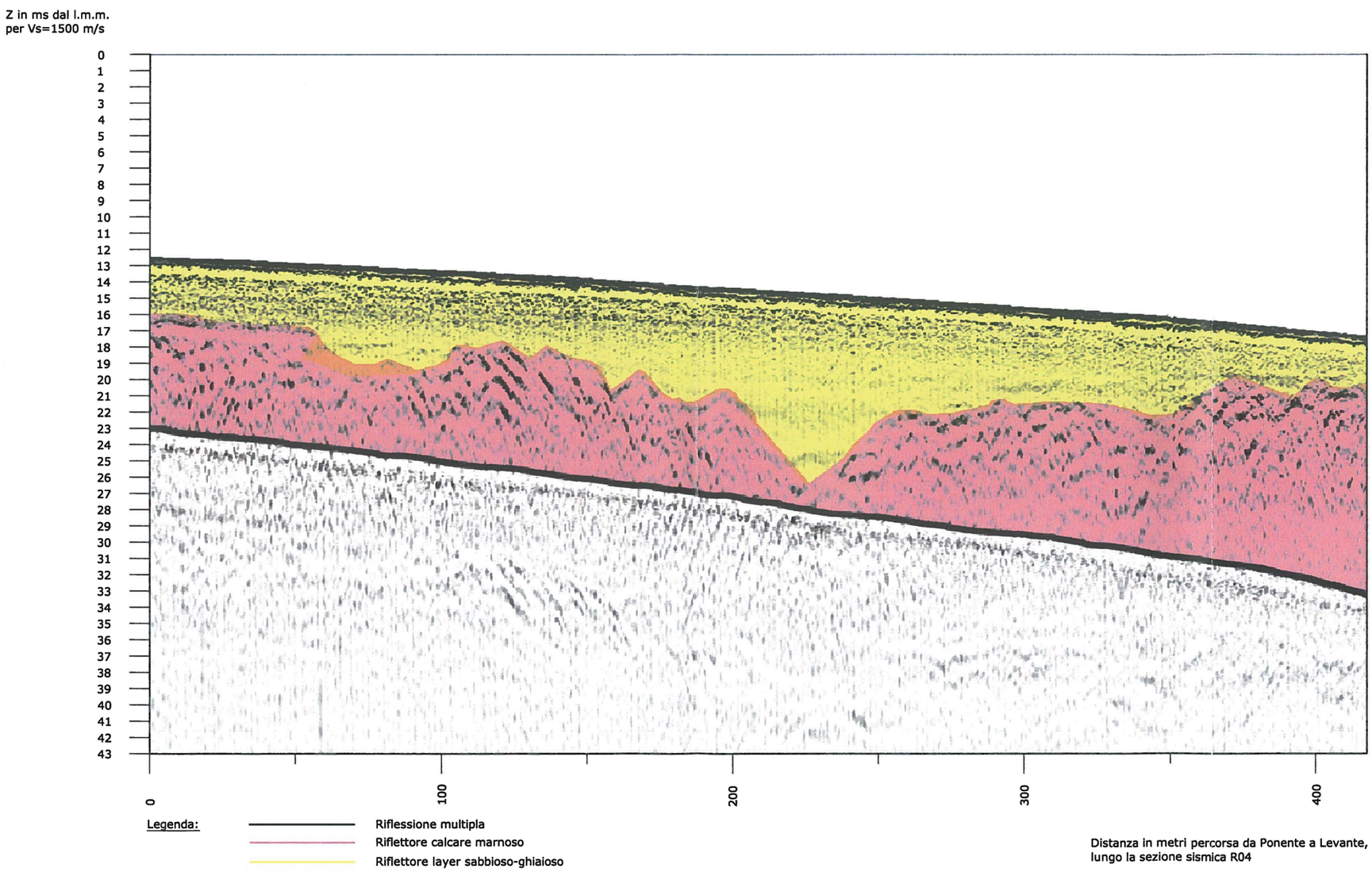
INDAGINE SISMICA - Sezione n°03 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750



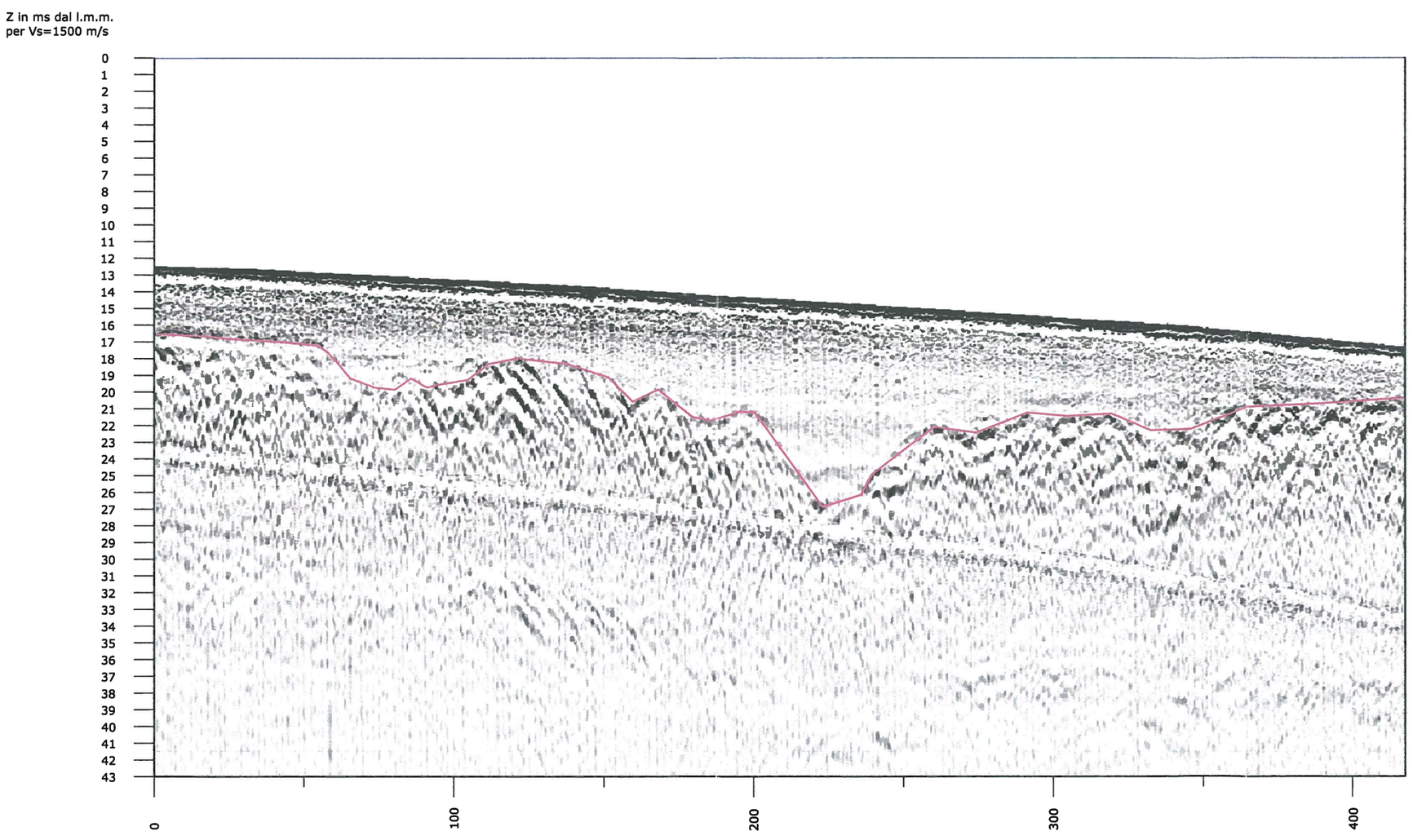
INDAGINE SISMICA - Sezione n°04 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750



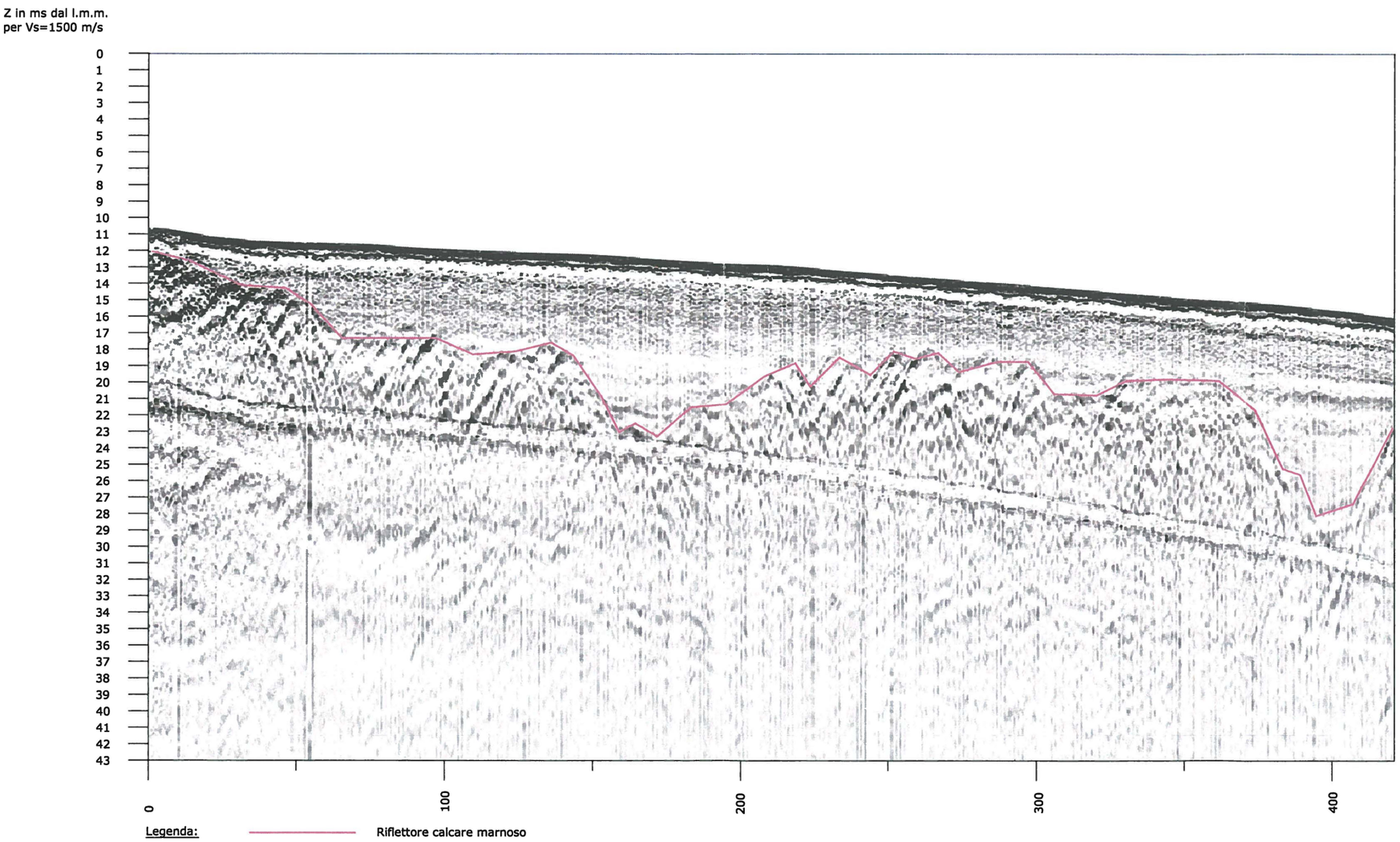
INDAGINE SISMICA - Sezione n°04 (Ponente - Levante)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750



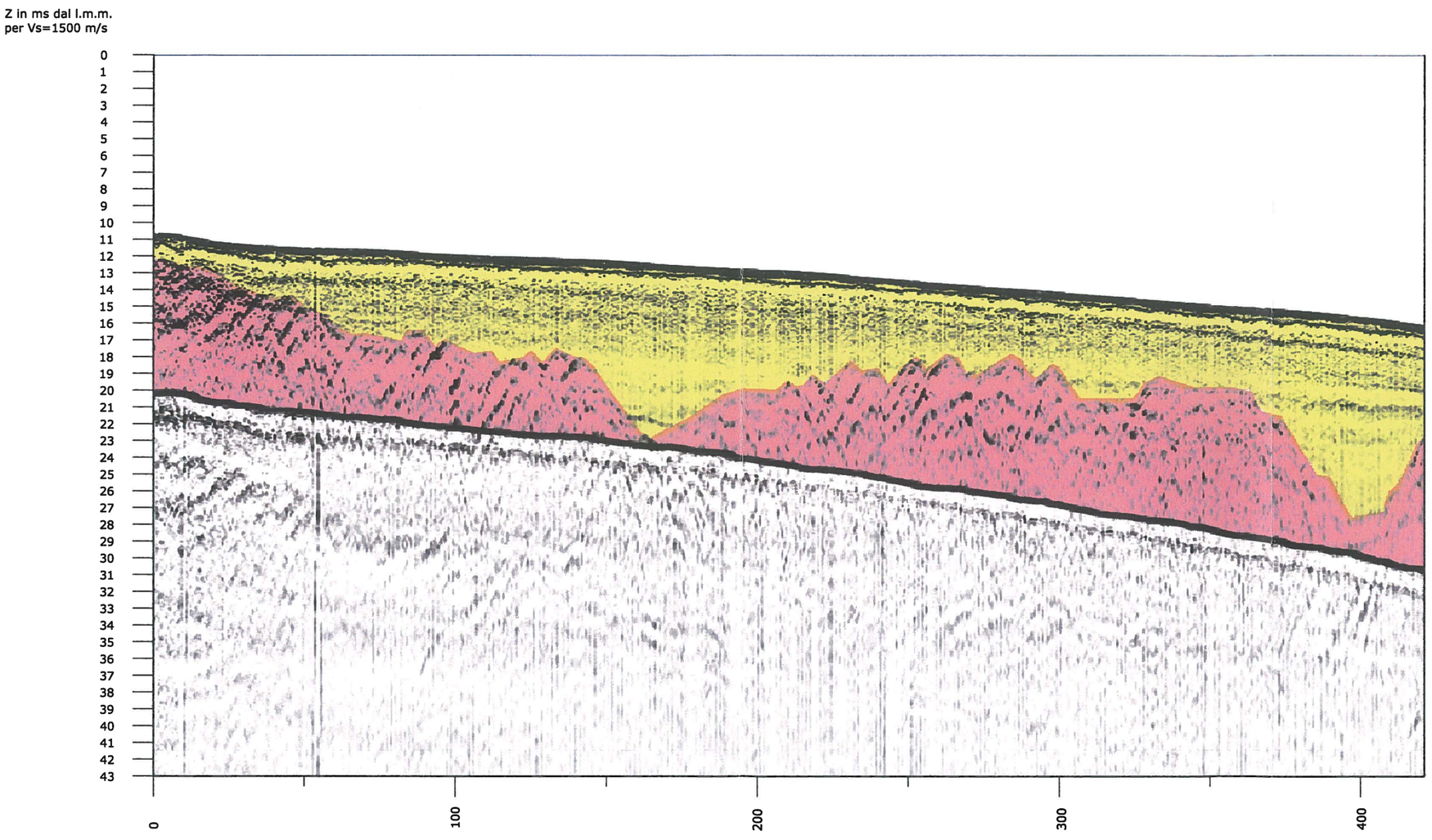
INDAGINE SISMICA - Sezione n°05 (NW - SE)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750



INDAGINE SISMICA - Sezione n°05 (NW - SE)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.06.2005	SCALA Z 1:750

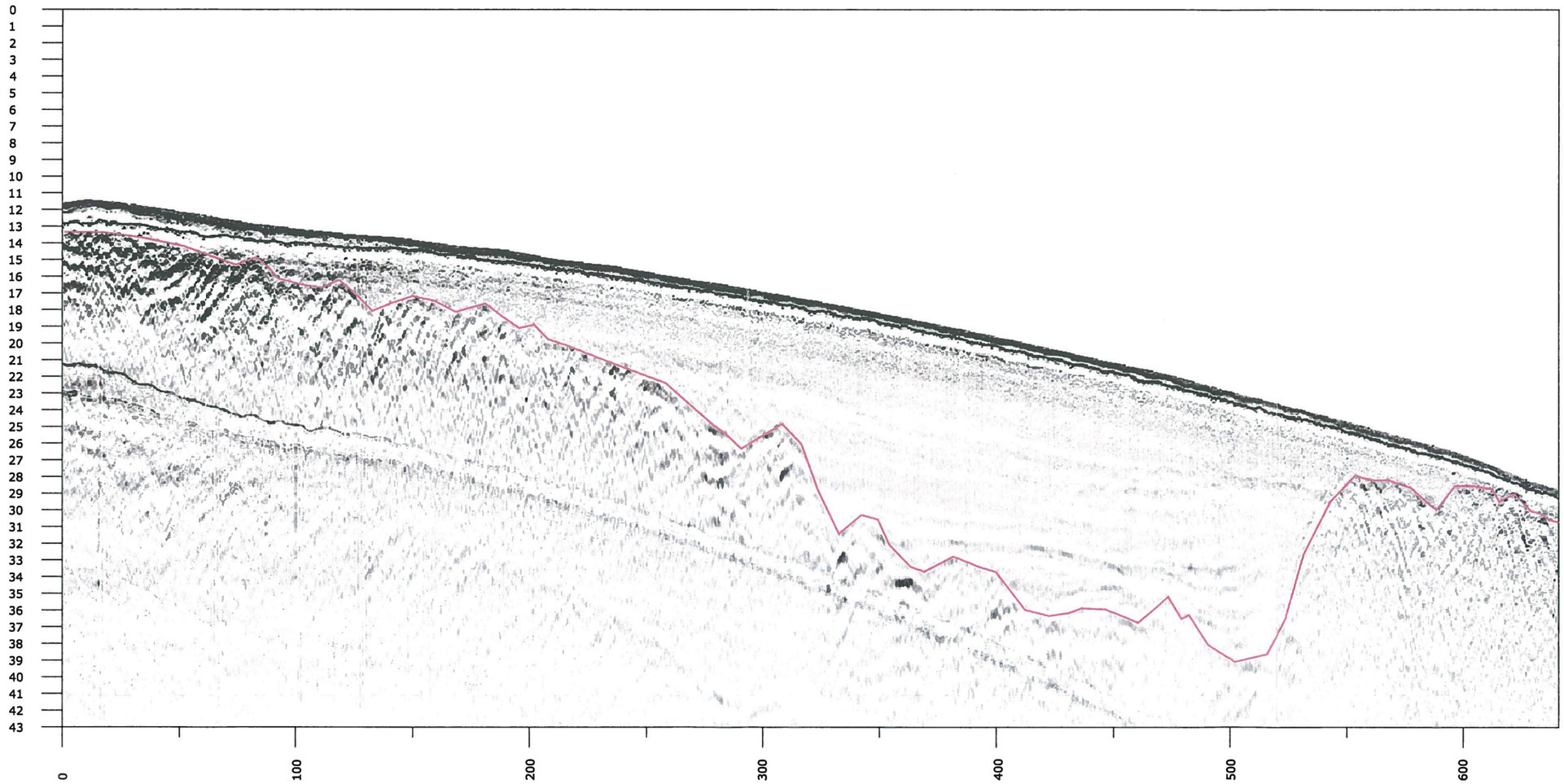


INDAGINE SISMICA - Sezione n°06 (NW-SE)

TECHNITAL S.p.a.

DISEGNATO da: | DATA: 01.06.2005 | SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s



Legenda:

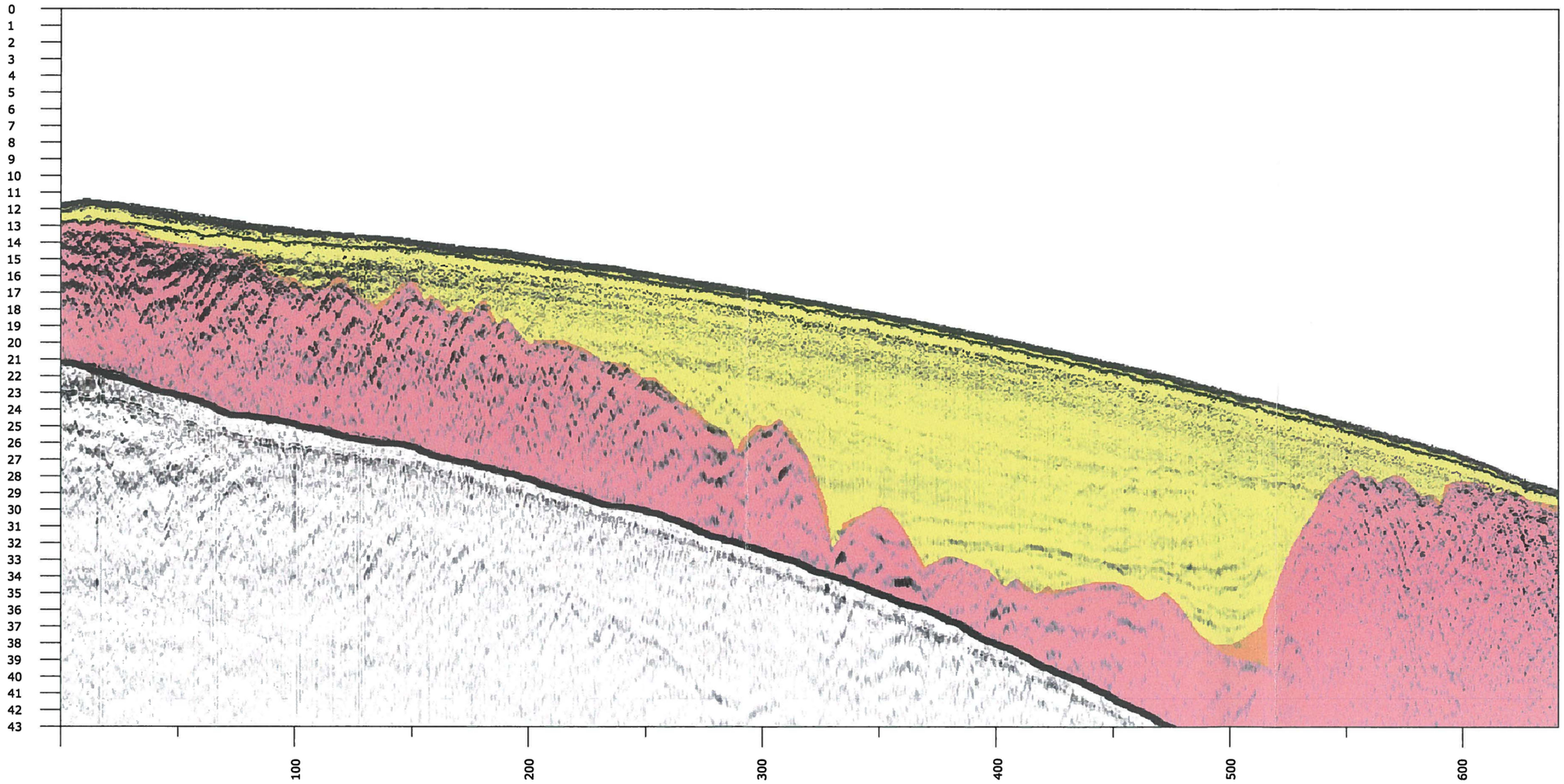
Riflettore calcare marnoso

Distanza in metri percorsa da NW a SE,
lungo la sezione sismica R06

INDAGINE SISMICA - Sezione n°06 (NW-SE)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.08.2005	SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s



Legenda:

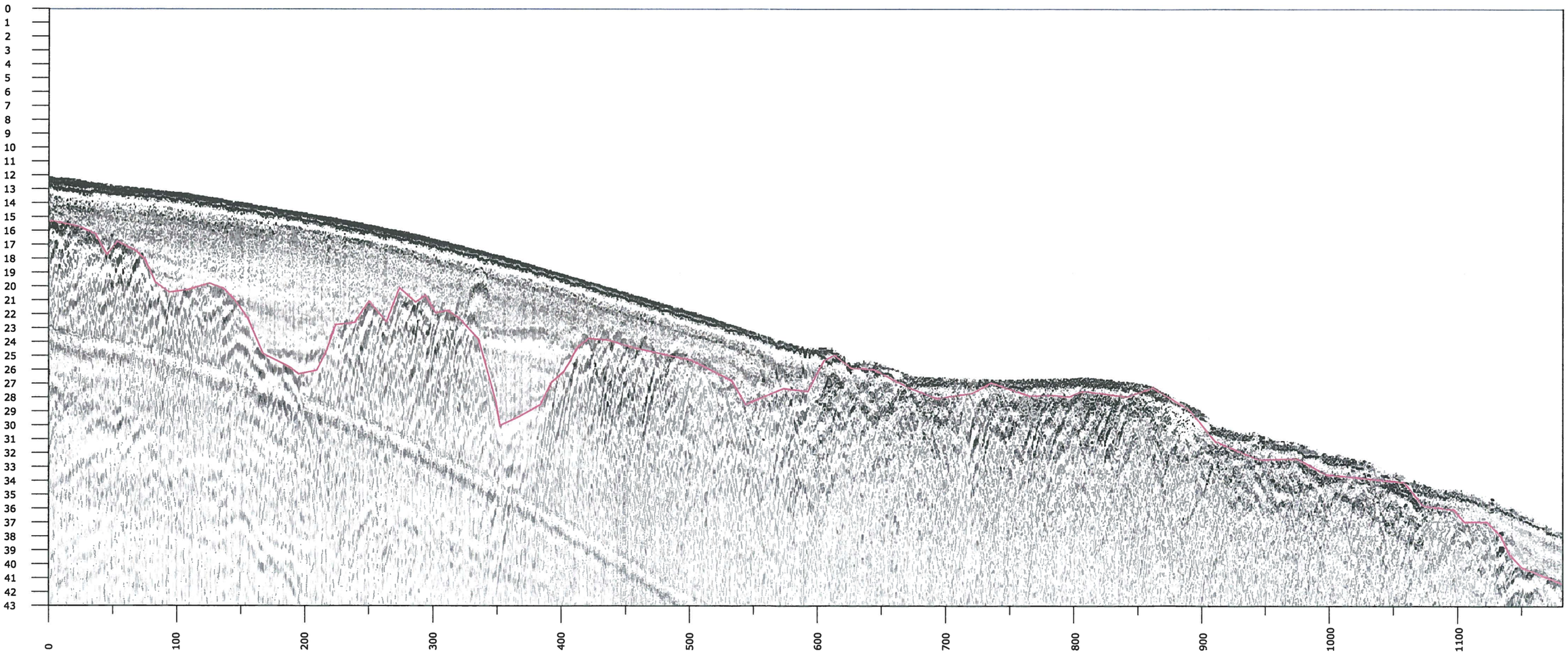
- Riflessione multipla
- Riflettore calcare marnoso
- Riflettore layer sabbioso-ghiaioso

Distanza in metri percorsa da NW a SE, lungo la sezione sismica R06

INDAGINE SISMICA - Sezione n°07 (NW-SE)

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 01.08.2005	SCALA Z 1:750

Z in ms dal l.m.m.
per Vs=1500 m/s



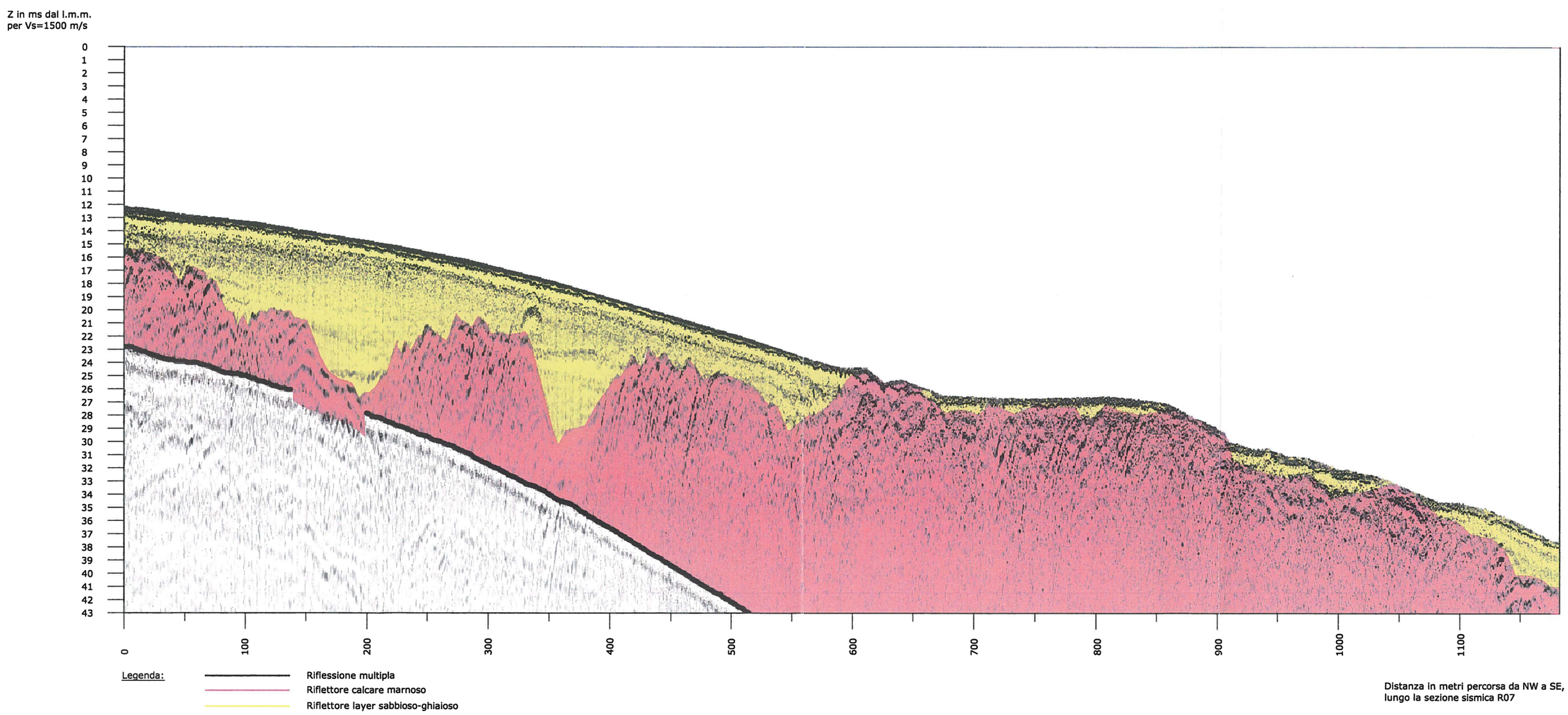
Legenda: Riflettore calcare marnoso

Distanza in metri percorsa da NW a SE, lungo la sezione sismica R07

TECHNITAL S.p.a.

DISEGNATO da: | DATA: 01.06.2005 | SCALA Z 1:750

INDAGINE SISMICA - Sezione n°07 (NW-SE)



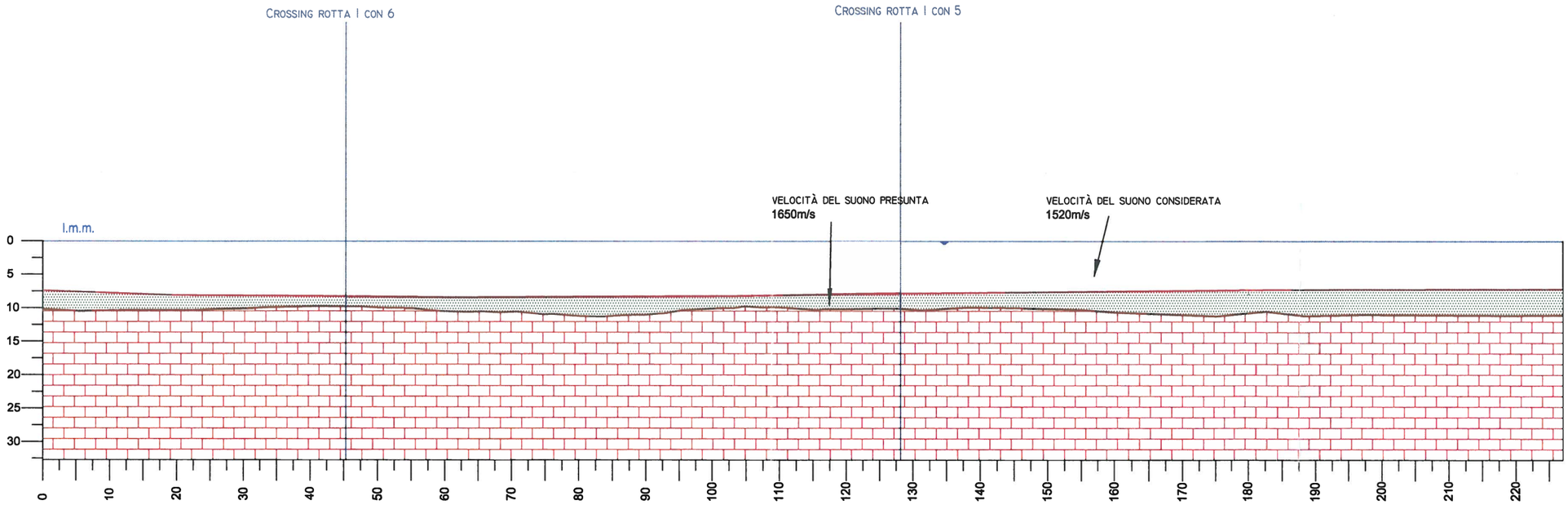
INDAGINE SISMICA - Sezione n°01 (W-E)

LEGENDA

CORPO SEDIMENTARIO

BEDROCK

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 02.09.2005	SCALA 1:750



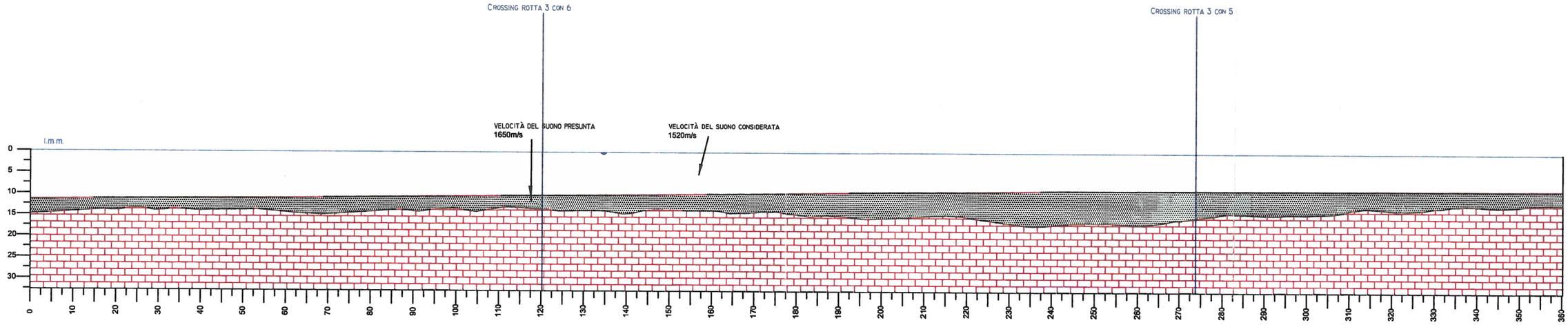
INDAGINE SISMICA - Sezione n°03 (W-E)

LEGENDA

CORPO SEDIMENTARIO

BEDROCK

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 02.09.2005	SCALA 1:1000



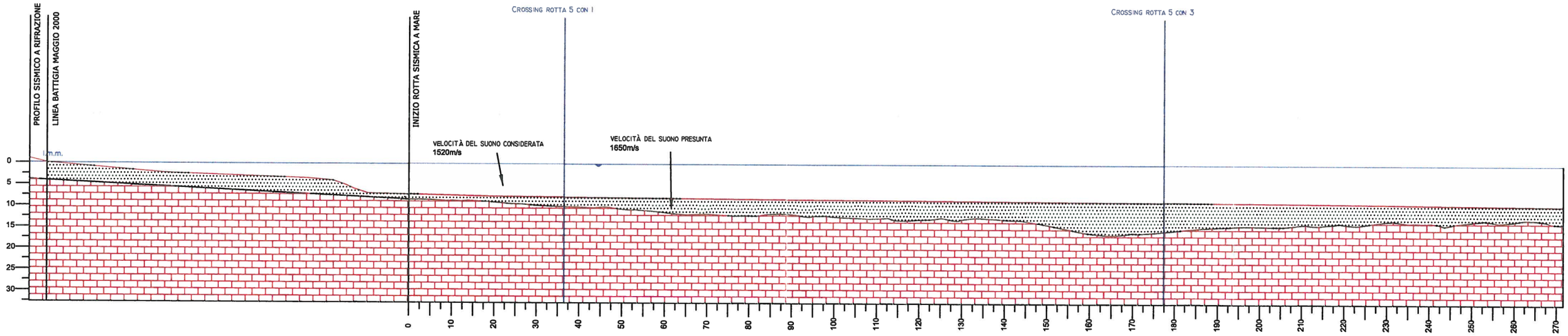
INDAGINE SISMICA - Sezione n°05 (SE-NW)

LEGENDA

CORPO SEDIMENTARIO

BEDROCK

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 02.09.2005	SCALA 1:1000



INDAGINE SISMICA - Sezione n°06 (NW-SE)

LEGENDA

CORPO SEDIMENTARIO

BEDROCK

TECHNITAL S.p.a.		
DISEGNATO da:	DATA: 02.09.2005	SCALA 1:750

