



**Università di Trieste**  
**Corso di Laurea in Geologia**

**Anno accademico 2020-2021**

**Geologia Marina**

Parte I

**Modulo 2.1 Sub Bottom Profiler**

Docente

**Fabrizio Zgur**

# SUB BOTTOM PROFILER

## OVERVIEW

OFFSHORE SURVEYS

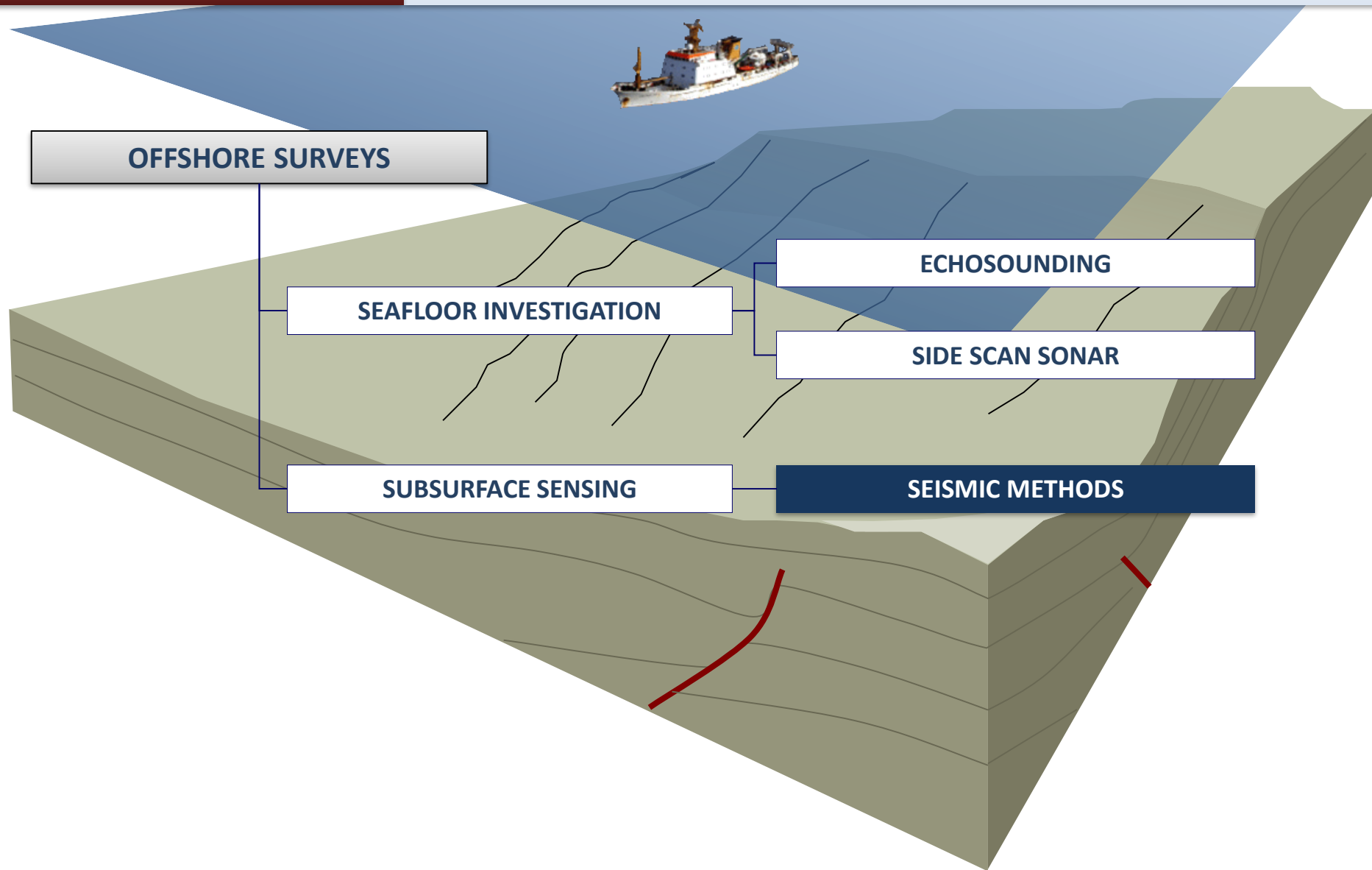
SEAFLOOR INVESTIGATION

SUBSURFACE SENSING

ECHOSOUNDING

SIDE SCAN SONAR

SEISMIC METHODS





## SUB BOTTOM PROFILER

## OVERVIEW

### IT IS USED FOR

SBP systems are used for fine-scale (decimetric) imaging of shallow subsurface sediments.

### HOW IT WORKS

A chirp system transmits selectable Frequency modulated (FM) pulses, "sweeping" through a range of frequencies, anywhere between about 400 Hz and 20 kHz. The sweep gives the source function a wide bandwidth, but also a long pulse length. To achieve the theoretical temporal resolution, the FM pulse is compressed using a digital compression filter, thus creating a "Klauder" wavelet.

## SUB BOTTOM PROFILER

## APPLICATIONS

### ENVIRONMENT AND SOCIETY

- Geohazard surveys
- Buried object location
- Bridge/Shoreline scour surveys
- Mining/Dredging surveys
- Archaeological surveys

### RESEARCH

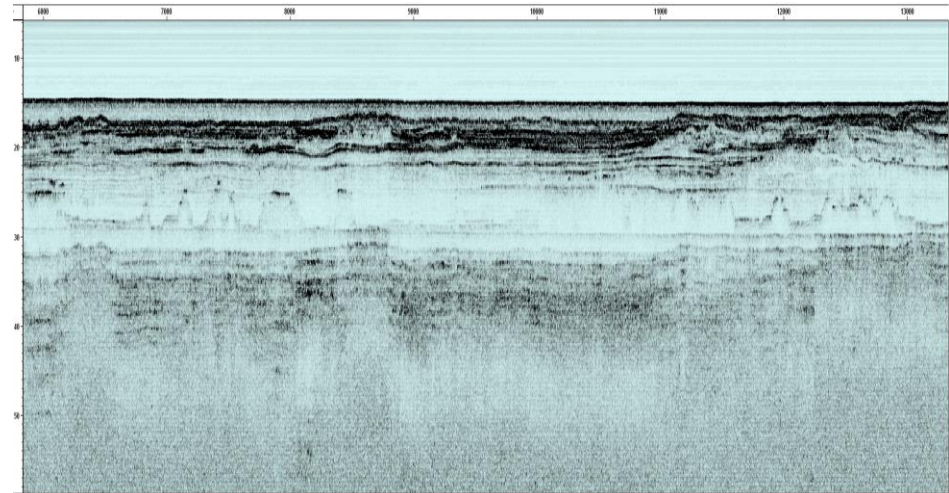
#### *Marine Geology and Biology*

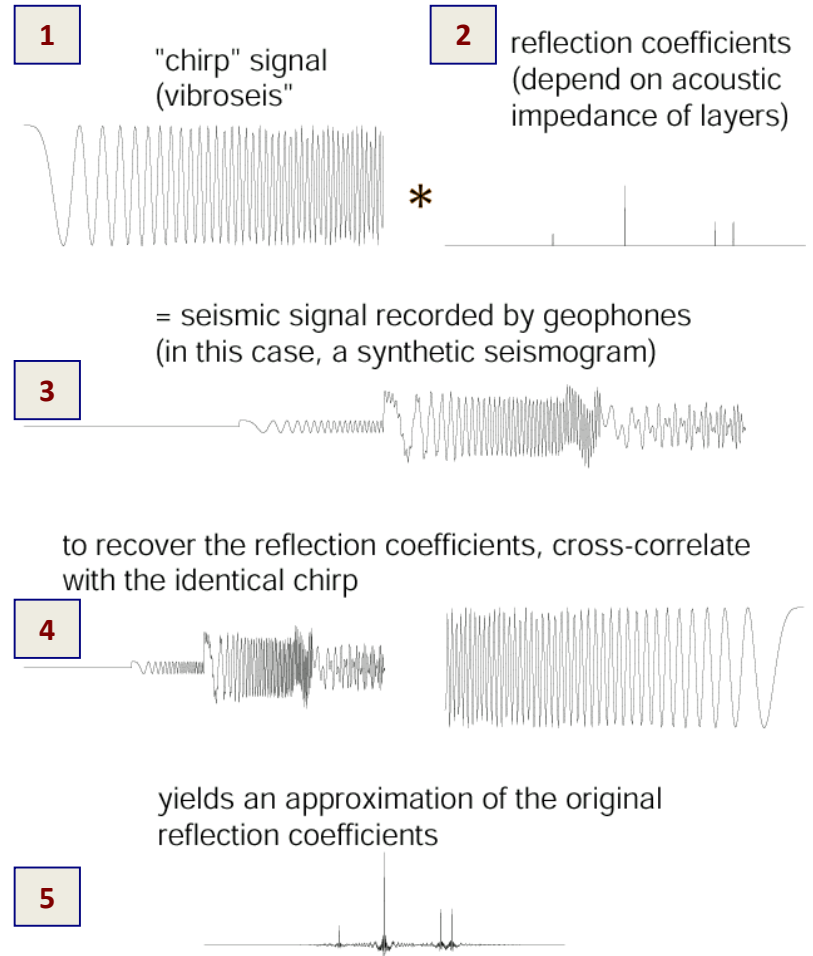
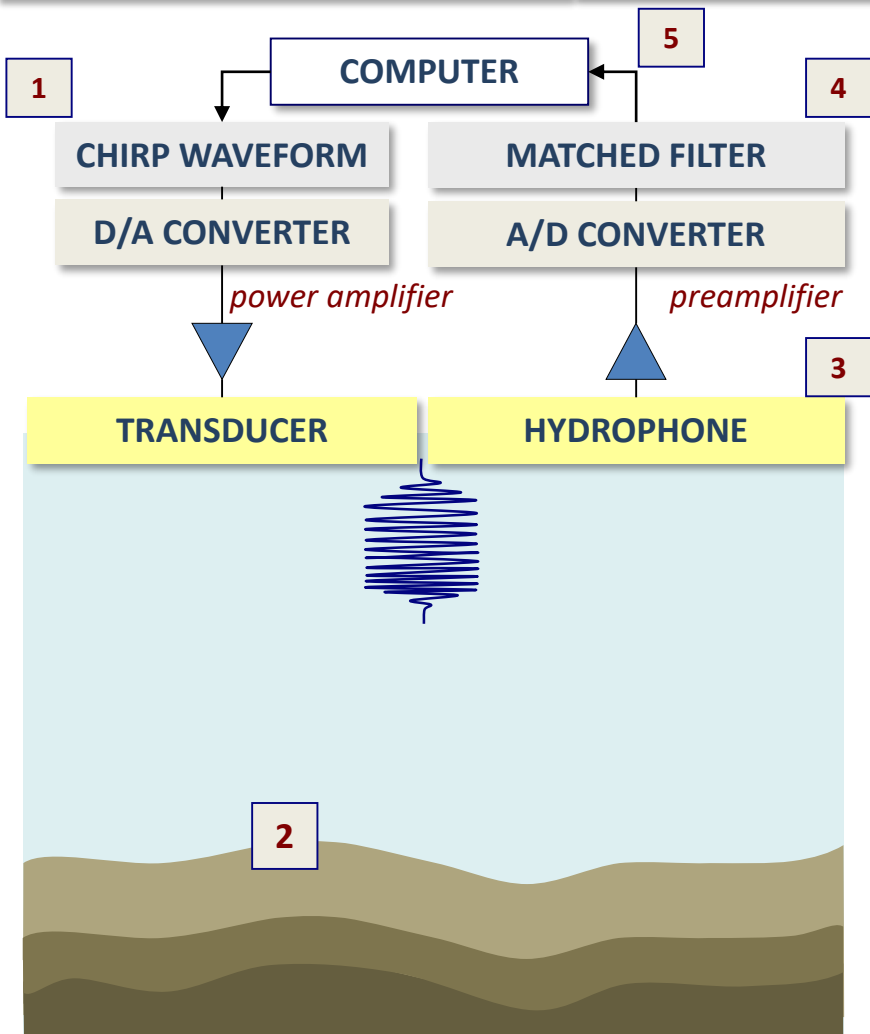
- Geological/Geophysical surveys
- Fluid escapes
- Neotectonic related surface expressions
- Sediment Classification

### INDUSTRY

#### *Foundation studies for offshore infrastructures*

- Cable surveys
- Well site surveys



**SUB BOTTOM PROFILER****BASIC CONCEPTS**

## SUB BOTTOM PROFILER

## RESOLUTION

### DEFINITION

The resolution of an imaging system is measured by its ability to separate closely spaced objects  
A sonar system with a 20 cm resolution will resolve layers that are at least 20 cm apart

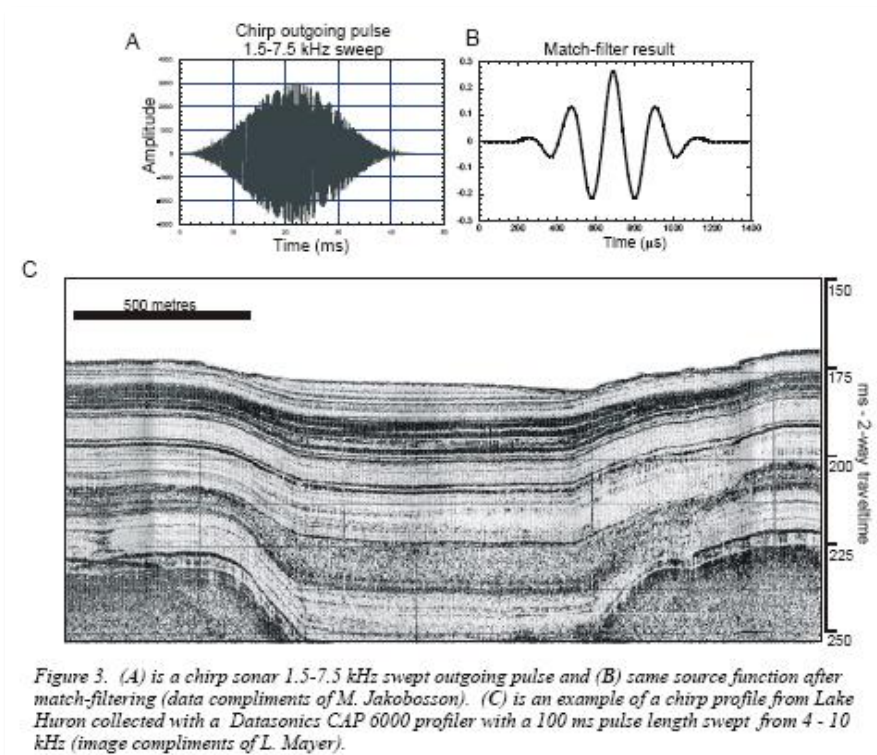
### MULTY-FREQUENCY SYSTEM

In a multi-frequency system, it is the bandwidth of the transmitted pulse that sets the system's theoretical resolution. The theoretical sonar range resolution, either cross-track in the case of side scan sonar or vertical in the case of sub-bottom profiling, is calculated by multiplying the length of the compressed pulse by the speed of sound, and dividing the product by two to account for the ping's round trip travel time. The frequency modulated signal is less sensitive to reverberations

**Pulse length = 1 / Bandwidth**

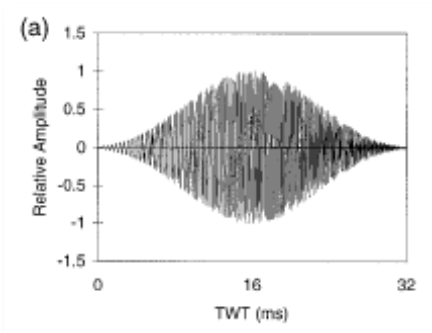
**Resolution =  $\frac{1}{2}$  \* velocity \* pulse length**

Mosher and Simpkin. Status and trends of marine high-resolution seismic reflection profiling: data acquisition

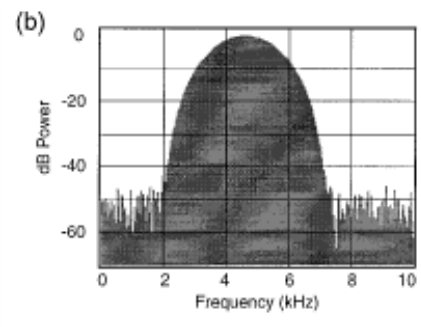


**SUB BOTTOM PROFILER**
**RESOLUTION**
**EXAMPLE**

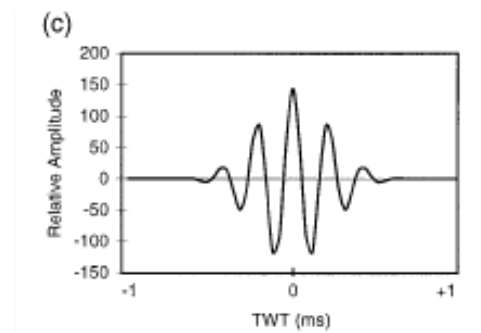
Band Range:	1-10 kHz	2-7 kHz
Bandwidth:	9 kHz	5 kHz
Pulse length:	$1/9 \text{ kHz} = 0.0001 \text{ s}$	$1/5 \text{ kHz} = 0.0002 \text{ s}$
$V_{H_2O}$ :	1540 m/s	1540 m/s
$\Delta H$ :	$0.0001 \text{ s} * 1540 \text{ m/s} = 0.154 \text{ m}$	$0.0002 \text{ s} * 1540 \text{ m/s} = 0.308 \text{ m}$
Range Resolution:	$\frac{1}{2} * 0.0001 \text{ s} * 1540 \text{ m/s} = 0.077 \text{ m}$	$\frac{1}{2} * 0.0002 \text{ s} * 1540 \text{ m/s} = 0.154 \text{ m}$



*32 ms frequency modulated chirp pulse; Band Range 2-8 kHz*



*Power Spectrum*



*Klauder wavelet  
(autocorrelation of chirp pulse)*

Quinn et al. Optimal Processing of Marine High Resolution seismic reflection (Chirp) Data. Marine Geophysical Researches 20: 13–20, 1998.

## SUB BOTTOM PROFILER

## INSTALLATION

### Hull mounted



NUMBER OF ELEMENTS: 16

PING RATE:  $\frac{1}{4}$ ,  $\frac{1}{2}$ , 1, 2 (S)

FREQ. RANGE: 2-7 KHZ

BANDWIDTH: 5 KHZ

PULSE LENGTH: 0.2 ms

RESOLUTION: 15.4 cm

PENETRATION: 10s of m

### Portable (towed)







**SUB BOTTOM PROFILER**

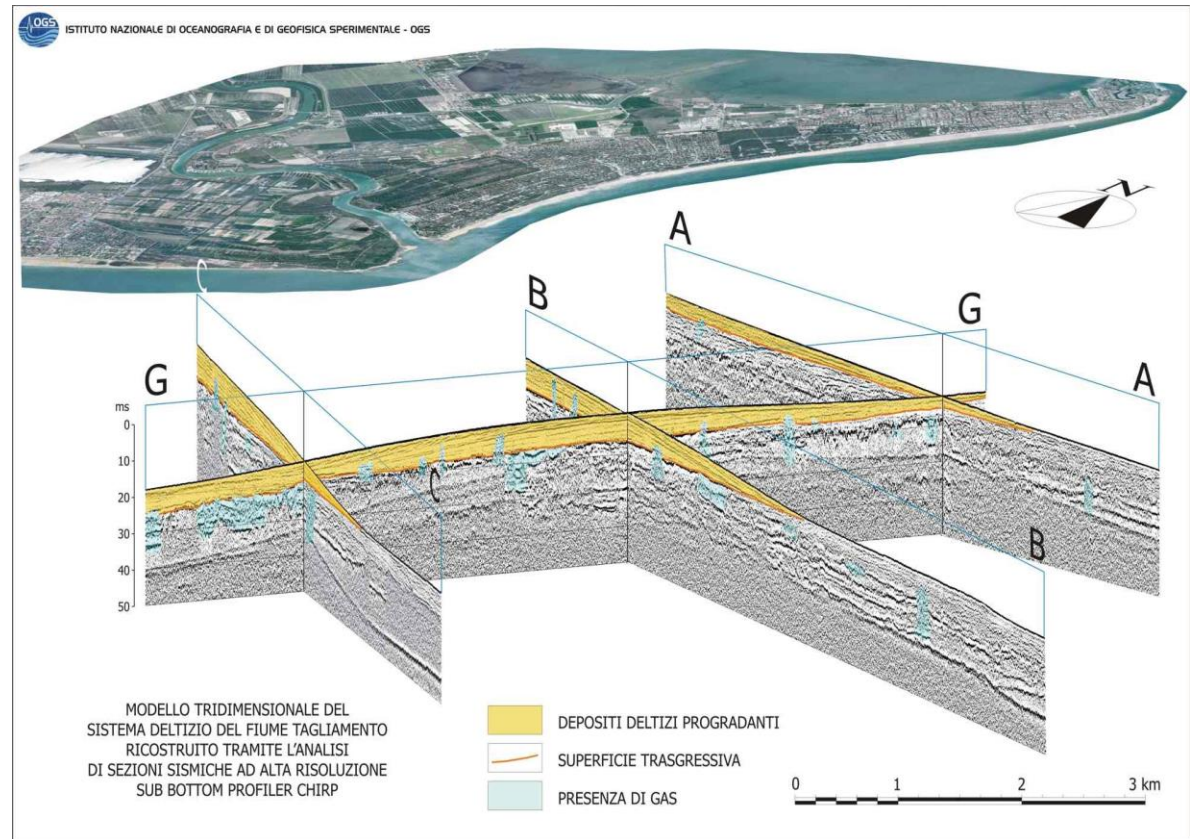
**OVERVIEW**



**SUB BOTTOM PROFILER**
**EXAMPLE**

**EDGETECH 3200 XS**

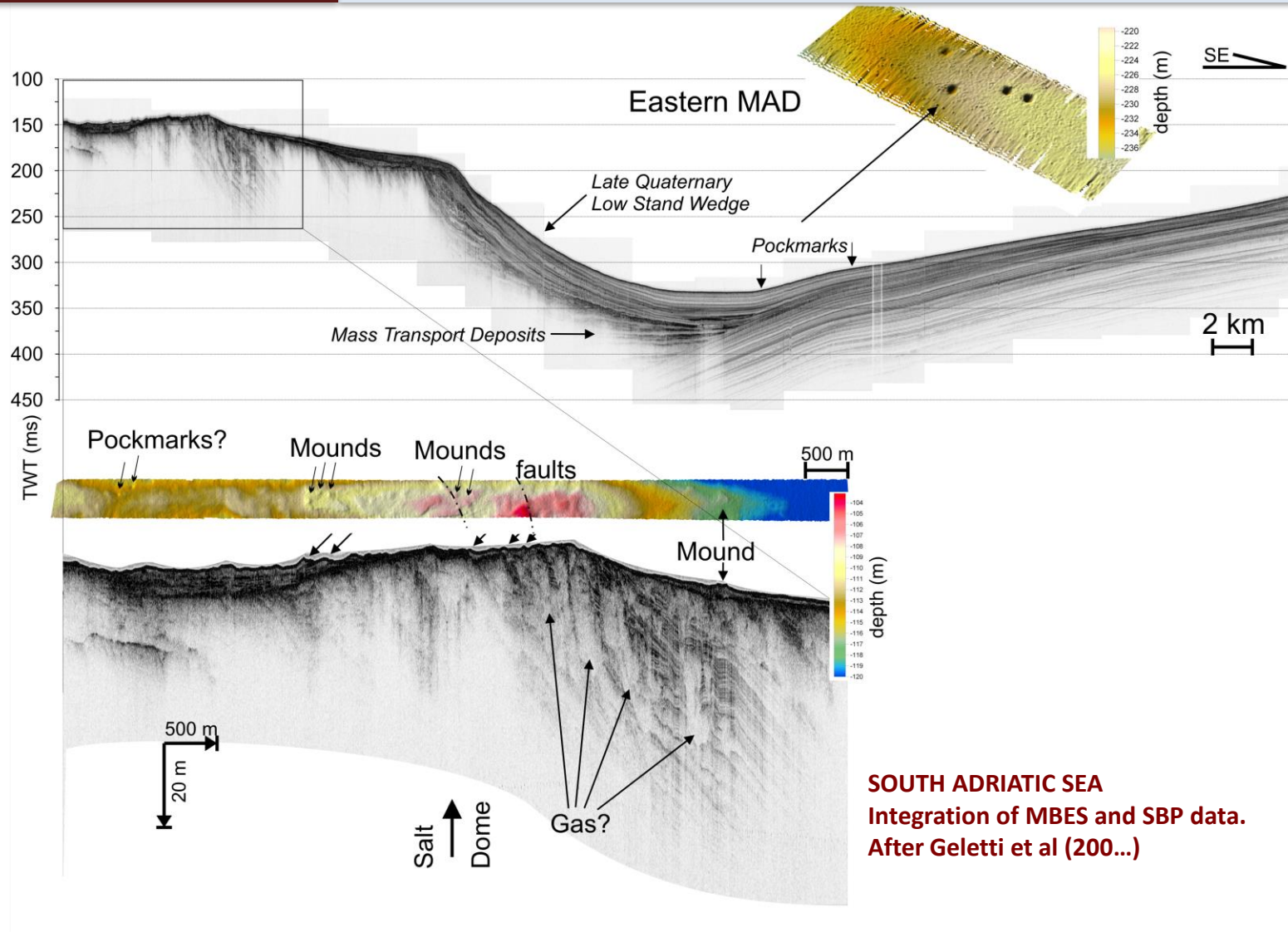
Frequency range	2 ÷ 12 kHz
Pulse type	FM
Pulse length	20 ÷ 40 ms
Beam width	16° ÷ 32°
Vertical resolution	8 ÷ 20 cm
Penetration	20 ÷ 200 m
Max depth	300 m

**Sub-bottom profiler CHIRP investigations of Tagliamento River delta (northern Adriatic Sea).**


Tridimensional model of the Tagliamento River delta system from sub bottom chirp analyses. Courtesy of R. Romeo

## SUB BOTTOM PROFILER

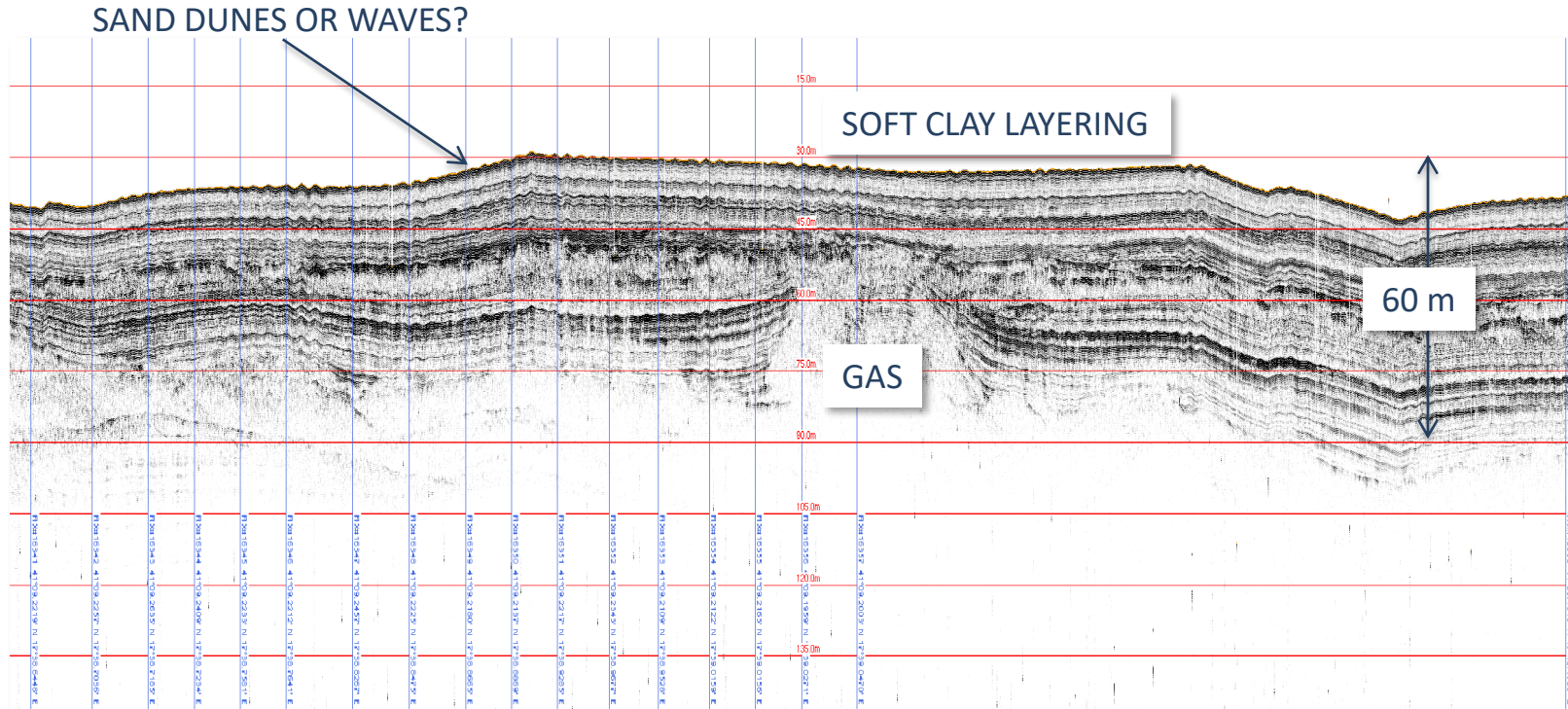
## DATA INTEGRATION



# SUB BOTTOM PROFILER

# CABLE SURVEY

## GAS IDENTIFICATION



Zgur et al., 2011. Bios Submarine Cable System TEL AVIV To BARI Survey Report For Alcatel-lucent Submarine Networks