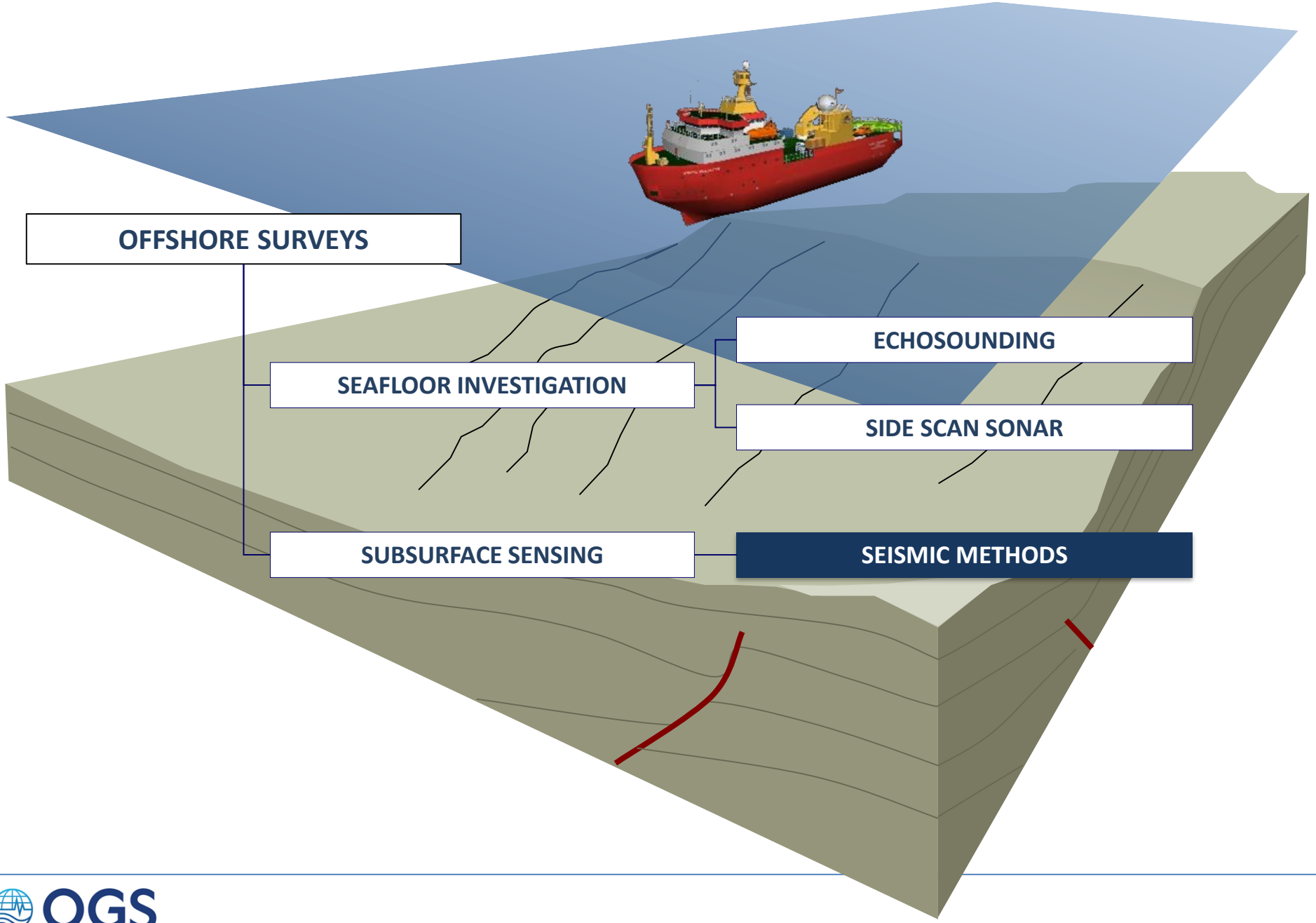
SUB BOTTOM PROFILER OVERVIEW



SUB BOTTOM PROFILER OVERVIEW

IT IS USED FOR

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

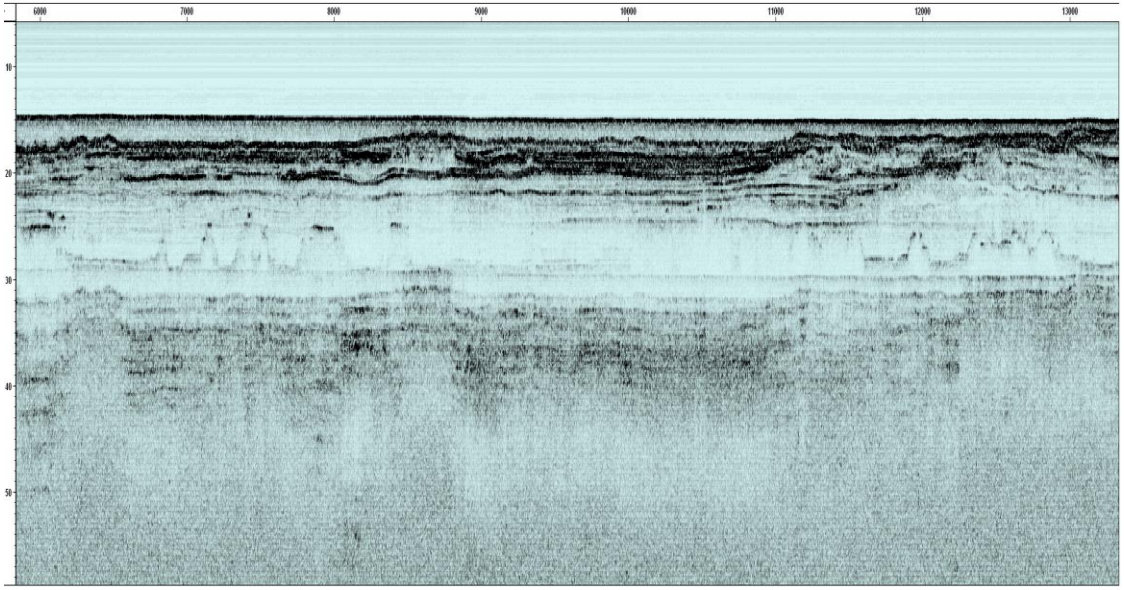
HOW IT WORKS

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

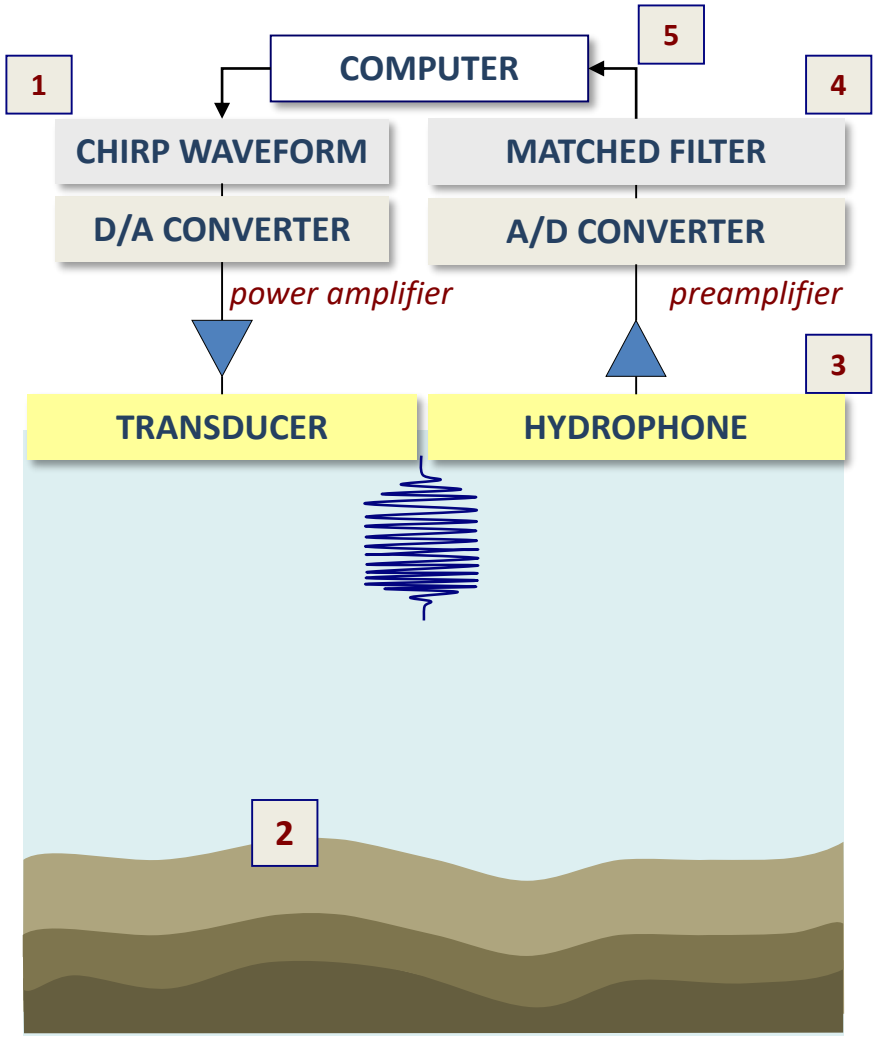
- Geological/Geophyscial surveys
- Fluid escapes
- Neotectonic related surface expressions
- Sediment Classification

INDUSTRY

Foundation studies for offshore infrastructures

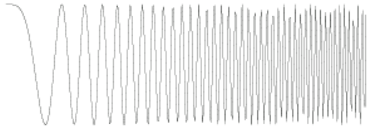
- Cable surveys
- Well site surveys

SUB BOTTOM PROFILER BASIC CONCEPTS



1

"chirp" signal (vibroseis"



2

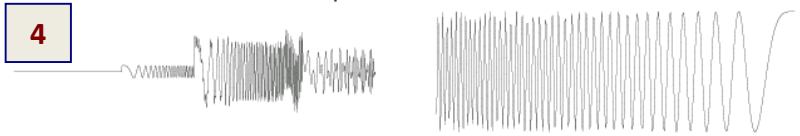
reflection coefficients (depend on acoustic impedance of layers)

= seismic signal recorded by geophones (in this case, a synthetic seismogram)

3

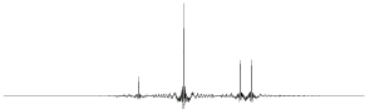
to recover the reflection coefficients, cross-correlate with the identical chirp

4



yields an approximation of the original reflection coefficients

5



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

Pulse length = 1 / Bandwidth

Resolution = ½ * velocity * pulse length

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.

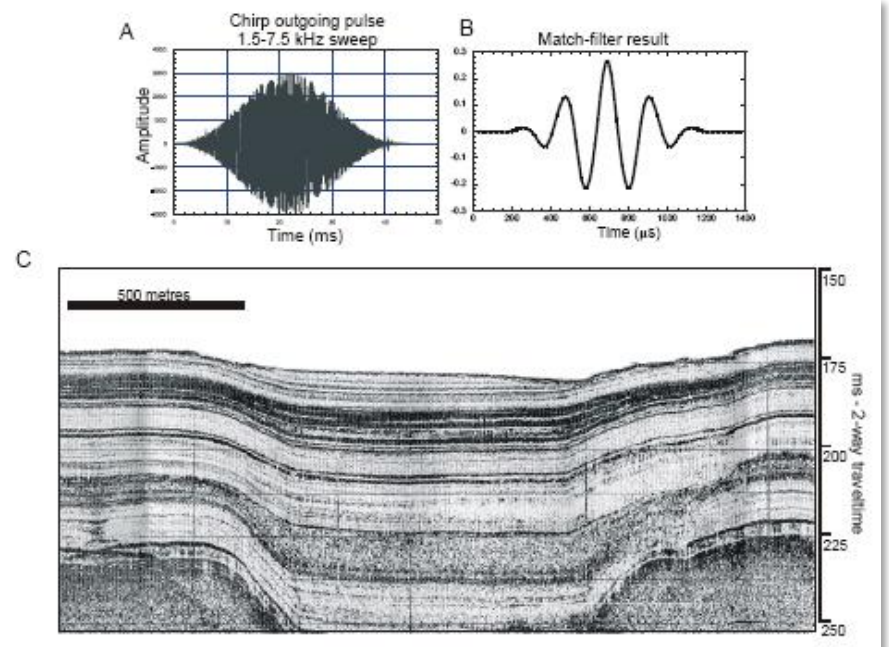
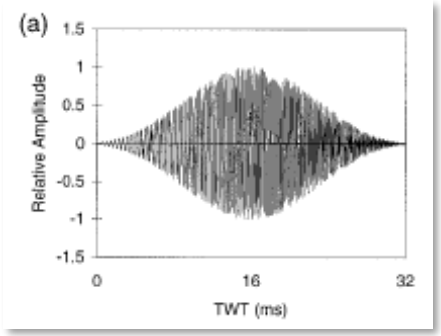


Figure 3. (A) is a chirp sonar 1.5-7.5 kHz swept outgoing pulse and (B) same source function after match-filtering (data compliments of M. Jakobosson). (C) is an example of a chirp profile from Lake Huron collected with a Datasonics CAP 6000 profiler with a 100 ms pulse length swept from 4 - 10 kHz (image compliments of L. Mayer).

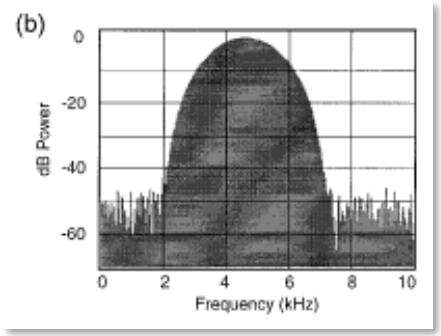
Mosher and Simpkin. Status and trends of marine high-resolution seismic reflection profiling: data acquisition

EXAMPLE

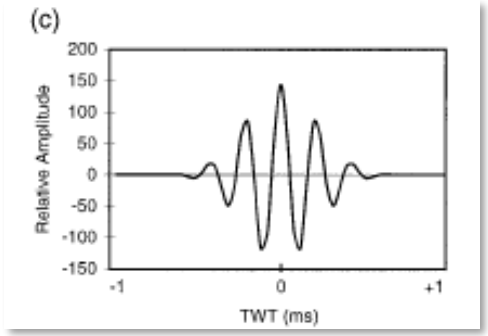
Band Range:	1-10 kHz	2-7 kHz
Bandwidth:	9 kHz	5 kHz
Pulse length:	1/9 kHz = 0.0001 s	1/5 kHz = 0.0002 s
V_{H20}:	1540 m/s	1540 m/s
ΔH:	0.0001 s * 1540 m/s = 0.154 m	0.0002 s * 1540 m/s = 0.308 m
Range Resolution:	½ *0.0001 s * 1540 m/s = 0.077 m	½ * 0.0002 s * 1540 m/s = 0.154 m



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 Highr Resolution seismic reflection (Chirp) Data. Marine Geophysical Researches 20: 13–20, 1998.

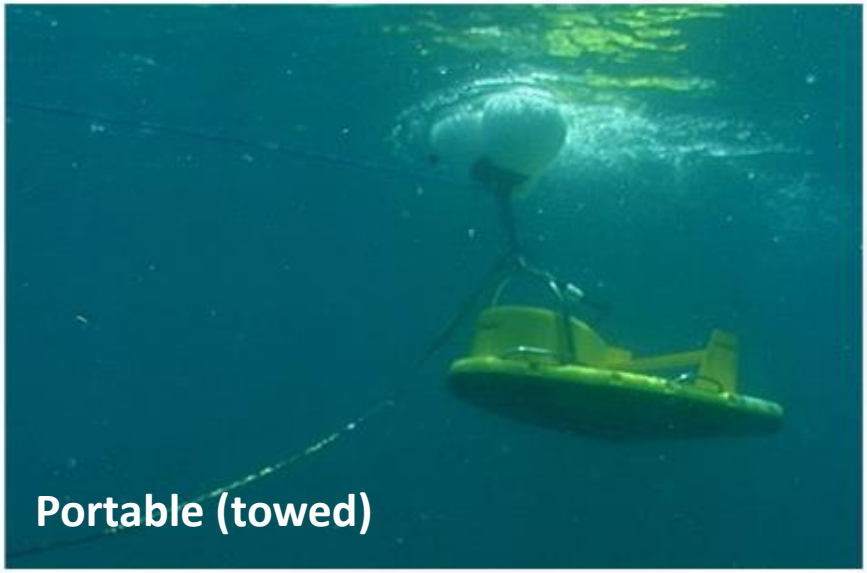
SUB BOTTOM PROFILER INSTALLATION

Hull mounted


OGS Explora


Laura Bassi

- NUMBER OF ELEMENTS: 16
- PING RATE: ¼ , ½, 1, 2 (S)
- FREQ. RANGE: 2-7 KHZ
- BANDWIDTH: 5 KHZ
- PULSE LENGTH: 0.2 ms
- RESOLUTION: 15.4 cm


Portable (towed)

OGS

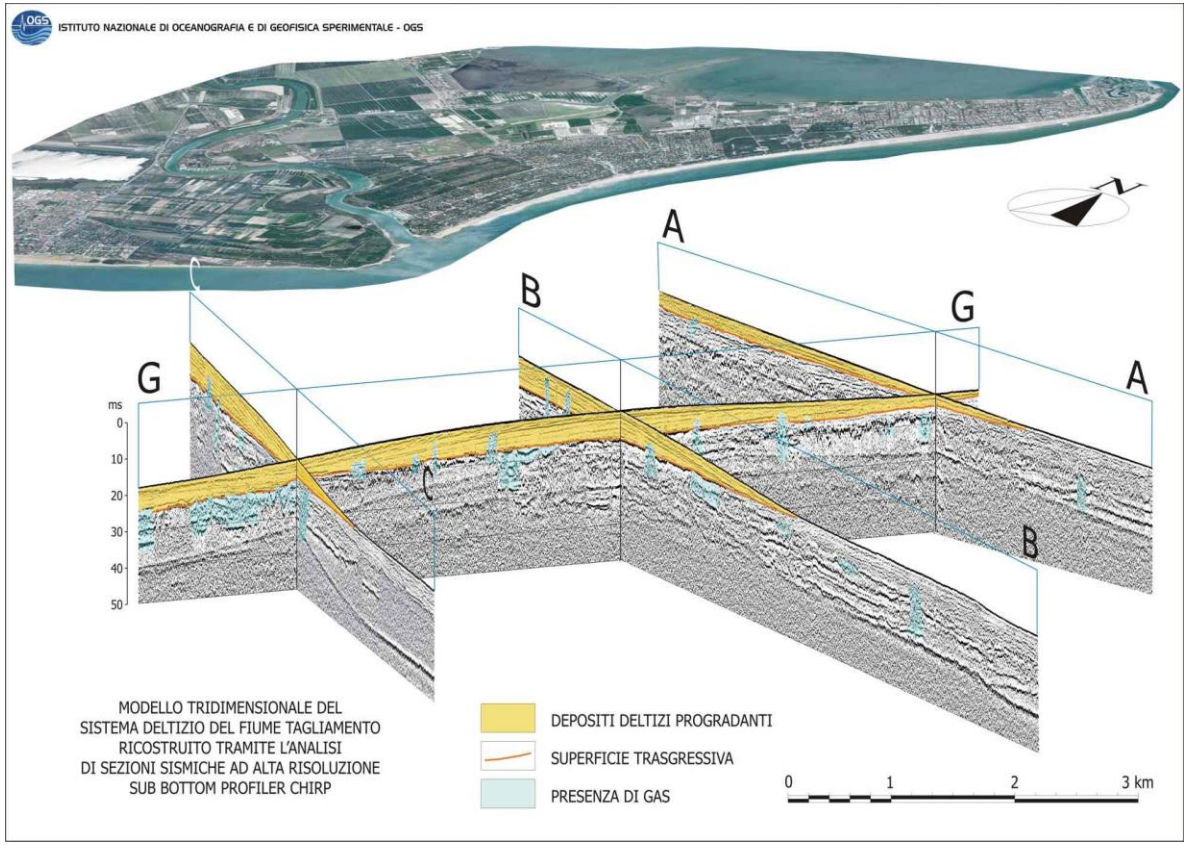
SUB BOTTOM PROFILER

HOW THE DATA ARE ACQUIRED

SUB BOTTOM PROFILER EXAMPLE 1

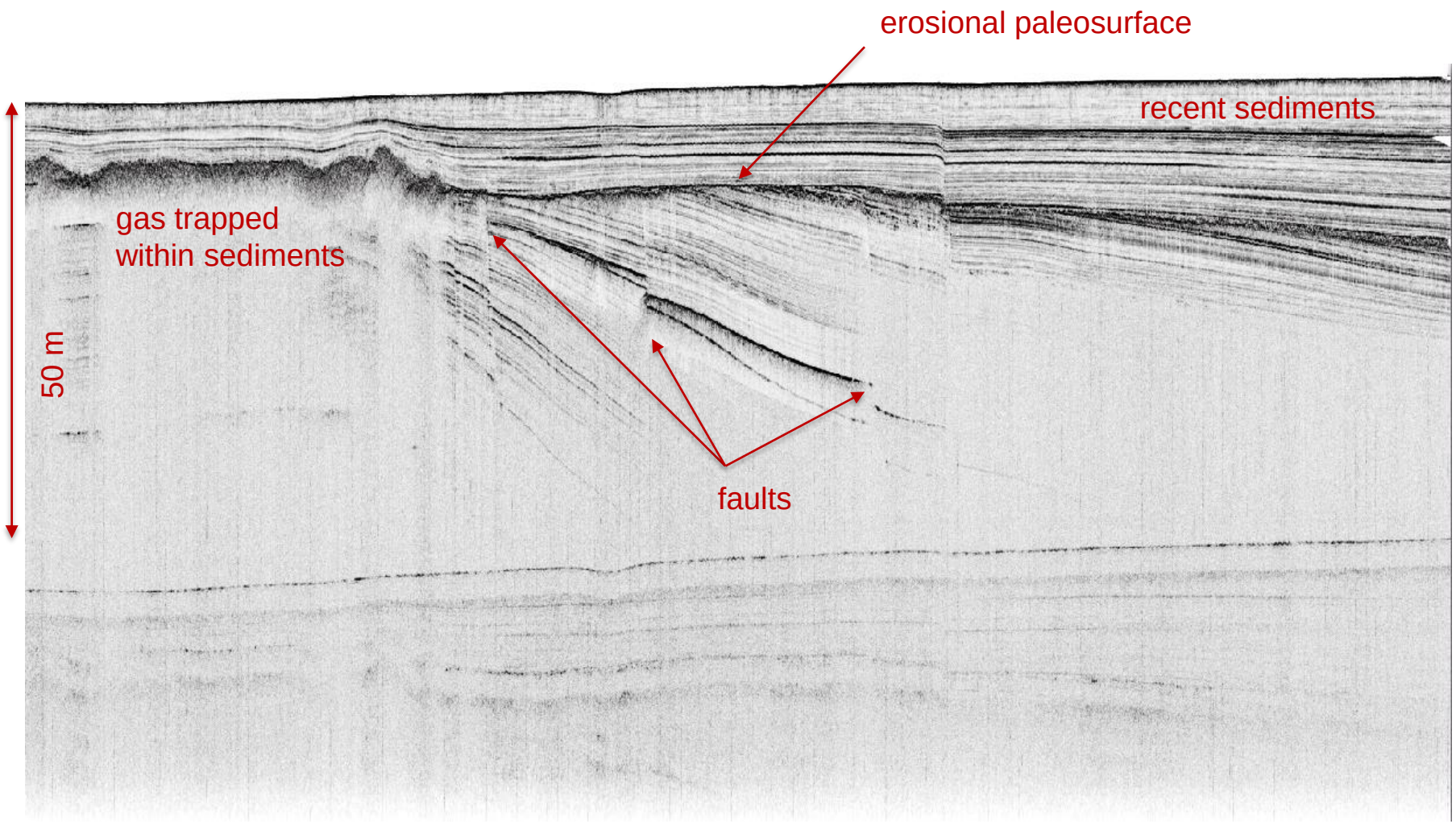
Sub-bottom profiler CHIRP investigations of Tagliamento River delta (northern Adriatic Sea).

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



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

Sub-seafloor sedimentary features



EXAMPLE 3

DATA INTEGRATION

Study of the deep water, Meso Adriatic CORAL MOUNDS

These communities are related to the presence of gas-seeps and brigth within Plio-Quaternary sediments at the margin of the Apulian carbonatic platform

After Geletti et al., 2010.