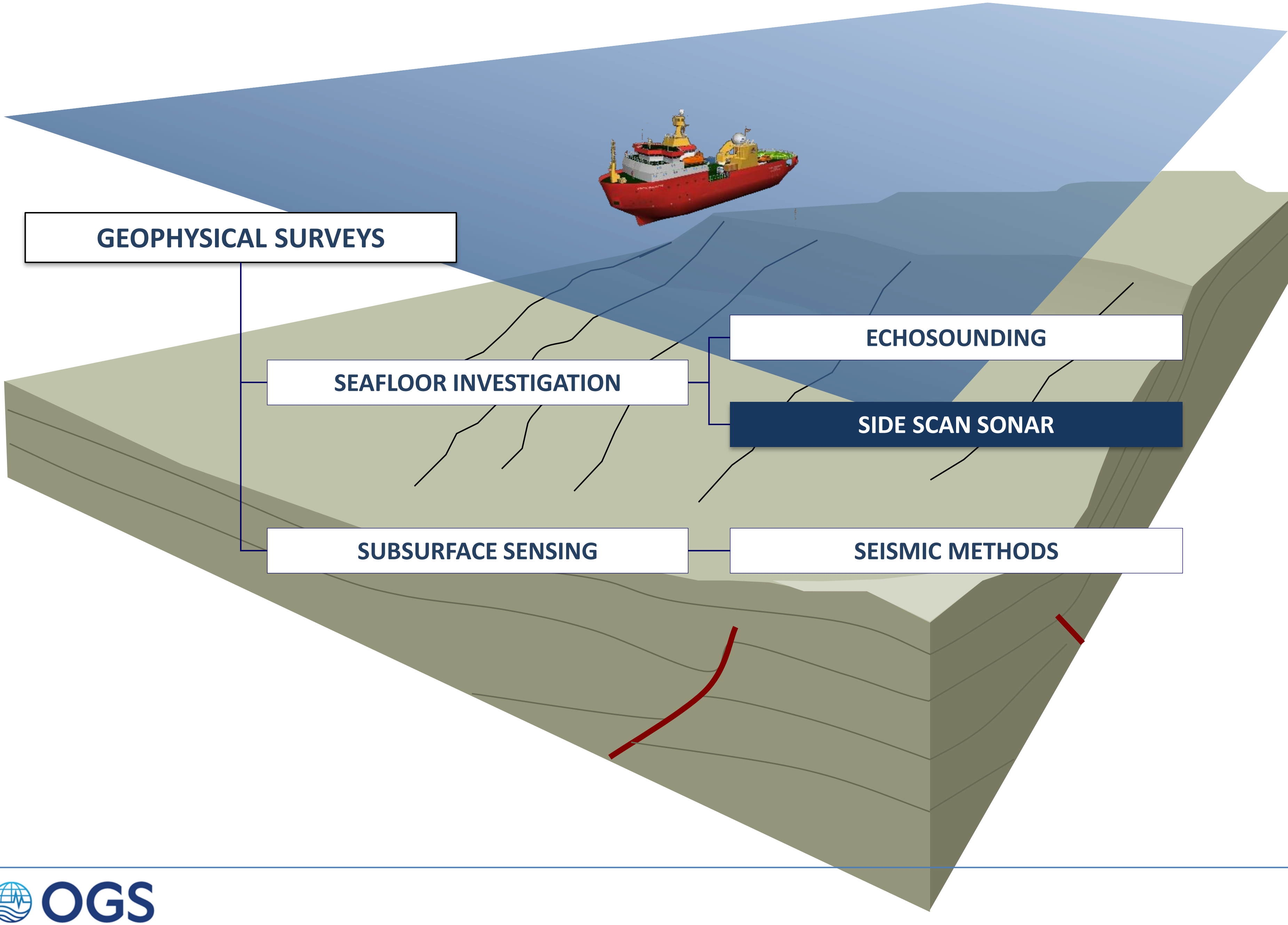
SIDE SCAN SONAR OVERVIEW



OVERVIEW

IT IS USED FOR

SSS reveals information about sea floor composition by taking advantage of the different sound **absorbing** and reflecting characteristics of different materials. Strong reflectors (rock, biogenic structures, metals) create strong echoes, while weak reflectors (silt, clay) create weaker echoes. Reporting the **strength of echoes** is essentially what a sidescan sonar is designed to do.

HOW IT WORKS

Pulses are transmitted using a projector (or array of projectors), and hydrophones receive echoes of those pulses from the ocean floor and pass them to a receiver system. Where sidescan sonar differs from a depth-sounding system is in the way it processes these returns.

USES AND OBJECTIVES

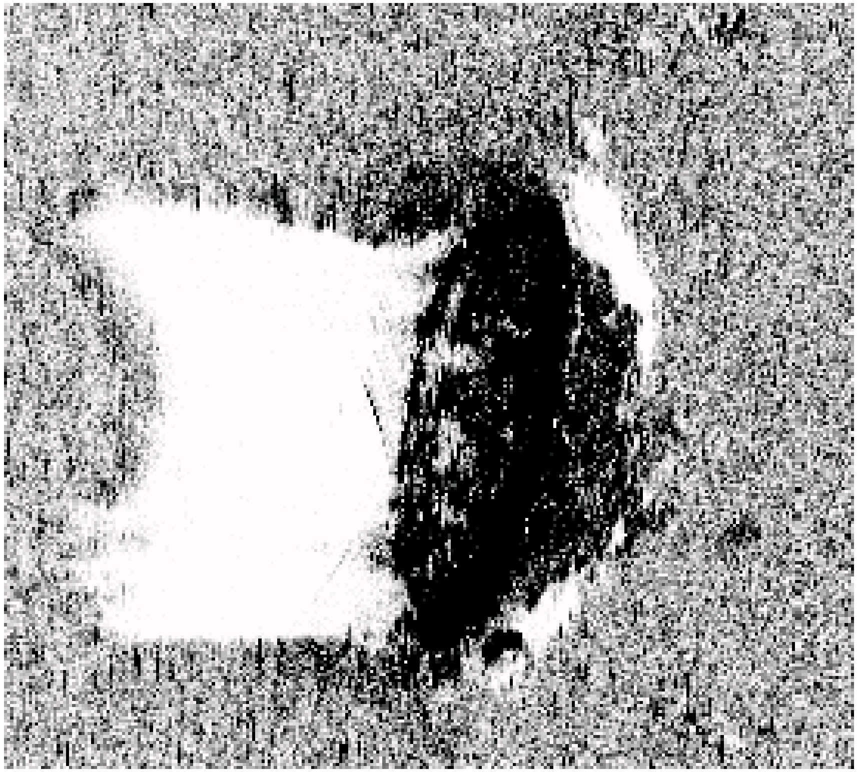
ENVIRONMENT AND SOCIETY

Navigation charts

- Objects detection and mapping

  mines, wrecks (ships, aircrafts), pipeline, lost cargos (containers, scientific equipment)
- Search and recovery
- Submarine infrastructures inspection

  wellhead, pipelines, etc.
- Pre / Post dredge surveys



RESEARCH

Marine Geology and Biology

- Seafloor classification

  rocks, very coarse sediment, coarse and fine sediment.
- Study of benthic habitats

INDUSTRY

Foundation studies for offshore infrastructures

- Cable surveys
- Well site surveys

WHAT KIND OF INFORMATION WE CAN (OR CAN NOT) GET

No depth information. Use a single beam or multibeam sonar for that.

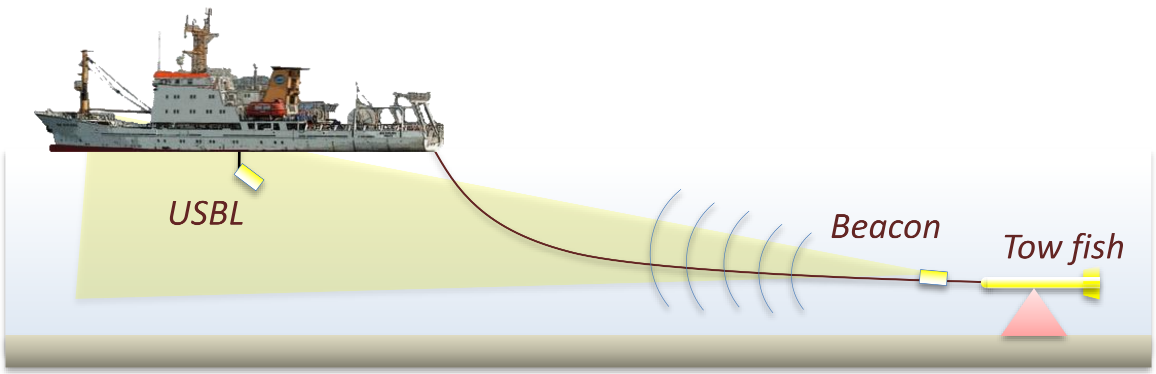
Information about targets on the seafloor (*position and height above the bottom)*

Real time information about the height of the fish above the bottom

It can be used for seafloor classification

SIDE SCAN SONAR

POSITIONING OF TOWED SYSTEMS

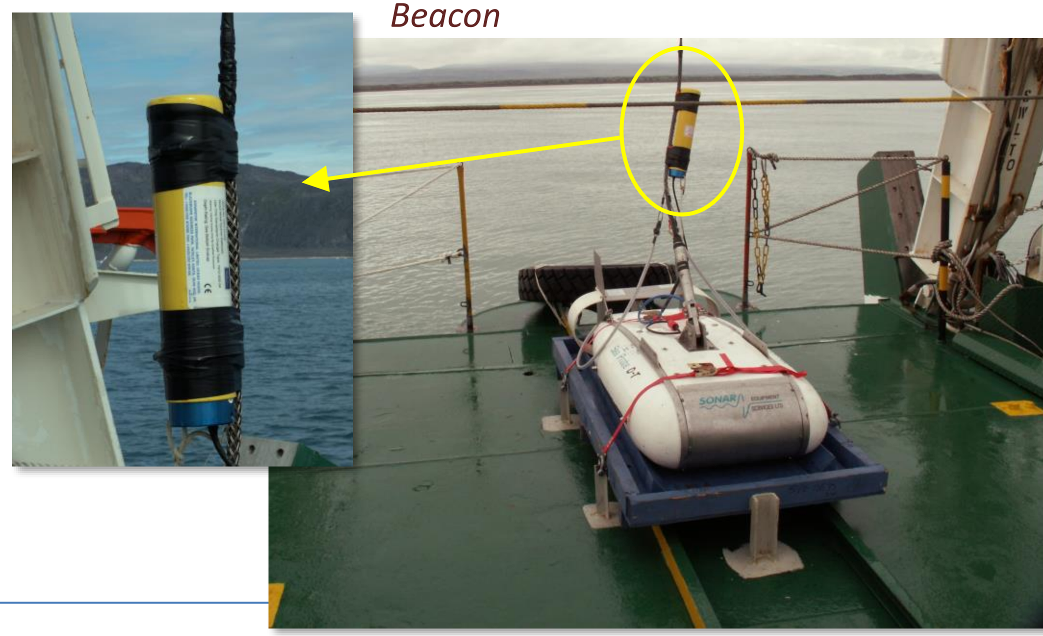


HOW IT WORKS

The beacon (transponder) emits a pulse at constant time interval. The pulse is detected by the USBL (responder) that is mounted on a pole immersed in the water.

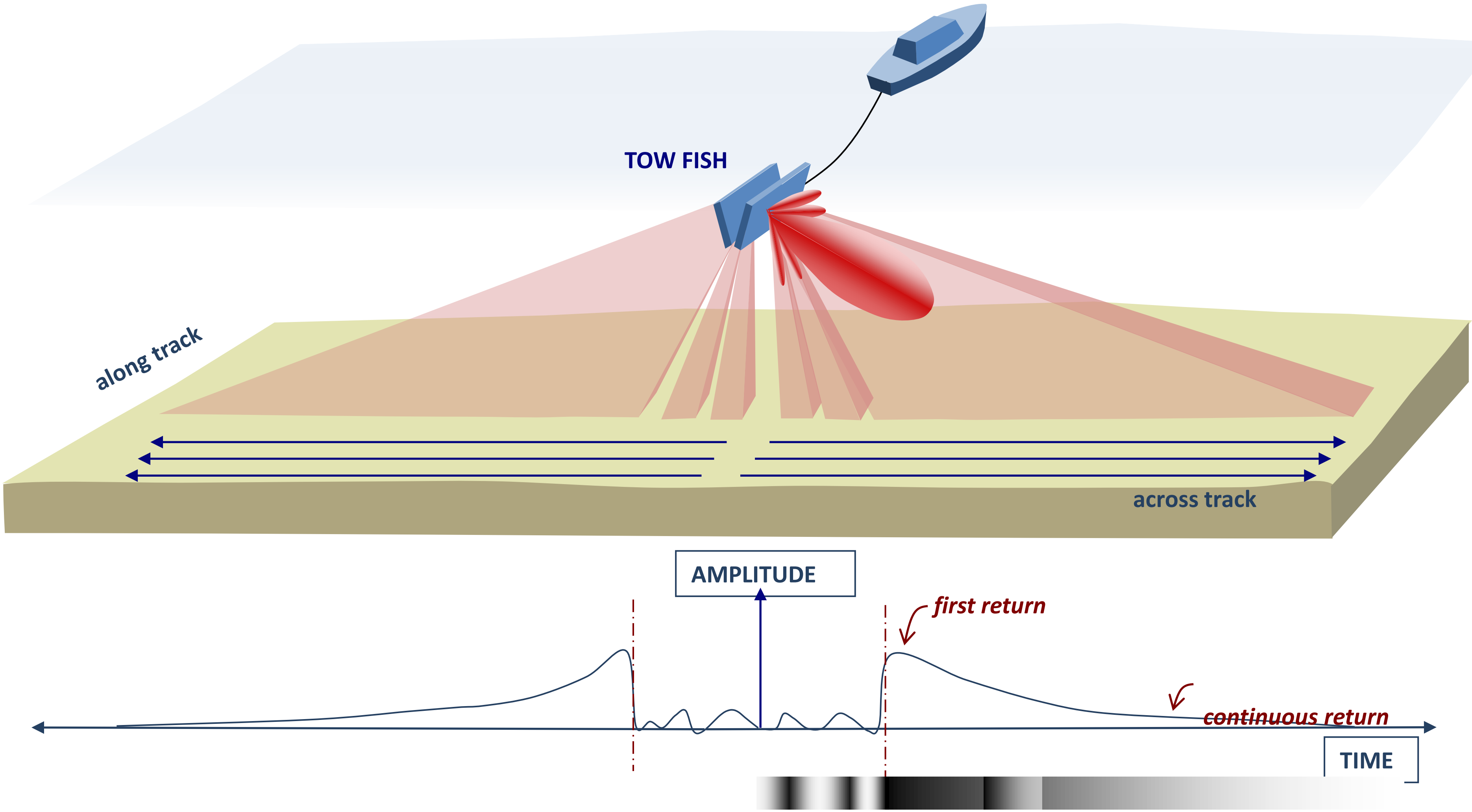
The USBL recognizes precisely both the position and the depth.

USBL (Ultra Short Base Line)



Beacon

HOW THE SONAR SEES THE OBJECTS



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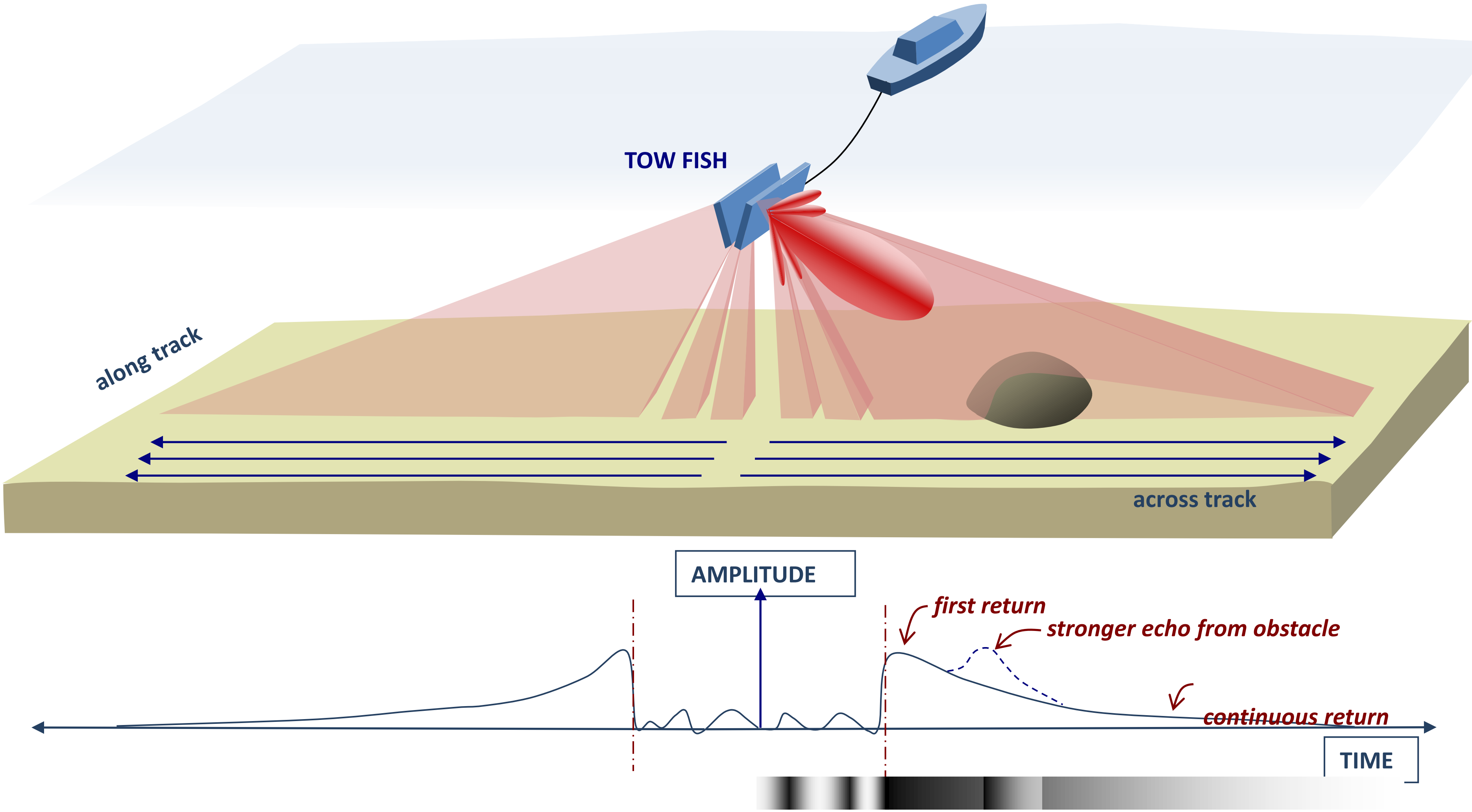
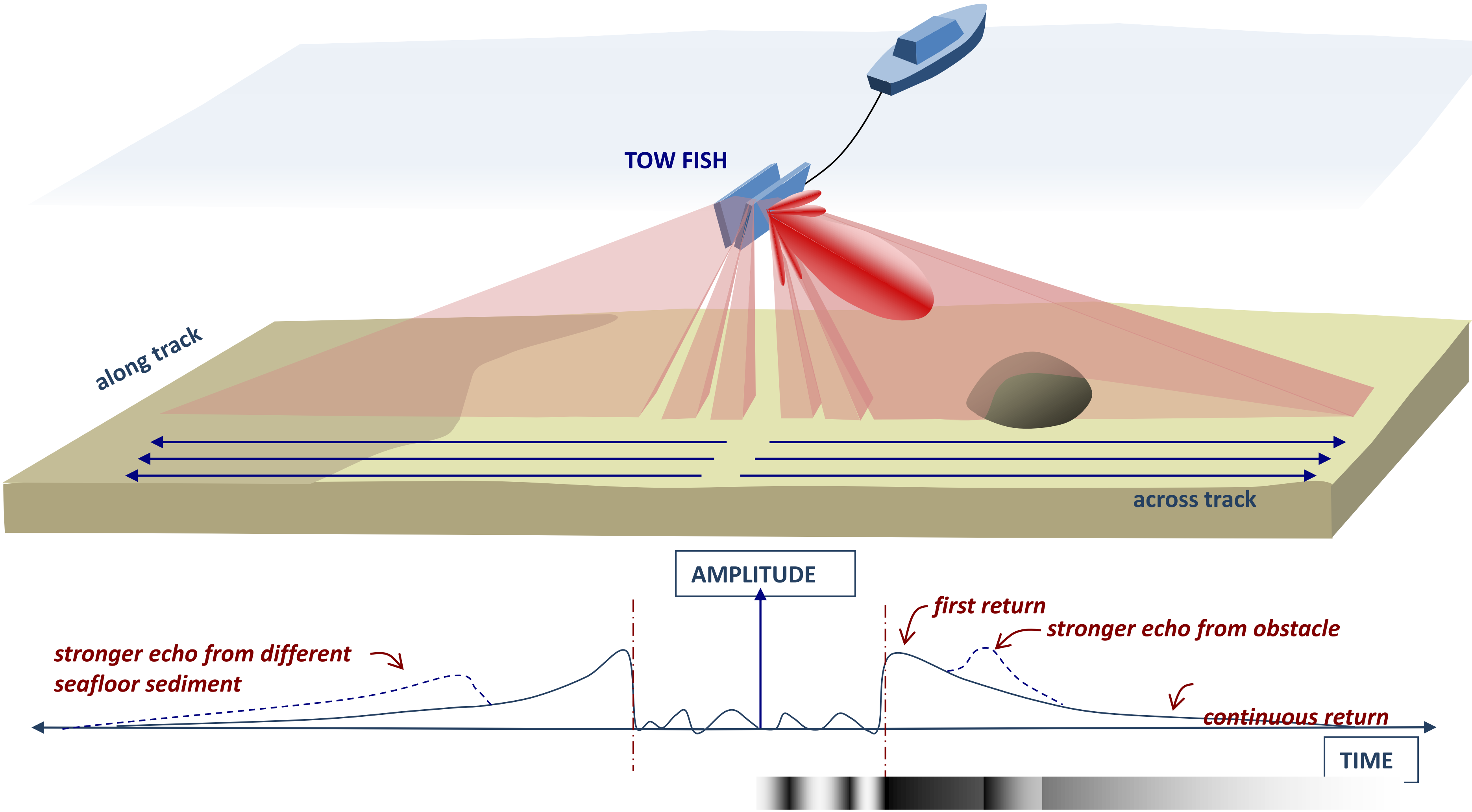


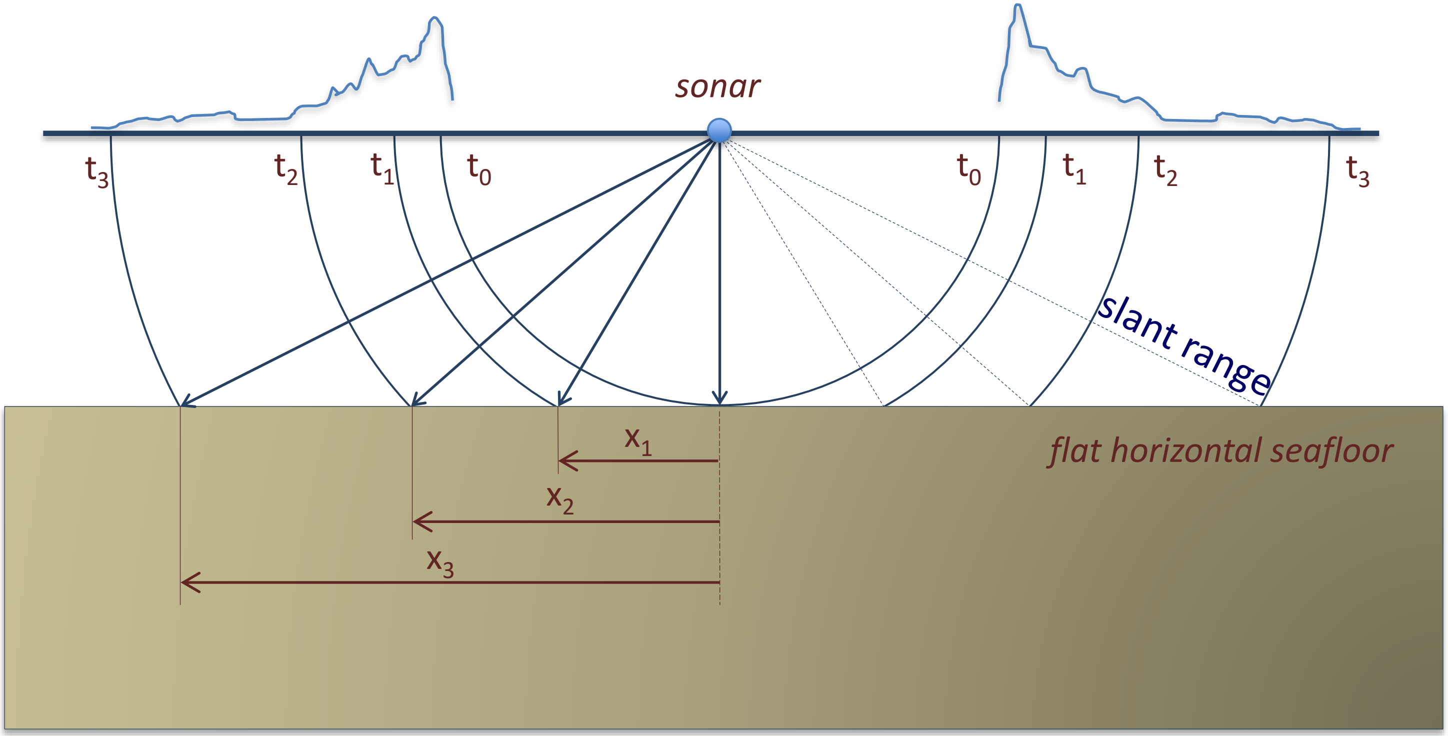
HOW THE SONAR SEES THE OBJECTS

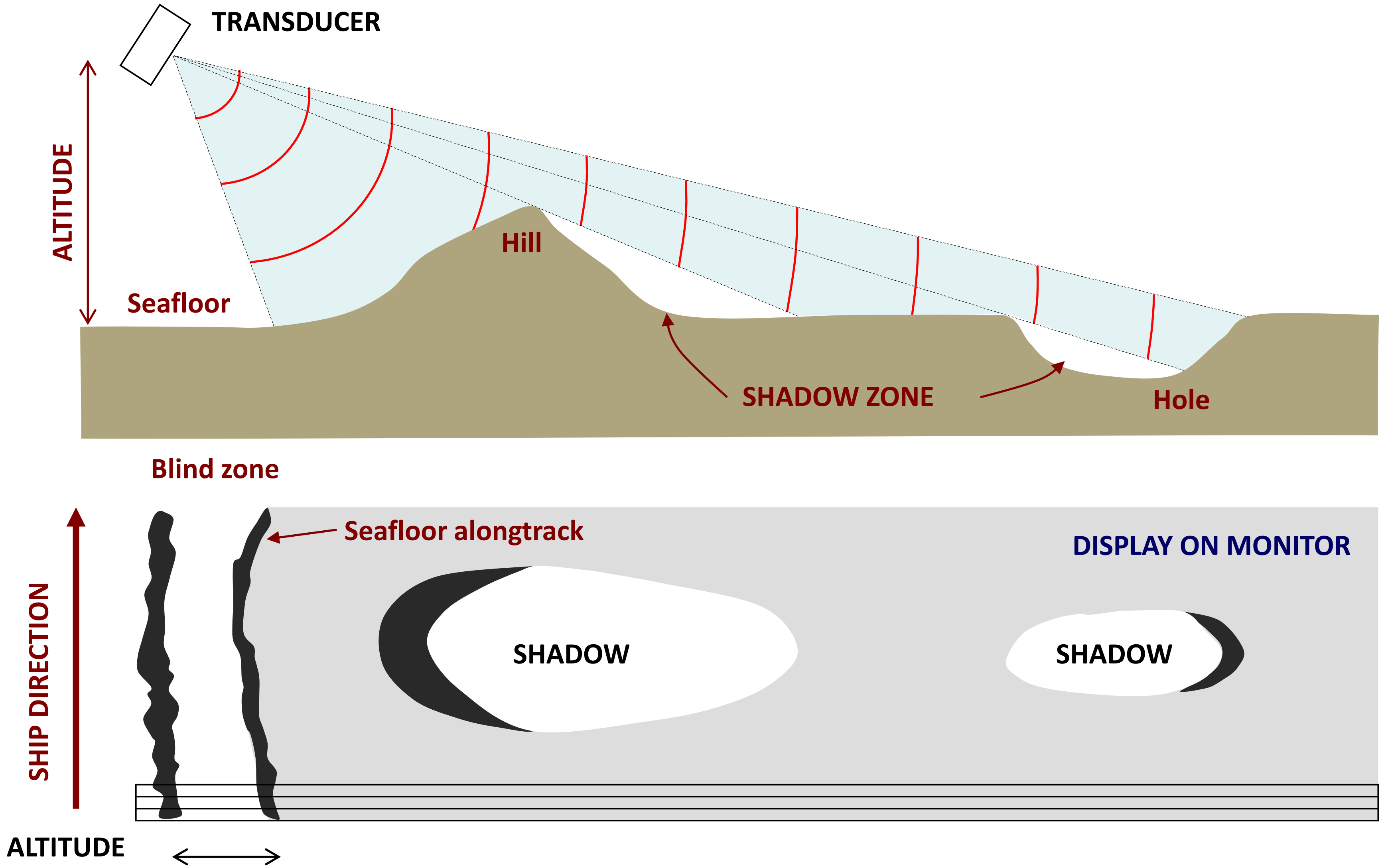


SLANT RANGE TO HORIZONTAL RANGE

measured one-way travel time t (s) → slant ranges $R_i = c\ t_i$ (m) with c = speed of sound (m/s)

range of first bottom echo $R_0 = c\ t_0$ → horizontal ranges $x_i = c\ (t_i^2 - t_0^2)^{1/2}$




TRANSDUCER
ALTITUDE
Seafloor
Hill
SHADOW ZONE
Hole
Blind zone
Seafloor alongtrack
DISPLAY ON MONITOR
SHIP DIRECTION
SHADOW
SHADOW
ALTITUDE

ALONG TRACK RESOLUTION

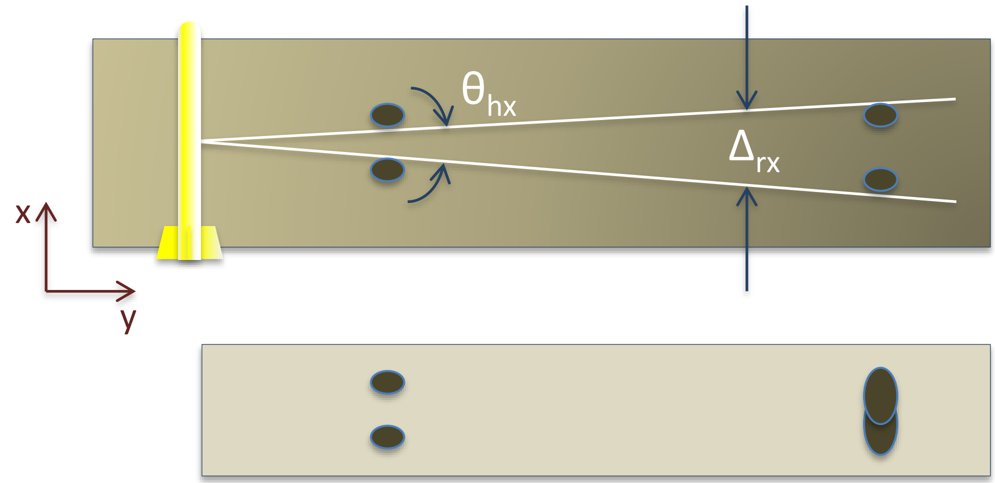
DEFINITION

The resolution is defined as the minimum distance between two detected objects that can be distinguished as separated entities in the sonar image.

In the along-track direction, Δ_{rx}, measures the resolution parallel to the line of travel. It is controlled by:

- the azimuthal beamwidth θ_{hx} of the aperture
- the range, R

When targets in the far field are inside the angular resolution of the sonar, they become indistinguishable and look as a single object. At the near field, these objects can be distinguished.



Seabed display

$$\Delta_{rx} = \theta_{hx} R$$

Δ_{rx} degrades with distance to the transducer

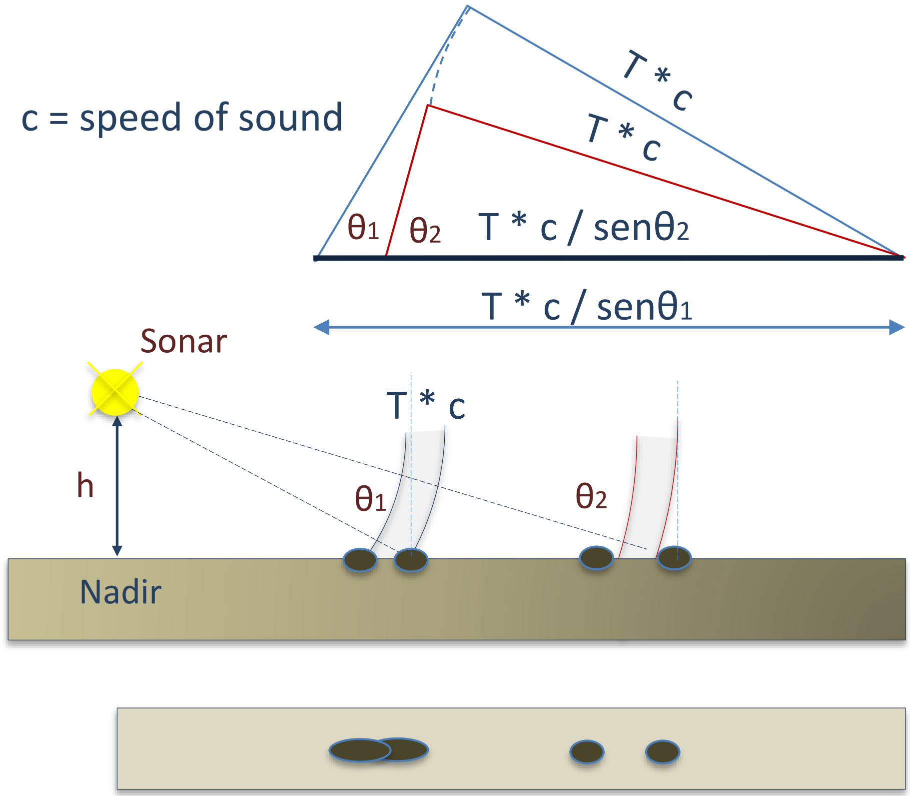
objects in the far field cannot be distinguished

SIDE SCAN SONAR

ACROSS TRACK RESOLUTION

DEFINITION

The across-track resolution is defined as the minimum distance between two objects perpendicular to the line of travel that can be distinguished as separated entities in the sonar image. The range resolution is controlled by the signal Bandwidth (Bw = 1 / T)



Seabed display

If two objects are too close, they will appear as one on the sidescan record. Getting these objects further apart will show them as independent objects. How close can they be? Half the pulse length.

$$\Delta_{ry} = , T\,c / 2\,\mathrm{sen}\theta n$$

Example

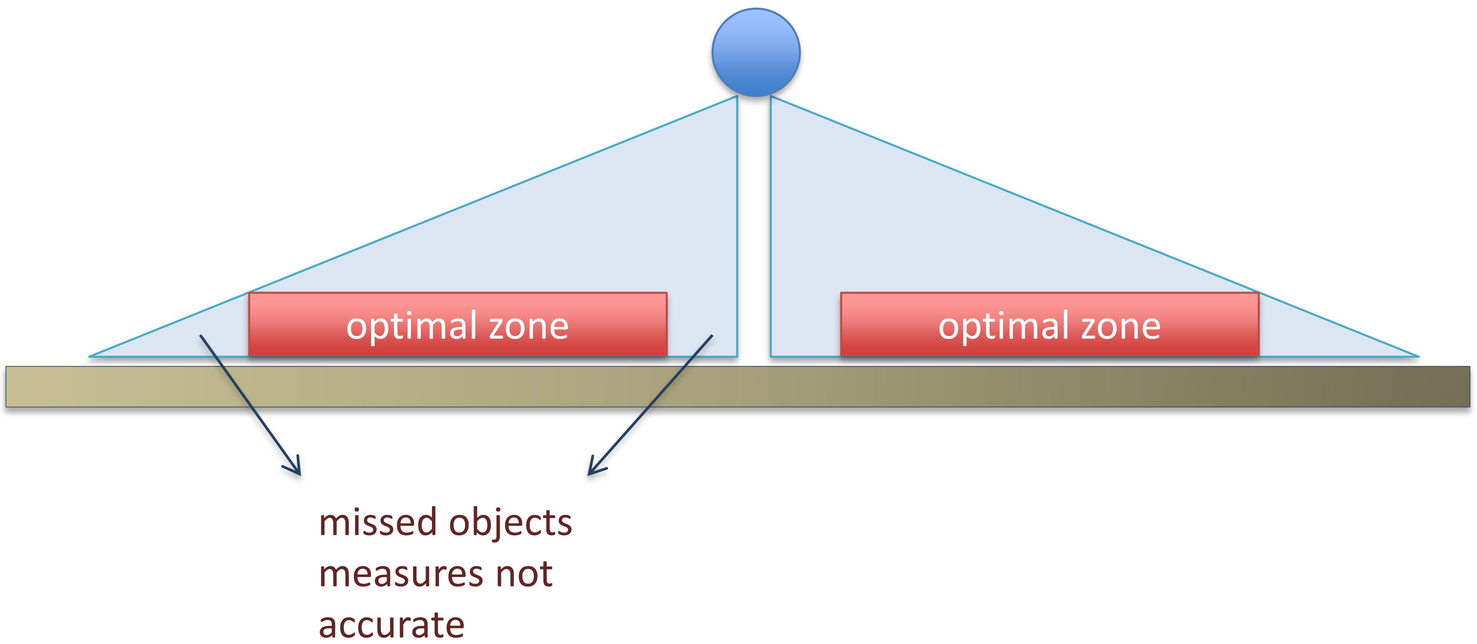
A 500khz system has a pulse length of 1.5 cm.

Δ_{ry} degrades approaching the transducer

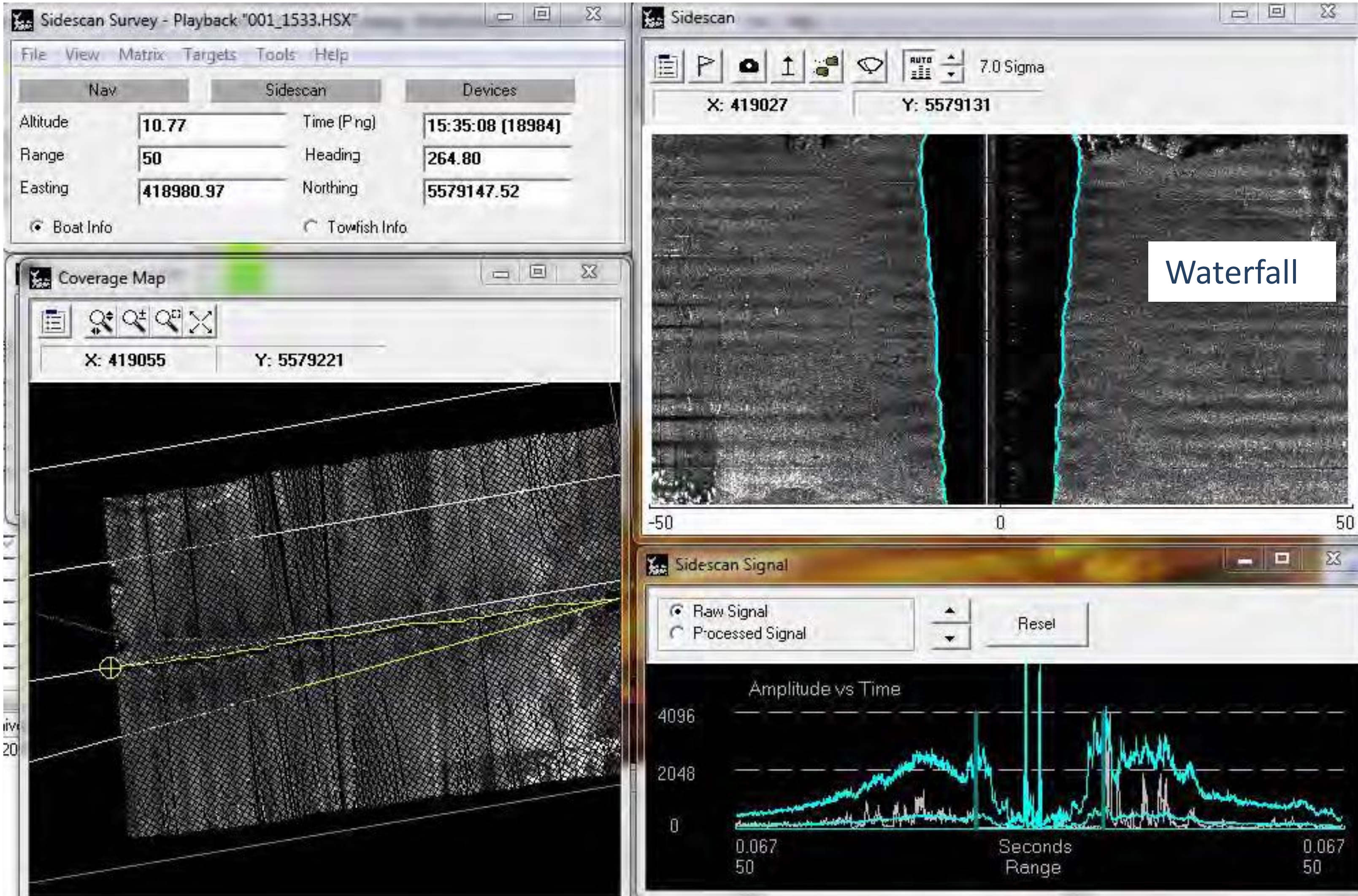
objects in the near field cannot be distinguished

THE OPTIMAL ZONE OF OPERATION

Looking at both the near field and far field constraints, as well as maximizing the best seen area, the sonar will work best in the region of the Optimal Zone of Operation (OZO)



SIDE SCAN SONAR AN ACQUISITION SESSION



Coverage map (real time mosaic)

Signal window

BOTTOM TRACKING

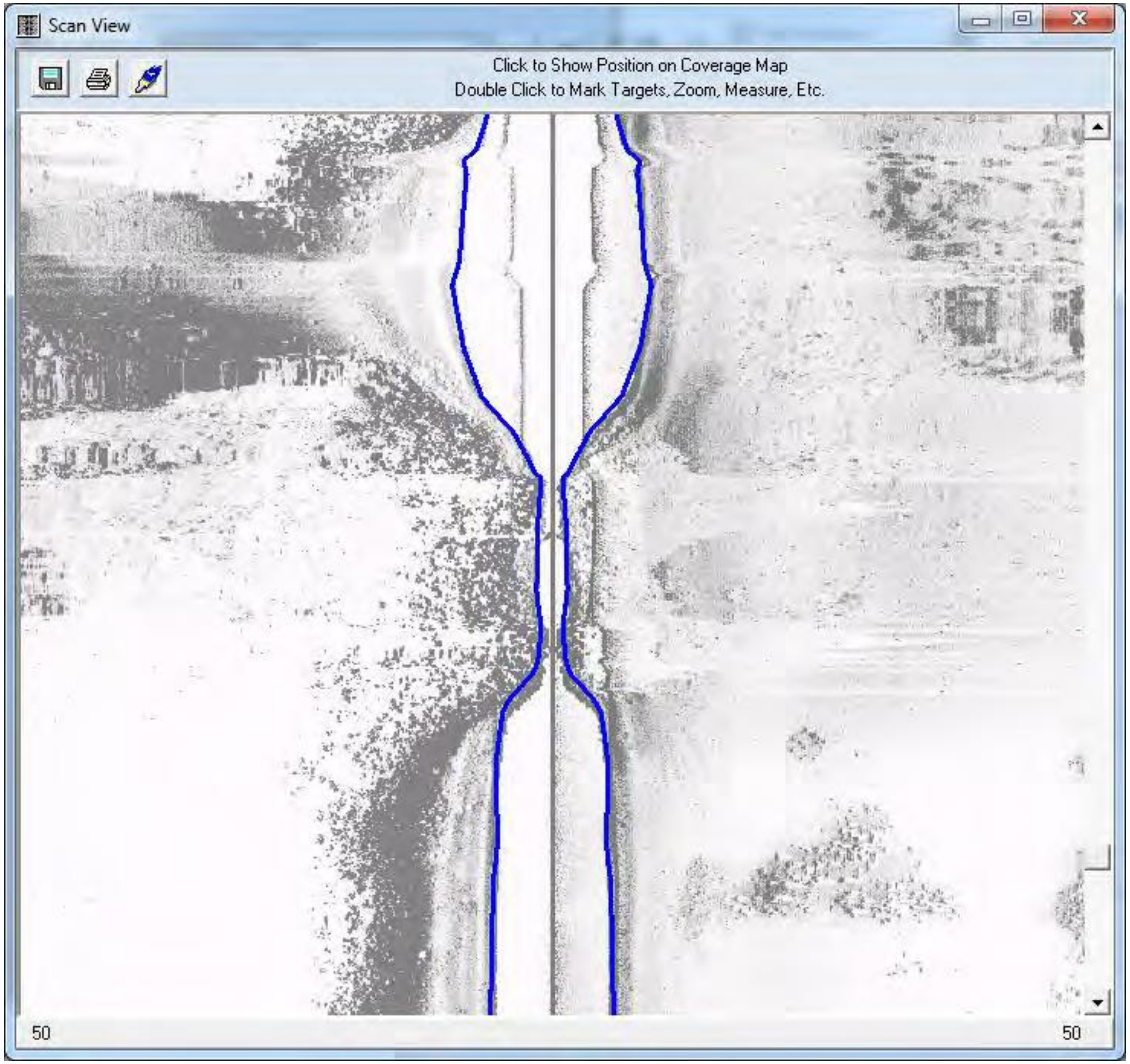
The bottom track provides

a visual display of how close the towfish

is to the bottom.

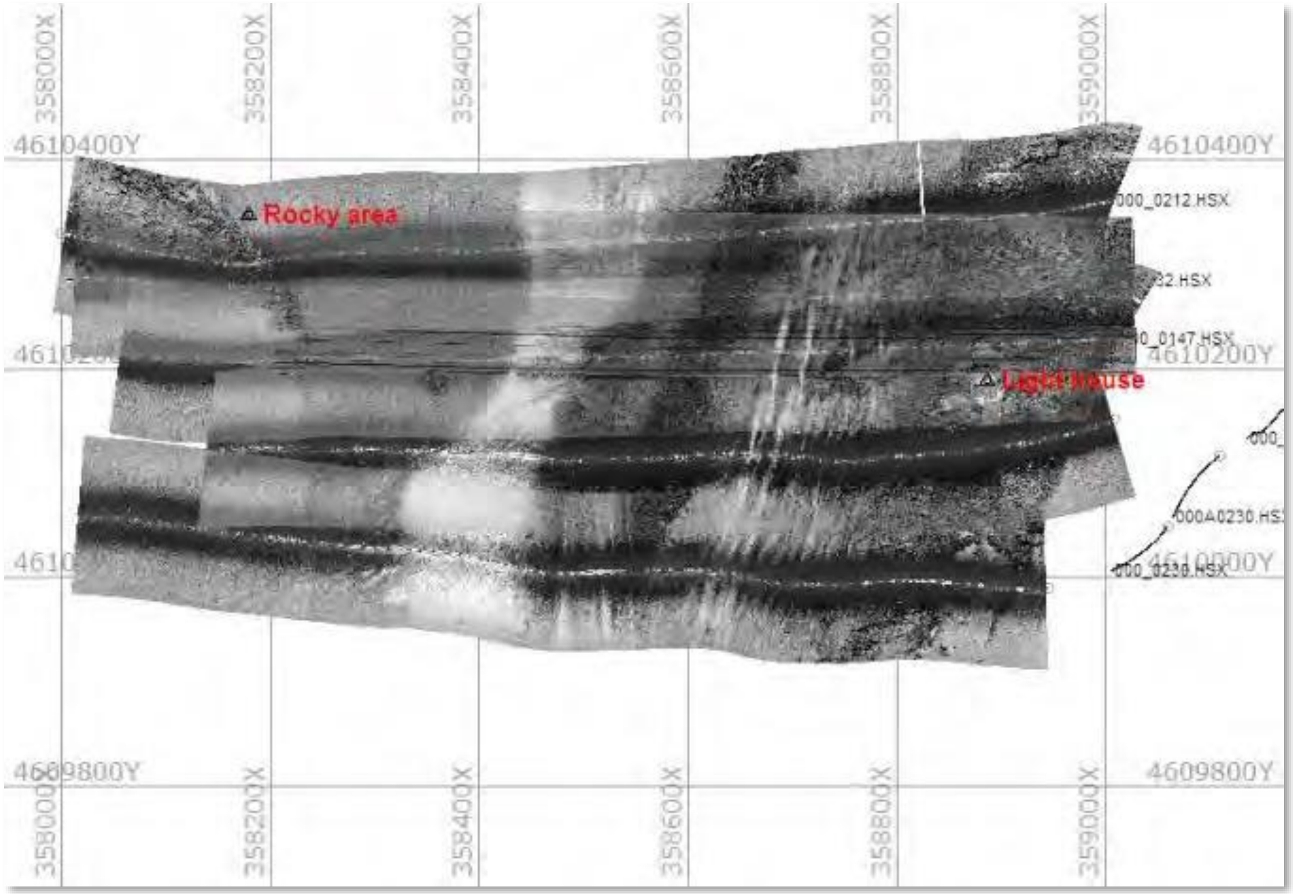
If the two opposite track get too cloose:

- Speed up the vessel
- Pull the cable in as fast as possible



MOSAIC

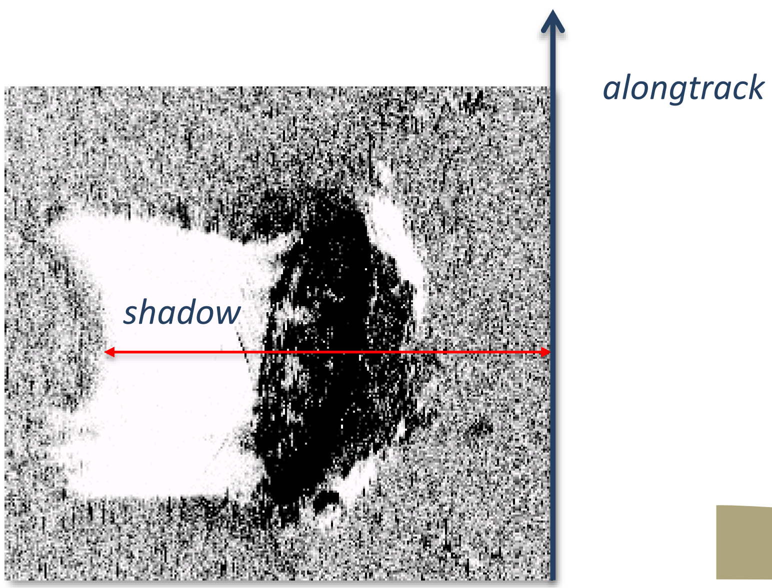
Survey lines can be merged together to provide a 2D representation of the seafloor and saved as a GeoTif file.

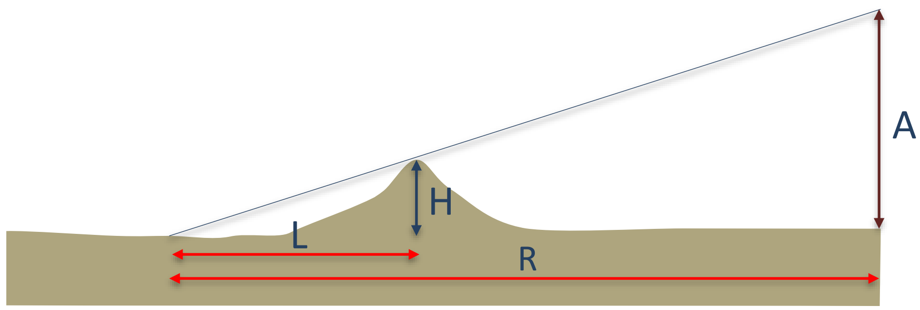


HEIGHT OF A CONTACT

- Altitude (A), from fish
- Shadow length (L), from direct measurement on waterfall view
- Total distance (R), from direct measurement

Height of Contact (H) = L * A / R





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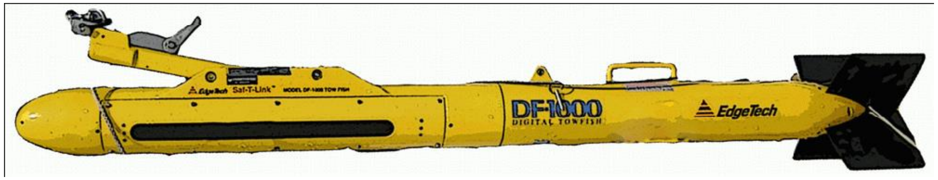
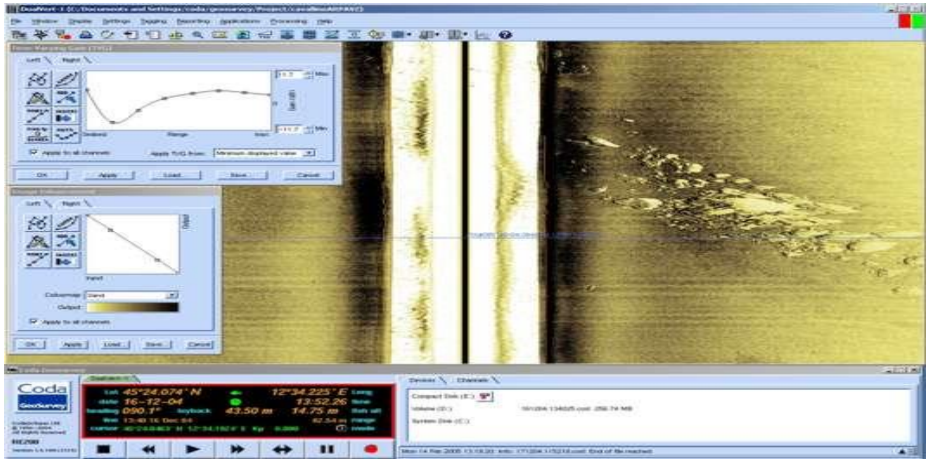
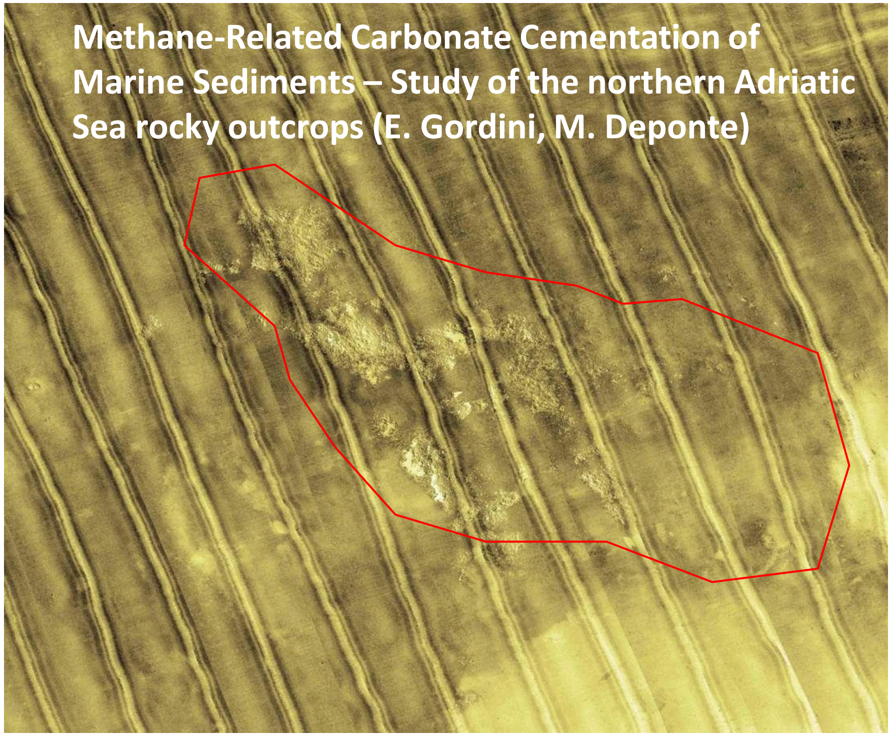


OPERATING FREQUENCY: 100 kHz – 400 kHz

PULSE LENGTH: 0.1 – 0.01 ms

HORIZONTAL BEAM WIDTH: 1.2°- 0.5°

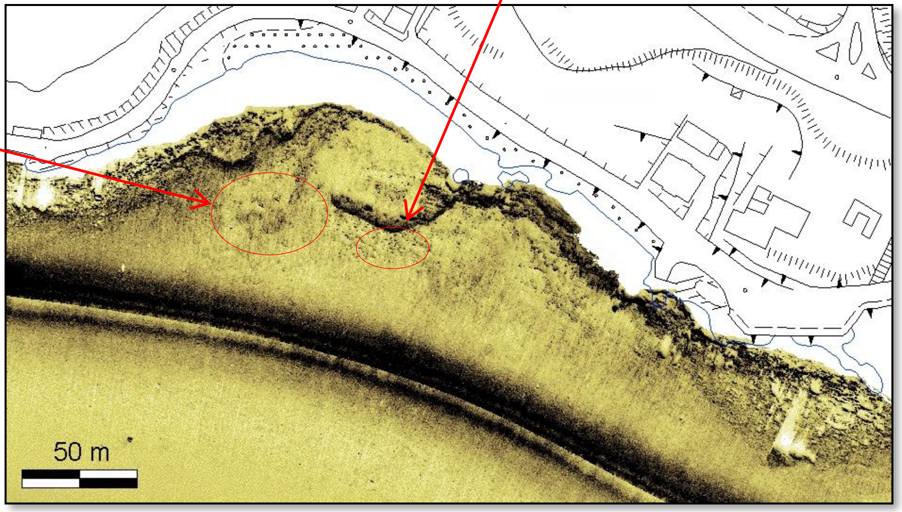




Caorle (northern Adriatic Sea) SSS mosaic. local high backscatter features indicating the occurrence of rock outcrops in a dominant sandy environment.

IMAGING OF SEAGRASS

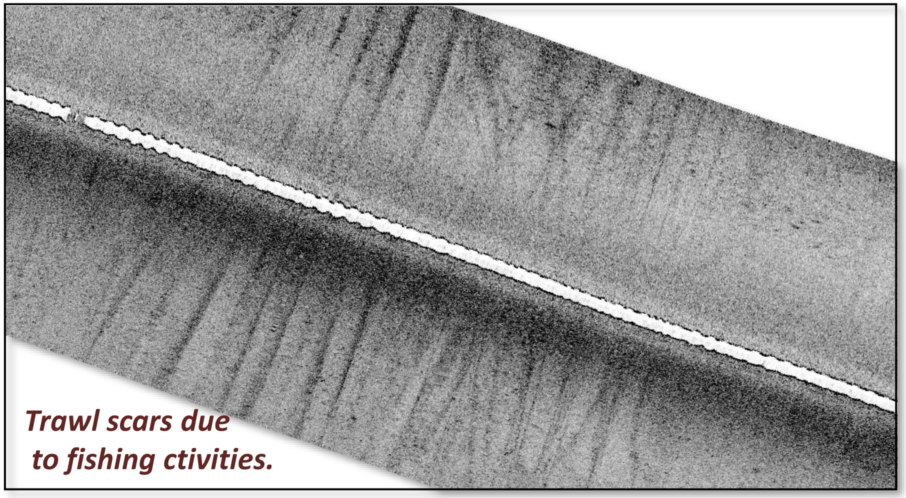
Seagrass (foto Ciriaco)

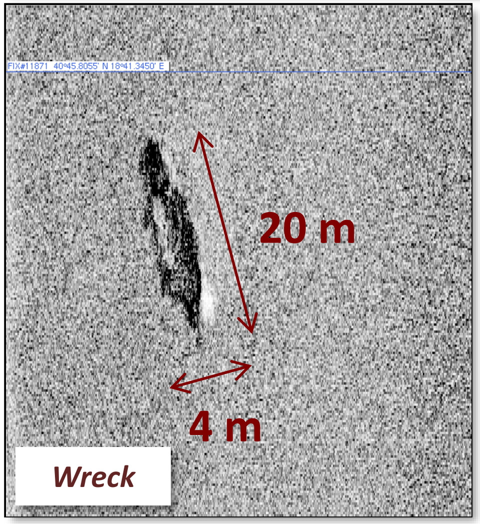


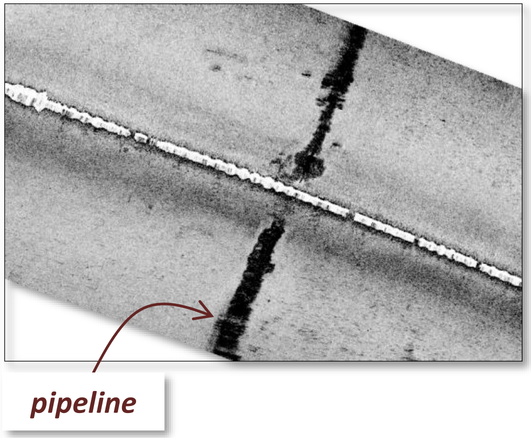
R. Romeo, 2009,PhD thesis.

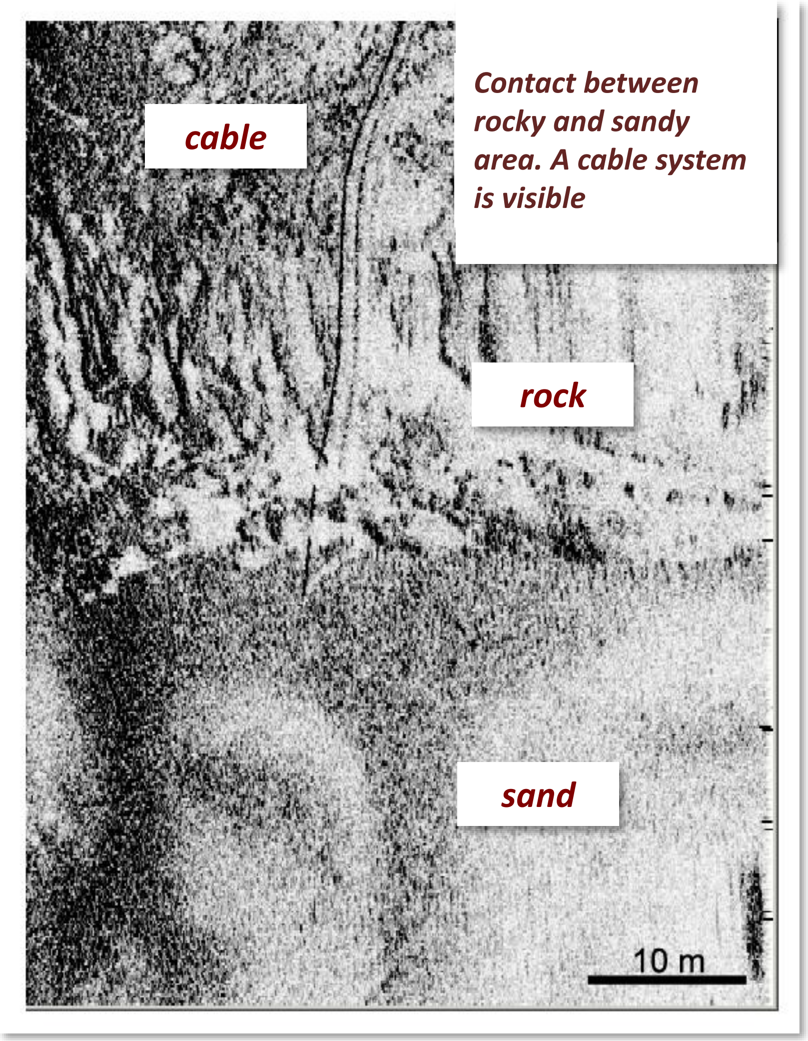
SIDE SCAN SONAR SEABED FEATURES

IMAGING OF SEAFLOOR HUMAN ARTIFACTS









OGS