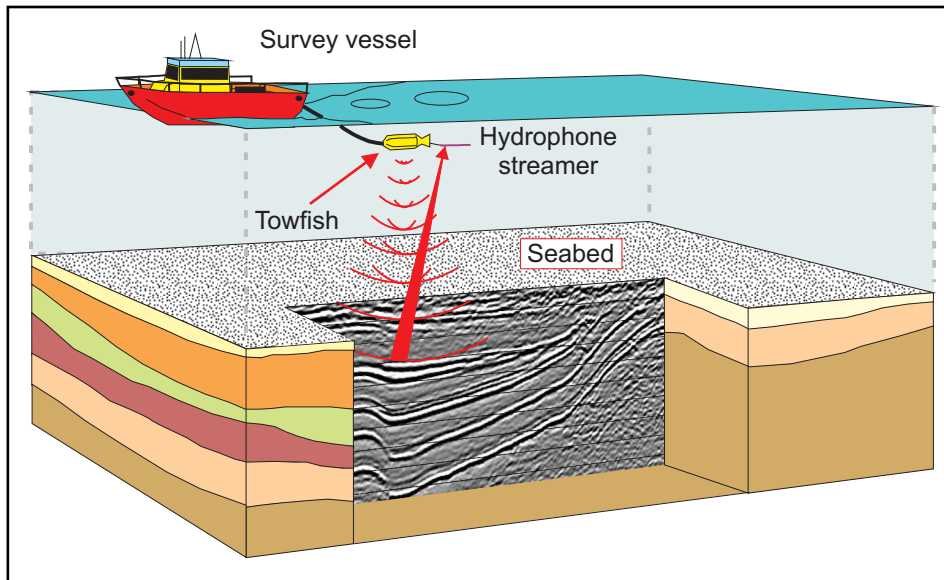


## High resolution over-water seismic reflection profiling

### Principles of operation

High resolution marine seismic reflection (aka *sub-bottom*) profiling produces continuous seismic sections to depths typically less than 500 m beneath the sea bed. Sub-bottom profiling systems employ the principle that a vertically propagating seismic pulse will undergo partial reflection at boundaries between media of differing density and acoustic transmission velocity. The acoustic pulse is produced by a source such as an electromotive plate, ceramic transducer or small-capacity airgun, which may be either hull-mounted or towed behind the survey vessel. Source selection is determined by the penetration and acoustic frequency range required; this is dictated by the depth to the base of the zone of interest. The reflected signals are measured using a hydrophone streamer towed either behind or alongside the source, with data being displayed and/or recorded on board ship. Sub-bottom profilers generally record a single channel of data, although some systems (e.g. those utilising airguns) record multiple channels of data at greater offsets.



**Figure 1:** Acquisition of single channel sub-bottom profiler data using towfish

### Applications and system choice

Choice of acquisition system depends upon the Client's requirements. Table 1 provides a rough guide to system capabilities:

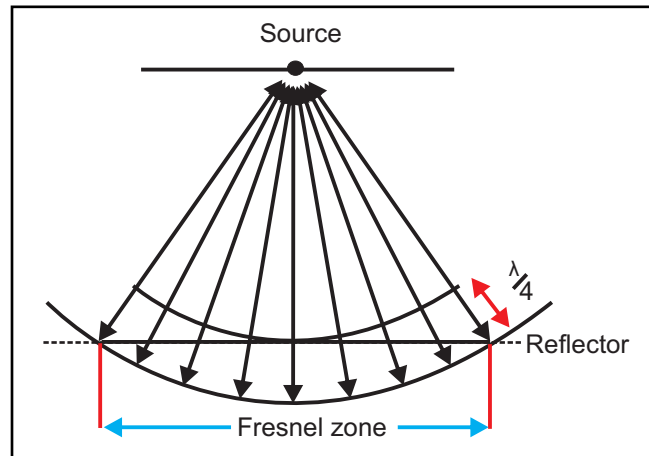
Source	Penetration (m)	Vertical Resolution (m)
Airgun	500	5-30
Sparker	500	5
Boomer	100-200	0.5-2
Chirp	20-40	0.3-0.6
Pinger	5-30	0.1-0.2

**Table 1:** Typical penetration and vertical resolution values for some common sub-bottom profiler sources.

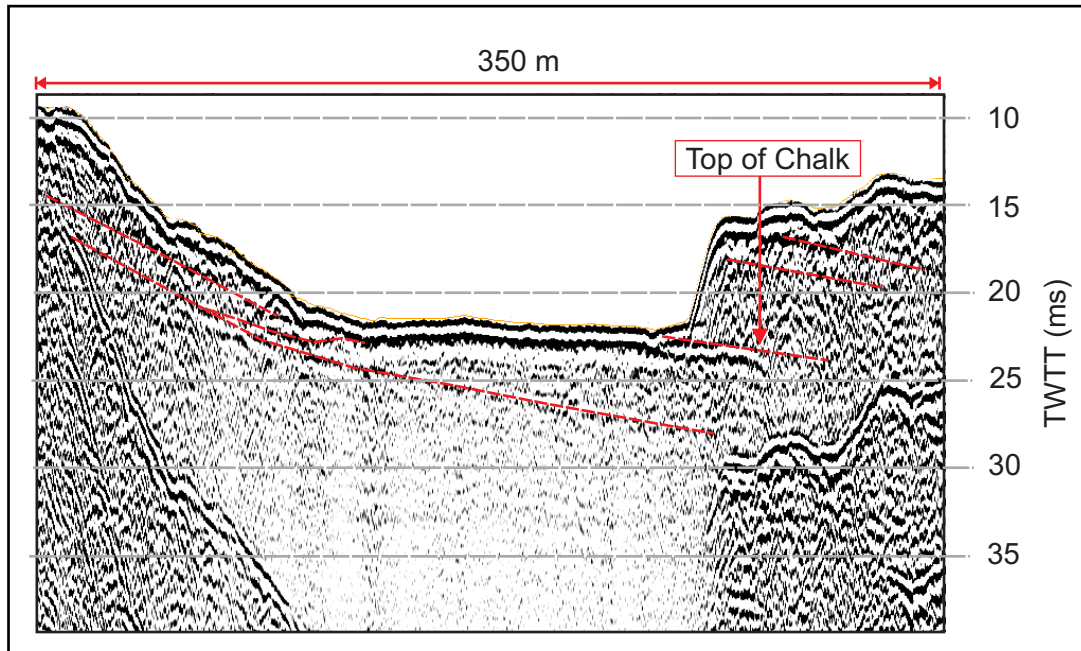
Vertical resolution can be defined by several criteria; the most common is that the resolution is equal to a quarter of the wavelength of the dominant acoustic frequency. Horizontal resolution is usually defined as being equivalent to the width of the first Fresnel zone, itself a function of signal frequency and sediment acoustic velocity (Figure 2, overleaf).

**Digital data acquisition and processing**

Digital data acquisition facilitates extraction of engineering parameters and post-survey processing of seismic data. Improvement of signal-to-noise ratios, removal of coherent noise and migration of data (Yilmaz, 2001) are common operations performed to improve section clarity. It should be stressed that the decision to post-process data should be made in light of the information required. Surveys with relatively simple aims (e.g. depth to bedrock), if properly performed, will require only hard copy output of raw data, whilst engineering or high-resolution stratigraphic investigations may require application of more complex data processing techniques. An example is shown in Figure 3.



**Figure 2:** Vertical and horizontal resolution: the first Fresnel zone, after Reynolds (2011).



**Figure 3:** Example boomer data from Woolwich Reach, London, showing structure in the Chalk (Lenham *et al.*, 2005).

**References and recommended reading**

Lenham, J.W., McDonald, R., Miller, S. and Reynolds, J.M. 2005. Seismic Investigation of Triassic sandstone bedrock depth, New Mersey Crossing. *Quarterly Journal of Engineering Geology and Hydrogeology*, **38**:7-22.

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Reynolds, J.M. 2011. *An introduction to applied and environmental geophysics*. John Wiley & Sons Ltd, Chichester & London, 2nd ed., 712 pp.

Yilmaz, O. 2001. *Seismic Data Analysis: Processing, inversion and Interpretation of Seismic Data*, Society for Exploration Geophysicists, 2,027 pp.