



Parametric Technology for High Resolution Sub-bottom Profiling



Innomar Technologie GmbH, Germany

THE LIMITS OF LINEAR SUB-BOTTOM PROFILERS

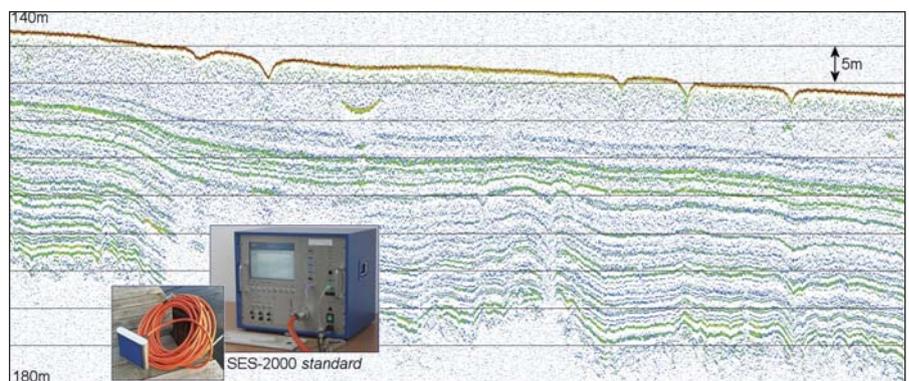
Common linear sub-bottom profilers (e.g. Pinger, Boomer) generate low-frequency sound pulses directly. Transducer dimension and transmit frequency determines the beam width, the appearance of side lobes, the footprint and in turn the lateral resolution. To transmit low-frequency pulses with narrow beams one would need large transducers. Furthermore these systems usually transmit rather long sound pulses and therefore get poor vertical resolution. Due to these combined properties such systems often are not applicable when used for short ranges such as in shallow waters or for ROV based surveys.

For deep water applications often chirp pulses (frequency sweeps) are used to increase the achievable vertical resolution. However linear chirp systems are still limited in their performance due to wide sound beams, the presence of side lobes and an increased volume and surface reverberation due to long pulses and wide beams.

NON-LINEAR OR PARAMETRIC TECHNOLOGY

A very successful approach to overcome the above mentioned problems is the use of non-linear or so called parametric technology. A physical effect is used, which generates low-frequency sound waves by transmitting two slightly different frequencies at very high sound pressure simultaneously. These primary frequencies interact during the sound propagation and the generated low-frequency pulses exhibit some very useful properties.

First of all, the sound beam is as narrow as the primary beam and does not show any significant side lobes. This directly improves the signal to noise ratio



Echoprint example obtained using the SES-2000 standard SBP (North Sea / Tomeliten area; water depth about 150m)

due to reduced bottom and volume reverberation and avoids the occurrence of ambiguous reflections. The transmitted pulses have no ringing effect and can be as short as one sine wave cycle. Therefore such parametric sound transmission results in very good lateral and vertical resolution. It is also important to note that these narrow beams are achieved with very small transducer dimensions, which makes parametric systems highly mobile. Furthermore, active beam stabilization and beam steering is possible. An additional advantage is the availability of the high frequency at the same time, which provides the user with a dual functionality, (like echo sounding for bathymetric surveys) in parallel to sub-bottom profiling.

INNOMAR PROFILERS

For more than 10 years now the German company Innomar Technologie GmbH has offered parametric sub-bottom profilers for different applications and a wide range of water depths including shallow-water (1 to 500 m) and deep-water operation (down to full ocean depth). These systems operate mainly with primary frequencies of about 100

kHz and generate low frequencies between 5 kHz and 15 kHz. Narrow sound beams with a total beam width of less than four degrees for all frequencies are produced in spite of small transducers.

Innomar offers profilers for different applications and wide range of water depths

Ping rates of up to 30 pings per second independent of water depth are especially useful for the detection of small-scaled morphological structures or embedded objects within the sediment.

Systems like the small and lightweight *SES-2000 compact* and *SES-2000 light* are widely used for numerous inshore and near-shore applications. This includes the determination of silt layers for dredging purposes and waterway maintenance as well as the search for and thickness determination of sand layers for dredging and marine construction purposes, like during the Palm Island project in Dubai.



A common task is the detection of buried objects, like pipelines or archaeological artefacts and structures. This application requires high resolution, especially close to the seabed, where common linear systems are quite limited in their usability. Furthermore, the scientific community successfully uses the *SES-2000* systems, especially when the application requires high mobility, for example during climate research in remote areas.

INNOMAR AND THE OFFSHORE INDUSTRY

Innomar provides also systems for more demanding applications and environments, like the offshore industry. The portable *SES-2000 medium* system with its actively stabilized sound beam is

SES-2000 medium system suitable for pipeline and cable route surveys, as well as site surveys

suitable for vessel based pipeline and cable route reconnaissance surveys, as well as for site surveys or geo-hazard surveys. The operational range covers the whole continental shelf with water depths down to 2000 meters. A system variant for ROV based surveys for detailed route and site investigations is also available and was used during the

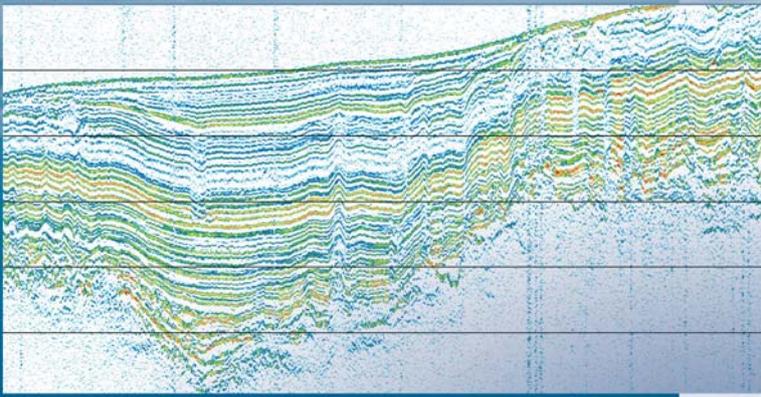
installation of the Langed gas pipeline between Norway and the UK.

For deep-water research activities a special system variant, the *SES-2000 deep*, is available. This parametric system uses primary frequencies of about 35 kHz to generate low frequencies in the range of 2 to 7 kHz and is applicable down to full ocean depth. |

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175 m
180 m
185 m
190 m
195 m

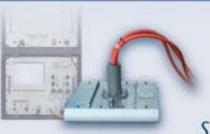
Frequency 8kHz, pulse length 375 μs (SES-2000 light), Baltic Sea



SES-2000 light | compact



SES-2000 standard



SES-2000 medium



SES-2000 deep



SES-2000 ROV

SES-2000 Parametric Sub-Bottom Profilers
Discover sub-seafloor structures and embedded objects with excellent resolution and determine exact water depth

- ▶ Different systems for shallow and deep water operation available
- ▶ Menu selectable frequency and pulse width
- ▶ Two-channel receiver for primary and secondary frequencies
- ▶ Narrow sound beam for all frequencies
- ▶ Sediment penetration up to 150 m (SES-2000 deep)
- ▶ User-friendly data acquisition and post-processing software
- ▶ Portable system components allow fast and easy mob/demob
- ▶ Optional sidescan extension for shallow-water systems




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