

Operating SES-2000 Sub-bottom Profilers on Small Boats

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Innomar Technologie GmbH

Among Innomar's SES-2000 sub-bottom profiler Series there are two devices that are particularly suitable for surveys on small boats: the SES-2000 *compact* and *light* systems. This application note describes both systems and gives examples for using these systems on small motor boats including rubber boats as well as a remote-controlled catamaran. The handling of the device on small boats is described and some echo prints showing the system performance are given.

SES-2000 *compact* and *light* sub-bottom profilers for small boats



SES-2000 *compact*

Size: 0.30m × 0.40m × 0.35m
Weight: 23kg

The system unit contains all the transmitter and receiver electronics. For system control and data recording an external PC or notebook (connected via USB) is used.



SES-2000 *light*

Size: 0.52m × 0.40m × 0.38m
Weight: 38kg

The system unit contains all the transmitter and receiver electronics as well as an integrated PC and TFT display for system control and data recording.



Transducer

Size: 0.3m × 0.26m × 0.07m
Weight: 25kg (incl. 20m cable)

The transducer consists of piezoceramic elements with an active area of about 0.22m × 0.22m (blue area in the picture) inside a streamlined stainless-steel housing. There are six M8 bolts on the upper side of the housing to fix the transducer.

The SES-2000 *compact* system is the smallest parametric sub-bottom profiler available today. The SES-2000 *light* system comes with integrated control unit and TFT display, there are no external components necessary. For this system a water protected cabinet is available as shown on the picture above.

Both systems, the SES-2000 *compact* and SES-2000 *light*, are mainly used in shallow inshore or near shore waters. But there were also successful applications in water depths of more than 400 meters.

The envelope of the received signals in the selected recording range for both, the HF (100kHz) and the LF channel (5 – 15kHz), are stored digitally together with navigation data and system parameters for post-processing.

SES-2000 compact / SES-2000 light Technical Data

Frequencies (LF / HF)	5, 6, 10, 12, 15kHz selectable / 100kHz fix
Primary source level (100kHz)	> 236 dB/μPa @ 1m
3dB Beamwidth	±1.8°
Pulse length	66 – 800μs
Pulse rate	≤ 50 pings per second
Water depth range	1 – 400m
Recording range	5 – 200m
Data recording	2 channels (LF / HF) envelope of the selected range
Sediment penetration	up to 40m (depending on sediment, frequency, noise level)
Multiple target resolution	> 5cm (depending on frequency and recording range)
Heave / Roll / Pitch compensation	✓ / – / –
Power consumption	< 800W (115-230V AC +5% / -10%, 50-60Hz)
Operating temperature	0 – 40 °C
Input	Navigation data (GPS); Motion sensor data

Side-scan extension

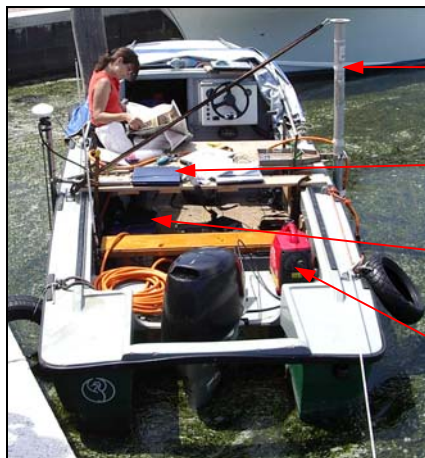


Optionally there is an additional side-scan transducer available to use the SES-2000 *compact* and *light* systems as digital side-scan device. The transducer fixing on the ship is the same as for the sub-bottom profiler transducer.

Frequency:	100kHz
Pulse length:	100 – 250μs
Beam width:	±0.9° / ±35° (along / across track)
Transducer angle:	40° or 60°
Recording range:	20 – 200m

Surveying the Lagoon of Venice using a small motor boat

In 2005 Innomar staff carried out a demo survey for the Marine Science Institute Venice¹ in the Lagoon of Venice using the SES-2000 compact system on a small motor boat. During this demo the SES-2000 sub-bottom profilers should be tested to produce pictures from the sub-seafloor in very shallow water (water depth about 1m) and to detect embedded archaeological objects like foundations of sunken buildings.



pipe for transducer mounting

notebook (control unit)

SES-2000 compact main unit

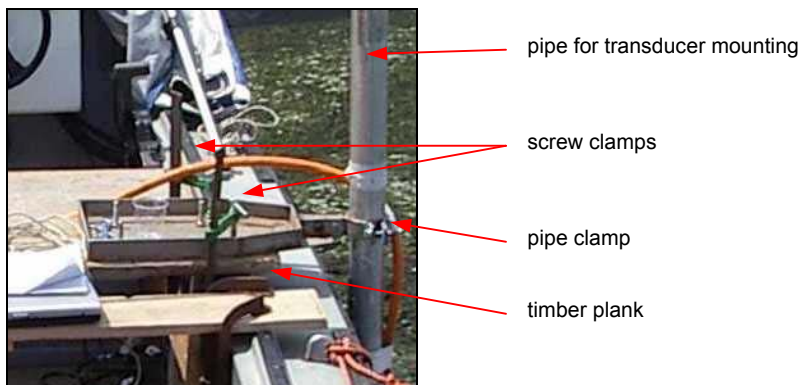
power supply (1kW generator)



Survey boat with installed SES-2000 *compact* sub-bottom profiler.
(Due to the bright daylight it was necessary to protect the TFT display of the notebook using a cardboard box, see right picture.)

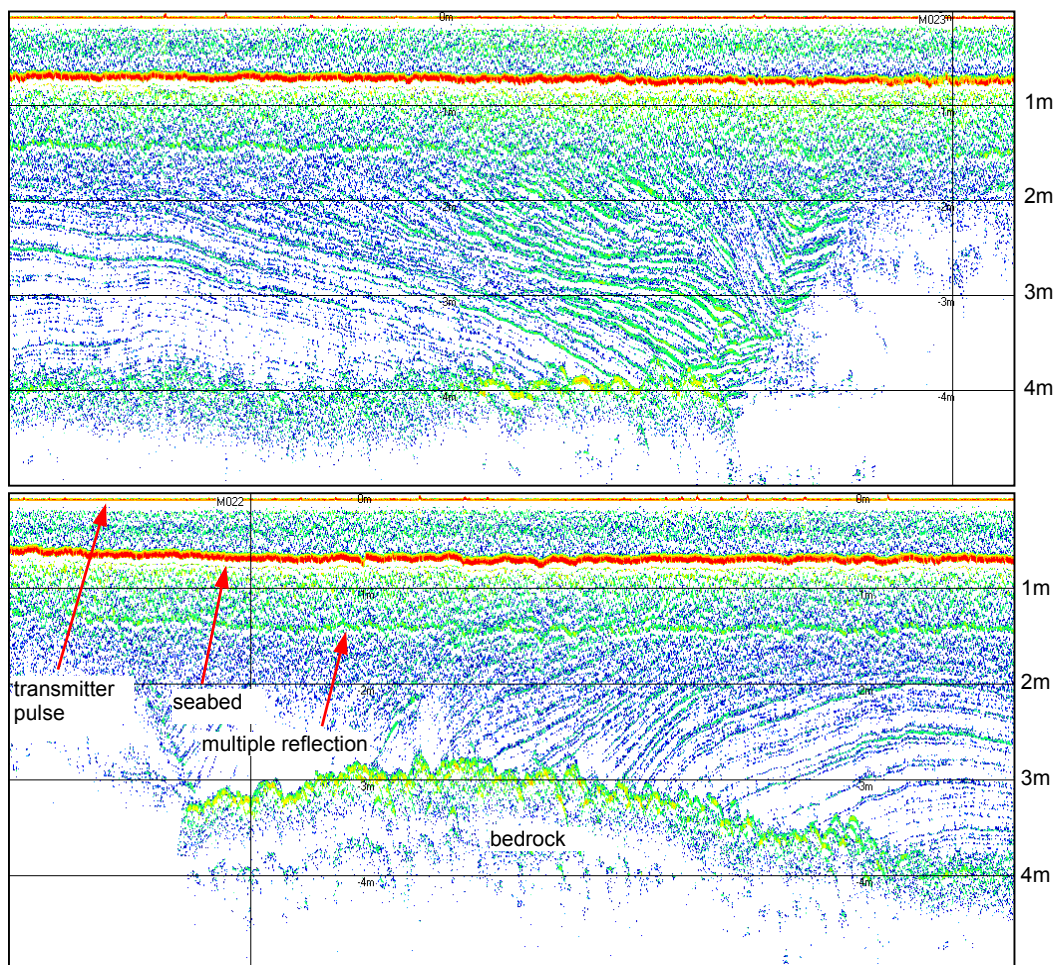
¹ Instituto di Scienze Marine, CNR

The transducer was fixed on the side of the boat using a pipe. The pipe was mounted on a plank that was fixed on the boat using four screw clamps, see figures below. As power supply for the SES-2000 system a Honda generator EU10i was used.



Transducer mounting at the survey boat using a timber plank fixed with screw clamps.

In the next figure two echo prints proving a penetration of more than 3m at a water depth of about 80cm are shown. This is only possible in very soft sediments and strong reflectors below the multiple return of the seabed echo. A problem with penetration that is often seen in shallow water, especially in inshore areas during summer, are gassy sediments.² Due to the warm water biologic productivity is high and a lot of organic material on the seafloor and/or the upper decimeters of the sub-seafloor causes a lot of tiny gas bubbles that make it almost impossible to penetrate the seafloor with acoustics.



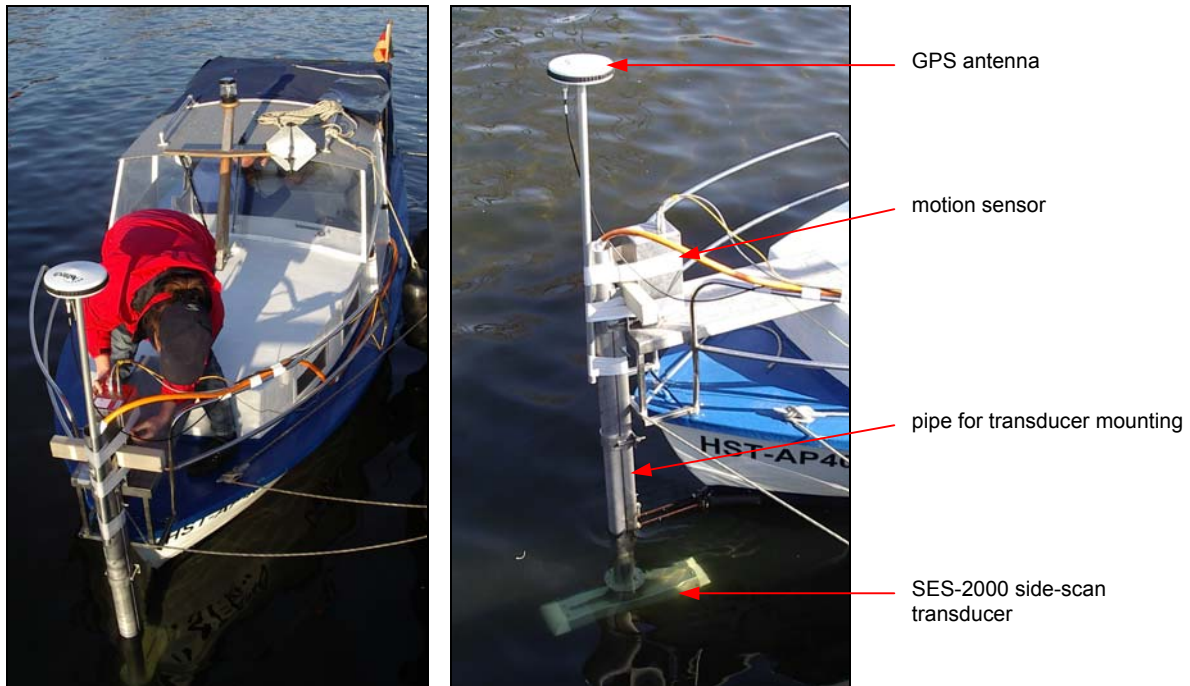
Echo prints obtained in the Lagoon of Venice showing a penetration of more than 3m at a water depth of about 0.8m.

² See also Innomar's application note "Sub-bottom profiling and gassy sediments".

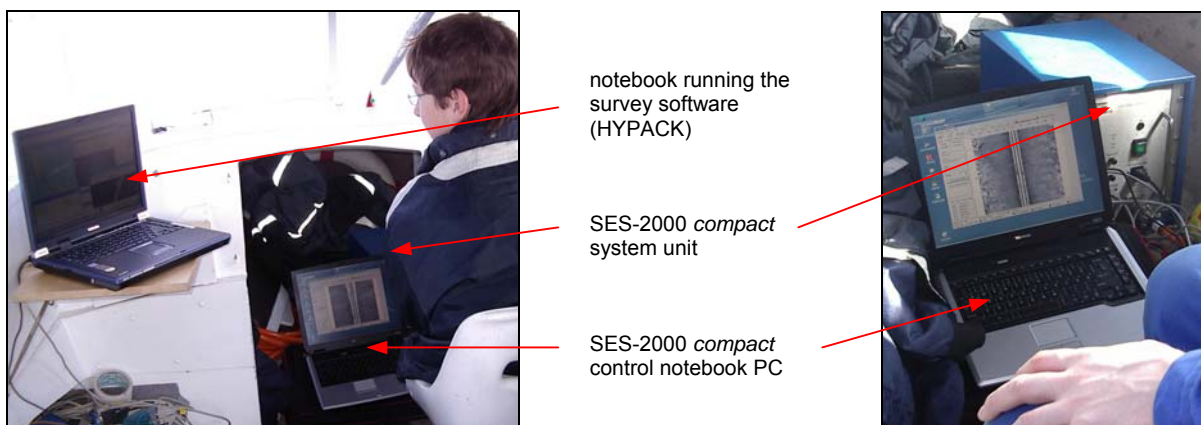
Surveying a shallow backwater area using a small motor boat and a remote-controlled catamaran

In the frame of two geological research projects hosted at the Baltic Sea Research Institute Warnemünde the late Holocene sediments at the Salzhaff area off Rerik/Germany should be investigated to contribute to a profound understanding of sedimentation processes in the Bay of Mecklenburg. The water depth in this area is between 0.5 and 5 meters. To get the best locations for coring, the area was first mapped using the SES-2000 *compact* sub-bottom profiler as well as the SES-2000 side-scan sonar extension.

The transducer was mounted at the survey boat's bow using a pipe as shown in the figures below. For heave compensation the ship's movements were measured with a motion sensor (Kongsberg-Seatex MRU-Z) that was positioned closely to the transducer.



Transducer mounting at the bow of the survey boat



SES-2000 *compact* during side-scan operation

Large parts of the surveyed area are extremely shallow and it is not possible to enter these areas using a survey-boat. Therefore a small catamaran was used to carry the sonar equipment, see figure below.

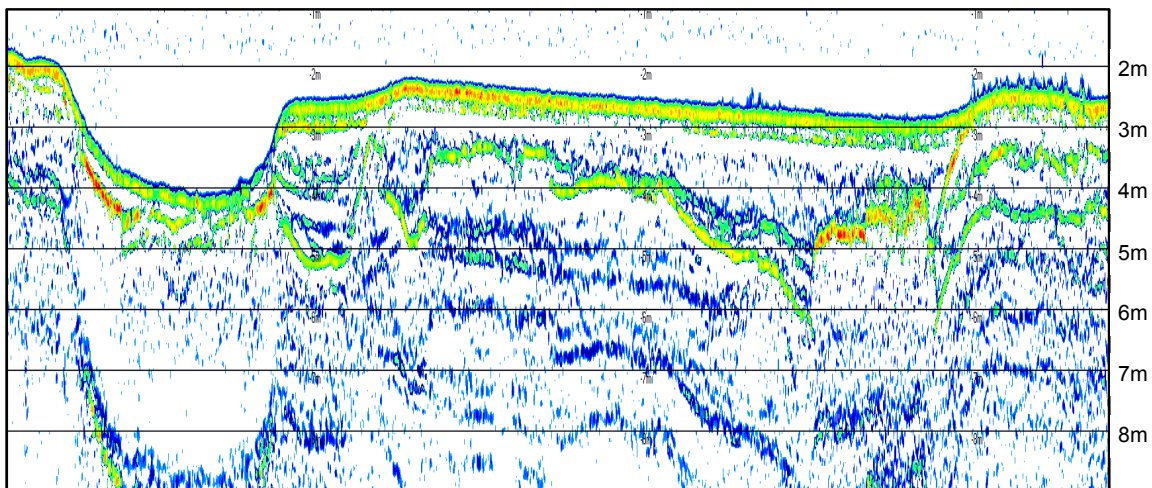
The catamaran is remote-controlled via UHF (433MHz) radio link and is able to carry up to 100 kg user load. The SES-2000 *compact* sub-bottom profiler was controlled remotely using an additional SHF (2.5GHz) radio link.



Survey catamaran MESSIN during operation

Length	3.3m
Width	1.7m
Draught	max. 0.4m
Weight	175kg
User load	max. 100kg
Propulsion power	2 × 400W
Speed	max. 3.5kn
UHF Radio link	9.6 kBaud (7.5km)
SHF Radio link	115 kBaud (1km)

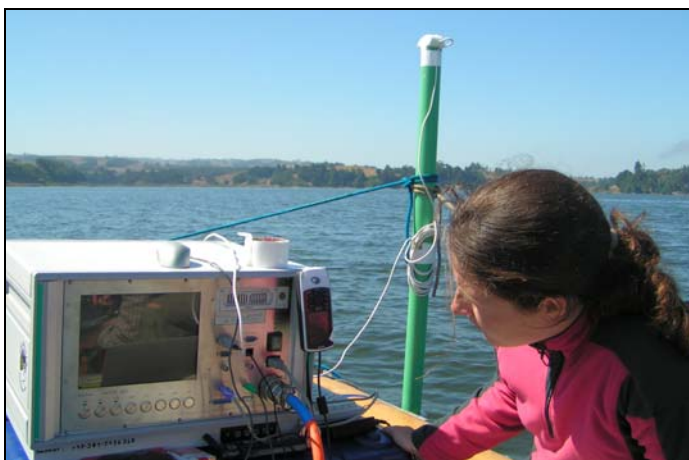
Catamaran technical data



Echo print example from the Salzhaff area showing a sediment penetration of about 3m at a water depth of about 2m.

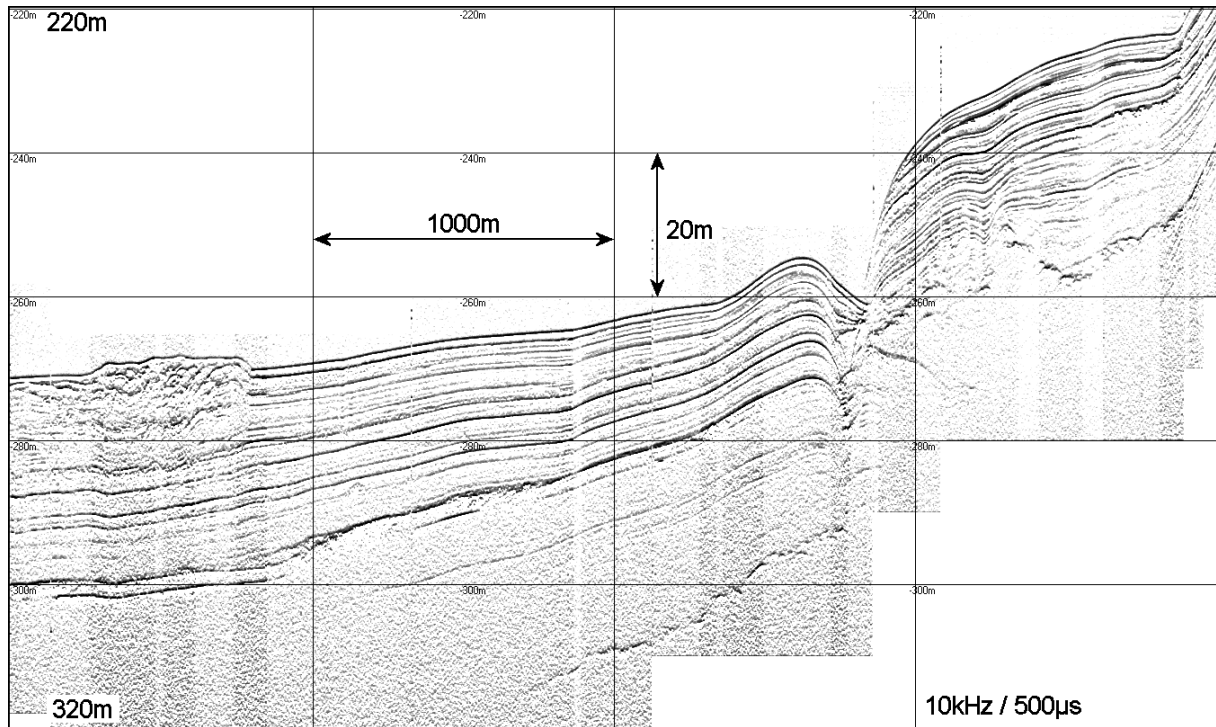
Surveying lakes using a rubber boat

The Institute of Geography of the Friedrich-Schiller-University Jena (FSU) operates a SES-96 *light* system (predecessor of the SES-2000 *light* system) since the year 2000. This system was used during several expeditions on small ships, including rubber boats. The following picture shows the SES-96 light system installed on a rubber boat. The transducer was mounted on the boat using a pipe and a supporting metal plate.

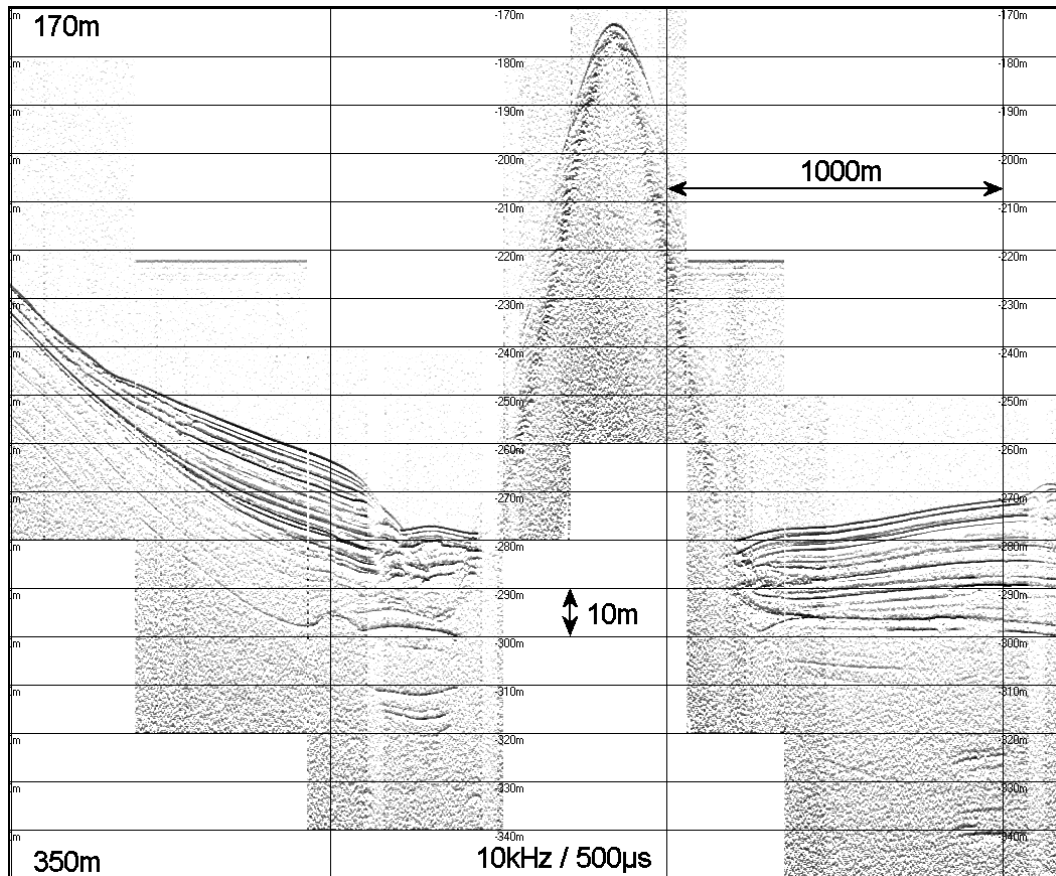


SES-96 *light* operated on a rubber boat. On the right hand picture the metal plate supporting the pipe can be seen, this time fixed at a ladder on board of a small motor yacht. (Photos courtesy of FSU Jena)

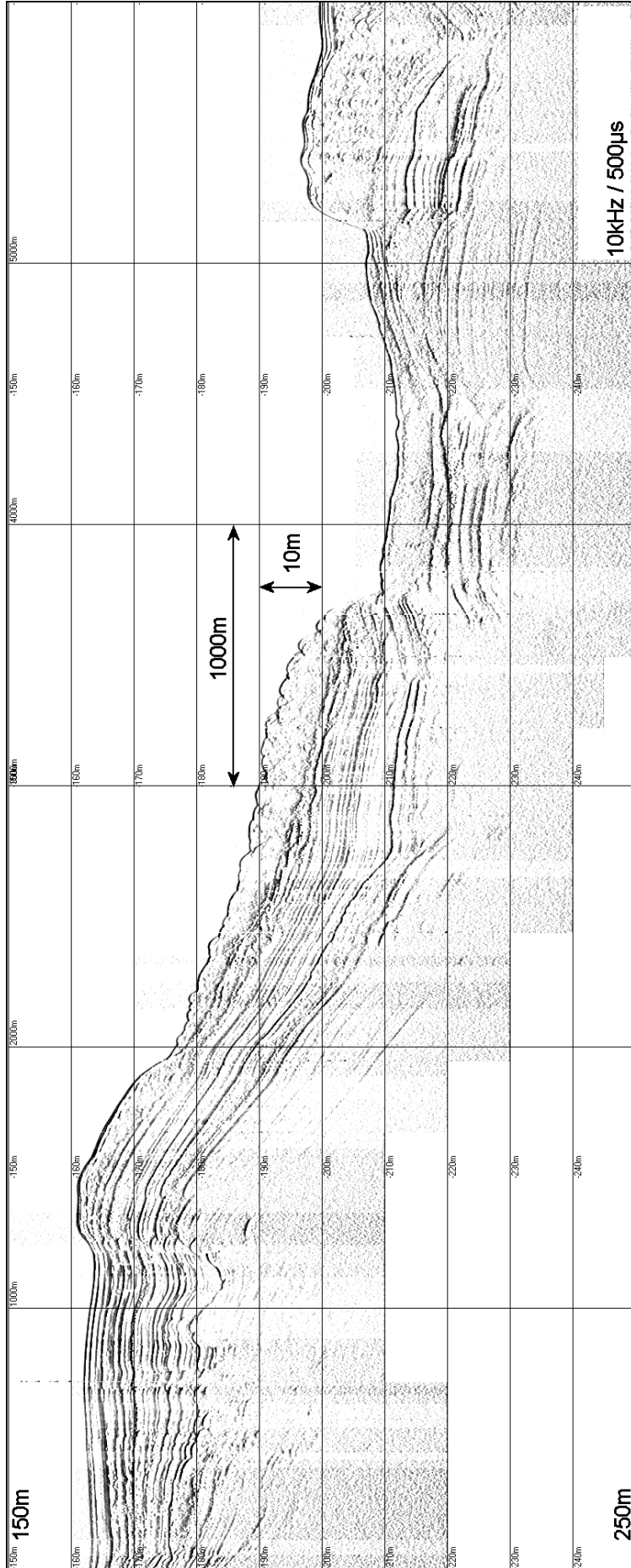
The next pictures show echo print examples, obtained during two expeditions using the SES-96 *light* system in 2005.



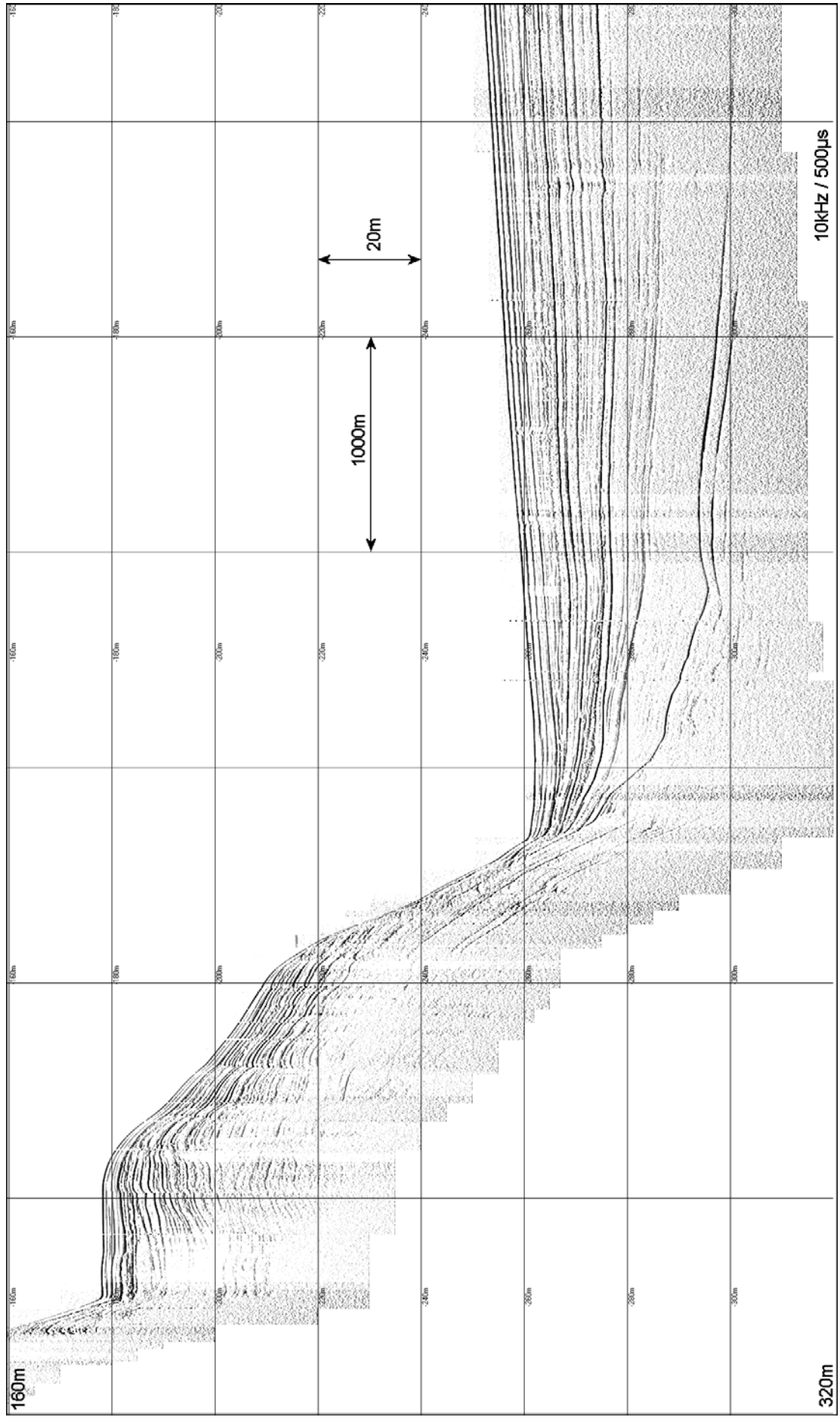
Range: 100m; Frequency 10kHz / 500µs (Data courtesy of FSU Jena / Germany)



Range: 180m; Frequency 10kHz / 500µs (Data courtesy of FSU Jena / Germany)



Range: 100m; Frequency 10kHz / 500µs (Data courtesy of FSU Jena / Germany)



Range: 160m; Frequency 10kHz / 500µs (Data courtesy of FSU Jena / Germany)