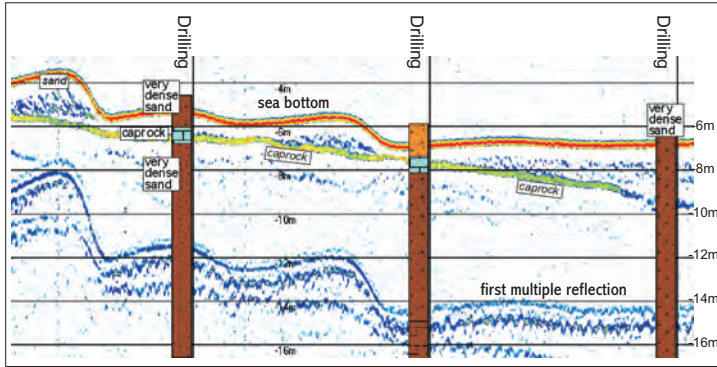


Coastal engineering projects often involve shallow waters where standard exploration and production facilities cannot be deployed. We use specialized high-resolution seismic tools to investigate the sea bottom and its subsurface:

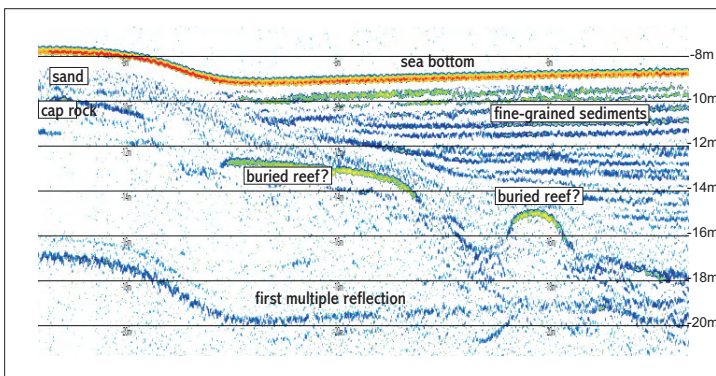
Sub-bottom sonar and MASW (multi-channel analysis of surface waves).

The aim is to map and characterize the geological subsurface: cap rock, limestone, sand deposits and fine grained sediments.



Echogram from sub-bottom sonar with drillings, confirming cap rock found in survey.

Our sub-bottom sonars have a highly focussed beam with a very small foot-print on the sea bed. It provides accurate water depth, shows objects on the sea bottom like pipes, and resolves reflectors in the subsurface like cap rock, buried reefs and layering.



Echogram from sub-bottom sonar detecting a sunken reef or cap rock layer.

Exact positioning of the data is recorded on-line through the navigation system of the ship. The survey speed is usually 3-5 knots depending on water depth. Roll and pitch are corrected in real-time by a motion sensor. Up to 100km of profile can be survey per day. Data processing and interpretation are done in a semi-automatic way using specialized software.

Multi-channel-analysis of surface waves (MASW) is a relatively new seismic method to investigate the shallow subsurface down to about 30m of depth. It uses surface (Rayleigh-) waves to produce shear-strength profiles and ground-velocity maps.

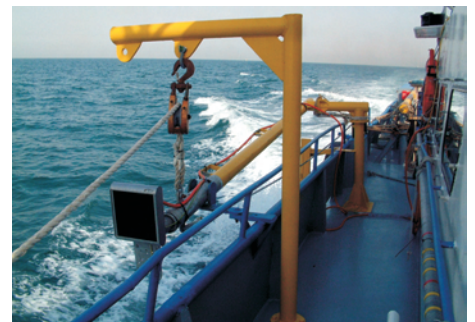
A seismic source is dragged along the sea bottom. Each shot causes a seismic wave which is recorded by a hydrophone streamer dragged behind and analysed upon its content in shear waves. Shear stiffness is derived from the shear wave velocity and associated depth information from the frequency content. The survey is done with 3-5 knots. More than 500 shots with one shot every 25m can be done in a day.



Survey vessel for sonar and MASW



MASW-survey off-shore Saudi-Arabia

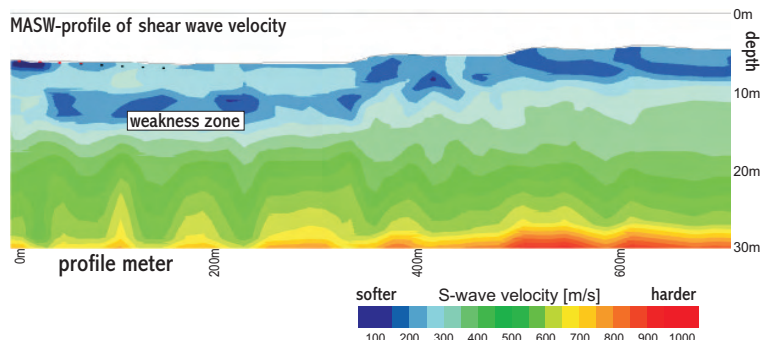


Transmitter/receiver of sub-bottom sonar



MASW-equipment (air gun and hydrophone chain)

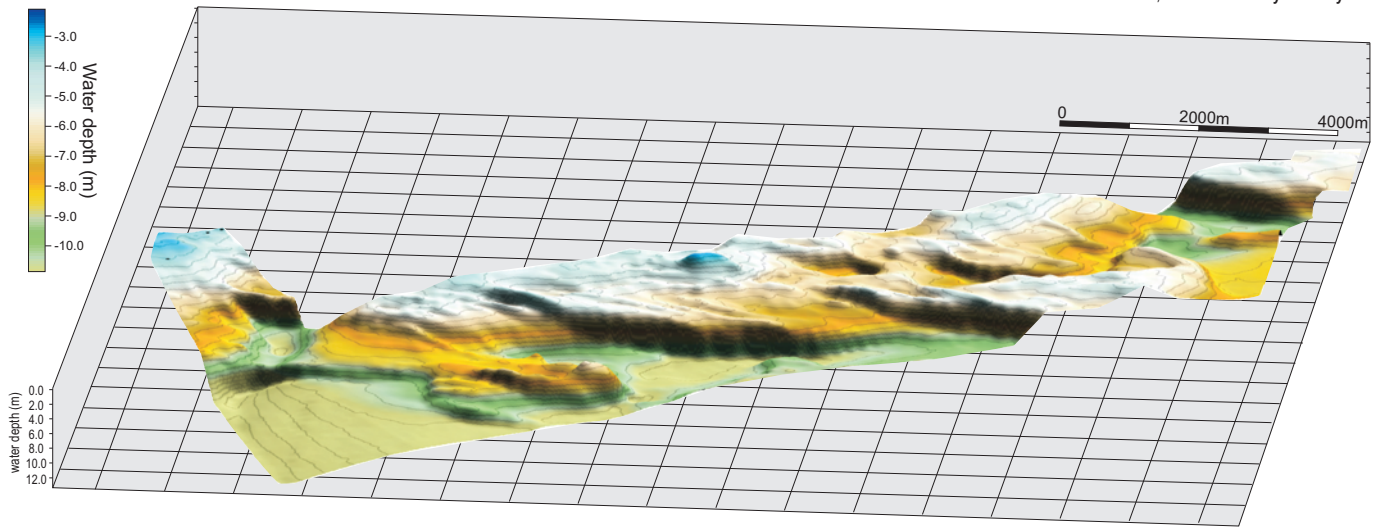
MASW-profile of shear wave velocity



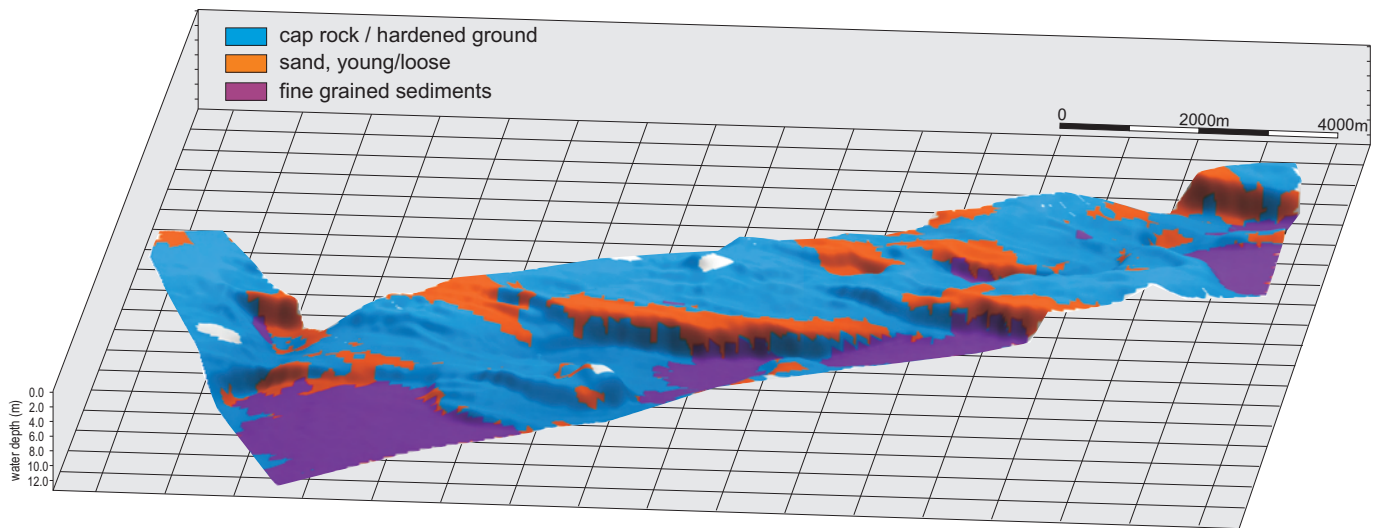
Examples:

Bathymetry from sub-bottom sonar

Survey grid along cross lines 200m x 200m, about 1200km total, time for survey: 20 days



Lithology at sea bottom, identifying areas of loose sands, fine-grained sediments and cap rock



P-wave velocity to identify cap rock and unconsolidated sediments at sea bottom

