VHR 3D subbottom imaging

Conventional subbottom profiling techniques (using boomer, sparker or echosounder) result in a 2D image of the sub-seafloor. Through close line-spacing and using interpolation techniques a pseudo-3D image of the subbottom can thus be constructed. This approach will in most cases give good results in landscape reconstruction, but small details in the subsurface structure (meter and sub-meter scale) will be missed or lost during the interpolation process. In other words, archaeological artefacts will easily be overlooked.

True 3D imaging of the sub-seafloor with very high spatial resolution is a complex matter due to the physical constraints placed on sampling and positioning accuracy. Recently, two commercial systems have been developed that are focused on the detection of buried objects.

The first system concerns a 3D Chirp system (© Applied Acoustics). It incorporates a rigid frame (2.75 m wide by 2.3 m long) that contains the Chirp source array (4 transducers) together with 60 receiver elements. Positioning is provided by integrated real-time-kinematic GPS. Frequency range is 1.5–13 kHz. A 3D image of the sub-seabed is obtained with dm-scale horizontal and vertical resolution. The system can be surface towed from a small survey vessel. Data processing includes a.o. geometry corrections, correlation, binning, and pre-stack migration. The system is typically applied for the detection of buried objects or structures (eg. small trenches or dams) but also to image buried shipwrecks.

The second system concerns a multi-transducer parametric echosounder system developed by Innomar. A line array of up to 5 transducers are fix mounted to a survey platform (thus avoiding complicated positioning correction) on a small vessel. The distance between two transducers is variable, depending on the structure size to be investigated. Frequency range is 5-15 kHz. A 3D subbottom image is obtained with cm resolution vertically and dm resolution laterally. The data set is immediately ready for 3D visualization with volume rendering methods after data acquisition (no migration processing is needed). The multi-transducer parametric array has been tested on archaeological sites containing a buried wooden structures.

Literature

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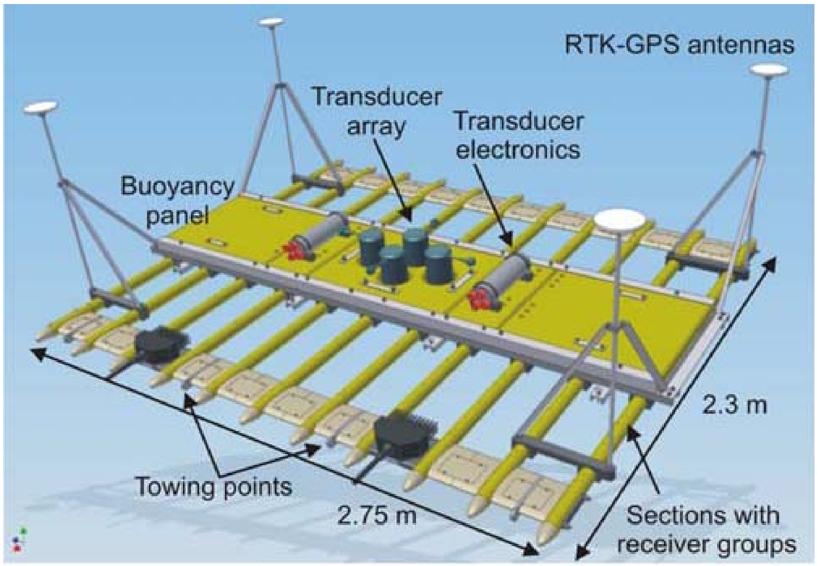

Fig. 1 3D Chirp array (© Applied Acoustics)


Fig. 2 Multi-transducer parametric echosounder system (©Innomar)

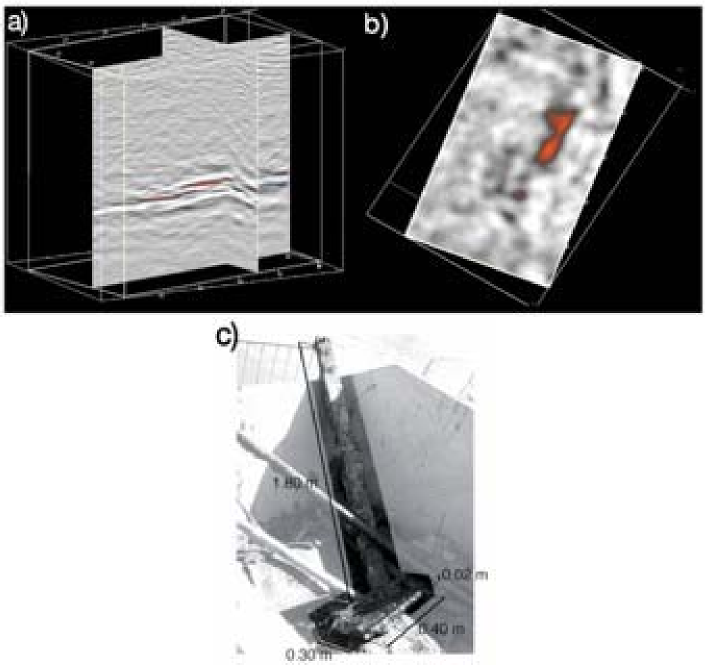

Fig. 3 (a) Two cross-sections and (b) time slice through 3D Chirp volume highlighting amplitude anomaly at a depth of 1m bsb. (c) Photograph of wooden pole (1.8 m x 0.13 m x 0.1 m) and attached metal sheet (0.40 x 0.30 m) retrieved by using a mechanical grab. (© Vardy et al. 2008).

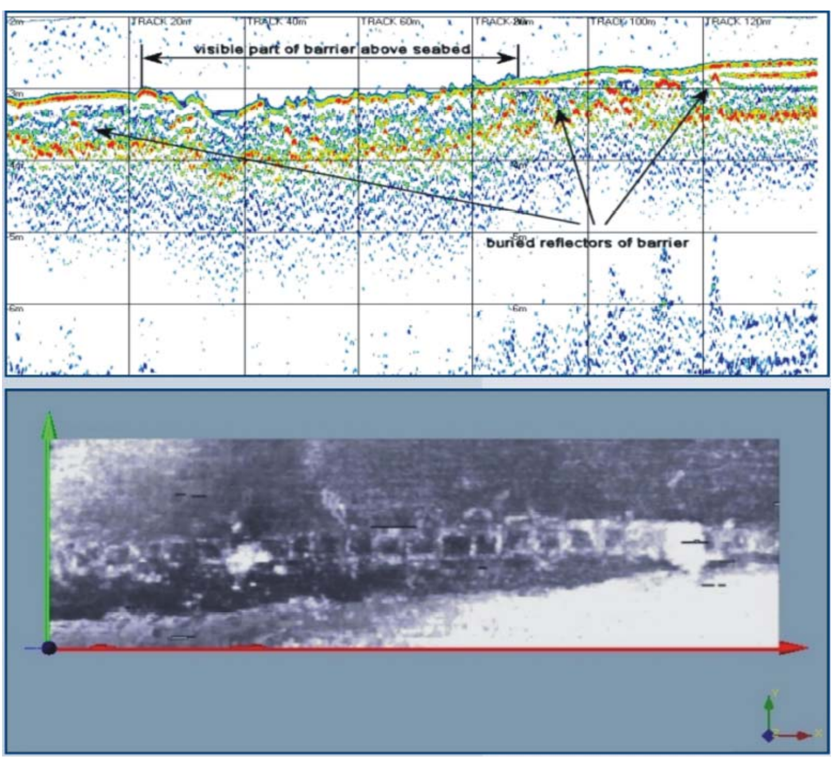

Figure 4: Multi-transducer parametric echosounder survey across a buried Viking site. Top: single sub-bottom profile of a buried wooden structure. Bottom: time slice through the 3D volume at the depth of the structure (approx. 30cm below seabed), showing individual crates over the whole area and some possible debris locations. size of area 130m x 40m, water depth ca. 3m. (© INNOMAR)