MODERN APPLICATIONS OF MARITIME TECHNOLOGY

EUGENIUSZ KOZACZKA

Naval University of Gdynia 69, 81-103 Gdynia ul. Smidowicza 69
Gdańsk University of Technology, ul. Narutowicza 11/12 Gdańsk

In recent times, we have been observing a significant development of acoustic methods in underwater research. At the same time, we have easier and cheaper means of access for acoustic sensors to survey with a greater detail and more precise positioning of underwater objects. Recently, detailed investigation of underwater military, but not only the applications, has involved state-of-the-art technologies.

Detection and examination of the shallow as well as deep underwater areas, using advanced technologies, have opened a new era in the ocean science. The human-operated vehicles, remotely operated vehicles and autonomous underwater vehicles have been employed for this purpose with great success. A new method of underwater observations, namely the acoustic time reversal method, has been applied in ocean investigations.

INTRODUCTION

The hydroacoustic devices used in underwater techniques have nowadays more efficient and more universal character. Few can remember the simple devices for passive determination of the source direction with the use of two detectors, whose signals were delayed in relation to each other, allowing for determination of the source direction in two-dimensional system. Progress in the development of the research tools, and the ones used for observing the underwater space, is so impressive that it is difficult to describe in few sentences.

Equally important is the research of the seabed, both from the cognitive and applicative point of view. Detection of the objects that are silted or situated under the surface of the bottom is important not only because of the military or economic, but also the cultural applications.

Moreover, underwater archaeology widely uses methods based on the application of acoustic waves. The more and more common application of underwater vehicles, initially man-operated, then remotely-operated, and presently autonomous underwater vehicles, equipped with advanced research instruments, provides further opportunities for thorough research of the underwater areas, especially of the seabed.

Current application of underwater acoustics can be considered, in great simplification, in the following categories:

- active and passive hydroacoustics, applied in stationary and mobile objects;
- precise underwater navigation;
- underwater communication;
- research on underwater environment;
- seabed exploration;
- drawing underwater sea maps;
- safety and control of the traffic and the underwater areas;
- monitoring of the seismic activity in underwater areas;
- monitoring of the underwater mining equipment;
- supporting underwater archaeological exploration;
- special activities;
- other.

Apparently, the list of tasks is long itself, and their realisation is extremely important, either form the economic, military, cultural and cognitive point of view. Their fulfilment poses a great challenge before modern technologies, and, at the same time, it is a significant task of scientific and cognitive character.

1. MODERN METHODS APPLIED IN UNDERWATER ACOUSTICS

Taking in consideration the current status of the development of underwater acoustics, it is impossible to specify its all achievements. Thus, in the paper, only some of the methods, relatively new in applications, which have significant impact on the progress in research and applications of underwater acoustics, will be presented.

They include, among others:

- Ocean Acoustic Tomography
- Acoustic imaging
- Ocean and Geoacoustic Inversion
- Synthetic Aperture Sonar
- Acoustic Time Reversal
- Parametric Sonars

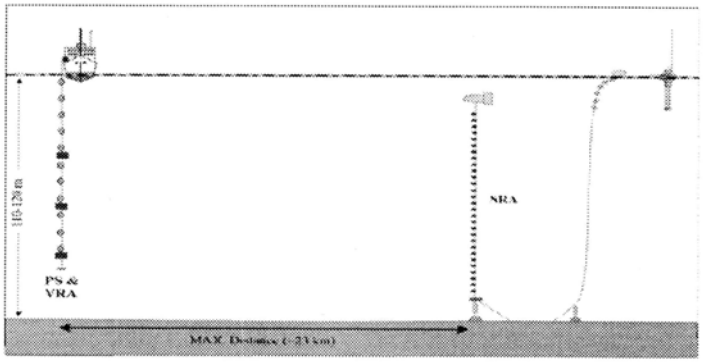

Fig.1 An example of experimental setup of generic time reversal mirror experiment in the ocean [1]

The introduction of the above techniques allowed for more thorough and precise performance of tasks. These methods can be involved individually or complementary, together with the ones formerly used. Their application provides new possibilities in detection, classification and identification of underwater objects or the underwater areas.

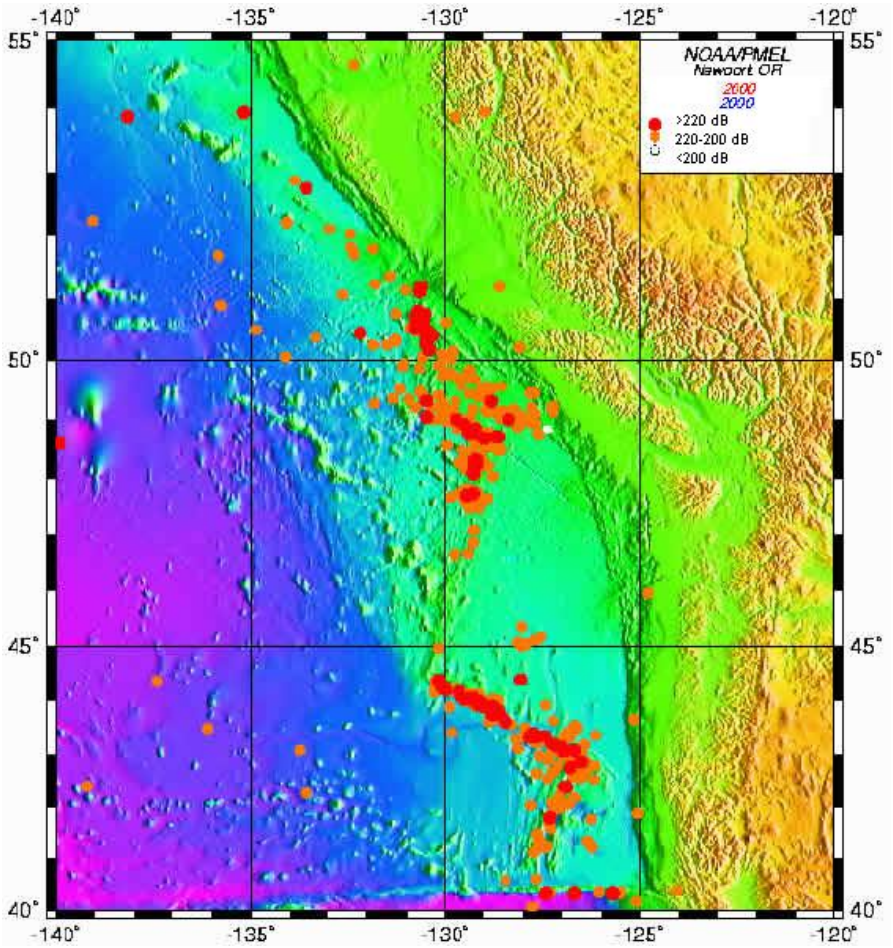

Fig.2 Geological disturbance detected in year of 2000

Special attention should be devoted to the possibilities of demarcating the areas of the sea bottom with the use of acoustic methods, whose resolution is close to the optical resolution. This allows for tracing more precise bathymetric maps of the sea bottom, where the natural as well as the artificial (e.g. wrecks) configurations of the bottom surface are taken in consideration.

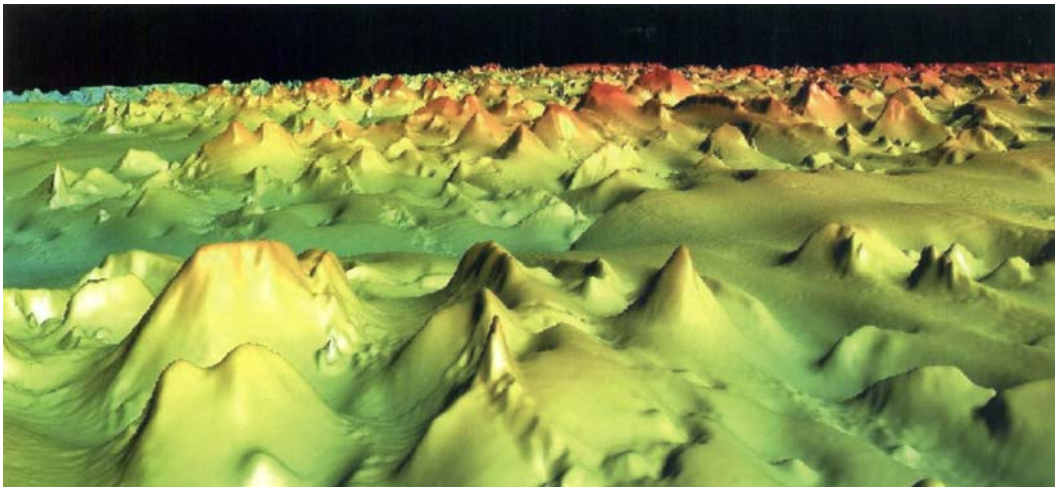

Fig.3 Bottom sea profile – North Sea, Ormen Lange Field [3]

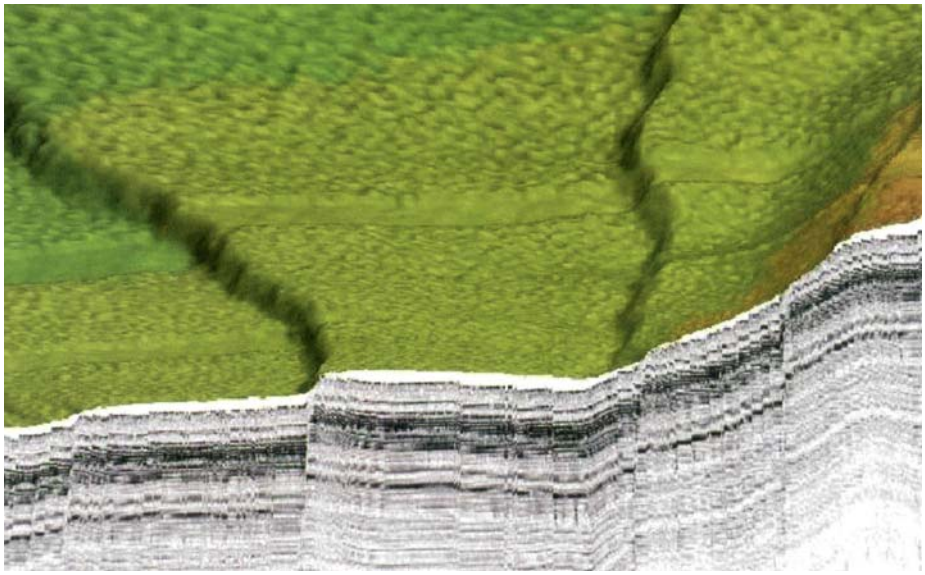

Fig.4 Bottom sea form of Mexican Gulf and view of its layers [2]

The method of Acoustic Time Reversal allows for more exact detection of objects, especially these silted in the sea bottom (e.g. objects of archaeological or military character – sea ground mines). It is impossible to overlook the important function of underwater acoustics in monitoring the geophysical activity of the sea bottom, now after the tragic disaster caused by an underwater earthquake in The Indian Ocean basin.

Fig.5 Sonar picture of ship's wreck founded on Persian Bay on the 50 m depth [3]

Involvement of these tools could safe thousands of human lives. Also in times of real threats, mainly the terrorist ones, thorough monitoring of the underwater sea, coastal and harbour areas obtains exceptional significance.

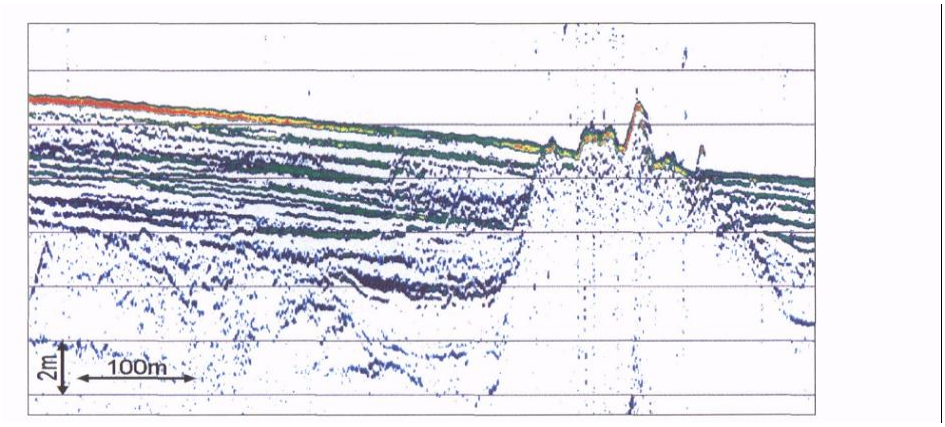

Fig.6 Echogram of bottom sea layers [2]

And, although the methods of observation and identification of acoustic signals have gained the character of routine procedures, their improvement is still a challenge standing before the researchers in this field. The knowledge on the evolution of broad-band acoustic signals propagating in limited media (shallow sea) is crucial in case of observations of the coastal or harbour areas. In this case, the impact of environmental noises on the source signal has a huge significance, and not infrequently decides about the success of the performed task.

2. CONCLUSION

The challenges posed before us by the current situation, as well as the natural requirements, inspire active operations aiming at improving the known and seeking for new acoustic methods facilitating more and more precise exploration and observation of the underwater areas. This aim is fulfilled not only through strenuous laboratory research, or "in

situ", but also by popularisation of the research outcomes or routine observations during specialist conferences or in publications in scientific and technical press.

New technologies in underwater acoustics are developing synchronically with other branches of theoretical and applied knowledge.

The harmonious technological and theoretical progress allows us to face the 21st century.

Nevertheless, a lot of important tasks related to underwater acoustics are still waiting to be solved.

REFERENCES:

[1] Proceedings of the Sixth European Conference on Underwater Acoustics. Gdansk, 2002
[2] Proceedings of the Seventh European Conference on Underwater Acoustics. Deft, 2004
[3] The Application of Recent Advances in Underwater Defection and Survey Techniques to Underwater Archaeology. Bodrum, Turkey