GARY L. SMITH

GUEST EDITOR'S INTRODUCTION

> Pitt was the greatest fool that ever existed to encourage a mode of warfare, which those who command the seas did not want and which, if successful, would deprive them of it.
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> *Lord St. Vincent's remark in 1804 about the interest of Sir William Pitt in Robert Fulton's submarine, the* Nautilus

Nearly two centuries have passed since Lord St. Vincent's prophetic admonition about the impact submarines might have on naval operations. Advances in technology, sometimes revolutionary and frequently motivated by the lessons of two world wars, allow modern navies to assign submarines central roles in both strategic and tactical mission areas. To fulfill these missions, it is axiomatic that submarines must be able to operate largely undetected by their adversaries.

For a number of years, the Applied Physics Laboratory has been engaged in efforts aimed at developing a more complete understanding of those elements of technology and ocean science related to submarine detection. In the early years of this effort, the focus quite naturally was on developing better measures of the performance of currently deployed Navy antisubmarine warfare systems. As the effort matured, however, the scope was broadened to include other technology areas that appeared to offer potential in submarine detection. The breadth of the subject areas under investigation has been matched by the range of techniques applied, running the gamut from purely theoretical analyses to full-scale ocean experiments, and including laboratory experiments, computer simulations, and large-scale data processing methods.

The theme articles in this issue of the *Digest* have been selected to illustrate the diversity of the Laboratory's contributions to this important Navy effort. To represent APL's work in submarine detection fully within a single issue would be impossible; nevertheless, it is hoped that the articles will provide the reader with a useful understanding of the scope and depth of the effort.

One of the less esoteric but very important ocean properties under investigation is that of sea surface temperature. The first article (Gasparovic *et al.*) describes an airborne infrared radiometer system that can measure sea surface temperature with higher accuracy, greater precision, and finer resolution than was heretofore possible, and reports some results obtained with the system.

Another ocean property being investigated is that of vertical stratification, i.e., the variation in density with depth. Many physical processes observed in the ocean and the atmosphere are dominated by vertical stratification, and its high degree of variability often confounds attempts to provide simple explanations for observed phenomena. The second article (Pao *et al.*) reports on one such process — vortex trails in a stratified fluid, describing a relatively simple framework that accounts for some of the properties of these trails over a wide range of scales.

The third article (Roth) treats the topic of *finestructure*, a term used to describe variations in vertical stratification on scales between approximately one and ten meters. Although finestructure itself is an important research area, the article considers the interference it produces when one attempts to measure fluid motion in the ocean. An innovative technique to reduce this interference effect is discussed and illustrated; it involves an application of the principle of least action.

The variations in vertical stratification that occur on still smaller scales, below about one meter, are labeled *microstructure*. The fourth article (Mack *et al.*) describes this property and some of the processes that may cause it to occur. Two instrument systems that have been developed to measure ocean microstructure are also described, and results of such measurements are reported.

The use of tracers in the measurement of ocean processes such as horizontal currents, current shear, and internal wave displacements is well established. The paper by Crawford *et al.* reports the results obtained using one special system to lay a dye tracer and another to determine the temporal and spatial evolution of the dye patch as it is affected by ocean dynamics.

These first five articles clearly illustrate the complexity of oceanic processes and the difficulties inherent in measuring and interpreting their properties. In many instances, highly useful insights into fundamental ocean processes can be gained economically by laboratory simulation under more controlled conditions than are possible in the field. The sixth article (Brandt and Hurdis) describes APL's comprehensive and flexible laboratory facility for performing research on stratified-flow phenomena and summarizes the results of a recent experiment in that facility.

The seventh article (Irani and Gotwols) returns to the general subject of ocean surface properties. The paper presents results from an extensive experimental investigation into the properties of wind waves in the deep, open ocean. The primary issue under investigation in that experiment was whether such waves are more properly characterized as the incoherent superposition of many near-linear wave trains — the classical assumption — or as a set of more strongly interacting, largely coherent wave trains that undergo amplitude and frequency modulation as they propagate.

The last two articles in the theme portion of this issue report on experiments that explore the propagation of extra-low-frequency (ELF) electromagnetic energy and medium-frequency acoustic energy in the ocean in contrast to the preceding articles that concentrate on descriptions of intrinsic ocean properties. The eighth article (Ko *et al.*) describes the systems employed, experiments conducted, results obtained, and comparisons with theoretical predictions in an investigation into subsurface-to-subsurface and subsurface-to-air electromagnetic propagation in and over the ocean. The last article (Boyles and Joice) provides a similarly complete description of an investigation into point-to-point acoustic propagation in the deep ocean. In the investigations reported in the last two articles, the agreement between experimental results and theoretical predictions is remarkably good.

In several of the areas discussed in these papers, and in many others not reported here, the Laboratory's work continues. The challenge is considerable. Progress has been substantial. Much remains to be done.

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