

Marine Physical Laboratory

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Processing and Analysis of SeaMARC II Data: (1) Fieberling Guyot; (2) Raw Phase Experiment in Norwegian- Greenland Sea

C. de Moustier and P. F. Lonsdale (Principal Investigators)

Final Report to the
Office of Naval Research
for Grant N00014-91-J-1073
for the Period 10-01-90 - 09-30-92

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**PROCESSING AND ANALYSES OF
SEAMARC II DATA: (1) Fieberling Guyot;
(2) Raw Phase Experiment in Norwegian-
Greenland Sea**

C. de Moustier, P. Cervenka and P.F. Lonsdale

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Long-Term Scientific Objective

To establish efficient and accurate signal processing techniques for seafloor remote sensing operations aimed at characterizing the bottom by acoustic methods.

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Project Objectives

The objectives of this work were to devise processing techniques for acoustic measurements made with bathymetric sidescan sonar systems and to apply them to data collected with the SeaMARC II system. The main goals were to provide end-users with co-registered acoustic imagery and bathymetry displayed in a geographic reference frame with a minimum of artifacts and with improved contrast or feature definition, while retaining as much as possible the relative acoustic backscatter contrast due to the geology of the area.

Research Results

The primary data set for this work came from a combined SeaMARC II, Sea Beam survey of Fieberling Guyot, conducted in 1989. The nearly complete (90%) coverage of the guyot with Sea Beam swath bathymetry provided a convenient reference to quantify the results of the processing methodology applied to the SeaMARC II data.

The first order of processing involved reducing the noise content of the bathymetry and imagery data using spatial filtering techniques that take into account the acoustic and

geometric characteristics of the sonar system. Artifacts that were clearly unrelated to the acoustic backscattering properties of the seafloor were isolated on a ping by ping basis through a spectral decomposition, using Chebyshev polynomials, to filter the low spatial frequency components of the image. In addition, a stochastic approach was implemented to deal with systematic across-track biases imparted by the real-time conversion from electrical phase angle to acoustic angle that is based on an empirical table established for a flat bottom at a given depth.

Because bathymetry and sidescanned acoustic imagery had been treated as two separate processes at the time the data were acquired, and because a flat bottom assumption was used to display the imagery, it was necessary to register the acoustic images with the bathymetry. This was done using a pixel relocation process based on a representation of the seafloor as viewed by the sonar system. This process identifies ambiguous areas to be avoided and, depending on the relative geometry of the transformed topography, it remaps pixels in the (x,z) plane or in the (x,s) plane. x represents across-track horizontal distances, z represents depths and s slant ranges.

With co-registered bathymetry and sidescanned imagery, the two sets of data can be mapped on a geographic grid and displayed as matching plane representations of the seafloor at various projections, or overlaid and presented in pseudo-3D perspective to help highlight specific relief features. In the transfer of pixels to a geographic grid, due account was taken of the geometry of the measurement and of the spacing between pings to minimize along-track smearing. To enhance the contrast of the mosaic of sidescanned swaths for the whole survey, a modified histogram equalization technique was implemented that balances local versus global histogram contributions, while preserving the relative acoustic backscatter contrast of the image due to the geology.

This project has been completed and results have been reported in several manuscripts, listed below, that have been submitted for publication.

Publications Supported by ONR

Masnadi-Shirazi, M.A., de Moustier, C., Cervenka, P. and Zisk S.H., 1992, Differential phase estimation with the SeaMARC II bathymetric sidescan sonar system, IEEE J. Oceanic Engineering, 17(3), 239-251, 1992.

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Cervenka, P. and de Moustier, C., 1991, Sidescan sonar image enhancement using a decomposition based on orthogonal functions: Applications with Chebyshev polynomials, Oceans '91, 942-947.

Cervenka, P. and de Moustier, C., and Lonsdale, P., 1991. Post processing of SeaMARC II bathymetry data, EOS, Trans., Am. Geophys. Union, 72(44) 249.

Cervenka, P., de Moustier, C., and Lonsdale, P.F., (submitted), Geometric corrections on sidescan sonar images based on bathymetry Application with SeaMARC II and Sea Beam, Marine Geophysical Res.

Publications Supported by ONR

Cervenka, P. and de Moustier, C., (submitted), Sidescan sonar image processing techniques, IEEE J. Oceanic Engineering

Cervenka, P., de Moustier, C., Lonsdale, P. F., (in preparation), Correction of sidescan sonar images based on bathymetry: application with SeaMARC II and Sea Beam, J. Geophys. Res.

Cervenka, P. and de Moustier, C., (submitted), Post-processing of bathymetry derived from sidescan sonar systems, IEEE J. Oceanic Engineering.

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Office of Naval Research (3)
Department of the Navy
Ballston Tower One
800 North Quincy Street
Arlington, VA 22217-5000
Dr. Mohsen Badiy, Code 1125OA

Administrative Grants Officer (1)
Office of Naval Research
Resident Representative N66018
University of California, San Diego
(Mail Code 0234) 8603 La Jolla Shores Drive
San Diego, CA 92093-0234

Director (2)
Naval Research Laboratory
Atten: Code 2627
Washington, D.C. 20375

Defense Technical Information Center (4)
Building 5, Cameron Station
Alexandria, VA 22314