

U.S. DEPARTMENT OF THE INTERIOR  
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**DIGITAL SHADED-RELIEF IMAGE OF THE MEDITERRANEAN SEA FLOOR  
AVAILABLE AS CONTINUOUS-TONE PHOTOGRAPHIC PRINTS  
FROM A FILM-RECORDER NEGATIVE**

by

**Robert K. Mark, Richard J. Pike, and Chip P. Stevens**

**Open-File Report 91-428**

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Introduction

A new shaded-relief image of the Mediterranean sea bed shows morphologic features as small as two kilometers across in their true location, detail, complexity, and regional context (fig. 1). The map exemplifies how image processing and computer graphics have mechanized the art of physiographic portrayal by combining two traditional artistic techniques--pictorial relief and hill shading--and executing them in digital form. Spatial resolution of the map is 10X better than that afforded by the digital bathymetry previously available for this area, which includes much of the Bay of Biscay and Black Sea between latitude 30<sup>0</sup> and 46<sup>0</sup> N. and longitude 6<sup>0</sup> W. and 37<sup>0</sup> E.

Our portrait of the Mediterranean sea floor may be the best to date. Its only detailed precursors are two manually executed relief panoramas, both in color. One, painted by H.C. Berann in 1968 from bathymetric studies by W.B.F. Ryan, B.C. Heezen, and Marie Tharp, is an unpublished map from the well-known series of ocean-floor graphics produced by Heezen and Tharp. The second map, by T.G. Toth (National Geographic Society, 1982), was painted from the 1:1,000,000-scale charts and thus is more accurate than the earlier work. An excellent source of place names, it nicely complements our digital image.

Technical details

This map was made from depth contours (200 m interval) digitally sampled on a 10-sheet 1:1,000,000-scale chart compiled from almost all bathymetric data available for the Mediterranean. Contours were digitized in Europe by private firms under supervision of the International Hydrographic Bureau. The resulting 1.5 million sample points, supplied to the U.S. Geological Survey by the Instituto di Geologia Marina, Bologna, Italy, were interpolated to a 1-km square grid by a minimum-curvature computer routine. The final digital depth model (DDM) has about 2.9 million values in a 1916 x 3792 array; the remaining 4.3 million cells in the array are null values (land areas in black; fig. 1).

The image was generated from the DDM by our own software on a VAX-11/785 computer, after the approach developed independently by Yoeli (1967) and by Batson and others (1975) for subaerial digital elevation models (DEMs). A simple photometric function equates slope steepness and azimuth (and positions of the observer and a simulated Sun) with a brightness value, or shade of gray. The synthetic Sun is at due northwest, 30<sup>0</sup> above the horizon. Vertical exaggeration is 7X and the projection is Lambert Conformal conic.

Accuracy of the image is limited by that of shipboard depth soundings, the compiled bathymetry, the digitizing of the contours, and the contour-to-grid interpolation. Alternating light and dark stripes are artifacts of the gridding process that affect gently sloping areas of sparse data. Inadvertent

reversals of topography by the unaccustomed eye may be corrected by focusing on unambiguous visual cues, for example, the northwest coast of Sardinia.

### Photographic Prints

The new digital image of Mediterranean sea floor physiography was first shown publically at 1:2,500,000 scale at the annual winter meeting of the American Geophysical Union in San Francisco, California, in December 1990 (Mark and others, 1990). The image and parts of it have since been reproduced at much reduced scales (Mark and others, 1991; Mark and Pike, 1991).

The map now is available, at cost, as continuous-tone glossy black-and-white photographs. Prints are made from a negative generated as row-by-row scans, at 50-micron resolution, on an Optronics film recorder from the VAX output tape. The image measures 9.5 cm x 19 cm on the negative. For best results, enlargement to a magnification of no more than 5X is recommended.

Prints made from this negative are available in different sizes on standard-weight photographic paper. For details and terms, inquire at:

Photographic Library  
Mail Stop 914  
U.S. Geological Survey  
Box 25046, Federal Center  
Denver, CO 80225-0046  
[303] 236-1010

Please note that print cost increases with size of the image requested, and that prices are subject to change without notice. Small prints are mailed flat; larger sizes are mailed rolled in a protective tube. When ordering, please specify either print size or the image magnification that is wanted.

### References cited

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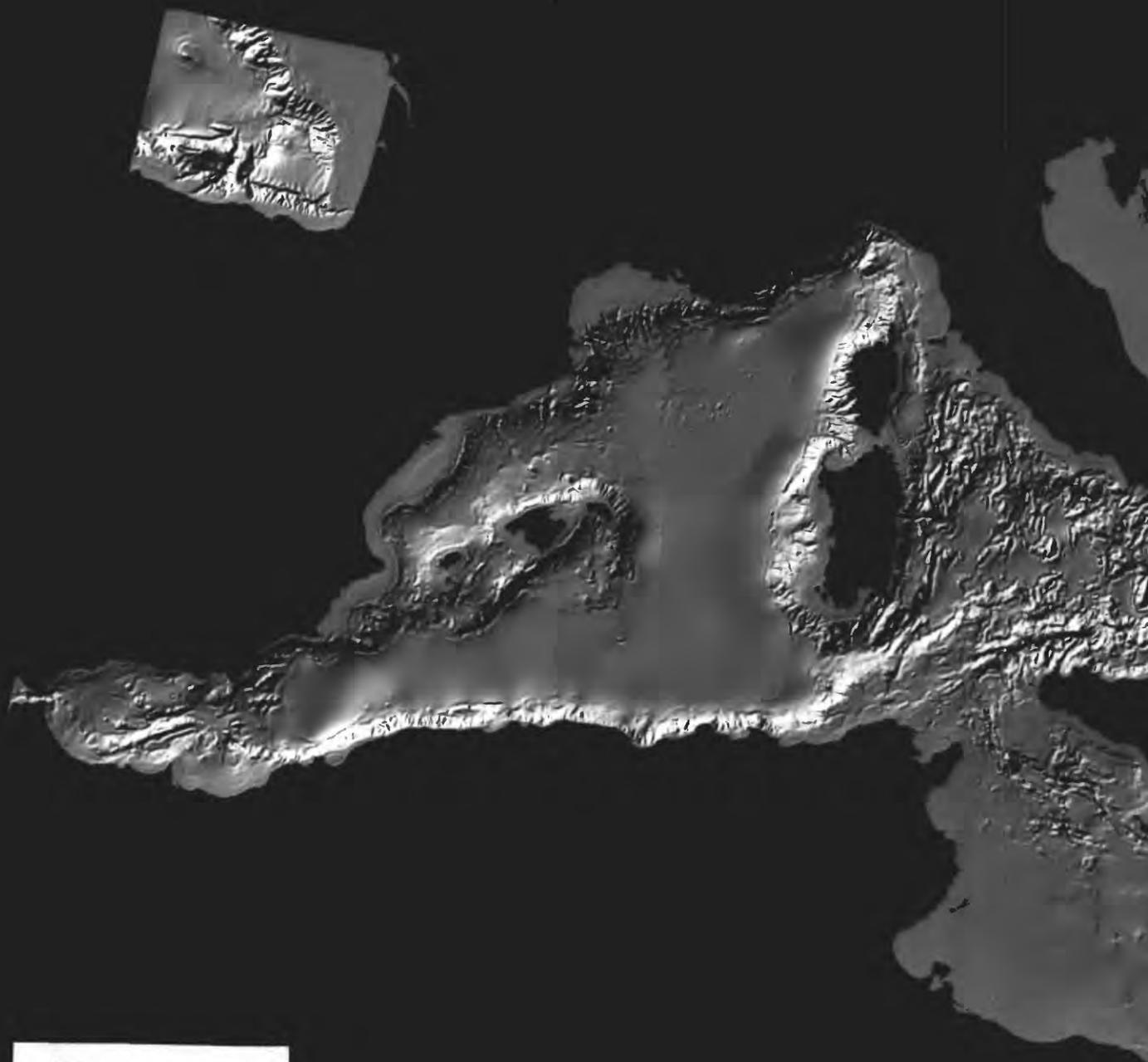


Figure 1

