# MAGNETIC DATA OVER GULF OF MAINE AND ADJACENT LAND AREAS: PREPARATION OF A DATA BASE FOR CONSTRUCTION OF A 1:500,000 MAGNETIC ANOMALY MAP

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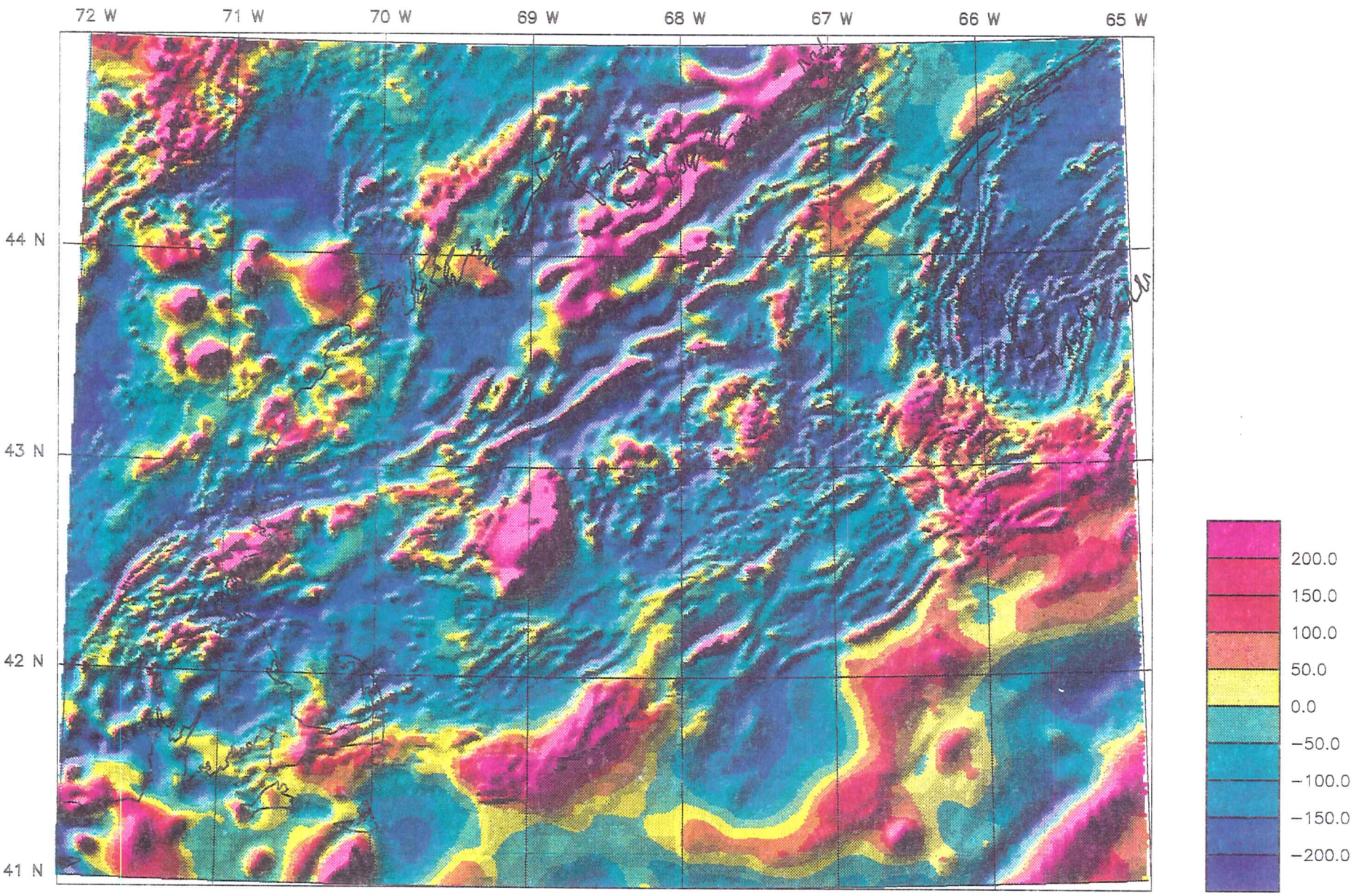
**FRONTISPIECE**

Shaded relief map of the magnetic anomaly field in the Gulf of Maine and adjacent land areas, produced from the data base described in this report. This figure combines the maps shown in Figures 8 and 9. Approximate scale: one to three million.


72 W
71 W
70 W
69 W
68 W
67 W
66 W
65 W
44 N
43 N
42 N
41 N
200.0
150.0
100.0
50.0
0.0
−50.0
−100.0
−150.0
−200.0

## 1. INTRODUCTION

This report describes the procedures followed in combining and adjusting a suite of digital data sets for the production of a proposed 1:500,000 magnetic anomaly map of the Gulf of Maine and adjacent land areas (Figure 1).

The final data base is gridded on a geographic matrix at spacings of .01° latitude and .0125° longitude. This information will be used in the automated production of colour separations for a map that portrays the magnetic anomaly field in solid colour, with relief superposed as variable grey shading (see Frontispiece for a reduced version of the final map). This will be published as a regular Geological Survey of Canada map.

## 2. THE DATA SETS

Table 1 describes the salient features of the data sets, which were acquired from several sources to cover different parts of the map area. The data came in three basic forms: aeromagnetic survey observations at intervals along flight lines (profile data); values of the magnetic field at matrix intersections (grid data); and geographic coordinates of contour lines defining different levels of the magnetic field (contour data). In most cases, the grid and contour data were the products of previous compilations.

As supplied, each data set had been processed in one of a variety of fashions to compensate for the regional field: calculation of the anomaly through application of the International Geomagnetic Reference Field (IGRF; IAGA, 1986); reduction to arbitrary levels; or zero-averaging and adjusting by a constant value to approximate the local level of the regional field.

### 2.1 Western Gulf of Maine, Massachusetts, New Hampshire and Maine

Covering the western Gulf of Maine and adjacent portions of Massachusetts, New Hampshire, and Maine (Figure 2), a large part of this data set was collected in 1976 on behalf of Boston Edison Company by Aero Service of Houston. Offshore, flight line spacing was 1.6 km (1 mi) at a constant elevation of 500 m; onshore, spacing was 0.8 km (0.5 mi), at a constant height of 500 m over terrain.

For about half the survey area, data were available in computer-readable profile form. For the other half, observations were not available in that form, and had to be digitized from contour maps that portrayed survey results over separate onshore and offshore areas (labelled as A and B in Figure 2).

Area A was digitized by Simpson et al (1980) at USGS Denver from 15 minute quadrangle maps of hand contoured analog data collected

along 0.8 km (0.5 mi) EW flight lines 122 m above ground. The digitized data were upward continued to 500 m.

Area B represents a combination of shipboard, Project Magnet, and Boston Edison data that was contoured, then digitized by USGS Woods Hole to produce a series of latitude-longitude coordinates that defined the offshore magnetic field contours.

## 2.2 Vermont, New Hampshire and Maine

For the purposes of this compilation, the data covering the regions illustrated in Figure 3 were assembled and processed at the University of New Hampshire and elsewhere.

Data in the extreme northwest corner of Figure 3 are taken from the lower half of the combined Lewiston-Sherbrooke two-degree maps (44-46°N and 70-72°W) that were compiled for the USGS CUSMAP (Conterminous United States Mineral Assessment Program) project by Bothner et al (1985). Most of these data were collected on surveys sponsored by the USGS and the US National Uranium Reconnaissance Evaluation (NURE), supplemented by digital information collected on the Deep Crust transect line across southern Quebec and Maine.

The NURE data were collected at 6.4 km spacing, while other digital surveys were flown at 0.8 - 1 km. These were draped 152 m above terrain. Magnetic anomaly was derived with the International Geomagnetic Reference Field. Observations were gridded to about .8 km to honour the original data, and then regridded to .5 km.

Other analog data representing a mix of draped and barometric aeromagnetic surveys were digitized along flight lines. Each survey was treated separately, gridded and regridded as above, and upward continued to 1000 feet above terrain. For flights in barometric mode, this meant terrain plus 1000 feet. The datum level was adjusted on all grids for consistency with the most recent contract data, followed by trimming to original borders and merging.

South of 44°N, a small portion of analog data (obtained at 1500 m barometric) was digitized along contour lines by Hassemer et al (1979) and subsequently draped to 300 m.

Data east of 70°W in Figure 3 were compiled from a mix of digital observations and analog maps by Stewart et al (1986).

## 2.3 West-central Gulf of Maine

These data were collected in 1978 by Aero Service of Houston, operating under contract to the USGS. Flight line spacing was 2 km, at an altitude of 500 m (Figure 4). Profile data were available in digital X,Y,Z form.

### 2.4 Eastern Gulf of Maine

These data were collected in 1982 by Kenting Earth Sciences Limited of Ottawa, operating under contract to the Geological Survey of Canada. Flight line spacings, generally, were 2 km over the continental shelf and 6 km over the continental slope (Figure 4). Altitude was 305 m. For this compilation, the data were not handled as a separate set, but as an integral part of the DNAG North America magnetic compilation (described below).

### 2.5 DNAG North America magnetic compilation

Produced as a 2 km by 2 km grid for the Decade of North America Geology (DNAG) Project (Committee for the Magnetic Anomaly Map of North America, 1987), this compilation combined all available magnetic data over land and sea. Among other purposes, it had been created for use in the preparation of a 1:5,000,000 magnetic anomaly map of North America. With a grid spacing that suited the target 1:500,000 scale of the Gulf of Maine map, portions of the North America compilation were extracted to fill blank areas that remained between the detailed survey observations described above.

### 2.6 AGC continental margin magnetic compilation

Covering the entire continental margin of northeastern North America, this compilation (referred to from now on as the AGC compilation) included all available magnetic data over the Gulf of Maine and adjacent land areas (Verhoef and Macnab, 1987).

Gridded at an interval of 0.05 degrees latitude and longitude, the AGC compilation lacked detail for this particular undertaking, and so was not actually incorporated in the Gulf of Maine data base. However, the procedures used to merge and adjust data sets in the AGC compilation were judged to produce a more coherent picture of the magnetic field in the study area. Consequently the AGC compilation was used as a reference for deriving individual adjustments that could be applied to each of the data sets described above.

## 3 PROCEDURES FOR PROCESSING AND MERGING THE DATA SETS

### 3.1 Converting to common coordinates and grid intervals

Preparatory to merging and adjustment, all individual data sets except the DNAG compilation were re-organized into six grid sets (listed in Table 2) covering different areas, but sharing a common origin and uniform grid spacings.

Where grid intervals were specified as distances in km to arbitrary

origins, grid point coordinates were converted from km to geographic positions expressed in degrees of latitude and longitude. The minimum curvature method was then applied to resample all grids at intervals of .01° latitude by .0125° longitude.

### 3.2 Adjusting the levels of the US data sets

Data sets covering the western half of the Gulf of Maine and land areas in the northwest corner of the map were individually adjusted: first the mean level of each set was reduced to zero; then the zero level was compared with the AGC compilation and adjusted to achieve agreement.

Reduction of the mean level to zero was accomplished by averaging the magnetic field values at all points within each grid set, then subtracting the calculated average from the same points. Average levels for each grid set are shown in the second column of Table 2.

For the final adjustment, values were extracted from each zero mean grid produced in the preceding step at intervals of .05° X .05°, and compared with corresponding grid points in the AGC compilation. Differences were averaged (third column of Table 2) and subtracted from all points in the grid set. The total adjustment for each grid set (listed in the fourth column of Table 2) thus consists of the average value of the grid set plus the correction required to shift its zero mean level to match the level in the corresponding area of the AGC compilation.

### 3.3 Adjusting the level of the DNAG compilation

A different procedure was employed to achieve local agreement between the DNAG and AGC compilations. Corresponding grid points were compared at intervals of .05° latitude and longitude over the map area and an external perimeter zone .5° wide. Point differences were averaged over areas of 2° latitude by 2° longitude to create the adjustment matrix shown in Figure 5; this was then used to generate a 2 km by 2 km adjustment grid (portrayed as a contour map in Figure 6) that contained level corrections for points in the DNAG grid that fell within the map area.

Following this procedure, the adjusted DNAG grid was re-sampled at the same intervals as the data sets above: .01° lat by .0125° long.

### 3.4 Merging adjusted grid sets and smoothing the joints

Adjusted grid sets were trimmed along common boundaries and inserted in their appropriate locations in the base grid of the study area (Figure 7), with strings of grid points left vacant along the boundaries.

Smooth transitions were created between neighbouring grid sets by re-constituting each boundary grid point as the average value of the magnetic anomaly at eight neighbour points. When the grid was plotted in colour (Figure 8) this smoothing technique left few easily discernable joints between the map's constituent grid sets. When rendered in shaded relief with gray tones (Figure 9), the data show minor north-south mismatches in at least two places (south of Martha's Vineyard and in southern Maine near 44°15'N, 70°20'W): these are not boundary misfits in the present compilation, but are carried over from the original grid sets.

### 3.5 Effect of different data densities in the constituent grids

Levels of detail are not uniform over different portions of the colour anomaly map and the gray scale relief map (Figures 8 and 9, respectively). In most areas, the magnetic anomaly field is rendered in considerable detail, with a fine structure reflecting the Appalachian grain that dominates the geology of the region.

In the remaining areas, the magnetic anomaly field is considerably smoother and bereft of fine structure, showing regional trends mainly. This is especially evident in the southeast corner of the map area, where thick sediments of the continental slope and the deeper parts of the continental shelf mask the magnetic effect of underlying material. In other areas (e.g. off the southwest coast of Maine, in southern New Hampshire), the lack of detail is the result of lower data densities.

## 4 AVAILABILITY OF DATA IN DIGITAL FORM

The final grid produced by this data base project is available in computer readable form and at a spacing of .01° latitude by .0125° longitude. Requests for copies of the data should be addressed to:

Geophysical Data Centre
Geophysics Division
Geological Survey of Canada
1 Observatory Crescent
Ottawa, Canada K1A 0Y3

Telephone: (613)995-5326

## 5 ACKNOWLEDGEMENTS

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**TABLE 1**

**Data sets assembled for the Gulf of Maine magnetic compilation**

| Locality (Figure No.) | Year | Sponsor | Survey Company | Navig | Line spacing | Altitude | Grid | Remarks |
|---|---|---|---|---|---|---|---|---|
| Western Gulf of Maine, MA, NH, ME: survey (2) | 1976 | Boston Edison | Aero Service | ? | .8-1.6 km | 500 m | 300 m (part) | Portions digitized by USGS |
| VT, NH, ME: compilation (3) | 1985, 1986 | USGS, NURE | Var | Var | Var | Var | 500 m, 1 km | Digitized by UNH, USGS |
| West-central Gulf of Maine: survey (4) | 1978 | USGS | Aero Service | Dop/Lor | 2 km | 500 m | - | Provided by USGS |
| Eastern Gulf of Maine: survey* (4) | 1982 | GSC | Kenting | Dop/Lor | 2-6 km | 305 m | - | Provided by GSC |
| N America: DNAG compilation | 1987 | DNAG | - | - | - | - | 2 km | Provided by GSC |
| Continental Margin: AGC compilation | 1987 | AGC | - | - | - | - | 5 km | Provided by AGC |

* incorporated in the North America DNAG compilation

**TABLE 2**

**Adjustments applied to US data sets**

| Data set | Mean level subtracted from grid points | Average difference from AGC compilation | Total adjustment |
|---|---|---|---|
| Western Gulf of Maine, MA, NH, ME: profiles | -56511 | -24 | -56535 |
| Western Gulf of Maine, MA, NH, ME: land grid (Area A Fig. 2) | -3176 | -69 | -3244 |
| Western Gulf of Maine, MA, NH, ME: offshore grid (Area B Fig. 2) | -56628 | -47 | -56675 |
| VT, NH, ME: compilation (NW corner Fig. 3) | -396 | 79 | -317 |
| Maine: compilation (remaining area Fig. 3) | -385 | 63 | -323 |
| West-central Gulf of Maine: survey (Fig. 4) | 0 | -35 | -35 |

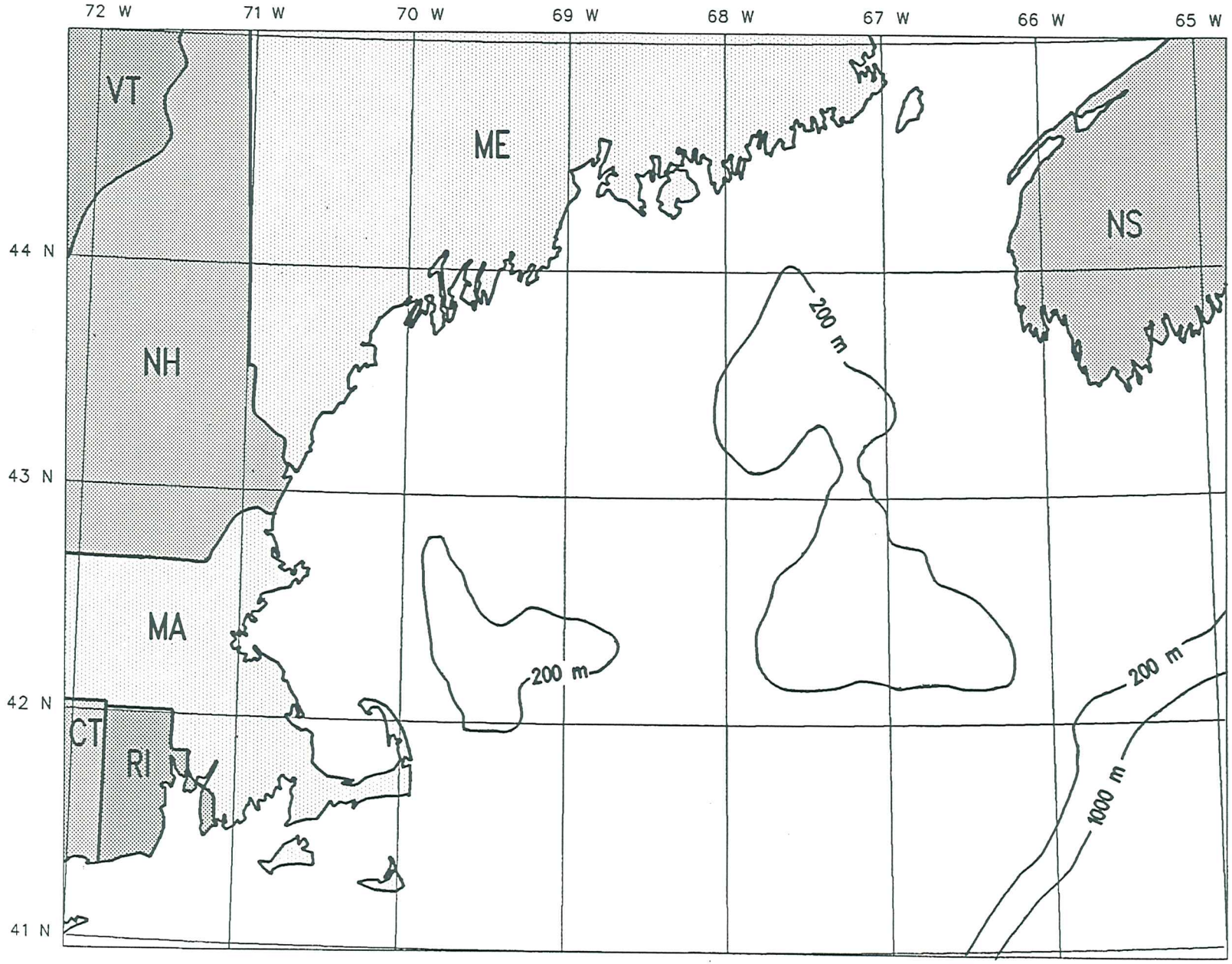


**Figure 1.** Map of study area, with generalized bathymetric contours.

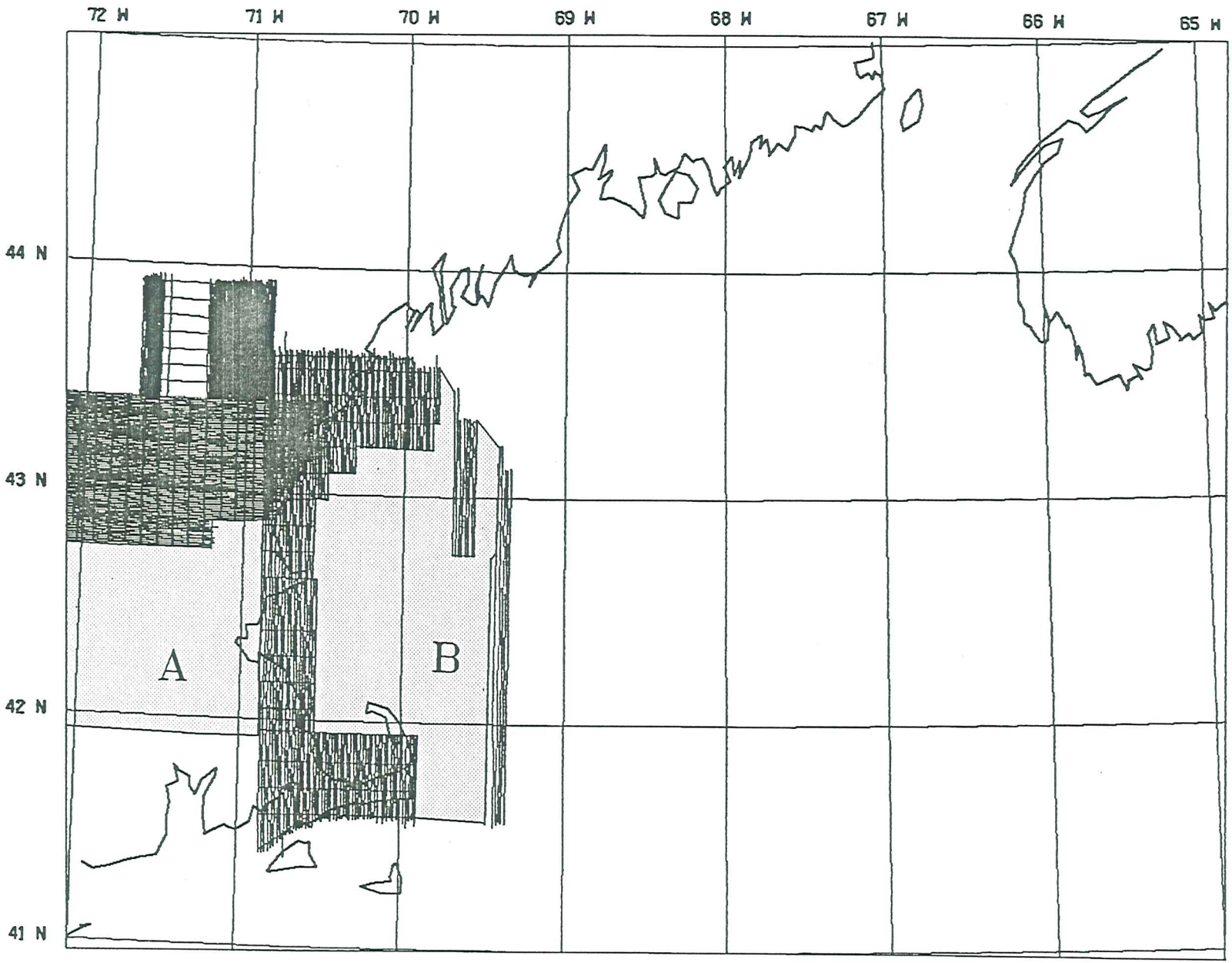


**Figure 2.** High resolution survey in the western Gulf of Maine and adjacent land areas, sponsored by Boston Edison. Digital data were unavailable in the labelled areas, and were digitized by USGS staff (see text for details).

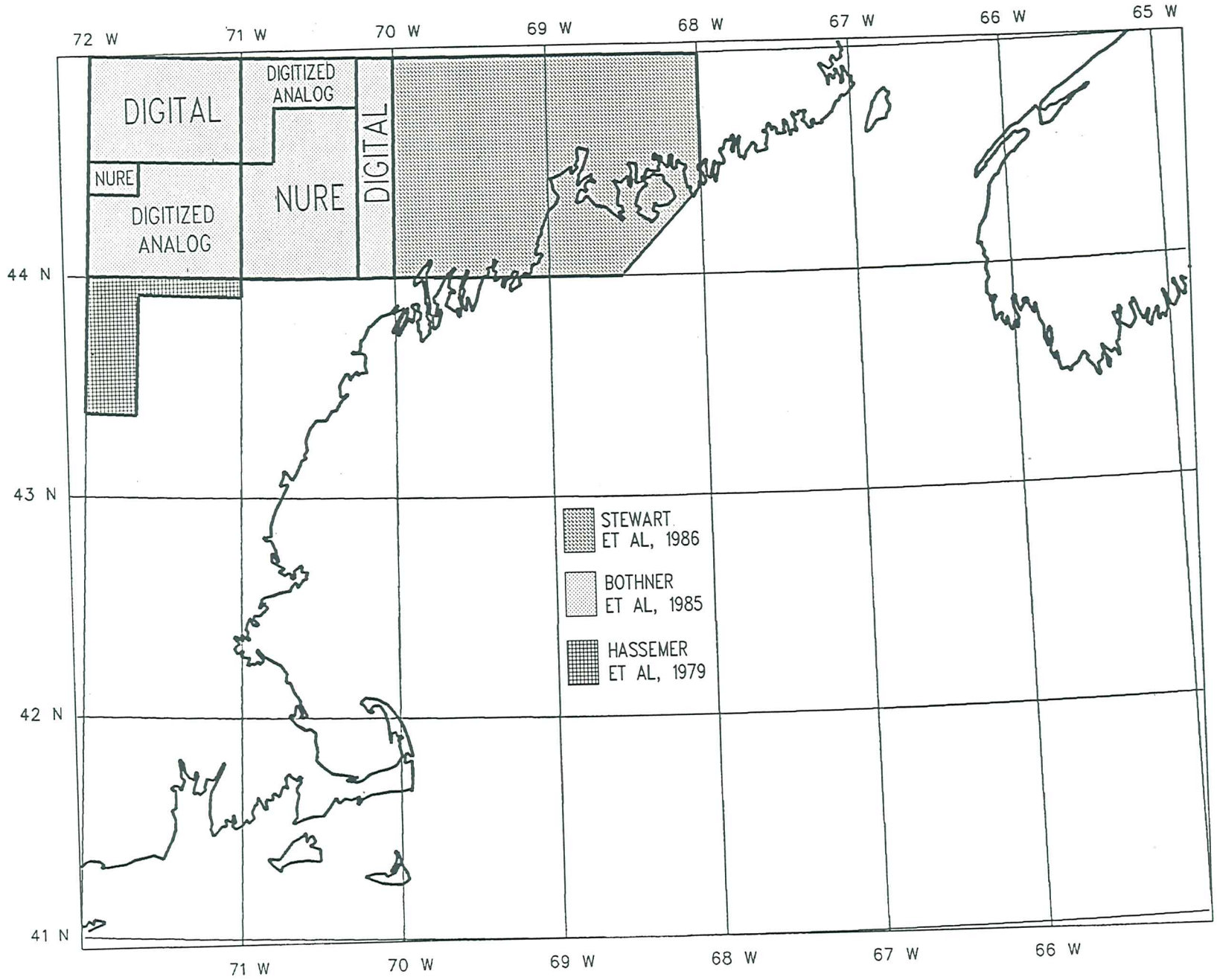


**Figure 3.** Surveys and compilations in Vermont, New Hampshire, and Maine (details in text).

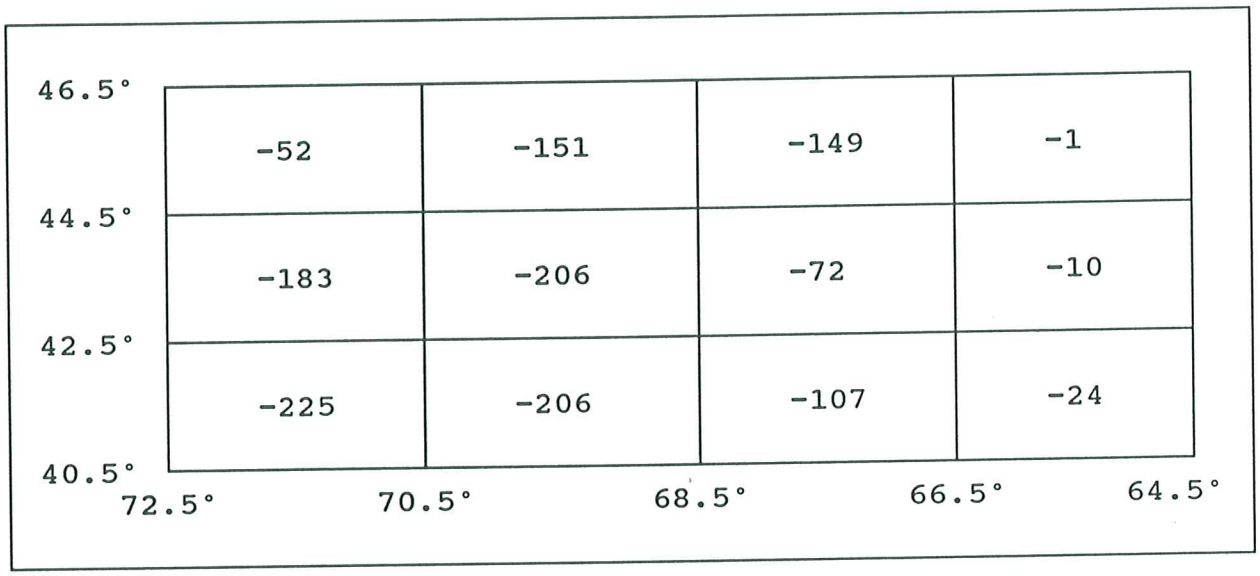


**Figure 5.** Adjustment matrix derived by averaging the differences between the DNAG and AGC compilations over two-degree squares.

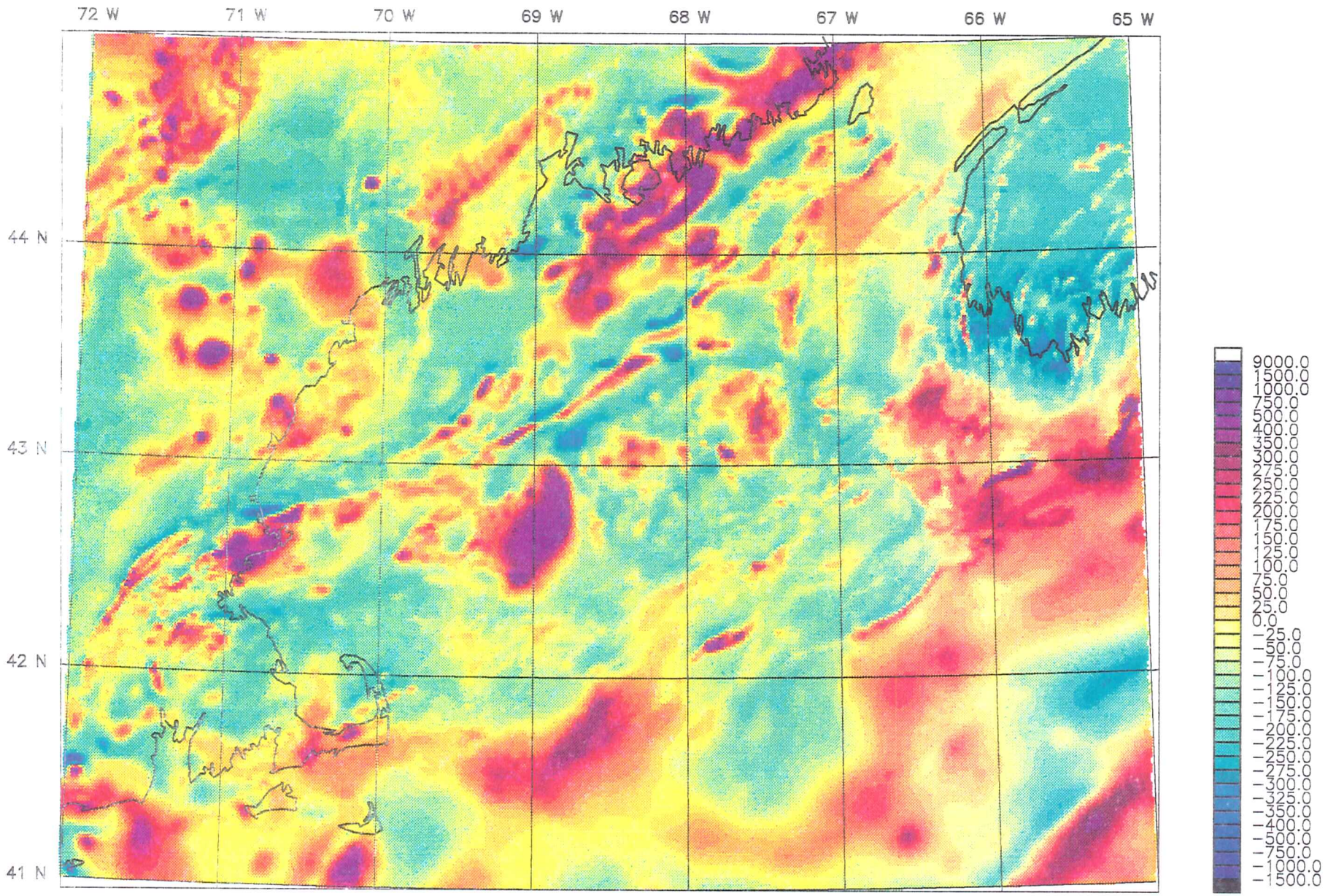


**Figure 8.** Plot of magnetic anomaly created from the gridded and merged data sets.

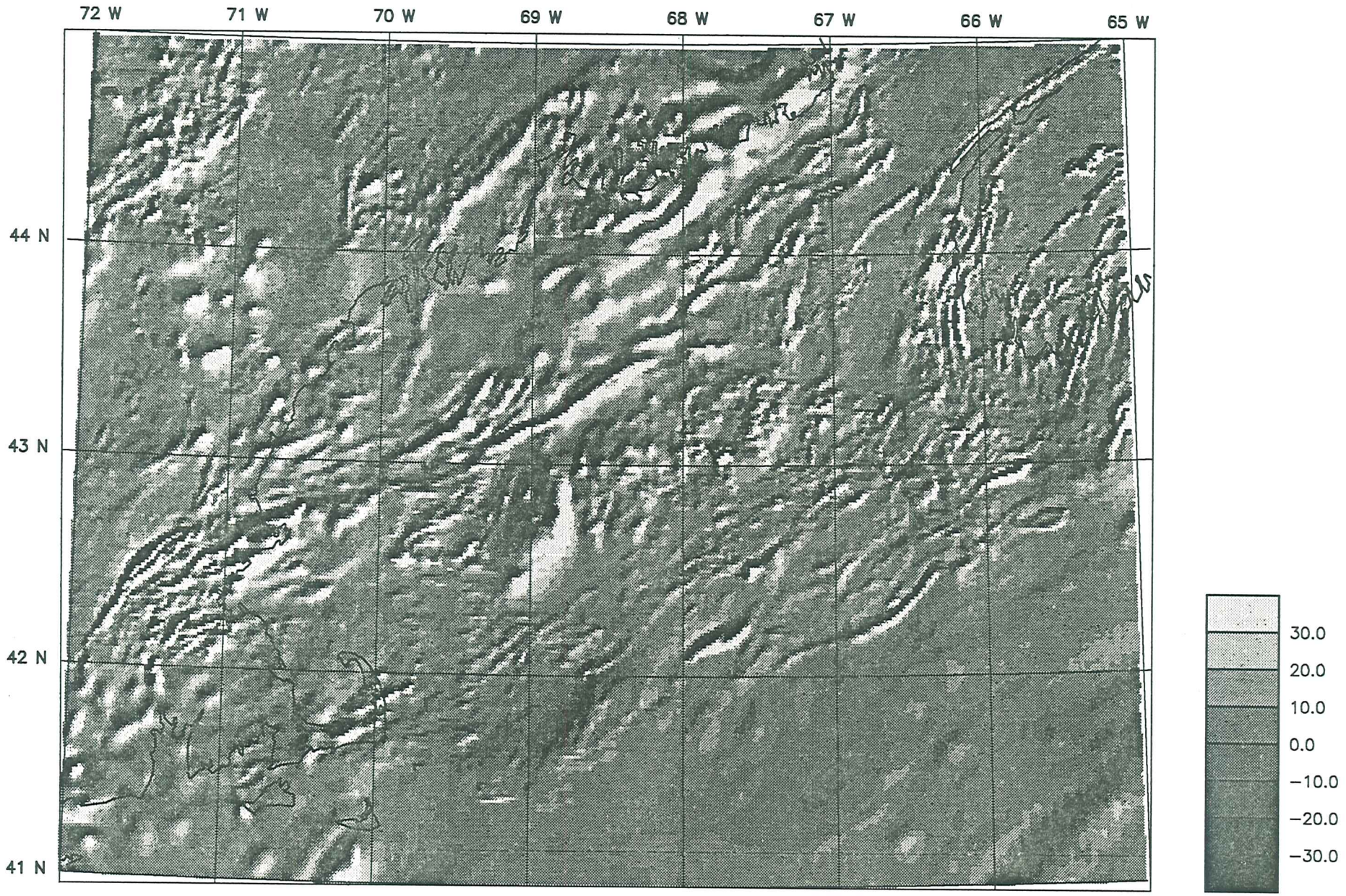


**Figure 9.** Shaded relief of the magnetic anomaly created from gridded and merged data sets.