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Multibeam bathymetry at Aegir Ridge

Hjálmar Eysteinsson
Peter E. Danielsen

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Hjálmar Eysteinsson and Peter E. Danielsen

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ORKUSTOFNUN – GEOSCIENCE DIVISION
Reykjavík: Grensásvegi 9, 108 Reykjavík – Tel: 569 6000 – Fax: 568 8896
Akureyri: Rangárvöllum, P.O.Box 30, 602 Ak. – Tel: 460 1380 – Fax: 460 1381
E-mail: os@os.is – Web site: http://www.os.is

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Key page

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Abstract:
An improved bathymetric map is presented of the Aegir Ridge, located between Iceland and Norway. The map is based on multibeam echosounder data acquired in 1990 by Lamont-Doherty Geological Observatory. We processed the data in order to improve the earlier map made from the data (Junge and Vogt, 1997) which was based on a reduced data set.

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1 Introduction

In 1990 Lamont-Doherty Geological Observatory performed a multibeam survey over the Aegir Ridge in the Norwegian Sea, between 64°N-69°N and 8°W-0°30'E (see Figure 1).

Jung and Vogt (1997) published gravity, magnetic and bathymetric maps based on data from this survey. For their study they used solely data from the centre beam bathymetry as this resolution was sufficient for the purpose of mapping large scale features. For our purposes we need much more detailed bathymetry. The raw multibeam data was acquired from the National Geophysical Data Center (NGDC) database in USA. The survey was performed during the months from July to September 1990, aboard the research vessel Maurice Ewing, for the U.S. Naval Research Laboratory. Each ping in the data consist of 59 beams. The total track length of the survey is about 18000 km, and the average vessel speed is around 18 km/hr. The data had previously been reemerged with corrected navigation.

The data did not contain any information on the sea sound velocity, used to calculate the depths.

2 Data Cleaning

The first step in data processing is to flag out bad data, which is done by visually inspecting all all the data and mark all data points which are not consistent with the neighbouring beams and pings. To do this we used the MB processing package (Caress & Chayes, http://www.ldeo.columbia.edu/MB-System/MB-System.intro.html). By looking at the distribution of all the depth values it became clear that data with depth values less then 1000 meters and greater then 4000 meters are of bad. Those data are initially flagged out, using the program "mbclean"from the MB processing package. After that we used the program "mbedit"to edit out manually all obvious bad beams in the data. Some examples of bad data are shown in Figures 2-4, which are screenshots from the program "mbedit".

On Figure 2 depth values for each beam are shown as a square, which are connected by line segments for each ping. The vertical axis is a relative depth scale (deeper is down), and the horizontal axis is the across track distance. The first beam is to the left and the last beam is to the right. Figure 2a shows an obvious spike, Figures 2b and 2c show typical bad data at the outermost beams.

Commonly the first one or two beams in each ping are bad. They tend to waver off in a downward or upward direction. An example of this is shown in Figure 3. An example of really bad data segment is shown in Figure 4.

After going through the all the data sets, the following statistic are found:

Number of Beams:	16.358.694	
Number of Good Beams:	13.698.978	84%
Number of Zero Beams:	1.990.631	12%
Number of Flagged Beams:	669.085	4%

3 Maps

The first step in gridding the data is to choose appropriate grid spacing. The histograms on figure 5 show that the average distance between beams is about 100 meters and the average distance between pings is around 60 meters. Therefore to ensure that about 10 datapoints exist at most of the grid cells, it is appropriate to use a grid spacing of about 250 meters. This is approximately equivalent to 20" in east-west direction and 8" in north-south direction. The histograms on figure 6 show the distribution of number of data points for each grid cell, and also the distribution of standard deviation of the beam values for the grid cells. The mean number of data points in a grid cell is about 8 and the mean standard deviation is around 7 meters.

The gridding and the plotting of the following maps, are done by using the GMT (General Mapping Tools) software (Wessel and Smith, 1991; http://gmt.soest.hawaii.edu/).

We use the GMT programs blockmean and surface to grid the data according to the folowing script:

```
mblist -R-8/1/63.8/70 -F-1 -IlistP -OXYZD -MA |
awk '{d=$4/100; if(d<0) d=-d; w=1/(1+d); print $1,$2,$3,w}' |
blockmean -R-8/1/63.8/70 -I20c/8c -Wi |
surface -R-8/1/63.8/70 -I20c/8c -Gaegir.grd -T0.25
```

As seen in this script we weight the data with the inverse of the distance from the center beam. The beams closest to the central beam are generally of better quality than the outer beams, and in some cases we have overlapping tracks where we would like to give the innermost beams more weight than the outermost beams.

Figure 7 shows a bathymetric map of the Aegir Ridge, whith a light illumination from south east. The same map is shown on Plate 1 in the scale of 1:1000,000. On this map we have kept areas blank with data gaps greater than 1 km^2.

Plates 2 and 3 show in the same scale the standard deviation and and number of measured beams in each grid cell, respectively. 60% of all grid cells have standard deviation less than 10 meters and 90% is less than 20 meters. The areas that show largest standard deviation are in most cases places with large variation in bathymetry. Plate 4 shows the data coverage, i.e. a point is plotted for each beam in the data set.

On Plate 5 we show a map using our proccessed data from Aegir ridge superimposed on the ETOPO2 bathymetry model (http://www.ngdc.noaa.gov/mgg/fliers/01mgg04.html). All areas with data gaps less than 100 km^2 are interpolated using the GMT program "surface". In other areas the ETOPO2 model is used. The ETOPO2 data fits rea-

sonably well with our bathymetry model in most cases. As expected our model shows much better resolution than the ETOPO2 model. This same map is shown in Figure 8 with a light illumination from south east. Figure 9 shows three different cross sections across the Aegir Ridge, both from our data (red lines) as well from the ETOPO2 model (green lines).

The 500 km long Aegir Ridge, that really is a valley rather than a ridge, is about 500 meters deep in the north and over 1000 meters deep in the south. It is about 20-30 km in width, and there are high elongated montains on both flanks of the valley.

4 Reference

Jung, W.Y. and P. R. Vogt, 1997: *A gravity and magnetic anomaly study of the extinct Aegir Ridge, Norwegian Sea. Journal of geophysical research, Vol 102, B3, p. 5065-5089.*

Wessel, P. and W. H. F. Smith, 1991: *Free software helps map and display data, EOS Trans. AGU, 72, 441.*

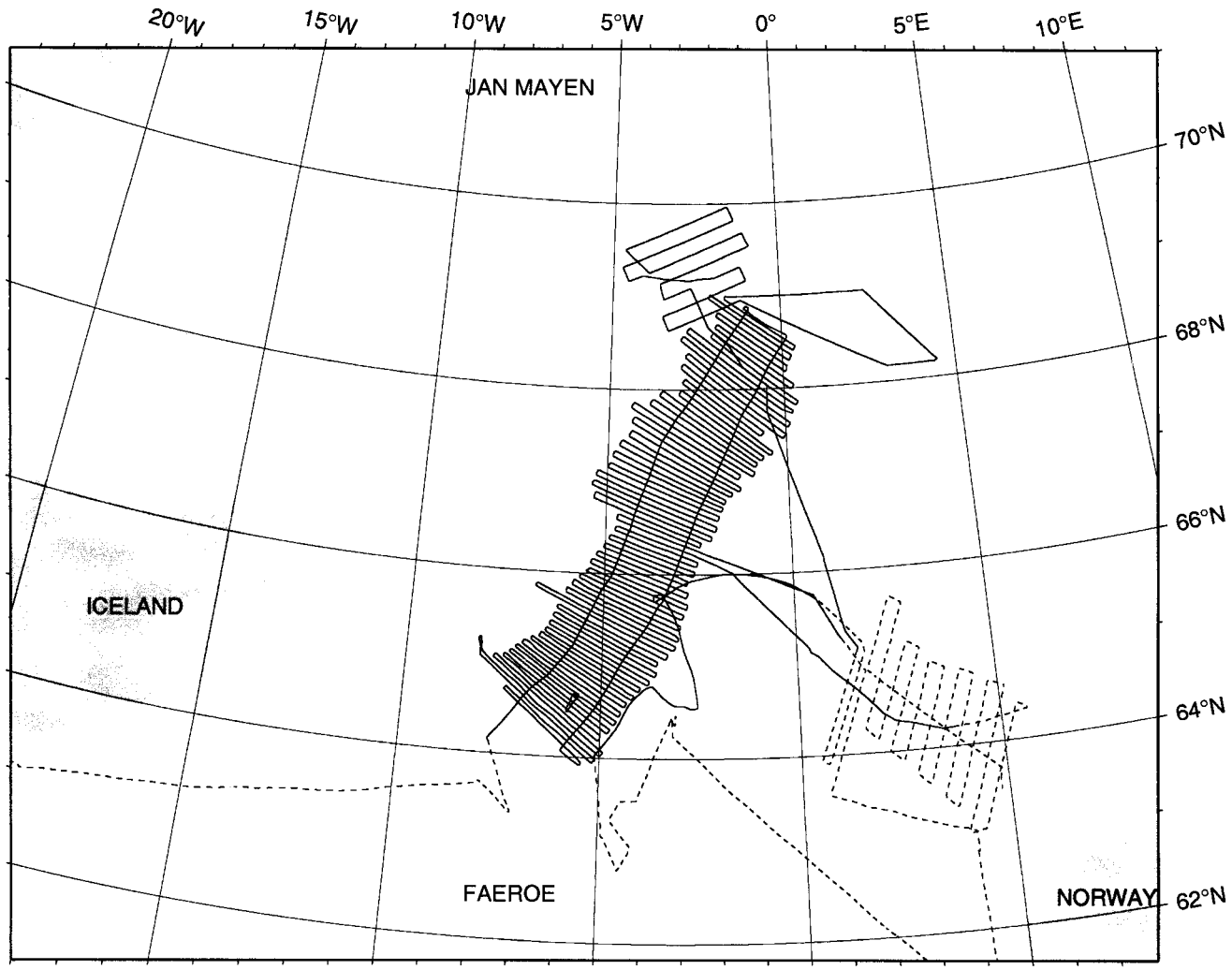


Figure 1: *Ship track lines of R/S Maurice Ewing during July through September 1990, across the Aegir Ridge. Solid lines are track lines used in this study. Dash lines are other ship tracks from the same survey.*

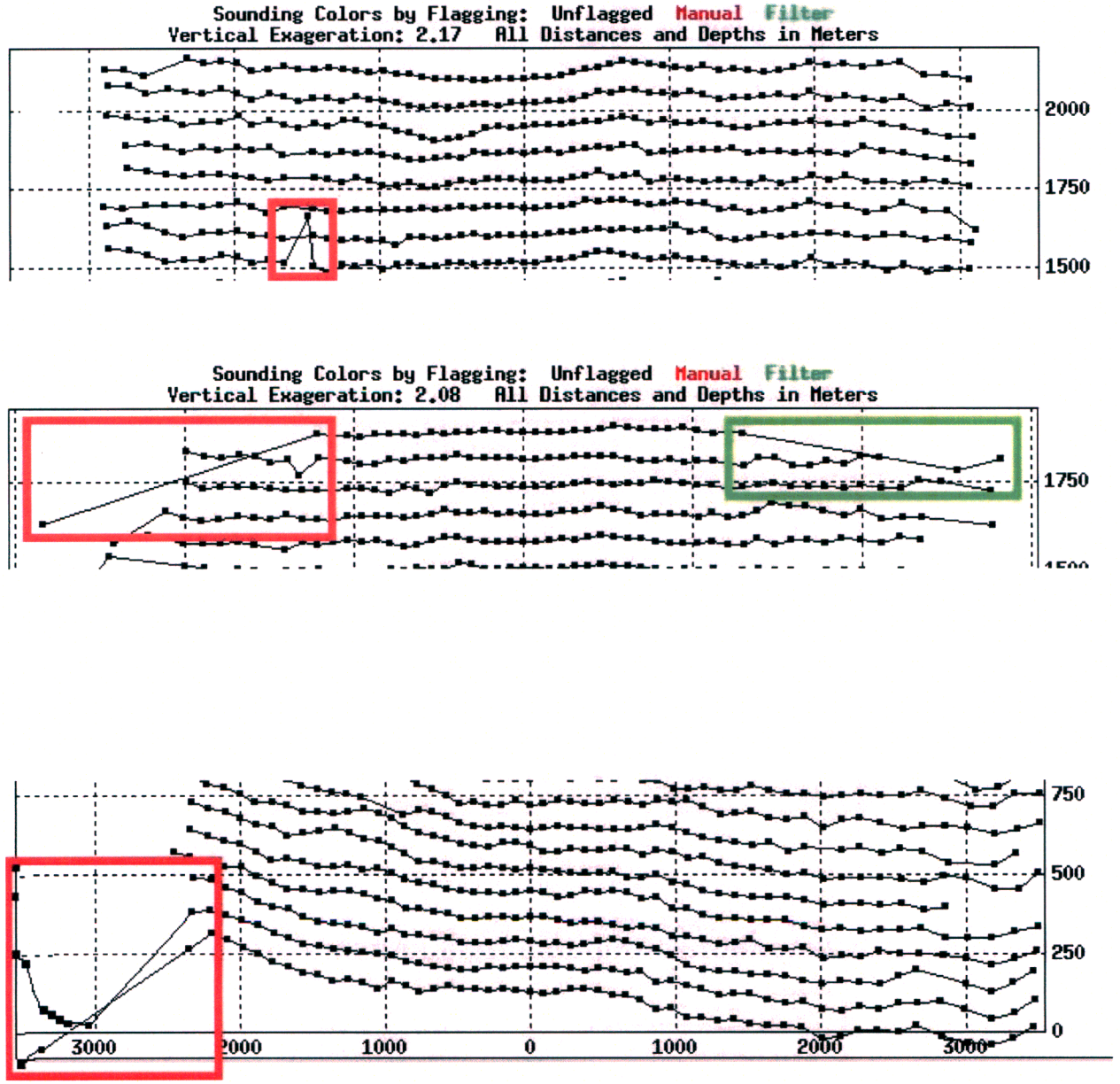


Figure 2: *Examples of bad data. The figures are screenshots from the program mbedit. Data points for one ping are shown with connected lines. The horizontal scale is the across track distance in meters, and the vertical scale is the relative depth in meters.*

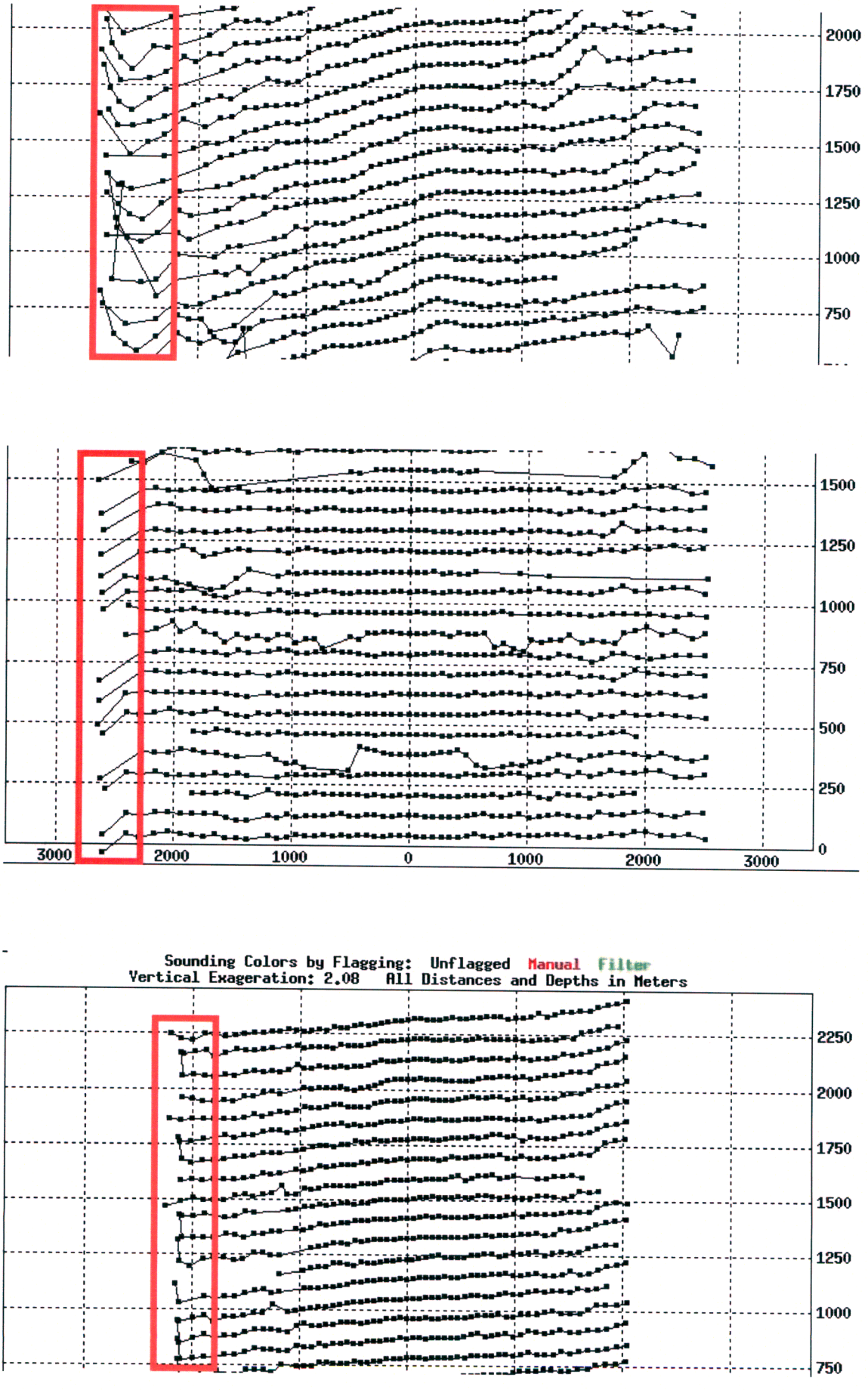


Figure 3: *Example of bad data at first few beams in each ping.*

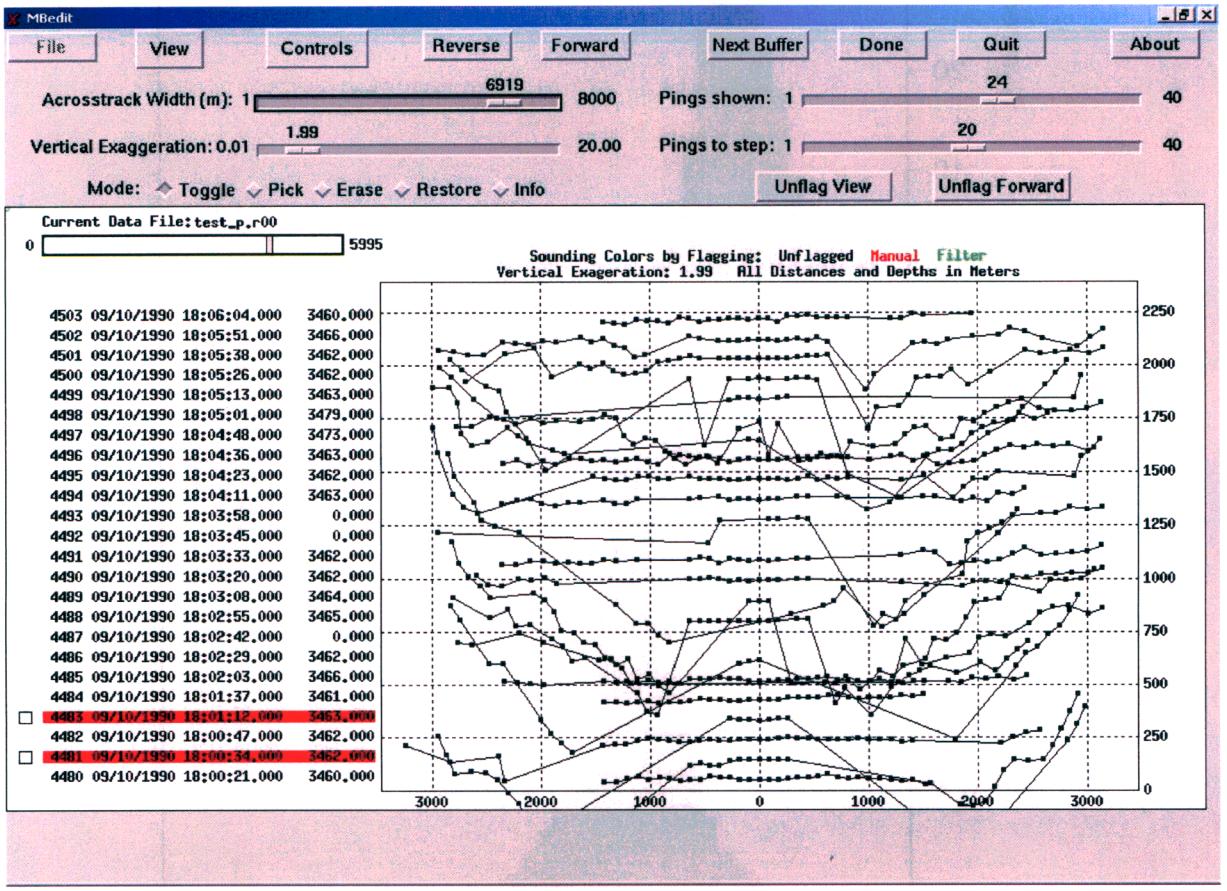


Figure 4: *An example of really bad data. The figure is a screenshot from the program mbedit.*

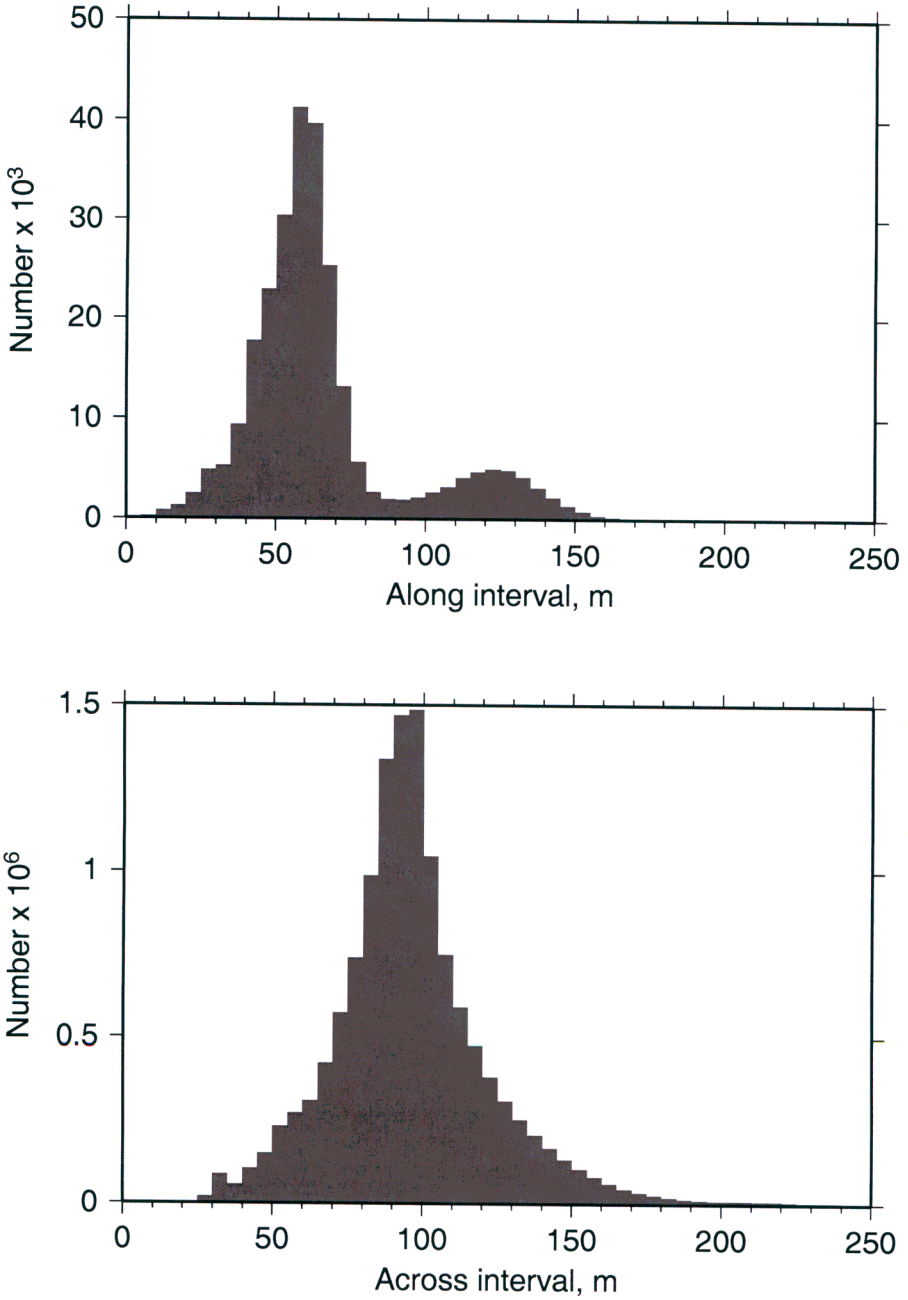


Figure 5: *Distance between beams in each ping (lower figure) and distance between pings (upper figure) for the whole data set*

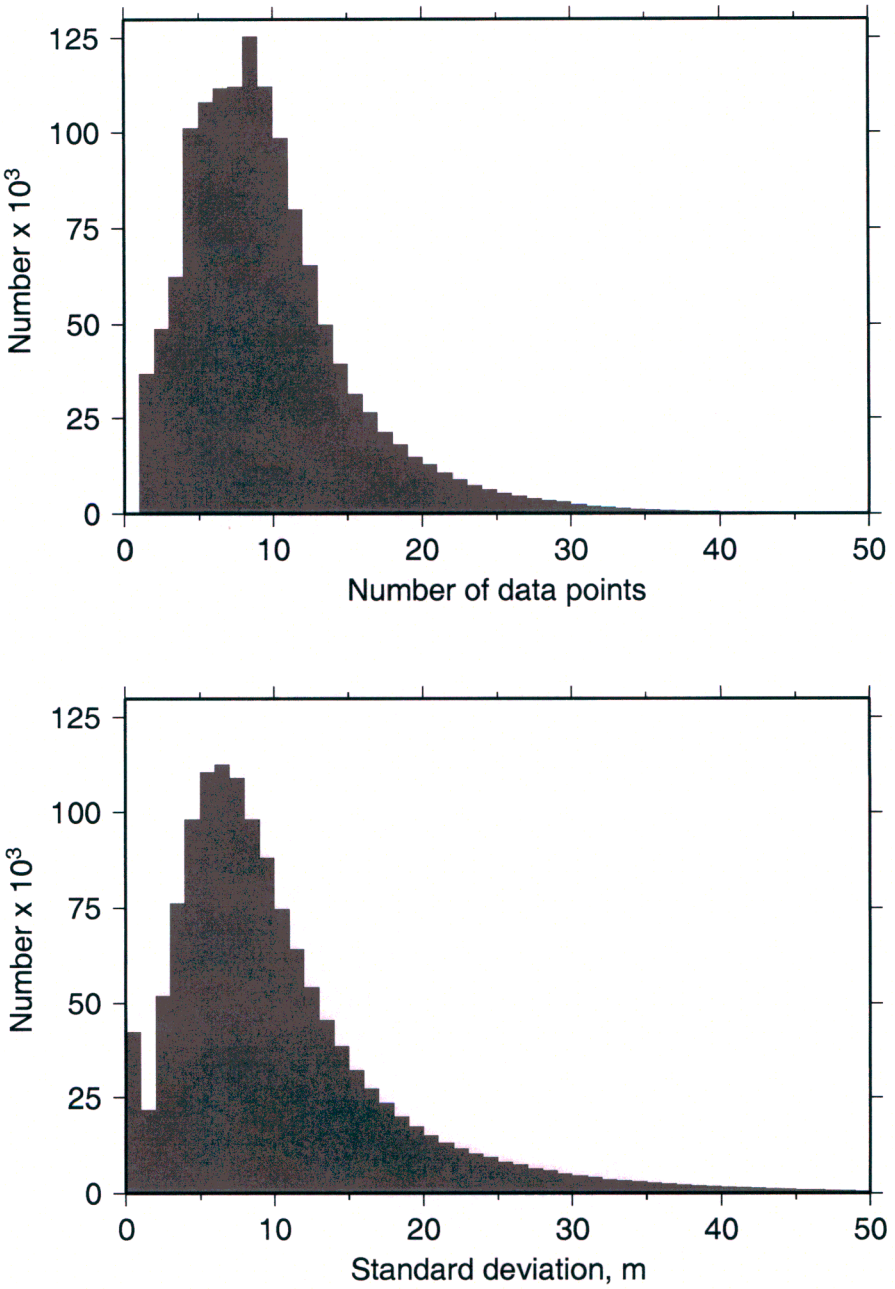


Figure 6: *Histograms of number of data points (upper figure) and standard deviation (lower figure) in each grid cell, using a grid size of 20" in EW and 8" in NS (approximately 250x250 meters).*

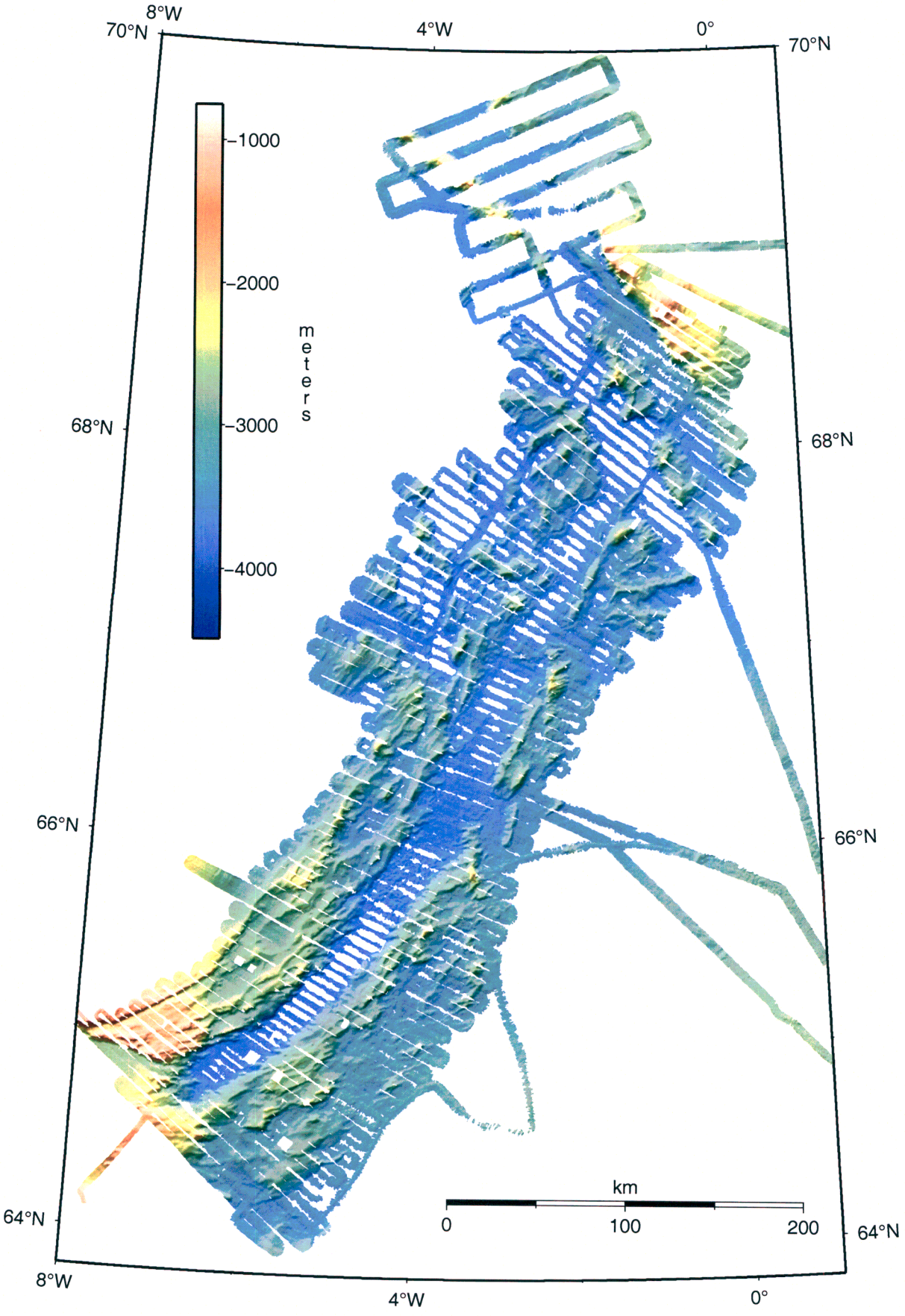


Figure 7: *Bathymetric map of Aegir Ridge.*

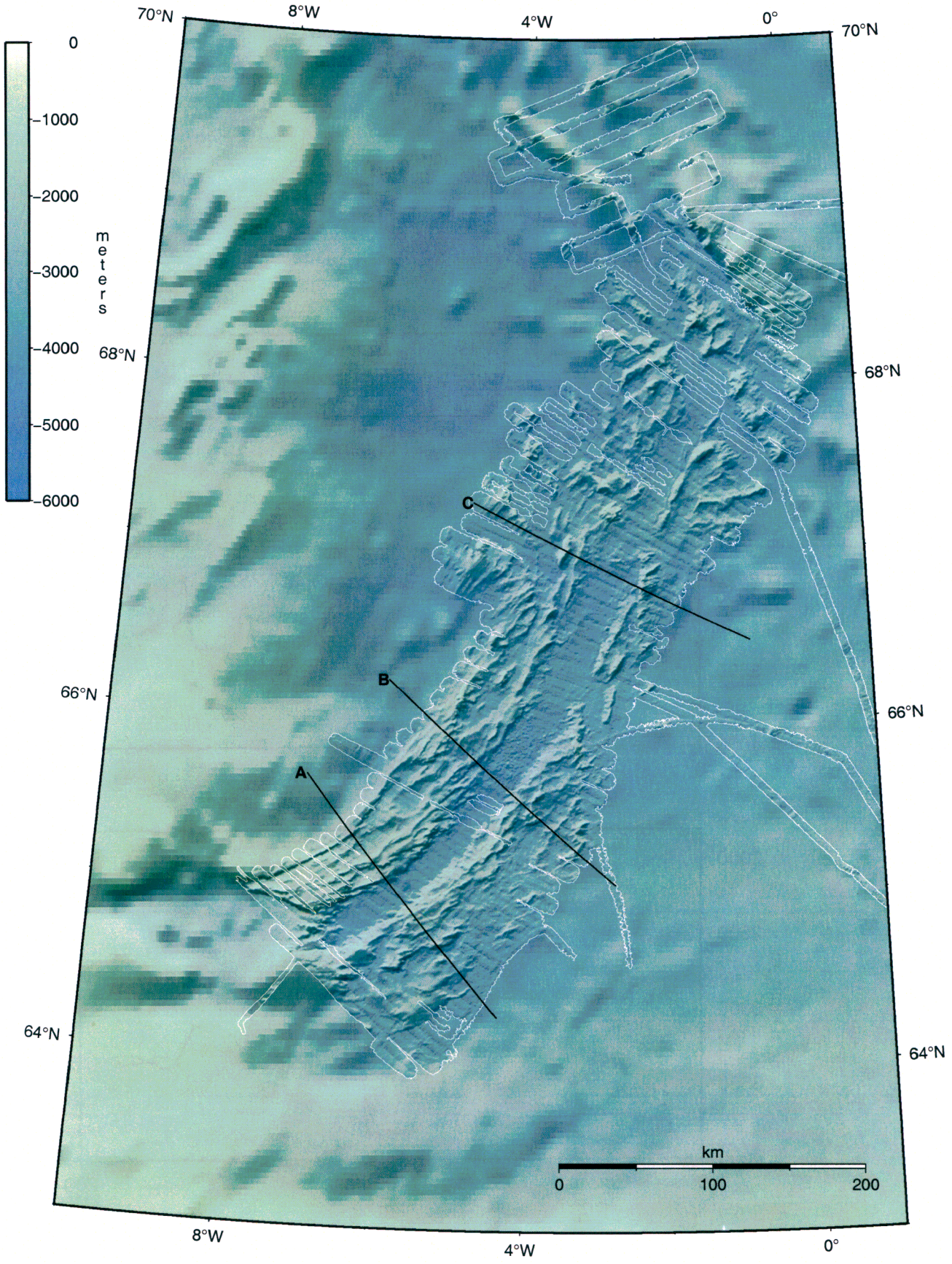


Figure 8: *Bathymetric map of Aegir Ridge. Data outside the white lines, as well as in areas with data gaps greater than 100 km^2 (inside closed white contours), are from the ETOPO2 bathymetry model.*

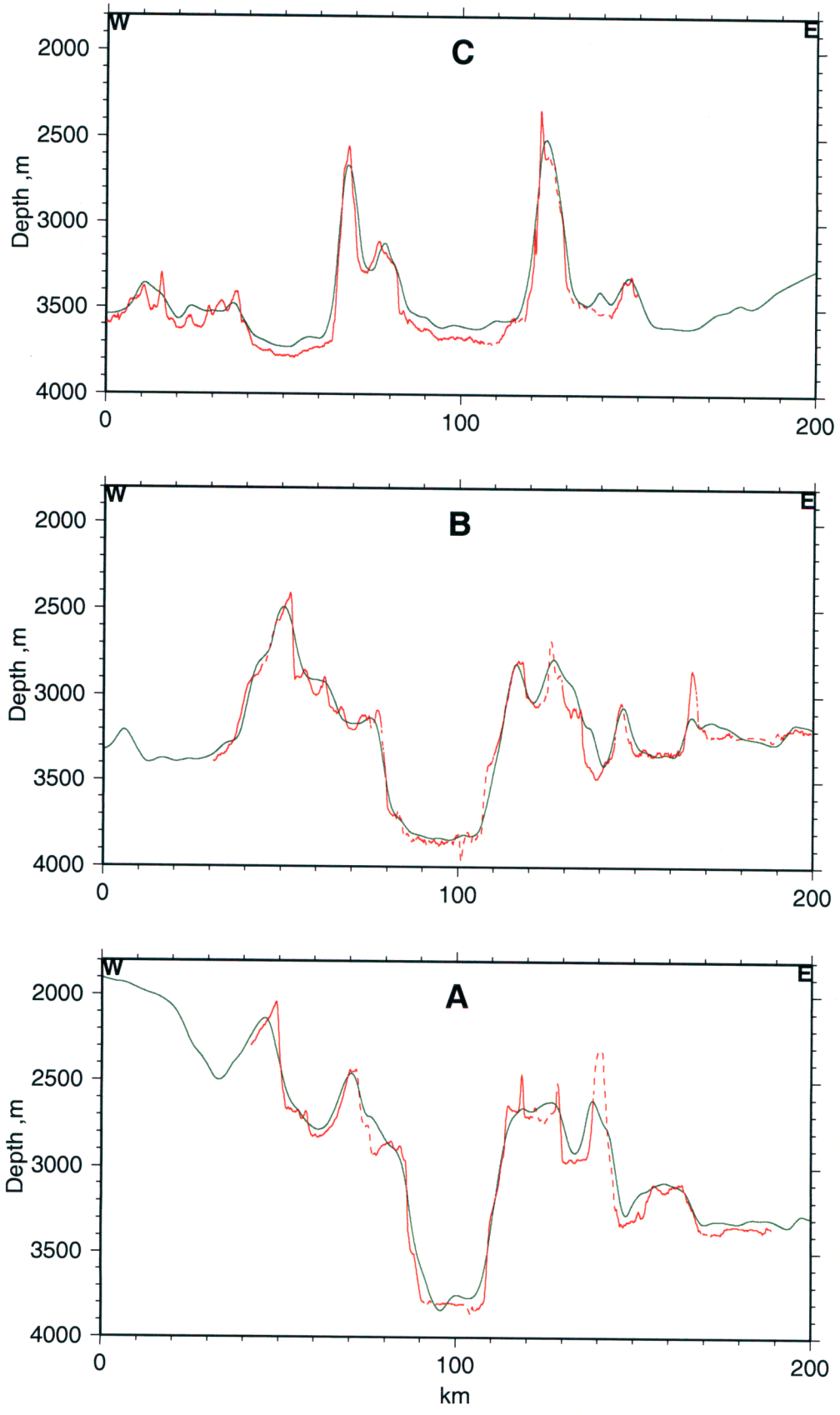


Figure 9: *Cross sections across the Aegir Ridge at three different locations, shown on Figure 8. Green curve is ETOPO2 data, red solid curve is our processed data, and red dashed curve is interpolated data in areas with data gaps.*

ROS 9000. HE/PED
April 2003 GMT

PLATE 1

AEGIR RIDGE BATHYMETRY

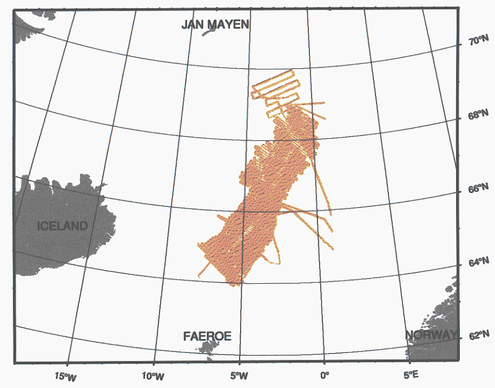
LEGEND:

3000 — Bathymetric contours at 500 meters intervals

Bathymetric contours at 100 meters intervals

1000 2000 3000 4000

meters



Scale 1:1,000,000

km

0 50 100

Ellipsoid: WGS–84
Scale factor: 0.9996
Projection: UTM zone 30

Data was acquired from the National Geophysical Data Center (NGDC) database in USA
Multibeam survey by Lamont–Doherty Geological Observatory onboard R/V Maurice Ewing
Data surveyd in July through September 1990
Grid size: 20˝x8˝ (about 250x250 meters)

Orkustofnun (National Energy Authority)
Grensásvegur 9, IS–108 ICELAND
Tel: +354–569–6000 Fax: +354–568–8896
Email: he@os.is

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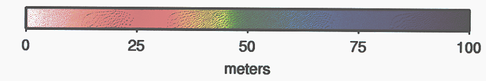
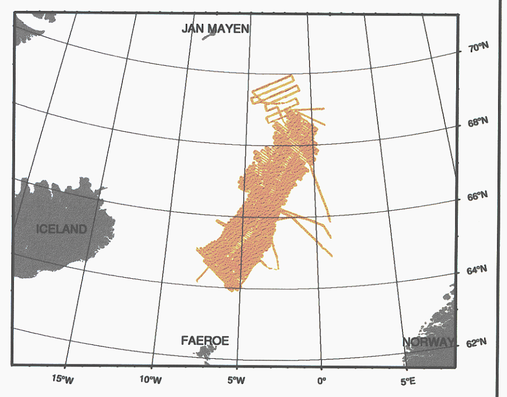
PLATE 2

AEGIR RIDGE
Error estimate

The color scale shows standard deviation of depth values within each grid cell.





Scale 1:1,000,000

km
0 50 100

Ellipsoid: WGS–84
Scale factor: 0.9996
Projection: UTM zone 30

Data was acquired from the National Geophysical Data Center (NGDC) database in USA
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Orkustofnun (National Energy Authority)
Grensásvegur 9, IS–108 ICELAND
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Email: he@os.is

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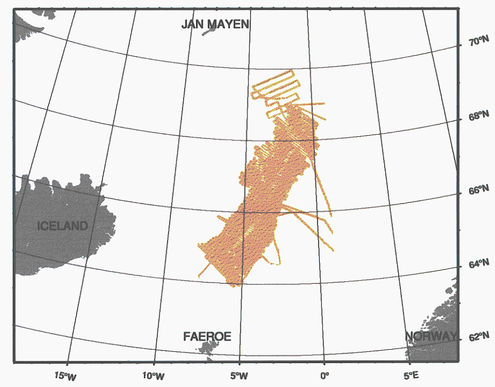
PLATE 3

AEGIR RIDGE
Beam density

The color scale shows the number of beams within each grid cell

0 25 50 75 100



Scale 1:1,000,000

km
0 50 100

Ellipsoid: WGS–84
Scale factor: 0.9996
Projection: UTM zone 30

Data was acquired from the National Geophysical Data Center (NGDC) database in USA
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Orkustofnun (National Energy Authority)
Grensásvegur 9, IS–108 ICELAND
Tel: +354–569–6000 Fax: +354–568–8896
Email: he@os.is

8°W 6°W 4°W 2°W 0°
70°N
69°N
68°N
67°N
66°N
65°N
64°N

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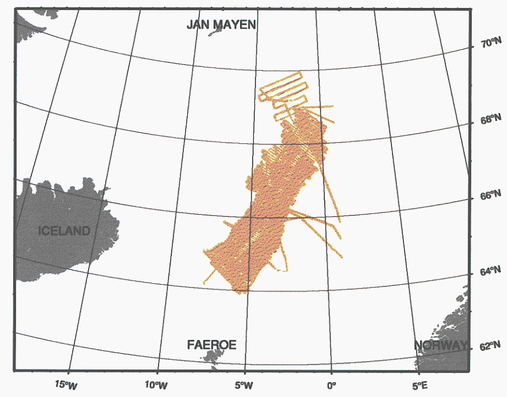
PLATE 4

AEGIR RIDGE
Beam location

Location of every valid data point is marked by a dot.



Scale 1:1,000,000

km
0 50 100

Ellipsoid: WGS–84
Scale factor: 0.9996
Projection: UTM zone 30

Data was acquired from the National Geophysical Data Center (NGDC) database in USA
Multibeam survey by Lamont–Doherty Geological Observatory onboard R/V Maurice Ewing
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Orkustofnun (National Energy Authority)
Grensásvegur 9, IS–108 ICELAND
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PLATE 5

AEGIR RIDGE BATHYMETRY

(Superimposed on ETOPO2 data)

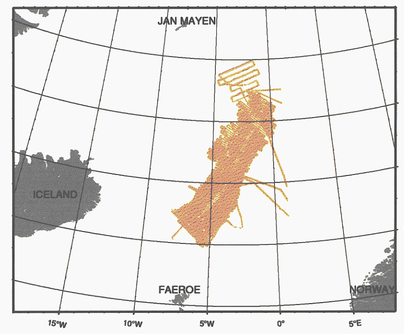
LEGEND:

3000 — Bathymetric contours at 500 meters intervals

Bathymetric contours at 100 meters intervals

0 1000 2000 3000 4000 5000 6000 7000

meters



Scale 1:1,000,000

km

0 50 100

Ellipsoid: WGS–84
Scale factor: 0.9996
Projection: UTM zone 30

Data from Aegir Ridge was acquired from the National Geophysical Data Center (NGDC) database in USA.
Multibeam survey by Lamont–Doherty Geological Observatory onboard R/V Maurice Ewing.
Data surveyd in July through September 1990
Grid size: 20˝x8˝ (about 250x250 meters)
Data surrounding the Aegir Ridge (outsite the white contour lines), and in areas where data gap is greater then 100 km^2, (within closed white contour lines) is from the ETOPO2 elevation model.
Grid size for ETOPO2 data is 2'x2'.

Orkustofnun (National Energy Authority)
Grensásvegur 9, IS–108 ICELAND
Tel: +354–569–6000 Fax: +354–568–8896
Email: he@os.is