NGU Report 2000.011

Data Acquisition and Processing - Helicopter
Radiometric Survey, Kragerø, 1998

NGU
Norges geologiske undersøkelse
Geological Survey of Norway

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REPORT

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Title:
Data Acquisition and Processing - Helicopter Radiometric Survey, Kragerø, 1998

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Client:
NGU, Telemark fylkeskommune

County:
Telemark

Commune:
Kragerø

Map-sheet name (M=1:250.000)
Skien

Map-sheet no. and -name (M=1:50.000)
1712 IV Kragerø

Deposit name and grid-reference:

Number of pages: 9 Price (NOK): 105,-
Map enclosures: 5

Fieldwork carried out:	Date of report:	Project no.:	Person responsible:
October, 1998	25.01.2000	2755.01	

Summary:

On 07 October, 1998, a helicopter radiometric survey was flown in the vicinity of Kragerø municipality. The purpose of the survey was to provide radiometric information to help assess radon hazard from radioactive rocks in the area. A total of 60 line-kilometers of radiometric data were acquired in a single flight, covering an area of approximately 3 square km with a 50-m line spacing. The data were collected by Geological Survey of Norway (NGU) personnel and processed at NGU. Radiometric data were reduced using the three-channel procedure recommended by the International Atomic Energy Association. All data were gridded using square cells with 30-m sides and geophysical maps were produced at a scale of 1:5000. This report covers aspects of data acquisition and processing.

Keywords: Geofysikk	Radiometri	Databehandling
Radonmåling	Helikoptermåling	Fagrapport

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1 INTRODUCTION

On 07 October, 1998, a single flight helicopter radiometric survey was carried out in the vicinity of Kragerø, a municipality on the Norwegian coast approximately 140 km southwest from Oslo (Fig. 1). The total area covered in the survey is approximately 3 km^2. Only radiometric data were collected. The primary objective of the survey was to provide information on radioactive rock units in the area so that radon hazard could be better assessed prior to new construction.

2 SURVEY VARIABLES AND CONDITIONS

Weather conditions were good the day of the flight. The radiometric data quality was good on all lines collected.

The resolution of geophysical sensors decrease exponentially with flying height. To achieve the greatest possible resolution, the aircraft should be flown as low as is safely possible. The target height was 50 meters above ground level, and this height was achieved over level terrain. However, because of the extreme topography around Kragerø the flying height necessarily varied from the target height.

3 DATA ACQUISITION

The survey aircraft was an Areospatiale Ecureuil B-2. Flying speed was approximately 70 km per hour (20 meters per second). Flight lines were in a north-south direction. The radiometric sensors were mounted immediately beneath the helicopter.

NGU personnel responsible for data acquisition were John Mogaard and Oddvar Blokkum.

3.1 Radiometric data

The radiometric system, purchased from Exploranium, Ltd. Of Canada, consists of four sodium iodide (NaI) crystals having a total volume of 1024 cubic inches (16.78 liter). The NaI crystals are coupled to an Exploranium GR820 gamma ray spectrometer. Registration rate is one per second. The crystal package is mounted in a frame underneath the helicopter.

The spectrometer is an energy pulse height analyzer which sorts data into 256 channels according to energy magnitude. Every channel is 0.012 MeV wide . Windows constructed

from selected groups of channels record the contributions of Potassium-40, Bismuth-214 (the daughter product of Uranium-238), and Thallium-208 (the daughter product of Thorium-232). These windows are labeled potassium, uranium, and thorium respectively. A fourth window, called the total count window, measures gamma ray energy between 0.4 MeV and 3 MeV.

3.2 Navigation, altimetry, and data logging

The navigation system consists of a Trimble SVeeSix 6 channel GPS receiver and a Seatex DFM-200 RDS reference receiver connected to a laptop computer. GPS signals are corrected in real time using a correction signal in RDS format from NRKs P2 transmitter. Differential GPS is calculated using software from Seatex, and the data is transferred to the navigation console and data logger. Position accuracy using this system is better than 10m.

The navigation console is a PNAV 2001 manufactured by the Picodas Group, Ltd. of Canada. Profile line data are entered into the console and the traces can be viewed by the helicopter pilot. The pilot can see his position with respect to these predefined lines and adjust accordingly. Visual navigation can also be used if necessary.

A King KRA-10A radar altimeter measures height above ground level, and is recorded digitally and displayed before the pilot. The altimeter is accurate to 5 percent of the true flying height.

The data logging system is an integral part of the Hummingbird electromagnetic system, manufactured by Geotech, Ltd. of Canada. Data is recorded both digitally and on a scroll.

4 PROCESSING

The data were processed at the Geological Survey of Norway in Trondheim using Geosoft processing software (Geosoft, 1996) designed for Windows-NT operating systems. All maps were gridded using a 30-m grid cell size. Obvious inaccuracies in navigation were manually removed from the data. The datum used was WGS-84 in UTM Zone 32. Leveling procedures were conducted flight-by-flight rather than a line-by-line, as this is the most efficient approach. Before gridding, the flights were split into lines and turns were trimmed away.

The Geosoft radiometric processing package (Geosoft, 1995) follows the procedures outlined in International Atomic Energy Agency Technical Report No. 323 (IAEA, 1991). A narrow nonlinear filter was applied to the radiometric data to remove spikes and a low pass filter was applied to smooth the data slightly prior to further processing. Background radiation levels were estimated by flying background calibration lines over water, usually two or three per flight, including one at the beginning and another at the end of the flight. After background

reduction, the data were corrected for spectral overlap using experimentally determined stripping ratios. The processed data are presented as counts per second of the uranium, potassium, and thorium channels normalized to a height of 50 meters.

Atmospheric radon did not appear to have been a major source of data contamination in the survey.

5 MAPS PRODUCED

All Kragerø maps were produced at a scale of 1:5000, and were presented in contoured color with shaded-relief. Shading was from the south at a 45° sun inclination above the horizon. The grid cell size for all maps was 30 meters. Flight lines are included on all maps.

A list of the 5 maps available for order from NGU is given on page 3 of this report. Data samples are shown in Figure 2 (total counts) and Figure 3 (uranium ground concentration).

6 ACKNOWLEDGMENTS

The Kragerø radiometric survey was funded by Telemark fylkeskommune and NGU.

7 REFERENCES

Geosoft Inc., 1996: OASIS montaj Version 4.0 User Guide, *Geosoft Incorporated, Toronto.*

Geosoft Inc., 1995: OASIS Airborne Radiometric Processing System Version 1.0 User's Guide, *Geosoft Incorporated, Toronto.*

IAEA, 1991: Airborne Gamma Ray Spectrometer Surveying, Technical Report 323, *International Atomic Energy Agency, Vienna.*

Statens kartverk, 1993. Map 1712 IV: 1:50000 scale topographic map of Kragerø, Norway.

Fig. 1. Location map for Kragerø radiometric survey. Surveyed area outlined in black, immediately west from Kragerø. (From Statens Kartverk, 1993.)

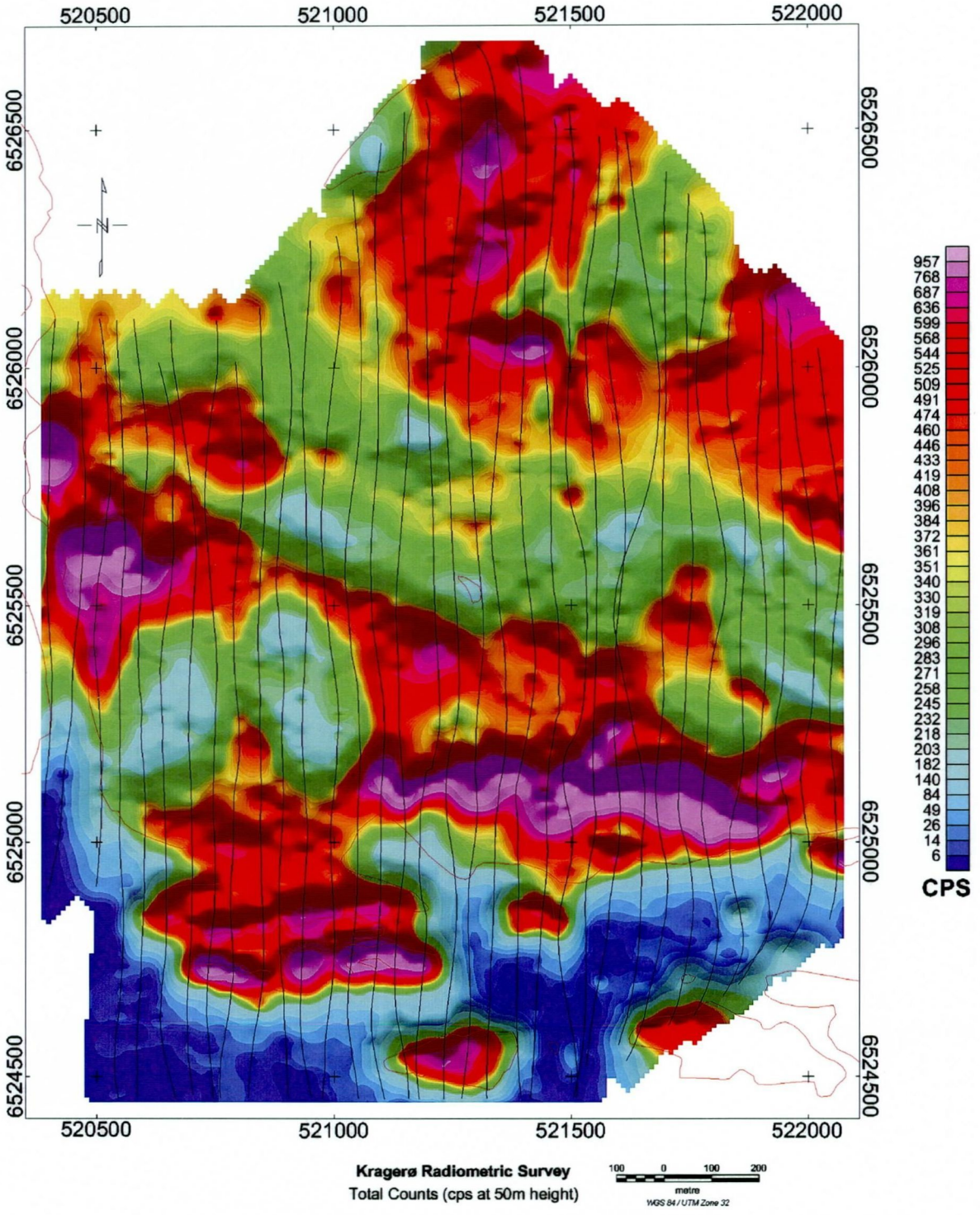


Fig. 2. Total counts measured at 50m above ground level, Kragerø survey. Flight lines in black, coastline in red.

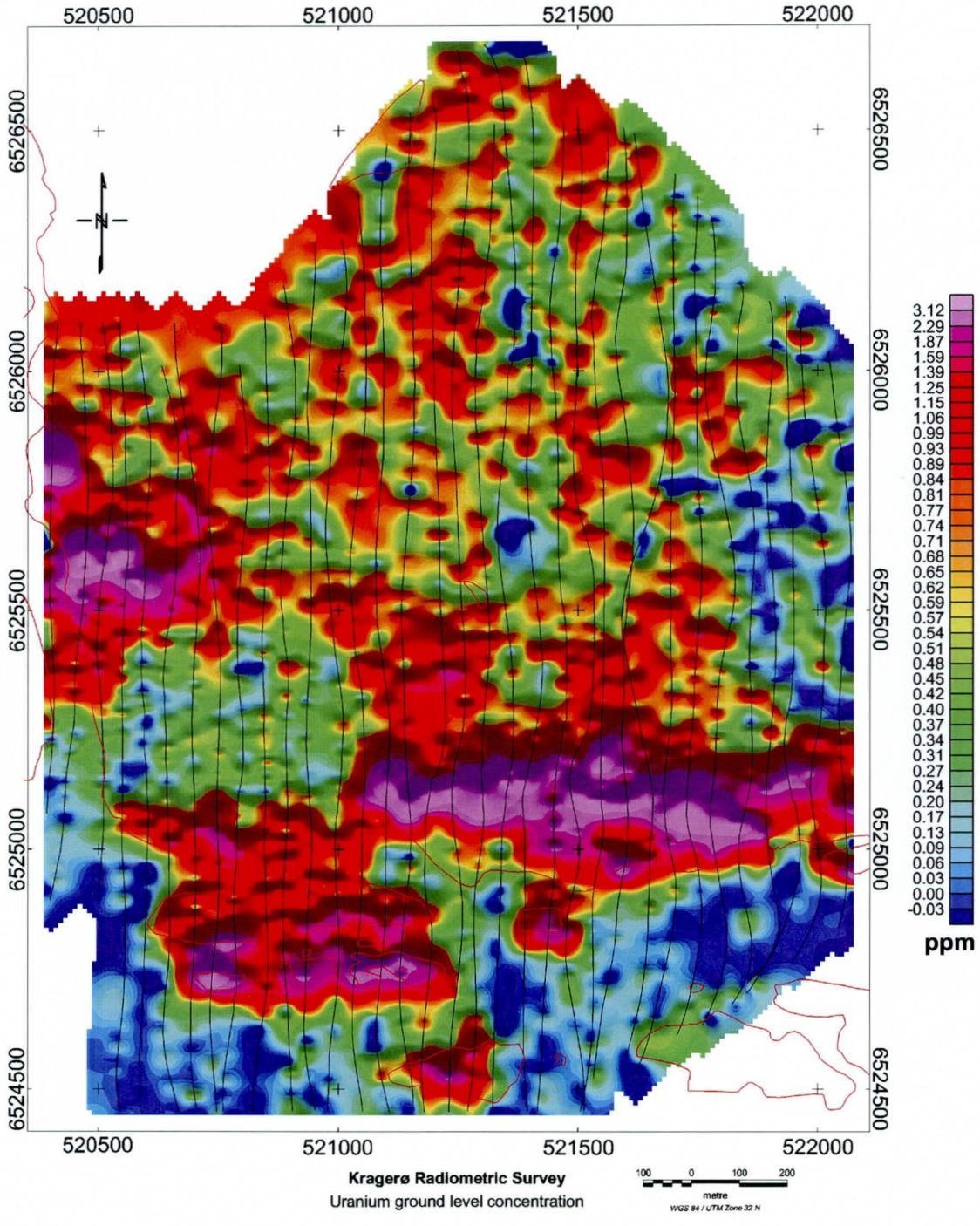
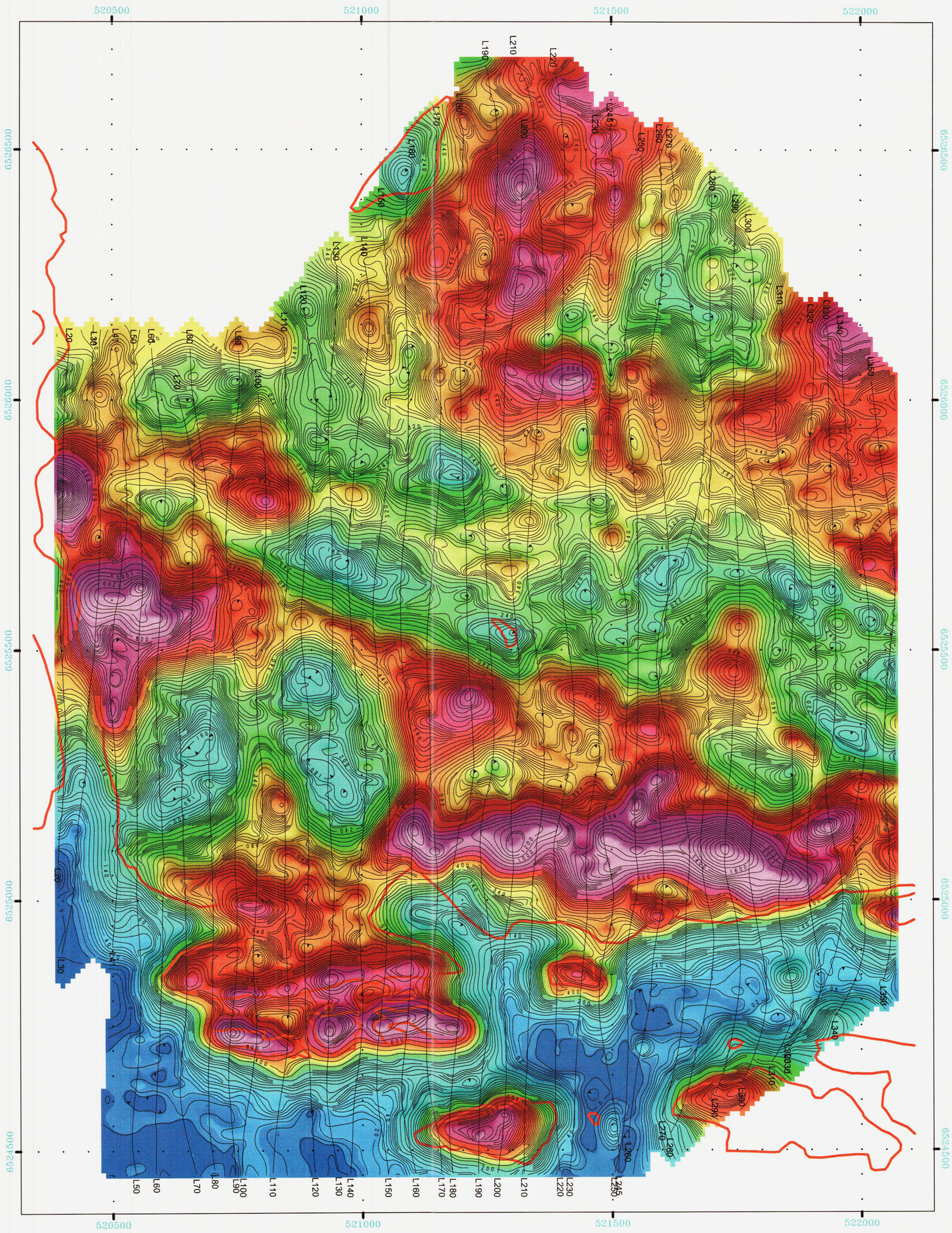


Fig. 3. Uranium ground level concentration in parts per million, Kragerø survey. Flight lines in black, coastline in red.



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Geology for Society since 1858

N

957.0
767.2
687.5
635.2
598.1
567.8
543.1
523.8
507.3
489.4
472.9
459.2
445.4
431.7
419.4
406.9
396.0
383.5
371.1
360.2
350.6
339.5
328.5
319.0
308.0
295.6
283.2
270.8
257.0
244.7
230.9
217.1
202.0
181.3
140.1
83.7
49.3
26.0
13.7
5.4

cps
(at 50 m height)

RADIOMETRIC DATA-TOTAL COUNTS

Radiometric data have been processed following procedures outlined in IAEA Technical Report 323 (IAEA, 1991). The effect of atmospheric radon was estimated and removed using data from survey lines over water. The leveled data have been normalized to a nominal survey height of 50 meters above ground level (counts per second at 50 m). Shading is from the south at 45 degrees inclination.

Average radiometric sensor height: 50 meters above ground level.

Shoreline and some streams and lakes outlined in red.

Contour intervals: 5 cps, 20 cps, 100 cps.

DATUM

Spheroid: WGS84

Projection: UTM zone 32.

NGU SURVEY-KRAGERØ

RADIOMETRIC DATA-TOTAL COUNTS

Based on 1998 helicopter survey

KRAGERØ AREA

NORWAY

Made by: *L. Beard*	Date: *Nov 1998*	Oper: *NGU*

Scale 1:5000

100 0 100 200 300

metres

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GEOLOGICAL SURVEY OF NORWAY
Leiv Eirikssons vei 39
N-7040 TRONDHEIM
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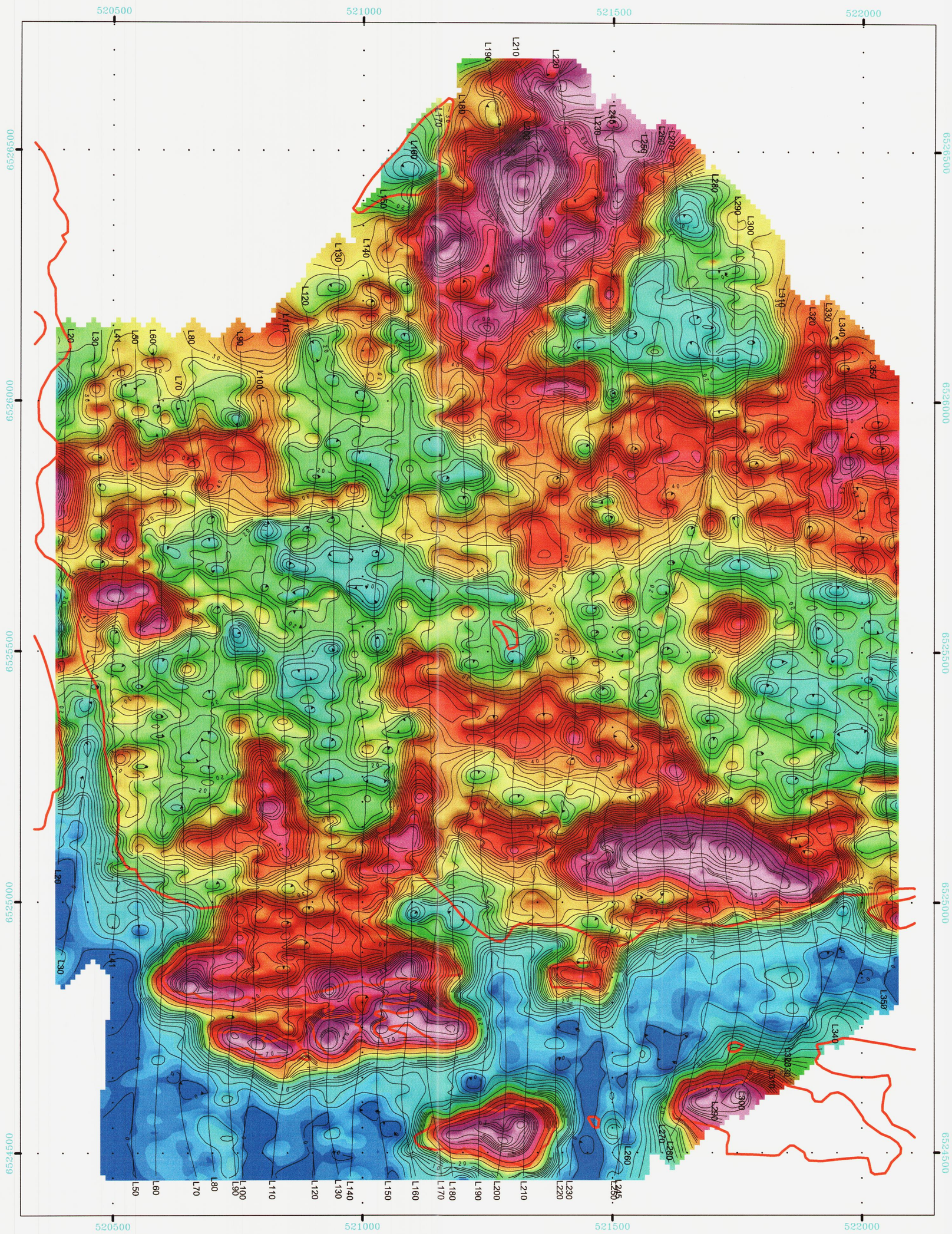
DRAWING: 2000.011-01



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75.0
65.4
58.7
53.7
50.1
47.5
45.2
43.3
41.8
40.3
39.0
37.6
36.0
34.6
33.2
31.9
30.7
29.9
28.9
28.0
27.1
26.1
25.2
24.3
23.5
22.6
21.7
20.7
19.7
18.6
17.4
16.1
14.5
12.6
9.9
5.9
3.1
1.6
0.6
0.1

cps
(at 50 m height)

RADIOMETRIC DATA-POTASSIUM

Radiometric data have been processed following procedures outlined in IAEA Technical Report 323 (IAEA, 1991). The effect of atmospheric radon was estimated and removed using data from survey lines over water. The leveled data have been normalized to a nominal survey height of 50 meters above ground level (counts per second at 50 m). Shading is from the south at 45 degrees inclination.

Average radiometric sensor height: 50 meters above ground level.

Shoreline and some streams and lakes outlined in red.

Contour intervals: 5 cps, 20 cps, 100 cps.

DATUM

Spheroid: WGS84

Projection: UTM zone 32.

NGU SURVEY-KRAGERØ

RADIOMETRIC DATA-POTASSIUM

Based on 1998 helicopter survey

KRAGERØ AREA

NORWAY

Made by: *L. Beard*	Date: *Nov 1998*	Oper: *NGU*

Scale 1:5000

100 0 100 200 300

metres

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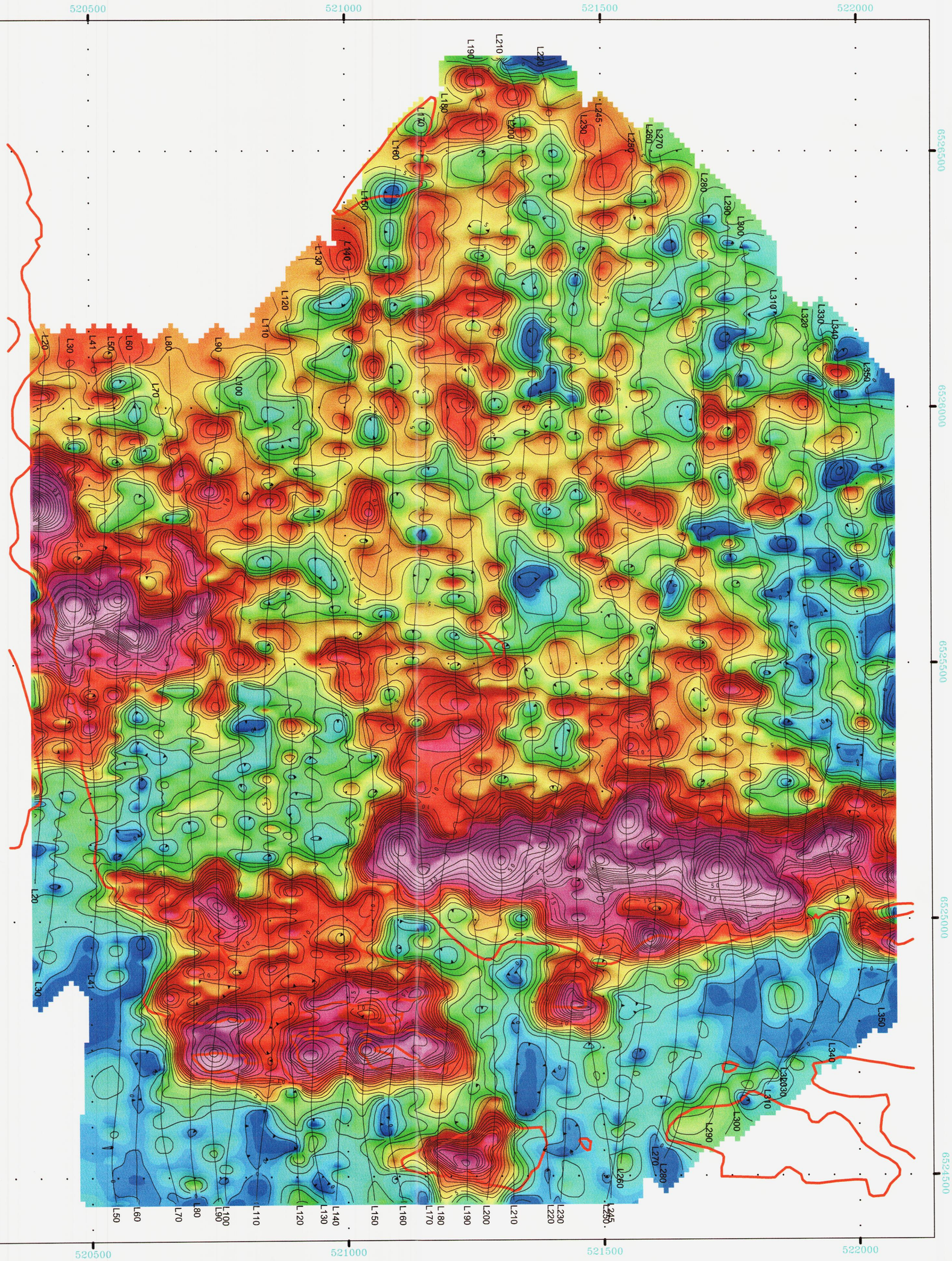

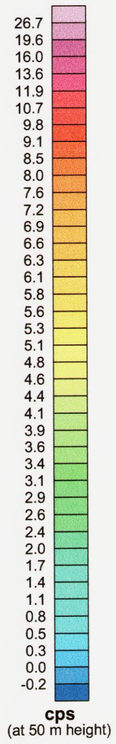

RADIOMETRIC DATA-URANIUM

Radiometric data have been processed following procedures outlined in IAEA Technical Report 323 (IAEA, 1991). The effect of atmospheric radon was estimated and removed using data from survey lines over water. The leveled data have been normalized to a nominal survey height of 50 meters above ground level (counts per second at 50 m). Shading is from the south at 45 degrees inclination.

Average radiometric sensor height: 50 meters above ground level.

Shoreline and some streams and lakes outlined in red.

Contour intervals: 1 cps, 5 cps, 20 cps.

DATUM

Spheroid: WGS84

Projection: UTM zone 32.

NGU SURVEY-KRAGERØ

RADIOMETRIC DATA-URANIUM

Based on 1998 helicopter survey

KRAGERØ AREA

NORWAY

Made by: *L. Beard*	Date: *Nov 1998*	Oper: *NGU*

Scale 1:5000

100 0 100 200 300

metres

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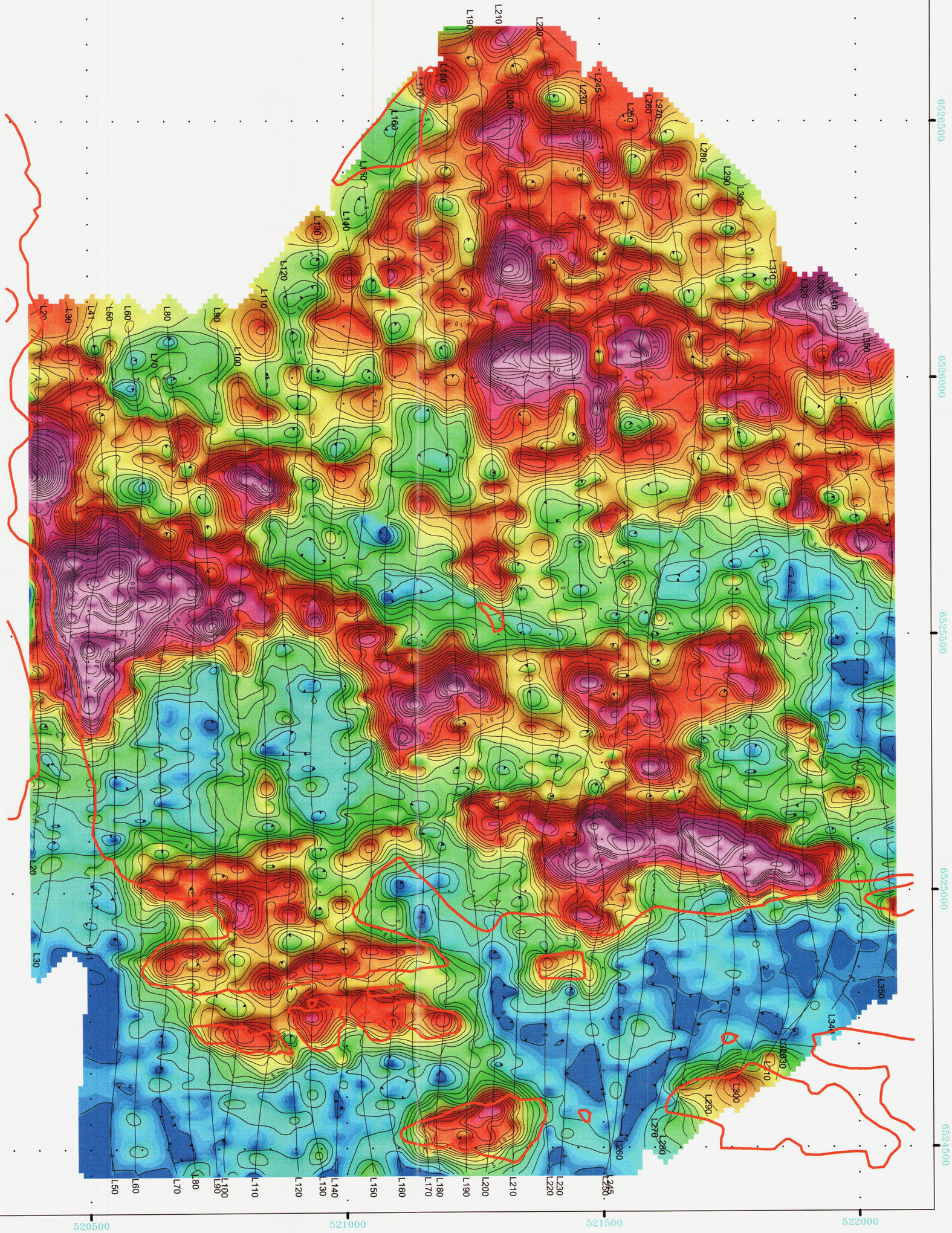
520500 521000 521500 522000

6526500 6526000 6525500 6525000 6524500



26.2
21.2
18.1
16.1
14.8
13.7
12.9
12.3
11.7
11.3
10.8
10.4
10.0
9.6
9.1
8.8
8.4
8.0
7.6
7.3
6.9
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
2.9
2.5
2.0
1.6
1.3
0.9
0.7
0.4
0.1
-0.0

cps
(at 50 m height)

RADIOMETRIC DATA-THORIUM

Radiometric data have been processed following procedures outlined in IAEA Technical Report 323 (IAEA, 1991). The effect of atmospheric radon was estimated and removed using data from survey lines over water. The leveled data have been normalized to a nominal survey height of 50 meters above ground level (counts per second at 50 m). Shading is from the south at 45 degrees inclination.

Average radiometric sensor height: 50 meters above ground level.

Shoreline and some streams and lakes outlined in red.

Contour intervals: 1 cps, 5 cps, 20 cps.

DATUM

Spheroid: WGS84

Projection: UTM zone 32.

NGU SURVEY-KRAGERØ

RADIOMETRIC DATA-THORIUM

Based on 1998 helicopter survey

KRAGERØ AREA

NORWAY

Made by: *L. Beard*	Date: *Nov 1998*	Oper: *NGU*

Scale 1:5000

100 0 100 200 300

metres

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