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GEOLOGICAL SURVEY OF CANADA



COMMISSION GÉOLOGIQUE DU CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES  
MINISTÈRE DE L'ÉNERGIE DES MINES ET DES RESSOURCES

Airborne Geophysical Survey  
Red Lake Area  
Ontario  
1991

NTS 52K/13 NW corner and parts of 52L/16, 52M/1 and 52N/4

Contents include gamma ray spectrometric, VLF, and magnetic  
colour maps, geology, flight path map and accompanying stacked profiles



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Canada

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2403

GEOLOGICAL SURVEY OF CANADA  
COMMISSION GÉOLOGIQUE DU CANADA  
OTTAWA

## AIRBORNE GEOPHYSICAL SURVEY

In 1991 a multi-parameter geophysical survey was flown by the Geological Survey of Canada in the Red Lake area of Ontario. The area surveyed is outlined on the index map. Gamma ray spectrometric, VLF electromagnetic and total field magnetic data were recorded.

All data were sampled at one second intervals. The airborne radiometric measurements were made using a 256 channel spectrometer, with twelve 102x102x406 mm NaI(Tl) detectors. A Geometrics proton precession airborne magnetometer model G-803 and a Hertz Totem 1A VLF unit were installed as ancillary equipment. The GSC Skyvan was flown at a mean terrain clearance of 125 m with average ground speed of 190 km/h. The survey flight line direction and spacing was northwest-southeast and 250 metres, respectively.

Data are presented as a set of colour contour maps at 1 : 50 000 scale. Stacked profiles at the same scale accompany the maps in this booklet. Profile data include the seven radiometric parameters, radar terrain clearance, magnetic total field and VLF total field and quadrature components for each flight line. The contour maps include : eight colour gamma ray spectrometric maps (exposure rate, potassium, equivalent uranium and equivalent thorium concentrations, the eU/eTh, eU/K, eTh/K ratios and a Ternary Radioelement map); a magnetic total field colour map; a calculated magnetic vertical gradient colour map; two gridded VLF total field colour map (one superimposed with VLF total field profile data the other with quadrature profile data); a flight path map and a composite geological map. Topographic features and geological contacts are shown on the geophysical maps.

### Gamma Ray Spectrometric Data

Potassium is measured directly from the 1.46 MeV gamma ray photons emitted by <sup>40</sup>K, whereas uranium and thorium are measured indirectly from gamma ray photons emitted by daughter products in their decay chains. Uranium is monitored by means of gamma ray photons at approximately 1.76 MeV from <sup>214</sup>Bi, and thorium, from 2.62 MeV photons emitted by <sup>208</sup>Tl. The energy windows used are as follows:

Potassium	<sup>40</sup> K	1.36– 1.56 MeV
Uranium	<sup>214</sup> Bi	1.66– 1.86 MeV
Thorium	<sup>208</sup> Tl	2.41–2.81 MeV

Uranium, thorium and potassium counts have been corrected for dead time, ambient temperature changes, background radiation, spectral scattering and deviations of terrain clearance from the planned survey altitude. The data as presented represent an average surface concentration which is influenced by varying amounts of outcrop, overburden, vegetation, soil moisture and surface waters. As a result, the concentrations as shown are usually lower than the actual concentrations in the bedrock.

Factors for converting the airborne measurements to concentrations were determined by relating the airborne count rates to the known ground concentrations of a test strip in the Ottawa area. The factors used to convert the airborne measurements to ground concentrations are:

1 % K	91.0 cps
1 ppm eU	9.1 cps
1 ppm eTh	7.0 cps

The exposure rate, in micro Roentgens per hour ( $\mu$ R/h) has been computed from the measured concentrations of potassium, uranium and thorium (Grasty, R.L., Carson, J.M., Charbonneau, B.W., and Holman, P.B., 1984, Natural Background Radiation in Canada, Geol. Sur. Can., Bull. 360). To compare these data with earlier total count maps expressed in Units of Radioelement concentrations (Ur), the conversion factor is  $1 \mu$ R/h = 1.67 Ur.

### VLF Data

The primary electromagnetic field is generated by VLF communication stations. For this survey, the receiving coils were tuned to station NAA at Cutler Maine, which transmits at a frequency of 24.0 kHz.

Anomalies reflect distortions in the primary field caused by a secondary electromagnetic field generated by eddy currents flowing in geological and man-made conductors. Anomalies produce positive peaks on the total field trace and are of the cross-over type (negative to positive) on the quadrature trace. Both parameters are plotted with positive deflections toward east. The profiles presented are the total field value (vector sum of the horizontal and vertical components) and the quadrature value (out-of-phase component). The mean value or line average of the total field and quadrature component were removed along each flight line. The resultant values are plotted with a two second lag. The quadrature, which depends on the flight line direction, was inverted for lines flown from southeast to northwest. A five point weighted average filter was applied to both total field and quadrature profile data for final presentation. A twenty one point triangular filter was applied to the line data and the resultant was then subtracted before the data was gridded. This effectively removed the long wave length response created by changing field strength, instrument drift, altitude effects, etc.

### Magnetic Data

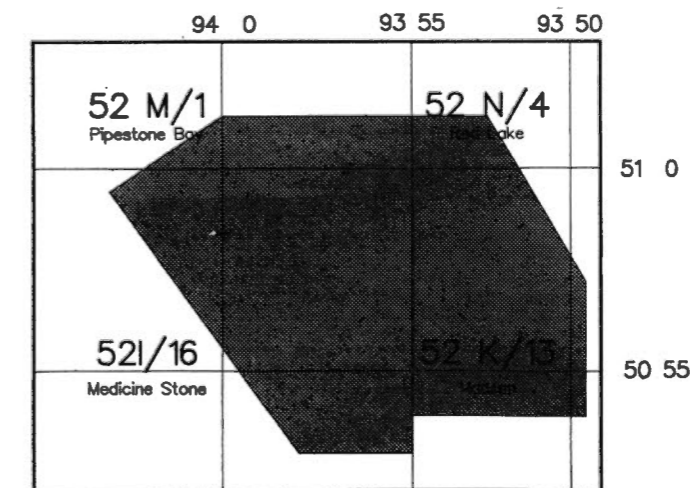
The aeromagnetic data were acquired using an instrument with one (1) nT sensitivity. Digital processing of the magnetic data was used to remove errors caused by spikes, heading effects or diurnal variations.

Information regarding Open File 2403 may be obtained from: Geological Survey of Canada, 601 Booth St., Ottawa, Ontario, K1A 0E8. Tel. : (613)995-4342. Copies of this Open File release may be purchased directly through: Ashley Reproduction Inc., 386 Bank Street, Ottawa, Ontario K2P 1Y4. Tel. : (613)235-2115

Base map material supplied by Surveys and Mapping Branch

Computerized Cartography by Geological Survey of Canada

**Airborne gamma ray spectrometer, VLF and magnetic survey flown, compiled and funded by Geological Survey of Canada**

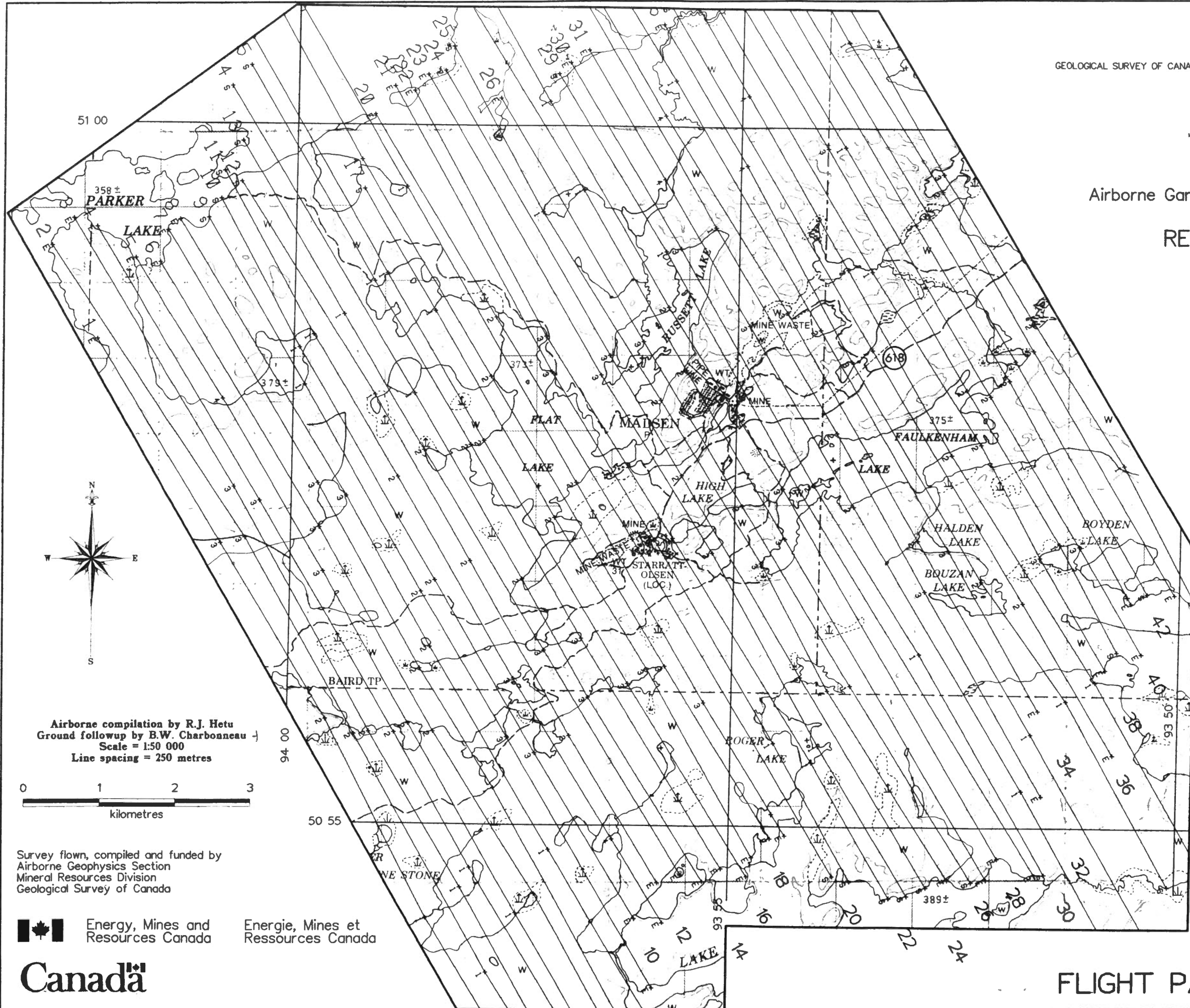


INDEX MAP





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Airborne Gamma Ray Spectrometer Survey  
of the  
**RED LAKE SURVEY**  
ONTARIO  
1990



Airborne compilation by R.J. Hetu  
Ground followup by B.W. Charbonneau  
Scale = 1:50 000  
Line spacing = 250 metres



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FLIGHT PATH MAP

## FIELD INVESTIGATION OF THE RED LAKE GEOPHYSICAL SURVEY (GAMMA-MAG-VLF)

B.W. Charbonneau and M.I. Legault

A brief field examination of the geophysical anomaly patterns took place during July 1991. This work involved field sampling, in situ magnetic susceptibility, scintillometer and gamma spectrometer measurements. The area of the field investigation is identified on the accompanying geological map. The findings are briefly summarized below.

The magnetic anomalies were found to relate to: 1) portions of the mafic intrusives (much of this lithology is not magnetic); 2) a belt of altered ultramafic volcanics; 3) portions of the margin of the Flat Lake granodiorite.

The principal rationale for the airborne survey was to study the potassium signature relating to gold along the Madsen-Starratt Olsen (Flat Lake-Howey Bay) shear zone as originally reported by Durocher, 1983. The Madsen-Starratt-Olsen Zone shows a weak but distinct potassium anomaly which is unusual considering the underlying mafic volcanic lithology which would typically have very low potassium. More prominent potassium anomalies can be seen over the granite and felsic metavolcanics within the survey. The potassium anomaly over the Madsen-Starratt-Olsen Zone can be differentiated from many of the anomalies over the granite-felsic volcanic terrain by virtue of the former having very low thorium (and uranium) levels accompanying the potassium resulting in low Th/K ratios. Potassium anomalies over most of the granitic and felsic volcanic rocks have higher thorium (and uranium) values accompanying the potassium resulting in higher Th/K and U/K ratios.

The in situ potassium levels measured during the follow-up are consistent with Durocher, 1983 who reported that alteration resulted in potassium increases of between 2 and 4 times the values in unaltered volcanics and that this potassium increase was accompanied by increases in a variety of other elements including gold, arsenic, sulphur, boron, antimony and a decrease in sodium and carbon dioxide.

Table 1 is a summary of representative potassium analyses determined by in situ gamma spectrometry. Potassium values in altered mafic volcanics along the mineralized zones previously mapped as tuff, i.e. "Austin Tuff" and "McVeigh Tuff" average 2.1%K, some 3x higher than values in unaltered mafic volcanics (0.7%K). The lower part of Table 1 shows typical potassium values in the McVeigh ore zone vs biotite alteration, epidote alteration, unaltered mafic volcanics, all part of the alteration envelope.

The dimension of the potassium enrichment at 2x background, i.e. 1.4%K is about 200 metres wide by four kilometres long. The area of 3x background is much more restricted and patchy. Increases to 4x background are only present as a few isolated spots along the ore zones where values may occasionally exceed 4%K.

Table 1

	K%
Average altered mafic volcanics (Austin Tuff, McVeigh Tuff)	2.1
McVeigh Ore Zone (maximum)	3.9
Biotite alteration	3.0
Epidote alteration	1.7
Unaltered mafic volcanics	0.7

Durocher, M.E. (1983) The Nature of Hydrothermal Alteration Associated with the Madsen Starratt-Olsen Gold Deposits, Red Lake area; in The Geology of Gold in Ontario, Ontario Geological Survey Miscellaneous Paper 110, pp. 123-140.









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**GEOLOGY MAP**  
LEGEND


INTRUSIVES

-  Granodiorite
-  Mafic & Ultramafic intrusives

THOLEITIC-KOMATIITIC SEQUENCE

-  Metasediments
-  Intermediate to Felsic metavolcanics
-  Mafic & Ultramafic metavolcanics
-  Altered Tuff (mafic volcanics)

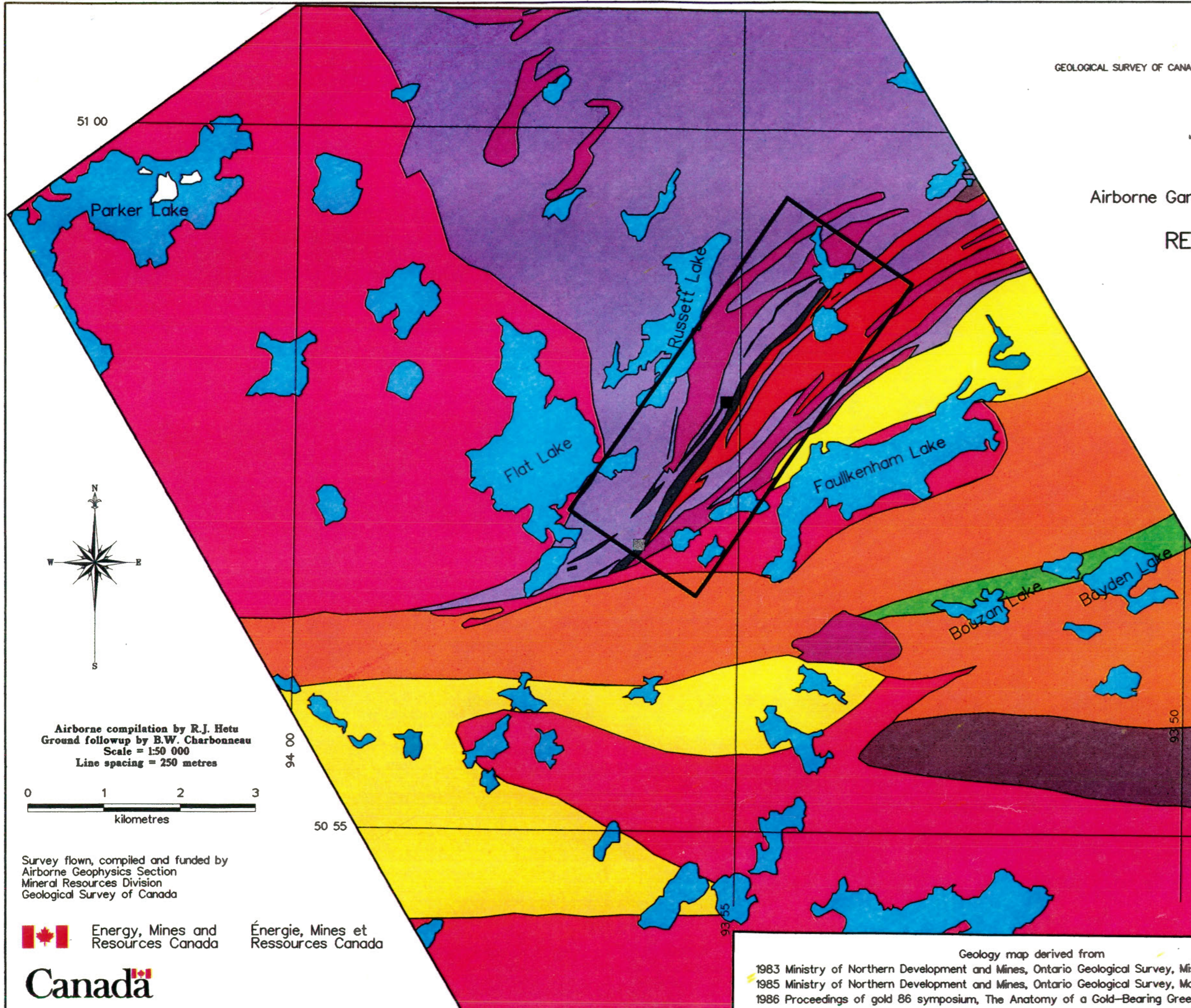
CALC ALKALIC SEQUENCE

-  Felsic metavolcanics
-  Intermediate metavolcanics
-  Mafic metavolcanics

MINE LOCATIONS

-  Madsen
-  Starratt-Olsen

  
Field investigation Area



51 00

Parker Lake

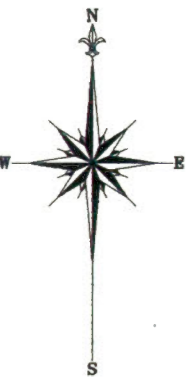
Flat Lake

Russett Lake

Faulkenham Lake

Bobzan Lake

Bayden Lake



Airborne compilation by R.J. Hetu  
Ground followup by B.W. Charbonneau  
Scale = 1:50 000  
Line spacing = 250 metres



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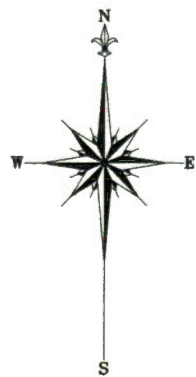
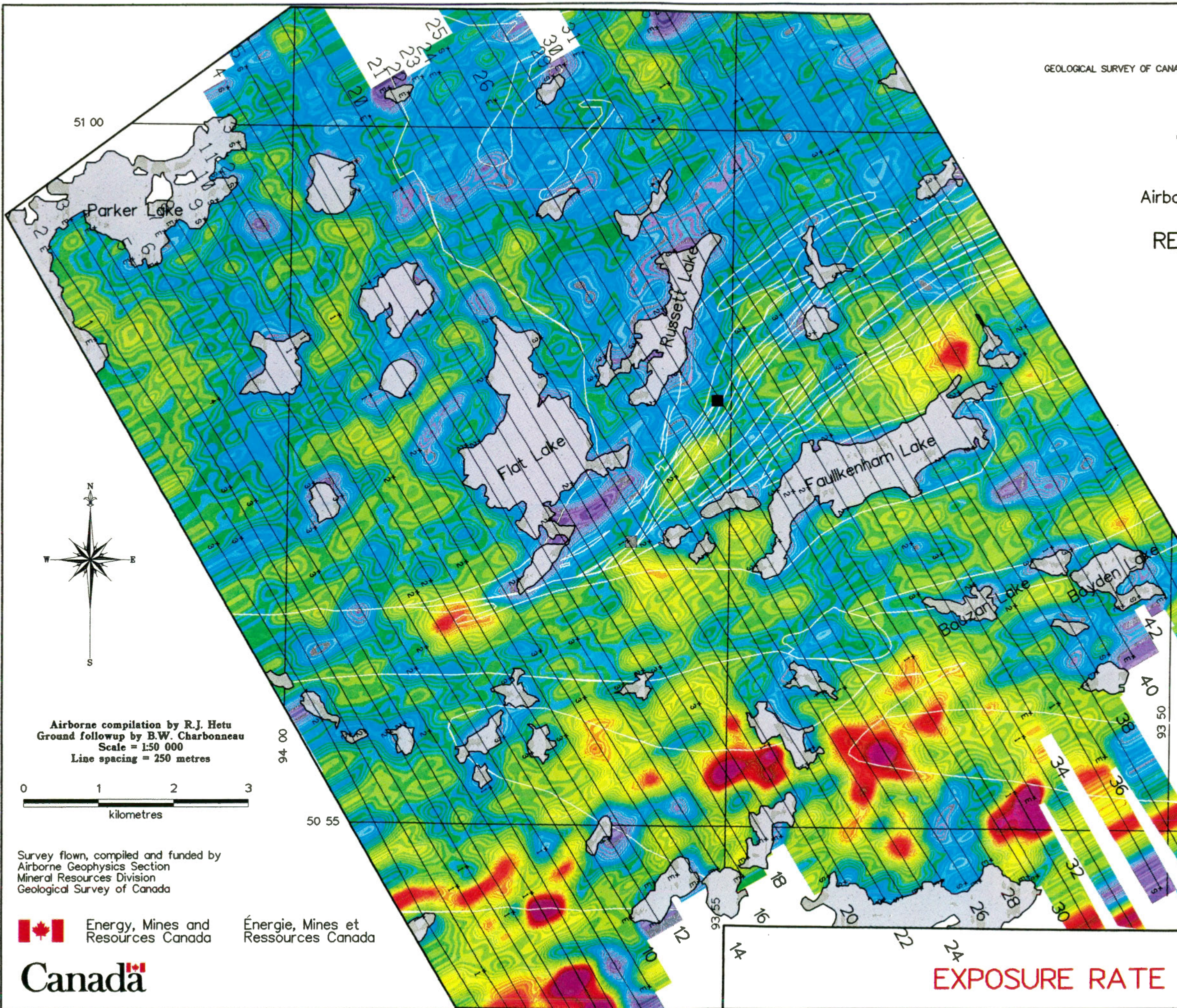
**Canada**

Geology map derived from  
1983 Ministry of Northern Development and Mines, Ontario Geological Survey, Misc paper 110, page 125  
1985 Ministry of Northern Development and Mines, Ontario Geological Survey, Map P.2857  
1986 Proceedings of gold 86 symposium, The Anatomy of a Gold-Bearing Greenstone Belt, page 19





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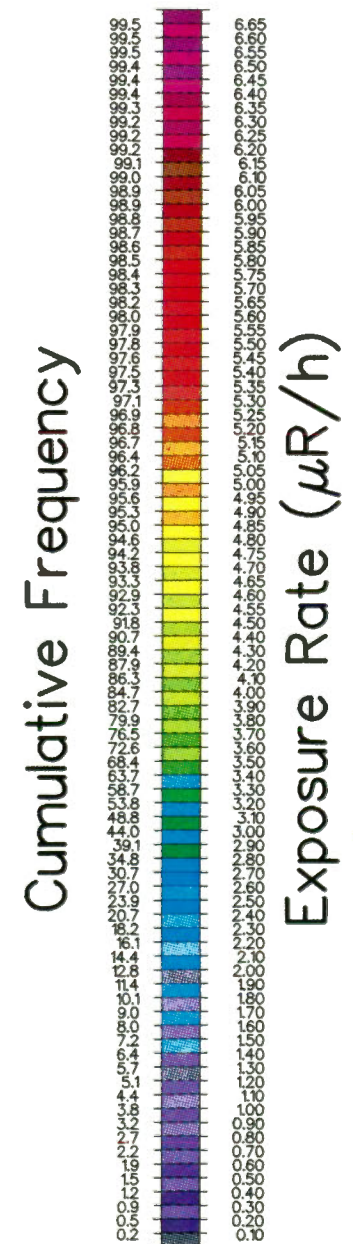


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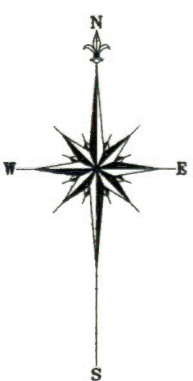
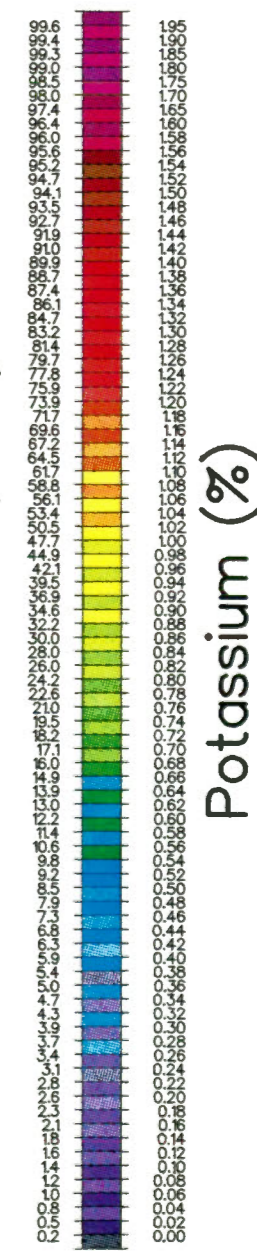
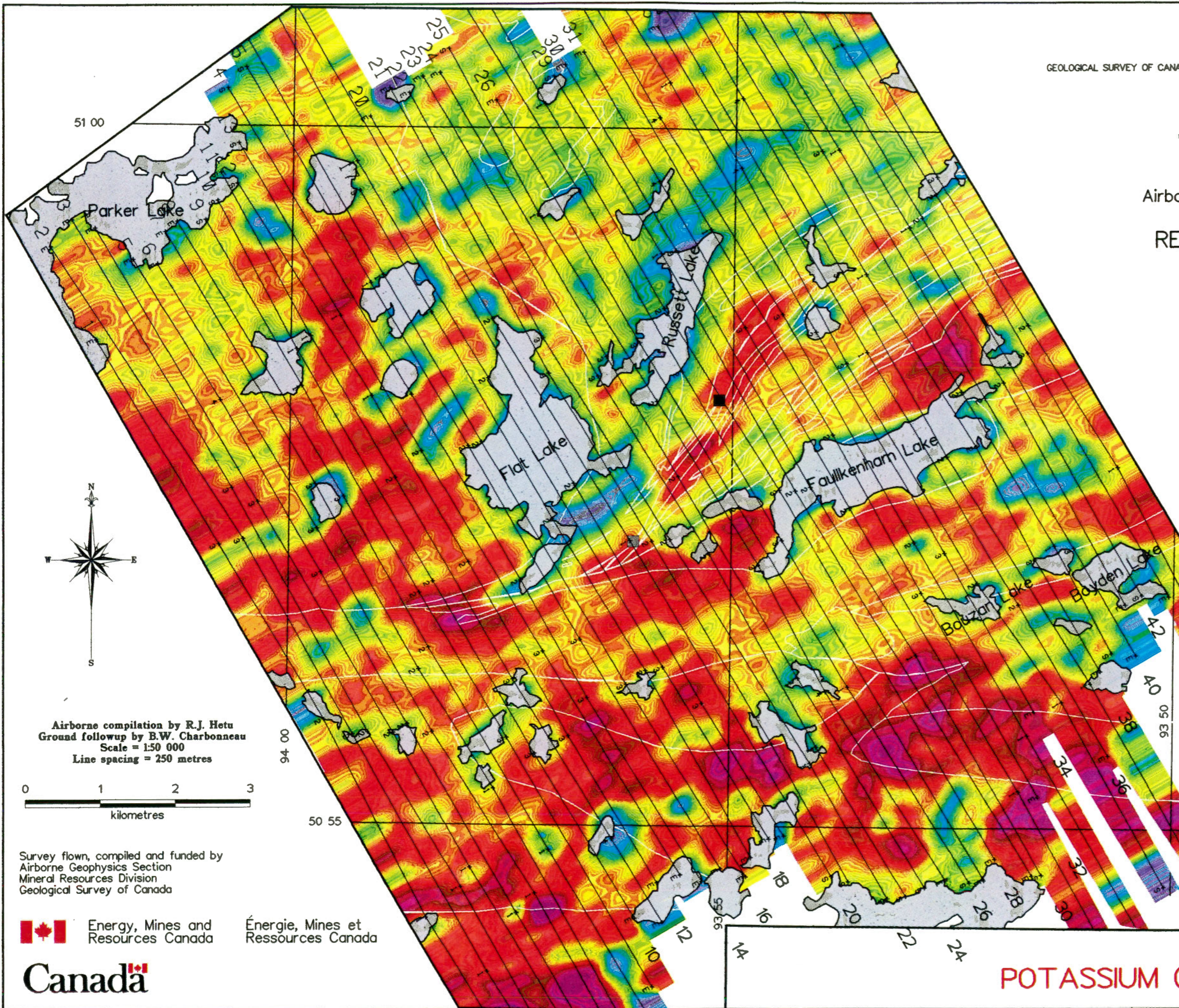


**EXPOSURE RATE (µR/H)**





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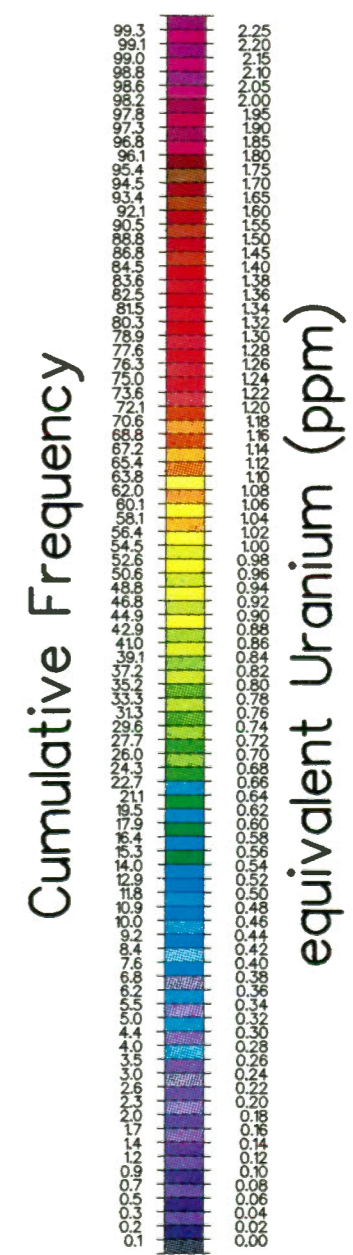
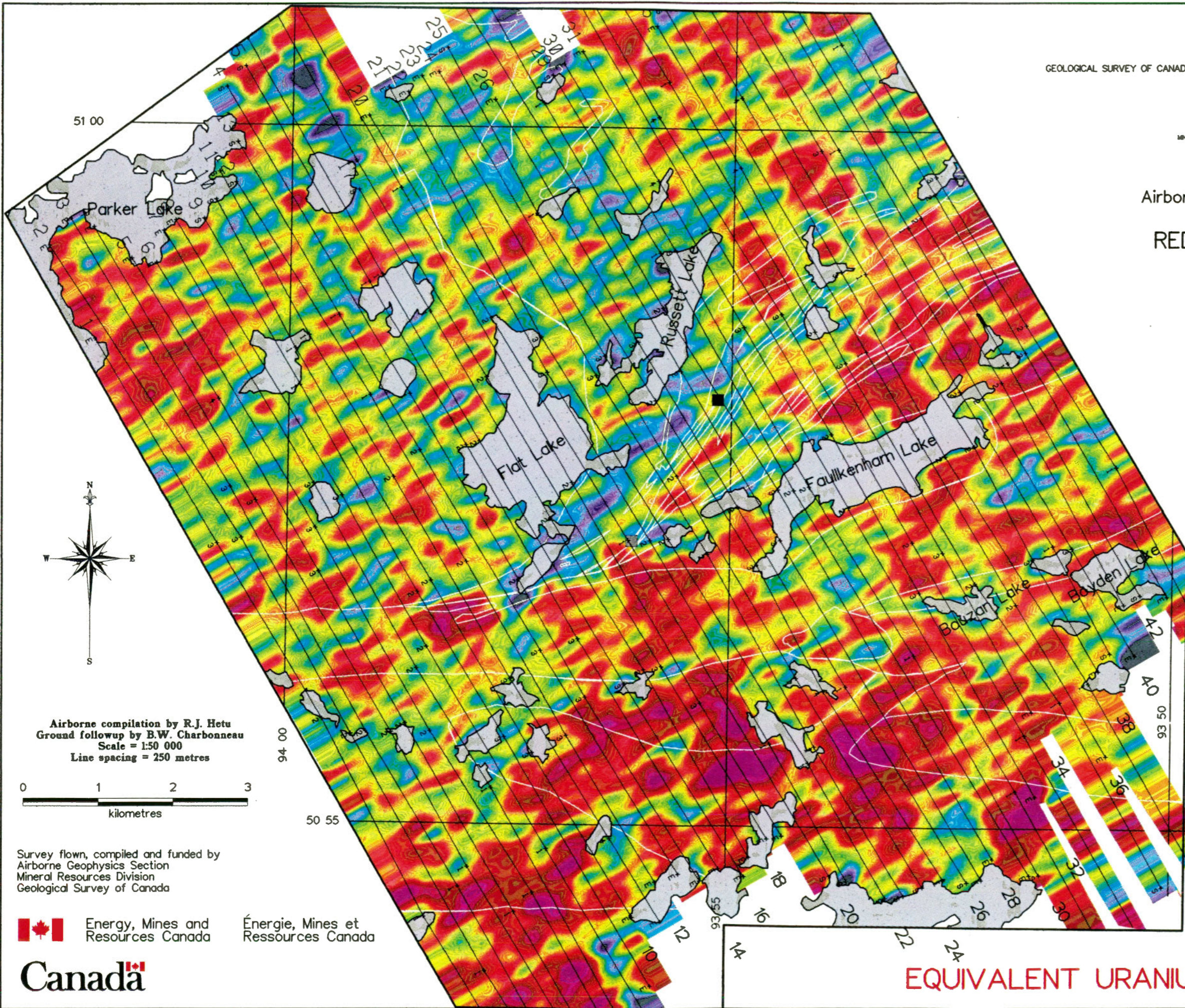


**POTASSIUM (%)**





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Cumulative Frequency

equivalent Uranium (ppm)

51 00

Parker Lake

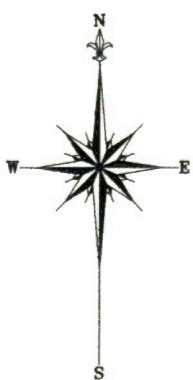
Russett Lake

Flat Lake

Faulkenham Lake

Bouzoni Lake

Bayden Lake



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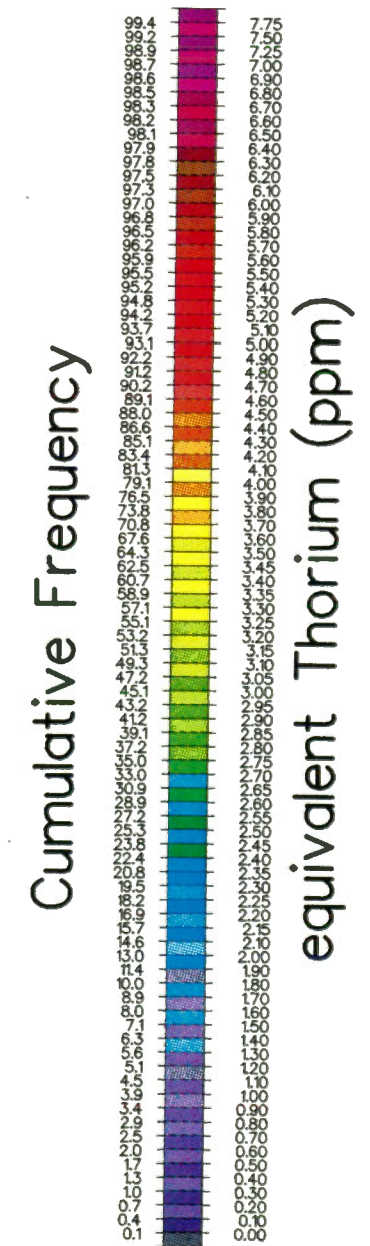
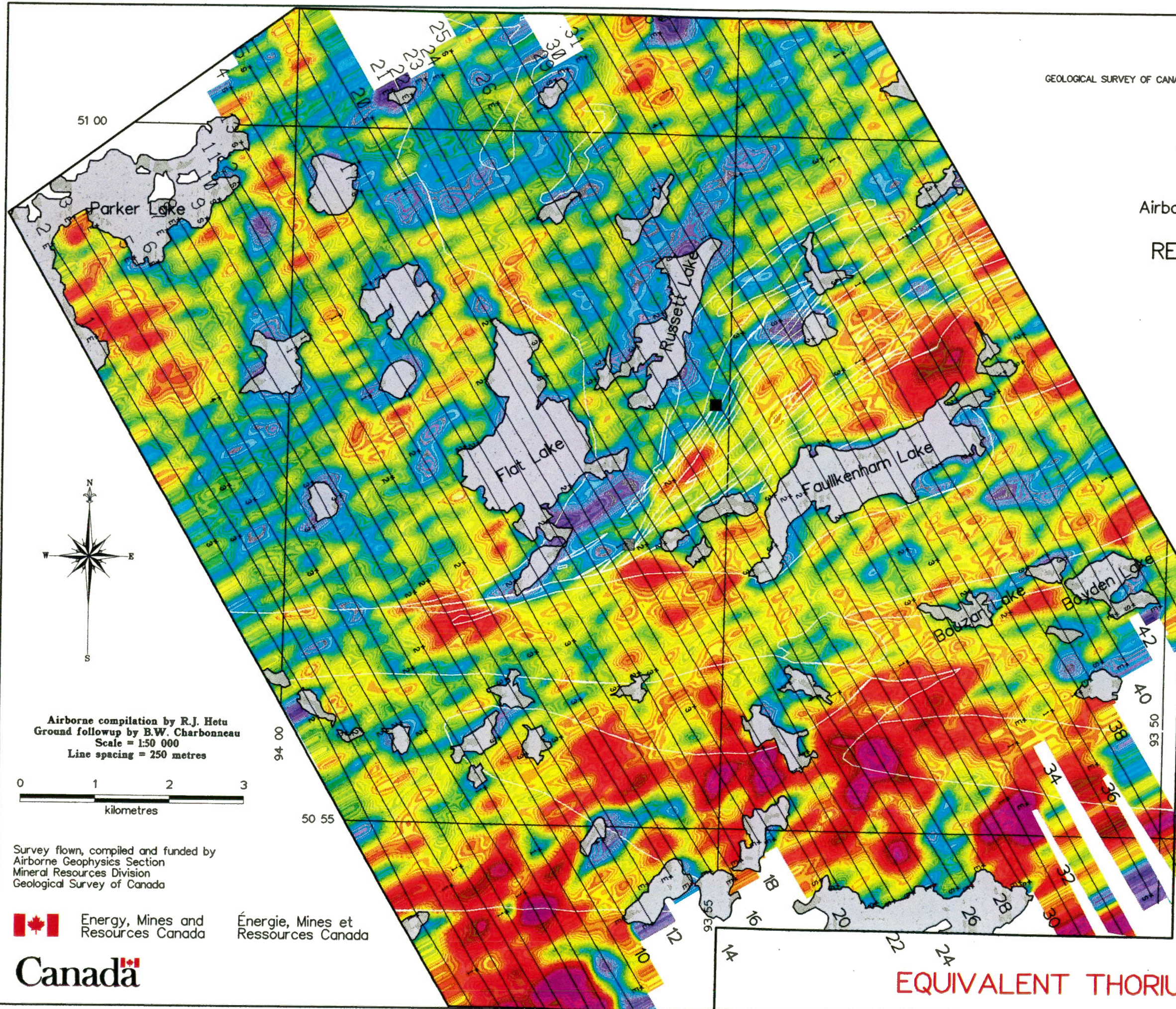


**EQUIVALENT URANIUM (PPM)**





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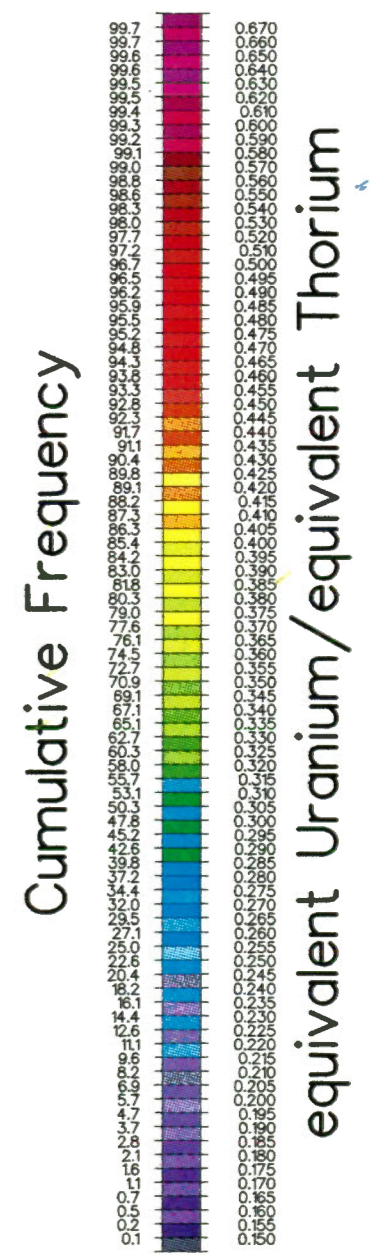
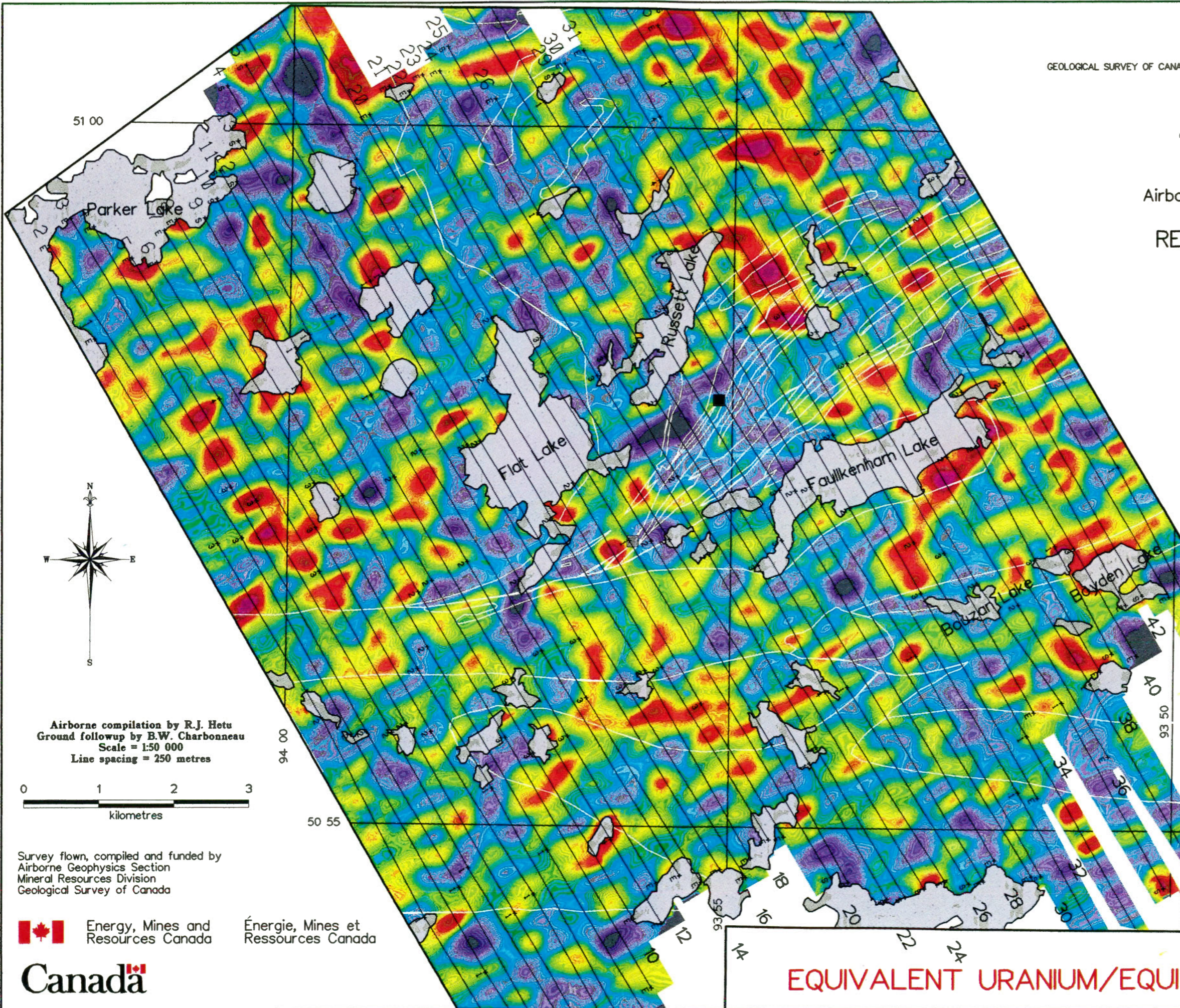


**EQUIVALENT THORIUM (PPM)**





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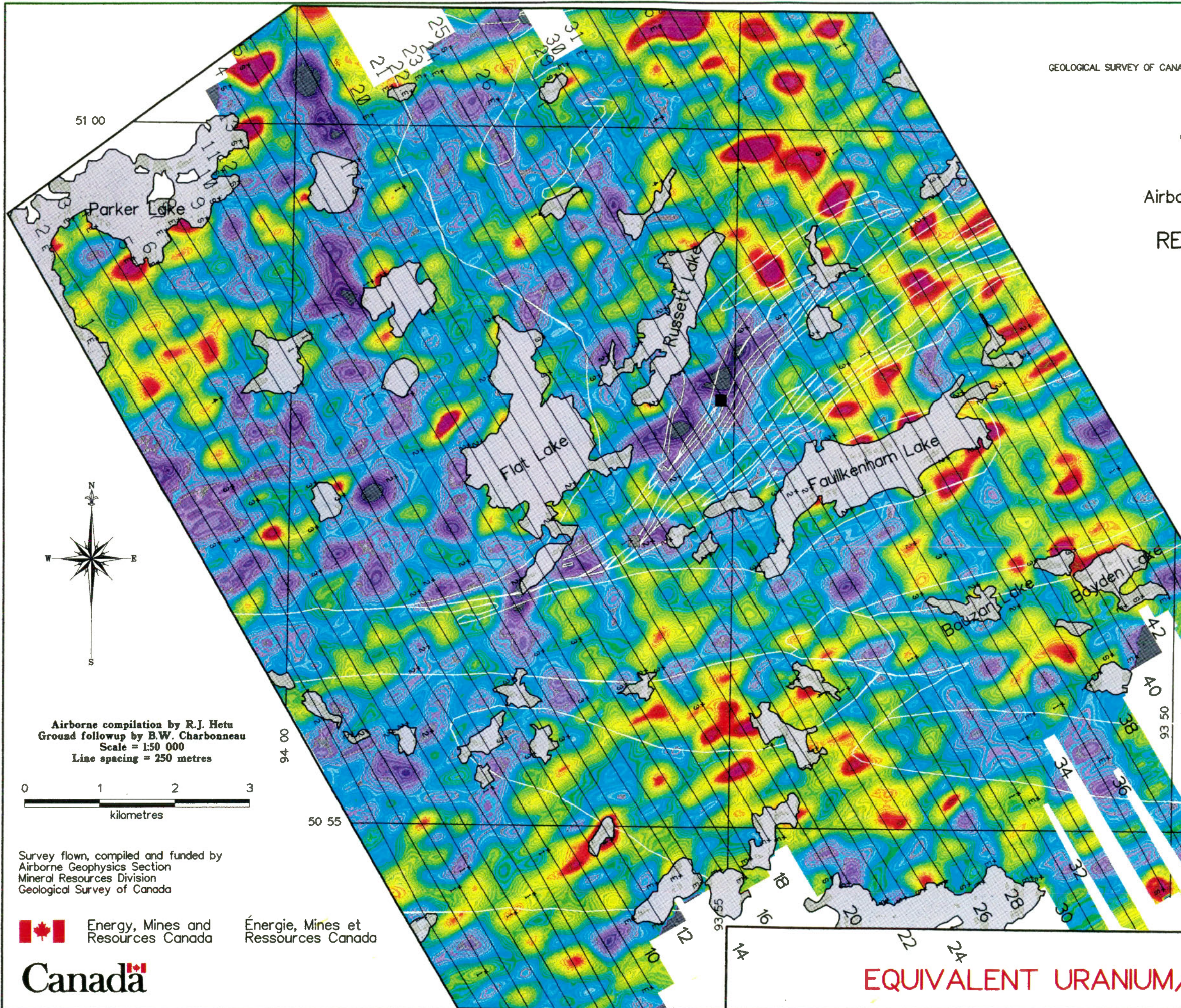
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**EQUIVALENT URANIUM/EQUIVALENT THORIUM**

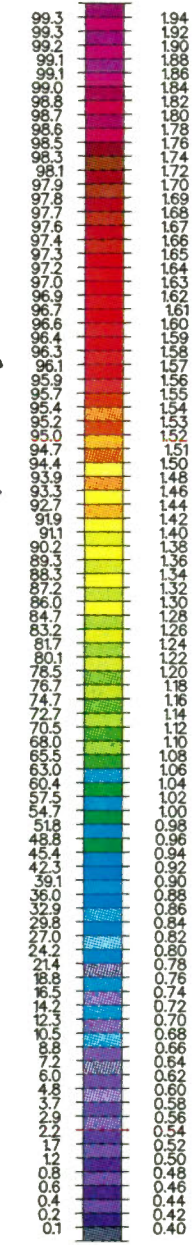




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Cumulative Frequency



equivalent Uranium/Potassium

**EQUIVALENT URANIUM/POTASSIUM**

51 00

Parker Lake

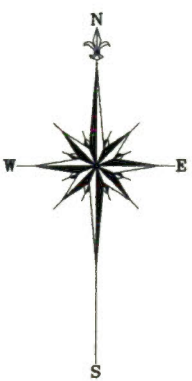
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Flat Lake

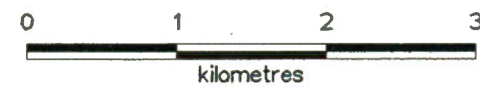
Faulkenham Lake

Bouzani Lake

Boyden Lake



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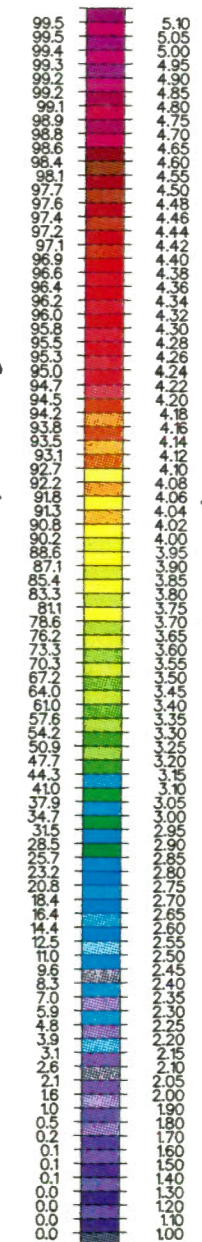
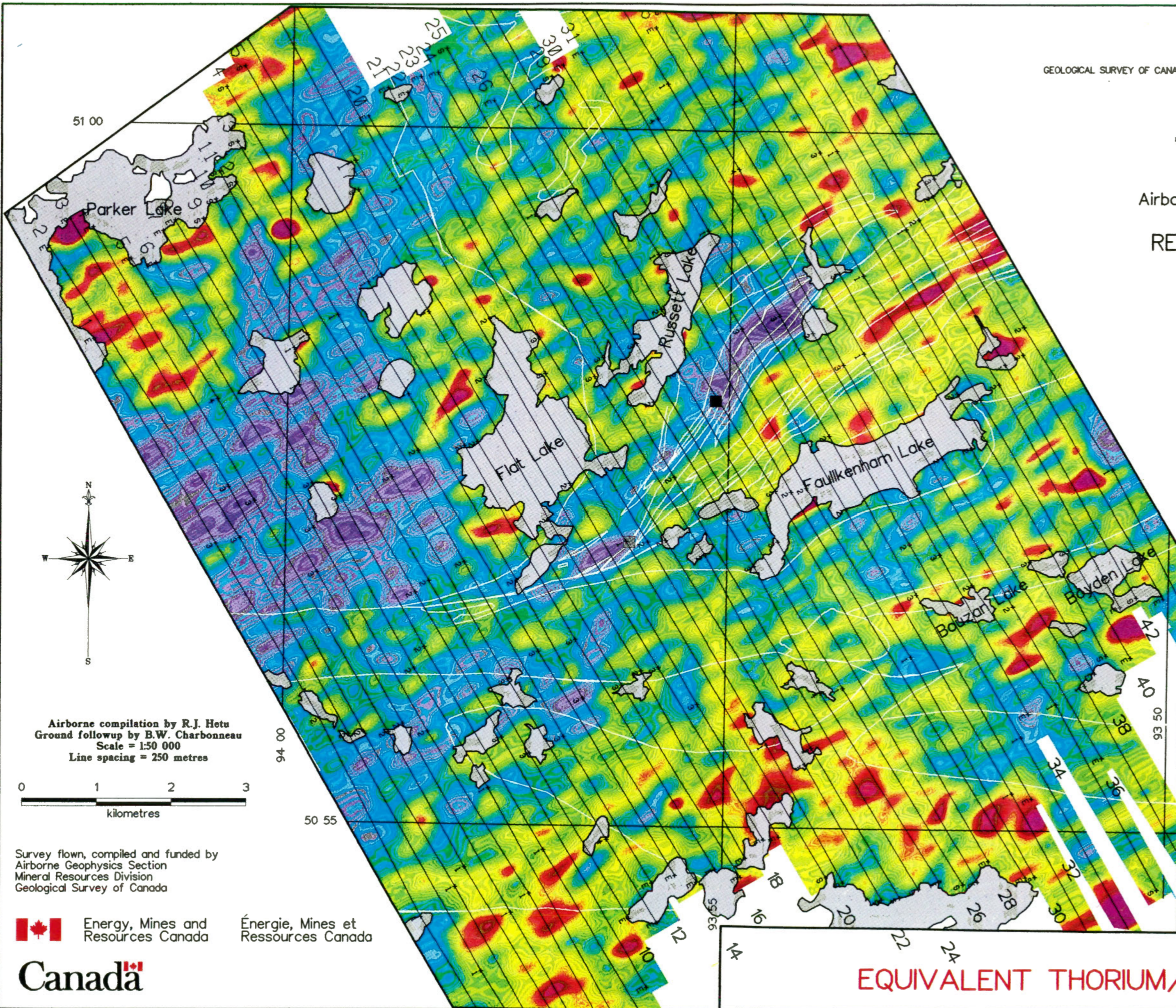
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Cumulative Frequency

equivalent Thorium/Potassium

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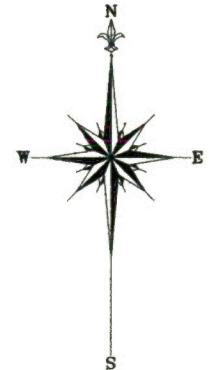
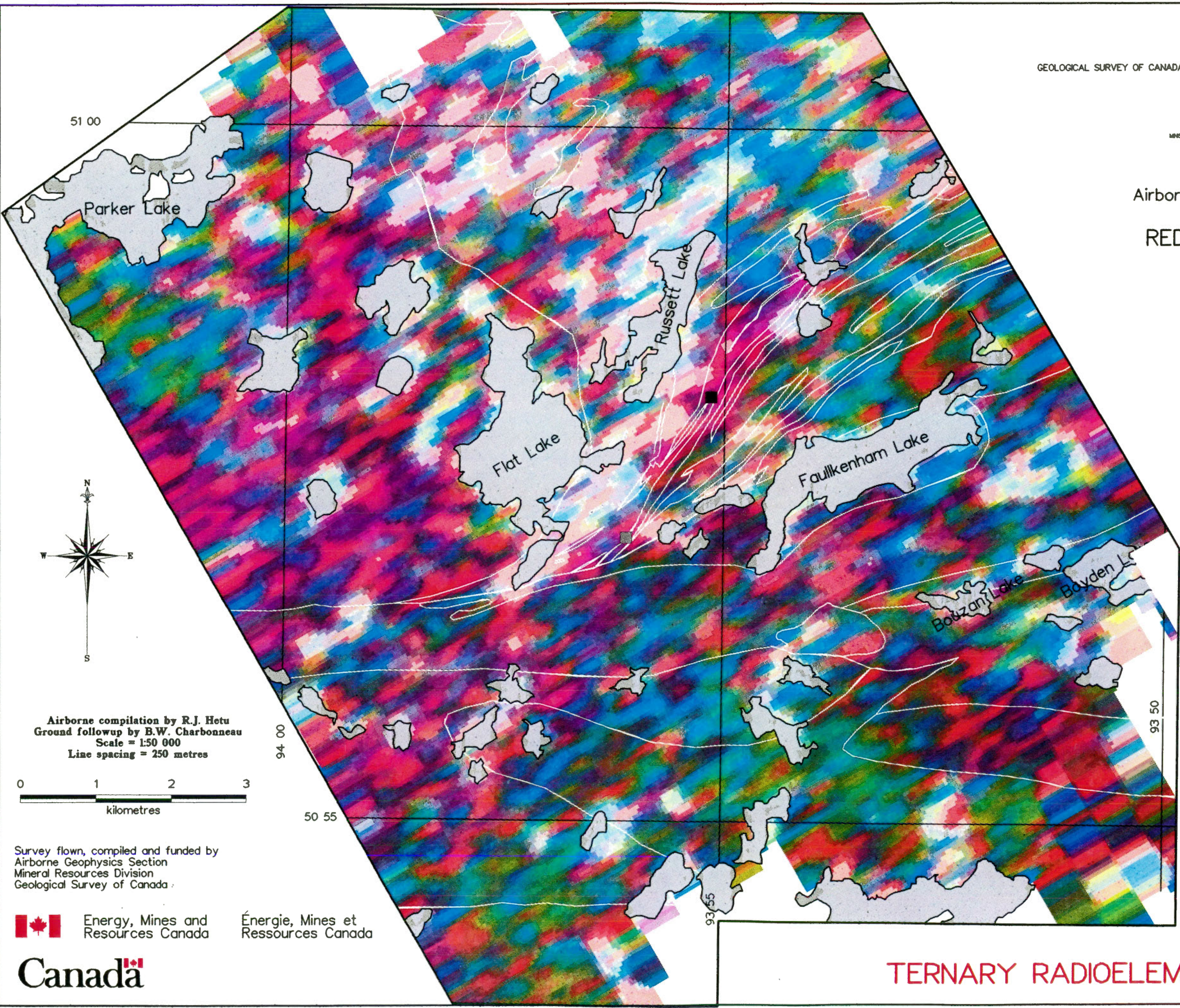


**EQUIVALENT THORIUM/POTASSIUM**

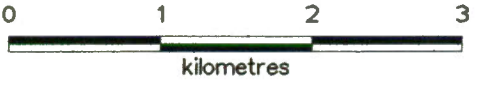




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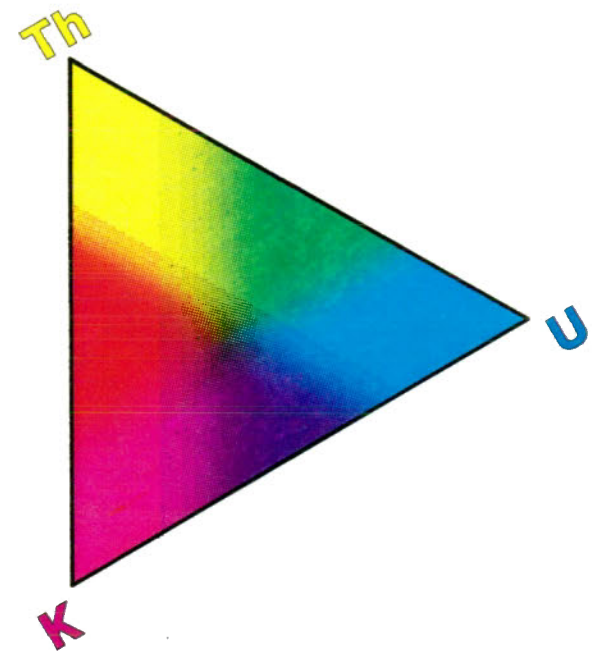


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**TERNARY RADIOELEMENT MAP**



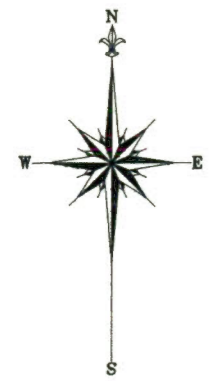
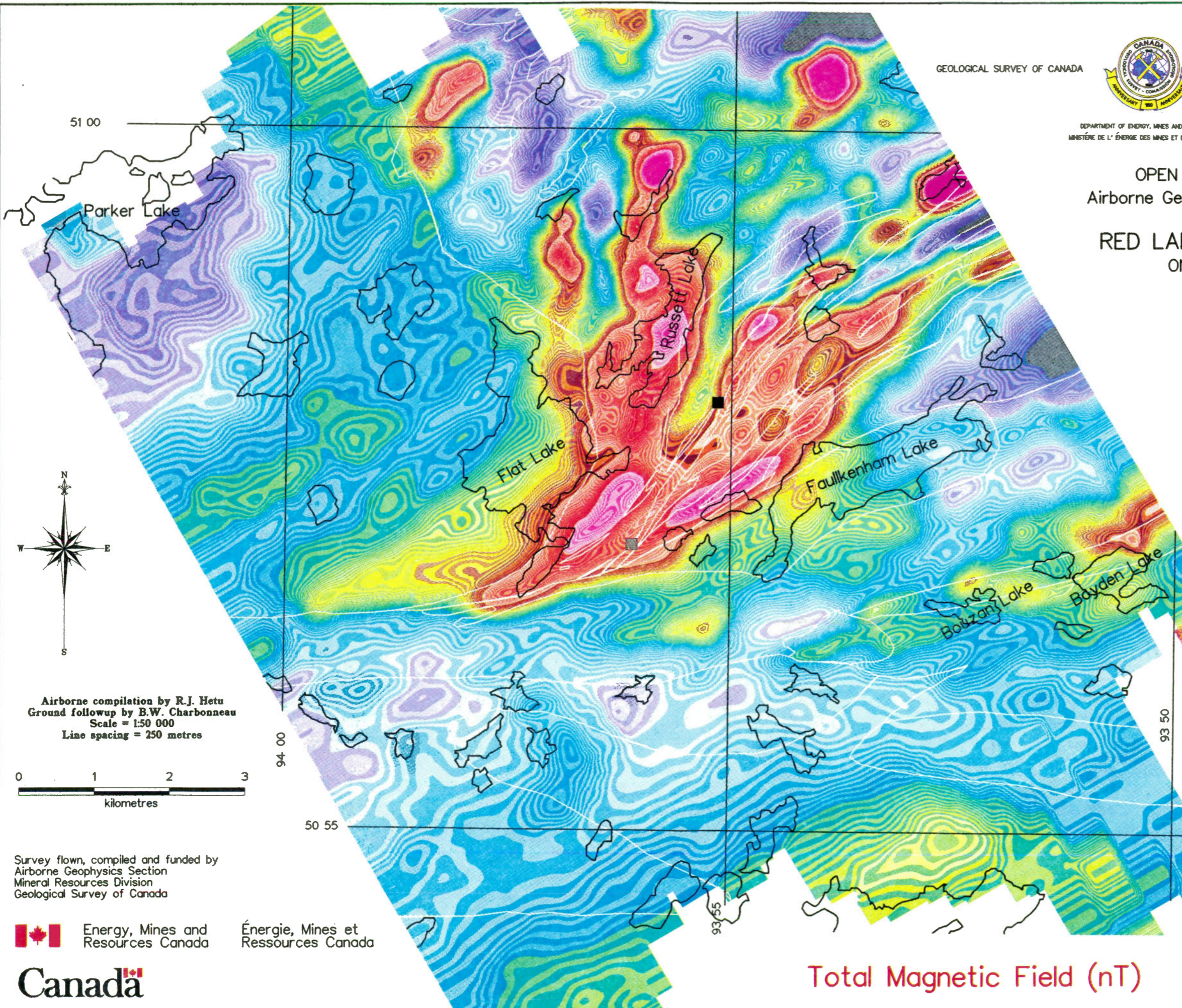
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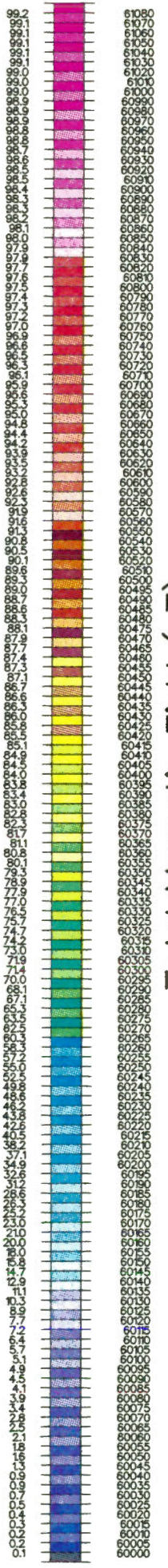


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Cumulative Frequency

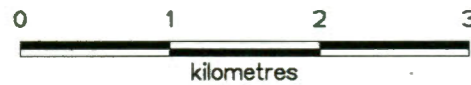
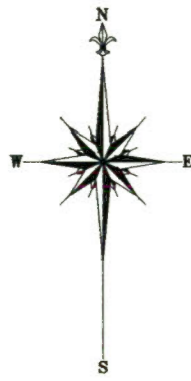
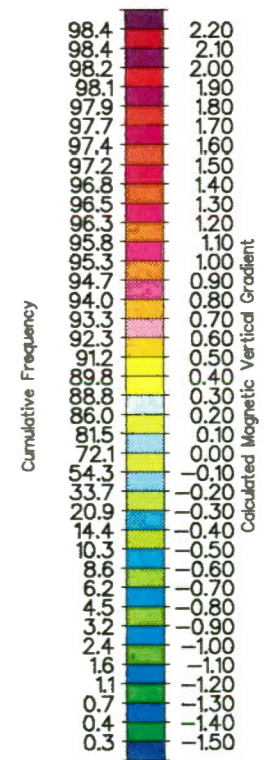
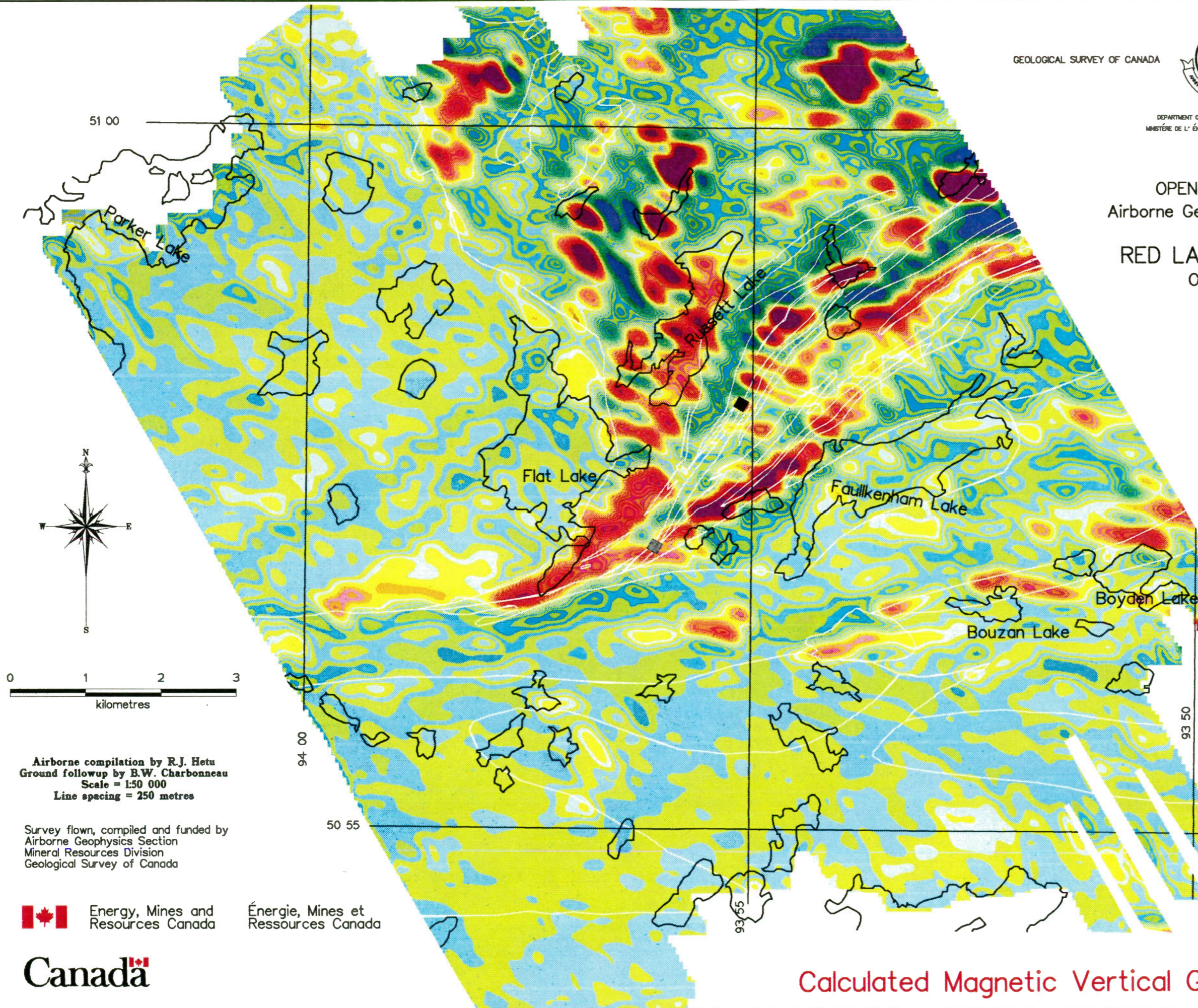


Total Magnetic Field (nT)





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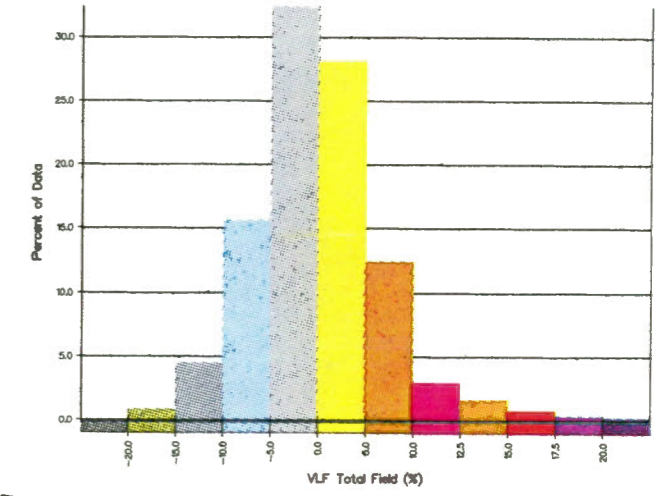
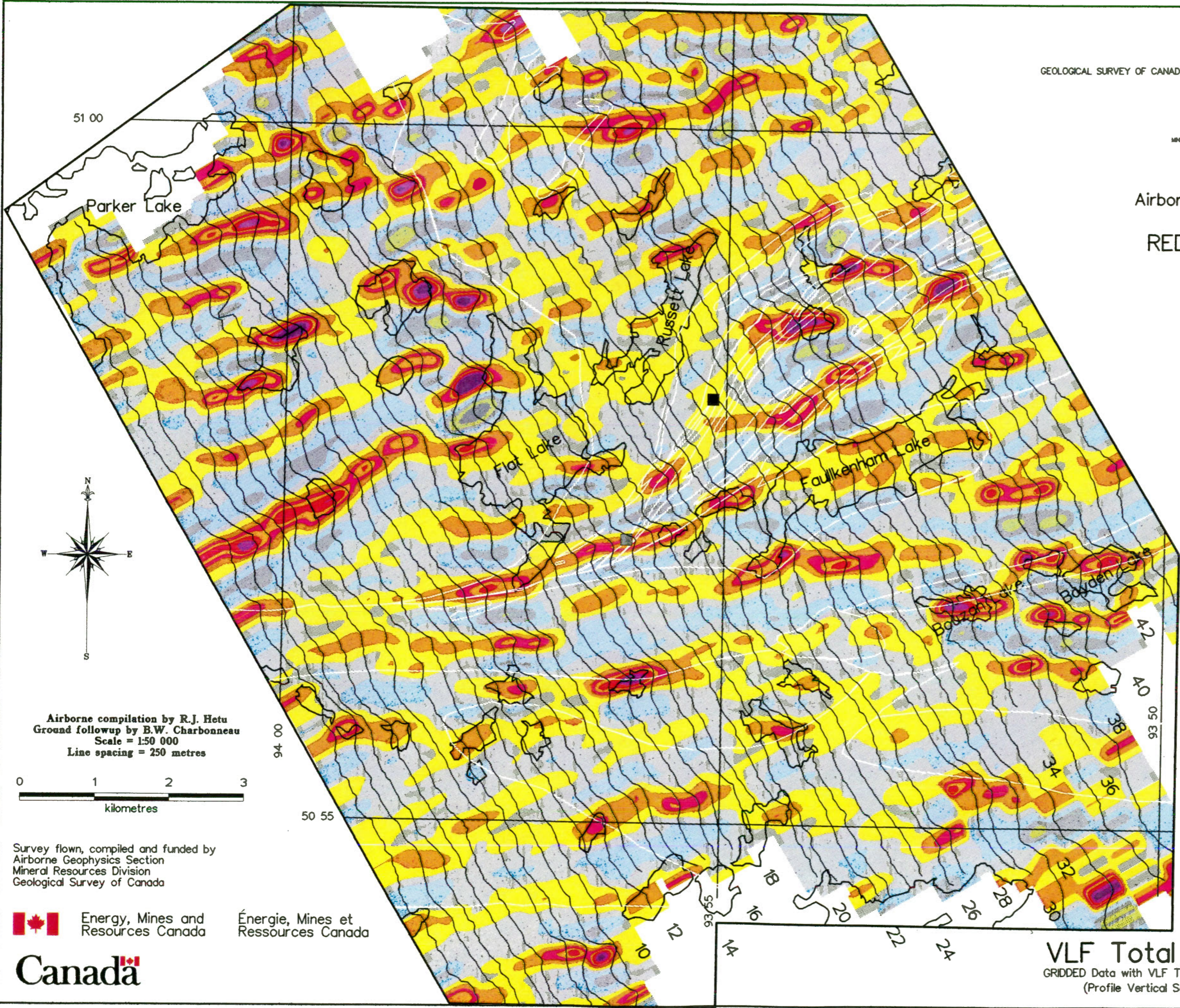


Calculated Magnetic Vertical Gradient

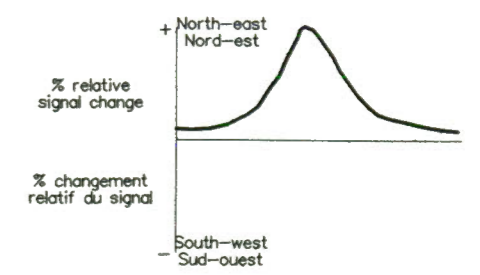




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Total field VLF response  
Reponse VLF du champ total



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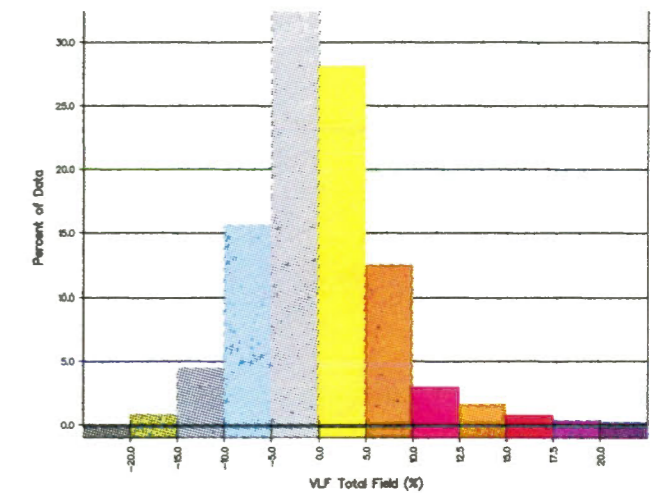
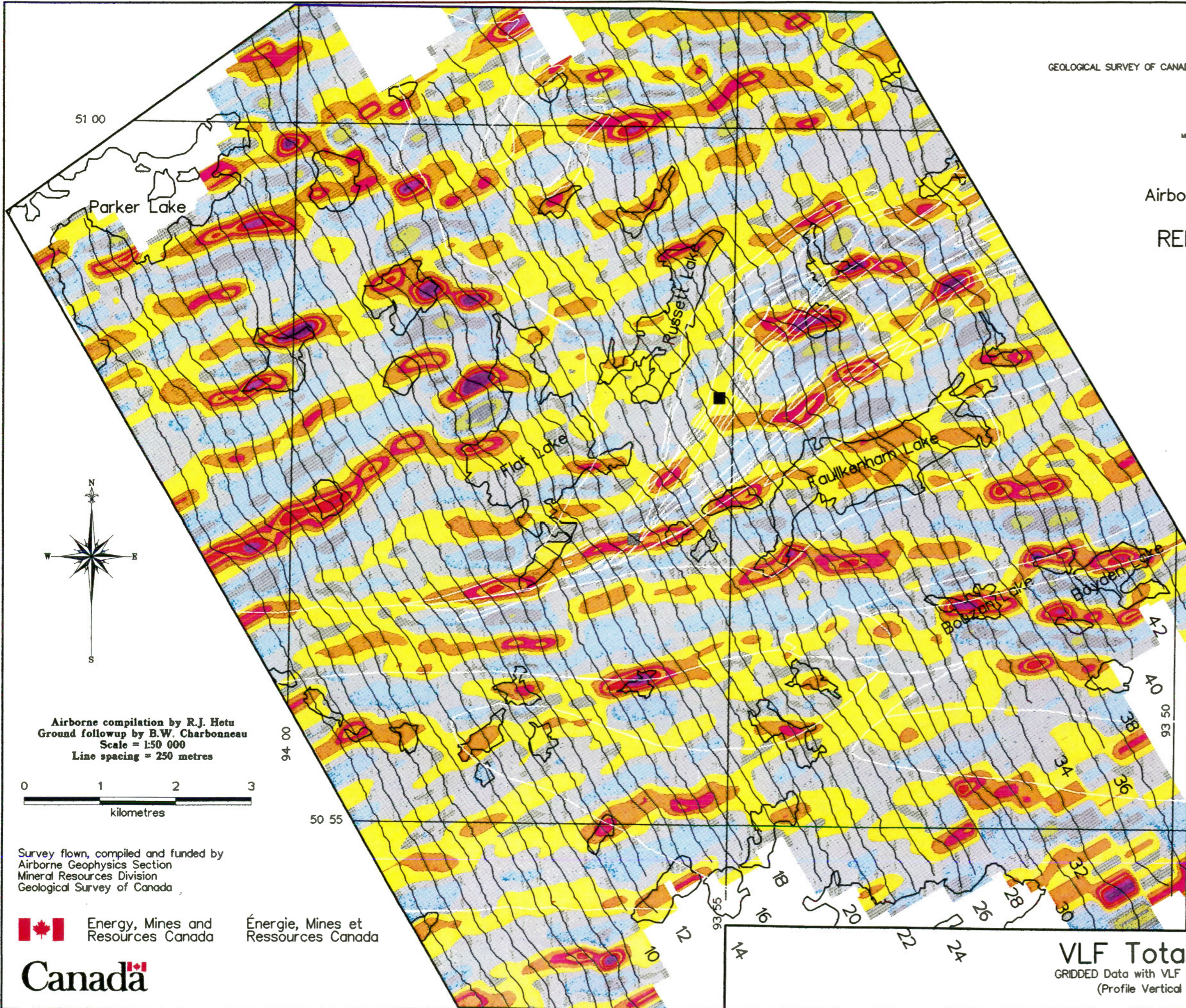


**VLF Total Field (%)**  
GRIDDED Data with VLF Total Field PROFILE Data  
(Profile Vertical Scale 100 %/cm)





OPEN FILE 2403  
Airborne Geophysical Survey  
of the  
**RED LAKE SURVEY**  
ONTARIO  
1990



Airborne compilation by R.J. Hetu  
Ground followup by B.W. Charbonneau  
Scale = 1:50 000  
Line spacing = 250 metres

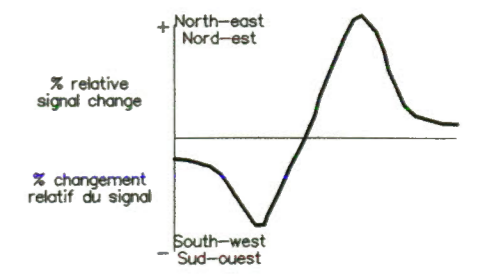


Survey flown, compiled and funded by  
Airborne Geophysics Section  
Mineral Resources Division  
Geological Survey of Canada

Energy, Mines and Resources Canada  
Énergie, Mines et Ressources Canada



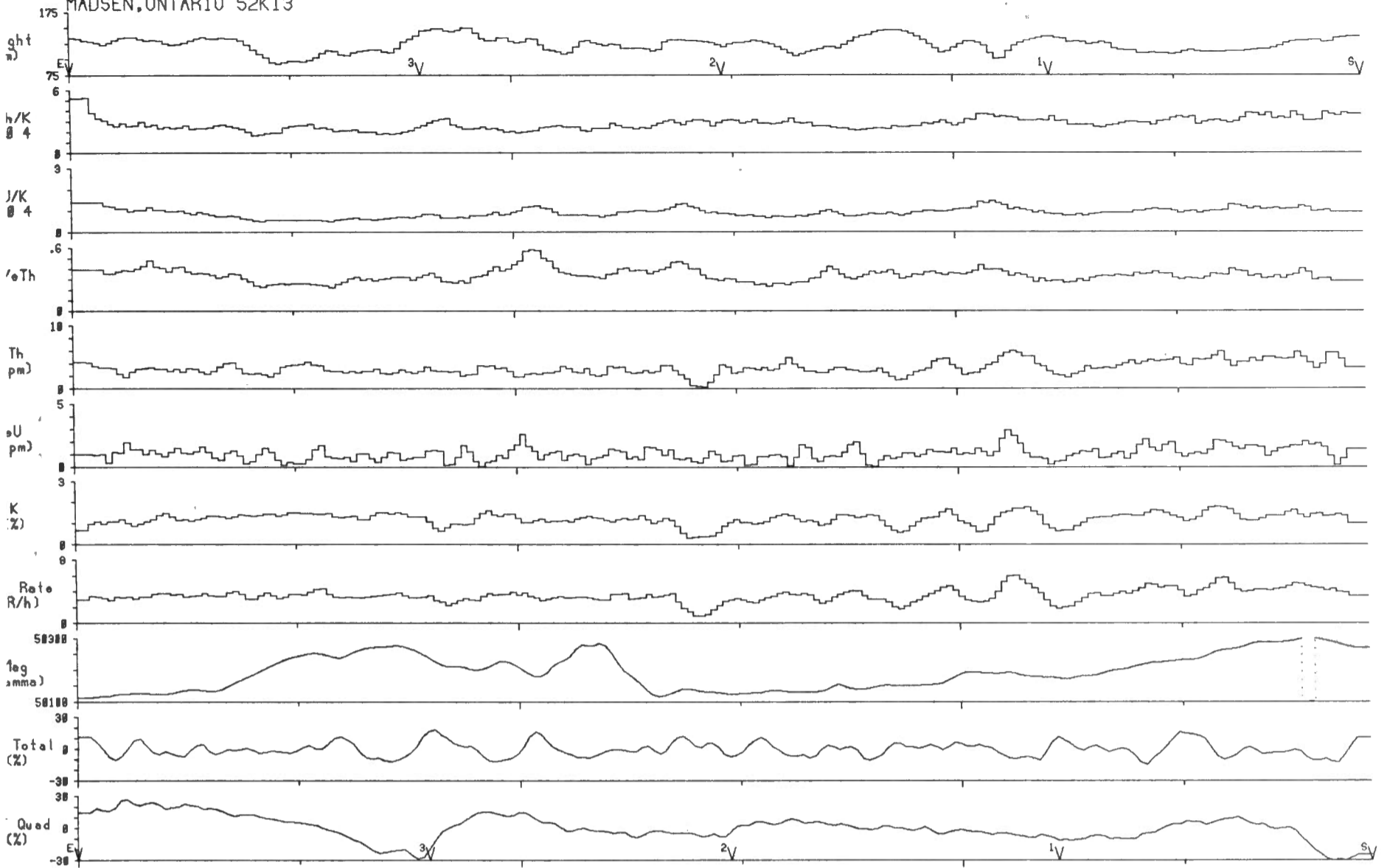
Quadrature VLF response  
Reponse Quadrature VLF



**VLF Total Field (%)**  
GRIDDED Data with VLF Quadrature PROFILE Data  
(Profile Vertical Scale 100 %/cm)



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

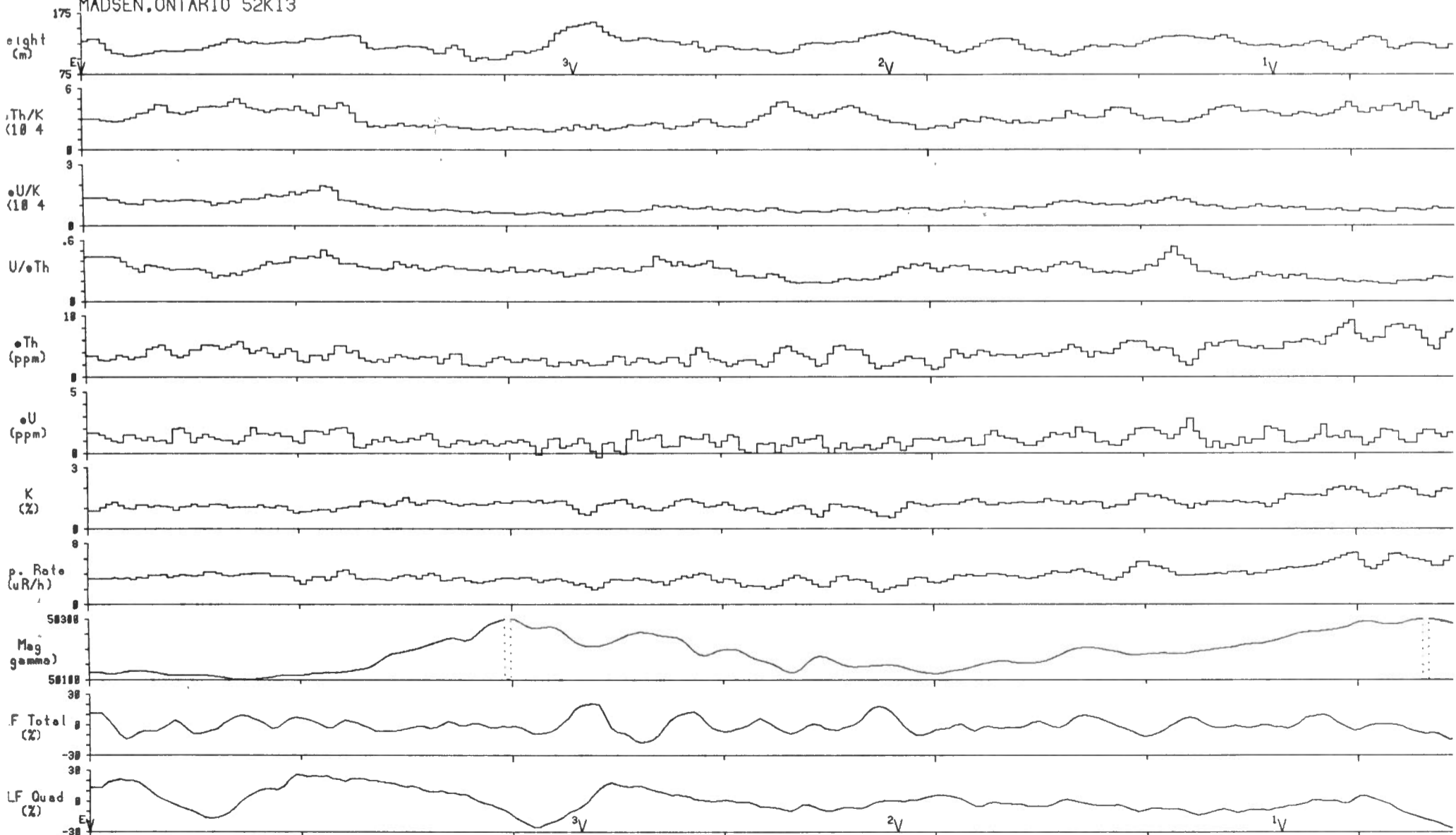


Line 1

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

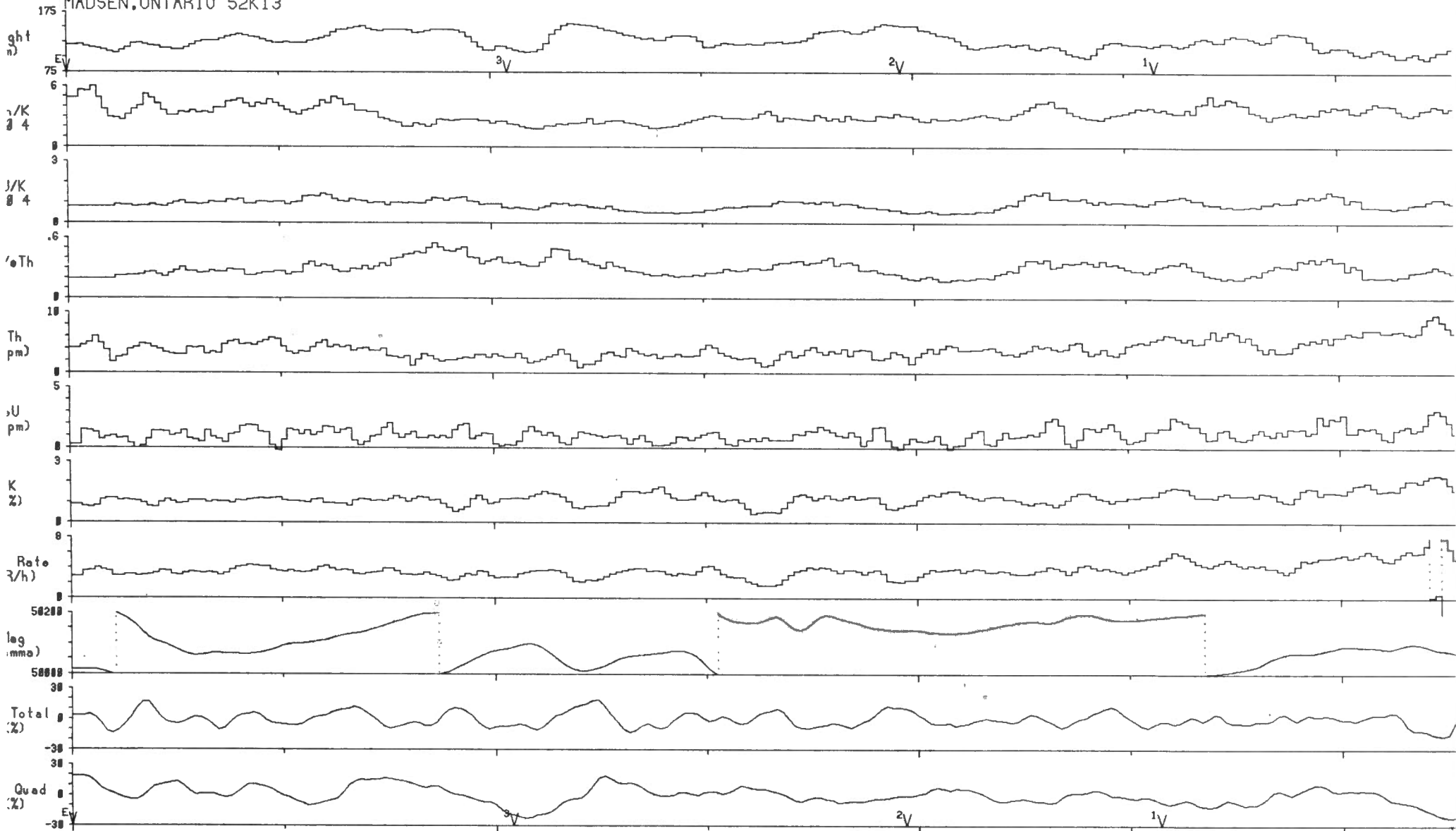


Line 2

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

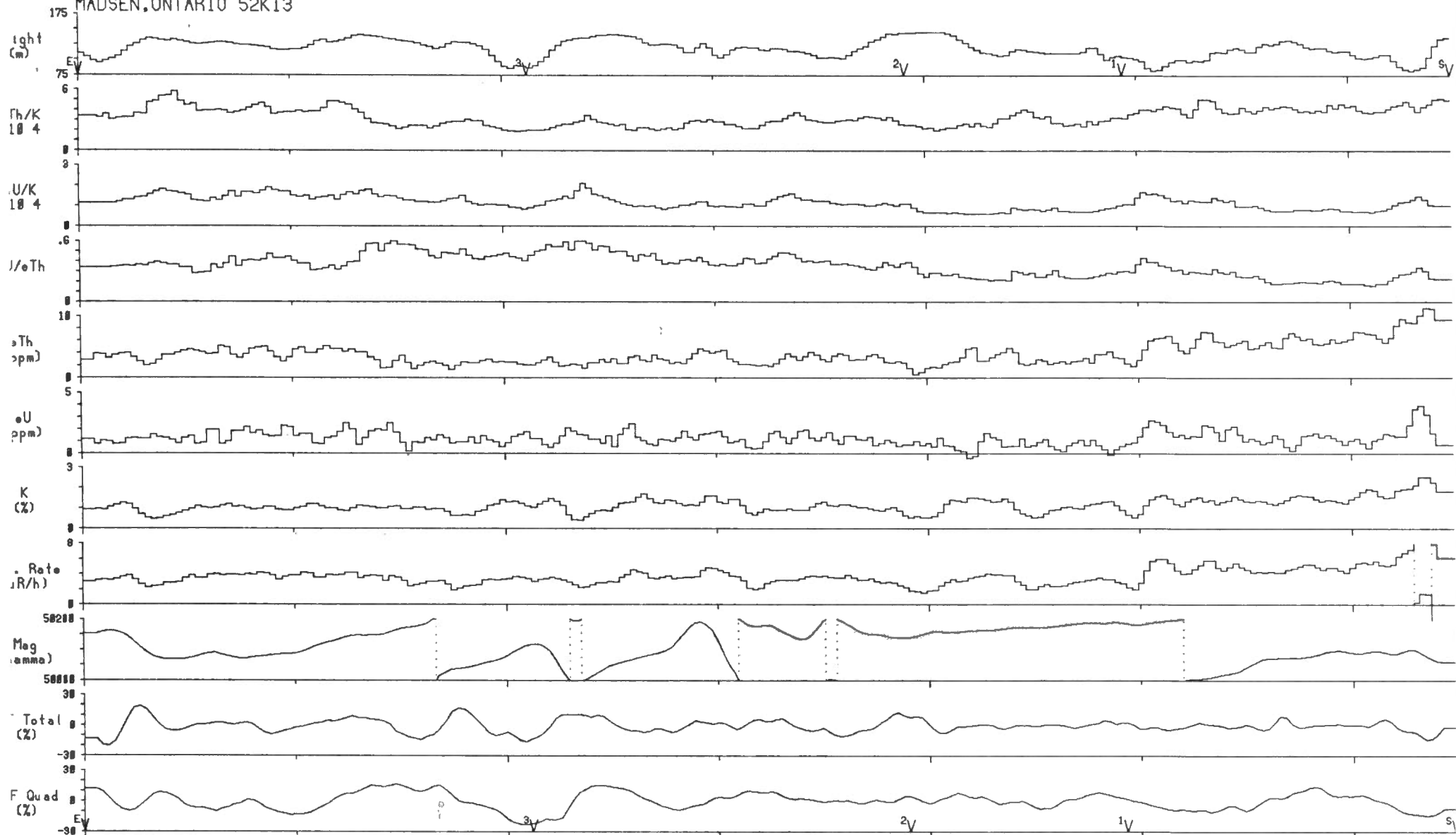


Line 3

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

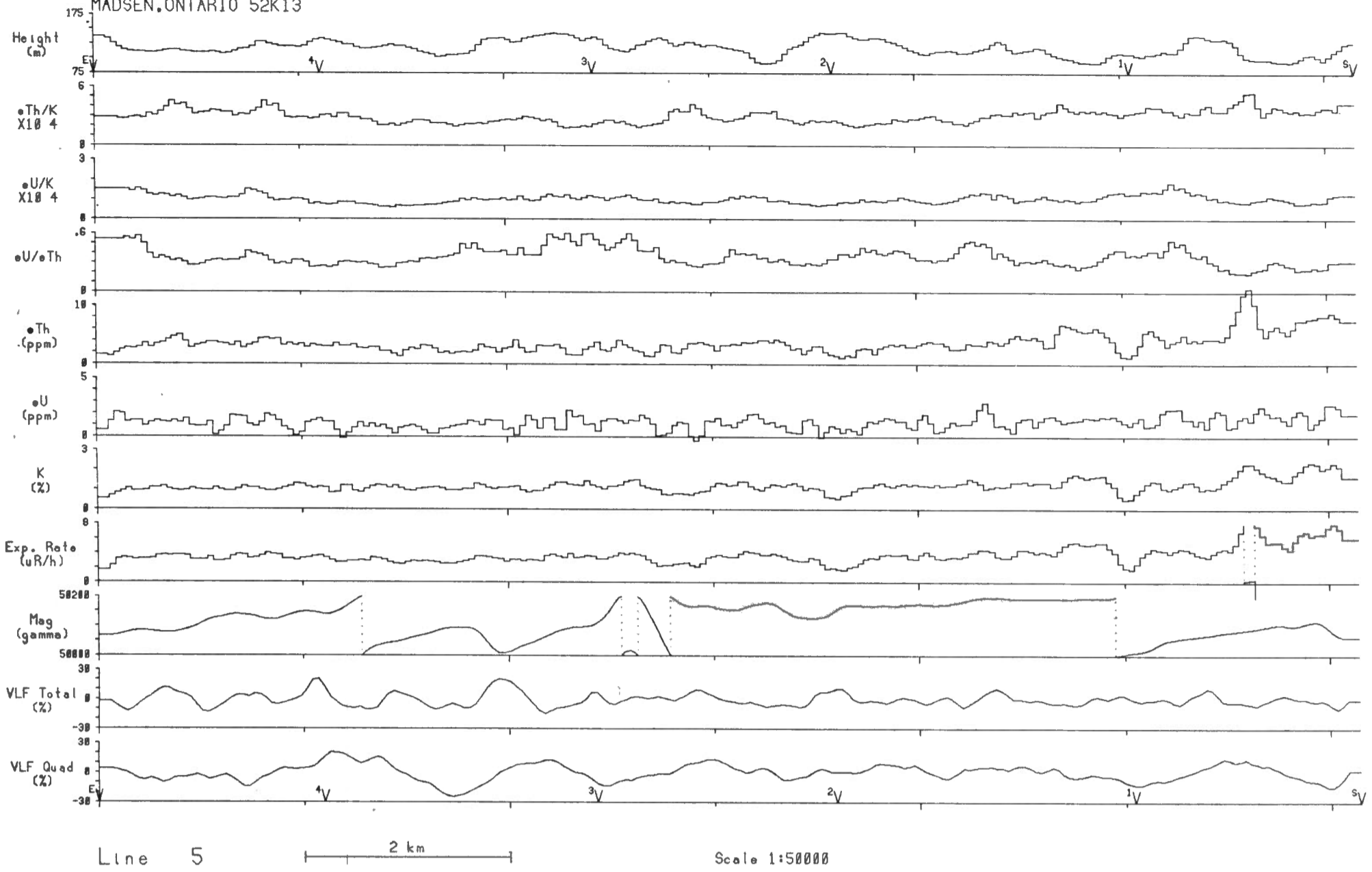


Line 4

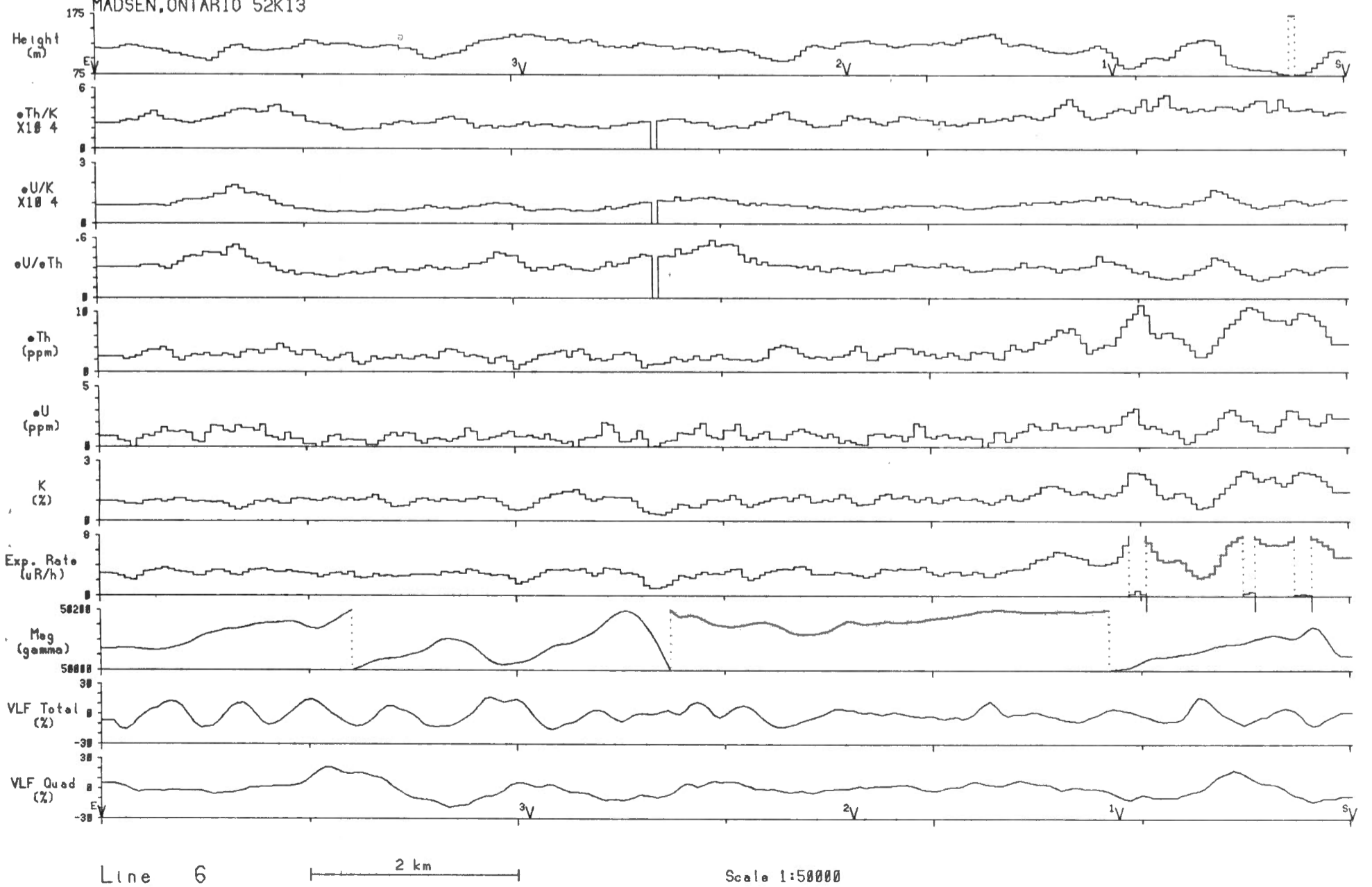
2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

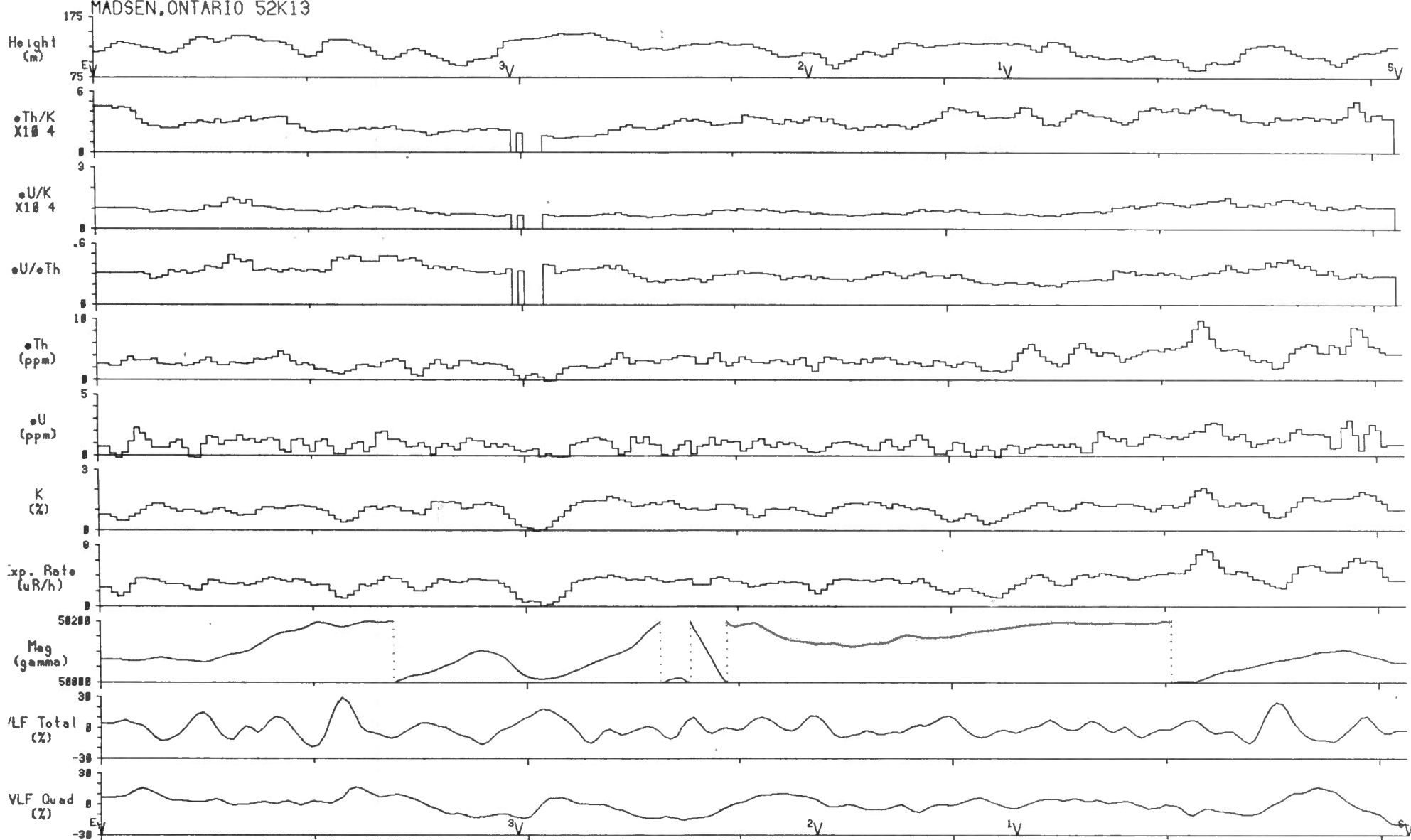


RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13





RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

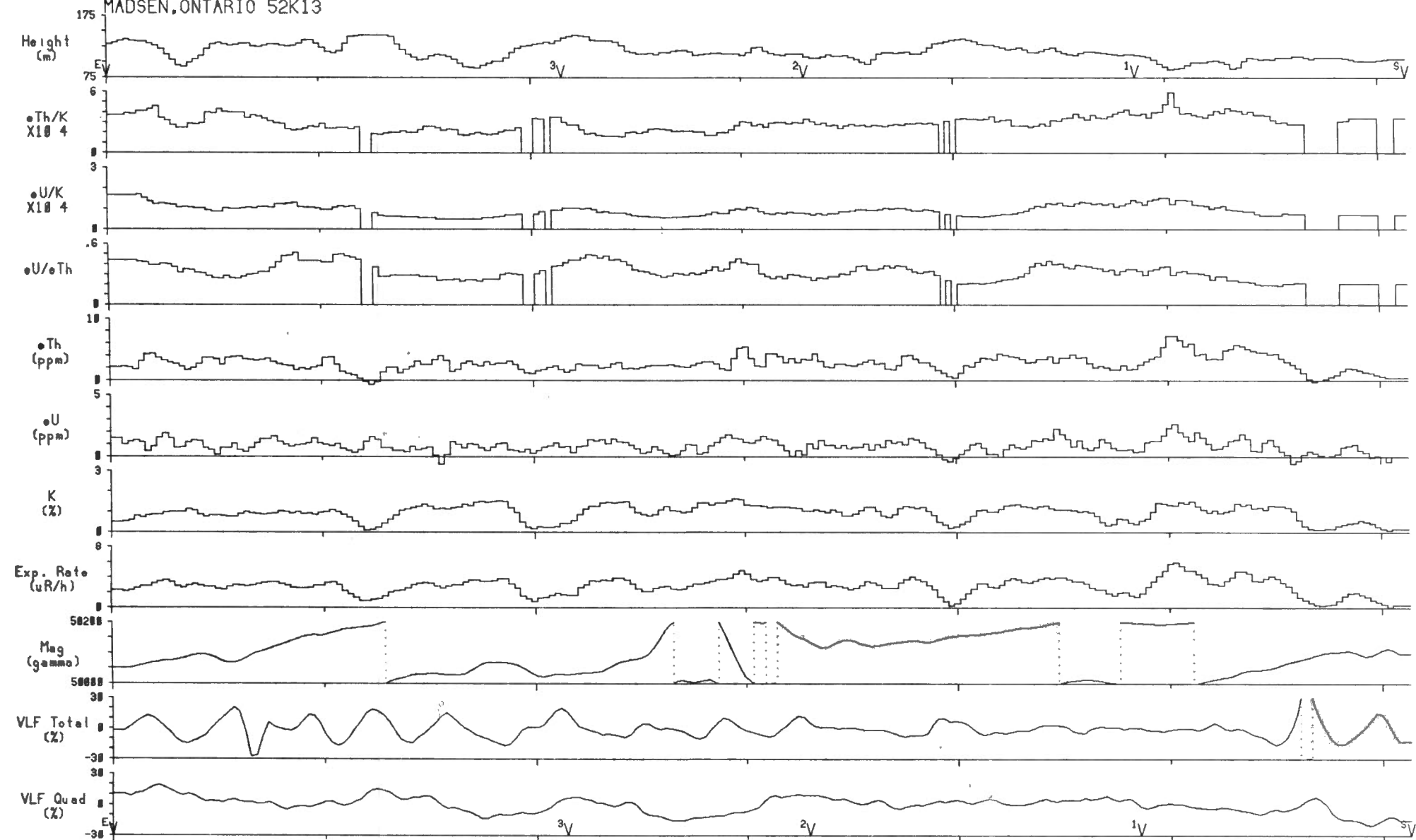


Line 7

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

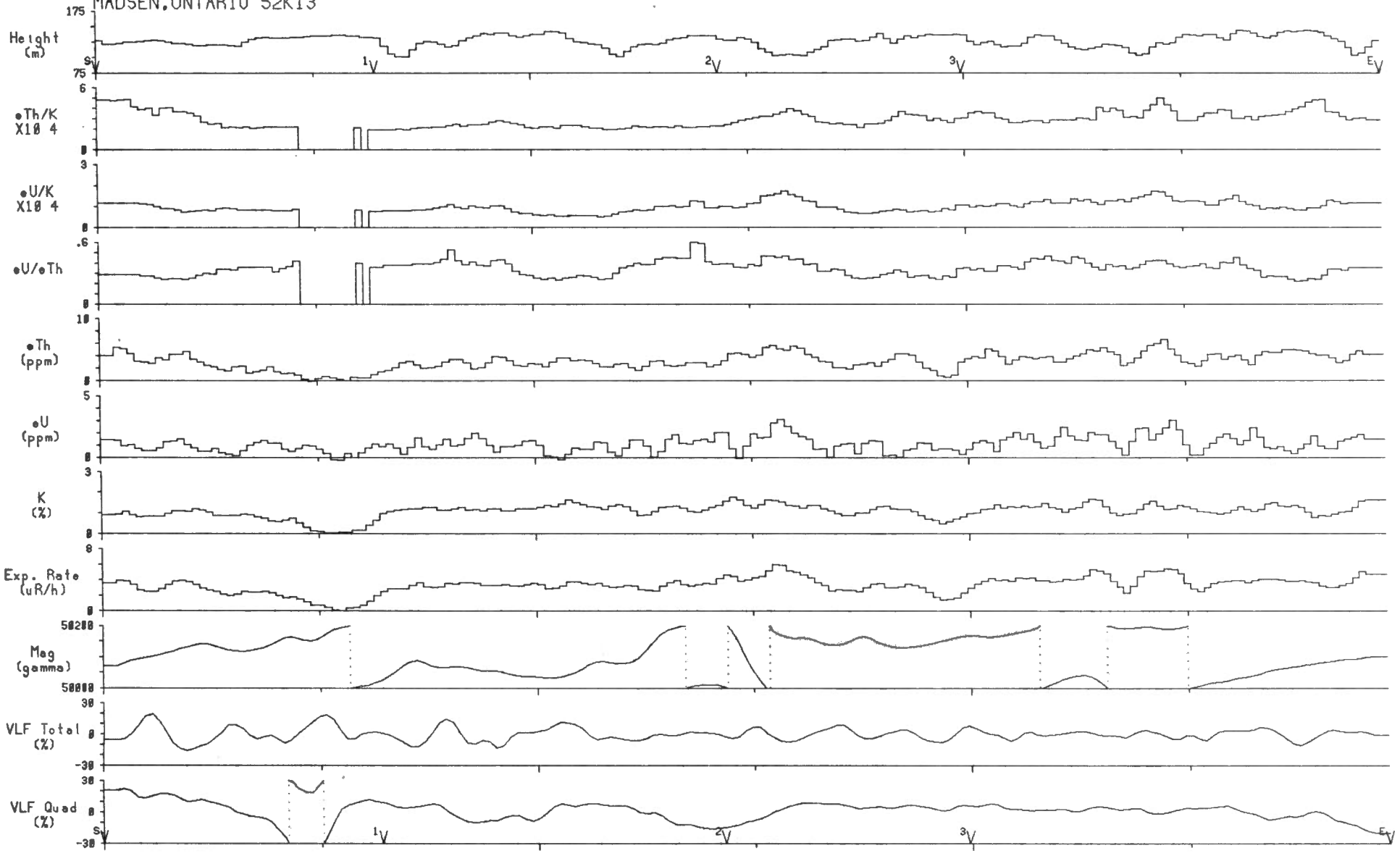


Line 8

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

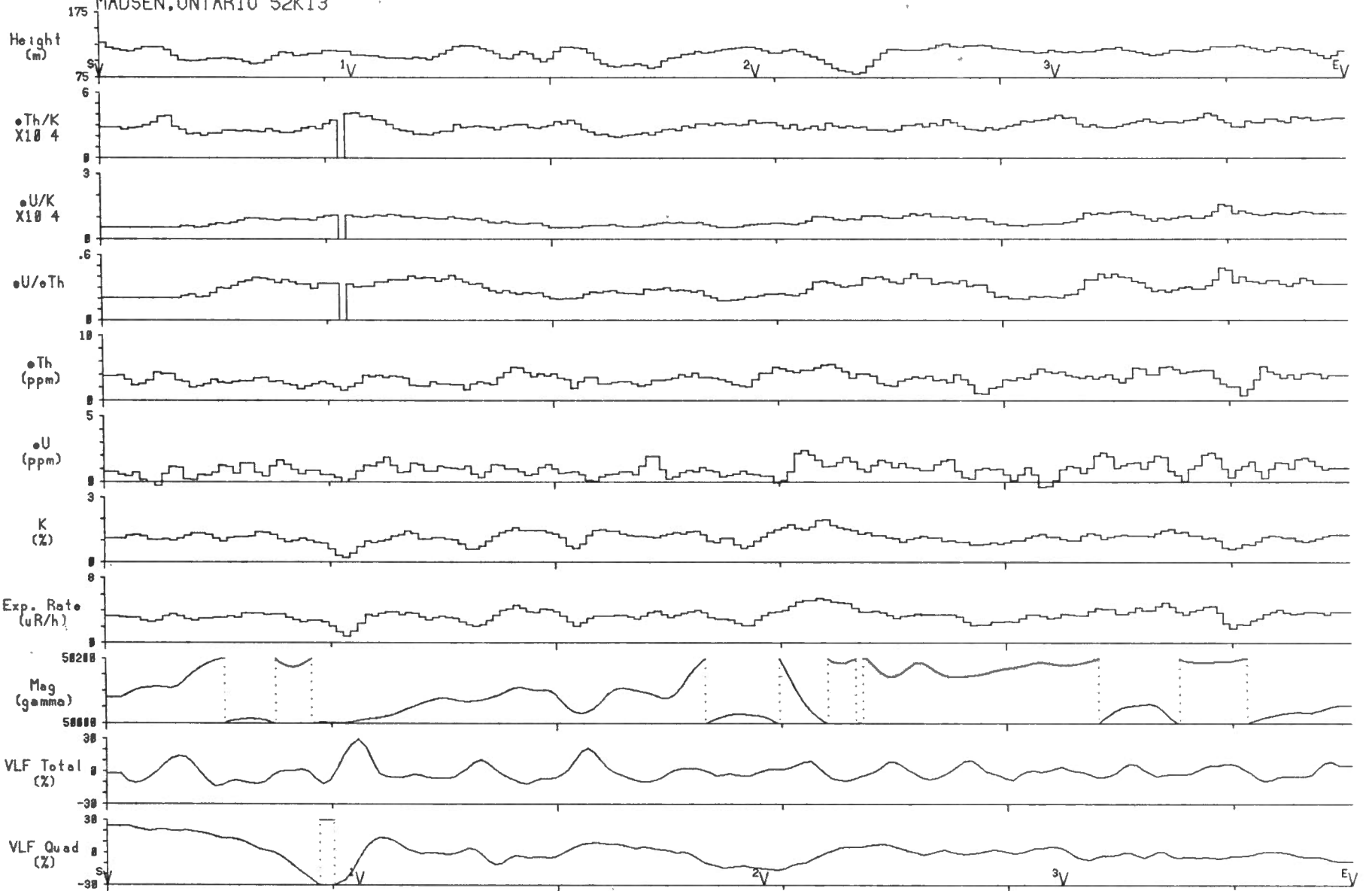


Line 9

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

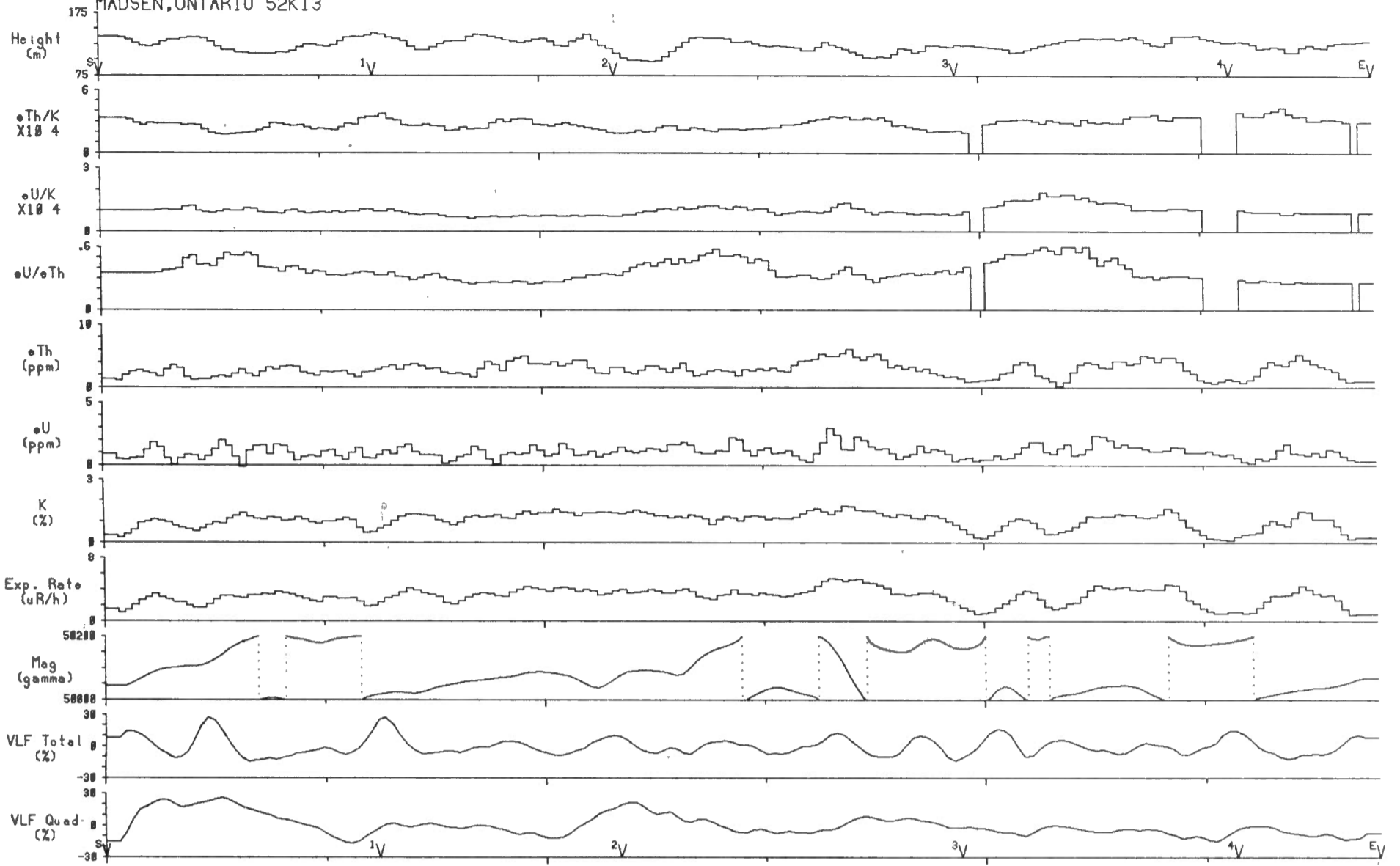


Line 10

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

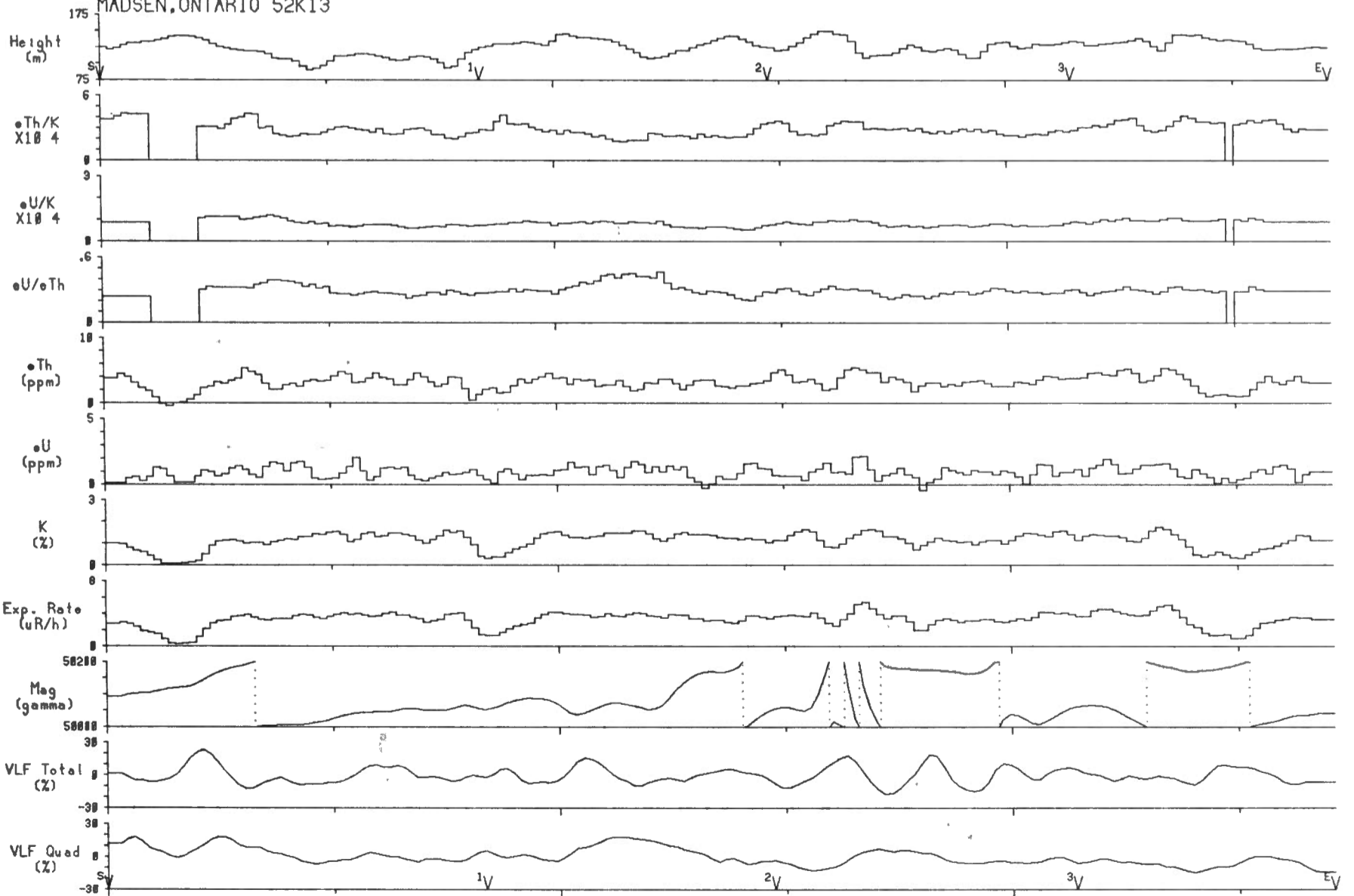


Line 11

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

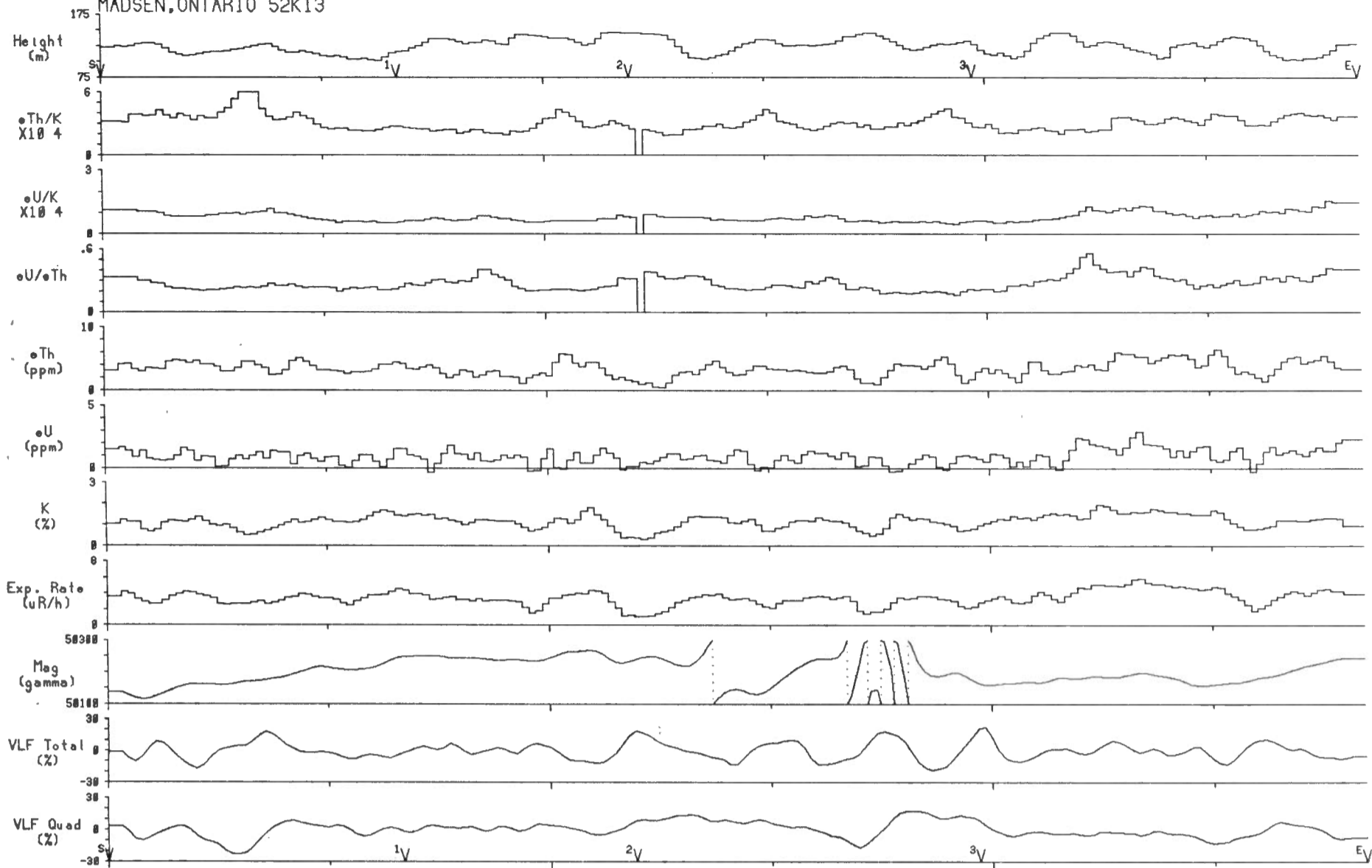


Line 12

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

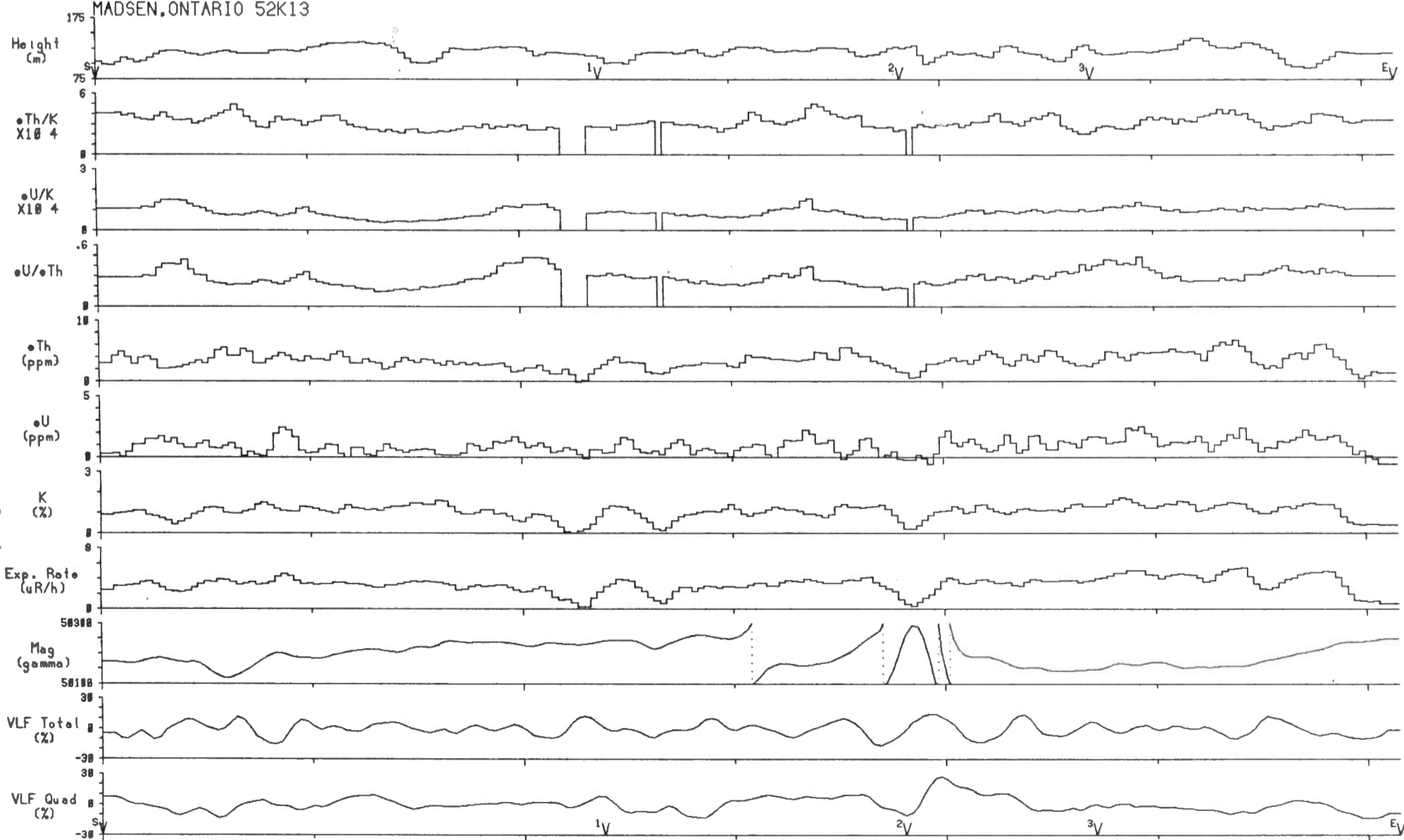


Line 13

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

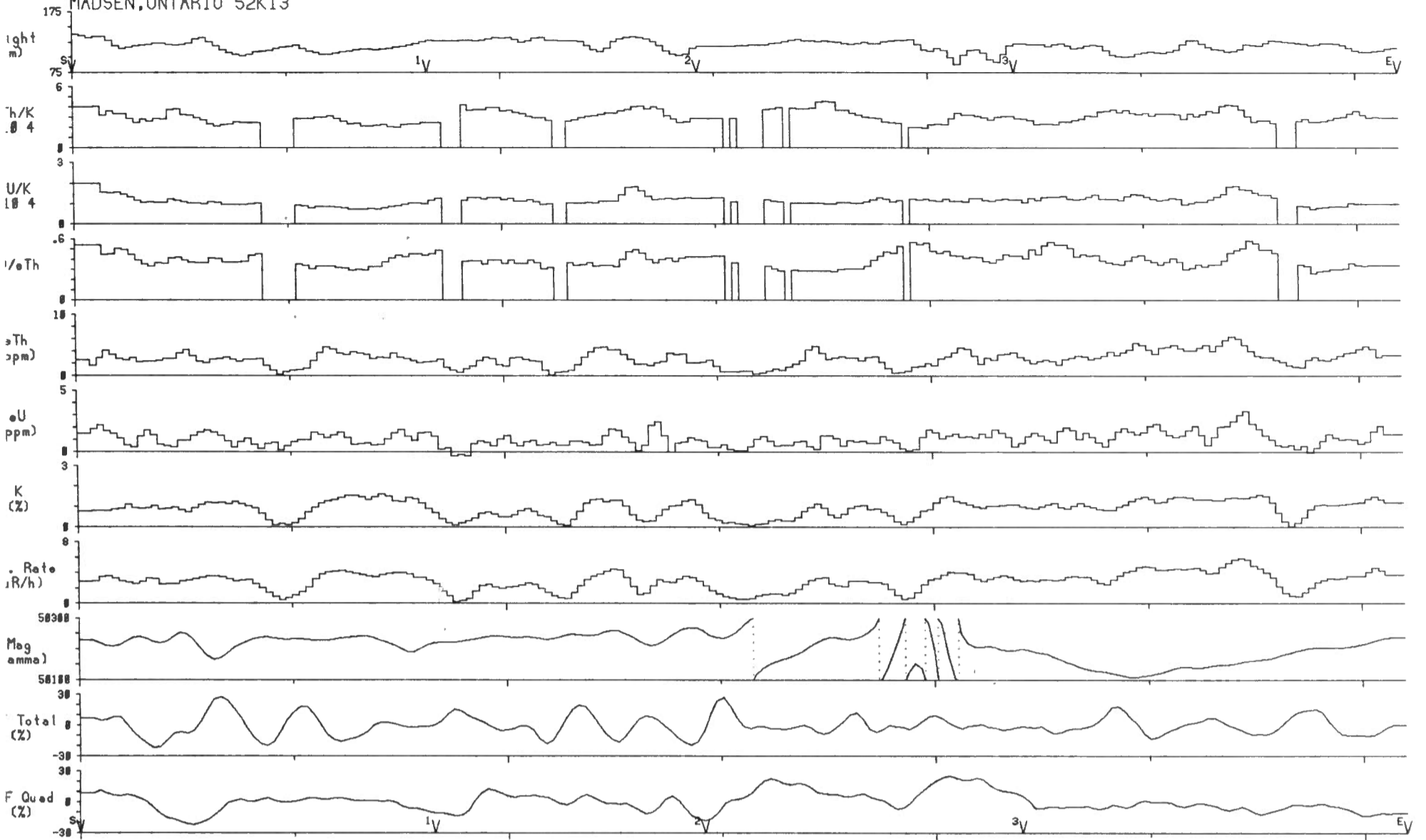


Line 14

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

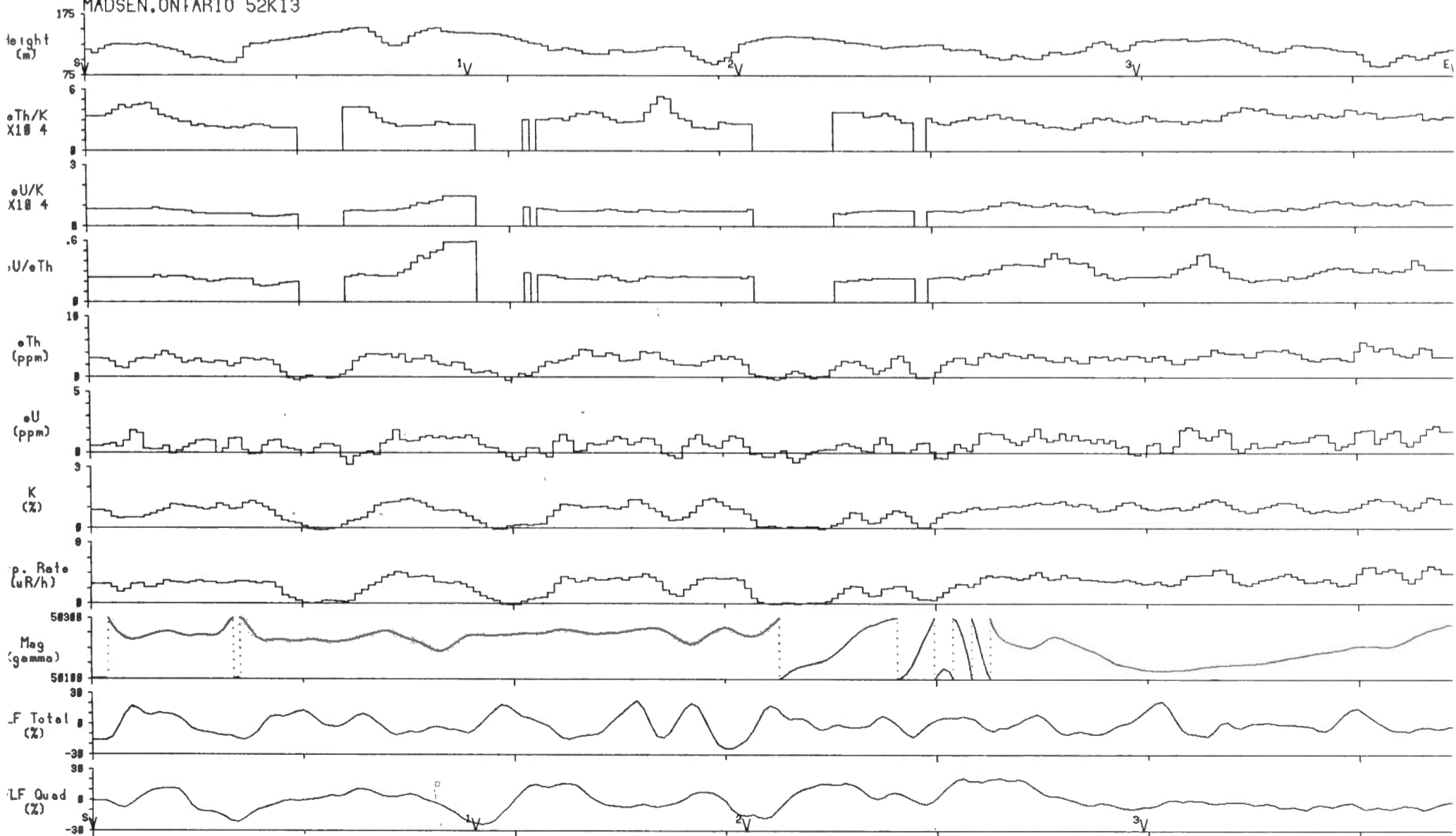


Line 15

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

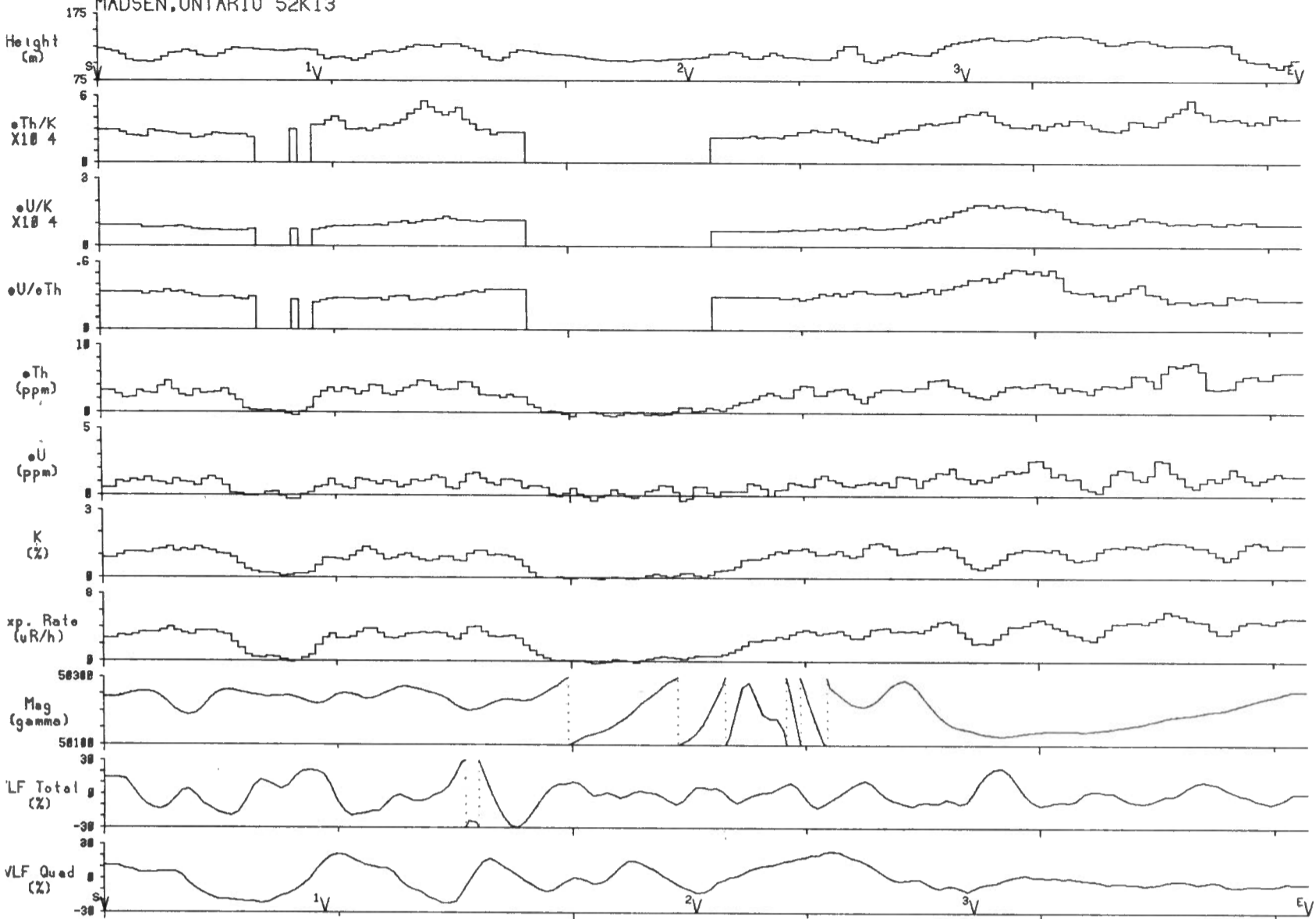


Line 16

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

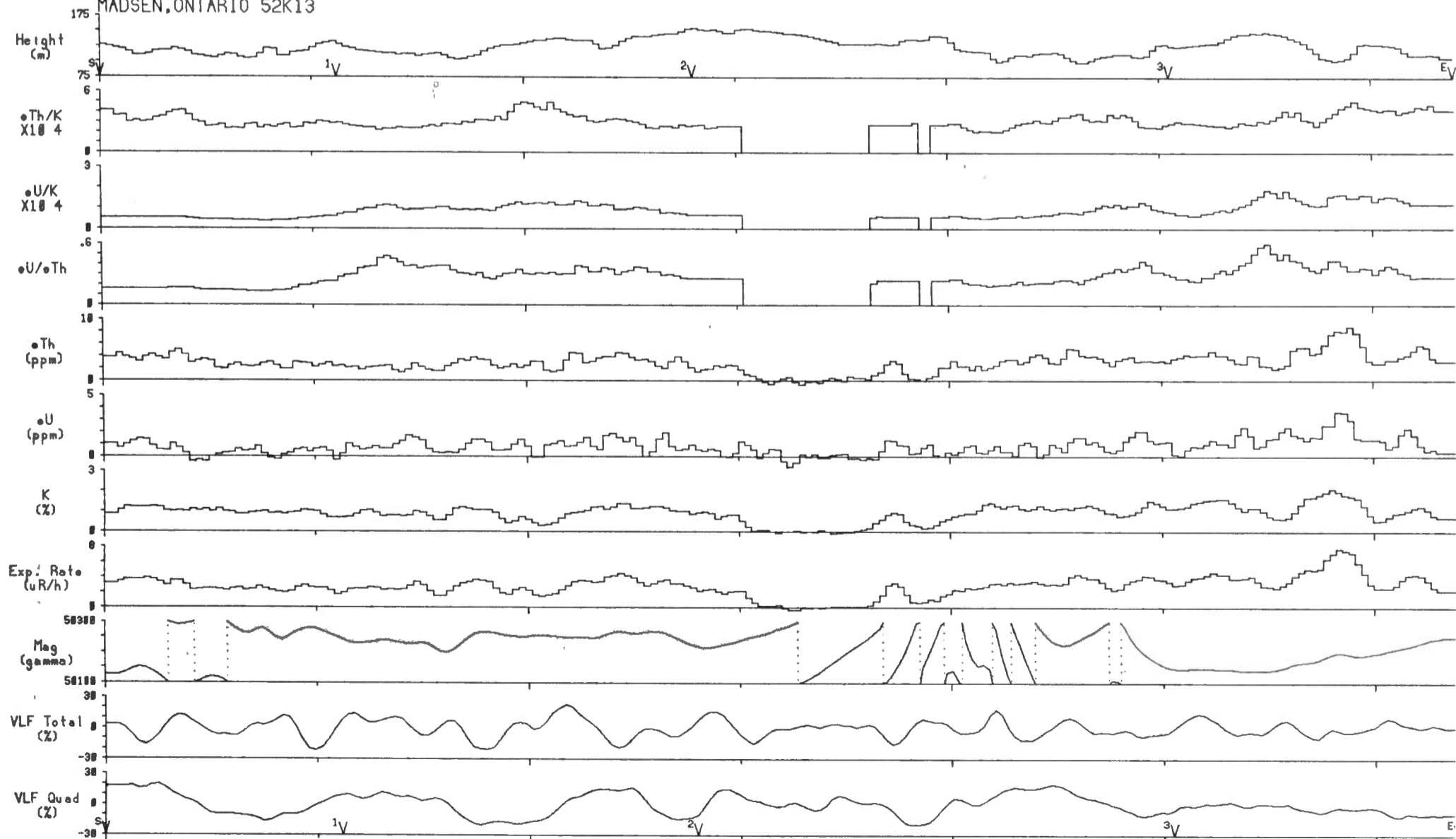


Line 17

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



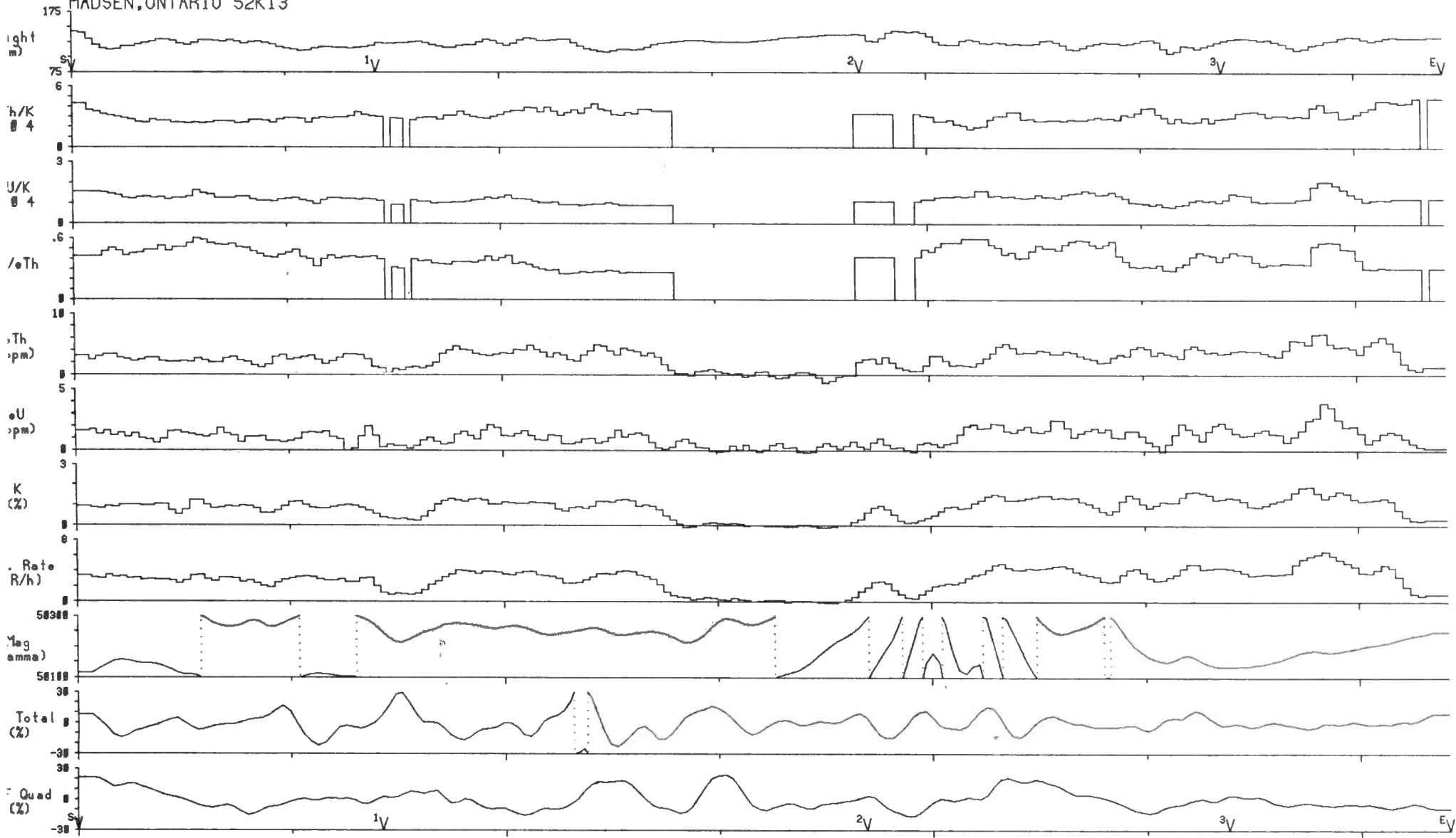
Line 18

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

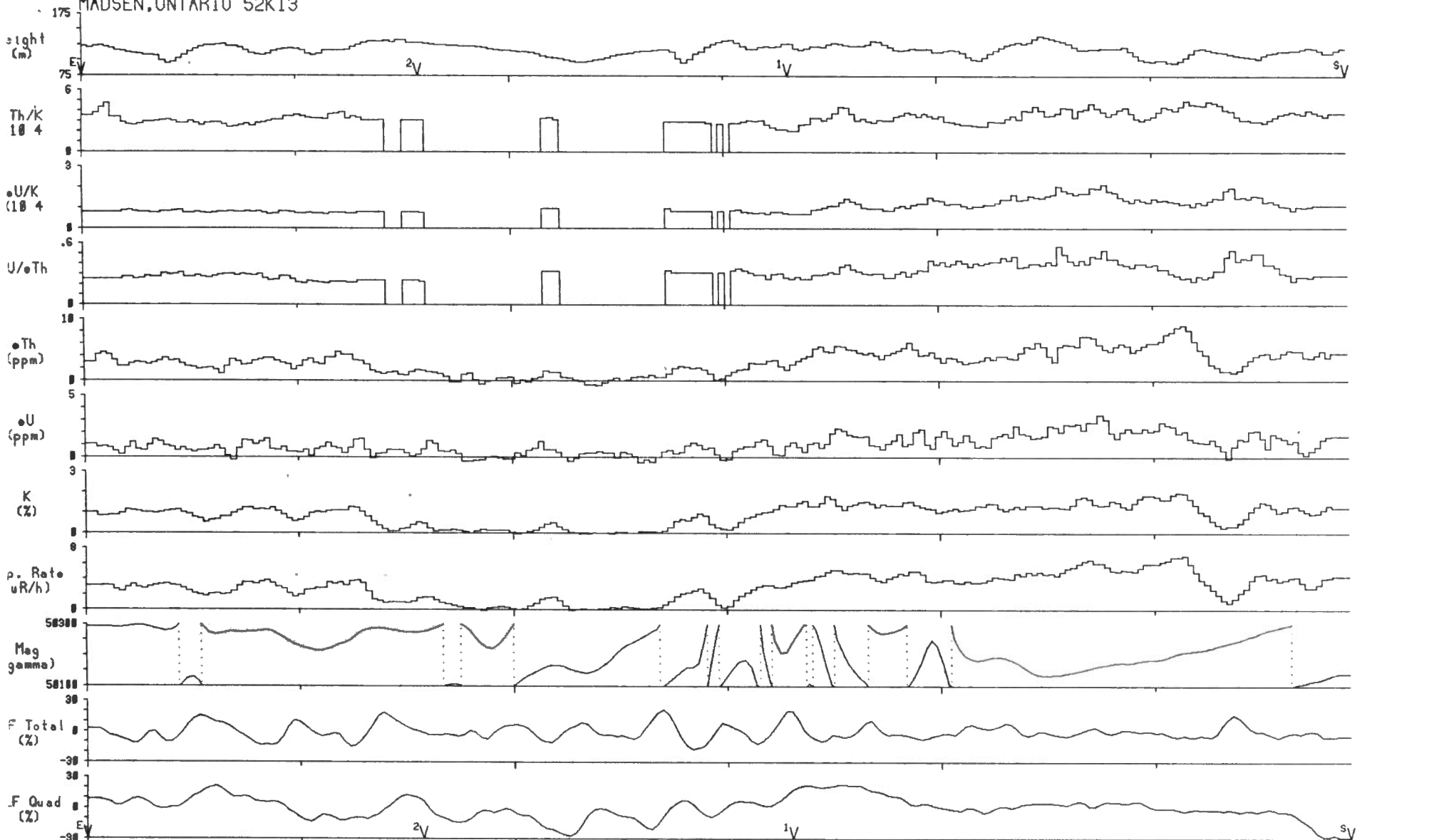


Line 19

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

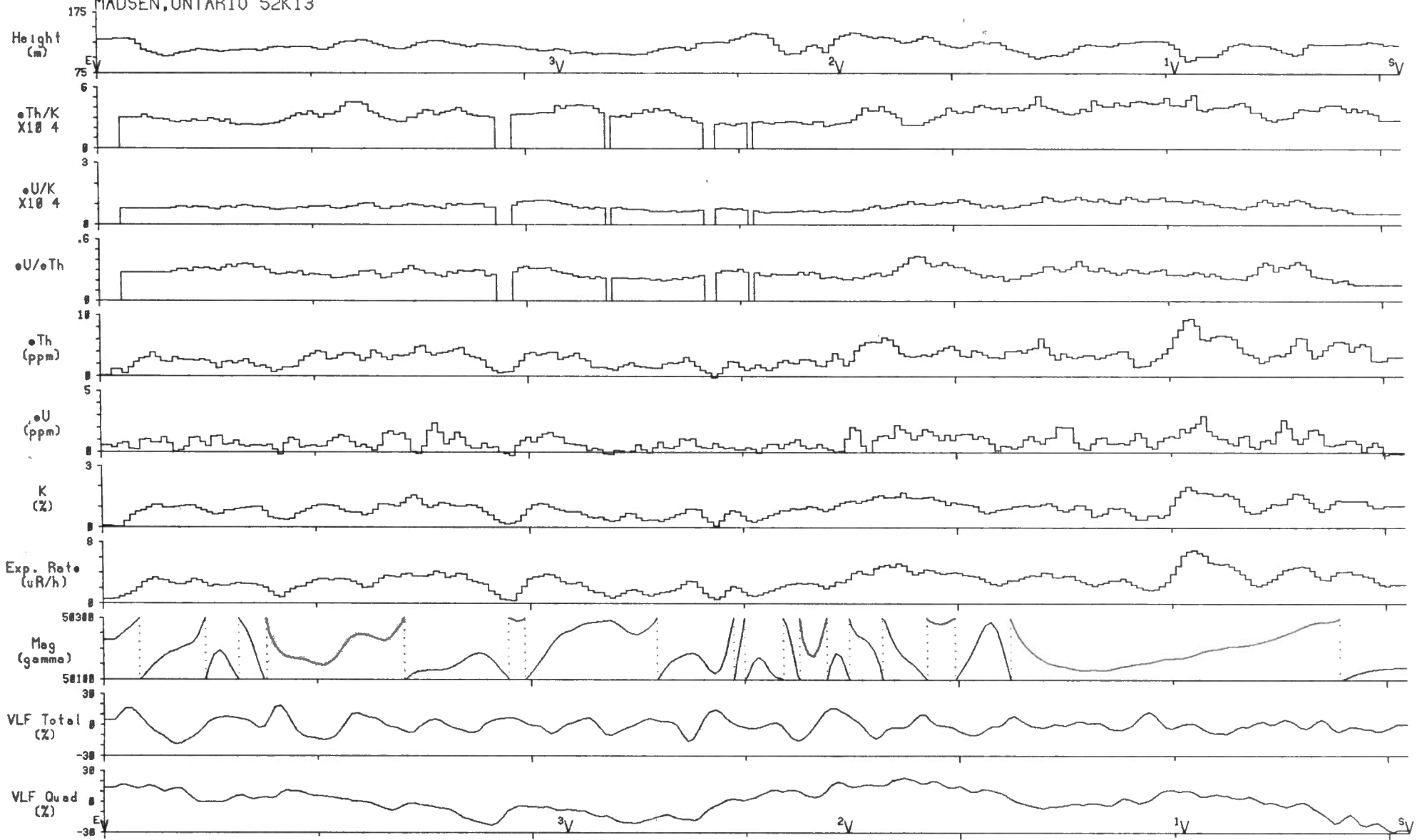


Line 20

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

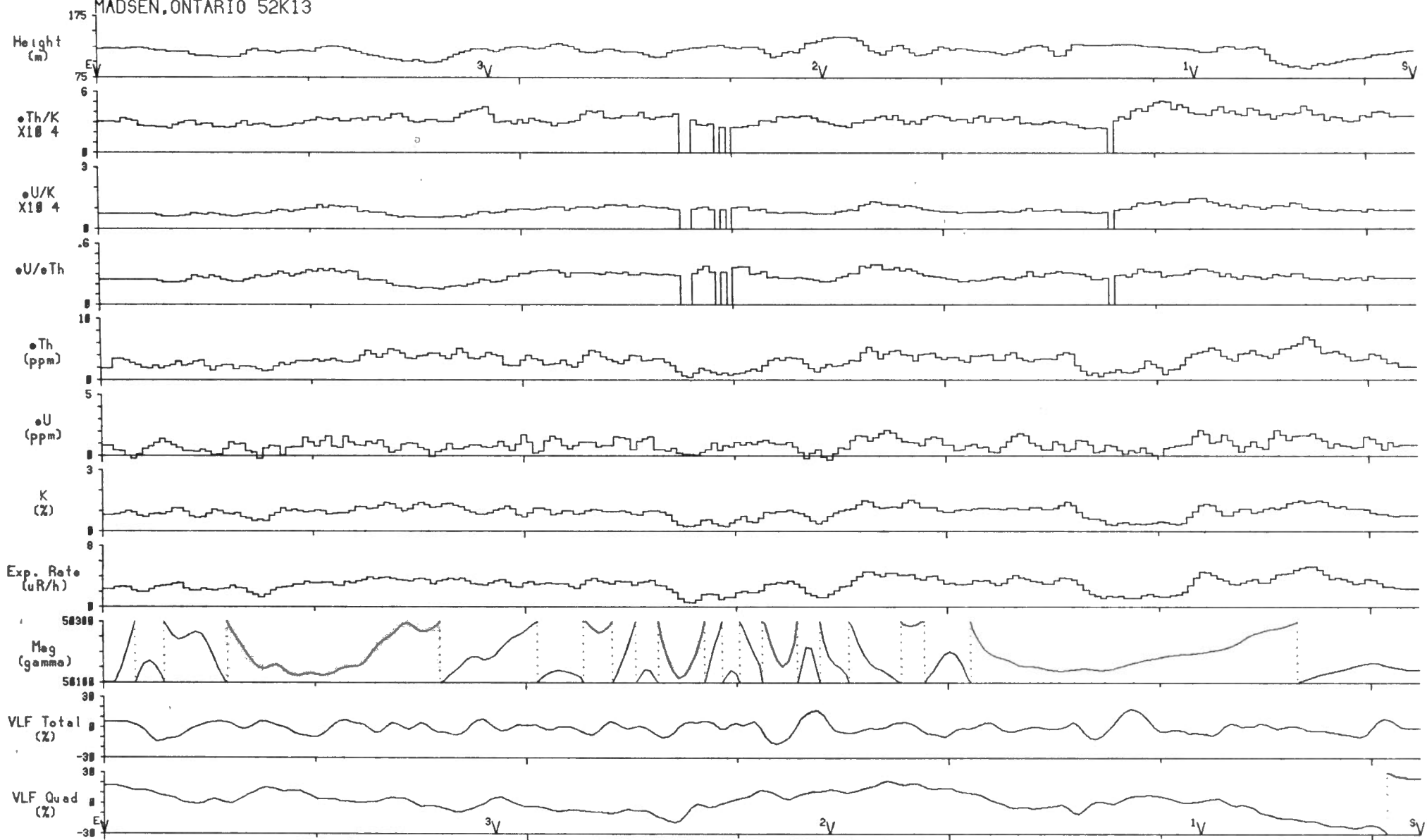


Line 21

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

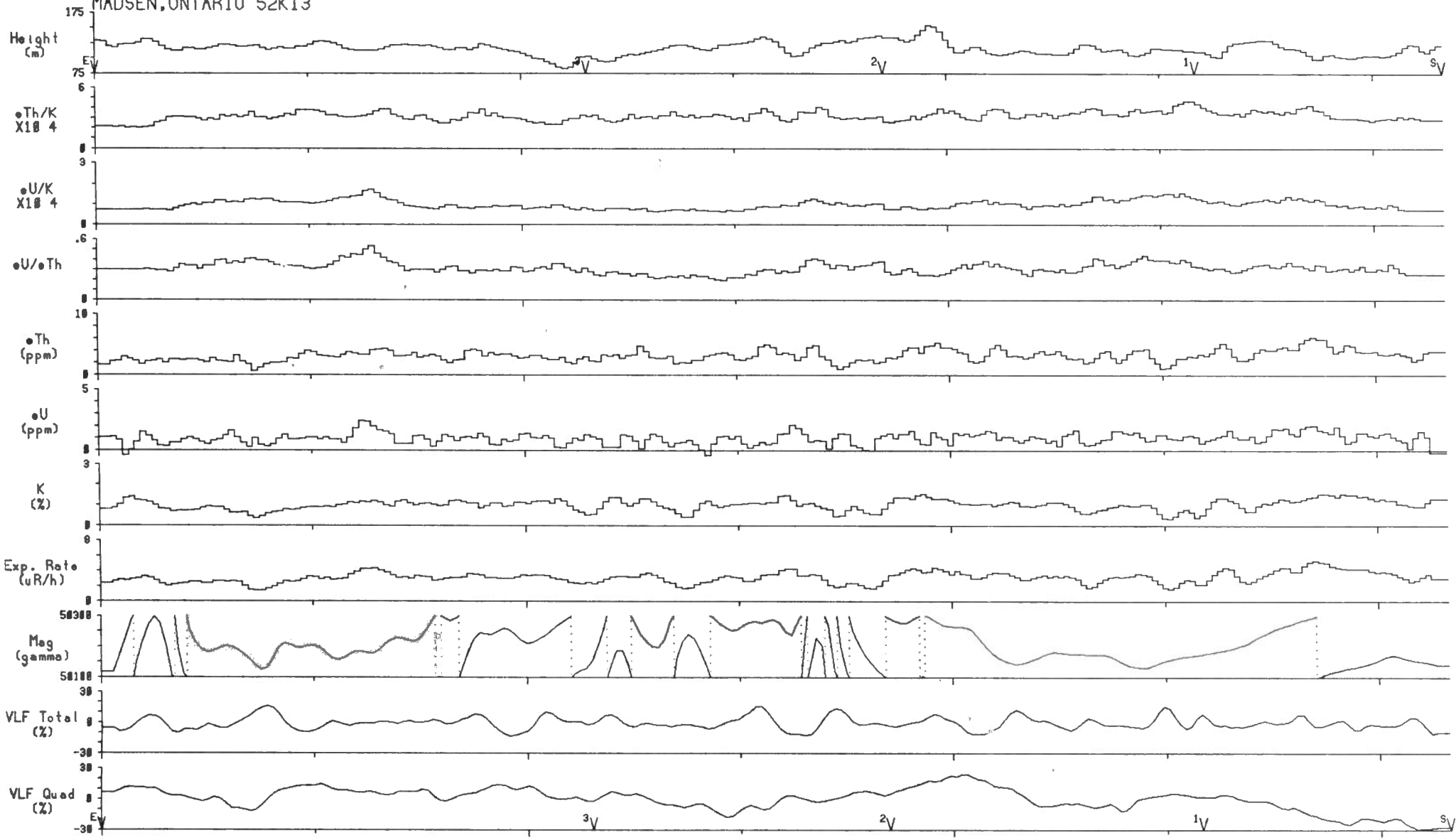


Line 22

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

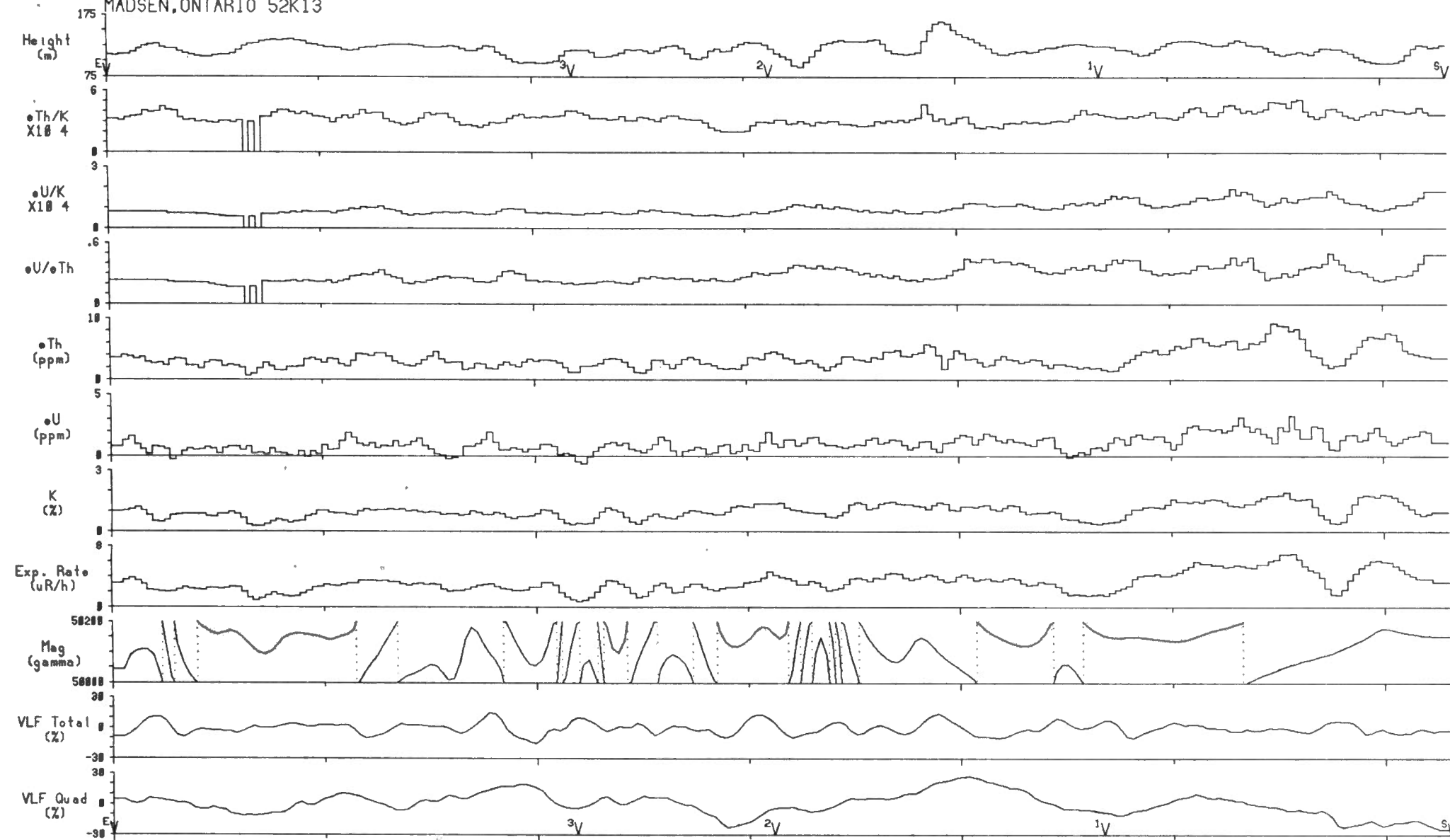


Line 23

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

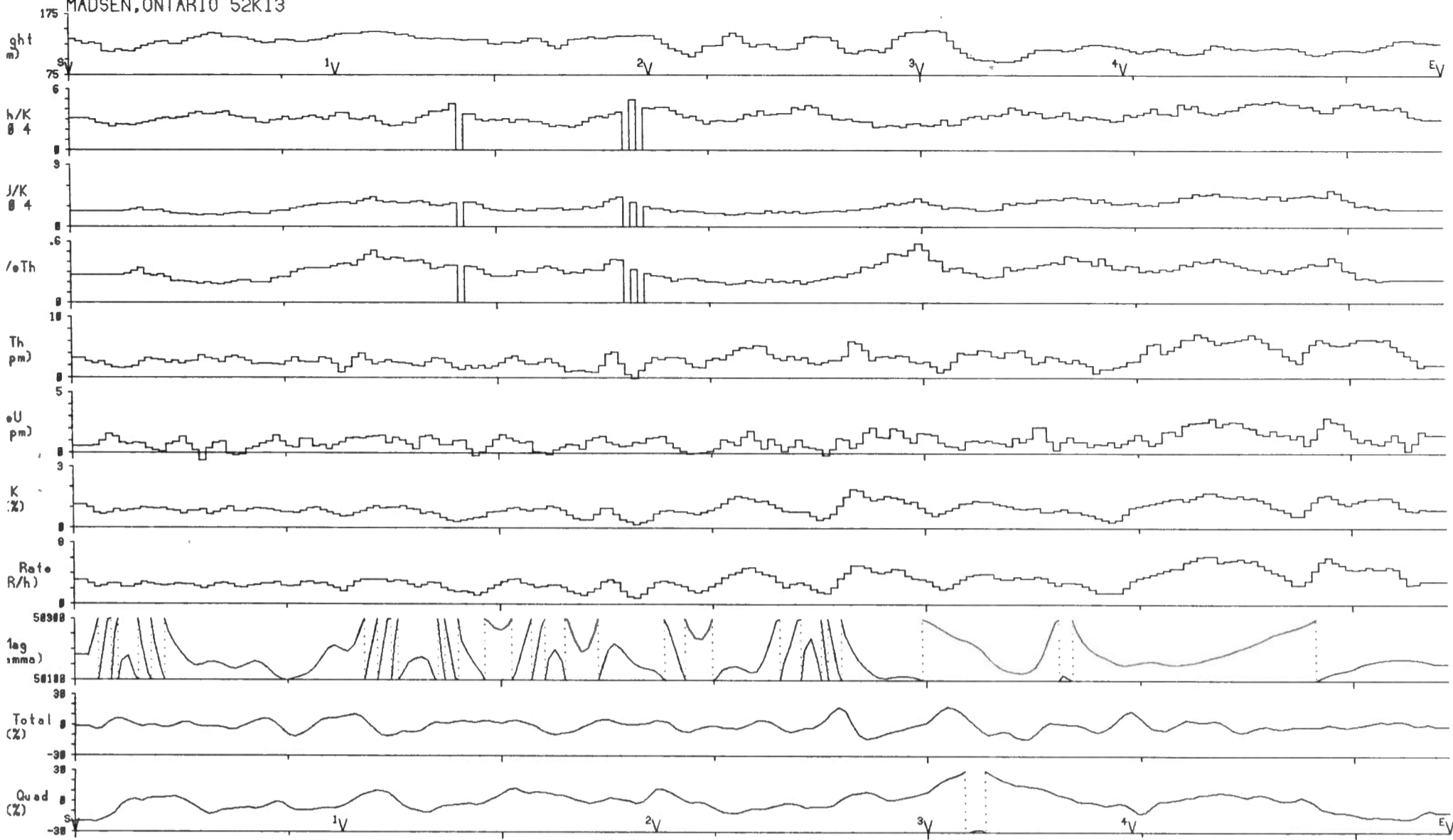


Line 24

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

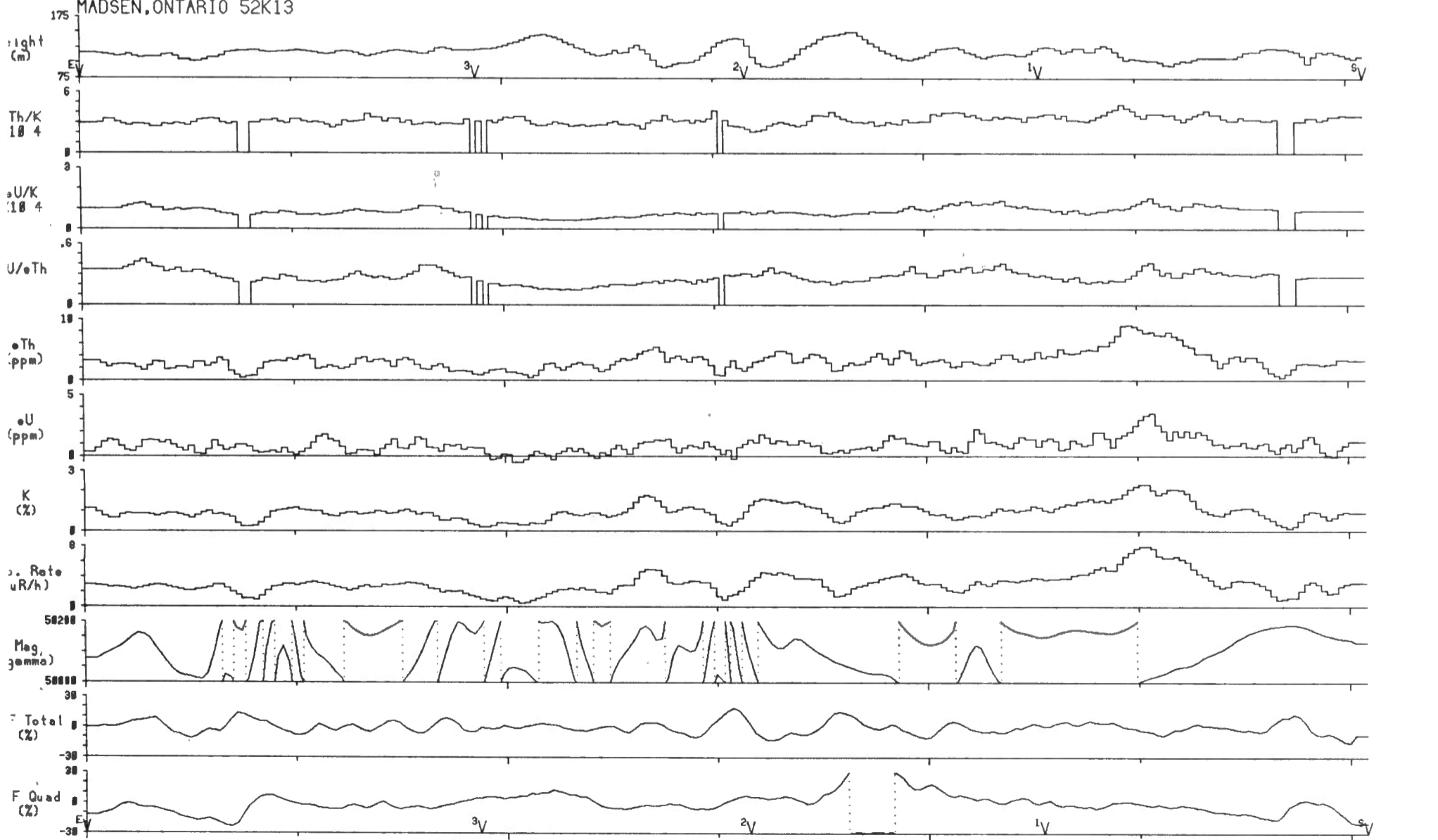


Line 25

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

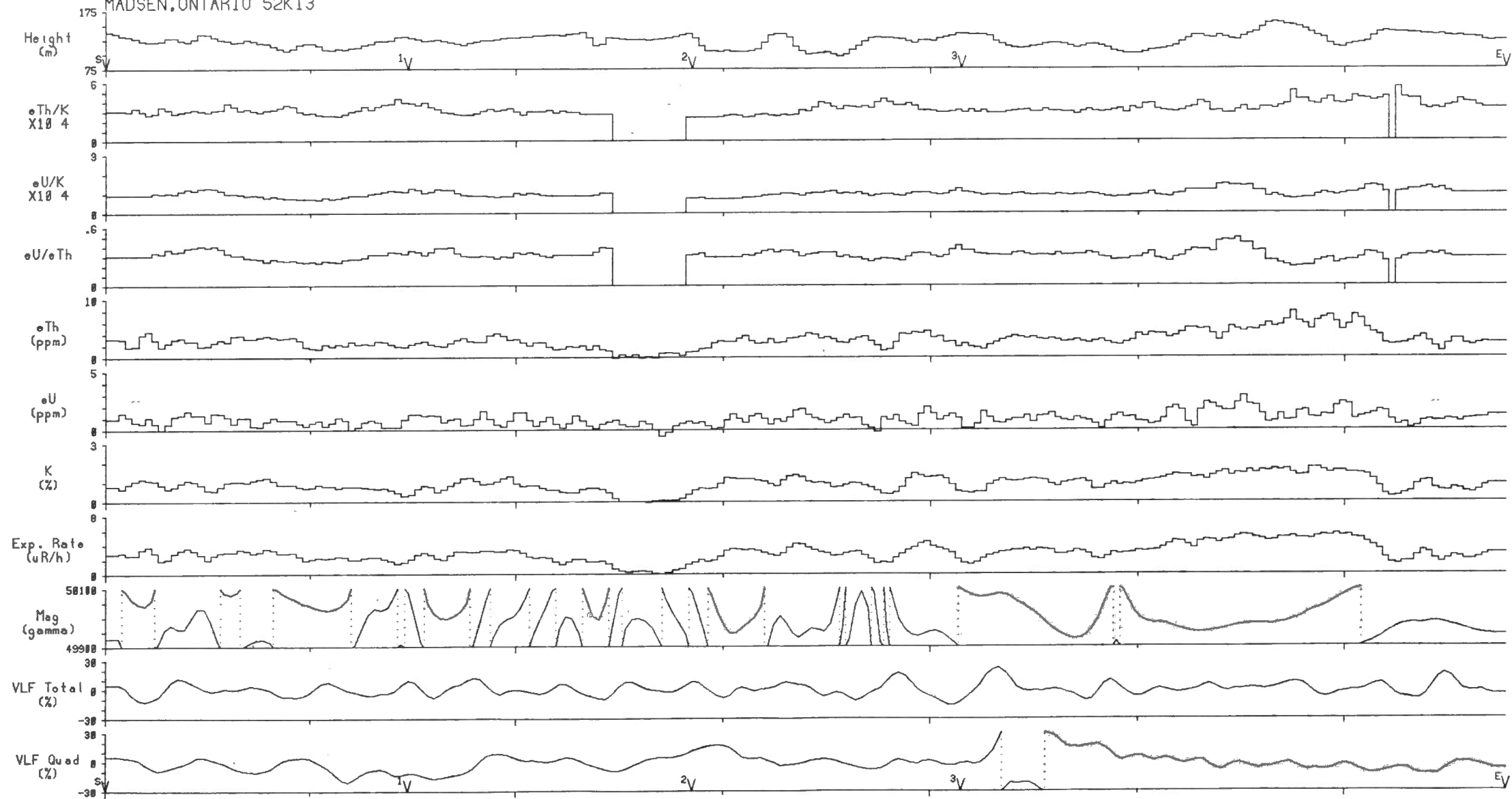


Line 26

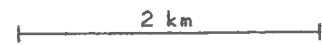
2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

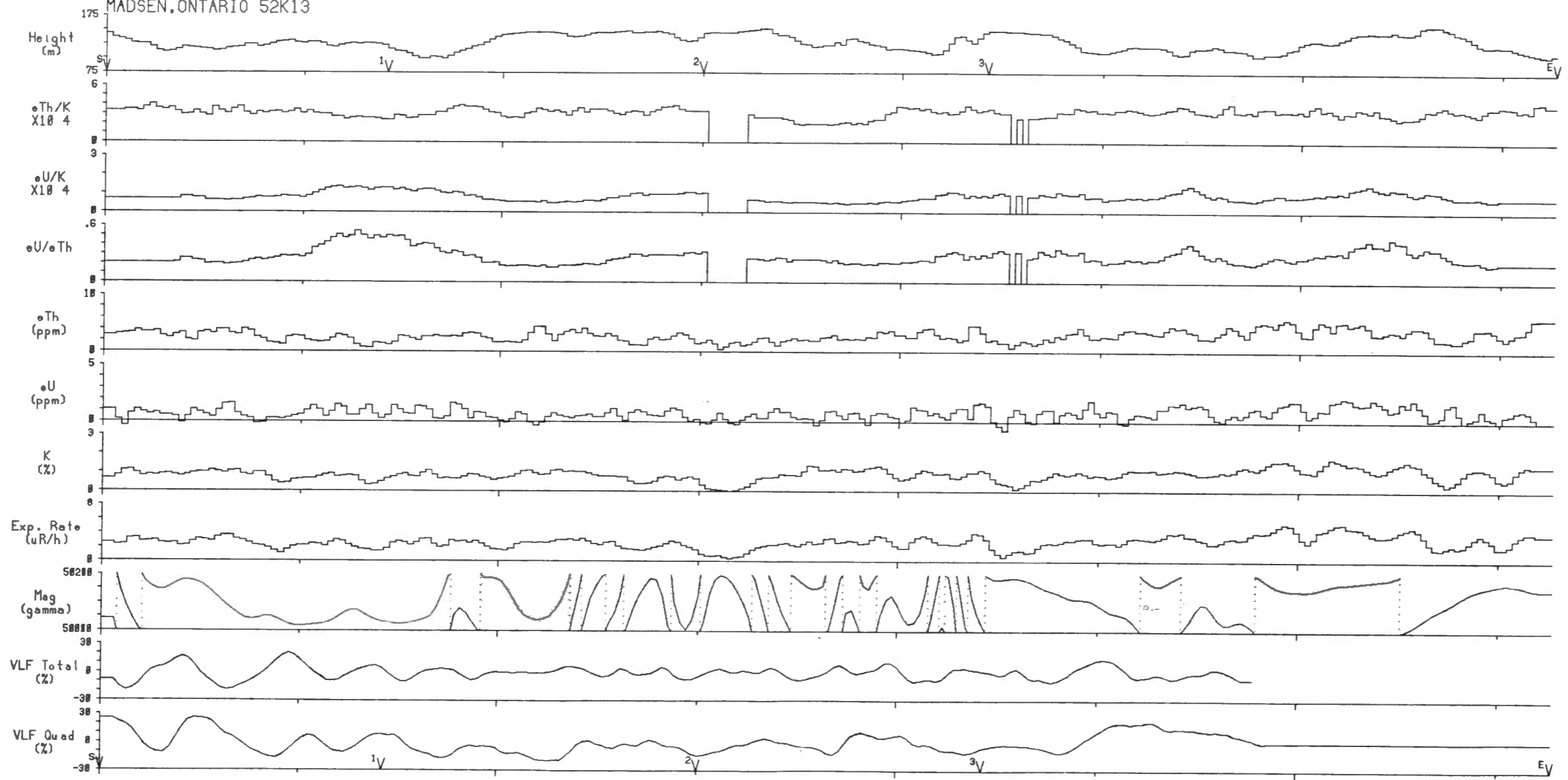


Line 27



Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

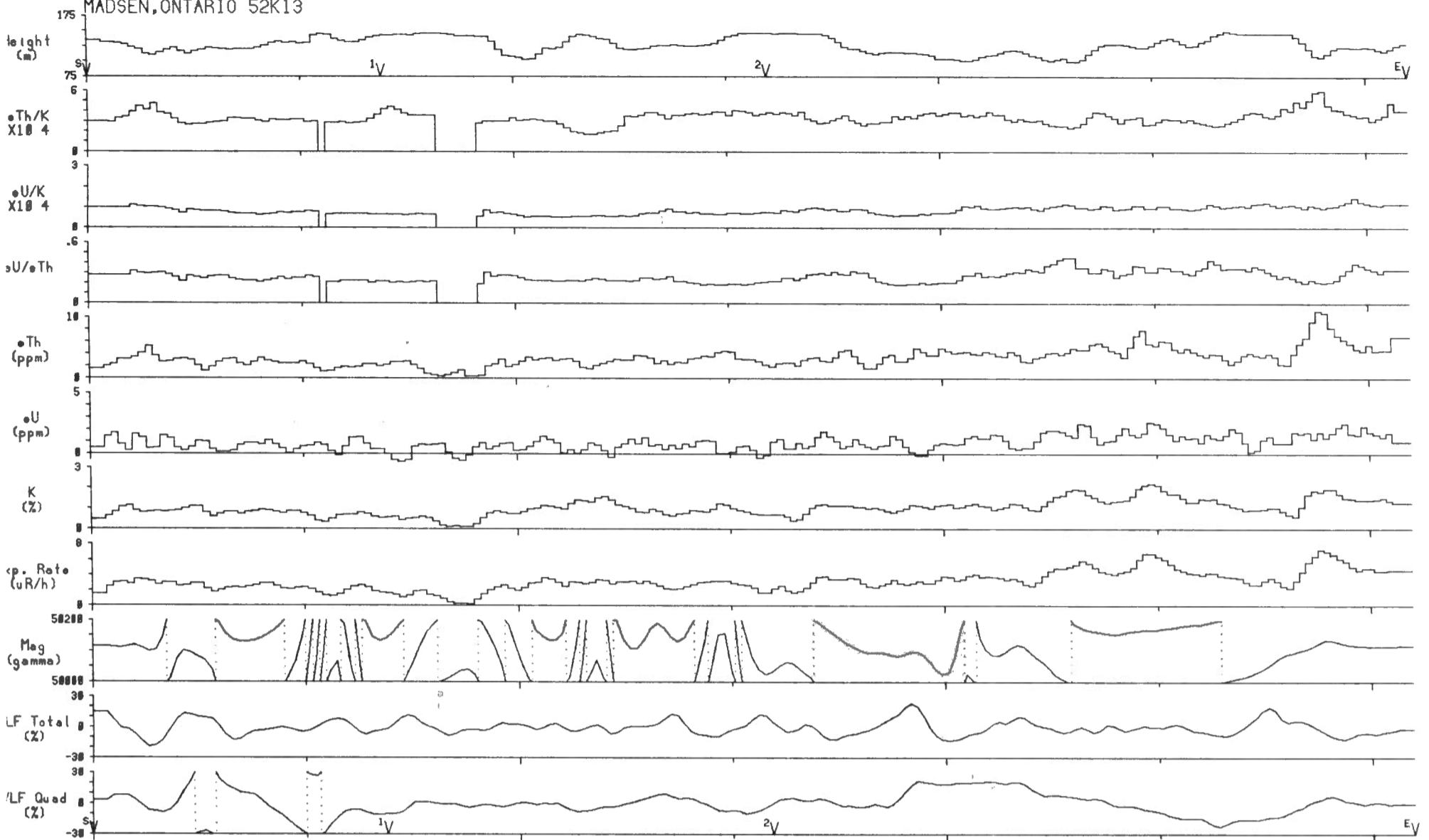


Line 28

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

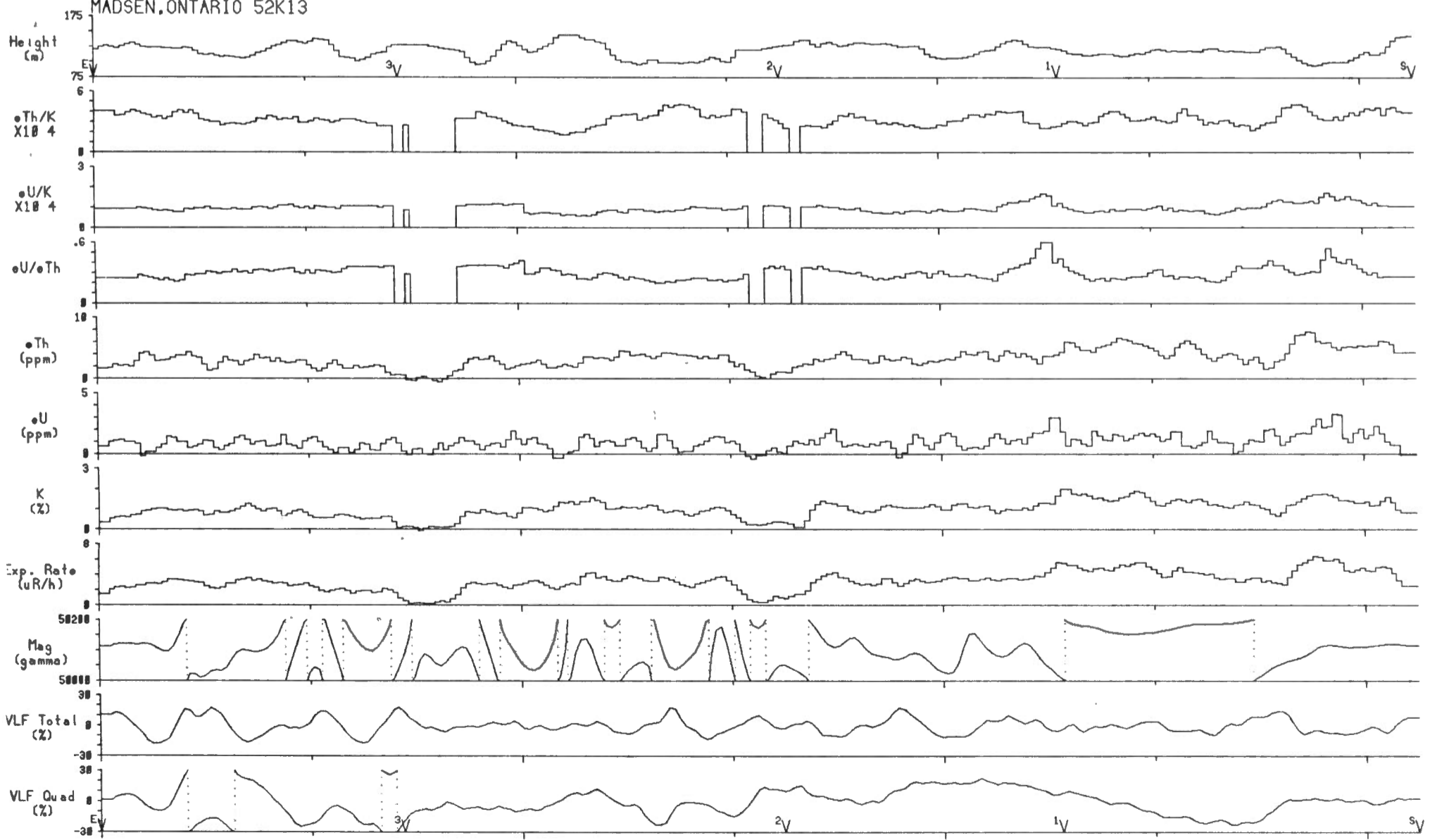


Line 29

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



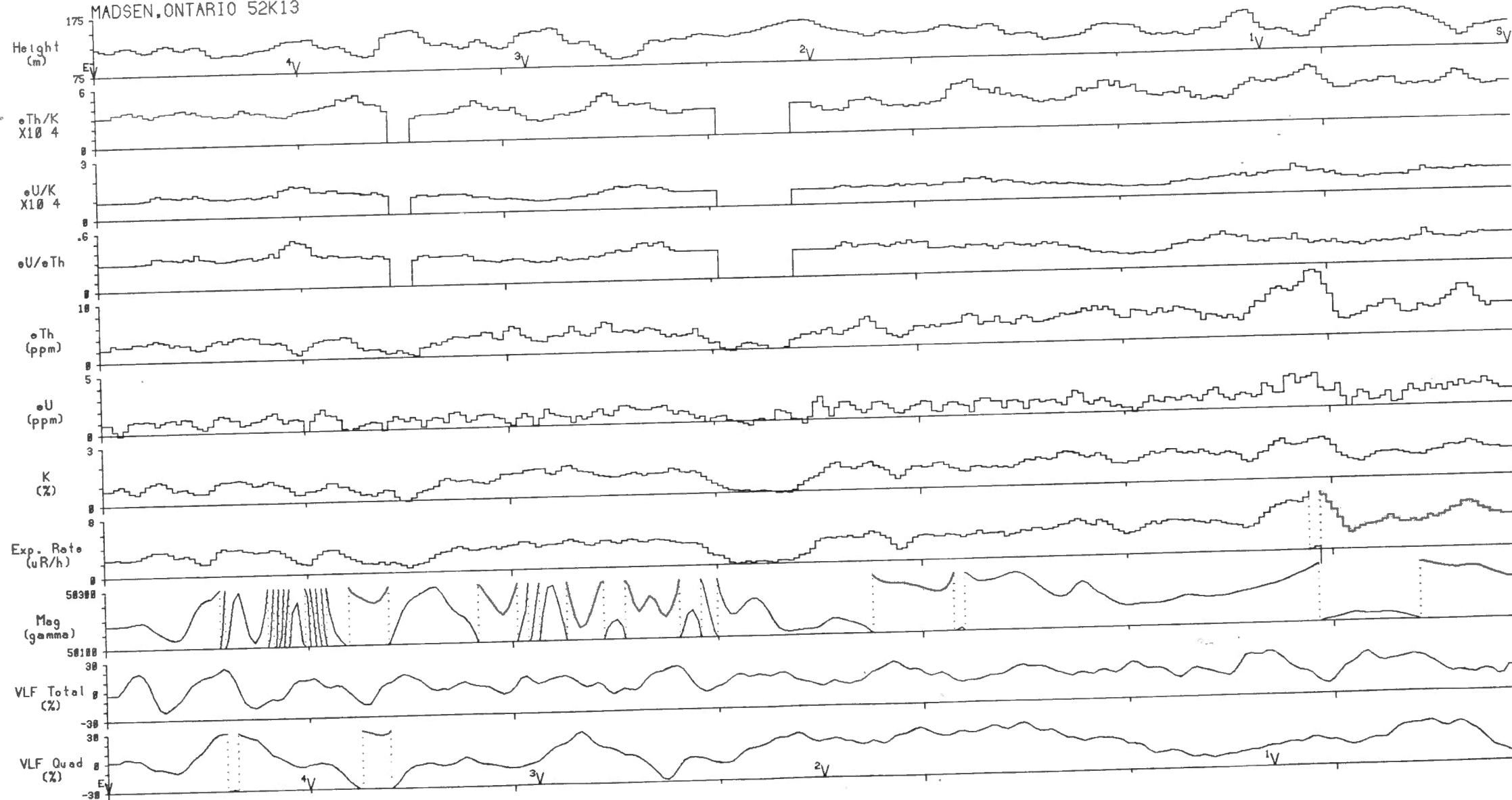
Line 30

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



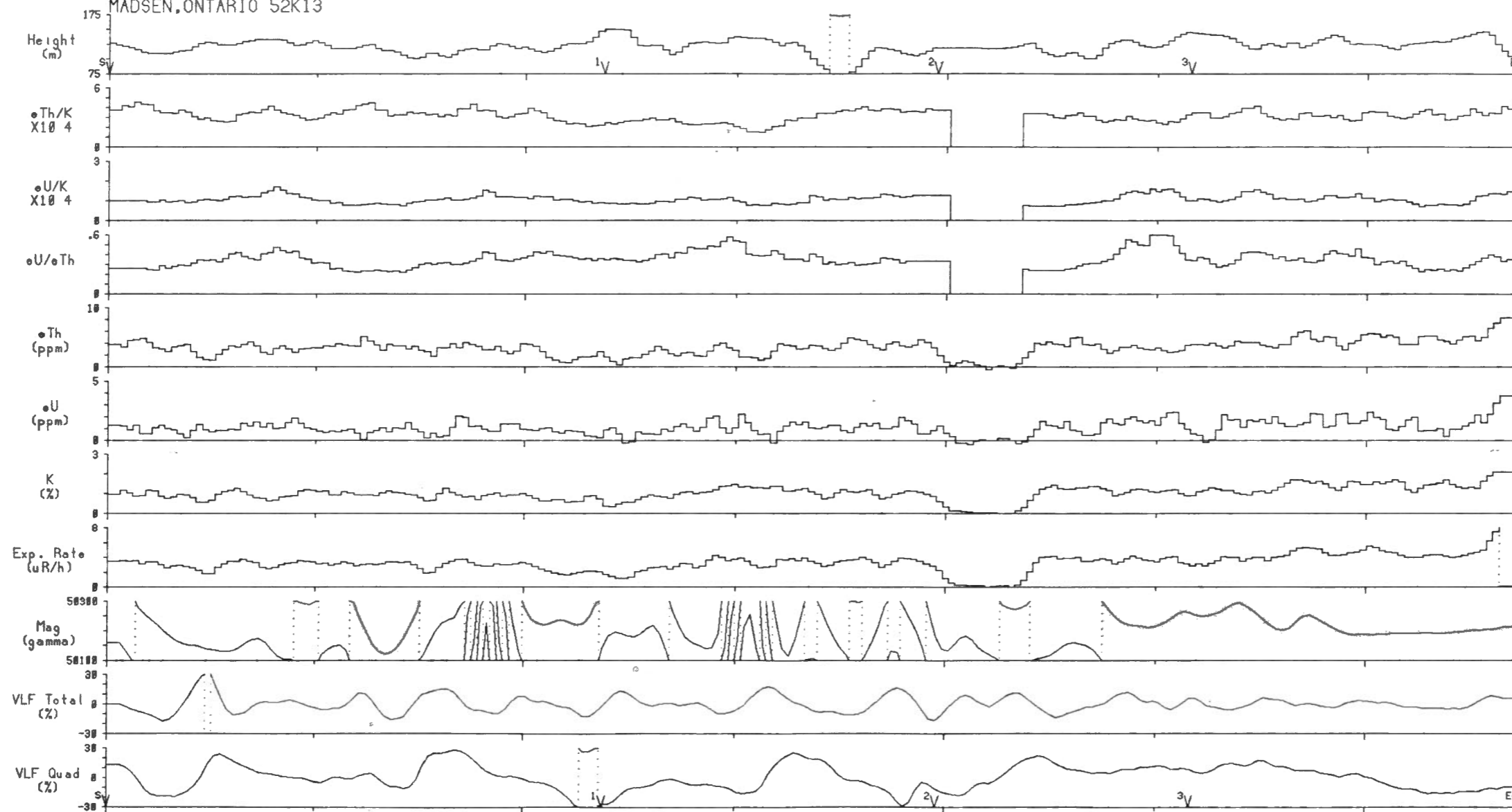
Line 31

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



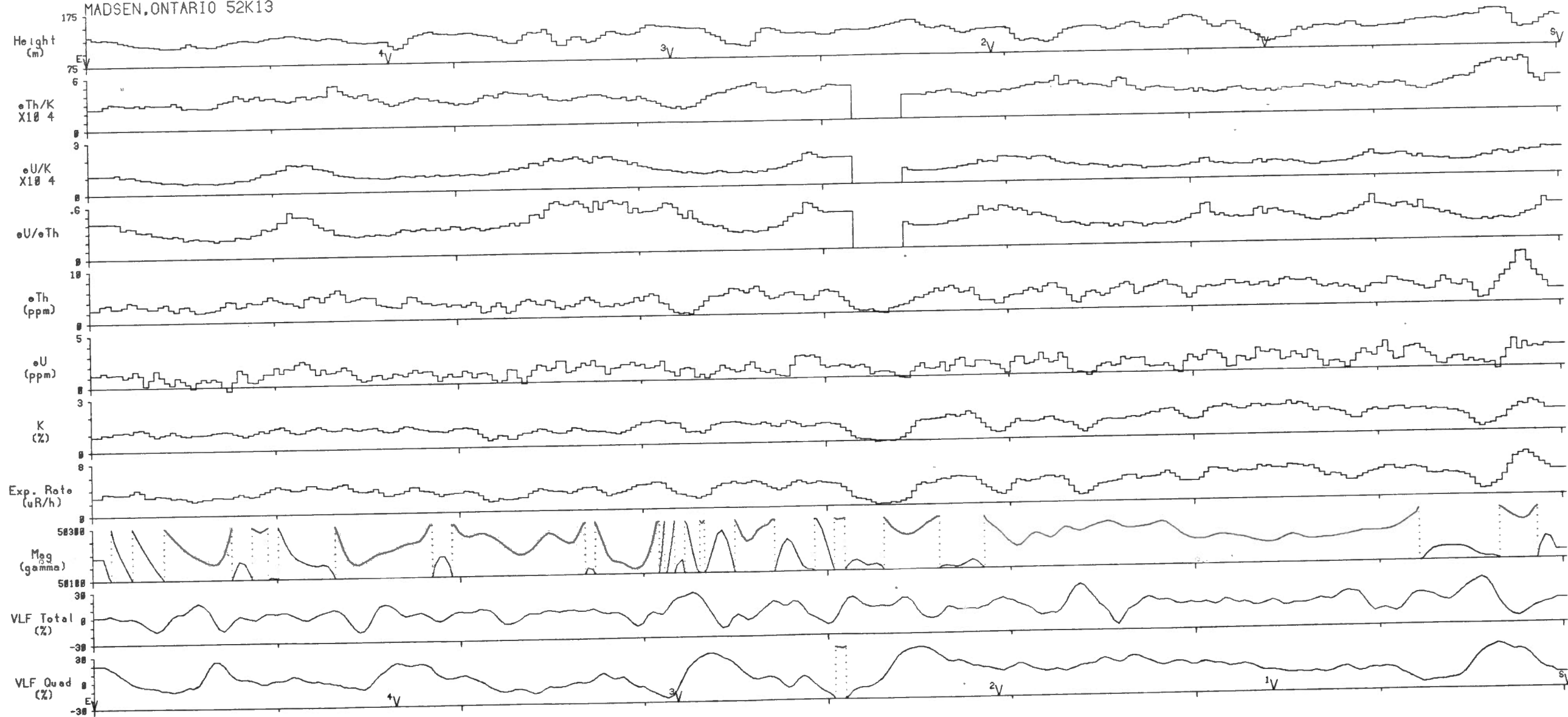
Line 32

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



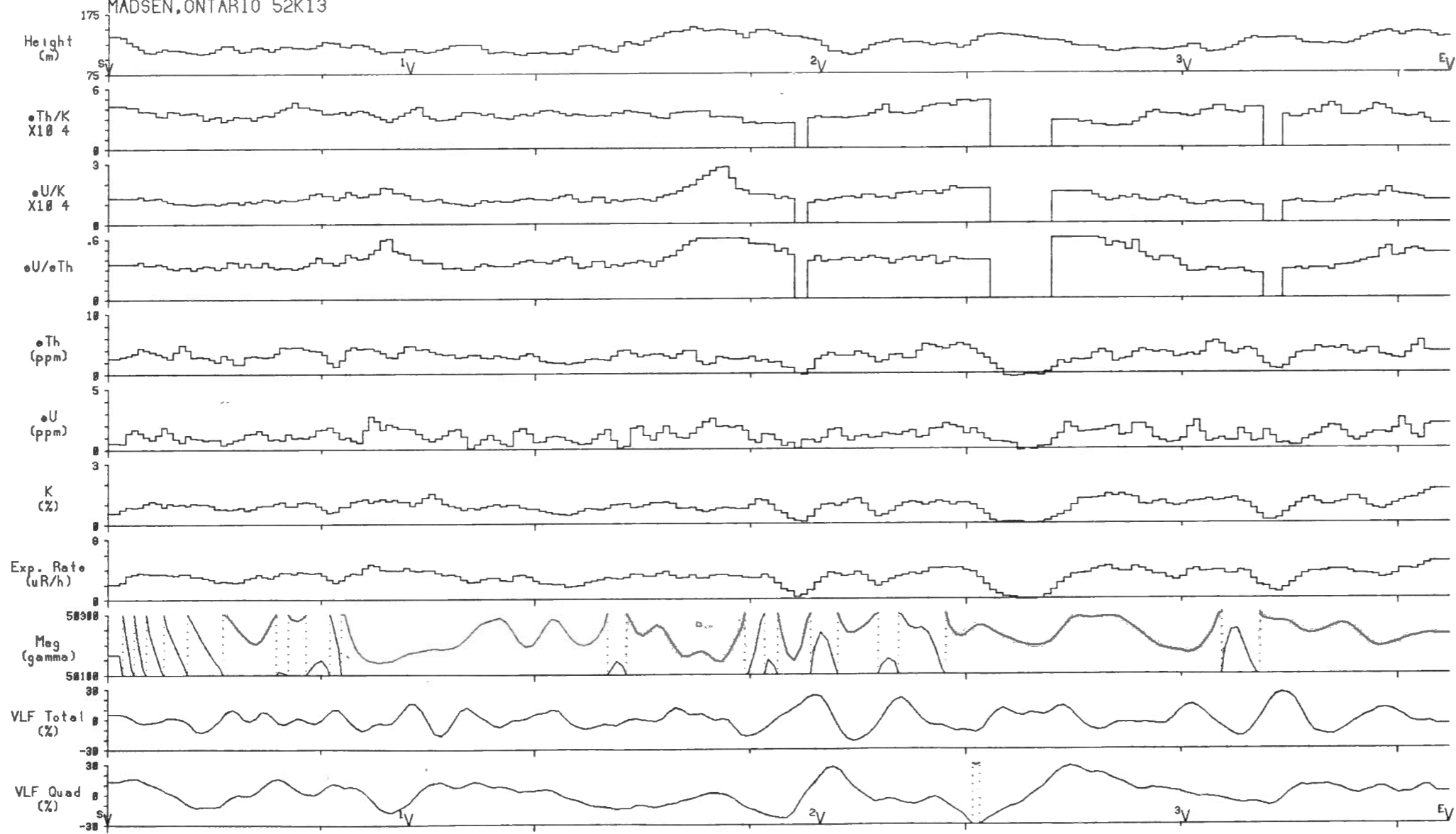
Line 33

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



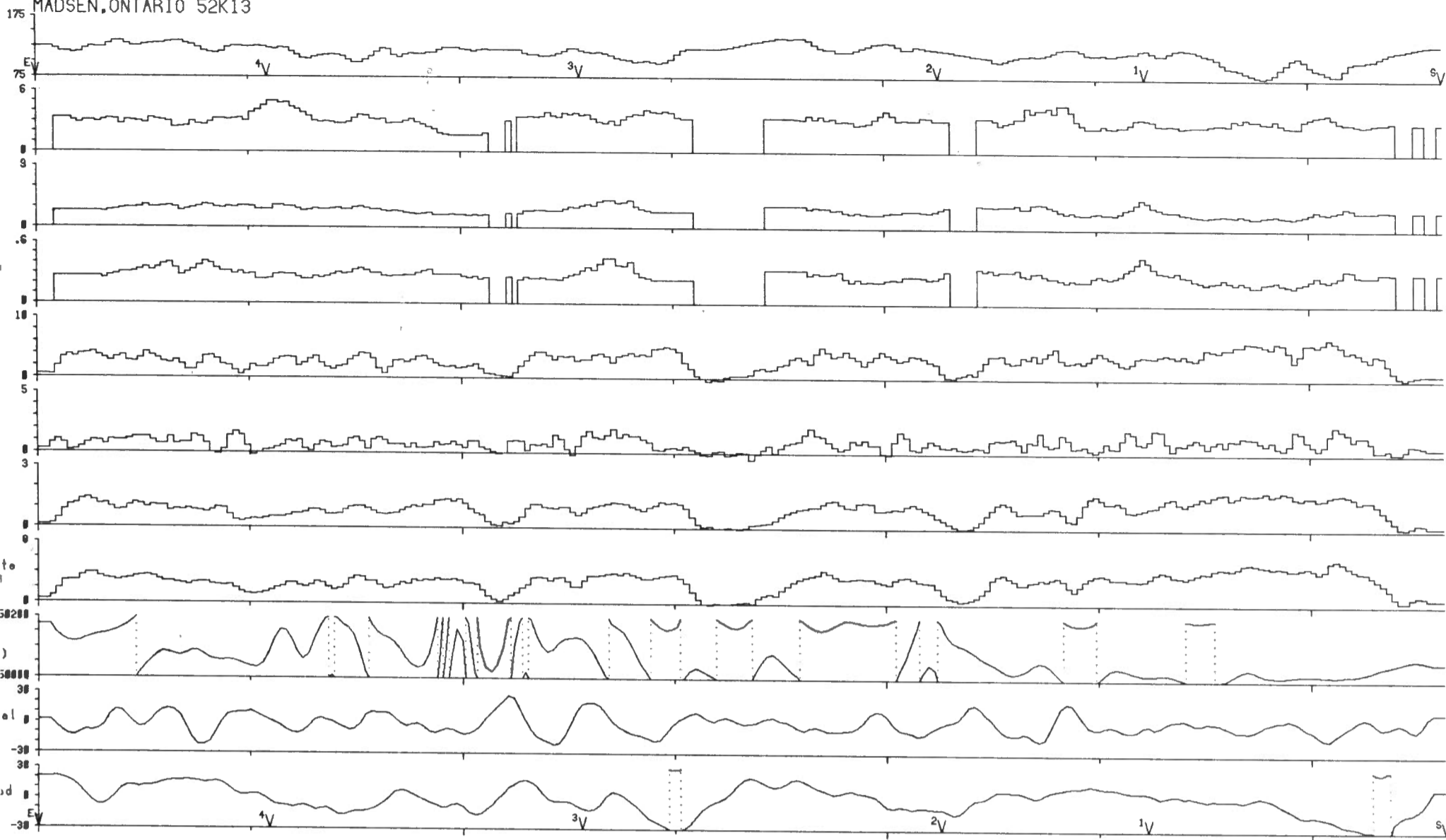
Line 34

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

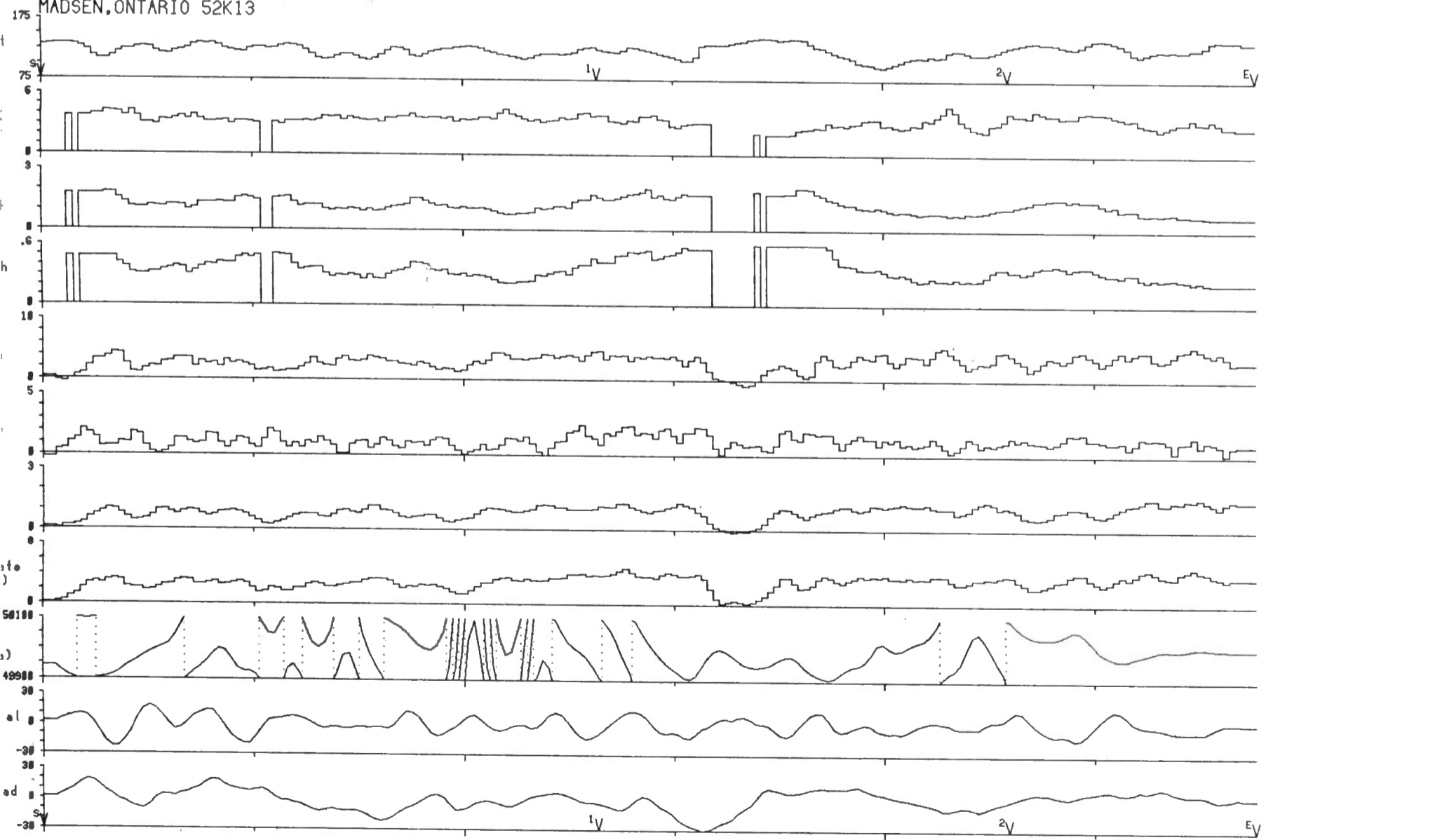


Line 35

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



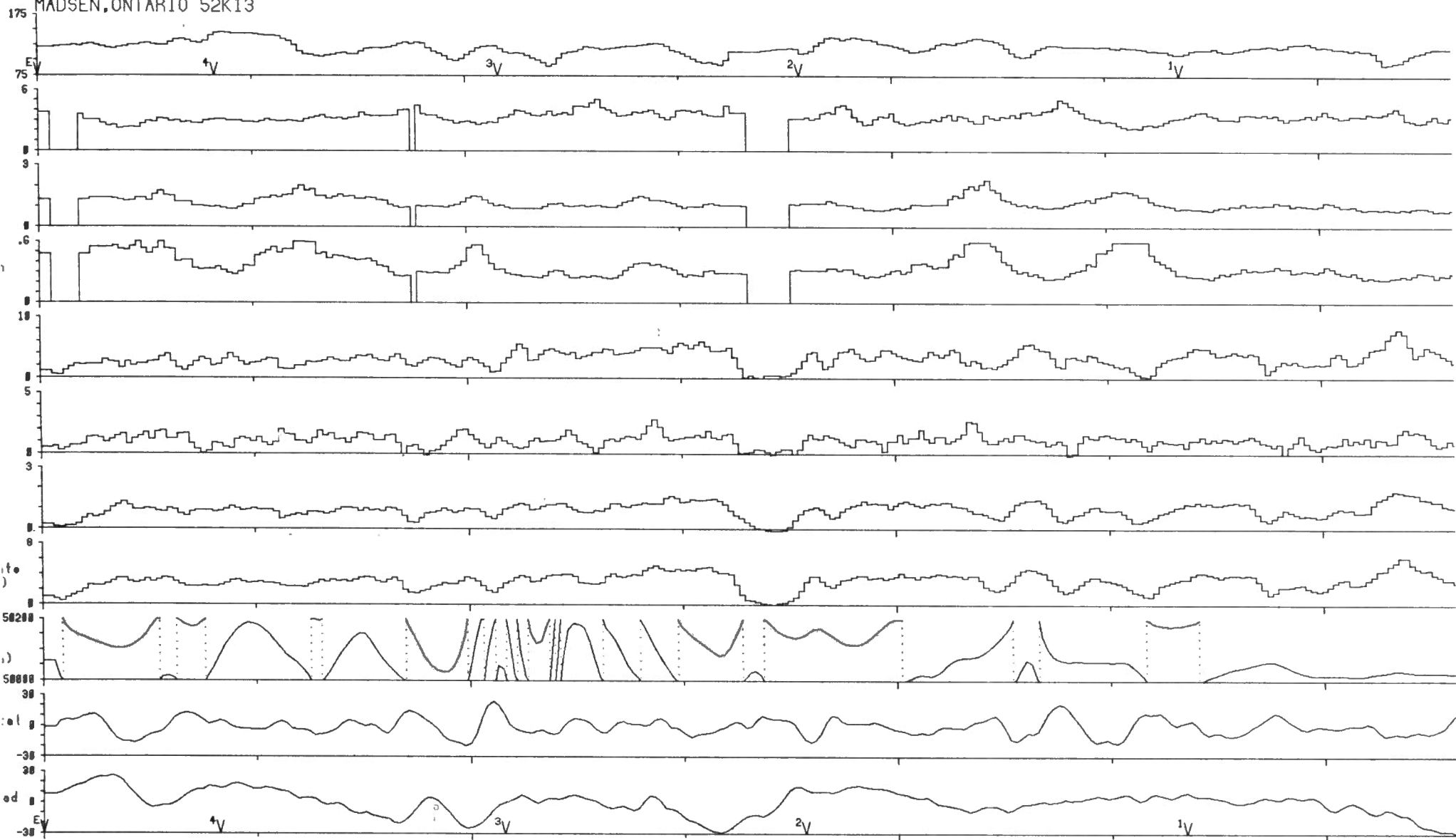
Line 36

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

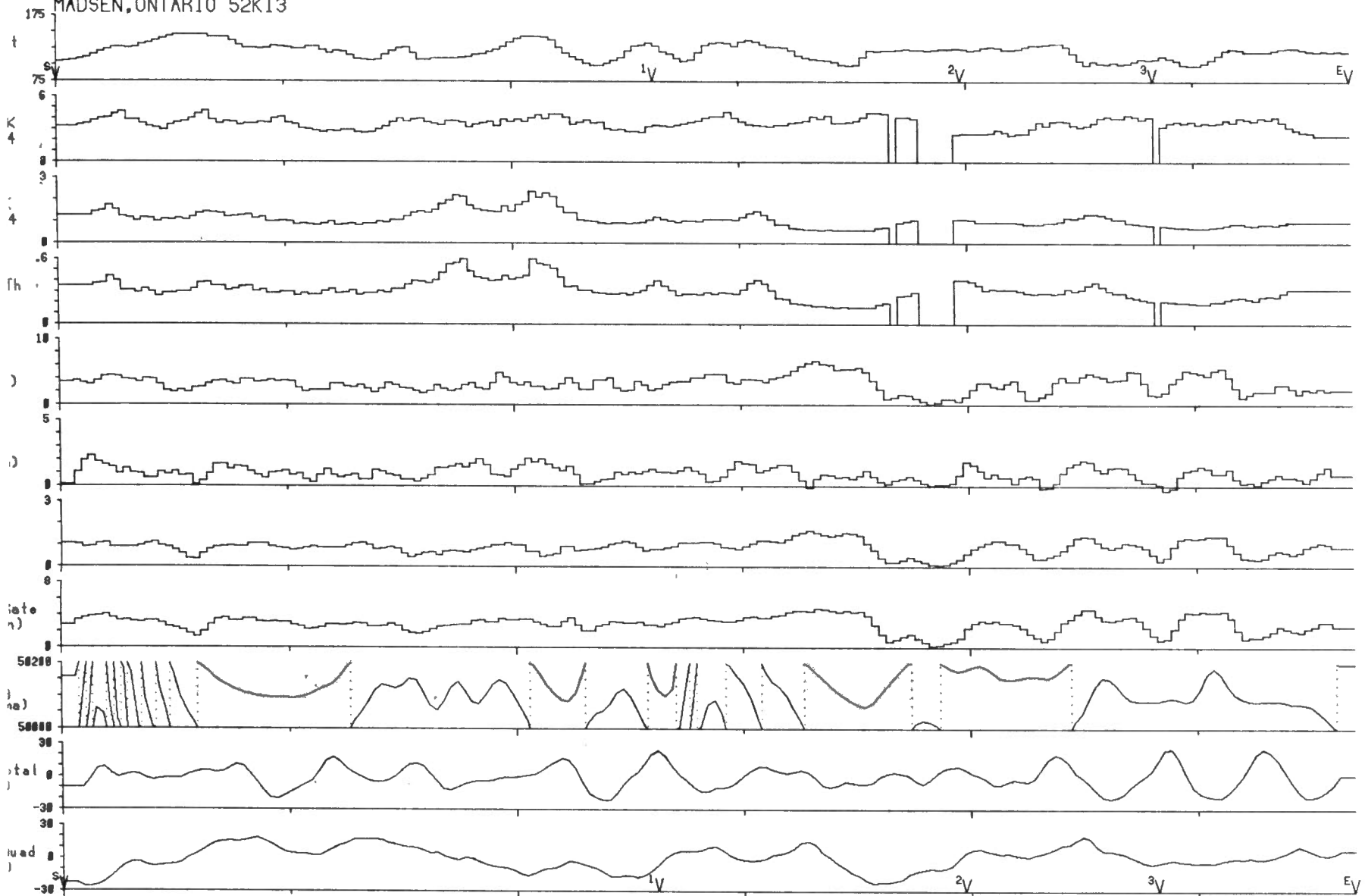


Line 37

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



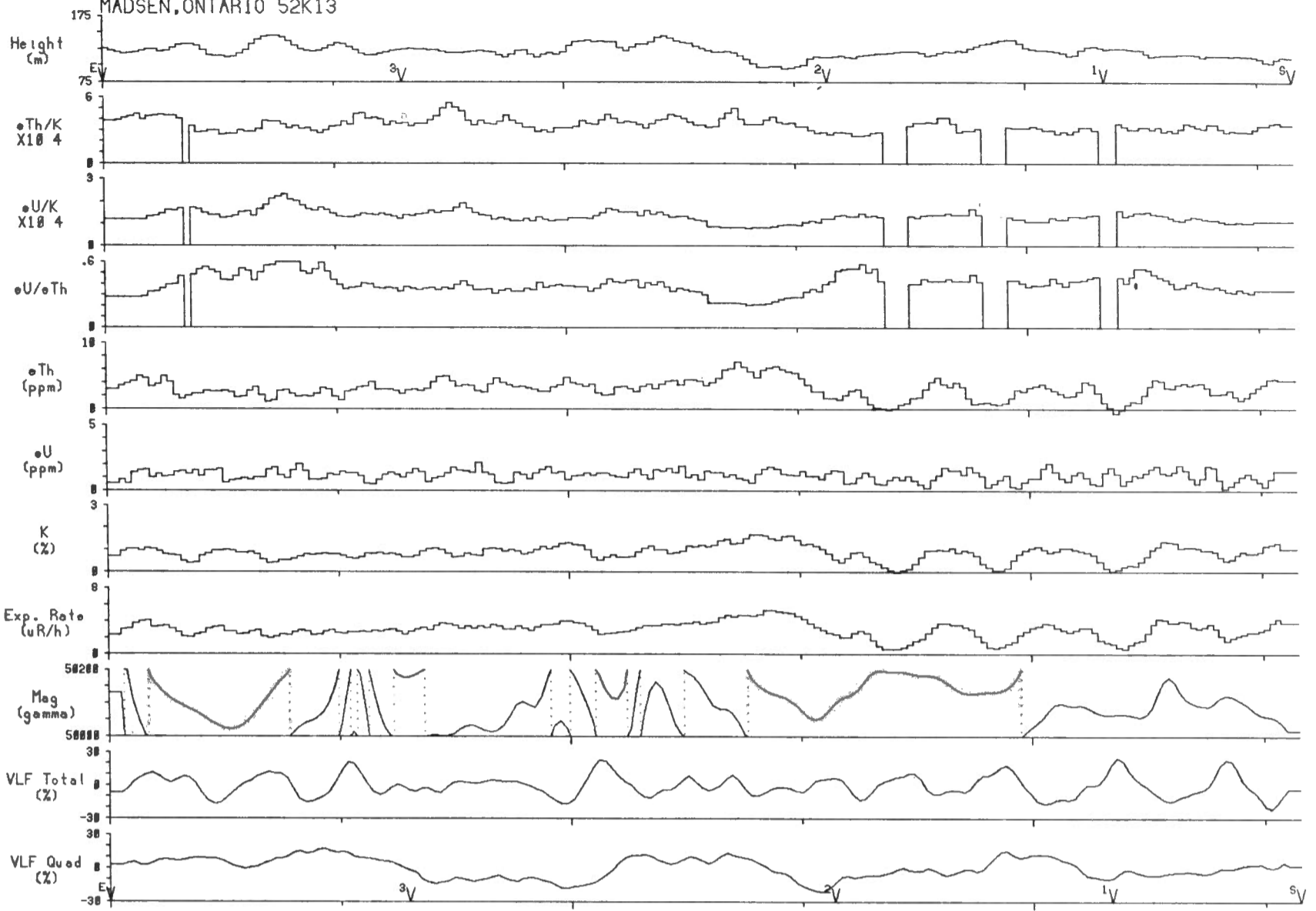
Line 38

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

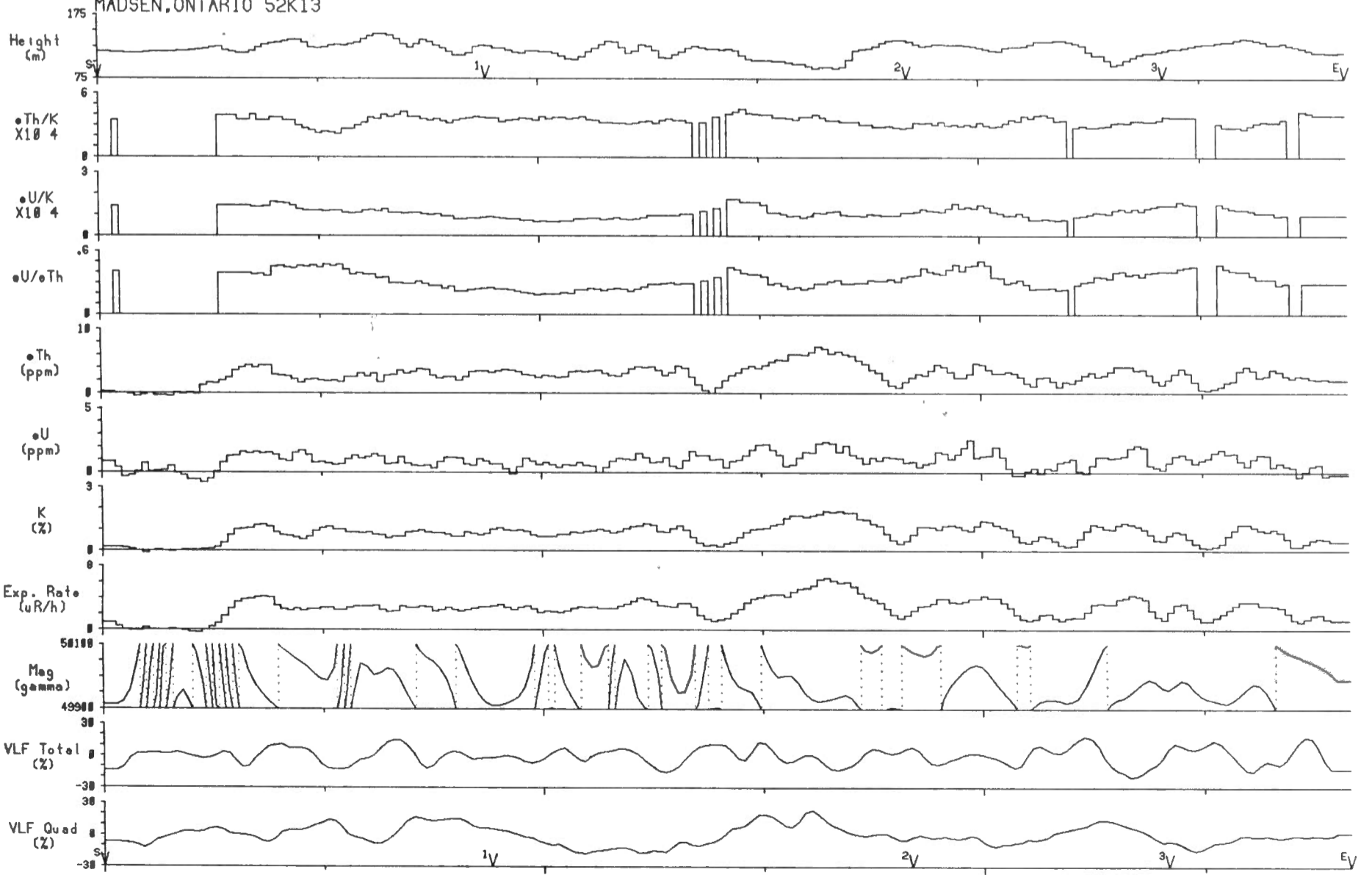


Line 39

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



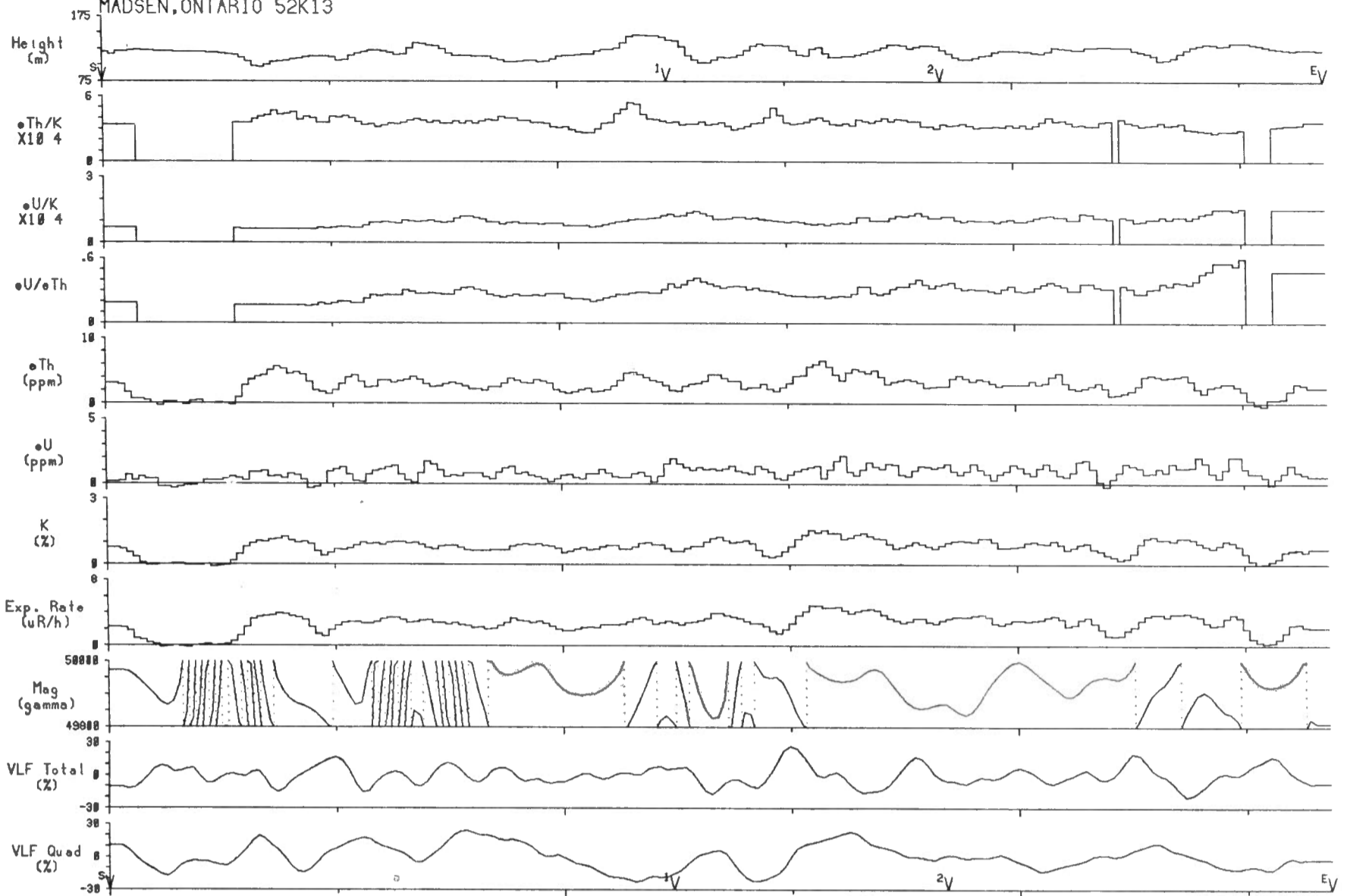
Line 40

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

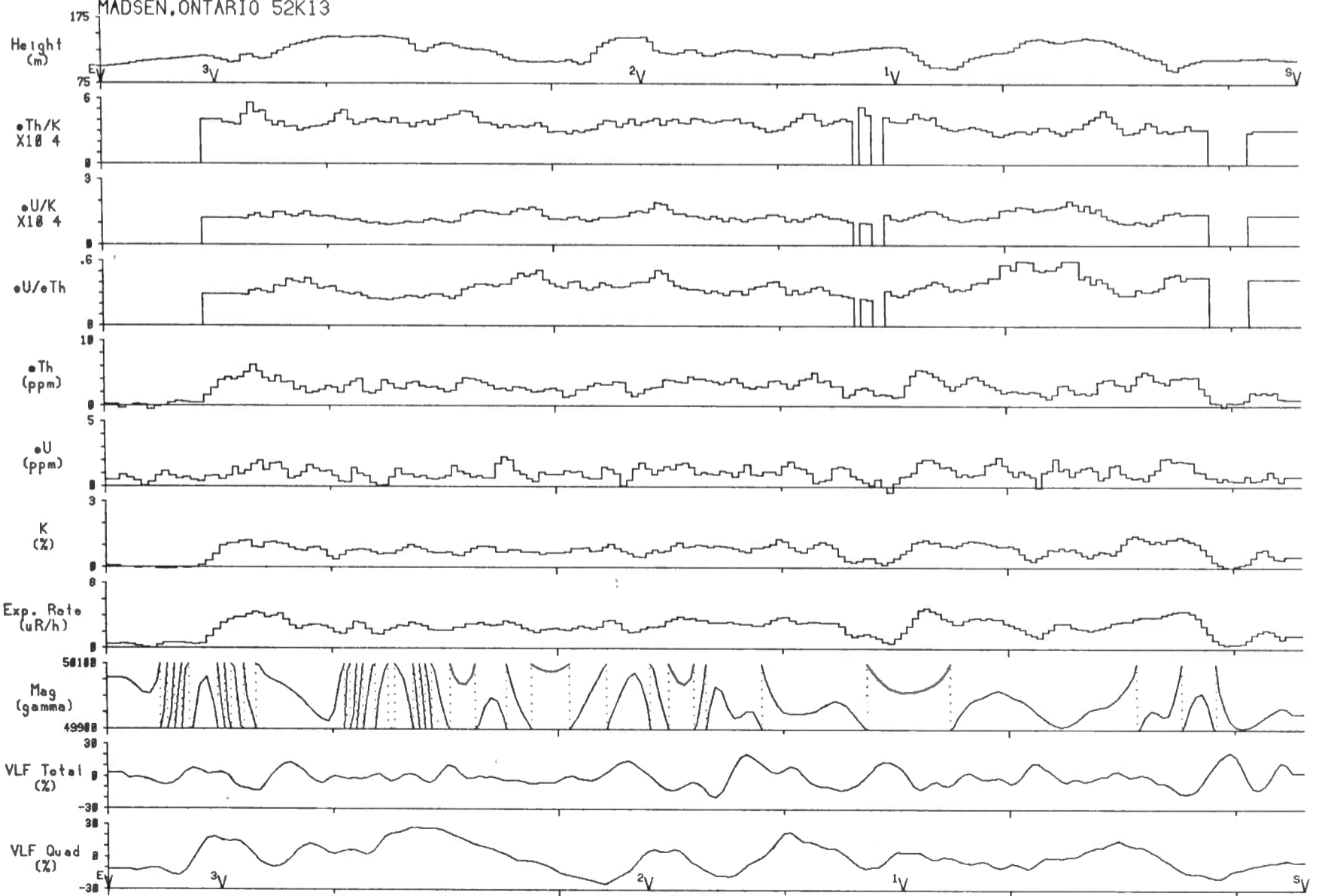


Line 41

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



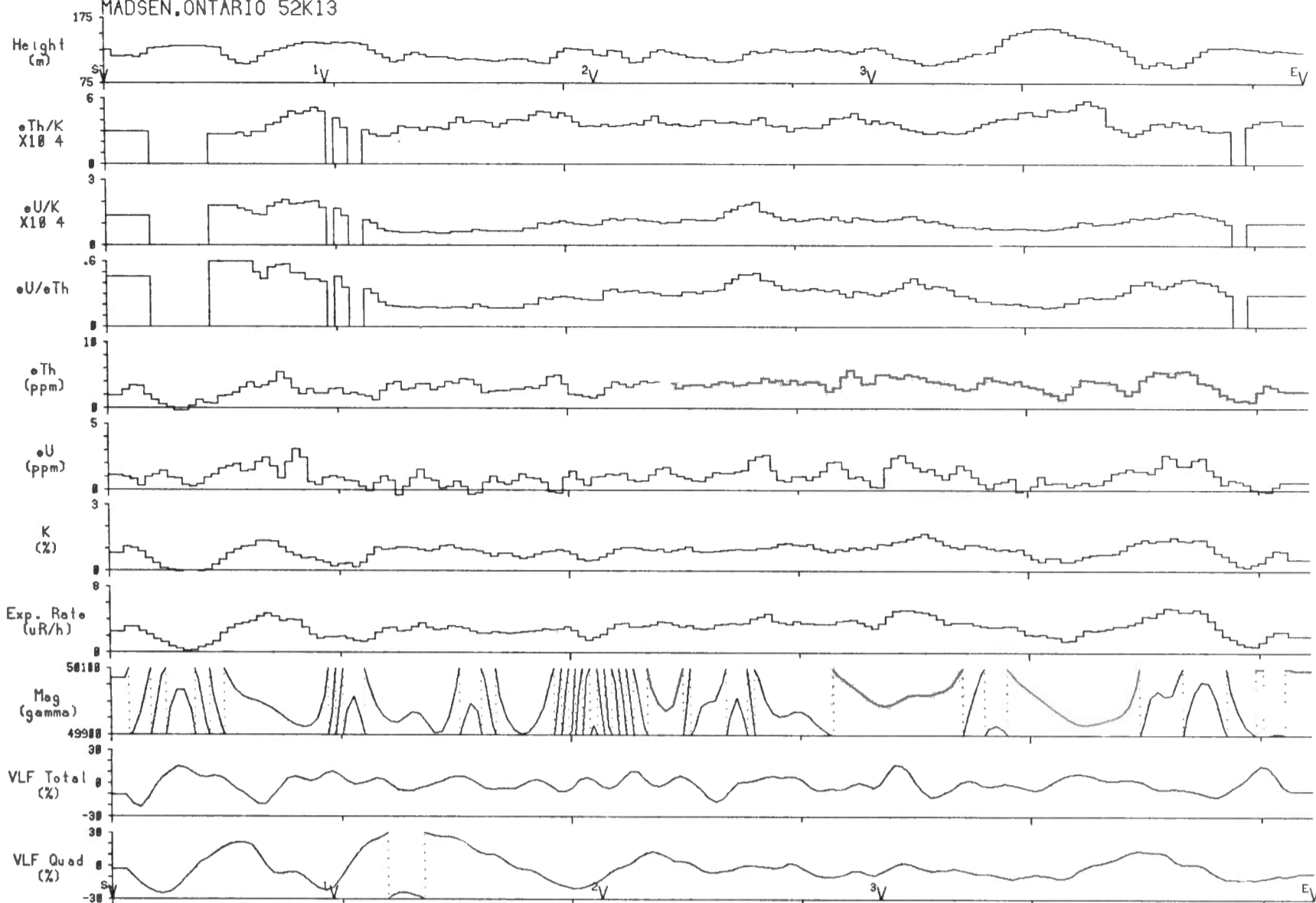
Line 42

2 km

Scale 1:50000



RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13

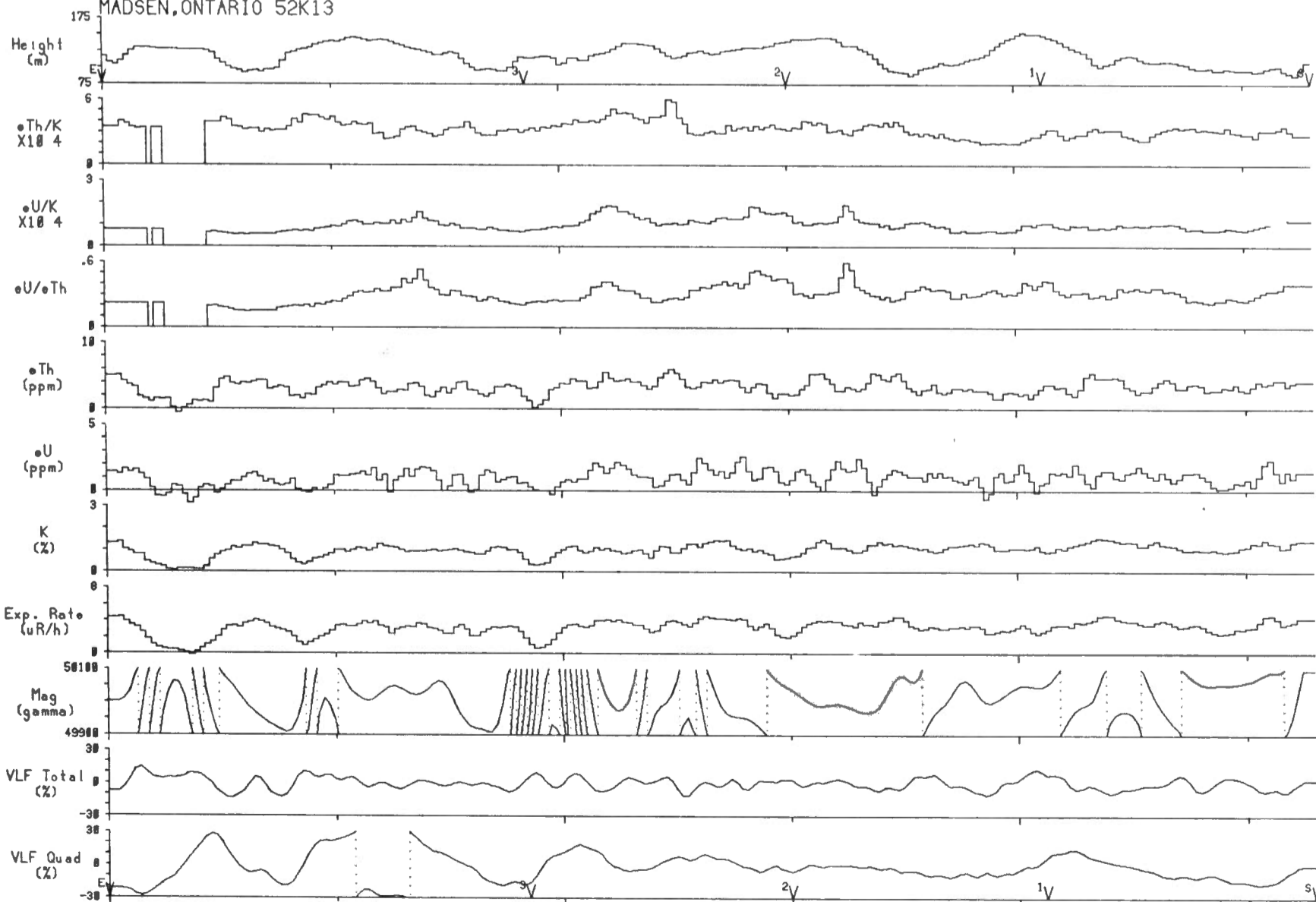


Line 43

2 km

Scale 1:50000

RED LAKE SURVEY, ONTARIO, 1990  
MADSEN, ONTARIO 52K13



Line 44

2 km

Scale 1:50000