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**OPEN FILE
REPORT
SERIES**

LATERITE GEOCHEMISTRY IN THE CSIRO-AGE DATABASE FOR THE CENTRAL YILGARN REGION

(Barlee, Bencubbin, Corrigin, Hyden, Jackson,
Kalgoorlie, Kellerberin, Southern Cross sheets)

Volume 2 - Appendices

E.C. Grunsky

CRC LEME OPEN FILE REPORT 22

September 1998

(CSIRO Division of Exploration Geoscience Report I21R, 1990.
Second impression 1998)

CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centres Program.



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RESEARCH ARISING FROM CSIRO/AMIRA REGOLITH GEOCHEMISTRY PROJECTS 1987-1993

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, "Exploration for concealed gold deposits, Yilgarn Block, Western Australia" (1987-1993) had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program included the following projects:

P240: Laterite geochemistry for detecting concealed mineral deposits (1987-1991). Leader: Dr R.E. Smith.
Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

P241: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1987-1991). Leader: Dr C.R.M. Butt.

The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented "an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains". This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

P240A: Geochemical exploration in complex lateritic environments of the Yilgarn Craton, Western Australia (1991-1993). Leaders: Drs R.E. Smith and R.R. Anand.

The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

P241A: Gold and associated elements in the regolith - dispersion processes and implications for exploration. Leader: Dr. C.R.M. Butt.

The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Although the confidentiality periods of the research reports have expired, the last in December 1994, they have not been made public until now. Publishing the reports through the CRC LEME Report Series is seen as an appropriate means of doing this. By making available the results of the research and the authors' interpretations, it is hoped that the reports will provide source data for future research and be useful for teaching. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authorisation to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian Mineral Industry.

This report (CRC LEME Open File Report 22) is a Second impression (second printing) of CSIRO, Division of Exploration Geoscience Restricted Report 121R, first issued in 1990, which formed part of the CSIRO/AMIRA Project P240.

Copies of this publication can be obtained from:

The Publication Officer, c/- CRC LEME, CSIRO Exploration and Mining, PMB, Wembley, WA 6014, Australia. Information on other publications in this series may be obtained from the above or from <http://leme.anu.edu.au/>

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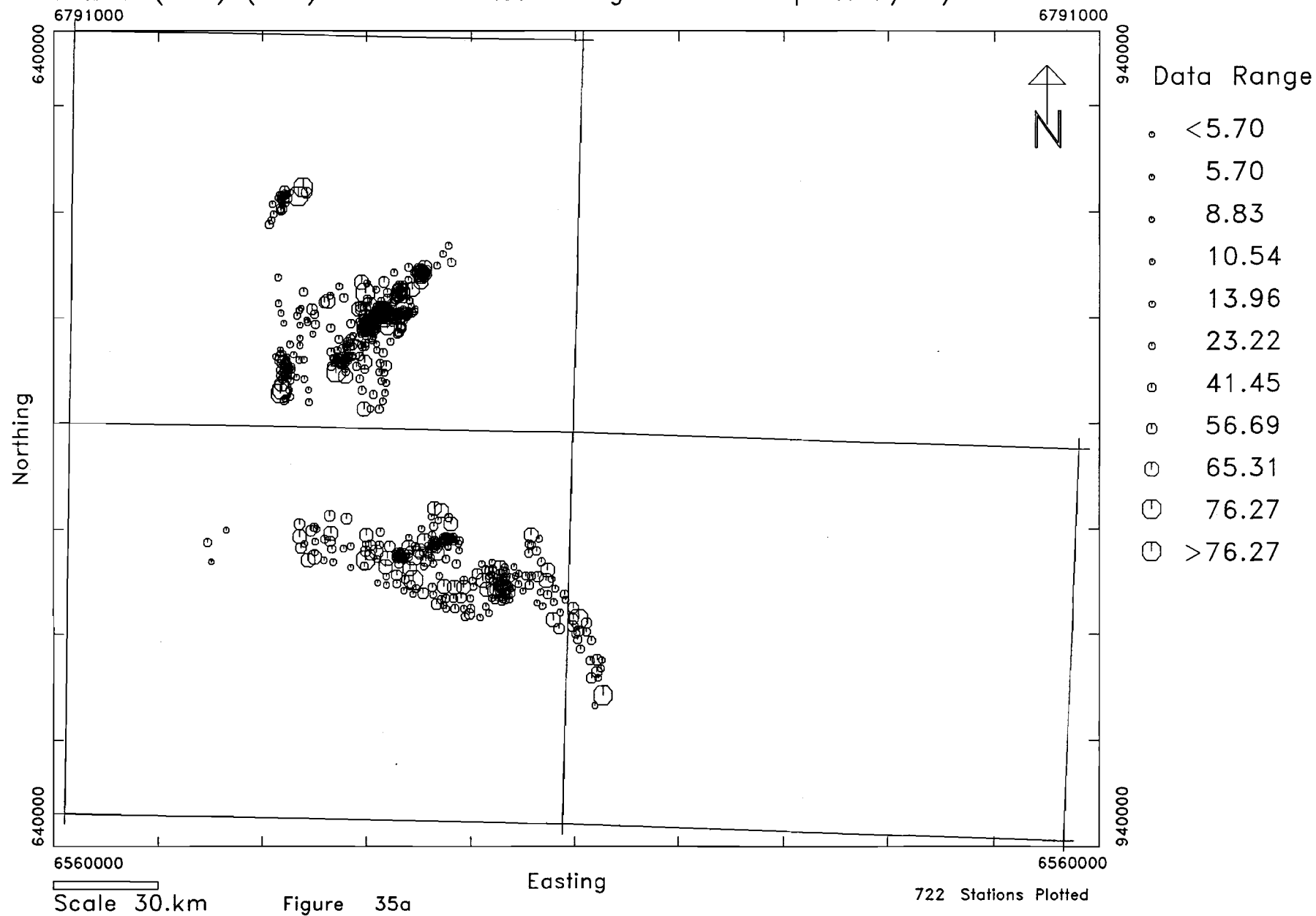
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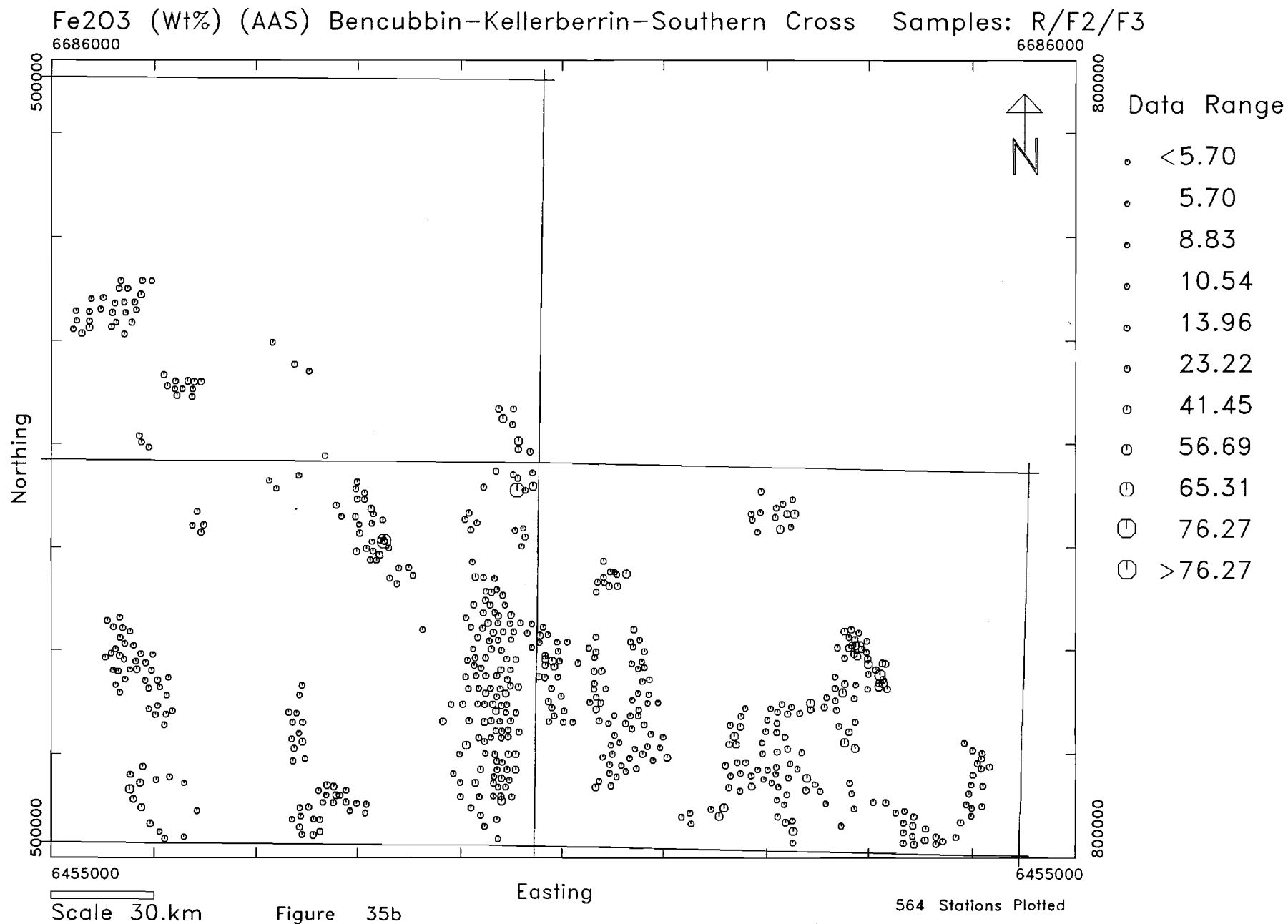
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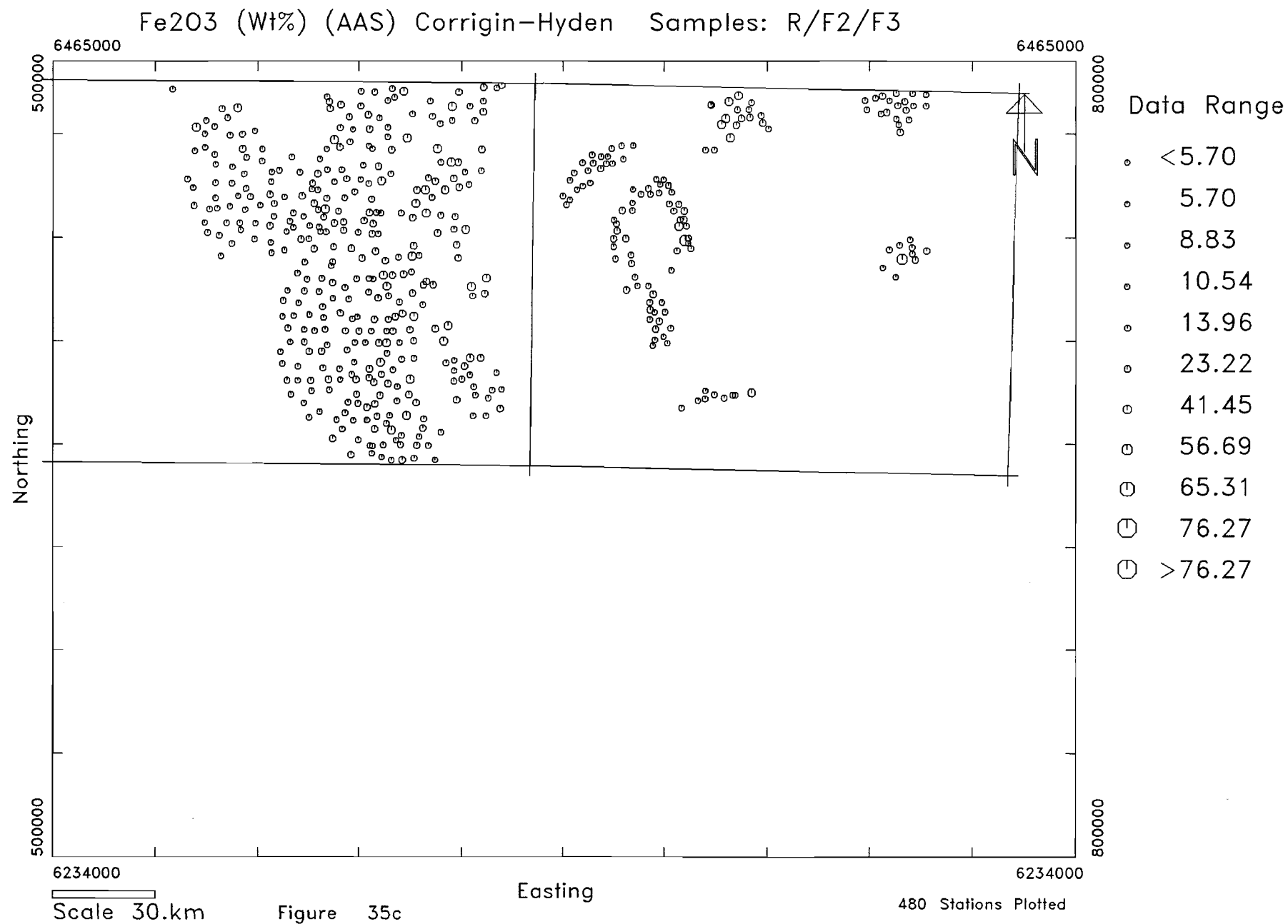
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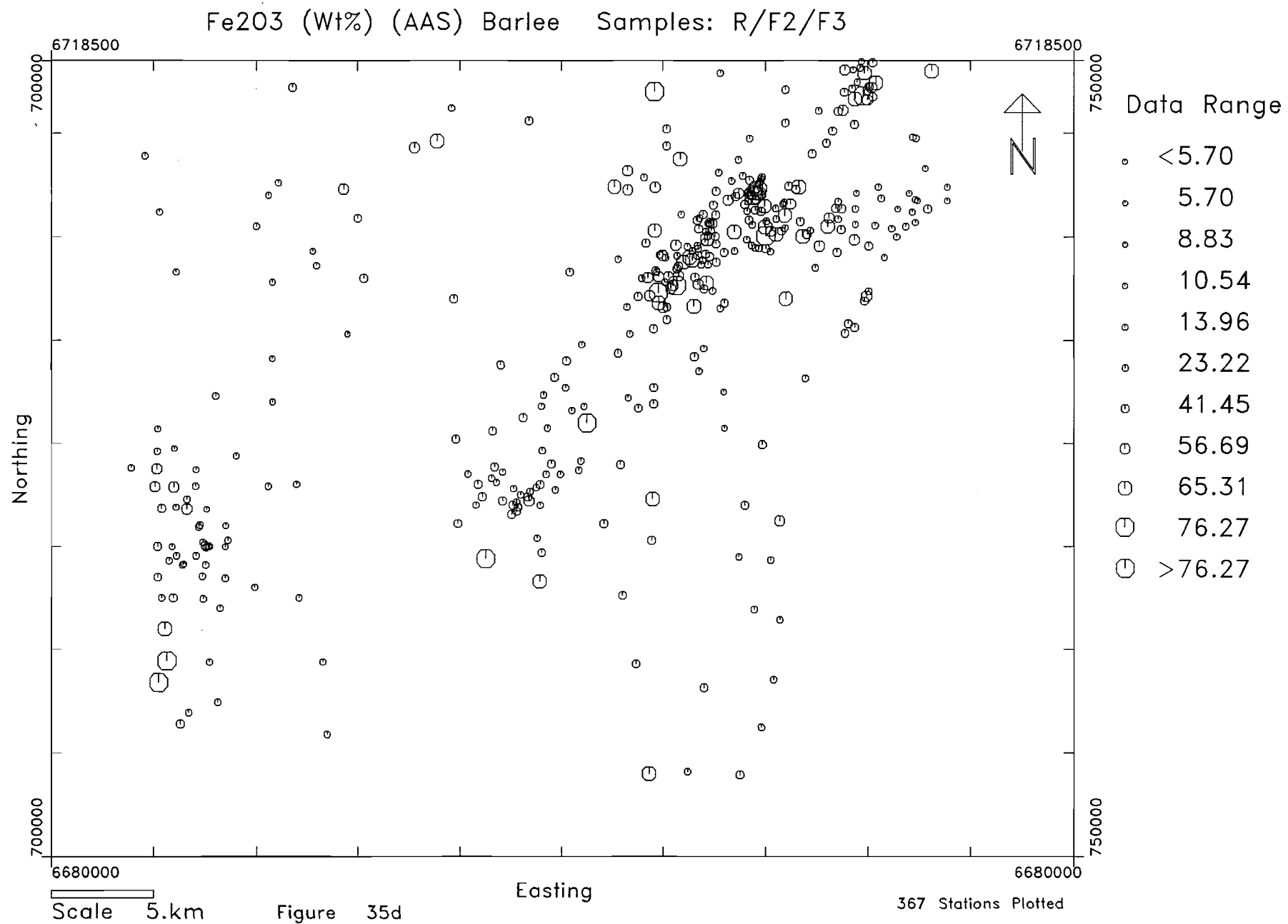
Figures 35 to 80.

Fe2O3 (Wt%) (AAS) Barlee-Jackson-Kalgoorlie Samples: R/F2/F3









TiO₂ (Wt%) (ICP) Barlee-Jackson-Kalgoorlie Samples: R/F2/F3

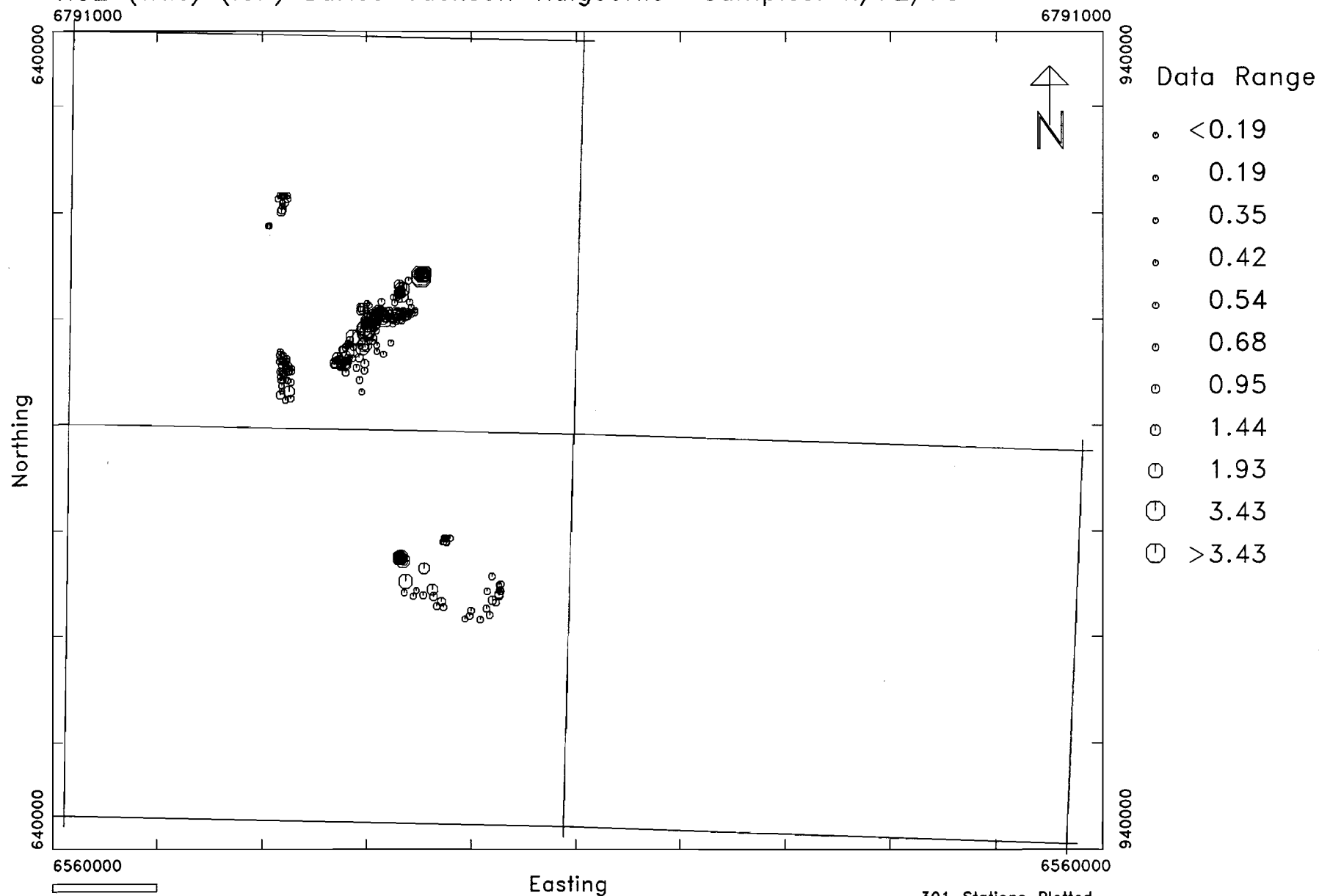
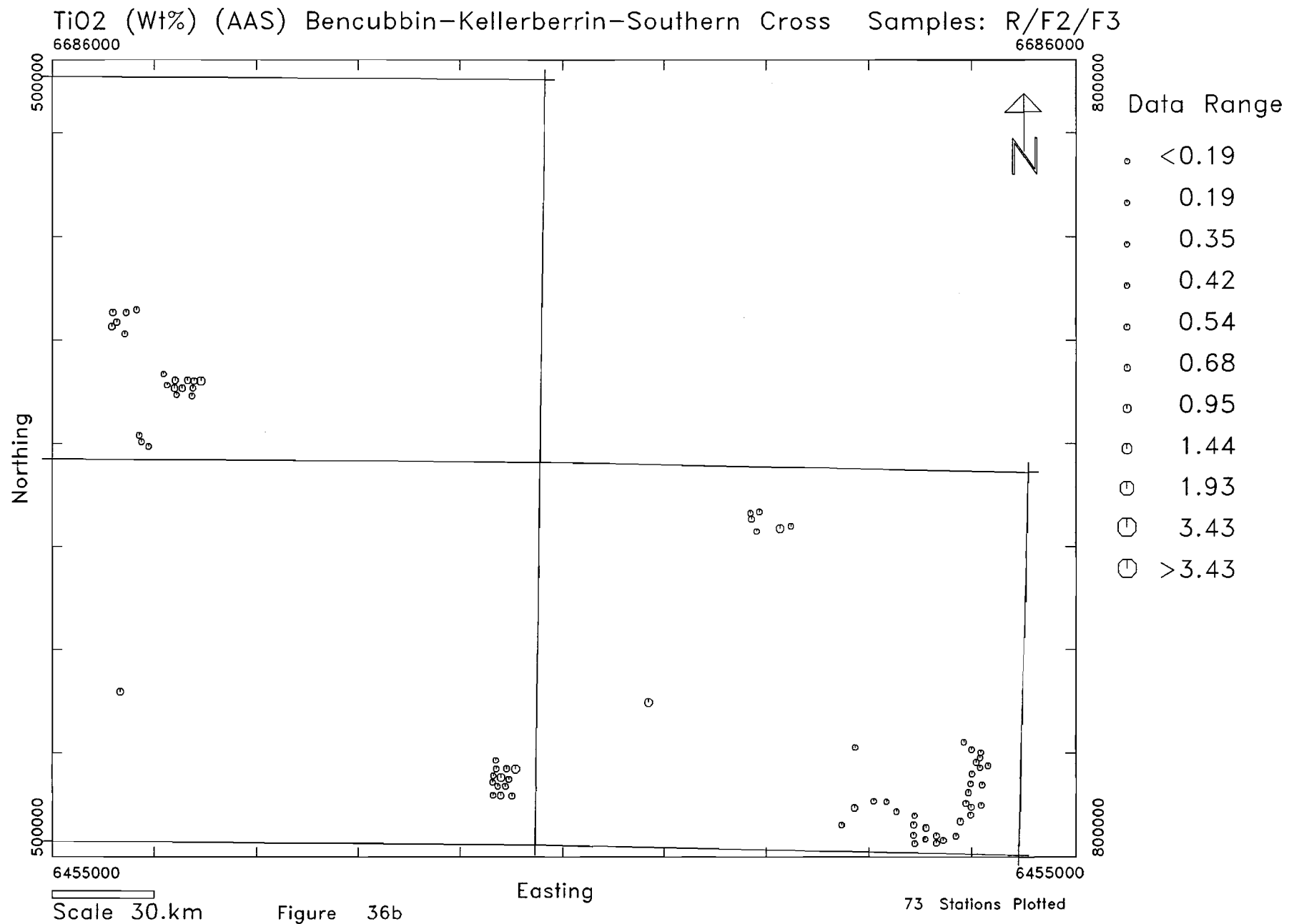
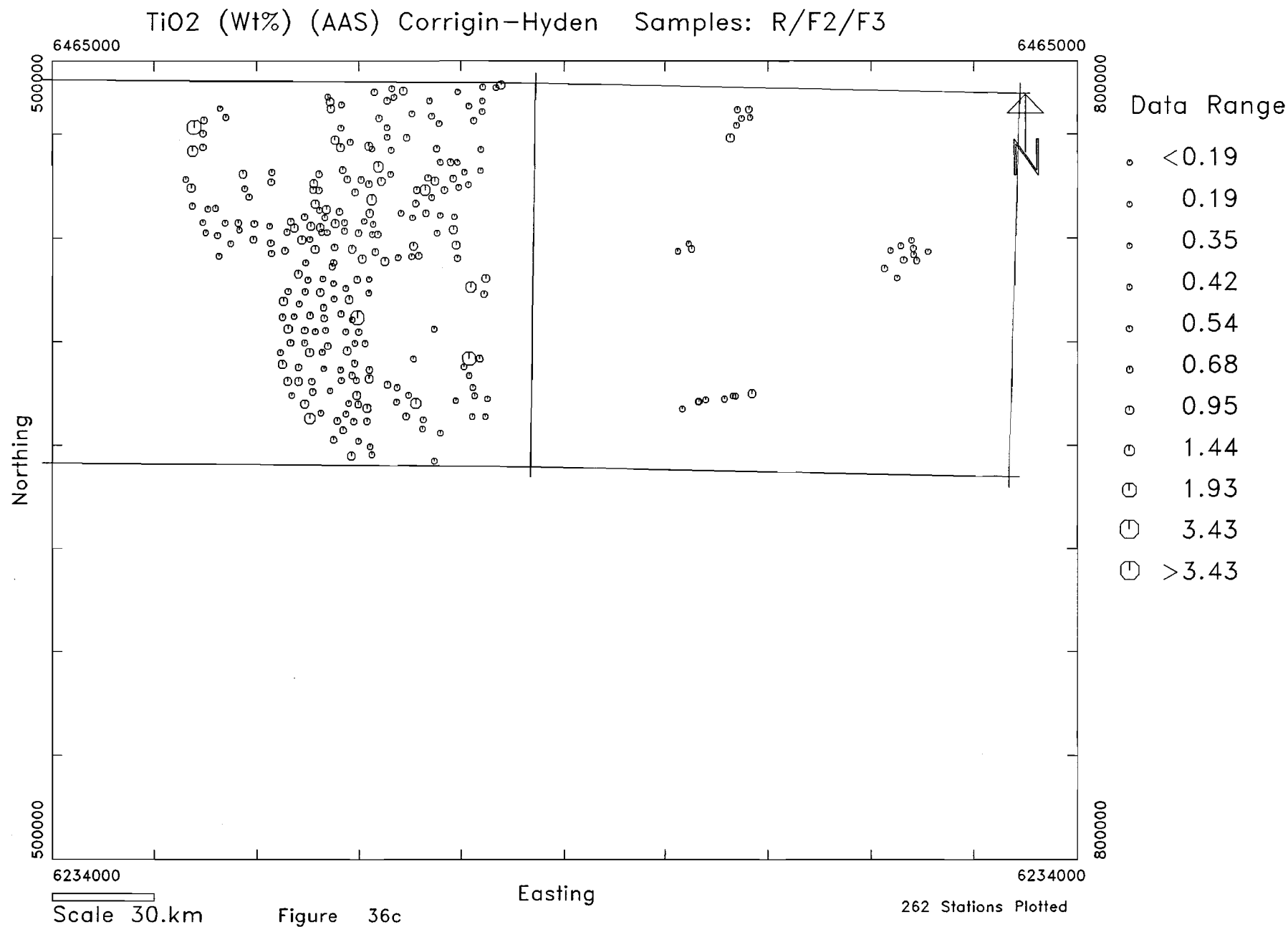
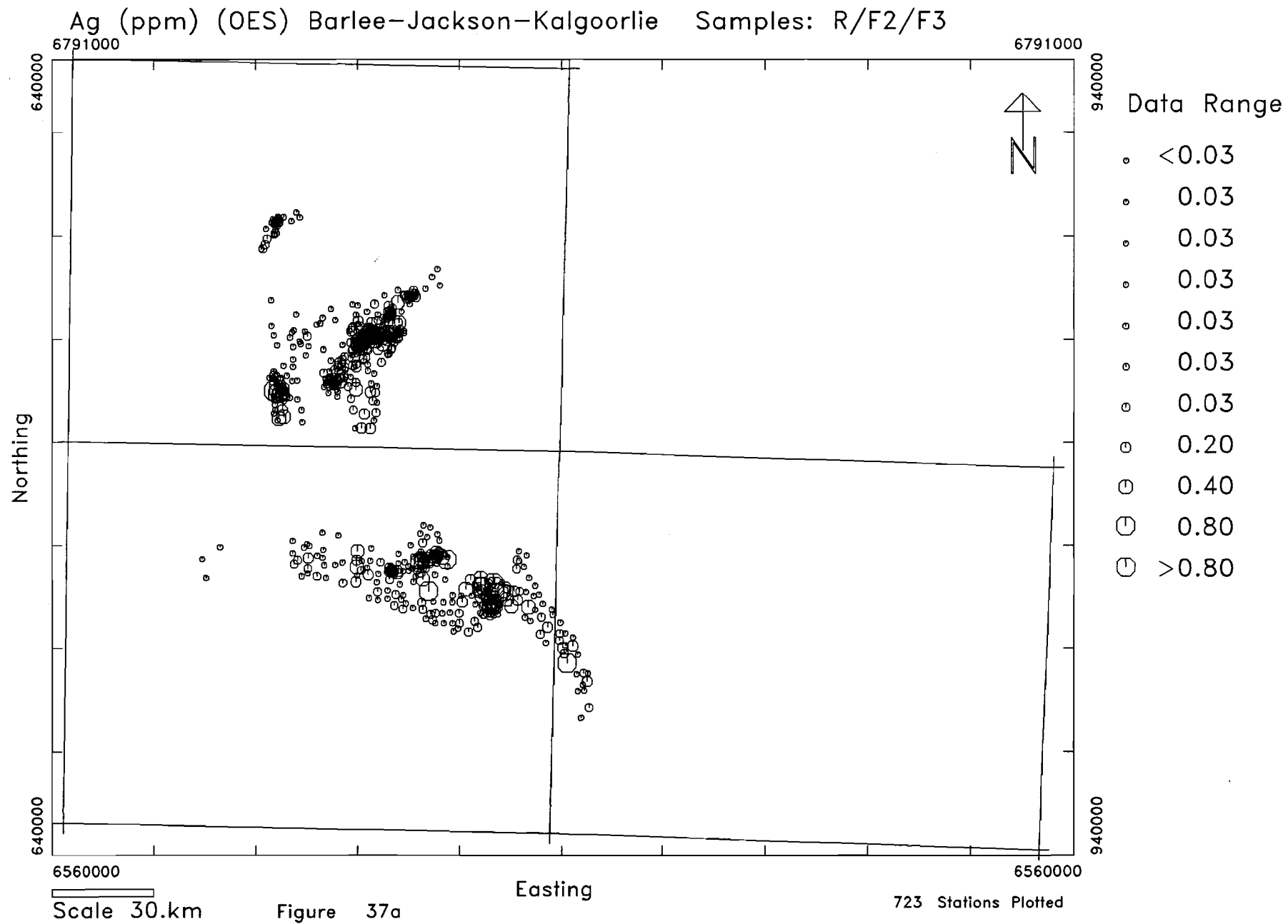


Figure 36a

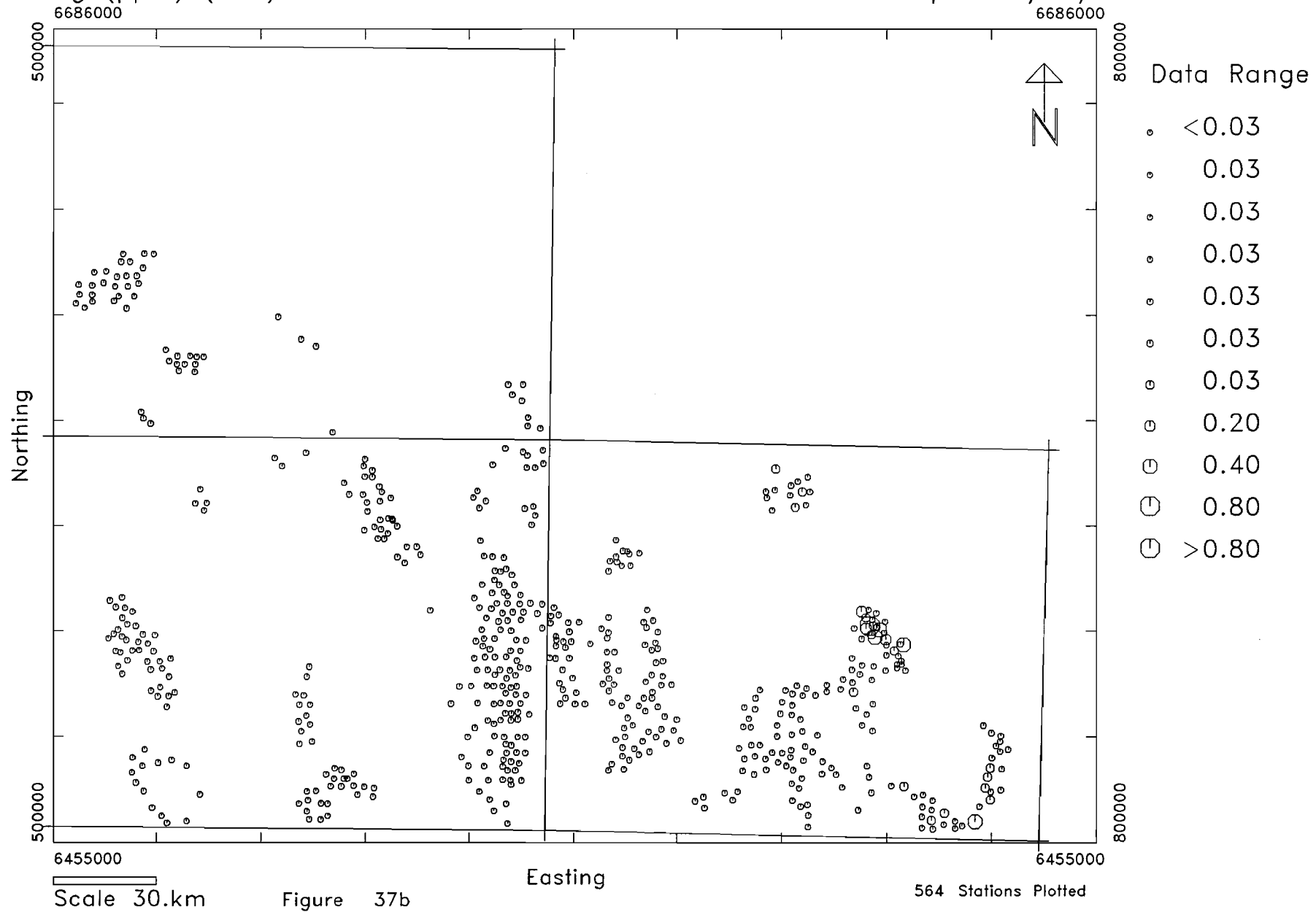
301 Stations Plotted

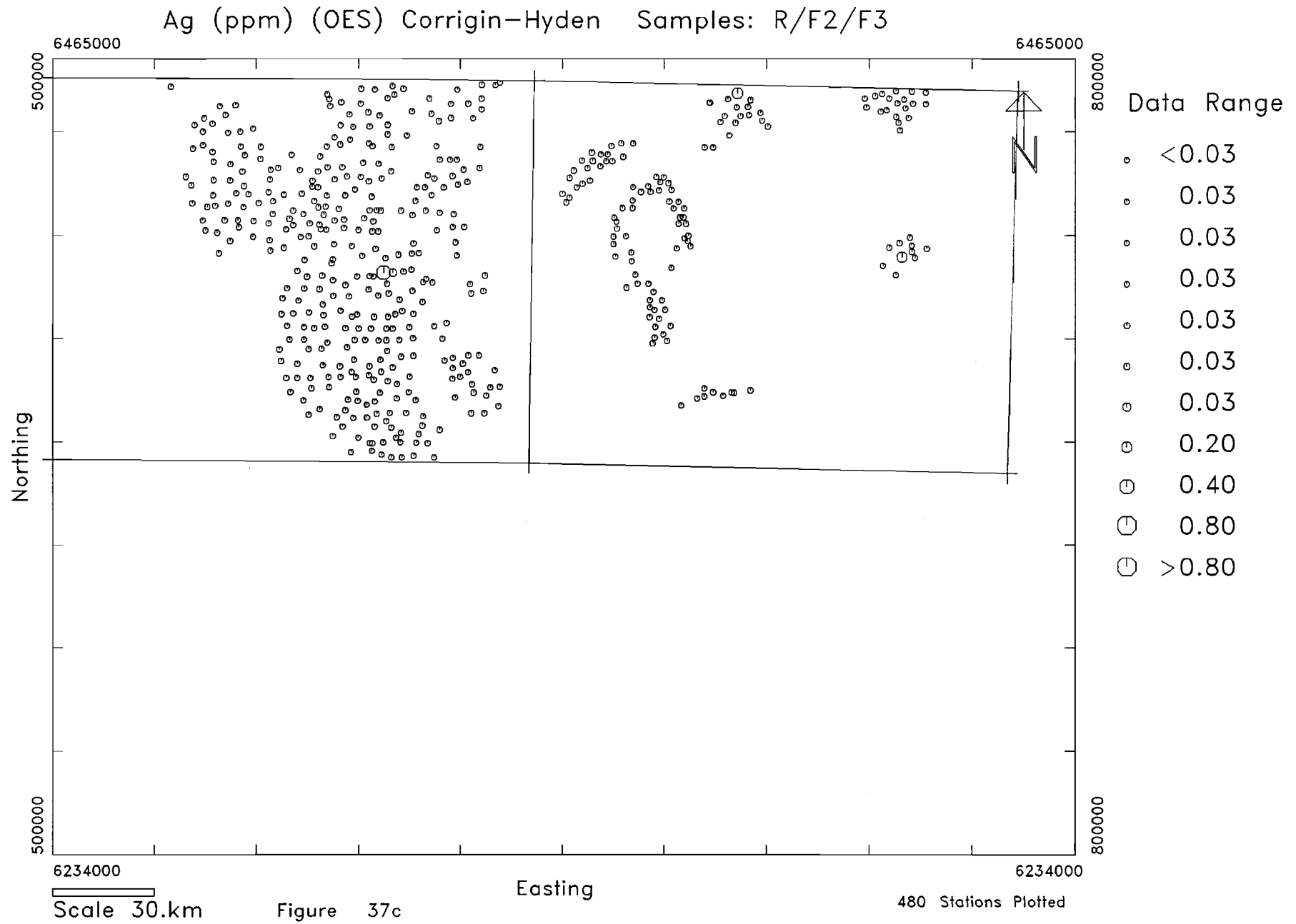


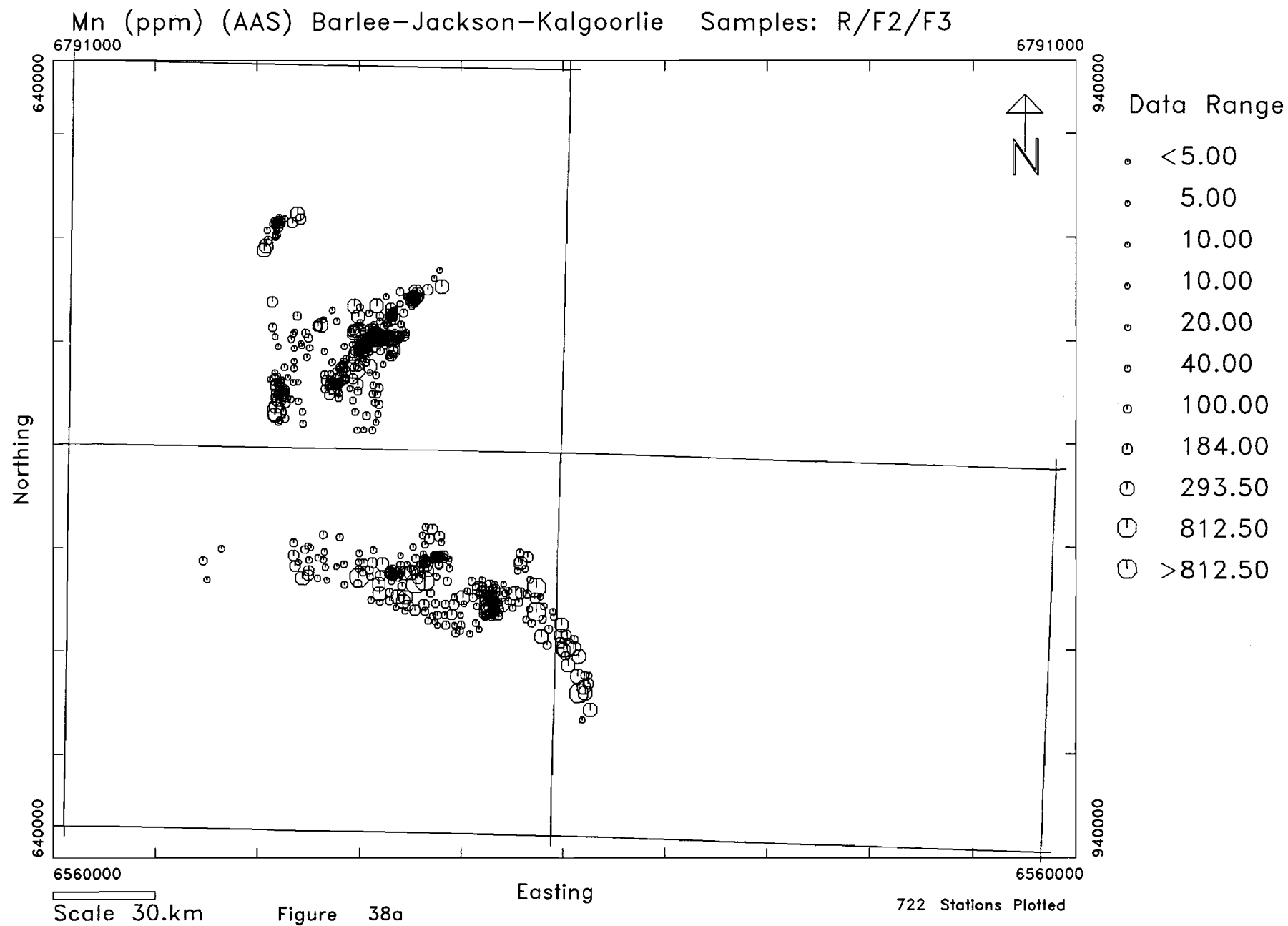




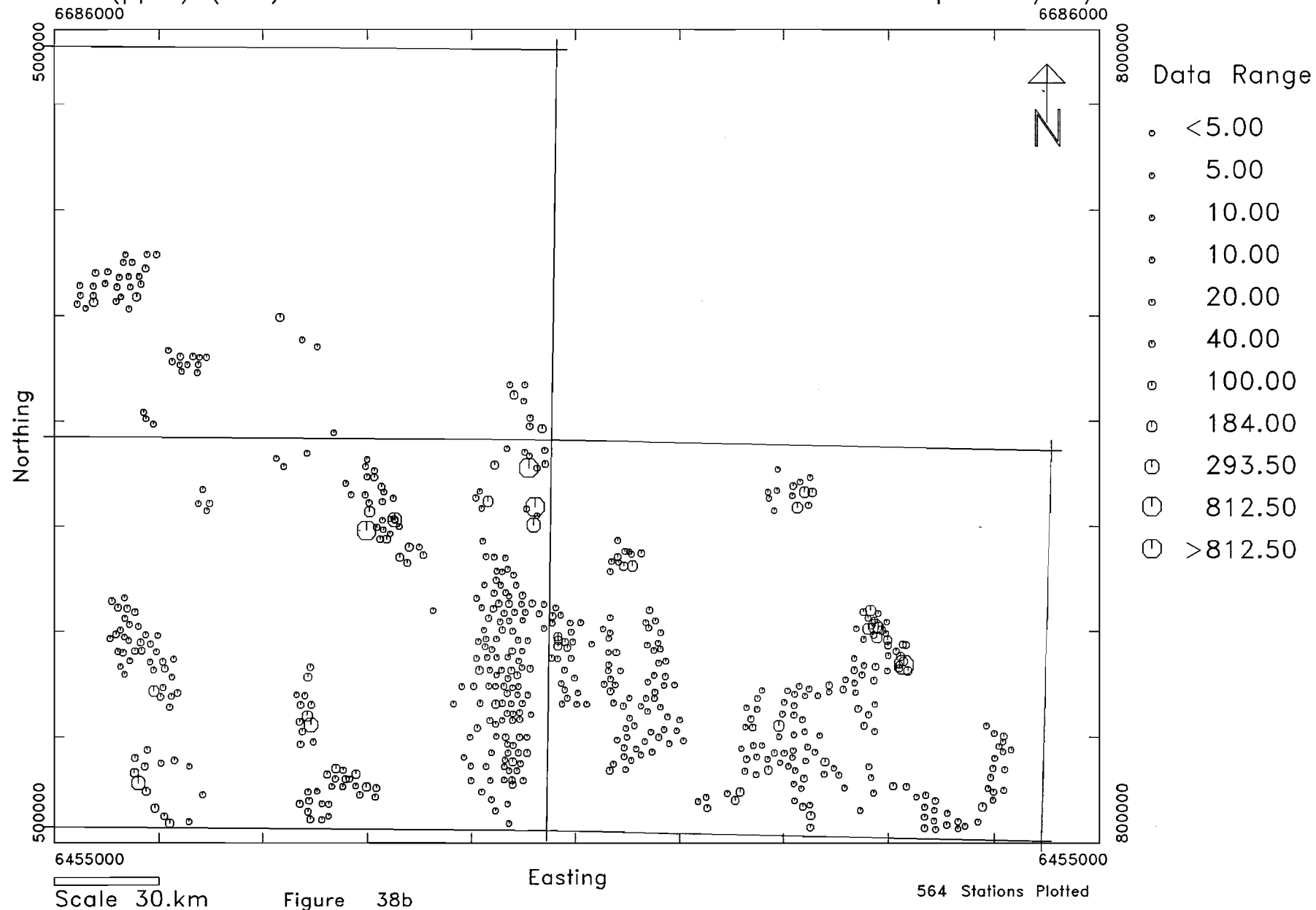
Ag (ppm) (OES) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

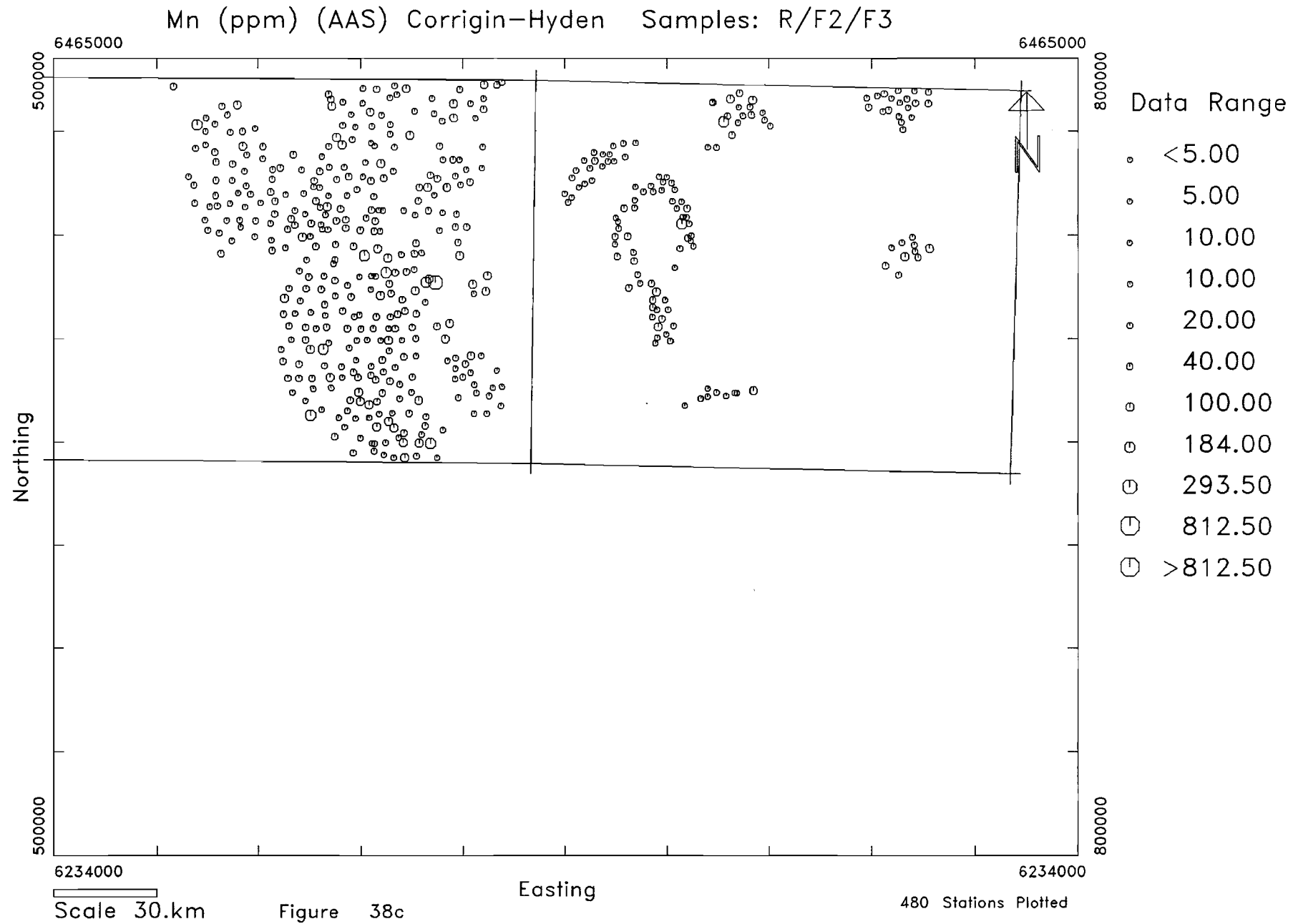




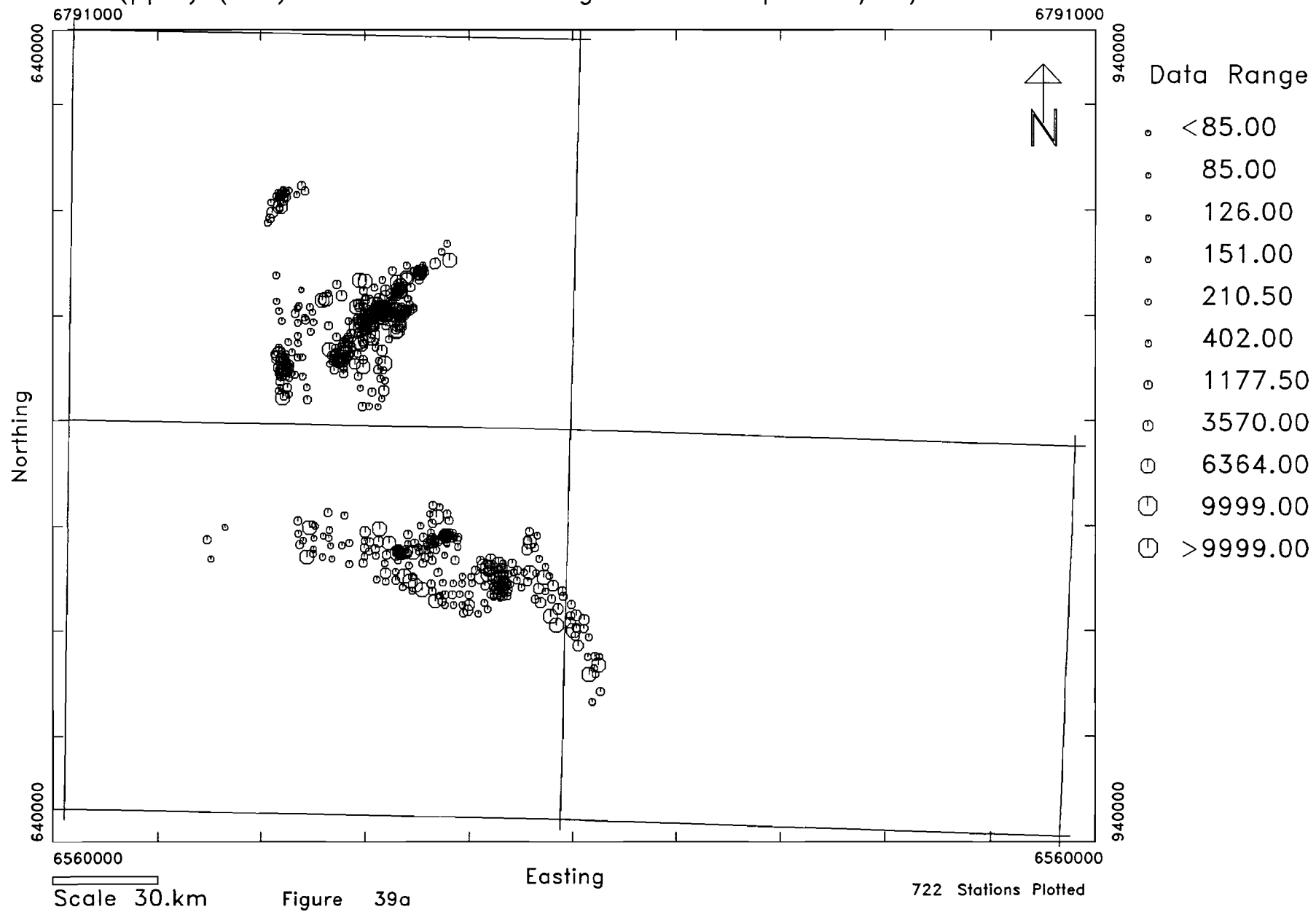


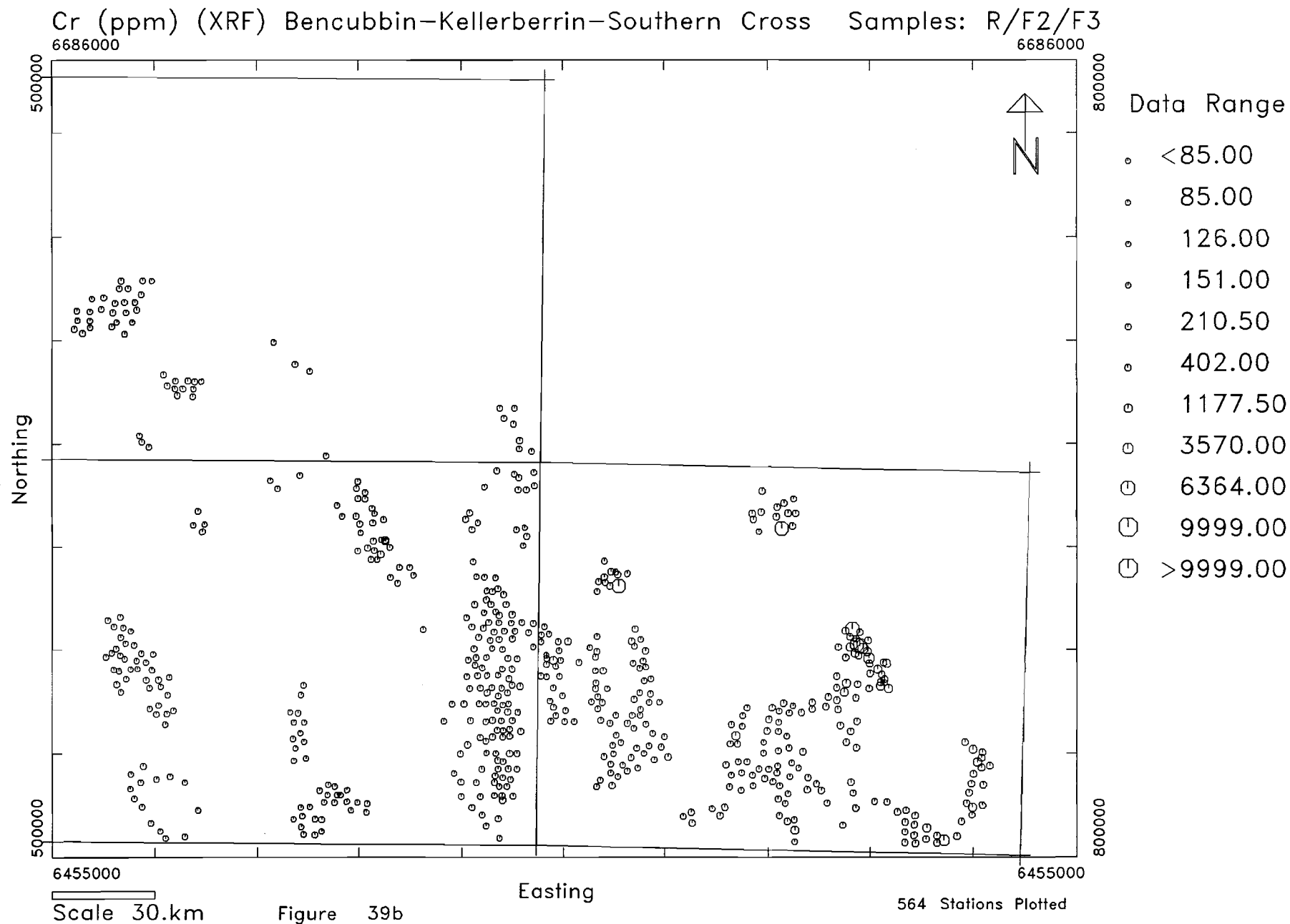
Mn (ppm) (AAS) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

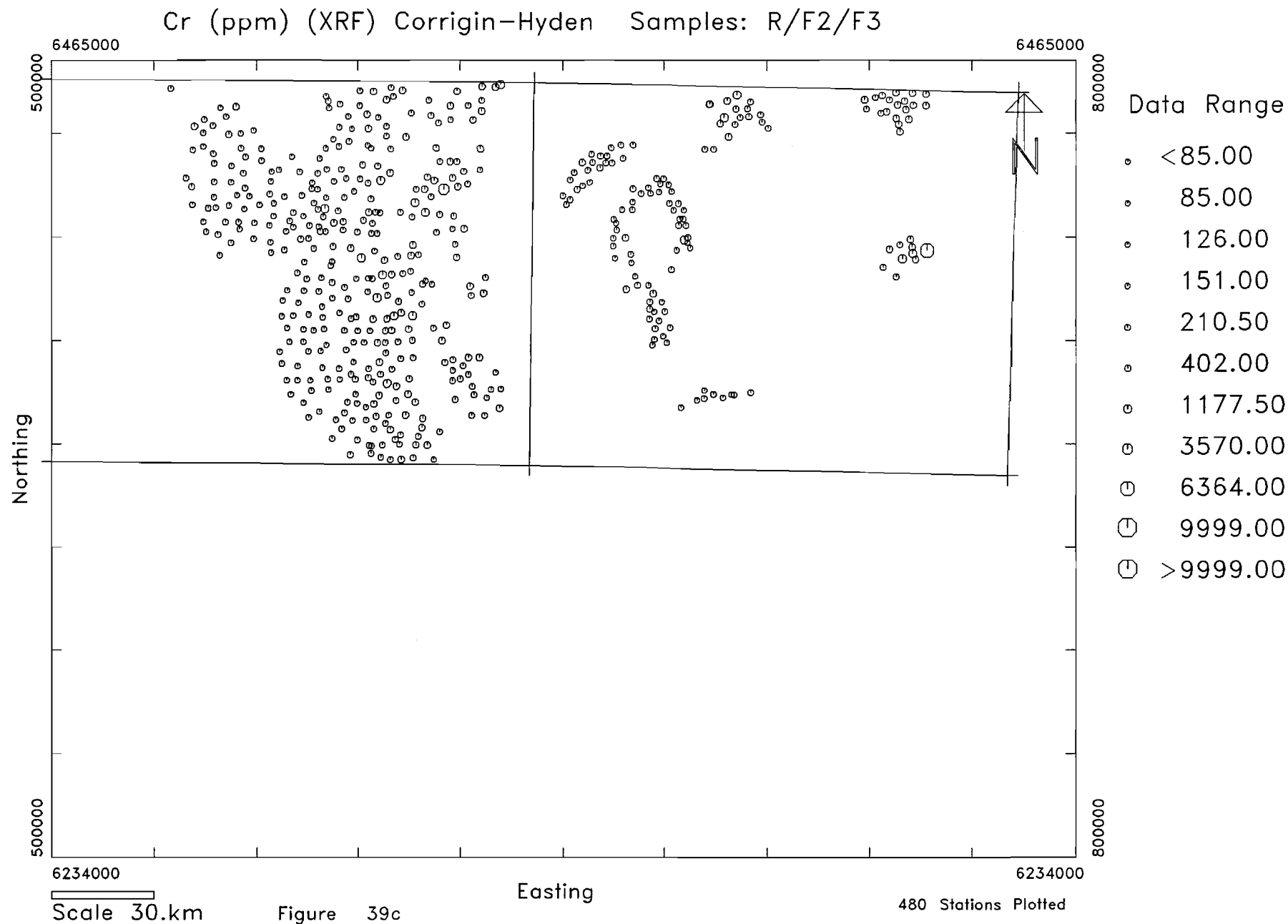


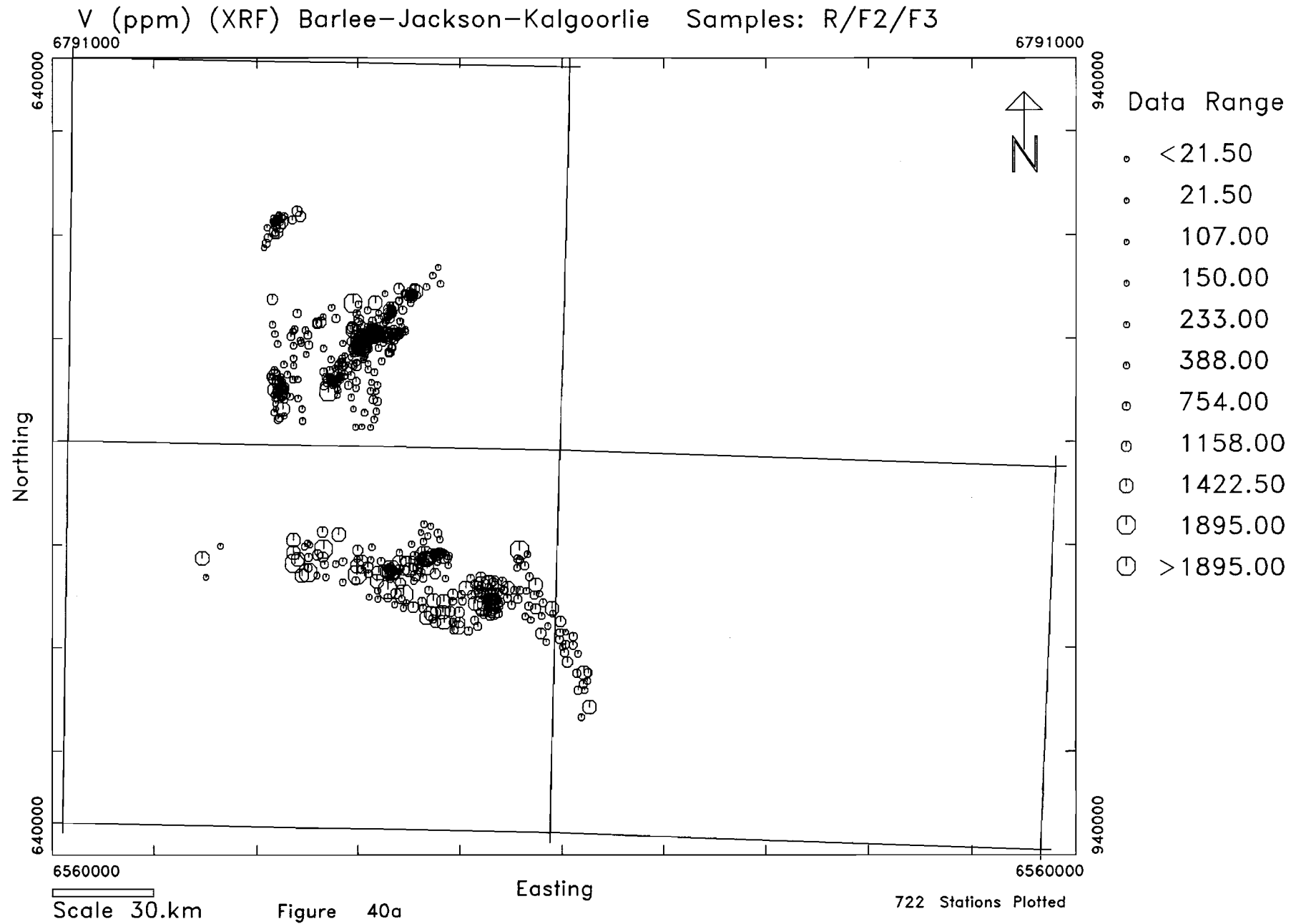


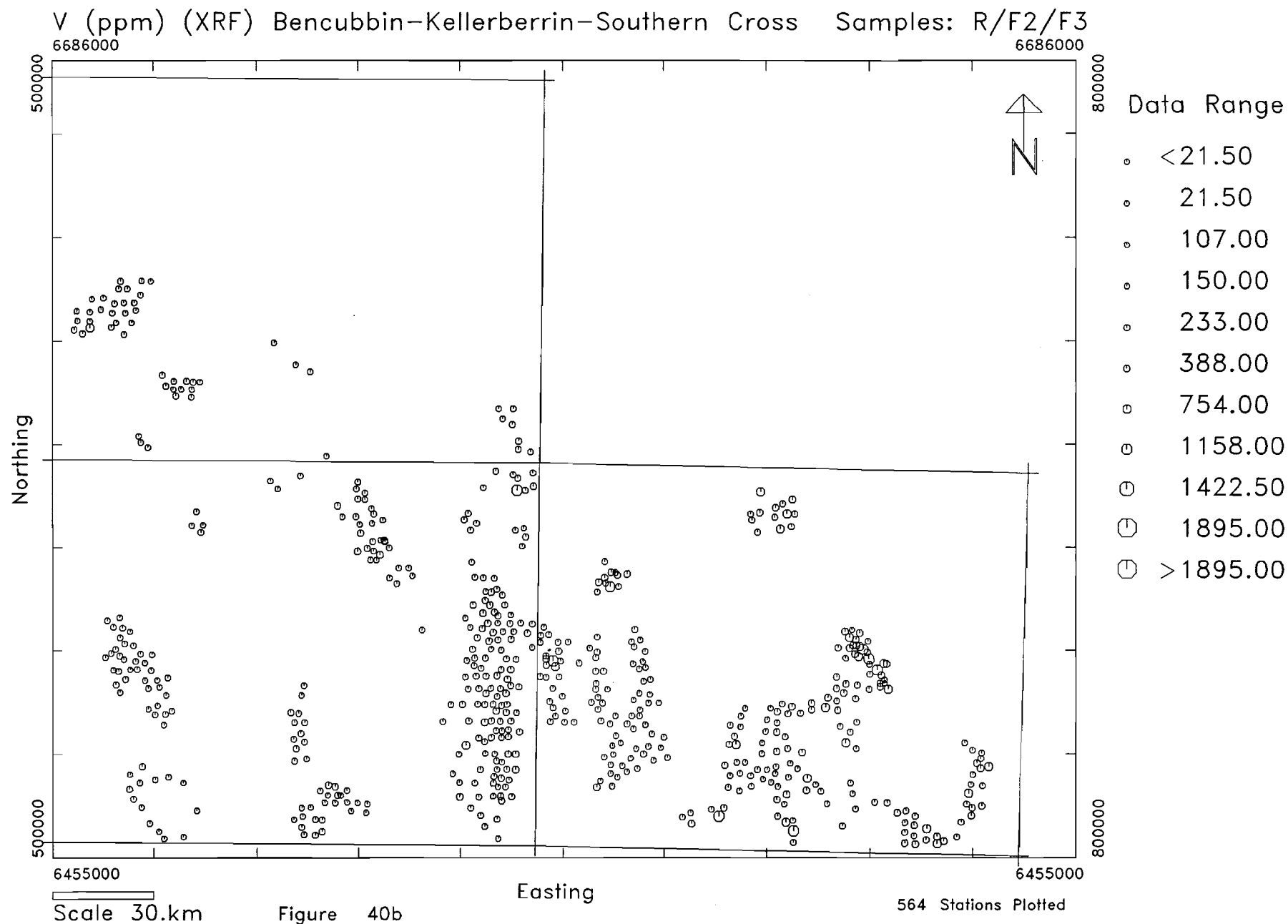
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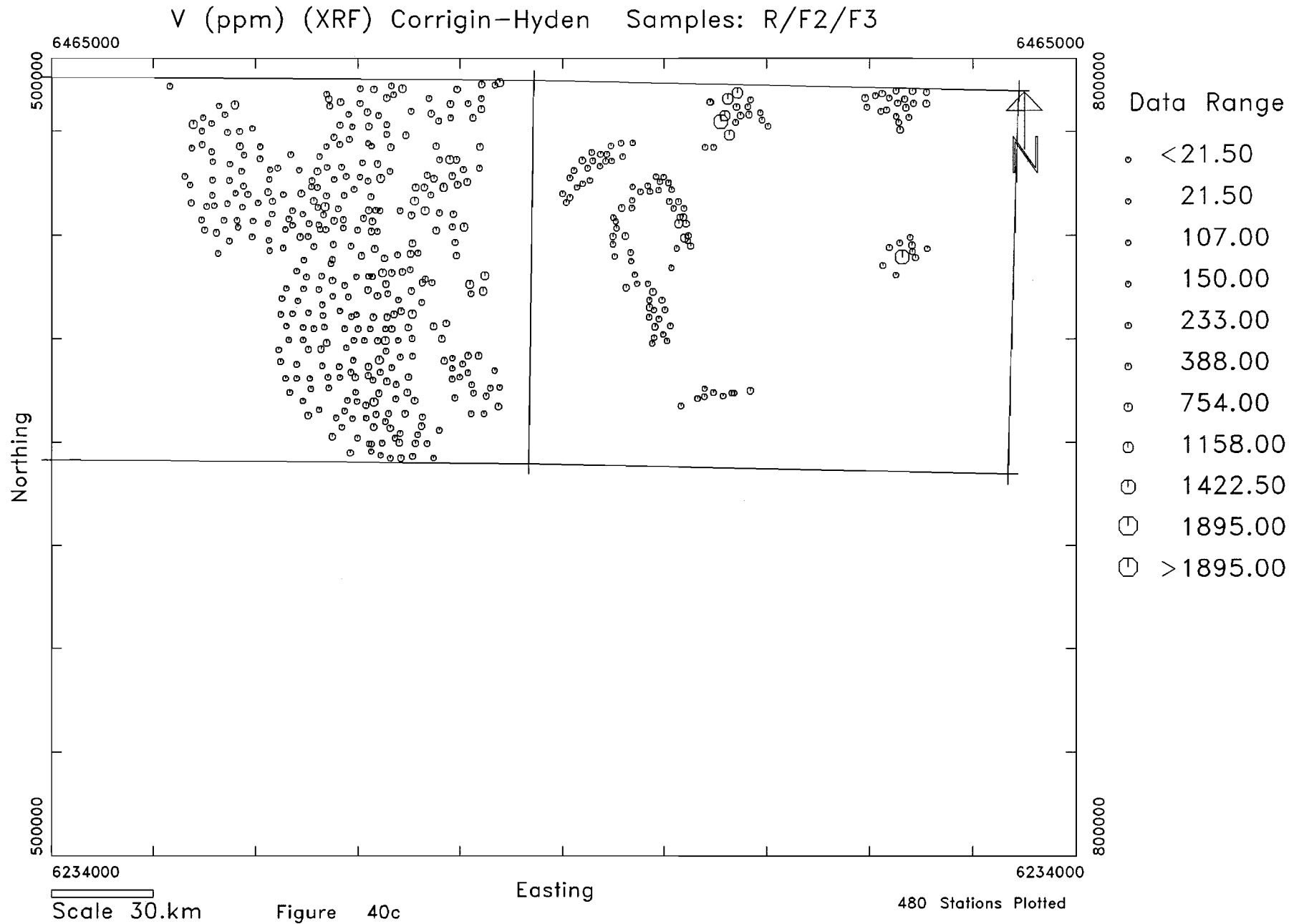


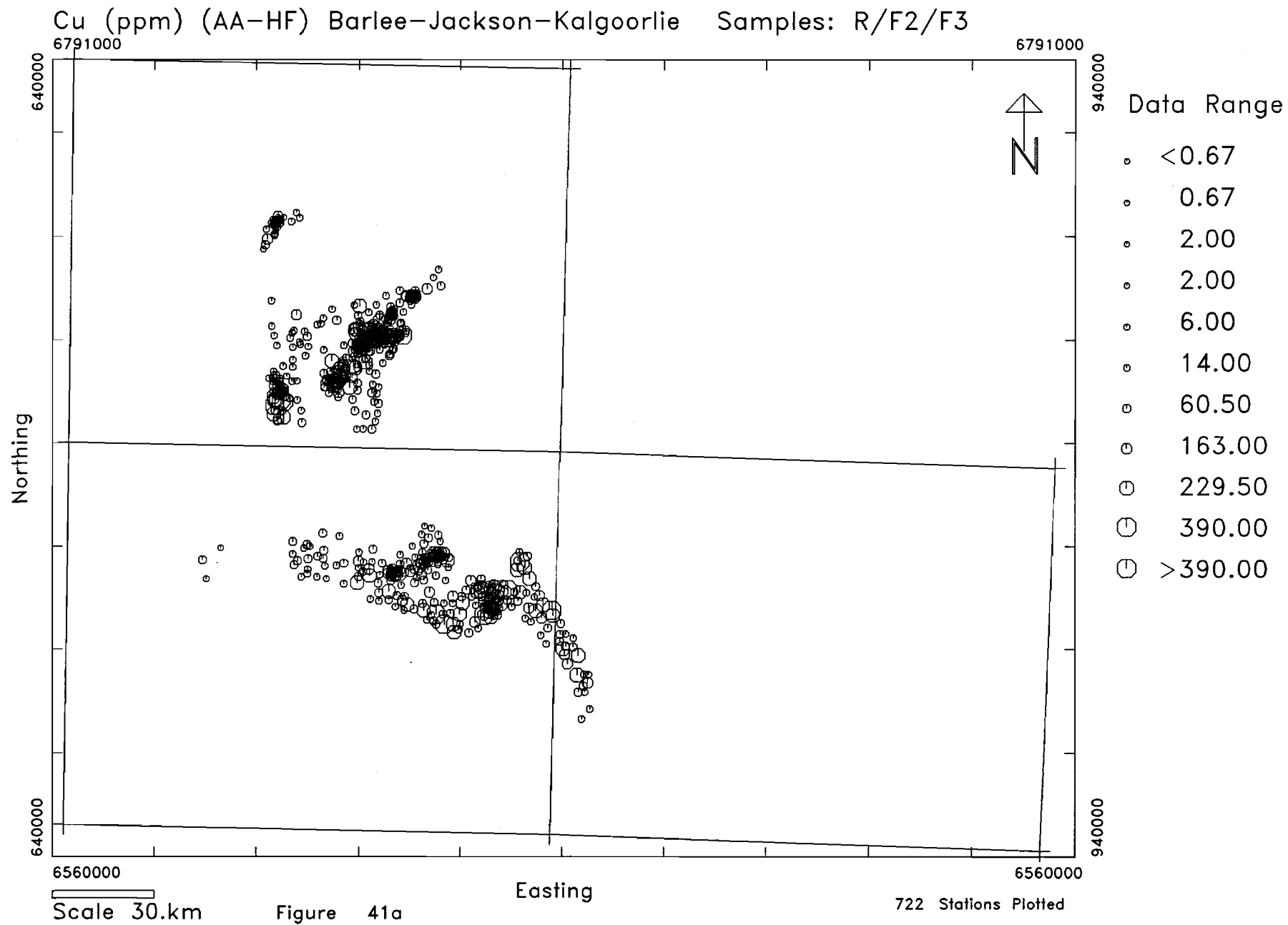


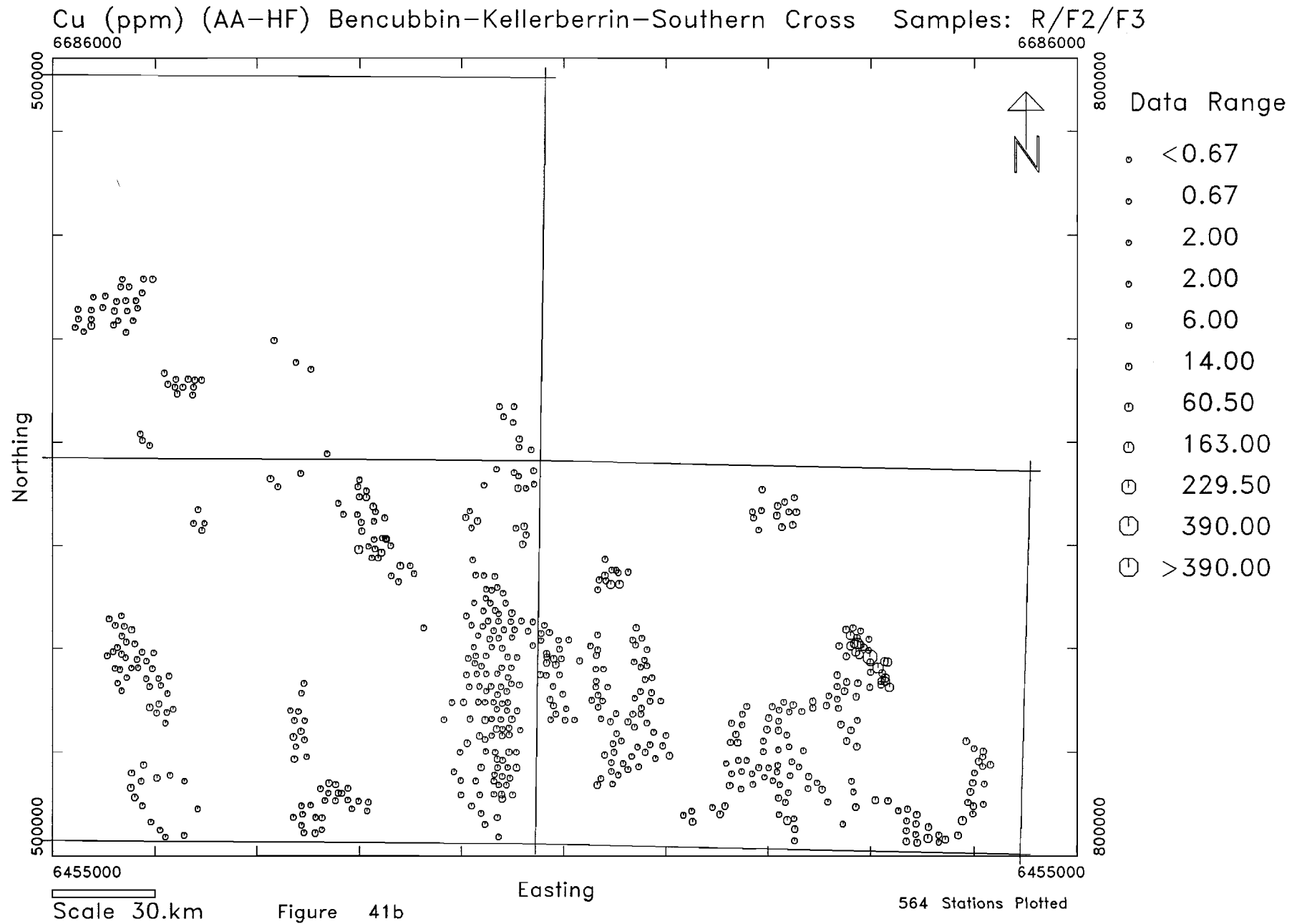


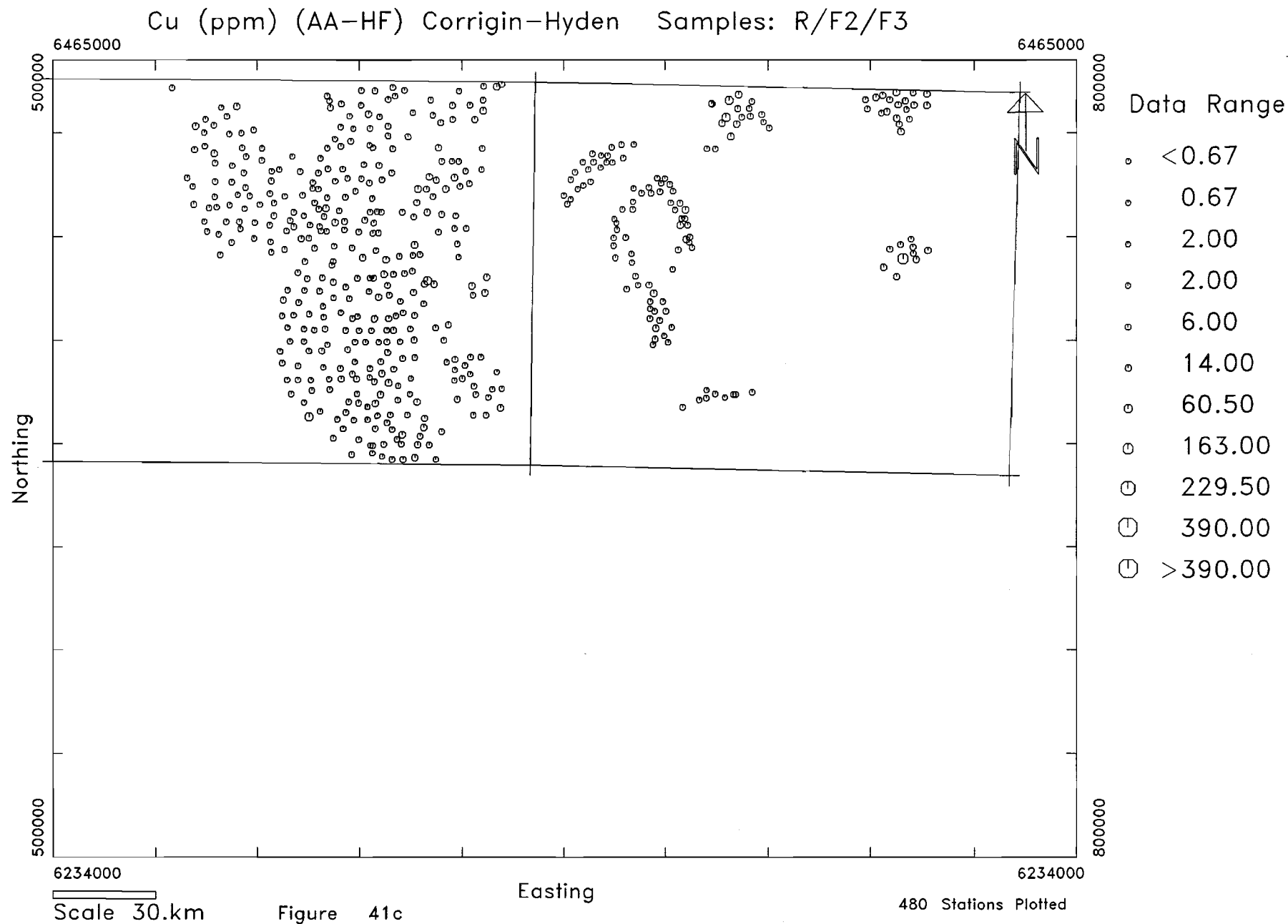


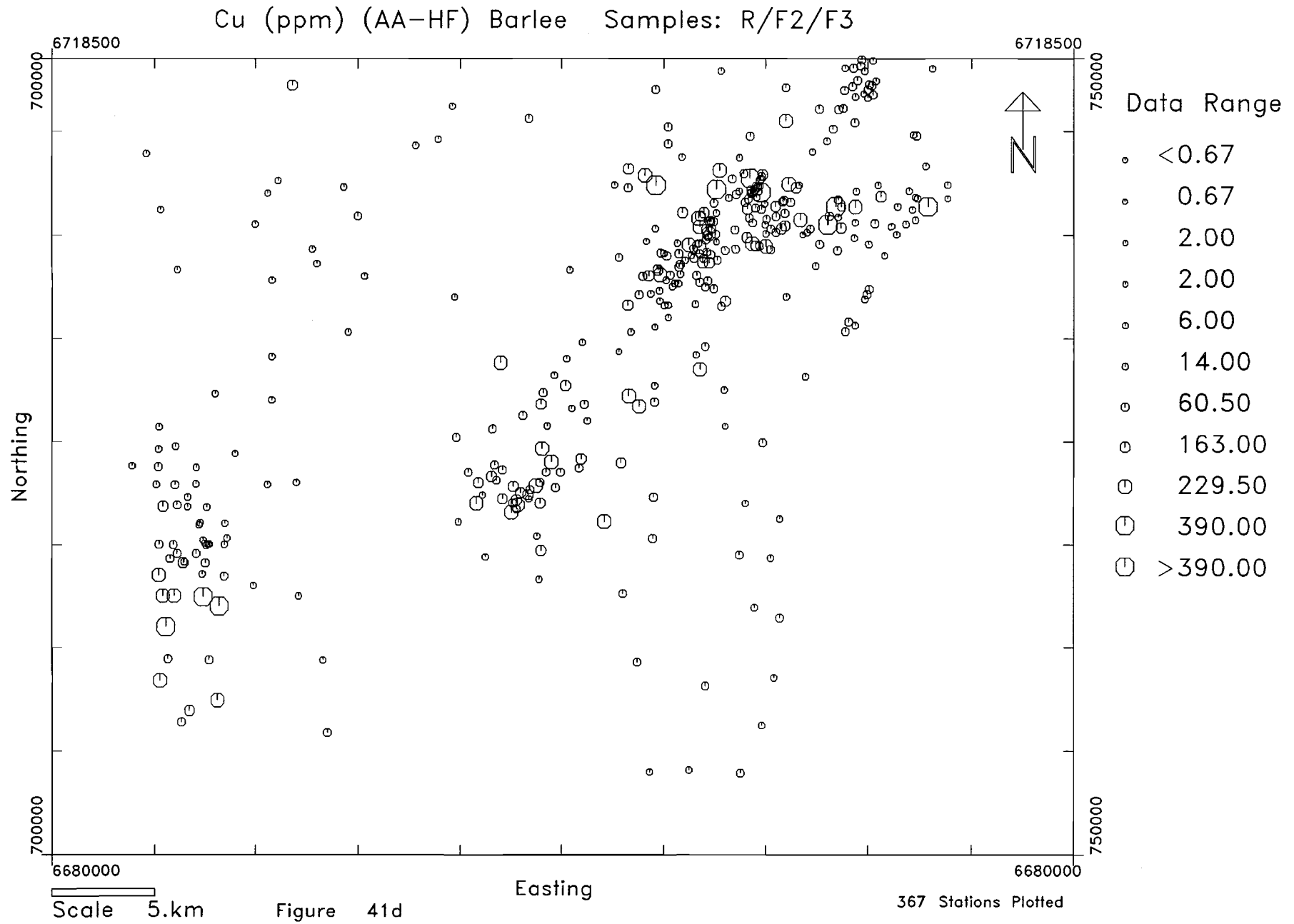




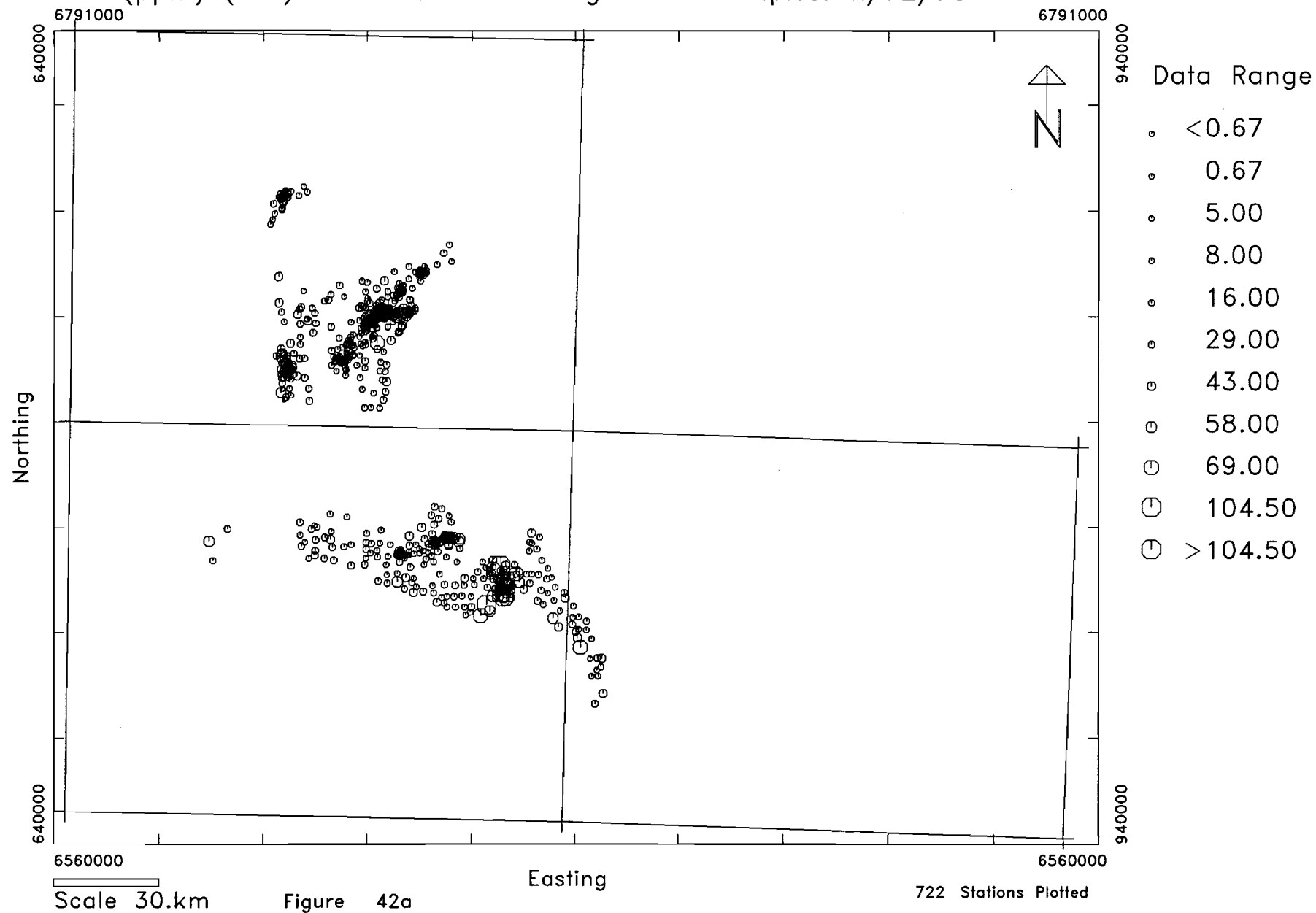


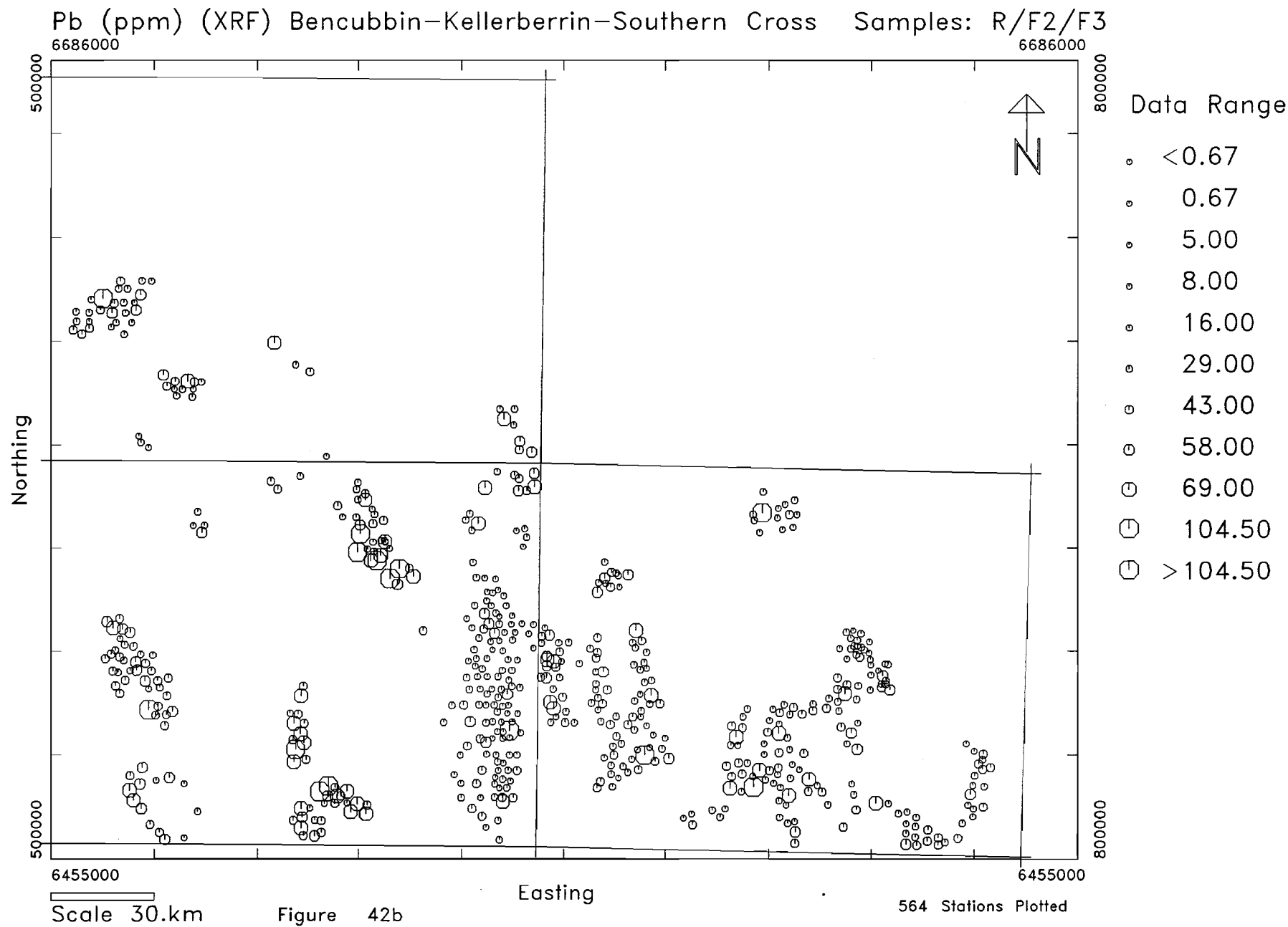


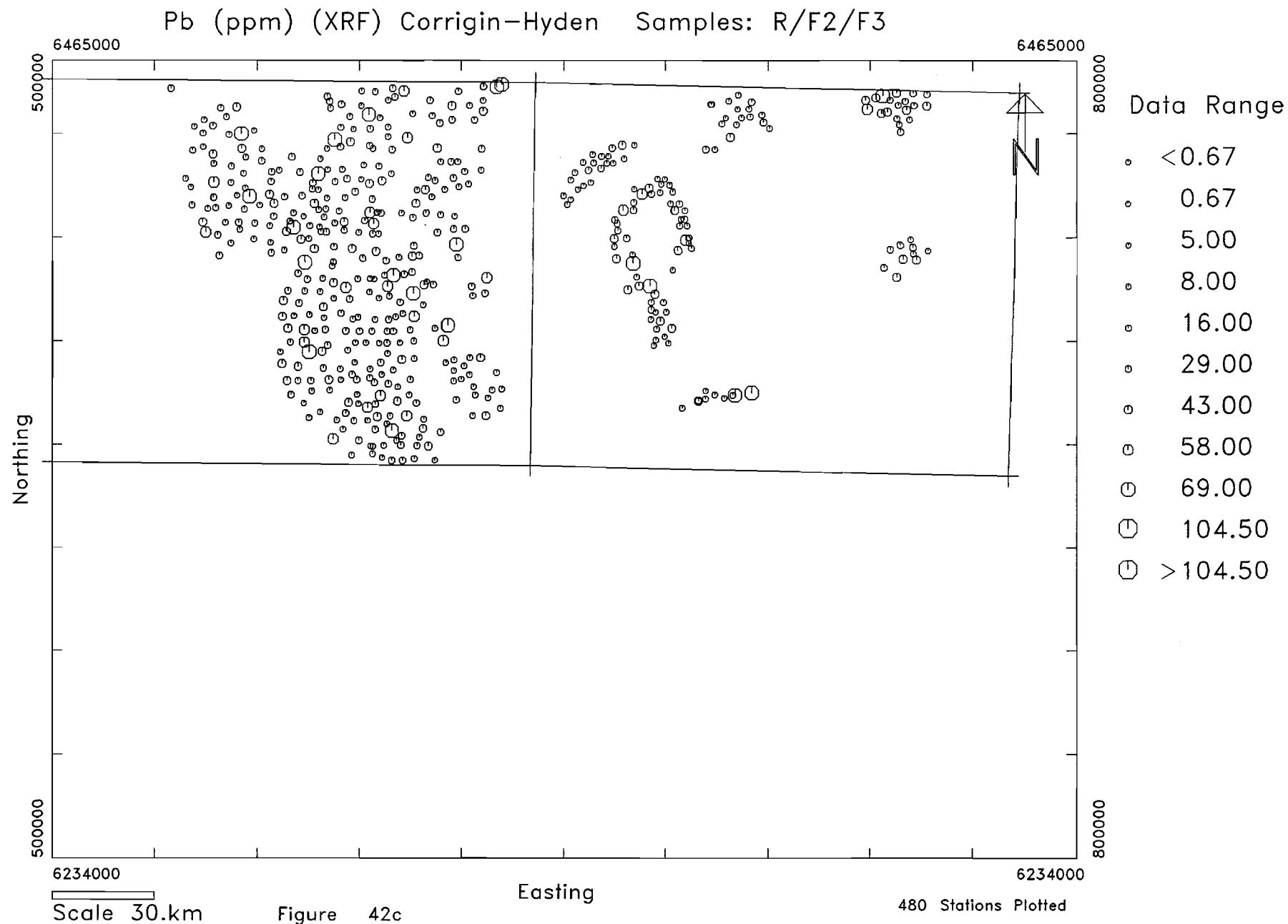


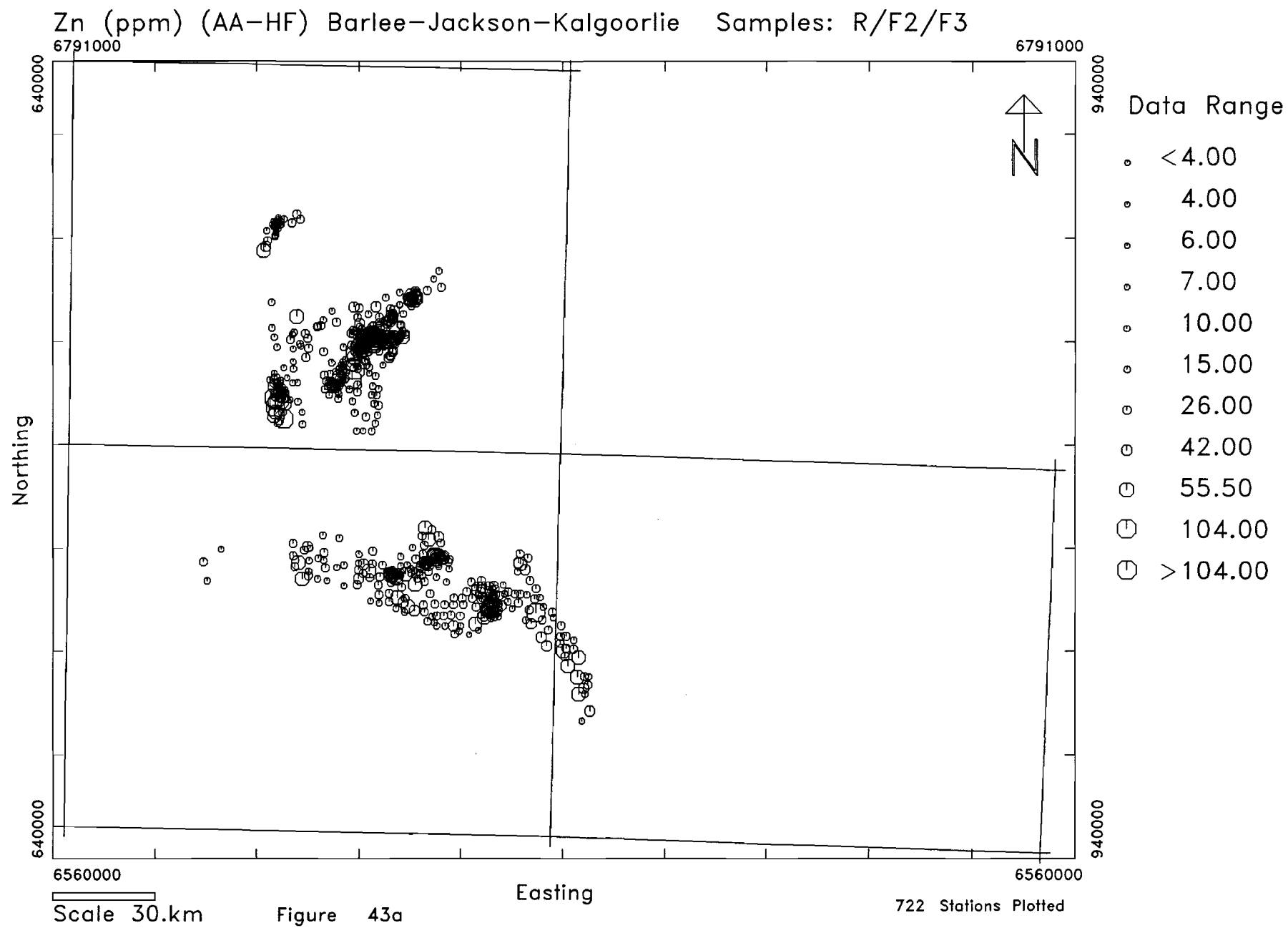


Pb (ppm) (XRF) Barlee-Jackson-Kaloorlie Samples: R/F2/F3

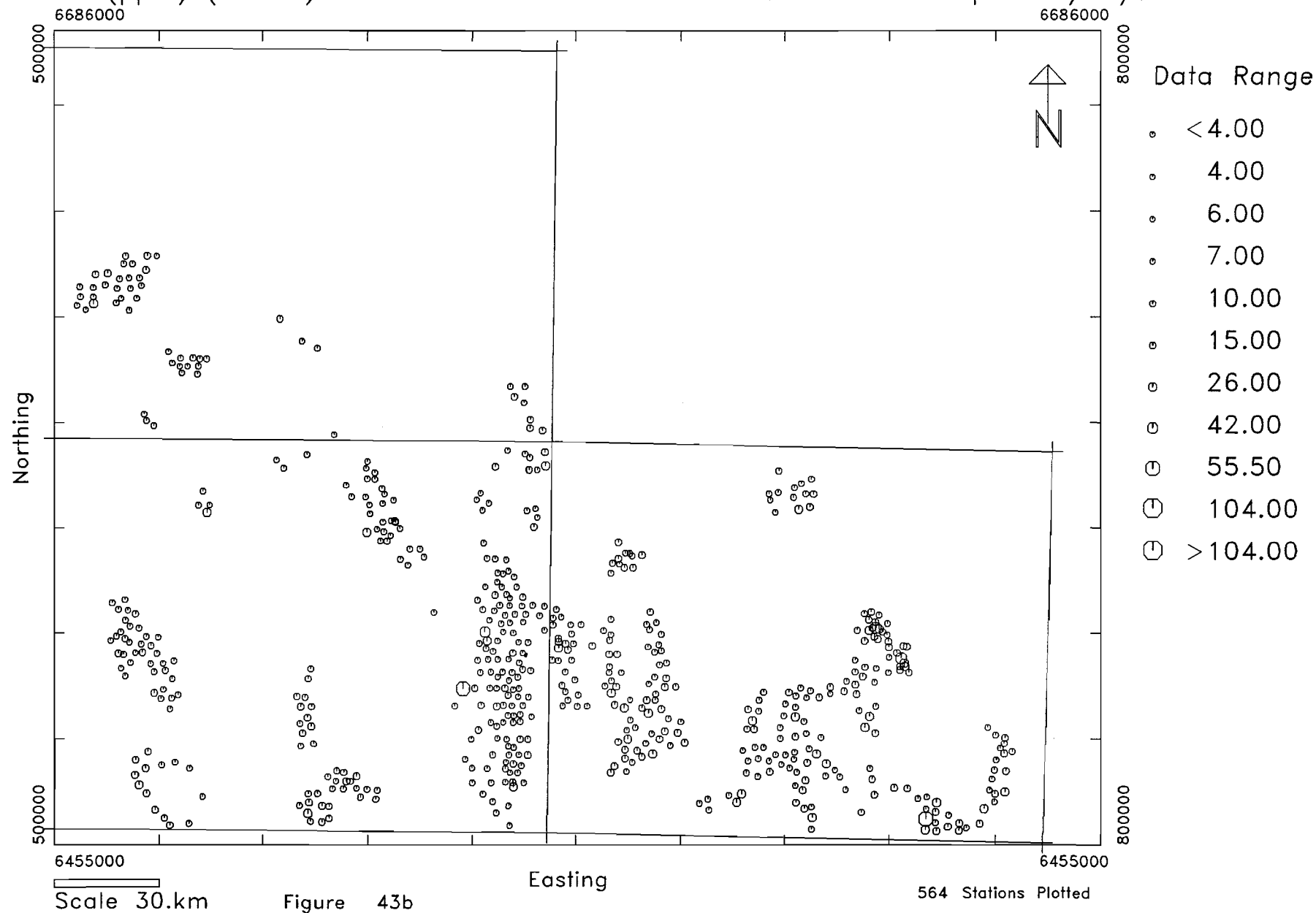


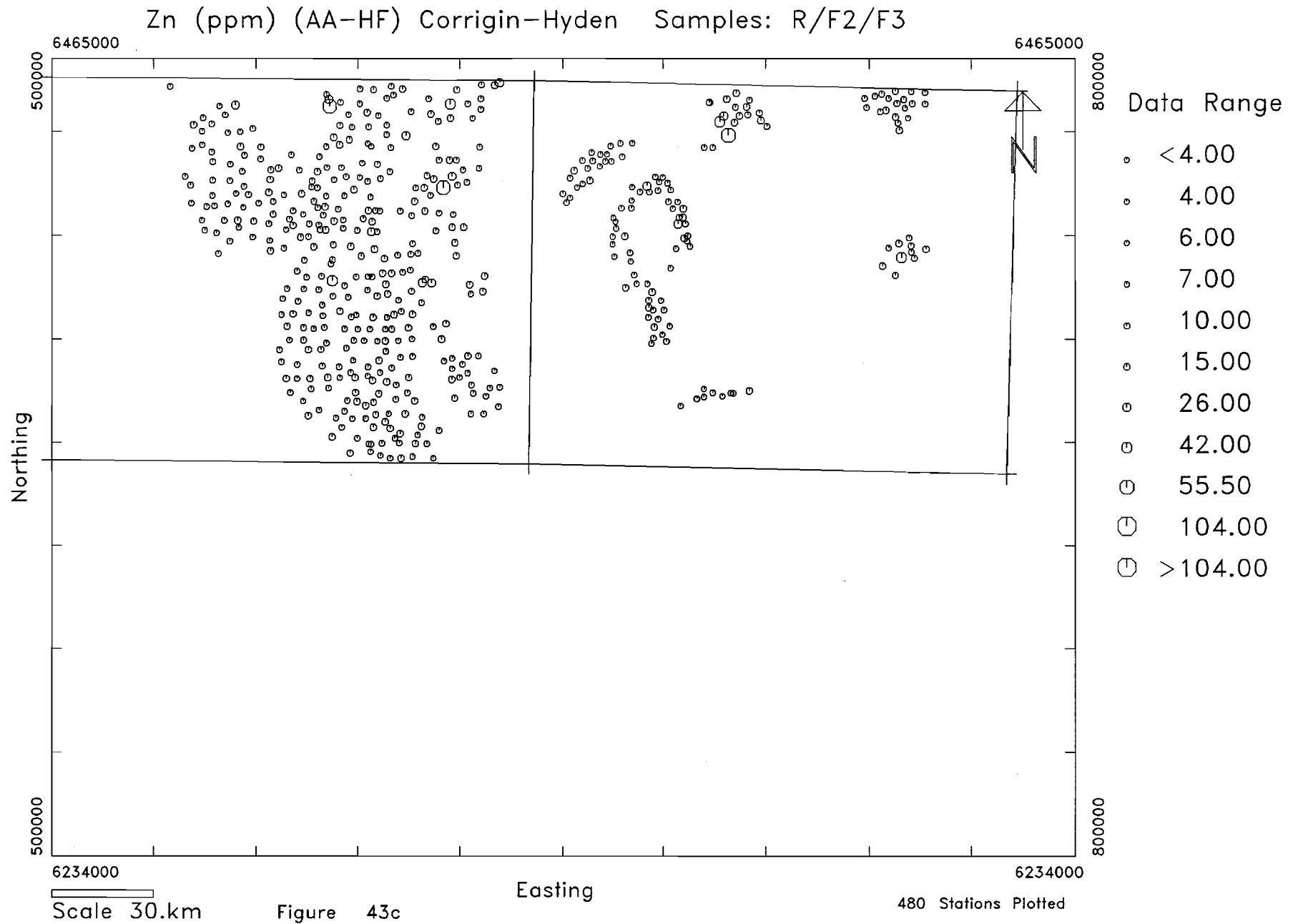


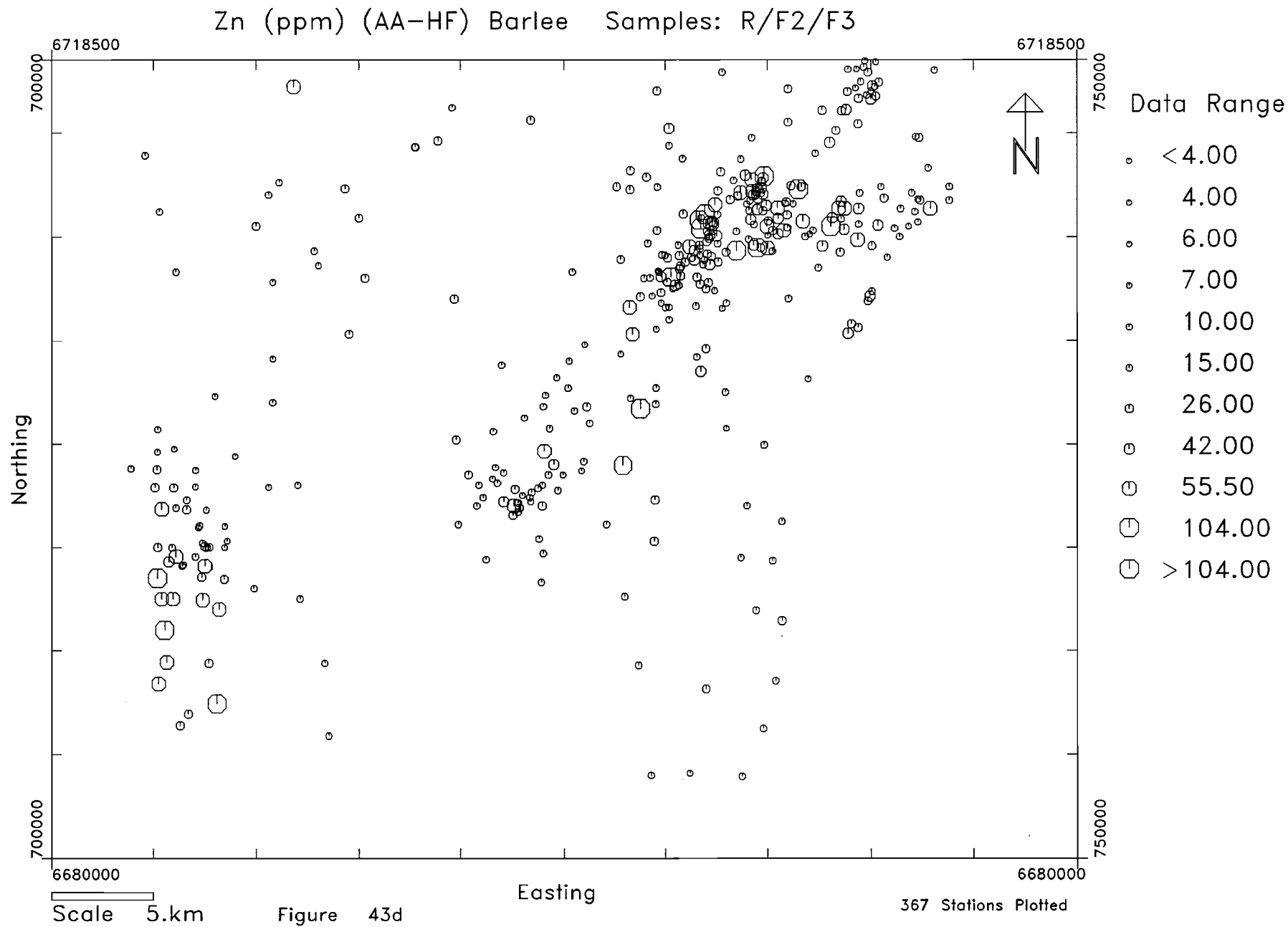


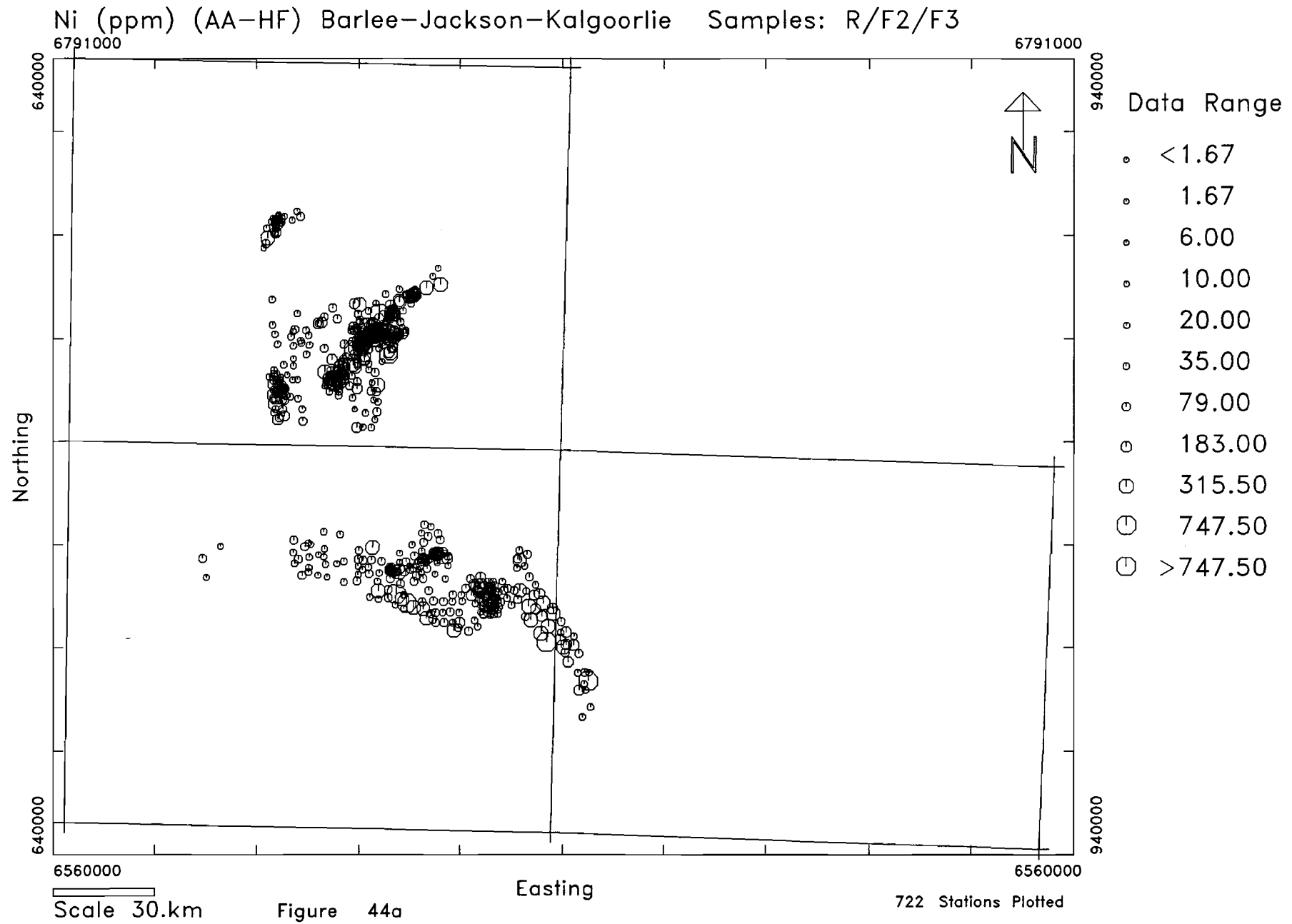


Zn (ppm) (AA-HF) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

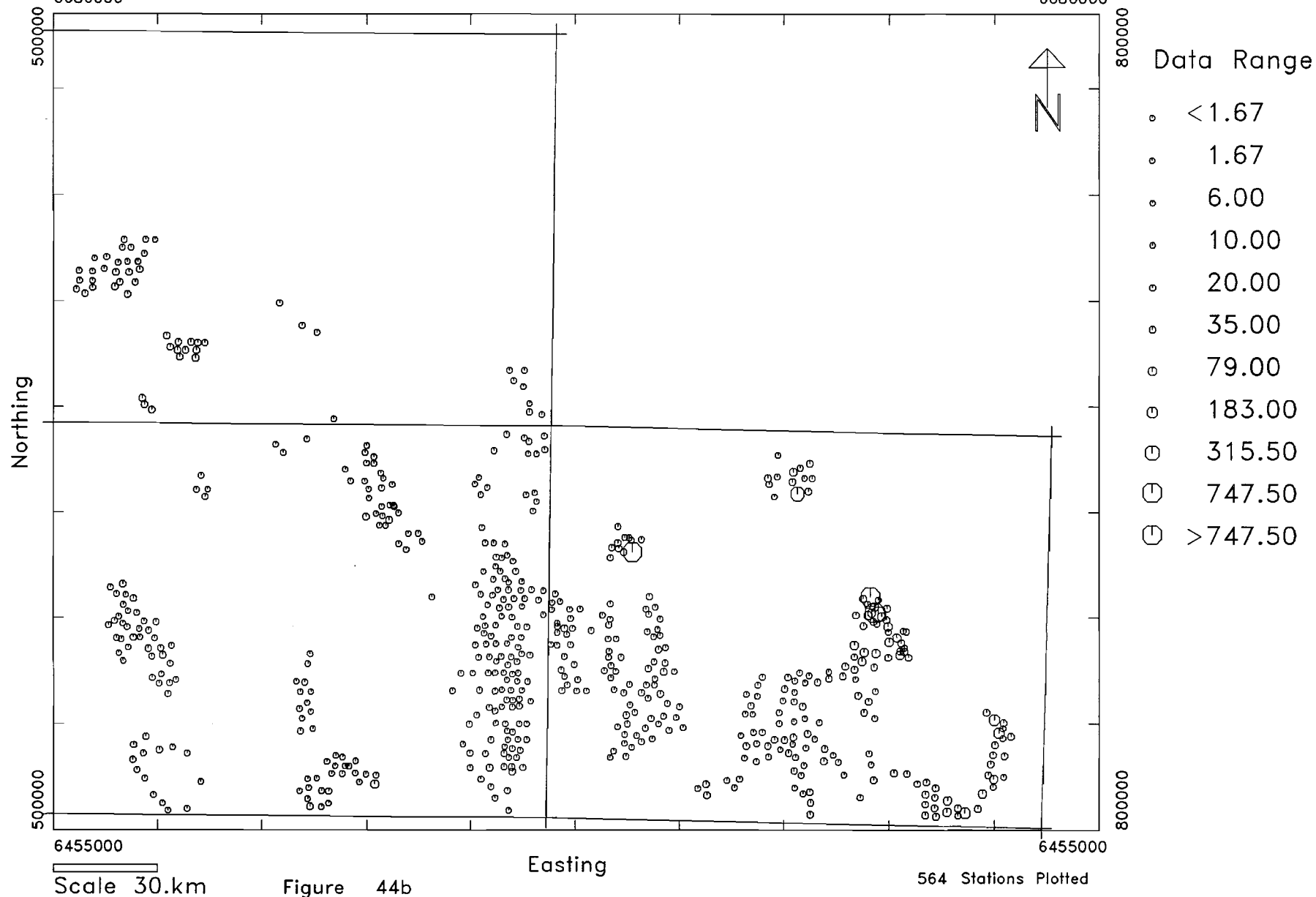


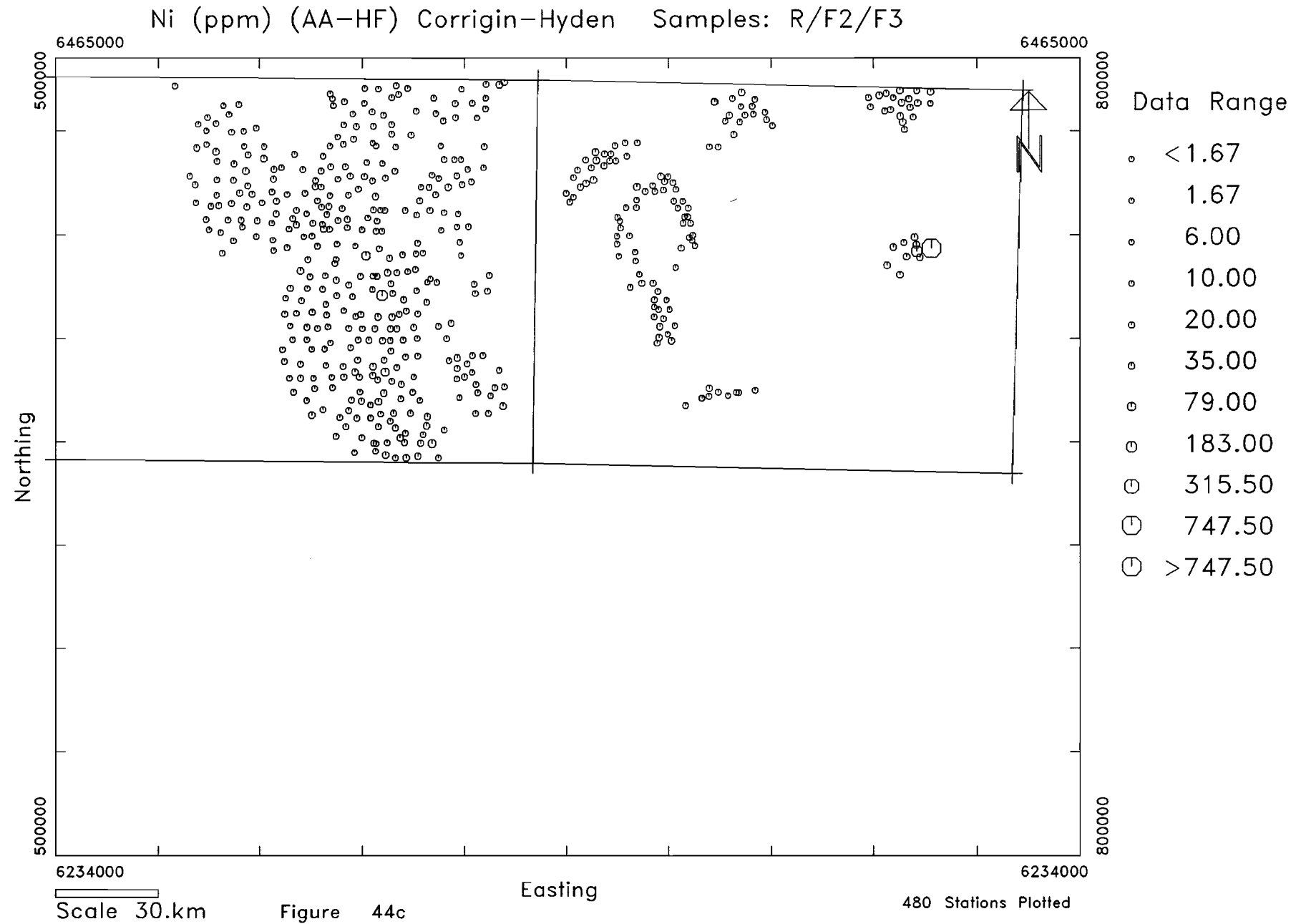




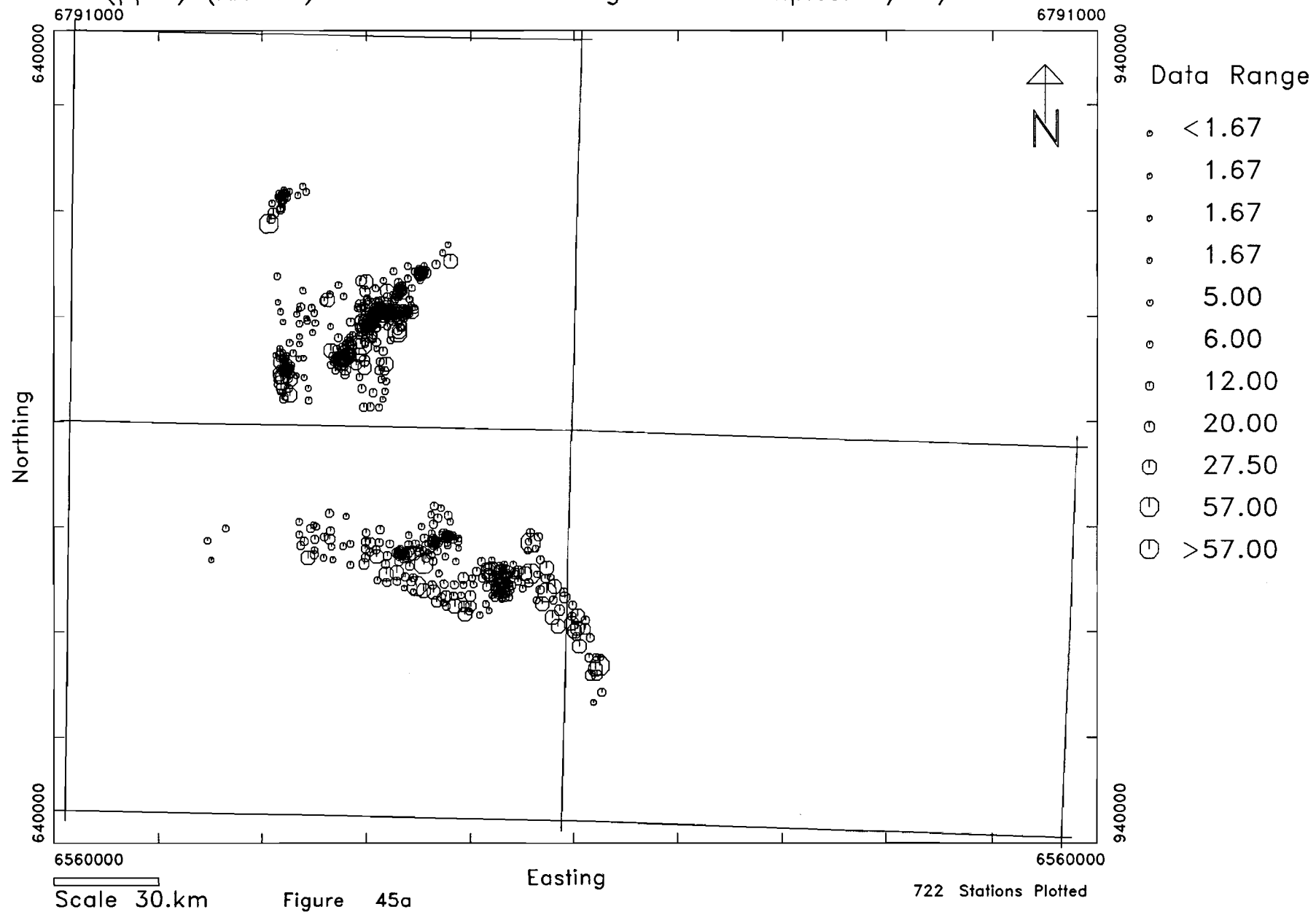


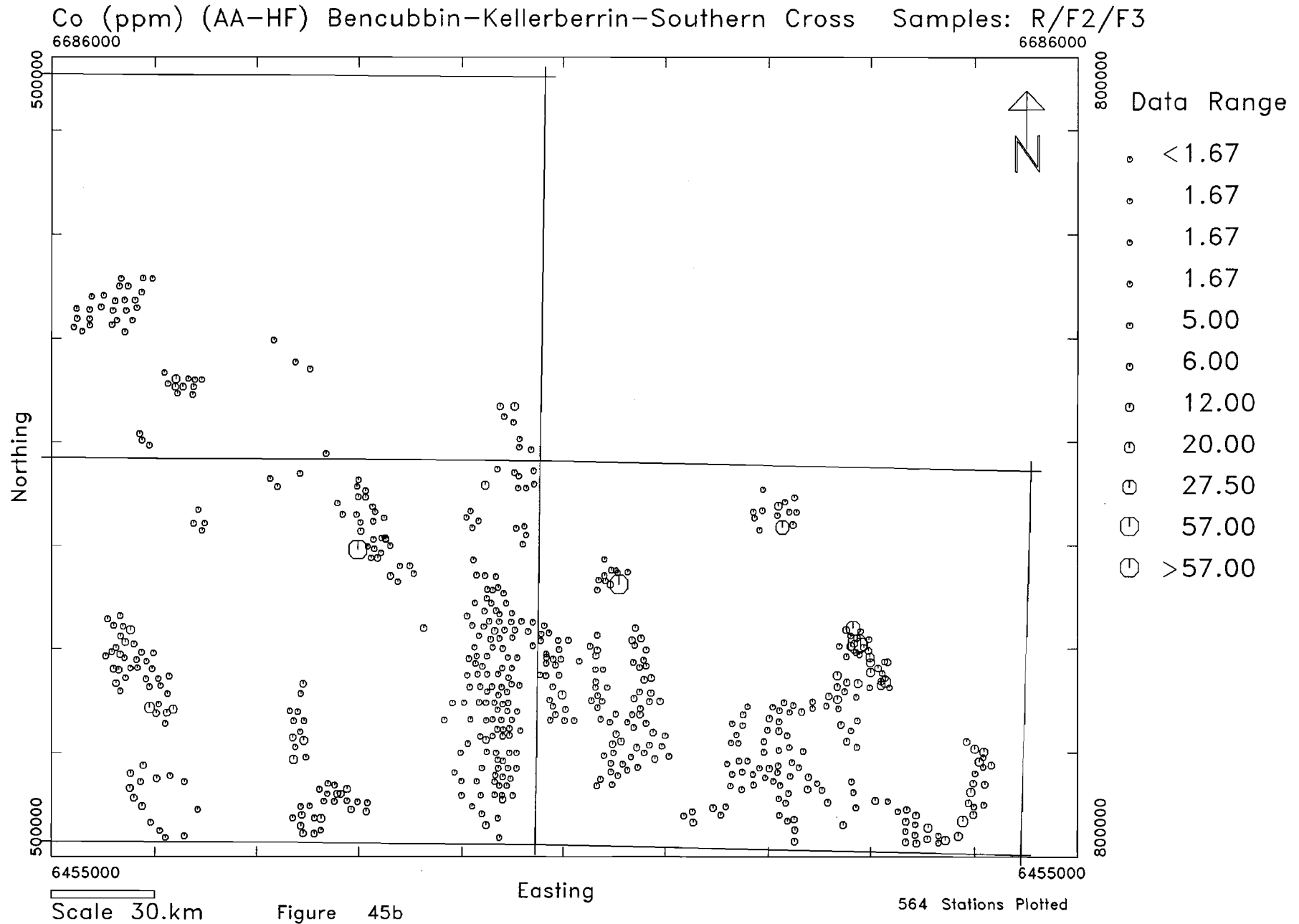
Ni (ppm) (AA-HF) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

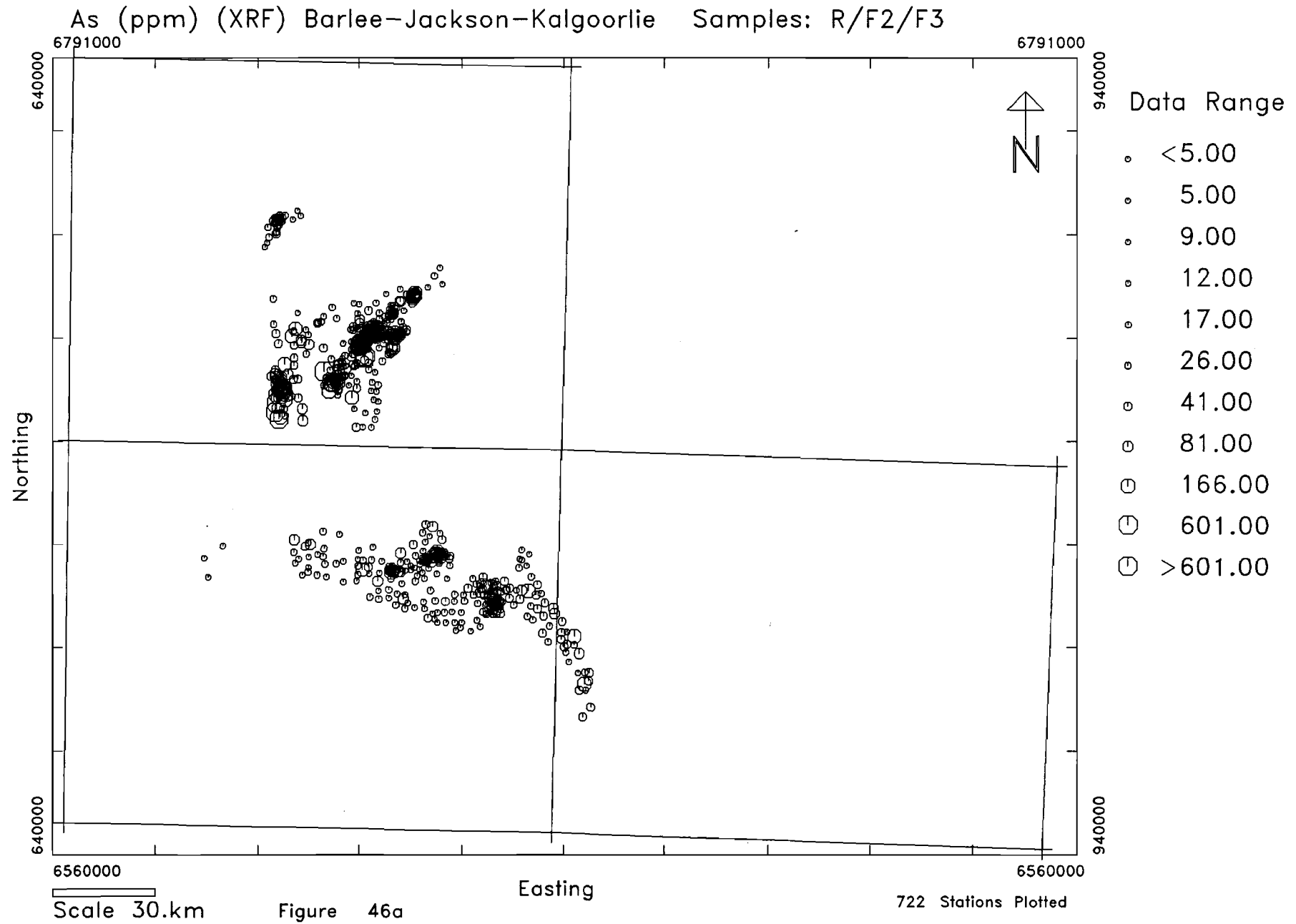


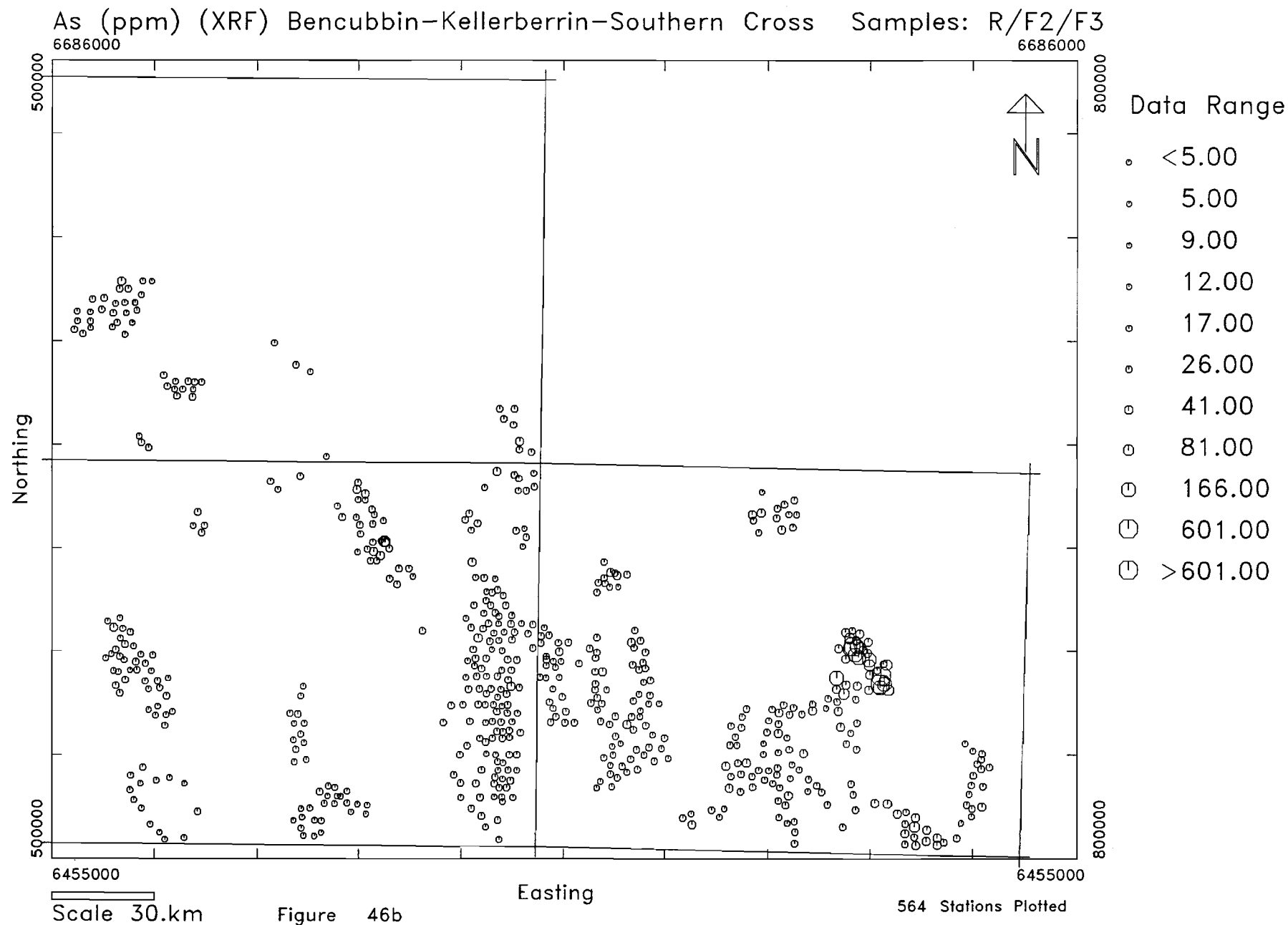


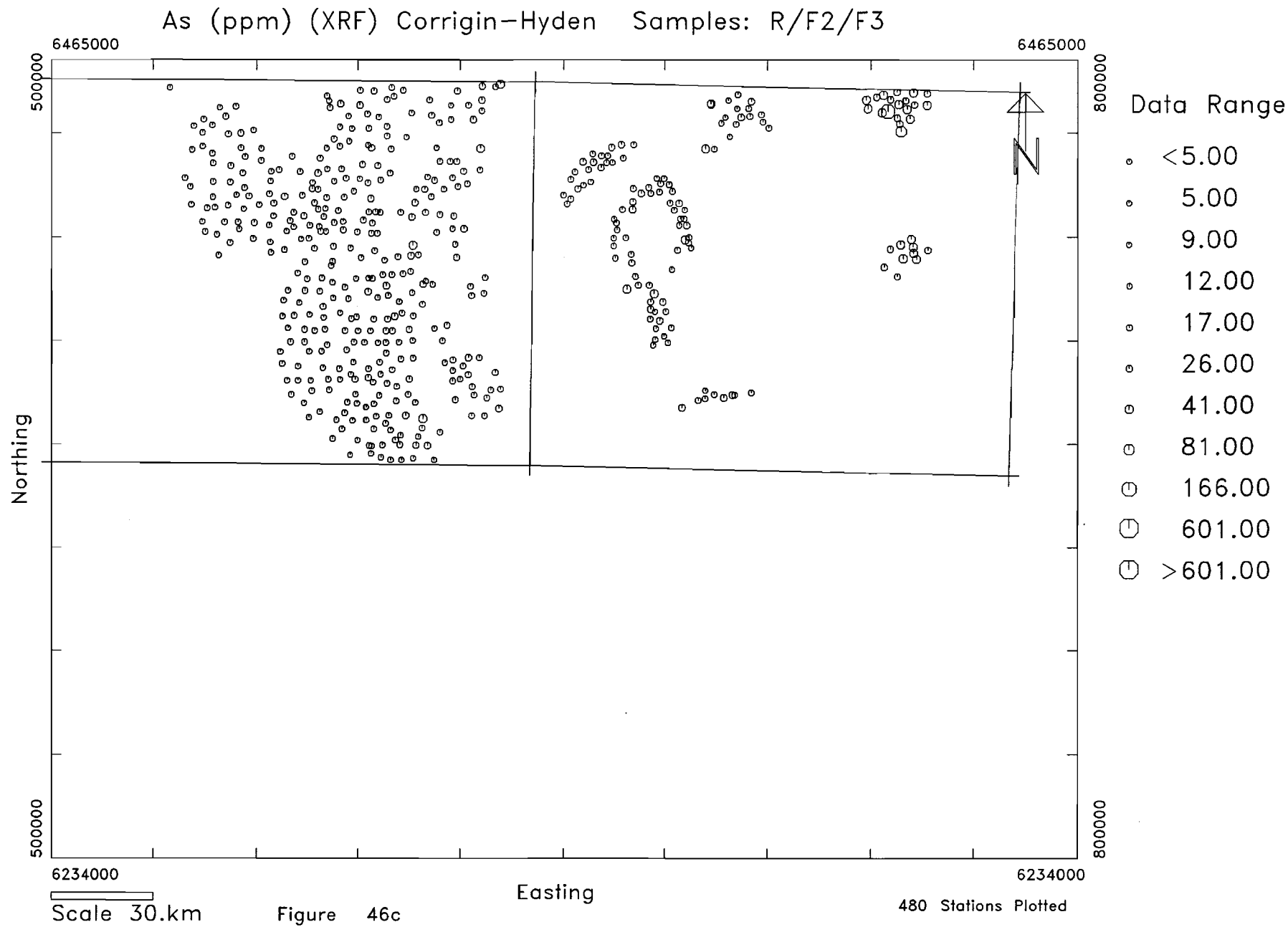
Co (ppm) (AA-HF) Barlee-Jackson-Kalgoorlie Samples: R/F2/F3



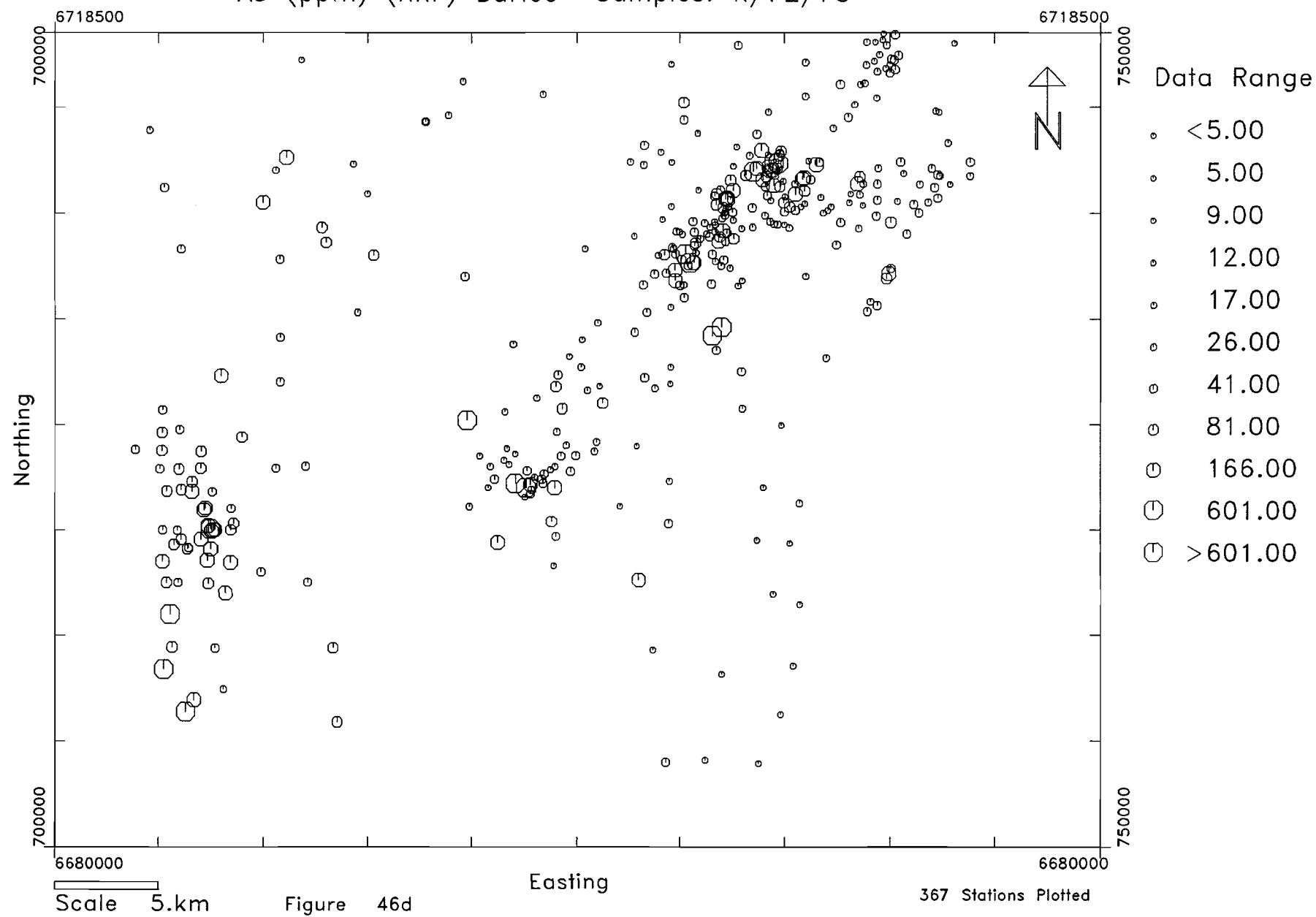


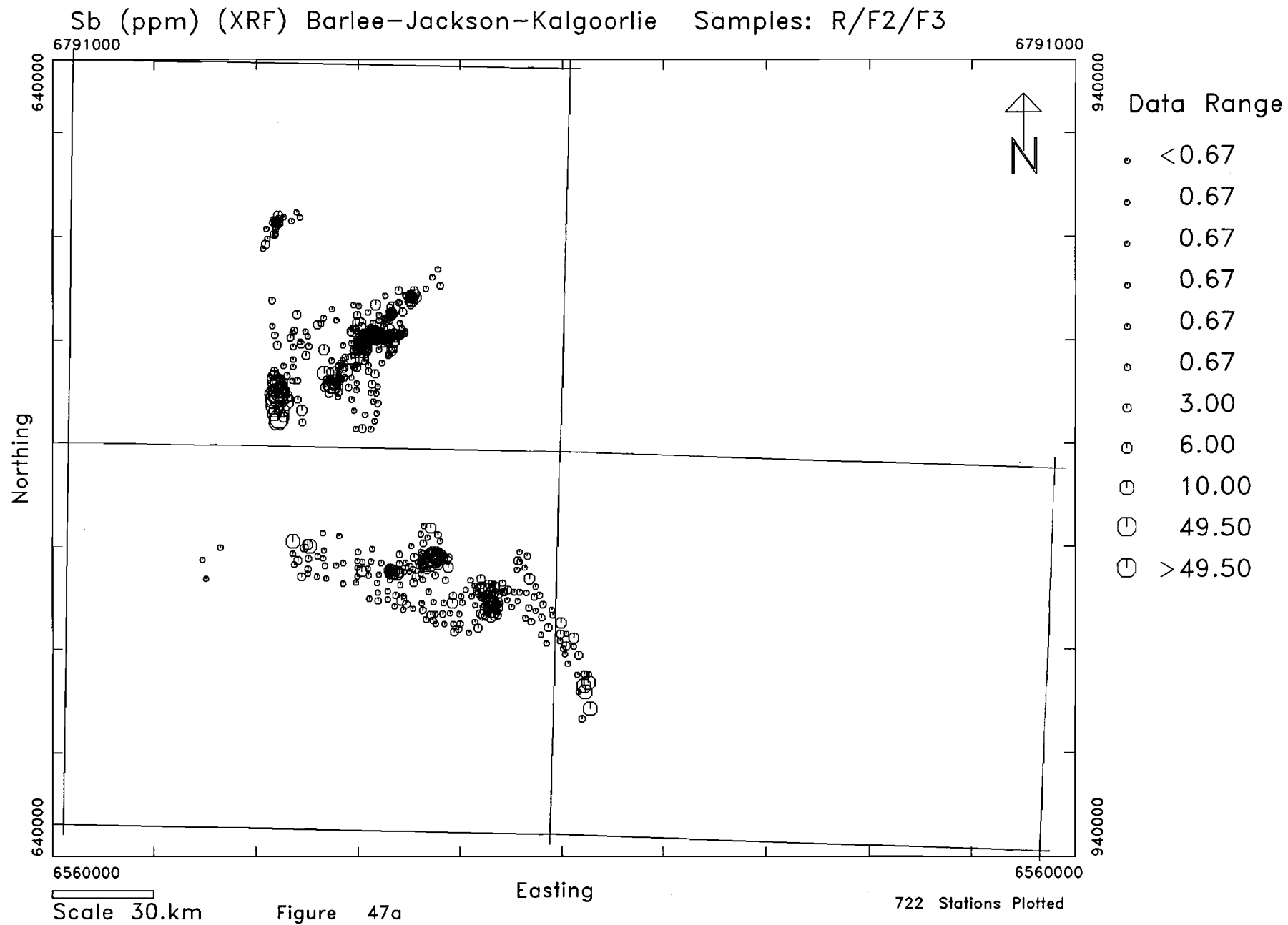




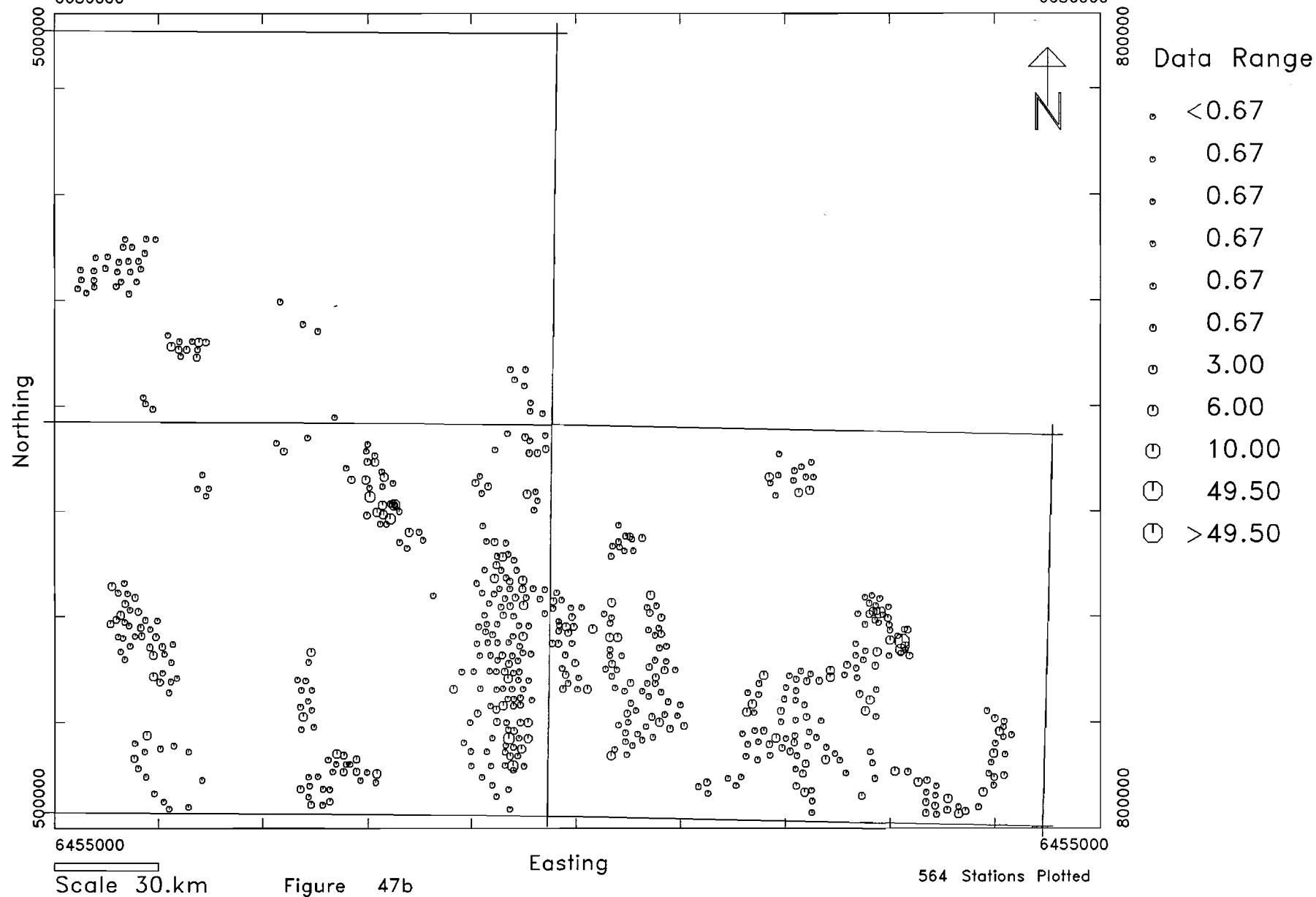


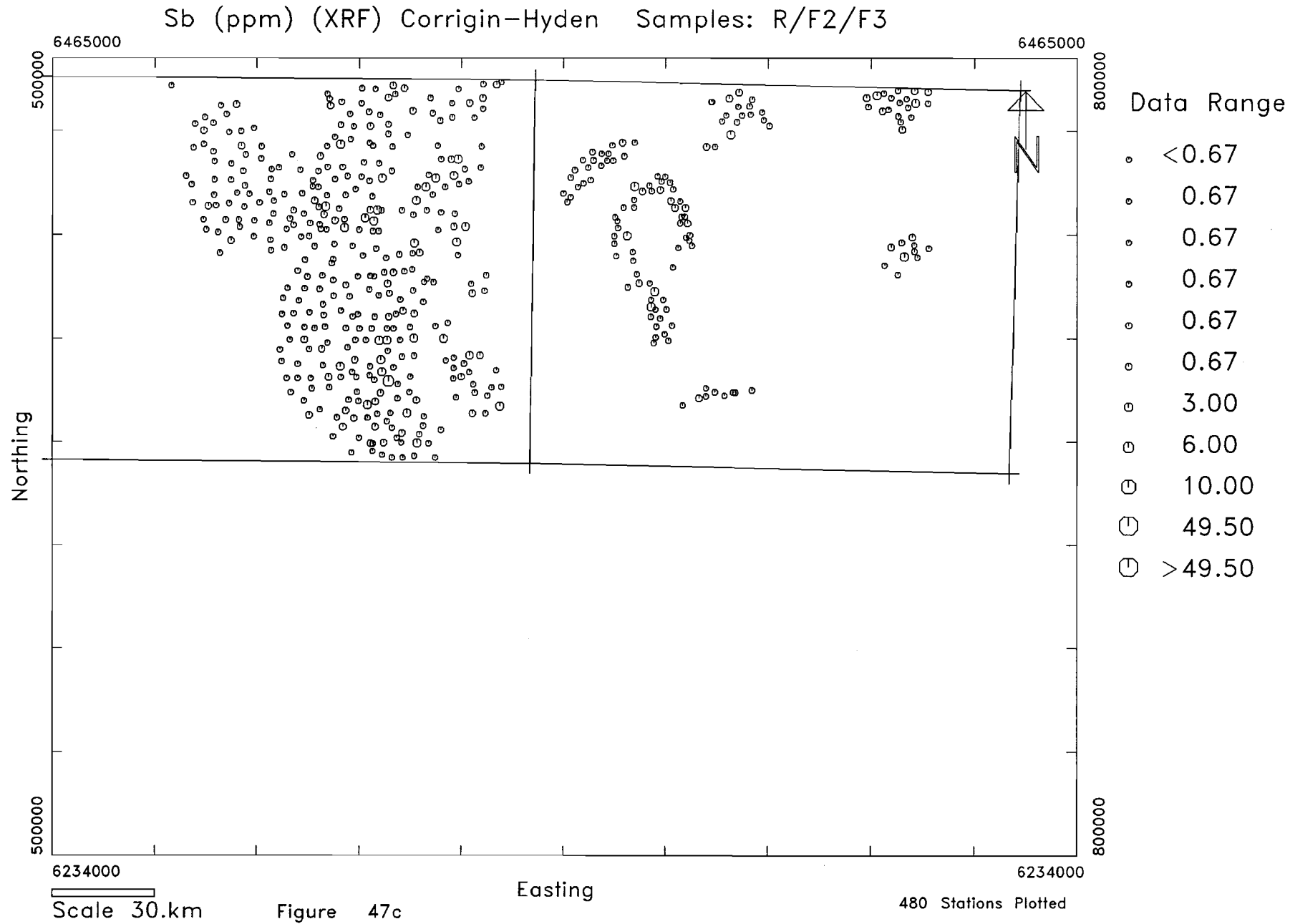
As (ppm) (XRF) Barlee Samples: R/F2/F3

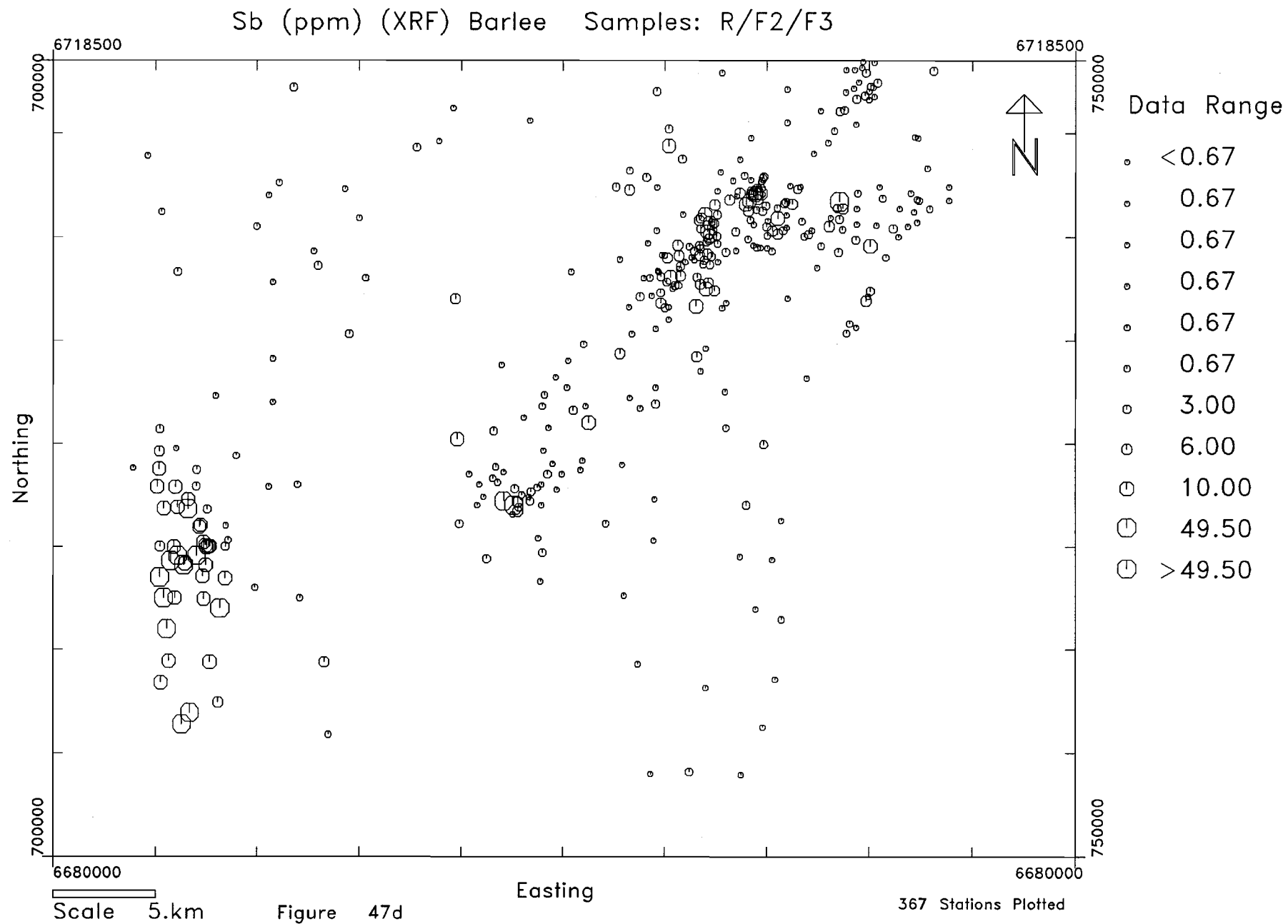


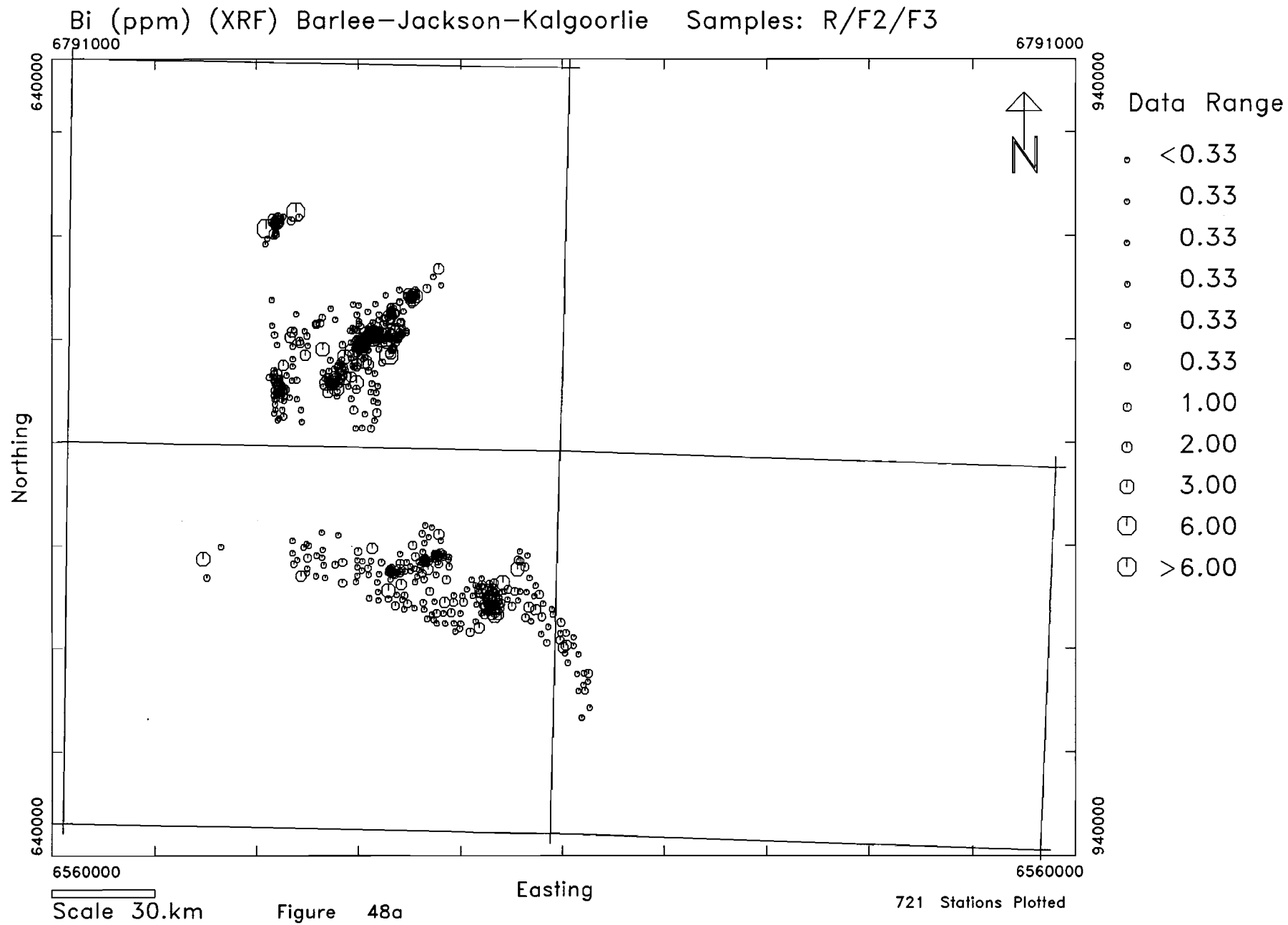


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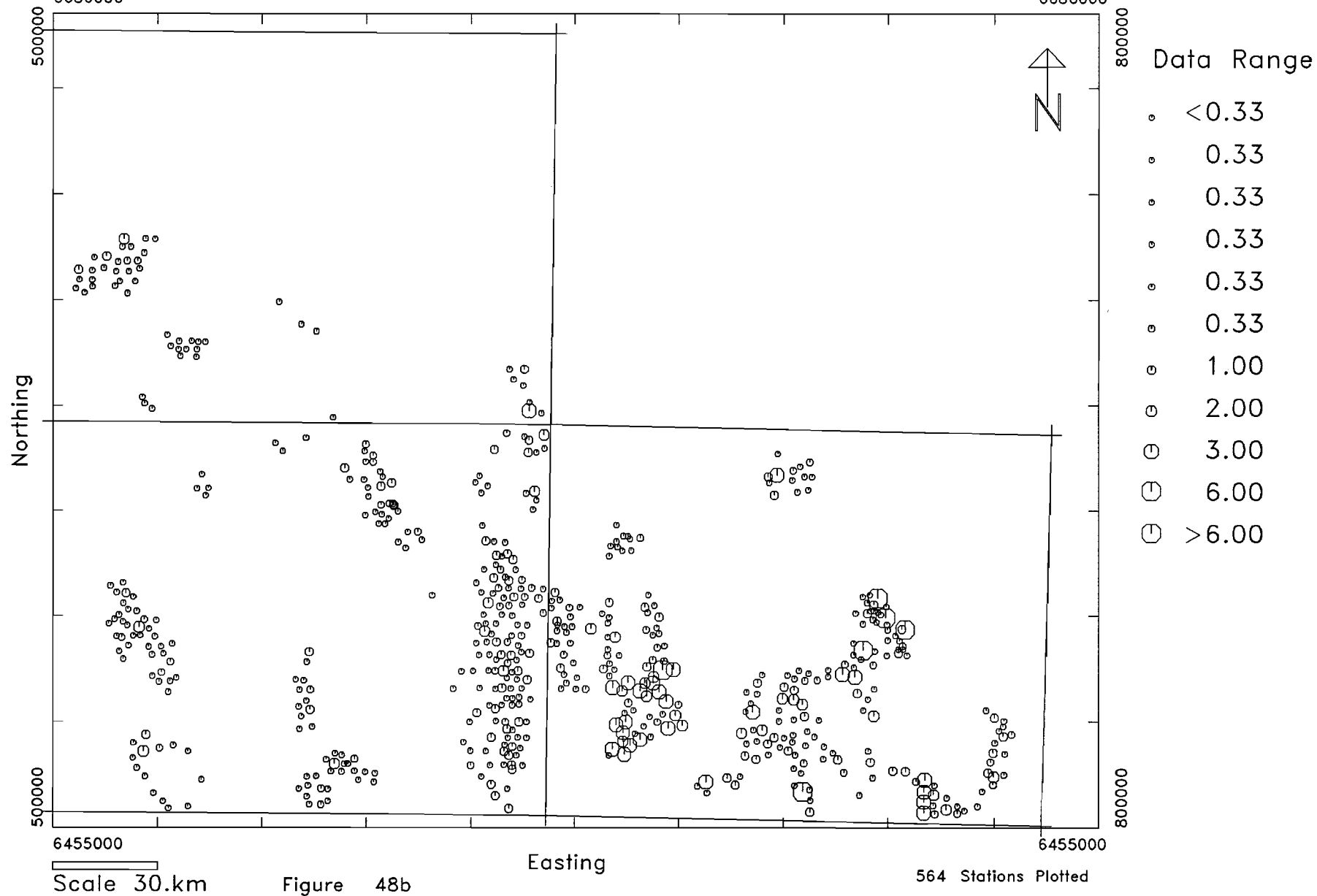


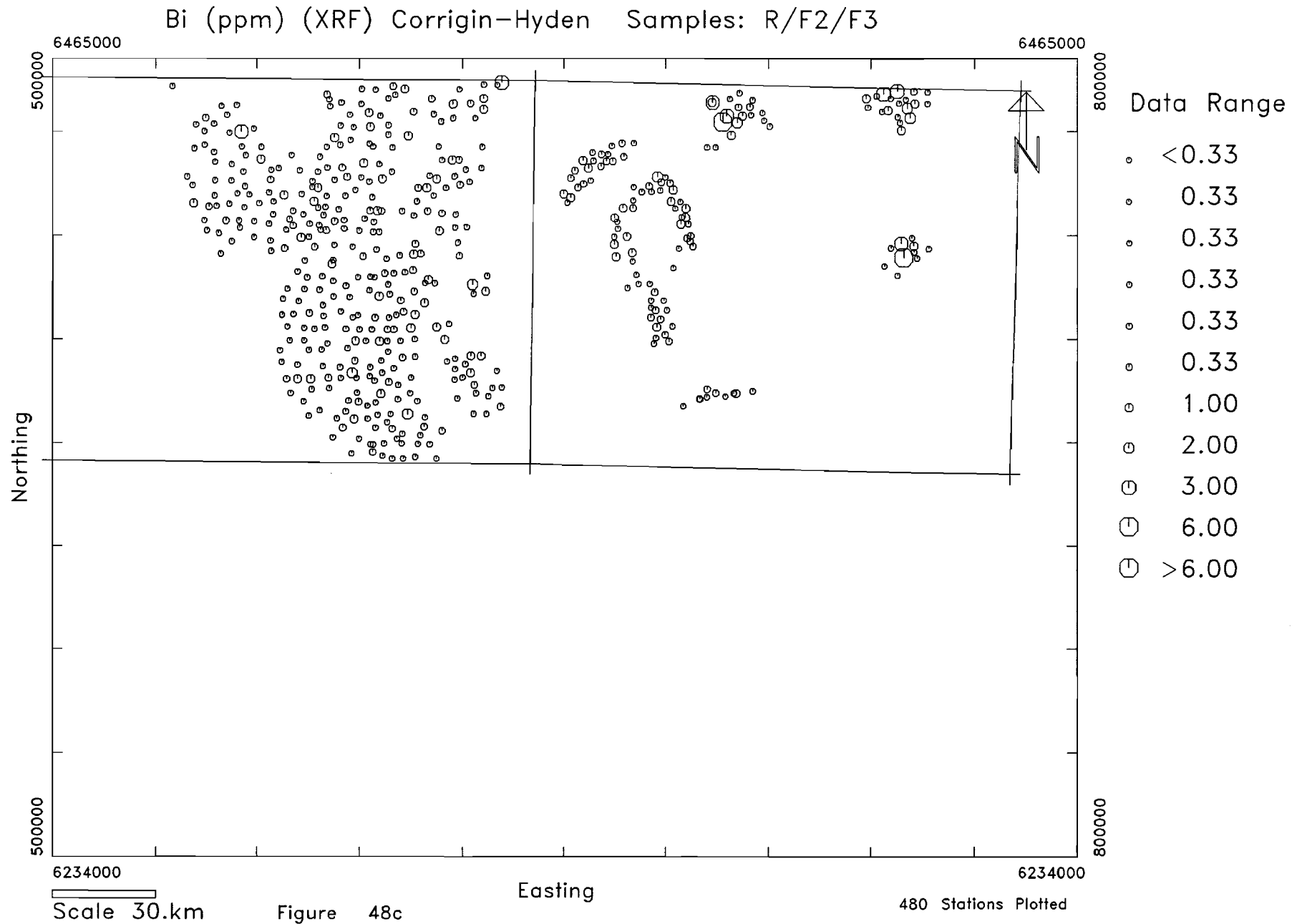


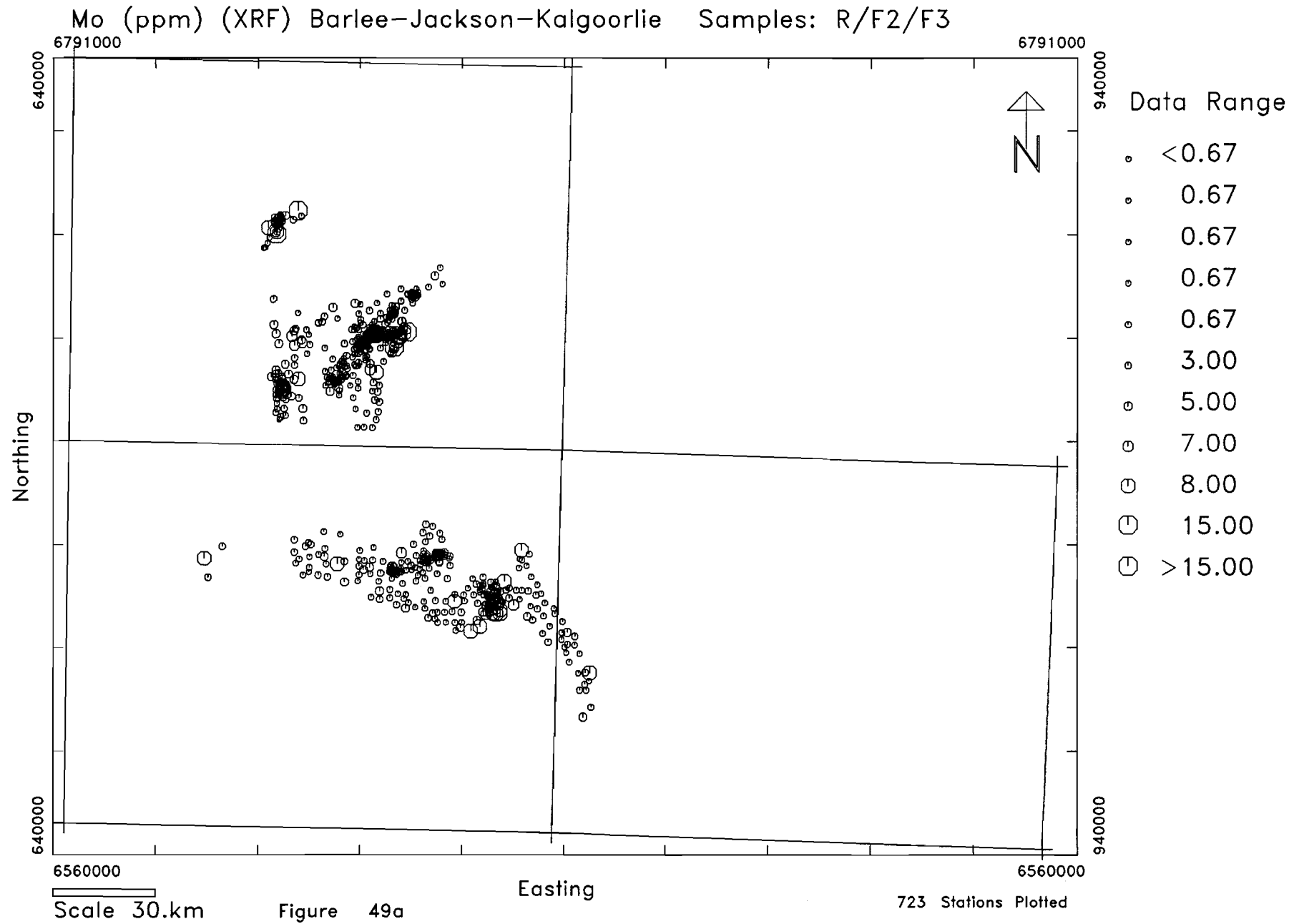




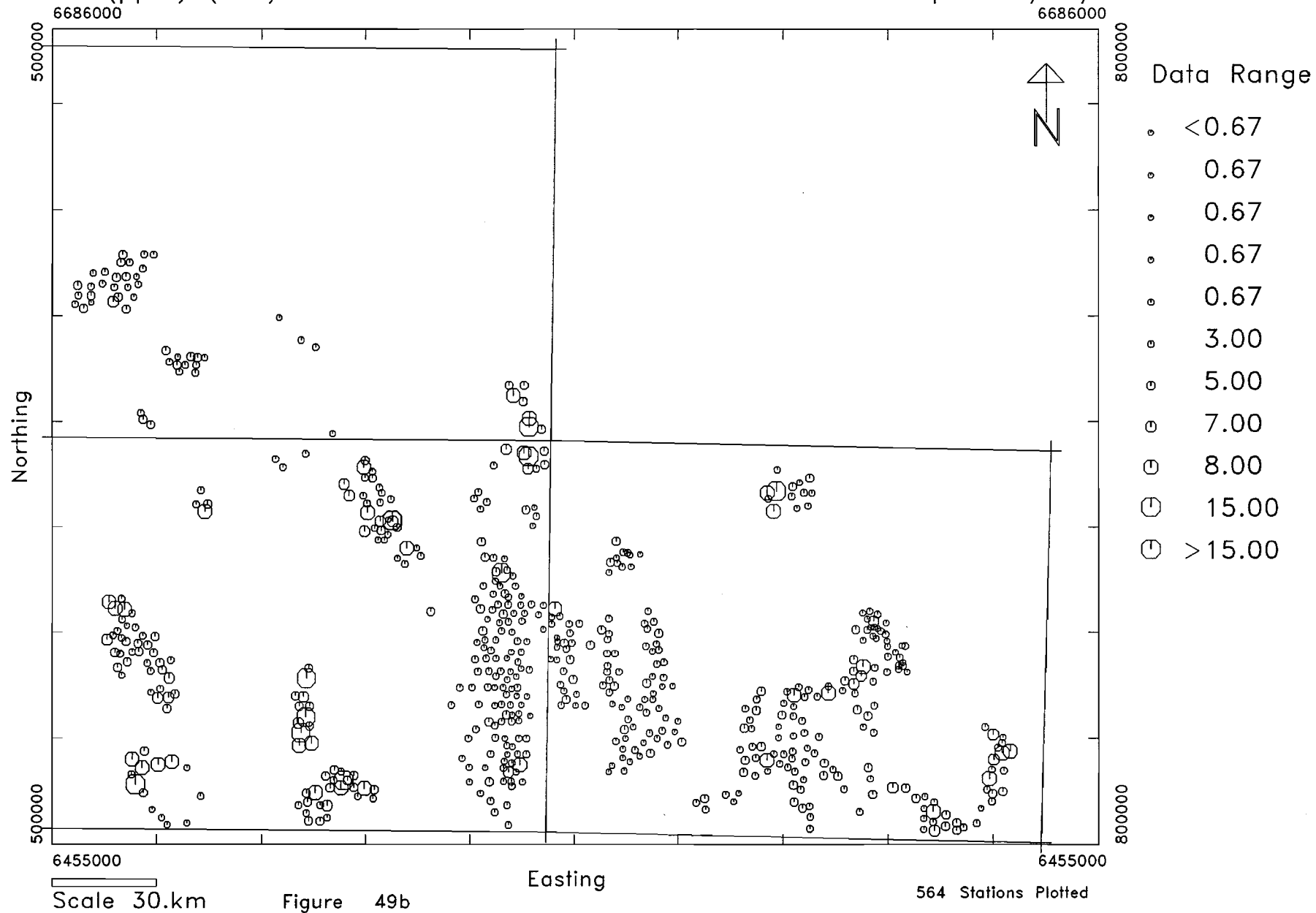
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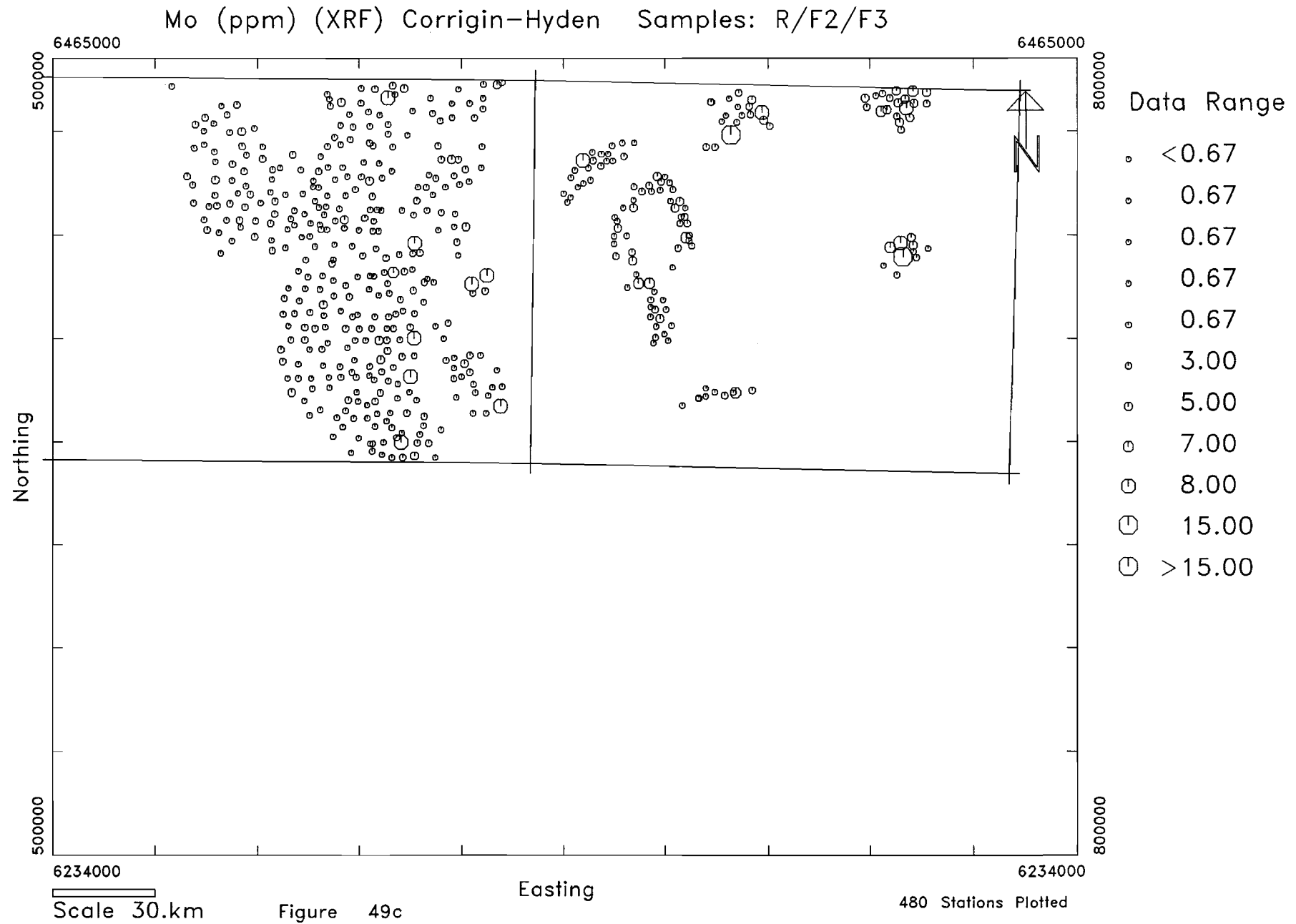


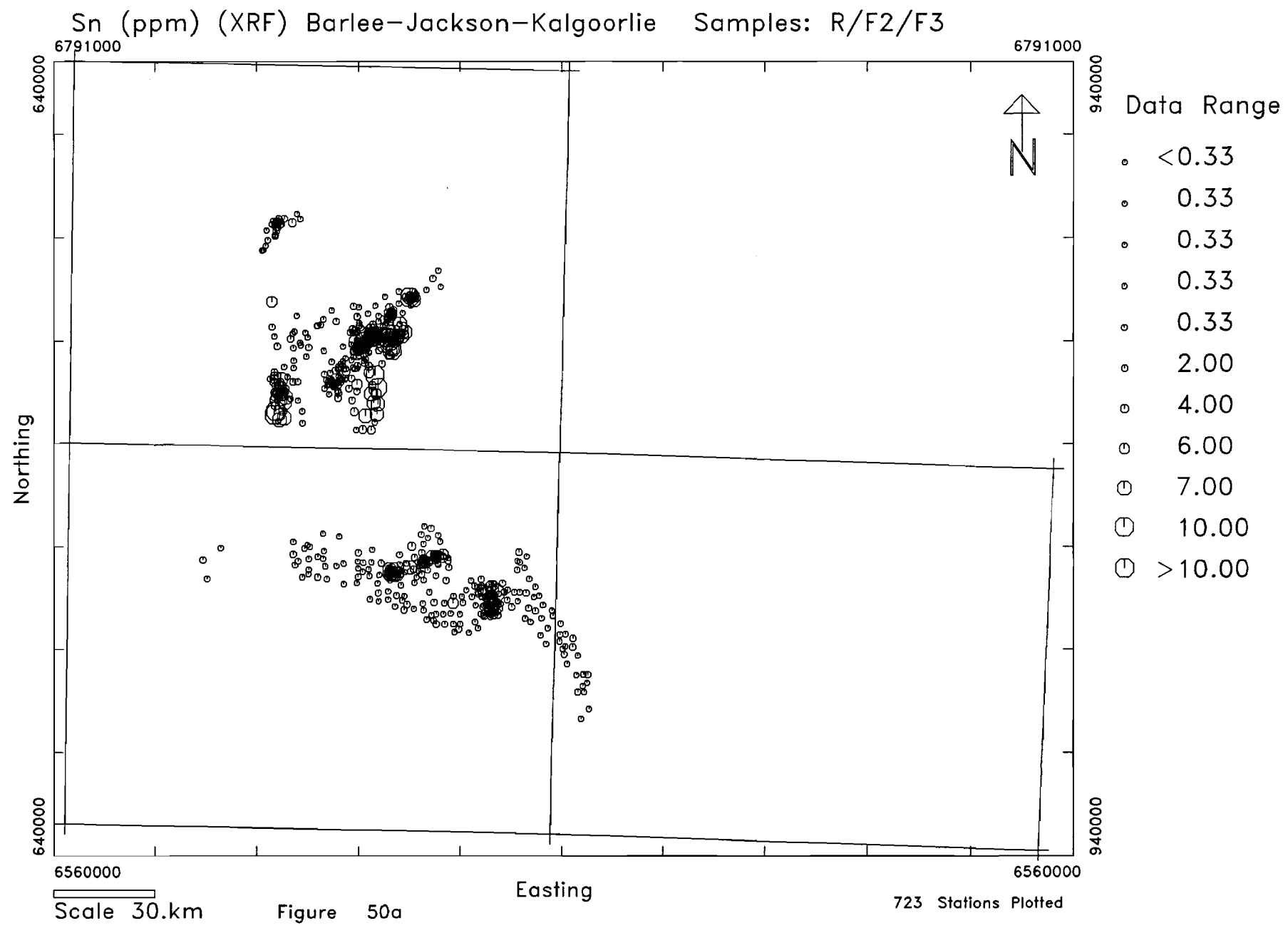




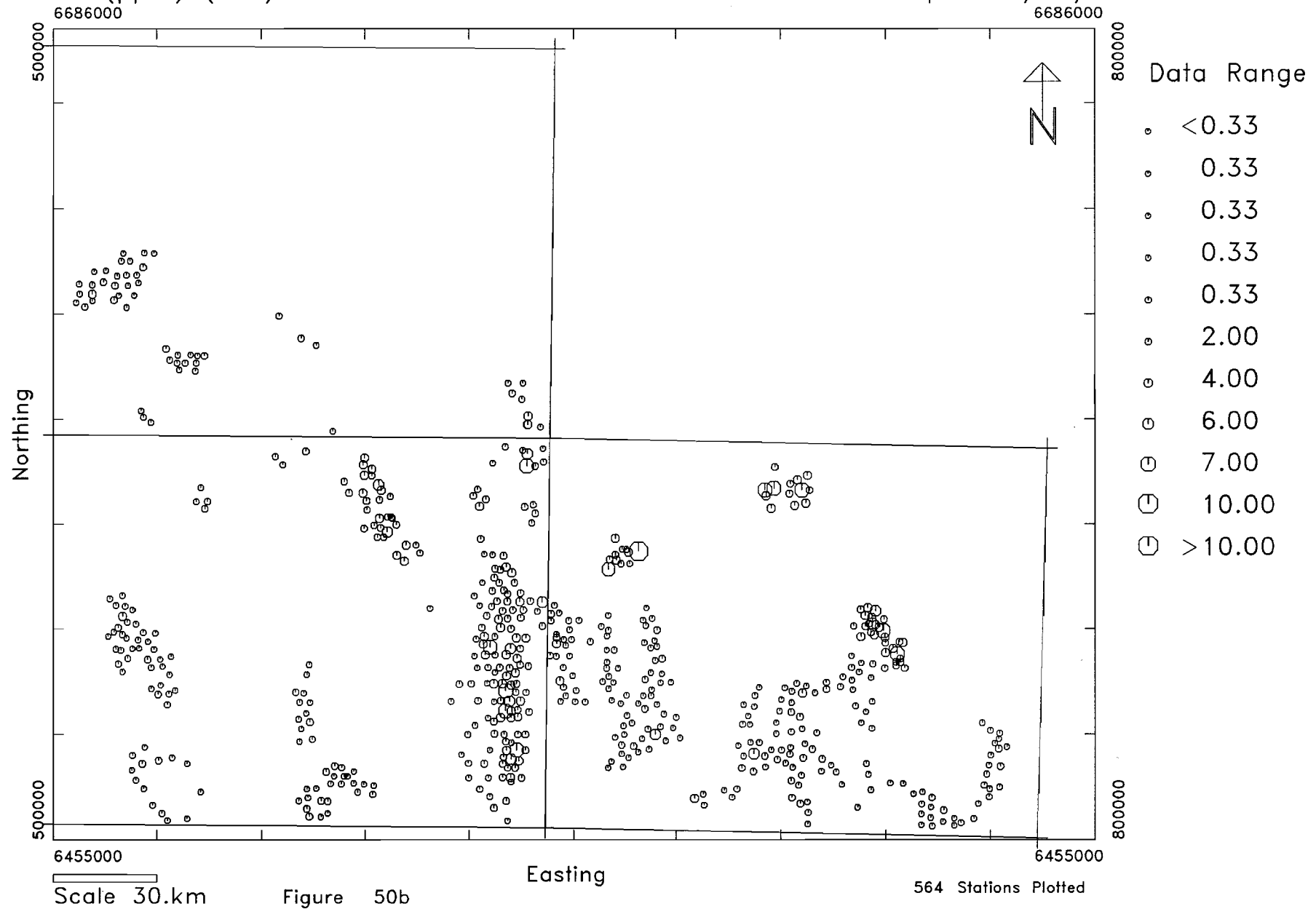
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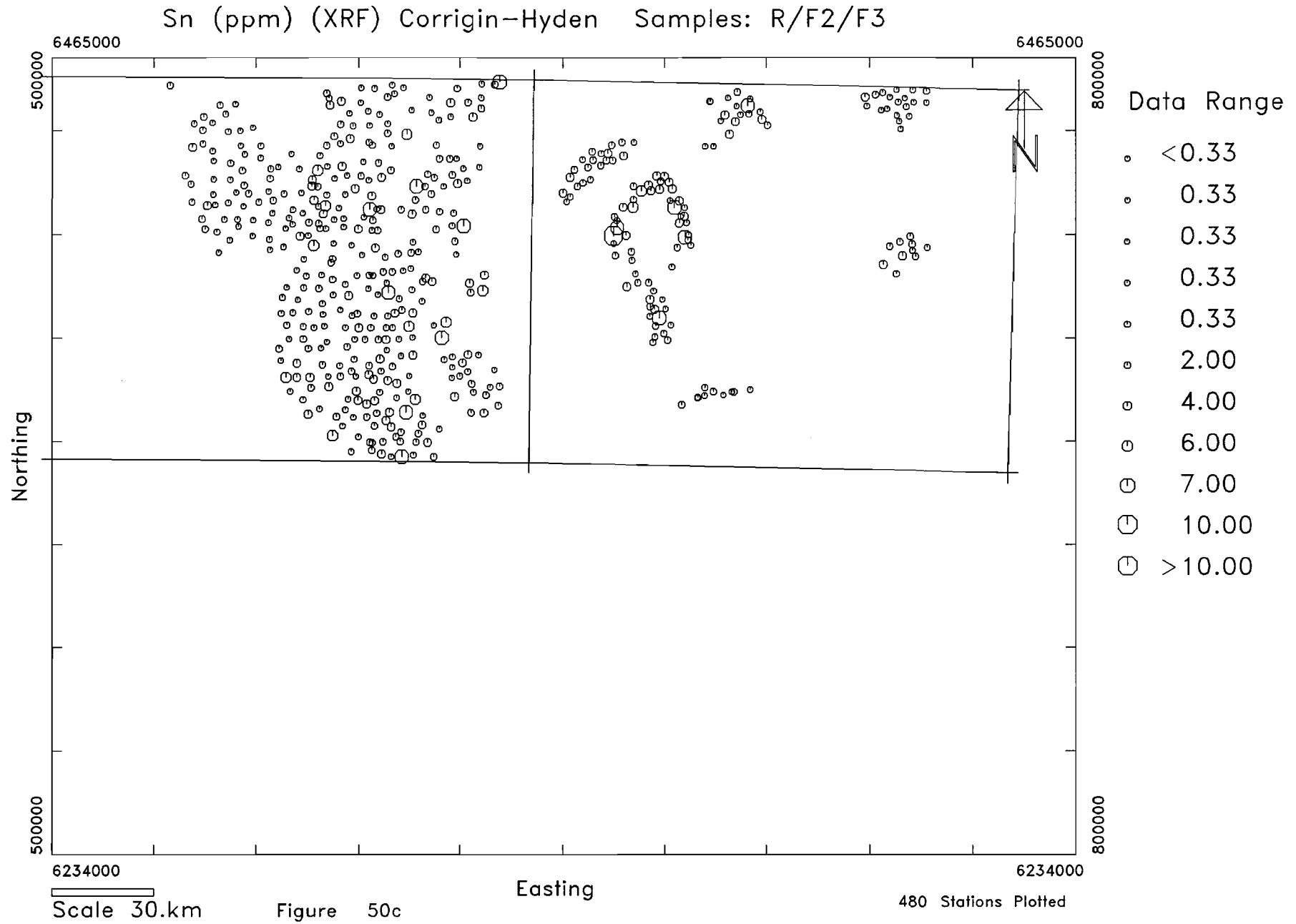


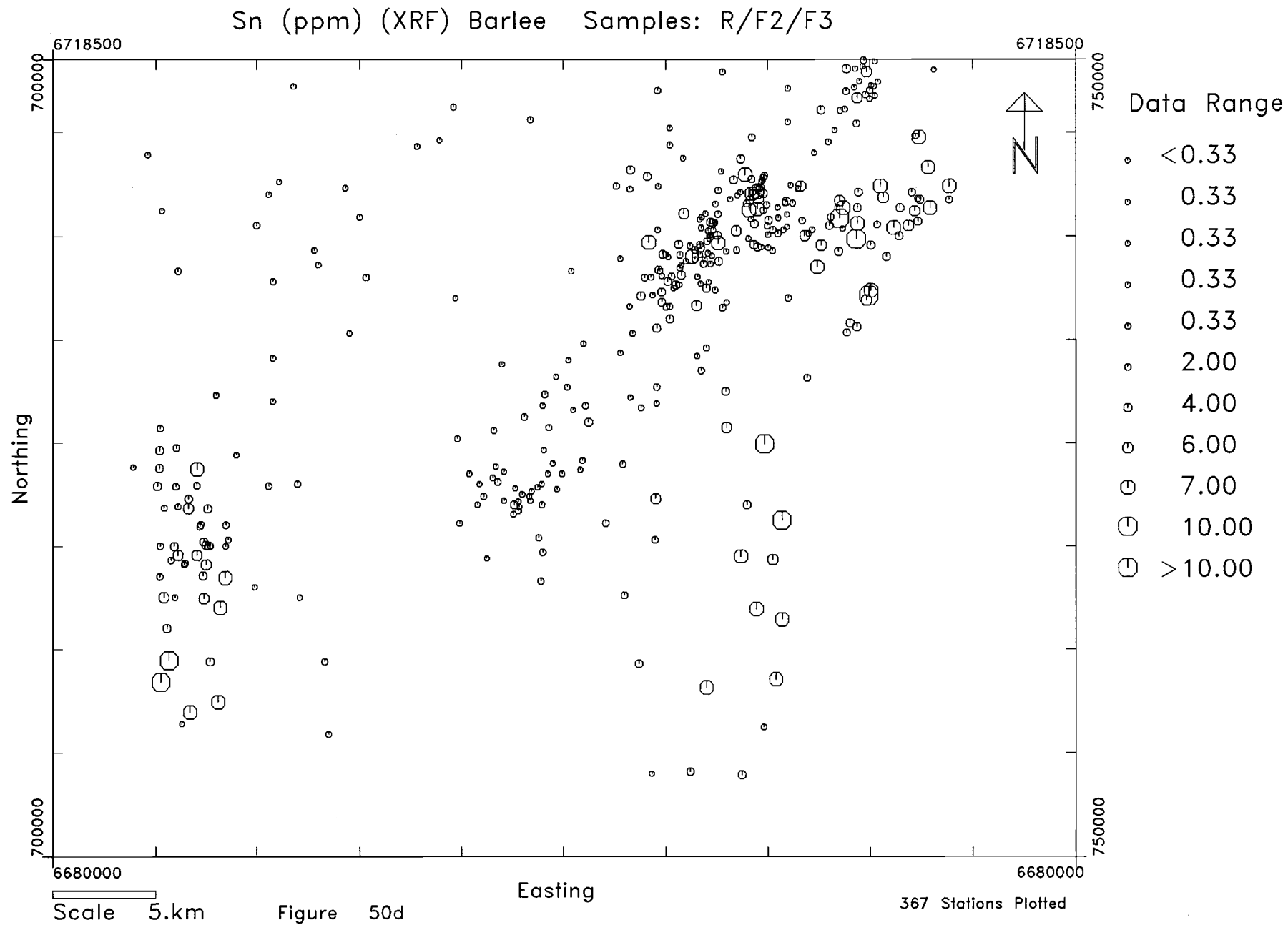


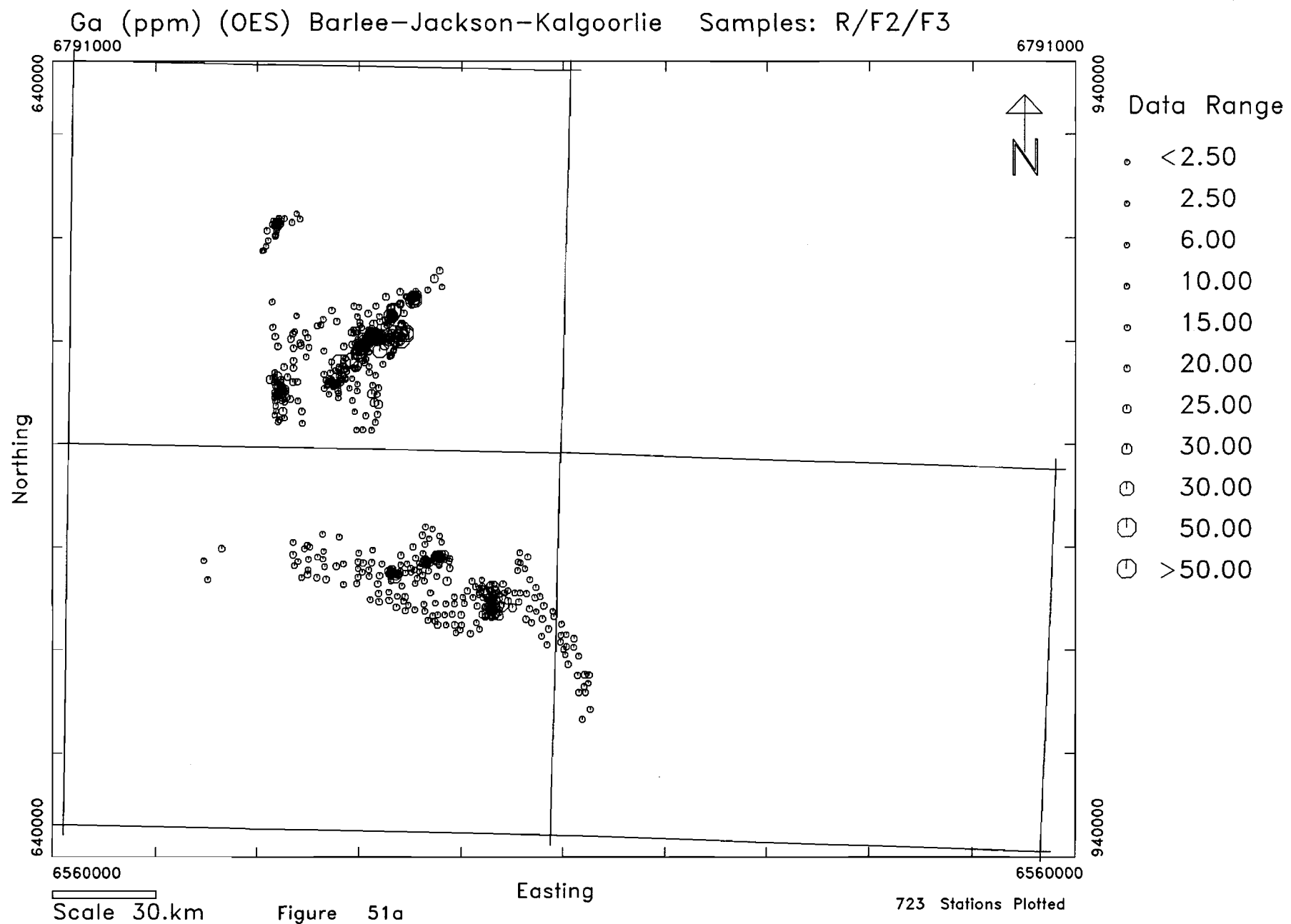


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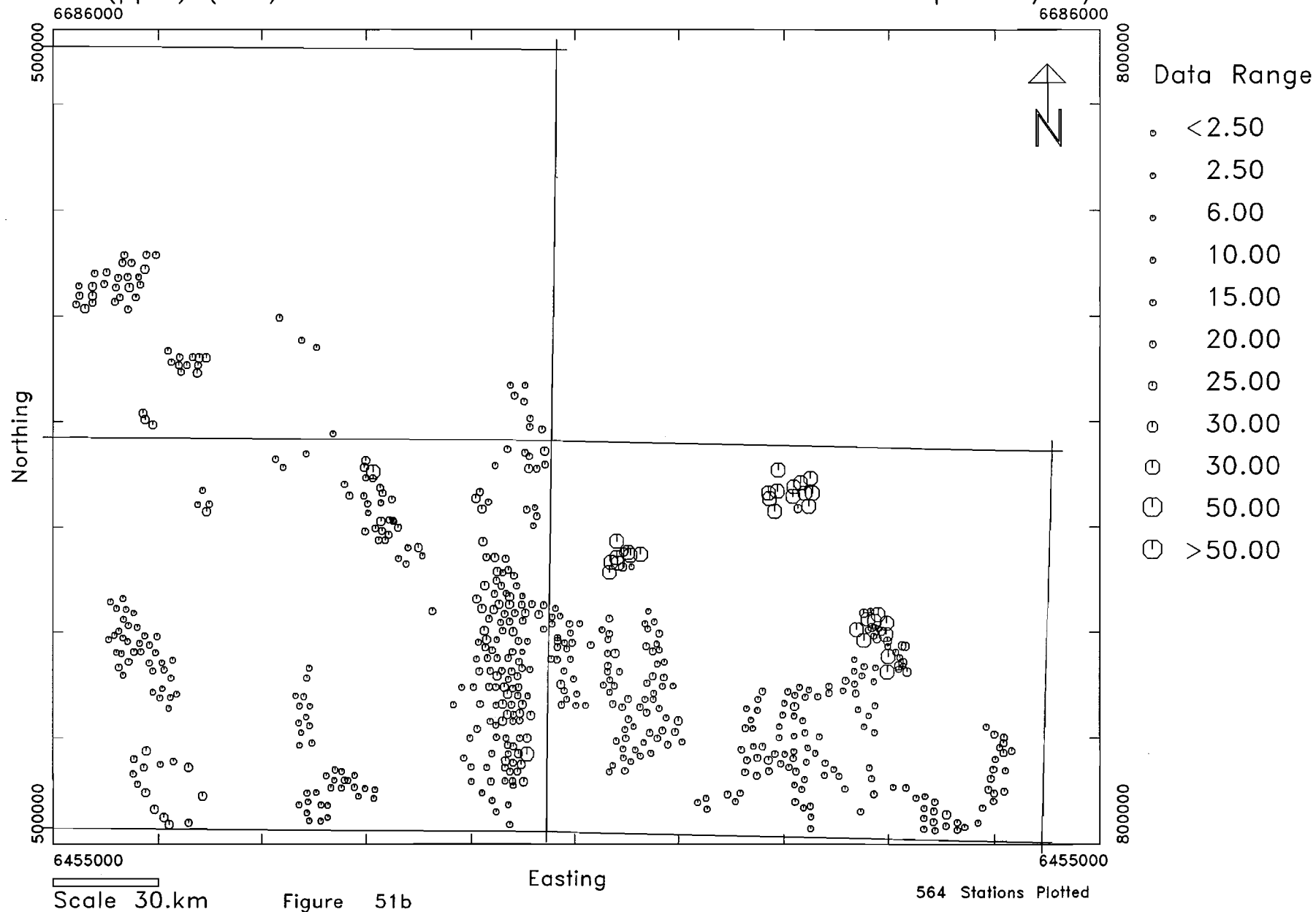


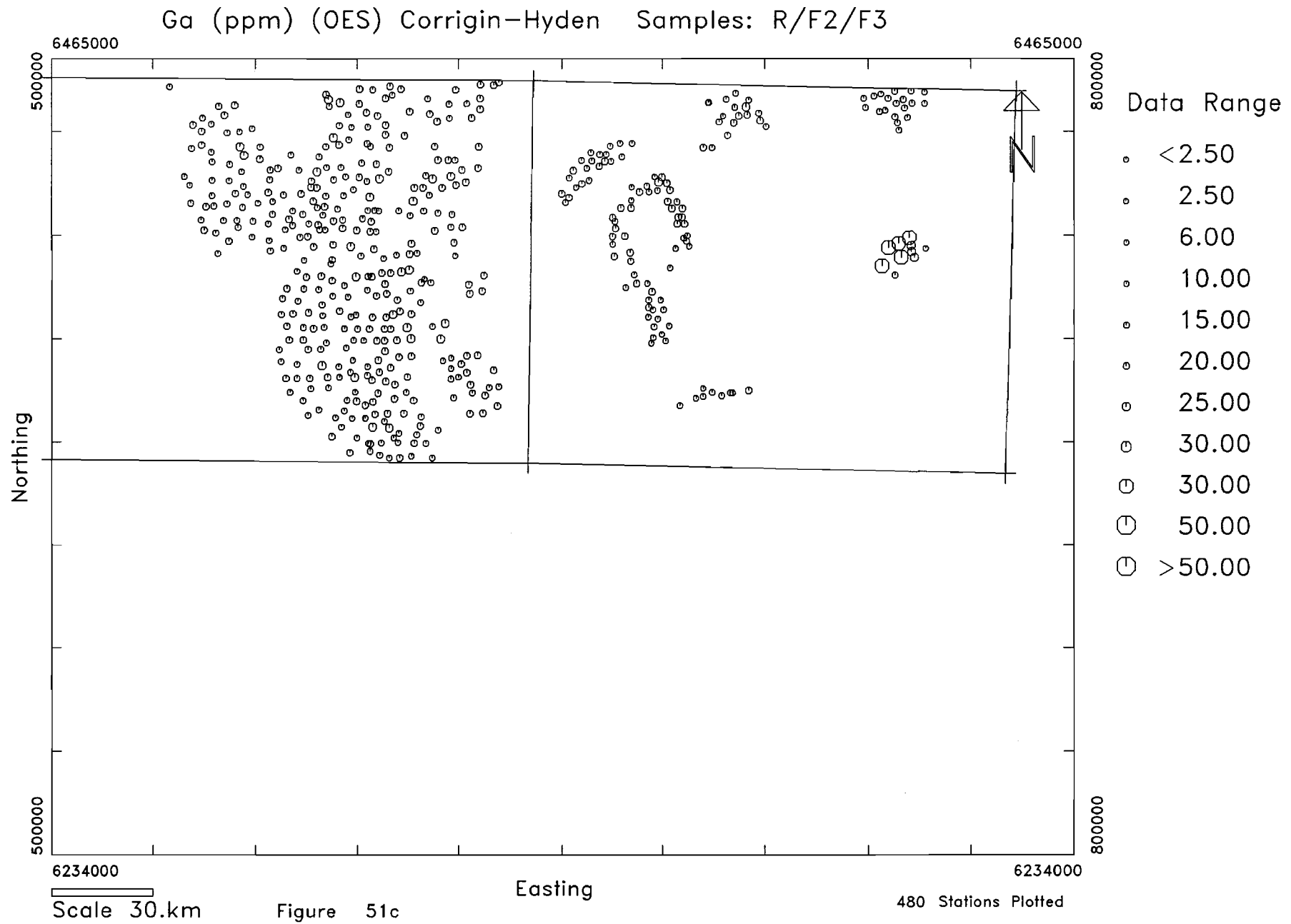


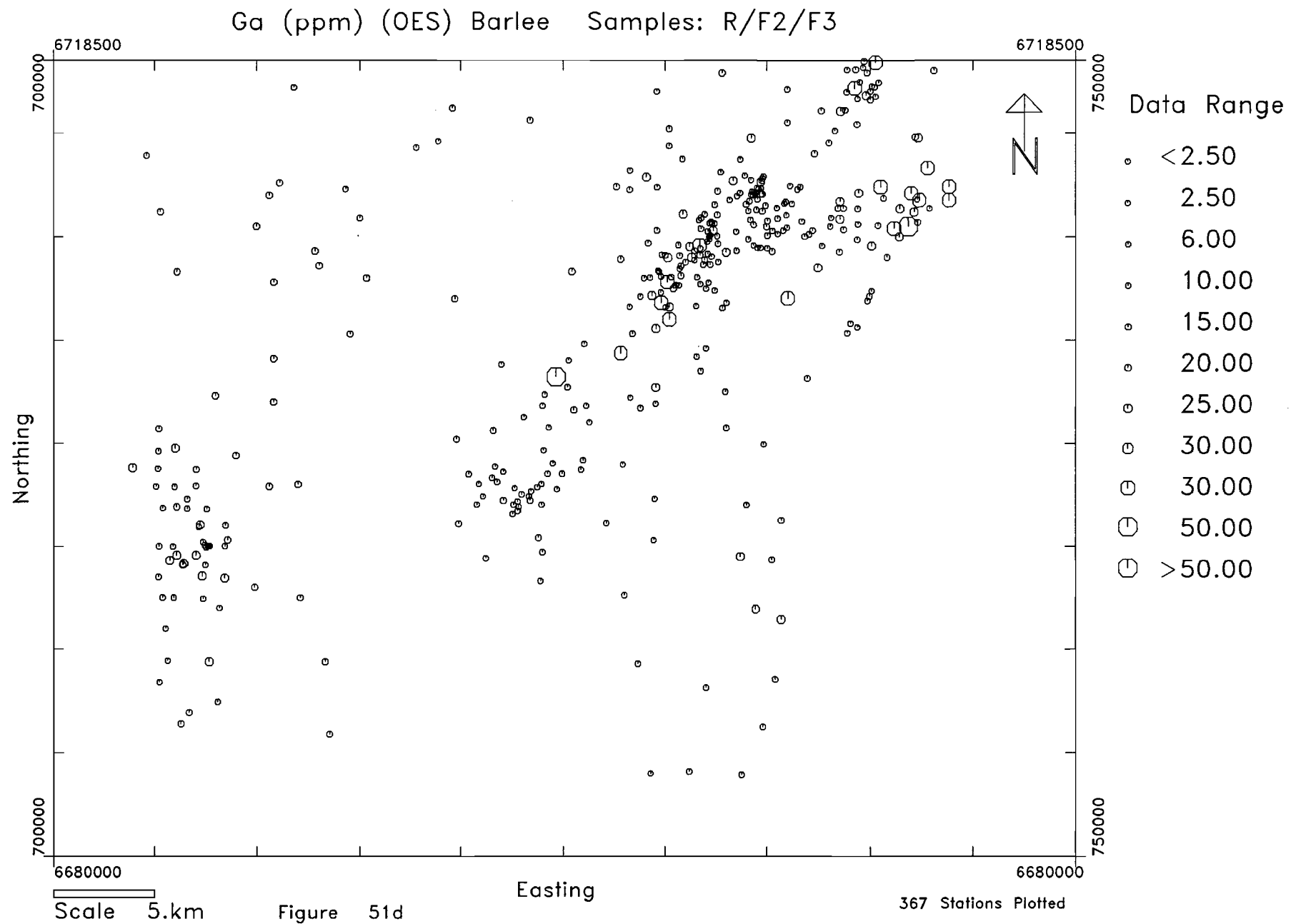


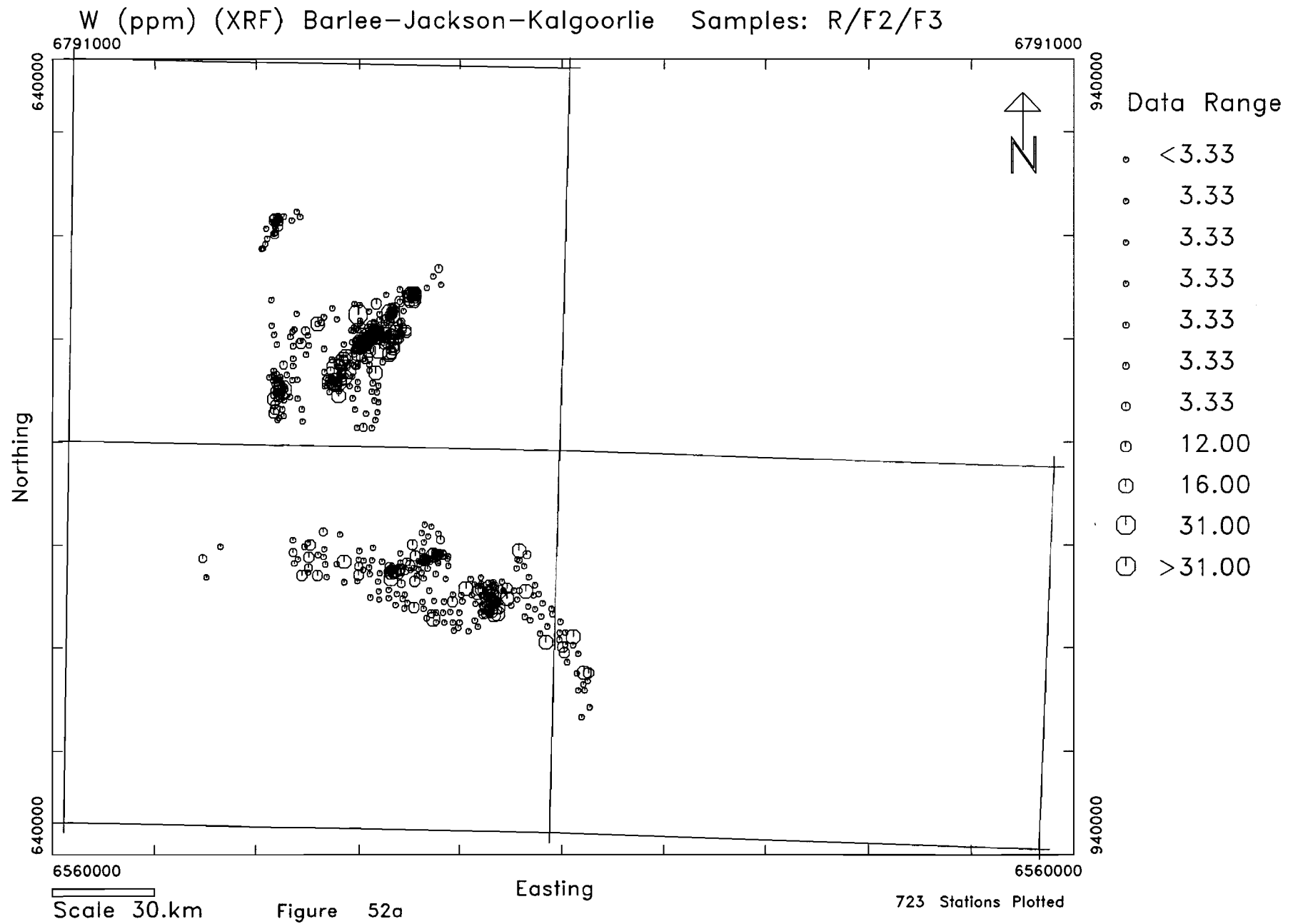


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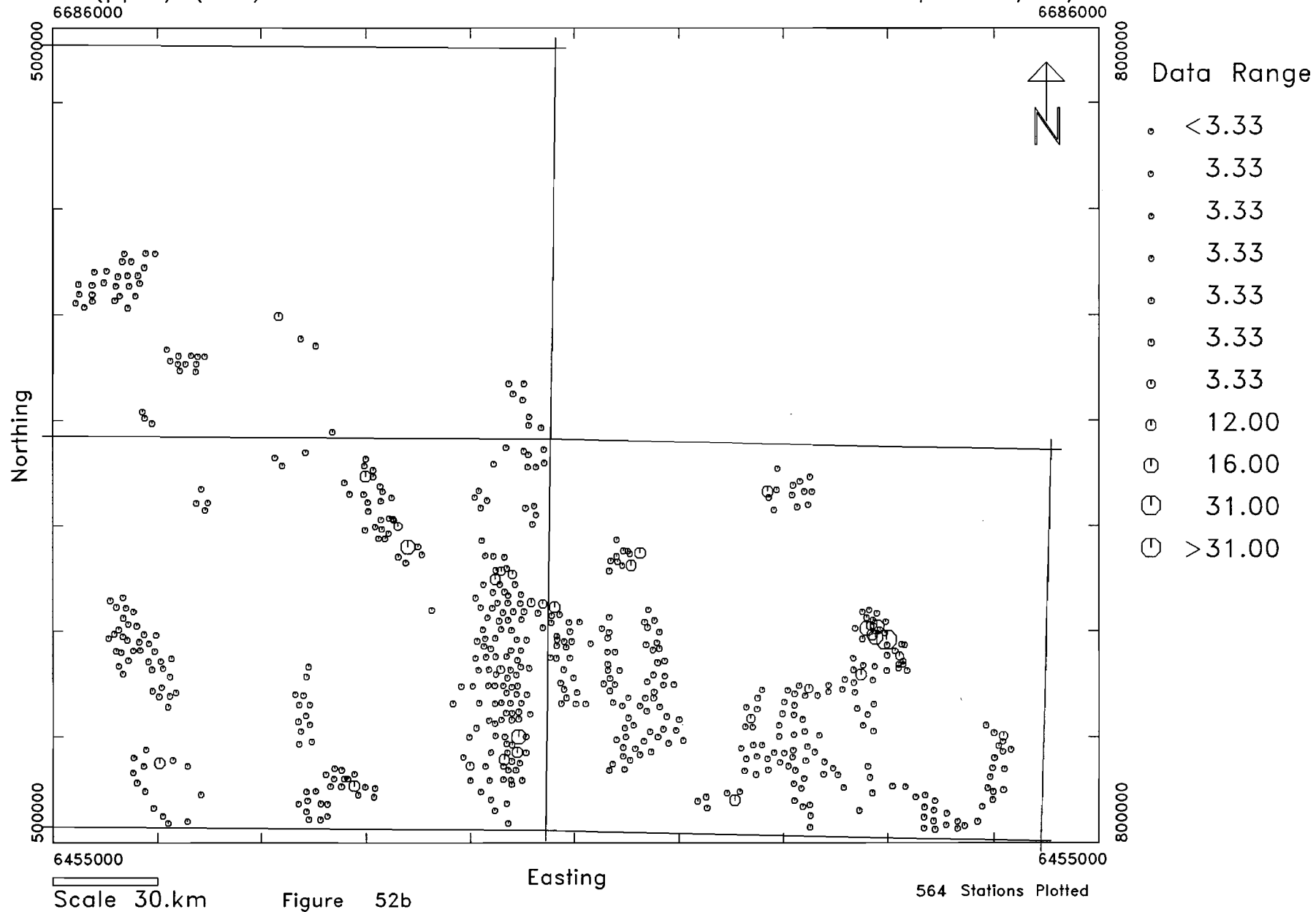


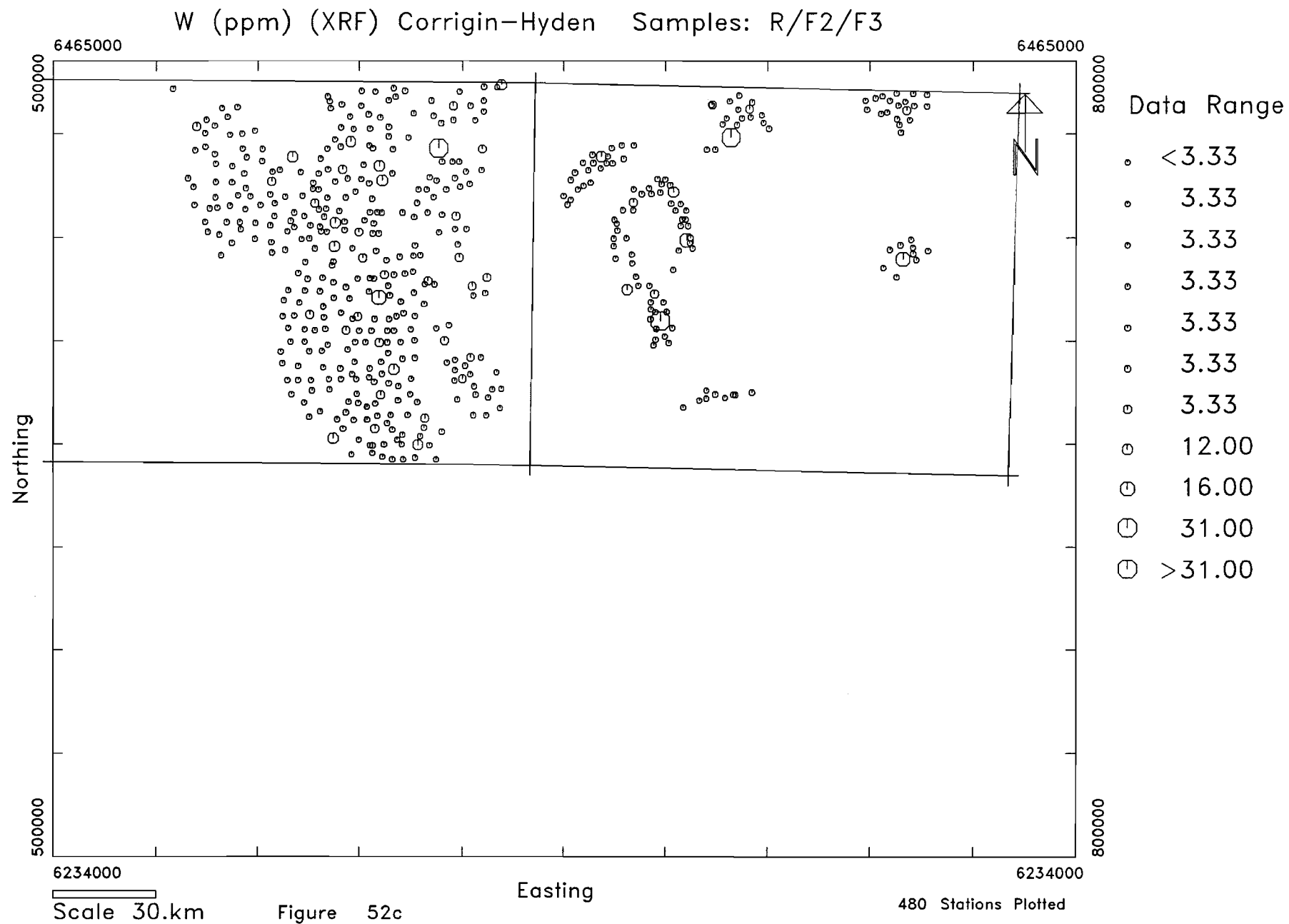


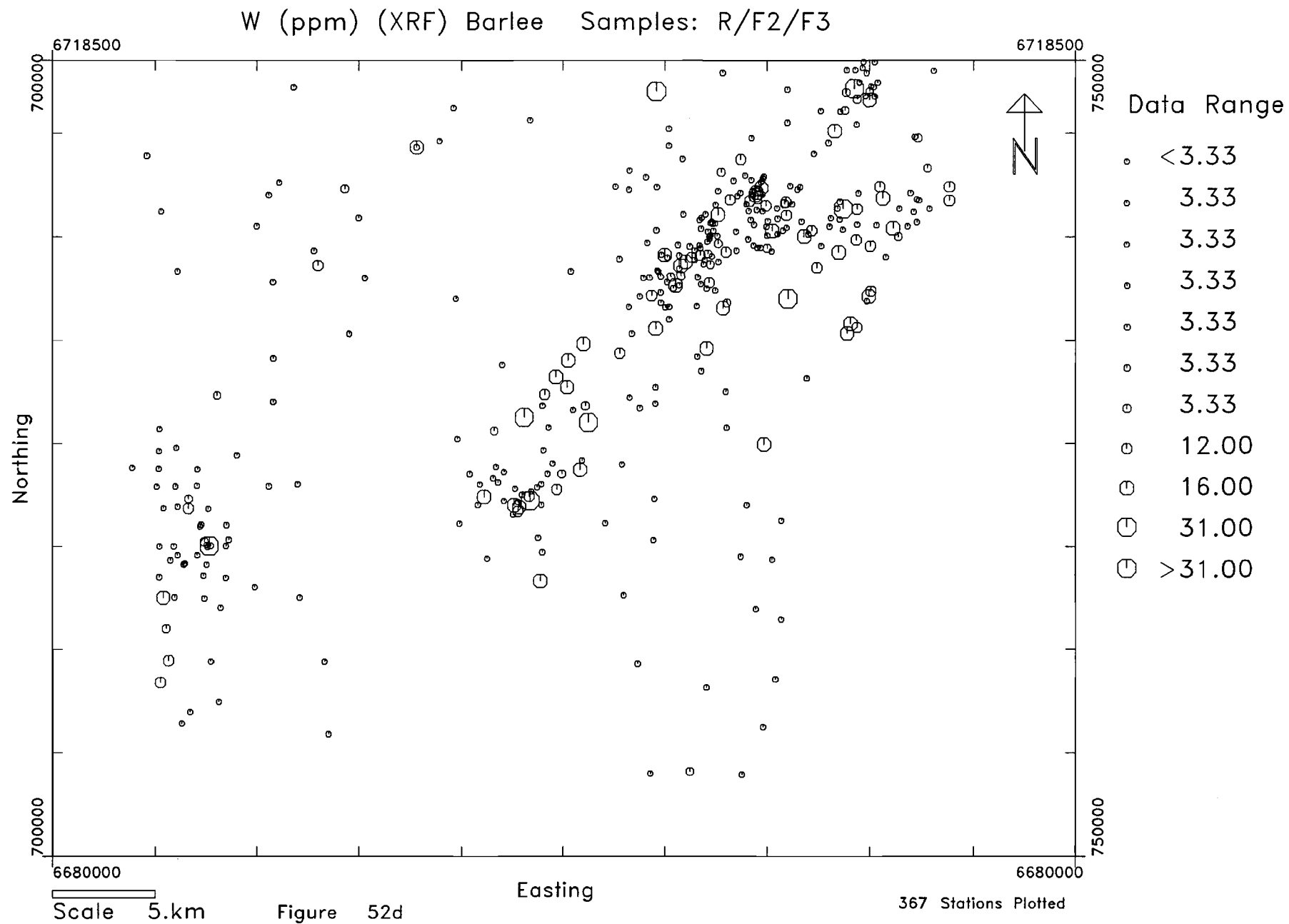


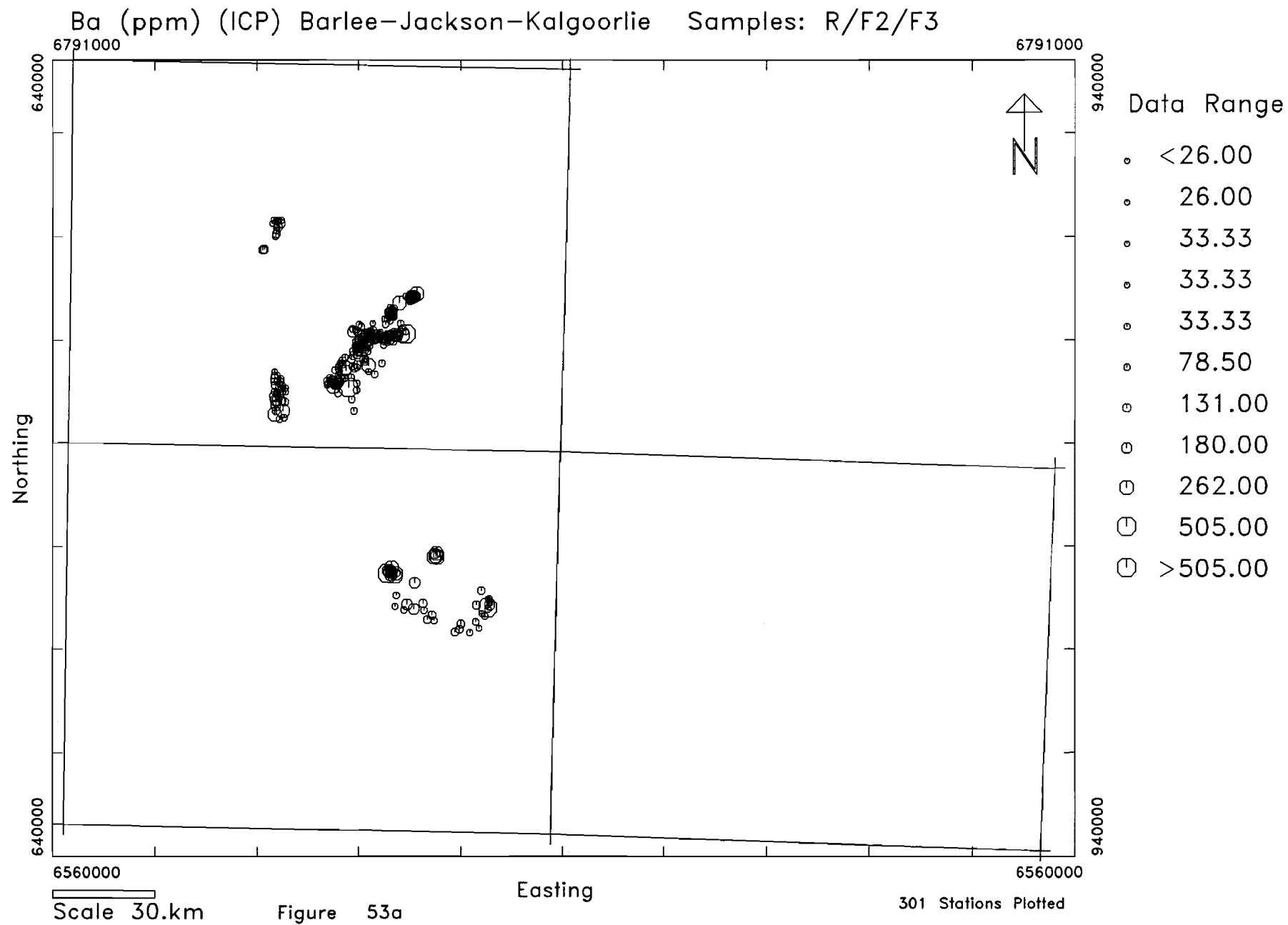


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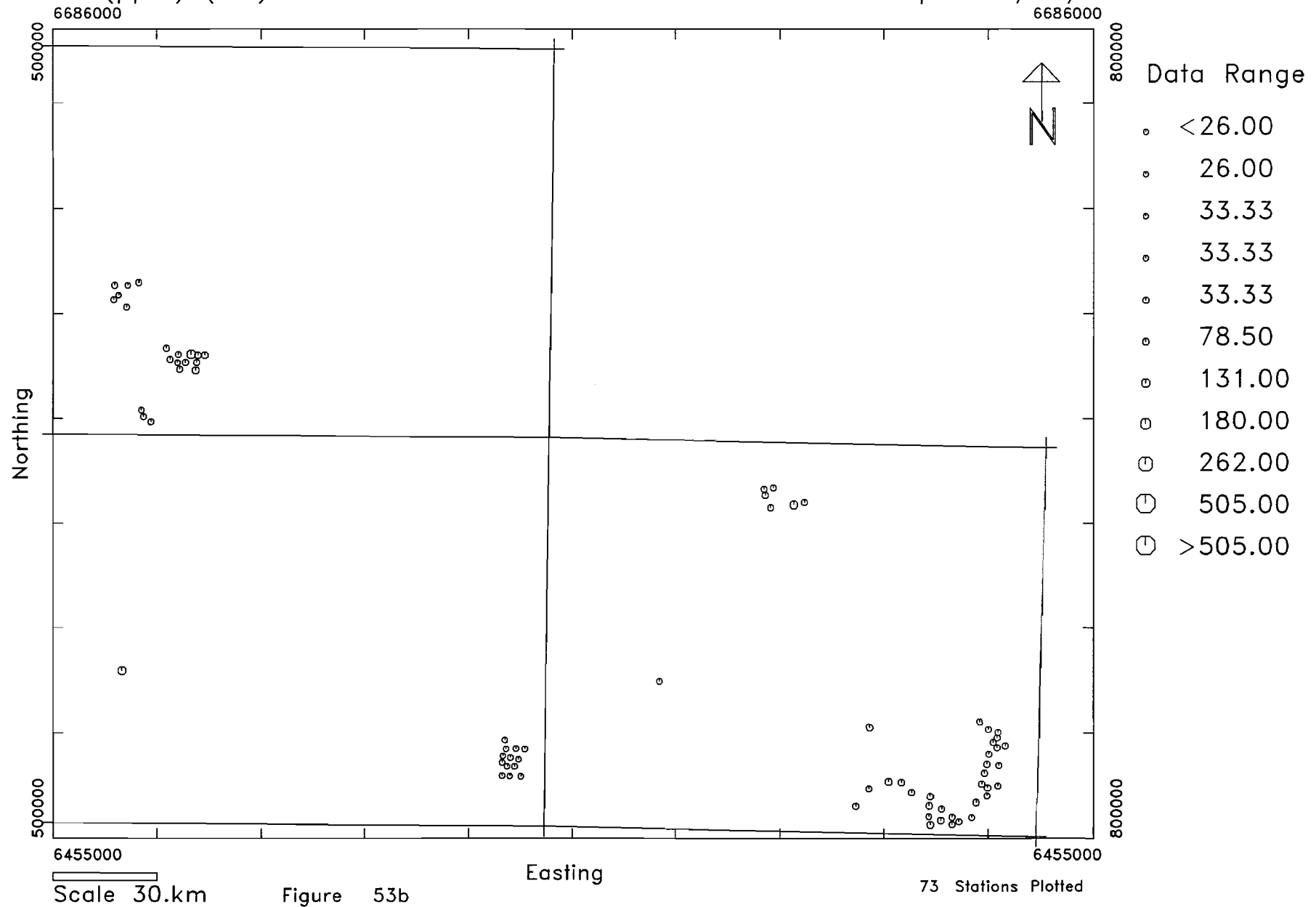


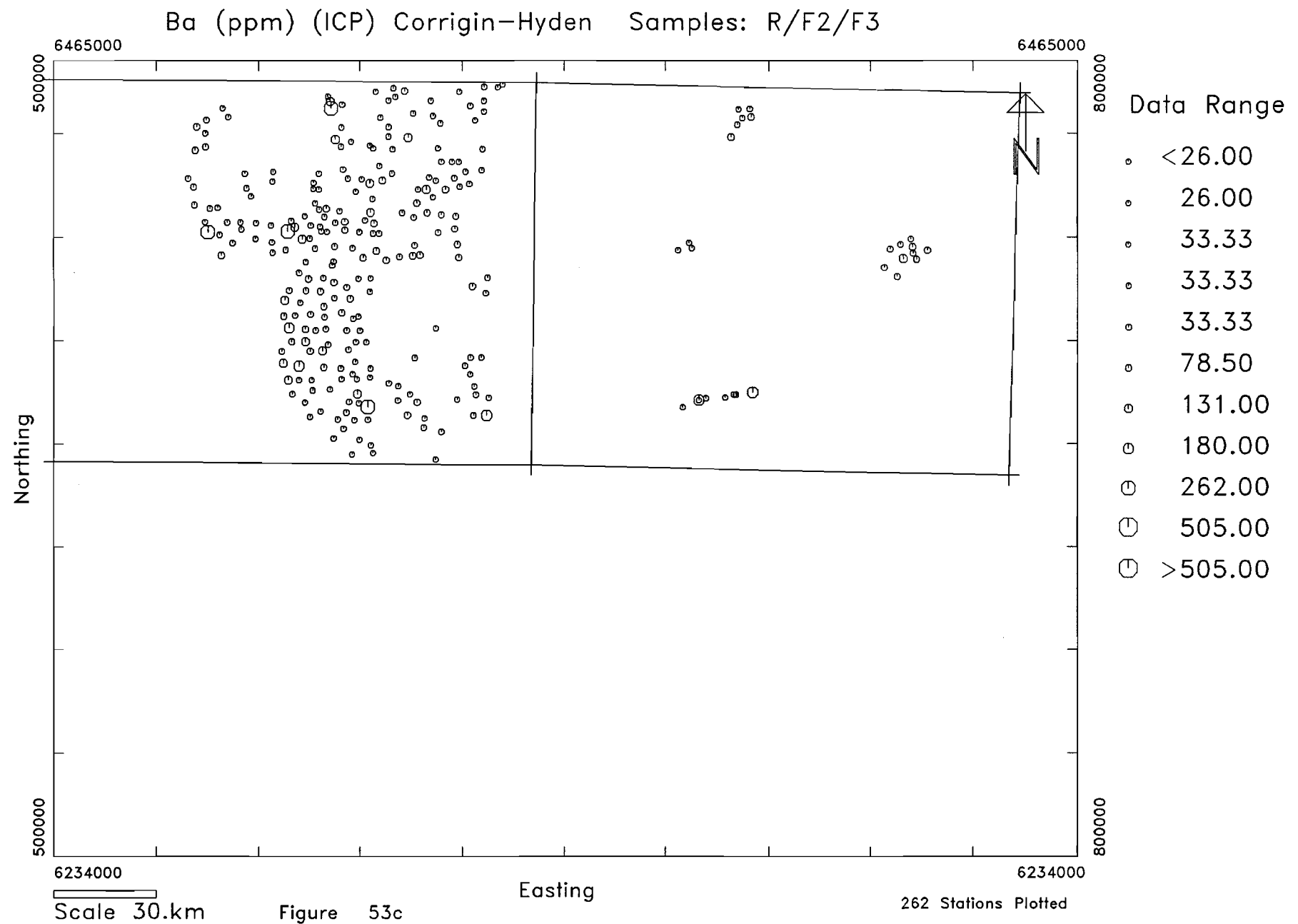




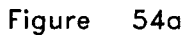


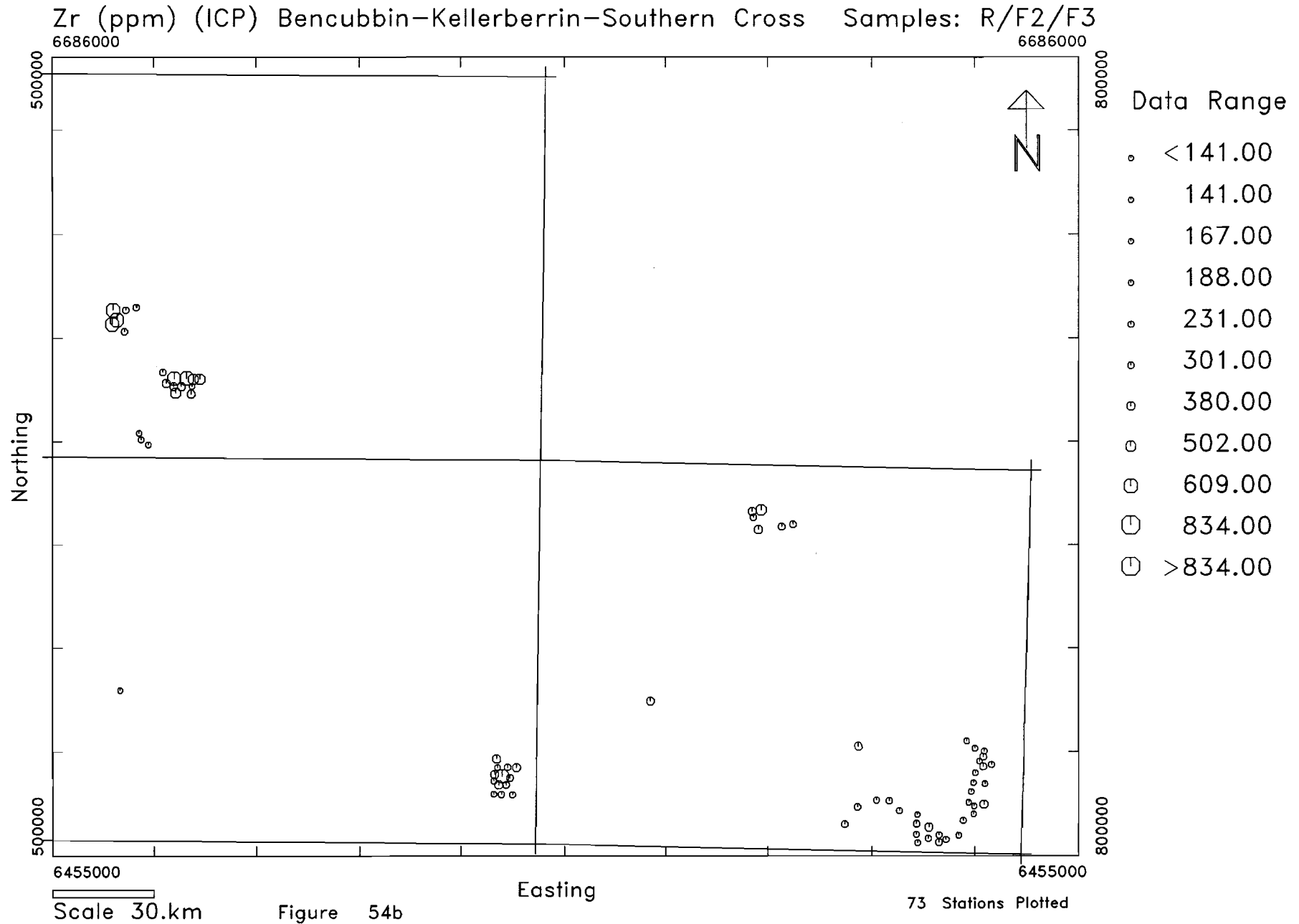
Ba (ppm) (ICP) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3



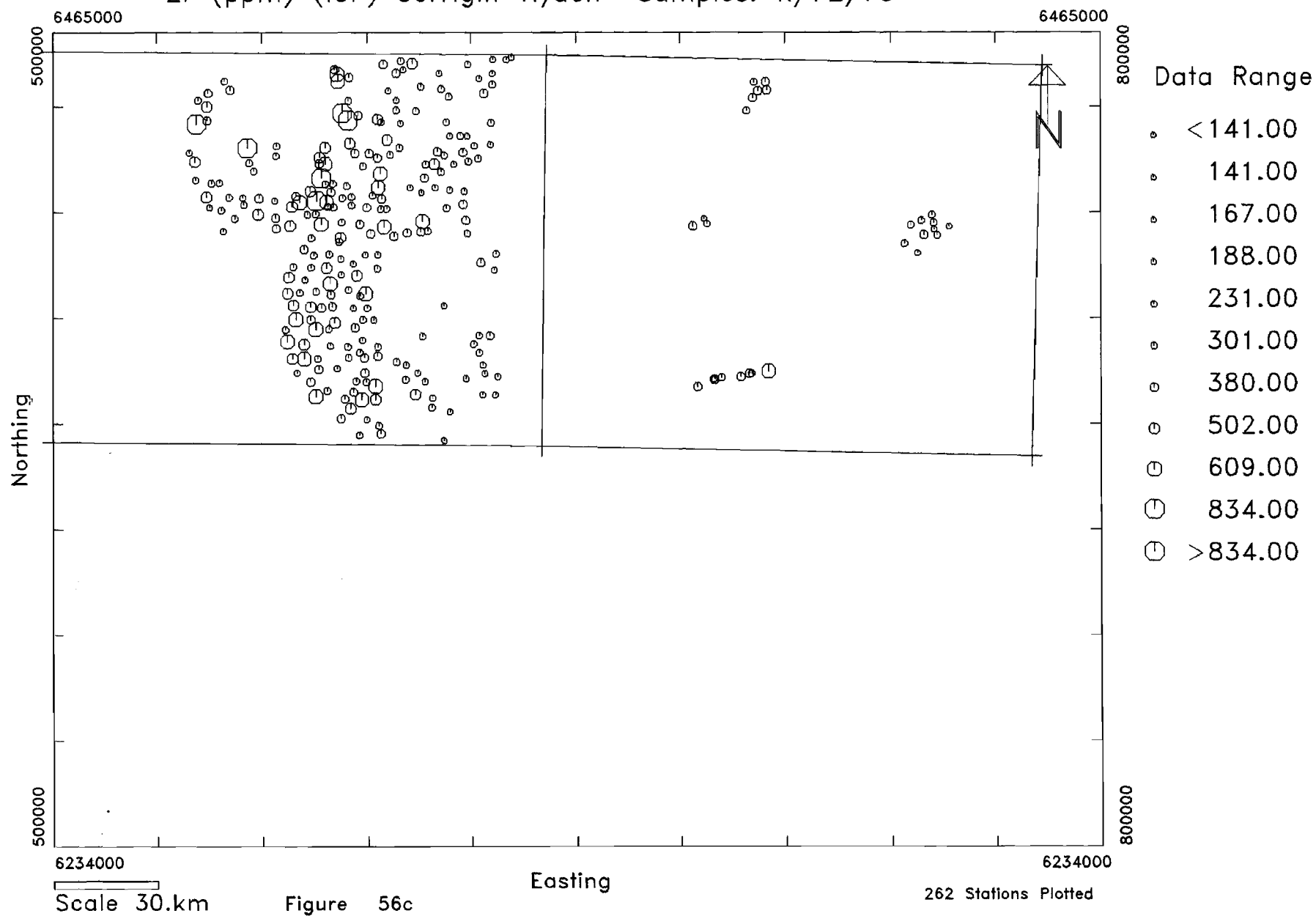


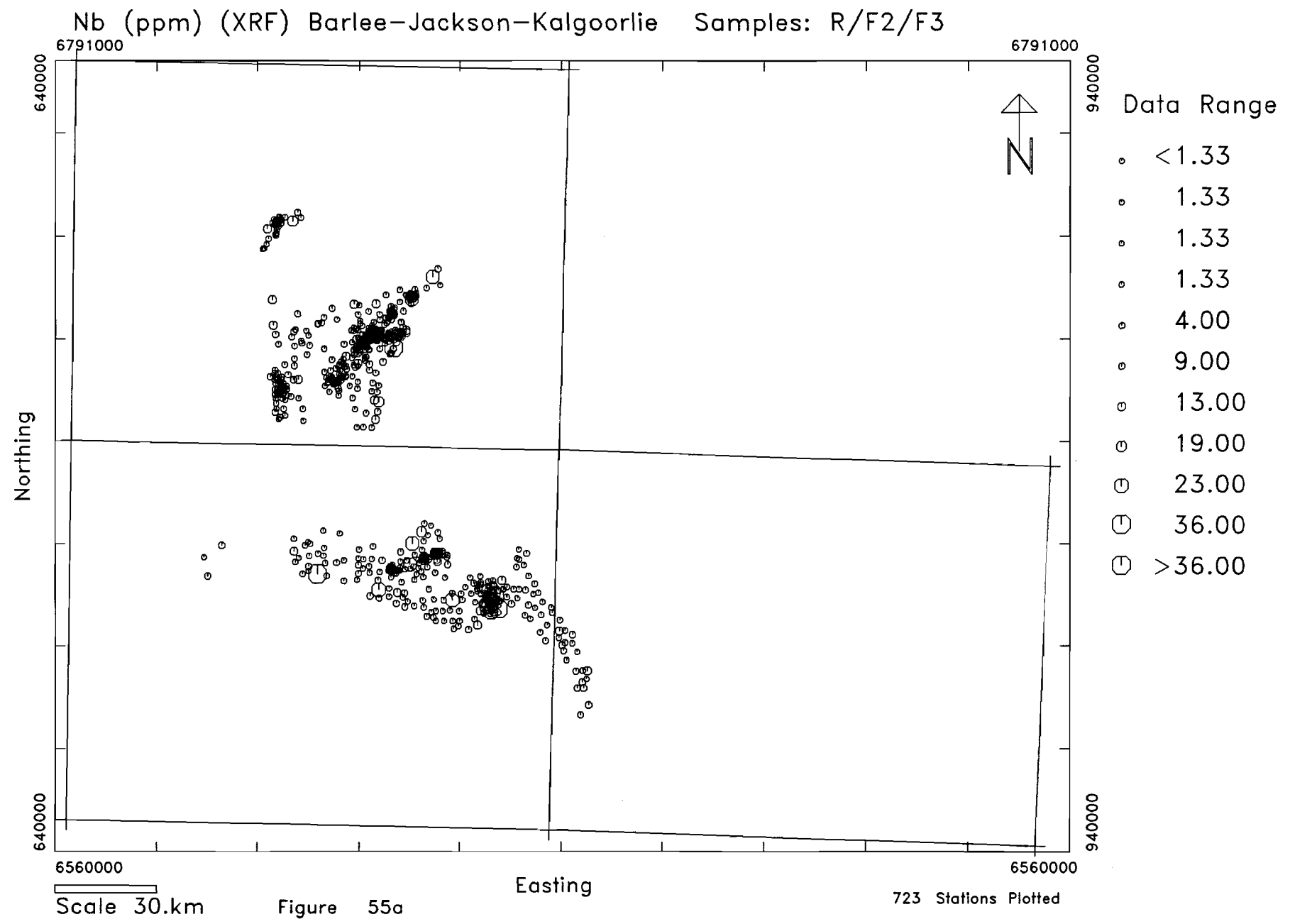
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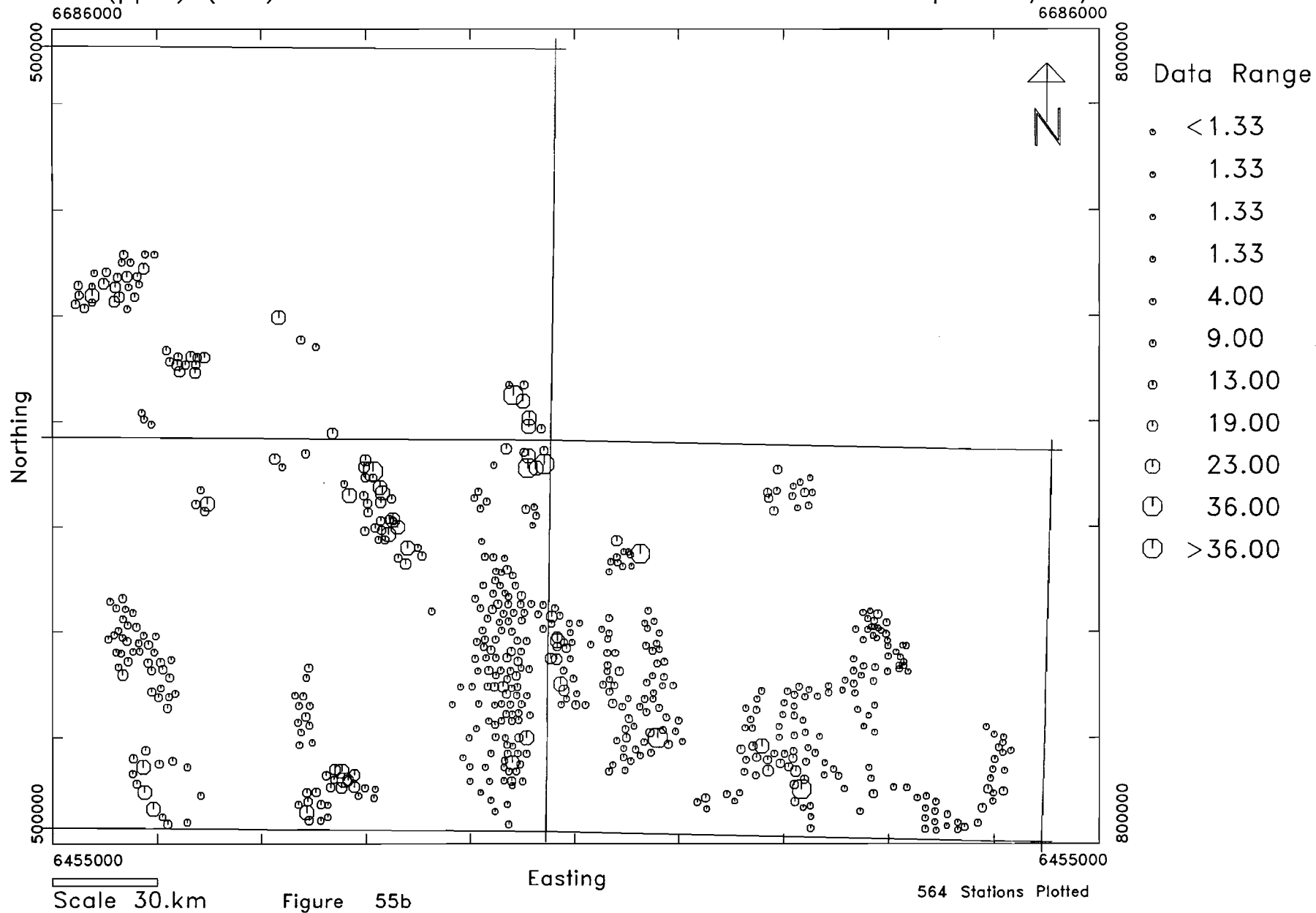


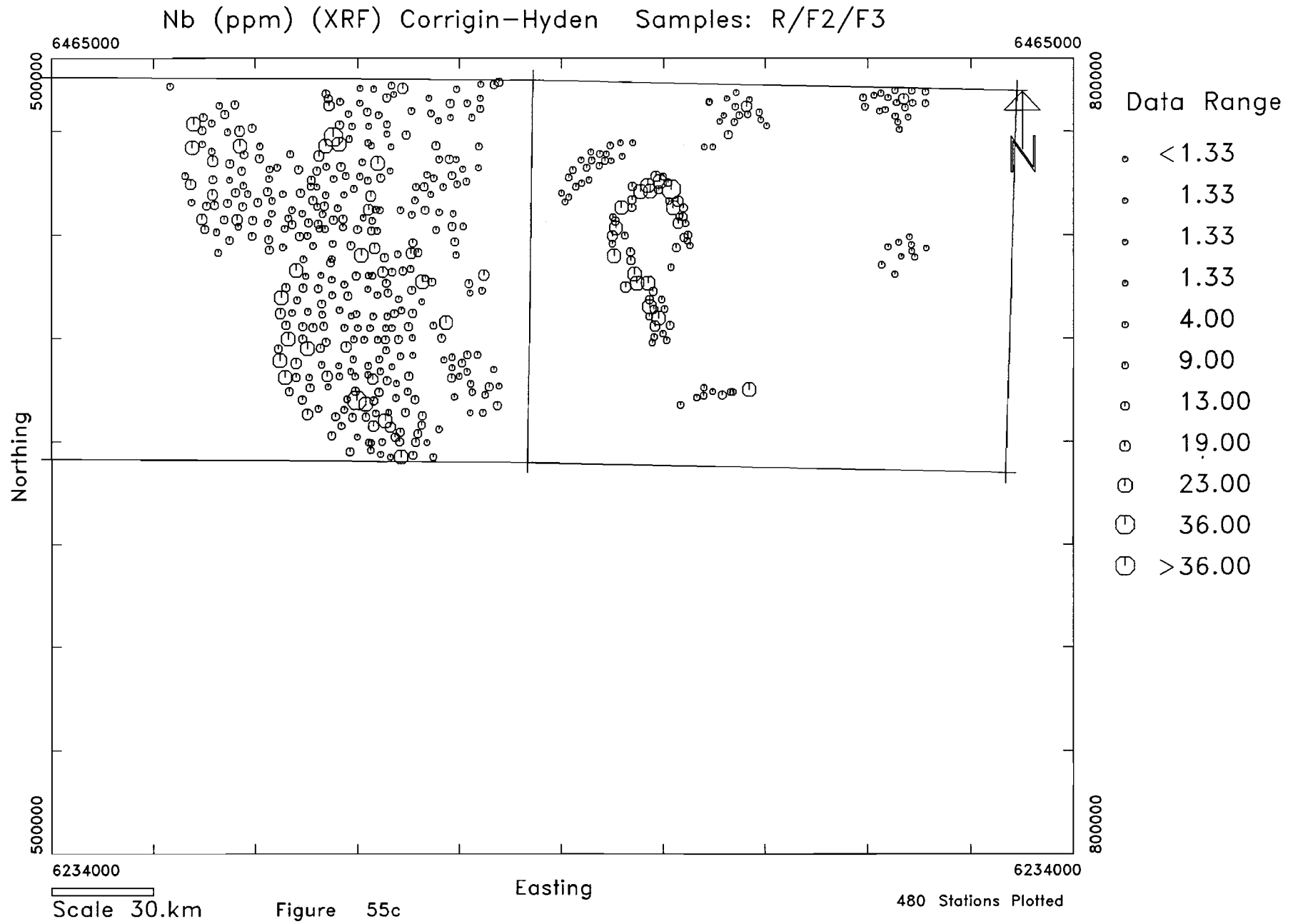
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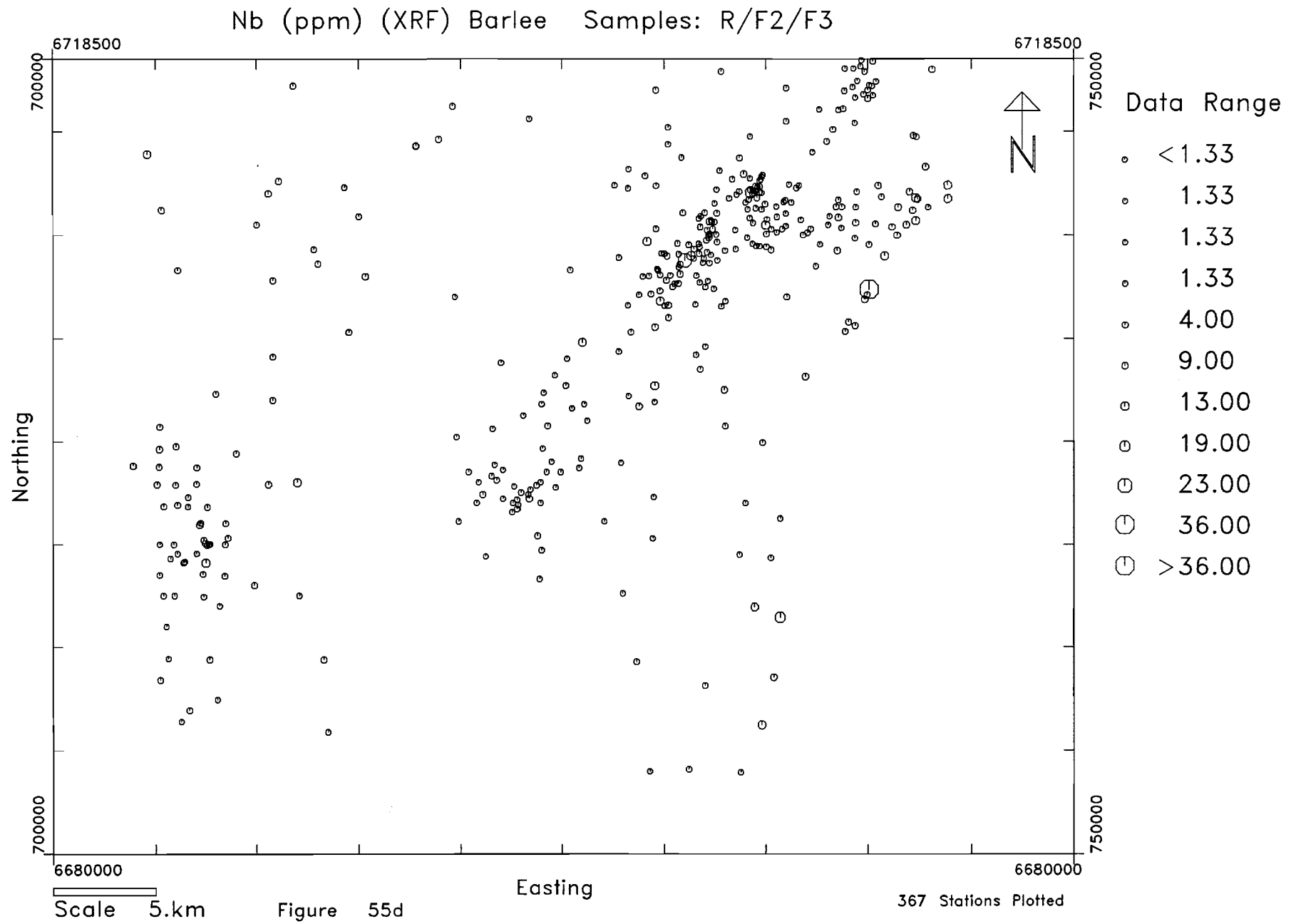


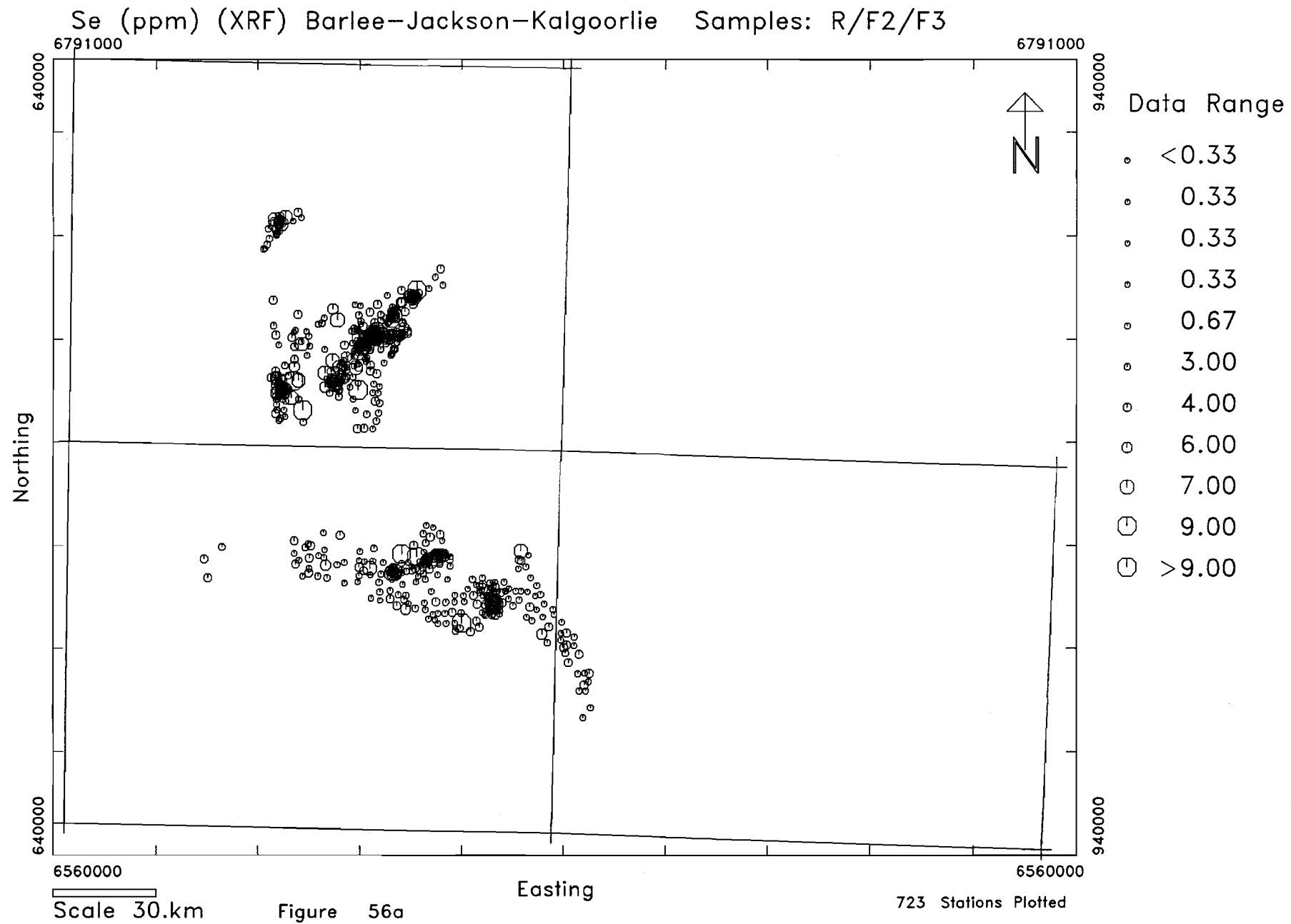


Nb (ppm) (XRF) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

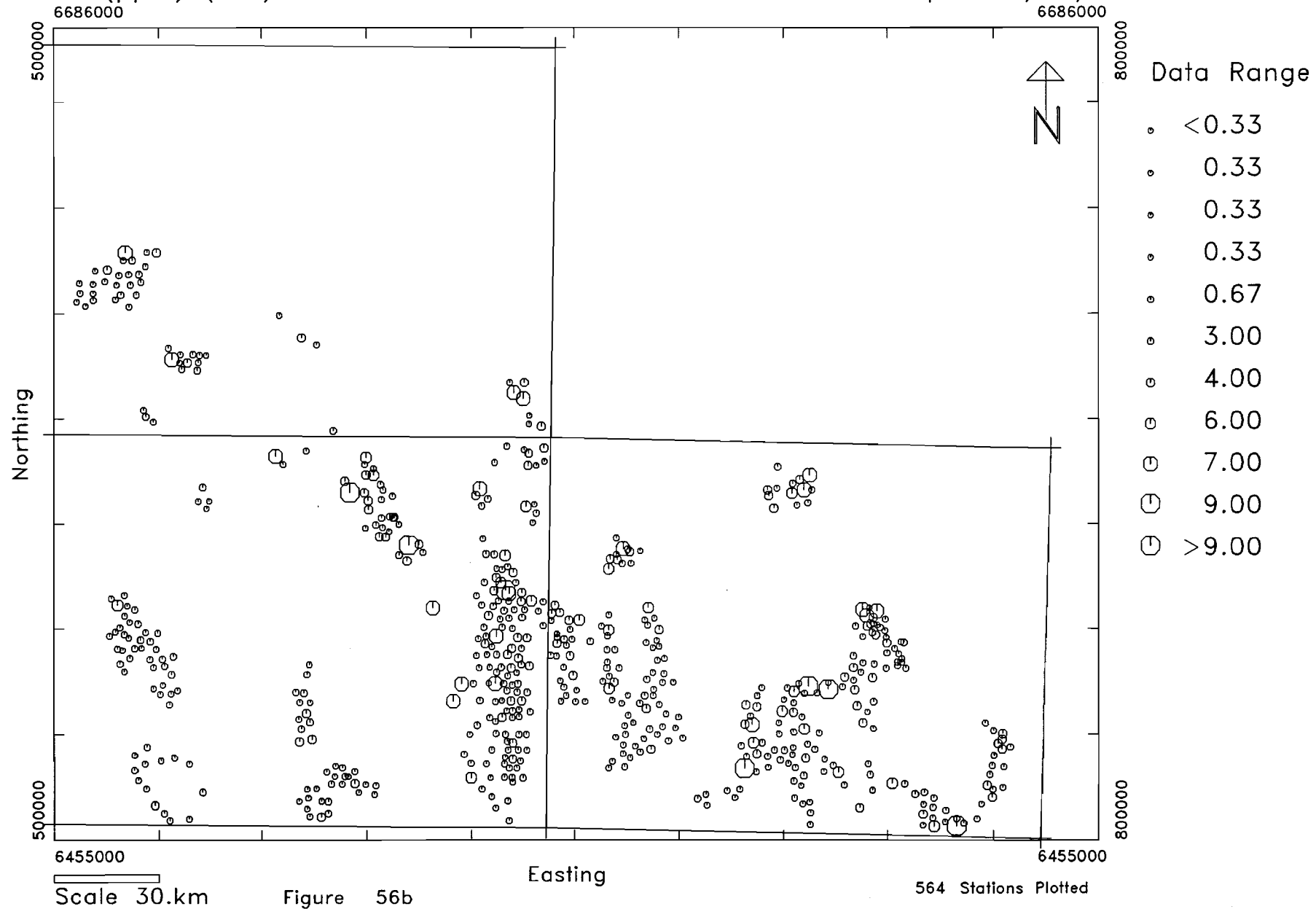


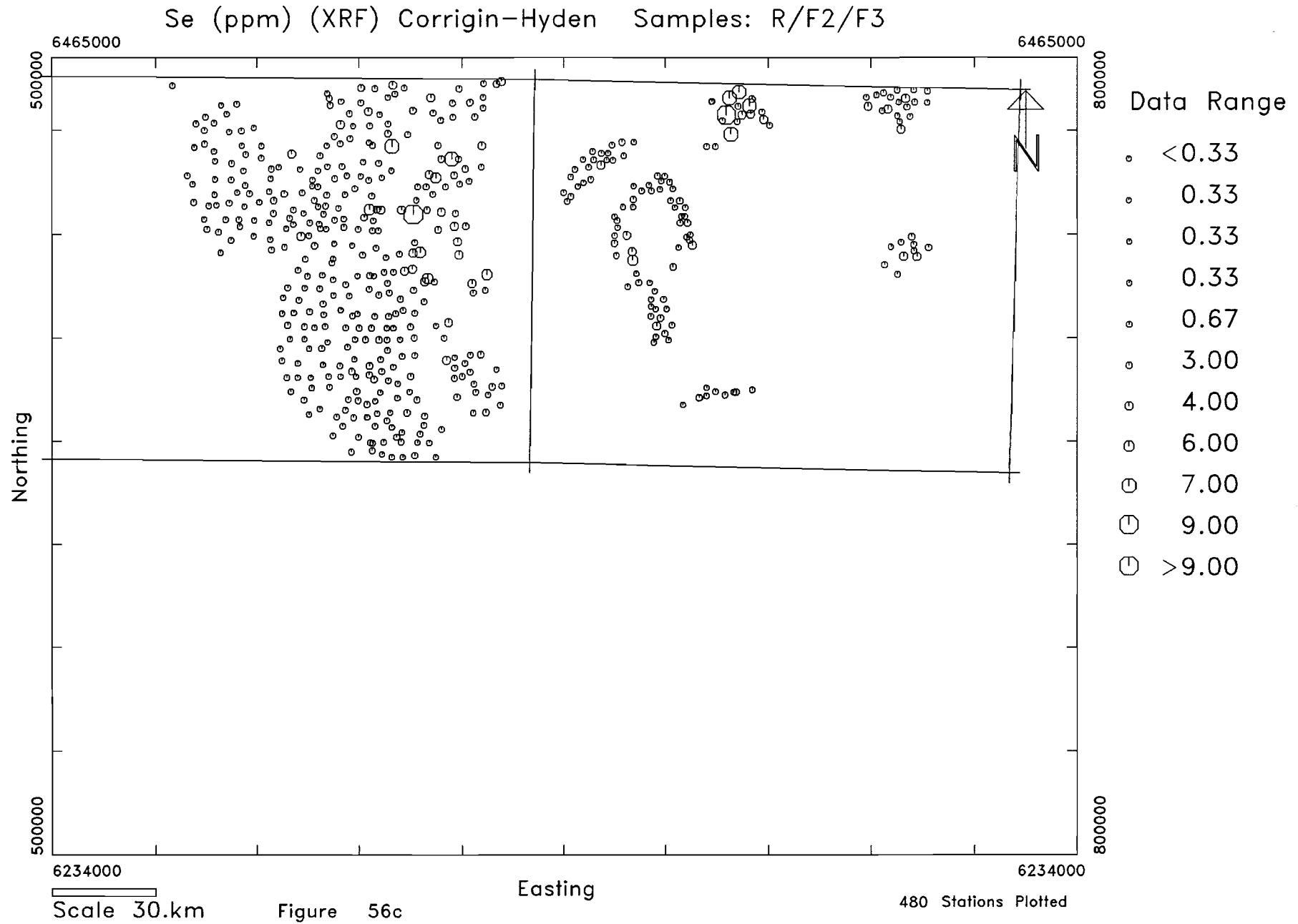


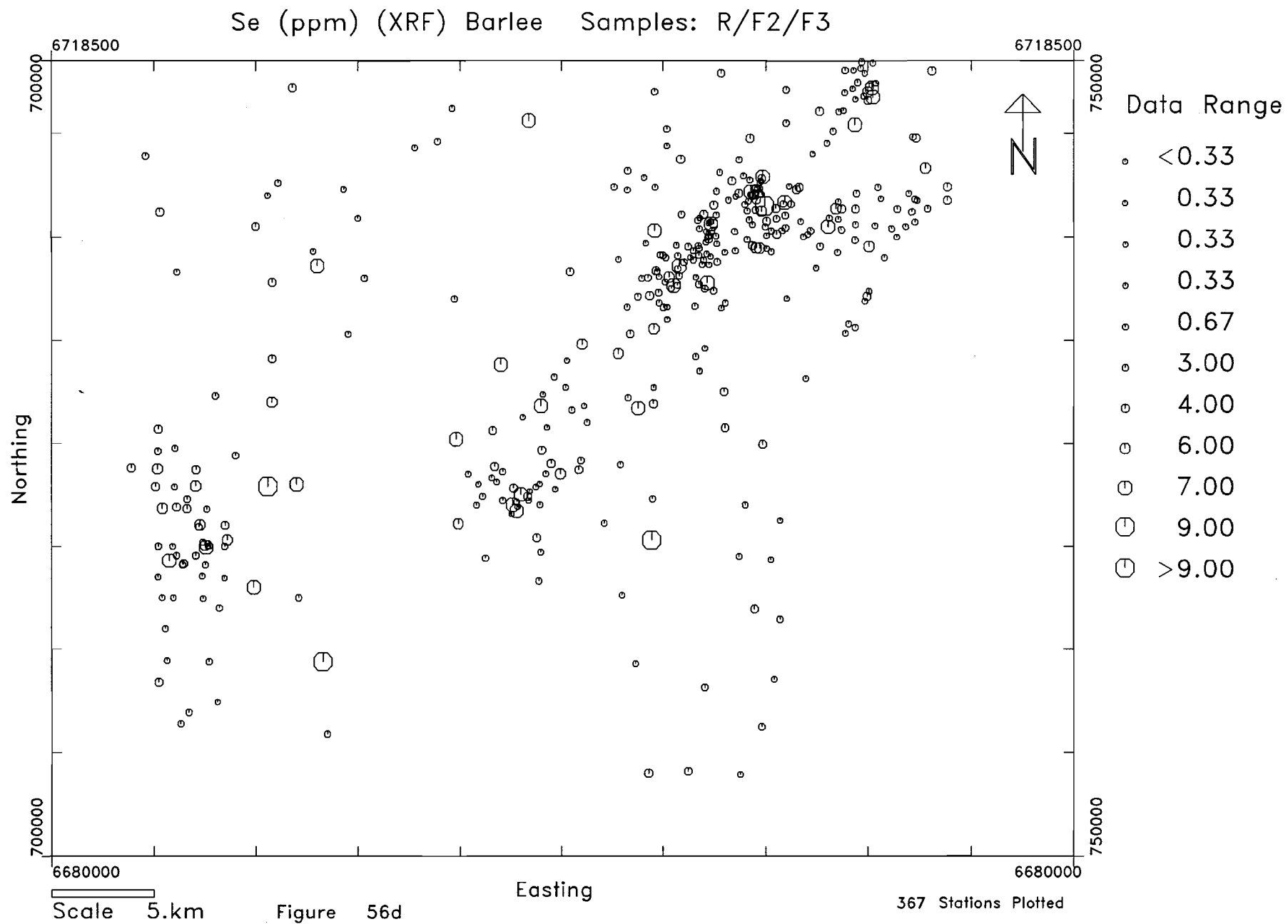


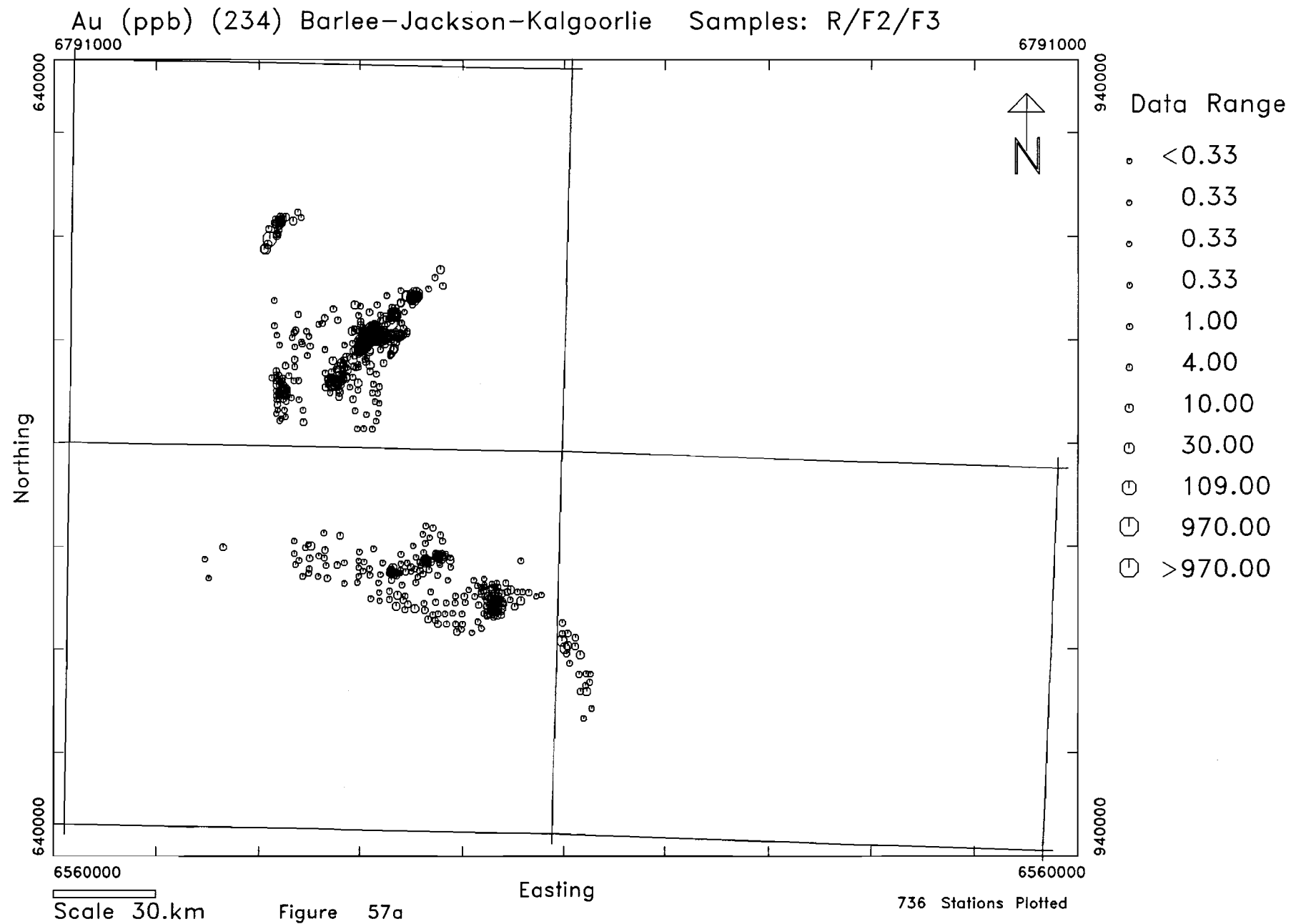


Se (ppm) (XRF) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3









Au (ppb) (234) Bencubbin-Kellerberrin-Southern Cross Samples: R/F2/F3

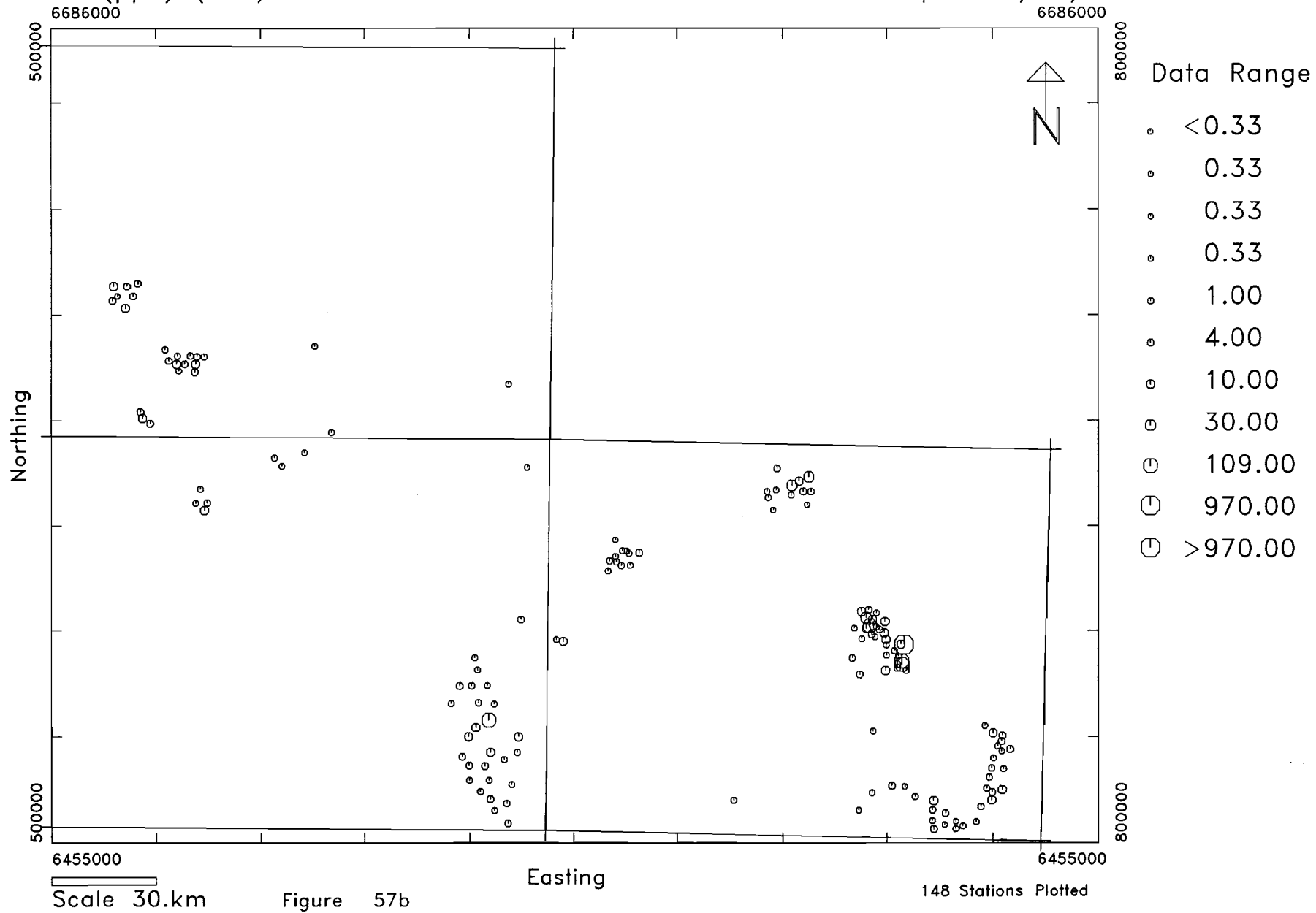
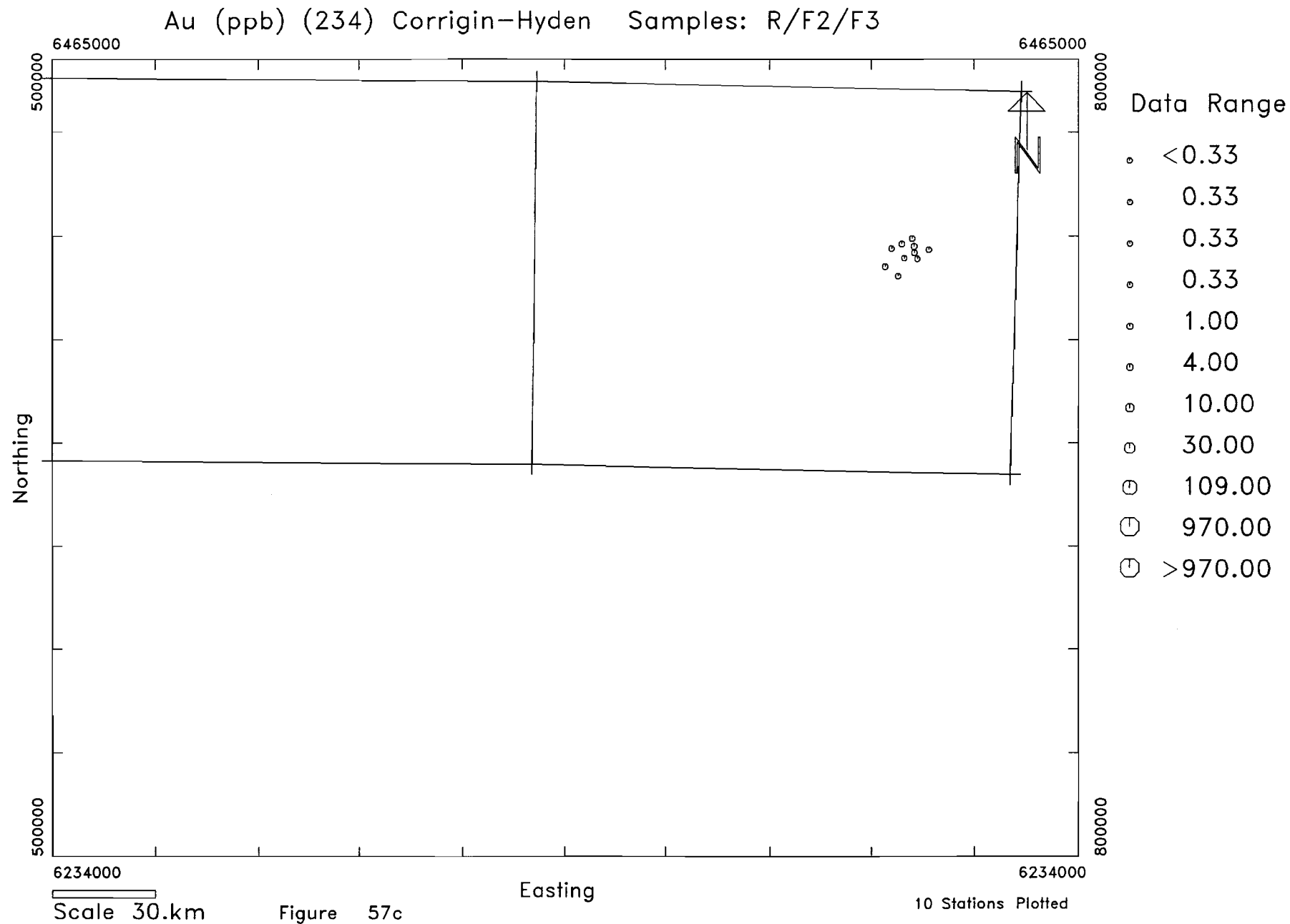
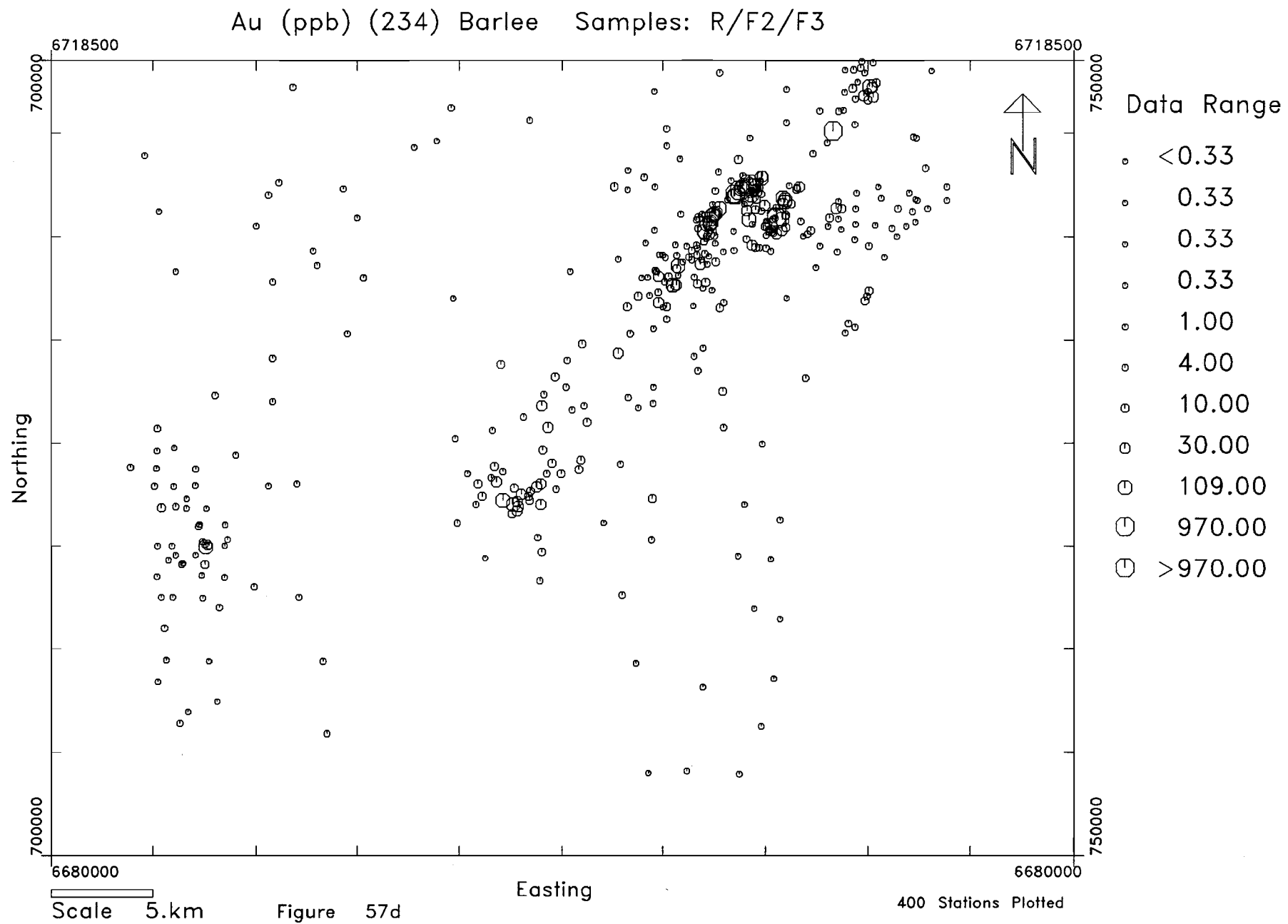
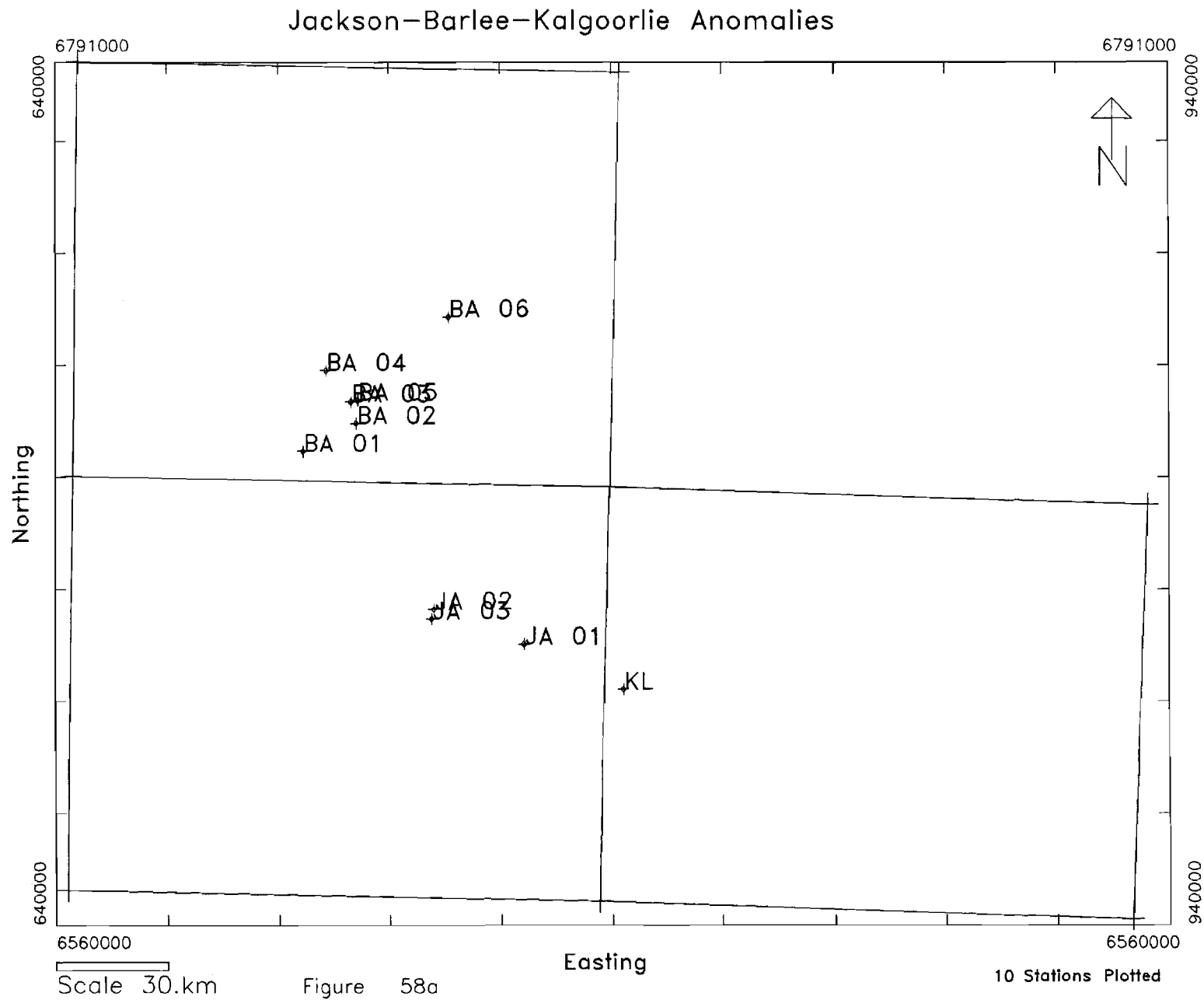


Figure 57b







Bencubbin-Kellerberrin-Southern Cross Anomalies

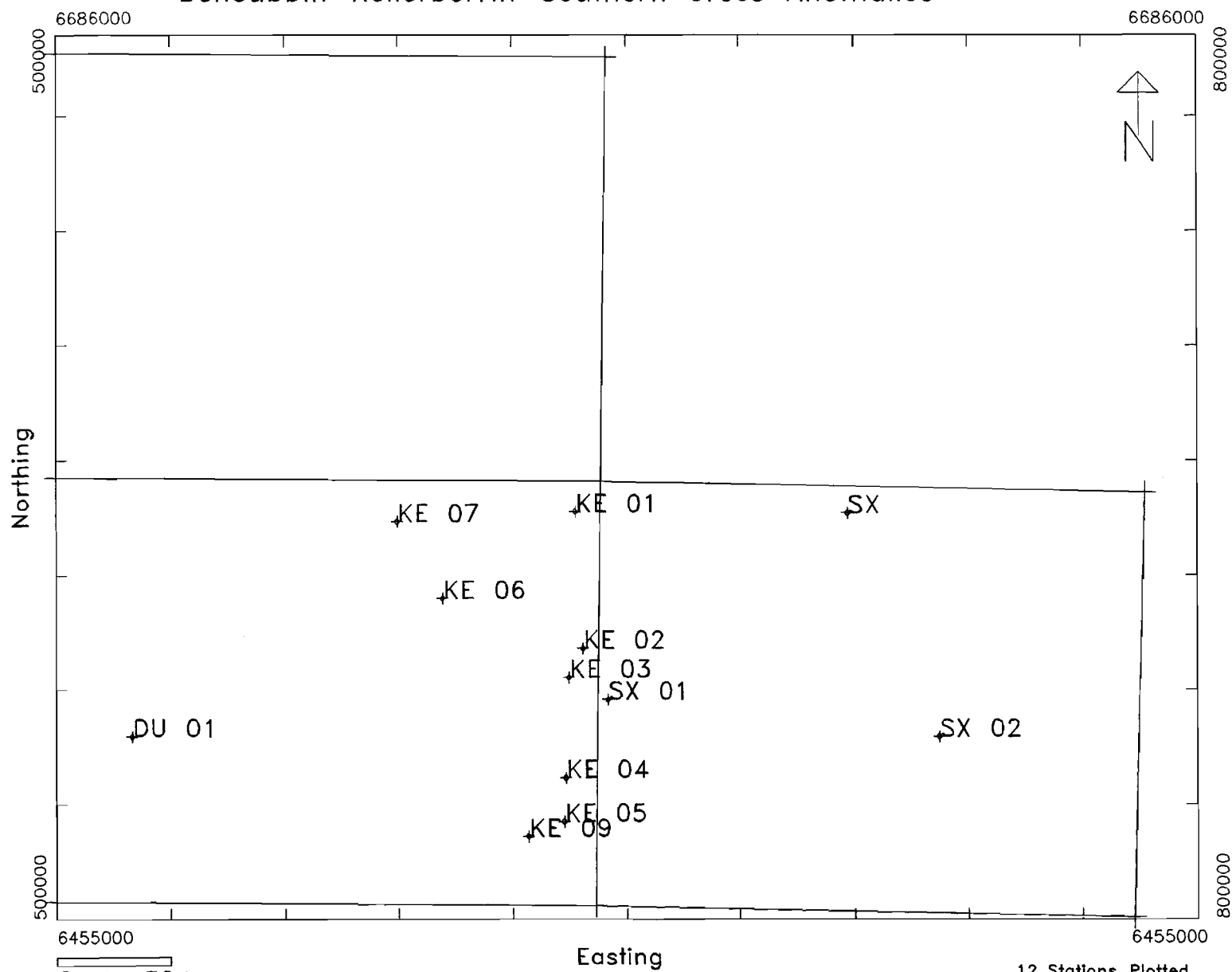


Figure 58b

12 Stations Plotted

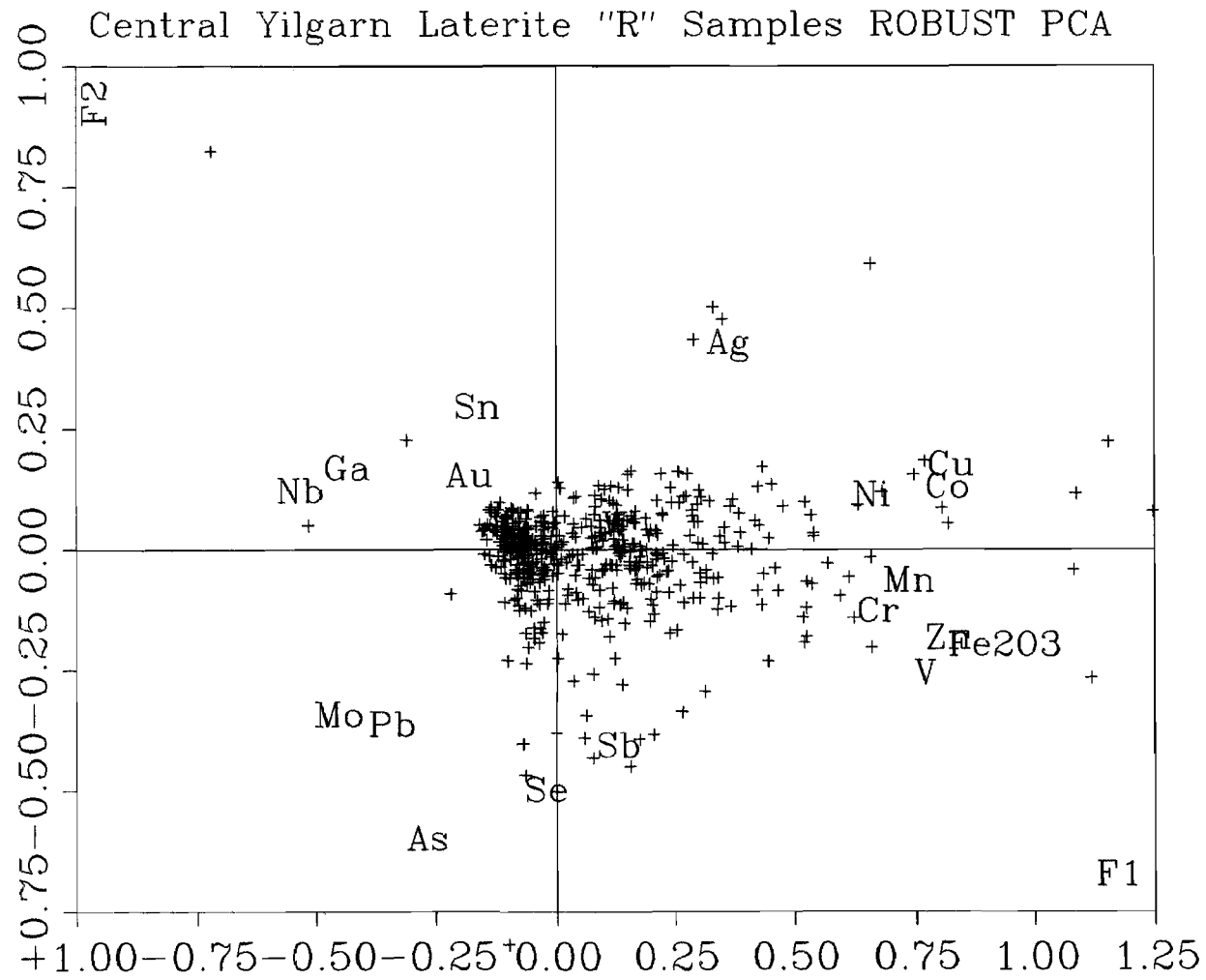
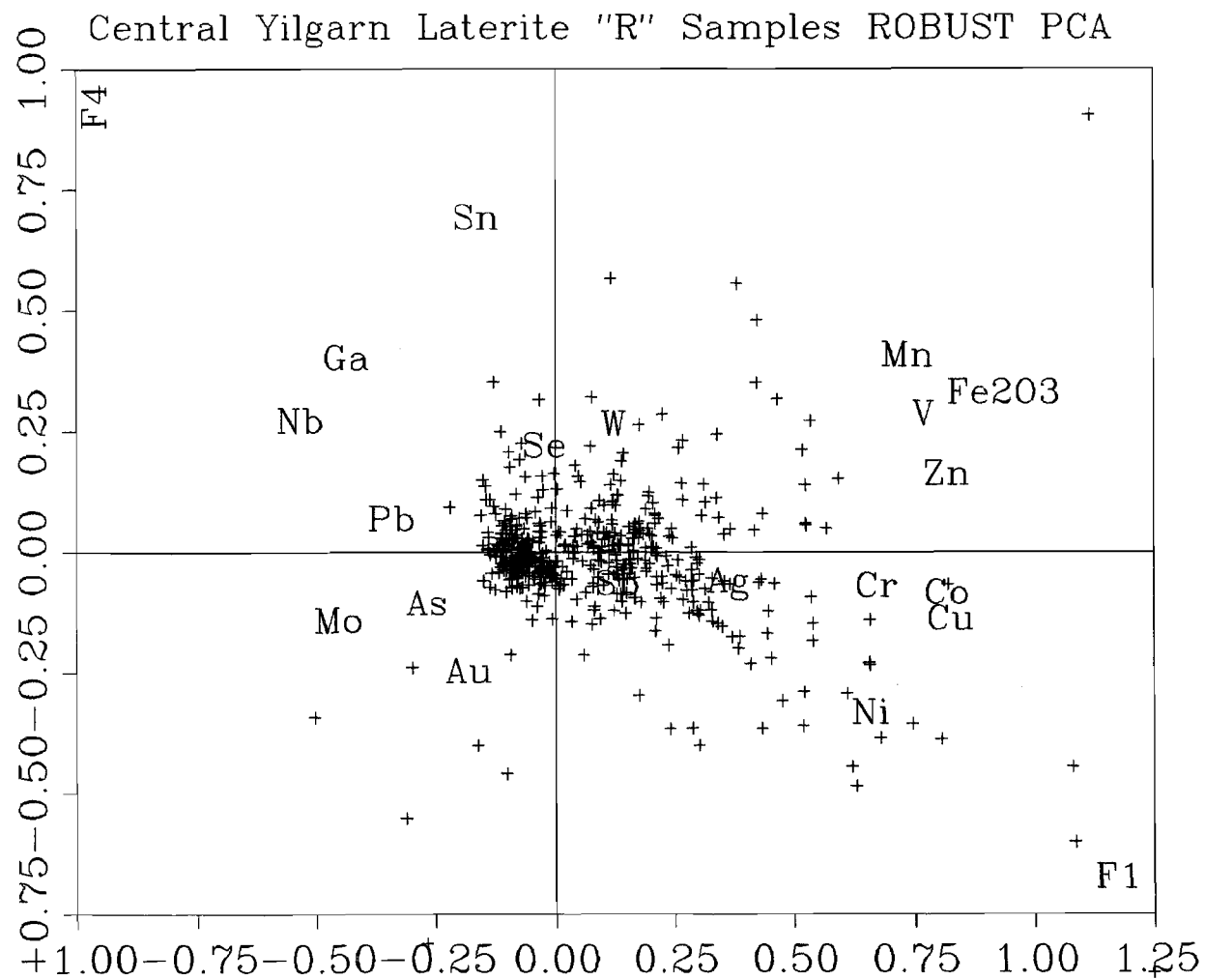
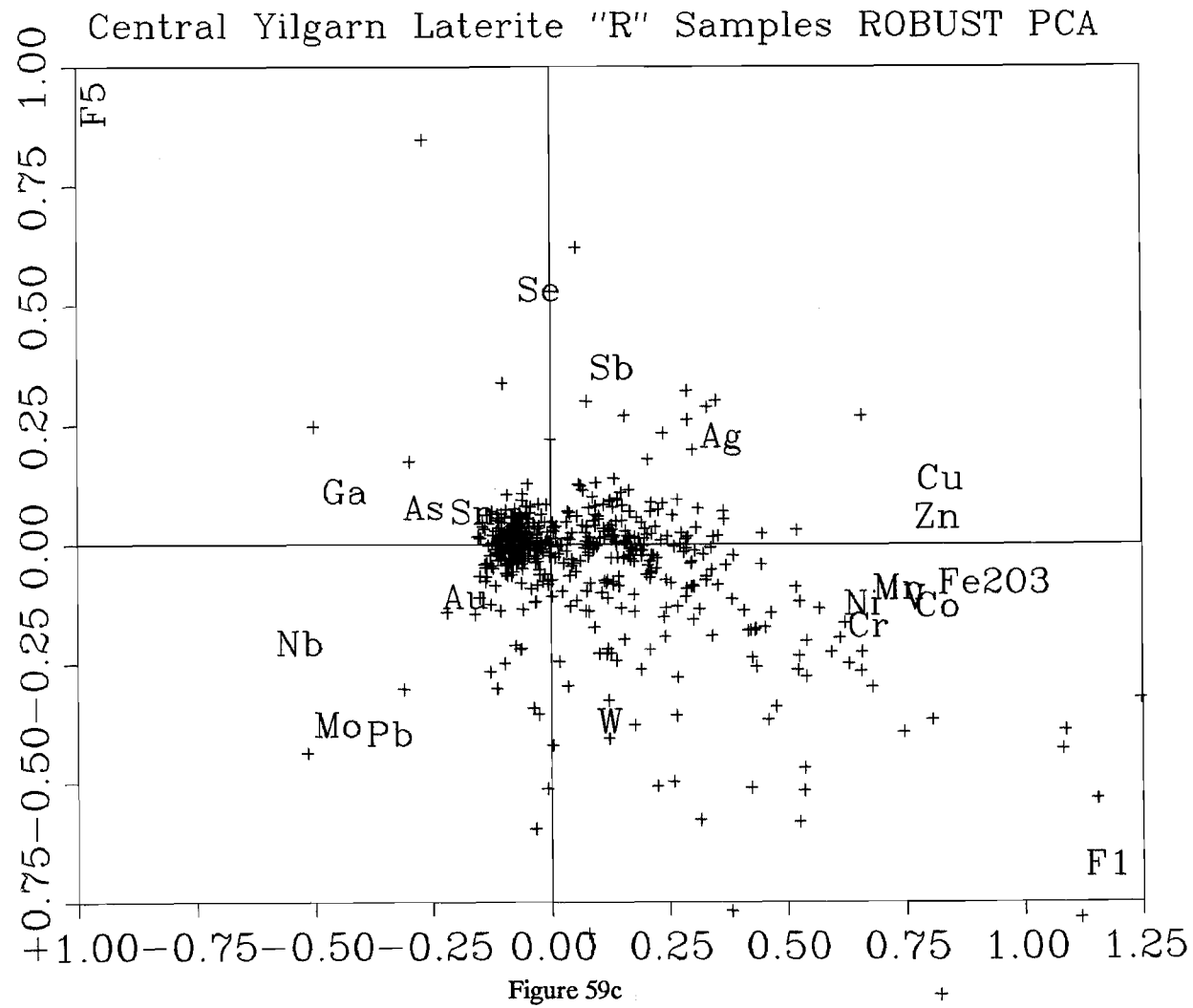


Figure 59a





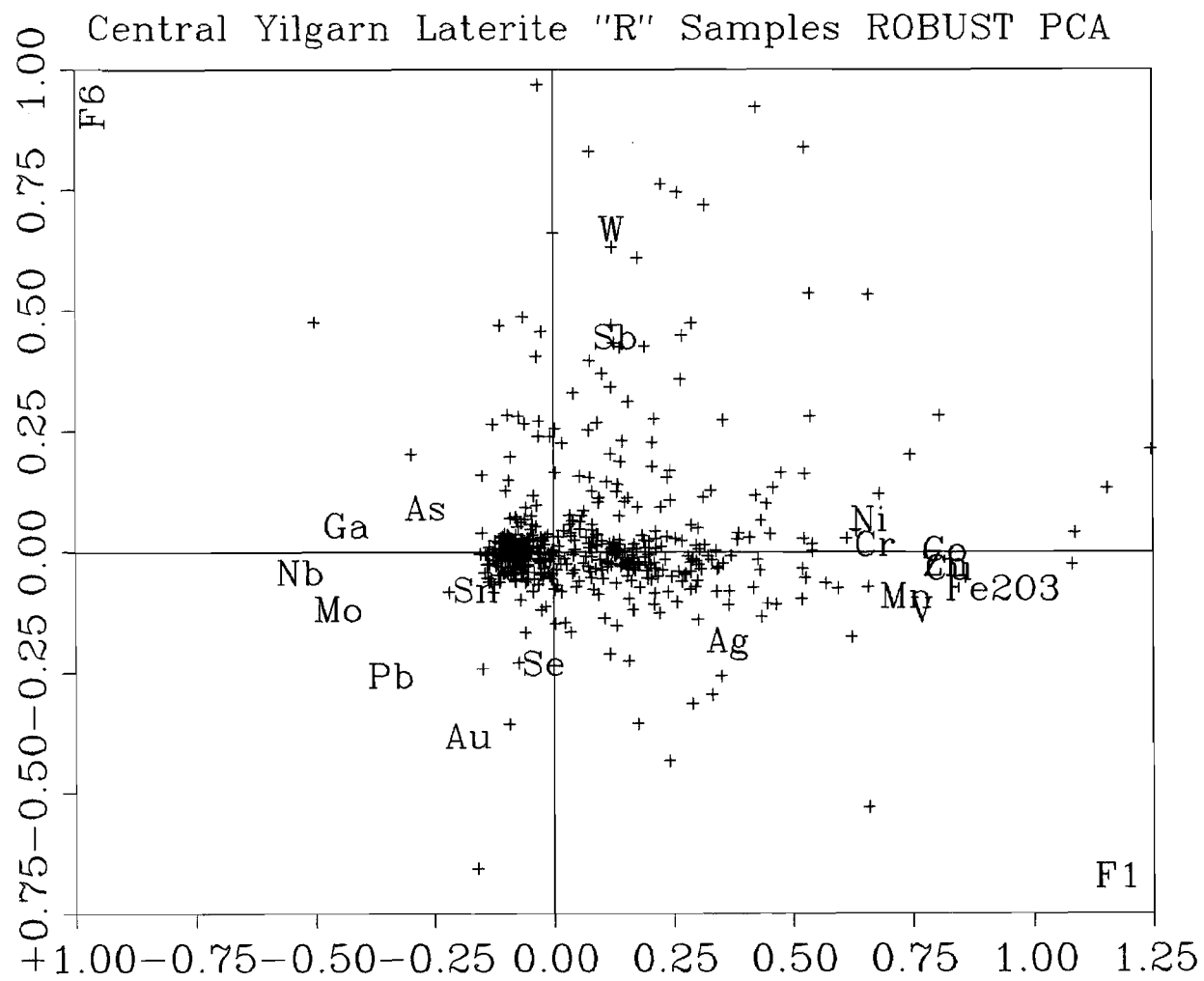


Figure 59d

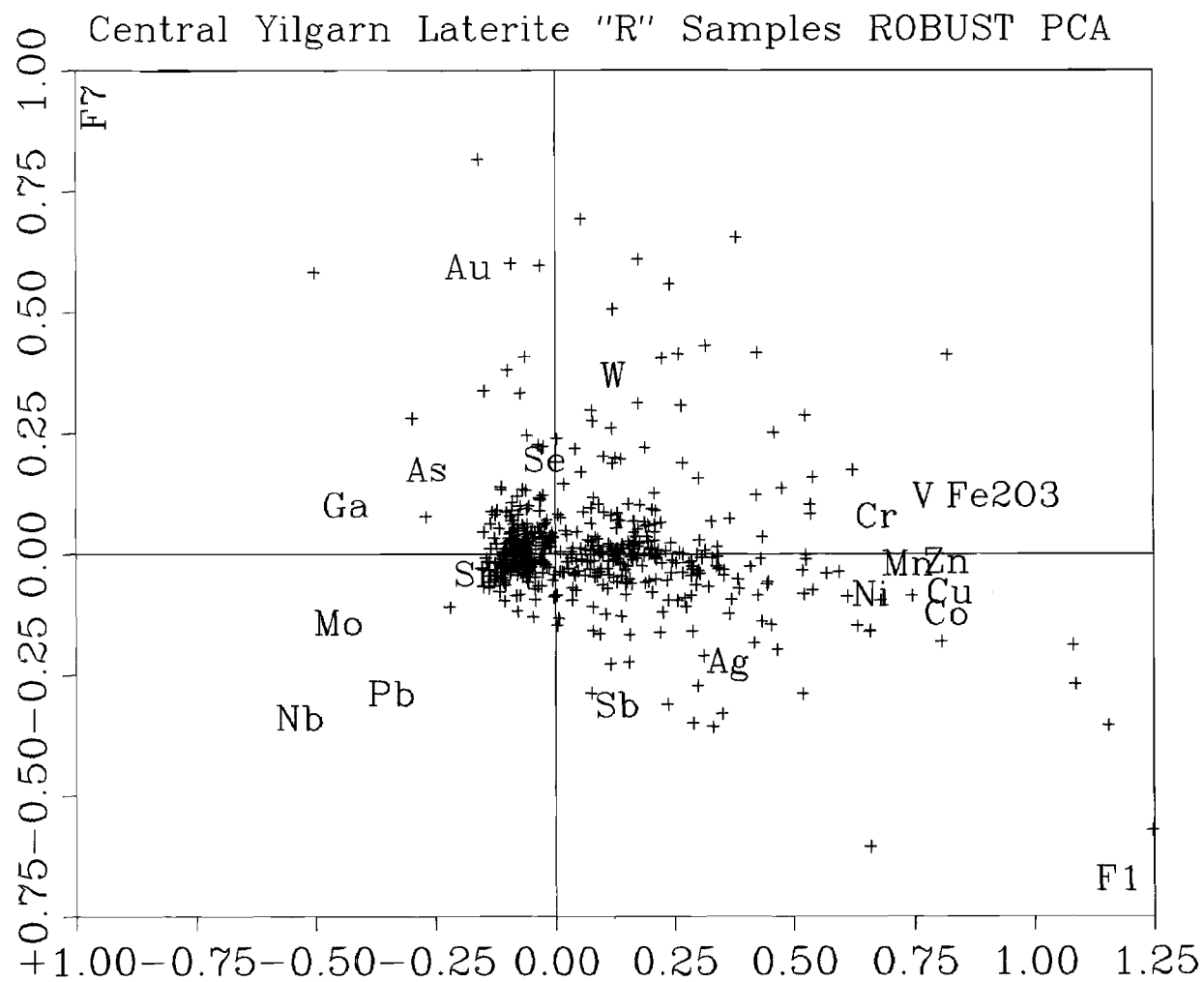


Figure 59e

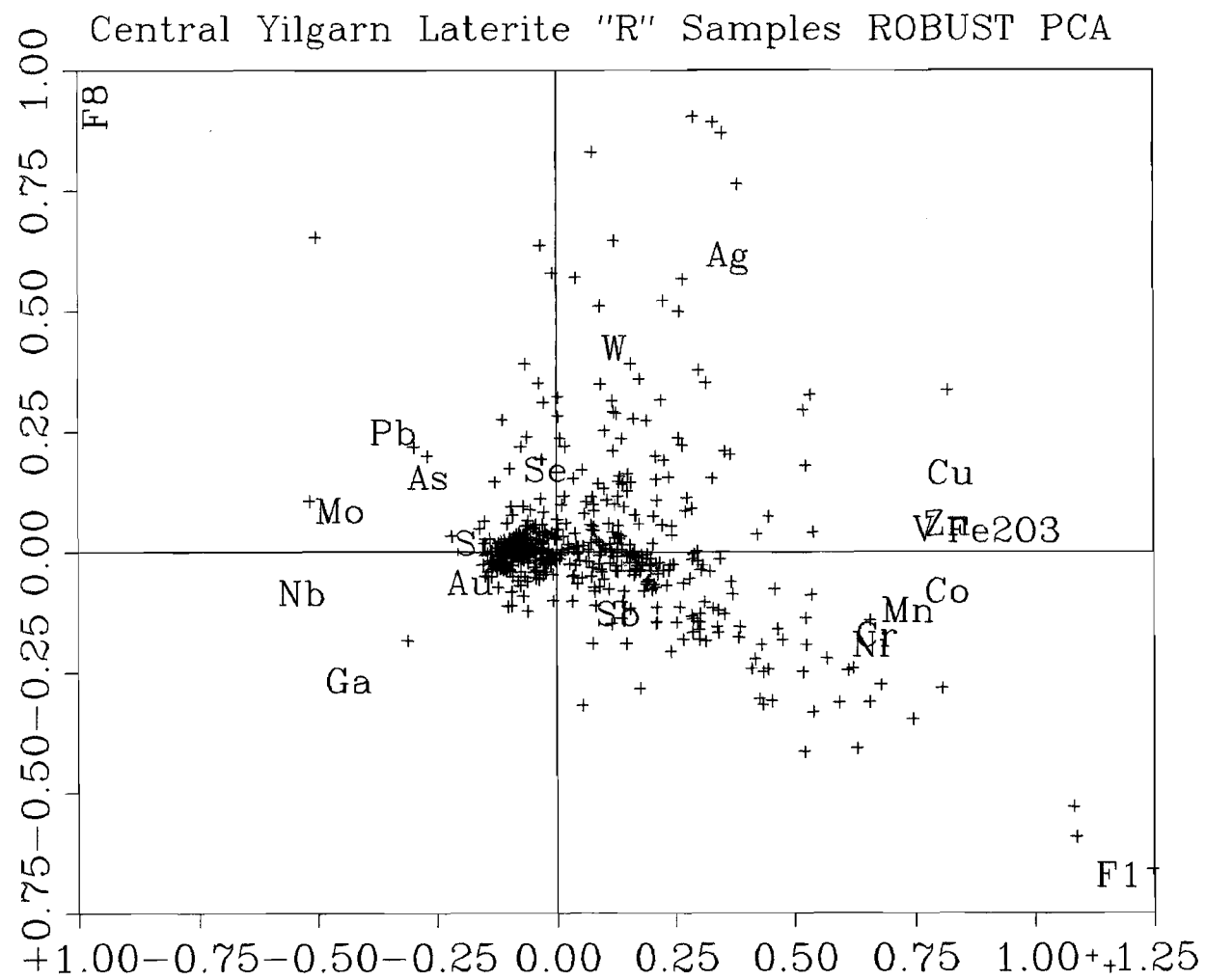


Figure 59f

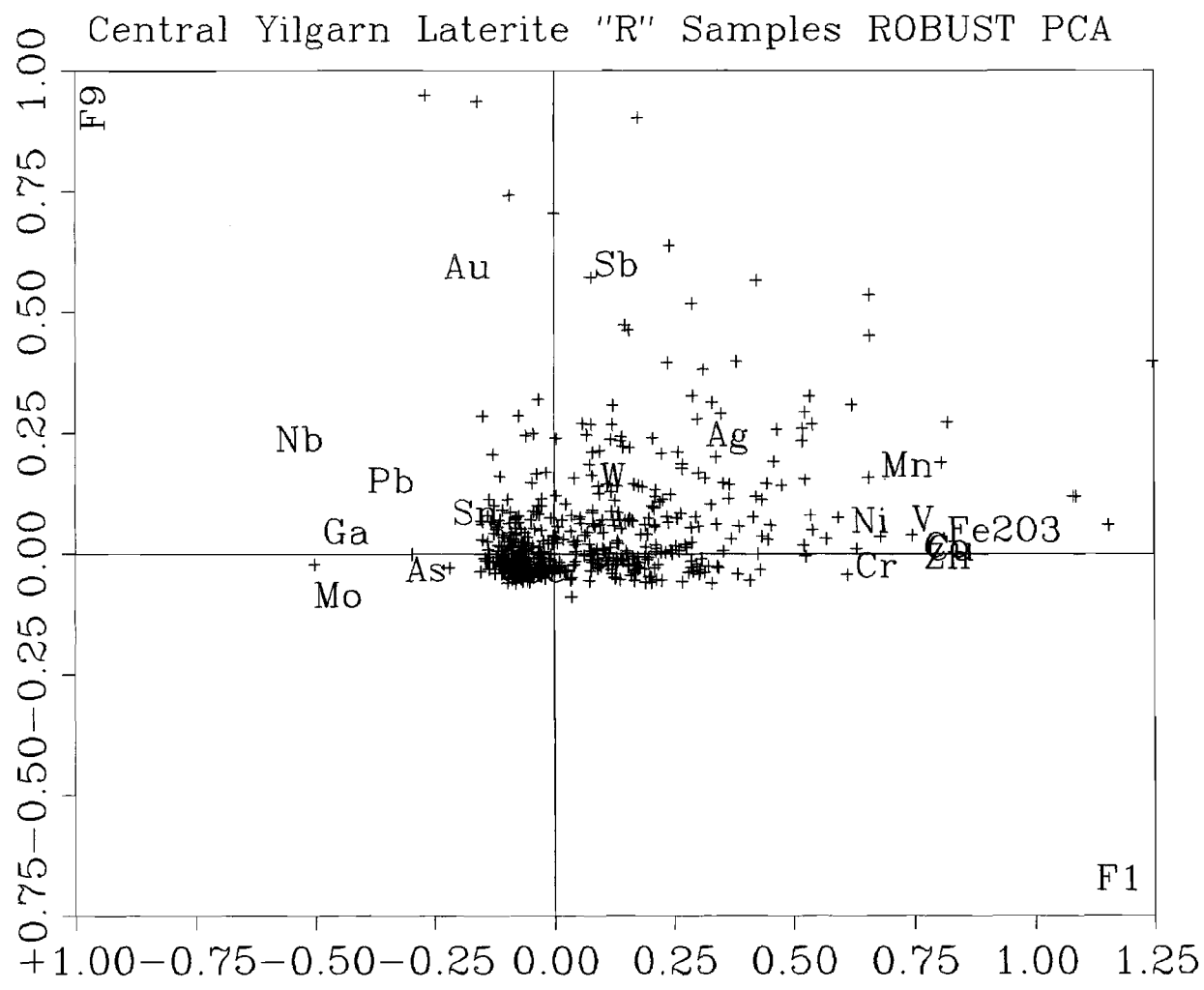
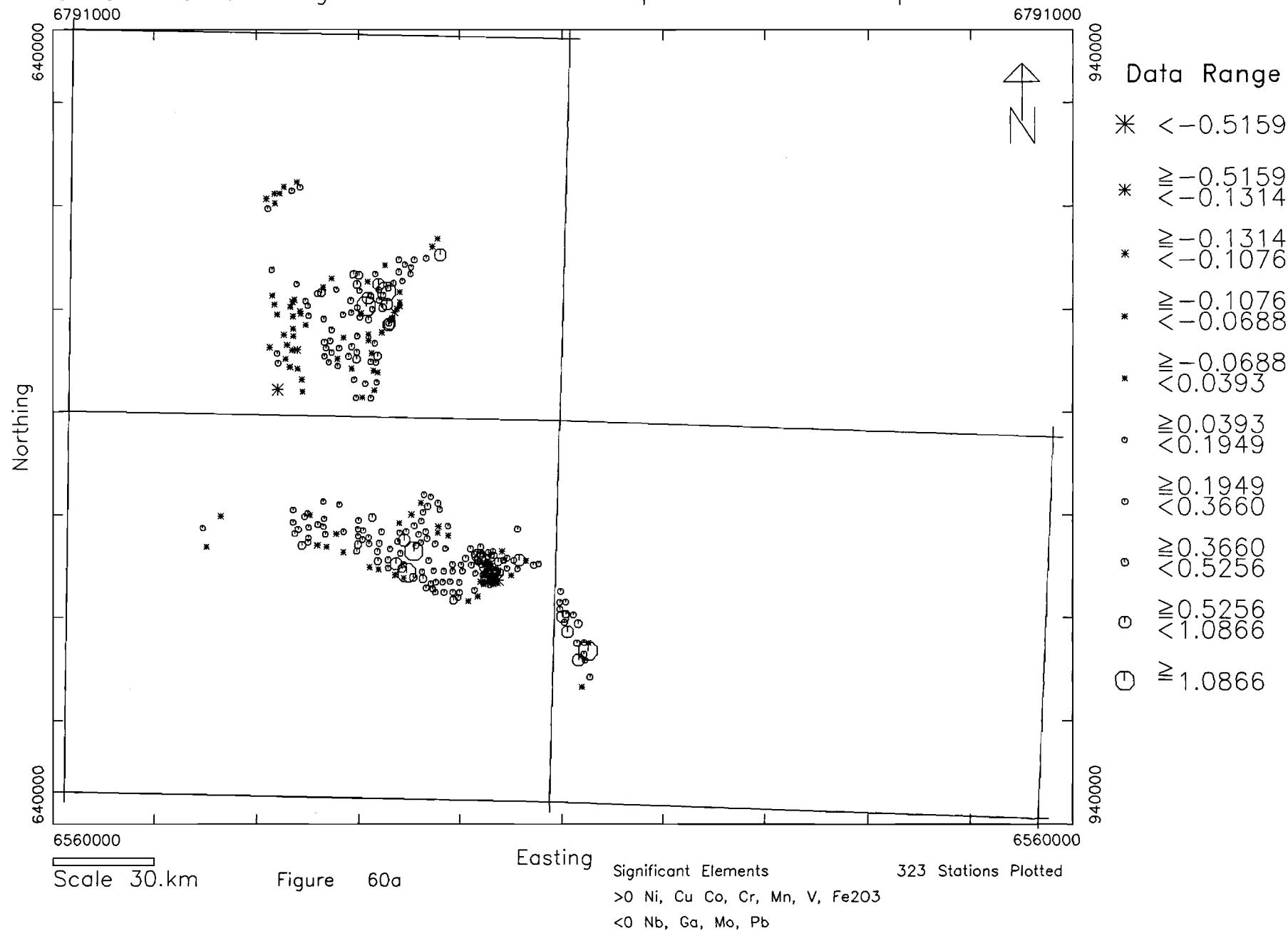
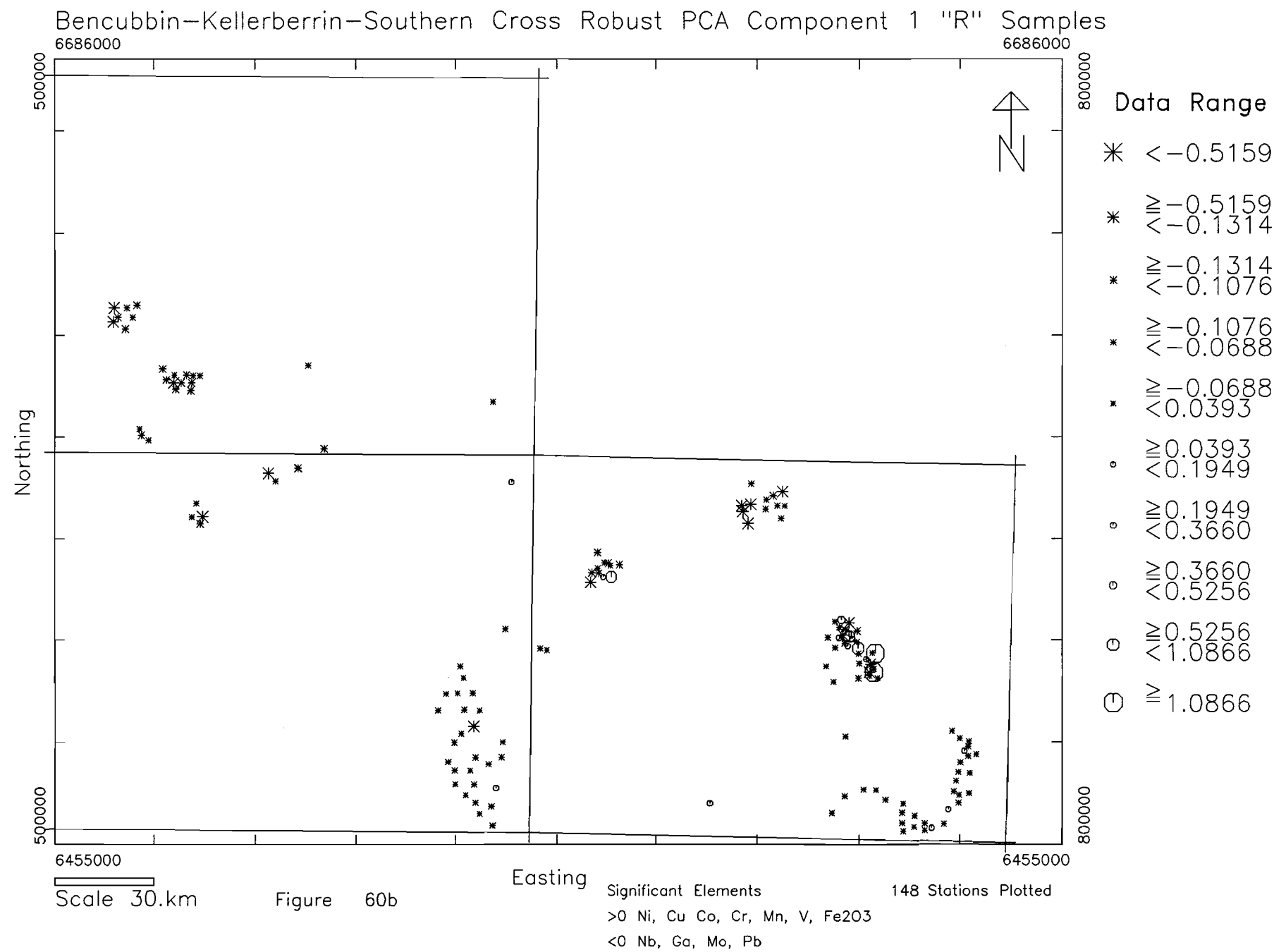


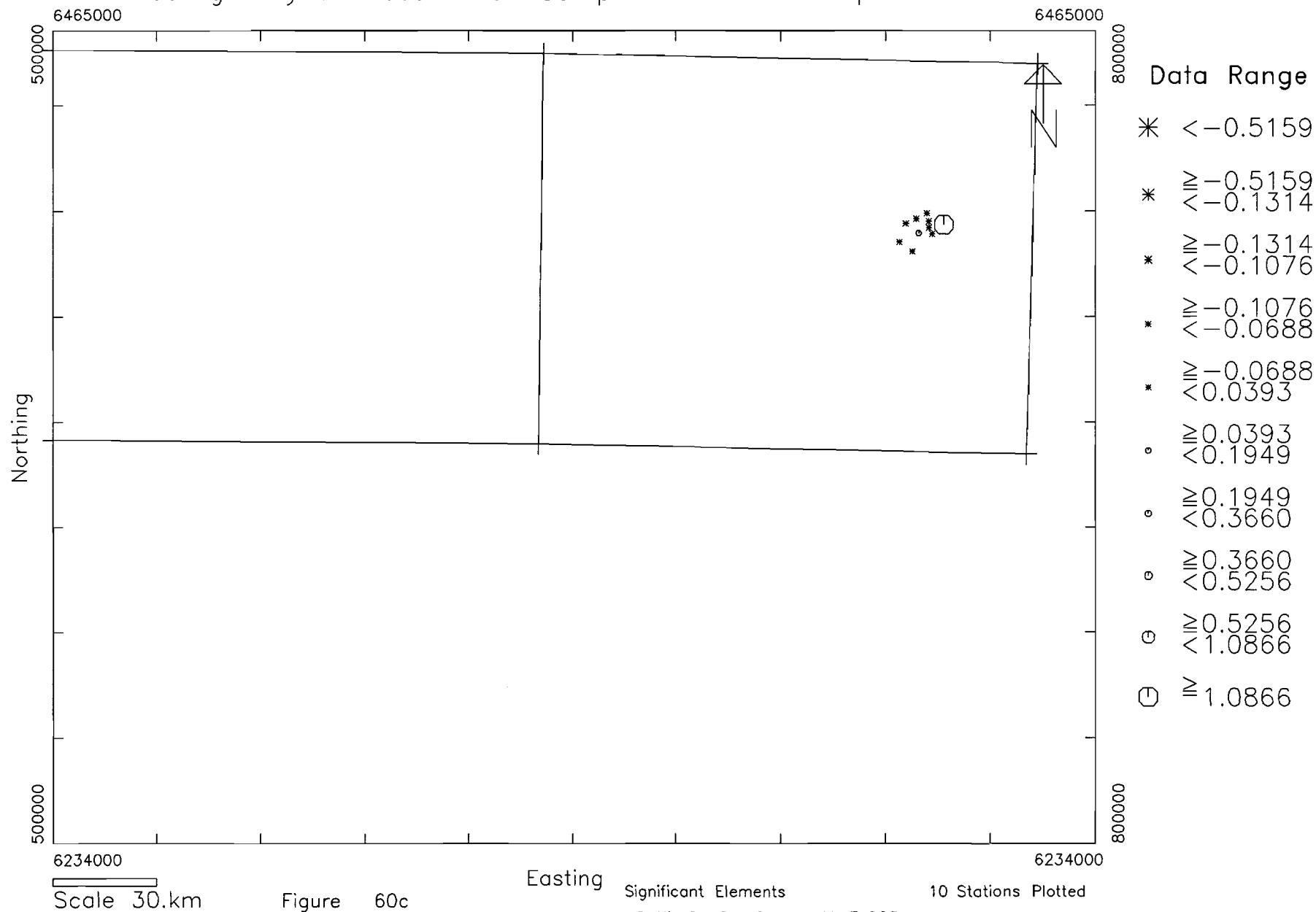
Figure 59g

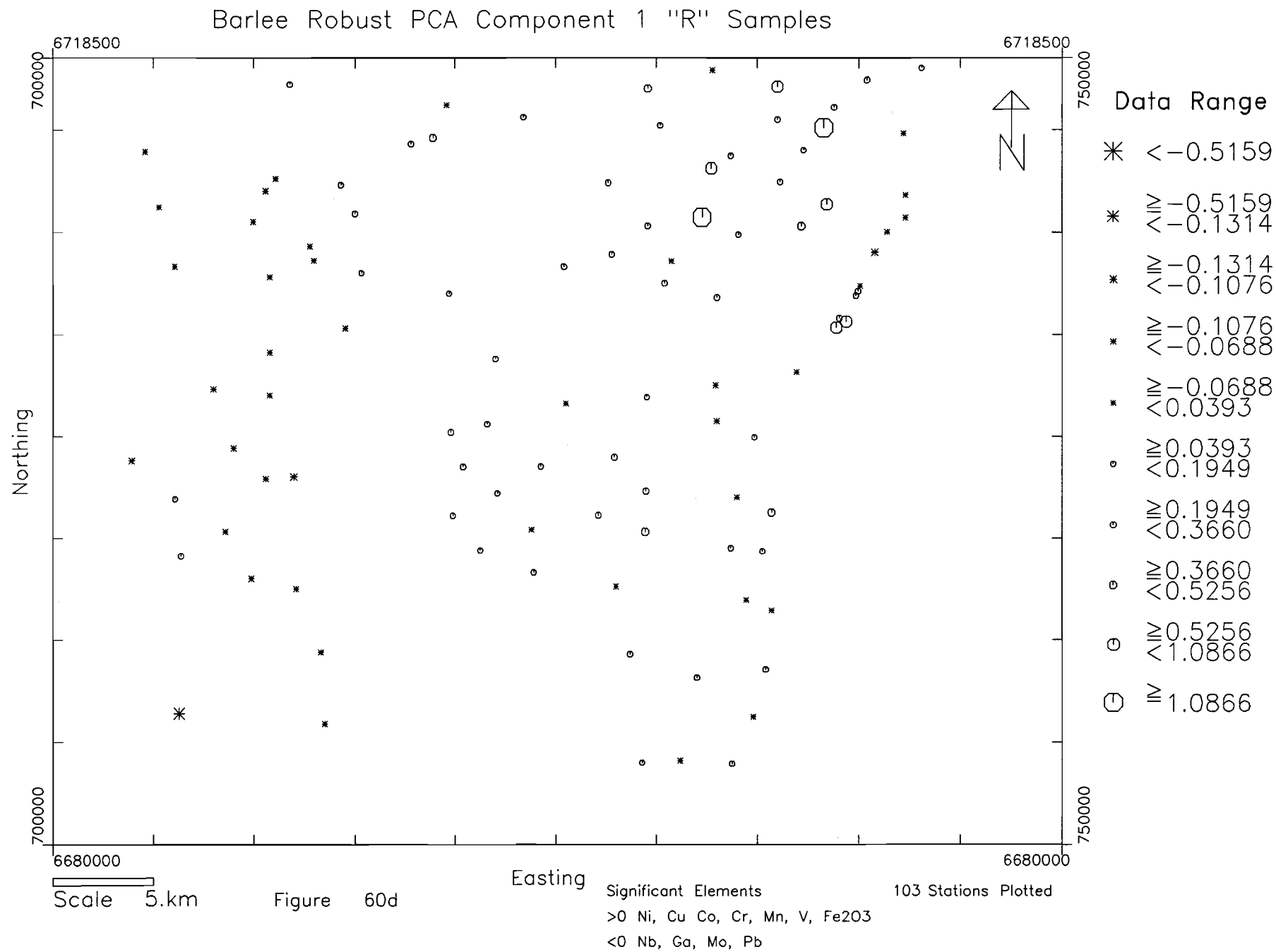
Barlee-Jackson-Kalgoorlie Robust PCA Component 1 "R" Samples



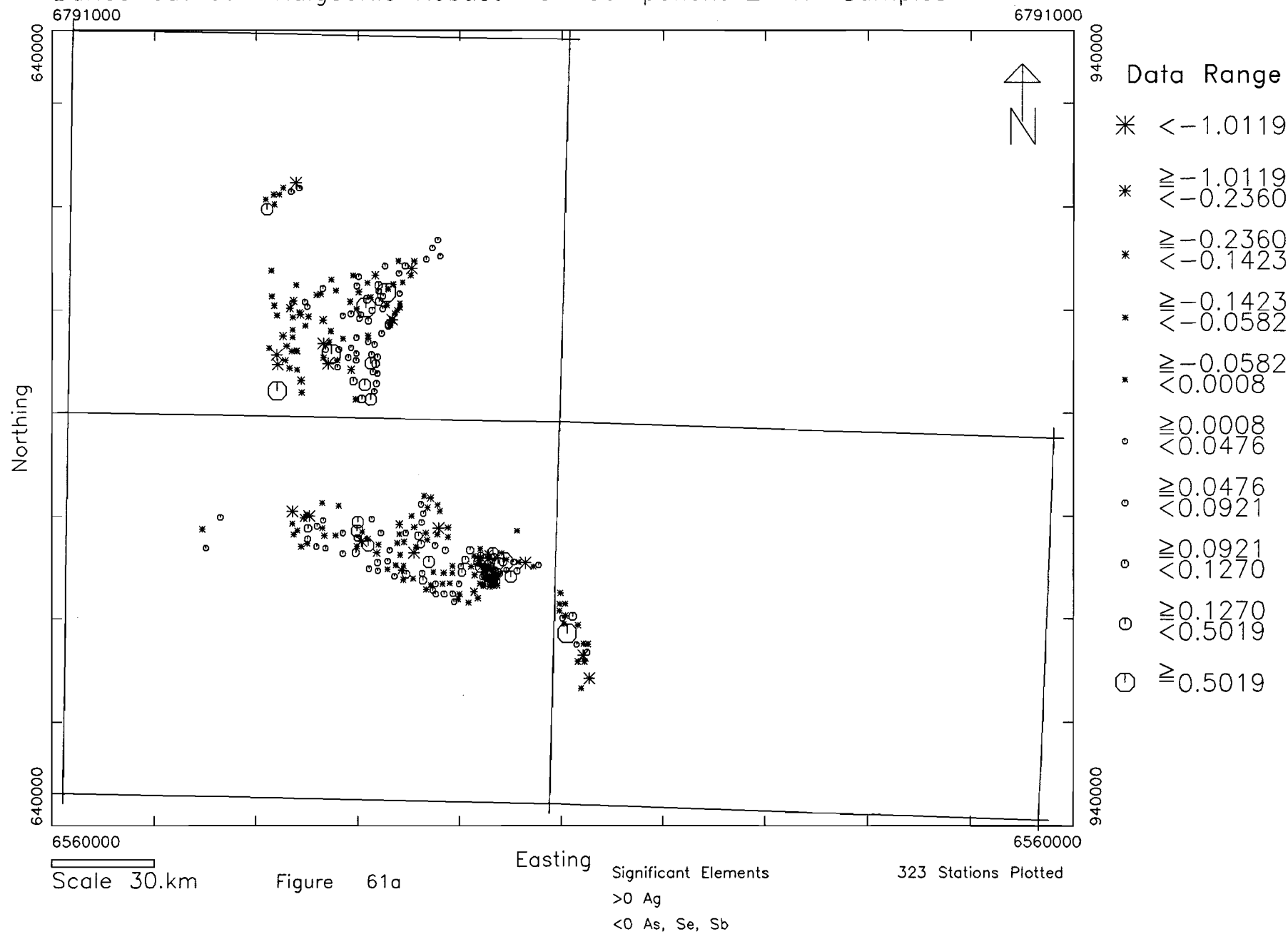


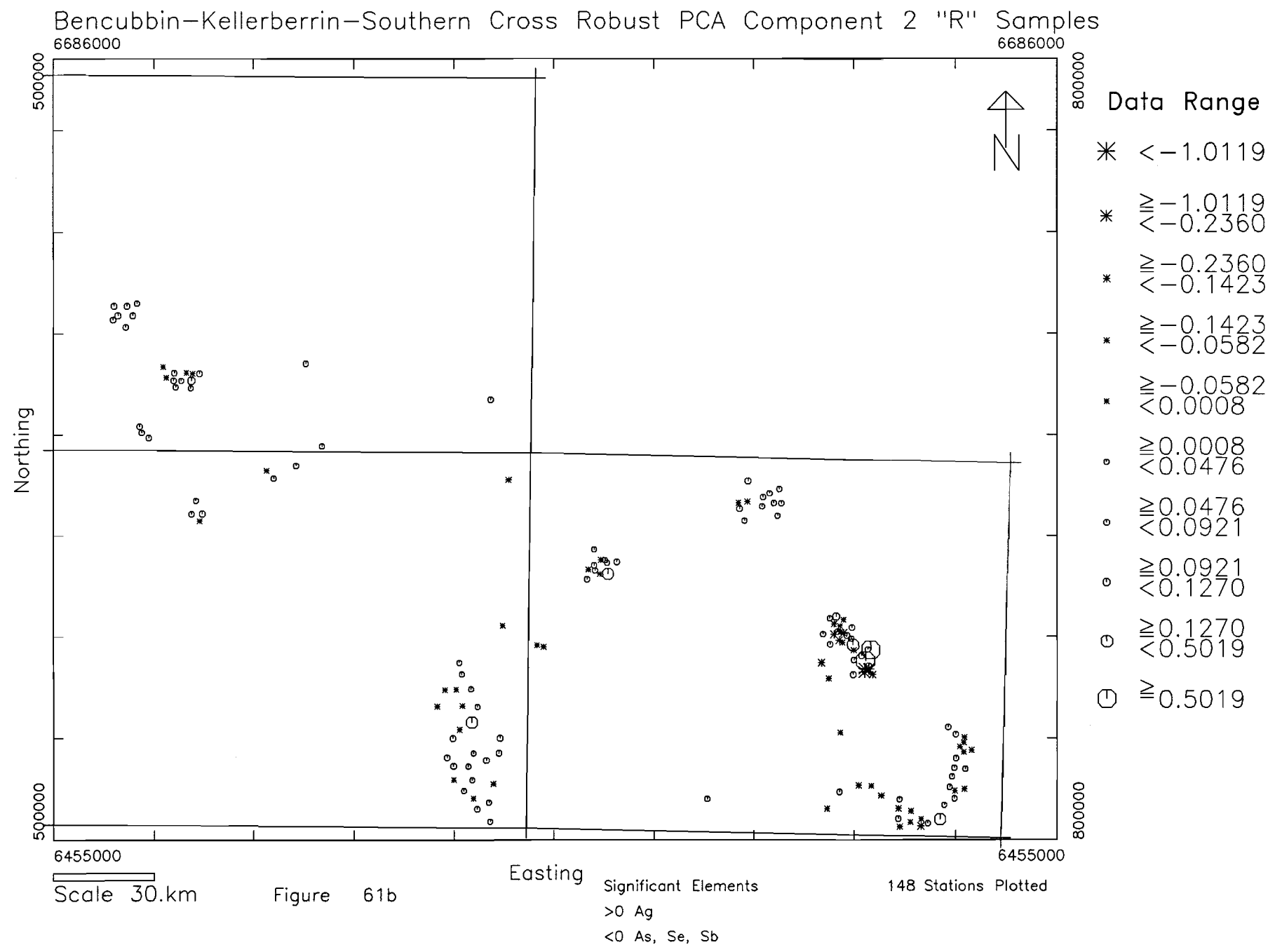
Corrigin-Hyden Robust PCA Component 1 "R" Samples



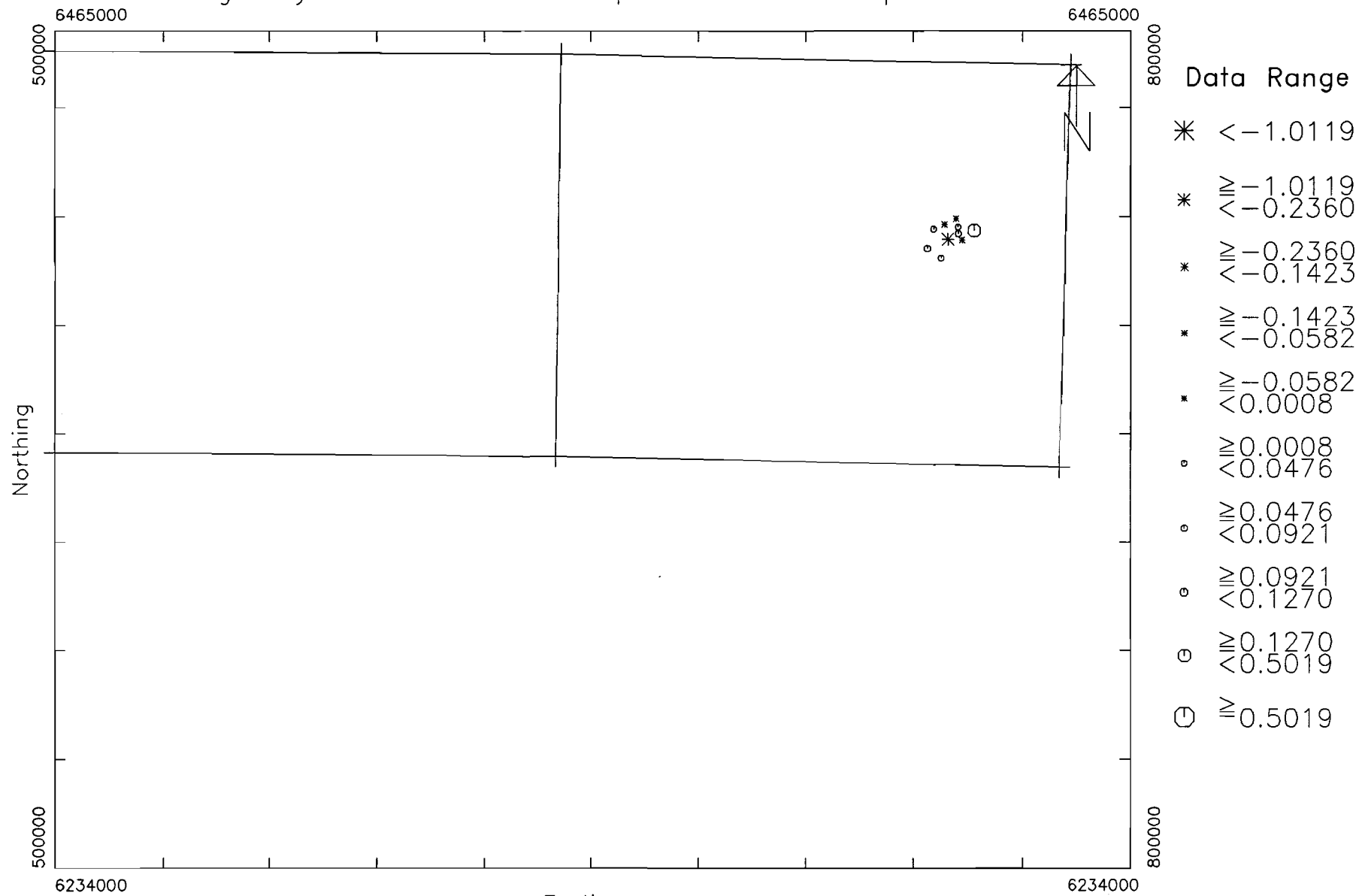


Barlee-Jackson-Kalgoorlie Robust PCA Component 2 "R" Samples





Corrigin-Hyden Robust PCA Component 2 "R" Samples



Scale 30.km

Figure 61c

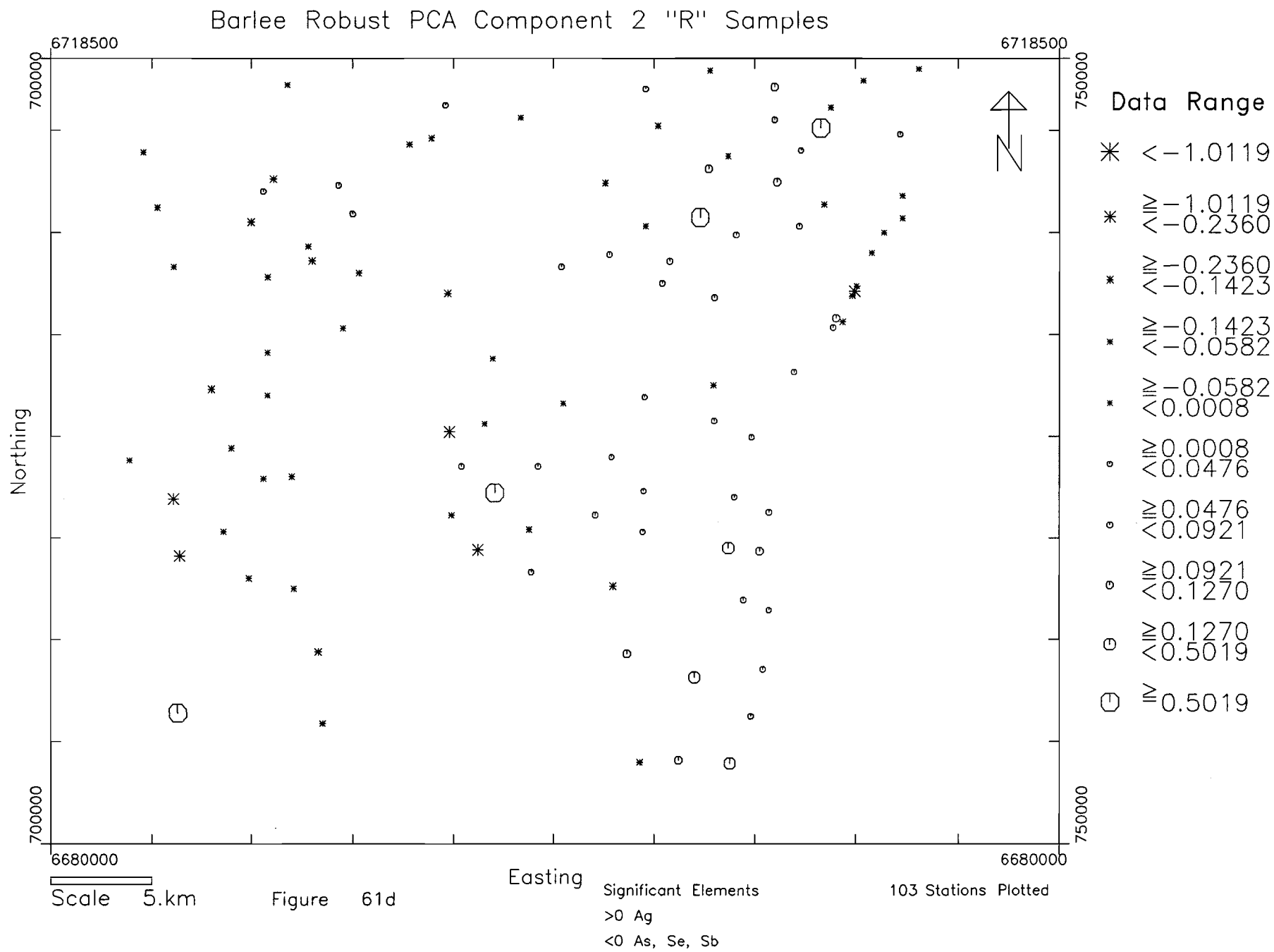
Easting

Significant Elements

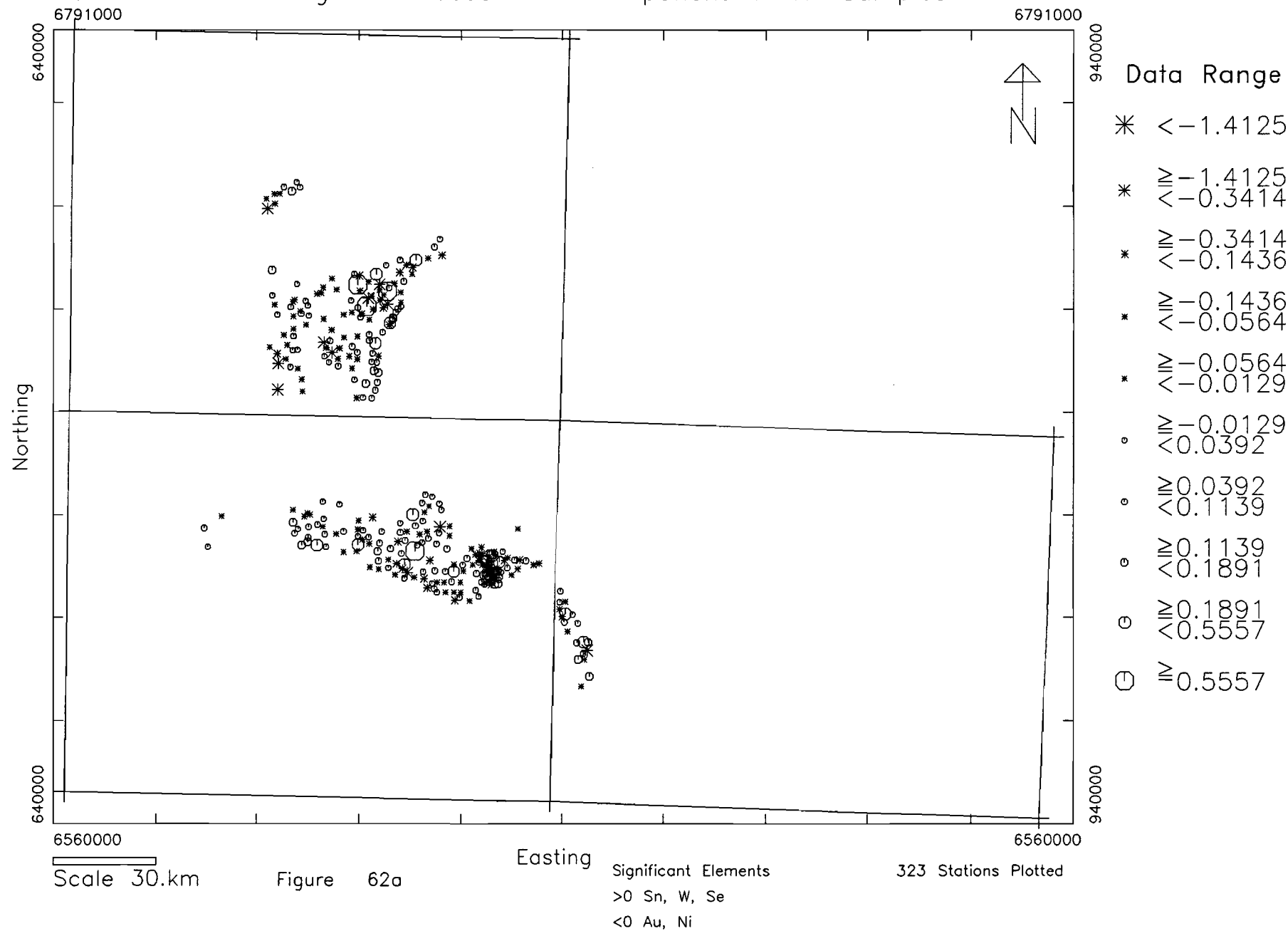
>0 Ag

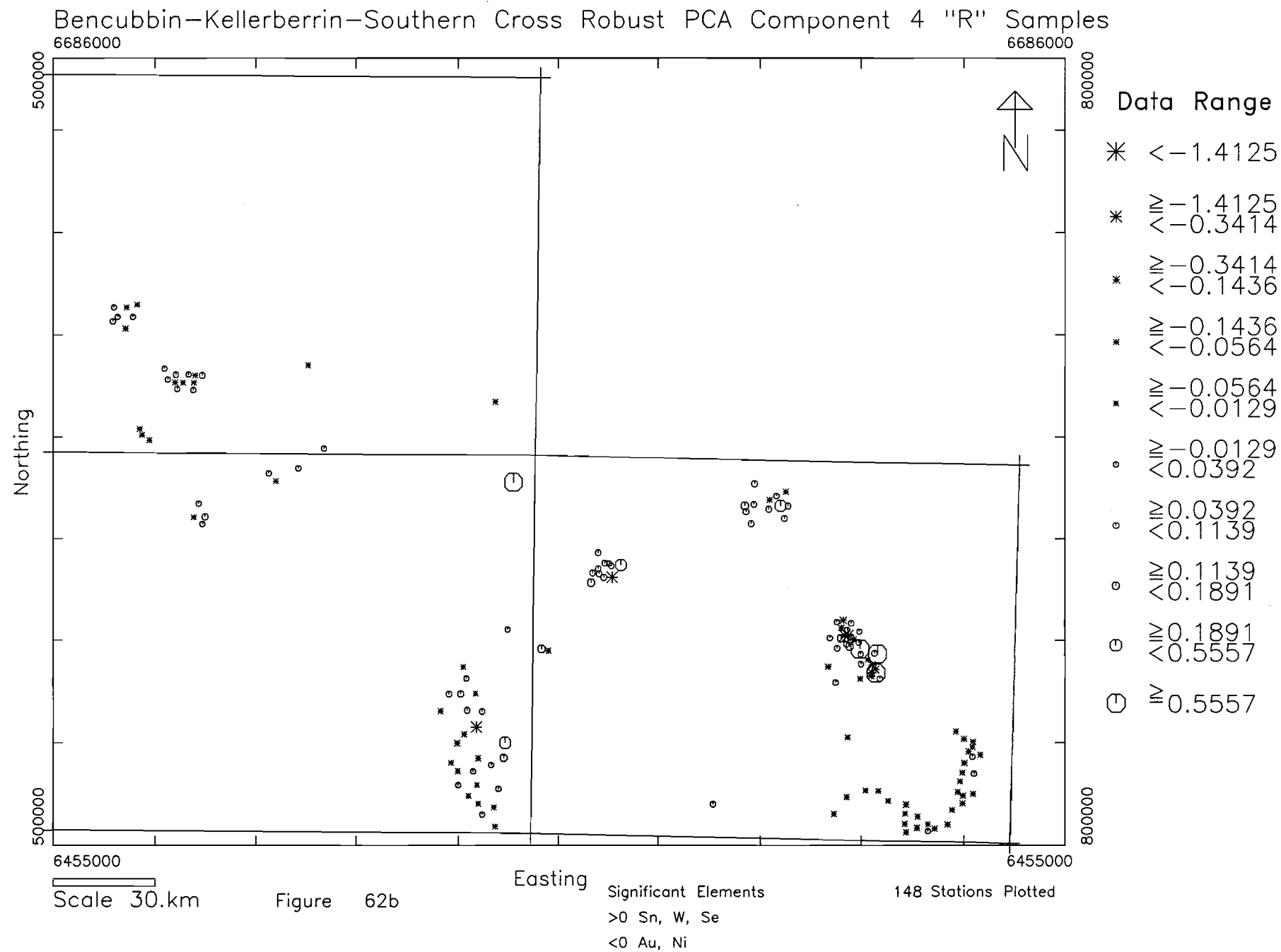
<0 As, Se, Sb

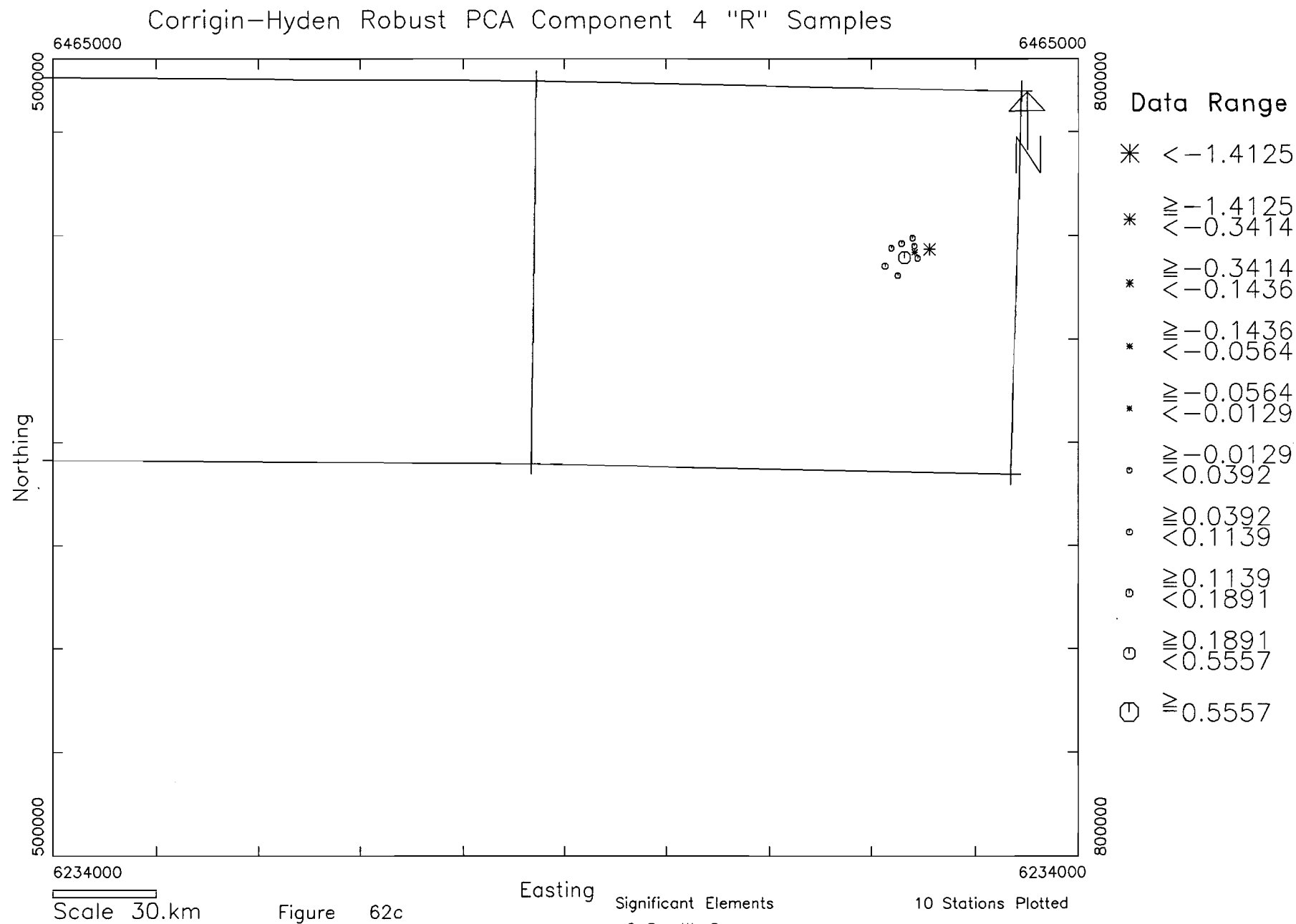
10 Stations Plotted

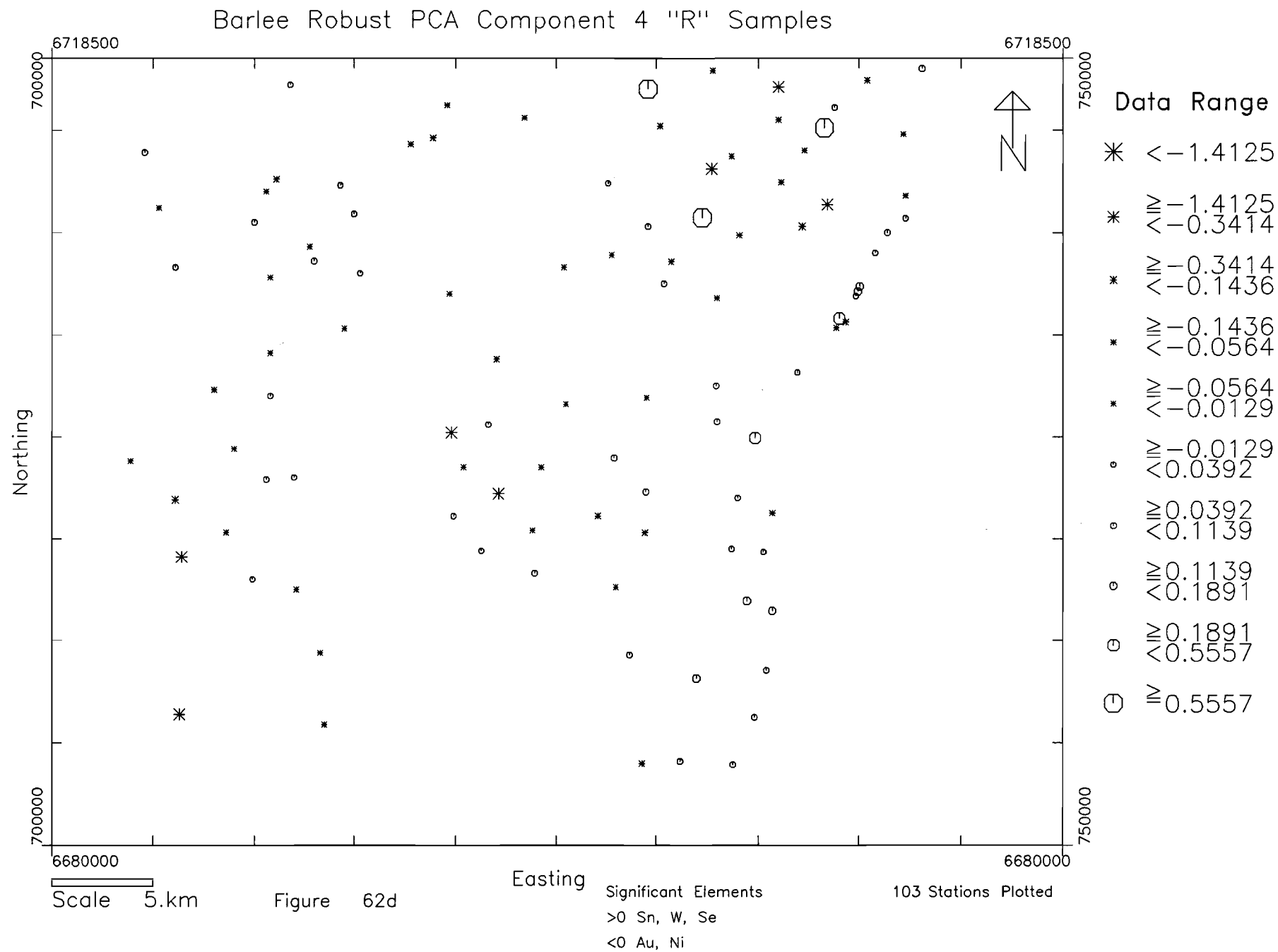


Barlee-Jackson-Kalgoorlie Robust PCA Component 4 "R" Samples

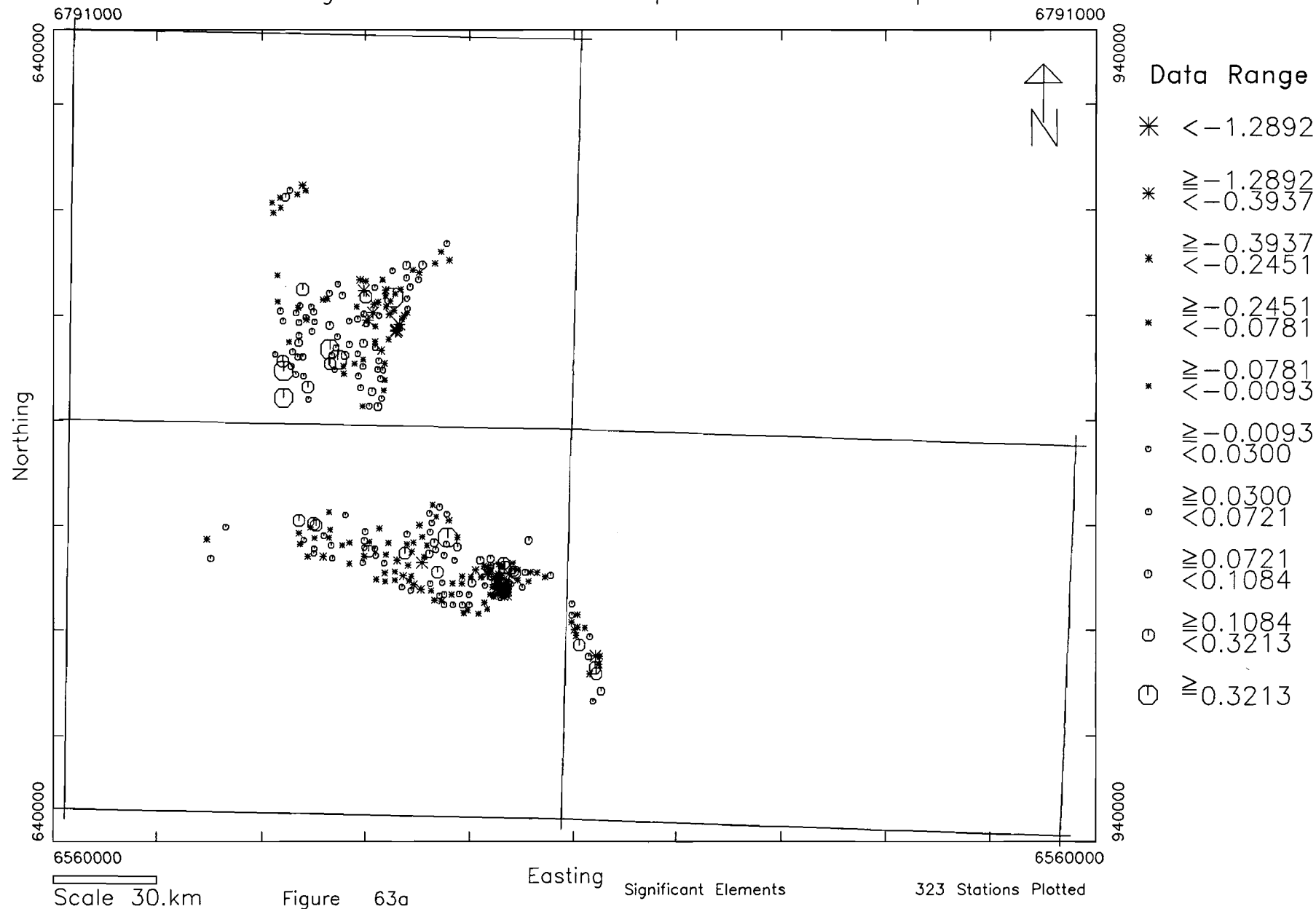


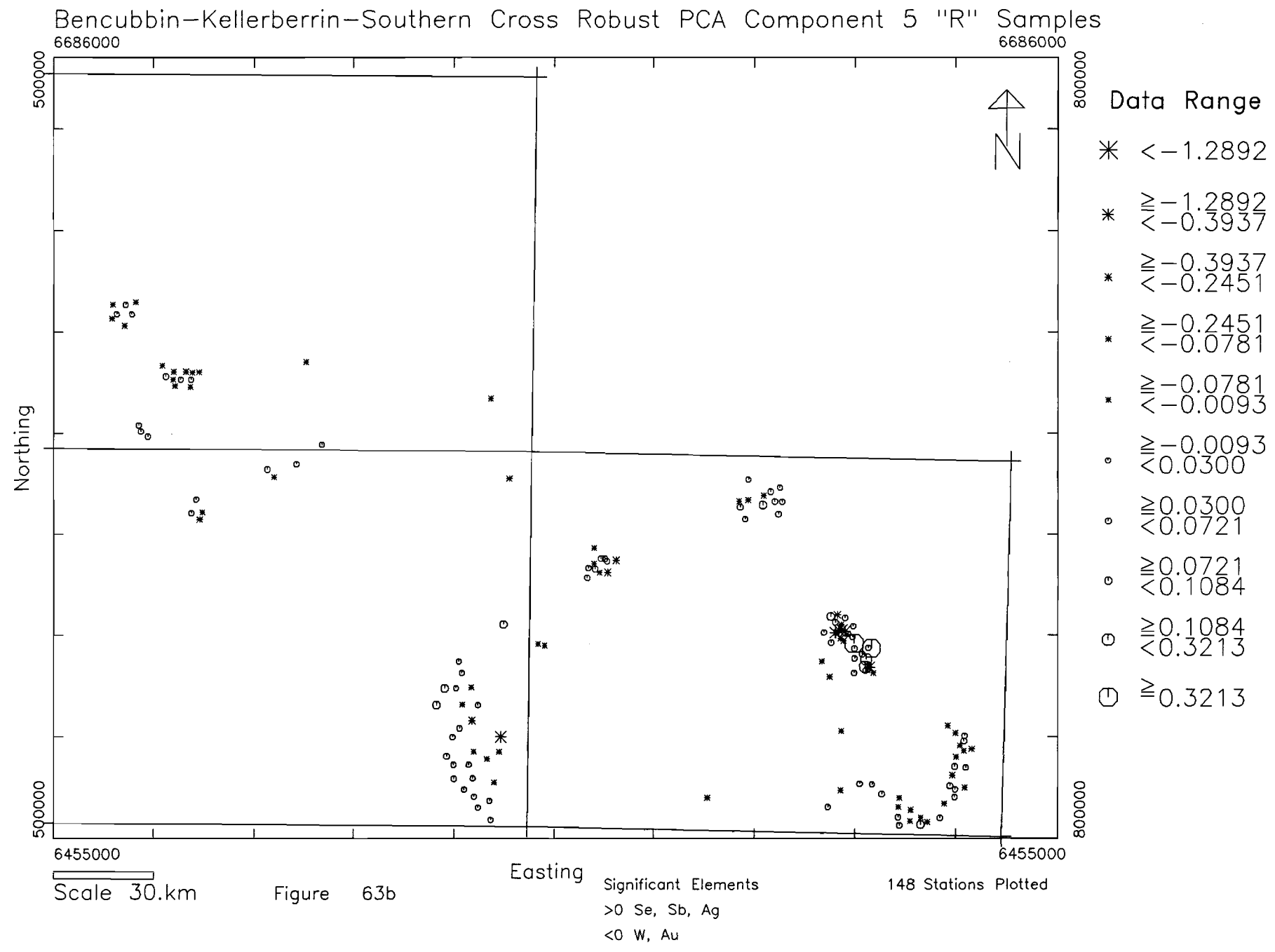




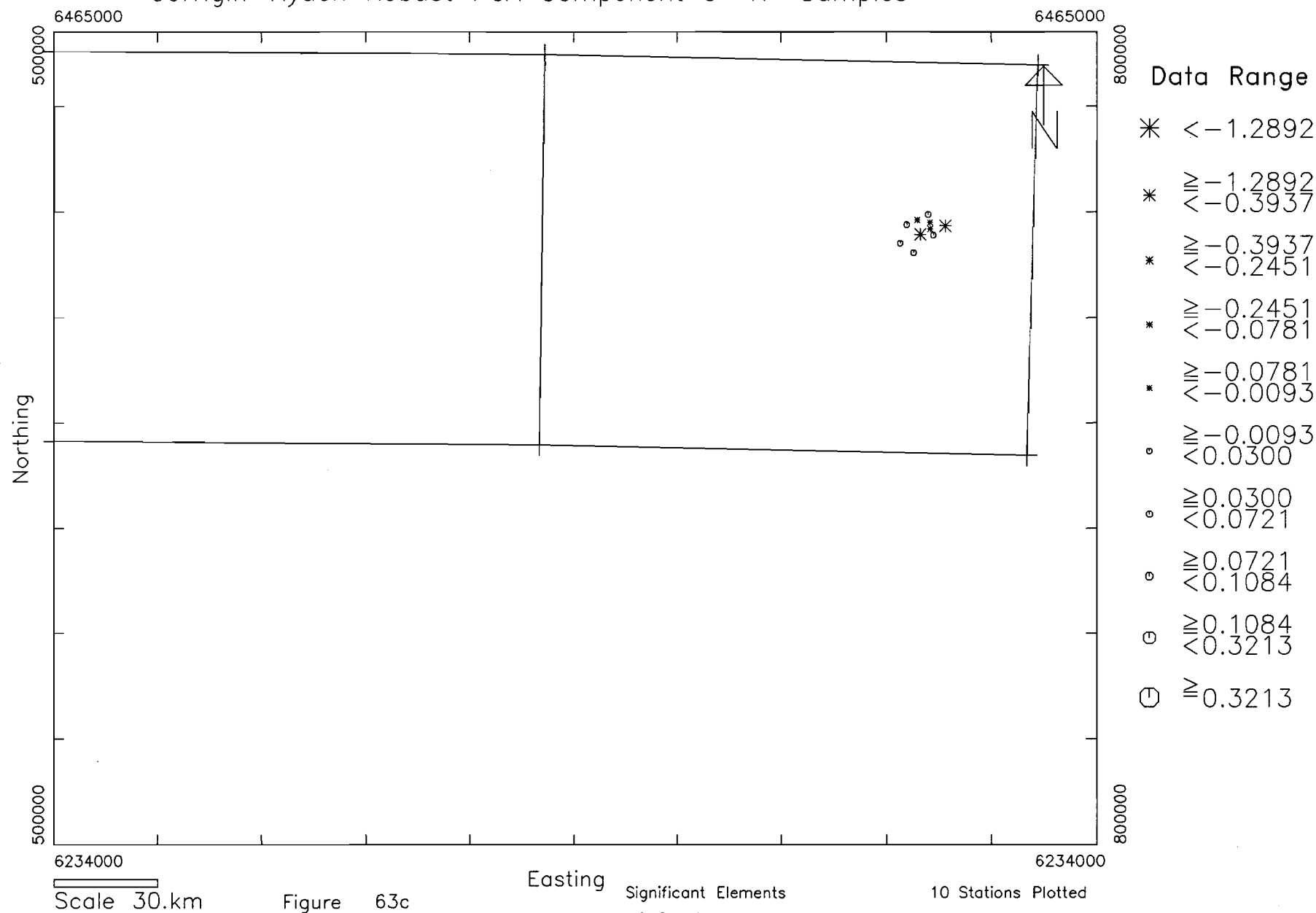


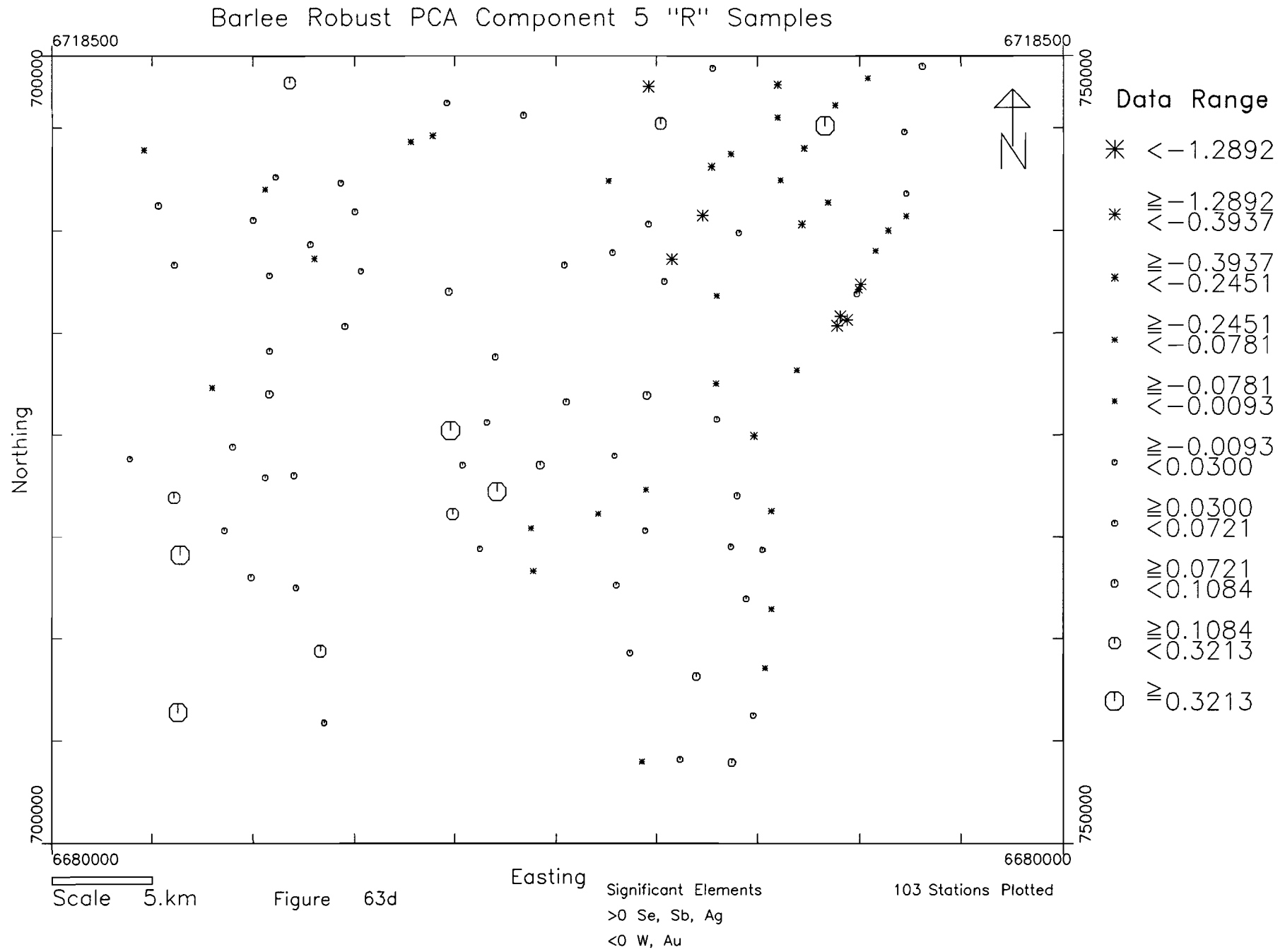
Barlee-Jackson-Kalgoorlie Robust PCA Component 5 "R" Samples



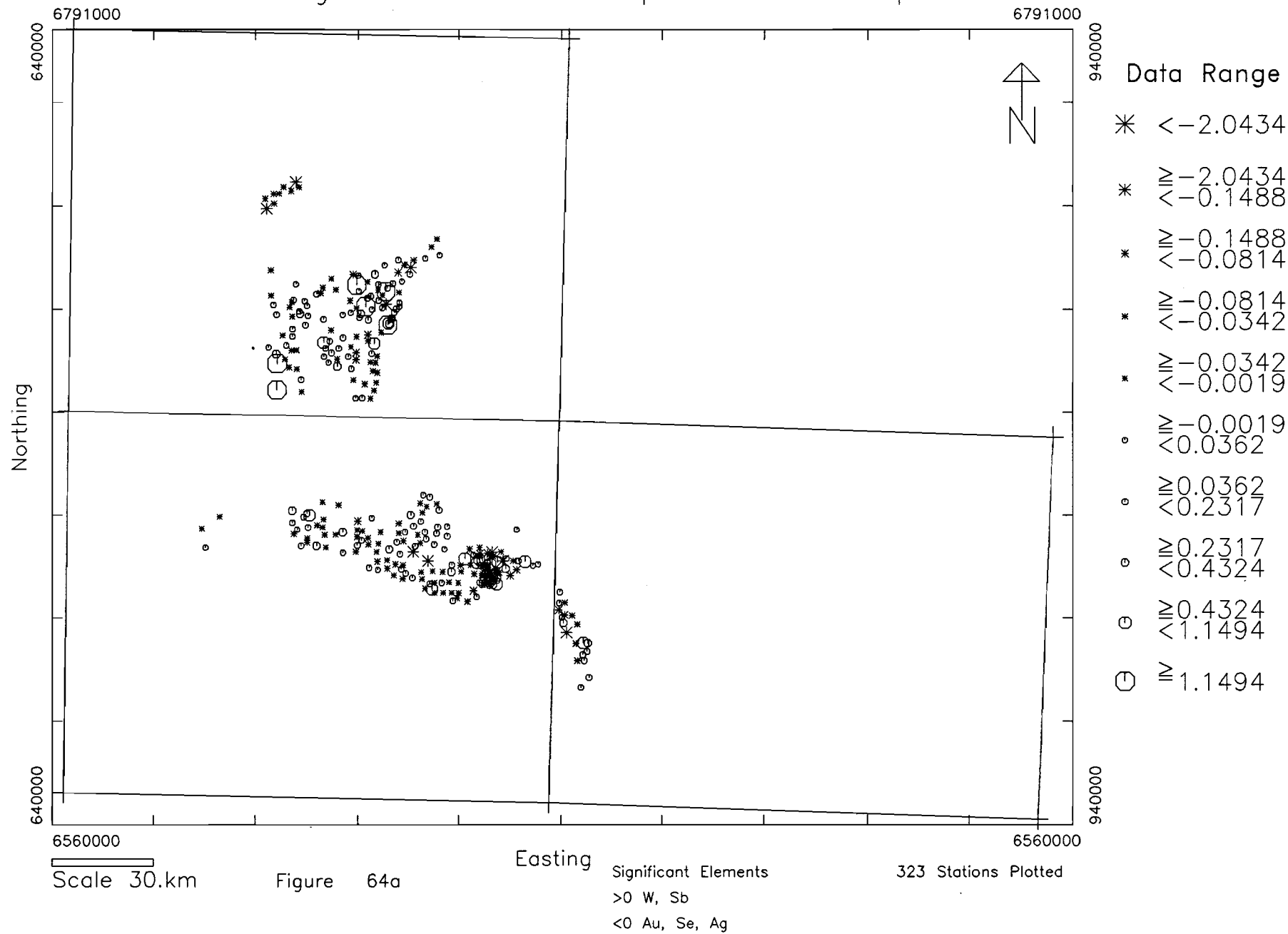


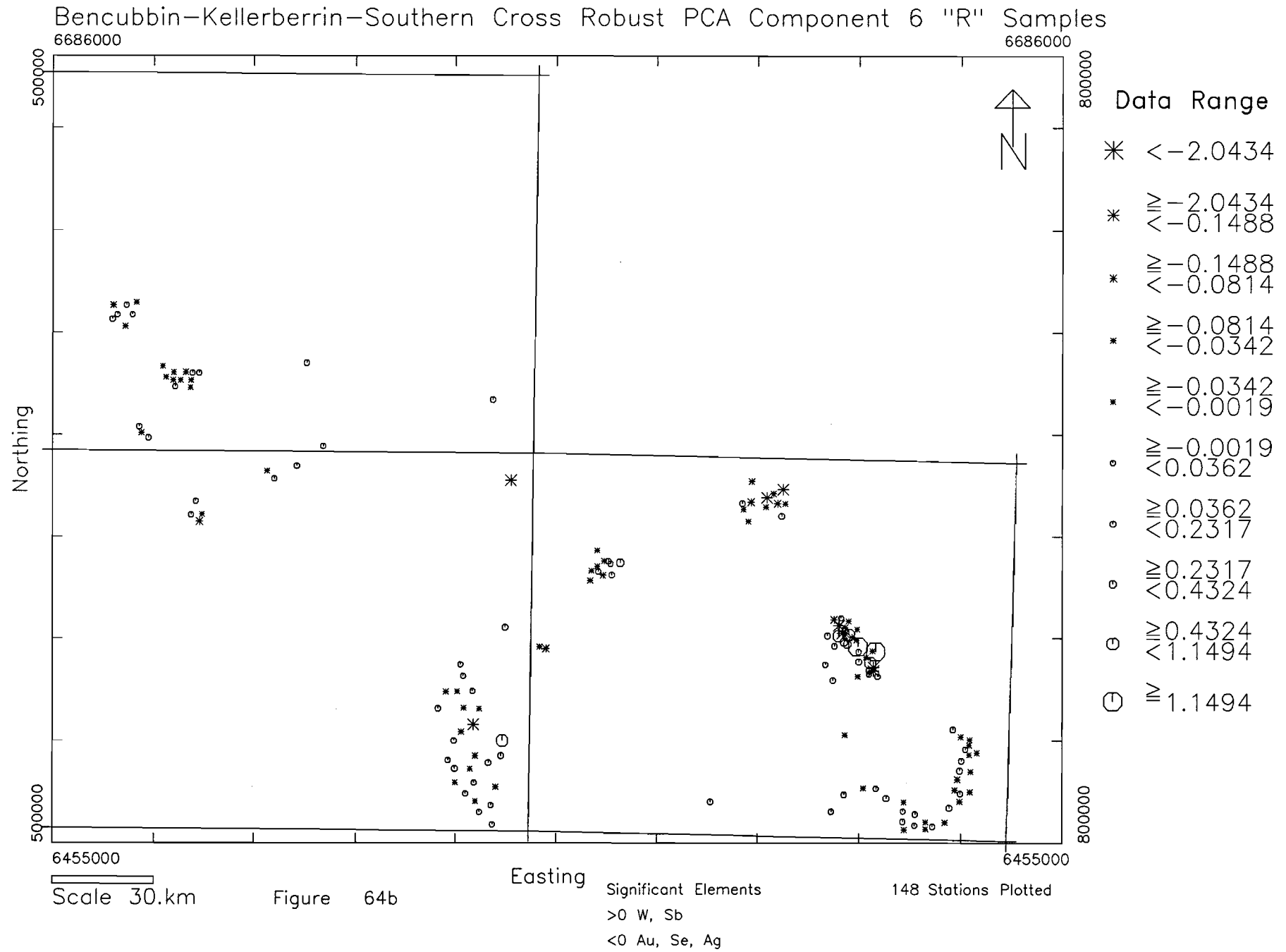
Corrigin-Hyden Robust PCA Component 5 "R" Samples



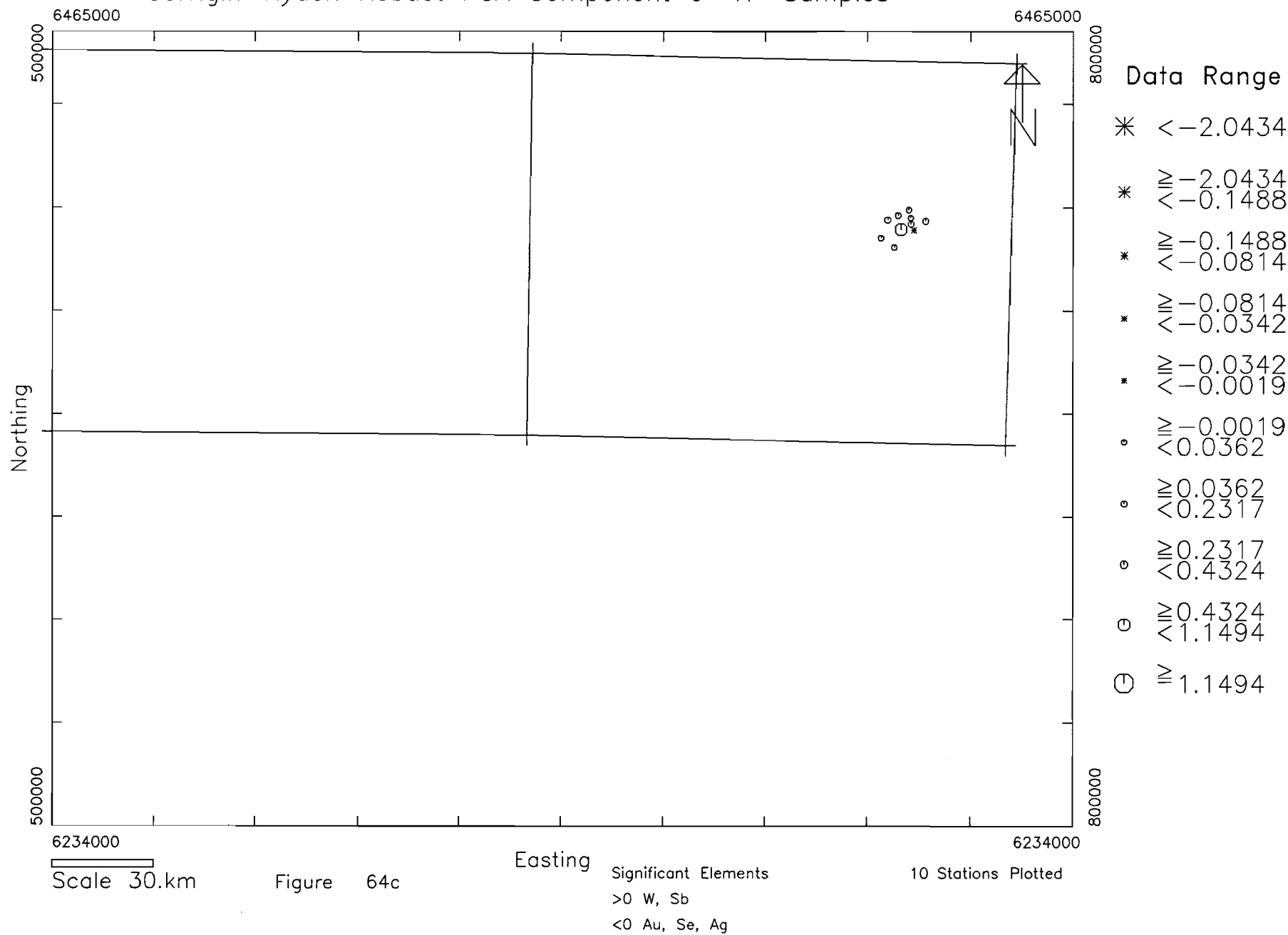


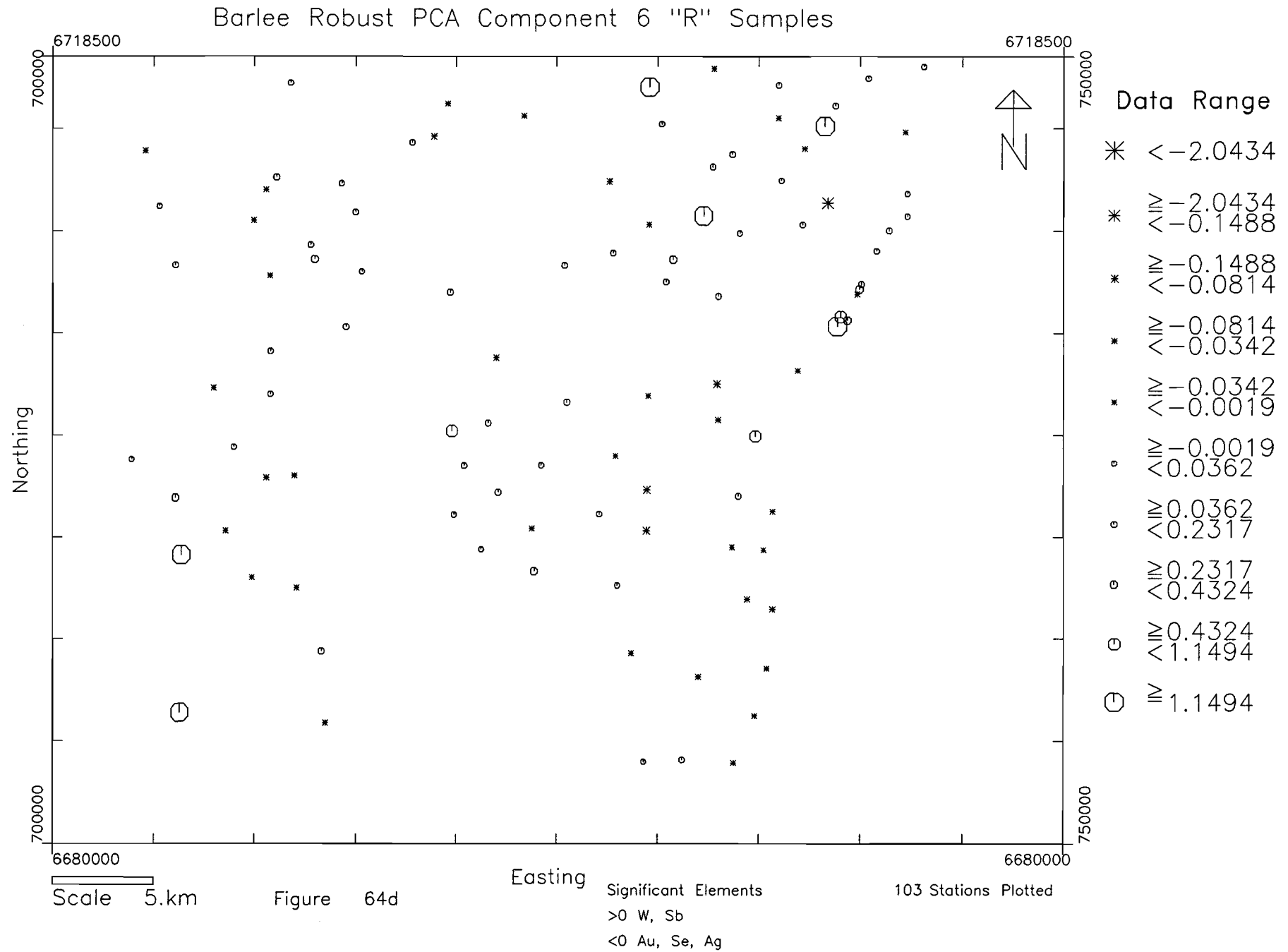
Barlee-Jackson-Kalgoorlie Robust PCA Component 6 "R" Samples



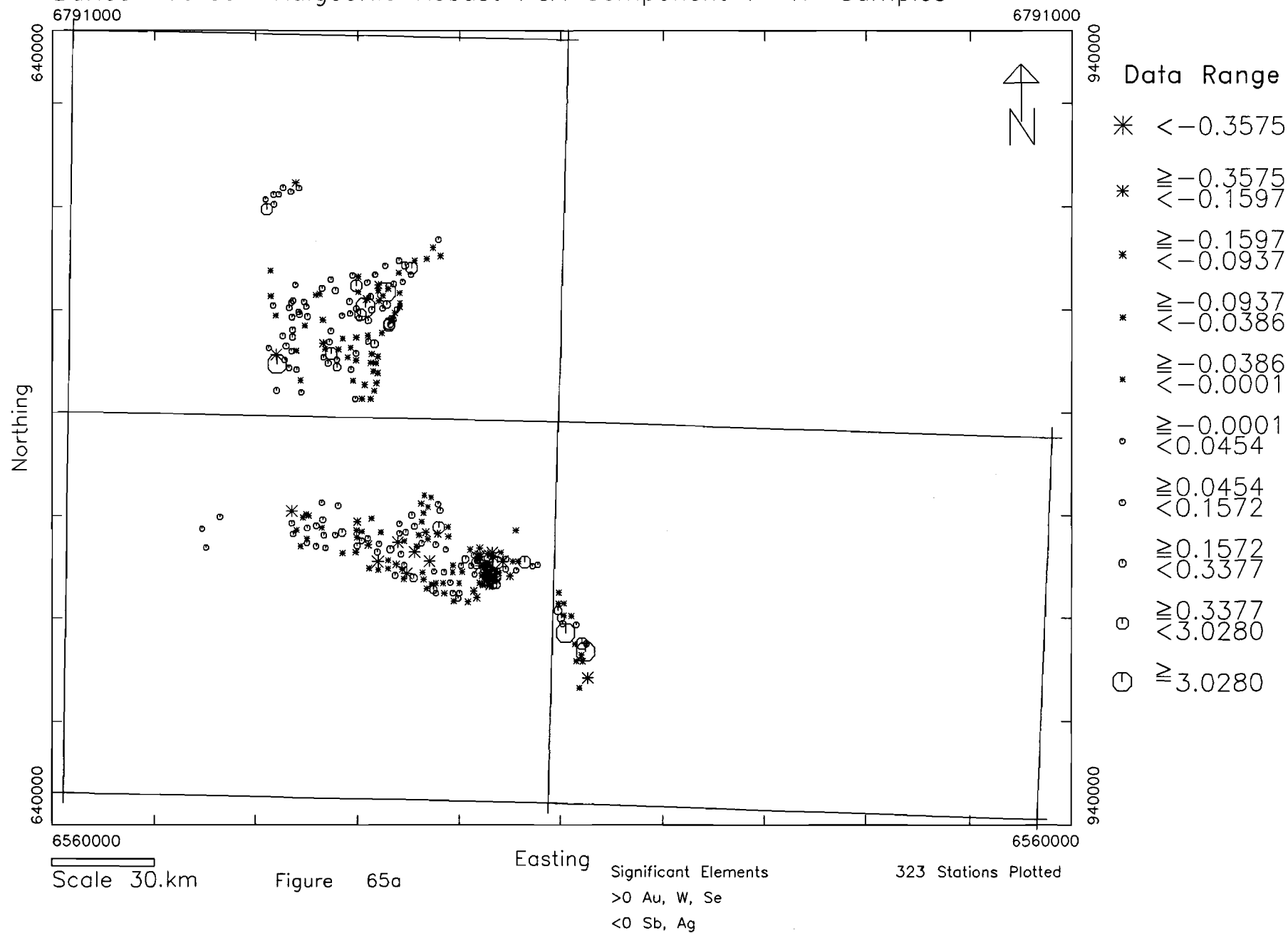


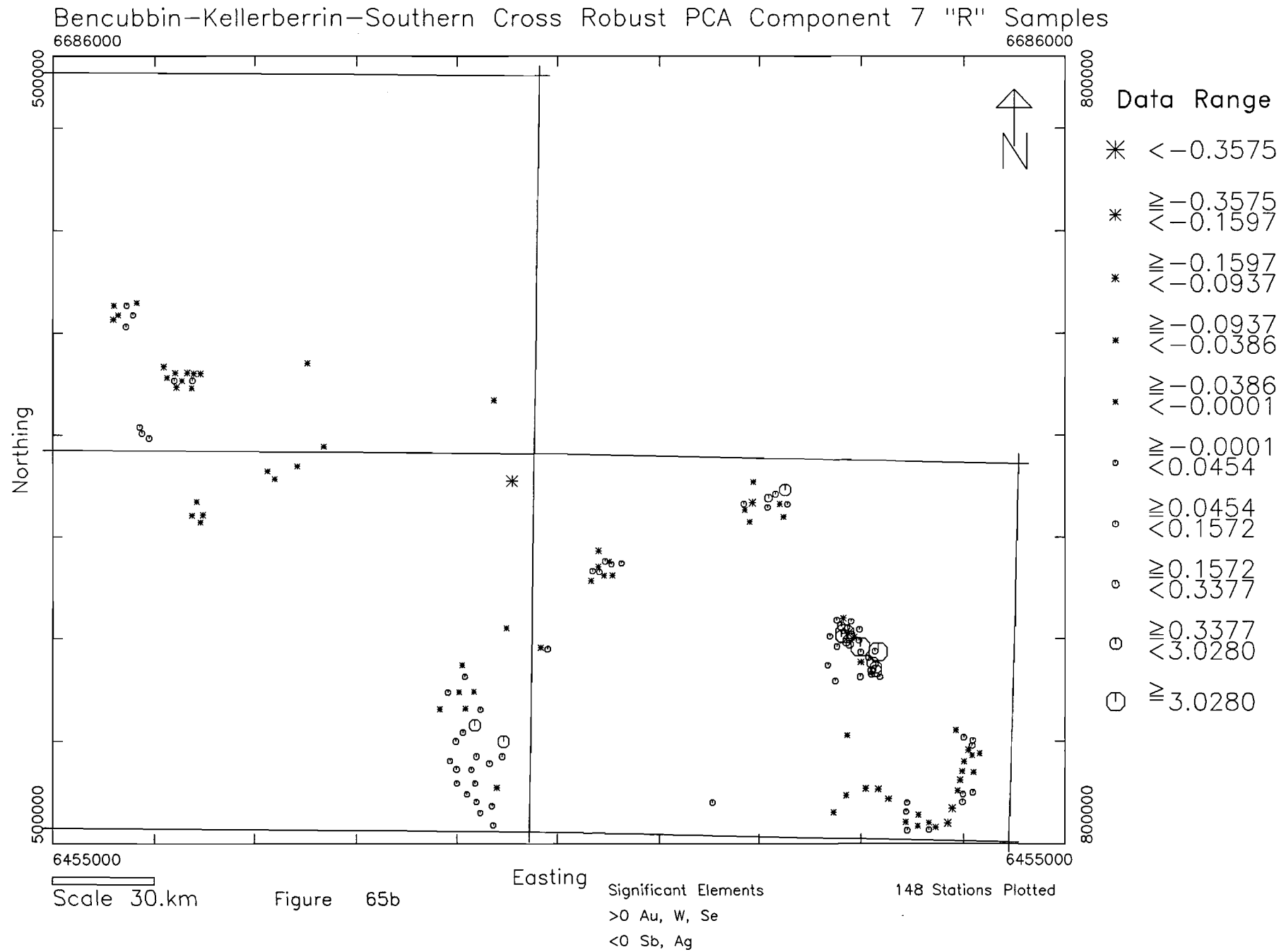
Corrigin-Hyden Robust PCA Component 6 "R" Samples



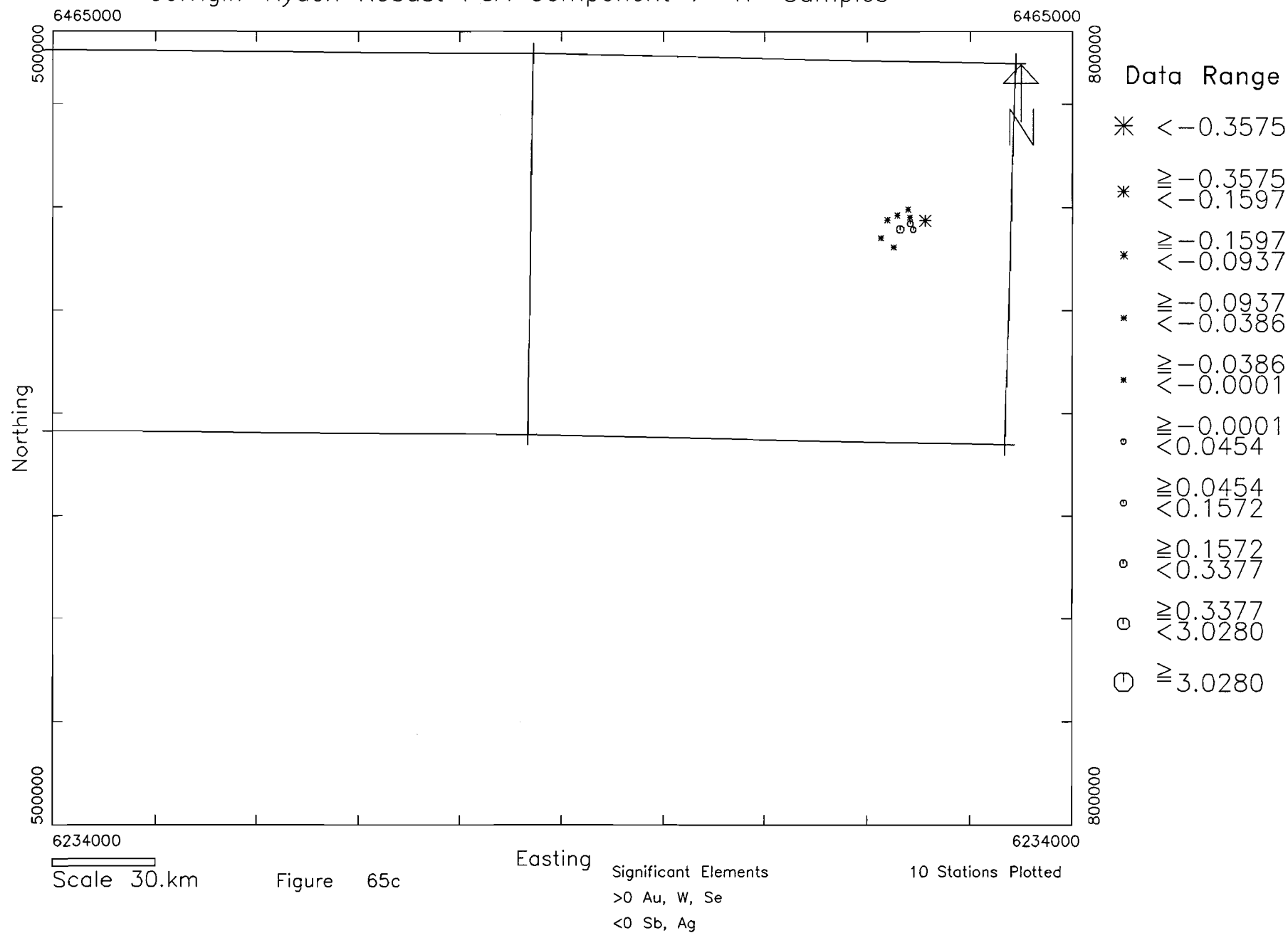


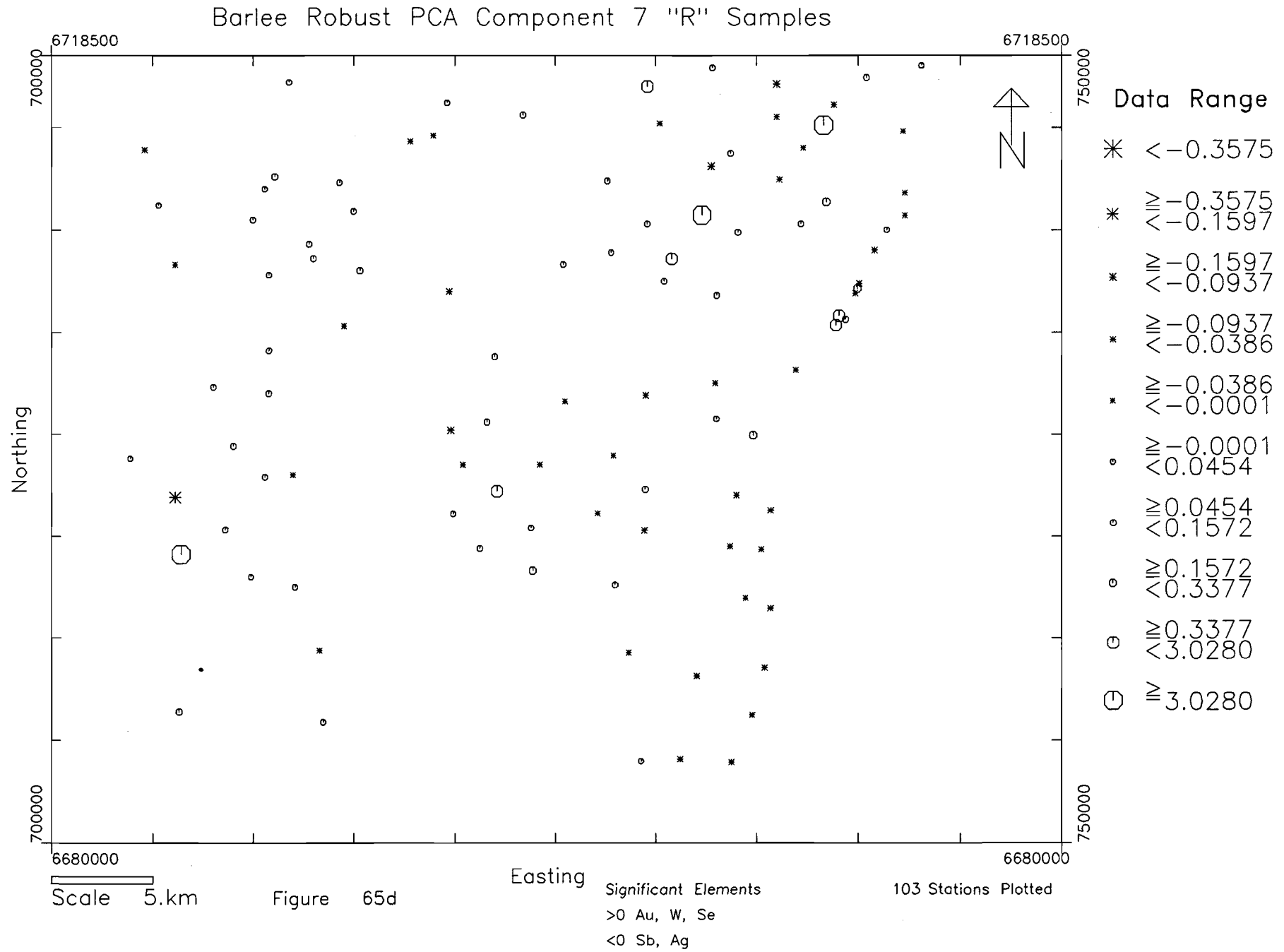
Barlee-Jackson-Kalgoorlie Robust PCA Component 7 "R" Samples



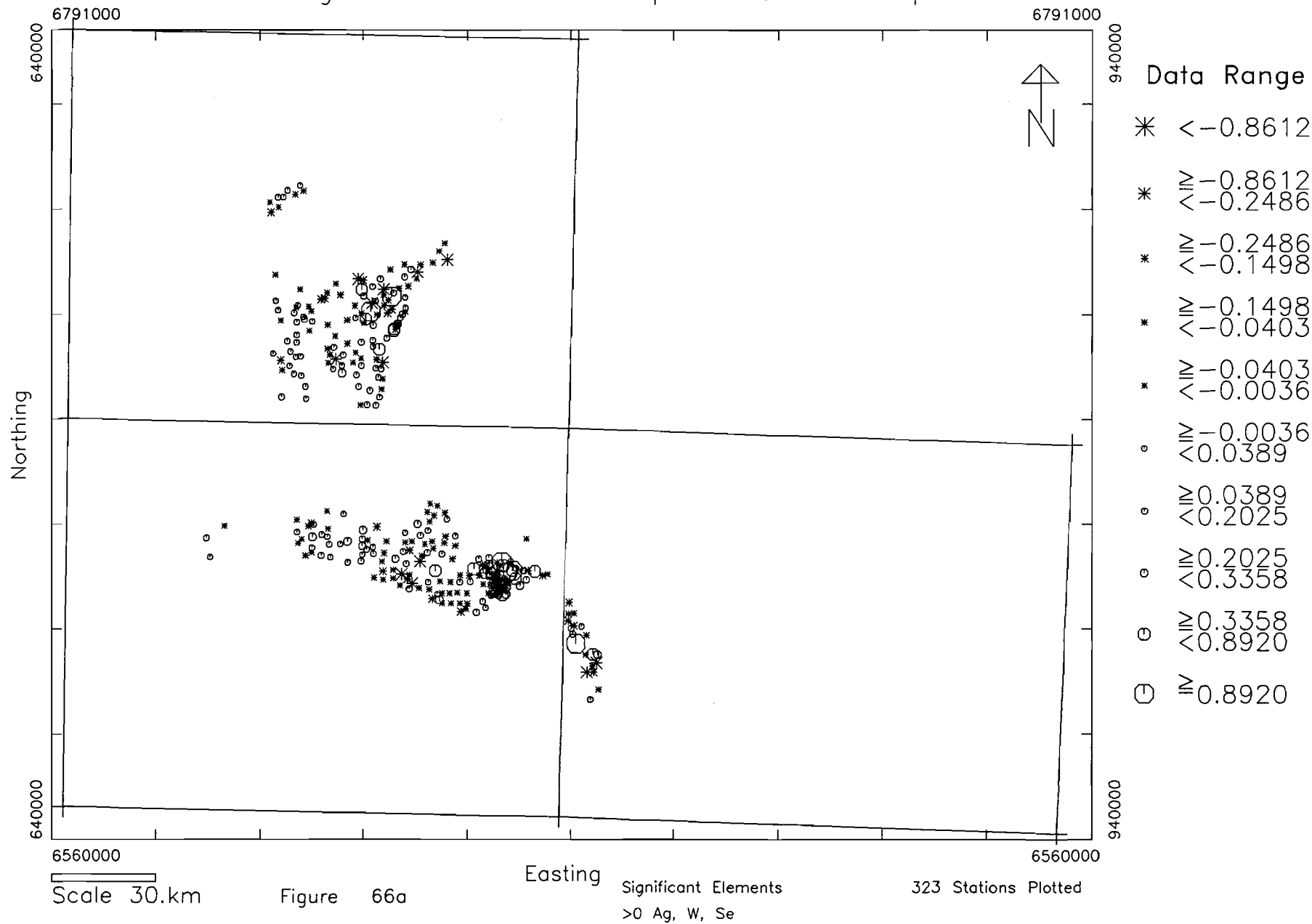


Corrigin-Hyden Robust PCA Component 7 "R" Samples

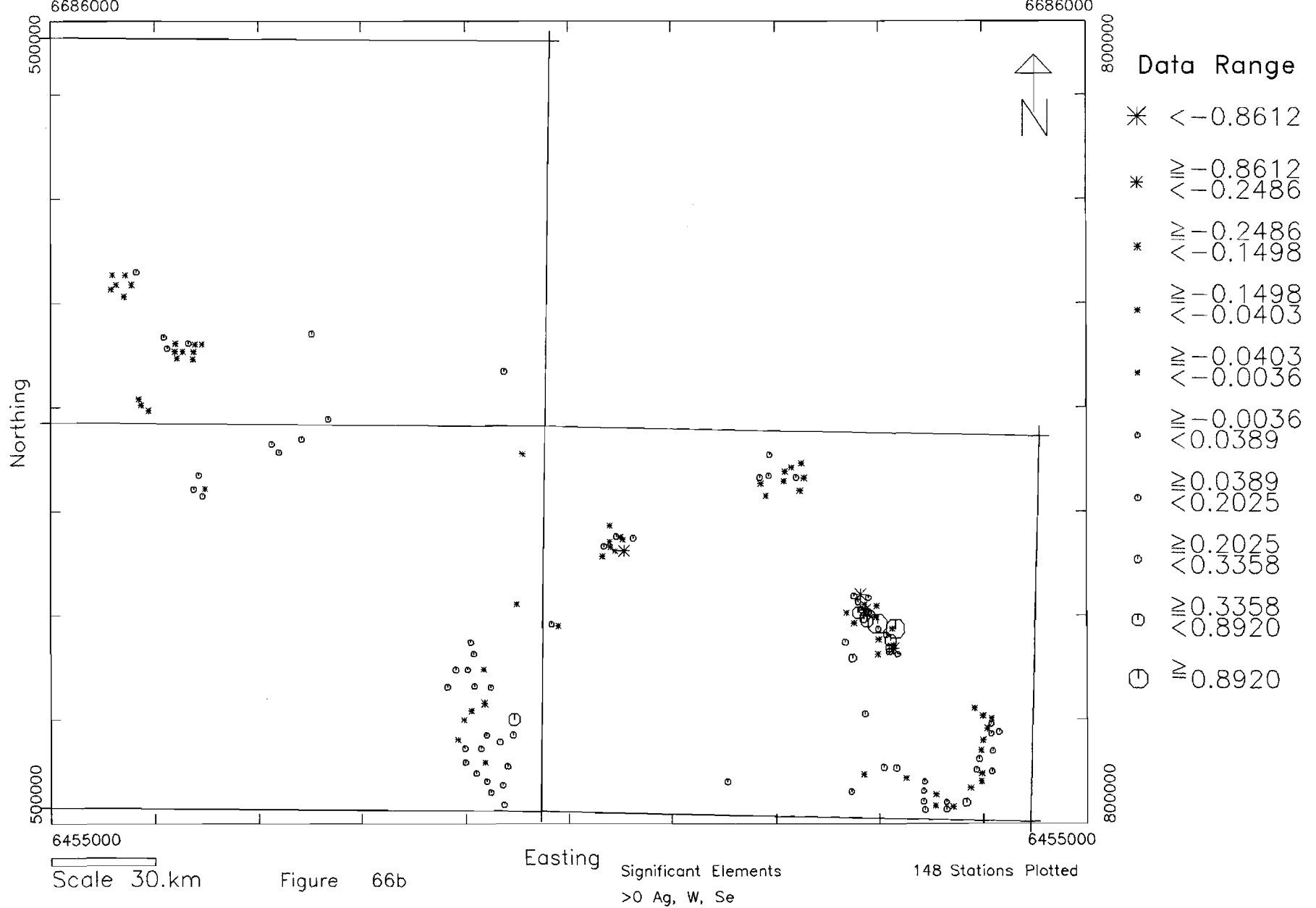




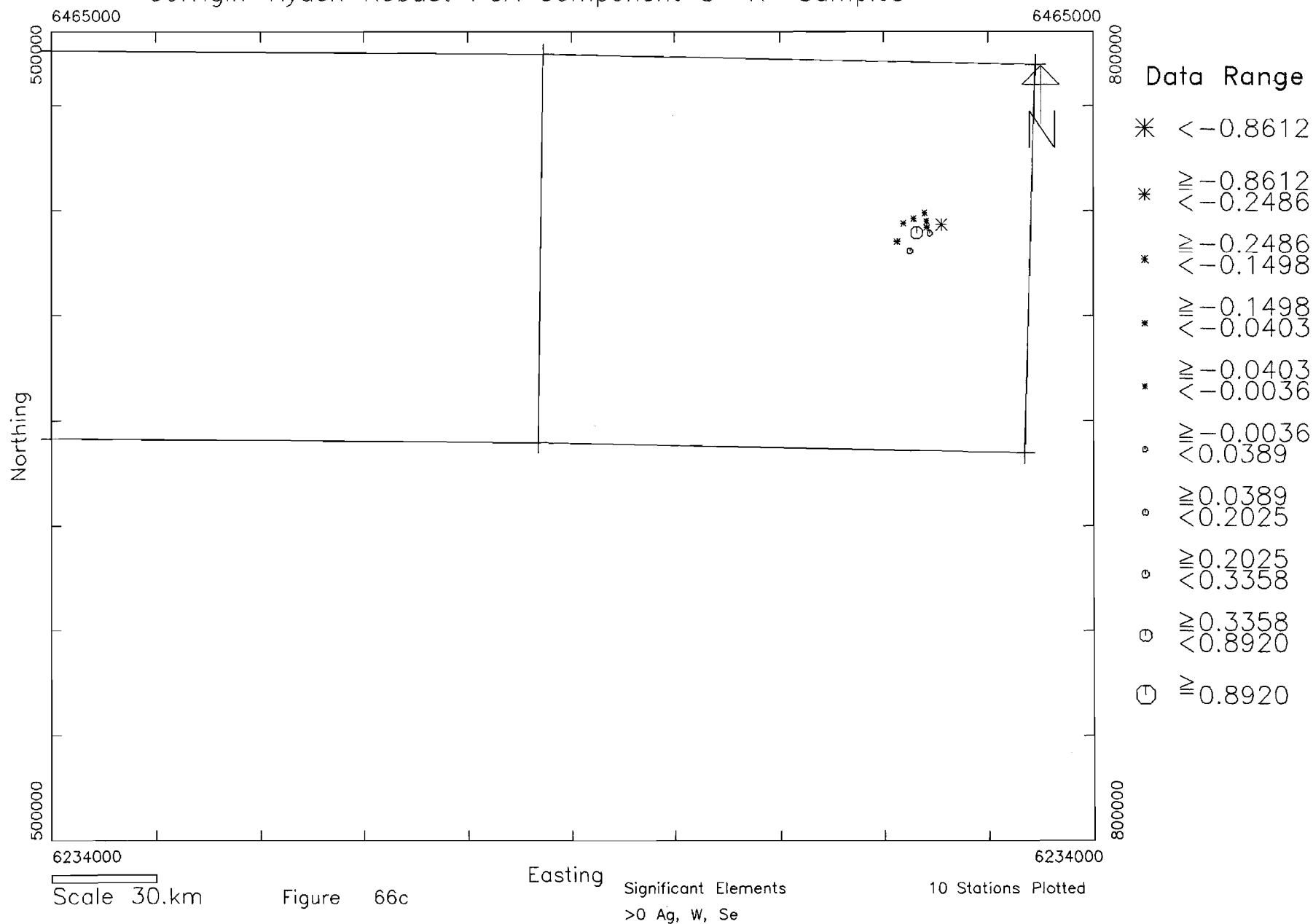
Barlee-Jackson-Kalgoorlie Robust PCA Component 8 "R" Samples

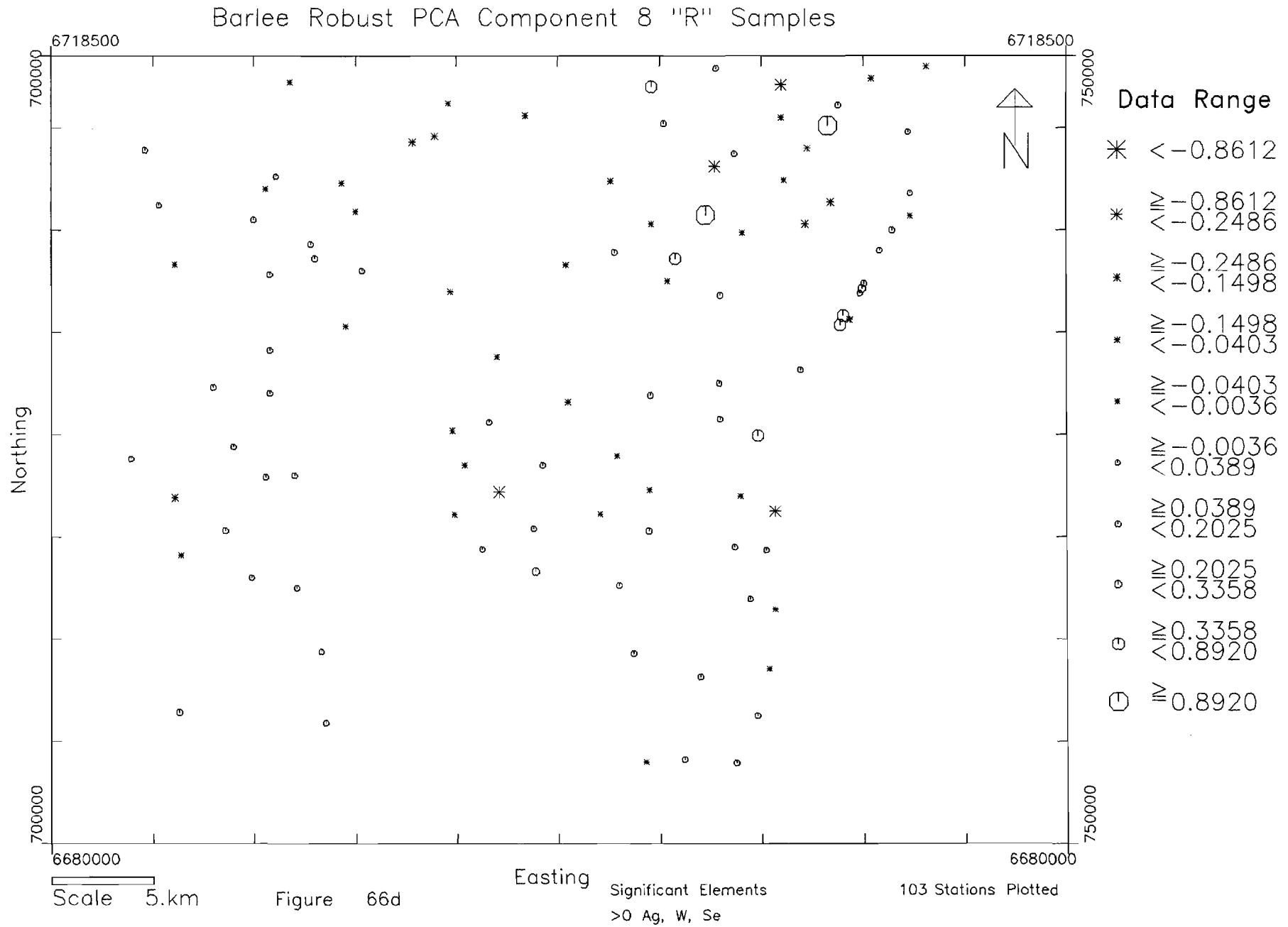


Bencubbin-Kellerberrin-Southern Cross Robust PCA Component 8 "R" Samples

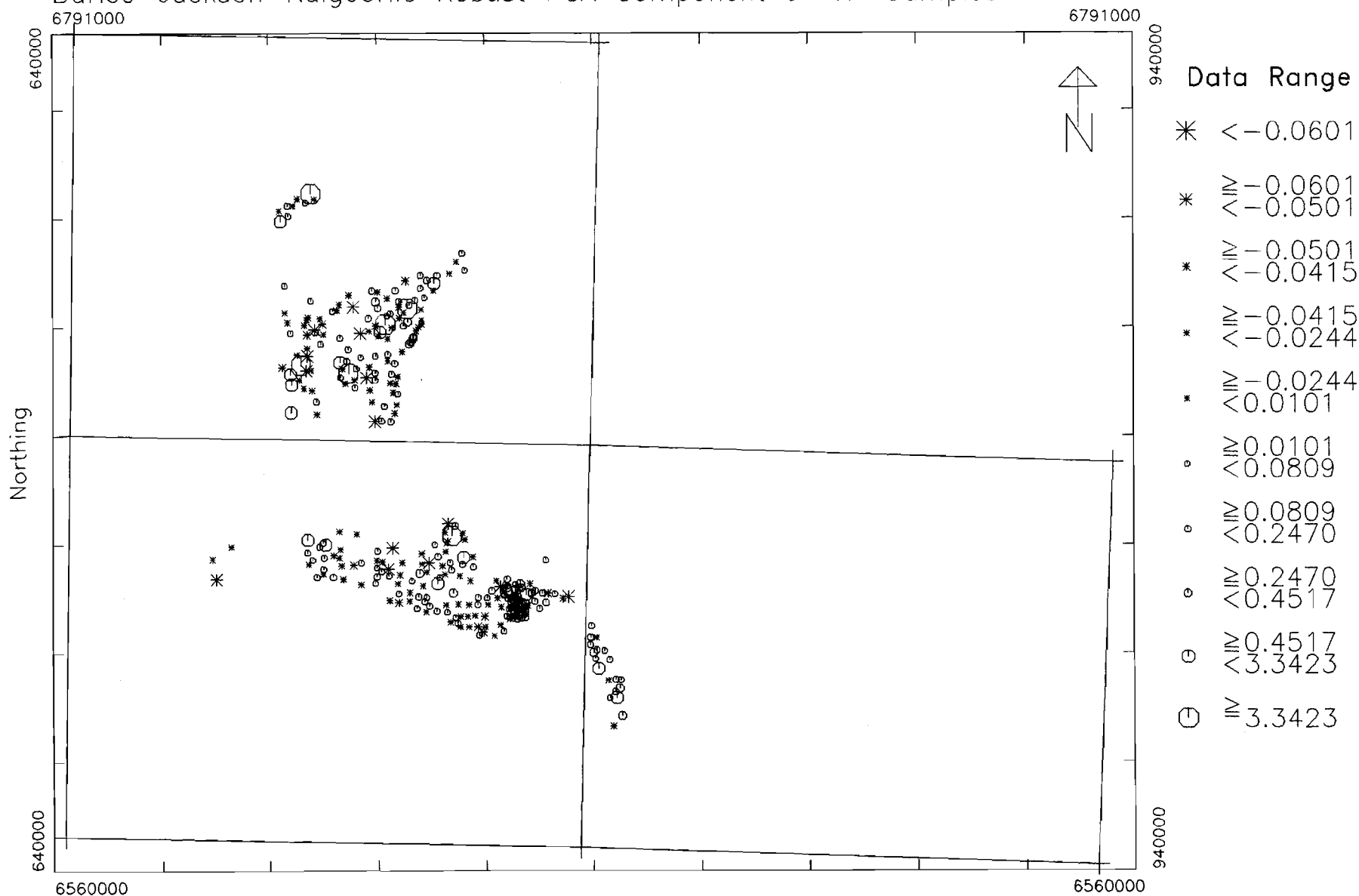


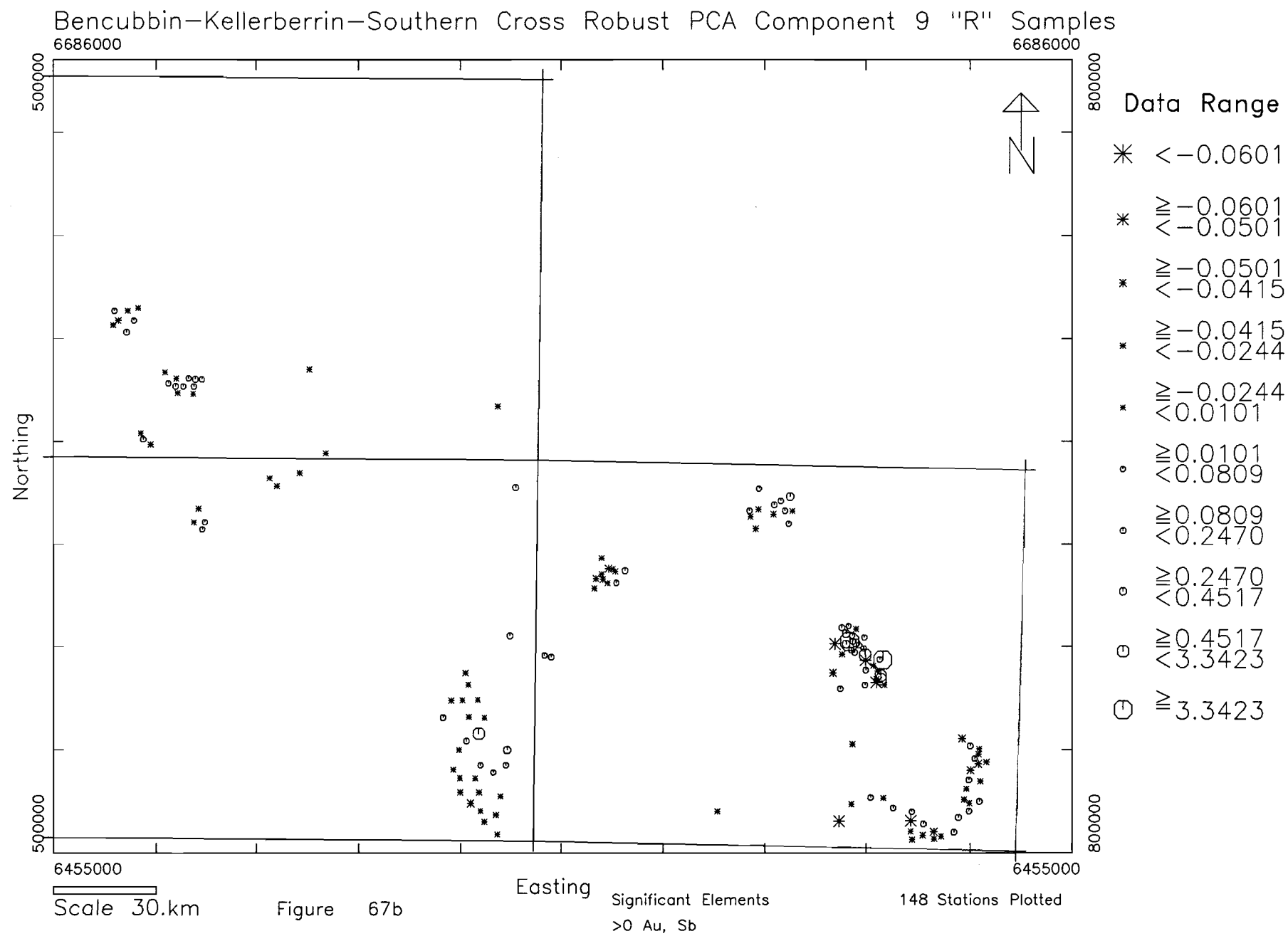
Corrigin-Hyden Robust PCA Component 8 "R" Samples



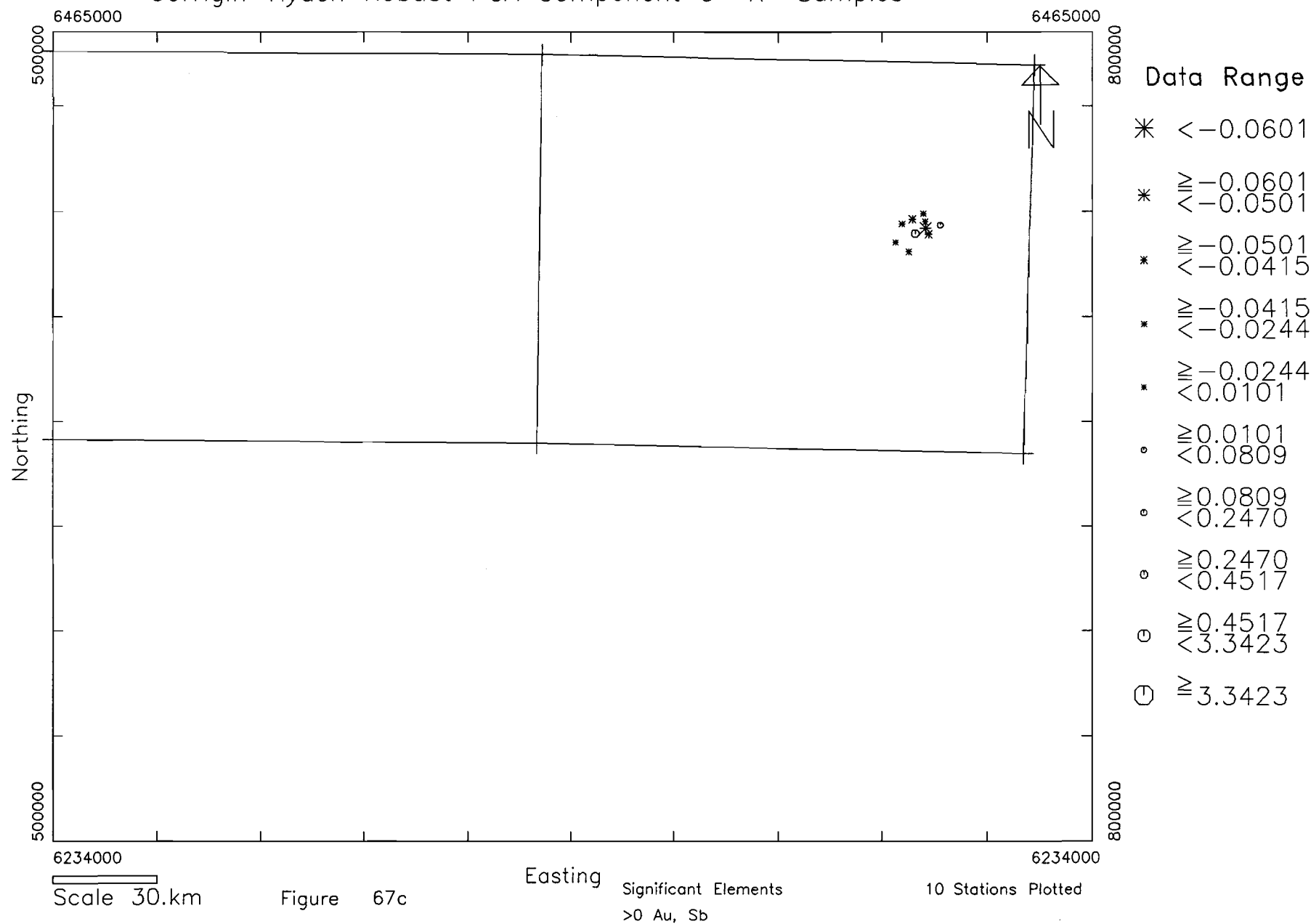


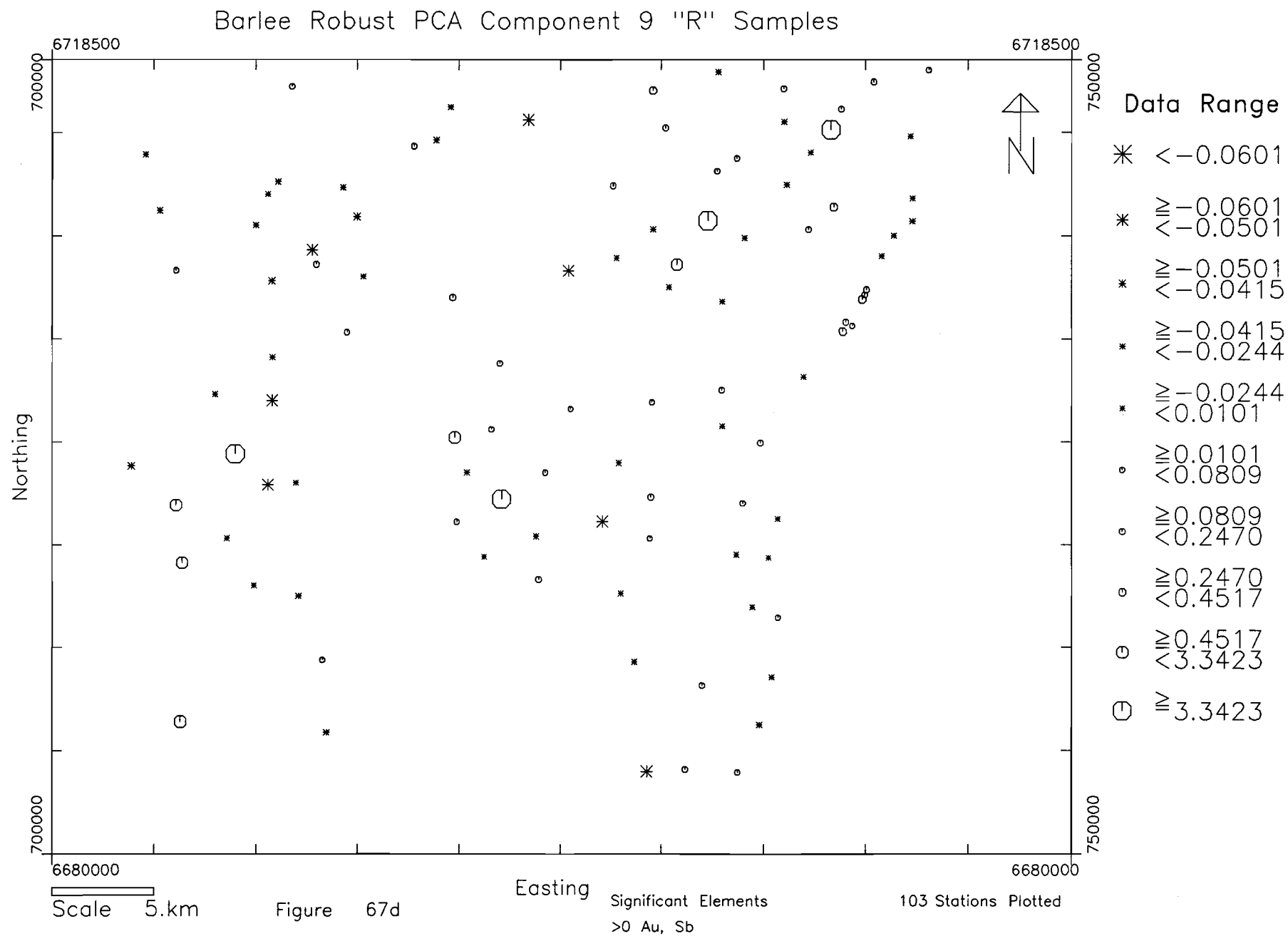
Barlee-Jackson-Kalgoorlie Robust PCA Component 9 "R" Samples





Corrigin-Hyden Robust PCA Component 9 "R" Samples





Central Yilgarn Laterite "F2/F3" Samples ROBUST PCA

F2

1.00

0.75

0.50

0.25

0.00

-0.25

-0.50

-0.75

+0.75

+1.00

+1.25

-1.00

-0.75

-0.50

-0.25

0.00

0.25

0.50

0.75

1.00

1.25

F1

Mo

Nb

Ga

Pb

Sn

Sb

As

V

Fe2O3

Mn

Zn

Cr

Cu

Ni

Co

Au

Ag

125

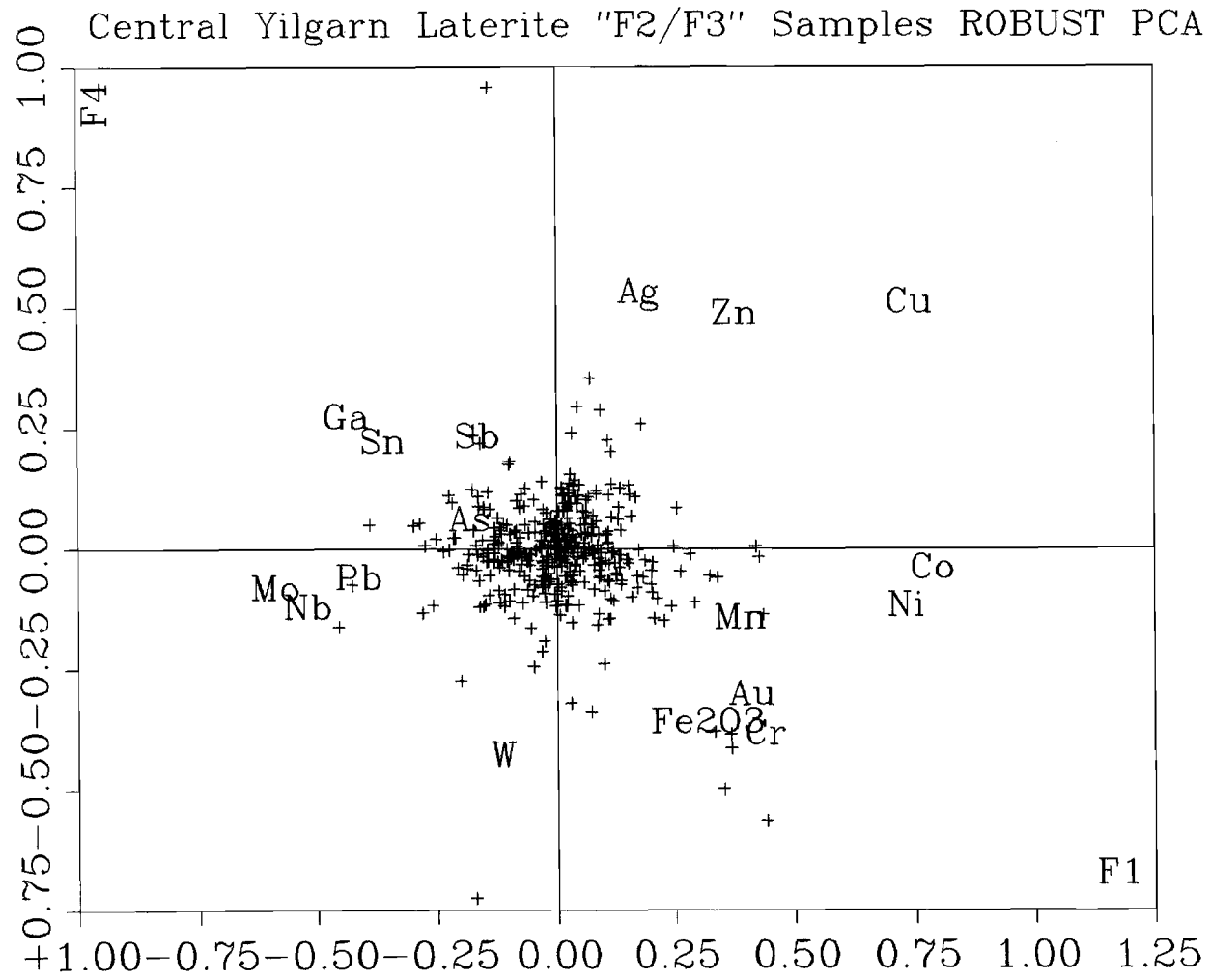
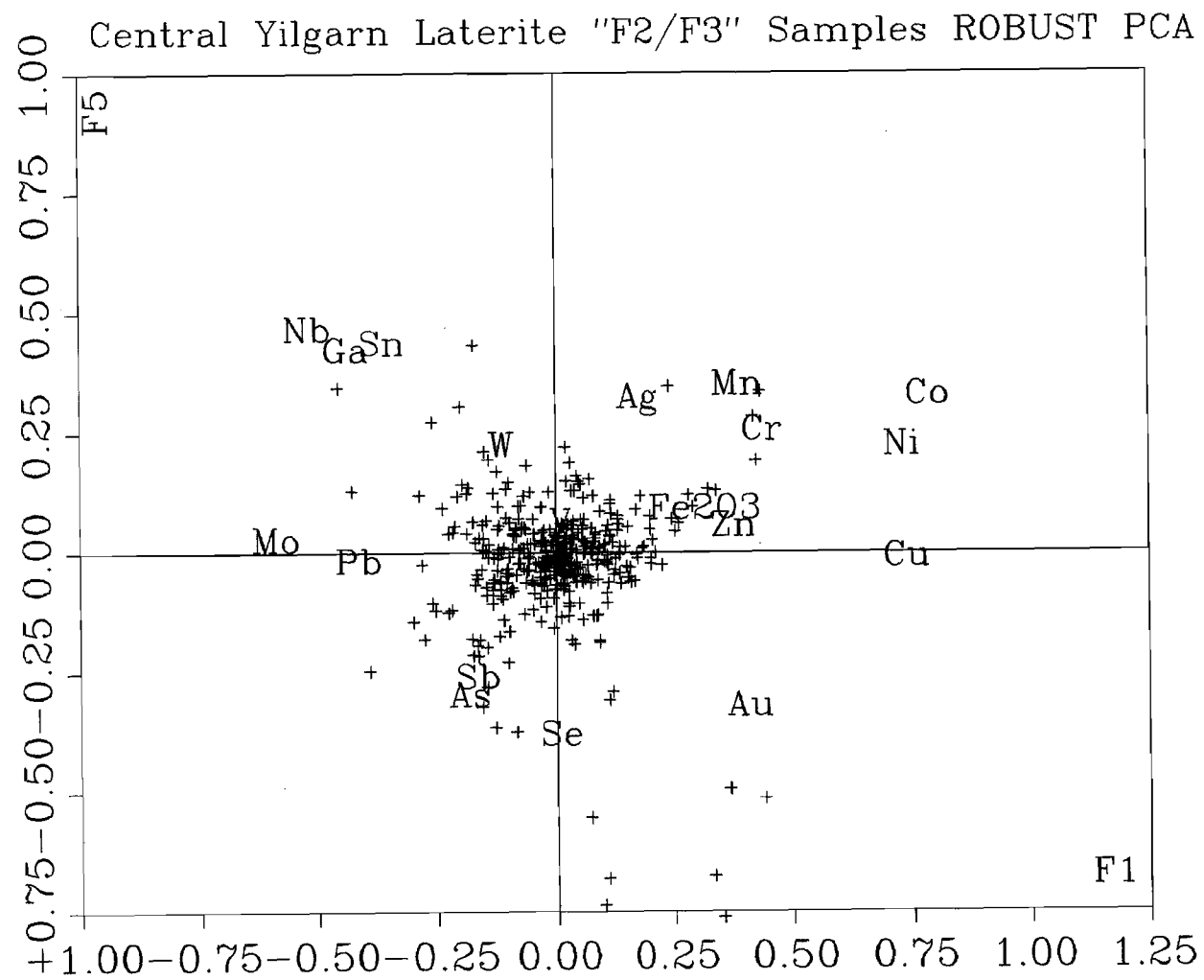


Figure 68b



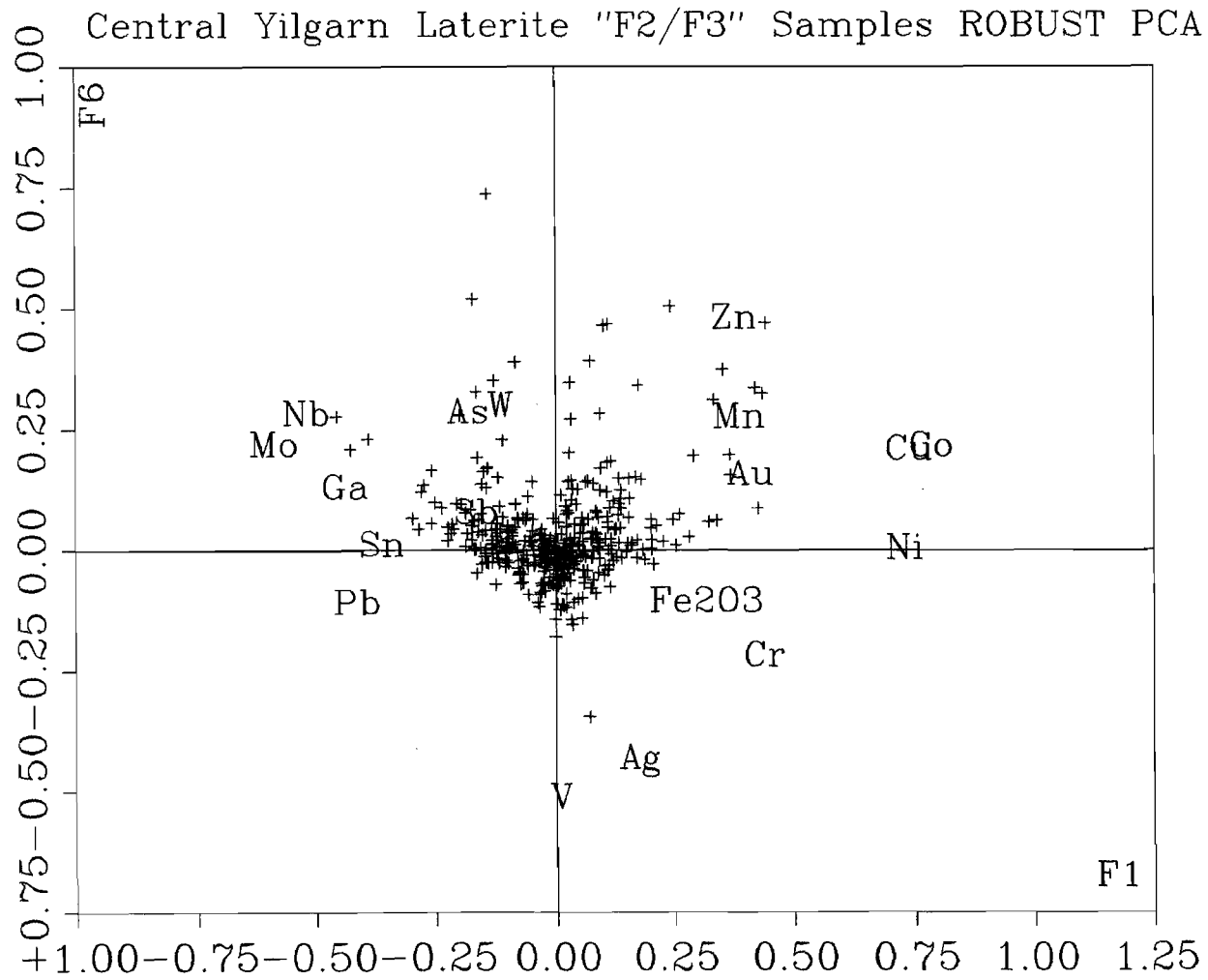


Figure 68d

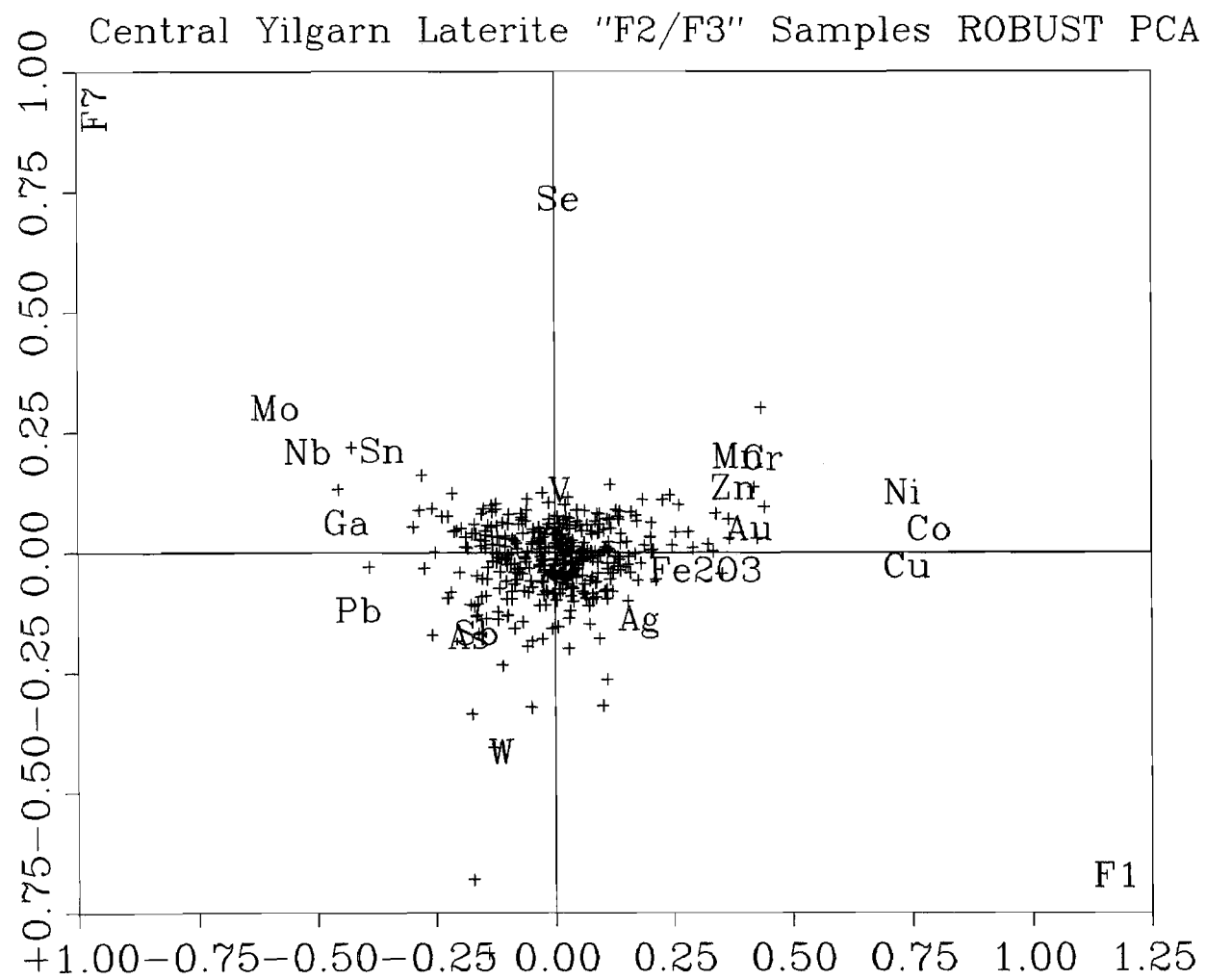


Figure 68e

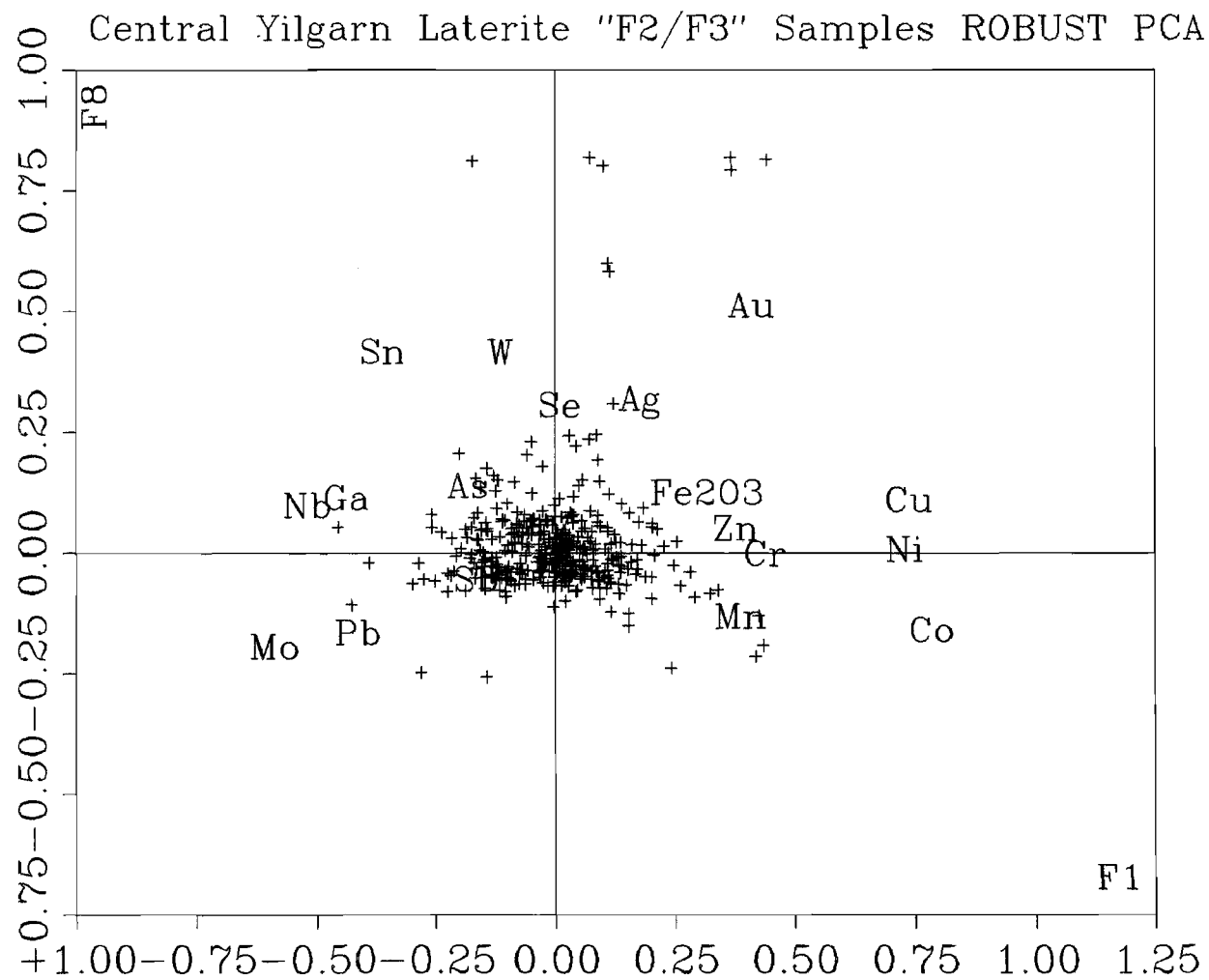


Figure 68f

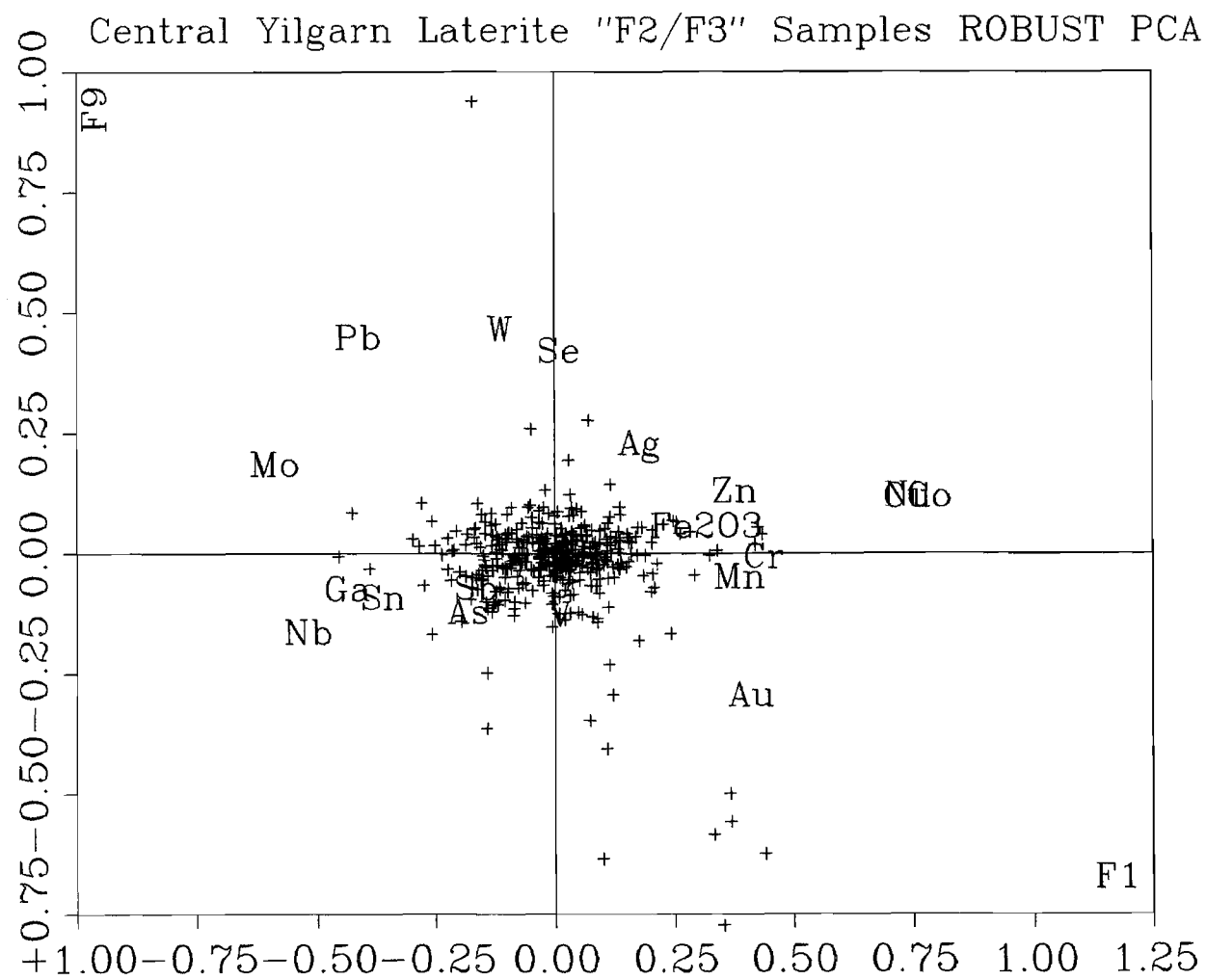
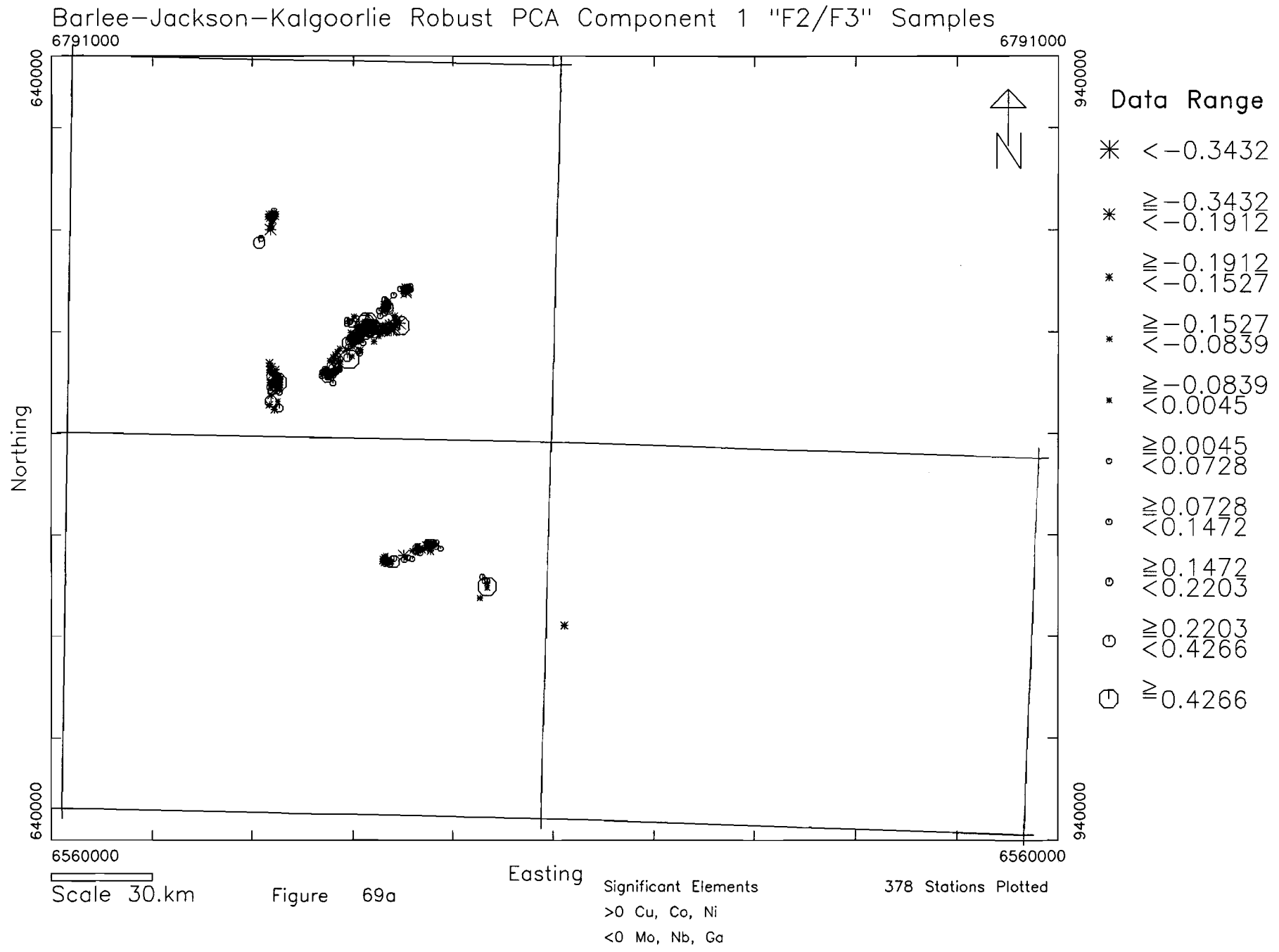
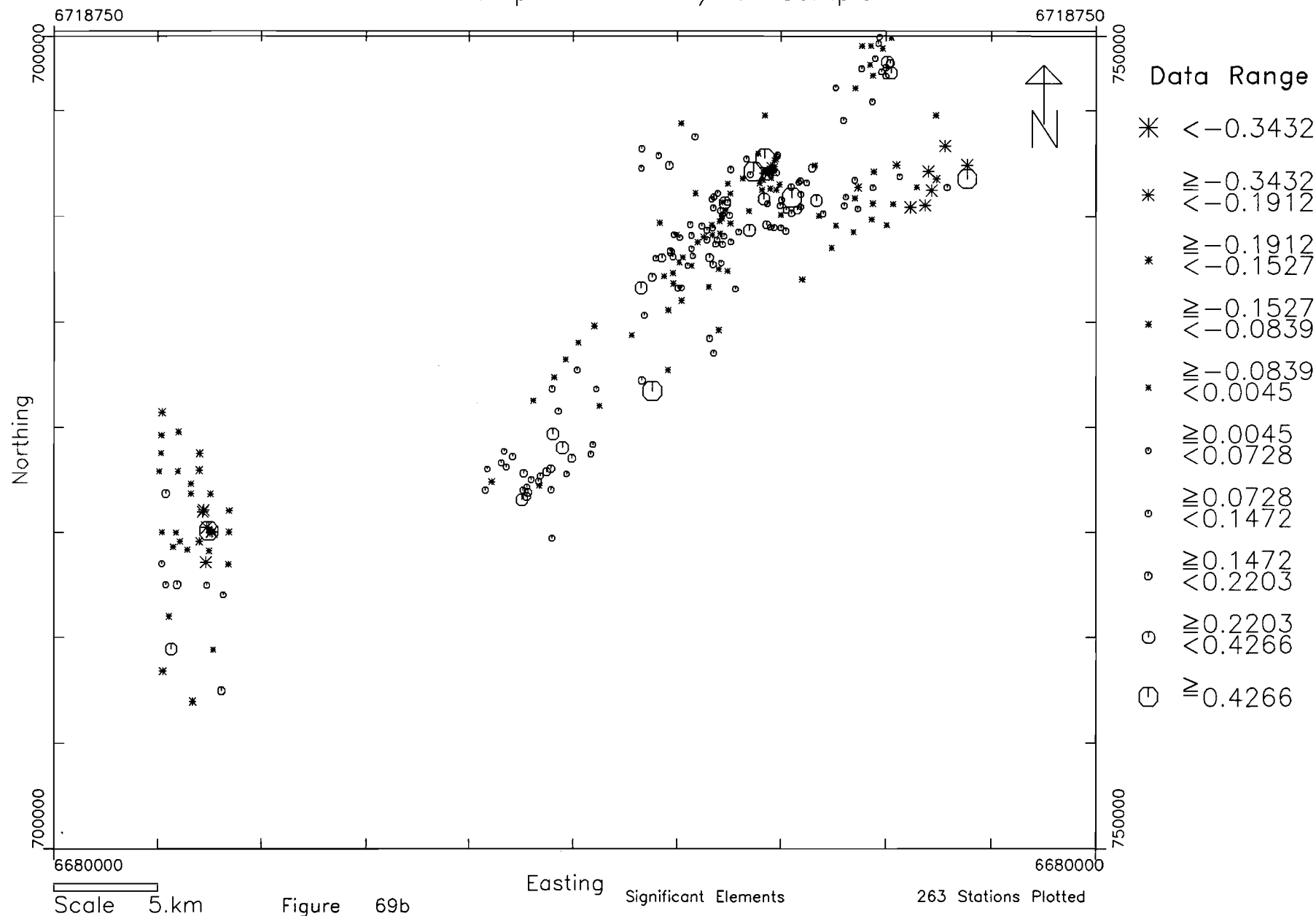
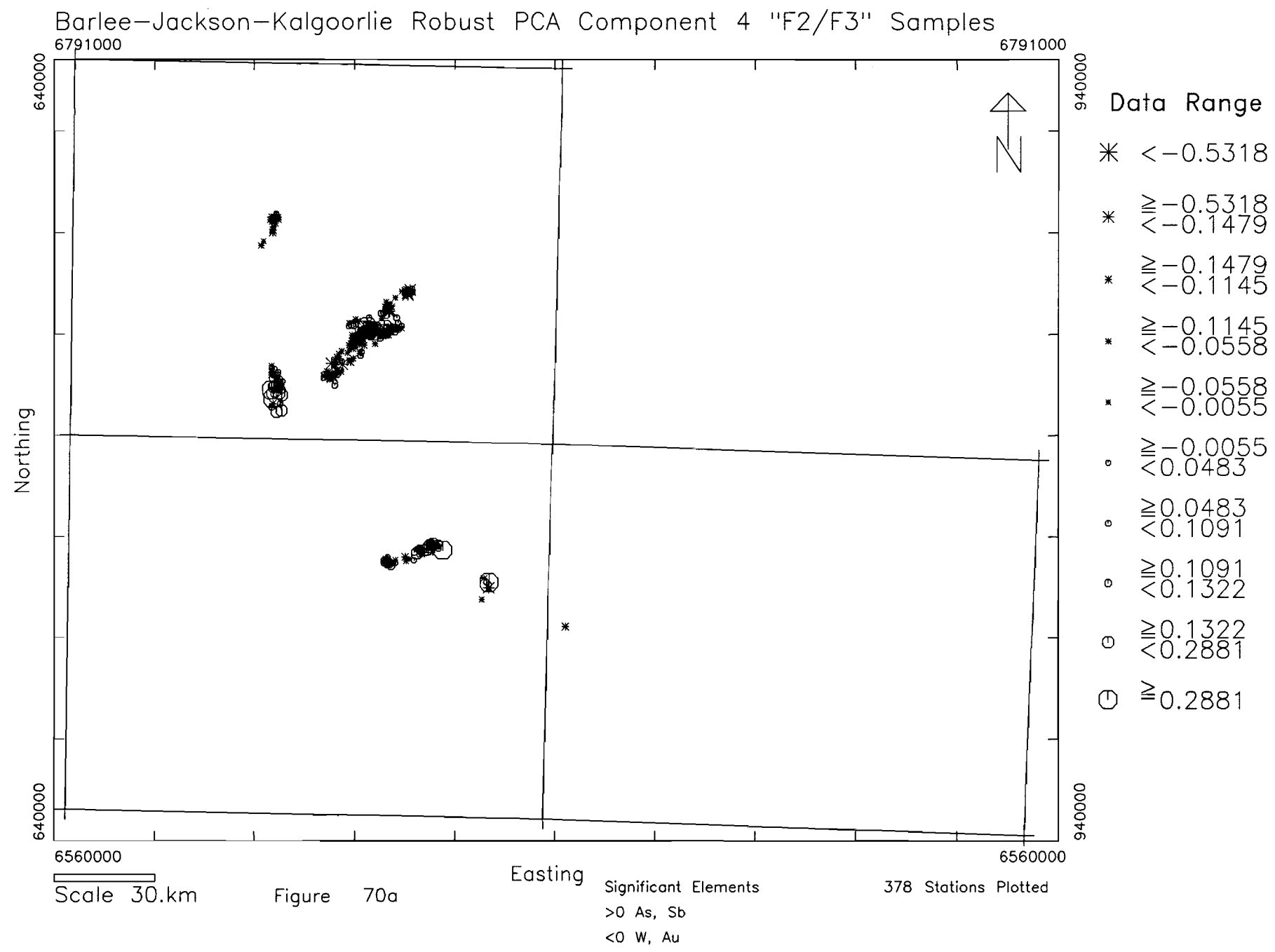


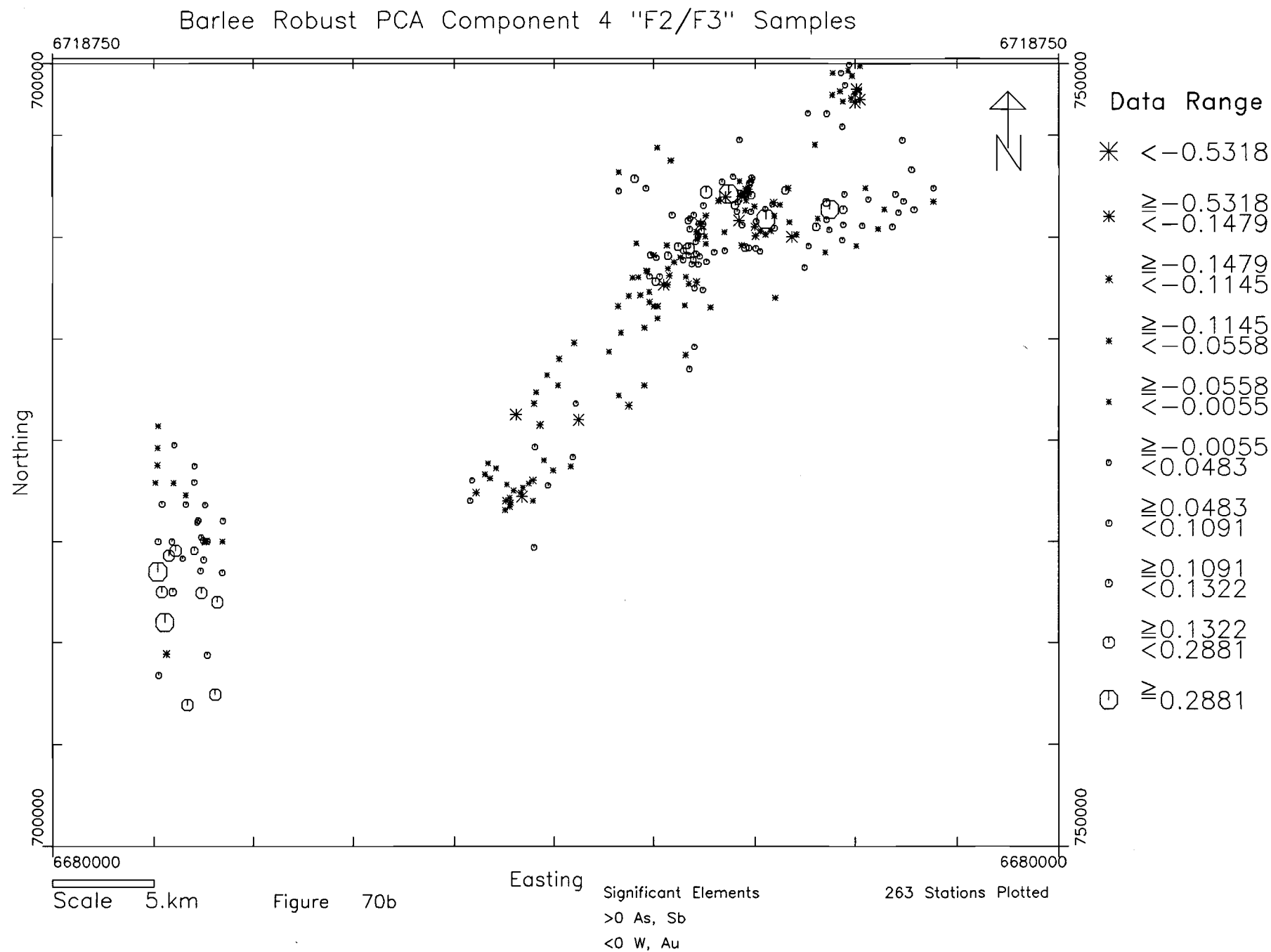
Figure 68g

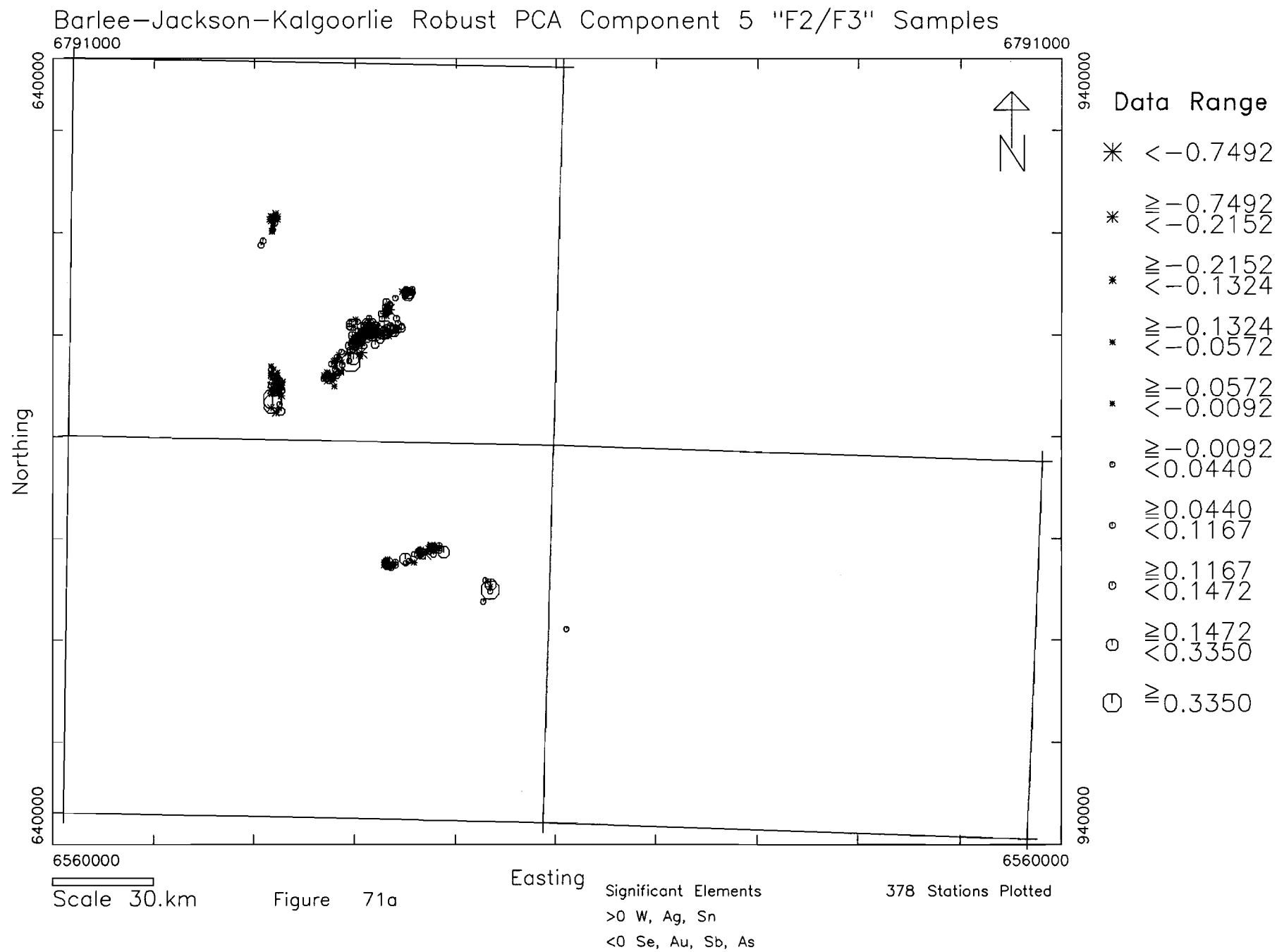


Barlee Robust PCA Component 1 "F2/F3" Samples

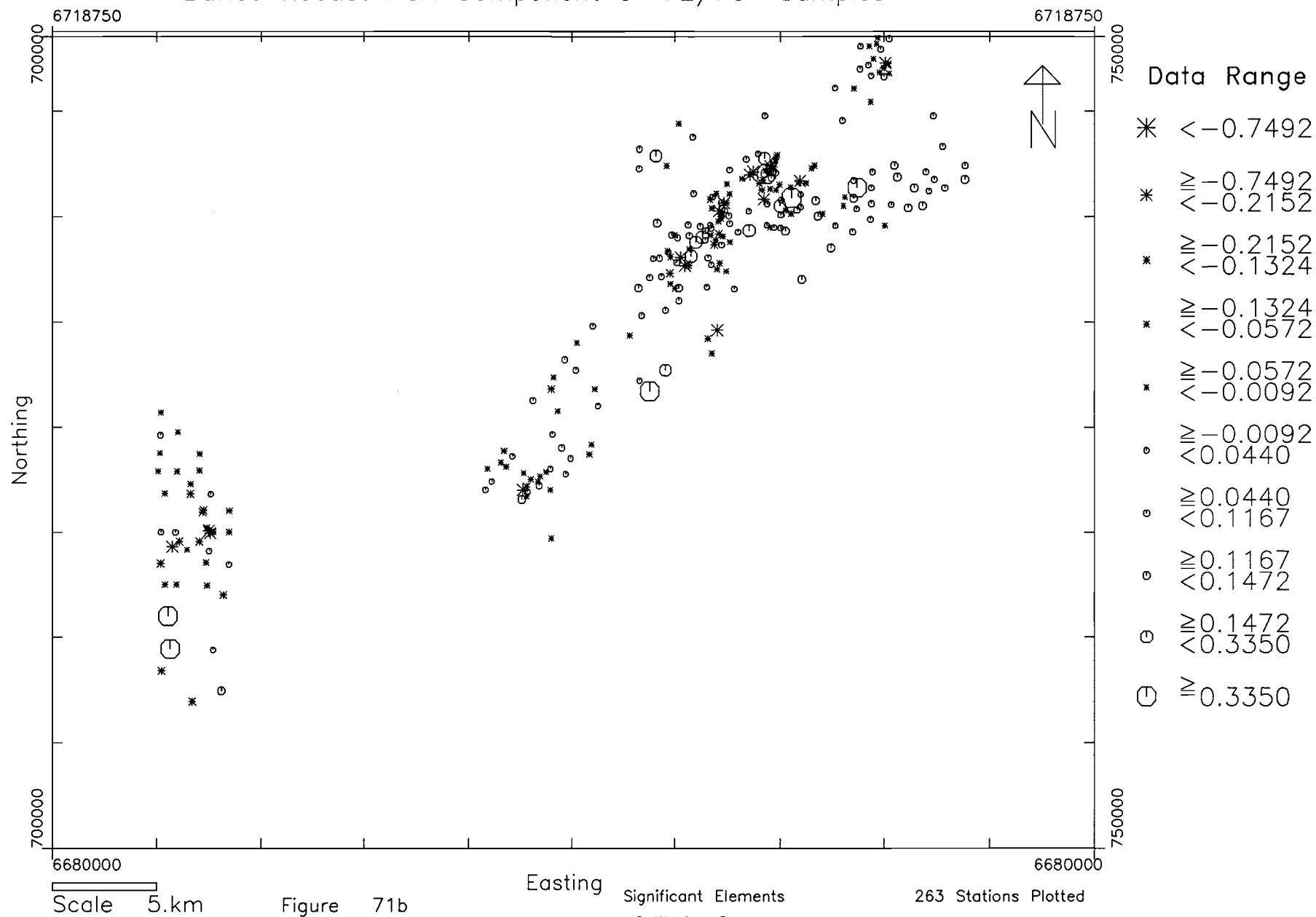


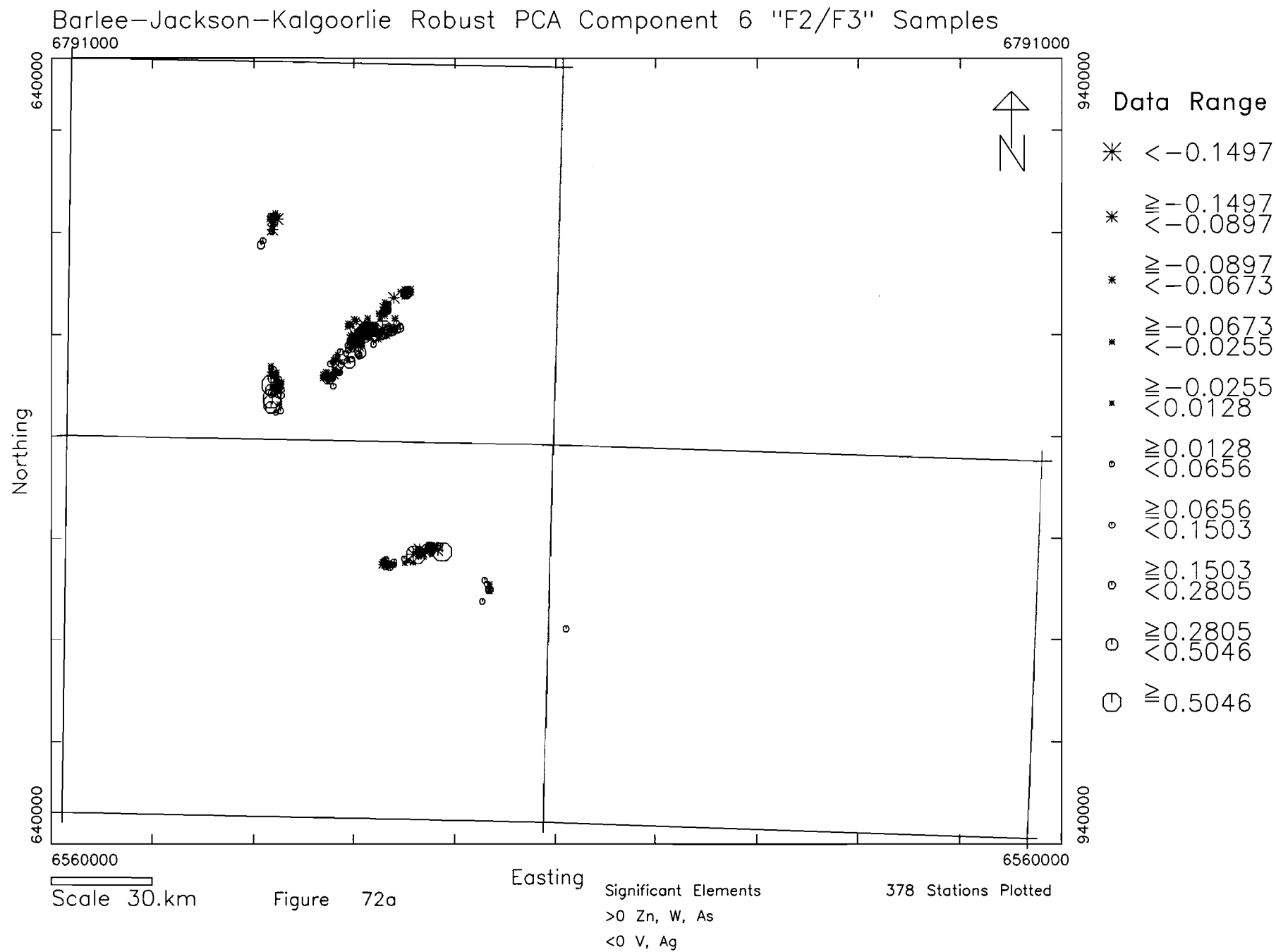


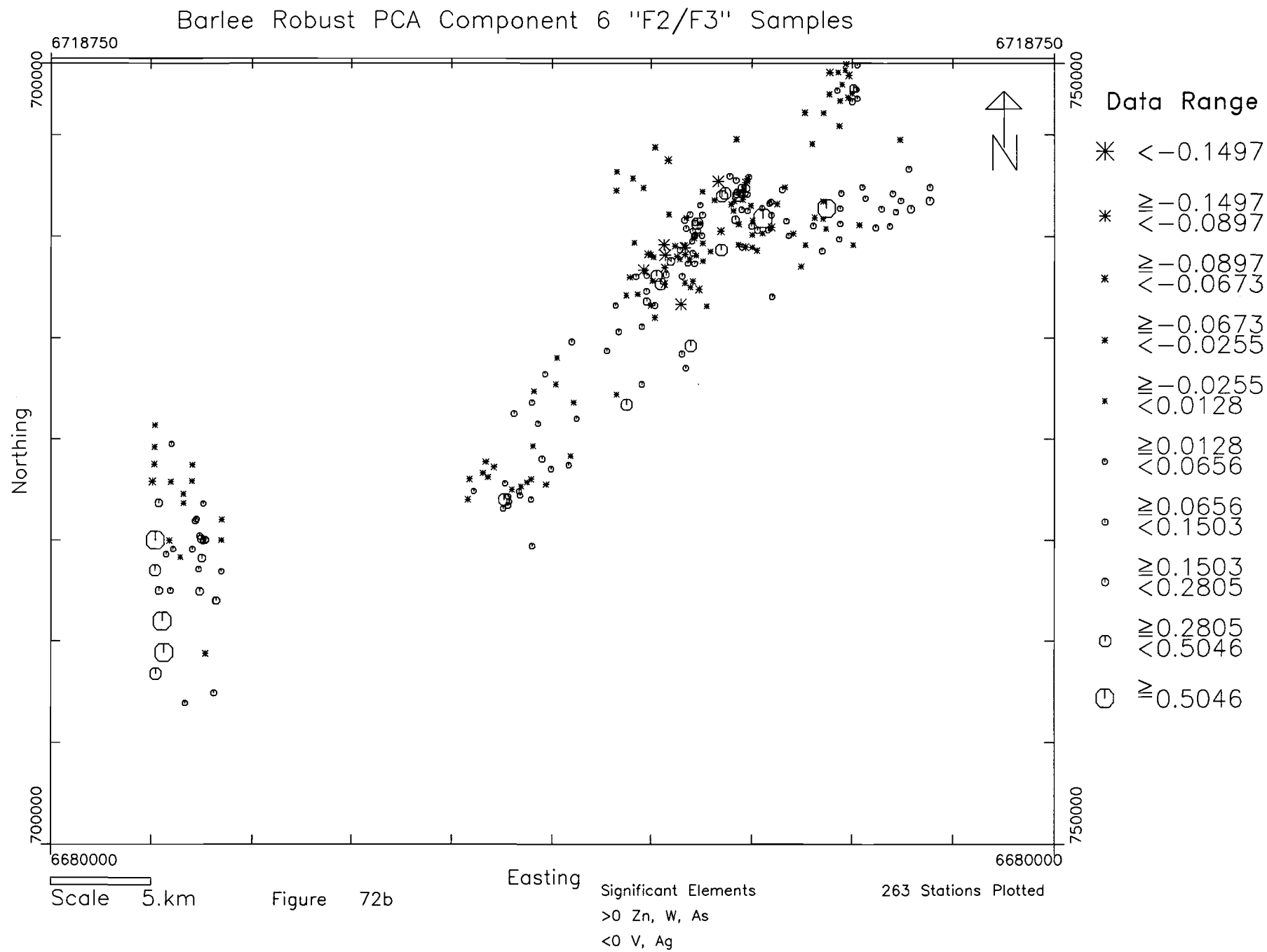


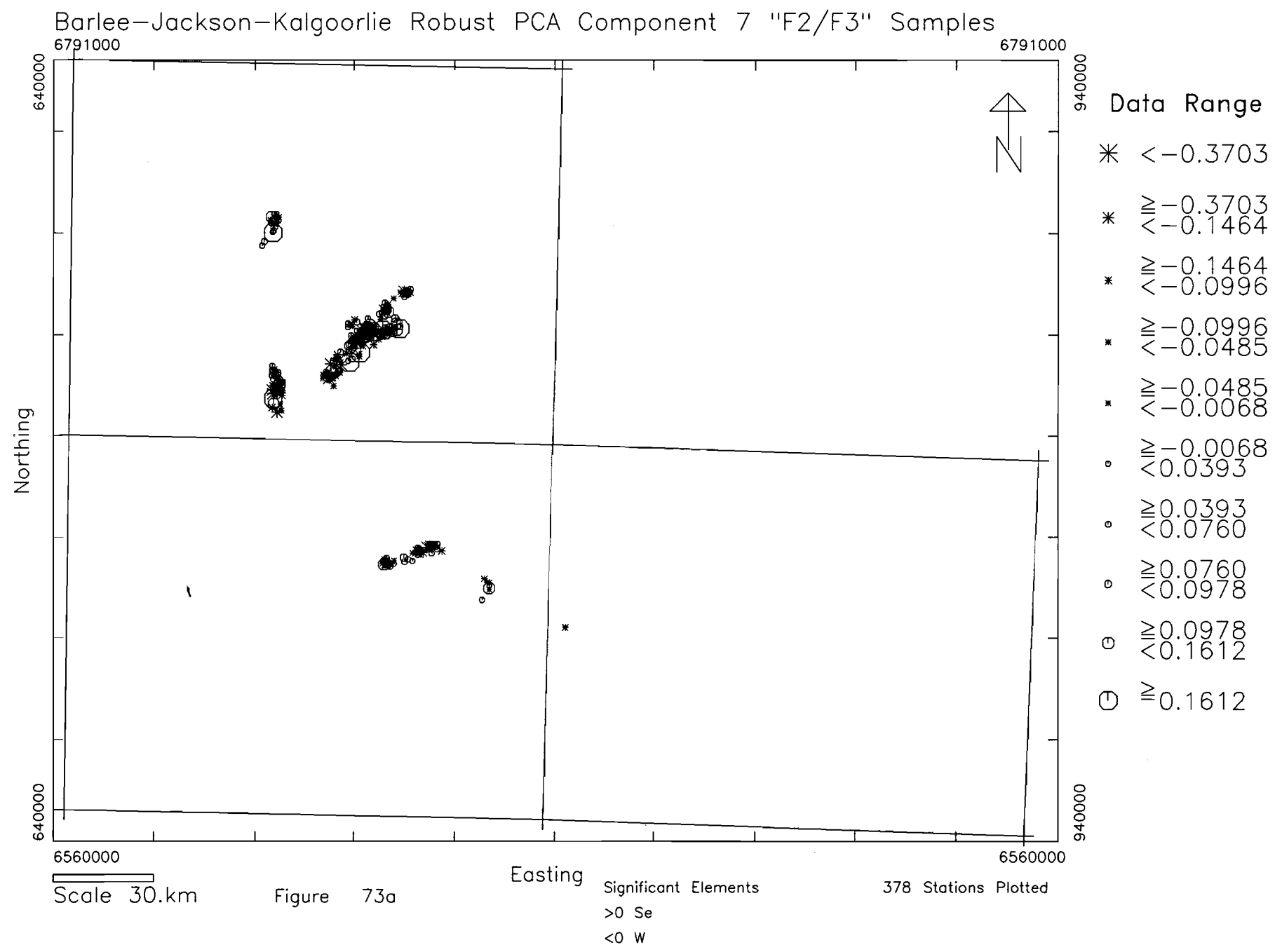


Barlee Robust PCA Component 5 "F2/F3" Samples

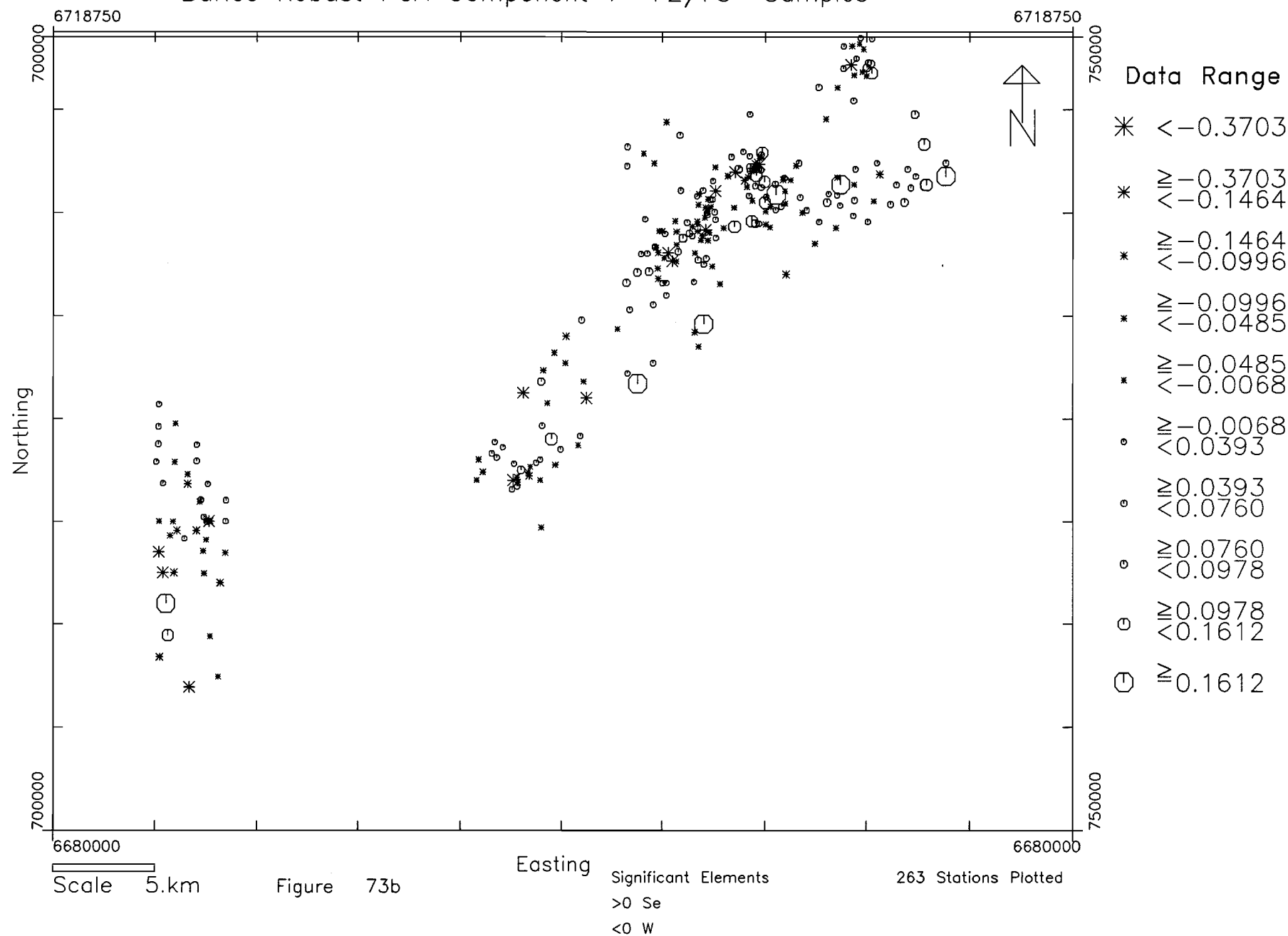


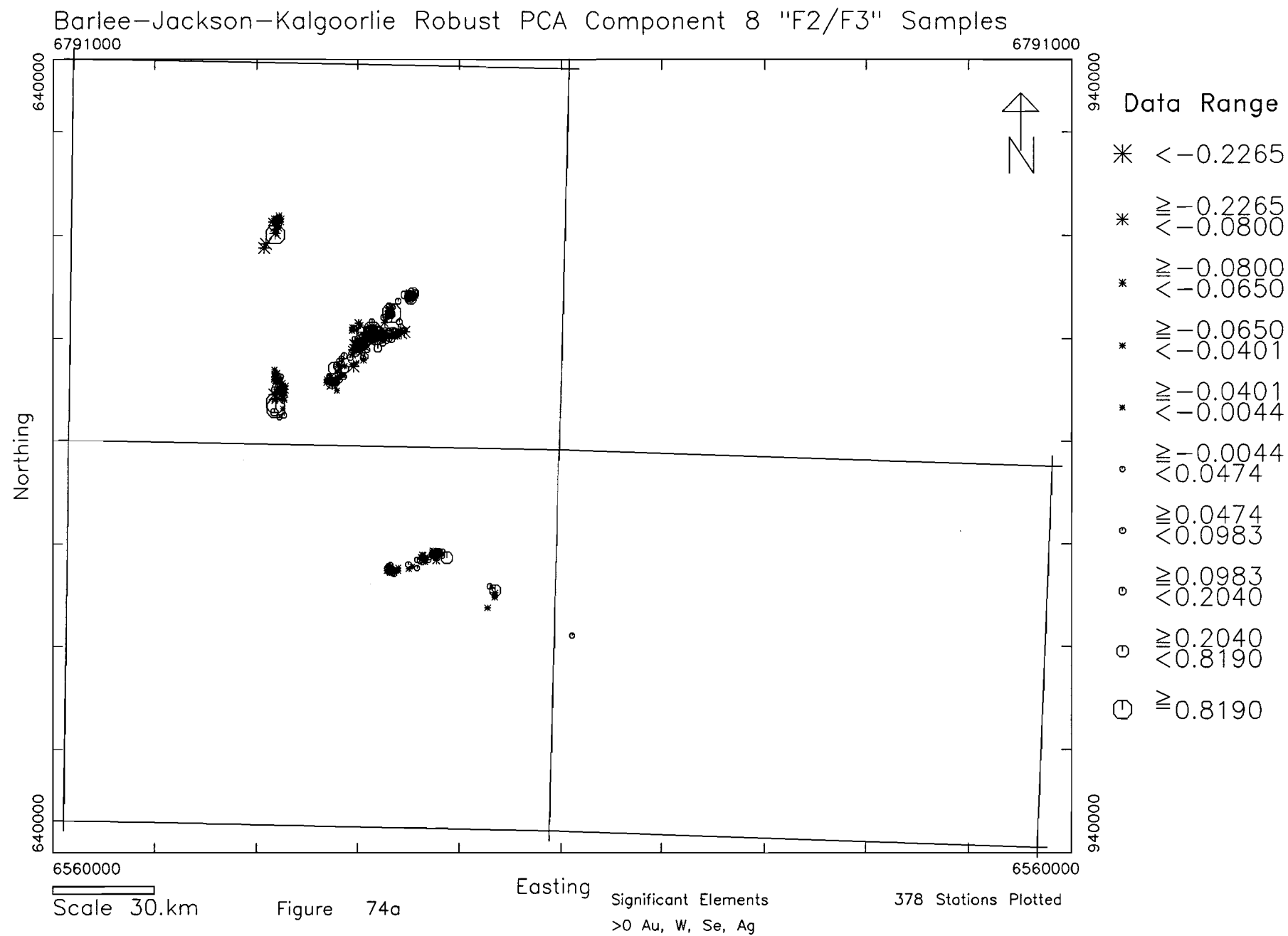




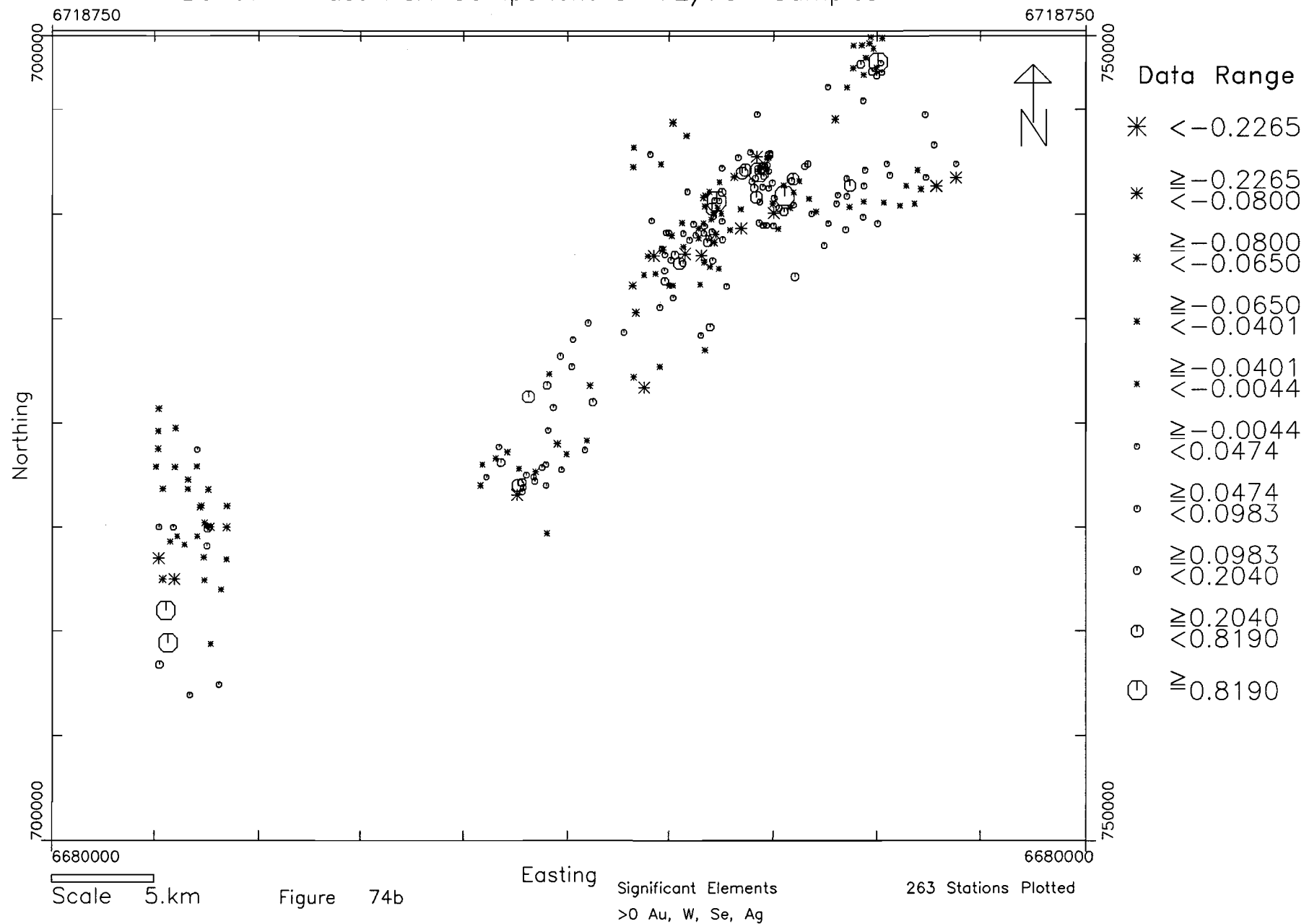


Barlee Robust PCA Component 7 "F2/F3" Samples





Barlee Robust PCA Component 8 "F2/F3" Samples



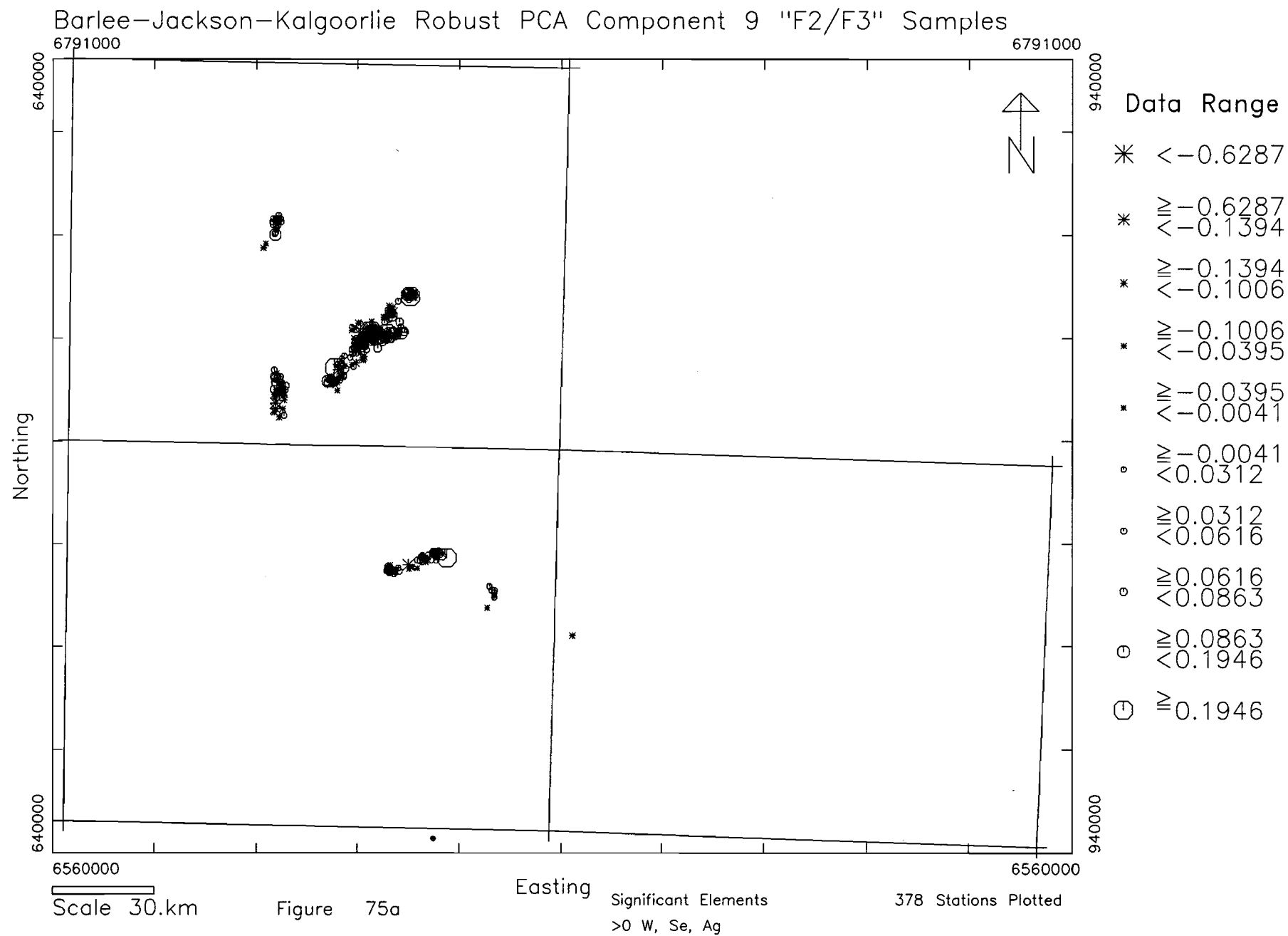


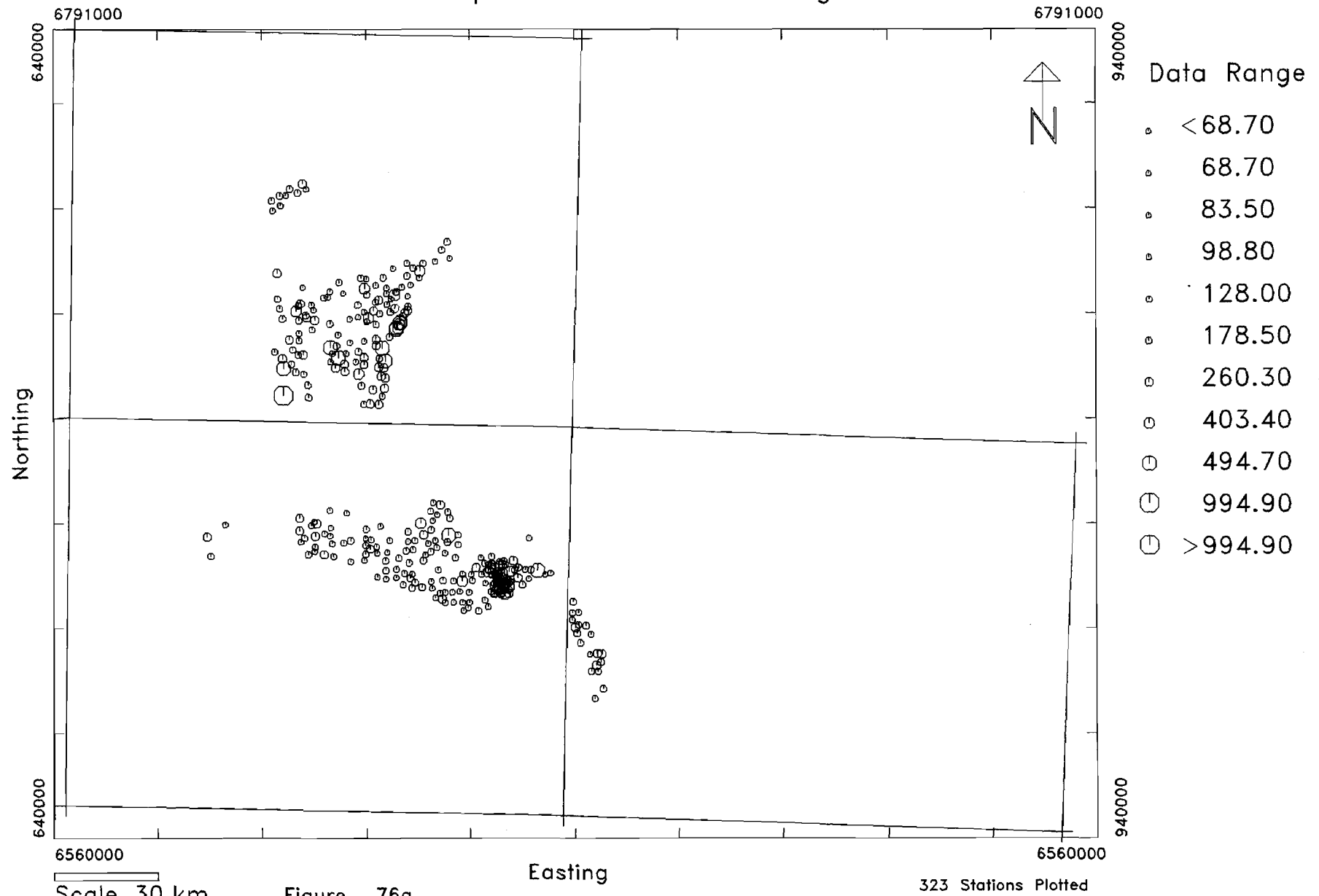
Figure 75b is a map of the study area showing 263 stations plotted. The map is a scatter plot with Easting on the x-axis (6680000 to 6718750) and Northing on the y-axis (700000 to 700000). A scale bar indicates 5 km. A north arrow is present. A legend on the right defines the symbols for significant elements:

Symbol	Range
*	< -0.6287
*	≥ -0.6287
*	< -0.1394
*	≥ -0.1394
*	< -0.1006
*	≥ -0.1006
*	< -0.0395
*	≥ -0.0395
*	< -0.0041
*	≥ -0.0041
○	< 0.0312
○	≥ 0.0312
○	< 0.0616
○	≥ 0.0616
○	< 0.0863
○	≥ 0.0863
○	< 0.1946
○	≥ 0.1946

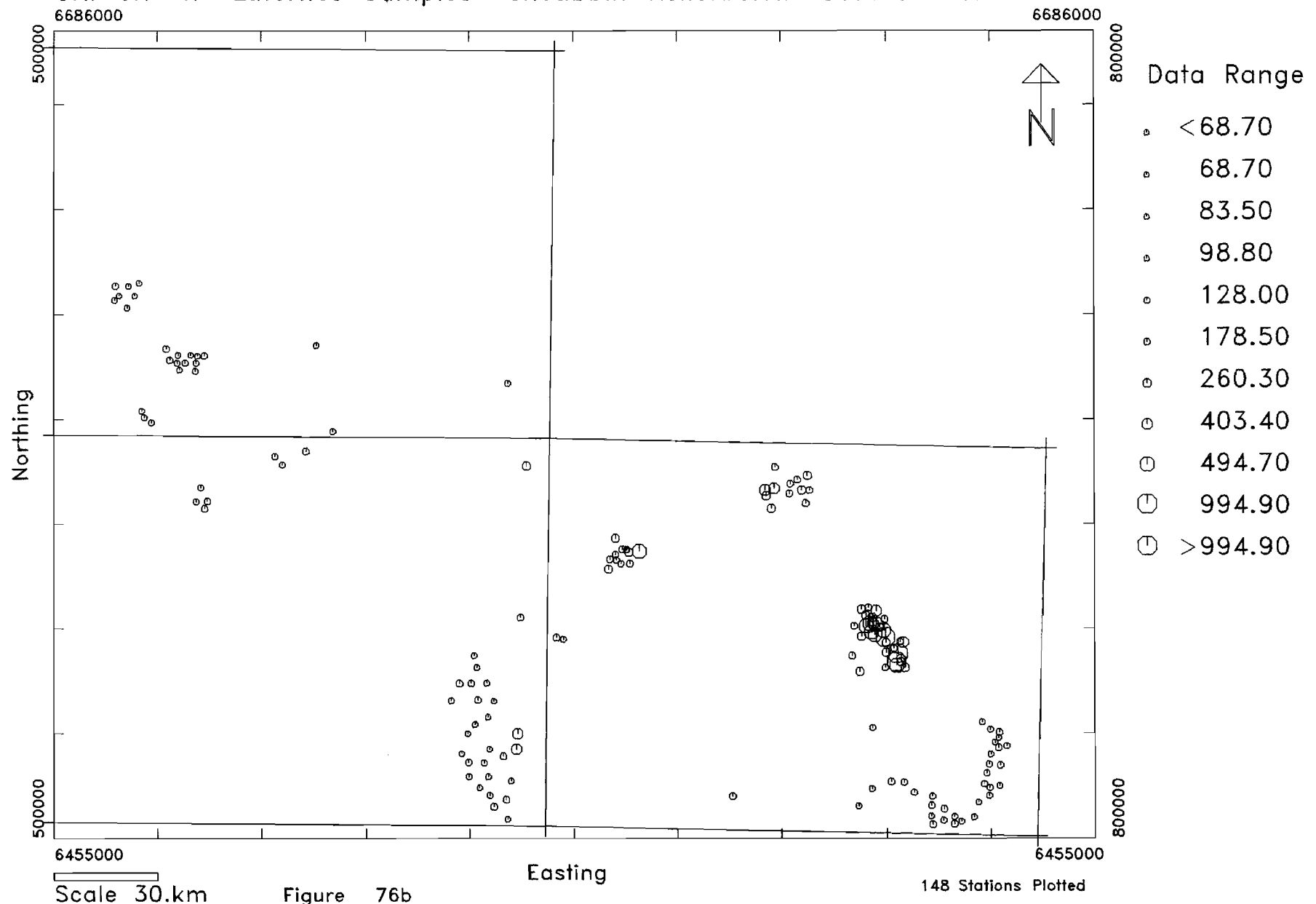
Significant Elements
>0 W, Se, Ag

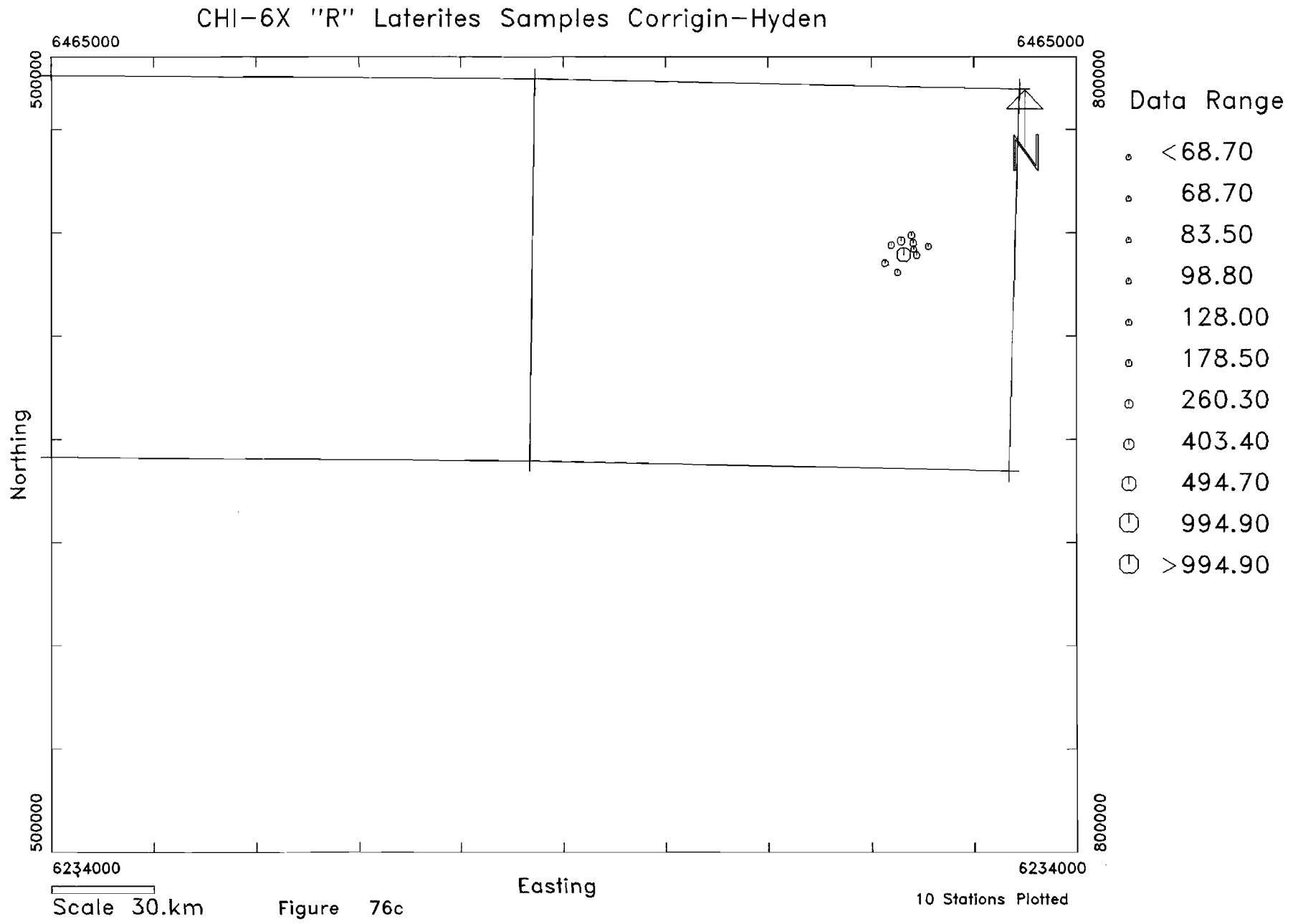
263 Stations Plotted

CHI-6X "R" Laterites Samples Barlee-Jackson-Kalgoorlie

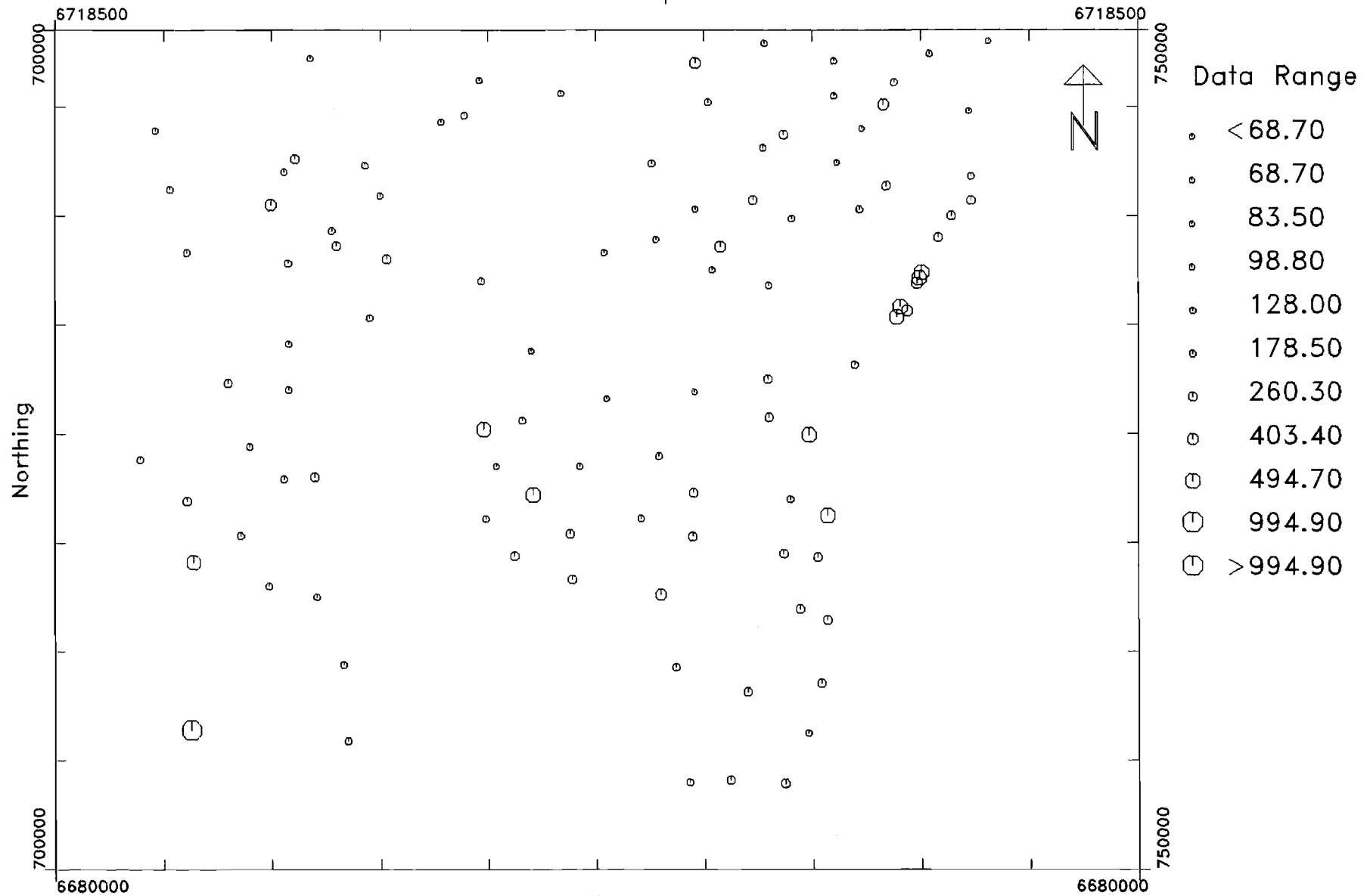


CHI-6X "R" Laterites Samples Bencubbin-Kellerberrin-Southern Cross





CHI-6X "R" Laterites Samples Barlee



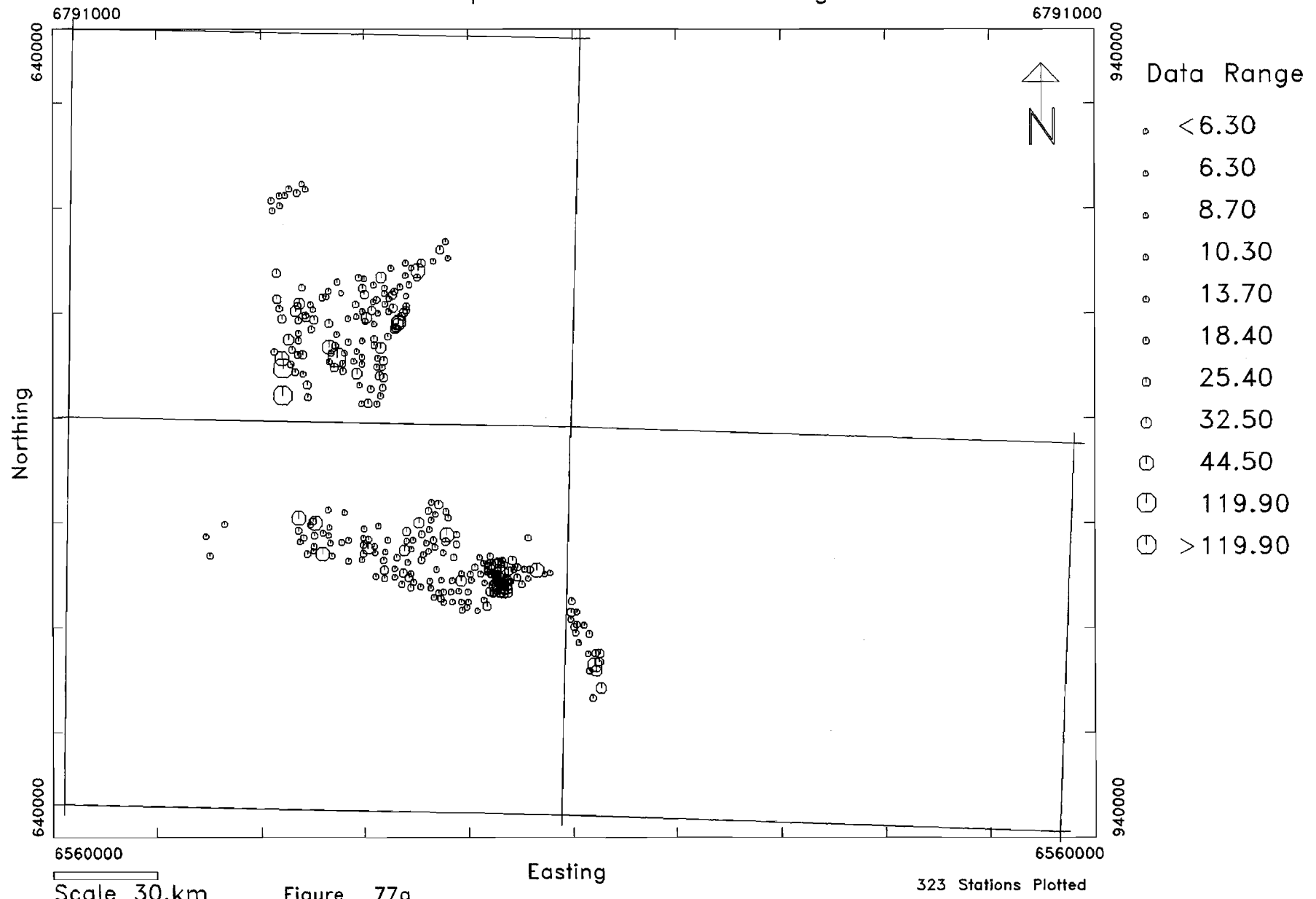
Scale 5.km

Figure 76d

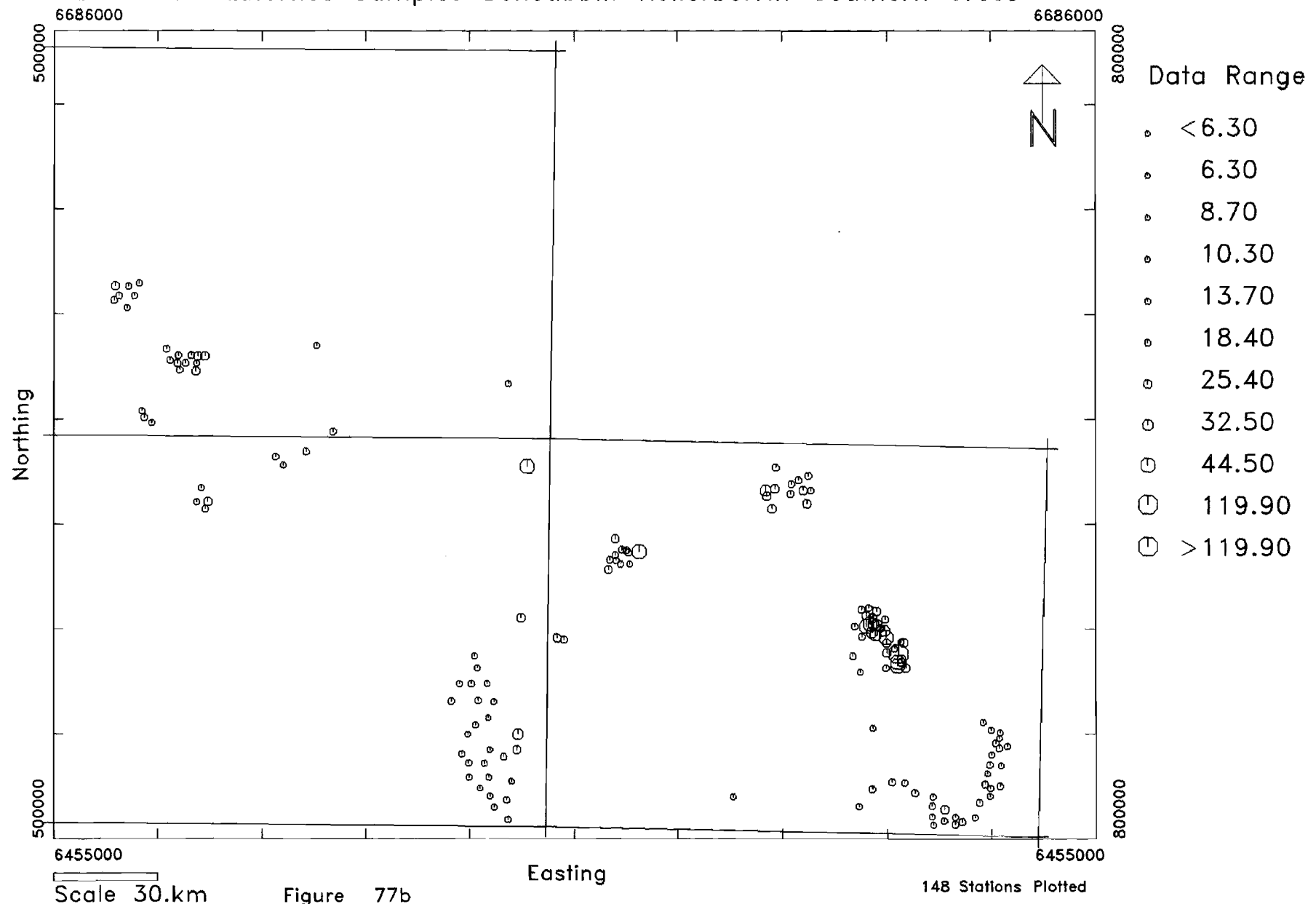
Easting

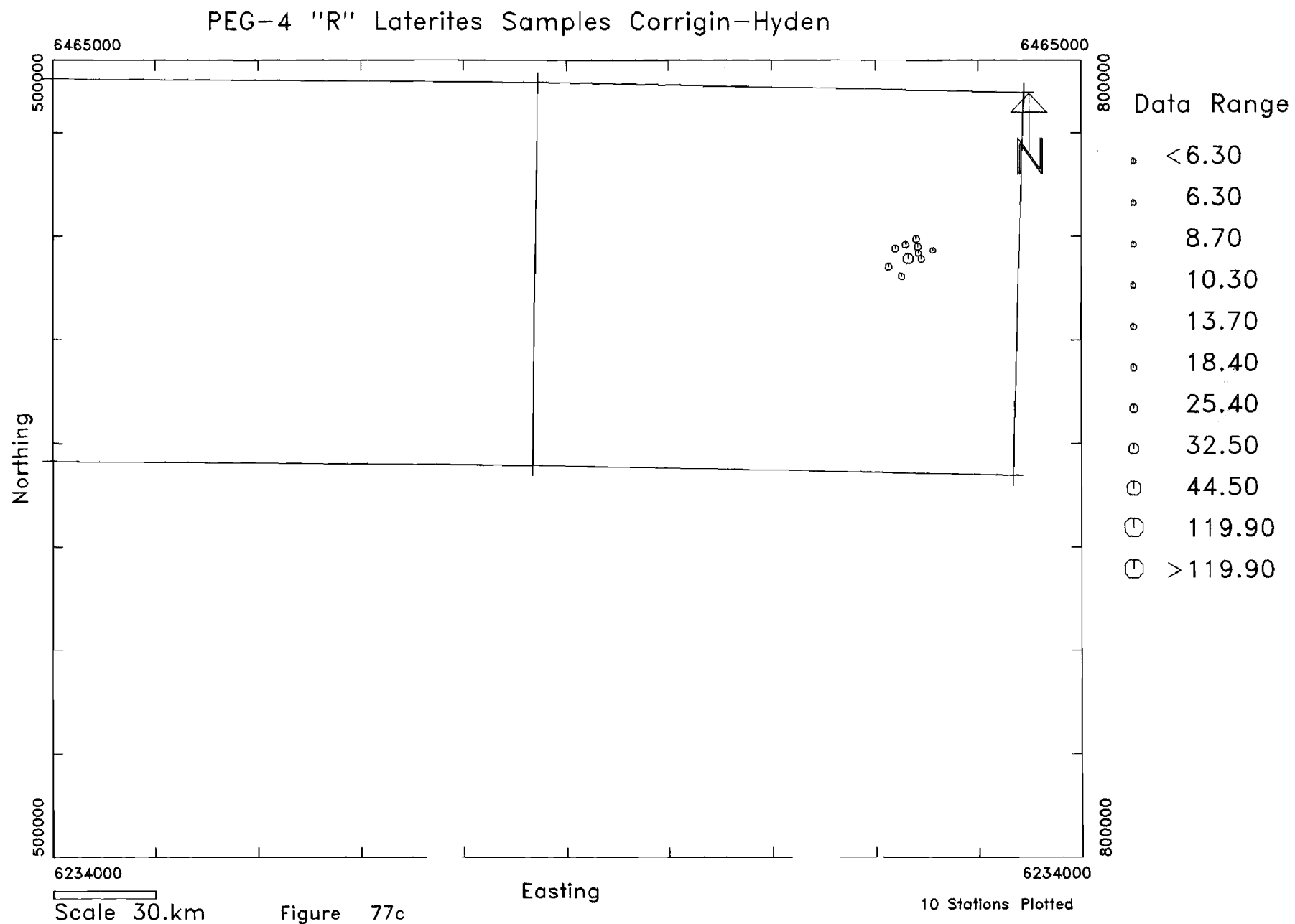
103 Stations Plotted

PEG-4 "R" Laterites Samples Barlee-Jackson-Kalgoorlie

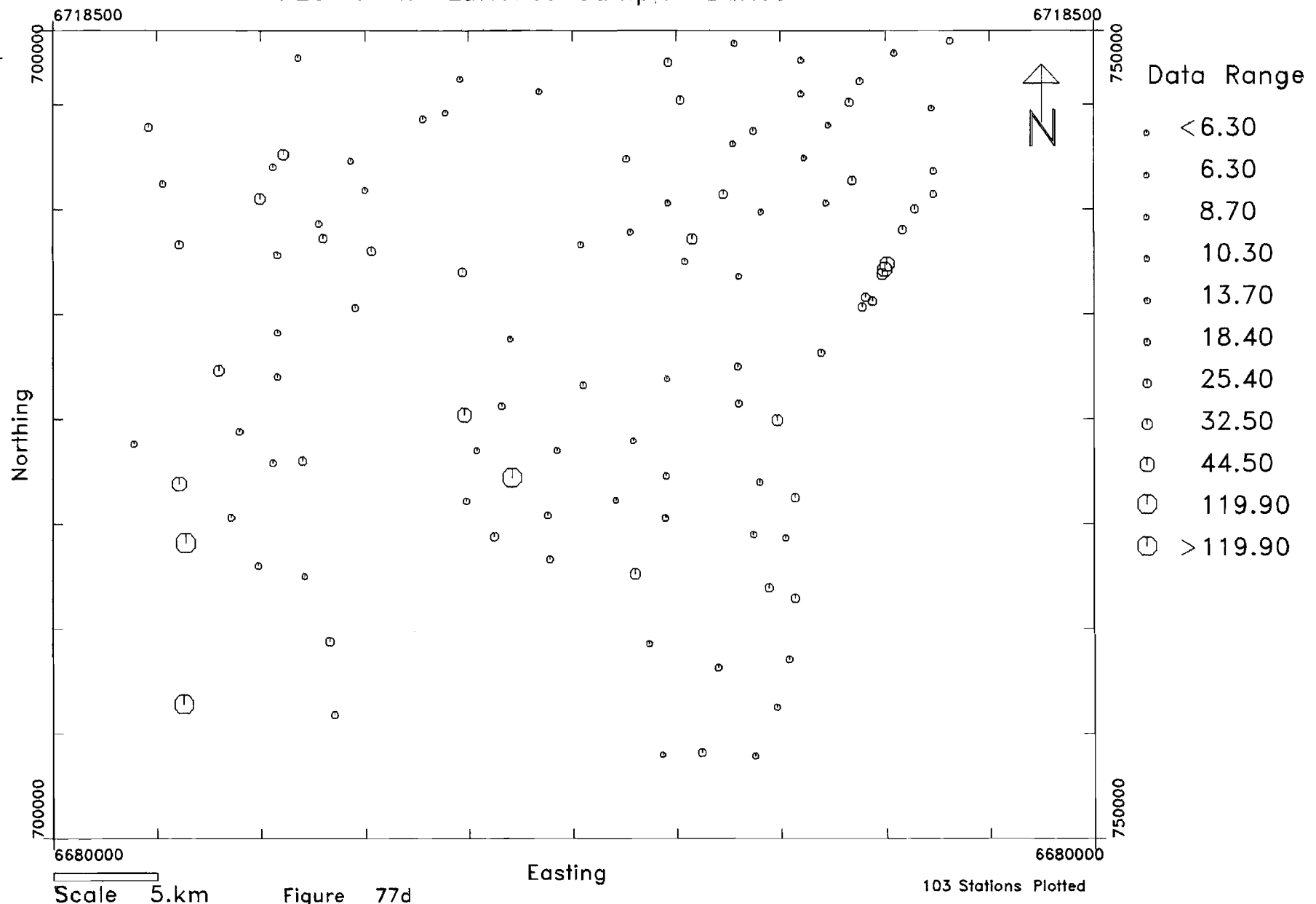


PEG-4 "R" Laterites Samples Bencubbin-Kellerberrin-Southern Cross

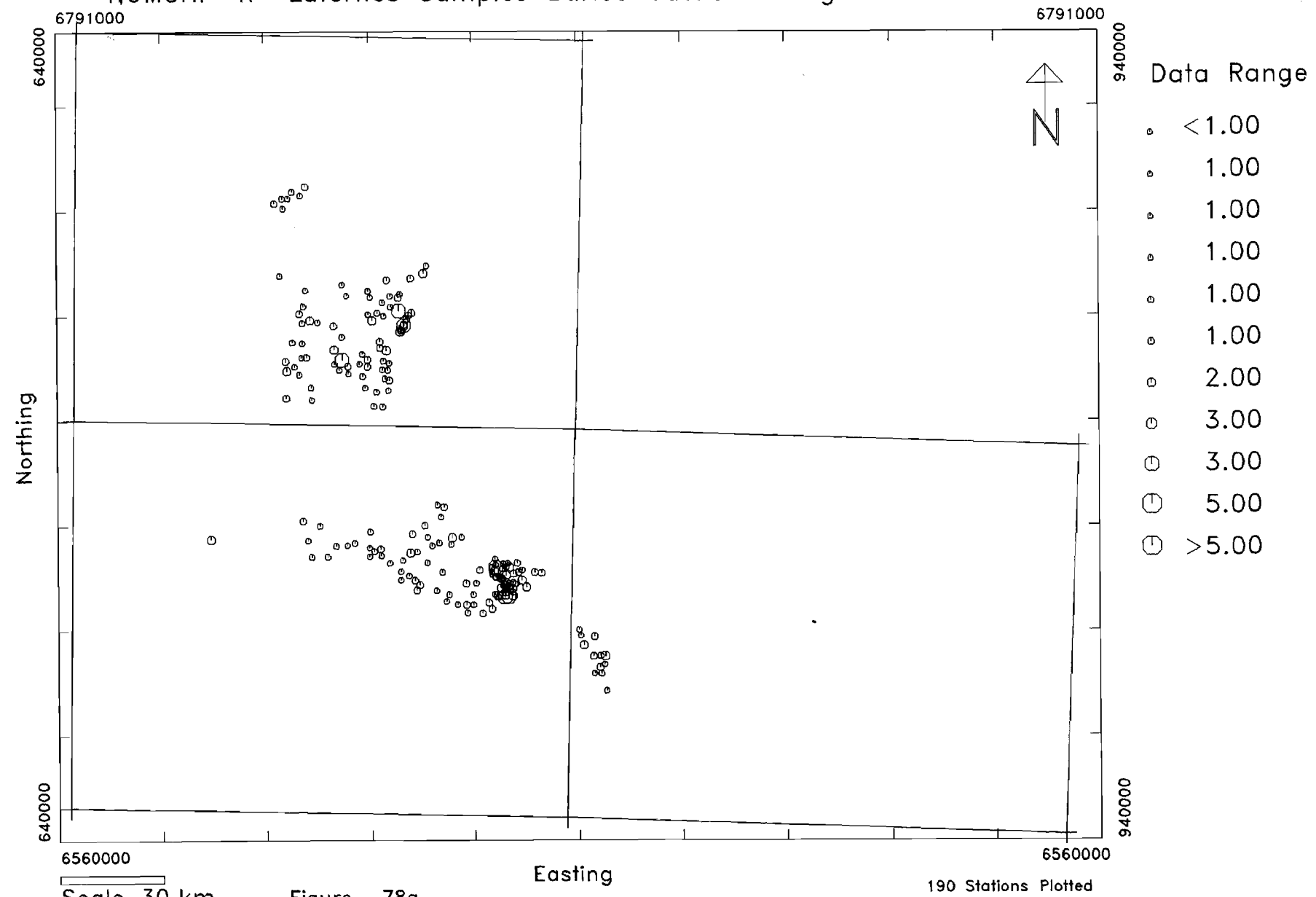




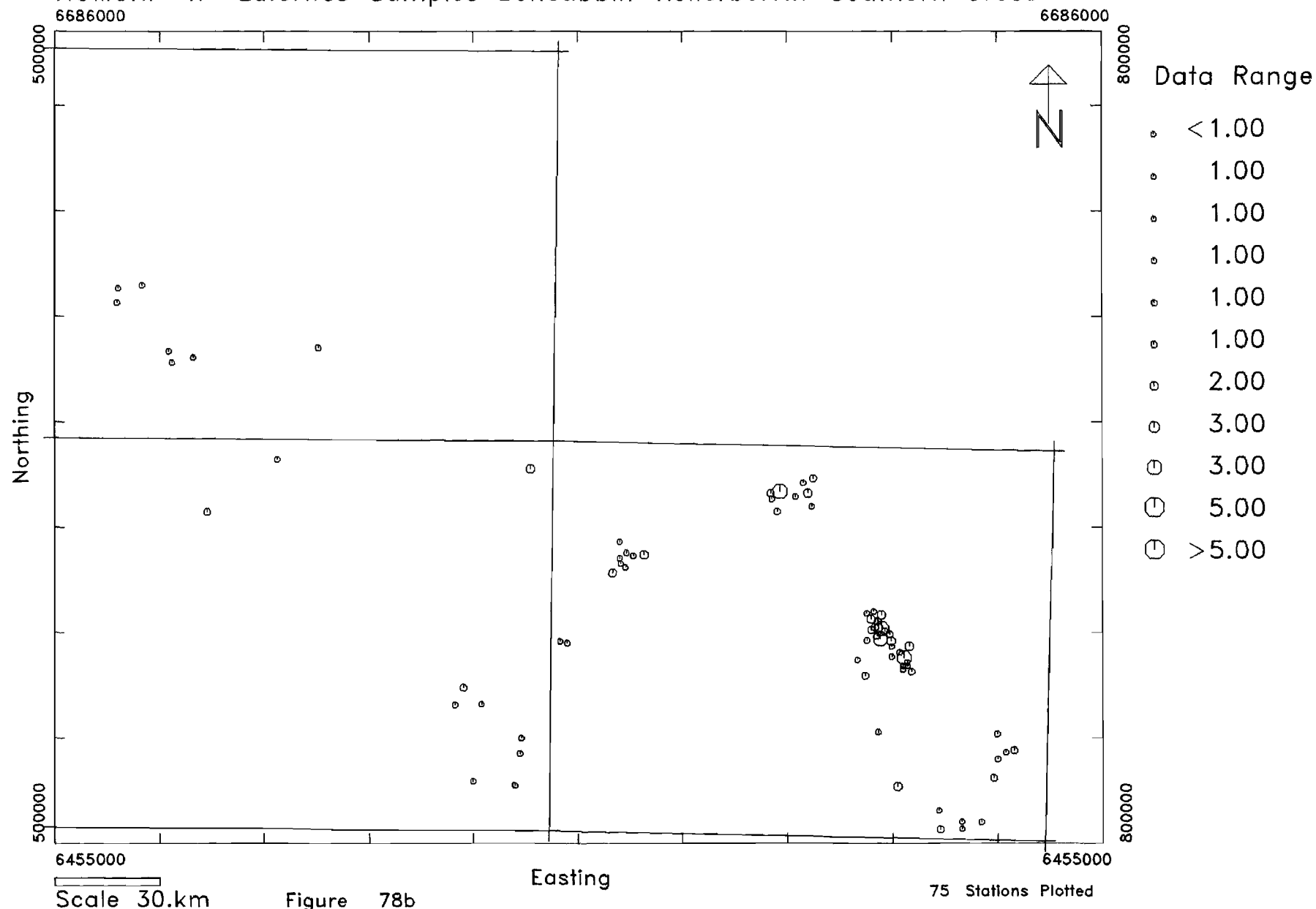
PEG-4 "R" Laterites Samples Barlee

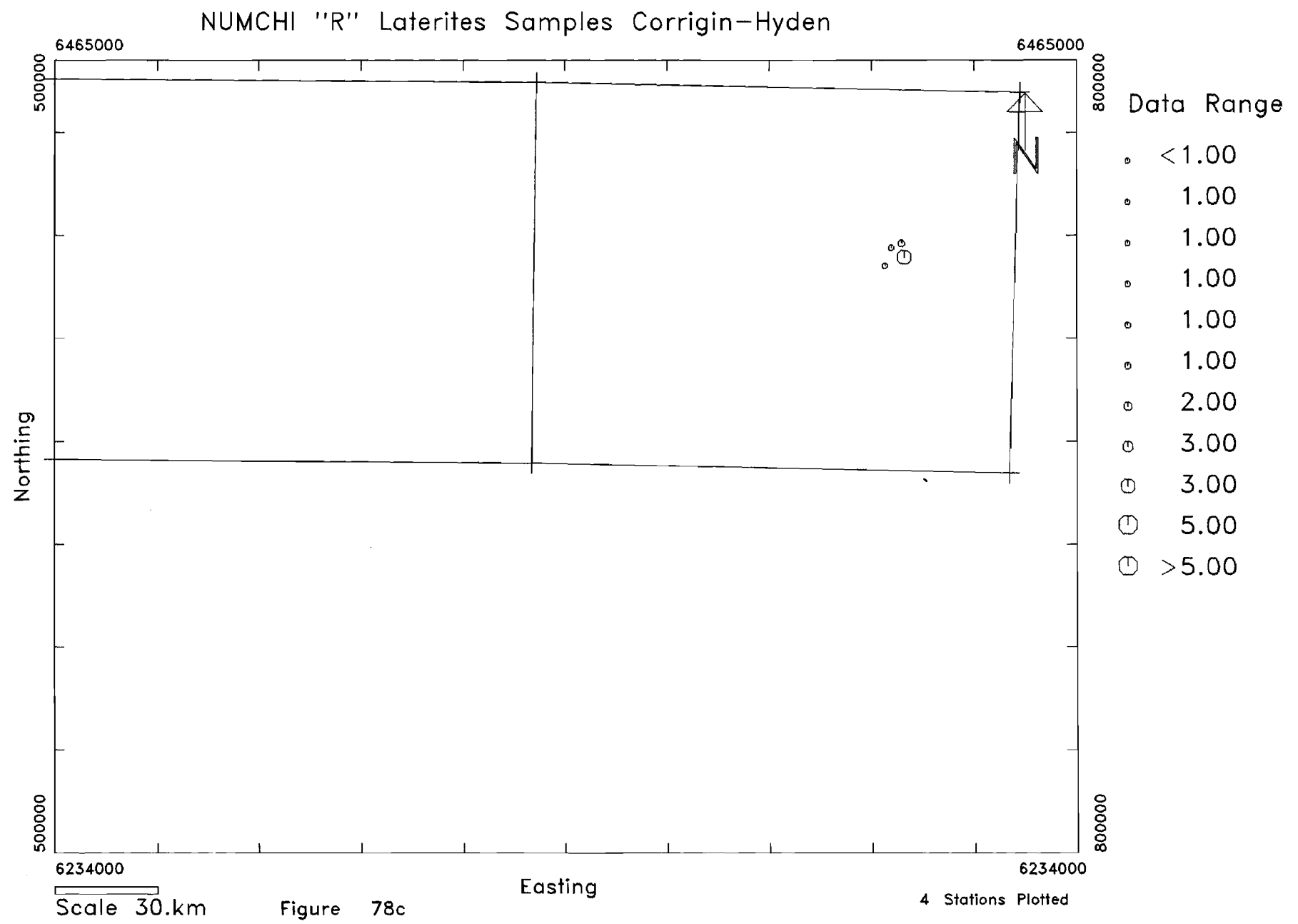


NUMCHI "R" Laterites Samples Barlee-Jackson-Kalgoorlie

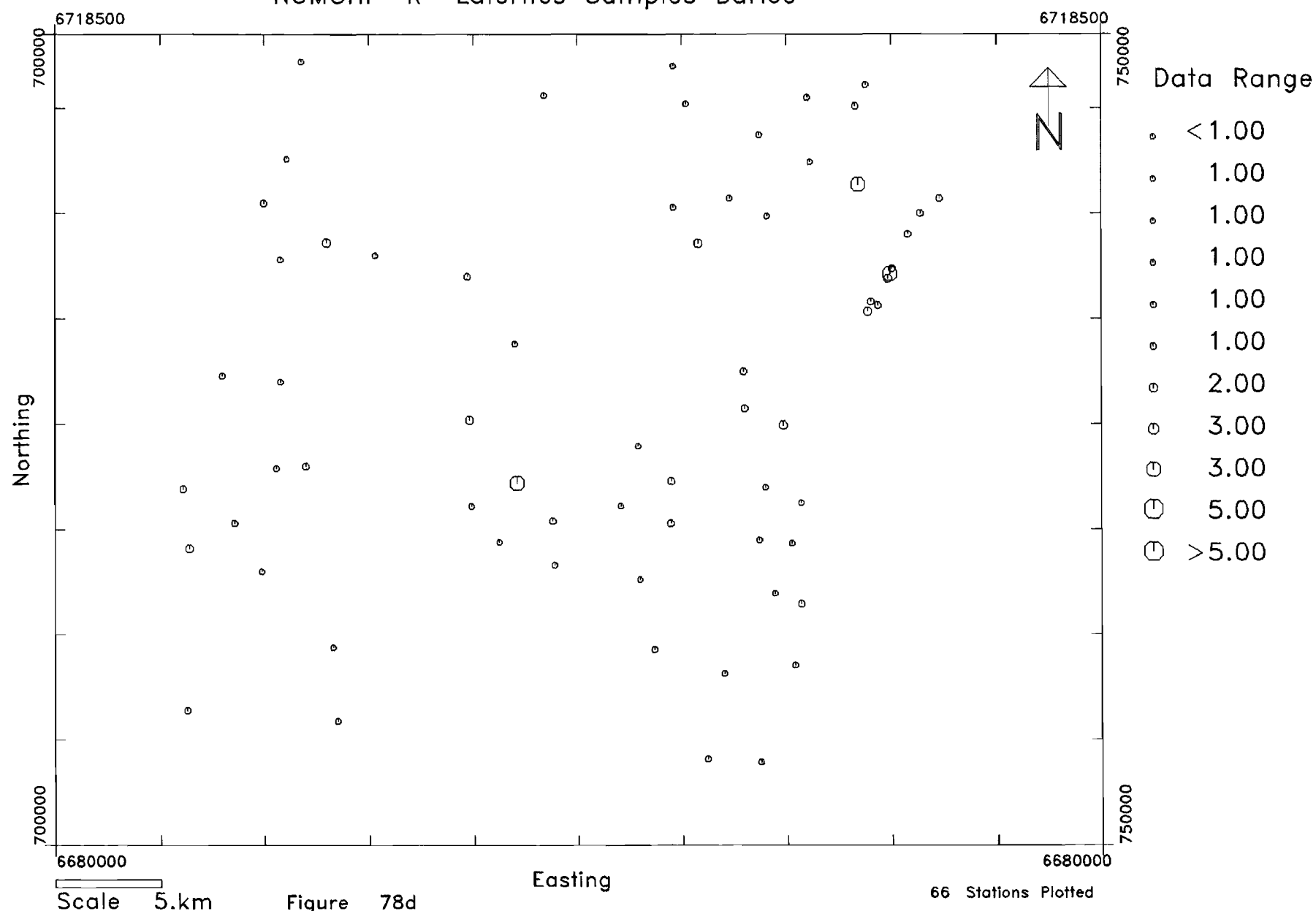


NUMCHI "R" Laterites Samples Bencubbin-Kellerberrin-Southern Cross





NUMCHI "R" Laterites Samples Barlee



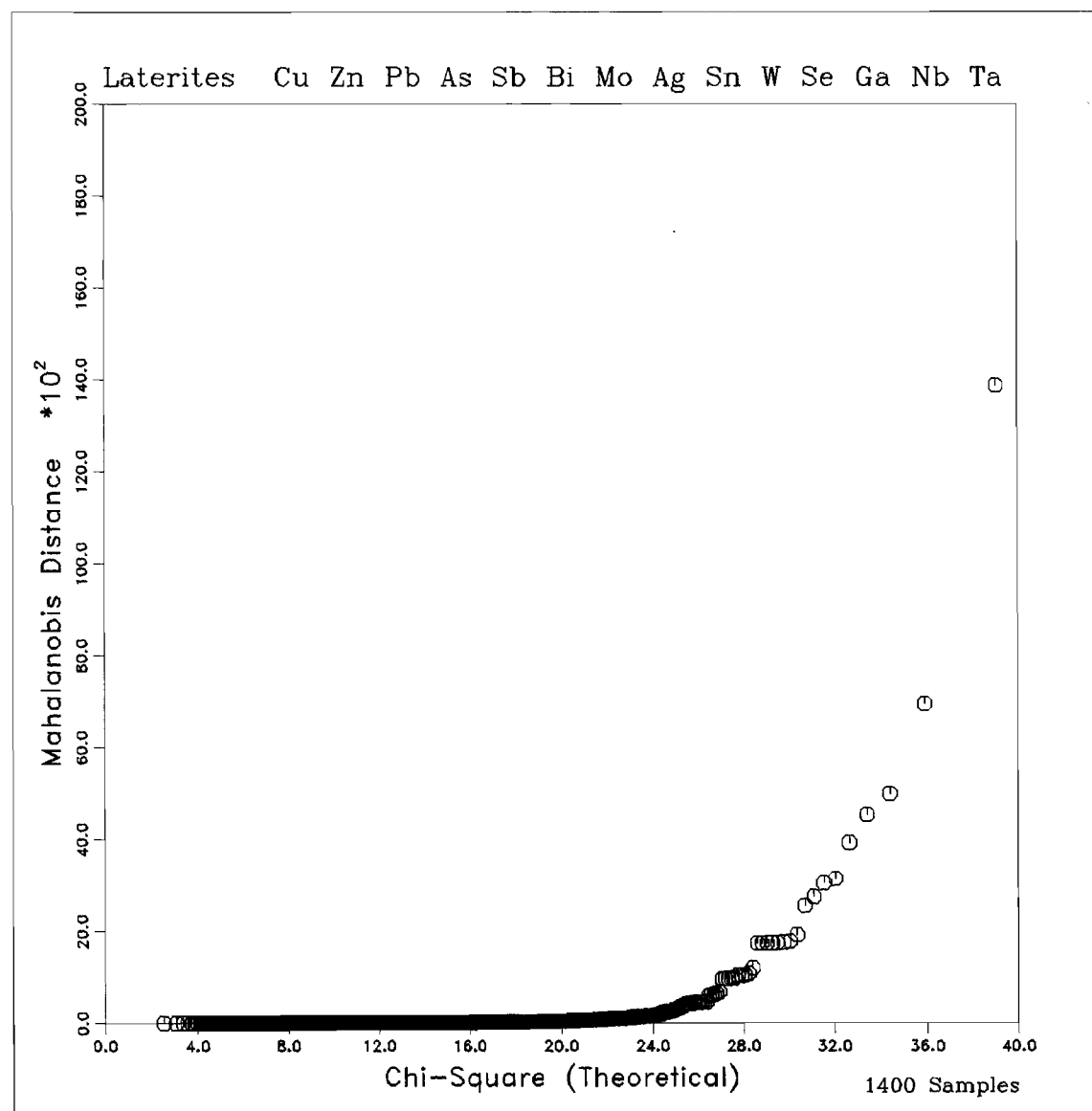


Figure: 79a

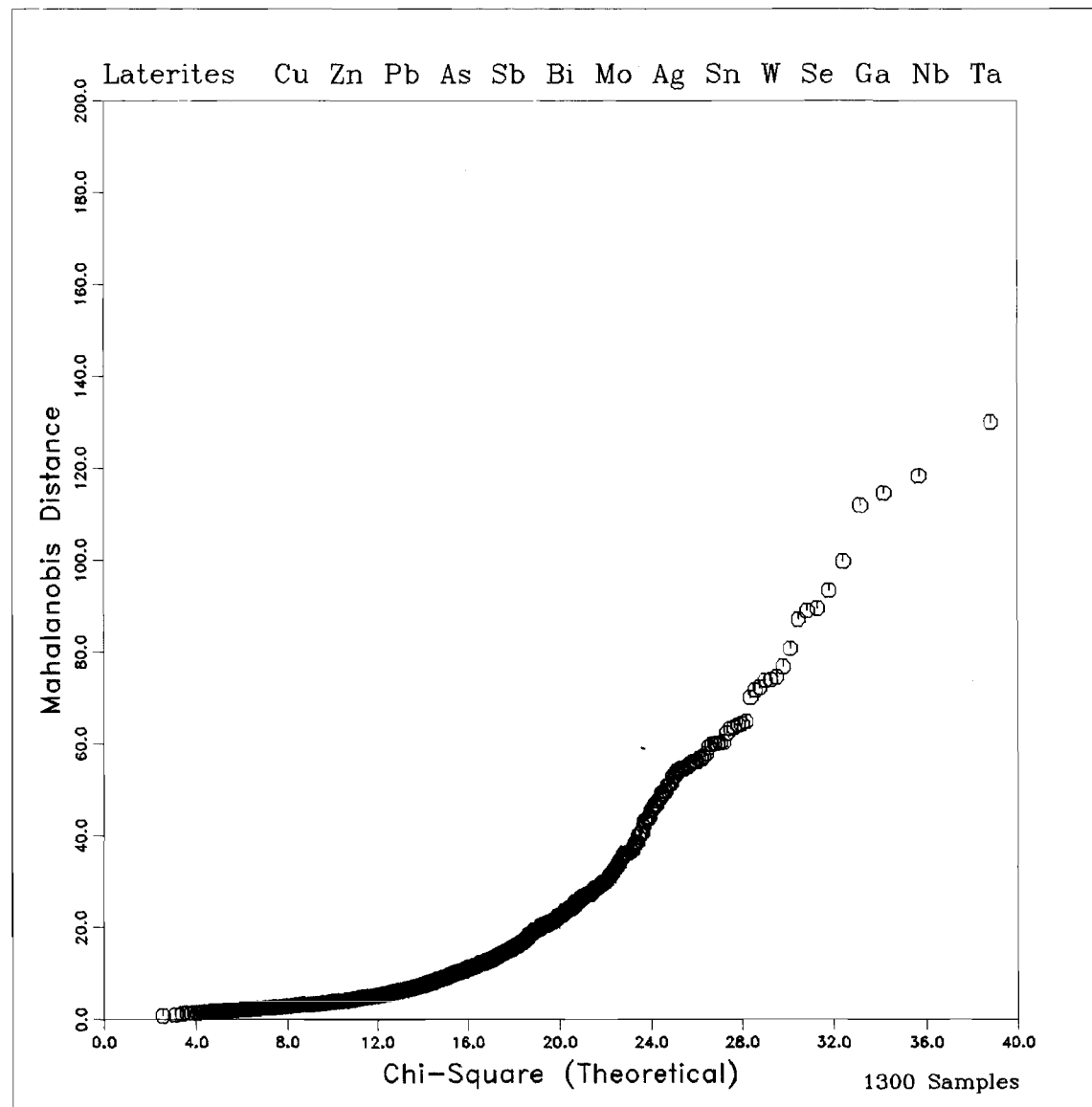
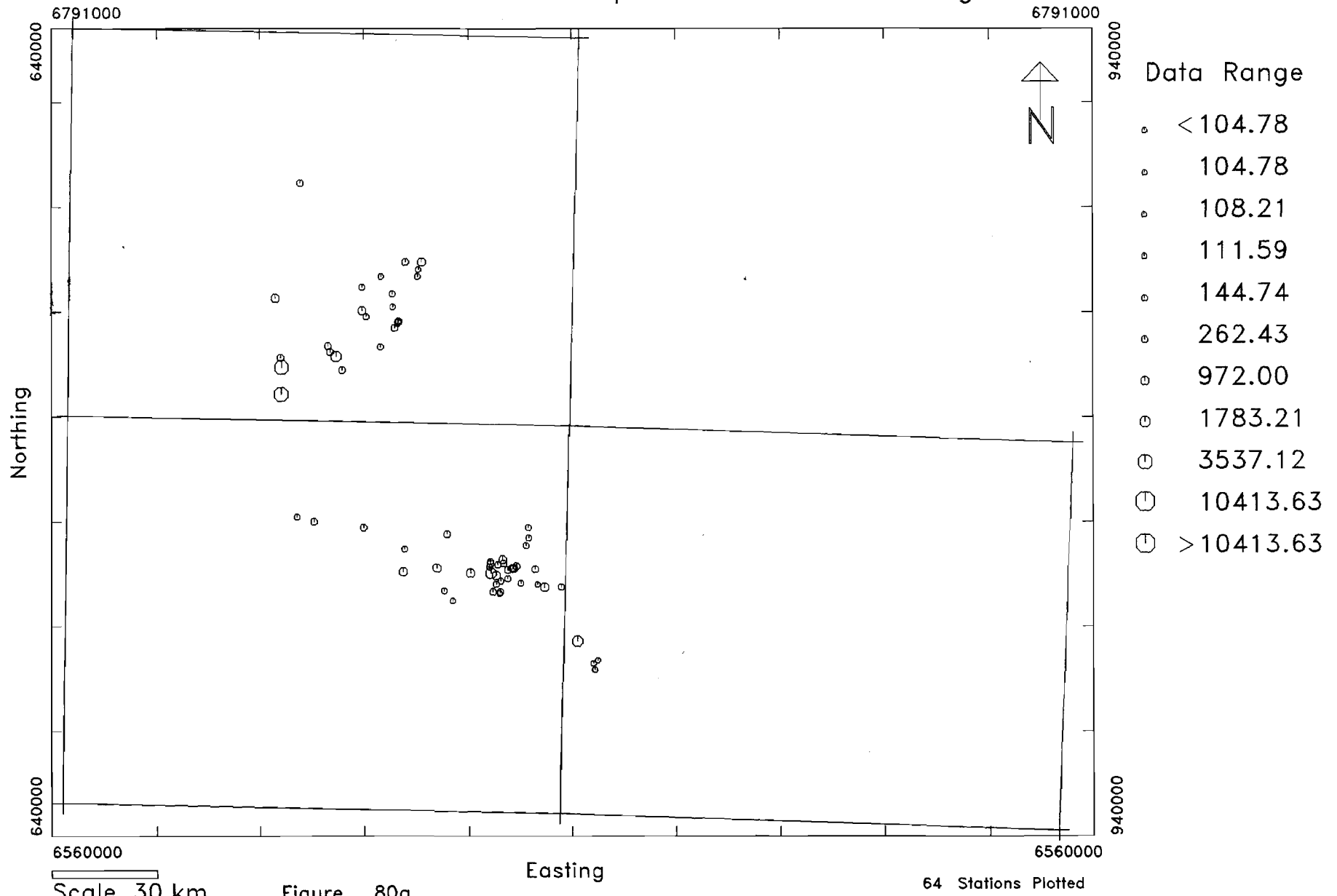


Figure: 79b

Mahalanobis Distances "R" Laterite Samples Barlee-Jackson-Kalgoorlie



6686000



