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Jan Van der Sluys, Augustin Brusselmans, Walter De Vos
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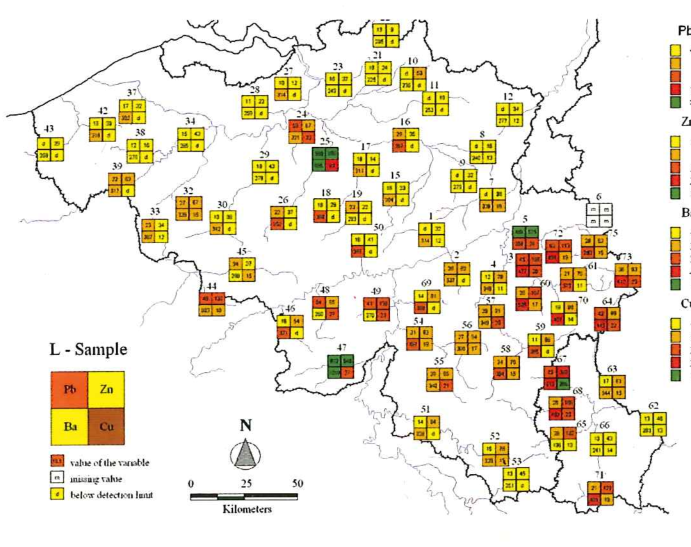

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by

Jan Van der Sluys[2] , Augustin Brusselmans[1], Walter De Vos[2] and Rudy Swennen[1]

1997

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Results of the chemical analysis L-, U- and S-samples

1. INTRODUCTION

This is the third of the four volumes dealing with the Geochemical mapping of Belgium and Luxembourg based on overbank sediments, initiated by the Belgian Geological Survey. This survey was conducted in the framework of an international research project entitled "Regional geochemical mapping of Western Europe towards the year 2000". More information about the history and objectives of the project, the used methodology and profile descriptions from this survey are given in volume I. The second volume presents the statistical treatment of the data set and its interpretation.
In this volume the geochemical maps of Belgium and Luxembourg based on overbank and active stream sediments will be presented. Different types of site related colour maps are given: (1) element correlation maps for each of the lower and the upper overbank sediment as well as the active stream sediment samples (the so-called L-, U-, S-sample types); (2) single element maps for pollution sensitive elements, with element contents in L-, U-, and S- sample types presented together on one map; (3) single element proportional increase maps for pollution sensitive elements, showing the increase in element contents from the L- to the U-sample and from the L- to the S-sample. Element contents and variations will be presented by means of both colour intensities and numerical values for each sampled site, to ensure an easy overview as well as to allow to infer the original data. Analytical results for all L-, U- and S-samples are also presented in annexe 3.

The other volumes are :
Swennen, R., Brusselmans, A., De Coene, E., De Vos, W., Van der Sluys, J. and Van Keer, I, **Basic data on the sampled overbank profiles from Belgium and Luxembourg**. In this report, precise site locations, overbank profile descriptions and results of the chemical analysis are provided. Each site is located by means of a topographical map on a 1:25000 or 1:50000 scale. Drawings of the described overbank sediment profiles, on a scale 1:10, illustrate the detailed descriptions. The results of the chemical analysis of the upper and lower overbank sample (respectively U- and L-sample) and active stream sediment (S-sample) as well as of the detailed overbank profile sampling which was carried out in the framework of a research project are presented in tabular forms.
Brusselmans, A., De Vos, W., Swennen, R. and Van der Sluys, J., **Statistical treatment of the geochemical data of overbank and active stream sediments from Belgium and Luxembourg**. In this report, the methods and results of the univariate, bivariate and multivariate statistical analysis applied to the geochemical data of the U-, L-, S-samples are grouped. Univariate statistical parameters (means, standard deviations, ranges), histograms and bivariate pearson correlation patterns are presented and commented. Differences obtained between the different populations are interpreted in terms of geochemical background signals and anthropogenic influences. Also the results of a principal component and factor analysis are discussed.
Verkeyn, M., De Vos, W., Moons, P., Swennen, R. and Van der Sluys, J., **Vertical element distribution patterns in selected overbank profiles from Belgium and Luxembourg**. In this report the geochemical distribution patterns of the vertical profiles will be presented and where possible also explained. For each analysed profile relevant geological and anthropogenically related information will be given.

2. MATERIAL AND METHODS

2.1. Presentation of the mapped data: sampling sites and analysed elements

By means of topographical maps and historical research, in this project initially 75 sites were carefully selected from drainage basins of 60 to 600 km^2 all over Belgium and Luxembourg, an area of approximately 33.000 km^2. During the on-field sampling campaigns, a certain number of these sites were left behind for reasons of sampling impracticability or lack of representativity. The final site selection therefore consists of 66 sites, which results in an average density very close to the WEGS recommendation of 1 sample site for an area of about 500 km^2. The sites are presented in figure 1 and listed in annexe 1. The site numbers vary from 01 to 75 and correspond to the originally selected site identification numbers. To correspond to the WEGS international conventional numbering, they should be preceded by the number 110, which refers to the Belgium and Luxembourg territories.
On each of these 66 sites, samples of upper and lower overbank sediment and of the active stream sediment (the so-called U-, L-, S-samples) were taken and analysed (see volume I). Univariate, bivariate and multivariate statistical analysis was applied to the geochemical data of these U-, L-, S-samples (see volume II).

2.2. The geochemical maps

The data will be presented in three types of maps (see annexe 2), namely:
- element association maps for the U-, L- and S-samples separately. A maximum of 4 variables will be presented together. Consequently, variables reflecting the different element associations are presented. The selection of these variables is mainly based on the results of the bi- and multivariate analysis. Sometimes, certain variables will be represented in more than one map to facilitate the interpretation.
- L-U-S-element maps displaying the concentrations of the L-, the U- and the S-sediment samples together for one element, which possesses clear concentration differences between the different sample types, namely As, Ba, Cd, Cu, Cr, Pb, Zn, P_2O_5 and Org. C.
- so-called "pollution maps" where the proportional increase/decrease in concentration in the U- and S-samples with respect to the concentration of the L-sample is given. The proportional changes were calculated as {[U]-[L]/[L]}x100 and {[S]-[L]/[L]}x100 respectively. In case of concentrations below the detection limit, half of the detection limit was taken as value in the latter formulas. Again, these maps only have been made for the nine elements listed above. From these maps, areas with severe pollution in the upper overbank or active stream sediment can be seen.

Apart from giving the real concentrations or proportional increase values, the data are also semi-arbitrary colour coded:
- for each mapped element, the sampling sites have been grouped into four categories ranging from low to high element contents. The threshold values determining the categories for each element are based upon their respective distribution patterns in the L-sample.
- the categories were colour-coded with colours ranging from yellow (lowest category, including values below detection limit) to red (highest category). Since SiO_2 presents a negative correlation with most other elements, an inverse colour coding was applied to it.
- additionally, extreme values (outliers) were grouped into a supplementary category, to which a dark green colour code was assigned.
- for the "pollution maps", the categorisation was based upon the degree of proportional increase/decrease in concentration in the U- and S-samples with respect to the concentration of the L-sample.

This allows to differentiate easily between areas with similar characteristics. In the text often reference will be made to particular sample locations. Here the river system will be followed by the sample location number.

To facilitate a more straight forward interpretation of the distribution maps, a geological map of Belgium (figure 2) and a map of southern Belgium with the most important mineralisations and/or mineral occurrences (figure 3) are given and briefly discussed. These maps were digitised based upon existing maps of the Belgian Geological Survey.

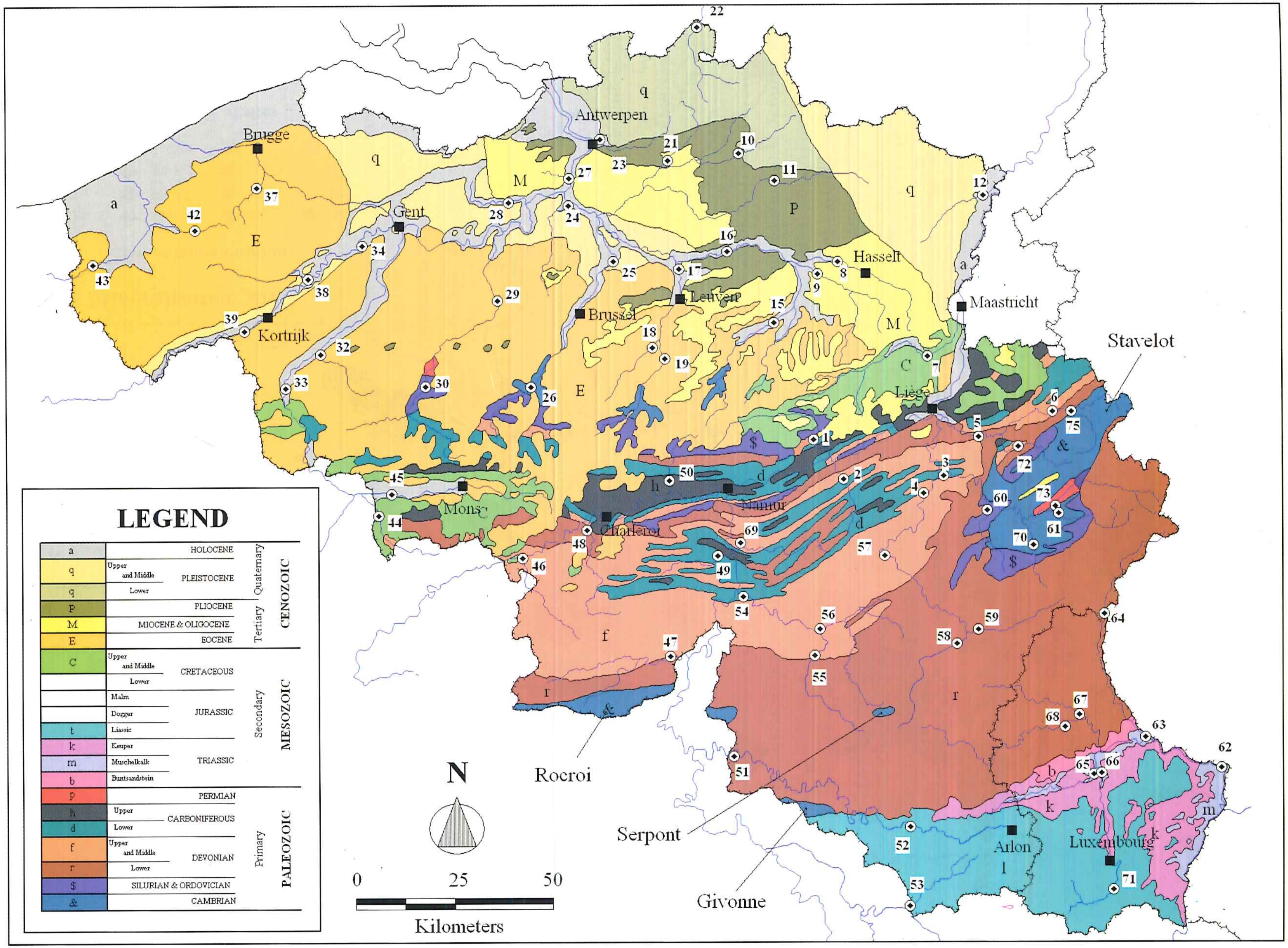
3. DISCUSSION

3.1. Brief description of the geology and mineral occurrences of the study area

In figures 2 and 3 respectively the different geological regions and an overview of the locations where metal mining activities have occurred in the past or where minor indications of ore accumulations have been reported are shown. From north to south the following regional units can be distinguished:

- most parts of Flanders and the northern part of Wallonia are covered by Cenozoic strata. They are dominated by unconsolidated, sometimes carbonate- or glauconite-rich sands and clays. Notice, however, that major parts of this area are also covered by loess and cover sand deposits (not shown in figure 2). In general, this area is poor in metal mineralisations. Locally, some elevated concentrations in heavy minerals in some of the sandy formations have been reported. In the headwater valleys of the Dijle, Gete, Senne and Dender (predominantly in the northern part of Wallonia) the Caledonian basement is outcropping. Here slates and quartzo-phyllites dominate. Due to the presence of arsenopyrite in some of these formations some elevated As concentrations have been recorded in the past.
- the Cretaceous chalk, which occurs in the Maastricht-Liège area as well as in the Mons basin and Tournai region, locally possesses important phosphate accumulations.
- the Namur, Verviers and Dinant synclinoria (Meuse valley and Condroz). In the Condroz area Upper Devonian siliciclastics, mainly sandstones and Lower Carboniferous carbonates occur. Within the siliciclastics several stratabound Fe-ore horizons have been mined in the past. In the area north and east of the Condroz similar lithologies dominate. However, apart from the Fe-ores, major occurrences of Mississippi Valley type Pb-Zn mineralisations have been mined here, especially in the Namur-Liège area and the area between Liège and Aachen (Vesdre, Hoegne and Geul catchment).
- in the Ardennes two lithological units dominate, namely slates, quartzites and quartzo-phyllites in the Caledonian massifs of Stavelot, Rocroi, Serpont and Givonne, and Lower Devonian siliciclastics and Middle Devonian shales and limestones in the rest of the region. In the Stavelot Massif some important Mn-ores have been mined in the Lienne valley, furthermore some minor gold and copper accumulations have been reported. Also some minor Cu-Mo accumulations have been discovered in association with a small tonalite intrusion in the Helle-basin. But in general the Caledonian strata are devoid of important metal accumulations. This can also be said for the Paleozoic siliciclastics in the Ardennes. However in the Middle Devonian carbonates some more important mineralisations have been mined, such as the Fe-, Pb, Zn- and F-ores in the catchments of the Viroin, Hantes and Eau Noire (Philippeville area) and the Ba-, Pb-ores in the Lesse catchment. Also in the border area between Belgium and Luxembourg some Ba- and Pb-mineralisations have been reported (catchments of Sûre and Wiltz).
- in the southernmost part of Belgium and in Luxembourg Triassic to Jurassic sandstones and marls dominate. In these strata some major phosphate-rich Fe-ores occur which explain the existence of an important steel industry in this region.

Figure 2:Geological map of Belgium and Luxembourg with indication of the sampled locations



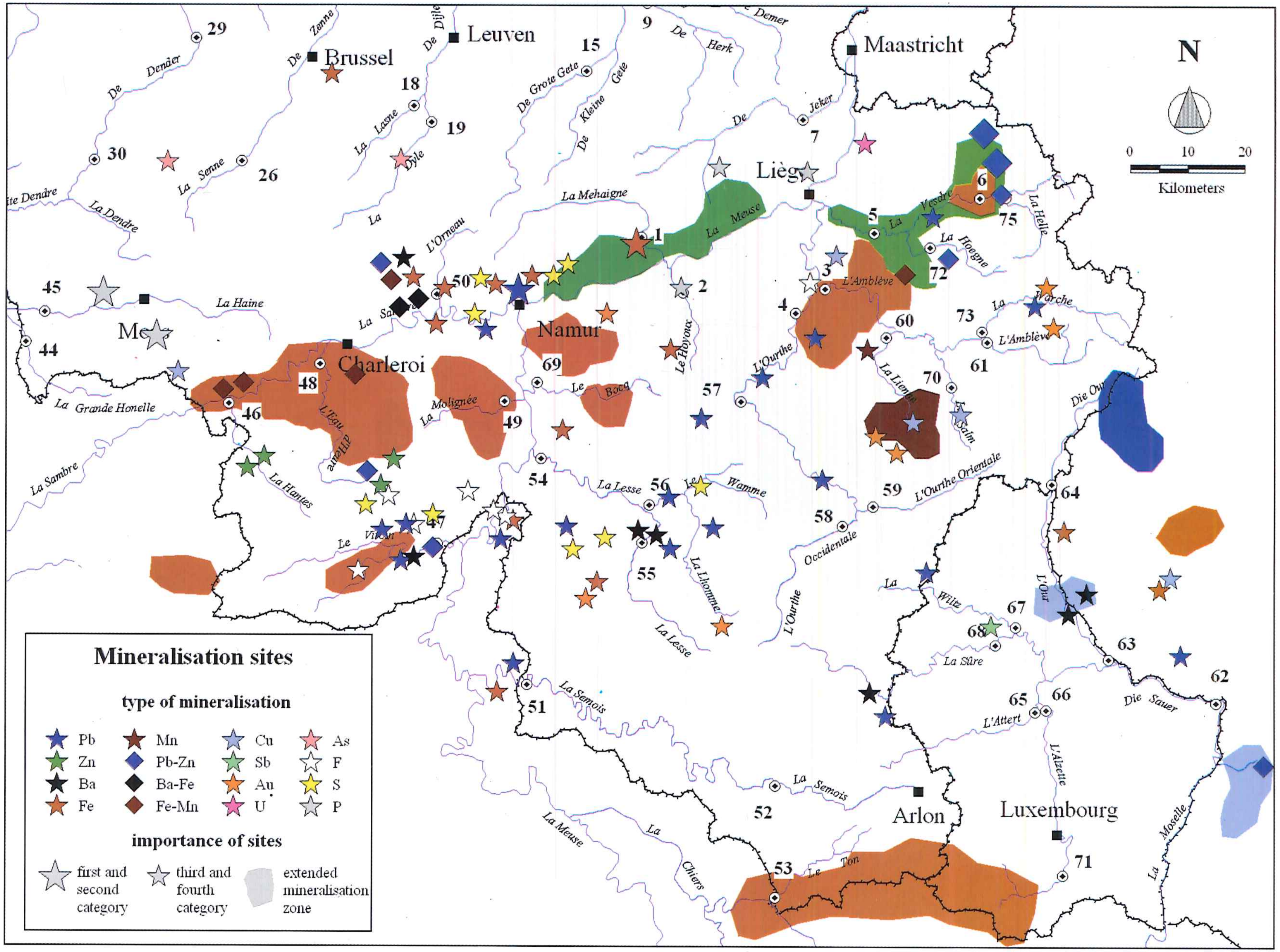


Figure 3: Map of Southern Belgium and surrounding regions, with mineralisation sites and zones

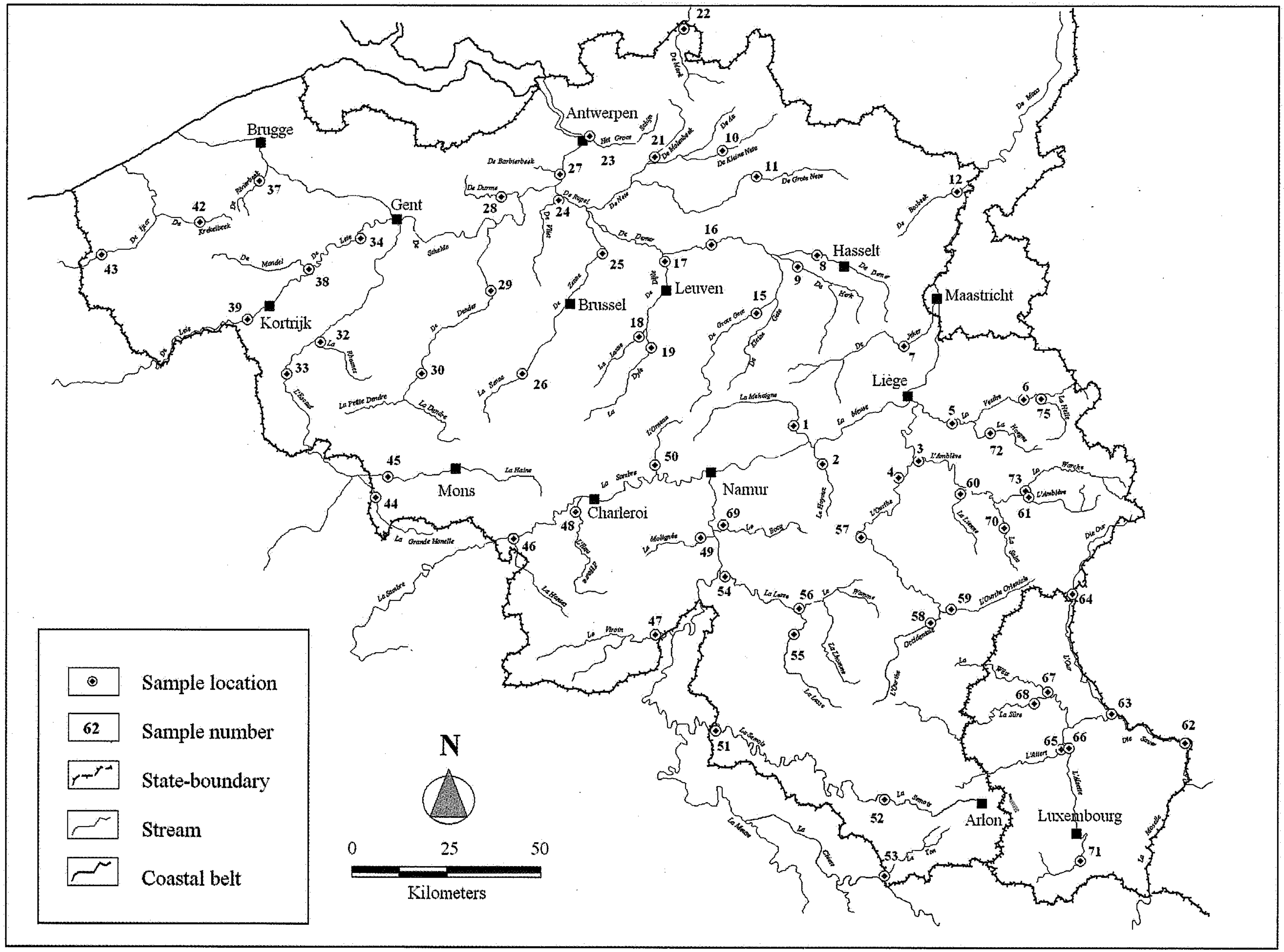


Figure 1:Location of the 66 sample sites selected for the geochemical survey of Belgium and Luxembourg

3.2. The element association maps

The element association maps discussed below are presented in annexe 2. They are referred to in the text as figures, with a numbering corresponding to the numbering in annexe 2, as presented in the index.

In the maps where Al_2O_3, K_2O, Sc and SiO_2 (figures 1-3), Al_2O_3, Ga, Rb and V (figures 4-6), as well as Fe_2O_3, MnO, Ni and Co (figures 7-9) of the U-, L- and S-samples are plotted, the contrast between the more clay-rich southern part and the more sandy northern part of Belgium is clearly visible. This is especially apparent in the maps displaying the L-data where the lowest values for the clay-related elements occur in the northernmost part of Belgium. Furthermore, the Liassic-Keuper strata with the Luxembourg sandstone in the southernmost part of Belgium and Luxembourg (samples 53, 65, 66 and to a lesser degree sample 62) are also very apparent and accentuate that the geological substrate exerts a major control on the distribution of these elements. In general one can state that this geological signal is also visible in the maps displaying the U- and S-samples, where however a smoothening of the contrasts occurs. Nevertheless, in major parts of the Ardennes no significant changes in concentrations occur. Some outliers are also apparent in these maps. In most of the just mentioned figures, sample locations 25, 24 and 23 in Flanders behave differently if compared with their surroundings. As mentioned in the uni- and multivariate analysis (Swennen et al., 1996; Brusselmans and Swennen, 1996) these profiles do not fulfil the so-called L-criterion, i.e. that the L-sample is pristine or at least pre-industrial in origin. As will be shown later, these sample locations also display very high heavy metal contents. Another feature which can be deduced from the maps mentioned above is the possibility to recognise sample locations where a clear deviation in elemental pattern with time occurs. This is for example the case for the Leie and the IJzer (respectively samples 39 and 43) in Flanders where an increase in Al_2O_3, K_2O, Sc, Ga, Rb and V, and a decrease in SiO_2 content is apparent in the U-sample. An opposite shift is present for sample S of Molignée, Bocq and Hoyoux (respectively samples 49, 69 and 2) in Wallonia.

Other particularities that can be seen in the Fe_2O_3-MnO-Ni-Co maps are for example the high concentrations of these variables, especially for MnO in the Stavelot area, where Caledonian strata outcrop and where Mn-rich shales and Mn-bearing coticulas have been mined in the past. The anomalous Fe_2O_3-Ni contents in the L-sample of the Molignée (sample 49) also may relate to the presence of Fe-ores in the catchment. The fact that the U- and S-samples are not anymore anomalous possibly indicates that the anomalous values in the L-sample relate to iron-exploitation or to differences in erosion of iron mineralisations in time. In the first case this sample would not represent a pristine or pre-industrial situation. No straight forward explanation can be given for the rather high contents for these four variables in the north of Luxembourg, however, the fact that they are consistent in the L-, U- and S-samples points towards a link with the geological substrate. The high Fe_2O_3 contents in L-samples 23 and 21 in the north of Flanders relates to the development of vivianite. And finally the doubling of the Fe_2O_3 content in the Alzette (sample 71 in south Luxembourg) can easily be correlated with the steel industry, upstream of the sampling location (see also volume IV).

The contrast between north and south Belgium and Luxembourg is also recognisable in the TiO_2-Y-Nb-La maps (figures 10-12) and the TiO_2-Ce-Cr-Zr maps (figures 13-15). An increase in concentration of TiO_2, Nb, La, Ce and Cr with increased Al_2O_3 content (figures 1-6) is apparent and is interpreted in terms of higher contents of these variables linked to clays. Notice that this is less apparent for Zr. The high concentrations of most of these variables in the northern part of Belgium with even extremely anomalous concentrations in the Kleine Nete (10) relate to the increased contribution of heavy minerals such as rutile, anatase, monazite, zircon, chromite, ilmenite, garnet, andalusite and pyroxene as confirmed by SEM-EDX and optical microscopy (Hindel et al., 1996).

Notice however, that these high concentrations fade away to some degree in the S-samples. This is most likely caused by the fact that the heavy minerals do not occur in high amounts in the very fine grained and organic-rich fraction which is more characteristic in the active stream sediment.

One could assume that these high heavy minerals were derived from the Miocene sands, however, not all sample locations with high contents drain these Miocene strata. Another possibility is that other Neogene formations contribute to the creation of these increased concentrations. An inventory of heavy minerals in Neogene Formations has been published by Geets and De Breuck (1991) and can serve as reference base. Finally the high Cr-concentrations in the Wiltz (sample 67, north Luxembourg) are noteworthy. They are consistent in the U-, L- and S- samples which suggests that they relate to the geological substrate. How far this may be linked to the Sb-mineralizations which are known from this region is unknown.

The element association maps of CaO-MgO-Sr-SO_3 (figures 16-18) display a more complex pattern. Apart from moderately high MgO contents, the bulk of the Lower Devonian Ardennes displays low concentrations for these variables. The northern part of the Ardennes where Middle Devonian and Dinantian carbonates outcrop as well as the major part of Flanders display higher concentrations. Furthermore, in Flanders two regions with characteristic patterns can be differentiated namely the north-east Campine area (samples 22, 10, 11, 8, 12, 9 and to a lesser degree 21) with low contents for these variables and the area north of the Leie (samples 42, 37 and 38). Notice however that this pattern with low contents remains consistent in the U- and S-samples in the north-east Campine area. In the area north of the Leie the pattern fades away with time (from the U- to the S-sample). Other remarkable features are the high MgO-concentrations of some of the Luxembourg-samples (samples 62, 63 and 68) which to some degree can be explained by the marls of the Keuper and Muschelkalk, but this does not account for sampling point 68. Notice that the values remain high in the L-, U- and S-samples and that no relations exists with CaO. The extremely high contents for these variables in the L-sample of the IJzer (NW-Flanders) are also striking. Here it is not unlikely that a sample of possible marine origin rich in carbonate tests (e.g. foraminifers) was taken. This would mean that the sample does not fulfil the L-criterion. Finally in some samples, like 28, 33, etc... a clear increase in time, especially of SO_3 can be observed. This increase, as will be described below, is clearly related to human activities.

The Org. C.-LOI-P_2O_5-SO_3 element association map of the L-sample (figure 19) reveals only limited information on the geological substrate. Only the Lower Devonian Ardennes and the Stavelot area display low contents for these variables. For the rest, variable concentrations occur in the northern part of Wallonia as well as in Flanders. In the central part of the latter region (samples 21, 23, 24 and 25) the high values for one or several of the above mentioned variables is striking. However, from the field observations as well as from the statistical analysis it was already concluded earlier that the L-sample in sample locations 25, 24 and 23 does not fulfil the L-criterion. Whether this also accounts for sample location 21 is not clear. Notice that the high P_2O_5 contents in samples 23 and 21 relate to the presence of the mineral vivianite. If we compare the L-sample distribution patterns with the ones derived for the U- and S-samples (figures 20 and 21) a clear increase in content of these variables is apparent and is explained by human activities which cause eutrophism. This effect is especially apparent in the results of the active stream sediment where an extreme increase in P_2O_5 can be seen. The increases in the Vesdre (samples 5 and 6 in E-Belgium) and the Alzette (sample 71 in South Luxembourg) relate to industrial activities such as steel industry in the latter region. A final remark addresses the relation between LOI and Org. C. In the L-samples certain locations exist where high to moderately high LOI values occur, despite the fact that the Org. C-concentrations are relatively low (e.g. samples 43, 71, 48 and 49). This is, to a certain degree, caused by the presence of carbonate particles within the sediment samples and by the relatively small proportion and importance of the organic fraction within the B-horizon. This discrepancy is less visible in the U- and S-samples. This phenomenon is responsible for the less developed correlation between Org. C and LOI in the L-sample which becomes very significant in the U- and S-samples ("organic association" and "factor" , see volume II).

In the element association maps of the L-samples of Pb-Zn-Ba-Cu (figure 22) and of Cr-As-Cd-Sn (figure 25) the contrast between north and south Belgium still is discernible as well as the presence in the southernmost part of Belgium and Luxembourg of the Luxembourg sandstones of Liassic age with clearly lower values than the clay dominated Ardennes. Other remarkable feature in the L-sample distribution pattern is the high contents in the Viroin, the Wiltz, the Vesdre and the Zenne (respectively sample locations 47, 67, 5 and 25). Where for the former three a relation with the presence of Pb-Zn- or Pb-mineralizations in the drainage basin can explain the high concentrations, the anomalous values in the Zenne L-sample clearly relates to human activities in the drainage basin. Comparison of the L-sample map for these elements with the U-and S-sample maps (figures 23, 24, 26 and 27) highlights drainage systems with severe contamination. This certainly accounts for the Leie and the Alzette (respectively sample locations 39 and 71). Here, the steel industry in Luxembourg and the north of France are responsible for these anomalies. Important concentration increases are also recorded in the Vesdre (sample location 5 and 6) and most likely relate to mining activities in the drainage basin as was also recorded in the Geul (Swennen et al., 1994). However, the important Cu anomalies (and to some extent Ba) support also contamination by other industries, especially since the Helle river (sample location 75) seems not to contribute important quantities of these metals.

In general it can be stated that contamination is more severe in Flanders than in Wallonia as will be illustrated better in the L-U-S-element maps and the pollution maps (see below). Anomalies which need further attention are the Viroin, Alzette, Wiltz, Warche and Vesdre for Wallonia and Luxembourg (respectively sample locations 47, 71, 67, 73, 5 and 6). A speciation research of the Cr-anomalies in the S-samples of the Amblève and the Wiltz (sample locations 3 and 67) and the U-samples of the Warche and the Wiltz (sample locations 73 and 67) is recommended. In Flanders further research should focus on the Leie, Durme, Groot Schijn, Zenne and to some degree on the Demer (respectively sample locations 39, 28, 23, 25 and 8). In the latter location a Cr-speciation research is recommended. The cause of the Cd-anomaly in the U-sample of the Vliet (sample location 24) should be investigated.

3.3. The L-U-S-element and the pollution maps

The single-element maps discussed below are also presented in annexe 2, and are again referred to in the text with the numbering corresponding to the numbering in annexe 2, as presented in the index.

L-U-S-element maps and pollution maps are available for As, Ba, Cd, Cu, Cr, Pb, Zn, P_2O_5 and Org.C (figures 28 to 54). In this volume the L-U-S-maps of each variable will be discussed first. Subsequently the pollution maps, giving the proportional increase/decrease in concentration of the U- and S-sample with respect to the L-sample will be given and will in most cases visually represent the conclusions drawn from the L-U-S-element maps.

An apparent feature from the As-map (figure 28) is that, with the exception of some locations, the As concentration does not change so much through time. Where its initial concentration was low it remains low, where it was high it remains high. The real clear exceptions mainly occur in Flanders. Areas of concern are the Zenne (sample 25) and the Leie (sample 39). Also the Alzette (sample 71) in Luxembourg displays high to very high concentrations. A speciation research in these locations is highly recommended. The pollution maps of As give a wrong impression since some locations are indicated with very high concentration increases due to the fact that the L-sample concentration initially was very low. Even with moderate concentrations for the U- or S-sample the impression appears that severe pollution occurs. Nevertheless, an obvious observation is that the increase in As content is best expressed in Flanders for the U-sample and less for the S-sample. In Wallonia an increase is present in the Semois (samples 52 and 51), however, concentrations are still low.

The general picture for Ba (figure 31) is the same as for As, namely locations with high concentrations in the L-sample continue to possess high concentrations in the U- and S-samples, such as the Stavelot area (samples 5, 72, 61, 73, 60, 30 and 64), the Viroin, Wiltz and Sûre (respectively samples 47, 67 and 68). Important increases are again present in Flanders, e.g. the Dijle, Groot Schijn and Leie (respectively samples 19, 22 and 30). In general the increase is somewhat more pronounced in the U- (figure 32) than in the S-samples (figure 33). The nature of the increase in the Demer profile should be further investigated.

The increase in Cd-concentration (figure 34) in the overbank sediments is once again very well developed in the central part of Flanders (samples 25, 24, 28, 27 and 23) and the Leie (sample 39). However, a remarkable feature here is that many of the active stream sediments display increased concentrations in West Belgium (samples 33, 30 and 29) and in some rivers of the Stavelot area (samples 60, 61, 72, 5 and 6). Whether all these increases relate to pollution in relation with mining activities is doubtful, especially since no dramatic increase has been recorded in the upper overbank samples of several of these river systems. The proportional concentration increase between the L- and U-sample (figure 35) and the L- and S- sample (figure 36) clearly reflects that the most important increases occur in Flanders. However, here again these maps should be treated together with the L-U-S-maps, since important proportional increases locally relate to the extremely low values recorded in the L-sample (for example at sample locations 11 and 8). Other increases are of major concern and should be investigated in more detail such as the anomalies in the Zenne, Vliet, Durme and Groot Schijn (respectively sample locations 25, 24, 28 and 23) in Flanders and the Vesdre (sample 5) in Wallonia.

From the L-U-S-map of Cu (figure 37) it is obvious that this element is very sensitive to human pollution. Most of the values for the L-samples in Flanders are below detection limit while in Wallonia and Luxembourg values between 10 and 25 ppm seem to be characteristic. Several places display high to very high concentrations in the upper overbank (samples 73, 10 and 39) or active stream sediment (samples 5 and 28) or in both (samples 6, 25 and 23). Only the Wiltz possesses high Cu-concentrations in the lower overbank sample. As previously mentioned this is interpreted to relate to mineralizations present in the drainage basin. A remarkable feature is that no elevated concentrations occur in the Helle (sample 75) despite the presence of a mineralized polymetallic Cu-Mo-bearing tonalite in the drainage basin. Also the low Cu-concentrations in the Viroin (sample 47), where Pb-Zn mineralizations occur, are remarkable.

The L-U-S-map of Cr clearly displays highest concentrations in the L-samples in the Lower Devonian clay dominated Ardennes (figure 40). Here the Wiltz possesses anomalous Cr-values in the L-sample as well as in the U- and S-sample. The geological contrast with the more sandy area dominated by the Luxembourg sandstone in the southernmost part of the study area and of Flanders, and the Famennian-Dinantian dominated part of the Ardennes is clear. Some L-samples in Flanders already possess very high Cr-concentrations, such as the Groot Schijn and Kleine Nete (samples 23 and 10). The latter anomaly relates to the presence of chromite as heavy mineral in the sampled sediment. Whether this is also the case for the Groot Schijn should be checked. In general Cr-concentration increases from the L- to the U-sample (figure 41) or from the L- to the S-sample (figure 42) are minor, with a few important exceptions. These are the Warche (sample 73) and Amblève (sample 3) for Wallonia. In Flanders, the active stream sediment of the Demer (sample 8) displays extremely high concentrations. For these anomalies a speciation research is highly recommended.

From the L-U-S-map of Pb (figure 43), it can be deduced that differences in Pb content in the different samples-types are moderate. However, anomalous values have already been recorded in the L-samples. In the Viroin (sample 47) it can be explained by the presence of Pb-Zn mineralizations in the drainage basin. The anomalies which also remain in the U- and S-samples of the Vesdre (samples 5 and possibly also 6) and the Zenne (sample 25) are, however, due to human pollution. The fact that also the lowermost overbank sample is anomalous can be explained by the fact that this sample does not fulfil the L-criterion i.e. that it is pristine or at least pre-industrial in origin. This was already deduced from the field observations (volume I) and the statistical analysis (volume II). Furthermore, in Flanders and the northern part of Wallonia different locations with important concentration increases in the U- or/and S-samples compared to the L-samples occur (figures 44 and 45). From the pollution maps this seems also to be the case for Wallonia, however here, many of the proportional increases are caused by the fact that the concentrations in the L-sample are very low. In general the increase in the upper overbank sample with respect to the lower overbank sample is caused by atmospheric deposition as illustrated in volume IV. Finally the anomalous values caused by the steel industry in the Alzette (sample 71) and Leie (sample 39) are noteworthy. The areal extent of several of these anomalies should be investigated.

The L-U-S-map of Zn (figure 46) is much more complex and in contrast to many of the other element maps displays important increases in the concentrations of the U- and the S-sample with respect to the contents of the L-sample. Many of the anomalous values in the upper overbank deposits relate to atmospheric deposition (Verkeyn et al., 1996). With the exception of the sample locations north of the Stavelot area (Vesdre, sample 5 and 6 and Hoegne, sample 72) and the Alzette (sample 71), the concentrations in the Ardennes are in general moderate and concentrations double to triple in the upper overbank and active stream sediment with respect to the lower overbank sample. Notice here the relative high contents in the L-sample of the Wiltz and Viroin which are interpreted in terms of natural contamination due to Pb-Zn mineralizations in the subsurface. Whether the anomaly in the Vesdre (sample 5) has a similar origin is doubtful and needs a more detailed investigation. The drainage basins with pollution from the steel industry (Alzette (sample 71) and Leie (sample 39)) display extreme concentration levels. Elevated Zn-concentrations in the active stream sediment have also been discovered in the Attert (sample 65) and the Haine (sample 45). In Flanders many of the drainage basins display clear indications of human related contamination such as in the Zenne (sample 25), Groot Schijn (sample 23), Dender (samples 29 and 30), Demer (sample 8) and Vliet (sample 24). The higher degree of anthropogenic pollution in Flanders and in southern Luxembourg is also visualised in the pollution maps given in figures 47 and 48. The areal extent of these anomalies, especially if they occur in the upper overbank sample should be investigated.

Also the P_2O_5 L-U-S-map clearly reflects the high contamination level in Flanders, especially the central part, which in this case most likely relates to the more intensive agriculture activities in the northern part of Belgium (figure 49). Especially the increase in concentration in the active stream sediment is noteworthy, and is also explained by the pollution of detergents from domestic origin. This feature is also apparent in the pollution maps displayed in figures 50 and 51. In Wallonia the anomalies in the Vesdre (samples 5 and 6) most likely can be explained by the higher population density and the industrial activities in the drainage basin. Agricultural influences and mining of phosphate-rich chalk are thought to be responsible for the anomaly in the active stream sediments of the Haine basin (sample 45). For the anomalous values in the Alzette (sample 71) again the steel industry in south Luxembourg can be made responsible since phosphate-rich iron ores, which occur in the catchment area, have been processed. Similar conclusions can be drawn from the L-U-S-map of Org. C (figure 52) and the related pollution maps (figures 53 and 54).

4. REFERENCES

Bölviken, B., Demetriades, A., Hindel, R., Locutura, J., O'Connor, P., Ottesen, R.T., Plant, J., Ridgway, J., Salminen, Salpeteur, I., Schermann, O. and Volden,T. (Editors), 1990. Geochemical Mapping of Western Europe towards the Year 2000. Project Proposal. Geological Survey of Norway (NGU) Report 90-106, 10 pages, 10 appendices.

Bölviken, B., Bogen, J., Demetriades, A., De Vos, W., Ebbing, J., Hindel, R., Ottesen, R.T., Salminen, R., Schermann, O. and Swennen, R., 1993. Final Report of the Working Group on Regional Geochemical Mapping 1986-1993. Forum of European Geological Surveys (FOREGS), Geological Survey of Norway (NGU) Open File Report 93/092, 18 pages, 6 appendices.

Brusselmans, A. and Swennen, R., 1996, Statistical treatment of the geochemical data of overbank and active river sediments from Belgium and Luxembourg. Unpublished report Belgian Geological Survey.

Geets, S. and De Breuck, 1991. De zware-mineraalinhoud van Belgische Meso- en Cenozoïsche afzettingen, Neogeen. Natuurwet. Tijdsch., 73: 3-37.

Hindel, R., Schalich, J., De Vos, Ebbing, J. Swennen, R. and Van Keer, I., elements in overbank sediment profiles from Belgium, Germany and The Netherlands. J. Geochem. Explor., in press.

Swennen, R., Van Keer, I. and De Vos, W., 1994. Heavy metal contamination in overbank sediments of the Geul river (East Belgium): Its relation to former Pb-Zn mining activities. Environmental Geology 24: 12-21.

Swennen, R., De Coene, E., Van Keer, I and Brusselmans, A., 1996, Basic data on the sampled overbank profiles from Belgium and Luxembourg. Unpublished report, Belgian Geological Survey.

Verkeyn, M., Moons, P. and Swennen, R., 1996, Vertical element distribution patterns in selected overbank profiles from Belgium and Luxembourg. Unpublished report, Belgian Geological Survey.

ANNEXE 1

LIST OF THE SAMPLED RIVERS

Site number	River name	Locality	Samples U	L	S	Det.	Sampling date	Site Coordinates	
11001	Mehaigne	Huccorgne	**x**	**x**	**x**	d	1/08/91	50° 33' 41" N	05° 10' 16" E
11002	Hoyoux	Roiseu	**x**	**x**	**x**	d	31/07/91	50° 28' 13" N	05° 16' 12" E
11003	Amblève	Halleux	**x**	**x**	**x**	d	17/07/91	50° 29' 07" N	05° 37' 00" E
11004	Ourthe	Hamoir	**x**	**x**	**x**	d	16/07/91	50° 26' 36" N	05° 32' 07" E
11005	Vesdre (1)	Fraipont	**x**	**x**	**x**	d	17/07/91	50° 34' 06" N	05° 43' 08" E
11006	Vesdre (2)	Membach	**x**		**x**	d	2/08/91	50° 36' 49" N	05° 59' 26" E
11007	Geer	Glons	**x**	**x**	**x**	d	13/08/91	50° 44' 56" N	05° 33' 42" E
11008	Demer (1)	Kermt	**x**	**x**	**x**	d	14/010/91	50° 57' 40" N	05° 15' 26" E
11009	Herk	Herk-de-Stad	**x**	**x**	**x**	d	15/07/91	50° 55' 48" N	05° 12' 32" E
11010	Kleine Nete	Lichtaart	**x**	**x**	**x**	d	29/07/91	51° 12' 18" N	04° 55' 38" E
11011	Grote Nete	Meerhout	**x**	**x**	**x**	d	14/08/91	51° 08' 41" N	05° 03' 33" E
11012	Bosbeek	Maaseik	**x**	**x**	**x**	d	12/08/91	51° 05' 37" N	05° 46' 02" E
11015	Grote Gete	Neerlinter	**x**	**x**	**x**	**d**	29/07/92	50° 49' 37" N	05° 01' 34" E
11016	Demer (2)	Langdorp	**x**	**x**	**x**	**d**	18/08/92	50° 59' 37" N	04° 52' 17" E
11017	Dijle (1)	Rotselaar	**x**	**x**	**x**	**d**	30/07/92	50° 57' 44" N	04° 42' 16" E
11018	Laan	Terlanen	**x**	**x**	**x**	d	19/07/92	50° 46' 35" N	04° 37' 08" E
11019	Dyle (2)	Gastuche	**x**	**x**	**x**	**d**	19/07/92	50° 44' 21" N	04° 39' 04" E
11021	Molenbeek	Viersel	**x**	**x**	**x**	**d**	15/09/92	51° 11' 21" N	04° 39' 40" E
11022	Mark	Meersel-Dreef	**x**	**x**	**x**	d	16/09/92	51° 29' 17" N	04° 46' 30" E
11023	Groot Schijn	Deurne	**x**	**x**	**x**	**d**	2/010/92	51° 12' 53" N	04° 29' 01" E
11024	Vliet	Puurs	**x**	**x**	**x**	**d**	26/08/92	51° 06' 03" N	04° 18' 15" E
11025	Zenne (1)	Weerde	**x**	**x**	**x**	**d**	8/09/92	50° 58' 09" N	04° 28' 41" E
11026	Senne (2)	Tubize	**x**	**x**	**x**	d	20/08/92	50° 40' 54" N	04° 11' 01" E
11027	Barbierbeek	Bazel	**x**	**x**	**x**	d	21/010/92	51° 09' 18" N	04° 18' 27" E
11028	Durme	Hamme	**x**	**x**	**x**	**d**	9/09/92	51° 06' 10" N	04° 07' 03" E
11029	Dender (1)	Denderleeuw/Welle	**x**	**x**	**x**	**d**	24/08/92	50° 54' 07" N	04° 04' 27" E
11030	Dendre (2)	Papignies	**x**	**x**	**x**	**d**	14/09/92	50° 41' 07" N	03° 49' 48" E
11032	Rhosnes	Escanaffles	**x**	**x**	**x**	**d**	27/08/92	50° 45' 19" N	03° 27' 47" E
11033	Escaut (Scheldt)	Pecq	**x**	**x**	**x**	**d**	16/010/92	50° 40' 09" N	03° 21' 26" E
11034	Leie (1)	Nazareth	**x**	**x**		**d**	21/08/92	50° 59' 39" N	03° 35' 41" E
11037	Rivierbeek	Nieuwenhove	**x**	**x**	**x**	**d**	26/010/92	51° 07' 37" N	03° 14' 08" E
11038	Mandel	Wakken	**x**	**x**	**x**	**d**	25/08/92	50° 55' 17" N	03° 24' 59" E
11039	Leie (2)	Wevelgem	**x**	**x**	**x**	**d**	5/11/92	50° 48' 40" N	03° 12' 01" E

Det. = detailed overbank profile samples
x,d = sampled; **x,d** = sampled and submitted to chemical analysis

Site number	River name	Locality	Samples U	L	S	Det.	Sampling date	Site Coordinates	
11042	Krekelbeek	Handzame	x	x	x	**d**	7/11/92	51° 01' 31" N	03° 00' 57" E
11043	Ijzer	Stavele	x	x	x	d	17/09/92	50° 56' 43" N	02° 40' 08" E
11044	Grande Honelle	Baisieux	x	x	x	d	10/09/92	50° 23' 23" N	03° 41' 20" E
11045	Haine	St. Ghislain	x	x	x	**d**	11/09/92	50° 26' 36" N	03° 44' 22" E
11046	Hantes	Erquelinnes	x	x	x	d	27/06/94	50° 18' 03" N	04° 10' 30" E
11047	Viroin	Treignes	x	x	x	**d**	20/06/94	50° 05' 18" N	04° 40' 05" E
11048	Eau d'Heure	Charleroi	x	x	x	d	20/07/94	50° 22' 24" N	04° 23' 28" E
11049	Molignée	Anhée	x	x	x	d	6/07/94	50° 19' 00" N	04° 50' 35" E
11050	Orneau	Jemeppe-sur-Sambre	x	x		d	15/07/94	50° 28' 32" N	04° 40' 40" E
11051	Semois (1)	Vresse-sur-Semois	x	x	x	d	12/08/94	49° 52' 47" N	04° 52' 22" E
11052	Semois (2)	Chiny	x	x	x	d	27/07/94	49° 42' 30" N	05° 27' 35" E
11053	Ton	Lamorteau	x	x		**d**	10/08/94	49° 31' 24" N	05° 27' 30" E
11054	Lesse (1)	Dinant	x	x	x	d	7/07/94	50° 13' 44" N	04° 54' 45" E
11055	Lesse (2)	Tellin	x	x	x	d	15/06/94	50° 05' 15" N	05° 09' 50" E
11056	Lomme	Rochefort	x	x	x	d	12/07/94	50° 08' 19" N	05° 09' 50" E
11057	Ourthe (2)	Hotton	x	x	x	d	23/06/94	50° 18' 19" N	05° 23' 27" E
11058	Ourthe Occidentale	Bertogne	x	x	x	**d**	5/07/94	50° 06' 29" N	05° 39' 40" E
11059	Ourthe Orientale	Houffalize	x	x	x	d	5/07/94	50° 08' 06" N	05° 43' 27" E
11060	Lienne	Târgnon	x	x	x	**d**	16/08/94	50° 24' 32" N	05° 46' 12" E
11061	Amblève	Bellevaux	x	x	x	**d**	22/09/94	50° 23' 16" N	05° 59' 53" E
11062	Sûre (1)	Rosport	x	x	x	**d**	11/010/94	49° 48' 06" N	06° 29' 41" E
11063	Our (1)	Wallendorf	x	x	x	d	4/010/94	49° 52' 45" N	06° 16' 42" E
11064	Our (2)	Ouren	x	x	x	d	23/08/94	50° 07' 54" N	06° 08' 07" E
11065	Attert	Colmar-Berg	x	x	x	**d**	12/010/94	49° 47' 02" N	06° 04' 35" E
11066	Alzette (1)	Colmar-Berg	x	x	x	**d**	13/010/94	49° 47' 38" N	06° 05' 50" E
11067	Wiltz	Goebelsmühle	x	x	x	**d**	5/010/94	49° 55' 24" N	06° 02' 56" E
11068	Sûre (2)	Goesdorf	x	x	x	**d**	5/010/94	49° 54' 57" N	05° 59' 28" E
11069	Bocq	Yvoir	x	x	x	**d**	1/07/94	50° 20' 24" N	04° 54' 32" E
11070	Salm	Grand-Halleux	x	x	x	**d**	29/06/94	50° 19' 10" N	05° 54' 40" E
11071	Alzette(2)	Roeser	x	x	x	**d**	18/010/94	49° 31' 54" N	06° 08' 33" E
11072	Hoegne	Sâsserotte	x	x	x	**d**	22/010/94	50° 31' 34" N	05° 50' 55" E
11074	Warche	Bellevaux	x	x		**d**	23/09/94	50° 23' 31" N	05° 59' 20" E
11075	Helle	Eupen	x	x	x	d	19/11/94	50° 36' 22" N	06° 03' 04" E

Det. = detailed overbank profile samples

x,d = sampled; **x,d** = sampled and submitted to chemical analysis

ANNEXE 2

GEOCHEMICAL MAPS

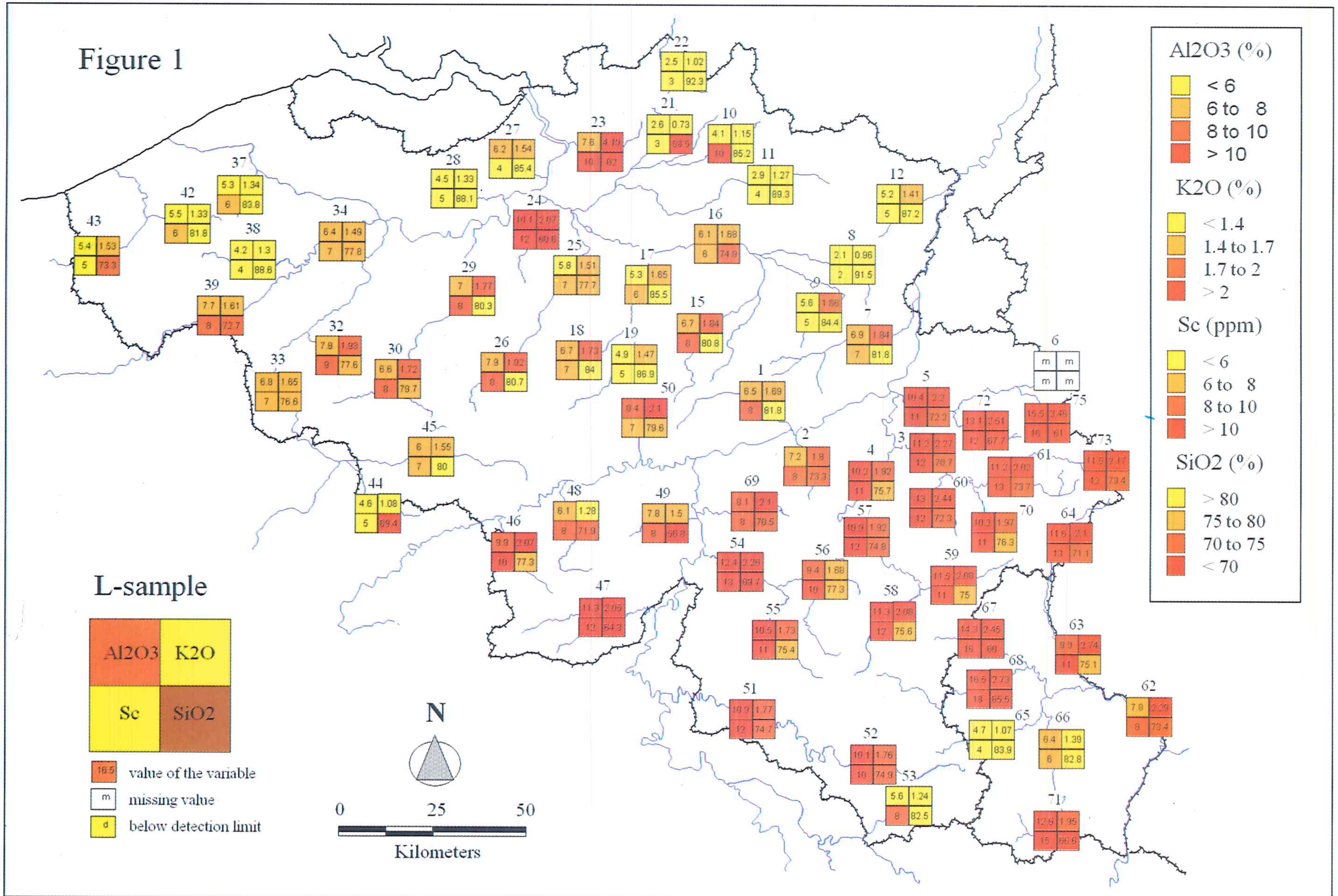


Figure 1
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
K2O (%)
< 1.4
1.4 to 1.7
1.7 to 2
> 2
Sc (ppm)
< 6
6 to 8
8 to 10
> 10
SiO2 (%)
> 80
75 to 80
70 to 75
< 70
L-sample
Al2O3
K2O
Sc
SiO2
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers

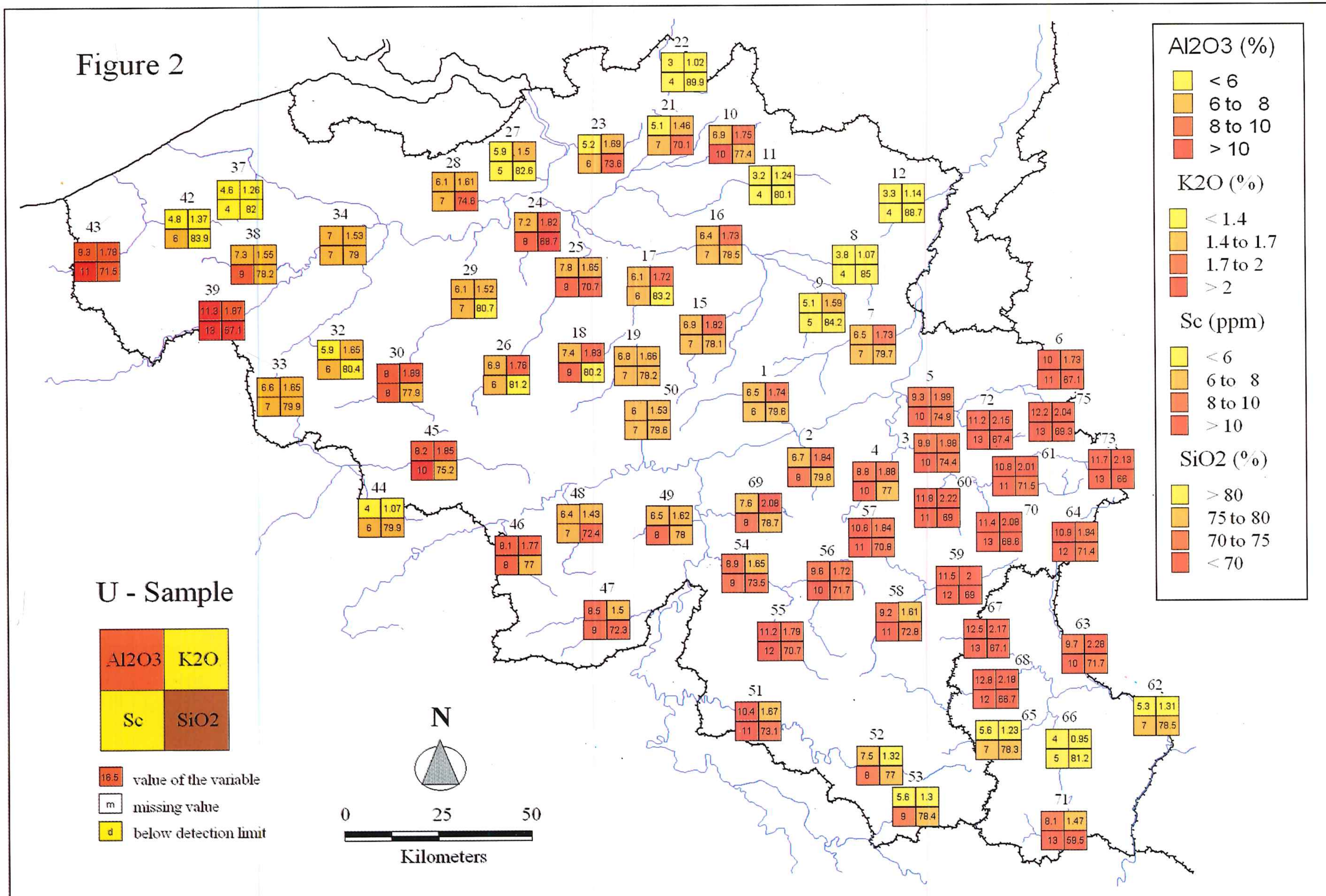

U - Sample
Al2O3
K2O
Sc
SiO2
18.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
K2O (%)
< 1.4
1.4 to 1.7
1.7 to 2
> 2
Sc (ppm)
< 6
6 to 8
8 to 10
> 10
SiO2 (%)
> 80
75 to 80
70 to 75
< 70
1 6.5 1.74 6 79.6
2 6.7 1.84 8 79.8
3 9.9 1.98 10 74.4
4 8.8 1.88 10 77
5 9.3 1.99 10 74.9
6 10 1.73 11 67.1
7 6.5 1.73 7 79.7
8 3.8 1.07 4 85
9 5.1 1.59 5 84.2
10 6.9 1.75 10 77.4
11 3.2 1.24 4 80.1
12 3.3 1.14 4 88.7
15 6.9 1.82 7 78.1
16 6.4 1.73 7 78.5
17 6.1 1.72 6 83.2
18 7.4 1.83 9 80.2
19 6.8 1.66 7 78.2
21 5.1 1.46 7 70.1
22 3 1.02 4 89.9
23 5.2 1.69 6 73.6
24 7.2 1.82 8 68.7
25 7.8 1.65 8 70.7
26 6.9 1.76 6 81.2
27 5.9 1.5 5 82.6
28 6.1 1.61 7 74.6
29 6.1 1.52 7 80.7
30 8 1.89 8 77.9
32 5.9 1.65 6 80.4
33 6.6 1.65 7 79.9
34 7 1.53 7 79
37 4.6 1.26 4 82
38 7.3 1.55 9 78.2
39 11.3 1.87 13 67.1
42 4.8 1.37 6 83.9
43 9.3 1.78 11 71.5
44 4 1.07 6 79.9
45 8.2 1.85 10 75.2
46 8.1 1.77 8 77
47 8.5 1.5 9 72.3
48 6.4 1.43 7 72.4
49 6.5 1.62 8 78
50 6 1.53 7 79.6
51 10.4 1.67 11 73.1
52 7.5 1.32 8 77
53 5.6 1.3 9 78.4
54 8.9 1.65 9 73.5
55 11.2 1.79 12 70.7
56 9.6 1.72 10 71.7
57 10.6 1.84 11 70.8
58 9.2 1.61 11 72.8
59 11.5 2 12 69
60 11.8 2.22 11 69
61 10.8 2.01 11 71.5
62 5.3 1.31 7 78.5
63 9.7 2.28 10 71.7
64 10.9 1.84 12 71.4
65 5.6 1.23 7 78.3
66 4 0.95 5 81.2
67 12.5 2.17 13 67.1
68 12.8 2.18 12 66.7
69 7.6 2.08 8 78.7
70 11.4 2.08 13 68.6
71 8.1 1.47 13 59.5
72 11.2 2.15 13 67.4
73 11.7 2.13 13 66
75 12.2 2.04 13 69.3

Figure 2

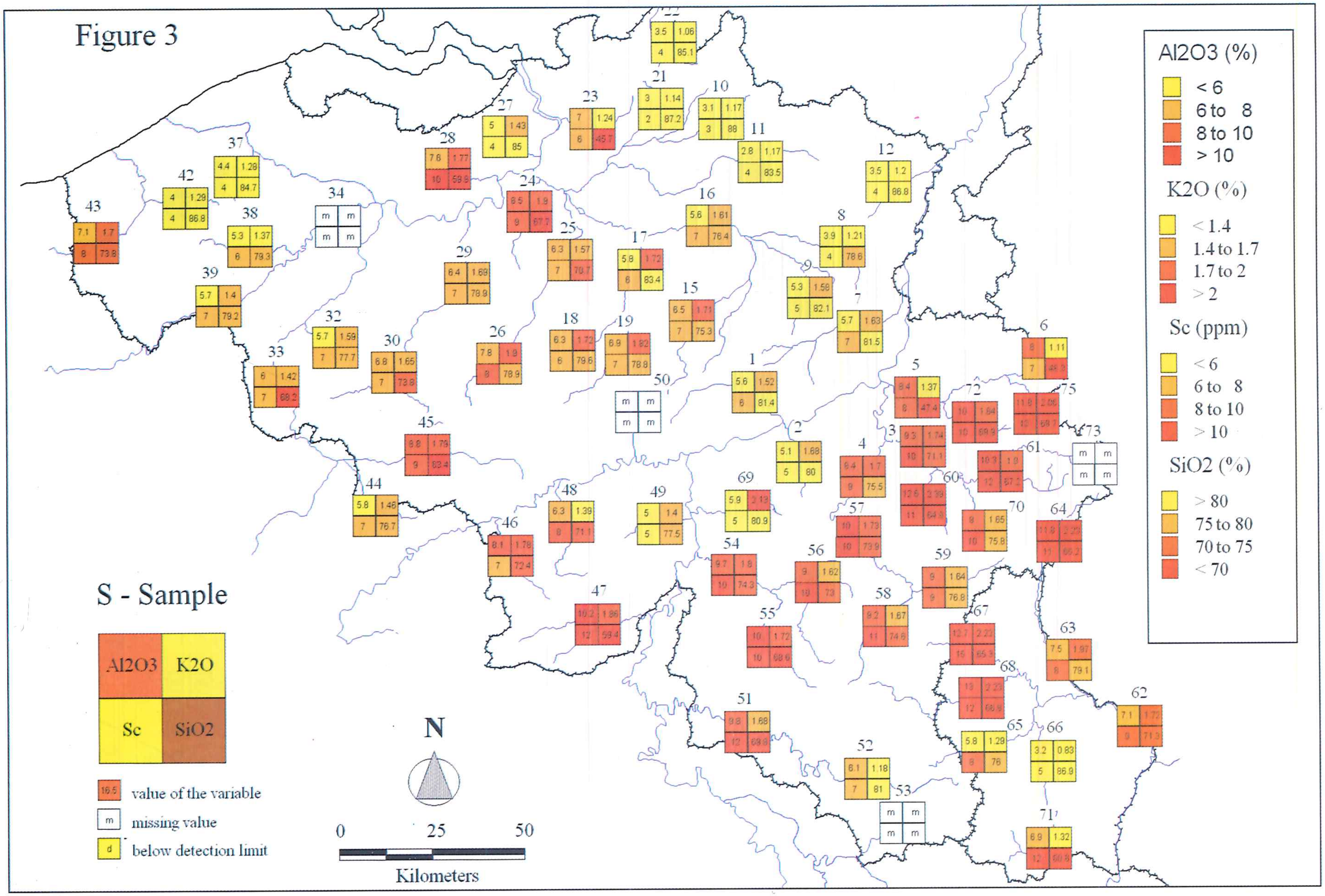


Figure 3
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
K2O (%)
< 1.4
1.4 to 1.7
1.7 to 2
> 2
Sc (ppm)
< 6
6 to 8
8 to 10
> 10
SiO2 (%)
> 80
75 to 80
70 to 75
< 70
S - Sample
Al2O3
K2O
Sc
SiO2
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers

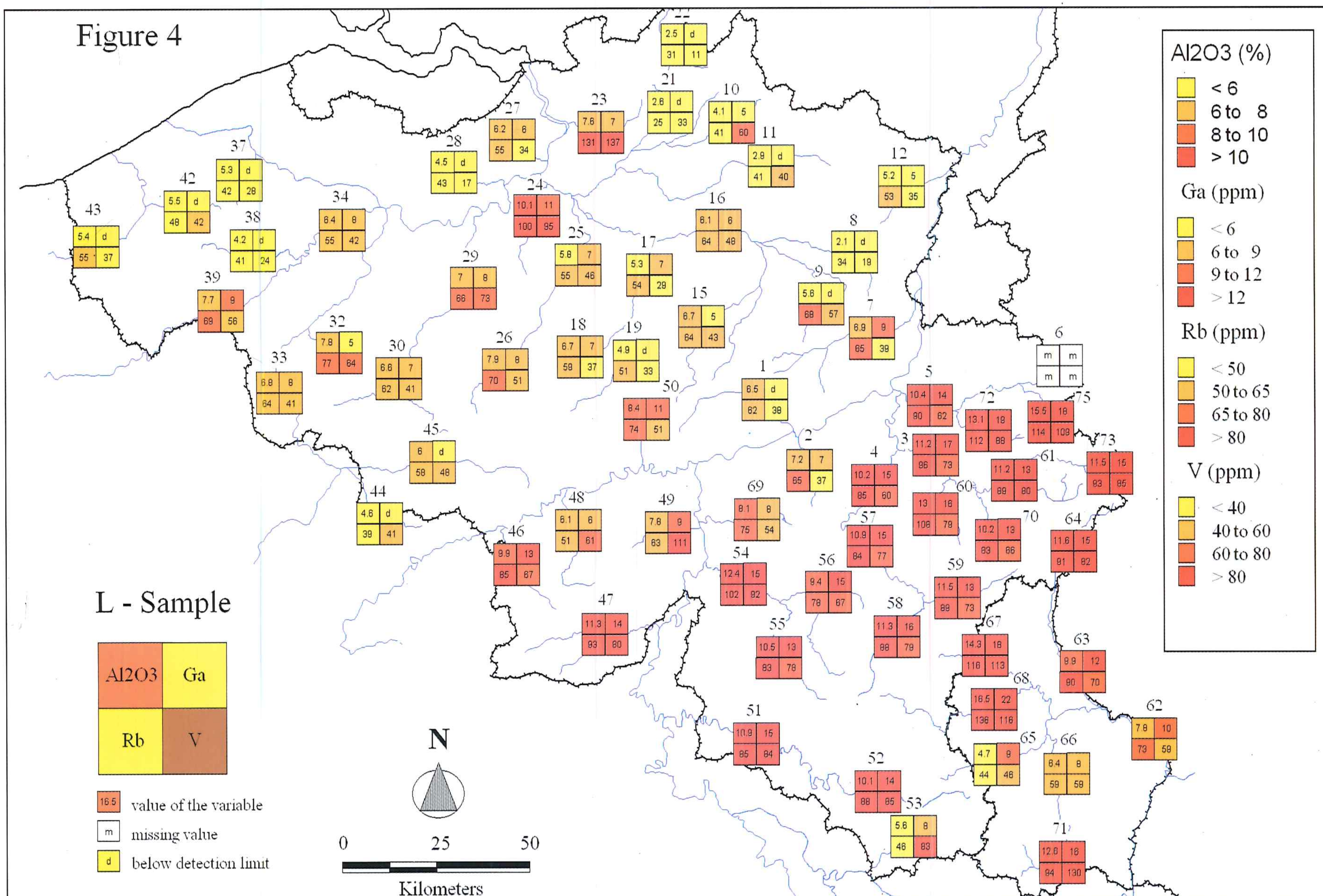
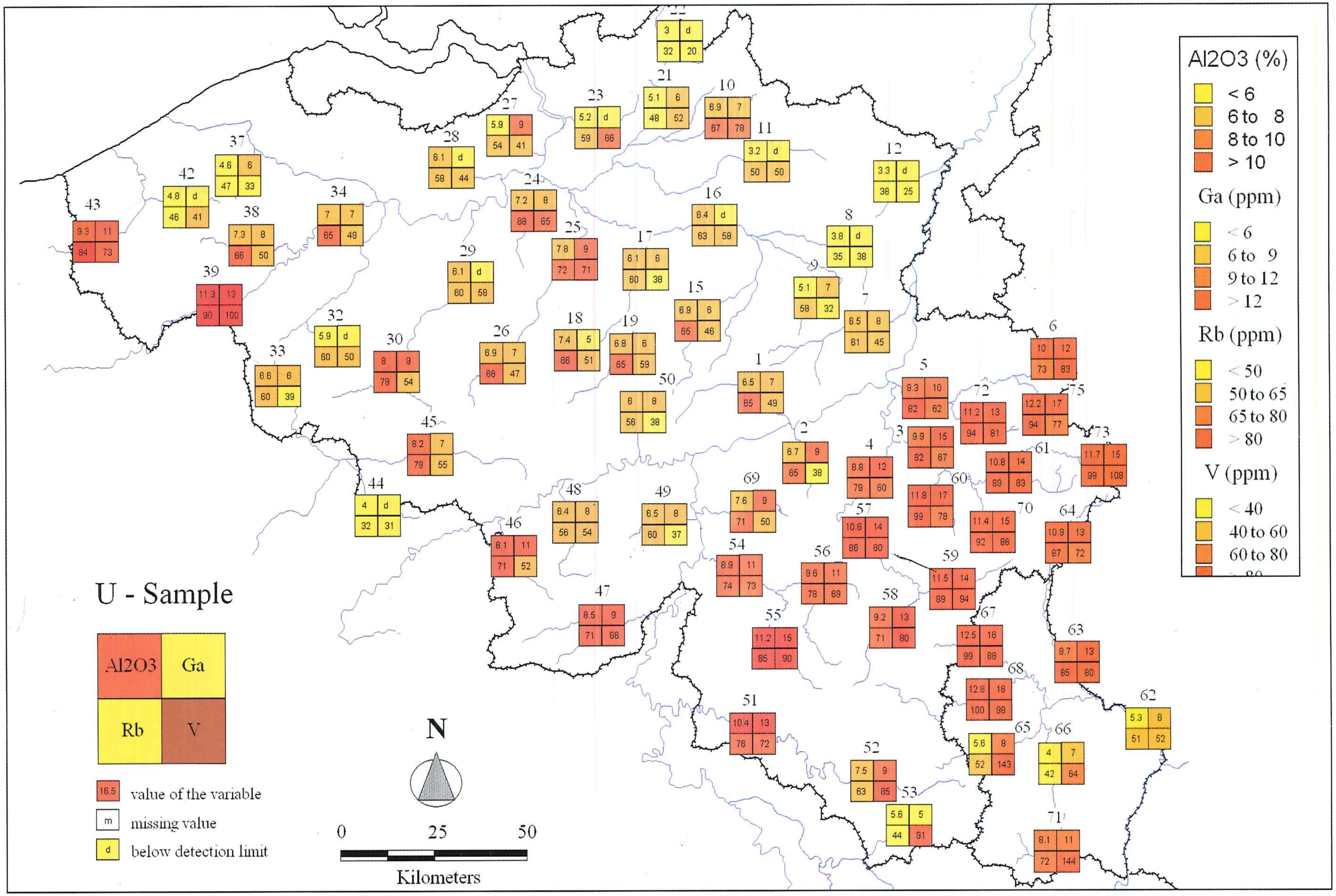

L - Sample
Al2O3
Ga
Rb
V
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
Ga (ppm)
< 6
6 to 9
9 to 12
> 12
Rb (ppm)
< 50
50 to 65
65 to 80
> 80
V (ppm)
< 40
40 to 60
60 to 80
> 80

Figure 4



U - Sample
Al2O3
Ga
Rb
V
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
Ga (ppm)
< 6
6 to 9
9 to 12
> 12
Rb (ppm)
< 50
50 to 65
65 to 80
> 80
V (ppm)
< 40
40 to 60
60 to 80

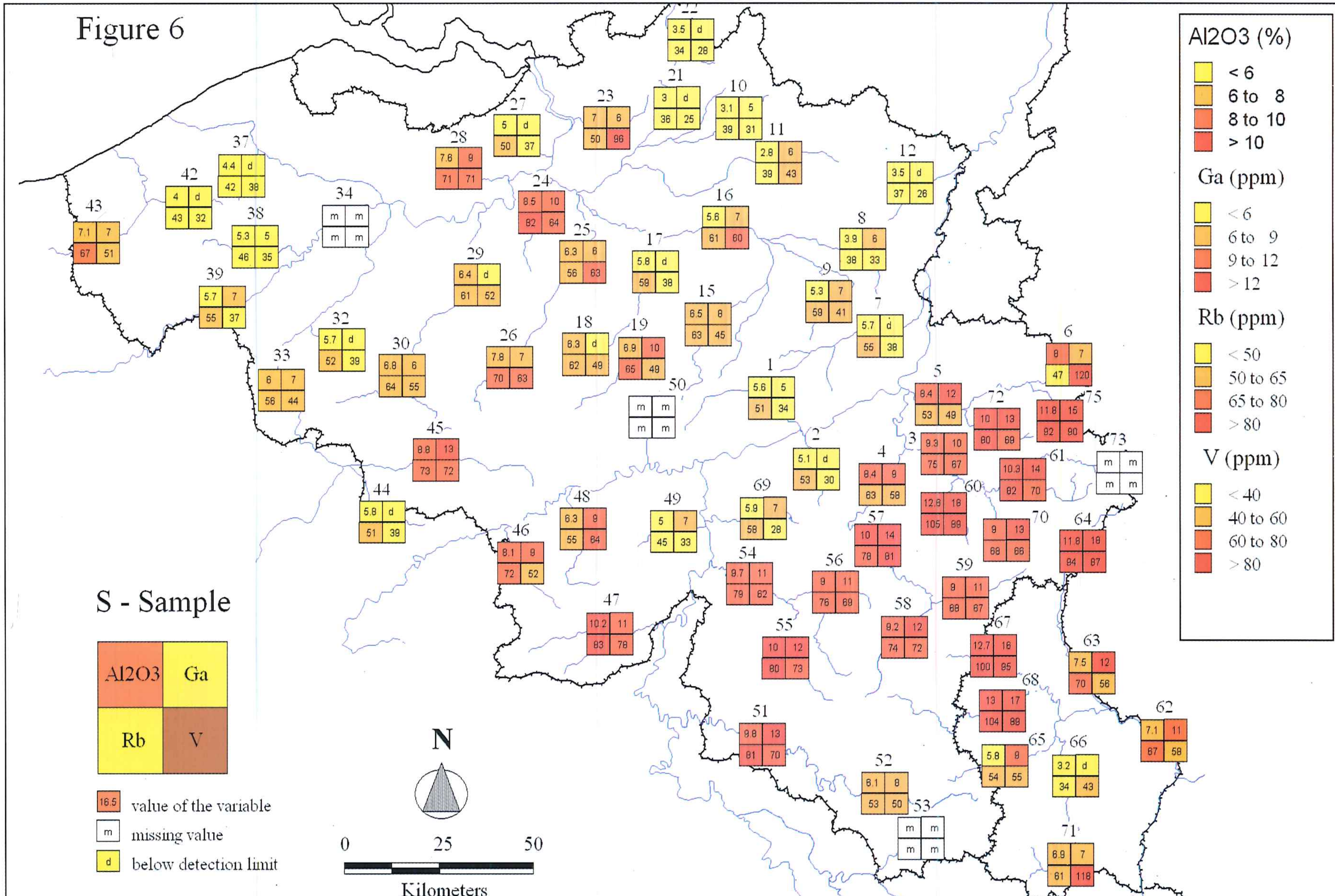


Figure 6
Al2O3 (%)
< 6
6 to 8
8 to 10
> 10
Ga (ppm)
< 6
6 to 9
9 to 12
> 12
Rb (ppm)
< 50
50 to 65
65 to 80
> 80
V (ppm)
< 40
40 to 60
60 to 80
> 80
S - Sample
Al2O3
Ga
Rb
V
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

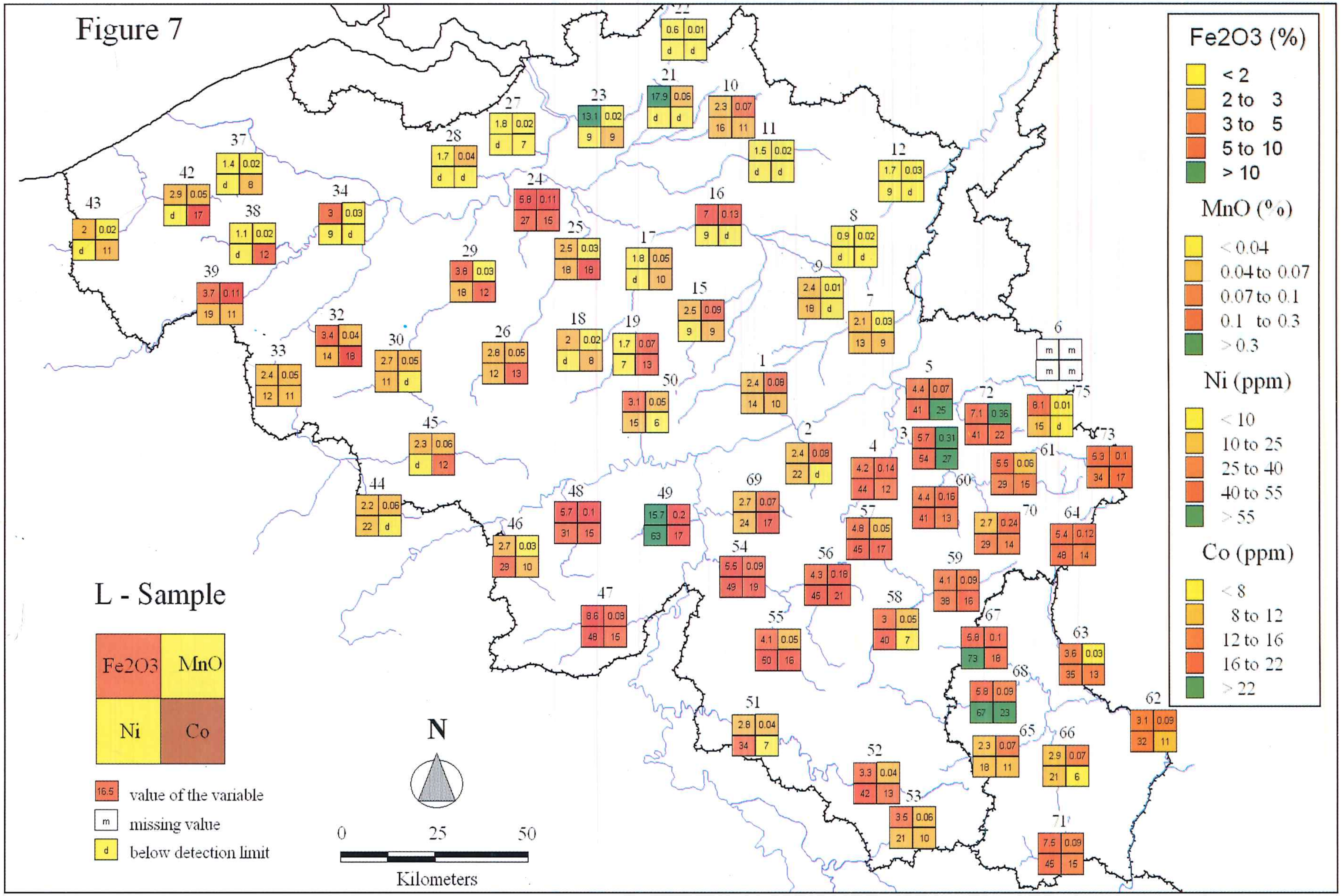


Figure 7
L - Sample
Fe2O3
MnO
Ni
Co
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers
Fe2O3 (%)
< 2
2 to 3
3 to 5
5 to 10
> 10
MnO (%)
< 0.04
0.04 to 0.07
0.07 to 0.1
0.1 to 0.3
> 0.3
Ni (ppm)
< 10
10 to 25
25 to 40
40 to 55
> 55
Co (ppm)
< 8
8 to 12
12 to 16
16 to 22
> 22

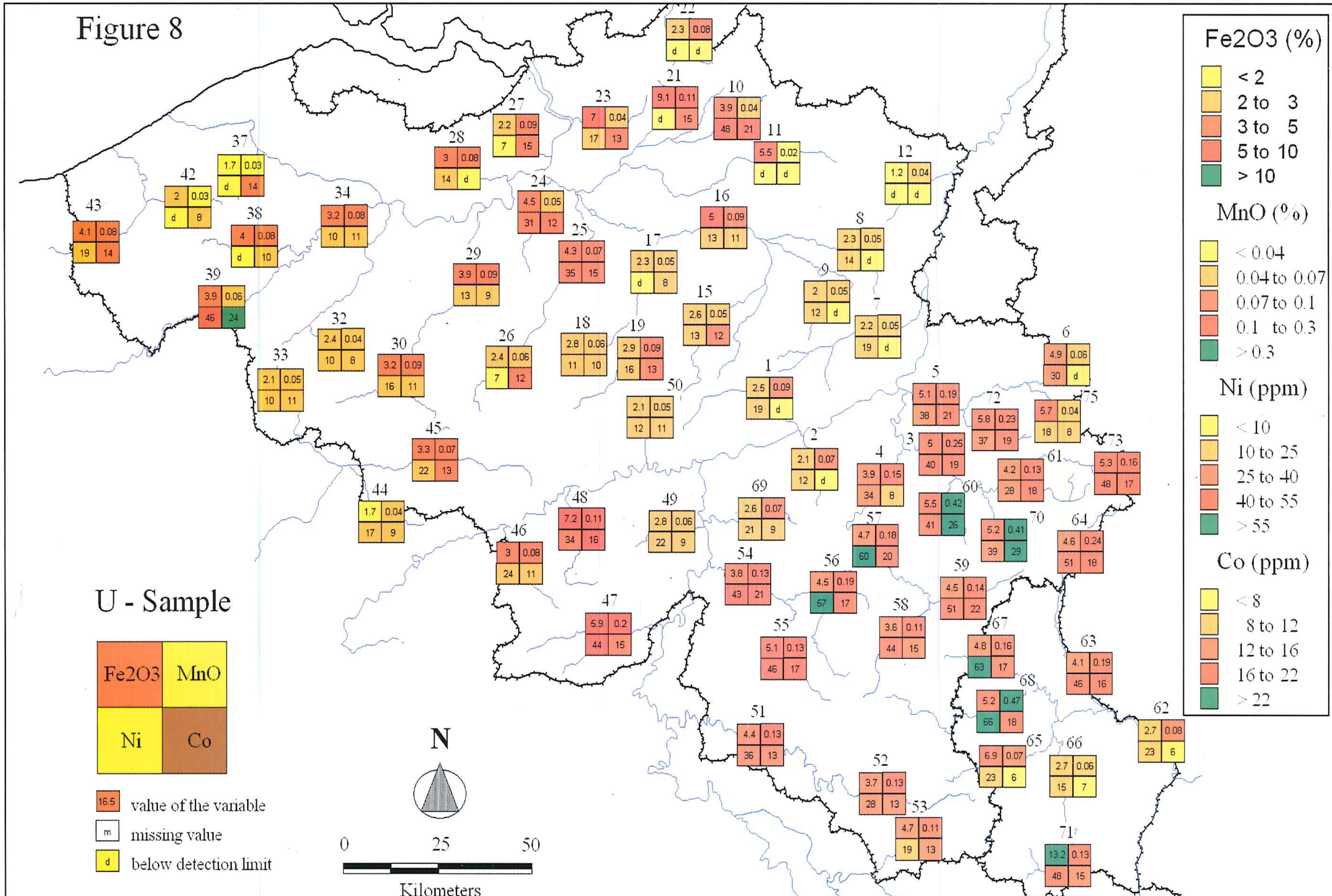

U - Sample
Fe2O3
MnO
Ni
Co
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
Fe2O3 (%)
< 2
2 to 3
3 to 5
5 to 10
> 10
MnO (%)
< 0.04
0.04 to 0.07
0.07 to 0.1
0.1 to 0.3
> 0.3
Ni (ppm)
< 10
10 to 25
25 to 40
40 to 55
> 55
Co (ppm)
< 8
8 to 12
12 to 16
16 to 22
> 22

Figure 8

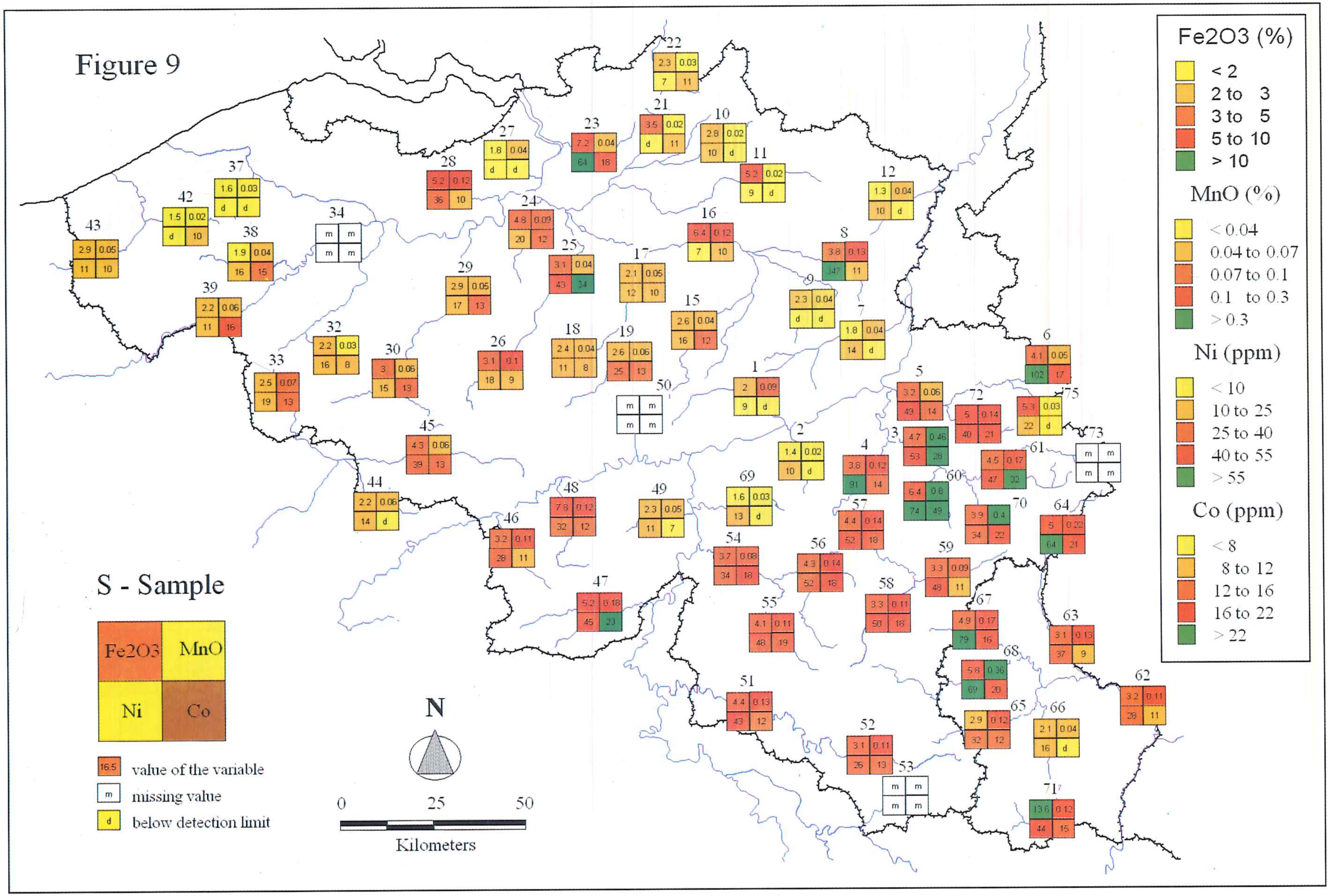
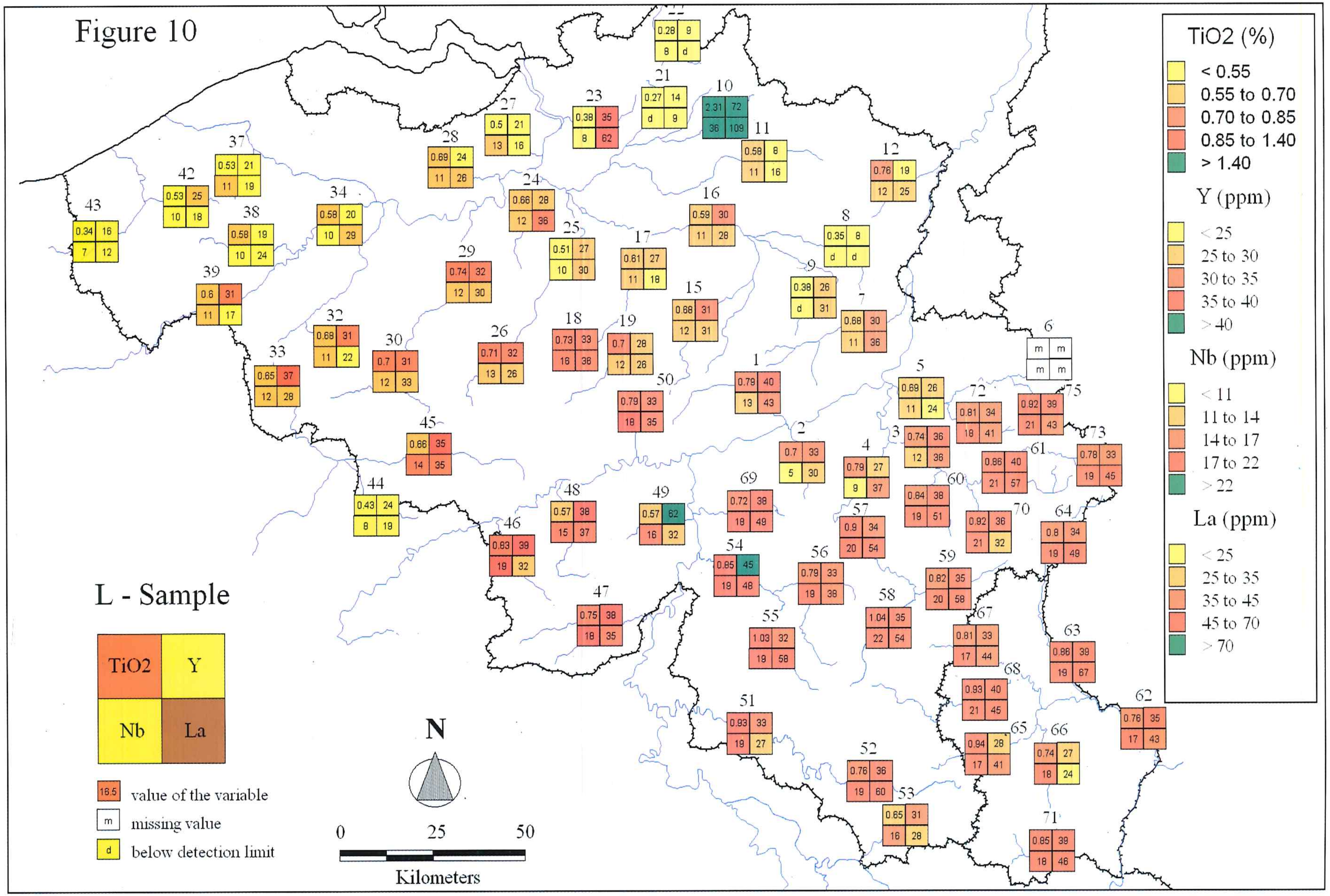

Fe2O3 (%)
< 2
2 to 3
3 to 5
5 to 10
> 10
MnO (%)
< 0.04
0.04 to 0.07
0.07 to 0.1
0.1 to 0.3
> 0.3
Ni (ppm)
< 10
10 to 25
25 to 40
40 to 55
> 55
Co (ppm)
< 8
8 to 12
12 to 16
16 to 22
> 22
S - Sample
Fe2O3
MnO
Ni
Co
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

Figure 9



L - Sample
TiO2
Y
Nb
La
16.5 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers
TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.40
> 1.40
Y (ppm)
< 25
25 to 30
30 to 35
35 to 40
> 40
Nb (ppm)
< 11
11 to 14
14 to 17
17 to 22
> 22
La (ppm)
< 25
25 to 35
35 to 45
45 to 70
> 70
43: 0.34 16 7 12
42: 0.53 25 10 18
37: 0.53 21 11 19
38: 0.58 19 10 24
39: 0.6 31 11 17
34: 0.58 20 10 29
33: 0.65 37 12 28
32: 0.68 31 11 22
30: 0.7 31 12 33
28: 0.69 24 11 26
27: 0.5 21 13 16
29: 0.74 32 12 30
24: 0.66 28 12 36
26: 0.71 32 13 26
45: 0.66 35 14 35
44: 0.43 24 8 19
46: 0.83 39 19 32
47: 0.75 38 18 35
48: 0.57 38 15 37
49: 0.57 62 16 32
18: 0.73 33 16 36
19: 0.7 28 12 26
25: 0.51 27 10 30
17: 0.61 27 11 18
23: 0.38 35 8 62
21: 0.27 14 d 9
22: 0.28 9 8 d
10: 2.31 72 36 109
11: 0.58 8 11 16
16: 0.59 30 11 28
15: 0.68 31 12 31
50: 0.79 33 18 35
1: 0.79 40 13 43
9: 0.38 26 d 31
8: 0.35 8 d d
7: 0.68 30 11 36
12: 0.76 19 12 25
6: m m m m
5: 0.69 26 11 24
72: 0.81 34 18 41
75: 0.92 39 21 43
73: 0.78 33 19 45
3: 0.74 36 12 36
61: 0.86 40 21 57
2: 0.7 33 5 30
4: 0.79 27 9 37
60: 0.84 38 19 51
69: 0.72 38 18 49
57: 0.9 34 20 54
70: 0.92 36 21 32
64: 0.8 34 19 49
54: 0.85 45 19 48
56: 0.79 33 19 38
59: 0.82 35 20 58
58: 1.04 35 22 54
55: 1.03 32 19 58
67: 0.81 33 17 44
63: 0.86 39 19 67
68: 0.93 40 21 45
51: 0.93 33 19 27
65: 0.94 28 17 41
66: 0.74 27 18 24
62: 0.76 35 17 43
52: 0.76 36 19 60
53: 0.65 31 16 28
71: 0.85 39 18 46

Figure 10

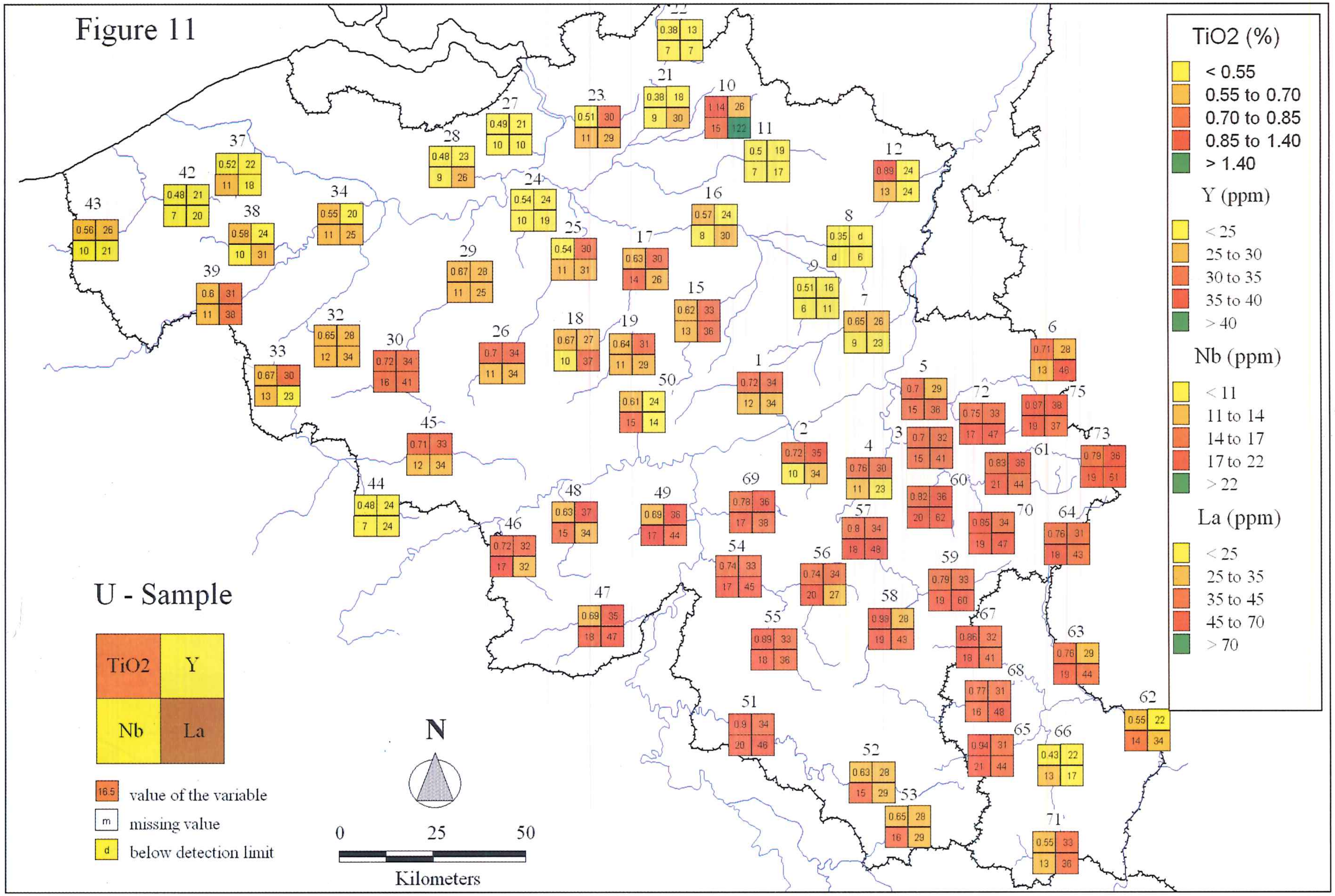
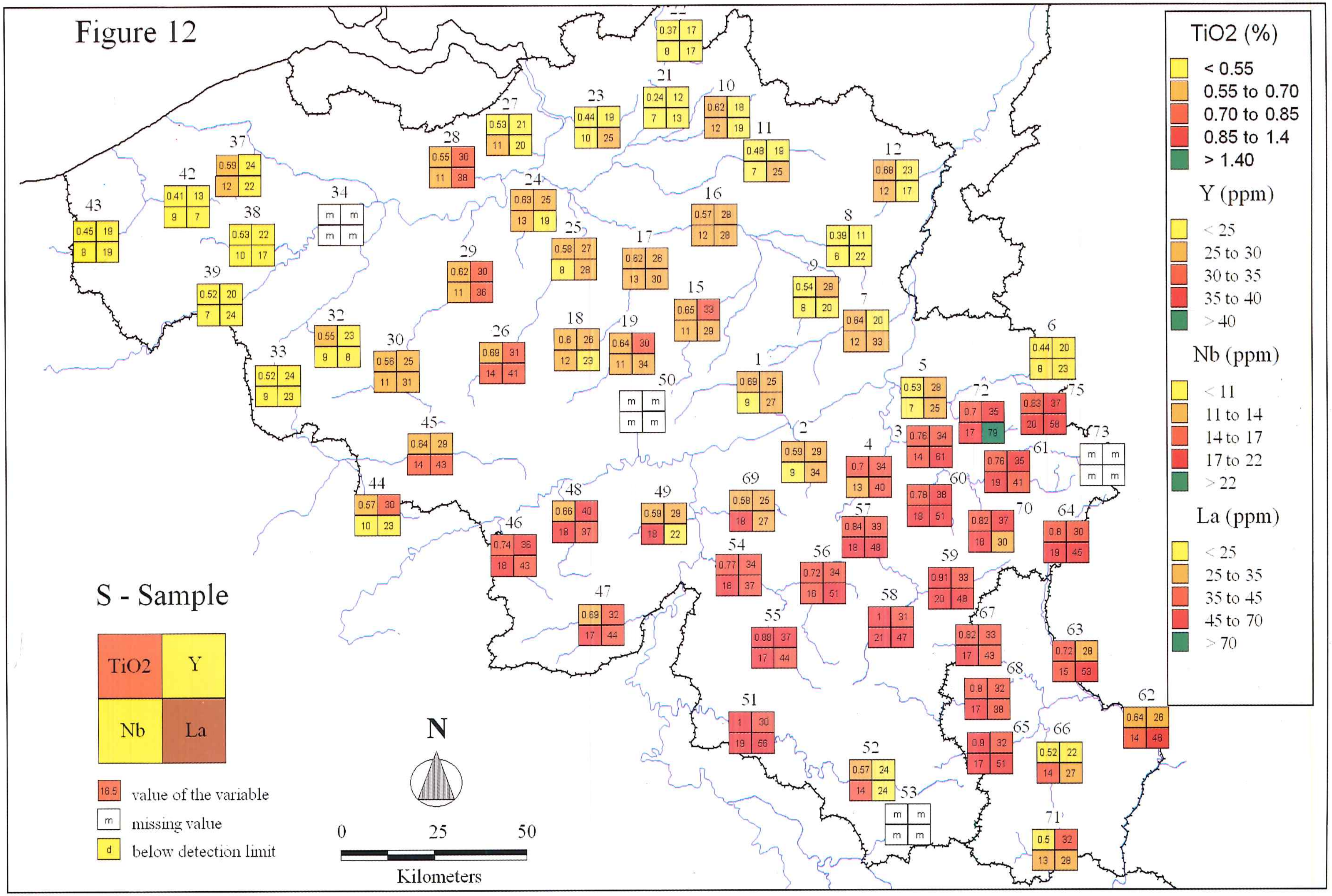


Figure 11
U - Sample
TiO2
Y
Nb
La
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.40
> 1.40
Y (ppm)
< 25
25 to 30
30 to 35
35 to 40
> 40
Nb (ppm)
< 11
11 to 14
14 to 17
17 to 22
> 22
La (ppm)
< 25
25 to 35
35 to 45
45 to 70
> 70

Figure 12



TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.4
> 1.40
Y (ppm)
< 25
25 to 30
30 to 35
35 to 40
> 40
Nb (ppm)
< 11
11 to 14
14 to 17
17 to 22
> 22
La (ppm)
< 25
25 to 35
35 to 45
45 to 70
> 70
S - Sample
TiO2
Y
Nb
La
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

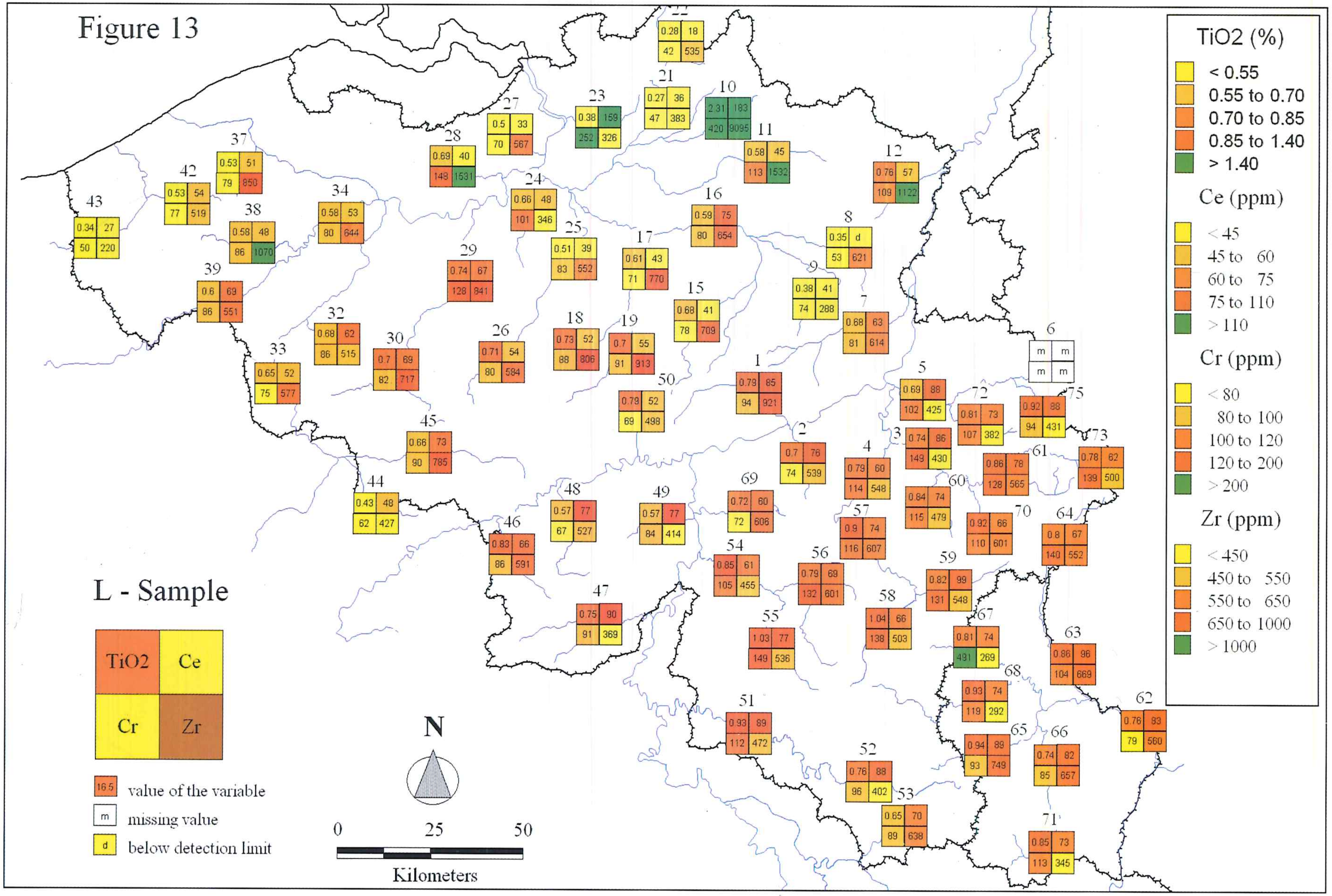


Figure 13
L - Sample
TiO2
Ce
Cr
Zr
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.40
> 1.40
Ce (ppm)
< 45
45 to 60
60 to 75
75 to 110
> 110
Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
Zr (ppm)
< 450
450 to 550
550 to 650
650 to 1000
> 1000

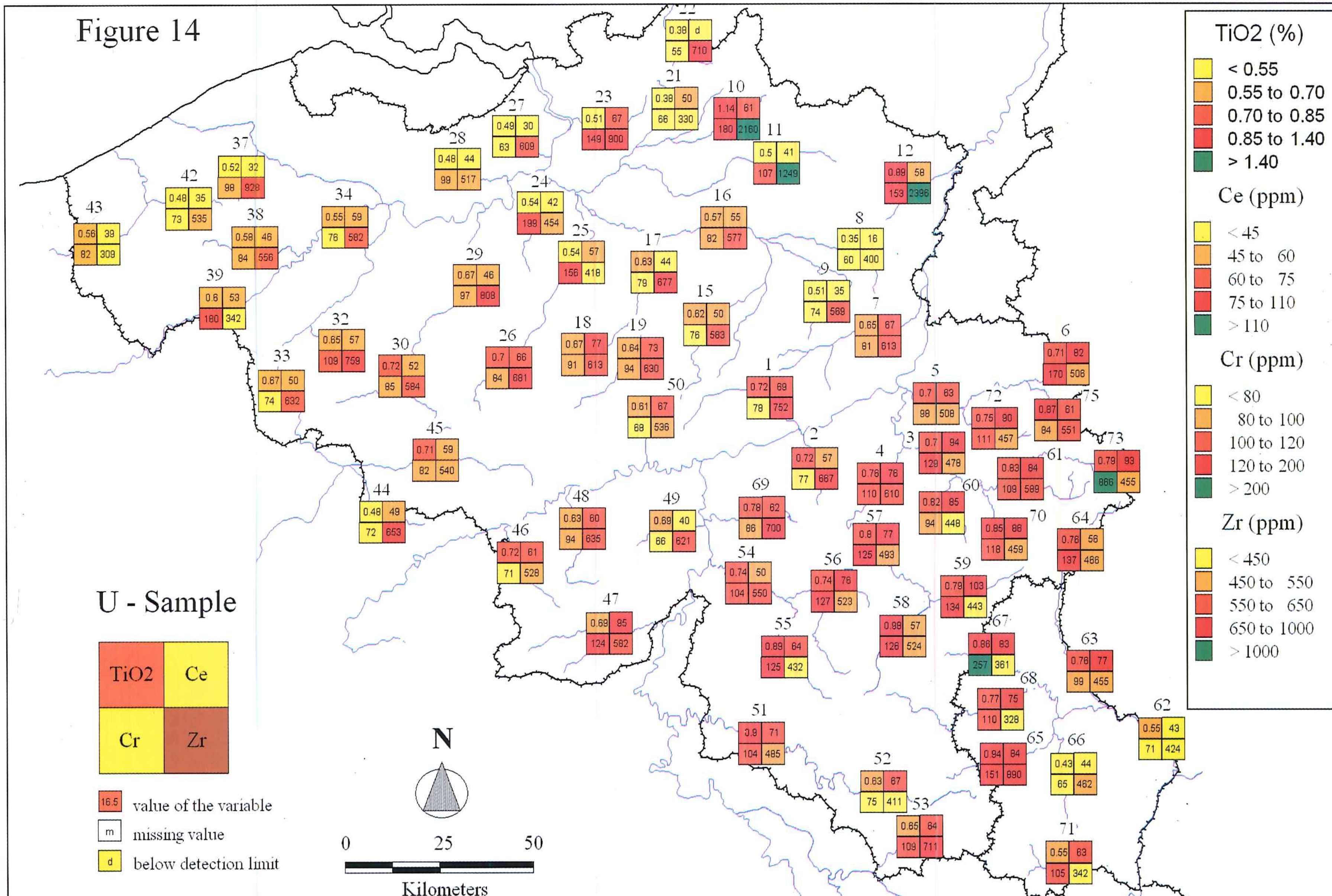


Figure 14
U - Sample
TiO2
Ce
Cr
Zr
16.5 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers
TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.40
> 1.40
Ce (ppm)
< 45
45 to 60
60 to 75
75 to 110
> 110
Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
Zr (ppm)
< 450
450 to 550
550 to 650
650 to 1000
> 1000

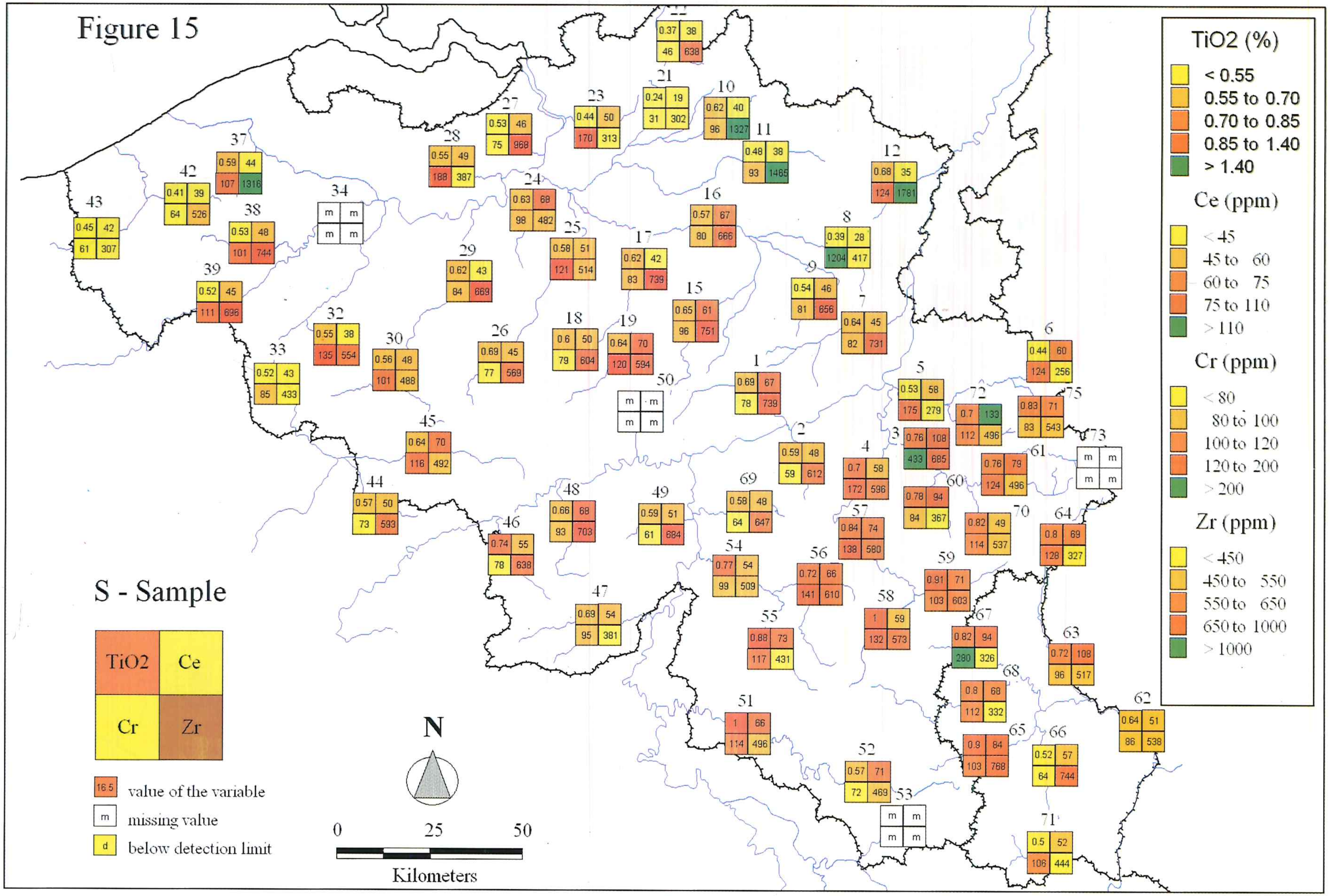


Figure 15
TiO2 (%)
< 0.55
0.55 to 0.70
0.70 to 0.85
0.85 to 1.40
> 1.40
Ce (ppm)
< 45
45 to 60
60 to 75
75 to 110
> 110
Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
Zr (ppm)
< 450
450 to 550
550 to 650
650 to 1000
> 1000
S - Sample
TiO2
Ce
Cr
Zr
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
22: 0.37 38 46 638
21: 0.24 19 31 302
10: 0.62 40 96 1327
11: 0.48 38 93 1465
23: 0.44 50 170 313
27: 0.53 46 75 968
28: 0.55 49 188 387
37: 0.59 44 107 1316
42: 0.41 39 64 526
43: 0.45 42 61 307
34: m m m m
38: 0.53 48 101 744
24: 0.63 68 98 482
12: 0.68 35 124 1781
16: 0.57 67 80 666
8: 0.39 28 1204 417
25: 0.58 51 121 514
17: 0.62 42 83 739
29: 0.62 43 84 669
39: 0.52 45 111 696
9: 0.54 46 81 656
15: 0.65 61 96 751
7: 0.64 45 82 731
32: 0.55 38 135 554
33: 0.52 43 85 433
30: 0.56 48 101 488
26: 0.69 45 77 569
18: 0.6 50 79 604
19: 0.64 70 120 594
6: 0.44 60 124 256
1: 0.69 67 78 739
50: m m m m
5: 0.53 58 175 279
72: 0.7 133 112 496
75: 0.83 71 83 543
45: 0.64 70 116 492
2: 0.59 48 59 612
3: 0.76 108 433 685
4: 0.7 58 172 596
61: 0.76 79 124 496
73: m m m m
44: 0.57 50 73 593
48: 0.66 68 93 703
49: 0.59 51 61 684
69: 0.58 48 64 647
60: 0.78 94 84 367
57: 0.84 74 138 580
70: 0.82 49 114 537
64: 0.8 69 128 327
46: 0.74 55 78 638
54: 0.77 54 99 509
56: 0.72 66 141 610
59: 0.91 71 103 603
47: 0.69 54 95 381
58: 1 59 132 573
55: 0.88 73 117 431
67: 0.82 94 280 326
63: 0.72 108 96 517
68: 0.8 68 112 332
51: 1 66 114 496
62: 0.64 51 86 538
65: 0.9 84 103 768
66: 0.52 57 64 744
52: 0.57 71 72 469
53: m m m m
71: 0.5 52 106 444

Figure 16

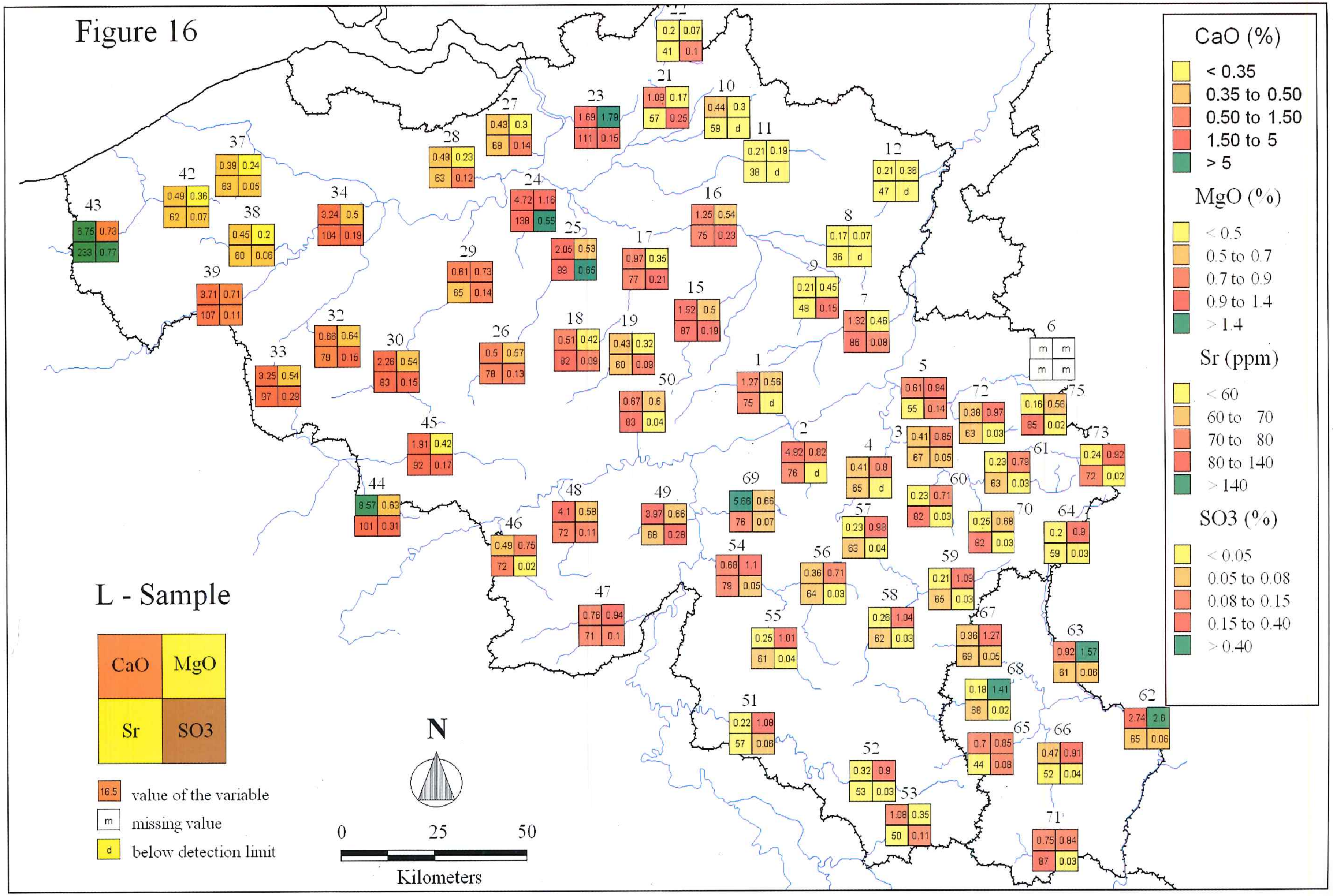
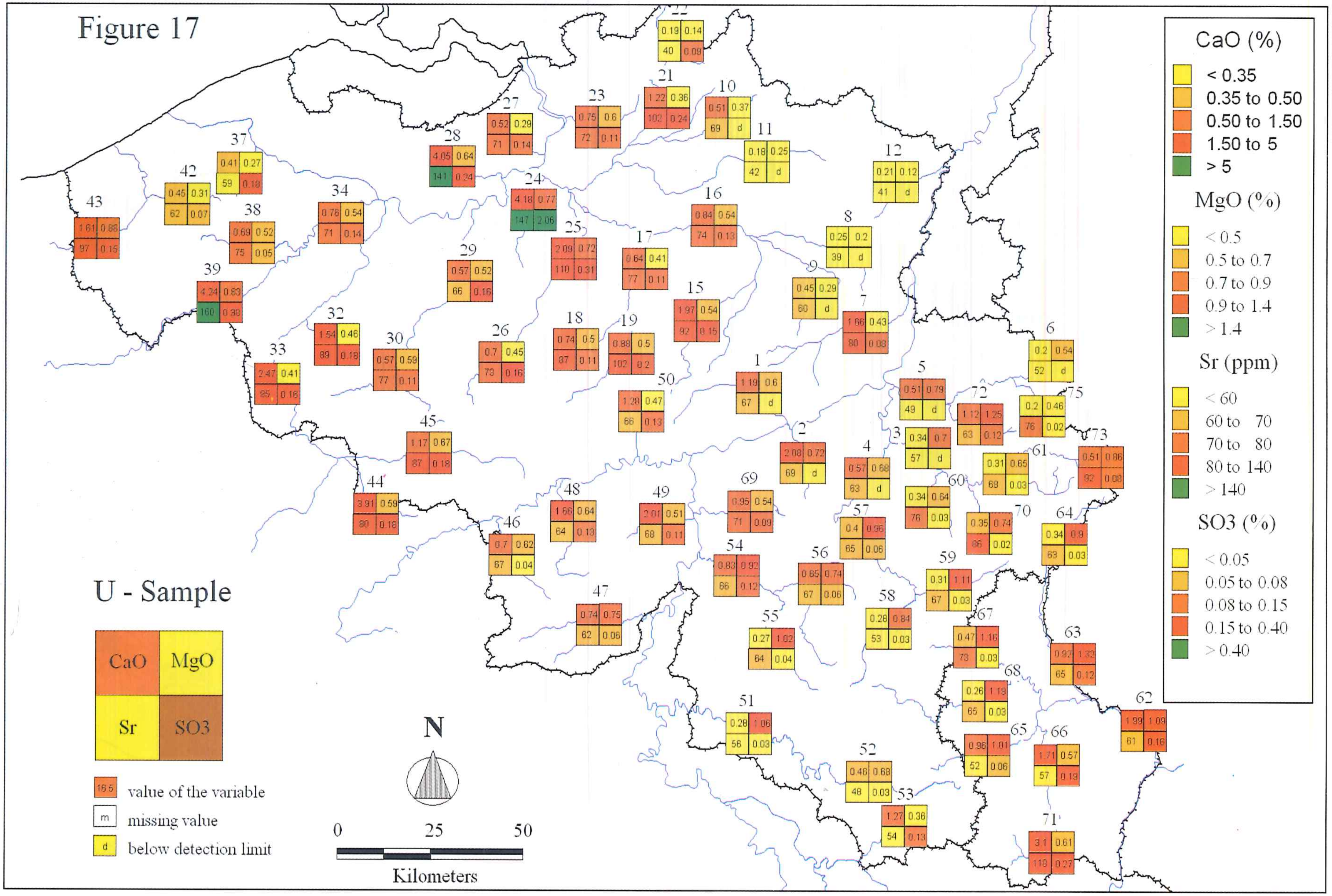

L - Sample
CaO
MgO
Sr
SO3
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
CaO (%)
< 0.35
0.35 to 0.50
0.50 to 1.50
1.50 to 5
> 5
MgO (%)
< 0.5
0.5 to 0.7
0.7 to 0.9
0.9 to 1.4
> 1.4
Sr (ppm)
< 60
60 to 70
70 to 80
80 to 140
> 140
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40

Figure 17


CaO (%)
< 0.35
0.35 to 0.50
0.50 to 1.50
1.50 to 5
> 5
MgO (%)
< 0.5
0.5 to 0.7
0.7 to 0.9
0.9 to 1.4
> 1.4
Sr (ppm)
< 60
60 to 70
70 to 80
80 to 140
> 140
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40
U - Sample
CaO
MgO
Sr
SO3
16.5
value of the variable
m
missing value
d
below detection limit
N
0
25
50
Kilometers

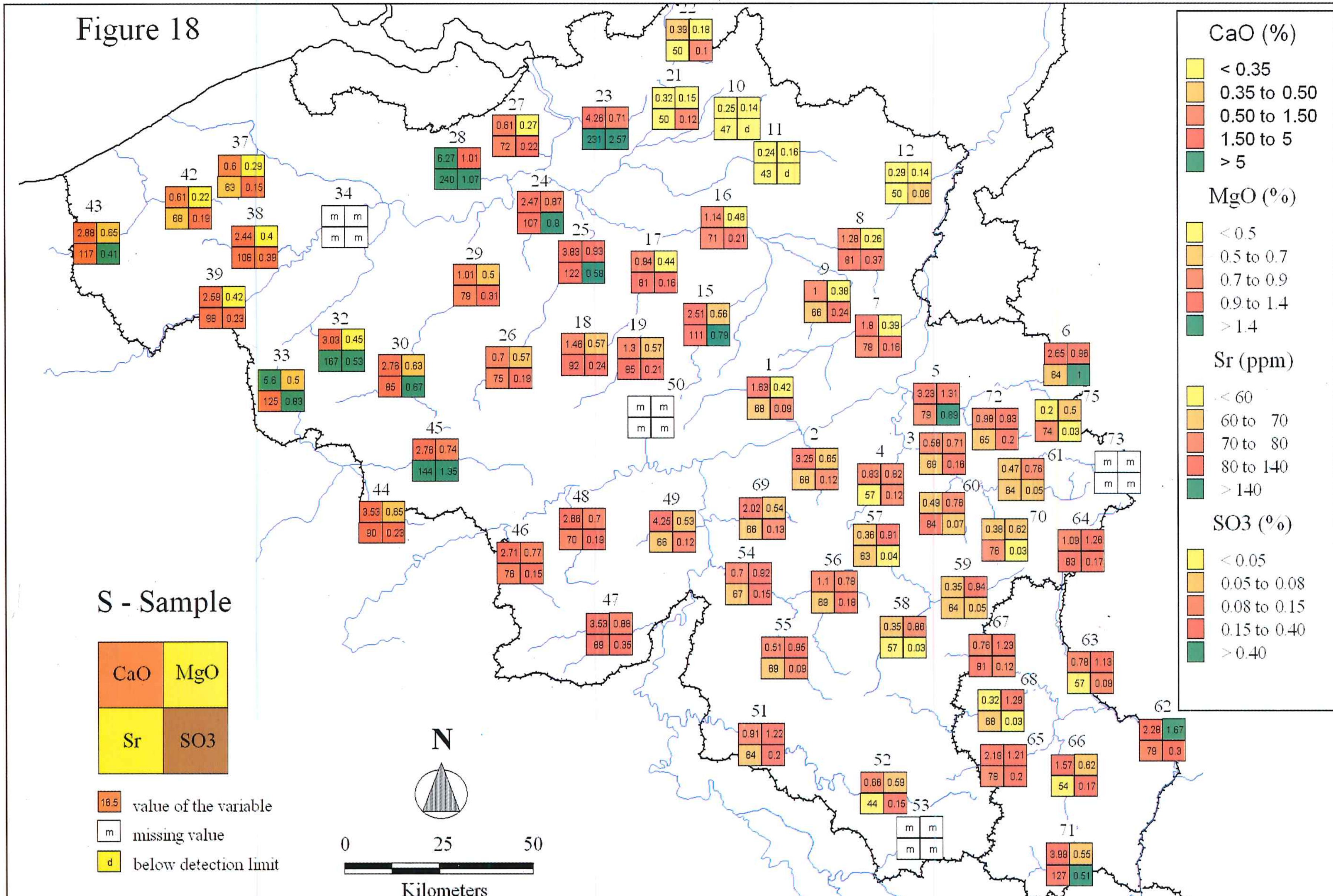
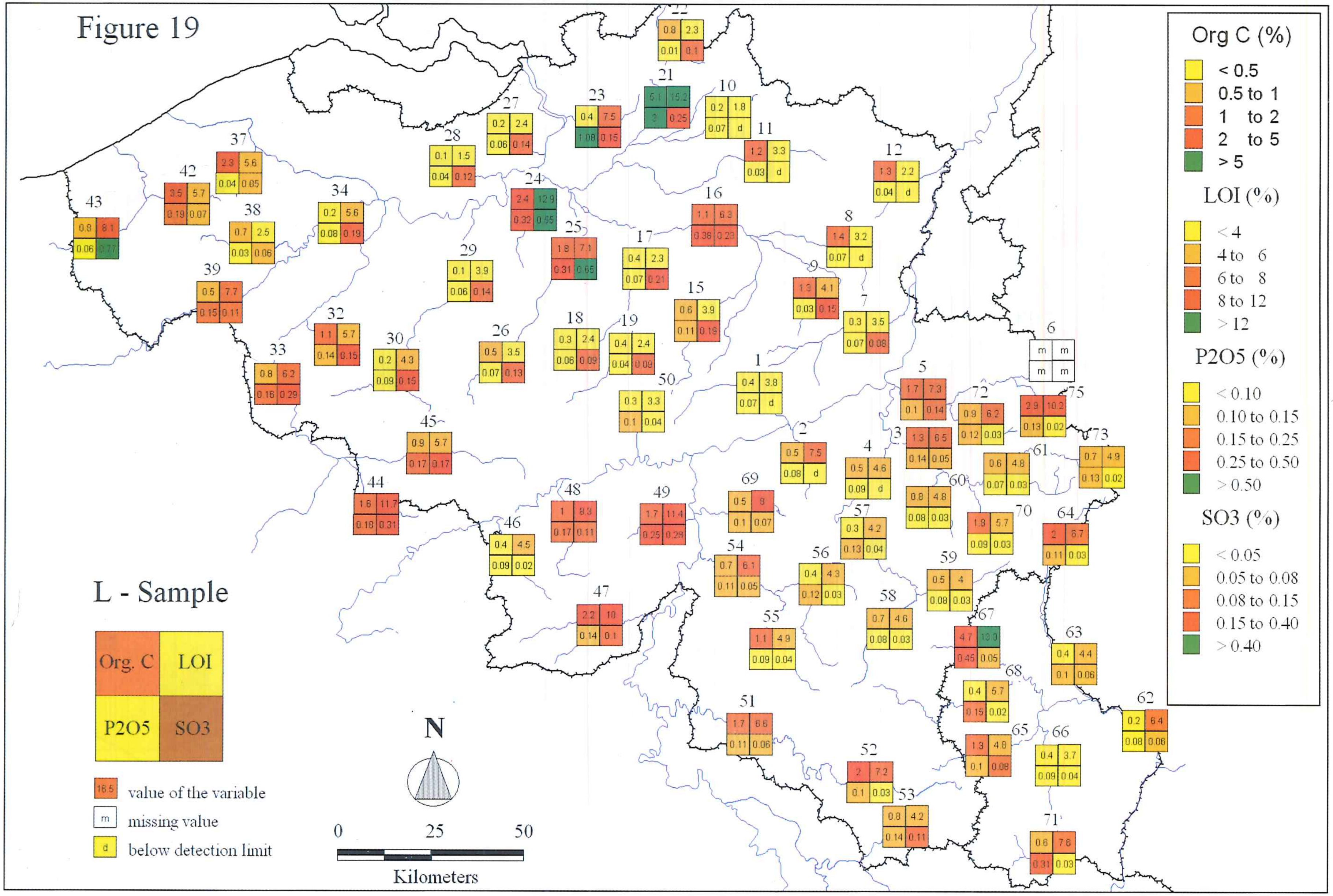

CaO (%)
< 0.35
0.35 to 0.50
0.50 to 1.50
1.50 to 5
> 5
MgO (%)
< 0.5
0.5 to 0.7
0.7 to 0.9
0.9 to 1.4
> 1.4
Sr (ppm)
< 60
60 to 70
70 to 80
80 to 140
> 140
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40
S - Sample
CaO MgO
Sr SO3
18.5 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers
22: 0.39 0.18 50 0.1
21: 0.32 0.15 50 0.12
10: 0.25 0.14 47 d
11: 0.24 0.16 43 d
23: 4.26 0.71 231 2.57
27: 0.61 0.27 72 0.22
28: 6.27 1.01 240 1.07
37: 0.6 0.29 63 0.15
42: 0.61 0.22 68 0.19
43: 2.88 0.65 117 0.41
38: 2.44 0.4 108 0.39
34: m m m m
24: 2.47 0.87 107 0.8
16: 1.14 0.48 71 0.21
12: 0.29 0.14 50 0.06
8: 1.28 0.26 81 0.37
25: 3.83 0.93 122 0.58
17: 0.94 0.44 81 0.16
29: 1.01 0.5 79 0.31
39: 2.59 0.42 98 0.23
9: 1 0.38 66 0.24
15: 2.51 0.56 111 0.79
7: 1.8 0.39 78 0.16
32: 3.03 0.45 167 0.53
33: 5.6 0.5 125 0.83
30: 2.78 0.63 85 0.67
26: 0.7 0.57 75 0.19
18: 1.46 0.57 92 0.24
19: 1.3 0.57 85 0.21
6: 2.65 0.96 64 1
50: m m m m
1: 1.63 0.42 68 0.09
5: 3.23 1.31 79 0.89
72: 0.98 0.93 65 0.2
75: 0.2 0.5 74 0.03
45: 2.78 0.74 144 1.35
2: 3.25 0.65 68 0.12
4: 0.83 0.82 57 0.12
3: 0.58 0.71 69 0.16
61: 0.47 0.76 64 0.05
73: m m m m
60: 0.49 0.76 84 0.07
44: 3.53 0.65 80 0.23
48: 2.88 0.7 70 0.19
49: 4.25 0.53 66 0.12
69: 2.02 0.54 66 0.13
57: 0.36 0.91 63 0.04
70: 0.38 0.62 76 0.03
64: 1.09 1.26 83 0.17
46: 2.71 0.77 78 0.15
54: 0.7 0.92 67 0.15
56: 1.1 0.78 88 0.18
59: 0.35 0.84 64 0.05
47: 3.53 0.86 89 0.35
55: 0.51 0.95 69 0.09
58: 0.35 0.86 57 0.03
67: 0.76 1.23 81 0.12
63: 0.78 1.13 57 0.09
68: 0.32 1.29 68 0.03
62: 2.28 1.67 79 0.3
51: 0.91 1.22 64 0.2
65: 2.18 1.21 78 0.2
66: 1.57 0.62 54 0.17
52: 0.86 0.59 44 0.15
53: m m m m
71: 3.98 0.55 127 0.51

Figure 18



L - Sample
Org. C
LOI
P2O5
SO3
16.5 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers
Org C (%)
< 0.5
0.5 to 1
1 to 2
2 to 5
> 5
LOI (%)
< 4
4 to 6
6 to 8
8 to 12
> 12
P2O5 (%)
< 0.10
0.10 to 0.15
0.15 to 0.25
0.25 to 0.50
> 0.50
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40
22 0.8 2.3 0.01 0.1
21 5.1 15.2 3 0.25
23 0.4 7.5 1.08 0.15
10 0.2 1.8 0.07 d
11 1.2 3.3 0.03 d
27 0.2 2.4 0.06 0.14
28 0.1 1.5 0.04 0.12
37 2.3 5.6 0.04 0.05
42 3.5 5.7 0.19 0.07
43 0.8 8.1 0.06 0.77
38 0.7 2.5 0.03 0.06
34 0.2 5.6 0.08 0.19
24 2.4 12.9 0.32 0.55
16 1.1 6.3 0.36 0.23
12 1.3 2.2 0.04 d
8 1.4 3.2 0.07 d
25 1.8 7.1 0.31 0.65
17 0.4 2.3 0.07 0.21
29 0.1 3.9 0.06 0.14
39 0.5 7.7 0.15 0.11
9 1.3 4.1 0.03 0.15
15 0.6 3.9 0.11 0.19
7 0.3 3.5 0.07 0.08
32 1.1 5.7 0.14 0.15
30 0.2 4.3 0.09 0.15
26 0.5 3.5 0.07 0.13
18 0.3 2.4 0.06 0.09
19 0.4 2.4 0.04 0.09
6 m m m m
33 0.8 6.2 0.16 0.29
1 0.4 3.8 0.07 d
50 0.3 3.3 0.1 0.04
5 1.7 7.3 0.1 0.14
72 0.9 6.2 0.12 0.03
75 2.9 10.2 0.13 0.02
45 0.9 5.7 0.17 0.17
2 0.5 7.5 0.08 d
3 1.3 6.5 0.14 0.05
4 0.5 4.6 0.09 d
61 0.6 4.8 0.07 0.03
73 0.7 4.9 0.13 0.02
44 1.6 11.7 0.18 0.31
48 1 8.3 0.17 0.11
49 1.7 11.4 0.25 0.29
69 0.5 8 0.1 0.07
60 0.8 4.8 0.08 0.03
57 0.3 4.2 0.13 0.04
70 1.8 5.7 0.09 0.03
64 2 6.7 0.11 0.03
46 0.4 4.5 0.09 0.02
54 0.7 6.1 0.11 0.05
56 0.4 4.3 0.12 0.03
59 0.5 4 0.08 0.03
47 2.2 10 0.14 0.1
55 1.1 4.9 0.09 0.04
58 0.7 4.6 0.08 0.03
67 4.7 13.3 0.45 0.05
63 0.4 4.4 0.1 0.06
68 0.4 5.7 0.15 0.02
62 0.2 6.4 0.08 0.06
51 1.7 6.6 0.11 0.06
65 1.3 4.8 0.1 0.08
66 0.4 3.7 0.09 0.04
52 2 7.2 0.1 0.03
53 0.8 4.2 0.14 0.11
71 0.6 7.6 0.31 0.03

Figure 19

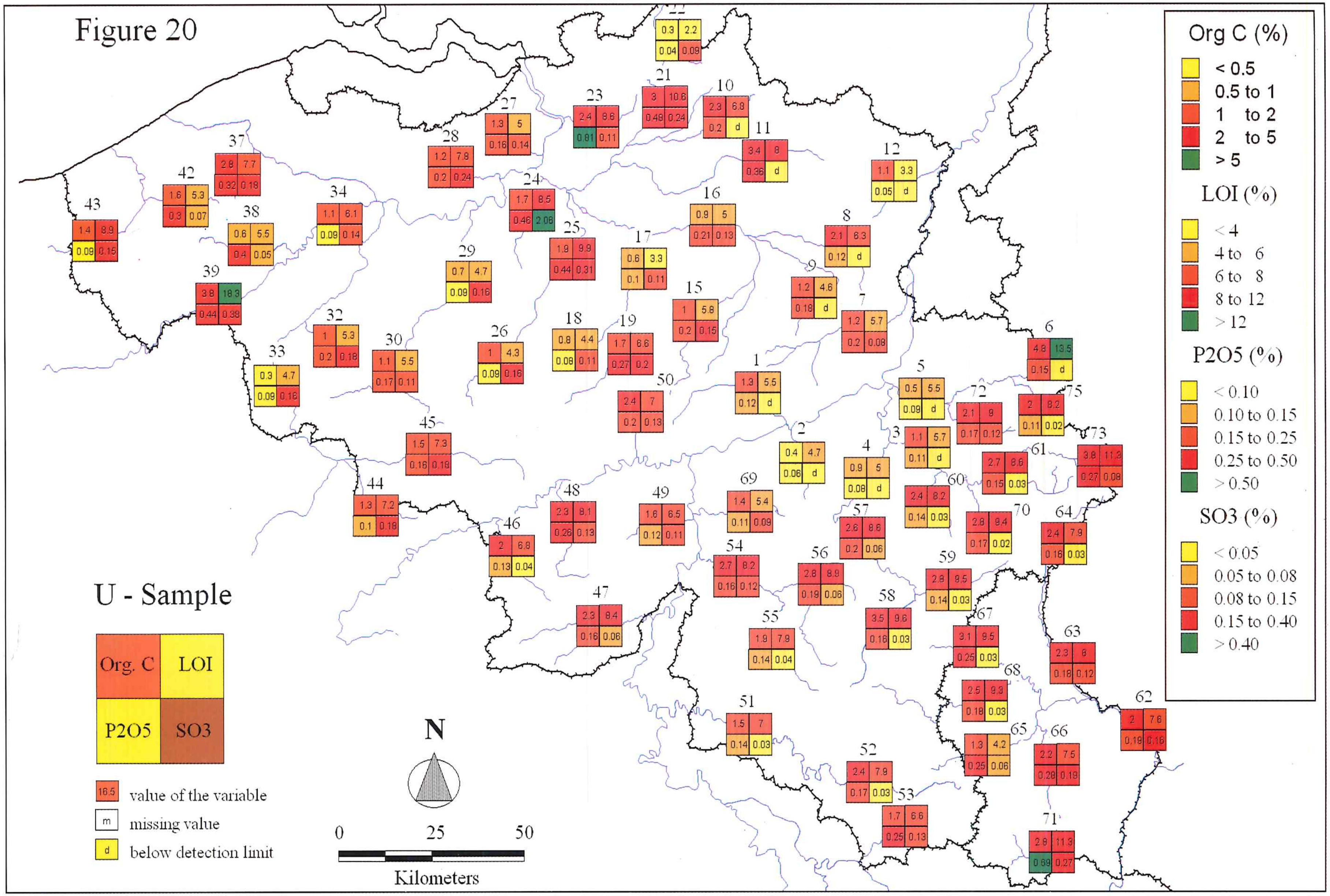


Figure 20
U - Sample
Org. C
LOI
P2O5
SO3
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
Org C (%)
< 0.5
0.5 to 1
1 to 2
2 to 5
> 5
LOI (%)
< 4
4 to 6
6 to 8
8 to 12
> 12
P2O5 (%)
< 0.10
0.10 to 0.15
0.15 to 0.25
0.25 to 0.50
> 0.50
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40
22 0.3 2.2 0.04 0.09
21 3 10.6 0.49 0.24
10 2.3 6.8 0.2 d
11 3.4 8 0.36 d
23 2.4 8.6 0.81 0.11
27 1.3 5 0.16 0.14
28 1.2 7.8 0.2 0.24
37 2.8 7.7 0.32 0.18
42 1.6 5.3 0.3 0.07
43 1.4 8.9 0.09 0.15
38 0.6 5.5 0.4 0.05
34 1.1 6.1 0.09 0.14
24 1.7 8.5 0.46 2.06
16 0.9 5 0.21 0.13
12 1.1 3.3 0.05 d
8 2.1 6.3 0.12 d
25 1.9 9.9 0.44 0.31
17 0.6 3.3 0.1 0.11
29 0.7 4.7 0.09 0.16
39 3.8 18.3 0.44 0.38
9 1.2 4.6 0.18 d
15 1 5.8 0.2 0.15
7 1.2 5.7 0.2 0.08
32 1 5.3 0.2 0.18
18 0.8 4.4 0.08 0.11
19 1.7 6.6 0.27 0.2
26 1 4.3 0.09 0.16
30 1.1 5.5 0.17 0.11
33 0.3 4.7 0.09 0.16
6 4.8 13.5 0.15 d
1 1.3 5.5 0.12 d
5 0.5 5.5 0.09 d
50 2.4 7 0.2 0.13
72 2.1 9 0.17 0.12
75 2 8.2 0.11 0.02
45 1.5 7.3 0.16 0.19
2 0.4 4.7 0.06 d
4 0.9 5 0.08 d
3 1.1 5.7 0.11 d
61 2.7 8.6 0.15 0.03
73 3.8 11.3 0.27 0.08
69 1.4 5.4 0.11 0.09
60 2.4 8.2 0.14 0.03
44 1.3 7.2 0.1 0.18
48 2.3 8.1 0.26 0.13
49 1.6 6.5 0.12 0.11
57 2.6 8.6 0.2 0.06
70 2.8 9.4 0.17 0.02
64 2.4 7.9 0.16 0.03
46 2 6.8 0.13 0.04
54 2.7 8.2 0.16 0.12
56 2.8 8.9 0.19 0.06
59 2.8 8.5 0.14 0.03
58 3.5 9.6 0.16 0.03
47 2.3 8.4 0.16 0.06
55 1.9 7.9 0.14 0.04
67 3.1 9.5 0.25 0.03
63 2.3 8 0.18 0.12
68 2.5 9.3 0.18 0.03
51 1.5 7 0.14 0.03
65 1.3 4.2 0.25 0.06
66 2.2 7.5 0.28 0.19
62 2 7.6 0.19 0.16
52 2.4 7.9 0.17 0.03
53 1.7 6.6 0.25 0.13
71 2.8 11.3 0.69 0.27

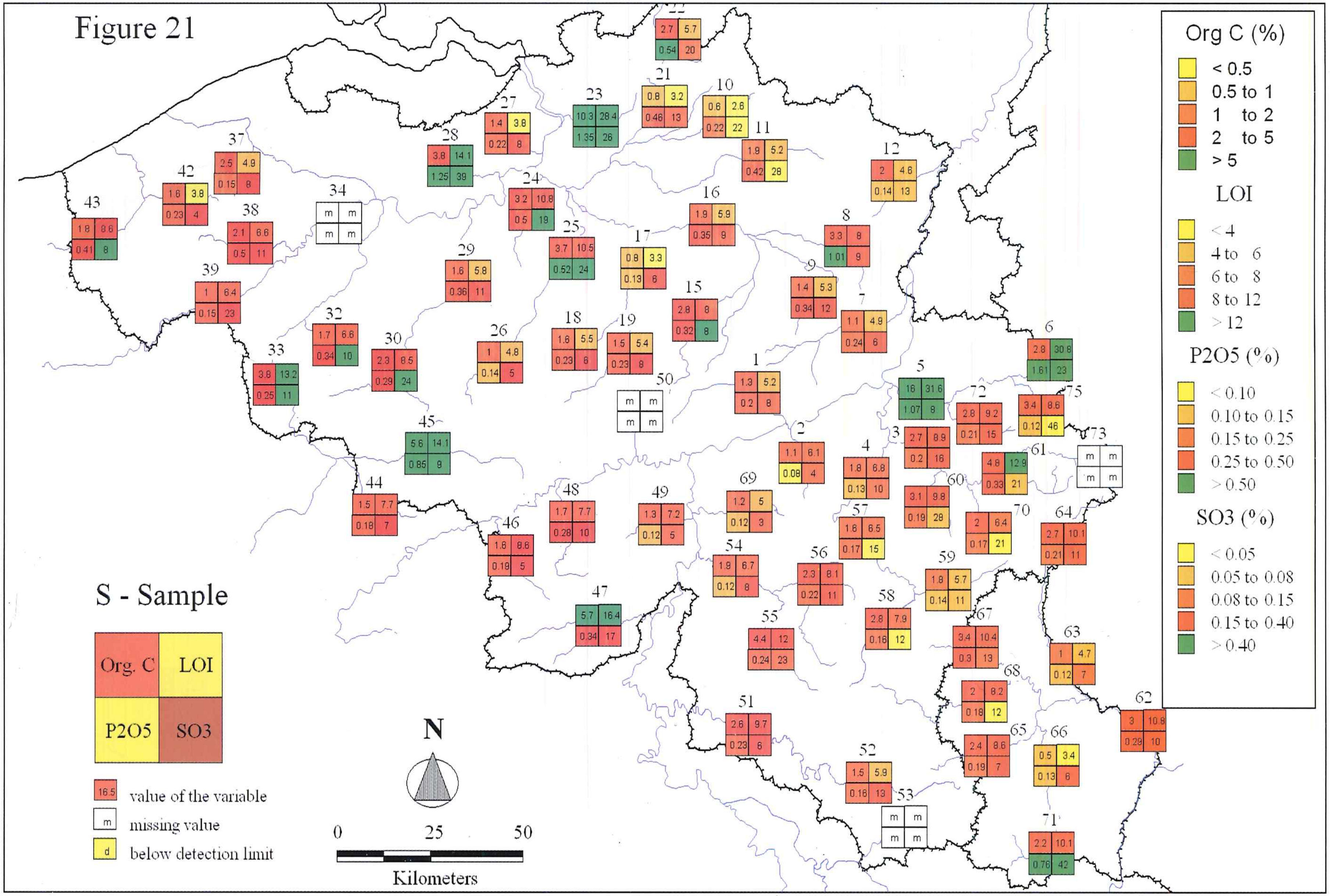


Figure 21
Org C (%)
< 0.5
0.5 to 1
1 to 2
2 to 5
> 5
LOI
< 4
4 to 6
6 to 8
8 to 12
> 12
P2O5 (%)
< 0.10
0.10 to 0.15
0.15 to 0.25
0.25 to 0.50
> 0.50
SO3 (%)
< 0.05
0.05 to 0.08
0.08 to 0.15
0.15 to 0.40
> 0.40
S - Sample
Org. C
LOI
P2O5
SO3
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers

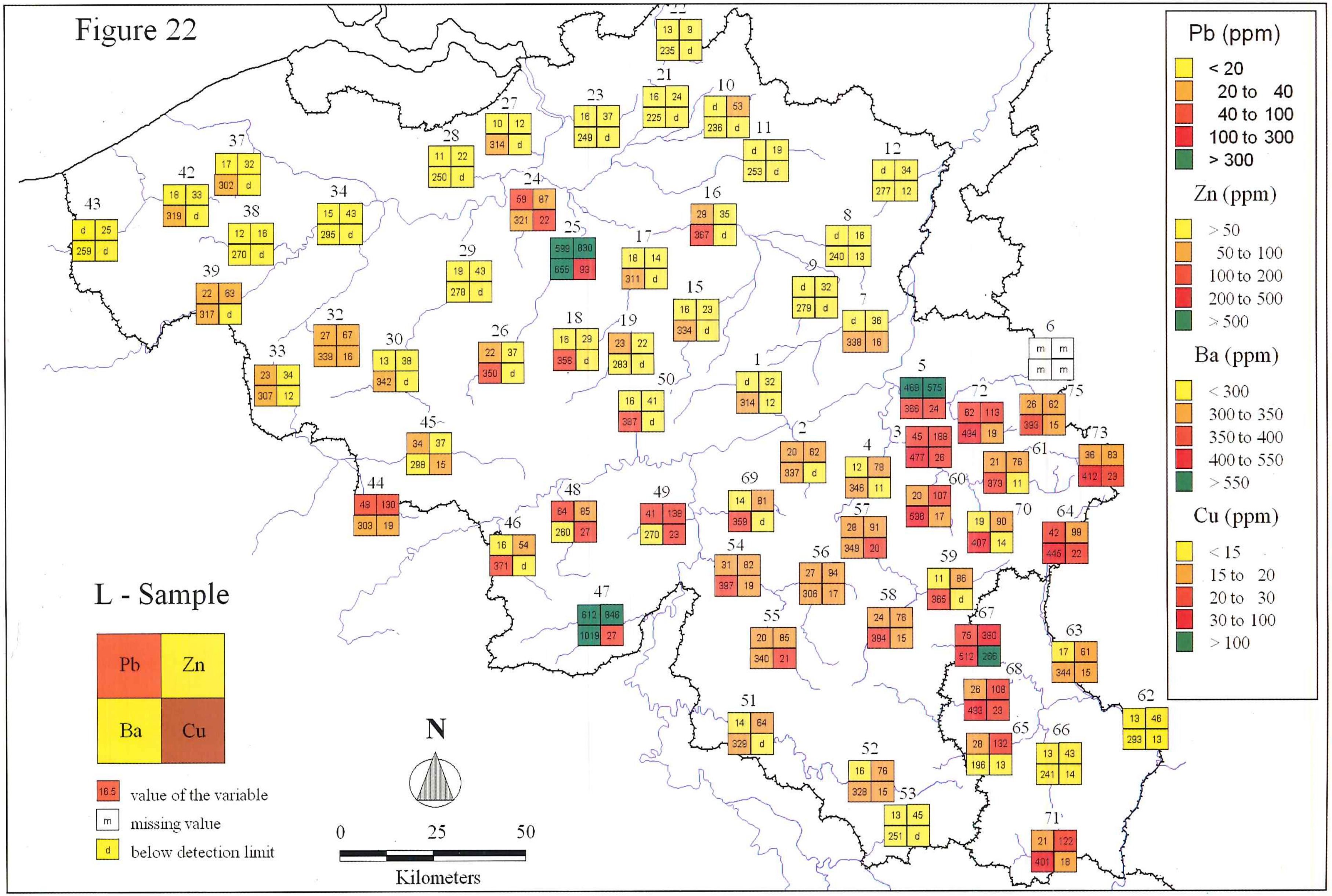


Figure 22
L - Sample
Pb | Zn
Ba | Cu
16.5 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers
Pb (ppm)
< 20
20 to 40
40 to 100
100 to 300
> 300
Zn (ppm)
> 50
50 to 100
100 to 200
200 to 500
> 500
Ba (ppm)
< 300
300 to 350
350 to 400
400 to 550
> 550
Cu (ppm)
< 15
15 to 20
20 to 30
30 to 100
> 100
13 9 235 d
21: 16 24 225 d
23: 16 37 249 d
27: 10 12 314 d
28: 11 22 250 d
10: d 53 236 d
11: d 19 253 d
12: d 34 277 12
37: 17 32 302 d
42: 18 33 319 d
43: d 25 259 d
38: 12 16 270 d
34: 15 43 295 d
24: 59 87 321 22
16: 29 35 367 d
8: d 16 240 13
25: 599 830 655 93
17: 18 14 311 d
29: 19 43 278 d
39: 22 63 317 d
9: d 32 279 d
15: 16 23 334 d
7: d 36 338 16
6: m m m m
32: 27 67 339 16
18: 16 29 358 d
19: 23 22 283 d
26: 22 37 350 d
30: 13 38 342 d
33: 23 34 307 12
1: d 32 314 12
50: 16 41 387 d
5: 469 575 386 24
72: 62 113 494 19
75: 26 62 393 15
45: 34 37 298 15
2: 20 62 337 d
4: 12 78 346 11
3: 45 188 477 26
61: 21 76 373 11
73: 36 83 412 23
60: 20 107 536 17
44: 48 130 303 19
48: 64 85 260 27
49: 41 138 270 23
69: 14 81 359 d
57: 28 91 349 20
70: 19 90 407 14
64: 42 99 445 22
46: 16 54 371 d
54: 31 82 397 19
56: 27 94 306 17
59: 11 86 365 d
47: 612 846 1019 27
58: 24 76 394 15
55: 20 85 340 21
67: 75 380 512 266
63: 17 61 344 15
68: 26 108 493 23
62: 13 46 293 13
51: 14 64 329 d
65: 28 132 196 13
66: 13 43 241 14
52: 16 76 328 15
53: 13 45 251 d
71: 21 122 401 18

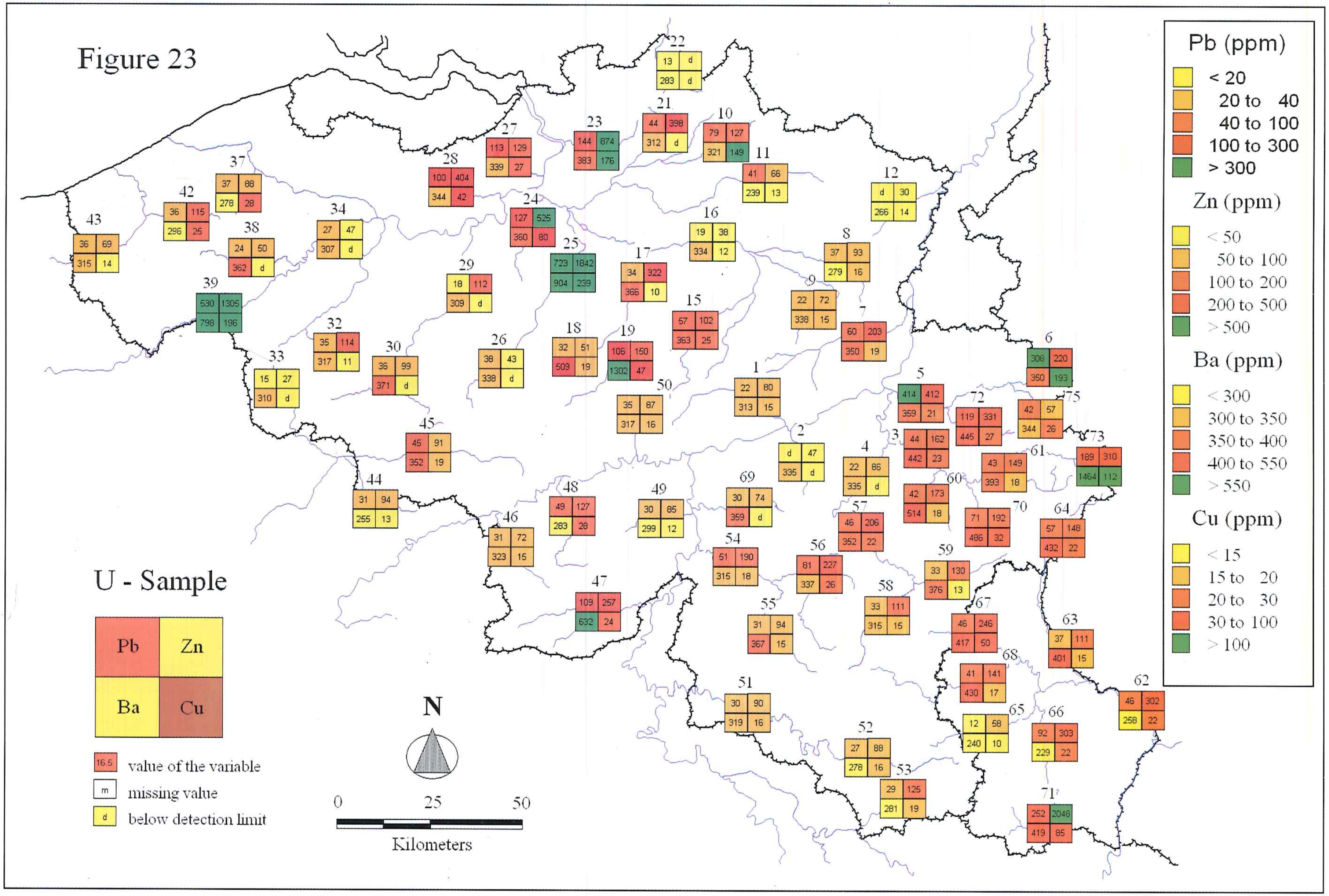


Figure 23
Pb (ppm)
< 20
20 to 40
40 to 100
100 to 300
> 300
Zn (ppm)
< 50
50 to 100
100 to 200
200 to 500
> 500
Ba (ppm)
< 300
300 to 350
350 to 400
400 to 550
> 550
Cu (ppm)
< 15
15 to 20
20 to 30
30 to 100
> 100
U - Sample
Pb
Zn
Ba
Cu
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
22: 13 d 283 d
21: 44 398 312 d
23: 144 874 383 176
27: 113 129 339 27
28: 100 404 344 42
10: 79 127 321 149
11: 41 66 239 13
12: d 30 266 14
16: 19 38 334 12
8: 37 93 279 16
24: 127 525 360 80
25: 723 1842 904 239
17: 34 322 366 10
37: 37 88 278 28
42: 36 115 296 25
43: 36 69 315 14
38: 24 50 362 d
34: 27 47 307 d
29: 18 112 309 d
39: 530 1305 798 196
9: 22 72 338 15
15: 57 102 363 25
7: 60 203 350 19
18: 32 51 509 19
19: 106 150 1302 47
26: 38 43 338 d
32: 35 114 317 11
30: 36 99 371 d
33: 15 27 310 d
6: 306 220 350 193
1: 22 80 313 15
50: 35 87 317 16
5: 414 412 359 21
72: 119 331 445 27
75: 42 57 344 26
45: 45 91 352 19
2: d 47 335 d
3: 44 162 442 23
4: 22 86 335 d
73: 189 310 1464 112
61: 43 149 393 18
44: 31 94 255 13
48: 49 127 283 28
49: 30 85 299 12
69: 30 74 359 d
60: 42 173 514 18
57: 46 206 352 22
70: 71 192 486 32
64: 57 148 432 22
46: 31 72 323 15
54: 51 190 315 18
56: 81 227 337 26
59: 33 130 376 13
47: 109 257 632 24
58: 33 111 315 15
55: 31 94 367 15
67: 46 246 417 50
63: 37 111 401 15
68: 41 141 430 17
51: 30 90 319 16
62: 46 302 258 22
65: 12 58 240 10
66: 92 303 229 22
52: 27 88 278 16
53: 29 125 281 19
71: 252 2046 419 85

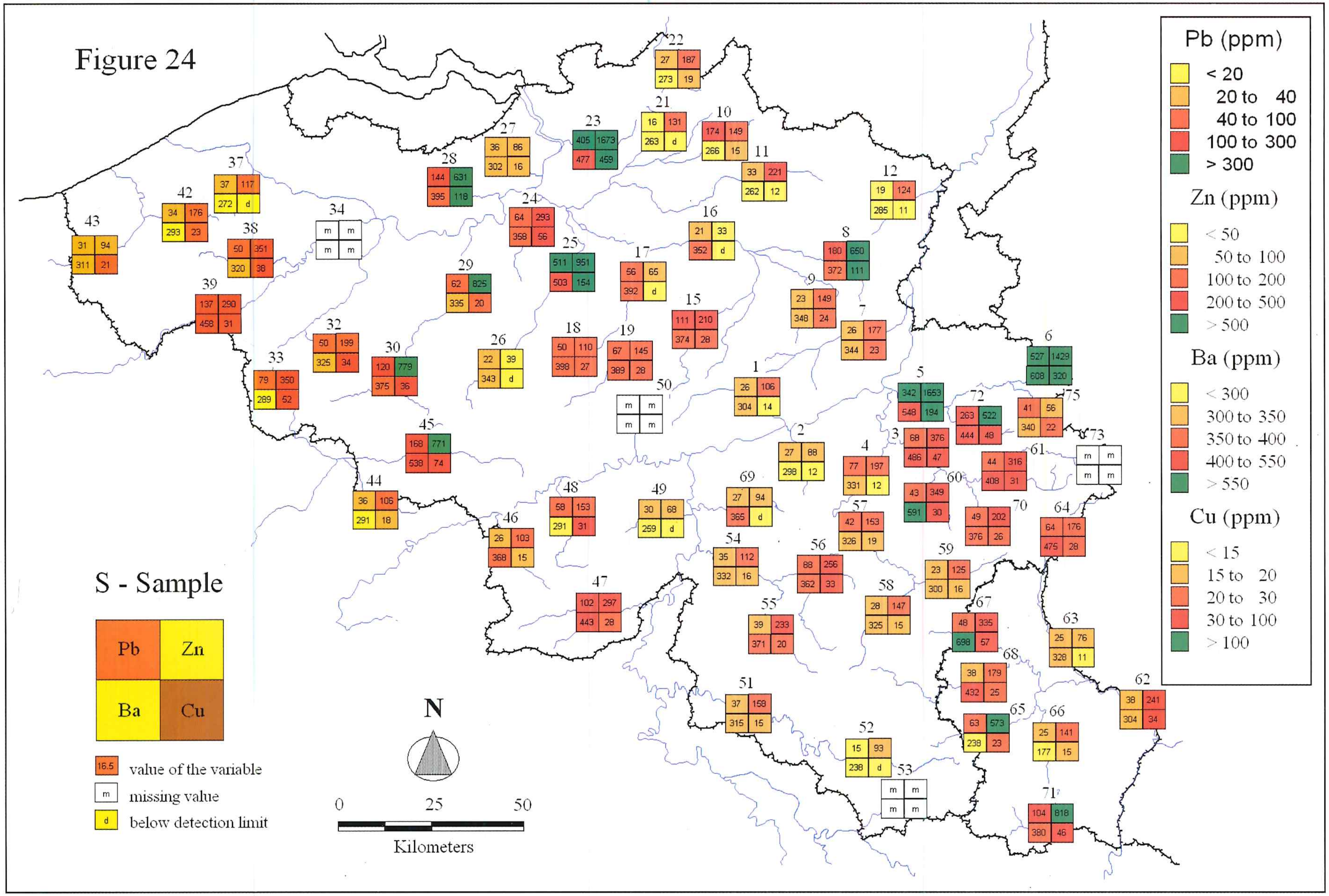

Pb (ppm)
< 20
20 to 40
40 to 100
100 to 300
> 300
Zn (ppm)
< 50
50 to 100
100 to 200
200 to 500
> 500
Ba (ppm)
< 300
300 to 350
350 to 400
400 to 550
> 550
Cu (ppm)
< 15
15 to 20
20 to 30
30 to 100
> 100
S - Sample
Pb
Zn
Ba
Cu
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

Figure 24

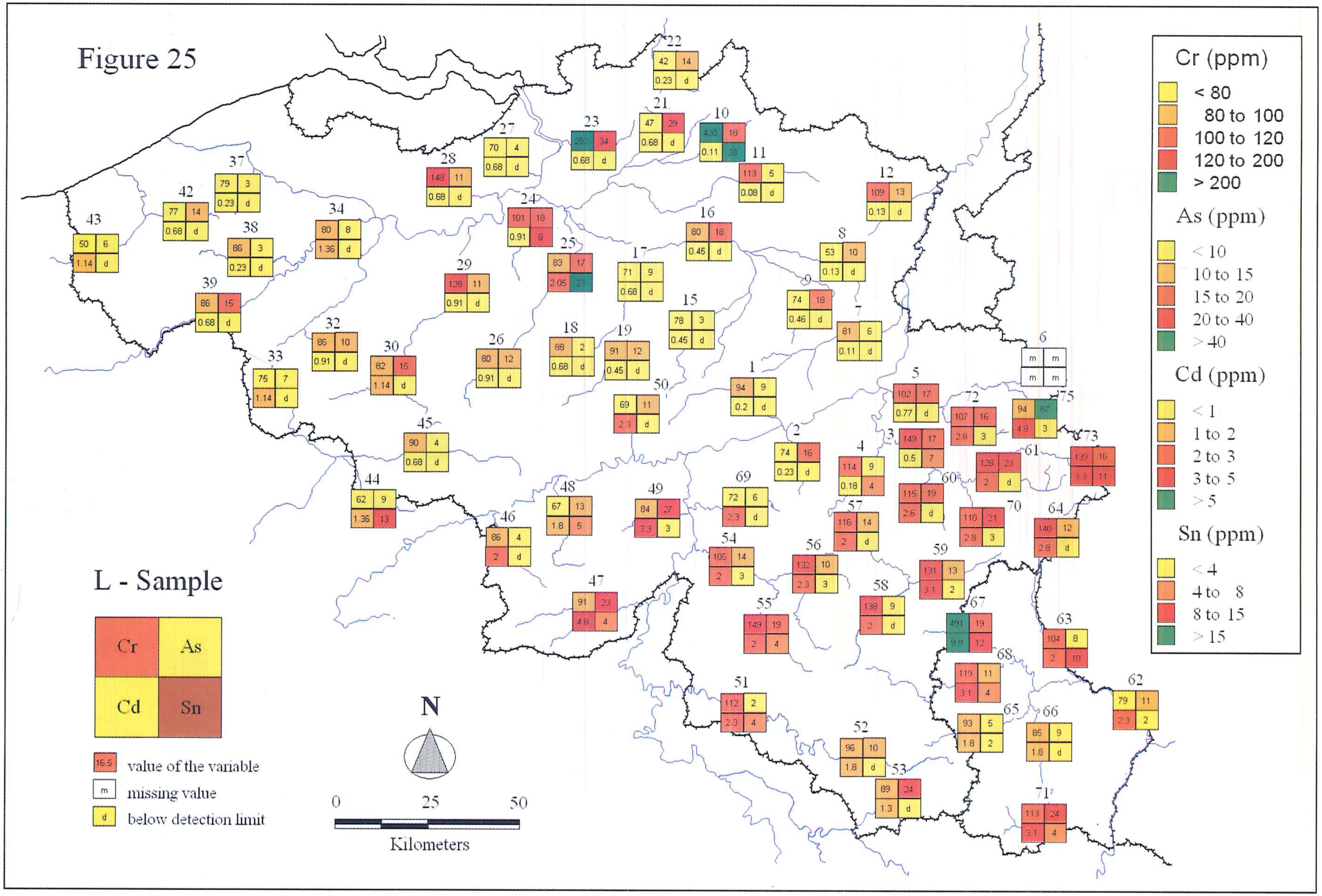

Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
As (ppm)
< 10
10 to 15
15 to 20
20 to 40
> 40
Cd (ppm)
< 1
1 to 2
2 to 3
3 to 5
> 5
Sn (ppm)
< 4
4 to 8
8 to 15
> 15
L - Sample
Cr
As
Cd
Sn
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

Figure 25

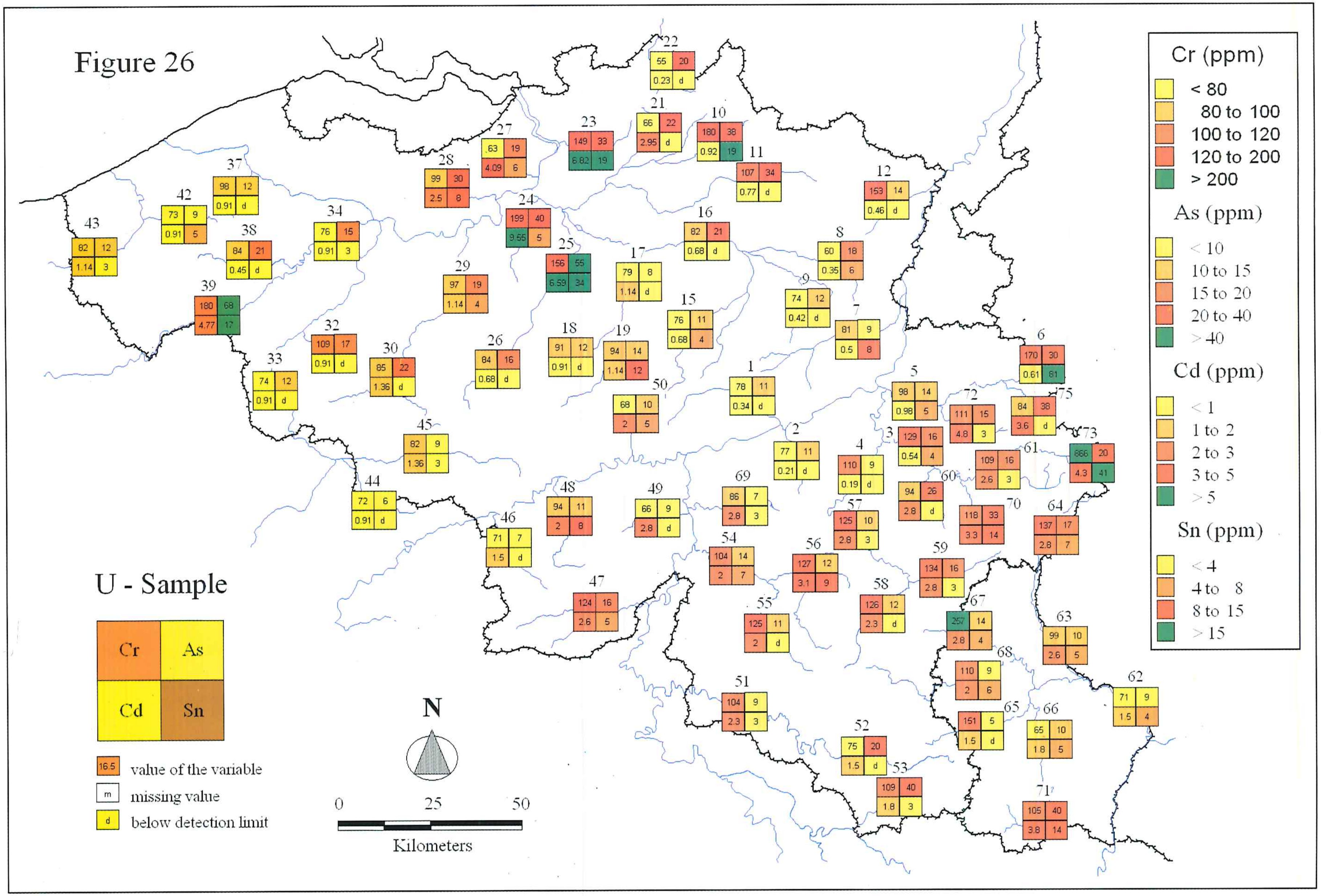


Figure 26
U - Sample
Cr
As
Cd
Sn
16.5 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers
Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
As (ppm)
< 10
10 to 15
15 to 20
20 to 40
> 40
Cd (ppm)
< 1
1 to 2
2 to 3
3 to 5
> 5
Sn (ppm)
< 4
4 to 8
8 to 15
> 15

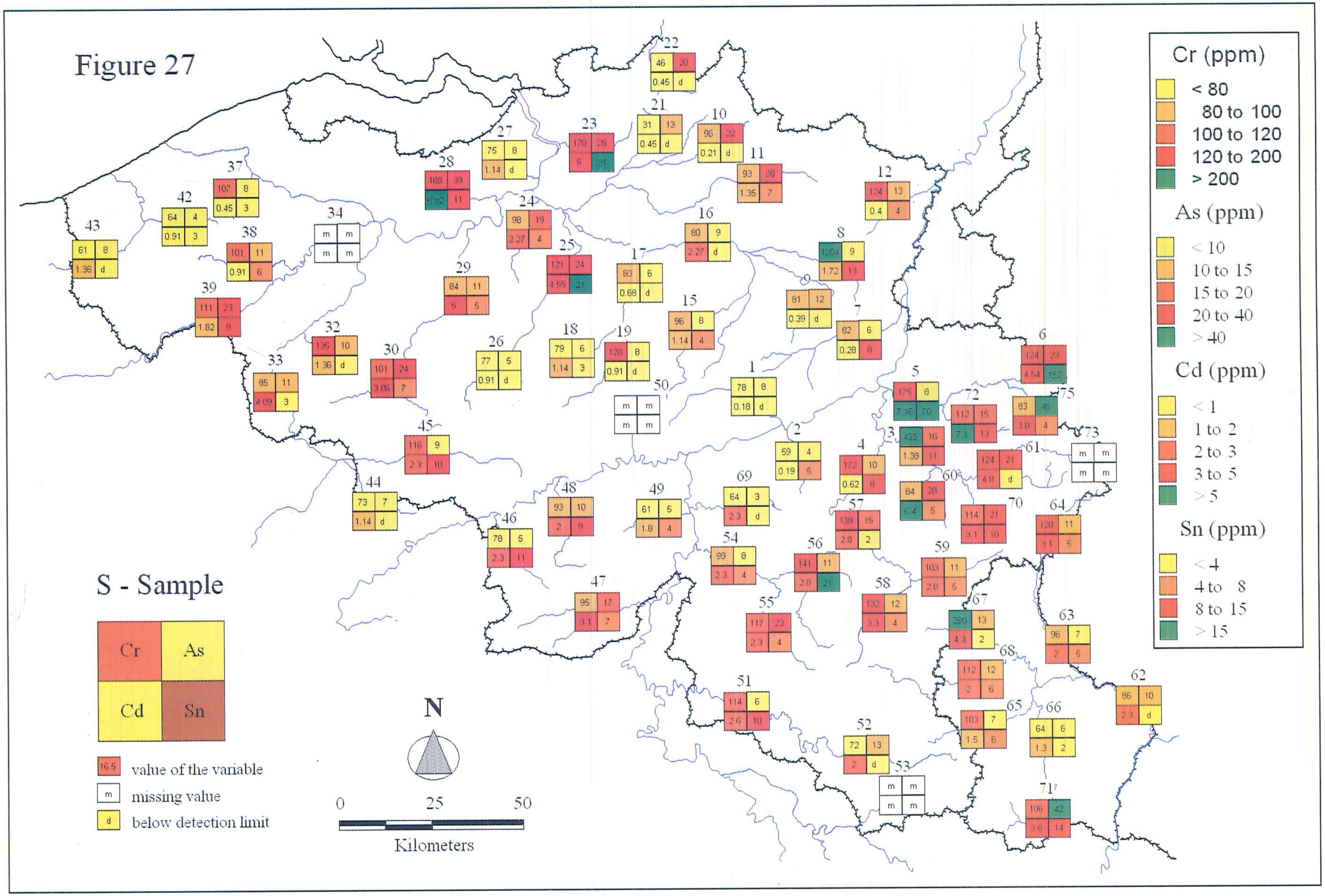

Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
As (ppm)
< 10
10 to 15
15 to 20
20 to 40
> 40
Cd (ppm)
< 1
1 to 2
2 to 3
3 to 5
> 5
Sn (ppm)
< 4
4 to 8
8 to 15
> 15
S - Sample
Cr
As
Cd
Sn
16.5
value of the variable
m
missing value
d
below detection limit
N
0
25
50
Kilometers

Figure 27

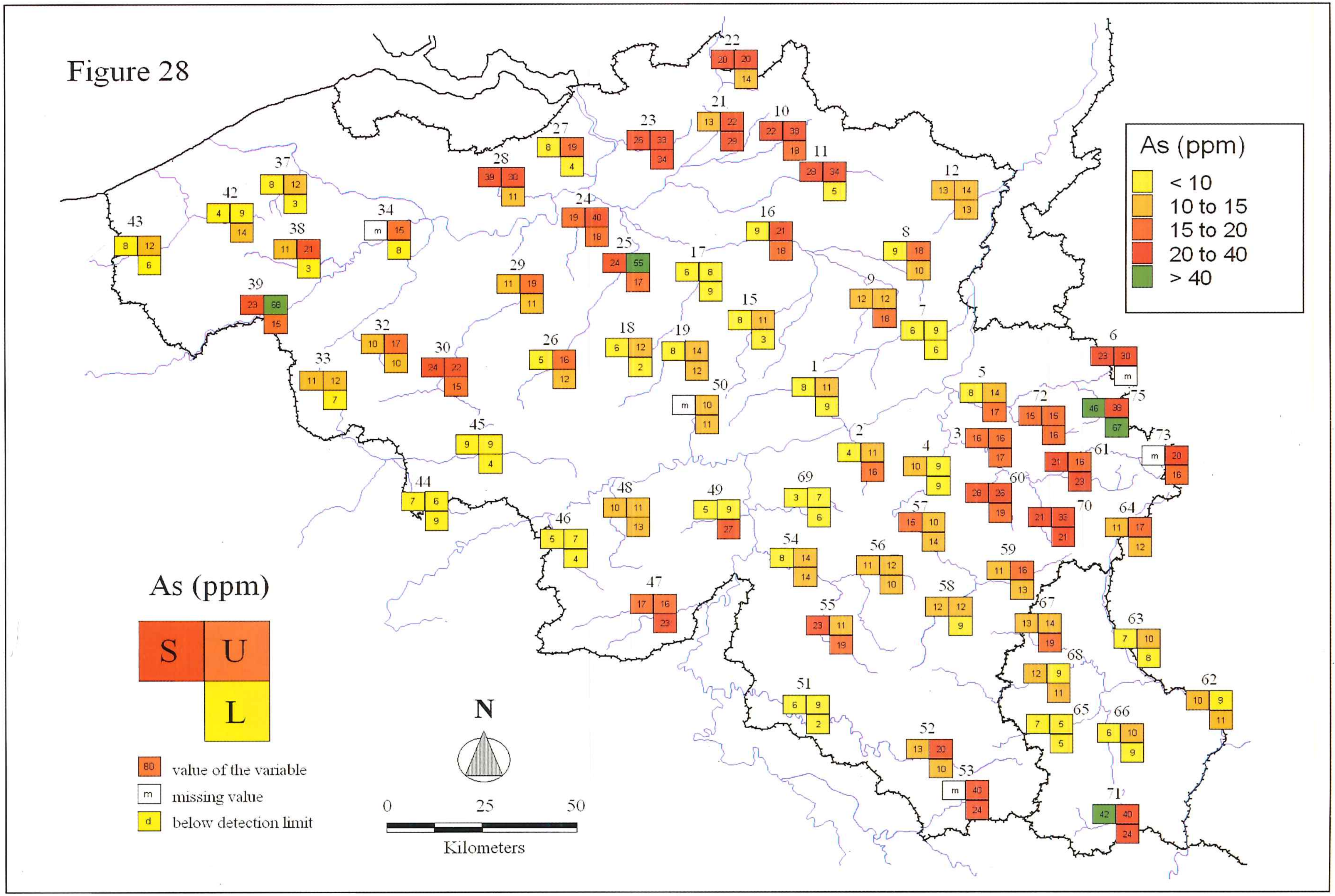
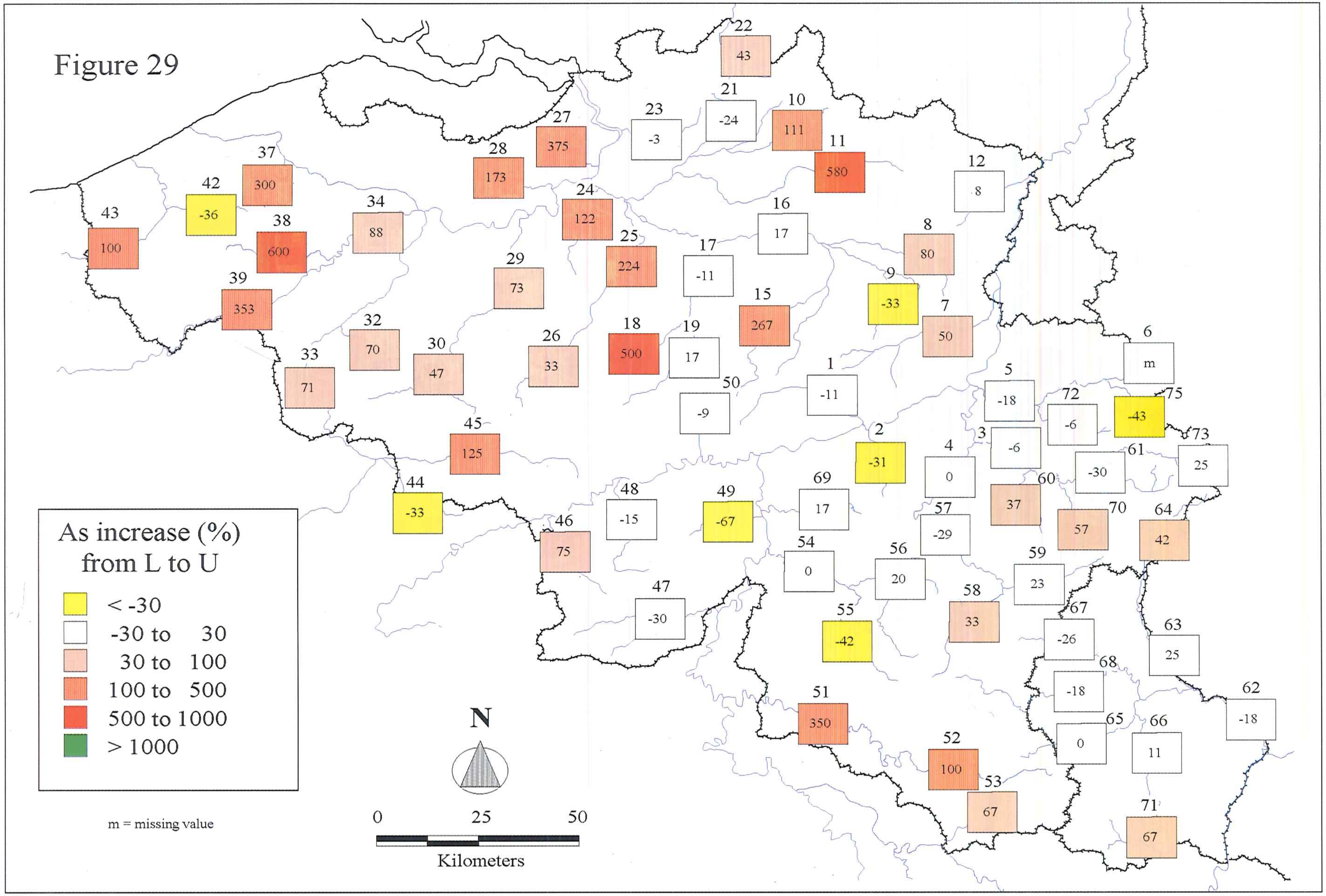

As (ppm)
< 10
10 to 15
15 to 20
20 to 40
> 40
As (ppm)
S
U
L
80 value of the variable
m missing value
d below detection limit
N
0
25
50
Kilometers

Figure 28

Figure 29


As increase (%) from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

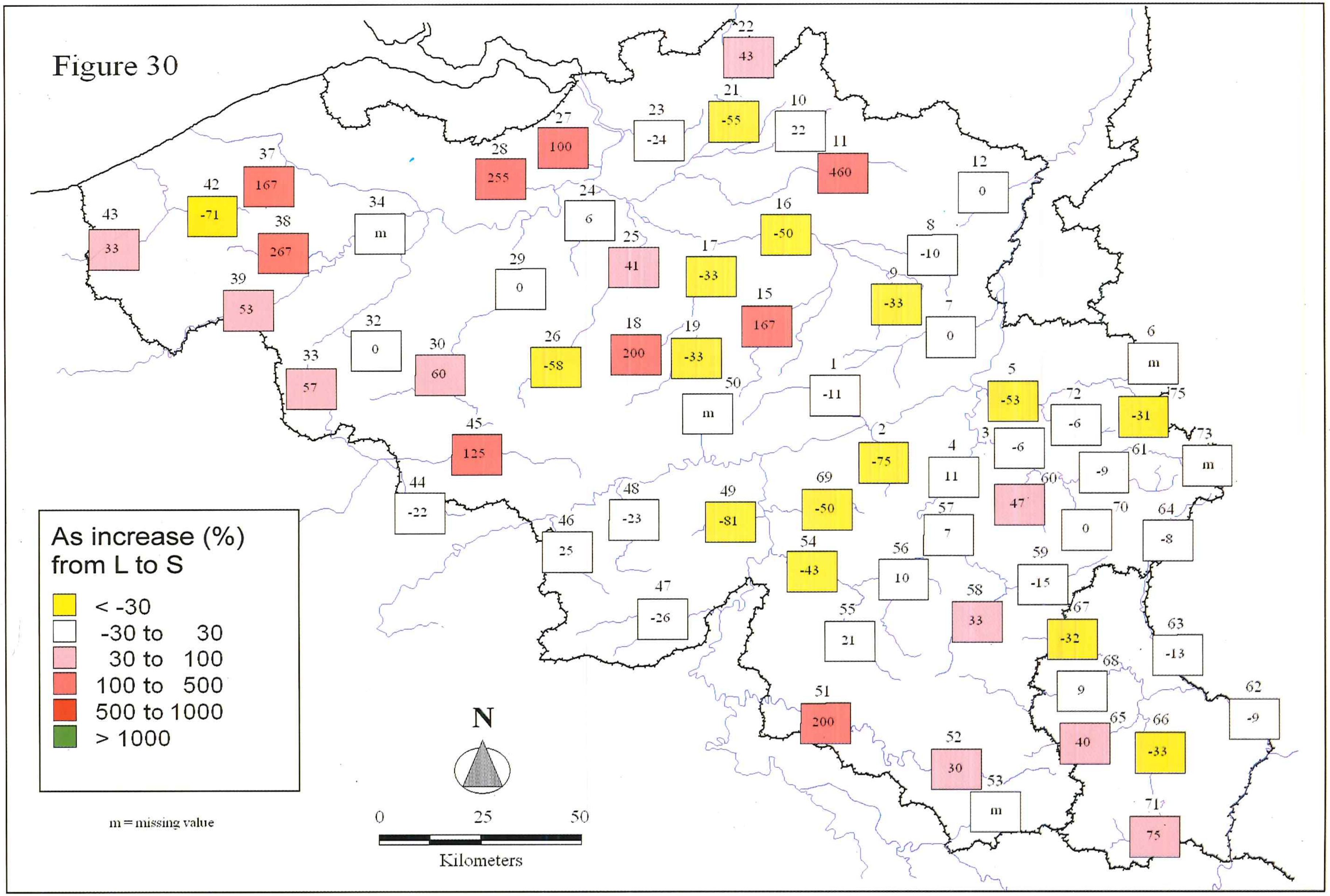

As increase (%)
from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 30

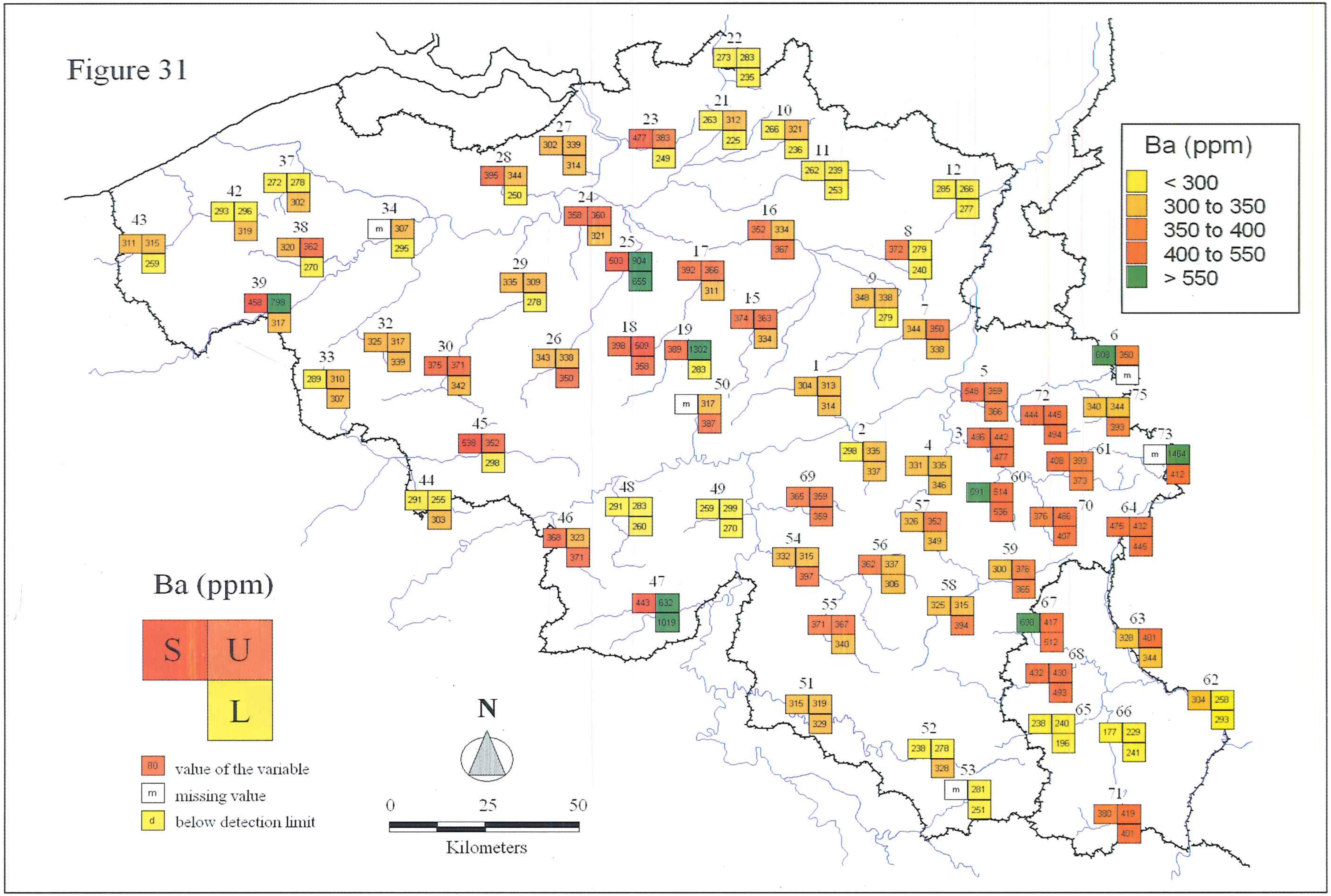
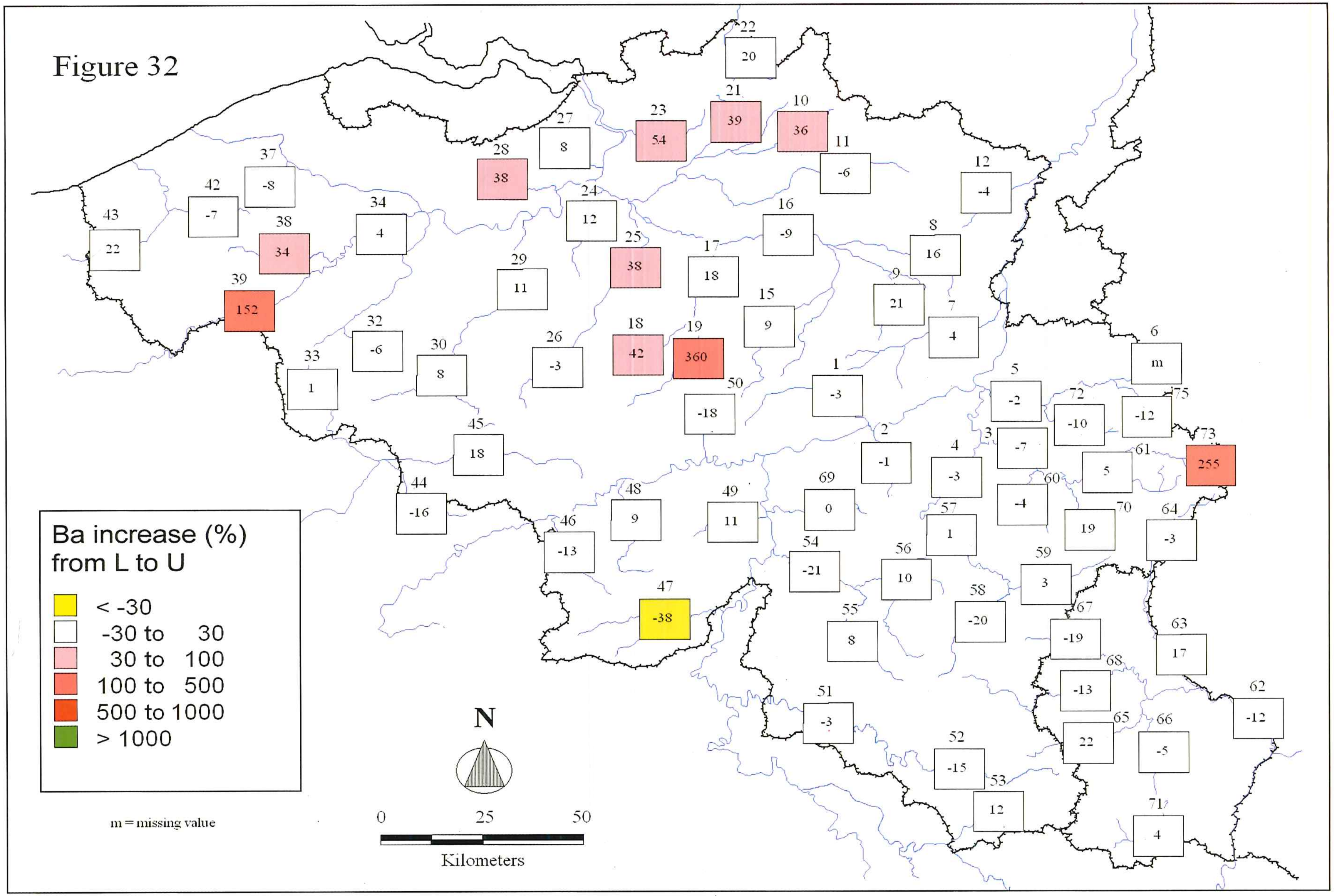

Ba (ppm)
< 300
300 to 350
350 to 400
400 to 550
> 550
Ba (ppm)
S
U
L
value of the variable
m
missing value
d
below detection limit
N
0
25
50
Kilometers

Figure 31

Figure 32



Ba increase (%) from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 33

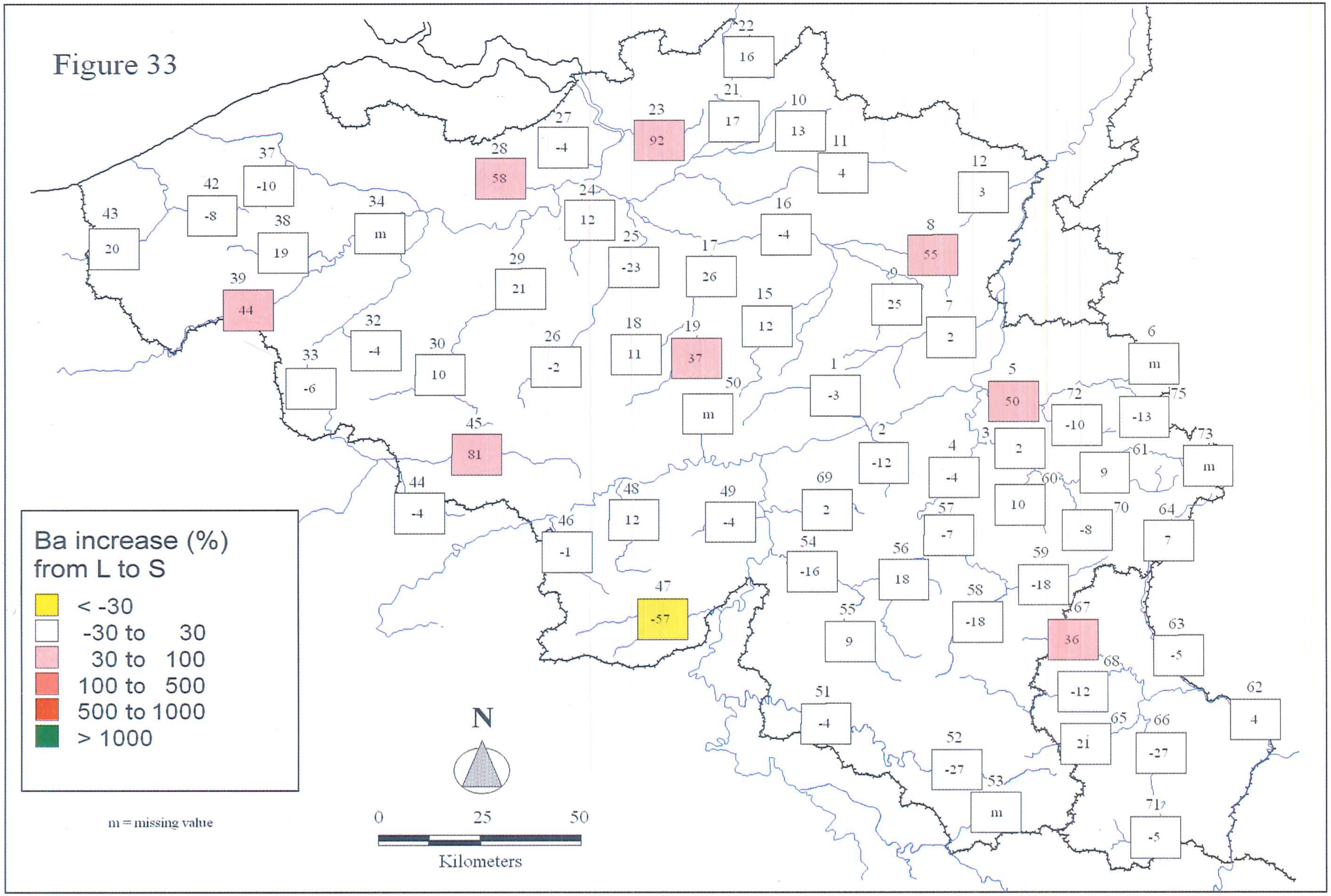
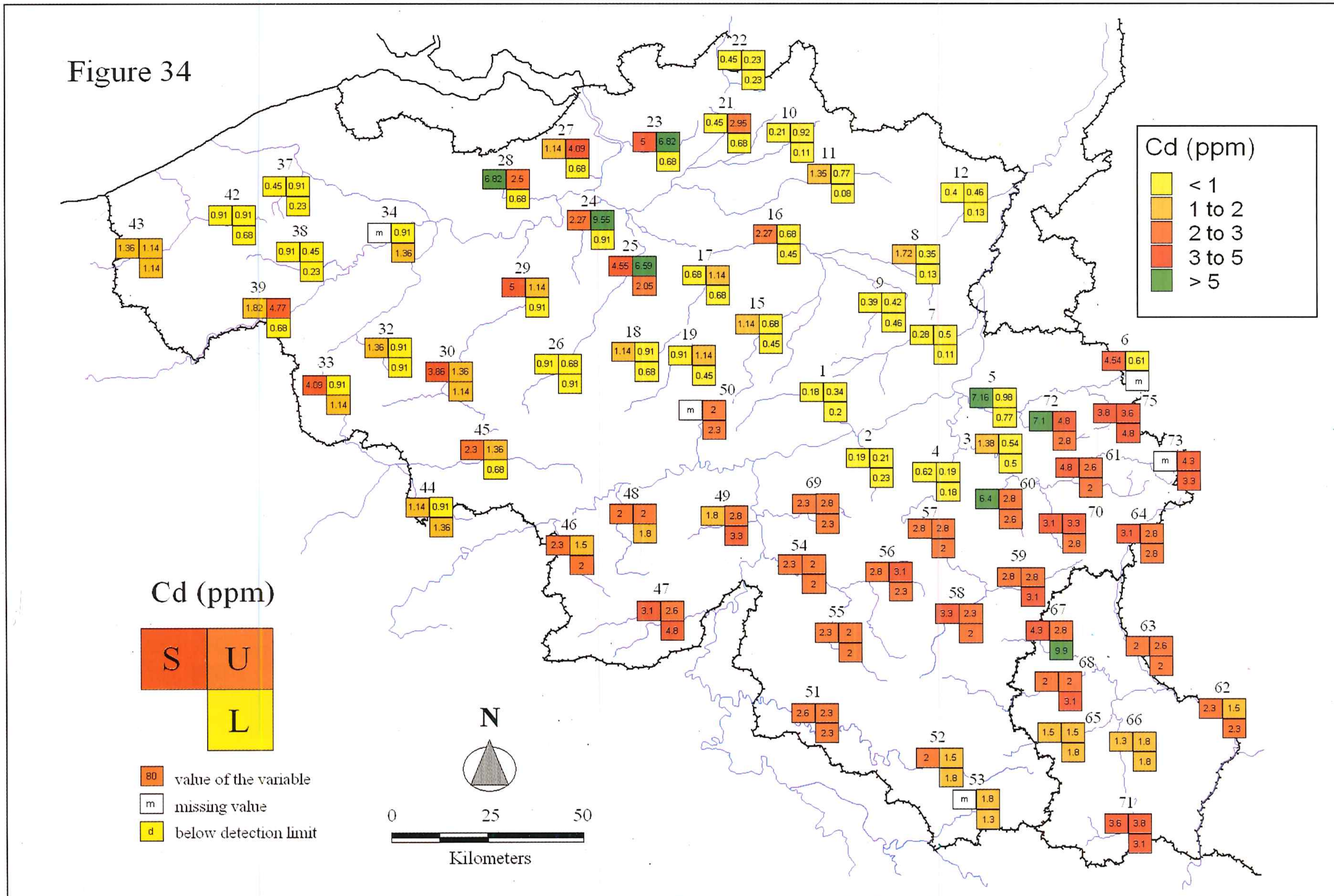

Ba increase (%)
from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

Figure 34


Cd (ppm)
< 1
1 to 2
2 to 3
3 to 5
> 5
Cd (ppm)
S
U
L
80
value of the variable
m
missing value
d
below detection limit
N
0
25
50
Kilometers

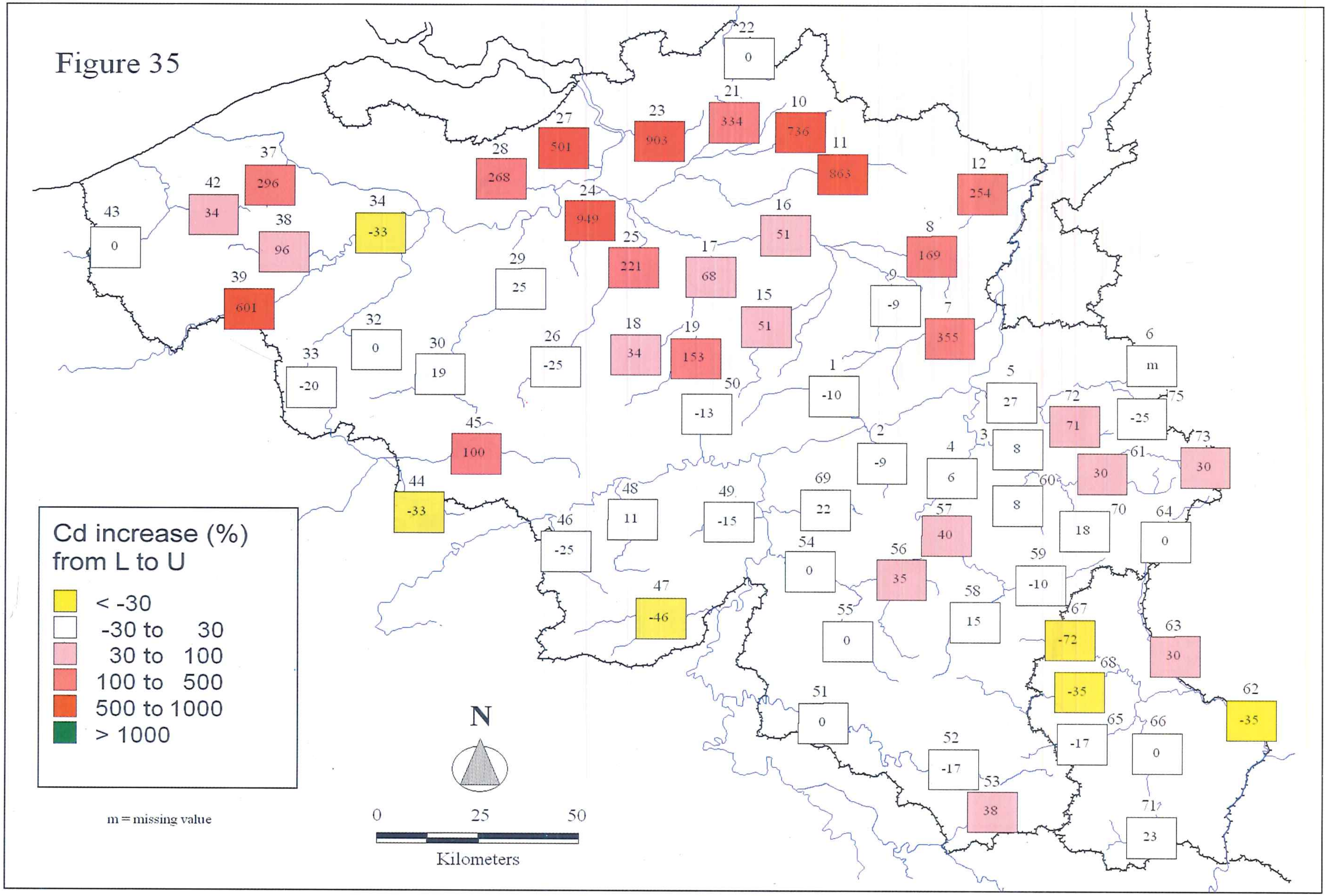

Cd increase (%)
from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers
22 0
21 334
10 736
11 863
23 903
27 501
28 268
24 949
25 221
17 68
16 51
12 254
8 169
9 -9
7 355
15 51
19 153
18 34
26 -25
29 25
37 296
42 34
43 0
38 96
34 -33
39 601
32 0
30 19
33 -20
45 100
44 -33
50 -13
1 -10
6 m
5 27
72 71
75 -25
73 30
3 8
61 30
2 -9
4 6
60 8
70 18
64 0
69 22
57 40
48 11
49 -15
46 -25
54 0
56 35
59 -10
47 -46
58 15
55 0
67 -72
63 30
68 -35
62 -35
51 0
65 -17
66 0
52 -17
53 38
71 23

Figure 35

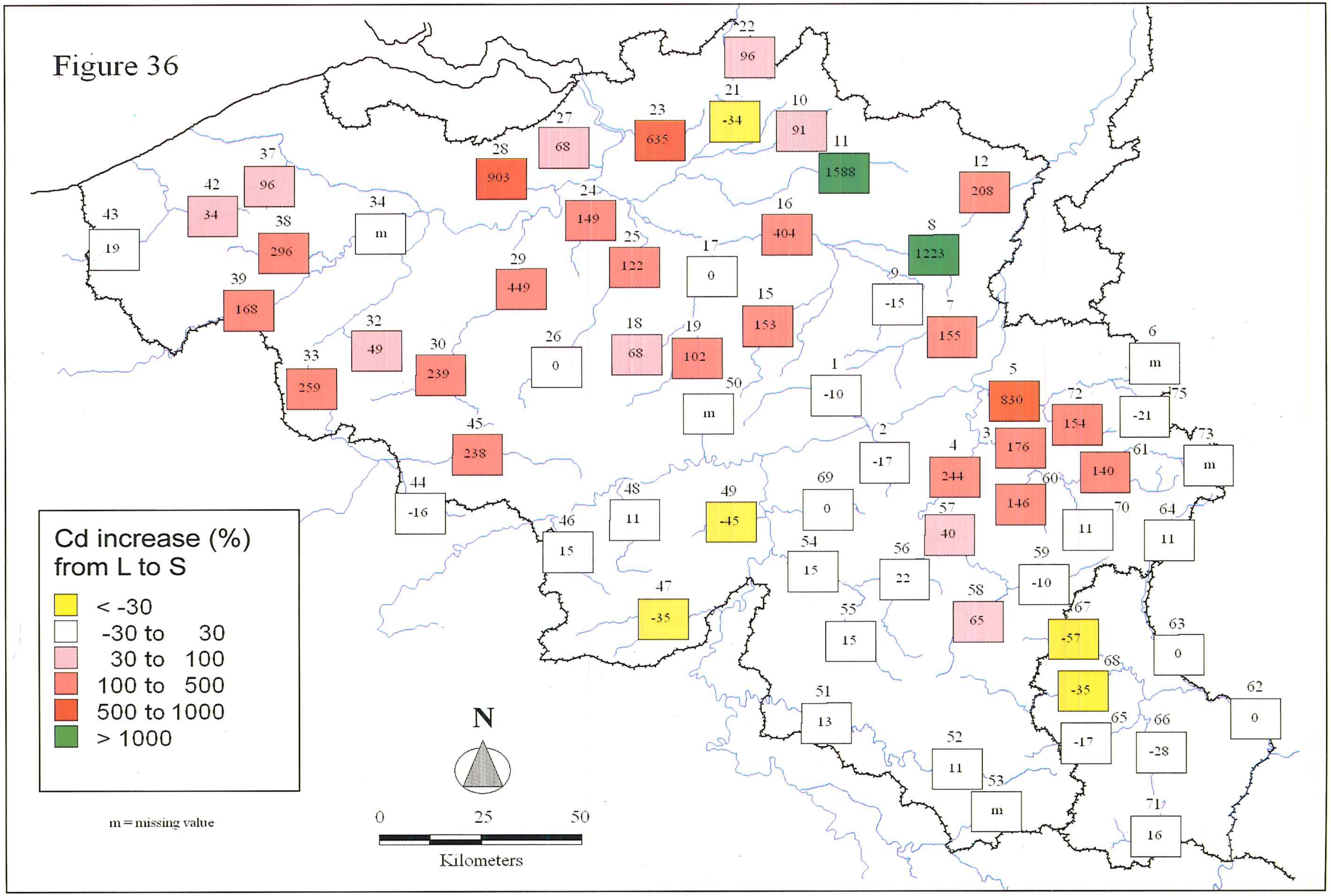

Cd increase (%)
from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 36

Figure 37

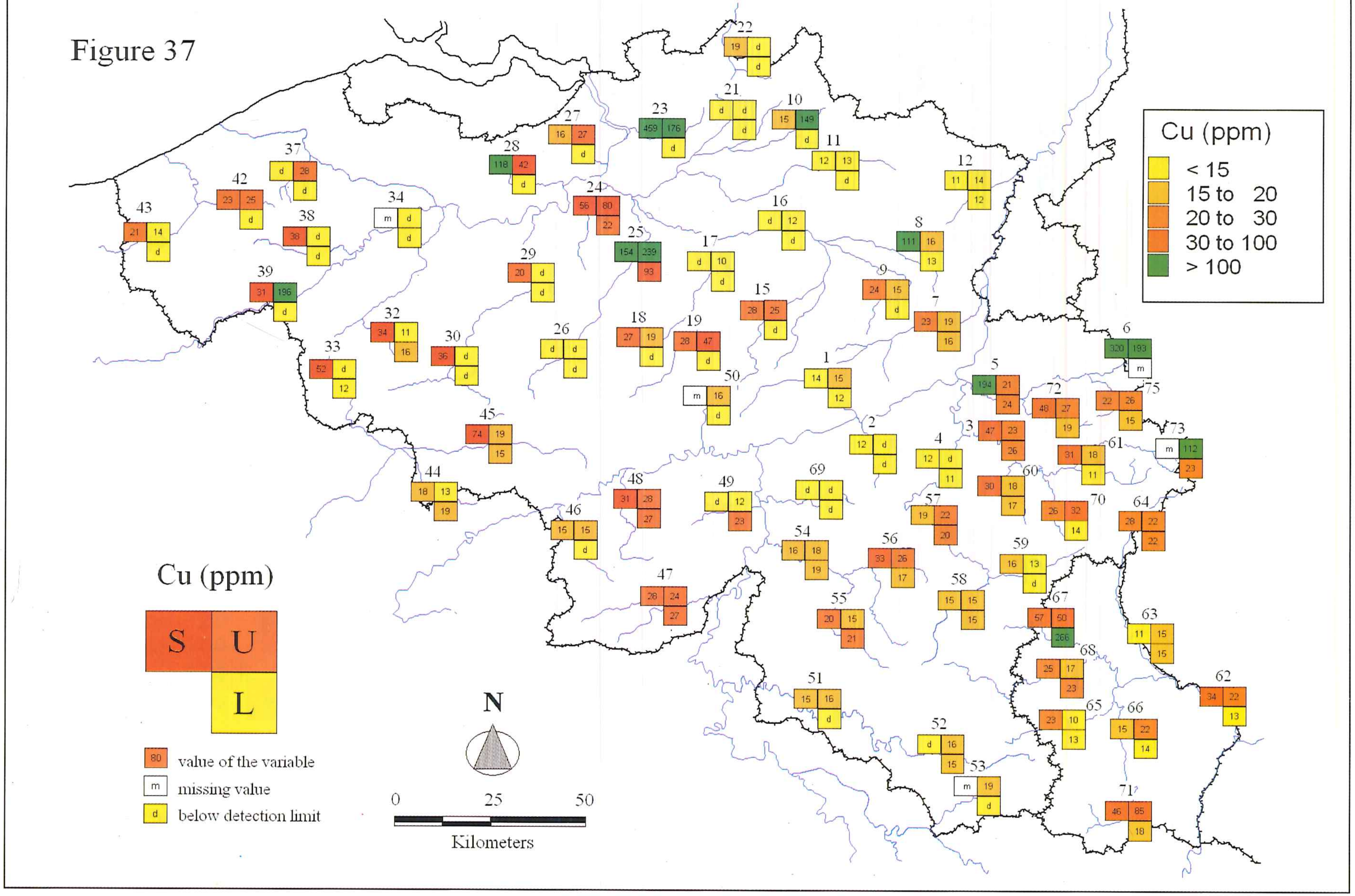
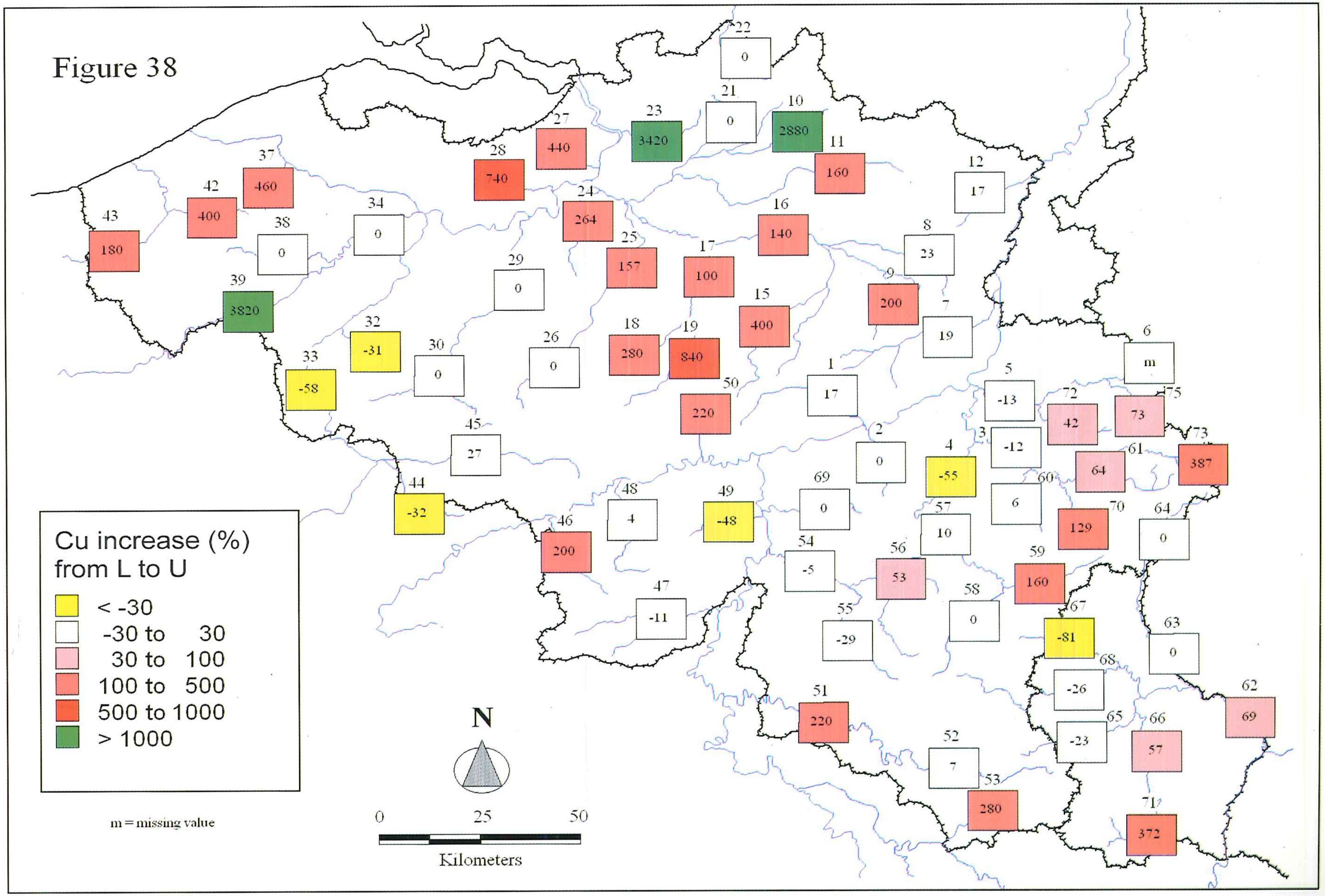

Cu (ppm)
< 15
15 to 20
20 to 30
30 to 100
> 100
Cu (ppm)
S
U
L
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers

Figure 38


Cu increase (%) from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

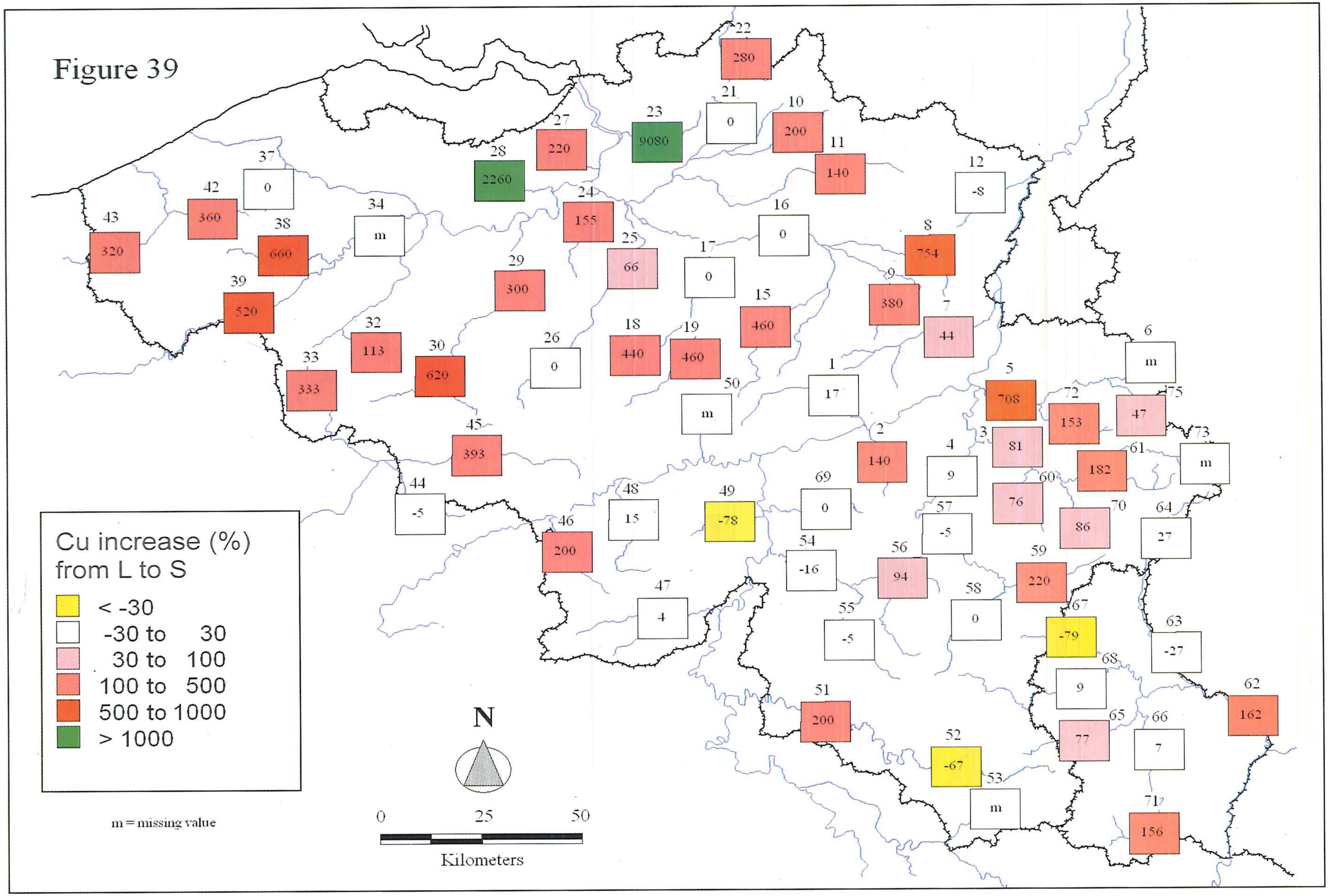

Cu increase (%) from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 39

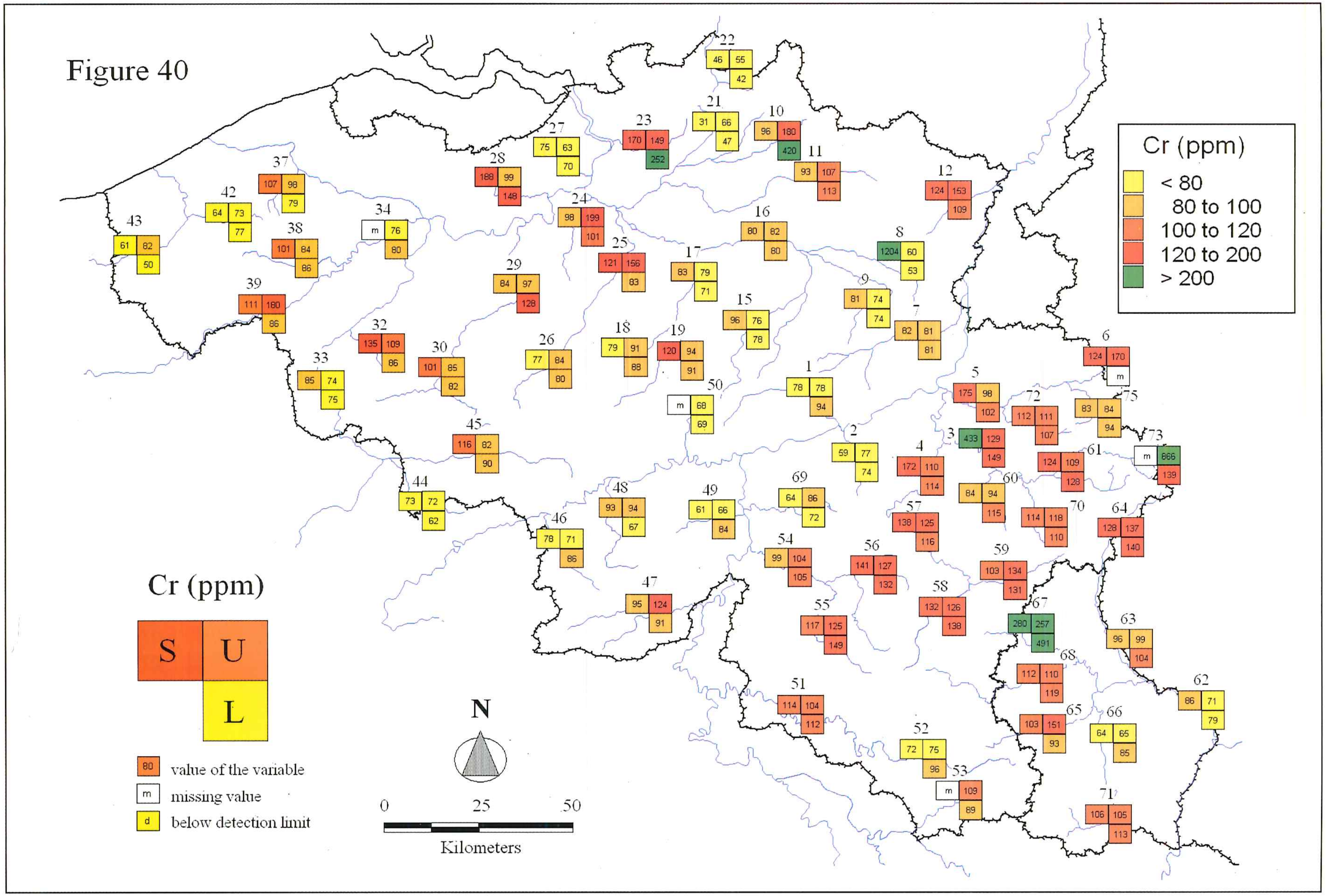


Figure 40
Cr (ppm)
< 80
80 to 100
100 to 120
120 to 200
> 200
Cr (ppm)
S U L
value of the variable
missing value
below detection limit
N
0 25 50
Kilometers
22 46 55 42
21 31 66 47
10 96 180 420
23 170 149 252
27 75 63 70
28 188 99 148
37 107 98 79
42 64 73 77
43 61 82 50
38 101 84 86
34 m 76 80
11 93 107 113
12 124 153 109
24 98 199 101
16 80 82 80
8 1204 60 53
25 121 156 83
17 83 79 71
29 84 97 128
39 111 180 86
9 81 74 74
15 96 76 78
7 82 81 81
32 135 109 86
33 85 74 75
30 101 85 82
26 77 84 80
18 79 91 88
19 120 94 91
50 m 68 69
1 78 78 94
6 124 170 m
5 175 98 102
72 112 111 107
75 83 84 94
45 116 82 90
3 433 129 149
2 59 77 74
4 172 110 114
73 m 866 139
61 124 109 128
60 84 94 115
69 64 86 72
44 73 72 62
48 93 94 67
49 61 66 84
46 78 71 86
57 138 125 116
70 114 118 110
64 128 137 140
54 99 104 105
56 141 127 132
59 103 134 131
47 95 124 91
58 132 126 138
55 117 125 149
67 280 257 491
63 96 99 104
68 112 110 119
51 114 104 112
62 86 71 79
65 103 151 93
66 64 65 85
52 72 75 96
53 m 109 89
71 106 105 113

Figure 41

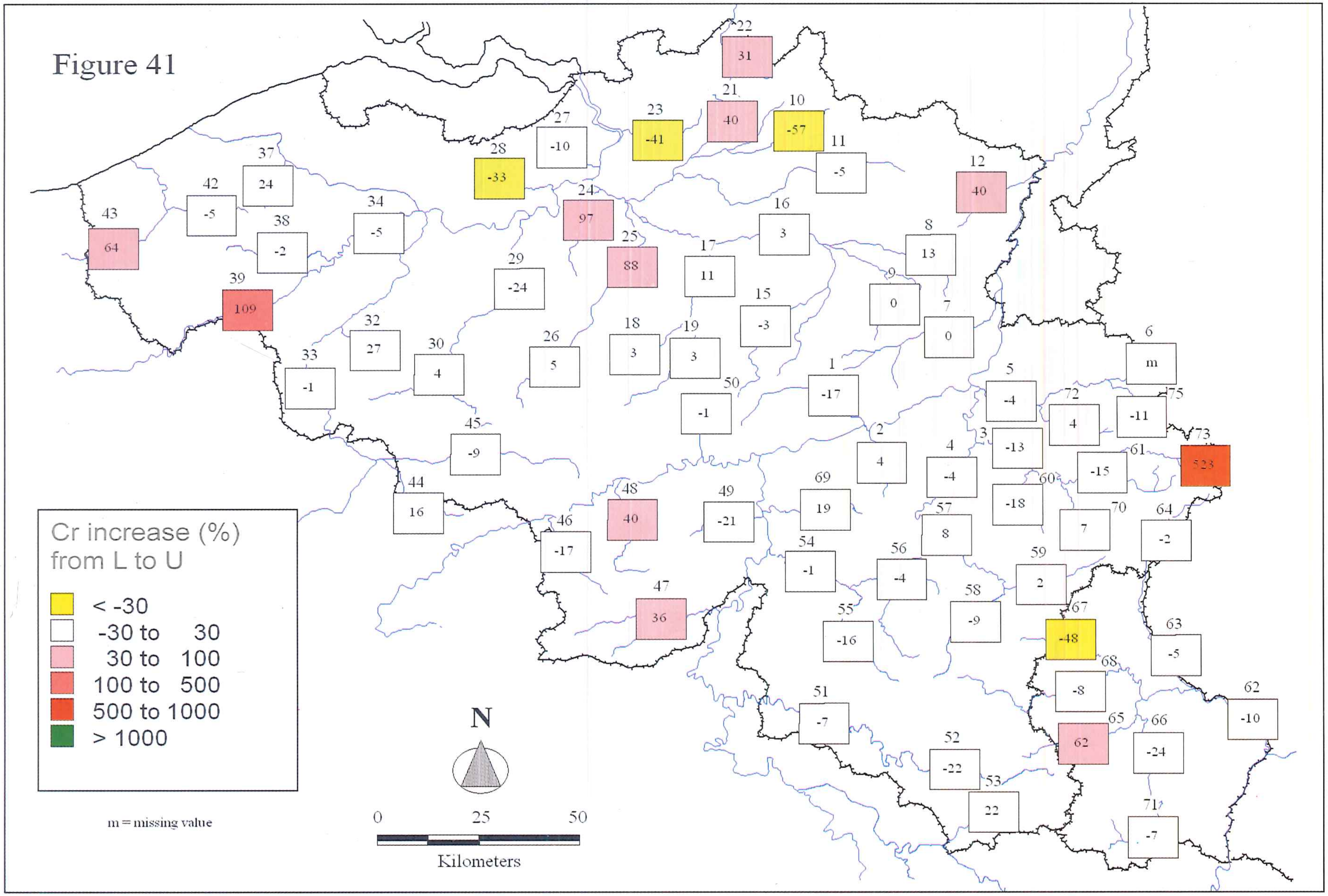
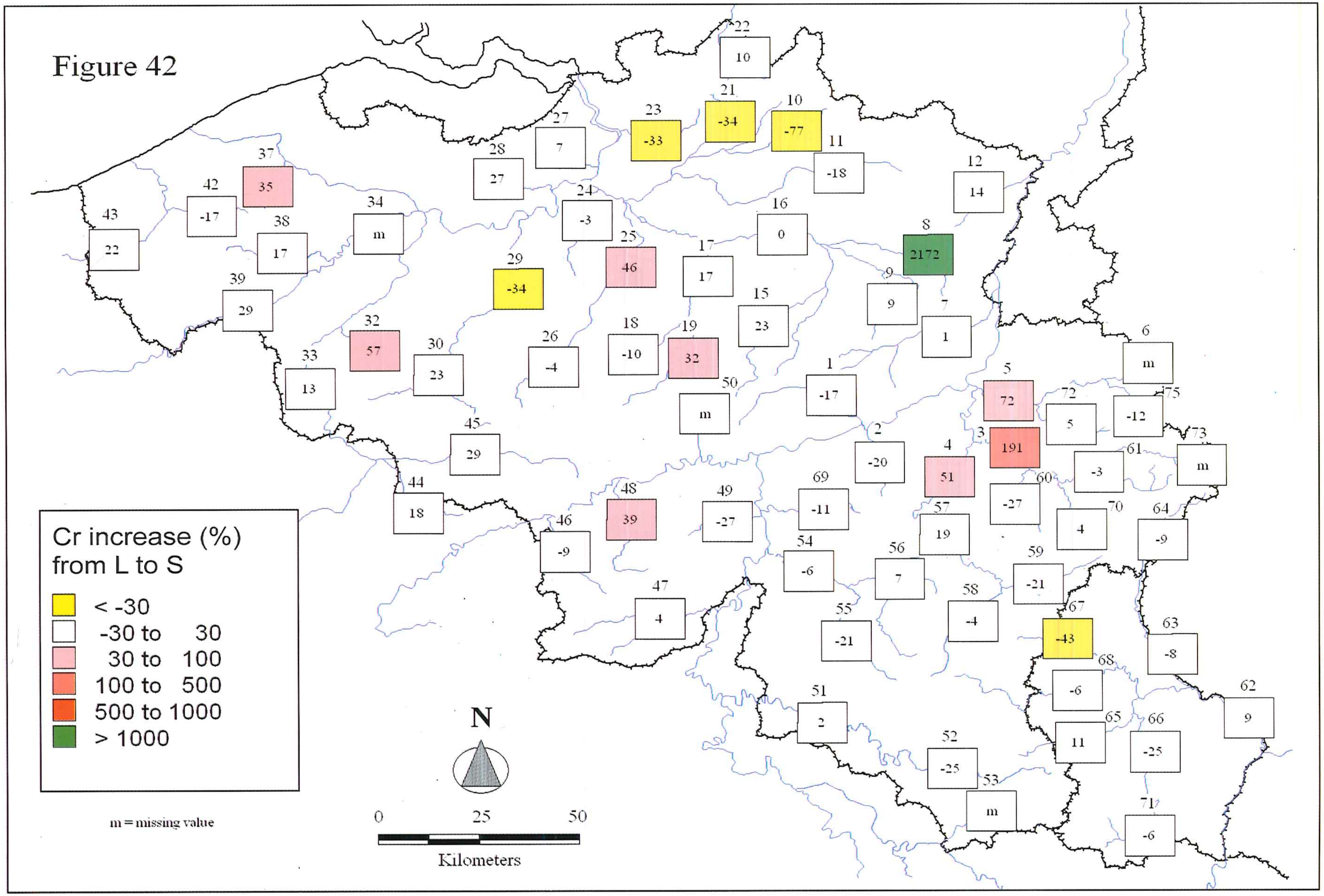

Cr increase (%)
from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 42


Cr increase (%)
from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

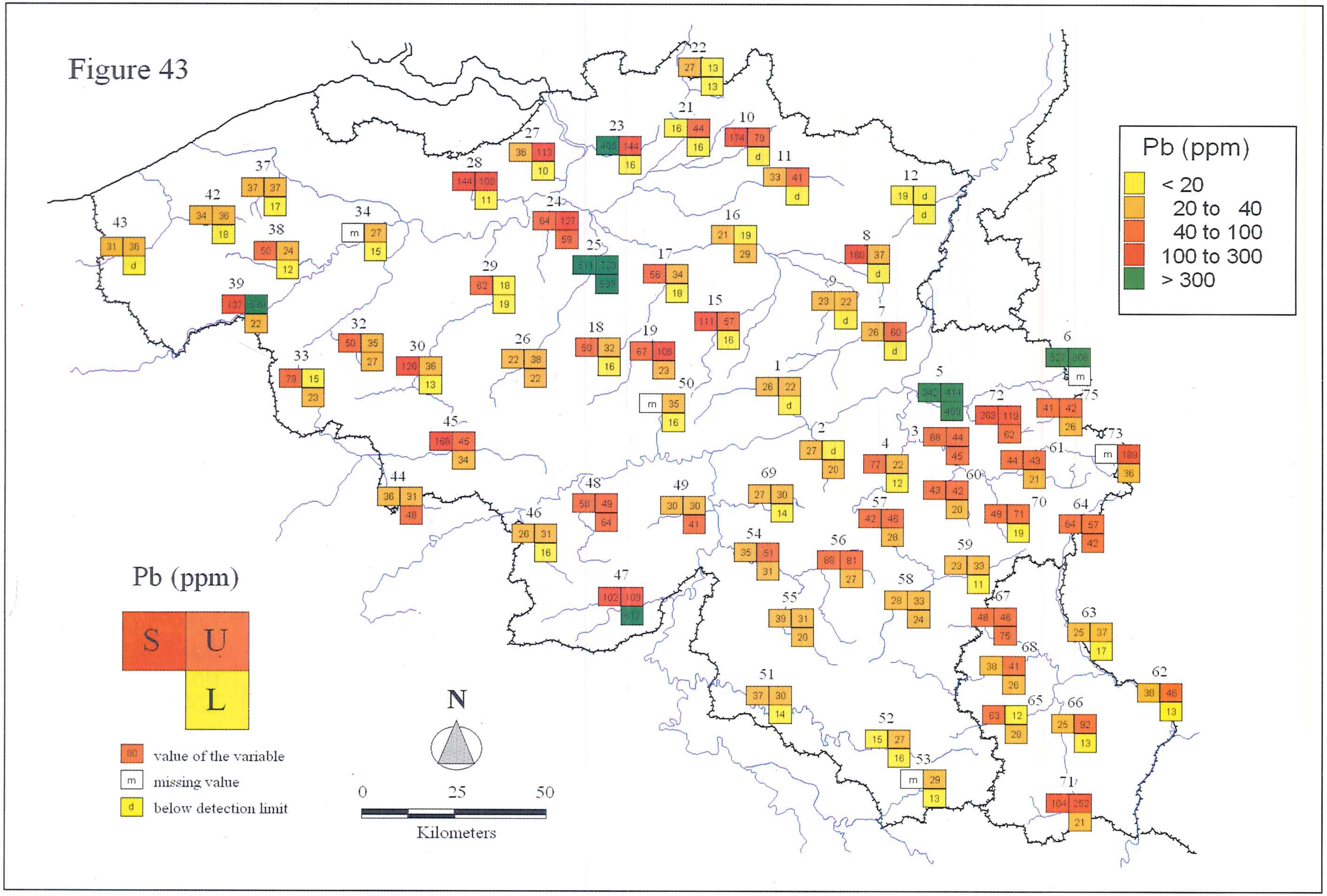

Pb (ppm)
< 20
20 to 40
40 to 100
100 to 300
> 300
Pb (ppm)
S
U
L
80 value of the variable
m missing value
d below detection limit
N
0 25 50
Kilometers

Figure 43

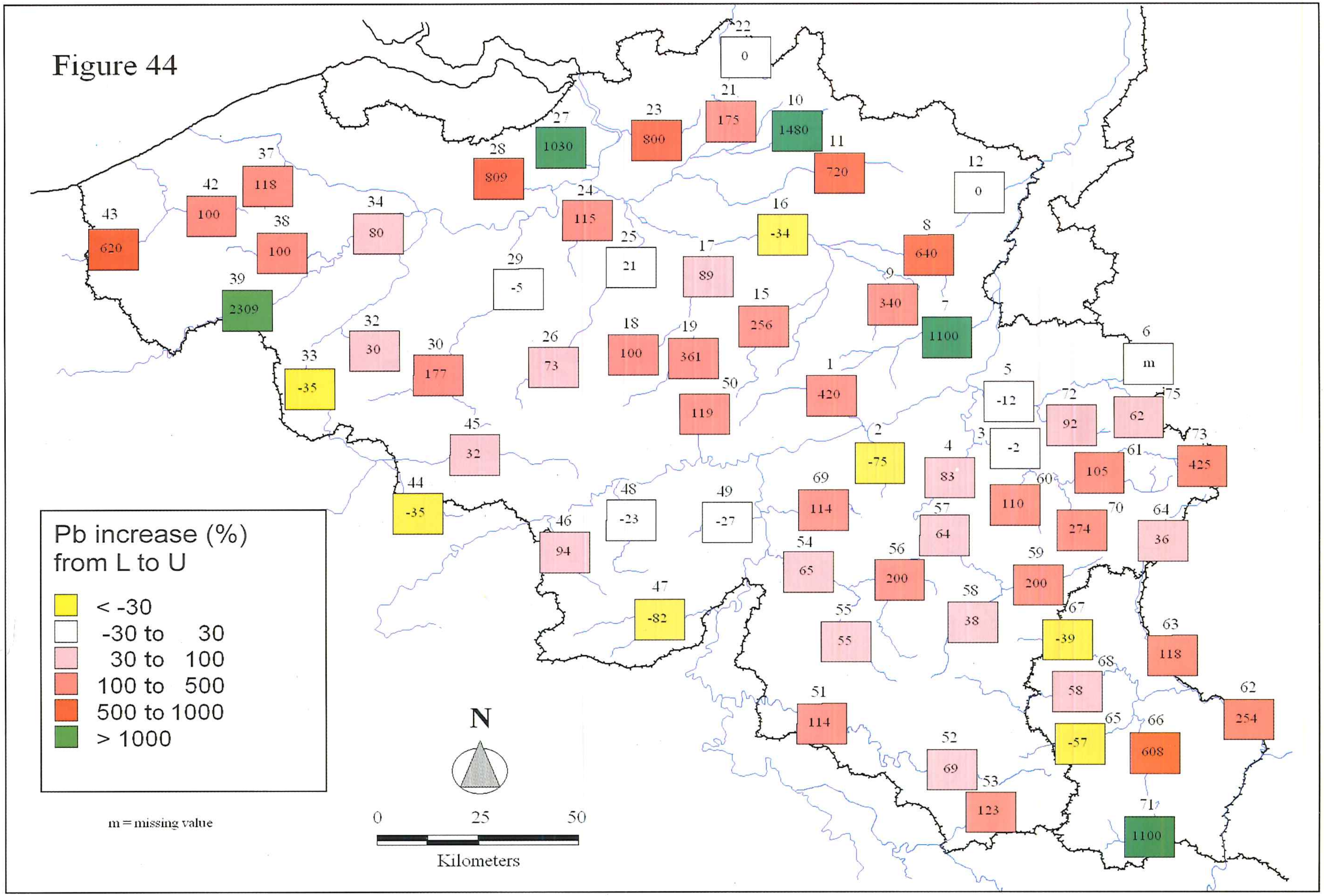

Pb increase (%)
from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0 25 50
Kilometers

Figure 44

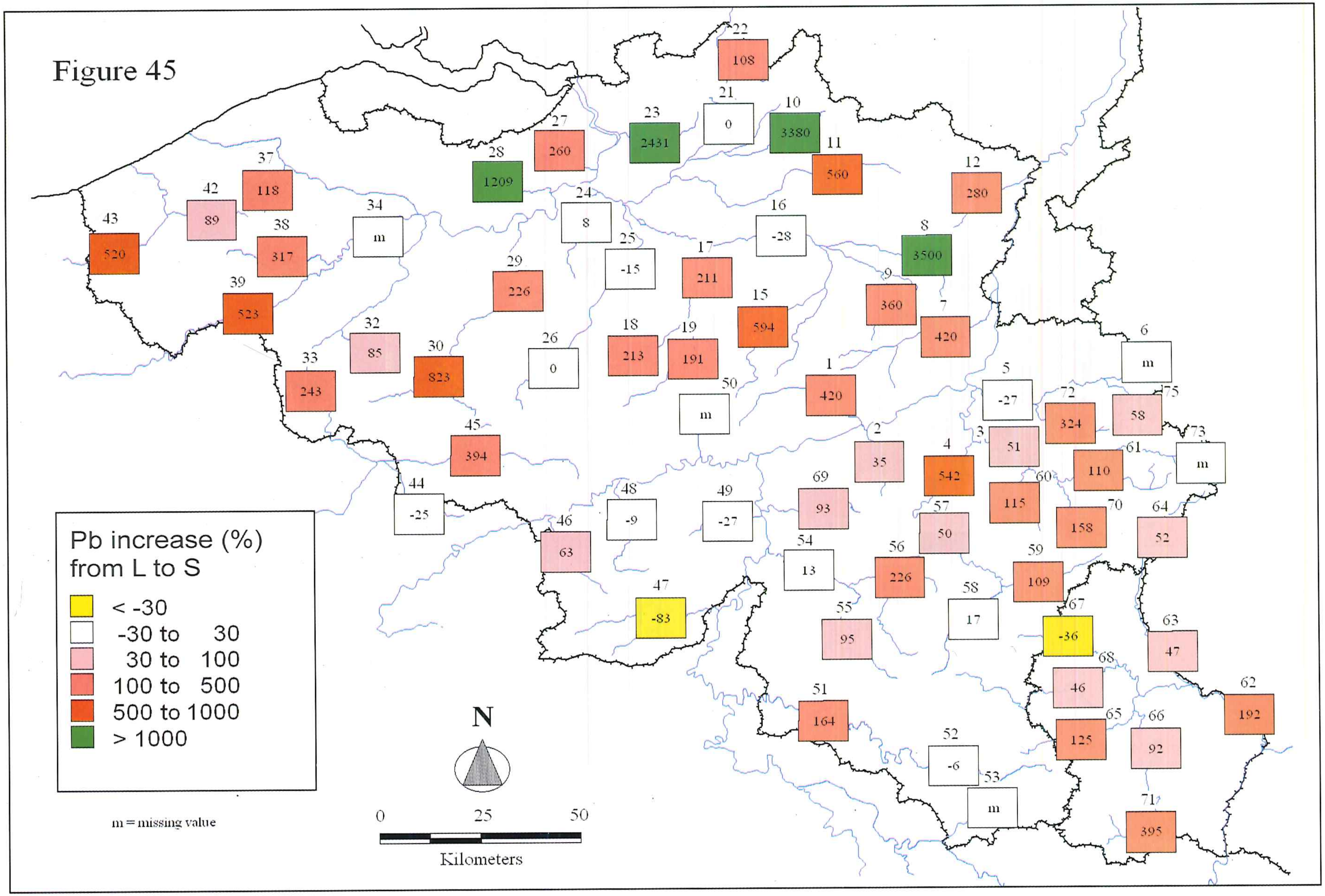

Pb increase (%)
from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

Figure 45

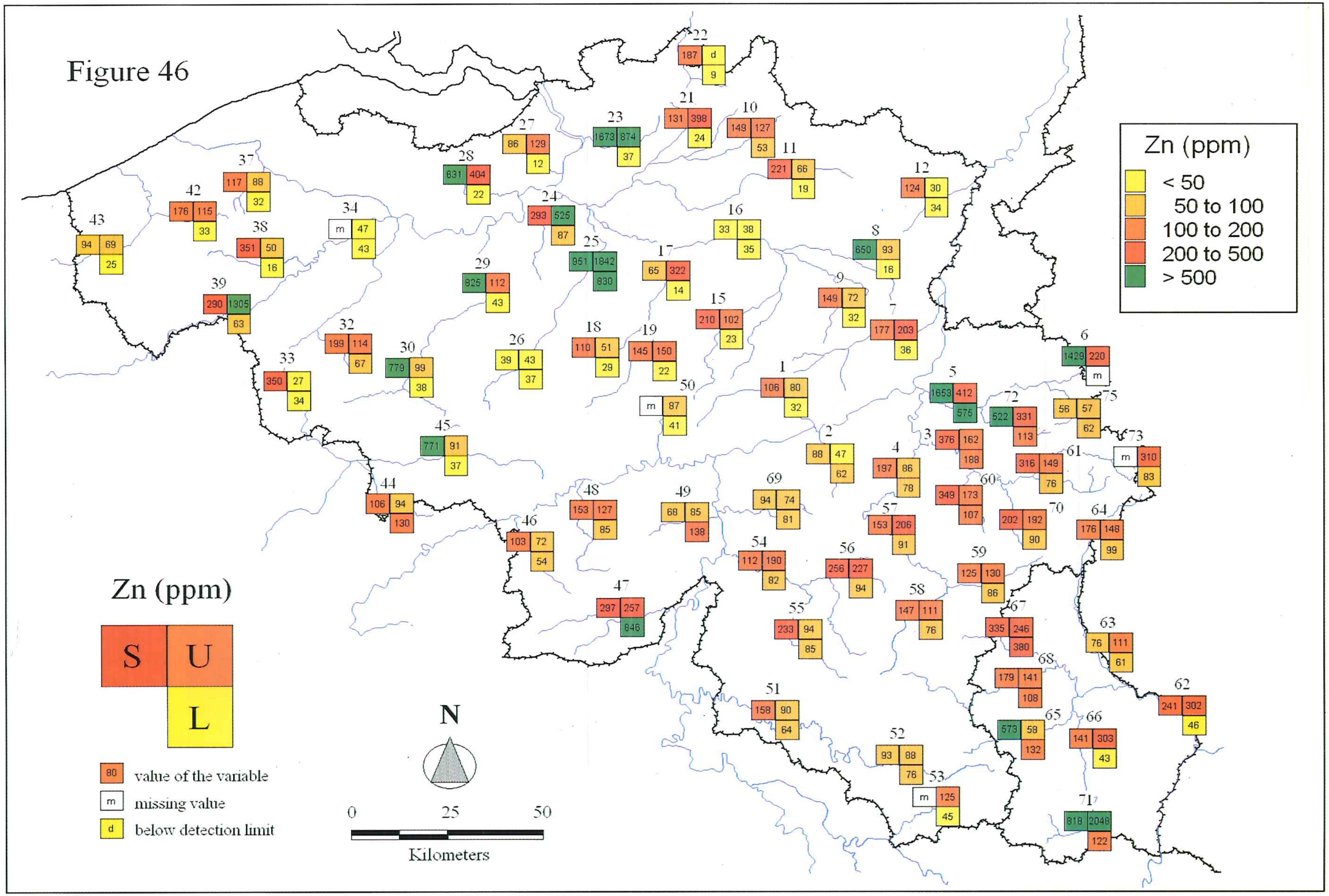

Zn (ppm)
< 50
50 to 100
100 to 200
200 to 500
> 500
Zn (ppm)
S
U
L
value of the variable
missing value
below detection limit
N
0
25
50
Kilometers

Figure 46

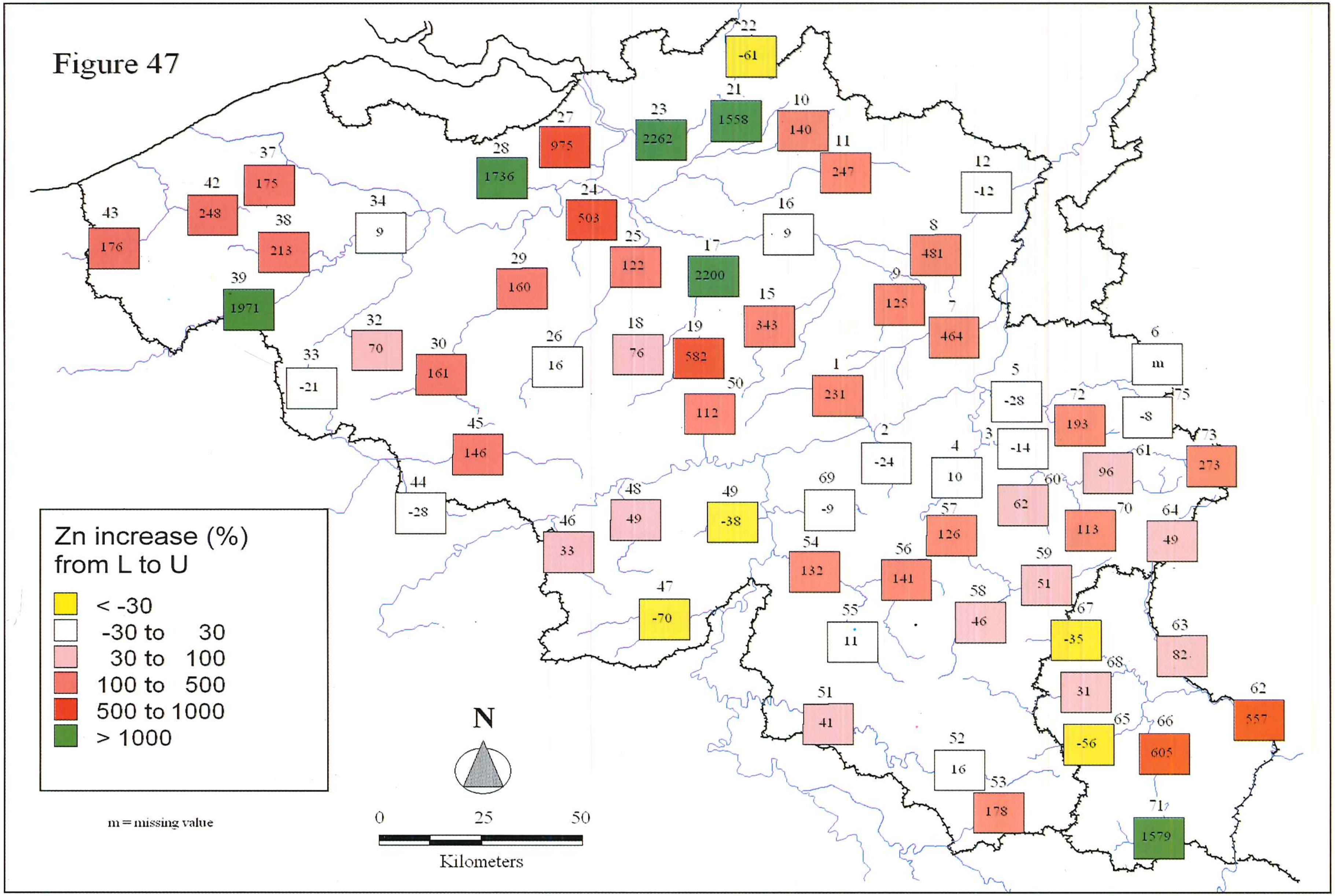
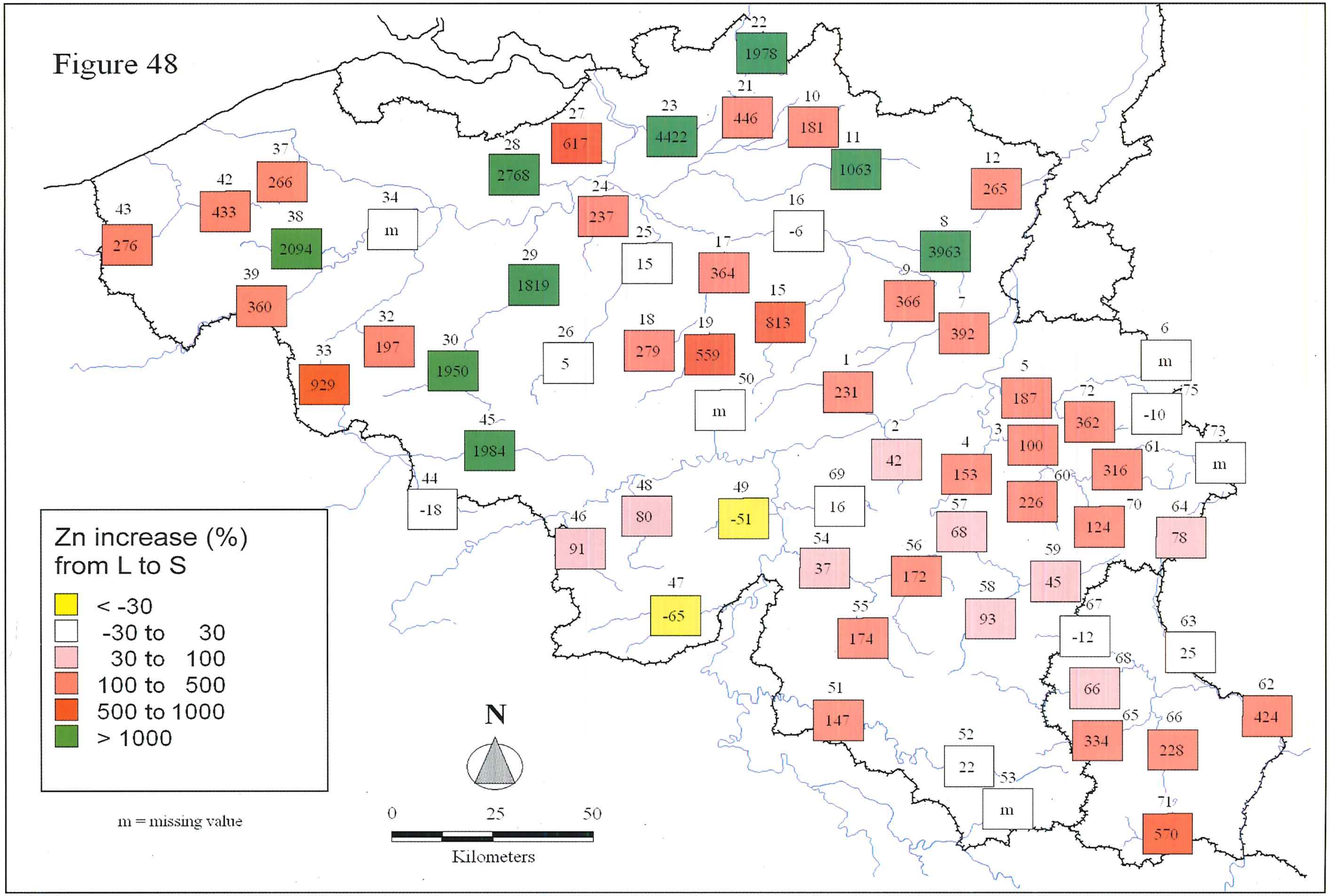

Zn increase (%)
from L to U
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

Figure 47

Figure 48


Zn increase (%) from L to S
< -30
-30 to 30
30 to 100
100 to 500
500 to 1000
> 1000
m = missing value
N
0
25
50
Kilometers

ANNEXE 3

RESULTS OF THE CHEMICAL ANALYSIS

L-U-S-samples

L - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
01	81.80	0.787	6.48	2.35	0.080	0.56	1.27	0.87	1.69	0.070	< 0.05	3.76	0.40	9	314
02	73.28	0.695	7.19	2.41	0.084	0.82	4.92	0.80	1.80	0.080	< 0.05	7.53	0.46	16	337
03	70.73	0.740	11.21	5.73	0.314	0.85	0.41	0.55	2.27	0.140	0.05	6.53	1.26	17	477
04	75.71	0.793	10.15	4.21	0.140	0.80	0.41	0.73	1.92	0.090	< 0.05	4.62	0.46	9	346
05	72.23	0.692	10.40	4.37	0.074	0.94	0.61	0.48	2.20	0.100	0.14	7.34	1.66	17	366
06	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
07	81.76	0.683	6.86	2.09	0.029	0.46	1.32	1.04	1.84	0.070	0.08	3.46	0.25	6	338
08	91.49	0.352	2.14	0.90	0.019	0.07	0.17	0.22	0.96	0.070	< 0.05	3.24	1.36	10	240
09	84.39	0.375	5.61	2.37	0.011	0.45	0.21	0.28	1.86	0.030	0.15	4.10	1.26	18	279
10	85.19	2.309	4.05	2.34	0.065	0.30	0.44	0.64	1.15	0.070	< 0.05	1.84	0.16	18	236
11	89.26	0.578	2.93	1.52	0.019	0.19	0.21	0.38	1.27	0.030	< 0.05	3.25	1.17	5	253
12	87.24	0.764	5.19	1.70	0.031	0.36	0.21	0.43	1.41	0.040	< 0.05	2.19	1.28	13	277
15	80.75	0.677	6.74	2.46	0.086	0.50	1.52	0.98	1.84	0.110	0.19	3.90	0.58	3	334
16	74.86	0.585	6.09	6.98	0.132	0.54	1.25	0.69	1.68	0.380	0.23	6.32	1.09	18	367
17	85.49	0.611	5.27	1.78	0.045	0.35	0.97	0.93	1.65	0.070	0.21	2.31	0.37	9	311
18	83.95	0.728	6.73	2.02	0.023	0.42	0.51	1.06	1.73	0.060	0.09	2.41	0.25	2	358
19	86.86	0.697	4.89	1.71	0.074	0.32	0.43	0.69	1.47	0.040	0.09	2.36	0.44	12	283
21	58.54	0.267	2.60	17.89	0.057	0.17	1.09	0.16	0.73	3.000	0.25	15.22	5.07	29	225
22	92.30	0.277	2.52	0.61	0.011	0.07	0.20	0.36	1.02	0.010	0.10	2.26	0.78	14	235
23	62.01	0.379	7.55	13.08	0.018	1.79	1.69	0.24	4.19	1.080	0.15	7.47	0.42	34	249
24	60.56	0.662	10.13	5.76	0.109	1.16	4.72	0.68	2.07	0.320	0.55	12.91	2.39	18	321
25	77.70	0.508	5.81	2.51	0.031	0.53	2.05	0.70	1.51	0.310	0.65	7.12	1.83	17	655
26	80.69	0.706	7.86	2.78	0.049	0.57	0.50	0.99	1.92	0.070	0.13	3.47	0.49	12	350
27	85.42	0.503	6.15	1.83	0.019	0.30	0.43	0.86	1.54	0.060	0.14	2.40	0.20	4	314
28	88.10	0.685	4.49	1.66	0.036	0.23	0.48	0.77	1.33	0.040	0.12	1.50	0.07	11	250
29	80.32	0.741	6.95	3.80	0.031	0.73	0.61	0.67	1.77	0.060	0.14	3.85	0.04	11	278
30	79.65	0.700	6.62	2.66	0.051	0.54	2.26	0.94	1.72	0.090	0.15	4.33	0.23	15	342
32	77.58	0.678	7.84	3.44	0.043	0.64	0.66	0.93	1.93	0.140	0.15	5.66	1.10	10	339
33	76.59	0.647	6.81	2.42	0.054	0.54	3.25	0.97	1.65	0.160	0.29	6.23	0.75	7	307
34	77.79	0.583	6.41	2.97	0.027	0.50	3.24	0.80	1.49	0.080	0.19	5.59	0.18	8	295
37	83.81	0.534	5.27	1.36	0.017	0.24	0.39	0.93	1.34	0.040	0.05	5.64	2.27	3	302
38	88.63	0.584	4.15	1.05	0.024	0.20	0.45	0.74	1.30	0.030	0.06	2.47	0.70	3	270
39	72.74	0.601	7.69	3.69	0.110	0.71	3.71	0.74	1.61	0.150	0.11	7.71	0.53	15	317

m = missing data

L - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
42	81.82	0.529	5.50	2.93	0.048	0.36	0.49	0.71	1.33	0.190	0.07	5.65	3.48	14	319
43	73.27	0.342	5.35	2.00	0.022	0.73	6.75	0.72	1.53	0.060	0.77	8.10	0.81	6	259
44	69.41	0.431	4.57	2.22	0.061	0.63	8.57	0.55	1.08	0.180	0.31	11.65	1.61	9	303
45	79.96	0.657	6.01	2.28	0.055	0.42	1.91	0.73	1.55	0.170	0.17	5.67	0.88	4	298
46	77.33	0.831	9.93	2.73	0.029	0.75	0.49	0.96	2.07	0.091	0.02	4.47	0.43	4	371
47	64.27	0.753	11.27	8.62	0.079	0.94	0.76	0.59	2.05	0.135	0.10	9.95	2.24	23	1019
48	71.94	0.566	6.06	5.71	0.097	0.58	4.10	0.56	1.28	0.169	0.11	8.26	1.04	13	260
49	56.78	0.567	7.81	15.71	0.198	0.66	3.97	0.49	1.50	0.250	0.28	11.40	1.65	27	270
50	79.58	0.792	8.36	3.06	0.051	0.60	0.67	1.11	2.10	0.095	0.04	3.27	0.32	11	387
51	74.72	0.932	10.92	2.77	0.036	1.08	0.22	0.61	1.77	0.112	0.06	6.55	1.66	2	329
52	74.94	0.761	10.07	3.31	0.036	0.90	0.32	0.39	1.76	0.099	0.03	7.16	2.02	10	328
53	82.46	0.652	5.62	3.52	0.055	0.35	1.08	0.30	1.24	0.142	0.11	4.20	0.76	24	251
54	69.70	0.852	12.40	5.52	0.085	1.10	0.68	0.81	2.26	0.110	0.05	6.13	0.65	14	397
55	75.41	1.026	10.48	4.07	0.049	1.01	0.25	0.70	1.73	0.089	0.04	4.88	1.14	19	340
56	77.32	0.788	9.36	4.33	0.180	0.71	0.36	0.58	1.68	0.115	0.03	4.29	0.44	10	306
57	74.78	0.903	10.94	4.76	0.052	0.98	0.23	0.82	1.92	0.129	0.04	4.19	0.29	14	349
58	75.56	1.044	11.29	2.98	0.047	1.04	0.26	0.73	2.08	0.081	0.03	4.59	0.67	9	394
59	74.95	0.824	11.46	4.10	0.086	1.09	0.21	0.82	2.08	0.076	0.03	4.02	0.54	13	365
60	72.31	0.844	13.04	4.39	0.156	0.71	0.23	0.67	2.44	0.076	0.03	4.82	0.76	19	536
61	73.65	0.858	11.21	5.50	0.059	0.79	0.23	0.50	2.02	0.070	0.03	4.82	0.55	23	373
62	73.36	0.762	7.81	3.06	0.089	2.60	2.74	0.38	2.29	0.083	0.06	6.40	0.18	11	293
63	75.11	0.864	9.90	3.57	0.031	1.57	0.92	0.39	2.74	0.096	0.06	4.40	0.42	8	344
64	71.13	0.797	11.62	5.42	0.122	0.90	0.20	0.57	2.10	0.106	0.03	6.74	2.03	12	445
65	83.94	0.941	4.66	2.30	0.069	0.85	0.70	0.21	1.07	0.102	0.08	4.76	1.29	5	196
66	82.78	0.743	6.37	2.90	0.070	0.91	0.47	0.31	1.39	0.091	0.04	3.68	0.37	9	241
67	59.96	0.810	14.32	5.81	0.096	1.27	0.36	0.69	2.45	0.450	0.05	13.33	4.72	19	512
68	65.48	0.930	16.53	5.77	0.085	1.41	0.18	0.73	2.73	0.145	0.02	5.70	0.38	11	493
69	70.47	0.720	8.12	2.67	0.067	0.66	5.66	0.82	2.10	0.101	0.07	8.01	0.51	6	359
70	76.27	0.919	10.20	2.74	0.240	0.68	0.25	0.60	1.97	0.093	0.03	5.72	1.82	21	407
71	66.59	0.853	12.61	7.50	0.087	0.84	0.75	0.62	1.95	0.311	0.03	7.60	0.55	24	401
72	67.69	0.813	13.09	7.07	0.363	0.97	0.38	0.53	2.51	0.124	0.03	6.15	0.87	16	494
73	73.37	0.778	11.51	5.27	0.097	0.92	0.24	0.39	2.17	0.126	0.02	4.85	0.72	16	412
75	60.97	0.919	15.54	8.14	0.013	0.56	0.16	0.65	2.46	0.125	0.02	10.21	2.85	67	393

m = missing data

L - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
01	0.2	85	10	94	< 5	12	< 5	< 20	43	13	14	< 10	62	8	< 3	75	< 10	38	40	32	921
02	0.2	76	< 7	74	6	< 10	7	< 20	30	5	22	20	65	8	< 3	76	< 10	37	33	62	539
03	0.5	86	27	149	9	26	17	< 20	36	12	54	45	96	12	7	67	26	73	36	188	430
04	0.2	60	12	114	10	11	15	< 20	37	9	44	12	85	11	4	65	19	60	27	78	548
05	0.8	88	25	102	14	24	14	< 20	24	11	41	469	90	11	< 3	55	< 10	62	26	575	425
06	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
07	0.1	63	9	81	< 5	16	9	< 20	36	11	13	< 10	65	7	< 3	86	16	39	30	36	614
08	0.1	< 15	< 7	53	< 5	13	< 5	< 20	3	3	< 7	< 10	34	2	< 3	36	< 10	19	8	16	621
09	0.5	41	< 7	74	< 5	< 10	< 5	< 20	31	3	18	< 10	68	5	< 3	48	15	57	26	32	288
10	0.1	183	11	420	7	< 10	5	248	109	36	16	< 10	41	10	28	59	38	60	72	53	9095
11	0.1	45	< 7	113	< 5	< 10	< 5	31	16	11	< 7	< 10	41	4	< 3	38	15	40	8	19	1532
12	0.1	57	< 7	109	< 5	12	5	26	25	12	9	< 10	53	5	< 3	47	14	35	19	34	1122
15	0.5	41	9	78	5	< 10	5	25	31	12	9	16	64	8	< 3	87	< 10	43	31	23	709
16	0.5	75	< 7	80	6	< 10	6	28	28	11	9	29	64	6	< 3	75	< 10	48	30	35	654
17	0.7	43	10	71	< 5	< 10	7	37	18	11	< 7	18	54	6	< 3	77	12	29	27	14	770
18	0.7	52	8	88	< 5	< 10	7	34	36	16	< 7	16	59	7	< 3	82	< 10	37	33	29	806
19	0.5	55	13	91	6	< 10	< 5	25	26	12	7	23	51	5	< 3	60	< 10	33	28	22	913
21	0.7	36	< 7	47	6	< 10	< 5	< 20	9	3	< 7	16	25	3	< 3	57	< 10	33	14	24	383
22	0.2	18	< 7	42	< 5	< 10	< 5	< 20	3	8	< 7	13	31	3	< 3	41	< 10	11	9	9	535
23	0.7	159	9	252	8	< 10	7	23	62	8	9	16	131	10	< 3	111	12	137	35	37	326
24	0.9	48	15	101	9	22	11	< 20	36	12	27	59	100	12	8	138	< 10	95	28	87	346
25	2.0	39	18	83	5	93	7	< 20	30	10	18	599	55	7	33	99	< 10	46	27	830	552
26	0.9	54	13	80	< 5	< 10	8	< 20	26	13	12	22	70	8	< 3	78	14	51	32	37	584
27	0.7	33	7	70	6	< 10	6	22	16	13	< 7	10	55	4	< 3	68	< 10	34	21	12	567
28	0.7	40	< 7	148	< 5	< 10	< 5	45	26	11	< 7	11	43	5	< 3	63	< 10	17	24	22	1531
29	0.9	67	12	128	9	< 10	8	32	30	12	18	19	66	8	< 3	65	< 10	73	32	43	841
30	1.1	69	< 7	82	7	< 10	7	22	33	12	11	13	62	8	< 3	83	< 10	41	31	38	717
32	0.9	62	18	86	< 5	16	5	< 20	22	11	14	27	77	9	< 3	79	< 10	64	31	67	515
33	1.1	52	11	75	6	12	8	32	28	12	12	23	64	7	< 3	97	11	41	37	34	577
34	1.4	53	< 7	80	< 5	< 10	8	< 20	29	10	9	15	55	7	< 3	104	< 10	42	20	43	644
37	0.2	51	8	79	< 5	< 10	< 5	< 20	19	11	< 7	17	42	6	< 3	63	< 10	28	21	32	850
38	0.2	48	12	86	< 5	< 10	< 5	36	24	10	< 7	12	41	4	< 3	60	< 10	24	19	16	1070
39	0.7	69	11	86	9	< 10	9	20	17	11	19	22	69	8	< 3	107	< 10	56	31	63	551

m = missing data

L - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
42	0.7	54	17	77	6	< 10	< 5	< 20	18	10	< 7	18	48	6	< 3	62	< 10	42	25	33	519
43	1.1	27	11	50	< 5	< 10	< 5	< 20	12	7	< 7	< 10	55	5	< 3	233	< 10	37	16	25	220
44	1.4	48	< 7	62	< 5	19	< 5	< 20	19	8	22	48	39	5	13	101	< 10	41	24	130	427
45	0.7	73	12	90	7	15	< 5	22	35	14	< 7	34	58	7	< 3	92	10	48	35	37	785
46	2.0	66	10	86	8	< 10	13	15	32	19	29	16	85	10	4	72	14	67	39	54	591
47	4.8	90	15	91	9	27	14	12	35	18	48	612	93	12	5	71	11	80	38	846	369
48	1.8	77	15	67	< 5	27	6	7	37	15	31	64	51	8	3	72	12	61	38	85	527
49	3.3	77	17	84	10	23	9	6	32	16	63	41	63	8	< 2	68	15	111	62	138	414
50	2.3	52	6	69	5	< 10	11	5	35	18	15	16	74	7	4	83	8	51	33	41	498
51	2.3	89	7	112	8	< 10	15	12	27	19	34	14	85	12	< 2	57	7	84	33	64	472
52	1.8	88	13	96	8	15	14	12	60	19	42	16	88	10	< 2	53	12	85	36	76	402
53	1.3	70	10	89	< 5	< 10	8	16	28	16	21	13	46	8	3	50	12	83	31	45	638
54	2.0	61	19	105	11	19	15	12	48	19	49	31	102	13	4	79	14	92	45	82	455
55	2.0	77	16	149	7	21	13	8	58	19	50	20	83	11	3	61	10	78	32	85	536
56	2.3	69	21	132	6	17	15	5	38	19	45	27	78	10	< 2	64	11	67	33	94	601
57	2.0	74	17	116	< 5	20	15	17	54	20	45	28	84	12	< 2	63	13	77	34	91	607
58	2.0	66	7	138	7	15	16	12	54	22	40	24	88	12	2	62	9	79	35	76	503
59	3.1	99	16	131	< 5	< 10	13	9	58	20	38	11	89	11	< 2	65	15	73	35	86	548
60	2.6	74	13	115	6	17	16	8	51	19	41	20	108	12	< 2	82	13	79	38	107	479
61	2.0	78	15	128	6	11	13	16	57	21	29	21	89	13	2	63	11	80	40	76	565
62	2.3	83	11	79	6	13	10	6	43	17	32	13	73	8	10	65	10	59	35	46	560
63	2.0	96	13	104	10	15	12	13	67	19	35	17	90	11	< 2	61	13	70	39	61	669
64	2.8	67	14	140	< 5	22	15	12	49	19	48	42	91	13	2	59	10	82	34	99	552
65	1.8	89	11	93	6	13	9	17	41	17	18	28	44	4	< 2	44	10	46	28	132	749
66	1.8	82	6	85	< 5	14	8	9	24	18	21	13	59	6	12	52	6	59	27	43	657
67	9.9	74	18	491	8	266	18	3	44	17	73	75	116	16	4	69	14	113	33	380	269
68	3.1	74	23	119	14	23	22	10	45	21	67	26	136	18	< 2	68	14	116	40	108	292
69	2.3	60	17	72	7	< 10	8	19	49	18	24	14	75	8	3	76	9	54	38	81	606
70	2.8	66	14	110	7	14	13	13	32	21	29	19	83	11	4	82	11	66	36	90	601
71	3.1	73	15	113	7	18	16	6	46	18	45	21	94	15	3	87	12	130	39	122	345
72	2.8	73	22	107	11	19	19	9	41	18	41	62	112	12	11	63	16	88	34	113	382
73	3.3	62	17	139	8	23	15	13	45	19	34	36	93	12	3	72	11	85	33	83	500
75	4.8	88	< 5	94	10	15	18	6	43	21	15	26	114	16	< 2	85	14	109	39	62	431

m = missing data

U - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
01	79.63	0.720	6.51	2.50	0.089	0.60	1.19	0.78	1.74	0.120	< 0.05	5.53	1.30	11	313
02	79.78	0.721	6.70	2.07	0.068	0.72	2.08	0.91	1.84	0.060	< 0.05	4.70	0.44	11	335
03	74.38	0.703	9.85	5.02	0.254	0.70	0.34	0.52	1.98	0.110	< 0.05	5.71	1.12	16	442
04	77.04	0.755	8.81	3.89	0.148	0.68	0.57	0.80	1.88	0.080	< 0.05	5.00	0.92	9	335
05	74.90	0.698	9.34	5.11	0.194	0.79	0.51	0.51	1.99	0.090	< 0.05	5.45	0.51	14	359
06	67.14	0.710	9.98	4.93	0.063	0.54	0.20	0.53	1.73	0.150	< 0.05	13.49	4.82	30	350
07	79.66	0.650	6.46	2.24	0.053	0.43	1.66	0.92	1.73	0.200	0.08	5.68	1.19	9	350
08	84.97	0.353	3.75	2.25	0.045	0.20	0.25	0.31	1.07	0.120	< 0.05	6.33	2.14	18	279
09	84.17	0.511	5.08	2.02	0.050	0.29	0.45	0.57	1.59	0.180	< 0.05	4.62	1.18	12	338
10	77.38	1.136	6.92	3.93	0.044	0.37	0.51	0.40	1.75	0.200	< 0.05	6.81	2.34	38	321
11	80.08	0.501	3.18	5.51	0.020	0.25	0.18	0.34	1.24	0.360	< 0.05	7.98	3.35	34	239
12	88.74	0.887	3.30	1.21	0.040	0.12	0.21	0.54	1.14	0.050	< 0.05	3.28	1.14	14	266
15	78.14	0.615	6.87	2.55	0.051	0.54	1.97	0.96	1.82	0.200	0.15	5.79	0.95	11	363
16	78.52	0.568	6.40	4.98	0.087	0.54	0.84	0.66	1.73	0.210	0.13	4.99	0.88	21	334
17	83.23	0.627	6.13	2.31	0.054	0.41	0.64	0.94	1.72	0.100	0.11	3.34	0.62	8	366
18	80.21	0.674	7.38	2.78	0.060	0.50	0.74	0.95	1.83	0.080	0.11	4.36	0.84	12	509
19	78.20	0.641	6.83	2.91	0.085	0.50	0.88	0.87	1.66	0.270	0.20	6.60	1.74	14	1302
21	70.11	0.380	5.14	9.13	0.108	0.36	1.22	0.47	1.46	0.480	0.24	10.60	3.04	22	312
22	89.90	0.379	3.03	2.27	0.083	0.14	0.19	0.38	1.02	0.040	0.09	2.20	0.29	20	283
23	73.59	0.513	5.22	6.98	0.039	0.60	0.75	0.47	1.69	0.810	0.11	8.64	2.43	33	383
24	68.71	0.543	7.24	4.51	0.047	0.77	4.18	0.65	1.82	0.460	2.06	8.46	1.68	40	360
25	70.71	0.537	7.81	4.34	0.073	0.72	2.09	0.68	1.65	0.440	0.31	9.88	1.85	55	904
26	81.19	0.696	6.88	2.40	0.059	0.45	0.70	1.01	1.76	0.090	0.16	4.30	0.97	16	338
27	82.56	0.492	5.88	2.22	0.091	0.29	0.52	0.83	1.50	0.160	0.14	4.95	1.29	19	339
28	74.57	0.483	6.11	3.00	0.078	0.64	4.05	0.69	1.61	0.200	0.24	7.82	1.20	30	344
29	80.72	0.673	6.07	3.89	0.089	0.52	0.57	0.72	1.52	0.090	0.16	4.67	0.71	19	309
30	77.89	0.720	8.01	3.18	0.087	0.59	0.57	0.94	1.89	0.170	0.11	5.45	1.11	22	371
32	80.36	0.649	5.94	2.39	0.035	0.46	1.54	0.83	1.65	0.200	0.18	5.29	1.04	17	317
33	79.92	0.672	6.55	2.12	0.049	0.41	2.47	0.97	1.65	0.090	0.16	4.65	0.33	12	310
34	79.03	0.548	6.98	3.20	0.078	0.54	0.76	0.79	1.53	0.090	0.14	6.05	1.08	15	307
37	81.96	0.519	4.57	1.70	0.028	0.27	0.41	0.68	1.26	0.320	0.18	7.67	2.82	12	278
38	78.20	0.577	7.31	4.02	0.081	0.52	0.69	0.80	1.55	0.400	0.05	5.53	0.56	21	362
39	57.12	0.598	11.25	3.87	0.061	0.83	4.24	0.62	1.87	0.440	0.38	18.26	3.78	68	798

m = missing data

U - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
42	83.92	0.482	4.80	1.99	0.032	0.31	0.45	0.66	1.37	0.300	0.07	5.25	1.60	9	296
43	71.49	0.556	9.30	4.08	0.076	0.88	1.61	0.64	1.78	0.090	0.15	8.89	1.37	12	315
44	79.86	0.481	3.99	1.73	0.042	0.59	3.91	0.53	1.07	0.100	0.18	7.15	1.26	6	255
45	75.21	0.710	8.19	3.31	0.067	0.67	1.17	0.81	1.85	0.160	0.18	7.28	1.46	9	352
46	77.02	0.718	8.12	2.96	0.077	0.62	0.70	0.83	1.77	0.134	0.04	6.75	2.02	7	323
47	72.28	0.693	8.47	5.89	0.202	0.75	0.74	0.56	1.50	0.162	0.06	8.38	2.29	16	632
48	72.44	0.634	6.41	7.23	0.110	0.64	1.66	0.66	1.43	0.261	0.13	8.08	2.28	11	283
49	77.97	0.689	6.48	2.81	0.064	0.51	2.01	0.78	1.62	0.117	0.11	6.52	1.61	9	299
50	79.63	0.605	5.98	2.12	0.053	0.47	1.28	0.76	1.53	0.202	0.13	6.96	2.43	10	317
51	73.10	0.899	10.36	4.39	0.128	1.06	0.28	0.67	1.67	0.141	0.03	7.01	1.48	9	319
52	77.04	0.627	7.46	3.65	0.131	0.68	0.46	0.33	1.32	0.174	0.03	7.87	2.43	20	278
53	78.44	0.650	5.56	4.65	0.110	0.36	1.27	0.38	1.30	0.245	0.13	6.58	1.67	40	281
54	73.47	0.738	8.93	3.82	0.134	0.92	0.83	0.71	1.65	0.162	0.12	8.20	2.70	14	315
55	70.66	0.893	11.17	5.07	0.132	1.02	0.27	0.68	1.79	0.137	0.04	7.89	1.88	11	367
56	71.74	0.740	9.63	4.52	0.186	0.74	0.65	0.60	1.72	0.186	0.06	8.91	2.79	12	337
57	70.79	0.800	10.61	4.69	0.180	0.96	0.40	0.63	1.84	0.199	0.06	8.56	2.63	10	352
58	72.81	0.983	9.16	3.60	0.114	0.84	0.28	0.57	1.61	0.158	0.03	9.59	3.54	12	315
59	69.01	0.793	11.53	4.45	0.137	1.11	0.31	0.73	2.00	0.137	0.03	9.48	2.75	16	376
60	68.96	0.815	11.80	5.45	0.419	0.64	0.34	0.68	2.22	0.135	0.03	8.22	2.35	26	514
61	71.52	0.833	10.75	4.23	0.130	0.65	0.31	0.51	2.01	0.154	0.03	8.58	2.66	16	393
62	78.51	0.547	5.28	2.65	0.078	1.09	1.99	0.24	1.31	0.193	0.16	7.56	2.00	9	258
63	71.71	0.755	9.71	4.05	0.190	1.32	0.92	0.44	2.28	0.182	0.12	8.04	2.34	10	401
64	71.38	0.757	10.85	4.63	0.240	0.90	0.34	0.58	1.94	0.161	0.03	7.93	2.35	17	432
65	78.27	0.936	5.58	6.87	0.067	1.01	0.96	0.21	1.23	0.252	0.06	4.24	1.29	5	240
66	81.16	0.430	3.98	2.73	0.063	0.57	1.71	0.20	0.95	0.275	0.19	7.49	2.15	10	229
67	67.07	0.858	12.47	4.83	0.161	1.16	0.47	0.75	2.17	0.245	0.03	9.46	3.05	14	417
68	66.71	0.772	12.77	5.22	0.467	1.19	0.26	0.70	2.18	0.177	0.03	9.29	2.51	9	430
69	78.66	0.777	7.56	2.62	0.065	0.54	0.95	0.84	2.08	0.110	0.09	5.37	1.44	7	359
70	68.62	0.845	11.36	5.15	0.409	0.74	0.35	0.53	2.08	0.174	0.02	9.42	2.84	33	486
71	59.50	0.547	8.12	13.16	0.126	0.61	3.10	0.44	1.47	0.689	0.27	11.34	2.76	40	419
72	67.40	0.752	11.20	5.75	0.230	1.25	1.12	0.46	2.15	0.168	0.12	9.01	2.07	15	445
73	66.02	0.786	11.65	5.25	0.157	0.86	0.51	0.44	2.13	0.267	0.08	11.27	3.76	20	1464
75	69.26	0.874	12.19	5.74	0.035	0.46	0.20	0.62	2.04	0.109	0.02	8.18	2.02	38	344

m = missing data

U - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
01	0.3	69	< 7	78	< 5	15	7	< 20	34	12	19	22	65	6	< 3	67	17	49	34	80	752
02	0.2	57	< 7	77	< 5	< 10	9	< 20	34	10	12	< 10	65	8	< 3	69	16	38	35	47	667
03	0.5	94	19	129	< 5	23	15	< 20	41	15	40	44	82	10	4	57	22	67	32	162	478
04	0.2	76	8	110	9	< 10	12	< 20	23	11	34	22	79	10	< 3	63	19	60	30	86	610
05	1.0	63	21	98	10	21	10	< 20	36	15	38	414	82	10	5	49	14	62	29	412	508
06	0.6	82	< 7	170	7	193	12	< 20	46	13	30	308	73	11	81	52	11	83	28	220	506
07	0.5	67	< 7	81	5	19	8	< 20	23	9	19	60	61	7	8	80	12	45	26	203	613
08	0.4	16	< 7	60	< 5	16	< 5	< 20	6	< 5	14	37	35	4	6	39	< 10	38	< 5	93	400
09	0.4	35	< 7	74	6	15	7	< 20	11	6	12	22	58	5	< 3	60	14	32	16	72	569
10	0.9	61	21	180	6	149	7	54	122	15	48	79	67	10	19	69	18	78	26	127	2160
11	0.8	41	< 7	107	< 5	13	< 5	< 20	17	7	< 7	41	50	4	< 3	42	< 10	50	19	66	1249
12	0.5	58	< 7	153	6	14	< 5	49	24	13	< 7	< 10	38	4	< 3	41	< 10	25	24	30	2396
15	0.7	50	12	76	< 5	25	6	< 20	36	13	13	57	65	7	4	92	< 10	46	33	102	583
16	0.7	55	11	82	< 5	12	< 5	< 20	30	8	13	19	63	7	< 3	74	< 10	58	24	38	577
17	1.1	44	8	79	5	10	6	< 20	26	14	< 7	34	60	6	< 3	77	< 10	38	30	322	677
18	0.9	77	10	91	7	19	5	< 20	37	10	11	32	66	9	< 3	87	< 10	51	27	51	613
19	1.1	73	13	94	6	47	6	24	29	11	16	106	65	7	12	102	11	59	31	150	630
21	3.0	50	15	66	5	< 10	6	28	30	9	< 7	44	48	7	< 3	102	< 10	52	18	398	330
22	0.2	< 15	< 7	55	< 5	< 10	< 5	22	7	7	< 7	13	32	4	< 3	40	< 10	20	13	< 7	710
23	6.8	67	13	149	5	176	< 5	25	29	11	17	144	59	6	19	72	< 10	66	30	874	900
24	9.6	42	12	199	6	80	8	21	19	10	31	127	68	8	5	147	10	65	24	525	454
25	6.6	57	15	156	9	239	9	< 20	31	11	35	723	72	9	34	110	< 10	71	30	1842	418
26	0.7	66	12	84	5	< 10	7	21	34	11	7	38	66	6	< 3	73	12	47	34	43	681
27	4.1	30	15	63	6	27	9	27	10	10	7	113	54	5	6	71	< 10	41	21	129	609
28	2.5	44	< 7	99	5	42	< 5	< 20	26	9	14	100	58	7	8	141	12	44	23	404	517
29	1.1	46	9	97	5	< 10	< 5	26	25	11	13	18	60	7	4	66	< 10	58	28	112	808
30	1.4	52	11	85	8	< 10	9	< 20	41	16	16	36	78	8	< 3	77	< 10	54	34	99	584
32	0.9	57	8	109	7	11	< 5	26	34	12	10	35	60	6	< 3	89	< 10	50	28	114	759
33	0.9	50	11	74	< 5	< 10	6	24	23	13	10	15	60	7	< 3	95	13	39	30	27	632
34	0.9	59	11	76	7	< 10	7	22	25	11	10	27	65	7	3	71	< 10	49	20	47	582
37	0.9	32	14	98	5	28	6	36	18	11	< 7	37	47	4	< 3	59	< 10	33	22	88	928
38	0.5	46	10	84	8	< 10	8	22	31	10	< 7	24	66	9	< 3	75	< 10	50	24	50	556
39	4.8	53	24	180	7	196	13	20	38	11	46	530	90	13	17	160	< 10	100	31	1305	342

m = missing data

U - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
42	0.9	35	8	73	< 5	25	< 5	21	20	7	< 7	36	46	6	5	62	< 10	41	21	115	535
43	1.1	39	14	82	8	14	11	21	21	10	19	36	84	11	3	97	< 10	73	26	69	309
44	0.9	49	9	72	< 5	13	< 5	< 20	24	7	17	31	32	6	< 3	80	< 10	31	24	94	653
45	1.4	59	13	82	7	19	7	10	34	12	22	45	79	10	3	87	<10	55	33	91	540
46	1.5	61	11	71	< 5	15	11	< 5	32	17	24	31	71	8	< 2	67	10	52	32	72	528
47	2.6	95	15	124	< 5	24	9	16	47	18	44	109	71	9	5	62	11	66	35	257	582
48	2.0	60	16	94	6	28	8	7	34	15	34	49	56	7	8	64	11	54	37	127	635
49	2.8	40	9	66	< 5	12	8	13	44	17	22	30	60	8	< 2	68	13	37	36	85	621
50	2.0	67	11	68	6	16	8	15	14	15	12	35	56	7	5	66	11	38	24	87	536
51	2.3	71	13	104	6	16	13	11	46	20	36	30	76	11	3	56	12	72	34	90	485
52	1.5	67	13	75	< 5	16	9	10	29	15	28	27	63	8	< 2	48	9	85	28	88	411
53	1.8	64	13	109	< 5	19	5	13	29	16	19	29	44	9	3	54	9	91	28	125	711
54	2.0	50	21	104	8	18	11	9	45	17	43	51	74	9	7	66	9	73	33	190	550
55	2.0	64	17	125	7	15	15	11	36	18	46	31	85	12	< 2	64	14	90	33	94	432
56	3.1	76	17	127	< 5	26	11	8	27	20	57	81	78	10	9	67	11	69	34	227	523
57	2.8	77	20	125	7	22	14	15	48	18	60	46	86	11	3	65	9	80	34	206	493
58	2.3	57	15	126	5	15	13	12	43	19	44	33	71	11	< 2	53	10	80	28	111	524
59	2.8	103	22	134	8	13	14	6	60	19	51	33	89	12	3	67	7	94	33	130	443
60	2.8	85	26	94	8	18	17	6	62	20	41	42	99	11	< 2	76	16	78	36	173	448
61	2.6	84	18	109	< 5	18	14	16	44	21	28	43	89	11	3	68	12	83	36	149	589
62	1.5	43	6	71	7	22	6	< 5	34	14	23	46	51	7	4	61	10	52	22	302	424
63	2.6	77	16	99	11	15	13	14	44	19	46	37	85	10	5	65	8	80	29	111	455
64	2.8	56	18	137	7	22	13	8	43	18	51	57	87	12	7	63	10	72	31	148	466
65	1.5	84	6	151	6	10	9	15	44	21	23	12	52	7	< 2	52	7	143	31	58	890
66	1.8	44	7	65	< 5	22	7	11	17	13	15	92	42	5	5	57	7	64	22	303	462
67	2.8	83	17	257	8	50	16	< 5	41	18	63	46	99	13	4	73	14	88	32	246	361
68	2.0	75	18	110	7	17	18	12	48	16	66	41	100	12	6	65	13	98	31	141	328
69	2.8	62	9	86	< 5	< 10	9	9	38	17	21	30	71	8	3	71	15	50	36	74	700
70	3.3	86	29	118	5	32	15	5	47	19	39	71	92	13	14	86	14	86	34	192	459
71	3.8	63	15	105	23	85	11	9	36	13	48	252	72	13	14	118	13	144	33	2048	342
72	4.8	90	19	111	7	27	13	12	47	17	37	119	94	13	3	63	10	81	33	331	457
73	4.3	93	17	866	9	112	15	11	51	19	48	189	99	13	41	92	11	108	36	310	455
75	3.6	61	8	84	9	26	17	10	37	19	18	42	94	13	< 2	76	14	77	38	57	551

m = missing data

S - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
01	81.40	0.687	5.59	2.02	0.089	0.42	1.63	0.80	1.52	0.200	0.09	5.19	1.32	8	304
02	79.99	0.587	5.12	1.36	0.024	0.65	3.25	0.71	1.68	0.080	0.12	6.10	1.13	4	298
03	71.06	0.757	9.30	4.73	0.455	0.71	0.58	0.82	1.74	0.200	0.16	8.92	2.70	16	486
04	75.49	0.700	8.39	3.79	0.124	0.82	0.83	0.64	1.70	0.130	0.12	6.82	1.78	10	331
05	47.39	0.532	8.36	3.24	0.058	1.31	3.23	0.47	1.37	1.070	0.89	31.61	16.00	8	548
06	48.31	0.440	7.99	4.11	0.051	0.96	2.65	0.33	1.11	1.610	1.00	30.75	2.79	23	608
07	81.50	0.637	5.71	1.84	0.039	0.39	1.80	0.89	1.63	0.240	0.16	4.87	1.10	6	344
08	78.59	0.386	3.93	3.79	0.129	0.26	1.28	0.49	1.21	1.010	0.37	8.04	3.26	9	372
09	82.06	0.543	5.34	2.30	0.041	0.38	1.00	0.61	1.58	0.340	0.24	5.26	1.40	12	348
10	88.00	0.618	3.06	2.84	0.021	0.14	0.25	0.45	1.17	0.220	< 0.05	2.64	0.55	22	266
11	83.49	0.481	2.83	5.19	0.023	0.16	0.24	0.34	1.17	0.420	< 0.05	5.16	1.92	28	262
12	86.81	0.683	3.46	1.28	0.037	0.14	0.29	0.73	1.20	0.140	0.06	4.63	1.96	13	285
15	75.32	0.647	6.53	2.57	0.039	0.56	2.51	0.78	1.71	0.320	0.79	7.95	2.80	8	374
16	76.37	0.567	5.64	6.43	0.118	0.48	1.14	0.59	1.61	0.350	0.21	5.92	1.87	9	352
17	83.43	0.618	5.83	2.10	0.045	0.44	0.94	0.89	1.72	0.130	0.16	3.27	0.81	6	392
18	79.56	0.599	6.32	2.41	0.044	0.57	1.46	0.95	1.72	0.230	0.24	5.52	1.63	6	398
19	78.83	0.638	6.88	2.64	0.064	0.57	1.30	1.02	1.82	0.230	0.21	5.38	1.54	8	389
21	87.22	0.243	2.98	3.51	0.018	0.15	0.32	0.40	1.14	0.460	0.12	3.19	0.78	13	263
22	85.11	0.368	3.52	2.25	0.029	0.18	0.39	0.44	1.06	0.540	0.10	5.68	2.69	20	273
23	45.70	0.439	7.00	7.16	0.038	0.71	4.26	0.40	1.24	1.350	2.57	28.41	10.33	26	477
24	67.66	0.629	8.46	4.75	0.091	0.87	2.47	0.74	1.90	0.500	0.80	10.79	3.15	19	358
25	70.67	0.580	6.34	3.11	0.041	0.93	3.83	0.71	1.57	0.520	0.58	10.49	3.72	24	503
26	78.85	0.693	7.75	3.07	0.096	0.57	0.70	0.96	1.90	0.140	0.19	4.77	1.03	5	343
27	85.02	0.526	4.96	1.76	0.044	0.27	0.61	0.75	1.43	0.220	0.22	3.78	1.44	8	302
28	59.80	0.547	7.59	5.24	0.115	1.01	6.27	0.67	1.77	1.250	1.07	14.05	3.79	39	395
29	78.94	0.620	6.42	2.86	0.052	0.50	1.01	0.81	1.69	0.360	0.31	5.78	1.56	11	335
30	73.76	0.561	6.78	3.03	0.059	0.63	2.76	0.88	1.65	0.290	0.67	8.45	2.30	24	375
32	77.69	0.545	5.71	2.21	0.034	0.45	3.03	0.85	1.59	0.340	0.53	6.60	1.72	10	325
33	68.16	0.516	5.95	2.48	0.070	0.50	5.60	0.66	1.42	0.250	0.83	13.24	3.83	11	289
34	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
37	84.69	0.592	4.41	1.63	0.026	0.29	0.60	0.89	1.28	0.150	0.15	4.89	2.49	8	272
38	79.26	0.528	5.29	1.93	0.037	0.40	2.44	0.73	1.37	0.500	0.39	6.60	2.14	11	320
39	79.20	0.520	5.73	2.23	0.059	0.42	2.59	0.63	1.40	0.150	0.23	6.37	0.97	23	458

m = missing data

S - sample

Site	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MnO (%)	MgO (%)	CaO (%)	Na2O (%)	K2O (%)	P2O5 (%)	SO3 (%)	LOI (%)	Org. C (%)	As ppm	Ba ppm
42	86.82	0.407	3.99	1.48	0.020	0.22	0.61	0.58	1.29	0.230	0.19	3.77	1.61	4	293
43	73.76	0.452	7.14	2.94	0.048	0.65	2.88	0.80	1.70	0.410	0.41	8.59	1.83	8	311
44	76.70	0.567	5.77	2.23	0.055	0.65	3.53	0.76	1.46	0.180	0.23	7.67	1.49	7	291
45	63.43	0.643	8.82	4.34	0.058	0.74	2.76	0.72	1.79	0.850	1.35	14.09	5.61	9	538
46	72.39	0.744	8.12	3.21	0.112	0.77	2.71	0.80	1.78	0.190	0.15	8.61	1.63	5	368
47	59.44	0.694	10.18	5.20	0.175	0.88	3.53	0.52	1.86	0.337	0.35	16.41	5.74	17	443
48	71.13	0.659	6.34	7.80	0.121	0.70	2.66	0.66	1.39	0.284	0.19	7.70	1.73	10	291
49	77.51	0.585	4.95	2.29	0.053	0.53	4.25	0.61	1.40	0.124	0.12	7.16	1.34	5	259
50	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
51	69.81	0.995	9.78	4.37	0.130	1.22	0.91	0.70	1.68	0.226	0.20	9.69	2.61	6	315
52	81.00	0.573	6.06	3.09	0.106	0.59	0.66	0.26	1.18	0.155	0.15	5.92	1.50	13	238
53	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
54	74.30	0.770	9.69	3.65	0.083	0.92	0.70	0.80	1.80	0.123	0.15	6.74	1.90	8	332
55	68.63	0.877	9.99	4.10	0.111	0.95	0.51	0.54	1.72	0.235	0.09	11.96	4.36	23	371
56	72.97	0.722	9.02	4.28	0.144	0.78	1.10	0.53	1.62	0.218	0.18	8.10	2.33	11	362
57	73.93	0.840	9.95	4.42	0.139	0.91	0.36	0.76	1.73	0.169	0.04	6.47	1.62	15	326
58	74.58	1.000	9.21	3.34	0.109	0.86	0.35	0.54	1.67	0.161	0.03	7.89	2.78	12	325
59	76.76	0.905	8.98	3.34	0.093	0.94	0.35	0.82	1.64	0.135	0.05	5.74	1.80	11	300
60	64.76	0.775	12.57	6.44	0.797	0.76	0.49	0.60	2.39	0.192	0.07	9.80	3.09	28	591
61	67.18	0.758	10.27	4.49	0.173	0.76	0.47	0.44	1.90	0.325	0.05	12.86	4.84	21	408
62	71.28	0.642	7.06	3.19	0.107	1.67	2.28	0.28	1.72	0.291	0.30	10.84	3.03	10	304
63	79.11	0.717	7.51	3.13	0.131	1.13	0.78	0.35	1.97	0.117	0.09	4.69	1.02	7	328
64	66.24	0.795	11.83	4.97	0.221	1.26	1.09	0.56	2.23	0.209	0.17	10.13	2.73	11	475
65	75.97	0.896	5.82	2.85	0.123	1.21	2.19	0.26	1.29	0.191	0.20	8.56	2.38	7	238
66	86.90	0.519	3.17	2.14	0.039	0.62	1.57	0.20	0.83	0.128	0.17	3.38	0.50	6	177
67	65.31	0.823	12.68	4.93	0.171	1.23	0.76	0.71	2.22	0.300	0.12	10.37	3.36	13	698
68	66.77	0.795	13.00	5.81	0.363	1.29	0.32	0.72	2.23	0.182	0.03	8.20	1.99	12	432
69	80.86	0.583	5.92	1.63	0.028	0.54	2.02	0.64	2.13	0.124	0.13	5.03	1.15	3	365
70	75.82	0.823	8.97	3.92	0.398	0.62	0.38	0.49	1.65	0.174	0.03	6.44	1.96	21	376
71	60.79	0.504	6.88	13.64	0.120	0.55	3.98	0.39	1.32	0.763	0.51	10.10	2.20	42	380
72	69.89	0.699	9.98	4.99	0.136	0.93	0.98	0.55	1.84	0.206	0.20	9.21	2.84	15	444
73	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
75	69.69	0.832	11.75	5.29	0.025	0.50	0.20	0.61	2.06	0.124	0.03	8.62	3.44	46	340

m = missing data

S - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
01	0.2	67	< 7	78	< 5	14	5	< 20	27	9	9	26	51	6	< 3	68	17	34	25	106	739
02	0.2	48	< 7	59	< 5	12	< 5	< 20	34	9	10	27	53	5	5	68	13	30	29	88	612
03	1.4	108	28	433	< 5	47	10	< 20	61	14	53	68	75	10	11	69	27	67	34	376	685
04	0.6	58	14	172	5	12	9	< 20	40	13	91	77	63	9	8	57	11	58	34	197	596
05	7.2	58	14	175	6	194	12	< 20	25	7	49	342	53	8	70	79	< 10	49	28	1653	279
06	4.5	60	17	124	6	320	7	< 20	23	8	102	527	47	7	152	64	11	120	20	1429	256
07	0.3	45	< 7	82	< 5	23	< 5	< 20	33	12	14	26	55	7	8	78	11	38	20	177	731
08	1.7	28	11	1204	5	111	6	< 20	22	6	347	180	38	4	13	81	10	33	11	650	417
09	0.4	46	< 7	81	6	24	7	23	20	8	< 7	23	59	5	< 3	66	< 10	41	28	149	656
10	0.2	40	< 7	96	5	15	5	27	19	12	10	174	39	3	< 3	47	14	31	18	149	1327
11	1.4	38	< 7	93	< 5	12	6	39	25	7	9	33	39	4	7	43	< 10	43	19	221	1465
12	0.4	35	< 7	124	< 5	11	< 5	52	17	12	10	19	37	4	4	50	13	26	23	124	1781
15	1.1	61	12	96	< 5	28	8	24	29	11	16	111	63	7	4	111	11	45	33	210	751
16	2.3	67	10	80	7	< 10	7	27	28	12	7	21	61	7	< 3	71	< 10	60	28	33	666
17	0.7	42	10	83	6	< 10	< 5	< 20	30	13	12	56	59	6	< 3	81	< 10	38	26	65	739
18	1.1	50	8	79	7	27	< 5	< 20	23	12	11	50	62	6	3	92	< 10	49	26	110	604
19	0.9	70	13	120	6	28	10	27	34	11	25	67	65	7	< 3	85	< 10	49	30	145	594
21	0.5	19	11	31	< 5	< 10	< 5	< 20	13	7	< 7	16	36	2	< 3	50	< 10	25	12	131	302
22	0.5	38	11	46	< 5	19	< 5	24	17	8	7	27	34	4	< 3	50	< 10	28	17	187	638
23	5.0	50	18	170	5	459	6	< 20	25	10	64	405	50	6	31	231	< 10	96	19	1673	313
24	2.3	68	12	98	6	56	10	21	19	13	20	64	82	9	4	107	11	64	25	293	482
25	4.5	51	34	121	7	154	6	< 20	28	8	43	511	56	7	21	122	< 10	63	27	951	514
26	0.9	45	9	77	7	< 10	7	< 20	41	14	18	22	70	8	< 3	75	< 10	63	31	39	569
27	1.1	46	< 7	75	< 5	16	< 5	30	20	11	< 7	36	50	4	< 3	72	< 10	37	21	86	968
28	6.8	49	10	188	7	118	9	26	38	11	36	144	71	10	11	240	10	71	30	631	387
29	5.0	43	13	84	6	20	< 5	< 20	36	11	17	62	61	7	5	79	< 10	52	30	825	669
30	3.9	48	13	101	6	36	6	29	31	11	15	120	64	7	7	85	11	55	25	779	488
32	1.4	38	8	135	7	34	< 5	22	8	9	16	50	52	7	< 3	167	< 10	39	23	199	554
33	4.1	43	13	85	5	52	7	< 20	23	9	19	79	56	7	3	125	< 10	44	24	350	433
34	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
37	0.5	44	< 7	107	6	< 10	< 5	33	22	12	< 7	37	42	4	3	63	< 10	38	24	117	1316
38	0.9	48	15	101	5	38	5	29	17	10	16	50	46	6	6	108	< 10	35	22	351	744
39	1.8	45	16	111	5	31	7	23	24	7	11	137	55	7	9	98	< 10	37	20	290	696

m = missing data

S - sample

Site	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Ga ppm	Hf ppm	La ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sc ppm	Sn ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm	Zr ppm
42	0.9	39	10	64	< 5	23	< 5	21	7	9	< 7	34	43	4	3	68	< 10	32	13	176	526
43	1.4	42	10	61	6	21	7	10	19	8	11	31	67	8	< 3	117	< 10	51	19	94	307
44	1.1	50	< 7	73	6	18	< 5	10	23	10	14	36	51	7	< 3	90	< 10	39	30	106	593
45	2.3	70	13	116	9	74	13	32	43	14	39	168	73	9	10	144	12	72	29	771	492
46	2.3	55	11	78	6	15	9	9	43	18	28	26	72	7	11	76	12	52	36	103	638
47	3.1	54	23	95	8	28	11	< 5	44	17	45	102	83	12	7	89	14	78	32	297	381
48	2.0	68	12	93	5	31	9	15	37	18	32	58	55	8	9	70	11	64	40	153	703
49	1.8	51	7	61	< 5	< 10	7	18	22	18	11	30	45	5	4	66	12	33	29	68	684
50	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
51	2.6	66	12	114	8	15	13	17	56	19	43	37	81	12	10	64	10	70	30	158	496
52	2.0	71	13	72	6	< 10	8	< 5	24	14	26	15	53	7	< 3	44	6	50	24	93	469
53	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
54	2.3	54	18	99	6	16	11	< 5	37	18	34	35	79	10	4	67	15	62	34	112	509
55	2.3	73	19	117	8	20	12	< 5	44	17	48	39	80	10	4	69	10	73	37	233	431
56	2.8	66	18	141	6	33	11	10	51	16	52	88	76	10	21	69	10	69	34	256	610
57	2.8	74	18	138	8	19	14	9	48	18	52	42	78	10	2	63	13	81	33	153	580
58	3.3	59	18	132	10	15	12	10	47	21	50	28	74	11	4	57	8	72	31	147	573
59	2.8	71	11	103	6	16	11	15	48	20	48	23	68	9	5	64	10	67	33	125	603
60	6.4	94	49	84	10	30	18	< 5	51	18	74	43	105	11	5	84	14	89	38	349	367
61	4.8	79	32	124	< 5	31	14	6	41	19	47	44	82	12	< 2	64	12	70	35	316	496
62	2.3	51	11	86	8	34	11	10	46	14	28	38	67	9	< 2	79	10	58	26	241	538
63	2.0	108	9	96	8	11	12	< 5	53	15	37	25	70	8	5	57	12	56	28	76	517
64	3.1	69	21	128	6	28	18	9	45	19	64	64	94	11	5	83	14	87	30	176	327
65	1.5	84	12	103	9	23	9	18	51	17	32	63	54	8	6	78	10	55	32	573	768
66	1.3	57	3	64	6	15	< 5	12	27	14	16	25	34	5	2	54	9	43	22	141	744
67	4.3	94	16	280	8	57	16	8	43	17	79	48	100	15	2	81	11	95	33	335	326
68	2.0	68	20	112	6	25	17	< 5	38	17	69	38	104	12	6	68	14	89	32	179	332
69	2.3	48	3	64	5	< 10	7	15	27	18	13	27	58	5	< 2	66	10	28	25	94	647
70	3.1	49	22	114	7	26	13	10	30	18	34	49	68	10	10	76	7	66	37	202	537
71	3.6	52	15	106	18	46	7	6	28	13	44	104	61	12	14	127	10	118	32	818	444
72	7.1	133	21	112	7	48	13	7	79	17	40	263	80	10	13	65	10	69	35	522	496
73	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
75	3.8	71	3	83	6	22	15	11	58	20	22	41	92	13	4	74	14	90	37	56	543

m = missing data

Elements with concentrations below detection limits and/or missing data in more than 50% of the samples																								
	L - sample								U - sample								S - sample							
Site	Cl	F	Bi	Mo	Sb	Ta	U	W	Cl	F	Bi	Mo	Sb	Ta	U	W	Cl	F	Bi	Mo	Sb	Ta	U	W
	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	ppm	ppm	ppm	ppm
01	m	m	m	<5	m	<10	<7	<10	m	m	m	7	m	<10	<7	<10	m	m	m	7	m	<10	<7	<10
02	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
03	m	m	m	<5	m	<10	<7	<10	m	m	m	5	m	<10	<7	<10	m	m	m	7	m	<10	<7	11
04	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	11	m	<10	<7	<10
05	m	m	m	<5	m	<10	<7	<10	m	m	m	6	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
06	m	m	m	m	m	m	m	m	m	m	m	5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	11
07	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	11
08	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	29	m	<10	<7	<10
09	m	m	m	17	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
10	m	m	m	33	m	<10	<7	11	m	m	m	5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
11	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	6	m	<10	<7	<10
12	m	m	m	9	m	<10	<7	<10	m	m	m	10	m	<10	<7	<10	m	m	m	10	m	<10	<7	<10
15	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	13	m	m	m	<5	m	<10	<7	<10
16	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
17	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	14	m	m	m	<5	m	<10	<7	<10
18	m	m	m	<5	m	<10	<7	13	m	m	m	<5	m	<10	<7	16	m	m	m	<5	m	<10	<7	<10
19	m	m	m	<5	m	<10	<7	15	m	m	m	<5	m	11	<7	10	m	m	m	<5	m	<10	<7	12
21	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
22	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
23	m	m	m	<5	m	<10	<7	12	m	m	m	<5	m	<10	<7	<10	m	m	m	7	m	<10	<7	13
24	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
25	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	17
26	m	m	m	<5	m	<10	<7	14	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
27	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
28	m	m	m	<5	m	<10	<7	10	m	m	m	<5	m	<10	<7	17	m	m	m	<5	m	<10	<7	<10
29	m	m	m	<5	m	<10	<7	12	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
30	m	m	m	<5	m	<10	<7	13	m	m	m	<5	m	<10	<7	14	m	m	m	<5	m	<10	<7	<10
32	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	11
33	m	m	m	<5	m	<10	<7	12	m	m	m	<5	m	<10	<7	11	m	m	m	m	m	m	m	m
34	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	12	m	m	m	<5	m	<10	<7	<10
37	m	m	m	<5	m	12	<7	<10	m	m	m	<5	m	<10	<7	13	m	m	m	<5	m	<10	<7	<10
38	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	11
39	m	m	m	<5	m	<10	<7	10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10

m = missing data

Elements with concentrations below detection limits and/or missing data in more than 50% of the samples

Site	L - sample Cl	F	Bi	Mo	Sb	Ta	U	W	U - sample Cl	F	Bi	Mo	Sb	Ta	U	W	S - sample Cl	F	Bi	Mo	Sb	Ta	U	W
	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	ppm	ppm	ppm	ppm
42	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	<10
43	m	m	m	<5	m	<10	<7	<10	m	m	m	<5	m	<10	<7	11	m	m	m	<5	m	<10	<7	<10
44	m	m	m	<5	m	<10	<7	12	m	m	m	<5	m	<10	<7	10	m	m	m	<5	m	<10	<7	13
45	m	m	m	<5	m	<10	<7	13	m	m	m	<5	m	<10	<7	15	m	m	m	<5	m	<10	<7	10
46	0.01	<0.02	<5	<3	8	<5	4	5	0.01	<0.02	<5	<3	9	7	<3	<5	0.01	<0.02	<5	3	<5	<5	5	<5
47	0.01	<0.02	<5	<3	12	<5	6	6	0.01	<0.02	<5	<3	<5	8	<3	<5	0.01	<0.02	7	<3	13	<5	3	<5
48	0.01	0.27	<5	4	<5	<5	<3	<5	0.01	<0.02	<5	<3	9	<5	<3	<5	0.02	<0.02	<5	<3	14	<5	<3	<5
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55	0.03	<0.02	<5	<3	<5	7	4	7	0.02	<0.02	<5	<3	<5	<5	5	<5	0.02	<0.02	<5	3	6	<5	5	<5
56	0.01	<0.02	<5	<3	<5	<5	<3	<5	0.01	<0.02	<5	<3	7	6	<3	<5	0.01	<0.02	<5	<3	5	<5	5	<5
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75	0.01	<0.02	6	3	5	9	6	<5	0.01	<0.02	<5	5	7	<5	4	6	0.01	<0.02	<5	5	7	9	4	<5

m = missing data