CHARACTERIZATION OF THE MINHO AND GALICIA SHELF SEDIMENTARY COVER

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1. OBJECTIVES

In the OMEX II the UAlg team is working to acquire a better knowledge on the sedimentary cover and evolution of the Minho/Galicia margin, i.e. it's chemical composition of the sediments, diagenetic processes affecting organic matter fractions including improved time scale for the long and complex process of organic carbon immobilisation.

In order to perform these studies a serie of analyses are being executed, namely sediment grain-size, composition and geochemistry, hydrolisable amino acids, total carbon, inorganic carbon, organic carbon and nitrogen. Data on seismic reflection profiles are also being used.

2. PERFORMED WORK

2.1. Compilation and analysis of existing data

2.1.1. Sedimentological data

An effort was done in order to get all the possible information of previously acquired sedimentological data. Difficulties were find in having access to some information mainly because original samples have been lost. A strong asymmetry between the knowledge on the Minho and Galicia shelves was found. This asymmetry is related to different sampling strategies and to different analytical procedures. As a matter of fact, sampling density is much higher on the Minho shelf. Also, sedimentological analyses were much more comprehensive in this shelf. Since these data were obtained during cruises performed in the 80's, it was not possible in general to recover original sampling in order to carry out new analyses.

However, it was possible to cross several sedimentological parameters with the integrated maps from the Minho/Galicia shelf were produced.

2.1.2. Seismic data

In what concerns light seismic reflection profiles, information is denser on the Galician shelf. Interpretation criteria were also different on both shelves. Nevertheless an integration effort was done leading to the production of a general surficial seismic unit isopac map.

2.1. Sampling

2.1.1. RRS Charles Darwin cruise 110, leg A

The OMEX team from the University of Algarve was only given the opportunity of participating on the RRS CHARLES DARWIN CRUISE 110, leg A (23 December 1997 to 5 January 1988). The bad weather conditions during the cruise did not allowed, in general, the recovery of sufficient material in quantity and quality to perform most of the proposed analytical tasks. During this cruise 4 sets of multicores and 1 Kasten core were collected "successfully" on the continental margin in the OMEX area (Table I). Shipeck grab samples were also collected. From 110 attempts only 37 were successful (Fig. 1). The remaining attempts did not yield enough material to be analysed or did not have any material.

2.1.2. CORVET 96 cruise

The participation on the CORVET 96 cruise, in November 1996, on board of the R.V. ALMEIDA CARVALHO, allowed the collection of 44 samples (Fig. 2) of superficial sediments on the Portuguese shelf (between 41º 05´ and 41º 52´) for geochemical analysis.

All the referred samples are being analysed at Present.

2.2. Analysis

2.2.1. Carbon, Nitrogen and Amino Acids Analysis

Samples collected during CD 110 cruise are now being analysed in a gas chromatography device for Carbon and Nitrogen contents. Amino Acids analysis is carried on the fluorescent derivatives of the amino acids (Lindroth & Mopper, 1979) in a reverse phase HPLC column. Major improvements are the addition of 3 recovery standards for the hydrolysis process (aminopimelic acid, hydroxyl-lysine and methyl-threonine) and a change to a new chromatography column with better peek resolution and short elution time.

2.2.2. Amino Acids Racemization and Sediment Dating

The samples provided by the Kasten core (W90K) are being analysed for the amino acid racemization (aspartic acid) of foraminifera shells. Analyses will be performed in an amino acid analyser and racemization/epimerization ratios of some amino acids will be calculated.

2.2.3. Grain-size, Coarse Fraction and Mineralogical Analysis

The samples collected during CD 110 are being analysed for grain-size, coarse-fraction, mineralogical and morphometric studies using standard methodologies.

2.2.4. Elemental analysis

Sample preparation and analytical procedures were accomplished according to a previously reported procedure (Araújo *et al.*, 1994). Chemical analyses have been carried out by energy-dispersive X-ray fluorescence spectrometry (EDXRF) for 16 elements (Al, Si, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Rb, Sr, Y, Zr and Pb). The accuracy and precision of the overall procedure are usually better than 10%.

3. OBTAINED RESULTS

3.1. Amino acids, carbon and nitrogen

The data from the total carbon, inorganic carbon, organic carbon and nitrogen analyses are being processed and the amino acids analysis are waiting for instrument time.

The racemization/epimerization analysis depends on the separation of a large amount of foraminifera shells from the same specie and that represents difficulties on the W90K kasten core due to the diversity of species in the samples. The samples from this core, in a preliminary analysis, possibly due to the proximity with the continent, present a large diversity of benthonic and planktonic species.

3.2. Sedimentary dynamic

Sedimentary dynamics on the Minho shelf is quite well studied (e.g.: Dias & Nittrouer 1984, Dias, 1987, Magalhães 1993 and Magalhães *et al*., 1995). At the Galicia shelf, beside the work of Rey (1993) there is no much information. The only part well studied on this shelf are the *rias* of Pontevedra (Vilas et al., 1996), Vigo (Vilas et al., 1995) and Arosa (Rey, 1993).

In order to have a better understanding of the Minho and Galicia shelves and upper slope, a first draft of sedimentary cover map was produced. Distribution maps of several sedimentological parameters were also drawn.

Analyses of these maps (fig. 3 to 6) show a net contrast between the Minho and Galicia shelves. The former is dominated by coarser fractions whether the latter is mostly muddy.

This contrast is evident in the **gravel** distribution map (fig. 3). Gravel on the Galician shelf is almost absent. In Minho shelf gravel percentage in samples often reach values higher than 50%. This contrast is certainly related to the different types of coast. As a matter of fact, the Galician coast is a submerged one (rias type); on the contrary, the Minho coast is an emerged one with a well developed wave-cut platform now in a subaerial position. The Galician rias work as efficient traps for coarse sediment, therefore gravel and coarse sand are deposited before reaching the shelf. Since coarse sediments on the Minho shelf are related to paleo-processes (old coastlines and ebb river deltas), it seems that this contrast and differential behaviour is persistent through time, or that these remnants of past environments are now covered by the present fine sedimentation on the Galician shelf.

This contrast between the Minho and Galicia shelves is also evident in the sediment **mean grain size** distribution map (Fig. 4). It is clear that in the Minho shelf there is a dominance of coarser material, while at the Galicia shelf the fine material is dominant. It is evident in this map the suggestion of two alignments of coarser sediment on the Minho shelf. Accordingly to Dias (1987) they correspond respectively to the first phase of deglaciation and to the Younger Dryas paleolittorals (the deeper one at around 100 m, and the shallower one at around 60 m deeper). These paleolittorals can be followed southward. However, they were not identified on the Galician shelf until now.

The contrast between the Minho and Galicia shelves sedimentary environments is also evident in the **mud** distribution map (Fig. 5). As expected, the percentage of mud at the Galicia shelf is much higher than at the Minho shelf. At the Minho shelf there are two main deposits (that can be expressed by the 90% isoline), one off Douro/Ave river mouths, at approximately 100 m water depth, and another, the Minho one, also around 100 m water depth, that continues northward, apparently dominating most of the Galician shelf. On the Minho shelf, dating on these mud deposits (Drago, 1995) revealed their recent origin (slightly older than 3 000 years). Also, accumulation ratios (e.g.: Carvalho & Ramos, 1990; Drago *et al*., 1994) indicate that they are active nowadays. Interpretation of this map enable the conclusion that these deposits work as sediment traps for the fine sediment exported by the rivers from Minho area and from the Galician rias. The fact that these deposits occur on the Galician shelf at shallower depths, reaching the rias, and on the Minho shelf they are present only below 100m water depth can be explained by different supply and distribution processes on both shelves.

This apparent northward shallowing of the muddy deposits is well expressed in the **dominant fraction** distribution map (fig. 6).

The **isopacs** map representing the surficial seismic unit (Fig. 7), presumably corresponds to the Holocene sedimentation. In spite of some lack of accuracy on the used data, it is still evident a significant contrast between Minho and Galicia shelves. At the Minho shelf the seismic unit seems to have a tendency to higher thickness then at the Galicia one. If this is confirmed in the future, this is a surprising result since the Galician shelf is submerging as is proved by the presence of the rias. However, tectonic effects could change this behaviour on the outer shelf (e.g.: the active Porto-Tomar fracture zone detected in the Minho shelf).

3.3. Geochemistry

Elemental analyses of the superficial sediments by EDXRF, allow to differentiate several types of sediments, which composition is related with the origin of the deposited material (terrigeneous and biogenic) and different grain-size fractions. In Table II are listed the ranges of variation (min – max) of the measured concentrations in the 44 samples as well as the values determined for the samples collected in the two mud fields. With the purpose of identification the anthropogenic influences on the shelf sediments, the values of the average shale (Salomons e Förstner, 1984), usually considered as non-polluted sediments are presented. The quartz and carbonate distribution obtained by X-ray diffraction are plotted in Fig. 8. In Figures 9 to 16 are plotted the elemental distributions of the Al, Si, Ca, Cu, Zn, Sr, Zr and Pb, that have exhibited the largest content variations in the shelf sediments.

In the case of the major elements, Si concentrations of the analysed sediments were found to be highly variable (18.03 – 36.03 %), with the higher values in the sediments of the inner and middle shelf. The Si concentrations decrease away from the coastline, which agrees with the quartz distribution, obtained by X-ray diffraction. Also, the Ca distribution varied appreciatively, ranging between 1.17 and 15.34 %, and in this case the highest concentrations were found in the outer shelf. The calcite concentration increases away from the coastline. Probably, this is a consequence of the presence of biogenic coarse shell remains (mostly calcium carbonate) (Libes, 1992). A high positive correlation was found between Ca and Sr (r = 0.90), due to the fact that both elements have the ability to form carbonates, that are present in these samples (Greenwood e Earnshaw, 1984).

Elemental distribution of the heavy metals does not show significant variations, being the concentrations related with the sample grain size. This concentrations are within the values usually refereed as background, showing no antropogenic influences in the shelf sediments. The Zr content in the sediments near the coast is higher, probably due to a faster deposition of the terrigenous heavy minerals ($ZrSiO_4$) (Cascalho e Galopim de Carvalho, 1993).

Elemental distribution in the two mud fields seems to be rather identical for all major, minor and trace elements suggesting a similar origin of the deposited material.

4. OTHER ACTIVITIES

The UAlg team prepared the WP3 Meeting/Workshop from April, 5th to 7th, 1998. Integrated in this workshop a field trip was organized together with the “Algarve Coast Field Trip Guide “.

5. FUTURE WORK

5.1. Compilation and analysis of existing data

The effort on getting data and samples previously collected will continue. Complementary data have already been acquired.

5.2. Sampling

Gathering of new sample sets is essential to complete the maps already produced as well as to determine variations on the sedimentary cover since the 80’s. It will be important to obtain samples in winter and summer cruises in order to characterise seasonal variations on supply and distribution processes. In order to fallfill this objective, participation on the following cruises is already scheduled: GAMINEX cruise (09/07/98 - 19/07/98); PELAGIA cruise (30/07/98 - 17/08/98); METEOR cruise (December 1998/January 1999); September Instituto Hidrográfico cruise. Nevertheless, those cruises are not still enough to get the appropriate sampling to completely reach the proposed results, reason why this team already asked for a bigger cooperation of the other project partners, including the access to the cores gathered during 1997 PELAGIA cruise

5.3. Results

Results on the sampling analyses of the CD 110 cruise will be available very soon. As soon as the core samples from the 1997 PELAGIA summer cruise are available, the analytical procedure will start. Integration of these data with the existing ones will enable a reinterpretation, enlargement and enhancement of previously developed models on the shelf sedimentary dynamics and evolution.

As expressed in the technical annex and following an already tradition cooperation between the University of Algarve, the Instituto Hidrográfico and the University of Bordeaux I, results of the several kind of analysis that are being performed in these institutions will be jointly interpreted, taking profit of the different skills of each member of this research team.

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Table I . Charles Darwin CD110 core collection data.

Name	*Type*	*Date*	*Latitude*	*Longitude*	*Depth(m)*	*Comments*
W90K	Kasten	24/12/1997	41º21´38	08º59´53	87	77cm 5 samples
W90M	Multi.	24/12/1997	41º22´58	08º59´35	86	15-30cm 22 samples
S300M	Multi.	27/12/1997	42º09´39	09º18´05	210	30-33cm 28 samples
S90M	Multi	28/12/1997	42º09´06	08º57´19	91	30cm 25 samples
U110M	Multi	29/12/1997	41º47´50	09º05´47	112	30-33cm 28 samples

Table II . Elemental composition of the sediment samples collected during CORVET 96 (min.-max.) and Average shale values (Salomons e Förstner ,1984)(values in mg/kg, unless otherwise indicated)

Elements	**CORVET 96 (44 samples) (min.- max.)**	**"Douro" mud field (11 samples) (min.- max.)**	**"Minho" mud field (3 samples) (min.- max.)**	**Average shale**
Al (%)	2.88 - 6.26	4.34 - 6.12	4.98 - 5.32	8.0
Si (%)	18.03 - 36.03	23.30 - 30.25	26.89 - 30.57	27.3
K (%)	1.46 - 2.14	1.86 - 2.13	1.97 - 2.01	2.7
Ca (%)	1.17 - 15.34	1.39 - 3.54	1.86 - 3.93	2.2
Ti (%)	0.11 - 0.54	0.27 - 0.39	0.31 - 0.37	0.5
Cr	18 - 77	22 - 77	70 - 77	90
Mn	149 - 385	212 - 335	222 - 242	850
Fe (%)	1.54 - 3.31	1.78 - 2.93	2.53 - 2.85	4.7
Ni	13 - 39	19 - 37	23 - 27	68
Cu	8 - 26	13 - 24	19 - 23	45
Zn	28 - 77	46 - 77	61 - 66	95
Rb	74 - 167	134 - 164	129 - 149	-
Sr	131 - 439	134 - 226	176 - 212	140
Zr	155 - 1300	215 - 418	262 - 360	160
Pb	15 - 50	24 - 50	27 - 47	20

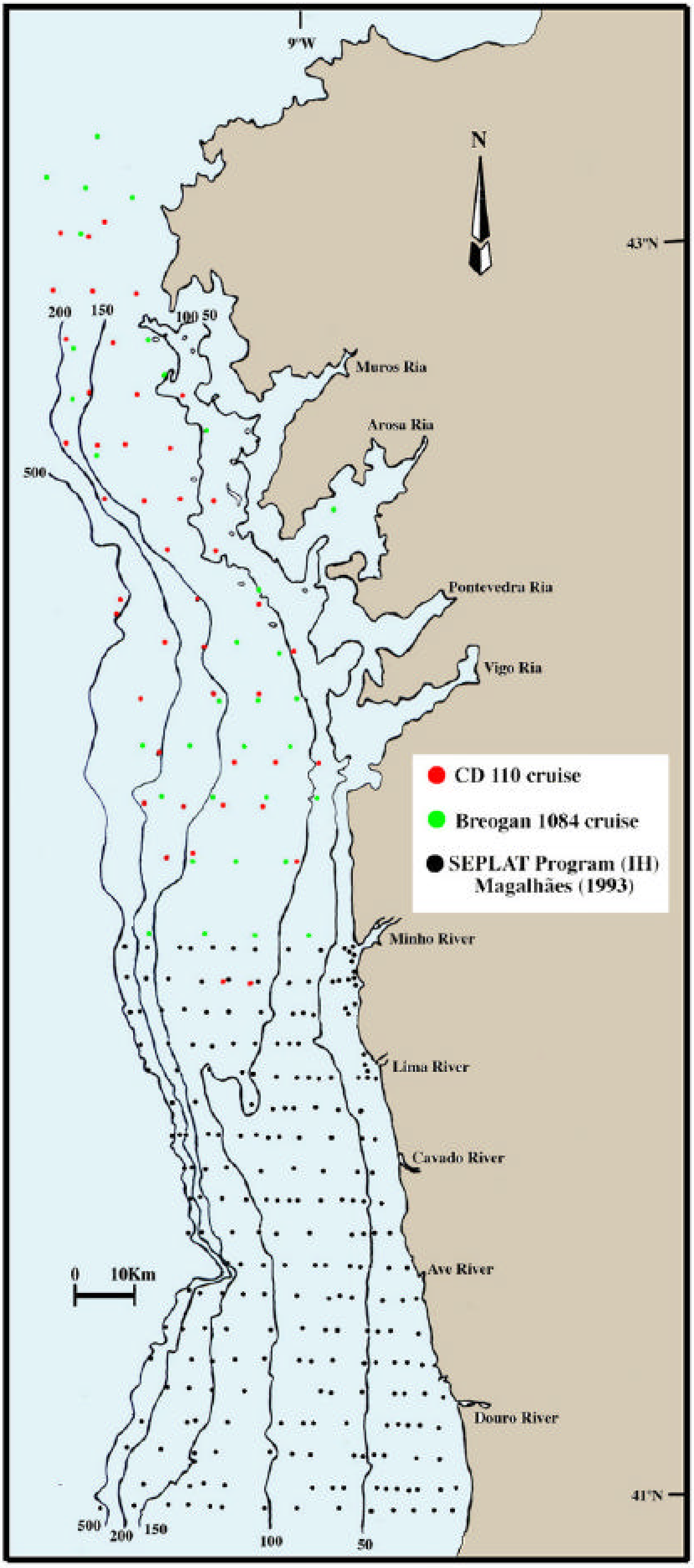


Fig. 1. Sample location

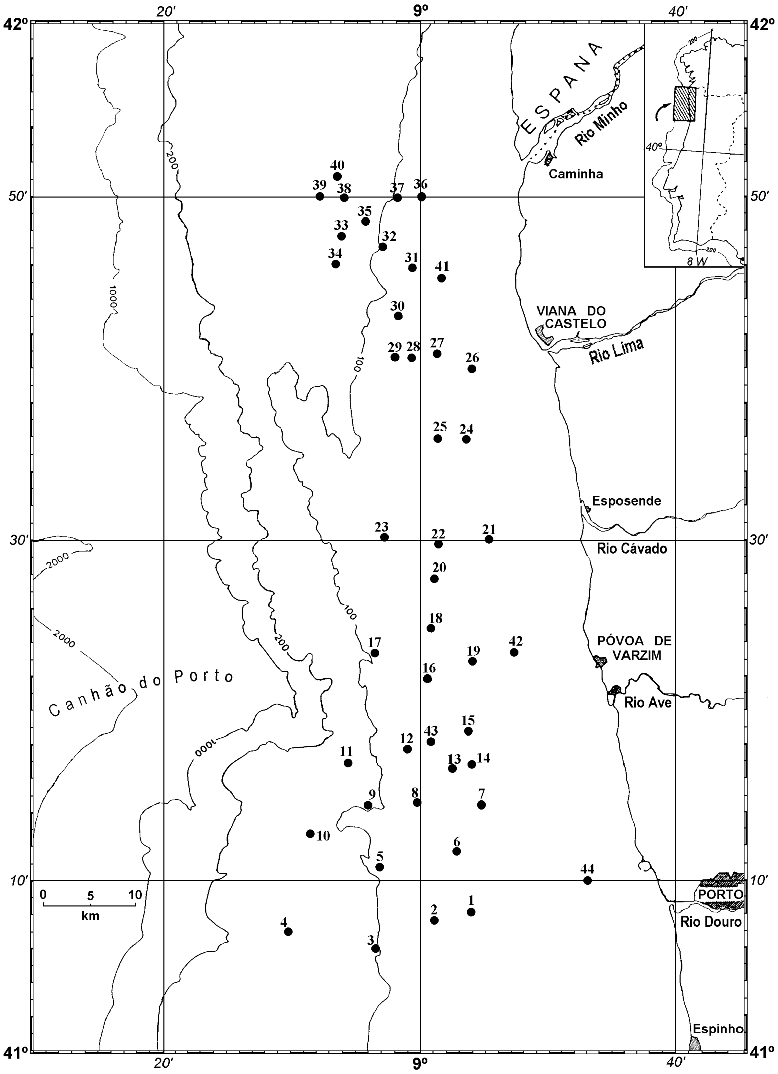
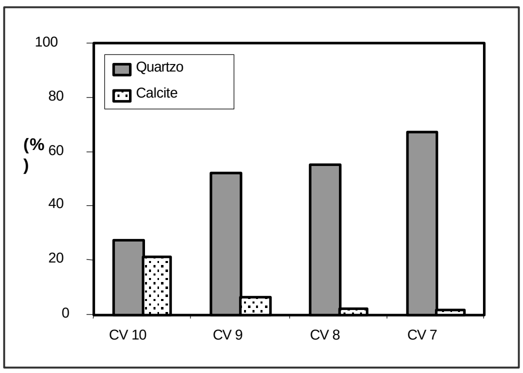


Figure.2. Sampling locations on the Portuguese shelf.

a)



b)

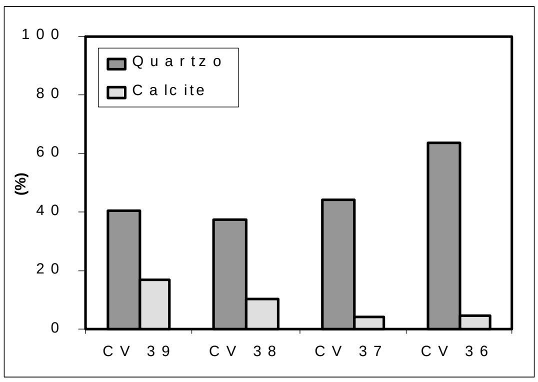


Figure 8. Quartz and calcite distribution:
a) “Douro” mud field; b) “Minho" mud field

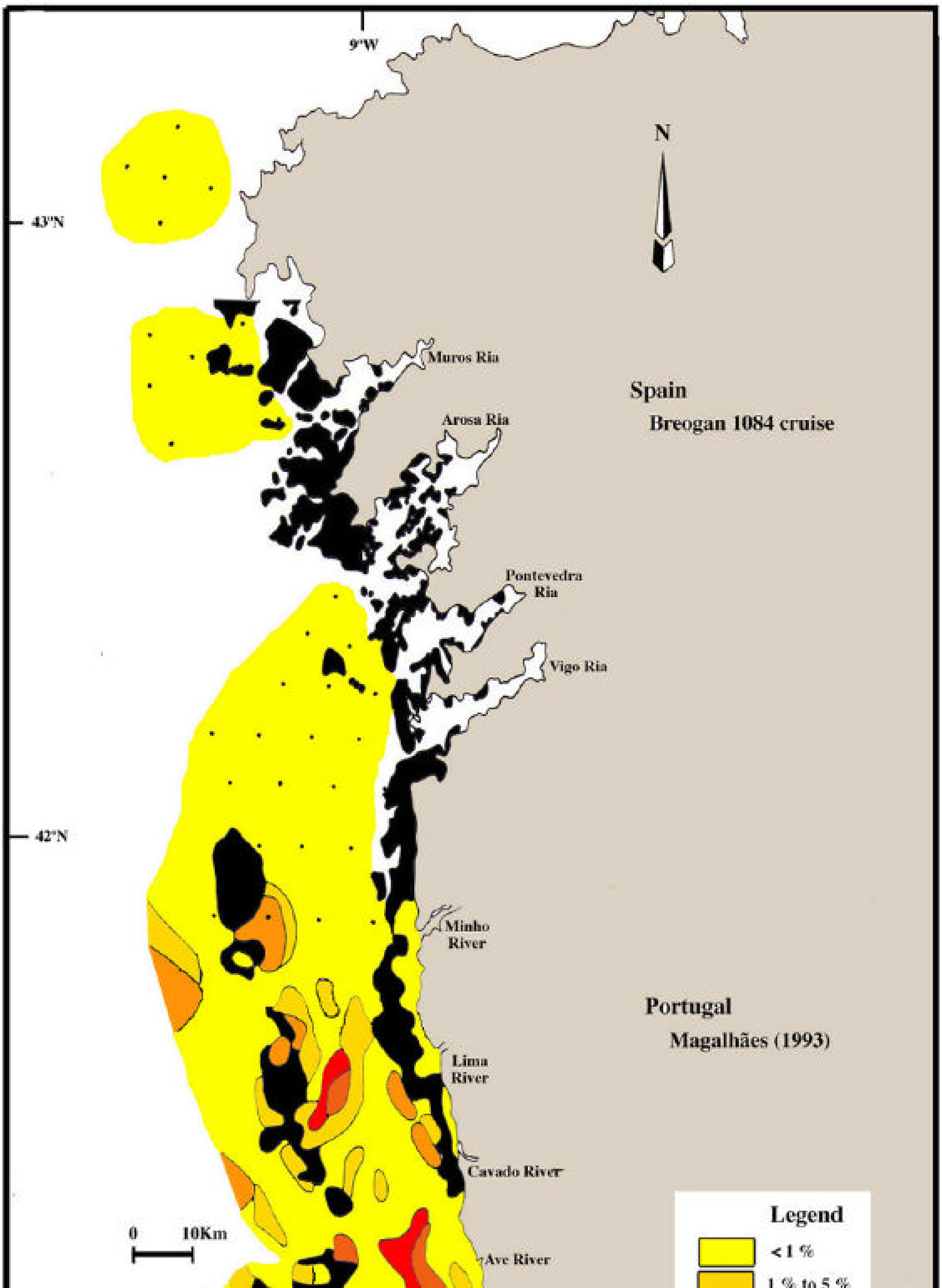


Fig. 3. Gravel fraction dominance

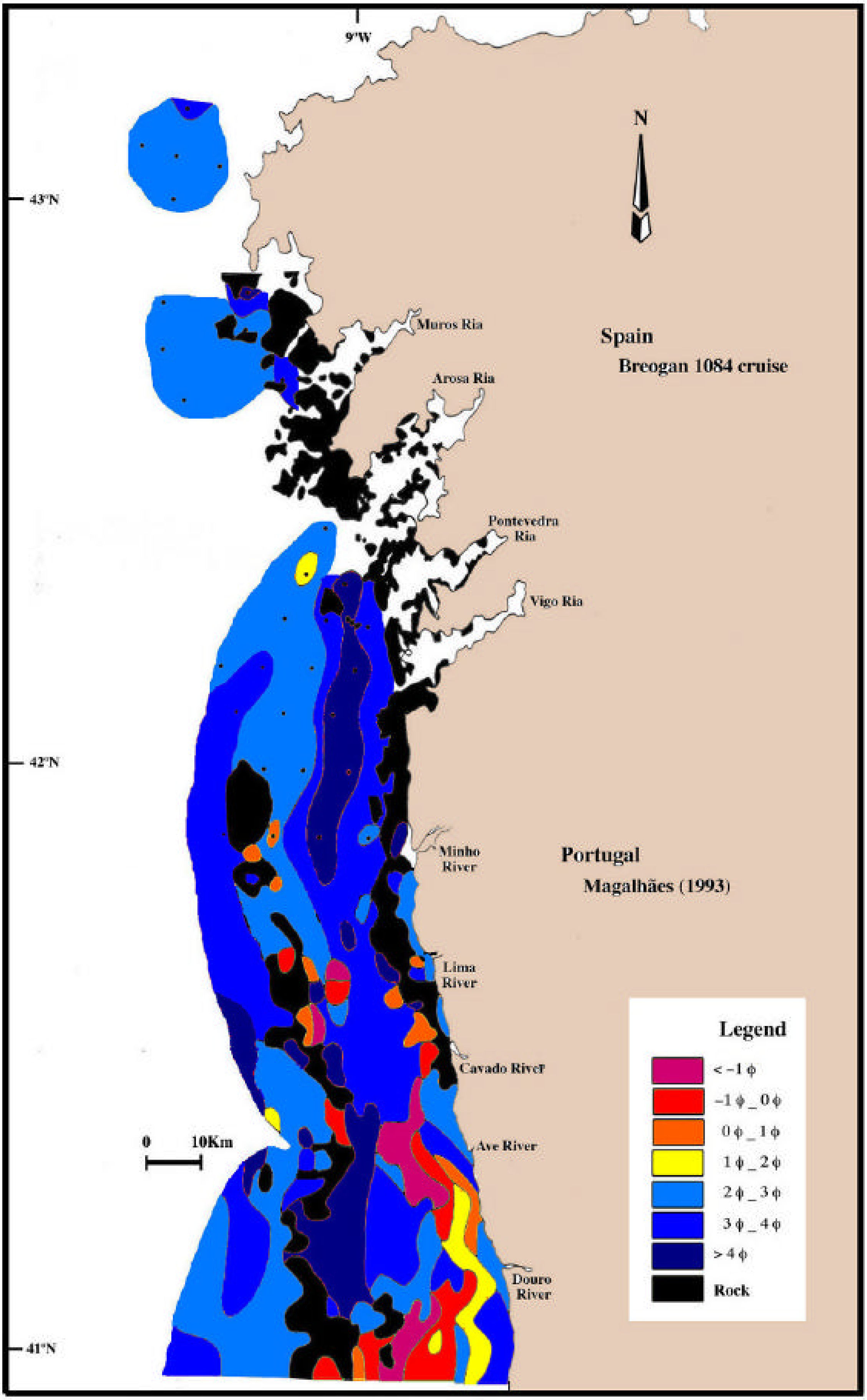


Fig. 4. Mean grain-size

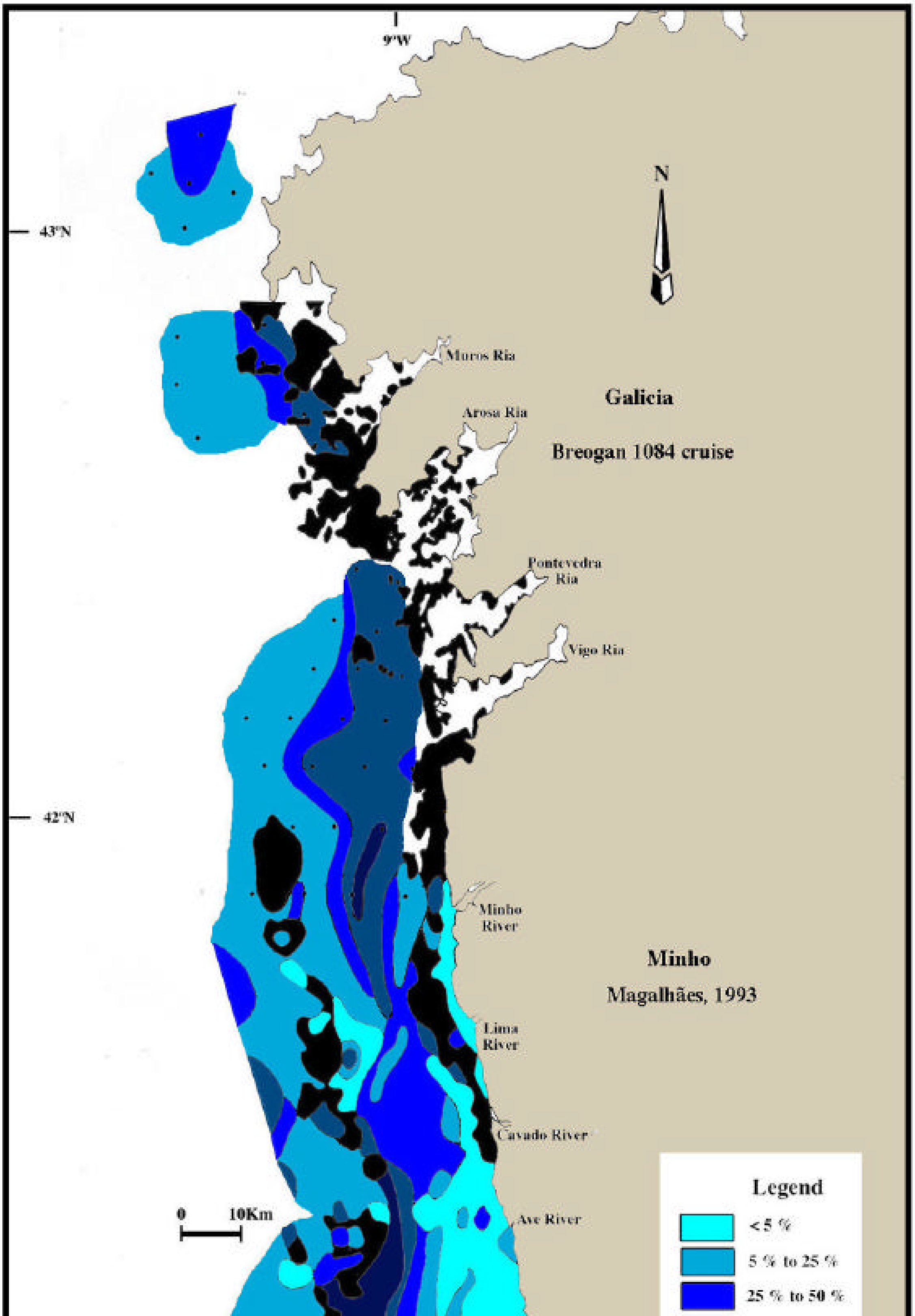


Fig. 5. Fine material dominance

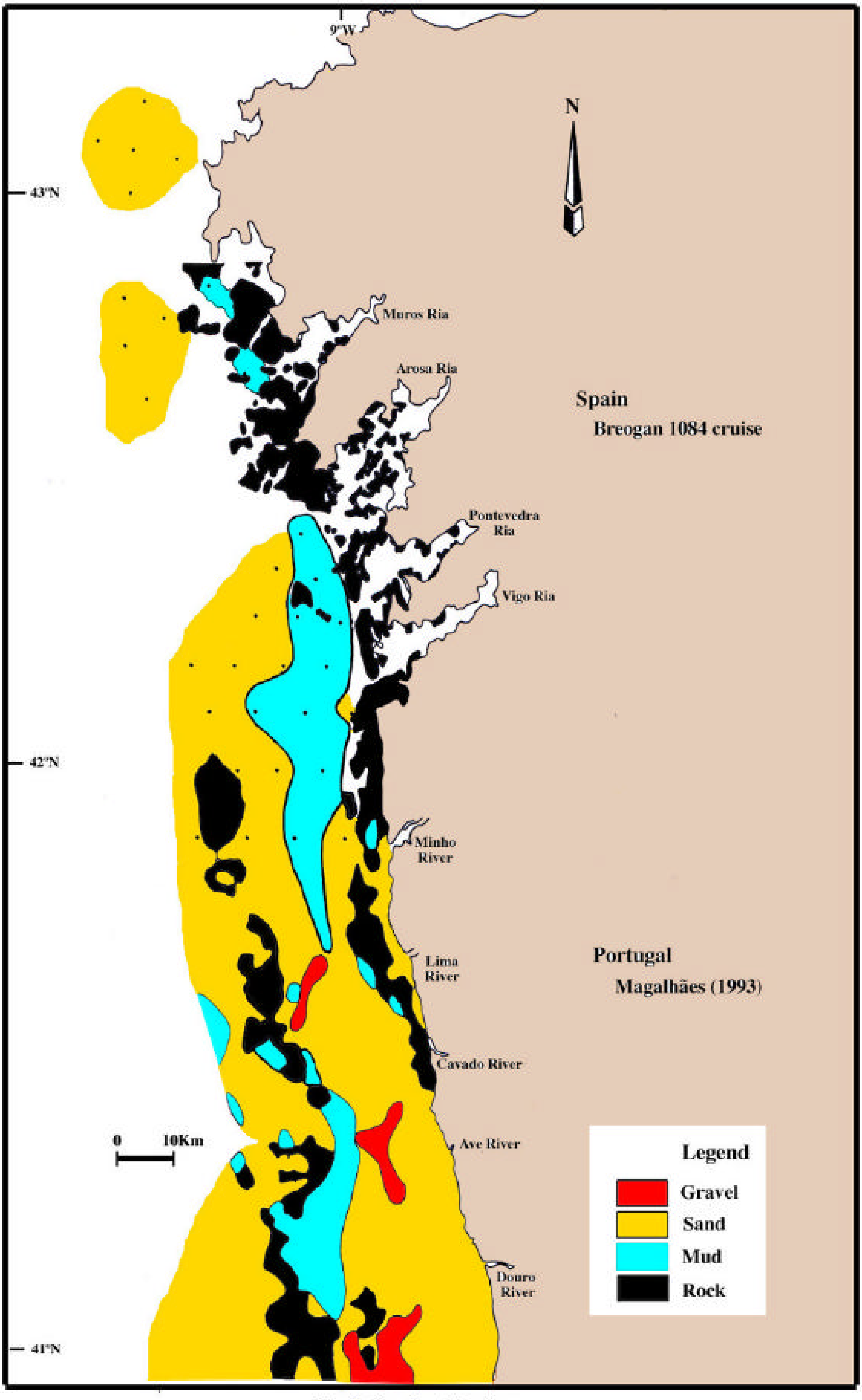


Fig. 6. Dominant fraction

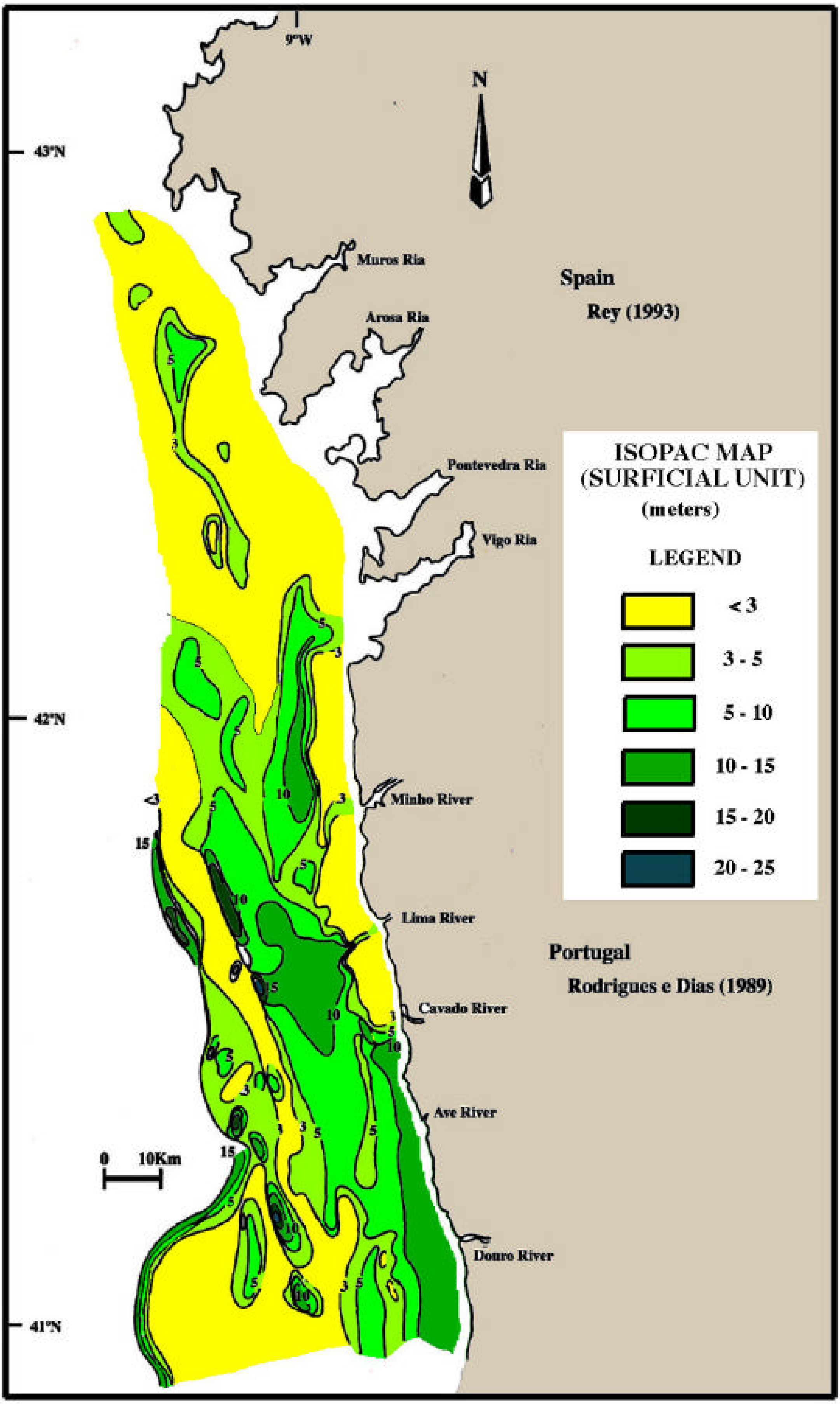
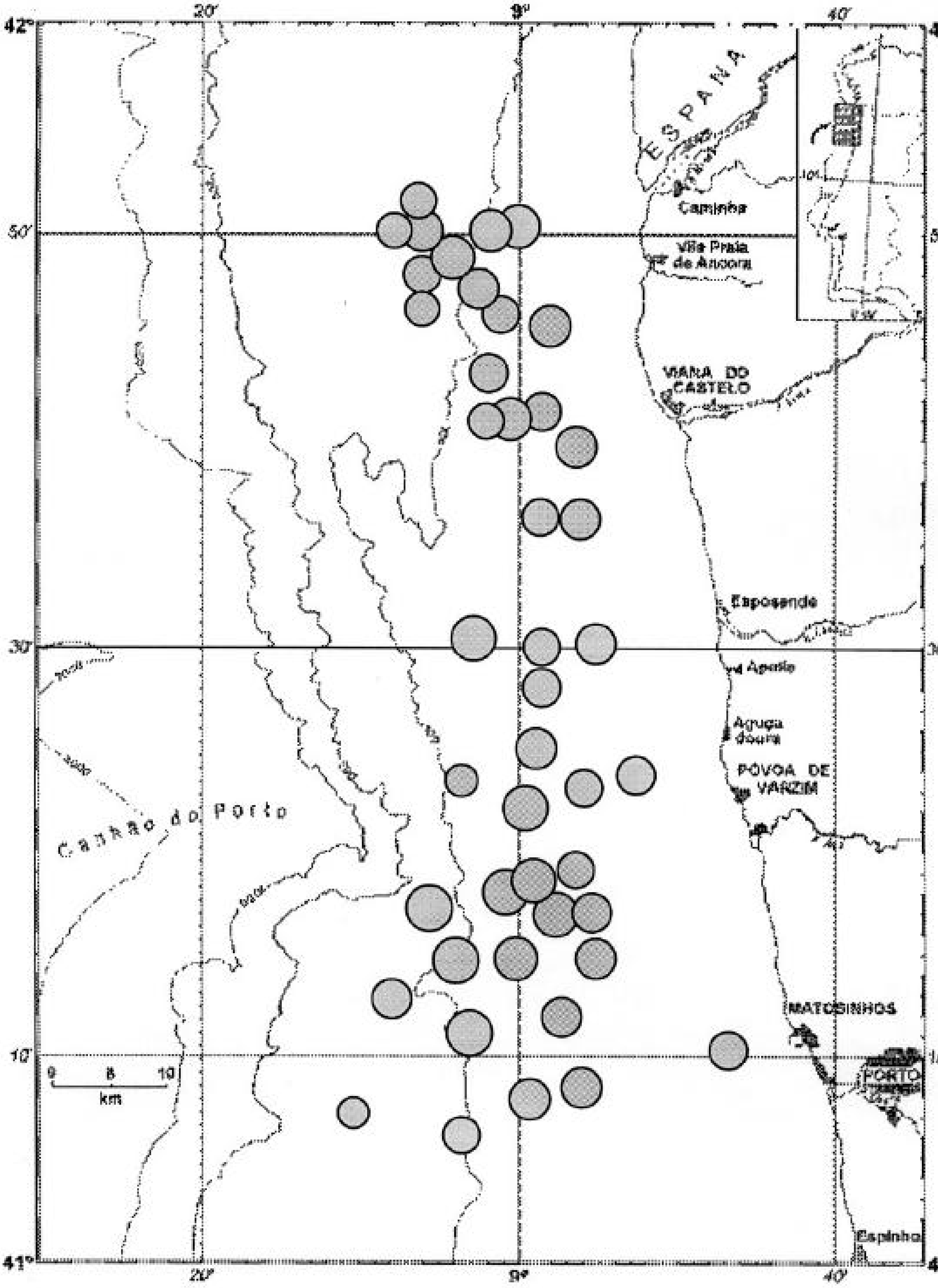


Fig. 7. Isopacs

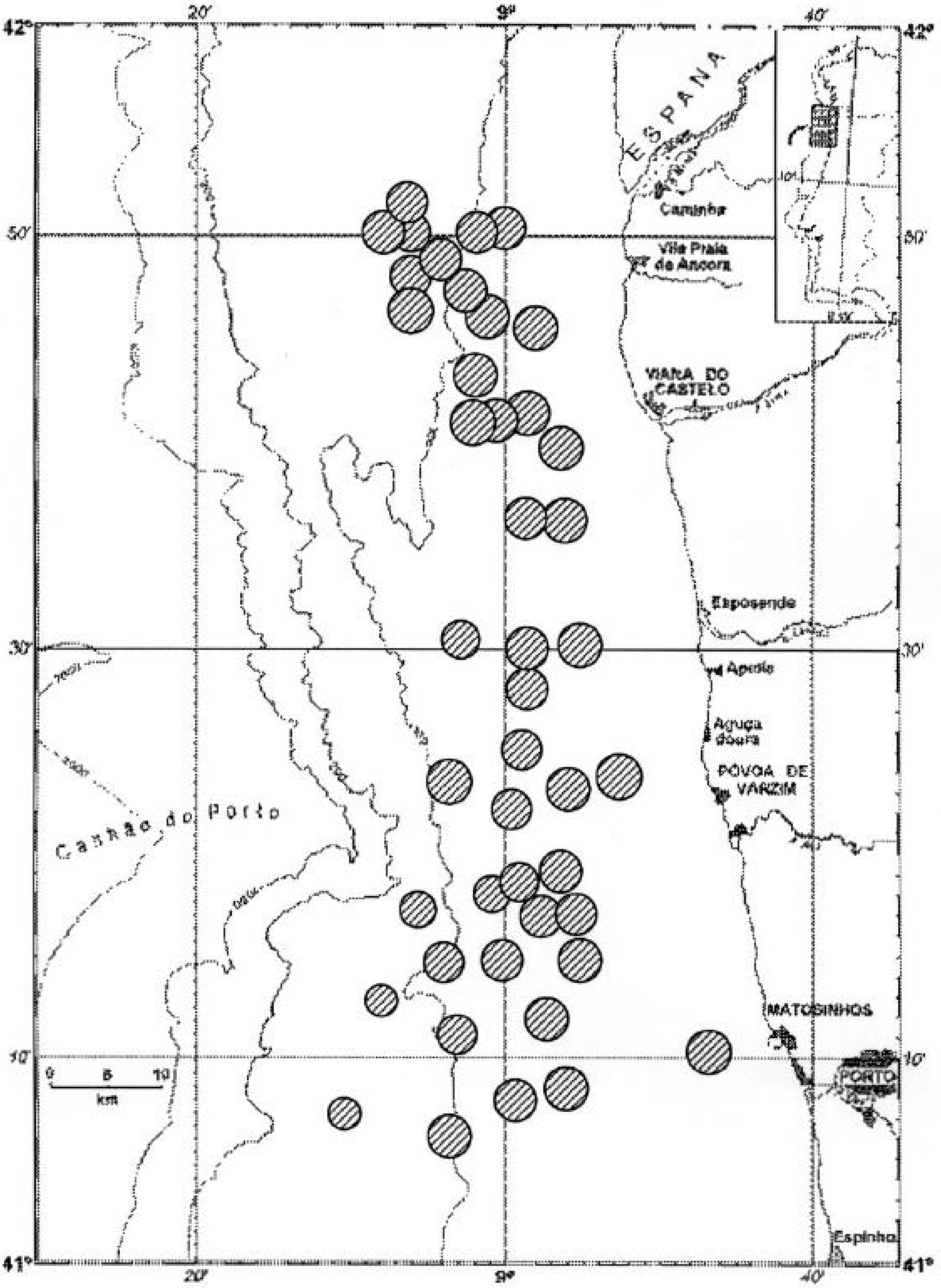
Al (%)



mín: 2.88 máx: 6.26

Fig. 9. Elemental distribution on the Al.

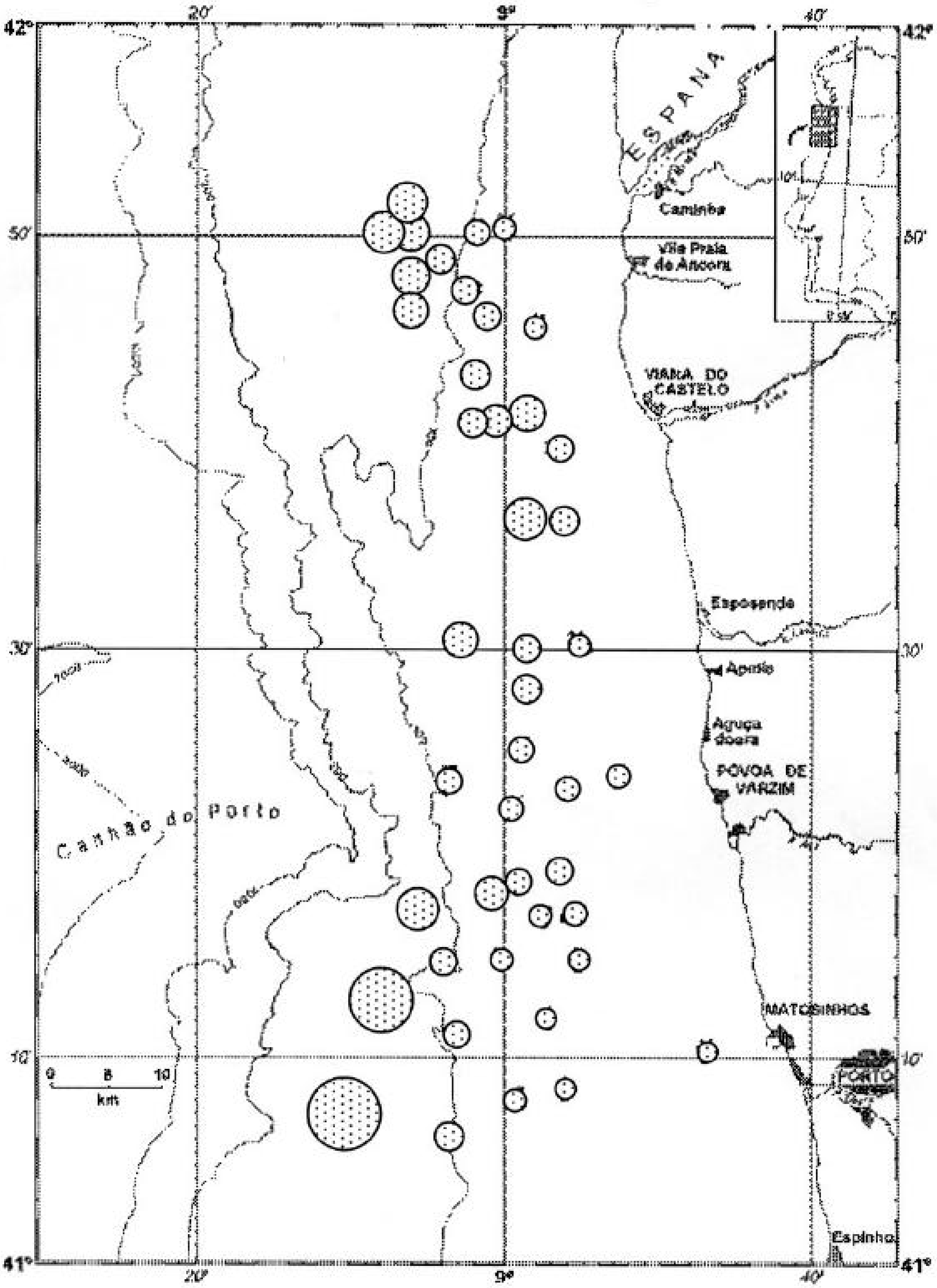
Si (%)



mín: 18.03 máx: 36.03

Fig. 10. Elemental distribution on the Si.

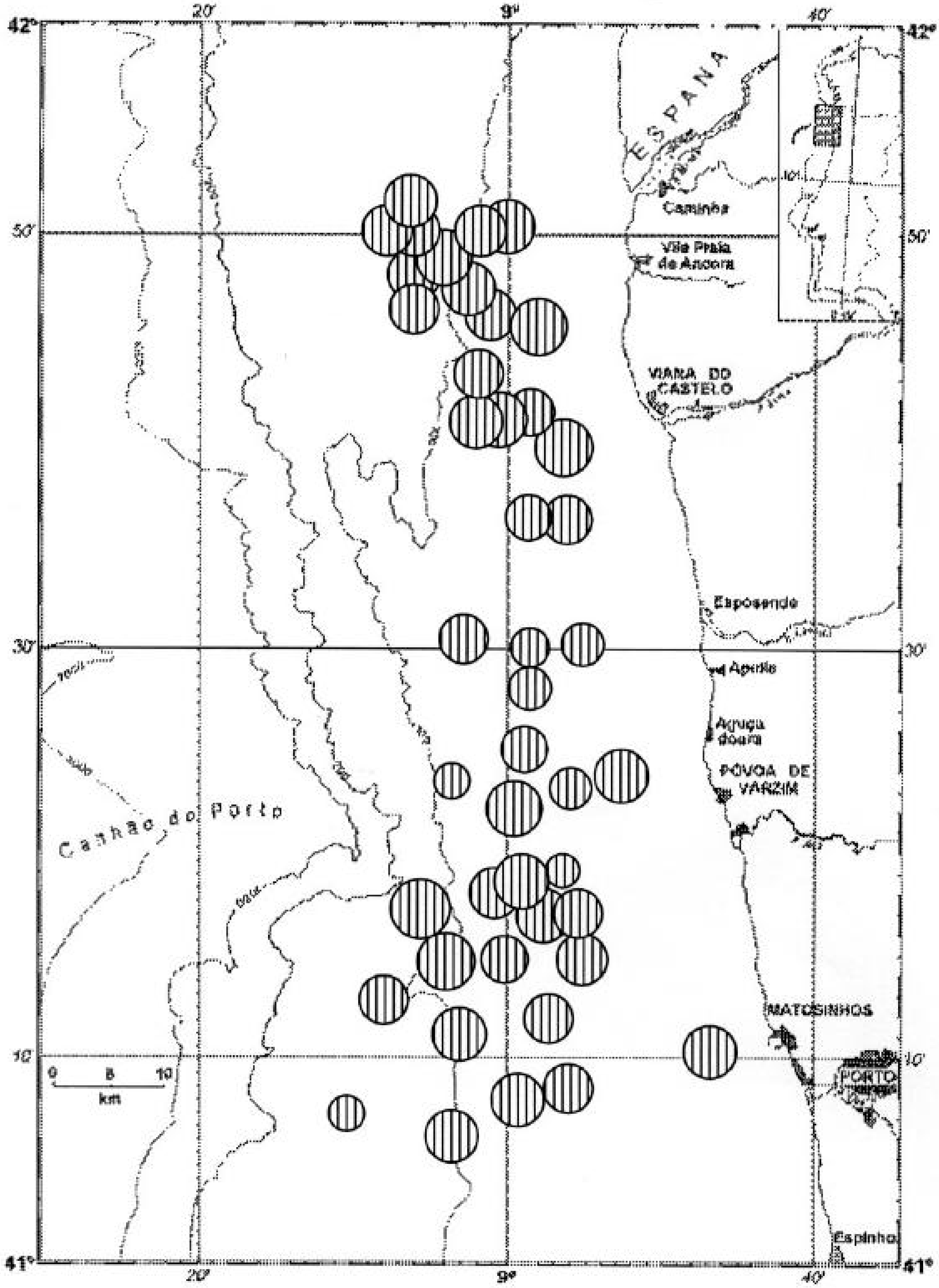
Ca (%)



min: 1.17 máx:15.34

Fig. 11. Elemental distribution on the Ca.

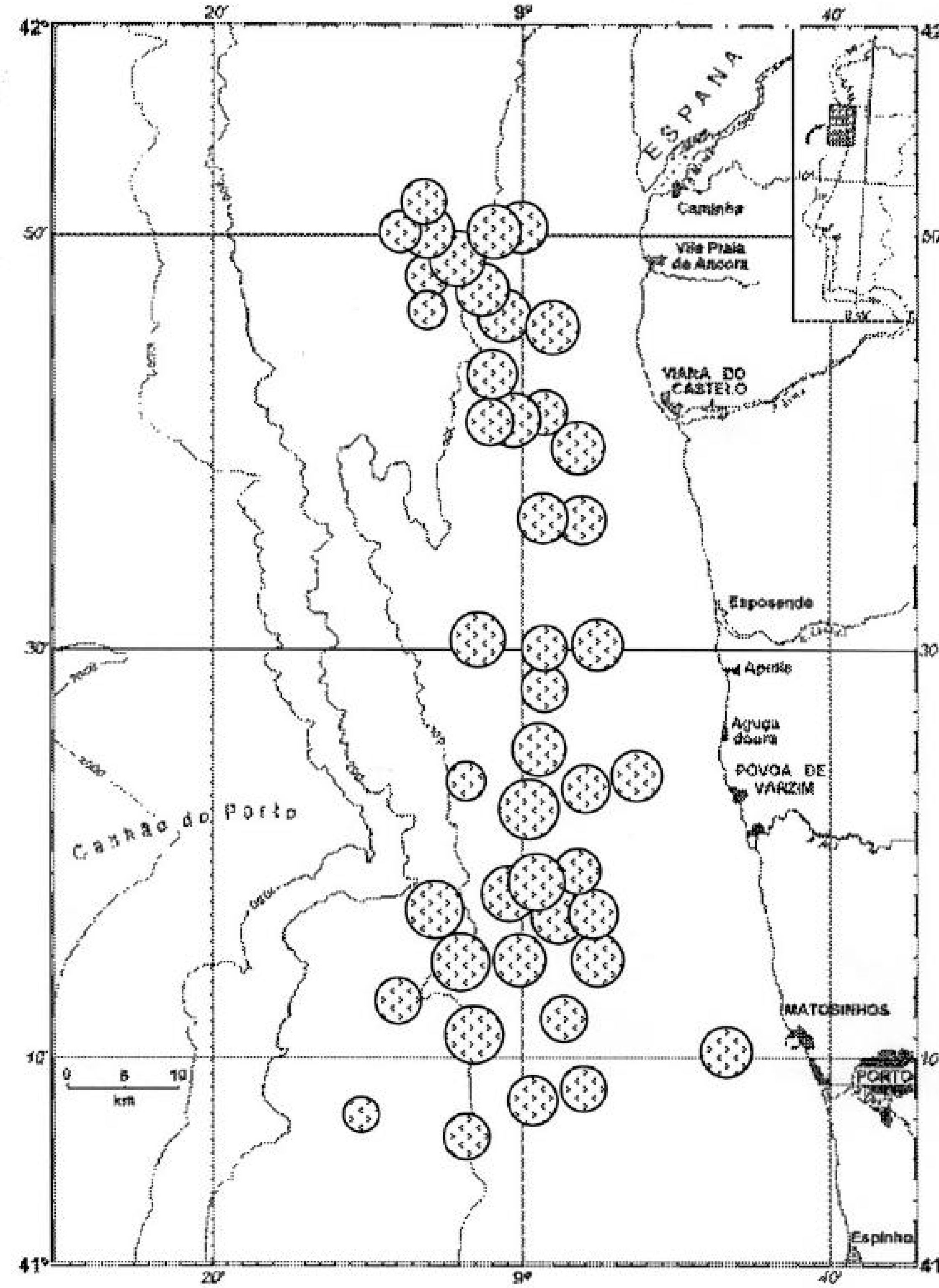
Cu (mg/kg)



mín: 8 máx:26

Fig. 12. Elemental distribution on the Cu.

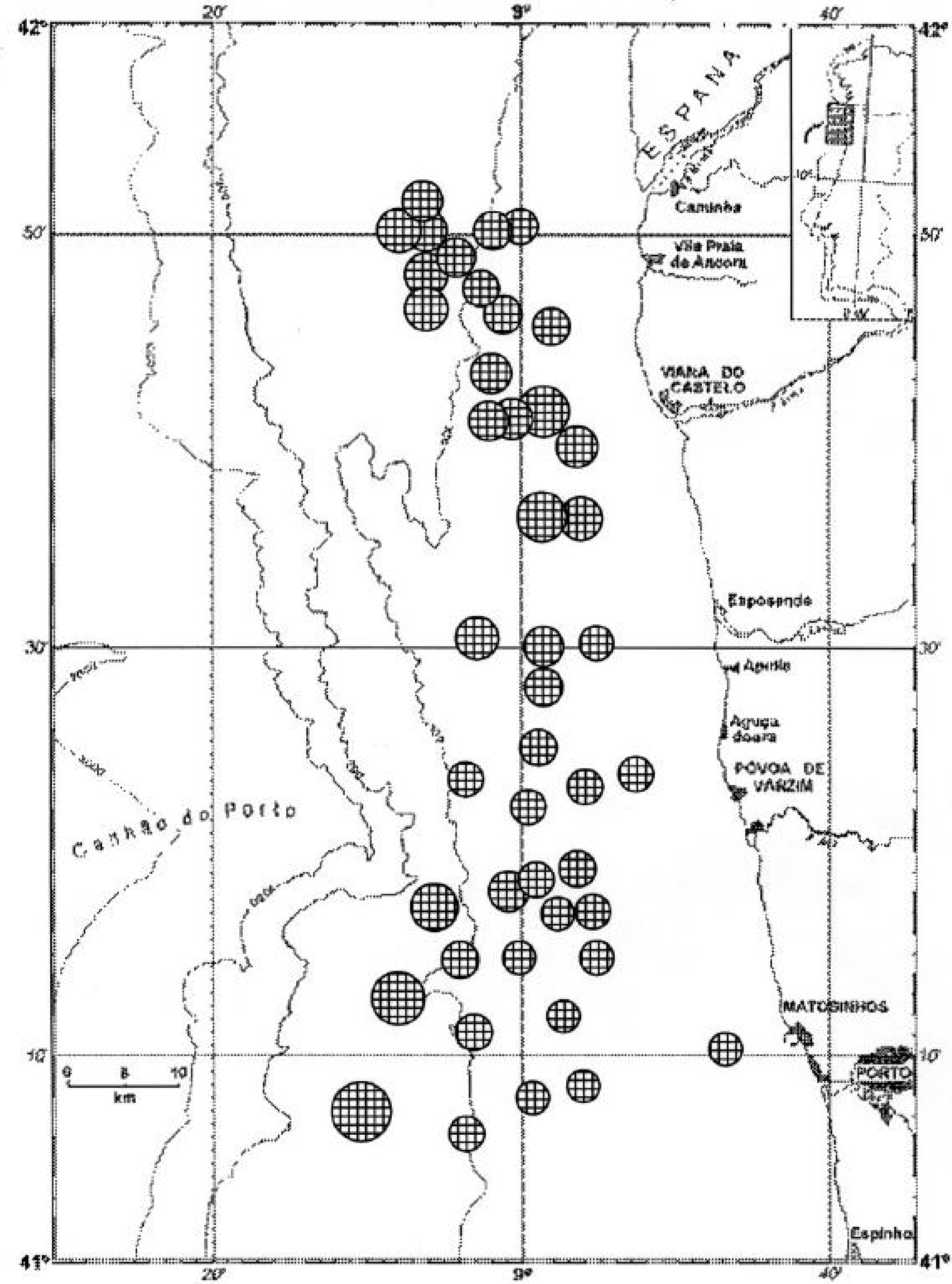
Zn (mg/kg)



mín: 28 máx: 77

Fig. 13. Elemental distribution on the Zn.

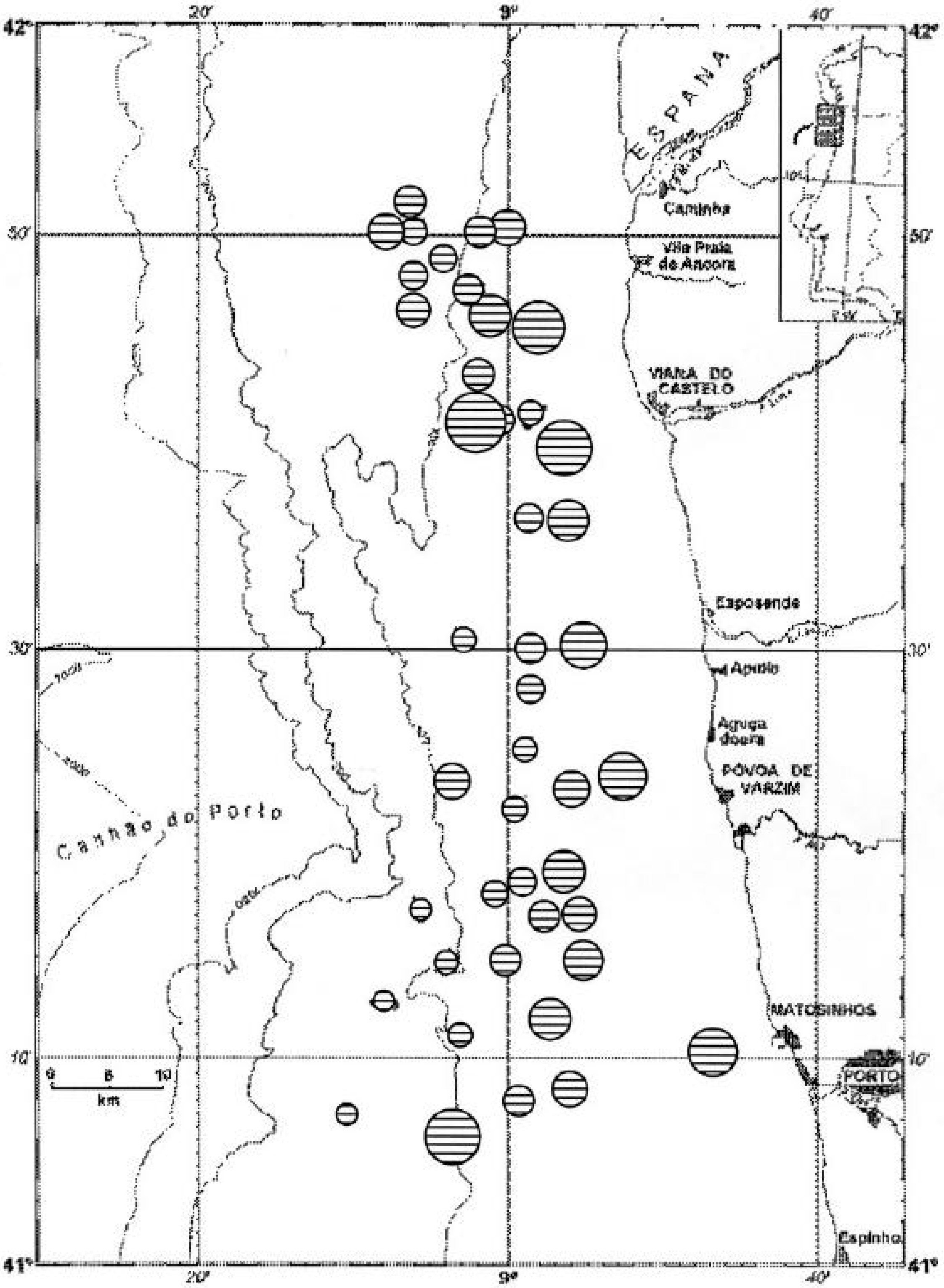
Sr (mg/kg)



min: 131 máx: 439

Fig. 14. Elemental distribution on the Sr.

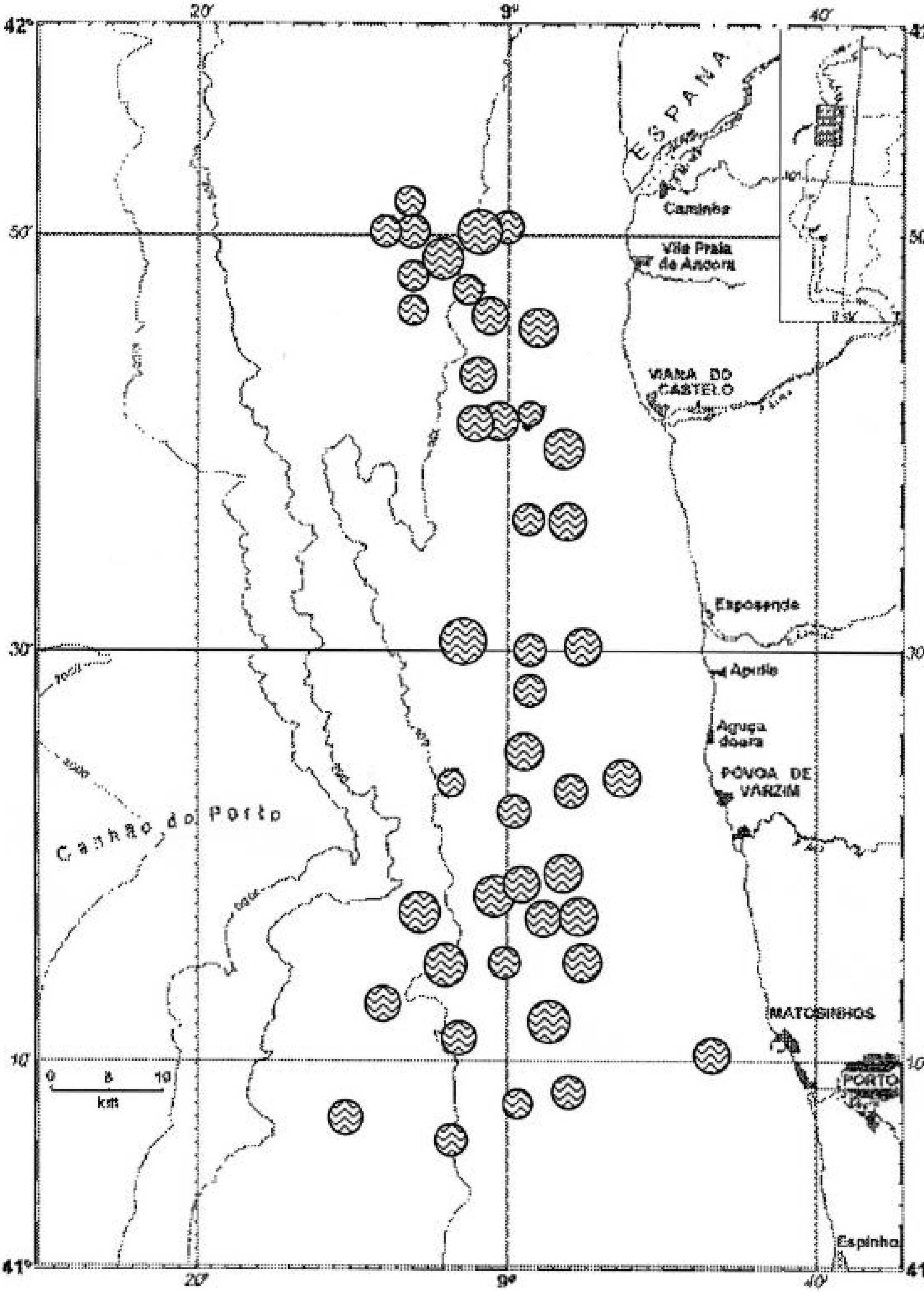
Zr (mg/kg)



mín: 155 máx: 1300

Fig. 15. Elemental distribution on the Zr.

Pb (mg/kg)



mín: 15 máx: 50

Fig. 16. Elemental distribution on the Pb.