

Focus on: Continental-Wide Geochemical Mapping in Europe

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Introduction

The need for high quality, multi-purpose environmental geochemical baseline data for Europe was justified by the first European Working Group on Regional Geochemical Mapping immediately after the Chernobyl accident in 1986, when it was realised that a baseline for radioactive and other polluting elements could not be defined (Bølviken *et al.* 1990, 1993, 1996). Subsequent compilation of inventories of existing regional geochemical databases in Europe revealed the existence of some 120 separate geochemical databases based on up to seven different sample media. Although a wide range of element concentrations were determined by 13 different analytical methods, many environmentally essential elements were, however, not measured. (Plant and Ridgeway, 1990; Plant *et al.* 1996, 1997). Because it was impossible to compile a homogeneous data set for the whole of Europe from these data, it was clear that the establishment of a harmonised European wide geochemical database was essential to satisfy the needs of present day national and European Union legislation. Plant *et al.* (1997) made the case thus:

“Throughout Europe public concern about the environment is growing. In response, national governments and the European Union (EU) are attempting to develop policies, legislation and infrastructure, such as the European Environment Agency (EEA). Attempts are also being made to establish ‘Safe Levels’ of Potentially Harmful Elements and Species (PHES), but these are often based on limited and/or inadequate information.

The available data on environmental geochemical baselines and radioactivity are not systematic in coverage or quality and, therefore, are not of the standard required to quantify the distribution of potentially harmful elements and species at the European scale as a basis for policy-making and monitoring future change to the environment.

In general, there is a failure to recognise that the natural geochemical background is highly variable and the natural levels of potentially harmful elements and species (such as As, Cd, Pb, NO₃, the radioactive elements and organic pollutants) can be as high or higher than those caused by man-made sources of pollution. Even where synthetic pollutants are concerned, it is the natural geology and geochemistry which frequently exert the fundamental controls on the distribution of the potentially harmful elements and consequently determine their potential to create hazards.”

Data on geochemical baselines are urgently needed, not only in Europe but also all over the world, because environmental authorities in most countries are defining limits for contaminants in soils and waters for different land

use purposes. The Commission of the European Union (EU) is preparing the Soil Protection Strategy and Directive for Europe. As geochemists know, the natural concentrations of elements are different in the different constituents of overburden, and vary markedly between geologically disparate areas. State authorities, however, are not always aware of these significant natural variations, which should be taken into account in defining action limits. There are already examples of action limits that are lower than natural concentrations.

Older national geochemical data sets in Europe, as it has already been pointed out (Plant and Ridgeway 1990; Plant *et al.* 1996, 1997), are not in a form that can be readily used for this purpose. It is not possible to define the present day European geochemical baseline for a single element on the basis of old geochemical data. Therefore, the data produced by the projects such as FOREGS Geochemical Baseline Mapping programme (Salminen *et al.* 2005) and the The Ecogeochemical Mapping of the Eastern Barents Region (Barents Ecogeochemistry) project (Salminen *et al.* 2004) should make a significant contribution to the European wide soil and water protection legislation, especially as a basis for defining action limits. Thus, systematic baseline environmental geochemical data are necessary to inform policy makers and to provide a sound basis for legislation. According to Plant *et al.* (1996), for this purpose such data are required to be:

1. *Standardised across national boundaries.*
2. *Available in digital form for use in GIS so that they can be viewed interactively with other datasets, such as those for land use and for animal and human morbidity and mortality data.*
3. *Comprehensive, to include the majority of potentially harmful elements and ideally as many harmful chemical species as possible, including synthetic compounds.*
4. *Based on a full suite of sample types including soil, stream sediment, surface water, groundwater and off-shore marine and estuarine sediment in the coastal zone.*

Worldwide, the aim of the International Union of Geological Sciences (IUGS) and the International Association of Geochemistry and Cosmochemistry (IAGC) Working Group on “Global Geochemical Baselines” is to compile a respective data, based on the Global Terrestrial Network sampling (GTN) - also called the Global Reference Network (GRN) - as recommended by the UNESCO International Geological Correlation Programmes IGCP 259, “*International Geochemical Mapping*”, and its successor, IGCP 360, “*Global Geochemical Baselines*” (Darnley *et al.* 1995) covering the whole Globe. In Europe, the FOREGS programme was originally planned to be the European contribution to that Global data, and also a practical example of how to carry out such an international survey. Geochemical mapping, which applies different sample media and analytical methods, has already been widely used in Nordic countries (Koljonen, 1992; Salminen, 1995; Lahermo, *et al.* 1996; Reimann, *et al.* 1998; Ottesen *et al.* 2000).

In the Barents Ecogeochemistry project, the project area is likely to be the focus of increased human activity in the near future, linked to further exploitation of natural resources such as the large hydrocarbon fields on land in

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the Timan-Pechora basin and the gigantic gas fields offshore, in the eastern Barents Sea. Development of such fields will, in all probability, necessitate building new pipelines on land, and new port facilities. These developments will, to a significant extent, take place in areas that have already experienced a human impact of various kinds (from earlier oil/gas and coal exploitation and other anthropogenic sources). A geochemical baseline study in the region gives the authorities and other involved interests a basis for assessing the existing state of the environment and for distinguishing impacts due to new developments from those

of an older date. Thus the environmental status of the whole region can be documented before the planned exploitation of new large oil and gas deposits.

Methodologies applied in the large-scale geochemical surveys in Europe

The FOREGS Geochemical Baseline Mapping Programme was approved in 1996 by the Forum of European Geological Surveys' Directors (FOREGS). In 1996, the Working Group representatives were nominated by each country and by the end of 1997 the principles of field and analytical methodologies were agreed. To this group belonged the representatives of 26 European countries (see Table 1.).

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Table 1. A summary table of the Foregs Geochemical Baseline Mapping programme and the Barents Ecogeochemistry project

	Foregs	Barents
Survey area	4.2 mill. km ²	1.55 mill km ²
Participating organisations	Geological surveys of Austria, Albania, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and UK; and from Italy Università' di Napoli "Federico II", University of Padova, and Università degli Studi di Siena	Geological surveys of Finland and Norway, Finnish Nuclear Safety Organisation, S/C Mineral, St.Petersburg, Russia, ZAO Arkhangelskgeolrazvedka, Arkhangelsk, Russia, ZAO Mireko, Syktyvkar Komi Republic of Komi, Russia
Number of sampling sites	808	1384
Sample media		
Stream water	808 samples	1334 samples
Minerogenic stream sediment	801 samples	None
Floodplain sediment	749 samples	None
Organic soil layer (humus layer)	367 samples	1409 samples
Minerogenic top-soil	845 samples	None
Minerogenic sub-soil	789 samples	1415 samples
Terrestrial moss	None	1316 samples
Analysed elements and other parameters		
Soils	Ag, Al, As, Ba, Be, Bi, Ca, Cd, C, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Hf, Hg, Ho, I, In, K, La, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, pH, Pr, Rb, S, Sb, Sc, Si, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr, TOC, Grains size	Al, As, B, Ba, Be, Bi, C, Ca, Cd, Cl, Co, Cr, Cs, Cu, F, Fe, Ga, Hg, I, K, La, Li, LOI, Mg, Mn, Mo, N, Na, Nb, Ni, P, Pb, Rb, S, Sb, Sc, Si, Sr, Te, Th, Ti, Tl, U, V, Zn, and Zr
Organic soil	Ba, Cd, Co, Cu, Ga, La, Hg, Ni, Rb, Sr, and Zn	Al, Ag, As, B, Ba, Be, Bi, Br, C, Ca, Cd, Co, Cr, ¹³⁴ Cs, ¹³⁷ Cs, Cu, Fe, Hg, K, LOI, Li, Mg, Mn, Mo, N, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, Th, Ti, Tl, U, V, and Zn
Sediments	Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Hg, Ho, In, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pr, Rb, S, Sb, Sc, Se, Si, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr, and TOC,	
Water	Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Ho, I, In, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, Pb, pH, Pr, Rb, Sb, Se, Si, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr, EC, HCO ₃ ⁻ , Br ⁻ , Cl ⁻ , F ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , and DOC	Ag, Al, Alkalinity, As, B, Ba, Be, Bi, Br, Ca, Cd, Cl ⁻ , Co, Cr, Cs, Cu, EC, F ⁻ , Fe, Hg, I, K, La, Li, Mg, Mn, Mo, Na, Ni, NO ₃ ⁻ , P, Pb, pH, Rb, Sc, Sb, Se, Si, SO ₄ ²⁻ , Sn, Sr, Th, Ti, Tl, U, V, Zn, Y, and Zr,
Moss		Al, Ag, As, B, Ba, Be, Bi, Br, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Li, Mg, Mn, Na, P, S, Mo, Ni, Pb, Rb, Sb, Se, Sn, Sr, Th, Tl, U, V, and Zn
Time period	1996 (1986) – 2005	1999 (1998) – 2004
Number of participating countries	2 (6)	26

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The fieldwork was carried out in each country independently according to the published field manual (Salminen, Tarvainen *et al.* 1998). Special sub groups did the interpretation of the data where the group members willing to do such a work participated. The national teams varied much according to the local conditions and financial possibilities.

In the Barents project, the project organisation was based on permanent national groups from Finland, Russia, and Norway. These groups were in charge of planning and carrying out the fieldwork in their countries and doing the interpretation of results from their countries. In Finland three field teams (two persons in each) and in Russia twelve teams (three to four persons in each) carried out the regional phase sampling. The fieldwork in Russia was a huge effort, because some 70% of sampling sites were accessible only by helicopters.

Sample Media

The geochemical data of both of these projects are based on the analysis of various sample media such as of stream water, stream sediment, floodplain sediment (or alluvial soil), residual minerogenic soil, organic soil layer (humus), and terrestrial moss. High quality and consistency of the data were ensured by using standardised sampling methods (Salminen, Tarvainen *et al.* 1998; Gregorauskiene *et al.* 2000), and by applying rigorous, harmonised quality assurance measures during chemical analysis and subsequent data handling stages. The choice of sampling media has been made in accordance with the recommendations of the IUGS/IAGC Working Group on Global Geochemical Baselines (Darnley *et al.* 1995). These media, described below, are considered to be the most representative of the Earth's surface environment, and are the most commonly used in past and current environmental geochemical investigations:

- Stream water (filtered and unfiltered);
- Stream sediment – mineral sediment (<0.150 mm);
- Residual soil, top soil – upper 0–25 cm horizon without the top organic layer (<2 mm);
- Residual soil, sub soil – lower C horizon, a 25 cm layer within a depth range of 50–200 cm (<2 mm);
- Organic soil layer (humus, where present);
- Overbank sediment – upper 0–25 cm horizon (<0.150 mm, optional);
- Overbank sediment – bottom layer (<0.150 mm, optional);
- Floodplain sediment – upper 0–25 cm horizon (<2 mm);
- Floodplain sediment – bottom layer (<2 mm, optional); and
- Terrestrial moss – the uppermost three shoots of *Hylocomium Splendens* or *Pleurozium Schreberi* species

Stream, floodplain and overbank sediment samples generally reflect the average geogenic composition of the whole catchment basin for most elements, although they are sensitive to pollution.

Stream waters reflect the interplay between geosphere/hydrosphere and pollution. At the same time, they can be a major source of drinking water.

Soil samples reflect variations in the geogenic composition of the uppermost layers of the Earth's crust. Because of this, it is important to avoid soil sampling at locations that had visible or known contamination.

Comparison of topsoil and subsoil data gives information about enrichment or depletion processes between the layers. One such process is anthropogenic contamination of the top soil layer. The <2 mm fraction is taken according to environmental standards. The <0.18 mm and finer fractions have been widely used in mineral exploration programmes. *Humus* samples can be used to determine the atmospheric (anthropogenic most cases) input of elements to the ecosystem. To reach this aim, samples should be collected in forested areas. To reflect the atmospheric input, the uppermost few centimetres of the organic layer are collected immediately under the green vegetation and litter (max. 3 cm).

Terrestrial moss samples are taken to reflect the atmospheric input (anthropogenic or geogenic) of elements over a limited time span. It has no roots and lives predominantly from the element input via the precipitation. Due to its large surface area it will also collect local (geogenic) dust. It has ion exchange properties and can enrich many elements over time. Moss is collected as a bio-monitor, reflecting variations in the regional composition of the atmosphere rather well for a limited time segment.

Sampling Strategy

The FOREGS sampling grid was based on GTN grid cells developed for the purpose of Global Geochemical Baseline mapping (Darnley *et al.* 1995). This grid divides the entire land surface of the Earth into 160 km x 160 km cells. The cells have their origin on the equator at the 0° (Greenwich) meridian. European cells have identifiers such as N36W01, which is defined as the 36th cell north of the equator and the first cell west of the meridian of Greenwich, each cell having a size of 160 km in north-south direction and on average 160 km in east-west direction

In the FOREGS programme, a list of the GTN cells, with five randomly generated, numbered points which should be sampled, was produced beforehand by the Geological Survey of Finland (GTK). Since some of the GTN cells in coastal areas consist of mostly water, it was agreed that in order to obtain as perfect coverage as possible these cells could be included in the sampling programme, but at least three sites should be sampled in order to fulfil the specifications of the IUGS/IAGC "Global Geochemical Baselines" mapping programme.

The given randomly generated points were used to select the five nearest small drainage basins of <100 km² in area. From the selected small drainage basins the site for stream water (filtered and unfiltered) and stream sediment sampling was chosen close to the confluence point with the main stream. The residual soil (top and subsoil), and humus samples were collected from an appropriate site, within the area of the small drainage basin, representing the dominant residual soil type.

From the larger drainage basin (area 1000-6000 km²), to which the small drainage basin is connected, the floodplain

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sediment samples, the uppermost 25 cm, and the optional lowermost were collected, either from a suitable point near its outlet with the sea or the confluence point with another major river system. If no suitable large size drainage basin was available, the floodplain sediment samples were taken from a smaller drainage basin of minimum size >500 km². In the Barents Ecogeochemistry project, the pre-labelled sample bags and bottles were mixed and then distributed in a random order to the organisations in charge of the fieldwork in each participating country. Thus the sampling proceeded in random order of site numbers. For site selection, all existing information on geology (bedrock and Quaternary deposits), soil types, morphology, and vegetation zones were used. The area was divided into drainage basins covering approximately 1000 km² each. These drainage basins were subdivided into drainage basins covering approximately 100 km² each. The sample site was located in that one of the 100 km² drainage basins that was thought to be the most representative for the whole area. A respective method was recently adopted generally in Russia (IMGRE, 1998). In the selection of the drainage basins first priority was given to the most pristine catchment. The dominant landscape conditions in the selected catchment guided the final site selection.

Field training

In the FOREGS programme, the field methodology was according to the first draft of the field manual tested and modified during a two days' field course in the Slovak Republic in June 1997. After the experiences from that field course were carefully analysed the "FOREGS Geochemical Field Manual" was published in early 1998 (Salminen, Tarvainen *et al.* 1998).

In the Barents project, after the experiences from the FOREGS programme a much stronger effort was put on training the field personnel and harmonising the field methodology. One aim being that after the project, the methodologies, which are widely accepted and standardised in western countries, were adopted in the Russian organisations and institutions participating in and responsible for the project. During the 1999 field season some 30 persons including all team leaders and people in response of practical work spent five weeks together in the field collecting more than one thousand samples from catchment areas representing different geochemical landscapes in the Barents region (Salminen, 2000).

Photographs

From each sampling in both Barents Ecogeochemistry project and FOREGS programme a suite of photographs were taken in order to document the local landscape and the sampling site. These photos are organised in special photo archives, which are or will be accessible via internet.

Analytical methods

In the FOREGS programme (Sandström *et al.* 2005), the analytical work was carried out in the laboratories of

nine geological surveys in such a way that all samples of one particular sample media was analysed by one particular method in one laboratory. In the Barents Ecogeochemistry project the responsibility of all analytical work was only in one laboratory, the laboratory of Geological Survey of Finland, and only a minor part of the analytical work was done in other laboratories in Norway and Russia.

A regional large-scale geochemical project with low sampling density sets some special requirements for the analysis. The methods must be sensitive enough to reach the background levels, the precision must be acceptable, and additionally the accuracy must be better than in normal geochemical exploration surveys. The data is planned to be extensively used for environmental purposes, such as the assessment of natural element concentrations in different materials as a basis to establish or refine national or European maximum contaminant levels. The FOREGS programme is considered to be a pilot project for the IUGS Global Geochemical Baseline Programme, which aims and methodological requirements are described by Plant *et al.* 1996. For this reason the methods used in the FOREGS programme will have a standard operation procedure character and should thus be reproducible in various laboratories all over the world. However, considering the requirements for the sensitivity and elemental coverage, the most sophisticated instrumental methods have to be utilised which may exceed the capabilities of some skilled, but poorly equipped, laboratories to participate the global project in the future.

The total concentrations are relevant for geochemical interpretation of data. This means, that the silicate matrix is either decomposed before instrumental analysis or methods for solid samples such as X-ray fluorescence are used. However, to address the needs of national and European level environmental authorities, the information on leachable concentrations of the elements was considered of high importance. In the environmental chemistry a slightly unscientific and unspecific term, "near total" is used to describe the absolutely maximum concentrations, which can be liberated from the materials in nature. Normally *aqua regia* leach or digestion is used for this purpose. Unfortunately almost every laboratory has its own procedure for *aqua regia* leach and the standardised but laborious methods are rarely used. In both FOREGS and Barents Ecogeochemistry projects *aqua regia* leach was adopted to analyse the leachable concentrations of the elements in minerogenic samples. The problem of diversity of leaching procedures was avoided by having only one laboratory perform the analyses.

Quality assurance

The sampling locations of both FOREGS and Barents project were randomised so as to randomly distribute minor errors in the analytical results. This approach minimizes their effect on the anomaly patterns on the maps.

Quality control samples

In the Barents Ecogeochemistry project, at every 15th sampling site, a full set of all materials were collected as

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duplicate samples. The whole sampling procedure was duplicated, e.g. a new pit at the distance of some metres was dug for sampling the C-horizon. During the water sampling, a blank sample was prepared from distilled and deionised water. It was acidified and handled in the same way as the normal samples. A blank water sample was prepared after every fifteenth sample (normally at the same site as a duplicate sample was collected).

Two different sets of project standard samples of moss, organic layer and C-horizon material were included in the sample set at the same rate as the duplicates. One set was collected from southern Finland and the other one from the Leningrad region. All samples were thoroughly homogenised and divided to sub samples, which were then used as project standard samples.

In the FOREGS programme, from each country at least one GTN cell was randomly selected for duplicate sampling. Countries with nine or more GTN cells collected duplicate samples from 2 or more cells. Duplicate samples of each material were taken from one geologically representative small catchment of the selected GTN cell, and its corresponding floodplain. The procedure of collecting the duplicate samples was identical with that of the normal samples. For residual soil sampling, a duplicate composite sample was collected from 3 to 5 new pits dug not further than 10 metres from the original soil sampling pits, and for floodplain sediment sampling a new pit was dug not further than 10 metres from the original floodplain sediment sampling pit.

Quality control in laboratory

Sampling and sample preparation may be considered the most critical steps influencing the overall quality of the process. To maintain consistent quality assurance and control, all the sample logistic control and preparation was conducted in the laboratory of the Geological Survey of Slovak Republic. In this way any confusions in sample identification, deviations in sample bags and bottles etc. could be assessed at the same level. Because sample splits were sent to analytical laboratories, the homogeneity of the processed samples was of major concern. A thorough homogeneity test scheme was implemented before submitting the samples for analysis. The protocol is described in more detail in the analytical manual (Sandström et. al 2005)

Another quality assurance measure was to analyse all samples of particular type and method in one nominated laboratory. The benefit of this is to avoid undetectable bias between laboratories even when using the same documented method. The drift control is also better arranged within one laboratory. The methods, which were decided to be used, were routine methods of the particular laboratories, which allowed utilising the history of the quality control records and the human experience of the laboratories. All the participating laboratories had their own quality control system.

The accuracy of the methods has been based on the existing validation data of the particular laboratory. In order to control the long-term stability of the methods and also to compare the methods with each other, two monitoring samples were regularly analysed with the unknown samples. In order to assess the precision of the analytical methods and compare that to the sample bias, duplicate sampling and duplicate analysis methods were used. The duplicates were analysed randomised along with the normal samples. Both members of the duplicates were analysed in duplicate and sampling uncertainty evaluated by the ANOVA statistical interpretation method.

Results

The results of both Barents Ecogeochemistry and the FOREGS Projects are published as atlas books, which include the maps (the Barents Ecogeochemistry atlas 190 maps and the FOREGS atlas 360 maps), description of the methodologies, and some background information. In the Barents Ecogeochemistry project (Salminen *et al.* 2004), a brief interpretation of the element distribution patterns is included, element by element, in the atlas book. In the case of the FOREGS atlas (Salminen *et al.* 2005), a larger interpretation will be published separately later. The main distribution way of the FOREGS atlas is via internet (<http://gsf.fi/publ/foregsatlas>). The Barents Ecogeochemistry atlas is also available via internet, as a service of its commercial publisher (Elsevier BV). The release of the original analytical data will probably be done in the near future. As an example of the published maps of both projects, the distribution of As concentrations in stream waters are shown in Figures 1 and 2.

Initial results show that the distribution patterns of both water and solid samples are related to such factors as large-scale tectonic provinces, geologic provinces such as areas of glaciated terrain, pollution reflecting industrialized areas, and areas of intensive agriculture. Because of different sampling density, the element distribution patterns of Barents Ecogeochemistry and the FOREGS programme describe source areas whose dimensions are different. In the Barents project, the distribution patterns of solid sample media can be connected to lithological units better than in the FOREGS programme where they preferably describe continent wide structural geological units.

Discussion

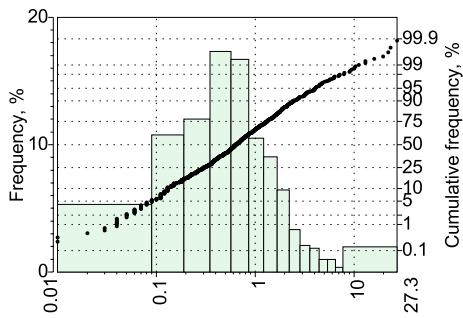
In the international survey projects, in order to guarantee the homogeneity of sample quality, it is important that all necessary equipment and other materials needed for collecting all samples are purchased and delivered from one source only to all parties. These include the complete field equipment such as GPS device, pH/Eh meter, camera, tools needed in sampling, all sample bags and containers (preferably beforehand numbered and labelled), syringes, filters, drip bottles, acids and other chemicals; in short absolutely everything necessary to take all samples at each site.

Training of the field-teams from various countries proved to be important in order to harmonise the

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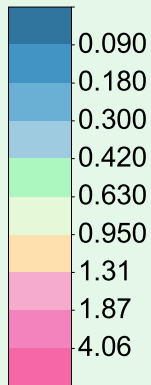


As
ICP-MS, detection limit 0.01 µg l⁻¹
Number of samples 807
Median 0.630 µg l⁻¹

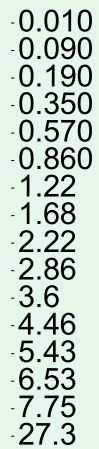
**Arsenic
Stream water**



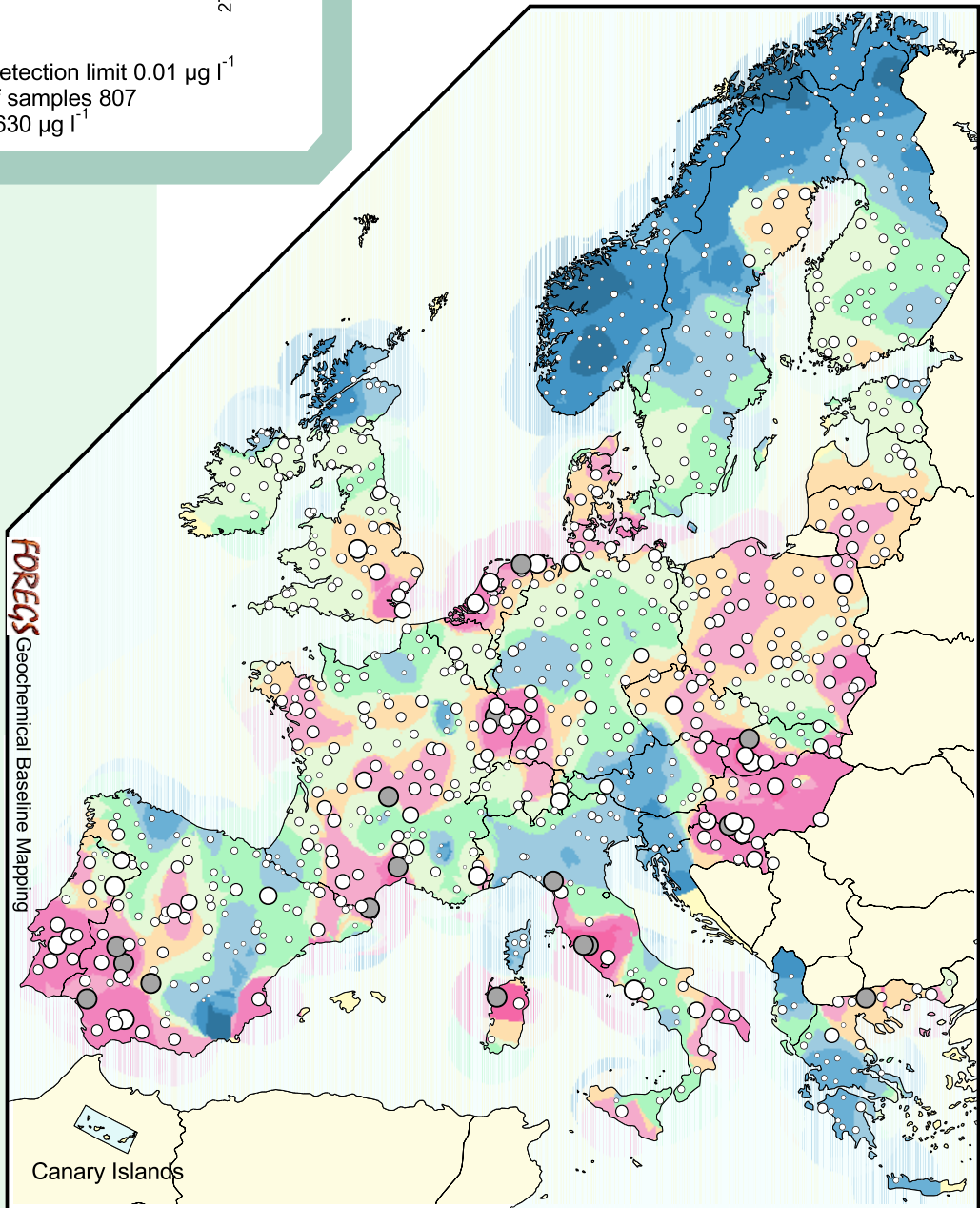
0 500 1000 Kilometers



As µg l⁻¹



FOREGS
Geochemical Baseline Mapping

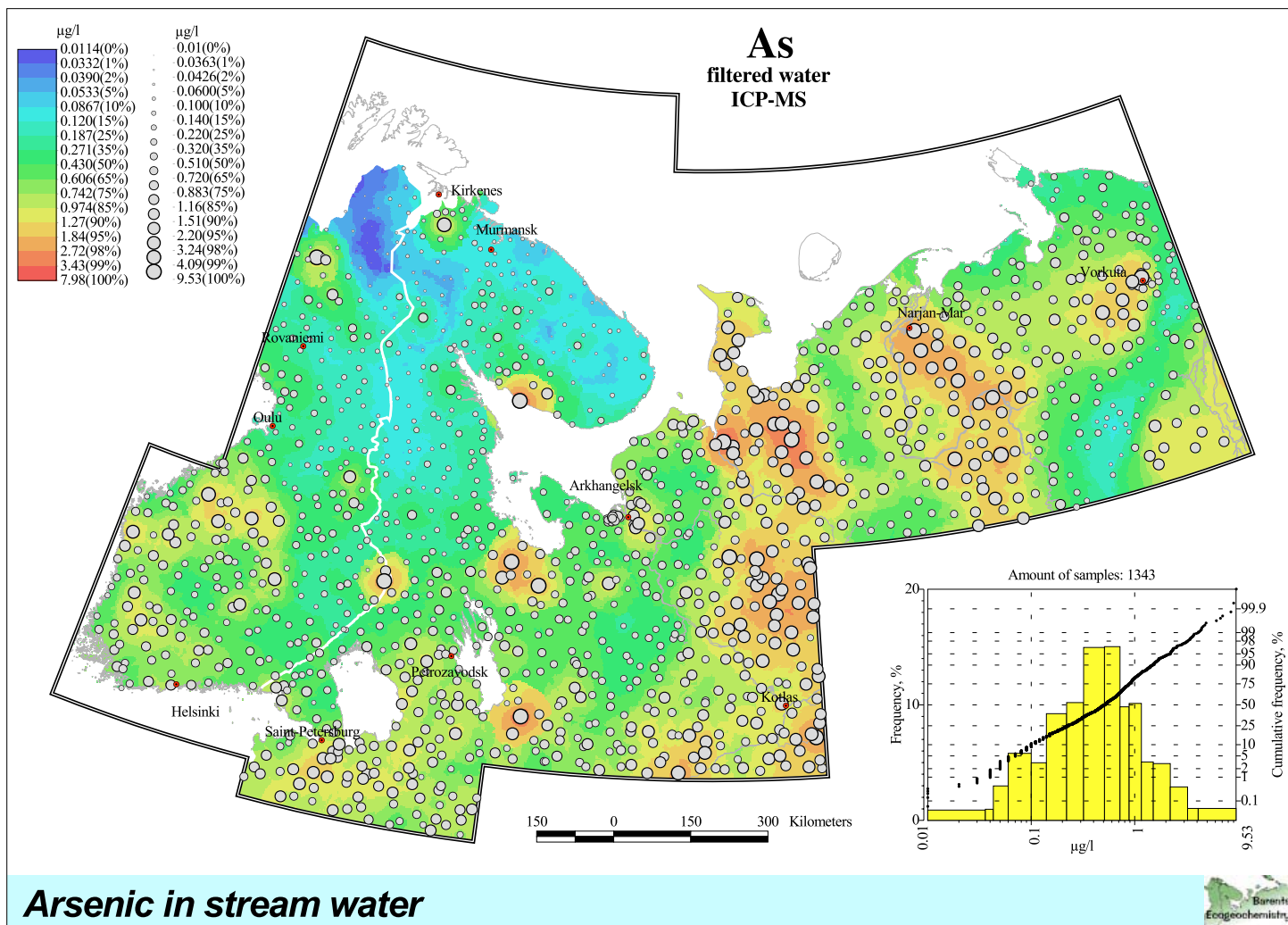


Canary Islands

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understanding of the field manuals. This was clearly proved by the more effective and longer field training period of the Barents Ecogeochemistry project which followed a year later the short field training of the FOREGS programme. This proved to be necessary to ensure the methods and the aim of the whole project were understood by all participating scientists in a similar way.

According to these experiences we can strongly recommend that a relatively long and also expensive training phase should be always included in respective projects. Such a field-training course actually becomes also a pilot phase of the whole project, and experiences collected during this phase improve much the practices and quality of samples in the regional phase field work and laboratory procedures.

It is a challenging and ambitious task to compile a global geochemical database as was proposed by Darnley *et al.* 1995. The data collected from the Barents region will be added later to a pan European database, which is a part of Global Geochemical Baseline program. Thus, it will be possible to compile the worldwide geochemical survey data, although there are big risks in compiling different data sets.

These large-scale geochemical surveys have not only scientific interest, but they can also be used for political purposes and developing legislation. For instance, the

Barents Ecogeochemistry project was considered as an example of the political concept 'the Northern Dimension of European Union'. Respectively the FOREGS data are used as a baseline data in developing the EU soil and water protection directives.

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