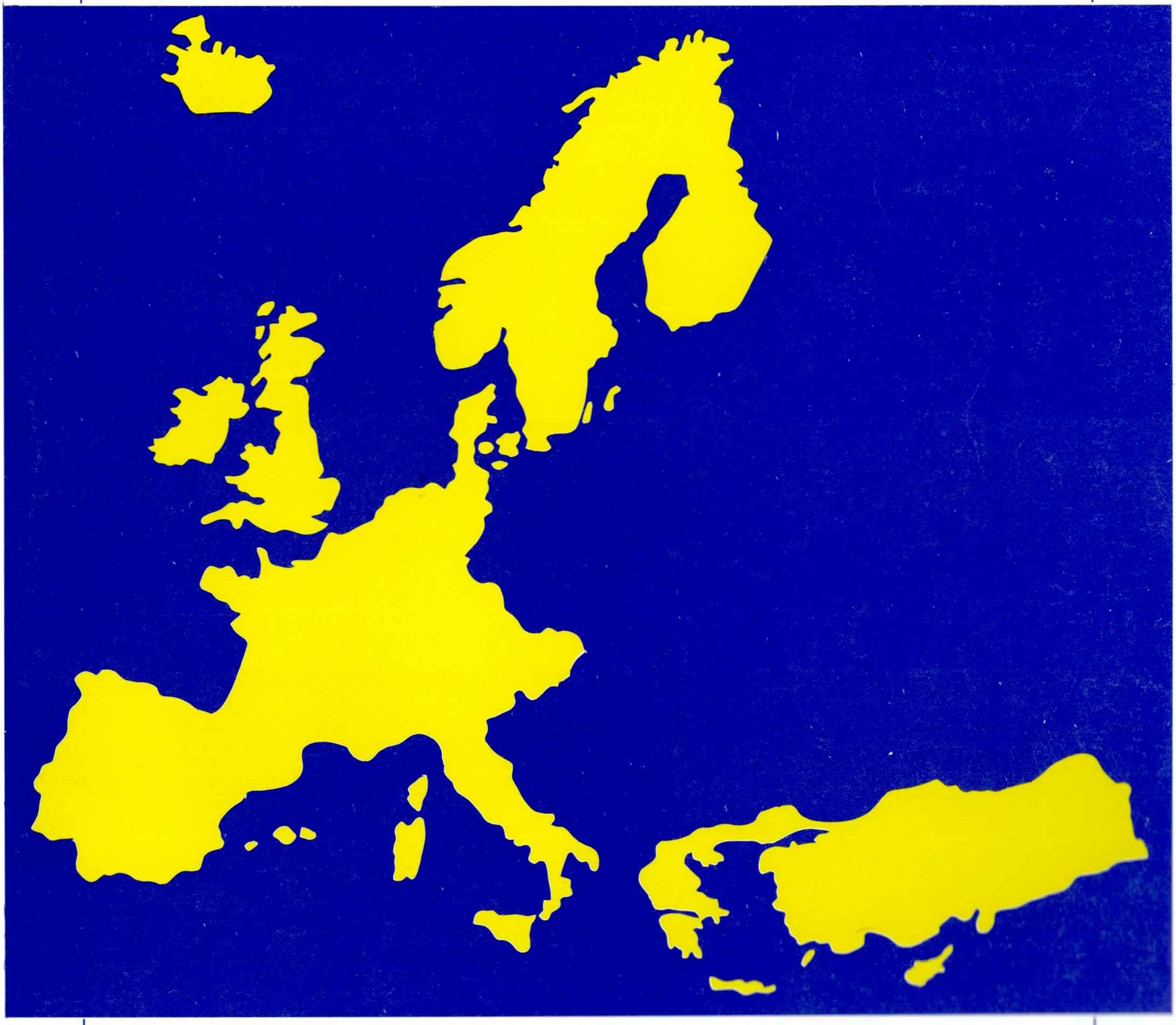
Geochemical Mapping of Western Europe towards the Year 2000.

Project Proposal



Western European Geological Surveys.

Western European Geological Surveys
Working Group on Regional Geochemical Mapping

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

August 1990

CONTENTS

APPENDICES

SUMMARY

There is particular concern in Western Europe about environmental problems and a recognition that solutions warrant urgent and concerted international action. An evaluation of the present state of pollution requires systematic, compatible data on the present distribution as well as the preindustrial, natural distribution of chemical elements in the surface environment. An inventory of available geochemical data for Western Europe shows that, although geochemical mapping is well advanced in several countries, this is mainly based on high sampling densities in limited areas, a variety of sampling media and different analytical methods. A new project is therefore proposed in order to provide a new data base and systematic geochemical maps of the region based on low sampling density. This will also provide a framework enabling existing national data sets to be linked.

The project is divided into three phases as follows:

1. Planning and Preparatory work, including
(a) Publication of Pilot Project studies.
(b) Investigation of sources of external funding.
(c) Detailed planning of Phases 2 and 3.

2. The Main Project, including
(a) Preparation of a geochemical data base for Western Europe.
(b) Compilation of a geochemical atlas based on low-density sampling and multielement analysis of overbank sediment.
(c) Establishment of a long-term storage facility for a geochemical sample archive.

3. Research projects utilizing the data obtained in phase 2 including studies of for example:
(a) Pollution.
(b) Geomedicine, agriculture, forestry, water resources and land use planning.
(c) Crustal and metallogenic provinces.
(d) Budgets for chemical and sediment transport.
(e) The relationships between results of overbank sediment surveys and data obtained in national and international geochemical mapping programmes.

The proposed time schedule is as follows: detailed planning in 1991, completion of field work in 1992-1993, chemical analysis in 1994, interpretation and map preparation in 1994-1995, publication of atlas by 1996.

It is recommended that a full time Project Manager and Secretary be appointed reporting directly to the WEGS Directors. Sub-projects will also be established, each with a leader responsible to the Project Manager. An advisory council with representatives from government and industry in addition to distinguished scientists from a wide range of diciplines might also be considered.

The total cost for the preparation of the Geochemical Atlas of Western Europe (Phases 1 and 2, 6 years) is ECU 9.361.000, of which it is proposed that WEGS contribute ECU 5.309.000, and external funding be sought for 4.052.000.

The suggested research projects cost ECU 1,210.000, of which it is proposed that WEGS contribute ECU 600,000, and external funding be sought for ECU 610,000.

INTRODUCTION

There is particular concern in Western Europe about environmental problems and a recognition that solutions warrant urgent and concerted international action [1]. An evaluation of the present state of pollution requires systematic, compatible data on the present distribution as well as the preindustrial natural distribution of chemical elements in the surface environment.

At the meeting of the WEGS Directors in Copenhagen in August 1988, the Working Group on Regional Geochemical Mapping proposed that a geochemical atlas of Western Europe be prepared [2]. It was agreed by the Directors that pilot field studies be carried out during 1988-1990 to assess the viability of such a programme. These have been completed and an inventory of regional geochemical data of Western Europe compiled. The information obtained [3] suggests that:

(1) Regional geochemical surveys have been carried out in most countries of Western Europe. With few exceptions, however, the coverage is partial and the surveys are not scheduled for completion until well into the next century. Moreover, sampling and analytical methods have varied. Therefore, in order to prepare geochemical maps of all Western Europe before the year 2000, a wide spaced new systematic sampling programme must be initiated based on common methodology.

(2) Overbank sediment (Fig. 1) is a suitable sampling medium because it is (a) representative of large drainage areas, allowing a low sampling density to be used, (b) available in all WEGS countries, (c) suitable for mapping pristine as well as polluted environments, and (d) relatively easy to sample and prepare, (e) useful for linking other geochemical data sets prepared at the national level, and (f) able to provide a European input to international work such as IGCP Project 259 "International Geochemical Mapping" [4].

This proposal outlines a 3-phase programme to prepare a systematic geochemical data base and atlas of Western Europe based on low-density sampling (1 sample station per 500 km^2) of overbank sediment complemented with active stream sediment. Provisional estimates of cost are included. Details of the methods to be employed, and outline research proposals, are given in appendices 1-10. Completion of such a programme will give Europe a world lead in geochemical mapping.

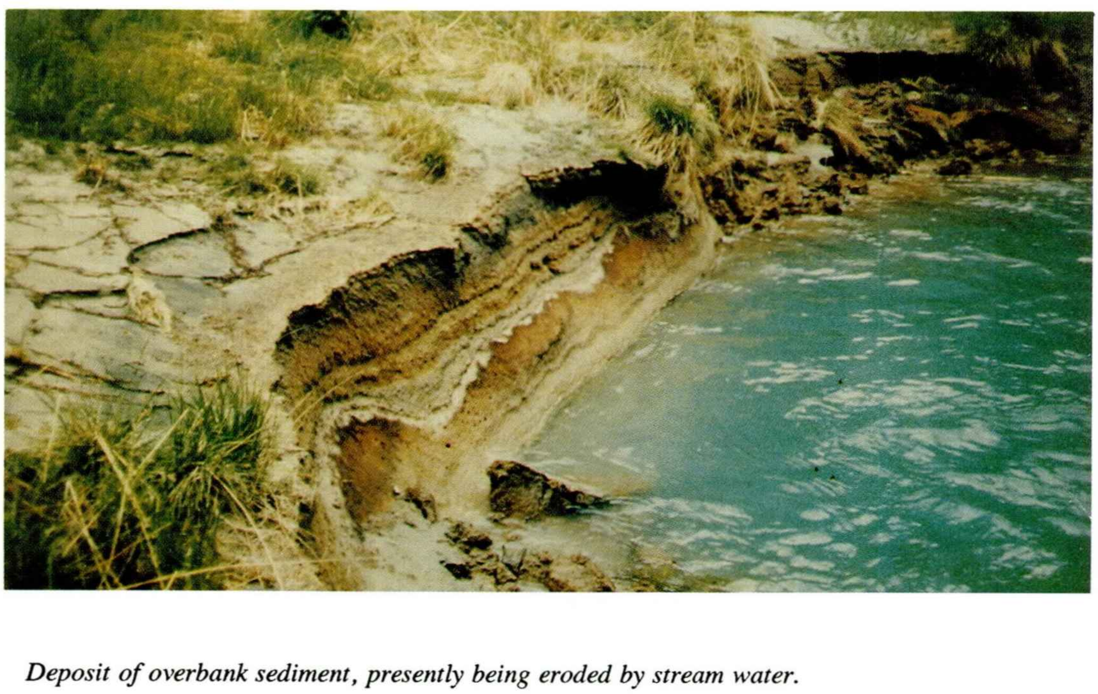


Fig. 1. Deposit of overbank sediment, presently being eroded by stream water.

AIMS

The major aims of the project are (a) to map the natural distribution of chemical elements in Western Europe, (b) to provide data on the present state of pollution in the surface environment and (c) to prepare systematic geochemical information for environmental and economic research and planning.

WORK PROGRAMME

The Project is divided into 3 phases: (1) planning and preparation, (2) main project, and (3) applications of data for research.

Phase 1. Planning and Preparation

a) Publication of selected pilot project studies in an international journal (App. 1).
b) Investigation of sources of external funding, and
c) Detailed planning of phases 2 and 3, including:
   (i) dissemination of information about the project to all WEGS countries;
   (ii) design of the geochemical database;
   (iii) detailed planning of field and laboratory operations, preparation of reference samples and investigation of potential long-term storage sites for a sample archive;
   (iv) initiation of contacts with other institutions for cooperative research,
   (v) preparation of detailed research programmes, and assignment of priorities to research.

Phase 2. Main Project

SAMPLING AND DATA ACQUISITION

A calculated 8771 sample stations located on river floodplains (60-600 km² drainage areas, 1 station per 500 km²) will be selected to cover Western Europe (Table 1). At each station 3 large samples will be collected comprising (1) overbank sediment at depth free from human influence, which will be used to map natural geochemical variations, (2) near surface overbank material to assess the impact of man on the environment, and (3) active stream sediment to facilitate linkage with other national geochemical datasets.

TABLE 1. ***Geochemical Mapping of Western Europe, Areas and Number of Sample Sites***

	Area km²	Sample sites
Austria	83,853	168
Belgium	30,513	62
Cyprus	9,251	18
Denmark	43,069	86
Finland	337,009	674
France	547,026	1094
F.R. Germany	248,687	498
Greece	131,944	264
Greenland[1]	341,700	682
Iceland	103,000	206
Ireland	70,283	140
Italy	301,262	602
Luxembourg	2,586	6
Netherland	40,844	82
Norway	324,219	648
Portugal	41,293	82
Spain	504,782	1008
Sweden	449,964	900
Switzerland	41,293	82
Turkey	780,576	1561
United Kingdom	244,046	488
Total	4.272,989	9453[2]

[1] The Geological Survey of Greenland has indicated that it will not be practicable to sample Greenland.

[2] When Greenland is not included 8771

Pilot studies suggest that a two-man field crew should be able to sample 2 locations a day. Samples will be sieved, according to strict specifications, in the individual countries. The minus 125 micron grain size fraction will be split into two subsamples for (1) national use and (2) international use. The national split will be retained in each country. The international split will be sent to BGR, Germany and split into two subsamples for (1) chemical analysis and (2) longterm storage (App. 2).

The fine grain size fractions of the samples will be analyzed for (App. 3):

- total content of elements,
- acid soluble content of elements, and
- easily extractable content of elements (for example exchangable cations)

Three main groups of elements will be determined (App. 3):

- elements potentially toxic to man, animal and/or plants,
- elements essential to health of man, animals and/or plants, and
- elements for geological and mineral exploration studies.

The samples will be analyzed in random order independent of country of origin, and analytical quality will be carefully controlled throughout the analytical programme using modern chemometric methods (App. 4).

Standardized field and laboratory data using a common system of coding will be entered into a data base which will be copied and distributed to all participating countries.

PREPARATION OF A GEOCHEMICAL ATLAS OF WESTERN EUROPE

The geochemical data will be presented at a scale of 1:10,000,000 on three basic types of maps (App. 5):

(i) Single element point source maps in black and white, with the data plotted as dots, the size of which increases with concentration (Fig. 2).

(ii) Single element moving median maps in colour, showing the main regional geochemcial variations (Fig. 3).

(iii) Derivative maps showing, for example, the present state of pollution.

Special purpose maps, at larger scales will be prepared for certain areas and particular themes.

The maps will be published in a geochemical atlas with descriptions of the methods used and short interpretative texts.

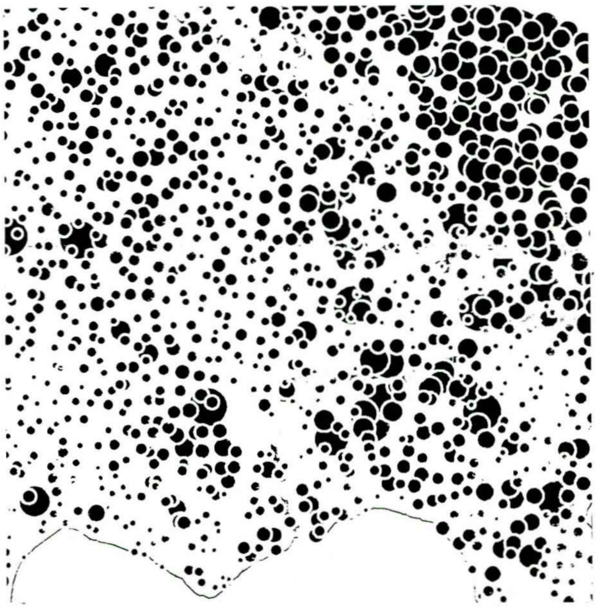


Fig. 2. *Example of single element point source geochemical map.*

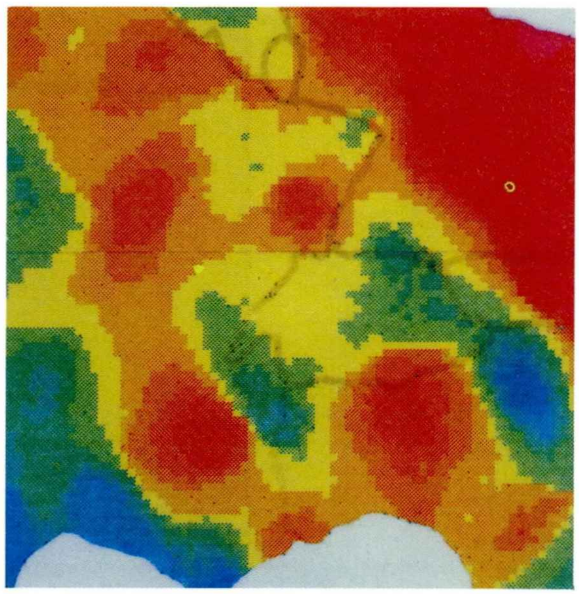


Fig. 3. *Example of single element moving median geochemical map.*

ESTABLISHMENT OF EUROPEAN STORAGE ARCHIVE FOR GEOCHEMICAL SAMPLES

The samples will represent a unique reference collection which should be stored under conditions giving minimal risk of contamination and further chemical alteration. The Working Group proposes that a long term Western European storage facility be established at a site which (1) has a low mean temperature, (2) is easily accessible, but still far from main pollution sources in Europe, and (3) is in international territory. Spitsbergen (78°N) seems to fulfil these requirements (App. 7).

Phase 3. Applications of Data for Research

Five research areas are proposed (App. 8):

1. POLLUTION STUDIES including

- research into tolerance of the surface environment to future pollution,
- delineation of areas that warrant more detailed investigation, and
- development of plans for pollution abatement strategies.

2. GEOMEDICINE, AGRICULTURE, FORESTRY, WATER RESOURCES AND LAND USE PLANNING

Statistical processing of the data for their utilization in studies of the effects of natural and anthropogenic chemical variations on the health of man, animals and plants. Research into statistical associations will require collaboration with scientists from appropriate disciplines.

3. CRUSTAL AND METALLOGENIC PROVINCES

Integrated analysis of the data with geological, geophysical and other spatially related datasets in order to identify major boundaries between geological terrains and the application of geochemistry to the understanding of the evolution of major crustal units, tectonic and metallogenic provinces.

4. BUDGETS FOR SEDIMENT TRANSPORT

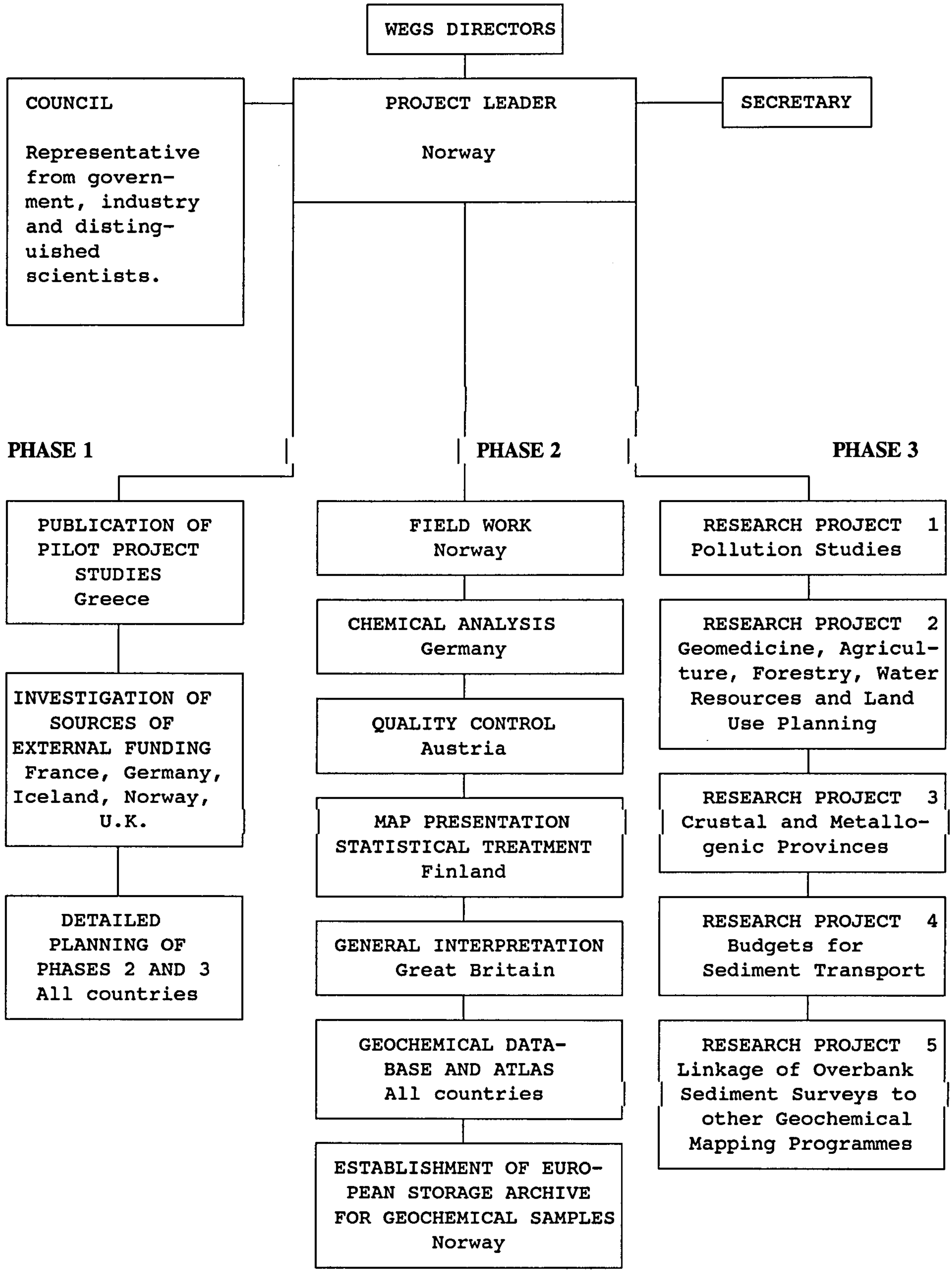
Quantitative estimation of the size of overbank sediment deposits and determination of composition and absolute ages of particular layers using isotopic and other techniques in order to (i) calculate the amount of natural and anthropogenic soil erosion and the solid phase transport of chemical elements into lakes, seas and oceans, and (ii) provide data for an appraisal of palaeoclimatic variations.

5. LINKAGE OF OVERBANK SEDIMENT SURVEYS TO OTHER GEOCHEMICAL MAPPING PROGRAMMES

Establishment of methods of (i) linking national geochemical datasets, and (ii) integrating the geochemical map of Western Europe into a global geochemical map series [4].

ORGANIZATION OF THE PROJECT

The Working Group on Regional Geochemical Mapping proposes the following organization of the project. Nations indicated in the boxes are suggested countries of origin of project/subproject leaders and/or subproject members, see also App. 9.



TIME SCHEDULE

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                                                     1990    1991    1992    1993    1994    1995    1996
Phase 1

Publication of Pilot Project studies                   ----------
Investigation of sources of external funding           -------
Detailed planning of phases 2 and 3                    ----------


Phase 2

Establishment of database                                            ----    ------------------------
Field work                                                           --------------
Sample preparation                                                         --------------
Chemical analysis                                                                    --------
Map presentation                                                                        ----------
General interpretation                                                                       --------
Publication of Geochemical Atlas                                                               -------
Establishment of sample storage                       ----                           -------------


Phase 3

Pollution studies                                                            --------------------------------
Geomedicine, agriculture etc.                                                        -----------------------
Crustal and metallogenic provinces                                                   -----------------------
Budgets for chemical and sediment transport                          ----------------------------------------
Linkage to other geochemical datasets                                                        --------------
```

BUDGET

Specified budgets, given in European Currency Units (ECU), are worked out for Phases 1 and 2, while the figures for phase 3 are more general estimates.

The following rates are used in the estimations:

Project Manager, salary	50,000 per year
Geochemist (senior graduate) salary	40,000 per year
Labourer, salary	25,000 per year
Field allowance	70 per day
Vehicle, running costs	1,100 per month

The budget presented in Table 2, is documented in Appendix 10.

The total cost for the preparation of the Geochemical Atlas of Western Europe (Phases 1 and 2, 6 years) is ECU 9,361,000, of which it is proposed that WEGS contribute ECU 5,309,000, and external funding be sought for 4,052,000.

The suggested research projects cost ECU 1,210.000, of which it is proposed that WEGS contribute ECU 600,000, and external funding be sought for ECU 610,000.

TABLE 2. ***Geochemical Mapping of Western Europe towards the Year 2000. Estimated Man-years, Costs and Tentative Plan for Funding.***

	Phase 1	Phase 2	Phase 3	Total
Number of man-years	21.7	71.6	15.0	108.3
Salaries	776,000	3,166,000	600,000	4,542,000
Running Expences	214,000	5,205,000	610,000	6,029,000
Total Cost	990,000	8,371,000	1,210,000	10,571,000
Tentative Funding Plan				
WEGS	776,000	4,533,000	600,000	5,909,000
External Funding	214,000	3,838,000	610,000	4,662,000

All the cost figures are given in European Currency Units (ECU).

REFERENCES

[1] Brundtland, G. Harlem et al., 1987: Our common future. *World Commission on Environment and Development. Palais Wilson, 52, rue des Paquis, 1201 Genève. Oxford University Press.*

[2] Bølviken, B. et al., 1988: Project Proposal. *Western European Geological Surveys. Working Group on Regional Geochemical Mapping. Published by the Geological Survey of Norway as NGU Report 88.147, 12 pages, 13 appendices.*

[3] Demetriades, A., Ottesen, R.T. and Locutura, J. (editors), 1990: Pilot Project Report on the Geochemical Mapping of Western Europe towards the Year 2000. *NGU Report 90-106, 9 pages and 10 appendices.*

[4] Darnley, A.G. and Garrett, R.G., 1990: A contribution to IGCP 259, International Geochemical Mapping. *Journal Geochem. Explor. Special Volume on Regional Geochemical Mapping. In print.*

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 1

PUBLICATION OF PILOT PROJECT RESULTS

A. Demetriades, Greece

The Pilot Project work that has been performed during 1988-1990 is innovative, and warrant the publication of a number of papers in an international geoscientific journal. The Working Group proposes the editing of the papers to be undertaken by A. Demetriades (Greece).

The Working Group will approach the Institution of Mining and Metallurgy for publication of the papers in a special issue. The reasons for suggesting the transactions (section 3) of the Institution of Mining and Metallurgy are: (a) the journal is European, (b) it has a good editorial staff, (c) colour geochemical maps can be published, and (d) the journal reaches a wide international geological/mining community.

The following papers are tentatively proposed:

1. **Regional Geochemical Mapping in Western Europe.**
   B. Bølviken (Norway), A. Demetriades (Greece) and R.T. Ottesen (Norway).

2. **The Occurrence of Overbank Sediment Deposits in Western Europe and their Use in Low Sampling Density Regional Geochemical Mapping.**
   R.T. Ottesen (Norway), and J. Bogen (Norway)

3. **Vertical Distribution of Elements in Overbank Sediment Profiles of Western Europe and Greenland.**
   O. Schermann (Austria), R. Hindel (F.R. Germany), A. Demetriades (Greece), T. Volden (Norway), J. Locutura (Spain), J.C. Croke (Ireland), M. Macklin and J. Ridgway (U.K.), A. Steenfelt (Denmark).

4. **Reproducibility of Sampling and Analysis of Overbank and Active Stream Sediment.**
   A. Demetriades (Greece), J. Locutura (Spain) et al.

5. **Distribution of Elements in Different Grain Size Fractions of Overbank and Stream sediment.**
   A. Demetriades (Greece), J. Locutura (Spain), and O. Schermann (Austria).

6. **Use of Different Analytical Methods and their Effectiveness in Regional Geochemical Reconnaissance.**
   A. Demetriades (Greece), J. Locutura (Spain), T. Volden (Norway), R. Hindel (F.R. Germany) and R.T. Ottesen (Norway).

7. **A Comparison of Overbank and Stream Sediment in Low Sampling Density Geochemical Surveys.**
   A. Demetriades (Greece), R.T. Ottesen (Norway), R. Hindel (F.R. Germany), J. Locutura (Spain) and R. Salminen (Finland).

8. **A Comparison of Widely Spaced Regional Geochemical Sampling with Conventional Reconnaissance Stream Sediment Surveys.**
   A. Demetriades (Greece) and R.T. Ottesen (Norway).

9. **An Inventory of Western European Geological Surveys Regional Geochemical Mapping Programmes.**
   J. Plant (U.K.) and J. Ridgway (U.K.).

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 2

FIELD WORK AND SAMPLE PREPARATION

O. Schermann, Austria
R.T. Ottesen, Norway
I. Salpeteur, France

Overbank sediment is deposited outside river channels, and above the gravel during catastrophic floods (Figs. 1 and 2). It consists mainly of sand to silt. The sampling density should be 1 sample per 500 km^2 with catchment areas of between 60 and 600 km^2. From every location two overbank samples should be taken. The one from shallow depth (below the humic A-horizon) represents the present situation including industrial and mining pollution. The other sample, which is taken at depth in a carefully selected site, represents the natural background prior to even pre-historic mining and industrialisation.

The field work includes various steps. First, catchment areas of the proper size (as large as possible, preferably above 350 km^2) should be selected on modern maps. If necessary, neighbouring areas for compositing a sample should be identified. Sattelite images (e.g. SPOT) might be used. Airphotos should be used. It is also recommended to use older maps, records of the mining in the catchment area and local to township' archives regarding flood events and flood lines, all, to provide a real old pristine sample reflecting the geochemical background. In some cases a sample can be found on the higher low-terrace or even high terraces, but this is only valid for the non-glaciated terraines and could incorporate secondary processes within the profile, which is less pronounced in an ordinary overbank sediment.

A variety of the mentioned procedure will be necessary in those parts of Europe where sheet erosion exists. There the pristine samples can only be found on the bottom of the terrace, some metres above the stream, whereas the young sediment will be found in a lower, recently formed terrace only half a metre or so above the normal water level.

On the field site a provided form should be filled in, the soil pH should be measured and the profile described using a soil colour chart. An overview photography with the indication of the sample site(s) should be taken as well as another photo which shows the profile(s) and the sample section (if not exposed in a narrow shaft). The sample location should be indicated on a map. If necessary, the site must be filled up again after sampling.

The sample section close to the surface should begin below the humic A-horizon. This section should not exceed 20 cm. The sample should weigh at least 5 kg, but in case a split of the sample is kept for domestic purposes a bigger amount has to be allowed for. The deeper, unpolluted sample should weigh about 15 kg (Fig. 3). In both samples layers rich in organic material or with conspicuous ironstaining should be avoided. Another sample site should be selected. If necessary to avoid such material possible artefacts (pottery etc.), wood, peat should be collected for dating.

A sample of active stream sediment (as fine grained as possible but not consisting of organic mud mostly) should be collected as close as possible to the site of the overbank sample (Fig. 3). The bulk dry weight of this sample should be 5 kg. The active stream sediment is, among other purposes, used as a link between the overbank sediment and earlier performed stream-sediment based geochemical surveys.

At some randomly selected field sites field duplicate samples should be collected. This will be indicated by the pre-numbering. The field duplicate should be taken from an immediately adjacent sample channel; in the case that the first channel is wider than 25 cm, both samples should be taken from four channels, one sample from channel 1 and 4, the others from 2 and 3.

The field samples from the overbank sediment should be filled into poly-ethylene bags, and the bags should be put into plastic boxes for protection. The stream sediment should be filled into paper bags with water-resistant glue to allow quick dewatering. As soon as possible the sample should be shipped to the lab for subsequent air-drying in a contamination-free environment. It should be avoided to keep (in particular the stream sediment), the samples in the bags for pro longerd periods of time, since there are possibilities for oxidation of sulphides, followed by destruction of bags and dissolution of minerals.

For the anlaysis of mercury an equivalent of the sampled section, that is in reality a narrower and not so deep channel should be collected separately and filled into a PE-bottle with a tight screw cap.

The samples should finally be dried at temperatures just below 80°C. The total sample is weighed with a reasonable accuracy and - according to the standards of the project management - sieved into the following fractions: +2 mm, 2 - 0.5 mm, 0.5 - 0.18 mm, 0.18 - 0.125 mm, and minus 0.125mm. Every fraction is separately weighed again. The fraction +2 mm may be discarded, 1 kg should be kept from the 2 mm - 0.5 mm fraction and all the smaller grained fractions are kept for further purposes. The -125 μ fraction (minimum 2 kg) should be sent as a whole to the central laboratory where it is split under the supervision of the project manager for the various purposes: analysis, WEGS sample archieve and domestic archieve.

In case that some of the individual fractions is kept for domestic purposes the splitting has to be done very carefully and this fact has to be considered already when sampling in the field.

The base for cost estimation is: planning for the selection of the sample localities; a field team, consisting of a highly qualified graduate, two labourors with car and van or pick-up, has a capacity of - in the average - two samples per day. Facilities for drying and sieving greater volumes of sample material will increase costs.

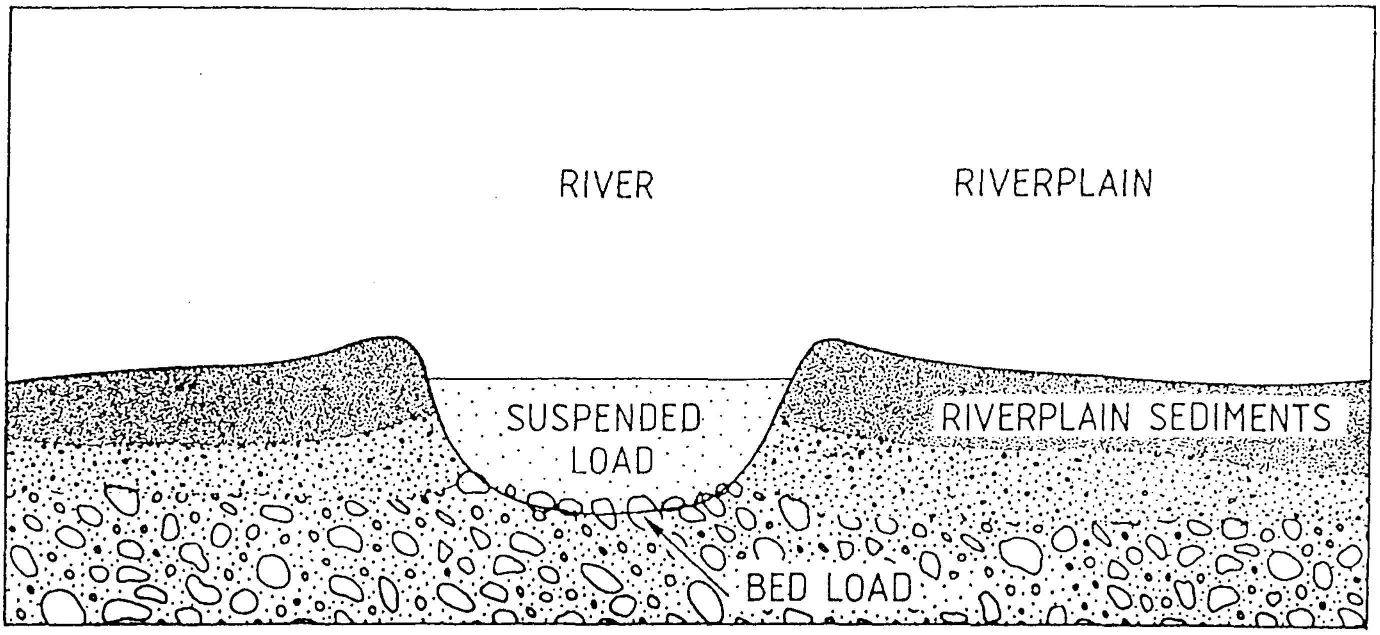


Fig. 1. Water discharge of river under ordinary conditions with normal amounts of water. (Ottesen et al. 1989, Fig. 6, page 262).

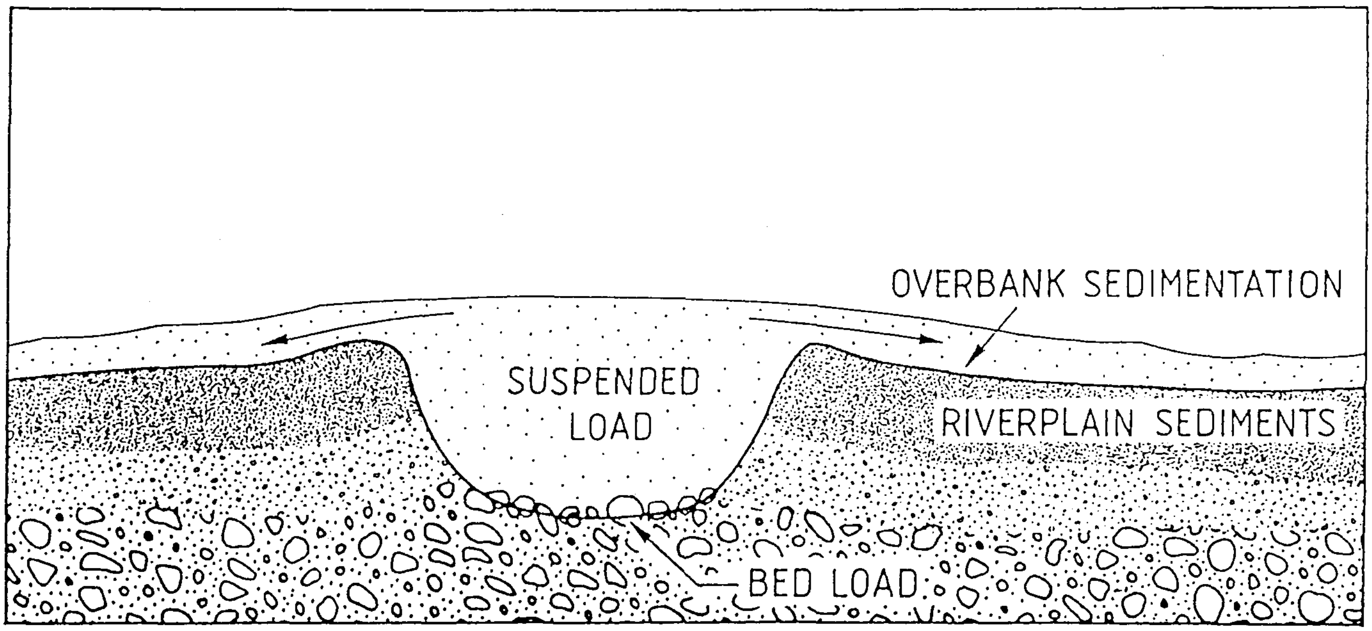


Fig. 2. Water discharge of a river during a major flood. Overbank sedimentation takes place on the river plain. (Ottesen et al. 1989, Fig. 7, p. 263).

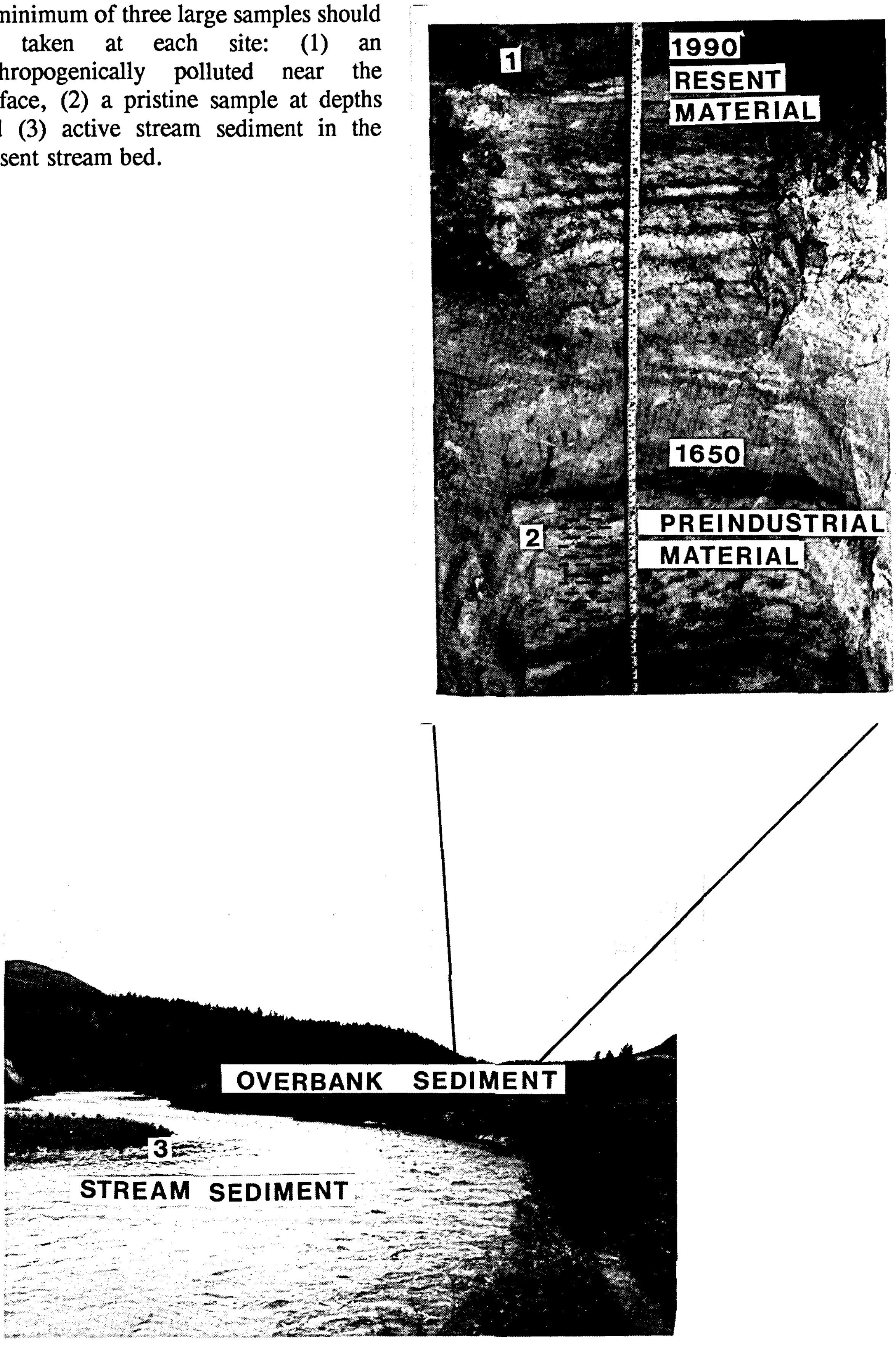


Fig. 3. A minimum of three large samples should be taken at each site: (1) an anthropogenically polluted near the surface, (2) a pristine sample at depths and (3) active stream sediment in the present stream bed.

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 3

CHEMICAL ANALYSIS

R. Hindel, Germany
T. Wippermann, Germany

In the proposed project it is planned to determine around 60 elements. These include environmentally sensitive elements (e.g. Cd, Hg, Se, As), ore-forming elements (e.g. Pb, Cu, Zn, Au, Pt) and petrogenetic elements (e.g. Li, Be, Sc, Sr, Zr, Nb, REE). This therefore requires determination of "total" element concentrations. The detection limits of the analytical techniques used for analyses of the overbank and stream sediment samples taken within the framework of this project must be lower than the expected element concentrations. Data on average element concentrations in overbank sediments are sparse. So far it is only in Norway that overbank sediment samples have been taken and analysed in a countrywide survey. Table 1 shows the average concentrations of the elements determined in overbank sediments during this survey. As far as the other elements are concerned the average concentrations in sand and sandstones as well as their crustal abundances might provide a rough idea of the expected element concentrations in overbank sediments.

The detection limits of the analytical techniques selected for this project should therefore be at least lower than the average element concentrations of Norwegian overbank sediments of the average element concentrations in sand and sandstones or the crustal aboundance. In the light of this, the required detection limits are given in Table 1.

Most of the analytical techniques selected for this project (Tables 2 and 3) have detection limits far below these average concentrations. However, problems might arise with As, Br and In where many of the overbank or stream-sediment samples might have element concentrations below these detection limits. In this case reliable statistical data (e.g. mean, variance) cannot be calculated. The use of analytical methods with lower detection limits (e.g. INAA) for these elements would however raise the cost of the analyses considerably.

In Fig. 1, a scheme for the preparation of overbank and stream sediment samples is shown. Tables 2 and 3 give the proposed analytical procedures. The elements are grouped in several packages according to the different analytical methods. This also facilitates the sharing out of the analytical work amongst the participating survey laboratories.

Since the analyses for gold, platinum and palladium are quite expensive and creates serious problems in the safe disposal of the used cuples it is recommended analysing only a selected number of samples for these precious metals.

The cost of analysing one sample for the proposed elements (excluding Au, Pt and Pd) are estimated as 110 ECU (proposal I) or 189 ECU (proposal II). Analysis of the 30.000 smaples planned to be taken during this project would therefore cost between 3.000.000 ECU and 5.670.000 ECU.

Fig. 1a: General sample preparation

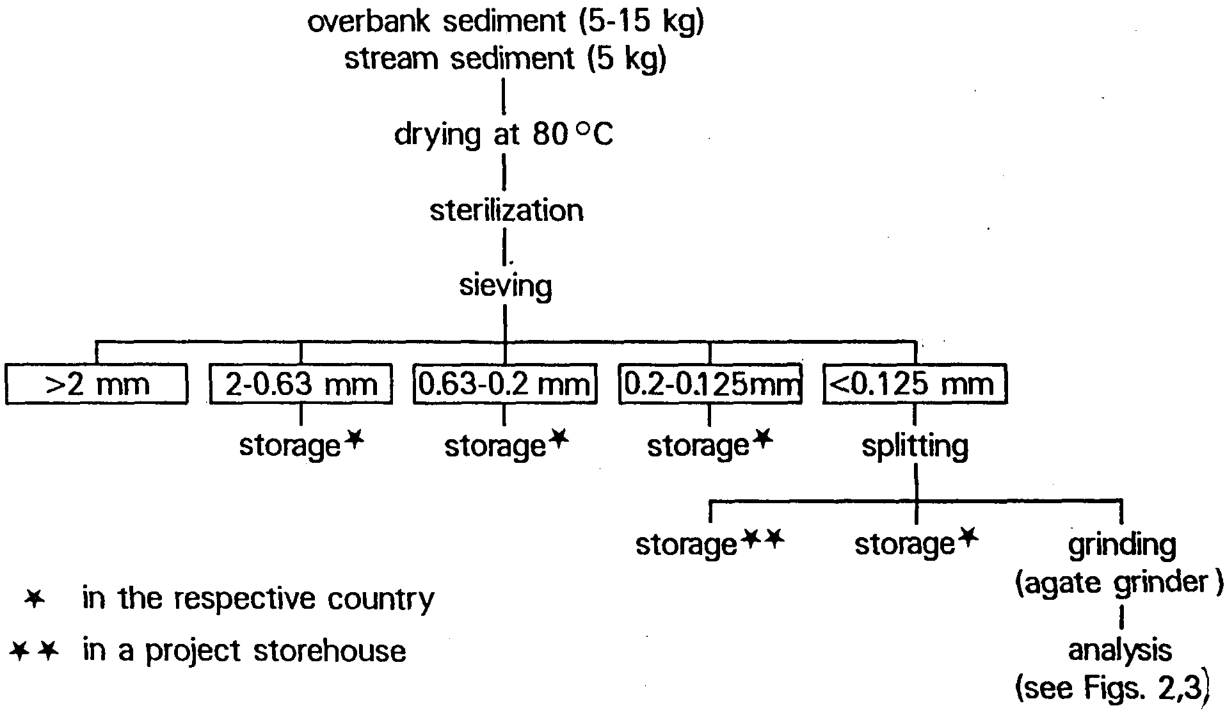


Fig. 1b: Special sample preparation for Hg analysis

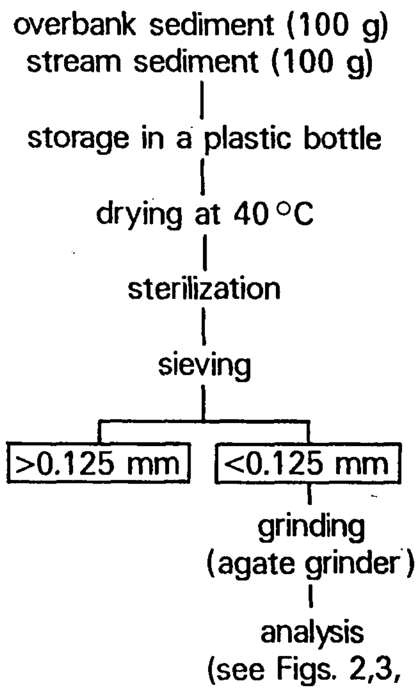
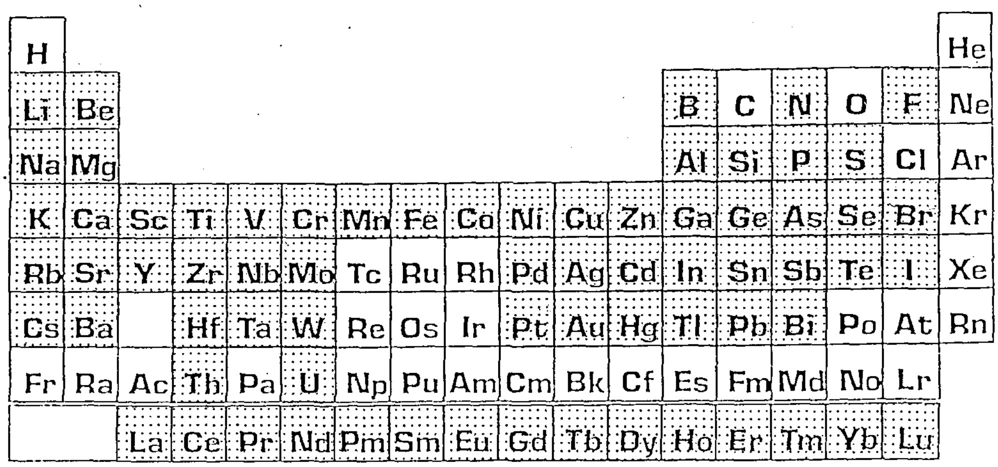


Fig. 2. Elements to be determined.



Tab.1: Abundance of elements (ppm) in various geological materials and required detection limits for analytical procedures in the framework of geochemical mapping

	Overbank Sediments (Norway)	intrusive rocks of the upper earth crust (WEDEPOHL 1967)	Sand, Sandstone (WEDEPOHL 1967)	Stream sediments (Geochem. Atlas BGR)	required detection limits for analytical procedures in the framework of geological mapping
Li	14	30	15	10	<10
Be	<1	2	<1		<1
B		9	35		<9
N		20			<20
F		720	270	26	<300
%Na	1.7	2.5	0.4		<0.4
%Mg	1.6	1.4	0.7		<0.7
%Al	6.8	7.8	2.5		<2.5
%Si	28.1	30.5	36.8		<28.0
P	1300	810	450		<450
S	300	310	240		<240
%K	1.83	2.8	1.1		<1.1
%Ca	2.21	2.9	3.8		<2.2
Sc	4.3	14	1		<1
Ti		4700	1500		<1500
V	41	95	20	32	<20
Cr	33	70	35	48	<35
Mn	600	690	250		<250
%Fe	1.8	3.5	1.0		<1.0
Co	13	12	1	10	<1
Ni	23	44	21	17	<17
Cu	26	30	30	9	<9
Zn	54	60	16	53	<16
Ga		17	12		<12
Ge		1.3	0.8		<0.8
As	2.8	2	1		<1
Se	0.1	0.1	0.05		<0.1
Br		2.9	1		<1
Rb	107	120	60		<60
Sr	34	290	20	82	<20
Y	58	34	14		<14
Zr	683	160	220		<160
Nb	37	20	<0.1		<0.1
Mo	1	1	0.2		<0.2
Pd		0.01			<0.01
Ag		0.06	<0.1		<0.06
Cd		0.1	<0.1	0.6	<0.1
In		0.07	<0.1		<0.07
Sn		3	<1	1	<1
Sb		0.1	<0.1		<0.1
Te		0.002			<0.002
J		0.5	2		<0.5
Cs		3	<1		<1
Ba		590	310	392	<300

	Overbank Sediments (Norway)	intrusive rocks of the upper earth crust (WEDEPOHL 1967)	Sand, Sandstone (WEDEPOHL 1967)	Stream sediments (Geochem. Atlas BGR)	required detection limits for analytical procedures in the framework of geological mapping
La	24	44	8		<8
Ce	50	75	92		<50
Pr		8	3		<3
Nd		30	11		<11
Sm		9	3		<3
Eu		1.4	0.6		<0.6
Gd		9	3		<3
Tb		1.4	0.4		<0.4
Dy		6	7		<6
Ho		1.8	0.5		<0.5
Er		3.4	1		<1
Tm		0.3	0.3		<0.3
Yb		3.4	1		<1
Lu		1.1	0.1		<0.1
Hf		3	4		<3
Ta		3.4	<0.1		<0.1
W		1	2	1	<1
Pt		0.005			<0.005
Au	0.004	0.004	.0006		<0.004
Hg		0.08	0.03		<0.03
Tl		1	0.8		<0.8
Pb	19	15	7	24	<7
Bi		0.1			<0.1
Th		11	2		<2
U		3.5	0.5	0.5	<0.5

Tab. 2. Analytical techniques for determination of 'total' concentrations of various elements in overbank and stream sediment samples; proposal I.

package 1	package 2	package 3	(package 4)	package 5	package 6	package 7	package 8	package 9	package 10
ICP-AES 0.5 gr decomposition with HF,HCl, HClO4	XRF (beads) 1.0 gr. fusion with LiBo2 / Li2B4O7	ICP-MS 1.0 gr. decomposition with HF/HNO3	Fire Assay 50 gr. fusion, cupellation of lead button, dissolution of resulting prill in aqua regia and AAS finish	Cold vapour and Hydride Technique (AAS) 0.2 gr. pyrolytic det.)	Det. by ionsensitive electrode 0.5 gr. cold acid leaching (HCl)	LECO 0.5 gr. IR-detector	AAS 1.0 gr. sublimation-decomp. (NH4J)	Spectrophotometric. det. 0.25-1 gr. acid/NaOH-leaching or KHSO4 fusion	Hydride generation AAS aqua regia digestion 0.5 gr.
Pb Cu Zn Cd Ni Be Li Sc Y V	Na K Mg Ca Al Ti Si Mn P Fe Cr Zr Ga Ba Rb Ce Sr	Nb Tb Mo Dy Ag Ho In Er Cs Tm Ge Yb Te Lu Se Hf La Ta Pr Tl Nd Bi Sm Th Eu U Gd	Au Pt Pd	Hg	F	S	Sn	W	As Sb Se
costs per sample: ECU: 16	10	48	(64) +65: safe disposal of used cupels	4	4	7	7	7	8

Tab. 3. Analytical techniques for determination of 'total' concentrations of various elements in overbank and stream sediment samples; proposal II.

package 1	package 2	package 3	(package 4)	package 5	package 6	package 7
XRF (pellets)	XRF (beads)	ICP-MS	Fire assay/	Cold vapour	Det. by	LECO
2.0 gr	1.0 gr.	1.0 gr.	ICP-MS	AA	ionsensitive	0.25 gr.
	fusion with	decomposition	fusion,	0.2 gr.	electrode	combustion
Ga	LiBO2 /	with	collection	pyrolytic	0.2 gr.	and IR-
Rb	Li2B4O7	HF/HNO3/HClO4	of precious	decomposition	hydropyrol.	detector
Sr			metals on a		decomposition	
Ba	Na K	Li Mo Dy	lead button	Hg		S
	Mg Ca	Be Cd Ho			F	
	Al Ti	B In Er	Au			
	Si Mn	V Sn Tm	Pt			
	P Fe	Cr Sb Yb	Pd			
		Co J Lu				
		Ni Cs Hf				
		Cu La Ta				
		Zn Ce W				
		Ge Pr Tl				
		As Nd Pb				
		Br Sm Bi				
		Y Eu Th				
		Zr Gd U				
		Nb Tb				
costs per sample:						
ECU 15	64	74	(45)	15	12	9

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 4

QUALITY CONTROL

O. Schermann, Austria

1. Random numbering

The first step will be a random numbering of all samples to be analysed. These numbers include the numbers of the 8800 samples to be taken plus 880 samples for the proposed controls. Later, the labs will be held to order and analyse the samples in ascending numbers in batches of 100, with each kind of control sample represented in every batch. Besides other advantages of this measure there will be an opportunity to correct data batchwise and this way to reduce the total spread of data to a minimum.

2. Accuracy

This is the most important item for the comparison between countries and projects. The word "accuracy" in this context means the closeness of the value to the true concentration of an element in the sample, which can be reproduced by different labs and different analytical methods. In practice it can be understood as "the most probable" or the "agreed" content, while the actual - the true - concentration is still unknown. The routine instrumental readings during the project will then be compared with the agreed values of the one or more "standards" and will be converted or corrected into chemical concentration.

To provide these agreed values, standard samples have to be analysed with various methods and by various labs. It is very important that the standard material is comparable to the project sample in respect to grain size distribution, mineralogical composition, similar range of chemical concentration and that it has undergone the same sample preparation routine (see below).

3. Precision

Generally speaking this term means the variance of results of the repetition of the same procedure. This may concern sampling, sample preparation, as well as e.g. analysis, but not the comparison between analytical methods, although they should give similar results if the calibration was done correctly.

3.1. Sample location

The representativity of sample locations should be tested on a few sites, apart from the objectives of the project, on one site per 100 to 300 locations, depending on the variety of morphology and climatical zones in the countries concerned. The procedure is simple:

Select a sample site as usual; then take one or more samples upstream and downstream at intervals of 150 - 200 m; then take 4-6 samples at more or less equal distances across the valley from the same sample locality; these data, which should be administrated separately from the project will give hints on the significance of the project and comprise a contribution to the pilot project of IGCP 259.

3.2. Sampling method

As the sampling method will be standardized there will not be - regarding the sample material - too much difference between sampling crews within a country or between countries. There might arise one problem: in case the proportion of fine-grained materials is low, care has to be taken to sample to depth in the same width (c.f. channel), but this is more a problem of sample reproducibility and will not really cause an error between samples.

3.3. Sample preparation

This item can be the source of very significant errors, i.e. bias or deviations from the actual chemical composition, depending on one side on the mineralogy, the mineral form and grain size, and on the other side on the (observation of the) processing standards, thus on the personnel.

It is of great importance that the project management will give standards obligatory for all involved organisations which should include process as well as gear (equipment). The supervision on the domestic level will still remain a great job.

For controlling or quantifying the remaining differences in processing (as well as analysis) it is proposed:

- Take a field duplicate with different numbers. This could either be a bigger sample quartered into two halves, accepting an unquantifiable splitting error; or take in the field two immediately adjacent channels; this way the sampling difference should be minimal. Two field duplicates should be contained in every batch.

- As a test of sample preparation as well as an almost blank sample for testing contamination in the course of sample preparation insert the fine-grained tailings (that is, with a reduced content in the fine-grained kaolinite) of two different kaolin plants, if possible, from two different countries. The sample weight should be around 5 kilos; fireclays are not a good substitute, mainly because of the too narrow grain size band. Each of the two kaolins should be represented in every batch.

3.4. Analysis

3.4.1. Subsampling

For analysis a fracture of a gram to a few grams of sample material are actually analysed. Hence it is a precondition for a good analysis that the subsample employed is a real equivalent of the total sample composition. Thus much emphasis has to be laid upon splitting and subsampling, in every stage of the sample handling. One example may illustrate the often unexpected sources of bias: when the sample is ground it usually is filled into a bottle, a number of bottles is loaded onto a cart and carried around in the lab. The vibrations cause the material to differentiate into various zones according to grain size, mineral form and probably specific gravity. The half gram scooped from the uppermost layer will deviate considerably from the composition of the total sample. To control this source of error it is proposed to hand over to the labs only a limited amount of sample material, subsampled under supervision of the project management.

3.4.2. Sample splits

Samples from primarily designed locations for this purpose or, maybe, in samples with a high proportion of the fine-grained fraction, a duplicate is produced after sieving and inserted into the sample sequence with a number unrecognizable for the lab. In total two samples per batch are proposed. These data, together with the kaolins and the field duplicates will give good information on the quality of analysis.

3.4.3. Project reference material

It occurs to be of great importance to produce a project standard, in the interest of the lab as well as of the quality control. The same standard material should be used for a ring test between labs for determination of the accuracy, an important item in an international project.

A standard gives comparable data with regards to the sample only when it is of similar composition, chemically as well as mineralogically, and when it has a comparable grain size distribution. Therefore it has to undergo the same processing. There is one more restriction with analysis: The dependency on the chemical matrix that is the prevailing of certain elements such as Ca, Mg, Ti etc.

Considering these restrictions it is proposed to prepare four standards, each from one or more sample sites; these sites should have easy access, and should be an outcrop to provide enough material for all batches and purposes as well as reserves for future use e.g. IGCP 259. One of the standards should come from northern Europe, one from more southern climates, one should have a carbonate matrix and the fourth one should be noticeably contaminated with heavy metals (to provide data for the higher values as well). Each of the four standards should be inserted into every batch. There only remains the question of whether the lab should know the numbers or not. In the case of yes, the advantage for the lab would be an immediate control of the correctness of the analysed batch. But this is a matter of trust.

As a compromise, the lab could know of one standard with a constant number, e.g. xxx49.

Besides, it is not forbidden for the lab (or the project manager) to extract a small portion from every sample, to grind it and to apply this as a lab standard, spiked or not.

4. Ring test

The term "accuracy" should tell how close an analytical values comes to the "true" concentration. Practically, accuracy means an "agreed" value, the value which is most often obtained in many analyses by different labs or "the most probable" value. Usually, the standard values of accuracy are obtained only in the course of a project, so the read-off values are recalculated afterwards instead of adjusting the analytical instruments in advance according to the type of sample material (which is an important parameter in analysis).

For calibration of the analytical instruments usually international standard reference materials are used, mainly finely ground rocks. As the type of materials used for analysis is of significant importance as well, and the reserves of these international standard materials are close to or already exhausted, it is proposed to use the 4 project standards as reference material for the determination of the "agreed values" for the respective analytical methods. And, for instance, as IGCP 259 will deal with comparable materials the project standards should be of use as well.

Therefore, subsamples of the project standards should be analysed by a number of laboratories in Europe, maybe also outside Europe. The methods applied for the ring test analyses should include the routine analytical methods of the project.

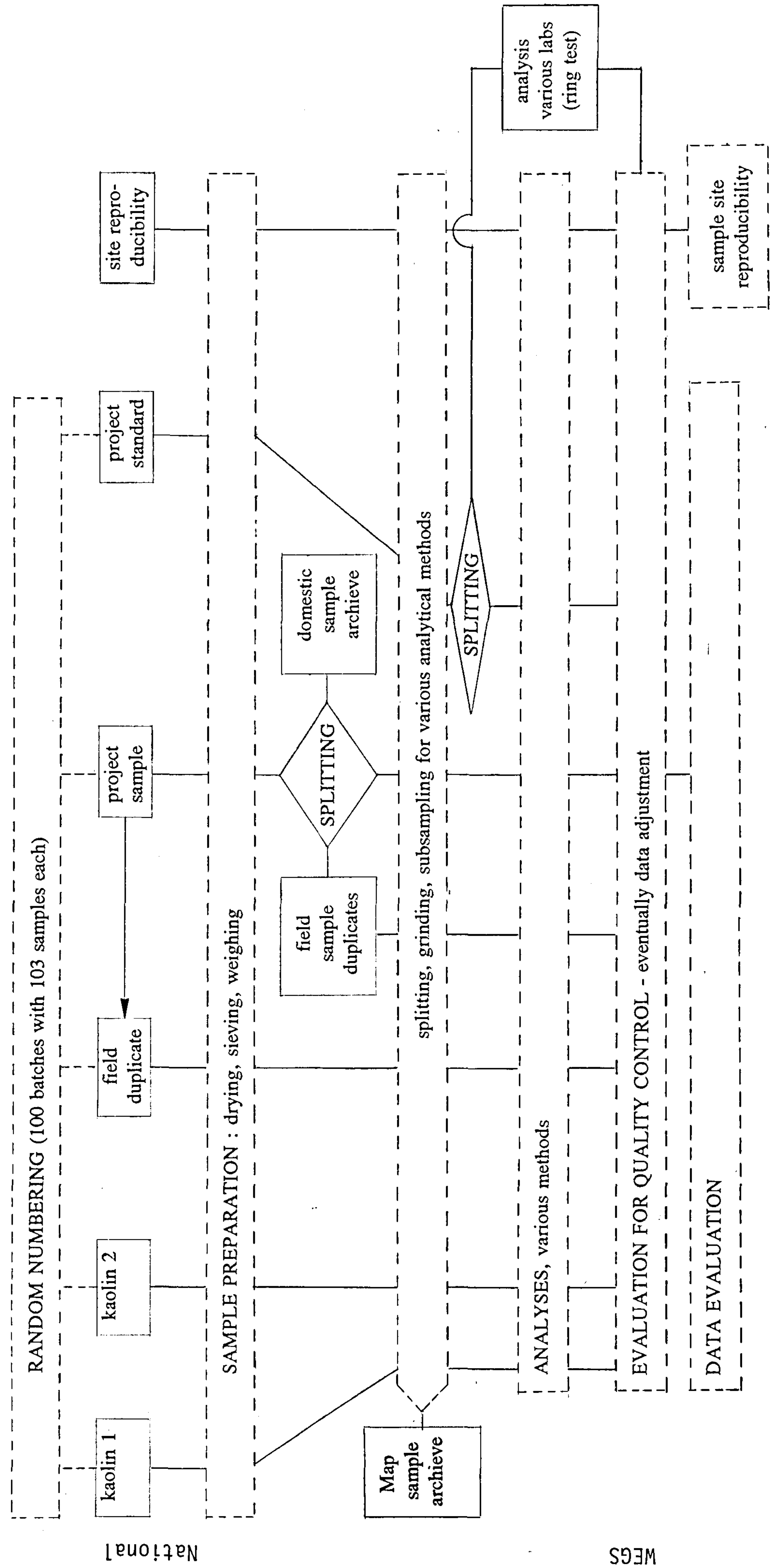
5. Summary

For quality control various kinds of samples are proposed, which sum up to 10% in addition to the required samples. These are:

	Proportion	N (on the basis 8800 samples in the project area)
kaolin 1	1%	88
kaolin 2	1%	88
field duplicates	2%	176
sample splits (after sieving)	2%	176
4 project standards (1% each)	4%	352
	control samples	880
	project samples	8.800
	total	9.680

This makes 97 batches of 100 samples or vice versa, namely 100 batches of 97 samples.

WEGS GEOCHEMICAL MAPPING - Scheme of quality control



WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 5

MAP PRESENTATION

R. Salminen, Finland
B. Bølviken, Norway

Map Production

The main map scale of the programme will be 1:10,000,000. If necessary, common work sheets at a scale of 1:5,000,000 will be prepared. Scales for work sheets within countries should be 1:2,500,000 and/or 1:1,000,000. Possible larger scales for field work is decided by the participating countries individually.

The Geological Survey of Finland will prepare the common base maps. The layout of the maps will be decided by the Project Management at an early stage of the programme. All the collected data will be digitized for computerized plotting on the established base maps. It will be endavoured to display existing geological, geophysical and other data of Western Europe on the same scales and formats as those of the geochemical maps.

The geochemical data will be presented in an atlas of maps at a scale of 1:10,000,000 on three basic types:

(1) Single element point source maps in black and white, with the data plotted as dots, the size of which will increase with concentration (Fig. 1).

(2) Single element moving median maps in colour, showing the main regional geochemcial variations (Fig. 2).

(3) Derivative maps, such as maps of the present state of pollution.

Special purpose maps, at larger scales will be prepared for certain areas and particular themes.

Frequency distribution diagrams, from which main statistics and experimental errors can be estimated, will accompany the geochemical maps.

Costs

Estimated costs of map production and other data presentation are given below. The cost figures are estimated from the prices at the Geological Survey of Finland, and include salaries, computer time etc.

1. Map production

Single element black and white dot maps for presentation of raw data. The price of one final map (an original for printing) is ECU 100,-.

Single element moving median coloured maps and derivative maps. Price for one final map (an original for printing) is ECU 350,-.

An estimated total of 300 different maps for the Atlas, 150 black and white and 150 coloured, will cost ECU 67.500.

2. Preparation of base maps, production of data base, diagrams, tables of statistics etc.

Standardized field and laboratory data using a common system of coding will be entered into a data base which will be copied and distributed to all participating countries. The database could be "Alkemia" at the Geological Survey of Finland or similar databases at other institutions. Special modifications must be created for the WEGS programme.

Three man-years are needed for this and the preparation of base maps, diagrams, statistics etc. Salaries are estimated at ECU 75,000 and computer time ECU 15,000, totalling ECU 90,000.

3. Part time subproject leader

A part time subproject leader will coordinate all the data processing work and consult with all participating countries. Estimated work time for a system analyst amounts to two man-years.

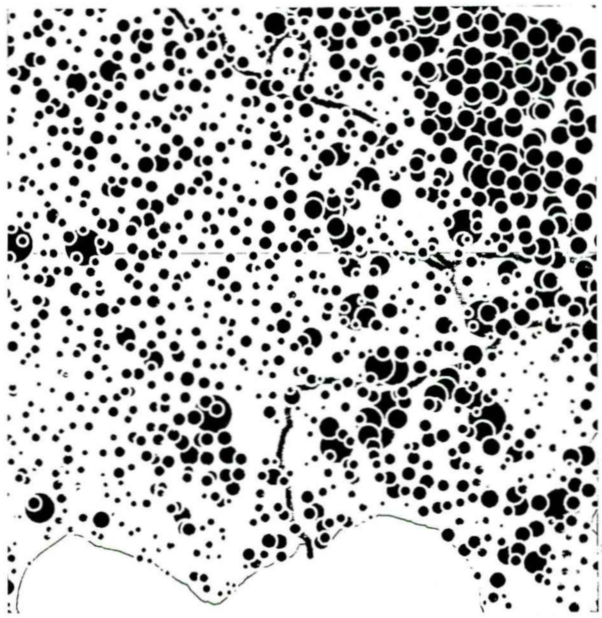
Salaries will be ECU 50.000 and costs for secretary, travelling etc. ECU 20.000, totalling ECU 70.000.

4. Printing of the geochemical atlas of Western Europe

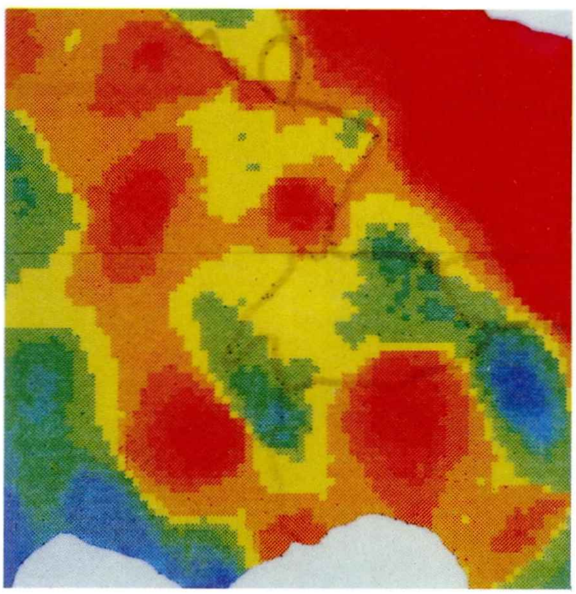
Printing and editing costs for 2000 copies are estimated at ECU 100.000.

Grand total of map production is ECU 332.500,-

These figures show the same data illustrated in two different ways.



App. 5. Fig. 1. Example of single element point source map.



App. 5. Fig. 2. Example of single element moving median geochemical map.

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 6

GENERAL INTERPRETATION

J. Plant, U.K.

Interpretation will accompany maps of individual chemical elements, as well as multi-element maps prepared using statistical methods, for publication in the atlas. The main aim of the interpretation will be to convey important feautres of the distribution of chemical elements to non-geochemists. These will be designed as follows:

A. GEOLOGY

A brief general description of the distribution of the each element will be given first in relation to average crustal abundance values and other reference data. This will be followed by a brief account of the theoretical behaviour of the chemical elements concerned in igneous, sedimentary and metamorphic rocks.

The relationship between the distribution of each element and the geology to indentify variations in the normal background content will then be discussed in relation to differences between the main tectonic provinces in Europe. For example the Caledonian, Hercynian and Alpine orogenic belts will be evaluated before considering variations within major crustal units such as the Baltica, America and Cadomian plates mooved in the Caledonian orogeny.

B. ECONOMIC GEOLOGY

Evidence of the presence and role of geochemical provinces in metallogenesis will be briefly reviewed with particular reference to potential crustal reserves of ore forming elements such as Au, Sn and Ba Pb and Zn.

C. QUATERNARY GEOLOGY

The results obtained on the samples at depth will provide information on the geochemistry of quaternary formations which cover much of lowland Europe for example Holland. They will also provide information og Pleistocene glacial and fluivioglacial deposits over Western Europe generally.

D. SURFACE ENVIRONMENT

The theoretical behaviour of the element in the surface environment and mobility in different Eh/pH conditions will be considered before describing some of the main areas thought to be affected by contamination. The importance of these will be briefly assessed in relation to the variations identified in the natural background. Some suggestions will be made on the potential significance of areas with exceptionally high and low concentrations of elements for environmental, epidemiological and agricultural studies and land use planning. The differences between the results observed on samples collected from depth in overbank profiles and these from the near surface will be used to comment as possible occurrences of pollution but no statements will be made as to its source.

Section and bedrock geology, economic and Quarternary geology will be based on samples collected from depth overbank and that on the surface environment will be based on the near surface overbank samples.

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 7

LONG TERM STORAGE OF SAMPLES

B. Bølviken, Norway

The samples that will be taken by the WEGS project represent a unique collection for future research in Europe, reflecting (1) the pristine, preindustrial geochemical conditions, (2) the situation in the early 1990's. and thereby (3) effects of pollution during historical times

A longterm sample storage facility should, therefore, be established, from which unchanged reference samples can later be retrieved.

Two types of chemical alteration are likely to occur in geochemical samples that are stored outside their natural environment namely (1) oxidation and other chemical reactions caused by air or chemical and/or biological agents within the samples, (2) contamination of the samples from sample containers, air dust or water.

Chemical alteration of type 1 can be minimized by storing at low temperatures. Chemical alterations of type 2 can be minimized by skilful selection of sample containers, careful handling and storage under nonpolluting conditions.

The Working Group proposes that a long term Western European storage facility be established at a site fulfilling the following requirements: (1) it should have a low mean temperature, (2) it should be easily accessible, but still located far from main pollution sources, and (3) the territory should be international. Spitsbergen (78°N) seems to fulfil these requirements.

Abandoned coal mines at Spitsbergen have a constant yearly temperature of 0 to minus 5°C depending on the location. Genebanks are already established there under such conditions. The Geological Survey of Norway is prepared to investigate the possibilities for establishing a European Geochemical Sample Storage at Spitsbergen.

An international treaty stipulates that such storage be administrated by Norwegian authorities (or their deputies) at Spitsbergen, but otherwise the countries which signed the treaty have equal rights. A board of WEGS representatives should have the authourity to approve/refuse future applications to retrieve sample splits from the storage.

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 8

APPLICATIONS OF DATA FOR RESEARCH

B. Bølviken, Norway, et al.

The geochemical mapping of Western Europe will result in data which can be utilized for research within various fields. The Working Group proposes five research projects:

(1) Pollution studies.
(2) Geomedicine, agriculture, forestry, water resources, land use planning.
(3) Crustal and metallogenic provinces.
(4) Budgets for sediment transport.
(5) Linkage of overbank sediment surveys to other geochemical mapping programmes.

The following account outlines main features of these projects. (The authors of the various chapters are given in parentheses).

RESEARCH PROJECT 1. POLLUTION STUDIES

(B. Bølviken)

Background

The natural concentrations of chemical elements in the surface environment vary regionally within wide limits. This variation must be taken into account when evaluating the degree of pollution.

Aims

Utilize data obtained in the main project in

- evaluation of the present state of pollution,
- appraisal of the tolerance of the surface environment to further pollution,
- delineation of areas that warrant further investigation,
- developement of plans for pollution abatement strategies.

Methods

Features of the present state of pollution can be estimated by determining differences between the composition of (1) stream sediment and near surface overbank sediment and (2) pristine overbank sediment. Toleranse to continued airborne pollution can be studied by (1) treating the samples with water and diluted acids and other liquids simulating various degrees of acid or otherwise polluted precipitation and (2) analysing the leachates for acidity and nutrition as well as noxious elements. The data may be used to prepare European maps of themes such as overburden resistivity to acidification and overburden release of various chemical elements when exposed to acid rain.

Delineation of areas that warrant further investigation can be made by interpretation of the obtained geochemical maps. The results may indicate that certain areas should be investigated in more detail in order to outline the extent and seriousness of the problem and to locate possible unknown sources.

Plans for pollution abatement strategies require thorough knowledge of pollution status.

Expected results

Presentation of European thematic maps showing degree of pollution, tolerance to acidification, release of various chemical elements when exposed to acid rain etc.

Certain areas may require more detailled investigation, and plans for pollution abatement strategies may be suggested.

Budget

The project is estimated to require 3 man-years of qualified researchers. In addition ECU 100,000 - 200,000 will be needed for analysis, computer work and map presentation. It is believed that external funding would be available for a project of this type. Cooperation with environmental agencies should be sought.

Time schedule

	1993	1994	1995	1996
Leaching and analysis of leachates	----------	--------		
Preparation of maps		----------	--------	
Interpretation and publishing			----------	--------

RESEARCH PROJECT 2. GEOMEDICINE, AGRICULTURE, FORESTRY, WATER RESOURCES AND LAND USE PLANNING

(B. Bølviken, Norway and P. Stavrakis, Greece)

Background

Geochemical maps have great potential application in geomedicine, agriculture, forestry, water resources and land use planning. Utilization in these field should be investigated at a continental scale.

Aims

The project should aim at

- a statistical processing of the data for their utilization in studies on the effects of natural and anthropogenic chemical variations on the health of man, animals and plants,
- demonstrations of examples of use,
- initiation of cooperation between the WEGS and research/administration organizations within public health, epidemiology, agriculture, forestry, water resources, land use planning and pollution.

Methods

In order to use geochemical data in geomedical research (epidemioloty, environmental geochemistry and health) the geochemical data must be available for the same geographical units as health statistics. This means that typical geochemical values have to be calculated and tabulated for municipalities, countries, states and/or countries.

Natural sources of chemical elements, some of which influence the health of humans, animals and plants can be divided into two groups (1) the local bedrock and overburden, and (2) remote sources such as oceans and vulcanoes, from which elements are dispersed over long distances through the atmosphere. Analogous local and remote sources are also present for anthropogenic material.

Since the geochemical data obtained in the programme will mainly reflect the bedrock/overburden geology and the effects of pollution of the surface environment it is desireable to aquire geochemical data which reflects the effects of the chemical climate, i.e. fallout of long transported chemical elements. Such data will be obtained through (1) special analyses of the samples and (2) from meteorological and air research institutions. Examples of use of the data in agriculture etc. will be demonstrated on maps, in tables, and diagrammes with interpretive texts. Various research institutions will be contacted in order to initiate cooperative research.

Expected results

It is expected that the research project will disclose large scale variations in the geochemical environment that may throw light upon health problems in humans, animals and plants.

Budget

The project is estimated to require 2-3 man-years by qualified researchers. In addition ECU 50,000 - 100,000 will be needed for data aquisition, computer work, map presentation and reporting.

Time schedule

	1994	1995	1996
Rearrangement and presentation of WEGS geochemical data	-------------		
Aquisition of other types of data	-------------		
Demonstration of examples of use			-----
Establishment of contacts with other research institution			-----

RESEARCH PROJECT 3. CRUSTAL AND METALLOGENIC PROVINCES

(J. Plant, U.K.)

Background

It is expected that the geochemical mapping programme will disclose broad geochemical provinces.

Aim

The research program will be aimed mainly at the delineation of major crustal provinces in Western Europe, such as orogenic belts, and identification of their geochemical signatures with particular reference to metallogenesis. The chemistry of particular rock types such as basalts, granites and shales will also be studied to provide information on the evolution of the mantle and lower and upper crust, for example the Precambrian shields and Caledonian, Hercynian and Alpine orogenic belts. The large scale variation of trace elements in sedimentary rocks of particular stratigraphic ages will also be used together with paleo-geographical information to prepare interpretation maps.

Method

The study will be carried out mainly using GIS methods to integrate the geochemical data for analysis with geophysical, geological and other spatially related data sets.

Expected results

Regional geochemical data at the national scale have been shown to identify major crustal features not aparent on classical geological maps. A better understanding of the large scale evolution of Europe is therefore expected as a result of the proposed study. Of particular importance is the potential to obtain information to relate the evolution of the Hercynian and Alpine belts to modern global tectonic theories.

More information should also be obtained on the role of geochemistry in the development of metallogenic provinces particular the significance of crustal reservoirs of the example Au, Sn, Ba, Pb and Zn.

Budget

The project is estimatet to require 3 man-years by qualified researchers and ECU 50,000 - 100,000 for additional costs.

Time schedule

	1994	1995	1996
Compilation of all available databases on GIS systems	--------	------	
Identification of major crustal and metallogenic provinces and formation of subproject teams e.g. Precambrian shields, Caledonian, Hercynian, Alpine and Quaternary geology	--------	---	
Subproject studies	---	-------	
Comparison of results and findings, e.g. for particular rock types between different subproject teams		-----	
Preparation of report and research publication		-----	---

RESEARCH PROJECT 4. BUDGETS OF SEDIMENT TRANSPORT

(J. Bogen and B. Bølviken, Norway)

Background

Soil erosion and river sediment transport are natural processes that have taken place in differing degree during the various geological periods. However, human activities also influence these processes. Man's influence on river sediment transport can be grouped into several classes (Fig. 1)

(1) Flood protection work, armouring of river beds, as well as building of dams and water divertions influence erosion rates and natural sediment load.

(2) Modern agriculture, forestry, ground leveling, road building etc. cause increased erosion rates and sediment transport.

(3) Energy production may cause climatic changes, which in turn may also increase soil erosion and river sediment transport.

The supply of nutritional and noxious elements into lakes, seas and oceans are a result of natural as well as anthropogenic processes, and it is important to understand all types of processes in order to evaluate the effects of human activities.

River sediment transport monitoring programmes are established in most European countries. By chemical analysis of the sediment load from European monitoring programmes it is possible to estimate the amounts of chemical elements that are presently being fed in solid state into lakes, seas and oceans in Western Europe. These amounts include a natural fraction and an anthropogenic fraction.

Overbank sediment reflects the sediment discharge of large floods throughout geological periods. By investigation of overbank deposits it may be possible to identify areas and river basins that have transported/transport major amounts of chemical elements into the sea. Overbank deposits can therefore be used to estimate the amounts and composition of naturally transported sediments in a river system in prehistorical times. This implies the possibilities for studying how various natural and man-made factors effect this load. The sensibility of the environment may depend on the natural transport (Fig. 1).

Variations in erosion rates through time as documented in overbank sediment strata may reflect features of the paleoclimate. The vertical distribution of certain isotopes (such as ^{10}Be which is formed only in the atmosphere and brought to the earth surface by precipitation) may also throw light upon paleoclimatic features. An estimation of the paleoclimate is important for the understanding of the effects of atmospheric CO_2 on present day climate. Knowledge about how climatic variations affect river systems is important for the use of geochemical maps in water resource management.

Aims

Develop methods for (1) an estimation of the natural and anthropogenic fractions of the present day sediment discharge of chemical elements and into lakes, seas and oceans. Prepare maps for such fractions in Western Europe, (2) using overbank sediment data for characterizing paleoclimatic features.

Methods

1. Record volumes of overbank sediment in various places in Western Europe and correlate with existing data from sediment transport monitoring programmes.

2. Perform chemical analysis of samples of suspended sediments and water at selected rivers.

3. Prepare maps of the data.

Expected results

The results may indicate (1) the natural and anthropogenic amounts of chemical elements being fed into the sea from various parts of Western Europe, and (2) variations in paleoclimatic features throughout Western Europe.

Budget

The project is estimated to require 6 man-years of skilled reserachers. Additional costs for field work, chemical analysis, computer time etc. are estimated at ECU 100,000.

Time schedule

	1992	1993	1994	1995	1996
Field investigation of overbank deposits	-------	-------	-------		
Chemical analysis		-------	-------	-------	
Acquisition of other data	-------	-------			
Map presentation, interpretation			-------	-------	
Publishing				-------	-------

RESEARCH PROJECT 5. LINKEAGE OF OVERBANK SEDIMENT SURVEYS TO OTHER GEOCHEMICAL MAPPING PROGRAMMES

(J. Plant and John Ridgway, U.K.)

Background

The inventory of regional geochemical data of Western Europe shows that most countries of Western Europe have carried out regional geochemical surveys. However, with few exceptions the coverage is only partial and completion is not scheduled in the near future. Moreover, sampling and analytical methods have varied. The IGCP Project 259, International Geochemical Mapping aims at preparing global geochemical maps.

It is, therefore, desireable to develope methods which if possible may link the existing data together into a more uniform collection.

Aim

Linking of geochemical data obtained at national, European and global levels.

Methods

Correlation analysis between WEGS and national geochemical data.

Expected results

Conclusion may be drawn about the possibilities for linking geochemical data obtained by different methologies.

Budget

The project is estimated to required 1 man-year of a geochemist/statistical. Additional costs (computer time etc.) would ammount to ECU 10,000.

Time schedule

The project should be performed during 1995 - 1996.

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
on
REGIONAL GEOCHEMICAL MAPPING

GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 9

ORGANIZATION AND PROJECT LEADER DUTIES

B. Bølviken, Norway

ORGANIZATION OF THE PROJECT

The project is divided into 3 Phases:

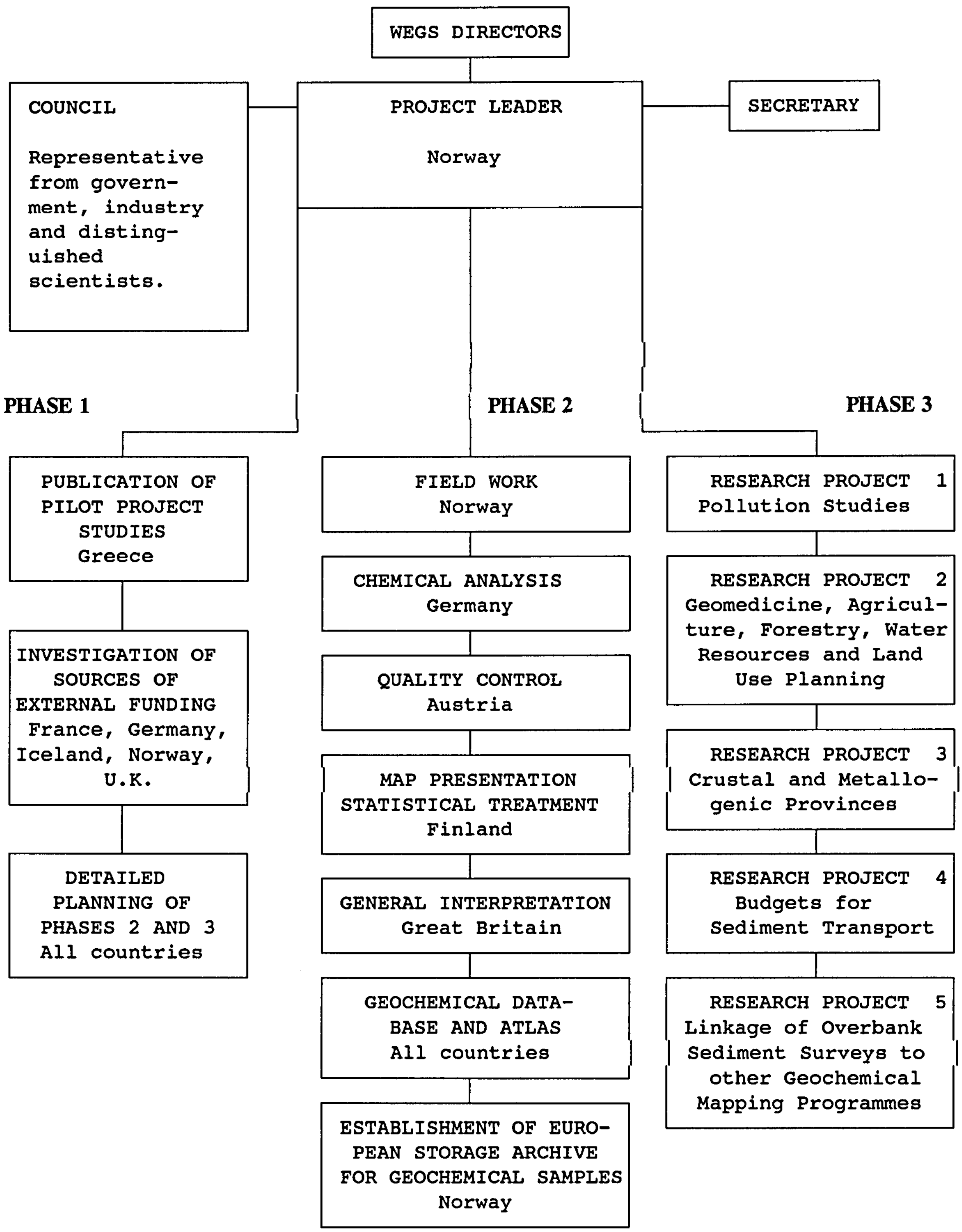
Phase 1. Planning and preparatory work.
Phase 2. Main Project,
- production of geochemical database and Atlas of Western Europe,
- storage of geochemical samples.

Phase 3. Utilization of data obtained in Phase 2 in various research projects.

The work is performed through a full time Project Manager with a full time Secretary. The Project Manager reports to the WEGS directors. An advisory council consists of persons representing government industry and scientists. The project is divided into a number of subprojects each with a Subproject Leader.

ORGANIZATION CHART

The Working Group on Regional Geochemical Mapping proposes the following organization of the project. Nations indicated in the boxes are suggested countries of origin of project/subproject leaders and/or subproject members, see also App. 9.



PROJECT MANAGER AND SUBPROJECT LEADER DUTIES

All Project leaders are responsible for the budgets that have been allocated. Time limits of the reports are given in Tables, pages 7 and 8.

Project Manager

Reports to : The WEGS directors

Duties :

- Work out detailed plans for the project based on subproject plans.
- Contact with WEGS directors, council and individual institutions in various countries.
- Scientifically and economically responsible for the performance of the project.
- Supervision of secretary and subproject leaders.
- External and internal information about the project.
- Establish West European storage for geochemical samples.
- Work out plans for reporting of the Project.
- Write progress reports.
- Edit the Geochemical Atlas of Western Europe.

Subproject Leader, Field Work

Reports to : Project Manager

Duties :

- Work out detailed plans for the field work, sample location, numbering system, time schedules etc.
- Secure uniform sample procedure throughout Europe.
- Secure correct use of sample numbering system.
- Furnish data bank with sample location and other field data.
- Supervise producing of national sample split and shipping of international sample.
- Write a final report and progress reports about the subproject.
- Contribute with text to the Geochemical Atlas of Western Europe.

Subproject Leader, Chemical Analysis

Reports to : Project Manager

Duties :
- Work out detailed plans for sample preparation, and chemical analyssis of samples such as:
  - sieving of samples
  - shipping of samples
  - laboratory for preparation
  - laboratories for various analysis
  - splitting of samples
  - methods of analysis
  - costs and funding of analysis
  - reports of analysis
- Organize the activities in chemical analysis.
- Report the results as tables, magnetic tape and one final report.
- Furnish the data base with all analytical values.
- Write progress report and a final report of the subproject.
- Contribute to the text of the Geochemical Atlas of Western Europe.
- Interlaboratory/ring-test control.

Subproject Leader, Quality Control

Reports to : Project Manager

Duties : Work out detail instruction for quality control
- Provide project standard
- Provide inert material, kaoline 1 and 2
- Collect and evaluate the data regarding quality control before the release of data for further treatment

Subproject Leader, Map Production

Reports to : Project Manager

Duties :

Work out detailed plans for:
- statistical description of data
- preparation of base maps
- preparation of geochemical maps

Produce:
- cummulative frequency distributions diagramme for all analytical results
- tables of statistics of results
- single point geochemical maps in black and white
  moving median maps in colour
- write progress reports and a final report about the subproject

Contribute to the text of the Geohcemical Atlas of Western Europe.

Subproject, Database

Reports to : Project Manager
Duties : Prepare detailed plans for the data base.
Produce the database
Furnish all participating countries with copies of the data base.
Write progress reports and a final report.
Contribute with thext to the Geochemical Atlas, of Western Europe.

Subproject, Sample storage

Reports to : Project Manager
Duties : Prepare plans for a West-European sample storage.
- Organize the establishment of a West-Eurpean sample storage.
- Recieve and store samples.
- Keep the storage.
- Make instruction for future retrieval of samples.
- Write progress reports.
- Contribute to the text of the Geochemical Atlas of Western Europe.

TIME SHEDULE

	1990	1991	1992	1993	1994	1995	1996
Phase 1							
Publication of Pilot Project studies	----------						
Investigation of sources of external funding	-------						
Detailed planning of phases 2 and 3	----------						
Phase 2							
Establishment of database			----	------------------------			
Field work			--------------				
Sample preparation				--------------			
Chemical analysis					--------		
Map presentation					----------		
General interpretation						--------	
Publication of Geochemical Atlas						-------	
Establishment of sample storage	----				-------------		
Phase 3							
Pollution studies				--------------------------------			
Geomedicine, agriculture etc.					-----------------------		
Crustal and metallogenic provinces					-----------------------		
Budgets for chemical and sediment transport			---				
Linkage to other geochemical datasets						--------------	

PLAN FOR REPORTS   Project Manager

	1991 1 Feb.	1991 1 Aug.	1992 1 Feb.	1992 1 Aug.	1993 1 Feb.	1993 1 Aug.	1994 1 Feb.	1994 1 Aug.	1995 1 Feb.	1995 1 Aug.	1996 1 Feb.	1996 1 Aug.
PHASE 1												
Publishing of Pilot Project Data		o										
Progress report		x										
External funding, final report		o										
Progress report		x										
Detailed planning, final report		o										
Progress report		x										
PHASE 2												
Field work, final report				o								
Progress report		x		x								
Sample preparation, final report						o						
Progress report		x		x		x						
Chemical analysis, final report								o				
Progress report		x		x		x		x				
Statistical discription, final report									o			
Progress report		x		x		x		x	x			
Map presentation, final report										o		
Progress report		x		x		x		x	x	x		
Geochemical atlas, printed												o
Progress report		x		x		x		x		x		x
Sample storage, final report		o										
Progress report		x										
Data base, final report		o										
Progress report		x										

PLAN FOR REPORTS

Subproject leaders

	1991 1 Jan.	1991 1 July	1992 1 Jan.	1992 1 July	1993 1 Jan.	1993 1 July	1994 1 Jan.	1994 1 July	1995 1 Jan.	1995 1 July	1996 1 Jan.	1996 1 July
PHASE 1												
Publishing of Pilot Project Data		o										
Progress report	x	x										
External funding, final report												
Progress report												
Detailed planning, all subprojects final report		o										
Progress report	x	x										
PHASE 2												
Field work, final report				o								
Progress report	x	x	x	x								
Sample preparation, final report						o						
Progress report	x	x	x	x	x	x						
Chemical analysis, final report								o				
Progress report	x	x	x	x	x	x	x	x				
Statistical discription, final report									o			
Progress report	x	x	x	x	x	x	x	x	x			
Map presentation, final report										o		
Progress report	x	x	x	x	x	x	x	x	x	x		
Geochemical atlas, printed												o
Progress report	x	x	x	x	x	x	x	x	x	x	x	x
Sample storage, final report		o										
Progress report	x	x										
Data base, final report		o										
Progress report	x	x										

WESTERN EUROPEAN GEOLOGICAL SURVEYS
Working Group
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GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000

PROJECT PROPOSAL

APPENDIX 10

BUDGET

O. Schermann, Austria
R.T. Ottesen, Norway

UNIT PRICES

Number of sample sites and number of samples are given in Table 1. The following rates are used in the budget estimations:

Project Manager	ECU	50.000,- per year
Secretary	"	33.000,- - " -
Geochemist senior graduate	"	40.000,- - " -
Labourer	"	25.000,- - " -
Field allowance	"	70,- per day
Vehicle	"	1.100,- per month inclusive mileage and fuel

The sampling costs are estimated on the basis of the collecting of two samples per day and the following rates:

- Salary plus field allowance	ECU	300	per sample
- Vehicle including mileage and fuel	"	50	- " -
- Containers, shipping cost etc.	"	40	- " -
- Unforeseen	"	20	- " -

The average estimated cost of sampling will be ECU 440 per site.

It is suggested that the "environmental elements" (As, Be, Cd, Cu, F, Hg, Li, Ni, Pb, S, Sb, Sc, Se, V, Zn, Y) be analysed in all three samples types using package 1, 5, 7 and 10 (Fig. 2 in appendix 3). The cost of analysing one sample for these elements is ECU 39.

The petrogentic and ore-forming elements will be determined in the pristine overbank samples, using package 2 (44 elements) (Fig. 2 in appendix 3). The cost of analysing one sample for these elements is ECU 72.

Gold and the platinum-group elements (PGE) will be determined in the pristine overbank samples, using package 4 (Fig. 2 in appendix 3). The cost of analysing one sample for Au and PGE is ECU 64.

The cost of map production is:

- Single element point source map:	ECU 100 per map
- Single element moving median map:	ECU 350 per map

<u>Overhead is not included in these figures</u>, since it is calculated in different ways at each participating surveys.

BUDGET

Specified budgets, given in European Currency Units (ECU), are worked out for Phases 1 and 2, while the figures for phase 3 are more general estimates.

Table 2 shows the summary budget. Estimated man-years, provisional cost figures and tentative funding plans are given in Tables 3 to 10, for the total project region and in Tables 11-15 for the individual countries.

The total cost for the preparation of the Geochemical Atlas of Western Europe (Phases 1 and 2) is ECU 9,361,000 , of which it is proposed that WEGS contribute ECU 5,309,000, and external funding be sought for ECU 4,052,000.

The suggested research projects cost ECU 1,210,000, of which it is proposed that WEGS contribute ECU 600,000, and external funding be sought for ECU 610,000.

In the following account main budget figures are shown for each Phase 1 to 3.

PHASE 1

21.7 man-years are required to fulfil Phase 1 (Table 3). The cost of Phase 1 is estimated at ECU 990,000 (Table 4) of which ECU 776,000 are saleries and ECU 214,000 are running expences.

It is tentatively proposed that for Phase 1 salaries be covered by the Geological Surveys and running expences be sought externally (Table 5).

Sample site identification costs are expected to vary between the WEGS countries depending on the portion of armed/artificial stream banks.

PHASE 2

71.6 man-years are required to fufil Phase 2 (Table 6). The cost of Phase 2 is estimated at ECU 8,371,000 (Table 7) of which ECU 3,166,000 are salaries and ECU 5,205,000 are running expences.

It is suggested that salaries and fieldwork expences be covered by the Geological Surveys. All other costs (equipment, chemical analysis etc.) should be externally funded (Table 8).

It is proposed that external sedimentological experts be attached to help sampling in difficult areas.

PHASE 3

15 man-years are required to fulfil Phase 3 (Table 9). The cost of Phase 3 is estimated at ECU 1,210,000 (Table 10) of which ECU 600,000 are salaries and 610,000 are running expences.

It is tentatively proposed that for Phase 3 salaries be covered by the Geological Surveys and running expences be sought externally (Table 10).

EXTERNAL FUNDING

The total external funding (for phase 1 and 2) is estimated at ECU 4,052,000, corresponding to ECU 675,333 per year for the period 1991 - 1996.

The Working Group has, (according to its mandate), not investigated possibilities for external funding. However, the Working Group would like to mention some possible sources, e.g.:

- The European Community STEP-program
- The National Research Councils in the individual countries
- The National Environmental Protection Agencies in the individual countries
- The Geological Survey in each country

TABLE 1 **Geochemical Mapping of Western Europe Towards the Year 2000. Areas, numbers of Sample Sites and Number of Samples (Including Quality Control Samples).**

	Area km²	Sample sites	No. of samples incl. quality control
Austria	83,853	168	555
Belgium	30,513	62	204
Cyprus	9,251	18	66
Denmark	43,069	86	285
Finland	337,009	674	2,226
France	547,026	1,094	3,609
F.R. Germany	248,687	498	1,644
Greece	131,944	264	870
Greenland *	341,700	682	-
Iceland	103,000	206	681
Ireland	70,283	140	462
Italy	301,262	602	1,986
Luxembourg	2,586	6	18
Netherland	40,844	82	270
Norway	324,219	648	2,139
Portugal	41,293	82	606
Spain	504,782	1,008	3,327
Sweden	449,964	900	2,970
Switzerland	41,293	82	270
Turkey	780,576	1,561	5,151
United Kingdom	244,046	488	1,611
Total	4,272,989	9,453*	28,665

* The Geological Survey of Greenland has indicated that it will not be practical to sample Greenland. The total number of sample sites will be reduced to 8,771 when Greenland is excluded.

TABLE 2. **Geochemical Mapping of Western Europe towards the Year 2000. Estimated Man-years, Costs and Tentative Plan for Funding.**

	Phase 1	Phase 2	Phase 3	Total
Number of man-years	21.7	71.6	15.0	108.3
Salaries	776,000	3,166,000	600,000	4,542,000
Running Expences	214,000	5,205,000	610,000	6,029,000
Total Cost	990,000	8,371,000	1,210,000	10,571,000
Tentative Funding Plan				
WEGS	776,000	4,533,000	600,000	5,909,000
External Funding	214,000	3,838,000	610,000	4,662,000

All the cost figures are given in European Currency Units (ECU).

TABLE 3. Geochemical Mapping of Western Europe Towards the Year 2000. Man-years in Phase 1 (1991).

	Project Management	Publication of Pilot Project Project Results	Detailed Planning, e.g. Sample site Location	Sum Man-years
Austria		0.4	0.8	1.2
Belgium			0.2	0.2
Cyprus			0.1	0.1
Denmark			0.2	0.2
Finland		0.2	1.0	1.2
France			2.0	2.0
F.R. Germany		0.7	1.0	1.7
Greece		1.0	0.5	1.5
Greenland[1]		0.2	-	0.2
Iceland			0.2	0.2
Ireland			0.4	0.4
Italy			1.2	1.2
Luxembourg			0.1	0.1
Netherland			0.2	0.2
Norway	2	1.5	0.8	6.3
Portugal			0.5	0.5
Spain		0.6	1.6	2.2
Sweden			1.2	1.2
Switzerland			0.4	0.4
Turkey			1.4	1.4
United Kingdom		0.5	0.8	1.3
Man-years, total	2	5.1	14.6	21.7

TABLE 4. **Geochemical Mapping of Western Europe Towards the Year 2000. Budget (1000 ECU) in Phase 1 (1991).**

	Project Management		Publication of Pilot Project Results		Detailed Planning, e.g. Sample site Location		Sum Salary and Running Expences	
	S	R	S	R	S	R	S	R
Austria			8		32		40	
Belgium					8		8	
Cyprus					4		4	
Denmark					8		8	
Finland			4		40		44	
France					80		80	
F.R. Germany			14		40		54	
Greece			40		20		60	
Greenland[1]			4		-		4	
Iceland					8		8	
Ireland					16		16	
Italy					48		48	
Luxembourg					4		4	
Netherland					8		8	
Norway *	150		60		72	64	132	214
Portugal					20		20	
Spain			12		64		76	
Sweden					48		48	
Switzerland					16		16	
Turkey					56		56	
United Kingdom			10		32		42	
Total budget	150		152		624	64	776	214

S: Salary R: Running expences

* Project Manager and Field Work Subproject Leader

TABLE 5. **Geochemical Mapping of Western Europe Towards the Year 2000. Tentative Funding Plan (1000 ECU) Phase 1 (1991).**

	Salary	Funding	Salary	Funding
Project management	80	External	70	External
Publication of pilot project results	152	WEGS		
Detailed planning, e.g. sample site location	624	WEGS	64	External

TABLE 6 **Geochemical Mapping of Western Europe Towards the Year 2000. Man-years in Phase 2 (1992-1996).**

	1	2	3	4	5	6	7	8
Austria	-	0,9	0,3	0,5	-	-	0,1	1,8
Belgium	-	0,3	0,1	-	-	-	0,1	0,5
Cyprus	-	0,1	-	-	-	-	0,1	0,2
Denmark	-	0,5	0,1	-	-	-	0,1	0,7
Finland	-	3,3	1,0	0,2	-	2,0	0,1	6,6
France	-	4,5	1,5	0,1	-	-	0,1	6,2
F.R.Germany	-	2,3	0,8	-	1,0	-	0,1	4,2
Greece	-	1,4	0,4	0,1	-	-	0,1	2,0
Greenland	-	-	-	-	-	-	-	-
Iceland	-	1,2	0,4	-	-	-	0,1	1,7
Ireland	-	0,9	0,2	-	-	-	0,1	1,2
Italy	-	2,6	0,9	-	-	-	0,1	3,6
Luxembourg	-	0,1	-	-	-	-	0,1	0,2
Netherland	-	0,5	0,1	-	-	-	0,1	0,7
Norway	10	5,2	1,0	-	-	-	0,1	16,3
Portugal	-	0,9	0,3	-	-	-	0,1	1,3
Spain	-	4,5	1,4	0,1	-	-	0,1	6,1
Sweden	-	4,1	1,2	-	-	-	0,1	5,4
Switzerland	-	0,5	0,1	-	-	-	0,1	0,7
Turkey	-	6,3	2,1	-	-	-	0,1	8,5
United Kingdom	-	2,3	0,8	0,2	-	-	0,4	3,7
Sum Man-years	10	42,4	12,7	1,2	1,0	2,0	2,2	71,6

1 Project Management
2 Field work (sampling)
3 Sample preparation
4 Quality control
5 Chemical analysis
6 Map production and Geochemical Atlas of Western Europe
7 General Interpretation
8 Sum Man-years

TABLE 7 **Geochemical mapping of Western Europe towards the Year 2000. Budget (1000 ECU) in Phase 2 (1992 - 1996).**

	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
Austria[1)]			50	24	5	3	20	42					2		77	69
Belgium			18	9	6	3							2		26	12
Cyprus			5	3	1	-							2		8	3
Denmark			25	12	3	1							2		30	13
Finland[2)]			200	95	20	11	4				125	208	2		351	314
France			327	154	32	18	2						2		363	172
F.R. Germany[3)]			149	70	15	176			80	2441			2		246	2689
Greece			79	37	8	4	2						2		91	41
Greenland			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iceland			62	29	6	4							2		70	33
Ireland			42	20	4	2							2		48	22
Italy			180	85	18	9							2		200	94
Luxembourg			2	1	-	-							2		4	1
Netherland			25	11	2	1							2		29	12
Norway[4)]		750	193	281	17	8							2		212	1039
Portugal			55	26	5	3							2		62	29
Spain			301	142	30	16	2						2		335	158
Sweden			269	127	27	14							2		298	141
Switzerland			25	11	2	1							2		29	12
Turkey			467	220	46	26							2		515	246
United Kingdom			146	69	14	8	4						4	30	166	77
Sum		750	2620	1426	261	308	34	42	80	2441	125	208	46	30	3160	5205

S: Salary
R: Running expences

1) Subproject Leader: Quality control
2) Subproject Leader: Map production
3) Subproject Leader: Chemical analysis
4) Subproject Leader: Field Work
5) Subproject Leader: General interpretation

TABLE 8 **Geochemical Mapping Of Western Europe Towards the Year 2000. Tentative Funding Plan (1000 ECU) for Phase 2 (1992-1996).**

	Salary	Funding	Running expences	Funding
Project Management	400	External	350	External
Field work	2,620	WEGS	1,227	WEGS
			189	External
Sample preparation	261	WEGS	140	WEGS
			168	External
Quality control	34	WEGS	42	External
Chemical analysis	80	WEGS	2,441	External
Map production	125	WEGS	208	External
General interpret.	46	WEGS	30	External

TABLE 9 **Geochemical Mapping of Western Europe Towards the Year 2000. Man-year in Phase 3, Research Project (1992-1996).**

Pollution studies	3 Man-years
Geomedicine, agriculture, forestry, water resource, land use planning.	2 - " -
Crustal and metallogenic provinces.	3 - " -
Budgets for sediment transport.	6 - " -
Linkage of overbank sediment surveys to other geochemical mapping programmes.	1 - " -

TABLE 10 **Geochemical Mapping of Western Europe Towards the Year 2000. Budget (1000 ECU) and Tentative Funding Plan in Phase 3, Research Project (1992-1996).**

	Salaries	Funding	Running expences	Funding
Pollution studies.	120	WEGS	300	External
Geomedicine, agriculture, forestry, water resources, land use planning.	80	WEGS	100	External
Crustal and metallogenic provinces.	120	WEGS	100	External
Budget for sediment transport.	240	WEGS	100	External
Linkage of overbank sediment surveys to other geochemical mapping programmes.	40	WEGS	10	External
Sum	600		610	

TABLE 11 Geochemical Mapping of Western Europe Towards the Year 2000. Man-years, Salaries and Running expences from Phases 1 and 2 (1000 ECU).

AUSTRIA

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	0.4	8	-
Detailed planning	0.8	32	-
PHASE 2:			
Project management	-	-	-
Field work	0.9	50	24
Sample preparation	0.3	5	3
Quality control	0.5	20	42*
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	3.0	117	69

* Austria is responsible for the Quality Control Subproject.

BELGIUM

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.2	8	-
PHASE 2:			
Project management	-	-	-
Field work	0.3	18	9
Sample preparation	0.1	6	3
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	0.7	34	12

CYPRUS

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.1	4	-
PHASE 2:			
Project management	-	-	-
Field work	0.1	5	3
Sample preparation	-	-	-
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	0.3	7	3

DENMARK

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.2	8	-
PHASE 2:			
Project management	-	-	-
Field work	0.5	25	12
Sample preparation	0.1	3	1
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	0.9	38	13

TABLE 12 Geochemical Mapping of Western Europe Towards the Year 2000. Man-years, Salaries and Running expences from Phases 1 and 2 (1000 ECU).

FINLAND

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	0.2	4	-
Detailed planning	1.0	40	-
PHASE 2:			
Project management	-	-	-
Field work	3.3	200	95
Sample preparation	1.0	20	11
Quality control	0.2	4	-
Chemical analysis	-	-	-
Map production	2.0	125	208*
General interpret.	0.1	2	-
Sum	7.8	395	314

* Finland is responsible for the subproject on map production.

FRANCE

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	2.0	80	-
PHASE 2:			
Project management	-	-	-
Field wrk	4.5	327	154
Sample preparation	1.5	32	18
Quality control	0.1	2	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	8.2	443	172

F.R. GERMANY

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	0.7	14	-
Detailed planning	1.0	40	-
PHASE 2:			
Project management	-	-	-
Field work	2.3	149	70
Sample preparation	0.8	15	176*
Quality control	-	-	-
Chemical analysis	1.0	80	2,441
Map production	-	-	-
General interpret.	0.1	2	-
Sum	5.9	300	2,687

* F.R. Germany is responsible for the subproject on chemical analysis including sample preparation. ECU 168,000 of sample preparation is sieving equipment.

GREECE

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	1.0	40	-*
Detailed planning	0.5	20	-
PHASE 2:			
Project management	-	-	-
Field work	1.4	79	37
Sample preparation	0.4	8	4
Quality control	0.1	2	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	3.5	151	41

* Greece is responsible for publication of the pilot project results in an international journal.

TABLE 13 **Geochemical Mapping of Western Europe Towards the Year 2000. Man-years, Salaries and Running expences from Phases 1 and 2 (1000 ECU).**

ICELAND

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.2	8	-
PHASE 2:			
Project management	-	-	-
Field work	1.2	62	29
Sample preparation	0.4	6	4
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	1.9	76	35

IRELAND

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.4	16	-
PHASE 2:			
Project management	-	-	-
Field work	0.9	42	20
Sample preparation	0.2	4	2
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	1.6	62	24

ITALY

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	1.2	48	-
PHASE 2:			
Project management	-	-	-
Field work	2.6	180	85
Sample preparation	0.9	18	9
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	4.8	246	96

LUXEMBOURG

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.1	4	-
PHASE 2:			
Project management	-	-	-
Field work	0.1	2	1
Sample preparation	-	-	-
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	0.3	6	3

TABLE 14 Geochemical Mapping of Western Europe Towards the Year 2000. Man-years, Salaries and Running expences from Phases 1 and 2 (1000 ECU).

NETHERLAND

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.2	8	-
PHASE 2:			
Project management	-	-	-
Fieldwork	0.5	25	11
Sample preparation	0.1	2	1
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	0.9	35	14

NORWAY

	Man-year	Salary	Running expences
PHASE 1:			
Project management	2.0	-	150*
Publication of pilot project	1.5	60	-
Detailed planning	0.8	72	60
PHASE 2:			
Project management	10.0	-	750
Field work	5.2	193	281*
Sample preparation	1.0	17	8
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	20.6	342	1.251

* Norway is responsible for project management and the field work subproject.

PORTUGAL

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.5	20	-
PHASE 2:			
Project management	-	-	-
Field work	0.9	55	26
Sample preparation	0.3	5	3
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	-	2
Sum	1.8	80	31

SPAIN

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	0.6	12	-
Detailed planning	1.6	64	-
PHASE 2:			
Project management	-	-	-
Field work	4.5	301	142
Sample preparation	1.4	30	16
Quality control	0.1	2	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	8.3	411	158

TABLE 15 Geochemical Mapping of Western Europe Towards the Year 2000. Man-years, Salaries and Running expences from Phases 1 and 2 (1000 ECU).

SWEDEN

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	1.2	48	-
PHASE 2:			
Project management	-	-	-
Field work	4.1	269	127
Sample preparation	1.2	27	14
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	6.6	346	141

SWITZERLAND

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	0.4	16	-
PHASE 2:			
Project management	-	-	-
Field work	0.5	25	11
Sample preparation	0.1	2	1
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	1.1	45	12

TURKEY

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	-	-	-
Detailed planning	1.4	56	-
PHASE 2:			
Project management	-	-	-
Field work	6.3	467	220
Sample preparation	2.1	46	26
Quality control	-	-	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.1	2	-
Sum	9.9	571	246

UNITED KINGDOM

	Man-year	Salary	Running expences
PHASE 1:			
Project management	-	-	-
Publication of pilot project	0.5	10	-
Detailed planning	0.8	32	-
PHASE 2:			
Project management	-	-	-
Field work	2.3	146	69
Sample preparation	0.8	14	8
Quality control	0.2	4	-
Chemical analysis	-	-	-
Map production	-	-	-
General interpret.	0.2	4	30*
Sum	4.8	210	107

* United Kingdom is responsible for the General interpretation subproject.