FORUM OF EUROPEAN GEOLOGICAL SURVEYS

(FOREGS)

FINAL REPORT

of the

Working Group

on

Regional Geochemical Mapping

1986-93

AUGUST 1993

NORGES GEOLOGISKE UNDERSØKELSE

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15 August 1993

CONTENTS

SUMMARY

The FOREGS Working Group on Regional Geochemical Mapping was established in 1985 and concludes its activities in 1993. This report is a summary of the results obtained by the Working Group. The following points are covered in the appendices: (1) composition of the Working Group, (2) chronological summary of activities, (3) extracts from minutes of FOREGS directors, (4) sedimentation processes in rivers, (5) list of titles of publications, reports etc., and (6) viewpoints of institutions and individuals.

In 1986 the Working Group proposed initiating low density geochemical mapping of western Europe based on a standardized methodology. Plans for such mapping were further elaborated in 1988 and 1990. During the preparation of these plans, an inventory was compiled of geochemical mapping already carried out in western Europe. The inventory showed that geochemical mapping is well advanced in several countries, but it is often characterised by high sampling densities in limited areas, and a variety of sampling media. The maximum regional geochemical coverage of western Europe currently available (approximately 35%) is based on stream sediment samples. A new coarse grid geochemical mapping programme for western Europe should, therefore, be designed with a view to compiling a systematic database and a multielement geochemical atlas.

Overbank sediment was found to be a suitable sampling medium for geochemical mapping in western Europe mainly because

(1) it is representative of large drainage areas, allowing a low sampling density to be used,

(2) it is available in all FOREGS countries,

(3) it can disclose existing broad geochemical distribution patterns,

(4) it is possible to obtain pre-industrial samples at depth from present or older flood plains even if the surface layers are strongly polluted. By analysing regionally distributed samples of pre- and post-industrial overbank sediment, it is therefore possible to define natural geochemical distribution patterns even in areas strongly polluted by waste from e.g. old mining, and to detect the degree of pollution against a variable natural geochemical background,

(5) it has been shown that in unpolluted drainage areas in Austria and Greece the element contents in only one sample of overbank sediment taken at depth from the lowest part (apex) of the drainage area corresponds rather well with the median value for the same elements in several hundred stream sediment samples taken throughout the whole catchment basin.

The Working Group proposed an average sampling density of 1 sample site per 500 km^2, each site representing a catchment area, the size of which should be between 60 and 600 km^2. Three samples should be taken from each site, i.e.,

(1) one sample of overbank sediment from the upper 15 cm of the sequence to assess the influence of man (airborne and riverborne pollution),

(2) one sample of pre-industrial overbank sediment at depth from present - or terraces of earlier - flood plains to map natural conditions, and

(3) one sample of active stream sediment to provide a linkage to data sets of national surveys and to contribute to the mapping of the present pollution of the drainage basins.

It is concluded that

(1) a considerable portion of river plains in Europe (roughly estimated as 30%) are severely polluted by waste from old and recent mining. Several of these plains have heavy metal concentrations that exceed threshold values or other limits set by national authorities. The work carried out by the Working Group has shown that chemical analysis of widely spaced samples of pre- and post-industrial overbank sediment provides an efficient tool for mapping the general geochemical background and quantifying the pollution of the sediments in European drainage basins.

(2) flood plains are important for human life as indicated by the following features: About 75% of the population of Europe live on river plains. River plains are locations for deposition of both natural sediments and great amounts of past and present waste from mining and other human activities. At many places flood plain sediments are excavated for the foundations of buildings, and the material is transported and dumped elsewhere. Sources of ground water for drinking purposes are often situated beneath river plains. Fluvial sediment is recognised as the important medium by which large amounts of natural and anthropogenic toxic substances are transported and stored. Human activities, such as dredging, regulating and diverting of rivers, agriculture, and road construction affect flood plains and river systems.

(3) polluted river plains represent a present and future environmental threat. Since rivers cross political boundaries, it is in the interest of many regions and countries to obtain detailed information about natural and polluted sediments, which may be exported from, or imported into their area. It is , therefore, an important task to determine the extent and degree of this pollution in order to evaluate its harmful effects and suggest mitigation and abatement strategies.

(4) none of the existing environmental monitoring programmes takes pollution from historical mining into account nor the variable nature of sediment transport. Transportation of heavy metals during floods is strongly underestimated in relation to transport under normal conditions. The sedimentary history of river plains will provide information on long-term sediment supply during floods, and represents an important supplement to routine data.

(5) an evaluation of the present state of pollution requires systematic, compatible data on the anthropogenic distribution as well as the pre-industrial, natural distribution of chemical elements in surface environments. National or international geochemical mapping programmes should be encouraged to include the methods recommended by the Working Group in order to fulfil this requirement.

(6) if it is not possible at the present stage to map all of Europe, it is recommended that selected river plains be investigated more thoroughly. Such surveys should comprise detailed geochemical investigations, estimation of amounts of pollutants stored in the area and the present spreading of pollutants, as well as sedimentological investigations designed to (a) find historical features such as sedimentation rates, frequency of catastrophic floods, etc., (b) evaluate the rates of present active erosion and downstream transportation of pollutants, (c) estimate the chances of biological systems being affected by agents such as catastrophic floods and acid rain, and (d) study how material from flood plains should be treated and stored if removed from its present position in connection with construction works.

(7) data can be used, for example, to (a) predict the dispersion of pollutants and other damage that may be caused by major floods, (b) identify the need of reinforcing river banks in order to control further erosion and transportation of contaminated river plain sediments, and (c) indicate critical loads and potential chemical time bombs, which may in turn be valuable in identifying river banks where future pH changes could cause movement of hazardous elements.

(8) such detailed investigations should be standardized among various countries and, ideally, should be carried out as bilateral or multilateral projects.

INTRODUCTION

The FOREGS Working Group on Regional Geochemical Mapping was established in 1985 and concludes its activities in 1993 [App. 3, p.p. 4 and 11].

At its inaugural meeting in 1986 the present Working Group proposed initiating a low density geochemical mapping of western Europe based on standardized methodology [3.1, App. 4]. Inspired by Norwegian data from chemical analysis of overbank sediment [App. 4] and (Fig. 1) for such mapping were further elaborated in 1988 [3.1] and 1990 [3.3]. During the preparation of these plans, an inventory of geochemical mapping already performed in western Europe was compiled [3.2, App. 19]. Various research projects were carried out, resulting in a standardized method using overbank and stream sediments as sampling media in regional geochemical mapping [3.3]. The method was subsequently tested in selected areas [2.1-2.11; 3.10-3.14].

This report is a summary of the results obtained by the Working Group. Details are given in Appendices 1 to 3 and in publications, manuscripts, reports, minutes, etc. listed in Appendix 5 (these works are indicated in the report by reference numbers in square brackets [ ]). Recommendations for follow up work are given at the end.

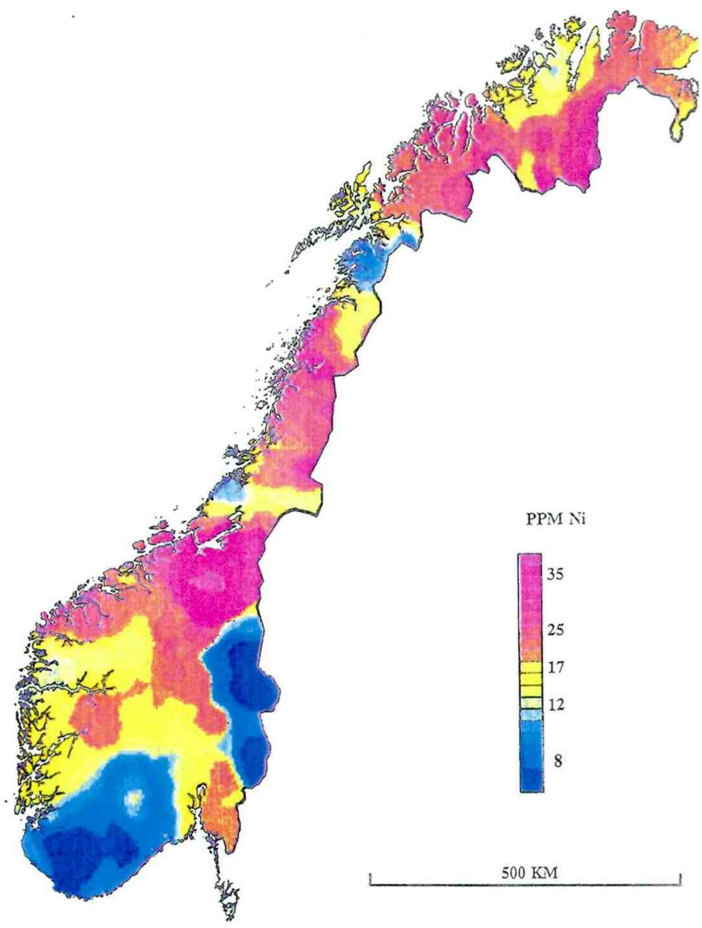

Fig. 1. *Distribution of the content of Ni in 684 samples of preindustrial overbank sediment, Norway. The colours indicate the moving median within circles of a diameter of 100 km.*

Bakside
på forsidetrykket

INVENTORY OF GEOCHEMICAL MAPPING IN WESTERN EUROPE

Geochemical mapping is well advanced in several countries, but is characterised by high sampling densities in limited areas and a variety of sampling media. The maximum regional geochemical coverage of western Europe currently available (approximately 35%) is based on stream-sediment samples; this compares with less than 15% for any other sample medium. The stream-sediment data are, however, for different suites of chemical elements, determined by different analytical methods (including 'total' and 'extractable') on different size fractions. A satisfactory geochemical atlas of western Europe could therefore not be compiled using available data sets. Moreover, although there are sample archives for approximately 20% of western Europe, the size fraction stored varies, so that re-analysis of this material is unlikely to provide compatible data. Complementary sampling with conventional sampling densities would be very time consuming and costly [2.13, 3.2, App. 10].

The Working Group concluded, therefore, that a new coarse grid geochemical mapping programme of western Europe should be designed with a view to compiling a systematic database and a multielement geochemical atlas.

METHOD OF GEOCHEMICAL MAPPING

Overbank sediment [App. 4] was found to be a suitable sampling medium for geochemical mapping in western Europe because it is

- representative of large drainage areas, allowing a low sampling density to be used,
- available in all FOREGS countries,
- useful for linking other geochemical data sets prepared at the national level, and
- able to provide a European input to international work such as IGCP Project 259 "International Geochemical Mapping" (now IGCP 360 "Global Geochemical Baselines").

The Working Group proposed sampling at an average density of 1 sample site per 500 km^2, each site representing a catchment area, the size of which should be between 60 and 600 km^2.

Three samples should be taken from each site, i.e.,

- one sample of overbank sediment from the upper 15 cm of the profile to assess the influence of man (airborne and riverborne pollution);

- one sample of pre-industrial overbank sediment at depth from the present flood plains, or from terraces of older floodplains, to map natural conditions, and

- one sample of active stream sediment to provide a linkage to data sets of national surveys and to contribute to the mapping of the present pollution of the drainage basins.

The samples should be treated in a uniform manner and analysed for total contents and extractable element species.

TEST MAPPING

The method described above was tested within altogether 61,000 km^2 in Belgium, Finland, Germany, Greece, The Netherlands and Norway with the following main results [2.1-2.4, 3.10-3.14]:

- Cases of pollution of river plains were found in all countries investigated. The most severe metal pollution is caused by waste deposited during past mining.

- Samples of pre-industrial overbank sediment can be obtained at depth from present or older flood plains even if the surface layers of the flood plains are strongly polluted (Figs. 2 and 3).

- Active stream sediment is strongly contaminated in drainage areas where heavy-metal pollution exists (Fig. 3), but the extent of contamination cannot be evaluated if only stream sediment is collected for chemical analysis.

- By analysing regionally distributed samples of pre- and post-industrial overbank sediment it is possible to (a) find natural geochemical distribution patterns even in areas strongly polluted by waste from old mining, and (b) detect the degree of pollution against a variable natural geochemical background (Figs. 2 and 3).

The cost of the proposed type of mapping will vary considerably from country to country due to local conditions (access, pollution, legal codes, salary levels, field allowances, etc.). In addition there are different opinions about how much detailed investigation (studies of sedimentation and pollution history, dating of sampling material, etc.) is necessary at each sample site. Members of the Working Group have estimated their national field expenses to be in the order of ECU 180-4700 per field site [3.10], but, even with figures from the upper part of this range, the cost per unit area is low compared to the cost of most conventional methods of geochemical mapping.

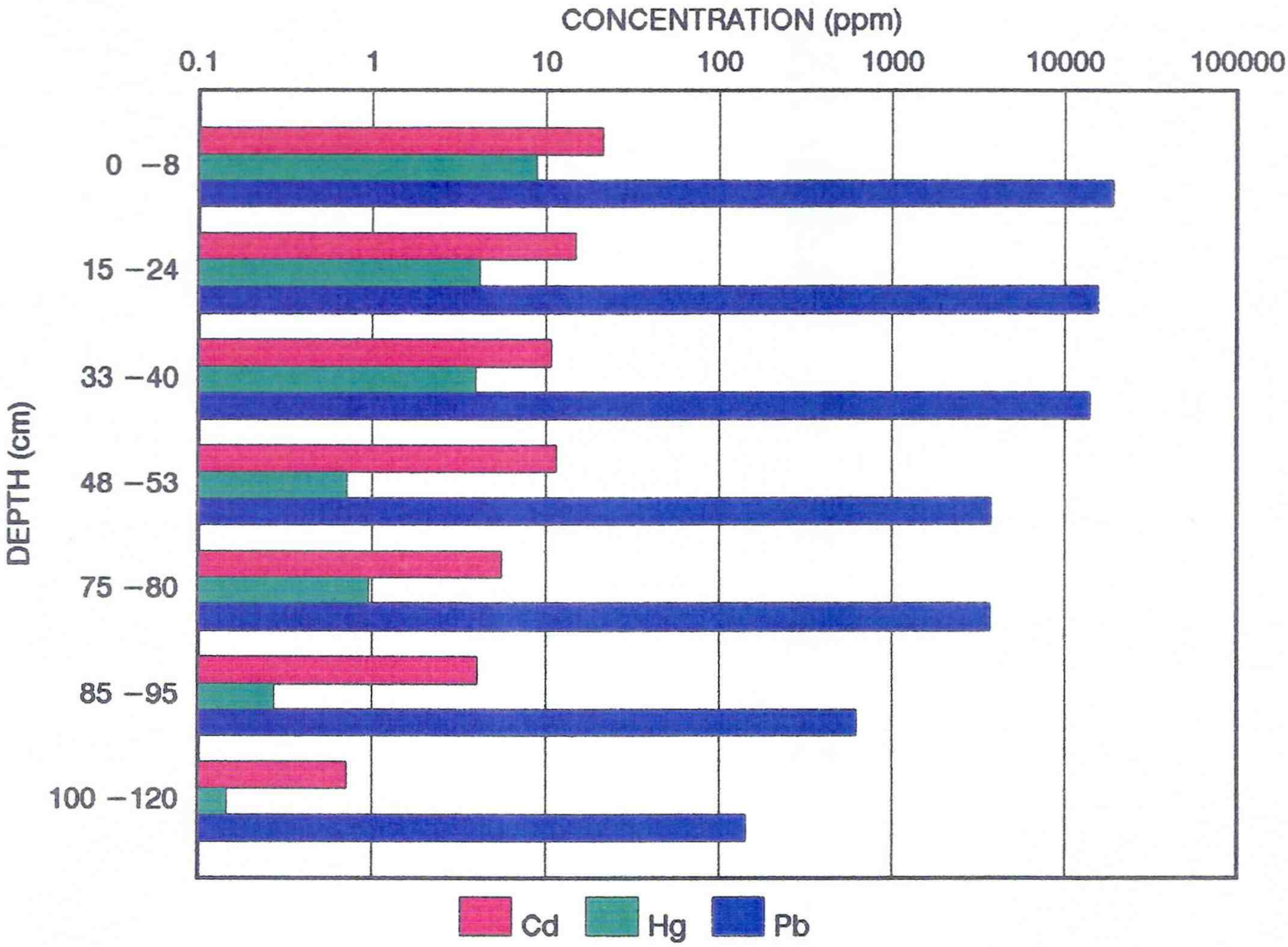

Fig. 2. *Distribution of Cd, Hg and Pb in a vertical section of overbank sediment north of Upen near Salzgitter Bad, Innerste River, Germany. Note the logarithmic scale of the abscissa. The upper part of the section is polluted by waste from hundreds of years of mining activities in the Harz mountains, while the lower parts reflect pre-industrial conditions [3.2, App. 5].*

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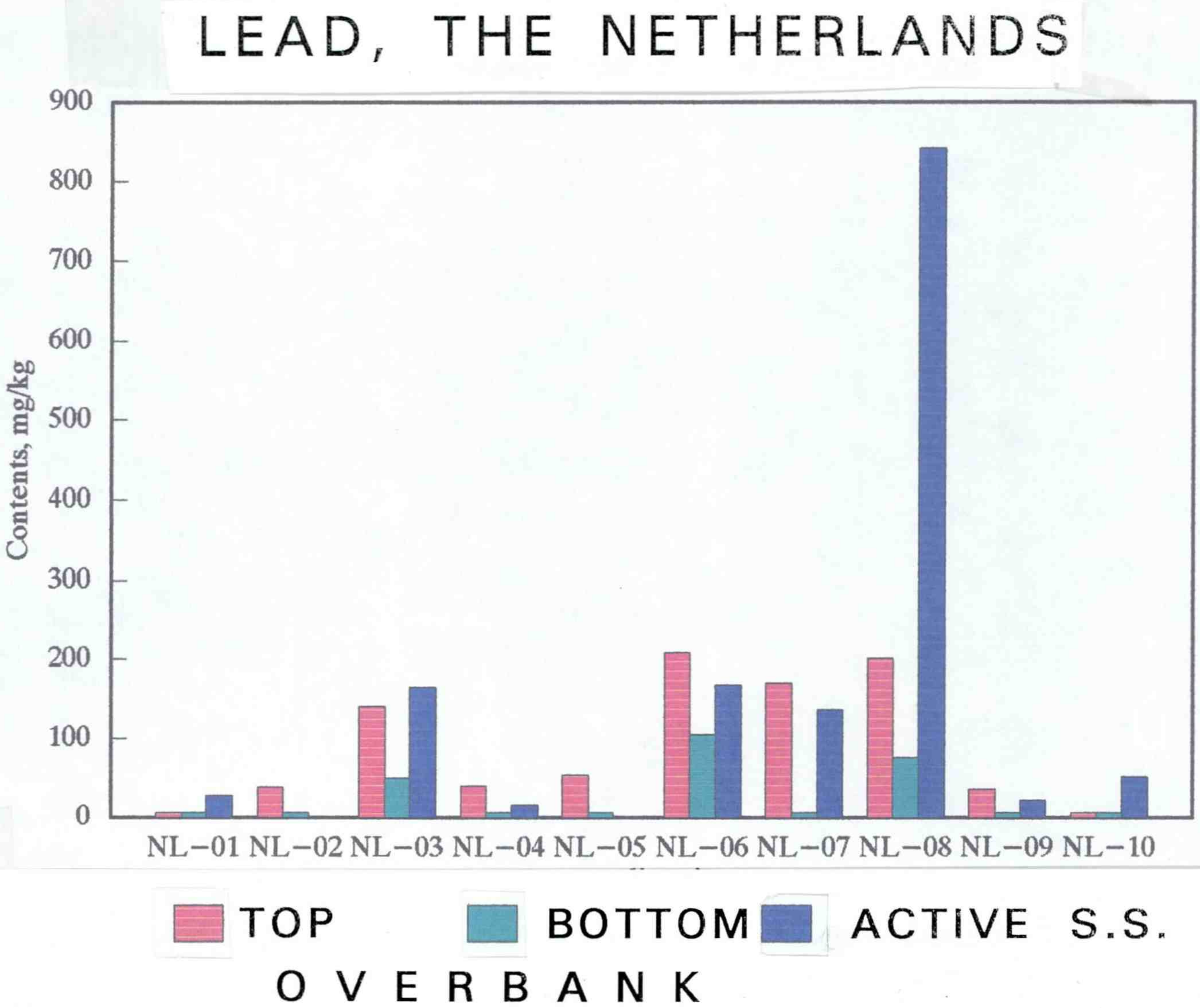

Fig. 2. Contents of Pb in samples of stream sediment (polluted, blue), surficial overbank sediment (polluted, red) and overbank sediment at depth (preindustrial, green). Data from 10 sample sites taken within a 5000 km^2 area in Limburg, the Netherlands. Simultaneous collection of the three sample types facilitates the disclosure of natural patterns and degree of contamination in areas of varying pollution. Some of the flood plains have Pb contents exceeding the C-values of Dutch signal levels. It is indicated that numerous flood plains in certain parts of Western Europe may have great amounts of noxious heavy metal-containing waste originating from upstream old mining activities. Since the waste material could be transported downstream, especially during flood events, it should be mapped in order to suggest plans for armouring of stream banks and other abatement strategies.

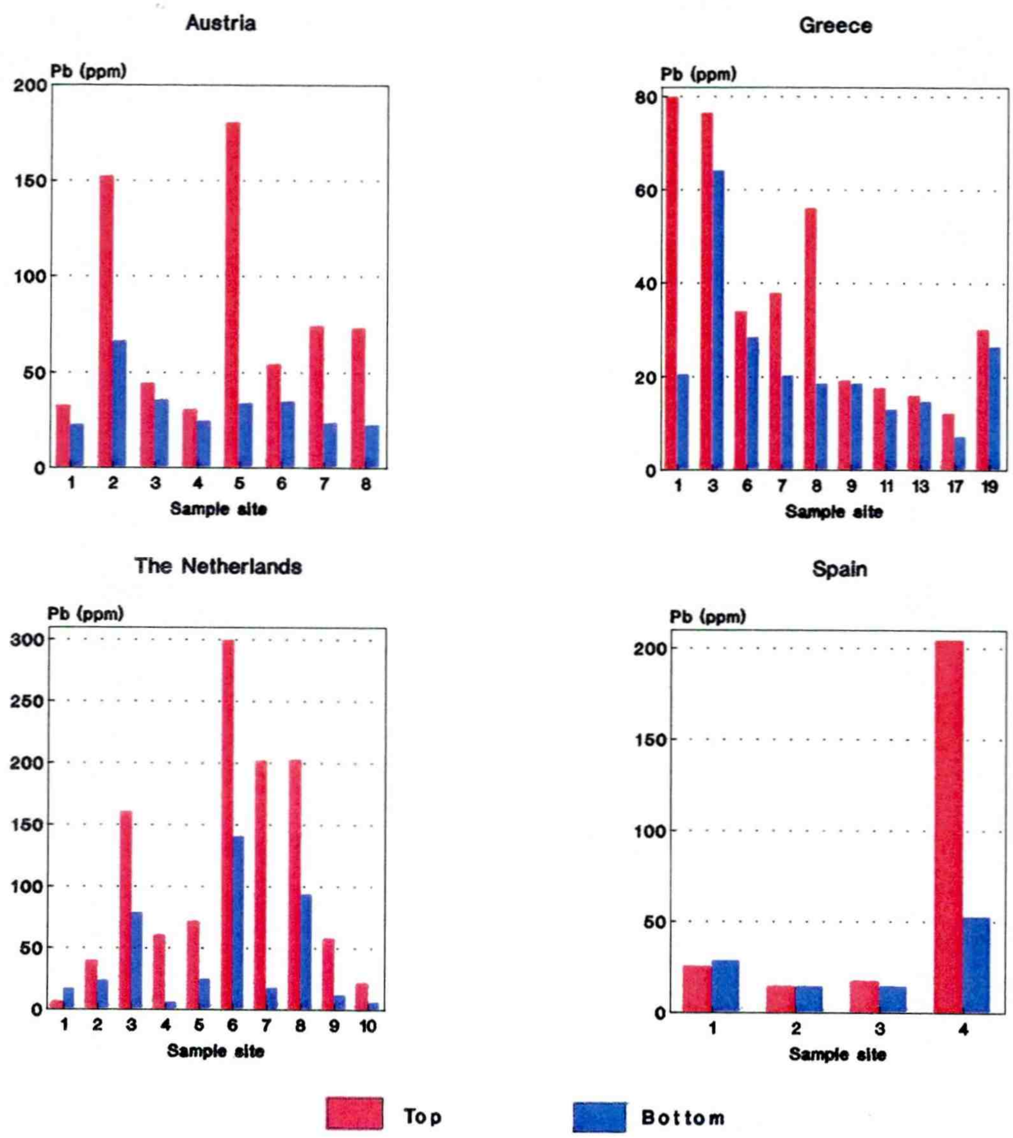

Fig. 3. *Contents of Pb in samples of post- (red) and pre- (blue) industrial flood plain sediments from Austria, Greece, the Netherlands and Spain. At each site, the pollution can be evaluated against the local, but regionally variable, natural background as the difference between the height of the red and blue columns. The pollution was caused by waste from old mining. Locations: Austria: an area west and south of Vienna, 370 km², 4 sample sites; Greece: the Eastern Macedonia and Thrace area, 20 000 km², 10 sample sites; The Netherlands: the Limburg area, 5000 km², 10 sample sites, and Spain: the Sierra de Guadarrama and Sierra de Demanda areas, 1700 km², 4 sample sites [2.3, 2.7, 2.8, 3.2, 3.11-3.15].*

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OTHER RESULTS

Additional results of interest for the use of overbank sediment in low-density systematic geochemical mapping of Europe are:

- Data from north-eastern Norway, Finland and the Kola Peninsula indicate that the influence of recent airborne pollution of Ni and Cu can be traced only in the upper 1-5 cm of overbank sediment profiles and for about 50 km from the source [2.9]. It is recommended, therefore, that an additional sample from depths of 0-5 cm of the overbank sediment profile be collected in some areas where recent airborne pollution is suspected.

- Statistical comparison between the composition of overbank and stream sediments in Austria and Greece showed that, in unpolluted drainage areas, the element contents in only one sample of overbank sediment taken at depth from the lowest part (apex) of the drainage area corresponds rather well with the median value for the same elements in several hundred stream sediment samples taken over the whole catchment basin. In polluted areas, however, the pre-industrial overbank sediment showed much lower values (probably natural) for heavy metals than the contaminated surface overbank and active stream sediments (Fig. 4) [2.3-2.6]. Often stream sediments display higher values than surface overbank sediments, probably due to relatively high contents of secondary Fe- and Mn- oxides and organic matter in the stream sediments.

- An investigation of the reproducibility of overbank sediment chemical data from Norway showed that, between sites, variation is significantly greater than within individual sites [2.16], while a British - Dutch - Greek study provided the following results [2.10, 3.9]: a) overbank sediment can be used to map variations between major geological terrain types; b) in some rivers the composition of overbank sediment varies considerably, both within and between profiles, the variation within a single flood plain in some cases being too great to recognize the difference between pre- and post-industrial overbank sediments. In such cases, dating of strata may be necessary, which would increase considerably the cost of sampling.

- The rate of formation of river plains has been studied by ^{210}Pb-, ^{14}C- and ^{137}Cs-dating, palynology and registration of archaeological objects [2.7-2.10, 2.14]. Data from Norway suggest that accumulation rates vary from 0.079 to 0.26 cm/year. The bases of profiles in Belgium have ages varying from 270 to 6000 years.

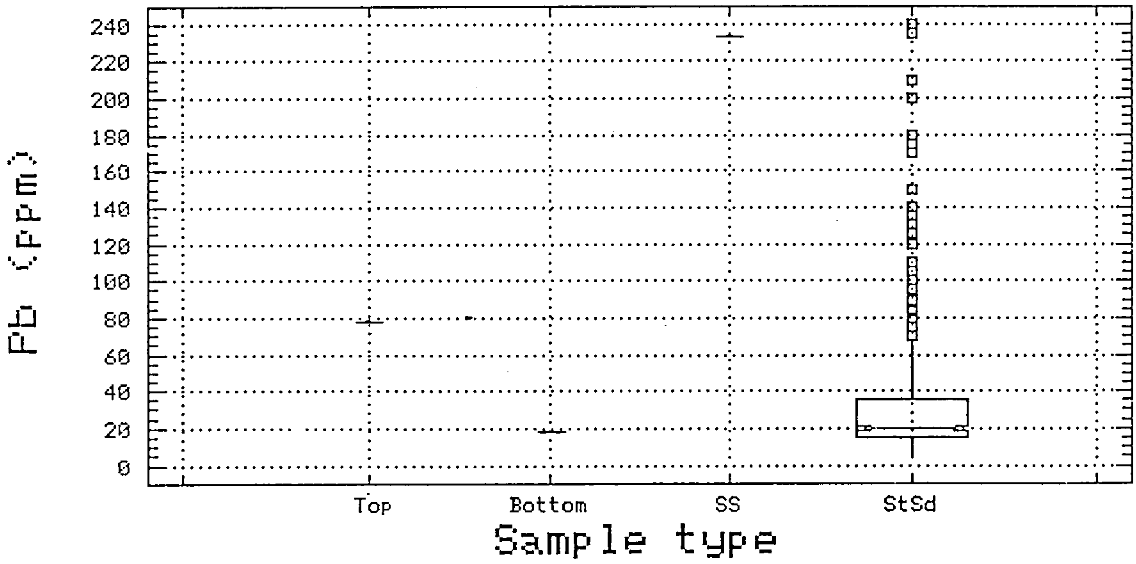

Fig. 4. *Box plot of the Pb content in one sample of post-industrial overbank sediment (Top), one sample of pre-industrial overbank sediment (Bottom), one sample of stream sediment from adjacent site (ss), and 802 samples (median value) of stream sediment taken within the whole catchment (st.sd.). Data from the Irene river, Greece [2.3, 2.5-2.6].*

CONCLUSIONS AND RECOMMENDATIONS

(1) A considerable proportion of river plains in Europe (roughly estimated at 30%, see [2.12]) are severely polluted by waste from old and recent mining. Several of these plains have heavy metal concentrations that exceed threshold values or other limits set by national authorities. The work carried out by the Working Group has shown that chemical analyses of widely spaced samples of pre- and post-industrial overbank sediment provides an efficient tool for mapping the general geochemical background and quantifying the pollution of the sediments in European drainage basins.

(2) Flood plains are important for human life as indicated by the following features:

- About 75% of the population in Europe live on river plains.

- River plains are locations for deposition of both natural sediments and for disposal of large amounts of past and modern time waste from mining and other human activities.

- In many places, flood plain sediments are excavated for the foundations of buildings and the material is transported and dumped elsewhere.

- Sources of ground water for drinking purposes are often situated beneath river plains.

- Fluvial sediment is recognised as a major transport and repository medium for toxic substances of natural and anthropogenic origin.

- Human activities, such as dredging, regulating and diverting of rivers, agriculture, and road construction affect flood plains and river systems.

(3) Polluted river plains represent a present and future environmental threat. Since rivers cross political boundaries, it is in the interest of many regions and countries to obtain detailed information about natural and polluted sediments that may be exported from, or imported into their area. It is, therefore, an important task to determine the extent and degree of this pollution in order to evaluate the potential hazard and suggest mitigation and abatement strategies.

(4) None of the existing environmental monitoring programmes take the pollution from old mining into account, nor the variable nature of sediment transport. Transportation of heavy metals during floods is strongly underestimated in relation to transport under normal conditions. The sedimentary history of river plains will provide information on long-term sediment supply during floods, and be an important supplement to routine data.

(5) An evaluation of the present state of pollution requires systematic, compatible data on the anthropogenic distribution as well as the pre-industrial, natural distribution of chemical elements in surface environments. National or international geochemical mapping programmes should be encouraged to include the methods recommended by the Working Group in order to fulfil this requirement.

(6) If it is not possible at the present stage to map all of Europe, it is recommended that selected river plains be investigated in detail. Such surveys should comprise

- Thorough geochemical investigations, estimation of amounts of pollutants stored in the area, and the present distribution of pollutants.

- Sedimentological investigations in order to (a) study historical features such as sedimentation rates, frequency of catastrophic floods, etc., (b) evaluate present active erosion and downstream transportation of pollutants, (c) estimate the risks to biological systems posed by agents such as catastrophic floods and acid rain, and (d) study how material from flood plains should be treated and stored if removed from its present position in connection with construction work.

(7) Data such as those obtained under 6 above can be used, for example, to

- predict the dispersion of pollutants and other damage which may be caused by future major floods;

- identify the need of armouring river banks in order to control further erosion and transportation of contaminated river plain sediments, and

- outline critical loads and potential chemical time bombs, which may be of importance in identifying river banks where future pH changes may cause mobilization and movement of hazardous elements.

(8) Such detailed investigations should be standardized among various countries and, ideally, should be carried out as bilateral or multilateral projects.

APPENDIX 1

FOREGS WORKING GROUP

ON

REGIONAL GEOCHEMICAL MAPPING

ACTIVE MEMBERS AND COUNTRIES

OF

PARTICIPATING INSTITUTIONS

FOREGS Working Group on Regional Geochemical Mapping 1986-93.

Table 1.1. FOREGS countries with active members **1986-93.**

	1986	1987	1988	1989	1990	1991	1992	1993
Austria	x	x	x	x	x	x	x	x
Belgium						x	x	x
Finland				x	x	x	x	x
France	x	x	x	x	x			
Germany	x	x	x	x	x	x	x	x
Greece	x	x	x	x	x	x	x	x
Ireland				x	x			
The Netherlands				x	x	x	x	x
Norway	x	x	x	x	x	x	x	x
Spain				x	x			
United Kingdom	x	x	x	x	x	x	x	

Table 1.2. Members of the Working Group 1986-93.

Austria	:	O. Schermann, GBA (1986-93)
Belgium	:	W. De Vos, BSG (1991-93), R. Swennen, KUL (1991-93), I. Van Keer (1992), E. Decoene, KUL (1992-93)
Finland	:	R. Salminen (1989-1993) and E. Pulkkinen, GSF (1991-93)
France	:	A. Bourgh, BRGM (1986), L. Laville-Timset, BRGM (1987), P. Lecompte, BRGM (1987), I. Salpeteur, BRGM (1988-90)
Germany	:	R. Hindel, BGR (1986-93)
Greece	:	A. Demetriades, IGME (1986-93) and P. Stavrakis, IGME (1989-90)
Ireland	:	P. O'Connor, GSI (1989-90)
Luxembourg	:	See Belgium
The Netherlands	:	J. Ebbing, GSN (1989-92) and G. Klaver (1992-93)
Norway	:	B. Bølviken*, R.T. Ottesen and T. Volden, NGU (1986-93), J. Bogen, NVE (1986-93)
Spain	:	J. Locutura, GITGM (1989-90)
United Kingdom	:	J. Moore, BGS (1986), P. Simpson, BGS (1988), J. Plant, BGS (1987, 1989-92) and J. Ridgway, BGS (1989-92)

* Convener

BGR	: Federal Institute for Geosciences and Natural Resources
BGS	: British Geological Survey
BRGM	: Bureau de Recherche Géologique et Minière
BSG	: Belgian Geological Survey
GBA	: Geologische Bundesanstalt
GITGM	: Istituto Tecnologico Geominero
GSF	: Geological Survey of Finland
GSI	: Geological Survey of Ireland
GSN	: Geological Survey of the Netherlands
IGME	: Institute of Geology and Mineral Exploration
KUL	: Katholieke Universiteit Leuven
NGU	: Geological Survey of Norway
NVE	: Norwegian Water Resources and Energy Administration

Note: Observers from various countries took part in Working Group meetings, i.e., Denmark (O. Jacobsen, 1989, 1991), Greenland (A. Steenfelt, 1989-90), Italy (M. Branca, M. Voltaggio, 1991), and Sweden (C.A. Nilsson, 1989).

APPENDIX 2

CHRONOLOGICAL SUMMARY OF ACTIVITIES

OF

THE WORKING GROUP

ON

REGIONAL GEOCHEMICAL MAPPING

1984 - 1993

CHRONOLOGICAL SUMMARY OF ACTIVITIES OF THE WORKING GROUP ON REGIONAL GEOCHEMICAL MAPPING 1984-1993

The period 1984-88

The WEGS Working Group on Regional Geochemical Mapping was first established in 1984 following a proposal by J. Goni, Bureau de Recherche Géologique et Minière (BRGM). After Dr. Goni's retirement from BRGM in 1985, the Geological Survey of Norway (NGU) agreed to be responsible for this item [App.3, 1986, point 32]. B. Bølviken, NGU, convened a meeting of the WEGS Working Group on Regional Geochemical Mapping in Trondheim in May 1986, and proposed that geochemical mapping of western Europe should be performed based on low density, multimedia sampling and multielement analysis of the samples. This idea was supported by the Working Group [3.1, App. 3] and a proposal was presented to the WEGS directors at their meeting in Uppsala in August 1986 [3.1, App. 4]]. The proposal met with general approval, although it was commented that the suggested five sampling media may be too many, and the sampling density (1 sample site per 500 km^2) too low [App. 3, 1986, points 35 and 37]. The comments of the directors were discussed at a meeting of the Working Group in Orleans in April 1987. The Working Group agreed that the management of such a great number of samples for all Europe would be very difficult [3.1, App. 7]. If possible one common sampling medium should therefore be employed. NGUs experiences under Norwegian conditions had already indicated that overbank sediment would be a representative sampling medium for countrywide geochemical mapping [1.1]. An excursion was arranged in October 1987 in order to study field conditions in Norway and the data obtained from chemical analysis of widely spaced samples of overbank sediment. The main conclusions of this excursion were that overbank sediment is a most suitable sampling medium for regional geochemical mapping in northern Europe [3.1, App. 9]. At a meeting of the Working Group in Hannover in August 1988 with field excursions in the surroundings of Hannover, it was demonstrated that deposits of overbank sediment are common in drainage systems in Germany, and that such sediment could be severely contaminated in the upper metre or so by heavy-metal-bearing waste from mining activities within the catchment area, but still retains pre-industrial (pristine) composition at depth [3.1, Apps. 10 and 11].

A proposal for a pilot geochemical survey based on overbank sediment was then presented to the WEGS directors at their meeting in Copenhagen in September 1988 [3.1]. The directors agreed that a two-year pilot project be carried out in order to assess the viability of a programme of geochemical mapping of western Europe [App. 3, 1988, points 33 and 34.].

Pilot Project 1988-90

The results of the pilot project are summarized in the Pilot Project Report [3.2]. The main aims of the project were to (1) prepare an inventory of geochemical surveys in western Europe; (2) determine the occurrence of overbank sediment in different environments in western Europe; (3) provide data on sampling and analytical errors for overbank sediment; (4) study variations of the chemical composition with depth in overbank sediment profiles;

(5) compare the chemical composition of overbank and stream sediments collected at adjacent sites; (6) compare results obtained by different analytical methods and (7) study the distribution of grain size fractions in overbank sediment and determine the optimum fraction for analysis.

It was concluded that (1) geochemical mapping is well advanced in several countries. Although most of the work is based on stream sediments, it is also characterized by a variety of sampling media, limited areas of coverage, high sampling densities and different methods of sample preparation and chemical analyses; (2) overbank sediment is present and can be sampled in all the WEGS countries; (3) the reproducibility of sampling and chemical analysis of overbank sediment is acceptable for regional geochemical survey purposes within the limits of analytical error; (4) pre-industrial samples of overbank sediment can normally be obtained at depth even in areas polluted by mining and other human activities; (5) overbank sediment is a composite medium which is more representative of the upstream drainage area than stream sediment; (6) different chemical agents for digestion of the samples produce complementary information; and (7) the minus 125 microns grain size fraction is considered to be the optimum after taking into account cost of sampling and available procedures for sample preparation and chemical analysis.

The overall conclusions of the Pilot Project ([3.2, p. 7] were that (1) the existing national geochemical mapping data in western Europe are not suitable for preparation of common geochemical maps, and (2) a geochemical mapping programme of western Europe based on the analysis of overbank sediment complemented with active stream sediment should be initiated by FOREGS.

Project Proposal 1990

On the basis of the results of the Pilot Project, the Working Group proposed as a main project the "Geochemical Mapping of Western Europe towards the Year 2000" [3.3].

The project should be divided into three phases as follows:

1. Planning and preparatory work, including publication of Pilot Project studies and investigation of sources of external funding.

2. The Main Project should establish a geochemical data base for western Europe and compile a geochemical atlas based on low-density sampling and multielement analysis of pre- and post-industrial samples of overbank sediment. Stream sediment sampling should be included in order to facilitate a linkage with national geochemical data sets. A long-term storage facility for a geochemical sample archive was also suggested.

3. The data obtained in the Main Project should be utilized in various fields such as pollution, geomedicine, agriculture, forestry, water resources, land use planning, crustal and metallogenic provinces, sediment budgets and world wide international geochemical mapping.

It was recommended that a full-time Project Manager and Secretary be appointed reporting directly to the WEGS Directors within the time schedule 1991-96.

The total cost for the preparation of the Geochemical Atlas of Western Europe and the subsequent utilization of the data were estimated as ECU 9,361,000 and ECU 1,210,000, respectively, of which about 50% was proposed as a WEGS contribution shared by the individual countries in proportion to their sizes, and the rest being sought from external funding.

This Project Proposal was presented to the WEGS directors at their meeting in Vienna in August 1990. The directors concurred that (1) the time is not yet ripe for a project that involves the whole of Europe, (2) any country that wishes to proceed further may do so, and (3) a start in the Benelux and other countries should be considered. The directors were concerned about the costs, and encouraged the Working Group to look into possible ways of obtaining financial support from external sources [App. 3, 1990, points 33 and 34].

The period 1990-93

The activities of the Working Group in this period can be divided into two parts: (1) test mapping in five countries and (2) further research. The results of these activities (see pp. 10-11, and [3.10]) were presented to the FOREGS directors at their meeting in Orleans, September 1992. Some of the directors then made critical remarks on the activities of the Working Group, in particular its initiative in approaching the European Environment Agency Task Force as a possible source of funding (although the establishing of such contacts had been recommended on two earlier meetings of the FOREGS directors, see App. 3, 1986, point 38 and 1990, point 33 (h)). It was decided that the present Working Group on Regional Geochemical Mapping should conclude its work and write a final report to be presented at the FOREGS meeting in Hannover, September 1993 [App. 3, 1992 point 38].

APPENDIX 3

MINUTES OF THE

FOREGS DIRECTORS' MEETINGS

1984 - 1992

EXTRACTS REGARDING

THE WORKING GROUP ON REGIONAL

GEOCHEMICAL MAPPING

FOREGS Working Group on Regional Geochemical Mapping

Extracts from minutes of the meetings of the FOREGS directors 1984 - 92.

1984

Item 6. Regional Geochemical mapping

21. Dr. Papavassilliou introduced his paper, "Brief Introduction on the targets and methods used in Regional Geochemical Exploration in Greece", that had been distributed for the meeting.

22. The points made during the ensuing discussion included:

    (a) Dr. Plant (BGS) is writing a book on this subject, with worldwide coverage, but with the emphasis on Western Europe.

    (b) Both sound and wrong conclusions can be drawn from the results of regional geochemical mapping programmes. The emphasis should perhaps be more on hydro-geochemical sampling than on stream sediment or soil sampling.

    (c) Gas geochemistry is particularly important in arid climate.

    (d) The question "What is a geochemical map;" should be considered. It is a map simply showing chemical anomalies in soils and streams: account must be taken of the relative mobility of elements.

    (e) If future funding is to be assured, the origin and significance of the anomalies must be investigated. Has the cost been justified? For example, have hitherto unknown mineral deposits been identified?

    (f) Examples were given of regional geochemical mapping both leading to a discovery (celsian and barytes at Aberfeldy Scotland) and to a major lead/zinc deposit (Navan, Ireland) not being discussed by the first.

    (g) The applications to environmental geology are likely to become increasingly important in the future.

    (h) A report on the use of applied geochemical research in the U.K. being prepared for the Royal Society is due to be issued late in 1984. Copies of a geochemical .... will be sent to all Directors, as will copies of an Atlas of the F.R.G. which is due to be published early in 1985.

(i) Most geological surveys are concerned only with that part of applied geochemistry that is relevant to their role, that is identifying the natural resources, rather than evaluating them; thus in some countries the later, more detailed, stages are undertaken by mining companies. Surveys also have as an objective the applications to environmental geology, to provide the factual basis to the environmental protection measures adopted by their governments.

(j) It is very important that samples are retained for later re-examination, although this can impose severe strains on storage capacities.

23. It was agreed that a short introductory paper outlining:

(a) the role of surveys with respect to applied geochemistry and

(b) the practical problems (not routine procedures) should be produced by the BRGM in consultation with Dr. Kalogeropoulos, for discussion in 1985. The point was made that this paper should not hesitate to point out the pitfalls, as well as the benefits, even if the truth is unpalatable.

24. To assist the preparation of this paper, all members are invited to submit a short note on the topics identified in para. 23 to Dr. Goni before the end of December, 1984.

1985

Item 4. Regional Geochemical mapping

27. Dr. Goni introduced his report (Appendix 4). Papers provided by Greenland, the Federal Republic of Germany and the Netherlands were also distributed.

28. The following points were among those made during the discussion of this report:

(a) There are still problems in persuading geologists to use the results of regional geochemical mapping, so that it is necessary to consider carefully how they should be presented. An example, developed in Finland, using different shades of grey was demonstrated, as were maps produced recently in Austria.

(b) An expert group should be established to make recommendations on this subject.

(c) Dr. Goni's comprehensive report contained too many points for discussion by such a Group, which should therefore select those it considered to be the most important. It was stressed that the Group should not be concerned with routine operations, but rather with such problems as the relationship between geochemical data and mineralogy.

29. It was agreed that a Working Group, which should decide its objectives, should be convened by Dr. Goni. Dr. Goni suggested the following terms of reference:

(a) Main objectives:
- (i) Interpretation of geochemical anomalies (in which form the elements really are in the samples).
- (ii) The relationship between element distribution and human health.
- (iii) Establishing geochemical and chemical standards (in water, soils, organic materials, gas, etc.).

(b) Subsidiary subjects:
- (i) The chemical mobility of elements as a function of concentration, climatic regime, topography, etc.
- (ii) Types of samples and density of sampling.
- (iii) The interpretation and selection of geochemical anomalies, particularly on a "tactical" scale.

30. Initially, the Group should include representatives from the United Kingdom, the Federal Republic of Germany, Norway, Spain, Greece and Austria.

31. It was also agreed that Dr. Goni would distribute to all members the papers summarised in Appendix 4.

1986

Item 5. Regional Geochemical mapping

32. Dr. Heier reported that he had agreed to be responsible for this item following Dr. Goni's retirement from the B.R.G.M.

33. Dr. Bölviken then introduced the report of the working Group that had met in Trondheim in May. The Group proposed that a geochemical atlas of W. Europe should be produced, based on a very low density of sampling (1 composite sample per 500 km^2). Samples at each station to be from the soil, water and stream sediments, analysed for the maximum possible number of elements. It would be essential for the analyses of all the samples by a particular method to be done in one laboratory.

34. Some of the principles involved were illustrated by maps produced during the Nordkalott Project. Dr. Bølviken demonstrated that major anomalies and distribution patterns, identified by close sampling (ca. 1 per 30-50 km^2) were also revealed by much lower sampling densities (down to 1 per 500 km^2). There is some reason to believe that such patterns are present at all scales.

35. During the discussion of the Group's proposal, the points made included:

(a) It would be necessary to decide how many samples were to be integrated in each composite sample.

(b) The Nordkalott area may be particularly favourable for a low-density survey, being relatively free from human industrial activities.

(c) In W. Europe there are very large ranges in temperature, rainfall and contamination.

(d) There may be political objections to the preparation of such an atlas, bearing in mind for example, concern about airborne pollution.

(e) It might be necessary to monitor changes due to contamination by selecting a limited number of reference sites at which sampling is repeated at intervals.

(f) Some Surveys (for example the B.R.G.M.) may find that funds are more accessible for such monitoring, rather that for further geochemical mapping.

(g) A pilot project (see p. 5 of the report) would be necessary because the experience gained during the Nordkalott Project may not be applicable to all of W. Europe.

(h) The costs would be split approximately equally between the field and laboratory work.

(i) Some surveys might be able to bear the field work costs, but external funding would be necessary to cover all the analytical costs.

(j) The results would be of particular relevance to environmental problems (in the widest sense, including for example epidemiological problems.

36. It was agreed that the working Group should meet in Orleans in April 1987 in association with the AEG/ICGC meeting and that all Surveys should send representatives if they wish. All Surveys should send information about long-term reference sites to Dr. Bølviken.

37. The idea met with general approval and it was therefore agreed that the Group should prepare a draft proposal, taking account of all the points raised in the discussion. The proposal should indicate the costs of the sampling programme and of the analytical work. The proposal will be considered by WEGS in 1987.

38. It was also agreed that there should be informal contact with the E.E.C.

1987

Item 5. Regional Geochemical mapping

31. Dr. Heier introduced the progress report of the Working Group on Regional Geochemical Mapping which had met in Orleans in April.

32. The first excursion in Norway mentioned in the report was now taking place. There would be another next Spring and it might be necessary, to ensure common sample types, to arrange an excursion in Southern Europe.

33. Dr. Heier went on to suggest that ample time is needed to allow the Group to develop a sound proposal. As mentioned in the report there is and increasing worldwide interest in the subject and a strong link between WEGS and this wider interest is assured by the participation of Dr. Bølviken in the work of a committee with much wider representation that is chaired by Dr. Bjørklund of Finland.

34. The following points were made in discussion:

(a) The Working Group should not lose sight of the three main purposes of the project as they were outlined when it was initiated.

(b) The solution of practical problems should have a higher priority than the preparation of an atlas which would not necessarily be the best result.

(c) It was also pointed out, however, that an atlas may have many valuable applications.

(d) Referring to the last sentence of the report it was suggested that WEGS should concentrate its efforts on the solution of West European problems, although an incidental benefit might be to help to solve worldwide problems.

(e) It is necessary to ensure that the members of the Working Group maintain good contacts with other organisations, for example water authorities, that are involved with similar problems.

35. It was agreed that the Working Group should continue and report to WEGS again in 1988.

1988

Item 6. Regional Geochemical mapping and related activities

30. Dr. Bølviken drew attention to the main points of the Report of the Working Group and to its recommendations, that is that there should be an orientation, with three successive components: an inventory of what has been done; an orientation survey in 6 or 7 countries, with 10 to 15 samples in each; an orientation survey in all WEGS countries.

31. Dr. Papavassiliou outlined the main points in the IGME proposal, which had been distributed. It was emphasized that the IGME is anxious to collaborate in joint programmes with other Surveys in WEGS, but that as Greece is geographically isolated it could not participate usefully in a WEGS Regional Survey. The IGME was concerned to avoid the duplication of effort by a Regional Geochemical Survey under the aegis of WEGS and the IGCP Project 259 "International Geochemical Mapping" organised by several prestigious international organisations.

32. During discussion of this item, the following were among the points made:

(a) The intention is that one laboratory should be responsible for the analysis for each element in all samples collected during the orientation survey, to avoid interlaboratory calibration.

(b) The absence of clear correlation between the geochemistry of overbank samples and the bedrock geology, pointed out in parts of Norway by Dr. Bølviken, was not surprising. The overbank sediments had been transported form distant areas.

(c) Elements respond in different way to different climatic and hydrological regimes, and in different sediments (depending, for example, on the presence of humus).

(d) Such questions would be addressed in a report of extensive research undertaken by the BGR, to be published later in 1988.

(e) The proposed 10 to 15 samples from each participating country appeared to be of doubtful value for the comparison of different sample types.

(f) The main point of the sampling programme during the orientation survey would be to establish the depth at which they should be collected to avoid anthropogenic influence.

(g) A sampling density of 1 per 500 km^2, indicated for the main project in the Report, might be adequate in some countries, but not in others.

(h) Sampling at a low density may identify regional, rather than localised, effects.

(i) Two Directors reported that recent attempts to co-operate with East European Surveys as suggested by Dr. Papavassiliou, including within IGCP Project 259, had proved to be unrewarding.

(j) The results of a WEGS orientation study could be of value to the West European group of IGCP Project 259.

33. Dr. Carlsson suggested that the orientation study proposed by the Working Group should proceed, subject to the following qualifications:

(a) It should consist, explicitly, of only the three components summarized in paragraph 30 above, without prejudice to further work being undertaken.

(b) A decision whether to proceed with a Regional Geochemical Survey will be dependent on a full evaluation of the orientation studies.

(c) The final report should include an account and evaluation of the methodology (Sweden and Finland offered to contribute to the evaluation).

(d) The survey should be completed within 2 years.

(e) Greenland is among the countries in which the initial orientation survey is carried out.

34. It was agreed that on this basis the orientation survey should proceed.

35. Dr. Carlsson distributed two papers on biogeochemical mapping in Sweden (see Appendix 6).

1989

Item 9. Regional Geochemical mapping and related activities

52. A report on the progress of the Group was circulated and introduced by Dr. Heier, who emphasized that it was hoped that all members of WEGS would be represented at a meeting in Hannover on 6-10 November, 1989.

53. Dr. Ghisler pointed out that the validity of regarding the orientation samples as representative, discussed by WEGS in Copenhagen in 1988, was being tested: samples had been collected from several different terrains in Greenland. He supported Dr. Heier's plea for attendance at the meeting in Hannover.

54. It was agreed that during the WEGS meeting in Vienna in 1990 an attempt would be made to include at least one exposure which demonstrates overbank deposits.

1990

Item 8. Regional Geochemical mapping and related activities

31. Dr. Bølviken introduced the results of the pilot project and the proposals for further work which had been distributed in two comprehensive reports.

32. Dr. Emmenegger introduced a paper which had been distributed during the meeting which explained the position of the Swiss Academy of Natural Sciences (Geological Commission) and the Swiss National Hydrological and Geological Survey with respect to the proposed project. He drew attention to the problem that there were almost no undisturbed overbank deposits in Switzerland. He informed that a Subcommission for Geochemistry of the Swiss Academy will study the WEGS proposal and prepare a report with recommendations within about a year.

33. The points made during the discussion of this item included the following:

(a) All concerned with the pilot project should be congratulated on their work and the way in which the results have been presented.

(b) The budget for the main project seemed to be too modest. The difficulties that are likely to be encountered may have been underestimated.

(c) The Swedish Geological Survey underlined the need for sedimentological investigation of each sample site, as a prerequisite for accepting the proposed method. It also noted that the cost of the project, specifically for Sweden, would be high. Swedish participation has not been decided.

(d) At present the Geological Survey in Italy would be unable to participate as it did not have the facilities for the collection of the necessary new samples. Furthermore the cost to Italy, of the order of one billion lire could not be met from the Survey's budget.

(e) The report contained a mistake about the area of Portugal.

(f) Although most Directors expressed considerable interest in the principle of the proposed work, many had objections on either scientific or financial grounds.

(g) The British Geological Survey, for example, would be able to participate in the project but it would not be possible for funding to be provided for work undertaken outside the United Kingdom. This problem might be overcome if it were possible for the analytical work to be undertaken in more than one laboratory. It was agreed that although it is desirable for all the analyses to be done in one laboratory, it was possible for the work to be distributed to several laboratories.

(h) Another example, in France it is very difficult to obtain funding for systematic work on data inventories rather than for specific projects in particular areas. It would be much more likely that pilot studies on, for example, specific geological environments in circumscribed areas would attract funding including from such external sources as the EEC; such projects could be linked to environmental protection measures including pollution problems.

(i) Some other Directors supported this French suggestion.

(j) It will be necessary to demonstrate the practical benefits that might flow from the project.

34. After further discussion it was agreed that the time is not yet ripe for a project evolving the whole of Western Europe. Obviously, any country that wished to proceed further could do so and it was suggested that the Working Group might like to consider making a start in The Netherlands, Belgium and Luxembourg and that the progress of this more limited project should be reported to WEGS at appropriate intervals.

1991

Item 8. Regional Geochemical mapping

37. Dr. Heier introduced the report for 1991 and indicated that more detailed reports were in the post to Directors.

38. The report was approved.

39. The next meeting of the Group would be in Uppsala on the 16th of September 1991.

1992

Geochemical mapping

33. Dr. Bølviken introduced the Report which had been distributed shortly before the meeting.

34. The chairman expressed concern that Dr. Bølviken had written to the Manager of the European Environment Agency Task Force without the approval of WEGS and pointed out that Directors had not been inactive but were taking all necessary steps to ensure that the appropriate components of the European Economic Communities were aware of the services that can be provided by Geological Surveys. The chairman's concern was shared by some other Directors, but not by all.

35. It was agreed that, without any doubt, the only contact between the FOREGS Geochemical Group and the EEC should be only with the full approval of Directors.

36. Of the conclusions of the Report (see page 16) only the third could be approved: "The research projects initiated by the Working Group should be rounded off and the results published. Further research shall be initiated on the basis of these results and on the experience being gained in the main project."

37. It was also agreed that such "further research" should be undertaken by a Group with a different composition with members nominated by Directors.

38. The work of the present Group should be concluded in 1993.

APPENDIX 4

SEDIMENTATION PROCESSES IN RIVERS AND THE FORMATION OF OVERBANK SEDIMENT

SEDIMENTATION PROCESSES IN RIVERS AND THE FORMATION OF OVERBANK SEDIMENT

A review of the literature about the formation and transportation of active stream sediments showed that information on processes controlling stream sediment composition is scarce [2.11].

It was also found that stream sediments in some cases fail to detect some existing natural geochemical features because (a) only a few sediment sources in a stream catchment area are actively being eroded at the time of sampling and (b) stream beds are polluted [1.1, 1.3, 2.1, 2.11]. Such pollution is common in Europe, and active stream sediments are, therefore, not suitable as a sample medium for geochemical mapping of all Europe.

OVERBANK SEDIMENT

Overbank sediments (flood plain sediments, alluvial soils) are produced when the water discharge exceeds the capacity of a river channel, a reason why parts of the suspended load are deposited on the river plains (flood plains) or on the river bank levees (Figs. 4.1 and 4.2).

Throughout a long time span, a sequence of layers of fine material is built up. Each layer in the sequence represents a single flood event. An overbank sediment sample integrates several layers and thus represents material deposited during several floods.

The chemical composition of overbank sediment, therefore, reflects the geochemistry of the river basin better than that of conventional stream sediments, which originate in discrete sediment sources unevenly distributed over the catchment area at locations that vary with time.

As the lowermost material in an overbank sequence may have been deposited before the onset of anthropogenic pollution, it is possible to obtain samples representing pristine conditions.

Man's interference with rivers may have caused large changes in the pattern of sediment sources and transportation. These changes may in turn involve modifications of the rates of overbank sedimentation. In this context, it is essential to distinguish between activities involving a change in chemical composition and those that only imply a decelerated or accelerated erosion rate.

It is necessary to have some general knowledge about sedimentation rates on river plains in order to be able to select the best locations for taking pristine and polluted overbank sediments. In regional surveys, a number of different types of river plains have to be dealt with. If the channel pattern of a river is complicated, a study of the sedimentary units at the sampling locations may have to be carried out before a sample is collected.

dealt with. If the channel pattern of a river is complicated, a study of the sedimentary units at the sampling locations may have to be carried out before a sample is collected.

In some of the fluvial systems, older sediments are reworked during floods. In such cases it may be difficult to identify material that represents pre-industrial conditions, and a more thorough study of sediment sequences may be necessary. Essentially, sample locations may be classified in to three categories according to river type:

(a) In meandering or straight reaches, the natural levee or slack water positions of the river plain may provide sites for both a recent and a pre-industrial sample.

(b) In braided rivers the layer of overbank sediment is generally thin and spread out over large areas. The ages of the braids, however, vary across the channel and in this case, it is also possible to distinguish between pristine and polluted deposits, provided sufficient sedimentological knowledge of the area exists.

(c) If river terraces are present, their relative ages have to be taken into account in order to identify locations for sampling old and young material.

Fig. 4.1. Deposit of overbank sediment on a river plain in Western Norway. Note the layered sedimentary sequence with a top surface covered with sediments from the last flood.

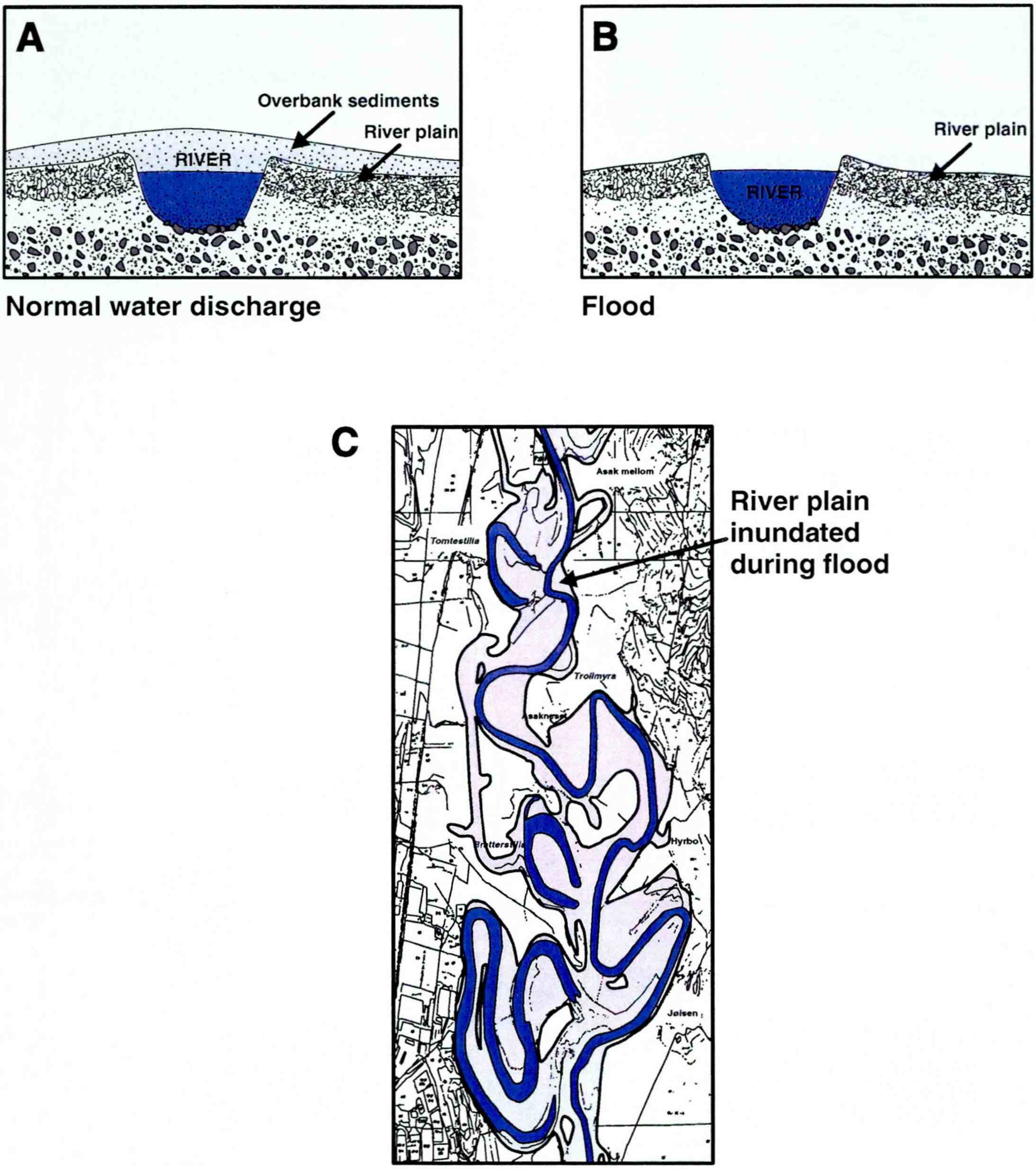

Fig. 4.2. River and river plain. A and B: Vertical section. A: Normal water level. B: During flood stage and deposition of overbank sediments. C: Map. Flooded part of river plains.

APPENDIX 5

PUBLICATIONS, PUBLICATION MANUSCRIPTS, REPORTS, ORAL AND POSTER PRESENTATION

FOREGS Working Group on Regional Geochemical Mapping 1986-93.

PUBLICATIONS, PUBLICATION MANUSCRIPTS, REPORTS, ORAL AND POSTER PRESENTATIONS

1. PRINTED PUBLICATIONS

1.1. Ottesen, R.T., Bogen, J., Bölviken, B. and Volden, T., 1989. OVERBANK SEDIMENT: A REPRESENTATIVE SAMPLE MEDIUM FOR REGIONAL GEOCHEMICAL MAPPING. *J. Geochem. Explor., 32: 257-277.*

1.2. Ottesen, R.T., Bölviken, B. and Bogen, J., 1992. KJEMISKE TIDSBOMBER I VEST-EUROPA. (In Norwegian, Chemical Time Bombs in Western Europe). *NGU Annual Report 1991: 18-19.*

1.3. Bogen, J., Bölviken, B. and Ottesen, R.T., 1992. ENVIRONMENTAL STUDIES IN WESTERN EUROPE USING OVERBANK SEDIMENT. In: Bogen, J., Walling, D.E. and Day, T.J. (eds.) Erosion and Sediment Transport Monitoring Programmes in River Basins. *International Association of Hydrological Sciences Publication No. 210: 317-325.*

1.4. Demetriades, A., Bölviken, B., Hindel, R., Ottesen, R.T., Salminen, R. and Schermann, O., 1993. THE GEOCHEMICAL IMPLICATIONS OF ENVIRONMENTAL POLLUTION. In: Proceedings of HELECO'93, 1st International Exhibition and Conference of Environmental Technology for the Mediterranean Region, Athens 1-4 April 1993. *Technical Chamber of Greece, Athens, Vol. I: 467-479.*

2. PUBLICATION MANUSCRIPTS

2.1. Bogen, J. and Ottesen, R.T.
FACTORS AFFECTING THE DEPOSITION OF OVERBANK SEDIMENTS IN RIVERS

2.2. Bölviken, B., Demetriades, A. and R.T. Ottesen
REGIONAL GEOCHEMICAL MAPPING IN WESTERN EUROPE

2.3. Demetriades, A. and Schermann, O.
A STATISTICAL COMPARISON OF WIDELY SPACED REGIONAL GEOCHEMICAL SAMPLING AND CONVENTIONAL RECONNAISSANCE STREAM SEDIMENT SURVEYS, EASTERN MACEDONIA AND THRACE, N.E. GREECE

2.4. Demetriades, A., Hindel, R., Ottesen, R.T. and Salminen, R.
USE OF DIFFERENT ANALYTICAL METHODS AND THEIR EFFECTIVENESS IN REGIONAL GEOCHEMICAL RECONNAISSANCE IN GREECE

2.5. Demetriades, A. and Salminen, R.
A COMPARISON OF OVERBANK AND STREAM SEDIMENT IN LOW SAMPLING DENSITY GEOCHEMICAL SURVEYS IN GREECE

2.6. Demetriades, A., Armour-Brown, A., Persianis, D., Salminen, R., Smith, A.Y and Zangouroglou, C.
A COMPARISON OF GEOCHEMICAL PATTERNS IN WIDELY-SPACED REGIONAL GEOCHEMICAL SAMPLING AND CONVENTIONAL STREAM SEDIMENT SURVEYS IN GREECE

2.7. De Vos, W., Ebbing, J., Hindel, R., Schalich, J., Swennen,R. and Van Keer, I.
GEOCHEMICAL MAPPING BASED ON OVERBANK SEDIMENT IN THE HEAVILY INDUSTRIALIZED BORDER AREA BETWEEN BELGIUM, GERMANY AND THE NETHERLANDS

2.8. Hindel, R., Schalich, J., De Vos, W., Ebbing, J., Swennen, R. and Van Keer, I.
VERTICAL DISTRIBUTION OF ELEMENTS IN OVERBANK SEDIMENT PROFILES FROM BELGIUM, GERMANY AND THE NETHERLANDS

2.9. Langedal M., Ottesen, R.T. and Bölviken, B.
DETECTION OF AIRBORNE POLLUTION BY CHEMICAL ANALYSIS OF OVERBANK SEDIMENTS

2.10. Macklin, M.G. and Ridgway, J.
CHEMICAL VARIATION IN OVERBANK SEDIMENT SEQUENCES IN THE UNITED KINGDOM

2.11. Ottesen, R.T.
STREAM SEDIMENT GEOCHEMISTRY: A REVIEW OF THE SAMPLE MEDIUM AND OF THE STREAM PROCESSES CONTROLLING STREAM SEDIMENT COMPOSITION WITH PARTICULAR REFERENCE TO FENNOSCANDIA

2.12. Ottesen, R.T., Bogen, J. and Bölviken, B.
EUROPEAN RIVER PLAINS - POTENTIAL CHEMICAL TIME BOMBS?

2.13. Plant, J. and Ridgway, J.
AN INVENTORY OF WESTERN EUROPEAN GEOLOGICAL SURVEYS REGIONAL GEOCHEMICAL MAPPING PROGRAMMES

2.14. Pulkkinen, E. and Rissanen, K.
VERTICAL DISTRIBUTION OF CHEMICAL ELEMENTS AND ^{137}Cs IN OVERBANK SEDIMENTS AS AN INDICATOR OF POLLUTION IN THE INARI AREA, NORTHERN FINNISH LAPLAND

2.15. Schermann, O.
QUALITY CONTROL FOR THE GEOCHEMICAL MAPPING OF WESTERN EUROPE

2.16 Bølviken, B., Ottesen, R.T. and Volden, T.
USE OF OVERBANK SEDIMENT IN GEOCHEMICAL MAPPING OF NORWAY: REGIONAL VARIABILITY VERSUS SAMPLING ERROR

3. OPEN FILE REPORTS

3.1. Bølviken, B., Hindel, R., Ottesen, R.T., Schermann, O., Simpson, P. and Volden, T., 1988.
WESTERN EUROPEAN GEOLOGICAL SURVEYS (WEGS), WORKING GROUP ON REGIONAL GEOCHEMICAL MAPPING. VOL I: PROJECT PROPOSAL, VOL.II: 13 APPENDICES NGU Report 88-147.
The appendices are:

1. WEGS meeting Reykjavik Sept. 1985. Item 4 of the Minutes.
2. WEGS Working Group on Regional Geochemical Mapping Representatives and activities 1986-1988.
3. Working Group meeting Trondheim May 1986. Minutes.
4. Working Group meeting Trondheim May 1986. Project proposal.
5. Overbank sediment: a representative sample medium for regional geochemical mapping.
6. WEGS meeting Uppsala August 1986.
7. Working Group on Regional Geochemical Mapping. Progress report July 1987.
8. WEGS meeting Ankara August 1987. Item 5 of the minutes.
9. Use of overbank sediments as a sampling medium in geochemical mapping. Report from excursion in Norway September 1987.
10. Working Group meeting Hannover August 1988. Minutes.
11. Heavy metals in alluvial soils, F.R. Germany and Norway.
12. Mapping the acid susceptibility of soils.
13. International Geochemical Mapping.

3.2. Demetriades, A., Ottesen, R.T. and Locutura, J. (eds), 1990.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. PILOT PROJECT REPORT. With 10 appendices.
NGU Report 90.105.
The appendices are:
1. Definition of overbank and active stream sediment
2. Historical outline of activities of the WEGS Working Group on Regional Geochemical Mapping
3. Field reports
4. Sampling and analytical reproducibility
5. Vertical distribution of elements in overbank sediment profiles
6. Distribution of elements in different grain size fractions
7. Comparision of overbank and stream sediment
8. Analytical methods
9. Publication
10. Inventory of geochemical surveys of Western Europe

3.3. Bølviken, B., Demetriades, A., Hindel, R., Locutura, J., O'Connor, P., Ottesen, R.T., Plant, J., Ridgway, J., Salminen, R., Salpeteur, I., Schermann, O. and Volden, T. (eds), 1990.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. PROJECT PROPOSAL. With 10 appendices.
NGU Report 90.106.
The 10 appendices are:
1. Publication of Pilot Project Results
2. Field Work and Sample Preparation
3. Chemical Analysis
4. Quality Control
5. Map Presentation
6. General Interpretation
7. Long Term Storage of Samples
8. Research Projects
9. Project Organization
10. Budget

3.4. Bølviken, B., Demetriades, A., Ebbing, J., Hindel, R., Ottesen, R.T., Plant, J., Ridgway, J., Salminen, R. and Stavrakis, P., 1991.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. MINUTES FROM MEETING IN ATHENS, GREECE 15-18 October 1990 (With an Appendix by Demetriades, A.: Publication of Pilot Project Results). NGU Report 91.202.

3.5. Bølviken, B. and Ottesen, R.T., 1991.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. ACTIVITIES AND PLANS 1991-92. NGU Report 91.204.

3.6. Bogen, J., Hasholt, B., Jacobsen, O. and Ottesen, R.T., 1991. ON THE OCCURRENCE OF OVERBANK SEDIMENT IN DENMARK. NGU Report 91.205.

3.7. Demetriades, A., 1991.
WESTERN EUROPEAN GEOLOGICAL SURVEYS, GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. MINUTES FROM PROJECT MEETING IN HEERLEN, THE NETHERLANDS 27-28 May 1991 (With two appendices:- 1) Plant, J. and Ridgway, J.: Within and between Site Variability in the Composition of Overbank Sediment; 2) Ebbing, J. and Swennen, R.: Excursion to the Geul River Valley, Belgium and The Netherlands. NGU Report 91.203.

3.8. Bølviken, B., 1991.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. ANNUAL REPORT 1990-91. NGU Report 91.206.

3.9. Demetriades, A., 1992.
MINUTES FROM PROJECT MEETING IN LEUVEN, BELGIUM, 1-5 June 1992. NGU Report 92.332

3.10. Bølviken, B., 1992.
GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. PROGRESS REPORT 1990-1992 AND RECOMMENDATIONS FOR FUTURE WORK. NGU Report 92.333

3.11. Swennen, R. and Van Keer, I., 1992.
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TUSSENTIJDS RAPPORT. PROJECT: GEOCHEMISCHE KARTERING VAN WEST-EUROPA. Project NAT 92-16B. Period 01.05.1992-15.12.1992.

3.13. Decoene, E., 1993.
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4.21. Swennen, R., De Vos, W., Ebbing, J., Hindel, R., Schalich, J. and Van Keer, I., 1993.
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WESTERN EUROPEAN GEOLOGICAL SURVEYS, GEOCHEMICAL MAPPING OF WESTERN EUROPE TOWARDS THE YEAR 2000. A PROPOSED PROJECT OF IMPORTANCE OF ENVIRONMENTAL ADMINISTRATION AND MANAGEMENT IN WESTERN EUROPE.

This poster was presented at several meetings.

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PRISTINE BACKGROUND VALUES IN HEAVILY INDUSTRIALIZED AREAS: A GEOLOGICAL APPROACH. Meuse-Rhine Euregion meeting, Leuven, Belgium, 4-5 June, 1993.

APPENDIX 6

VIEWPOINTS ABOUT THE PROJECT PROPOSAL/ USE OF OVERBANK SEDIMENT FROM FOREGS ORGANIZATIONS AND EXTERNAL EXPERTS

VIEWPOINTS ABOUT THE PROJECT PROPOSAL/USE OF OVERBANK SEDIMENT FROM FOREGS ORGANIZATIONS AND EXTERNAL EXPERTS

FOREGS institutions/geochemists

Table 6.1 FOREGS surveys state of scientific acceptance of the methods for geochemical mapping proposed by the Working Group.

Country	Accepted	Comments
Austria	Yes	Work in progress. Problems with finance
Belgium	Yes	Work in progress
Cyprus	Not known	
Denmark	Yes	Application for funding
Finland	Yes	Work in progress in Northern Finland
France	No	
Germany	Yes	Work in progress in selected areas
Greece	Yes	Work in progress in selected areas
Greenland	No	
Iceland	Not known	
Ireland	Yes	Problems with finance
Italy	Not known	
Luxembourg	Yes	Cooperation with Belgium
Netherlands	Yes	Work in progress
Norway	Yes	Work in progress in selected areas
Portugal	Not known	
Spain	Yes?	Overbank sediment not included in national plans
Sweden	No	
Switzerland	Not known	
Turkey	Not known	
United Kingdom	Yes?	Problems with finance. Overbank sediment not included in national plans.

External experts

Dr. Arthur Darnley, Project Leader of the International Geochemical Mapping Project 259 (IGCP 259) reported that this project plans to establish a common primary data base at international level. The proposed "Global Geochemical Baselines" project (IGCP 360) is intended to start implementing recommendations for international geochemical mapping, beginning with the acquisition and analysis of regionally appropriate reference materials for on-going use by both national and international institutions. Of the suggested sample materials, stream sediment is of lesser importance to scientists concerned primarily with environmental questions. Material such as flood plain sediment (overbank sediment) is of more direct environmental concern and must be in the data set [IGCP 259, Newsletter No.5, March 1993, p. 3].

Newfoundland Deptartment of Mines and Energy has published 2 reports\publications on the use of overbank sediments (Mc Connell, J.W and Horvar, P. 1991: A comparison of overbank and stream sediment as geochemical sample media in southern Newfoundland (1M). Newfoundland Department of Mines and Energy, Geological Survey Branch, Open File 1M (319), and Selecting sieve fractions and sample preparations to enhance overbank and stream sediment surveys. Current Research (1991) Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 91-1, p. 289-299). These studies suggest that for many elements, overbank sediment provides an alternative to active sediment for geochemical exploration. Advantages of its use include speed of sample collection, representivity, and in areas of anthropogenic contamination of stream sediment, the ability to sample pre-industrial sediment.

Dr. M.G. Macklin (Newcastle University, United Kingdom) believes that overbank sediment is a better sampling medium than active stream sediment for similar reasons as those outlined in the Pilot Project Report [3.2, App. 2, p.10-11]. He considers, however, that in UK single profiles and even flood plains may not span the time range from pre-anthropogenic to present day sediments. Abrupt lateral and vertical variations in chemistry may make the choice of sample sites difficult, and age determinations of the strata are essential in order to be able to interpret the distributions obtained [2.10].

Professor G.E. Petts (Loughborough University, United Kingdom) considers that overbank sediment is a better sampling medium than active stream sediment for geochemical reconnaissance [3.2, App. 2, p. 11].

Professor A. Sundborg (University of Uppsala, Sweden) gave verbal support to the methods proposed by the Working Group during the general discussion at the IAHS international meeting on the Erosion and Sediment Transport Monitoring Programme in River Basins (Oslo, August 1992).

Professor D.E. Walling (University of Exeter; President of the International Commission of Continental Erosion, ICCE) states that the approach proposed by the Working Group on Regional Geochemical Mapping offers very considerable potential, since overbank flood plain sediments can provide a valuable record of suspended sediment transported by a river from its upstream drainage basin over the recent past. As such, they provide an essentially unique basis for both spatial and temporal integration of the response of a river basin. More generally he was impressed by the benefits of increased collaboration between geochemists and fluvial geomorphologists/hydrologists. [Letter dated 3 September 1992 from Professor D.E. Walling to Dr. J. Plant, BGS]

Professor Xie Xuejing (Institute of Geophysical and Geochemical Exploration, China) has demonstrated convincing evidence of the suitability of flood plain sediments to provide natural composite samples with the characteristics required for global reconnaissance purposes [IGCP 259, Newsletter No. 5, March 1993, p.4].