UNIVERSITY OF JOS
MEDICAL RESEARCH PROJECT

ANNUAL REPORTS

1983
1984
1985

University of Jos
Japan International Cooperation Agency(JICA)

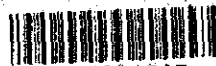## UNIVERSITY OF JOS/JAPANESE INTERNATIONAL CO-OPERATION AGENCY
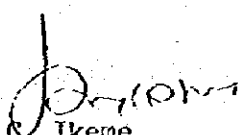### RESEARCH PROJECT

1. The Master Plan for this project was approved and the Record of Discussion signed in June 1982. Members of The Japanese Team arrived in October 1982.

   Following the arrival of the members of The Team, the Co-ordinating Committee was formed under the Chairmanship of The Dean, Faculty of Medical Sciences. The function of this Body was to define the various research groups and co-ordinate their activities from time to time.

2. From the period January 1983 to October 1983, the various research groups planned their projects and in a number of cases conducted pilot activities. The Research groups broke themselves up into a number of sub-groups concerned with specific projects. With the arrival of equipment in September 1983 most of the groups were able to commence work in their various projects and the enclosed reports represent a summary of their activities in the last three months.

3. These activities reflect the Faculty objectives - that the Faculty will organise means of studying the health needs of the population and of providing practical solutions to them. In organising to achieve these objectives a wider participation than the Faculty has been involved. The following Departments have been actively involved in the research projects under this scheme and the attached reports emanate directly from them:

   a) Department of Community Health
   b) Department of Microbiology
   c) Department of Chemical Pathology
   d) Department of Paediatrics
   e) Department of Biochemistry
   f) Department of Zoology
   g) Department of Chemistry
   h) Department of Geology and Mining
   i) JICA Project Team

It is envisaged that at a later stage other Departments such as Medicine, Pathology, Social Sciences etc. may become involved in the Project.

A.B. Ikeme
January 1984

cc: Vice Chancellor

ACI/eitn

ANNUAL REPORT

UNIVERSITY OF JOS/JICA RESEARCH PROJECT ON DISTRIBUTION OF ENVIRONMENTAL TRACE ELEMENTS IN PLATEAU STATE AND ITS IMPACT ON THE HEALTH OF LOCAL INHABITANTS

1   INTRODUCTION

This study is made up of -

1.1 Trace element analysis in surface water in Plateau State by Potentio-metric and voltametric methods

1.2 Trace element distribution in bed rock, latrite and stream sediments of the Jos Plateau, and its environmental significance

1.3 An analysis of the trace element composition of various categories of natural and artificial water bodies in the Jos Plateau and the bioaccumulation of the elements in some aquatic organisms in relation to water sources and mining activities

1.4 Plasma and tissue levels of important trace elements and the metallo carrier-proteins among the inhabitants of the mining district of Plateau State

1.5 The evaluation of the trace element levels of city water supplies for the Jos metropolis and their metabolic/health significance

In the 1982/83 academic session, some work had commenced on Sub-Project 2 & 3 whereas Sub-project 1 is just about taking off with preliminary sampling and analysis. Sub-project 4 is designed to take substantial bearing from preliminary results arising from the other parts of this study.

2   ACTIVITIES OF THE GROUPS

2.1 Sub-Project 1   Trace element analysis in surface water in Plateau State by Potentiometric and Voltametric methods

2.1.1 Investigators

Mrs E Akueshi	Department of Chemistry
Mr C F Oduoza	Department of Chemistry
Dr A Russer	Department of Chemistry

In respect of this project, work is concentrating on standardization of methods for analysis of water from the various studies mentioned on Projects 2 & 3, using Iron Selective Electrodes.

2.1.2 Preliminary results

For the calibration of bromine selective electrode, (OP-Br No 802 from TMD radelkis BUDAPEST), bromide standard solutions ranging from 10^{-1}M to 10^{-5}M were prepared. Potassium bromide (Analytical grade from MERCK) dried between 100°C and 115°C in the oven was used in preparing the standard solutions. Salt bridge was prepared using ammonium nitrate and agar powder.

Using the expanded scale pH meter (Model 290 Mk 2 pH Meter from PYE.UNICAM) or the digital pH meter (PW 9409 digital pH meter, Philips from PYE UNICAM) and the calomel reference electrode, (EIL No 1370710), the bromine selective electrode will be calibrated and in about ten days time the water samples collected will be abalysed.

Paralell to those interference effect between Br⁻ anions and other anions present in solutions will be investigated in order to compute the true activity of Br⁻ anions in samples.

2.2 Sub Project 2 -- Trace element distribution in bed rock, latrite and stream sediments of the Jos Plateau, and its environmental significance

2.2.1 Investigators

Dr A E O Ogezi   Department of Geology and Mining
Dr M Alam   Department of Geology and Mining
Mrs M E Adiku-Brown Department of Geology and Mining

This project is aimed at examining the effects of mining and mineral processing on the distribution of certain environmental sensitive trace elements, such as lead, arsenic and mercury, examining the distribution of economically important elements for their mining potential and environmental impact, the effects of weathering and sedimentation on the different elements, and a source of geochemical baseline information for mining, industrialisation and determination of sites for dams, urban water supply and irrigation.

2.2.2 Preliminary results

More than 250 sediments and rock samples have been collected. Most of them are from around Jos city, especially from Gurum River, Delimi River, ponds and lakes from Rayfield area. The rest of the samples are scattered over the State (see Map and localities).

Almost 150 of these samples have been analysed from sedimentological point of view. Silt and clay fractions of each of these samples have been separated and are ready waiting chemical analyses.

Chemical analysis of the sediments and hard rock samples are being delayed because of lack of chemicals, platinum and teflon beaker ware, as well as lack of centrifuge and rock crushing equipment. Study of the fine-grained sediments, especially their hydrodynamic behaviour and their rates of absorbing and releasing chemicals into the water mass and the biota is also being delayed due to lack of necessary equipment.

Since the beginning of the year, a systematic water, sediments and rock sampling has been carried out with other Zoology Group handling Project 3. Water collected from these trips are being analyzed using the Department of Geology and Mining Atomic Absorbtion Unit. So far water, sediments and rock samples have been collected from Jos International Brewery Lake, Rayfield Sailing Club's Lake, Shendam, Jing River, Heipang, Shendam Dam, Pan-Dam, Dep River, Bukuru Water Supply Lake, Mine Lakes and rivers between Bukuru and Pankshin Panyam Fish Farm ponds and Pankshin Water reservoir.

A number of elements for which AAS Lamps are available are being analysed at this moment. More standards and lamps for AAS not available for other elements would facilitate the investigation.

In some cases, it may be necessary to concentrate the water because the concentration levels of certain elements may be too low to be detected by the AAS.

2.2.3 Constraints

This group is encountering difficulties in carrying out chemical analysis of the sediments and bed rock samples. The following alternative materials for digestion of the samples are needed –

A (1) Hydrofluoric Acid – 4 litres
   (2) Teflon Vessels – Hydrofluoric Acid resistance – 30 ml capacity

OR

B (1) Sodium Carbonate – 2 kg
   (2) Nickel Crucible – 3 ml capacity

OR

C (1) Sodium Peroxide – 2 kg
   (2) Nickel Crucible – 30 ml capacity

OR

D (1) Lithium Tetraborate
   (2) Platinum Crucible (95% platinum coated with 5% gold)?

2.3 **Sub-Project 3** - An analysis of the trace element composition of various categories of natural and artificial water bodies in the Jos Plateau and the bioaccumulation of the elements in some aquatic organisms in relation to water sources and mining activities.

2.3.1 **Investigators**

Prof Chiweyite Ejike   Department of Zoology
Dr D I Anadu   Department of Zoology
Mr I J Chidobem   Department of Zoology
Mr E C Kemdirim (MPhil/PhD candidate) Department of Zoology

Investigations on the general biological aspects of this work commenced during 1983. Three categories of waters have been examined for their levels of lead, zinc, cadmium and copper and the associated distribution of planktons, macro-invertebrates and fish. These water types are -

(1) The Hill Stream (the Delimi) which developes into a third other stream that courses through the city of Jos.

(2) The Reservoir for city water supply arising from damming of the Shen River.

(3) Ponds in artificial fish farm at Panyam.

2.3.2 **Preliminary results**

The investigations show fairly high levels of Pb, Zn, Cd and Cu in water sediments, planktons and macro-invertebrates. During the latter part of the year 1983 and since the beginning of 1984 the scope of this Sub-Project has been expanded and sampling locations/ sites chosen. Parallel areas representing mining(M) & non-mining(N) areas have been chosen. Twenty such sites which come under three broad zones of (a) Jos area, (b) Highlands outside Jos, and (c) Lowlands, have been delimited (see Fig I and Table I, showing the Map of the general area of study and sampling locations and sites).

Systematic collection of samples has commenced and so far water sediments, plankton, fish food organisms, eg aquatic insect lavae and other macro-invertebrates including some fish where possible have been taken from the following sites which can be identified from the figure and table refered to above -

(1) Old Mine Lake from which the local Brewery takes its water.

(2) Old Mine Lake being used for recreational activities by a Sailing Club.

(3) The Shen River reservoir.

(4)   Old Mine Lake used for city water supply for Bukuru.

(5)   Down stream rivers, draining from old mine lakes and used for irrigation of vegetable farms at Bisichi and Kassa respectively.

(6)   Kassa Dam.

(7)   Panyam Reservoir for city water supply on the River Rim.

(8)   Pankshin Water Supply Dam.

(9)   River Jing at Zong.

(10) The City Water Supply Reservoir under construction at the city of Shendam and on river Shamanka.

(11) Pan Dam Lake.

(12) Dep River.

(13) City Water supply, Akwanga.

(14) Ansob River, southern edge of the Plateau.

Twenty-five batches of samples representing surface water, sediment, planktons and macro-invertebrates have been collected. Water samples are being analysed using the JICA Atomic Absorbtion Spectrophotometer for trace elements. In addition, the biological samples, namely plankton, macro-invertebrates and fish are being pre-treated for evaluation of distribution of trace elements.

As anticipated, a good range of variations is noted in relation to concentration of the trace elements as well as in other water quality characteristics, but analysis of data is not yet in a stage to allow for correlative generalizations.

2.3.3   Constraints and Projections

The work has generally no major constraint except for the availability of the urgently required reagents as contained in our request to the Team Leader, Japanese Mission, Dr H Takahashi. The original protocol has been slightly modified to create a separate dimension to be covered in Sub-project 5.

2.4 <u>Sub-Project 4</u> - Plasma tissue levels of important trace elements and the metallo carrier-proteins among the inhabitants of the mining district of Plateau State

8.4.1 <u>Investigators</u>

Dr U P Isichei Dept of Clinical Chemical Pathology
Dr S C Das   Dept of Clinical Chemical Pathology

The research plans as outlined in the paper presented by the Department to the Convener for the Trace Element Project, Prof Chiweyite Ejike on 8 November 1983 remains unaltered.

The list of the reagents and other laboratory equipment needed for the investigation has been submitted to Dr H Takahashi and are being expected.

Sample collection is in progress and would be processed periodically in batches.

During the last vacation when Mr Noda was giving the senior staff members of the Trace Element Group some instruction on how to use the atomic absorbtion spectrophotometer our most senior technologists were away from the Department. Mr Noda returned to Japan in December but our technologists are now back and would learn what they missed from their colleagues.

2.4.2 <u>Preliminary results</u>

:The collection of samples have now commenced and the baseline picture in apparently normal people in Plateau State is being determined. Thereafter, we hope to carry out an assessment of the trace element pattern among the mining population in Plateau State. In addition, blood and tissue samples would be collected from various population groups of interest after the assessment of the data collected from other teams in the Trace Element Group from the Faculty of Natural Sciences and the Department of Biochemistry. An assessment of the plasma and tissue trace element levels among some patients with certain clinical conditions, eg liver cirrhosis, hepatomegaly and cardiomegaly, etc would then be conducted in the final stages of the study.

2.4.3 <u>Projection</u>

As mentioned in the project plan which was submitted last year, we intend to compare the trace element levels derived from the above population groups with the pattern in the low-lying non-mining district of some suitable area in the southern part of the country.

2.5 Sub Project 5 – The evaluation of the trace element levels of city water supplies for the Jos metropolis and their metabolic/health significance.

2.5 1 Investigators

Dr K K Sen   Department of Biochemistry
Dr G A Ubom   Department of Biochemistry

This report represents the preliminary work and data obtained by the Biochemistry Department, Faculty of Medical Sciences, as part of its participation in the JICA project for the year ending December 1983. All the data were obtained using the atomic absorbtion spectrometer which was successfully installed and tested around November 1983.

2.5.2 Preliminary results

Other than the test runs which were necessary to ascertain the reliability of the AAS, water samples from several sources – rivers, treatment reservoirs, pipe-borne and wells – have been analyzed for health-related cations content. These have included Sn, Mg, Ca, Pb, Mn, Cu, Na, K, Zn, Fe and Cd. There appears to be some disparity in the levels of these metals in treated tap water and that of well water. The levels in these water samples are to be compared with acceptable international levels to verify the suitability of these waters for drinking. Previous water analysis studies have implicated some of these cations as being responsible for some of the diseases arising from pollutants and deficiencies of the elements. The results are too preliminary to permit such association.

Crops and vegetables have been collected from gardens irrigated with industrial and mining wastes. The wastes from these mining and industrial areas are being analyzed. The crops and vegetables from these gardens have been digested and are to be analyzed in order to establish if the heavy metal pollutants found in the industrial and mining effluents are incorporated into the vegetables. Analysis on the crops and vegetables harvested from farms irrigated with the industrial and tin-mining effluents are at present not complete.

2.5.3 Projection

These preliminary studies have provided data that will guide us in designing and achieving our goals of (i) determining the concentrations of health-related inorganic (cations) constituents of drinking water, food, soils and plants in Jos (Plateau) area, (ii) generating a water quality map for the Jos metropolis under studies and (iii) establishing the effects of the detected cationic levels on animals. The monitoring of the levels of pollutants found in the industrial and mining effluents, as they are transferred to man is a necessary corollary of this investigation and will be pursued in Sub-Project 4. Titration techniques are being worked out for the determination of Hg, As and I. This has become necessary because the AAS which is the major equipment for the "trace" elements assay is not presently set-up for their determination.

Fig 1.

Table I

		LOCATION	AREA	ROCKTYPE	MINING ACTIVITY	ASSOC. RIVER/STR.
A	Jos Area	JOS 1	GOLD BASE GRUM RAFIN JAKI SHEN RAYFIELD	BIOTITE GRANITE	M	KARAMI DELIMI SHEN R.
			MIANGO ROAD MIANGO AREA	BIOTITE GRANITE	N	RAFIN RAUWA NGELL RIVER
		JOS 2	HELPANG AREA	BASALT	M	
			PANYAM	BASALT	N	
		JOS 3	BARKIN GANGERE	OLDER - GRANITE	M	KASSA R.
			DOGON GARBA	OLDER - GRANITE	N	QURCE R.
B	HIGHLANDS	PANKINSHIN 1		SYENITE	DYKES	
				SYENITE	-DYKES	
		PANKINSHIN 2		MIGMATITE	OLD MINING LOCATION	
				MIGMATITE	N	
		AKWANGA 1	AKWANGA- (WAMBA) ABU	MIGMATITE GNEISSES	M	ABU
			GUDI		N	GUDI
		AKWANGA 2	NASARAWA EGON	YOUNGER GRANITES	M(?)	MADA TRIB & MAGAMA TRIB
					N(?)	
		NASARAWA	ODEGI	BIOTITE	M	OKONA MADA
			(?)		N	
C	LOWLANDS	LAFIA	AZARA	SHALES SANDSTONES GNEISSES	M	
			PANYAM		N	DEEP RIVER
		SHANDAM	WASE	SEDIMENT SANDSTONES &SHALES LEAD,PBS,ZINC	M	WASE RIVER
			SHANDAM		N	

UNIVERSITY OF JOS/JICA RESEARCH PROJECT

REPORT FOR 1983 ON ENDEMIC GOITRE STUDIES

The overall objectives of JICA-UNIJOS Research Project on Endemic Goitre are as follows:-

1. To study the prevalence and geographical distribution of endemic goitre in Plateau State.

2. To study the possible etiological factors of endemic goitre in the area.

3. To study the prevalence of such conditions as deaf mutism, endemic cretinism, hypothyroidism etc. which are known to be associated with endemic goitre prevalence.

4. To study the chemico-pathological, histopathological, immunological and clinical profile of endemic goitre cases in the area.

The above objectives are aimed to be achieved by a multi-disciplinary study phased out over a period of five years. The following workers are currently involved in the study:-

Department of Community Health

1. Dr. I.C. Tiwari
2. Ms. G. Onyejuruwa
3. Mr. Mba Okoronkwo

Dept. of Chemical Pathology

1. Dr. U.P. Isichei
2. Dr. S.C. Das

Phase 1 of the Study:

A WHO seminar on Endemic Goitre* has suggested "A prevalence of 5 percent and above of enlargment of thyroid in pre-adolescent age group" as the criterion for endemicity of endemic goitre.

Phase 1 of the present study therefore envisages goitre survey among secondary school children of Plateau State. A total of 6000 boys and girls of adolescent and pre-adolescent age group will be examined for the purpose using the following WHO criteria for goitre enlargement:-

Grade of thyroid Size	Description of the gland
0a . . .	Normal thyroid gland
0b . . .	Gland distinctly enlarged on palpation but not usually visible when head extended.
1 . . .	Gland enlarged on palpation, usually visible whean head thrown back and neck extended fully.

*Perez, c. et al. Bulletin of World Health Organisation, 18, 217, 1955

..../

2   .   •   •   Goitre visible with head in normal position, palpation not necessary to establish enlargement.

3   .   •   •   Goitre grossly visible at a distance.

The survey was started in the month of December 1983 in the Secondary Schools of Bassa Local Government Area.

The following is the analysis of data of goitre survey carried out in the school children of Zagun and Binchi Secondary Schools covering students of Form 1 to 5 -

Table 1:   Age and Sex-wise Prevalence of Endemic Goitre Among Secondary School Children

Age (Years)	Male			Female		
	Examined	With Goitre	%	Examined	With Goitre	%
Below 16	43	6	13.9	19	4	21.1
16 and Above	180	28	15.5	53	33	62.3
Total	223	34	15.2	72	37	51.4

Table 2:   Sex-wise Prevalence of Different Grades of Endemic Goitre Among Secondary School Children

	Male		Female		Both Sex	
	No.	%	No.	%	No.	%
0a (Normal)	189	84.8	35	48.7	224	75.9
0b (Enlarged on palpation)	32	14.3	29	40.2	61	20.6
1 (Enlarged Visible)	2	0.9	8	11.1	10	3.5
Total	223	100	72	100	295	100

..../3

Table 3:   Prevalence of Endemic Goitre According to Source
of Water Supply

Source of Water	Children Examined	With Goitre	%
Well	199	43	21.1
Stream	96	28	29.1

Observations – From the data analysis the following observations can be
made, although the data is not sufficient to make any
conclusions at this stage –

1. Of 295 Secondary School Children examined 61 (20.6%) had
   grade 0b and 10 (3.5%) had grade 1 enlargement of thyroid
   giving a total prevalence rate of 24.1%

2. Amongst male children the prevalence of endemic goitre was
   15.2 as compared to 51.3% in female children a difference of
   more than 3 times. However grade one enlargement was more
   than 10 times higher in female children than male children.

3. Prevalence of endemic goitre was 17.0% in children below
   16 years age as compared to 25.7% in children 16 years and
   above. While among male children difference in prevalence
   between two groups was marginal (13.9% against 15.5% respec-
   tively) the difference in female children was three times i.e.
   21.1% in female children below 16 years as against 62.3% in
   female children 16 years and above.

4. Children consuming stream water has higher prevalence of
   endemic goitre as compared to children consuming well water
   for drinking (29.1% against 21.1% respectively).

Plan of Action during 1984:

1. The goitre survey amongst school children is expected to be completed
   by May/June 1984. Based on the survey results it would be possible
   to identify geographical areas which are endemic for goitre.

2. Survey for endemic goitre and other clinical conditions viz. deaf
   mutism, endemic cretinism etc. associated with endemic goitre will
   be carried out in the general population where goitre endemicity is
   established by school survey.

....../4

The goitre survey among general population will be started in July 1984 and will continue during 1984/1985 depending on the size of geographical and population distribution of endemic goitre as determined by school survey date.

3. Along with goitre survey of general population studies on iodine and other trace elements content of water supply, food and soil is planned to be carried out in collaboration with JICA research group on trace elements.

4. The departments of Chemical Pathology and other disciplines are expected to join the goitre study in their respective fields once the population survey is started.

List of equipments:

This has already been submitted by the Departments of Community Health and Chemical Pathology to JICA for their action.

DEPARTMENT OF MEDICAL MICROBIOLOGY
FACULTY OF MEDICAL SCIENCES
UNIVERSITY OF JOS

FIRST ANNUAL PROGRESS REPORT OF THE JICA/UNIVERSITY OF JOS
RESEARCH COLLABORATIVE PROJECT ON DIARRHOEAL DISEASES IN
CHILDREN UNDER 5 - YEARS IN JOS PLATEAU STATE, NIGERIA:
UNIVERSITY OF JOS/JICA/MEDICAL MICROBIOLOGY/COMMUNITY
MEDICINE/PAEDIATRICS GROUP PROJECT 1983

1. **List of Participants/Investigators**

    ACADEMIC RESEARCH STAFF: DIARRHOEAL DISEASES RESEARCH GROUP

R.A.O. Shonekan	Ag. Head: Dept. of Medical Microbiology	Principal Investigator Convener
Dr. W. Kozak	Senior Lecturer (Bacteriology)	
Dr. V. Kumar	Senior Lecturer (Virology/Imm.)	
Dr. I.C. Tiwari	Head of Dept. (Community Health)	Principal Investigator
Dr. U.P. Nwene	Lecturer I (Community Health)	
Prof. I. Swiatkowska	Paediatrics	Principal Investigator
Dr. Z. Lazowski	Ag. Head Paediatrics	
Mr. I. Takahashi	J.I.C.A. TEAM	Collaborative Research:
Mr. H. Saida	J.I.C.A.	Med. Microbiology Laboratory

1.1 TECHNICAL STAFF

Miss Agatha Ani	Lab. Technologist (Bacteriology)	Seconded full-time to JICA/UNIJOS Medical Microbiology collaborative
Mr. Joseph Ona	Lab. Attendant Med. Microb. Unijos	Research Laboratory.

2. PREPARATORY STUDIES FOR STANDARDISATION AND COLLECTION OF BASIC STATISTICAL DATA

2.1 While awaiting the arrival of the bulk of JICA Equipments and Reagents consigned from JAPAN, preparatory studies were carried out from March - June 1983 on samples collected from all diarrhoeic patients at the Jos University Teaching Hospital. Attention was concentrated on narrowing discrepancies observed in the diagnostic results of same sample by reviewing and standardising the methods of sampling, treatment of materials, testing the activity and potency of Sera as well as Reference Strains of Cultures. As a result a working protocol was drawn up which has since become valuable for the surveilance carried out on JUTH Clinical samples from August - December 1983, and thereafter on the on-going Research Project.

2.2 Following on the final presentation to the University by H.E. the Japanese Ambassador in Nigeria of the J.I.C.A. Equipment in October 1983, the modern Research Laboratory was taken over completely and fitted with newly arrived equipment for the JICA/UNIJOS Medical Microbiology Research Team to commence work promptly on Infantile Diarrhoeal Disease project. The protocoal drawn up by the Committee after several consultative meetings formed the basis for the investigations.

2.3 The first phase of Year I of the Research Project commenced in October 1983 with planned investigation on ten samples collected daily from the children with Clinical Diarrhoea from the Paediatric Ward of J.U.T.H. After the first month the multi-disciplinary investigation - involving the Departments of Medical Microbiology, Paediatrics, Community Health and J.I.C.A. Team - suffered initial set back with drastic reduction in patients' population which led to small numbers and irregular flow of samples. Plans have now been concluded to augment samples from the Paediatrics Ward of the Plateau Hospital from February 1st, 1984, to be supplemented later from the S.I.M. Jankwano Hospital at Jos and the VOM S.U.M. Hospital.

3. OTHER ACTIVITIES: Results

3.1 Recruitment of two personnel are on hand to meet our crucial needs, namely:

i) A "Collector" from the Dept. of Community Medicine who would also ensure adequate completion of data forms.

ii) A Lab. Technologist qualified in Parasitology to handle efficaciously, the investigations on Diarrhoea Stools and Blood for concomittant Malaria infections.

..../3

3.2 The results of the single stool specimens collected from each of the children have been collated and are attached as Appendices as follows:-

Appendix I   Bacteriological data from Infantile Diarrhoeal Cases from October - December 1983.

Appendix II   Parasitological investigations from Diarrhoeal Cases of Children 5 - years and under treated at JUTH from August - December 1983.

Appendix III Epidemiological Data on 88 cases of Diarrhoea in children 5 - years and under examined between October - December 1983.

3.3 The data gathered from this pilot study - characterisation of causative agents & their prevalence etc - will serve as a basis by which the results of projected activities may be subsequently judged - especially of any changes; in meeting the useful goal of documenting the prevalence of faecally transmitted microbiological agents and parasites; in assessing activities designed to improve sanitation and intensify health education; to provide interim as well as long - term drug prophylaxis directed against the infective agents.

4.   PROGRAMME FOR 1984

4.1 For the remaining period of the year I Research project, i.e. January to September 1984 - sampling would be increased to about 20 daily and extended to VOM S.U.M. Hospital. Closer relations will be maintained between the three departmental groups Microbiology/Paediatrics/Epidemiology so that results could be integrated. The investigation into the Malarial aspect of Infantile Diarrhoeal Diseases will be introduced and the typing of the actological agents would be more detailed.

4.2 Year II Programme will take on the Viral Aspects investigation into the Diarrhoeal Diseases of children. The draft protocol (Appendix IV) has been prepared and a list of the equipment and reagents required have been forwarded to the Team Leader of JICA, Dr. Takahashi. A Lab. Technologist (Virology) has been interviewed and processing of his appointment being pursued. Subject to arrival of the equipment and reagents, the inclusion of Viral investigations should commence by May 1984.

4.3 In September 1983 - the combined results of the year I project will be studied and a joint review of the progress made so that account will be taken of experience gained to introduce appropriate modifications to the plans for Year II programme.

.....4

4.4 Details of the pilot project as planned for the under - five children on hospital - based communities in two contrasting areas - Highland; Urban/Rural, and Lowland: Rural/Urban - will be worked out after item No. 3 above has been implemented.

R.A.O. Shonekan,
Principal Investigator,
Medical Microbiology.

APPENDIX I

JICA PROJECT: DIARRHOEA IN CHILDREN PRELIMINARY REPORT - BACTERIOLOGICAL DATA-BACTERIOLOGY TEAM - DR. W. KOZAK

During the period October - December 1983, 88 single stool samples of children
below 5 years of age suffering from diarrhoea, were collected and bacterio-
logically examined. From these samples, 75/85% were obtained from children's
Health Clinic, and OPD, JUTH, and the remaining 13/15% of samples were provided
by Paediatric Ward of the same hospital.

Collection of specimens and laboratory diagnosis were carried out as described
in an earlier submitted protocol.

From specimens examined, just about 11% yielded Escherichia, Salmonella and
Shigella strains, which are well documented as causative agents of diarrhoea.
In 4 cases, various bacterial strains were isolated, which in some conditions
can be responsible for that disease.

The quality of the number of specimens examined cannot permit a definite
conclusion yet on the prevalence of bacterial diarrhoea nor the frequency of
a particular causative agents of this disease among children. Curtailment of
specimens arose at JUTH from recent introduction of fees paid by patients.
However, the working team secured co-operation in this respect for additional
samples from paediatric clinics. These should result in increase in number of
available specimens for investigation.

APPENDIX II

JICA PROJECT: DIARRHOEA IN CHILDREN UNDER 5 YEARS
PARASITOLOGICAL DATA/PRELIMINARY REPORT OCTOBER - DECEMBER
1983 - R.A.O. SHONEKAN

A total of 49 samples (55%   ) only were available from
October - December 1983 for Parasitological study as compared with 88
specimens which were employed for Bacteriological and Clinico -
Epidemiological study reported above. The disparity in numbers resulted
from failure to obtain stools in 39 children.

Of the 49 diarrhoeic samples examined the analysis of the samples age
grouping showed that 57% were 1 - 6 months old, 30% were among 7 - 11
months old, while 13.0% were those of 1 - 3 years. Result of the examina-
tion showed only two positive cases of the protozoan Entamoeba coli
representing 4% prevalence.

Comments: Althought the sample number is too small for analysis, the
meagre recovery of intestinal parasites from the 49 samples submitted
raised questions of possible faulty presentation of stool, or inadequacy
of the stipulated routine techniques viz. recovery of ova and cysts by
concentration methods. This has become manifestly obvious when
compared with the results hereunder of the base-line data whose results
for the corresponding period showed among the under-five year a 14%
overall prevalence of intestinal parasitism.

> Harboured in descending order of prevalence were:-
> Ascaris lumbricoides, Hookworm, T.enia spp, H. nana,
> Trichuris trichuria and Strongyloides stercoralis
> among the Helminths; while among the Protozoans, they
> were in similar order T. hominis, Giardia lamblia and E. coli.

PARASITOLOGICAL FINDINGS - CHILDREN UNDER FIVE TREATED AT OPD
& CHILD HEALTH CLINIC JUTH AUGUST - DECEMBER 1983:
BASE - LINE DATA STUDY - R.A.O. SHONEKAN

This study was conducted from August - December 1983 to
obtain base - line data on parasitological aetiological agents.
The total number of single stool specimens examined was 327
from children under five - with diarrhoea and/or abdominal
disturbances - who had attended the O.P.D. and Children's
Clinic of the Jos University Teaching Hospital. The overall
prevalence rate was 26% (85) while the distribution according to
sex of the positive samples was 56% for Boys and 44% for Girls.

The sequence of helminthic prevalence was Ascaris lumbricoides,
Hookworms, Hymenolepis nana and S. mansoni, Trichuris trichuria,
Taenia spp and Strongyloides stercoralis.

The four protozoan species detected showed the prevalence rate
in sequence with Trichomonas hominis, Entamoeba histolytica,
Giardia intestinalis and Entamoeba coli.

The picture of the earliest detection of infections with
intestinal parasitiam recorded were:-

    1 - 2 month old: Trichomonas hominis and Giardia lamblia

    3 - 5 month old: Ascaris lumbricoides.

    6 -11 month old: Hookworm.

    1 - 3 year old: H. nana & S. mansoni + above

Evidence of multiple infections was noted on eight of the
children.

The above are furnished merely as progress report but the base -
line data will form eventually useful controls for the rest
of year I pilot study of the project when completed.

JICA-UNIJOS RESEARCH PROJECT ON DIARRHOEAS IN CHILDREN UNDER FIVE

CLINICO-EPIDEMIOLOGICAL DATA

The study on diarrhoeal diseases in Children under five was started in October, 1983. In all 104 cases of diarrhoeas attending the O.P.D., Child Health Clinic and Paediatric ward were studied. Of these, 2 cases were rejected as they did not fall in the study group.

The following tables show the clinical and socio-economic, environmental characteristics of the cases studied. It is not epidemiological data as neither the population nor the data from controls (for case-control study) are available.

Table 1: Age and Sex-wise Distribution of Children Suffering from Diarrhoea

Age	Male (n=62) No.	%	Female (n = 40) No.	%	Both Sex(n=102) No.	%
Below 7 months	36	58.06	26	65.00	62	60.78
7 - 12 months	18	29.03	9	22.50	27	26.47
2 - 3 years	8	12.90	5	12.50	13	12.75

Table 2   Environmental Sanitation in the Families of Children Suffering from Diarrhoea

Water Supply (n = 102)	Tap	Well	Not Recorded
	No. 8	No. 9	No. 11
	% 80.39	% 8.82	% 10.78
Toilet Facility (n = 102)	Available No. 76	Not available No. 15	Not recorded No. 11
	% 75.51	% 14.71	% 10.78

Table 3   Literacy Status of Mother

Literacy	No. (n = 102)	%
Illiterate	50	49.0
Primary School	26	25.5
Secondary & above	16	15.7
Not recorded	10	9.80
Total	102	100

Table 4   Method of Feeding of Children under Examination

Feeding Method	No. (n = 102)	%
Breast alone	37	36.27
Breast & Bottle	51 *	51.00
Solids	3	2.94
Not recorded	12	11.76
	103	

*One child was also on solids, so he has been double counted raising the total to 103

Table 5   History of other cases of Diarrhoea in the family

Other Cases of Diarrhoes	No. (n= 102)	%
Yes	14	13.73
No	60	58.82
Not recorded	28	27.45
Total	102	

..../3

Table 6   <u>Consistency of Stool i n Diarrhoeal Cases</u>

Consistency	No. (n = 102)	%
Soft	13	12.75
Watery	85	83.33
Not recorded	4	3.92

*59 Cases had mucus while 8 cases had blood in the stool.

Table 7   <u>Associated Symptoms in the Diarrhoeal Cases</u>

Symptoms	No. (n = 102)	%
Vomiting	44	43.14
Abdominal Pain	28	27.45
Fever	40	39.22
No other symptom	25	24.51

Some children had more than one symptoms.

Table 8   <u>Treatment Received by the Child before coming to The Hospital</u>

Treatment	No. (n = 102)	%
No Treatment	9	8.82
Home/Native	16	15.69
Modern Medicine	37	36.27
Not recorded	40	39.22
	102	

....../4

Observations:-

Based on the above data (Table 1 - 8) the following observations are made:

1) Sixty percent of the children examined for diarrhoea were below 7 months age. This was not due to higher incidence of diarrhoea in this group but because majority of children examined were from child Health Clinic where mostly young children are brought by the mothers.

2) Eighty percent of the families had tap water supply and 75.5% had toilet facilities. Most of the children examined were from Jos metropolis where water supply and toilet facilities are available to the households.

3) Almost half (49%) of the mothers were illiterate while another one quarter were educated up to primary school only. Low literacy among mothers is known to be associated with poor child rearing practices leading to higher morbidities among children.

4) More than fifty percent women were practicing bottle and breast feeding both. But when this data is contrasted with the fact that about 60% of the children examined were 6 months and below, it is clear that a large proportion of children are put on bottle feeding quite early. This may have implications in terms of diarrhoeal diseases.

5. In about 14% of cases history of another case of diarrhoea in the family was present. It would therefore worthwhile to screen other members of the family for carrier status, sub-clinical and mild cases. The source of infection may also be possible to detect on screening of human cases, animals and environment of the case thus compling the epidemiological picture of diarrhoea among children.

6. In majority (83.3%) cases children had watery stools. A large number of cases (about 60%) had mucus in their stool.

7. While one quarter of the cases did not have any other symptom, vomiting, abdominal pain and fever were commonly seen to be associated with diarrhoea.

8. More than one third of the cases were already on modern anti-diarrhoeal drugs while another 16% had home/native treatment. Because of introduction of drug, the bacteriological isolation of cases may be adversely influenced.

Dr. Tiwari)
Dr. Hwene) Dept. of Community Health

UNIVERSITY OF JOS/JICA RESEARCH PROJECT

FIRST ANNUAL PROGRESS REPORT OF THE RESEARCH COLLABORATIVE PROJECT TEAM ON MEDICAL ENTOMOLOGY AND PARASITOLOGY

re: JAPANESE INTERNATIONAL COLLABORATIVE AGENCY (J.I.C.A) PROJECTS 1983

The following is the position so far with respect to the JICA - UNIJOS collaborative projects on Medical Entomology and Parasitology, for the period 1982/83.

A total of seven (7) Academic/Research staff of the University and J.I.C.A. Project were involved in the Team, plus some two (2) Postgraduate Research students.

Academic/Research Staff

Prof. M.O.E. Iwuala	-	Department of Zoology
Dr. D.M. Roberts	-	" " "
Dr. R. Irving Bell	-	" " "
Dr. C.O.E. Onwuliri	-	" " "
Mr. R.O.A. Shonekan	-	Dept. of Medical Microbiology
Dr. I.C. Tiwari	-	" " Community Medicine
Dr. H.Takahashi	-	J.I.C.A. Research Project

Postgraduate Students:

Mr. M. Maduabum	-	Department of Zoology
Mr. D. Boakye	-	" " "

Six sub-projects were clearly mapped out as detailed in the original proposal. The position so far regarding each sub-project is as follows:

PROJECT 1: "STUDY OF DISTRIBUTION OF BLACK-FLIES (SIMULIUM SPECIES) ON THE JOS PLATEAU" - PROF. M.O.E. IWUALA, MR. M. MADUABUM AND R.H. TAKAHASHI

Following some preliminary work, this project was commenced actively by April 1983.

For some eight months (April - November) regular bi-monthly samples have been taken from various river systems in the Jos Plateau area, to establish presence or absence of immature stages of Silulium species.

Altogether 13 rivers have been consistently sampled, and of these black flies have been found to breed in three rivers viz: River Assob, River Farin Ruwa, and Gambo River located respectively in Riyom, Bokkos and Bassa Local Government Areas of Plateau State.

..../2

<u>Simulim</u> breeding in the rivers was more noticeable in the mid-rainy season months of June to August, and so far six species of blackflies have been identified from the samples viz: <u>S. aloockl</u>; <u>S. aureosimile</u>; and <u>S. cervicornotum</u> <u>C. damnosum</u> s.l; <u>S. hargreavesi</u>; and <u>S. mcmahoni</u>.

It is intended to continue the sampling exercise over some 18 to 24 months' period and subsequently to investigate in due course the factors conditioning the distribution and breeding of the various <u>Simulium</u> species.

PROJECT 2:   "EFFECT OF WATER VELOCITY ON BLACK-FLY
             RELATIVE ABUNDANCE": DR. D.M. ROBERTS

This project is still awaiting the arrival of much needed equipment, especially the water velocity meter. A suitable site has been chosen in the River Assob for the study, but preliminary sampling cannot be made without the velocity meter.

PROJECT 3:   "EFFECT OF TEMPERATURE AND HUMIDITY ON PUPAL SURVIVAL":
             DR. D.M. ROBERTS & MR. D. BOAKYE

This project was started in January 1983, but progress of work is being delayed by lack of cooled incubators in the Zoology Department (2 are still being awaited from JICA). Consequently, so far only the four low temperatures earlier listed in the Research Proposal have been tested at a saturated humidity. The following results were obtained:-

Laboratory studies were conducted to compare pupal survival, adult emergence and adult longevity after pupae had been exposed to four temperatures:- 0, 4, and 12° C; for different time periods:- 1 - 7 days. The greatest mean survival were obtained at 8 and 12°C and the least at 0 and 4°C for old pupae (pupae with dark coloured cuticle) and for young pupae (pupae with pale coloured cuticle) respectively. At 0 and 8°C, there was no significant difference between the mean pupal survival for both pupal ages. Young pupae survived significantly longer than old pupae when exposed to 12°C, while old pupae survived better at 4°C. Generally, 8°C had the best survival rate, and 0°C the poorest. Adult emergence occured mainly during the day and extended over 4 days. Mean adult longevity varied among adults from pupae exposed to different temperatures and time periods, but were generally non-significantly different. In the field, pupation times were similar to that in the laboratory, which was mainly diurnal with a major peak in the morning (6 - 9.00 h) and a minor peak in the evening.

PROJECTS 4 & 5:   "DISTRIBUTION OF IMMATURE MOSQUITOES ASSOCIATED WITH
                  THE RIVER SYSTEMS OF THE PLATEAU" AND "SEASONAL AND
                  VERTICAL DISTRIBUTION OF TREE-HOLE MOSQUITO BREEDING"
                  - DR. R.J. IRVING-BELL

Shortened taxonomic keys have now been composed for the identification to species of the adults and larvae of the major genera present in the northern guinea savannah of Nigeria.

..../3

Collections of mosquito larvae and preliminary observations have been made in the following areas with a view to choosing specific study sites:-

Ngell River near Miango: Has a limited range of habitats owing to lack of trees.

Assob River: This is a possible study site although tree holes are present together with the usual rock pools and mud pools.

Kurra Falls complex: The area is atypical owing to the reservoir system and Eucalyptus plantings.

Kagoro Forest: Provides a wide range of habitats including many tree-holes; however the river with its rain forest border is not typical of the savannah region.

Other rivers need to be visited before a selection of the two sites required in the proposal can be made.

In addition the following requirements must be satisfied before the projects can be run fully effectively:

a) Funds for locally-bought materials and transport.

b) The arrival of specialist items requested from JICA, in particular, larval preservative fluid (lactophenol).

c) Student researchers willing to undertake the projects as part of their higher degree programmes.

PROJECT 6: THE PREVALENCE AND DISTRIBUTION OF ONCHOCERCIASIS -
C.O.E. ONWULIRI, I.C. TIWARI, AND R.O.A. SHONEKAN

Stategies for the above investigation have been mapped out although actual field surveys of the endemic areas have not been carried out. However, it is hoped that the greater part of the work in Phase 1 (as specified in the original proposal) would be finished before the end of December 1984. The delay in the take-off of the actual field survey was due mainly to the absence of a Corneosceral punch needed for taking skin-snips.

PROF. M.O.E. IWUALA
UNIJOS/JICA MEDICAL
ENTOMOLOGY RESEARCH GROUP

UNIVERSITY OF JOS
JOS, NIGERIA

DEAN'S OFFICE   PRIVATE MAIL BAG 2084
FACULTY OF MEDICAL SCIENCES   JOS, NIGERIA

                                       Telex:81136UNIJOS NG
                                       Telephone: Jos 55930
                                       Ext. 225

SECOND ANNUAL REPORT - DECEMBER 1984

University of Jos/Japanese International Cooperation Agency
Research Project.

....

1) Following the signed Agreement of the University of
   Jos/JICA Research Projects, the members of the
   Japanese Team arrived Jos in October 1982 and research
   began on the various sub-groups of the research
   projects.

   The first Annual Report of these Research Projects
   was compiled by Professor A.C. Ikeme in December 1983.
   This volume is the Second Annual Report incorporating
   the preliminary reports of December 1983 and the mid-
   term results from January 1984 to December 1984.

Sub-Group (1): Project: Trace Element Analysis
   (a) Dr. G.A. Ubom and Mr. C. Noda- Preliminary report
          on the trace elements detection in natural sources
          in Plateau State, Nigeria.
   (b) Prof. C. Ejike, Dr. D. Anadu and Dr. J. Chidobem -
          Distribution of trace Elements in some surface
          waters.
   (c) Mrs. M. Adiuku-Brown and Dr. A. Ogezi - Comparative
          sample de-composition techniques for the analysis
          of simple sulphide minerals.

(d) Dr.A.E. Ogezi, Mrs. M.E. Adluku-Brown and Dr. M. Alam-
    Environmental and economic studies of trace elements
    associated with mining and mineral processing in
    parts of Plateau State, Nigeria. a preliminary
    report.

Sub-Group (2): Project - Goitre

(a) Prof. I. Tiwari and Mr. M. Okoronkwo - JICA/UniJos
    project on endemic goitre.

Sub-Group (3): Project - Diarrhoea

(a) Dr. W. Kozak and Mr. R. Shonekan - Bacteriological
    investigation of diarrhoea in children.
(b) Miss. A. Ani and Mr. M. Takahashi - Aetiological
    studies of infantile diarrhoea disease seen in
    Jos University Teaching Hospital. A preliminary
    report.
(c) Dr. U.P. Nwene - Date on clinical presentation and
    socio-demographic profile of diarrhoeal cases.

Sub-Group (4): Project - Medical Entomology

(a) Prof. M. Iwuala, Mr. Maduabun and Dr. H. Takahashi.-
    Study of distribution of black flies (Simulium
    species) on the Jos Plateau
(b) Dr. D. Roberts and an MSC student - Effect of
    water velocity on the relative abundance of
    immature black flies
(c) Dr. D. Roberts, Mr. D. Boakye and Mr. J. Ogidi -
    Effect of temperature and humidity on black fly
    pupal survival
(d) Dr. R. Irving-Bell and Mr. I. Sessay -
    Distribution of immature mosquitoes associated
    with two riverine sites.

(e) Dr. R.J. Irbing-Bell and Mr. I. Sesay -
Mosquitoe breeding habitats: Distribution and
relative abundance of species at a Kagoro forest
stream in Northern Nigeria.

(f) Dr. C. onwuliri, Dr. I. Lawal and Mr. B. Nwoke -
Prevalence of distribution of onchocerciasis on
the Jos Plateau.

(g) Prof. M. Iwuala, M. M. Maduabum and Dr. H. Takahashi -
Study of the seasonal abundance and population
characters of immature stages of black flies in the
Jos Plateau area

(h) Dr. D. Robert s and Mr. J. Davis-Cole - Effect of
predators and type of substrate on the relative
abundance of immature black flies.

(i) Dr. D. Roberts and Dr. Irving-Bell - Dispersal of
Adult black flies

(j) Dr. R. Irving-Bell - Niche distribution in relation to
physiological state of adult populations of black
flies and mosquitoes.

The Faculty objective of identifying the health needs of
the population and providing solutions to these is continually
kept in mind and in these research. Expansion of the research
to include other Faculties, we feel will provide a broader base
for data acquisition for the solution of these problems.

24, December 1984.

Revd Prof. E. O. Oji
Dean, Facul;ty of Medical Sciences

PRELIMINARY REPORT ON THE TRACE ELEMENTS
DETECTION IN NATURAL SOURCES IN PLATEAU STATE,
NIGERIA.

Gregory Abraham UBOM   and Chiyoichi NODA
Department of Biochemistry, Faculty of Medical Sciences,
University of Jos

This report is a summary of work and data collected
by the Biochemistry Department, Faculty of Medical Sciences,
as part of the participation in the JICA project up to the
period ending December 1984. The cationic concentration
data were obtained using the Atomic Absorption Spectro-
meter(AAS) which was succesfully installed and tested in
the Department by November, 1983. The Anionic levels-studies
were performed with the Ion Chromatographic Analyzer(ICA)
which was installed in the Department around June, 1984.
The remaining data - total organic carbon (TOC), soluble
silicates (SiO_2), ammonia (NH_3) etc, were determined using
the facilities at the Tokyo Metropolitan Research Laborato-
ries of Public Health by Dr. Ubom during his JICA sponsored
leave in Japan between October and December, 1984.

Table 1 and 2 are comparative cationic and anionic
concentration data on water samples from goitrous and non-
goitrous locations.

Table 3 shows the trace and heavy metals composition
in water samples collected from chemically treated(tap) and
untreated sources (streams, wells, dumps and industrial
effluents) and Table 4 is the organic and inorganic composi-
tion of water samples collected from different locations
of Jos Metropolis.

The observation in all cases of analyzed waters is
that water whether treated or untreated is soft (ie. low
in Mg^{++} and Ca^{++}). The quality of water analyzed is
generally good and falls within the internatioally specified
limits with the exception of high iron concentration in
some industrial runoffs. The organic components, oxygen
(Biochemical and chemical)demands, disinfectant quality
of these waters should be monitored in order to be able to
make broader assesments of the water.

Table 1. Anions, trace and heavy metals concentrations in waters at the Goitrous villages.

unit: I ug/l, rest mg/l

LOCATION	I-	F-	Cl-	NO$_2$	NO$_3$	PO$_4$	Br-	SO$_4^{2-}$	K	Ca	Mg	Na	Zn	Cu	Fe	Mn	Cd	Total hardness
ASSAK (ST)	0.5	0.1	0.5	0.0	0.3	0.0	0.0	0.6	0.7	0.2	0.1	1.3	0.011	0.002	0.45	0.016	0.000	0.9
BIMBOP 1 (W)	0.0	0.1	0.6	0.0	4.4	0.0	0.0	1.2	4.1	2.5	0.2	4.2	0.005	0.001	0.37	0.050	0.000	7.1
BIMBOP 2 (W)	0.0	0.7	14.2	0.0	52.6	0.2	0.0	9.1	3.6	17.9	1.6	8.1	0.000	0.000	0.70	0.023	0.000	51.5
BINCHI 1 (W)	0.0	0.3	0.9	0.0	1.9	0.2	0.0	1.2	2.1	4.3	2.7	8.3	0.012	0.006	0.54	0.062	0.002	22.2
BINCHI 2 (W)	2.4	0.2	3.6	0.0	0.1	0.0	0.0	6.9	7.1	24.5	2.2	8.8	0.018	0.000	2.75	0.141	0.000	70.6
DUTSENKURA(ST)	0.0	0.1	0.2	0.0	1.7	0.0	0.0	0.4	0.6	0.2	0.1	1.4	0.000	-	0.15	0.009	0.000	0.9
IBANDI (ST)	0.0	0.2	0.7	0.0	0.3	0.0	0.0	0.4	1.3	1.0	0.9	2.9	-	0.000	1.60	-	0.000	6.4
KISANCHI 1(SP)	0.0	0.2	1.7	0.0	0.9	0.0	0.0	1.7	1.1	3.1	1.4	7.9	0.003	0.000	0.45	0.014	0.000	13.7
KISANCHI 2(W)	0.0	0.2	3.9	0.0	0.5	0.2	0.0	1.0	2.5	2.9	1.1	6.0	0.005	0.000	0.50	0.027	0.000	11.9
KISHI-II 1(W)	0.0	0.3	3.0	0.0	9.7	0.5	0.0	2.2	2.1	3.2	0.9	8.3	0.014	0.000	1.03	0.028	0.002	11.8
KISHI-II 2(W)	0.0	0.2	6.7	0.0	3.9	0.5	0.0	0.6	2.3	3.1	0.5	8.2	0.010	0.000	0.57	0.018	0.000	9.9
Mean	0.3	0.2	3.3	0.0	6.9	0.2	0.0	2.3	2.5	5.7	1.1	6.0	0.008	0.001	0.83	0.039	0.000	18.3

Note: Figures are average of 2-5 tests.
ST-stream
W-well
SP-spring

Table 2. Anions, trace and heavy metals concentrations in waters in Jos area

unit: I^- µg/l, rest mg/l

LOCATION		I^-	F^-	Cl^-	NO_2^-	NO_3^-	PO_4^-	Br^-	SO_4^{2-}	K	Ca	Mg	Na	Zn	Cu	Fe	Mn	Cd	Total hardness
DOGONDUTSE	(W)	0.0	0.2	1.5	0.0	4.5	0.0	0.0	1.1	1.5	0.1	0.1	4.0	0.008	0.000	0.05	0.013	0.003	0.7
JARAWA	(W)	2.7	0.1	4.2	0.0	14.1	0.0	0.0	1.0	2.9	1.8	0.3	6.9	0.020	0.000	0.19	0.036	0.000	5.8
JOS RIVER	(R)	0.0	0.1	1.1	0.0	1.5	0.0	0.0	0.7	1.5	0.2	0.1	2.3	0.005	0.000	0.19	0.004	0.003	0.9
LIBERTY DAM	(D)	1.5	0.2	0.8	0.0	0.1	0.0	0.0	0.6	1.3	0.8	0.3	1.1	0.000	0.000	0.40	0.011	0.000	3.3
NARAGUTA	(ST)	3.9	0.1	1.7	0.0	0.4	0.0	0.0	0.6	1.4	1.0	0.5	3.8	0.007	0.005	0.61	0.065	0.002	4.6
TIN MINING 1	(P)	7.0	0.2	0.6	0.0	0.1	0.0	0.0	0.5	0.6	0.8	0.2	0.9	0.005	0.003	0.16	0.016	0.000	2.9
TIN MINING 2	(P)	1.3	0.2	0.4	0.0	0.0	0.0	0.0	0.3	0.7	0.9	0.3	0.9	0.010	0.014	0.26	0.039	0.000	3.5
Mean		2.3	0.2	1.5	0.0	3.0	0.0	0.0	0.7	1.4	0.8	0.3	2.8	0.008	0.003	0.27	0.026	0.001	3.1

Note: Figures are average of 2-5 tests.

W-well
R-river
D-Dam
ST-stream
P-pond

Table 3.7. Comparative trace and heavy metal contents in treated
and untreated waters in Jos and its surburbs.

LOCATION	Sn (PPB)	Mg (PPM)	Ca (PPM)	Pb (PPB)	Mn (PPB)	Cu (PPB)	Na (PPM)	K (PPM)	Zn (PPM)	Fe (PPB)	Cd (PPB)
1. Gangare Well (W)	206.	1.0	3.0	5.4	8.6	15.9	11.0	5.5	0.0	162.7	0.2
2. Gangare Jos Well (W)	138.6	2.0	14.0	7.0	3.2	7.0	16.0	7.0	0.0	255.8	0.4
3. Aze Gangare Well (W)	160.9	2.0	8.0	5.3	14.8	21.4	16.8	14.4	0.0	262.1	0.3
4. Zaria Road Tap (T)	195.9	0.5	7.0	4.7	3.0	3.1	2.2	1.8	0.1	104.7	0.5
5. Warden Barrack(Blk) Well (W)	147.6	0.0	1.3	3.4	5708.4	26.0	1.2	1.3	0.0	17,769.6	0.4
6. Warden Barrack(Blk)Tap(T)	141.3	28.0	228.0	5.5	6.4	19.6	42.0	9.8	0.7	332.5	2.6
7. St.Loius College Jos-Tap. (T)	129.2	0.3	1.0	7.8	6.7	6.8	1.3	1.3	5.6	7,152.0	0.5
8. Gada Biu Tap (T)	132.1	0.5	2.0	5.3	10.6	8.9	1.1	1.2	0.3	335.3	0.5
9. St.Loius College Jos-Tap (T)	140.6	0.2	0.8	7.8	780.0	41.5	10.5	1.5	0.3	42.0	0.5
10. Gada Biu Well (W)	120.1	2.0	12.0	8.6	16.6	31.5	30.0	6.3	0.0	0.0	0.3
11. Mr.Ali Stream (S)	130.5	1.5	2.5	7.1	41.0	43.3	9.0	1.0	0.0	2892.0	0.3
12. Mr.Ali Well (W)	139.7	0.3	3.0	7.1	15.4	35.1	2.8	0.8	0.0	316.0	0.4

W - Well   S - Stream

Table 3-2

Location	Sn (PPB)	Mg (PPM)	Ca (PPM)	Pb (PPB)	Mn (PPB)	Cu (PPB)	Na (PPM)	K (PPM)	Zn (PPM)	Fe (PPB)	Cd (PPB)
13. Katako Well Water (W)	215.8	2.5	1.6	5.9	16.8	238.2	24.5	3.0	0.0	638.0	0.8
14. Katako Street Tap (T)	173.8	1.5	14.0	11.1	7.8	18.7	1.2	1.3	0.0	201.0	0.5
15. JZ 54 Apata Tap (T)	122.9	0.5	2.0	5.9	5.5	23.3	1.0	1.1	0.7	94.0	0.6
16. JZ 28 Apata Well (W)	136.8	1.0	3.5	7.6	148.0	42.6	23.0	7.2	0.7	169.9	0.5
17. Lake Chad (W)	160.2	5.5	7.5	10.1	780.0	19.6	6.5	3.0	0.0	7192.0	0.5
18. Pan Well (W)	179.4	5.0	6.5	6.2	54.0	70.4	12.0	2.5	0.0	702.0	0.7
19. Pan Dam (D)	140.9	5.0	6.0	5.2	1248.0	0.0	9.5	2.7	0.5	3684.4	0.6
20. Pan Un (D)	158.1	1.5	7.5	7.2	36.4	10.4	16.0	3.2	0.0	345.4	0.6
21. Treated Brewery (H)	198.0	1.5	6.0	6.6	21.3	36.0	2.1	10.8	0.0	1028.0	0.7
22. Brewery Exhaust (H)	3613.0	0.2	0.8	8.2	218.0	6.8	17.5	1.8	0.0	5420.0	0.7
23. Human Activity (H)	202.1	0.2	3.5	34.5	2.2	0.6	14.4	1.8	0.2	96.0	0.7
24. Bukuru Sn Mining (H)	277.6	1.0	3.5	9.2	2.4	0.2	1.8	2.0	0.0	61.0	0.5

Table 3.-5

LOCATION	Sn (PPB)	Mg (PPM)	Ca (PPM)	Pb (PPB)	Mn (PPB)	Cu (PPB)	Na (PPM)	K (PPM)	Zn (PPM)	Fe (PPB)	Cd (PPB)
25. Inside Water (Waste)	220.8	1.5	2.0	8.4	8.8	8.9	30.0	2.0	0.0	239.0	0.7
26. Treated Water	201.1	1.0	2.0	10.8	32.4	13.0	2.4	1.3	0.0	2040.0	0.6
27. Ind. Exhaust (1)	220.1	1.0	2.0	7.5	40.4	63.2	2.5	1.8	0.6	203.0	0.6
28. PAN SAMPLE (1)	371.3	1.0	1.5	9.6	34.1	104.4	2.6	1.5	0.3	376.0	0.8
29. Drytex Exhaust (1)	144.0	1.5	10.8	349	212.0	179.3	3.9	10.5	0.2	607.0	0.7
30. Coca Cola Exhaust (1)	186.5	3.0	102.0	475	84.0	53.3	3.8	42.9	0.3	16280.0	0.8
31. Combined Brewery - Treated + Exhaust (1)	306.9	0.2	32.0	35.8	32.0	83.9	3.5	2.5	0.2	3200.0	1.3
32. Bukure #2 Mining (1)	220.1	6.5	32.0	576	1488.0	173.0	18.5	7.0	0.8	1160.0	0.8
33. Coca Cola Mixt. Exa. (1)	292.4	3.9	1.0	218	760.0	-54.0	6.0	22.0	0.2	18040.0	0.7
34. Coca Cola Exhaust (1)	253.7	1.0	1.9	177	12.2	30.0	3.5	1.5	0.1	12744.0	0.7

6

Table 4. Organic and inorganic composition of water samples collected from Jos Metropolis.

LOCATION	PH	Na ppm	K ppm	As ppb	Cd ppb	Pb ppb	Mn ppb	Mg ppm	Ca ppm	Zn ppm	Sn ppm	Cu ppb	Fe ppm	SiO$_2$ ppm	TOC ppm	F ppm	Cl ppm	NO$_3$ ppm	SO$_4$ ppm	PO$_4$ ppm	OCS ppm
1. NARAGUTA STREAM.	6.8	5.6	1.7	ND	ND	1.5	0.7	0.7	2.9	0.01	0.025	ND	0.19		0.24	1.9	0.14	1.14	0.6		—
2. TUBUN WADA WELL (STATE SECRETARIAT)	6.0	5.9	2.9	0.12	0.2	ND	0.9	0.36	6.2	0.02	0.04	ND	0.04/6.7		0.09	0.23	1.2	16.1	1.2	ND	154
3. TIN MINING No 1 POND	6.5	2.4	0.28	ND	ND	ND	1.4	0.2	1.1	0.002	0.01	ND	0.03	2.8	0.102	0.23	0.6	0.2	0.2	ND	3.0
4. " No 2 "	6.6	2.2	0.28	ND	ND	ND	0.4	0.5	1.3	0.004	0.005	ND	0.03	4.8	0.155	0.27	0.4	1.3	0.3	ND	5.0
5. JOS TAP WATER.	8.6	3.0	1.5c	ND	ND	0.2	0.3	0.3	10.0	0.161	0.05	ND	0.06	8.3	0.049	0.2	6.9	1.5	22.3	ND	28.4
6. LIBERTY DAM.	6.6	2.4	1.32	ND	0.3	ND	0.9	0.4	1.6	0.007	0.025	ND	0.16	8.3	0.270	0.16	6.4	0.16	0.2	ND	7.6
7. LAMINGO DAM.	6.43	0.132	ND	ND	3	ND	0.3	1.7	ND	0.025	2	0.18	11.1	0.200	0.13	0.4	0.16	6.1	ND	5.0
8. RAIN WATER (FROM ROOF) JOS.		1.8	0.28	ND	0.2	ND	4.3	0.2	2.0	3.2	0.05	3.0	0.36	1.2	0.29						

PROJECTIONS: Eventhough the AAS and ICA are installed in the Biochemistry Department, there was an initial understanding that other Departments including Chemical Pathology, Zoology and Geology would send representatives to study and master the use of these equipments. So far, the goal of training representatives has not been attained because the various Departments have not availed themselves of this opportunity. It is envisaged that this training will be continued till the end of May 1985 when the Japanese expert (Mr. Noda), attached to the project, will be leaving for home. Training in the maintenance and repair procedures on these equipments are to be intensified, especially to the Biochemistry Department Nigerian counterpart who may take full responsibility for these equipments after the Japanese expert leaves.

Goitre studies will be extended to include analysis on foods and soils along with the water analysis which we have been surveying in the "goitre villages". This extended studies may allow us to make the correct associations between cations, anions and the incidence of goitre - which cationic or anionic deficiencies potentiate goitre.

The impact of human activity on drinking water will be studied using variables that include ammonia, nitrate, nitrite and phosphate detection. The effects of disinfection of drinking water and the correlation between the lack of disinfection with diarrhoea and dysentry will be investigated. Comparative studies will be continued between treated purified and untreated waters.

Studies on the heavy metal content of vegetables, crops harvested in Jos tin mining and industrial effluents will be continued. The concentration patterns for these metals starting from the soil, water, crops, vegetables and animals will be established. Our results so far show that for nearby all the elements studies, the elemental concentrations are as much as 100 fold higher in the crops than in the waste effluents. This work will be pursued further to establish the extent of elemental concentration in mammals.

We anticipate to start monitoring the organic constituents of health significance in water and foods. Our interest would involve the determinations of the concentration of benzene, chlorinated alkanes and alkenes, chlorophenols,

polynuclear aromatic hydrocarbons, triholomethanes and
pesticides in our waters and foods. Most of these organic
species are presursors to carcinogens or are carcinogens
themselves and should be detected and controlled even when
they occur in low levels in our environment. For this
phase of the research we request that JICA supply us with
1) a gas chromatograph (GC) - the type that is sensitive
enough to meet our needs. 2) A mini electrophoretic equip-
ment to be used in monitoring any changes in protein
pattern and concentration in mammalian sera as a result of
the presence of those organic toxins in the human system.
3) Reagents for the determination of dissolved oxygen in
water and industrial wastes. 4) Reagents for the determ-
ination of turbidity, colour, soluble silicates (SiO_2) and
ammonia.

PRELIMINARY REPORT ON THE DISTRIBUTION OF TRACE ELEMENTS
IN SOME SURFACE WATERS STREAM SEDIMENTS AND TISSUE DIGESTS
OF AQUATIC BIOTA IN WATERS OF JOS PLATEAU.

By

EJIKE, C., D. I. ANADU & J. I. CHIDOBEM

INTRODUCTION
abatement
Effective/of aquatic trace elements pollution
depends not only on treatment and control of
waste waters but largely on the efficient monitoring of
the general aquatic environment. Monitoring inland
freshwater ecosystems involve two basic approaches.

i. Direct measurement of the spatial and temporal
    concentration of the trace-element or of
    important biologically active substances such
    as oxygen which are depleted by pollution

ii. The use of biological indicators which range
    from micro-organisms, macroinvertebrates and
    fish and physiological indices such as
    Biological Oxygen Demand (BOD) measurements to
    total community indicators such as changes in
    community structure.

The latter is widely employed in monitoring
aquatic pollution. It includes such indices as the
general species indicator index, community structure
index, oxygen production (P) and utilisation (R) index and
the consequent P/R ratios. '

Defining the maximum permissible level of trace
element in aquatic systems is of fundamental importance
in monitoring trace-element distribution. High concentrations
of heavy metals are probably responsible at times for
reducing faunastic diversity in aquatic system. Often a
mixture of trace-elements are present in varying levels in
a freshwater body simultaneously and it is then extremely
difficult to estimate the contribution of individual or
component trace-elements.

Extensive methodologies have been developed for
evaluating the effects of discrete trace elements toxicants
on various aquatic organisms. Many of these have been
amplified by concern over the environmental implication of
bioconcentration of these trace elements. Hazards to
aquatic biota as well as to human health caused by local
contamination of the aquatic environment have been reported
on by various workers.

METHODS

Analysis of trace-elements and pretreatment of
sediments and Macroinvertebrates were carried out after
the methods of Thomas and Chamberlin (1974). Digestion of
water was done as recommended in APHA (1974). Trace elements
levels in water, substrate and tissue digests were then
monitored by the Atomic absorption spectophotometry. The
study design allowed for sampling of streams, mine lakes and
reservoirs. For the first two, selection was made from
mining and non-mining zones and as far as possible from
upland and lowland waters (See first JICA report).

Special attention was paid to the following elements Si, P, Mn, Fe, Cu, Zn, As, Se, Cd and Pb. While animal tissue digests of aquatic insects, decapod crustaceans, gastropod molluscs and fishes were investigated.

Because rainy season values are complicated by changing dilution factors greater reliance is placed on dry season values which apart from being more stable are likely to impact more on the life of the aquatic forms because of their higher levels of concentration.

Below is a tabulated form of the animal groups collected at the different stations in the dry season of 1984. Most of the sampled rivers and lakes drain into the Southern rivers which finally are drained into the Atlantic. The Delimi and a few other rivers North of Jos town drain into Shari river which is finally drained into the Lake Chad.

Table 1: Dominant animal groups during the dry season in some Jos Plateau Waters.

Sampling date	Site description and Name	Rocktype	Drainage type	Common Aquatic Animals	Bottom type
29/1/84	Pandam Lake		Into R/Benue through Dep river	Freshwater cray fish (large number) (Requires full identification) Ephemeroptera larvae Corixidae, the dragon fly larvae Anisoptera. Coleoptera, Hemiptera Diff. Fish species including Alestes, Labeo, Citharinus etc.	
29/1/84	Shendam Impoundment	Sandstones and shales		Cray Fish (requires full identification Hemichromis, Water snails of the gastropod type	
29/1/84	Shendam bypass Stream with weirs & bridge at Jing		Into River Benue	Odonata (diff. types) Water beetles Coleoptera Biompharia	Sand stones
12/2/84	Kuru BaBa River		Possibly R/Benue	Tillapia zilli Garra waterloti Water Scorpion Dragon Fly, Damsel Fly larvae, Coleoptera, Corixidae	Gravels
12/2/84 8	Asob at Gangere Kibo		River Benue	Garra waterloti Aphyosemion sp Corixidae Dragon Fly larvae, Hemiptera Ephemeroptera nymphs.	Boulder & gravels

Table 1 Cont'd.

Sampling date	Site description and Name	Rock type	Drainage type	Common Aquatic Animals	Bottom type
12/2/84	Riom river	Weath-ered basalt	R.Benue	Garra waterloti Aphyosemion sp Hemiptera (stick-insects) Dragon Fly larvae Coleoptera, Crab.	Sandy
12/2/84	Asob on Jos-Akw-anga Rd		R.Benue	Cray Fish (Large numbers) Dragon Fly larvae Garra wateroti Emphe-meroptera Coleop-tera Damselfly larvae, Trichoptera	Boulder
12/2/84	Barmo Cement Kaduna/Plateau		R.Benue	Garra sp Enough fish for population studies & electro-fishing collection Hemiptera, Ephem-eroptera Dragon fly larvae	Sandy
8/3/84	Miango Bukuru Goro river	Granite & sand	R.Benue	Odonata, Damselfly larvae, Hemiptera, Water stridders & skaters Garra sp	Boulder & brown colour
8/3/84	Miango reservoir			Damselflies, Ephemeroptera, Fish-Lates niloticus	
8/3/84	River Delimi at Tilindin Fulani	Migmati-te	L.Chad	Chara Garra wateroti Berillius sp. Ephemeroptera Dragon Fly larvae Damselfly larvae Chironomid larvae Biomphalaria (snails).	Sand & Boulder
12/3/84	Stream supplying Lafia Fish pond on Pankshin Rd		Benue River	Crayfish Astacus? Lots Catfish probably of Ephemeroptera Dragonfly larvae.	

Results resume

2. ## Trace elements levels

The results so far indicate that some of the surface waters especially those located in mining zones and therefore likely to receive some form of effluents from mine wastes, contain more than the recommended levels of trace elements. The following elements have been identified as presenting possible hazards.

Table 2. Observed range in Jos Plateau Waters (1) PPb; (2) ppm

1	Cd	(1)	0.2 - 2.5
2	Zn	(1)	7.0 - 2,000.
3	Cu	(1)	3.0 - 700
4	Pb	(1)	1 - 45
5	Mn	(1)	7 - 20,000
6	Se	(1)	T - 40
7	Fe	(2)	0.05 - 3.0

The data for sediments and tissue digests will be presented in a future report.

REFERENCES

APHA (1974) Standard Methods for examination of Water and Waste Water American Public Health Association Washington. D.C.

Thomas and Chamberlin (1974) Colorimetric Coemical Analytical methods. Tintometer L.T.D. England.

COMPARATIVE SAMPLE DECOMPOSITION TECHNIQUES
FOR THE ANALYSIS OF SIMPLE SULPHIDE MINERALS

H. E. Adiuku-Brown (Mrs) and A. E. Ogezi
University of Jos, Department of Geology and Mining, Jos, Nigeria.

Abstract

Although a number of analytical techniques exist for the analysis
of the metal content of sulphide minerals, one of the most favoured
methods is by atomic absorption spectrophotometry (AAS). This is due
to its precision, accuracy and convenience. The various sample
decomposition techniques described in the literature for the analysis
of sulphide minerals using atomic absorption spectrophotometry include
the use of single acids of various strengths, such as nitric acid;
a mixture of two strong acids, such as aqua regia; and a combination
of more than two acids, such as hydrofluoric/perchloric/nitric and
hydrochloric acids.

In this investigation, seven standard and modified standard
procedures were used in the analysis of ten sulphide minerals from
different parts of Nigeria with a view to finding out the relative
advantages of the methods in terms of time, convenience, cost,
accuracy and precision as a basis for a larger geochemical and
environmental programme involving sulphides and other minerals
associated with mining and mineral processing. The effects of the
digestion techniques on the liberation and subsequent determination
of eleven elements - Au, Ag, Cd, Ni, Cr, Co, Mn, Cu, Fe, Zn and Pb -
were investigated. The results show that most of the elements could
be efficiently, cheaply and conveniently leached using simple acids,
such as 50 percent nitric acid, which is one of the simplest of the
leaching techniques.

Introduction

In view of the importance of geochemical analysis in geology,
several geochemical techniques have been developed for the elemental
analysis of geochemical samples (Stanton, 1976; Westwood & Cooper, 1973).

These include gravimetric and titrimetric (classical) methods of analysis, molecular fluorimetry, radiometric and radioactivation methods, mass spectrometry and spark-source spectrography, x-ray emission spectrometry, flame emission and atomic absorption spectrophotometry.

Since geochemical prospecting techniques are critically dependent on precise and reasonably accurate analytical methods that are rapid enough to permit thousands of analyses to be carried out in a short time, most analysts have resorted to the use of the atomic absorption spectrophotometry. This is due largely to its precision, accuracy, convenience and the relatively less operator skill required in the use of the instrument (Reeves and Brooks, 1978).

Most substances requiring geochemical analysis are complex and consist of several elements or compounds. Quite frequently, these materials fall short of the ideal in terms of solubility, volatility, stability or homogeneity, and s   all determinations in which the atomic absorption spectrophotometer (AAS) is used require that the element to be determined be in solution, several sample decomposition techniques prior to analysis have appeared in the literature (e.g. Stanton, 1976). The methods described usually differ depending on the nature of the sample and elements to be analysed.

Reeves and Brooks (1978) recommended the use of hot or cold hydrochloric acid (HCl), for the decomposition of most carbonates; solutions of nitric acids (HNO_3), for attacking ores of metals, like cobalt, copper, manganese, nickel and lead; and boiling concentrated HNO_3 for leaching sulphides of elements, such as lead and zinc from a silicate matrix. They also suggested the use of a mixture of HCl and HNO_3 (aqua regia) for facilitating the decomposition of carbonates, and the dissolution of sulphides using aqua regia or making the nitric acid medium more oxidizing through the addition of bromine.

In the decomposition of sulphide minerals, Rubeska (1968)
specifically suggested the addition of mercuric nitrate solution
to a mixture of nitric , sulphuric and tartaric acids in order to
analyse for silver, zinc, cadmium-copper and lead in sphalerite,
chalcopyrite, pyrite and galena. Donaldson (1982), in her "Methods
for the Analysis of Ores and Related Materials," suggested the use
of HNO_3, HCl, $HClO_4$ and HF in the analysis of sulphide minerals for
copper, nickel, zinc, colbalt, cadmium and iron. Other analysts
(e.g. Jeffery and Hutchison, 1981) recommended the use of fusion
methods in the analysis of alkali metals, carbonates, hydroxides,
peroxides, nitrates and berates. In this study, some of the above
methods were employed in the analysis of some common sulphide minerals
collected from several locations and mines, largely in sedimentary
rocks in the Benue Trough of Nigeria, with a view to finding out
precisely if the very simple methods yield data comparable with the
most complicated ones in the analysis of lead, copper, iron, nickel,
cobalt, manganese, zinc, gold, silver, chromium and cadmium using the
same sample solutions. Such a study would contribute to reducing the
risks involved in geochemical analysis using mixtures of several
concentrated acids and encourage more analysts to study real geochemical
samples. The use of the simple acids might also be faster, cheaper and
easier for use by geoscientists with little formal training in
analytical chemistry. This report, which is part of a major geochemical
and environmental programme, discusses scientific, technical, economic
and geochemical significance of the data.

Sampling

All the samples used were obtained from staff of the Department
of Geology and Mining, University of Jos, and from the members of the
public requesting for free advice on mineral resources of Nigeria.
Therefore, no rigorous sampling procedure was undertaken in the
classification and collection of the samples. Several samples are
composed of mixed sulphides with gangue minerals, such as quartz,
carbonates and sulphates.

All samples were crushed to very fine sizes, usually 100 mesh, using porcelain mortars. Details of the samples and their localities are given in Table 1.

Analytical Methods

The major equipment used in the determination was a manually operated Perkin-Elmer Atomic Absorption Spectrophotometer, Model 2380, with a digital readout. In addition, some equipment of the Nigerian Mining Corporation was used. Samples were weighed into $500cm^3$ conical flasks or teflon beakers and the required acids added. The mixtures were covered and heated on electric heating blocks or sand bath in a fume cupboard.

All reagents used were analytical grade reagents, unless otherwise stated. Solutions for standard calibration were obtained from the American Bureau of Standards and standard mineral samples were also analysed and used as standards.

Table 1: Details of Sulphide Samples Used

Sample Number	Sample Description	Sample Locality
A1	Altered sphalerite with minor galena	New Zurak Mine, Plateau State.
B2	Less altered sphalerite	New Zurak Mine, Plateau State.
C3	Galena	Ishiagu, near Abakaliki, Anambra State.
D4	Sphalerite	New Zurak Mine, Plateau State.
E5	Sphalerite	Ishiagu, near Abakaliki, Anambra State.
F6	Mine Dump Powder (White)	New Zurak, Plateau State.
G7	Galena	Azara, Near Lafia (probably)
H8	Sphalerite	Abakaliki, Anambra State.
I9	Chalcopyrite	"
J10	Arsenopyrite	Probably from Rishi, Bauchi State.

All glassware and plastic containers were washed using acid washing liquid containing one percent nitric acid solution.

About 0.2g of each mineral sample was accurately weighed into a 500cm³ clean, dry, conical flask and decomposed according to the methods briefly described below. Blank solutions were also prepared during each procedure and digestions were carried out in fume cupboards.

Method 1: 50 percent HCl/Conc HNO₃ (Reeves and Brooks, 1978) Modified

To 0.2g of each sample weighed into a conical flask, was added 10cm³ of 50 percent hydrochloric acid. The mixture was heated on a hot plate for about 30 minutes. This boiling was to ensure that sulphur escaped as hydrogen sulphide to avoid precipitation of lead as sulphate. This was followed by the addition of 20cm³ of concentrated nitric acid. After cooling, the mixture was boiled until the quantity of acid left in the conical flask was reduced to about 2cm³.

The conical flask was then brought down, the sides washed with 25cm³ distilled water and the contents of the flask returned to the hot plate and heated to boiling. The digest/solution was left to cool, transferred to a 100cm³ volumetric flask and diluted to volume. Appropriate dilutions of these stock solutions were made where necessary prior to the determination of the elements concerned.

Method 2: 50 percent HCl/50 percent HNO₃ (Reeves and Brooks, 1978)

In this modified method of Reeves and Brooks (1978), the procedure followed was exactly the same as in the above method except that both acids were of 50 percent dilution.

Method 3: Aqua Regia (3:1 HCl:HNO₃) (Stanton, 1966)

The aqua regia used was prepared just before use. 30cm³ of the mixture was used for the digestion of each 0.2g of sample. The rest of the procedure was as described in Method 1 above.

Method 4: Concentrated Nitric Acid (Reeves and Brooks, 1978)

In this method, 30cm³ of concentrated nitric acid was used on each 0.2g of sample digested.

6

Method 5: 50 percent Nitric Acid (Stanton, 1966)

In this modified method after Stanton (1966), $30cm^3$ of 50 percent HCl was used on each 0.2g of sample digested.

Method 6: Tartaric Acid/Nitric Acid/Mercuric Nitrate (Rubeska, 1968)

In this method, $10cm^3$ of 10 percent tartaric acid was added to 0.2g of each sample in a conical flask followed by the addition of $6cm^3$ of concentrated HNO_3. The mixture was left to stand at room temperature overnight. The following day, the mixture was heated on a steam bath for one hour, cooled and $3cm^3$ of mercuric nitrate containing 10mg Hg/ml was added. The mixture was returned to the steam bath and heated until the sulphur turned white. The content of the flask was filtered and the undissolved residue and sulphur thoroughly washed with distilled water, collected into a $100cm^3$ volumetric flask, and made up to volume.

**Method 7: Concentrated $HCl/HNO_3/HClO_4/HF$ Mixture (Donaldson, 1982)**

0.2g of powdered sample was transferred into a teflon beaker and $10cm^3$ of HCl added. The beaker was covered and boiled for several minutes. The beaker was removed from the hot plate and $10cm^3$ of concentrated HNO_3 was added and the mixture boiled until most of the sulphide minerals were decomposed. Then $10cm^3$ of perchloric acid and $5cm^3$ of hydrofluoric acid were added. The solution was boiled for several minutes after which the cover was removed and the solution evaporated to white fumes of perchloric acid. The solution was cooled, the sides of the beaker washed down with distilled water and the solution evaporated to a moist paste. To the moist paste, $3cm^3$ of concentrated nitric acid and $25cm^3$ of water were added and the mixture heated to dissolve the soluble salts. Some high quality dry paper pulp was added to the solution, where necessary, using Whatman No. 40 filter paper, the solution was filtered into a $100cm^3$ volumetric flask. The paper and residue were washed properly and the solution made up to volume.

Results and Discussions

The results of this study are as presented in Tables 2 to 12. In general, the results show that iron, copper, nickel, chromium,

cobalt, manganese, cadium and zinc were easily leached out using any
of the acid digestion techniques. The most complicated methods,
such as those utilising HCl, HNO_3, $HClO_4$ and HF in one digestion
mixture did not always produce the highest and most consistent results.

In the analysis for lead, it was observed that lead sulphate easily
precipitated out of solution, giving the erratic results shown in
Table 10. However, a repeat of the analysis with a smaller sample
weight 0.1g rather than 0.2g proved very suitable as seen in Table 12.
Table 12 also shows that all the seven digestion methods gave
comparative results which are in agreement with earlier suggestions
by several analysts. The results on Table 3 show that Methods 1, 2,
4, 5 and 7 gave silver contents very close to those of Method 6.
Method 6, suggested by Rubeska (1967), describes a particular
modification for the analysis of silver. In general, low results
were obtained in the analysis for silver using aqua regia (Method No. 3).
This is because this acid mixture proceeds as follows:

$$3HCl + HNO_3 \rightleftharpoons 3H_2O + NOCl + Cl_2$$
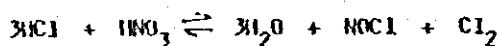
Nascent chlorine is expected to attack precious metals and some
sulphides taking most metals into solution either as their simple
chlorides or as complex chloro-anions. However, as silver chloride
is not very soluble, this may have contributed to the low values
obtained for silver using the aqua regia method of sample attack.

It was generally observed that there is the need for a little
quantity of the acid to remain in the digestion flask at the end
of the digestion. In cases where the acids were allowed to completely
dry up, lower results were obtained, particularly for lead. The
precipitates formed were insoluble in water, probably because of
oxidation. It was also observed that the sphalerite samples were
digested very easily using any of the methods, and as would be expected,
they did not create the problem of producing insoluble precipitates
even if the solutions dried up. Therefore, the published general
analytical descriptions or methods for sulphides are not of general
applicability since some sulphides create less digestion problems than
others. As noted from above, lead sulphides probably give most problems.

For example, the starting quantity in the analysis for lead in galena should not be the same as the starting quantity for the analysis of zinc in zinc sulphide-sphalerite. For sphalerite, the major, minor and trace elements can easily be determined in the same sample solution, but for lead, which requires a smaller amount of sample to be digested, an analyst may run the risk of not being able to detect the trace elements if analysis for lead must be done on the same sample solution as precipitates of lead salts may co-precipitate other trace elements.

Another important factor which needs mentioning here is that the digestion flask should be covered during sample digestion to avoid the mixture drying up even before the sample is completely digested. Since drying up of samples would lead to the addition of more acids to the digested samples, this would raise the possibility of contamination and the amounts of elements present in the blanks.

In all the samples analysed, gold could not be detected probably because of the low contents of gold in the samples. To assay for gold, higher sample weights would have been digested for this specific purpose, in view of the generally lower gold contents in these types of sulphides. Although detailed geochemical and genetic discussions will be carried out elsewhere, the data presented in the tables show that the Zurak and Lafia(?) area sulphides contain the highest amounts of silver, and that, in general, the trace element contents reflect the environment from which the samples were obtained.

Conclusion from the Results

It can be concluded that 50 percent nitric acid is a convenient, simple and cheaper method for the digestion of simple sulphide minerals prior to the determination of lead, iron, copper, zinc, manganese, chromium, silver, nickel, cobalt and cadmium, using atomic absorption spectrophotometry. The use of concentrated acids or a mixture of concentrated acids in addition to the possible hazards

and high cost involved, does not always produce exceptionally
different results from those obtained using 50 percent nitric acid.

This study suggests that simple, easy to obtain and work with
acids should be used for the digestion of sulphide samples rather
than wait for the purchase of platinum crucibles or teflon beakers
at exorbitant prices before sulphide samples can be decomposed for
analysis with a mixture of hydrofluoric, hydrochloric, perchloric
and nitric acids as suggested by Donaldson (1982). In this era of
recession and high cost of imported materials, such laboratories
can conveniently carry out digestions using beakers or conical flasks
with concentrated nitric acid, or better, cheaper and safer still,
with 50 percent nitric acid.

References

Donaldson, E.H. (1982): Methods for the Analysis of Ores, Rocks
            and Related Materials. Monograph 881, 2nd Ed., p. 35.
Jeffery, P.G. and Hutchison, D. (1981): Chemical Methods of Rock
            Analysis, 3rd Ed. Pergamon Press, London, p. 18.
Reeves, R.D. and Brooks, R.R. (1978): Trace Element Analysis
            Geological Materials, Volume 51. John Wiley and Sons,
            New York, pp. 29-30.

Rubeska, Z.S.: Anal. Chim. Acta, 40, 187 (1968).

Stanton, R.E. (1976): Analytical Methods for use in Geochemical
Exploration. Edward Arnold Ltd., London, pp. 36-53.

Mainardi, R.E. and Ilken, E.A. (1971): Modern Method of Geochemical
Analysis. Plenum Press, New York, p. 54.

Westwood, W. and Cooper, B.S. (1973): Analytical Methods in use
in Non-Fer. Mining and Metallurgy: A Selective Review.
Institution of Mining and Metallurgy, London, p. 39.

Table 2: Iron Content (Weight Percent) in some Nigerian Sulphides

DIGESTION METHODS

Samples	1 50% HCl/ Conc HNO₃	2 50% HCl/ 50% HNO₃	3 Aqua Regia	4 Conc. HNO₃	5 50% HNO₃	6 Tartaric/ Nitric/ Mercuric Nitrate	7 HCl/ HNO₃/ HClO₄ HF	Sample Locality and Type
A	2.00	2.00	2.00	2.00	2.00	2.00	1.80	Zurak sphalerite (altered)
B	2.00	2.00	2.00	1.80	2.60	2.00	2.20	"
C	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Ishiagu galena
D	8.60	8.60	9.40	9.40	8.60	9.60	9.00	Zurak sphalerite
E	1.00†	1.00	1.00	1.00	1.00	1.00	1.00	Ishiagu sphalerite
F	1.40	1.40	1.40	1.40	1.40	1.20	1.40	Zurak white mine dump powder
G	3.80	3.80	3.80	3.60	3.60	3.20	2.60	Lafia-Azara galena
H	4.80	4.60	4.40	4.80	4.80	4.80	4.40	Abakaliki sphalerite
I	35.40	35.80	36.40	36.20	36.20	33.00	31.60	"
J	27.00	26.80	26.80	26.80	20.60	14.00	27.40	Rishi-Bauchi arsenopyrite

n.d. = not detected.

Table 3: Silver Content (in parts per million) in some Nigerian Sulphides

DIGESTION METHODS

Samples	1 50% HCl/ Conc HNO$_3$	2 50% HCl + 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tarteric/ Nitric/ Mercuric Nitrate	7 HCl/HNO$_3$/ HClO$_4$/ HF	Sample Locality and Type
A	836	758	26	1117	930	1172	883	Zurak sphalerite
B	125	94	31	172	156	164	172	"
C	172	172	156	227	219	211	294	Ishiagu galena
D	94	109	47	148	102	109	94	Zurak sphalerite
E	258	273	16	289	281	273	297	Ishiagu sphalerite
F	438	404	94	461	469	453	547	Zurak white mine dump powder
G	1430	1461	55	1461	1445	1781	1875	Lafia-Azara galena
H	31	36	8	31	36	39	31	Abakaliki sphalerite
I	195	211	94	188	195	211	211	Abekaliki chalcopyrit
J	102	102	86	94	94	109	102	Rishi Bauchi arseno-pyrite(?)

Table 4: Copper Content (ppm) in some Nigerian Sulphide Samples

DIGESTION METHODS

Samples	1 50% HCl/Conc HNO3	2 50% HCl + 50% HNO3	3 Aqua Regia	4 Conc. HNO3	5 50% HNO3	6 Tartaric/Nitric/Merc. Nitrate	7 HCl/HNO3/HClO4/HF	Sample Locality and Type
A	556	536	571	571	554	554	607	Zurak sphalerite
B	1429	1429	1429	1464	1429	929	1500	"
C	36	36	36	36	37	36	37	Ishiagu (Abakaliki) galena
D	714	730	730	732	714	732	732	Zurak sphalerite
E	643	536	661	607	625	661	571	Ishiagu (Abakaliki) sphalerite
F	536	571	571	571	579	554	554	Zurak white mine dump powder
G	79057	78929	78929	78929	79057	80357	78571(?)	Lafia-Azara galena
H	571	589	607	607	607	625	643	Abakaliki sphalerite
I	245536	251706	251786	248214	250000	2393	2527	Abakaliki chalcopyrite
J	212	214	214	179	196	214	196	Rishi-Bauchi arseno-pyrite(?)

Table 5: Nickel Contents (ppm) in some Nigerian Sulphides

DIGESTION METHODS

Samples	1 50% HCl/ Conc HNO₃	2 50% HCl/ 50% HNO₃	3 Aqua Regia	4 Conc. HNO₃	5 50% HNO₃	6 Tartaric/ Nitric/ Mercuric Nitrate	7 HCl/HNO₃/ HCl/HF	Sample Locality and Type
A	45	45	30	30	30	20	30	Zurak sphalerite (altered)
B	45	40	35	35	40	15	15	"
C	20	20	n.d.	20	20	20	20	Ishiagu (Abakaliki) galena
D	20	20	20	20	20	20	20	Zurak sphalerite
E	15	15	15	15	15	15	10	Ishiagu (Abakaliki) sphalerite
F	50	50	50	55	65	50	50	Zurak sphalerite
G	n.d.	n.d.	n.d.	20	20	n.d.	n.d.	Lafia-Azora galena
H	25	20	n.d.	25	25	n.d.	n.d.	Abakaliki sphalerite
I	210	275	22	260	255	210	220	Abakaliki chalcopyrite
J	55	55	n.d.	40	50	n.d.	20	Rishi-Bauchi arsenopyrite(?)

n.d. = not detected.

Table 6: Chromium Content (ppm)

DIGESTION METHODS

Samples	1 50% HCl/ Conc HNO$_3$	2 50% HCl/ 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tartaric/ Nitric/ Mercuric Nitrate	7 (HCl/HNO$_3$)/ HClO$_4$/HF	Sample Locality and Type
A	30	30	15	35	35	35	40	Zurak sphalerite (altered)
B	30	30	10	25	30	30	30	"
C	35	35	5	30	30	30	35	Ishiagu (Abakaliki) galena
D	20	20	20	20	20	20	20	Zurak sphalerite
E	25	25	5	15	20	20	20	Ishiagu (Abakaliki) sphalerite
F	30	30	5	20	20	25	20	Zurak white zinc dump powder
G	10	10	n.d.	10	10	10	5	Lafin-Azara galena
H	5	5	n.d.	5	5	5	5	Abakaliki sphalerite
I	10	10	n.d.	n.d.	5	10	10	Abakaliki chalcopyrite
J	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Richi-Bauchi arsenopyrite

n.d. = not detected.

Table 7: Cobalt Content (ppm) in some Nigerian Sulphide Samples

DIGESTION METHODS

Samples	1 50% HCl/ Conc HNO$_3$	2 50% HCl/ 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tarteric/ Nitric/ Mercuric Nitrate	7 HCl/HNO$_3$/ HClO$_4$/HF	Sample Locality and Type
A	335	335	335	335	335	335	335	Zurak sphalerite (altered)
B	775	775	775	775	775	775	775	"
C	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Ishiagu (Abakaliki) galena
D	835	835	835	835	835	775	775	Zurak sphalerite
E	335	335	335	335	335	335	335	Ishiagu (Abakaliki) sphalerite
F	335	335	335	335	335	335	335	Zurak white mine dump powder
G	110	110	110	110	110	110	110	Lafia-Azare galena
H	500	500	445	500	500	390	400	Abakaliki sphalerite
I	335	335	335	335	335	335	335	Abakaliki chalcopyrite
J	665	665	720	665	665	555	665	Rishi-Beuchi arsenopyrite

n.d. = not detected.

DIGESTION METHODS

Samples	1 50% HCl Conc HNO_3	2 50% HCl 50% HNO_3	3 Aqua Regia	4 Conc. HNO_3	5 50% HNO_3	6 Tartaric/Nitric/Mercuric Nitrate	7 HCl/HNO_3/HClO_4/HF	Sample Locality and Type
A	555	575	555	600	605	600	520	Zurak sphalerite (altered)
B	130	130	130	130	125	135	150	"
C	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Ishiagu (Abakaliki) galena
D	2760	2775	2760	2840	2755	2900	2770	Zurak sphalerite
E	5	5	5	5	5	5	5	Ishiagu (Abakaliki) sphalerite
F	745	740	745	750	760	760	610	Zurak white mine dump powder
G	40	60	35	35	35	35	35	Lafia-Arere galena
H	840	840	845	805	000	020	035	Abakaliki sphalerite
I	13750	14000	13500	13730	13500	13750	14250	Abakaliki chalcopyrite
J	25	25	20	30	25	20	25	Richi Bauchi arsenopyrite

n.d. = not detected.

DIGESTION METHODS

Samples	1 50% HCl Con HNO$_3$	2 50% HCl 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tartaric/ Nitric/ Mercuric Nitrate	7 HCl/HNO$_3$/ HClO$_4$/HF	Sample Locality and Type
A	607	634	598	589	643	616	536	Zurak sphalerite (altered)
B	2197	2197	2232	2268	2278	2116	2045	"
C	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Ishiagu (Abakaliki) galena
D	1366	1348	1331	1322	1340	1241	1215	Zurak sphalerite
E	1697	1652	1625	1643	1652	1664	1590	Ishiagu (Abakaliki)
F	696	674	679	679	696	706	652	Zurak white mine dump powder
G	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	Lafia-Azara galena
H	2241	2241	2206	2232	2295	2259	2277	Abakaliki sphalerite
I	90	90	80	80	80	n.d.	18	Abakaliki chalcopyrite
J	27	27	27	27	27	27	27	Rishi-Bauchi arsenopyrite

n.d. = not detected.

Table 10: Lead Content (weight percent) in some Nigerian Sulphides

DIGESTION MEDIUS

Samples	1 50% HCl Conc HNO$_3$	2 50% HCl 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tartaric/ HNO$_3$/ Mercuric Acetate	7 HCl/HNO$_3$/ HClO$_4$/Air	Sample Locality and Type
A	21.00	44.72	18.00	33.80	17.42	30.54	30.74	Zurak sphalerite (altered)
B	0.03	0.03	0.03	0.03	0.03	0.03	0.03	"
C	44.72	56.60	25.22	30.40	47.32	44.04	72.30	Ishiagu (Abakaliki) galena
D	0.03	0.02	0.01	0.03	0.03	0.03	0.03	Zurak sphalerite
E	0.03	0.03	0.02	0.03	0.03	0.03	0.03	Ishiagu (Abakaliki) sphalerite
F	7.67	7.21	7.00	7.50	7.15	7.12	7.00	Zurak white zinc dust powder
G	62.60	67.34	15.11	63.28	45.34	44.50	69.00	Lafia-Azara galena
H	1.47	1.47	1.45	1.47	1.54	1.55	1.51	Abakaliki sphalerite
I	1.00	1.01	1.21	1.00	1.03	1.02	1.00	Abakaliki chalcopyrite
J	0.04	0.06	0.04	0.05	0.04	0.04	0.04	Richi-Bauchi arsenopyrite(?

Table 11: Zinc Content (weight percent) in some Nigerian Sulphide Samples

DIGESTION METHODS

Samples	1 50% HCl Conc HNO$_3$	2 50% HCl 50% HNO$_3$	3 Aqua Regia	4 Conc. HNO$_3$	5 50% HNO$_3$	6 Tartaric/ Nitric/ Percuric Nitrate	7 HCl,HNO$_3$/ HClO$_4$,HF	Sample Locality and Type
A	26.00	26.00	26.05	27.00	27.80	27.70	26.05	Zurak sphalerite (altered)
B	52.20	52.10	52.11	52.24	52.20	52.23	52.23	"
C	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Ishiagu (Abakaliki) galena
D	49.73	49.73	49.70	49.73	49.73	49.73	48.85	Zurak sphalerite
E	62.72	62.72	62.71	62.70	62.74	62.73	62.60	Ishiagu (Abakaliki) sphalerite
F	30.48	30.50	30.32	30.69	30.50	30.50	30.04	Zurak white mine dump powder
G	0.11	0.11	0.11	0.12	0.11	0.11	0.12	Lafia-Azara galena
H	61.73	61.70	61.70	62.90	62.01	61.98	61.70	Abakaliki sphalerite
I	0.09	0.05	0.05	0.05	0.05	0.05	0.05	Abakaliki chalcopyrite
J	0.004	0.004	0.004	0.004	0.004	0.004	0.004	Richi-Enuchi arsenopyrite(?)

Table 12: Lead Content (weight percent) in some Nigerian Sulphide Samples using smaller (0.1 g) Sample Weights for Digestion

DIGESTION METHODS

Samples	1	2	3	4	5	6	7	Sample Locality and Type
	50% HCl Conc HNO$_3$	50% HCl 50% HNO$_3$	Aqua Regia	Conc. HNO$_3$	50% HNO$_3$	Tartaric/Nitric/Formic Nitrate	Nitric/HClO$_4$/HF	
A	38.50	38.90	38.90	36.10	37.50	35.50	38.70	Zurak sphalerite (altered)
C	83.30	83.30	83.50	77.80	77.40	76.40	76.30	Ishiagu (Abakaliki) galena
F	8.50	8.30	7.50	7.90	7.90	7.60	8.00	Zurak white mine dump powder
G	68.50	69.00	64.00	69.00	69.70	68.20	69.20	Lafin-Azara galena

-66-

ENVIRONMENTAL AND ECONOMIC STUDIES OF TRACE ELEMENTS
ASSOCIATED WITH MINING AND MINERAL PROCESSING IN
PARTS OF PLATEAU STATE, NIGERIA — A PRELIMINARY REPORT*

A.E. Ogezi, M.E. Adiuku-Brown and M. Alam[+]
Department of Geology and Mining, University of Jos,
P.M.B. 2084, Jos, Nigeria.

ABSTRACT

The Plateau State of Nigeria has a surface area of about
58000 km^2 and elevation above mean sea level ranges from
about 200 to 1800 metres. A number of major tributary river
systems which flow to the Rivers Niger and Benue and to
Lake Chad rise from the Plateau. The State is covered by
igneous, metamorphic and sedimentary rocks of Precambrian
to Recent age within which, under favourable geological
conditions, are several mineral occurrences and economic
deposits. Economic deposits of cassiterite, columbite-
tantalite, lead-zinc, thorite, zircon, barytes, salt, clays,
mineral water, limestone, coal, iron ore, marble and
gemstones are known in the State. A number of these have
been mined, processed and smelted on large- or small-scale
basis.

A large number of samples of rocks, minerals, stream sediments, soils and laterites, mine dumps, slags, water and plant materials have been carefully collected from areas of known mineral occurrences and mineral processing plants and also from apparently 'barren' areas and analysed for major, minor and trace elements. This forms the basis for students' training and systematic baseline trace element data used for a multidisciplinary study in mineral exploration, fundamental studies of crustal evolution and ore-forming processes, and environmental studies, including those in agriculture, medical geography, pollution studies and ecological fields of interests since major metal pollution originates from geological weathering, industrial processing of ores and metals, the use of metals, leaching of metals from domestic and solid waste dumps, and animal and human excretions.

Preliminary results from this on-going study show that although mining and mineral processing have contributed a lot to the national economy and the growth of a number of towns in Plateau State, it has also contributed immensely to environmental pollution. However, with careful monitoring and mineral exploitation using modern techniques of large- and small-scale mining and mineral processing, the mining industry in Plateau State could continue to provide jobs, save and earn foreign exchange and supply major alloy metals

(such as tin, tantalum, niobium, molybdenum, tungsten
and titanium) and probably by-product metals (such as
silver, antimony, cobalt, germanium, ca-'nium, copper,
uranium, thorium, hafnium and zirconium). However,
under the current practice without strict environmental
protection laws and enforcement, major environmental and
health hazards for the State and other parts of Nigeria
which are drained by rivers flowing from the high plateau
might result.

1 INTRODUCTION

Metals make up the largest group of the chemical
elements, but their characteristics differ greatly within
the biosphere. It is now widely recognised that the
important factor determining the effects of a metal on
organisms is not generally its total concentration but
rather its speciation - the specific forms and nature of
the element . Metals may occur as hydrated ions, as
complex inorganic or organic ligands, as adsorbed and
absorbed ions, as colloids, as precipitates, and in live
and dead biota. Some metals may also be essential to
human life, whereby as trace elements they are always present
in certain proportions in all healthy living tissues of the
same species and deficiency symptoms may be noted with their
depletion or removal which can be attributed to distinct

biochemical defects. Examples include potassium, sodium, magnesium and calcium. When the supply of some essential trace elements, such as zinc, becomes excessive, they become toxic. Toxic levels are generally 40- to 200-fold of the minimum levels required for correct nutritional activity in the organism. Hence, in the studies of trace elements from the possible sources to man, the general trend followed is that an undersupply leads to element deficiency, sufficient supply results in optimum conditions, and oversupply results in toxic effects and, possibly, death in the end.

The essential metals, whose ions are used by biological systems must of necessity be both relatively abundant in nature and readily available as soluble species. However, when considered from environmental pollution point of view, metals may be classified (i) as non-critical, such as Na, K, Mg, and Ca, which are essential metals and hard acceptors of electrons (Lewis acids) and which form stable bonds with hard donors (Lewis bases), such as H_2O, OH^-, Cl^-, etc; (ii) toxic, but very soluble or very rare; and (iii) very toxic and relatively accessible metals. The two last groups are generally soft acceptors which form stable bonds with soft donors, such as -SH groups and other active sites of proteins. Some common elements which, at toxic levels,

become major health hazards are As, Be, Cd, Cr, Cu, Pb,
Hg, Mo, Se, Ag, Th, and Zn. In some cases, unusual
concentrations have produced intoxicating or catastrophic
effects, as in the cases of mercury poisoning in Minamata Bay,
Japan; Cadmium poisoning causing the "itai itai" disease in
the Japanese villages on the banks of the Jintsu River,
Toyama, Japan; lead poisoning, as in Leipzig, Germany, during
the summer of 1930, etc. (Forstner and Wittmann, 1983).
A large number of such studies have been documented from
Japan, Europe and U.S.A., but similar studies are yet to be
published on Nigeria.

In a number of developed countries, variable but
enforcable national standards that determine the quality
of water for different uses have been set. Although no
such enforcable standards or environmental protection laws
currently exist in Nigeria, the quality of Nigerian surface
and underground waters can be compared with these
international standards so as to establish concentration
levels below which harmful effects may be produced. Toxic
metals may occur in aqueous ionic forms derived from minerals
and from man-made sources, such as herbicides, fertilisers,
detergents, metal processing and industrial processing and
products. Permissible limits for waters must take cognisance
of the accumulation by organisms through the food chain and

the environmental impact of waters discharged to the environment, especially for domestic, recreational, agricultural and industrial purposes. Drinking water quality criteria have been proposed by the World Health Organisation (WHO) and several developed countries. These limits show wide fluctuations which often vary by up to a factor of 200.

In general, there are five different major sources from which metal pollution of the environment originates. These are geological weathering of rocks, industrial processing of ores and metals, the widespread use of metals and metal components, leaching of metals from domestic refuse and solid waste dumps, and animal and human excretions, which generally contain heavy metals. Plateau State has several mineral occurrences, most representatives of Nigerian igneous, metamorphic and sedimentary rock types, and has a long history of mining, mineral processing and smelting. Hence, the resultant extensive environmental and human pollution through geological and human activities provides a key area for the environmental and economic geological study of trace element mobility from baseline or background sources in rocks and minerals through geological, human and biological activities to man via the food chain.

In areas characterised by metal-bearing rocks, these trace elements will necessarily occur at much higher levels

than the baseline or natural background levels in the water, soil, plants and bottom sediments of the area. Areas with economic deposits are exploited to recover and process the ore. This in turn leads to the disposal of tailings, discharge of effluents to specially constructed lakes or natural drainage systems, discharge of effluents and possibly processing and smelting operations. These processes result in atmospheric and hydrological pollution. The general problem which, therefore, arises is how to distinguish between natural geological weathering and metal enrichment attributable to human and industrial activities.

This study is, therefore, aimed at determining the trace element contents in rocks, stream sediments, minerals, soils, plant and water samples from the tin and lead-zinc mining and non-mining areas of Plateau State with a view to establishing their negative and positive environmental effects and economic significance (Ogezi, 1984). Another aim is that since critical pollution, geochemical and mineral exploration studies are often hampered by cumbersome, costly and often dangerous analytical techniques, simple, cheap and reasonably accurate and precise methods of analyses will be devised and developed to facilitate the large number of analyses involved (Adiuku-Brown and Ogezi, 1984 and this volume). Another important aspect of the study is

scientific students' training for the acquisition of new knowledge and skills and updating of ideas, especially in the fields of environmental geochemistry and mineral exploration (Adiuku-Brown, 1983; Agada, 1983; Bob-Manuel, 1983; Ekpo, 1984; Hamza, 1984; Ochonogor, 1984; Okeke, 1984; Onyeji, 1984). It is also hoped that in collaboration with the metal mining, processing and fabrication organisations, through the investigation of mineral processing of tin and its associated by-products and lead and zinc, cheap methods of extraction will be found for such metals as niobium and tantalum from tin and associated ores, and silver, cobalt, lead, zinc, etc. from lead-zinc ores. This would provide suitable indigenous alloying metals for virile Nigerian metal-based industries as well as save and earn foreign exchange, provide jobs and aid in the acquisition of technical skills.

2. SAMPLING AND SAMPLE PREPARATION

In view of their significance, it was decided to use samples of rocks, minerals, waters, stream sediments, mine dumps, ores, slags, soils, laterites and plant material for this study. Based on a detailed knowledge of the geology of the State, the possible sampling sites covering the high and low altitude areas of Plateau State were selected to include areas with different rock types, different types of water bodies, mineral occurrences, economic mineral deposits, mines, mineral processing and apparently barren areas. These areas cover the whole State. Based on this, about 10 areas and about 22 sampling localities were selected for coverage. In spite of this pre-sampling decision based on regional geology, a detailed geological reconnaissance was carried out at each sampling locality to deduce the local geology, evidence of mineral exploitation, topography, vegetation, drainage and other features of the area. Samples were labelled in the field and details recorded in field notbbooks and on geological and topographic maps. A summary of the type and approximate number of samples collected is presented in Table 1.

At each point where a water sample was taken, air and water temperatures, conductivity, pH, Eh, turbidity and the colour of the water was recorded prior to a minimum

Table 1:   Summary of Types and Localities of Samples
            Collected for Preliminary Regional Study
            and Numbers treated so far.

S/No.	Sample Types	Approximate Total No. Collected	Approximate No. Partially Collected
1	Rocks	200	40 - for mineralogy, major and trace elements
2	Stream sediments	100	25 - for mineralogy, trace elements and sizes
3	Soils and laterites	50	10 - for size fractions
4	Minerals	20	15 - for mineralogy, major and trace elements
5	Mine dumps	10	5 - for mineralogy
6	Smelting slags	5	-
7	Stream and lake waters	120	50 - for Ca, Mg, Cu, Fe, Zn, Mn and Pb
8	Plants	20	-
9	Well waters	20	15 - for pH, T and trace elements

of 250-500 ml of water being taken into clean, carefully
rinsed-out plastic water bottles which were previously
washed with dilute nitric acid.

Water samples were preserved in a refrigerator and
analysed shortly after collection. To minimise the effects
of organic substances, bring all the ions to the same form
or oxidation state in solution and minimise metal absorption
onto the walls of containers, all water samples were
acidified with analytical reagent grade nitric acid to a pH
of about 2. The possibility of sample contamination by
substances leached from the container walls and absorption
of constituents onto container walls were considered and
tested for, but negligible. Standardised strict water
sample collection, preparation and analytical procedures
as well as the use of blanks and standard determinations
are being devised for the detailed stage of this investigation.
Similar procedures and basic equipment for pore waters in
sediments and for plant materials are being collated.

For rock samples, fresh large samples weighing a
minimum of 2 kg are collected, and representative fresh
portions sawn for thin section preparation or crushed into
powder for analysis. Sulphide minerals and stream sediments
were leached using hot dilute nitric acid or acid mixtures
as described in Adiuku-Brown and Ogezi (1984, and this volume).

For the major and trace element analysis of rocks and
laterites carried out at the Technical University of Berlin,

the lithium tetraborate fusion technique was used. To do this, 0.3000 ± 0.0002 g finely ground (-120 mesh) material was weighed and completely homogenised for at least 10 minutes in an agate mortar with 1.2000 ± 0.0002 g lithium tetraborate. After complete homogenisation, 1.2500 g of the mixture was weighed into a 6 cm^3 graphite crucible and put in the furnace set at $1000^{\circ}C$ for 30 minutes for fusion to be complete. The molten mixture was quickly and completely transferred into a beaker, on a hot plate, containing 30 ml of 4 per cent nitric acid (made from 10 ml HNO_3 and 165 ml distilled water) and the mixture stirred until completely dissolved. The solution was quickly filtered, the filter paper thoroughly washed and the filtrate made up to 50 ml, thereby giving a 200-fold dilution for the atomic absorption spectrophotometric determination of trace elements. For the determination of major elements, a 2000-fold dilution was used. Although the lithium tetraborate digestion technique is simple, effective and cheap when compared with other digestion techniques, the major problems are those of complete recovery of the molten mixture from the crucible and consistent analytical results.

PERFORMANCE AND RESULTS

So far, a review of and the acquisition of relevant literature and analytical techniques have been completed. However, in view of the limited sensitivity of the sample preparation and analytical facilities and materials available, progress has been necessarily slow. Preliminary analysis of over 50 water samples using the Departmental Manual Perkin-Elmer 2380 Atomic Absorption Spectrophotometer (AAS) has been completed for Ca, Mg, Cu, Fe, Zn, Mn, Pb and Cd (Tables 1 to 5). This has largely confirmed the necessity for preconcentration of samples prior to AAS analysis of samples or analysis using more sensitive equipment that can analyse concentrations at parts per billion (ppb) levels instead of parts per million (ppm) possible with the AAS.

Since the inception of the project, seven B.Sc. (Honours) theses projects have been completed (Agada, 1983; Ekpo, 1984; Hamza, 1984; Manuel, 1983; Ochonogor, 1984; Okeke, 1984; Onyeji, 1984) and one research (M.Phil/Ph.D.) project has been initiated (Adiuku-Brown, 1983). In addition, two conferences papers have been presented in which it was shown that sulphides could be leached using simple dilute acids and that mining activity poses major environmental hazards in the Zurak area (Adiuku-Brown and Ogezi, 1984 and this volume; Ogezi, 1984).

In a study of an area of about 28 km^2 of the area around Delimi River Basin, off the Jos-Bukuru Road from Narabi to Tilden Fulani in Bauchi State, Agada (1983) carried out a sedimentological analysis of the upper reaches of the Delimi, which flows several hundred kilometres to Lake Chad in the northeast. He showed that the sediments are poorly- to moderately-sorted down the river basin and composed of coarse- to medium-grained sands which were deposited in one phase of deposition. The moderate rounding was as a result of the corroding ability of the channel bedrock. The winning of economic deposits of cassiterite, sand and gravel and shallow groundwater from alluvial sediments recharged by the Delimi River, which drains Jos, could have major effects on water quality. Detrital minerals and minor radioactive element mineralisation in the sediments of parts of Bauchi and Bornu States, several hundred kilometres north-east of Jos, have been ascribed to the rocks of the Younger Granite Province (C. Okujeni, oral communication, 1983). Pollution could similarly extend downstream towards Lake Chad.

In a similar geological, mineralogical and geochemical study of the northeast part of Naraguta Sheet 168, covering the Permanent Site of the University of Jos, Ekpo (1984) showed that the major rocks of the area are the migmatites, gneisses and the Jurassic Younger Granites, together with

minor intrusions of basic dykes and aplo-pegmatitic gneisses. By studying the geochemistry and mineralogy of the rocks, stream sediments and water, it was shown that the finest-clay-size fractions had the highest concentration of iron, copper, manganese, cobalt, lead, calcium and zinc. Concentrations could be correlated with the mineralogy, the geology and environmental factors. Elements, such as lead, cobalt and copper, detected could be correlated with pollution from metropolitan Jos.

Hamza (1984), in a similar study of the area south of the Jos-Rukuba Road, in Plateau State, studied the geology, trace element content and mineralogy of stream sediments within the area to provide a basis for predicting the environmental hazards and mineralisations of the area. Although the raw water samples had relatively low trace element contents, Hamza (1984) showed that in the stream sediments, the coarsest-size fractions formed the bulk of the samples and that the relative proportions decreased with progressively finer fractions. This may be due to sampling, or more likely, due to nearness of stream sediments to source rocks. After hot extraction with 4M HNO_3, it was found that, with very few exceptions, the finest or clay-size fractions of stream sediments had the highest contents of Fe, Cu, Mn, Pb, Ca, Mg and Zn (Table 2).

This was attributed largely to adsorption to clay fractions, but individual variations along the same streams of trace element concentrations was correlated with rock type and environmental factors, such as mining, mineral processing and human activities (Table 2).

Table 2: Trace Element Contents (ppm) of Different Stream sediment near Jos after Hot Extraction with 4M HNO_3 (after Hamza, 1984, Table 3 p. 47, and Table 7.1, p. 58). The highest concentrations are in the finest size fractions. Note lower concentration in water samples.

Sample No.	Mesh Size of Stream Sidiments	Trace Elements (ppm)							
		Fe	Cu	Mn	Co	Pb	Ca	Mg	Zn
STS-1	+0.5mm	200	0.5	3.0	0.3	0.5	0.0	1.8	1.1
	-0.5+0.25mm	275.7	0.3	3.8	0.3	0.6	0.1	1.8	1.6
	-0.25+0.125mm	298.6	1.4	5.8	0.4	1.0	0.3	66.3	2.2
	-0.125mm	586.5	16.9	14.0	0.7	2.0	0.8	12.4	12.5
	Water	4.0	n.d	1.0	n.d	n.d	3.5	2.7	0.3
STS-2	+0.5mm	119.0	0.6	1.0	0.4	0.5	1.1	0.4	70.0
	-0.5+0.25mm	118.9	0.0	1.0	0.4	0.8	1.0	0.3	45.0
	-0.25+0.125mm	167.6	0.6	1.0	0.4	0.8	1.9	0.5	90.0
	-0.125mm	275.7	3.9	3.0	0.6	3.6	2.1	0.6	5.0
	Water	4.0	n.d	n.d	n.d	n.d	3.5	2.7	n.d
STS-3	+0.5mm	127	1.3	1.6	0.1	0.6	0.1	2.8	1.1
	-0.5+0.25mm	137.8	0.3	1.8	0.1	0.9	0.1	1.8	0.9
	-0.25+0.125mm	210.8	0.7	2.8	0.3	2.0	0.2	2.8	1.4
	-0.125mm	437.8	7.1	8.0	0.5	2.5	0.4	9.8	4.0
	Water	3.3	n.d	n.d	n.d	n.d	3.3	2.7	n.d

n.d. = not detected.

Manuel (1983), in a stratigraphic and sedimentological study of the tin mineralisation in parts of the Gold and Base Company Mines in the Rayfield-Barakin Delimi areas, Jos, showed that the sediments are poorly sorted, angular to sub-angular, medium- to coarse-grained river sands deposited in an oxidizing environment in stream channels averaging 6 metres each in depth and width. Manuel (1983) also showed, from stratigraphic correlations and heavy mineral analysis, that the highest concentration of cassiterite and associated ores occurred at sediment depths ranging from 4 to 8 metres, due largely to their higher density. Detailed sedimentological analysis showed that the sediments were mainly saltated by the river currents and the poorly-sorted angular nature was due to the action of eddy currents on these materials deposited close to source areas.

Ochonogor (1984), in a geological and environmental geochemical study of the Rayfield-Bukuru area, where there was extensive past alluvial mining and mineral processing, showed that the concentration of most trace elements in the waters were within permissible international standards. Although a much larger sample population was required for firmer conclusions, Ochonogor (1984) tentatively ascribed the variations in elemental concentrations to environmental, human and geological factors, and recommended detailed multi-

-disciplinary study, especially since endemic goitre and

other diseases,which occur in the general area,may be due

to geochemical factors. Ochonogor also obtained trends

of trace element concentrations in stream sediments similar

to those of Ekpo (1984) and Hamza (1984), whereby trace

elements generally increased with decrease in grain sizes

of sediments (Table 3). Well water samples contained

significantly lower Ca, Mg, Fe, Zn and Mn than adjacent stream

waters, hence well waters would provide purer drinking

waters (Table 3). However, in the absence of thick weathered
superfical cover wells dry up during the dry season

Table 3 : Trace Element Contents of Stream Sediments (S),
Stream Waters (SW), and Well Waters (WW) from the
Rayfield-Bukuru area, near Jos (after Ochonogor,
1984, Table 3, p. 45, and Table 4, p. 47).
Compare data with Table 2.

Sample	Stream Sediment Mesh Size (MM)	Trace Elements (ppm)							
		Fe	Cu	Mn	Co	Pb	Ca	Mg	Zn
S1	+0.5mm	62.2	0.0	1.1	0.1	0.0	0.3	0.4	0.3
	-0.5+0.25mm	180.1	0.1	2.2	0.1	0.0	0.6	1.2	0.7
	-0.25 - 0.125mm	173.0	0.1	3.2	0.2	0.0	0.6	1.8	1.1
	-0.125mm	200.0	1.4	8.0	0.2	0.3	32.0	7.0	5.0
S2	+0.5mm	91.9	0.1	0.6	0.1	0.0	0.1	0.3	0.4
	-0.5 + 0.25mm	127.0	0.5	1.0	0.1	0.1	0.1	0.6	0.9
	-0.25+0.125mm	105.4	0.5	1.8	0.2	0.2	0.4	1.2	1.4
	-0.125mm	78.4	2.8	3.1	0.4	0.5	0.8	2.0	3.0
S3	+0.5mm	59.5	0.0	0.6	0.2	0.0	0.1	0.3	0.5
	-0.5 + 0.25mm	75.7	0.1	0.9	0.2	0.1	0.1	0.7	0.6
	-0.25+0.125mm	87.8	0.1	1.2	0.4	0.0	0.3	0.9	1.2
	-0.125mm	229.7	4.5	4.3	0.8	0.0	1.6	3.1	7.7
SW1	Stream Water	9.7	n.m	0.2	n.m	n.m	2.5	0.1	0.0
SW2	" "	8.7	n.m	0.3	n.m	n.m	16.0	2.7	0.0
SW3	" "	9.0	n.m	0.4	n.m	n.m	11.8	1.8	0.1
SW4	" "	9.7	n.m	0.2	n.m	n.m	2.4	0.1	0.0
WW1	Well Water	0.0	n.m	0.0	n.m	n.m	0.0	0.0	0.0
WW2	" "	0.0	n.m	0.0	n.m	n.m	0.0	0.0	0.0

n.m = not measured.

Okeke (1984), in a geological and hydrogeological study of the northern part of Naraguta Sheet 168 NE, between the Jos-Bukuru and the Rukuba Younger Granite Complexes of the Jos area, identified three hydrogeological units consisting of the Quaternary sedimentary deposits, the weathered zones in the crystalline igneous and metamorphic rocks, and the tectonically fractured zones in the crystalline rocks. The thickness of each unit varies and water levels fluctuates widely, resulting in several dry wells at the peak of the dry season, about April/May. Okeke correlated the chemical quality of the groundwater in the study area with the geology. When compared with World Health Organisation (WHO) standards for drinking water, both the surface and groundwater of the area have total hardness, pH, cations and anions, etc., within permissible limits. However, the colour and turbidity of the Delimi River and some wells, as well as their ammonia, taste and amount of total dissolved solids are largely, from preliminary examinations, excessive. These waters need treatment prior to domestic and industrial uses as they have been polluted by agricultural practice, the extensive use, especially along stream valleys of animal and manufactured fertilisers, disposal of solid and animal waste into and along the banks of the Delimi River and its tributaries

(such as near Gada Bauchi and Gada Biyu), leachates from the extensive past mining activities in the Naraguta area, and poor sanitation from cemetries, septic tanks and liquid waste from open gutters draining Jos, especially as storm run-off. In areas of relatively thin superficial cover, or excessive concentration of water wells, where over-abstraction of water occurs, the water wells, which supply purer water than the stream water, most wells become dry during the dry season. A complete assessment of the quality of the surface and subsurface waters must include bacteriological studies.

Mineralogical examination of the Bisichi-Jantar mine dumps
shows that the dump contains zircon, monasite, thorite, and
opaque ore minerals, such as magnetite with ilmenite in oriented
intergrowth, magnetite martitised, or replaced by limonite or
replaced by rutile, pseudorutile or leucoxene. The oxidation
and leaching is caused by the presence of water. Columbite-
tantalite, and rare chromite and tapiolite are also present
(A. Mücke, personal comm., 1984). Preliminary examination of
these mine dumps and stream sediments indicate high radioactivity
and mobile trace element contents.

In a geological study, with particular reference to the
sedimentation pattern of the Delimi River valley north of Jos,
especially in order to delineate the paramaters which determine
the sedimentation of tin-bearing minerals, Onyeji (1984)
indentified tectonic structures, such as joints, veins, dykes,
folications and lineations in crystralline rocks, and graded
bedding, cross bedding, massive bedding and mudcracks in
stream-laid sedimentary rocks. The Delimi River is erosional
and highly channelised when it passes through ridges. Grain
size analysis shows largely unimodal distribution but with
symmetrical and asymetrical distribution. Samples with asymmetrical
distribution of grains contain large amounts of heavy minerals,
including cassiterite, and these samples largely occur upstream
of channel bars. Mineralogical and textural features of grains
suggest that the sources of the sediments are very close by,
largely from the surrounding Younger Granite and Basement Complex
rocks.

Like the proportional distribution found by Hamza (1984), Onyeji's more ditailed sieving showed that although the greatest portion (over 80 percent) were the 2mm to 0.5mm fractions, there was also systematic decrease in the relative proportions from the 0.5 to 0.125mm mesh fractions. The major components of grains were 60-80 percent quartz, 10-30 per cent feldspars, 5-15 percent opaque oxides and up to 10 percent rock fragments for the light fractions, while the heavy minerals included monazite, zircon, magnetite, ilmenite and cassiterite.

Adiuku-Brown and Ogezi (1984 ; and this volume) analysed ten different sulphide minerals, consisting largely of galena, sphalerite and arsenopyrite, from different parts of Nigeria using acids, acid mixtures and different acid strengths and found that dilute nitric acid, which is one of the cheapest, safest and simplest of the leaching solutions used, gave results comparable to those using stronger and more dangerous acids or acid mixtures, or using the specific methods for sulphides. These sulphides could be correlated with their geological environments and could provide significant by - product elements, such as Cd, Sb, Cu, Ag from the sphalerite and galena, Sb from galena, and Ge and Cd from the sphalerite (Table 4). Elements which could also cause impurities and metallurgical problems are also discernible (Table 4). In view of the large number of samples that may be treated for a comprehensive study, as well as considerations of safety, procurement and technical problems, the use of simple dilute leachates is of vital importance, especially

Table 4: Major and Trace Element Contents of Samples from the New Zurak Lead-Zinc Mines, SW Plateau State, Nigeria.

Sample No.		Sample Type	Majors (wt-percent)			Trace Elements (ppm)								
			Fe	Zn	Pb	Cu	Sb	Ag	Cd	Ni	Cr	Co	Mn	Ge
1	A1	Altered Sphalerite	2.0	26.0	38.8	564	–	950	603	40	34	335	575	–
2	B2	Less altered Sphalerite	2.1	52.2	0.0	1447	–	158	2190	40	30	775	130	–
3	D4	Less altered Sphalerite	9.0	49.7	0.0	726	–	109	1340	20	20	820	2795	–
4	F6	White Mine Dump powder	1.4	30.5	8.0	562	–	475	685	52	25	335	750	–
5	7663	'S' Galena	–	0.1	65.0	200	900	1900	–	–	–	–	–	–
6	7665	'H' Galena	–	0.5	70.0	400	2200	500	–	–	–	–	–	–
7	7660	'S' Sphalerite	2.5	58.62	2.0	–	–	200	2380	–	–	–	–	–
8	7664	'H' Sphalerite	2.6	59.0	1.0	–	–	180	2000	–	–	–	–	–
9	7659	'P' Occurrence Galena	–	0.0	73.0	200	500	600	–	–	–	–	–	–
10	7651	'O' Occurrence Sphalerite	3.5	58.3	0.8	–	–	–	2600	–	–	–	–	–
11	7652	'O' Occurrence Galena	–	0.5	70.0	500	300	450	–	–	–	–	–	–

Notes: Serial Nos. 1-4 = Mean values of analyses from Adiuku-Prown and Ogezi(this vol.)
Serial Nos. 5-11 = From NECCO Consultancy Report for Nigerian Mining Corporation, Jos (1976) on Geological Investigations of Lead-Zinc mineralisation in the areas of Abakaliki and Zurak, Nigeria (p137 – P138)(p137 – P138)
– = Not determined or measured
n.d. = Not detected.

in developing countries short of foreign exchange, technical personnel and equipment.

In an economic and environmental study of the lead-zinc mining area of Zurak, south-eastern Plateau State, (Ogezi, 1984; and in Prep) showed that apart from the major economic significance of the Zurak mine, which has been closedfor about 45 years since 1937, because of the metallurgical and infrastructural problems and depressed metal markets, the dumps are a major source of pollution to surface and underground water: as well as plant and animal life in the area (Table 4).

The mineralogy of the sphalerite - and galena-rich sulphides from the Zurak Pb-Zn mine consists of galena (PbS), sphalerite (ZnS), marcasite and pyrite (FeS2), and minor bravorite $(Ni, Fe)S_2$, chalcopyrite $(CuFeS2)$, bournonite (CuPbSbS3) and bravoite boulangerite $(Pb_5 Sb_4 S_{11})$. White, highly corrosive mine dump powder is scattered over the mining area and has resulted from the partial decomposition of the sulphides to altered sphalerite, galena, chalcopyrite, pyrrhotite, graphite and some sulphates. (A. Mücke, pers. comm., 1984). Some of these minerals are reported for the first time in Nigerian sulphide ores.

The Zurak mine pit water used for domestic purposes by the inhabitants of New Zurak is green in colour, has typical sulphide smell, and largely devoid of animal life and generally contains much higher concentrations of Ca, Mg, Zn, Pb and Cd than Jos tap water, streams and reservoir waters in the Jos area and the Zurak

area pond water not polluted by haman activity (Table 5).
A multidisciplinary study of the area is planned to assess the
total effects of mining and mineral processing on the small
rural community of New Zurak Village and on plant and animal life
in the area.

Apart from the investigations reported above, a preliminary
investigation of the effects of human activity on the chemical
quality of surface water has been carried out on samples of water
from the Lamingo (Liberty) Dam and along a tributary stream to
the Delimi from Lamingo Dam to the bridge on the Ring Road, near
the Gospel Faith Church, Jarawa, Jos (Table 5). Apart from Mn,
the dam water contains lower or similar amounts of Ca, Mg, Na,
Zn and Fe. Stagnant waters with significant biological activity
and areas along the streams defecated or used for laundary contained
significantly higher Ca, Fe, and Na (Table 5). This type of study
is being conducted throughout Jos area in streams and wells, but
the necessity for integrated bacteriological studies cannot be
overemphassised.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of the preliminary stages of this research project
reported above has, apart from providing invaluable students'
training, brought out clearly a number of problems and suggested
a number of lines that could be followed in the next stage of the
research:

    i) Standardised instructions covering sample collection,

        preparation, treatment, storage and analysis procedures

Table 5: Concentration in parts per million (ppm) of Trace Elements in Liberty Dam Reservoir and Upper Delimi Tributary Waters (LD) near Jos, Jos City Tap Water, Zurak Mine Pit Water and Sabon Gari Pond Water, from unmineralised area near Zurak.

Field Sample No.	Sample Type and Locality	Trace Elements (ppm)								
		Ca	Mg	Mn	Na	Zn	Fe	Pb	Cd	Cu
1	LD1	Eastern bank, Liberty Dam Reservoir	1.00	0.30	38.0	2.12	0.01	0.2	-	-	-
2	LD2	Small northern overflow west of Sherre Hills	0.91	0.28	41.6	1.79	0.01	0.1	-	-	-
3	LD3	Small southern overflow west of Sherre Hills	8.40	0.34	11.5	2.10	0.02	0.1	-	-	-
4	LD4	Stagnant confluence of LD2 and LD3	3.18	0.37	15.0	2.10	0.02	0.1	-	-	-
5	LD5	Stream "laundry" ca 50m	4.95	0.54	26.1	2.60	0.01	1.2	-	-	-
6	LD6		0.61	0.09	26.4	3.20	0.01	1.3	-	-	-
7	LD7	Small spring to stream from NW	1.59	0.35	2.7	5.10	0.03	2.0	-	-	-
8	LD8	Water west (downstream) of Ring Road bridge near Gospel Faith Church, Jarawa, Jos	1.46	0.32	1.2	5.03	0.02	2.1	-	-	-
9	J2A	Jos Tap Water, Unijos	n.d.	2	n.d.	-	n.d.	n.d.	n.d.	n.d.	n.d.
10	ZW1	Zurak Mine Pit Water, south pit	2	111	3	-	14	n.d.	3	1	n.d.
11	ZW2	" ", north pit	30	135	n.d.	-	98	n.d.	2	4	n.d.
12	ZW3	Sabon Gari, Zurak Pond Water	2	27	n.d.	-	n.d.	1	n.d.	n.d.	n.d.

- = not determined or measured
n.d. = not detected.

should be prepared, together with details of field determinations and observations, preferably in a card form.

ii) The forms of ions to be determined and their significance should be looked into rather than the total ions being determined as at present since the ions which move with water are those which are either soluble in water or those that occur as components of stable suspensions as cations and anions, uncharged atoms, organic complexes, as colloids and suspended matter, and as ions absbobed on suspended matter. Their   toxicity and effects depend on their speciation or the forms and nature of the atoms.

iii) In view of the relatively low concentrations of most trace elements in the water samples analysed and of (ii) above, preconcentration of atoms by ion exchange, solvent extraction, etc., or the use of more sensitive methods and equipment should be considered. Seasonal variations should also be checked in all waters.

iv) With the acquisition of more basic equipment and
                    systematic
reagents, more/sample colection, preparation, digestion and analysis would be embarked upon, especially for stream sediment, water and rock samples.

The following tentative scientific·and environmental recommendations and conclusions could be reached from the results of these preliminary investigations:

v) Most of the alluvial stream sediment deposits are derived

from nearby sources and, often, contain minerals with high radioactivity, such as monazite, thorite and zircon. These minerals may have harmful effects when used for houses.

vi) Although some elements may be leached from mining, mineral processing and mine dumps, etc., their concentrations in sediments, waters, soils, plants and animals depend on their solubility and speciation as well as the season. Some lake water not suitable domestic and industrial uses could be investigated for recreational and agricultural purposes.

vii) Dilute nitric acid is adequate for the extraction of most major and trace elements from sulphides and stream sediments.

viii) The clay-size or finest fractions of stream sediments generally had the highest concentration of the environmentally significant trace elements, and most variations could be explained by geological and human factors.

ix) The well waters generally contained less trace elements and are more suitable for domestic and industrial purposes than stream waters, but seasonal variations are to be investigated in both waters. In general, their trace element contents reflect season, and geological and human factors. Bacteriological tests are necessary on the waters to deduce their optimum uses.

x) Some sulphide and other ore minerals contain significant
amounts of by-product trace elements which could make
their mining, processing and extraction more economic
than as of now.

REFERENCES

Adiuku-Brown, M.E. 1983: Studies on Trace Elements
Associated with Mining in Jos Plateau.
Ph.D. Research Proposal submitted to the
University of Jos.

Adiuku-Brown, M.E. and Ogezi, A.E. 1984: Comparative of
Sample Decomposition Techniques for the
Analysis of Simple Sulphide Minerals. Bull.
Sci. Assoc. Nigeria, Vol. 10, No. 1, P. 62
(Abstract).

Adiuku-Brown, M.E. and Ogezi, A.E. This volume.
Comparative sample decomposition techniques
for the analysis of simple sulphides (full
paper - 10p + 12 tables).

Agada, S.I.G. 1983: Geology of the Area Around River Delimi
Basin (from Narabi to Tilden Fulani) in Bauchi
State. Unpublished B.Sc. Thesis in Geology
and Mining, University of Jos.

Ekpo, B.O. 1984: The Geological, Mineralogical and Geoche-
mical Investigations of NE Naraguta Sheet
(The Jos University and its Environs).
Unpublished B.Sc. Thesis in Geology and Mining,
University of Jos.

Forstner, U. and Wittmann, G.T.W. 1983: Metal Pollution in
the Aquatic Environment. 2nd Ed. Springer -

Verlag, Berlin. 486p,

Hamza, K.A. 1984: Geologic and Trace Element Studies of
the Area South of Jos-Rukuba Road in Plateau State.
Unpublished B.Sc. Thesis in Geology and Mining,
University of Jos.

Manuel, M.K.I. 1983: Geology of Barakin Delimi Sabuwa and
its Environs with particular reference to the
Stratigraphic and Sedimentological Aspects of tin
mineralisation in parts of the Gold and Base Mine,
Jos. Unpublished B.Sc. Thesis in Geology and Mining
University of Jos.

Ochonogor, R.N. 1984: The Geology and Environmental Geochemistry
of part of Rayfield-Bukuru Area. Unpublished B.Sc.
Thesis in Geology and Mining, University of Jos.

Ogezi, A.E. 1984: and in Prep. the Economic and Environmental
Significance of Sulphide Mineralisation in the
New zurak Area, Plateau State. Bull. Sci. Assoc.
Nigeria, Vol. 10, No. 1, P. 35 (Abstract). Full
Paper in Preparation.

Onyeji, B.N. 1984: Geology of the Delimi River Valley North of
Jos Main Town in Plateau State with particular
reference to the Sedimentation Pattern of the River.
Unpublished B.Sc. Thesis in Geology and Mining,
University of Jos.

Okeke, F.U.N. 1984: General Geology and Hydrogeological Study
of Jos Area. Unpublished B.Sc. Thesis in Geology
and Mining, Uninversity of Jos.

Prof. I. Tiwari and Mr. M. Okoronkwo

Department of Community Health, Faculty of Medical Sciences

The last report of JICA-UNIJOS Research Project on Endemic Goitre which covered the period for second half of 1983 had outlined the overall objectives of the study, the methodology employed for survey, classificat- ion of goitres phasing of the project, plan of action for 1984 etc.

The survey of endemic goitre among pre-adolescent children in schools of Bassa L.G.A. of Plateau State was carried out. The following work has been completed up to the 1st half of 1984, ending June 1984.

1. A total of 1104 school children in the Government Secoundary Schools of Binchi, Zagun, Jengre and Miango have been surveyed. (See enclosed map). The results of survey have been outlined in Tables 1 - 5 in Appendix A.

2. A total of 81 blood samples from the school children, both with and without thyroid enlargement, have been collected by the department of Chemical Pathology for Thyroid Function Tests. These samples have been frozen and stored for analysis at a later date.

3. The village leaders in Bassa L.G.A. (the Chief of Bassa and Heads of the villages) have been contacted to elicit their support and co-operation for the purpose of extending the goitre survey work to the general population in the area. The response have been most encouraging and support for the survey work for endemic goitre in villages has been promised.

4. A total of 19 drinking water samples from as many villages in the area has been collected for physico-chemical examination of water samples as well as determination of iodine (iodide ions by ion chromatography analyser) in the drinking water. Some samples have already been analysed and the results on the remaining are expected to be available soon.

Constraints in Carrying out the work:

According to the time schedule coutlined in the initial report of the project a total of 6000 students were expected to be covered up by the survey team by the end of June 1984 as part of phase I of the study. Due to non-availability of the vehicle for survey work from April '84 onwards no survey could be carried out during the last quarter and the target of coverage of 6000 school children has not been achieved. Meanwhile the

schools have closed down for long vacation till September 1984. The equip-
ment and chemicals needed by Chemical Pathology Department for thyroid
function tests have not yet arrived and work has not been possible to be
started.

Plan of action during Second Half of 1984:-

On the basis of experience gained till date the study team feels that
within the multiple pressures of work on the academic staff involved in the
study it would not be possible to cover the entire Platear State under the
survey work. This would be particularly so in view of the distances of
different L.G.A. from Jos. The resource position for carrying out the
study is also not expected to improve dramatically in near future. In view
of the above, it is therefore necessary to modify the targets for achieve-
ment mentioned in earlier reports. The study team proposes the following
changes -

(i)   The original target of coverage of 6000 school children for
        survey will be reduced to about 3000.

(ii)   A total of about 2000 school children yet to be covered up will
        be surveyed as soon as the schools open after long vacation.

(iii)   However, the remaining children will be covered up in two
        L.G.A. other than Bassa, the selection being made on the basis
        of their topographical location and physical features. The
        department of Land Survey of Plateau State has been approached
        and they promised to make available necessary data to help
        select the L.G.A. for the study.

(iv)   The community response for the survey of general population for
        endemic goitre has been very encouraging in Bassa L.G.A. This
        will be fully exploited to carry out the study of the prevalence
        of endemic goitre and the related clinical entities viz. cretini-
        sms, hypothyvoidism etc. Blood samples for study of thyroid
        function test will also be collected.

(v)   Water and soil samples from the area will be collected and
        subjected to iodine estimation. Thus a composite data on
        prevalence, clinical picture, thyroid function and iodine
        availability for at least one L.G.A. (Bassa) sill be collected
        by the end of 1984, thus devetailing phase I and phase II of the
        study.