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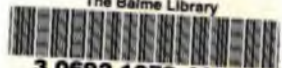
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**THE HEALTH AND ENVIRONMENTAL IMPLICATIONS
OF SMALL-SCALE GOLD MINING OPERATIONS
IN THE BOLGATANGA DISTRICT**

SUBMITTED BY:

EMMANUEL APORI OBENG

**TO THE SCHOOL OF PUBLIC HEALTH,
UNIVERSITY OF GHANA, LEGON**

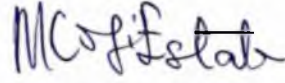
**IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF MASTER OF PUBLIC HEALTH
(MPH) DEGREE.**



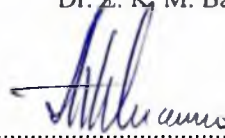
JUNE 1997

ACCEPTANCE

Accepted by the School of Public Health, University of Ghana, Legon, in partial fulfilment of the requirements for the award of Master of Public Health (MPH) degree.



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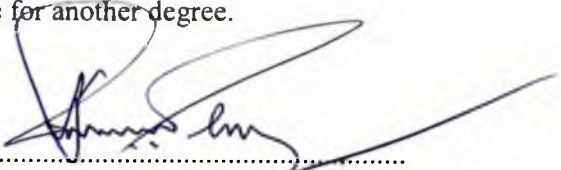
Date: June 1997



DECLARATION

I hereby declare that, except for reference to other people's work, which have been duly acknowledged, this work is the result of my own research and that it has neither in part nor in whole been presented elsewhere for another degree.

Signed:



Emmanuel Apori Obeng
(Candidate)

Date: June 1997



DEDICATION

To Emmanuel, Papaa, Kobby and Betty for their unflinching spiritual, emotional, and physical support during the study period (May 1996 - June 1997) and to the memory of my late father, Enoch Kofi Asare Apori.



ACKNOWLEDGEMENT

I am deeply indebted to all those who in diverse ways helped to make the development of the final proposal, collection of data, analysis and presentation of this dissertation a reality.

They include Dr. J. Adda and J. Atobra, Mr. Mumuni Seidu and all the staff of the District Hospital and District Health Administration, Sandema. The names of Mr. David Syme, Mr. Chaahaa, Mr. Adu-Sarkodie and Mr. Roberto, all of the Builsa District Administration are worth mentioning. The incalculable help offered by the aforementioned people contributed immensely to make my Field Residency Programme in the Builsa District of the Upper East Region a memorable one.

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Ms. Quayson and Mr. Alex Baba, both key informants who were responsible for much of the background information on the study area.

The Chief of Gbani, Tipoktaaba Nagbil for granting me audience and permitting me to conduct the research in his area of jurisdiction. Mr. Walter of Soci t  Exploitation de Mini re for his exposition on non-mercurial methods of gold extraction. Drs. Odoi-Agyarko

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Lastly to my Academic Supervisors, Drs. Z.K.M. Batse and A.B. Quainoo, I say thanks a million for painstakingly reading through the script to ensure that it met the requisite standards.

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LIST OF ABBREVIATIONS

1.	AGC	Ashanti Goldfields Corporation
2.	ARP	- Arsenic Removal Plant
3.	DEMC	District Environmental Management Committee
4.	EAP	Environmental Action Plan
5.	EIA	Environmental Impact Assessment
6.	EMP	Environmental Management Plan
7.	EPA	Environmental Protection Agency
8.	HDPE	High Density Polythene
9.	KNUST	Kwame Nkrumah University of Science & Technology
10.	NEAP	National Environmental Action Plan
11.	PMMC	- Precious Minerals Marketing Company
12.	PNDC	Provisional National Defence Council
13.	PNDCL	Provisional National Defence Council Law
14.	TGL	Tarkwa Goldfields Limited
15.	US	United States

ABSTRACT

This was a descriptive cross-sectional study to ascertain the health and environmental implications of small-scale gold mining operations in the Bolgatanga District of the Upper East Region.

Small-scale gold mining started actively in an area designated the Small-Scale Gold Mining Area about two (2) years ago. The three main types of gold mining operations were alluvial, colluvial and lode gold mining. Alluvial and colluvial gold mining involved both sexes but lode gold mining was the exclusive preserve of males. Whereas mercury was used in the processing of ore in colluvial and lode gold mining, alluvial gold mining did not require its use. Explosives, though prohibited were freely used in lode gold mining because gold was encased in granite buried several metres below ground level.

The 40 underground lode gold miners, chosen conveniently and interviewed were multi-ethnic in nature with a non-indigenous (non-Upper East) to indigenous (Upper East) ratio of 3:2. They were relatively young with a mean age of 28.8 ± 5.8 SD years. Forty five percent (45%) smoked tobacco, 50% drank alcohol and 37.5% drank alcohol and smoked tobacco. Two and a half percent (2.5%) admitted smoking marijuana. They described their working conditions as good but agreed that working in single pits without adequate ventilation could be suffocating.

The common health complaints among them were headache and bodily pains, abdominal pain and diarrhoea, catarrh, cough and chest pains. Other ailments were seasonal. Cholera and Pneumonia were rife during the wet season whereas Cerebrospinal Meningitis, Chicken Pox and Measles were common during the dry season. Malaria, Sexually Transmitted Diseases (STDs), Scorpion and Snake Bites were also prevalent. The job-related injuries included lacerations and abrasions, foreign body in the eyes and falls in the pits. Cerebrospinal meningitis (CSM); Cholera, Snake bites, Inhalation of 'Smoke' (Carbon monoxide fumes), Cave-ins, Dynamite explosions and Falls into pits were mentioned as causes of death among miners.

There was total disregard for the use of protective clothing during working hours. The reasons given were non-availability, non-affordability, suitability and a false sense of security. Almost everyone knew about the side effects of carbon monoxide (smoke) inhalation but 37.5%, 45% and 70% did not know of any side effects of dynamite, dust and mercury respectively.

The environment was characterized by substandard housing, overcrowding, poor water and sanitation facilities, high noise levels and atmospheric pollution with dust, fumes from water-pumping machines and detonation of dynamite. Numerous rock and soil 'waste' dumps, land denuded of trees, shallow excavations and abandoned pits littered the environs of the small-scale gold mining area.

Concerted actions by the stake-holders, i.e. the Government through the review of existing legislation, technical and financial support for small-scale gold miners; the

District Assembly through the monitoring and evaluation of gold mining activities and the setting up of an Environmental Rehabilitation Fund, and lastly the willingness of both miners and the non-mining community to observe good health and environmental hygiene practices, are some of the ways required to make small scale gold mining operations both health and environment-friendly.

CHAPTER ONE

INTRODUCTION

1.1 HISTORICAL PERSPECTIVE OF SMALL-SCALE GOLD MINING IN GHANA

The history and economy of Ghana are inextricably linked with Gold. Ghana was called the Gold Coast prior to her Independence in 1957. According to Green (“The World of Gold” - pg.101); ‘Once upon a time, Ghana really lived up to its historic name of the Gold Coast; before the South African discoveries, nearly one-third of the world’s gold production came from there ...’

It was gold that attracted the Portuguese vessels under the command of Joan do Santarem and Pedro de Escobar to the Gold Coast in 1471 which marked the beginning of the European Trade in Gold.¹ Christopher Columbus who later discovered the American mainland was said to have done so after his cartographic voyage to the Gold Coast in the company of Don Diego D’ Azambuja. The Portuguese were followed by the English explorers and by the end of the 16th century a regular trade in gold dust and nuggets had developed.

The development of modern gold mining in Ghana started in 1877 with the granting of the first gold concessions in Tarkwa to a French national Mr. Pierre Bonnat. Prior to this all the gold produced in the Gold Coast was through the efforts of the indigenous gold miners. T.E. Anin quotes Bossman, Meredith and Sir William Bradford Griffiths to give a vivid description of the indigenous gold mining process¹.

Bossman, in his book entitled “A New and Accurate Description of the Coast of Guinea”, published in 1698; described the activities of women and boys in Elmina and Axim after violent rains. ‘They filled large trays with sand and gravel which they washed repeatedly until gold was segregated and removed’ - a process called Panning. Meredith, in 1812, also described the attempts by indigenous diggers in the forest at surface mining. In their search for lode gold the ‘natives dig as if forming a well until they came to a dark coloured stone which is interspersed with gold, which is recovered by grinding the stone to powder and washing it.’ The shafts were 80 feet or less deep, 2 feet wide and not timbered. They used hoes in digging and the loose soil was hoisted up in calabashes. Imported hammers and chisels, purchased from the forts and castles along the coast were used to break the ore. The ore was then carried to the house, ground to a fine powder on a slab of granite, collected in calabashes and washed to obtain gold by the women folk.

Sir William Bradford Griffiths in 1889, provided a description of ‘native gold workings’ during his visit to Prestea. ‘I witnessed an interesting sight of some native shafts, about 200 feet square, timbered with light poles in some instances and untimbered in others, with windlasses worked occasionally with ropes made of native lianes and fibres, and each with an air shaft along side of it.’

Indigenous gold digging was tedious, hazardous and back-breaking and was limited to above the water table. The miners had no means of combating the inflow of water because there were no water pumps until the last two decades of the 19th century. Most of the digging was restricted to the dry season when the water level was low.

According to T.E. Anin, 'The Colonial authorities actively discouraged alluvial gold mining by means of legislation. Under the provision of the Mercury Ordinance, the mere possession of mercury, vital for the extraction of gold, was made a criminal offence. Secondly, under the provision of the Rivers Ordinance, the diversion of river courses for the purposes of extracting gold, diamonds and other minerals was forbidden....' Apart from these legal obstacles, alluvial gold mining in the post - 1918 era was unremunerative. The price of gold had been pegged at US\$20 per ounce until it was increased to US\$35 per ounce by President Roosevelt in 1934. This increase however, failed to provide sufficient incentive to the indigenous gold diggers who had been attracted to cocoa-farming because of the higher prices offered for cocoa. The much improved price of gold during the early 1970s led to an upsurge in alluvial gold digging in Ghana. It was however carried out illegally and clandestinely because there had been no change in government policy with regards to alluvial gold digging in Ghana since independence.

One of the main aims of the Economic Recovery Programme embarked on by the PNDC in 1982-86, was the rejuvenation of gold mining activity in Ghana. With the support of the World Bank, the Gold Mining Industry entered a period of renewed development and growth.

The Government of Ghana participated in this process by promulgating the following mining decrees:

1. The Minerals Commission Law 1986 (PNDCL 154)
2. Minerals and Mining Law, 1986 (PNDCL 153).

These provided fiscal and other incentives to would-be mining companies. They were later followed by the Small-Scale Gold Mining Law in 1989 (PNDCL 218) which made alluvial and lode gold mining by indigenous gold miners legal.

‘Galamsey’ (Gather and Sell) refers to the activities of indigenous small-scale gold miners. It is legal where a licence is obtained in accordance with Section I, Subsection I of the Small-Scale Gold Mining Law, 1989 (PNDCL 218). This states inter alia “..... no person shall engage in or undertake any small-scale gold mining operation unless there is in existence in respect of such mining operation a licence granted by the Secretary of Lands and Natural Resources or by an Officer authorised in that behalf by the Secretary.”² It could be likened to the ‘Asantrofié’ bird in Akan folklore. The ‘Asantrofié’ bird though a tasty game bird, is associated with bad omen. Similarly ‘Galamsey’ could increase both local and foreign revenues as well as reduce unemployment, but leave in its trail enormous health and environmental hazards.

Small-Scale gold mining operations flourished as part of the underground economy and formed the basis of smuggling activities, prior to the promulgation of PNDCL 218 in 1989. The regularisation policy has brought in its wake an increase in small-scale gold mining activities. By 1992, 302 small-scale mining licences have been issued and about 50,000 people were working legally as small-scale miners. Total gold purchased by the Precious Minerals Marketing Company (PMMC) from 1989 to 1991 was 15.312 million US dollars made up of 3.730, 6.257, and 5.325 million US dollars respectively for 1989, 1990 and 1991.³

The upsurge in gold mining activities, both large and small-scale, led to increased gold production from an annual total of 400,000 oz (4 tonnes) in 1987 to 1.2 million oz (10.2 tonnes) by 1994. Thus reestablishing Ghana as the second largest gold producer on the African continent after South Africa.⁴

Mining presently employs over 7% of the labour force in Ghana and in 1994, for example, accounted for 48.4% of the country's gross foreign exchange earnings (Iddrisu, 1996)⁴. Small-scale gold mining contributes almost 10% of the total gold production in Ghana (William Wallis - 1996).⁵

1.2 PROBLEM IDENTIFICATION

Despite the revenue and employment generating potentials of small-scale gold mining, there have been repeated calls by individuals and communities for its banning because of the health and environmental consequences.

A report on the activities of small-scale miners in the Tankwiddi East Forest Reserve at Sirigu near Bolgatanga in January 1996 revealed:

“The destruction of the forest reserve through the felling of trees, pollution of rivers and streams with mercury, the use of explosives by miners, non-adherence to the use of protective clothing such as masks, helmets or gloves and social problems such as the peddling of drugs, alcohol and marijuana abuse and attraction of school drop-outs to the site.” (Omanhene - 1996)⁶

Following this report a combined team of the Police and Armed Forces had to be brought in to dislodge the miners numbering about 2,000 from the Sirigu site.

Dzigbodi-Adjimah had this to say

“Legalising small-scale or ‘galamsey’ mining has been acclaimed an achievement of the current gold boom. But ‘galamsey’ has unleashed considerable havoc onto the environment. The Ghanaian country side is being turned upside down and natural reserves are devastated in the uncontrolled search for gold. Roads, bridges and arable farm lands are destroyed with wanton abandon, mercury is peddled and handled by untrained hands while rivers and streams are freely polluted by gold mining activities..”⁴

However, PNDCL 218 allows the small-scale gold miner to purchase mercury from an authorised dealer (Section 14) but bans him from the use of explosives (Section 13). It also enjoins him to ‘observe good mining practices, health and safety rules and pay regard to the protection of the environment.’ (Section 11). It is anybody’s guess as to whether these regulations are being followed by small-scale gold miners.

Whilst there is a fair amount of literature on the effects of large-scale gold mining on the health of the miners as well as the environment in Ghana, the converse is true for small-scale gold mining activities. For example, a workshop on ‘Health and Safety in Workplaces’ organised by the West African College of Physicians (Faculty of Community Health) from 11th - 13th June, 1992, dealt among other things, with the health hazards associated with large-scale gold mining at Tarkwa and Obuasi.

Similarly a seminar on ‘The Effect of Mining on Ghana’s Environment with particular reference to the proposed Mining Environmental Guidelines’ held in Accra from June 24th to 26, 1992 dwelt mainly on experiences from the large-scale mining companies.

The need for the objective identification and analysis of the health risks to the individual miners and the community, as well as the environmental hazards associated with small-scale gold mining, cannot be over emphasised.

A study of this nature is justifiable if we are to avoid the fears expressed in a paradox by Rousseau in (1970) that ‘*mankind deteriorates as material civilization advances.*’

This study therefore seeks to find out the Health and Environmental Implications of small-scale gold mining operations in the Bolgatanga District. It is my hope that this would lead to further case studies of small-scale gold mining activities scattered all over the country with a view to making them ‘health and environment-friendly.’

1.3 OBJECTIVES

The main objective of the study was to analyse and report on the health and environmental implications of small-scale gold mining operations in the Bolgatanga District of the Upper East Region.

The specific objectives were:

- (i) To identify the hazards to which small-scale gold miners were exposed and their implications for health.
- (ii) To ascertain their working conditions and the use of protective equipment.
- (iii) To find out their knowledge about the effects of various mining hazards on their health.
- (iv) To identify the environmental problems posed by small-scale gold mining operations.

- (v) To articulate the concerns of the communities living in and around the mining sites.

1.4 METHODOLOGY

1.4.1 Study Type

This was a descriptive cross-sectional study of the health and environmental implications of small-scale gold mining operations in the Bolgatanga District.

1.4.2 Study Population

The study population consisted of small-scale gold miners operating in the area delineated in figures 2 and 3 i.e the small-scale gold mining area. The study specifically covered the communities at ‘Obuasi’, ‘Kejetia’, ‘Crusher’ and ‘World Bank’ (figure 4). The total population was estimated to be about 3,000 people. These comprise the small-scale gold miners and other service providers such as shopkeepers, blacksmiths, food vendors and gold buyers.

1.4.3 Variables

Apart from the background variables such as Sex, Age, Region, Marital Status and Level of educational attainment, the following were also explored.

Health:

- i. Hazards resulting from the gold mining process.
- ii. Working conditions.
- iii. Use of protective equipment.
- iv. Common ailments.

- v. Accidents.
- vi. Causes of death
- vii. The use of alcohol and tobacco/self medication.
- viii. Knowledge of health risks associated with hazards.

Environment:

1. Types of Housing.
2. Environmental degradation.
3. Sources of water supply and sanitation.
4. Food and meat hygiene practices.

1.4.4 Data Collection Techniques and Instruments

Two pre-study visits were paid to the small-scale gold mining area in September and March which corresponded to the Wet and Dry seasons respectively. These visits gave me a fair idea of living and working conditions in the mining area during those two seasons. Through informal discussions with the miners and observation on those two occasions, I had some insight into the health and environmental problems associated with the small-scale gold mining process. I learnt of the existence of specialised group of workers among the miners from a key informant during the second visit. These experiences helped me to develop the methods for collecting data for this study.

The data collecting instruments e.g. Interview Schedule, Focus Group Discussion guide and Interview guides were all pretested and the necessary corrections made after permission had been obtained from the Chief of Gbani's representative at the mining site.

The community entry was facilitated by a representative of the Regional Health Directorate, Bolgatanga who was a member of a team that did a baseline study on the small-scale gold mining area about six months prior to my study visit.

I divided the miners into two broad groups, i.e. Underground and Surface workers. The underground workers included those who sunk the pits, blasted the ore and brought it to the surface, and the surface workers were those who reduced the ore into chipping sizes, pounded them, sifted them, ground them, took the powder to the 'sumps', amalgamated the gold with mercury and finally heated the amalgam to recover the gold. (See detailed description of the small-scale gold mining process/job description under section 2.3).

In all, 40 underground miners were interviewed using the interview schedule in Appendix I. This number though chosen conveniently represented about 1.3% (40 out of 3,000 people) of the total population of the area studied and I realised it could give me fairly accurate information about the variables being explored; the study being a descriptive one. Time and financial constraints, the non-use of a research assistants and the fact that I had to travel 60km every day, and stay at the mining site from about 9.00am to 6.00pm prevented me from interviewing more than the said number.

The miners were chosen by convenience (non-probability sampling) because they were a very mobile group of people, not available for interviews during working hours, and some declined interviews. To maximise the response rate, the miners were interviewed after they had received vaccinations against cerebrospinal meningitis and/or yellow fever, a 'felt need' they had expressed during the community entry period.

Focus group discussions were arranged for the ‘Blastmen’, ‘Locoboys’, ‘Kaamen’ and ‘Shanking girls’ (detailed job descriptions on pages 19-24), to obtain information on specific job-related health problems using the Guide in Appendix II. Individual discussions were held with the grinding mill operators “Crushers” and workers at the ‘Sumps’.

I interviewed the Medical Assistant in charge of the Tongo Health Centre, the Doctor in charge of Odoi-Agyarko Clinic, Bolgatanga and a Senior Medical Officer at Bolgatanga Central Hospital. These were to corroborate the morbidity and mortality information obtained from the miners.

I tried but never succeeded in having discussions with the two health care providers who operated ‘clinics’ at the small-scale gold mining site. They could have provided me with data on the day to day ailments they treated.

I was granted audience by the Chief of Gbani and reviewed an unpublished data on the small-scale gold mining operations compiled by the Regional Health Administration. These enabled me to find out the concerns of the non-mining communities living within the small-scale gold mining area.

The offices of the Environmental Protection Agency and Minerals Commission in Bolgatanga made available to me reports on their activities in the district. Through informal discussions with an employee of Societé Exploitation de Minière, I was able to obtain information on non-mercurial methods of gold extraction and mineral sampling instruments.

I used observation and check lists to ascertain the occupational hygiene practices among the miners, the types of housing, sources of water for domestic and industrial use,

sanitation, environmental degradation, and food and meat hygiene practices. To ensure confidentiality, no names were recorded on the interview schedules. The data collected were sorted out into interviews, focus group discussions, checklists and labelled accordingly. Analysis of the data was done manually.

1.4.5 Limitations of the Study.

The use of convenient (non-probability) sampling to select underground miners for the interviews meant that the semi quantitative data expressed in the findings might not be a true reflection of what pertained at the site.

There was no verbatim recording of proceedings of the focus group discussions on paper. Proceedings were recorded solely on a tape recorder; which made cross-checking of information difficult during the transcription stage.

CHAPTER TWO

BACKGROUND INFORMATION ON STUDY AREA

2.1 THE BOLGATANGA DISTRICT (Figure 1)

2.1.1 Geography

It is one of six districts in the Upper East Region. It is bordered by Bongo District on the North, West Mamprussi District on the South, Bawku West District on the East and Kassena-Nankana District on the West.

The district covers an area of about 1,444 square kilometres. The White Volta runs through the district from Burkina Faso and the climate is similar to what exists in the Upper regions of Ghana with mean monthly temperatures ranging from 22°C to 35°C. There are two main seasons, a dry season which runs from November to May and a wet season from May to October. The harmattan comes with very dry winds from November to February.

The vegetation is mainly savannah woodland with economically viable trees such as shea, dawadawa, baobab, and acacia interspersed with grasses and shrubs. Part of the district is hilly and rocky, notably the Tongo hills and Tanzin rocks.⁷

2.1.2 Demography

The district has 167 communities with a total population of 227,568, giving it a population density of 158 persons/square kilometre compared with a regional average of 125 persons/square kilometre. The major ethnic groups includes Grunis, Nabdams and Talensis.

3.1.3 Socio-Economic Infrastructure

(i) **Health:**

The district has a Regional Hospital in addition to four Health Centres at Bolgatanga, Zuarungu, Tongo and Pelugu. Other health care providers are Odoi-Agyarko Clinic, Asukande Clinic, Presby Rural Health, Traditional Birth Attendants, Bone Setters, Sooth-Sayers and Circumscisioners.

(ii) **Education:**

The number of schools are as follows:

Primary	=	80
Junior Secondary	=	44
Technical	=	2
Senior Secondary	=	5
Vocational	=	4

(iii) **Utility Services:**

Bolgatanga and its immediate vicinity have electricity from the national grid and pipe-borne water. All other settlements have water from either boreholes or hand dug wells. They have no electricity.

(iv) **Housing:**

Bolgatanga, the district capital and its environs have well-planned layouts and block houses.

The rural communities are poorly-planned, and the houses built mostly with

mud and roofed with thatch. They may or may not have windows rendering living and bed rooms poorly ventilated and lighted. People rear animals and farm around their houses. Settlements are therefore far apart from each other.

(v) **Festivals:**

There are two main festivals

- (a) The Goligo festival which ushers in the farming season from April through May to June.
- (b) The Daaga festival which ushers in the harvesting season begins from October through to December.

(vi) **Traditional Power Structure:**

There are four paramountcies in the district with traditional Chiefs heading all the communities.

2.1.4 Employment

Agriculture, in the form of small-scale farming and animal husbandry, is the mainstay of employment. Crops cultivated include rice, maize, guinea corn, corn, groundnuts, millet, beans and tomatoes.

A minor fraction of the working population consist of civil and public servants, businessmen and traders. Small-scale gold mining is the latest addition to the economic activities in the district.

2.2 THE SMALL-SCALE GOLD MINING AREA.

(Figs. 2, 3, 4 - culled from Reference No.8)

Small-scale gold mining activities started in the Bolgatanga District in the early parts of 1995. The gold was discovered by old miners from the region who had worked in the Ashanti Goldfields Corporation at Obuasi. Returning home they recognised the tell-tale signs of gold hidden in the rocky outcrops and in the dry earth surrounding their own town.⁵

History also had it that gold was mined in the Nangodi area from 1928 to 1939.¹

This eventually led to the reservation of 72 square kilometers of land by the Minerals Commission for small-scale mining operations. (See Photo I).

It is located about 32 km southeast of Bolgatanga and can be reached from Bolgatanga through either the Winkogo - Tongo - Shiega - Damko/Datoko or Zuarangu - Tongo - Shiega - Damko/Datoko laterite roads. Tongo which is 20km from the site has a Health Centre and the nearest electricity supply is at Winkogo which is about 27km away.

Accessibility is quite good during the dry season but two consecutive heavy rains are enough to render the site inaccessible during the rainy season.

The area is drained by the Kulubiliga and Owon which is a tributary of Kuldage. Kulubiliga and Kuldage are the main tributaries of the White Volta. The Kulubiliga stream provides water for drinking and sorting of ore. These rivers overflow their banks during the rainy season but dry up during the dry season.

It is divided into smaller settlements (Fig. 4) and has an estimated population of 3,000 people. 'Kejetia', 'Obuasi', 'Crusher' and 'World Bank' were the settlements included in

the present study. The area lies within the lower Proterozoic rocks of Ghana. These rocks form the Birimian System which is noted for its gold mineralization (Figure 5). Locally it lies south of and adjacent to the Nangodi Gold Belt which is part of the Bole-Navrongo Belt. Mining activities had occurred in the following areas within the Nangodi Belt starting from the north towards the south, Widinaba, Nangodi (1928-1939), Midas, Money Palava, Strong Reef, Zug Mine, Blasted Oak and Dushie.⁸

The advent of small-scale gold mining activities in the Bolgatanga District has brought about the formation of a District Mining Committee in accordance with Section 10 (PNDCL 218). It is made up of one member each from the following Departments:

- (i) Environmental Protection Agency
- (ii) District Administration
- (iii) Town and Country Planning
- (iv) Forestry
- (v) Water and Sewerage Corporation
- (vi) Minerals Commission

There are in addition to the above, 7 members and 2 ex-officio members from the District Assembly. The functions of the Committee include:

- (i) Deliberation on issues relating to mining activities in the District.
- (ii) Consideration of individuals and companies for mining concessions.
- (iii) Assisting the District Small-Scale Mining Centre to effectively monitor, promote and develop small-scale mining operations in the designated area.

The District Assembly has reconstituted a special mining task force consisting of members of the District Mining Committee, the Police Force and the Property Protection Associates to enforce mining bye-laws in the District.

The office of the Minerals Commission i.e. the District Small-Scale Mining Centre, was established at Bolgatanga in 1996 and became fully operational in January 1997. The office is responsible for:

- (i) Compilation of a register of all small-scale gold miners and prospective small-scale gold miners.
- (ii) Supervision and monitoring of the operations and activities of small-scale gold miners and prospective small-scale gold miners.
- (iii) Advice and provision of such training facilities and assistance as may be necessary for effective and efficient small-scale gold mining operations.
- (iv) Submission of reports and other documents and information on small-scale mining activities in the district to the Minerals Commission in such form and at such intervals as may be directed by the Commission.

The Environmental Protection Agency, established in Bolgatanga since 1987/88, is actively involved in activities of the District Mining Committee. It has granted permission to a mining services company, to exclusively crush and grind ore for licenced small-scale gold miners at the site.

The Precious Minerals Marketing Company (PMMC) is the latest to open an office at Bolgatanga in January 1997 to purchase gold from the small-scale gold miners.

2.3 THE SMALL-SCALE GOLD MINING PROCESS/ JOB DESCRIPTIONS (Photos 2 - 15)

There were three types of small-scale gold mining operations in the area studied.

2.3.1 **Alluvial gold digging** (Photo 3) referred to as ‘Sambariga’ i.e dig and wash, in the local dialect. This is similar to what was described by Bossman earlier on and is undertaken mainly by women, children and some Burkinabe men. Digging is limited to a depth of about 1 metre and when a layer containing a mixture of sand and clay is reached it is collected, repeatedly panned until gold is obtained in the form of nuggets. Others dredge the river beds using pans or calabashes and follow a similar panning process to recover gold. No mercury is used.

2.3.2 **Colluvial gold mining** (Photo 2) - “Doma doma” meaning Come out, come out in the local dialect. These miners are young men and women who dig to a maximum depth of about 1.5 metres and collect stones suspected to contain gold. Such stones are crushed and when the tell-tale signs of gold are found, they are pounded, pulverised, processed and mercury added to amalgamate the gold. Gold is obtained by heating the amalgam to evaporate the mercury.

2.3.3 **Lode gold mining** (Photos 4-15). This is the most laborious of the three small-scale gold mining processes because the gold here is encased in a granite-like stone buried several metres under rocky ground. It involves pit/shaft siting, sinking, timbering and cementing, ventilation, management of water-logging, drilling and blasting, hoisting/hauling and treatment of gold ore. Each of these processes are undertaken by a specialised group of

workers. (Agomor -1996).

2.3.3.1 Pit/Shaft Siting

No detailed prospecting work has been done in all cases and the places being mined are Inferred areas (believed to harbour gold). Siting is done on purely speculative basis, the colluvial/alluvial gold miners acting as guides to the lode gold miners. The miners are usually organised into groups or gangs.

The leader of the group who acquires the piece of land for pit siting is referred to as the 'Ghetto owner'. He is responsible for financing the sinking of the pit, maintaining discipline and seeing to the well-being and safety of the miners in his group. If he is not financially capable, he looks for a 'Sponsor' who invests financial capital until the gold-bearing rocks are reached. For his investment, the 'Sponsor' receives a third of all the ore mined from the shaft ('Division three'). This is similar to the 'Abusa' system in the Akans' remuneration for work.

2.3.3.2 Sinking of Pits/Shafts

The pits are rectangular, square or circular in shape, and usually run vertically until a cross cut or level is driven to intersect the ore. The sinking of the pit is done by the 'Chislers' (Photo 4) who use pickaxes and shovels initially and resort to chisels and hammers as the pits get deeper and the weathered rocks are met. They leave alternate shallow pouches about 30 cm (one 'leg') apart on opposite sides of the vertical walls which serve as steps for the ascending and descending of the pits.

Dynamite is used to break the rocks where necessary to facilitate the sinking of pits.

Not all pit sinking result in the finding of the right stone.

The Collars of the pits are usually supported with timber and soil and the entrance cemented to a depth of about 2 meters to prevent runoff of rainwater into shafts. Pieces of timber referred to as 'chock packs' are used to support areas considered risky at the hanging walls. Enough room is left for movement and hoisting of material.

The clustering of the pits sometimes results in interconnections at certain levels, allowing for natural ventilation. Some miners purposefully create ventilatory holes to improve air circulation in the pits. These holes however represent weaknesses in the walls and sometimes facilitate cave-ins. To ensure that such interconnections do not create unnecessary social disorders and cave-ins some experienced miners leave 'pillars' of stone between adjacent walls. Ventilation is usually poor in single pits.

2.3.3.3 Management of Water-Logging in Pits

This is by far the most difficult problem miners face and it accounts for the migration of miners from one site to the other. Water pumping machines are used for dewatering by lowering them into the pits.

The miners are forced to adopt this measure because most of these machines cannot pump water below 10 metres due to the opposing force of gravity. The 'Operators' (Photo 5) ensure that the machines are in good working condition and they are also responsible for putting the machines on and off.

In shafts without interconnection (single shafts) and therefore with poor ventilation the accumulation of exhaust fumes from these machines have sometimes resulted in the death of miners. Few miners use pumping machines with submersible pumps in the pits and the machines on the surface. This serves the dual purposes of preventing the accumulation of fumes and providing lighting in the pits.

Where the inflow of water is not high dewatering is done with rubber containers attached to a rope.

2.3.3.4 Drilling and Blasting.

Once a stone suspected of containing gold is intersected, a piece is taken for sampling to determine the gold content. The piece is crushed, pulverised, pounded and panned using a circular piece of tyre inner tube called 'sample tyre'. Having satisfied themselves of the gold content, the stone containing the gold is drilled and blasted by the "Blastmen" (Photo 6) They use a diamond-tipped drill ('Moyer') and a hammer to make a circular tunnel depending on the length of the dynamite; which is usually cut into 50 cm lengths. The caps of the fuse are well inserted into the drill holes and the holes are then sealed with sand compacted in papers about 8 cm long ('Food'). The dynamites ('Kaagum') are lighted by the 'Blastmen' who must get out quickly to avoid being caught in an explosion.

2.3.3.5 Hoisting/ Hauling

The miners use ropes, buckets, fertilizer, rice and cocoa sacks and plastic containers to haul/hoist materials from the pits. This work is performed by the 'Locoboys' (photo 7). They stand at vantage points in the shaft, and the load is pulled with rope from one

‘Locoboy’ to the other until it reaches the final person on the surface who discharges it. Their work continues until all materials are mucked out before they take a break.

2.3.3.6 Treatment of Gold Ore.

This consists of size reduction, sieving, primary separation, secondary separation, obtaining an amalgam and heating the amalgam to recover the gold.

The ore is reduced to chipping sizes after it has been brought to the surface. It is placed on a piece of granite and crushed with hammer. The work may be done by the miners themselves or by a group of workers (‘Crushers’) (photo 8) under the eagle eyes of the ‘Ghetto owner’ or a security man.

A piece of jute is wrapped around the ore to prevent the scattering of chippings. The chipping sizes are further reduced by pounding in iron mortars and pestles by a gang of two or three people called ‘Kaamen’(photo 9).

After the ore has been pounded into powder form (pulverized), it is sifted using headkerchiefs as sieve. This is usually done by women (‘Shanking girls’) - (photo 11). This screening process is referred to as ‘Shanking.’ Their reward is part of the chippings after sieving. The chippings left after sifting may either be pounded further or sent to the grinding mills to be reduced into powder. These mills are corn milling machines which have been converted into ore grinding machines for purely economic reasons (photo 10).

The millers argue that grinding gold ore fetches more money than milling corn or millet.

The powdered ore from pounding, sifting and grinding is mixed with water and processed using sluice boxes. This is done at the 'sump' (photo 12). The 'sumps' may be constructed by a group called 'Sump owners' or by a 'Ghetto owner.' They provide steel mortars and pestles, water for sluicing the boxes and materials for matting. The reward of the 'sump owners' is the tailings from sluicing. The miners are only allowed to sluice their prepared ore once.

During the sluicing process the miners cleanse their mats into bowls containing water at intervals of about 15 to 30 minutes to recover the heavy minerals and gold.

The concentrates are panned repeatedly to obtain as minimum as possible concentrate with gold using a 'Sample tyre' (photo 14).

After the initial sluicing by the miners the 'sump owners' recycle the tailings for gold. Following this second sluicing the tailings are scooped from the 'sumps' and left to dry. They are later bagged in fertilizer bags and sold to another group of people who specialise in the buying, further milling and processing of tailings.

The gold obtained from panning is amalgamated with mercury which is later evaporated to recover the gold. (Photo 13).

Both mercury and amalgam are freely handled with the hands and the mercury is never recovered.

The gold is sold either to registered buyers or illegal gold buyers, mostly aliens. It is weighed using scales and blades. A blade worth of gold sells between eleven and fifteen thousand cedis (photo 15).

CHAPTER THREE

LITERATURE REVIEW

3.1 HEALTH HAZARDS ASSOCIATED WITH GOLD MINING

Gold mining, one of the oldest industries in the world, has always been hazardous. There was almost complete disregard for the health of miners in ancient Greece and Egypt because mining was done by prisoners, criminals and slaves.

Agricola and Paracelsus, both renowned physicians made the first observations on miners and their diseases. Agricola, in 1556, described in ‘De Re Metallica’ the diseases prevailing in mining communities. Paracelsus, in 1567, described tuberculosis as a miner’s disease, and indicated that increasing risk of occupational chest disease was the result of industrial development such as mining.

Bernardino Ramazzini, emphasized in the 17th century that lung diseases were not due to the type of labour performed but the materials worked on.

The health hazards encountered in gold mining can be classified into:⁹

- (i) Physical
- (ii) Chemical and
- (iii) Biological

3.1.1 Physical Hazards

These include Temperature and Humidity, Noise and Vibration, Working Space, Lighting and Accidents.

Temperature and Humidity.

The deeper the mine the higher the ambient temperature and the relative humidity in which the miner is required to work. Symptoms like lassitude, irritability, lack of concentration and anxiety could result from prolonged exposure to high temperature and humidity. The miner may suffer from heat cramps, which usually starts from the calves and spreads to the lower limbs and abdomen, where large amounts of salts are lost from the body through sweating.

Noise and Vibration

High noise levels in the order of 100 or 110 dBA are usually caused by blasting with explosives and compressed air drilling. Miners in confined spaces exposed to these may suffer from noise-induced hearing loss.

Transmission of vibrations to the hand from drill hammer and pneumatic picks may cause osteoarticular lesions and in severe cases, vibration induced white finger.

Working Space

Miners assume contorted posture while working in confined spaces. Repeated pressure on the knees, elbows and hands may result in the development of callouses, bursitis and cellulitis often with superimposed infection. Postural abnormalities such as Kyphosis, Scoliosis and Kypho-scoliosis may result from adapting to the insufficient working space.

Lighting

Poor lighting underground causes miners' Nystagmus. This is characterised by rhythmic involuntary movement of the eyes. The relative absence of rods at the macula causes

a defect in fixation which is symptomless. Where there are symptoms, they are, in addition to nystagmus, those of vertigo, photophobia, headache, insomnia and blepharospasm. Defective vision is sometimes reported.

Accidents

Accidents like lacerations on the head, hands and toes, and falls are rampant in the mining industry as a result of insufficient headroom, carrying or loading materials and working with machines.

3.1.2 Chemical Hazards

The chemical hazards are Dusts, Oxides of Nitrogen, Carbon Monoxide, Mercury and Cyanide.

Dusts

The most important of these, is the exposure to free crystalline silicon dioxide (Silica) which leads to Silicosis. Silicosis is characterised by a permanent alteration or destruction of the alveolar architecture, collagenous stromal reaction of moderate to maximal degree and permanent scarring of the lung. (4th ILO Conference on Pneumoconiosis, 1971).

The commonest complication of the disease is Tuberculosis, which is a major cause of morbidity and mortality among miners with silicosis. Agadzi et al in 1980, estimated the prevalence of Tuberculosis among adult non-miners as 1% and among adults of the major mining areas in Ghana as 6.2%, six times more prevalent than in the general population.¹⁰

The degree of risk of silicosis depends on

- (i) concentration of dust in the atmosphere
- (ii) percentage of free silica and
- (iv) duration of exposure.¹⁰

Tuffour-Kwarteng in 1992 reported the incidence of silicosis at Tarkwa Goldfields Limited (TGL) as 3.1 cases per 1,000 employees per annum. The annual incidence for underground workers was 4.6 per 1,000 per annum, while that for surface workers was 0.96 per 1,000 per annum, making underground workers five times more vulnerable to silicosis than surface workers. Within the working groups, the highest incidence in underground workers was recorded among machine drivers (drillers) at 10.1 per 1,000 per annum. On the surface, the highest incidence was observed among mill crushing plant workers at 18.7 per 1,000 per annum.⁹

Forson did a comparative study of the incidence of Pneumoconiosis among miners of Tarkwa Goldfields Limited (TGL), Tarkwa and Ashanti Goldfields Corporation (AGC), Obuasi in 1992, and reported thus:

- (i) Silicosis occurred five times as frequently among underground workers at Tarkwa (TGL) as among surface workers (4.6/1000 per annum and 0.96/1000 per annum respectively Forson quoting Tuffour-Kwarteng)¹⁰. At Obuasi (AGC), the incidence was 0.12/1000 per annum among underground miners but the disease was not observed among the surface workers.

Thus silicosis was 38 times more common in underground workers at Tarkwa

than at Obuasi (4.6/100 per annum and 0.12/1000 per annum respectively).

- (ii) The overall incidence of Silicosis and Silico-tuberculosis were 3.1 and 0.07 cases/1000 workers per year at TGL and AGC respectively. Thus the incidence of both diseases was 44 times more often at Tarkwa than at Obuasi.
- (iii) The overall incidence of pure Silicosis were 1.9 and 0.04 cases per 100 workers per year for TGL and AGC respectively. Silicosis occurred 47.5 times more frequently at TGL than at AGC.
- (iv) For Silico-tuberculosis, the incidence rates were 1.2 and 0.03 cases/1000 workers per year for TGL and AGC respectively; it being 40 times more frequent at Tarkwa than Obuasi.¹⁰

These findings are explained by the different types of rock mined at the two sites. The Tarkwaian rock at the Tarkwa Goldfields Limited, Tarkwa, is mainly quartzite with a higher proportion of silica than the lower Birimian rocks, composed mainly of grey wacke and graphitic phyllite, which is mined at Ashanti Goldfields Corporation, Obuasi.

There are three types of silicosis depending on the time period of exposure to silica dust. (Dunhill, 1982).

- (i) Acute silicosis is very rare and is found within weeks or months of exposure to very high levels of silica dust.
- (ii) Accelerated silicosis. This occurs within 5-10 years of indulging in an occupation with a high risk of exposure to silica dust.

- (iii) Chronic silicosis develops gradually and shows symptoms after a long time of exposure, ie. more than 10 years.¹¹

The relation of chronic bronchitis and respiratory dysfunction to age, tobacco smoking and occupational exposure to surface and underground mining were examined in a cross-sectional survey of 1363 men employed in the Kalgoorlie Mining Industry in 1985. After control of confounding by age and smoking, it was estimated that compared to a life-time non-miner, the odds ratio (OR) of chronic bronchitis was 1.8 (95% confidence interval, 1.0 - 3.3) for one to nine years underground gold mining, 2.5 (1.2 - 5.2) for ten to nineteen years and 5.1 (2.4 - 10.9) for twenty years or more. It was estimated that the proportion of cases of chronic bronchitis in working underground miners due to occupational factors was 50%.¹²

The effects of exposure to gold mining dust with a higher concentration of free silica and tobacco on mortality from lung cancer was assessed in a sample of 2209 white South African gold miners. The miners started mining during 1936-43 and were selected for a study of respiratory diseases in 1968-71 when they were aged 45-54 years. The mortality follow-up was from 1968-71 to 30th December 1986. The relative risk for the effect of dust cumulated to the start of the follow up period was estimated as 1.023 [95% confidence interval (CI) 1.005 - .042] for a unit of 1000 particle years. The combined effect of dust and tobacco smoking was better fitted by the multiplicative model than the additive model, suggesting that the two exposures act synergistically.

No association between lung cancer and silicosis of the parenchyma or pleura was found, but a positive association existed between silicosis of the hilar glands and lung

cancer.¹³

In a study of the combined effects of underground gold mining dust with a high content of free silica and tobacco smoking on the prevalence of respiratory impairment among 2209 South African gold miners and 403 non miners, tobacco smoking was found to potentiate the effect of dust on respiratory impairment.¹⁴

An excess of mortality from stomach cancer has been observed in Ontario gold miners. [Obs. 104, Standardized Mortality Ratio (SMR) 152, 95% CI 125-185]. No excess of stomach cancer could be detected in other miners in Ontario (Obs. 74, SMR 102 95% CI 80 - 120). The excess appeared 5 to 19 years after the miners began gold mining in Ontario. A statistically significant association between the relative risk of mortality from stomach cancer and the time weighted duration of exposure to dust in gold miners was found in miners under 60 years.¹⁵

Oxides of Nitrogen

Nitrogen oxides are the products of detonation of explosives and exhaust gases of diesel engines. Nitrous fumes are an equilibrium mixture of two compounds of Nitrogen; Nitrogen dioxide (NO₂) and Dinitrogen tetroxide (N₂O₄) in the ratio of 3:7. They are produced in mining when dynamite is used for blasting and it burns quietly instead of exploding. Nitrous fumes are reddish-brown in colour and are the most insidious because the margin between concentrations which will cause mild symptoms and those which will produce fatal results is small. Moreover miners may inhale potentially lethal amounts without the ill-effects being noticed for two to twenty-four hours.¹⁶

Exposure to concentrations in the range of 100-500 ppm may cause sudden bronchospasm and death from respiratory failure. Moderate exposure results in the development of a chemical alveolitis characterized by dyspnoea, haemoptysis, cyanosis, circulatory failure and eventually death if immediate intensive treatment is not given. Repeated exposure to concentrations in the range of 20-50 ppm may cause Bronchiolitis Fibrosa Obliterans, an autoimmune inflammatory response in the lung.

Carbon Monoxide

The exhaust gases of petrol and diesel engines contain carbon monoxide, produced by the incomplete combustion of carbon compounds. It is colourless and odourless, and the early signs of intoxication are insidious, factors which combine to make it especially dangerous. Carbon monoxide has a greater affinity for haemoglobin than oxygen and combines with it to form carboxyhaemoglobin. This is a stable pigment which only slowly becomes dissociated.

Concentrations of 3,500 parts per million (ppm) are immediately hazardous to life. Initial symptoms include giddiness and headache, and then the patient loses power in his legs and becomes unconscious. Death occurs when the blood is 60 to 80 percent saturated with carboxyhaemoglobin. No cyanosis is produced despite the profound tissue anoxia and the patient is classically described as cherry pink.

Mercury

Liquid mercury is added to the ground ore to separate gold by amalgamation. Gold is then recovered by heating the amalgam to evaporate the mercury. Mercury evaporates

even at room temperature. Although both inhalation and ingestion of mercury may occur, inhalation is the major hazard by far. It may also be absorbed through the unbroken skin.

A study of fifty-five (55) self-referred patients with signs and symptoms consistent with a history of mercury exposure revealed that 22 of them were gold miners who sieved the river sediment and added mercury to separate gold by amalgamation. Eleven were gold shop workers who purified gold by heating the amalgam and evaporating mercury, and 22 were patients defined as non-occupationally exposed urban dwellers.

There were no significant difference in the relevant symptoms and signs between the 3 groups, although tremors were observed in 2 of 11 gold shop workers (18%) and only 2 of 22 (9%) miners or occupationally non-exposed patients. The median blood mercury was also highest 3.8ug/dl in gold shop workers and there was hardly any difference between miners (2.3 ug/dl) an the control group (2.2ug/dl).¹⁷

Acute mercury poisoning may arise when workers in the gold room inhale heated mercury in a confined space. Prominent symptoms of acute poisoning include cough, dyspnoea, tachypnoea, fever, nausea, vomiting and a feeling of tightness in the chest. Tremor may indicate nervous system involvement, but pulmonary distress is usually the cause of death.

Early symptoms of chronic exposure include the development of a pale brown complexion, dyspepsia and headaches, gingivitis and excessive salivation. Teeth may become loose and drop out, leaving those which remain blackened and eroded. A 'mercury line' may rarely be seen on the gums. Irritant dermatitis and discrete ulcers may also occur.

Chronic poisoning affects the nervous system, the kidney and behaviour. Neurological signs include tremors of the hands, eyelids, lips and tongue. Motor and sensory nerve disorders like spastic gait, cerebellar ataxia, paraesthesiae, alteration in taste and smell, hyperactive tendon reflexes and loss of proprioception in the fingers and toes. There is also gross peripheral constriction of the visual fields. The most pathological lesion found in fatal cases is atrophy of the cerebellar cortex which accounts for many of the signs and symptoms found during life. Effects on the kidney include proteinuria which may be found in up to 5% of men chronically exposed to mercury. Nephrotic syndrome has been reported in some workers. Both are said to remit completely when exposure is discontinued, but proteinuria may progress to chronic renal disease and nephrotic syndrome may persist.

Mercuria lentis refers to a brownish coloured reflex from the anterior capsule of the eye when it is examined using a slit lamp. It is usually accompanied by punctate opacities in the lens. The chief value of this sign is an indication of prolonged exposure to mercury for forensic purposes, although the sign may appear within a few months of exposure.

Erethism is a distinctive psychiatric disorder due to prolonged exposure to mercury. It may present as an abnormal state of timidity or anxiety neurosis. Later irritability, apathy, drowsiness and headaches occur. The emotional disorder may be accompanied by signs of vaso-motor disturbance, including flushing and excessive perspiration.

Cyanide

Cyanide poisoning may occur during gold extraction by cyanidation using sodium or potassium cyanide. It acts by inhibiting cytochrome oxidase thereby interfering with tissue

oxidation. Symptoms occur after inhalation or when small amounts are ingested. They include headache, rapid weak respiration, vomiting, tachycardia, convulsions and coma leading to death.

3.1.3 Biological Hazards

Helminthiasis is rife if the general sanitation in the mine is poor. The damp warm environment of the mines favours the development of the ova of intestinal worms such as *Necator americanus* and *Ascaris lumbricoides*.⁹ The prolonged use of boots especially those made of impermeable material facilitate maceration of the foot contributing to a high prevalence of interdigital mycosis (*Tinea pedis*). As stated earlier on, the incidence of tuberculosis among miners is higher than in the general population.

In a review of malaria epidemiology in the Brazilian Amazon, it was found out that the many human activities carried out in the region coincided with the peaks observed in the biting activities of the *Anopheles* mosquito. These activities include gold mining, rubber tapping and nocturnal hunting and fishing.¹⁸ Once the effect of vector exposure were controlled for, individual socio-economic characteristics were only weakly linked to malaria prevalence in these special mining communities. Individual costs associated with malaria infections were found to be a significant portion of the miners incomes.¹⁹

Between 1983 and 1990 in a gold mining area of Amapa, Brazil, the sensitivity of *Plasmodium falciparum* to antimalarials were evaluated in vitro. Of 75 studies with chloroquine and 74 with amodiaquine, 81% and 27% of the *Plasmodium* were resistant, respectively. Of 75 studies with quinine and 76 mefloquine, 10.6% and 1.3% showed

resistance respectively.²⁰

3.2 **ENVIRONMENTAL HAZARDS ASSOCIATED WITH GOLD MINING**

These include poor accommodation, pollution of water sources, environmental degradation, air pollution, noise and dust pollution, and ground subsidence.

3.2.1 Poor Accommodation

Most of the workers of the various mining companies are accommodated with their families in one-room units on the mine property where environmental conditions are deplorable. There is overcrowding which has implications for airborne diseases such as upper respiratory tract infections, pneumonia and tuberculosis, and skin diseases like scabies, which are spread through contact.

3.2.2 Pollution of Water Sources

Mine-imposed sediment loading of natural drainage is the most significant and pervasive physical environment impact from mining in Ghana.²¹

Through the water erosion of left over material, fine sediments are introduced into the local drainages. Local populations usually complain of sediment contaminated water supplies and that downstream water has been rendered unsuitable for drinking and other domestic purposes. For example the Offin River has been polluted by dredging and sluicing operations that render it permanently muddy along the stretch from Dunkwa to the coast. All the communities that live downstream are deprived of a major source of potable water.⁴



The main potential water-pollutants from gold-processing plants which impact adversely on human health are the heavy metals arsenic, lead and mercury. Some streams around the Prestea mining area like the Mpompo and Ankobra rivers have high content of arsenic in the drinking water around 170 mg/l compared with the recommended WHO standard of 10 mg/l (Smedley and West, 1995).⁴

Acute poisoning following ingestion of arsenic results in vomiting, colic, diarrhoea, followed by fever, cardiotoxicity, oedema and shock which can lead to death within 12 to 48 hours. Under chronic exposure conditions, a polyneuropathy results causing paraesthesiae in the extremities, muscle weakness, motor incoordination and neuralgic pains. Skin manifestations include chronic eczema, hyperpigmentation of the skin and hyperkeratosis of the soles and palms, squamous and basal cell carcinoma could occur later.

Acute lead poisoning in adults could lead to a weak handshake and decreased function of the extensor muscles of the forearm, impairment of kidney function and symptoms of the gastrointestinal tract such as anorexia, constipation and dysphagia. Chronic exposure in children results in a reduced chance of a child's being admitted to high school several years later. It lowers IQ tests.²²

Mercury pollution tends to be persistent. The distribution of mercury in water and sediments from Lerderderg River, Victoria, Australia, where gold mining operations using mercury amalgamation were carried out in the rivers catchment area until about 50 years ago, was investigated. Mercury concentrations in water were low (0.01 to 0.33 mug/litre) and showed no clear correlation with sites of sampling. However mercury concentrations up to

130ug/g in sediments revealed a pattern of contamination which could be related to past gold mining activities.²³

The widespread use of mercury to remove impurities from gold in Brazil and the discharge of waste into water bodies has resulted in mercury contamination of the food chain, posing a risk for the local population who eat a lot of fish.²⁴ Minamata disease, first diagnosed in Minamata Bay, Japan, is a chronic neurological disorder caused by methylmercury. It may occur in persons who consume fish from water bodies polluted with mercury. The initial symptoms are paraesthesiac in the fingers, tongue and face, particularly around the mouth. Later on disturbances may occur in motor functions, resulting in ataxia and dysphasia. The visual fields are decreased and in severe cases total blindness may result.

However, no clear cut cases of intoxication have been reported in some populations with high consumption of large marine fish or mammals. The possibility is that methylmercury accumulated in natural food chains is associated with selenium, which has a protective effect against the toxic actions of mercury.²²

The Madeira River is a gold-mining area in Brazil, and according to conservative estimates, about 100 tons of mercury were lost into its environment between 1979 and 1985. In water suspended particles and bottom sediments higher concentrations were measured in forest streams adjacent to the river than in Madeira River itself. Thus the mean \pm SD values in forest streams were

3.05 ± 4.5 ug/l in water, 1.21 ug/g in suspended particles (only 3 values) and

10.2 ± 3.3 ug/g dry weight in bottom sediment.

In the river these values were 1.56 ± 2.9 ug/l; 0.50 ± 0.13 ug/g and 0.13 ± 0.11 ug/g respectively. Concentration in fish ranged from 0.21 to 2.7 ug/g. There were no noticeable difference between fish caught in the gold mining area and 180km downstream. Mercury concentration in hair depended more on eating habit than mining. In a mining area where diet did not include fish, the mean hair mercury concentration was 2.4 ± 2.1 ug/g whereas in 2 fish-eating areas mean concentration were 4 to 8 times higher, with 40 ug/g maximum.²⁵

Another toxic chemical is cyanide which is used in heap leaching method of gold beneficiation, introduced into the country by Southern Cross Mining Limited in 1986 and later adopted by other mines, namely, Sansu, Cluff and Teberbie.

Contamination of rivers by cyanide may occur by runoff from leach pads during torrential rains or through leakage from the high density polythene (HDPE) liners used to provide a barrier to groundwater pollution. Acquah (1993), pointed out that even these liners have a rate of seepage ranging from 45 litres to 450 litres a day per hectare due to pinhole leaks and poor seaming techniques.⁴

3.2.3 Environmental Degradation

This begins with the removal of vegetation cover and topsoil especially in surface mining. Once the plant cover is disturbed, soil degradation occurs in the form of water erosion, soil compaction or surface crusting, with resultant loss of soil fertility. Pollution of land may result from toxic dust, contaminated mine water or flooding of land by polluted streams leading to the death of vegetation, crops and livestock.

Valuable farmlands, grazing land and habitats of wildlife are also destroyed. It was estimated in 1990 that 1,166 square kilometres of land (0.5 percent) of Ghana's total area had been alienated by industrial mining. The total disturbance of land due the direct effects of mining was approximately 60 square kilometres.²¹ The levelling of hills, building up of heaps of mine dumps, location of waste ponds, fixed plant and buildings, rail and access points result in destruction of the natural scenery.

The flood plains of the Birim, Ankobra, Offin and Jimi associated with alluvial gold occurrences in Ghana have been turned over and littered with cobbles and boulders, the waste dumping of dredging.⁴

3.2.4 Air Pollution

Atmospheric emission from ore roasting (Calcination) plants generates severe airborne pollution, especially in major lode gold mines like Obuasi, Prestea and Konongo. The stack emissions contain arsenic trioxide, sulphur dioxide and oxides of nitrogen, and rain caused by arsenic trioxide and sulphuric dioxide may render mango and tomato plants in the mining areas barren. Residual arsenic in soils promotes the denudation of wooded slopes leading to subsequent erosion.

3.2.5 Noise and Dust Pollution

The emission of dust, and noise from various equipment and blasting vibrations occur in most mining communities. The inhalation of silica-rich dust from drilling, blasting and crushing of ores can cause respiratory tract diseases such as common colds, silicosis and silico-tuberculosis. The noise could interfere with human activities like sleep, speech,

hearing and cause the stress-related disease hypertension. Buildings could develop cracks due to the recurrent vibrations.

3.2.6 Ground Subsidence

This occurs when timber is covered in the slopes with waste materials. With time the timber shrinks and rots resulting in sinking of the ground. There have been reported cases at Wawase residential area in Obuasi which was mined about 100 years ago⁴ and at Tarkwa Goldfields Limited in 1992²¹

3.3 SOCIAL HAZARDS

Lifestyles including smoking, alcoholism, drug abuse and sexual networking constitute social problems which impact adversely on the health, wellbeing and safety in mining communities.

Cigarette smoking potentiates the effect of dust on the lungs making them more susceptible to silicosis, tuberculosis and pneumonia. Certain tasks in mining operations such as blasting entail precision and good judgement to prevent the occurrence of accidents.

Alcoholism and drug abuse are important causes of accidents in mining. Sexually transmitted diseases have high prevalence in mining communities because of the activities of commercial sex workers. Despite the high incidence of several risk factors in mining communities, sera collected in 1983 during a measles epidemic from 250 miners mainly from South East Brazil were all negative for HIV antibodies.²⁶

Psychosocial problems may occur from the removal and relocation of whole communities in new settlements, especially where large scale surface gold mining are to be

undertaken.

3.4 **HEALTH PROMOTION IN GOLD MINING INDUSTRIES**

Gold mining is very hazardous and therefore the need to maintain and promote the physical and mental wellbeing of the workers cannot be overemphasised.

Mining industries usually have implant Occupational Health and Safety Departments to ensure that the health of the workers is not adversely affected by their occupation as enshrined in Recommendation 112 (1959) of the International Labour Organisation.

To maintain the overall health of all employees, limit sickness, absenteeism and increase labour turnover, the following are done:

- (i) Pre-employment medical examination to ensure that able-bodied workers are employed in the mines.
- (ii) Periodic medical examination and screening to detect onset of diseases. For example chest X-rays may be done yearly to detect onset of silicosis.
- (iii) Examination upon return to work after an accident or prolonged illness.
- (iv) Medical treatment for all employees and their dependents.
- (v) Pre-retirement examination.

Other management controls include:

- (i) *Design of the mines*: Measures to reduce hazard exposure begins in the blue print stage. It includes provision of sufficient headrooms, securing of rocks and ensuring that the underground mines are well ventilated and lighted.

- (ii) *Alteration of a process*: Dust is reduced at the point of the origin by wetdrilling of the rocks. For example, an arsenic scrubber (Arsenic Removal Plant - ARP) to trap all arsenic from its stack and to reduce sulphur dioxide emissions into the atmosphere was installed by Ashanti Goldfields Corporation at Obuasi in 1992.⁴
- (iii) *Reduction of exposure time*: Miners wait several hours after blasting of rocks before entering the mine to reduce exposure to oxides of nitrogen. Blasting is usually done overnight.
- (iv) *Good Housekeeping*: This involves the inspection of all tools, equipment and materials to ensure that they are in good working conditions and in their proper places whilst production goes on. Regular preventive maintenance is conducted on all equipment. It also covers all aspects of cleaning of the workplace, waste disposal, adequate toilet and potable water, insect and rodent control.
- (v) *Personal Protective Equipment*: Protective clothing are usually provided to all employees at no cost. The wearing of personal protective equipment therefore becomes a condition for employment and failure to wear them could attract severe sanctions including dismissal. For example, face masks are worn to prevent inhalation of dusts and helmets to forestall the falling of objects onto the head.

- (vi) *Accident Investigation and Prevention:* Accidents which cause serious injuries or damage to equipment are thoroughly investigated and control measures taken to prevent future occurrences. Such investigations are usually documented and published for employee education. All equipment operators are trained and certified by the training departments. No employee is allowed to operate any equipment if he is not trained, certified and authorized to do so, both in and outside the mining site.
- (vii) *Health Education and Counselling:* This important aspect of hazard prevention starts before the worker enters the mine. Risks involved in the industry are made known to him. The correct use of protective devices like masks and gloves are fully explained and workers advised that some degree of discomfort is better than the loss of an eye, deafness or some disability and that they have only one life to lose. Simple rules of hygiene like handwashing and body cleanliness are encouraged and workers are constantly reminded of the dangers of the industry through the media of health education such as charts, posters, billboards and hand bills.
- Other indirect methods include rewards in the form of financial bonuses for certain level of accident-free man working hours achieved.
- (viii) *Environmental Monitoring:* The environmental concerns expressed by the Government have led to the establishment of Environmental Management Departments in some mining industries, for example at Billiton Bogosu Gold,

Bogosu in Ghana.

3.5 CURRENT MINING LEGISLATION IN GHANA

3.5.1 The Minerals Commission Law, 1986 (PNDCL.154) ²⁷ Section I of this law allows for the establishment of the Minerals Commission to be solely responsible for formulating recommendations of national policy on the exploration for and exploitation of mineral resources in Ghana.

The Commission is a statutory corporation vested with all the legal attributes such as power to sue and be sued in its own name, power to own and dispose of property and to enter into contractual obligation. Its chairman is appointed by the Government and the day to day management of the commission is the responsibility of the Chief Executive who is also a Government appointee.

3.5.2 Minerals and Mining Law, 1986 (PNDCL 153) ²⁸

Under Section I of this law *“All minerals are the property of the Republic of Ghana and the Government has power to acquire compulsorily any land which may be required to secure the development or utilization of any mineral resource.”*

“The Secretary for Lands and Mineral Resources shall on behalf of the Republic have power to negotiate, grant, revoke, suspend or renew any mineral right under this law.”

(Section 14, Subsection 2).

He is also empowered to make (by legislative instrument) regulations to restrict prospecting near any water body, prevent pollution of water, ensure public safety and the

safety and welfare of workers, prevent injury to persons or property by chemicals and set penalties for offences against the regulations.

The holder of a mining right 'shall at all times have a responsible Manager in charge of his mining operations.' This law also provides for the appointment of a Chief Inspector of Mines, who shall generally supervise the proper carrying out of provisions of the Law (Section 9). He is empowered to enter into a mining area, and among other things, to take samples of rocks, tailings and ore and to inspect explosives magazines. He must satisfy himself that all documents and records which must be kept by the mining companies are duly kept. He also has powers to hold enquiries into mining fires or other occurrences on the mines which result in serious injury.

Section 15, states that "*No person shall qualify for the grant of a mineral right unless it is a body corporate or an incorporated body of persons established in Ghana.*"

Though the law allowed the Secretary for Lands and Mineral Resources to grant exemptions from section 15, there was the necessity for a fresh legislation to permit the granting of gold digging licences to individual Ghanaian entrepreneurs. This led to the promulgation of the Small-Scale Gold Mining Law.

3.5.3 Small-Scale Gold Mining Law. 1989 (PNDCL.218)²

Section I, subsection I of this law states inter alia '*.... No person shall engage in or undertake any small-scale gold mining operation unless there is in existence in respect of such operation a licence granted by the Secretary for Lands and Mineral Resources or by an officer authorised in that behalf by the Secretary.*'

Section 2, limits the granting of licences to only citizens of Ghana who have attained the age of 18 years and have been registered by the District Small-Scale Gold Mining Centre.

Section 8 allows for the establishment of an area designated as a small-scale gold mining area under Subsection I of Section 77 of the Minerals and Mining Law, 1986, (PNDCL 153) and a centre to be known as the District Small-Scale Gold Mining Centre (District Centre).

All prospective small-scale gold miners are required to register the designated areas they operate or intend to operate with the District Centre (Section 9).

A small-scale gold mining committee is to be established in every designated area to assist the District Center to effectively monitor, promote and develop small-scale mining operations in the designated area. (Section 10).

With regards to the operations of small-scale miners the law states under Section II that *“A person licenced to mine gold under this law may win, mine and produce gold by any effective and efficient method and shall in his operations observe good mining practices, health and safety rules and pay due regard to the protection of the environment.”*

The use of explosives is prohibited under Section 13, i.e. *‘No small-scale gold miner shall use any explosive in his operations.’*

The purchase of mercury is however allowed under Section 14, *“A small scale gold miner may purchase from any authorized mercury dealer such quantities as may be reasonably necessary for the purposes of his mining operations.”*

Lastly, the sale of gold is to be made to authorised buyers only (Section 17).

3.6 **THE BRAZILIAN GARIMPOS**

Alluvial gold digging and dredging operations are actively encouraged by Governments in Venezuela, Colombia and the Phillipines (where it is estimated that nearly 90,000 gold panners work in the Mindanao and North Luzon area alone).

The most spectacular development in alluvial gold digging has occurred in Brazil during the last decade and has resulted in a quintupling of Brazilian gold productions.¹ The Brazilian Government actively encourages the surface mining of gold in the various Garimpos (Portuguese for Diggings). They cover large districts in the upper sections of the Amazon River and are about a hundred square miles in each area. The leading Garimpos are located in the Sierra Pelada, Tapajos, Rio, Madeira, Cumaru and Ala Floresta areas.

Tens of thousands of Brazilian gold diggers known as Garimperios are licenced to work in the Garimpos. The Garimperios are provided with basic extraction equipment to improve the rate of gold extraction by the Brazilian authorities. The Government also provides detailed geological surveys of the various Garimpos to facilitate their activities. Officials of the Brazilian Geological Department carry out regular inspections to ensure that conditions of working are not only safe but hygienic. For example when a major mudslide affected operations in the Sierra Pelada area, the Government stepped in, closed the operations, and reopened it after the necessary repairs had been carried out.

The Brazilian Central Bank plans to purchase all gold from the Garimperios by offering them a premium over ruling international prices. This is to encourage increased production of gold and discourage the smulggling of gold for sale outside Brazil.

3.7 **THE ENVIRONMENTAL PROTECTION AGENCY AND THE ENVIRONMENTAL GUIDELINES FOR THE MINING INDUSTRIES**

The Environmental Protection Agency was established by Act 490 of 1994 (the Environmental Protection Agency, EPA Act). It was until December 1994, referred to as the Environmental Protection Council.

The EPA regularly monitors environmental quality, carries out environmental education and law enforcement. It is also responsible for the assessment of Environmental Impact Assessment (EIA) and Environment Management Plans (EMP) of mining and other industries.

In the context of the National Environmental Action Plan (NEAP) the Mines Department monitors and enforces the regulations concerning the working environment and within the mine 'fence' while EPA monitors and enforces the regulations regarding the external environment.

District Environmental Management Committees (DEMC) of district assemblies have the broad responsibility for monitoring and coordinating environmental protection and implement activities in the district.

Realising that controls for the environmental impact of mining were not specified in the Minerals and Mining Law, PNDCL 153 of 1989, the Minerals Commission was asked by the Ministry of Land and Mineral Resources to coordinate a study by the World Bank on 'the effect of mining on Ghana's Environment..'²¹

The study resulted in baseline information on all large mines in the country and the formation of draft guidelines in 1991. A seminar was held in June 1992 to discuss the guidelines. This eventually led to the publication of “Ghana’s Mining and Environmental Guidelines’ prepared by Minerals Commission and Environmental Protection Council in May 1994. The guidelines require interalia that *“Any company proposing to develop a mining project that will affect an area of the land surface greater than 25 acres (10 hectares) shall submit an EIA.”* and *“All existing mining operations shall submit an EAP every two years. The plan shall cover five years and shall comprise a two year EAP and three year rolling plan for the subsequent years. New mining companies shall submit EAP as part of the EIA.”* *“Copies of environmental audit report(s) undertaken by the companies should also be submitted to the Minerals Commission, Environmental Protection Agency and Mines Department.”*²⁹

CHAPTER FOUR

FINDINGS AND DISCUSSIONS

4.1 DEMOGRAPHIC CHARACTERISTICS

All the underground miners interviewed were males. Their regional distribution (see Table 1) were Upper East 16 (40%); Central 6 (15%); Western 5 (12.5%); Ashanti and Eastern 4 (10%) each; Upper West 3 (7.5%) and Volta and Northern 1 (2.5%) each. None hailed from the Great-Accra and Brong-Ahafo regions. The non-indigenous (non-Upper East) to indigenous (Upper East) ratio was 3:2 (24:16).

TABLE 1: REGIONAL DISTRIBUTION OF UNDERGROUND MINERS

REGION	NUMBER	PERCENTAGE (%) OF TOTAL
Upper East	16	40.0
Central	6	15.0
Western	5	12.5
Ashanti	4	10.0
Eastern	4	10.0
Upper West	3	7.5
Volta	1	2.5
Northern	1	2.5
Greater Accra	0	0
Brong-Ahafo	0	0
TOTAL	40	100.0%

The mean age of the miners was 28.8 ± 5.8 SD years. 28 (70%) of them were married; 10 (25%) were single and 2 (5%) were cohabiting. Only 6 (21.4%) of those married lived

with their families at the mining site, the other 22 (78.6%) lived separately from their families.

With regards to educational attainment, 1 (2.5%) had no formal education, 14 (35.0%) each of Primary and Middle School education and 2 (5.0%) each of Junior and Senior Secondary School education, 5 (12.5%) and 2 (5.0%) had secondary school (Form Five) and Polytechnic/Technical School education respectively. (See Table 2).

TABLE 2: EDUCATIONAL STATUS OF UNDERGROUND MINERS

LEVEL OF EDUCATION ATTAINMENT	NUMBER	PERCENTAGE (%) OF TOTAL
None	1	2.5
Primary	14	35.0
Middle	14	35.0
Junior Secondary School (JSS)	2	5.0
Senior Secondary School (SSS)	2	5.0
Secondary School (Form Five)	5	12.5
Other (Technical/Polytechnic)	2	5.0
TOTAL	40	100.0%

Thus 75% had first cycle school education (i.e. Primary, Middle and JSS); 22.5% second cycle school education (SSS, Secondary School Form Five and other) and 2.5% had no formal education.

4.2 HEALTH

4.2.1 SUBSTANCE ABUSE

The use of alcohol, tobacco and marijuana (Cannabis) is depicted in Table 3 below.

In all 18 (45%) smoked tobacco and 20 (50%) drank alcohol. 15 (37.5%) took both alcohol

and tobacco, 5 (12.5%) alcohol only, 3 (7.5%) tobacco only, 1 (2.5%) marijuana. However, 16 (40%) did not take either tobacco or alcohol. Though only 1 (2.5%) admitted smoking marijuana, the smell of marijuana pervaded the air, miners openly smoked it and I came across two marijuana peddling shops.

TABLE 3: SUBSTANCE ABUSE AMONG MINERS

SUBSTANCE	NUMBER	PERCENTAGE (%) OF TOTAL
No Alcohol/Tobacco	16	40.0%
Alcohol and Tobacco	15	37.5%
Alcohol only	5	12.5%
Tobacco only	3	7.5%
Marijuana only	1	2.5%
TOTAL	40	100.0%

4.2.2 WORKING CONDITIONS

Fourteen (35%) of the miners had previous experience with small-scale mining operations ('Galamsey') at Tarkwa, Abooso and Konongo. They were all non-natives. Two (5%) were former employees of Tarkwa Goldfields Limited, Tarkwa and Ashanti Goldfields Corporation, Obuasi. The rest, 24 (60%), had on-the-job training at the small-scale mining site.

They described their working environment as conducive especially where there existed ventilatory holes between adjacent pits, but, on the other hand complained of excessive heat, sweating and a feeling of suffocation in single pits.

A gang or team consisted of about 10-12 people who worked from about 6am to 6pm. Where there were more than this number, the gang was divided into two groups. One group

then worked from 6am to 6pm (day shift) and the other 6pm to 6am (night shift).

They usually had a break for meals in between working hours; to attend to nature's call or resurface after about 4 hours continuous work to breathe in 'fresh' air on the surface. These underground workers do not operate on Fridays. Friday has been declared a 'no-ground-breaking' day by the Chiefs and people of Gbani area in reverence to the gods of the land. They either worked at the 'sumps' extracting gold or went to Bolgatanga to socialise.

4.2.3 COMMON AILMENTS. CAUSES OF DEATH AND HEALTH-SEEKING BEHAVIOUR

The common complaints among them were headache and bodily pains, abdominal pains and diarrhoea, catarrh, cough and chest pains. Other ailments were seasonal. For example, Cholera and Pneumonia were rife during the wet season whereas Cerebrospinal Meningitis (CSM), Measles and Chicken Pox took their turn in the dry season. Malaria, Skin diseases and Sexually Transmitted Diseases (STDs) were prevalent throughout the year. Scorpion and snake bites were rampant with the onset of rains. Though there was no statistical data to support his claims, a private Medical Practitioner whose clinic is patronized by the miners had found that some miners with sexually transmitted diseases (STDs) tested HIV positive and acid-fast tuberculosis bacilli were also detected in some cases of pneumonia.

The work-related injuries included lacerations and abrasions from sharp-edged stones and falling rocks, foreign body (sand) in the eye and falls during their travel down and up the shafts.

They sought treatment for their illness in the following ways:

- (i) Self-medication through the purchase of drugs from peddlers;
- (ii) Private 'Clinics' in the camps. Though they were not sure of the credentials of the 'Doctors' manning those clinics, they were the best they could have in their peculiar circumstances. Treatment in these clinics were considered exorbitant. For example, a course of Malaria treatment could cost one $\text{¢}14,000$ and Suturing of lacerations between $\text{¢}60 - 80,000$.
- (iii) Tongo Health Centre which is about 20 kilometres from the mining site.
- (iv) Bolgatanga Central Hospital
- (v) Odoi-Agyarko Clinic, Bolgatanga.

Seventeen (42.5%) of them admitted taking drugs without prescription. These included Brufen, Indocid and Paracetamol for bodily pains. Prednisolone (popularly called P) and Dexacortin for 'Asthma' (difficulty in breathing). These were sometimes combined with the pain killers mentioned earlier for severe bodily pains.

Antibiotics such as Penicillin V, Ampicillin and Chloramphenicol were taken for Stomach aches, Sexually transmitted diseases and persistent fever respectively. The other frequently abused drug was Chloroquine for Malaria.

They mentioned Cerebrospinal Meningitis, Cholera, Snake bites, and Accidents such as inhalation of 'smoke' (carbon monoxide poisoning) as the causes of death among mining communities. They recalled with sorrow the death of six (6) out of ten (10) miners 'caught by smoke' about 2 months ago. Other causes of death were Cave-ins, Dynamite explosions

and Falls into pits.

4.2.4 USE OF PROTECTIVE EQUIPMENT

From both observations and interviews it became clear that the miners did not use any protective clothing in the course of their work. Apart from the torchlight which served as a light source, neither helmets, masks, goggles, gloves nor boots were worn. The reasons given for their non-compliance were:

- (i) Availability: They lamented over the fact that no shops in the District sold protective equipment needed for mining.
- (ii) Affordability: They wondered whether they could afford the prices of those items even where available. From their experience it was only those working in the big mines who wore protective clothing provided free of charge.
- (iii) Suitability: Some miners stated that their torchlights could not be attached to the helmets unless there were modifications, because they could not afford miner's lamps. Wearing boots might result in slipping ('Slacking') while ascending or descending the pits using their improvised 'steps'. They could wear boots if they were designed to have a good grip or when rope ladders were available for their use in the pits.
- (vi) False sense of Security: A few thought there was no need to wear masks because they were at a lesser risk of dust inhalation, compared to the 'Kaamen', 'Shanking girls' and Grinding mill operators.

4.2.5 KNOWLEDGE ABOUT HEALTH HAZARDS

Their knowledge about the health risks associated with the various hazards i.e. ‘Smoke’ (Carbon monoxide); ‘Kaagum’ (Dynamite) Dust and Mercury had led to the adoption of certain coping mechanisms.

‘Smoke’ (Carbon Monoxide):

Each of them knew that being trapped by the exhaust fumes of water-pumping machines, was the most fatal of all the accidents. It had, according to their estimation, caused most of the deaths. It usually occurred when attempts were made to restart water-pumping machines which had stopped abruptly or were not pumping as effectively as expected. The poisoning was severe where there were no ventilatory holes especially in ‘single’ pits. Victims were usually brought out dead, but those who survived the ordeal later said they initially felt weak, especially in their legs and later fell into a sleep-like state. The first aid given to victims consisted of holding them in a head down position, flooding with cold water and giving them milk to drink. Victims were later taken to Bolgatanga Hospital. Those who survived were usually the ones that could drink or vomit the milk given.

To overcome this problem, they usually created ventilatory holes between adjacent pits. Secondly, miners often waited for about 30 to 40 minutes after stopping the pumping machines before entering the pits. Others have purchased mist blowers used for the spraying of insecticides to blow out the fumes from water pumping machines, especially in single pits.

The use of submersible pumps with the electrical (power) supply unit on the surface, is on a very limited scale at the mining site. It has the twin advantages of not discharging exhaust fumes into the confined atmosphere of the pits and also provides a light source for underground mines.

'Kaagum' (Dynamite):

It was common knowledge that one could die or sustain serious injuries if trapped in the shaft before explosion occurred. The causes of dynamite accidents included:

- (i) late detonation, i.e. explosion just when miners have re-entered the pits thinking that detonation was complete.
- (ii) falls into the pits while attempts were being made to get out as soon as practicable after lighting the fuse wires;
- (iii) inadvertently hitting the fuse while packing the drill hole with compacted sand in paper ('food').
- (iv) Miners in adjacent pits unaware of 'blasting' by their colleagues.

To overcome these difficulties, they usually shouted 'far away' to alert others of imminent explosions. Everyone then got out as hurriedly as possible. By experience they knew that the time taken for a wire to burn through to the fuse depended on its length. For example, a 50cm wire took about 3 to 5 minutes. 'Swiftness' and 'accuracy' were their watch words because most of them never went down with wrist watches. Moreover, the diamond drills used did not allow for long drill holes which were only possible with pneumatic drills. They waited for about 30 to 40 minutes after the last explosion which must

correspond with the number of dynamites ignited before entering the pits. The counting was done once the 'Blastmen' were out of the pits and the first explosions was heard. There was however the possibility of missing the count where explosions from several pits took place simultaneously.

Fifteen (37.5%) of those interviewed did not know of any other side effects of dynamite apart from injuries and death. The rest 25 (62.5%) mentioned headache cough, chest pains, weakness of the body as resulting from the inhalation of fumes from 'kaagum'.

Dust:

Twenty two (55%) of the interviewees mentioned headache, irritation of the eyes, catarrh, cough productive of sand-laden sputum, cough productive of bloody sputum, tuberculosis, cancer and heart problems as side effects of dust. The rest (45%) simply said they did not know of any. The sad aspect was that no attempts were made to mitigate these effects. The only attempt I saw was the use of a disposable face mask by one of the 'Shanking girls' during a focus group discussion.

Mercury:

About 28 (70%) did not know of any side-effects of mercury on the human body. They handled mercury freely with the hand oblivious of its absorption through the skin, wore no masks while heating the amalgam and I was told the chilling story of people sucking mercury from the amalgam with the mouth.

Abdominal pain and diarrhoea when ingested; cough, headache and dryness of the throat when inhaled, were some of the side effects attributed to mercury. The wrong

attributes were Tuberculosis and Cancer. No gloves were worn and there were no attempts to recover the mercury.

4.2.6 SURFACE WORKERS:

These included the 'Crushers'; 'Shanking girls'; 'Kaamen'; 'Sump' workers, Colluvial and Alluvial gold miners and Grinding mill operators.

They had complaints similar to those underground miners mentioned earlier. For example, Cave-ins 'Smoke', Cerebrospinal Meningitis and Cholera were mentioned as the main causes of death among miners. There was also little regard for the use of protective clothing such as masks, goggles, gloves and boots among this category of workers.

The 'Crushers' complained of pieces of stone in the eye and accidental crushing of the fingers with the hammer. A piece of jute sack was wrapped around the ore to prevent accidental splintering of ore into the eyes.

The 'Shanking girls' had no fixed working hours and their job could extend from 6am to 6pm depending on the amount of pounded ore to be sifted. Catarrh, cough, chest pain, redness and irritation of the eyes which sometimes progressed to discharge from the eyes were their main job-related ailments. The grievous aspect of their work was that some nursing mothers 'shanked' with their children on their backs or within the vicinity, thus subjecting them to dust inhalation.

The job of the 'Kaamen' was the most energy-demanding. Muscular aches, chest pain, catarrh and cough were rife among them. Others complained about excessive drinking of water consequent upon sweating and itching of the body whenever they came into contact

with powder from a rich gold-bearing ore. Irritation of the eyes from dust and the development of callouses in the palms which sometimes became infected and prevented them from work, were common. They used no gloves, the explanation being that callouses were the price they had to pay for the type of job they did. A blind 'Kaaman' had this to say: "Master, you see every job has its own 'palaver'. The initial two weeks of this job are quite tough because one has to grapple with extreme hand, wrist, chest and bodily pains, but he becomes used to it sooner than later. I sometimes feel shy shaking hands with other people because they might complain of the 'woody' nature of my palms but I cannot quit because this job pays." He was an SSS graduate of a blind school, specializing in the weaving of handicrafts but dire economic circumstances had forced him into the gold 'business'. He was happy that people were generally sympathetic towards him and therefore brought him ore to pound.

The grinding mill operators complained of catarrh, cough, chest pain and inability to hear people well unless they spoke loudly. One of them recounted the story of his friend dying from cough productive of blood which the doctor diagnosed as Tuberculosis. Though a hood was tied around the spout of the grinding machine to prevent spillage of the gold bearing dust, the operators were literally smeared with dust from 'head to toe'.

Excessive breaking of the finger nails, fungal infections of the hands and feet, lacerations from sharp-edged stones, sometimes with secondary bacterial infection were common among the colluvial/alluvial gold miners. (Photo 24). A patient with cellulitis of the left hand resulting from an infected laceration of the palm was seen and referred to the

Tongo Clinic during a visit to the Yale alluvial/colluvial gold mining site.

Skin rashes and fungal infections of the hands and feet were a bother to the ‘Sump’ workers who had their hands and feet immersed in water while sluicing the grounded gold ore.

4.3 **THE ENVIRONMENT**

4.3.1 **HOUSING**: (Photo 16, 17)

The areas inhabited by the miners could be aptly described as sprawling ‘Thatch-cities’. Most houses were built with wood, clad with thatch and roofed with thatch. These all ‘thatch-and-wood’ buildings were usually covered with large polythene sheets or tarpaulin during the rainy season to prevent seepage of water into the rooms. A few houses were built of mud and roofed with mainly thatch or iron sheets. ‘Summer’ huts were constructed over the opening of the pits to serve as both resting places for the miners while at work and sleeping ‘rooms’ during the hot dry season.

The houses were either rectangular or round in shape, in most cases without windows and in a few cases with an apology of a window. The doors allowed entry in a stooping position. Married couples shared accommodation with their children, but the singles and those married but without their families in the camp were often crammed in their rooms. It was not uncommon to find 10 to 12 people in a room measuring 4 metres by 4 metres in size. Overcrowding is the norm.

There was no zoning. The result was that houses were crowded together and it was not unusual to find a petrol selling outlet next to a drinking bar with people smoking

profusely; a recipe for fire outbreaks. The houses were surrounded with the various mining pits, their heaps of 'waste' and 'sumps' where ore is sluiced.

These houses had neither drainage nor toilet facilities. Thus free range defaecation was the rule rather than the exception. A few individuals had public bathrooms where miners paid 200 cedis per bath.

4.3.2 LAND DEGRADATION:

Deforestation was evident and resulted from the activities of the miners. Trees were cut down or uprooted

- (i) to allow for the construction of the many access roads;
- (ii) for construction of houses;
- (iii) for fuelwood;
- (iv) to be used as stulls ('chock packs') to prevent collapse of hanging walls.
- (v) to make way for the sinking of shafts/pits for lode gold mining;
- (vi) During the surface digging by colluvial/alluvial miners which expose the roots of trees to the vagaries of the weather. They are by far the most destructive as far as land degradation is concerned. The speculative nature of their job led to the removal of top soil from large tracts of land which were left uncovered.

This has resulted in numerous craters which trapped rain or runoff water from bathrooms and also served as rubbish dumps. (Photo 21).

Mountains of waste soil were found around the shafts because no attempts had been made to evacuate or use them as backfill. They might be washed down the valleys into rivers causing siltation. (Photo 22).

4.3.3 **POLLUTION:**

The mercury used in the amalgamation process was largely not recovered. It was either thrown into waste water in the 'sumps', on the ground or evaporated by heating the amalgam. The worse of it all was that some miners were found using the dry river bed of the Kulubiliga River as 'sumps' for the processing of ore and amalgamation with mercury. This was the 'mother of all mercury pollutions.' (Photo 23)

The atmospheric air was constantly being subjected to

- (i) Discharge of dust from the activities of the 'Crushers', 'Kaamen', 'Shanking girls' and Grinding mill operators.
- (ii) Fumes from the diesel operated grinding machines, water-pumping machines using petrol and dynamite explosions.
- (iii) Mercury vapour from the heating of amalgam.
- (iv) Smoke from tobacco and marijuana.
- (v) High noise levels from the intermittent dynamite explosions, pounding of stones with metal mortars and pestles, grinding of stones and the numerous radio/cassette player sets (Ghetto-blasters).

4.3.4 **WATER:**

The miners had their water supplies for both domestic and industrial use from:

- (i) The Kulubiliga River which lay in a valley about 100 meters from the Kejetia mining site. It was dry at the time of my visit but shallow wells had been dug in the river bed to allow for the collection of water. (Photo 18).

- (ii) Water pumped out of the pits.
- (iii) Boreholes from the surrounding villages. Natives brought drinking water from these boreholes to the mining site for sale.
- (iv) 'Iced' water parcelled in polythene bags from Bolgatanga, which sold at 100 cedis per satchet compared to 20 cedis at Bolgatanga. The price of iced water was thus 5 times more at the mining site than at the district capital.
- (v) Water storage tanks constructed by individuals who receive their supply of water through tankers from Bolgatanga.

4.3.5 **SANITATION:**

As mentioned earlier, the free range system of human excreta disposal was the norm, there being no individual household or communal places of convenience. Liquid and solid waste disposal was done indiscriminately. The rubbish consisting mainly of food remnants and polythene bags were either thrown into the surrounding bushes or abandoned shallow craters nearby. (Photo 21).

4.3.6 **FOOD AND MEAT HYGIENE:** (Photo 19, 20)

Food was openly cooked and sold in the many 'chop' bars dotting the mining sites. There was a slaughter slab in the open where animals were killed but their entrails were discharged into uncovered shallow pits nearby. There was neither pre nor post mortem inspection of animals and the sale of carcasses was done in the open with houseflies (Musca domestica) having a field day.

The numerous 'khebab joints' had thrown caution to the dogs in so far as hygiene was concerned.

4.4 CONCERNS OF THE MINERS

These included:

- (i) The lack of adequate health facilities, the presence of numerous drug peddlers and 'quack' doctors as well as the exorbitant charges for the treatment of ailments. Malaria could cost one 10 to 14,000 cedis and suturing of lacerations 60 to 80,000 cedis. They reported late to hospital because of the high cost of hiring a car (80 to 100,000 cedis) from the site to Bolgatanga in cases of emergency.
- (ii) The quality of water i.e. light brown in colour due to excessive siltation, unpleasant odour, and distasteful coupled with the high cost, 100 cedis per satchet of 'iced' water were a source of worry to them. Their frustration with the quality of water served in the 'chop' bars is summed up in the following statement by a miner. "We know our main source of water is contaminated with our own faeces and the rubbish dumps nearby especially during the rainy season. But what else can we do? God is our only protector here."
- (iii) Poor food and meat hygiene: Their main concern here was the lack of proper meat inspection. They even suspected that some of the animals offered for sale at the mining site were either stolen or dead before being smuggled to their slaughter slab. They were apprehensive of Anthrax which was common

in the area just after the onset of the rains.

- (iv) Lack of discipline and security: Each one was his own master and most of them lived by the dictum “Each one for himself and God for us all.” Marijuana was smoked in the open, tobacco and alcohol consumed with reckless abandon and followed by revels with music at the highest decibel level possible. The revels eventually end up in fighting and injuries. Theft was rampant because some of them live with ‘poverty in the midst of plenty’ especially where days of toil and labour did not result in the finding of the elusive gold bearing ore.
- (v) Their inability to form a multi-ethnic committee to oversee the welfare and discipline in the various mining communities.
- (vi) Interestingly enough issues of the environment such as degradation and mercury pollution did not feature prominently among the concerns expressed by the miners.

4.5 **CONCERNS OF THE CHIEF OF GBANI AND SURROUNDING COMMUNITIES**

They agreed that the small-scale mining operations had brought about some measure of economic prosperity to their area in terms of employment. Their young men were engaged in mining and do not move to the south in search of menial jobs. The women and children were engaged in the sale of food, water and act as ‘Shanking girls’, and alluvial/colluvial gold miners. People have acquired means of transport such as bicycles,

motorbikes, and they are able to buy clothing and food.

However, “to every liver, there is the gall bladder.” Small-scale gold mining was impacting adversely in the following ways.

- (i) Destruction of economically important trees like sheabutter (their cocoa), dawadawa and baobab and loss of grazing land for domestic animals.
- (ii) Increase in the number of accidents on their roads because of reckless driving, and cramming of miners into rickety old vehicles.
- (iii) Upsurge in (a) prostitution and infidelity because miners were generous with money; (b) fighting and rowdy behaviour due to alcohol intake and marijuana smoking; (c) teenage pregnancies and school drop outs due to the lure of gold money.

The Chief of Gbani was particularly worried about the lack of a multi-ethnic committee to oversee discipline, security and meat hygiene in the camps. Both miners and the surrounding communities appealed to the Government and the District Assembly to come to their aid by providing them with water, sanitation and health facilities, and equipment like water pumping machines to facilitate their stay and work at the mining site.

4.6 **DISCUSSIONS**

4.6.1 **DEMOGRAPHIC CHARACTERISTICS**

The demographic characteristics of the underground miners interviewed revealed that they were exclusively male, youthful (mean age 28.8 ± 5.8 SD years) and came from all over

the country. Alluvial and colluvial gold mining however, attracted both sexes. This is not surprising because socio-culturally lode gold mining is considered a “man’s job”. (Ofei-Aboagye 1995). Women’s participation in alluvial gold mining has been known since precolonial times as described by Bossman. Though the regularization of the small-scale mining of gold in 1989 provided the environment for both men and women to participate actively in the sector, very few women took advantage to own concessions or enter the marketing of the industry as licensed buying agents. In 1991, they constituted about 6% of both categories of operators (Ofei-Aboagye, 1995).

They usually participated in the subsector as workers on concessions (panning gold, providing support services to male gangs by way of carrying gravel or cooking meals, traders in food and petty items); sponsors or financiers of work gangs and equipment owners who provided tools to gangs on rental basis. Even in these instances women made up less than 15% of participants in the undertaking.³⁰

The fact that about 3,000 people were estimated at the site meant that if properly harnessed, small-scale gold mining could help alleviate unemployment in Ghana, and contribute to the economy by attracting foreign exchange. The policy regularising small scale has yielded some positive results. It had by 1992, three years after its promulgation, created over 50,000 rural jobs and the total value of gold and diamonds purchased by the Precious Mineral Marketing Company (PMMC) from May 1989 to 1991 was US\$49million, some ₵20 billion with gold contributing US\$15.3 million of the total amount.³ Artisanal (small-scale) miners account for 20% of gold, 40% of the diamonds and nearly all gem

stones mined in Africa.³¹

The multi regional nature of the miners interviewed and the predominance of non-natives (non-native to native ratio of 3:2) is typical of several mining companies. According to Acquah (1996), “In almost all instances, the original local population in a mine project area was neither sufficiently large nor did it possess a full range of required milling skills, nor more importantly, was it especially anxious to substitute its economic activities for mining work. Consequently, the mining companies drew in workers from other parts of the country and from beyond its borders.”²¹ The large influx of non-natives to the small-scale gold mining area in the Bolgatanga District initially created social conflicts in the form of gold seizures, muggings and controversies over who owned which piece of land. With the realization that these non-natives possessed the requisite techniques for lode gold mining (35% of miners interviewed who had previous ‘Galamsey’ experience were all non-natives), attempts were made to reconcile their differences, paving the way for the formation of gangs consisting of natives and non-natives. In the words of a native ‘There were a lot of accidents especially cave-ins (collapsing of walls of pits) which resulted in the death of our people before the arrival of the southerners. *They taught us how to sink the pits, create ventilatory holes, insert and detonate dynamites, as well as the extraction of gold in the ‘sumps’.*”

4.6.2 HEALTH

The health implications of small-scale gold mining operators in the Bolgatanga District can be viewed against the backdrop of health hazards to which the small-scale miners are exposed. It is evident from the division of labour/job descriptions described earlier that

small-scale gold mining operations have progressed from the simple panning used in alluvial gold mining through colluvial gold mining to lode-gold mining. The latter required methods similar to those used in large scale mining companies. The resultant health problems were therefore a mirror image of what usually pertained in the large scale mining companies.

Dust:

As stated earlier in the text reviewed, the development of Silicosis depended on the length of exposure, the concentration of dust in the atmosphere and the type of rock being mined. There was no shred of doubt that the miners were exposed to high concentrations of dust in the atmosphere and the development of Silicosis was just a matter of time. The 'Grinders', 'Shanking girls' and 'Kaamen' were seen surrounded by 'clouds of dust' while working.

Nearly all miners did not use masks. The high prevalence of smoking among the interviewees (45%) may potentiate the effects of dust on the respiratory system. Tobacco was found to potentiate the effect of dust on respiratory impairments. (Hnizdo et al - 1990). However, cases of Silicosis may not be seen among the miners at the moment because of the relatively short period of existence of the mines. Mining has been actively done in the area since 1995 (i.e. 2 years ago). Apart from Acute Silicosis which may take a few months of exposure to develop, others need longer periods of exposure, i.e 5 to 10 years or more. (Dunhill, 1982).

Another factor is the Birimian nature of rocks being mined at the site which has a lower silica content compared to the Tarkwaian type of rocks. The findings of a higher

incidence of Silicosis among miners at Tarkwa (1.9/1,000 workers per year) compared to those at Obuasi (0.04 cases/1000 workers per year) i.e. 47.5 times more frequent at TGL than AGC, by Forson in 1992, was attributed to the differences in silica contents of the Tarkwaian and Birimian rocks at Tarkwa and Obuasi respectively.

The lack of pre-employment and intermittent medical examinations in the small-scale mining operations may put susceptible individuals, e.g. asthmatics and bronchitics at higher risks of respiratory tract diseases and prevent the early detection of Silicosis. The prevalence of tuberculosis in the Bolgatanga District may go up once Silicosis cases emerge; tuberculosis being six times more common in mining communities than the general population (Agadzi et al - 1990 quoted by Forson).

Mercury:

The effects on the body may be in the respiratory, renal or nervous system. The exposure to mercury is favoured in the small-scale gold mines by

- (i) the free handling of mercury which enhanced absorption through the skin;
- (ii) The inhalation of fumes during the heating of amalgam because miners do not use masks. This is by far the most common mode of poisoning;
- (iii) Sucking by mouth of mercury from amalgam.
- (iv) Drinking of water or eating fish from the Kulubiliga stream and its tributaries which may have been contaminated by run off water from the mining sites.
- (v) The widespread lack of knowledge about health hazards associated with mercury (70% of interviewees were ignorant of mercury's toxicity).

The environmental pollution of rivers by mercury may impact adversely on the health of the miners in particular, the people in the Bolgatanga District in general and generations yet unborn.

Mercury pollution tends to be persistent as evidenced by the finding of mercury contamination of Lerderberg River, Victoria, Australia, 50 years after the abandonment of gold mining activities nearby (Bycroft et al, 1982).

The mercury contamination of the rivers may extend beyond the borders of the Bolgatanga because the Kulubiliga River which serves as a source of drinking and sluicing water for the miners is a tributary of the White Volta which eventually drains into the Volta Lake. These water bodies serve as sources of fish.

The contamination of fish with mercury in the White Volta is a possibility. Malm et al, (1990) found no noticeable difference between fish caught in the gold mining area and 180km downstream when they estimated the extent of mercury pollution due to gold mining in Madeira River basin, Brazil. People who eat fish from these rivers may be at risk of developing chronic neurological symptoms (Minamata disease) because of bio-accumulation. The mitigating factor would be the combination of selenium with methylmercury in the fish. Selenium is known to inhibit the effects of methylmercury on the body.²²

Carbon Monoxide:

Carbon monoxide poisoning from the inhalation of diesel fumes from water pumping machines was the most dreaded of all accidents because its effects was dramatic usually

ending in death. Though miners had created ventilatory holes to aid the escape of the gas, their continual dependence on water pumping machines which are lowered into pits makes carbon monoxide a potential killer in the mines.

Acquisition of submersible water pumps may allay the fears of miners as well as make the pits safe.

Dynamite:

Though the Small-Scale Gold Mining Law PNDCL 218 of 1989, Section 13, prohibits the use of explosives, they are freely used in the mines because lode gold is encased in granite which cannot be easily broken using ordinary chisels and hammers. Agomor (1996) estimated that 14 pit owners he interviewed used about 1216 dynamites ('Kaagum') a week giving an average of 87 dynamites per pit per week. This aspect of the law should be reviewed so that miners could be taught the proper handling of explosives as well as purchase them from authorized dealers. One cannot tell whether their present sources of supply are authentic. Counting the number of detonations to ascertain whether all the dynamites inserted had exploded is at best crude. This is because other explosions which occur simultaneously in nearby pits may interrupt counting.

I wondered whether some of the sudden deaths could not be due to the effects of nitrous oxides from the burning of dynamite without explosion. Nitrous oxides from dynamite could cause bronchospasm and sudden death and sometimes its effect might be delayed for 2 to 24 hours. Miners did not know about this danger and this might account for their entering the pits/shafts in less than an hour after the last explosion. On a familiarisation

tour of Tarkwa Goldfield Limited in October, 1996, I learnt that blasting was done overnight when miners had left the mines. The overnight wait ensures that the nitrous fumes do not pose a danger to the miners.

Noise:

Noise levels at the small-scale mining site could exceed the order of 100 to 110 dB(A) and lead to noise-induced hearing loss in miners. The noise is generated from intermittent explosion from dynamite, the pounding of ore with iron mortars and pestles and music emanating from the numerous giant-size radio/cassettes, a status symbol in the mines.

The noise levels are aptly captured by this description. “The mining site announces itself before it is seen as the earth occasionally reverberates from dynamite explosion. The smell of marijuana pervades the air and the sound of rock resisting metal and muscle mixes with the sound of reggae on the radio.” (William Wallis, 1996).

The reasons given for not using protective clothing while working, though frivolous in some cases, were tenable in others. There is no company engaged in the sale of protective equipment for mining at Bolgatanga, the district capital. Secondly, a look at the prices of mining protective equipment revealed that they were beyond the financial reach of the small scale gold miner. For example, a Helmet costs ₵19,500; Goggles - ₵10,500; Safety boots with metal toe cap ₵45,000; Safety boots without toe cap - ₵26,000; Gloves - ₵6,950-₵9,800; Nose mask - ₵78,500. Disposable masks ranged between ₵500 and ₵5,500 and a miners lamp cost ₵388,000. Thus it would cost up to ₵450,000 to fully equip a miner. (Courtesy: R.Co. Ltd, P. O. Box 718, Accra).

The only solution is to find cheaper but effective alternatives. For example, a face mask could be made from grey baft (calico), washed and reused. The provision of rope ladders could encourage miners to wear boots once they are confident, they would not fall. Lacerations from sharp-edged stones, falls into pits and foreign bodies in the eyes are a result of non-adherence to good house-keeping in the mines and the non-use of protective clothing.

The use of alcohol and marijuana may impair judgement especially for jobs like insertion of dynamite which requires precision. There is also the possibility of some miners developing cannabis-induced psychosis later in life.

The bottom-line is that one needs a lot of courage and determination to work for about 12 hours under the dark and claustrophobic conditions underground. For some miners marijuana provides that necessary fillip.

4.6.3 **THE ENVIRONMENT**

The environmental implications of small-scale gold mining operations are best viewed from the environment's impact on health. Tutu in 1992 estimated that for the daily reported illness in Ghana for 1987 and 1988, environmentally-related ones such as Malaria, Upper Respiratory Tract Infections and Intestinal Worms, formed 72% and 70% respectively.

Malaria accounted for 43% of all cases, followed by diarrhoea, upper respiratory infection, skin diseases and intestinal worms.³² Upper respiratory tract infections, pneumonia, cerebrospinal meningitis are favoured by the overcrowding at the mining sites. Cholera and diarrhoea diseases are consequent upon the lack of adequate food and meat hygiene as well as the contamination of their water sources by faecal matter in run off surface

water. The putrefaction of organic matter in the rubbish dumps offers favourable breeding conditions for the housefly (Musca domestica) which acts as a mechanical transmitter for bacteria. Similarly malaria is rampant due to the breeding places offered by the trapping of water in abandoned shallow pits and 'sumps' for the mosquito (Anopheles gambiae). The darkness in the rooms, which are by and large windowless, provides hiding places for the endophilic (preference for indoors) Anopheles gambiae. Most of the miners sleep indoors during the rainy season and outdoors during the dry season. The overcrowding in the rooms favours the transmission of the plasmodium parasite from one person to the other through the bites of the endophagic (feeding indoors) female Anopheles gambiae. Resistance to chloroquine is likely to develop because chloroquine is among the drugs used for self-medication by the miners.

Cuoto et al. (1993) found out that of 75 studies with chloroquine and 74 with amodiaquine among miners in a gold prospecting area of Amapa State, Brazil from 1983 to 1990, 81% and 27% of the Plasmodium falciparum were resistant respectively.²⁰

Sexually transmitted diseases (STDs) and HIV infection result from the unbridled sexual networking at the mining site. It is an open secret that most of the young ladies who troop to the mining site ostensibly to trade are commercial sex workers who are more than willing to offer their 'services' to the highest bidder. The small-scale gold miners like their large-scale mining counterparts are known to be generous with money and being youthful could fall prey to the machinations of the 'red-light' ladies. Even among the married ones, living apart from their families, (78.6% of married interviewees), may provide the

opportunity to commit adultery.

The total cost, in terms of morbidity and mortality from these diseases, to the miners could be quite enormous. Tutu (1992) estimated that the total cost of environmentally-related ill health comprising drugs, loss of man hours of work and the use of resources come to ₵1.3 billion. This was even an underestimate because several patients either had personal medication; sought help from herbalists or did nothing, and data on the daily cases represented 58% to 65% response rate for the nation.³² Vosti (1990) found that individual costs associated with malaria infections formed a significant portion of miners incomes; when he studied the effects of malaria on gold miners in Southern Para, Brazil.

Environmental degradation created by the small-scale gold mining activities in the Bolgatanga District has already elicited protests from the inhabitants. Corn mills have had to be relocated from Bolgatanga to the mining site because inhabitants complained about the contamination of their food with ore due to the use of corn mills for the grinding of gold bearing ores. Destruction of the Tankwiddi forest reserve near Sirigu by small-scale gold miners was eventually stopped by the combined team of the army and the police in January 1996.

The loss of scenic beauty would be better appreciated if one took a trip to the site. Heaps of boulders and earth (waste) are left near the entrance of pits, large areas of land are riddled with holes; and the sprawling and unplanned settlements are made chiefly of thatch without adequate water and sanitation facilities. The thatch houses covered with polythene sheets, the smoking of marijuana and tobacco with reckless abandon in the numerous bars which may be next to a fuel selling hut, provide ideal conditions for fire outbreaks. These

fears were confirmed by a story in the Ghanaian Times of 15th February, 1997, under the caption ‘Fire Sends Galamsey Men Packing Home.’

“..... Hundreds of small-scale gold miners started packing home after fire swept through over 500 huts and sheds at the largest mining settlement at Kejetia in the Bolgatanga District on Wednesday. Personal effects and cash worth over half-a-billion cedis (¢500 million) were said to have been destroyed, but there were no casualties”³³

The fire was interspersed with intermittent explosion from dynamite used for blasting rocks. Intense heat and explosions from the fire made it impossible for people to attempt to fight it. There is therefore no gainsaying that the health and environmental implications of small-scale gold mining operations in the Bolgatanga District, represent a public health ‘time-bomb’. We ignore them at our own peril.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

“Gold has changed a lot of lives in the dusty village of Bolgatanga, in northern Ghana. It has given wealth to some, and taken everything, including life, from others.” (William Wallis - 1996).

There is no iota of doubt that small-scale gold mining operations has brought economic prosperity to the Bolgatanga District. They have on the other hand brought in their wake environmentally-related health and social problems as evidenced by the health and environmental implications discussed earlier. Governments and people worldwide have become more sensitive to issues of the environment following the United Nations Conference on Environment and Development (The Earth Summit) held in Rio de Janeiro, Brazil from 1 to 12 June 1992.

The idea of sustainable development enjoins humanity to be a good steward of the environment and its resources, for in the words of Nana Sir Ofori-Atta I, “The land belongs to the dead, the living and generations yet unborn”. We shall be shirking our responsibilities towards the environment as a nation if we enjoy the economic benefits of small-scale gold mining, but criticise its adverse effects on the environment without putting in the necessary environmental regulations to guide ‘Galamsey’ operations. Such an attitude could be likened to ‘little children who after enjoying the hunter’s game later turned around to deride his dirty hunting attire.’

Ghana's Mining and Environmental Guidelines form the basis for Environmental Regulations under the Minerals and Mining Law, 1986 (PNDCL 153). Under it, Environmental Impact Assessment (EIA) is a prerequisite for gold mining leases for concession areas exceeding 10 hectares (about 25 acres). The EIA should include baseline information, impact assessment, mitigating measures and environmental management/action plan. The Environmental Management/Action Plan (EAP) should indicate a final land use policy or plan when operations cease.

Since concessions granted to small-scale gold mining operators do not exceed 25 acres, (Section 5, PNDCL 218) miners are by law precluded for submitting EIA and EAP. However, section 11 of PNDCL 218, i.e. the Small-Scale Gold Mining Law, 1989, enjoins the miner to 'observe gold mining practices, health and safety rules and pay due regard to the environment.' It however lacks the specifics as to how these objectives can be achieved. Most of the damage, done to the environment by small-scale gold miners, is due to a lack of knowledge but part is due to neglect. How best can we convince these miners who have been driven to this kind of job by tough economic circumstances, that it is essential to protect the environment for sustainability? It would require patience and tact in dealing with the small-scale gold miners.

Review of existing legislation, Health and Environmental education and promotion, and last but not the least, the willingness of the miners to adopt the necessary measures designed by all the stake-holders, will help make small-scale gold mining health and environment-friendly.

The following recommendations are therefore being made with the hope that they would stir more debate on the issue of 'small-scale gold mining operations and their implications for health and the environment'. I should like to see these debates finally culminate in the preparation of 'Ghana's Small-Scale Mining and Environmental Guidelines' similar to the one fashioned out for large scale gold mining operations.

5.1 **THE GOVERNMENT OF GHANA**

Legislative Reforms: (i) For example the regulation that bars miners from the use of explosives should be repealed. (Section 13 of Small-Scale Gold Mining Law, 1989). The fact of the matter is that this law is a 'toothless bulldog' because dynamites are being purchased and used at the mining site. Regularising the use of explosives would allow for the purchase of dynamite from authorised dealers and enable experts to teach the miners how to use explosives safely.

(ii) The small-scale gold miner is allowed to use mercury in his operations. From this study it is evident that it is being handled inappropriately posing danger to both miners and the environment. The use of a Knielson concentrator and a shaking table is believed to recover about 90% to 95% of the gold in the ore. Secondly, the method does not involve the use of mercury.

However, it costs between US\$12,000 an US\$27,000 to purchase the two units (personal communication with Mr. Walter, Societé Exploitation de Minière). This is obviously beyond the financial reach of small-scale miners. An alternative would be to amend the law which makes small-scale gold mining operations the exclusive preserve of Ghanaians (Section 2 (a) of Small-Scale Gold Mining Law, 1989, PNDCL

218). This would allow foreign nationals with the requisite technical assistance in the form of equipment to form joint ventures with their Ghanaian counterparts.

Technical Assistance

Ghana should follow the example of Brazil, which gives every encouragement and assistance to the Garimpeiros. The small-scale gold miners do not have the capacity to prospect and adopt appropriate technologies. Much of their labour may be in vain where they do not 'hit' a gold bearing ore after months of digging, leading to speculative sinking of several pits which impact negatively on the environment.

Secondly, the use of 'sumps' for processing gold results in the loss of gold in the tailings. Analytical results by Agomor (1996) revealed that assay values of gold ranged from 55g/t to 350g/t of ore; while the gold contents of tailings ranged between 9.2g/t to 66.g/t. The miners were mining only free gold from the reefs. Gold associated with the sulphides cannot be removed by them. It was estimated that recovery varied between 51.6% and 94.8%.⁸

- (i) Geological survey maps should be made available to the small-scale miners where appropriate;
- (ii) Every encouragement should be given to the use of a Knelson concentrator and shaking table, which have the twin advantages of higher gold recovery rate and the non-use of mercury. As stated earlier the cost may be prohibitive to the small-scale gold miner, unless they received financial assistance as cooperative groups or entered into joint ventures with foreign investors.

- (iii) The Amalgam Retort is another instrument whose use could lessen mercury pollution of the environment. When the amalgam is heated in the retort, the mercury vapourises leaving the gold. The vapour is then conducted through a condenser which coverts it into mercury which is collected in a receptable at the end of the apparatus.
- (iv) The development of a Magnetic Gold Extractor by Mr. Henry Appiah and Mr. David I. Norman, reported in the Ghanaian Times on 5th May, 1997, should receive Government's support to ensure its perfection. The two are a Senior Lecturer at the KNUST School of Mines and a Professor at New Mexico Technology respectively. According to the Ghanaian Times 'the only tools required are a large sheet of paper, a small paint brush, a magnifying glass, a magnet and a small pointed object like a needle to pick out the smaller sand grains'.

Financial Assistance

Miners should be assisted to acquire appropriate tools and equipment on affordable hire-purchase terms. This would however be possible where miners form cooperatives. Banks would not feel comfortable dealing with gold activities based on speculation by people who are highly mobile and without collateral.

Such assistance could result in miners purchasing rope-ladders to help in the descent an ascent of pits; thereby lessening falls. The use of submersible pumps could definitely reduce the incidence of carbon monoxide poisoning, because the power unit is on the surface.

5.2 DISTRICT ASSEMBLY

- (i) The District Mining Centre and the District Mining Committee at Bolgatanga should be equipped with the necessary logistics such as manpower and transport to enable

them carry out the supervisory role and the health and environmental education of miners more effectively. The present centre has a District Mining Officer, an Assistant Geologist and a one four-wheeled drive car for all the various roles assigned to it.

- (ii) Should set up a Minerals Development Fund similar to the Government's because minerals like gold are wasting assets. About 10% of all royalties would then be reserved to (a) provide local infrastructure like toilets and water bore-holes; (b) invest in forms of development other than mining in the mining areas e.g agro-based industries. Another 10% of the royalty payments should be used to finance regulatory institutions in the District such as the District Mining Centre and the District Environmental Management Committee, which have broad responsibilities for monitoring and coordinating mining procedures and environmental protection. A further 10% should be reserved for the implementation of a District Environmental Action Plan for the areas being mined.
- (iii) Should in collaboration with Central Government encourage research into the Health, Environmental and Social Impacts of small-scale gold mining activities in the District. Such baseline studies would form the basis for further environmental action plans, health and environmental education and promotion. The educational messages should be simple, effective, devoid of technicalities and delivered in Ghanaian dialects where appropriate. Most of the interviewees in this study (75%) have had only first cycle school education and 2.5% were illiterate.

- (iv) Should include a health personnel, preferably the Senior Medical Officer (Public Health) in the District Mining Committee.

5.3 **DISTRICT HEALTH ADMINISTRATION**

- (i) Should extend outreach services to the small-scale gold mining areas at least once a week. The area is a potential public health ‘time bomb’. Communicable disease like Cholera, STDs, Meningitis which were mentioned in the study as being prevalent in the mining area, could easily spread through the District because the miners are a highly mobile population, coming to the capital, Bolgatanga to socialize on Fridays.
- (ii) Health and Environmental education and promotion should be high on the agenda of Public Health Education Campaigns meant for the mining areas.

5.4 **THE MINING COMMUNITY**

- (i) Should consider the formation of a Committee which is multi-ethnic in nature, to spearhead the management of their affairs. The settlements are at the moment acephalous, that is they are without a central authority to see to their social, health and environmental needs. The committee if formed could act as a liaison between the miners and the District Assembly. Sub-committees could also be appointed to oversee specific areas such as Health, Environment, Law and Order, Food and Meat Hygiene;
- (ii) Should realise that their destiny lies in their own hands. They should therefore take educational campaigns seriously and begin to use face masks, goggles and gloves and boots which may be affordable and stop smoking so as to mitigate the effects of the various hazards on their health. This is important because they cannot afford the

elaborate measures taken by the large mining companies to forestall occupationally-related diseases.

- (iii) Should convert some of the abandoned shafts into pit latrines and backfill the rest with 'waste'. The 'chislers' and 'blastmen' could help provide water bore-holes for the community. Tolls collected from the use of these facilities could be used to finance other local development projects like the repairing of their roads during the rainy season. The 'Dependency syndrome' whereby Governments and District Assemblies are expected to provide all social amenities, is to say the least, anachronistic.
- (iv) Communities living in the gold mining area should just not savour the economic prospects but should be alive to their responsibilities, by ensuring that miners adopt measures to prevent undue destruction of the environment. This could be done through friendly interactions with the miners and constantly reminding them of their commitments to the environment.

Lastly, everyone in the Bolgatanga District and its environs should be made aware of the health and environmental implications of small-scale operations through (a) public fora by the National Commission on Civic Education (b) Non-formal education classes and (c) as part of the curricula for first and second-cycle schools.

The Bolgatanga District does not have to suffer the fate that has befallen many a gold-mining town; for a Russian proverb says "A wise man learns from other people's mistakes. A fool learns from his own." Secondly, the Akans have a saying that 'one should ensure that he has water by his side whenever he learns that someone else's beard has caught fire.'

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APPENDIX I**INTERVIEW SCHEDULE**

TOPIC: THE HEALTH AND ENVIRONMENTAL IMPLICATIONS OF SMALL-SCALE GOLD MINING OPERATIONS IN THE BOLGATANGA DISTRICT

I am a Resident of the School of Public Health, interested in the health and environmental implications of small-scale gold mining operations ('Galamsey') in the Bolgatanga District.

I am going to have a discussion with you to enable me gather information to ascertain the extent of the problems mentioned earlier. I assure you of confidentiality of all information given by you.

BACKGROUND INFORMATION

1. Name of Camp
2. Date of Interview dd/mm/yy
3. Name of Interviewer

DEMOGRAPHIC DATA

4. Sex of Respondent Male []
Female []
5. Age (Completed years)
6. Region
7. Marital Status Single []
Married []
Cohabitation []
8. If married asked whether they live with their family in the camp? Yes []
No []
9. Have you ever attended school? Yes []
No []

10. If yes, what was your last grade?

- | | |
|-------------------------------|-----|
| Primary | [] |
| Middle | [] |
| JSS | [] |
| SSS | [] |
| Secondary School (Form Five) | [] |
| Other (Technical/Polytechnic) | [] |

HEALTH

11. Have you ever worked as a gold miner? Yes []
No []
12. If yes, where?
13. When do you usually start work?
14. When do you close from work?
15. Is there any day you do not work? Yes []
No []
16. If yes, which day and why?
17. How many of you work at a particular time in a pit?
18. Do you think there is enough working space underground? Yes [] No []
19. If yes, probe.
20. If no, probe.
21. Mention five common ailments that affect people in this mining area.
22. What type of injuries do you sustain while working?
23. Where do you seek treatment when ill?
24. Do you sometimes take drugs without prescription? Yes [] No []
25. If yes, probe. Which types of drugs and for what complaints?
26. Do you use face masks while working? Yes [] No []
Probe further. If yes, why?
If no, why not?
27. Do you use protective eye glasses (goggles)? Yes [] No []
Probe as in (26)
28. Do you use helmets? Yes [] No []

Probe as above.

29. Do you use gloves Yes [] No []

Probe.

30. Do you wear boots? Yes [] No []

Probe.

31. Do you smoke tobacco? Yes [] No []

32. Do you drink alcohol? Yes [] No []

33. Do you know of any death of miners within the last six (6) months?

Yes [] No []

34. If yes, how many people were involved?

35. What were the cause(s) of death? Kindly describe what happened.

36. Do you know of the effects of the following on the human body?

(a) 'Smoke' (carbon monoxide) Yes [] No []

If yes, mention them.

(b) 'Kaagum' (Dynamite) Yes [] No []

If yes, mention them.

(c) Dust. Yes [] No []

If yes mention them.

(d) Mercury Yes [] No []

If yes mention them.

ENVIRONMENT

37. How many of you sleep in a room?

38. What are your sources of drinking water?

39. What toilet facilities do you have?

40. What refuse disposal facilities do you have?

41. Where do you buy meat from?

42. Where do you buy food from?

CONCERNS

43. What are some of the problems you face living in this small-scale gold mining area?
44. What suggestions do you have for improvement?

Thank you.

APPENDIX II**FOCUS GROUP DISCUSSION GUIDE**

Introduction: Exchange pleasantries with the group, explaining the rationale behind the meeting.

1. How long has this mining site been in existence?
2. Describe the processes involved in your work?
3. What hazards are you exposed to in the course of your work?
Probe whether they know of any side-effects of those hazards.
4. Do you use any protective clothing while working?
Probe for reasons why they do or do not use clothing.
5. What preventive measures do you take to forestall accidents?
6. Name some of the common diseases found in this community?
7. Have there been any deaths?
Probe for causes ... i.e verbal autopsy.
8. What are some of the problems you face in this settlement?
9. What are your suggestions for solving those problems mentioned above?

Thank you.

APPENDIX II**CHECK LIST****ENVIRONMENT****Housing:**

Types

Room Occupancy rate

Zoning

Water:

Sources of water for domestic and industrial purposes

Cost

Potability

Food and Meat Hygiene

Abattoir/Slaughtering slabs

Pre and post mortem inspection

Sale outlets for food and meat

Pollution of Air/Water

Noise levels

Mercury

Dust

Land Degradation

- Craters
- Abandoned pits/'sumps'
- Waste dumps
- Number of trees felled

Sanitation

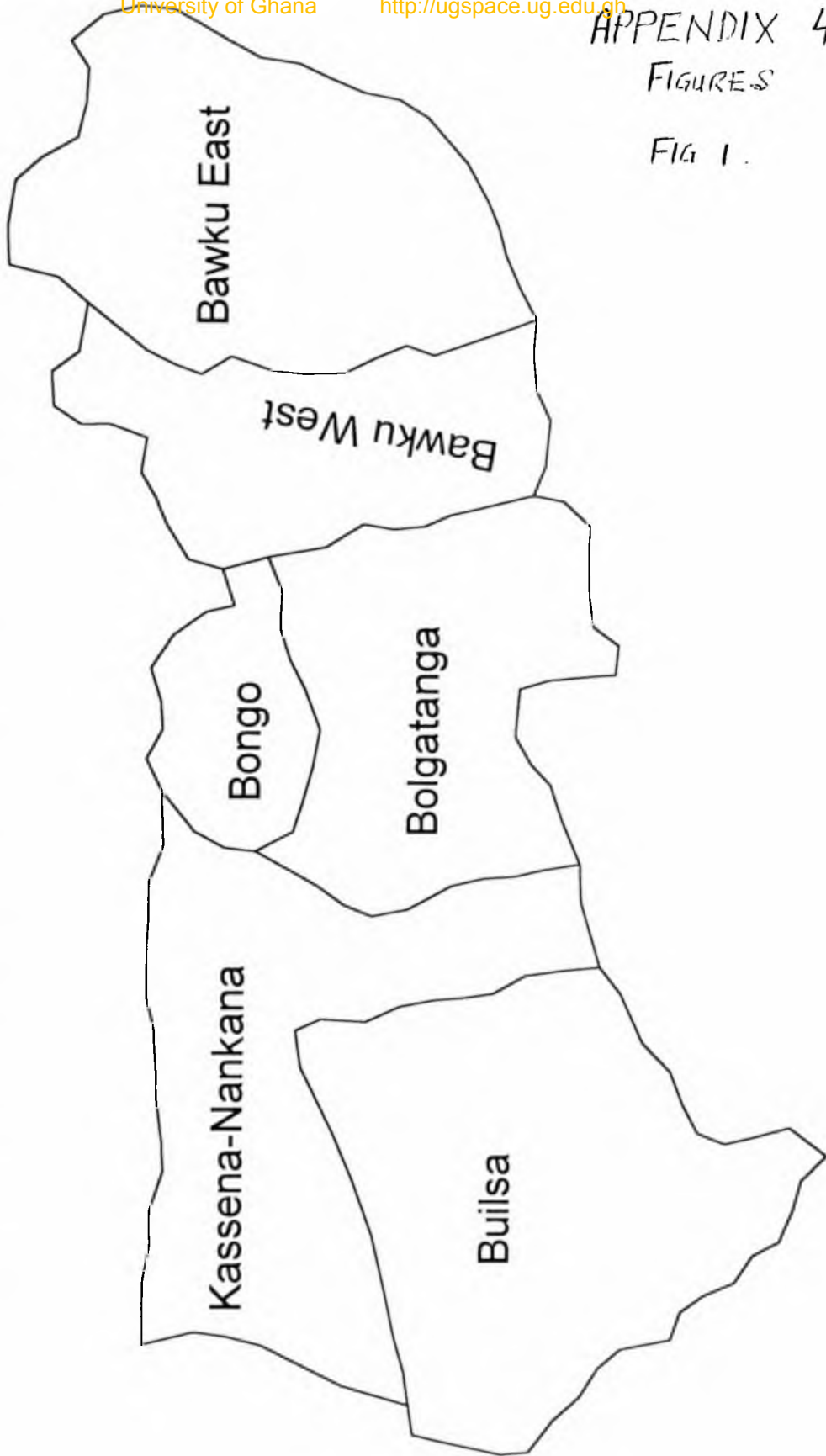
Toilet Facilities

Drainage

Solid waste disposal methods.

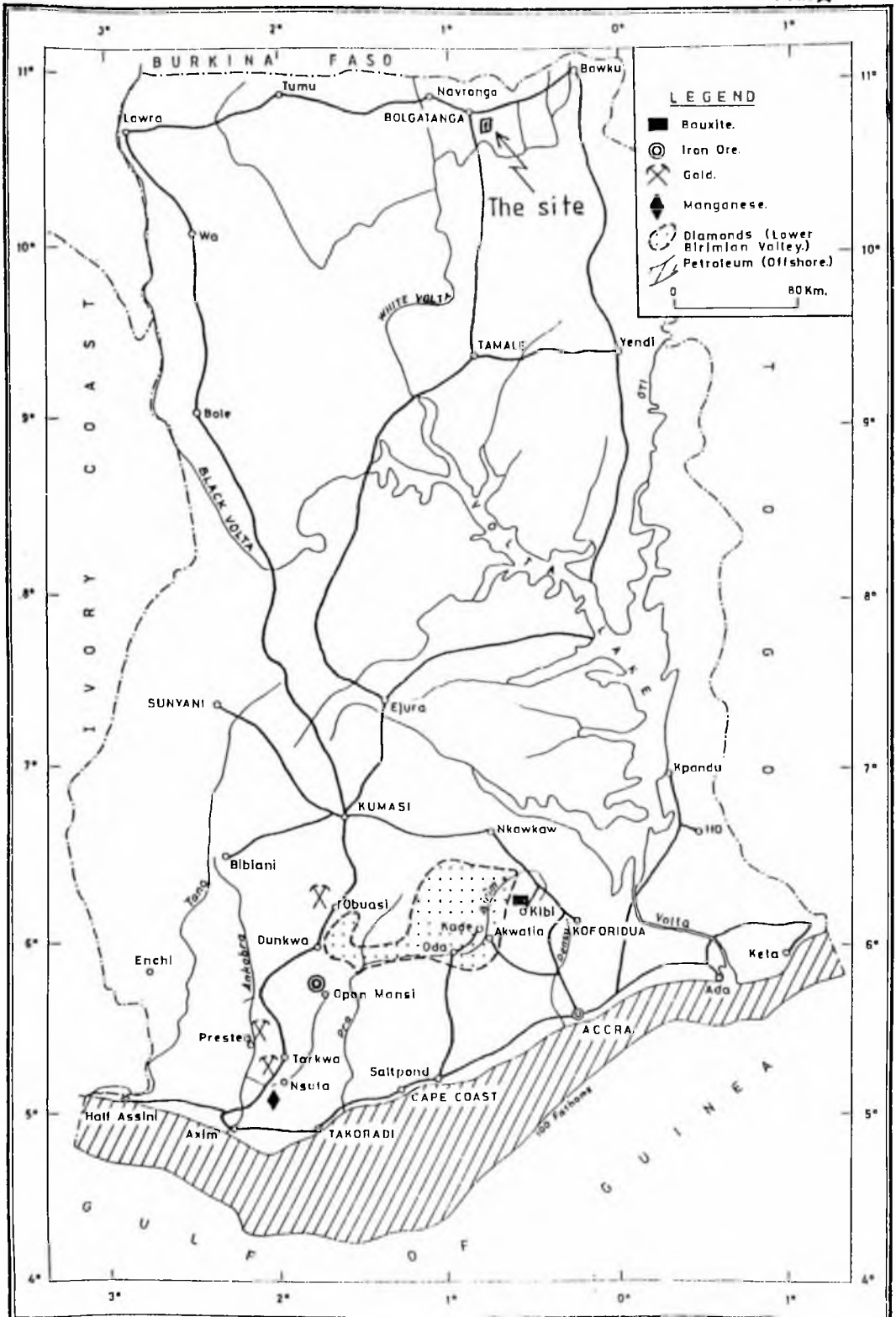
MAP OF UPPER EAST REGION

FIG 1



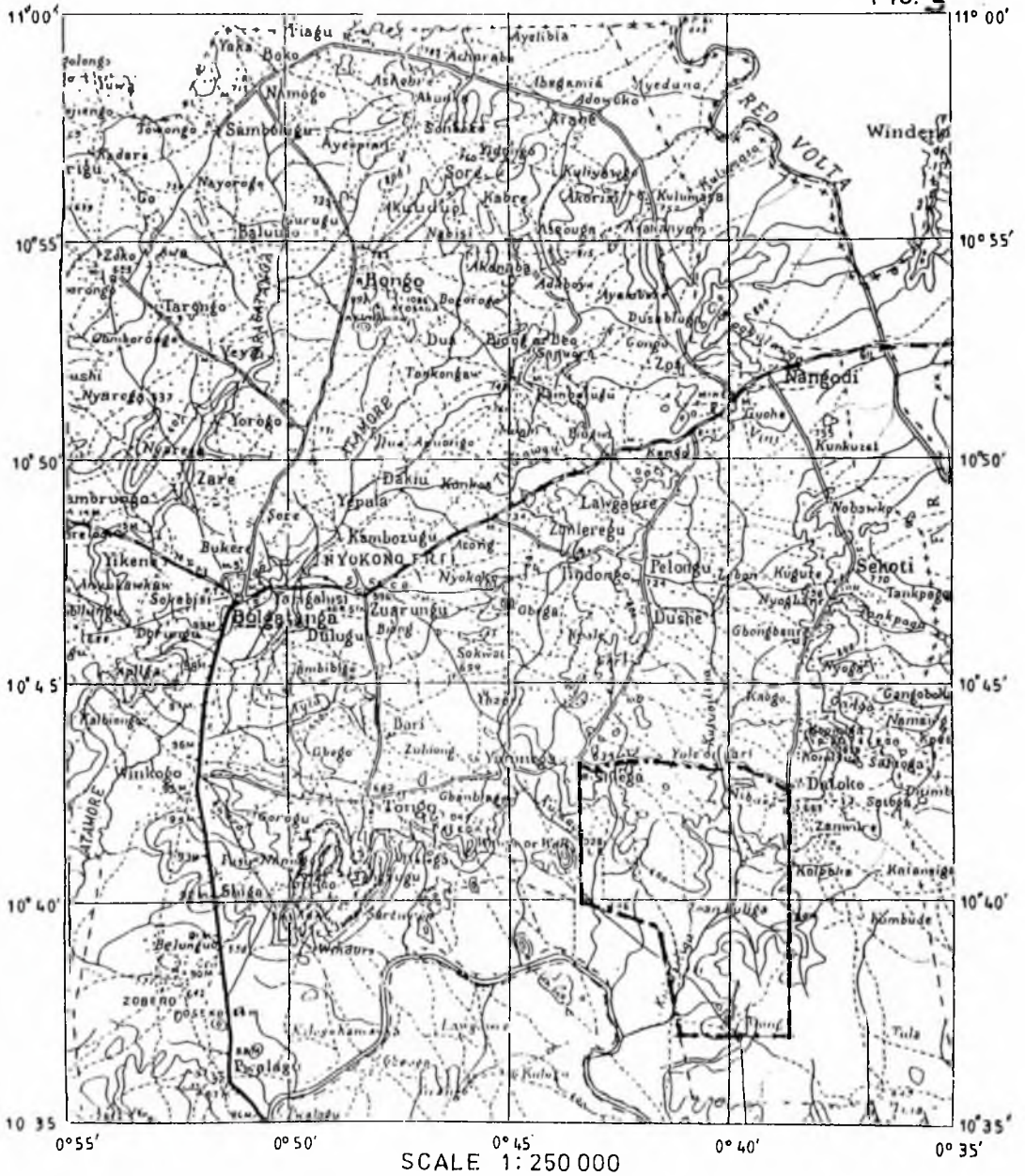
LOCATION MAP

FIG. 2

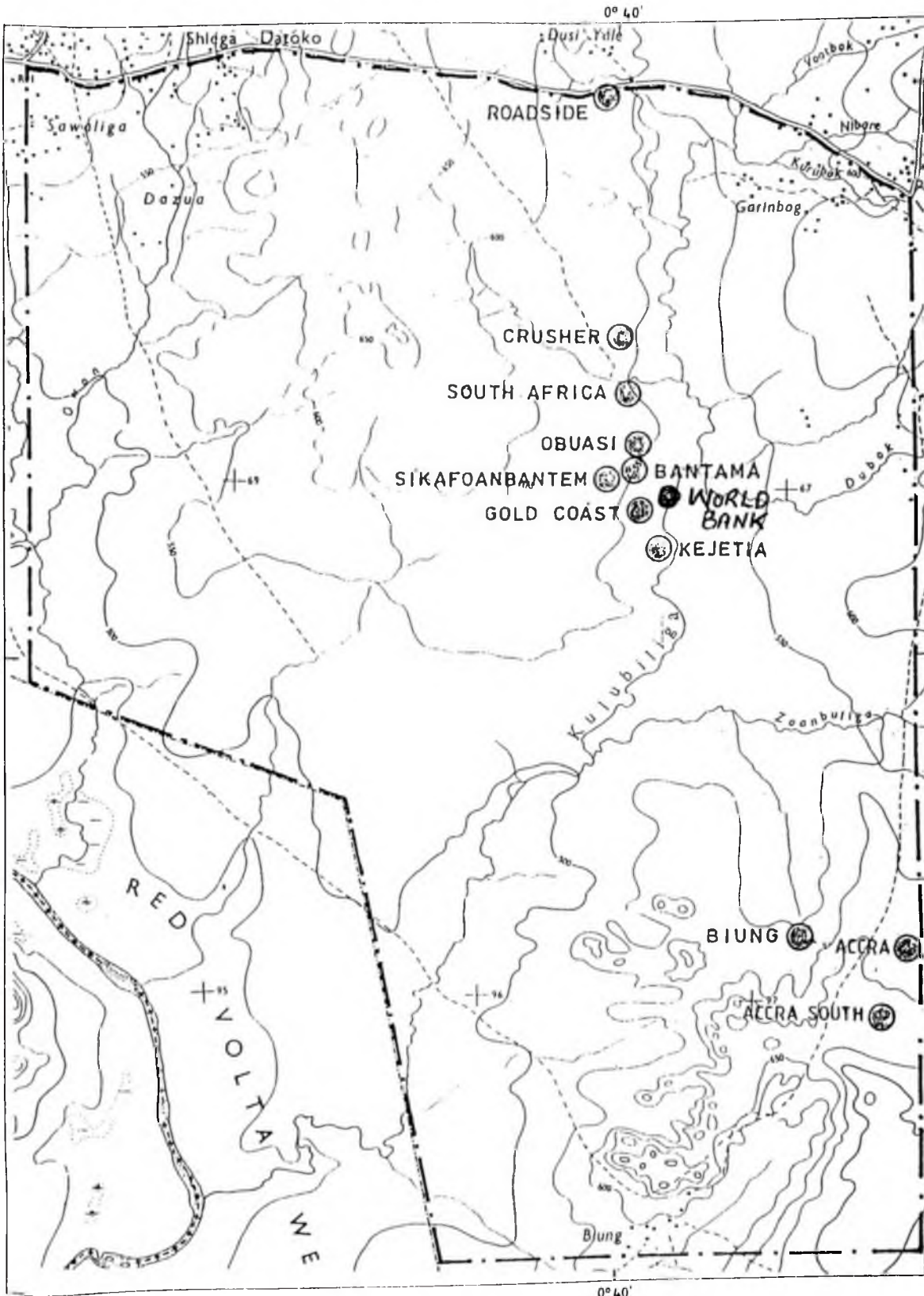


SMALL SCALE MINING AREA RELATIVE TO BOLGATANGA

FIG. 2



MAP OF MINING SITES



SCALE 1 : 50 000

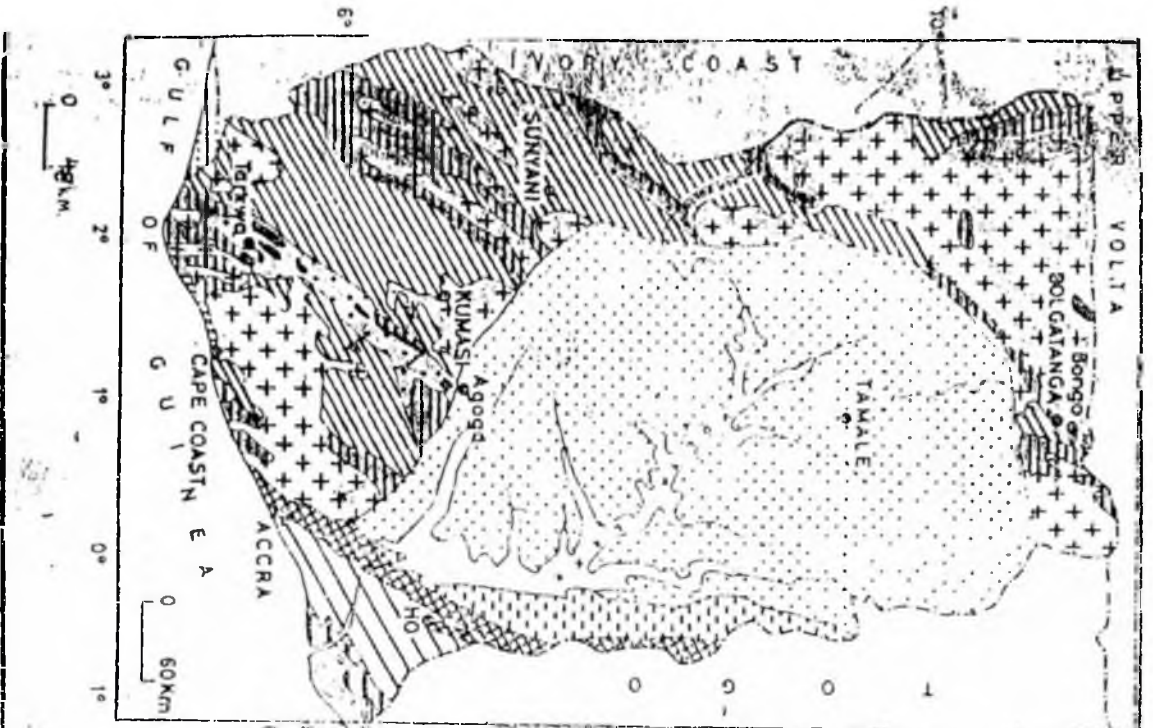


TABLE OF SYSTEMS/SERIES/FORMATIONS

RECENT		Unconsolidated sand, clay and gravel.
10° TERTIARY		Red continental deposit mainly limonitic sand, sandy clay and gravel.
APOLICHIAN FORMATION (Upper Cretaceous)		Alternating sands, clay and limestone.
ANJIAN FORMATION (Upper Jurassic - Lower Cretaceous)		Interbedded soft pebbly grits, conglomerates, sandstone, arkose and clay.
SEKONGIAN SERIES (Middle Devonian - Lower Cretaceous)		Sandstones and shales with conglomerates, pebble beds, grits and mudstone.
ACCRAIAN SERIES (Early or Middle Devonian)		Alternating shales, sandstone, mudstone and pebbly grits.
VOLTALIAN SYSTEM (Late Proterozoic - Early Palaeozoic)		Quartzite, shale, mudstone, conglomerate, limestone, arkose.
BUEM FORMATION (Upper Precambrian)		Shale, sandstone, arkose, lava.
TOGO SERIES (Upper Precambrian)		Quartzite, shale, phyllite.
TARNAWAIAN SYSTEM (Middle Precambrian)		Quartzite, phyllite, grit, conglomerate.
BARILIKI SYSTEM (Upper Middle Precambrian)		Metamorphosed lava and pyroclastic rock.
DAHOMEYAN (Middle - Late Precambrian)		Phyllite, schist, tuff and greywacke.
BASIC INTRUSIVES		Gabbro, dolerite, epidiorite.
GRANITES (Middle Precambrian)		Granite and granodiorite.

PHOTOGRAPHS

PHOTO 1
SMALL-SCALE
GOLD MINING
AREA



PHOTO 2
COLLUVIAL
GOLD MINERS



PHOTO 3
ALLUVIAL
GOLD DIGGERS



PHOTO 4
"CHISLERS"



PHOTO 5
WATER- PUMPING
MACHINE
"OPERATORS"



PHOTO 6
"BLASTMEN"



PHOTO 7
"LOCOBOYS"



PHOTO 8.
"CRUSHERS"



PHOTO 9.
"KAAMEN"



PHOTO 10.
GRINDING
MACHINE
“OPERATORS”



PHOTO 11.
“SHANKING”
GIRLS



PHOTO 12.
“SUMP”
WORKERS



PHOTO 13
AMALGAMATION
WITH MERCURY



PHOTO 14
GOLD DUST



PHOTO 15
WEIGHING GOLD
WITH SCALES
AND BLADES



PHOTO 16.
MAIN STREET:
OBUASI CAMP



PHOTO 17.
HOUSING



PHOTO 18.
SHALLOW WELL
IN DRY
KULUBILIGA
RIVER BED



PHOTO 19.
“CHOP” BAR



PHOTO 20
BUTCHER'S
SHOP



PHOTO 21
RUBBISH DUMP



PHOTO 22.
ROCK AND SOIL
"WASTE" DUMPS
SURROUNDING
PITS/SHAFTS



PHOTO 23
"SUMP" IN
DRY KULUBLIGA
RIVER BED



PHOTO 24.
CELLULITIS/ABSCESS
OF LEFT HAND OF
AN ALLUVIAL
GOLD DIGGER

