

A Contextual Review of the Ghanaian Small-scale Mining Industry

Gavin Hilson

Imperial College Centre for Environmental Technology,
London, UK

This report was commissioned by the MMSD project of IIED. It remains the sole responsibility of the author(s) and does not necessarily reflect the views of the MMSD project, Assurance Group or Sponsors Group, or those of IIED or WBCSD. The Report has been edited by an MMSD editor.

Copyright © 2002 IIED and
WBCSD. All rights reserved

Mining, Minerals and Sustainable Development is a project of the International Institute for Environment and Development (IIED). The project was made possible by the support of the World Business Council for Sustainable Development (WBCSD). IIED is a company limited by guarantee and incorporated in England. Reg. No. 2188452. VAT Reg. No. GB 440 4948 50. Registered Charity No. 800066



International
Institute for
Environment and
Development



World Business Council for
Sustainable Development

Gavin Hilson
Environmental Policy and Management Group (EPMG)
Imperial College Centre for Environmental Technology
Royal School of Mines
Prince Consort Road
London SW7 2BP
g.hilson@ic.ac.uk

<i>Introduction</i>	3
<i>An Overview of Small-scale Mining in Ghana</i>	3
Historical Perspective	3
Geological Setting	4
<i>Socio-economic Impact of Small-scale Mining in Ghana</i>	5
Employment	5
Production from Small-scale Mining and Revenues Accrued	7
The Precious Minerals Marketing Corporation (PMMC)	8
<i>Organization of Small-scale Mining Operations in Ghana</i>	9
<i>Support Schemes for Small-scale Mining in Ghana</i>	12
<i>Environmental Impact of Small-Scale Mining in Ghana</i>	15
<i>Land Use Disputes Between Large- and Small-scale Miners</i>	18
<i>Regulatory Framework for Small-scale Mining in Ghana</i>	21
<i>Contact Information</i>	24
<i>Background Reading</i>	25
Grey Literature, Reports and Unpublished Studies	25
Journal Articles, Books and Book Chapters	26
Literature Cited	27

Introduction

The aim of this report is to provide a detailed overview of the Ghanaian small-scale mining industry. Special emphasis is given to gold and diamonds, the most important commodities mined on a small scale in the country. For decades, the extraction and subsequent processing of these precious minerals has provided thousands of indigenous peoples with employment. These grassroots industries have also made important contributions to foreign-exchange earnings, and are now recognized by the government as the cornerstones of a multimillion-dollar industrial sector, the products and sales from which are controlled.

Under the auspices of the German NGO Gesellschaft Technische Zusammenarbeit (GTZ) and the World Bank, the Ghanaian government has undertaken a number of initiatives in recent years to formalize and regularize resident small-scale mining operations. Although these efforts have noticeably improved the efficiency of operations, certain problems — principally, environmental impacts and land-use conflicts — continue to be largely ignored by government and are becoming increasingly unmanageable. It is therefore imperative that measures are taken immediately to address pressing sector-specific environmental complications such as mercury pollution and land degradation, and to resolve disputes between small- and large-scale miners competing over land concessions. Increased assistance is needed from both the Ghanaian government and the international agencies that have networking capabilities and the means to disseminate valuable informational, technological and educational resources to small-scale miners.

The report is organized as follows. First, an overview of small-scale mining in Ghana is provided in which a historical perspective of the industry is given, regional geological characteristics are highlighted, and the industry's regulatory framework is detailed. Next, the socio-economic importance of the industry is examined with particular reference to employment and earnings. The environmental impacts of small-scale mining in Ghana are then detailed, along with the land-use disputes that have occurred in the industry. The report concludes by providing contact information for some important people involved in small-scale mining research and regulation activities in Ghana, and provides details of some important background reading.

An Overview of Small-scale Mining in Ghana

Historical Perspective

The Ghanaian small-scale mining industry is well over 2,000 years old. Vestiges of alluvial gold extraction and winning activities have been found that date as far back as the sixth century, and there is a wealth of evidence indicating that precious metals recovered from regional artisan activities were attracting Arab traders to certain areas of the country as early as the 7th and 8th centuries AD. In fact, it was the rich gold deposits of the western Sahara that were largely responsible for the wealth and strength of large ancient Ghanaian empires and cultures [1], and by the 15th and 16th centuries, at the peak of European colonial exploration, Ghana was fittingly labelled the 'Gold Coast'.

Small-scale mining in Ghana, as in most developing countries, was for decades treated as an informal industrial sector, employing thousands of people but featuring largely rudimentary, unmonitored and uncontrolled practices. Up until the 1980s, small-scale mining activities in Ghana remained largely unregulated and received little, if any, support from governmental bodies. This, however, changed with the implementation of the national Economic Recovery Plan (ERP), which, following years of careful planning, was finally launched in the mid-1980s. In a desperate move to revitalize a stagnating economy, the then Provincial National Defence Council (PRDC) government consulted authorities from both the World Bank and International Monetary Fund (IMF) to assist in the drafting of national economic plans and policies. The Ghanaian minerals sector was heavily targeted, which, between 1960 and 1980, had experienced mass declines in mineral output: gold production had declined from 900,000oz in 1960 to 232,000oz in 1982; manganese output had dropped from 600,000t in 1960 to 160,000t in 1982; bauxite production declined from 407,000 in 1974 to 64,700t in 1982; and diamond output had declined from 2,340,000 carats in 1975 to 683,524 carats in 1982 [2]. Foreign investment was promoted, and a series of tax breaks and benefits were offered to foreign companies seeking to acquire mineral prospecting licences in Ghana.

The small-scale mining segment of the industry was also heavily targeted. For the first time in history, the Ghanaian government discussed plans to formalize the sector after identifying the potential earnings in the industry, revenue that under an informal organizational scheme, is largely lost via smuggling and other avenues of illegal trading. By the end of the 1980s, the government had fully regularized the small-scale mining sector through a series of policies and regulations.

Geological Setting

Naturally, it is the favourable geological setting that enables widespread small-scale gold mining to occur in Ghana. The country is situated mostly within the West African Craton, which stabilized during the early Proterozoic Period some two billion years ago [2]. In a series of tectonic processes, large areas were folded, faulted, metamorphosed, subjected to igneous activity, erosion and sedimentary processes, giving rise to a series of gold belts [5]. As Dzighbodi-Adjimah and Bansah [6] explain, geologists today place these gold deposits into one of two general categories [5, 7–8]. The first of these is Birimian Gold. The Birimian supracrustal rocks of West Africa, which extend from Ghana westwards to Senegal and Mauritania, and northwards into Burkina Faso, are richly endowed with Proterozoic greenstone-type gold lode deposits. Deposits are variable and structurally complex, featuring gold that occurs in both quartz-filled shear zones and in altered rocks adjacent to shear zones. The metamorphosed volcanic belts in which they are found average between 15km and 40km in width, and cover approximately one-sixth of Ghana's surface area. The bulk of Ghanaian gold is derived from Birimian rocks. The second category is Tarkwaian Gold. Auriferous quartz-pebble conglomerates deposits occur within the Tarkwaian supercrustal rocks of Ghana. The matrix is fine-grained quartz and black sands (mainly hematite, and to a lesser extent, ilmenite, magnetite and rutile), and over 90 per cent of the pebbles are vein-quartz, and the balance, quartzite and phyllite.

In short, Ghana is covered by the Paleoproterozoic rocks of the Birimian Super group and the overlying clastic sedimentary Tarkwaian group [9]. A result of a series of erosional

events, however, significant portions of these rocks have been re-deposited as placer formations in a number of streams and channels. Placer Gold Deposits, which are also referred to as 'alluvial gold', are found in the majority of rivers draining Birimian rocks. Large deposits of placer gold also occur along the terraces, floodplains, channels and river beds of the Offin, Pra, Ankobra, Birim and Tano rivers, where large Birimian and Tarkwaian gold deposits have experienced several episodes of erosion and subsequent deposition. Small-scale gold mining is, for the most part, confined to these areas, since most operators lack the requisite mechanized equipment to mine hardrock deposits of the Birimian and Tarkwaian Belts. The rivers and waterways highlighted on the map contain the placer gold deposits in the country and are quintessentially the main locations of small-scale gold-mining activities.

Small-scale diamond mining is more localized, with 60 per cent of licensed operations occurring at the Ghana Consolidated Diamonds (GCD) site at Akwatia, and the balance within surrounding areas [4]. In fact, small-scale diamond mining occurs either under licences issued by the Minerals Commission or tributer permits granted by GCD on its concession.

Socio-economic Impact of Small-scale Mining in Ghana

Employment

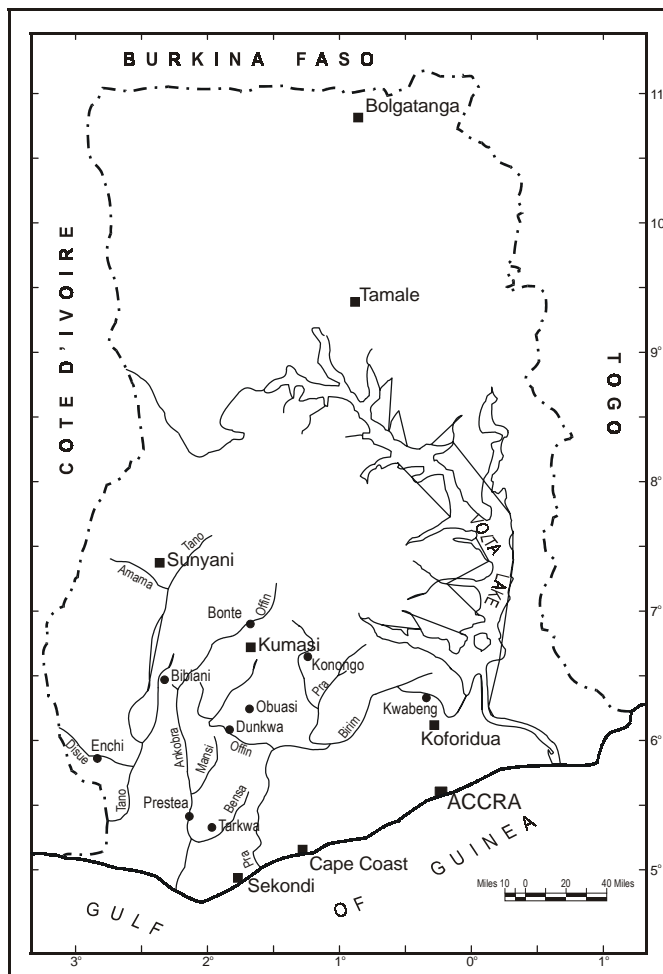
Most small-scale miners in Ghana are engaged in the extraction of gold and diamonds simply because they can generate wealth quickly. In fact, with the exception of specialist commodities, in most instances, it is economically unviable to mine anything *other* than precious metals and stones. Approximately two-thirds of Ghana's small-scale miners are engaged in the extraction of gold, and most of the balance extract diamonds [4]; only a small group of miners are involved in industrial minerals production.

Small-scale mining brings several benefits to developing countries, manifested mainly as employment and revenue. Although not capital intensive, small-scale mines require sufficient manpower; labour-intensive small-scale mining operations are economically feasible because investment costs per job are typically only 10–12 per cent as those costs in large mining operations [10]. Small-scale mining, therefore, has a major impact on the employment situation in the developing world, especially in rural areas where there are few alternatives. Moreover, the enactment of relevant legislation and effective legalization of small-scale mining has had a positive impact on the economies of certain developing countries. By formalizing operations, illegal smuggling channels are being eliminated, thereby enabling the complete capture of internally mined product. The successful containment of the minerals mined on a small-scale contributes enormously to sector revenues, and also contributes positively to foreign-exchange earnings.

No precise small-scale mining employment figures can be found for Ghana, although it is estimated some 200,000 are involved directly in the extraction of gold and diamonds [11], the great majority of which are *galamsey*. In a technical paper published by the World Bank entitled *Strategy for African Mining* [4], it is estimated that some 30,000 people are employed within the legalized segment of the Ghanaian small-scale mining sector. This figure was

confirmed during interviews with representatives from the Minerals Commission and Ghana Chamber of Mines, who also noted that 60 per cent of the country's mining labour force is, in fact, employed at small-scale mines. Regional employment assessments have also been made, most notably that of Agyapong [12], who estimates that over 6,000 illegal and 117 registered artisanal gold mines are found in Tarkwa alone. Nevertheless, as was explained by a senior correspondent of the Minerals Commission, the difficulty in obtaining precise employment figures for the sector stems from the fact that district centres — namely, regional branches of the Minerals Commission — keep manual tabulations of regional activities, much of which are undisclosed to the public.

Map. Rivers in Ghana associated with placer gold deposits [6]



Overall, women constitute some 15 per cent of the legalized segment of Ghanaian small-scale mining labour force. Women account for 6 per cent of licensed buyers, 10 per cent of concession holders and 15–20 per cent of the sponsors of work groups, members of cooperatives or mining groups [14]. Participation is more widespread, however, in small-scale clay mining and stone quarrying, where there is a need to perform more basic washing, transport and sieving activities. Furthermore, 75 per cent of the Ghanaian small-scale salt-mining workforce is female as well as 50 per cent of the illegal *galamsey* industry [15]. The small percentage of female participation is attributable to both a lack of training and socio-economic attitudes. As Tråore [13] explains, in Africa, women generally have

minimal education and an insufficient knowledge of small-scale mining techniques, and are therefore confined to basic scratching, panning, transport and washing activities. Furthermore, because of traditional cultural values — more specifically, the continental perception of men playing a more prominent role in society — African women experience difficulties in securing bank loans for small-scale mining equipment, which more often than not, discourage female involvement.

Although there is some degree of child participation in Ghanaian small-scale mining activities, it was discovered during personal interviews with employees from the Mineral Commission that accurate tabulations of the total number of children employed in the country's small-scale mining operations do not exist. Furthermore, most of the child-employment statistics that have been maintained are manually recorded, are stored separately in a number of different regional offices around the country and are highly inaccessible to researchers.

Production from Small-scale Mining and Revenues Accrued

It is estimated that mineral production from small-scale mining accounts for approximately one-sixth of global mineral output. In Ghana, since complete legalization of its small-scale mining segment, significant revenues have been generated in the sector. To reiterate, prior to legalizing and regularizing operations, most of these revenues were lost through illegal smuggling channels. Significant quantities of valuable mineral product — in particular gold and diamonds, and to a lesser degree, precious and semiprecious stones — was lost to neighbouring Togo, Burkina Faso and Nigeria.

Table 1. Small-scale Gold and Diamond Mining Production in Ghana, 1990–1997 [2]

Gold			Diamonds	
Year	In ounces	Revenue in US\$ (000s)	Carats	Revenue in US\$ (000s)
1990	17,234	6,257	484,876	14,280
1991	8,493	3,800	541,849	17,444
1992	10,867	7,714	442,000	12,781
1993	33,647	11,480	368,195	11,575
1994	89,520	36,090	405,830	10,000
1995	127,064	53,540	337,457	7,314
1996	112,240	43,340	443,244	9,500
1997	107,093	33,094	558,241	10,956

Source: Minerals Commission. 2000

Since 1989, Ghanaian small-scale mines have produced over US\$117 million worth of gold and \$98 million worth of diamond product [16], a commendable feat considering that these operations are only being 20 per cent efficient. Between 1989 and 1994 alone, 30,000 small-scale miners reportedly produced and sold to governmental offices \$68.56 million in gold and \$71.5 million in diamonds [15]. In fact, as Davidson [17] explains, during the first four years of operation, some 400 properties registered under the newly introduced legalization scheme, produced over 45,000oz of gold. As Table 1 shows, annual small-scale gold production has increased nearly tenfold over the past decade, rising from 17,234oz in 1990 to 107,093oz in 1997. Diamond production from small-scale mines has also been

significant. Although annual totals vary, production from small-scale diamond mines has also been significant, accounting for between 60 and 70 per cent of total production. Even in 1992, when total diamond output dipped from 541,849 to 442,000 carats, small-scale miners still accounted for some 80 per cent of national output.

It is important to clarify that in Ghana, significant numbers of rural inhabitants are attracted to small-scale mining because the industry pays substantially higher wages than most other sectors of industry. In a country where GNP per capita is \$390, as Appiah [11] explains, the average small mine worker earns approximately \$7 each day, which, for a five-day work week, amounts to \$1,820 annually. Box 1 highlights some important revenue and employment characteristics of the Ghanaian small-scale mining industry.

The Precious Minerals Marketing Corporation (PMMC)

In an attempt to create avenues for small-scale miners to sell product, the Precious Minerals Marketing Corporation (PMMC) was established. Although vestiges of the organization go as far back as 1963, when the Diamond Marketing Corporation was established and shortly after incorporated by Legislative Instrument (LI) No. 401 of 1965 as a state corporation, the Precious Minerals Marketing Corporation Law (PNDC Law 219) of 1989 officially established the PMMC. The law granted the organization authority to buy and sell gold in addition to diamonds. Its mission is to buy from small-scale miners, and to sell precious minerals profitably in order to enhance foreign-exchange earnings from the sector. The corporation has some 750 licensed buying agents and subagents who travel the country, purchase gold from artisanal miners and in turn sell it back to the corporation; only ingots are purchased by the Corporation, which mandates that all customers smelt gold in the form of dust before offering it for sale [15].

Box 1. Characteristics of the Ghanaian Small-scale Mining Industry

Employment statistics

- Estimated 30,000 working on registered plots, 170,000+ illegal *galamsey*.
- 15% female participation in legal segment, 50% female participation in illegal segment.
- 60% of the known Ghanaian mining labour force is employed at small-scale mines.

Revenue statistics

- Approximately two-thirds of the Ghanaian small-scale mining industry is engaged in the extraction of gold, with most of the balance involved in diamond mining.
- Over \$117 million in gold and \$98 million in diamond product has been obtained from small-scale mining operations since complete legalization of the industry in 1989.
- Gold production from the small-scale gold-mining industry has increased nearly tenfold since 1989, from 17,234oz in 1990 to 107,093oz in 1997.

In addition to buying and selling, however, the PMMC performs a number of other tasks, including the following:

- The grading, assaying, valuing and processing of precious minerals;

- The appointing of licensed buying agents for the purchase of precious minerals produced by small-scale miners; and
- Promotion of the development of precious minerals and jewelry industries in Ghana.

As it is a state organization, a government-appointed Board of Directors controls day-to-day operations. A managing director — assisted by three department heads of finance/administration, operations and auditing — heads the corporation. Its head office is based in Accra but substations and regional offices are found throughout the country [18].

Table 2 presents annual purchase and exports totals from the small-scale mining sector by the PMMC.

Table 2. Small-scale gold production and export proceeds in Ghana

Year	Ounces	Value (US\$)	Carats (000s)	Value (US\$)
1989	9,272.60	3,730,000	151.61	2,110,000
1990	17,233.50	6,257,280	484.88	14,280,000
1991	15,601.03	5,325,236	541.85	17,440,000
1992	17,297.48	6,148,121	479.88	13,040,000
1993	35,144.51	12,647,290	368.19	11,580,000
1994	55,225.13	21,285,265	411.40	11,550,000
1995	55,544.94	21,329,842	335.17	7,310,000
1996	51,317.34	20,292,842	450.70	9,820,000
1997	51,317.34	20,100,000	560.70	11,290,000
1998	58,860.00	19,990,000	556.60	10,620,000
Total	374,356.55	137,105,302	4,340.98	109,040,000

Source: PMMC

Organization of Small-scale Mining Operations in Ghana

As already indicated, gold and diamonds are the most important minerals mined on a small scale in Ghana, although industrial minerals are mined by a small contingent of the population. In the case of gold, operators are awarded licences by the government to mine in a designated area not exceeding 25 acres for three to five years. Typically, a licensed operator employs between five and 20 groups of tributers consisting of five to 10 workers each that excavate ore and process gold. The arrangement is that the tributers keep two-thirds of the profits, and the remaining third is given to the concessionaire [11].

The most common equipment used are basic hand tools such as picks, axes, sluice boxes and shovels, although occasionally Honda water pumps, explosives and washing plants are seen within regions. It was discovered during visits to certain small-scale gold-mining regions, however, that even the sites that feature the most advanced of machinery are, for the most part, rudimentary in design. The most organized of set-ups have separate ‘stations’ or locations for performing the necessary activities of the gold-production process. First, ore is crushed into pebbles by hand or machine, and is contained in storage sacks in sheds. Next, the pebbles undergo primary, secondary and tertiary grinding in preparation for washing. Carried to the riverside in cloth bags, the finely crushed sediment is laid along washing blankets or is hand washed along riverbanks (see photos) to separate valuable gold

particles. The sediment is then panned using mercury, and the resulting amalgam is roasted over a charcoal fire in the open air (see photo).

The processing of diamonds is far less rigorous as it involves fewer production phases. As with gold, however, a number of people are employed as diggers, transporters and washers. Some 60 per cent of small-scale diamond miners operate within the concession of Ghana Consolidated Diamonds (GCD) in Akwatia, where as Iddirisu and Tsikata [19] explain, a tributer system applies, whereby small-scale miners obtain plots for a nominal fee. Plot owners employ gangs of individuals and the profits earned from the concentrate obtained is shared between owners and the workers (typically, the plot owner keeps one-third of the profits, and the balance is distributed to workers).



Blanket washing of sediment alongside a river in Ghana.



Roasting of mercury amalgam over charcoal at a small-scale Gold-mining site in Tarkwa

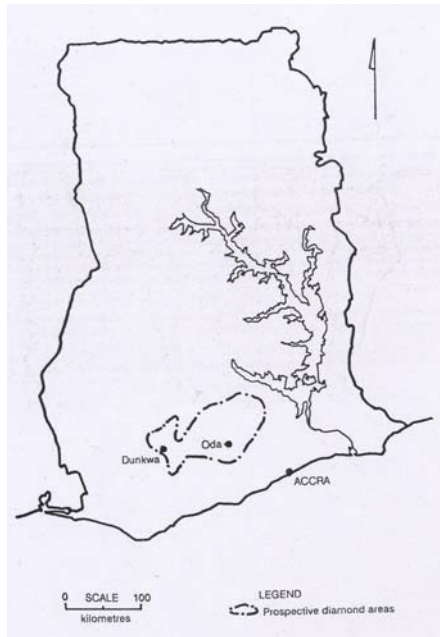


Hand washing of gold-infested sediment in a small-scale gold mining district

The two maps highlight the prospective small-scale gold and diamond regions of Ghana.



Map Prospective small-scale gold mining regions in Ghana [21]



Map. Prospective small-scale diamond mining regions in Ghana [21]

As already noted, there is some small-scale mining of industrial minerals in Ghana. Mensah [20], for example, provides some perspectives on the country's small-scale sand mining industry. The collection of silica sand occurs throughout Tarkwa and the Western Region, as local glass factories require sand as a raw material input. There is also a flourishing salt-mining industry in the country, involving the participation of hundreds of women. Salt typically collects near the sea, where seawater evaporates and leaves noticeable deposits. Pickaxes and headpans are used to collect and carry the salt to market [19].

It cannot be overstated that gold and diamonds are by far the most important minerals mined on a small-scale in Ghana. The government now recognizes the importance of these industries and, over the past 10–15 years, has undertaken a series of initiatives to provide support to these industries. The next section of the report details the existing small-scale mining support schemes in Ghana.

Support Schemes for Small-scale Mining in Ghana

To reiterate, the government has undertaken a series of initiatives to support small-scale miners. The literature provides a detailed analysis of these efforts but what it fails to describe are how and why many of the other attempts made to improve the sustainability of resident small-scale mining operations have failed. Both the successes and failures are documented in the discussion that follows.

When the Small-Scale Mining Project (SSMP) was launched in 1989 four institutions were given the responsibility to providing institutional support for the project: the Geological Survey, Mines Department, Minerals Commission and PMMC. As explained in a personal interview with Joseph Eyison, chief engineer and deputy director of the SSMP at the Minerals Commission: the Minerals Commission, Mines Department, the Geological Survey and the PMMC were initially identified as the four main pillars of the project. The Minerals Commission was to recruit district officers for the Project; the Mines Department

was to recruit mines wardens; the Geological Survey was to give mineralizations and identify areas suitable for small-scale mining; and the PMMC was to ensure that products would be 'captured', by establishing purchasing centres and recruiting licensed buying agents. However, once these initial tasks were performed, virtually all small-scale mining responsibilities were given to the Minerals Commission.

Initially, under the auspices of GTZ, the Minerals Commission worked to improve the technological aspect of the Ghanaian small-scale mining sector and introduced three-horsepower water pumps (for alluvial mining), sluice boxes and pick axes. The Minerals Commission stored equipment locally, and a district officer dispensed it on a high-cost basis — more specifically, at prices beyond the budgets of small-scale miners. As a result, the majority of the equipment was not purchased, or was sold off at a loss, and all revenues returned to the project. Shortly after, in what was arguably a move of desperation, the Minerals Commission cornered the Central Regional Development Commission (CEDECOM) for consultation support. Management asked CEDECOM to make recommendations for the provision of equipment but the suggestions provided, overall, were highly ineffective largely because CEDECOM, which had had no interaction with small-scale miners in the past, used information drawn heavily from experiences with small-scale fisheries to craft each. The Minerals Commission soon discontinued the scheme, sold newly purchased equipment at discounted prices, and again, returned what funds remained to the SSMP.

It is important to clarify that the Ghanaian government, in regularizing and formalizing small-scale mining operations, has taken a necessary first step toward improving the sustainability of the sector. More specifically, as Noestaller [22] explains, legalization, intervention and control are keys to eliminating unacceptable work practices and the illicit marketing of minerals, and are a necessary prerequisite for removing operational constraints limiting productivity and competitiveness. However, these efforts have only led to the creation of a much-needed regulatory framework for use by government. Needless to say, they have not translated into real benefits for small-scale miners, who had operated illegally using the same methods before the enactment of pertinent legislation. What efforts have since been made to provide support to small-scale miners?

Apart from a series of lectures held at the University of Ghana, few support projects have been undertaken to promote environmental improvements in resident small-scale mines. The baseline studies carried out by the University of Ghana, the combined purpose of which was to quantify the environmental impacts of small-scale mining, included climate and air quality, water bodies, geology, soil, ecology and environmentally sensitive areas. The Minerals Commission, throughout the 1990s, did sponsor a series of independent studies but most of the recommendations made are still in the process of being analysed. Some of the more promising studies include an economic analysis of small-scale mining reclamation practices, a socio-economic study of the upper east region of Bolgatanga, and a review of marketing functions under the small-scale mining project. However, resource and manpower shortages have prevented the Minerals Commission from putting a number of these recommendations into practice.

Perhaps the most significant move has been the establishment of district support centres (see, for example, Figure 6), the initial aims of which were to provide regional registration

and purchasing services to precious metals miners. Because centres are centrally located within prospective mining communities, there is great potential for providing additional services — ranging from environmental management, through education to training — at each. Eight small-scale mining district centres were initially constructed in the southern part of the country, although only seven remain today. In addition to a district officer, each is staffed with a mine engineer and a mines inspector who register claims, provides technical advice, and encourages the safe and productive operation of mines [17]. The unit holds public meetings, draws site plans, and provides basic small-scale mining equipment such as measuring tapes and compactors, stores valuable regional production data and site plans and issues prospecting licences. Attempts have also been made to organize training sessions at district centres, the aim being to educate miners on important issues of health and safety, business management, environmental protection and use of technology.

Loans are also provided to needy small-scale miners looking to purchase handheld and mechanized equipment. At present, the Minerals Commission through GTZ, awards loans at subsidized rates. Initially, the Minerals Commission had provided loans directly to miners but then encountered repayment complications. Representatives of the Minerals Commission are highly in favour of abandoning the existing loans scheme and promoting the development of rural banks also capable of providing loans to miners at subsidized rates, the key difference being that money would not be channelled through the Minerals Commission, and miners, as a result, would be more inclined to view funds as ‘borrowed’.

A final important initiative undertaken by the government was mandating PMMC to provide competitive rates for mined small-scale gold and diamond product. As is explained in detail in the World Bank technical paper, *Staff Appraisal Report, Republic of Ghana, Mining Sector Development and Environment Project* [4], prior to 1993, PMMC set its gold-buying price at the world market rate less 3 per cent for its commission and 4 per cent for a Land Rehabilitation Fund. This rate, however, was not competitive with that of unauthorized buyers, and in 1993, a more aggressive approach was adopted. The organization now sets a buying price weekly, at a guaranteed rate of 98 per cent of the world market price. The move resulted in the immediate doubling of small-scale mining purchases in that year. In the case of diamonds, purchasing is carried out at PMMC’s head office in Accra. A two per cent fee is charged on the value of the diamonds purchased to cover PMMC’s cost of providing these services. In a move to become more competitive, PMMC authorized three additional diamond buyers to operate in Accra.

More recently, the World Bank has been involved in small-scale mining research in Ghana, most notably, through its Mining Sector Development and Environment Project, launched in the early 1990s. The aim of the project, parts of which are still ongoing, ‘is to support the sustainable development of Ghana’s mining sector on an environmentally sound basis through the application of improved technology and strengthened mining institutions’. As far as small-scale mining is concerned, the project seeks to provide pilot testing of small-scale mining equipment for improving productivity and yields; making available valuable geological information to small-scale miners; improving the regulatory framework for small-scale miners; and reclaiming abandoned land. The World Bank did provide some input into most of the aforementioned initiatives but many of these support services and strategies have since disintegrated, particularly the environmental-related activities. In fact,

as is explained in the next section of the report, the environmental component of the industry has not been prioritized whatsoever and is in dire need of attention.



A small-scale mining district support centre (in Tarkwa)

Environmental Impact of Small-Scale Mining in Ghana

In Ghana, the principal environmental problems caused by small-scale mining activity are mercury pollution from gold processing and land degradation. As is the case in most developing countries, the mercury amalgamation technique is relied upon heavily as it is a cheap, dependable, portable operation for concentrating and extracting gold from low-grade ores. It is now well known, however, that the chemical, in sufficient quantities, poses a serious threat to human health and is deleterious to a wide-range of ecological entities. Once in the natural environment, mercury undergoes a change in speciation from an inorganic to a stable methylated state (MeHg) by non-enzymically and microbial action, and when ingested, eco-toxicological effects result.

In Ghana, mercury research in small-scale gold-mining regions has been largely neglected. In fact, it is safe to say that outside of a select group of regional studies carried out independently by local universities and agencies, no mercury pollution study of the sector has been undertaken to date, despite the fact that an estimated five tons of mercury are released into the environment each year from small-scale gold-mining operations [4]. Research undertaken and reported by NRS Consultants [21] reveals that small-scale miners occupationally exposed to mercury, are, in fact, contaminated. Analysis of hair samples obtained from miners in Tarkwa and Accra shows a mean value of $7.4\mu\text{g/g}$; it is recommended by the World Health Organization that the average weekly intake of mercury should be no more than $5\mu\text{g/kg}$ of body weight, of which no more than $3.3\mu\text{g/kg}$ should be MeHg. Two unpublished studies commissioned recently by UNIDO confirm further that there is a mercury pollution problem — although with unknown dimensions — within certain small-scale gold-mining regions in Ghana. The first [23] involved analysing hair, urine, blood and nail samples from 187 adults residing in an artisanal gold-mining community, some 40 per cent of whom claimed to have health problems. Clinical examinations identified 13 men as having slight neurological disorders (as a result of

mercury overexposure), many gold washers having elevated concentrations of mercury in their bloodstreams, and that there is an exposure to mercury in the community through contaminated food. The aim of the second study [24], which was carried out in Dumasi (Western Region of Ghana), was to depict mercury environmental impacts prior to the introduction of plans for mercury recycling. Soil, sediments, fish, chicken, vegetables, surface water and groundwater were sampled in April 2000 in order to determine levels of mercury contamination. Results indicate that although surface water and groundwater feature mercury concentrations below WHO standards, sediments are seriously polluted and fish are contaminated to the point where they should not be consumed.

The careless handling of mercury was witnessed during visits to individual mine sites. Even in the most sophisticated and organized of operations, small-scale miners were observed to be using mercury without appropriate respiratory or skin protection. For example, the Small-Scale Mining Society, an organized group working an abandoned plot of land previously worked by Gold Fields Ghana, employs a number of locals — many of whom are children — to pan gold by hand. Typically, mercury is added and mixed by hand without using gloves. More significantly, however, once the amalgamation process has finished, the ore is roasted in the open air over charcoal fires.

A second major environmental impact of small-scale gold mining in Ghana is land degradation — more specifically, clearing vast expanses of forest, digging trenches and the upturning of vegetation which in turn leaves land bare and exposed to agents of erosion (see Figure 7). Approximately 15,000ha of land are potentially affected by small-scale mining activities [4], and as Iddirisu and Tsikata [19] explain, it is quite common for prospective sites to be stripped bare of vegetation topsoil, and where deep underground mining has occurred, that pits are left uncovered and abandoned. Agyapong [12], who conducted fieldwork in the Tarkwa region of Ghana, reports that vast tracts of the region have been deforested as a result of small-scale gold mining.

Artisanal miners, who allegedly ‘clear the vegetation’ and then dig ‘for mineral-bearing ore’, have scarred the landscape with ‘excavated pits and trenches’, which in turn renders the ‘land unsuitable for any other purpose’. Many of these pits have filled with water and serve as breeding grounds for malaria-infected mosquitoes. During personal visits to Tarkwa, it was observed that resident small-scale gold mining operations have, in fact, caused a disproportionate amount of damage to land. Miners were witnessed to be working deposits on cliff tops as well as alluvial deposits within ponds and rivers. Most of the underground operations are constructed haphazardly, excavated to unsafe depths and supported flimsily by logs and branches. Furthermore, in certain areas, huge patches of forest have been removed to establish quarters or ‘resting grounds’ for miners (see Figure 8). These areas have also played a major role in altering local hydrological patterns.

Surprisingly, little has been done administratively to rectify these and related environmental problems. There was a government effort in the early 1990s to disseminate mercury retorts — which effectively enable the recycling of spent mercury, and reduce emissions of the chemical — but a refusal to subsidize the equipment caused the project to fail. In an attempt to implement policies for reclaiming small-scale mining sites, the Minerals Commission also introduced a Reclamation Fund, which called for a certain percentage of revenue from small-scale mining sales to be ‘held’ by the government and used to finance

reclamation programmes. As Davidson [17] reports, between 1989 and 1991, \$17,000 was contributed to the Land Reclamation Fund but communications with representatives from the Minerals Commission revealed that the initiative has long been abandoned, principally because of the challenges associated with extracting money from small-scale mining parties.

One of the prerequisites for securing a small-scale mining plot is completion of an environmental impact assessment. In a highly discretionary procedure, the applicant identifies, generally, how he or she plans to address relevant environmental matters and the Minerals Commission, along with the EPA, uses this information to determine whether or not the proposed initiatives are environmentally sufficient. The main problem with this EIA procedure is that it does not target the specifics of environmental management, but rather asks vague environmental questions such as ‘Give a brief overview of the likely environmental impacts of the mining activities?’ and “Describe the mitigation measures proposed?” Certainly, with few environmental support programmes in place for small-scale miners — mainly in the areas of technology and education — even if it were made a requirement that specific areas of environmental management be addressed in the environmental impact statement, it would be highly unlikely that proactive measures would *ever* be carried out by individual miners, who simply lack the finances and knowledge to undertake anything significant beyond the norm.

Issues that are perhaps more pressing than these environmental matters, however, are the series of land-use disputes that occur between small- and large-scale miners. Often, a land concession is leased by the Minerals Commission to a large-scale mining company, and, following intense prospecting, illegal *galamsey* are discovered to be working on the same plot. The next section of the report examines these issues more in detail, and outlines some of the steps that have been taken by selected large-scale mining companies to improve relations with encroaching *galamsey*.



Typical landscape destruction from small-scale mining



'Resting grounds' established by small-scale miners at sites

Land Use Disputes Between Large- and Small-scale Miners

The issue of land use disputes between small- and large-scale miners is particularly pressing in Ghana at the moment. The government, which is continuously looking for strategies to increase foreign investment in its minerals and mining sector, is awarding land to large-scale mining companies. This is displacing a great number of local small-scale miners, most of whom are operating illegally but nevertheless rely upon their mining for subsistence. Although the policies used to encourage investment in Ghanaian mining have been extremely successful, the mining land-use disputes that have accompanied this economic expansion have proven to be challenges of monumental proportions for regional governmental authorities.

The small- and large-scale miners of Ghana are in constant competition over the plots of land overlying the country's rich deposits of gold and diamonds. As already explained, the Minerals Commission, with a staff of 35-40 people, has been assigned the task of formalizing the small-scale mining segment of the industry, an incredible challenge considering that an estimated 200,000 small-scale miners are currently involved in the extraction of gold and diamonds in the country [11]; these *galamsey* commonly 'encroach' on the land concessions awarded by the Minerals Commission to large-scale mining companies. Prior to the launching of the ERP, the illegal nature of *galamsey* had been an issue largely ignored, principally because a great number of large-scale mining operations had been suspended or closed down entirely because of cash flow problems. However, accompanying the pattern of increased foreign investment that has occurred within the Ghanaian mining sector in recent years, has been a pattern of intensified land-use disputes between the *galamsey* and large-scale miners. Suspended operations have reopened, previously unexplored regions of the country are being prospected and new sites are being

excavated; in the process, land is being ‘taken away’ from *galamsey* operators. Because of cultural relationships with the land — namely, ancestral ties — a significant number have been reluctant to relocate, which in turn has resulted in a number of disputes over mineral-rich land concessions.

Most of the land use conflicts between small- and large-scale miners have occurred within the Tarkwa and Ashanti (near Oda) Regions of Ghana. One company that has experienced great difficulty in removing invading *galamsey* from its Tarka property is Teberebie Goldfields Ltd, which is 90 per cent owned by the Pioneer Group in Boston. As Agyapong [12] explains, conflicts between the company and local small-scale miners began shortly after operations commenced in 1991. Miners are still unwilling to leave the area, contending that they have no alternative source of livelihood. Their activities have caused significant environmental damages in various portions of the concession, mainly water pollution and incomplete reclamation of pits. They refuse to take any responsibility for this damage, and continue to avoid taking any of the necessary safety precautions at sites.

Ashanti Goldfields, which ranks as the world’s 11th-largest gold miner, has experienced similar problems with *galamsey* invading their concessions. At its complex in Obuasi, one of the richest mines in the world and produces some 38 per cent of Ghana’s gold [27], major conflicts have occurred that have been among the most serious reported in the country. Violent clashes erupted in 1996 between *galamsey* and local security forces, resulting in over \$1 million in damages at the site, and more recently, in December 2000, vandalizing *galamsey* set ablaze the poultry farm at Obuasi, and stole valuable livestock. Management has since made a concerted effort to improve security, and there are now policemen stationed at the site. In addition, at its smaller Bibiani property, located slightly west of Obuasi, management reports needing police help in Kumasi to control resident *galamsey*.

The management of Ghanaian large-scale mining operations has expressed considerable frustration over the illegal activities of the *galamsey*. Selected managers and mine engineers also feel that the efforts governmental policymaking bodies have made to resolve these land-use conflicts have been marginal at best. As the chief mining engineer of a property in Tarkwa explains, ‘it is extremely frustrating for a mine and its investors to endure *galamsey* attacks, especially in a system that cannot effectively differentiate between its registered small-scale miners and illegal operators’. Another manager complained that it was extremely aggravating to have to ‘monitor the activities of small-scale miners operating on a concession’, because if not done appropriately and effectively, ‘they would destroy the environment and the company would be held responsible by the EPA’.

It is evident from communications with representatives from the Minerals Commission, Mines Department, and EPA that the main cause of land-use conflicts between large- and small-scale miners is, in fact, irresponsible behaviour on the part of the *galamsey*, combined with their reluctance to be trained and educated to work in more specialized areas of mining or in different industries entirely.

There have, however, been some partnerships forged between large- and small-scale miners in Ghana, which has enabled both parties to coexist within the same land concessions. Gold Fields Ghana Ltd, formerly Tarkwa Goldfields Ltd, managed an underground complex through to the end of 1999, and commenced operations at its main Tarkwa surface mine in

April 1998. The area, however, has long been occupied by thousands of *galamsey*, some of whom are displaced workers from neighbouring large-scale mines, and others, simply local villagers. Mine management, in an attempt to prevent land-use disputes, undertook a series of initiatives to improve relations between the parties. Management first ascertained that certain areas of the land concession contained alluvial gold deposits suitable for small-scale mining, which was then awarded to resident small-scale miners (see Figure 9). Purchasing services have also been established, whereby the mined product can be sold — at prevailing market prices — to Gold Fields Ltd on site.

Abosso Goldfields Ltd (AGL) has also been proactive in improving relations with small-scale miners. In 1996, the company began organizing *galamsey* mining groups that were operating on their property (also near Tarkwa). As Agyapong [12] explains, prior to issuing a prospecting licence to AGL in 1990, seven groups of small-scale mining cooperatives were mining an area of 155 acres within the same land concession awarded to AGL. Shortly after AGL began extensive prospecting, over 600 miners migrated from other parts of the concession on to the company's trenches, where explosives were being used. After failing for months to prevent the conflict with these resident illegal miners, management decided to pursue a different strategy. Following successful communication with the cooperatives, it identified, registered and regrouped the small-scale miners, and equipped them with Abosso Goldfields' identification cards. Initially, 700 miners were registered, most of whom were using small picks and shovels to work alluvial and consolidated gravel deposits. A commissioned agent periodically visits the site to purchase product from these miners [11].



Small-scale gold miners working land within the Gold Fields Ghana concession in Tarkwa

One final and notable example is the Small-Scale Mining Society, a cooperative comprised of some 1,500 workers. Shortly after acquiring an underground mine in Tarkwa from the State Gold Mining Cooperative, Gold Fields Ghana Ltd, in light of low gold prices, suspended operations. This caused serious agitation among the indigenous and redundant labourers, who were left unemployed as a result of the closure. The company, therefore,

established a small-scale mining cooperative — since named the ‘Small-Scale Mining Society’ — in early 2000 to work the suspended underground operation. It is evident, from having visited the site, that this cooperative is highly organized. It features a chief security officer, director of operators and designated areas for performing the particular tasks necessary in the gold-production process. It was learned that although the cooperative features miners from all over Tarkwa, each must register before entering the mine. By establishing the society, Gold Fields Ghana Ltd, has reduced tensions between small- and large-scale miners on what the company has classified as ‘marginal land’.

In summary, land-use disputes between small- and large-scale miners are quite common in Ghana. In most instances, a large-scale mining company leases a plot of land from the Minerals Commission and later discovers illegal *galamsey* mining within the same concession. Some companies have shown, however, that with improved communications and increased assistance, cohabitation can work.

Regulatory Framework for Small-scale Mining in Ghana

Initially, only diamonds could be legally mined on a small scale in Ghana. However, in 1989, a much-needed move was taken to legalize small-scale gold mining, which, from an economic perspective, is by far a more important sector of the economy. The following three laws [3] were passed:

- The Small-scale Gold Mining Law (PNDCL 218): provides for the registration of activity; the granting of gold-mining licences to individuals or groups; the licensing of buyers to purchase product; and the establishment of district-assistance centres.
- The Mercury Law (PNDCL 217): legalized the purchasing of mercury (for mineral-processing purposes) from authorized dealers.
- The Precious Minerals Marketing Corporation Law (PNDC Law 219): transformed the Diamond Marketing Corporation into the Precious Minerals Marketing Corporation (PMMC), which was authorized to buy and sell gold.

Whereas some countries define small-scale mining operations in terms of output and manpower, the Ghanaian government adopts a definition of small-scale mining based upon concession size. In principle, a small-scale mining operation in Ghana is that which is based on a land plot measuring less than 25 acres [4]. Discussions with representatives from the national Geological Survey, Mines Department, Environmental Protection Agency (EPA) and Minerals Commission confirmed this, although they did indicate that there are supplementary indicators that are occasionally used for classification purposes as well. These include manpower, equipment type and operating time. The procedure by which an individual obtains a small-scale mining licence is tedious, requiring the completion of several forms, and final approval from governmental authorities. A number of criteria must be met, and several restrictions apply (see Box 2). The process, overall, is largely voluntary, which is why most of the country’s small-scale miners — referred to locally as *galamsey* — continue to operate illegally, easily evading governmental authority. Separate prospecting licences are issued to individuals, which give a holder the exclusive right to search for specific minerals using geological and geophysical means. The initial grant of the licence is

limited to a maximum area of 150km² over a period of three years, although it may be renewed for up to two two-year terms. Most commonly, however, the plots of land issued to register small-scale miners have already been geo-prospected, in which case, exploration is not needed.

Institutionally, it is the Ghanaian Minerals Commission that is responsible for all policymaking and regulatory activities in the industry. Established under the Minerals Commission Law of 1986, the Mineral Commission, which is one of four main departments of the Ministry of Energy and Mines, seeks to help formulate government policy with respect to ‘exploration for and exploitation of mineral resources’ and to handle ‘all public agreements relating to mining’. As already noted, its actions have brought small-scale mining into legal channels through the establishment of the Precious Minerals Marketing Corporation (PMMC) buying offices and licensed traders, and is the main sectoral agency responsible for ensuring that operations are carried out in an environmentally sound manner [4]. When a prospective applicant notifies a local branch of the Minerals Commission of his or her intentions, a representative evaluates the chosen site to determine its suitability. If deemed appropriate, the area is then demarcated and site plans are prepared; a notice of intention to allocate the area for small-scale mining is published by the District Assembly for a period of 21 days, and if no objections are made, the applicant completes the necessary forms, which, along with an environmental impact assessment statement, are then submitted to the Minerals Commission in Accra [2]. A Small-Scale Mining Unit comprised of some 35 personnel was established in the Minerals Commission to handle these and related responsibilities.

The series of laws and policies that constitute the Ghanaian small-scale mining regulatory framework are outlined in Box 3.

Box 2. Classification and Registration Criteria for Ghanaian Small-scale Mining

- Licences are granted only to Ghanaian nationals.
- A licence issued to an individual shall not exceed three years but can be renewed for a period of no more than three years for two consecutive terms.
- A licence issued to a cooperative shall last for a period of five years but is renewable for a period no longer than five years for two consecutive terms.
- A group of individuals not exceeding four shall be granted an area no more than three acres; a group exceeding four but not more than nine shall be granted an area no more than five acres; and a company or a cooperative society shall be granted an area not exceeding 25 acres.
- An applicant must complete the application form fully and have it endorsed by district administration.
- Although all small-scale miners are exempted from payment of taxes and royalties for the first three years of operation, they are not exempted from local imposts.
- After successful application, the mine operator must erect concrete posts at the four corners of the concession atop of the four discs (with number engraved) provided; the edges of the concession must be kept clear for concession purposes; and successful applicants must also erect a signpost within the concession with their name and number written on it.

Box 3 Small-scale Mining Regulatory Framework in Ghana

General Mining Laws

- Minerals and Mining Law (PNDCL 153)
- Minerals Commission Act, 1993 (Act 450; formerly PNDCL 153)
- Small Scale Gold Mining Law, 1989 (PNDCL 218)
- Diamonds (Amendment) Law (PNDCL 217)
- Environmental Protection Council Decree, 1974 (NRCD 239)
- Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219)
- Diamonds Decree, 1972 (NRCD 32)
- Additional Profit Tax Law, 1985

Regulations

- Mining Regulations, 1970 (LI 665)
- Explosives Regulations, 1970
- Minerals (Royalties) Regulations, 1987

Small-scale Mining Enactments

- Diamond Mining Industry Protection Regulations, 1927 (No. 9/ 1927)
- Concessions Ordinance, 1939 (c.136, Laws of G.C. 1951 Revision), s.38 and Form of Schedule
- Gold Mining Products Protection Ordinance (c.149, Laws of the Gold Coast, 1951 Revision)
- Mining Health Areas Ordinance (c. 150, Laws of the Gold Coast 1951 Revision)
- Mining Health Areas Regulations, 1935 (Vol. VIII, 1954 Laws of the Gold Coast p. 1123)
- Prospecting & Digging License Regulations, 1950 (Vol. VIII, 1954 Laws of the Gold Coast, p. 1032)
- Minerals Regulation, 1962 (L.I. 231), especially regulation I and Form 5 of the first schedule
- Minerals Regulations, 1963 (L.I. 253)
- Mining Regulations, 1970 (L.I. 665), especially regulations 4,6,10 and 194–205
- Explosives Regulation, 1970 (L.I. 666)
- Diamonds Decree, 1972 (NRCD 32) (as amended by the PNDCL 216)
- Minerals and Mining Law, 1986 (PNDCL 153, especially Part X – s.73-76, and s.77)
- Mercury Law, 1989 (PNDCL 217)
- Small-Scale Gold Mining Law, 1989 (PNDCL 218)
- Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219)
- Minerals Commission Act, 1993 (Act 450)
- Environmental Protection Agency Act, 1994 (Act 490)
- Water Resources Commission Act, 1996 (Act 552)

- The Constitution, 1992

Relevant Codes of Practice

- Code of Practice for Small-scale Gold-mining Operations
- Ghana's Mining and Environmental Guidelines

Contact Information

This section of the report provides contact information for individuals involved with small-scale mining regulation, research and monitoring in Ghana.

Peter C Acquah
Executive Director
Environmental Protection Agency
PO Box M.326
Ministries
Accra
pca@epa.gov.gh

B R Yakubu
Director, Small Scale Mining
Minerals Commission
No. 9 Switchback Road
Residential Area, Cantonments
PO Box M 248,
Accra
Byakubu@mincomgh.org

Joseph Eyison
Deputy Director,
Small Scale Mining Minerals
Commission
No. 9 Switchback Road
Residential Area, Cantonments
PO Box M 248,
Accra
jeyson@mincomgh.org

Fui Tsikata
PO Box 821
Accra, Ghana
61 Jones Nelson Road
Adabraka, Accra
reichamb@ghana.com

J Banson

Ghanaian Geological Survey
No. 12, 7th Avenue, adj. To Ecobank
PO Box M.80
Accra
(233-21) 228093

Alhaji Yakabu Iddirisu
Geological Management Consultancy
PO Box 172
Legon
(233-21) 238242/232655
gconsult@ghana.com

George Ashante
Precious Minerals Marketing
Corporation
Diamond House
PO Box M108
Accra,
(233-21) 664931-4
pmmc@ghana.com

Background Reading

Grey Literature, Reports and Unpublished Studies

Agyapong, E (1998) Streamlining Artisanal Gold Mining Activities and the Promotion of Cleaner Production in the Mining Sector in Sub Saharan Africa: Ghana as a Case Study. Thesis for Master of Science in Environmental Management and Policy, International Institute for Industrial Environmental Economics, Lund University, Sweden.

Assante, G (2000) Enhancing Performance in Jewelry Production at Precious Minerals Marketing Corporation (PMMC) Ghana. Unpublished thesis, Mediterranean Institute of Management, Cyprus.

Babut, M, Sekyi, R, Rambaud, A, Pottin-Gautier, M, Tellier, S, Bannerman, W and Beinhoff, Ch (2001) Assessment of Environmental Impacts Due To Mercury Used in Artisanal Gold Mining in Ghana United Nations International Development Organization (UNIDO), unpublished study.

Coakley, G (1999) The Mineral Industry of Ghana. US Geological Survey Report, Washington.

GFG (1998) Gold Fields Ghana Ltd 1997 Annual Report. Company report.

GFG (1999) Gold Fields Ghana Ltd 1998 Annual Report. Company report.

Iddirisu, A Y and Tsikata, F S 1998. Mining Sector Development and Environment Project. Regulatory Framework Study to Assist Small Scale Miners, prepared for the Minerals Commission.

Minerals Commission (2000) Minerals Commission of Ghana Website. At www.ghanamincom.gsf.fi

NSR (1994) Environmental Impact Assessment of Small-scale Mining in Ghana: Part I Physical and Biological Aspects. NSR Environmental Consultants, Australia.

PMMC (2001) Company Profile: Precious Minerals Marketing Corporation. Company report, Accra.

Rambaud, A, Casellas, C, Sackey, O, Ankrah, N, Potin-Gautier, M, Bannerman, W, Claon, S and Beinhoff, Ch (2001) Mercury Exposure in an Artisanal Mining Community in Ghana. United Nations International Development Organization (UNIDO), unpublished study.

Sraku-Lartey, K (1998) Environmental Education – Perspectives from the Minerals Industry of Ghana. Paper presented at the University of Science and Technology, Kumasi.

Journal Articles, Books and Book Chapters

- Acquah, P (1995) *Natural Resources Management and Sustainable Development: The Case of the Gold Sector in Ghana*. United Nations Conference on Trade and Development (UNCTAD).
- Acquah, P and Boateng, A (2000) Planning for Mine Closure: Some Case Studies from Ghana. *Minerals and Energy* 15(1): 23–30
- Addy, S N (1998) Ghana: Revival of the Mineral Sector. *Resources Policy* 24(4): 229–39.
- Amegbey, N A, Dankwa, J B K and Al-Hassan, S (1997) Small-scale Mining in Ghana – Techniques and Environmental Considerations. *International Journal of Surface Mining, Reclamation and Environment* 11: 135–8.
- Appiah, H (1998) Organization of Small-scale Mining Activities in Ghana. *The Journal of the South African Institute of Mining and Metallurgy* 98(7): 307–10.
- Botchway, F (1995) Pre-colonial Methods of Gold Mining and Environmental Protection in Ghana. *Journal of Energy and Natural Resources Law* 13(4): 299–311.
- Davidson, J (1993) The Transformation and Successful Development of Small-scale Mining Enterprises in Developing Countries. *Natural Resources Forum* 17(4): 315–26.
- Dzigbodi-Adjimah, K (1993) Geology and Geochemical Patterns of the Birimian Gold Deposits, Ghana, West Africa. *The Journal of Geochemical Exploration* 47: 305–20.
- Dzigbodi-Adjimah, K and Bansah, S (1995) Current Developments in Placer Gold Exploration in Ghana: Time and Financial Considerations. *Exploration and Mining Geology* 4(3): 297–306.
- Huq, M (1989) *The Economy of Ghana: The First 25 Years Since Independence*. Macmillan, London.
- ILO (1999) *Social and Labour Issues in Small-scale Mines*. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines, International Labour Organization, Sectoral Activities Programme, International Labour Office, Geneva.
- Jackson, R (1992) New Mines for Old Gold: Ghana's Changing Mining Industry. *Geography* 77(2): 175–8.
- Laffoley, N and Laidler, C (1997) Pre-European Gold Mining at Ashanti, Ghana. *Mining History* 13(4): 12–16.

- Lunt, D J, Kirby, E and Ritchie, I C (1995) Design of Gold Projects in Ghana. *African Mining '95*, Institution of Mining and Metallurgy, London
- Oberthür, T, Weiser, T, Amanor, J A and Chryssoulis, S L (1997) Mineralogical Siting and Distribution of Gold in Quartz Veins and Sulfide Ores of the Ashanti Mine and Other Deposits in the Ashanti belt of Ghana: Genetic Implications. *Mineralium Deposita* 32: 2–15.
- Tsikata, F S (1997) The Vicissitudes of Mineral Policy in Ghana. *Resources Policy* 23(1–2): 9–14.
- UN (1996) Recent Developments in Small-scale Mining: A Report of the Secretary-General of the United Nations. *Natural Resources Forum* 20(3): 215–25.
- Utter, T (1992) Gold Mining Potential of West Africa. *Erzmetall* 46(10): 563–72.
- World Bank (1995) *Staff Appraisal Report, Republic of Ghana, Mining Sector Development and Environmental Project*. World Bank Report No. 13881-GH, Industry and Energy Operations, West Central Africa Department, Africa Region.

Literature Cited

1. Botchway, F (1995) Pre-Colonial Methods of Gold Mining and Environmental Protection in Ghana. *Journal of Energy and Natural Resources Law* 13(4): 299-311.
2. Minerals Commission (2000) *Minerals Commission of Ghana Website*. www.ghanamincom.gsf.fi
3. Tsikata, F S (1997) The Vicissitudes of Mineral Policy in Ghana. *Resources Policy* 23(1–2): 9–14.
4. World Bank (1995) *Staff Appraisal Report, Republic of Ghana, Mining Sector Development and Environmental Project*. World Bank Report No. 13881-GH, Industry and Energy Operations, West Central Africa Department, Africa Region.
5. Lunt, D J, Kirby, E and Ritchie, I C (1995) Design of Gold Projects in Ghana. *African Mining '95*, Institution of Mining and Metallurgy, London.
6. Dzigbodi-Adjimah, K and Bansah, S (1995) Current Developments in Placer Gold Exploration in Ghana: Time and Financial Considerations. *Exploration and Mining Geology* 4(3): 297–306.
7. Leube, A, Hirdes, W, Mauer, R and Kesse, G (1990) The Early Proterozoic Birimian Supergroup of Ghana and Some Aspects of Its Associated Gold Mineralization. *Precambrian Research* 46: 139–65.
8. Hammond, N Q and Tabata, H (1997) Characteristics of Ore Minerals Associated with Gold at the Prestea Mine, Ghana. *Mineralogical Magazine* 61: 879–94.

9. Oberthür, T, Weiser, T, Amanor, J A and Chryssoulis, S L (1997) Mineralogical Siting and Distribution of Gold in Quartz Veins and Sulfide Ores of the Ashanti Mine and other Deposits in the Ashanti Belt of Ghana: Genetic Implications. *Mineralium Deposita* 32: 2–15.
10. UN (1992) *Mining and the Environment: The Berlin Guidelines, Study Based on an International Round Table in June 1991*. Mining Journal Books, Department of Technical Cooperation, United Nations, New York.
11. Appiah, H (1998) Organization of Small-scale Mining Activities in Ghana. *The Journal of the South African Institute of Mining and Metallurgy* 98(7): 307–10.
12. Agyapong, E (1998) *Streamlining Artisanal Gold Mining Activities and the Promotion of Cleaner Production in the Mining Sector in Sub Saharan Africa: Ghana as a Case Study*. Unpublished thesis, Lund University, Lund.
13. Tráore, P A (1994) Constraints on Small-scale Mining in Africa. *Natural Resources Forum* 18(3): 207–12.
14. ILO (1999) *Social and Labour Issues in Small-scale Mines*. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines, International Labour Organization, Sectoral Activities Programme, International Labour Office, Geneva.
15. UN (1996) Recent developments in small-scale mining: A report of the Secretary-General of the United Nations. *Natural Resources Forum* 20(3): 215–25.
16. PMMC (2001) Company Profile: Precious Minerals Marketing Corporation. PMMC, Accra.
17. Davidson, J (1993) The Transformation and Successful Development of Small-scale Mining Enterprises in Developing Countries. *Natural Resources Forum* 17(4): 315–26.
18. Assante, G (2000) *Enhancing Performance in Jewelry Production at Precious Minerals Marketing Corporation (PMMC) Ghana*. Unpublished thesis, Mediterranean Institute of Management, Cyprus.
19. Iddirisu, A Y and Tsikata, F S (1998) *Mining Sector Development and Environment Project*. Regulatory Framework Study to Assist Small-scale Miners, prepared for the Minerals Commission.
20. Mensah, J V (1997) Causes and Effects of Coastal Sand Mining in Ghana. *Singapore Journal of Tropical Geography* 18(1): 69–88.
21. NSR (1994) *Environmental Impact Assessment of Small-scale Mining in Ghana: Part I Physical and Biological Aspects*. NSR Environmental Consultants, Australia.

22. Noetstaller, R (1994) Small-scale Mining: Practices, Policies and Perspectives. In A.K. Ghose (ed) *Small-scale Mining: A Global Overview*. Rotterdam.
23. Rambaud, A, Casellas, C, Sackey, O, Ankrah, N, Potin-Gautier, M, Bannerman, W, Claon, S and Beinhoff, Ch (2001) *Mercury Exposure in an Artisanal Mining Community in Ghana*. United Nations International Development Organization (UNIDO), unpublished study.
24. Babut, M, Sekyi, R, Rambaud, A, Pottin-Gautier, M, Tellier, S, Bannerman, W and Beinhoff, Ch (2001) *Assessment of Environmental Impacts Due To Mercury Used in Artisanal Gold Mining in Ghana*. United Nations International Development Organization (UNIDO), unpublished study.
25. Hilson, G (nd) The Environmental Impact of Small-scale Gold Mining in Ghana: Problems and Solutions. *The Geographical Journal* (submitted for publication).
26. Hilson, G (nd) Land Use Disputes Between Small- and Large-Scale Miners: A Case Study of Ghana. *Land Use Policy* (in press).
27. Coakley, G (1999) *The Mineral Industry of Ghana*. US Geological Survey Report.