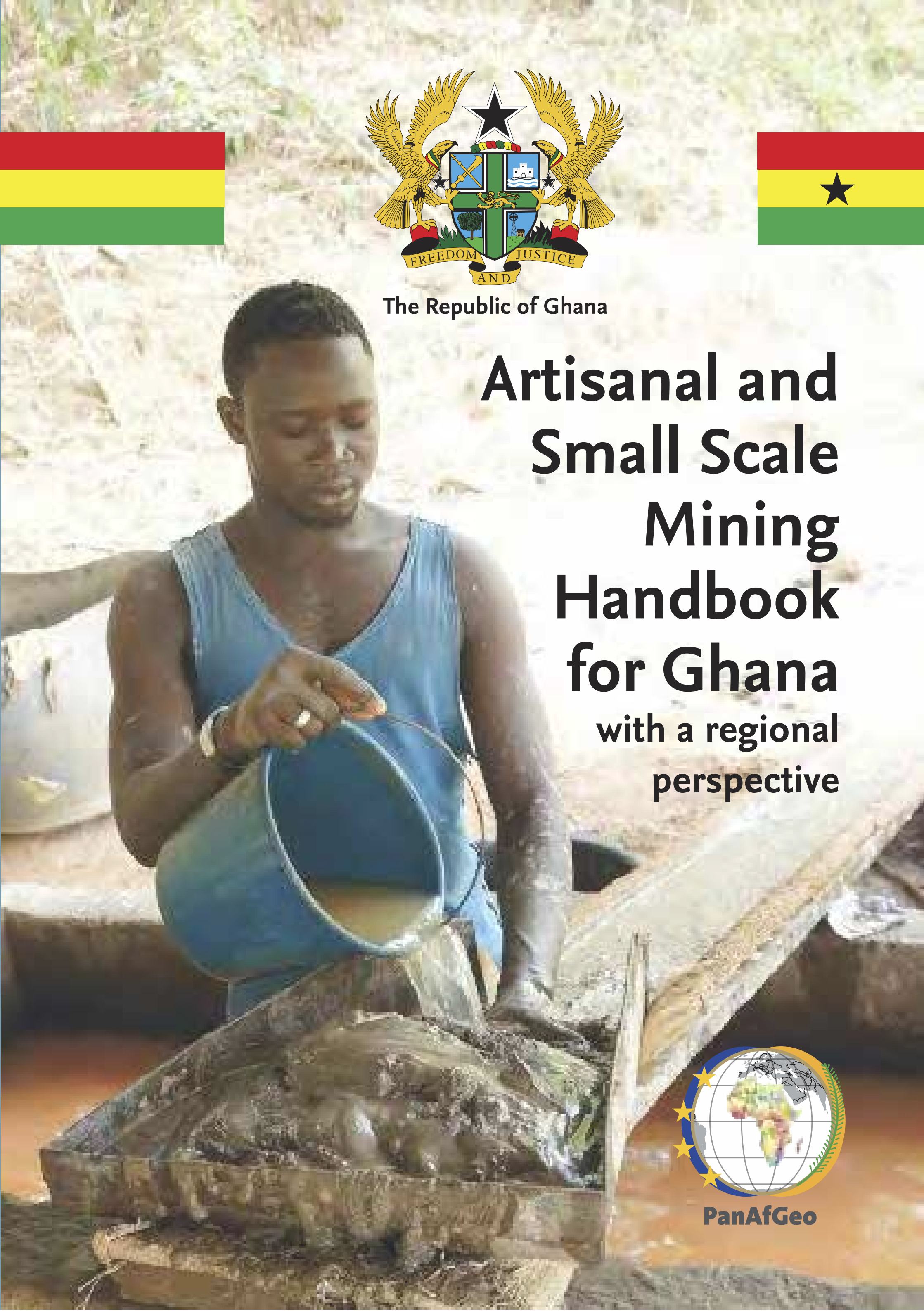

The Republic of Ghana

# Artisanal and Small Scale Mining Handbook for Ghana

## with a regional perspective

PanAfGeo

THE REPUBLIC OF GHANA

Ministry of Lands and Natural Resources

# Artisanal and Small-Scale Mining Handbook for Ghana

Prepared by the
Geological Survey of Denmark and Greenland
October 2017

GEUS

PanAfGeo
Geoscientific Knowledge & Skills in African Geological Surveys

The Pan-African Support to the EuroGeoSurveys-Organisation of African Geological Surveys Partnership, abbreviated to PanAfGeo, is a project which supports training of geoscientific staff from African Geological Surveys through the development of an innovative training program. This specific training program, conducted by world-class geoscientific experts from Africa and Europe, includes the acquisition and development of important professional skills that complement geoscientific staff members' technical qualifications.

The PanAfGeo project allows trainees to acquire a state-of-the-art geoscientific tool kit, to learn new and relevant research methods on geology, and to take part in field trips covering eight geoscientific domains.

This Artisanal and Small-Scale Mining (ASM) Handbook for Ghana is the result of a training session held in Ghana in September 2017 through the sub-program on ASM under the overall PanAfGeo project.

The ASM sub-program is co-funded by the European Commission's Directorate-General of Development and International Cooperation (DG-DEVCO), the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) and the Geological Survey of Denmark and Greenland (GEUS).

GEUS, acting as the editor of this ASM Handbook for Ghana, is solely responsible for all results and conclusions presented, which do not necessarily reflect the positions of DG-DEVCO and IGF.



**Tychsen, J; Boamah, D; Ahadjie, J; Sandow Ali, M; Alidu, S; Awuah, P; Quaicoe, I; Amankwah, R; Fobil, J; Nyame, F; Davis, E (2017)**, "ASM Handbook for Ghana" Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark, 160 pp.



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Editor: Mr. John Tychsen, GEUS.
Text Editor: Ms. Julie Sophie Hübertz, Freelancer.
Layout and DTP: Mr. Henrik Klinge Pedersen, GEUS.
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The Danish Ministry of Energy, Utilities and Climate
10 Oester Voldgade
DK-1350 Copenhagen
Denmark

# Contents

# ABBREVIATIONS

| | |
|---|---|
| **ASM** | Artisanal and Small-Scale Mining |
| **CEO** | Chief Executive Officer |
| **DG-DEVCO** | Directorate-General of Development and International Cooperation |
| **EIA** | Environmental Impact Assessment |
| **EIS** | Environmental Impact Statement |
| **EPA** | Environmental Protection Agency |
| **ERP** | Economic Recovery Programme |
| **EU** | European Union |
| **GEUS** | Geological Survey of Denmark and Greenland |
| **GGSA** | Ghana Geological Survey Authority |
| **GIZ** | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| **GSD** | Geological Survey Department |
| **IGF** | Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development |
| **MLME** | Ministry of Lands, Mines, and Energy |
| **MOP** | Mining Operating Plan |
| **MPF** | Mining Policy Framework |
| **OASL** | Office of the Administrator of Stool Lands |
| **PanAfGeo** | Pan-African Support to the EuroGeoSurveys-Organisation of African Geological Surveys Partnership |
| **PER** | Preliminary Environmental Report |
| **SDG** | Sustainable Development Goals |
| **SG** | Specific Gravity |
| **UMaT** | University of Mines and Technology |
| **UN** | United Nations |
| **UNCTAD** | United Nations Conference on Trade and Development |
| **UNDP** | United Nations Development Programme |
| **WP3** | Work Package 3 |

*Artisanal mining operation, north of Tarkwa, Western Ghana.*

*Woman collecting water for the household at river near the mining site. Central Ghana.*

Source: John Tychsen, GEUS.

# FOREWORDS

## Ministry of Lands and Natural Resources, Ghana

*By H.E. John-Peter Amewu, Minister of Lands and Natural Resources*

Source: Ministry of Lands and Natural Resources.

This ASM Handbook has been developed by technical experts and advisors from African and European Geological Surveys, Universities in Ghana, the Minerals Commission of Ghana, and the Environmental Protection Agency of Ghana in close collaboration with the Ghana Geological Survey Authority under the Ministry of Lands and Natural Resources of Ghana. It is the outcome of a training programme, held under the auspices of PanAfGeo WP3 in Accra, Ghana, from 18th to 21st September 2017. The primary objective of this training was to upgrade the knowledge of geoscientific staff from African Geological Surveys through adoption of innovative techniques, including acquisition of relevant professional skills and tools, to help mitigate or minimise the increasingly negative socio-economic and environmental impacts of ASM activities but also to identify ways to maximise benefits of ASM activities. This ASM Handbook for Ghana, therefore, comes at a very opportune time when the Government of Ghana has invested huge resources, political and socio-economic capital, to arrest the distressingly disastrous effects of ASM activities in the country.

The Handbook begins with basic but useful information on the role that the newly established Ghana Geological Survey Authority formerly Ghana Geological Survey Department, could play in the ASM sector, especially given the sector's significance as a vehicle for poverty reduction, opportunities for employment, income generation and creation of varied livelihood options and alternatives to rainfed or weather-dependent subsistence agriculture for many unskilled people in rural and mineral-rich areas in the country. In this context, aspects such as making geological information available and delineating mineralised zones prior to licence acquisition and/or exploitation of ore by miners are all briefly highlighted. In addition, the need for miners to undergo periodic training in basic geology, the search for mineral deposits, surveying and how to effectively and efficiently extract and process ore material is also indicated.

The Handbook continues with information on the obligations of the Minerals Commission and Environmental Protection Agency, the former on guidelines for acquiring an ASM license and applicable regulating procedures, and the latter on environmental permits, impacts and monitoring of ASM activities in Ghana.

Other important components of the Handbook include organising and developing an ASM mining site, processing of minerals, health, safety and environmental issues and business planning for ASM in Ghana.

*Source: John Tychsen, GEUS.*

As Sector Minister, I am not only convinced of the Handbook's launch as timely and worthwhile for all stakeholders in the ASM sector, including ASM practitioners, but I am of the strong view that it will serve to galvanise widespread support in the fight against illegal ASM activities in the country. I do, therefore, offer the unwavering support of the Ministry of Lands and Natural Resources towards the many policy-oriented objectives as laid out in the Handbook, all aimed at ensuring that ASM activities are carried out in a socio-economically sound and environmental friendly manner through the adoption of international best practices. It is my hope that this handbook will serve as a very useful tool to the ASM sector in Ghana.

Hon. John Peter Amewu
*Minister, Ministry of Lands and Natural Resources*

*Small resting place providing shadow at a mining site, central Ghana.*

# EU Delegation to Ghana

*By H.E. Ambassador William Hanna, Head of EU Delegation to Ghana*

For many years, the EU has been committed to supporting sustainable development of extractive activities in developing countries worldwide.

*Source: EU Delegation, Ghana.*

Some developing countries have succeeded in transforming their natural resources into assets for positive change, but for many this abundance of riches has been a curse, and natural wealth has not led to economic and human development of the country and its people.

At the highest political and managerial levels in both Europe and Ghana, leaders of today are emphasising sustainable development and showing a new commitment to fighting unsustainable practices.

The ASM sector involves hard physical labour, often carried out with little consideration for workers, surrounding local populations and the environment. ASM miners tend to operate with little awareness of health, safety and environmental concerns.

To scale up mineral extraction, ASM must be based on technically sound and responsible production practices. This requires an efficient and responsible private sector, which not only creates new job opportunities to match the needs of a growing population, but one that is also capable of sharing skills in order to transition to a full circular economy.

The EU Delegation to Ghana hopes that this Handbook on ASM in Ghana will help disseminate best practices to ensure the sustainable development of the country's ASM sector, improve working and living conditions of women, eliminate child labour, and promote decent work conditions.

This Handbook on ASM in Ghana is the result of the work of the Organisation of African Geological Survey and EuroGeoSurveys. The EU Delegation to Ghana thanks these organisations for their work on this EU-funded Project and Handbook and for their ability to overcome many challenges.

## The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development

*By Mr. Matthew Bliss, Deputy Director, Programs, IGF*

Source: IGF

Ghana continues to demonstrate to the world the importance of managing ASM in a manner that benefits miners, host communities, and the citizens of the host country. Ghana's recent efforts to manage tensions surrounding ASM is consistent with the country's commitment to the IGF's Mining Policy Framework (MPF), which sets out concrete objectives and processes for good governance in the mining sector. Ghana's approach to ASM supports its MPF-related goals to leverage mining to achieve their sustainable development goals and reduce poverty.

The IGF is a member-driven international partnership established voluntarily by its Member Governments under the United Nations (UN). It was proposed in 2002 at the UN Summit on the Environment in Johannesburg by South Africa and Canada. In 2005, 25 Governments met for its inaugural General Session in Geneva, hosted by the United Nations Conference on Trade and Development (UNCTAD.)

ASM is a top priority for IGF Member Governments. At the forum's 12th Annual General Meeting in October 2016, IGF released a draft Guidance to help Governments manage ASM. Ghana was one the IGF Members to pilot the implementation of the Guidance at a regional workshop held in the spring of 2017. This workshop provided 13 other IGF Member Governments with the opportunity to learn from Ghana's hard-earned ASM experience. Due to the success of this pilot workshop, other regional workshops have been requested by IGF Member Governments to be held in the French language in West Africa and in the Spanish language in Latin America.

IGF Member Governments are grateful for the opportunity to collaborate with and benefit from the PanAfGeo Work Package 3 (WP3) on ASM. The PanAfGeo WP3, generously supported by EuroGeoSurveys in partnership with the Organisation of African Geological Surveys, coordinated by the French Geological Survey (BGRM), and funded by the EU, GEUS, and the Ghana Geological Survey Authority (GGSA), and co-funded by IGF is being delivered by GEUS in partnership with Ghana. The depth of coverage of this ASM Handbook is backed up by in-country training with Ghanaian experts and others from neighbouring countries' geological surveys and was co-developed by the trainees.

The enclosed is a practical Handbook, created on the basis of experience on ASM in Ghana and neighbouring countries – use it as such, and feel free to ask questions or provide comments to its authors.

The collective governance of ASM is evolving. IGF is pleased to have been part of delivering this Handbook on ASM in an effort to help to continue to improve on the performance of leveraging ASM to achieve sustainable development goals for its host countries.

IGF is happy to have supported Ghana in its efforts on ASM and looks forward to learn more about ASM with its Ghanaian colleagues.

# ACKNOWLEDGMENTS

*By John Tychsen, International Director and ASM Handbook Editor, GEUS*

The Editor is indebted to so many people and organisations, who have contributed, in one way or the other, to the successful production of this ASM Handbook. They are:

*Source: GEUS.*

Dr Daniel Boamah, Director of GGSA, who not only hosted the ASM training workshop in Accra, Ghana in September 2017, but he has also been supportive in the planning and implementation of the PanAfGeo project.

Hon. Benito Owusu Bio, Deputy Minister of Lands and Natural Resources; Hon. Barbara Oteng-Gyasi, Deputy Minister of Lands and Natural Resources; and H.E. William Hanna, Ambassador and Head of Delegation of the EU to Ghana, who all recognised the importance of the ASM sector and the future role of GGSA in their opening remarks at the training workshop in Accra, Ghana.

The large group of Ghanian experts and academics, who acted as facilitators, co-trainers and authors for both the training workshop and this ASM Handbook. Their excellent presentations provided valuable local input to the discussions during the group work.

The technical staff of the Ministry of Lands and Natural Resources, EPA, and representatives from the ASM community, who actively participated and provided relevant input to the discussions during the training workshop in Accra, Ghana.

The participants from the national geological surveys of Sierra Leone, Liberia, Gambia and Nigeria, who provided valuable regional input to the discussions on the ASM sector in Ghana during the training workshop in Accra, Ghana, but also for this ASM Handbook.

The Text Editor, Ms. Julie Sophie Hübertz, and the Project Assistant, Mrs. Ulla Holm, for their enthusiastic engagement and hard work in preparing this ASM Handbook and organising the training workshop.

# INTRODUCTION

*By Jean-Claude Guillaneau, Programme Coordinator, PanAfGeo Project*

PanAfGeo is a project, which supports the training of geoscientific staff from African Geological Surveys through several training programmes.


*Source: PanAfGeo.*

This 3-year (2017-2019) Pan-African cooperation programme provides about 50 training sessions for some 1,200 geologists coming from 54 African countries. The PanAfGeo project has a budget of 10.3 million euros and is co-funded by the EU, through DG DEVCO, and a consortium of 12 European Geological Surveys, led by BRGM. The PanAfGeo project allows trainees to acquire a state-of-the-art tool kit, methods and/or the possibility to take part in field trips within eight geoscientific domains: Geoscientific Mapping, Mineral Resources Assessment, ASM, Environmental Management of Mines, Geohazards, Geoheritage, Geoinformation Management, and Communication and Promotion.

The PanAfGeo project's WP3, "Training on ASM", is carried out through seven "in-country workshops" with regional participation. A world-known expert, John Tychsen, GEUS, leads this WP3.

The main aim of the workshops is to train staff from the geological survey authorities, the regulatory agencies and the universities involved in the ASM sector to strengthen their capacity to better assist the country's ASM operators. Particular emphasis is on how the knowledge and skills resources of the geological survey authorities can be mobilised more actively in the service of ASM operators so as to ensure more profitable, efficient, environment friendly, safe and sustainable mining operations in the countries concerned.

In addition to the training provided, another major outcome of the workshops is a country-specific ASM Handbook, which is intended to serve as a reference book for the future involvement of the geological survey authority's staff in the country's ASM sector.

The first WP3 training workshop on ASM, held in Accra Ghana, was hosted by Dr Daniel Boamah, Director of GGSA, who also is the African co-lead of WP3.

The next training workshops on ASM are planned for Zambia and Malawi in 2018. Other countries, such as Kenya and Burkina Faso, may follow in 2019.

The entire PanAfGeo project team is grateful for the kind words provided at the official opening of the training workshop in Accra, Ghana, by H.E. William Hanna, Head of the EU-delegation to Ghana, and Hon. Benito Owusu-Bio, Deputy Minister of Lands and Natural Resources, who both emphasised the need to involve the geo-scientists of GGSA in the future development of the ASM sector in Ghana.

For more information on the PanAfgeo project visit http://panafgeo.eurogeosurveys.org/ and/or follow it on Twitter, @PanAfGeo.

# OBLIGATIONS OF THE GHANA GEOLOGICAL SURVEY AUTHORITY

*By Dr. Daniel Boamah, Ghana Geological Survey Authority (GGSA)*

## Introduction

In Ghana, ASM has grown in size and significance. Though it can be regarded as a source of foreign currency earnings to the limited extent only, it does help to reduce unemployment, especially in most rural areas where there are few alternatives to agriculture. It is labour intensive and thus provides employment and incomes to large numbers of people who are generally uneducated, poor and live in remote areas where no opportunities exist for formal employment.

Gold's lucrative character, interwoven with legendary stories of rich gold occurrences, has resulted in many hasty mining ventures, doomed to failure. The majority of miners in Ghana operate informally without access to geological data, land, finance and ease of licensing. Since no exploration activity of any kind is carried out, the discovery of new ore reserves is left to chance and some of these ASM operators mine by mere speculations without exploration. Due to this, many continue to view it as a dirty, unprofitable and fundamentally unsustainable way of mining; hence the technical and commercial aspects of ASM operations must be carefully thought through.

## Ghana Geological Survey Authority

### *Functions and Responsibilities*

The Ghana Geological Survey Authority (GGSA), formerly named the Geological Survey Department (GSD), was established in 1913 by the colonial administration under the directorship of Sir Albert Kitson to, among other, investigate and establish the extent and quality of both existing and yet undeveloped areas of mining activity in the Republic of Ghana and to prepare for their exploitation. According to the GGSA Act 928 of 2016, some of the objectives of the GGSA are to:

- carry out systematic geological mapping, assess, monitor and evaluate geological hazards and risks, collect geoscientific data, manage and disseminate geoscientific information;
- promote the search for, and exploitation of minerals in the Republic of Ghana, undertake research in the field of geoscience and furnish specialised geoscientific services; and
- conduct research into matters of importance for the exploration, exploitation and protection of the nation's geological and geoscientific natural resources.

Section 3(b) of the GGSA Act 928 states, that the GGSA shall conduct geological, geochemical, geophysical, seismological, hydrogeological, geotechnical and geo-environmental surveys, mineral exploration, systematic mapping of rocks and other geological or geoscience materials including soil and clays of the Republic of Ghana, both onshore and offshore. This means that the GGSA has a mandate to promote the exploration and exploitation of the natural resources of the country. In the pursuit of this mandate, various samples (rock, stream, soil samples) are collected from the land and examined for their economic mineral content. After this, areas of possible economic mineralisation are marked on the geological map of the country, which is made available to the public. This map allows ASM operators to better select a suitable mining site and to avoid rampant abuse and misuse of land with the hope of hitting an ore body.

Section 3(a) of the GGSA Act 928 states, that the GGSA shall advise the Government to make informed decisions on geoscientific issues concerning mineral and ground water resources, environment, geohazards and land use planning. This also entails advising ASM operators on available and applicable mining methods for a given identified mining area, i.e. ore deposit.

### *The Ideal Future of the Ghana Geological Survey Authority*

As stated above, one function of the GGSA is to provide “improved geology” for ASM operators in Ghana in order to help them identify suitable land for mining of minerals and unlock finance through the provision of bankable documents. Furhermore, enhanced geodata of land for ASM may make it easier to undertake and improve the quality and accuracy of ASM Environmental Impact Assessments (EIAs). However, the GGSA requires funding and needs to be better involved in ASM policy-making and dialogue in order to fully realise this function.

Due to their limited resources and background, most of the individual ASM operators are not in a position to conduct exploration activities. Thus, if the industry is to be sustained, it is important that the GGSA is well-resourced and funded to continue with exploration and delineation of mineralised deposits and come up with the mineral inventory available for exploitation at the ASM level. Information already available at the GGSA from its earlier activities and additional material gathered from abandoned concessions of prospecting and exploration companies could be a good starting point for this renewed investigation. The success of the continuing levels of exploration is required to maintain and increase existing levels of production in the industry. It will also allow the ASM operators to work in areas where the minerals are known to be available; hence reducing the investment risks, unnecessary land degradation and water pollution arising from their frequent wild searches for mineralised areas. It is also important that large-scale mines are encouraged to release mineralised areas of their concessions that are not suitable for large-scale mining operations for licensing to small-scale miners. Other areas could also be released for the GGSA to explore in detail for ASM operations.

With geologically prospected land earmarked solely for ASM operations, miners will have the necessary bankable documents to access formal finance and enter into formal partnerships, investments and agreements with one another and/or financial institutions. This legal status and access to land will encourage licence purchasing, provided the process can be further streamlined. Once licensed, the Government knows exactly where miners are operating. Moreover, it is argued that once legally recognised, miners will be able to access support and education services (provided by the Government, development organisations and the private sector) to improve the efficiency and mitigate the negative impact of their operations. This, in turn, will enable licensed miners to pay for additional support services (such as geological prospecting, business development, equipment leasing, technical support and best practice mining methods) to further formalise their activities and mitigate adverse environmental and social impacts.

# OBLIGATIONS OF THE MINERALS COMMISSION

*By Jerry Ahadjie, Minerals Commission*

Prior to the Economic Recovery Programme (ERP), initiated in 1983, the mining industry in Ghana was attracting virtually no new investments. Indeed no new mine had opened in Ghana since 1945. The mining sector was characterised by falling levels of productions, worn out and outdated infrastructure and machinery, and an exodus of skilled personnel, among other things. One of the measures under the ERP was the establishment of a body - the Minerals Commission - with a focused function of developing and coordinating mineral sector policy and monitoring its implementation in September 1986 under the Minerals Commission Law (PNDCL. 154). With the promulgation of the 1992 Constitution, Parliament enacted the Minerals Commission Act of 1993 (Act 450) to give continued legal backing to the existence of the Minerals Commission, as required by Article 269(1) of the Constitution.

## Mandate

The Minerals Commission is responsible for the regulation and management of the utilisation of the mineral resources of Ghana and the co-ordination and implementation of policies related to mining.

## Functions

The Minerals Commission Act of 1993 (Act 450) stipulated the functions of the Minerals Commission as follows:

- To formulate recommendations of national policy for exploration and exploitation of mineral resources with special reference to establishing national priorities having due regard to the national economy;
- To advise the Minister of Lands and Natural Resources on matters relating to minerals;
- To monitor the implementation of laid down Government policies on minerals and report on this to the Minister;
- To monitor the operations of all bodies or establishments with responsibility for minerals and report to the Minister;
- To receive and assess public agreements relating to minerals and report to Parliament;
- To secure a firm basis of comprehensive data collection on national mineral resources and the technologies of exploration and exploitation for national decision making; and
- To perform such other functions as the Minister may assign to it.

In fulfilling its functions, the Minerals Commission undertakes the following activities:

- Investigates the background, processes applications for mineral rights and recommends their grant or otherwise to the Minister responsible for Mines;
- Reviews agreements relating to minerals;
- Collects, collates and analyses data on the operations of mining companies for decision-making and for dissemination;
- Organises and attends workshops/seminars/conferences, as well as issues publications to promote mineral sector activities;
- Liaises with other governmental agencies, notably the Bank of Ghana and the Ghana Revenue Authority, to ensure that the spirit of the sector's fiscal regime is maintained; and
- Liaises with other governmental agencies, notably the GGSA, and the EPA, to monitor and ensure the adherence of mining companies to the terms and requirements of mineral rights granted to them.

## Vision

"The Minerals Commission strives to make Ghana the leading destination of mining sector investment in Africa through creating a congenial atmosphere in which all stakeholders work as partners in a safe environment to achieve one common goal; sustainable development through mining".

## Mission

The Minerals Commission's primary responsibility is to foster the efficient and effective regulation and management of the utilisation of Ghana's mineral resources. This shall be accomplished through the development of solid knowledge-based, self-led organisation, which recognises that investments in mining will take place and be sustained only if it is under "win-win" circumstances.

## Organisational Structure

The Minerals Commission is governed by "The Commission/Board", which is appointed by the President. The Secretariat of the Commission is headed by a Chief Executive Officer (CEO), who is a member of the Minerals Commission. The Secretariat comprises three (3) major divisions namely: Inspectorate Division, Policy Planning Monitoring & Evaluation Division, and Finance & Administration Division.

# OBLIGATIONS OF THE ENVIRONMENTAL PROTECTION AGENCY

*By Michael Sandow Ali, Environmental Protection Agency (EPA)*

The Environmental Protection Agency (EPA) of Ghana was established by the Environmental Protection Agency Act of 1994 (Act 490) as the lead Agency for environmental protection in Ghana. The EPA was established to oversee, coordinate and regulate all issues regarding the environment in Ghana. Subsequently, the promulgation of the Environmental Assessment Regulations, 1999 (LI 1652) provides the necessary legal backing for the Environmental Impact Assessment (EIA) procedure/system in Ghana.

Within the EPA, the ASM sub-sector is regulated by the Mining Department, whose primary objective is to promote and facilitate the application of best practice environmental management throughout Ghana's mining industry.

## Classification of an ASM Operation

Currently, the EPA classifies an undertaking as an ASM operation based on concession size (≤ 25 acres) as well as the duration of the environmental permit (max. 2 years).

## Requirements of an ASM Application

Regulations 1 and 4 of the Environmental Assessment Regulations, 1999 (LI 1652) duly recognise ASM activities as those likely to have adverse effect on the environment or public health and therefore classified as activities for which an environmental permit is necessary prior to the commencement of the undertaking.

Applicants for an environmental permit for an ASM operation are required to provide the following:

- Completed Environmental Overview for Small and Medium Scale Mining Form (SMMI 1);
- Site Plan endorsed by the Regional Surveyor;
- Brief description of operational methods (mining and/or processing);
- Costed reclamation and abandonment proposals;
- Response from the relevant District/Municipal Assembly from the 21 Day Notice of Publication; and
- Payment of the requisite fees (processing and permit fees) as approved by the Parliament of Ghana.

The prerequisite for consideration for an environmental permit is evidence of consultation with the Minerals Commission.

## Obligations of an ASM Operator

Persons and/or companies issued with an Environmental Permit for an ASM operation are required to comply with the requirements of their Permit Schedule, which contains the following, among other:

- Payment of adequate and prompt compensation to affected persons prior to the initiation of mining activities;
- Adherence to appropriate buffer zones as prescribed by the Riparian Buffer Zone Policy for surface water bodies;
- Adherence to other relevant buffer distances, such as forest reserves, rail lines, high tension poles, etc.;
- Evidence of conduct of progressive/concurrent reclamation of disturbed areas;
- Adherence to EPA's sector specific effluent guidelines for all discharges from the mining and/or processing activities; and
- Attainment of relevant and valid permits for each site, given that permits are site specific - validity period for an ASM operation is two (2) years), subject to renewal following satisfactory performance.

## ASM Permitting Process and Procedures

The EPA's process for reviewing, accepting or rejecting an ASM application for an environmental permit comprises the following steps:

1. Receipt of completed Form SMMI1, including all relevant attachments, such as concession map, Notice of Publication, mining and processing methodology, costed reclamation and abandonment proposals;
2. Screening/field inspection of the concession by Officers of the EPA taking into consideration the location, size, output, technology, land use, public concerns, sensitivity of area, etc.;
3. Review of all relevant information/ documentation:
4. Decision-making:
   a. Approval, in which case an environmental permit is issued (including a schedule containing the conditions of the permit); or
   b. Objection, in which case the permit is declined; and
   c. Request for the submission of a Preliminary Environmental Report (PER) or Environmental Impact Statement (EIS), if the Agency in its assessment considers that the undertaking could have extensive and far-reaching effects on the environment.
5. Undertake compliance enforcement monitoring of permitted ASM undertakings when operational.

## Technical Support to be Provided by the EPA

The EPA provides the following technical support to ASM applicatants and other relevant stakeholders:

- Facilitation of the processing of ASM applications (by the creation of some new EPA Area Offices especially in the mining hotspots);
- Decentralisation of the permitting procedure (permitting of ASM operations is being done completely at the regional level without recourse to the Head Office);
- Education/sensitisation and awareness creation of proponents/applicants during the registration and screening processes as well as during the collection of the permit;
- Training of ASM operators/EPA Regional Officers/District Mining Inspectors of the Minerals Commission on the environmental requirements and best practices associated with the entire life cycle of the mining and processing process;
- Provision of technical advice on rehabilitation and disposal on waste and tailings; and
- Complaints investigations.

## Suspension, Cancellation or Revocation of Permit and Certificates

Regulation 26 of LI 1652 indicates that the Agency may suspend, cancel or revoke an environmental permit or certificate issued where an ASM operator is in breach of any provisions of the Regulations or any other enactment relating to environmental assessment, acts in breach of any of the conditions to which the permit or certificate is subject; or fails to comply with mitigation commitments in his assessment report.

## Offences and Penalty

Regulation 29 of LI 1652 indicates that any person who:

- Commences an undertaking without an environmental permit issued in respect of the undertaking contrary to Regulation 1(1);
- Fails to comply with Directives of the Agency to register an undertaking and obtain an environmental permit contrary to Regulations 1(2) or 2;
- Submits or provides the Agency with information required under any provision of these Regulations which she/he knows to be false; or
- Contravenes any provision of the LI1 652;

commits an offence, and is liable on summary conviction to a fine and/or imprisonment.

*Sluicing at an Artisanal Mining Site in Western Ghana.*

*Selection of matts for sluicing, mining site north of Osino in Central Ghana.*

Source: John Tychsen, GEUS.

# BASIC GEOLOGY – A GUIDE TO DISCOVER MINERAL DEPOSITS

*By Seidu Alidu, Ghana Geological Survey Authority*

Even though Ghana is widely known for its gold, diamond, manganese, and bauxite production, the country also plays host to other industrial minerals, such as brown clays, kaolin, clam shells, silica sand, jasper, aggregate and dimension stone, and salt.

Acquiring knowledge of basic geology enables ASM operators to better understand the geological processes and environment of formation of the minerals, which they are exploring, mining and exploiting.

## Understanding the Earth's Processes in Forming Rock and Mineral Deposits

### *Types of Rocks*

As shown in Figure 1, the different continents of the World consist of rocks of different origin - some are remnants of volcanic eruptions, such as lava and volcanic ash; others are sediments, such as clay, sand and gravel all deposited on the Earth's surface; while others are formed deep in the crust of the Earth.

There are three (3) main classes of rocks, classified according to how they originated, namely:

- Igneous rock
- Metamorphic rock
- Sedimentary rock

#### Igneous Rock

Igneous rock (derived from the Latin word, ignis, meaning fire) is formed through the cooling and solidification of magma (a mixture of molten or semi-molten rock) or lava. The magma can be derived from partial melts of existing rocks in either the Earth's mantle or crust. Typically, the melting is caused by one or more of three processes: an increase in temperature, a decrease in pressure, or a change in composition. Solidification into rock occurs either below the surface as intrusive rocks, such as gabbro and granite, or on the surface as extrusive rocks, such as basalt and rhyolite.

#### Metamorphic Rock

Metamorphic rock arises from the transformation of an existing rock type, in a process called metamorphism, which means "change in form". The original rock (protolith) is subjected to heat and pressure causing profound physical and/or chemical change. The protolith may be a sedimentary, an igneous, or even an existing type of metamorphic rock.

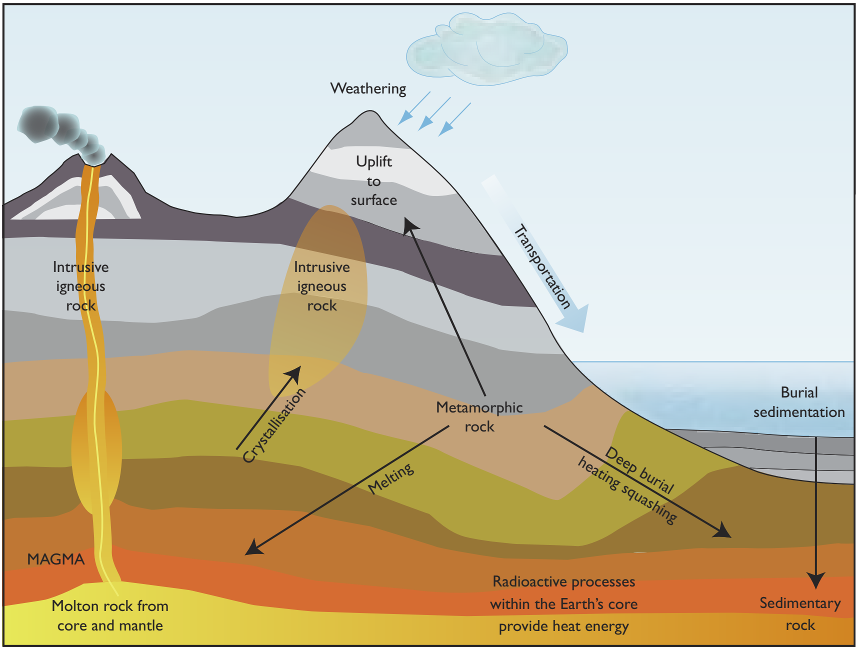
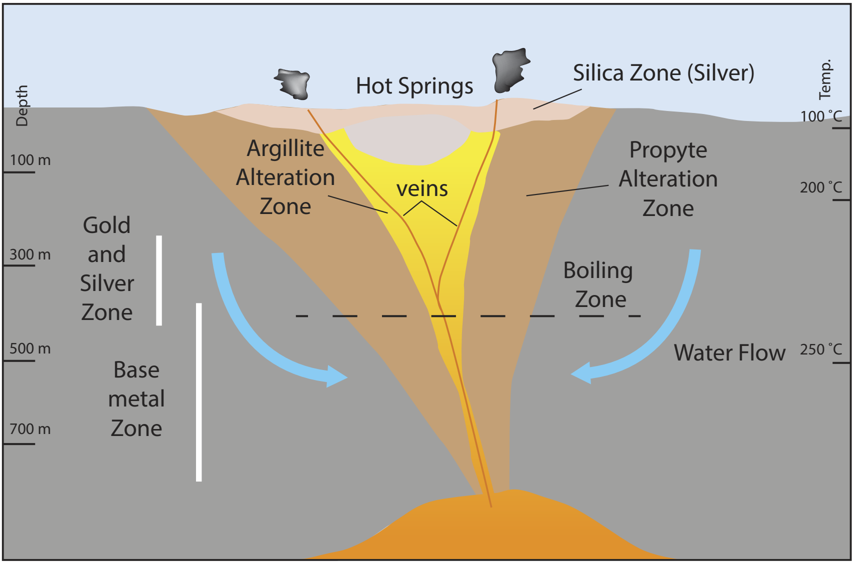



*Figure 1. Simplified cross section of the upper Earth's crust showing the geological environment in which many economic mineral deposits are formed. (Modified from: TACC 2008).*

Metamorphic rocks make up a large part of the Earth's crust and form 12% of the Earth's current land surface. Some examples of metamorphic rocks are gneiss, slate, marble, schist, and quartzite.

## Sedimentary Rock

Sedimentary rocks are types of rock that are formed by the deposition and subsequent cementation of that material at the Earth's surface and within bodies of water. Sedimentation is the collective name for processes that cause mineral and/or organic particles (detritus) to settle in place. The particles that form a sedimentary rock by accumulating are called sediment. Before being deposited, the sediment was formed by weathering and erosion from the source area, and then transported to the place of deposition by water, wind, ice, mass movement or glaciers. Sedimentary rocks are only a thin veneer over a crust consisting mainly of igneous and metamorphic rocks. The sedimentary rock cover of the continents of the Earth's crust is extensive (73% of the Earth's current land surface), but the total contribution of sedimentary rocks is estimated to be only 8% of the total volume of the crust.




Source: TACC 2008, modified by Henrik Klinge Pedersen, GEUS.

*Figure 2. Simplified cross Section of a hydrotermal mineral deposits (Modified from: TACC 2008).*

## *Types of Mineral Deposits*

A mineral deposit refers to an aggregate of a mineral in an unusually high concentration.

Certain kinds of mineral can be smelted more readily than others; these are commonly referred to as ore minerals. Ore minerals tend to be concentrated in small, localised rock masses that form as a result of special geologic processes, and such local concentrations are called mineral deposits. No deposit consists entirely of a single ore mineral. There are always admixtures of valueless minerals, collectively called gangue. The more concentrated an ore mineral, the more valuable the mineral deposit. For every mineral deposit there is a set of conditions, such as the level of concentration and the size of the deposit that must be reached if the deposit is to be worked at a profit. A mineral deposit that is sufficiently rich to be worked at a profit is called an ore deposit.

Mineral deposits have been found both in rocks that lie beneath the oceans and in rocks that form the continents, although the only deposits that actually have been mined are in the continental rocks.

### Hydrothermal Mineral Deposit

A hydrothermal mineral deposit refers to any concentration of metallic minerals formed by the precipitation of solids from hot mineral-laden water (hydrothermal solution), as shown in Figure 2. The solutions are thought to arise in most cases from the action of deeply circulating water heated by magma (melted rock).

There are basically two types of hydrothermal deposits:

1) magmatic-hydrothermal; and
2) hydrothermal without a relationship to magmatism.

At high temperatures some of the rocks start to melt and eventually form magmas, which are large bodies of molten rocks called igneous rocks. These magmas are gradually squeezed further up in the crust, where they start to cool and crystallise. Many elements such as gold, tantalum and boron cannot be accommodated in the minerals, which crystallise in the magma, but are concentrated at the top of the magma chambers. When pressure builds up, the rocks above start to crack and fluids from the top of the magma chamber flow up into the cracks. These hot fluids are called hydrothermal fluids. The cracks are gradually filled with quartz and with the elements, which could not be accommodated in the magma, such as gold, tantalum-forming tantalite and boron-forming tourmaline (rube lite) found in quartz veins. These types of deposits are collectively called magmatic-hydrothermal deposits and are found close to the igneous rocks, commonly granite.

The second type is found in the form of quartz-carbonate veins or as impregnations in sediments and volcanic rocks. These rocks are often strongly overprinted and do not look like their original counterparts. Such unusually looking sediments or volcanic rocks can be used as a tracer to find hydrothermal deposits. These deposits also form from hot fluids that migrated through the rock, but have not been formed from crystallising melt. They could be old rain water that percolated through the rocks for some time picking up the elements of interest that can be gold, barium, copper, lead and zinc. Barium forms barite that is very often associated with a massive sulphide accumulation hosting a copper-lead-zinc mineralisation. Gold mineralisation is often hard to distinguish from the first type of hydrothermal deposits, because it is also hosted within quartz veins.

Conditions necessary for the formation of hydrothermal mineral deposits include (1) presence of hot water to dissolve and transport minerals, (2) presence of interconnected openings in the rock to allow the solutions to move, (3) availability of sites for the deposits, and (4) chemical reaction that will result in deposition. Deposition can be caused by boiling, by a drop in temperature, by mixing with a cooler solution, or by chemical reactions between the solution and a reactive rock.

## Magmatic Deposits

There are again two types of magmatic deposits; (1) light-coloured, coarse- grained rocks as dykes, and (2) dark to black, medium-grained rocks.

Sometimes, part of the magma is squeezed into the cracks where it cools and crystallises to a coarse-grained rock type, namely pegmatite, which occurs in dyke-shaped bodies. Pegmatites often contain rare minerals such as tantalite, emeralds and rubelite.

During crystallisation of magmas, economic minerals such as chromite, magnetite, nickel and platinum will appear as bands in the magmatic rocks. These deposits can be recognised by checking for magnetite and for massive and semi- massive sulphide occurrences, because it is those that host nickel and platinum. These types of mineral deposits, called magmatic deposits, are prime targets for ASM operators.

## How to Identify Interesting Minerals

Minerals can be indentified by a number of characteristics of which the following represent the first steps in the identification of the mineral:

- Colour
- Streak
- Lustre
- Transparency
- Hardness
- Cleavage and Fracture
- Specific Gravity
- Magnetism

### Colour

Colour is best described by using primary or simple colours, with descriptors and subsidiary colours added as necessary, e.g. dull reddish-brown, pale greenish-blue. Colour variants, e.g. khaki, mauve, turquoise etc, should be avoided as these are subjective and definitions may vary from person to person.

Although distinctive for some minerals, colour is often not a reliable mineral property as it can show considerable variation within a mineral. Minute amounts of impurities can change the colour of a mineral dramatically, especially that of usually colourless or white minerals. For example, quartz, which is normally colourless can be violet (amethyst), pink (rose quartz), yellow (false topaz), smoky brown-black (cairngorm), etc.

### Streak

The "streak test" is a method used to determine the colour of a mineral in powdered form. The colour of a mineral's powder is often a very important property for identifying the mineral.

The streak test is done by scraping a specimen of the mineral across a piece of unglased porcelain known as a "streak plate." This can produce a small amount of powdered mineral on the surface of the plate. The powder colour of that mineral known as its "streak."
The streak test should be done on clean, unweathered, or freshly broken specimens of the mineral. This is done to reduce the possibility that a contaminant, weathered coating, or tarnish will influence the results of the test.

The streak test is valuable because many minerals occur in a variety of apparent colours - but all specimens of that mineral share a similar streak colour. For example: specimens of hematite can be black, red, brown, or silver in color and occur in a wide variety of habits; however, all specimens of hematite produce a streak with a reddish colour. This is a valuable test for hematite. It can be used to differentiate hematite from a large number of other opaque minerals with a high specific gravity and similar colour and habit.

## Lustre

Lustre refers to the quality and intensity of light reflected from the surface of a mineral, such as:

- Metallic - strong reflection, shines like metal, may be very shiny (like a chrome car part) or less shiny (like the surface of a broken piece of iron);
- Vitreous - glassy, bright (shines like glass);
- Resinous - a resin-like shine (resembling amber for example);
- Greasy - a dull sheen, has the appearance of being coated with an oily substance;
- Pearly - a whitish iridescence (resembling pearl for example);
- Silky - a sheen like that of a fibrous material, e.g. silk;
- Adamantine - a brilliant lustre such as that of diamond; or
- Earthy – like the surface of unglazed pottery.

## Transparency

Transparency refers to the degree to which light can pass through a mineral, such as:

- Opaque - no light can pass through the mineral;
- Translucent - light can pass through the mineral but is diffused so that images cannot be seen clearly; or
- Transparent - light can pass through the mineral and images can be seen clearly.

## Hardness

Hardness is a measure of the ease with which a smooth surface of a mineral can be scratched, or of its resistance to abrasion.

Mohs' scale of hardness is one of the best practical methods of estimating a mineral's hardness, from hardest (10) to softest (1), ref. Figure 3.

| Mineral | Mohs hardness | Absolute hardness | Chemical formula |
|---|---|---|---|
| Diamond | 10 | 1600 | $C$ |
| Corundum | 9 | 400 | $Al_2O_3$ |
| Topaz | 8 | 200 | $Al_2SiO_4(OH^-,F^-)_2$ |
| Quartz | 7 | 100 | $SiO_2$ |
| Orthoclase Feldspar | 6 | 72 | $KAlSi_3O_8$ |
| Apatite | 5 | 48 | $Ca_5(PO_4)_3(OH^-,Cl^-,F)$ |
| Fluorite | 4 | 21 | $CaF_2$ |
| Calcite | 3 | 9 | $CaCO_3$ |
| Gypsum | 2 | 3 | $CaSO_4 \cdot 2H_2O$ |
| Talc | 1 | 1 | $Mg_3Si_4O_{10}(OH)_2$ |

Source: www.geology.com

*Figure 3. Mohs Scale of Hardness.*

## Cleavage and Fracture

Cleavage refers to the tendency of a mineral to break along flat planar surfaces as determined by the structure of its crystal lattice. These two-dimensional surfaces are known as cleavage planes and are caused by the alignment of weaker bonds between atoms in the crystal lattice. Cleavage planes are distinguished from fracture by being smooth and often having reflective surfaces.

Fracture refers to the way a mineral breaks other than along a cleavage plane.

## Specific Gravity

Specific Gravity, also known as SG, is a measurement that determines the density of minerals. Two minerals may be the same size, but their weight may be very different. The specific gravity of a mineral determines how heavy it is by its relative weight to water. The specific gravity value is expressed upon how much greater the weight of the mineral is to an equal amount of water. Water has a specific gravity of 1.0. If a mineral has a specific gravity of 2.7, it is 2.7 times heavier than water. Minerals with a specific gravity under 2 are considered light, between 2 and 4.5 average, and greater than 4.5 heavy. Most minerals with a metallic luster are heavy. The specific gravity may slightly vary within a mineral because of impurities present in the minerals structure.

Specific gravity (G) is calculated by the following formula:

$$G = W_{Air}/W_{Air} - W_{Water}$$

## Magnetism

Several minerals react when placed within a magnetic field. Some minerals are strongly attracted to the magnet, others are weakly attracted, and one mineral is actually repelled. There are also several minerals that are attracted to magnetic fields only when heated. Magnetic properties of minerals are defined as follows:

- **Ferromagnetism:** Describes a strong attraction to magnetic fields. This property is exhibited in few minerals, notably Magnetite and Pyrrhotite.
- **Paramagnetism:** Refers to weak attraction to magnetic fields. The attraction is usually discernible, but it may be so weak that it is undetectable. Most paramagnetic minerals become strongly magnetic when heated. A small number of paramagnetic minerals, such as Platinum, are not essentially paramagnetic, but contain iron impurities, which are responsible for the paramagnetism. However, some specimens lacking iron also exist, and these are not paramagnetic. Some examples of paramagnetic minerals are Hematite and Franklinite.
- **Diamagnetism:** Only one mineral, Bismuth, is diamagnetic, meaning it is repelled from magnetic fields.
- **Magnetism:** Only a variety of one mineral acts as a magnet, generating magnetic fields on its own. This mineral is Lodestone, the magnetic variety of Magnetite, which is found in only a few deposits throughout the world. Although it is only weakly magnetic, its magnetism is definitely discernible.

## Examples of Minerals Available in Ghana

Characteristics of the most common minerals extracted by ASM operators in Ghana are:

**Gold,** in its natural mineral form, almost always has traces of silver, and may also contain traces of copper and iron. A gold nugget is usually 70 to 95 % gold, and the remainder mostly silver. The colour of pure gold is bright golden yellow, but the greater the silver content, the whiter its color is. Gold is one of the heaviest minerals. When pure, it has a specific gravity of 19.3. Due to its weight, it can be panned because the gold sinks to the bottom. In addition, it can be easily separated from other substances due to the weight differences. Gold is also one of the most resistant metals. It will not tarnish, discolour, crumble, or be affected by most solvents. This adds on to the uniqueness and allure of this mineral

**Diamond** has many unequaled qualities and is very unique among minerals. It is the hardest known substance, it is the greatest conductor of heat, it has the highest melting point of any substance (4,090°C), and it has the highest refractive index of any natural mineral. Diamond is number 10 on the Mohs' scale of hardness. It also has the densest atomical configuration of any mineral, and is transparent over the greatest number of wavelengths. Because of heat conduction, diamonds are cold to feel at or below room temperature. When heated, a diamond will remain hot long after the heat source is removed.

## How Do Minerals Frequently Exploited by ASM Operators in Ghana Occur?

### *Gold*

The principal gold belts of Ghana are largely grouped within the volcanic belts with which they are associated, as shown in Figure 4. The various gold belts have become very important, but the Ashanti Belt dwarfs all others in its natural endowment in gold.

The vast majority of gold deposits:

- occur along the flanks of the volcanic belts
- are present within volcanic belts where they show spatial association with belt-type granitoid intrusion
- are associated with 'corridors' characterised by chemical sediments (sulphides, chert, Fe-Ca-Mg- carbonates and rocks rich in carbon)
- are found within fractures, faults or shear zones within the meta sedimentary rocks; and
- are found within hydrothermally altered granitoids (e.g. Ayanfuri, Mpasatia).

Gold mined by ASM operators in Ghana usually occurs as:

- Hard rock deposits (including quartz vein and paleoplacer type gold deposits)
- Eluvial deposits (oxide and laterite deposits); or
- Alluvial deposits.

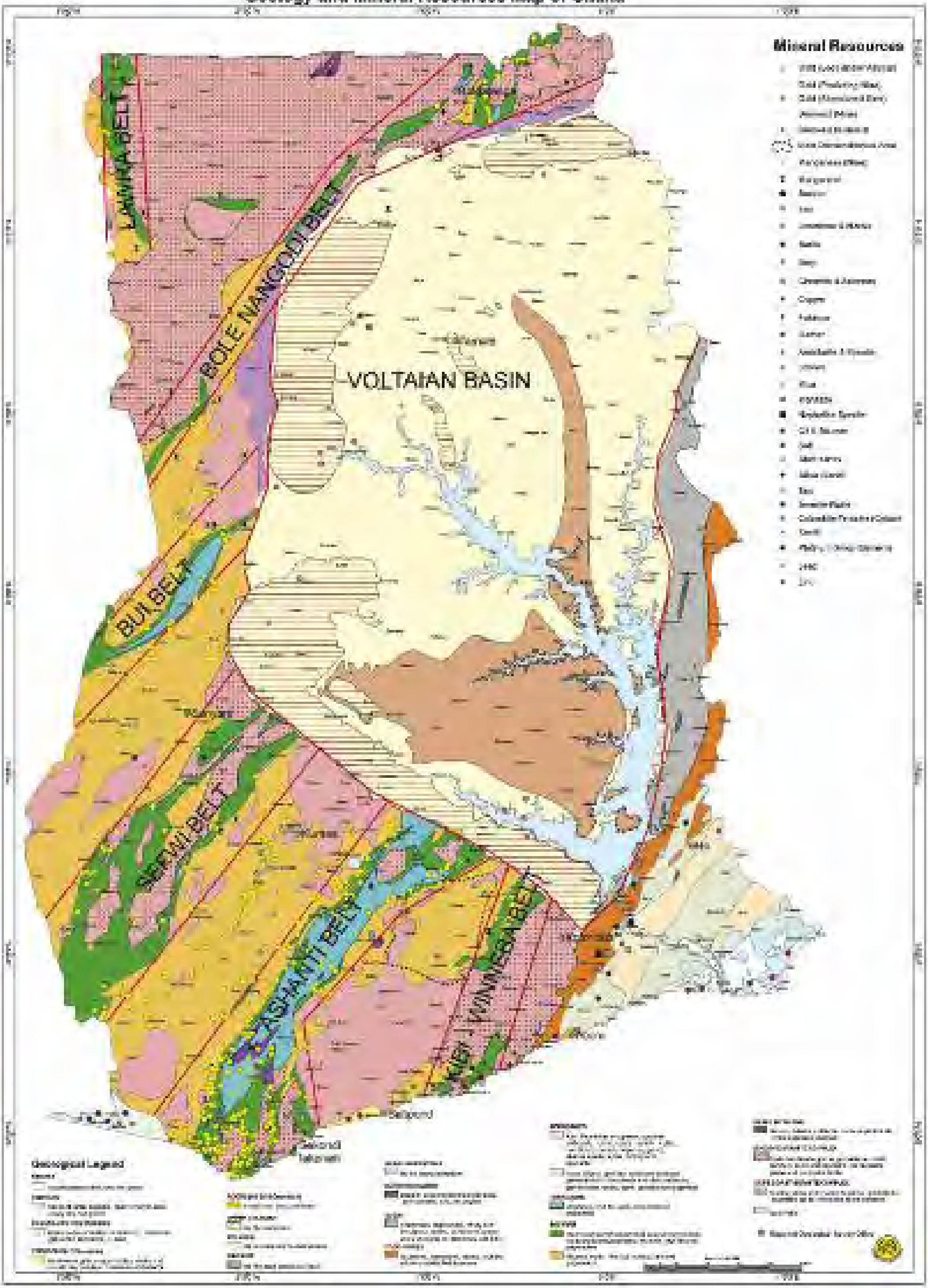
#### Hard Rock Gold Deposits

This type of deposit mined by ASM operators is characterised by gold bearing quartz cutting through wall rocks with a sharp contact. The mineralised quartz veins are medium to dark grey with widths, which range from a few millimetres to about 2 metres, as shown in Figure 5. The veins also can extend to considerable depth about 500metres or more. The vein sometimes may pinch out downwards and disappear below the reach of ASM operators.

#### Eluvial Deposits

This type of deposit occurs as a result of weathering of primary gold. The resulting oxide caps are major targets for most ASM operators, because the gold is free-milling, easy to mine and treat. The deposits, which are usually found close to the surface, are softer and permeable due to oxidation and have their gold liberated from sulphide minerals. In the Kanyankaw area, south of Tarkwa, a substantial amount of gold in the iron laterites has been mined by ASM operators.

## Ghana Geological Survey
## Geology and Mineral Resources Map of Ghana



Source: Ghana Geological Survey Authority

Source: John Tychsen, GEUS.

*Figure 5. Sample Of White Quartz With Gold.*

## Alluvial Gold Deposits

This type of deposit occurs in gravels of stream, flats, and old valleys, on terraces and in beach gravels and sand, as shown in Figure 6. The placers are derived mainly from the primary vein and lode-type deposits in the Birimian. These primary deposits have been subjected to several cycles of erosion and deposition. In Ghana, alluvial gold is concentrated mainly in basal gravel overlying weathered Birimian units. The gravel is quite variable in thickness, but usually in the range of 1 to 6 metres, and it is overlain by barren silt and clay overburden. Some notable places in Ghana where this type of deposit is being exploited by ASM opertators include Kwabeng, Manso Kran, Anyinam, Twifo Morkwa, Dunkwa, Jeninso, and Awudua.

## *Diamonds*

Artisanal and small-scale mining of diamonds has taken place in many places in Ghana, especially along the Birim diamond field area and Bonsa River area. The diamonds mined by ASM operators in Ghana are from alluvial deposits. The vast majority of diamonds come from the Birim River valley where gravels, from which the diamonds are recovered, are often less than 1 millimetre thick. About 80% of the diamonds are less than 2 millimetres in diameter.

*Figure 4. Geological Map of Ghana Showing Major Gold Beltsa and Mineral Occurrences.*

Source: Seidu Alidu, GGSA, 2017

*Figure 6. Mining Of An Alluvial Gold Deposit.*

*Note: ASM of alluvial gold by local people at Jeninso in the Ashanti Region of Ghana. Gravel in the stream channel is dug out prior to gold panning and recovery.*

## *Industrial Minerals*

### Brown Clays

Brown clays are exploited by the local populace throughout Ghana to make pottery and other household items. Common clay can be used in the manufacture of cement and as lightweight aggregate. Fired clay is used in structural clay products, and heavy-clay products are used in the manufacture of tile, bricks, and pipes. In Ghana, brown plastic clay can be found in Ada in the Greater Accra Region, Nkroful in the Western Region and Adidome in the Volta Region.

### Kaolins

Several deposits of kaolin are currently being exploited in Ghana. These include the Abandze-Saltpond, Teleku Bokazo-Aluku, Wassaw Akropong, and Anfoega deposits. Kaolin is part of the clay group of minerals. Kaolin is a relatively pure, plastic, whitish form of clay. It has many uses, such as the manufacture of paper and paint, but is also used as a filler, coater, ceramic raw material, and electrical insulator. In pharmaceutical manufacturing, kaolin is used as a suspension agent. Most commonly, kaolin is used as a paper filling and coating (40 % of all production), in plastic manufacturing where it gives resistance to chemical attack and provides smooth surfaces, in paint, adhesive, and ink pigment, as a rubber reinforcing, extending, and filling agent, as a primary ingredient in porcelain, dinnerware, tile, and enamel manufacture, as a catalyst base for petroleum cracking and in auto exhaust emission catalytic control devices, as a cosmetics base, and as an additive in digestive coating remedies.

### Clam Shells

In Ghana, lime is extracted from extensive alluvial deposits of oyster and clamshells along the lower Volta River from Akuse to Sogakope. Shells are collected, burnt, and slaked; resulting lime is dried, sieved, and bagged. Clamshells are also crushed to produce quicklime, chalk, terrazzo chippings, and abrasives, and are used as an additive in paint, poultry feed, and aggregate, and in glass manufacture.

### Jasper

Jasper occurs in Kwamikrom, Jasikan and Hohoe area of Volta Region. Jasper is commonly used in making abrasives, decorative objects and ornaments. It is also used as building stone. Jasper is manually crushed and sold by the local populace in Kwamikrom, Jasikan and Hohoe for use in concrete and terrazzo making.

## How to Follow-Up on a Promising Mineral Discovery

When a promising mineral occurrence has been found, the next step is to discover whether it is big enough to start a mining operation. This can be done in a number of ways depending completely on the type of commodity and the geometry of the deposit.

### *Vein Deposits*

When the vein has been located, its width must be found as well as how far it can be traced. The concentration of the commodity must also be estimated.

In order to locate the vein, small pits or trenches have to be dug down to the bedrock. The number of trenches and pits to be dug depends on the size of the vein. Once the vein is located and the width and length have been determined, the grade of the vein has to be evaluated. This will require sampling and analysing a number of samples across the width of the vein and along the vein.

### *Alluvial Deposits*

In order to follow up on a promising alluvial gold occurrence observed from an initial heavy mineral panning of stream sediments, a series of hand-dug pits would have to be sunk through the overburden, and gravel layers to the top of the weathered bedrock.
The following steps have been outlined in a follow-up phase:

Source: John Tychsen, GEUS.

1. The first step involves cutting and surveying a baseline parallel to the stream. Cross-lines are then cut and surveyed, for example, every 800 metres along the baseline with pickets placed at 100 metre intervals along these lines.
2. Sinking of pits after first marking out a one metre by one metre square area, by using a native "soso" or narrow spade-like digging tool and a pick axe to excavate the over-burden down to the bedrock (usually severely weathered).
3. It is important to take accurate measurements regularly to ensure that the excavation is straight and the walls are square. To avoid caving in by pit walls from groundwater inflows, water pump and small buckets can be used to remove the water as digging progresses.
4. The gravels are then collected from the pit by buckets on ropes. Gravel samples are separated into 0.5 metre intervals as the pit is deepened. Once the bedrock has been reached, another sample should be taken at 30 centimetres into bedrock to check for gold that may have migrated downwards.
5. All the 0.5 metre samples should be piled individually on tarpaulins around the perimeter of the pit collar.
6. Washing of the samples involves the use of wooden sluice boxes. Concentrates are recovered in the sluice box, which is fitted with astro turf matting or jute sacks.
7. The jute sacks, which were used as linen in the sluice box, should be removed after washing each heap of material (0.5 cubicmetres volume of approximately) and then washed into big washing bowl before the final panning to recover the free gold.
8. The free gold is then weighed and expressed in terms of the volume of the material treated.

## *Eluvial Deposits*

This would involve the collection of representative samples in a given exploration area in order to determine the quality and tonnage of the reserve. Test pits are dug on a surveyed grid pattern and (in the case of kaolin/clay deposits) the chemical and physical properties of the samples collected are assessed in the laboratory. Laboratory tests involve mineralogical, chemical, and physical techniques that will determine the appropriate use for any given clay.

*Sluicing mining site north of Osino in central Ghana.*

*Sluicing at a small artisanal mining site, north of Tarkwa in Western Ghana.*

Source: John Tychsen, GEUS.

# GUIDELINES FOR ACQUIRING AN ASM LICENSE IN GHANA

*By Peter Awuah, Minerals Commission*

Every mineral, in its natural state in, under or upon any land, river, stream, water course throughout Ghana, including the country's exclusive economic zone and any area covered by territorial waters or continental shelf, is the property of the Republic of Ghana and is vested in the President for and on behalf of and in trust for the People of Ghana.

In Ghana, an ASM License is required for ASM of all minerals, including gold, diamonds, limestone and granites. ASM operators are obliged to observe good mining practices, health and safety rules and pay due regard to the protection of the environment during mining operations. An ASM License is granted to a person, a group of people, a co-operative society, a registered enterprise/venture, or a company for a period of no more than five years from the date of issue, but it may be renewed upon expiry for a further time period as set by the Minister.

The size of the area in respect of which a licence may be granted for ASM shall not exceed 12 Small Scale Cadastral Blocks, i.e. 25 acres or 10.2 hectares.

Only Ghanaians of at least 18 years of age are eligible to apply for and be granted an ASM License.

## Procedure for Acquiring an ASM License

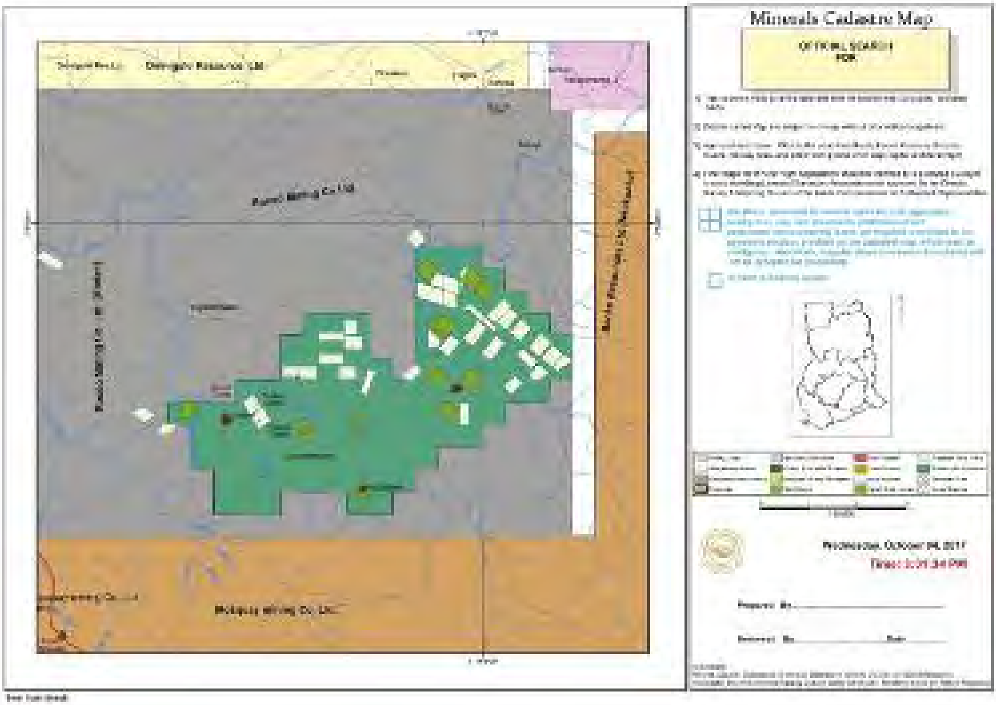
To acquire an ASM License in Ghana, one (Applicant) must follow the procedures outlined below and summarised in Figure 8 at the end of this chapter.

### *Identification of an Area of Interest Within Designated Area*

To apply for an ASM License, an Applicant must first conduct a cadastral search at the Minerals Commission to ensure that the area of interest is within a designated area, i.e. an area designated for ASM, and is free or not under a license or pending application, ref. enclosed Form O, Appendix A.

Upon receipt of an Applicant's request for an ASM License, the Cartographic Unit of the Minerals Commission undertakes the following:

- Determines the number of sectors covered by the Identified Area of Interest submitted by the Applicant;
- Generates an invoice for the Applicant to effect payment at the Accounts Section and presents evidence of payment; and
- Generates a Cartographic/Cadastral Search Report for the Applicant, ref. Figure 7.




Source: Minerals Commission, Ghana, 2017

*Figure 7. Cadastral Search Report of Area of Interest.*

## *Submission of an ASM License Application Form*

Once an available area of interest has been identified, an Applicant must complete and submit an Application for Small Scale Mining License, ref. enclosed Form 68, Appendix A, together with the following supporting documentation:

- Evidence of payment of the applicable fees, i.e. an official receipt;
- A copy of the Cadastral Search Report, indicating that the area of interest is free immediately prior to submission of the application;
- A map or site plan of the area of interest (1:50,000 scale and signed by a licensed surveyor);
- A form of national identification, i.e. a passport, voter identity card, or national identity card;
- If the Applicant is not an individual: certified copies of incorporation documents or documents showing registration as a co-operative society and the rules governing the conduct and relationship of members of groups, societies, associations or cooperatives, as the case may be; and
- A recommendation for the grant of a license signed by the local government authority,

i.e. Metropolitan, Municipal or District Assembly, which has jurisdiction over the applicant's area of interest.

If the Applicant provides all the information required, the Applicant is issued with an Application Certificate, ref. enclosed Form 2, Appendix A.

### *Review and Pre-Licensing Site Inspection*

The Minerals Commission thoroughly reviews the information provided by the Applicant to ensure that it is accurate. If any errors are not corrected within ten days, upon notification, or if the Applicant submits any false information, the Minerals Commission will reject the application for an ASM License.

If the Applicant's application for an ASM License is approved, the District Officer of the Minerals Commission conducts a Pre-Licensing Site Inspection to determine whether the Identified Area of Interest is suitable for mining and to ensure that the Site Plan submitted by the Applicant is exactly the same as depicted on the ground and boundaries pillared.

Before the Pre-Licensing Site Inspection, the Applicant shall undertake the following:

- Demarcate the boundaries of the proposed site with type C pillars erected on the concession with the assistance of a licensed surveyor; and
- Erect a minimum of 60 centimetres concrete pillars at all the vantage points on the concession boundaries at an interval of 61 meters (numbered and bearing the initials of the Applicant).

Note that an application for an ASM License is not subject to publication because the entire designated area has already been published and gazetted in accordance with the law.

### *Environmental Permit*

The Minerals Commission issues a Letter requesting the Applicant to obtain an Environmental Permit from the EPA.

### *Consideration of Application for ASM Licence*

Upon submission of an Environmental Permit from the EPA, the Minerals Commission considers the application, including the Report of the Pre-Licensing Inspection and makes an appropriate recommendation to the Minister.

### *Notice of Grant or Rejection of Application for ASM Licence*

Where the Minister approves a recommendation to grant the application and notifies the Minerals Commission accordingly, the Minerals Commission gives notice of the grant to the Applicant by means of a Notice of Grant of Small Scale Mining License, ref. enclosed

Form 69, Appendix A. The notice requires the Applicant to pay the applicable mineral right fees to the Commission and annual ground rent to the Office of the Administrator of Stool Lands (OASL). Where the Minister approves a recommendation to reject the application and notifies the Minerals Commission accordingly, the Minerals Commission gives notice of the rejection to the Applicant, including the reasons for the rejection, by means of a Notice of Rejection of Application, ref. enclosed Form 4, Appendix A.

### *Acceptance of Grant of an ASM License*

Within sixty (60) days after being notified by the Minerals Commission of the grant of an ASM License, the Applicant is required to pay the prescribed fees and give notice to the Minister and the Minerals Commission in writing of acceptance of the grant.

### *Execution of Agreement*

The grant of an ASM License is by an agreement in triplicate between the Minister on behalf of the Government and the Applicant, which is signed by both parties. The ASM License includes the terms and conditions on which the License is granted.

### *Issuance of License*

The Minister issues the ASM License to the applicant within thirty (30) days after being notified of the Applicant's acceptance of the grant of the License. On receipt of the signed agreements, the Applicant is required to stamp and register them with the Lands Commission. The Applicant is also required to swear an oath and obtain a Certificate of Proof from the High Court Registry.

### *Operating Permit*

Upon the issuance of the ASM License, the Applicant is required to obtain an Operating Permit from the Chief Inspector of Mines before commencement of any mining activity. The Applicant is also required to make available to the District Officer of the Minerals Commission for record purposes, a copy of the Operating Permit obtained each year from the Chief Inspector of Mines

## Guidelines for the Preparation of Mining Operating Plans

A Mining Operating Plan (MOP) is a tool used by the Inspectorate Division of the Minerals Commission to monitor the progress of mining and rehabilitation activities over the life of a mine. The Guidelines for Preparation of MOPs require industry to identify and provide measurable data and demonstrate that the proposed rehabilitation outcomes are achievable and realistic within a given time frame.

An ASM is required by law to develop a MOP that applies current best practices to achieve good mining and environmental outcomes and which includes the following information:

- Name of the Mine
- Name of Mineral Title Holder
- Expiry Date
- Number of Title
- Address of Mineral Title Holder
- Name and Qualification(s) of Technical Manager (If Different)
- Postal Address
- Telephone Fax/E-mail
- Boundary of Leases
- Cadastral Information (Land Ownership Boundaries)
- A Title Block Showing the Date of Preparation of the Plan, Title and Serial Number
- The Name, Title and Signature of the Person Responsible for the Plan
- Mine Design
- Mine Development Plan
- Mineral Production Plan
- Mine Restoration, Reclamation and Rehabilitation Plan
- Mine Health and Safety Scheme
- Mine Tailings and Waste Disposal Plan
- Mine Closure Plan

## Obligations of the ASM License Holder

A holder of an ASM License shall:

- Commence mining operations under the License within six months of issue;
- Conduct mining operations within the concession in compliance with the MOP approved by the Minerals Commission;
- Demarcate and keep demarcated the concession boundaries in the manner prescribed in the stipulated Regulations;
- Comply with the terms and conditions of the ASM License; and,
- Comply with directives issued by the Minerals Commission or an authorised officer in accordance with the Minerals and Mining Act and relevant Regulations.

## Record Keeping and Reporting Requirements

A holder of an ASM License shall keep at the holder's registered head office, complete and accurate records of mining operations including:

a) Copies of maps, geological reports, sample analyses and other data obtained and compiled by the license holder;
b) Documentary details of minerals discovered;
c) Results of analyses obtained and compiled by the license holder;
d) Results of studies, surveys, tests and other work undertaken in the title area, including any interpretation and assessment of those tests and surveys;
e) The geological interpretation of the records maintained under paragraphs (a) to (d);
f) Details of minerals won, quantities sold, revenue received, taxes and royalties payable;
g) Financial statements and other books of account that the Commission may require;
h) The number of persons employed; and
i) Any other information specified by the Minerals Commission.

A holder of an ASM License shall provide samples from the title area to the Minerals Commission, which may reasonably request and keep such samples.

A holder of an ASM License shall submit a semi-annual report no later than thirty (30) days after the half-year to which the report relates to the Minerals Commission. The report shall summarise the results of mining operations undertaken in the title area during the half-year and contain the information required under sub-regulation (1) of Regulation 25 of the Mineals and Mining (General) Regulations, 2012 (LI 2173).

A holder of an ASM License shall submit an annual report no later than thirty (30) days after the end of the year to which the report relates to the Minerals Commission. The report shall summarise the results of mining operations undertaken in the title area during the previous year and and provide a description of the ensuing year together with an estimate of production and revenue to be obtained from the mining operations.

A holder of an ASM License shall submit a copy of the annual financial report, duly certified by a qualified practicing accountant, to the Minerals Commission no later than ninety (90) days after the end of each financial year.

A holder of an ASM License:

- who fails to keep a record or information required to be kept under sub-regulations (1) and (2) of Regulation 25 of the Minerals and Mining (General) Regulations, 2012 (LI 2173).; or
- who fails to submit a record to the Minerals Commission in accordance with sub-regulations (4) to (6) of Regulation 25 of the Minerals and Mining (General) Regulations, 2012 (LI 2173); or
- who submits false or misleading records or gives false or misleading information to the Minerals Commission,

commits an offence under section 106 of the Minerals and Mining Act, 2006 (Act 703).

## Payment of Royalties

A holder of an ASM License shall pay royalties in respect of minerals obtained from the mining operations to the Republic of Ghana at the rate of 5% of the total revenue earned from minerals obtained by the holder.

## Transfer of License

An ASM License granted under section 82(1) of the Minerals and Mining Act, 2006 (Act 703) may be transferred ONLY to a citizen of the Republic of Ghana and with the consent of the Sector Minister.

## Revocation of License

The Minister may revoke an ASM License granted under section 82(1) where:

- The Minister is satisfied that the Licensee has contravened or failed to comply with a term or condition of the license or a requirement applicable to the licensee;
- The Licensee is convicted of any offence relating to the smuggling or illegal sale or dealing in minerals; or
- The Minister is satisfied that it is in the public interest to do so.

## Other Offences and Penalties under the Minerals and Mining Legal Regime

Under the new amendment act, i.e. the Minerals and Mining (Amendment) Act, 2015 (Act 900), a person who sells or buys minerals without a Licence granted or without valid authority commits an offence and is liable to a summary conviction to a fine of not more than 3,000 penalty units or to a term of imprisonment of not more than five years or to both.

As of September 2017, a penalty unit is equivalent to Twelve Ghana Cedis (GH¢12.00). A foreigner who undertakes ASM operations contrary to the provisions of the law commits an offence and is liable on summary conviction to a fine of not less than 30,000 penalty units and not more than 300,000 penalty units or to a term of imprisonment of not more than 20 years or both.

A Ghanaian who employs or engages a foreigner to illegally undertake or participate in ASM in the country commits an offence and is liable on summary conviction to a fine of not more than 17,000 penalty units or to a term of imprisonment of not more than 10 years or to both.

| # | Offences | Penalty | Applicable Legal Reference (Act 900) |
|---|---|---|---|
| 1 | Engaging in small-scale mining or a mining operation without a licence. | Summary Conviction to a fine of not more than the cedi equivalent of US$5,000.00 (at first instance).<br><br>The cedi equivalent of US$500.00 for each day the offence is continued (after first conviction). | Section 82; Section 106 (1) (a); 106 (1)(l); (of Act 703) |
| 2 | Transfer of a licence to a non-citizen. | Summary Conviction to a fine of not more than the cedi equivalent of US$5,000.00 (at first instance).<br><br>The cedi equivalent of US$500.00 for each day the offence is continued (after first conviction). | Section 106 (1)(l); (of Act 703) |
| 3 | Use of explosives without the written permission of the Minister. | Summary Conviction to a fine of not more than the cedi equivalent of US$5,000.00 (at first instance).<br><br>The cedi equivalent of US$500.00 for each day the offence is continued (after first conviction). | Section 106 (1)(l); (of Act 703) |
| 4 | Use/Purchase of mercury from an unauthorised dealer. | Summary Conviction to a fine of not more than the cedi equivalent of US$5,000.00 (at first instance).<br><br>The cedi equivalent of US$500.00 for each day the offence is continued (after first conviction). | Section 106 (1)(l); (of Act 703) |
| 5 | Sale of minerals without authorisation by the Minister. | Summary Conviction to a fine of not more than the cedi equivalent of US$5,000.00 (at first instance).<br><br>The cedi equivalent of US$500.00 for each day the offence is continued (after first conviction). | Section 106 (1)(d); (of Act 703) |
| 6 | Buying or selling minerals without a licence or valid authority. | Summary Conviction of a fine of not more than three thousand penalty units (3000p/u) or to a term of imprisonments of not more than five (5) years or to both. | Section 99 of Act 703 as amended by section 2 of Act 900. New Section 99(1)) |

*Source: Minerals Commission, Ghana, 2017*

| # | Offences | Penalty | Applicable Legal Reference (Act 900) |
|---|---|---|---|
| 7 | Undertaking small-scale mining operation without a licence. | Summary Conviction of a fine of not more than three thousand penalty units (3000p/u) or to a term of imprisonments of not more than five (5) years or to both. | Section 99 of Act 703 as amended by section 2 of Act 900. New Section 99(2)(a)) |
| 8 | Undertaking small scale mining as a foreigner. | Summary Conviction of a fine of not more than three thousand penalty units (3000p/u) and not more than three hundred thousand penalty units (300,000 p/u) or to a term of imprisonments of not more than twenty (20) years or to both. | Section 99 of Act 703 as amended by section 2 of Act 900. New Section 99(3)) |
| 9 | Employing a or engaging a foreigner to undertake or participate in small scale mining. | Summary Conviction to a fine of not less than two thousand penalty units (2000 p/u) and not more than twenty thousand penalty units (20,000 p/u) or to a term of not less than five (5) years and not more than ten (10) years or to both. | Section 99 of Act 703 as amended by section 2 of Act 900. New Section 99(4)) |

*Table 1. Summary of offences and penalties under Act 900.*

| ACTIVITIES | OPERATOR | REQUIREMENT/MEDIUM |
|---|---|---|
| Identify Area of interest | Applicant | Maps (1:50,000), Geol. info |
| Obtain Cadastral Search Report | Applicant | Site plan (1:50,000 scale) to ensure area is within Designated Area |
| Apply for License | Applicant | Completed application form, search report, work programme/ feasibility report, etc. |
| Pay Processing Fee | Applicant | Payment to the Commision by Banker's Draft |
| Review and Pre-licensing Inspection | Minerals Commission | Application Area by District Officers |
| Register undertaking at EPA | Applicant | a) Registration forms<br>b) Obtain Environmental Permit |
| Evaluation of application | Minerals Commission | Background information on Applicant |
| Recommendation to Hon. Minister to grant/reject application | Chief Executive Officer Minerals Commission | Memos/Reports |
| Acceptance of Grant | Applicant | a) Payment of Annual Mineral Right Fee<br>b) Payment of Annual Ground Rent |
| Execution of License | Minister/Applicant | Public agreement (Small Scale Mining Licenses, etc) |
| Insuance of License | Hon. Minister | Small Scale Mining License |
| Obtain Mining Operation Permit | Applicant | Preparing of Mining Operating Plan |

*Source: John Tychsen, GEUS.*

*Source: Minerals Commission, Ghana, 2017*

*Figure 8. Summary of Procedures for Obtaining an ASM License In Ghana.*

*Mining in alluvial deposit using sluicing and water pumps at mining site in central Ghana.*

*The owner is inspecting the mining operation, north of Osino in central Ghana.*

Source: John Tychsen, GEUS.

# ORGANISING AND DEVELOPING AN ASM MINING SITE

*By Ishmael Quaicoe, University of Mines and Technology (UMaT)*

## Satisfying Statutory Requirements

Prior to commencing ASM operations in Ghana, one is required to acquire an ASM License from the Minerals Commissions and satisfy all requirements provided by the Minerals and Mining Act of 2006 (Act 703) of Ghana.

## Mine Planning and Designing

Mine planning and designing is a decision-making process that involves establishment of a mine and a mining sequence that lead to a profitable extraction of valuable minerals from a proposed mine in the safest manner possible. In other words, the process of getting the right material (ore) out of the mine at the right time, at the lowest possible cost and fulfilling the business targets of the company is termed “mine planning and design”.

Some guiding objectives for effective mine planning include (Tychsen, J. *et. al.*, 2011):

- Mine the best ore to generate income as early as possible;
- Maintain proper operating parameters (adequate bench width and haul roads);
- Maintain sufficient exposure of ore to overcome miscalculations or delays in-drilling and blasting;
- Defer stripping as long as possible without constraining equipment, man-power, or the production schedule;
- Follow a logical and achievable start-up schedule (for training, equipment procurement and development etc.) that minimises the risk of delays in the initial cash-flow;
- Maximise pit slopes, while maintaining reasonably low likelihood of slope failure;
- Examine the economic merits of various production rates and cut-off grades; and
- Subject the favoured choice of method, equipment and pit sequence to exhaustive contingency planning before proceeding with development.

Some of the key factors often considered while planning a mine are (Tychsen, J. *et. al.*, 2011):

- Natural and geological factors (geological conditions, ore types and grades, hydrological conditions, topography, metallurgical characteristics, climate and environmental variables of the site);
- Social, economic and polictical factors (ore grade, ore tonnage, stripping ratio, cut-off grade, operating cost, investment cost, desired profit margin, production rate, processing and/or smelting costs, market conditions, demographics and occupational skills of

local population, political situation, security level of local area, and environmental legislation); and
- Technological factors (equipment, pit slope, bench height, road grade, property lines, transportation options and pit limits).

## Key Factors for Consideration

### *Cut-Off Grade*

Cut-off grade refers to the minimum grade required in order for a mineral or metal to be economically mined (or processed) at the prevailing conditions and below which its exploitation is not viable. The initial mine cut-off grade is estimated during a mining feasibility study, but is subject to change given greater knowledge obtained about the deposit or changes in market conditions. For any block to be mined, it must pay for the cost of mining, processing and marketing. The grade of ore that can pay for this but not for stripping is the break-even mining cut-off grade.

In the planning stage, all direct costs of mining, milling and marketing should be taken into account. In the mining stage, the drilling, blasting, loading and hauling costs should be used. In the processing stage costs should include crushing, conveying, grinding and concentration.

### *Strip Ratio*

In simple terms, stripping ratio or strip ratio, refers to the ratio of the volume of overburden (or waste material) required to be removed in order to mine some tonnage of a valuable mineral ore. For example, a 4:1 stripping ratio means that mining one tonne of a valuable ore will require mining four tonnes of waste rocks. Notably, stripping ratios are not only about the volume of unwanted material present at a site; they also take into account the types of material that must be removed to reach the ore and even the quality of ore that will be mined.

The pit design will also determine the tonnage of waste and ore that the pit contains. The ratio of waste and ore will give the average strip ratio for the pit, which must be higher than the break-even strip ratio. The maximum allowable stripping ratio ($SR_{max}$), used in determining the pit limits, is as follows (Tychsen, J. *et. al.*, 2011):

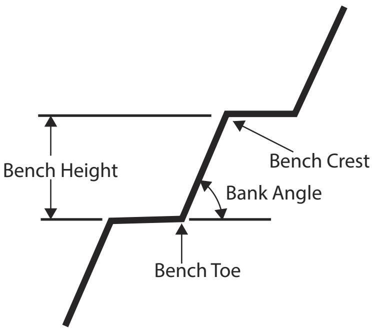
$$SR_{max} = \frac{\text{Value of Ore} - \text{Production Cost}}{\text{Stripping Cost}}$$

### *Bench Height*

Bench height is the vertical distance between the crest and toe of a bench, as shown in Figure 9 (Fourie and Dohm, 1992). The bench height is a key parameter in selecting bench dimensions in pit design, since once this parameter is set, the rest of the dimensions follow directly from it. In practice, the bench height is usually decided by the economic reach of the mining equipment used, i.e. a bench height is equal to the economic bucket height of an excavator (such as a shovel or loader) plus 3 meter (Hem, 2012). However, the thickness and dip of the orebody and the overburden also play a pivotal role in deciding the bench height.

Generally, the bench height depends on:

- Deposit character and geology (selectivity);
- Production strategy (ore/waste ratios, blending requirements, number of working faces, operating/capital costs, etc.);
- Slope stability considerations; and
- Equipment set/equipment specific optimum geometry.



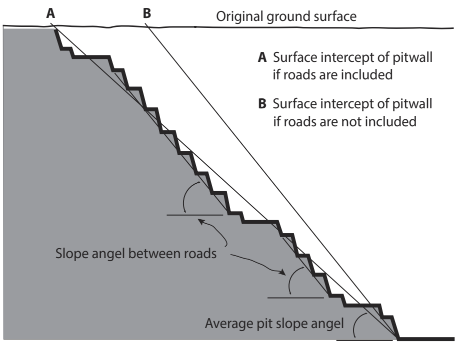

Source: Atkinson, 1983

*Figure 9. Bench Cross Section.*

## *Pit Slopes*

The pit slope is expressed in degrees from the horisontal plane and helps to determine the amount of waste that must be removed to mine the ore. The pit slope is one of the factors that affects the size and shape of the mine pit. Rock strength, presence of water, faults, joints etc. are key factors used in evaluating the proper slope angle as they tend to change the pit slope as their conditions vary from one location to another. There are three major components of a pit slope: bench configuration, inter-ramp slope, and overall slope, as shown in Figure 10. The bench configuration is defined by the bench face angle, the bench height, and bench width. The inter-ramp angle is the slope angle produced by a number of benches. Where there are haul roads, working levels, or other wide benches, the overall slope angle is the angle of the line from the toe to the crest of the pit; the slope angle will be flatter than the inter-ramp angle.

A pit wall must remain stable as long as mining activity is undertaken in that area. This can only be obtained by a proper pit slope evaluation. A pit slope should be designed as steep as possible to minimise a mine pit's stripping ratio, i.e. waste to ore. The overall pit slope used for the construction of the mine must be flatter to allow for the road system in the ultimate pit. This will depend on the width, grade, and anticipated placement of the road (Tychsen, J. *et. al.*, 2011).




Source: Atkinson, 1983

*Figure 10. Vertical Section Through a Pit Wall.*

Source: John Tychesen, GEUS.

## *Equipment Selection*

Mine process and auxiliary equipment are selected based on the following factors:

- Scheduled production rate and type of method to be used in carrying out the activity
- Depositional characteristics of drilling equipment and mineral processing equipment
- Initial cost of equipment
- Operational cost as well as availability of spare parts.

The equipment that will produce the required scheduled production rate at least cost is mostly selected.

Overall, effective mine planning involves making good decisions in pit design, mine sequencing, production rate, process method, ore selection, and mining method. All these decisions need to be made simultaneously and in conditions of great uncertainty.

## Mine Development

Mine development refers to the process of constructing a mining facility and the infrastructure to support the facility. The process encompasses all the work required in order to bring a mine to full, scheduled production. The mine development process covers access to the mineral deposit, permitting entry of miners, equipment, supplies, power, water, ventilation air, and exits for the mineral being mined and the waste produced.

Mine development for surface mines entails removal of overburden (stripping) to expose the mineral value. The overburden is then placed in disposal areas for later reclamation.

Mine development for underground mines is generally more demanding and expensive that the surface mines. The principal openings may be shafts to allow for the passage of workers, machines, ore, waste, air, etc. Metal mines are mostly located along steeply dip-


Source: John Tychesen, GEUS.

*Figure 11. ASM Operators Using a Winch to Raise Material From a Deep-Shaft Mine.*

ping mineralisation resulting in the need to open up the mineral ore from adits or shafts, with drifts, winches, and raises serving as production areas, as shown in Figure 11.

Modes of entry for pitching veins, as shown in Figure 12, could be either a vertical shaft (CD) started in the hanging wall, a footwall vertical shaft (AE), a footwall inclined shaft (AB) or an inclined shaft (GH) in the vein. Except in the last case, crosscuts will be needed at intervals to reach the vein. A vertical shaft is the right entry for flat or vertical deposits.

## *Sequence of Mine Development*

The steps usually carried out during mine development for both surface and underground mines after the acquisition of land and mineral rights are as follows:

1) Adoption of the feasibility report as a planning document subject to modification as the project is developed and mined;
2) Confirmation of mining methods and general sequence of mining including the initial choice of equipment types and size of workforce;
3) Arrangement of financing based on confirmation of ore reserves and cost estimates by independent assessors;
4) Erection of mineral processing plant, if required, and mineral handling and shipment facilities as well as preparation of stockpiling and waste disposal facilities. These facil-

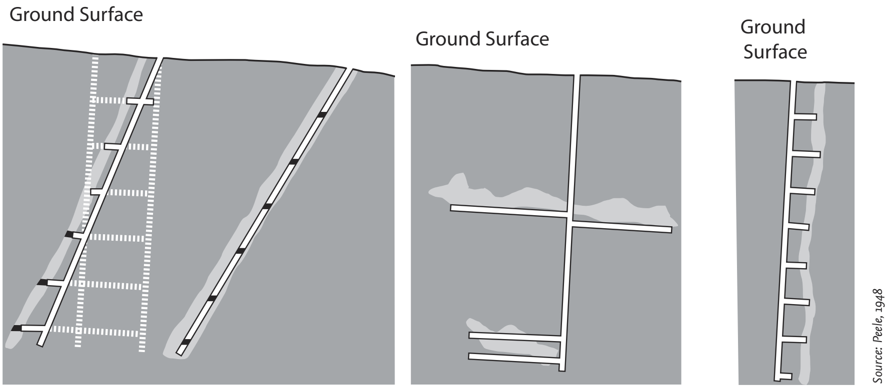



*Figure 12. Modes of Entry to a Mine.*

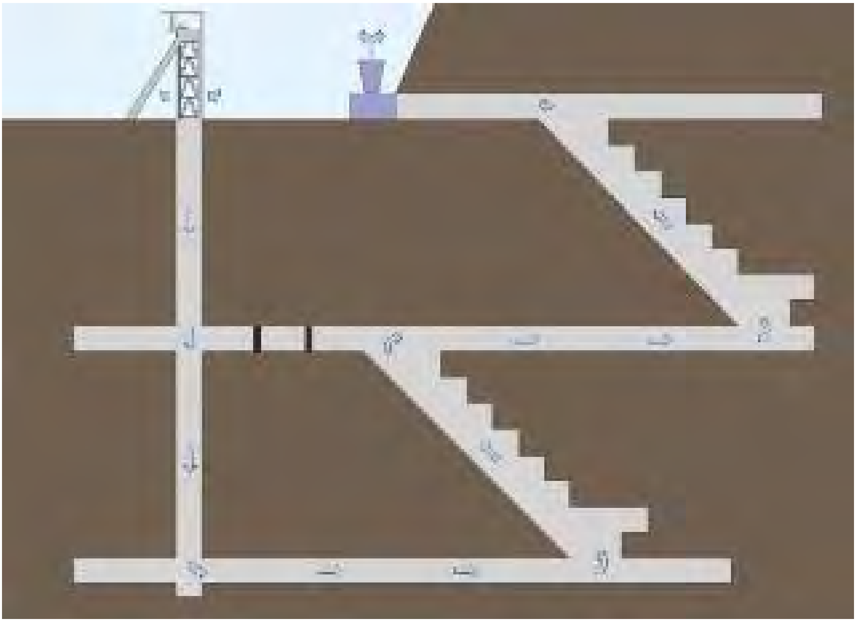
ities should be located in areas that would not in any way disrupt mineral extraction activities;

5) Acquisition of mining equipment for development and exploitation; and
6) Construction of main opening to the mineral body in underground mining or advanced stripping in surface mining to provide direct access to the ore zone.

## *Mine Ventilation*

Mine ventilation involves the provision of fresh, cool air into the mine in order to provide sufficient oxygen for workers to breathe and to regulate the temperature of the environment to ensure that the working conditions allow for maximum efficiency of work. Ventilation also ensures the dilution and displacement of gases (e.g. monoxide, carbon dioxide, nitrogen oxides, methane and hydrogen sulphide) and dusts that would otherwise contaminate the mine atmosphere. The fresh, cool air is often introduced into the mine workings via the main shaft to displace foul air caused by the presence of gases and dusts that are exhausted through the ventilation shaft as shown in Figure 13 (Tumbde and Caldwell, 2011; Tychsen, J. *et.al,* 2011; Anon, 2017b).

To achieve an efficient flow of the air in the underground workings, a pressure difference is often established to overcome the mine resistance to air flow. For ASM underground mines, this is achieved by natural ventilation pressure due to the difference in the weight of the air columns in both shafts, whilst in large scale mines an exhaust fan is often installed over the collar of the ventilation shaft, reinforced by booster fans placed strategically in the main mine ventilation circuit to secure adequate pressure difference. Some of the low-cost mechanisms or technologies that can be used in the ASM sector include air-jet ventilator, bell blower, baaders blower, box blower, ventilation oven, wind sail, small blowers, manual fans, hydro-compressor, bricked brattice, and bricked duct (University of Waikato, New Zealand, 2017).



Source: www.wikipedia.org/wiki/Underground_mine_ventilation

*Figure 13. Schematic of underground mine ventilation.*

## Mine Exploitation

Mine exploitation refers to the stage in mining where the delineated orebody is extracted from its natural habitat using orebody-specific mining techniques or methods. The methods used in mineral extraction are classified into two broad categories: surface and underground mining methods. Surface mining includes mechanical excavation methods, such as open pit and open cast (strip mining), contour mining, dredging, hydraulic mining, and aqueous methods, such as placer and solution mining. Underground mining includes unsupported, supported and caving excavation. The most common and general mining methods used for ASM operations are listed in Table 2.

| Category | Class | Sub-Class | Method | Commodity |
|---|---|---|---|---|
| Surface | Mechanical | | • Open Pit Mining*<br>• Quarrying<br>• Open Cast (Strip) Mining*<br>• Auger Mining | • Metallic<br>• Non-Metallic<br>• Coal, Non-Metallic<br>• Coal |
| | Aqueous | • Placer<br>• Solution<br>• Borehole mining<br>• In-Situ leaching* | • Hydraulicking<br>• Dredging<br>• Non-Metallic<br>• Metallic | • Metallic, Non-Metallic<br>• Metallic, Non-Metallic |
| Underground | Unsupported | | • Room and pillar mining* | • Metallic, Non-Metallic |

Source: John Tychesen, GEUS.

*Table 2. Classification Of Mining Methods. * The most important and commonly used methods.*

Given that most ASM operators in Ghana are engaged in gold mining, specific mining methods suitable for the various gold ore deposits in the country are stated in Table 3.

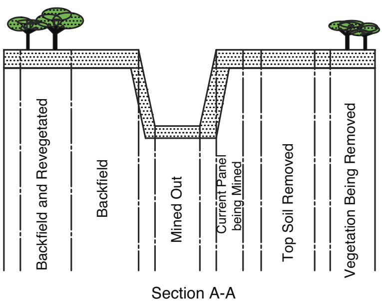
| Type of Deposit | Mining Methods |
|---|---|
| Alluvial/Eluvial/Colluvial | Strip Mining |
| Weathered Gold Lodes, Phyllitic, Quartzitic and Lateritic Mateirals | Terrace Mining |
| Auriferous Lodes and Quartz Veins with Depth ≤ 15 m | Shallow Open Pit Mining |
| Auriferous Lode and Quartz Vein Deposits in Hilly Terrains or Flat Plains with Depth > 15 m and < 50 m | Underground Mining (Adit or Vertical Shaft Openining) |
| Old Tailings (Chemically Treated) | Not to be Mined for Environmental and Safety Consideration |

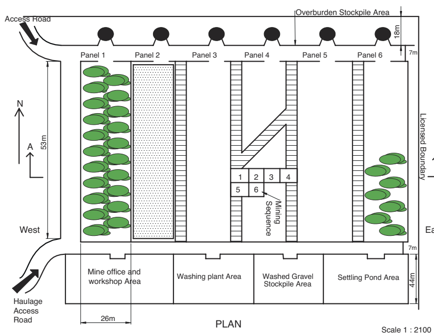
*Source: Salati, 2015*

*Table 3. Mining Methods for Gold Ore Deposits in Ghana.*

## *Surface Mining Methods*

Surface mining methods, e.g. terrace, strip and shallow open pits, are employed to exploit typical alluvial, collovial and eluvial deposits with vertical cross section consisting of vegetation, overburden, mineral/metal-bearing gravel and/or underlying bedrock. According to Salati (2015), responsible surface mining can be undertaken by ASM operators according to the layout and method shown in Figure 14. Generally speaking, the concession is demarcated in panels/sections where the overbuden of panel 1 is removed and dumped as the overburden stockpile area for future use in reclamation. The metal/mineral-bearing material is then removed, processed and the waste returned to backfill panel 1. The overburden/topsoil of panel 2 is then used to cover the gravels of panel 1 and the process continues in this manner for other panels until the end of the operation.



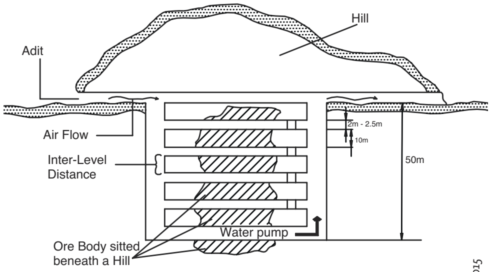

*Source: Selati, 2015*

*Figure 14. Proposed Surface Mining Method Layout for ASM Operation.*

## *Underground Mining Methods*

Underground mining methods, e.g. adit or vertical shaft openings, can be used by ASM operators to exploit ore deposits in hilly terrains or flat plains which extent beyond the 15 metres recommended working depth for a shallow open pit mining. Underground mining is either done in levels through a small adit, as shown in Figure 15, or a vertical shaft opening, as shown in Figure 16, where mining at inter-level distance ranging between 10 metres to 50 metres is permissible to ensure safe working environment. For adequate ventilation, easy movement of ore, equipment, materials and workers, an adit and shaft diameter of 2000–2500 millimetres is considered appropriate.

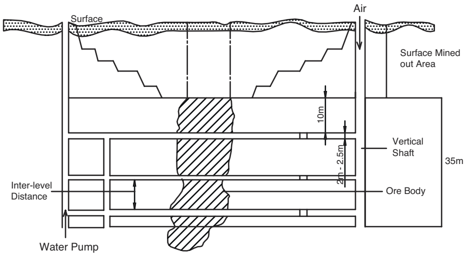
Source: John Tychesen, GEUS.




Source: Selati, 2015

*Figure 15. Proposed Underground Mining for ASM Using Adit Method.*

Source: John Tychesen, GEUS.




Source: Selati, 2015

*Figure 16. Proposed Underground Mining for ASM Using Vertical Shaft Openning.*

## *Guidelines and Procedures for Selecting Mining Methods*

In general, selecting suitable mining methods for a given ore deposit depends on the following factors;

- Spatial characteristics of the deposit (such as size, shape and depth of the deposit from the surface, etc);
- Geological, geomechanical/geotechnical and hydrological conditions (such as mineralogy, petrography and chemical compositon, strength of surrounding rocks);
- Productivities and machinery capacities;
- Capital requirements and operating costs;
- Ore recoveries and revenues;
- Safety and health aspects associated with the mining methods;
- Environmental impacts, during and after mining; and
- Reclamation and restoration requirements and costs.

Nilsson (1992) further observes and recommends that:

- For a buried horizontal ore deposit, mining of the deposit will be optimised by using either a surface method or an underground method, but not using both;
- For a steeply dipping vein or a massive deposit that outcrops on the surface and extends to depth, mining of the depot will be optimised by first using surface methods and subsequently switching to underground methods.
- The use of surface mining methods should be switched to underground mining method when the costs of surface mining reach the costs of underground mining, provided that ore production rates do not change at this point.

In general, cost comparisons should be employed to decide which mining method to use for a buried horizontal ore deposit. However, for a steeply dipping ore deposit that extends to depth, a thorough analysis of the optimum point of switching from surface to underground mining methods should be used. Irrespectively, both socio-economic and environmental considerations should be integral to final decision on mining method to employ for a given ore deposit.

## *Reclamation*

To safeguard both human and environmental interests, adequate plans for mine closure should be devised before mining an ore deposit, be it surface or underground.

To avoid, or at least lessen, negative environmental impacts from ASM operations, ASM operators are required to restore a mining area to its natural state upon closure of mining activities. For underground mining operations, ASM operators shall seize work at a vertical limit of 50 metres and initiate the necessary closure plan. For surface mining operations, reclamation entails filling the mined out areas with overburden materials after completion of mining activities to prevent flooding, human and animal casualties, and to promote natural vegetation, as shown in Figure 17.

*Source: Bansah et al., 2016*

*Figure 17. Reclamation of Mining Site.*

*Note: Reclamation Procedure: 1) Back-filling of the excavated pit with the overburden material stockpiled adjacent to the pit periphery using dozers and excavators; 2) Leveling the materials in the pit with the dozer and contour appropriately to fit surrounding terrain/topography; 3) Cover the levelled overburden material with organic material (topsoil); and 4) Plant or re-vegetate the area covered with the topsoil with native species.*

*Mining an alluvial deposit at the Stone Gold Mining site central Ghana.*

Source: John Tychsen, GEUS.

# MINERALS PROCESSING

*By Richard Amankwah, University of Mines and Technology (UMaT)*

In the field of extractive metallurgy, minerals processing, otherwise known as ore dressing, deals with the separation of commercially valuable minerals from their ores. Ore dressing performs two jobs, liberation and separation. It combines a series of quite distinct unit operations, which include comminution, particle classification, separation of solids from liquids, and materials handling. Comminution, which is used to achieve liberation of the valuables, involves crushing and, if necessary, grinding. The level of particle size reduction depends on how the valuables and the gangue are associated. In the course of comminution, screening may be used to group the relatively coarse particles, while the fines are grouped using classifiers.

The most common commodities that can be mined at small-scale levels in the Republic of Ghana include, ref. Figure 18;

**Metal/Metallic Mineral:**

- Gold

**Industrial Minerals:**

- Diamonds
- Limestone
- Clay
- Sand
- Aggregates
- Salt

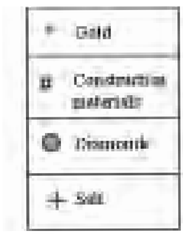




*Figure 18. Location of Mineral Deposits in Ghana.*

Source: Ministry of Lands and Natural Resources, Government of Ghana

## Gold Mining Minerals Process

Gold's qualities make it one of the most sought-after metals in the world. Its quality has made it the metal of choice for a wide variety of industries and is used in jewelry, for coinage, dentistry etc. The properties of gold exploited during its processing and recovery include; solubility in acidic and alkaline solutions in relatively high oxidising environments, metallic yellow colour, high specific gravity and ability to form an amalgam with mercury.

### *Classification of Gold Ores*

The gold extracted by most ASM operators in Ghana is derived from reef, vein or lode-type gold deposits (Birimian System); auriferous and quartz-pebble conglomerates (Tarkwaian System) and from recent placer deposits (Kesse, 1985). The gold grade generally varies from a few grams up to several hundreds of grams of per tonne. Gold ores may be classified in several ways, according to either the associated geological environment or the extraction technique. One general classification, based on the extraction technology, classifies gold ores as either refractory or non-refractory. Non-refractory ores include placer, free milling and oxidized ores from which a very high percentage of gold (about 95%) can be recovered by gravity concentration and/or simple cyanidation. Refractory gold ores may contain sulphides, tellurides and carbonaceous matter.

The occlusion and inclusion of gold particles in the matrix of these minerals makes it impossible to fully liberate gold by mechanical means, thus making it difficult to process by direct cyanidation. Such ores require pre-treatment to decompose the gold bearing minerals before gravity concentration and extractive metallurgy in the ASM operations. Pre-treatment methods include roasting, which has large environmental implications. Refractory ores can also be well fluxed and smelted. ASM operations are, by law in Ghana, not allowed to use cyanide and therefore the operations are limited to gravity concentration and pyrometallurgical applications. Electrometallurgical applications however are not being used by ASM operations due to lack of technical know-how and cost implications.

### *Gold Beneficiation Processes*

#### Placer Gold Ores

For placer gold ores, most of the gold exists in the free-state as discrete particles, usually, not associated with the gangue. Placer gold ores require no comminution because the gold is already liberated. Recovery involves a pre-treatment step in which the ore is scrubbed and screened. The screen undersize, which usually contains the gold, is then subjected to gravity separation. The most commonly used gravity separators found in most ASM sites include the sluice board and pans. In addition to these two, centrifugal concentrators may also be found at some ASM sites. Depending on the gold particle size range, a centrifugal concentrator or a sluice board may be used. The advantage of the use of centrifugal concentrator over the sluice board is that it is very efficient and works faster. The gravity concentrate may be smelted directly after cleaning on a pan, secondary centrifugal concentrator or shaking table. The final concentrate may then be amalgamated, retorted and smelted to get the bullion. Figure 19 shows the current processing route used by ASM operators for placer and hard rock operations. The only difference between the two is that crushing and grinding is required for consolidated and semi-consolidated operations.

| PLACER OPERATIONS | HARD ROCK OPERATIONS |
|---|---|
| Washing/Scrubbing | Ore (Hard Rock) |
| ↓ | ↓ |
| Gravity Concentration | Crushing/Grinding |
| ↓ | ↓ |
| Mercury → Amalgamation | Gravity Concentration |
| ↓ | ↓ |
| Filtration of Excess Mercury → Liquid Mercury | Mercury → Amalgamation |
| ↓ | ↓ |
| Burning of Amalgam → Mercury Vapor | Filtration of Excess Mercury → Liquid Mercury |
| ↓ | ↓ |
| Sponge Gold | Burning of Amalgam → Mercury Vapor |
| ↓ | ↓ |
| Smelting | Sponge Gold |
| ↓ | ↓ |
| Bullion | Smelting |
| | ↓ |
| | Bullion |

*Figure 19. Processing Routes for Placer and Hard Rock Mining Operations.*

## Comminution

The term comminution simply means "to make small". The processes involved in comminution are employed in minerals processing just to make large particles smaller or to achieve liberation of encapsulated valuables. In the minerals industry, comminution begins with the miner, as rock cutting and blasting may be considered the first stage of comminution. After mining of rocks and ores, several comminution technologies may be utilised to prepare the mine product for direct application or for further treatment. In Ghana, comminution (crushing and grinding), performed by ASM operators, is achieved with low-cost equipment such as the hammer mills and disc mills as shown in Figure 20. However, it is not uncommon to see ASM operators crushing rocks manually with a hammer, especially when the sizes are too big to be fed directly into a hammer mill. At more advanced ASM sites, miners have invested in a jaw crusher, which crushers the ore to create a stockpile for further size reduction.


*Fig. 20. Hammer mill and disc mill at Takote Mine in Western Ghana.*

Studies conducted shows that the hammer mill grinds material to a size of 80% passing 1 millimetre whereas the disc mill grinds material to a size of 80% passing 0.425 millimetre. However, in several parts of Ghana gold particles may not be liberated by ASM operators given the weight percentages and sizes of gold particles in ores available, as shown in Figure 21.

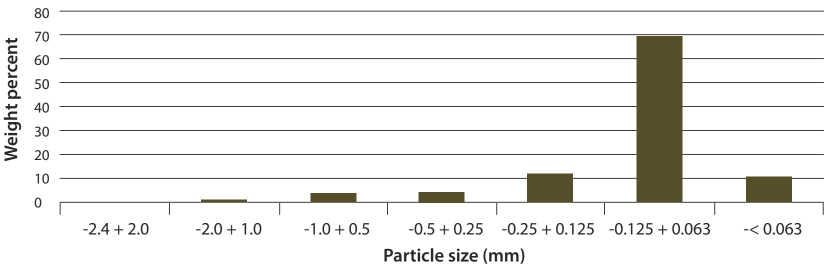



*Fig. 21. Weight Percentages and Particle Sizes of Ores at ASM Centres, Ghana.*

Since gold is malleable, each comminution equipment generates different shapes of gold after grinding, as shown in Figure 22. The shape of a gold particle also influences gravity concentration, since the drag force on a particle prevents it from settling easy, as shown in Figure 23. Hence, all other parameters being equal, particles generated by the hammer mill will settle faster and be more concentrated than those of the disc, ball and stamp mills.

Source: Styles et. al., 2010

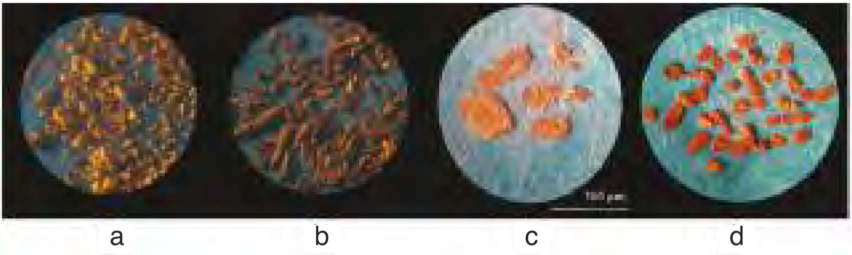
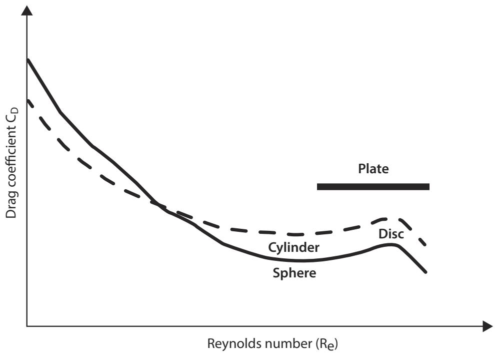



*Fig. 22. Gold Particle Shapes By Various Comminution Equipment.*

*Notes: a) Hammer Mill; b) Disc Mill; c) Stamp Mill; and d) Ball Mill.*

## Concentration Process




Source: Styles et. al., 2010/Henrik Klinge Pedersen, GEUS.

*Fig. 23. Influence of Particle Shape on Drag Coefficient and Settling Velocity.*

Concentration processes exploit differences in physical properties between the mineral of interest and the associated gangue minerals. Some of these include differences in specific gravity, optical properties, magnetic susceptibility and surface energy. A gravity concentration is used by ASM operators to separate mineral particles in which a marked difference in density exists. Separation is brought about by the relative movement of the particles in response to gravity and fluid resistance forces. Since the effect of fluid resistance forces is influenced by size and shape, it is important to present a closely sized feed to gravity separation units. Different kinds of separators are in use. These include jigs, shaking tables, gold pans, sluices, spirals, cones and centrifugal concentrators. Some are used for roughing operations while others are for cleaning purposes. Mostly, concentrators, such as sluice boards, gold pans and centrifugal concentrators, are used by small scale-miners.

### *Sluice Board*

The sluice board is a gravity concentration device employed by the majority of ASM operators. It is a long shallow box with a roughened bottom, as shown in Figure 24. The board may be made of hard wood, split bamboo and iron or aluminium sheets. The bottom may be roughened with strips of wood, corduroy, jute sacks or other synthetic mats. The obstructions are placed at right angles to the major axis of the unit. When in use, it is inclined to the horizontal at an angle of about 10 degrees. It is most effective when the mineral of interest is free, finely divided and has a concentration criterion of at least 3.5. Feed to the unit may be pulped before introduction or the dry material may be placed at the head (a section at the top of the incline without riffles) and washed with a stream of water. As the feed advances, the dense particles settle behind the riffles while the light ones crawl over. As feeding continues, the concentrate progresses towards the discharge end but terminated when it is realised that further addition of feed would cause the mineral of interest to report in the tailings. The concentrate on the mat used is washed into a receiver and the cycle is then repeated.

*Source: John Tychsen, GEUS.*

*Fig. 24. Sluicing at Artisanal Mining Site North of Tarkwa, Western Ghana.*

Source: Peter Appel, GEUS.

*Fig. 25. Goldpanning starting by washing the cloth from the sluicing followed by panning.*

## *Panning*

Panning is essentially a secondary concentration or cleaning operation in which sands and/or gravel are swirled with water in a shallow conical dish or pan, as shown in Figure 25. The dense particles stratify in the bottom while the lighter ones, being more buoyant, remain partly in suspension and can be decanted with water from time to time. Panning is most successful when small heavy grains are being separated from relatively coarse gangue.

Source: Richard Amankwah, UMaT

*Fig. 26. Example of a Seperating Bowl of a Centrifugal Concentrator.*

## *Centrifugal Concentrators*

All centrifugal concentrators, such as the Knelson, Icon, Knudson, and Falcon centrifuge, respectively, operate on the same principle. The centrifuges are all dynamic concentrators with a radial acceleration force in the order of 60 times accelera tion due to gravity. The slurry is introduced through a pipe at the bottom of the unit and forced up the annular, slightly conical rotating receptacle by centrifugal force, as shown in Figure 26. A counter flow of backpressure water is pressed into the annular spaces to keep the bed of heavy particles fluidised. While heavy particles are forced out against the walls and are trapped between the ribs, the lighter particles are carried by the flow of water into successive annular spaces and eventually out over the rim. For good separation, it is necessary that the mineral of interest be fully liberated in the slurried feed of pulp density around 30% solids. Very clayey material usually requires pre-treatment prior to centrifugal sorting.

## Winnowing

In the Northern part of Ghana, where water is not readily available and the wind speeds are strong enough, winnowing is employed to effect separation. The winnowing process is generally applied to eluvial ores. Generally, the ore is spread on the ground and dried. Sticks are then used to beat the material in order to disintegrate them into fines, while at the same time stones, pebbles and other larger materials are removed. The fines are then put into a bowl and swirled to allow the heavy materials to settle at the bottom of the bowl and the top lighter materials to be discarded by the swirling. A tray is then placed on the ground and the material is allowed to fall from the bowl at a height. This is done when the wind is blowing so that lighter materials are hurled away and the heavy ones are caught in the tray below. This is repeated and then the concentrate is sorted for gold with some small amount of water.

## Recovery Process

### *Amalgamation*

Amalgamation is a process in which metallic gold (or other precious metals), which may be part of a pulp, is incorporated into mercury. ASM operators have used amalgamation as a gold extraction technique for thousands of years. Amalgamation is efficient when the precious mineral particles are the only metallic substances and the particle surfaces are clean.

The amalgamation process is a very easy and inexpensive gold extraction technique used by ASM operators. Figure 27 shows how ASM operators use the amalgamation extraction technique to recover gold. In the simplest form, mercury is added to the mineral (gold) concentrate obtained from the gravity concentrator. The mercury is mixed thoroughly by hand with the concentrate to form a metal-laden mercury (amalgam), which is separated from the pulp. The separated amalgam is filtered and excess mercury squeezed into a piece of cloth. The amalgam obtained is then placed in a can and heated. The mercury evaporates and leaves the gold behind. Sometimes not all the mercury evaporates, giving a pale yellow gold colour.

However, the amalgamation method has some serious drawbacks and negative implications given that mercury is a highly toxic substance to humans and other living organisms.


*Figure 27. Flowchart. Gold extraction using mercury. Amalgamation Process.*

Fortunately, control measures and methods to reduce/stop mercury usage by ASM operators do exist. Examples of such methods are the use of the retort, a simple device designed to distil mercury and direct smelting.

ASM operators can avoid direct contact with mercury by pouring their mining concentrates into plastic bottles with the aid of a funnel and shaking the bottle for up to 5 minutes after adding mercury. Aftwerwards, the operator can then pour the contents of the bottle back into the gold pan and separate the amalgam formed from the black sands, as shown in Figure 28.

*Source: Richard Amankwah, UMaT*

*Figure 28. Safer alternative to separate Amalgam from black sands.*

## *Retorting*

The retort technique helps to reduce mercury loss and prevent mercury vapour pollution of the surrounding environment. Samples of retorting devices are presented in Figure 29. Retorting involves heating the amalgam above the vapourization temperature of mercury. It is carried out at about 800°C to produce what is generally referred to as "sponge gold". For the retorting method, the amalgam is placed in the retorting device and heated on a burner with the other end of the tube placed in a bowl of water. After 15-20 minutes of heating, the retort is removed and allowed to cool slowly. Afterwards, the retorting device is opened and the gold removed.

Figure 29 A. Two retorts made of a few pieces of plumbing tubes. The scale is 10 cm.

Figure 29 B. The amalgam is placed in the cup of the retort on some ash to get the cup airtight.

Figure 29 C. The retort with amalgam in the cup is heated in a charcoal burner.

Figure 29 D. Most of the mercury has evaporated and the gold is left behind.

Sources: Peter Appel, GEUS.



Source: John Tychsen, GEUS.

*Figure 30. The retorting is carried out at some distance from the mining site due to the danger of mercury vapor.*

## *Direct Smelting*

To date the conventional technique for recovering gold from black sand in ASM operations is amalgation. However, as explained above, although this method is quick and easy to operate, it has severe environmental and health hazards that make this process undesirable.

An alternative to amalgation, and also retorting, is the direct smelting of the gold bearing black sand. This method is quicker and cheaper than the two other methods plus clean smelted gold is obtained in a one-step process.

A charge, comprising gravity concentrate and fluxes (borax and soda ash), is prepared. The ratio of the weights is 1 part black sand, 0.5 part borax and 0.5 part soda ash, 1:0.5:0.5. The charge is mixed thoroughly in a bowl with a spoon and afterwards poured into a crucible. The crucible is then heated in a furnace, a sika bukyia. After 30-40 minutes of heating, the molten charge is poured into a metal mould and allowed to cool for about 10-15 minutes to solidify. After cooling, the content of the mould is discharged onto a metal slab. The cooling of the molten charge leads to the formation of a cone glass with gold bead at the bottom of the cone glass. The cone glass is tapped with a hammer to separate the gold bead from the glass. The gold produced is clean, bright and ready to sell.

## Diamonds Mining Minerals Process

### *Diamond Winning*

Diamond winners, i.e. ASM operators, locate diamonds by washing gravel to remove clay and coarse gravel. In Ghana diamonds are usually of a size below 8 millimetres, but since diamonds below 1 millimetre are of no commercial value, ASM operators wash and screen gravel for particles between 8 millimetres and 1 millimetre and then sort these by hand to detect diamonds

## Salt Mining Minerals Process

In Ghana, common salt is mined from seawater, i.e. Atlantic Ocean, using either one of three available techniques, namely: traditional, stoved or three-stage crystallisation.

### *Traditional Technique*

The traditional technique, also known as the Ada technique, entails winning salt by using saltpans, which involves digging trenches and pits and then allowing brine to seep into them. As the brine evaporates, by means of solar energy, the salt crystallises whereafter it is scraped or harvested by ASM operators. This traditional technique usually produces large crystals of salt with low purity. The sodium chloride content of the salt may be about 60% and it may be slightly bitter since it contains bitterns. Bitterns are brine enriched with sulphates, magnesium and potassium, which have a bitter taste.

### *Stoved Technqiue*

The stoved technique involves collecting and storing seawater in pans until evaporation is complete, i.e. dry. Leftover brine is then heated by means of steam pipes or directly with oil burners or firewood. This stoved technique produces fine-grained salt.

### *Three-Stage Crystallization Technique*

To increase the purity of salt, the three-stage crystallization technique is used. Using this technique, seawater is pumped into pre-evaporation ponds where solids and organic matter are allowed to settle. As the brine evaporates, calcium carbonate ($CaCO_3$) crystallises and settles. Upon reaching 6% NaC1, the brine is fed into evaporation ponds where the concentration is increased to 25% NaC1. The 25% brine then flows into crystallisation pans whereafter the salt is harvested and washed with seawater. With time the pans are drained

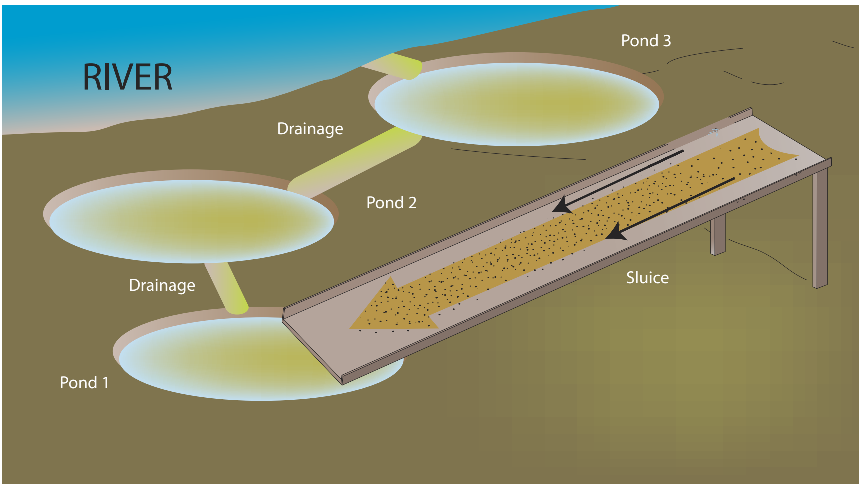
Source: John Tychsen, GEUS.

and the brine pumped back into the sea. The salt harvested may be air dried or heated and marketed. It may be sieved into various size fractions, if necessary, or milled to produce table salt.

## Waste Disposal and Management in ASM Operations

The majority of ASM operators dispose off their waste but they may not necessarily manage how it is actually disposed. In most cases, waste rocks may be stockpiled on sections of the work area making housekeeping difficult. ASM operators who deal with hard rock may sell their waste to large-scale mining companies, which then leach the fine gold from the tailings. One of the worst practices is the direct discharge of tailings from sluice boards/trommels and mercury polluted effluents into rivers and streams.

These practices have resulted in disturbed landscapes and high-suspended solids in several rivers and streams in Ghana. One way by which ASM operators can handle the discharge of tailings from trommels and sluices is the use of a 3-pond purification system, as shown in Figure 31. Using this technique, ASM operators create 3 ponds, the size of which will depend on the scale of the operation. Fresh water from a river, stream or borehole is pumped into the third pond used for processing the ore. The discharge end of the sluice or trommel is directed to the first pond used for collecting tailings material. Solids settle and water overflows with time into the second pond where finer particles settle and water with a lower load of suspended solids overflows into the third pond for re-use. Using this 3-pond purification system, ASM operators will be able to undertake mining work without directly polluting surface water bodies.




Source: Richard Amankwah, Henrik Klinge Pedersen.

*Figure 31. Principles for 3-Pond Water Purification System for ASM Operations.*

*The cleaned water from the pond is disbursed into the nearby river.*


*Proper information for the workers at the mining site is important. Takote Mining Site, outside Tarkwa in Western Ghana.*

Source: John Tychsen, GEUS.

# HEALTH AND SAFETY ISSUES IN ASM IN GHANA

*By Julius Fobil, University of Ghana*

## Introduction

ASM is growing in many regions of the world, including Ghana. ASM in Ghana is largely undertaken at an informal level, which is unregulated and characterised by application of outdated methods often with adverse consequences on human health and the environment; notably in communities within which the mining activities take place.

ASM is one of the most significant sources of mercury releases into the environment in the developing world, with at least a quarter of the world's total gold supply, for example, coming from such sources. Artisanal miners combine mercury with gold-laden silt to form a hardened amalgam that has picked up most of the gold metal from the silt. The amalgam is later heated with blowtorches or over an open flame to vaporise the mercury, thereby leaving behind small gold pieces. The gaseous mercury is inhaled by the miners and often also by their immediate family members, including their children. Mercury that is not inhaled during the burning process settles into the surrounding environment or circulates globally for future deposition far from the site of processing activity, where it is absorbed and assimilated by a variety of living organisms. This transforms elemental mercury into methylmercury, which is one of the most dangerous neurotoxins that contaminate the food chain through bioaccumulation.

## Environmental Pollution

Key pollutants in the water systems are typically pathogens arising from human waste (bacteria and viruses), heavy metals and organic chemicals from industrial waste. Ingestion of pathogens through drinking contaminated water or with food prepared using contaminated water is the most common pathway. Eating fish from contaminated waters can be risky, since they can absorb and concentrate both pathogens and toxics such as heavy metals and persistent organics. In addition, human health may be affected by crops that take up pollutants from contaminated water used for irrigation or from land flooded by polluted rivers. Toxic contaminants in fish or other food products are less likely to cause acute poisoning but can have serious long-term negative effects, depending on the pollutants and the doses. Understandably, fishing communities along rivers are particularly at risk since they have a steady diet of the local fish over many years. Municipal sources of groundwater contamination include open dumpsites, poorly constructed or maintained landfills, latrines and other waste sites. Each of these can contain a range of pathogens and toxins, including heavy metals that can migrate downward and contaminate aquifers. Industrial pollution of groundwater can come from dumping of wastewater or waste, from mining activities and from leakage or spillage from other industrial processes. Mining primarily affects groundwater through leaching of mine tailing piles.

## Health Effects

The two primary inhalational exposures of concern with regard to ASM activities are crystalline silica expected to be present in gold ore and smoke from biomass fuels used in cooking. Here, measurements of pulmonary function and of respiratory symptoms were performed for comparision in an ASM community, Kejetia, and an agricultural community, Gorogo, in the Upper East Region of Ghana in May-July 2011. Of 172 participants, 159 performed spirometry, yielding 119 and 95 valid measurements for FEV1 and FVC, respectively. Percentages measured for FEV1, FVC and FEV1/FVC were not significantly different between Kejetia and Gorogo. Abnormal lung function, measured by FEV1 (15.0%) and FEV1/FVC (22.0%), were above that of a healthy population, i.e. 5%. Even though this first examination of pulmonary function in an ASM community in Ghana (and possibly worldwide) did not show an obvious relationship between mining involvement and lung function abnormality, it did show links between the use of biomass fuels, adverse respiratory symptoms, and reduced pulmonary function in both populations. A number of factors including age differences between the populations and the required lag time after silica exposure from the onset of respiratory disease may have affected results. Additional research is needed with larger sample sizes and with more detailed questionnaires to further assess the impact of multiple stressors on respiratory health in ASM communities. Children that are exposed to mercury are particularly at risk for developmental problems. Exposure to mercury can cause kidney problems, arthritis, memory loss, miscarriages, psychotic reactions, respiratory failure, neurological damage and even death.

## Scale and Impact of ASM Activities in Ghana

ASM activities do not only pollute rivers and other water bodies but also create physical hazards for miners and non-miners. These activities, commonly referred to as 'galamsey', are mostly conducted in the major river basins in Ghana; especially, in the East Akyem District, where the Birim, Densu and Ayensu rivers serve as sources of water for communities in these catchment areas. In these areas, it is not uncommon to hear of reports on the destruction of natural resources, such as pollution of water bodies, e.g. in 2005, several media outlets reported on galamsey activities polluting the rivers. Irrespective of the negative effects of illegal mining on rivers and other water bodies, many communities in the rural areas still use and depend on these polluted rivers for domestic water sources due to lack of alternative sources of drinking water. The residents of the communities where the galamsey activities take place also rely on water from the rivers for all household chores, including drinking, cooking, bathing and all other domestic water uses despite the fact the there is a high risk of contracting water related, water-based and/or water-borne diseases such as cholera, dysentery, and gastroenteritis, among other.

Moreover, the pollution of rivers by the ASM activities also has implications for water treatment for domestic use in the formal and public sector. For instance, there are reports that the Ghana Water Company, in its mandate to provide safe drinking water to Ghanaians, incurs extra treatment costs in treating water collected from the polluted rivers compared to relatively unpolluted rivers that do not run through areas where galamsey or ASM activities take place in the country. Only a few years ago, the Ghana Water Company had to shut down a water treatment plant due to the fact that the volume of chemicals required for treating polluted water had to be increased, meaning that the company was essentially running at a loss. The company also had to shut down its water treatment plant at Kyebi for one-and-half years due to the pollution of the Birim River. There has been growing public concerns about the activities of galamsey or ASM in the country; notably in the last ten years, with the influx and emergence of Chinese immigrants who have taken over the ASM industry. On account of the adverse impacts of galamsey activities on the sustainability and long-term social security of the communities, leaders and other stakeholders representing the Government, NGOs, environmentalists and traditional authorities are now raising concerns and calling for action to tackle the challenges associated with galamsey or ASM in the country. Having now fully understood the adverse effects that the 'galamsey' menace poses to the sustainability of livelihoods in communities affected by these illegal mining activities, NGOs and community leaders are taking actions to stop the illegal galamsey or ASM activities. In 2014, for example, the Project Officer for Friends of the Nation; a local community-based NGO, appealed to communities living along the Bonsa River in the Tarkwa Nsueam Municipality in the Western Region to fight against illegal mining operations in the Bonsa River. Following intense public pressure on the Central Government, a Deputy Chief of Staff also called for stakeholder efforts in April 2017 to end illegal mining, which has had a devastating impact on potable water supply in the country.

ASM activities seem to be out of control; especially at a time when the country is at a crossroad with regard to its economic development, i.e. Ghana has managed to join the league of middle-income countries. At the present rate of destruction of the country's natural resources, ASM is certainly not a sustainable resources exploitation industry; hence it needs to be addressed at the highest national level with all the political will and commitment it deserves. This is particularly important if the country is to achieve some of the 17 goals outlined in the UN's Sustainable Development Goals (SDGs) to be achieved by 2030. For example, goals 6, 11 and 13, which focus on clean water and sanitation, sustainable cities and communities, and climate action respectively may not be achieved by 2030 if the unrestrained destruction of the environment is allowed to continue through the activities of ASM operations.

Despite the obvious adverse consequence of ASM (galamsey) activities on the environment and human health, the industry continues to grow due to several factors, such as the country's failed land tenure system, among other. Furthermore, to date mining has been poorly regulated. While the Government controls mineral production through institutions, such as the Minerals Commssion, regulatory bodies, such Ghana's EPA, which enforces strict environmental regulations for mining operations, does so independently. As a result, not only are there gaps in enforcement and policing of mining activities, the allied institutions are often engaged in conflicts over resources and operational budgets at the peril of the tasks to be undertaken. Moreover, the management of concessions and concessionary rights is often complicated by chieftency institutions, which exist as competing authorities at the local level. This introduces tension between the central governmental authorities on the one hand and the traditional on the other hand; the consequence of which is the festering of bribery and corrupt practices. On account of this, the environmental restoration fund, set aside to address the adverse effects of the destructive mining practices, is often mismanaged by officials of both central government and local authorities. Some of the methods used in the ASM activities are so environmentally destructive that prices of minerals cannot offset the full environmental costs. Today's low mineral prices reflect only the immediate economics of extraction and distribution and woefully fail to capture the full environmental and social costs of eroded land, pollution of both surface and underground water resources and displacement of people. Virgin area lands are destroyed by ASM activities at a great cost to agriculture and food protection to the detriment of future generations.

The level and scale of impacts of ASM activities are multiple and extensive, affecting practically every aspect of human welfare both directly and indirectly. At the economic level, ASM activities destroy natural resources and ecosystem/environmental services, thereby leading to pervasive and systemic poverty in ASM communities. Indirectly, the ASM activities lead to child-destitution and delinquency at school. Children of school-going age drop out from school to engage in these activities for short-term economic benefits. As a result, academically promising children, who would otherwise grow up to become scholars of the future of this country, give up school to pursue ASM activities.

For the children, this is an opportunity to make their own money in order to become financially independent without having to take money from their parents. In many cases, these children are income earners providing for household incomes. The main motivation for children to engage in ASM activities is monetary reward at the expense of education and overall development. In communities where ASM activities occur, absenteeism, low enrolment and school dropout are some of the major development obstacles facing the local school authorities, ref. Figure 32. Most of the young people in such communities do not value the significance of education and therefore opt for ASM activities at the expense of their education. Additionally, the availability of money among male children, coupled with high poverty among female children in ASM communities, serves as an incentive for child-prostitution. A report by the Daily Guide on May 4, 2015, under the headline "Pupils Abandon School for Galamsey", supports this reality and lists ASM as the biggest obstacle to education in the ASM communities. Many educational evaluation reports indicate that schools in ASM communities suffer from low enrolment, low teacher acceptance of postings to schools in these areas, general aparthy and low morale among teachers, and poor performance in general school certificate examinantions. Despite the often high risk of injuries and fatalities associated with the ASM activities, economic considerations remain the main motivation for children to abandon school for ASM activities. Other indirect impacts of ASM activities on the communities include increased frequency of crimes and criminal activities, moral decadence as a consequence of the intrusion of alien cultures and cultural practices which clash with indigenous cultures.


Source: John Tychsen, GEUS.

*Figure 32. Children Undertaking ASM Activities.*

Although ASM activities impact on several aspects of human wellbeing, the specific impacts on the environment, human health and safety are most pronounced. Most notably, the methods used in these activities have devastating impacts on the natural environment, particularly soil and water. Where it is undertaken, ASM activities destroy vast acreages of land; causing widespread soil erosion and land degradation. Much of the process of extraction of minerals involves the use of mercury to remove gold from the crusts and rocks, resulting in mercury being released into the natural environment, as shown in Figure 33. For this reason, ASM/galamsey activities are characterised by extensive and widespread environmental contamination by mercury. The global burden of mercury is already enormous and continues to increase steadily at a rate corresponding to its use in gold mining activities. Mercury is preferred for use in gold mining because it offers several benefits in gold processing due to the following qualities:

- easy to use, and it works quickly;
- can be used by one person independently;
- effectively extracts gold in most field conditions;
- cheaper than most alternative techniques;
- facilitates precise transactions; and
- permits custom processing of small individual ore batches.

Source: John Tychsen, GEUS.

*Figure 33. Water Contamination.*

Often miners are not aware of the risks involved in using mercury, and/or they may not have a choice in the matter because there are no known or cheaper alternatives. Those miners who are aware often cannot afford or do not have access to safer alternatives. Mercury is therefore a persistent health and safety problem in the ASM industry. More mercury is used for ASM—an estimated 1,400 metric tons in 2011—than for any other use of the metal. The ASM industry contributes an estimated annual average of 1,000 metric tons of inorganic mercury, about one-third of which is thought to go into the air while the rest winds up in piles of mining waste ("tailings"), soils, and waterways. Some of the inorganic mercury, which reaches aquatic ecosystems, also gets converted by microbes into organic methylmercury, which then accumulates in fish. Indeed, mercury from ASM operations travels beyond the job site, exposing not only miners but also their families to elemental mercury that spreads through the air and soil in mining communities. In addition, mining pollution in aquatic ecosystems can expose downstream communities to methylmercury through their diet. Both the inorganic and organic forms can cause neurological problems. However, methylmercury, which passes more easily into the brain, is generally considered the more toxic species, particularly among children, who can experience IQ losses, delayed speech, and other neurodevelopmental deficits from exposure. Early-life exposures are the most harmful because they can damage the whole brain. Exposures later in life, on the other hand, produce more localised damage to the cerebellum, visual cortex, and motor strip. In adults, these exposures can lead to visuospatial problems and effects on executive functioning, memory, and mood. Some 10–15 million people in 70 countries work in the ASM trade.

## Accidents

Mining work is both lucrative and hazardous and for that reason the frequency of accidents is very high in mine working environments. Mine accidents range from minor tool crushes through collapse of walls to a total caving of mine tunnels, which often leads to fatal trapping of mine workers underground. Deaths due to mine accidents far exceed deaths due to global abortion and HIV infections combined. In countries where ASM is practised, the frequency of mine accidents is so high that national authorities worry about their continued operations and start to take steps to outlaw the activity. In Ghana, the spate of mine accidents has increased considerably with the growth of the activity as a business, as articulated by the following news highlights:

- *"A recent mining accident that killed 16 people at an unlicensed artisanal gold mine in Ghana underscores the need for tougher measures to end child labour and protect the safety of adult artisanal miners"; and*
- *"On April 15, at around 6:45 a.m., a mud wall collapsed in a large open pit at a gold mine where over 20 people were working near Kyekyewere, Upper Denkyira East District, and Central Ghana. A few of the miners were pulled from the mud with injuries, but 16 died. Among the victims was a 17-year-old boy named Abroso Kwabena Donkor, an orphan who had dropped out of school at 15 to work in the mines."*

In all low- and middle-income countries, such news reports are commonplace and yet, this does not stop people from getting involved in this activity.

## Injuries

ASM is inherently risky, but little is known about mining-associated hazards and injuries despite the tremendous growth worldwide of ASM and the benefits it offers. To fill this gap, a study with an aim to characterise the physical injuries associated with ASM in Ghana was conducted to guide policy formulation. A cross-sectional survey was carried out in the Tarkwa mining district of the Western Region of Ghana in 2014. A total of 404 small-scale miners were recruited and interviewed regarding their occupational injury experiences over the preceding 10 years using a paper-based structured questionnaire. Nearly one-quarter (23.5%) of the miners interviewed reported getting injured during the previous 10 years, and the overall injury rate was calculated to be 5.39 per 100 person-years. The rate was significantly higher for women (11.93 per 100 person-years) and those with little mining experience (e.g., 25.31 per 100 person-years for those with less than one year of work experience). The most injury-prone mining activities were excavation (58.7%) and crushing (23.1%), and over 70% of the injuries were reported to be due to miners being hit by an object. The majority of the injuries (57%) were lacerations, and nearly 70% of the injuries were to the upper or lower limbs. Approximately one-third (34.7%) of the injuries resulted in miners missing more than two weeks of work. One-quarter of the injured workers believed that abnormal work pressure played a role in their injuries, and nearly two-fifths believed that their injuries could have been prevented, with many citing personal protective equipment as a solution. About one-quarter of the employees reported that their employers never seemed to be interested in the welfare or safety of their employees. These findings greatly advance our understanding of occupational hazards and injuries amongst ASM workers and help identify several intervention points. Artisanal and small-scale gold miners are confronted with numerous hazards often resulting in varying degrees of injuries and fatalities. In Ghana, like many developing countries, there is paucity of information on the causes and nature of the accidents that result in the injuries. Fractures and contusions constituted the most frequently occurring injuries, with collapse of the mine pits and falls being the most frequent cause of accidents reported both by the hospital and media records.

*Source: John Tychsen, GEUS.*

*The cloth for the sluicing is washed to release the separate material containing gold-, at an ASM mining site, north of Tarkwa.*

*Marks from the excavator, at a mining site, Central Ghana.*

Source: John Tychsen, GEUS.

# ENVIRONMENTAL ISSUES IN ASM IN GHANA

*By Frank K. Nyame, University of Ghana*

## ASM and the Environment in Ghana

Environmental issues in the ASM sector in Ghana are closely related to the minerals commonly exploited by artisanal miners, such as gold and diamonds, which occur in three main rock types, i.e. igneous, metamorphic and sedimentary rocks, or materials derived from any one and/or a combination of these three rock types. Because these rocks, or materials, often differ in how and where they were formed as well as the elements or substances they are composed of, the type and composition of the material, in which the mineral of interest occurs largely determine the impacts, or potential impacts on the environment when these minerals are mined or exploited (Plumlee, 1999).

In general, the relationship between ASM activities and the environment in Ghana can be broadly described, among others, in terms of the following parameters;

- Nature of ASM activity, i.e. formal (legal) and informal (illegal or galamsey) mining;
- Type of mining that is undertaken, i.e. surface mining or sub-surface/deep mining;
- Geological features of the mineral or material mined, e.g. gold, diamond, sand, quarry stone, limestone, clay, and how it occurs in the host environment;
- Type of ore material, i.e. alluvial or hard rock, primary/unaltered or secondary/altered or oxidized;
- Stage of mining, i.e. exploration, extraction, processing, marketing, closure;
- Location or area where mining takes place, e.g. forest/tropical, savanna, near settlements such as towns and villages, in and around stream or river channels and valleys;
- Number of people involved, i.e. few individuals, groups of people or hundreds or thousands of people;
- Scale or spatial extent of activity, i.e mining confined to a small or large area;
- Duration or period of active mining, e.g. less than 6 months or more than 2 years;
- History of mining activity in an area, i.e. active versus abandoned mine;
- Method(s) of mining, i.e. extraction or removal of ore material from where it is located;
- Processing method(s) used;
- Prevailing rules or regulations governing mining activity, i.e. legal/governance regime; and
- Knowledge and awareness of miners and mining communities on environmental issues.

### *Nature of ASM and Environmental Impacts*

In Ghana, the nature of an ASM activity greatly influences observed impacts on the environment. Formal or legal ASM operators are required to obtain permits from mine-regulatory institutions such as the Minerals Commission and the EPA before they can commence mining activities. The mining activities, including the mineral or material extracted, where and how to mine, processing methods and plans to restore affected areas, are subject to monitoring and evaluation by relevant regulatory bodies. Because of this, legal and licensed ASM operators often adhere to environmental regulations since non-compliance with these could lead to cancellation of an ASM operator's license to mine. On the contrary, informal and illegal (galamsey) ASM operators do not obtain required licenses from institutions that regulate mining but proceed to mine in various areas, especially when they are assured of "reasonable economic presence" of the mineral in a given area. Because the mine sites or places where they work are usually not known beforehand by regulatory authorities, such as the Minerals Commission and the EPA, the activities of illegal ASM operators become very difficult to monitor. As a result, many illegal ASM operators are often either unaware of the environmental implications of their activities or have complete disregard for environmental issues, as shown in Figure 34.

Source: Frank Nyame, University of Ghana, 2017

*Figure 34. Illegal ASM Operations.*

*Note: Illegal miners processing ore material in stream (a) or near stream (b) channels. In spite of the turbid (dirty) nature of the water, miners often operate in such places for many hours making them vulnerable to infection by water borne disease-causing bacteria.*

## *Environmental Impacts and Type of Mining*

Surface mining involves extraction of ore bearing materials at or close to the surface of the earth; whereas sub-surface/deep mining concerns excavation of ore minerals usually at variable depths below the earth's surface. In Ghana, ASM operators who undertake surface, mainly alluvial mining of gold and diamonds, generally impact on a greater surface area of land than those that operate deep mining, as shown in Figure 35.

## *Geology and Type of Ore Mined*

The geological features of the mineral or material mined, e.g. gold, diamond, sand, quarry stone, limestone, or clay, and how it occurs in the host environment also have an effect on environmental impacts when the mineral/material is mined. For example, ASM operators who work alluvial gold or oxidized (lateritic) deposits easily extract gold and leave behind waste rock composed essentially of gravel-sized inert (unreactive) waste material. However, ASM operators who extract primary gold bearing rocks present in un-weathered hard rock first have to mill (or pulverize) the material in order to chemically separate gold from the

Source: Frank Nyame, University of Ghana, 2017

*Figure 35. Surface Vs. Sub-surface Mining And Impacts On Land Areas.*

*Note: Alluvial mining (a) generally impacts on large tracts of land compared to hard rock, sub-surface mining (b).*

waste. The waste material left behind is prone to further breakdown and release of potentially toxic heavy minerals or elements into the surrounding environment.

## *Stage of Mining*

The various stages in the mining process tend to influence the impacts that occur (or potentially occur) in the surrounding environment. Of all the stages involved in any mining process (i.e. exploration or search for the useful material or mineral; extraction or removal of the material from where it is located; processing or separation of the useful material or mineral from unwanted material; marketing or sale of the separated mineral; and closure where mining at a particular location comes to an end for whatever reason), the most significant stages, in terms of impact on the environment, are: extraction, processing and closure. At each of these stages, ASM operators, particularly illegal ones, excavate pits to various depths over large areas, separate and leave piles of waste material of various sizes, or release huge volumes of turbid waste water which either immediately or subsequently and directly or indirectly pollute or contaminate the surrounding environment. Because ASM operators often abandon mined-out sites without reclamation, the landscapes are dotted with uncovered pits, trenches and heaps of waste material that pose serious risks to the health of the environment, particularly the health of animals and humans.

## *Location of Mine*

The location or area where mining takes place may also determine the impacts on the surrounding environment. In the tropical forest belt of southwestern Ghana, ASM activities destroy far more forest cover or vegetation than ASM activities in the northern savanna region. Again, more ASM activities or sites occur in the southern and southwestern tropical to sub-tropical areas than the northern savanna region. Because of the high annual precipitation, heavily forested and high organic productivity, the rate of weathering, or breakdown of materials, is high compared to the semi-arid north. Again, ASM activities that take place near towns and villages are more likely to affect these settlements with physical and chemical pollution than those that are done far from human settlements. Furthermore, alluvial mining, in and around stream channels and valleys, tends to pollute stream water more than hard rock mining that is done on higher ground.

### *Number of People Involved in Mining, Spatial Extent and Duration of Mining*

An ASM site with tens or hundreds of people working at the same time may show far more impact on the surrounding environment than a site that has few individuals or groups of people. Also, the scale or spatial extent covered by mining may determine the overall impact on the environment. For example, alluvial mining of gold and diamonds tends to affect a wider area compared to hard rock mining, which is usually confined to a small area.

### *Duration and History of Mining in an Area*

The period during which mining is actively done influences the impacts of ASM activities on the surrounding environment. For example, an alluvial mine that operates in an area for two years may affect a greater portion of the surroundings than one that takes place for about six months, assuming that the levels of operations are similar. Also, a hard rock artisanal pit done for two years may have a greater volume of waste rock and tailings compared to one that only operates for a month. Some chemical species and components in, for example, mine waste materials take a very long time to break down and to release their constituent elements. For example, whereas some ASM waste abandoned for nearly a century may react with water and air to produce acid drainage, which can be observed here and now, the same waste from an active ASM site may not show any acid drainage at all.

### *Method(s) of Mining (Extraction)*

Methods used in ASM greatly influence the environmental impacts. Usually, huge open pit mines or excavations expose greater volumes of fresh rocks to water and oxygen, which therefore enhance the breakdown of rocks and materials. A narrow, below the surface or deep mine restricts contact of fresh rocks with water and air thereby limiting the natural breakdown of rocks and release of elements into the surrounding environment.

### *Processing Method(s) Used*

Processing of ore materials leads to separation of the useful or valuable mineral or substance from unwanted material or waste, as shown in Figure 36. In general, minerals occur in small amounts compared to waste or gangue material in any given rock in any given area (Plumlee, 1999). Hence in order to take out useful minerals from the host material, far more waste products are generated, which ends up in the surrounding environment. Again, because processed waste material has smaller size fractions and greater surface area compared to unprocessed ore, more waste per volume is produced after processing of gold or diamond bearing rocks. Furthermore, waste material that results from processing of ore can be in solid, liquid or gaseous forms, all of which have the potential to impact negatively on the surrounding environment.

Sources: Frank Nyame, University of Ghana

*Figure 36. Examples of Typical ASM Processing Sites, Ghana.*

*Note: During ore processing, large amounts of solid, liquid and gaseous waste may be generated, which can affect the surrounding environment in various ways.*

## *Mining Regulations and Institutions in Charge of Mining*

Environmental impacts may also be influenced by the regulations governing mining activity in a given country. Where the laws are easily understandable and take into consideration the interests of important stakeholders, miners are more likely to comply with them. However, when the rules and regulations, governing ASM actitivies, are viewed by ASM operators as unsatisfactory, they may not adhere to them. In Ghana, the EPA is mandated to issue permits or licenses to legal and formal ASM operators before they undertake mining activities. Informal and illegal ASM operators, however, ignore such requirements and work in various areas of the country without official recognition or documentation. Monitoring of illegal mining activities by environmental agencies is therefore a difficult or impossible task to undertake. Legal ASM operators also complain about bureaucracy and lengthy period of mineral licence acquisition, which serves as a disincentive for environmental compliance and discourages people from obtaining permits and be regulated. Again, regulatory bodies, such as the EPA, are either not well known in local mining communities or under-resourced to undertake periodic monitoring of ASM activities in their assigned districts.

## *Knowledge and Awareness of Miners on Environmental Issues*

Knowledge and awareness of miners and mining communities of environmental issues are crucial in the efforts to minimise negative impacts that result from ASM activities. In many areas in Ghana, however, miners or mining communities have limited knowledge of both short- and long-term negative impacts of artisanal gold and diamond mining on either the health of people, whether directly or indirectly, or the environment. Miners therefore undertake mining activities without much information on the negative impacts that their activities could have on themselves and the environment in general.

## Specific Impacts of ASM Activities on the Environment in Ghana

In Ghana, impacts of ASM activities on the environment vary from insignificant to significant and affect land resources, water resources, air quality and human health, among others.

Source: Frank Nyame, University of Ghana, 2017

*Figure 37. Deforestation of Land to Make Room for ASM Activities.*

*Note: Large tract of land stripped of vegetation to make way for artisanal gold mining. Note lush-green forest cover in the adjacent or un-mined area.*

### *Land Resources*

In many areas where ASM activities take place, large tracts of land, including forest reserves are often stripped of vegetation cover in order to get access to ore material that is mined on the surface or even in sub-surface or deep mining, as shown in Figure 37. This exposes the land's surface directly to rainfall, enhances infiltration by rain water into soils and removes material that binds soil particles together leading to erosion and transport of soil material away from mining sites. Increased surface run-off (water) also erodes topsoil, resulting in soil infertility. In addition, such areas are prone to severe evapotranspiration leading to loss of soil water, which helps to loosen soil particles and further increases the rate of erosion. Fauna and flora are also affected as some are dislodged from their habitats, destroyed or lost as a result of removal of vegetation. Soil nutrients, elements and microbes essential for growth of plants and animals are also affected.

When rocks are stripped of the soil cover, minerals that are contained in the rock become unstable and break down in the presence of water (from rainfall) and air to release various elements that make up the rock (Plumlee, 1999). Depending on their chemical nature, these elements released from their primary or original rock through breakdown or dissolution can affect the immediate environment in various ways. For example, acid-bearing gold ore that is frequently extracted by ASM operators in the Prestea, Obuasi and New Abirem areas would, after processing, leave behind waste that is rich in arsenic, which finds its way into the surrounding soil and water bodies. For example, because arsenic, in even small concentrations, can be very toxic, release of this element will pollute or contaminate the surrounding soil, plants, streams or rivers in an area. This can eventually affect the people in the area as some depend on the soil as their source of food, streams for water and fish in the streams. Again, rocks that are exposed in mine pits, trenches and excavations also become susceptible to breakdown and release of their constituent elements, which ultimately contribute to surface, ground water and soil pollution or contamination.

Artisanal gold miners extensively use mercury during processing to take out gold from processed gold-bearing materials. The resulting gold-mercury mixture (usually called amalgam) is then heated to obtain "fairly pure" gold, as shown in Figure 38. Some artisanal gold miners also sprinkle or deposit mercury on sluice boxes used for processing to collect much of the gold along the sluice box. Even though this process reduces losses of fine gold at the initial stage of processing and thereby leads to better recovery, it tends to directly contaminate wastewater that runs off into the environment as well as surrounding soils. Miners also usually gather around the gold-mercury mixture during heating to prevent possible theft of gold. This makes miners extremely vulnerable to mercury poisoning as they directly and unknowingly inhale mercury vapour that is released during heating of the amalgam making them prone to mercury-related illnesses such as neurological disorders and organ failures.

*Source: Frank Nyame, University of Ghana, 2017*

*Figure 38. ASM Operator Heating Gold-Mercury Mixture (Amalgam) to Recover Gold.*

*Note: Bending directly over the furnace makes the ASM operators extremely vulnerable to mercury inhalation and possible mercury poisoning.*

## *Surface and Groundwater Resoures*

In many areas in Ghana, people depend heavily on surface and shallow ground water resources for domestic water supply and use. Alluvial (mainly gravel) gold and diamond deposits occurring in streams, rivers and adjacent valleys are easily extracted and processed by ASM operators compared to gold in hard rock, primary, or weathered (oxidized) material. ASM operators therefore prospect or search for, mine and process such materials within or near the banks of streams and rivers thereby directly polluting the water with various forms of waste, including physical and chemical waste. Some solid waste materials are directly dumped into streams and rivers or indirectly washed into stream channels by surface run-off. Some waste materials are also dumped or piled close to or along stream channels. These deposited materials find their way into streams resulting in siltation or shallowing, i.e. partly or completely blocking, of stream channels, which ultimately increase the risks of flooding in such areas. Pits and excavations created in mined-out areas also collect water and contaminants, which infiltrate and pollute ground water. In addition, turbid water that remains after processing of ore materials is released directly into soils and streams, which heavily pollutes the water. A diversion of streams or river courses (channels) is commonly done by ASM operators for them to get access to and mine gold and diamond -bearing gravels in the streams and rivers, as show in Figure 39. Mining in stream channels and valleys not only greatly pollute streams and groundwater but also increases the rate at which streams dry up during the dry season in such areas, affecting both aquatic life and people in communities that depend on such water sources.

*Source: Frank Nyame, University of Ghana, 2017*

*Figure 39. Diversion of Stream Channel by Artisanal Alluvial Miners.*

*Note: The stream originally flowed approximately along the margin of the mined area and the forested vegetation.*

## Air Quality

ASM practices often release lots of dust during extraction, transport and processing of ore materials, which affect the quality of air both at the mine site and in the surrounding areas. Depending on the nature, composition, size fraction and wind direction, for example, these dust particles can affect the health of ASM operators as they unknowingly breathe in air whilst working (Plumlee, 1999). Communities in the vicinity of the ASM site can also be affected as dust particles are transported and inhaled by people. Waste material left at ASM sites after mining and processing can also be picked up and transported by wind to affect air quality in areas surrounding ASM sites. Such transported material can seriously impact the quality of air long after mining has ceased in an area.

## Noise and Vibrations

In comparison to simple methods used by ASM operators about two decades ago, ASM operators recently began to employ sophisticated extraction and processing methods that generate lots of noise and vibrations. For example, tools, equipment or machinery including excavators, bull dozers, vehicles, bore mills and other mechanised processing and grinding equipment that can seriously affect the health of ASM opertaors and the local mining communities. In some cases, unauthorised drilling and blasting of ore materials lead to deafening noises and vibrations that lead to hearing impairment and crack in residential facilities of neighbouring communities, respectively. ASM operators and mining groups are also directly affected because they mostly do not employ safety or monitoring equipment to reduce the effects and determine the extent of impacts, respectively.

## Mine Waste Materials

ASM waste materials, including waste rock (gangue) and tailings (fine-sized materials left after processing), are often dumped in and around mine sites. With time, these materials break down as a result of interaction with water, air and organisms to release various elements and/or substances into the surrounding environment. In some cases, toxic elements such as mercury, arsenic, cadmium and lead either present as natural components in the waste rock or introduced during processing are released into and contaminate the surrounding environment (Plumlee, 1999).

## Health and Safety of Miners and Communities

Because humans depend directly on air and indirectly on various resources available on land and in water, the overall health of ASM operators, mining groups and local mining communities in an area where ASM activities take place may be linked to the nature and extent of ASM activities and, in particular, interactions between the materials or minerals mined and occupation or behaviour of people. Many ASM operators disregard basic health and safety regulations, such as wearing personal protective gear during mining. Many do not put on helmets, earplugs, dust masks, safety googles, hand gloves and hard boots to protect themselves, as shown in Figure 40. This makes them excessively vulnerable to in-

Source: John Tychsen, GEUS.

juries some of which may be fatal. Many ASM operators and communities are also often unaware or unconcerned about environmental issues and only consider the short-term gains made from ASM activities. Landscapes dotted with un-reclaimed pits and excavations, some of which are filled with water, serve as traps especially when covered with vegetation and have resulted in loss of lives of many people including ASM operators and local inhabitants.

Source: Frank Nyame, University of Ghana, 2017

*Figure 40. Sub-Surface Hard Rock Miners in Ghana at The Entrance of an Excavated Mine Shaft.*

### *Aesthetics*

ASM activities in Ghana often render huge areas of landscapes barren, soils infertile, pits and excavations filled with water and solid waste material dumped in and around many mined-out areas. Such scarred landscapes obviously reduce the aesthetic value or beauty of the areas after ASM activities cease. For example, forested areas that are reduced to bare lands in the vicinity of thickly vegetated land demonstrate the negatively aesthetic and environmentally reduced scenery in such areas.

## Some Challenges of Mitigating ASM Environmental Impacts

In order to mitigate, or help reduce, the environmental impacts associated with ASM activities in Ghana, it may be necessary to first identify and map, or systematically record, areas that have already been impacted to show their geographic distribution or spread. Such disturbed areas can then be ranked according to, for example, the extent of impacts, expected mitigation measures and approximate cost involved in rehabilitation. Invariably, local, community-level bottom up approaches may be needed to help improve on the environmental performance of the ASM sector in the country.

*A 3-step sluice used at mining site, North of Osino in central Ghana.*

*Children carrying water for the household, collected at or from a river near the mining site, central Ghana.*

Source: John Tychsen, GEUS.

# SOCIO-ECONOMIC PROFILE OF ASM IN GHANA

*By Frank K. Nyame, University of Ghana*

ASM is generally defined as that type of poverty-driven, low skilled and low capital investment mining activity usually undertaken by individuals or groups of people (Hilson and Potter, 2003; Hilson *et.al.*, 2006).

In Ghana, two main forms of ASM are present, i.e. formal (or legal) and informal (or mostly illegal) ASM. The "formal or legal" ASM is the one in which ASM operators obtain permits from the agencies that regulate mining activities in order to undertake mining. The "informal or illegal" ASM, popularly called "galamsey", denotes, ASM operators, who operate or undertake mining activities without obtaining a license or permit from the relevant mine regulatory agencies.

Source: Frank K. Nyame, University of Ghana, 2017

*Figure 41. Typical Demographic Profile of ASM Site, Ghana.*

## Demographic Profile of People Engaged in ASM Activities

Due to the highly dynamic nature of ASM activities, i.e. nomadic, seasonal, ease of entry and exit of participants, etc., it is often very difficult to obtain reasonably accurate estimates of ASM populations within any given period. Observations at many ASM sites generally suggest that people of diverse age groups (young and old) and backgrounds (ethnic, social, education, gender, skill, occupation, economic, political) are involved either directly or indirectly in the ASM sector in Ghana, as shown in Figure 41. For instance, at some ASM sites, children as young as eight (8) years or below to people as old as seventy (70) and above may be present. Again, contrary to previous studies, which suggested that people in remote agricultural regions tended to undertake ASM as a seasonal activity, there is increasing evidence that many participants present at ASM sites nowadays consist of a mix of educated to illiterate (uneducated), skilled to unskilled, local to international migrants. Thus ASM activities at any particular site may present a complex mix of people of different socio-economic background and interest.

## Features of ASM Activities in Ghana

### *Migration*

Both national and transnational migrations are essential features of the ASM landscape in Ghana. In many gold- and diamond-rich areas of the country, ASM sites that operate anywhere from about six months to several years often display a multiplicity of ethnic groups or people of different ethnicity all of whom migrated from various regions of the country to congregate at ASM sites. Transnational migrants, though comparatively fewer than migrants from various regions of the country, are also typically present. Nyame and Grant (2012) observed at Akwatia in eastern Ghana people from within the West African sub-region (Togo, Burkina Faso, Mali) and southern Africa (Angola) at the diamond mine site. Recently, an influx of foreigners, many of whom provide critical investment in the form of money, machinery and "manpower", have transformed the ASM landscape from an essentially simple, low capital, low investment and low output activity to a fairly mechanised or complex economic venture with substantial net profits not captured by official statistics or documentation.

### *Transitory Mining*

Transitory mining is used to describe the phenomenon whereby migrating groups of ASM operators strategically "hop" from one mine to another in a bid to exploit low-yield gold and diamond deposits in some mining regions of the country (Nyame and Grant, 2014). In order to accomplish this, ASM operators forge strong bonds with host communities by sending pre-mining negotiation teams and employing extended family networks to arrange mutually beneficial agreements with local actors. These strategies and techniques lower the entry barriers into ASM by facilitating access to mineral-bearing lands.

### *Land Tenure and Land Availability or Access*

ASM operators secure access to land through either formal licensing from the Minerals Commission or informal arrangements with traditional or customary land-owning groups through agreements with families, clans, skins and chiefs, who are usually the alloidal landowners (Nyame and Blocher, 2010). In some cases, customary landowners, their relatives or representatives also engage in illegal mining activities on their own lands. Through such relationships, mineral-rich lands are frequently traded between local landowners and ASM opertaors or interested groups outside the official legal regime. According to Nyame and Blocher (2010), such informal arrangements not only perpetuate illegal mining but also contribute significantly towards proliferation of illegal ASM activities in many areas in Ghana and thus potentially hinder attempts by the Government and development partners to formalise the ASM sector.

### *Labour Specialisation*

Specialisation of labour relates to quite distinct processes used in the production of goods and services (e.g. Lindbeck and Snower, 1977; Luthans, 1998). In Ghana, as in many other ASM countries, research and policy studies have been done over the years, some of which documented limited occurrence of mainly gender (male-female) and/or age (children-adults) related labour differentiation in the mining process (e.g. Yakovleva, 2007). Women and children, for instance, have been reported to frequently work as porters or carriers of ore and waste rock from mine pits to processing and waste dump sites, respectively, whereas young men predominated in the physically demanding, strength sapping chiselling, digging and shovelling of ore bearing or waste materials. Even though observations at artisanal gold and diamond mining sites still reveal such differences, there is increasing evidence to suggest tremendous transformation towards distinct differentiation or "specialisation" beyond the gender-and/or age-based categorisation (Nyame, 2013). It is thus quite common to see individuals or groups of people perform "specialised or semi-specialised" tasks (labour) for a fee that may include the search for minerals (exploration), removal of ore (extraction), conveying ore to prepared sites (transportation) and separating the mineral from associated waste material (processing). Other important services that are integral components of an ASM activity include financing of operations through sponsors (investors), equipment leasing or rentinging and tradeing in various goods.

## Socio-Cultural Practices and Dynamics

### *Socio-Cultural Practices*

Social and cultural practices of various ethnic groups that participate in ASM activities are often brought to ASM sites as part of the belief systems of ASM operators. Where ASM operators are mainly migrants, they are still required to adhere to the traditional practices of people in host ASM communities in the belief that good or bad omens befell people depending on whether they followed such beliefs and practices or not. For example, on certain taboo days, ASM operators are not expected to work and may only choose to do so at their own risk. Fetish priests and priestesses also provide spiritual protection for ASM operators, perform some rites before extraction of gold or diamond and are sometimes called upon to cast spells out when production is very low or when ASM operators suddenly fall into problems that they find difficult to explain or understand. In the event of calamities, certain rites are performed to pacify the gods and ancestral spirits. Some people also believe that fatalities, such as death or loss of life of ASM operators in pits or cave-ins, usually "bring good output" of gold or diamond, for example. Again, women may not be allowed to participate or even go near processing sites for fear of the gold or diamond vanishing.

Also because it is a male dominated activity, women in their menstrual periods may not even be allowed at ASM sites.

## *Socio-Cultural Dynamics*

The effects of ASM activities on certain socio-cultural dynamics within local communities are yet to be fully explored. By bringing together people of different ethnicity, tribe, culture, belief system, status, interest and in some cases nationality into a spatially small local community to mine gold or diamond, ASM activities tend to forge closer cooperation, strong bonds and social harmony between ASM operators and local communities. People of different cultures inter-mingle, inter-marry or work together without many problems. At the same time, however, having so many people with different socio-cultural backgrounds can be a potential source of or lead to social disruption, tension and conflict which, if not managed properly, can have serious implications that may threaten community cohesion. For example, research work done in some artisanal gold and diamond mining communities in Ghana suggests that ASM activities may have affected the mainly rural, traditionally conservative communities in which traditional family structures became unstable or are partly or wholly destroyed due to an influx of ASM operators.

## *"Growth" in Local Mining Communities*

Communities or towns where ASM activities take place appear to show "physical growth in size and population", which encourage or stimulate local economic activity or enterprise development. Many inhabitants therefore not only welcome but also actively seek ASM operators to explore and exploit, where available, gold and diamond in their areas. For example, about two decades ago, the mining towns of Prestea, Tarkwa, Dunkwa and Konongo were nearly ghost towns after the collapse of large-scale mining activities that operated in those areas for a long time. When ASM operators thronged to these areas to exploit marginal or low-grade gold ores, these towns suddenly sprang back to life with brisk economic activities (Nyame et al., 2009).

## *Socio-Political Factors*

Over a decade ago, large-scale mining companies were seen as the main culprits of social disruption, displacement and re-settlement of local mining communities (Akabzaa, 2000). Governments, regulatory bodies and civil society organisations all faulted such companies for encumbering large tracts of unused or unmined land to the detriment of subsistence agricultural land users. With the present outcry over environmental degradation and other social ills in the ASM sector, one would have assumed that large-scale mining companies, many of which have for long borne the brunt of illegal ASM activities on their legally acquired mining properties, would have been fully engaged and/or involved as partners or stakeholders in the fight against illegal ASM activities. The activities of illegal ASM also seem to fairly correlate with the political calendar of the country with governments at the start of their tenure often coming down hard on the practice but tolerating and probably even tacitly encouraging the activity close to national election periods.

# Major Socio-Economic Aspects of ASM in Ghana

The overall socio-economic importance of the ASM sector in Ghana can be categorised in terms of benefits accrued and challenges prevailing in the sector. In effect, the net impact at any given time or period may be determined by the relationship between these two issues.

## *Benefits of ASM Activities*

### Livelihood Option

ASM is undoubtedly an important livelihood option for many poor, unemployed and low-income mainly rural people in mineral-rich areas of the country (Hilson and Potter, 2003). Indeed, many ASM sites in Ghana, as shown in Figure 42, still reveal or depict predominantly low-income, less skilled and probably unemployed people directly undertaking various tasks such as extraction, carrying and processing of ore materials. Other people also indirectly perform various tasks such as trading in goods and services including clothing, foot ware, tools (e.g. chisel, hammer, shovel, pick axe, machine parts), medicine, drinks and food that are essential for ASM activities. The livelihoods of these vendors, just as the ASM operators, depend mostly on the ASM activities. The scale and duration of business activities are usually an indication of the level of ASM activities at any particular site. The more intense or extensive the ASM activities undertaken in a particular area, the more brisk the trading activities as more people may be found to be involved in ASM activities. In the Tarkwa-Prestea (Western Region), Akwatia-Akantin-Kobriso (Eastern Region), and Wasa Akropong-Japa and Agona Amenfi-Dominase-Sompre (Western Region) areas, for instance, many ancillary businesses sprang up to service the burgeoning illegal ASM activities that took place from year 2010 to 2017.

*Source: Frank K. Nyame, University of Ghana, 2017*

*Source: Frank K. Nyame, University of Ghana, 2017*

*Figure 42. ASM – A Livelihood Option, ASM is as an important livelihood option for people directly involved in mining and non-miners in local rural communities.*

## Employment Opportunities

No reliable data exists on the number of people engaged in ASM activities in Ghana at any time. It is, however, generally agreed that apart from subsistence agriculture, ASM serves as a source of employment for many people in rural, gold- and diamond-rich communities throughout Ghana. In such areas, people, especially the youth, patronise ASM activities because of the low entry barriers and the attractions offered such as no rigid requirements for the acquisition of skills and formal education prior to entry into the sector. Thus, compared to formal employment, ASM offers an alternative route for many less skilled, low educated, unemployed people from rural or urban communities to secure work even if on temporary basis.

## Income Generation

People engaged in ASM activities derive direct income from the many and varied jobs done at ASM sites. If they are directly involved, such as diggers, they may be paid either according to the work done in a day or as part of ore proceeds made. For example, an ASM operator may be paid on daily basis at a rate of about GhC60-GhC80 per 8-hour working period or have a share in the ore mined or produced over a period. In the latter case, the ASM operator may process and sell his/her portion of the ore (gold or diamond) or barter for goods to other workers. Indirectly, people, such as traders and investors, also derive their income from the services rendered to miners and mining groups.

## Poverty Reduction

ASM, whether legal or illegal, has been identified as an important vehicle for poverty reduction in many communities in mineral resource-rich, mainly developing countries. In Ghana, ASM activities are cited as an important vehicle for poverty reduction (Hilson and Potter, 2003). Whereas such a characterisation was significantly true decades ago, this notion of ASM as mainly a “poverty, seasonal and rural-driven” activity is challenged by the presence of people of diverse socio-economic backgrounds, some of whom sponsor, grant access to, purchase or make land available to ASM operators.

## Contribution to National Economy

Apart from serving as an important source of livelihood, employment and income for many people, ASM activities contribute significantly to Ghana’s foreign exchange earnings. Data, obtained from the Minerals Commission, suggests that total gold production from ASM operators (legal and illegal) increased from an estimated 2.2% in 1989 to 31% in 2016. However, due to closure of the only large-scale diamond mining company in Ghana, diamond production over the past decade has been exclusively undertaken by ASM operators.

## *Drawbacks of ASM Activities*

### Social Amenities at ASM Sites

Because ASM, unlike large-scale mining, usually springs up spontaneously when ASM operators discover a deposit in an area, not enough planning goes into settlements or shelters to cater for the infrastructural needs of ASM operators and communities. In addition, many ASM sites are very far from towns and/or villages; hence, infrastructural facilities, such as electricity and pipe-borne water supply, are usually absent. Make-shift structures, established to shelter or accommodate ASM operators and mining groups, not only lack adequate utilities, such as clean water and sanitation, but they also tend to lead to a spread of diseases among ASM populations due to unhygienic living conditions.

### Teenage Pregnancy and Physical Abuse of Women

At many ASM sites, women are typically engaged to carry ore materials from pits or points of extraction to processing sites for a fee or undertake petty trading of goods and services, including sale of food, to ASM operators. Because of limited economic opportunities in such rural, often remote areas, young sexually active teenage girls who dominate the female population are extremely vulnerable to various incidences that lead to teenage pregnancy, physical abuse and violence by their male counterparts at ASM sites.

### Formalisation

Even though laws have been enacted and numerous attempts have been made to formalise the ASM sector, evidence available suggests these have been largely unsuccessful. The nature of ASM operations makes it very difficult to know, even at any one site, the total number of people involved, the actual work done and output per person or group. In addition, the driving forces behind this widespread activity are still not well established. Because they are not well-organised, documented or registered, taxing ASM operators of the profits accrued from their work is a difficult proposition. Local and national governments, therefore, annually forego tax revenue, which could have helped to develop various local communities and Metropolitan, Municipal and District Assemblies (MMDAs) and also the nation at large.

### Illegal Business Dealings

Because the ASM sector is largely informal and unregulated, there is very little transparency and accountability in the way ASM operations are conducted, unlike formal large-scale mining companies, which are required to provide good accounting and management practices. This means that a greater portion of gold and diamond produced by ASM operators are not only undocumented but also do not go through official channels. A great portion finds its way into a huge black market trade in gold and diamond either within or smuggled across the country's borders, which denies the Government substantial tax revenue and also encourages black marketeering. In addition, chemicals, such as mercury, which is used extensively at gold mining sites, are traded through the black market with little or no control by regulatory agencies.

## Nomadic Nature

ASM operators often work on marginal gold and diamond deposits at historic, pre-colonial and post-colonial mining sites, recently discovered deposits by the ASM operators themselves or by past exploration and mining companies. Because ASM operators generally lack basic geological information on, for example, the estimated resource including quantity (inferred or proven reserves) and quality (minerals present, optimum mining and beneficiation methods), they tend to move from one area to another in search of new deposits as old ones are easily exhausted or completely mined out within a short period of time. Also, because they mostly mine alluvial deposits of gold and diamonds, whose distribution are more erratic, unpredictable, much easier to extract and process compared to hard rock deposits, ASM operators quickly move from one deposit to another.

*Source: Frank K. Nyame, University of Ghana, 2017*

*Figure 43. Disregard for Health and Safety Issues at ASM Site, an ASM operator descending and working in a pit without health and safety gear.*

## Health and Safety Concerns or Issues

Because most ASM sites often spring up in a spontaneous manner compared to large-scale mining sites, little or no effort is made to put in measures to address the health and safety needs of ASM operators and those that depend on the ASM activity. This results in serious disregard for basic health and safety concerns, as shown in Figure 43. For example, the walls of pits may not be supported with wood, which results in frequent caving-in of overlying material that lead to unfortunate fatalities. The management of waste, i.e. both directly from the mining activities and those generated domestically, therefore becomes a problem such that both solid and liquid wastes are often strewn around mining sites posing serious health risks to people.

## Child Delinquency and Child Labour

Children in ASM areas tend to be attracted to mining activities, either out of curiosity or to work as errand boys and girls to ASM operators. Many children of school-going age thus do not go to school and others already in school stop going to school. Truancy in schools is therefore a serious problem in such communities and is having an effect on the education of children in such areas. Again, some children actually participate in ASM activities, a form of "mining child labour" which is prevalent in ASM areas in Ghana.

## Substance Abuse

Due to the often physically demanding nature of ASM work, substance abuse is an increasingly worrying problem. ASM operators patronise a range of pain-relieving and narcotic substances, including amphitamines, paracetamol, indomethacin (locally called akokora bebo in Akan language the old man will be able to play soccer), marijuana, cocaine, alcoholic drinks, etc., to help them overcome excessive pain after a day's work. Because the demand for these substances increases among ASM operators, these are also introduced to other people in the ASM communities. ASM operators also become addicted to these substances, which, in the long term, create or lead to serious health problems.

## Prostitution and Promiscuity

Due to the lack of a rigid social control at temporarily constructed or settled ASM sites or camps compared to what often prevails in surrounding communities, prostitution and promiscuity among ASM operators and mining groups are of great concerns. These camps often display hastily or shabbily constructed dwellings in which mining groups dwell or inhabit. Even where ASM activities take place in the communities themselves, instantaneous disruption of the social structure in towns and villages by groups of different tribes or ethnicity or nationalities mean traditional authorities are either unable to, become powerless or find it difficult to exert authority and control over such people. This, in most cases, becomes a recipe for chaos and disorder in the communities.

## Sexually Transmitted Diseases

Data on incidences of diseases or disease burdens at ASM sites are not easy to come by. However, there is a general perception of a prevalence of sexually transmitted diseases in ASM areas in Ghana as most ASM sites, being spontaneous settlements, tend to be populated by sexually active young men and women under no strict parental control.

## Food and "Economic" (In)security

Because many people in artisanal, mainly rural, mining communities abandon traditional subsistence agriculture for mining, food becomes scarce in the immediate environments of ASM sites. Even though data on spatial extent or acreage of destroyed cocoa farms and resultant economic implications (through loss of revenue to the state) is still unknown, it is generally held that economic security via, e.g. cutting of cocoa trees in favour of mining, potentially harms overall cocoa production in many originally cocoa growing areas. Furthermore, long-term sustainability of farming incomes in many rural households may be seriously affected as people, especially the young, abandon traditional agriculture and transit into mining, which activities and economic benefits are only temporary. These two effects, i.e. abandonment of food and cash crop farming and destruction of cocoa farms, tend to impact negatively on and/or threaten the overall economic health of both communities and the country.

## Crime, Gangsterism and Human Security

ASM sites, as local centers of economic activity, attract not only ASM operators and groups that provide essential services to ASM operators but also bands of people who threaten, rob and occasionally kill ASM operators or raid communities for gold, money, vehicles and other valuable items. At some sites, fairly organised criminal groups periodically tax or take tolls from ASM operators either in the form of cash or portions of the gold or diamonds produced. Clashes between ASM operators and criminals appear to have increased with increasing ASM activities throughout the country in the past decade. In response to these, some ASM operators arm themselves with weaponry, which also poses a serious threat to the lives of ASM operators, communities, security agencies and national security as a whole.

*Source: John Tychsen, GEUS.*

*Two young girls working at a mining site in central Ghana.*

*Miners coming up from a underground section of the Takote Mine outside Tarkwa in Western Ghana.*

Source: John Tychsen, GEUS.

# FINANCING AND BUSINESS PLANNING FOR ASM IN GHANA

*By Eric Bright Davis, Minerals Commission*

## Marketing and Selling Mining Products

### *Marketing*

Marketing refers to "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large" (American Marketing Association, 1937).

The answer to the question "can the product be sold?" should be found before setting up an ASM business. If there is nowhere to sell a product or the price is too high for customers to pay, there is no point in setting up the business in the first place.

The market for minerals comprises the customers, people or other businesses that are willing to pay money for the minerals mined.

To understand and also segment a market, one has to ask and answer the following questions, i.e do market research:

- Who are the customers, i.e. who buys minerals?
- How large is the market, i.e. how many customers and how much do customers buy?
- What kind of mineral products do the customers want?
- What kind of prices are customers willing to pay?
- Where are the buyers/customers, i.e. where are they physically located?
- Where and when do customers buy?
- How often and how much do customers buy at a time?
- Who are the main competitors that are selling similar minerals?
- How good are the competitors in producing and selling minerals?

When doing market research:

- Talk to buyers: Why do they buy from you? Are they satisfied with the product? Are there other minerals they would like to buy?;
- Find out why other buyers have stopped buying. Are there better quality minerals, better service, better distribution or better prices elsewhere?;
- Study competitors to find out what minerals or services they sell, at what price and how they attract buyers;
- Ask professional people, such as the Ghana Chamber of Mines and the Minerals Commission, on how best to produce, sell and identify markets; and
- Read newspapers, trade journals and magazines to know which minerals sell best.

*Source: John Tychsen, GEUS.*

*Figure 44. ASM operator displaying his product.*

## *Selling*

Selling is the process of exchanging minerals for cash. The selling process involves 4 Ps: Product, Price, Place and Promotion.

### Product

Product refers the metal, mineral or mining related product produced and thus offered. The product should be of a good quality and in a sufficient quantity to sustain market demand. Poor quality products often lose their markets because buyers want value for money. Mineral products are generally classified as "good quality" when:

- Cassiterite concentrate contains at least 60% of tin;
- Gold produced has less than 15% impurity; or
- Dimension of stones cut are of equal thickness, width and length.

Source: John Tychsen, GEUS.

*Figure 45. ASM gold miner sellings his gold to the Government in the local bank branch.*

## Price

Price is the value of the product offered for sale by the business. The sale price is a combination of product costs and profits. One should be able to cover the costs of the initial investment, operation al costs and at the same time make some profit from the business.

## Place

"Placing" a product refers to the method used to distribute the mineral product. For precious metals, this will be through a dealer (licensed or not). Many ASM operators find it convenient to sell their products directly at site. This is a reasonable approach for mining businesses such as quarrying, brick making and sand mining. ASM operators can also distribute their products through retail shops located in strategic towns and trading centres.


*Figure 46. At the ASM mining sites, women often establish a small business preparing food to the miners.*

### Promotion

Promotion refers to the process of making the minerals that produced/mined known to potential and existing buyers. This can be achieved in a number of ways, e.g. personal selling, advertising, public relations and sales promotion.

## Costing and Buying for an ASM Business

### *Costing*

Costing refers to calculating the total costs of making and selling a product or providing a service. The costs of mining and mineral processing usually include:

- Equipment, tools and machinery;
- Materials (e.g. for construction);
- Purchase of supplies, goods and materials to operate the mine (e.g. fuel); and
- Initial licensing, taxes, rents and royalties and other fees.

Determing mining costs enables ASM operators to:

- Estimate how much money is needed to start and operate a mine;
- Budget for the various mining activities to ensure that sufficient funds are in place to operate effectively;
- Determine if mining business is profitable or not;
- Identify specific areas of the mining business where cost reductions are needed, resulting in greater profits; and
- Determine the minimum production level (break-even) point for the business in order to make a profit.

## Types of Costs

There are many different types of costs involved in ASM operations. These are divided into two broad categories: direct and indirect costs.

- **Direct Costs:** These are costs that are directly related to a specific activity in the mineral production chain, e.g:
  - Labour for digging, hauling, crushing, and processing rock;
  - Equipment and tools used for extraction, hauling and processing;
  - Water and chemicals used in processing; and
  - Construction of tailings dams and drainage system.

- **Indirect Costs**: Sometimes also called “overhead costs”, these are costs that cannot be attached to any specific activity but they affect the whole business, e.g:
  - Rent, lease fees, licensing fees royalties and taxes;
  - Total fuel and lubricant costs;
  - Energy and portable water costs;
  - Transport of supplies to and from the mine;
  - Lost time due to bad weather or illness;
  - Maintenance of equipment;
  - Machine depreciation – decline in value of a machine due to wear and tear;
  - Construction of shelters for workers;
  - Meal costs at work;
  - Insurance;
  - Interest on loan;
  - Indirect labour costs (site security, accounting/administrative costs);
  - Stationary;
  - Telephone;
  - Construction of pit latrine; and
  - Labour for cleaning up the site.


*Figure 47. At the ASM mining sites, women often stablish a small business selling products to the miners.*

## *Buying*

Buying refers to the purchasing of tools, equipment, machinery and other items needed for mining. Some items are consumables, such as explosives, beans, maize, and first-aid kit. In every business certain items are needed before and throughout the life of the business.

Using good buying methods can be the difference between profits and losses. There are four sound principles of buying, namely:

- Buying the right quality;
- Buying the right quantity;
- Buying at the right price; and
- Buying at the right time.

## An ASM Business Plan

A business plan is a formal written document describing the nature of a business, its goals and plans for attaining these goals.

For an ASM operation/business, the business plan is integrated with the mining plan for the ASM site – the main goal is to operate a profitable mine until the mineral resource is depleted. This involves looking at how the mine is technically developed over time while also considering the management, administrative and financial operation of the mine. The main reasons for developing a business plan are to:

- Help estimate how much money is needed to set up or expand an operation;
- Submit it to potential investors and other sources of financing;
- Understand how much profit is really being made and foresee how much profits can be expected to be made in a certain period of time;
- Provide information that helps to serve buyers better. If a reliable schedule of production exists, buyers will know how much is available and when; and
- Identify areas where costs are too high.

The level of detail in a business plan depends on the size of the ASM operation in question; hence, when planning for an ASM operation one should answer the following questions:

- What is the size and grade of the deposit? What methods will be used to mine the deposit?
- Where will you establish infrastructure (mine waste, access roads etc.)? How much will it cost?
- What tools, equipment and machines would be needed and where will they be bought?
- When do you need the equipment and for how long?
- How much do they cost to buy? How much do they cost to maintain?
- How much can you realistically expect to produce in a day, week, month or year?
- Where will the mineral product be sold and at what price?
- How much is to be paid in taxes, licences, rents, royalties or other fees?

A typical ASM business plan comprises:

1. **Cover Page:** Title of mine or project, name of the organisation, and date.
2. **Executive Summary:** A brief summary of the contents of the plan. Make sure it is very well written.
3. **Background and Purpose:** Summaries: (i) the history of the company/cooperative and mining project, (ii) current status of the company/cooperative and mining project, (iii) objectives of the mine or project and (iv) business goal of the company/cooperative. Provide a brief overview of the history and current status of the company/cooperative

and mining project. Also describe what the goals of the mine or project are e.g. to exploit the gold or diamond deposit with due care and attention to the environment.

4. **Market Analysis:** The overall market for the product, who the expected customers are, the competition and expected sales forecasts.
5. **Operational Set-Up:** A technical description of the mine or proposed mine, how it is or will be mined, ore reserves, how the mine will be closed and environmental problems managed.
6. **Financial Data:** Current financial position of the company/cooperative, organisation and costs. Costs and payment history (sales and costs sheets), cost control measures, break-even analysis and financial projects (how much profit and costs are expected in the future).
7. **Organisational Structure and Management:** Key personnel, i.e. directors, board members, professional advisers, and labour force (current and projected).
8. **Ownership:** Who owns the project or mine? What percentages will the different parties hold? How will these partnerships be terminated (exit strategy)? What are the royalty and licensing agreements?
9. **Risk Factors:** Identify clearly all potential risks to the mine or project and how they will be addressed. This includes: changes in commodity prices, problems with labour, suppliers or distributors, social conflict, environmental accidents, lack of capital, other risks.
10. **Conclusion:** Summarise key points and include a timetable of when funding is needed for future developments.

## Available Organisational Structures of an ASM Business

In planning for a mining business, ASM operators must organise and structure their businesses in accordance with their business needs, finance, and the legal entities or business forms available as prescribed by the laws of Ghana. An ASM business must be registered with the Registrar General's Department and other regulatory bodies before it can legally operate in Ghana.

There are five common ways to structure and organise a business and each form of business type has its advantages and disadvantages:

### *Sole Proprietorship*

A sole proprietorship is a business entity owned solely by an individual, who is responsible for providing all the finances, making all the business decisions, taking all profits of the business and bearing all losses and liabilities of the business. This business entity is the easiest to form and dissolve and the least expensive of ownership to organise. However, it is very difficult for the individual to raise funds for the business and the liabilities are unlimited.

Source: John Tychsen, GEUS.

*Figure 48. Some of the ASM gemstone miners can learn lapidary and earn the value addition by cutting and polishing.*

## Partnership

A partnership is an association of two or more individuals up to a maximum of twenty doing business for the purpose of generating a profit. A partnership is easy to form and manage because it is regulated by a partnership agreement. This agreement clearly states how much capital each partner will contribute, duties of each partner, how profit will be shared, how decisions and disputes will be settled, how future partners will be admitted and, where necessary, how the partnership will be dissolved. Since the partners are more than one they bring complementary skills, experience and are able to raise funds to finance the partnership. The partners take all the profits from the partnership but they are held liable for all losses and liabilities and are joint and several liable for the actions of the other partners.

## Limited Company

A limited company is a company owned by two or more owners, named shareholders. The owners can be investors in the business, and may or may not be active in the business. The company appoints a board of directors, which makes many of the decisions and appoints managers to run the business on a daily basis. The owners, board of directors and manager can all be the same people. The shareholders can be paid a salary from the company, which is taxed like any salary.

### *Cooperative*

A cooperative is formed by a group of people who decide to work together for a common purpose. This purpose might be for profit (running a mine) or for providing services for cooperative members (pooling resources to provide health care insurance for members). Members of a cooperative share profits from the business and bear the losses. Members bring complementary skills, experience and are able to raise funds to finance the cooperative. The liability of members is limited to their contribution to the cooperative. It is often easier for cooperatives to get external support, such as funding, resources and training from various institutions and Government agencies.

### *Joint Venture*

A joint venture is a business entity in which two or more persons, or companies, agree to undertake or develop, for a limited period, a business or a project. Parties of a joint venture pool their capital and complementary skills to ensure that the object of the business/project is achieved.

## Available Financing Options for an ASM Business

The two main sources of financing available to ASM businesses are short-term finance and long-term finance.

### *Short-Term Finance*

Short-term finance refers to borrowing money to finance business operations for a period up to or less than one year to meet recurrent expenditure, i.e. day-to-day operational activities, and comprises the following sources:

- **Bank Overdraft:** A short-term loan granted by banks to clients to withdraw money above an agreed current account balance to supplement the working capital short fall. A bank overdraft is flexible, cheap and the risk is less compared to long-term loan and the interests are tax deductible. However, the interest rate on a bank overdraft is usually higher than for a negotiated short-term loan.
- **Short-Term Loans:** A loan from financial institutions and banks to businesses to meet their short-term financial obligations, e.g. to finance a new project or purchase new equipment and/or materials.
- **Micro-Credit:** A short-term loan granted to microenterprises and the self-employed poor by micro-financing institutions. The cost of this loan is very high compared to traditional bank loans because most microenterprises are not credit-worthy, i.e. lack the financial capacity to ensure full repayment of a loan. In Ghana, the Government has set up the Microfinance and Small Loans Centre (MASLOC) to provide micro and small

loans for start-ups and small businesses to grow and expand their businesses as well as stimulate job and wealth creation.

- **Trade Credit:** A trade credit is an arrangement between a business and its suppliers where the suppliers grant or allow the business to settle payment for it purchases at a later stage, i.e. beyond the standard 30-day payment terms.
- **Commercial Paper:** Financial institutions issue a commercial paper to businesses as evidence of borrowing from the banks on a short-term basis. A commercial paper is usually only issued to large credit-worthy companies to finance their operations.
- **Factoring:** Factoring refers to obtaining funds by outsourcing the responsibility for collecting debt owed to an institution, i.e. a factoring company, in order to ensure a strong cash-flow situation for the business.
- **Invoice Discounting:** Invoice discounting is an arrangement established to obtain finance against debtors by transferring an invoice to a finance house in exchange for immediate cash at a value lower than the invoice value.
- **Promissory Notes:** A promissory note is a legal document or note that stipulates the terms of a loan granted a business or inputs purchased by a business, which promises to make payment at a future date. This arrangement is usually with a bank, a financial institution, suppliers or manufacturers of equipment.
- **Counter Trade:** Counter trade involves trading goods instead of money, i.e. a counter transaction.

### *Long-Term Finance*

Long-term finance refers to borrowing money to finance business operations for a period more than one year, e.g to expand the business or buy new large assets.

- **Long-Term Bank Loan:** A loan from financial institutions and banks to businesses to meet their long-term financial obligations, e.g. to finance expansion of a business, acquire or invest in new buildings, buy large assets etc.
- **Equity:** Equity refers to raising capital, i.e. money, by issuing new shares in the company or selling existing shares. By issuing new shares, i.e. increasing the number of shares, a company dilutes it shareholding, i.e. each share is worth less.
- **Franchising:** Franchising refers to allowing another party/business to sell a business concept of the original business for a monthly or annual fee, e.g. McDonalds. The original business, i.e. the franchisor, lets the other party/business, i.e. the franchisee, to use its name, marketing material, and product and service concept in exchange for a monthly or annual fee.
- **Venture Capital:** Venture capital refers to obtaining outside funding for a business via external investors for either a share of a business or an agreement payback scheme. In Ghana, Fidelity Investment Limited and Ventural Capital Fund provide venture capital to both foreign and domestic businesses.

- **Leasing:** A lease is an agreement between two parties, the ''lessor'' (provider of finance) and the ''lessee'' (the user of the assets). The lessor owns the assets but agrees to allow the lessee to use it. The lessee makes payments (monthly, quarterly, semi-annually or annually) under the terms of the lease to the lessor.
- **Hire Purchase:** The hire purchase arrangement involves a finance house and the hirer. A supplier sells the assets to the finance house but delivers the assets to the hirer. The finance house demands an upfront payment, a deposit, from the hirer. The hirer pays off the assets in weekly or monthly instalments and assumes ownership of the assets upon full payment of the assets.
- **Retained Earnings:** Retained earnings refer to re-investing profit made in one year to the next year to finance new investments etc.
- **Government Sources:** Funds provided by the Government in the form of cash grants, working capital, equipment and technical support. The main purpose of such public funding and assistance is to help grow the local economy, generate employment and obtain foreign exchange earnings. In Ghana, the Government has established the Business Assistance Fund (BAF), Export Development and Investment Fund (EDIF) and Microfinance and Small Loans Centre (MASLOC) to help indigenous and start-ups businesses. The Government, through the Minerals Commission, has also put in place some interventions and policies to help finance or assist the artisanal and small-scale miners, e.g a revolving fund for organised ASM groups.

## Cash Management and Record Keeping for ASM Businesses

AMS operators who misapply and/or misuse funds hardly get funding, because funders, banks, financing and microcredit institution and Government will not offer funds and assistance to such businesses. Therefore ASM operators must manage and exercise control over their cash flows and cash resources in order to keep the business sufficiently liquid and the mine operation profitable. The efficient management of cash will ensure that the mine operation has sufficient funds to meet recurrent financial obligations, purchase new assets, loan repayments and to take advantage of market opportunities by investing the surplus funds to ensure continuous flows of funds to the mine operation.

ASM businesses must keep up to date records and relevant documents for all receipts and payments for the mine operations. This will enable them to prepare the necessary and required financial statements for the stakeholders.

# ASM SECTOR OF THE GAMBIA

The Gambia is not known to be a mineral endowed country and is yet to discover precious minerals, such as diamond, platinum, copper etc. The mining sector, though in its infant development stages, witnesses ever intensifying activities in industrial minerals, such as ilmenite, rutile, zircon, silica sand, kaolinitic and plastic clays, cockle shells, ironstone and other construction materials. The exploitation of the mineral resources in The Gambia is mainly in the form of ASM operations. The sector needs to be regulated to ensure that the mineral resources are optimally and efficiently exploited for the benefit of the economy and with minimal damage to the environment.

## Legal and Institutional Framework

### *Legal Framework*

The Mines and Quarries Act of 2005 is the legal document for the administration of the mineral resources of The Gambia. This Act defines minerals and lays out the procedures and requirements for the exploration and exploitation of these minerals. The Government's Geological Department is currently developing regulations to fully capture the ASM sector within the Act in order to give better effect to the Mines & Quarries Act.

### *Institutional Framework*

The Geological Department is mandated by the Government to carry out geological surveys and to administer the Mines and Quarries Act 2005.

The Geological Department initiates, promotes, implements and evaluates all geo-scientific programmes pertaining to mineral exploration and development in the country. The Geological Department also conducts studies on environmental geology, including geohazard assessments, and geophysical and geochemical investigations. The Survey Section of the Geological Department also offers services to other Government departments, the private sector and the general public on geotechnical matters.

Administering the Mines and Quarries Act involves processing and issuing permits, and licences for prospecting, mining and quarrying operations, including that of the ASM sector. The regulatory function of the Geological Department also entails monitoring and supervising quarrying and mining activities, which enables the Geological Department to interact directly with the ASM sector, thereby making regulating, managing and monitoring the sector ASM more feasible.

## Mining Sector

In The Gambia, mining operations are classified as either major or minor mining operations, in which ASM falls under minor mining operations.

The development path for the mining sector in The Gambia is quite unique as it differs from the more conventional approach to mining sector development adopted elsewhere in Africa. Whereas the production and export of ore minerals are the overall goals in many African countries, in The Gambia the emphasis is on the production and processing of earth materials to supply the domestic construction market. However, the nature, practice, impact, environmental damage, and driving force of the ASM sector are similar to any other African country.

The principal mineral resources mined in the Gambia for export from the 1950s to date are heavy mineral sands. ASM operations for earth materials for the construction market have over the years contributed greatly to the national economy.

In The Gambia the ASM sector is both complex and diversified with about 90% of those involved in mining activities overall belonging to the ASM sector. It is both an important source of income for the local community and of environmental damages. The sector is growing rapidly in the Gambia, as it has the potential to provide quick and reliable sources of income and more realistically, a means of ensuring daily subsistence. Usually even farmers, students and various other unskilled workers join the ASM sector during the dry season to supplement their income. Many rural workers depend on ASM to feed their families, send children to school etc;

The type of ASM activities in the Gambia varies from informal individual quarry miners seeking a subsistence income, organised groups of people to small registered mining companies.

## The Main Challenges of ASM in The Gambia

Due to widespread poverty, The Gambia is witnessing an increasing number of children and women undertaking, often risky, work in the ASM sector. Furthermore, given that quite a few ASM operations are illegal, operating without any legal license and/or permission from landowners, disputes and conflicts arise between ASM operators and local communities.

The absence of an adequate regulatory and policy framework prevents formalisation of the ASM sector and also makes protection of the environment much more difficult.

Without easy access to relevant geological information, such as the location of ore bodies, the majority of ASM operators waste time, money and resources in exploiting areas with no or small mineral deposits. Additionally, given that ASM is often seen as an uneconomical and risky investment, obtaining the necessary funds for its operation is usually quite difficult for ASM operators.

The main environmental problem of the ASM sector in The Gambia is desforestation. During the past ten years huge surface land areas have been badly quarried leaving behind eyesore land surfaces and destroyed natural habitats. Given that agriculture is one of The

Gambia's main economic sectors, the huge environmental negative impacts of ASM operations, such destruction of natural habitats, arable land, soil eroision, sediment and water runoff from quarry sites, are both devastating and worrying for the future of the country.

### *Way Forward for the ASM Sector in the Gambia*

The first step in improving condictions is to recognise the importance of the mining and quarrying of construction raw materials by the ASM sector in The Gambia. However, having proper regulation in place for managing and monitoring ASM operations is imperative for a sustainable development of the ASM sector. In this regard, the National Environment Act of 1994 shall be fully implemented and enforced so as to avoid further damages to human health and the environment.

Sustainable livelihoods require participation and social capital development. They require access to good governance and ecological, socio-cultural, and economic resources. In order to improve the ASM sector, the Geological Department should be involved in promoting, assisting and making geological information available and accessible to the ASM sector.

# ASM SECTOR OF LIBERIA

It is estimated that about 100,000 people are engaged in the ASM sector of Liberia. Artisanal mining of predominantly gold and diamonds contributes to Liberia's national economy through royalties and taxes paid by licensed dealers and through income generated by those working in the sector, most of whom are rural dwellers. Prior to the commencement of operations of the first industrial gold mine in 2014, all gold and diamonds exported from the country were mined by artisanal miners – today this still remains the case for diamonds. This clearly shows the significant contribution of the ASM sector to the Liberian economy and society.  However, the sector remains largely under-regulated.

This informal nature of Liberia's ASM sector presents further risks of smuggling of minerals and an inflow of illicit money. The result of this lack of formalisation is a loss of potential revenues from the sector as well as negative impacts on the health and safety of those engaged in mining activities, the environment - and thus potentially on the livelihood of others - as well as social distortions, ranging from drug abuse to conflicts between migrant miners and host communities.

Legally, the ASM sector is restricted to Liberians. Section 4.2(h) of the Mineral and Mining Law of Liberia of 2000 limits ASM rights (Class C license) to Liberian citizens only. However, foreigners, from mostly West African countries, participate in ASM activities as well – as manual laborers, so-called shovel boys, working the claims of license holders, as well as in other roles – or illegally, without licenses.

Barriers for entering into legal mining activities include, among other, high cost of mining licenses and the fact that they can only be obtained in the capital city, lack of access to financing, limited knowledge on better mineral recovery techniques and mineral valuation as well as nontransparent supply chains.

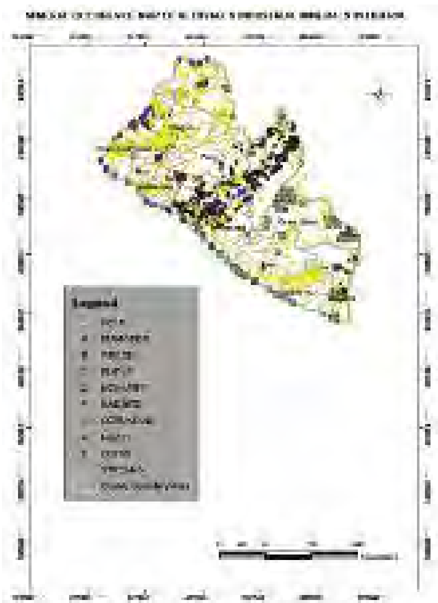
Given the economic significance of the ASM sector and acknowledging the need for action in order to properly manage the sector, Liberia's Ministry of Lands, Mines, and Energy (MLME) began a process of formalising the ASM sector in 2014, with the support of the Regional Resource Governance in West Africa Program, funded by the German and Australian Governments and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH as well as with initial support from the United Nations Development Programme. As an important milestone, this process has now resulted in a Regulatory Roadmap that clearly outlines the ground works, strategies, and resources that are required to formalise the ASM sector in Liberia.

The process of developing the Artisanal Mining Regulatory Roadmap involved several community and regional level engagements. As a first step, pre-assessments of ASM communities were held in regions of the country with known intensive gold and diamond mining activities with the objective of collecting baseline data, while at the same time building stakeholder awareness about the ASM formalisation process. Following the successful conduct of these pre-assessments, regional level consultations were held with all relevant stakeholders (amongst others were miners, shovel-boys, local leaders and authorities, government agencies and civil society). The purpose was to gather a comprehensive range of inputs and perspectives regarding the formalisation themes as well as to better understand the different roles of the various actors involved along the ASM value chain. As a final step in preparation of the Roadmap, policy sessions were held with senior officials of the MLME, to critically look at key thematic policy areas considered crucial for the formalisation process and to develop adequate policy responses.

## Results Achieved to Date

Liberia has established a unit within its tax authority to specifically inspect mining operations. Initial inspections led to payment notices for over USD 10 million in additional taxes and duties. The country has also started to merge its electronic systems for managing mining licences with those used by its tax authorities to ensure that it is able to efficiently monitor mining companies' payment liabilities at all times.

Furthermore, the Liberian Government has also introduced a new system to manage the granting and administration of mining licences. The increased reliability of the system meant that in 2014 the Government was able to lift a moratorium on granting exploration licences that had been imposed in 2013 as a result of weaknesses in the issuing process.



Finally, public information centres have been set up in Liberia to provide access to academic publications on the mining industry and resource governance. To this end, in 2014, Liberia received international recognition for setting up debating clubs as part of its Extractive Industries Transparency Initiative compliance process, where more than 400 school students took part in debating competitions on issues relating to resource governance.

# ASM SECTOR OF NIGERIA

ASM is the oldest form of mining operation in Nigeria. The ASM sector has dominated the Nigerian mining industry in recent times and currently produces the bulk of Nigeria's minerals output (about 90%). ASM is the main means of subsistence livelihoods to the communities where it is taking place and thus a potential for poverty alleviation and eradication.

The Nigerian Minerals and Mining Act of 2007 supports and provides legal standing for ASM activities in Nigeria. In the Act, an ASM operation is defined according to the size of the concession (scale of operation) and the level of technology employed.

The Act further distinguishes between "Artisanal" and "Small-Scale" Mining. "Artisanal Mining" is limited to the utilisation of non-mechanised methods of reconnaissance, exploration, extraction and processing of mineral resources within a Small-Scale Mining Lease Area. "Small-Scale Mining" is described as operations involving low level of technology or application of methods that does not require substantial expenditure for the Conduct of Mining Operations within Small-Scale Lease Areas.

In Nigeria, it is estimated that about 500,000 individuals are directly engaged whilst over 1.2 million are indirectly engaged in ASM operations.

ASM is recognised by law and therefore regulated by the Government through the ASM Department in the Ministry of Mines and Steel Development.

The ASM Department has the following statutory responsibilities:

- Coordination and formalisation of informal miners in the country;
- Provision of Extension Services to performing Mining Cooperatives and quarry associations on exploration, exploitation, mineral processing, entrepreneurial training, environmental management, health and safety issues etc.; and
- Registration/licensing and administration of Mining Cooperatives and Mineral Buying Centres.

Under the Act, individuals, mining cooperatives and quarry associations can obtain a licence to conduct mining under a small-scale mining lease area. Mining artisans, who, based on their individual capacities, cannot acquire the necessary mining licence/lease are formalised into mining cooperatives and quarry associations. About 1,380 cooperatives applications have been received. Out of these, about 618 mining cooperatives/associations dealing with different classes of minerals have been registered and certified. Mining artisans operating outside the Government's regulatory framework, without valid mining licence/title or lease, are referred to as illegal miners.

## Challenges of ASM Sector in Nigeria

Identified challenges associated with ASM in Nigeria encompass social, environmental, economic and legal aspects, namely:

- Poverty driven, i.e. minimal level or lack of mechanisation plus a great amount of physically demanding work;
- Unskilled personnel and methods of operation;
- Inefficient mining and processing techniques, low recovery of values and low level of production;
- Lack of relevant geo-scientific knowledge and skills, such as estimation of mineral reserve, the structural orientation of the mineral/ore deposits, the grade of the ore deposits, spatial orientation of the mineral deposits, and engineering properties of rock;
- Occupational health and safety challenges;
- Little or no regard for the environment;
- Social vices, e.g. women (prostitution, spread of HIV/AIDS, STD and conflicts), illicit use of drugs and child labour;
- Chronic lack of working and investment capital plus lack of financial support from banks and other financial institutions and low levels of income;
- Lack of value addition to minerals products;
- Lack of access to market, i.e. haphazard sales of mineral products;
- Seasonality, i.e. periodical operation by local peasants or according to the market price development;
- Operating without legal mining titles;
- Smuggling of mineral products and loss of revenue to the Government; and
- National security risks, ie. illegal migration of foreigners from one site to another.

To overcome challenges of the ASM sector in Nigeria the followings could be considered:

- Demarcate areas for licensed ASM;
- Provide microcredits to ASM operators, i.e. to purchase equipment and alleviate poverty;
- Enhance education, i.e. eradicate the use of child labour, provide access to better techniques and better educational facilities;
- Enforce environmental legislation and monitoring;
- Provide support for “Agriculture Cash Crops” to discourage illegal mining; and
- Provide international training and capacity-building support to further develop the ASM sector.

The Nigerian Geological Survey Agency has a crucial role to play for the ASM sector in Nigeria, but it currently lacks the resources and skills to provide geoscientific information to ASM operators.

## The Role of the Nigerian Geological Survey Agency in the ASM Sector

The Nigerian Geological Survey Agency, formally established in 2003 by the Federal Executive Council and ratified by an Act of the National Assembly in 2005, dates back to 1919.

The Nigerian Geological Survey Agency is overall responsible for collecting, archiving, processing and making available geological data on igneous, metamorphic, and sedimentary rocks in Nigeria.

The Agency performs the following functions:

- Producing geosciences information for the development of a viable mining industry and for poverty alleviation;
- Carrying out basic geo-scientific research to advance the knowledge of geology and the mineral deposits in Nigeria and elsewhere;
- Producing geological data that encourages sound environmental management; and
- Serving as the national depository of all geo-scientific information relating to the earth, the marine and geomagnetic space.

The Agency provides its functions towards social, economic and industrial development of the country through its different departments and laboratory by:

- Engaging in Regional Geological Mapping;
- Engaging in Economic Geological Mapping;
- Undertaking Applied and Engineering Geological Activities;
- Acting as the National Geosciences Research Laboratory;
- Undertaking Marine and Geo-Hazard Monitoring; and
- Disseminating Data and Information.

A major impediment to the success of an ASM operator in Nigeria is the lack of knowledge about the geologic environment of the ASM site.

The Agency contributes to the development and growth of the ASM sector by providing advocacy and technical support services, such as training of local miners in:

- Basic mineral exploration;
- Geological mapping;
- Mining and processing methods;
- Marketing of minerals; and
- Monthly Mineral Clinics.

The Agency also cooperates with the ASM Department of the Ministry of Mines and Steel Development to provide simplified geological information on minerals deposits by means of pamphlets on mineral commodities to mining cooperatives, among other.

The Agency also plays a vital role in informing the mining community on the need to strictly adhere to best practices in the management of mine tailings/wastes to protect the environment from harmful toxics.

Occassionally, the Agency also advises the Ministry of Mines and Steel Development on the best policy to advance the course of the ASM sector in Nigeria

Last but not least, the Agency is scaling up its data gathering and analysis capacities by:

- Completing and securing the release of all geosciences data projects in Nigeria;
- Expanding coverage and resolution of geosciences data in Nigeria to further stimulate an adequate level of mineral exploration discovery;
- Accelerating the production of 1:100,000 and 1:50,000 maps of Nigeria;
- Ensuring demarcation of environmentally sensitive parts of the country, e.g. wetlands that are off-limits to mining;
- Upgrading existing National Geosciences Research Laboratories to conduct analysis and provide accredited services in terms of mineral ore assaying, ore reserve evaluation, etc. to ASM operators; and
- Packagaging existing data by state, mineral type and other relevant parameters, and making it available via electronic means to every Government authority, private investors and stakeholders.

# ASM SECTOR OF SIERRA LEONE

A unique attribute of Sierra Leone's policy and legislative framework for mining is that it distinguishes between "Artisanal Mining and "Small-Scale Mining". As stated in the Mines and Minerals Act of 2009, "Artisanal Mining" in Sierra Leone is described as restricted to Sierra Leoneans (100% SL ownership); no heavy equipment allowed, i.e. labour intensive, using rudimentary methods (shovels and pick axes); application certified and approved by the DoM/Regional Manager; require an environmental management plan and also demonstration of financial capability prior to licence issuance; size of one half hectare (0.005 sqkm) and maximum of depth of 10 meters; and the licence is for a one-year duration, renewable per annum for up to 3 years. "Small-Scale Mining" is described as: open to both Sierra Leoneans and foreigners (25% minimum SL ownership); heavy equipment allowed; application certified by the MAB, approved by the Minister of Mines; require an EIA and environmental licenses and also financial assurance against potential liabilities; maximum size of 100 hectare (1sqkm) and a maximum depth of 20 metres; and the license is for a 3-years duration, renewable every 3 years.

ASM constitutes a very significant part of the local economy and the national economy of Sierra Leone. It is practiced throughout the country but concentrated in the Eastern and Central parts of Sierra Leone where geological conditions for gold, diamonds and coltan are favourable, as shown in Figure 46.


Source: Mines Directorate of Sierra Leone

*Figure 46. Sierra Leone ASM Licenses*

The Principal minerals mined from ASM operations are diamonds and gold. However, because of the growing use of technology, columbite-tantalite (coltan) and zircon are also mined.

## Legal and Institutional Framework

Sierra Leone's mining sector has undergone a number of reforms over the past few decades and years, with a number of laws and regulations being adopted to tackle criticisms of the mining sector, promote transparency and local content, stronger governance, and encourage foreign investments.

In an effort to promote good governance in the mining sector, the National Minerals Agency, a semi-autonomous Government agency, was established in April 2012 by the National Minerals Agency Act of 2012. Its mandate is to administer and enforce the Mines and Mineral Act of 2009, and any other acts related to the trade in minerals and related regulations, and to make recommendations to the Minister for amendments and/or improvements to these laws and regulations.

The Geological Survey Directorate is overall responsible for collecting, storing and managing the country's geo-science information and for facilitating and monitoring exploration activities in the country, ensuring that reconnaissance and exploration companies conduct their activities in a responsible manner and in compliance with the country's mining laws.

The Mines Directorate is responsible for administering mineral rights and monitoring mining operations. Among other things, the Directorate plays a leading role in promoting and facilitating the effective and efficient management and the development of mineral resources.

To ensure safe and professional operations of all mining activities in Sierra Leone and conformity with international best practice standards, the Mines and Mineral Operational Regulations were adopted in July 2013, which provide for requirements in relation to surface, open pit and underground mining operations, reporting of mineral resources, health and safety standards, waste disposal, and explosives and blasting.

## Environmental and Social Problems of ASM Operations in Sierra Leone

The legacy of ASM operations includes widespread environmental degradation and numerous social problems, such as:

- Land and soil degradation as a result of rudimentary and inefficient mining and processing methods, including effects of uncontrolled pit digging with no routine backfilling and destruction of vegetation and topsoil removal;
- River bank erosion affecting gravel and soils, with adverse downstream effects on human health and agricultural land;

Source: John Tychsen, GEUS.

- Deterioration of water quality and breeding of mosquitoes and microorganisms through disruption of natural drainage and silting of drainage courses;
- Discharge from machines, including seepage and pollution of residual oils to water and soil;
- Creation of irregular spoil heaps, and generally uncontrolled disposal of waste;
- Use of child labour and resultant lost opportunities for schooling;
- Drug addiction; and
- Overcrowding in mining areas, intensifying health problems, and creating an insecure environment for the young.

These problems are compounded by the fact that very few ASM operators make any effort at reclaiming their mining sites. The sites are merely covered by sands and clays, mixed in such a way that reduces the opportunity for any meaningful rehabilitation of the area other than a simple refilling of the holes created during the mining process.

Furthermore, ASM operators regularly alter the course of rivers and streams and use crude cofferdams to gain access to river gravels.

At present, the only legal environmental requirement stipulated for an ASM License is the payment of an annual fee to a rehabilitation fund, which is used to cover the cost of rehabilitation and reclamation of mined-out areas. Currently this fee is 150,000 Leones (approximately $20) per acre per year, which is grossly insufficient to cover the actual cost of the environmental damage made by ASM operators.

Since the establishment of the National Minerals Agency, comprising 4 regional and 3 sub-regional offices, to monitor ASM operations in the country, the rate of illicit mining has gradually declined.

*To avoid, or at least lessen, negative environmental impacts from ASM operations it is important that the mining area is restored to its natural state. This photo is an example of reclamation at a mining site north of Osini in central Ghana.*

*Conglomerate: Altered argillaceous conglomerate from the Banker Series. Banda Nkwanta. Ghana.*

Source: John Tychsen, GEUS.

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# APPENDIX A

# - ASM License forms and certificates

#12 Switchback Road Residential Area, Cantonments, P. O. Box M248 Accra-Ghana
Tel: 233 302 772783,779823, 773053, 771318 Fax: 233 302 773324
Website: www.ghana-mining.org Email:Mincom@mc.ghanamining.org

Minerals and Mining (Licensing) Regulations, 2012 (LI 2177)
Form 0
Regulations: RL -5(2),PL- 89(2), ML -172, SSM - 202

# REQUEST FOR CARTOGRAPHIC SEARCH REPORT

| TYPE OF APPLICANT | | | |
|---|---|---|---|
| ☐ Individual ☐ Co-operative Society /Mining Group ☐ Registered Enterprise/Venture ☐ Registered Company | | | |
| **Type of Operation** | ☐ Small Scale | ☐ Large Scale | |
| **Full Name of Applicant** | | | |
| **Name of Co-operative Society /Mining Group Registered Enterprise/Venture / Registered Company** | | | |
| **Nationality/ Country of Incorporation** | | | |
| **Postal Address** | P. O. Box | **City/Town/Village** | |
| **District** | | **Region** | |
| **Registered Office Address** | | | |
| **Website** | | **Email Address** | |
| **Fixed Phone Line #** | | **Facsimile #** | |

| CARTOGRAPHIC SEARCH DETAILS | | |
|---|---|---|
| **Location 1** | **Metropolitan /Municipal/ District Assembly of the Area** | |
| | **Name of Nearest City/Town/Village /Landmark** | |
| | **Region** | |
| **Location 2** | **Metropolitan /Municipal/ District Assembly of the Area** | |
| | **Name of Nearest City/Town/Village /Landmark** | |
| | **Region** | |
| **Location 3** | **Metropolitan /Municipal/ District Assembly of the Area** | |
| | **Name of Nearest City/Town/Village /Landmark** | |
| | **Region** | |

**OFFICIAL USE ONLY:**

| TOPOGRAPHIC MAP REFERENCE | |
|---|---|
| Field Sheet (s) Numbers | |

Please provide coordinates for the Perimeter/Area below or attach a Site Plan/Map:

| | Latitude | | | | | | | | |
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| | Deg. | | Min. | | Sec. | | | | |
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| 2 | | | | | | | | | |
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| 10 | | | | | | | | | |

| | Longitude | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Deg. | | Min. | | Sec. | | | | |
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| 10 | | | | | | | | | |

Site Plan or Map attached Yes ☐ No ☐

Where the search is being conducted on existing property (ies) for EPA Permit, please provide below information on the Perimeter/Area of the existing property (ies):

| Property Name or Identification | Licence Type | Location |
|---|---|---|
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| I ………………………………………………..…, request for a Cartographic Search Report for the Perimeter/Area/ Coordinates based on the information submitted. | Date: ……/……/……. <br> ………………………………………..……. <br> *Signature of Applicant* |

#12 Switchback Road Residential Area, Cantonments, P. O. Box M248 Accra-Ghana
Tel: 233 302 772783,779823, 773053, 771318 Fax: 233 302 773324
Website: www.ghana-mining.org Email:Mincom@mc.ghanamining.org

Minerals and Mining (Licensing) Regulations, 2012 (L.I. 2176)
FORM 2
Regulation 6(4), 21(2), 30(6), 39(3), 51(3), 74(3), 90(3), 105(2), 114(6), 124(3), 136(3), 147(3), 159(3), 173(3), 190(2), 203(3), 218(2), 228(3), and 240(3)

# APPLICATION CERTIFICATE

**CODE:** 

| | | | |
|---|---|---|---|
| **Full Name of Applicant** | | | |
| **Postal Address** | | | |
| **Registered Office Address** | | **Email Address** | |
| **Fixed Phone Line #** | | **Facsimile #** | |
| **Type of Mineral Right Applied for** | | **Location of Concession** | |
| **Type of Transaction** | | | |
| **Submission Date** | ………../………./……. | **Submission Time** | ………..:……….:……. |
| **Submitted by Name & Signature** | | **Certificate issued by: Name & Title of Officer** | |

**The Mineral Titles Department of the Commission certifies that the above referenced application and supporting documents have been received and recorded in the Priority/ General Register.**

…………………………….………. **Dated** ………… **Day of** ………………..……… **20**………
**Signature & Stamp**

------------------------------------------------------------

#12 Switchback Road Residential Area, Cantonments, P. O. Box M248 Accra-Ghana
Tel: 233 302 772783,779823, 773053, 771318 Fax: 233 302 773324
Website: www.ghana-mining.org Email:Mincom@mc.ghanamining.org

Minerals and Mining (Licensing) Regulations, 2012 (L.I. 2176)
FORM 2
Regulation 6(4), 21(2), 30(6), 39(3), 51(3), 74(3), 90(3), 105(2), 114(6), 124(3), 136(3), 147(3), 159(3), 173(3), 190(2), 203(3), 218(2), 228(3), and 240(3)

# APPLICATION CERTIFICATE

**CODE:** 

| | | | |
|---|---|---|---|
| **Full Name of Applicant** | | | |
| **Postal Address** | | | |
| **Registered Office Address** | | **Email Address** | |
| **Fixed Phone Line #** | | **Facsimile #** | |
| **Type of Mineral Right Applied for** | | **Location of Concession** | |
| **Type of Transaction** | | | |
| **Submission Date** | ………../………./……. | **Submission Time** | ………..:……….:……. |
| **Submitted by Name & Signature** | | **Certificate issued by: Name & Title of Officer** | |

**The Mineral Titles Department of the Commission certifies that the above referenced application and supporting documents have been received and recorded in the Priority/ General Register.**

…………………………….………. **Dated** ………… **Day of** ………………..……… **20**………
**Signature & Stamp**

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Form 4
Regulation 8(2), 23(2), 32(2), 41(2), 53(2),65(2), 76(2), 92(2), 107(2), 116(6), 126(6), 138(2), 149(2), 161(2), 175(2), 192(2), 205(2), 220(2), 230(2) and 242(2)

# NOTICE OF REJECTION OF APPLICATION

………………………………………………………………………………………………………………………..
**(*Name of Company*)**

………………………………………………………………………………………………………………………..
**(*Address of Company*)**

**We refer to your application for ……………………………………………………..…………………………, dated**
***(Type of Mineral Right)***
**……. day of ……………………….. 20…… received at the Commission on …..…. day of ………………………….. 20……**

**Your application has been rejected for the following reason(s):**
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………

**………………………………………… ………………………………. ……………………**
**Director Responsible for Mineral Titles Signature & Stamp Date**
**FOR: Minister Responsible for Mines**

#12 Switchback Road Residential Area, Cantonments, P. O. Box M248 Accra-Ghana
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Minerals and Mining (Licensing) Regulations, 2012(LI 2177)
Form68
Regulation 202(1)

# APPLICATION FOR SMALL SCALE MINING LICENCE

## SECTION 1: APPLICANT'S IDENTIFICATION DATA

| TYPE OF APPLICANT |
|---|
| ☐ Individual ☐ Mining Group ☐ Co-operative Society ☐ Registered Enterprise/Venture ☐ Registered Company |

## SECTION 1A: INDIVIDUAL APPLICANT'S IDENTIFICATION DATA

| | | | |
|---|---|---|---|
| **Full Name of Applicant** | | | |
| **Evidence of Ghanaian Nationality** (*Please attached a photocopy*) | ☐ Passport<br>No: | ☐ Voter Identity<br>No: | ☐ National Identity Card<br>No: |
| **Postal Address** | P. O. Box | **Registered Residential Address** | |
| **City/Town/Village** | | **Email Address** | |
| **Region** | | **Website** | |
| **Fixed Phone Line #** | | **Facsimile #** | |
| **Date of Birth** | | **Place of Birth** | |

## SECTION 1B: GROUP APPLICANT'S IDENTIFICATION DATA

| | | | |
|---|---|---|---|
| **Mining Group/Co-operative Society/ Registered Enterprise or Venture/ Registered Company Applicants** | | | |
| **Full Name of Mining Group/ Co-operative Society/ Registered Enterprise or Venture/ Registered Company Applicants** | | | |
| **Postal Address** | P. O. Box | **Facsimile #** | |
| **City/Town/Village** | | **Email Address** | |
| **Region** | | **Website** | |
| **Fixed Phone Line #** | | **Mobile Phone Line #** | |

## SECTION 2: MINERAL RIGHTS DETAILS

| | | | | | |
|---|---|---|---|---|---|
| **Address of Metropolitan /Municipal/ District Assembly of the Area** | | | | **Estimated/Projected Weekly Production** | |
| **Traditional Council of the Area** | | | | **Name of Nearest Town** | |
| **Number of Blocks Applied for** | | **Approximate size of the Area Applied for (sq km)** | | **Mineral (s) for which it is intended** | |
| **Capital for Mining** | | | | | |
| **Area of Interest** | | | | | |
| **Metropolitan /Municipal/ District AssemblyRecommendation** | | | | | |

…………………………………. …………………………….. ……/………/…………
Signature Full Name Date

……………………………………………….

| TOPOGRAPHIC MAP REFERENCE | | | |
|---|---|---|---|
| Field Sheet (s) Numbers | | Code | |

Please provide coordinates for the Perimeter/Area below and attach a Site Plan/Map:

| | Latitude | | | | | | | | | | Longitude | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deg. | | Min. | | Sec. | | | | | | Deg. | | Min. | | Sec. | | | | |
| 1 | | | | | | | | | | 1 | | | | | | | | | |
| 2 | | | | | | | | | | 2 | | | | | | | | | |
| 3 | | | | | | | | | | 3 | | | | | | | | | |
| 4 | | | | | | | | | | 4 | | | | | | | | | |
| 5 | | | | | | | | | | 5 | | | | | | | | | |
| 6 | | | | | | | | | | 6 | | | | | | | | | |
| 7 | | | | | | | | | | 7 | | | | | | | | | |
| 8 | | | | | | | | | | 8 | | | | | | | | | |
| 9 | | | | | | | | | | 9 | | | | | | | | | |
| 10 | | | | | | | | | | 10 | | | | | | | | | |

Site Plan or Map attached Yes ☐ No ☐

I ……………………………………………, solemnly and sincerely declare that the above information
(*Applicant/Representative*) submitted is true and correct to the best of my knowledge.

……………………………… ……/………/…………
Signature/Thumbprint Date

SECTION 4: DOCUMENTS SUBMITTED BY APPLICANT (OFFICIAL USE ONLY)

| | |
|---|---|
| ☐ 25Copies of Site Plan<br>☐ Cartographic Search Report (*Where Applicable*) | ☐ Receipt of Payment for Application Form<br>☐ Evidence of Payment of Prescribed Application Processing Fee (Receipt #: ……………………) |
| Individual or Group of Individuals<br>☐ Any form of national identificationincluding a Passport, Voter's identity card, or National identity card<br>☐ Two (2) Passport Size Pictures | Members of Groups, Societies, Associations or Co-operatives<br>☐ Certified copies of incorporation documents or documents showing registration as a cooperative society<br>☐ Rules governing the conduct and relationship of members of groups, societies, associations or cooperatives as the case may be |
| Registered Enterprise/Venture (*which has mining listed as its core business*)<br>☐ Certificate ofRegistration & Form A | |
| Registered Company (*which has mining listed as its core business*)<br>☐ Certificate of Incorporation, Certificate toCommence Business&Companies Codes 1963 (ACT 179). | |

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Minerals and Mining (Licensing) Regulations, 2012 (L.I. 2176)
Form 69
Regulation 210(1)

# NOTICE OF GRANT OF SMALL SCALE MINING LICENCE

…………………………………………………………………………………………………………………………
**(*Name of Company*)**

…………………………………………………………………………………………………………………………
**(*Address of Company*)**

**We refer to your application for a small scale mining licence in the ……………………….. area of the …………………. Municipality/District of the ………………………………. Region dated the ……… day of ……….. 20….. and received by the Commission on the ……… day of ……….. 20…..**

**We wish to inform you that the Minister has approved the recommendation for the grant of your application.**

**The small scale mining licence will be issued subject to the payment of the following fees:**

1. **Mineral Right Fee of ………………….(*Amount in words*) payable to the Minerals Commission and;**
2. **Annual Ground Rent of ……….……….(*Amount in words*) payable to the Administrator of Stool Lands, Accra.**

**You are hereby required to pay the applicable fees and notify the Minerals Commission in writing of your acceptance or otherwise of the grant within sixty (60) days of the date of this Notice.**

**If the grant is not accepted within the specified period the grant will be revoked.**

**NB. A legal representative of the Company (i.e. *a Director/Group Leader*) and a witness are required to call at the offices of the Minerals Commission to sign all relevant documents, after full payment of the fees specified above.**

……………………………………… ………………………………. ……………………
Director Responsible for Mineral Titles Signature & Stamp Date
FOR: Minister Responsible for Mines

This Artisanal and Small Scale Mining (ASM) Handbook has been written to help improve the performance of Artisanal and Small Scale Mining (ASM) operators in Ghana. Every chapter responds to needs and issues that the female and male miners have said are important to them.

Artisanal and Small Scale Mining (ASM) operators throughout Ghana face many challenges, the most important being lack of training and information in:

- Geology
- Mining methods
- Mineral processing methods
- Business skills to improve mining operations
- Safety and health practices
- Environmental management.

GEUS

Co-founded by European Union and
by the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development IGF

IGF

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