REPUBLIC OF MALAWI

Ministry of Natural Resources, Energy and Mining

Artisanal and Small-Scale Mining Handbook for Malawi

with a regional prespective

Edited by the
Geological Survey of Denmark and Greenland
April 2019

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 Malawi is the result of a training session held in Lilongwe, Malawi in November 2018 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 Malawi, is solely responsible for all results and conclusions presented, which do not necessarily reflect the positions of DG-DEVCO and IGF. However, each individual author is responsible for the scientific content of his/her chapter.

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CONTENTS

ABBREVIATIONS

ACEMP	Africa Centre for Energy and Mineral Policy
AIDS	Acquired Immune Deficiency Syndrome
ASM	Artisanal and Small-Scale Mining
BGRM	French Geological Survey
CF	Calonda Formation
CSO	Civil Society Organisation
DG-DEVCO	Directorate-General of Development and International Cooperation
DoM	Department of Mines
EAD	Environmental Affairs Department
EC	European Commission
EIA	Environmental Impact Assessment
EITI	Extractive Industries Transparency Initiative
EMP	Environmental Management Plan
EU	European Union
FDI	Foreign Direct Investment
GAM	Gemstone Association of Malawi
GDP	Gross Domestic Product
GEMMAP	Geological Mapping and Mineral Assessment of Malawi
GEUS	Geological Survey of Denmark and Greenland
GGM	Geita Gold Mine
GGSA	Ghana Geological Survey Authority
GSD	Geological Survey Department
GST	Geological Survey of Tanzania
HIV	Human Immunodeficiency Virus
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
IIED	International Institute for Environment and Development
ILO	International Labour Organisation
MAWIMA	Malawi Women in Mining Association
MCL	Mining Claim Licences
MNREM	Ministry of Natural Resources, Energy and Mining
MoITT	Ministry of Industry, Trade and Tourism
MP	Mineral Permit
MPF	Mining Policy Framework
NEPL	Non-Exclusive Prospecting Licence
OHS	Occupational Health and Safety
PanAfGeo	Pan-African Support to the EuroGeoSurveys-Organisation of African Geological Surveys Partnership
PML	Primary Mining Licences
PPE	Personal Protective Equipment
REEs	Rare Earth Elements
RML	Reserved Minerals Licences
SADC	Southern African Development Community
SMEs	Small and Medium Sized Enterprises
SODIAM	State Diamond Trading Company
SSML	Small Scale Mining Licence
STDs	Sexually Transmitted Diseases
TB	Tuberculosis
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
URT	United Republic of Tanzania
WASH	Water, Sanitation and Hygiene
WP3	Work Package 3

Source: John Tychsen, GEUS.

ASM mining site at Majiashaba in Northern Region. This is Aquamarine mining from a pegmatite vein.

ASM mining site at Majiashaba in Northern Region. This is aquamarine mining from a pegmatite vein. Chief Mining Engineer (DoM) George Maneya is providing assistance to the miners.

FOREWORDS

Ministry of Natural Resources, Energy and Mining

By Hon. Aggrey Masi (MP), Minister of Natural Resources, Energy and Mining

Source: MNREM

Malawi is endowed with several known mineral resources and occurrences, which are exploited at all levels of mining operations - ranging from large-scale through medium to artisanal and small-scale. Notable minerals in the country include uranium, niobium, heavy mineral sands, bauxite, graphite, rare earth elements, coal, limestone, dimension stones, iron sulphide, vermiculite, nickel, platinum group metals, gold, copper and gemstones. Despite the existence of such a potential most of the minerals mentioned remain largely underexplored and undeveloped.

ASM in Malawi has grown considerably over the years and is a source of livelihood for many rural settings; a source of construction raw materials, precious and semi-precious minerals; and exploits small deposits that are of little interest to large-scale mining operations. ASM largely operates in an informal setting, usually without legal licences; is unregulated; and ASM operators lack formal training in geology, mining and occupational health and safety. Such practices lead to great health risks, poor working conditions, environmental degradation, and illegal trading of the minerals.

The Government of Malawi has recognised mining as a sector that can lead to sustainable economic growth of the country as stipulated in the Malawi Growth and Development Strategy. To achieve this, several strategic steps are implemented by the Ministry of Natural Resources, Energy and Mining, such as a review of the Mines and Minerals Act of 1981, the Mines and Minerals Policy of 2013, and the approval of the first ever Artisanal and Small-scale Mining Policy of 2018. The review of the legislation instruments is a major step taken to effectively manage the sector. Furthermore, the Government is updating its existing geoscientific and mineral occurrence data through acquisition and interpretation of high resolution airborne geophysical data conducted between 2013 and 2016; remapping the geology of the country through Geological Mapping and Mineral Assessment Project (GEMMAP); and establishing a web-based Mining Cadastre System and Geological Data Management Information System at the Department of Mines and Geological Survey Department respectively for the efficient and transparent management of the mining sector and improve access to geoscience data.

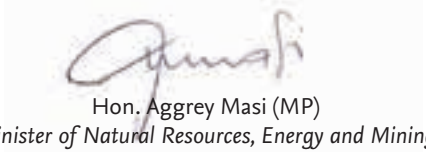
As such, the ASM Handbook for Malawi has come at the right time when the Government is implementing strategies targeting both ASM and large-scale mining activities in order to achieve sustainable socio-economic development of the country.

Source: John Tychsen, GEUS.

The ASM Handbook for Malawi is an invaluable guide book for the ASM sub-sector with information on mineral tenements, governance, environment, geology, mining, mineral processing, and value addition just to mention a few. This Handbook will help to improve and concretise ASM operations in the country and across borders.

The Handbook also draws experiences from other African countries regarding sustainable management of the ASM sector. The Handbook is easy to read and understand the concepts even to those that are not professional geoscientists.

Let me take this opportunity to thank the European Union (EU), through the PanAfGeo Project, for providing technical and financial support to produce the first ASM Handbook for Malawi and also to all contributors to this Handbook.



Hon. Aggrey Masi (MP)
Minister of Natural Resources, Energy and Mining

EU Delegation to Malawi

By H.E. Ambassador Sandra Paesen, Ambassador of the EU to the Republic of Malawi

Source: EU-Delegation to Malawi

A quarter of global GDP and half the World's population depend in one or the other way on the extractives sector. Africa alone is home to about 30% of the World's mineral reserves and much more is still to be discovered. The challenge for the African continent, like others before, is to ensure that this richness turns into a clean, sustainable industry, which generates economic growth, job creation and results in poverty reduction.

The European Union (EU) is committed to supporting sustainable development of extractive activities in developing countries worldwide and is a strong advocate of the Extractive Industries Transparency Initiative (EITI). Making these industries profitable is usually the fruit of a long process, where high research and start-up costs are being weighed against potential benefits. Legal angles and questions of sustainability will have to be addressed by government, stakeholders, shareholders and companies involving civil society in a transparent way to ensure that benefits generate true wealth, and not only short-term benefits.

Malawi is the first country in Africa where there is an Artisanal and Small-scale Mining (ASM) policy, which is an important legal framework to ensure that the mining sector can help generate growth in an equitable manner in Malawi. The rising value of mineral prices and the increasing difficulty of earning a living from agriculture and other rural activities play a role in explaining the growing interest of this industry. Indeed, there are approximately 100 million artisanal miners globally, of which an estimated 30% are women. The sector represents an important livelihood and income source for poverty affected and under-privileged local populations. It is due to this socio-economic importance for the poor that the ASM subsector is attracting increasing attention from governments, civil society, and development partners.

It is therefore of utmost importance to strengthen the capacities of institutions mandated to regulate ASM activities in order to streamline ASM operations, improve mining efficiency, generate growth, and create decent jobs for the miners themselves.

The EU co-funded PanAfGeo Project is supporting training of geo-scientific staff from African Geological Surveys through the development of an innovative training programme. The project has successfully delivered training to key stakeholders in Malawi with the aim of strengthening the capacity of regulatory agencies and the civil society actors involved in the ASM sector to assist and manage ASM operators in the country.

This ASM Handbook for Malawi is the result of the work of the Organisation of African Geological Survey and EuroGeoSurveys, and the Delegation of the European Union to Malawi appreciates the effort and work of these organisations in developing it. We trust this Handbook will become a useful reference for mining sector stakeholders in Malawi and beyond.

I wish you good readings and hope that you find this topic as interesting as I do!

Sandra Paesen
Ambassador of the European Union to the Republic of Malawi

African Union Commission

By H.E Ambassador Albert Muchanga, Commissioner Department of Trade and Industry

Source: Commision for Trade and Industry

In the recent past, Africans have taken important steps towards galvanizing the continent's transformation and sustainable development. The new dynamism is laying a strong foundation for our prosperity and with it, skills development that is critically required to achieve the vision and objectives of the African Union Agenda 2063: the Africa We Want. Skills and capacity building are strategic elements of empowerment to fish. This is what the PanAfGeo projects is all about"PanAfGeo" which is a partnership project between Euro-GeoSurveys and the Organization of African Geological Surveys (EGS and OAGS). It is working hand in hand with the National Geological Surveys for the training of geoscientific staff from African Geological Surveys. It is beingimplemented within the AU-EU Joint Partnership. It aims to increase Africanowned geological knowledge and skills for sustainable mineral resource development, infra- structure development as well as natural disaster prevention and mitigation.

In 2009, the African Union Heads of State and/or Government endorsed the Africa Mining Vision (AMV) as a blue print for ensuring that mineral resources (gas, liquid and solid) play their transformative role in the social and economic transformation of African economies to foster inclusive growth and sustainable development. The AMV is one of the key instruments for achieving commodity based industrialization and job creation, which is of critical importance to our youth. Ultimately, the AMV will generate wealth for all African nations and their nationals.

The PanAfGeo project will strengthen the geological sector in Africa through capacity building of national geological surveys to deliver on their mandate; increasing the activities of national geological surveys in regional mapping and exploration; strengthening the level of geological knowledge and skills in national geological surveys and strengthening OAGS' potential to meet the needs of the African continent.

In this regard, I would like to thank the EGS and OAGS and more specifically Mr. John Tychsen of ASSM Consult ApS, who is the Leader of Work Package Three (WP3) Training on Artisanal and Small-Scale Miners (ASM), assisted by Co-Leaders: Mr. Daniel Boamah of Ghana Geological Survey Authority (GGSA) and Mr. Jules Cesar Yaganza of Central African Republic Geological Survey for the job well done.

The African Union Commission is committed to the integration of the ASM into Regional and Global Value Chains and it is hoped that such training will go a long way to assist Member States such as Malawi in achieving this strategic objective.

H.E Ambassador Albert Muchanga
Commissioner Department of Trade and Industry

This is a kyanite mine at Kadzandira - Ntchisi in Central Region

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development

By Matthew Bliss, IGF Deputy Director, Programs

Source: IGF

Malawi's rich mineral endowment is reflected well in its peoples' and others' ASM activities. The past year or two have seen the Government establish formalisation consultancies, support and offer training, encourage and witness cooperatives and associations for miners, and engage in a difficult area of its economy. Recent challenges confirm that work remains, which is why the IGF is pleased to support Malawi in sustainable development of its mining sector together with the PanAfGeo Project and the Geological Survey of Denmark and Greenland (GEUS).

Together, and with this Handbook on ASM, developed by its trainees, Malawi continues to demonstrate to the World the importance of managing ASM in a manner benefitting miners, host communities, and citizens of the host country. Managing tensions and preventing conflict surrounding ASM remains a challenge, demonstrated by recent arrests of illegal miners and last year's death related to ASM. The effort remains consistent with the country's commitment to its sustainable development and poverty reduction goals and the IGF's Mining Policy Framework (MPF), which sets out concrete objectives and processes for good governance in the mining sector.

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). There are currently 64 member countries of the IGF, including Malawi.

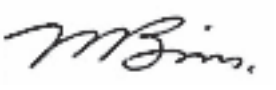
ASM is a top priority for IGF member governments, as demonstrated by the theme being voted as the inaugural guidance document by members. In October 2016, IGF released its Guidance for Governments: Managing Artisanal and Small-Scale Mining, designed to guide member countries to develop and implement an ASM strategy and related governance. Malawi was one the IGF members to pilot the implementation of the guidance at a regional workshop held in 2017, which provided 13 other IGF member governments with the opportunity to learn from Malawi's hard-earned ASM experience. Due to the success of this pilot, regional workshops have been requested for Francophone and Spanish members, in Cameroon and Dominican Republic, respectively during 2018.

Source: John Tychsen, GEUS.

What are our hopes for ASM in Malawi moving forward? Based on the Government's efforts, our own work and that of others, we look forward to learning with Malawi about: conducting formal dialogue with ASM actors; leveraging training of trainers to develop a strategy with miners and further train miners; undertaking efforts to formalise the sector, perhaps with the use of ASM zones; encouraging cooperatives and association; as well as improving transparency, accountability, and dialogue among stakeholders.

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, supported by EuroGeoSurveys and the Organisation of African Geological Surveys, coordinated by the French Geological Survey (BGRM), and funded by the European Commission (EC), GEUS, and the Malawi Geological Survey, and co-funded by IGF, has been delivered by GEUS and Malawi. The depth of coverage of this ASM Handbook is backed up by in-country training and experts from here and neighbouring countries.

Here is a practical Handbook, based on Malawi's ASM experience - use it as such; ask questions or provide comments to its authors. The collective governance of ASM is evolving, and we are pleased to partner on the delivery of this Handbook to help improve ASM's contribution to sustainable development and poverty reduction for the women, men, boys, and girls of host countries.



Matthew Bliss
IGF Deputy Director, Programs

Geological Mapping and Mineral Assessment of Malawi (GEMMAP)

By Thomas Fullgraf, GEMMAP Project Manager

Source: Thomas Fullgraf

In Malawi, ASM mainly concerns gems and precious stones, minerals from pegmatites, ornamental stones, carbonates and coal. Extraction and processing of these commodities are not new in Malawi, and industrial projects exist. Significant, but more dispersed, artisanal mining takes place mainly around major urban centres, where the main consumer markets are located. Mining and processing are mostly manual, with little mechanisation, and can involve anarchic uses of peri-urban lands.

The ASM sector has a significant potential to contribute towards the rapid economic growth and development of Malawi through rural job creation and provision of alternative economic activities. However, there are several challenges that exist in the sub-sector that need to be addressed, such as: limited access to modern technologies; capital for investment in mining; mineral value addition; and established markets. The ASM operators have inadequate marketing skills, their mining operations are informal, they are unable to understand geological information and usually disregard basic mining occupational health, safety (OHS) and environmental considerations.

The GEMMAP Project is an opportunity to provide technical support as an operational application of a policy to develop ASM in Malawi. The activities comprise: i) compilation of an inventory of ASM in Malawi; ii) assessment of the methods used by ASM operators, together with possible environmental challenges and environmental issues at the mining sites; iii) give recommendations for their improvement; and iv) provide training related to gemstone activities. More specifically, the three examples given in the following, demonstrate these activities.

Formalisation is the process or a way of making the informal ASM sector become formal or operate within the legal framework, which has a high priority in the Government of Malawi. GEMMAP is supporting the Department of Mines, in collaboration with the Ministry of Industry, Trade and Tourism, to increase the number of ASM groups to be formalised and through this obtain additional support from the Government.

The gemstone sector is very important in Malawi. The export of gemstones requires evaluation of their quality and value by the Geological Survey Department (GSD). To guarantee that such evaluation complies with international standards, GEMMAP has sent a geologist of the GSD for training to IGM in Madagascar. The GSD will therefore soon have an expert with an internationally recognised certificate for gemstone evaluation.

The World Bank-funded Mining Governance and Growth Support Project has supported the mining sector in Malawi for some years but is now terminated. GEMMAP's training in lapidary, formalisation etc. is in line and continues this work.

The present ASM Handbook is a valuable contribution from a third partner, the PanAfGeo Project, to achieve these goals and I hope it will serve as an important tool for both the small-scale miners and decision makers in Malawi and contribute to the improvement of the ASM sector.

Thomas Fullgraf
GEMMAP Project Manager

ACKNOWLEDGMENTS

By John Tychsen, Director of ASSM Consult ApS and ASM Handbook Editor

Source: GEUS.

Malawi's new Mines and Mineral Law of 2018 was approved by the Parliament in late 2018. This is a big achievement and will provide the Government with a modern tool to develop the mining sector in Malawi. Further, the Cabinet approved the National Artisanal and Small-Scale Mining Policy of 2018, which has been under development for a couple of years as a participatory process. At present, Malawi is the only country in Africa, which has an ASM policy to guide the future development of the ASM sector.

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:

H.E. Ambassador of the European Union to the Republic of Malawi, Sandra Paesen; Director of Mines, Jalf Salima; Acting Director of Geological Survey Department, Kondwani Dombola; and Deputy Director of IGF, Matthew Bliss, who all recognised the importance of the ASM sector in their foreword to this Handbook.

The relatively large group of Malawian experts and academics, who have 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 Natural Resources, Energy and Mining (MNREM), the Ministry of Industry, Trade and Tourism (MITT), the Universities and representatives from the ASM community, who actively participated and provided relevant input to the discussions during the training workshop in Lilongwe, Malawi.

The participants from the national geological surveys of Ethiopia, Kenya, Tanzania, Sudan, Rwanda, Angola and Mozambique, who provided valuable regional input to the discussions on the ASM sector in Malawi as well as the future role of a national geological survey in the support to the ASM sector.

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

John Tychsen
Director of ASSM Consult ApS and ASM Handbook Editor

INTRODUCTION

By Jean-Claude Guillaneau, Programme Coordinator, PanAfgeo project and International Manager BRGM

Source: BRGM

The PanAfGeo initiative facilitates the training of geoscientific staff from 54 African Geological Surveys via training programmes conceived and conducted by 12 European Geological Surveys.

Dr. Daniel Boamah, Director of Ghana Geological Survey Authority (GGSA), hosted the first WP3 Workshop on ASM in Accra, Ghana in October 2017 with a total of 56 trainees. We were pleased to also welcome trainees from national Geological Surveys in Gambia, Sierra Leone, Nigeria and Liberia. The ASM Handbook for Ghana received praise by Hon. John-Peter Amewu, Minister of Lands and Natural Resources, Ghana.

Mr. Chipilauka Mukofu, Director of Geological Survey Department (GSD) of the Ministry of Mines and Minerals Development, Zambia, hosted the second WP3 Workshop on ASM in Lusaka, Zambia. We were pleased to also welcome trainees from the national Geological Surveys in Namibia, South Africa, Swaziland, South Africa, Botswana, Malawi and Zimbabwe. The ASM Handbook for Zambia was applauded by Hon. Richard Musukwa, Minister of Mines and Minerals Development, Zambia at the launch of the workshop.

The 3-year (2017-2019) Pan-African Cooperation Programme facilitates 45 training sessions for app. 1,200 geoscientists from the 54 African countries. The PanAfGeo Project has a budget of EUR 10.3 million and is co-funded by the EU, through DG- DEVCO and a consortium of 12 European Geological Surveys, managed by BRGM. The PanAfGeo Project allows trainees to acquire a state-of-the-art tool kit and the opportunity to take part in field trips within eight domains: Geoscientific Mapping, Mineral Resources Assessment, ASM, Environmental Management of Mines, Geohazards, Geoheritage, Geoinformation Management, and Communication and Promotion.

The WP3 is a training programme specifically on ASM to be implemented in four countries with regional participation. The WP3 is spearheaded Dr. John Tychsen of GEUS and co-directed by Dr. Daniel Boamah of GGSA. The deputy co-lead is Mr. Jules César Yaganza Director of the Geological Survey Department in the Central African Republic. To extend the learning process and number of beneficiaries, a country specific ASM Handbook, intended to serve as a guide on how to benefit from geological survey involvement in the ASM sector.

The WP3 objective is to train staff of the national geological surveys, the regulatory agencies and the universities involved in the ASM sector in order to strengthen their capacity to assist ASM operators in their respective countries. 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 to ensure more profitable, efficient, environmentally friendly, safe and sustainable mining operations in the countries concerned. In an effort to encourage regional input, PanAfGeo WP3 always invites trainees from Geological Surveys in neighbouring countries.

The third WP3 training workshop on ASM, held in Lilongwe, Malawi was hosted by Mr.Kondwani H.A. Dombola, Acting Director, Geological Survey Department (GSD) of the MNREM in Malawi. We were pleased to have trainees from the national geological surveys in Ethiopia, Kenya, Tanzania, Sudan, Rwanda, Angola, Congo DRC and Mozambique. The Hon. Aggrey Masi (MP) Minister of Natural Resources, Environment and Mining, Malawi praised this ASM Handbook for Malawi during the official opening of the workshop and stated that the Ministry looks forward to distributing the ASM Handbook to a large number of stakeholders in Malawi. In Malawi, we were pleased to work in cooperation with the French funded Geological Mapping and Mineral Assessment Project (GEMMAP). providing a whole country geological mapping of Malawi and an extensive geochemical mapping as well as an inventory of the ASM sector in Malawi.

The next ASM training workshop will be a regional workshop in French for the French speaking countries in Western Africa. The training will be in Dakar in Senegal on 17 to 20 of June and be hosted by Dr Rokhaya Samba DIENE, Director of the Geological Survey of Senegal (Directrice de la Prospection et de la Promotion Minière). Following the training a regional ASM handbook for Western Africa will be produced (GUIDE PRATIQUE. La mine artisanale en Afrique de l'Ouest francophone).

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

Jean-Claude Guillaneau
Programme Coordinator, PanAfgeo project and International Manager BRGM

OBLIGATIONS OF THE MALAWI GEOLOGICAL SURVEY DEPARTMENT

By Kondwani H.A.Dombola, Acting Director of the Geological Survey Department

Introduction

The Malawi GSD is one of the seven technical departments within MNREM. The other six departments within the Ministry are:

- Mines Department;
- Energy Department;
- Environmental Affairs Department;
- Parks and Wildlife Department;
- Forestry Department; and
- Climate Change and Meteorological Department.

The primary objective of Malawi GSD is to expedite the development of mineral resources of the country. This is achieved through regional geological mapping and reconnaissance mineral exploration and prospecting. Ground water exploration, which was previously a mandate for GSD, is delinked from GSD and is currently with the Department of Water Affairs within the Ministry of Agriculture, Irrigation and Water Development.

The Mandate, Mission and Vision of GSD are:

- **Mandate:** To collect, assess, disseminate and archive all geo-scientific data related to geology and minerals resources of the country in order to foster mineral resource development.
- **Mission:** To acquire, monitor, update, archive and disseminate geo-scientific information of Malawi in order to foster socio-economic development.
- **Vision:** To be a dynamic institute of excellence that is innovative, self-motivated, developmental oriented and responsive to the clients' needs for geo-scientific development.

Organisational Structure of GSD

GSD, previously known as Geological Survey of Nyasaland, was established in 1922 by the British Colonial Government, which recruited the first geologist in 1918. Its headquarters is in Zomba with two regional offices in Lilongwe and Mzuzu. The department has six stations in: Bangula in Nsanje, Feremu in Mwanza, Chileka in Blantyre, Linthipe in Dedza, Mponela in Dowa and Bunda in Lilongwe.

At the helm of GSD is the director, who is deputised by three deputy directors within its three main technical divisions, namely the Geological Services Division, the Mineral Exploration and Evaluation Division, and the Geoscientific Research and Laboratories Division.

The Geological Services Division is entrusted with regional geological mapping of the country, environmental geology and seismology, and cartography, library (geodata unit). The Mineral Exploration and Evaluation Division is mandated to conduct all exploration activities e.g. geochemistry, geophysics, drilling etc. Finally, the Geological Research and Laboratories Division mainly deals with all chemical analytical studies, lapidary services and industrial research.

Core Functions of GSD

GSD's major functions can be summarised as follows:

- Conducting systematic mapping and documentation of the geology of Malawi;
- Carrying out mineral exploration to unveil the mineral potential of the country;
- Mapping and documenting geological hazards for proper land use planning and instituting possible mitigation measures;
- Providing laboratory services to the general public, other government institutions and the private sector;
- Collecting, updating, curating and disseminating geo-scientific data;
- Providing technical services to ASM operators in prospecting and mineral identification;
- Undertaking collaborative geo-scientific research with local and international institutions;
- Providing technical and advisory services to the general public, other government institutions and the private sector on geo-scientific matters; and
- Promoting the mineral resources of the country.

Specific Role of GSD in ASM Operations

Like most countries in Africa, Malawi has a lot of ASM activities, which usually operate in an informal setting and without social and environmental consideration. Commonly known ASM operations in the country include: gemstone mining, gold panning, stone aggregate quarrying, limestone and marbles, kaolinitic clay mining for ceramic ware production, salt making, brick making and sand mining among others. Despite the sector largely being informal, the Government, through GSD and the Department of Mines (DoM), has a very huge role to play in order to improve operations of the sub-sector. GSD specifically assists in the development of the ASM sector in Malawi in the following ways:

- Providing geological information to all parties interested in mining, including ASM;
- Collaborating with DoM in provision of training to ASM operators in areas such as prospecting, health and safety and sustainable mining etc.;

- Providing laboratory services for mineral identification for ASM operators;
- Providing certificates of inspections to ASM operators, which enable them to get export permits from the Commissioner of Mines and Minerals; and
- Assisting ASM operators in interpreting potential prospecting areas, on request.

Conclusion

Most of the ASM activities operate at an individual level and usually very informal. This is a challenge, since the Government is unable to provide the much needed support in such operations. Due to limited budget by most ASM activities, there is no substantial exploration of mineral deposits in this sub-sector. This implies lack of sustainability of most of the activities. It is therefore imperative that GSD is given extra mandate and financial support to deliberately explore and delineate most potential deposits that can be exploited by the ASM sector. Additionally, this would help in updating the existing inventory within DoM, which can then be used by the ASM sector for exploitation purposes.

Source: John Tychsen, GEUS.

ASM Mining at Kacheule, This is a rose quartz mine with limited activity at present

OBLIGATIONS OF DEPARTMENT OF MINES

By Jalf William Salima, Director of Department of Mines

Obligations of the Department of Mines

DoM, established in 1983, is headed by a Director of Mines; appointed from within the ranks of the Civil Services. DoM works closely with GSD and the Commissioner for Mines and Minerals. Other relevant departments include the Environmental Affairs Department (EAD) and the Ministry of Finance and Economic Development.

DoM is divided into three main Technical Divisions and an Administration and Accounting Division, namely:

- Minerals Development and Planning;
- Mining Inspectorate;
- Mineral processing and Analytical Laboratory Services; and
- Administration and Accounting.

The Mandate, Mission and Vision DoM are:

- **Mandate:** To promote and facilitate sustainable mining development and utilisation of the country's mineral resources;
- **Mission:** To coordinate, facilitate, and promote participation of all stakeholders in the sustainable development, utilisation, and management of mineral resources for socio-economic growth and development; and
- **Vision:** To become a vibrant institution that promotes exploration, sustainable exploitation and management of mineral resources.

The core functions of DoM are to:

- Disseminate information and promote minerals in Malawi for investment and mining;
- Provide technical support to ASM operators to exploit mineral deposits suitable for ASM operations;
- Facilitate orderly, accident-free, safe and sustainable mining operations;
- Encourage development of ASM-based industries;
- Conduct research in mineral processing and assist operators in ensuring uninterrupted mineral production;
- Provide value-adding services and promote marketing of resultant products; and
- Ensure the safe use of explosives in compliance with the Explosive Act.

Obligations of the Commissioner for Mines and Minerals

The Commissioner for Mines and Minerals is mandated to administer the Mines and Minerals Act of 1981. The State President appoints the Commissioner. The Office of the Commissioner works closely with DoM, especially the Minerals Development Division.

The core functions of the Commissioner for Mines and Minerals are to:

- Provide technical advice and guidance in the administration of the Mines and Minerals Act;
- Coordinate implementation of the Mines and Minerals Policies and Strategies;
- Periodical review of the mining legislation and the Mines and Minerals Policy and Strategies to ensure consistency with the overall national development policy and other sectoral policies;
- Recommend to the Minister for the issuance, cancellation, suspension and renewal of licences for mineral rights to mineral exploration and mining companies on the recommendation of the Mineral Licencing Committee;
- Issue Non-Exclusive Prospecting Licences (NEPL), Mining Claim Licences (MCL), Mineral Permits (MP) and Reserved Minerals Licences (RML);
- Inquire and decide on all disputes between parties involved in mineral prospecting and mining; and
- Maintain a mining cadastre system for orderly exploration and mining operations in the country.

Mining site at Majiashaba in Northern Region. The miners are using terracing to reduce the risk for collapse.

OBLIGATIONS OF THE ENVIRONMENTAL AFFAIRS DEPARTMENT

By Tawonga Mbale-Luka, Director of Environmental Affairs

EAD of MNREM is responsible for promoting, coordinating, monitoring and overseeing compliance with the environment and natural resources programmes, policies, and legislation to ensure sustainable development and poverty reduction.

EAD's long-term vision is to provide excellent services with regard to compliance and to facilitate integration of environmental concerns into sectoral policies, plans and programs to ensure sustainable development.

EAD is responsible for ensuring sound environmental management, conservation and sustainable utilisation of natural resources through the integration of environmental considerations into development planning, design and implementation. In terms of mining, EAD is committed to ensuring safe and sustainable mining through the provision of environmental education and awareness to ASM operators, facilitation of environmental assessments, and environmental compliance monitoring of ASM activities in the country.

MNREM is mandated to protect and foster management, development and sustainable utilisation of natural resources and environment. This mandate is implemented through its specialised departments of Environmental Affairs, Mines, Geological Surveys, Energy Affairs, Climate Change and Meteorological Services, National Parks and Wildlife and Forestry.

Functions of EAD in Relation to ASM

Environmental Policy and Legislation

EAD has a duty enshrined in the Environment Management Act of 1996 to:

- Promote the right to a clean and healthy environment;
- Formulate and implement policies for the protection and management of the environment and the conservation and sustainable utilisation of natural resources. This includes policies for the sustainable utilisation of minerals exploited by ASM operators;
- Prepare plans and develop strategies for the protection and management of the environment and the conservation and sustainable utilisation of natural resources; and
- Support integration of environmental and social issues in mining through environmental assessment, environmental audits and compliance monitoring.

It is worthwhile to note that the Environment Management Act of 1996 has recently been revised to take into account emerging issues and current trends in approaches to sustainable use and management of natural resources and the environment.

Source: John Tychsen, GEUS.

Environmental Education and Awareness

EAD has a dedicated Division for Environmental Information, Education and Outreach that provides environmental awareness and education on the benefits of sustainable environmental management, including the consequences of misuse of natural resources.

Considering that ASM operators are predominantly local people with limited education, EAD will endeavour to reach out to them in a bid to actively involve them in the protection of the environment and sustainable utilisation of the mineral resources.

Environmental Assessments

Section 24 of the Environment Management Act of 1996 requires that all development projects, including mining projects, undergo Environmental Impact Assessments (EIAs) prior to commencement. Currently, the ASM sector in Malawi is not regulated as such there are no EIAS conducted before the start of an ASM operation. EAD will require EIAs for all ASM operations once the sector becomes formalised and DoM starts issuing permits.

Environmental Inspections and Monitoring
EAD conducts environmental inspections of mining operations mainly to check compliance of mine operators to Environmental and Social Management Plans contained in EIAs. Inspections are also conducted to check compliance to national and international legislation and standards.

EAD will conduct environmental inspections of all ASM operations in the country. This will be easy once all ASM operations start to conduct EIAs. EAD will also endeavour to monitor existing ASM areas across the country.

Other obligations of EAD

- Review mining sector specific EIA guidelines to include ASM operations;
- Train ASM operators on the promotion of sustainable ASM and best practices in the ASM sector; and
- Provide technical support for rehabilitation of ASM areas, including legacy sites.

Photo: John Tychsen, GEUS

A Tourmaline mining site at Kauta in Central Region.

Accredited Gemmologist Rodrick Phiri from DoM is investigating tourmaline from Kauta mining site in Central Region.

BASIC GEOLOGY – A GUIDE TO DISCOVER MINERAL DEPOSITS

By Nathan S. Banda, Chief Geologist, Geological Survey Department

The Earth

Planet Earth is believed to have formed by the accretion of primordial solar material similar in composition to chondrites. The Earth has had a long history of about 4.5 billion years (Klein & Philpotts, 2016). The main evidence for the internal structure of the Earth comes from the study of the paths and velocities of seismic compressional (P) and shear (S) waves passing through the Earth. The Earth's radius is 6,371km and the major divisions of the earth are: the core, mantle and crust, as illustrated in Figure 1 below.

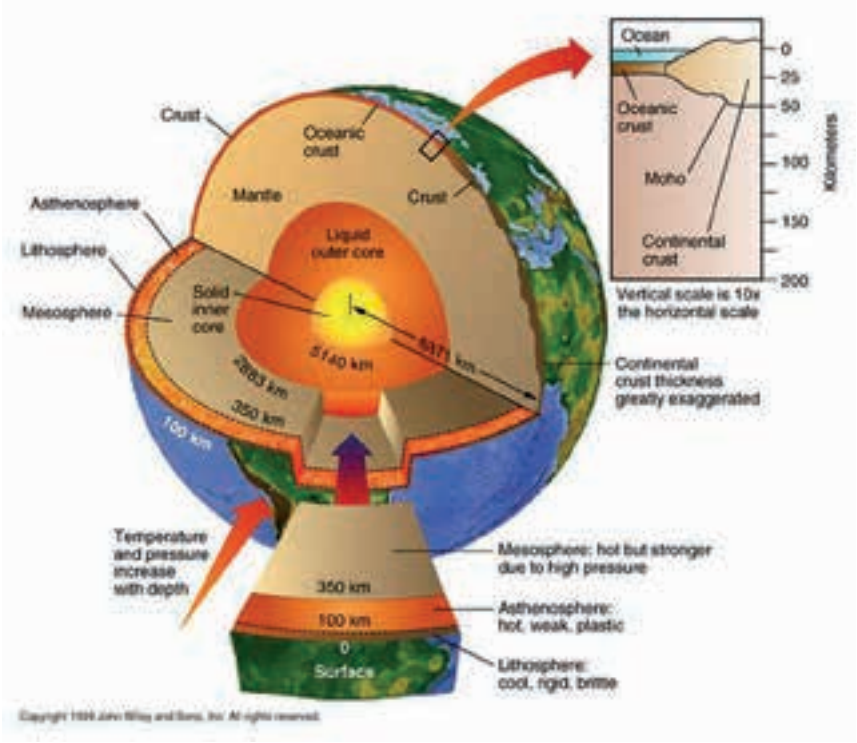


Figure 1: Earth's Internal Structure

Source: https://aplanetruth.info, "#29 How Does Science Know the Earth's Core?"

Photo: John Tychsen, GEUS

The inner core of the Earth is believed to be a solid pressure-frozen sphere of iron and nickel suspended within a molten outer core of similar composition. This core is slowly crystallising from the centre and as the liquid in the outer core crystallises onto the inner core it liberates the latent heat of crystallisation of iron and nickel, which helps to drive the convection cells in the outer core. This is where the Earth's magnetic field is generated. The core is about 240km thick and thus consists of about 3% of the Earth's total mass. Above the core lies the largest unit in the Earth, the mantle. Although the mantle is solid, it behaves like a plastic material that slowly convects. A major discontinuity between the outer core and the lower mantle is known as the "D" layer or Gutenberg Discontinuity.

The constituents of the lower mantle are believed to be mainly silicon, magnesium, and oxygen with smaller amounts of aluminium, calcium and iron.

The upper mantle is bounded on its lower side by the 660km seismic discontinuity. The region between this depth and another prominent discontinuity at 410km is called the "Transitional Zone". The upper mantle terminates at the base of the crust at the prominent Mohorovicic discontinuity.

The crust is the outermost layer of the Earth. The Earth's crust is primarily composed of lighter minerals formed by lighter elements. The crust is from 25 to 70km thick beneath continents and 7 to 10km thick beneath oceans. The rocks in the continental crust are less dense than those in the oceanic crust, and a result of isostasy (buoyancy), continents stand higher than ocean floors (Klein & Philpotts, 2016). Oxygen (O) and silicon (Si) are the most abundant elements in the Earth's crust and the mantle.

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

Minerals are solid, inorganic elements or elemental compounds. These have definite atomic structures and chemical compositions, which vary within fixed limits. However, exceptions include mercury and opal (Pellant, 2000). Rocks on the other hand are aggregates of minerals. Minerals are sometimes grouped according to their chemical composition and their crystal structure, as described below. Native elements refer to free uncombined elements, among other gold and silver.

Mineral Characteristics/Identification

Minerals exhibit a number of properties that are used for identification, such as:

- **Crystal Systems:** The geometrical shapes in which minerals crystallise are organised according to their symmetry into six main groups called crystal systems, namely: cubic, tetragonal, orthorhombic, monoclinic, triclininc and hexagonal (trigonal).
- **Habit:** This refers to the characteristic appearance of a crystal that is determined by its predominant form. Several descriptive terms to identify a crystal's habit are used. These

include prismatic (shows a uniform cross section/terminated prisms), acicular (slender needle-like masses), dendritic (plant-like shape), bladed (looks like a blade of a knife), massive (indicates no definitive shape) or reniform (rounded kidney shaped masses).

- **Twinning:** This refers to parallel symmetrical intergrowth of two or more crystals of the same species. It can occur by contact or interpenetration. Multiple and polysynthetic twins involve more than two individual crystals.
- **Cleavage:** This refers to the way a mineral breaks along well-defined planes of weakness. Often the planes are between layers of atoms or other places where the atomic bonding is weakest. Cleavage surfaces are not perfectly smooth like crystal faces though they are very consistent and reflect light evenly. Cleavage is described as perfect, distinct, indistinct or none.
- **Fracture:** When a mineral breaks and leaves rough and uneven surfaces, it is referred to as fracture. Most minerals fracture and cleave but some will only fracture. Common fracture terms include: uneven, conchoidal (shell like), hackly (jagged), and splintery.
- **Hardness:** The hardness of a mineral is its resistance to being scratched. The scale of hardness ranges from 1 to 10 and was devised by Fredrick Mohs. Minerals with higher Mohs' numbers will scratch those lower in the scale, ref. Figure 2 below.
- **Specific Gravity:** Comparing the weight of a mineral with the weight of an equal volume of water gives a mineral's specific gravity. A specific gravity of 2.5 indicates that the mineral is two and half times as heavy as water
- **Colour:** This refers to the colour of a mineral as seen in natural light. Although this helps in identifying those minerals with characteristic colours, there are pitfalls in relying solely on this feature because many minerals occur in a variety of colours while a larger number of minerals are either white or colourless.
- **Streak:** This refers to the colour of a mineral's powder. This is determined by rubbing a specimen across a surface of an unglazed porcelain tile. Streak is a better diagnostic feature than just colour since it is far more consistent.
- **Transparency:** This refers to the way in which light passes through a mineral specimen. This property depends on the way mineral atoms are bonded. When light passes through a mineral clearly it is referred to be transparent, when it cannot be clearly seen then it is translucent and when it cannot pass through a specimen then it is referred to be opaque.
- **Lustre:** This describes the way light is reflected off a mineral's surface. The type and intensity of lustre vary according to the nature of the mineral's surface and the amount of light absorbed. Descriptive terms for lustre include: dull, metallic, silky, vitreous, greasy and pearly.

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 2. Mohs Scale of Hardness.

Types of Minerals

Minerals can be grouped or sub-divided on the basis of their two fundamental characteristics: composition and crystal structure. Using this classification system, minerals are referred to as silicates or non-silicates (Montgomery, C. W., 1992).

Silicates

These are compounds containing silicon (Si) and oxygen (O) atoms that have bonded together to form silica tetrahedra. Most of the compounds contain other elements as well. This is the largest group of minerals. Because this group is so large, it is further sub-divided on the basis of crystal structure, by the ways in which the silicon and oxygen atoms are linked together (Hefferan & O'Brien, 2010).

Six major silicate groups are distinguished based upon the linkage patterns of silica tetrahedra. These include: nesosilicates, sorosilicates, cyclosilicates, inosilicates, phyllosilicates and tectosilicates.

Nesosilicates also known as "island silicates" are characterised by isolated silica tetrahedra that are not linked to other silica tetrahedra through shared oxygen ions. Minerals in this group include: garnet, olivine, kyanite, sillimanite and andalusite.

Sorosilicates contain pairs of silica tetrahedra linked through shared oxygen ions, e.g. epidote. In cyclosilicates, also known as "ring silicates", each silica tetrahedra is linked to two others through shared oxygen ions into ring shaped structural units. Minerals in this group include: beryl, tourmaline and cordierite.

In single chain inosilicates, each silica tetrahedra is linked through shared oxygen anions of two other silica tetrahedra in the form of a long, one-dimensional chain-like structure e.g. pyroxene group of minerals. On the other hand, when two chains are linked through shared oxygen anions, a double-chain inosilicate structure is formed.

When chains are infinitely linked to one another through shared oxygen anions, a two-dimensional sheet of linked silica tetrahedra is formed which is the basic structural unit of phyllosilicates ("sheet silicates"). Minerals in this group include: talc, clays, members of mica group and serpentine.

Finally, when silica tetrahedra are linked to adjacent silica tetrahedra by sharing all four oxygen anions, a three-dimensional framework of linked silica tetrahedra is formed. This is the basic structure of tectosilicates ("framework silicates"). Examples of minerals in this group are feldspars, nepheline, leucite and sodalite.

Non-Silicates

These are defined by chemical constituents or characteristics that all members of the group have in common. Most often, the common component is the same negatively charged ion or group of atoms.

Carbonates contain carbon and oxygen combined in the proportion of one carbon atom to three oxygen atoms (written CO_3). Carbonates dissolve relatively easily, particularly in acids. Geologically, the most common carbonate minerals are calcite, which is calcium carbonate, and dolomite, which contains both calcium and magnesium in approximately equal proportions. Carbonates may contain other elements as well such as iron, manganese or lead.

Sulphates contain sulphur and oxygen in the ratio of one to four (SO_4). A calcium sulphate, gypsum, is the most important, for it is both relatively abundant and commercially useful. Other sulphates include barium and lead strontium. When sulphur is present without oxygen, the resultant minerals are called sulphides. A common and well-known sulphide mineral is the iron sulphide pyrite popularly known as "fool's gold. Lead sulphide mineral, galena, often forms in silver-coloured cubes. Sulphides of copper, zinc and numerous other metals may also form valuable ore deposits.

Minerals containing just one or more metals combined with oxygen and lacking the other elements necessary to classify them as silicates, sulphates, carbonates and so forth, are oxides. Iron combines with oxygen in different proportions to form more than one oxide mineral. Typical examples of oxides include magnetite, hematite and corundum.

Hydroxides form when a metallic element combines with water and hydroxyl (OH). A common example is brucite (magnesium hydroxide). Hydroxides, formed through a chemical reaction between an oxide and water, are usually of low hardness: brucite for example, has a hardness of 2.5; gibbsite (aluminium hydroxide) is 2.5 -3.5.

Halides are compounds in which metallic elements combine with halogens (the elements chlorine, bromine, fluorine and iodine). Halides are common in a number of geological environments. Some, such as halite, are found in evaporite sequences. This refers to alternating layers of sedimentary rock, which contain evaporites, such as gypsum, halite, and potash rock in a strict sequence, interbedded with rocks such as marl and limestone.

Native elements consist of a single chemical element, and the minerals' names are usually the same as the corresponding elements. Some of the most highly prized materials, such as gold, silver and platinum often occur as native elements. Diamond and graphite are both examples of native carbon. The following may also occur as native elements: sulphur, copper, tin, iron and antimony.

The Geology of Gem Occurrences

Gemstones are supposed to be durable, rare and beautiful. Most gemstones are minerals. When continental plates collide or ocean crust descends under the continental edge, mountains are built. Large bodies of rock melt, granite forms, and heat and pressure transform existing minerals into new ones. Many important gems, including ruby, sapphires and garnet, can form at this time.

Molten rock from the mantle taps deep layers in the crust and brings existing gems to the surface. Large bodies of granite or other igneous rock provide heat for metamorphism and inject pegmatites into fractures in the rock. Later, the same granite releases hydrothermal fluids that mix with colder water from the surface to form mineral veins.

Primary Gemstone Deposits

The gemstones are found in their original host-rock. The profitability of such a deposit is highly dependent on the concentration of gemstones (per ton of rock) and the weathering stage of the host-rock. A lot of large-scale diamond mining operations work primary kimberlite deposits in the search for diamonds. Many primary coloured gemstone mining sites are found in decomposed pegmatite veins, e.g. for topaz, beryl etc. Certain gemstones, such as emeralds, are nearly exclusively found in gem-quality in primary deposits.

Secondary Gemstone Deposits

When a primary gemstones deposit is weathered or eroded, more durable gemstones, such as diamond, corundum and chrysoberyl, may be transported by water or wind energy and accumulated later in a secondary gravel deposit (sedimentary regime), e.g. along a river or in a delta. Such rich concentrations of dense rough gemstones are often called gem pockets.

The vast majority of natural gemstones occur in the form of colourful and durable minerals that originate from the rocks of the Earth's crust. Therefore, some knowledge of these rocks and minerals will greatly assist in the development of a better understanding and appreciation of gems.

Rocks

A rock is an aggregate of minerals; the Earth's crust is mainly made of rocks. Rocks are grouped into three classes, namely: igneous, sedimentary and metamorphic rocks.

Igneous Rocks

These are rocks, which are formed from molten magma. The entire crust of the Earth was originally igneous in nature. Igneous rocks that have the potential to host gem deposits are divided into two groups: intrusive and extrusive, based on the method of their formation (Thomas A, 2009).

Intrusive Rocks

There are four categories under intrusive rocks, namely: plutonic, pegmatitic dykes, ultramafic and lamproites.

Plutonic rocks occur at depth, where the magma cools slowly, thereby forming clearly visible individual crystals. Good examples of the rocks are granites, syenites and anorthosite.

Pegmatitic dykes refer to narrow bodies of rock that seldom exceed 20m in width. They have similar composition as granites; however, these dykes exhibit crystals of very large grain sizes. The dykes penetrate weak points of a country rock, cutting discordantly pre-existing structures. Pegmatites seldom occur in isolation, they form parallel outcrops, dip at almost the same angle and also tend to have similar mineralisation. Pegmatitic magma is typified by its high-water content and as it cools and contracts, cavities, filled with gas and mineral-rich aqueous solutions, are created. Such conditions promote the formation of the well-developed euhedral crystals that frequently line the walls of pockets in the pegmatite. Pegmatites are an important source of such gem minerals as apatite, beryl, cassiterite, chrysoberyl, feldspar, quartz, topaz, spessartite, spodumene and tourmaline.

Ultramafic occur in volcanic pipes, dykes, fissures and sills. Good examples include kimberlites or lamproite. Dark in hue, fine grained and olivine-, serpentine- or mica-rich kimberlites may contain both xenoliths, fragments of eclogite and peridotite rock from the upper mantle, and xenocrysts, comprising foreign minerals such as chrome diopside, spinel and diamond. Gems recovered from these rocks include: chrome diopside, diamond, garnet, spinel and zircon.

Lamproites originate from depths in excess of 150km. Silica deficient mantle derived minerals are predominant in their composition. They may carry xenoliths of diamond.

Extrusive Rocks

These are formed when liquid magma flows out of breaks in the Earth's crust and then undergoes a rapid drop in temperature on exposure to the atmosphere. They are either fine-

grained (e.g. basalt) or grassy (e.g. obsidian) in texture. Gas trapped by the rapidly cooling lava creates innumerable cavities variously described as geodes, vugs and vesicles. Mineral rich solutions frequently fill these cavities with secondary minerals.

Pyroclastic rocks are formed through the compaction fragments, ash and dust that have accumulated during a period of volcanic activity.

Sedimentary Rocks

There are two groups of sedimentary rocks, namely: clastic and non-clastic rocks.

Clastic rocks are formed by the compression of accumulated detritus that has resulted from the erosion of pre-existing rocks by wind or water in the form of rain, snow, hail, frost, glaciers, streams, rivers and the constant movement of the seas. Rock debris transported by streams and rivers are often deposited as gravel beds along the watercourse. Medium-sized fragments may be carried for considerable distances and thereby become increasingly water-worn and rounded. Small particles are sometimes carried far up to the sea before they settle to the bottom before being covered by millions of similar particles in addition to the skeletal remains of marine organisms. Typical examples of clastic rocks include: breccia, conglomerates, sandstone, shale, siltstone and mudstone.

Non-clastic rocks are formed as a result of chemical precipitation, crystallization, evaporation or the lithification of organic matter. Typical examples of non-clastic rocks include: limestone, dolomite, chalk and coal.

Other sedimentary deposits include: surface sediments, laterites and placers.

Surface sediments can also host a variety of mineral deposits. Ore minerals in these sediments are concentrated through the flow of surface fluids such as rainwater or rivers.

Laterites are red coloured iron-rich soils that have been leached through tropical weathering processes. They can host important mineral deposits including Iron, Nickel, Bauxite (Aluminium) and rare earth elements (REEs).

Mineral deposits formed by the concentration of moving particles through wind or water action are called placer deposits e.g. gold and diamond.

Metamorphic Rocks

These are formed from pre-existing igneous, sedimentary or metamorphic rocks that have undergone significant alteration in their nature while retaining their solid state, through the influence of heat, pressure and/or the intrusion of gases or liquids. There are three main groups of metamorphic rocks that have the potential to host significant gem deposits. These are contact, hydrothermal and regional.

Contact metamorphism describes the marked changes that take place in rocks lying within the immediate periphery of an intrusive body of molten magma. In addition to being subjected to high temperature and pressure, the surrounding rocks may also be permeated by the hot fluids carrying new elements. In this case the process is termed metasomatism and it may result into the formation of such gem minerals as corundum, grossular, lazurite, spinel, and wollastonite.

Hydrothermal metamorphism refers to the altered state of rocks that have been impregnated by hydrothermal fluids at high temperatures and under moderate pressure. Basaltic and rhyolitic rocks are frequently subjected to this form of metamorphism. Gemstones such as agate, amethyst, chalcedony, opal, turquoise may occur as secondary fillings in the numerous cavities of this environment. Hydrothermal vein deposits may be a result of hot solutions emanating from bodies of magma and moving up through the crust. Vein deposits of metallic ores also form in this way. Minerals may also be emplaced through the action of chemical weathering or cool solutions. For instance, copper-rich aqueous solutions form azurite or malachite in the presence of carbonates.

Regional metamorphism describes the overall changes that take place in a vast mass of rock, situated deep in the Earth's crust, when subjected to increased temperatures and pressure. These are the forces, which convert limestone into marble and sandstone into quartzite. In cases where impurities are present, they may be converted into other minerals.

The Geology of Malawi

The geological history of Malawi is that of a Precambrian "mobile belt" (Basement Complex) overlain by Permo-Triassic sediments (Karroo system), cut by Mesozoic igneous intrusions (Chilwa alkaline Province), and disrupted by Cenozoic rift faulting, as shown in

Most of Malawi is overlain by Precambrian to early Palaeozoic sequences of metamorphic rocks of both sedimentary and igneous origin. This is termed the "Malawi Basement Complex". The bulk of the most significant economic mineral occurrences occur within the igneous metasomatic and high-grade metamorphic rocks of this Complex. Marble is the most important economic rock type found in this unit. Other mineral commodities associated with the Malawi Basement Complex include vermiculite, corundum, graphite, iron sulphides, kyanite and apatite.

The Karroo System occurs in the north and south of the country. This consists of sedimentary and subordinate volcanic rocks, which unconformably overlie the Basement Complex. These are restricted to six small-fault-blocked outliers. Coal is the main mineral commodity in this category. Other potential minerals commodities include uranium and limestone.

The Chilwa Alkaline Province comprises at least two large syenitic massifs as well as numerous small, but economically significant nepheline syenite, pyroxenite bodies, carbonatite centres, alkaline dykes and swarms and agglomerates veins. In the north, equivalent

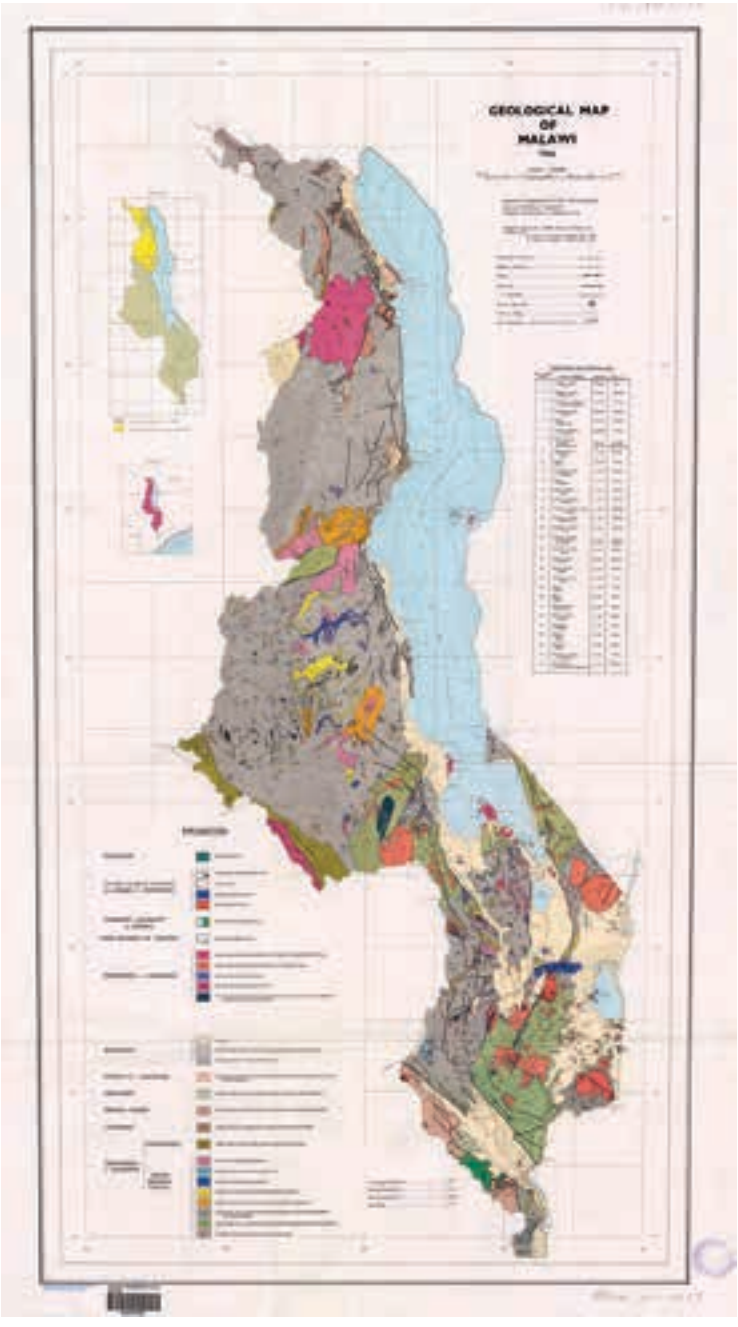


Figure 3. Geological Map of Malawi

Source: Edward Stanford Ltd., London, UK

Mesozoic intrusive activity includes kimberlitic breccias cutting Karroo sedimentary rocks in the Livingstonia coalfield and numerous dolerite dykes, diorite and pyroxenite intrusions. The main mineral commodities associated with this group include REEs and niobium.

Superficial tertiary and quaternary lucastrine and alluvial deposits occur in the north along the western shore of Lake Malawi and in the Vwaza Basin along the Zambian border. Extensive deposits also occur along the southern shoreline of Lake Malawi and in the general vicinities of Lake Malombe, Lake Chilwa and the Shire Valley. Important residual and alluvial/eluvial concentrations in this category include: ceramic and brick clays, phosphates, gypsum and silica sand.

This is a former rose quartz +aquamarine mining site near Manduwa in Northern Region. It is a pegmatite vein, which has been mined.

GUIDELINES FOR ACQUIRING AN ASM LICENCE

By Gibson Bright Nyirenda, Senior Mining Engineer, Mineral Rights Section, Cadastre Office, Department of Mines

Every mineral, in its natural state in, under or upon any land, river, stream, water course throughout Malawi, including any area covered by territorial water, is the property of the Republic of Malawi and all minerals are therefore vested in the Republic of Malawi. Thus, any mineral separated from the land or under an authorisation under the Mines Act remains the property of the Republic. The ownership of minerals therefore vests in a person, who legally separates the minerals from the land, pursuant to an authorisation issued under Mines Act. The new Mines and Minerals Act of 2018 govern the search for minerals and disposal of these minerals. The administration of the Act is the responsibility of the Ministry responsible for mining through its Departments.

The main functions of the Ministry through its Department of Mines, Geological Surveys, and Commissioner for Mines and Minerals Office as regards to mining are:

- Acquiring, monitoring, updating, archiving and disseminating geo-scientific information of Malawi;
- Promoting and developing orderly and sustainable exploration, exploitation and value addition of mineral resources;
- Granting various licences and permits;
- Providing mining engineering and inspectorate services;
- Promoting ASM services; and
- Providing general support services.

In liaison with the Ministry of Lands and Environmental Affairs Department (EAD), the Ministry provides:

- Guidance on land compensations and re-allocation issues; and
- Guidance on environmental related issues, respectively.

The ASM sector in Malawi is regulated by the following legislation, which defines rules in the form of rights, duties and obligations of ASM players in the mining sector:

- Mines and Minerals Act of 2018;
- Explosives Act of 2005;
- Environment Management Act of 1996; and
- Occupational Safety, Health and Welfare Act of 1997.

In Malawi, at least a Small-Scale Licence is required for small-scale mining of all minerals, including all precious and semi-precious stones and other industrial minerals. All ASM

Photo: John Tychsen, GEUS

operators under a licence are obliged to observe good mining practices, OHS rules and pay due regard to the protection and preservation of the environment during mining operations.

Generally an ASM Licence is granted to an individual person, or a group of people in form of a co-operative society, a registered enterprise/venture, or a company for a period of not more than one year from the date of issue, but it may be renewed upon expiry for an unlimited further time period of extensions. However, renewal of the licence depends on satisfactory individual licence performance during the previous term of the licence.

Types of ASM Licences

In Malawi, no ASM is permitted to carry on prospecting, mining operation or any dealings in precious and semi-precious stones without a licence, such as a NEPL, Small Scale Mining Licence (SSL), RML or a MP. The first three types of licences are issued by the Commissioner for Mines and Minerals whereas the latter permit is issued by the District Commissioner for his/her respective districts of applicants. This clearly means that no minerals shall be removed from any land from which they have been obtained, or disposed of, in any manner, without authorisation issued under the Mines and Minerals Act of 2018.

To acquire an ASM Licence in Malawi, one (applicant) must follow the procedures outlined and summarised as per individual licence below:

Non-Exclusive Prospecting Licences (NEPL)

There is only one type of this licence under ASM that is used for prospecting or search for minerals known as NEPL.

Applicants wishing to conduct small-scale prospecting operations as an individual, who is a Malawian citizen and of the age of 18 years or above, or a cooperative mining society registered pursuant to section 299, or a mining partnership registered pursuant to section 299, or a company registered under the Companies Act of 2013 that is 100% owned by Malawians, or a company duly incorporated under the Companies Act, 2013 that is one hundred per cent owned by Malawian citizens, or an association incorporated under the Trustees Incorporation Act, that comprises only Malawian citizens, who cannot afford large-scale prospecting operations, but have technical expertise and financial resources can apply for a NEPL. The application form(s) in duplicate must be addressed and hand delivered to the Registrar of Mineral Rights or the Commissioner for Mines and Minerals or the Director of Mines at the following address: Department of Mines, P.O. Box 251, Lilongwe, Malawi.

General application details for NEPL in the prescribed form will include the following details in case of:

- An individual: Full name, address (which shall be the registered address upon the grant of the licence) for notifications;
- A mining cooperative society or mining partnership: Name of each member of the society or partnership and his/her nationality, and the address (which shall be the registered address upon the grant of the licence) to which all correspondence relating to the licence shall be sent;
- A company: Names and nationalities of all its members or directors and, if a corporation with share capital, the name and nationality of any person, who is the beneficial owner of more than 5% of the issued share capital, and the company's address (which shall be the registered address upon the grant of the licence);
- Descriptions of targeted minerals to be prospected;
- Prescriptions of the district(s) targeted for prospecting operations and identification of up to three contiguous districts wherein the approved prospecting work programme will be executed;
- Program of prospecting operations;
- Expected expenditure on prospecting; and
- Expected equipment to be used.

In addition to the above, applicants will also be required to submit the following information/documentation:

- In the case of a company, a copy of the company's certificate of registration;
- A statement describing in reasonable detail the prospecting work programme proposed to be carried out in the area of land over which the licence is sought, including an estimate of the cost of performing the programme;
- A statement describing the potential effect of the prospecting work programme on the environment, and on any known monument, shrine or relic in the requested licence area, and including a description of the applicant's plans for environmentally responsible prospecting activities;
- A description of any circumstances that may require the licence to be granted subject to particular conditions;
- Other materials as may be prescribed;
- Any other material addressing matters that the applicant wants to be considered; and
- The prescribed application fee or proof that such fee has been paid.

Rights under a NEPL:

- Authorises the holder to only prospect in the district (s) identified in the licence and for the mineral(s) that is prescribed in the licence.

- The holder shall not prospect in:
  - In a large-scale Reconnaissance Licence area for a mineral in respect of which the holder of such large-scale licence has been granted exclusive rights.
  - In a large-scale Prospecting Licence area or Retention Licence area for any mineral to which the large-scale prospecting licence relates
  - In a mining licence area.
  - In a SSML area unless he/she is the holder of the said licence.
- Is not transferable and any person wishing to renew a NEPL has to make application in writing in that respect in the prescribed forms not more than two months or less than one month before expiry of the licence to be renewed.
- An application for renewal of NEPL has to be submitted to the Registrar of Mineral Tenements or the Commissioner of Mines and Minerals with the following documents:
  - A copy of the expired licence and a detailed report of the prospecting operations previously carried out by the applicant.
  - A description of the prospecting operations that the applicant intends to carry out during the renewal period

Term and renewal of Non-Exclusive Prospecting Licence:

- The Licence is valid for one year from the date of issue or grant.
- The licence can be renewed once for a further period of one year in subsequent years.

The application fees to be paid for the licence will be depended on the number of the district proposed in the application, which is charged at:

- K2,000 per district on first grant; and again
- K2, 000 per district during renewal.

Restrictions on exercise of rights under a NEPL include:

- No extraction of minerals in the form of mining is allowed under this licence, except searching of minerals prescribed under a district;
- All minerals collected in the course of prospecting operations must be disposed of by way of selling off to RML holders and reports (data base) of the same compiled;
- All protected areas i.e. Forest Reserve area, National Parks, Game Reserves etc. are strictly out of bounds unless permission is obtained from relevant authorities to conduct prospecting operations;
- Only smaller lighter tools are used under this licence and no heavy machinery is allowed;
- This licence is not issued to an individual unless he/she is a citizen of Malawi; and
- Not issued to a company unless it is a company whose entire share capital beneficially

is owned by citizens of Malawi or by a corporation, which, in the opinion of the Minister, has been established for a public purpose, or partly by such citizens and partly by such corporation.

Small Scale Mining Licence (SSML)

Upon discovery of viable quantities of minerals, a holder of a NEPL is advised to apply for SSML, which gives exclusive rights to prospect and mine any mineral specified in it.

A SSML cannot be applied in respect of land in which the applicant applying for the SSML is not entitled to prospect or is subject to another SSML, a Medium Scale Mining Licence, or a Large Scale Mining Licence or an Exploration Licence (unless a consent is granted by the holder of Exploration Licence) or unless the applicant is the holder of the Exploration Licence.

Any person desiring to apply for a SSML must submit an application for the grant of a SSML to the Registrar of Mineral Tenements in the prescribed form.

The application must be submitted to the Registrar of Mineral Tenements together with:

- An application fee as prescribed in the regulation per SSML area;
- A sketch map, in the prescribed form, showing the boundary of the proposed SSML and such other natural features and the location of principal villages and neighbouring mineral tenements, if any, as will enable the area to be correctly located;
- Documentary evidence that consent to use the land for mining purposes has been given to the applicant by lawful occupiers or landowners of the land the subject of the application;
- A description of the mining method;
- The potential effect of the proposed mining operations on the environment; and
- The potential impact on the local population, if any, and proposals for mitigation and compensation measures.

An area of land over which a SSML is applied should be:

- No more than two hectares;
- No less than one hectare; and
- Bounded by the boundaries (which is rectilinear in shape defined by the coordinate reference system approved by the government department responsible for land survey matters, which is the UTM Coordinates.

If the Commissioner is satisfied that the application is in order, a SSML is granted and registered accordingly.

The SSML entitles the holder to mine, hold, process and sell the minerals that are identified in the licence and mined within the area that is also identified in the licence. This means that under the condition of the SSML the holder has the right to enter a SSML area and the exclusive right, while the SSML is valid, to prospect and mine therein, and to remove there from and dispose of, the minerals in respect of which the SSML relates.

The holder is supposed to commence mining within 180 calendar days from the registration date of the licence.

The holder of a SSML is not allowed to use mechanised mining methods, except for such limited mechanisation as specified in the licence by the Commissioner.

The holder is supposed keep accurate records of winnings from the licence area and such records shall be produced for inspection on demand by the Commissioner or a duly authorised officer.

The holder is also supposed to carry out rehabilitation and reclamation of mined out areas.

A SSML is valid for an initial period of two years and the term may be extended upon satisfactory performance for further periods not exceeding two years at a time. The term of a small-scale mining licence commences on the date on which the licence is granted. There is no limit on the number of term extensions that may be granted to the holder of a SSML. An application for renewal of a SSML is made no later than 30 calendar days prior to the expiry of the licence. The applied period for renewal must be up to two years past the date the licence was first registered or last extended. The Commissioner only approves to extend the term of a SSML if the licence holder has complied with the application requirements and substantially complied with the terms and conditions of the licence and the obligations.

Prior to application submission a holder of a SSML is required to mark out the boundary of the licence area with markers at least one metre high from the ground level each visible from its two neighbouring markers using the Global Positioning boundary coordinate system approved by the Land Survey Department. The personnel of the Department of Mines in collaboration with officials from Land Surveys Department are available to assist the applicant to demarcate the area of interest and to draw the requisite sketches on their behalf when the applicant requests their services only during the official scheduled field trips or the applicant may commit to meet the cost of the exercise if the requested period has not coincided with official scheduled demarcation exercise.

The application fees to be paid for the registration and application of a SSML are:

- On first issue at K3,500
- On renewal at K3,500
- K2,000 for ground fees per SSML per year, irrespective of the size of the area under the licence.

In deciding whether or not to register and approve a SSML, the Commissioner, sometimes in consultation with the EAD, takes into account the need to conserve the natural resources in or on land to be covered by the licence or over which the claim is to be registered, or in or on neighbouring land. Therefore, despite the use of non-mechanised or light tools, a SSML contains terms and conditions regarding environmental protection and adherence which a licence holder has to comply with relating to the reinstatement, levelling, regressing, reforesting and contouring of any part of the licence area that may have been damaged or deleteriously affected by prospecting or mining operations, and the filling in, sealing or fencing off, of excavations, shafts and tunnels, as may be prescribed, or as the Commissioner may, in any particular case, determine.

Depending on the scale of operations and size of some equipment requested by the holder of a SSL to be used in the licence area, the EAD may recommend an Environmental Management Plan (EMP) to be undertaken by the applicant and submitted for approval before commencement of such mining operations.

Where, in the course of prospecting or mining operations within a SSML area, any disturbance of the rights of the lawful occupier of any land or damage to any crops, trees, buildings, stock or works thereon is caused or expected:

- The holder of the SSML is liable to pay the lawful occupier fair and reasonable compensation in respect of the disturbance or damage according to the respective rights or interests of the lawful occupier concerned; and
- The amount of compensation payable to a lawful occupier may be determined by agreement between the holder of the SSML and the lawful occupier or, if not so agreed, may be assessed by the Commissioner of Mines in consultation with the Ministry of Lands.

The holder of a SSML has to keep accurate and regular accounts containing full particulars of all minerals obtained under the licence, and the manner in which they have been disposed of, and a record of the number of persons employed in mining operations in the licence area.

The holder of a SSML is required to send to the Commissioner a written statement in duplicate at the end of every six months setting forth:

- A summary of the mining work undertaken in connection with the licence during the six-month reporting period;
- The type and quantity of any minerals mined;
- A description of the how the minerals mined were disposed of including the total value of all mineral sales;
- A summary of all royalties paid;
- A description of any accidents that occurred that led to death or significant bodily harm and what steps have been taken to avoid a recurrence; and
- A summary of rehabilitation and reclamation work.

Additionally, the holder shall furnish any further particulars or information relating to the foregoing that the Commissioner may require.

If the holder of a SSML fails to comply with conditions of the licence or any requirement of the Mines and Minerals Act, the Commissioner may, on that ground, by notice in writing served on the holder of the claim suspend or cancel the licence.

A SSML is not transferable, meaning that the licence cannot be transferred or assigned to another party.

(Artisanal) Mineral Permit (MP)

The District Commissioner, through the Local Government Act, is empowered to grant or issue to any person or company an (Artisanal) MP within his/her areas or district of jurisdiction to mine minerals used in the local construction sector, such as sand, gravel, stones, clay, aggregate, and earth, and minerals used for the making pottery and bricks upon payment of a prescribed fee. The holder of an MP may enter upon public land or customary land and mine the prescribed industrial material. The fee paid under this permit depends upon the quantity to be extracted.

An Artisanal MP cannot be used for the purpose of mining precious stones, REEs, coal or any metallic minerals.

The holder of a MP cannot enter:

- A forest reserve as defined in the Forest Act;
- A national park established as defined in the National Parks Act
- Game reserve declared or proclaimed in the Game Act; or
- Upon any monument or relic which is protected under the Monument Act, or mine therein any prescribed mineral unless with special permission from the relevant authorities.

Furthermore, the holder of a MP shall not mine any prescribed mineral in a prospecting area, a SSML area or a mining area, without the consent of the holder of the licence or claim concerned.

The holder of a MP cannot:

- Carry on mining operations underground;
- Use explosives; or
- Use any powered or mechanised machinery in his mining operations except for the purpose of loading material in, or moving material from, the area where he carries on those operations.

The District Commissioner, issuing an Artisanal MP, shall supply a copy of the permit to the Registrar of Mineral Tenements, which shall maintain a record of all MPs currently in force, in such manner and containing such particulars as he/she may determine, of copies so supplied to him/her.

An Artisanal MP or any interest therein cannot not be transferred, assigned or dealt with in any other way unless such action is done in accordance with a by-law made for that purpose by the local authority that granted the permit.

The prescribed fee on the issued MP will depend on the total tonnage to be extracted under the permit charged per tonne of the required industrial mineral. District Assemblies generate revenue from such fees and part of which may be used for environmental damage remediation that include such activities relating to the reinstatement, levelling, regressing, reforesting and contouring of any part of the extracted area that may have been damaged or deleteriously affected by extracting or mining operations.

Reserved Minerals Licence

This licence also referred to or commonly known as a "Dealers Licence" allows the holder of the licence to buy, possess and sell "reserved minerals" defined as precious metals and precious and semi-precious stones. "Reserved Minerals" means precious metals, precious stones and any other mineral which may be prescribed as below.

"Precious metals" means gold, silver, platinum and platinoid metals, in an unmanufactured state, and includes all such slimes, concentrates, slags, tailings, residues and amalgams as are valuable for their content of the aforementioned precious metals.

"Precious stones" means rough and uncut diamonds, emeralds, rubies and sapphires, and all other gemstones not forming part of any tool or instrument or abrasive powder used in an industrial process, and include any other stones, which may be prescribed by Commissioner for Mines.

This means that a jeweller, refiner or other commercial enterprise in Malawi that buys reserved minerals in a raw state for a manufacturing process, such as cutting, polishing, setting or refining, or for reselling and the holder of a mineral tenement that buys or acquires reserved minerals in a raw state or allows others to use its facilities for processing reserved minerals, shall possess a Reserved Minerals Licence.

An application for a RML or licence extension can be made under First Schedule Part I & II–Form of application by an individual, irrespective of nationality, or a registered Company or anybody corporate registered in Malawi to the Registrar of Mineral Tenements in the prescribed form and shall be accompanied by the prescribed application or extension fee.

A RML authorises the holder to buy only from the licenced miners or areas or other reserved minerals licence holders within Malawi, only reserved minerals that are identified in the licence.

The holder of a RML is only authorised to buy any reserved minerals from any person unless that person is a holder of minerals licence issued under the Mines Act to possess those reserved minerals.

The holder of a RML is required to keep detailed records in such form and containing such particulars as:

- The name and address of the seller;
- The serial number, description and location of vendor's mineral right, claim or non-exclusive prospecting licence;
- The weight and description of the reserved minerals purchased;
- The amount paid, and date of payment, to the seller; and
- The date of delivery of the reserved mineral to him.

Similarly the seller of the reserved minerals, is required to keep a records of:

- The name and address of the purchaser;
- The mass and description of the reserved minerals;
- The amount paid, and the date of payment, to him; and
- The date of delivery of the reserved minerals to the purchaser.

Subject to the provisions of the Mines Act, all holders of ASM licences, such as a SSML and RML, are supposed to pay royalty to the Republic in respect of minerals obtained by them in the SSML area or upon export of such minerals.

Royalty is payable at the rate fixed in, or computed in accordance with the provisions of the Mines and Minerals Act as follows;.

- Building and industrial minerals (obtained under Mineral Permit) at the rate of:
  - 7% of the gross value of the minerals where the minerals are exported in an unmanufactured state; or
  - 5% of the gross value of the minerals in any other case.
- Precious and Semi-Precious stones (obtained under MCL or RML) at the rate of:
  - 10% of the gross value of the minerals where the precious stones are exported as rough uncut stones; or
  - 5% of the gross value of the minerals in any other case.

Permit to Export Minerals

The Minister or the Commissioner for Mines and Minerals may grant any person a permit to export minerals from Malawi on determined conditions and specified in the permit. This means that no person is allowed to export reserved minerals, unless:

- They are holders of a valid export permit issued under the Mines Act; or
- The reserved mineral is packed in a sealed parcel addressed to a named consignee and

marked with a stamp of the Department of Geological Survey approved by the Minister or the Commissioner for Mines and Minerals, certifying the mass (weight) and description of the mineral.

All ASM operators, who wish to export reserved minerals, are supposed to keep a record of:

- The serial number of the parcel;
- The date of certification by the Department of Geological Survey Department;
- The number and date of export permit; and
- The estimated value in the Malawi Kwacha.

Every licensee shall, within fourteen days after the end of the month in which he/she purchased, sold or exported a reserved mineral, submit to the Registrar of Mineral Tenements a copy of the record kept in respect of that reserved mineral which were exported.

Procedures for Processing of Applications and Granting of ASM Licences

1. All ASM licence applications will be made and addressed to the Registrar of Mineral Tenements and submitted to the Department of Mines through the Mineral Rights Sections or Cadastre Office as per the prescribed form(s);
2. The Registrar of Mineral Tenements, through the Mineral Rights Section or Cadastre Office, will summarise the applications and submit the summary including the applications to the Commissioner for Mines and Minerals;
3. The Commissioner for Mines will study the applications and liaise with the Registrar of Mineral Tenements to convene a meeting of officials from relevant departments (that forms the Licencing Sub-Committee) to scrutinise the applications and to look at other relevant issues pertaining to the application and make necessary recommendations to the Commissioner. The Registrar of Mineral Tenements will then give notice to the successful applicants of the Commissioner's intention to grant an ASM licence on specified conditions;
4. In case of specific terms granted under a licence, the applicant will have to give notice to the Registrar of Mineral Tenements, within 30 days, of his or her willingness to accept the licence by signing for acceptance of the specified terms and conditions for granting the licence, otherwise the application will lapse; and
5. On signing of the conditions, or payment of ground fees if any by the applicant, the Commissioner grants the ASM licence to the applicant giving him/her full rights to commence activities as specified therein.

ASM mining site at Majiashaba in Northern Region. This is Aquamarine mining from a pegmatite vein.

ORGANISING AND DEVELOPING AN ASM SITE

By George J. Maneya, Chief Mining Engineer, Department of Mines and Chikomeni Manda, Manager, Mzimba Gemstone Mining Cooperative

ASM is a well-recognised sub-sector in Malawi. The sub-sector encompasses prospecting, mining, processing and marketing of industrial, precious and semi-precious minerals. Though the sub-sector looks disorganised and largely informal, it contributes significantly to the socio and economic development of the rural communities. From a governance perspective, ASM is recognised in the country's mining policies and legislations namely:

- The Mines and Minerals Policy of 2013;
- The Artisanal and Small-scale Mining Policy of 2018; and
- The Mines and Minerals Act.

There are legal requirements and good practices involved in organising and developing an ASM mining site in the country.

Meeting Statutory Requirements

In Malawi, meeting statutory requirements is a priority. Formalisation of ASM activities is done through licensing. It is a requirement to obtain a licence prior to commencement of any mining operations. ASM licences and mineral permits are granted upon fulfilling requirements stipulated in the Mines and Minerals Act. A formalised ASM sub-sector provides a favourable environment for organising and developing mining sites.

Phases of an ASM Project

A well formalised ASM mine goes through a phased cycle. Each of these phases is associated with different activities as shown below.

Prospecting and Exploration Phase

Prospecting comprises:

- Obtaining a Prospecting Licence: This marks the first stage in the mining cycle of any prospective ASM operator. At this stage, an ASM prospector formally acquires a prospecting licence, i.e. a Non-Exclusive Prospecting Licence for those interested in gemstones.
- Consulting Landowner: In order to obtain the rights to prospect and develop a mine in an area, an ASM prospector needs to obtain consent from the surface (land) owner. Land ownership in Malawi varies from customary, public to private. Depending on the type of land ownership, the prospector has to enter into an agreement with the landowner. The prospector needs to compensate the landowner(s) both within and outside the area of land granted

Photo: John Tychsen, GEUS

under the Prospecting or Mining Claim Licence for the anticipated damages or damages caused by the mining operations, regardless of whether or not such damage is accidental or anticipated.
- Erecting or Constructing Shelter and Sanitation Facilities: An ASM operator is obliged to erect temporary shelter and sanitation facilities within the prospecting area.

Prospecting involves surface and sub-surface level surveys to further confirm the availability of a mineral deposit in the area. Prior to this stage, there are other activities, such as a familiarisation site visit and review of geological literature (geological bulletins and any geological data available).

A prospecting/exploration action plan is developed as presented in the application form for a Non-Exclusive Prospecting Licence. The following methods can be employed for prospecting/exploration in an area of interest:

- Remote sensing;
- Geological: Pitting, trenching and drilling;
- Geophysical:
  - Detailed surface methods – gravity, magnetic, electrical, seismic, etc.;
  - Subsurface/borehole methods – gravity, electric logging, etc.; and
- Geochemical surveys: Bulk sampling and drilling (core or destructive).

Most of the ASM prospectors in Malawi, particularly those involved in coloured gemstones mining, are familiar with the geological methods of prospecting, such as trenching and pitting as shown in Figure 4.

Mine Planning and Design Phase

The mine planning and design phase is important in the mining cycle of any ASM project. An ASM operator evaluates primary and secondary data relating to the prospecting/exploration phase. Sufficient time is set aside to consider the best layout of the mine and equipment to be used during the mining phase. This phase helps to optimise mine production while considering safety and health issues during the working life of the mine. It further provides an opportunity to establish means of conducting mineral processing, assessing available markets and potential transportation routes.

Each mine plan is guided by specific objectives as outlined by 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;

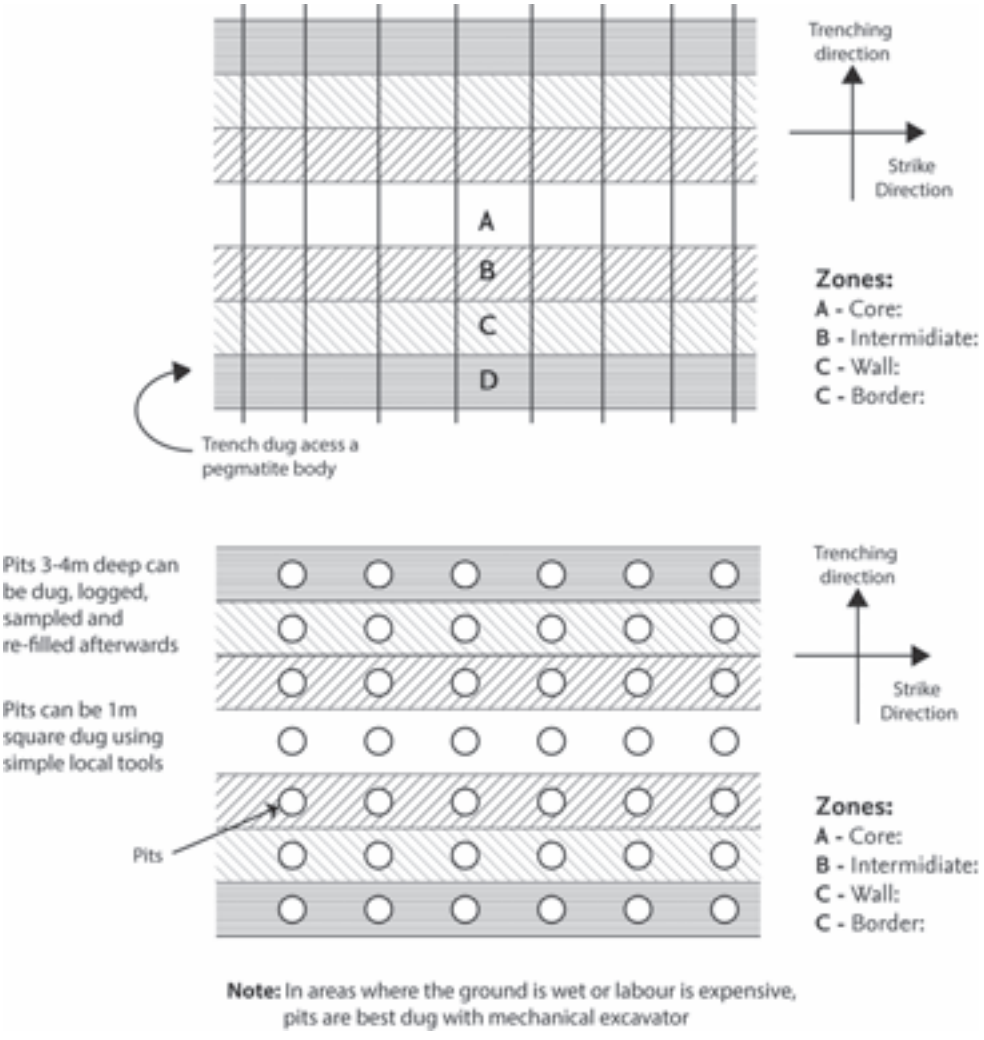


Figure 4. Trenching and Pitting across a Pegmatite Body

- Follow a logical and achievable start-up schedule (for training, equipment procurement and development, etc.) that minimise 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.

Mine Development Phase

Mine development involves several distinct components. The implementation of each component is not an exclusive job of a dedicated team of professionals. It involves, among other, compliance with legal requirements - in particular those set forth in mining and environmental regulations - and raising the necessary funds to cover the planned investments.

A significant number of steps are usually taken under mine development for both surface and underground mines, such as:

- Feasibility Study: Developing and adopting a feasibility study report as a planning document subject to modification as the project is developed and mined;
- Mining Method: After conducting prospecting activities successfully, choosing the appropriate mining methods and general sequence of mining including the initial choice of equipment types and size of workforce;
- Financing of a Mining Project: Making the necessary financial arrangement for the mining project based on confirmation of mineral reserves and cost estimates;
- Mineral Processing Plant: Erecting a mineral processing plant, if required, and mineral handling and shipment facilities as well as preparing for stockpiling and waste disposal facilities. These facilities should be located in areas that would not in any way disrupt mineral extraction activities;
- Mining Equipment: Making the right choice in the acquisition of mining equipment for development and exploitation of the mineral deposit; and
- Open a Mining Pit: Considering location of the main opening to the mineral body in order to provide direct access to the ore zone.

Mine Exploitation Phase

Mineral exploitation is an important phase in any mining cycle. Different methods are used worldwide depending ore body size, depth, location and factors. However, there are two major methods: surface and underground. In the Malawi context, ASM operators are recommended to engage surface mining method regardless of the nature of the deposit, equipment and manpower.

Surface Mining Method

Surface mining methods are most economical in situations where mineral deposits occur close to the surface or form part of surface deposits and allow easy access. They involve exposing and mining ore, often by the removal of solid (rock) materials surrounding the ore.

Three common components are associated with surface mining method:

- The people, who operate equipment and work at the mine;
- The equipment or plant used to assist in the exposure, removal and processing of the material. These can be primitive tools, such as hoes, picks, chisels, crowbars, shovels, wheelbarrows and wire mesh. In some instances, heavy equipment/machinery, such as dozer, excavators and dump trucks assist in the exposing, removing and processing of minerals; and
- The rock or material being mined; whether it be ore or waste-and the excavation created by its removal.

The mining method is defined by how these basic components are combined and more importantly the safety, risks and hazards to which people are exposed.

Surface mining can encompass various types of mining, including:

- Small mini-pits (shallow open-pits), often associated with sand, clays, gemstones and gravel mining;
- Open-pits, for larger scale mining of various commodities
- Quarries and terrace mining operations, for small and larger scale rock aggregate and dimension stone mining
- Strip mines, for small and larger scale mining, often associated with coal and limestone; and
- Dredge-ponds, for larger scale mining, often associated with heavy mineral sands.

Ore reserves suitable for surface mining can be classified initially as:

- Relative horizontal stratified reserves with a thin or thick covering of overburden;
- Stratified (layered) vein-type deposit with an inclination steeper than the natural angle of repose of the material so that waste cannot be tipped inside the pit; and
- Massive deposits, deep and very large laterally, such that dumping of waste within the pit is not possible.

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

- Geometry of the deposit and the physical characteristics of the deposit;
- Method adaptable to irregular ore limits, yielding good recovery and minimal dilution;
- Deposit strike length and dip;
- Consistency of the orebody width;
- The dimensions and regularity of deposit;
- The geo-physical properties of wall rocks and ore, such as:
  - Hardness of the rock (quartz, feldspar, mica, etc.)
  - Compressive strength
  - Continuity—joints

- Cohesion-angle of friction
- Nature of the grade distribution which can be either low or high grade;
- Hydrogeology (ground water and water present in rock); and
- Slope stability, which can be either of short- or long-term.

Shallow Open Pit

In open pit mining, any overburden is stripped and transported/shovelled to a disposal area to expose the mineral deposit. In this instance, both stripping and mining are held from one or sequence of benches. ASM operators, who are typically extracting sand, salt, clays, gemstones and gravel, commonly use a shallow open pit.

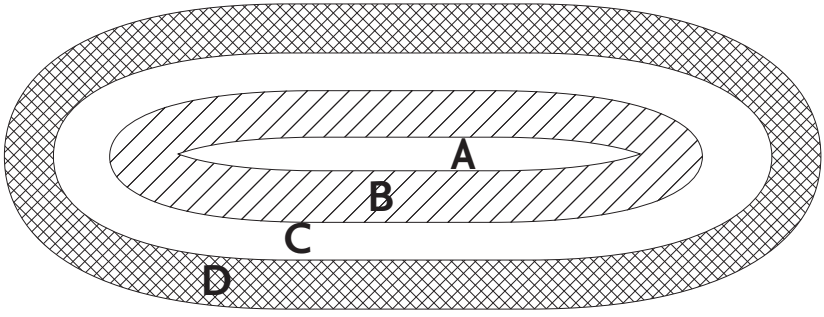
As for pegmatite (gemstones) mining, it is generally conducted in semi-arid environments, particularly in the northern region of the country. Pegmatite deposits are reasonable resistant to weathering and often stand out as positive topographical features.

Generally, there are two mining techniques, which are applied to pegmatites. They depend largely on the existence of pegmatite zoning and the mineral assemblage. Some pegmatites show a significant degree of concentric zoning, ref. Figure 5, and a basic mineral assemblage of quartz, feldspar and muscovite, with accessory beryl and black tourmaline. Of economic value at this pegmatite mine, it can be beryllium (aquamarine) and quartz minerals hosted in the intermediate and core zones respectively.

The core zone (A) is usually dominated by quartz, which varies in appearance from milky-white to rosy colour. The intermediate zone (B), on either sides of the core, consists of feldspar, muscovite mica, tourmaline and aquamarine form. The wall zone (C) consists of fragmented quartz, feldspar, and some muscovite mica. The border zone (D) marks the boundary between the country rock (metamorphic rock) and the pegmatite body.

Mine pit design is determined by the nature of pegmatite zoning. Mining techniques applicable to a concentric pegmatite belt can be classified as:

- **'Slice the Flanks':** This mining technique is applicable to a full concentric pegmatite body whose intermediate and wall zones have minerals of economic potential value, such as beryllium, tourmaline, tantalite, and fragments of quartz. The core (usually composed of milky quartz) is largely left untouched and is considered of non-economic value. In the course of mining, the benches are developed on either sides of the pegmatite body. Bench dimensions are determined by the width of zones (e.g. intermediate zone).
- **'Mine it All':** With this mining technique, the approach is to exploit both the core and intermediate zones. These zones may host minerals of high economic value, such as rose or clear quartz in the core zone. The intermediate zone may host beryllium, tantalite, mica and tourmaline. However, it requires removing the outer zones (border and wall).



Zones:
A - Core: Quartz
B - Intermidiate: Feldspar, Byrillium, Quartz, Mica, Tourmaline
C - Wall: Feldspar, Quartz, Mica, Tourmaline
D - Border: Feldspar, Schists

Source: George Maneyaf Mines

Figure 5. A Concentric Pegmatite Body

In some instance, the 'Mine it All' mining technique is applicable where a pegmatite body does not have fully developed zones (incomplete zoning). The core zone (quartz) is discontinuous and at times intermingles with the intermediate and wall zones. Minerals of potential economic value in this set up can be beryllium and tourmaline. A minimum of 3m extension (opening) on either sides of the core zone can be set in order to provide enough space for the movement of the workers involved in shovelling out waste rock.

Strip Mining

Strip mining is ideally applied where the surface of the ground and orebody itself are relatively horizontal and not too deep under the surface, and a wide area is available to be mined in a series of strips. Some examples of this type of mining are coal and limestone mining operations occurring in many parts of Malawi.

Strip mining is suitably used under the following favourable conditions:

- Relative thin overburden (0-50m maximum otherwise stripping ratio and cost of stripping becomes too high);
- Regular and constant surface topography and coal/limestone layers (not more than 20 degree variation from horizontal on the coal/limestone seam); and
- Extensive area of reserves (to give adequate life of mine {LOM} and to cover all capital loan repayments.

Potential Waste and their Disposal Sites

Potential solid wastes include mine waste rocks (quartz, mica and feldspar) and overburden materials (shrubs and soils), which shall need to be disposed on the either edges of the mine pit. Some shall be required to backfill the mine pit.

Liquid waste shall include used diesel from heavy machines, mine water and some from sanitation. Some pits shall be required to dispose the liquid waste in form of groundwater.

Decommissioning (Mine Closure) Phase

Decommissioning marks the final phase in any conventional mining project. It usually occurs when the mineral deposit has been exhausted or finally exploited. It is usually neglected by most of the ASM operators who abandon the site. It is an important phase to all stakeholders, who include government, landowners, local communities, civil societies, miners and others. These stakeholders have an interest in the formal mine closure, which addresses environmental and social issues.

It is common knowledge that the majority of ASM operators in Malawi exploit small deposits in remote rural areas from which it is difficult to monitor. They cause significant damage to public health and the social, physical and biological environment. In many cases, their operations have been destroying natural vegetation, landscape and spreading pollutants.

However, ASM operators are currently only subject to simple requirements, such as backfilling and fencing the pit, with the main objective to protect the health and safety of people living in areas surrounding the site.

It is therefore appropriate to put into consideration adequate mine closure plans before any mining operations begin.

Environmental compliance must be planned into a mining project. ASM miners are encouraged to:

- Integrate environmental considerations in a project's planning thereby promoting sustainable livelihood;
- Ensure that environmental and socio-economic costs and benefits of a project are properly accounted for;
- Ensure that negative impacts are avoided or mitigated at an early stage of planning;
- Set up a framework for carrying out mitigation and monitoring; and
- Make sure that interested and affected parties participate in the process.

The paramount goal is to ensure that ASM operators are able to restore mining areas to their near original status upon closure of activities.

Photo: John Tychsen, GEUS

This is rose quartz mine near Mjinge in Northern Region

This is Aquamarine mined in a pegmatite vein at Thoza in Northern Region.

MINERAL PROCESSING IN THE ASM SUB-SECTOR – INITIATIVES, CHALLENGES AND OPPORTUNITIES

By Burnett Msika, Chief Mining Engineer, Department of Mines

Mineral processing is, by definition, a branch of science and technology dealing with the processing of minerals in order to provide them with or retain the desired physical and chemical properties for other important uses (Drzymala, J., 2007). Mineral processing is also defined as an art of treating crude ores and mineral products in order to separate the valuable minerals from the waste rock, or gangue (Granner, H and Lorig, C.H, 2012). It is also termed as ore dressing, mineral beneficiation, and recently mineralurgy or mineral-lurgy (Drzymala, J., 2007).

The minerals exploited by ASM operators in Malawi include: alluvial gold, limestone, salt (sodium chloride), kaolinitic clay, rock aggregate, iron ore, sand, coal, gemstones and gypsum.

Most of these minerals are extracted by ASM operators either without or with minimal value addition or beneficiation. In essence, most ASM operators in the country prefer mining and selling the minerals in raw form instead of also processing them in order to obtain money for immediate use, since processing, a technological procedure, arguably takes more time, energy and resources before money is earned. Additionally, lack of necessary mineral processing skills and equipment by the miners push most of them to sell minerals in a raw form. Notwithstanding this circumstance, a few small-scale miners and companies make some efforts to process the minerals once they mine them using some traditional mineral processing techniques.

This section looks into processing alluvial gold into a saleable product, limestone into hydrated lime, salt-incrusted soil into consumable domestic salt and kaolinitic clay into ceramic products. Furthermore, this section will look into some mineral processing challenges in the ASM subsector, initiatives, taken by the Government to address these, plus potential mineral processing opportunities in the country.

Alluvial Gold Processing

Alluvial gold occurrences have been reported in several areas across Malawi in the Geological Bulletins produced by the Geological Survey Department in MNREM. These include; Makanjira in Mangochi, Dwangwa in Nkhotakota, Lisungwe in Neno, Mchinji, Salima, and Nkhata Bay.

In Malawi, most alluvial gold mining is done illegally by ASM operators along the riverbanks and surrounding fluvial terrains. ASM operators extract alluvial gold by flowing auriferous sand soil mixed with water (slurry) into an improvised simplistic 'sluice' box made

Photo: John Tychsen, GEUS

from iron metal, with several perforations of diameters between 2 and 10mm, at the base on one tilted end and supported sideward by planks of wood. A polyethylene sack with woven spirals is placed at the base of the improvised sluice box to capture the undersize believed to contain gold particles, as shown in Figure 6 below.

The collected undersize, pregnant with gold particles, is scooped from or scraped off the polyethylene sack into a plastic bowl for washing in order to eliminate the sand soil particles, as shown in Figure 7.

Following the removal of the sand particles and suspended matter, the gold particles are dried, placed in a small plastic bag and stored, as shown in Figure 8.

Source: Burnett Msika, Department of Mines

Figure 6. Gold Panning in Progress at Makanjira, Mangochi

Source: Burnett Msika, Department of Mines

Figure 7. Panned Gold Particles Washed Down to Remove Sand Particles

Source: Burnett Msika, Department of Mines

Figure 8. Dry Panned Alluvial Gold Flowers in The Plastic Bag

Processing of Limestone into Lime for Use in the Construction and Agricultural Industries

Limestone is one of the valuable mineral commodities extracted in Malawi by ASM operators as a raw material for the production of lime used in the construction and agricultural industries, among other uses.

Several types of limestone occurrences have been documented, of which the most important are marble bands in the basement complex gneisses. Large occurrences exist also in carbonates and sedimentary rocks.

Production of Slaked Lime for the Construction Industries

The production of slaked lime from limestone by ASM operators involves three main stages. These are:

1. Limestone preparation;
2. Limestone burning (calcination); and
3. Hydration.

Limestone preparation involves mining/quarrying and sizing. Mining/quarrying is conducted using picks, hoes, jackhammers and crowbars. Some ASM operators sometimes use excavators and bull dozers.

Some ASM operators use dry logs of wood to fire the limestone boulders and then pour cold water on the heated boulders in order to induce rapid expansion and contraction of the boulders in a quest to facilitate the breaking down of the steel-strong boulders into smaller rock particles for further breaking down. Sometimes, the ASM operators hire a blaster to assist them in the blasting of the limestone rocks into smaller boulders for further breaking down.

The limestone rocks are further broken down into smaller particles of about 50mm (or less) to 100mm in diameter by ASM operators using hand-held hammers in readiness for combustion (calcination).

Calcination (limestone burning) is done to volatilize carbon dioxide from calcium carbonate (limestone) to obtain calcium oxide (quicklime). This process is summarised in the following chemical equations (Wills, B.A., 1988):

$CaCO_3$ (calcitic limestone) + heat (1000 to 1300°C) = CaO (quicklime) + CO_2 (carbon dioxide)
or
$CaCO_3$. $MgCO_3$ (dolomitic limestone) + heat (900 to 1200°C) =
CaO.MgO ((quicklime) + **2**CO_2 (carbon dioxide)

Lime calcination is performed using either traditional batch kilns or modern vertical kilns.

Traditional Batch Kiln for Limestone Calcination

The traditional batch kiln is a rectangular box-type kiln with an open top, constructed from rough marble blocks cemented with a mud/lime mortar, as shown in Figure 9 below. The internal dimensions of the box vary but an average-sized kiln would be approximately 6m long x 4m wide x 2m high. The kiln walls are buttressed, normally with stone abutments, but sometimes with soil forming a ramped access to the kiln. It has two firing openings at the base on each of the short sides, which lead into two trenches running along the length of the kiln connecting the firing openings.

Arched vaults are built over the trenches with large marble boulders. The kiln is charged with 5 alternate layers of fuel wood and marble starting with kindling and small logs at the base and ending in a heaped layer of marble feed at the top.

Approximately 75 tonnes of marble and 55 tonnes of wood are required for each batch. The kiln is ignited and stoked for about 48 hours, after which the firing holes are sealed and the kiln is left to bum out, which takes approximately 2 to 3 days. The kiln is then allowed to cool for a further 6 to 8 days before discharging.

Vertical Kiln for Limestone Calcination (Burning)

The vertical kiln, cylindrical in shape, is constructed about 7m high, with at least 1m in diameter of void (air-filled) space inside, as shown in Figure 10 next page. The interior has

Source: Burnett Msika, Department of Mines

Figure 9: A Traditional Batch Kiln for Limestone Combustion

Source: Burnett Msika, Department of Mines

Figure 10. An Example of a Vertical Kiln for Limestone Burning

a lining comprising 2 layers of refractory bricks, followed by another 2 to 3 layers of ordinary burnt bricks. A chimney is constructed at the top of the kiln for release of gases, such as carbon dioxide during the limestone burning.

The loading of limestone and either fuel wood or charcoal or coal for firing is done from the top. Doors (openings) are constructed at the base of the kiln. Furthermore, in the interior of the kiln at the base, a conical shaped cemented-refractory-brick structure is constructed to ease the firing and the discharging of quicklime from the kiln. Initial firing takes place at the base. Sometimes a fan is used to pump air into the kiln necessary for calcination through any of the openings at the base. Generally, the base is covered with a bundle of dry shrubs and a few pieces of split fuel wood to facilitate initial firing. This layer is followed by a layer 0.25m of either fuel wood or charcoal or coal up to the top of the kiln. This layer is followed on by a metre of limestone. The process is repeated until the kiln is full.

Then, as indicated earlier, the initial firing is done at the base. Fanning is done periodically to fast track the limestone combustion inside the kiln.

When the limestone calcination is observed to be complete (generally, after a period of at least 6 hours), depending on the fuelling material used and mixing ratios of the limestone and the fuelling material, the quicklime produced is discharged. The discharged quicklime is allowed to cool for a period between 6 and 8 hours. Then, the lime is hydrated.

Hydration, Sieving and Milling

During hydration, quicklime reacts with water to form calcium hydroxide (slaked lime). This reaction is highly exothermic and the heat released (heat of hydration) is approximately 1134 and 886 kJ/kg for calcitic and dolomitic quicklime respectively (Malunga, G.P.W., 2017).

The hydration reaction equation is shown below:

CaO (quicklime) + H2O (water) = $Ca(OH)_2$(slaked lime) + heat

This reaction is reversible. However, during the reaction, the equilibrium spontaneously shifts to the right to obtain more slaked lime as more and more quicklime is being hydrated.

The quicklime (calcium oxide, CaO) discharged from the kiln is mostly fragmented to less than 5mm in diameter, due to both the friable character of the rock and to air slaking.

Noteworthy, slaking is performed by pouring water on to a reasonably large pile of quicklime, which is then turned manually using a shovel, much in the same way as concrete is mixed by hand.

The hydrated lime (calcium hydroxide, $Ca(OH)_2$) is then sieved through a hand punched metal sheet sieve to remove the coarse unburnt material. In practice, material of less than 10mm will pass through the sieve and therefore the product will contain quite large quantities of smaller unburnt cores.

The product from sieving is then milled in a hammer mill, powered by a diesel engine, of the type normally used for milling maize. The milling is undertaken in order to produce a reasonably fine and uniform product. The milled hydrated lime is then bagged by hand.

Processing of Limestone into Agricultural Lime

Agricultural lime is one of the soil conditioners produced by the ASM operations from milled limestone. The principal active ingredient is calcium carbonate. Unlike quicklime (calcium oxide, CaO) and slaked lime (calcium hydroxide, $Ca(OH)_2$), milled limestone does not need limestone combustion in a kiln. On the contrary, it only requires the milling of the limestone ($CaCO_3$).

Summarily, the run-off mine is subjected to communition (size reduction), manually using hammers or mechanically using the mobile rock crushers or jaw crushers. Then, the undersize is subjected to further grinding using either a pulveriser or a rod mill. The milled or pulverised product is then bagged, ready for marketing.

Source: Burnett Msika, Department of Mines

Figure 11. Salt Leaching Process at Chigweshe Village, Chikhwawa

Salt Processing

Some superficial salt deposits are known to naturally occur in several parts of the country for several decades. These include; Chigweshe at Nchalo in Chikhwawa, some dambo areas in Nsanje, areas around Lake Chilwa in Phalombe, Vwaza in Rumphi, some low-lying plains of Kasungu Salima and Mzimba.

Much of the salt is produced from evaporites forming on rapidly evaporating low-lying areas (dambos, ponds and pans) that become swamps during at least part of the rainy season and that most of these areas are overlain by a covering of clay and silt washed in from the surrounding hills (Nkhoma, J.E.S., 1985).

Succinctly, in the salt-forming process, the salt rises to the surface of the soil from the deeper soil layers through capillary action of the water and forms a thin layer on the ground. The saline topsoil layer, about 2 to 5cm deep, is scraped off by the locals using plastic or metal blades. The salt is then extracted by a locally derived traditional process. The extracted salt-incrusted topsoil is placed in a crude filter consisting of a hessian or poly-woven sackcloth supported by four wooden poles. Water is poured from the top, which slowly percolates through the salt bearing earth and emerges below in thin trickles. This is the main determining step in obtaining quality salt - the filtration or leaching stage.

During the process, the water extracts salt and a brine solution is collected beneath the filter in buckets or pans, as shown in Figure 11 above.

In Chikwawa, the water, from which salt is extracted, is rich in sodium chloride (Na-Cl), chloride-bicarbonate (HCO_3-Cl) and calcium bicarbonate (Ca-HCO_3) with electrical con-

Source: Burnett Msika, Department of Mines

Figure 12. Brine Boiling Process to Enable Salt Crystallisation

ductivities of up to 17,500minihos/cm. The source of the water is believed to be from cretaceous Lupata sediments because surface water contains 15-27ppm Na while ground water contains 120-3,035ppm Na (Malunga, G.P.W., 2017).

The salt content in the brine is tested organoleptically. If the content is found lacking, the brine is poured back on to the filter bed until it has adequate salt incrustations. This process takes about a day. The leachate is mixed with a few milligrams of aluminium sulphate $(Al_2SO_4)_3$ s a purification reagent (about 3 to 4g) for every 20 to 30 litres of leachate and wait for 40 to 60 minutes for the purification process to take place. $Al_2(SO_4)_3$ is used in the treatment of the leachate for the coagulation of organic and mineral colloids which are removed by sedimentation prior to brine boiling process. The alum destabilises fine colloidal suspensions and promotes the formation of conglomerations of this material bound in a chemical precipitate (called floc), which is able to be removed from the leachate by either sedimentation or filtration.

The brine is then boiled in a large pot over wood fire until the water evaporates and the salt is left as a deposit, as shown in Figure 12 above. This process takes about 2-3 hours and is completed through the burning of the fuel wood inside specially built sheds, which serve

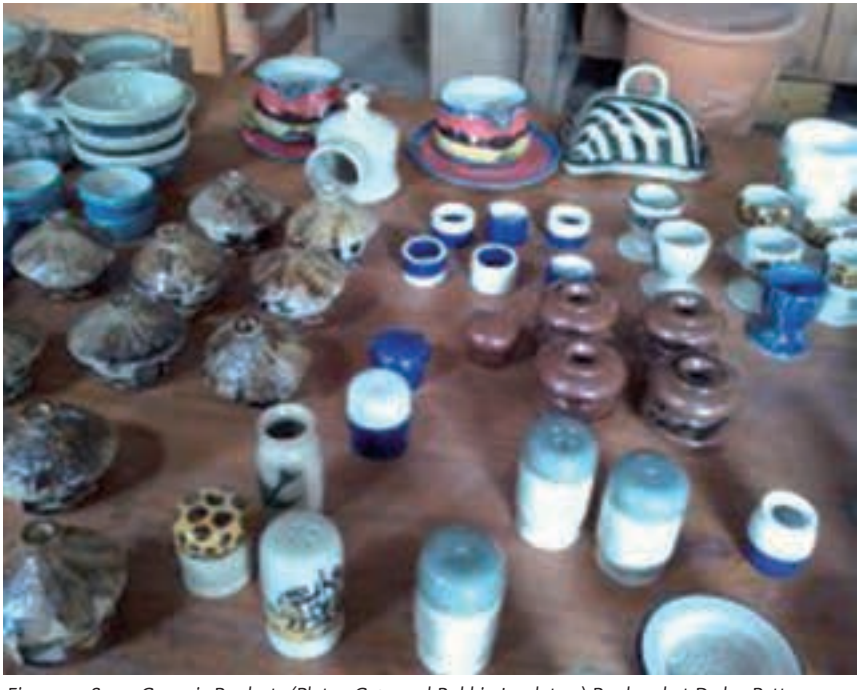
as a shield from the wind and also a storage facility for the salt production implements and firewood, inter alia.

In some parts of the country, Chikhwawa, for example, a filtrate (leachate) obtained from about 300kg of saline soils may yield 25 to 50kg of salt, depending on the grade of the saline soils (Nkhoma, J.E.S.,1985).

Thereafter, the salt is conditioned (dried) and finally iodized using potassium iodate (KIO_3). The iodization of salt is conducted in a manually rotated mixer fashioned like a motorised concrete mixer used in the construction industry. A few milligrams (6.8 – 13.2mg) of KIO_3 is mixed with 20kg of salt and rotated manually for complete iodization for a period of 20-30 minutes. Then the iodised salt is bagged, ready for marketing.

Ceramic Processing from Kaolinitic Clay

Ceramics can be defined as a class of inorganic, non-metallic solids that are subjected to high temperatures for manufacturing use. The ceramics industry is so large and covers a wide range of products from traditional ceramics, such as pottery and chinaware to more complicated technical ceramics for chemical, mechanical or thermal applications.



Source: Burnett Msika, Department of Mines

Figure 13. Some Ceramic Products (Plates, Cups and Bobbin Insulators) Produced at Dedza Pottery

Ceramics are generally made by taking mixtures of clay, earthen elements, powders, and water and shaping them into desired forms. Once the ceramic has been shaped, it is fired in a high temperature oven known as kiln. Usually, ceramics are covered in decorative, paint-like substances known as glazes.

The term "traditional ceramics" refers to the ceramic products, including ceramic pots, plates, cups and other decorations, produced from unrefined clay and combinations of unrefined clay and powdered or granulated non-plastic materials, which serve as glazing material.

Some ASM operators, mostly women, are involved in pottery or production of ceramic products in the country. Additionally, quite a small number of small scale mining companies are involved in ceramics production. One notable small-scale company involved is Paragon Ceramics also known as Dedza Pottery, ref. Figure 13.

In order to produce the traditional ceramic products, the ceramic matter (kaolinitic clay) goes through the following traditional manufacturing steps:

Step 1: Milling of the Mined Kaolinitic Clay and Glazing Material

The raw materials, kaolinitic clay and glazing material, often mineral oxides, for example: feldspars, kyanite, fluorite and quartz, among others, are separately milled using size reduction (communition) equipment such as jaw crushers, roller grinders and ball mills. The idea is to liberate any impurities in the materials allowing for better mixing and forming which in essence produces a more reactive material when firing.

Step 2: Sizing/Screening

The milled materials undergo a sizing or screening process in order to separate desirable material from non-usable. This is done in order to control the particle size of the raw materials. By controlling the particle sizes, the raw materials are enabled to provide proper bonding and a smooth surface on the finished product. This is accomplished using fine mesh vibratory screens, when dealing with fine powder mixes in ceramics. Multiple mesh sizes are available. Screen deck sizes vary depending on slurry thickness and the percentage of the solids present in the mix

Step 3: Mixing of Raw Materials

In order to obtain a more chemically and physically homogeneous material prior to forming, the constituents of the ceramic powder is combined by mixing them. Most often, pug mills are the preferred piece of machinery in this step of the process, when using dry mixes. Binders or plasticizers are added at this step as well. For wet slurry mixtures, a filter press is used to remove the water from the slurry and yield the clay body from the mix. Deflocculants and antifoaming agents are added to wet mixtures in order to improve the processing of the materials.

Step 4: Forming

For this step, materials, such as dry powders, pastes or slurries, are consolidated and moulded to produce a cohesive body of whatever ceramic end product. In the particular case of dry forming, a vibratory jogger table is usually used to achieve the desired shape. In case of wet forming, the potter's wheel is often used by the ASM operators.

Step 5: Drying

The formed materials hold water and binder in their mix than can in turn cause shrinkage, warping or distortion of the product. Generally, convection drying is the most commonly used method in which heated air is circulated around the ceramic piece that alleviates the risk of imperfections in the final product.

Step 6: Glazing

This is another important step before firing. Typically, the glaze consists of oxides that give the product the desired finish look. As indicated earlier, the raw materials for this step are ground using communition equipment such as ball mills or attrition mills. The milled glaze is screened using vibratory screens in order to give the mixture a uniform consistency that, when applied to the ceramic, would be smooth and even. The glaze is often applied by spraying.

Step 7: Firing

In this step, also known as sintering or densification, the ceramics pass through a controlled heat process where the oxides are consolidated into a dense, cohesive body made up of uniform grain.

Some general points to remember about different types of firing end products:

- Short firing time gives a final product that is porous and low density;
- Short-intermediate firing time results in fine-grained, high-strength products; and
- Long firing time produces a coarse-grained product that is creep resistant; thus, the material will not distort when under a load for an extended period of time.

These are some of the important steps, which are followed by small-scale mining companies, such as Dedza Pottery, in the production ceramics in the country.

Mineral Processing Challenges

Some challenges, which ASM operators are grappling with in the country include: 1) lack of capital as well as equipment for mineral processing; 2) lack of knowledge and skills in mineral processing; 3) poor public sector institutional research infrastructure – lack of modern mineral processing laboratories (with well-equipped plants and equipment) for promotion of mineral processing research and development in the country; 4) Inadequate energy supply; 5) dormant networking and lack of mineral processing technology data-sharing between ASM operators in Malawi and those in other countries at both regional and international levels; 6) inadequate human resource capacity in mineral processing in both public and private sectors to support ASM operators – evident from the latter, there is acute shortage of mineral processing entrepreneurs in the country; 7) weak collaboration between the mineral sector and the training, research and development institutions in the country to support and promote sustainable artisanal and small-scale mineral processing; and 8) lack of robust national mineral processing and mineral value-addition strategy and its attendant implementation plan in the country.

Government's Mineral Processing Initiatives

Notwithstanding the challenges faced in the ASM sub-sector, Malawi is one of the countries in Africa that ambitiously nurtures the vision to optimally increase the mining sector's contribution to the country's Gross Domestic Product (GDP) through the promotion of the implementation of robust mineral processing technologies and use of improved mining policy and legislative framework that, inter alia, seek to promote mineral processing even among ASM operators.

As part of the initiatives to spearhead sustainable mining in the country, the Government approved the first ever Mines and Minerals Policy in February 2013 and the National Artisanal and Small-scale Mining Policy, both of which, inter alia, seek to promote mineral processing and down-stream mineral value-addition.

Additionally, the Government waivered duty on all mining plants and equipment, including those used in mineral processing and value-addition of minerals in the country.

Furthermore, the Government intends to promote mineral processing in the country through: 1) formalising ASM operations by organising them into mining cooperatives, providing them with technical capacity in mineral processing entrepreneurship, licensing them and facilitating their access to loans in the lending financial institutions; 2) conducting aggressive, promotional, mining and mineral value-addition exhibitions and sensitisation workshops in the country; 3) facilitating and providing training in mineral processing and mineral value-addition across the country; 4) involving independent power producers in the generation of power to support the mining industry other than leaving the generation of power to one Government-Owned Electricity Generation Company; 5) facilitating collaboration between the mineral sector and the training, research and development institutions in the country in order to promote the development of mineral pro-

cessing technologies for use by ASM operators; and 5) developing a robust national mineral processing and mineral value-addition strategy and implementation plan to support ASM operators in the country.

Mineral Processing Opportunities

The Government established DoM with a view to promote sustainable mining, including mineral processing. Among other Divisions, DoM has the Mineral Processing Research and Analytical Services Division.

This Division has the core function of promoting mineral processing and beneficiation in the country through facilitation and actual conduction of trial beneficiation and pilot test studies on Malawi ores.

Once ores are found to be viable, in terms of processing methods, they are then promoted so that investors, including artisanal and small-scale miners, can take up the challenge of mining that particular ore. On the other hand, where difficulties are encountered in the Minerals Sector, regarding processing methods, the challenge is taken up by DoM, through this Division, to provide solutions for continued development of the particular ore.

More importantly, Malawi is endowed with abundant and diverse mineral resources that have potential for being developed into: 1) metallic mineral products or mineral concentrates mined essentially for export, such as uranium, heavy mineral sands, REEs, including strontianite and monazite; 2) processed products for local consumption or export, such as phosphate, bauxite, gypsum, vermiculite, precious and semi-precious stones and ceramic clays; 3) semi-processed products, as feedstock for the existing or upcoming local industries such as limestone, dimension stone, talc, silica sands and sulphides; and (4) minerals used with very little upgrade such as coal. Furthermore, some significant indications of alluvial gold, diamondiferous mineralization and other Platinum Group of Metals (PGMs) have also been reported in the country recently. Already, artisanal miners are following up on alluvial gold occurrences and conducting gold panning illegally.

The mining policies and laws have been developed and reviewed in an effort to promote investment in mining and mineral processing in the country.

Conclusion

There is a need for both the Government and the private sector to join hands in supporting ASM operators in mineral processing. Mineral processing, if optimally promoted, can be one of the realistic priority weapons for fighting poverty and unemployment in Africa and beyond, especially for those countries, which have high mineral resource potential buried in the belly of the earth, including Malawi. Promisingly lucrative as it is and despite the current challenges Malawi is still geared towards making mineral processing better until the better becomes the best for sustainable economic growth and development of the country through the implementation of sound mineral processing initiatives.

Photo: John Tychsen, GEUS

This is a rose quartz mining site near Mdzimwanda. The commodity is sold to a Chinese buyer weighing before loaded on a truck.

Women at a water pump near a former mining site for Green Granite in Edundu – Mzimba district in Northern Province. Chief Mining Engineer (DoM) George Maneya in the background

HEALTH AND SAFETY ISSUES IN ASM OPERATIONS

By Ignatius Kamwanje, Conquest Geo-Consulting Services

Introduction

ASM is defined as a single unit mining operation with an annual production of unprocessed material of 50,000 tons or less. It is usually characterised as informal, illegal and unregulated by most governments. It is undercapitalised, utilising simple tools, lacking in technology, and hazardous under labour intensive conditions. However, it is a source of income for those living in rural, remote, and poor areas of the country. Hence, ASM operators are described as poor people or small groups, who are largely dependent on mining for sustenance (Aryee et. al., 2003). ASM in Malawi is at oftentimes carried out informally, characterised by archaic methods of extraction leading to adverse effects and consequences on human health and safety in communities where such type of mining activities take place. Besides, it is mostly unregulated by the Government, done illegally. In Malawi, it is largely poverty driven and provides a means of employment and source of income for the individual. Women and children are often involved in ASM operations, from the extraction to the selling of the commodities to the organisation of the mining areas. Due to the unregulated nature of this sector, participation in ASM operations involves many health and safety risks, hazards, environmental degradation and detrimental effects on education.

ASM activities in Malawi have grown considerably in recent years and are a source of livelihood for many families in rural areas. In 2016, it was estimated that there were about 25,000 ASM operators in Malawi with 65 licenced ones. However, by 2018 there are about 40,000. ASM has the potential to limit rural-urban migration and stimulate local processing and manufacturing industries. ASM encourages local entrepreneurship thereby creating employment and contributing to poverty reduction. This sub-sector has been identified as a key area to encourage economic growth to help the poor, which is in line with the results of the recent global Extractive Industries Review. Most ASM operators exploit small deposits in remote areas from where it is generally difficult to get their products to the market. The miners often operate illegally and receive little supervision or support from the local or central government authorities. Their operations are labour intensive, low paying, hazardous, and largely unregulated. ASM operations cause significant damage to public health and the environment by destroying the landscape and spreading pollutants. In 2014, the Malawi Government ordered all ASM operators to be licenced and their mining activities to be regulated. However, with adequate support, ASM can contribute to economic and sustainable development, particularly in rural areas (Government of Malawi, 2014).

ASM activities do not only pollute rivers and other water bodies but also create physical hazards for miners and non-miners. In Malawi, these activities are mostly conducted in the river basins, especially for gold and sand mining, which serve as sources of water for communities in these catchment areas. In these areas, it is common to hear of reports on

Photo: John Tychsen, GEUS

the destruction of natural resources, such as pollution of water bodies and loss of vegetation leading to erosion of the land surface. Other areas in which these activities take place include parts of the Shire Highlands of Southern Malawi, where limestone is mined for terrazzo, lime, rock aggregate, and other uses, and also the Lower Shire where corundum, agate, galena are also mined. In the Northern Malawi, especially the Mzimba Gemstone Belt and other areas, massive hollows can be identified due to ASM activities, mainly for gemstones. These also contribute negatively by destroying the aesthetic beauty of the land surface and creating massive holes that may result in breeding grounds for mosquitoes posing a health hazard to the surrounding communities. Irrespective of the negative effects of illegal mining on rivers and other water bodies as for gold and sand mining, 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. In such communities, it is a common practice to see different households relying on water for different home use. These include bathing, drinking, cooking, domesticated animal ecosystems, irrigation etc. However, people in these areas are also at a high risk of contracting water-borne diseases. Water and sanitation infrastructure is frequently lacking or inadequate in ASM camps because many sites are in remote locations that are hard to reach and mining is often a transient activity. In some mining areas, toilets are rare and pit latrines, if available, are usually shallow and can easily contaminate other water sources (Phillips et. al., 2001); thus increasing the risk of waterborne diseases, such as cholera. In the highland regions of Malawi, where such activities are also taking place, the presence of dust and fine particles suspended in the air resulting from digging activities generate increased hazards of lung diseases, such as Tuberculosis (TB), silicosis, and eye contamination.

Due to the unregulated nature of ASM in Malawi, including health and safety concerns, the Government drafted an Artisanal Small-Scale Mining Policy in 2014. The policy noted that the sector lacks appropriate knowledge, training and environmental management, which makes the operation environmentally unfriendly. On the other hand, the Government admitted that there is inadequate monitoring and enforcement of mining environmental standards in the sector. Therefore, the policy statement addresses to support the provision of training in environmental management and requires the Government to facilitate monitoring and enforcement of compliance of mining environmental standards. On OHS, the Malawi Government noted that a critical issue in ASM is inadequate adherence to OHS Standards. Knowledge, awareness and training in OHS are rarely disseminated and even more rarely enforced. Furthermore, inadequate specific legislation addressing issues on OHS in this sub-sector coupled with inadequate capacity to inspect and enforce OHS issues effectively lead to negligence in the use of safety equipment. Therefore, the policy statement addresses the provision of training in OHS Standards to both inspectors and ASM operators and requires the Government to set up a mechanism for routine monitoring and inspection of ASM operations. There has been growing public concerns about the activities of ASM operations in Malawi, especially the influx of foreigners who are seen as a threat to the local communities in terms of securities. For example, in the Mangochi gold rush, the Government involved the use of police and immigration officers to stop the activities and vacate the area because these activities seem to be out of control especially at a time when there is a rush.

Occupational Health and Safety Issues of ASM Operations in Malawi

One of the most popular issues in mining is non-compliance with OHS Standards. Many ASM operations are said to be lacking in the following safety regulations: reinforcement of mine safety requirements; awareness of the risks inherent in mining; and access to better equipment (Hentschel et. al., 2002). These risk factors lead to higher health risks and poorer working conditions in small-scale mining compared to formal and large-scale mining. Generally, in Malawi, ASM workplaces do not always report accidents and injuries to the Directorate of Occupational Safety and Health unless there is public concern. This explains why there is currently very scanty data on occupational accidents, diseases and dangerous occurrences in the Directorate. No reliable data is available on occupational diseases because mechanisms for monitoring the health of workers are not necessarily established and enforced.

The Occupational Safety, Health and Welfare Act in Malawi was enacted in 1997 and provides for the notification and recording of accidents. It says that if any accident occurring in any workplace causing loss of life to a person employed in that workplace or disables or is capable of disabling any person from carrying out normal duties at which he is employed, a written notice of the accident should be sent to the Director of the Directorate of Occupational Safety and Health in the Ministry of Labour. Forms are available, which are supposed to be filled by management of a workplace should any accident occur. Details required in these forms include the name of the injured person, his age, and the time the accident occurred and cause of injury among other pieces of information. In case of death or serious injury the Act calls on workplaces, in addition to written notices, to immediately report to the Director by phone or any other fastest available means of communication to facilitate immediate investigation.

Apart from regulating activities to do with mining and exploration, the Act also provides for regulation of accidents and other dangerous occurrences occurring in the mining sector. The Mines and Minerals Act of 1981 requires that any accident occurring in the mining sector shall be reported to the Department of Mines within 24 hours. The Department has inspectors who deal with OHS matters, including investigating accidents reported to the Department. In investigating accidents, the Department works closely with the Directorate of Occupational Safety and Health in the Ministry of Labour and also with District Labour Officers at district level for purposes of compensation of injured persons. Once the investigations are concluded the final reports are sent to the Ministry responsible for mining and to the Ministry of Labour for final determination and next course of action. Every mining company, though not necessarily all, submits monthly returns to the Department of Mines indicating the number of accidents that occur in the mine. This means that the Department has information on accidents reported. This information has not been computerised and analysed. In other words, national data for accidents in the mines is not organised.

ASM operations for mining gold are the World's second worst mercury polluter, responsible for one-quarter to one-third of global mercury pollution (Siegel and Veiga, 2010). So many tonnes of mercury are released per year from different countries. Mercury is released either into the atmosphere or into rivers, lakes, soils, and tailings. Mercury is discarded in tailings and released when gold–mercury amalgam is burnt during processing. The health effects of mercury include: impairment of brain function; damaging coordination and memory; lowering of intelligence (IQ); hearing loss; birth defects and miscarriages. The risks are therefore heightened for pregnant women, children and babies.

Poor regulation and poverty means that few miners consider mercury pollution, especially from gold processing, where profits are high. Processing gold ore using mercury is an easy one-person job that is highly effective under field conditions. Miners most often say that they use mercury because it produces quick wins for daily subsistence (Ban Toxics!, 2011). Mercury tends to be highly accessible and extremely cheap compared to the price the gold is sold for. The alternatives are not as easy to use, are more expensive, and are usually less accessible. Many miners are not aware of the risks to health and the environment or alternative technologies. Many have no choice of alternatives.

To mitigate the health aspects, the standard approach is to monitor the health of the workers through pre-employment medical examinations followed by periodic health checks. Such programmes are not well established within the mining sector in Malawi. The gap to undertake workers' health surveillance has resulted in having no data on occupational diseases.

Accidents

Mining work is both lucrative and hazardous. For these reasons the frequency of accidents is very high in mine working environments. Mining accidents range from minor tool crushes through collapse of walls to a total caving of mine tunnels, which often lead to the fatal trapping of mine workers, landslide, lack of air, emission and extraction of noxious gas. These accidents mainly apply to underground ASM operations. The most common causes of accidents among ASM operators are rock falls and subsidence, use of poorly maintained equipment, and non-compliance with Personal Protective Equipment (PPE), erosion, suffocation, poisoning, explosions, and unsafe practices.

Deaths due to mine accidents far exceed deaths due to global abortion and HIV infections combined. Recently, the International Labour Organization (ILO) reported that occupational fatality rate in small scale mining in developing countries rose up to 90 times higher than in industrialised countries. 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 Malawi, the spate of mine accidents has increased considerably with the growth of the activity as an income generating business.

Injuries

Research on OHS issues, particularly injuries, has largely been conducted in high and middle-income countries. Routinely collected occupational health and safety data from low-income nations are often unavailable or incomplete and unreliable. Much of the data on occupational health and safety from the Southern African Development Community (SADC) is primarily from South Africa. There is only a paucity of data from the rest of the SADC region. Hence, the negative impact of poor work conditions on health and safety is unappreciated and the scientific basis for interventions and policy formulation is to a great extent absent in this region (Siziya et al, 2010).

ASM is inherently risky, but little is known about mining-associated hazards and injuries in Malawi, since there is no updated data. ASM operators in Malawi must be trained in OHS with emphasis on Job Safety/Hazard Analysis to reduce injuries and fatalities. Data obtained from the National Compensation Commission from 2000 to 2011, comprising industrial occupational injuries, indicated that ASM injuries in Malawi accounted for 1.9% out of 2,034 accidents. However, it did not specify: which type of injuries/accidents had contributed the most; what safety measures were implemented; which type of ASM section was affected most; contributing factors (hazards); existing preventive measures; consequences; and which measures could have been implemented to avoid or lessen injuries.

To fill this gap there must be a separate study with the aim to characterise the physical injuries associated with ASM operations in Malawi in order to guide of policy formulation. Surveys need to be carried out in those districts where ASM activities are undertaken. ASM operators must be interviewed with regard to their occupational injury experiences over the years using structured questionnaires. Such findings will greatly advance the understanding of occupational hazards and injuries among ASM workers and help identify several intervention points.

Effects on Health

ASM is associated with devastating health impacts for both men and women, but as work on the fields is often quite segregated, the health impacts are quite specific. Miners are particularly susceptible to negative impacts on health. Women are heavily involved in ore processing and because of these activities their children suffer from exposure to mercury, which can result in neurological damage, and dust, which can lead to asthma or lung disease. Reworking of tailings also gives more exposure to cyanide. This is especially typical of artisanal gold mining.

The main diseases occurring in Malawi due to ASM include: silicosis, cancer, pneumoconiosis, TB, and abnormal lung function, though no quantifiable data is available. It has been observed that most of these activities in Malawi take place without the use of PPE on the miners/workers, as shown in Figure 14. This possesses a serious threat in as far as health and safety is concerned.

Source: mininginmalawi.com

Figure 14. Rose Quartz ASM Operations in Mzimba District, Northern Malawi with no PPE

There is considerable disagreement between mining communities and mining companies concerning the real health impacts of the industry as well as the different responsibilities of key role-players. Literature reveals that mining activities can impact the health of communities related to mine operations at various levels (Stephens and Ahern, 2001). Firstly, there are adverse health effects that result from environmental exposure to air, water, soil and noise pollution (Cronjé and Chenga, 2007). Secondly, and equally important for community health, there are non-environmental exposure and events, such as mining disasters, pit closures, migration trends, poverty, unemployment, and poor infrastructure, which affect mining communities both indirectly and directly at different levels.

Generally, OHS issues are disregarded by ASM operators due to the following factors:

- Economic considerations: many of the owners use their entire income for daily living and do not invest in equipment;
- Exaggerated safety requirements that discourage them and inspire them to ignore all advice; and
- Lack of hazard and risk awareness.

Increases in waterborne diseases and infections, and general illness due to unsanitary working conditions, poor health and safety, and hazardous and dangerous working conditions leading to serious injury as well as death often as a result of the collapse of pits, an increased instances of substance and alcohol abuse, violence, and sexually transmitted diseases in mining communities, a greater risk of sexually transmitted infections and diseases, and suffering acts of gender-based violence, mercury poisoning, poor education

and regulation around the use of mercury in gold amalgamation (removing and combining small gold particles from sediment) and the open burning of the amalgam during refinement can cause mercury poisoning, the release of mercury into water bodies used by local communities resulting in bioaccumulation of cyanide poisoning(may sometimes be used by small scale miners to leach gold from rock ore) are but some of the negative health impacts. Cyanide has the ability to block the transfer of oxygen from the blood to the tissues. Signs and symptoms of cyanide poisoning include rapid breathing, tremors, gasping, convulsions and death. Mild poisoning manifests in headache, dizziness and thyroid enlargement. Findings of the study in and around small-scale gold mining camps in Tanzania showed that workers handling mercury, mainly the small-scale gold miners, were highly at risk of mercury poisoning (Van Straaten, 2000). In another study, high levels of mercury in the urine samples were detected among the eight amalgamation workers in Venezuela, and four workers showed symptoms of mercury poisoning such as nausea, stomach irritation, headache and behaviour changes.

On the other hand, generally there are also some environmental (natural) threats to health that can reach disastrous proportions arising from ASM operations namely:

- Dust and other harmful particles in the air and water;
- Excessive noise from blasting, free dig and other mining operations; and
- Overcrowded and unhygienic living conditions.

The most common illnesses and diseases associated with these environmental threats include: TB, silicosis, airborne and water-associated illnesses (asthma, other chronic chest infections, sinusitis, eye problems, diarrhoea and cancer) and hearing problems.

In Malawi, measurements of pulmonary function and of respiratory symptoms, quantitative assessment of mercury exposures and other toxic metals as well as health risks that these activities and the surrounding communities are exposed to, are lacking. There is also not much information on existing data on cardiovascular and respiratory health, water, sanitation and hygiene (WASH), sexual and psychosocial health, nutrition as far as data collected are concerned. Malawi, like any other SADC country, has registered high rates of lung disease occurrence. This has been attributed to poor working conditions in mines and HIV/AIDS prevalence. The seasonal and migratory nature of ASM can lead to high-risk behaviour that can facilitate the spread of sexually transmitted diseases (STDs), HIV/AIDS infection coupled with occupational exposure to dust are important risk factors for TB, particularly among the miners. OHS and the environment need to be promoted in order to protect miners and their families. Besides, the absence of regular environmental audit, inspection, monitoring to small-scale miners by the responsible government body and limited access to healthcare services makes it very difficult to attribute specific diseases that are associated with the impacts of mining operations on the environment. However, environmental health and safety studies elsewhere than Malawi have shown that mining increases the health risks for people living in areas near artisanal small-scale mining activities.

Source: Ignatius Kamwanje, 2017

Figure 15. Alluvial Gold Sluicing Using Sluicing Board Along the Nathenje River, Central Malawi

Effects on Children

Indirectly, ASM activities lead to child-destitution and delinquency at school. During a site visit in areas where alluvial gold mining by ASM operators is taking place in Malawi (Mangochi and Lilongwe districts), children of school-going age are either absent or drop out from school to engage in these activities for short-term economic benefits, ref. Figure 16 below. For the children, they think 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 these activities is monetary reward at the expense of education and overall development. Almost all work performed by children in ASM operations is hazardous and has characteristics that fit the definition of a "worst form of child labour" under ILO Convention No. 182 (ILO, 1999). It is difficult, however, to eliminate or limit the participation of children in ASM operations, given its family orientation, transient and informal nature, and associated levels of poverty. In communities where such activities occur, absenteeism, low enrolment, gangsterism and school dropout are some of the major development obstacles facing the local school authorities. Generally, ASM is one of the worst forms of child labour because of widespread and severe hazards that risk death, injury and disease (ILO, 1999). Children undertake risky tasks, such as heavy lifting, digging, ore haulage and transport of ore/waste. Child labour also includes children working and being exposed to most hazardous conditions, involved in prostitution, drug and alcohol abuse and violence. Some of them often become slaves to mine owners or pit owner/occupier who employs them and work throughout the day without having enough rest. De-

Source: Ignatius Kamwanje, 2017

Figure 16. Children Undertaking Small-Scale Alluvial Gold Panning Activities Along Unga River, South Eastern Malawi

spite the often-high risk of injuries and fatalities associated with the ASM activities, economic considerations remain the main motivation for children to abandon school. Poor regulation of health and safety exposes children to extreme risks. ASM's poverty-driven nature and low margins force families to use child labour and its associated migration patterns disrupts children's' schooling.

Effects on Women

Women constitute a large share of the workforce in the mining sector, particularly with regard to ASM operations, as shown in Figure 17 below. According to the ILO, 3.5 - 4.0 million women are engaged in mining activities out of the 11.5 - 13 million small-scale miners. Africa has the highest percentage of female miners at 40-50%. In Zimbabwe, 50% of small-scale miners are women, 40% in Tanzania, and 30% in India. In Asia, less than 10% of miners are women and in Latin America, women comprise only 10-20% of the labour force in the mining sector. Generally, women work unofficially or are found at the lowest end of the sector's hierarchy; even though most of the mining activities are carried out by them

Source: Ignatius Kamwanje, 2018

Figure 17. Women Undertaking Small-Scale Alluvial Gold Panning Activities Along Nathenje River, Central Malawi, Lilongwe District

(Dreschler, 2001). While men work primarily in the mines, women and children can work both in and around the mines and at home, balancing mining and household responsibilities. This blend of mining and household work results in an array of health problems for miners, family members and surrounding communities. Women are often involved in processing and waste disposal, exposing them to harmful chemicals, with severe consequences for family well-being and health, including during pregnancy. Women often suffer crime, domestic violence and rape and are forced into prostitution. Women's "economic" activities are an addition to their domestic responsibilities. Women make less money for similar tasks; rarely control mining income; and usually work near the home in less profitable seasonal activities. Degradation of nearby natural resources needed for food, firewood and medicine particularly affects women. According to Chakravorty (2001), women are employed in mining activities because of their alleged feminine characteristics, such as being assiduous, regular, and dependable. Their work comprises panning, hand-sorting, picking, manual grinding/breaking of ores and stones, filling up the measuring boxes, transporting, and improving the quality of extracted minerals through blending. All of these activities are manually done (Chakravorty, 2001).

Effects on Environment

Mining workers are not only exposed to the direct and harmful effects of physical, chemical, and ergonomic hazards in ASM operations but also to safety and health hazards due to contamination of the larger environment through water run-offs, air contamination, and ground contamination from landslides and subsidence.

The main primary effect of ASM operations is leachate of mine tailings that contaminates groundwater. The whole groundwater system is heavily polluted with heavy and toxic metals and organic chemicals that are applied during mineral separation and some waste material that is released. Some plants absorb polluted water, which may contain disease pathogens. The adverse effects of mining to the environment include: contamination of water due to improper waste disposal from mines, erosion in the mining sites, and mercury and cyanide poisoning. One of the adverse effects of ASM operations is contamination of rivers and lakes. River siltation and pollution due to ASM operations affect drinking water.

The major environmental impacts are visual in nature, e.g. in sensitive areas habitat destruction and the destruction of archaeological heritage may have significant impacts, as shown in Figure 18 below. Poor waste management practices are particularly extensive due to lack of established waste disposal facilities, ignorance of how to dispose of certain waste streams and failure to train in appropriate waste disposal. The impact of stone mining on air quality is limited to the generation of dust. These fines, lacking cohesion, are washed away by rainfall and may be transported by either suspension or saltation, from the higher lying areas where it is taking place to discharge points into the river system.

Source: Ignatius Kamwanje, 2017

Figure 18. Environmental Degradation Along the Unga River Following Extraction of Alluvial Gold, Mangochi District, Malawi

Potential environmental impacts of ASM operations on rivers in Malawi could be changes in hydrology and water quality, particularly increased turbidity, as a result of land clearing, soil erosion and land degradation due to mining and processing activities. Changes in hydrology can alter available hydrological habitat for aquatic biota, and increased turbidity may lead to smothering of aquatic plants, habitats, and biota. Clearing of riparian vegetation, unregulated sewage from mining camps and rubbish disposal can impact on the rivers nutrient concentrations and habitats. With ASM operations, especially gold in Malawi, these environmental impacts are temporally variable due to the fact that there is high demand for water during dry seasons and excess water in wet seasons altering the flow of the river/stream. Further, degradation of the river water quality and ecology can have flow-on impacts to cultural values associated with the river, as well as fishing and suitability for drinking. Toxic contaminants in fish or other food products in rivers and streams can have serious long-term negative effects, depending on the pollutants and the doses. ASM operations bring toxins, including heavy metals that can migrate downward and contaminate aquifers. These activities affect groundwater through leaching of mine tailing and stockpiles.

Photo: John Tychsen, GEUS

Women gathered at Mindale-Lunzu in Southern Region. They are mining hematite for use in cement industry. The men are doing the mining and women transport the hematite to the nearby road for transport.

This is Aquamarine mining from a pegmatite vein near Watereka in Northern region. No activity at the moment due to lack of funding.

ENVIRONMENTAL ISSUES IN ASM OPERATIONS

By Charles Kaphwiyo, Independent Geological Consultant

Malawi is known to be endowed with a variety of mineral resources, some of which can only be exploited by ASM methods.

ASM activities are concentrated in:

- Limestone or marble crushing and burning for lime production for the construction industry, agricultural use and chicken feed production;
- Rock aggregate crushing for quarry stone and terrazzo for construction;
- Sand extraction for construction;
- Extraction of clay for ceramics, pottery and brick making;
- Gypsum mining for chalk moulding;
- Extraction of saline soils for salt making;
- Gemstone mining; and
- Gold panning.

Just like in other countries in Africa and beyond, it is difficult to define ASM in Malawi. However, ASM activities are conducted across the whole country, as shown in Figure 19 below, and vary from district to district depending on what mineral resource is found in the district. What is clear is that ASM in Malawi is a poverty driven activity dominated by a large number of people engaged in informal activities that are not regulated and bring with them serious environmental problems. Most of the ASM operations impact negatively on the environment during exploration, exploitation, processing and closure. The existing environmental regulations and the provision of technical solutions cannot solve the environmental problems as most of the operators are scattered across the country in very remote areas and may be difficult to reach by the regulatory authorities. For instance, gemstone miners operate in very remote areas and you only see middlemen selling the stones in cities and towns. On the other hand, many lime and terrazzo producers operate in their backyards or gardens and only sell the lime and terrazzo to middlemen who bag the product and sell on the roadside. Furthermore, most ASM activities are frequently migratory as miners move from site to site in search of minerals. Hayes (2008) noted that the rate at which they move and the geographic area within which they travel depend on a combination of factors among which are the life of the mine, the temptation of high value mineral strikes in other areas which create a 'rush' to that site, relocation by traders, pressure from conflicts, exclusion from a site by new restrictions, such as the arrival of a large-scale mining company, rain and the availability of water, environmental shocks and the agricultural season. Therefore the impact on the environment and its severity will depend on the type of ASM activity and all the above factors.

Photo: John Tychsen, GEUS

ASM activities in Malawi can be grouped into three categories:

1. Mineral extraction done under MCL, which entitles the holder to extract the mineral for sale or use;
2. MP, which entitles the holder to extract minerals which are traditionally used for construction; and
3. Mineral Prospecting done under NEPL, which entitles the holder of the licence to prospect for minerals on a non-exclusive basis.

The final category, which does not involve mining or extracting per se, is done under the RML, which entitles the holder to buy, hold and sale gemstones.

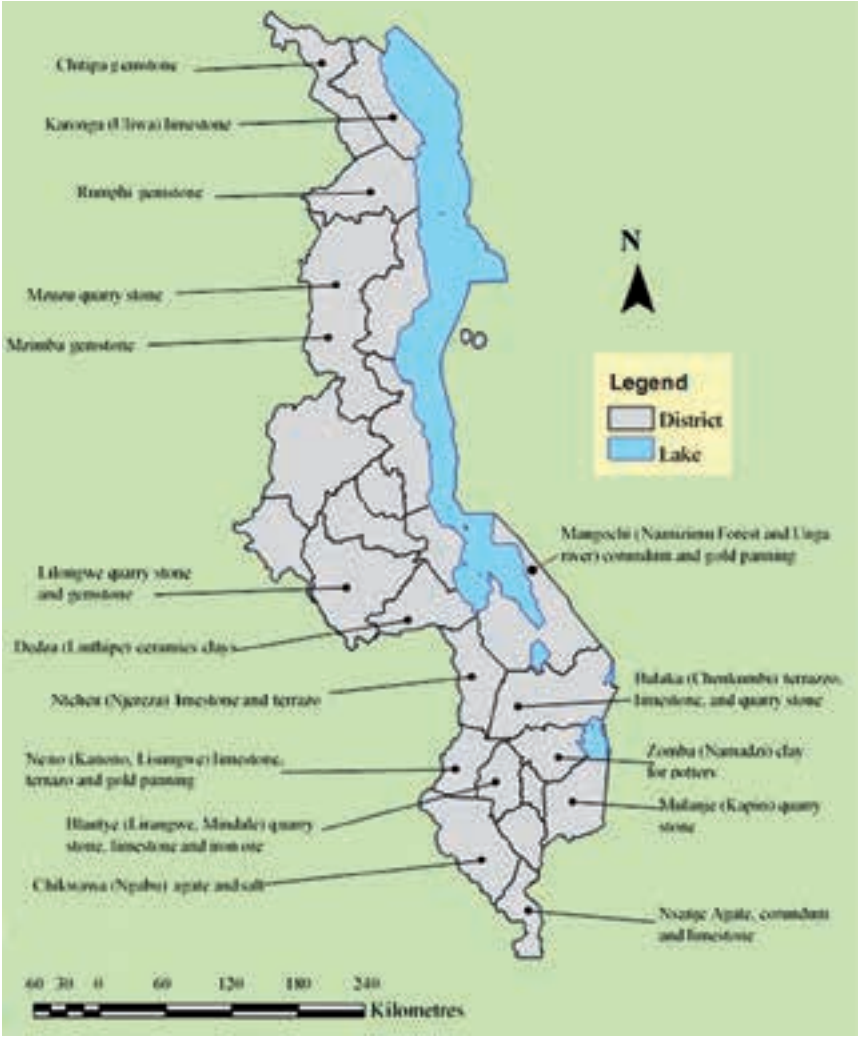
ASM activities are largely poverty driven and the majority of workers in the sub-sector exploit small deposits in remote or rural areas from which it is difficult to get their products to the market. ASM operations:

- Are labour intensive without the use of heavy mining machinery and equipment;
- Involve manual movement and shifting of ore and waste;
- Produce products that are sold locally and few are exported;
- Are low paying, but spread across the country;
- Cause significant damage to the environment;
- Are not sensitive to public health; and
- Expose miners to harsh working conditions for minimal income.

ASM Operations and their Impact on the Environment

Heath (2005) has described some of the most important environmental impacts caused by ASM operations in Southern Africa as the following:

- Accelerated erosion of areas adjacent to workings that have been de-vegetated for construction materials or fuel wood leading to increased suspended sediment loads in nearby streams and rivers;
- Increased instability of riverbanks and scouring as a result of excavation of flood terraces and riverbanks;
- Alteration of river channels and flows due to mining of alluvial deposits in the riverbed;
- Gold panning and operation of sluice boxes which increases loads of suspended sediments in downstream reaches;
- Wash-off of mercury used to concentrate gold, which leads to increased risks of mercury toxicity to aquatic and terrestrial organisms, as well as to the miners;
- Wind-blown dust from unprotected tailings and waste rock dumps which enter aquatic environment;
- Loss of arable land due to lack of rehabilitation; and
- Large tracts of land becoming a safety hazard (for people and livestock).



Source: Charles Kaphuiyo

Figure 19. Map of Malawi Showing Districts and Areas of Active Artisanal and Small Scale Mining

While the duration of these impacts is mainly long-term or forever, in some cases, e.g. deforestation, the impacts can actually be reversed.

The majority of the impacts from ASM operations are diffuse in nature and are consequently difficult to manage unless appropriate mining methods are undertaken at the onset of the mining activity.

In Malawi, the type of impact(s) to the environment depends on the type and nature of mining activity. The following describes the main ASM activities in the country and their associated environmental impacts.

Limestone or Marble Crushing and Burning for Lime Production

The traditional method for lime production involves mining of the limestone or marble using basic tools, such as picks, crowbars, hammers shovels, and wheelbarrows. The limestone is crushed with hammers to about 50mm-sized pieces. The crushed limestone pieces are fed into a rectangular trench-type kiln together with fuel wood arranged in alternating layers, as shown in Figure 20 below. The feed is fired at once to a temperature above 9000C for three days. This method of calcining limestone consumes a lot of fuel wood, since one ton of limestone requires 10 tons of firewood, which leads to deforestation. The result of deforestation is increased erosion and hence siltation of the drainage system. This can lead to perpetual flooding, affecting aquatic life and decreased hydroelectric power generation due to progressive siltation particularly in the Shire River, where almost all the hydropower in Malawi is generated.

After the limestone has been burnt to produce quicklime, it is slaked by adding water to produce hydrated lime. The quick lime or hydrated lime is milled into fine powder for final bagging and sale. The milling produces a lot of lime dust, which affect the quality of air both at the milling site and the surrounding areas. This air is directly inhaled by the workers and people in the vicinity, thereby posing a potential health hazard.

Source: John Tychsen, GEUS

Figure 20. Limestone Burning in a Rectangular-Type Kiln

The areas where the limestone has been mined is often not rehabilitated leading to loss of arable land.

Rock Aggregate Crushing for Quarry Stone and Terrazzo for Construction

Quarry stone is produced from any hard rock, mostly the dark basic types, while terrazzo is produced from limestone or marble and any hard rock mostly the pink and dark varieties. The mining of such rocks leaves open pits, which are not refilled. This degrades the land and result in a loss of aesthetic value of the landscape. Further, the crushing, bagging and selling of the terrazzo leave a lot of dust in the surrounding areas, as shown in Figure 21 below.

Source: Ntcheu Njereza

Figure 21. Terrazzo Crushing and Bagging Causing a Lot of Dust in Air

Sand Extraction for Construction

Sand for construction is extracted from either the riverbanks or the riverbed. Extracting from the riverbank causes instability and failure of the banks resulting in increased siltation and decreased water flow in rivers, thus affecting aquatic life. The increased siltation also contributes to flooding. Extracting the sand from the river channel may have the advantage of unblocking the channel, but it increases the turbidity of the water, which affects aquatic life.

Extraction of Clay for Ceramics, Pottery and Brick Making

Clay for ceramics and pottery in Malawi is extracted from either dambos (vernacular for broad grass covered swampy area) or anthills. The extraction will normally leave unsightly pits that may fill with water during the rainy season and become favourable breeding environment for mosquitos, which can increase the prevalence of disease such as malaria.

The curing of ceramic and pottery articles and bricks require burning with a lot of firewood, which contributes to deforestation.

Gypsum Mining for Chalk Moulding

In Malawi, gypsum crystals form in dambos, where calcium from marble or limestone reacts with sulphate and forms a layer in the dambo sometimes as thick as 2m. The gypsum crystals are extracted, burnt in ovens and crushed for chalk making. The environmental effects are therefore the same as for extraction of clay for ceramic-ware production and brick making.

Extraction of Saline Soils for Salt Making

Salt making involves scraping of mostly topsoil and soaking the soil in water before filtering to dissolve the salt. The solute is then boiled in half drums to evaporate the water and leave the salt accumulate at the bottom of the drum. The boiling of the solute requires a lot of firewood, which contributes to deforestation. The loss of forest cover accelerates erosion leading to siltation of the drainage system.

Gemstone Mining

The main environmental degradants of gemstone mining comprise the hundreds of mine pit excavations of which a large percentage are inactive and have not been refilled causing massive destruction of land. The pits can be as deep as 50 metres, in some cases more. Furthermore, no protection is provided to both active and inactive mine pits. Along with this are large stockpiles of excavated materials, which have not been removed but left around the mine pits. The land is not properly reclaimed to enable other economic activities once the gemstones have been depleted or abandonment due to technical reasons or on economic grounds. The unsightly pits also result in the loss of aesthetic value of the landscape and loss of arable land. The large number of pits is a safety hazard for people and livestock.

Other gemstones, such as garnet are found in riverbeds or riverbanks. This activity has led to an influx of workers, but without requisite sanitation facilities and disposal of effluent in the rivers. This can lead to reduced healthy standards and increased waterborne diseases as the workers help themselves within the surrounding bushes. Furthermore, the excavation of such deposits has the same environmental effects as sand extraction. Extracting from the riverbank causes instability and failure of the banks resulting in increased siltation and decreased water flow in rivers, thus affecting aquatic life.

Gold Panning

The only known gold mining method in Malawi involves the panning of river gravels and sand in the Lisungwe and Unga rivers in Ntcheu and Mangochi districts respectively. The main impacts of artisanal gold mining on the environment include pollution of rivers and

Source: John Tychsen, GEUS

Figure 22. Abandoned Aquamarine Mine Pit at Majishawa in Mzimba District, which has led to the Loss of Aesthetic Value of The Landscape

dams through excavation of river sediments, which exposes the sediments to oxidising conditions and enhances the solubility and release of any metal ions that may have been previously trapped as insoluble sulphides. The actual gold panning and operation of sluice boxes or in the rivers increases loads of suspended sediments in downstream reaches leading to siltation of riverbeds, dams and the lake. The influx of workers in the vicinity of the mining areas has led to poor sanitation, which can lead to the prevalence of diseases such as cholera. Furthermore, the forest reserve has been invaded for construction materials or fuel wood resulting in deforestation and wildfires by the illegal miners. This will eventually accelerate erosion and lead to increased suspended sediment loads in the nearby streams and rivers.

The use of mercury in gold amalgamation process is not done in Malawi because the gold is mostly alluvial requiring only panning to concentrate. However, the resultant pollution from mercury use cannot be ruled out in the future, as more and more people get involved in gold mining.

Source: John Tychsen, GEUS

Figure 23. A Man Mining Garnet on a River Bank at Nathenje in Lilongwe District, which leads to Instability of the River Banks and the Likelihood of Increased Flood Scouring and Siltation of The River

Challenges of Mitigating ASM Environmental Impacts

ASM operators lack appropriate basic knowledge and training in best mining methods and environmental management, which makes their operations environmentally unfriendly. On the other hand, there is inadequate monitoring and enforcement of mining environmental standards in the sector due to the informal nature of the operations, remote location of the operations and lack of resources to enable the regulatory authorities reach out to the miners. Furthermore, lack of mechanisation, which limits production, results in unstable resource realisation and poor cash flows. The ASM operators have no financial resources to apply reasonable and sustainable mining and mineral processing methods and rehabilitate or reclaim mined out areas.

SOCIO-ECONOMIC PROFILE OF ASM IN MALAWI

By Rachel Etter-Phoya, Researcher, Tax Justice Network

Overview of ASM in Malawi

ASM in Malawi takes place in rural areas and for many people it is a livelihood diversification strategy from agriculture. Most gemstones are produced in Malawi's ASM sector and industrial minerals (including clay, limestone, aggregates, sand and salt) are also mined. Gemstone mining and limestone quarrying are the most important ASM activities. Despite a lack of accurate data, a 2001 study (Drechsler, 2001) estimates that there are 40,000 people directly engaged in ASM in Malawi. However, this number should be treated with caution since this figure is likely to be "extremely conservative" (Hilson and McQuilken, 2014). This is, in part, due to the seasonality and periodic nature of ASM activities and its respective employment levels (World Bank, 2009). Furthermore, with "an estimated six downstream jobs 'created' per individual employed directly in the sector" (Hilson and McQuilken, 2014), most job creation spawns from activities that support the sector.

Source: John Tychsen, GEUS

Figure 24. Asm Operators in Action, Malawi

Artisanal methods (picks, chisels, shovels and hammers) are used in the production of limestone, gemstones and stone aggregate. Most mining takes place in the dry season because of difficulties in accessing mine sites and in using kilns, although people are engaged in river and dambo sand mining during the wet season.

Both formal and informal mining exist. Formal mining is the legal form of ASM, where operators abide by the law and obtain the required permits from agencies (primarily the Department of Mines and District Councils, as per the Mines and Minerals Act of 2018) that regulate activities. Informal mining is illegal as miners do not acquire the appropriate permits and follow the regulations to mine. Even when mining may be informal and illegal, it is not necessarily seen as illegitimate by miners or nearby communities who may accept it as an alternative source of income.

Most ASM activity in Malawi is unlicensed. Thus, data on "production, employment and sales make accurate estimates of the amount being lost via smuggling impossible to pinpoint" (Kamlongera and Hilson, 2011). No reliable data exists on the economic contribution of the ASM sector to Malawi's economy or the impact of mining at the household level because of the informality, temporality and transience of most ASM operations. Nevertheless, some qualitative information is available. Consequently, this chapter is based on interviews and conversations with small-scale miners and cooperatives, field research conducted for an ASM inventory under the project Geological Mapping and Mineral Assessment of Malawi, and limited published articles and grey literature on Malawi's ASM sector.

Who is Engaged in ASM in Malawi?

The majority of people in Malawi are engaged in smallholder farming. However, "a growing number of its [Malawi's] inhabitants are engaging in both smallholder farming and ASM", which is a pattern that can be seen across southern Africa (Kamlongera & Hilson, 2011). Typically, ASM brings in greater income than other non-farm activities, like charcoal making, ganyu (temporary work), or firewood selling (Kamlongera, 2011).

In a study in Finishi Village (Chikhwawa), where people have been mining blue agate on an artisanal level since 1999, one farmer turned miner explained (Kamlongera, 2011):

"For most people, farming had been the only source of both subsistence and disposable income. Apart from its failure to cater for the livelihoods due to poor harvests, the long wait does not help as it takes a year to realise the benefits. Sometimes you do not even get what you hoped for because of poor harvests or bad selling prices for crops. Turning to mining as long as you have mined something one is assured of ready income, which can keep you going day by day. Mining is now providing the much needed alternative and those of us engaging in the activity find it very relevant as it provides much more income regularly than any other activities bring to our families".

In this community, like others, some people, mainly pit owners, now engage in mining activity fulltime, which mean that they are fully dependent on ASM. They tend to have completed more formal education and hire others to mine for them once they earn some money; they also may take on the role of middleman, setting the prices of stones they buy (Kamlongera 2011). In contrast, there are also many who are involved in ASM on a seasonal basis, largely when they are not farming. ASM is a means to supplement their income and they do not intend to stop farming. There are also sometimes linkages between mining and farming as money from ASM goes into buying farming inputs.

Some labourers at mine sites receive a daily wage, while others work and are paid by the owner for the stones they find. Labourers often receive about MWK 1000 per day (just over USD 1) and sometimes one meal, lodging and bonuses. At some mining sites, those who use hammers and chisels receive a slightly higher amount than those using shovels. Mine owners often pay the landowner as well; this can be a one-off upfront payment, a monthly rent, and a bonus when minerals are sold. At gold rush sites, miners say that their proceeds "range from K100,000 to K200,000 in every three days, but when luck strikes, one can cart home in excess of a K1 million or two in a day" (Jere, 2018).

What are the Key Characteristics of and Challenges in ASM in Malawi?

Preparation to Mine

Acquiring a Licence

Doing business legally can be a challenge for miners. Many miners find the delay in the issuance of permits problematic. It usually takes between 6 to 9 months after an application is made to acquire a permit. The permit is valid for one year and this may be shorter as the effective start date is often the date of application (Zidana and Mezuwa, 2016). Even miners who do have the relevant licences to mine tend not to pay tax.

Access to Credit and Finance

Small-scale miners face huge challenges in accessing capital from formal institutions, such as banks. As a result, they typically rely on the income they make from selling stones to either pay for labour or meet their household livelihood needs. Financial support from family members is also another channel of income.

Although there has been some interest from banks to support ASM, the perceived high-risk nature of ASM means no miners have been able to secure substantial credit from a financial institution. Some buyers have paid upfront for an agreed amount of stone, but evidence suggests that without business training, miners do not use the money in a way so as to make enough profit to plough back into the business and meet their personal and family needs. Even when ASM have accessed training, the majority do not have business plans in place (Zidana and Mezuwa, 2016).

In a study of 31 small-scale miners, including 9 focus group discussions across seven districts in Malawi, Zidana and Mezuwa (2016) make recommendations based on the need of small miners in terms of access to finance:

- Improved information flow and accessibility of information (i.e. to ensure comprehensibility of information regardless of literacy levels) on services and products by lending entities to small-scale business and cooperatives;
- Establish partnerships, such as with organisations or government, through which miners can be linked to lending institutions and where partners can negotiate formally on behalf of miners as they will have more clout;
- Lending institutions should develop innovative approaches to enable cooperatives to access loans and to ensure they are repaid. This could include support in developing business plans and monitoring activities; and
- Financial institutions should strive for inclusivity so that remote customers can save and make investments with profits from mining.

At the Mine Site

Children in ASM

Children sometimes assist their families in mining. There is a risk of human trafficking to work as labourers in mines and as sex workers. There is little information available on the extent of children working in the ASM sector, yet it is likely comparable to agriculture for those involved in ASM operations as a complementary activity to farming. The Nation covered a story of artisanal gold mining in Balaka District where "children as young as 10 of age are busy, some are turning the rocks, others collecting the sand and others moving here and there" (Kabango 2017).

Women and Mining

The majority of women in Malawi's mining sector are working in ASM operations (Adam Smith International & International Women in Mining, 2017). Women are involved across the value chain from mining to sales and value addition. Women face some particular challenges. In a gender analysis of the extractive industries in Malawi, women who were involved in cooperatives said that men sometimes take deliberate action to prevent women from accessing economic opportunities (Kachika 2014). In addition, women said they were vulnerable as mining often takes place in remote areas, with poor dwelling structures, and in some mining areas, "girls have been known to drop out of school to cohabit with miners" (Kachika, 2014) although the reasons for dropping out of school are multifaceted and not specific to ASM.

Environmental Issues

Environmental management is generally weak. Most miners do not have the resources to finance the cost of rehabilitation; this can result in health and accident risks beyond the environmental impact. Some mine owners do not want to rehabilitate (backfill the excavated area) because they believe there may still be more minerals to exploit if improved technology were available (Kachika, 2014). The small scale of mining operations means that miners are not required to conduct Environmental and Social Impact Assessments or to develop Environmental Monitoring Plans. However, the implementation of any further assessments to licencing procedures needs to consider the potential consequences of making licencing more problematic and exclusionary.

Waste produced and disposed during the mining process varies depending on the mineral. Generally, disposal is haphazard and around the mining area, sometimes including topsoil and poor quality stones (Drechsler, 2001). Governmental environmental management of mining sites tends to be limited, primarily because of understaffing and financial constraints, as well as the remoteness of many mining sites. Operators may also believe it is the responsibility of the Government and not themselves to rehabilitate.

In the case of rush ASM, the situation can be acute. For example, in a gold mining site in Balaka (30km from Phalula Trading Centre), residents complain that the river camp is placing strain on the environment. This includes soil erosion, sink holes, loss of vegetation and trees, water pollution and a greater risk of landslides and siltation (Kabango, 2017).

Source: John Tychsen, GEUS.

Figure 25. Mining Without Protective Clothing, Malawi

Community and Occupational Health and Safety

Most miners do not wear protective clothing; it is not a priority, costly and hard to get hold of. For example, along Nyuludzi River in Ntcheu, where gold is being mined, one woman interviewed by a journalist said: "we believe that God will take care of us. For now, my major concern is to put food on the table for my family". Access to medicine and medical care in case of an accident is often also limited (Kabango, 2018). In 2017, at a rush gold ASM site in Makanjira, Mangochi, four miners died after a tunnel collapsed (Chimwala 2017) and, three women are believed to have died around another non-licenced mine site along a river in Nathenje (Khamula 2018).

Sanitation (toilets and waste disposal) at the mine site tends to be problematic and malaria is one of the most common sicknesses. The nearest healthcare facilities can be up to 20 kilometres away from remote mining sites. Due to the lack of protective clothing, respiratory conditions are also common among miners and coughing is seen as part of the process of mining. Operational accidents tend to affect lower limbs and hands.

Some ASM communities in Malawi are mobile and male mine workers often live away from their families. "Men recklessly spend money on sex and beer, commonly boasting that 'we will make more tomorrow' (by digging and selling more gold)" (Kachika 2014). When miners live at a remote mining site, alcohol tends to be consumed on Sundays when they are not at work, but this is not unique to mining communities only.

Malawi's draft inventory of mercury releases states that they could not establish "for certain [that] the small-scale mining does use mercury amalgamation" (EAD, 2017). In Ntcheu, Mangochi, Balaka and Mzimba Districts where gold is being mined on a small scale, miners are using gold panning methods. Yet the EAD said further research is needed. In other countries, even when small-scale miners are unable to acquire mercury themselves, mercury is often provided to miners by buyers of gold. This may be the case in Malawi. People tend to be less careful with mercury when they have not purchased it themselves, which increases the risk of mercury contamination.

ASM and Large-Scale Mining

At some mining sites, there is tension between ASM and medium- or large-scale mining, and between customary landowners and miners/operators. Some large-scale miners in Malawi argue that ASM is not able to maximise extraction from a resource and that the limited marketing and low prices short-change the country (Gilbert, 2015).

After Mining

Marketing and Pricing

"Predatory middlemen" (Kamlongera and Hilson, 2011) mean that those involved in production often receive lower prices than if they were directly dealing with the end markets themselves (Kachika, 2014). However, most ASM operators have not received formal training in gemmology. One result is that stones go ungraded and high value stones are sold cheaply alongside cheaper ones (Kachika, 2014).

Source: John Tychsen, GEUS.

Figure 26. Weighing Rose Quartz on Site, Malawi

A functioning cooperative could help to improve miners' access to markets, enabling them to meet the demands of larger contracts and to control prices. However, "members are in competition with their own cooperatives [...by] cheaply sell[ing] commodities individually on the side-lines, instead of using the cooperative as a central marketplace" (Kachika, 2014).

Often miners are reliant on a single buyer, which makes it hard to determine prices. For example, the Titukulane Cooperative in Chitipa survives on a single South African based buyer for their amethyst. In Zidana and Mezuwa's study (2016), this cooperative complained that they do not receive a fair price for the stones or their labour. They also suggest that the main factors limiting miners' access to markets are:

- Inadequate information about miners (on prospecting, mining, processing) and for miners (on potential buyers, value addition, market research and business management);
- Lack of knowledge and technical skills to identify market needs;
- Poor or no supportive infrastructure (such as being in areas impassable in the rainy season and limited mobile connectivity, which also increases the cost of doing business);
- Lack of institutions to support ASM.

Value Addition

Little value addition takes place and most people involved in ASM do not have the skills or access to equipment to cut and polish. Some cooperatives do have access to equipment, but either they do not know how to use it or it does not work well (Gilbert, 2015). Beyond this, knowledge is required of the market – the type, quality and quantity of products in demand.

Smuggling

Anecdotal evidence suggests gemstone smuggling is a problem. There are a number of reasons for this. One gemstone dealer based in Karonga explained (Manda, 2016):

"I applied for a dealer's Licence 8 months ago, but up to now it has not been issued. So how can I export officially without a licence? And it is expensive for me to travel to Lilongwe to process an export permit; it could have been better if we were doing it at the district assembly. Therefore, it is easier for me to sell anyhow".

Besides administrative hurdles and delays, the high royalty rate and lack of expertise among enforcement authorities, such as customs, increase the risk of smuggling.

What is the Outlook for ASM in Malawi?

The development of Malawi's ASM sector in the medium- to long-term "depends critically on increased organisation of miners and communities, access to capital and more efficient technology" (World Bank, 2009). Kamlongera (2011) notes that "in Malawi, ASM is providing a refuge for people who have few viable alternative income-earning activities". ASM may also help to increase employment and ease urban migration (World Bank, 2009).

There are few functioning ASM cooperatives in Malawi. Supporting these – with business and technical training, facilitation of market linkages, and access to capital – may prove to be a catalyst for improved ASM practices and outcomes for miners and the economy.

Nevertheless, further information is required by the Government on both formal and informal mining to understand how ASM can better contribute to non-farm household income and the economy (Kamlongera and Hilson, 2011). Without empirical evidence on both legal and illegal ASM, "interventions and programmes carried out by the Government, non-governmental organisations and private sector may not be based on evidence and hence are bound to be misdirected" (Zidana and Mezuwa, 2016). Such research is vital for the implementation of Malawi's National ASM Policy of 2018.

Photo: John Tychsen, GEUS

Mining in a pegmatite vein. A compressor and generator are used to remove the groundwater from the mining area

A small shaft for preparing food for the miners at the tourmaline mining site near Kauta.

VALUE ADDITION TO GEMSTONE IN MALAWI

By Rodrick Phiri, Accredited Gemmologist, Department of Mines

Malawi just like her neighbours enjoys abundant occurrence of gemstones, which include rubies, sapphires, aquamarines, tourmalines, quartz, and garnets. These gemstones have been exploited from as far back as the early 1950s, such as rubies and sapphires from the Ntcheu District, and aquamarines from Mzimba.

These gemstones have primarily been exploited ASM operators with the use of rudimental methods/tools, such as pick and shovels, which have resulted in slow production and non-reliance on small scale mining; as such most people see ASM as a seasonal activity.

However, many countries have enjoyed significant contribution to their GDP from ASM. But this is not the case in Malawi, largely because this sub-sector is still in its infancy and does not enjoy adequate support from both public authorities and private actors. Some countries have stepped up initiatives in value addition of gemstones (turning raw material into finished products to acquire a higher price) realising that they are scarce resources; hence, the value should be maximised to the benefit of the country and its citizens.

Current Gemstone Trading in Malawi

Statistics show that there are about 240 active ASM operators in Malawi of which more than 50% are in gemstone production. There also about 1,000 gemstone dealers who buy from these miners. These statistics translate into approximately 14,000 people who benefit from the sub-sector directly and indirectly not including those that hold Non-Exclusive Prospecting Licences.

It is estimated that Malawi produces approximately 2000 tonnes of various gemstones; dominated by rose quartz, agates, aquamarines, garnets and rubies and sapphires. Over 90% of these are exported to the overseas markets in their raw form thereby attracting very low values.

What Gemstone Value Addition Entails

Value addition to gemstones simply means cutting and polishing the raw gemstones. Cutting and polishing add value and make the gemstones look real. A finely finished piece of a gemstone can increase a gemstone's price hundred times more than an uncut piece of the same gemstone.

There are different players in the gemstone industry, namely: miners, dealers or middlemen, cutters, jewellers and end users.

Photo: John Tychsen, GEUS

It is very rare that a miner has a direct link to the cutter. In most cases, the miner will not even know who the cutter is as this is mostly the part of dealer or middleman. The same applies to pricing, i.e. the miner will sell their material in rough form to dealer, who will take them to cutter and then to the jeweller. As one moves up the value chain so does the price.

In a perfect scenario, a country would be able to add value to gemstones before exporting them to increase income to the country and its citizens. This would require miners, cutters, dealers and jewellers to be located in the same country.

Efforts by Government in Introducing Value Addition

Malawi, although having abundant gemstone resources, does not have many cutters plying the trade. Very few cutters can be found in Lilongwe, Blantyre and Mzimba. As for jewellers the situation is even worse with only two or three located in the country.

However, some strides are being made to improve the situation. For example, the Government has been conducting some training of trainers in gemstone cutting and polishing with an aim to promote value addition. Recently, a total of 12 people received basic training in cutting and polishing of gemstones with support from the Geological Mapping and Mineral Resource Assessment Project. The Government has also procured a few sets of cutting and polishing equipment that will be made available in three regions of the country for people to access them.

The Government is also in the process of formalising all ASM groups into cooperatives, since these make it easier to regulate the sector and channel technical and extension services to ASM operators. Furthermore, by forming cooperatives, ASM operators achieve stronger price bargaining capabilities thereby reducing exploitation by dealers/middlemen.

Certificate of Origin

Another important aspect related to value addition of gemstones is the ability of a country to provide authentication of its gemstones. As history tells us, in some countries, money realised from the sale of (often illegal) gemstones is often used to propel civil or ethnic wars. This fact has necessitated the requirement to declare country of origin of almost all high-value precious and semi-precious stones.

Furthermore, the proliferation in the sale of synthetic stones, without disclaimer, also necessitates a certificate of origin for some gemstones, especially cut and polished ones.

At present, Malawi does not issue a certificate of origin for gemstones. However, plans are at an advanced stage by the Government of Malawi to train one gemmologist, who will be responsible for issuing certificates of origin for all gemstones, which may require such documents when being exported.

Conclusion

Adding value to gemstones is a key to attaining an improved gemstone sub-sector. Considering the efforts taken by the Government of Malawi to date, one is hopeful for the future of value addition in the country. However, the Government should not act alone; the private sector should also be encouraged to participate in the process.

ASM mining hematite for use in cement industry at Mindale-Lunzu in Southern Region

FORMALISATION OF THE ASM SECTOR

By Henry Mandere, Department of Small and Medium Enterprises and Cooperatives, Ministry of Industry, Trade and Tourism

What is ASM Formalisation?

Formalisation is the process, or a way, of making the informal sector become formal or operate within the legal framework. As such, formal ASM operations have requisite legal licences and permits and above all, in carrying out their operations, they conform to all legal, regulatory, policy frameworks and mining practices. Formalisation also involves monitoring and enforcement of the laws and regulations and takes on board marginalised miners when developing or revising legal frameworks, including working with them to meet such regulatory obligations in order for them to be effective. Formalisation also includes the process of generating an enabling environment for a sector to ensure that the sector is integrated into the formal economy.

Importance of Formalisation

In Malawi, the number of ASM operators is very uncertain; it is estimated to range between 22,000 and 40,000. According to Kamlongera (2011) at least 40,000 are engaged in ASM, while the Malawi Annual Economic Report (Government of Malawi, 2015,) estimates it to be over 22,000. Like in many other countries, the ASM sector in Malawi is dominated by informal operators engaged in the exploitation of gemstones, gold, coal, gypsum, lime stones, construction stones, sand etc.

Source: John Tychsen, GEUS.

Photo: John Tychsen, GEUS

Figure 27. Examples of Mineral Stones Mined by ASM Operators

Informal ASM operations bring about several socioeconomic, health and environmental challenges, which exacerbate the existence of poverty among miners and rural communities. It also becomes difficult for the Government and other organisations to effectively provide technical, financial, moral assistance and legal protection to the miners and communities. Informal miners are also prone to exploitation and it is very difficult for them to access essential services, such as appropriate technologies, mining skills and marketing services that they may need to acquire to effectively grow and advance their mining businesses.

As stated in the Malawi Annual Economic Report (Government of Malawi, 2015), the Government realises the importance of the ASM sector in the economy. It also recognises that if well harnessed, ASM operations have the potential to create jobs directly and indirectly, increase income levels and ensure economic participation of the larger communities and hence contribute to the reduction of poverty on rural communities.

Considering the significance of the ASM sector to the country's economy, the Government is facilitating the formalisation of ASM operators, in particular, into cooperatives in order to formerly encourage inclusive participation of rural communities in social and economic activities. Formalisation will also enable the Government to establish ASM statistics for policy guidance as well as facilitate marketing and regulation of mineral extraction.

Source: John Tychsen, GEUS.

Figure 28. Example of a Typical ASM Community

Collaboration between the Department of Mines and Ministry of Industry, Trade and Tourism in ASM Formalisation

DoM and the Ministry of Industry, Trade and Tourism (MoITT) work closely together in the formalisation of the ASM sector. Focus is centred on formalisation through the formation of Mining Cooperative Societies. DoM takes responsibility for mobilising miners to form cooperatives. The two offices together sensitise the miners and potential miners on the benefits of forming mining cooperatives. The sensitisation process ensures that miners develop an interest in undertaking their mining business through the cooperative business model. The MoITT takes responsibility for training and ensuring that the potential mining cooperative members understand the cooperative concept including its principles and values before registration. On the other hand, DoM ensures that all the necessary requirements for ASM licencing are fulfilled and done through the provision of guidance, including training in appropriate mining techniques.

Efforts Made to Facilitate the Formalisation Process

The following efforts have been made to facilitate the formalisation process:

- DoM, in collaboration with the Department of SMEs and Cooperatives in the MoITT, has and continues to sensitise and encourage ASM operators to form Cooperative Societies;
- DoM works with MoITT in mobilisation of members for Cooperatives;
- The mobilised miners and potential miners in the ASM sector are organised into Cooperatives. Through such organisations, ASM miners are trained in appropriate/safe mining practices and mining business through the Cooperative business model;
- Registration and licensing of ASM Cooperatives has been facilitated for the groups that have been trained and their capacities built;
- Talks and agreements with some banks, such as the FDH Bank and the New Finance Bank, have been facilitated to finance SMEs, including the ASM sector, using Cooperatives as a form of collateral;
- The Department of Mines has established a specific section designated for the promotion of the ASM sector;
- An ASM Policy to address the challenges and issues affecting the ASM sector has been formulated and approved for implementation; and
- Two departments are providing technical assistance in form of training in Cooperative management, including leadership, Cooperative mining business techniques and value addition to strengthen and enhance management capacities of the existing ASM Mining Cooperatives to improve their incomes.

ASM Organisational Structures in Malawi

Creating formal ASM businesses in Malawi requires that ASM operators become organised and structured according to the country's relevant laws and regulations.

ASM operators may obtain a Mining Licence as a Cooperative Society, an Association, a Partnership or a Sole Miner (with or without a registered business name) in Malawi.

Cooperative Societies

The Cooperative Societies Act (1998) defines a Cooperative as "an autonomous association of persons united voluntarily to meet their common economic and social needs in accordance with cooperative principles through a jointly owned and democratically controlled enterprise".

Cooperative Societies are member-owned through shareholding. The members own, control and direct all the affairs of the Cooperative and enjoy all the benefits accruing from the Cooperative. They elect the Board of Directors to run the day-to-day activities of the Cooperative. The Board normally employs a capable management team to manage the Cooperative as a business entity capable of being competitive on the local and international market.

Cooperative societies are registered under the Cooperative Societies Act by the Registrar of Cooperative Societies in the MoITT. According to the MoITT Cooperative statistics, there are 9 mining Cooperative Societies in the country. These Cooperative Societies are mainly engaged in gemstone, gypsum and lime stone mining for lime making. In addition, 14 groups from three regions (Central, Southern and Northern parts of Malawi) are currently being organised and trained in preparation for Cooperative registration.

Cooperative Advantages

The main objective for forming a Cooperative Society is to provide desired goods and services to its members at low prices. Even though Cooperatives make surpluses, profit maximization is not their main motive; rather it is the members who make profits through the Cooperative. They provide training to their members on best practices of running their business and provide facilities, such as health care to its members.

Unlike in other business entities, the overall powers in a Cooperative are vested in the members through the Cooperative General Assembly. Members have equal rights irrespective of the number of shares a member holds. This ensures that members participate fully in all the affairs of the Cooperative. Management affairs of Cooperative Societies are entrusted to the managing committee elected by the members. When instituting the leaders, the Cooperative accords its members equal chances of being elected to manage the Society and representation by proxy is not allowed in Cooperative Societies.

Source: John Tychsen, GEUS.

Figure 29. Procurement of Heavy Equipment Via a Cooperative Society

A Cooperative ensures that weaker miners, who are normally prone to exploitation by middlemen, are protected. The Cooperative provides them with necessary services, such as marketing to enable member's access to markets that could not be accessed at an individual level. It also provides members with important information on the demands of the market. Through information and skills sharing, Cooperatives produce products of high quality, which can easily access local as well as export markets.

One of the challenges the ASM sector faces is pricing of the precious stones. Cooperatives provide bargaining power and ensure that members obtain fair prices for their products by centralising marketing and selling. Through Cooperatives, members can easily obtain business advisory services since they are easily reached by government agencies and other organisations, including buyers.

Cooperative societies are body corporates and operate as separate legal entities. This means that an exit of members, due to death, insolvency, retirement or insanity does not affect the perpetual existence of a Cooperative Society. The liability of the members of Cooperatives is limited to the extent of their capital in the Cooperative Societies. As such, Cooperative members are relieved from the fear of losing their private property, in case the Society suffers financial losses.

Cooperatives are founded on the basic Cooperatives philosophy of self-help and mutual help. They foster fellow belonging among Cooperative members and indoctrinate moral values in them for a better living ensuring that no member is left behind. Membership of Cooperative Societies is open to all irrespective of religion, political affiliation, colour or creed. As such, there is no limit on maximum membership and shares. This enables co-operatives to pool together substantial capital, which they may invest in appropriate capital equipment for excavation as well as value addition.

Unlike other groups or associations, the management of Cooperatives is anchored and guided by the universal cooperative principles, i.e. open and democratic. Furthermore, as opposed to other forms of businesses, a Cooperative Society is generally exempted from income/corporate tax and surcharge on its earnings up to a certain limit. Since the Government recognises the importance of Cooperatives as an effective instrument of socio-economic transformation and inclusive economic participation of communities, it supports Cooperatives through technical assistance, grants, loans and or any other financial assistance to facilitate their activities.

Cooperative Disadvantages

On the other hand, a Cooperative Society is in most cases formed by people with limited capital resources, which limit its capabilities to make important investments, such as procuring the right equipment for extraction. In addition, the democratic principle which accords equal rights to members may discourage some members from investing large amounts in the Cooperative. Furthermore, Cooperative members, in most cases, lack business acumen to effectively run the Cooperative business and at the same time, because of financial limitations, may not afford to employ and pay competent managers. There is normally capital erosion because shares of a Cooperative Society are not transferable. Members who want to withdraw from their membership from a Society get their money back upon submission of notice to withdraw. Like in most groups, misunderstandings among members do happen and loyalty of members to the Cooperatives may not be that strong.

At times, if the paid office-bearers do not understand the Cooperative business model, they are often not motivated to take interest in the functioning of Cooperative Societies because of the lack of a profit motive. As a consequence of this, Cooperatives become less innovative, inactive and end up folding up.

Association

An association refers to the coming together of two or more individuals or body corporates for a common undertaking. Associations are normally formed to advance the interests of its members. Business Associations normally bring together businesses (legal or natural) working in a similar business from a designated area like national, regional or any area designated by the members. In Malawi, associations are registered under the Trustees Act; hence, at times they may loosely be referred to as Trusts. The major objective of associations is to play an advocacy role on behalf of its members. It is a mouthpiece for the members.

The ASM sector in Malawi has two main associations operating at national level; the Gemstone Association of Malawi (GAM) and the Malawi Women in Mining Association (MAWIMA).

The main objectives of GAM include: representing, promoting and uplifting the interests of local miners and gemstone holders; enhancing the image of the extractive industry by adding value to their products; providing training and bringing forward the most efficient methods of mining that could also be injury-free and friendly to the environment; assisting in estimating value; curbing levels of illegal mining trade by working with the Government; professionally exposing and exhibiting gemstones from members on world platforms; lobbying for markets and highest ethical standards possible in the mining industry; promoting fairness in the trade; and providing health and legal covers for the mineral holders in the country. GAM draws its membership from local miners nation-wide including MAWIMA.

MAWIMA, on the other hand, was formed mainly to advance the interest of women in mining in the country. The membership for MAWIMA is mostly women drawn from all regions of the country. The two associations have been instrumental in lobbying for mining policy and legal reforms to create a conducive mining business environment for ASM operators, create a structured mineral markets and provide access to appropriate mining skills and technology.

Advantages of Associations

Associations provide networking opportunities to its members. They share both human and capital resources and information to advance the interests of the members. As a mouthpiece for its members, associations provide a collective voice to lobby, advocate and promulgate the interests of its members.

Disadvantages of Associations

Even though associations have elected presidents or chairpersons, the affairs of the association are run and managed by Trustees. Most if not all the powers are vested in the Trustees and as such they have supreme powers to direct the affairs of the associations. Members have very little or no say in the running affairs of the association. Any benefits for members from the association normally depend on the leadership or management styles of the Trustees. An association is generally a mouthpiece for its members. Legally, an association is not seen as a business entity, rather it is a trust. An association therefore, is or may not be given a Mining Licence, but it is the members, who are licenced. As such, it may still be difficult for its members to be reached physically, since each member does business as a sole proprietor despite being affiliated to an association. Furthermore, members of an association are not shareholders, they become members through annual subscriptions; meaning that every year they have to renew membership.

Partnerships

A partnership is an association of two or more people doing business together using the registered business name other than their personal names. They draw their constitution based on partnership agreements to guide their conduct and operations, rights and obligations. The partners contribute to the capital in equal proportions or as per their agreement and share the profits realised from the business. ASM partnership businesses are licenced for mining as legal entities using the registered business name. The business names are registered under the Business Names Registration Act by the Registrar of Business Names in the office of the Registrar General.

Partnership Advantages

A partnership is easy to form and the registration process of the business name is simplified and easy as well. Partnership businesses work better because there is knowledge and skills sharing and capital mobilisation through partner contributions compared to the sole business,

Partnership Disadvantages

The business names registration for partnership business is normally unlimited and as such the partners are held liable for all the actions of the partner business. Rifts between or among the partners may ensue and derail progress of the business. Partnership businesses are generally not very popular within the ASM sector in Malawi.

Sole Proprietor

A sole proprietor owns and carries out his or her business as an individual. This is the most common mode of business operation of the ASM sector in Malawi. The Business Names Registration Act requires that where a sole proprietor carries out business using another name other than his or her personal names, that name must be registered under the Business Names Registration Act. The sole ASM proprietors, therefore, either obtain a Mining Licence using personal names or a business name, when they are using names other than their personal names.

Advantages of Sole Proprietorship

Sole proprietorship is very easy to form because it only requires a proprietor's unilateral decision to start the business. There is no pressure to do certain things because there is flexibility in decision-making, such as work scheduling. The owner amasses all the profits accruing from the business.

Disadvantages of Sole Proprietorship

A sole proprietorship is however challenging because capital mobilisation is not easy for an individual because of limitations in personal funds as well as access to loans and vital

information. Furthermore, the owner is solely responsible for all liabilities that may be incurred by the business. It is not easy for the owner to access essential services, including funding from the Government and organisations because the numbers are too large to be reached and managed at individual level.

Formalisation and ASM Financing through Cooperatives.

Like all other SMEs, ASM operators face financing challenges. The financing institutions, such as banks and microfinance institutions, offer very limited opportunities for ASM operators to access financing in the form of loans. The reason being that they consider ASM operators as risky borrowers. The institutions that offer loans normally require collateral, which most of ASM operators do not have. Above all, the bank interest rates are relatively very high. According to information obtained from Nyasa Mining Cooperative Society Limited's Chairperson, less than 1% of ASM operators are able to access loans from banks.

The role of Cooperatives in financing is to ensure that the operators are self-financing through shares and collective business operations as well as acting as social security for obtaining loans from financing institutions. Cooperatives, unlike individual ASM operators, have better opportunities to obtain grants or donations from the Government and other organisations as well as loans from a bank or financial institution without collateral.

Through the cooperative principle of continuous education and training, the MoITT provides training in financial management and costing to ensure that ASM Cooperatives effectively manage their financial resources and are able to cost their business operations to ensure that their Cooperatives make business sense.

Conclusion

The ASM sector provides a source of livelihood for most of the poor communities in the areas where mineral stones are found in Malawi. This sector is therefore here to stay and we cannot afford to ignore, abandon or suppress it. As such, formalisation of this sector is the only way and key for a sustainable mineral extraction by the ASM sector in Malawi.

Women carry wood from the forest above Zomba town

WOMEN IN ARTISANAL AND SMALL-SCALE MINING: INTERVENTIONS FOR GREATER PARTICIPATION

By Fitsum Weldegiorgis, Senior Researcher, International Institute for Environment and Development (IIED)

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Introduction

Building on the findings of the previous report [1], this case study provides a synthesis of perspectives by a select informant group on the ways forward to putting in place an enabling environment and support mechanism that is practical and achievable. This study solely relies on interviews with select respondents who are involved in the sector in various ways and have the knowledge and/or expertise in the topic of women in ASM. A total of 20 participants were interviewed representing miners, academia, miners' group leaders, and practitioners. Each participant was sent a one-page information sheet with the study aims, interview guidelines and reporting plans, and a document containing interview questions. Interviews were conducted following a semi-structured research protocol to guide discussions. Participants were encouraged to engage more on some areas than others depending on experience and expertise, with flexibility for some follow-up questions arising during the interview based on responses. Interviews lasted between an hour and an hour and half with each individual participant.

Key Interventions

Interview respondents generally agreed that a holistic effort encompassing economic, social, technical, and political empowerment should be the target of interventions by multi-stakeholder collaborations. Within this holistic approach, some of the target interventions are summarised as follows.

1) *Please consider this case study along with previous report on women's challenges and opportunities available on: http://pubs.iied.org/G04307/?k=towards+inclusive+responsible+mining; and www.iisd.org/library.*

Photo: John Tychsen, GEUS

Communications and Engagement

Most of the interviewees noted the need for women's education and awareness about their legal and human rights, which they identified as perhaps the single most important ingredient to raising women's confidence to force and inspire change. As one respondent explained, women need to have self-belief that they can be engineers, geologists and leaders, and this comes as a result of extensive education and awareness campaigns. Basic education (literacy campaigns) should be developed for women in mining communities, with provision of access to information using innovative platforms. Another respondent highlighted that information on such issues as land use and land management knowledge, land policies and regulations, simple geological data, and available technologies should be communicated to women in ASM through user-friendly methods such as local media and mobile phone systems.

"Norm change comes from within, and that can be transmitted to others through creative communication."

One interviewee noted that acceptance of scientific data is low in most communities, such as in Madagascar, where customary practice sometimes obliges people to sacrifice a zebu (cattle) believing that doing so helps discover minerals. Awareness and literacy campaigns are therefore crucial for successful communication of information. One of the best methods that one interviewee pointed out is encouraging the involvement of "champion women" (i.e., those who have excelled in their fields either through education or experience) to educate, mentor and support other women by being role models. This can have a powerful impact if well supported. Other interviewees underscored the need to consider the crucial role that men in leadership positions (gender-championing men) can play, pointing to the fact that men are the "gate keepers" and can be influential in removing the hurdles women face. Through such an approach, other men can be educated to appreciate the advantages of empowering women.

"If men are the problem then men have to be part of the solution."

Most of the interviewees recognised the need for education, awareness and dialogue at the local level, not only involving women but also traditional rulers and media. Educating and engaging with communities, community leaders and media (particularly TV and radio) at the local level have a significant impact in dispelling myths about women in ASM. Furthermore, it was highlighted that sensitisation also needs to extend to religious leaders, who have great influence on society. One of the interviewees cited her own experience, pointing out that some role model fathers and elders can be encouraged to demonstrate to others about the roles and opportunities they give their daughters and other women. This could have significant result at the community level to address issues of discrimination against women in ASM.

Sensitisation and sharing of accurate information about women's potential as mining entrepreneurs should not only be confined to society, government and media but also ex-

tended to the financial sector. One interviewee recommended engaging with banks and microfinance institutions to raise awareness of women's saving capacities and to de-risk lending to women in ASM. This is crucial, given that access to finance is one of the main challenges that women in ASM face due to the extra burdens related to gender bias on grants, loans and collateral, which in many cases require male approval. While banks can be enlightened on the role of women in ASM, one interviewee highlighted the harsh reality that the onus is upon women miners themselves as people in need of financial support, and that banks as profit makers require appropriate evidence.

"I would not blame banks, I would start educating women."

Most agreed that documenting and communicating success stories of women in ASM should be a part of such engagement and sensitisation campaigns. The most effective way of sharing those stories would be by active involvement of the women in ASM themselves through the creation of a conducive engagement platform.

"ASM mostly is not for intellectuals, and discussions and language need to be simplified so the miners and everyone at the lower level get involved openly."

While the above-mentioned suggestions could have major impacts on transforming women's attitudes and confidence—as well as societal and sectoral attitudes toward women in ASM—it is important to recognise that addressing traditional norms (and the burdens of domestic chores) while promoting women's voices and intellectual and technical capabilities could take time. On the flip side, as one interviewee underscored, there is limited knowledge or even consideration of the societal implications and the impact on gender relations if women were to have more money, power and capabilities. It is therefore important that research tools are applied on the ground to understand these issues at the same time as conducting those crucial literacy, engagement and sensitization campaigns.

Capacity Building

Capacity building goes hand in hand with raising awareness, literacy and sensitisation of and about women in ASM. There are some key skills that are critical to achieving the overall objective of having well-qualified, self-confident, self-sustaining, productive and effective women operators in various capacities in ASM. One skill that many interviewees mentioned is women's leadership, be it in their capacity as managing owners of mines, mining cooperative leaders, or leaders of miners' associations. In most cases, particularly in women's groups or associations, a common issue that most interviewees pointed out is that women in leadership positions compete with one another— and in some cases fail to work in harmony and instead promote their own self-interest—suggesting that those women need sensitization and leadership training. Another issue mentioned is the lack of capital and other resources (mainly for those leading various associations) to function well. However, a strong leadership and working structure along with clearly set out goals can be the foundation that helps attract financial and other resources.

"Women can defeat barriers if they are trained enough to lead by example."

Secondly, interviewees identified the need for technical skills training, particularly on how to use geological data, simple field geology and gemmology, efficient ways of sieving, simple techniques for using retorts—and gradually, more advanced equipment like crushing mills. While most women miners carry out some basic mining and processing techniques like sieving, ore purification, gemmology and stone cutting, there is a significant need to upgrade their skills on responsible and productive mining and processing techniques. This will help reduce their dependency on male counterparts, some of whom are believed to exploit women and deny them their due benefits. One interviewee suggested that such skills training should be done so that those trained can also train other women to ensure transfer of skills and knowledge.

It was generally agreed among the interviewees that women can succeed in the processing of minerals, although some pointed to the heterogenous nature of women's activities in ASM and warned of the risk in focusing on one or two areas, as women have demonstrated they can succeed in multiple mining business types. Training women in value chain activities such as cutting, polishing, jewellery making and ore processing can, however, be less challenging to support than pit-level activities, as many women are already involved in those activities with some success. There are a few notable examples where, either inspired by individuals or supported by development partners, women receive such training in practice. One interviewee, for example, mentions the new lapidary centre in Sakaraha, Madagascar, that is aimed at training women to acquire skills in stone processing, ref. Figure 30 below.

"Developing women's capacity in leadership and technical training, and ensuring genuine participation is more important than just giving them quotas."

Technical skills are insufficient if they are not complemented by business management skills - a skill set that in many cases (not just for women) determines the sustainability of mining businesses. Many interviewees pointed out the training needs for women in finance and business management, accounting and bookkeeping. Accounting and reporting issues are among the challenges that ASM businesses (particularly those operating in groups) have faced. Thus, providing regular training courses on business and finance management and making such accreditation a prerequisite for issuing grants and loans would not only be to the advantage of miners but could also serve as a guarantee for lending and funding institutions. Furthermore, women can benefit from the knowledge and skills related to understanding the supply chain and larger markets. Empowering women with such skills can bolster their success rate in ASM, thereby motivating other women.

Furthermore, interviewees highlighted the need for regular training courses on issues of acquiring mineral rights, acceptable occupational health, safety and environmental management practices and standards, with training modes conducive for women. While there have been many interventions through such things as capacity-building exercises and

Photo Credits: Lynda Lawson

Figure 30. Sakaraha Lapidary Centre
This centre located in Sakaraha District, Atsimo-Andrefana Region of Madagascar was created through a collaboration between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Australian government, and its aim is to provide training for women on Cabochon cutting and jewellery making. GIZ implemented a series of training of women on costume jewellery to better integrate women into the value chain and gradually introduce the sector in the field of trade fair. The purpose of the training is to professionalize women in value addition and promote local trainers to scale up the production of costume jewellery. Through the first and second training in October 2017, 15 women were beneficiaries, with four of them promoted to the next level of training in cutting coloured and precious stones.

workshops organised by ministries of mines and/or development partners, these are mostly done in towns and not rural areas, and so most miners do not benefit due to travel issues. Women in particular suffer due to their domestic responsibilities and inability to travel to towns and cities. Thus, many interviewees suggested the need to involve civil society organisations (CSOs) in collaboration with local government branches to help build women's capacity through training and sensitisation, with one noting that results are realised when the CSOs take lead, with government only providing support through legal and policy frameworks.

This is not to ignore the views of many, as reflected by one interviewee, that the performance of CSOs with respect to women in ASM has been somewhat mixed, with some isolated cases of support in various capacities. CSOs in Tanzania, for example, are trying to assist those women who are willing to own PMLs by holding meetings and sensitisation on rules and regulations that apply to them. Some interviewees believe that CSOs can be

integral in providing legal and technical guidance to women in ASM to identify parcels of mineral-rich land and obtain licences. Similarly, they can help prepare women miners to advocate for their mineral, land, socio-economic and environmental rights, and to hold duty bearers/policy-makers accountable. However, the general understanding is that CSOs can do much better, despite being challenged by their lack of in-depth knowledge about the sector's challenges and opportunities and their misconceptions of ASM as a "messy" affair. In addition to addressing the knowledge and misconception issues, CSOs, as with governments, will need to become better coordinated to have any significant effect.

Finally, one interviewee warns of the "fatigue" that many miners feel about the number of training initiatives at various levels and periods, underscoring that while these are important it is equally important to moving into the next level of implementing platforms through which trained capacities are deployed. The key message is that capacity building should not just be about delivering training in a certain skill with no follow-up after completion: instead, there should be well thought-out programs that aim to see the skills taught put into practice. This would necessitate that those programs include pilot programs, such as model mine pilots in which trained women can deploy their newly acquired skills, in the process gaining valuable on-the-job experience and accreditation.

Business Support

There are rare cases where individual women miners have excelled in what they do as miners, engineers, geologists and mining processors. Interviewees noted that some women have succeeded in establishing and operating their own mines—along with businesses in mineral-value addition, ore processing, and providing services such as food supplies in mining areas. One respondent also referred to a few who have managed to build their own houses and took their children to good schools, including outside the country. These isolated and very rare success stories beg for a collective effort to utilise those disjointed skills and experiences and demonstrate the heights of women's potential in the mining sector.

"How about initiating a pilot model mine with some of the successful and talented women in charge of the areas of their respective skill sets."

The overall understanding among interviewees is that women in ASM have the potential to run successful businesses, but they also need support in many key areas, mainly loans, capital, equipment and technical know-how, and market access. Many pointed to the role of governments through such mechanisms as creating loans, revolving funds and grants facilities. However, some interviewees cautioned that such mechanisms need to be undertaken cognisant of the limitations that only a few women can be supported, and expectations can become high. As such, they can be carefully targeted with the objective of promoting a multiplier effect through training, funds management support, monitoring and evaluation. Some interviewees noted that local governments are closer to communities and should take a greater role in addressing some of the issues women face, like making sure male signature is not made a requirement; using women who have done well to motivate others; and ensuring grants are given to those who show hard work. Some also

suggested the need to encourage and support microfinance schemes to package loan facilities suitable for women in ASM.

One interviewee noted that SMEs programs improve livelihoods in communities, and considering ASM as part of SMEs could help channel support mechanisms needed to maximize ASM's potential. According to this school of thought, SME support mechanisms, such as financial schemes (e.g. value added tax and other tax exemptions when purchasing equipment), technical and business skills, and marketing opportunities can be provided with gender fairness in mind. Another interviewee suggested that government and financial institutions need to reduce terms and conditions of capital and loans to women to encourage ASM project establishment and development.

Supporting women who are active in value addition should, according to one interviewee, involve promoting partnerships and networks with other similar but successful and advanced businesses to inspire knowledge transfer. Reflecting on her own experience, the interviewee pointed out that women need careful mentorship by business people, with opportunities for international learning experience through time spent in places like India and Thailand to understand the value chain and learn from advanced processing techniques. Partnerships could also involve linking women miners with established SMEs through some agreement like the one between the Ntungamo Women Tin Dealers Association based in Ntungamo District Western Uganda and Hills Resources Ltd[2)].

Helping women access markets, according to most of the interviewees, is as crucial as supporting business management and productivity. One of the interviewees highlighted the need for markets to be set up with institutional buying arrangements prioritising women, as women are currently exploited by buyers. Another alluded to the issue that some women do all the hard work of mining and, for reasons of security and cultural norms, give their finds to their husbands to sell, only for the husbands to conceal the real value from them. Yet another interviewee suggested that a one-stop lapidary centre could serve as a market centre, while also promoting market knowledge, skills training, and women's market networks, including sponsorship for gem shows in different countries. Encouraging a fair-trade business model was also suggested to help address the barriers faced, including differing languages, knowledge of international market values, responses to international consumer demand and complying with standards requirements.

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2) The Africa Centre for Energy and Mineral Policy (ACEMP) is working with 40 members of the Ntungamo Women Tin Dealers Association based in Ntungamo District, Western Uganda to build their skills, with the goals of enabling them to add to value to their mineral products, generate more income and ultimately lift their households out of poverty. ACEMP noticed the need for and supported the Association to acquire mining rights that would legalize their activities. ACEMP did this by linking the Association up with another partner, Hills Resources Ltd, which agreed to allow the women to set up their processing centre on the company's licence. Hills Resources acquired a location licence and entered an agreement with the women to use that licence for their operations. In return the women sell their mineral commodities to Hills Resources at a negotiated fee that is at least 20 per cent above market rates.

Most of the interviewees highlighted the importance of the health and safety of women in ASM, and mechanisms to address women's health and safety risks could be key to women's capacity to develop and run successful businesses. These should include: i) awareness raising and education on health and safety risks; ii) provision of basic tools and safety gear (e.g., helmets, boots gloves); iii) childcare and education facilities for children to keep them out of dirty water; iv) improving mineral processing practices in which women have active roles that involve hazardous chemicals and v) provision of mechanised equipment, technology and technical skills. All of these are crucial for responsible and productive operations. There is a need for research to be conducted to identify gender-appropriate and affordable mining equipment and technologies that suit local settings.

"Women need to be considered within the overall rural development plans."

As pointed out by one interviewee, in some cases women should be supported to diversify their mining business in terms of the commodities they mine (e.g., away from gold and gemstones to industrial and building materials) and in the long run into other non-mining businesses. Many women are already engaged in quarrying, and despite its low value per quantity the industrial and building industry can be a reliable source of income for women. The long-term objective for women should, however, be to deploy earnings from mining and quarrying by investing in non-mining sectors such as tourism (hotels, restaurants, cafes and shops), service delivery, and modernize agriculture (for those who depend on it). This way women can avoid dependency on limited and uncertain mining resources.

Women in Groups

According to many of the interviewees, women need to be encouraged to form groups, which in many respects is key to empowering them. Two types of women's groupings need to be distinguished according to their objectives and mandate: (1) women's associations, which are more like unions representing miners and promoting their interests; and (2) women's mining operators' groups, which are usually called cooperatives, and are groups of miners investing in and operating mining businesses. While the role of women's associations is discussed in detail in the previous report of this research series, leadership skills development is one of the recommendations that applies equally to both women's cooperatives and associations. This is because the lack of leadership and managerial capacity - combined with the misuse of power - often hinders the real progress that women miners can make as groups. Most interviewees highlighted the need for setting a framework on ethical practices and governance of associations and cooperatives, and functionally linking them to higher structures more closely linked to policy-makers for greater impact.

Women miners' cooperatives should not necessarily be taken to mean women-only groups, although that is possible. They could be a group of mostly women miners led by a woman, and as one interviewee noted they could involve men as part of their operations to account for physical and technical gaps. Most interviewees agree that there are very few cooperatives led by women, which could be attributed to the lack of trust among women. The reasoning given is that some may feel they would fail in their home responsibilities,

and so they migrate, and groups of migrant women often do not trust one another. Others, on the other hand, pointed to poor management and accounting as a reason for failed co-operatives. Strengthening associations of women miners can help upgrade women's skills to form cooperatives, given that those associations know and work closely with miners and can be instrumental in identifying miners with a potential to form cooperatives, at the same time facilitating support mechanisms to address the governance, leadership, management and accounting challenges faced.

Some interviewees noted the need for cooperatives to be well recognised by law, which would help provide an enabling environment for supportive mechanisms by the public and private sectors. In addition, it was suggested that crucial factors include funding and a dedicated body with close links and influence on policy making to oversee and monitor functioning of these cooperatives. That dedicated body can be an umbrella cooperative that oversees member cooperatives in regions and provides an accessible network to markets, suppliers, processing plants, financial means, technical skills and other support mechanisms. Some of the interviewees, however, warn about the danger of relying too much on - and/or perhaps forcing - cooperative formation as a solution when in fact it can be counterproductive, particularly when groups don't gel and fail to work together. It is, therefore, important to support cooperatives structurally, focusing on organisational and governance strengthening.

Policy and Regulatory Reforms

Interviewees generally agreed on the desperate need for legislative reforms that promote women's case in mining, which can lay a positive foundation for many other support mechanisms. While cautioning against overgeneralization, one respondent points out that the ongoing review of mining policies presents an opportunity for governments to introduce policies specific to the ASM sector aimed at realizing its development potential. The general understanding is that many governments have the desire but lack the instruments and capacity to implement gender-reform measures. According to one interviewee, there is progress in terms of verbal agreements and recognition of gender mainstreaming, but this does not translate into policy strategy, as governments are usually unsure about what to do.

"There are policy provisions but in reality, it is a man-eats-woman sort of world in the mining sector."

One interviewee alluded to the risk that the current formalisation push might be overwhelmed by the historical background that has legitimised the non-recognition of women as miners. Accordingly, this begs for an adaptation of a human rights approach to get to the bottom of the problem so that women's access to justice mechanisms and procedures is accorded more attention to address sexual and gender-based violence, discrimination, exploitation and harassment. Furthermore, gender-impact assessments need to be mandatory as part of EIAs.

"'Invisiblisation' of women is happening through the formalisation push."

Many interviewees agreed that involving women in policy framework discussions could be crucial to account for their views and rights; and put in place gender-based targets in regulatory instruments. One respondent suggested the need for an independent entity that is armed with legal, financial and institutional instruments and is mandated to ensure participatory policy reform and enforcement of legal provisions on the ground. Having such an entity - well connected with the reality on the ground and with a well-established relationship and trust with miners and other key stakeholders - can be crucial. Governments for their part have the responsibility to reveal and ensure understanding of policy frameworks and legal fairness among miners in general and women in particular.

"Innovative approaches emerge but don't really address the issue, as there is a mismatch with the reality on the ground."

According to most interviewees, governments should also work with local NGOs and involve existing miners' associations, which can be less bureaucratic, more transparent and effective, as these NGOs and associations have close working relationships with miners. However, interviewees also point to the challenges governments face when working with miners' associations, which tend to be personality-driven with one or two personalities dominating and, in the process, promoting individual interests. Overall, it was agreed that the real actors are at the regional and local levels, and it makes sense that national governments involve either local government authorities, NGOs or regional miners' associations working on improving governance and transparency.

"The voices of many are drowned in those of few personalities."

Although large-scale mining (LSM) companies' involvement in ASM issues is limited mainly to management of "ASM risk," one interviewee argues that they can play a role supporting government initiatives by setting standards.

"As opinion leaders with a lot of power, LSM companies can mobilise opinion and people, and in so doing can promote women's need for access to land and education."

Therefore, to implement the stated desire of governments to address women's legal and policy issues in ASM, they will need to pull together all the resources working with local entities and women miners themselves in order to formulate policies that account for women's needs and realize their potential. Governments also will need to work with development organisations, who are increasingly refocusing their approach on gender. In the past, a number of international development organisations have been heavily involved by providing financial support and developing new initiatives; however, many of the interviewees felt that effectiveness and impact are missing. They point to the fact that in many cases there is a serious lack of transparency and accountability, and that most miners and communities do not know the whereabouts of huge financial investments on new initiatives that usually fail to take off. Some interventions also lack coherence and fail to align

with existing policy and regulatory frameworks in host countries, further hindering their continuity.

Concluding Remarks

Women have played - and continue to play - multiple and significant roles in communities, and they can potentially act as powerful agents of change. Greater research is needed to document women's various activities in the ASM sector, unpack the complexity and (in)formality of financial flows involving intermediaries, and understand the interaction of stakeholders in their dealings with respect to gender issues in ASM. Not many targeted government-led programs exist that specifically work on the agenda of women in ASM; CSOs and development organisations themselves have been dedicating significant efforts to mainstreaming gender, which in practice have translated in the women's issue ending up relegated to the bottom of priorities. Oftentimes, isolated interventions and practices occur, and the lack of alignment with existing ones leads to failure to address gaps and bring changes badly needed on the ground.

Concrete reform should be inspired by multi-stakeholder collaborations for collective funding and consolidated action to address women's needs in mining operations. Governments, in alignment with local entities, have a major role to play in leading the reform process by introducing gender-sensitive policies and regulatory requirements aimed at ensuring fair, productive and responsible participation of women in ASM. With an enabling environment laid by governments, it is incumbent upon CSOs and development partners to proactively engage with women in ASM and respond to their needs in critical support areas by pulling resources in collaboration with government. Above all, the ultimate responsibility falls on women in ASM and their representatives to take advantage of support mechanisms provided and raise their levels of awareness, knowledge, confidence, information, and technical and leadership skills.

Angola landscapes

ASM SECTOR OF ANGOLA

By the Geological Institute of Angola

In 2017, the GDP per capita in Angola was recorded at USD 3,484.60, which is equivalent to 28% of the World's average. From 1980 and until 2017, GDP per capita in Angola averaged USD 2,428.38; with an all-time high of USD 3,746.70 in 2014 and a record low of USD 1,323.30 in 1994.

ASM in Angola comprises formal and informal operations with predominantly simplified forms of exploration, extraction, processing and transportation. An estimated 2 million people in Angola rely on this mining sub-sector for income generation. Worldwide, the ASM sector produces approximately 20% of all diamonds, ornamental rocks, building material and industrial materials (sand, clay, gypsum, limestones and gravel). ASM is often a seasonal occupation, worked in conjunction with farming, with mine output volumes decreasing during harvesting times.

After oil, diamonds are the main source of revenue in Angola; being the country with the largest diamond production in the world. In 2017, the increase in production of diamonds was 1.04%. Although not a substantial increase, the production is expected to increase even further in the coming years. In terms of sales, the increase was 9.3%, which is a result of improvements in the quality of diamonds as well as in the market value of diamonds.

Legislation on ASM in Angola

Angola is aligned to the Africa Miming Vision by including the ASM sector in its legislative framework.

The overall goal is to fight poverty and decrease the level of social asymmetry.

Investment in ASM is regulated by the Angolan Mining Code, approved by the Law n.º 31/11, of 23rd September.

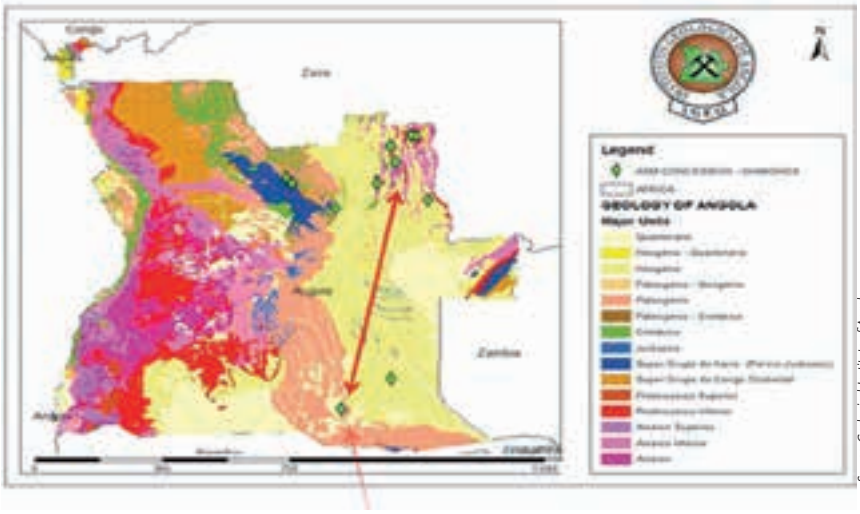
The New Diamond Trading Policy, approved by the Presidential Decree n.º 175/18 of 27 July, states that "the State Diamond Trading Company (SODIAM) has the right to buy a percentage of the stones for trading. In addition to this, the artisanal diamond production will also be sold by SODIAM…."

Impact of ASM in Angola

The African Mining Vision is a shared vision supported by Angolan Government to transform and build a well-governed and sustainable mining industry.

As in most other countries, in Angola the ASM sub-sector is recognised as a key development vehicle for rural communities submerged in poverty. ASM has been identified as an

Source: Colourbox, #226536



Source: Geological Institute of Angola

Figure 31: Geology of Angola

important platform, which allows otherwise disadvantaged Angolans to participate and benefit from the mining industry. As such, the Government has sought to support this specific mining sub-sector.

Role of the Geological Institute of Angola in ASM

As shown in Figure 31 below, ASM occurs in areas with lesser overburden (sedimentary cover). However, Angola has its eastern side basement, covered by the diamondiferous gravel of Calonda Formation (CF), which is the major source of secondary deposits of diamonds.

The Geological Institute of Angola has the responsibility of mapping the extent of the CF, particularly the areas where the cut-off grade is not viable for large-scale/industrialised mining. This information is to be passed onto ASM operators, since ASM operators often lack such information, including technical mining and processing techniques, minerals marketing, regulatory and legislation issues, and compliance.

Source: Colourbox, #226536

Angola lansdscape

ASM mining site near Geita. Crushing of material before brought to the sluices for further treatment

ASM SECTOR OF TANZANIA

By P. Kaspana, S. Mzee and O. Balambilwa, Geological Survey of Tanzania

The exploitation of Tanzania's mineral resources is undertaken by two large sub-sectors: the large-scale mining sub-sector, which is associated with Foreign Direct Investment (FDI) and characterised by infrastructure development, advanced technology, high productivity and high export earnings; and the ASM sub-sector, which, in most cases, is characterised by limited investment and thus poor utilisation of technology, which result in low productivity and lack of re-investment.

ASM in Tanzania often involves local miners, using basic methods to extract near-surface deposits in an informal, low investment and instead labour-intensive operations, and the use of informal marketing channels.

About two-thirds of Tanzanian ASM operations are involved in the extraction of gold; other minerals include gemstones (including diamonds), industrial minerals and metallic ores, such as copper. Many ASM operators have no basic formal mining training and no access to formal credit facilities, such as commercial banks loans. The sector still has considerable potential to reduce poverty; according to national statistics, ASM communities fare better in reducing poverty than other communities do.

In Tanzania, there is no central office or hub, where data, information and research on ASM are archived, making it difficult to document ASM numbers over time. By 2017, 36 areas had been designated for mining by ASM operators - with a total area of 2,438 km^2, and 8,800 Primary Mining Licences (PML). The Mining Act of 2010, supplemented by the Miscellaneous Amendments Act of 2017, centralised the issuance of PMLs from the Commissioner for Minerals to the Tanzania Mines Commission.

Recent estimates indicate that more than one million people are engaged in the ASM sector in Tanzania (Ministry of Energy and Minerals, 2017). Another study commissioned by the International Institute for Environment and Development (IIED) on the interaction of ASM and agriculture estimated the number of active ASM participants in Tanzania to be around 1.5 million with 9 million people depending on the sub-sector for their livelihoods (Hilson, 2016).

Tanzania's Minerals Production

Tanzania is endowed with a variety of minerals, building materials, including metallic minerals, such as gold, iron, silver, copper, platinum, nickel and tin, and gemstones, such as diamond, tanzanite, ruby, garnet, emerald, alexandrite and sapphire. The industrial minerals include kaolin, phosphate, lime, gypsum, diatomite, bentonite, vermiculite, salt and beach sand; the building materials include stone aggregates and sand; and the energy minerals include coal and uranium (URT, 1997).

Photo: John Tychsen, GEUS

The various minerals occur in the following areas, ref. Figure 32 below:

- Gold: The greenstone belt south, east and west of Lake Victoria;
- Diamonds: The kimberlite pipes in central and south Tanzania and the southern part of Lake Victoria Goldfield;
- Nickel, cobalt, copper, tin and tungsten minerals: The north–western Tanzania;
- Titanium, vanadium and iron: The south-western Tanzania;
- Coal: The south-western Tanzania;
- Uranium: The central and southern Tanzania;
- Soda ash, salt, gypsum, travertine and trona (evaporites): The rift valley and along the coast; and
- Kaolin, mica, phosphate, magnesite, beach sand, diatomite, stone aggregates, dimension stone and sand: Different parts of Tanzania.

Most ASM activities are carried out without regard to health, safety and environmental regulatory requirements, or widely accepted good practices and standards. In Tanzania, ASM has always run in parallel to large-scale mining operations. In recent years, illegal ASM activities in the Geita Region have increased substantially, attracting large numbers of people and becoming a material threat to the large-scale Geita Gold Mine (GGM) operations. Illegal incursions by ASM operators onto GGM's premises include the theft of waste rocks and ores, accompanied by an increase in security clashes leading to injuries

Figure 32. Map of Mineral Commodities Found in Tanzania

and fatalities of illegal miners. Other ASM gold mining areas are found in Tarime, Musoma, Sekenke, Chunya, Tanga, Morogoro, and Arusha.

Policies and Legislation Governing ASM in Tanzania

The current ASM framework largely reflects the Mining Policy of 1997 and the Mining Act of 1998; both were part of the overall economic restructuring undertaken by the Government in the second half of the 1980s. The enactment is a change in the Government's role in the mining sector, from being that of an operator and owner to that of a regulator and facilitator.

In the early 2000s, national poverty reduction papers largely overlooked ASM, but by 2005, the Government began to emphasise that "the livelihoods of artisanal miners need to be balanced with commercial mining". The Tanzania Mineral Policy 2009 notes that although the Government, since 1997, has made efforts to formalise artisanal miners into small-scale miners and provide extension services, their contribution to the economy has remained insignificant. As such, the 2009 Policy adopted the objective to support and promote Tanzania's governance framework for ASM, current policy and practice development of small-scale mining to increase its contribution to the economy (URT, 2009).

The Mineral Policy of 2009 laid out a number of strategies aimed at changing ASM from being unorganised, unsafe and with negative environmental impacts. These included:

- Recognising ASM within the legal framework;
- Providing support services to ASM;
- Establishing formal marketing channels; and
- Rationalising ASM through promoting more organised operations that comply with the principles of small-scale business enterprises.

Known Challenges for the Sustainability of ASM in Tanzania

The ASM sector has always faced challenges, including:

- Limited access to mining land and long delays to register primary mining licences;
- Inadequate extension services to improve skills and care for the environment;
- Poor market arrangements, and lack of opportunities for value-addition;
- Lack of a systematic exploration process that would enable resource evaluation and estimation of mineable reserves;
- Poor planning and management of the mining process that result in wide dispersal of the mine;
- Shifting from one site to another, working in both licenced and unlicensed lands; and
- Lack of mine closure plans, which leads to widespread and hazardously situated mined-out and un-reclaimed pits.

Measures taken by the Ministry of Minerals to Address the Challenges

The Ministry of Minerals has taken the following measures to address the above-mentioned challenges:

- Restructuring the Mineral Department by establishing a Small-Scale Mining Development Section and setting aside several areas designated for ASM activities in active mining districts. ASM in Tanzania is gradually becoming better organised, employing appropriate technology, having access to reliable markets, and putting in place programmes for environmental, health and safety management; and
- Establishment of the Tanzania Mining Commission, which, among many functions, is responsible for issuing, suspending and revoking licences and permits under the mining laws and regulations as amended from time to time, and monitoring compliance with the laid down standards in mining operations, laws and the terms and conditions of mineral rights.

The role of Geological Survey of Tanzania

The Geological Survey of Tanzania (GST) is the government institution, established in 1925, which is responsible for the acquisition and storage of geoscientific data and information used in the mineral resources sector and other sectors of the economy. The institution operates under the Ministry of Minerals of Tanzania.

GST is active in promoting mineral exploration and mining in Tanzania. GST's core activities are: geological mapping, mineral exploration, evaluation, and processing, and research work on geological processes and mineral systems and geohazards. GST's vision is to evolve as a centre of excellence providing national geoscientific data and information for use in the evaluation and sustainable utilisation of natural resources. GST maintains a balance of resources between its primary responsibilities of conducting geological mapping, geodata management, technological and conceptual research and development, and providing services to both public and private sector. Therefore, the role of the institution to ASM include:

- Providing geo-scientific information, data and advisory services;
- Providing geo-scientific services to ASM on geological investigation, ore classification and characterisation, as well as suitable beneficiation methods;
- Providing geo-scientific data and information through geo-scientific mapping, research in the fields and through laboratory analysis of varieties of samples for preparation of geo-scientific/mineral occurrence maps, reports, resource assessment and other developmental programs;
- Facilitating, supporting and promoting increased participation of Tanzanians in gemstone mining (Mining Act) where not less than 50% shares of gemstone Mining ope-

rations has to be owned by Tanzanians;
- Demarcating special areas for ASM;
- Simplifying procedures for acquiring PMLs;
- Decentralizing the licensing programs, inspections and extension services functions of ASM to newly established Tanzania Mines commission; and
- Providing technical support and/or financial assistance to ASM who are willing to improve their operations.

Conclusion

The Government of Tanzania has already taken considerable steps towards formalising the ASM sector, recognising its value to national and local economies. Bringing more ASM operators into the legal framework governing the sector will help generate additional revenue and mitigate the ongoing health, safety and environmental concerns in ASM operations.

Mountain gorillas in the Northern forest of Rwanda

ASM SECTOR OF RWANDA

By Donat Nsengumuremyi, Director of Mineral Extraction and Processing Unit, Rwanda Mines, Petroleum and Gas Board

Geology and Key Potential Minerals

Mineral exploration programs in Rwanda have been carried out since colonial times. Extensive mineral explorations works peaked during the United Nations Development Program, which lasted for almost two decades. The geological knowledge obtained through various mapping projects has resulted in a geologic map of the country with a scale of 1/100,000.

However, despite several mineral exploration programs, undertaken by the Government of Rwanda and its development partners, there are still huge gaps and major challenges. A detailed geological mapping is still needed, i.e. minimum at a scale of 1/50,000, and so is a mineral anomaly verification for the identified anomalous areas. In other words: the mineral resources for Rwanda are still unknown.

Rwanda is largely underlain by the Kibaran Orogeny rock system, which predominantly consists of basement and Meso-Proterozoic rocks that have been intruded by two generations of granitic and mafic rocks.

The geology of Rwanda consists of Middle-Proterozoic meta-sedimentary formations, which emerged following the long-lived Kibaran tectonic events. These meta-sediments are covered by volcanic layers - with unknown thickness (of Rusizi- Nyamasheke axis) of Tertiary age and ca. 800m thick K-rich mafic volcanic rocks (North-western Birunga Mountains) generated from the East African Rift system, which started in Upper Tertiary and is up to now ongoing. These meta-sediments of the Rwanda super-group have been subdivided into four key groups, which are named from youngest to oldest: Rugezi, Cyohoha, Pindura, and Gikoro.

The general pattern of the Kibaran, or Meso-Proterozoic, in Rwanda comprises resistant cores (high-grade units) characterised by weak deformations separated by North/South to North-East/South-West "Intensely Deformed Zones," denoted Shear Zones. Rwanda hosts a large number of historical mineral occurrences and workings and a few operating mines, the major commodities being Sn, W, Ta/Nb with Au and minor base metals. Studies of the major Sn and W deposits indicate that the primary tin and tungsten deposits are hydrothermal quartz vein related. Tin and tungsten deposits are associated with steep faulting and folds coincident with "highs" on intrusive granite cupolas. The late phases of tin granite, which functioned as the heat source for the mineralising fluids (reported as G4-granite of ca. 986Ma), correspond to multiple small to medium fertile pegmatite bodies, which mostly host Ta/Nb mineralization.

Photo: Colourbox, Rosa Furtado

Key minerals ores in Rwanda and their corresponding mineralization are: Cassiterite (SnO_2); Niobo-tantalite, also called Colombo-tantalite or Coltan $(Nb, Ta)_2O_5$; Wolframite $(Fe, Mn)WO_4$); Gold (Au); gemstones; and other minerals occurrences under exploration, such as lithium, iron, rare earth elements and polymetallic minerals.

Status of Mining Operations and Its Transformation

The mining sector in Rwanda is going through a transition, as is the case with many African countries. Moving from its traditional nature of being an enclave with limited interlinkages with the rest of the economy, but one of the major export earners, to be one of the drivers of sustained economic growth, transformation, and industrialisation with appropriate safeguards for environmental and community issues.

ASM in Rwanda is primarily undertaken with limited technology, limited skills and limited capital that lead to limited production and destructing of the environment. However, its labour-intensive approach provides significant employment opportunities for low-skilled workers and benefits in terms of flexibility and applicability, despite challenges related to fluctuating mineral markets and infrastructural conditions.

Therefore, mechanisation of the ASM sector is currently promoted by the Rwanda Mines, Petroleum and Gas Board (RMB); the agency in charge of management and regulations of mining operations. This agency supports small miners by increasing their knowledge of available minerals in the country by conducting detailed mineral exploration into bankable projects for investment attraction, also by assisting them to introduce best practices and modern mining and processing machines.

RMB is putting in place the right and sound mining strategic reforms to transform the small mining operations by maximizing all associated opportunities for transforming the mining sector toward its modernisation.

Photo: Colourbox, information

Beautiful landscape in the country of Rwanda

Fishmen at Tana River in Kenya

ASM SECTOR OF KENYA

By Statement Department for Mining, Ministry of Petroleum and Mining

Kenya is located in East Africa. It covers a surface area of about 586,600km^2 with 480km of coastline on the Indian Ocean.

Geologically it can be classified as follows:

a) The Archean Nyanzian Craton area of Western Kenya, where metallic mineralisation of base and precious metals are known to occur, i.e. gold, copper and silver have been mined in the past. There is also potential for ferrous and no-ferrous metals. Kimberlitic bodies have also been reported;
b) The Proterozoic Mozambique Belt that is most extensive in Central Kenya, North to South, where minerals, such as kyanite, corundum, graphite, wollastonite, marble, asbestos, fluorspar, magnesite, kaolin and a variety of gemstones are found together with minerals associated with basic and granitic rocks;
c) The sedimentary rocks of Palaeozoic to Quaternary are widespread. These rocks are sources and hosts of limestone, gypsum, clays, manganese, construction materials and possibly hydrocarbons. Base metal mineralisation, lead-zinc-barite and copper are known to occur in the sedimentary basin along the coastal belt. Heavy mineral sands also occur along the coastal beach sands and recent deposits of about 3.2 billion tons of titanium bearing have been discovered (Norbert et. al., 2013); and
d) Tertiary volcanic rocks associated with the Rift System host a variety of minerals and construction materials. The volcano-sedimentary accumulations have deposits of clays, evaporites, trona (soda ash), diatomite, natural carbon dioxide, kunkar and gypsum. Gem quality rubies have also recently been discovered (Norbert et. al., 2013).

Carbonatites are known to be host of several minerals found in the Nyanzian shield area, around Lake Victoria shores and in the southern part of the coastal sedimentary basin. Mrima Hill contains one of the carbonatites known for niobium and rare earth elements.

The Government aims to increase the mining sector's contribution to GDP. In 2015, the mining sector's share was 0.8% of GDP. By 2030, the Government aims for the sector to contribute 10% of GDP through value addition and the implementation of the recently approved Mining and Minerals Policy (Government of Kenya, 2016).

The Mining and Minerals Policy (a 20-year vision), in combination with the new Mining Act of 2016, outlines a long-term mining strategy for the country. Although large-scale mining companies operate in the country, ASM continues to remain a significant source of employment for Kenyans. Although no official data is available, the ASM population was estimated at about 146,000 people in 2012. The sector remains largely informal, but produces around 60% of the country's gemstones, most of its gold, quarried stones and other construction materials (Kenya National Bureau of Statistics, 2016).

Source: John Thycsen, GEUS.

Figure 33. Mineral Occurrence Map of Kenya

Distribution of ASM in Kenya

ASM refers to informal mining activities that are carried out using low technology or with minimal machinery.

Kenya, like all other African countries, has a long artisanal mining tradition starting from basic mineral, rock production and processing sector. Artisanal mining occurs in almost all the regions of the country and entails gold, gemstones, dimension stones, aggregates, soapstone and sand harvesting.

As stated above, mining in Kenya is a relatively small sector, dominated by the exploitation of non-metallic minerals, such as soda ash, diatomite, gypsum, limestone, fluorite, constructional stone, and sand harvesting, of which a large percentage (estimated at 70–80%) is done by ASM operators (Barreto et. al., 2018).

Different minerals are mined in different parts of the country by ASM operators. Some of the areas include: the Eastern region, i.e. Mbeere, Tharaka Nithi and Kitui Counties in which gemstones and industrial minerals are mined; the coastal region, i.e. Taita Taveta County in which gemstone, commercial mineral and construction material are mined; and the Kakamega, Migori, Transmara, Turkana, Moyale and Narok counties where gold mining is a major community activity.

Gemstone mining (precious and semi-precious stones) occurs all over the country, but is concentrated in Taita Taveta. It is estimated that about 500 gemstones mine sites in Taita Taveta sustain approximately 20,000 persons.

Economic Importance of ASM

Kenya is a lower-middle income country with an informal sector representing 83% of the country's employment. In Kenya, the GDP per capita is USD 1,246 with a Gross Net Income (GNI) per capita of USD 2,780. As stated above, mining contributes 1% of GDP at present, but has a potential of 4-10% (Kenya National Bureau of Statistics, 2016).

ASM has proven to be a central source of employment for rural communities and youth, especially in areas where it is possible to use small-scale mining methods. This sector has also contributed to the social-economic well-being of the country.

In recent years, ASM has greatly contributed to the economy of the country. The Government is attempting to facilitate ASM activities within the country. In 2016, total exports of gemstones amounted to USD 3,185,947 of which 60% was contributed by the ASM sector (Barreto et. al., 2018).

Within the construction materials sector, quarrying (extraction of stone) is estimated to employ more than 40,000 workers nationally; in Nairobi alone it employs 10,000 people.

In Eastern Kenya, sand harvesting provides another 30,000 jobs, predominantly ASM workers. When it comes to gold mining, Mutagwaba estimates that about 10,000 people are directly involved and approximately 15,000–20,000 are indirectly involved in this activity in the western (Migori) region (Barreto et. al., 2018).

Role of State Department of Mining on ASM

The State Department of Mining within the Ministry of Petroleum and Mining has been operating according to an old policy dating back to colonial times, but after deliberations, the Ministry developed a regulatory framework, which is now in the process of implementation. The Mining Act of 2016 has addressed several issues that will regulate all the mining activities in the mining sector including the formalisation of artisanal miners. However, mining regulations will need to be promulgated to fully develop and refine this framework.

The Government has taken several measures geared towards benefitting the ASM sector due to its contribution to the micro and macro economy of country.

The Government intends to remove barriers that hold back the development of ASM, particularly the lack of access to finance, recognised mineral rights, inadequate technical capacities and incentives to operate legally. This will be done through:

- Providing extension services to ASM on mineral processing and value addition by establishing a Gem Centre;
- Facilitating access to credit through various means, such as cooperative savings, pooled equipment leasing arrangements, government-supported concessional lending schemes and assistance in obtaining finance;
- Setting up a minerals licensing system under the new mining legislation that will offer specific mineral titles suited to small-scale mining expressly reserved for Kenyans using simplified application procedures. This has been achieved by establishing ASM committees at county level for accessibility of mineral rights and introduction of a dealers permit, which allows trading within the country;
- Delineating ASM areas. The Mining Act empowers the Cabinet Secretary to set aside areas designated for ASM. Formally the ASM was regarded illegal;
- Carrying out sensitisation of the artisanal miners on sustainable mining procedures and awareness of the regulatory framework, health and safety (Wafula et. al., 2018);
- Developing a transparent licensing system, which will enable the efficient management of concessions and allocations of mineral rights, involving an online mining Cadastre Portal, which enables online applications (Press, 2016);
- Providing mining tools and equipment to ASM operators at subsidised rates to help them mechanise their operation to law and also in areas of mine, health and safety;
- Assisting ASM operators in identifying minerals and also in areas that are suited for mining;

- Carrying out mineral exploration and offering technical assistance by paying them a visit in the mining areas; and
- Carrying out baseline studies, e.g. areas in Nyanza, Western and Taita Taveta County (Draft strategy of ASM in Kenya).

Challenges of ASM Sector

Challenges depend on the minerals mined in different parts of the country. The most common challenges that cut across this sector are:

- Lack of professional knowledge in mining matters;
- Lack of geological knowledge, minerals identification, structure, associated minerals and the surface indicators of the mineralised zones;
- Exploitation by middle-men within the mining areas (Wafula et. al., 2018);
- Lack of proper mining equipment;
- Limited technology in extraction of minerals, which reduces recovery (Thomas Hentschel et. al., 2003);
- Lack of land tenure, mineral rights, i.e. miners are constantly evicted by the landowners when they strike mineralisation;
- Formalisation challenges as most of them are not in organised groups or organisation;
- Lack of personal protection mining equipment;
- Mine collapse, which is a common phenomenon in gold mining areas especially during the wet season due to poor mine design;
- Lack of infrastructure, e.g. roads, water, electricity and poor communication network. Accessibility into and within the mining areas as roads are not well maintained. This also hinders the transportation of minerals to the market;
- There are no public facilities, such as dispensaries and schools around mining areas for some families working and living around mines;
- Storage of explosives needed within the mines as they are forced to use illegal explosives from neighbouring countries;
- Lack for proper waste management plan since most operate before carrying out environmental impact assessment; and
- Environmental degradation and loss of agricultural land.

Conclusions

ASM operators are distributed throughout the country, where they contribute to the economy of the country. There are many minerals in which ASM operators are involved, which is why the Government has taken the necessary steps to facilitate their safety during processing. The new Mining Act recognises the ASM sector contrary to previous years where formulated policies did not.

Formalisation of ASM operations is implemented through the Mining Act. A committee, responsible for issuing licences to ASM operators will be formed in every county. Although informal, ASM has significant direct and indirect social and economic impacts in Kenya. However, urgent formalisations policies are needed. With three of four workers informally employed, the cost of keeping this sector out of the formal sphere is high, particularly due to the environmental impacts that follow informal mining. The challenges faced by the ASM sector are addressed in different forums by sensitisation.

Source: John Thycsen, GEUS.

Village in the coastal region of Kenya

Village near the mining site for gemstone in the Rift Valley area in central Ethiopia.

ASM SECTOR OF ETHIOPIA

By Ferede Chumburo Gobena, Technology Expansion and Training Team Leader, Artisanal Mining Production, Supporting and Coordinating Directorate, Ministry of Mines and Petroleum, Ethiopia

Officially the Federal Democratic Republic of Ethiopia is a country unique among African countries, where its people kept their freedom from colonial rule with the exception of the Italian occupation from 1936 through 1941 during World War II.

Ethiopia is located in the horn of Africa, bounded by geographic coordinates of 3000` to 15000` latitudes and 33000` to 48000` longitudes with a surface area of 1.13km^2, ref. Figure 34 below. The neighbouring countries are Eritrea to the north and northeast, Djibouti and Somalia to the east, Sudan and South Sudan to the west, and Kenya to the south.

ASM Activity in Ethiopia

ASM in Ethiopia has been the basic mineral and rocks production and processing sector throughout the older civilianisation of the country; from pre-Axumite kingdom to present

Source: Mountain Maps.

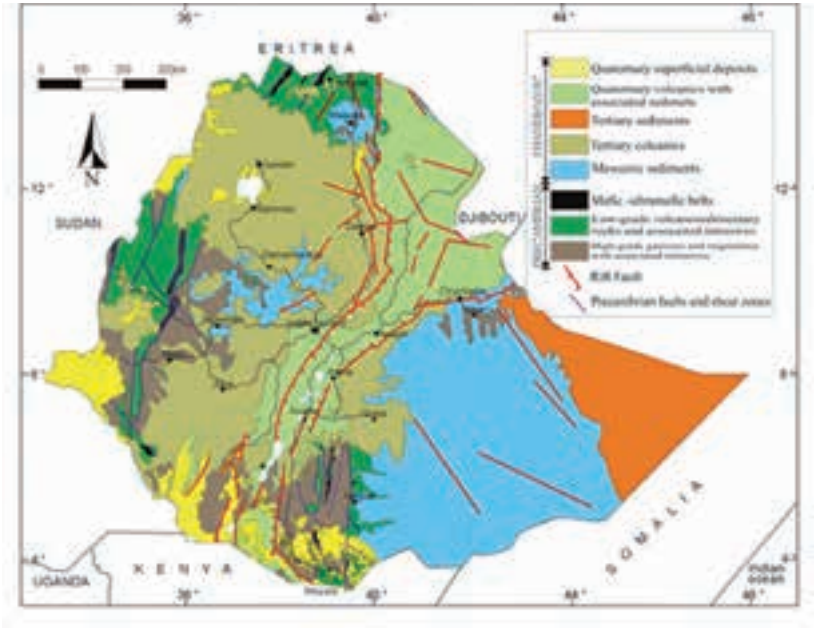
Figure 34. Location Map of Ethiopia

Photo: John Tychsen, GEUS

time. ASM activity in Ethiopia has been known since Biblical times, referring to the Queen of Sheba's gift of gold and gemstones to the King Solomon of Israel. Historically, unique heritages of obelisk, churches, mosques and others of the country believed to be crafted and produced by thousands of commonly unskilled artisanal miners. ASM is a non-mechanised mining operation by non-professionals of gold, gemstones, tantalite, salt, clay, industrial and construction minerals/ rocks and others.

Nowadays, ASM is taken as a primary source of employment for job seekers from various parts of the country. Thus, the number of people entering into this sector is significantly increasing. ASM is also assumed to be an important source of income; increasing the wealth of rural population by providing opportunities for alternative livelihoods and contributing to poverty reduction and export earnings.

However, most ASM activity is done in uncertain environments; i.e. operators lack basic infrastructure, inadequate technical supports and often confronted with unfair market prices. People are working in unhealthy and unsafe working environments. The Ministry of Mines, Petroleum and Natural Gas, together with stakeholders, are taking steps to improve the situation by creating an environment conducive to ASM operators in different parts of the country.



Source: Ministry of Mines and Petroleum, Ethiopia

Figure 35. Geological Map of Ethiopia

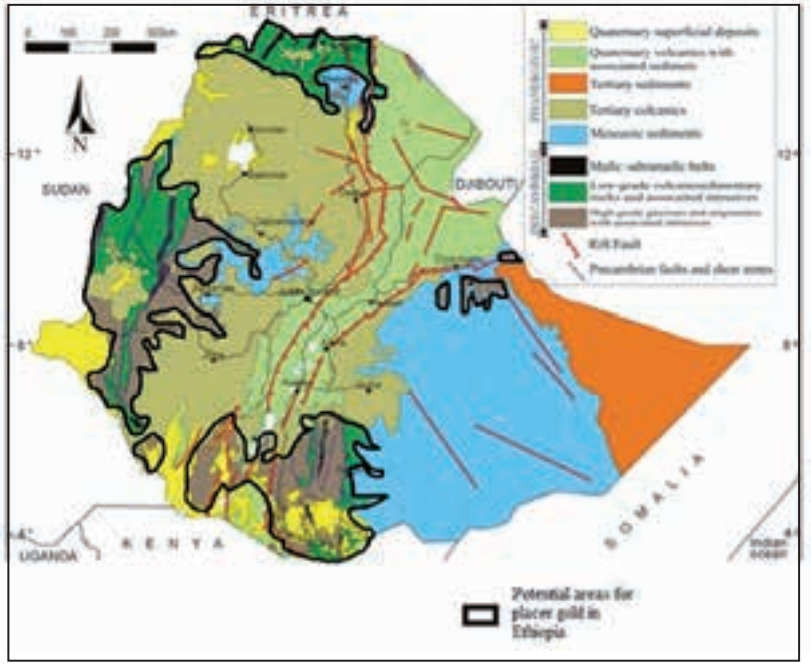
The Ministry of Mines, Petroleum and Natural Gas, in collaboration with development partners, is working towards formalising and assisting ASM operators, such as legalising through licensing, providing materials and training to build their technical capacity, laying down basic infrastructure and technological supports, facilitating and strengthening the legal market system, etc. This will help improve the well-being of ASM operators and increase the exports of high value minerals and earning of foreign currency.

The Organisational Structure of ASM

In Ethiopia there are different government bodies responsible for ASM activity to explore, extract, process and market the minerals. The Ministry of Mines, Petroleum and Natural Gas regulates, controls and supports ASM and other mining activities. The Geological Survey of Ethiopia maps geology and explores the mineral potential of the country. For ASM activity in the Federal Ministry, the Regional States and lower administrative levels each have their respective duties.

Mining Activity in Ethiopia

Ethiopia is a nation endowed with various mineral resources. According to the Ethiopian Geological Survey of the former Ministry of Mines and Energy, the resources discovered



Source: Ministry of Mines and Petroleum, Ethiopia

Figure 36. Map of Potential Gold Mining Areas in Ethiopia

in different regions of the country are mainly gold, tantalum, phosphorus, iron, salt, potash, soda ash, gemstones, coal, geothermal and natural gas. Other mineral resources are platinum, niobium, copper, nickel, manganese and molybdenum. Ethiopia is also endowed with a range of industrial mineral deposits, including potash, limestone, coal, iron ore, tantalite, feldspar, quartz, dimension stones and dolomite, among others. Marble is found extensively in most parts of the country.

However, the minerals are not yet been well explored and exploited to the maximum benefit of its inhabitants. The mineral distribution varies with rock types. Geologically, the country is underlain by Precambrian metamorphic rocks and associated intrusive igneous rocks, Palaeozoic sedimentary rocks, Mesozoic sedimentary rocks and, Cenozoic volcanic rocks and superficial deposits, as shown in Figure 35 below.

The high potential deposit areas for gold are the Precambrian metamorphic rock, mostly found in the greenstone belt, which are variably intercalated metavolcanic rocks and metasedimentary rocks, as shown in Figure 36 below. The high potential deposit areas for opal are ignimbrite around the Wegel Tena area in the Wello Province of North Central Ethiopia. The other minerals presently being mined by ASM operators in Ethiopia are tantalum, platinum, emerald, sapphire, chromite, kaolin, niobium, quartz, salt, potash, silica sand, pumice, construction rocks, dimension stones and others.

The Mining Law and Licences

The Mining Law

There are legal frameworks to regulate, control and support the mining activity in Ethiopia. The legal and fiscal environment instituted by the Government permits a free market driven economy, allowing both foreign and local companies to participate in the mining development of the country. Ethiopia opened its mining sector to private investors in mid-1991 because of the political change in the country. Mining in Ethiopia is governed by an independent legal regime. From the last two decades, several proclamations were issued (some with amendments) driven by the growing demand for metallic and industrial minerals and the need to create highly competitive legal frameworks for mining investment in Ethiopia. The country's mining proclamations constitute the following particular proclamations:

- Mining Operations Proclamation No. 678/2010;
- Amended Operations Proclamation No. 816/2013; and
- Transaction of Precious Minerals Proclamation No. 651/ 2009.

The Mining Operations Proclamation governs all mining and related activities in the country. It underlines that mineral resources of the country are the property of the State and the People. The Government, custodian of mineral resources, acts through the licensing authority to control and administer mineral resources. Mining activities are open for private investment and the mining law provides legal safeguards for tenure security. The

stakeholders, who participated in the drafting of the Ethiopian mining regulation, include the Ministry of Mines, Geological Survey of Ethiopia, the Environmental Protection Authority and the regional mining agencies.

According to Proclamations No. 678/2010 and No. 816/2013, the Licensing Authority can issue four types of mining licences:

- Artisanal Mining up to 2 years initial – Non-renewable;
- Special small-scale mining up to 10 years + renewable for 5 years;
- Small-scale mining up to 10 years initial + renewed for 5 years unlimitedly; and
- Large-scale mining up to 20 years initial + unlimited renewals 10 years.

Requirement for Artisanal Mining Licence

In Ethiopia, the cost or qualification required to gain an Artisanal Mining Licence is not prohibitive. Proclamations No. 678/2010 and 816/2013 specify that no financial resources or technical or professional competence are required to acquire an Artisanal Mining Licence.

Artisanal Mining Licences can be obtained from the regional state governments, at zonal administrative level in the regional states, or district (woreda) levels in the zonal administrative. An Artisanal Mining Licence provides an exclusive right to explore and mine for minerals within the licence area. Artisanal miners, who obtain a licence, are offered a large degree of security. A licensee shall be obliged to undertake mining operations according to the environmental, health and safety standards, prescribed for artisanal mining in the relevant laws. Licence fees are set by the State, but are invariably low, and artisanal mining is exempted from taxes.

As per the Proclamation, the only universal payment that the artisanal miners should make is the mineral royalty. Every licenced groups or cooperatives engaged in artisanal mining are supposed to pay the royalty to the local district (woreda) Revenue and Customs Authority at the end of the budget year. The artisanal mining licence is valid for the period of up to two years and shall not be renewed. The Proclamation also states types and requirements for transaction licences to facilitate marketing of mineral products, specially mined by artisanal miners.

The Mining Community and Its Characteristics

Legal artisanal miners are those organised as a formal Mining Development Group (composed of three or more persons) or as a Mining Cooperative. The Mining Operation Proclamations No. 678/2010 and the preceding proclamations underlined that miners should necessarily be organised as cooperatives. On the other hand, the amended Proclamation No 816/2013 totally deletes the relevance of Cooperatives in mining; instead, it encourages Special Small-Scale or Small-Scale Mining. This has created confusion with the concerned

stakeholders as to what to do with the already established cooperatives and how to organise the newly coming miners. Now, the consensus is that artisanal cooperatives should be dissolved once their licence expires; to be transformed either into Small-Scale Mining or totally be shifted from the mining activity to any other business. Immediately after two years of operation, the Mining Development Group can be transformed into "Special Small-Scale Mining" if it successfully meets the criteria (adequate financial resource, use of modern technologies, etc.), or it would totally abandon the mining sector and shift to other business as per Proclamation No 816/2013.

The majority of artisanal miners (legal or illegal) are between the ages of 18 and 45. They belong to the very active economic class and, moreover, they are at the pick of the productive/reproductive age. The majority of the artisanal miners are males (65%) as compared to females (35%) (Tadesse, 2016). For the majority of the artisanal miners (legal or illegal), mining is the backbone of their livelihood. On average, ASM accounts for 74% of the livelihood of the miners. Agricultural activities and petty trade are the second and third source of income for mining households, but they only contribute 9% and 8% of the household income, respectively. Mining is also practiced to supplement the seasonal farming and livestock husbandry, where land is relatively available. It is common to see migrants in abundance in many ASM locations. Interestingly, the migrants and the local people are working together harmoniously with occasional severe conflict. Sometimes serious conflicts exist between artisanal miners and large-scale miners due to overlapping of the mining sites. The stakeholders are trying to ease the working conditions for artisanal miners in every aspect at different parts of the country.

Artisanal Mining Operations and Economic Contribution

Artisanal Mining Operations

Gold, opal, emerald, sapphire, tantalum, chromite and others are extracted, processed and under transaction presently in Ethiopia. The artisanal miners (legal and illegal) are estimated at 1.26 million with direct involvement and 7.5 million indirect beneficiaries (Tadesse; 2016). Major reasons for such a larger estimate of artisanal miners include: (i) recent government policy to encourage the youth to aggressively engage in mining; (ii) diminishing farm income due to climate change; and (iii) increasing inflow of migrants. Of the total estimated number of artisanal miners about 94% operate informally (unlicensed) and only about 6% are formally organised and licenced (Tadesse, 2016). The licenced miners are organised into three: (i) Mining cooperatives, (ii) Small and Micro Enterprises and (iii) Mining Development Groups.

Types of mining where artisanal miners exercising presently in Ethiopia are:

- Open surface mining;
- Open-pit mining; and
- Sub-surface mining/tunnelling.

Minerals Production and Economic Contribution

Estimating the volume of production of minerals by the artisanal miners is very complicated due to the lack of historical records and suspicions by many producers to give information. But ASM has an immense economic and social contribution at macro and micro level.

The Mining Proclamation obliges payment of royalty by any level of miners. Accordingly, artisanal miners are obliged to pay royalties. The regional governments attempted to implement collection of royalties through their respective offices of customs and revenue at zonal administrative office or district (woreda) level.

ASM miner village Nametile in Central Mozambique

ASM SECTOR OF MOZAMBIQUE

By Ilídio António Chiziane and Silvetre Mário Ribisse, National Directorate of Geology and Mines, Ministry of Mineral Resource and Energy, Republic of Mozambique

ASM refers to mining operations carried out by individuals organised in groups or individually, who are financed by limited and full-time resources using simple techniques and rudimentary instruments with a very low level of mechanisation.

ASM operations in Mozambique date back to the time of the Monomotapa Empire of the 14th Century; however, it was not until 1989 that ASM was accepted by the Mozambican Government (Drechsler, 2001). Today, ASM is an important activity in Mozambique - widely practiced in rural areas by more 150,000 miners.

The following minerals are explored and exploited in Mozambique, as shown in Figure 37 below:

- Gold;
- Precious and semi-precious stones;
- Building materials, such as clay, limestone, kaolin, building stone, sand, coal; and
- By-products of pegmatites, such as industrial beryl, feldspar, quartz, among others.

Legal Framework of ASM

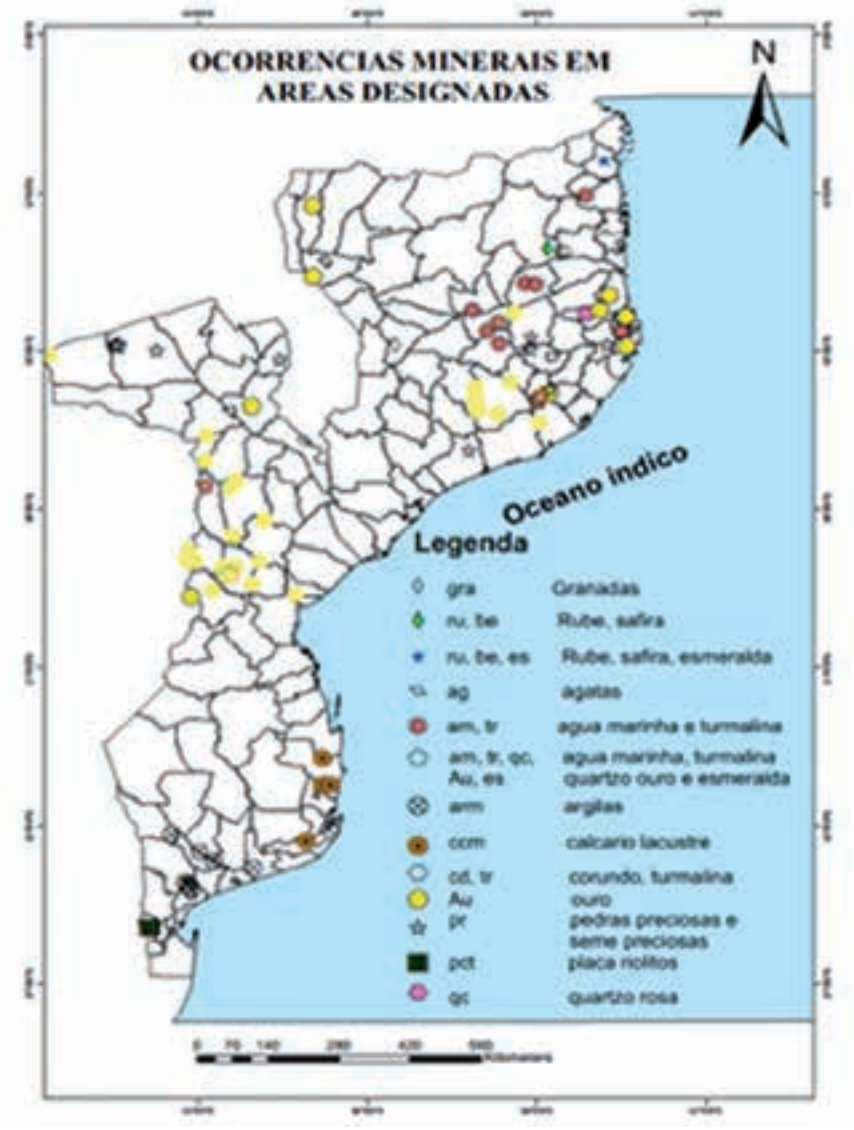
In Mozambique, ASM operations are covered by the National Decree 31/2015, Chapter III, Article 98. According to this Decree, ASM operations are defined as:

a) An annual production of mineral resources for construction purposes of less than 100,000 tons;
b) An annual production of precious metals of less than 12kg;
c) An annual production of gems of less than 250kg;
d) Underground works of less than 20m deep;
e) Underground galleries of less than 50m fulfilment; and
f) Employ less than 15 workers

Current Issues of ASM

One of the challenges of the National Directorate of Geology and Mines, through the Department of Artisanal Mining and Small Scale, is to transform rudimentary artisanal mining into small-scale mining – in other words, transforming associations into cooperatives, which corresponds to the introduction and collective use of modern environmentally

Source: John Tychsen, GEUS.



Source: Ministry of Mineral Resources and Energy of Mozambique (MIREME)

Figure 37. Occurences of Minerals in Mozambique

sound technologies technology and equipment for both extraction and processing of minerals to protect the environment and future generations.

Sustainable and equitable development of the ASM sector should be a process of creating opportunities for all as a basis for improving the quality of life of the community. ASM uses natural resources to meet the needs of the community today. It recognises that the miners' organisation is essential and must have the means to achieve the economic development of its members, their families and the local community.

The benefits of ASM operations should reach all members of the organisation and its workers. The organisation must therefore have a democratic structure and transparent management.

ASM is an employment alternative for young people unable to continue their studies, although in many cases as seasonal, a source of income increase and consequently the contribution of improving the well-being of the mining communities, resulting in improved houses, means of transport acquired and attracting other parallel activities, such as trade and the boost of agricultural production

Despite the positive impacts of ASM, it is also causing immense environmental and public health problems, such as soil erosion, pollution and silting of rivers.

Nuer/Ngundeng Pyramid Mound in South Sudan

ASM SECTOR OF SUDAN

By Tarig Galal

Sudan is one of the largest countries in Africa - covering approx. 1.3 million km² and inhabiting 32 million people. With such a big area and large variation in geology, Sudan has a huge mineral potential yet to be evaluated and developed.

In 2010, the Government of Sudan established a new ministry responsible for minerals development, the Ministry of Minerals.

In Sudan, there are three types of mining, determined by size of mining area and use of mining equipment, namely:

- Artisanal-Scale Mining (ASM): Use of primitive/simple equipment.
- Small-Scale Mining (SSM): Mining area between 1 and 5 km².
- Large-Scale Mining (LSM): Mining area greater than 5 km².

In Sudan, ASM took off in 2009 and is now undertaken by more than one million people in 324 sites spread across 14 of the country's 18 states.

The Government's vision for ASM in Sudan is for it to be undertaken in a sustainable manner with respect for the environment and human health while at the same time contributing to the economic development of the country and its citizens.

With the establishment of the Ministry of Minerals, the Government aims to organise and legalise ASM activities and to encourage the use of scientific research and proper tools in order to achieve sustainable and environmentally sound ASM operations.

The following policies and activities were adopted and undertaken by the Ministry of Minerals to legalise and organise ASM:

- Establishment of workshops and seminars to study ASM and its impacts;
- Establishment of an ASM conference;
- Creation of a vision for legalising, organising and developing ASM by having the states participating in this, and then issuing the directory of legalisation and regulation;
- Establishment of coordination councils across all levels, i.e. national, regional, local and markets councils;
- Establishment of a specialised general management agency for ASM within the structure of the Sudanese Minerals Resources Company Ltd.;
- Creation of a vision for markets of ASM products, such as establishment of centres for gold purchases under the auspices of the Central Bank of Sudan;

- Establishment of civil community organisations, i.e. associations and assemblies, to create awareness and provide guidance on mining operations, and to solve disputes among miners;
- Promotion of modern mining techniques and environment friendly mining equipment; and
- Development of a National Plan to abandon the use of mercury in mining operations by 2020; and
- Establishment of a new law to regulate mining licences and mining activities.

Components of National Plan to Abandon Use of Mercury in Mining Operations

The National Plan to abandon the use of mercury in mining operations by 2020 comprises the following components:

- Laws and Regulations: Penalising the use of mercury in mining operations and signing the Minamata Convention on Mercury[3)] in 2013;
- Substitutions: Promoting different alternatives to mercury and signing an agreement on alternatives to mercury in mining operations with the governments both Germany and Russia;
- Training: Improving the skills of workers in extraction of minerals and use of mercury, including available substitutes;
- Waste Administration: Ensuring proper management and disposal of mercury to safeguard human health and the environment; and
- Awareness and Guidance: Providing workers with sufficient information about the risk of using mercury and how to protect the surrounding environment and human health.

Granting and Obtaining Mining Licences in Sudan

The Technical Mining Commission, working under the auspices of the Minister of the Ministry of Minerals is responsible for:

- Receiving and studying all incoming applications for mining licences;
- Recommending granting of licences for prospecting and exploration to the Minister;
- Signing contracts and agreements relating to mining activities;

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3) The Minamata Convention on Mercury is an international treaty designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. This Convention was a result of three years of meeting and negotiating, after which the text of the Convention was approved by delegates representing close to 140 countries on 19 January 2013 in Geneva and adopted and signed later that year on 10 October 2013 at a Diplomatic Conference held in Kumamoto, Japan.

- Recommending contracts/agreements subject to tax exemptions to the Minister; and
- Preparing proposals for policies, plans and general programs for prospecting and exploration to the Minister.

To obtain a mining licence in Sudan, one first has to register an Independent Business Name, which requires:

- Submission of application for an Independent Business Name, including acceptance of Business Name by the General Commercial Registrar, a Certificate of Financial Ability, and detailed bank accounts for the last 6 months;
- Submission of profile, organisation and business procedures of the company. Mining shall be one of the company's main activities; and
- Payment of prescribed fees for obtaining an Independent Business Name.

Conditions for Granting Licences of General Exploration of Small-Scale Mining

- Submission of regulation of the company foundation, valid company registration certificate and Independent Business Name certificate issued by the General Registration Department under the Ministry of Justice;
- Declaration of applicant's current bank account in a local commercial bank of minimum EUR 200,000 or equivalent in local currency;
- Declaration of financial ability for a foreign applicant authenticated by Sudan Embassy or Ministry of Foreign Affairs;
- CV of applicant, which shall include work and experiences in the mining field;
- CV of the company's experts, which shall include work and experiences in the mining field, supported by documentation;
- Detailed addresses for the applicant in Sudan (in case of companies from the General Commercial Registration Department)
- In case of a partnership, the applicant shall submit contract of partnership and documents of financial and technical ability;
- Declaration of clearance of taxes;
- Declaration of clearance of Zakat; and
- Payment of prescribed fees.

Conditions for Granting Inclusive Exploration Licences

- Submission of application for licence, which shall show coordinates of the required mining exploration site. The required site shall not exceed 5 km2;
- Attainment of a valid General Exploration Licence;
- Submission of technical report prepared by a knowledgeable and experienced geologist supported by results;
- Submission of a chart for the required site, which must be approved by the State and National Survey Department;

- Submission of detailed information of the company's contractors, who will undertake exploration work along with copies of their contracts; and
- Payment of prescribed fees.

Conditions for Granting Small Scale Mining Concession

- Submission of application for licence;
- Attainment of a valid Inclusive Exploration Mining Licence;
- The contracted block must not exceeded 2 km2, except for industrial mining purposes. The required site for the industrial mining is 10 acres for one licence;
- Submission of technical report prepared by a knowledgeable and experienced geologist supported by analytical results; and
- Payment of prescribed fees.

Center of Wadi Halfa, Sudan, from hilltop

Artisanal Mine in Easter D.R. Congo, Mukungwe.

ASM SECTOR DEMOCRATIC REPUBLIC OF CONGO

By La Commission Géologique

Présentation de la RDC

Cadre Géographique

La République Démocratique du Congo (RDC) est un pays d'Afrique centrale, peuplé de 80 000 000 d'habitants et se subdivise en 26 provinces. La RDC partage ses frontières avec 9 pays.

Cadre Géologique et Géologie Générale

La RDC comprend deux grands ensembles géologiques:

- Les formations de substratum constituant le bourrelet annulaire, ces formations sont représentées par des roches plissées et métamorphisées et des roches magmatiques, qui se sont mises en place dans la période comprise entre l'Archéen et le Néoprotérozoïque. Ce sont ces formations qui renferment de nombreuses minéralisations Cu, Co, Zn, Pb, Ag, Au, Sn, Sb, Ta, etc.;
- Les formations de couverture (Phanérozoïque) occupent surtout la cuvette centrale et constituent le raccord avec le bourrelet annulaire périphérique. Ces formations sont âgées du Carbonifère au Pléistocène. Ces terrains sont affectés par des failles et des gauchissements (légers plissements) et renferment quelques ressources minérales: charbon, pétrole, bitume, diamant; et
- Elles affleurent également le long de la côte Atlantique et constitue une bande de 100 km de large ou affleurent les roches sédimentaires marines très fossilifères d'âge Mésozoïque et Cénozoïque.

Minéralisation

La variété des nombreuses minéralisations de la RDC est liée à son contexte géologique très riche:

- Le groupe du cuivre (cuivre – cobalt – (uranium) – zinc – plomb – cadmium – germanium) : il s'agit de gisements de la ceinture cupro-cobaltifère Katangaise exploitée en plusieurs endroits (ex. dolomie de KAKONTWE);
- Les gisements du faisceau R2 ou série des Mines fournissent presque la totalité de la production du cuivre, cobalt et d'uranium. Il faut y ajouter les amas discordants à Zn-Cu-Pb-Ge du KUNDELUNGU inférieur, le gisement filonien de KIPUSHI (Cu-Cd-Ge-

Source: third part photograph

Pb-Zn-Ag), le gisement de TSHIBENDA et d'autres gisements et indices: Bamba KILENDA, LUBI-LUKULA, UBUNDU, etc. ;

- Le groupe de l'étain (étain – wolframite – colombo-tantalite – béryl – monazite). Les minéralisations se localisent dans la partie orientale de la RDC, formant une ceinture de plus de 700 km de long (chaîne Kibarienne). Les différents gisements du groupe de l'étain sont liés à des pegmatites et à des environnements lithologiques et structuraux spécifiques;
- Les minéralisations liées à la différenciation des magmas basiques et alcalins (chrome – nickel – niobium – diamant): les gisements et les indices sont rapportés aux gîtes à kimberlite (diamant), gîtes carbonatitiques à pyrochlore (Nb-Ce), gîtes filoniens à barytine. Les éluvions et alluvions diamantifères des pipes kimberlitiques sont localisés en plusieurs endroits : Mbuji-Mayi et Tshikapa étant les plus importants. Les teneurs et réserves des carbonatites de la LUESHE et de Bingo permettent de classer des gisements à pyrochlore parmi les plus importants au monde. Les gîtes résiduels à chrome et nickel sont situés dans la région du Kasaï Occidental (NKONKO et LUTSHATSHA);
- Les métaux précieux (or, argent, platine) : l'or a été signalé sur toute l'étendue de la « ceinture précambrienne » de la RDC, en liaison avec les roches du craton archéen et des cycles orogéniques Kibalien et Burundien. Les gisements les plus importants sont localisés dans la province Orientale et dans le Nord-Kivu. On trouve des gîtes dans le Kasaï, le Katanga et le Bas-Congo. L'argent provient en grande partie du traitement des minerais cupro-zincifères de KIPUSHI et de la Province Orientale et du Kivu; Les gîtes et indices de platine sont liés à des intrusions basiques (Kasaï), à des intrusions de composition intermédiaire (Province Orientale) et aux gîtes stratiformes de la « ceinture cuprifère »;
- Le fer et le manganèse: l'existence d'importants gîtes de fer a été reconnue dans la Province Orientale, le Kasaï et le Katanga. Les réserves des gîtes de la Province Orientale et du Kasaï sont estimées à plusieurs millions de tonnes. Le manganèse apparaît cependant comme un élément accessoire dans de nombreuses associations minérales. Les gisements de KASEKELESA et KISENGE sont les plus importants (réserves évaluées à 14 Mt); et
- Les combustibles fossiles (charbon, schistes bitumeux, pétrole et ses dérivés gazeux et solides): les bassins houillers de la RDC sont localisés dans la Province du Katanga (LUENA, LUKUGA, Tanganyika) et présentent des caractéristiques similaires à ceux de l'Afrique australe et de Madagascar. Les schistes bitumeux sont rencontrés dans les sédiments marins des séries de Kisangani et de la Loi qui affleurent sur la bordure de la cuvette centrale (Province Orientale, Congo-Central). Des indices d'hydrocarbures solides et liquides sont connus dans les formations de couverture, d'âge crétacé à récent de la zone littorale Atlantique de la cuvette Centrale du rift des Grands Lacs. Il faut y ajouter un gisement très particulier de gaz naturel dans le lac Kivu à l'est de la République Démocratique du Congo.

État des Lieux de la Mine Artisanale

Cadre Légal et Réglementaire

L'exploitation minière artisanale et à petite échelle est consacrée dans le code Minier de la RDC, promulgué par la Loi n°007/2002 du 11 juillet 2002 telle que modifiée et complétée par la Loi n°18/001 du 09 mars 2018 et ses mesures d'application, principalement le Règlement Minier notamment le décret n°038/2003 du 26 mars tel que modifié et complété par le décret n°18/024 du 08 juin 2018. Les deux textes sont complétés par des arrêtés Ministériels et Notes-Circulaires, au titre des mesures d'application.

Cadre Institutionel

Le secteur minier artisanal et de la petite mine est une sous-composante du secteur minier géré par le Ministre en charge des Mines, conformément aux dispositions de l'article 10 du Code Minier.

Partant de l'article 1er de la Loi n°18/001 du 09 mars 2018 portant sur le Code Minier, l'exploitation minière artisanale est définie comme toute activité par laquelle une personne physique de nationalité congolaise détentrice d'une carte d'exploitant artisanal en cours de validité, membre d'une Coopérative minière se livre, dans une Zone d'Exploitation Artisanale à l'extraction et à la concentration des substances minérales en utilisant des outils, des méthodes et des procédés non-industriels. Vu sous cet angle, il ressort que la Loi minière exclut l'exploitation minière artisanale individuelle d'une Zone ouverte à l'Exploitation Artisanale (ZEA). En effet, constatant les nombreux défis de l'exploitation individuelle, des efforts ont été fournis en vue d'une suppression progressive de celle-ci pour une exploitation par des groupements d'exploitants miniers artisans appelés « Coopératives minières », non seulement pour un meilleur encadrement et une assistance adéquate aux exploitants-artisans, mais aussi, pour poser les bases d'une classe moyenne congolaise du secteur des mines par la mutation de celle-ci vers les sociétés minières à petite échelle. Ainsi, le Gouvernement de la RDC a mis en place une structure : le SAEMAPE « Service d'Assistance et d'Encadrement de l'Exploitation Minière Artisanale et à Petite Echelle) ayant pour mission essentielle d'assister et d'encadrer sur l'ensemble du territoire national toutes les coopératives minières.

Les mandats du SAEMAPE peuvent se résumer comme suit:

- L'encadrement technique;
- L'appui à la formation du secteur;
- L'organisation de missions de vulgarisation et sensibilisation auprès des exploitants miniers artisans et de la petite mine; et
- Le contrôle opérationnel sur le terrain.

Des cadres de dialogue entre parties-prenantes (Gouvernement, société civile, représentants des coopératives minières et collectivités territoriales) sont mis en place, tant au niveau national (Groupe thématique Mines), que provincial et local (des comités provinciaux et locaux des activités minières).

Organisation du Secteur Minier Artisanal et de la Petite Mine

- Il sied de rappeler que l'émergence du secteur minier artisanal remonte aux années 1970, et prend de l'expansion dans les années 1980, période au cours de laquelle l'Ordonnance-Loi n°082/039 du 05 novembre 1982 a libéralisé le secteur minier artisanal en général et celui de l'exploitation des matières précieuses, à savoir le diamant et l'or;
- En 1998, suite au déclin de la grande entreprise minière du cuivre, le Ministre des Mines prend un Arrêté Ministériel n°009bis/CAB.MIN/00/MN/1999, le 19 février 1999, pour légaliser l'exploitation minière artisanale dans la filière cupro-cobaltifère, principalement « l'Hétérogénéité » dans la province du Katanga;
- Quant à l'organisation du secteur minier, il y a lieu de retenir ce qui suit:
  - L'exploitation minière artisanale n'est autorisée qu'aux personnes physiques adultes de nationalité congolaise (exploitants-artisans, orpailleurs et négociants), détentrices d'une carte d'exploitant-artisan et aux coopératives minières agréées par voie d'Arrêté du Ministre en charge des Mines.
  - Cette activité ne peut se dérouler qu'à l'intérieur d'une zone ouverte à l'exploitation artisanale, instituée par un Arrêté Ministériel du Ministre en charge des Mines.
  - Au niveau de la chaîne de commercialisation, le manuel de Commercialisation et le manuel des Procédures de traçabilité des produits miniers, de l'extraction à l'exportation, validés par un Arrêté Interministériel des Ministères ayant les finances et les mines dans leurs attributions, reconnaissent:
- Des centres de négoce: lieu où se dérouleront les opérations d'achat et de vente des substances minérales provenant de l'exploitation artisanale;
- Des comptoirs d'achat et de vente des substances minérales de production artisanale (personnes morales de droit congolais), principalement le diamant et l'or;
- Des entités de traitement des substances minérales de production artisanale pour les 3T, le cuivre et le cobalt (personnes morales de droit congolais).
- S'agissant de la petite mine, elle est l'une des innovations apportées par le Code minier de 2002 tel que modifié par le Code minier de 2018, du fait qu'il a institué un droit minier dénommé « Permis d'Exploitation des Petites Mines » (PEPM). Celui-ci confère à son titulaire le droit d'exploiter un gisement minier à petite échelle.
- Le permis d'exploitation de petite mine est un droit réel, immobilier, exclusif, accessible, amodiable et transmissible; et
- La durée de validité de permis d'exploitation de la petite mine est de cinq ans renouvelable une fois pour la même durée. Toutefois, moyennant l'avis de la Direction des Mines, le Ministre peut proroger le Permis d'Exploitation de la Petite Mine (PEPM).

L'Importance Sociale et Économique de L'Exploitation Artisanale et à Petite Échelle en RDC

Le secteur minier artisanal et à petite échelle occupe une place de choix dans le secteur minier de la RDC. Sa part dans la production minière globale le confirme par filière:

- 100% de la production de la filière stannifère et ses accompagnateurs est artisanale;
- 95% de la production de la filière du diamant provient de l'exploitation minière artisanale; et
- 20% de la production de la filière cupro-cobaltifère sont issus de l'exploitation minière artisanale et à petite échelle.

Ce secteur représente en RDC plus ou moins 2 000 000 d'exploitants-artisans et d'orpailleurs et plus ou moins 50 000 négociants. Ainsi, au moins 10 000 000 à 12 000 000 de congolais dépendraient économiquement de ce secteur. C'est donc un secteur source d'emplois et de revenus non seulement pour une frange importante de la population mais aussi pour le Trésor Public et les finances des Entités Territoriales Décentralisées (ETD).

Rôle de la Commission Géologique

En RDC, il n'existe pas de Commission géologique mais plutôt:

Une Direction de la Géologie

Cette Direction dépend du Secrétariat Général des Mines. Elle est notamment en charge des tâches suivantes:

- Concevoir et élaborer:
  - Les avant-projets de politique et de stratégie du secteur minier en matière de géologie et d'en assurer la mise en application;
  - Les avant-projets de textes législatifs et règlementaires du secteur minier en matière de géologie et d'en assurer la mise en œuvre;
- S'assurer de l'archivage et de la conservation des échantillons de sols, de roches, des carottes et des minerais déposés par les titulaires de droits miniers et de carrières;
- D'émettre un avis technique sur les travaux de recherches à entreprendre à l'extérieur du périmètre couvert par un droit minier ou de carrière;
- Recevoir de toute personne, titulaire de droits miniers ou de carrière, la déclaration écrite des levés géophysiques ou de campagne de prospection géochimique et de se faire communiquer les résultats; et
- Participer aux travaux de:
  - La Commission Interministérielle d'Adjudication des offres;
  - La Commission Interministérielle d'approbation des listes des biens à importer sous le régime douanier privilégié; et

- Le Comité Permanent d'Évaluation « CPE », l'investigation du sol et/ou du sous-sol et l'identification des indices des gîtes minéraux, des ressources hydrologiques et des structures vulnérables à l'activité sismique.

Un Centre de Recherches Géologiques et Minières « CRGM »

Un établissement public placé sous la tutelle du Ministère ayant la recherche scientifique dans ses attributions. Il a été créé aux termes de l'Ordonnance-Loi n°82-040 du 05 novembre 1982 portant organisation de recherche scientifique et technologique.
De manière pratique, le « CRGM » constitue pour le Gouvernement un des outils d'application de la politique minière et environnementale du pays.

Il est chargé de:

- La conception et l'exécution des projets de recherche à caractère géologique et minier pour une bonne connaissance du sous-sol de la RDC;
- La prospection géologique et minière des substances minérales (minerais métalliques, substances minérales non métalliques, matériaux de construction, pierres précieuses et semi-précieuses);
- La prévention des catastrophes naturelles d'origine géologique;
- L'étude hydrogéologique basée sur l'exécution des forages d'eau;
- L'expertise de minerais, roches, minéraux, sols et eau;
- L'étude environnementale des zones urbaines, rurales et sites miniers;
- La diffusion des cartes géologiques, gîtologiques, hydrologiques et géotechniques;
- La publication d'une revue scientifique dénommée « Bulletin du CRGM ».

Un Service Géologique National du Congo « SGNC »

Le Service Géologique National du Congo « SGNC » est notamment chargé de procéder à:

- La cartographie géologique assistée par la télédétection, les levés géophysiques et les études géochimiques; et
- L'investigation du sol et/ou du sous-sol en vue de l'identification des indicateurs de gîtes minéraux et des produits de carrière.

À ce titre, le Service entreprend des études géologiques de base faisant appel à:

- La géologie générale et la géologie appliquée;
- La métallogénie;
- La géologie marine;
- La minéralogie;
- La géotechnique; et
- La géomorphologie.

Une mise à jour de la carte géologique et une étude géophysique est en cours.

Cependant, il convient de noter que la RDC, de par ses différents contrats notamment avec la Banque Mondiale et le RSA a:

- Mis à jour la carte minière;
- Fait le survol en vue d'une étude géophysique; et
- Fait beaucoup d'avancées en matière de connaissances géologiques.

N.B.: Les textes créant le SGNC existent, il ne reste qu'à nommer les animateurs.

Défis et Perspectives

Défis

À ce stade, le secteur est confronté à plusieurs défis:

- Harmonisation du régime fiscal entre les provinces (en cours)
- Harmonisation du régime fiscal avec les pays voisins dans le cadre de la CIRGL, du CEAC et de la SADC;
- Harmonisation du cadre légal de l'EAPE avec les autres lois sectorielles;
- L'insuffisance des effectifs (nombre et qualifications) et le manque des moyens financiers et logistiques
- L'insuffisance des ZEA et leur viabilité;
- Accessibilité et excentricité des ZEA;
- Etc.

Perspectives d'Avenir

a) La RDC est dotée d'un document de stratégie nationale. La stratégie nationale de la SAEMAPE s'inscrit dans la continuité et l'expansion de la vision du Ministère des Mines pour la période 2015-2021. Elle énonce clairement les objectifs fondamentaux pour le secteur en créant un consensus autour de leur validité, à savoir:

- Le renforcement des capacités de l'Administration et des services spécialisés des Mines, en particulier du SAESSCAM, devenu depuis le 04 avril 2017 le SAEMAPE par un décret du Premier Ministre;
- La fourniture d'une assistance technique efficace et de services de vulgarisation aux exploitants miniers artisans;
- L'augmentation des contributions du secteur au développement économique du pays; et
- L'amélioration des conditions sociales et environnementales dans les zones d'exploitation minière artisanale et à petite échelle.

L'objectif majeur et commun consiste à créer un tissu entrepreneurial et semi-industriel minier évolutif, technique et responsable permettant de créer une véritable valeur ajoutée sur le long terme, pour la population locale et pour l'État.

b) Les axes principaux de la stratégie nationale. Les principes fondamentaux qui sous-entendent la stratégie nationale du secteur EAPE sont les suivants:

- La reconnaissance de l'importance économique et sociale du secteur pour le pays en particulier dans le cadre de l'émergence économique;
- La prise en compte d'une diversité d'acteurs des exploitants artisanaux traditionnels jusqu'aux opérateurs nationaux ou étrangers, travaillant sur des schémas très productifs et mécanisés;
- La responsabilité légale, sociale et environnementale de tous les acteurs;
- Le principe d'un devoir des autorités administratives en charge du secteur d'apporter des outils permettant d'atteindre une excellence en matière des pratiques minières et facilitant l'accès au financement et à la législation des activités;
- La reconnaissance du rôle fondamental des femmes dans le secteur et leur accession à des postes à responsabilités au sein des structures productives et représentatives;
- La nécessité absolue du respect des droits de l'Homme par tous les acteurs du secteur; et
- Le principe selon lequel le renforcement des capacités des opérateurs et leur accession aux droits d'exploitation constitue le préalable et la base indispensable pour une large contribution du secteur aux recettes de l'État.

Autres Perspectives

- Poursuite de l'identification et de l'enregistrement des exploitants-artisans;
- Regroupement en coopératives minières selon les normes OHADA d'où la nécessité d'opérationnaliser les coopératives et de former les formateurs;
- Poursuite de l'institution des ZEA viables, minéralisées et accessibles;
- Amélioration des conditions de vie des communautés minières environnantes;
- Contribution au respect des exigences internationales (OCDE, PK, CIRGL, SADC, etc.);
- Création d'un fonds de crédit minier ouvert aux coopératives et aux opérateurs des mines à petite échelle;
- Poursuite de la formalisation du secteur de la mine artisanale;
- Mutation de l'exploitation artisanale en mines à petite échelle; et
- Harmonisation du taux.

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