Ministry of Energy & Mineral Development

DIRECTORATE OF GEOLOGICAL SURVEY AND MINES

CELEBRATING 100 YEARS of Geological Survey in Uganda

CELEBRATING 100 YEARS

1919 2019

GEOLOGICAL SURVEY OF UGANDA

Statement from the State Minister For Mineral Development

It is my pleasure to join you as we celebrate a 100 years of geological survey in Uganda. The mandate of the Ministry of Energy and Mineral Development (MEMD) is "To Establish, Promote the Development, Strategically Manage and Safeguard the Rational and Sustainable Exploitation and Utilization of Energy and Mineral Resources for Social and Economic Development of the country."

Through the Directorate of Geological Survey and Mines, the Ministry of Energy and Mineral Development has managed to exploit Uganda's natural resources to impede issues affecting the country.

That is, through various mapping and exploration programmes. The DGSM has provided geotechnical services to other sectors to determine rock strengths for infrastructure development like dams, buildings and road construction, provided technical advice to societies prone to geohazards and capacity building in form of internship training to tertiary institutions. Our minerals are now exploited as raw materials for construction hence boosting social and economic development in terms of revenues generated and urbanisation. Examples include marble, dimension stones, kaolin, limestone for cement, sand, iron and many others.

Hon. Sarah Opendi Achieng, Minister of State for Mineral Development

Currently the sector is trying to set up structures which shall enable formalising and regulating activities of artisanal and small-scale miners (ASMs) in order to create jobs, generate revenues from their operations and also monitor their working environments for health and safety measures.

Over 10,000 people have registered as artisanal miners in Kasanda, Buhweju and Mubende for gold, aggregates, sand, clay, salt and other industrial minerals hence reducing the unemployment challenge in the country.

Our focus in the coming years shall be on; policies and legal and regulatory frameworks that are helpful in developing a robust mining sector; establishment and operationalisation of a mineral certification system; and prioritizing mineral value addition in order to achieve the NDP III development goal of transforming Uganda into a mineral growth country through industrialisation.

I am happy to report that the mining bill was presented to cabinet and should be passed by cabinet during 2021 and approved by parliament.

I would like to thank the general public, MDAs, civil society organisations, investors and all other stakeholders for the support rendered to the sector through development partnerships and for choosing Uganda as an investment destination in the past 100 years, which we are celebrating.

Lastly, I would like to thank His Excellency the President of the Republic of Uganda, for his guidance and support rendered to the mineral sector.

I congratulate the Directorate of Geological Survey and Mines.
"For God and my Country".

FOREWORD: The Permanent Secretary - MEMD

I joined the Ministry of Energy and Mineral Development in 1988 and I have seen the Directorate of Geological Survey and Mines grow exponentially over the years.

Mr. Robert Kasande - Permanent Secretary, Ministry of Energy & Mineral Development

In line with the event theme of "Celebrating 100 years of Geological Survey", the Ministry of Energy and Mineral Development, through the Directorate of Geological Survey and Mines, has over the years carried out various mapping and exploration activities that have generated vast amounts of data indicating mineral occurrences, geohazards and clean ground water supplies. This has been achieved from recurrent and development budgets and foreign aid.

The major projects implemented included; BRGM, France (1989- 1991) which carried out regional geochemical survey in South Eastern Uganda and acquired so much stream and soil data that led to the reserve estimation of gold in Eastern Uganda, which today has resulted in the establishment of two gold mines. That is Greenstone Resources Ltd and Wagagai Mining Company Ltd.
The UNDP project in 1992 was designed for purposes of capacity building and to eliminate the information gaps in key mineral areas. This project enabled the Ministry to acquire data on minerals from places like Muko for iron ore, Busumbu for phosphates, salt in Lake Katwe and many others which have been licensed to-date.

Sustainable Management of Mineral Resources Project (SMMRP) in 2003 covered 80% of the country's geological surveys hence acquiring high-resolution geology, geochemical and geophysical data which led to discovery of 11 new mineral targets, currently being followed up to confirm reserves. The Mineral Wealth and Mineral Infrastructure Development project has established an online application system (Mining Cadastre System), strengthened the mining and mineral legal framework as well as established Mineral Beneficiation Centres that shall be used as skills development centres for artisanal and small-scale miners. Other projects include; The Uganda Geothermal Resources Development Project (UGRDP) which conducted the pre-feasibility study of Katwe, Buranga, Kibiro and Panyimur geothermal prospects and has completed drilling in Kibiro, Hoima. Plans are underway to do the same in Panyimur since we are targeting 1,500MegaWatts of geothermal energy.

Design, Construction and Installation of Uganda National Infrasound Network Project (DCIUNIN project) focused on the infrasound infrastructure development to monitor the correlation between lightning occurrences and geophysical features. Currently, procurement is ongoing to install an infrasound station at Entebbe.
In terms of mitigating earthquakes, there are five seismic stations, at Entebbe, Hoima, Nakawuka, Kabale and Mbarara that have been set up to measure earthquake occurrences in the country. Recently, due to human activity, we have had interventions to mitigate activities of landslides, especially in mountainous areas of Bugisu and Rwenzori.
Mineral Laboratories Equipping and Systems Development Project (2017 – 2020) whose objective was to develop a modern mineral laboratory, has refurbished the Laboratory facilities at DGSM to a standard acceptable by the ISO/IEC 17025:2017 Accreditation for Testing and Calibration Laboratories.

It is, therefore, with great honor that I interest you to read this century magazine that provides details of our achievements, challenges and future plans related to mineral certification which is commencing with tin, tungsten and tantalite (3Ts), minerals on demand like lithium which is used in electric cars; rare earth elements (REEs); and iron ore for steel production infrastructure used in development.

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WELCOME: Remarks by the Director - DGSM

I am delighted to have you join us celebrate 100 years of Geological Survey in Uganda. A journey that commenced in 1919 during the colonial era, in the heat of World War I, when the world was searching for minerals like Tantalite, Tungsten, Tin among others, to support the military industry.
Our theme for celebrations is “Celebrating 100 years of Geological Survey for industrialisation, job creation and shared prosperity’.

Ms. Agnes Alaba, Acting Director DGSM and Commissioner Mines

These discoveries resulted in the formation of mines like Kilembe Mines Ltd, Hima Cement, Tororo Cement, Tiira Gold Mines, Buyaga Wolfram Mine, Nyabushenyi Beryl Mine and the search for crude oil in Hoima.
As of today, the Directorate celebrates successes like; the discovery of oil in 1919 that has now progressed to a fully-fledged directorate of its own. Borehole drilling for clean water is still in existence especially in areas with no tapped water, under the Ministry of Water and Environment. The feasibility studies conducted at Jinja in 1947 to check for bedrock strength for a potential site led to the construction of the hydroelectric power plant in 1954, which is still operational.

With more research, limestone production has increased from 200,000T to 800,000T per annum. Hence leading to the establishment of five cement factories, using limestone and pozzolana locally produced in the country; five gold refineries have been set up to promote gold processing as a way of mineral value addition; phosphate reserves have increased from 230MT to approximately 300MT in Sukulu.
Current projects on the watch include; 3MT of aluminous clay in Makutu and the graphite project in Orom. This is a battery mineral that supports automobile industry; the Zeu project in West Nile, now at the drilling stage; SIPA project in Kitgum which is looking for Platinum group of metals and copper, REE, Salt in Lake Katwe, Copper exploration project within the vicinities of the Rwenzori.
For efficiency, we are happy to point out that the DGSM transformed its license application system and information system from hard copy paper to an online system. That is the Mining Cadastre System for online application process to reduce on the application time and also increasing transparency in application and the Geology and Mineral Information System (GMIS) for information management which allows inquirers to access Geodata services at their convenience.
During the century, DGSM has strengthened its legal framework to fit the times. That is from the Mining Act of 1949 changed to the Mining Act 1964, this was later revised to the Mining Act 2003 which was operationalized by the Mining regulations 2004 and Mineral Policy 2001.

The Mining regulations of 2019 were later put in place to enable the DGSM transition to an online application system.
In terms of health and safety of the country, DGSM has tirelessly laid strategies for natural hazards like earthquakes and landslides which have hindered social development.

I would like to extend my sincere gratitude to the general public, staff at the Directorate, former directors, development partners, investors and all MDAs for the support you have accorded to us over the years.

ABOUT US: The Directorate of Geological Survey and Mines

Directorate of Geological Survey and Mines (DGSM) headquarters building in Entebbe - Uganda

The Directorate of Geological Survey and Mines (DGSM) was founded in 1919 as Geological Survey of Uganda. It has undergone transformation through the years.

In 1964, after independence, it was known as the Natural Resources Department, responsible for minerals, petroleum and water resources.

In the 1990s, when there was restructuring of government ministries, the Geological Survey and Mines Department was created within the Ministry of Energy and Mineral Development (MEMD), with a mandate to establish, promote and safeguard the exploration and exploitation of the mineral resources of the country.

This exempted DGSM from managing petroleum and water resources, and, therefore, creating independent departments in MEMD for petroleum and in the Ministry of Water, Environment and Natural Resources for water resources.

In 2014, there was restructuring in MEMD which led to the elevation of the Department of Geological Survey and Mines to a Directorate, comprising of three departments: Geological Survey Department (GSD), Mines Department (MD) and Geothermal Resources Departments (GRD). The Directorate is headed by a Director and each department is headed by a Commissioner.

Roles and Responsibilities

1. **GEOLOGICAL SURVEY DEPARTMENT**

GSD has the mandate to undertake geoscientific investigations, to collect, collate and disseminate geo-information for, among others, natural disasters and geohazards management, as well as to establish, promote the development and strategically manage and safeguard the rational and sustainable utilization of mineral resources for social and economic development of the country.

The Department comprises of four divisions, each of which is headed by an Assistant Commissioner, and they include; Geology Division, Laboratories Division, Geophysics and Seismology Division and Geodata Division.

Geology Division

i) **The role of this division is to:** Establish the mineral potential of the country.
ii) Provide geotechnical advisory services to construction works like roads, buildings, bridges and so on.

Laboratories Division

The Laboratories Division plays the role of offering analytical and mineral beneficiation test services under three (3) sections. That is:

i) The Mineral Dressing Laboratory offers sample preparation and mineral beneficiation test services using crushers, gravity separation, bench and pilot floatation and magnetic separation.
ii) The Petrology, Mineralogy and Gemology Laboratory section, prepares thin section samples, polished mounts, rock slabbing and polishing and core splitting.
iii) The Chemistry and Environment Laboratory performs elemental analysis on geological materials as well as water samples using Titrimetric, fire assay, UV Visible spectrometry, XRF, AAS, Carbon Sulfur Analyzer (CSA), Ion Chromatography and Induced Coupled Plasma Optical Emission Spectrometry (ICP-OES).

Geophysics & Seismology Division

This Division has two sections. That is; the Exploration Geophysics section and Seismology section.
The Exploration Geophysics section is responsible for:

i) Carrying out geophysical investigations for mineral exploration (magnetics, gravity, electro-magnetic, etc.).
ii) The Seismology section is responsible for monitoring geohazards like earthquakes, landslides and mudslides.

Geodata Division

This division is also made of two (2) sections. The Documentation section and Cartography section.

i) The Documentation section is responsible for acquisition, processing, storage and dissemination of information to staff, inquirers and also promotion of the Directorate to the general public through its information systems and various platforms.
ii) The Cartography section is responsible for making, storage and dissemination of maps and work plans to staff investors and the general public.

2. MINES DEPARTMENT:

Mines Department is made of three divisions. These are:

Licensing and Administration Division

Responsible for:

i) Managing the on-line mineral licensing system.
ii) Checking the eligibility of applications for mineral rights, licenses and permits.
iii) Carrying out administrative functions in respect of mineral rights including grant, renewals, transfers, amalgamation, cancellation and revocation, among others.
iv) Formulating polices and legal framework that govern the exploration and exploitation of the minerals of Uganda.

Soil samples from geochemical surveys being spread for drying.

Portable XRF sample analysis in the analytical labor

Monitoring & Inspection Division
Responsible for:
i) Monitoring and inspection of mining operations in the country for compliance.
ii) Monitoring health and safety of mining communities.
iii) Registration and training of ASMs.
iv) Operationalizing of the mineral certification (ICGLR).

Geoscience Division
Responsible for:
i) Acquisition and management of spatial data-related mineral rights and other mineral occurrences.
ii) Updating the Mining Cadastre System with applied-for shapes.
iii) Evaluation of areas submitted for mineral rights application.

3. GEOTHERMAL RESOURCES DEPARTMENT

GRD is responsible for:
i) Exploration of the geothermal resources of Uganda.
ii) Promoting and facilitating the effective and efficient management and the development of geothermal resources.
iii) Exercising regulatory administration and supervision over all geothermal exploration and exploitation operations.
iv) Monitoring, investigations and inspections necessary to ensure compliance with the provisions of the geothermal policy and legislation.
v) Maintaining a geothermal resource database and website.


Sample preparation in the crushing and drying unit of the DGSM laboratories in Entebbe


atory.


A reservoir engineer at his station

DGSM: TOP MANAGEMENT TEAM

DR. FRED ALEX TUGUME
AG. COMMISSIONER/ GSD - ASST. COMMISSIONER GEOPHYSICS & SEISMOLOGY

GABRIEL DATA
ASST. COMMISSIONER GEOLOGY DIVISION

CHRIS LUBANGAKENE
ASST. COMMISSIONER LABORATORIES

HENRY NGADA
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JAME F. NATUKUNDA
PRINCIPAL GEOLOGIST/ MAPPING

GRACE LAJWE
PRINCIPAL CHEMIST

ISAIAH TUMWIKIRIZE
PRINCIPAL GEOPHYSICIST

SYLVIA GRACE NASSAKA
PRINCIPAL DOCUMENT OFFICER

MS. AGNES ALABA
ACTING DIRECTOR DGSM AND COMMISSIONER MINES

GODFREY BAHATI
COMMISSIONER/ GRD

ENG. JOSEPH OKEDI
ASST. COMMISSIONER MONITORING AND INSPECTION

VINCENT KEDI
ASST. COMMISSIONER LICENSING AND ADMINISTRATION

GRACE NASSUNA
ASST. COMMISSIONER GEOSCIENCE

VINCENT KATO
ASST. COMMISSIONER GEOLOGY AND GEOCHEMISTY

CHRIS RUDIGIZAH
PRINCIPAL INSPECTOR OF MINES

EDWARD ISABIRYE
PRINCIPAL GEOLOGIST

The Birth and Continuing Journey of Geological Survey in Uganda

Henry Ngada, Assistant Commissioner /GEODATA

The Geological Survey Department was formed towards the end of World War 1 (1914-1918) when plenty of resources were spent and there was still demand for minerals necessary to manufacture ammunitions of war. So, under the British Ministry of Munitions, all British colonies were tasked to explore for minerals on demand.

By Henry Ngada

The geological survey team occupied the office structure that previously hosted the Department Headquarters and a simple laboratory which was inherited from the British team and field staff (geological and mineral surveys and prospecting).

Pioneer staff during the inauguration included the Director, Mr. Edward James Wayland, who was appointed in August 1918 and he arrived on 12th January 1919 via the Cape. Mr. W. C Simmons was appointed as the Assistant Geologist and arrived on 25th March 1919. In collaboration with the lands office, Mr. C. Bloomfield was called upon to assist the Department by carrying out the duties of the clerk while efforts to hire a reliable clerk were ongoing. A permanent clerk for the Department was recruited on 3rd September 1919.

At that time, the headquarters of the Geological Department for British East Africa were in Nairobi, Kenya. So, all resources like books and instruments were acquired from there. The challenges faced during collection of these items (travel time and delays in research work) led to the birth of the Geological Library in Entebbe and this started off with 250 volumes of geological books. A number of items like two force pumps and a pair of boring rigs were also sent for to be used for laboratory work and field work.

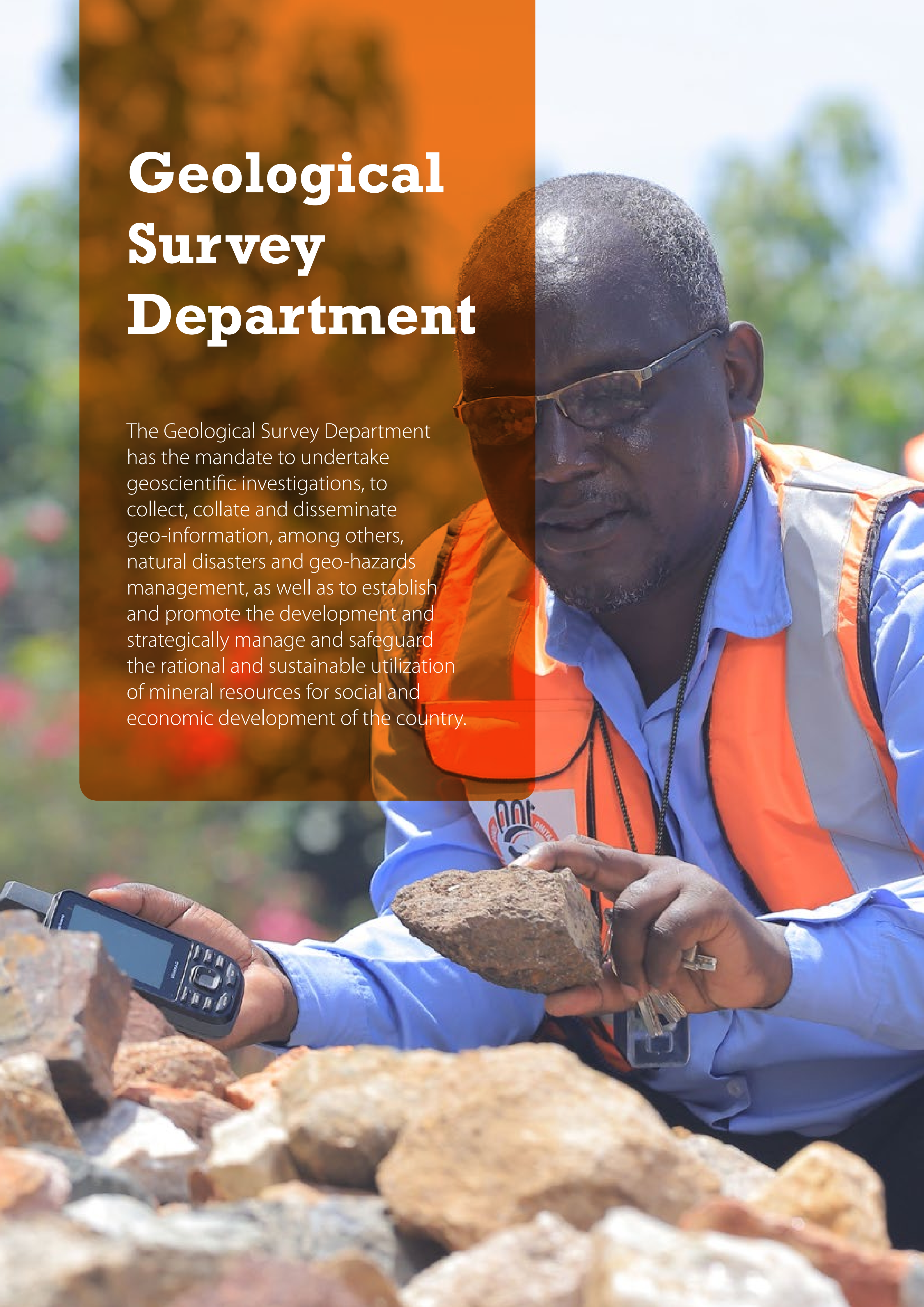
Initially, the mandate of the Geological Department was to explore and exploit all natural resources in the Uganda. These included solid minerals (beryl, phosphates, iron and so on), oil and gas. The mineral exploration methodology applied was triangulation on areas reported to have valuable minerals. With time, the search for clean water supply became another priority to reduce on diseases and later the need to monitor earthquakes and landslides was also considered important to the country.

Today, the DGSM has upgraded, using modern tools that enable the discovery of more resources. These include GPS, portable XRF, compass, GEM systems magnetometers, Scintrex gravimeters and IRIS resistivity equipment, to mention but a few.

The DGSM's roles and responsibilities were also expanded to include issuance of mineral rights and inspection of all mining operations in the country, a role that was initially handled by Ministry of Finance.

For efficiency, the role of siting boreholes was moved to Ministry of Water and Environment, while the role of petroleum exploration and production was moved to an independent Directorate within the Ministry of Energy and Mineral Development called the Directorate of Petroleum.

As we celebrate 100 years of existence, we specially celebrate our contribution to the country by discovering natural resources that have greatly boosted the economy of Uganda like gold, limestone, oil and gas, geothermal energy and clean water.



Geological Survey Department

The Geological Survey Department has the mandate to undertake geoscientific investigations, to collect, collate and disseminate geo-information, among others, natural disasters and geo-hazards management, as well as to establish and promote the development and strategically manage and safeguard the rational and sustainable utilization of mineral resources for social and economic development of the country.

Charting Uganda's earthquake activity during the past century

By Dr. Fred Alex Tugume (PhD)

Occasionally, in certain parts of the country, the ground will rumble and move and may cause cracks in walls, buildings to sway slightly and in worst cases kill people. This is as a result of earthquakes.

Dr. Fred Alex Tugume (PhD) Assistant Commissioner-Geophysics and Seismology Division - DGSM

Earthquakes are a result of release of energy in the earth's lithosphere in forms of waves. Earthquakes in Uganda are associated to the East African Rift System (EARS) where Uganda is directly in contact with the Western arm of the EARS hence making Rwenzori mountain, Katonga fault and Aswa shear zone prone to earthquakes. Earthquakes are measured in magnitudes using a seismometer. A magnitude of 3 and below is a low scale while a magnitude of 7 and above is considered as destrustive to communities.

Earthquake monitoring activities in Uganda started nearly a century ago, specifically in October 1925, with the installation of Milne-Shaw seismograph equipment at a station in the confines of the Geological Survey offices at Entebbe under the then Protectorate government. However, the station had to be closed down in January 1932, due to a shortage of staff to run it.
Recording and monitoring activities then resumed in April 1933 when the British East Africa Meteorological Department took over the responsibility. Two years after independence, the Geological Survey of Uganda repossessed the station, but the Department continued to provide the services of a technician.

Unfortunately, in 1976, the seismograph equipment developed a fault which was not rectified and ultimately it was destroyed during the widespread looting that followed the 1979 Liberation War bringing the earthquake recording and monitoring to a standstill.

Sometime in 1985, the Government, through the Department of Geological Survey and Mines (DGSM), proposed the revival of earthquake monitoring. Although the idea was well received and accepted in principle, funds were not available for its implementation until 1989.

With the help of UNESCO and the International Program in the Physical Sciences (IPPS), DGSM received a donation of US$40,000 to purchase four seismographs/stations. The donation enabled the Geological Department to revive the Uganda National Seismological Network.

IPPS also started providing support to the Network in terms of training technicians, scientists and the purchase of spare parts to ensure maintenance of the equipment.

In 1991, three MEQ 800 analogue stations were installed at Kilembe, Hoima and Entebbe. Four years later, a broadband digital station was purchased and installed at Dundu with assistance from the Norwegian Seismic Array (NORSAR).

Then in 1995, Uganda, represented by the then Ministry of Natural Resources, signed an MoU with University of California San Diego (UCSD), USA (IRIS-IDA Project) to establish a Global Seismographic Station (GSN) (MBAR) at Kyahi Forest, near Mbarara town. The MBAR station was commissioned in October 1999.

In 2002, the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) earmarked and upgraded the MBAR GSN station to International Monitoring System (IMS) standards of the CTBTO to serve as an auxiliary seismic station (AS103, MBAR) to the CTBTO-IMS monitoring network. MBAR is now a fully certified IMS auxiliary seismic station.

In 2011, through SMMRP/CBP co-founded by the Government in a five-year program, seven REFTEK (RT130) stations were acquired and used to further upgrade the local seismic network and temporary field deployments. In 2016, a new station was installed at Nakawuka (NAK). Currently we have five permanent stations located at Entebbe, Nakawuka, Hoima, Kilembe and Mbarara.

The statistics of earthquakes frequencies in Uganda show that Uganda has registered over 1,000 earthquake events between 1977 to date and these are summarized in the map below. With the highest magnitude being 6.5 a Richter scale and these are within the Western EARS.

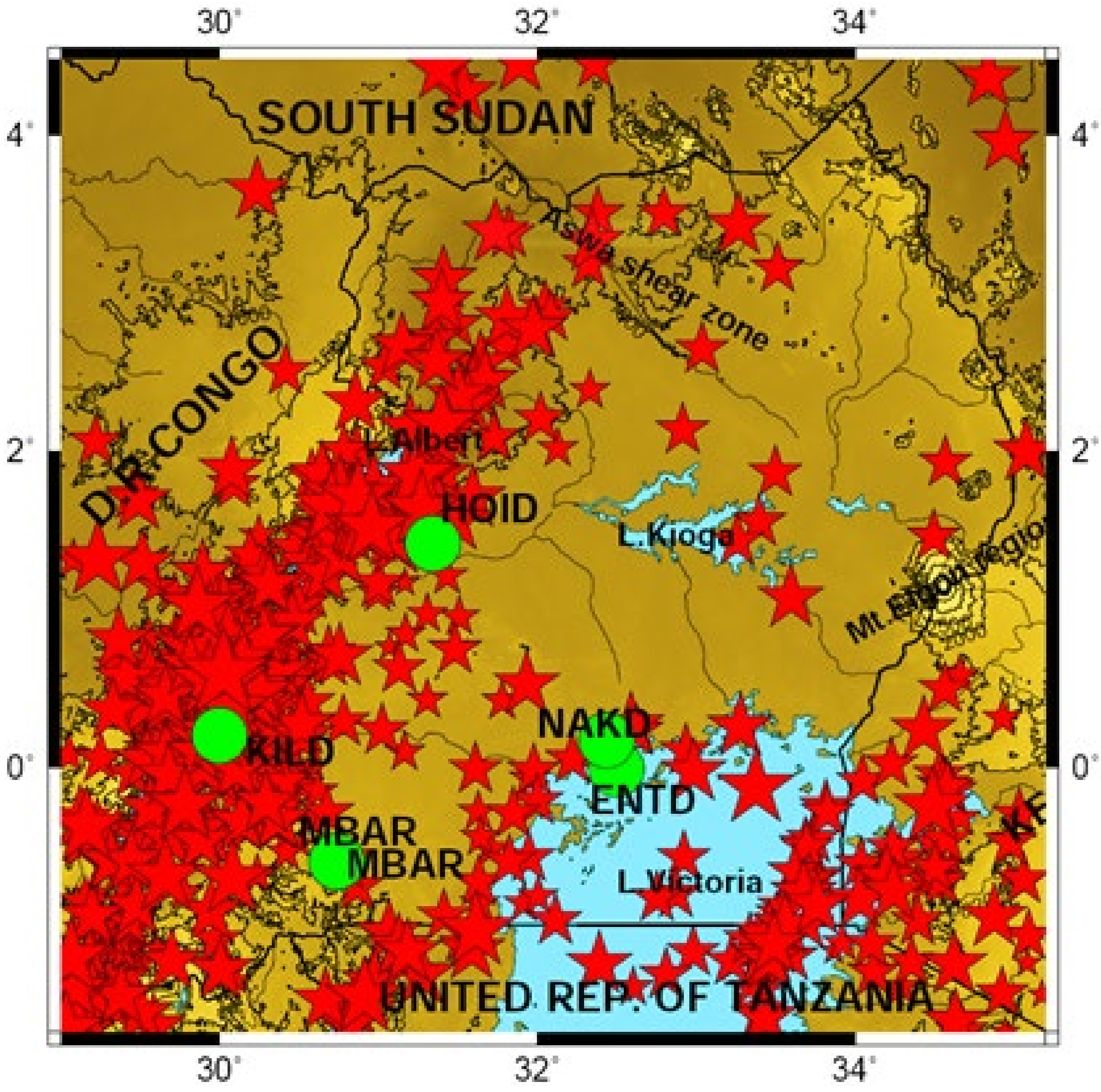


Figure 8: Seismicity Map of Uganda and the Surrounding Region for the Period 1970 to 2021

Insight into Uganda's Strategic Minerals


Gabriel Data, Assistant Commissioner- Geology

By Gabriel Data

Strategic minerals are those that are essential components of energy needs; national security/defence; health safety; development of infrastructure, agriculture and technology; and have potential to create jobs and promote local content by securing our manufacturing industry and revitalizing the local economy.

Not long ago, the government put in place the Mining and Mineral Policy, 2018 with the main goal of developing the mining industry through increased investment, value-addition, national participation and revenue generation to contribute significantly to socioeconomic transformation and poverty eradication.

Core policy areas of priority include promotion of value-addition and identifying strategic minerals that are critical for socio-economic development of the country.

The new policy strategy emphasizes the optimization of value-addition along the value chain from production to processing of semi-finished, and finished products in Uganda. In order for this to succeed, the mining code is being revised to clearly define and set standards of grades of mineral ores in respect to mineral processing of ores while addressing constraints to value addition.

This policy takes into consideration categorization of mineral resources being critical in forecasting the future availability and this enables the government to make a rational decision on the prioritisation of certain mineral commodities for domestic beneficiation and value addition while those commodities that cannot be fully beneficiated could be exported as at prescribed grades.

The two factors considered in designating strategic minerals are: (a) the critical nature of their uses and (b) the availability for domestic supply that is often limited and subject to disruption.

Situational analysis
Uganda has a variety of minerals broadly categorized as precious, metallic and industrial. These natural resources have not been largely developed due to limited exploration and, therefore, inadequate knowledge of their reserves. However, over the years, some have been mined by artisans, raising questions about the economic quantities for industrial and commercial development.

Uganda is a developing country with huge infrastructure development projects that use mineral products often imported, leaving our local mineral ores underdeveloped. For example, the construction of power dams, bridges, railway lines, oil and gas pipelines, houses and automobiles use products from iron ores, copper, limestone, marble, pozzolana, gypsum and kaolin, among others.

Being an agricultural country with a rapidly growing population, the practice of maximizing agricultural production per unit area of land is becoming important. Locally available fertilizer minerals such as phosphates, limestone and vermiculite have become critical, given their demands and restricted reserves.

One of the reasons for limited industrial development in Uganda has been the inadequate energy use by the manufacturing sector. The government undertakes to explore, develop and utilize the uranium potential to upscale the energy mix and increase the power generation for peaceful purposes. Uranium as a radioactive element is also used in the health sector to treat critical sicknesses.

In line with the Sustainable Development Goals (SDGs) and the National Development Plan (NDPIII), Uganda has an obligation to meet set targets. The low GDP per capita ($770.062 as of December, 2019, according to IMF), the high percentage of Ugandans living below the poverty line (21.4% in 2018 - UBOS) and the high level of unemployment have become a huge concern which requires all sectors to contribute to the improvement of the status quo.

The mineral sector has great potential to create decent employment opportunities and improve the wellbeing of Ugandans. This can be achieved through promotion of in-country value addition and participation of Ugandans throughout the value chain.
Therefore, minerals that are available in Uganda but in short or restricted supply globally; and can easily be processed in finished products or high grades and are also on demand due to political situations or technological innovations, become strategic.
Such minerals are uranium, battery minerals, cobalt, nickel, graphite and the 3Ts.

Strategic minerals in Uganda
Limestone, marble and pozzolana are critical in infrastructure development. They have proven to be the most successful examples of minerals that undergo full beneficiation in Uganda and are locally processed to final products such as cement. Hima Cement Limited and Tororo Cement Limited have benefitted from an enabling environment to successfully develop heavy industrial plants for cement production that has met local demand as well as being exported within the region. Limestone occurs in Muhokya and Hima in Kasese (14.5 tonnes), Dura in Kamwenge (11.6 Mt) and Sukulu in Tororo. Marble occurs in Moroto district (higher than 600 tonnes).

Iron ore can be processed into iron and steel products for the country's much-needed and most-imported products for infrastructure development. The process requires a reductant and also availability of high thermal energy resources.

The most widely used reductant is coking coal which is not available in Uganda. The nearest available coking coal resources to Uganda are in South Africa and Mozambique.

Feasibility studies on development of iron and steel industry in Uganda conducted under European Union funding concluded that the economic viability of the iron ore processing is dependent on the proven quantity of the iron ore reserves which is currently about 300 tonnes of hematite in southwestern Uganda and 111 tonnes of magnetite in eastern Uganda.
The study recommended detailed exploration and evaluation of iron ore resources of Uganda. It noted the lack of a cost-effective railway network that is likely to impact on its commercial viability. The alternative for processing of iron ores is to use natural gas which could be sourced from Tanzania or Rwanda as a reductant. However, a feasibility study is to be undertaken to establish the efficiency of this option as a reducing agent.

Domestic production of steel will be an additional advantage towards manufacturing of automobiles in the country.

Uranium, as a strategic mineral, provides the opportunity of incorporating nuclear power within the energy mix. But this involves unique technology with unique requirements such as developing the

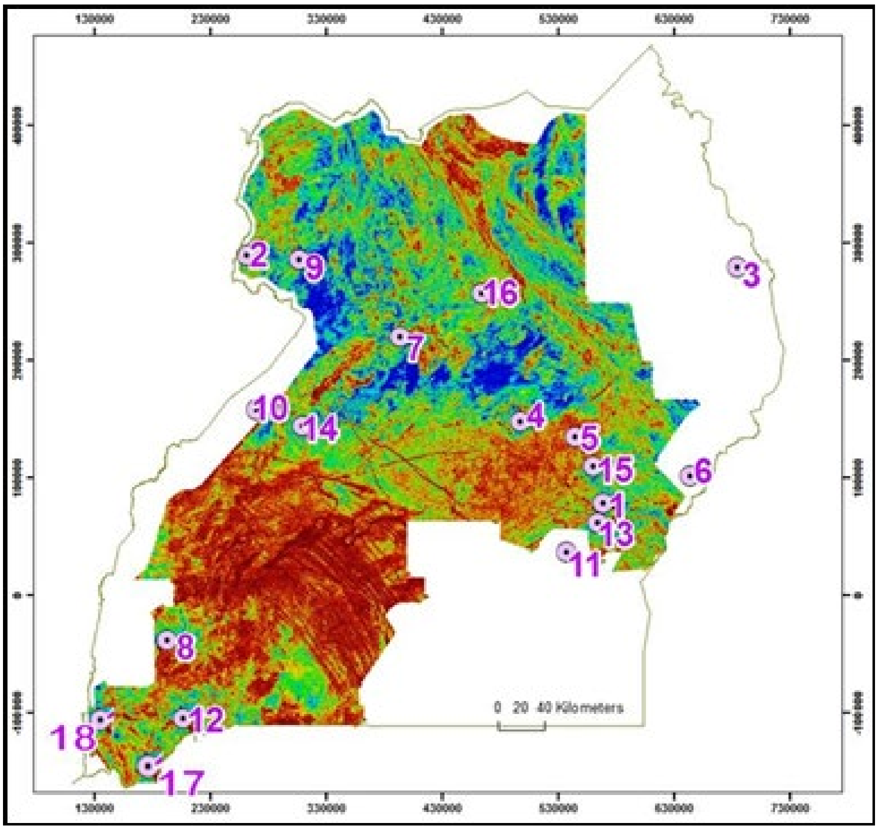


Figure 9 : The new mineral potential targets generated during SMMRP.

relevant expertise for the whole value chain. It requires putting in place an appropriate legal and regulatory framework and ensuring the highest standards of safety, security and other safeguards. The building of a nuclear power plant is very expensive and once in place, the whole nuclear fuel cycle has challenges such as high operational and waste management costs.

Currently, the government, with the help of International Atomic Energy Agency (IAEA), is undertaking capacity building in interpretation of radiometric data of Uganda. This is to generate targets for ground follow-up. Notable targets followed include Ndale in Fort Portal, Lwensakala and Boma in Sembabule and Karata in Buhweju.

Phosphate derives its importance as a fertilizer mineral for use in agricultural production. It is usually found with other strategic minerals such as magnetite (iron mineral), uranium and rare earth elements within the carbonatite complexes in eastern Uganda. The processing of apatite, the ore of phosphate, was undertaken in the past to produce single superphosphate fertilizer.

However, currently Guangzhou Dong Song Energy Group (Uganda) Ltd is planning to develop the Sukulu Phosphate Comprehensive Project that will produce 300,000 tonnes of superphosphate per annum; 200,000 tonnes of sulphuric acid per annum; and 300,000 tonnes of iron and steel products per annum.

With additional mineral exploration on other carbonatite areas in the country, it is anticipated that other deposits of similar ores will be identified and quantified and comprehensive beneficiation through the whole value chain shall be undertaken. The steel produced shall support the manufacturing process of automobiles in future.

Vermiculite is another fertilizer mineral that has attracted investment for its exploration and development. The quality of Uganda's vermiculite is among the best in the world. Beneficiation of vermiculite has been undertaken in Uganda where its quality is improved from mine grades of about 30% to 40% to a product grade of at least 90% and is shipped to international markets. Vermiculite reserves at Namekhara in eastern Uganda alone are 54.9 tonnes. Sensitization on use as soil conditioner in agriculture and floriculture, which are important sectors of Uganda's economy, will make it a strategic natural resource.

> "Core policy areas of priority include promotion of value-addition and identifying strategic minerals that are critical for socio-economic development of the country.

Copper is the only metal to have been mined in the past and processed through the value chain, from concentrate (20-30% Cu) to blister copper (95% Cu) prior to export for refining and fabrication of final products such as copper wires. Uganda was able to beneficiate the copper locally owing to the existence of the railway line which transported copper concentrate from Kasese to the smelting plant in Jinja, close to the Owen Falls dam power source.

The re-development of Kilembe Mines is aimed at extensive exploration and establishment of additional quantities (reserves) of copper to justify setting up beneficiation and smelting investments to produce copper wires as final products. The wires are a vital input for automobiles. Copper can also be used in the manufacture of firearm bullets for national security.

Battery minerals (cobalt, graphite, lead, manganese, lithium, beryl) are minerals that are used in the manufacture of batteries. These will soon be in demand for automobiles following the current global trend. Battery manufacturing is simple and not capital-intensive; investors can be attracted to develop the industry and produce car batteries within Uganda.

This will contribute to industrialization and result in job creation and more revenue. Cobalt ore occurs at Kilembe, Kasese (5.5 tonnes at 0.17% Co) and will be beneficiated together with copper; graphite occurs at Orom, Kitgum (1.7 billion tonnes); lead is found in Kampono and Kitaka in Kamwenge district (under exploration); manganese ores occur at Isandara, Kirongo, Kisinga and Gweitengya in Kyenjojo district (not evaluated); lithium is found at Ruhuma in Kabale district; Mwerasandu, Rwamwire and Nyabushenyi in Ntungamo district; Lunya in Mukono district; Nampeyo and Mbale Estate in Mubende district (not evaluated).

Rare earth elements (REEs) are essential for electronics and have found use in high-tech applications and automobiles. Geographically, it is restricted to China which is the biggest producer and having the advanced technology to process and utilize the REEs. There is need to discover and develop REE resources in other parts of the world in order to survive China's monopoly. World-class deposits have been discovered in Uganda and occur in the aluminous clays at Makuutu, Bugweri district (one billion tonnes at 23% REE and 27% alumina) and the carbonatite centers of eastern Uganda (73.6 million tonnes of rare earth elements estimated at Sukulu alone with grade of 0.32% La_2O_5).

Depending on the prevailing factors of critical uses, demand and availability of mineral ores, the list of strategic minerals can be revised from time to time. But it is best to pay attention to mineral commodities that have the potential to support industrial development, create employment and spur socio-economic transformation.

Jervois Mining activities in Uganda

Jervois Mining Ltd. ("Jervois") is an Australian publicly listed company focused on the supply of battery metals with an emphasis on cobalt, copper, nickel and related minerals.


An aerial view of parts of the Kilembe Mines in Kasese District - Western Uganda

Jervois' principals have a strong track record in all aspects of exploration, financing, construction, commissioning and operation of mines and downstream beneficiation facilities (smelters, refineries), including across Africa.

Internationally, their projects include development of the Idaho Cobalt project, the only cobalt mine in the United States, the Sao Miguel Paulista Nickel-Cobalt Refinery in Brazil and advanced nickel-cobalt exploration projects in Australia.

Within Uganda, Jervois have been undertaking intensive mineral exploration with the goal of discovering and developing world-class deposits of cobalt and associated metals such as copper and nickel.

To achieve this aim, Jervois has invested heavily in their large Ugandan exploration teams and work on the ground.

To date, this has included (but is not limited to): 3,075 line-km of helicopter airborne geophysical VTEMTM surveys; over 4,960 line-km of ground magnetic surveys; collection and analysis of over 23,000 soil and over 3,200 rock samples collected and assayed, and over 8,600 metres of diamond drilling to date.

As a publicly listed international mining company held to exceptionally high standards, Jervois is proud of their strong commitments to health and safety, environmental stewardship and the development of meaningful and valued relationships with communities and governments.

In response to the global Covid-19 pandemic, Jervois adheres to extremely strict procedures in compliance with its own safety standards, government directives and in response to guidance from the World Health Organization (WHO) and other public health officials.

Jervois Mining Ltd has been intensively exploring in Uganda with the aim of discovering and developing world-class deposits of copper, cobalt and associated minerals.

Jervois' exploration licenses are located in the vicinity of Kilembe Mine and in Central region.

Activities have included extensive geochemical surveys, airborne and ground geophysical surveys and drilling on its exploration licenses. All projects in Uganda are at target drilling stage.

Government Sets Up Modern Mineral Laboratory

By Chris Lubangakene

The Mineral Laboratory at the Directorate of Geological Survey and Mines has been in existence since the establishment of the former Geological Survey and Mines Department in 1919 and has been used to test geological material to determine elemental and mineralogical content. However, there has been a decline in mineral occurrences reported from the laboratories.

Chris Lubangakene, Assistant Commissioner Laboratories

This is as a result of some of the challenges the Directorate faced which range from an inadequate budget, physical infrastructure constraints that took considerable time to resolve, government procurement procedures obscure to most laboratory service providers, and lengthy procurement cycles. This in turn has affected investment decisions made to the sector due to lack of sufficient information to base on to make decisions. In the past, in case there was need to carry out any sample testing, samples were transported and tested from Tanzania, South Africa, Canada and Australia which have ISO accredited mineral testing laboratories hence increasing exploration costs and time taken.

This called for government intervention in revamping the DGSM laboratories to meet international standards. Therefore, commencing in July 2017, Government embarked on upgrading the laboratories at DGSM so as to provide effective and sustainable analytical and mineral beneficiation test services for the mining industry.

This follows a presidential directive which directed that the Geological Survey and Mines Department is equipped with a modern laboratory to test and, therefore, help to quantify the mineral presence in an area and determine its quality, as opposed to depending on mineral prospectors to do it. This is in line with Government's aspirations reflected in Uganda Vision 2040, of effectively exploiting the country's mineral resources and building a strong mining industry, which industry will be the major driver in employment creation and Gross Domestic Product (GDP) growth.

The laboratories at DGSM have been designed into three sections which include the Chemistry and Environment Laboratory, Petrology, Mineralogy and Gemology Laboratory, and Mineral Processing Laboratory. And these have been equipped as required by the ISO/IEC 17025:2017 accreditation. That is;

The analytical chemistry techniques available so far include: titrimetric technique, UV Vis spectrometry, portable X-Ray Fluorescence (XRF) spectrometry, bench-top XRF spectrometry, and Atomic Absorption Spectrometry (AAS). With these techniques, the laboratories can perform analysis of precious metals and geochemical analysis for major elements, whole rock analysis and trace elements.

Arrangements are also being made to have Induced Coupled Plasma Optical Emission Spectrometry (ICP-OES); additional portable XRF spectrometer, particularly for precious metals; Carbon Sulfur Analyzer (CSA); and an Ion Chromatography System (ICS) installed and commissioned before the close of this year. The ICP-OES shall provide capacity for analysis of higher volumes of samples and to much lower detection limits than the available analytical techniques.

Petrological study and mineral and gemstone identification techniques currently available include transmittance and reflective light microscopy, carat balance and hydrostatic balance; whereas an X-Ray Diffractometer (XRD) is to be installed and commissioned before the close of the year. With these capacities, the laboratory shall be able to support the country's geological mapping, as well as mineral prospecting activities.

As for mineral beneficiation test techniques, the Mineral Processing Laboratory currently has capacity to undertake gravity separation test-work using shaking table, mineral jig, spiral concentrator, and enhanced gravity using a Knelson concentrator. The laboratory also has capacity to perform both bench and pilot scale flotation test-work and magnetic separation tests, as well as physical tests such as; specific gravity, pulp density, grind ability using a bond mill, particle size distribution, and uniaxial compression strength.

DGSM is also optimistic that before close of this financial year the Mineral Processing Laboratory will be able to acquire a modern laboratory concentration table and a mineral jig for gravity separation test-work, a hydro cyclone test rig for hydro cyclone bank design, a modern magnetic separator for magnetic separation test-work, a laser diffraction particle size analyzer for particle size distribution tests to nanometer range, and density balance for determination of density of drill core samples and bigger sample sizes. This lot of equipment is to include a modern swing mill/ pulverizer to beef up sample preparation capacity.

From the ongoing interventions, the Laboratories' sample preparation capacity has also greatly been enhanced, such that; it now boasts of brand new bench-top oven and a large-size oven for drying samples; a planetary ball mill with milling pots of agate, zirconium oxide, hard metal tungsten carbide, sintered corundum, and stainless steel which provide for specialist sample preparation minus contamination; rotary sample divider; and a cupellation furnace for a now fully constituted fire assay unit.

To ensure service delivery, DGSM Laboratories staff have also been capacitated to use the newly acquired equipment as well as with modern testing techniques that meet international standards. A Laboratory Management Information System (LMIS) is also under contruction to manage all laboratory test work for records management and also improve service delivery as it shall provide a platform to monitor performance.

Despite a number of challenges faced during this drive, among which is the coronavirus pandemic and subsequent global lockdowns and budget cuts, by closure of this financial year 2020/21 DGSM commits to pursue a modern laboratory on the path to ISO/IEC 17025:2017 accreditation as required by the Mining and Mineral Policy 2018 in order to attract investment, promoting mineral value addition, and supporting national participation and revenue generation and thereby contribute significantly to socio-economic transformation and poverty eradication.

A mineral dresser holds one of the milling pots of the planetary ball mill containing grinding media.

An analyst inserts a sample vial into the UV-Vis Spectrometer prior to taking readings to determine elemental content.

Using Lightning as a Tool for Mineral Exploration

By Dr. Isaiah Tumwikirize (D.Sc)

Our own research at the Directorate of Geological Survey and Mines has shown lightning gives data that are a helpful tool for natural resource exploration.

Dr. Isaiah Tumwikirize (D.Sc), Principal Geophysicist.

Lightning is a sudden release of electricity or an electrostatic discharge between intra-cloud, clouds and clouds to the ground generating thunder and flash-light during storms.

Studies conducted by DGSM showed lightning to be a helpful tool for natural resource exploration. Hence lightning occurrences have a strong correlation to minerals occurrences.

Studies conducted show that areas reporting high incidences of lightning, also give off evidence of mineral presence. For example, clay formations indicate high potassium concentrations in radiometric data. These findings also show that about 80% of the relevant population is highly vulnerable to lightning risk which is attributed to the geological factors and natural resources located beneath them.

Based on ground surveys using induced polarization and magnetics geophysical techniques at three locations where lightning struck schools, the lithological units of rocks observed are arranged in plates as underground capacitors of dolerite dykes bounded by sandy, clays and laterite formation.

This is a new discovery about lightning that can be used to discover exploration hot-spots for minerals and oil and gas deposits.

The initial work started in 2010 by interpreting infra-sound data from the Nairobi Infra-Sound Station where lightning signature was discovered. The finding supported the work and the preparation of research documentation as a proposal in 2015 and field work started in the Financial Year 2016/17.

Empirical electrical conductivity data from fieldwork analysis of dielectric material properties using LCR meters.

The dielectric constant k is defined as the ratio of the capacitance of the material to the capacitance of air, Where Cx = capacitance with a dielectric material and Co = capacitance without material, or vacuum. The k value of dry air is 1.00053, which for most measurement applications is usually close enough to the value of a vacuum, which is 1.0000.

Conclusion

Lightning data supports exploration for natural resources and geological mapping of structures such as dykes and faults, among others. This study shows a correlation of zones with high mineralization to high lightning frequency.

Our findings call for more research work which should be supported by installation of network collection of lightning data and analysis to promote mineral exploration. This is a new finding that has not been realized before.

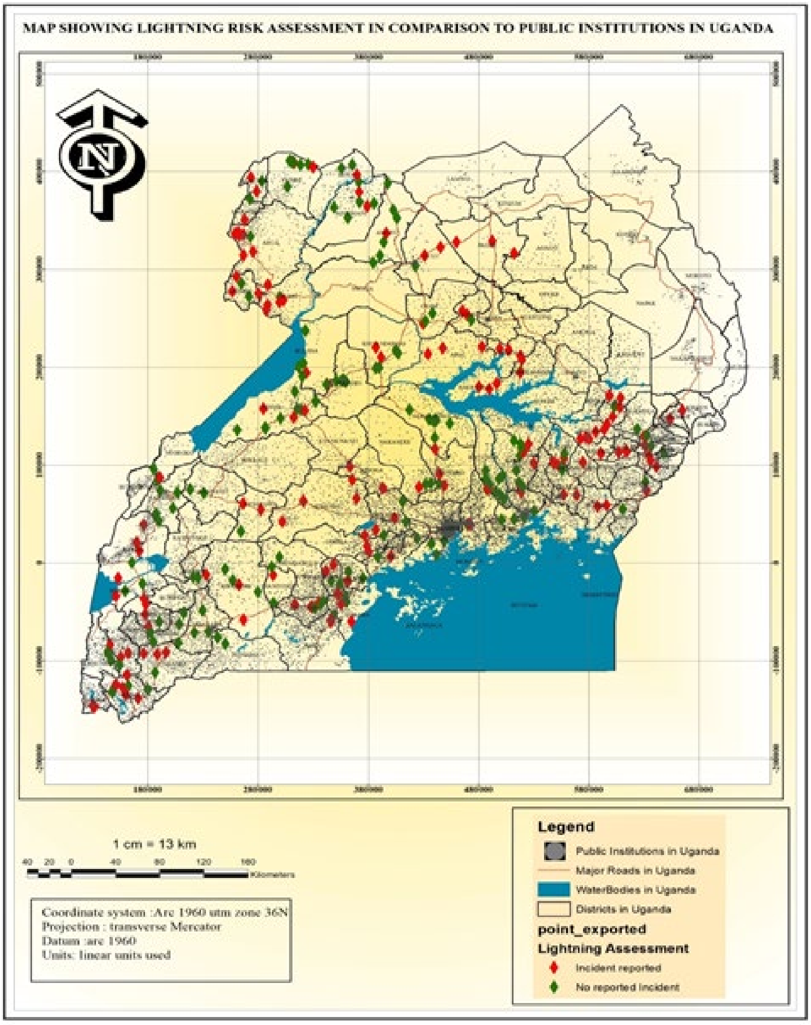


Figure 10: Lightning incident map of Uganda
Source Work in Progress by Tumwikirize et .al 2018)

VSAT Communication at Entebbe National Data Centre.

Uganda's Geology and Mineral Potential

By James Francis Natukunda

The geology of Uganda possesses a wealth of metallic and non-metallic minerals due to its diversified geology. Uganda's geology is dominated by old rocks of up to 3,100 million years old and this is favourable geology for discovery of world-class mineral deposits. The previous and recent geological mapping and exploration studies done during the past 100 years show that the mineralisation in Uganda falls into tectono-thermal domains or building blocks.

James Francis Natukunda, Principal Geologist/Mapping

From various studies conducted in the past century, the geology of Uganda was carried out under different techniques and platforms. The major ones include: the British colonial times, UNDP Development Program, Kilembe Mines Limited, Hunting Survey Ltd, Government of Uganda, SMMRP project and now MWAMID Project.

The first Geology map was compiled in 1967 at a scale of 1: 2,000,000 by the then Principal Geologist Professor McDonald during the reign of the British Geological Survey. And this showed the geology of Uganda in terms of rock types which were classified mostly by age. These included:

The Archaean basement of Uganda (from 3,200 to 2,500 million years)

This is divided into (a) West Nile Block [western segment of the Bomu-Kibalian Shield]; (b) Lake Victoria Terrane; (c) West Tanzania Terrane; and (d) North Uganda Terrane. The West Nile Block hosts gold and asbestos.

The Lake Victoria Terrane is characterized by Archaean greenstone belt and banded iron formations in the southeast of the country and is part of the well-known Lake Victoria goldfield extending from northern Tanzania and southwest Kenya into Uganda. The West Tanzania Terrane has a high potential for granite resources that can be used to make dimension stones and construction materials. The North Uganda Terrane is a host to numerous gold occurrences, nickel, copper, PGM, mica, and graphite.

The Mesoproterozoic rocks (from 1,550 to 950 million years)

These are divided into: (a) rocks of the North Kibaran Belt of southwestern Uganda; and (b) rocks of the Madi-Igisi Belt in northwestern Uganda. The North Kibaran Belt rocks are a major host of iron ore (haematite), tin, tungsten, beryl, columbite, tantalite, lithium, bismuth and kaolin and have potential for nickel and platinum group of elements (PGE) while the Madi-Igisi Belt has potential for iron and kyanite.

The Neoproterozoic rocks (from 900 to 550 million years)

These comprise of: (a) platform rocks of the Malagarasi Supergroup; and (b) rocks in the Karamoja Belt of eastern Uganda and other Pan-African granitoids. These rocks host both metallic and industrial minerals. The metallic minerals include: gold, chromites, magnetite, tantalite, nickel, platinum, copper, zinc, niobium (pyrochlore), vanadium, baddeleyite (zirconium oxide mineral), rare earth elements (REEs), radioactive elements (uranium, thorium), industrial minerals that include marble /limestone, diopside (garnet marble), apatite, asbestos, graphite, muscovite, talc, serpentinite, and a variety of gemstones.

The Phanerozoic rocks (from 540 to 18 million years)

These are divided into lithologies pertaining to: (a) Karoo and (b) East African Rift System (EARS). The crater lakes and sediments in the Rift Valley in western Uganda host a number of evaporites such as salt and gypsum. In west and northwest Uganda, the EARS sediments host bentonite and diatomite clays. Some parts of the EARS sediments host hydrocarbon resources (oil and gas) while some volcanic fields associated with EARS and faults have potential for geothermal energy resources.
The alkaline carbonatite complexes of Eastern Uganda that fall within this age are endowed with iron (magnetite), niobium, rare earth elements, uranium, base metals, phosphates and vermiculite.
Recent geophysical surveys, geological mapping, geochemical surveys and mineral resources assessment under Sustainable Management of Mineral Resources Project (SMMRP) identified new rocks series with new mineral contents. And these were shared on the new Geology map of Uganda.

We are happy to know that Uganda is a mineral-rich country. In the next century, the Directorate plans to embark on the new potential mineral targets that were generated during SMMRP.

These include:
1. Iganga gabbro intrusion with potential for nickel and platinum group of elements (PGE);
2. Zeu area with potential for gold;
3. Moroto area with potential for chromite PGE, marble and gold;
4. Kidera with kimberlite potential, which may host diamonds;
5. Naigobya geophysical anomaly with potential for nickel, chromium, copper, cobalt and rare earth elements (REE);
6. Bukusu carbonatite which hosts limestone, phosphates, iron ore, titanium, vermiculite and REE potential;
7. Masindi–Karuma Falls area with potential for nickel, chromium, PGE and iron;
8. Kitaka–Buhweju area that hosts gold and base metals;
9. Packwach area that hosts diatomite;
10. Kaiso-Tonya that hosts kaolin and bentonite clays;
11. Mayuge area with potential for iron;
12. Kafunzo area with potential for nickel and platinum group of metals (PGE);
13. Makuutu area with potential for REE, aluminium and uranium;
14. Hoima-Kafu area with potential for gold;
15. Kaliro-Ivukula area with potential for gold;
16. Aboke-Aloi area with potential for gold;
17. Buhara- Kabale with potential for iron; and
18. Butogota–Kanungu with potential for iron.

A large part of Uganda remains geologically unexplored and the mineral potential of this area is yet to be evaluated.

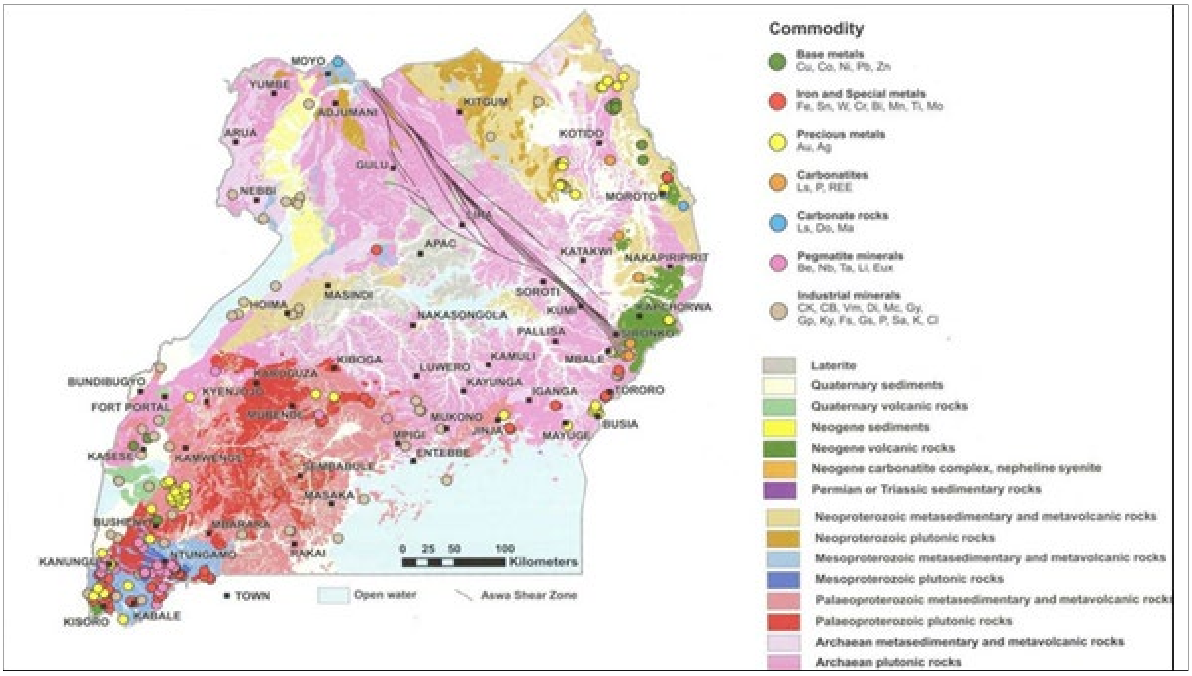


Figure 11: The geology map of Uganda with mineral occurrences.

Exploration and Geotechnical Investigations

By Isa Lugaizi


Isa Lugaizi, Senior Geologist/Mapping

The Directorate of Geological Survey and Mines of Uganda started in 1919 as the Department of Natural Resources. One of its key responsibilities was geological mapping of the country at different scales for resource exploration (minerals, geothermal, water and petroleum), government planning (roads, railways and dams), academic and geohazard management.

Geological mapping is the process of making observations of geology in the field and recording them to generate different types of maps. These include, but not limited to, geological reconnaissance maps, regional geological maps, detailed geological maps and specialized maps (e.g. large-scale maps for research, for economic purposes such as open pit and underground mine plan; and engineering site investigation). Geological mapping has been and will remain as one of the key techniques in the resource exploration and geotechnical investigation undertaken prior to major infrastructure development projects. It requires prior planning (research), data collection and reporting. Some tools and equipment used during geology mapping include; topographic map, compass, GPS, geology hammer, camera, note book and sample bags.

Some of the common geological mapping techniques include field mapping, geochemical mapping, geophysical mapping and geotechnical investigations.

The traditional method of field mapping requires the geologist to have an inquisitive mind and plenty of energy to traverse the identified area. He/she spends hours studying rock sample to describe grain size, colour, texture and also conducting studies on the various structures (for example, folds and faults) of the rocks, in flat terrain, valleys, hills or mountains with an intention to see how these structures influence the mineralisation/existence and shape of natural resources (for example, minerals, geothermal petroleum) viable for both social and economic development, once exploited. Such studies of rocks and their structures are also useful in establishing the degree of slope or mountain stability to mass movement (e.g. land or rockslides) and the strength of the subsurface while undertaking the geo-technical investigations preceding to any infrastructure development projects.

Changes in technology have seen the utilization of modern geological mapping techniques that include on-line ground truthing of rock formations, contacts and structures from processed and interpreted remote sensing imagery on digital image pads while in the field work. This has made it possible to produce more accurate geological maps.

Geochemical mapping involves the collection of soil samples from the land and streams for laboratory analysis to determine the mineral content and distribution of chemical elements in the area being investigated.

Geophysical mapping requires a geophysicist to study the physical aspects of the earth (including gravity, magnetism, electrical and seismic activities) and its atmosphere and apply scientific principles in order to solve problems, which may include location of minerals, geothermal petroleum and gas resources or otherwise. They additionally interpret the data from such physical aspects of the earth to undertake geo-technical investigations prior to infrastructure development projects.

Once all the three techniques are combined, the Directorate of Geological Survey and Mines (DGSM) begins the process of identifying and confirming the existence and locations of different categories of minerals like gold, tin, wolfram, limestone, clay, petroleum and geothermal energy; and offers geotechnical advice to government where to set up infrastructure and geohazards like earthquakes.

Some of our key success stories include:

Geological mapping for dam site on the Victoria Nile near Jinja in 1947, to check the type and strength of the bedrock. This led to the construction of Owen Falls Dam, Uganda's first hydroelectric power plant in 1954, later renamed Nalubaale Power Station. Up until today, the dam continues to generate nearly 180MW of electricity for Uganda and other parts of East Africa.

Since 1950, geological surveys have been done on various map sheets at scales of 1: 50,000 and 1: 10,000 eventually leading to the discovery of 30 minerals located all over Uganda.

As a result, extractive operations started, including Hima Cement, Tororo Cement, Kilembe Mines Limited, Nyabushenyi Beryl Mine, Buyaga Wolfram Mine and the search for crude oil in western Uganda.

Mapping led to the discovery of oil in Uganda in 1919 as stated by E. J Wayland the first Director of the Geological Survey of Uganda.

A geological survey for geothermal energy was first documented in 1890 by Henry Morton Stanley. This triggered more surveys for other potential sites with the major ones being Kibiro, Katwe-Kikorongo, Buranga and Panyimur.

The recent mapping exercise carried out in 2004 to 2012 funded by the World Bank, Nordic Development Bank and the Government of Uganda under the Sustainable Management of Mineral Resources Project (SMMRP) generated updated geological data of Uganda and massively acquired new geological maps at various scales. That is at; 1: 1,000,000 scale, 19 geological maps at 1: 250,000 scale, 74 at 1: 100,000 scale and 52 at 1: 50,000 scale; and high-resolution airborne geophysics data covering 80% of the country

If more funding is made available for geological mapping and exploration exercises, the Directorate of Geological Survey and Mines shall identify more bankable mines for development.

Our plan for the next century is to map for more mineral resources that would be used for local use for boosting industrialisation in the country. As well as explore for minerals termed as "Minerals on Demand" suitable for immediate use in solar power systems, vehicles and homes for social and economic development of the country.

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A team of geologists carrying out mine inspection work at Kikagati, Isingiro District Western Uganda.

Women's Increasing Role in Geosciences

By Annet Tumwine

The Public Service standing orders endorse the right of any qualified gender to serve in any office. However, the specialized work in geosciences attracts more men than women.

Annet Tumwine, Senior Geologist at the Directorate of Geological Survey and Mines.

It has been 100 years since the Department of Geological Survey was first set up at Entebbe. However, we should celebrate something else that is equally important, our pioneer women geoscientists.

In spite of several challenges in a largely male-oriented profession, they have endured and ultimately succeeded. They are an example that deserves to be emulated.

Basically geoscience is the study of the earth and its properties. The geoscientists are required to study, rocks, soils, ground water, atmosphere, energy transitions, natural hazards, mine plans, mining techniques, mineral dressing, petrology and so on. Some of the common professions in geoscience include; Geologist, Geochemist, Geophysicist, Mineral Dresser, Analytical Chemist, Mining Engineer, Environmental scientist, Hydrogeologist and others.

For decades, long before the advocacy for equity and equality, geosciences were a male-domain. On the other hand, women didn't have much interest in pursuing professions that would divert them from their traditional roles as mothers and housewives hence continued to pursue careers in education and nursing. In addition to these, were the numerous barriers a Ugandan girl-child had to overcome if she wanted to complete her studies and compete for jobs with men specifically in the geosciences field.

Fortunately, times have changed for the better. Women now regularly vie with men to join the survey profession. The government of Uganda also took a leading role in advocating for women emancipation by introducing the affirmative action policy at university level allowing more female enrollment to good courses. Internationally, there are more scholarship programs for women, to help them attain the required qualifications needed to apply for such positions as geoscientists.

Here are some of the benefits observed during the time women have been working in geosciences:

Increased earnings:
With more employment opportunities for females in different professions of geoscience, since women are more than males, unemployment burden has been reduced. Today, women are able to contribute to their families' upkeep, which lightens the financial burden on the men.
And since women have proved to be better financial planners (according to several studies), their participation strengthens family growth and wellness.

Improved participation in research:
Female participation in natural resources research is crucial in providing another perspective to relevant issues.

Conducive work environment:
The increased presence of women in a previously male-dominated profession tends to improve the working environment, especially by adding to

competitiveness which tends to raise performance levels.

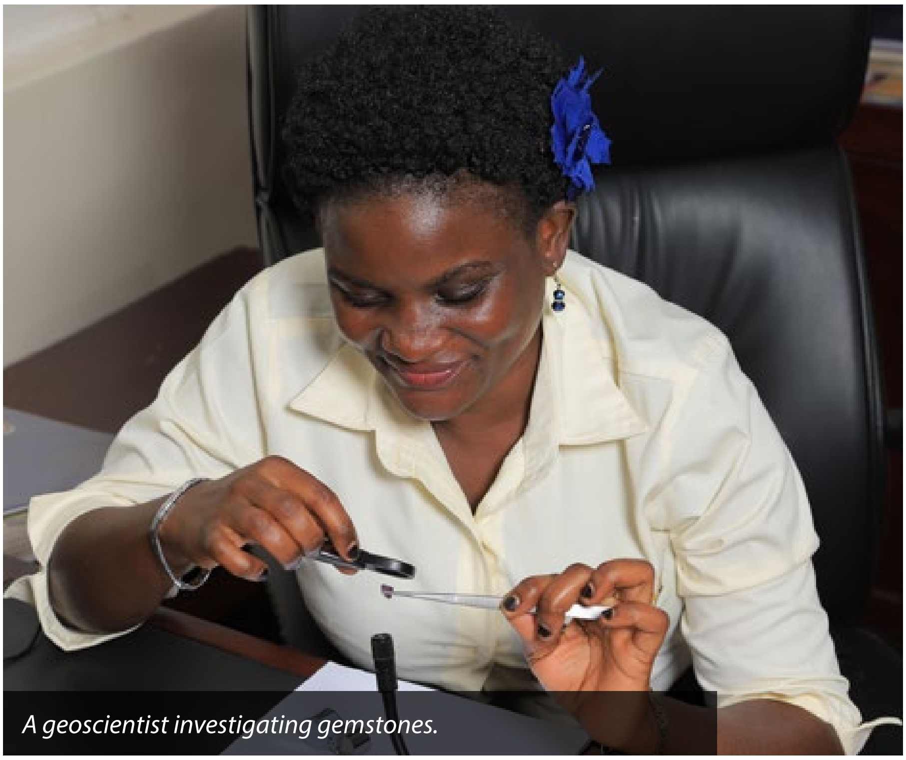
Nonetheless, gender mainstreaming in organizations is often a slow and laborious process. There are still some ways to go for women in fulfilling their aspirations.

The problem of gender-based violence frequently disrupts young girls' education and discourages many from pursuing any professional goal, because it demeans their self-respect. Even for the relatively few females who make it into employment, working conditions can be taxing if one is not prepared for it. For instance, typically, a geoscientist spends much of the time in the field, leaving them with limited time at home with family.


Some of the female geologists at the DGSM, Entebbe.

Also the nature of the job for geoscientists dictates gender to be employed. For example, since Geology has no boundaries, as a geologist, one is forced to climb hills and sloping down into valleys, all in search of mineral potential. You also have to be energetic and quick on your feet in case of sudden encounters with wild animals.

> " Geology has no boundaries and as a geologist, you may find yourself climbing hills and sloping down into valleys, all in search of mineral potential.


A geoscientist investigating gemstones.

Mining engineers are required to go down mines and sometimes you are never sure if it's safe. Mineral analysis requires one to be in contact with chemicals used to purify or test minerals which is also another risk especially for females whose bodies are more prone to health hazards once exposed.

These are just a few of the challenges that have caused some women to think twice before taking a career in the geoscience profession. Some decide to quit but this speaks volumes for the perseverance of those who have stayed.

As we celebrate 100 years of geological survey, it is encouraging to report that presently there are 17 female geoscientists out of 75 and of those 17, the Directorate saw the appointment of its first female commissioner in 2017.

With the continued efforts by the Ugandan government to support gender mainstreaming in the mineral sector, we believe that more female participation in geosciences will increase, especially at top management levels. That is something to look forward to in the next 100 years!

Geophysics Helps Us Understand Subsurface Conditions

By Richard Nelson Birungi

The term 'geophysics' was first used around 1863 and simply put, is the application of the principles of physics to study the Earth and its surroundings or vicinity.

Geophysics is a great tool to estimate resource abundance by way of modeling. None of the metallic and non-metallic minerals, (such as the Sukulu phosphates, oil and gas, gold, vermiculte, tin, iron ore, ground water, etc) that have been discovered in the past 100 years could have been exploited without the input of geophysics. It has many applications including; mineral, oil and gas, geothermal, geotechnical investigations and groundwater prospecting (groundwater contamination studies).

As a distinct science, geophysics entered the foray around the early 19th century, but by the twentieth century, it had started to transmute into a 'new normal' of the Earth sciences. It was the new kid on the block, so to speak, and many people were increasingly curious to find out exactly what it was all about.

It was, in fact, during the World War I period that most geophysical methods were invented and developed. An example is the seismic method which was used by the warring parties to detect enemy submarines and is now widely employed in mineral, oil and gas exploration.
Since then, the field of geophysics has steadily grown both in technology and methodology.

Richard Nelson Birungi, Senior Geophysicist

Geophysics is divided into a variety of components; airborne (within the Earth atmosphere), ground (Earth surface), marine (water) and space-borne (outside Earth's atmosphere).

Airborne and ground geophysics are widely employed for Uganda. In the former, geophysical surveys, measuring equipment were mounted on an aircraft or an Unmanned Aerial Vehicle (UAV) which is flown at a particular height above the ground while taking measurements. This helps to cover very large areas in a short period of time. Ground geophysics is then carried out to ascertain targets or areas that the airborne survey identified as potentially mineralized for further follow-up.

The first airborne geophysical survey in Uganda was done in 1961 by Hunting Surveys Limited with funding from the United Nations Special Fund and the Government of Uganda for selected areas high in mineral occurrences like copper in Kilembe and gold in Busia, Buhweju and Mubende.

These areas were called A, B and C/D. Area D was the northeastern Karamoja where minerals like copper, gold, chromite and pegmatite are occurring. Area C covered the Aswa River with a major structure being the Aswa shear zone. A belt of radioactive rocks has been detected.

Area A and B covered Tooro and Ankole districts to specifically search for sulphides and copper in Kasese. The survey was completed in December 1962. However, another airborne geophysical survey was carried out south of 10 North by Geosurvey International GmbH between 1979 and 1980 on behalf of the Government.

With the advancement in technology of airborne surveys, the government started on a survey which covered 80% (Blocks 1-8) of the country between 2008 and 2009. Fugro Airborne Surveys Pty was contracted to carry out the High-Resolution Airborne Geophysical Survey Programme.
This involved magnetic, radiometric and electromagnetic measurements. Due to security issues prevailing at the time, the Karamoja region was not flown. However, the process of performing another survey is in the pipeline and is expected to start before the end of 2020 and will be completed before the end of 2021.

The commonly used airborne techniques are magnetics, radiometrics, electro-magnetic and gravity. All the airborne techniques have a corresponding ground equivalent method, but not all ground methods have an airborne equivalent.

An example is all methods that require direct contact with the ground, to make measurements like the induced polarization/resistivity method.
This means driving metallic stakes into the ground and transmitting electric current through them to measure the output voltage. We apply this method for example, when prospecting for metallic sulphides which may give an indication of the occurrence of gold.
Today, with the help of airborne geophysical data from the survey flown in 2008, DGSM acquired high-resolution data that led to the discovery of 16 new mineral targets which if explored, may lead to new mines.

"Today, with the help of airborne geophysical data from the survey flown in 2008, DGSM acquired high-resolution data that led to the discovery of 16 new mineral targets which if explored, may lead to new mines.

These include; Iganga gabbro intrusions (Ni-PGE potential), West Nile Arua area stream sediment survey (gold potential), marble resources in Moroto area, Karamoja, potential for kimberlites in Southeastern Uganda, Naigobya geophysical anomaly, Bukusu alkaline-carbonatite complex (limestone, P, Fe, Ti, vermiculite, REE), Masindi Karuma Falls area (Ni, Cr, PGE, Fe potential), Kitaka-Buhweju area (Au potential), diatomite in Pakwach area, Kaiso kaolin and bentonite clays, Mayuge iron ores, Kafunzo, Ntungamo District (Ni potential), Makuutu radiometric anomaly in Iganga (REE, U potential), Hoima area stream sediment survey (gold potential), Kaliro-Ivukula gold in quartz veins, Aboke –Aloi gold potential structures in connection to Aswa shear zone.

Presently, ground geophysical follow-up of these mineral targets is ongoing to cross-check whether future mining is viable. And this is done alongside the drilling, geology and geochemistry activities to give a holistic picture.

What's more is that in this age of Artificial Intelligence (AI), prediction models are being developed by way of neural networks and deep (machine) learning to estimate resources from various data.
Once fully developed, this will save time taken to manually develop models but no model, however appealing, will ever eliminate the need to drill a target. For drilling is the litmus test of whether the model is correct or not.

Our plan in the next century is to acquire more geophysical data from Karamoja region using airborne and ground geophysical surveys. Data from these areas were never collected due to the insecurity that was taking place in 2011.
This would not allow low-flying planes over the area. Xcalibur Geophysical Survey was contracted to collect the airborne geophysical while Patterson & Grantt shall do the data quality control. DGSM shall carry out the ground geophysical surveys.

The Geophysics team and equipment at the Directorate of Geological Survey and Mines, Entebbe - Uganda.

Geosites and Geoparks Raise Uganda's Tourism Profile

The Directorate of Geological Survey and Mines (DGSM) under the Ministry of Energy and Minerals Development (MEMD) supports the promotion of Geosites and Geopark development initiative, among others.

By Molly Kibalama Bakka Male

Molly Kibalama Bakka Male - Geologist.

Geoparks must demonstrate geological heritage of international significance. The main purpose of a Geopark is to explore, develop and celebrate the linkage between geological heritage and all other aspects of the area's natural, cultural and intangible heritage.
Geosites are potential tourism occurrences of one or more elements of geodiversity well geographically delimited and with exceptional scientific value. Other values may also be present. Others are the geodiversity elements such as fossils for tourists and kept in Geological Museums of both the DGSM, and of the Ministry of Tourism, Wildlife and antiquities.

All geologists and related professionals, geoscientists and organisations, have a part to play in protecting this heritage. Geoheritage has contributed to the nation's development and contributes a lot to the country's GDP.

Geotourism is a form of tourism that relates to geological heritage of special value: intrinsic, scientific, educational, functional, economic and aesthetic, amongst other values. The occurrence may be a land formation such as the Rwenzori block mountain or Muhavura volcanic mountains, escarpments, crater lakes, fossils, historical and fossil sites, stalagmites, hot springs, flora, fauna and others.

The International Union of Geological Sciences IUGS had in 1994 got interested in having the Africa Geosites Atlas for purposes of introduction and promotion of Geoscience in Africa. Also, for purposes of understanding the world geoheritage in order to promote tourism, geoeducation and geoconsevation, whose main objective is the conservation and management of geological heritage, as well as geodiversity sites.

The geosites compilation programme started when the Geological Survey and Mines Department was invited by the Organisation of African Geological Surveys (OAGS) to make a contribution towards the African Geosites Atlas.

Uganda, also named "the Pearl of Africa", is endowed with unique sites and was ranked 30th among 52 places to go to in 2020, by *The New York Times Travel Magazine*, an influential reference point.

In 2008, the Directorate of Geological Survey and Mines started on the compilation of Uganda's potential Geosites and other geological sites. The Ministry's MWAMID Project has facilitated a team of geologists in a collaborative effort with stakeholders and communities to document the best of the irreplaceable resource. The activities are in line with the broader goal: promotion of resources, development, production and value Addition (MTEF 30503).

The identified potential sites that should be gazzeted and developed for geotourism include:

- Nyero Rock Shelter and Paintings of Teso
- Napak Volcano in Karamoja
- Bukwa Fossil Sites
- Nkondo-Kaiso Fossil Site in western Uganda
- Kisegi-Nyabusozi Fossil Site
- Nyakasura Caves with the breast-shaped stalactites and stalagmites (locally known as Amabeere ga Nyinamwiru).

Amabeere Ga Nyinamwiru: Limestone caves in Fort Portal - Western Uganda.

- Kibiro Hotsprings with travertine and sulphurous fumes
- Mt. Elgon
- Sipi Falls
- Tororo Rock
- Murchison Falls
- Lake Katwe
- Nsongezi rock shelter

Lake Bunyonyi and Lake Mutanda in South Western Uganda were formed after a lava flow was dammed across the river valley.

DGSM was assisted by the Geological Survey of Finland (GTK) to update the first preliminary map of Geosites in Uganda that was made by the team.

This map was shared in a poster at the GIS conference in Kampala in 2009 and at the First International Conference on African and Arabian Geoparks in November 2011, in Morocco and many more.

Today, at various international conferences, we see some of the known Ugandan sites displayed in posters; complete with descriptive documentation and their current status. This has created awareness to other societies around the world.

> "As we continue to improve Uganda's tourism profile, there is need to continue to preserve the country's gazetted sites.

The paper titled 'Appraisal of the Nyakasura Cave and Waterfall Geosite' was published in the *American Journal of Environmental Sciences* and can be googled.

The Directorate of Geological Survey and Mines team continues to identify more potential geological sites all over the country. In a recently concluded GPS tracking effort to demarcate the Tooro Region scenic area, a potential Western Region Geopark was proposed by the team.

The features therein include Tooro Caldera area, the beautiful crater lakes of the Tooro-Ndale area, the Rwenzori ranges, the Kitagata warm springs and the western Rift Valley.

Other attractions include the Kyambura Gorge, the Katwe Salt Lake and Lake Bunyonyi, while further south we come across the Kabale-Kisoro terraced mountains, Kisiizi Waterfalls, and the Muhavura extinct volcano.

There has been exposure and study trips to several GGN geoparks in Europe, Australia and China by our teams over the years.

Uganda's tourism profile will further improve with the development of Geoparks and gazzeting of Geosites for the added aspect of Geotourism.

The team proposes four Geoparks developed following the four regions starting with the Western Region Geopark. There is still need to create awareness to the public through the introduction and education on Geoparks and related concepts.

The Geoparks and Geosites development is possible but requires funding, human resource, skills and expertise. The way forward includes writing well-packaged proposals from the related ministries, request for funding and any other support from international organizations such as UNESCO in order to develop the Geoparks.

Lake Bunyonyi: Kabale, South Western Uganda

Geological Museum Undergoes Phased Revamp

By Fred Kigereigu

The Geological Museum which is located at the Directorate of Geological Survey and Mines (DGSM) in Entebbe was first set up in the 1930s to provide a well-preserved illustration of Uganda's geological environment and mineral potential in addition to actual pieces on display that help profile the country's strata.

Fred Kigereigu, Senior Geologist/Petrology

The museum hosts mineral specimens, rock samples and the by-products derived from several minerals and rocks found in Uganda.

And a prototype design of the structures of Uganda which include mountains, valleys, folds and faults. It is unfortunate that a considerable part of the specimens were looted in the aftermath of the 1979 and 1985 wars that marked changes of government in Uganda. Until about 1999, a combination of these chaotic events and the dilapidated structure housing the museum caused constant difficulties in conservation before funds were found to pay for a drastic rejuvenation programme.

With the help of well-wishers and staff participation in revamping the museum by donating numerous specimens collected from within and outside Uganda, the museum was restocked.

Visitors are able to view mineral samples, rock samples, fossils and other natural elements reflective of Uganda's geological history. Our major visitors are mostly schools for education purposes, and investors.

Our biggest challenge today is the uncontrolled access to the museum which puts the specimens at risk of theft and damage yet replacing them is difficult. Hence there is need to have more security measures installed in the museum.

On our next agenda, we plan to setup a modernized museum structure with a digital database which hopefully will serve to increase public awareness and promote greater private sector participation in Uganda's mineral sector and also increase investment across the board.

The conceptual design and implementation strategy for a modern geological museum shall involve, among other activities, carrying out an inventory of the mineral specimens on display and defining clearly their different categories.

Modernizing the museum will take time, but the commitment behind this move reflects the growing interest and appreciation in Uganda's geological heritage.

Humble Minerals that Sustain Uganda's Economic Growth

People will forever be chasing after gold and dream of becoming rich, but a humble category of minerals called development minerals (low-value minerals) holds a far greater importance to Uganda's economy. For one thing, so many of those things we use in our daily lives, at home, the office and in our industries, are as a result of exploiting Uganda's rich deposits of these vital minerals, writes **Naomi Nangoku.**

As we celebrate 100 years of the existence of the mining sector in Uganda, it's imperative to also celebrate the contribution of development minerals to the Ugandan economy. So many of the things we use in our daily lives, at home, in the office and in our industries, are as a result of exploiting Uganda's rich deposits of these low-value minerals for construction, manufacturing and agriculture.

Development minerals are minerals that have been earmarked as minerals of low values yet contribute highly to social development. These minerals are classified into four categories; (1) construction materials; clay, sand, limestone, gravel, aggregates, (2) semi-precious stones: opal, grant, tourmaline, beryl, agate, amethyst, citrine, (3) industrial minerals; gypsum, salt, bentonite, graphite and (4) dimension stones; marble, granite, slate, sandstone, to mention just a few.

These minerals have greatly contributed to social, economic and human development of Uganda in terms of job creation since they are easily mined, contribute to revenues and community development. Ugandans have now upgraded from mud to brick houses, more people have acquired skills of making decoration pots and stones.

In 2018, a Baseline Assessment and Value Chain Analysis of Development Minerals in Uganda study report carried out by Levin Resources under the ACP-EU Development Minerals Programme implemented by the Ministry of Energy and Mineral Development in partnership with UNDP reported the contribution of development minerals.

Naomi Nangoku, Senior Mineral Dresser

This subsector predominately involves artisanal and small-scale miners (ASMs) and provides a crucial source of livelihood for over 390,000 Ugandans. Most are disenfranchised, low-skilled workers with limited alternatives. The majority are also engaged and invest in other economic activities, thus further supporting economic diversification.

Once the government organizes and regulates the production of these minerals, Uganda's GDP is expected to increase by 1.4% which amounts to an estimated US $350 million per annum. Currently of the VAT generated from the average household consumption patterns in Uganda, miners contribute an estimated US $9.9 million per annum to VAT (equating to almost 2% of VAT collected in 2016). And the miners' incomes are estimated to annually contribute almost US $124 million spent into local economies, towards education, health care and other family needs and as investment in diversifying economic activities, for instance in agriculture and trade. This is a vital catalyst for local economic development.

Given these statistics, this sector can no longer remain neglected since it's one of the driving forces to infrastructure development. It's with this background in mind, that the revised mineral policy of Uganda accommodated these minerals which were once excluded from the Mining Act.
The government has earmarked them as key inputs to achieving

DGSM geologists on an inspection, are shown marble cut and polished into slabs at the Sunbelt processing facility in Moroto District, Karamoja

the NDP III development goal of transforming Uganda from a resource-based country to an industrialized state. Think of toothpaste which is a fast-moving consumer product, but basically a combination of several development minerals during manufacturing, ceramic ware (cups and plates) and all other items that can be manufactured from our natural resources. We are fortunate because Uganda is well endowed with all these minerals, hence can sustain the market locally without importing from around the world.

The African Guarantee Facility for SMEs (AGF), in partnership with the ACP-EU Development Minerals Programme, has committed a $12 million credit guarantee, being disbursed through private financial institutions as loans to SMEs.

Some of the equipment at the Guangzhou Dong Song Phosphate Fertilizer Manufacturing Plant in Tororo District - Eastern Uganda

From Analogue to an Integrated Information System

By Sylvia Grace Nassaka

Sylvia Grace Nassaka, Principal Documentation Officer

In the beginning when the Department of Geological Survey was formed, the authorities never felt the need to have a library section in Uganda. Hence the whole of East Africa shared one library that was located in Kenya at the joint headquarters for the British East Africa. Geologists would borrow books which would be moved to Uganda, this was complicated because of time spent in transit, since delivery of borrowed items took a while to get to the readers.

From this, a small library section that used card catalogue, classified under the headings of authors and subjects was started in Uganda in 1929 with only 252 documents. The library was also in charge of storing the Geological Survey Department staff field reports and also coordinating the publishing of these reports at the printing press in London.

An information management system involves the capture, processing, storage and dissemination of information to inquirers. And this is a continuous cycle.

The first local report, apart from the Annual Report 1919, was Outlines of the Geology of Uganda by E.J. Wayland in 1920. With time, more reports were published from different field investigations on minerals, water and geohazards.

Unfortunately, after the British rule, the new leadership paid little attention to the library but with efforts in the 90s, a new Documentation Centre was revived by the then Documentation Officer called Mr. John Odida, who with the help of France, managed to classify all the existing library reports and developed a manual bibliography that was used as a library location index.

However, with the advancement in technology, the Library was transitioned into a digital library in 2011, during the Sustainable Management of Mineral Resources Project (SMMRP). The computerised library increased efficiency in service delivery and also allowed staff to capture library stock without duplicating and also allowed users to access the library both on-site and off-site using the Internet.

The digital library operated using the Unpublished Document Information System (UDIS) for unpublished reports and LIBERO system for other library stock. The system worked, but was challenged by costly maintenance. DGSM had to pay an annual subscription fee for LIBERO but soon found this unaffordable and the license expired, hence the system failed.

Also, since DGSM had many information systems for different departments developed by different service providers. The various systems couldn't communicate. That is; apart from the Library Information System, the Mining Cadastre System (flexicadastre system) was used in the Mines Department to manage licensing and mineral occurrences in Uganda; the Laboratory Information System used was being set to capture data on samples analyzed, the Geology and Mineral Information System used to capture data on geology, geochemistry and geophysics activities carried out; the geothermal database was also planned for geothermal data and the Electronic Records Management System (ERMS) used for file movement.

An ultra modern digital production printer at the DGSM document centre.

The Library Information System didn't have access to these other databases since they were all operated with different software by different service providers. Users were required to login and out of one system before accessing another. Hence the need for an integrated information system. It's from this background that in 2019, under the Mineral Wealth and Mineral Infrastructural Development (MWAMID) Project, the Documentation Centre acquired an integrated information system, a one-stop information platform that allows users to have comprehensive access to all the information in DGSM without noticing the different information systems. This system is called the new GMIS (Geology and Mineral Information System).

The new GMIS is multi-user and an interactive web-based system that provides users a platform to view all information systems in the DGSM and also allows users to query the system. It was built using Beak Advangeo software operating on ArcGIS and the Microsoft SQL server.

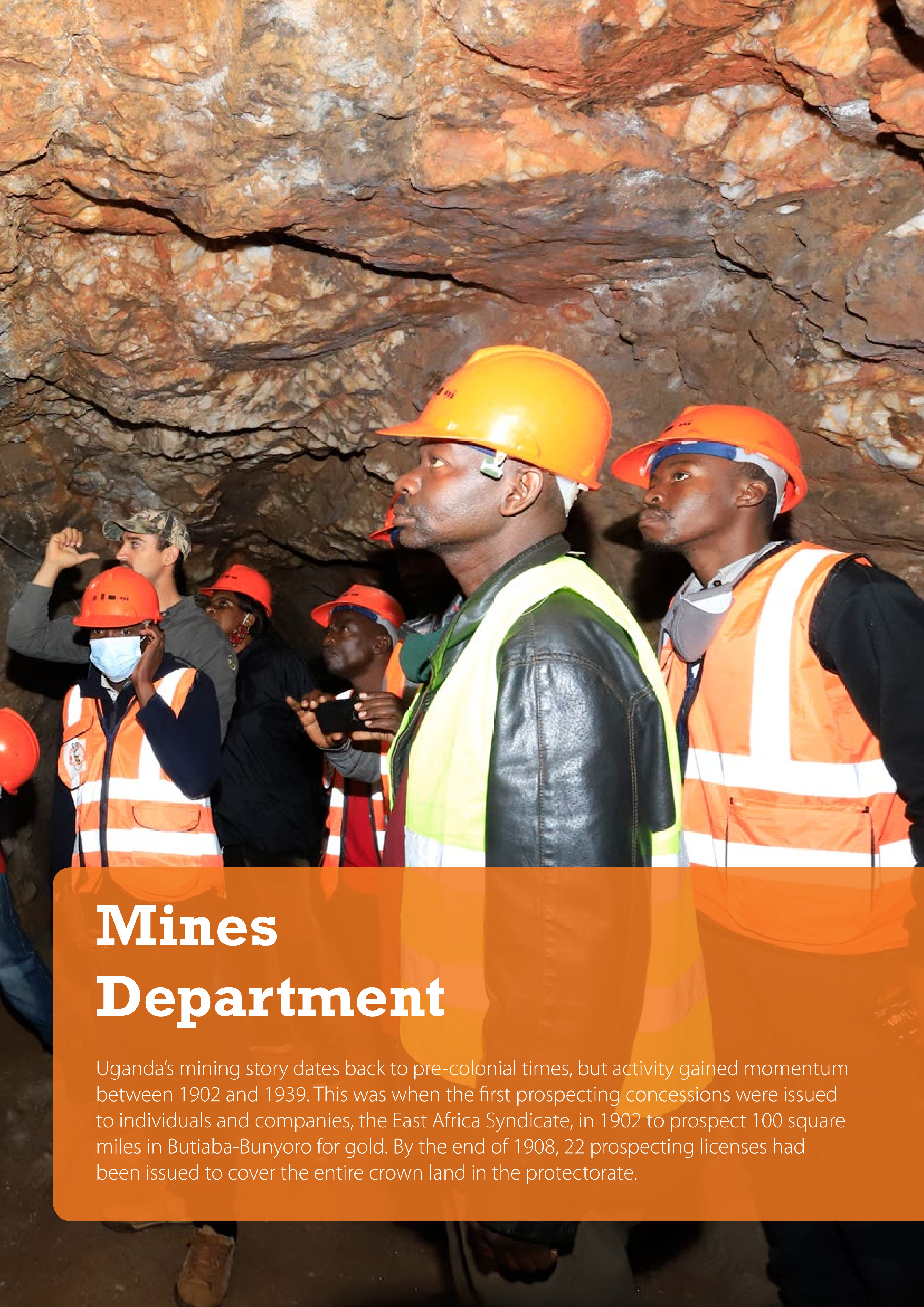
For security of information and maintenance of copyrights, the new GMIS provides links to other information systems without tampering with the access rights of those external systems. The system also has user rights to protect data on the system from malice.

We believe that this system has managed to eliminate the challenges faced by the first digital library system.

Our biggest worry now is the changes in technology, which happen to take place constantly since the system runs on ArcGIS 10.0.

As we celebrate 100 years, we celebrate the progress of management of geoinformation. That is from tools and techniques used to capture data, process data, store and disseminate data to users.
In this new century, DGSM, through its Documentation Centre, plans to increase publicity of its activities. With the help of the production printer - Xerox Versant 180, DGSM plans to publish more publications and promotional materials like booklets, brochures and flyers which will make it easier for information sharing with stakeholders.

Digital map printing machine: at the Directorate of Geological Survey and Mines, Entebbe - Uganda.



Mines Department

Uganda's mining story dates back to pre-colonial times, but activity gained momentum between 1902 and 1939. This was when the first prospecting concessions were issued to individuals and companies, the East Africa Syndicate, in 1902 to prospect 100 square miles in Butiaba-Bunyoro for gold. By the end of 1908, 22 prospecting licenses had been issued to cover the entire crown land in the protectorate.

Trends of Mineral Investment In Uganda

By Agnes Alaba

The mining industry in Uganda reached peak levels in the 1950s and 1960s when the sector accounted for up to 30% of Uganda's export earnings. However, political and economic instability experienced in the country in the 1970s and the recent global economic slowdown led to the drastic decline in the contribution of the sector.

Ms. Agnes Alaba, Acting Director DGSM and Commissioner Mines

Uganda's mining story dates back to pre-colonial times, but gained momentum between 1902 and 1939. Over the last 30 years, there have been a number of government interventions to revive the mineral sector and improve on the investment climate. This period has seen steady progress and interest in the mineral sector.

The number of mineral licenses generally increased from less than 50 in the eighties to a peak of 873 licenses in 2013, and then dropped to the current total of 675 licenses.

During the last three decades, Government has been prioritizing the development of the mineral sector and has made key strategic decisions including acquisition of geoscientific data, legal and regulatory reforms and transparency in the mineral sector to promote investment in the sector.

The period from 1986 to date has been marked by a favorable business climate and conducive legislation which have led to a growing interest in the mineral potential of the country.

A number of companies have taken up exploration and mining licenses for a variety of minerals; notably gold, tantalite, columbite, wolfram, beryl, nickel, cobalt, gypsum, iron ore, kaolin, apatite, dimension stone, granite, lead, zinc, vermiculite and gemstones, limestone and marble.

As a result, the sector has attracted investment in major projects such as the Sukulu polymetallic deposit by a Chinese company Guangzhou Dongsong, Namekhara vermiculite resources by world-class companies such as Rio-Tinto in 2007 and Gulf Resources in 2010 and the coming on board of major players such as Wagaigai for gold in Busia, SIPA Resources for the platinum group of metals (PGMs) in Kitgum and Lamwo districts, Simba Mines for gold in Ibanda/Kamwenge districts and emerging of gold refining facilities to support mineral-based industrialization in the country.

Other players in the sector include: SAMTA Uganda Limited for (PGMs) in Arua; Jervois Mining Limited for copper and base-metals; Consolidated Africa for graphite in Kitgum; and Rwenzori Rare Metals Limited in Makuutu and Bunawaya in Eastern Uganda.

A number of cement and ceramic industries are utilising inputs from the country such as Tororo Cement, Hima Cement, National Cement, Sunbelt Mining Company, and Goodwill Ceramics. This has resulted into increased mineral production and investment in the cement industry.

With the improved infrastructure for mineral value addition, better investment climate and legal reforms, the mineral sector is expected to regain and surpass its original contribution to the Gross Domestic Product.

Introduction

Uganda's mining story dates back to pre-colonial times, but gained momentum between 1902 and 1939. This was when the first prospecting concessions were issued to individuals and companies. The East Africa Syndicate received a concession in 1902 to prospect 100 square miles in Butiaba in Bunyoro for gold. By the end of 1908, 22 prospecting licenses had been issued to cover the entire Crown land in the protectorate.

Furthermore, the opening of the Kilo-Moto mines in the Congo during 1905 led to a rush by other prospecting companies such as Nile Congo Divide Syndicate from Congo to the West Nile sub-region. Here the company established the existence of low-grade copper in Manya area in West Madi instead of gold. More discoveries of commercial deposits of minerals were made throughout the country with gold reported in Busia in 1915, and tin in southwestern Uganda in 1925.

Commercial mining was recorded way back in 1922 with beryllium in southwestern Uganda and wolfram in 1933. In the 1950s, the Kilembe Copper Mine was developed and it became the country's largest mine. The 1950s and 1960s were an important phase for mining when it made a 30 percent contribution to the total exports of the nation. At the time of independence, the copper/cobalt from Kilembe in Kasese accounted for five per cent of the value of Uganda's exports and the mining sector generally performed modestly. The Kilembe mine was in operation from 1957 to 1978 and accounted for 95 per cent of the value of the country's mineral exports.

> "The level of investment increased from US$5 million in 2003 to US$340 million by the end of 2011

These earnings gradually dropped over the years to its current contribution of less than one per cent to GDP due to a number of factors.

Government interventions included geological and geochemical survey, geological mapping, investigations and mineral resource assessment in areas of southwestern Uganda.

As a result, there was an increase in the number of licenses issued for mineral exploration and increased production.

The period 1992-1996

Government, with assistance from the United Nations Development Programme (UNDP), supported a project "Strengthening of the Department of Geological Survey and Mines (DGSM)".

The period 2003-2004:

The Mining Act (1964) was overhauled and a new Mining Act (2003) was enacted and thereafter the Mining Regulations (2004) were put in place. The new internationally competitive legislation coupled with an investor-friendly fiscal regime has been responsible for the influx of both foreign and local investors, taking up mineral licenses in Uganda. However, after over 15 years of implementation, a number of issues and challenges emerged that need to be addressed to reposition the sector. The Government, therefore, is revising its current Mining Act 2003 in order for the country to remain competitive. It has put in place a new Mining and Mineral Policy 2019, and Mining Regulations 2019 to enable online mineral licensing.

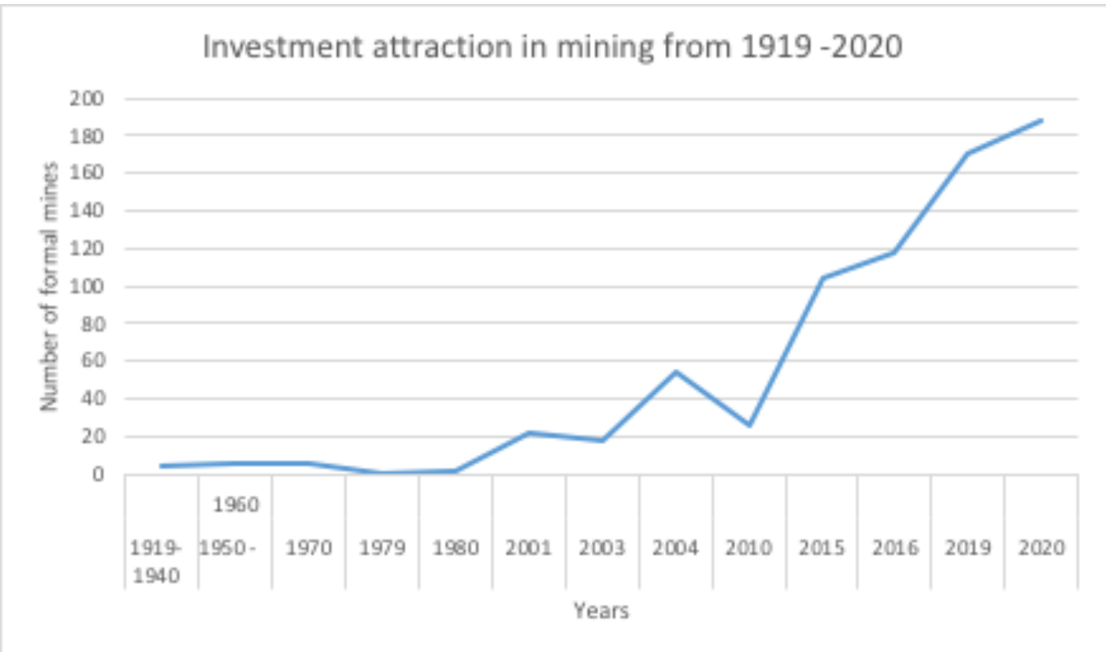


Figure 1: An overview of the investment attraction in mining from 1919 to 2019

The period 2004-2012

Government acquired a US$ 47.70 million loan from World Bank, African Development Fund and a grant from Nordic Development Bank (ADF) to invest in acquisition of modern scientific data and rehabilitate infrastructure at the Department of Geological Survey and Mines.

The Sustainable Management of Mineral Resources Project (SMMRP) was launched in 2004. The principal output of the SMMRP was an extensive high-resolution airborne survey of Uganda's mineral resources. By the end of the project in 2012, the government had produced detailed maps of mineral resource endowments covering 80 per cent of the country.

New mineral targets and investment in the sector

Following acquisition of high-resolution data and ground follow-up of some mineral targets, the government registered a significant increase in the mineral resource base of the country that has acted as an investment tool in the sector.

For example, in addition to the previously known iron ore deposits of Muko (30 million tonnes), Bukusu (23 million tonnes), and Sukulu (45 million tonnes), new ore reserves were discovered at Buhara in Kabale (48 million tonnes), Nangara in Kisoro (eight million tonnes) and Rugando, Butogota in Kanungu (55 million tonnes), which total 111 million tonnes of iron ore that have a gross value of US$ 15.6 billion and will earn Government US$ 783 million in royalties.

> "... revenues from license fees increased from US$0.5 million in 2003 to US$14.6 million in 2011

Additionally, a total of 7.3 million ounces of gold which have been proven at Tiira in Busia (500,000 ounces), Kamalenge in Mubende (five million ounces), Mashonga in Bushenyi (one million ounces), Kampano in Ibanda (500 ounces) and at Alupe in Busia (800,000 ounces) have a gross value of US$ 10.9 billion which will earn Government US$ 545 million in royalties.

Vermiculite reserves have increased from five million tonnes to 54.9 million tonnes at Namekhara in Manafwa district and the reserves have a gross value of US$ 11.5 billion which will earn royalties worth US$ 199.6 million.

The limestone/marble reserves in the country have increased from the known 30 million tonnes in Hima, Dura Muhokya and Tororo to over 300 million tonnes after quantifying reserves in Karamoja.

Other mineral deposits and targets identified includes the three billion tonnes of aluminous clay reserves at Mukutu, Buwaya in Mayuge district which contain alumina and rare earth elements, the new various mineral targets (platinum group of elements, iron ore, base metals and rare earths) in the country, the 10 priority targets of uranium ore, and bentonite clays in Kaiso-Tonya area of Hoima and abundant resources of granites and similar stones for dime stone.

Trends for investment in mineral exploration and mining in the sector generally remained positive but with fluctuations due to a number of factors including commodity prices,

DGSM staff Inspecting Namekhara Vermiculite Mine, Manafwa District, Eastern Uganda.

government strategic policies and interventions and shifts in the global market (Figures 1 and 2).

The level of investment increased from US$5 million in 2003 to US$340 million by the end of 2011, and revenues from license fees increased from US$0.5 million in 2003 to US$14.6 million in 2011. Similarly, mineral rights increased dramatically over the same time period: in 2003, there were 208 mineral licenses, and by the end of 2012, there were 873.

The period of 2012/13 to 2018 was marked by a big shift in commodities and market prices; during this period, mineral production and number of mineral licenses dropped to the current level of 675 licenses by June 2019.

Mineral production

The country is endowed with varieties of minerals that include copper, cobalt, tin, phosphates, vermiculite, gold, chromite, lead, wolfram, tantalite, iron ore, limestone, marble, pozzolana, kaolin and vermiculite, among others.

The potential for viable exploitation for most of the minerals is being established in line with government policy of mineral value addition.

However, the annual production of limestone and pozzolana has generally increased from 1970 to 2019; from 292,000 tonnes to 812,000 tonnes of limestone and from zero to 853,303.79 tonnes of pozzolana.

Conclusion and recommendation

Despite the achievements over the years, large-scale mining still accounts for a negligible portion of the national economy: in 2010, mining accounted for just 0.5 per cent of Uganda's GDP. Mineral production itself remains dominated by artisanal and small-scale mining operations, which account for 90 per cent of national production and employ directly over 200,000 Ugandans (World Bank, 2013) and indirectly over one million Ugandans.

Industrial mining is concentrated on a few minerals, with limestone (for cement production), vermiculite, granites and pozzolana as the primary minerals in terms of tonnage. Gold is the country's biggest export in terms of value but remains concentrated in the informal sector. Iron ore mining as well as other base metals, while of growing importance, has been halted on the national scale as the country attempts to build up domestic value-addition capacities.

With the current vision and strategy in place, supported by a fairly strong legal and regulatory environment, the greatest need at present is for Uganda to allocate sufficient amount of long-term financial and human resources toward monitoring, inspections and implementation of existing laws; invest in mineral exploration to define and expand the current resource base; provide adequate infrastructure for mineral value addition; and establish mineral buying centers to curb illegal trade in minerals.

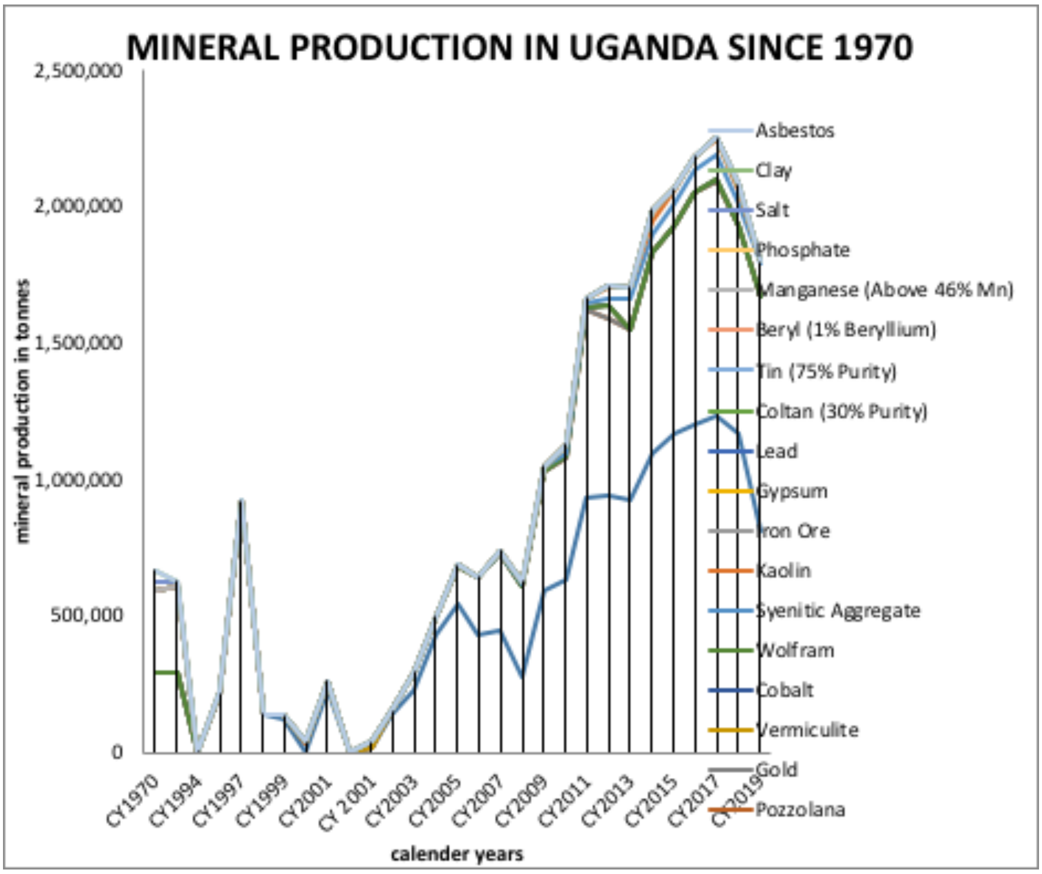


Figure 2: Mineral Production 1970 -2019

Government Overhauls Mineral Regulatory System to Fit the Times

By Vincent Kedi

Up until 2018, the mining industry in Uganda was regulated under the Mineral Policy 2001, the Mining Act 2003, the Mining Regulations 2004 and other relevant laws governing extractives and all underpinned by Article 244 of the Constitution of the Republic of Uganda.

Vincent Kedi, Assistant Commissioner – Licensing and Administration

The first Mining Act in 1949 addressed the known mineral occurrences of the time, their beneficiation and sale on the international market. Back then, ownership of minerals was vested in the Governor of the Uganda Protectorate on behalf of Her Majesty the Queen of England.

This law was revoked and replaced with the Mining Act (1964) when an independent department was created within the Ministry of Lands and Mineral Resources to coordinate the discovery, safeguard and protection of the country's mineral resources after the colonial era.

The Mining Act 2003 replaced the Mining Act 1964, following the promulgation of a new Constitution in 1995. The passage of the Mineral Policy 2001 spelt out all the relevant provisions on mining and mineral development. The centerpiece was to vest ownership and control of all minerals in the government.

However, it also provided for the acquisition of mineral rights and their administration. This Act was operationalized by the Mining Regulations 2004.

The Mining (Licensing) Regulations 2019, replaced the Mining Regulations 2004 to cater for the transition of Uganda's mineral licensing system from paper-based to an e-government mineral licensing system.

Adapting to the changing times is crucial and after implementing the Mineral Policy 2001 for over 15 years, the Ministry reviewed the strengths, weaknesses, opportunities and threats of this policy, in consultation with relevant stakeholders. The analysis clearly showed that there was need for reforms.

The Mineral Policy 2001 had been in force for at least 15 years, during which time the mineral subsector had undergone various transformations and changes. As such, the policy was inadequate in dealing with the new developments in the subsector as well as government strategic directions. For example, as stated in Vision 2040 and the various phases of the National Development Plan (NDP) as well as continental aspirations as enshrined in the Africa Mining Vision.

In addition, the subsector's contribution to the national economy stood at a dismal 1.4%, despite its huge earning potential. Consequently, on 7th May 2018, Cabinet approved the new Mining and Mineral Policy for Uganda with implementation still ongoing. To effectively enforce the tenets of this new policy, the government also embarked on changes to strengthen the legal, regulatory and institutional provisions to effectively cater for emerging issues in the mineral sub-sector.

Consultations were made with various stakeholders at national level. These include various ministries, government departments and agencies together with members of the general public; exploration and mining companies; the Uganda Chamber of Mines and Petroleum; artisanal and small-scale miners; Episcopal Conference of the Catholic Church; district local governments; Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF); Development Partners; Civil Society; mining communities; NGOs; and the academia.

In addition, the laws governing the mineral sector within the East African Community and in selected countries globally were reviewed so as to benchmark and inform the amendments process for international best practice.

The following country mining laws were studied: Australia, Canada, Ghana, Namibia, Tanzania, Rwanda, Ethiopia, South Africa, Peru, Gabon, Senegal, Philippines, Botswana, Zambia, Zimbabwe, Papua New Guinea, Sierra Leone and Kenya.

Arising from the wide stakeholder consultations, it was agreed that the legal, institutional, and regulatory framework be periodically reviewed to address the prevailing inconsistencies.

In this way, it would be easier to fill in the gaps identified in order to be compliant with the new and emerging trends in the global mining industry.

The new Mining and Mineral Bill, 2020 has been drafted to; provide a robust predictable and transparent legal regime; improve mining and mineral administration and business processes; and ensure efficient collection and management of mineral revenues.

It also aims to promotes value addition to minerals and increase mineral trade; organise, register, license, regulate and transform artisanal and small-scale mining in Uganda; and minimize and mitigate the adverse social and environmental impacts of mining activities.

There are new provisions to promote local content and national participation in the mineral industry, including the use of Production Sharing Agreements and free carry

> " The mining subsector's contribution to the national economy stood at a dismal 1.4%, despite its huge earning potential.

shareholding in mining contracts. It provides for the regulation of substances that were excluded from the definition of the word "mineral" in Article 244 of the Constitution (sand, clay, murram or any stone commonly used for construction or similar purpose). These are often referred to as 'Development Minerals'.

Efforts have been made to domesticate regional and international conventions, treaties, agreements, protocols and initiatives; provide for the regulation of mineral processing, refining and smelting; provide for establishment of specialized institutions to manage specific functions in the sector such as a Mineral Exploration Unit, a Mining Cadastre Department, a mineral promotion unit; an ASM unit, among others; and provide for establishment of an Environmental Decommissioning Fund.

In addition, the new Bill shall: provide for establishment of the Mineral Protection Force as an enforcement arm of the mineral subsector; promote and protect human rights in the mining sector including gender, labour and children; provide for ISO- certified mineral laboratory services and strengthen the mineral laboratory to support geoscientific investigations, regulation and monitoring.

There are plans for the establishment of the Earth Scientists Registration Board to regulate them and associated professionals; provide guidelines for engineering geology assessments and geotechnical investigations and monitor geo-hazards and seismic activity; enforce penalties, sanctions and fines on illegal mining and non-performing mineral rights; develop or adapt an appropriate mineral classification and reporting code; and strengthen the institutional framework for the effective governance of the mineral subsector.

In line with Vision 2040, the proposed new Bill will seek to develop a mining sector that can catalyse agriculture as well as offer broad-based growth and development of downstream linkages into value-addition and manufacturing, upstream linkages into mining capital goods, consumables and services industries and side-stream linkages into infrastructure, such as power, logistics; communications, water and skills and technology development.

Hopefully, the proposed new Bill will result in an increased annual budget for the Directorate of Geological Survey and Mines. The revenues generated from the mining industry are expected to rise steadily as the industry performance improves. In addition, licensing of all mineral rights, licenses and permits shall be done through the Minister responsible for mining.

The draft Mining and Mineral Bill was presented to Cabinet on 26th October 2020 and its passage was deferred to the next sitting of Cabinet. However, once passed, the Bill will be gazetted and forwarded to Parliament for consideration, debate and hopefully quick enactment.

Mineral Licensing System Evolves into Online Platform

On 1st October 2019, the Directorate of Geological Survey and Mines switched from a paper-based mineral licensing system to a fully operational online platform.

By Vincent Kedi

Although the paper system greatly achieved its purpose during many decades of use in terms of long-life record keeping, the paper-based system was largely cumbersome and sometimes led to delays or caused incorrect decision-making. Some stakeholders even blamed it for excessive bureaucracy and a leading source of the perceived corruption in the process.

Sometime back and in efforts to improve efficiency, the Directorate started on the gradual process of changing its licensing system to an e-government mineral licensing platform:

Landfolio Back-office portal: https://miningcadastre.minerals.go.ug/Site/Login
Landfolio View only portal: http://portals.flexicadastre.com/Uganda/
Landfolio E-gov portal: https://dgsmportal.minerals.go.ug/site/Login

The main motivation behind this major shift from paper-based to an e-government platform was to:

1. Improve efficiencies by putting in place a system that is paperless, searchable and auditable.

2. Ensure full legal compliance to Laws and Regulations, Mining Agreements and guarantee that all correct processes are followed.

3. Attract and manage investments in mining, both local and foreign, from upstream to downstream as well as in-country beneficiation processes.

4. Optimize state revenues by assessing and collecting fees, rents, royalties and taxes.

5. Manage and control the large-scale mining sector which is a key revenue base for the country and a source of exports and foreign exchange.

6. Manage and control the small-scale mining sector which is a source of local employment and facilitator of community development.

7. Allow effective stakeholder management by enabling integrated processes as well as unmask complex relationships.

8. Improve inspectorate functions including mine health and safety, work program compliance and explosives permitting, among others.

9. Environmental monitoring and control including environmental permitting, compensation of PAPs and water use planning.

10. Improve production and royalty monitoring through production monitoring, royalty reconciliation and issuance of export permits.

11. Improve export and trade monitoring through issuance and management of mineral dealing licenses, export permits and tracking of the mineral trade.

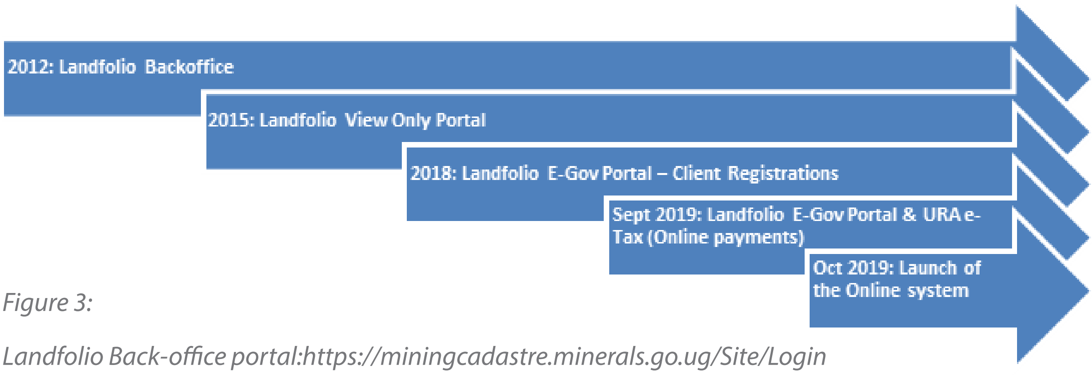


Figure 3:

Landfolio Back-office portal:https://miningcadastre.minerals.go.ug/Site/Login
Landfolio View only portal:http://portals.flexicadastre.com/uganda/
Landfolio E-gov portal: https://dgsmportal.minerals.go.ug/site/Login

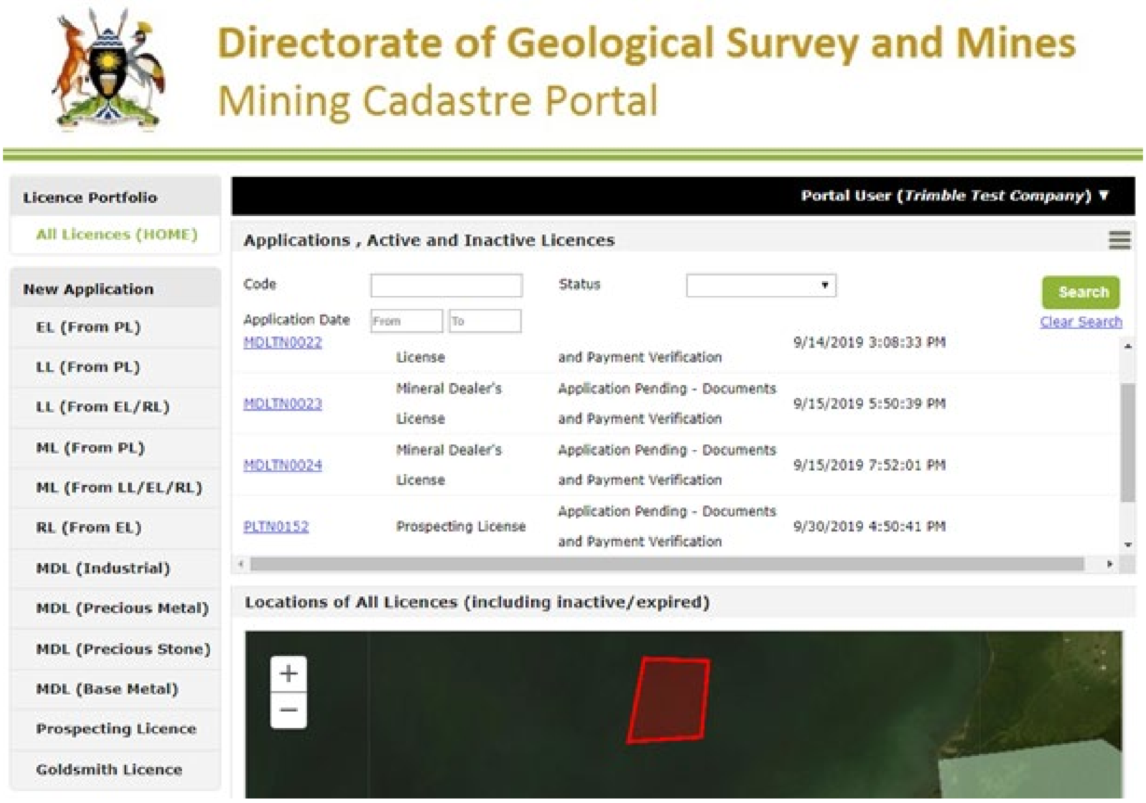


Figure 4: How Uganda's online mineral licensing system was designed.

To develop this system, the Ministry contracted Spatial Dimension, now a Trimble company, to upgrade its mineral licensing system, culminating into the launch of the online version on 1st October 2019.

Consequently, all licensees in the mining sector are now able to:

- View their License Portfolios
- Submit New License Applications online
- Track their Application Status and submit Statutory Reports
- Make all mineral-related online payments
- Apply for renewal, retention and amalgamation of their mineral rights
- Perform transfers, surrenders and withdrawals
- Make inquiries online rather than offline.

This move from an analogue to a digital regime represents a dynamic shift in the administration and management of mineral resources in Uganda and ushers in a more transparent, robust and efficient mineral licensing and monitoring system.

Figure 5: A schematic of the e-government platform from which Uganda's online mineral licensing system was designed.

Mineral Production Statistics in Uganda

PERFORMANCE MEASURE - The performance of the mineral sector is measured by its contribution to economic growth and social development under certain parameters. These include the number of mining investors attracted, mineral production, mineral exports, employment opportunities, capacity building and contribution to the country's Gross Domestic Product (GDP).

By Grace L. Nassuna

As the number of companies obtaining licenses to mine increases, the mineral production volumes also rise. The exports enable the country to earn foreign exchange, which is reflected in Uganda's economic growth.

Prior to independence, the mineral sector was mainly taken up by exploration and mapping under a series of geological mapping and mineral exploration programmes. There were very few formal mines, apart from Kilembe for copper and stockpiling cobalt and Mwerasandu for tin. Others were the Bjordal wolfram mine, Ruhija mine for wolfram, and Kirwa mine for more wolfram.

Grace L. Nassuna, Assistant Commissioner - Geoscience.

Uganda 's formal mining started in the 1920s with medium-scale mining in tin and tungsten in southwest Uganda, followed by gold in Busia. In the 1950s, the Kilembe copper mine was developed and started operations in 1956. It became the country's largest mine then. During this period from the 1950s to the late 1960s, mining reached peak levels.

Due to the political and economic instability that began in 1971 up to 1979, attracting further formal investment in mining was adversely affected. Even the once flourishing tin mines in the west were abandoned. Kilembe continued on a care-and-maintenance basis. The formal labour force of the nation of over 10,000 workers became unemployed. Informal mining with illegal exports of gold, tin, tungsten and columbite grew steadily.

Although these activities increased rural revenues, they also resulted in environmental degradation and losses of fiscal revenues and formal foreign exchange earnings. The mining techniques also were rudimentary and the health and safety of miners was very poor.

In the years 1980 to 1986, there was a gold rush in the districts of Bushenyi, Kanungu and Rukungiri. Then there was a resolution to place a ban on prospecting, exploration, exploitation and marketing of gold all over Uganda which, however, did not stop the illegal operators.

When political stability was restored, demand for road construction in the late 1980s led to better returns in industrial minerals for small-scale miners.

From the 1990s to date, the sector has experienced sustained recovery. This has seen a number of mining companies obtaining licenses. Between 1996 and 2003, there was a waive for royalty on production which led to a hike in gold exports and more foreign exchange.
In 1995 and 1997, mining investment went up including artisanal mining in the community leading to higher revenues.

Government has tried to initiate policies and reforms aimed at encouraging formal investment in mineral exploration. The passing of the Mining Act 2003 resulted in a reduction of illegal mineral production.

From 2008 to 2013 under the Sustainable Management of Mineral Resources Project (SMMRP), artisanal miners in the community were trained and encouraged to form associations.

The Directorate of Geological Survey and Mines is currently registering these local artisanal miners' associations while encouraging them to formalise and obtain Location Licenses.

The relevant mineral rights responsible for mineral production are Mining Leases for big players and Location Licenses for small investments where expenditure to achieve production will not exceed 500 currency points. These licenses together increased from four to 170 by December 2019.

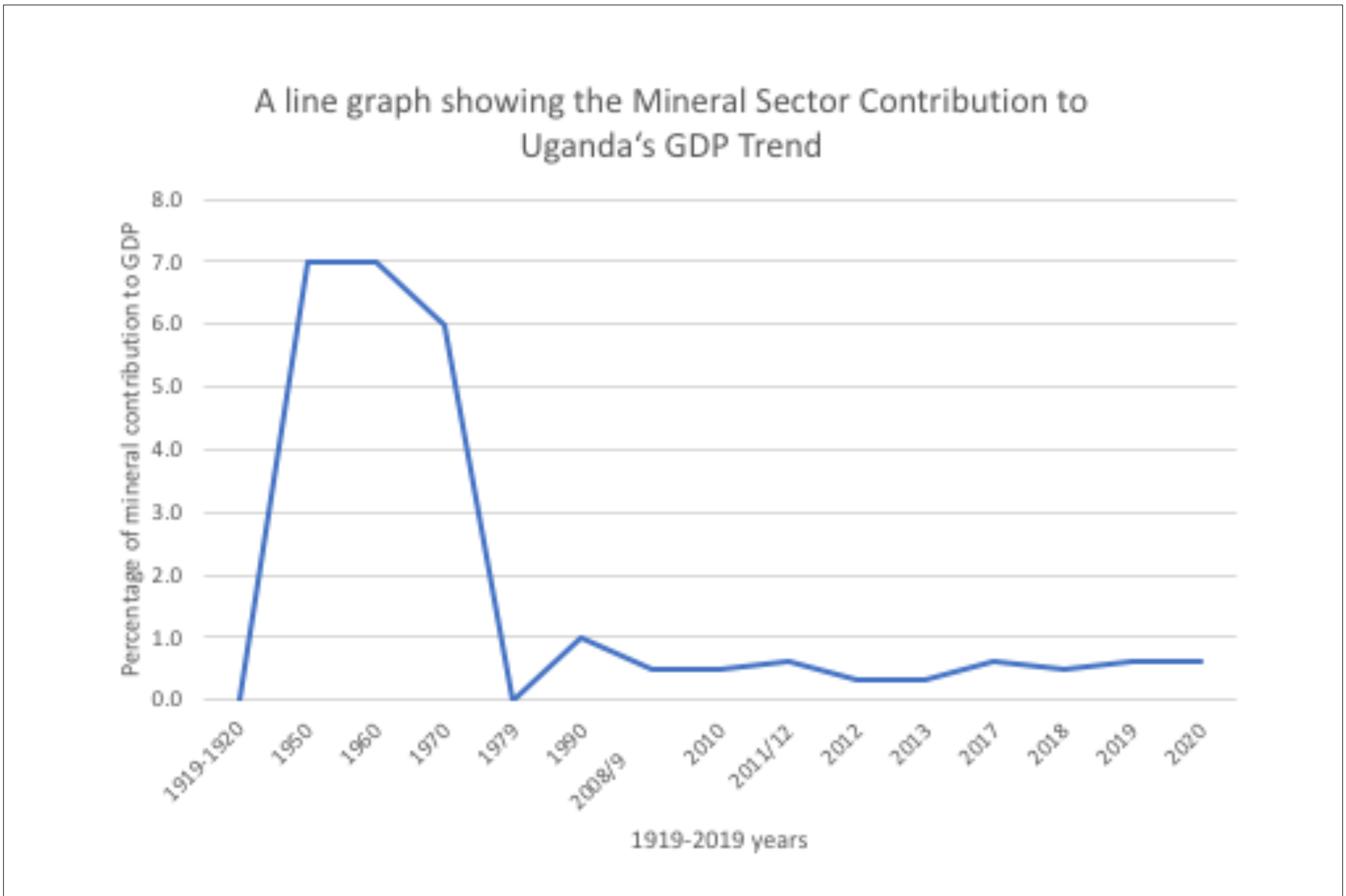


Figure 6: Mineral Sector Contributions to Uganda's GDP

Artisanal & Small-Scale Miners' Role in Uganda's Mineral Sector

By Engineer Joseph Patrick Odong Okedi, Assistant Commissioner (Inspection and Monitoring) & John Kennedy Okewling, Mining Engineer

Engineer Joseph Patrick Odong Okedi, Assistant Commissioner (Inspection and Monitoring)

Artisanal and small-scale mining (ASM) in Uganda comprises a spectrum of activities carried out by a variety of players ranging from small, formal companies that employ some degree of mechanization to illegal subsistence miners.

Artisanal and small-scale miners (ASMs) are the small groups and individuals engaged in low-cost and labour-intensive excavation of minerals using minimal mechanization.

ASM is a massive industry in the country which dates way back before the colonial era. In fact, most of these ASMs were used as pathfinders to some of the mineral discoveries by the British colonialists. Many communities around the country were and are still mining, processing and smelting mineral ore without any geological information about these locations producing minerals like gold, tin/cassiterite, tungsten/wolframite, columbite-tantalite, salt, vermiculite, marble, limestone, gypsum, gemstones, beryl, magnesium, iron ore, pozzolana, aggregates, clay and sand, among others. Prominent areas known for ASM activities in Uganda include: Namayingo, Kassanda, Mudende, Buhweju, Busia, Amudat, Abim, Moroto, Kaabong, Isingiro, Ntungamo, Rubanda and Kisoro. The mining of development minerals, especially aggregates and sand, is sporadically distributed all over Uganda.

Gold is the commonest mineral mined by artisanal and small-scale miners. Without any formal knowledge about rock and minerals, artisanal miners clearly understand that gold occurs in veins which they diligently follow and exploit, disregarding existing structures like pit latrines and graveyards that are intersected by the gold veins. Some miners have even become nomadic, going to wherever the gold veins can lead them or to areas with better gold recovery.

Although the elite consider ASM as a dirty activity, unprofitable and fundamentally unsustainable business option known for high environmental costs, and poor health and safety records, this subsector employs a significant number of Ugandans around the country, stimulating local economies by increasing the cash component of rural and peri-urban households in those mineral-rich communities and regions. The 2009 National Strategy for the Advancement of Artisanal and Small-scale Mining in Uganda by the Ministry of Energy and Mineral Development found that an estimated 4.2 million Ugandans, constituting about 10% of the Ugandan population, directly or indirectly relied on the ASM subsector. The subsector has created informal employment for women such as; rock crushing, sluicing, washing, panning, sieving, transporting, and creating ancillary businesses like selling food and goods around mining sites.

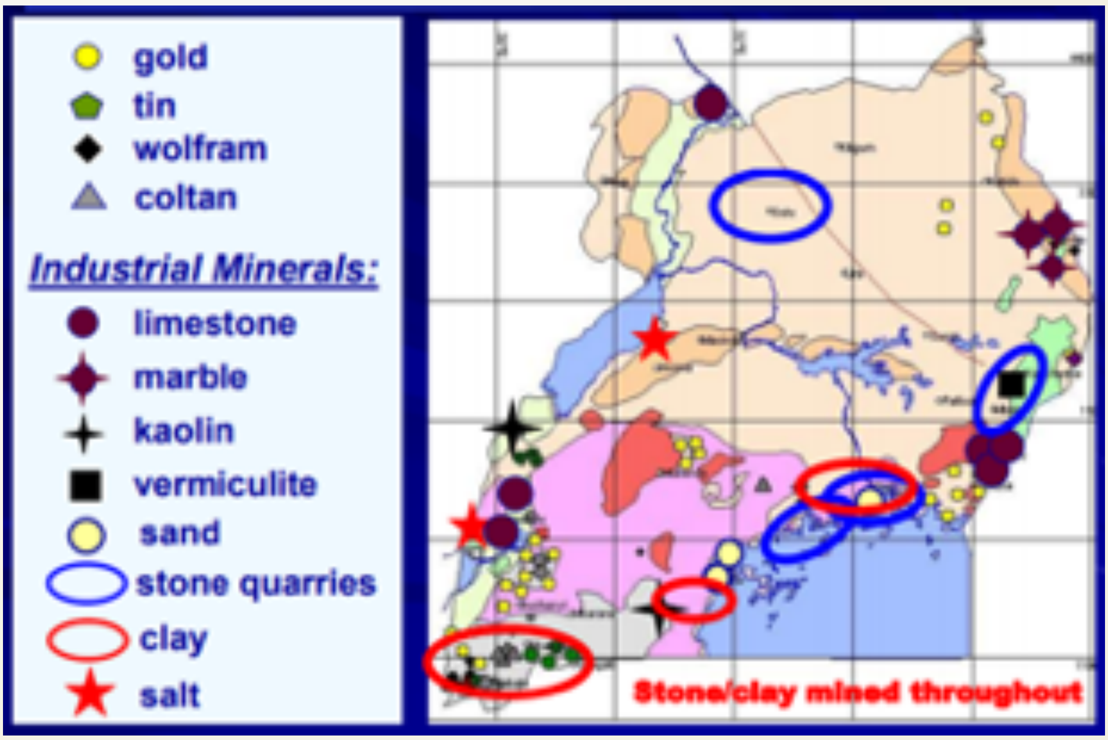
Despite the advantages found in ASMs, in the 1990s, the subsector was largely viewed as illegitimate and a threat to the more efficient and profitable investments. Since the government didn't recognize the ASMs, they were not bringing in any revenues to the country and they were not regulated. Miners were operating secretly under dangerous conditions, not observing operational standards and causing risks to life and damage to the environment. They continued to block investment opportunities in these areas, hence the low revenues generated by the sector.

> " 4.2 million Ugandans, constituting about 10% of the Ugandan population, directly or indirectly relied on the ASM subsector.

As a way forward, government, in its recent policy measures, sought to formalise and regulate artisanal and small-scale miners (ASMs). The objective was to regulate their operations by charging them a reasonable fee for them to retain a sizable area of operation so as to generate revenues as well as develop skills among themselves in order to minimise and mitigate the adverse social and environmental impact of their mining activities. Thus now, the Ministry of Energy and Mineral Development, through the Directorate of Geological Survey and Mines (DGSM), encourages artisanal miners to form associations and raise money as an association to officially apply for mineral rights in their areas of operation. And as an incentive, the government conveys skills to these associations in sustainable resource exploitation, health and safety, environmental protection and commodity marketing.

The activity of formalizing ASMs has had positive impact on the social, economic and environment development of Uganda. Statistics have shown that since 2017 to date, there are 18 registered associations of artisanal and small-scale miners in the country. Against this backdrop, the country has seen some impressive growth rate of the mineral sector standing at an average of 19.4%. An arrangement of resource sharing in terms of gazetting land for ASM activities has led to an increase in investment in the sector with new mines coming on-stream and boosting trade especially in gold and iron. The sector, therefore, presents strong potential to generate substantial revenue and employment and provide more visible economic benefits to the country (up to 5% GDP) and improved livelihood for the population. The ASM subsector is increasingly being recognised by the government, development partners and researchers for its role in national development.

More efforts to harness the untapped potential of ASM and propel contribution to the national economy are being put in place by the Government of Uganda in order to formalize and regulate the ASM subsector. As of today, the implementation of Biometric Registration of Artisanal and Small-



scale Miners (BRASM) project, which includes the biometric registration, formalization and management of ASM in Uganda, is ongoing. The BRASM project was launched in March 2019 and the biometric registration is expected to be completed in the next financial year.

Challenges still faced by ASM subsector

However, despite the opportunity given to ASMs to formalize their operations, a number of them are still resisting the arrangement. This hinders efforts to know the exact number of people participating in the mining activities and to stop child labour in mines. Most ASMs continue to use rudimentary technology which has degraded the environment. The DGSM has limited funding to equip these miners with modern tools.

The use of mercury in gold mines is still ongoing, causing health-related problems to people around; and the presence of many miners in forests has caused deforestation. Since ASM operations require low skills to indulge, the practice has attracted poorly trained and illiterate people, luring children to participate in mining activities.

In conclusion, the benefits of formalizing and regulating ASMs outweigh the challenges of not regulating them. With support from the Government of Uganda, the DGSM plans to increase support to ASMs with an aim of protecting the environment. The DGSM continues to interpret the legal framework to these ASMs in order to eliminate child labour, enhance health and safety in mining sites and the benefits of compliance with payment of government revenues.

Artisanal gold mining activity in Rupa Sub-County, Moroto District, Karamoja

Mineral Tracking in Uganda

The Great Lakes Region (GLR) is endowed with vast mineral resources including, but not limited to, gold, tin/cassiterite, tungsten/wolframite, tantalum/tantalite and copper.

By John Kennedy Okewling

These high-value mineral resources have been illegally exploited to facilitate and support funding of the civil wars in some member states within the GLR for a long time.
The International Conference on the Great Lakes Region (ICGLR), which is an inter-governmental organization of the countries in the African Great Lakes Region, was established in 2000 with headquarters in Bujumbura, Burundi to coordinate, facilitate, monitor and thereby ensure the implementation of the Pact on Security, Stability and Development in the Great Lakes Region, which was signed by the 11 Heads of State and Government in 2006.

The Lusaka Declaration of 15th December 2010 by the Heads of State and Government committed each member state to the fighting of illegal exploitation of natural resources through national, regional and international legal means.
The Member States today are Angola, Burundi, the Central African Republic, the Republic of the Congo, the Democratic Republic of the Congo, Kenya, Rwanda, Sudan, South Sudan, Tanzania, Uganda, and Zambia.
The Pact contains ten (10) protocols including the Protocol Against the Illegal Exploitation of Natural Resources consisting of a Regional Initiative against the Illegal Exploitation of Natural Resources (RINR).

The Government of Uganda domesticated the Protocols of the Pact on Security, Stability and Development in the Great Lakes Region under the International Conference on the Great Lakes Region (Implementation of the Pact on Security, Stability and Development in the Great Lakes Region) Act, 2017.

John Kennedy Okewling Mining Engineer, (B.Eng. IEM, MSc Mining Engineering)

The Government of Uganda through the Directorate of Geological Survey and Mines (DGSM) under the Ministry of Energy and Mineral Development is implementing the tools in the regional initiative to curb the illegal exploitation of natural resources in the Great Lakes Region, which include: Regional Certification Mechanism (RCM), Harmonization of National Legislations, Regional Database on Mineral Flow, Formalization of the Artisanal and Small-Scale Mining Sector, Extractive Industries Transparency Initiative (EITI) and Whistleblowing Mechanism.
The Regional Certification Mechanism (RCM) for the exploitation, monitoring and verification of natural resources within the Great Lakes Region constitutes the core tool of the RINR, consisting of three (3) components:
1) Mine Site Inspection and Certification; this involves inspection and examination of a mine site and determination of its conformity with the regulations and standards.
2) Chain of Custody System (traceability); a system that can track mineral flows from a certified mine site to the point of export.
3) Certification (issuance of certificates); a system for certifying mineral exports and issuing certificates.

The RCM is fully compliant with the OECD Due Diligence Guidance for Responsible Chains of Minerals from Conflict-Affected and High-Risk Areas. The member states that are already implementing the RCM in which certificates are being issued include Rwanda, Burundi and the Democratic Republic of the Congo.

The Government of Uganda is setting up a National Certification Unit at DGSM in Entebbe to be responsible for the implementation of the initiative. The relevant laws for the implementation are at final stages of completion; the Act is completed and the Regulations are being finalized. The personnel for the Certification Unit has been recruited, including but not limited to, inspectors, database expert and chemist.

The Government of Uganda has planned to roll out the issuance of certificates in the financial year 2021/22.

Geothermal Department

Geysers, hot springs, steam vents, underwater hydrothermal vents, and mud pots are examples of geothermal energy. According to investigations surveys in archives of Geological Survey in Entebbe, knowledge of the existence of these resources goes back to 1919. However, it was not until 1993 that detailed focused surveys were carried out in Kibiro, Katwe-Kikorongo and Buranga in Western Uganda.

Geothermal Policy, Legislation & Investment Opportunities in Uganda

Godfrey Babati, Commissioner Geothermal Resources Department

Currently, Uganda does not have a policy dedicated solely to the management of geothermal resources but under the National Energy Policy for Uganda, 2002 and the Renewable Energy Policy for Uganda, 2007, Uganda plans to recognise the potential of the technology for power generation, although they make only superficial consideration of issues for its development.

By Godfrey Bahati

Geothermal energy is one of the clean energy resources that have to date not been exploited for economic and social development. It has a potential for power production (into the national grid or mini grids) and has the additional benefit of providing heat for agricultural and industrial uses in local communities. Therefore, the Government of Uganda needs to provide a conducive environment to harness geothermal resources' unique attributes which include: base-load generation, high-capacity factor, near-zero emissions of greenhouse gases, small land footprint, direct-use applications, flexibility, predictability, reliability and durability in generation.

Geothermal exploration and development have been on Government's agenda since 1993. The Government aims at becoming the leading generator of geothermal energy by 2025. It has invested in geo-scientific surveys comprising geology, geochemistry, and geophysics. The potential for geothermal energy has been estimated at 1500MW for the two geothermal areas located along the Western branch of EARS and this estimate shall continue to be updated with collection of more data and information from other geothermal sites. The current predicted reservoir temperatures of 150-250 degrees Celsius, 110-140 degrees Celsius, 120-150 degrees Celsius, and 130-150 degrees Celsius for Kibiro, Panyimur, Buranga, and Katwe-Kikorongo respectively shall be confirmed by drilling.

Current legal framework for geothermal energy resource.

The activities under geothermal exploration and development are currently operating under the Energy Policy, 2002; Renewable Energy Policy, 2007; Mining and Mineral Policy for Uganda 2018; Mining Act, 2003; and Electricity Act, 1999.

The Mining Act 2003 acknowledges geothermal resource as a liquid mineral, hence can be mined as any other mineral and also offers a framework through which to partially regulate geothermal activities. The Energy Policy 2002 and the Renewable Energy Policy, 2007 recognize the potential of the resource for power generation, but make only superficial consideration of issues for its development: The Energy Policy, 2002 highlights evidence of the geothermal resource existence and acknowledges that it could play a role in base-load power generation. However, it also notes that there is limited knowledge of the economic potential for geothermal energy in Uganda; the Renewable Energy Policy, 2007 introduced a feed-in tariff for geothermal energy – including a standardized Power Purchase Agreement (PPA) – and various tax incentives for renewable energy technologies. The latter also set a basis for the establishment in 2014 of the Geothermal Resources Department (GRD) within the Ministry of Energy and Mineral Development (MEMD) to act as the government custodian of the resource.

From the identified occurrences of geothermal energy, Government has so far issued fourteen (14) geothermal exploration licenses in 2010 which later reduced to three (3) in 2018 due to the weak legal framework governing the exploration for geothermal energy.

The identified gaps include; the above legislation does not provide for the licensing of private sector geothermal developers in line with Public-Private Partnership (PPP) procedures, the negotiation of power purchase and direct use agreements, the financial and economic analysis of prospects in line with geotechnical analysis, the technical regulation of licensees and improving human resource capacity in the geothermal industry.
The Mining Act, 2003 does not offer sufficient clarity and flexibility for resource development and management. For example, the Act defines geothermal as a mineral, and prescribes in Section 28 (2) that "where an area is subject to an exploration license, no other exploration license shall be granted in respect of that area", which means a geothermal license cannot be granted over another mineral right; this has blocked licensing of potential geothermal areas to the private sector.

> Attempts by the private sector to participate in the exploration for geothermal resources has failed

The current licensing regime of first-come-first-serve under the Mining Act, 2003 encourages passive speculation and hoarding of geothermal resource rights by licensees incapable of meeting the required exploration obligations. The Electricity Act, 1999 provides for electricity generation but does not cater for the direct uses of geothermal energy and mineral extraction from the geothermal brines.

There is also no policy that addresses exploitation of geothermal energy resource for other uses other than for energy. For example; geothermal energy can offer an affordable, reliable and low greenhouse gas emitting source of base-load power generation to complement other sources of power.

The lack of a specific and clear policy, legal and regulatory framework governing the effective exploration, development and utilisation of geothermal resources has hindered the development of the geothermal industry. Hence, the emerging trends in the global geothermal industry and the anticipated opportunities and challenges call for a specific and focused policy to provide clear guidance on sustainable geothermal resources development.

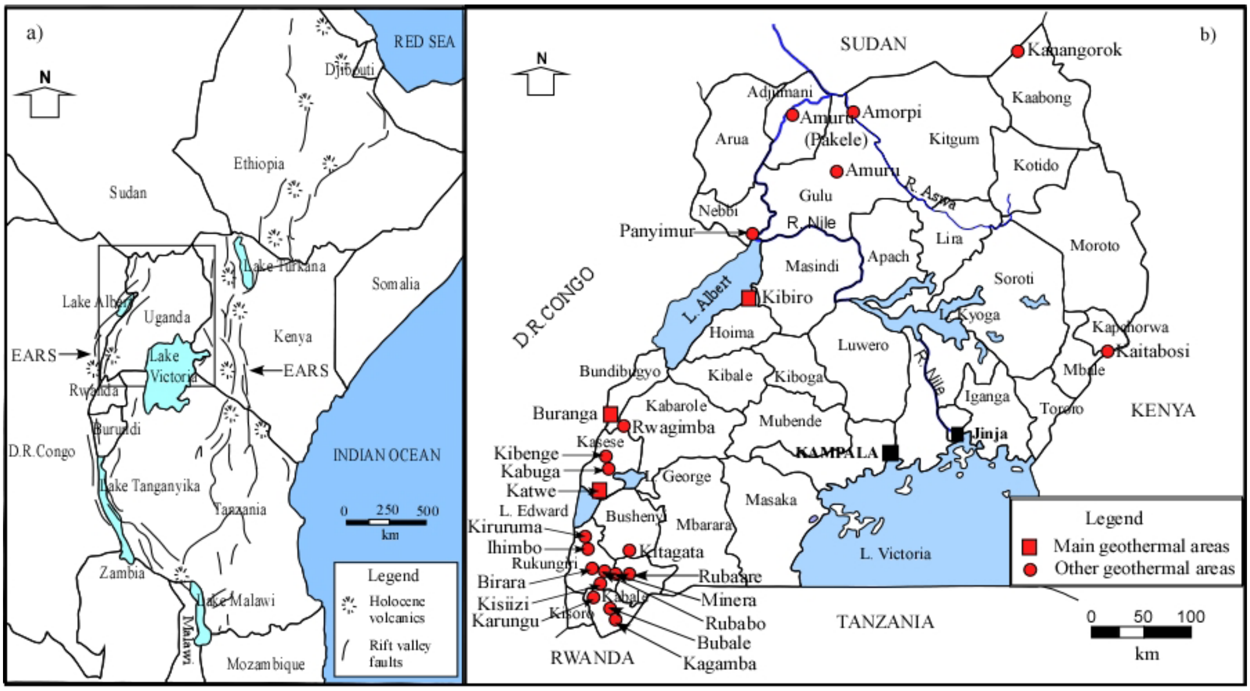


Figure 7: The Geothermal Areas of Uganda. After Bahati et al. 2005.

It's from this background that a new legal framework to separate geothermal tenure rights from minerals and more effectively manage the expectations of both public and private developers through the licensing process was needed. The new policy addresses technology development, increased Health and Safety standards land price equalization for all.

Government, therefore, needs to fund upstream geothermal exploration up to feasibility, including exploration drilling before the areas can attract private sector interest.

The new comprehensive geothermal policy

A geothermal policy was formulated between 2016 and 2019. The exercise involved a wide range of consultation with stakeholders that included Government officials, private sector, development partners, local government, communities, civil society organizations, cultural leaders and academia. Other consultations were done at regional and international levels.

> " The Government aims at becoming the leading generator of geothermal energy by 2025.

The new geothermal policy addresses exploitation and utilization of geothermal energy as electrical power and thermal energy for heating and industrial processes. Hence allowing multiple licenses in the same location.

The new policy discusses public private partnership to promote sustainable commercial development of geothermal resources based on an integrated resource plan. Government can carry out feasibility studies and take over geothermal resource exploration. Government is also authorized to establish feed-in tariffs and incentives to create a predictable business environment for geothermal energy projects; and Government shall recruit, equip and train skilled staff capable of maintaining a sustainable geothermal industry.

The draft was presented to Cabinet which advised that it should be incorporated into the National Energy Policy to avoid duplication. The National Energy Policy 2020 is now before Cabinet for discussion and approval.

Boiling eggs (direct use) at Sempaya Hot Springs - Semuliki National Park , Bundibugyo

Emin Pasha was first to spot Geothermal Potential of Uganda

That steaming ground you often come across in parts of Uganda is an economic asset waiting to be exploited. Research findings show that the country is well endowed with geothermal resources which can be developed to generate power as well as for other non-electrical uses.

By Vincent Kato

Vincent Kato, Assistant Commissioner, Geology and Geochemistry / GRD

Geysers, hot springs, steam vents, underwater hydrothermal vents, and mud pots are examples of geothermal energy. According to investigations survey in archives of Geological Survey in Entebbe, knowledge of the existence of these resources goes back to 1919. However, it was not until 1993 that detailed focused surveys were carried out in Kibiro, Katwe-Kikorongo and Buranga in western Uganda.

The leading advantage of geothermal energy is that it is renewable. This is an important factor as the world moves to reducing greenhouse gas emissions. Under these circumstances, getting an insight of Uganda's progress towards harnessing this resource is a useful exercise.

Official geothermal investigation surveys trace back to when the Geological Survey of Uganda (GSU) was established in 1919 under the leadership of Director Edward James Wayland. However, it was in 1885, when Emin Pasha first documented hot springs in Uganda. In his report he mentions that his discovery was based on heating rubber boots and hissing sounds coming from fumaroles. Fumaroles are openings in the earth's surface that emit steam and volcanic gases, such as sulfur dioxide and carbon dioxide.

Between 1920 and 1935, Wayland and several other GSU staff undertook reconnaissance surveys and reported about thermal and mineral springs in Uganda, giving descriptions and physical measurements. There have been several studies on Uganda's geothermal potential.

Geothermal Energy Exploration Programme Phase 1 (1993-1994).
This is the interlude when the first detailed exploration programme was carried out at the three highly ranked prospects. The project was funded by the Uganda Government, the United Nations Development Programme (UNDP), the Organization of Petroleum Exporting Countries (OPEC), and the Government of Iceland through the Icelandic International Development Agency (ICEIDA).

Notably, Iceland is the world's pioneer in the development and use of geothermal energy, with just under 30% of its electricity generated from these sources.

The project was implemented by the Directorate of Geological Survey and Mines (DGSM) and executed by Department of Development Support and Management Services of United Nations (UNDDSMS). Work included geological, geochemical and isotopic surveys, in Kibiro, Katwe-Kikorongo and Buranga (Gíslason, G, *et al,* 1994). The results justified further exploration efforts.

Isotope Hydrology for Exploring Geothermal Resources Phase-1 (1999-2003)
This was funded by the International Atomic Energy Agency (IAEA) together with the Ministry of Energy and Mineral Development (MEMD). The main objective was upgrading and refining the exploration models of Kibiro, Buranga and Katwe-Kikorongo prospects by using isotopes. This was a data gap closure and follow-up of the UNDP- ICEIDA project of 1993-1994.

Katwe-Kikorongo Preliminary Exploration (2003)
The African Development Bank (AfDB) funded another set of geothermal surveys in the Katwe-Kikorongo area, under the 'Uganda Alternative Energy Resource Assessment and Utilization Study (UAERAUS)'. This was to upgrade the exploration model of Katwe-Kikorongo to pre-feasibility status, making it easier to determine, analyze, and select the best business scenarios.

Kibiro Prospect Investigations (2004)
This exploration project was implemented by ICEIDA experts together with the government counterparts in refining the pre-drilling assessment initiated by the Ministry of Energy and Mineral Development. Activities included geophysical studies and geological mapping.

GEOTHERM Project
The German Federal Institute for Geosciences and Natural Resources (BGR), together with Ministry of Energy and Mineral Development (MEMD) conducted preliminary surveys in Buranga beginning in 2003. This was under the GEOTHERM Programme, which promoted the use of geothermal energy in developing countries.

Exploration workflow included surface water sampling and analysis, isotopic studies and geophysical surveys (Gravity, TEM, and Schulmberger sounding). Micro-earthquake survey was conducted around Buranga to map seismically active structures (Ochmann, *et al,* 2007). Results indicated active Rwenzori bounding faults presumed to control geothermal fluids flow. A magma body was inferred under Rwenzori Mountain. The 3He/4He ratios of geothermal fluids were measured to determine if a deep mantle signature was present. These elevated 3He/4He ratios were believed to be evidence of deep permeability and possibly deeper, higher-temperature fluid reservoirs.

ICEIDA-World Bank Power IV Program
ICEIDA together with MEMD then undertook studies in Kibiro and Katwe-Kikorongo. Project activities included drilling swallow thermal gradient holes (TGH). TGH results were not encouraging. Under this project, a countrywide preliminary resource assessment was carried out to down-select prospective areas for future advanced studies.

UGA/8/005 - Isotope Hydrology for Exploration Geothermal Resources- Phase 2:
IAEA funded project 'UGA/8/005 - Isotope Hydrology for Exploration Geothermal Resources- Phase 2'. This was another data gap closure intended to refine exploration models for Kibiro, Buranga and Katwe-Kikorongo prospects using isotopes.

Introducing Isotope Hydrology for Exploration and Management of Geothermal Resources, RAF/8/047:
The IAEA, together with the Uganda Government, initiated this project aimed at improving the exploration models of the geothermal systems in Uganda.

JICA-2014:
Following the situation analysis, JICA and MEMD undertook a joint venture technical study of Uganda's geothermal resources. The preliminary survey was implemented by West Japan Engineering Consultants Inc. and Mitsubishi Materials Techno Corporation. Seventeen geothermal sites were sampled for geochemical surveys. These included Kagamba, Karungu, Bubaale, Kiruruma, Ihimbo, Kanyinabalongo, Rubaare, Kitagata, Minera, Rubabo, Kizizi, Biarara, Rwimi, Kibenge, Muhokya, Rwagimba and Bugoye-Ndugutu. On-ground verification of interpreted satellite data was undertaken as well as preliminary geological mapping. Satellite images used included LANDSAT/ETM and SRTM/DEM, ASTER, and ASTER/GDEM. The main objective of this study was to down-select prospective sites for possible further technical assistance from JICA.

UNEP-ARGeo Study-2016:
UNEP-ARGeo under its programme, Technical Assistance for Surface Studies, funded pre-feasibility study of Kibiro prospect. Exploration efforts were complemented by MEMD and GDC of Kenya. Preliminary conceptual models of Kibiro were developed for this fault hosted extension (non-magmatic) system. UNEP donated micro-seismic equipment which were installed around Kibiro to delineate active faults presumed to control geothermal activity.

Ongoing Government-led Exploration.
Since 2011, the government has conducted focused surface studies at Kibiro, Buranga, Katwe and Panyimur. Technical assistance was provided by the East Africa Geothermal Energy Facility (EAGER) to develop conceptual models which will help pinpoint siting and drilling exploration wells.

Hon. Sarah Opendi Achieng launching the DGSM @ 100 Magazine.

100 Years' Celebration in Pictures

The Minister, Permanent Secretary and the Acting Director of DGSM pose for a photo moment with award winners during the 100 years' celebrations.

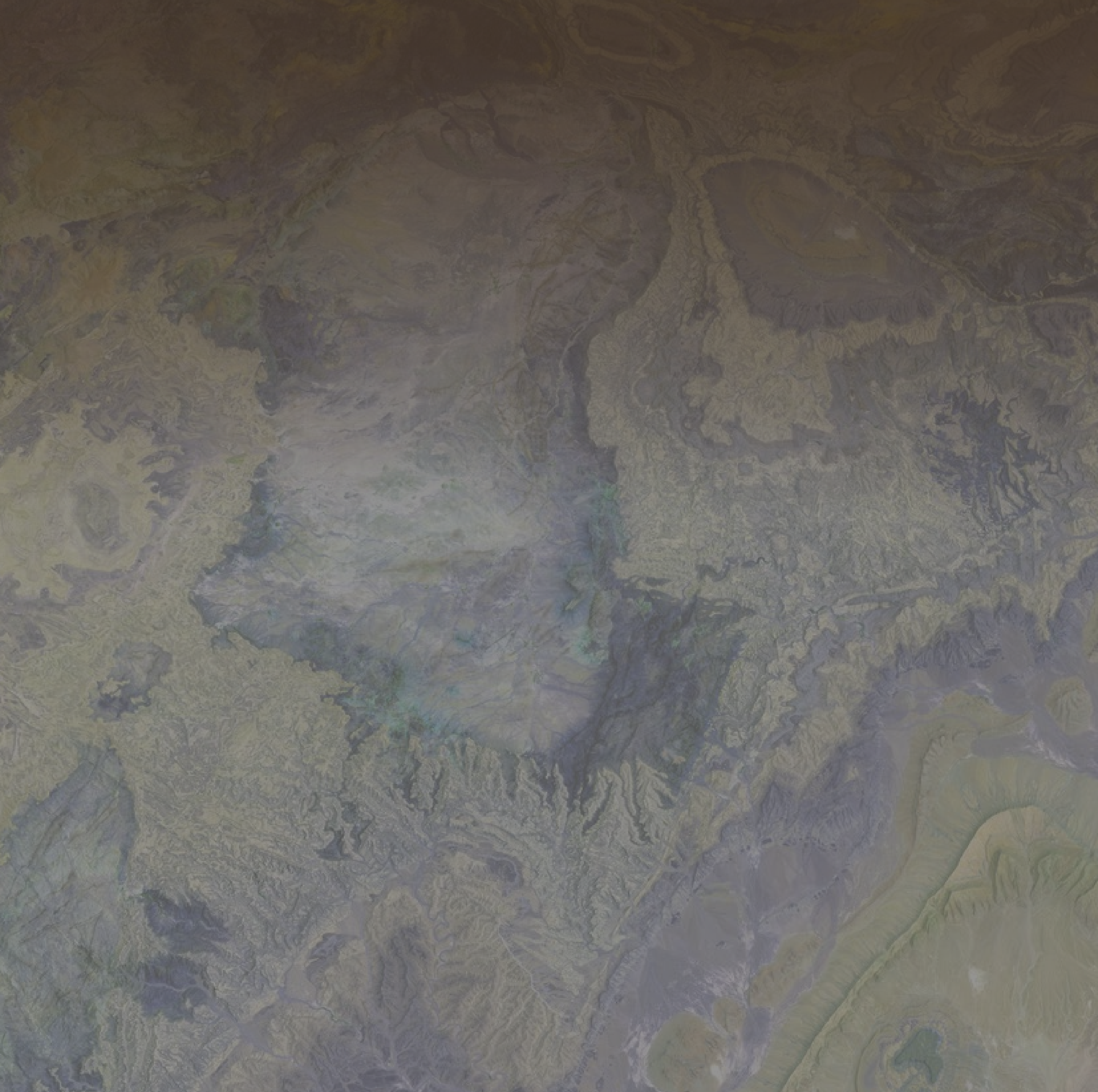
The DGSM staff in a group photo with Hon. Sarah Opendi Achieng, Minister of State for Mineral Development.

Cutting a cake to mark century

A time for chit-chat during the cocktail

Staff display the kind of energy that defines the DGSM spirit

Nothing like drums to herald an achievement



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