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[3503] Coal Mining inMalawi: Towards Economic Diversification
Coal Mining inMalawi: Towards Economic Diversification

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Due to poor agricultural production in Malawi, mining is the promising economic driver with coal as the strategic target commodity. The mining sector is in its infancy stage compared to other sub-Saharan countries. The paper discusses coal production trends and contributions to the overall economy of Malawi. Following analysis of problems in coal mines, a research investigating the effect of humidity on the strength properties of coal bearing rocks in Malawi is introduced. The aim is to improve the status of safety and risk management issues in underground coal mines. Method involves in-situ measurement of humidity, collection of rock samples and conduction of a multistage triaxial test for strength properties. The expected results are humidity variations in the sublevels, a weakening effect in the existing rupture surfaces in hanging roof and collapse. A conclusion can be drawn that technical and financial support brought to coal mines correlates with productivity.

1. Introduction

Malawi, in southeastern Africa, occupies a thin strip of land between Zambia and Mozambique protruding southwards into Mozambique along the valley of the Shire River. In the north and northeast it also shares a border with Tanzania. Malawi is connected by rail to the Mozambican ports of Nacala and Beira. Its most notable geographic feature is Lake Malawi in the east, measuring 500 km by 75 km, starting at the northern border and stretching nearly two-thirds of the country's north-south length.

Malawi's economy has for many years been agro-based and this industry did not have the needed muscle to increase the country's economy. Following the need to expand its economic base, Malawi made a firm decision to promote extraction of its mineral resources. Despite its previous idleness of the mining sector, which was mostly as a result of lack of interest in mining by the immediate post-colonial Government who focused on putting in place policies that promoted the agricultural sector, Malawi is now becoming one of the active mining countries in Africa, as evidenced by the various exploration and mining activities taking place currently.

The country's macro-economic vision is indicated in the Malawi Growth and Development Strategy (MGDS II). In this strategy, the mining sector is pointed out as one of the key priority sectors for economic growth. In view of this strategy, the Government's policy direction is to have:

- A viable and transparent fiscal and taxation regime that attracts investors in the minerals sector and ensures that a substantial amount of revenue is retained in Malawi.
- A clear, transparent and equitable regulatory framework for the minerals sector.

2. Legislative Framework

The Government of Malawi recognizes that the mining sector has significant potential to contribute towards rapid economic growth and development of the country. Having identified its strategic mineral commodities, the Ministry responsible for Mining produced a Mines and Minerals Policy document whose main goal was to guide and enhance the administration of the extractive industry. This would steer the economic driver from being an agriculture-based to a mineral based economy.

In addition to that, the Mines and Minerals Act, 1981 has undergone review to match international mining standards. Currently, the MMA Bill is ready for parliamentary action. With the new Act in place, mining industry will be properly regulated so as to ensure the benefit of Malawians on the minerals production.

Another milestone achieved by the Malawi government in enhancing the transparency in the mining industry was attainment of the membership of the Extractive Industries Transparency Initiative (EITI) in October 2015. EITI is a global transparency standard that was launched over a decade ago following a civil society movement to promote open and accountable management of natural resources. It seeks to strengthen government and company systems, inform public debate, and enhance trust within country's population. In return, Malawi natural resources sector is expected to develop and flourish in addition to enhancing transparency and accountability in use of public resources.

This will be coupled by a vibrant Malawi Chamber of Mines and Energy which, among other objectives, will act to

- to promote, advance and protect the mining industry of Malawi
- to consider all questions connected with the mining industry and to promote public interest therein;
- to collect and circulate information relating to the mining industry

3. Coal Resources

Malawi has been known for some time to contain coal deposits and this has been the country's strategic target commodity. There are four main coal-bearing areas in Malawi, two in the Shire Valley, Southern region, and two in the Northern region near to Lake Malawi. The most important coalfields of the Northern region, which are also the most promising coalfields in Malawi, are at Livingstonia and near Ngana on the Tanzania border.

Stratigraphically, in northern Malawi, the Karroo System strata are preserved in a number of N—S trending basins and down-faulted troughs and they display both unconformable and faulted relationships to the underlying Basement Complex gneisses. Coal is the only mineral of economic interest known to occur in the Karroo System (Permo-Triassic).

The coal resources occurrence in the Northern region of Malawi is shown in the Figure 1 below. In the figure, Livingstonia coalfield is marked 13 and Ngana coalfield is marked 5.

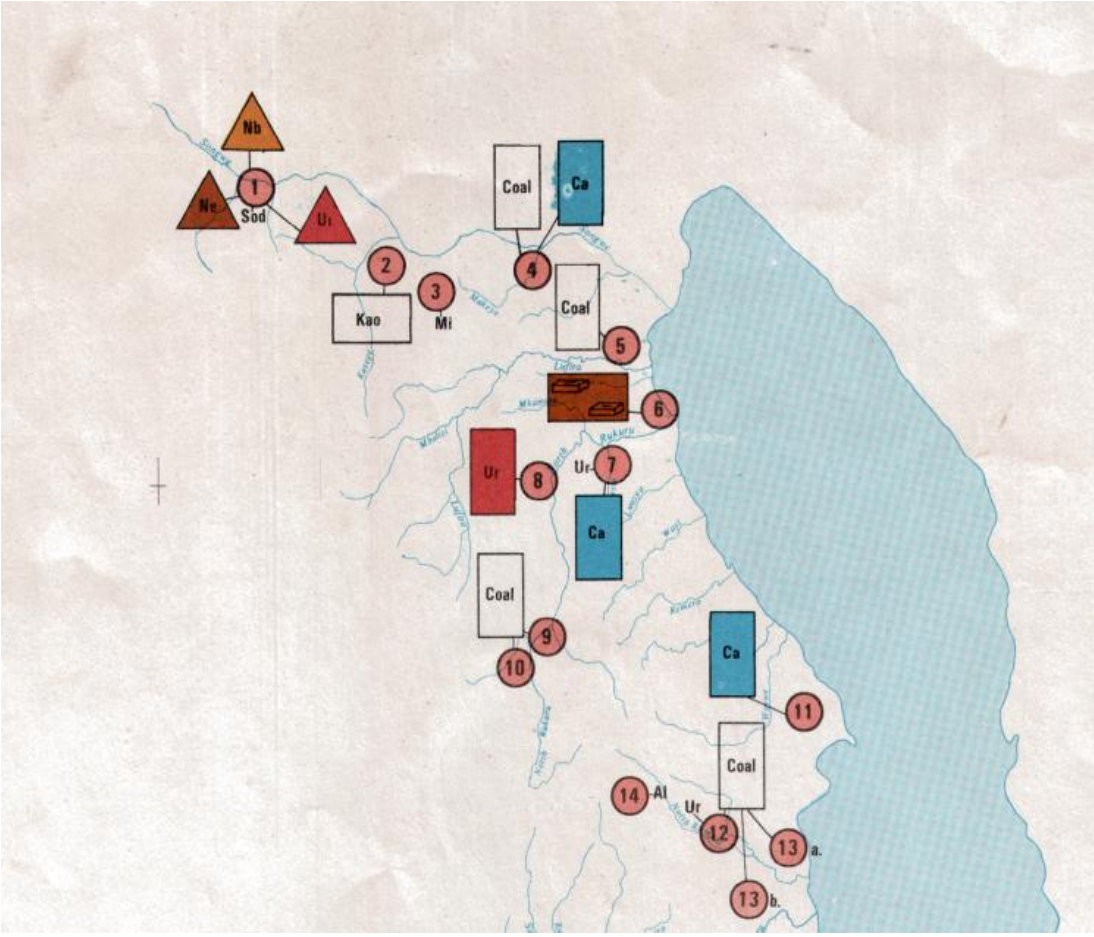

Figure 1: Mineral Resource and Occurrence Map (Northern Region) *(Source: Geological Survey Department - Malawi)*

The coal fields in Malawi and potential reserves as reported are shown in Table 1. Available proximate analyses include inherent moisture, fixed carbon, volatile matter, ash and heat content as also shown in this table.

Table 1. Approximate Analysis of Coalfields

Location	**Coal field**	**Potential reserve (million tonnes)**	**Moisture (%)**	**Sulphur (%)**	**Volatile Matter (%)**	**Fixed Carbon (%)**	**Ash Content (%)**	**Calorific Value (kcal/kg)**
Northern Malawi	Ngana	65	4.5	1.2	25	_	27	5,733
	Lufira	2.6	6.6	_	26.1	32.1	35.2	5,021
	Mwankenja	1	--	_	--	--	--	5,000
	North Rukuru	165	3.5	0.32	21.6	42.8	32.1	5,021
	Livingstonia	120.9	0.7	0.5	23	67	10	7,284
Southern Malawi	Mwabvi	4.7	1.1	0.76	6.8	50.5	44.1	4,173
	Lengwe	10	3.8	_	14.1	36.8	55.2	_
TOTAL		**369.2**						

Source: Geological Survey Department - Malawi

In Malawi, the coals are predominantly Sub-bituminous in rank as evidenced from the calorific values of most samples analysed by the Coal Analysis Laboratory of the Geological Survey Department in Lilongwe [1]. Most of the coalfields have been regionally explored. However, some more exploration work is to be continued in some coalfields to ascertain the quality and hence help in deciding the method of mining.

4. Coal mining

The solid fuel required for the basic industries of tobacco curing, textiles and cement. However, most of Malawi's industries are located in the southern part surrounding the city of Blantyre, the commercial capital. Therefore coal has been imported from Mozambique to the south, due to its lower price. Due the better quality of the coal in the north, underground mines have been developed in the northern coalfields. Currently five coal mines are producing in the north; Lufira, Malcoal, Eland, Kaziwiziwi and Mchenga mine, working in the Ngana and Livingstonia coal fields.

4.1 Mining Methods

Coal mining in Malawi is extracted by both underground mining and surface mining methods.

The underground mines developed along the Livingstonia coalfield all employ the room-and-pillar mining method. Room-and-Pillar or Bord-and-Pillar is the predominant mining method practiced because it suits the rugged terrain and stability of the hanging walls in the Livingstonia Coalfield and Hara area. The coal pillar dimensions vary from one mine to another ranging from 9 m x 9 m to 12 m x 12 m centre-to-centre. Nearly all underground mining sections are accessible by either one or two adits with well constructed canopies (Figure 2). These adits are situated either near the river banks or hillsides.

Figure 2: Mine adit with well constructed canopy at Mean- Jalawe Coal Mine

On the other hand, open cast mining is practiced in two other mines, name Eland and Malcoal mining companies. The use of machinery in these mines increase the total volume production of coal per annum.

Figure 3: Malcoal mining company - Karonga

4.2 Coal production and utilisation

In general, coal remains one of the most energy mineral mined for industrial use in the country. Coal production in 2014 declined due to non-availability of fuel for processing and transportation. However in 2015, the production trend slightly increased with a 3% due to increased demand with companies that are venturing into coal fired power production. This is projected to continue increasing the production of coal in the following years.

The Mchenga, Kaziwiziwi and Eland coal mining companies continue to be the mining sector’s largest producers of coal in Malawi, contributing about 90%. The companies have a combined maximum capacity of up to 11,000 metric tonnes of coal production per month when they are fully operational. The coal is mainly used for provision of energy for different production

processes in the cement, tobacco, textile, brewery, and food processing and ethanol industries. Besides mining the three companies have all embarked on expansion projects by, among other activities, continuing with exploration outside their current mining areas so as to increase their respective production capacities and meet the ever growing demand for coal.

5. Future plans

As Malawi looks to increase its energy output, the Ministry of Energy announced plans to build a 300 MW coal-fired power plant at the Kammwamba area in Zalewa [3]. This was coined with an agreement signed between the Malawi Government and Import & Export Bank of China. With this project in the pipeline, coal mining in Malawi will take an expansion route with increased technical and financial support. It is projected that a huge investment will be seen in expanding the coal mines and the hiring of more labour with technical expertise.

On the same note, since increase in production is directly affected by safety of the mine, a research to clarify the mechanism of the roof fall in the underground coal mines is crucial. This comes from a background that underground coal mines in the Livingstonia coalfield experience common incidence of hanging roof falls during the rainy season. This research will also try to find countermeasures against the hanging roof falls. The methodology will involve in-situ measurement of humidity using coin-type data loggers, analysis of roof fall data to ascertain a relationship between roof fall frequency and humidity levels, collection of rock samples and conduction of a multistage triaxial test for strength properties. The expected results will be a distinct humidity variation in the sublevel adits, causing a weakening effect in the existing rupture surfaces in hanging roof and collapse.

6. Impacts of Coal mining

6.1 Revenue

Revenues from coal mining come from payment of ground rent fees, royalties and, to some extent, coal export royalties which has recently experienced an increase [2]. The coal is exported to Tanzania for cement manufacturing. It is considered cheaper because the distance to Tanzania is shorter from other parts of the country.

Export of coal in 2015 by different mine operators continued to be dominated by coal, ornamental/dimension stones and gemstones, as shown in Table 2 below:

Table 2: Coal Exports

2013		**2014**		**2015**	
Quantity (tons)	**Value (K' million)**	**Quantity (tons)**	**Value (K' million)**	**Quantity (tons)**	**Value (K' million)**
9,310	103,151	8,845	97,993.45	7,835	107,893.45

Source: Malawi Economic Report (2015)

6.2 Employment

The mining and mineral industry generates substantial employment (directly and indirectly) opportunities in the country. In coal mining, the employment numbers is quite small though due to the scale of the operations. Although number of males dominates the coal industry, the employment numbers are expected to increase in 2016. Female workers are employed by Malcoal Mining Limited as dump-truck and front-end wheel loader operators. The combined workforce in the coal industry is shown by the following table:

Table 3: Workforce in the coal industry

YEAR	**2013**	**2014**	**2015**
Workforce	637	606	706

Source: Malawi Economic Report (2015)

6.3 Environment

Every mining investor has an obligation to conserve the environment and address all environmental concerns within and around the concession area. Legally, each mine needs to implement its Environmental Management Plan (EMP). It provides guidelines on how to address any and all environmental concerns. Underground mine water management, waste rock, potentially acid mine drainage and contaminant leaching are the serious environmental concerns identified during the recent inspections especially in underground mines. These will soon pose a serious problem.

7. Concluding remarks

Although coal mining in Malawi is still in its infancy stages as compared to other sub-Saharan countries, it has a great potential to improve and contribute more to the economy considering the amount and quality of coal reserves in the country. The mining regulations and legislations of the country will continue to be the key part of the governance framework for the mining sector, such that if effectively implemented it will generate consistent incentives for responsible behaviour of all companies and other actors regardless of their size. With the impacts and effects on the spheres of life in mind, there is need for consented efforts from all players in the mining industry to see these problems solved. A conclusion can be drawn that technical and financial support brought to coal mines correlates with productivity.

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