INNOVARE JOURNAL OF SOCIAL SCIENCES

Vol 12, Issue 1, 2024

ISSN - 2347-5544

Research Article

BENEFITS OF LITHIUM MINING TO NIGERIA'S ECONOMIC DEVELOPMENT

EBIKEMEFA EBIMOBOWEI CLINTON*, MARTINS BASU

Department of Mining Engineering, University of Jos, Jos, Nigeria. Email: clintonebiks@gmail.com

Received: 21 September 2023, Revised and Accepted: 27 December 2023

ABSTRACT

Lithium mining goes beyond the extraction of lithium ore; it involves the technological importance of the mineral together with its application. This refers to eco-friendly applications such as the production of electric cars, the production of lithium batteries for solar panels, and other electrical devices. Obtained lithium (spodumene) samples from visited mine sites in Gidan Kwano (Nasarawa State), Kokona (Nasarawa State), and Takushara (Abuja-Kuje LGA) were taken to the laboratory for analysis. The atomic absorption spectrometry result shows a lithium percentage that ranges from 1% to 4.5% (low to high grade). A statistical analysis of data for total production of lithium in a month (through interactive sessions with miners on-site) shows that over 20 tons of lithium can be produced in a month by an active lithium mine site. Conclusively, if 20 tons is used as the benchmark, this means that a total of 40 trucks worth ₦20,375,000,000 will be made per month and a total of ₦244,500,000,000 per year. With this amount of money, after the removal of various royalties, it can go a long way in handling various issues in the state, local government, and even at the federal level. Well-monitored lithium mining can create jobs for indigenous people in the community, and the financial contribution can increase the internally generated revenue. The production of electric cars in Nigeria will also help solve the issue of carbon emissions and create a friendly eco-system.

Keywords: Lithium, Spodumene, Electric cars, Financial contributions, Pegmatite.

 DOI: http://dx.doi.org/10.22159/ijss.2024v12i1.49993. Journal homepage: https://innovareacademics.in/journals/index.php/ijss

INTRODUCTION

New technologies and innovations translate to new ways of producing and consuming materials and energy sources. The sudden shift from the usage of cars that consume fuel to electric cars is a clear indication that man is evolving, and it also shows the need to help the eco-system in terms of reducing the emission of carbon into the atmosphere, which is the major driving during force for an eco-friendly system or application. In general, technologies are becoming more sophisticated, and products require the use of materials that are eco-friendly. Among these materials, metals have essential applications in technologies such as rechargeable batteries for hybrid and electric cars, permanent magnets for maglev trains, wind turbines, motors, and solar panels, Talens Peiro *et al*. (2013).

Even though such metals are used in low concentrations, demand has risen significantly, and consequently, their availability and potential recovery need to be considered, Talens Peiro *et al*. (2013). Although lithium has a low supply risk and there are possible substitutes depending on its applications, it is considered a critical metal due to its high economic importance.

Most of lithium economic importance are as follows:

i. As a material for the production of batteries for electrical devices, solar systems, and electric cars
ii. Lithium is the lightest and most highly reducing of metals, which confers on the battery having the highest gravimetric and volumetric energy densities (typically over 160 Wh/kg and 400 Wh/L), >50% of conventional batteries
iii. Lithium is a good conductor of electricity.

Countries in Africa, such as Nigeria and other African countries, must take the move into the usage of electric cars very seriously because the consumption of carbon from fuel-consuming cars and other domestic usage that affects the eco-system, leading to the depletion of the ozone layer, has led to an increase in radiation, which is felt from skin burns, and an increase in heat generated during the day.

DEMAND FOR LITHIUM MINERALS

The high demand for lithium minerals is a result of the increase in demand for the usage of electric-drive vehicles (EDVs). This drive for the use of EDV's came as a result of the need for the control of carbon emissions and also the need for an eco-friendly system, of which lithium batteries present themselves as most applicable. The current EDV demand projections may vary depending on the increase in demand by consumers. From recent projections in the demand for EDVs, the United States has been seeing a growing demand for EDVs. According to the projection, market share has reached over 9% of the total vehicles sold in 2017, as seen in Fig. 1. Sales of EDVs directly translate into demand for batteries, and in turn, lithium minerals. In terms of power capacity, to travel a 40-mile trip in an electric vehicle using a single charge, it would require 1.4–3.0 kg of lithium equivalent (i.e., 7.5–16.0 kg of lithium carbonate). The amount of lithium in the batteries of current EDVs ranges from 4 kg in a compact Nissan Leaf's battery to 63 kg in a Tesla Model S battery pack. To meet the current demand, the market share of lithium in rechargeable batteries has gone up from 0% in 1991 to 80% in 2007, according to Agusdinata *et al*. (2018).

Sources of lithium

The major sources of lithium are contained in brine lake deposits (also referred to as salars) and pegmatites.

From pegmatite deposit

The extraction of lithium in Nigeria is from a rich pegmatite deposit. Pegmatites are coarse-grained igneous rocks formed by the crystallization of magma at depth in the crust, Gruber *et al*. (2011).

Lithium is found in more than 145 different minerals, but it is extracted from the following types of lithium as seen in Table 1, while Fig. 2 shows the view of an observed pegmatite. Spodumene is the most abundant lithium ore, with a high percentage concentration of lithium.

From brine lakes

Lithium from brine lakes is obtained as lithium carbonate (Li_2CO_3) using the lime soda evaporation to dryness process. This consists

Fig. 1: United States sales volume and market share for electric vehicle. Source: Agusdinata *et al.* (2018)

Fig. 2: A visited pegmatite deposit

of evaporating salty water for 12–18 months in ponds using solar energy. Because evaporation occurs through the use of solar energy, the production of lithium from dry lakes is the most affordable and competitive of all processes, Gruber *et al*. (2011).

Methods used in the excavation of lithium from a pegmatite outcrop
The following steps are used in the excavation of lithium ore from a pegmatite deposit:

Reconnaissance survey/mineral exploration

This involves the search for a rich pegmatite outcrop. This stage is effectively carried out by a professional geologist, and such a team must have a very good understanding of the geology of the visited environment. It also gives detailed information about the quantity of the mineral deposit. This tells us if it is an economic mineral deposit.

Geophysical survey

The geophysical survey is another stage that comes after mineral exploration. This stage, if well done, has the ability to reveal the direction of the lithium vein. It also has the ability to reveal the location of the lithium vein, which makes it very easy for the mining engineer to make a decisive decision on how the mine design or mining operation should look, and it tells if it should be an underground mining operation or an open-cast mining operation. A geophysical result is generated at this stage.

Core drilling operation

This involves the process of using a core drilling machine to locate the depth of lithium ore, which comes out as core samples. The core drilling operation cannot be carried out without a geophysical survey report because, with the report, areas and points allocated for drilling and probable areas with high precision will be the areas where core samples will be obtained for geochemical analysis.

Importance of core drilling operations

i. Presents unadulterated core samples for analysis
ii. It tells the depth of the lithium ore from the obtained core samples

Table 1: Lithium types and their formulae

S. No.	Lithium types	Formulae
1	Spodumene	$(Li_2OÆAl_2O_3Æ4SiO_2)$
2	Lepidolite	$(KLi_2Al[Al, Si]_3O_{10}[F, OH]_2)$
3	Petalite	$(LiAlSi_4O_{10})$
4	Amblygonite	$([Li, Na]AlPO_4[F, OH])$
5	Eucryptite	$(LiAlSiO_4)$

Table 2: Classification of lithium grade by percentage as seen in Nigeria

S. No.	Lithium percentage	Grade/remarks
1	0.00–0.99	Poor grade
2	1.00–1.99	Low grade
3	2.00–2.99	Medium grade
4	3.00–4.00 and above	High/highest grade

iii. It also gives the mining engineer an idea of how the mining operation would look like
iv. If an underground mining technique is to be used, it gives the mining engineer an idea of how the shaft will be designed in terms of angle of inclination.
v. Geochemical analysis: With the aid of geochemical analysis (XRF, atomic absorption spectrometry [AAS], etc.), the obtained core samples are analyzed. This reveals the percentage purity or percentage concentration of lithium in the core sample.
vi. Excavation operation: After the geochemical analysis has been conducted, it tells the percentage of lithium in the core sample. With this information, if the percentage of lithium (Li) is high, the mining engineer draws a mine design that fits the kind of mining operation that is obtainable within the area. After this, the excavation operation continues, which includes the removal of overburden before hitting the lithium vein, but the stripping ratio must be calculated before the mining operation continues.

MATERIALS AND METHODS

Materials

(a) sample bag; (b) global positioning system; (c) note book.

Methods

Obtained samples of lithium (spodumene) were obtained from different lithium sites located in different states of Nigeria (research work was limited to some sites in Nasarawa and Abuja-Kuje LGA), states such as Nasarawa (Gidan Kwano, Angwa Kede-Kokona LGA), and Abuja (Takushara-Kuja LGA). The obtained samples were taken to the laboratory for analysis using AAS, and from the obtained results, it was observed that the percentage grade of lithium (Li) concentration ranges from 1% to 4.5%. This shows that it ranges from low grade to high grade. This is seen in Table 2.

The visited sites, the state where the site is located, and their coordinates are inputted in Table 3, while the schematic diagram of lithium formation is seen in Fig. 3.

As seen in Fig. 3, it shows the formation of lithium and the depth of lithium formation as observed at the visited site. In a very rich pegmatite deposit, the depth of getting lithium veins ranges from 10 to 20 feet, and sometimes it might be less or more, but in a poor pegmatite deposit, one may likely go deeper than 20 feet due to the geologic formation of the environment. The movement of the lithium vein goes either to the right or to the left of the formation, and it continues to travel in that order until the vein has been fully excavated. Table 4 shows the local price of different lithium grades in Nigeria.

Table 3: States visited, their locations, and co-ordinates

S. No.	State	Location	Coordinate
1	Nasarawa	Gidan Kwano	N08° 25.794' E07° 42.479'
2	Nasarawa	Angwa- Kede (Kokona LGA)	N9°0′0″N E8°03′0″
3	Abuja	Takushara (Kuje LGA)	N8°52′56″ E7°13′13″

Source - Clinton *et al.* (2023)

Table 4: Different prices for different grade of lithium in Nigeria (2023 price)

S. No.	Grade of lithium	Local price (s)/50 kg
1	Low-grade lithium (1.00–1.99%)	N10,000–N13,000
2	Medium-grade lithium (1.99–2.00%)	N13,000–N20,000
3	Poorly formed crystals but good trace of lithium	N35,000 - above
4	Highest grade lithium (well-formed crystals) - (4–5.00%)	N130,000/ N150,000- above

Source- Clinton *et al.* (2023)

RESULTS

Fig. 1 shows United States sales of electric vehicles and how it has positively impacted their economy. This can be replicated in all African nations if there is room for good policymaking with respect to lithium mining and its technological applications.

Lithium ore can be sourced in two different ways, as earlier discussed in Section 2.1. Fig. 4 shows the schematic breakdown for sourcing out lithium ore, and Fig. 2 shows the pictorial view of a visited pegmatite deposit.

Financial implications of mining lithium

Data collected from lithium mining sites has shown great financial contributions, which is both good for a businessman and also for a nation. With good collation of data from all lithium mine sites and collection of royalties paid at the state and federal levels, both the state and the federal level can be able to solve certain issues that face them, hence stopping the move to collect loans from different countries, which will consistently affect the development of the country and also devalue the currency of the nation.

DISCUSSION

1 kg of lithium (2023 price) = ₦20,375

50 kg of LiO_2 = ₦1,018,750

1 container of lithium (LiO_2): 500 bags of 50 kg = ₦509,375,000

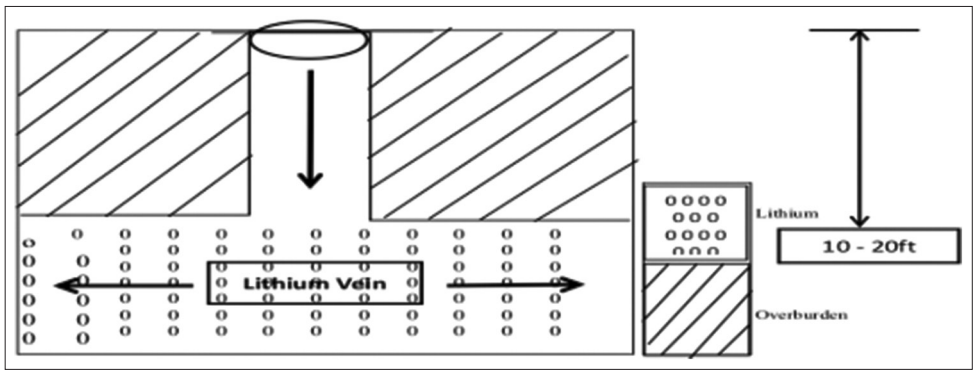

Fig. 3: A schematic diagram of lithium formation in Gidan Kede, Kokona LGA, Nasarawa state. (Underground Mining Design). Clinton *et al.* (2023)

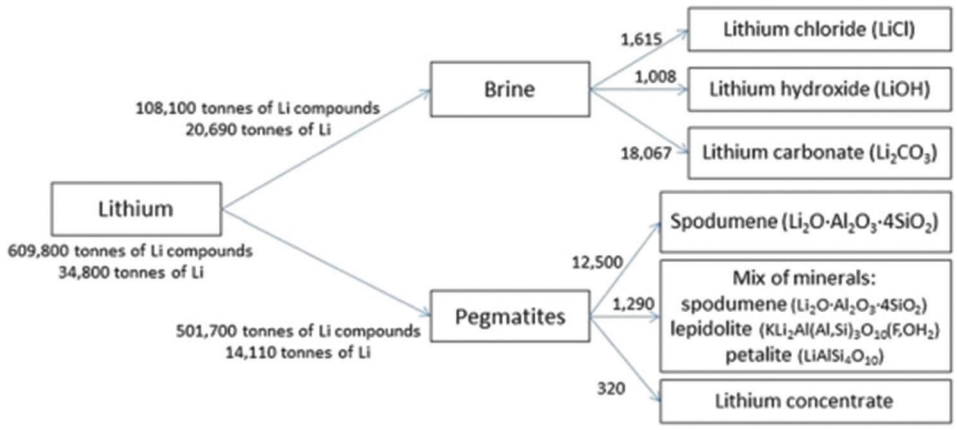

Fig. 4: Production sources of lithium in 2011 (in tons). Source: Talens Peiro *et al.* (2013)

An estimation of 20 tons per month (40 trucks) = ₦20,375,000,000

In a year, a total net worth = ₦244,500,000,000 per year.

CONCLUSION

Nigeria has often times acted as though she does not have the financial ability to be able to solve her problems, but this is not totally true because in different states of the federation, Nigeria has different types of mineral deposits of great economic importance. In the North, Nigeria is blessed with solid minerals like lithium and others, while in the South, she is blessed with liquid minerals (petroleum), which have been a major source of revenue for the nation, but it is high time she starts looking at other sectors like the solid mineral sector because this will help the nation financially and also economically. The major drive in the mining sector is lithium mining, and this has brought many foreigners to the country, which is a good sign for business and nation-building. With the estimation of 20 tons produced in a month from different mine sites, it was realized that a total sum of ₦20,375,000,000 will be made per month and a grand total of ₦244,500,000,000 per year.

Note: This price is subject to the International market, which depends largely on demand.

Recommendations

i. Strict laws should be placed by the federal government to restrict the illegal mining of lithium by illegal miners
ii. International trading of lithium should be fully supported and regulated by the federal government to help in terms of economic development
iii. Production of electric cars should be fully accepted by both the state and federal government, and the technology should be shared by foreign investors with indigenous citizens
iv. A proper database of lithium mined at various mine sites should be well collated for proper record-keeping and good identification of illegal miners. This will also help to give an idea of the ore reserve.

DECLARATIONS

Ethics approval and consent to participate

As approved by the Department of Mining engineering at a University of Jos, Nigeria, for the purpose of "Academic Research" and "Addition to Knowledge".

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Funding

No funding was obtained for this study.

Authors contributions

Both EEC and MB were involved in the field work, site visitation, collection of data, and writing and typing of the research. All authors have read and approved the final manuscript.

Acknowledgment

The authors wish to thank all the staff in the Mining Department, University of Jos, Nigeria, for their support.

REFERENCES

Agusdinata, D. B., Liu, W., Eakin, H., & Romero, H. (2018). Socio-environmental impacts of lithium mineral extraction: Towards a research agenda. *Environmental Research Letters*, *13*, 123001.

Ebikemefa, C.E., & Basu, M. (2024). Benefits of lithium mining to Nigeria's economic development. Innovare Journal of Social Sciences, 12(1), ???.

Gruber, P. W., Medina, P. A., Keoleian, G. A., Kesler, S. E., Everson, M. P., & Wallington T. J. (2011). Global lithium availability: A constraint for electric vehicles? *Journal of Industrial Ecology*, *15*, 755-760.

Talens Peiro, L., Villalba Mendez, G., & Ayres, R. U. (2013). Lithium: Sources, production, uses, and recovery outlook. *JOM*, *65*(8), 989-996.