

Occurrence of Galena and its Potentials for Economic and Green Energy Revolution in Nigeria

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Abstract -- It is estimated that Nigeria has over 100 million tons of lead ore deposit and it is an important component in car battery, however, significant amounts are also used to make lead sheets and pipe. It is also used to make low-melting-point alloys. Silver which is often produced as a by-product is also an important raw material. The prospect of Galena in global economy is promising, so the automotive industry which is closely related to the lead market, is witnessing growth thereby creating more demands for the product. Galena is an important mineral in this era of green energy revolution, therefore, this paper seeks to examine the occurrence of Galena in Nigeria, its composition, properties and financial viability or otherwise of establishing Lead ore mine in Nigeria.

I. INTRODUCTION

Nigeria is blessed with abundant mineral resources; fossil fuels and solid minerals. The most popular being the fossil fuels since these constitute the nation's greatest foreign exchange earner. They have, therefore, tended to overshadow the solid mineral sector of mining industry. Solid minerals are of many types occurring in many diverse environments in response to many diverse geology and geologic events.

The resources can be grouped under the following category:

- Iron and Iron-alloy metals
- Non-ferrous Industrial metals
- Precious metals
- Metal fuel
- Industrial minerals

Galena belongs to the Non-ferrous industrial metals with other minerals like copper, zinc, tin and other aluminum bearing minerals. All the categories of the solid minerals are found in Nigeria at varying concentrations and different forms.

II. GALENA AND ITS OCCURRENCE IN NIGERIA

Galena is the primary ore mineral of lead. Its discovery dates back to 3000 BC, and its name is derived from the Latin word galena, meaning dross from melted lead [1]. Galena is a lead sulfide mineral with a chemical composition of PbS. It is the world's primary ore of lead and is mined from a large number of deposits in many countries. It is found in igneous and metamorphic rocks in medium- to low-temperature hydrothermal veins. In sedimentary rocks it occurs as veins, breccia cements, isolated grains, and as replacements of limestone and dolostone.

Galena deposits are found in various environments in Nigeria. Galena is found in large deposits mainly in Ishiagu, Ebonyi State, with an estimated reserve of 15 million tonnes[2], other states with these deposits includes; Taraba, Kwara, Ogun, Kogi, Ekiti, Plateau, Bauchi and Nasarawa. Galena is mostly found in association with other minerals like fluorite, calcite, sphalerite, marcasite, pyrite, chalcopyrite, siderite, dolomite, quartz, silver minerals and many other hydrothermal minerals.

III. COMPOSITION OF GALENA

Galena is composed majorly of Lead and sulphide, with trace amount of copper, antimony and bismuth as shown in Table 1.

Table 1 Percentage Composition of elements in Galena

Elements	Content (%)
Pb	85.9
Cu	0.6
Sb	0.7
Bi	0.2

S	12.6
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Galena deposits often also contain significant amounts of silver as included silver sulfide mineral phases or as limited solid solution within the galena structure. These argentiferousgalenas have long been the most important ore of silver.

The typical specimen of galena is about 85.9% lead and 12.6 % sulfur by weight. However, some specimens of galena contain up to a few percent silver by weight as shown in fig 2. They are called "argentiferous galena" because of their silver content. In these specimens, silver can substitute for lead in the atomic structure of the galena, or it can occur in tiny grains of silver minerals included in the galena.

Silver within the galena disrupts the crystal structure, which often causes the galena to have curved cleavage faces [3]. This tiny bit of knowledge can be a powerful prospecting tool. In addition to silver, galena can contain minor amounts of antimony, arsenic, bismuth, cadmium, copper, and zinc. Sometimes selenium substitutes for sulfur in galena.

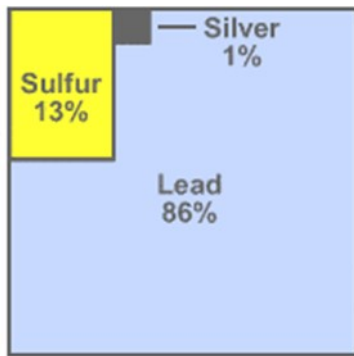


Fig 2: Structure of Galena

V. PHYSICAL PROPERTIES OF GALENA

Table 2 shows the Physical properties of Galena. Freshly broken pieces exhibit perfect cleavage in three directions that intersect at 90 degrees [5]. It has a distinct silver color and a bright metallic luster. Galena tarnishes to a dull gray. Because lead is a primary element in galena, the mineral has a high specific gravity (7.4 to 7.6) that is immediately noticed when picking up even small pieces. Galena is soft with a Mohs hardness of 2.5+ and produces a gray to black streak. Crystals are common and they usually are cubes, octahedrons, or modifications

Table 2: Physical Properties of Galena

Physical Properties of Galena	
Color	Fresh surfaces are bright silver in color with a bright metallic luster, tarnishes to a dull lead gray
Streak	Lead gray to black
Luster	Metallic on fresh surfaces, tarnishes dull
Diaphaneity	Opaque
Cleavage	Perfect, cubic, three directions at right angles
Mohs Hardness	2.5+
Specific Gravity	7.4 to 7.6
Diagnostic Properties	Color, luster, specific gravity, streak, cleavage, cubic or octahedral crystals.
Chemical	Lead sulfide, PbS

IV. STRUCTURE OF GALENA

Galena has a chemical composition of PbS as shown in fig 2. That means it contains an equal number of lead and sulfide ions. The ions are arranged in a cubic pattern that repeats in all directions. This structure is what causes crystals of galena to have a cubic form and causes galena to break in three directions at right angles [4]

Fig 1: Composition of Galena by weight%

Composition	
Crystal System	Isometric

Other properties of Galena such as Electron density, photoelectric, fermion index and radioactivity are shown in Table 3.

Table 3: optical/mechanical properties

Electron density	Bulk density (electron density) = 6.23 g/cm ³ note: Specific gravity of Galena = 7.60 g/cm ³
Photoelectric	$PE_{Galena} = 1623.65$ barns/electron $U = PE_{Galena} \times \rho_{electron\ density} = 10108.40$ barns/cm ³
Fermion index	Fermion index = 0.19 Boson index = 0.81
Radioactivity	GRapi = 0 (Gamma Ray American Petroleum Institute Units) Galena is not radioactive

VI. MINING AND PROCESSING

Galena is the principal source of lead (II) sulphide with a melting point of 1,114 °C and a boiling point of 1,281 °C [6]. A process known as smelting is used in extracting Galena from the mineral bearing rock bearing m, Galena is very easy to smelt, the process involves placing the rocks that contain galena on fire and the ashes collected as lead after the fires burnt out.

People have taken advantage of this simple smelting for thousands of years. Archaeologists have found lead beads and statues in Turkey that date back to about 6500 BC [7].

VII. ECONOMIC POTENTIALS OF GALENA

Galena is a very vital ore for the electrical and electronic industries because of its principle constituents which Lead and it is also because of this reason that it is mined in Nigeria, Africa and other countries of the world. Galena is a very important mineral because it serves as an ore for most of the

world's lead production. It is also a significant ore of silver. Used also in making lead-acid batteries and as kohl in cosmetics industries.

The number one use of lead today is in the lead-acid batteries that are used to start automobiles. The typical auto battery contains about twenty pounds of lead and must be replaced every four or five years. There are millions of these batteries in Nigeria. Lead-acid batteries are also used as standby power supplies for computer networks, communication facilities, and other critical systems. Lead is also one of the metals used in energy storage systems associated with power generation and hybrid vehicles.

In some deposits galena contains about 1–2% silver, a byproduct that far outweighs the main lead ore in revenue. Some mines has the potential to produce more revenue from the silver content of their galena than from the lead content. Assume that we have a mine that produces argentiferous galena with an average composition of 86% lead, 13% sulfur and just 1% silver as shown in fig.1. The small amount of silver has a huge impact on revenue because the price is many times more valuable than an equal weight of lead.

VIII. CONCLUSION

Galena is a sulphide mineral and the most abundant of the group it is the main ore of lead, used since ancient times. Because of its somewhat low melting point, it was easy to liberate by smelting. Galena has numerous uses and application. Lead which is the main constituent serves as raw material to numerous industries. Nigeria is blessed with abundant deposit of Galena which is not optimally exploited. There exist a big potential for development of small and big scale manufacturing enterprise in the Mining, processing and utilization of Galena with multiple benefits to our economy.

It is reassuring to note that the government has progressively in recent past years shown great interest in the exploitation of Nigeria's solid minerals as a means of diversifying our economic base.

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