American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-03, Issue-12, pp-150-154
www.ajer.org

Research Paper Open Access

Iron ore Development and supplies from Third world: A Potential for Sustainable Development.

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ABSTRACT: *This paper discuss the qualitative leaching of iron ore in hydrochloric acid and multi gravity separation method as new strategies for reducing lost of iron during production. The focus of the paper is on the potential of iron ore development and supplies from Third world for Sustainable Development and to enter and sustain in the export global competitive Market..*

KEY WORDS*: Sustainable Development, Iron ore, Potential, Strategies.*

I. INTRDUCTION:

The occurrence of mineral resources in commercial quantities alone does not however guarantee optimum benefit, factors such as technological capacity, finance and market are also equally important. Nigeria for example is blessed with abundant mineral resources and human resources capable of tapping these resources for industrial growth, however, what is witnessed today is that most of the mineral development, especially the exploitation is done by informal and in most cases illegal miners using very crude techniques with no consideration for the environment or human health. The Ministry of Mines and Steel Development has identified, and is promoting the development of 34 mineral resources in Nigeria which include iron ore, gold, coal, tantalite, bitumen, limestone, barite, gypsum, kaolin etc. Some Third world countries are endowed with enormous mineral resources which when properly harnessed can lead to industrial development and prospects. It is a known fact that countries abundantly endowed with mineral resources become great industrial nations [1]. While on the other hand, the level of greatness of a nation is often a reflection of how its resources have been planned, managed and utilized [2] The importance of mineral development of any nation cannot be overemphasized as it is one of the sources of industrial raw material supply, what must however, be emphasized is the manner in which the resources are developed. Iron ore deposits have been found in various locations in Nigeria, but mainly in the north-central, north-east and south-east regions. Iron ore deposits in Nigeria typically occur in the following forms: hematite, magnetite, metasedimentary, bands of ferruginos quartzites, sedimentary ores, limonite, maghemite, goethite and siderite. [3]

Below are some of the notable iron ore deposited in central Nigeria.

S/N	Deposit Area	Estimated Reserves (million tones)
1	Itakpe	310
2	Ajabanoko	60
3	Agbado-okudu	60
4	Tajimi	20
5	Anomaly K-3	30
6	Anomaly K-2	20
7	Ochokochoko	12
8	Agbaja	370.5

The most notable iron ore occurrence in this region include Itakpe,Ajabanoko, Ochokochko, Tajimi, Agbado-Okudu, Ebiya, Ero, Echakaraku, Ozenyi, Udiarehu and some others. They occur as bands and lenses of banded (and sometimes massive) iron formation dipping between 21 and 85 and mostly conformable to the host rocks (gneisses and amphibolities). The tabular ore bodies, up to 45m thick, and extending for distances from hundreds of meters to over 5km, are developed to a depth of over 300m, and are often displaced by small to large faults, The ore are mostly magnetite and/or hematite with quartz, biotite and amphiboles in the groundmass, iron content ranges between 15% and 65%, averaging 30-36.

(i) Rich ores with more than 50% Fe, and constitutes about 4.5% of the total reserves.

(ii) Medium grade ores, with 30-50% Fe, and constitutes about 85.4% of the reserve.

(iii) Lean ore, with 25-30% Fe, which constitutes 13.1% of the reserve.

The numerous occurrence of banded iron formation associated with the metasediments of the schist belt areas occur sporadically in minor bands and lenses These locations extend from Tsofon Birni Gwari -Farinruwa to south of Birni goga, and west of Kaura-Namoda, Baraba hills , 5km west of Maru, Koriga river, kalangai and Jamare areas. Magnetite and hematite are the major ore constituents in variable percentages. Average ore grade is usually between 38.9 -57.4% $Fe_2 0_3$. Three occurrences of iron bodies at Oko, Gbede, Ajashe have been mapped around Ogbomosho area as narrow lenses and bands. They are mostly hematite, magnetite iron formation with an Fe grade of 34.4% at Oko, 42.7% at Gbege and 39.0% at Ajashe. They are extensively laterally enough to attract detailed economic evaluation. Although the thickness of occurrence have not yet been ascertained.

II. EMERGING INVESTMENT OPPORTUNITIES

While the Itakpe iron ore deposits are being mined as raw material feeds for Ajaokuta smelting facilities, opportunities for investment in the iron ore resources of Nigeria exist for the deposits in the Northwestern and Southwestern Nigeria. Investors are invited to explore the possibilities of either wholly owning the mineral titles or partnering with existing title holders in exploiting the resources for economic development of Nigeria. Investment opportunities abound in the following areas:

1. Applying for mineral titles with a view of wholly owning the mining rights for the iron deposit
2. Partnering with existing title holders for detailed exploration as consultants and specialists
3. Partnering with existing title holders in joint venture agreement to explore, mine and market the iron ore resources of areas of interest [4]
4. Legal transaction in iron ore won in quarries and operations for export.

III. IRON ORE WORLD TRADE

Developing countries accounted for 57.7 % of world iron ore production (down from 58.6 % in 2010), the CIS countries for 10.6 % (slightly down from last year) and the industrialized economies for almost 31.7 %. The decrease in the share of the developing countries was due mainly to growth of production in Australia - up over 55 Mt. Chinese production, on a comparable grade basis, was 321.9 Mt, or 16.6 % of total world production in 2011, down from 17.3 % in 2010 but below the top level of 20 % in 2007. In more general terms, for the long run, Australia and Brazil will be the dominating forces in iron ore production. India, which has large and good quality resources of iron ore, will be hampered by red tape and an on-going internal struggle of use. Over time, as the Indian steel industry grows, most of the iron ore will be used domestically. We also foresee a slow decline in Chinese output. If prices fall, it will decline more rapidly and a major “Great Chinese shake-out” will begin. In 2011, international iron ore trade reached a new record level as exports increased for the tenth year in a row and reached 1117.0 Mt, up 6.7 %. The increase was the result of higher demand from mainly China while most other countries in the world had trade levels similar to the year before and most of them have not reached their import levels of 2008. These figures include all export trade including intra-CIS trade, while re-exports figures have been deleted as far as possible. World total iron ore exports have increased by 109.7 % since 2002. Developing countries accounted for 49.0 % of total in 2011, and their exports have grown by 100.2 % since 2002. Developed countries accounted for 51 %, including CIS republics (with about 6.6 % of total world exports). Australia’s exports increased by 8.9 % to 438.8 Mt in 2011 compared to 2010. With important markets in Europe and the Americas picking up pace, Brazilian exports, which fell sharply in 2009, had definitely turned around by 2011 with an increase of 12.1 % in 2011, compared to 2010, up to 348.6 Mt up from 310.9 Mt. Exports from India fell for the second consecutive year, 2010 was the first time in twelve years with falling exports but the country, at its 78.4 Mt down 18.2 % from 95.9 Mt, is still the third most important exporter.

In 2011 the Ukraine, Kazakhstan and Russian Federation increased their exports. China has become an important market for all three countries. Transport capacity has been a limiting factor for further expansion.
In 2003, China outstripped Japan to become the world's largest iron ore importer. In 2011, its imports were 686.7 Mt, an increase by 11.0 % compared to 2010. In 2010, China accounted for almost 59 % of total wor1ld imports. In 2011, this figure had increased to 61.5 %. Almost everywhere else, imports fell: in Japan by 4.4 % to 128.4 Mt, and in the Republic of Korea by 15.3 % to 64.9 Mt. European imports (excluding the CIS countries), decreased by 1.4 %, reaching 132.1 Mt down from 133.9 Mt and corresponding to just under 12 % of world imports. In Europe, Germany, France, Italy and the United Kingdom are the largest importers. Though these countries were hit by the crisis in 2009 with falling imports, all four have saw increases in 2010. However imports in Europe have fallen in 2011 for all countries except Italy, and are still lower than 2008 levels. As a group, developing countries accounted for almost 68.1 % of total iron ore imports in 2011 (66 % in 2010). Due to a strong growth in imports of China, the developing world's share of total imports increased from only 31 % in 2002 to 46 % in 2005, 50 % in 2006 and 55 % in 2008. The CIS republics do not yet import iron ore from outside the CIS, and their internal trade in 2011 was only 1.2 % of the world total. Developed economy countries accounted for about 30.7 % of world imports in 2011.

Challenges of Mining Industry
The major challenges faced by the industry can be categorized into the following heads:

• **Project funding**

Due to the long period of inactivity and the slow implementation of the Federal Government's reform agenda in the sector, multinational corporations have been reluctant to fund major mining projects in the country. However, the progress made in the regulatory reform, so far, is expected to stimulate activities by new investors in the sector.

• **Infrastructure development**

A major challenge to the development of the sector is the infrastructural imbalance within a country, particularly, adequate electricity supply, and access roads to sites of mineral deposits.
However, the ongoing privatization of the national utility and reform of the power sector started in 2005 are stimuli for private investment in the sector. As capacity increases with new investments in the generation, transmission and distribution sectors, the shortages currently being experienced will be overcome. Meanwhile, mining investors can meet their power needs by engaging independent power producers for captive generation and supply of energy to the mines. Furthermore, access roads will ultimately improve with ongoing investments by the Federal and State Governments in road infrastructure. The ongoing rehabilitation of the rail lines will also facilitate product evacuation across the country for export. [4]

• **Security**

Militancy and insurgency in Developing countries has pose a threat to communities where mining ndustries are located, Security concerns are of the magnitude that discourage investors in some third world countries mining sector. However, investors are well advised to have a robust corporate social responsibility programme to address the needs of their host communities. Therefore Government security agencies should be equipped to respond appropriately to social conflicts as and when they arise.

• Illegal mining and community challenges

There are pockets of Illegal mining activities in some of the regions, with the attendant risks and community challenges. However, with the enactment of the Mining Act, foreign investors with the necessary permits and licenses are guaranteed unfettered operation of their legitimate business in the country.

IV. METHODS OF OBTAINING HIGHER PERCENTAGE OF IRON FROM IT'S ORE

(1) **Quantitative Leaching of Iron Ore in Hydrochloric Acid**

Metallurgy of iron is a process of extracting iron from ores and preparing it for use. These extraction and preparation processes involve the conversion of naturally occurring iron-bearing minerals into metallic iron. The major process for the production of iron is the smelting process in blast furnace. It entails two major procedures: ore preparation and reduction of oxide concentrates, and the overall reaction for the reduction of say hematite to metallic iron with carbon monoxide is:

$\frac{1}{2} Fe_2O_3(s) + \frac{3}{2} CO(g) \rightarrow Fe(s) + \frac{3}{2} CO_2(g)$ (1)

Iron may be efficiently extracted from its principal ores with hot conc. HCl, but not with conc. H_2SO_4 or

HNO_3. The efficiency of HCl extraction is ascribed to the formation of ferric chloride complexes (Encycl. Sc. & Tech., 1997). Ore also contain Si and SiO_2 and silicates. Iron may be extracted from some kinds of silicates, rovided that the sample is finely ground, but the process is slow. $SnCl_2$ increases the rate of extraction by reducing Fe(III) to Fe(II), and is particularly effective for haematites and magnetites [7]. The kinetics of dissolution of sulphidic inerals or the related form in chloride media has received considerable attention recently. There are several justifications for this interest. Among them is the ability of materials of construction with improved resistance to chloride attack. More importantly, however, are the substantially faster dissolution rates exhibited by most sulfides in chloride media and the potential application of such electrolytes in the treatment of complex sulphide [8]. They reported and proposed results of the overall leaching reaction which are consistent with the following stoichiometry [9],relating to pressure oxidation of the base metal sulphides:

Chalcophyrite: $CuFeS_2 + 2HsSO_4 + O_2 \rightarrow CuSO_4 + 2S^0 + H_2O$ (2)

Pyrite: $FeS_2 + H_2SO_4 + ½O_2 \rightarrow FeSO_4 + S^0 + H_2O$ (3)

Furthermore, the leaching of the iron-ore in different media has been studied by many investigators [10]. To the best of our knowledge, there is no reported works viz a viz the quantitative leaching of a Nigerian iron ore. Therefore, this strategy has provided data on the quantitative leaching and the kinetics of dissolution behavior of the iron ore in hydrochloric acid solutions. This strategy is interesting from the industrial perspective, as it could provide optimum conditions for the commercial production of ferric chloride from the indigenous iron ore [5]. Ferric chloride is an important material for water and industrial liquid effluents treatment [11].

(2) **The Multi Gravity Separator Method**

The Multi Gravity Separator (MGS) is reported to be promising equipment for the separation of particles in fine size range. The MGS is suitable for the treatment of fines with a maximum particle size of approximately 0.5 mm. Maximum concentrate grade and maximum recovery is of today's demand with MGS concentration as it is with many concentration processes [12]. The equipment is based on a concept developed by M/s Richard Mozley Limited, U.K. [13]. The principle of MGS may be visualized by rolling the horizontal surface of a conventional shaking table into a drum and rotating the same along the horizontal axis. This causes application of an enhanced gravitational force, many fold higher than the normal one, on the mineral particle flowing across the surface. This leads to improvement in the treatment of fine particles in comparison to conventional separator like shaking table. Conventional gravity separation process of iron mineral fines is not very effective. In present work Multi Gravity Separation (MGS) process has been studied. This study was performed on a low-grade iron ore namely goethiticlateritic ore (GLO) from Eastern India. Detailed mineralogical, physical and chemical characteristics of a goethiticlateritic iron ore showed that the sample contained porous and friable oxides and hydroxides of iron. The ore sample had a feed grade of 54.43% total Fe, 9.27% SiO_2 and 8.02% Al_2O_3. Hematite and goethite are main iron-bearing minerals while kaolinite and gibbsite are the major gangue mineral constituents. Considering the characterization data, these ores were ground separately to three size fractions, namely -300 μm, -250 μm and -150 μm sizes and subjected to flowing film concentration in Wilfley Table. As revealed by the liberation study, higher concentration was obtained by the processing of -150 μm crushed sample. The grade of the ore was improved from 54.43% Fe to 65.71% Fe. However, significant amount of fine iron ore particles were lost during the processing of -150 μm size ore, because it is not very effective for particles less than 15 μm. Thus, fine hematite and goethite particles are usually not recovered resulting in the loss of valuable iron ore fines. To recover this fine, Multi Gravity Separator was used in place of Wilfley Table and was found to be effective in reducing loss of fine iron particles and increasing the grade of the concentrate.[6] The MGS process improved the Fe from 54.43% to 66.5% along with decreasing the alumina from 8.02% to1.17%..

IV. CONCLUSION

Some Developing Countries are well endowed with metallic minerals which include iron ore, However the minerals are not fully harnessed for industrial development, also the mineral development is so slow because of inadequate funding and also lack of awareness on the importance of the minerals in industrial development. If this trend continues then there is little hope of fully harnessing the mineral resources fully for industrial and technological development. This paper has discussed the possibility of Developing countries to produce up to 80% of world iron if the strategies of obtaining pure iron are well applied.

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