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ROLE OF VALUE ADDITION TO MINERAL RESOURCES IN ENHANCING ECONOMIC GROWTH - A CASE FOR ZIMBABWE.

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Abstract
Economic growth is a result of value addition that creates wealth for nations. Nations utilise the gifts of nature which are the raw materials to manufacturing. Africa has abundancy of these natural resources but lacks appropriate economic development due to lack of Science and Technology. In the worst case, raw materials are extracted from Africa and exported in their raw state at very low prices. Value addition or processing is done outside the countries of origin and the finished goods or processed materials imported as finished products that attract more money. The importation at high prices opens the gap between poverty and wealthy nations. This paper highlights the plight of Zimbabwe due to lack of appropriate technologies to engage in complete value addition to the raw materials that are abundant in their nations. This unavailability of such technologies is quickly capitalized by rich nations who already have the technology but do not have adequate raw materials in their nations. Such a scenario creates exploitation of natural resources from African nations. This then makes it difficult to meet the Millennium Development Goals (MDGs) that were agreed upon by the United Nations member states. The paper highlights the case for Zimbabwe which prides the mineral rich Great Dyke which has various precious minerals but extraction is limited by appropriate technologies to go the full length on the value addition. Lack of science and technology leaves Zimbabwe among other developing nations at the mercy of developed countries. Efforts are being made at national level to promote Science and Technology but the associated political policies are affecting the same. Developing countries need to foster a "win-win" partnership with developing nations so as to promote science and technology enterprises targeted at capacity building in value addition.
1. **INTRODUCTION**

Mineral wealth should be a source for equitable growth and poverty reduction. Zimbabwe has wealth in minerals with the major ones being Gold, Platinum, Chromium, Nickel and Asbestos, Copper among others. Most of these are found in the Great Dyke. Closing the gap between rich and poor nations has been a problem for a long time now. The richest countries in the world owe their economic success to manufacturing - value addition to raw materials. Going back in history, Britain was the first country to industrialise and subsequently was the dominant power then until other countries in Europe and Asia followed suit. A case in point is China which has experienced rapid transformation economically thanks to an ever growing and diversified manufacturing industry and has overtaken Germany as the largest exporter of finished goods. All this phenomenal growth hinges on the availability of cheap raw materials from Africa. This paper seeks to highlight that Zimbabwe, a Southern African country endowed with numerous mineral resources some which have not been meaningfully exploited ought to be in a much better economic state. There is need for a shift in policy and thrust from being a net exporter of ore, coke, coal, mineral concentrates, and partially refined metals to a net exporter of consumer goods like automobiles, industrial machinery, and electrical and electronic goods, among other things. The thrust to utilize Science and Technology enterprises to support sound research and investment policies. The focus is on Platinum Group Metals (PGM) found in the Great Dyke of Zimbabwe. The paper looks at the state of the mining sector in Zimbabwe and other line industries and suggests ways in which wealth creation can be enhanced through value addition. It starts by outlining the mining industry in Zimbabwe and its earnings, the current state as well as the ownership of particular mines and downstream industries. It looks at available infrastructure and how value addition is done in Zimbabwe and identifies the appropriate gaps that exist for the conversion of mineral wealth to economic wealth. We also discuss what the government needs to do to stimulate economic growth powered by the manufacturing industry. Finally we conclude and summarise the economic threats from mineral resource exploitation.

1.1. **Value Addition**

In the context of this paper, value addition is the enhancement added to minerals by a company before selling to customers. Processing of raw materials is the solution to African economies in the wake of the global financial crisis, says UN Secretary General Ban Ki-Moon (2009). He also maintains that a slowdown in the global economy will hit exporters of primary products hard, (Tradeinvestafrica, 2009). The secretary general said the continent is especially vulnerable to global economic shocks because primary products account for more than 50% of the value of exports. According to the same source presently, Africa contributes only 1% to global manufacturing. It has relied heavily on trade in commodities thereby failing to transform its industrial landscape. It is therefore apparent that Zimbabwe needs to be able to process its minerals into higher-value products for exportation and local consumption and this will translate into economic growth.
2. Mining in Zimbabwe

Zimbabwe is a mineral rich country. It has more than half of the world’s known chromium reserves and is the second largest producer of platinum after South Africa, which accounts for approximately 80% of the world’s total annual platinum production and contains an estimated 88% of the world’s platinum reserves, with a proved and probable reserve of 6,223 tons, or 223 million ounces (Mbendi, 2009). Mining contributes significantly to Zimbabwe’s economy by producing a wide range of minerals for export and for domestic usage as raw materials to the manufacturing and agricultural sectors. Before the major economic downturn in Zimbabwe, the mining sector played a major role in economic growth though it was not its full potential. In the year 2002, the mining sector accounted for 27% of exports, making it the country’s leading industry. Platinum is among the major minerals that are exported from Zimbabwe but it is exported to South Africa as concentrate hence Zimbabwe production figures end up being credited to South Africa. Platinum has been known to exist for several decades in Zimbabwe, but it is not until now that platinum mining companies are starting to make real progress in extraction and processing (McCoach 2008).

The mining industry is a significant employer of workers who, with their dependents, are mainly housed around the mines themselves and are supplied with social and medical facilities more or less like was the situation on the commercial farms. Most of the mining is done by a small number of large mining consortiums comprising well known multinationals, complemented by indigenous companies. There are quite a number of operating mines (mainly gold), worked by small companies, syndicates and individuals. Gold contributes about half the value of mineral production. The most significant mineral/mineral related exports are gold, platinum, ferro-chrome alloys, nickel and asbestos. With most of these being exported for use as raw materials or for further processing, Zimbabwe stands to benefit if it processes them further into high value consumer goods. Other exports include coke, dimension stone (black granite), diamonds, graphite, lithium minerals and emeralds. Most of the coal production is used locally, as are chromite and iron ore (Zimtrade, 2009).
2.1. The Great Dyke
The Great Dyke is a 2.6 billion-year-old geological feature that runs right through the heart of Zimbabwe for about 550 kilometers in a north-south direction with a maximum width of just 11km. The geologist and explorer Dr. Carl Mauch first recorded the Great Dyke in 1867, but it was not until the early 20th century that the presence of platinum, and other minerals, was discovered.

The platinum group metals abbreviated PGMs; collectively refers to six metallic elements clustered together in the periodic table. These elements are all transition metals, lying in the d-block (groups 8, 9, and 10, periods 5 and 6). The six platinum group metals are

- Ruthenium
- Rhodium
- Palladium
- Osmium
- Iridium
- Platinum

They have similar physical and chemical properties, and tend to occur together in the same mineral deposits (Wikipedia 2009).

Early attempts at mining the platinum out of the ground were generally unsuccessful, and it has only been relatively recently that platinum production has reached significant levels (Matthey, 2008). The platinum group metals occur in a layer known as the Main Sulphide Zone, which is typically about 3 metres thick. However, the economic mining width may be as little as one metre, depending on grade, metal prices and the chosen mining method. The platinum group metal content is lower than that of South African ores, with head grades generally below 4 grams per tonne, of which about 55 per cent is platinum. Nickel and copper values are typically higher than those found in South African platinum ores (Matthey, 2008). Figure 1 below shows the Great Dyke profile against the background of the map of Zimbabwe. Platinum-bearing deposits hosted in the Great Dyke include Musengezi, Hartley, Selukwe and Wedza.

As of mid-2005, total proven and probable reserves at Ngezi were estimated to be 266.5Mt grading 1.64g/t platinum (Pt), 1.28g/t palladium (Pd), 0.14g/t rhodium (Rh) and 0.26g/t gold (Au), plus nickel, copper and cobalt. This gave a combined ‘4E’ (Pt+Pd+Rh+Au) grade of 3.31g/t. Overall, the reserves contain 28.4Moz of 4E, including 14Moz of platinum in an orebody that averages 2.7m thick.

Hartley's resource base is 188Mt grading 4.5g/t platinum-group metals equivalent, plus minor copper and nickel.
2.2. Platinum Mining

One of the most mined mineral in Zimbabwe is Platinum. There are three major mines all of which are extracting and semi processing the ore for export. The refining and casting processes are done in South Africa. The orebody covers an area of 8km north to south and 1km to 1.5km east to west, and outcrops at surface. Platinum-group metal mineralisation occurs within a 4m vertical interval within the stratiform deposit. The sulphide ore is oxidised at the outcrop, but remains unweathered at depths of 20m or more.
2.2.1. Mimosa

Zimbabwe’s oldest platinum mine is the Mimosa operation, located in the southern part of the Great Dyke on the Wedza Geological Complex. Ownership is currently split 50:50 between Impala Platinum and Aquarius Platinum.

The deposit at Mimosa was exploited briefly in the 1920s, and trial mining was undertaken by Union Carbide Zimbabwe between 1966 and 1975. Zimasco (a ferrochrome mining and smelting company) took over Mimosa in 1992. The pilot plant was refurbished, and mining recommenced in 1994, gradually building up to a rate of just less than 30,000 tonnes of ore per month. Although small, the operation was highly successful, and began to attract the attention of the South African platinum group metals producers. A proposed acquisition by Anglo American collapsed in 2000, but the following year Impala Platinum acquired a 35 per cent stake in the mine. In 2002 Impala took a further 15 per cent, with Aquarius Platinum taking the remaining 50 per cent of the company. Since 2002, output at Mimosa has gradually been expanded, and the mine – which is among the lowest-cost platinum producers in the world - extracts around 85,000 oz of platinum annually (Matthey 2008).

2.2.2. Zimplats

During the early 1990s, a second mine, the Hartley Platinum Project, was developed by a joint venture between the Australian companies BHP and Delta Gold. It opened in 1995, but following a string of geological and metallurgical problems, underground operations were suspended in June 1999. BHP’s interest in Hartley Platinum was sold to Zimbabwe Platinum Mines (Zimplats), a spin off of Delta Gold’s platinum assets, which began to develop a new open-cast mine further south, at Ngezi. Operations at Zimplats began in 2001, following the acquisition of a share of the project by Impala Platinum and the South African bank ABSA. Impala Platinum now holds 100% stake in Zimplats.

In 2006, Ngezi produced about 90,000 oz of platinum, from an open pit and from a newly-developed underground section. Impala now plans to increase production to over 150,000 oz of platinum per annum, which will involve the construction of two new underground sections and will cost an estimated US$258 million (Matthey 2008).

2.2.3. Unki

A third platinum mine, Anglo American’s Unki project, expected to process around 120,000 tonnes of ore per month once it is fully operational (Matthey 2008). The mine is owned by the world’s largest platinum miner Angloplat and is expected to be commissioned in December 2009. In 2008, Angloplat reached an agreement with the government to release 31.3 percent of its claims in return for empowerment credits (Reuters, 2009).
2.3. Conclusion on Platinum mining

The mining companies mentioned in this section process platinum to concentrate which is then exported to South Africa where refining and onward exporting is done.

3. Uses of Platinum

The platinum that is exported from Zimbabwe is in the form of concentrate and matte, which obviously do not fetch as much as the refined metal or finished platinum products such as jewelry, catalytic converters. In order to envision the role that value addition can play in improving the economy of Zimbabwe we look at the uses of platinum so as to determine the technologies that need to be imported into the country to produce platinum products.

Platinum is extensively used as a catalyst, in jewelry, wire, vessels for laboratory use and in thermocouple elements. It is also used for electrical contacts, corrosion-resistant apparatus, and in dentistry. The metal form is used in the coating of missile nose cones, and jet engine fuel nozzles. Platinum is the active element in catalytic converters that convert unburned hydrocarbons into carbon dioxide and water vapour. Platinum catalyses the conversion of methyl alcohol to formaldehyde, that is used in cigarette lighters and hand warmers. Platinum dies are extensively used in glass production (Paulos 2002). Platinum is available in coin and bar form for investors and speculators. Platinum is a component in magnetic coatings for high-density hard disk drives and some of the newer optical storage systems.

From the uses of platinum outlined here we identify some manufacturing industries that could be set up in the country or could benefit if they already exist, from using locally produced platinum.

- Catalytic converters, spark plugs, and sensors
- Jewellery
- Sulphuric acid production
- Platinum resistance thermometers
- Glass production
- Petroleum refining
- Dental equipment
- Manufacture of coins and bars.

All these industries would employ quite a decent percentage of the country’s skilled and unskilled workforce. The country has highly trained manpower in pharmaceuticals, manufacturing, metallurgy, process technology just to highlight a few. Furthermore there is an abundance of other raw materials needed by these industries. For example, there are abundant reserves of pyrite needed for sulphuric acid production. In this same vein it is worth pointing out that if companies like Zimphos (a sulphuric acid manufacturing entity) produce more sulphuric acid in a cost effective manner this will translate to lower costs for consumers. These consumers include battery and fertiliser manufacturers. It has to be
remembered that agriculture is another pillar of the Zimbabwean economy and lately it has been affected by shortages of inputs like fertilizer. What this means is if platinum is processed into high value goods in the country, the economy will benefit in multiple ways. These include creating employment, increasing production in existing companies, more earnings from exports and domestic sales of platinum products, more revenue for the state from taxes levied on companies and their employees, less forex outflows on importing things that can be produced locally like fertilizer, jewellery, chemicals and batteries.

4. Role of science and technology
Science refers to a system of acquiring knowledge. This system uses observation and experimentation to describe and explain natural phenomena. The term science also refers to the organized body of knowledge people have gained using that system. Less formally, the word science often describes any systematic field of study or the knowledge gained from it. The purpose of science is to produce useful models of reality.

Technology is a product of engineering and science, the study of the natural world. It is the process by which humans modify nature to meet their needs and wants. Technology includes the entire infrastructure necessary for the design, manufacture, operation, and repair of technological artifacts, from corporate headquarters and engineering schools to manufacturing plants and maintenance facilities. The knowledge and processes used to create and to operate technological artifacts - engineering know-how, manufacturing expertise, and various technical skills - are an equally important part of technology. In essence, technology is the primary engine of economic growth. Thus technology is the key and fundamental requirement for value addition to raw materials and people. It provides the key to unlocking any country’s potential, in terms of decreasing overhead costs associated with outsourcing and creating employment opportunities. Analysis of technologically advanced economies shows that at each level of the economy, science and technology provide the engine for economic growth. For example, in the case of primary products, application of science and technology significantly increase the yield from agricultural and mineral beneficiation. According to Egbogah (2009) technology is not static but extremely dynamic, and companies need continuous adaptation to its application. This is the key to success and continued growth. Consequently, companies must position themselves to take advantage of new technology to maintain domestic and international competitiveness.

4.1 Science and Technology in Platinum Production

Science and technology play a strategic role in all industrial processes. Here an assessment is done of the application of science and technology in the production of this extremely precious metal, starting with extraction from the ore to subsequent processes. To make this assessment, we do a case study of Hartley Complex which processes ore from Hartley and Ngezi mines operated by Zimplats.

Hartley has an integrated processing plant, consisting of a mill, concentrator, smelter and converter, base metal refinery and on-site laboratories.
The plant currently has a capacity of 180,000t of ore per month. Run-of mine ore is ground in a Fuller Traylor SAG mill before flash flotation to recover a coarse, high-grade primary concentrate, followed by regrinding, and rougher and scavenger flotation. Concentrates produced by flotation are smelted, and then converted to give a final low-iron matte, containing 44% nickel, 33% copper, 21% sulphur and 1,500g/t precious metals, that is sold to Impala Refining Services for subsequent precious-metals recovery. The flow sheet in figure 2 shows the processes occurring in platinum extraction at the complex.

![Figure 2 Hartley plant flow sheet](http://www.mining-technology.com/projects/hartley/hartley5.html)

The process at the plant which is done in Zimbabwe ends at Matte preparation and that leaves PGM Toll Refinery and Base Metal refinery being done outside the country. (South Africa)

5. **Training for Science and Technology in Zimbabwe**

Training in Zimbabwe is offered through Institutions of Higher learning with the Zimbabwe School of Mines offering courses in Mining related field. The University of Zimbabwe offers degrees in Mining Engineering and Metallurgical Engineering which include mineral processing among other courses. The National University of Science and Technology caters for efficient running of the processes through the Industrial and Manufacturing Engineering degree as well as degrees in Chemical Engineering. These qualifications provide for skills and competence in mineral processing, extractive metallurgy and research and development. This qualifies the notion that all processes can be done in Zimbabwe to include refining. What is lacking is the appropriate technology which is based locally to do the refining. Mining companies are private owned and it is in their interest to fully process the ore outside the country. Little accrue to the nation where
the minerals are being extracted from. In the case of Zimbabwe and the PGM, other metals such as Nickel, Copper and Silver are being sold outside the country instead of the production figures accruing to its country of origin.
6. Creating a win-win situation
At the moment most foreign investment in the country is in the primary industries of mining, agriculture, and forestry. In mining government has adopted a policy of 51% local ownership and 49% foreign which is being resisted. This is however a good policy but the shortcoming is that locals who benefit are mainly politicians or government associates who are just too eager to get hold of quick profits for themselves and do not appreciate the value of developing the downstream industries identified above. In some cases what has happened is the exploitation of ore bodies at the expense of sustaining the life of the mine by mining both the high and low grade ore seams and then blending them. Mhangura Mine is a good example where the mine folded up because the remaining ore bodies contained very little copper to mine economically. This could have been avoided by close monitoring. The government should grant mining licenses to companies that will support downstream industries in the country and will do full processing of platinum in the country. At least refined platinum would fetch a lot more. Multinational companies should also have a policy of assisting developing countries develop their own tertiary industries or rather invest in the tertiary sector. It might appear imprudent but in the long term it will yield dividends. There are a string of multinationals that have done this and they include Bata Shoe Company, Unilever, Coca-Cola Company, and Toyota. Zimbabwe has relatively cheap labour just as much as the Asian countries where Western firms have found root. Of course the political situation in the country is not encouraging but Zimplats, Mimosa and Angloplat continue to report astronomical profits in spite of this. It is no secret that Western firms are now facing a strong threat to their control of metals and minerals in Africa from Chinese firms. This is the leverage needed in bargaining for investment in the tertiary sector. They will ultimately comply.

7. Conclusion
Any meaningful growth of Zimbabwe’s economy hinges on the manufacturing sector. It has to be diversified and at the same time produce finished goods that can compete on the international market. The agricultural industry can only operate profitably if inputs like fertiliser are sourced locally. All this depends on the value addition to minerals like platinum, and profits realised will go into other sectors of the economy directly or indirectly. Technology transfer to developed nations is essential for this to be realised considering that technology is the vehicle for value addition to raw materials and people. There is urgent need for overhauling the whole manufacturing sector and investing in new technologies to make the industries viable especially after a decade of decline. The infrastructure and human resources are there. Mineral reserves are abundant and more are awaiting discovery. What is lacking is the political will and goodwill of investors. It is hoped this paper adds some noise to the ever-growing call for an end to the exportation of raw materials in favour of the exportation of value added goods. Only then can they achieve the increasingly impossible millennium development goals.
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