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Ferrochrome smelting and smelting capacity investment in Zimbabwe

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Abstract – Four smelting plants currently make up the ferrochrome smelting capacity in Zimbabwe. Zimbabwe Alloys and Zimasco represent more then ninety per cent of Zimbabwe's ferrochrome smelting capacity, while Maranatha and Oliken contribute the difference.

Very limited investment in the sector (even for the expansion of existing smelters) has been experienced over many years, despite the fact that about 95% of the world's chrome ore resources are in the Bushveld Igneous Complex of South Africa and the Great Dyke of Zimbabwe. The Bushveld has a greater quantity but a lower grade than the Great Dyke. A ten per cent increase in Zimbabwean ferrochromium production has been recorded in the past ten years, showing an almost stagnant capacity investment.

INTRODUCTION

Four smelting plants currently make up the ferrochrome smelting capacity in Zimbabwe. Zimbabwe Alloys and Zimasco represent more then ninety per cent of Zimbabwe's ferrochrome smelting capacity, while Maranatha and Oliken contribute the difference. Zimbabwe Alloys, one of the oldest ferrochrome plants in Africa, was established in 1949. Zimasco was the second to be built in the country. By contrast, South Africa, even though it has lower-grade chromite, established bigger capacity smelter units, with better technology compared to the early plants. South Africa currently accounts for about three quarters of the ferrochromium production in the world, with Samancor Chrome and Xstrata Alloys being the biggest producers.

In Zimbabwe, the availability of chrome ore reserves, most of which would be produced by open-cast mining, with a high Cr/Fe ratio, should have attracted a smelting capacity increase. Despite the better quality and high quantity of chrome ores/reserves, Zimbabwe does not have the corresponding smelting capacity.

ORE CLASSIFICATION AND RESERVES IN ZIMBABWE

The classification of the chrome ores according to a Russian geologist are shown in the table below.

Table I: Old and new classification of chromium ores

OLD CLASSIFICATION	COMPOSITION OF ORE	NEW CLASSIFICATION
Metallurgical Grade	> 46% Cr_2O_3 > 2.1 Cr/Fe ratio	High chrome content
Chemical Grade	40-46% Cr_2O_3 < 2.1 Cr/Fe ratio	High iron content
Refractory Grade	> 20% Al_2O_3 > 60% (Al_2O_3 + Cr_2O_3)	High aluminium content

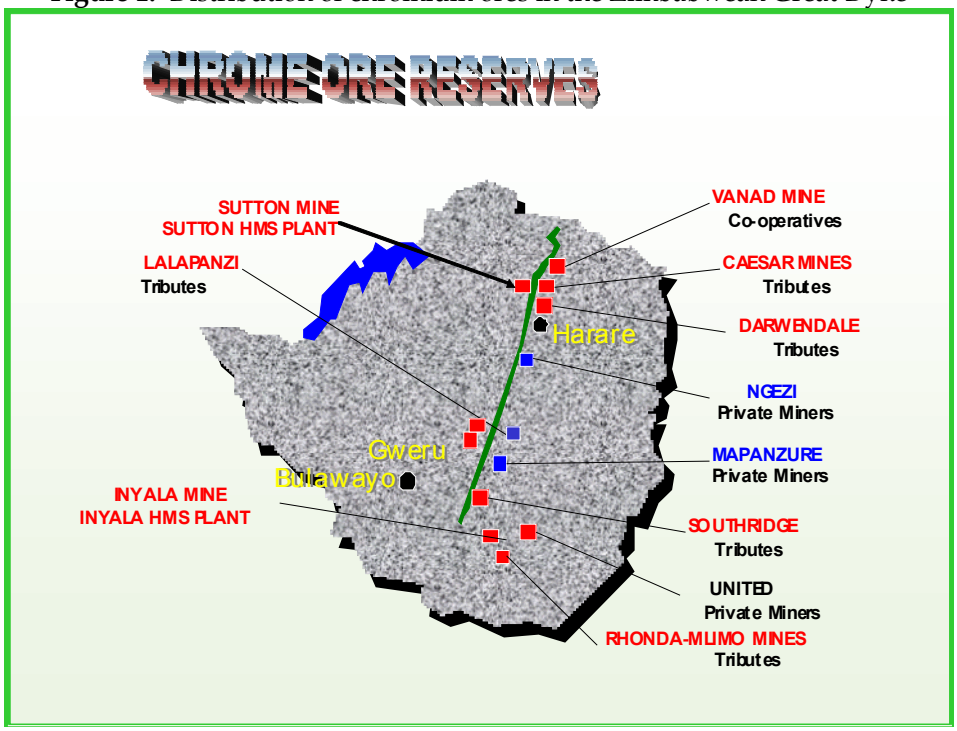
A schedule of chrome ore reserves was published in the early 1980s to show the distribution by quality and quantity. Table II shows the world reserves of chrome ore that would not have changed so much to date.

Table II: Official world reserves of chromium ores

ORE TYPE	RESERVES (MIILION TONNES)		
	Zimbabwe	South Africa	Rest of the World
High Chrome and High Cr/Fe ratio	560	← 90 →	
High Iron and Low Cr/Fe ratio	56	1100	44

The Great Dyke in Zimbabwe holds most of the world's high-grade chrome ore and high Cr/Fe ratio reserves. Figure 1 shows the distribution of the chrome ore reserves in the Great Dyke.

Figure 1: Distribution of chromium ores in the Zimbabwean Great Dyke



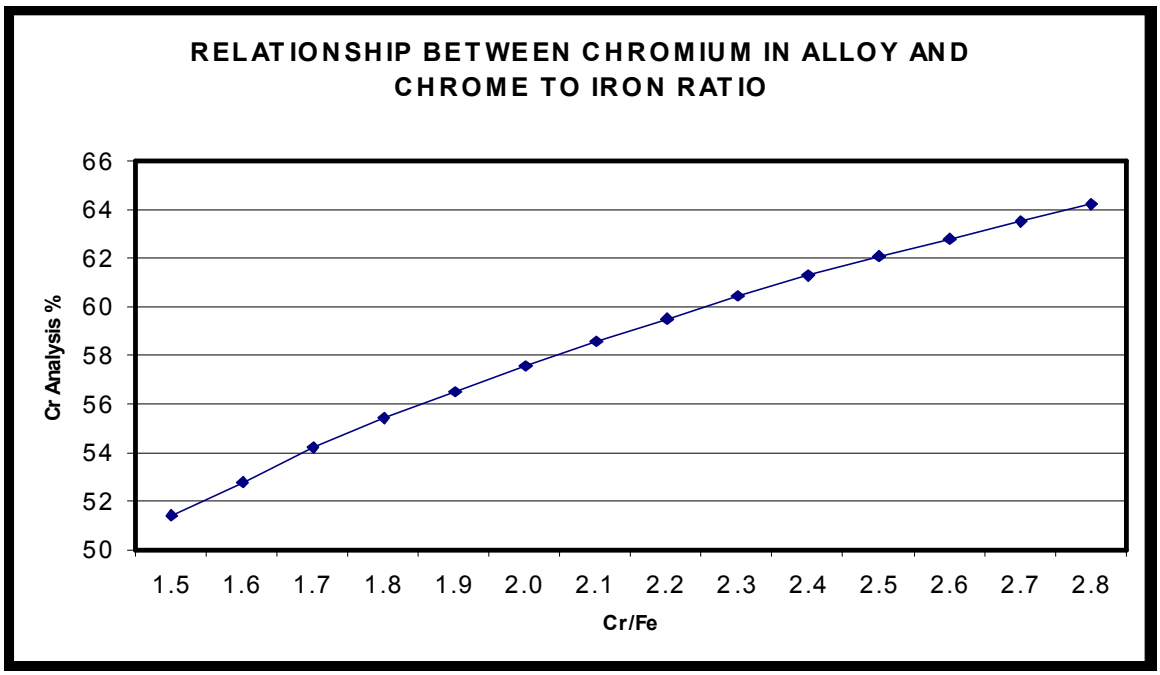
The Great Dyke is where most of the Zimbabwean chrome ores are found, and, therefore, has the highest concentration of mining activities, as shown on the map (Figure 1). In the North Dyke, chrome ore grades are very high, up to 55% Cr_2O_3, with a Cr/Fe ratio greater than 3.3.

Middle Dyke grades are on the lower side compared to the North, but are still substantially better quality than some of the world reserves, with 40% Cr_2O_3 and a Cr/Fe of 2.0 minimum.

Chrome ores are also found off the Dyke in the southern part of the country, and these deposits are refractory and podiform in nature, but have high grades.

The Republic of South Africa has the largest low Cr/Fe ratio chrome ore reserves, which gives rise to the production of charge chrome as the main product. The importance of chromium to iron ratio to the quality of alloy is demonstrated in the relationship below. It is a useful factor in the assessment of the reserves that will impact on ferrochromium alloy quality.

Figure 2: Relationship of Cr/Fe ratio to the grade of alloy



Ownership of Reserves

Zimbabwe Alloys and Zimasco own most of the chrome ore reserves, and have the biggest capacity to produce about 450 000 metric tons of product of the almost 500 000 tons built capacity. Removal of the restrictions to export ores has put a lot of pressure to shed off reserves to other small mining ventures who need to earn a living exporting ores and fines. This has encouraged illegal

mining activities that will result in the sterilization of the resource due to improper and uncontrolled mining methods.

CURRENT AND FUTURE SMELTING CAPACITIES

Overview of smelting capacity in Zimbabwe

Zimbabwe produces three different ferrochrome products from its smelters around the country. Table III summarises Zimbabwe's smelting capacity by product.

Table III: Production by product

	Zimasco	Zim Alloys	Others	Total
HCFeCr (High Carbon Ferrochrome)	220 000	146 000	55 000	421 000
FeSiCr (Ferrosilicon Chrome)		29 200		29 200
LCFeCr (Low Carbon Ferrochrome)		40 150		40 150
Total	**220 000**	**215 350**	**55 000**	**490 350**

Zimbabwe has the capacity to produce 490 350 tons of ferrochromium product, which is only about 6.3% of the world production, and 15.8% of South Africa's production in 2008, according to the United States Geological Survey Mineral Resources.

In addition to producing High Carbon Ferrochrome, Zimbabwe Alloys is also the only producer of Low Carbon Ferrochrome (with the best technology in the world) and ferrosilicon chrome in the country.

Of the four plants that are currently operating, the biggest were established over 40 years ago, and the other two have been operational only during the past eight years. There has been no expansion by the two biggest smelters in the past 25 years of operation.

Recently, small (1.1 MVA) Chinese furnaces have been installed all over the central part of the Great Dyke. However, their contribution to the overall capacity is relatively insignificant. One could expect ferrochrome smelting investment to increase, as has been the case for platinum and diamonds, because the investment climate is the same if proper consultation with the government is done.

Oliken is building a second 2 MVA furnace.

Zimbabwe Alloys, which has sold a forty per cent stake to Metmar, announced the upgrading of the 31 MVA and the 2 x 24 MVA furnaces, and the construction of a DC arc furnace in 24 months.

Zimasco also announced the construction of a sinter plant and an additional furnace. Considering all these changes, an additional 20% of product is expected to come onto the market.

This will bring the chrome ore consumption to 1.77 million tons per annum. At this rate of consumption, 300 years will be required to deplete the reserves, which are estimated at 560 million tons of high-grade ores only.

Zimbabwe needs new smelting capacity in the country, as it has more than adequate reserves, and favourable investment conditions can be negotiated with the government (as has happened in the platinum industry).

FACTORS AFFECTING SMELTING CAPACITY INVESTMENT

Negative factors

- The non-availability of chrome ore reserves to other producers, as Zimbabwe Alloys and Zimasco own most of them
- Perceived political/economic instability in the country (although investment in platinum production continues to increase)
- The erratic power supply to most industries, and the requirement to upgrade the infrastructure
- Capital availability, as mining require a significant initial capital injection
- Transport, which is also a capital-related issue

Positive Factors for investing in ferrochrome smelting

Zimbabwe's abundant high-grade reserves are amenable to the production of high-quality ferrochrome products, due to a high Cr/Fe ratio.

Table IV shows the properties required in chrome ores for the efficient production of high carbon ferrochrome. These properties are the characteristics of most of the Great Dyke chrome ores.

Table IV: Properties of chrome ores deemed suitable for HCFeCr production

CHEMICAL	PHYSICAL
• High Cr_2O_3 content • High Cr/Fe ratio • High refractory : non refractory ratio	• Low friability • Low decrepitation • High bulk density • High gangue softening or melting temperature

- Adequate reserves for the production of coke for chromium smelting (with low phosphorus), if there is investment in 2M mining at Hwange
- Railway infrastructure network can be reliable if re-capitalized
- Investment conditions can be negotiated to suit the investor, as is the case with platinum

10 000 tonnes of chrome ore (44% Cr_2O_3 , 2.0 Cr/Fe minimum) could produce either 3 000 tons of HCFeCr, 6 000 tons of LCFeCr, or 6 000 tons of FeSiCr. At current prices, this represents a revenue stream, following a sequence of increasing value, from US $1.2 million for the sale of ore, to US $13 million for the sale of FeSiCr. (Current prices are assumed to be $120/t for the ore, $1.20/lb of Cr in HCFeCr, $1.80/lb of Cr in LCFeCr, and $2200/t for FeSiCr.)

CONCLUSIONS

The large reserves and high quality of ore are the major positive factors encouraging investment in ferrochrome smelting in Zimbabwe.

The government is offering a number of flexible investment options and incentives in all mining or smelting operations that can match the current platinum conditions. Zisco Steel is a good example what new investors can expect in Zimbabwe. Zimbabwe has experienced political and economical stability for investment in the smelting of chromium, although this is not the international perception.

It is believed to be more economically favourable to produce and sell beneficiated products than merely selling the chrome ores, but this obviously requires a proper economic analysis.

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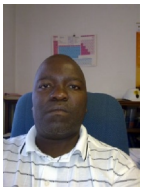

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Jabulani obtained a BSc Honours Engineering (Metallurgical) degree from the University of Zimbabwe in 1992, and an MBA degree. He previously worked for Mhangura Copper Mines, the Department of Metallurgy-Ministry of Mines in Zimbabwe, and African Chemicals. Jabulani has worked for Zimbabwe Alloys for the past 15 years in the following positions: Plant Metallurgist, Technical Assistant, Technical Manager, Furnaces Manager (6 years), and Production Manager (5 years). He was seconded for a Zimbabwe Alloys – Japanese (JMC)/Mitsui joint venture in Japan for one year. Jabulani has authored papers for the past three Infacon conferences, the most recent being the one in Finland in 2010.
