1. Introduction

Copper production plays a vital role as one of the major driving forces in Zambia's economy. On the overall, Zambia has about eight (8) major underground mines, and five (5) major open pit mines operating in copper production. These are private owned companies with the government of the Republic of Zambia (GRZ) holding some shares. This paper illustrates a summary of copper mining in Zambia's Copperbelt province in terms of social, technical and environmental issues.

2. Historical background

Post-colonial period

In Zambia, the first commercial copper mine was established in 1928. This was a mine owned by the Rhodesian Selection Trust (RST). However, copper would be produced in small scale as early as 1908 and 1911 at Kansanshi and Bwana Mkubwa mine respectively (Sikamo et al., 2016). From 1928 to 1969, two private mining firms operated in Northern Rhodesia (now Zambia) namely; Rhodesia Select Trust (RST) and Anglo American Corporation (AAC). These were subsidiaries of two multinational corporations, American Metal Climax Inc. and Anglo American Corporation respectively (Robert, 1966).

Post-Independence period

When Zambia gained political independence in 1964, the government had great hopes for development, which were influenced by the rapid growth of the copper industry due to favourable world prices of copper through the late 1960s and early 1970s. Despite the rise in copper prices, there was still dissatisfaction among the workers.

Mining nationalization era

Therefore, during the Mulungushi economic reforms of 1968, the government announced it’s intention to acquire equity holding in the mining companies. This became part of a series of reforms called the “Zambian Economic Revolution”. In 1969, the government announced the Matero reforms, which resulted in the government getting 51% shares in the mining companies. This marked the beginning of mining nationalization, and in 1970, the two mining firms were renamed Roan Select Trust (RST) and Nchanga Consolidated Copper Mines (NCCM), and these were operated under Zambia Industrial Mining Corporation (ZIMCO). In 1973, the government completed payments for the purchase of 51% shares in the mining companies. In 1982, Roan Select Trust (RST) and Nchanga Consolidated Copper Mines (NCCM) were merged to form Zambia Consolidated Copper Mines Limited (ZCCM), in which the government owned 60.3% shares and Anglo American Corporation (AAC) owned the remaining shares.

Economic crisis and re–privatization of copper mines

After the nationalization process, the mines took on several social services as part of their responsibility in order to appease the workers. The mines did not just look after their workers, but provided services to the whole communities in the mine townships (Lungu, 2008), and during a short period the country saw an exceptional investment in the construction of new schools, hospitals and roads. Corresponding to the oil crisis of 1974 and 1979, copper price declined and the economy of Zambia began to decline. In addition to falling copper prices, the industry faced a number of challenges such as lack of investment, over-staffing, poor technology, and the cost of production relatively increased as mining progressed to deeper levels in the underground mines, which left Zambia the 25th poorest country in the world in 1994. In the year 2000, the mines were re-privatized with the government holding some minority shares through Zambia Consolidated Copper Mines – Investment Holdings (ZCCM-IH).

3. Geology

The Zambian Copperbelt is comprised of rocks of the Neoproterozoic Katanga Supergroup which is the host of the Cu–Co deposits, as well as numerous other deposits of Cu, Pb, Zn, U, Au, Fe, etc. (Master et al., 2005), with the average ore grade of 3 wt. % for Cu and 0.18 wt. % for Co, (Bohdan et al., 2009, Ondra et al., 2011). Fig. 1 shows the geological map of Zambia, and illustrates how much of the Copperbelt is covered by the Katanga Supergroup. These are meta-sedimentary rocks which are believed to have been metamorphosed and deformed during the age (600–544 Ma) as a part of the north–west–east trending Lufilian Arc (Ondra et al., 2011). In Zambia, the copper-cobalt deposits are predominantly found in the Copperbelt province, and the same copper mineralization also extends to the North-western province, but at a lower grade.
Copper deposits in the Katanga Supergroup are hosted primarily in the Lower Roan Subgroup. Therefore, mining generally takes place in the Lower Roan Formation, where ore mineralogy is dominated by pyrite (FeS₂), chalcopyrite (CuFeS₂), bornite (Cu₄FeS₉), chalcocite (Cu₂S), digenite (Cu₃S₂), linnaeite (CoS₂), and carrolite (Cu(FeNi)₃S₄), embedded in carbonate-rich shale, argillite or in sandstone (Ondra et al., 2011).

4. Mining Methods and Copper Production

The most common mining method used in underground mines is Sublevel Open Stoping, and even some of the other mining methods used are just variations of Sublevel Open Stoping. Table 1 shows a summary of common mining methods used. However, some mines apply more than one mining method. Different contributions from many authors have indicated that copper production peaked in 1969 to about 750,000 tonnes, but soon afterwards gradually began to decline until it reached about 250,000 tonnes in the year 2000. After privatization, copper production began to increase. Fig. 3 gives the trend of copper production from the year 2010 to 2017.

Table 1. Common mining methods

<table>
<thead>
<tr>
<th>Underground mining method</th>
<th>Number of mines</th>
</tr>
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<tbody>
<tr>
<td>Vertical Crater Retreat</td>
<td>1</td>
</tr>
<tr>
<td>Sublevel Open Stoping</td>
<td>3</td>
</tr>
<tr>
<td>Mechanized Continuous Retreat</td>
<td>1</td>
</tr>
<tr>
<td>Sublevel Caving</td>
<td>2</td>
</tr>
<tr>
<td>Cut and Fill</td>
<td>1</td>
</tr>
<tr>
<td>Room and Pillar</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 3 Trends of copper production

5. Environmental Impacts of Copper Mining

The major environmental problems in the Copperbelt are related to the geotechnical integrity of waste dumps. More than 12,000 hectares of land is covered with mineral waste, which has also led to Acid Mine Drainage. Other impacts include air pollution due to sulphur dioxide (SO₂) emission, soil contamination, surface water pollution and siltation in the Kafue River, accumulation of metals in vegetables, fruit and fish (Joanna, 2014). However, the Zambian government is implementing various mitigation measures towards these environmental impacts through a body called Zambia Environmental Management Agency (ZEMA).

6. Conclusion

According to the report written by AFRODAD in 2016, within the range of time from 2010 to 2015, Copper exports accounted for a minimum of 27 percent of GDP and a maximum of 34 percent (AFRODAD, 2016). Various research contributions have indicated that Zambia’s GDP growth changed in direct proportions to change in copper prices since the post-independence era. Therefore, copper is likely to continue playing a major role as Zambia’s major export for many years to come.

References


