Decarbonization Applying Micro-fragmentation in Bauxite Mining from Hydro Paragominas, Brazil

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https://doi.org/10.71659/icsoba2025-bx012

Abstract

Mineração Paragominas (MPSA), located in Paragominas city, state of Pará, is one of the main bauxite extraction operations in Brazil. The mine has a nominal capacity of 11 million tonnes of bauxite product per year, which are transported by pipeline to the refinery, located in the municipality of Barcarena, also in the state of Pará. The mine applies strip mining method for exposure, mechanical rock dismantling and loading of the ore, which is transported to the beneficiation plant. Conventionally, bauxite mining operations use the mechanical rock fragmentation method with surface miners, hydraulic excavators and dozers. However, since 2023, MPSA has been testing and implementing the rock dismantle with micro fragmentation. It was found this type of rock blasting is a technique that can significantly contribute to the reduction of diesel consumption in mining operations using controlled explosives. The process consists of a chemical reaction to release energy in the form of shock waves and gases, used in the biggest mines all over the world. The gases resultant of the blasting have a composition of CO_2 = 14.76 %; H_2O = 58.37 %; and N_2 = 26.87 %. It is possible to compare the amount of CO_2 generated by explosives and by conventional mechanical mining equipment. Although the use of micro-fragmentation itself does not eliminate CO_2 emissions, the efficiency of the blasting leads to a considerable reduction in mechanical energy consumption and, consequently, a lower need for equipment that consumes fossil fuels, such as surface miners, hydraulic excavators and dozers. Thus, it is estimated that the use of micro-fragmentation in MPSA in the next years will generate an annual reduction of approximately 5 thousand tonnes of CO_2 emitted (approximately 41 % less than the CO_2 emitted by mechanical mining).

Keywords: Bauxite, Decarbonization, Micro-fragmentation, Explosives, CO_2 emissions.

1. Introduction

Mineração Paragominas (MPSA), located in Paragominas city, state of Pará, Brazil, is one of the main bauxite extraction operations in Brazil. Production started in 2007, and the mine has a nominal capacity of 11 million tonnes of bauxite product per year. The bauxite with is processed and transported in the form of slurry by pipeline to the refinery, located in the municipality of Barcarena, also in the state of Pará.

According to geometric and spatial characteristics of the bauxite deposit (occurring on flat plateaus), with mineralized bodies presenting an average thickness of 2 meters in a tabular and horizontal form, with average capping of around 13 meters, the mining method used at MPSA is strip mining. The method basically consists of mining the deposit in successive strips, with the overburden removed from a given strip being thrown into the pit resulting from the mining of the immediately preceding strip. This results in minimizing the distance of transport of overburden, an important factor for the extractive activity in question, given the high waste/ore ratio, which is around 6.47 in volume. Bauxite mining at MPSA consists of the following stages:

a. Vegetation removal and cleaning of mining areas.
b. Removal and storage of organic soil.
c. Overburden removal.
d. Mechanical dismantling of the bauxite layer.
e. Excavation and loading of bauxite.
f. Spreading of organic soil and recovery of mined areas.

Figure 1 shows the geometry of mining area.

Figure 1. Mine geometry.

The entire mine operation process described is carried out using diesel-powered equipment. In 2024, the total diesel consumption for all processes, including overburden removal, mechanical dismantling, ore production and mine infrastructure, was 33.64 million liters, inducing CO_2 emissions of almost 90 000 tonnes. In this context, Hydro has global sustainability goals, such as a 30 % reduction in emissions by 2030 and zero emissions by 2050 and has been developing studies and initiatives to reduce its carbon footprint.

As highlight, since 2023, it is in an advanced stage of study the replacement of the conventional mechanical dismantling of the bauxite layer for a new method that's say micro fragmentation. Micro fragmentation is a project that uses drilling and controlled blasting with explosives, and the main objective is to reduce the burning of fossil fuels and, consequently, carbon emissions. MPSA is the first bauxite mine in Brazil to use this technology and has been obtaining positive gains with reduction in diesel oil consumption and estimated costs.

2. Conventional Mechanical Dismantling of the Bauxite Layer

Bauxite compressive strength ranges from 20 to 50 MPa, so according on its characteristics, it requires mechanical dismantling before loading for beneficiation.

The process of mechanical dismantling and fragmentation of bauxite is the object of this study, where historically the conventional mining method with equipment powered by diesel combustion, divided in four steps:

a. Surface miners: responsible for 65 % of the volume moved of ore annually, whose operating principle is the simultaneous fragmentation and loading of trucks. However, this equipment leaves a volume equivalent to 10 % of the area mined volume on the sides and manoeuvre areas (access).

MPSA is in the final testing phase and beginning the partial transition process to micro-fragmentation. For the coming years, a 70 % share in the rock dismantling process using new methodology in MPSA bauxite mining is already expected.

6. References

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