

## Vertical Cutter Mining – A sustainable technology for mining of small vertical kimberlite bodies and veins

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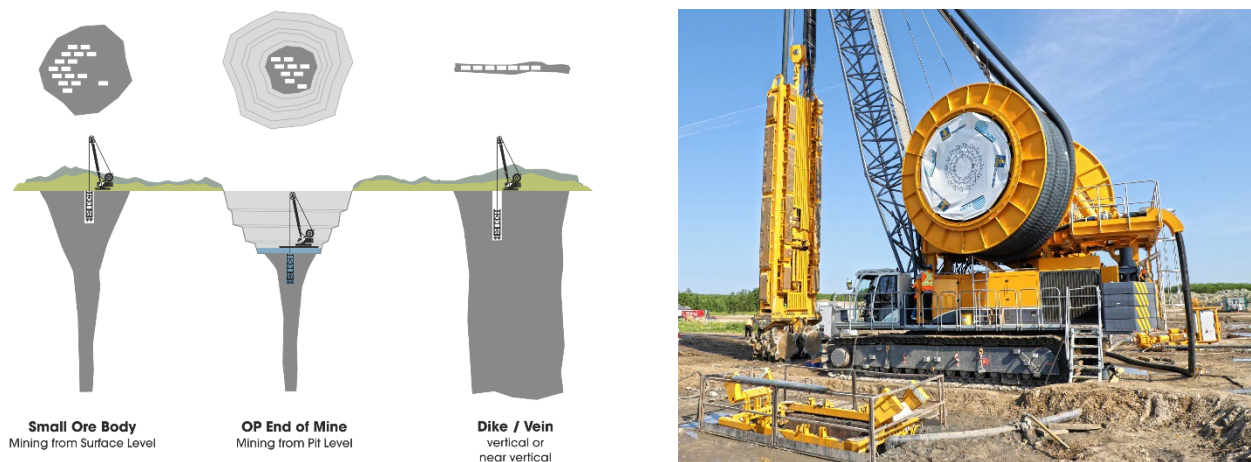
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### Current boundaries for conventional mining of small kimberlite bodies and veins

Small vertical kimberlite bodies and vertical or near-vertical veins often pose a challenge to the mining industry. The relatively small size of the kimberlite deposits over great depths or lengths, with only limited exposure to the surface often makes economical mining difficult. Open pit mining of such ore bodies might lead to an early end of mine life even if a significant quantity of residual ore is left behind because of the high stripping ratio and the enormous environmental impact or is unprofitable from the very beginning. Massive stripping of waste rock leads to high material hauling times and costs, intensive roadway and bench construction and maintenance, intensive surface water management and massive waste dump requirements. In addition, it can be assumed that increasingly extensive rehabilitation measures will be required in the future after mine closure.

### Request for alternative mining solutions

Economic and at the same time environmentally acceptable mining of small vertical kimberlite bodies and veins to great depths is calling for alternative and selective mining methods. Mining should concentrate on the valuable mineral resources - the amount of mined waste rock should be minimized. The ecological footprint must be minimized by avoiding large open pit mines with huge dumps of waste rock and groundwater lowering. The time-to-mine should be shortened to generate early revenues and the entire mining infrastructure should be reduced. Alternative and customized mining solutions are required to turn small ore bodies in economically viable mining projects and to help to operate existing open pit mines that are at the end of their mine life for many more years without additional impact on the natural environment.



**Figure 1:** left: Application area for Vertical Cutter Mining – right: Kimberlite bulk sampling, FalCon Diamond Project

For the mining of such small vertical kimberlite bodies and vertical or slightly inclined veins directly from surface or in open pits from pit bottom further onwards (Figure 1), Bauer Mining Solutions sees great synergies in using the well-proven Bauer cutter system as an alternative and selective mining method. Originally developed for civil engineering, the trench cutter technology for construction of cut-off walls and diaphragm walls follows the same principles when utilized as a mining tool for the vertical extraction of ore and provides solutions to the mining industry beyond current mining and exploration standards.

### The Vertical Cutter Mining System

The Vertical Cutter Mining (VCM) is an innovative cross-over system from proven applications in civil engineering to provide fit-for-purpose solutions for mining mineral resources, especially kimberlite bodies. The cutter system has already been applied at several bulk sampling and trial mining operations onshore and offshore for mining companies such as BHP Billiton, Rio Tinto and De Beers / Anglo American. In 2019, a Bauer trench cutter system – customized to the project requirements – was used on the Star Orion Kimberlite fields for Rio Tinto in Saskatchewan, Canada, to carry out a large-scale bulk sampling program. By using the cutter technology, large volumes have been excavated from great depths of up to 250 m, allowing a better assessment of the deposit (Figure 1). This project has successfully proven that the Bauer cutter technology is also suitable for the mining industry and especially for the kimberlite extraction. The diamonds have been safely recovered and as already proven in previous bulk sampling projects and trials, the Bauer cutter system has only minor effect on the diamond breakage, which is quite similar to the breaking expected in traditional mining methods.

The VCM mining sequence will be designed according to the dimensions and layout of each individual ore body for maximum ore recovery and minimum dilution. Mining takes place in two stages. In the first mining step the deposit is perforated with vertical primary trenches. The size and spacing between the primary trenches are defined by the stability of the deposit. The remaining ore body is usually excavated in a subsequent second mining step after the primary trenches have been sufficiently backfilled. Depending on the nature of the deposit, flooding of the perforated ore body after the first mining step in combination with a floating cutter system can eliminate the need to backfill the primary trenches and increase the recovery rate of the ore body.

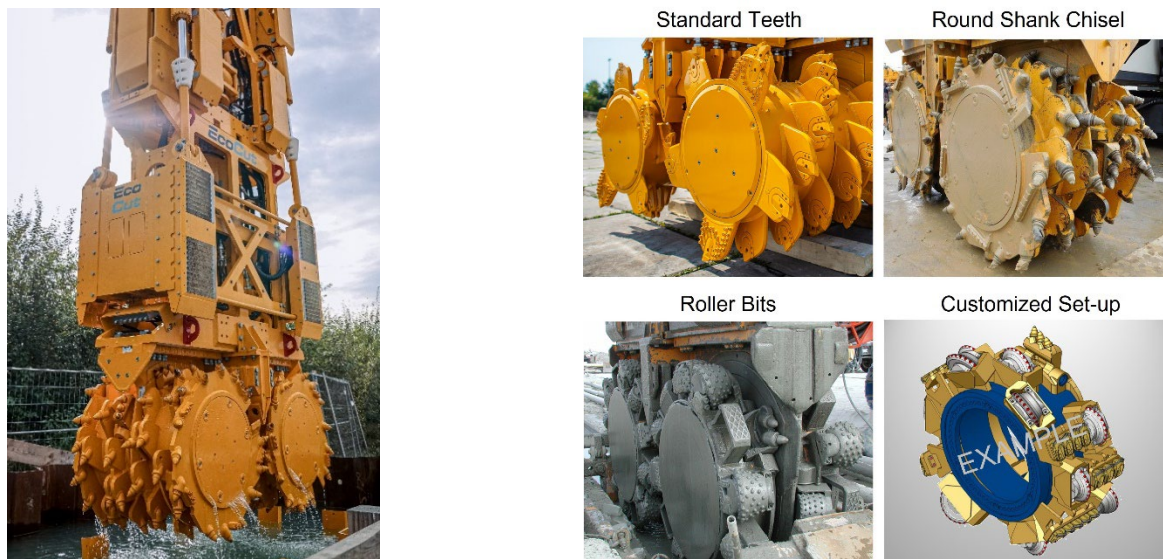


Figure 2: left: Bauer cutter with Hard Rock Cutter System – right: Typical ground-dependent cutter wheel set-ups

## **VCM developments to a full-scale mining system**

The economic success of the VCM system depends to a large extent on the characteristics of the deposit. Among other factors, grade, hardness, abrasiveness and the geological, petrographic and geotechnical characteristics of the orebody and host rock have a direct influence on the mining performance and thus the economic viability. Because no two deposits are alike, the cutter mining system must also be adapted to the individual project parameters. Bauer has been continuously developing the trench cutter system since 1984 and is now considered, especially in the civil engineering, the world market leader in this vertical cutter technology with more than 500 units working on all continents of the globe.

In order to cover the wide range of geological differences in the various kimberlite deposits, the cutter wheels can be fitted with different teeth arrangements for excavation of various types of soils and rocks. In industrial production rock with strengths of up to 200 MPa has been cut by Bauer trench cutters. For enhanced penetration in hard soil or rock formations, The Hard Rock Cutter System (Figure 2), a clamping system of the cutter body with controlled feed, has been developed to achieve higher and constant load on bit. In parallel, several studies were carried out with the Colorado School of Mines (Denver, Colorado) to increase efficiency and production rates, especially for hard kimberlites with more than 80 MPa.

## **Sustainability of the VCM system**

Mining has always been in the focus of various interests. Economic viability, environmental impact and social acceptance are key factors that need to be balanced to achieve a sustainable mining solution.

**Economic viability:** The Bauer alternative mining method makes it possible to optimize the entire mine infrastructure and shorten the time to mining significantly, which allows revenues to be generated at a very early stage of a mining project. Concentrating on the kimberlite and minimizing the dilution reduces the material hauling and processing costs significantly. In addition to its application in new mining projects, the cutter system also offers great advantages in ongoing mining projects. The life of a mine can be extended by mining the remnants of an ore body without increasing the environmental footprint.

**Environmental aspects:** The VCM system minimizes the overall environmental footprint of mining operations and also optimizes the overall project costs by:

- Minimized strip ratio, avoiding extensive mine dumps and water drawdowns
- Minimizing reclamation costs at the end of mine life

**Social acceptance:** Cutter mining, which involves very little environmental impact and optimizes the economic efficiency of a mine through selective mining of the ore body, can achieve significantly better acceptance by authorities and the public compared to conventional mining.

The Bauer cutter mining system has the ability to turn small kimberlite bodies and veins into economic and ecologic mining projects.

## **References**

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