

# The Python – An Underground Processing Plant for Narrow Vein Mining

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## ABSTRACT

Gekko Systems has developed an underground pre-concentration plant (Python) to reduce mine operating costs.

Many ores liberate favourably using either high pressure grinding rolls (HPGR) or vertical shaft impactors (VSI). Using this comminution circuits for mineral liberation; rather than for the final recovery process and by utilising a high mass pull, high recovery process route (gravity/flotation), a narrow, low head, compact processing plant was developed that can sensibly be operated underground.

The Python underground processing plant can provide a number of advantages for narrow vein mines including lower haulage costs, improved mine call factor and lower operating costs. The focus on fine crushing reduces the power requirement of the plant to approximately 8 kWh/tonne.

The Python underground processing plant has been designed to be towed down the decline or lowered down a shaft, and is capable of being installed in sloping, non-linear drives for placement close to the working face.

The overall benefit to mining companies of this concept has been estimated to be a saving in mining costs and a significantly smaller environmental footprint.

## BACKGROUND TO PROJECT

During 2004/2005 Gekko Systems was awarded an AusIndustry research grant to both investigate and commercialise the idea of underground processing of primarily gold bearing ores.

The key concept of the project is to fine crush and pre-concentrate the ore underground and as close to the working face as possible with a combination of gravity and flotation

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methods. The valuable component is then the only material removed from underground to the surface while the non-valuable tailings remain underground for backfilling (see Figure 1).

Gekko Systems has built a prototype processing plant (Python) to demonstrate the concept and successfully commissioned the unit on surface in September 2007.

## PYTHON PROCESSING PLANT

The principle of the Python processing plant involves size reduction, screening, gravity and flotation pre-concentration underground and as close to the working face as possible. In order to achieve this, a low tonnage Gekko Modular unit has been designed to be installed in drives at each of the working stopes, such that as the ore is blasted it is removed by a LHD or similar unit and delivered directly into the Python's grizzly feed hopper. The limited handling minimises the possibility of fines losses into footwall cracks and the operating costs of internal haulage.

The ore is then crushed and ground to minimum economic liberation size for gravity and flotation pre-concentration. The liberation size is determined by testing the ore and by interpreting typical gravity yield recovery curves for different type ores. A typical yield recovery curve for a Witwatersrand ore is presented in Figure 2.

These curves represent the un-optimised single pass gravity recovery. A rougher/scavenger type application has been recently commercialised, which increases the recovery achievable in practice. The addition of a flash flotation module further increases the recoveries of the fine (-150 µm) fractions.

Gekko are proposing that only the pre-concentration step be performed underground. The conventional understanding of gravity concentration is the utilisation of extremely high grade, very low mass pull equipment (eg centrifugal concentrators); however the Python exploits the use of a mass pull of ten to 35 per cent using inline pressure jigs resulting in very high recoveries, typically in the +90 per cent region. This results in

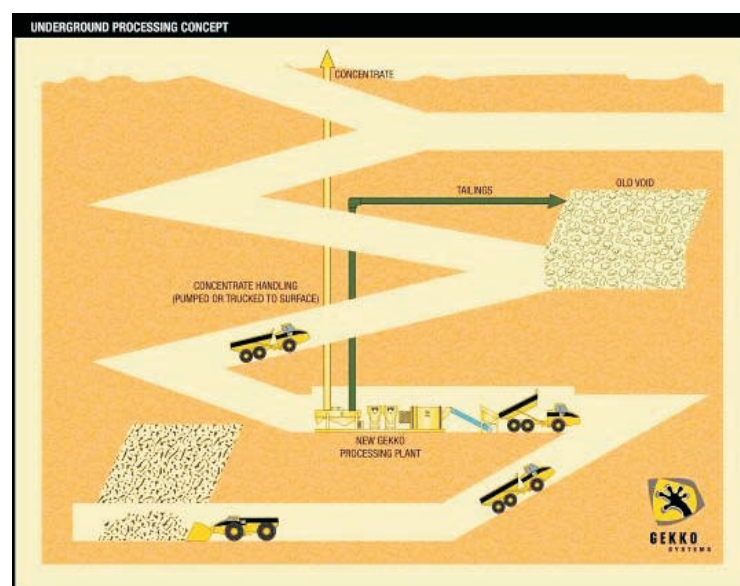


FIG 1 - Conceptual underground processing plant layout.

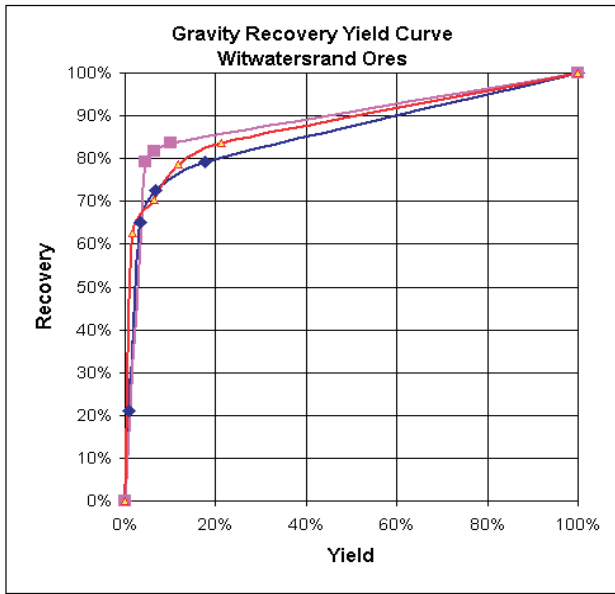


FIG 2 - Laboratory gravity yield/recovery curves for a typical Witwatersrand ore.

concentrate grades of three to ten times the mined grade, and removes secondary issues such as security concerns which normally accompany 'gravity concentration'. For the Python the risks are no greater than those associated with any conventional mining process.

The schematic flow sheet for the Python Processing Plant is presented as Figure 3.

The Python utilises a jaw crusher and vertical shaft impactor (VSI) in a closed circuit to achieve a -5 mm product suitable for the rougher gravity concentrator, an inline pressure jig (IPJ1500). The tails from the IPJ are screened to remove any oversize back to the VSI with the undersize product reporting to flash flotation.

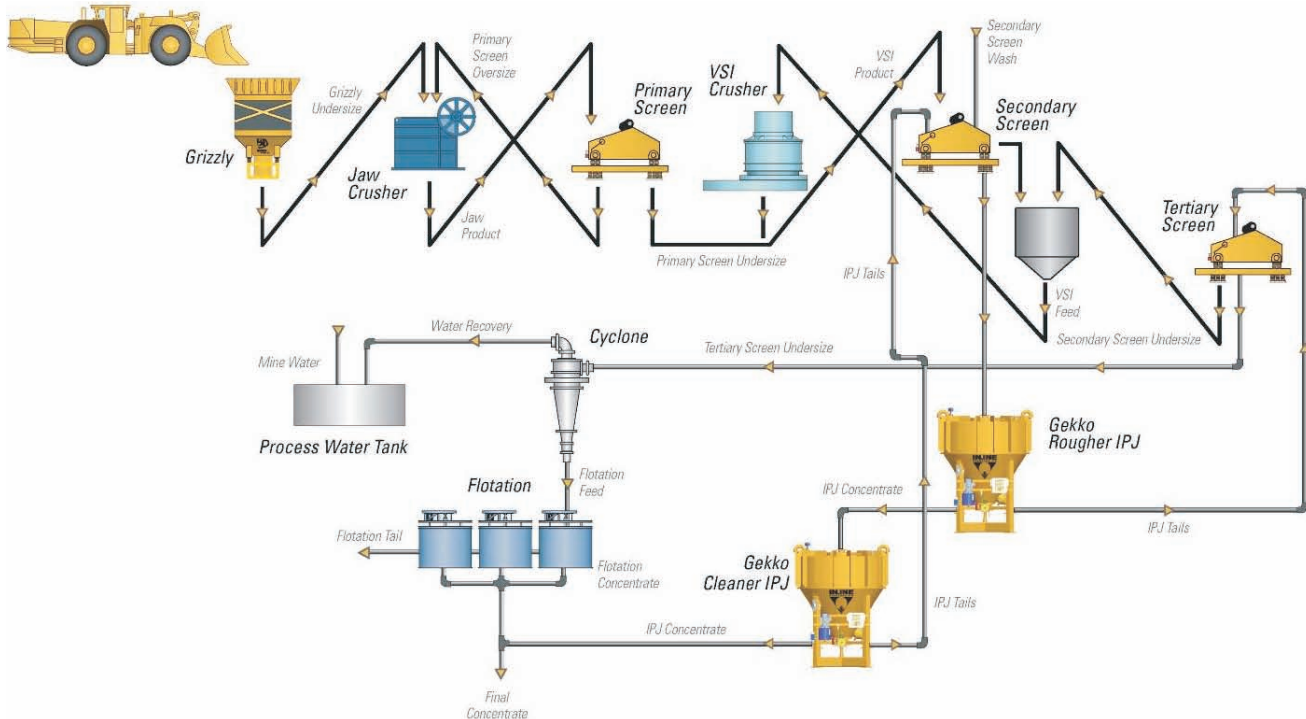


FIG 3 - Python – underground processing flow sheet.

The rougher IPJ concentrate is cleaned using an IPJ1000 with the cleaner concentrate and flotation concentrates transported to the surface for final treatment. The cleaner tail is recirculated back to the rougher IPJ and the flash flotation tails are available for backfill.

The configuration of the plant can be changed to suit individual ore types and mining methods.

### PYTHON SPECIFICATIONS (PYTHON200)

The current Python processing plant (Figure 4) has an estimated capacity of between 10 - 20 t/h run of mine ore feed.

- Target grind size (P80 = 500 to 800  $\mu\text{m}$ ).
- For soft ores – vertical shaft impactor used. For hard ores or less than 500  $\mu\text{m}$  grind, high pressure grinding rolls can be used.
- Installed power is 8 kWh/t, excluding pumping of concentrates and tails to final destinations.
- Labour requirement is estimated as one to two dedicated operators, one to drive loader (LHD) and operate plant front end, and a concentrator circuit operator. (This is unlikely to change as the size of plant increases, unless loader driver becomes a full time job.)
- Plant dimensions: 2.4 m wide  $\times$  5 m high  $\times$  67 m long. Plant can be split in two, same width and height but in two sections 35 m and 32 m long and installed on two mining levels with piping and power cables run between them.
- Plant is to be designed to be towed down the decline or lowered down a vertical shaft.

### ADVANTAGES OF THE PYTHON

There are a number of advantages in pre-concentrating the ore underground, which were the driving forces for the development of the Python. These are summarised as follows:

- improvement in mine call factor (MCF) due to less handling points for the ore en-route to the plant;



FIG 4 - Python processing plant.

- reduction in tramping and hoisting costs due to the movement of lower tonnage;
  - no necessity for backfill to be produced on surface and sent back underground;
  - reduced surface plant costs as lower tonnes will be treated at a higher grade (30 per cent of mass);
  - considerable reduced power consumption over conventional processing (estimate of underground installed power 8 kWh/t versus 14 - 16 kWh/t using conventional milling power consumption);
  - minimal underground infrastructure required due to plant capable of being installed in sloping, non-linear drives for placement close to the working face;
  - no detoxification required on the backfill product; as it has not been exposed to toxic chemicals; and
  - general environmental advantages, lower power, less surface disturbance, noise, etc.
- Some site specific issues that Gekko have identified that will need to be addressed before full implementation underground include:
- the concept of lower recovery at the face being offset by an improved MCF and lower operating costs;
  - heat generated by the underground processing facility needs to be managed;
  - mine layout will need to be designed around the principles of underground processing, for pumping of concentrates, swell factor, backfill, etc; and
  - the use of multiple units will need to be considered, ie are  $1 \times 100$  t/h units centralised better than  $2 \times 50$  t/h units localised.
- Gekko Systems strongly believe that the Python underground processing plant will be of benefit to mining companies with substantial savings in mining costs, both capital and operating and a significantly smaller environmental footprint.

