

Sukari revise Gold production in Egypt

**Modern Mining &
processing Technology
at Sukari Gold mine**



Location

- Sukari Gold mines is located in the eastern desert of Egypt, 800 Km south of Cairo and about 25 Km west of The Red sea town Marsa Alam.
- Sukari gold is well located in relation to sealed roads from the red sea to the Nile.
- There are international Airport about 70 Km north of Sukari between the towns of Marsa Alam and Qusier , and a deep-water port at safaga



History Of Gold at Sukari



**Pharaohs
3900-50BCE**



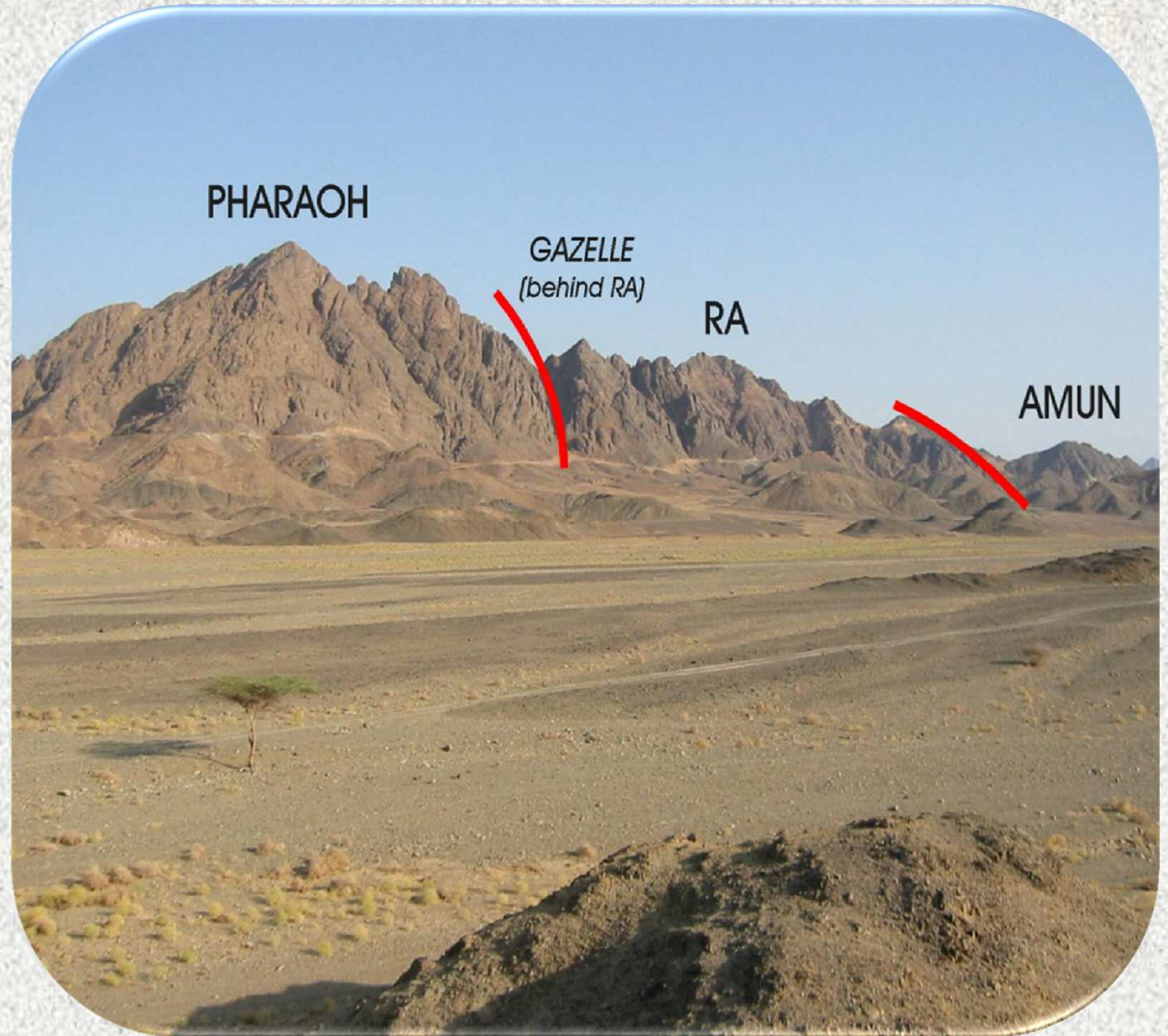
**Romans
31 BCE**



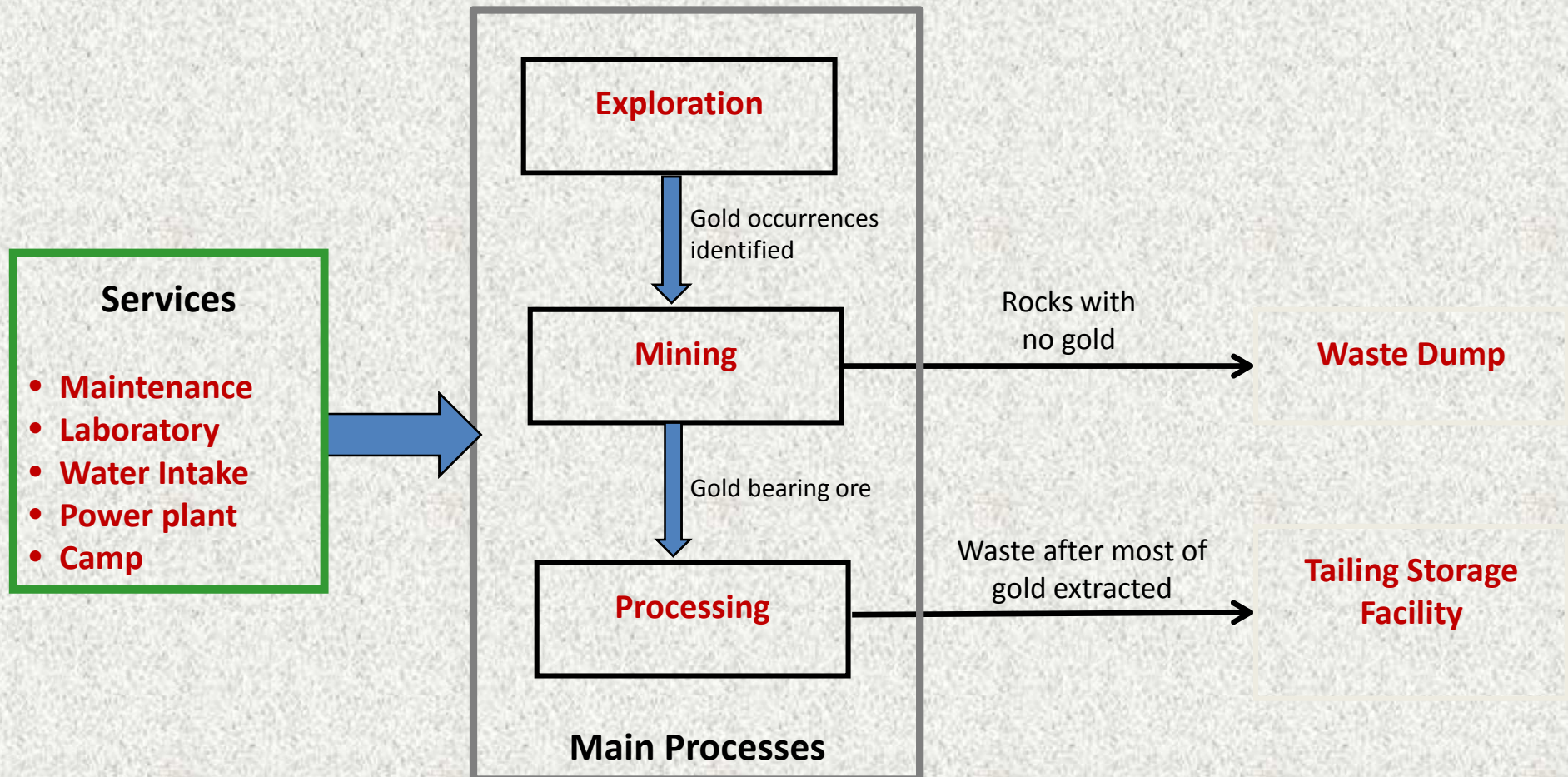
**Egyptian - British
1882-1952**

Sukari Hill

- 2.5km long ridge
- 100m wide in the south
600m wide in the north
- 4 main zones: Amun, Ra, Gazelle and Pharaoh
- Sukari Porphyry host gold mineralization



Gold ...From the Rocks to the Bar



Exploration

- **Surface exploration drilling program**
 - Started in 1998,
 - Over 600,000 metres drilling completed to date
 - Modern hard rock drilling equipment was brought to Egypt for the first time in October 2000

- **Underground exploration drilling**
 - Targeting the Sukari ore body along strike at depth
 - Drilling from underground is quicker and cheaper
 - Drilling increasing with more underground development



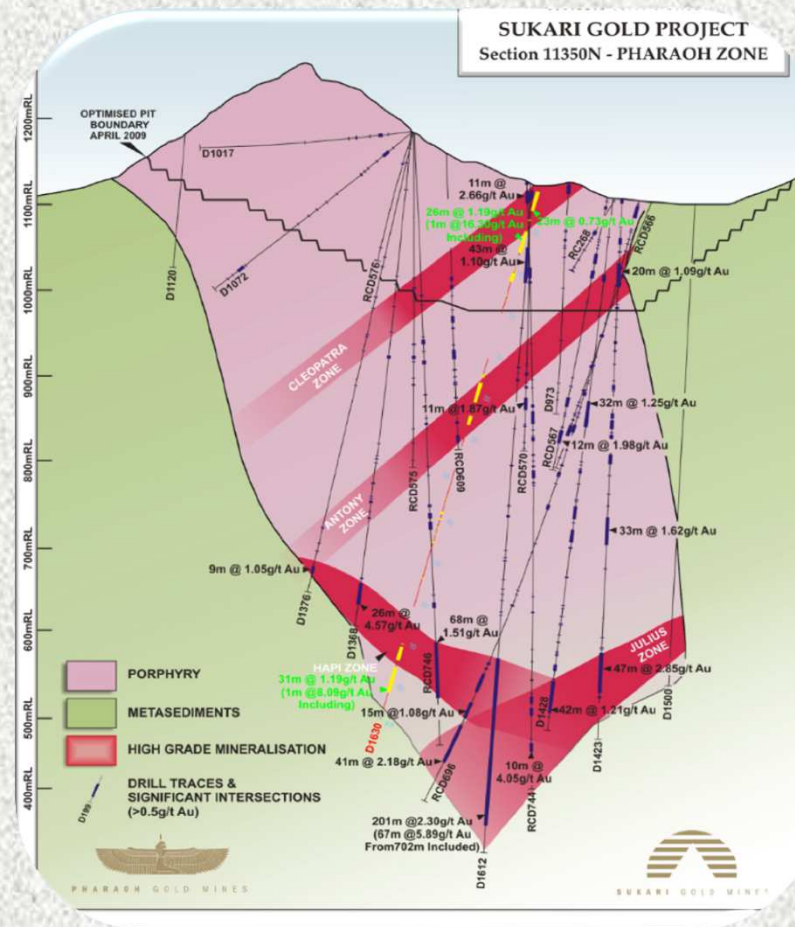
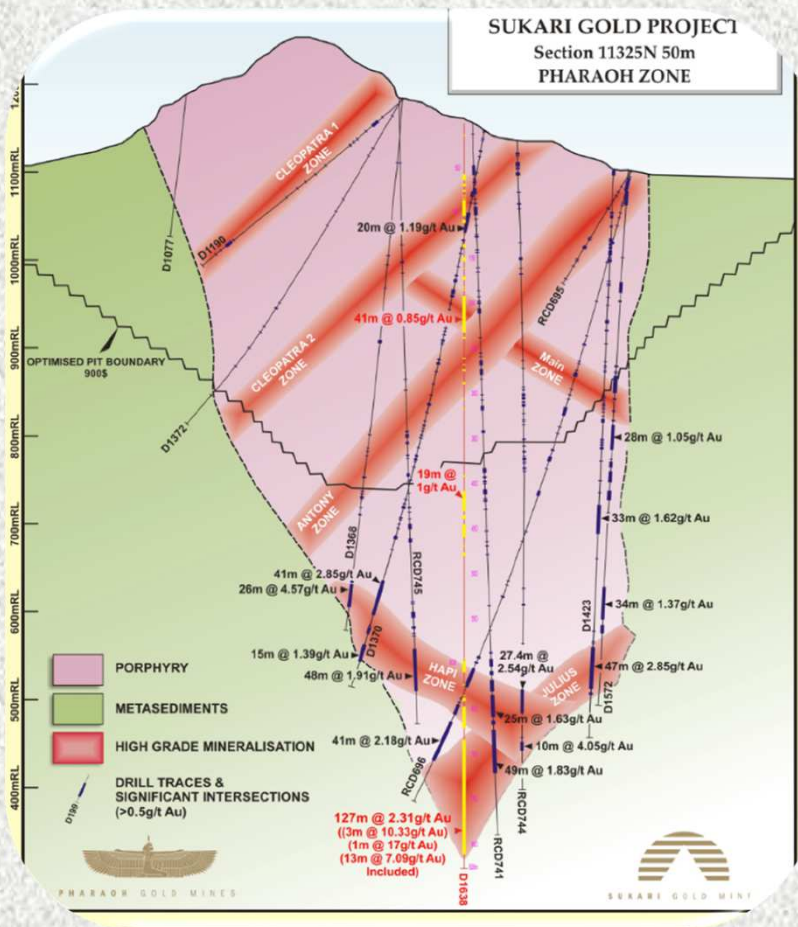
Core Log and Sampling

- **Core Logging:**
 - Mechanical and geological core logging for all rock core samples produced by drilling must be done before send samples to processing Lab.
- **Mining samples analyzed on-site**
- **Exploration samples analyzed in Australia**



Interpretation

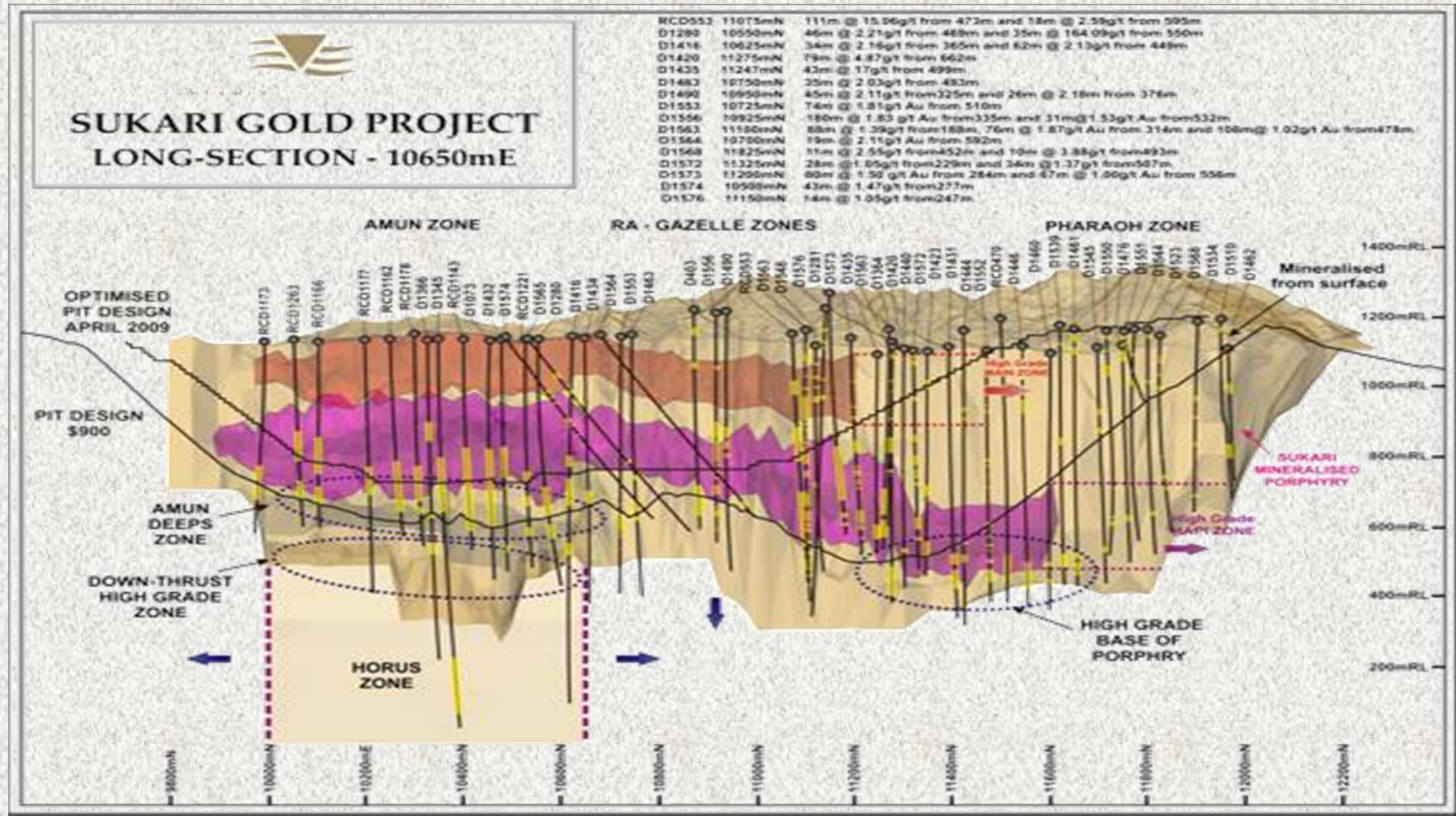
- Data from logging and sample assay plotted to sections (25m interval).
- Interpretation for data done on section to find out (High grade zones, Rock type , and any geological structure)





SUKARI GOLD PROJECT LONG-SECTION - 10650mE

RCD0553	11075mN	111m @ 15.56g/t from 473m and 18m @ 2.59g/t from 595m
D1289	10550mN	46m @ 2.21g/t from 488m and 35m @ 164.09g/t from 550m
D1416	10625mN	34m @ 2.16g/t from 365m and 62m @ 2.13g/t from 449m
D1420	11275mN	79m @ 4.87g/t from 662m
D1435	11247mN	43m @ 17g/t from 499m
D1483	10750mN	25m @ 2.03g/t from 483m
D1490	10950mN	45m @ 2.11g/t from 325m and 26m @ 2.16m from 376m
D1553	10725mN	74m @ 1.81g/t Au from 510m
D1556	10925mN	190m @ 1.83 g/t Au from 335m and 31m @ 1.53g/t Au from 532m
D1563	11150mN	88m @ 1.39g/t from 188m, 76m @ 1.87g/t Au from 314m and 106m @ 1.02g/t Au from 478m
D1564	10700mN	19m @ 2.11g/t Au from 582m
D1568	11825mN	11m @ 2.55g/t from 452m and 10m @ 3.88g/t from 493m
D1572	11325mN	28m @ 1.05g/t from 229m and 34m @ 1.37g/t from 507m
D1573	11200mN	80m @ 1.50 g/t Au from 284m and 47m @ 1.86g/t Au from 558m
D1574	10500mN	43m @ 1.47g/t from 277m
D1576	11150mN	14m @ 1.05g/t from 247m

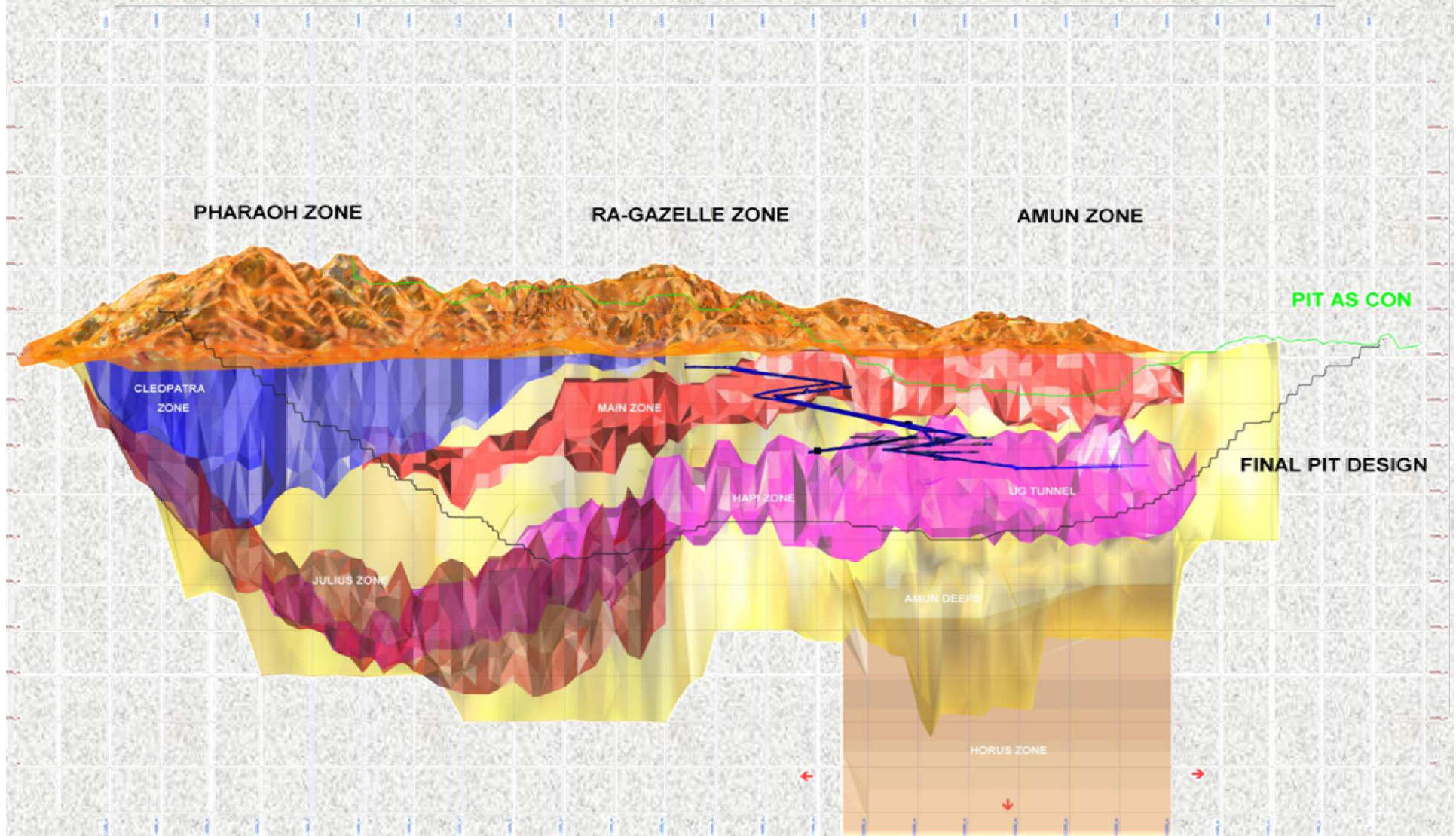




SUKARI
GOLD MINES

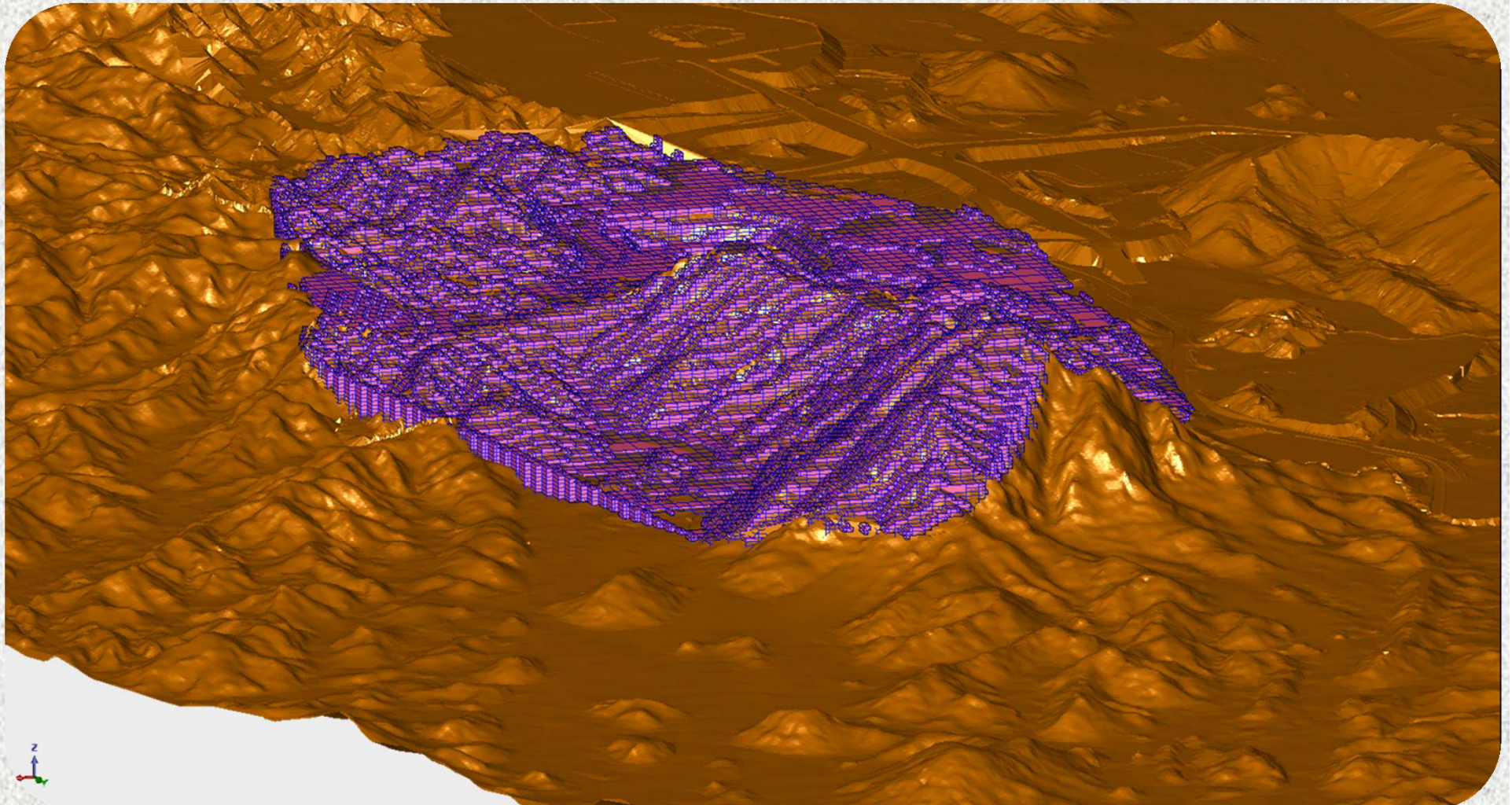
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- Final product of Interpretation generate solids on ORE body's, to be used to generate Block Model of it.



Ore Body Block Model

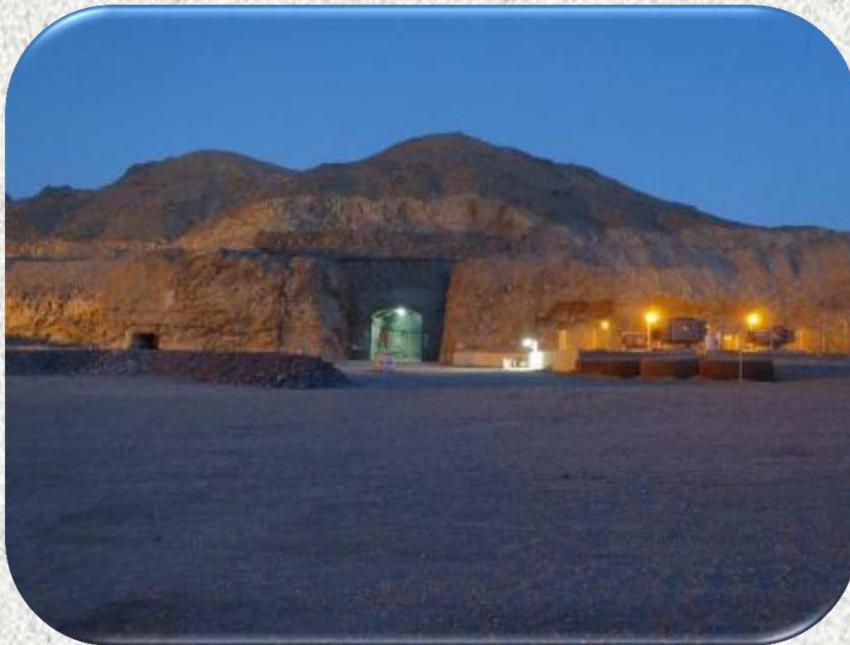
- Each block contain all information need for Geological and Engineering purpose.



Underground Mining

The underground development strategy:

- Increase the reserve (extend life at current mining rate)
- Improve flexibility to deliver a consistent head grade
- Reduce sensitivity to equipment down-time



Underground Mining – Key Figures

- Start development late 2009.
- First ore mined in October 2010.
- End of December 2012:
 - Over 10,000m of drives.
 - Depth of 270m from the mine entrance.
 - Over 600,000t of ore mined.
 - Over 220,000oz of gold mined.
 - Over 4,700,000t in reserves.
- Lifetime of at least 5 more years in the Amun zone, much longer in the Ptah zone.



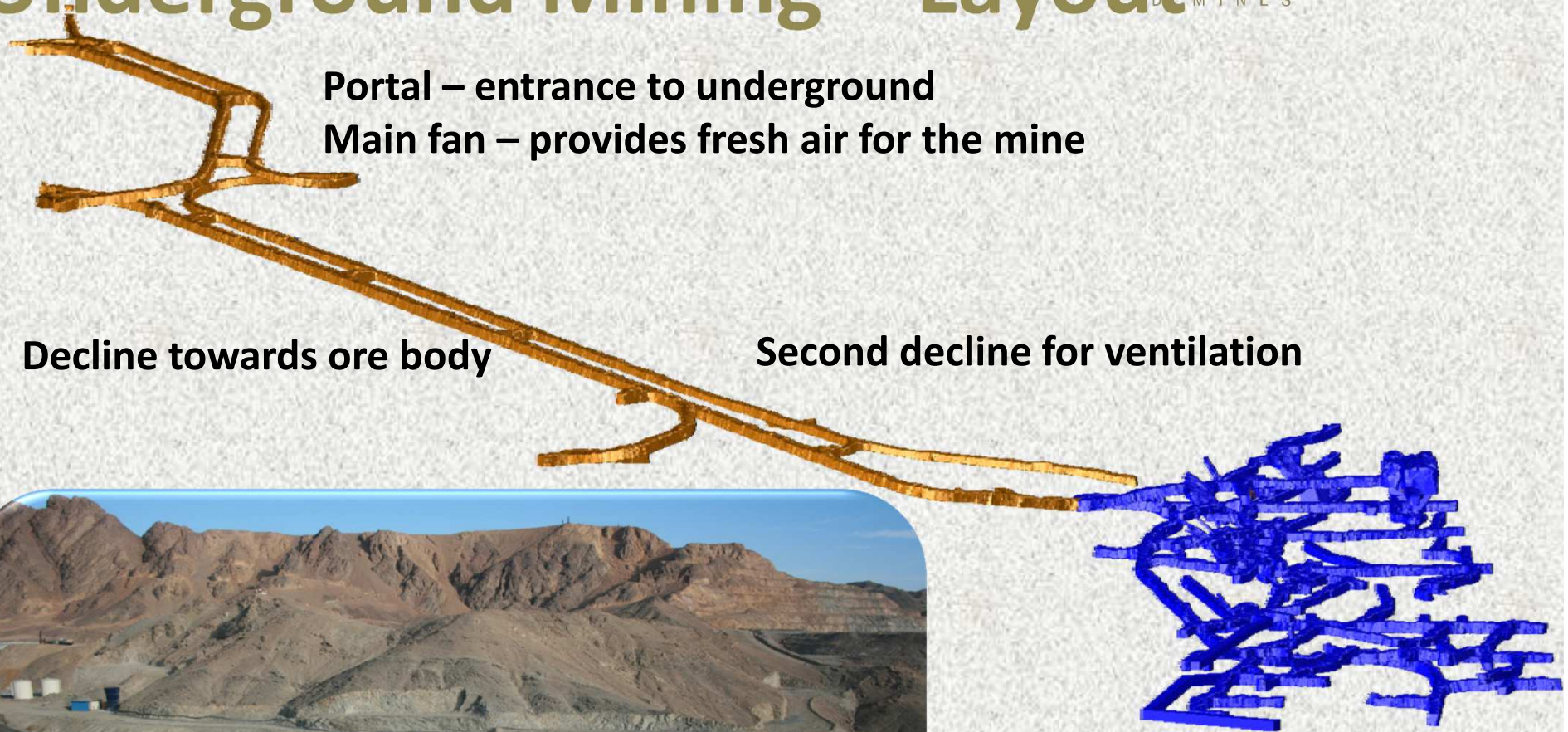
Underground Mining – Layout

Portal – entrance to underground
Main fan – provides fresh air for the mine

Decline towards ore body

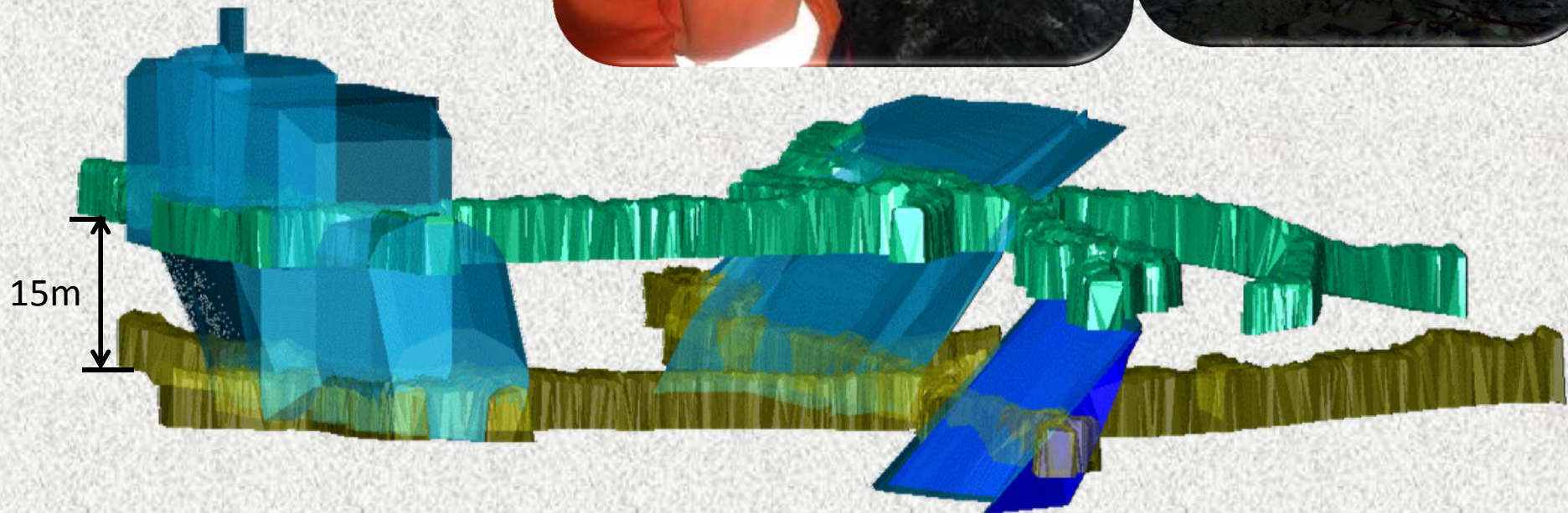
Second decline for ventilation

Level development in ore body
By drives



Underground Mining Activity

- 1- Mapping for current face.
- 2- Development Blast in declines slop 1:7.
- 3- Stopping Blast slop 1:100 for water drainage.



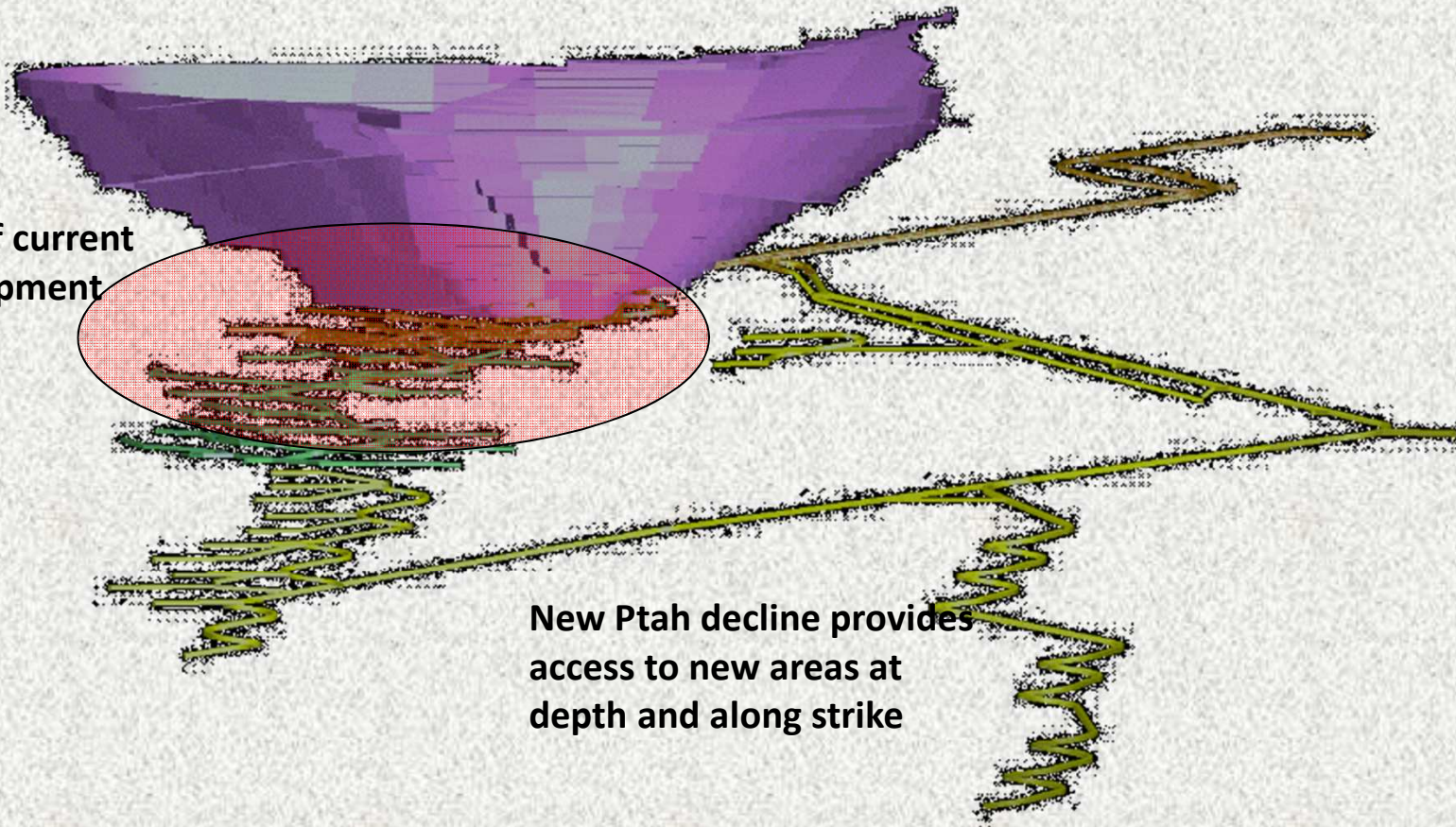
Underground Mining Activity

- 4- supporting (fibercrete 50mm, Mish and plot & cable plotting in cross section areas)
- 5- Load and haul.



Area of current
development

New Ptah decline provides
access to new areas at
depth and along strike

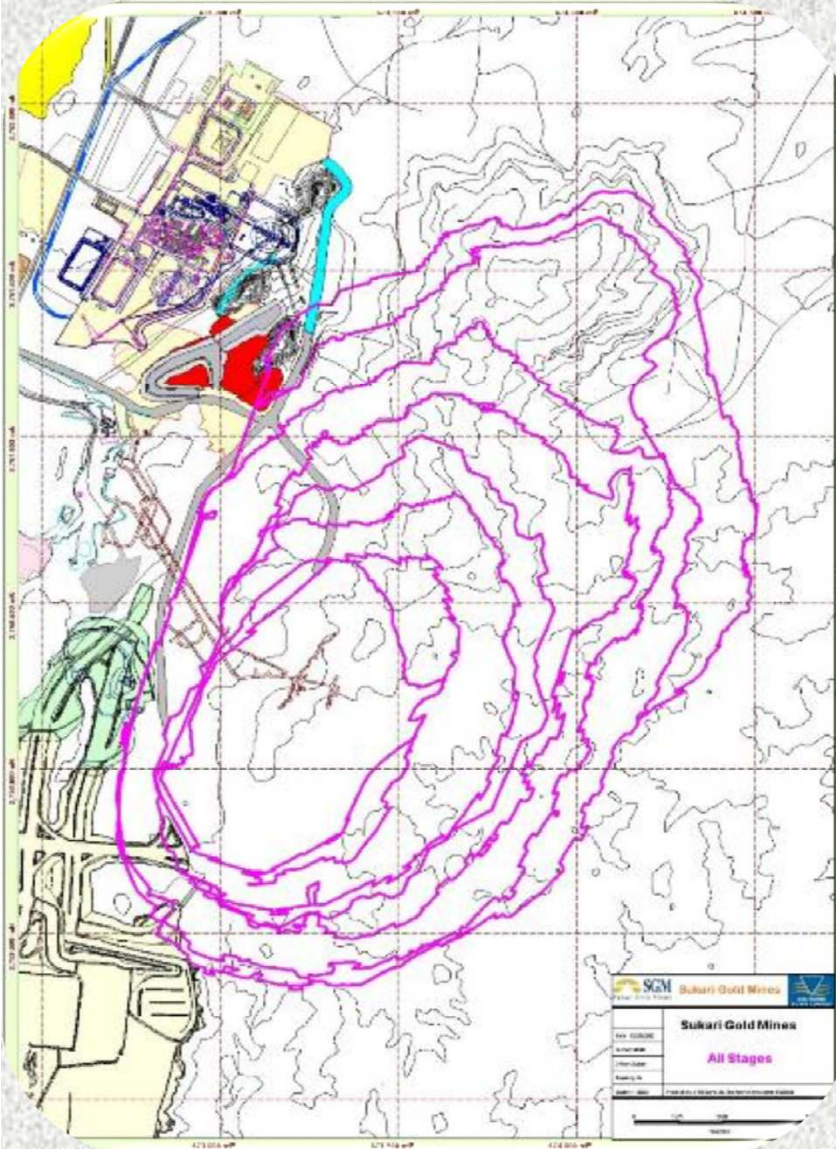


Open Pit

- Open pits are excavated in benches, giving their sides the appearance of giant steps.
- Each flat horizontal slice or bench is about 10m in height.
- The material is excavated and hauled out the pit along the ramps.
- The pit is designed to safely remove the maximum quantity of ore at the lowest cost



Open pit stages development



- 7 stages of pit design
- Final pit size: 2.5km long by 1.6km wide and 735m on the largest high wall, extracting in total 1800Mt

Mining Activity

Grade Control Drilling



Blast Hole Drilling



Blasting



Ore Marking



Load & Haul



Crusher Feed



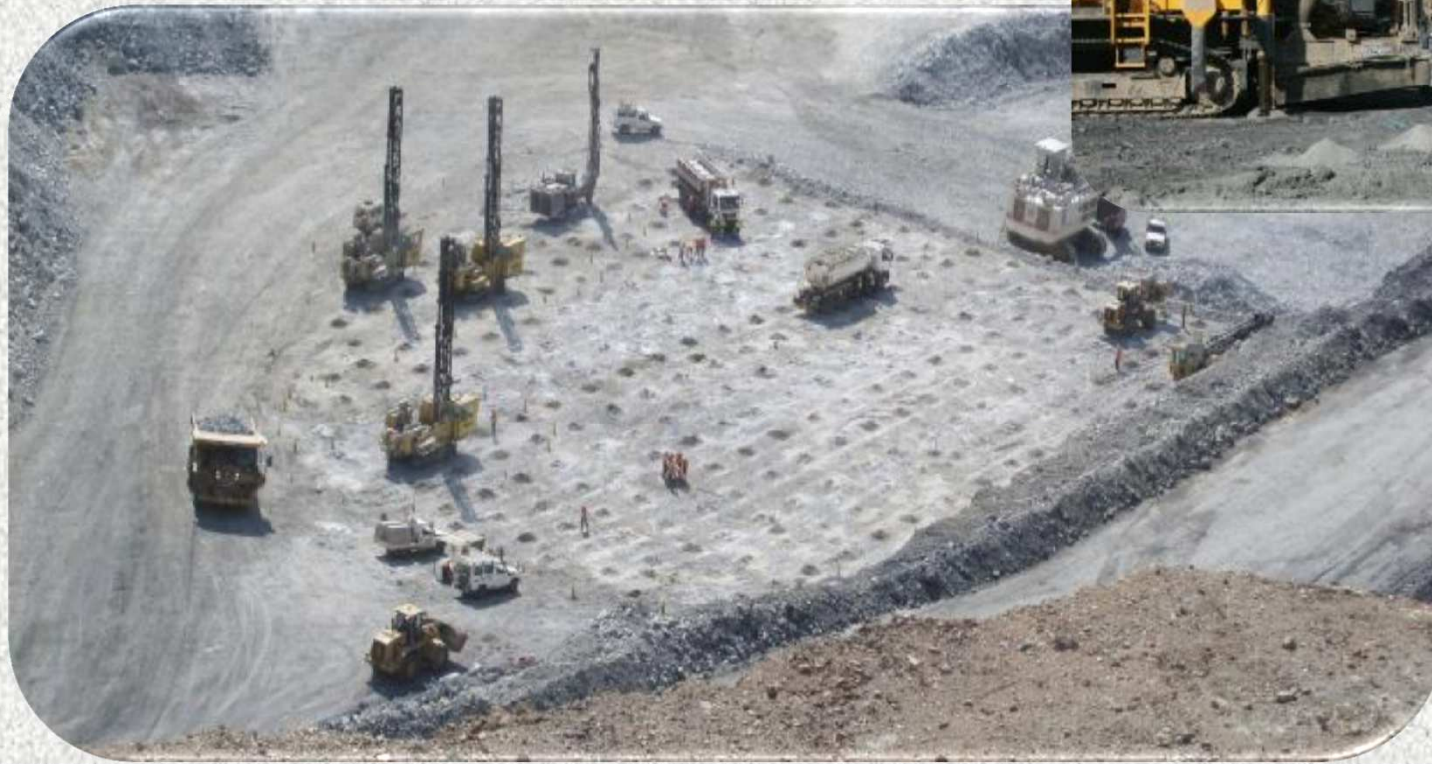
Grade Control

- **Aim...to properly define grade distribution ahead of blasting/mining**
 - A regularly-spaced pattern of drill holes in each mining bench
 - Samples taken every 1.5m and assayed in site lab
 - Ore and Waste are classified and modeled



Drilling and Blasting

- Aim...to fragment the rocks and ensure ease of digging
 - Small blast holes drilled, based on the specific blast design
 - Explosives put inside holes and blasting is confined
 - As with all areas in the mine, **safety comes first**
 - Full presence of the Ministry of Interior officials



Ore Marking

- **After blasting, the grade control team delineates different areas**
 - waste goes to waste dump
 - Depending on grade, ore is sent to either (1) stock piles or (2) the crusher



Loading and Hauling

- Giant 4 excavators (RH120) with 30T bucket
- Giant 1 face shovel (RH170) with 45T bucket



Loading and Hauling

- **Excavators**
 - 4 RH120 (with 1,375 t/hr digging rate)
 - 1 RH170 (with 2,000 t/hr digging rate)
 - 1 RH70 (with 965 t/hr digging rate)
 - 2 small excavators are used in preparations projects
- **Trucks**
 - 18 CAT 785C (with 150 t capacity)
 - 5 CAT 775 (with 70 t capacity)
 - 3 CAD 740 ADT (with 40 t capacity)
- **Ancillaries**
 - 3 Wheel Loaders
 - 5 Track Dozers
 - 3 Wheel Dozers
 - 5 Graders
 - 1 Compactor



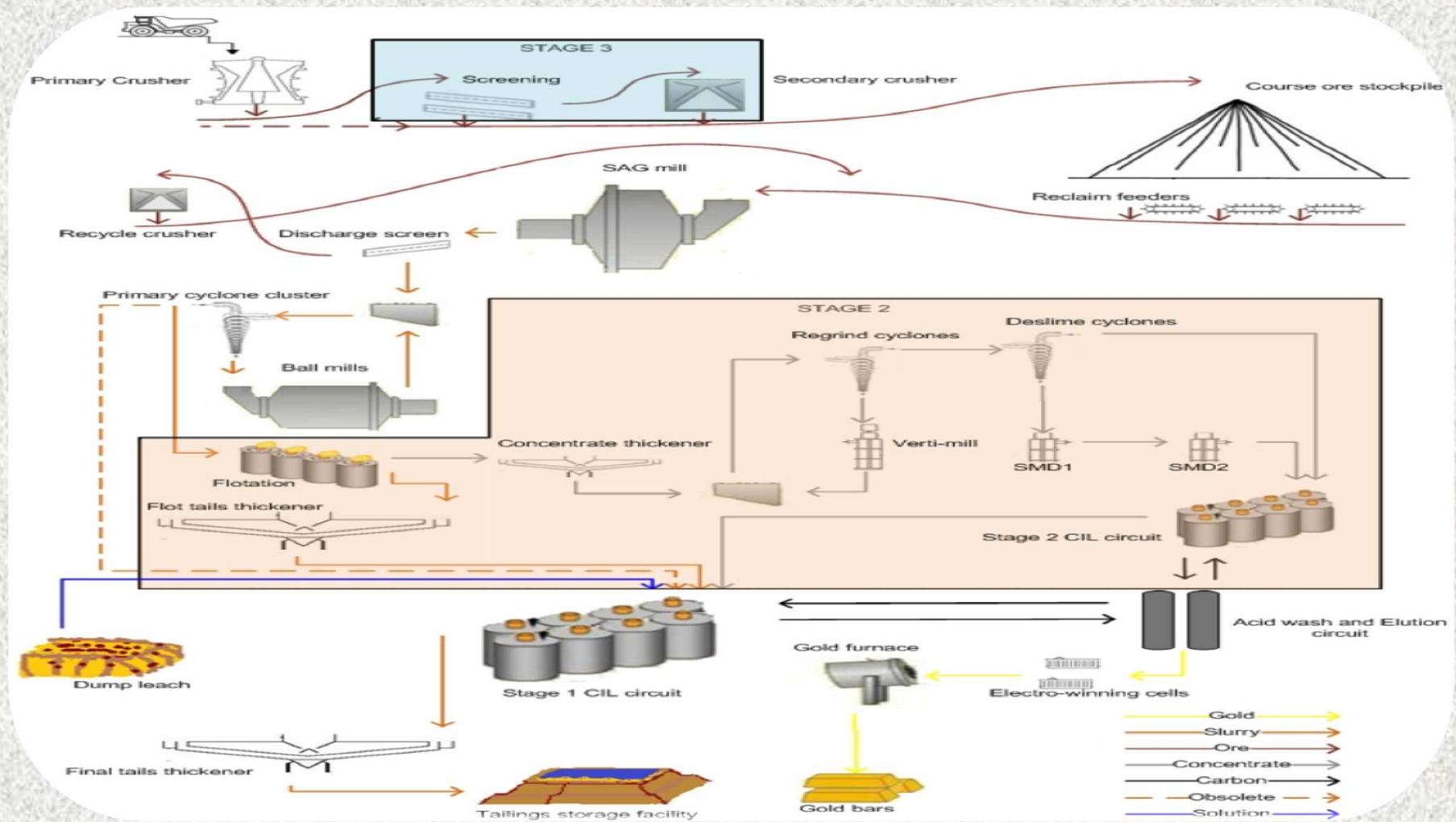
Sukari Gold Mine

Modern Gold Extraction

30 January 2013

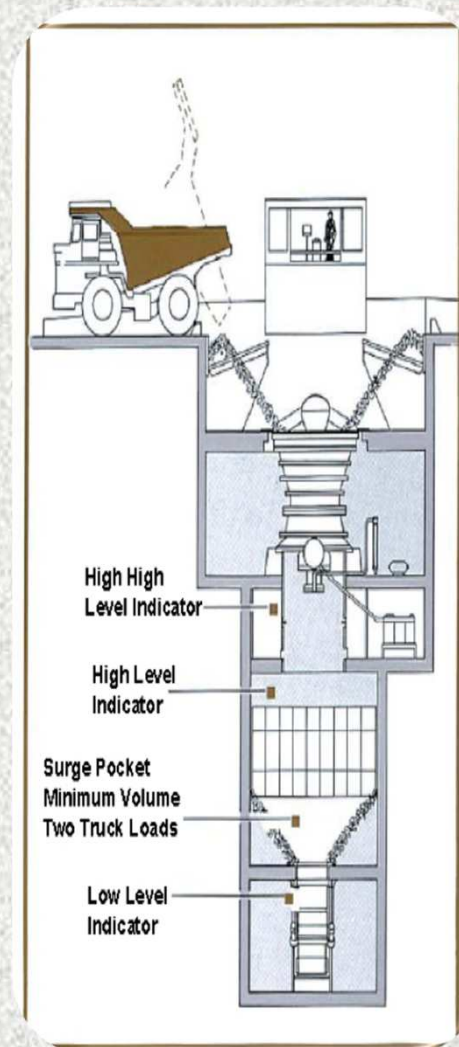


Process Plant Flow Diagram



Crushing Process Over View

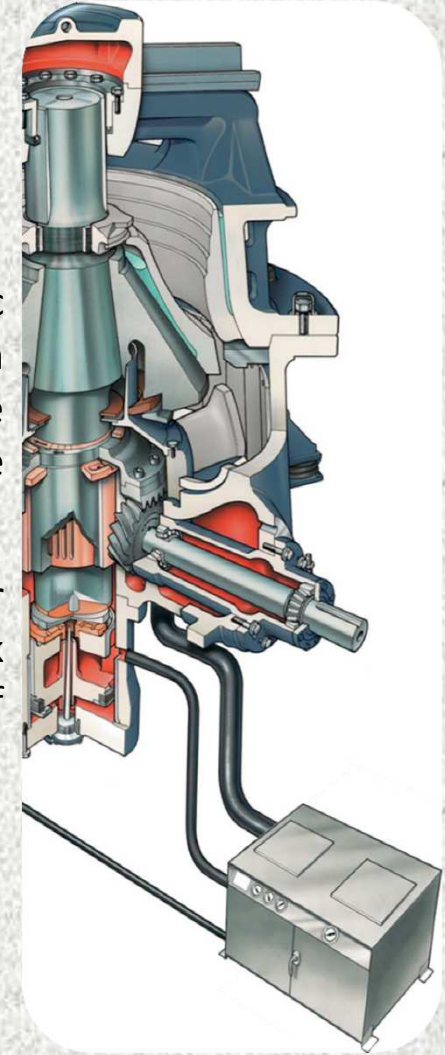
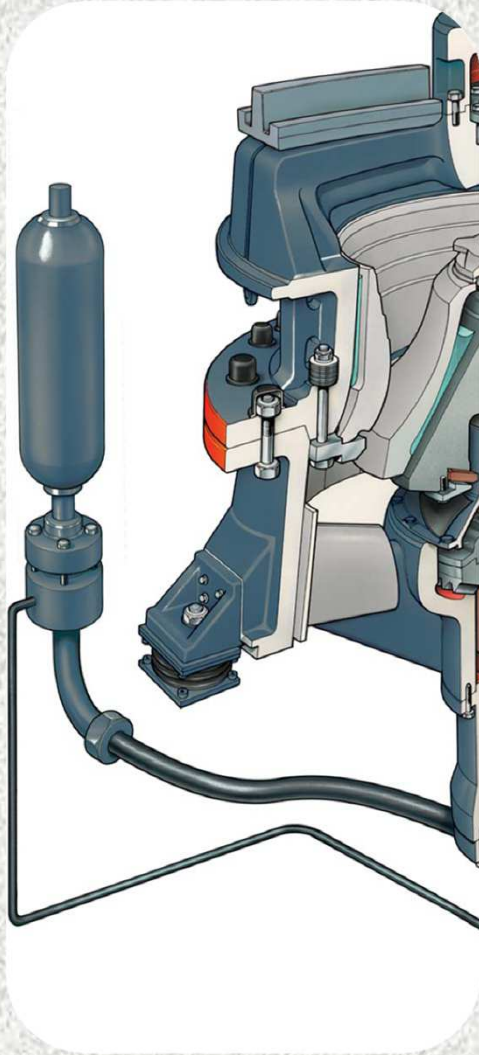
- The crushing process is the first step in size reduction progressively reducing ore to finer sizes.
- This Circuit consisting of primary crusher(gyratory crusher) , screening and Secondary crushers (Sandvik Cone Crushers).
- This size reduction achieved by putting ore through the gyratory crusher The crushed ore is withdrawn from the surge pocket / bin onto conveyor belts to the screening deck , the over size(40-120mm) go through secondary crushers and after it get crushed it gathering with the under size of the screens on conveyor belts and to the Reclaim Stockpile where three apron feeders under the reclaim can feed ore onto the Grinding mill feed conveyor into the Grinding mills for further treatment in the grinding operation.
- Final product size from the crushing circuit is (28-35mm)



Modern Crushing Technology

Sandvik Cone Crusher:

- Sandvik Cone crushers provide automatic overload protection and is equipped with automatic setting which can optimizes cone crusher efficiency and automatically adapts the crusher to variations in feed conditions.
- Automatically assists in keeping the crusher choke feed. This maximizes rock-on-rock crushing, which helps to optimize the quality of final product.



Grinding process Overview

- The grinding process is the second step in size reduction, progressively reducing ore to finer sizes.
- The grinding circuit reduces the size of the crushed ore from the Crusher in preparation for the separation of valuable minerals in the flotation circuit .
- A grinding mill is essentially a motor-driven rotating cylindrical shell containing the charge (the charge being a combination of ore, water and the grinding media).



Purpose of Grinding process

- The grinding circuit uses a conventional SAG and Ball Milling circuit with crushing of the more competent rocks (pebbles) to produce a product with a P80 of 150 microns.
- The general purpose of grinding is to liberate the gold particles so that they are freely available for chemical dissolution by cyanide.

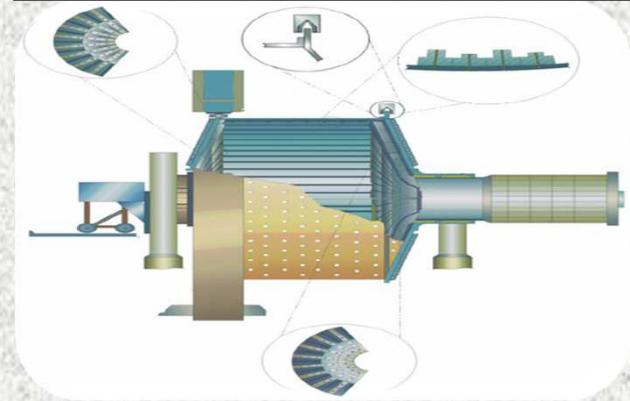


Non-liberated Au
Before Grinding

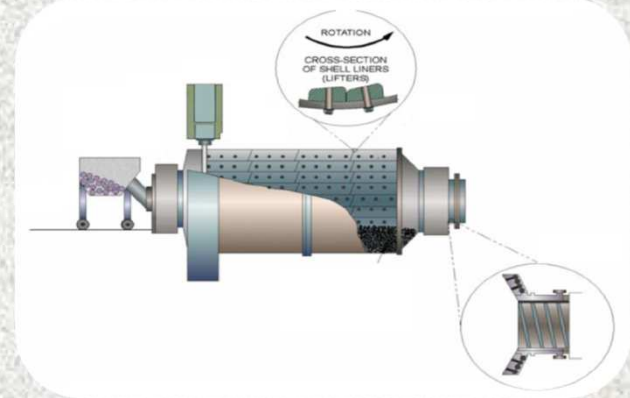
Liberated Au
After Grinding

- This circuit is designed to grind 650 tph.

SAG Mill



Ball Mill

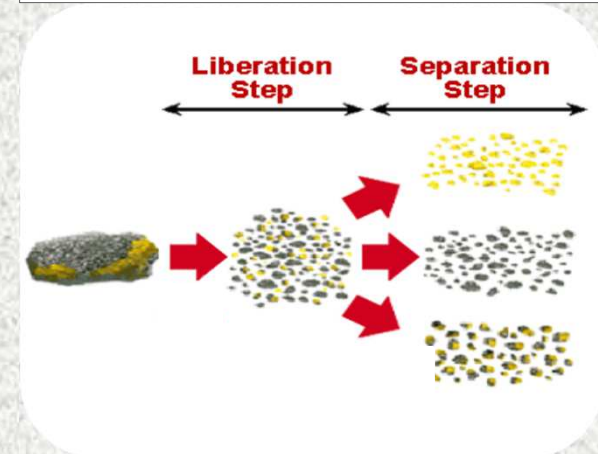


Flotation Process Overview

Why Flotation??

- Sukari gold particles are predominantly contained within the sulphide minerals and are extremely small at around 10µm in size.
- Grinding process reduces the size to be 80% less than 150 µm and only a low percentage of gold would be recovered if it was to report directly to leaching.
- The use of ultra-fine grinding is therefore required to break down the ore particles to 10µm so that they are liberated to be available for cyanide
- Ultra-fine grinding technology (Vertimill's and SMD's) are high cost units to operate and to grind the entire ore throughput (650tph) to 10µm would be uneconomical.
- Fortunately for Sukari, sulphide minerals can be separated from the remainder of the ore by the flotation process. The concentrate that is produced is approximately 5% of the total ore but contains approximately 95% of the total Au .

Au Liberation & Separation



Sukari Flotation Cells



Flotation Mechanism

- Bubbles of air are made to rise through the mineralised slurry and form froth on the surface of the flotation cell
- There are two sets of conditions that can describe the flotation environment

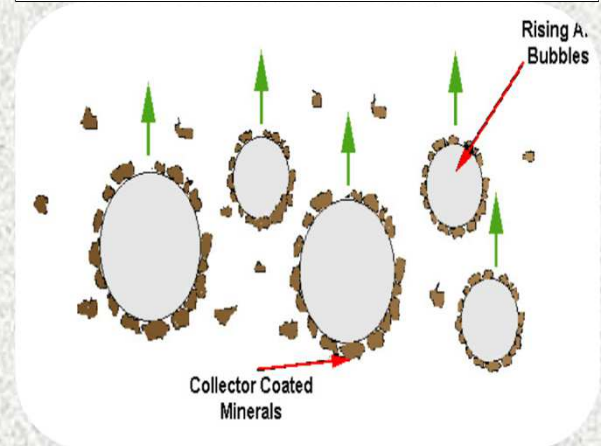
Chemical conditions:

- The interaction of chemical reagents with the mineral particles to make the valuable minerals selectively attaches to the air bubbles, making minerals hydrophobic.
- If the particle is hydrophilic, water loving, the water will cover the particle. If the particle is HYDROPHOBIC, water hating, the particle will prefer the air and reject the water.

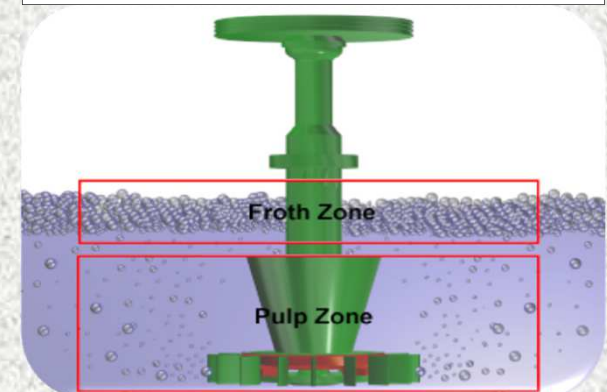
Physical-mechanical conditions:

- Which are determined by the flotation, machine.
- The flotation cell consists of an agitator/impellor which creates bubble by injecting air , mixes the slurry and bubble/particle contact

Air bubbles float to the surface carrying as many particles as the bubble can



Flotation Cell Agitator



Ultra-fine Grinding Technology

- The use of ultra-fine grinding for gold extraction is a relatively modern practice for which it has only been typically applied within the industry within the past 12 years.
- The regrind circuit consists of a tower mill and two SMD mills operating in series.
- The final product, with a P80 of 12 microns, from the regrind circuit is leached in a CIL (carbon-in-leach) circuit.

Tower Mill (VERTIMILL):

- The Vertimill is typically arranged in closed circuit and fed by the cyclone underflow.
- The motor power turns the Vertimill screw at constant speed to stir the grinding balls and slurry.
- As the particles are ground, they rise to the top of the mill and overflows into the a hopper (small tank)
- And the product from the Vertimill get pumped to the cyclone again.
- The over flow from the cyclone pumped to other cyclone which split the particles to over flow (12micron) which combined with the products from the SMDs.

VERTIMILL

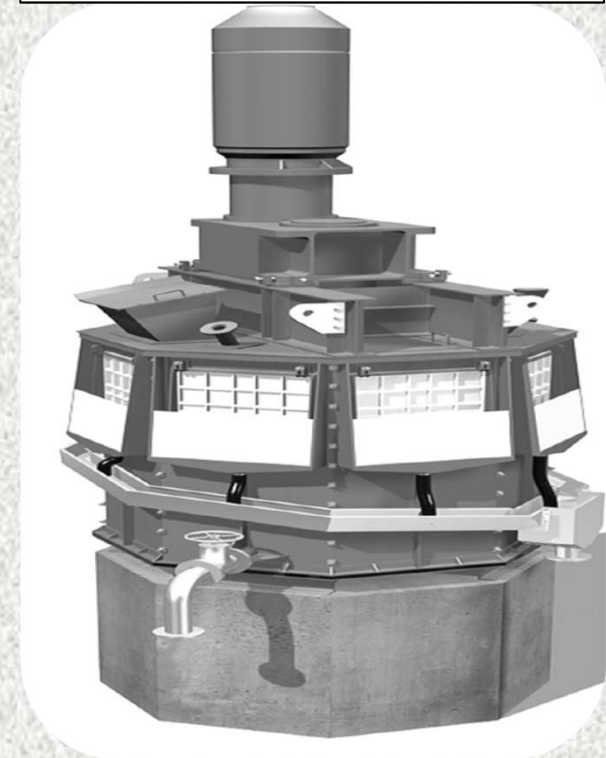


Ultra-fine Grinding Technology

Stirred Media Detritor (SMD)

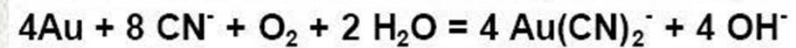
- The feed slurry (the under flow from the second cyclone) enters through a feed spout in the top cover which directs the feed into the bottom of the vortex (bottom of the mill) without any inlet head.
- Grinding media is added either by the automatic Media Addition System through one of the unused feed ports or manually through the media feed chute.
- Final product leaves the SMD through the media retention screens, situated around the top of the body and is collected in an external launder and is then pumped to feed another SMD and then reported directly to the leaching process.

SMD



Gold Leaching & Recovery

- Gold is leached using cyanide and adsorbed onto activated carbon particles advanced counter-currently through the tanks.



- Carbon loaded with gold is removed from the tanks on a batch-by-batch basis and the gold is stripped off the carbon using a conventional pressure Zadra elution circuit, with the gold plating onto stainless steel wool cathodes.
- The gold sludge is washed from the cathodes, dried and smelted into bullion.

