A Robot Miner for Low Grade Narrow Tabular Ore Bodies: The Potential and the Challenge

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Agenda/programme

- Contextualise mining
- How it is done now
- What is proposed
- The financial justification
- The plan
Where did the gold come from?

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after McCarthy and Rubidge, 2005
Gold Deposition

modified after McCarthy and Rubidge, 2005
World Wide Historical Gold production

- CANADA: 8,900
- UNITED STATES OF AMERICA: 14,100
- NORTH AMERICA: 25,850
- CENTRAL AMERICA CARIBBEAN: 2,850
- SOUTH AMERICA: 10,100
- SOUTH AFRICA: 47,800
- TOTAL AFRICA: 59,300
- REST OF AFRICA: 11,500
- EUROPE: 5,400
- NORTHERN ASIA AND ASIA MINOR: 17,000
- EAST AND SOUTH ASIA: 10,000
- AUSTRALASIA: 12,500

After Handley, 2004
Witwatersrand - historical

Total Tons Gold Produced up to 2002 = 47000 tons

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after Handley, 2004
What is a mine

- Gold in the ground does not = money.
- To mine it you need to get to it.
- People mine it therefore it needs people sized holes to get to it.
- Minerals in the ground – with a mining plan = A mineral Reserve
- Uneconomical to mine narrow ore bodies of limited grade
Ore Classification

**EXPLORATION RESULTS**

- **MINERAL RESOURCES**
  - Reported as in situ mineralisation estimates
- **INFERRED**
- **INDICATED**
- **MEASURED**

Consideration of mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the 'modifying factors')

- **PROBABLE**
- **PROVED**

Increasing level of geoscientific knowledge and confidence

**MINERAL RESERVES**

- Reported as mineable production estimates
Witwatersrand – available in stopes < 50 cm

Total Unmined Gold (tons)
- Central Rand: 570 t, East Rand: 200 t, Evander: 725 t, South Rand: 190 t,
- Carletonville: 1810 t, Potchefstroom Gap: 5980 t, Klerksdorp: 714 t, Welkom: 893 t
- Bothaville Gap: 317 t

- Total: 11 199 tons
- Estimated: 11 419 tons
- Estimated Total: 22 618 tons

LEGEND:
- CENTRAL RAND GROUP
- WEST RAND GROUP
- MAJOR FAULTS
- EXISTING GOLDFIELDS
- < 50cms Thick, No Previous Mining
- < 50cms Thick, Extensive Previous Mining
Case Study
Middelvlei Reef: Doornfontein Mine

Bottom Band thickness

< 50 cm
> 50 cm

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after Engelbrecht et al., 1986
Case Study

Middelvlei Reef: Doornfontein Mine

Total Au
Conventional Mining
495kg

Total Au
Nederburg Miner
1055kg

Additional Au
560kg
= R88.8 Million

Bottom Band thickness

< 2 000 cmg/t

> 2 000 cmg/t

< 50 cm

> 50 cm
So how much gold is there?
Case Study
Middelvlei Reef: Doornfontein Mine - Extrapolated

22 618 tonnes of gold
= R3.588 Trillion
(at $638, R: $ 7.05)
What is the Nederburg Miner?
A system for mining reefs of less than 30cm thickness with no dilution

- Mechanized
- South African
- Novel – not scaled down
- Probably
  - Low cost
  - Low height
  - Not automated at first
The Plan? More like the challenges

- How to break rock
- How to locate underground
- How to localise underground
Where are we now? The Concept

- 30cm height
- Swarm of mini mining robots
- Each with their own job to do
  - Break rock
  - Clean up the broken rock
  - Measure the environment
  - Track the reef
  - Provide power for rock breaking
  - Positioning of locating beacons
The Plan current decisions

- Ultra sonic beacon system for underground localisation
- Single prototype goal (not the entire team yet)
- WiFi communication methodology
- South African Built platform
- Electric Rock breaking technology
- Interim deliverable of a safety platform
What we don’t know yet

• How to track the ore deposit
• How to provide the required power for the system (aim for a non tethered system)
• How to manage to power for the system
• How to control a team of robots
• How to manage a team of teams
• What the mine design will look like
• What the impact of narrow stopes will be in the host rock
• How to control the rock breaking tool
• What we don’t know
Questions

- Looking for partners
- Interesting and challenging journey

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Thank you