# Technology Contribution to Operational Excellence

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**Cape Town 2000**

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It is a great pleasure for me to have this opportunity of addressing the Investing in African Mining Conference. My presentation will focus on technology, looking at what AngloGold has achieved to date and where it is heading. Before examining this topic in greater detail, however, I will start with an introduction to the company.

Following the recent acquisition of Acacia Resources in Australia, AngloGold:

- produces 7.5 million ounces of gold a year;
- has reserves and resources of 130 million ounces and 184 million ounces respectively;
- is active on four continents with 25 operations in seven countries and exploration programmes in 11 countries; and is listed on the Johannesburg, London, Paris, Brussels, New York and Australian stock exchanges.


To give AngloGold focus the management team has developed four strategic objectives and these serve to drive the company forward.

These objectives are to:

- extend and enhance future reserves and resources;
- achieve operational excellence to increase productivity and to improve safety;
- grow shareholder value; and
- undertake gold market development.


Let us take a closer look at the first objective: to extend and enhance future reserves and resources. With AngloGold producing 7.5 million ounces of gold a year the need to find replacement reserves and resources is a very real one. This is done through a combination of in-house exploration programmes, exploration joint ventures, the procurement of late-stage exploration prospects and the outright acquisition of companies or existing operations.

Importantly, we seek to acquire only those ounces that will add economic value to the company. *Guidelines* for acquisitions and projects arising from exploration include:

- double-digit real rate of return;
- potential for at least 200 000 ounces of annual production;
- reserves of at least 2 million ounces; and
- cash costs below US$200 per ounce.


When AngloGold was formed in June 1998 its activities were confined to the African continent. Since then it has become a global player as the accompanying map showing our operations and exploration sites makes clear. These new acquisitions have spread our technical, operational and country risks.


Nevertheless, AngloGold remains firmly rooted in and committed to Africa. Sixteen of our 25 operations are on this continent -in South Africa, Namibia and Mali. It is an important area for exploration with programmes in five countries: South Africa, Mali, Senegal, Tanzania and the Democratic Republic of the Congo.


We now move on to the second strategic objective: achieving operational excellence in order to increase productivity and to improve safety. Our goal is to have 21st century employees and managers in a 21st century workplace and to help us achieve this we need to deploy 21st century technology.


AngloGold's commitment to technology is considerable: last year we spent US$1 per ounce on a broad range of research and development projects and we have a five-year vision and a three-year programme to ensure that this area receives close attention.

Let us first take a closer look at the five-year vision. I will be discussing non-explosive continuous mining and improved occupational health, safety and environmental conditions in greater detail.

## Non-explosive continuous mining

Rock splitter

To overcome the problems associated with the use of explosives – the hazards, the clearance of an area before blasting and the possibility of gold losses – AngloGold is researching and developing several breakthrough technologies. These are:

- Rock splitting, which uses shockwaves to fracture and break rock, is currently being tested at some of our operations.
- The oscillating disc cutter which works through a combination of impact and rotation to break the rock while in tension. Although still in its infancy, this technology has great potential.

## Non-explosive continuous mining

Diamond saw

Diamond wire is capable of precision cutting and is ideally suited to the extraction of remnant pillars and to stoping in narrow ore reefs where it can produce stoping widths of 300 millimetres. Trials have shown that it is not suitable for our deep-level mines but it is ideal for shallow to medium depth mining with regular narrow ore bodies. It is already being used successfully at an operation in Fiji for pillar removal and is being tested in Western Australia. Brazil is another country where the mining conditions indicate the potential for diamond wire application.

The diamond saw shown in the picture avoids the stress problems experienced by the diamond wire machine.

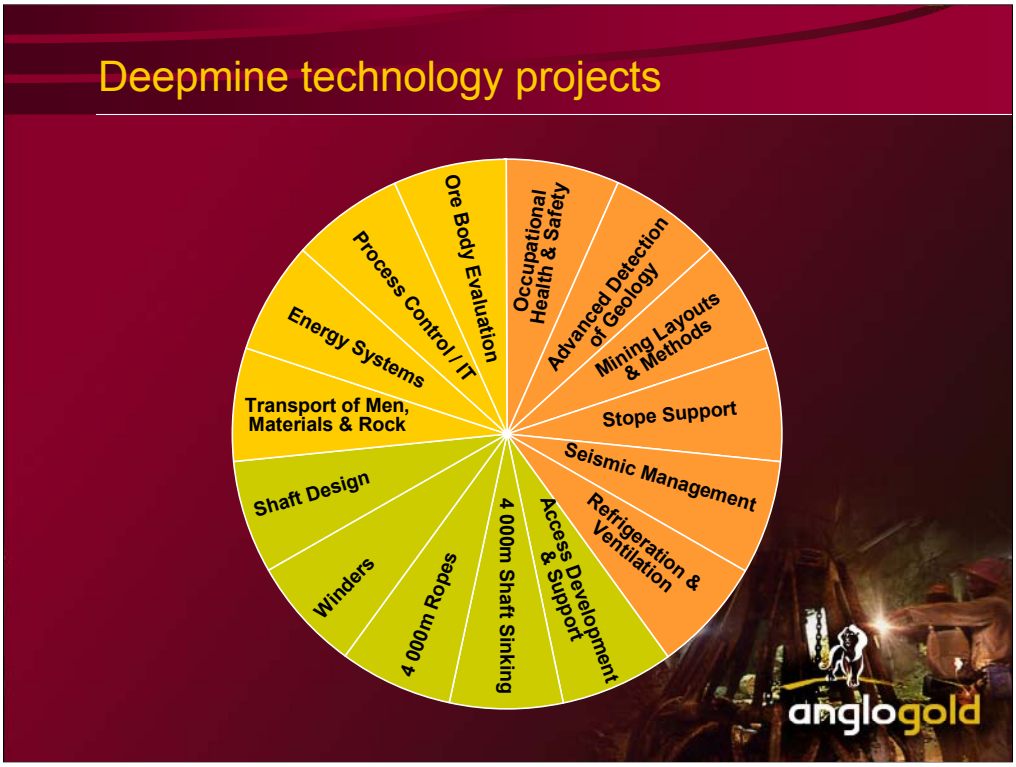
These are the sort of developments which will enable AngloGold to move away from cyclical mining, towards a 24-hour continuous operation where remote-controlled equipment will dominate


AngloGold is actively researching technologies which will lessen the heat, dust, noise and harmful fumes associated with deep-level mining.

Mining at the depths that we do (well below 3 000 metres beneath surface where rock temperatures are in the order of 55ºC) cooling systems are a crucial part of every operation and it is in this area that we have had an exciting breakthrough. Mponeng Mine near Carletonville, which is being deepened to 4 117 metres below surface, is the first mine in the world to be cooled by four vacuum ice refrigeration plants – an adaptation of leading edge technology developed by the Israelis.

To achieve the same effect as one of these plants, which has the power of 3 megawatt refrigeration, would require about 4 000 conventional office air-conditioners. Each plant produces 750 tonnes of ice a day – that's enough ice for about 30 million whiskies! The major benefit of this technology is greater efficiency: a chilled water system would use five times as much water and require an extensive pumping and piping infrastructure. Also, since no refrigerants such as CFCs or HFCs are used, these plants are completely environmentally friendly.

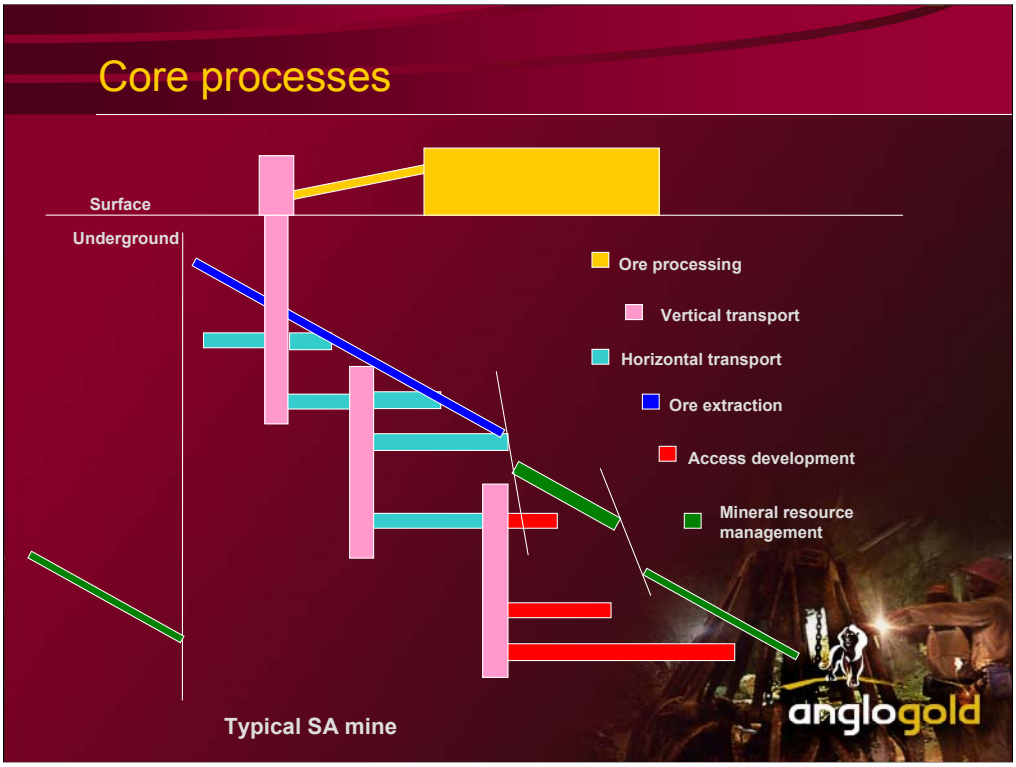

AngloGold is one of the few gold mining companies with significant in-house research and development capabilities. The company has allocated US$8.3 million for technology development this year. The management team is committed to ongoing expenditure on appropriate technologies.




The Deepmine collaborative research programme, which started in July 1998, is a four-year project with a total expenditure of US$11.4 million. It is designed to acquire knowledge and develop appropriate technology to enable safe, efficient and profitable ultra deep-level mining down to 5 000 metres. Fifteen key technology research areas have been identified and the benefits of these projects can be applied to the current mining operations.

International contacts are maintained by working with Amira, an Australian mineral industries research association and the Centre for Mining Technologies in Brisbane.

One of the challenges facing AngloGold is to overcome resistance to change, fear of job losses and to implement certain technologies with the aim of improving safety, productivity and the creation of a 21st century workplace



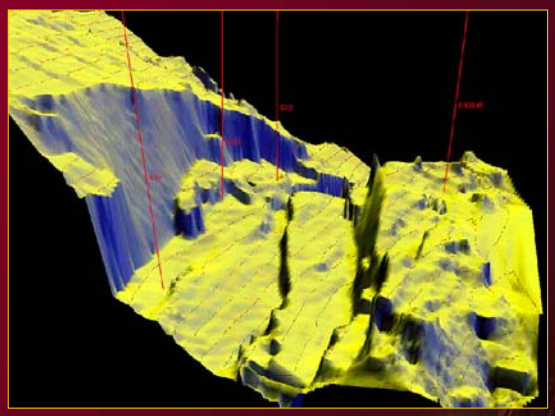

This diagram highlights the core processes of a typical South African mine. As you will see, technological advances are having an effect on each of these processes.


AngloGold has developed advanced methods of generating model-based exploration targets. Seismic reflective technology has been used to form an accurate picture of the underlying geological structure of the Western Ultra Deep Levels, Moab Khotsong, Tshepong and Tau Lekoa ore bodies. Different rock types have varying densities and transmit acoustic energy at different velocities. These acoustic properties are captured by using a vibroseis truck and geophones. The records are then converted into an interpretable format using specialised computing. The result is a series of horizons and faults along with their depths and geometric properties. Faults as small as
15 metres can be defined as was the case at Tau Lekoa.

One of the great advantages of this technology is the more accurate siting of deep diamond drill holes. And the information yielded – about faulting, rock conditions, strengths of various stata and so forth – is invaluable when it comes to mine planning, helping to ensure that shafts are placed in exactly the right position and underground stations cut at correct positions for the development of the ore body.

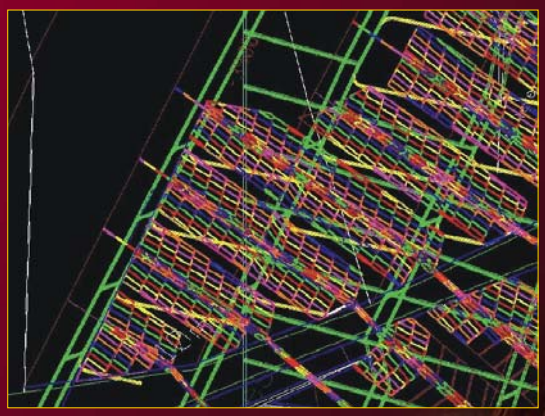
The CADS mine system is used for designing mining layout as well as for directing and controlling ore extraction.

# Mineral resource management



3-D image of VCR reef

# Mineral resource management



CADS mine system

## Access development

Jumbo drill rig

AngloGold does its own raise boring – up to a diameter of 3.6 metres – for the excavation of ore passes and ventilation shafts. The company completes some 130 kilometres of tunnelling a year. We are constantly seeking ways in which we can do this more quickly and more effectively.

The replacement of diesel LHDs by electro-hydraulic LHDs, which are found to be more efficient and environmentally friendly, is a good example. This conversion is being done in-house.

# Access development

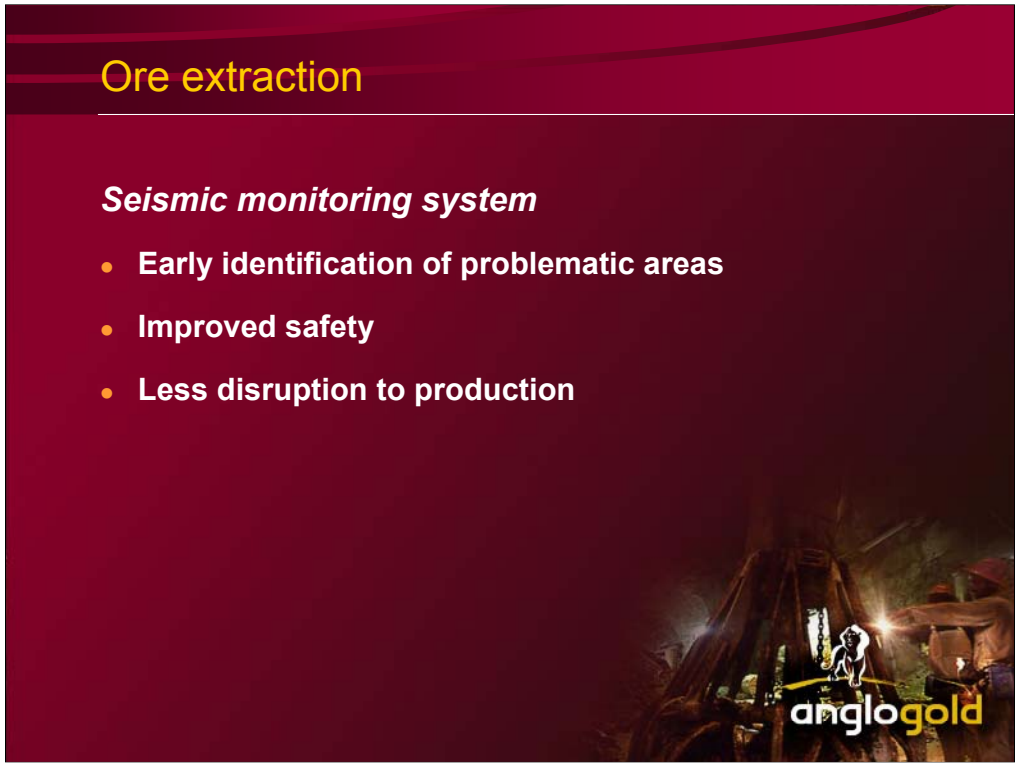
Electro-hydraulic LHD

# Access development

Track-bound Hagloader

# Access development

Automated shotcreting




We are testing and implementing a number of techologies to make ore extraction a safer and more efficient process. We will look at three aspects in greater detail.

Seismicity is a major cause of fatalities when mining at depth; resultant damage can set production back by months and make heavy inroads into revenue and profits as well as into employee morale. We were involved in the development of the world's first digital integrated seismic monitoring system which is installed at all of our mining operations. Interpretation of the seismic activity is monitored on an ongoing basis and facilitates:

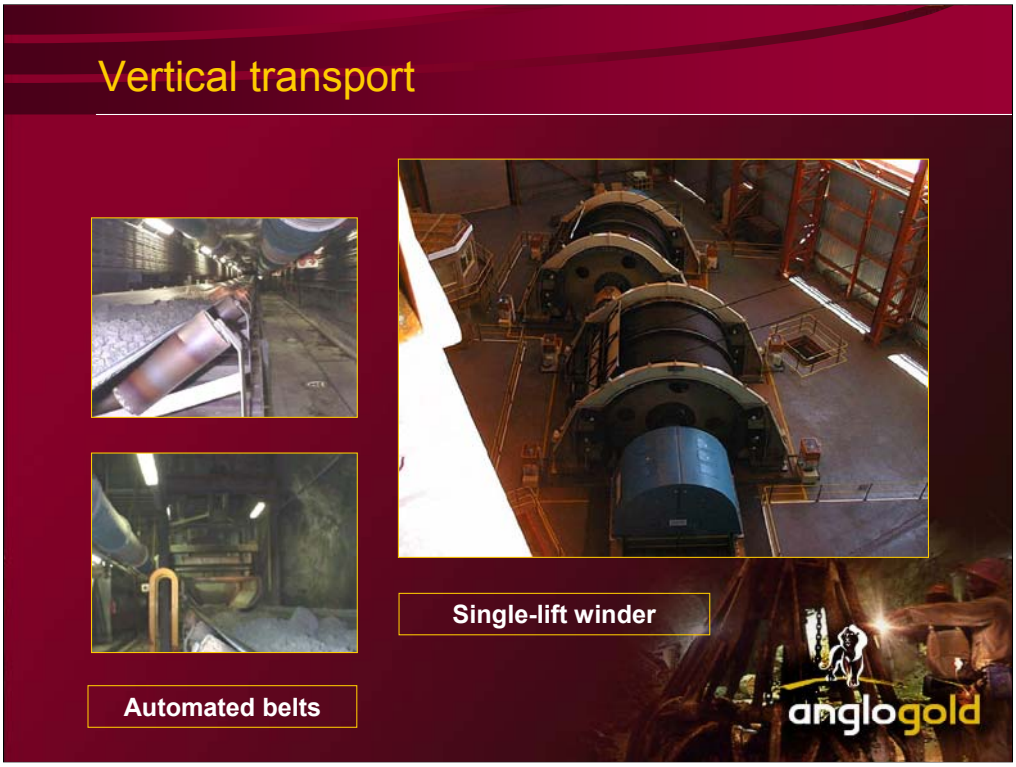
- early identification of problematic areas;
- improved safety; and
- less disruption to production.

Our aim is to develop the seismic monitoring system into a short time frame, early warning system.

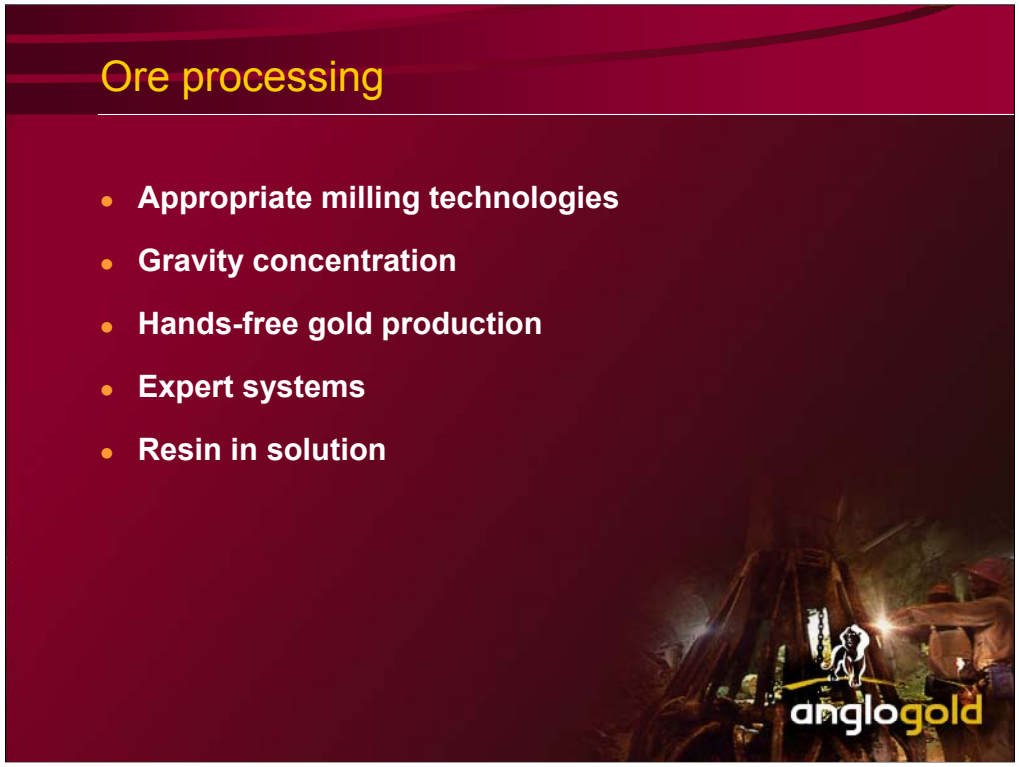

AngloGold has put considerable resources into developing and improving the design of stope drill rigs. The purpose is to remove people from direct contact with the rock face. The rig operator is positioned 2 to 3 metres from the stope face and yet he can achieve better results than someone who operates a hand-held drill. The equipment allows for angles to be pre-set so that all holes are equally spaced and parallel. Some of our mines are using these rigs and they report a 10 to 20 per cent improvement in face advance.


We have pioneered the use of backfill for primary face support through an invention known as the "pack in the pipe" – specially treated backfill in hessian casings is already being used in place of timber on three of our mines. In excess of 70 per cent of the area mined at our deep TauTona and Savuka mines is backfilled. The "pack in the pipe" reduces the danger of fire as well the time employees spend in installing support.


In terms of safety and ergonomics, the locos in use at AngloGold operations are outdated. Our goal is to introduce 21st century locos which are front-driven, more operator-friendly and lend themselves to communication and process control systems.




AngloGold is moving away from multi-stage shafts which require more services and absorb travelling time, towards longer single-lift shafts that can hoist economic payloads from greater depths. To achieve this better rope techniques, lighter skip materials and sophisticated automation are needed.




With the proven technology now available, existing multi-mill circuits can be replaced by larger mills that are more energy efficient and operate at lower cost. Gravity concentrators, low-pressure pebble breakers and expert systems can be added to these circuits.

This project is linked to the fundamentals of milling techniques. The objective is to focus on particle liberation as opposed to pure size reduction. Equipment will be looked at that could grind coarser yet yield the same degree of liberation as fine grinding.

An advantage of installing a gravity circuit within the milling circuit is that a portion of the gold feeding the plant can be removed earlier. Other benefits include residue reduction, less capital expenditure for greenfield plants and reduced operating costs. The Acacia reactor in Australia is being evaluated for wider application of this technology.

The objective of hands-free gold production is to replace the current smelthouse technology with units that would permit gold productions without staff intervention. This would significantly reduce the security risk at gold plants and improve produtivity.

An intelligent system “thinks” for the operator. It is rules-based, works on mathematical models, performs dynamic simulation and can learn from previous events. While Jerritt Canyon in the United States has an intelligent system installed which has resulted in significantly improved throughput, intelligent or expert systems are not fully implemented in the company.

Resin has the potential to replace carbon in certain specific applications, for example, for low-grade heap leach operations and for ores with a propensity for preg robbing. Gold selective resins are available and are being tested as a pilot project at Vaal River.

## Conclusion

- **AngloGold – a true global player**
- **Operations and exploration in Africa provide returns for shareholders**
- **Technology initiative driven by operational excellence strategy**
- **Technology transfer remains a challenge**


- AngloGold can rightfully claim to be a true global player.
- Operations and exploration in Africa continue to provide returns for shareholders.
- The technology initiative is driven by the strategy for operational excellence.
- Technology transfer remains a challenge.