MINING RESEARCH:

Cailey Barker
+44(0)20 7601 6132
cailey.barker@hansonwesthouse.com

Phil Swinfen
+44(0)20 7601 6140
phil.swinfen@hansonwesthouse.com

Robyn Storer
+44(0)20 7601 6131
robyn.storer@hansonwesthouse.com

SALES:

Sanjiv Pandya
+44(0)20 7601 6130
sanjiv.pandya@hansonwesthouse.com

Neil Hobson
+44(0)20 7601 6134
neil.hobson@hansonwesthouse.com

Simon Hodges
+44(0)20 7601 6136
simon.hodges@hansonwesthouse.com

SALES TRADING:

Martin Dobson
+44(0)20 7601 6135
martin.dobson@hansonwesthouse.com

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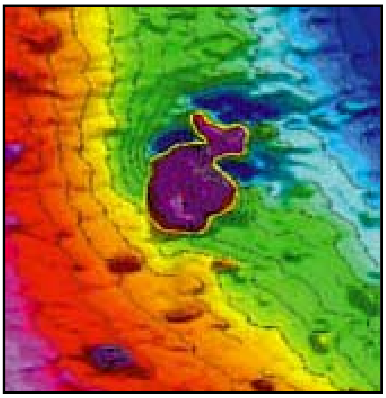
Sector Review
Metals & Mining

The Diamond Industry



The diamond industry

Why invest in diamonds?

⇧ Increasing demand from jewellery sector
\+ ⇩ Decreasing mine supply as existing reserves are depleted
\+ ⇩ Lack of recent exploration discoveries
= ⇧ Increasing diamond prices…demand exceeds supply

Diamonds – not all equal

Gem diamonds

- High quality (clarity, colour) and weight (carats) to be used for jewellery
- Kimberlite pipes and fissures are the primary source of diamonds – deposits display a wide range in quality and size
- Alluvial deposits are a secondary source of diamonds - derived by weathering of pipes and fissures – Alluvial deposits typically yield high proportions of gem-quality diamonds, as poorer quality diamonds are broken down during transport and deposition

Low-quality and small 'gem' quality

- Low end of the jewellery market
- 'Pave' diamond jewellery and low-cost cutting in India has expanded this end of the jewellery market

Industrial diamonds

- 80% of mined diamonds are unsuitable for use as gemstones and destined for industrial use (often known as bort), where they are valued for their hardness and heat conductivity. The dominant industrial uses are in cutting, drilling, grinding, and polishing which do not require large diamonds

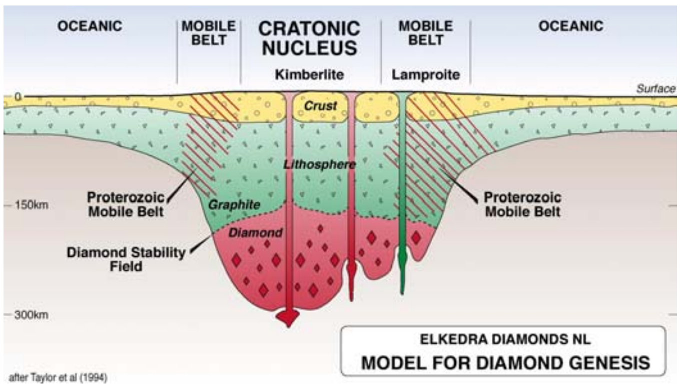
Synthetic diamonds

- Vast majority of synthetic diamonds are small imperfect diamonds suitable only for industrial-grade use
- Manufactured using high temperature, high pressure techniques
- Gem-quality synthetic diamonds whilst visually identical to natural diamonds can be distinguished by spectroscopy

How are natural diamonds formed?

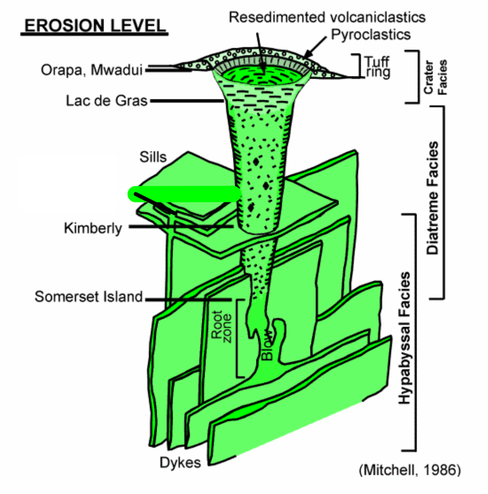
Kimberlites

- Diamonds are formed deep within the earth's crust (150-200km) and brought to the surface by volcanic eruptions
- These rocks are called kimberlites (or lamproites*) depending on their chemical composition (*Argyle and Ellendale in Australia are among the few diamond-bearing lamproites to have been mined)*
- The magma rises to the surface producing a violent eruption which creates a carrot-shaped pipe (diatreme), topped by a crater of pulverised rock pieces that, after being ejected into the air, fall back to earth, forming layered 'pyroclastic tuffs'



Alluvial

- Alluvial diamond deposits are produced by the erosion of diamond bearing kimberlites, freeing the diamonds along with other 'indicator' minerals which are then dispersed into rivers and/or the sea
- The constant reworking during transport in rivers and/or by wave action in the ocean ensures that alluvial deposits contain a higher percentage of gem diamonds than in the source kimberlite
- Size is inversely related to the transportation distance from source and dependant on the size range of diamonds in the 'source' kimberlite



Grade & value

Grade - Usually expressed as carats per hundred tonnes (cpht)

Diamond weight (carats) ÷ sample weight (tonnes) or volume (m^3)

Value - The value of diamonds (US$/carat) depends on the 4 Cs:

- Cut - A well cut diamond produces facets whose placement and angles maximise the diamond's brilliance and fire
- Carat - The universal measure of weight for a diamond. Larger diamonds are rarer and more valuable
- Colour - Colourless diamonds are generally more valuable. Stones are graded from totally colourless to light yellow
- Clarity - Refers to how many flaws or imperfections are in the diamond. Internally flawless diamonds are the most valuable

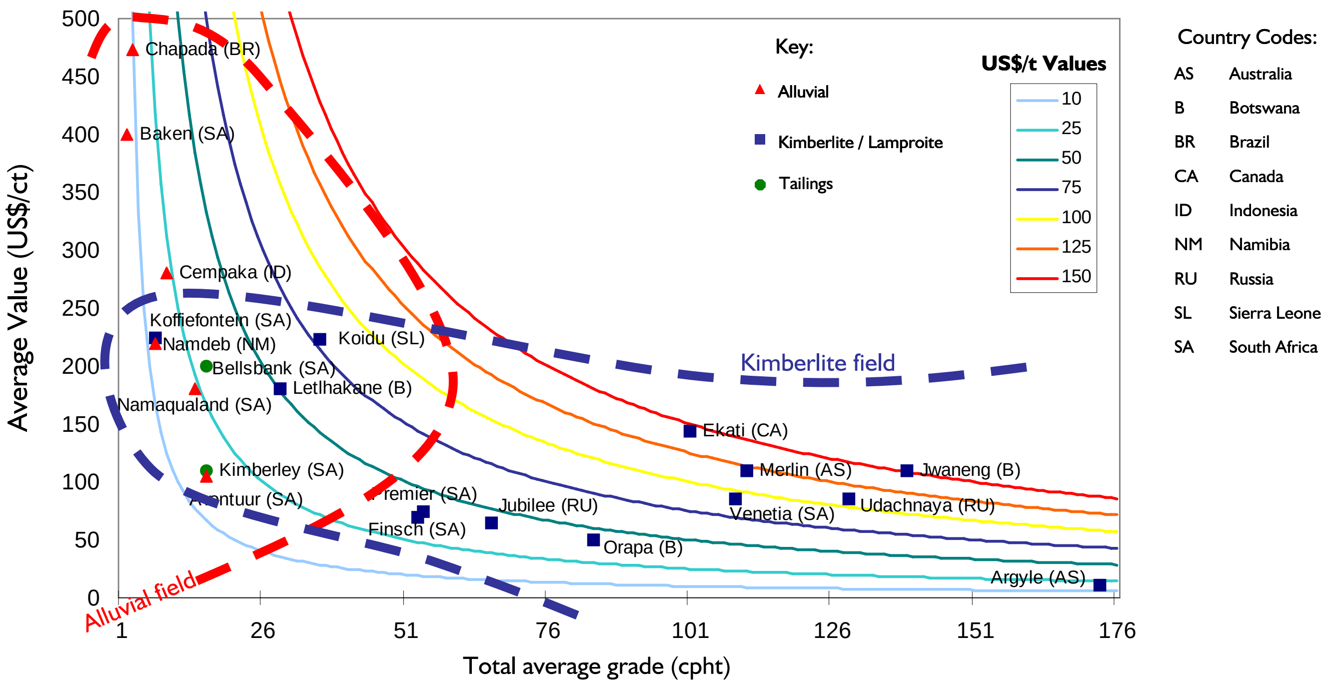
World averages for commercial diamond mining operations

Grade	70 cpht
Diamond size	0.4-0.5ct/st
Diamond value	US$64/ct
US$ / tonne value	US$45/t

Source: nrcan

Grade + Value - The only real way to value deposits well is to determine grade and value (in US$/tonne)

US$/tonne value = carats per tonne X US$ per carat

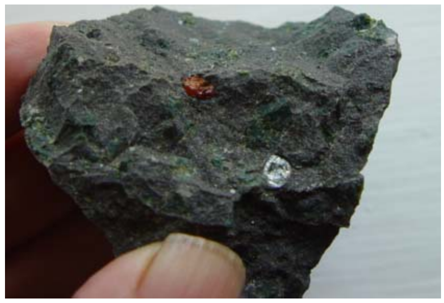


Kimberlite vs. Alluvial

Kimberlite Typical value range: US$25-150/t

- Larger, lower quality stones (% terms) with higher grades and tonnages, i.e. kimberlites are 'un-sorted'
- Exploration for kimberlites is a costly and time consuming
- Only ~1% of kimberlites contain diamonds in economic quantities
- Presently about 30 major kimberlites are being mined world-wide
- Exploration risk is high but production risk is fairly low. Diamond grades tend to be more uniform and more consistent.
- Operating profits are usually higher and easier to forecast

Diamond in-situ in kimberlite



Source: KimCor Diamonds Plc

Alluvial Typical value range: US$10-75/t

- Higher quality stones (well-sorted), commanding higher prices
- Exploration is relatively quick and low cost, reducing exploration risk
- Resource estimation is difficult due to high variability of grade
- Operational risk is higher, while operating profits are lower and more difficult to forecast

Diamondiferous alluvial gravels

Source: Elkedra Diamonds NL

Exploration – how do you find a kimberlite?

Economic kimberlites are exceptionally rare which makes diamond exploration a very risky business. However….the rewards can be substantial.

Step 3
Ok….You've got a diamondiferous kimberlite, but is it economic?

If so…mine it!!

Mine Development
Construction
Licensing and Permitting
Financing

Economic Appraisal
Social Impact Studies
Environmental Studies
Feasibility Studies

Step 2
Does the kimberlite contain diamonds?

Sampling main tool

Grade and Value Test
Determining Grade (cpht)
Determining Stone Value ($/ct)
Bulk Sampling

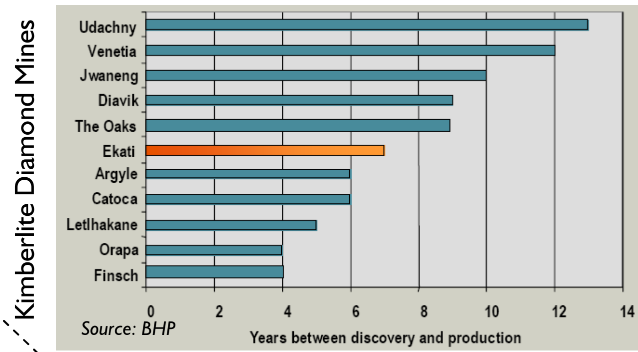
Test for Larger Stones
DMS Processing for diamond Recovery
Mini-bulk Sampling

Target Testing
Microdiamond Testing
Target Drilling

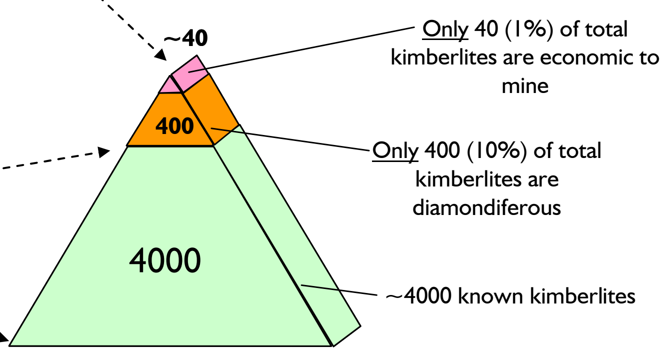
Step 1
Find a kimberlite…
…using *geophysics*

Target Delineation
Indicator Mineral Sampling
Geophysics
Area Selection

Exploration risk and reward



On average it takes 8 years from discovery to production

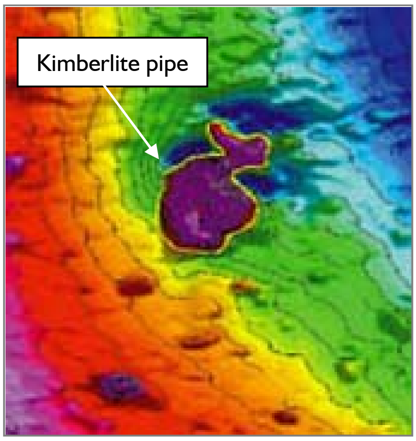


Step 1: Finding kimberlites

Airborne Geophysics

- Initial exploration often involves flying an airborne geophysics survey over prospective ground. Diamond-bearing kimberlites tend to be located on Archaean cratons, areas which have been unaffected by major tectonic events
- Airborne surveys are flown using small planes and helicopters to collect data
- Geophysics takes advantage of the fact that different rocks have distinctive physical properties such as magnetic susceptibility, conductivity and density
- Kimberlites often have unique geophysical signatures but not all circular anomalies are kimberlites and not all kimberlites are circular

Kimberlite identification



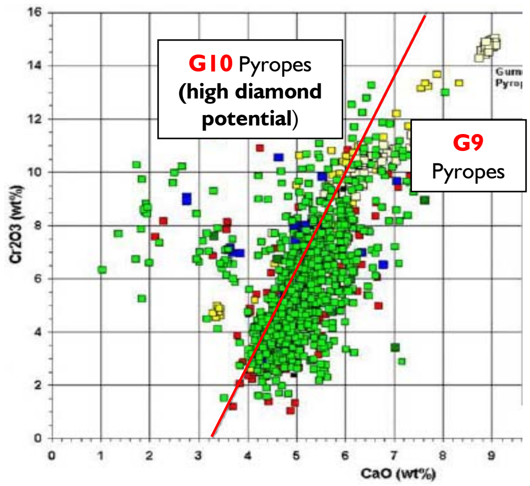
Source: Ashton

Kimberlitic indicator minerals

- Formed together with diamonds at depths of 150-200km
- Include: pyrope garnets, ilmenites, chrome-diopsides, chromites
- Indicator minerals are more abundant than diamonds and are therefore more easily detected in samples taken in the rivers downstream from the pipes
- The chemistry of the 'indicator mineral' can identify the type of source rock, including 'kimberlites'
- Indicator mineral chemistry can indicate a 'probability' of whether or not the 'kimberlite' will/can contain diamond
- Indicator mineral chemistry WILL NOT indicate if the diamondiferous kimberlite is economic – cannot predict grade and value of diamonds

- Chemical analysis distinguishes G10 from G9 garnets
- 85% of garnets associated with diamonds plot in the G10 field
- Therefore: the presence of G10 garnets in exploration samples may indicate proximity to a diamondiferous kimberlite

Plot of pyrope garnet geochemistry



Source: Stornaway

Step 2: Evaluating kimberlites

Microdiamond sampling

- A microdiamond is a diamond <0.4mm in size (<0.001carats) and is only of geological importance, as they do not have any commercial value
- They are often the first diamonds discovered during the exploration phase and the first step in assessing the economic potential of a kimberlite
- It is common to quote the ratio of microdiamonds per 100kg of rock and the ratio of microdiamonds to macrodiamonds. In Canada, a rule-of-thumb is to recover at least one microdiamond larger than 0.1mm per kg of rock and 1 macrodiamond (>0.5mm) per 10 kg of rock is required to indicate economic potential (Hamilton and Lewis, 2002)

- The presence of microdiamonds is a strong positive milestone in the evaluation of a project

Bulk Sampling

- Sampling is performed to assess the grade of the commercial-sized diamonds and their average value
- This involves processing via a dense medium separation plant (DMS or HMS), jig or diamond pan. A "bulk sample" of 10t-100t is required to recover macrodiamonds (>0.4 mm in size). At least a 5,000 carat parcel is needed for reliable price valuation

DMS plant, Merlin, Australia

Source: North Australian Diamonds Ltd

Step 3: Mining kimberlites

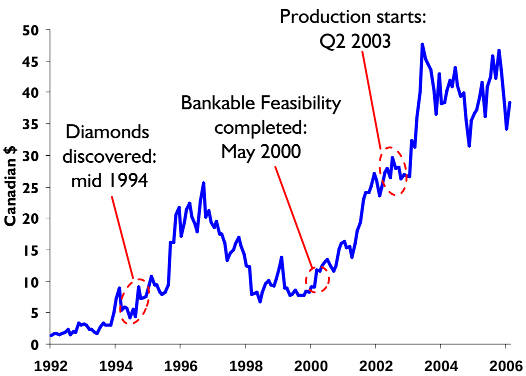
As can be seen from the two examples below, the rewards can be very high.

DIAVIK

Source: Aber

Market Cap (Aber)=US$ 1.9 Billion

• Ownership:	60% Rio Tinto, 40% Aber
• Mining started:	2003
• Capital Cost:	US$1.5 billion
• Reserves:	29.8 Mt
• Contained:	95 million carats
• Grade:	395 cpht
• Average value:	~US$60/ct
• Average $/t value:	US$244/t
• Mine life:	22 years

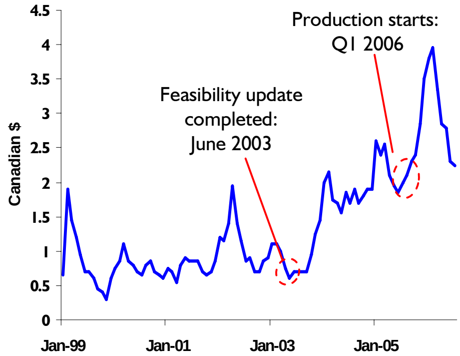


JERICHO

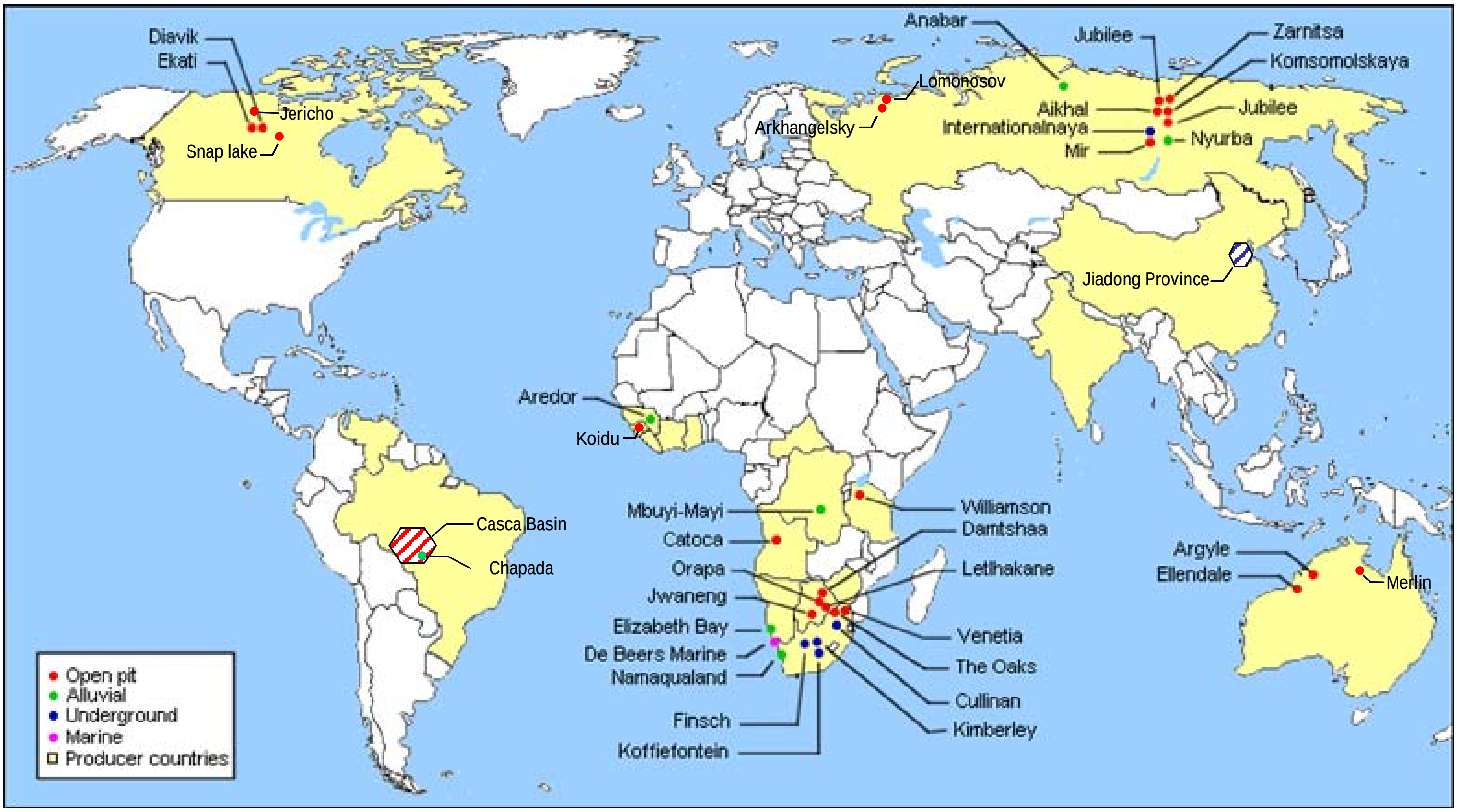
Source: Tahera

Market Cap =US$ 313 Million

• Ownership:	100% Tahera
• Mining started:	2006
• Capital cost:	US$115 million
• Reserves:	5.5 Mt
• Contained:	4.7 million carats
• Grade:	85 cpht
• Average Value	US$88-97/ct
• Average $/t value:	US$77/t
• Mine life:	9 years



Location of major diamond mines



Source: Hanson Westhouse & Diamants infos

Mining & processing

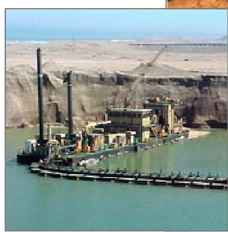
Diamond mining and processing is usually relatively simple, with low operating and capital costs.

Mining

Kimberlite pipe deposits are typically mined by large open pit mines. The relatively low grade requires that a large amount of earth has to be removed relative to the number of diamonds recovered. Once the surface deposits have been exhausted, shafts or declines are sunk to access deeper ore. This is usually more costly than open pit mining. Kimberlite rock is usually fairly competent and so requires blasting before excavation/digging.

Alluvial diamonds are usually contained within alluvial sediments (gravels) from riverbeds, old river terraces, ocean beaches or the sea floor. These are mined by simple excavation (strip mining) or by dredging in the case of marine deposits.

Strip mining



Dredging

DMS

X-ray sorting

Source: Elkedra Diamonds, http://members.iinet.net.au

Processing

Excavated ore is transported to a processing plant, which removes diamonds by virtue of their weight and density. Hard rock deposits are crushed first, where as alluvial gravels normally report straight to the plant. The plant consists of a series of screens, jigs and scrubbers and a gravity pan or Dense Media Separator (DMS) to remove lighter material and create a concentrate of heavy material. Diamonds are then extracted by x-ray machine or grease table and checked by hand sorting.

Reprocessing of diamond-bearing dumps

- Involves the reprocessing of dump tailings and concentrates leftover from previous mining operations
- Many tailings dumps still contain diamonds due to the inefficient processing of high grade kimberlites and alluvial deposits
- Simple processing using conventional gravity circuit and grease tables
- Low capital cost, Low operating cost, High margins

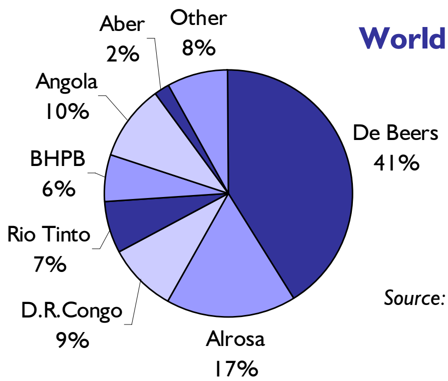
Production

Annual world production of natural rough diamonds has been steadily increasing over the last 35 years from around 40 million carats in 1970 to 180 million carats in 2005 (US$12.7bn in value terms).

Botswana remains the largest producer (25%), followed by Russia (13%) and Angola (10%). Canadian production has increased due to the Diavik start up and increased production from Ekati.

World production by producer

100% = ~US$13bn

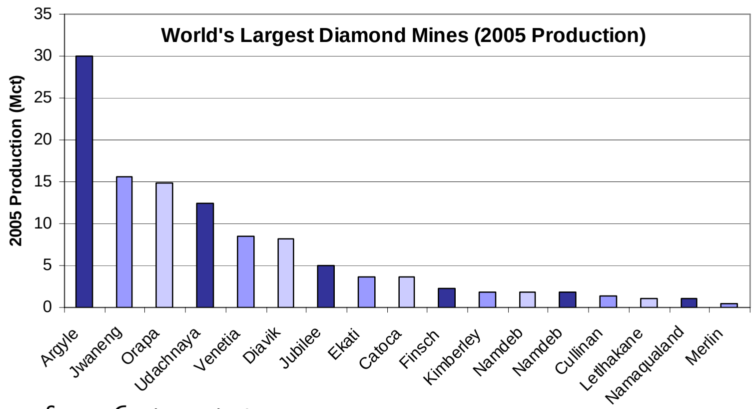


Source: Rio Tinto

Annual Rough Diamond Production (Value)

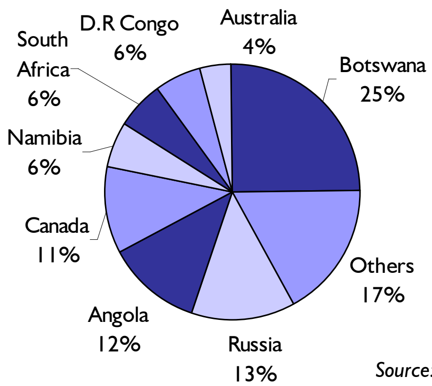
	Dollars (billion)						
	2004	2005	2006	2007	2008	2009	2010
Botswana	2.9	3.3	3.1	3.1	3.1	3.4	3.4
Russia	2.2	2.5	2.5	2.4	2.3	2.3	2.5
Canada	1.5	1.4	1.4	1.6	1.8	2.1	1.9
S.Africa	1.4	1.6	1.5	1.5	1.4	1.4	1.7
Angola	1.1	1.2	1.3	1.4	1.4	1.4	1.4
D.R.Congo	1.0	1.1	1.1	1.1	1.1	1.1	1.1
Namibia	0.8	1.0	1.0	1.0	1.0	1.0	1.0
Australia	0.3	0.6	0.6	0.6	0.6	0.6	0.5
Others	0.6	0.7	0.8	0.8	0.9	0.9	0.9
Total Dollars	11.8	13.4	13.3	13.5	13.6	14.2	14.4

Source: WWW International Diamond Consultants Ltd



Source: Company reports

World production by country (2005)



Source: Rio Tinto

Cutting & polishing

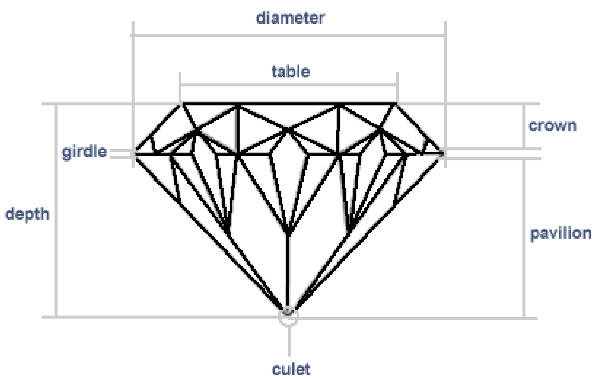
The process of shaping a rough diamond into a polished gemstone is both an art and a science. The choice of cut is often decided by the original shape of the rough stone and location of any inclusions or flaws to be eliminated. In addition, the preservation of the weight and popularity of certain shapes amongst consumers affects the decision.

The round brilliant cut is preferred when the crystal is an octahedron, as often two stones may be cut from one such crystal.

The cutting and polishing of a diamond crystal always results in a dramatic loss of weight; rarely is it less than 50%. Sometimes the cutters compromise and accept lesser proportions and symmetry in order to avoid inclusions or to preserve the carat rating.

There are numerous diamond cutting centres but the most important are:

- Antwerp / Tel Aviv - Standard gem quality cutting
- India - Specialises in small / pave stones
- New York - Highly skilled and generally only work large stones of >2cts



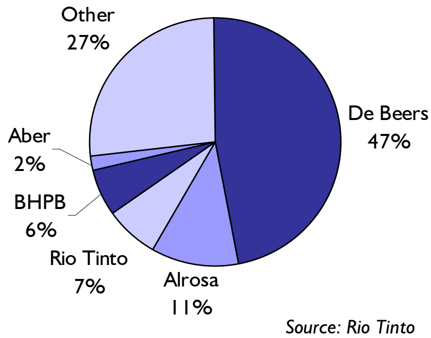
Source: Gembaby.com

Marketing

The dominance of De Beers – now a thing of the past

De Beers was incorporated in 1888, 22 years after the first authenticated discovery of a diamond on the banks of the Orange River. In 1890, De Beers created The Diamond Corporation, which in turn formed the basis of the Central Selling Organisation (CSO) and by the beginning of the 20th Century De Beers controlled 90% of the international diamond trade.

World supply by marketer (100%= US$13bn)



Source: Rio Tinto

Through the CSO, De Beers controlled prices by regulating supply and perpetuating the luxury and scarcity perception associated with diamonds (in 1999 De Beers had a diamond stockpile worth US$4.8bn). As a result of growing consumer awareness of conflict diamonds, increased production outside De Beers' control and anti-trust laws, De Beers launched a new strategy based around being the "Supplier of Choice". Once sorted, diamonds are blended into selling mixtures in preparation for sales to the De Beers' Sightholders which take place 10 times a year in London and Johannesburg.

Diamond sales

Diamond gemstones are sold on exchanges called "bourses". There are 24 registered diamond bourses. This is the final tightly controlled step in the diamond supply chain; wholesalers and even retailers are able to buy relatively small lots of diamonds at the bourses.

The main diamond exchanges are located in: Antwerp, Bangkok, Bharat, Vienna, Florida, Moscow, Los Angeles, Singapore, Dubai, Shanghai, South Africa, Israel, London and Tokyo.

The most important bourses are in Belgium (principally Antwerp) where over half the world's market of rough diamonds pass through the exchanges.

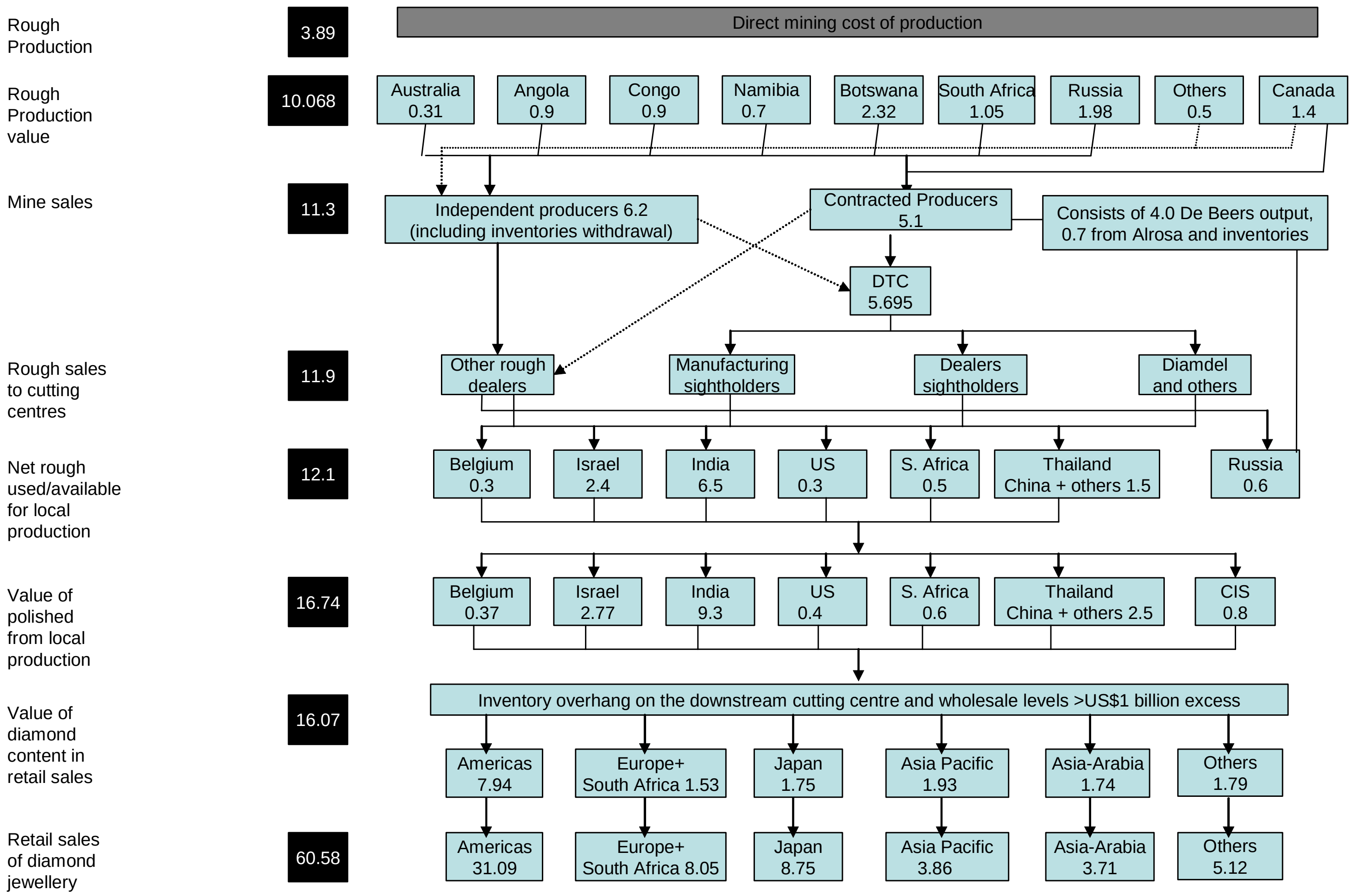
The Kimberley Process

The Kimberley Process Certification Scheme (KPCS) is a scheme designed to prevent conflict diamonds entering the mainstream rough diamond market. 98% of the world's trade in rough diamonds takes place in and between countries taking part in the scheme.

The scheme originated from a meeting of South African diamond producing states in Kimberley in May 2000, and ensures that any diamond originating from the country does not finance a rebel group or other entity seeking to overthrow a UN-recognised government. Every diamond export must be accompanied by a Kimberley Process certificate, which is controlled and issued by the government.

The World Diamond Council is an organisation consisting of representatives from diamond manufacturing and diamond trading companies. The Council was set up in July 2000 to examine ways to reduce the number of conflict diamonds entering the diamond market.

The diamond pipeline (US$bn)



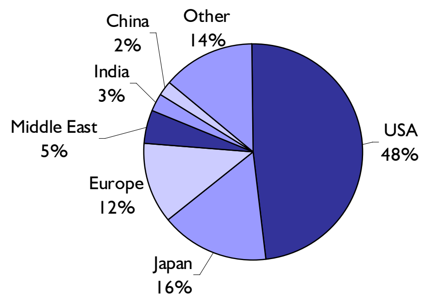
Source: Mining Journal, 29 April 2005

Demand fundamentals

The U.S. dominates

The U.S. is the largest market accounting for almost 50% of global demand, followed by Europe and Japan, which together account for ~30%. The rough diamond market in the US is worth about US$9.5bn which translates downstream into a ~US$60bn diamond jewellery market.

Global demand for diamond jewellery 2004
(100%=US$65bn)



Source: Rio Tinto

China and India set to lead growth

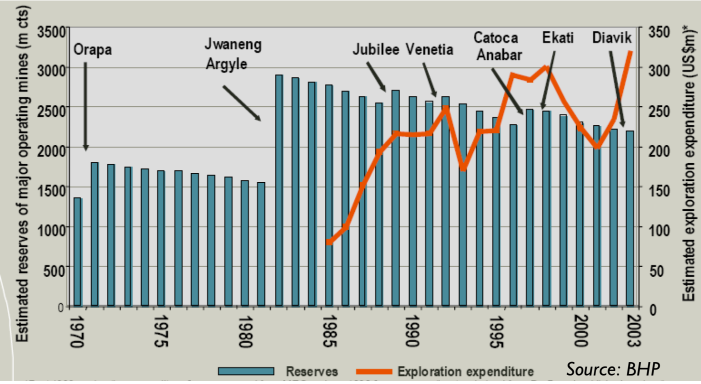
The U.S. has traditionally been the key driver of growth whilst Europe and Japan have been languishing in a period of stagnation since the early 1980's. In the future, demand will be driven increasingly by China, India and the Middle East due to increased marketing activities and the rise of the middle classes.

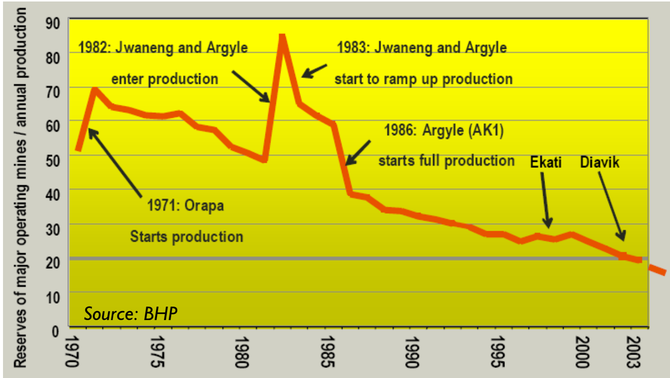
Demand is expected to grow by 3% annually to reach US$90bn in 2015. It is predicted that demand might outstrip supply by as much as US$7bn by 2012.

The Diamond Jewellery Value Chain

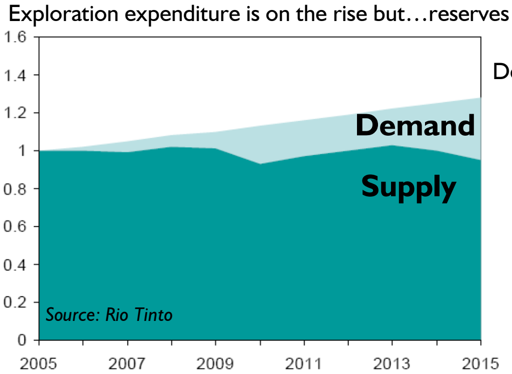
Source: WWW International Diamond Consultants Ltd

The supply problem…





Exploration expenditure is on the rise but…reserves are on the decline



Demand set to outstrip supply…

The answer….

<u>New</u> mine production needed:

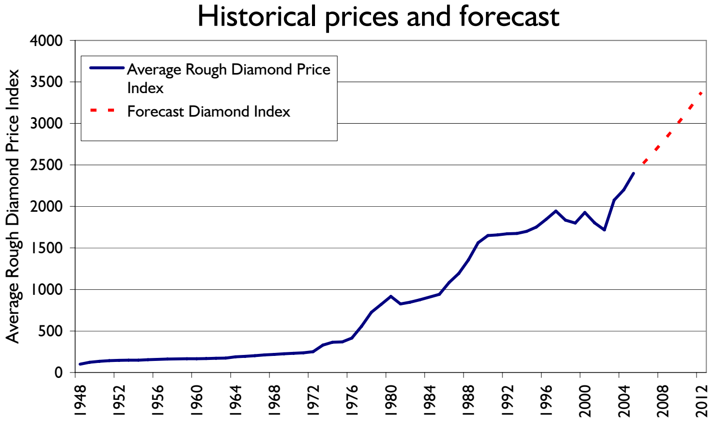
The industry needs to bring on stream one new "Ekati sized" deposit every two years…to keep up with growing demand

Price forecast

The average price of rough diamonds rose by ~60% between Jan 2003 and May 2005, largely as a result of increased demand and tightening supply. Diamond prices have not participated in the recent bull market for commodities due to the inability of institutions and investors to buy diamonds on the open-market. Thus it remains that diamond prices are still largely determined by consumer supply and demand fundamentals.

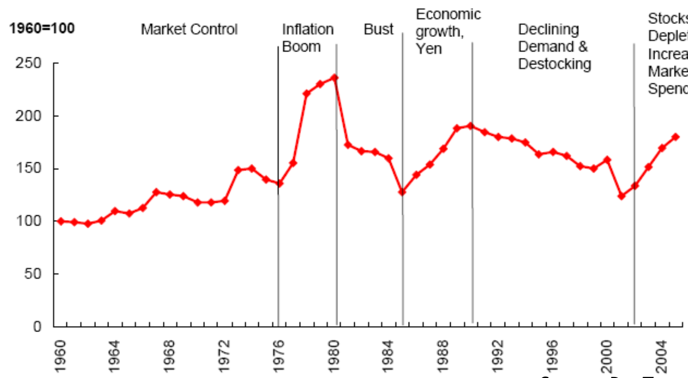
The restructuring of the diamond industry was driven by De Beers in 1999 and resulted in the adoption of the "Supplier of Choice" (SOC) strategy. A key element of the SOC was the elimination of De Beers' rough diamond stockpiles, which it has used in the past to regulate supply and demand. This has resulted in an increase in short-term price volatility.

Historical prices and forecast



Source: WWW International Diamond Consultants Ltd

Historical price drivers



Source: Rio Tinto

Prices have been bolstered in the last 2 years by production problems encountered by many major producers. Small stones have experienced the highest price increases as a result of falling production at Argyle in Australia (Argyle is mainly a small-stone producer). Prices increased by 9% in 2005 and in the absence of further major discoveries, the market price in 2012 is expected to increase by about 30%.

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