TGDG Meeting – Tuesday, October 23rd, 2012

PALEOPLACERS:

Are Archean/Proterozoic diamondiferous placers/paleoplacers potentially new sources of diamond supply to meet the looming diamond shortage?

John Ryder P.Geo

DISCLAIMER

Certain information contained in this presentation constitutes forward-looking statements. Forward-looking statements are frequently characterized by words such as "plan," "expect," "project," "intend," "believe," "anticipate" and other similar words, or statements that certain events or conditions "may" or "will" occur. Forward-looking statements are based on the opinions and estimates of management at the date the statements are made, and are subject to a variety of risks and uncertainties and other factors that could cause actual events or results to differ materially from those projected in the forward-looking statements. These factors include the inherent risks involved in the exploration and development of mineral properties, the uncertainties involved in interpreting drilling results and other ecological data, fluctuating commodity prices, the possibility of project cost overruns or unanticipated costs and expenses, uncertainties relating to the availability and costs of financing needed in the future and other factors. The Corporation undertakes no obligation to update forward-looking statements if circumstances or management's estimates or opinions should change. The reader is cautioned not to place undue reliance on forward-looking statements.

Diamond Market Fundamentals

- Global production declining with ageing mines
- World diamond reserves in decline, no new major primary diamond discoveries in past 17-20 years*
- Diamond demand growing in BRIC countries
- Diamonds becoming a safe haven like gold
- I million carat rough diamond shortfall in 2012

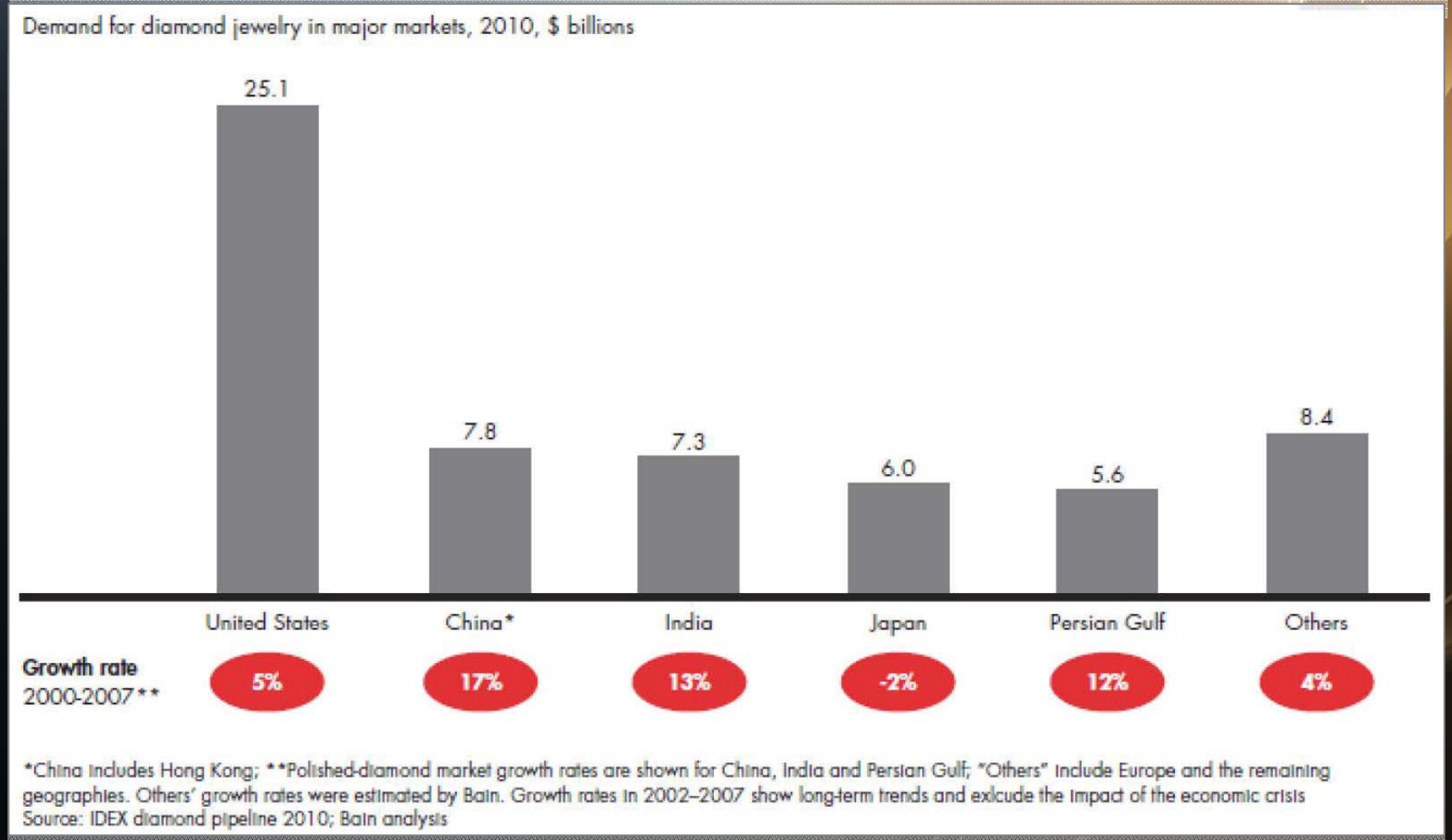
*Source RBC Capital Markets, Bain Report 2011, * Desjardins*

Diamond Market Demand (1)

- **The USA : 38% of global demand;**
- **China/ Hong Kong :11% of global demand currently[1].**
- **China and India should account for >50% of incremental global demand growth to 2017[1].**
- **Chinese jewellery giant Chow Thai Fook is planning to open 1,000 new jewellery stores by 2020[2].**
- **If Chinese middle class diamond demand is equivalent to that of Taiwan, the global diamond industry must double diamond supply annually to meet the incremental demand[1].**

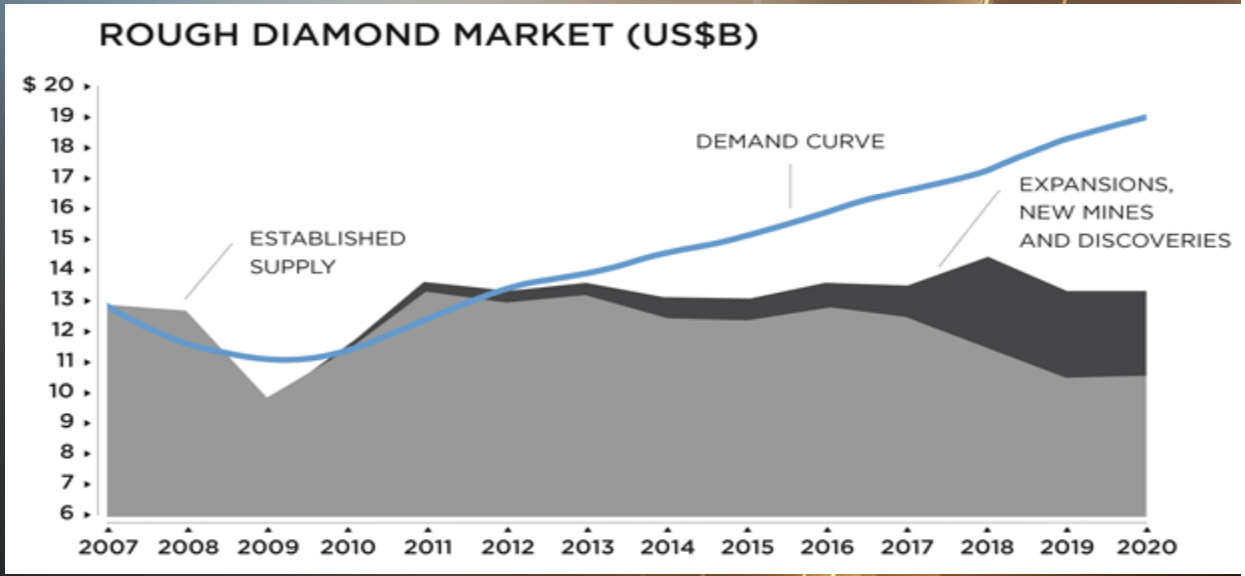
⑩ ***Source: RBC Capital Markets' 4th Annual Diamond Conference – 1. DeBeers; 2. McKinsey and Co; 3. Chow Thai Fook., Bain report 2011.***

Diamond Market Demand (2)



Source: Bain Report 2011

Diamond Market Supply (1)



Source: ALROSA 2011

Source: Harry Winston Corporation 2011

Diamond Market Supply (2)

2010: 133 Mct

2011: 124 Mct

2112: 120 -130Mct

2112:

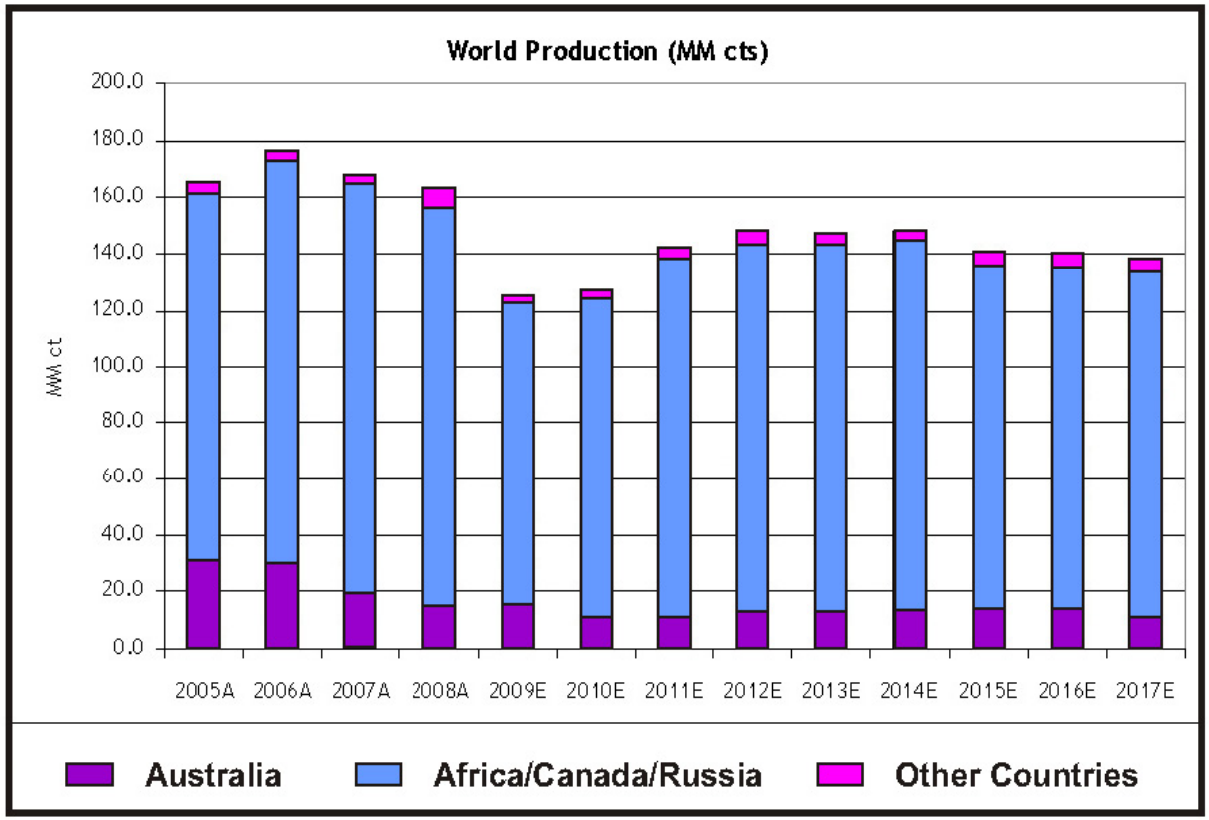
Diavik: Lower production to 7.4Mcts

Ekati: Down 20%+

Alrosa: Lower production 7%??

Rio Tinto expects 7% increase in production

Source: Alrosa 2011

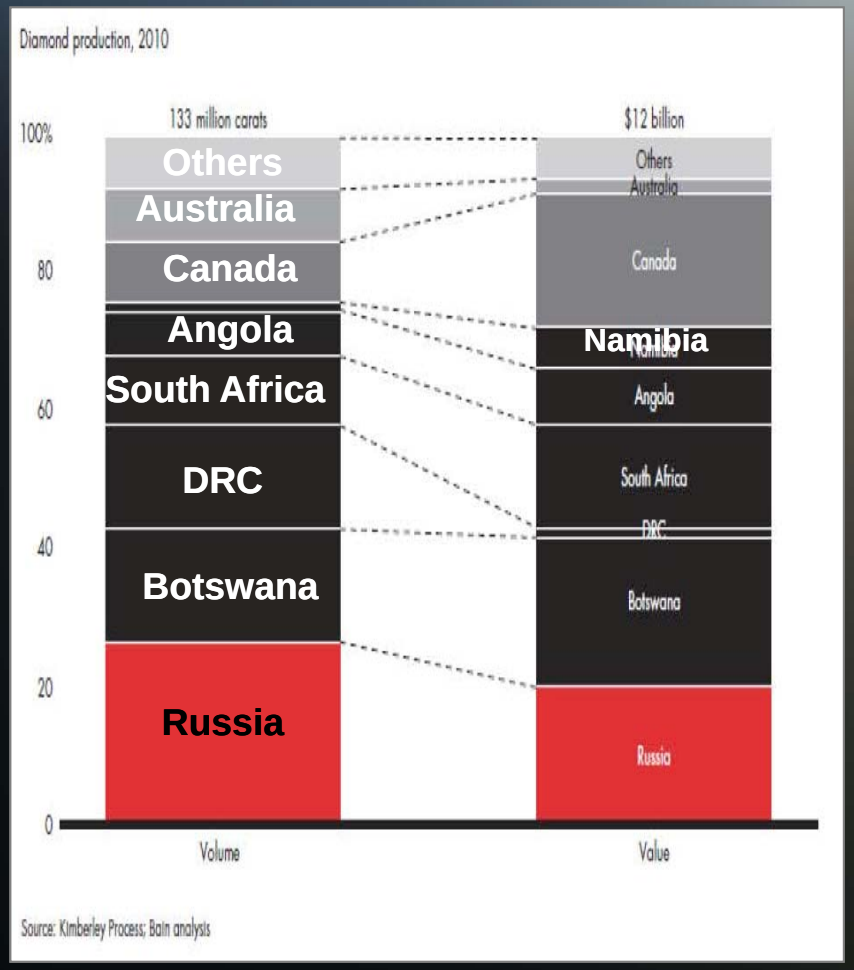


Source: Company reports and RBC Capital Markets' estimates

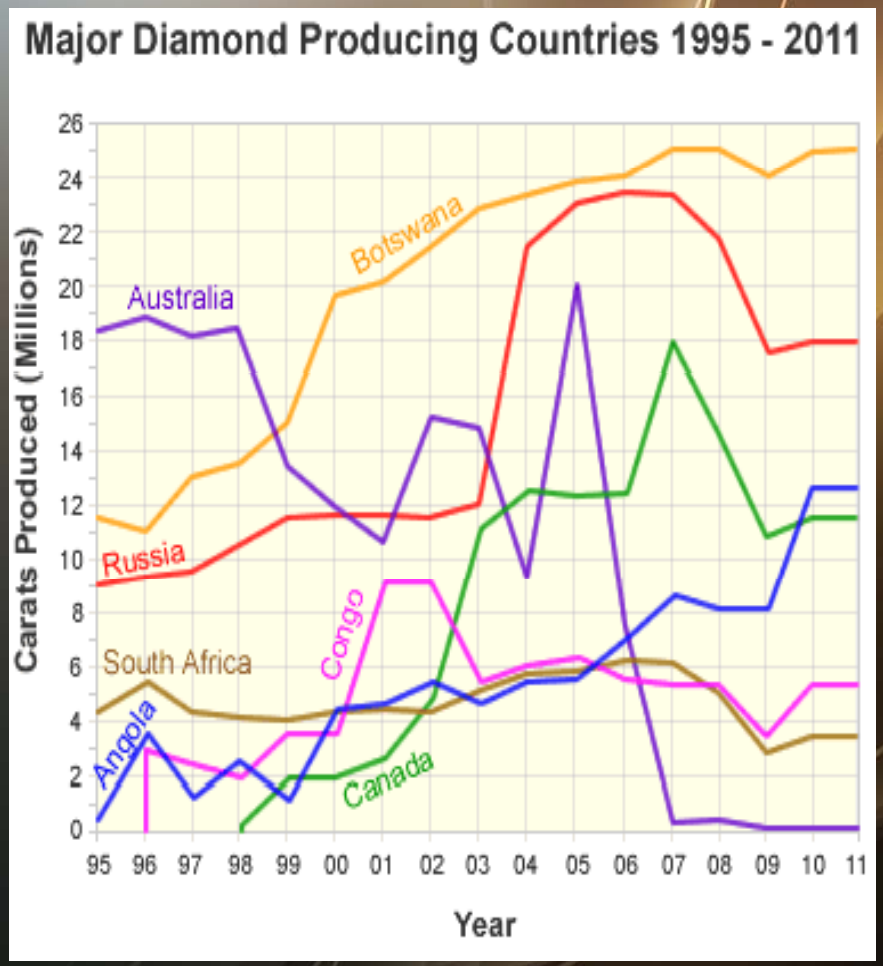
Diamond Producers (1)

Map by Geology.com and MapResources. Data from USGS Mineral Commodity Summaries

Diamond Producers (2)

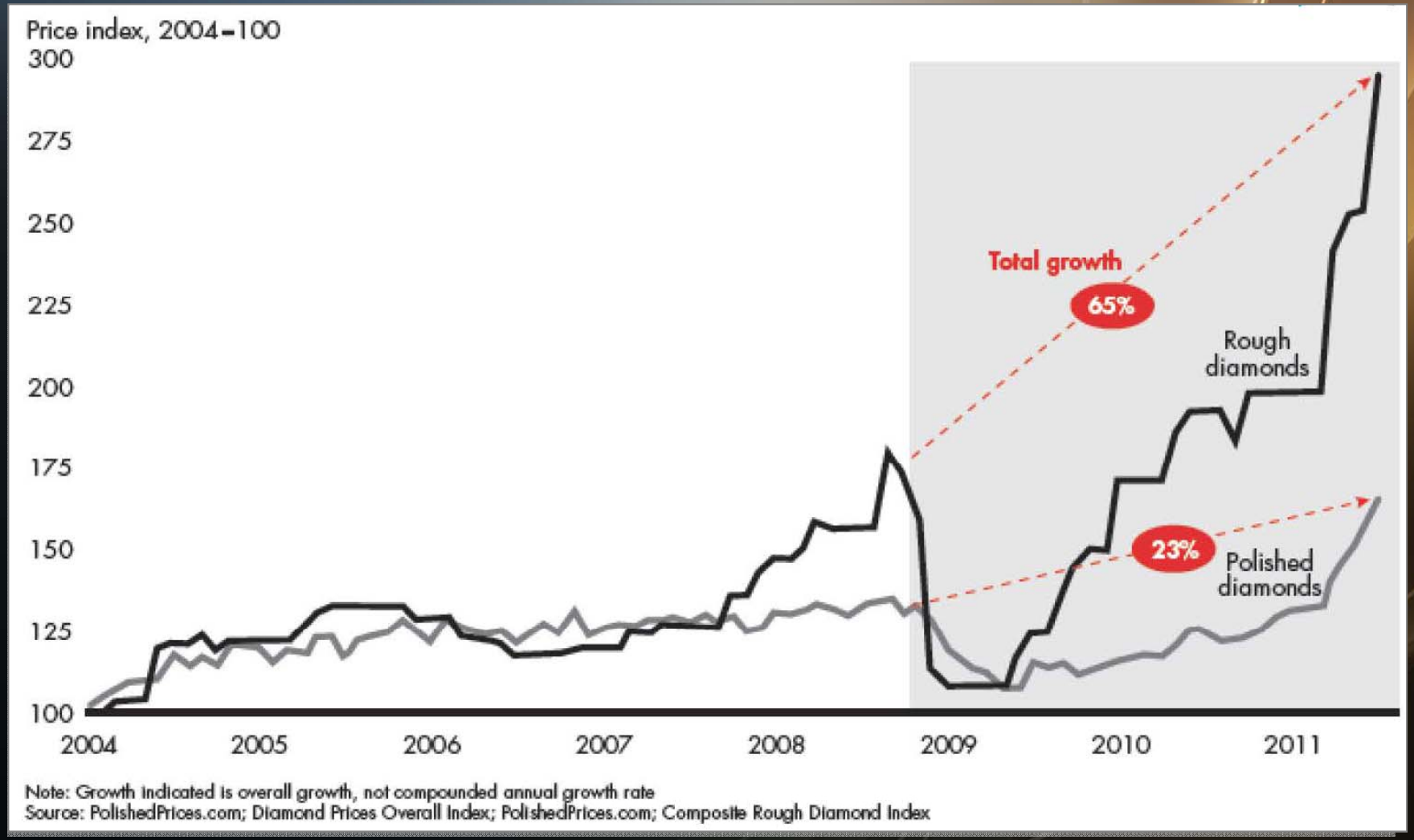


Source: Bain report, December 2011



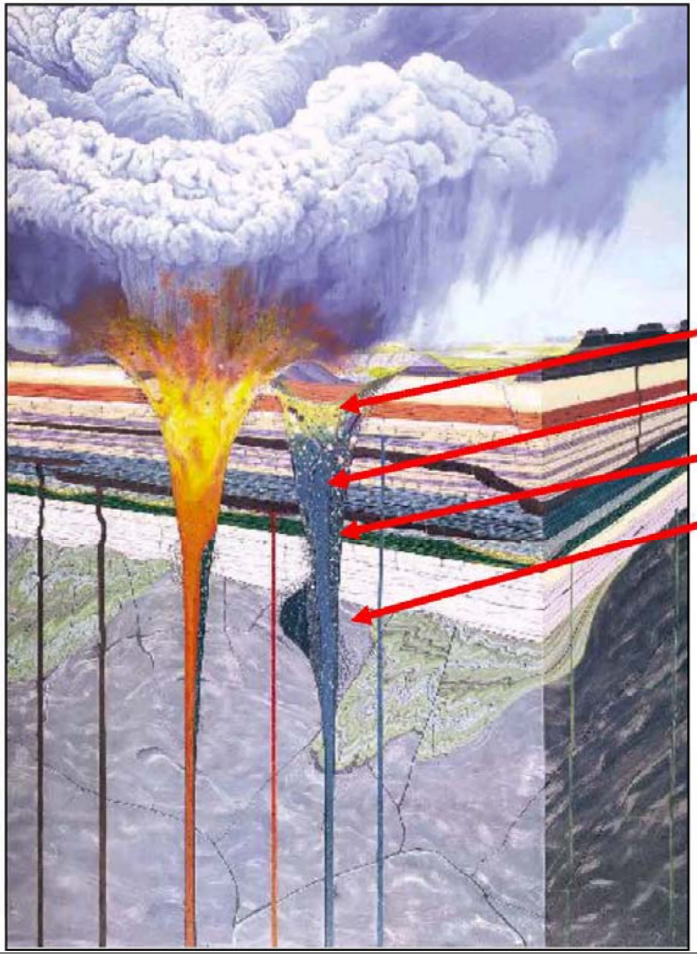
Graph by Geology.com

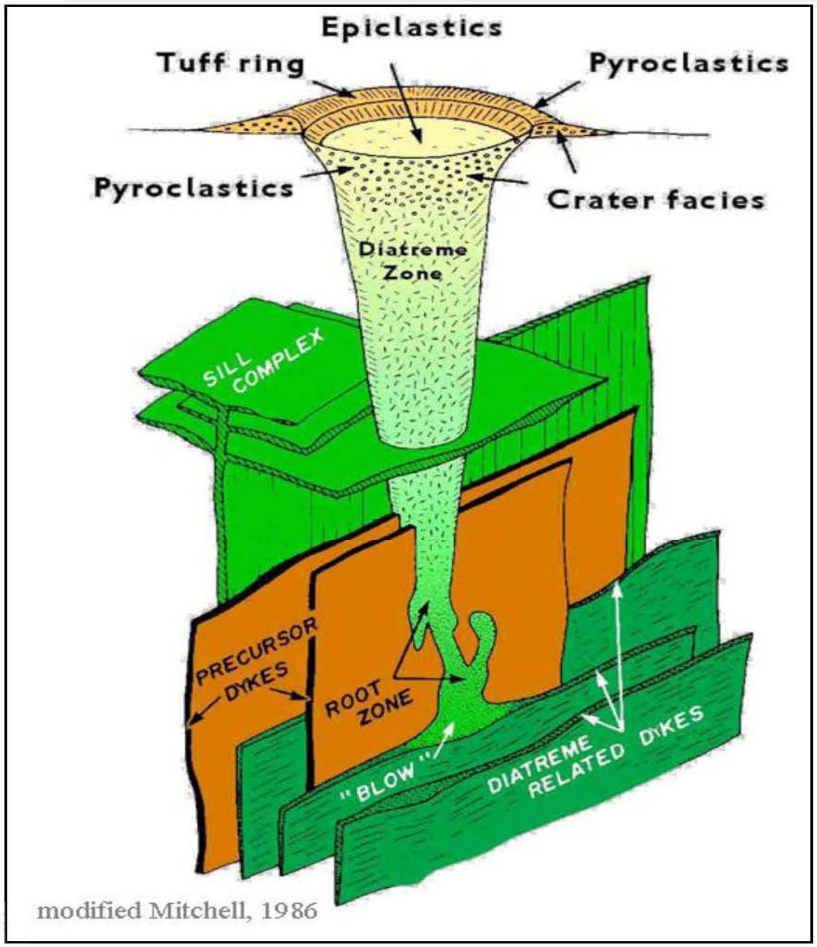
Diamond Market Pricing



Source: Bain report, December 2011

Kimberlite(Primary)





Source: Botswana Diamonds

Diamond Producers (1)

PRIMARY DIAMOND DEPOSITS: KIMBERLITE/LAMPROITE MINES

Adapted from Botswana Diamonds PLC.

Diamond Producers (2)

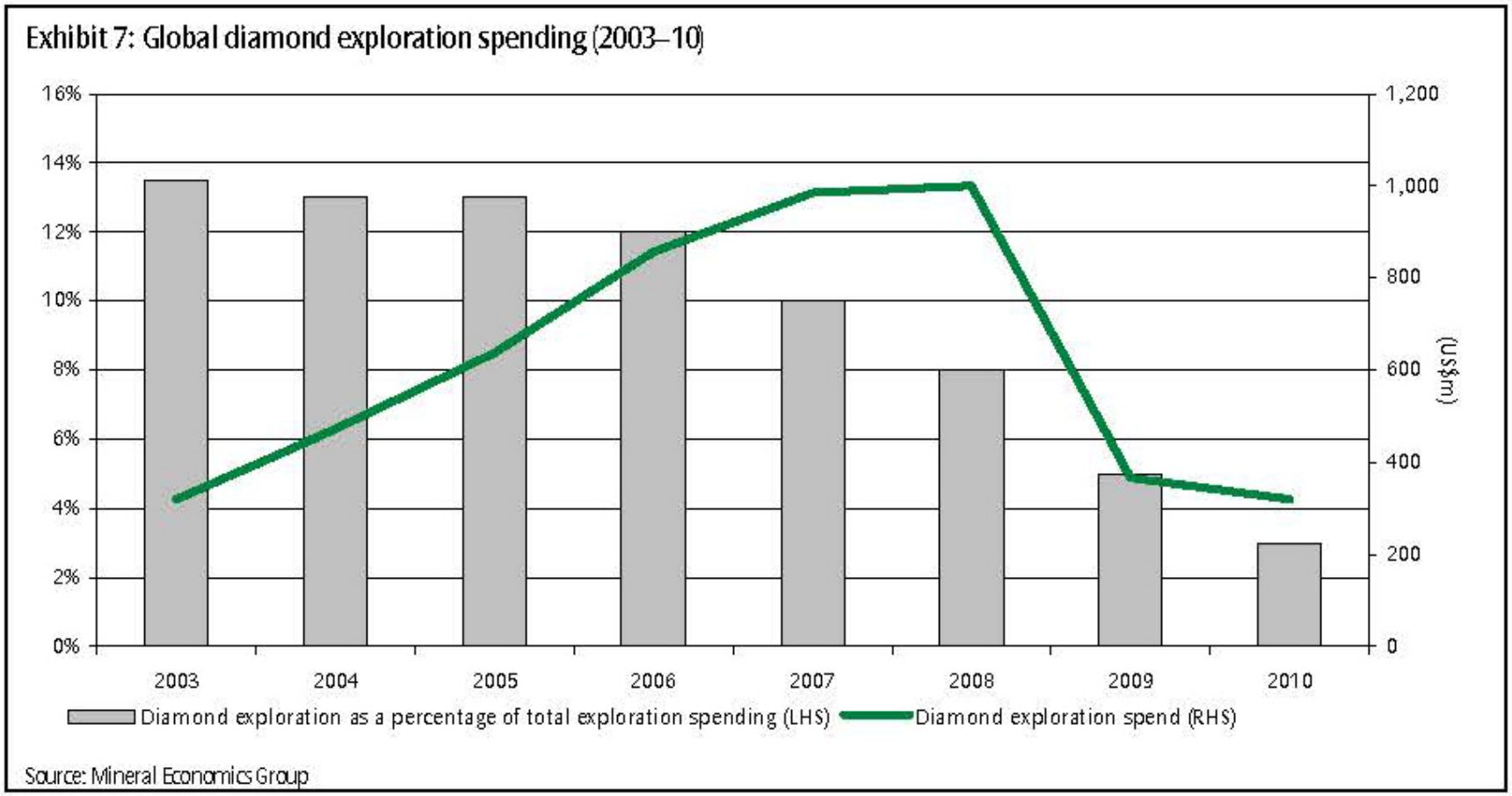
Exhibit 4: Global diamond producers

Project	Company	Location	Start-up date	Ore reserves (m tonnes)	Grade (cpht)	Total carats (m carats)	Price (US$/carat)	Revenue (US$/carat)	Production (m carats/year)	Expected minelife (years)
Arkhangel	Severalmaz	Russia	2006	110.0	52.0	57.0	48	25	5.0	20
Camatchia	Endiama	Angola	2008	80.0	17.0	14.0	200	34	1.0	12
Catoca	Endiama	Angola	1997	271.0	70.0	189.0	78	55	6.7	20
Cullinan	Petra	South Africa	1910	437.0	37.1	208.0	120	45	0.5	20
Damtshaa	Debswana	Botswana	2002	38.0	17.0	6.0	101	17	0.5	30
Diavik	Rio/HWD	Canada	2003	28.0	311.0	88.0	120	373	7.0	22
Ekati	BHP	Canada	1998	78.0	109.0	85.0	200	218	2.4	18
Jubilee	Alrosa	Russia	1986	304.0	11.0	32.0	100	11	NA	NA
Jwaneng	Debswana	Botswana	1982	288.0	141.0	413.0	143	202	13.7	25
Koffiefontein	Petra	South Africa	2007	103.0	5.9	4.0	470	28	0.1	20
Letlhakane	Debswana	Botswana	1975	63.0	26.0	16.0	243	63	1.2	NA
Letšeng	Gem	Lesotho	2004	222.0	1.7	3.7	3291	56	0.1	35
Lomonosov	Alrosa	Russia	NA	160.0	80.0	128.0	63	51	NA	NA
Murowa	Rio Tinto	Zimbabwe	2004	16.5	90.0	14.8	65	59	0.3	50
Orapa	Debswana	Botswana	1971	NA	85.0	NA	NA	NA	9.5	NA
Snap Lake	De Beers	Canada	2007	18.0	108.0	27.0	140	151	0.9	20
Udachnaya	Alrosa	Russia	1965	55.0	165.0	91.0	85	141	9.0	NA
Venetia	De Beers	South Africa	1992	117.0	110.7	116.0	85	94	7.5	11
Victor	De Beers	Canada	2007	28.0	31.0	6.0	320	99	0.8	10
Voorspoed	De Beers	South Africa	2008	50.0	20.0	10.0	150	30	0.8	12
Williamson	Petra	Tanzania	1940	995.0	6.2	40.0	175	11	0.1	19
Average (excluding highest & lowest)				**136.1**	**62.2**	**62.9**	**159**	**77**	**3.1**	**20**

Source: Mountain Province Diamonds Inc., Peregrine Diamonds Ltd., company reports

Source: Desjardins 2011

Exploration Expenditures



Source: Desjardins 2011

Diamond Producers (3)

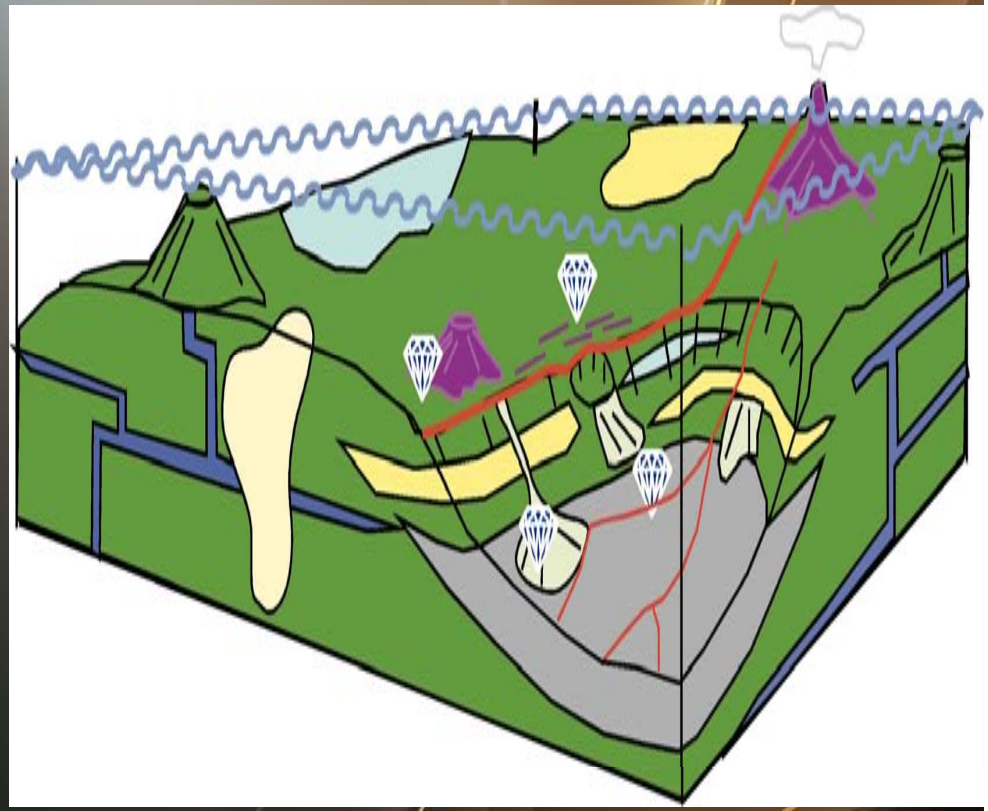
Exhibit 5: Global diamond development projects

Project	Company	Location	Start-up date	Ore reserves (m tonnes)	Grade (cpht)	Total carats (m carats)	Price (US$/carat)	Production (m carats/year)	Expected minelife (years)
AK6	Lucara	Botswana	2011	72.0	20.0	15.0	162	1.3	11
Bunder	Rio Tinto	India	NA	37.0	75.0	27.6	50	0.7	37
DO-27	Peregrine	Canada	NA	19.5	94.0	18.2	51	1.0	NA
Gahcho Kué	De Beers/MP	Canada	2014	31.0	157.0	49.0	172	4.5	11
Grib	AGD/ADC	Russia	NA	98.0	69.0	67.0	110	4.0	NA
Gope	Gem	Botswana	2013	105.0	19.4	20.5	203	0.6	30
Kao	Global	Lesotho	2011	186.0	17.3	12.6	146	0.3	25
Lerala	Mantle	Botswana	NA	10.9	28.3	3.1	55	0.4	9
Merlin	NA Diamonds	Australia	2012	30.0	24.0	7.1	200	0.1	10
Mothae	Lucara	Lesotho	NA	NA	2.4	NA	549	NA	NA
Renard	Stornoway	Canada	2015	57.7	71.0	46.0	164	1.2	25
Star-Orion South	Shore Gold/Newmont	Canada	2016	279.0	12.3	34.4	242	1.7	20
Average (excluding highest & lowest)				**57.8**	**40.2**	**20.9**	**125**	**1.0**	**15**

Source: Mountain Province Diamonds Inc., Peregrine Diamonds Ltd., company reports

Source: Desjardins 2011

PALEOPLACERS



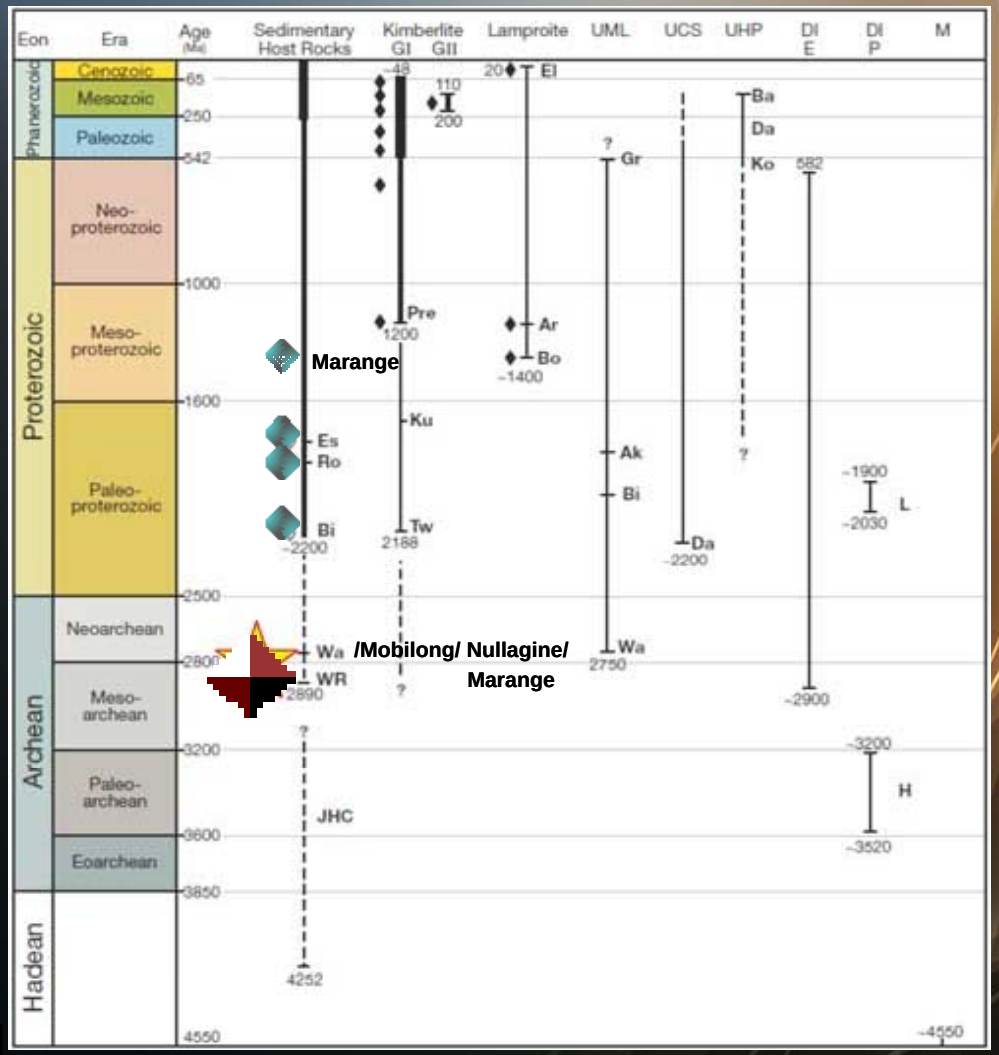
A paleoplacer is a fossilized placer deposit. In other words, the unconsoldiated deposits originally formed at the surface by running water was buried to sufficient depth to lithify the sediment into solid sedimentary rock (GEOL3600)

Secondary Diamond Deposits

SECONDARY DIAMOND DEPOSITS: PALEOPLACERS

Adapted from Konstantinovski 2003

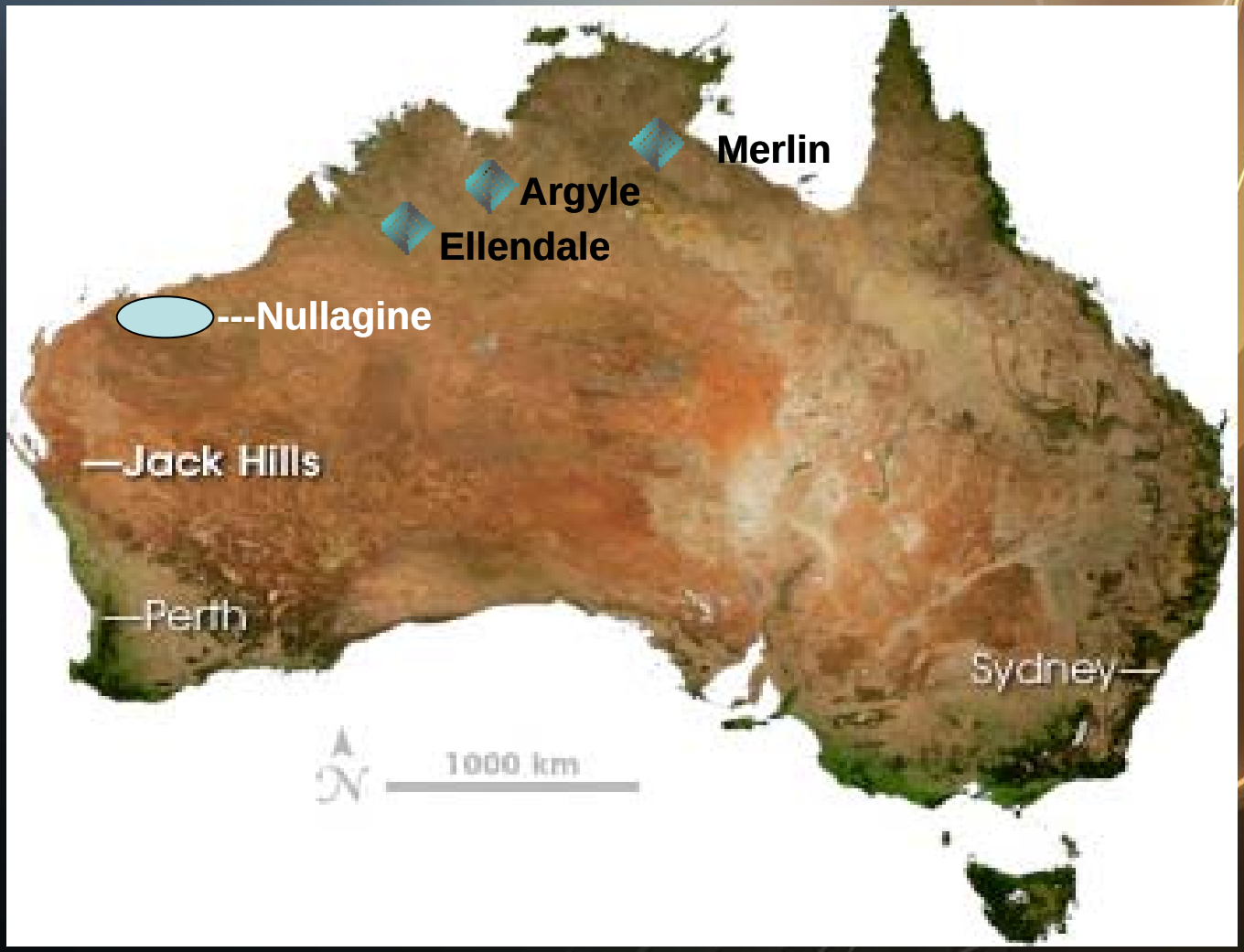
Paleoplacer -Timescale



Modified

Adapted from NWT Geoscience office

Australia-Oldest Diamonds

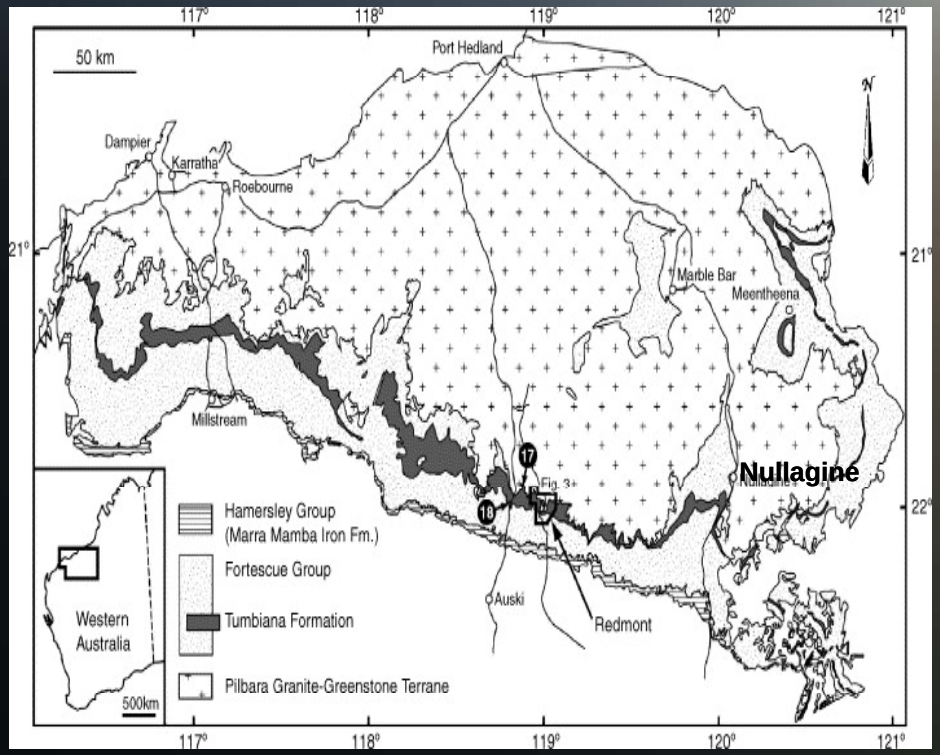


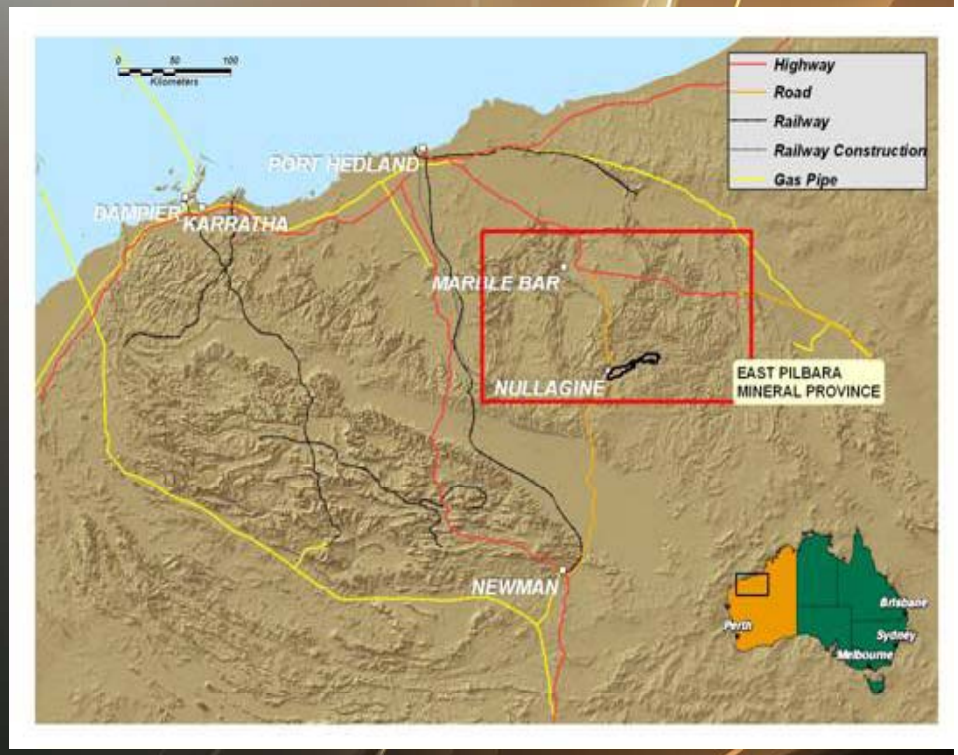
Jack Hills/ Nullagine

- The **Jack Hills** are best known as the source of the oldest material of terrestrial origin (Gneiss of Kilgam Craton) found to date : zircons that formed around 4.4 billion years ago
- Diamonds as inclusion in the zircons, dated at 3.7Ma,found in sedimentary siliclastic rocks that include BIF, quartzite, mature metaconglomerates, interlayed meta sandstoneschert, in 80 km belt, interpreted as fan delta deposits *(Baxter et al 1986)*

- The Nullagine area to the North , part of the Pilbara Craton contains gold and uranium conglomerates with local commercial grade diamonds.
- Discovered in 1902, Australia's first diamond discovery
- In conglomerate beds of the Hardy Formation of the 2.5 – 3 km thick basal Fortesque Group which sit unconformably on the Pilbara Craton

Nullagine Area

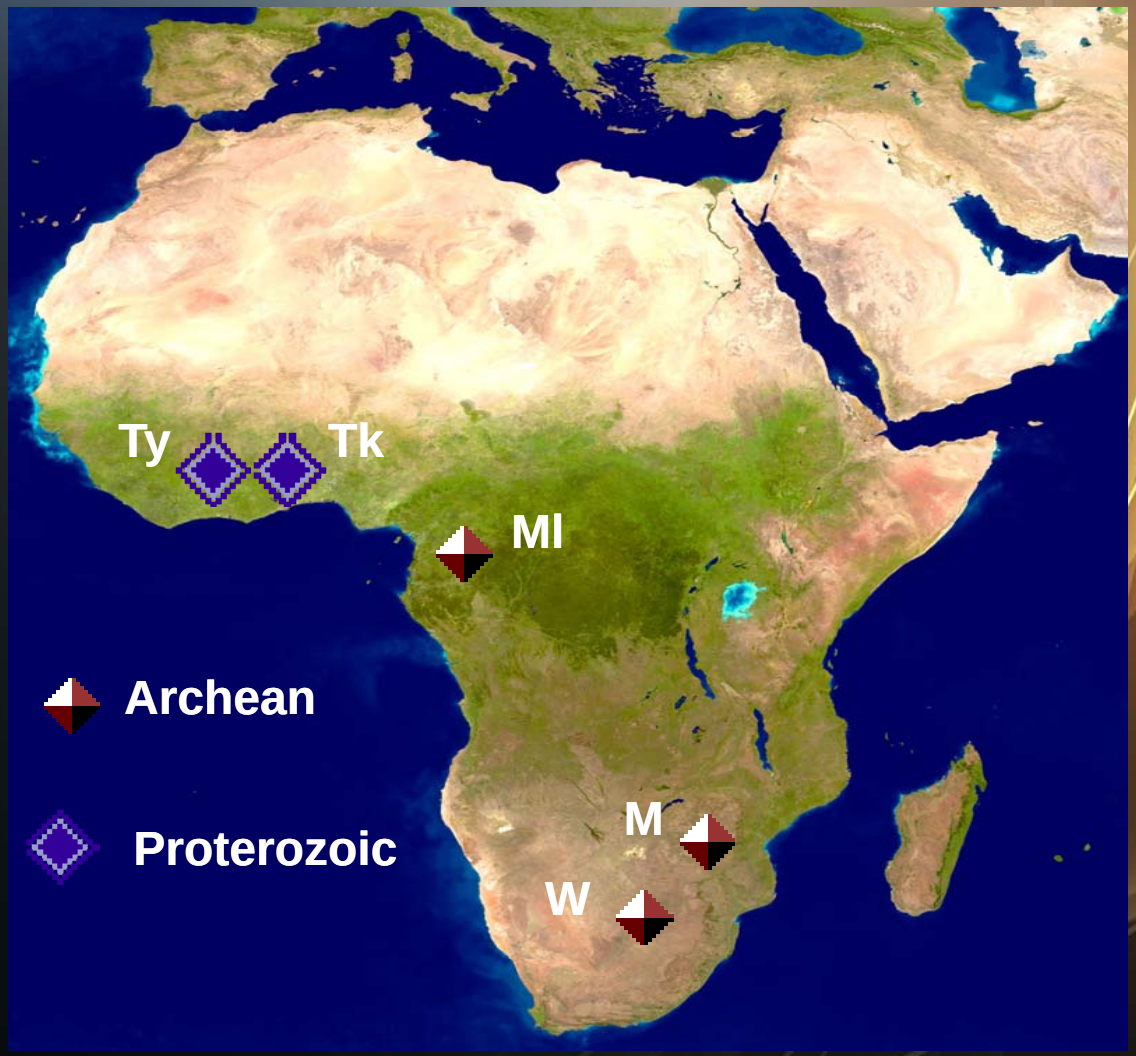




Nullagine: Paleoplacer Facts:

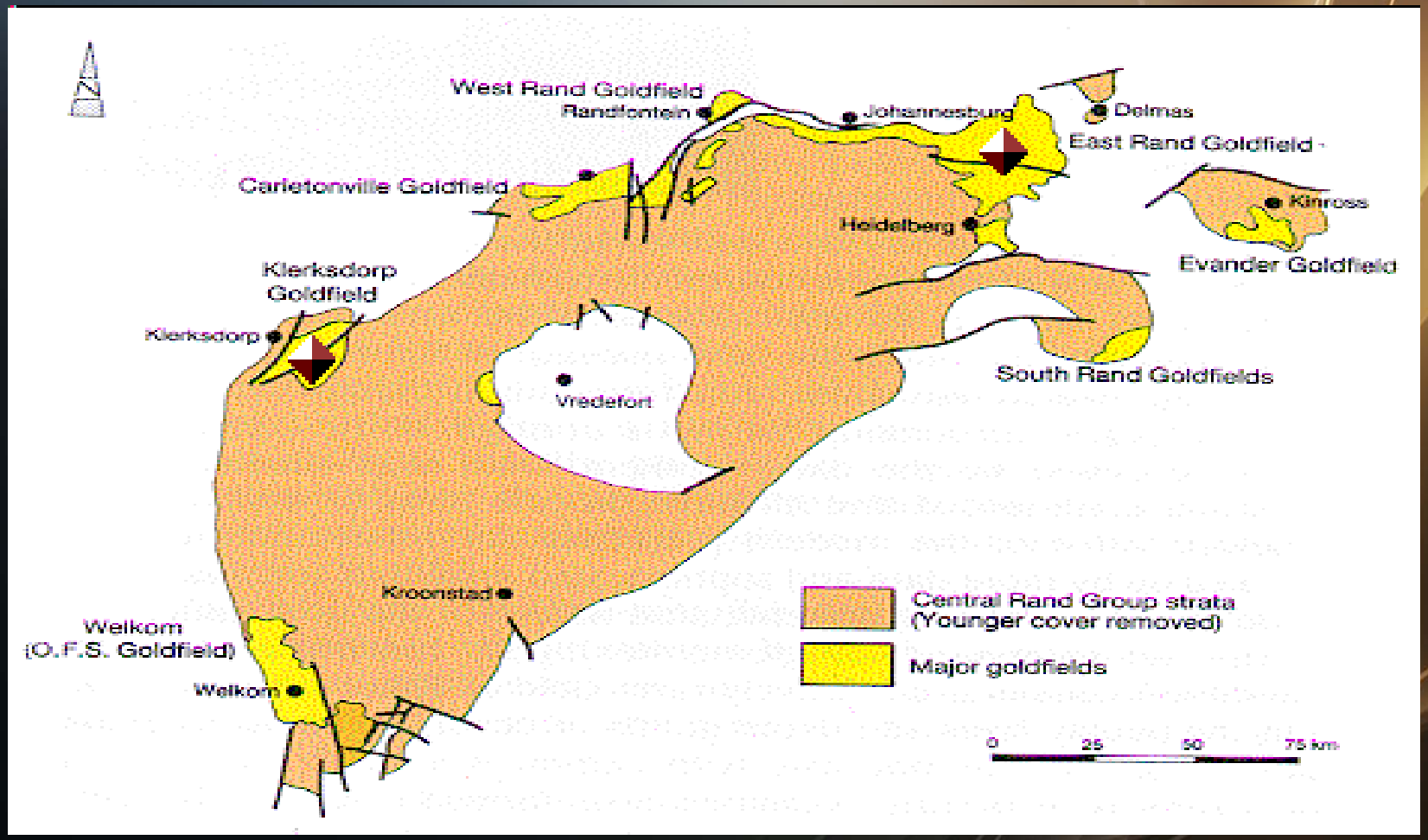
- Host Rock: Conglomerate unit in quartzite sandstone
- Age: Archean - 2.7ma
- Thickness: 2 to 5 metres, locally 40 -60 metres
- Extent: 10 kms along strike
- Type & Origin: Quartz pebble, coastal-marine
- Diamond:
  - Content/Grade: not uniform but highs of 75 to 100 cpht
  - Average size: 0.25 carats, high quality, colorless, transparent
  - Largest: 3.5 carats
  - Predominant crystal shape: Octahedron
- Other minerals: Pyrite, Gold, Uranium
- Primary source: Unknown, Kimberlite???
- Similar deposits/settings:
  - Jacobina ore field (Au & U bearing reef) in Brazil
  - Elliot Lake conglomerates
  - Witwatersrand conglomerates

African Paleoplacers



South Africa

Witwatersrand

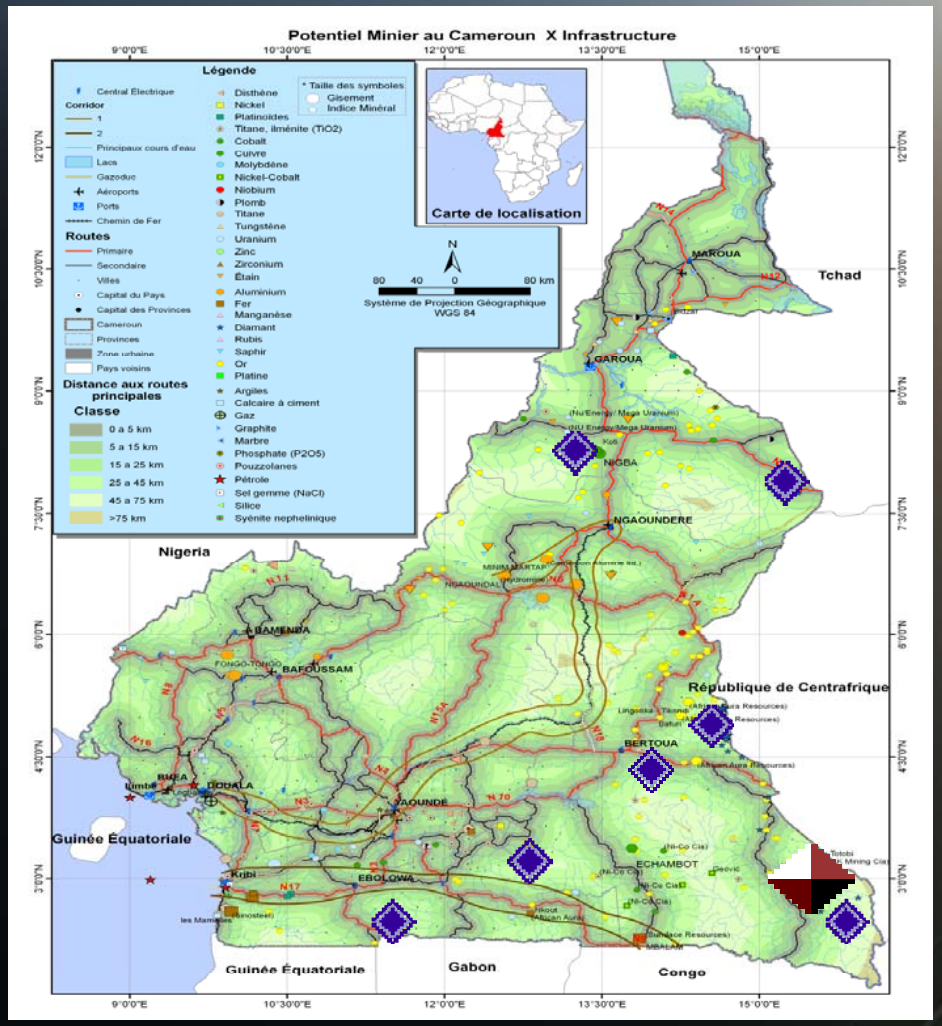


Diamondiferous Conglomerates

Witwatersrand: Facts

- Host Rock: Conglomerates of Upper series of Witwatersrand Supergroup
  Only found in two of the eight gold fields
- Age: Archean 2.5 - 2.89 Ma
- Thickness: 3 metres, locally ????/ metres
- Extent: 10 ??kms along ore reefs.
- Type & Origin: Quartz pebble, Fluvial (braided streams) paleofans (deltas)
- Diamond:
  Content/Grade: Only a few hundred diamond recovered.
  Average size: 0.1 to 0.25 carats, high quality. Green superficial coating
  Largest: 1.5 - 8 carats
  Predominant crystal shape: ????
- Other minerals: Pyrite, Gold, Uranium
- Primary source: Unknown, Kimberlite???
- Similar deposits/settings:
  Jacobina ore field (Au & U bearing reef) in Brazil
  Elliot Lake
  Nullagine

Cameroon

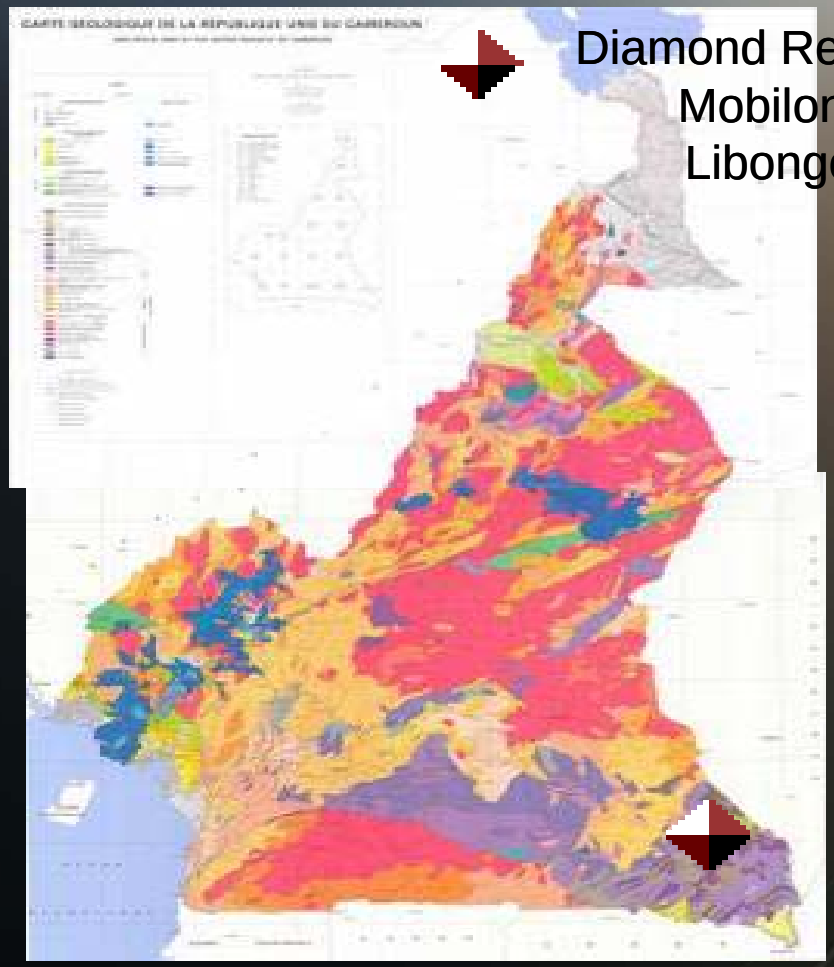


Paleoplacers.

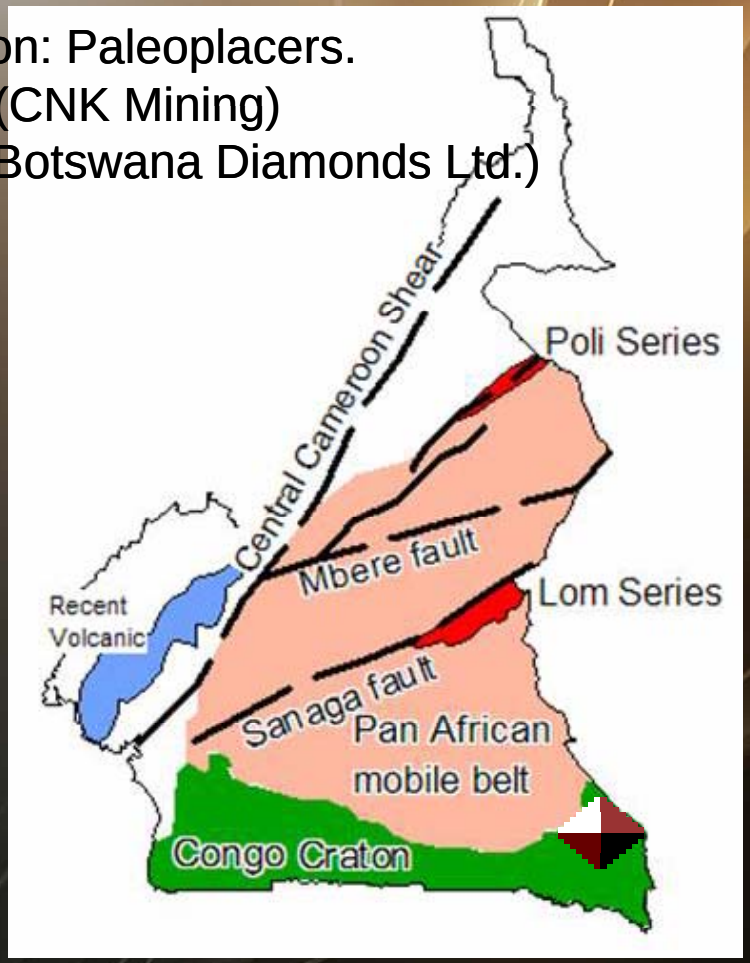
1.Mobilong Zone
2.Libongo Area

Other Diamond occurrences (placers)

Cameroon Geology



Diamond Region: Paleoplacers.
Mobilong (CNK Mining)
Libongo (Botswana Diamonds Ltd.)



Source: Cameroon Ministry of Industry, Mining and Development

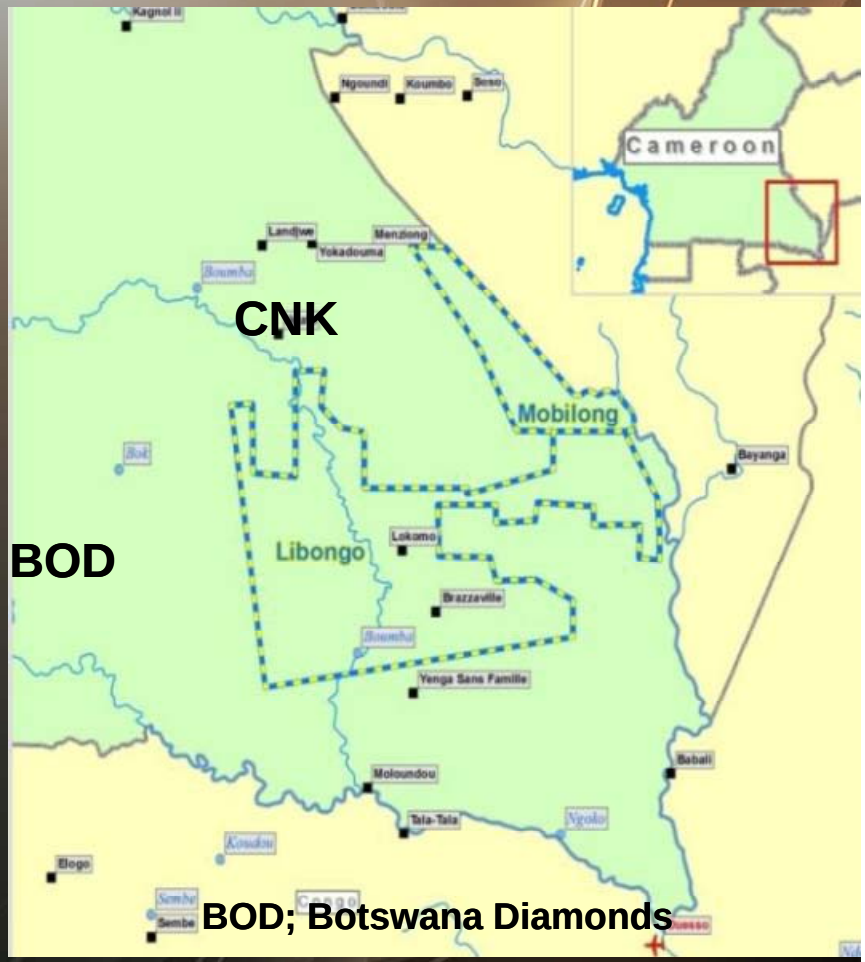
Mobilong & Libongo

1. New paleo-conglomerate diamond field emerging in east Cameroon since initial exploration commenced in 2006. Artisinal mining since 1930's CAR

2. CNK Mining (Korean) are constructing a 1 million carat p.a. mine in Mobilong Construction commenced in March 2012

3. Exploration on surrounging areas: Botswana Diamonds Plc.: 482 sq. km concession area

4. Large area on Congo Craton in Cameroon unexplored



Source; Botswana Diamonds Plc.

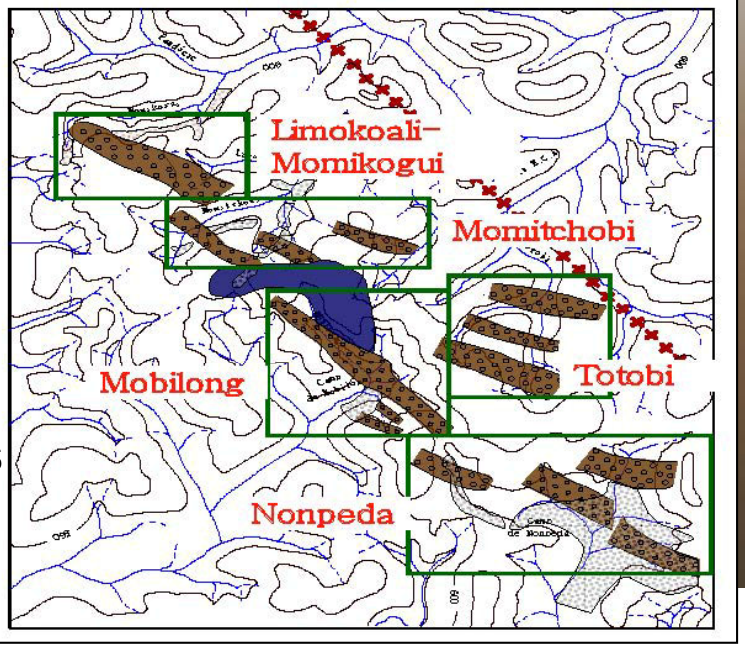
MOBILONG (1)

Alluvial Deposit

Conglomerate

CNK

Mobilong Conglomerates



Map of Mobilong Conglomerates
&
Estimated Diamond Reserve

Dr. Gentry, Ministry of Industry, Mines & development
2010

Area	Average thickness(m)	Fold Factor	Grade (ct/m^3)	Total Reserve (cts)
10,000m (N-S) × 3,000m (E-W)	100	1.8	0.7 CNK;	3,780,000,000 420,000,000

Initial Euphoria!!!!

Source: Cameroon Ministry of Industry, Mining and Development

MOBILONG (2)

Source: Cameroon Ministry of Industry, Mining and Development

Libongo

- 480sq km of Exploration License – Botswana Diamonds Ltd.
- Several outcrops of paleo-conglomerate identified
- Three diamonds already found, helping to confirm value of the resource 0.25 and 2 carat near gem, and 1.3 carat industrial.
- Evidence of artisanal workings in area;
- Three 100 tonne bulk samples still in progress

Source: Botswana Diamonds Plc.

Cameroon: Paleoplacer Facts:

- Host Rock: Mobilong quartz pebble Conglomerates over extensive area
- Age: Archean 2.7 Ma
- Thickness: 200 metres ??
- Extent: 10 ??kms along ore reefs.
- Type & Origin: Quartz pebble, Fluvial (braided streams) paleofans (deltas)
- Diamond:
  - Content/Grade: unconfirmed 12 cpht
  - Average size: ? carats, mixed quality.
  - Largest: 2 carats
  - Predominant crystal shape: ????
- Other minerals: Gold, (Uranium – not known)
- Primary source: Unknown, Kimberlite???
- Similar deposits/settings: Not enough available information. Size and thickness ---Wawa Leadbetter deposit in Ontario

Diamondfield in early stage of exploration and study.

Zimbabwe: Emerging Diamond Powerhouse ?

1. It is likely that Zimbabwe will be among the top diamond producers. From 10% to 25% of worlds rough by 2018.

2. 2011 diamond production 8.5 to 11.1 million carats, an 1,000% increase in 3 years. 14.5 mc by 2014?

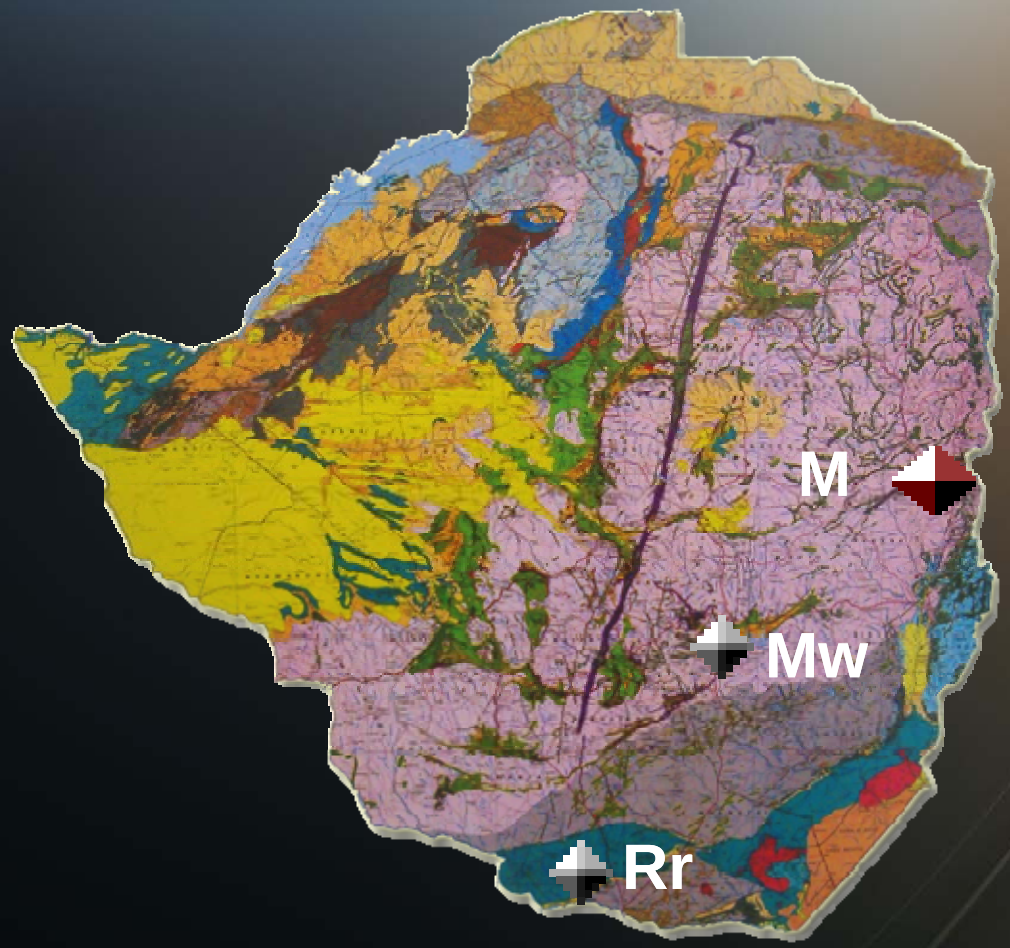
3. 96% of production from placer/paleoplacers of the Marange - Chiadzwa fields

Zimbabwe - Caution

"To be sure, we have not been able to verify information on Marange because the official position is that this information is not supposed to be made public. Nevertheless, the scale of operations by Anjin in particular and Mbada, to a lesser extent, suggest that the massive production figures proffered are plausible" Independent consultants Equity Communications

Politically unstable country

Zimbabwe - Geology



M: Marange Diamond fields: Placers & paleoplacers

Mw: Murowa kimberlite

Rr: River Ranch kimberlite

Marange- Chiadzwa

The Marange diamond fields are spread out over 566 kilometers area, a 70km long belt from the Chiadzwa district of Marange to the Chimanimani Mountains.

Diamond grades are from 4,000 to 8,000 cpht with average diamond size of 5 carats. Prices range from $3 to $60 per carat

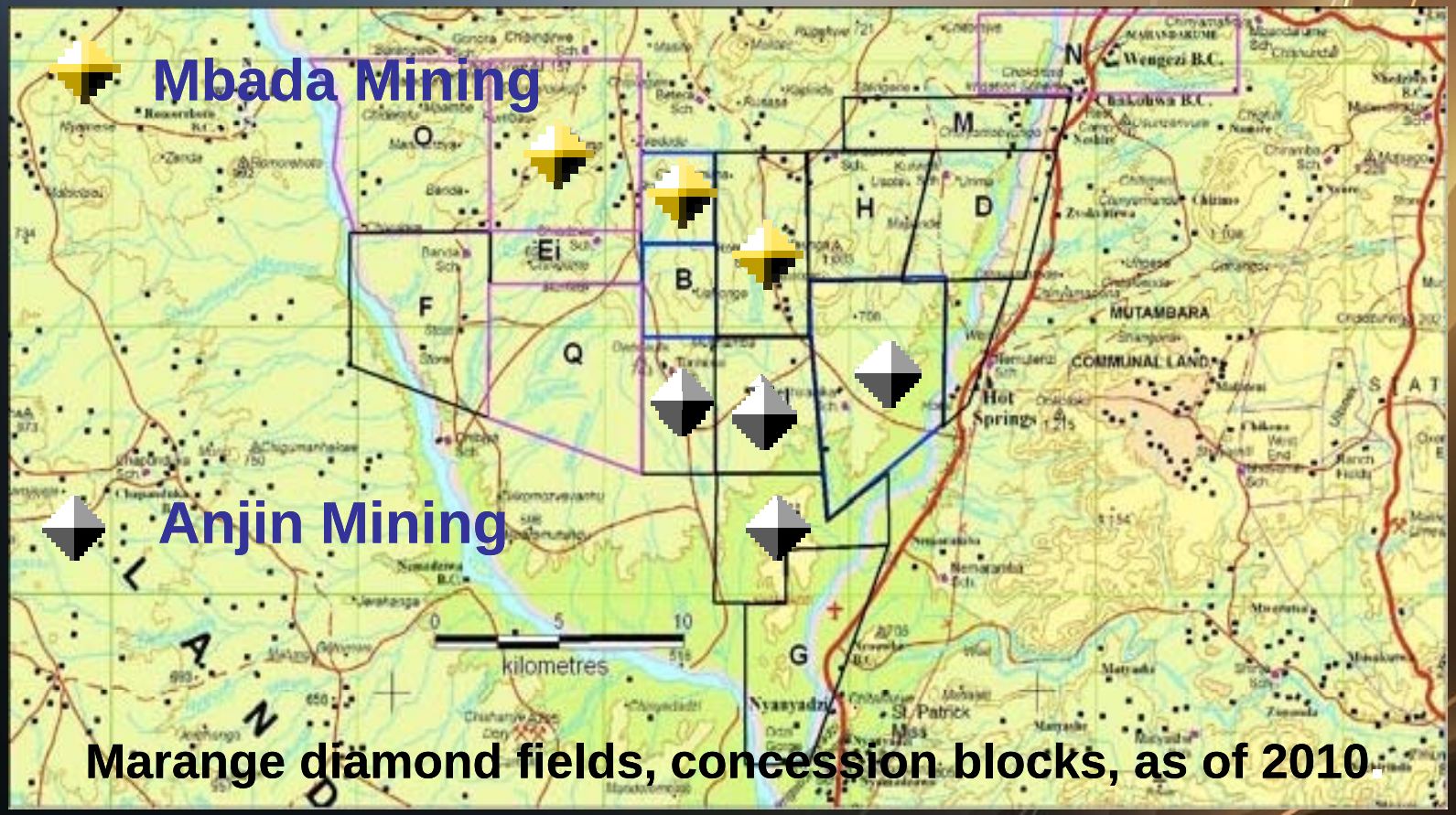
< 15% of the diamonds are gems and sell at higher prices up to $132 per carat

Potential revenue is estimated at US$1 billion-US$1.7 billion a year

Only 20% of the diamondfields allocated.

Number of mining operations in existance: largest are Mbada and Anjin

Concession Blocks: Marange



Source: Global Witness February 2012

Marange: Mbada Mining

- Production commenced in December 2010
- Capital expenditure $185 million.
- Producing 150,000 rough carats per month. 12 million carats produced since January 2011
- 1,000 ha concession area, to increase to 7,700 ha.
- Life of mine 25 years based on 1,000 ha DMS production at 50 tph increasing to 200 tph DMS capacity

Marange Raw Diamonds, Mbada Mine, Zimbabwe

Marange: Anjin Mining

Mining Commenced: 2012

$400 million capital expenditure

Production target: 1 million carats per year

Conglomerate: 0.6 to 1.5 m thick

By 2018 expected to produce 10% of global rough .

Marange Diamonds

Chimanimani

- 70 kms south of Marange.
- Diamonds discovered in 2008.
- Exploration commenced in 2011
- Pilot plant producing, 1,000 carats per month (June 2012)
- Diamonds valued $120 per carat (October 2012)
- Diamonds smaller and lower grade than marange.
- Current 80,000 carat reserve
- Same geology/ age as marange- Umkondo???
- Conglomerate is < 1 metre thick.

Zimbabwe: Paleoplacer Facts:

- Host Rock: Thin Conglomerates over extensive area
- Age: Archean 2.7 Ma ?? Or Proterozoic1.5 Ma??
- Thickness: 0.6 to 1.5 m
- Extent: 70kms by 6 kms???
- Type & Origin: Unknown
- Diamond:

  Content/Grade: 4,000 -8,000 cpht placer: 100 – 600 cpht ??

  Average size: 5 carats, < 15% gem

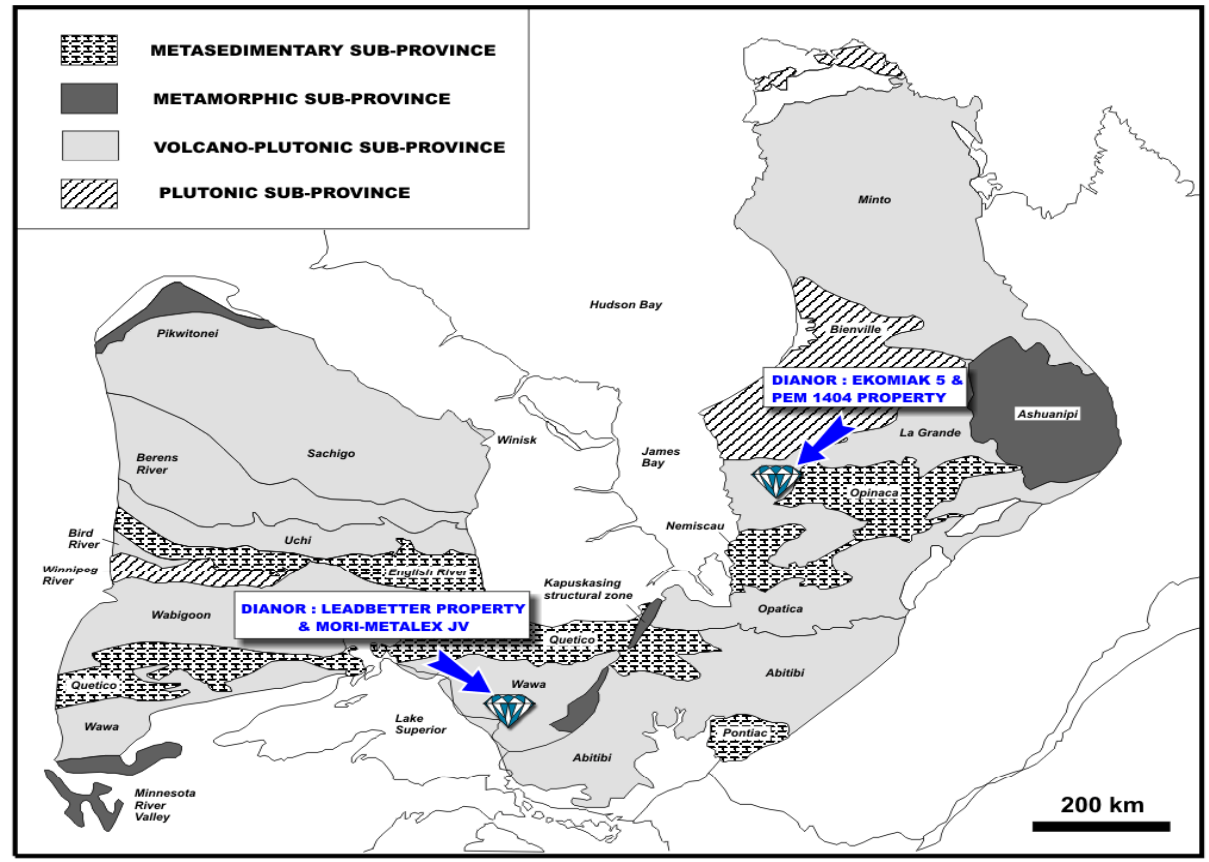
  Largest: 50+ carats?

  Predominant crystal shape: ????
- Other minerals: Gold, (Uranium – not tested)
- Primary source: Unknown, Kimberlite???
- Similar deposits/settings: Not enough available information.

Technical knowledge – "State Secret"

Canada: Diamond Deposits

Canadian Plaeoplacers



Leadbetter Project

PEM 1404

Wawa Paleoplacer

LARGE UNDEVELOPED PALEOPLACER

- **549 to 583 million tonnes**
  - **2.7 billion years old**

- 

(from Leadbetter 70 tonnes sample)

(illustration only)

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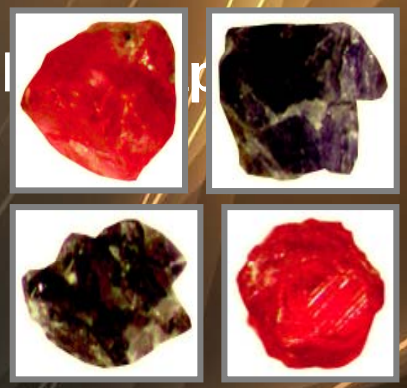
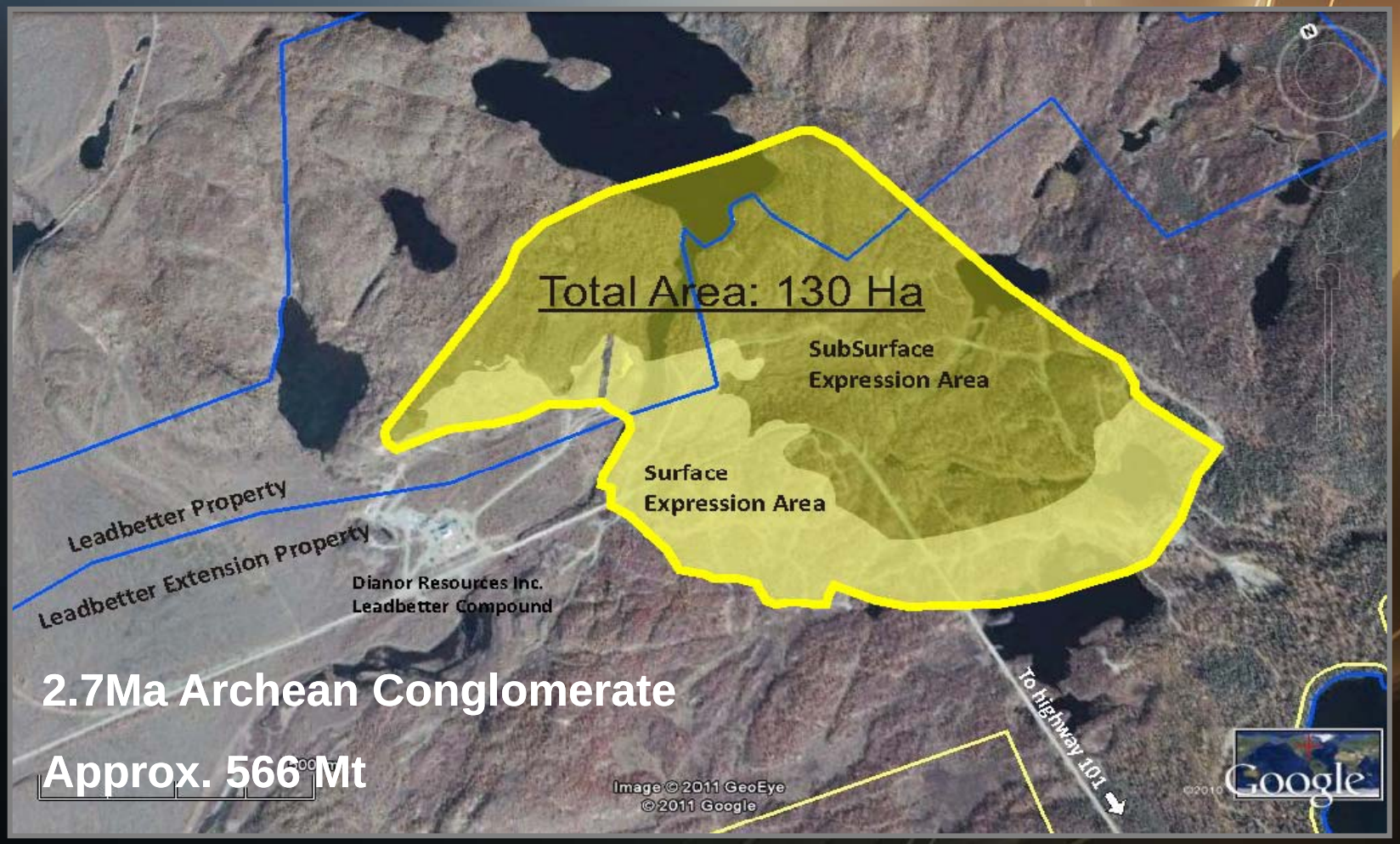


(from Leadbetter 6 tonnes sample)

Leadbetter Deposit

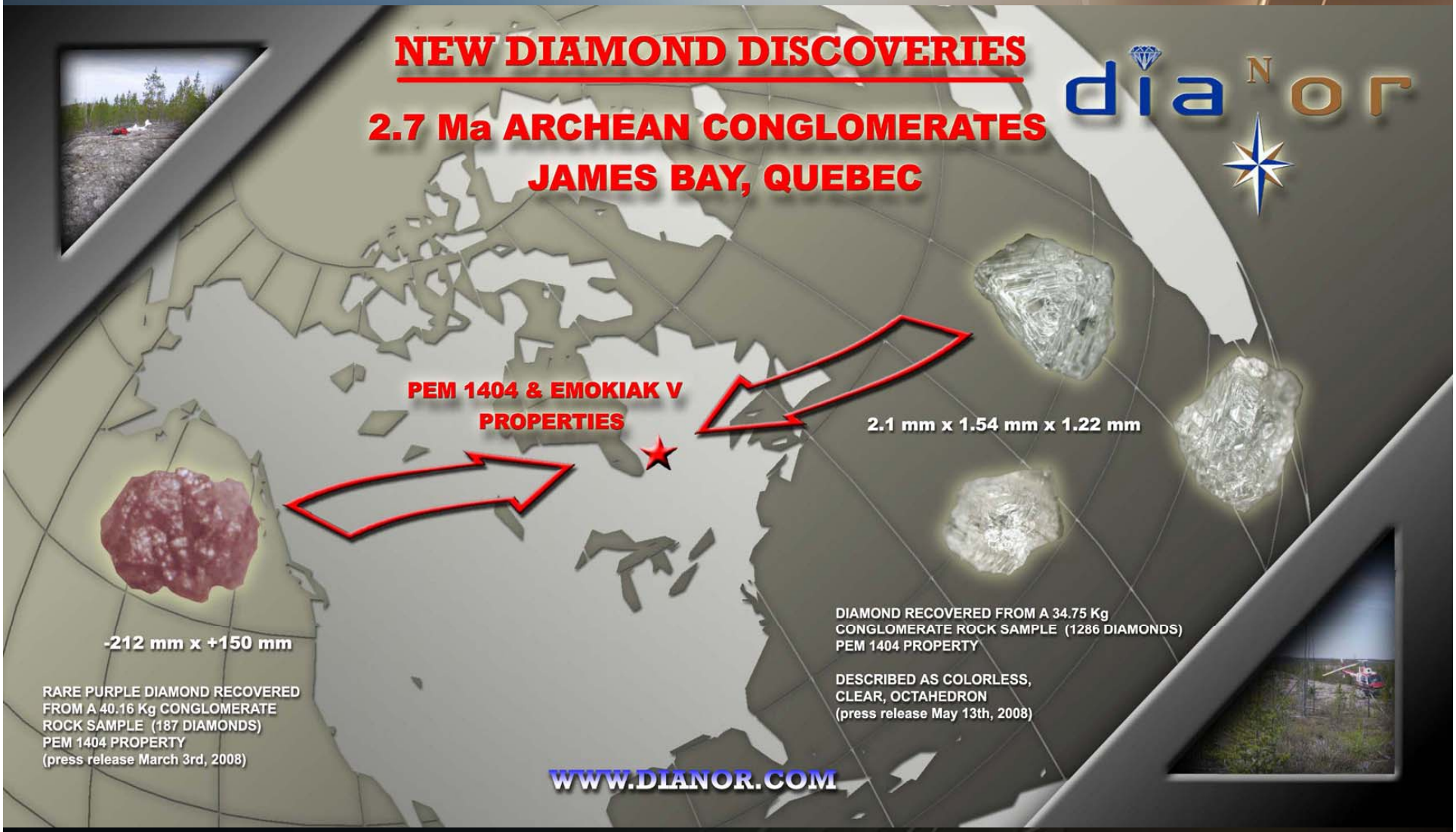


2.7Ma Archean Conglomerate

Approx. 566 Mt

dia N or

Archean Conglomerates Quebec,



Paleoplacer Summary

Name	Location	Age	Diamodiferous Units	Thickness	Extent	Potential	Diamonds			
							Average	Largest	Grade	Quality
						tonnes	carats	carats	cpht	
Nullagine	Australia	2.7 Ma	Hardly FM	2 - 60m	10kms	700 Mt +	0.25	3.5	75 -100	High
			Fortestque Group		50sq.km +					
Witwatersrand	South Africa	2.5-2.89	Upper Series	3m	10kms paystreaks	700Mt+	?	8	?	Medium
					Two reefs	to 4 Billion	?			High
Mobilong	Cameroon	2.7 Ma	Mobilong Congl.	100 m	10 kms	18 Mt to 420Mt	?	>3	25?	Medium
										High
Libongo	Cameroon	2.7 Ma	Mobilong Congl.	100+ m	?	?	?	2		Medium
	Cameroon	2.7 Ma	Mobilong Congl.	200 m	6 kms	1.7 billion	?	?	12	?
Marange	Zimbabwe	1.5Ma??	? ?	1.5 m	70 Kms+	500Mt+	5	?	100 -500?	<15%
										High
Chimnimani	Zimbabwe	1.5ma??	Umkondo ??	0.5 m	5 Kms+	10 - 20Mt+	5	?	100 -500?	<15%
										High
Wawa	Canada	2.7 Ma	Leadbetter Conglomerate	200m	5 kms+	600 Mt+	?	1.5	42	Medium

Conclusion

Paleoplacers are underexplored and recent discoveries in Africa and Canada make the case for development of these deposits to alleviate future diamond shortages.

Potential for large tonnage low-moderate grade open pit deposits

Final Conclusion

When we run out of diamonds on Earth perhaps MARS would make a good Paleoplacer exploration play!!!!!

Source: NASA 2012