

# Mineral resources and ore reserves cont.

# 2009

## Free State

**Geology:** The Harmony Free State Operations are located on the south-western corner of the Witwatersrand Basin, between the towns of Allanridge, Welkom, Theunissen and Virginia. The basin, situated on the Kaapvaal Craton, has been filled by a 6-kilometre thick succession of sedimentary rocks, which extends laterally for hundreds of kilometres.

The Free State goldfield is divided into two sections, cut by the north-south striking De Bron Fault. This major structure has a vertical displacement of about 1 500m in the region of Bambanani, as well as a lateral shift of 4km. This lateral shift can allow a reconstruction of the orebodies of Unisel to the west of the De Bron and Merriespruit to the east. A number of other major faults (Stuirmanspan, Dagbreek, Arrarat and Eureka) lie parallel to the De Bron Fault.

To the west of the De Bron, the currently operating mines are Target, Tshepong, Phakisa, Nyala, Unisel, Brand, Bambanani and Joel operations. Dips are mostly towards the east, averaging 30 degrees but become steeper approaching the De Bron Fault. To the east of the fault lie Merriespruit 1 and 3, Harmony 2 and Masimong mines. These mostly dip towards the west at 20 degrees, although Masimong is structurally complex and dips of up to 40 degrees have been measured. Between these two blocks lies the uplifted horst block of West Rand Group sediments with no reef preserved.

The western margin area is bound by synclines and reverse thrusts faults and is structurally complex. Towards the south and east, reefs sub-crop against overlying strata, eventually cutting out against the Karoo to the east of the lease area.

Most of the Ore Resource tends to be concentrated in reef bands located on one or two distinct unconformities. A minority of the Mineral Resource is located on other unconformities. Mining that has taken place is mostly deep-level underground mining, exploiting the narrow, generally shallow dipping tabular reefs.

The Basal Reef is the most common reef horizon and is mined at all shafts except Target and Joel. It varies from a single pebble lag to channels on more than 2m thick. It is commonly overlain by shale, which thickens northwards. Tshepong has resorted to undercutting of its mining panels to reduce the effect of shale dilution.

The second major reef is the Leader Reef, located 15-20m above the Basal Reef. This is mostly mined at the shafts to the south – Unisel, Harmony 2, Merriespruit 1 and Merriespruit 3. Further north, it becomes poorly developed with erratic grades. The reef consists of multiple conglomerate units, separated by thin quartzitic zones, often totalling up to 4 metres thick. A selected mining cut on the most economic horizon is often undertaken.

The B Reef is a highly channelised orebody located 140m stratigraphically above the Basal Reef. Because of its erratic nature, it has only been mined at Masimong and Tshepong. Within the channels, grades are excellent, but this falls away to nothing outside of the channels. Consequently, both shafts have undertaken extensive exploration to locate these pay channels.

The A Reef is also a highly channelised reef, located some 40m above the B Reef. This is currently only mined at Harmony 2 and Brand, although an extensive channel lies along the western margin from Nyala to Lorraine. It consists of multiple conglomerate bands of up to 4m thick and a selected mining cut is usually required to optimise the orebody.

Joel Mine, located 30km south of Welkom, is the only Harmony Free State operation to mine the Beatrix Reef. This varies from a single-pebble lag to a multiple conglomerate, often showing mixing of the reef with some of the overlying lower grade VS5 (mixed pebble conglomerate) material. None of the other reefs are present this far south, having sub-cropped against the Beatrix Reef.

The Target operations are located at the northern extent of the Free State Goldfields, some 20km north of Welkom. The reefs currently exploited are the Elsburg-Dreyerskuil conglomerates, which form a wedge-shaped stacked package, comprising 35 separate reef horizons, often separated by quartzite beds. The Elsburg Reefs are truncated by an unconformity surface at the base of the overlying Dreyerskuil Member. Below the sub-crop, the Elsburg dips steeply to the east, with dips becoming progressively shallower down dip. Close to the sub-outcrop, the thickness of the intervening quartzites reduces, resulting in the Elsburg Reefs coalescing to form composite reef packages that are exploited by massive mining techniques at the Target mine. The Dreyerskuil also consists of stacked reefs dipping shallowly to the east. These reefs tend to be less numerous, but more laterally extensive than the underlying Elsburg Reefs.

## Free State – Gold mineral resources

Operations	Measured		Gold		Indicated		Gold		Inferred		Gold		Total		Gold	
	Tonnes (Mt)	g/t	(000kg)	(000oz)	Tonnes (Mt)	g/t	(000kg)	(000oz)	Tonnes (Mt)	g/t	(000kg)	(000oz)	Tonnes (Mt)	g/t	(000kg)	(000oz)
<b>Underground</b>																
Bambanani	11.4	11.20	127	4 087	6.4	9.67	62	1 993	3.8	9.02	34	1 101	21.6	10.36	223	7 181
Joel	4.3	6.44	28	895	3.9	6.82	27	855	12.3	6.50	80	2 580	20.5	6.55	135	4 330
Masimong	14.0	7.55	106	3 401	14.9	6.51	97	3 128	100.3	6.69	671	21 576	129.2	6.76	874	28 105
<b>Phakisa</b>																
Phakisa	0.2	9.72	2	65	22.1	12.29	272	8 745	57.8	7.02	405	13 036	80.1	8.48	679	21 846
Nyala	4.4	6.91	31	985	3.9	4.76	18	592	–	–	–	–	8.3	5.91	49	1 577
<b>Total</b>	<b>4.6</b>	<b>7.03</b>	<b>33</b>	<b>1 050</b>	<b>26.0</b>	<b>11.17</b>	<b>290</b>	<b>9 337</b>	<b>57.8</b>	<b>7.02</b>	<b>405</b>	<b>13 036</b>	<b>88.4</b>	<b>8.24</b>	<b>728</b>	<b>23 423</b>
Target*	6.3	9.81	62	1 991	13.9	7.65	106	3 412	5.2	6.26	32	1 043	25.4	7.90	200	6 446
Tshepong	14.0	11.03	154	4 949	14.3	11.32	162	5 211	13.8	8.85	122	3 922	42.1	10.42	438	14 082
<b>Virginia</b>																
Harmony 2	10.2	4.75	48	1 559	7.1	3.30	24	757	77.1	3.67	282	9 082	94.4	3.76	354	11 398
Merriespruit 1	8.5	5.20	45	1 421	3.8	5.25	20	635	39.6	4.19	166	5 334	51.9	4.43	231	7 390
Merriespruit 3	8.8	5.25	46	1 491	2.8	4.91	14	436	7.0	4.08	29	917	18.6	4.76	89	2 844
Unisel	11.2	5.56	62	1 989	12.0	4.73	56	1 828	20.6	4.65	97	3 086	43.8	4.90	215	6 903
Brand 3	4.1	6.78	28	892	4.1	6.91	29	916	10.0	5.15	51	1 650	18.2	5.91	108	3 458
<b>Total</b>	<b>42.8</b>	<b>5.35</b>	<b>229</b>	<b>7 352</b>	<b>29.8</b>	<b>4.77</b>	<b>143</b>	<b>4 572</b>	<b>154.3</b>	<b>4.05</b>	<b>625</b>	<b>20 069</b>	<b>226.9</b>	<b>4.39</b>	<b>997</b>	<b>31 993</b>
<b>Total Underground</b>	<b>97.4</b>	<b>7.58</b>	<b>739</b>	<b>23 725</b>	<b>109.2</b>	<b>8.12</b>	<b>887</b>	<b>28 508</b>	<b>347.5</b>	<b>5.67</b>	<b>1 969</b>	<b>63 327</b>	<b>554.1</b>	<b>6.49</b>	<b>3 595</b>	<b>115 560</b>
<b>Surface</b>																
Phoenix	130.8	0.27	36	1 148	–	–	–	–	5.3	0.26	1	44	136.1	0.27	37	1 192
St Helena	289.6	0.25	72	2 327	–	–	–	–	–	–	–	–	289.6	0.25	72	2 327
Other	421.8	0.22	93	2 984	142.0	0.33	47	1 500	195.2	0.23	45	1 444	759.0	0.24	185	5 928
<b>Total surface</b>	<b>842.2</b>	<b>0.24</b>	<b>201</b>	<b>6 459</b>	<b>142.0</b>	<b>0.33</b>	<b>47</b>	<b>1 500</b>	<b>200.5</b>	<b>0.23</b>	<b>46</b>	<b>1 488</b>	<b>1 184.7</b>	<b>0.25</b>	<b>294</b>	<b>9 447</b>
<b>GRAND TOTAL</b>	<b>939.6</b>		<b>940</b>	<b>30 184</b>	<b>251.2</b>		<b>933</b>	<b>30 008</b>	<b>548.0</b>		<b>2 015</b>	<b>64 815</b>	<b>1 738.8</b>		<b>3 889</b>	<b>125 007</b>

\* Target's mineral resources are stated as work in progress – the process has been independently reviewed by SRK.

## Modifying factors

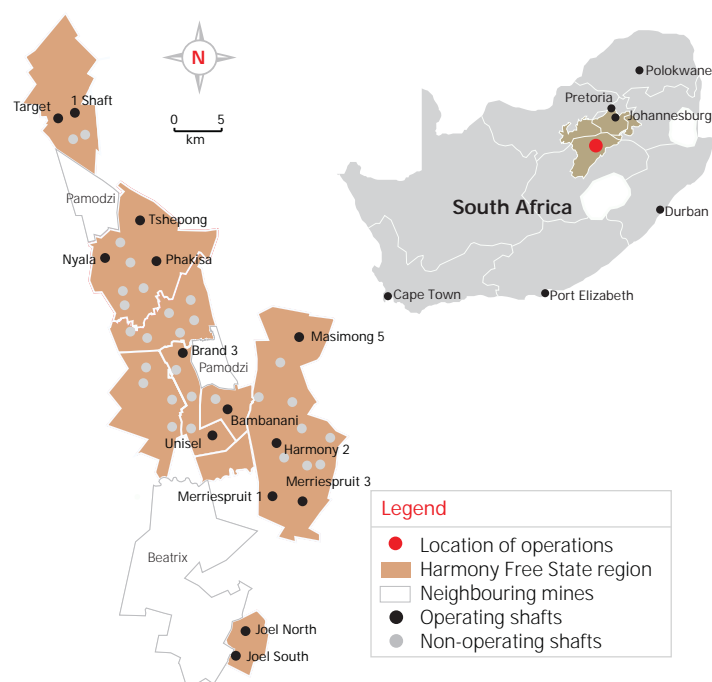
Operations	MCF (%)	SW (cm)	MW (cm)	PRF (%)
Bambanani	78	200	218	96
Joel	93	150	198	96
Masimong	67	130	154	95
Phakisa	81	100	129	95
Nyala	87	150	191	94
Tshepong	65	105	142	97
Harmony 2	69	154	178	95
Merriespruit 1	75	162	205	95
Merriespruit 3	67	218	246	95
Unisel	80	175	193	95
Brand 3	94	193	229	96

MCF = Mine call factor    MW = Milling width    SW = Stopping width

PRF = Plant recovery factor

Operations	MCF (%)	Dilution (%)	PRF (%)
Target	95	5	96
Phoenix	100	–	47
St Helena	100	–	47
Other	100	–	47

MCF = Mine call factor    PRF = Plant recovery factor



# Mineral resources and ore reserves cont.

## Free State – Gold ore reserves

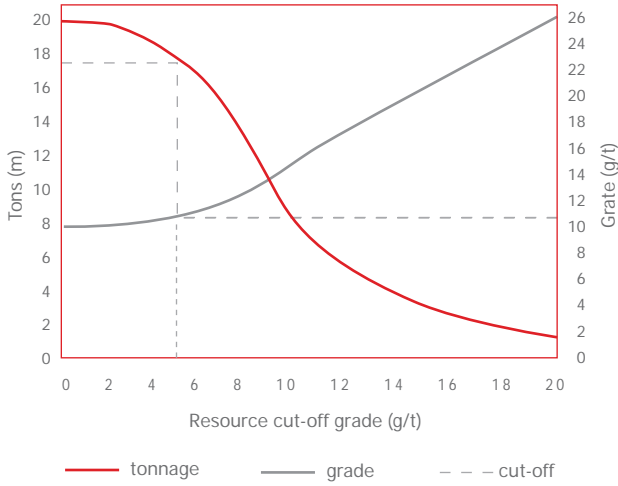
Operations	Proven				Probable				Total			
	Tonnes (Mt)	g/t	Gold (000kg)	Gold (000oz)	Tonnes (Mt)	g/t	Gold (000kg)	Gold (000oz)	Tonnes (Mt)	g/t	Gold (000kg)	Gold (000oz)
<b>Underground</b>												
Bambanani	3.5	8.48	30	965	1.2	10.90	13	420	4.7	9.09	43	1 385
Joel	0.9	5.74	5	161	2.2	5.52	13	404	3.1	5.58	18	565
Masimong	4.5	5.20	24	751	1.4	5.27	7	233	5.9	5.22	31	984
<b>Phakisa</b>												
Phakisa	0.3	5.38	1	43	20.1	8.12	163	5 234	20.4	8.08	164	5 277
Nyala	0.1	4.01	1	13	0.0	3.37	0	5	0.1	3.82	1	18
<b>Total</b>	<b>0.4</b>	<b>4.98</b>	<b>2</b>	<b>56</b>	<b>20.1</b>	<b>8.11</b>	<b>163</b>	<b>5 239</b>	<b>20.5</b>	<b>8.05</b>	<b>165</b>	<b>5 295</b>
Target*	4.8	6.10	29	942	9.0	5.60	50	1,617	13.8	5.77	79	2 559
Tshepong	12.8	5.30	68	2 184	11.5	5.78	66	2 130	24.3	5.53	134	4 314
<b>Virginia</b>												
Harmony 2	0.9	3.56	3	103	0.1	3.28	0	9	1.0	3.53	3	112
Merriespruit 1	1.2	4.55	6	183	0.6	4.45	2	86	1.8	4.52	8	269
Merriespruit 3	0.9	3.69	3	102	0.2	2.80	1	16	1.1	3.54	4	118
Unisel	3.0	4.95	15	482	1.8	4.85	9	276	4.8	4.91	24	758
Brand 3	0.6	3.92	2	70	0.1	4.42	1	20	0.7	4.02	3	90
<b>Total</b>	<b>6.6</b>	<b>4.43</b>	<b>29</b>	<b>940</b>	<b>2.8</b>	<b>4.56</b>	<b>13</b>	<b>407</b>	<b>9.4</b>	<b>4.47</b>	<b>42</b>	<b>1 347</b>
<b>Total Underground</b>	<b>33.5</b>	<b>5.57</b>	<b>187</b>	<b>5 999</b>	<b>48.2</b>	<b>6.75</b>	<b>325</b>	<b>10 450</b>	<b>81.7</b>	<b>6.27</b>	<b>512</b>	<b>16 449</b>
<b>Surface</b>												
Phoenix	130.8	0.27	36	1 148	–	–	–	–	130.8	0.27	36	1 148
St Helena	289.6	0.25	72	2 326	–	–	–	–	289.6	0.25	72	2 326
Other	421.8	0.22	93	2 985	101.7	0.26	26	845	523.5	0.23	119	3 830
<b>Total Surface</b>	<b>842.2</b>	<b>0.24</b>	<b>201</b>	<b>6 459</b>	<b>101.7</b>	<b>0.26</b>	<b>26</b>	<b>845</b>	<b>943.9</b>	<b>0.24</b>	<b>227</b>	<b>7 304</b>
<b>GRAND TOTAL</b>	<b>875.7</b>		<b>388</b>	<b>12 458</b>	<b>149.9</b>		<b>351</b>	<b>11 295</b>	<b>1 025.6</b>		<b>739</b>	<b>23 753</b>

\* Target's ore reserves are stated as work in progress – the process has been independently reviewed by SRK.

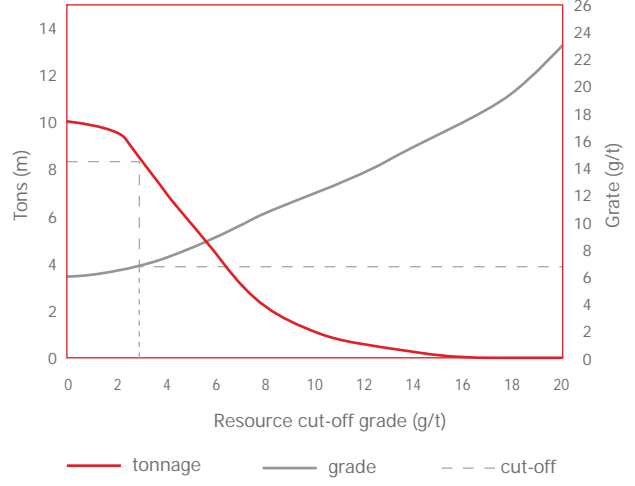
## Free State – Uranium mineral resources

Operations	Measured				Indicated				Inferred				Total			
	Tonnes (Mt)	Kg/t	U <sub>3</sub> O <sub>8</sub> (M kg)	U <sub>3</sub> O <sub>8</sub> (M lbs)	Tonnes (Mt)	kg/t	U <sub>3</sub> O <sub>8</sub> (M kg)	U <sub>3</sub> O <sub>8</sub> (M lbs)	Tonnes (Mt)	kg/t	U <sub>3</sub> O <sub>8</sub> (M kg)	U <sub>3</sub> O <sub>8</sub> (M lbs)	Tonnes (Mt)	kg/t	U <sub>3</sub> O <sub>8</sub> (M kg)	U <sub>3</sub> O <sub>8</sub> (M lbs)
Surface	358.8	0.09	33	72	36.5	0.10	4	8	68.4	0.07	5	11	463.7	0.09	42	91

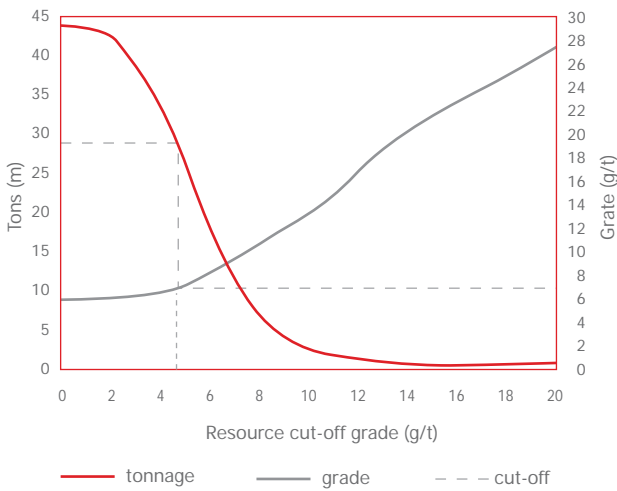
Bambanani: grade tonnage curve  
(measured and indicated resources)



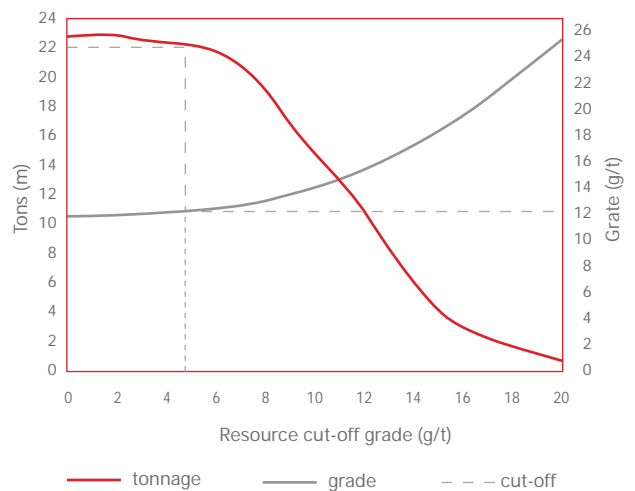
Joel: grade tonnage curve  
(measured and indicated resources)



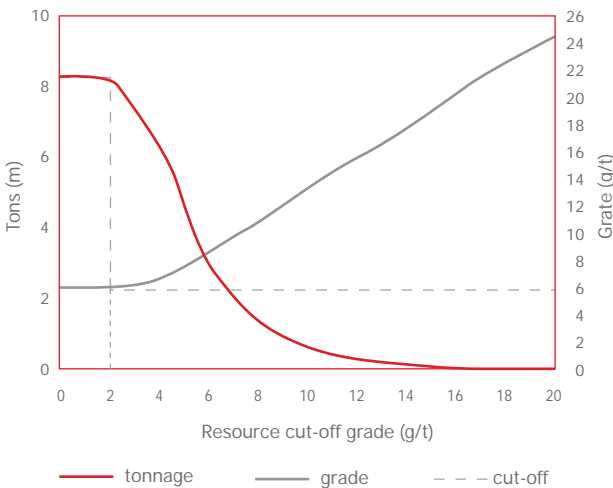
Masimong: grade tonnage curve  
(measured and indicated resources)



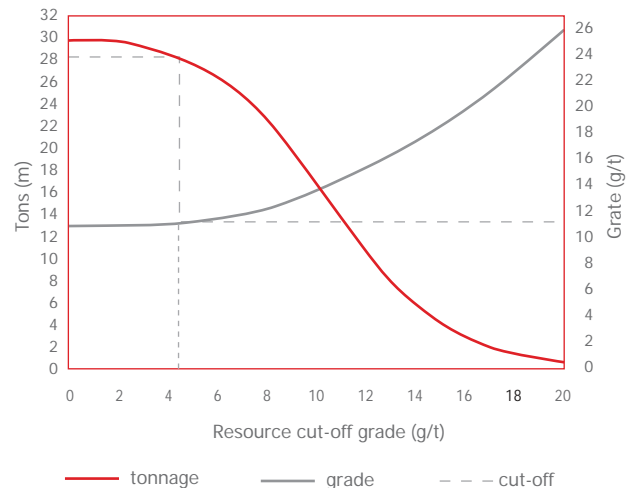
Phakisa: grade tonnage curve  
(measured and indicated resources)



Nyala: grade tonnage curve  
(measured and indicated resources)



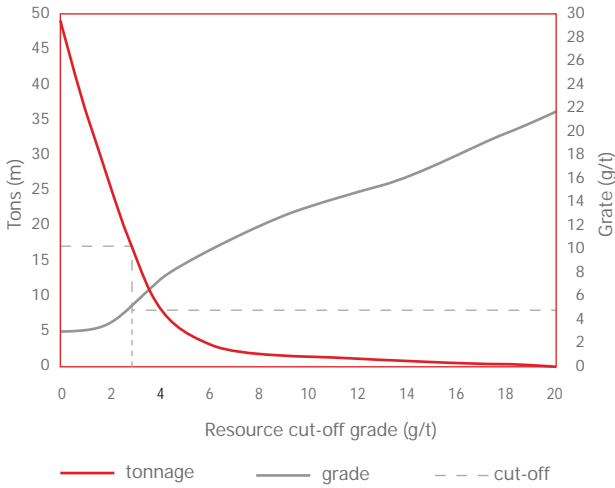
Tshepong: grade tonnage curve  
(measured and indicated resources)



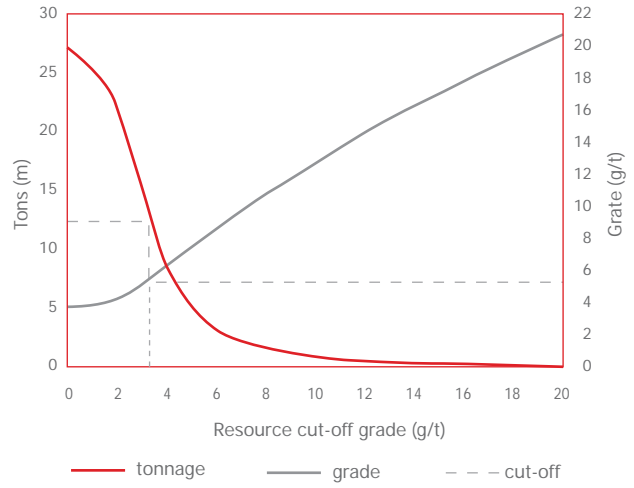
# Mineral resources and ore reserves cont.

# 2009

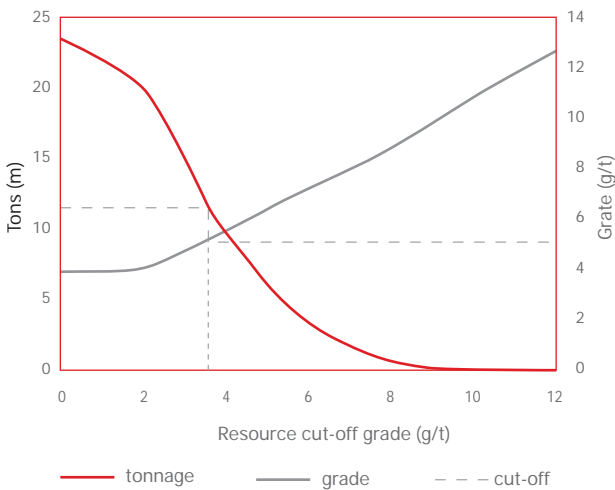
Harmony 2: grade tonnage curve (measured and indicated resources)



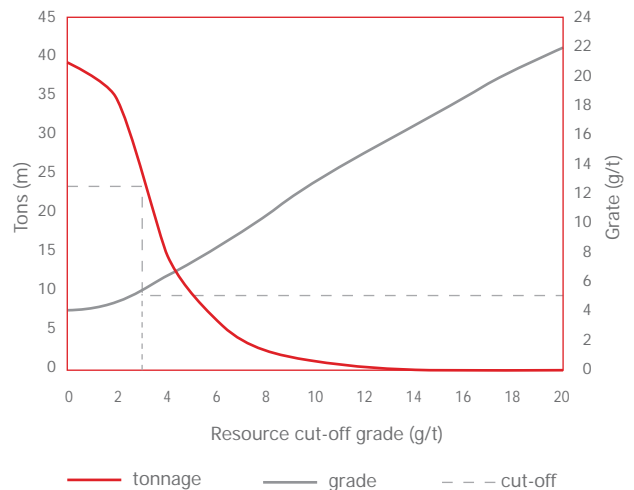
Merriespruit 1: grade tonnage curve (measured and indicated resources)



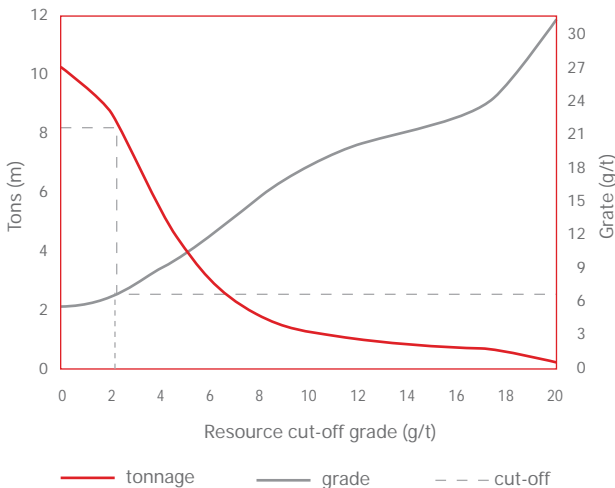
Merriespruit 3: grade tonnage curve (measured and indicated resources)



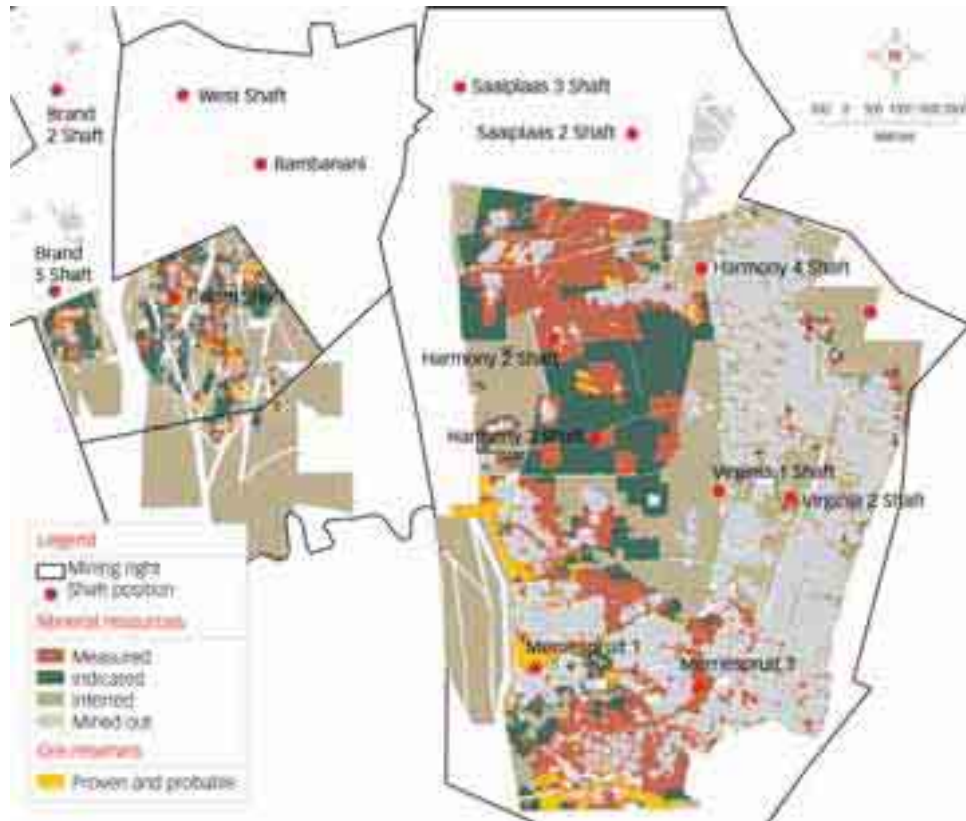
Unisel: grade tonnage curve (measured and indicated resources)



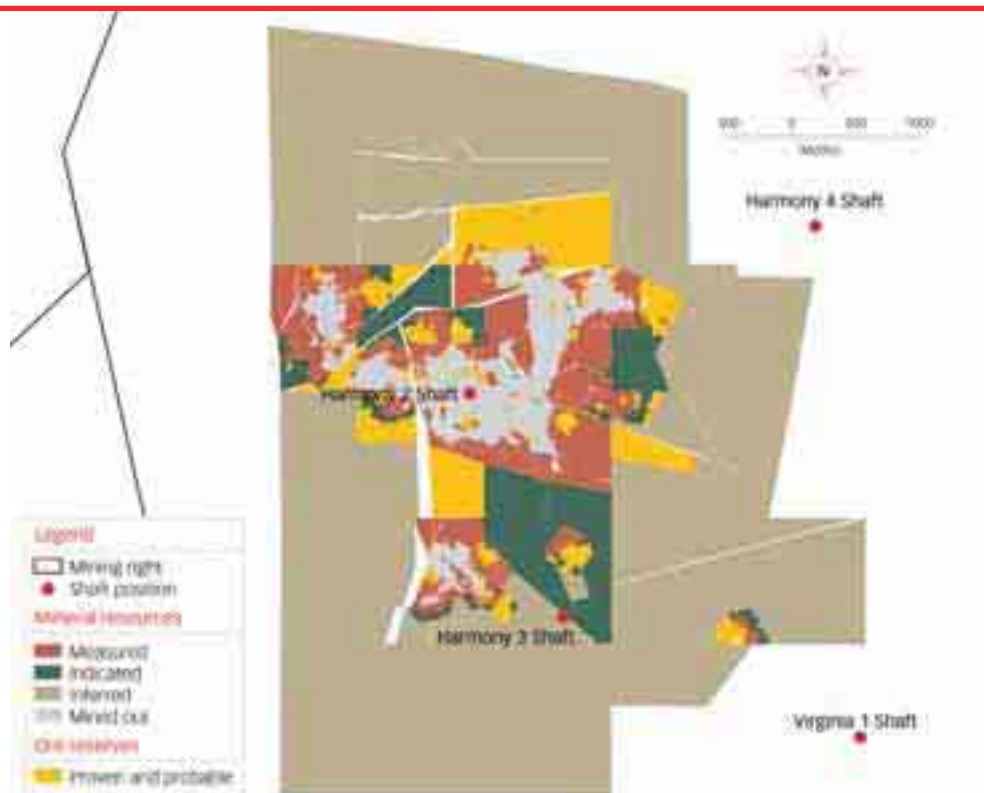
Brand 3: grade tonnage curve (measured and indicated resources)



Virginia operations: Harmony 2, Merriespruit 1, Merriespruit 3 and Unisel shafts  
Leader Reef



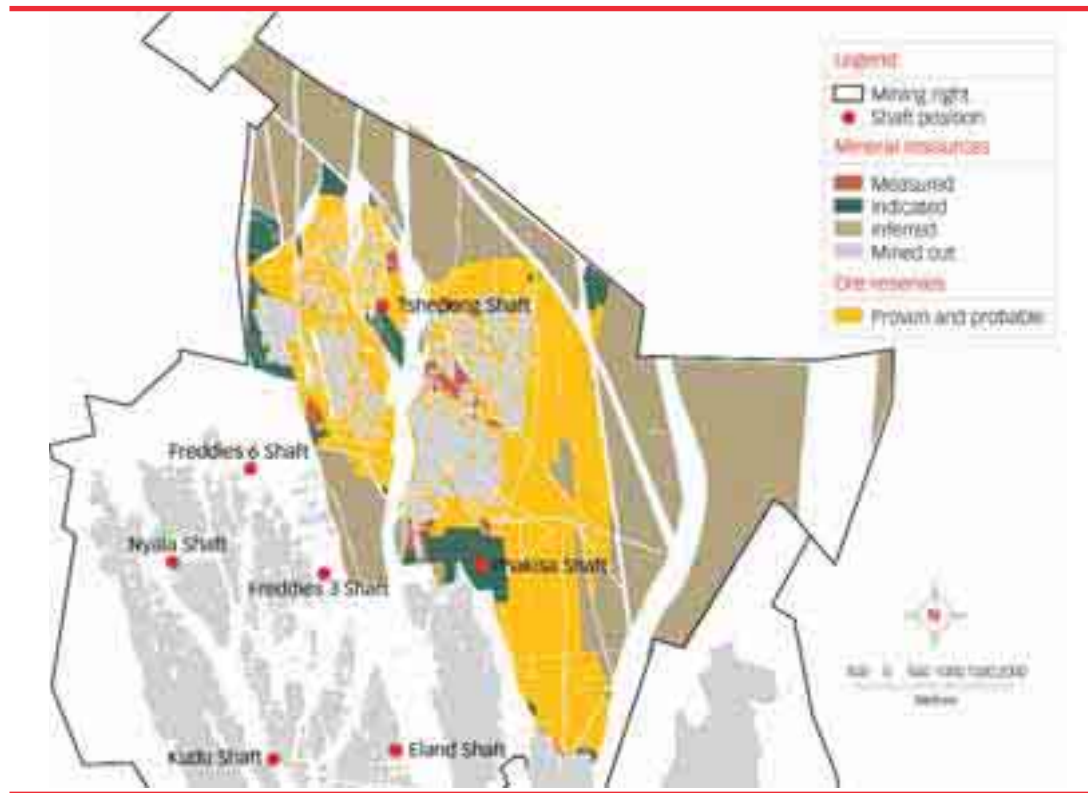
Virginia operations: Harmony 2 shaft  
A Reef



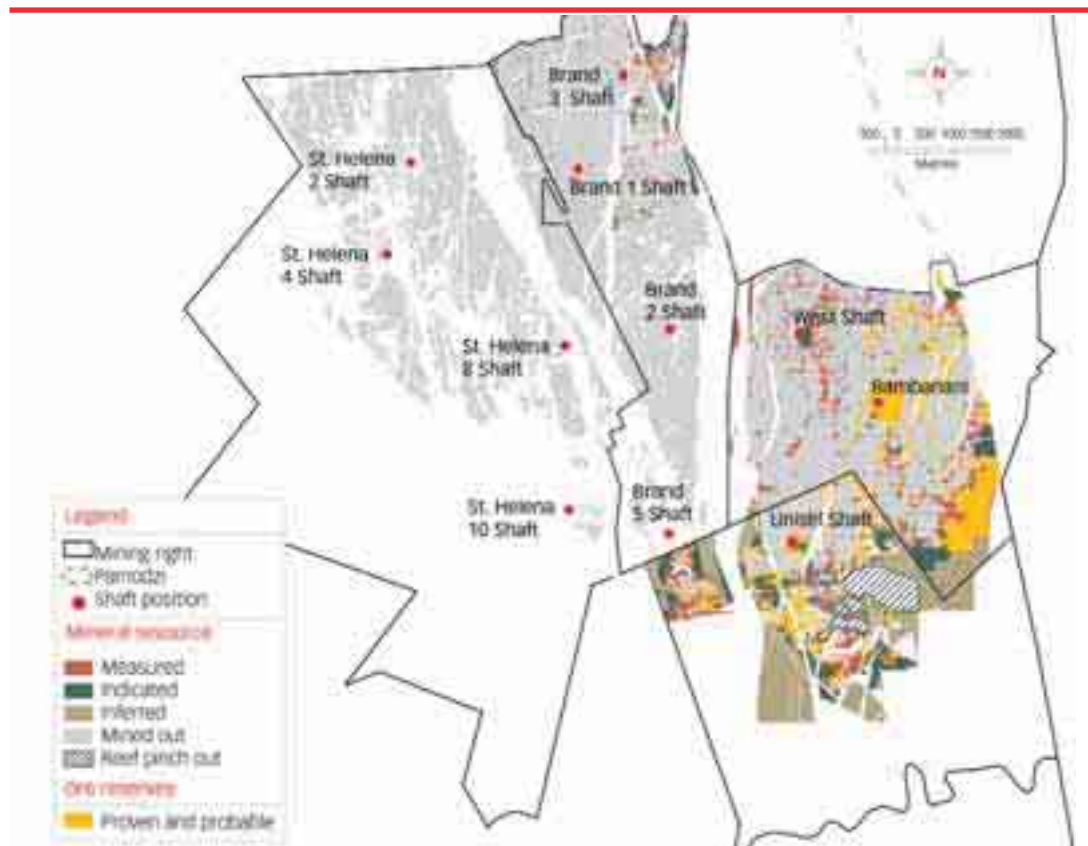
# Mineral resources and ore reserves cont.

# 2009

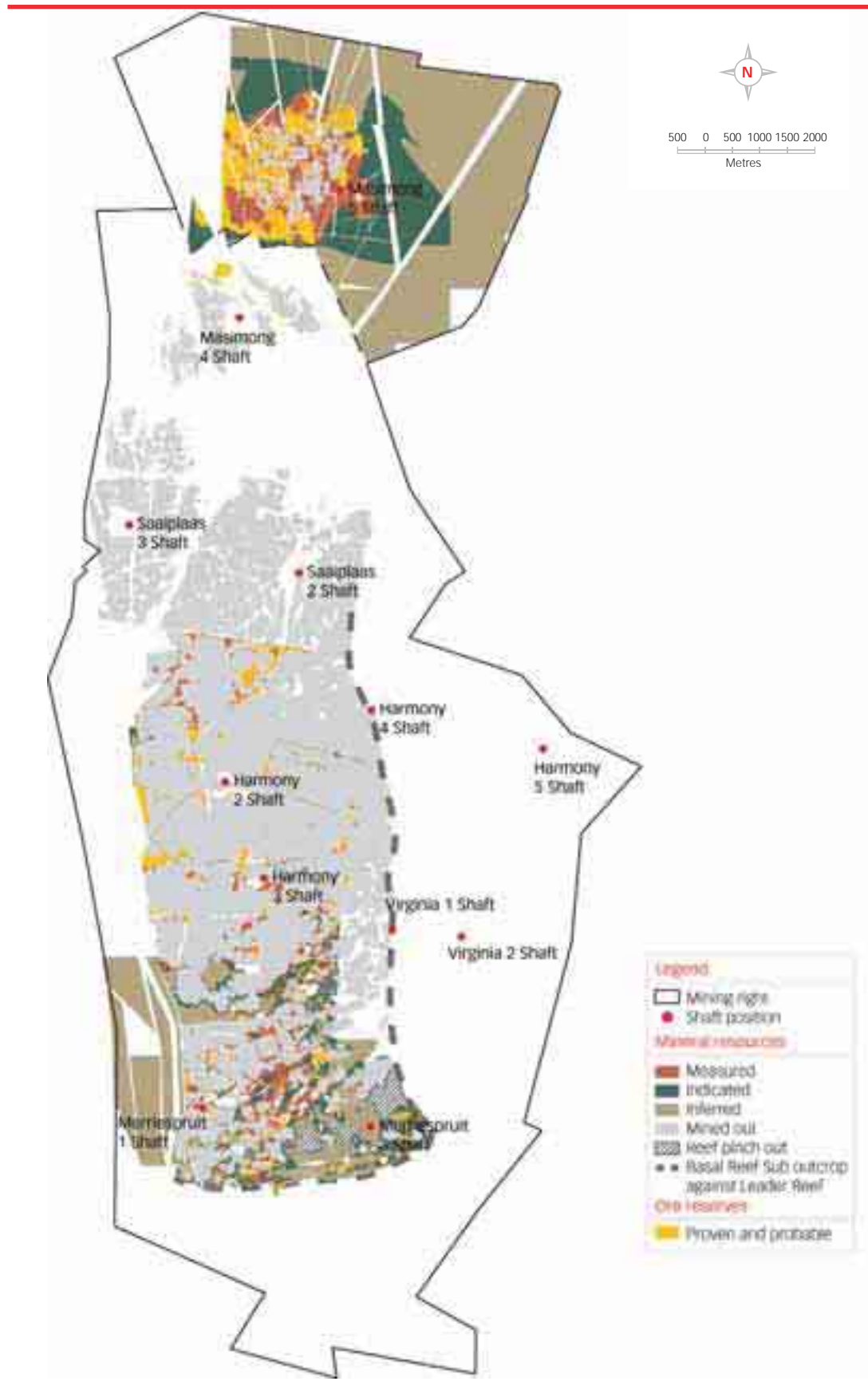
Tshepong shaft, Phakisa shaft  
Basal Reef



Brand 1 and 3 shafts, Bambanani and Unisel shafts  
Basal Reef



Merriespruit 1 and 3, Harmony 2 and Masimong 4 and 5 shafts  
Basal Reef

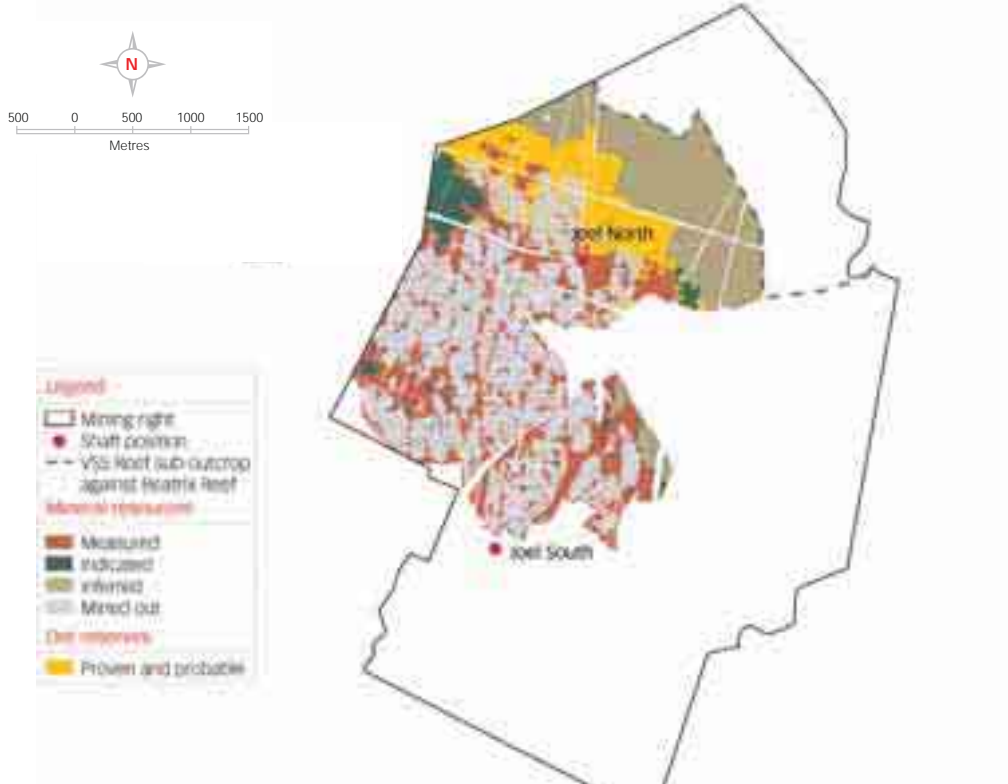




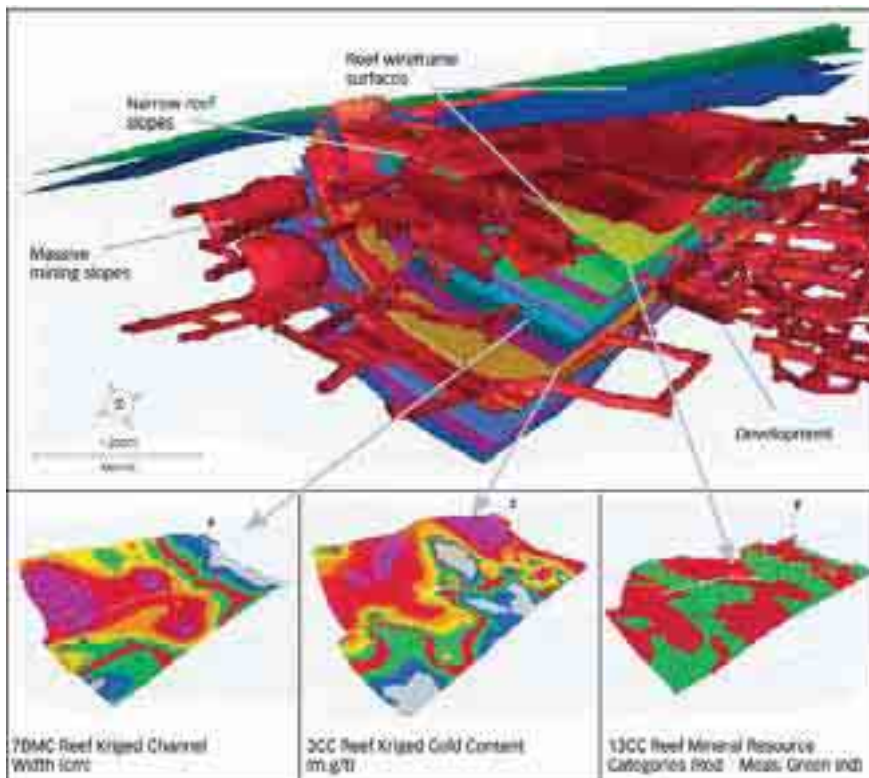
# Mineral resources and ore reserves cont.

# 2009

## Joel Beatrix Reef



## Target mine Elsburg and Dreyerskuil Reefs



Target mine resource blocks  
 Elsburg and Dreyerskuil Reefs

