



Development of a best-practice mineral resource classification system for the De Beers group of companies

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Overview

1. Classification of diamond deposits
2. Historical & current classification methodologies at De Beers
3. The De Beers mineral resource classification system (MRCS)



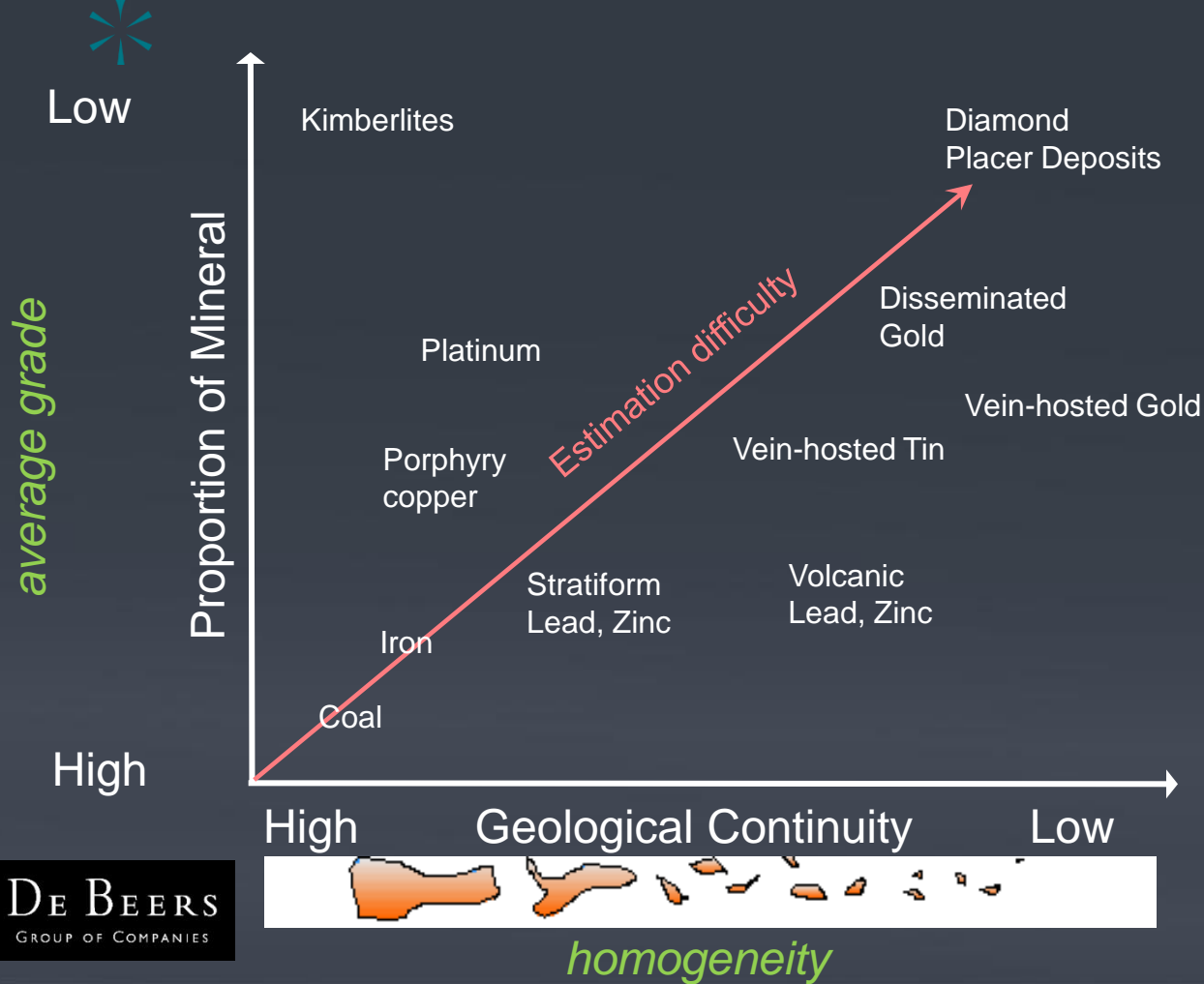


Some key characteristics of diamond deposits

- Particulate, generally highly variable and extremely low grade
- Complex in terms of estimation and classification
- Significant variability of parameters associated with estimating diamond deposits
- Representative sampling is difficult & costly
- Revenue estimation is critical - based on SFD & assortment models
- Exhibit high levels of uncertainty compared to other mineral deposits

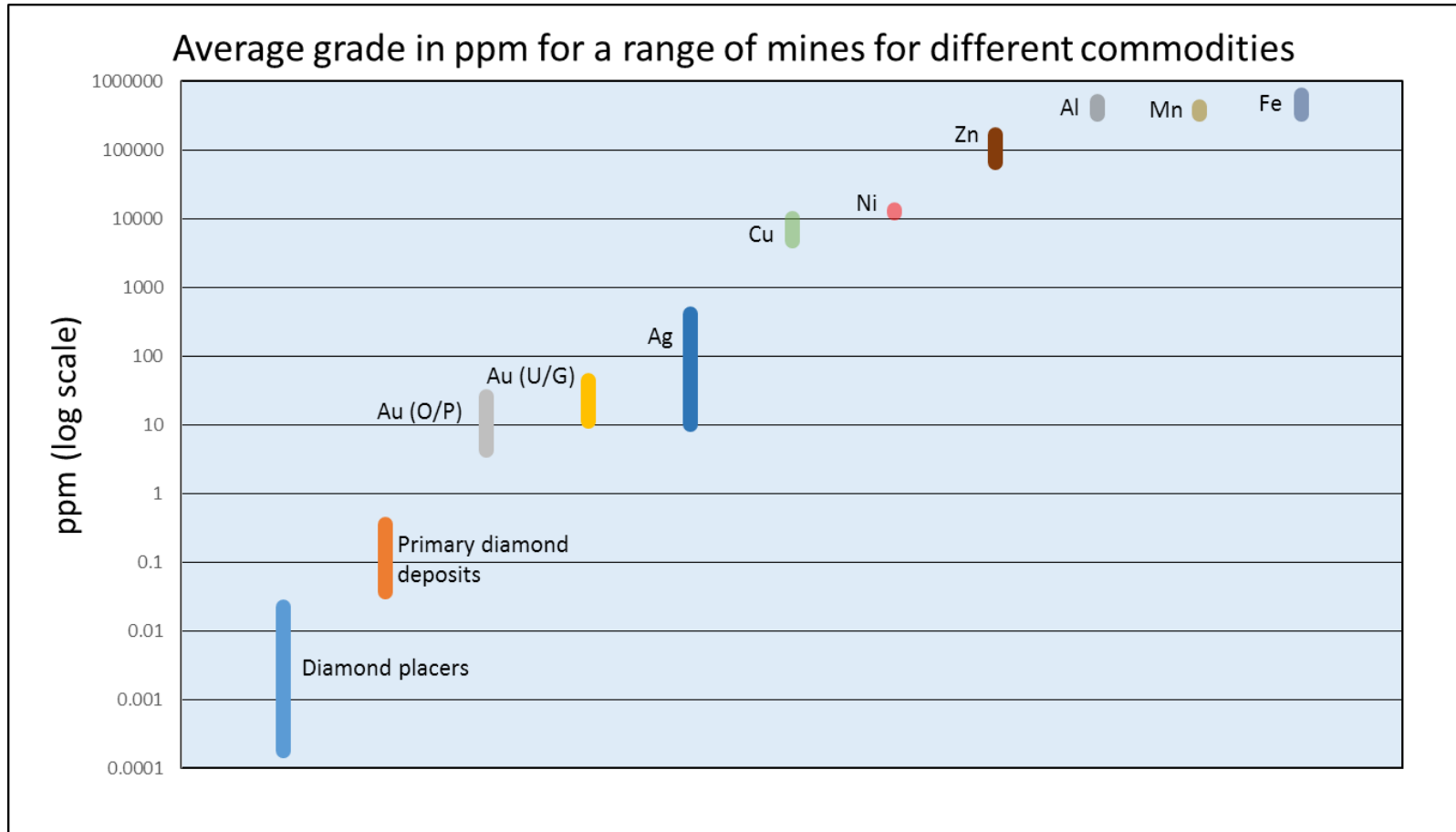
Grade and Continuity

(modified after King 1983)





Classifying diamond deposits





Diamond deposit types

- Primary kimberlites
 - Pipes
 - Dykes, sills and fissures
- Secondary placers
 - Fluvial
 - Marine (raised beach, shallow & deep water)
 - Aeolian
- Tertiary deposits
 - Stockpiles
 - Tailings Mineral Resources (TMR's)



Diamond deposits: key classification criteria

- Geology: the thinking behind the emplacement or deposition model
- Grade: data integrity, estimation methodology, process and validity of results
- Volume: 2D or 3D representation of the geological thinking
- Revenue: data integrity, SFD and assortment modelling and validity of results
- Density: data integrity, estimation methodology and process, and validity of results



De Beers classification pre 2004

- Non-quantitative methods, mostly undertaken by an estimator with input from project geologist(s)
- Diamond sections of JORC/SAMREC codes broadly followed
- Some debate within diamond fraternity, in particular defining and placing a value on the Inferred category (more difficult for diamond deposits to attain an Indicated level of confidence)
- Group Mineral Resource Manager accepted responsibility as the CP



Classification using scorecard

- Definition of the portion of deposit to be classified;
- Five main scorecards
 - geology, grade, volume, revenue & density
- Set of questions grouped into sub categories
 - e.g. data integrity, sample accuracy, estimation methodology
- Allocation of scores to all questions with answers justifying the score
- Reviewed by MRCC
- Ratified by MRCC Chairman



De Beers classification, 2004 and beyond

- In 2004 De Beers identified the need for a single classification system for all operations
- Appropriate governance in place
- Semi-quantitative method reflecting the uncertainty, i.e. a scorecard approach
- Classification Committee (MRCC) initiated
- Development of the MRCS
- 2015: Classification by CP utilising Windows based SQL scorecard (MRCS)



De Beers Competent/Qualified Person

- Each year a CP is officially appointed for each operation
- CP for diamond resources and mineral reserves
- MRCC no longer utilised
- The CP uses the MRCS for classification and is responsible for finalising each classification



De Beers current classification methodology

- Preparation phase
 - deciding on the details of the deposit to be classified
- Step 1: Initial classification
 - project geologist: set up classification, complete scorecards
- Step 2: Operational review
 - MRM and peers of project geologist
- Step 3: Independent external review
 - recommendations only
- Step 4: Final approval/ratification
 - CP sign-off



De Beers current classification methodology

Method of scoring

- Individual score assigned to each of 84 questions
- Assigned scores within each group of questions are averaged
- Average scores added to provide an overall score out of 100

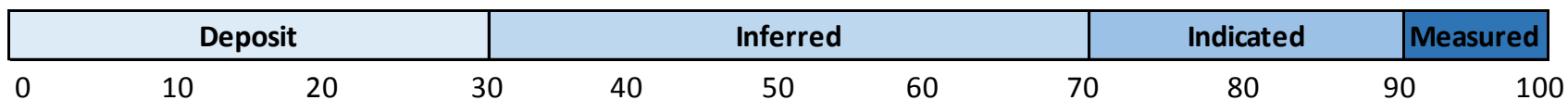
Group	Geology	Grade	Volume	Revenue	Density
Knowledge techniques	20				
Sampling/data integrity	20	15	30	20	20
Sample representivity	20				
Sample accuracy		15			
Sampling programme		10		10	10
Estimation methodology		20	30	20	20
Definition of the geological model	40				
Other risk analysis techniques		40	40	50	50
Totals	100	100	100	100	100



De Beers current classification methodology

Method of scoring

- Classification limits were assigned as follows:
 - 0-30 Deposit (excluded from the mineral resource)
 - 30-70 Inferred Mineral Resource
 - 70-90 Indicated Mineral Resource
 - 90-100 Measured Mineral Resource



Mineral Resource Classification System (MRCS)



Designed to simplify the process of mineral resource classification and ensure appropriate governance

All data and documents stored on Microsoft SQL Database

Central database and used over the De Beers intranet

Developed by Z* exclusively for De Beers



De Beers MRCS: hierarchical structure

DE BEERS GROUP OF COMPANIES MRCS Home Navigation MRCS Production MRC Compete

COMPANY	MINE/OPERATION	RESOURCE	GROUP	CLASSIFICATION
De Beers Canada (12)	Damtshaa (4)	AK1 0 - 265 mbgl (1)	Historical Data (3)	ORA_K03 RAT 11Feb... (RAT)
De Beers Consolidated... (9)	Jwaneng (6)	AK1 265 - 685... (1)		ORA_K01 PRE 695 - 2... (RAT)
Debswana (4)	Lethakane (5)	A/K1 0 - 265 mb... (1)		ORA_K01 RAT 24Jun... (RAT)
Exploration Projects (3)	Orapa (8)	A/K1 265 - 685... (1)		
Xternal (3)		A/K1 265 - 550... (1)		
Namdeb (7)		A/K1 550 - 685... (1)		
Namdeb Other (1)		AK20 0 - 260 mbgl (1)		
Tanzania (1)		TMR (1)		
Tanzania Other (1)				
Xternal Other (1)				
De Beers Canada Other (1)				
Debswana Other (3)				
De Beers Consolidated... (5)				



MRCS: Resource

- Define the geology, e.g. kimberlite, fluvial placer, TMR, etc.
- Define the deposit type: primary, secondary, tertiary
- Upload documents, e.g. geology reports, estimation reports, etc.
- Resource name, date, user etc.



MRCS: Group

- The option to store and manage classifications according to criteria specified by the user
- Group classifications by year
- Geographical grouping
- Also enables comparative statistical analysis
- MRCS requires a name, a brief description and a dimension (3D or 2D and an option for including co-ordinates)



Creating a Classification

- Selection of appropriate area or volume of the deposit for classification
 - homogenous in terms of geology
 - density of information
 - grade considerations
- Classification name, user name, date, etc.
- Promoting classifications (locking)
- Permissions



Creating a Classification

DE BEERS GROUP OF COMPANIES MRCS Home Navigation TEST SITE Sean Competent Person

COMPANY

- De Beers Consolidated... 9

MINE/OPERATION

- Venefia Mine 20

RESOURCE

- K1 696 - 1044m 2

GROUP

- VEN 2015 0

Create

Classification

Classification Name: VEN_K2 600-800m Prelim

Previous Years Mining: 0

[Create](#) [Cancel](#)

DE BEERS GROUP OF COMPANIES MRCS Home Navigation TEST SITE Alex Competent Person

COMPANY

- De Beers Canada 12

MINE/OPERATION

- Gahcho Kué 6

RESOURCE

- 5034 East & North Lobes 1

GROUP

- Historical Data 4

CLASSIFICATION

- Test Classification PRE

Test Classification

Classification

[Questions](#) [Docs](#) [Compare](#) [Reports](#) [Options](#)

Classification	Test Classification
Status	Preliminary
Locked	False
Previous Years Mining	0
Date Created	14 Dec 2015
Created By	Alex Leibhammer
Date Modified	14 Dec 2015
Modified By	Alex Leibhammer
Classification Category	n/a

Link	Model	Weighting	Recorded Score



Creating a Classification

DE BEERS GROUP OF COMPANIES | MRCS | Home | Navigation

TEST SITE | Sean Competent Person

- COMPANY
 - Debswana (4)
- MINE/OPERATION
 - Jwaneng (6)
- RESOURCE
 - DK2 454 - 154m amsl (N... (1))
- GROUP
 - Historical Data (1)
- CLASSIFICATION
 - JWA_K03 RAT 11Feb2008 (RAT)

Questions Grade ▾ ⚙️

SAMPLE INTEGRITY

- ✓ 1.) Were contracts/policies/procedures for the physical
- ✓ 2.) How efficient was spiking and/or audit sampling?
- ✓ 3.) Were security policies/procedures covering the entire
- ✓ 4.) Has the grade sampling been undertaken according to
- ✓ 5.) Has logging of evaluation sampling been undertaken as
- 6.) Have accurate positioning surveys been conducted and
- ✓ 7.) Has the raw evaluation sampling data been stored and

SAMPLE ACCURACY

- ✓ 8.) Has the sample area/volume been measured accurately?

SAMPLING PROGRAMME

- ✓ 9.) Was each grade sampling campaign optimised to ensure
- ✓ 10.) Was the grade sampling optimisation plan followed?
- 11.) Is there compatibility in the data between different

ESTIMATION METHODOLOGY

- ✓ 12.) Has the data for estimation been validated?
- ✓ 13.) Has the appropriate estimation methodology been
- ✓ 14.) What is the resolution of the grade estimation?
- ✓ 15.) Do the sample results honour the geology model?

SAMPLE INTEGRITY

(15 Points)

📊 « Previous Next »

Question 6

Have accurate positioning surveys been conducted and utilised for each grade sampling technique?

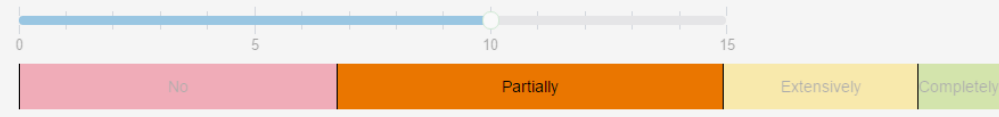
Hint

Accurate locations for grade data is imperative. This applies to both:
(i) the surface coordinates of drillholes (collars), trench excavations or any grade sampling method; and
(ii) the downhole surveys of drillholes (GYRO survey preferred).

Answer

Collar surveyed for Schramm, holes assumed vertical; bulk-sample only per block centroid.

Confidence Level: (Max: 15)





MRCS classification reports

DE BEERS GROUP OF COMPANIES MRCS

Home Navigation

COMPANY

Debswana 4

MINE/OPERATION

Orapa 8

RESOURCE

A/K1 265 - 685 mbgl (AK... 1

GROUP

Historical Data 1

CLASSIFICATION

ORA_K01 RAT North 17... RAT

TEST SITE

Sean
Competent Person

ORA_K01 RAT North 17 MARCH 2014

Classification

Performance Docs Compare Reports

Classification ORA_K01 RAT North 17 MARCH 2014
Status Ratified
Locked True
Date Created 18 Mar 2014
Created By Historical Data
Date Modified 16 Dec 2014
Modified By Historical Data
Classification Category HIGH INFERRED (60 - 69)

Link	Model	Weighting	Recorded Score
	Density	1	76
	Geology	3	79
	Grade	3	41
	Revenue	3	64
	Volume	2	73
	FINAL SCORE		64

External Reviewer: General Comments

- No General Comments -





MRCS: Promoting a Classification

COMPANY

 De Beers Consolidated... 9

MINE/OPERATION

 Venetia Mine 20

RESOURCE

 K1 696 - 1044m 2

GROUP

 VEN 2015 2

CLASSIFICATION

 VEN_K2 600-800m Pre... PRE

Promote Classification

Classification: VEN_K2 600-800m Prelim - Copy

Classification	VEN_K2 600-800m Prelim - Copy
Status	Preliminary
Locked	False
Previous Years Mining	8
Date Created	7 Dec 2015
Created By	Sean Duggan
Date Modified	7 Dec 2015
Modified By	Sean Duggan

Please Note:

You have **85** Questions that are unanswered.

Promote

Cancel



MRCS comparative analysis

Companies De Beers Consolidated Mines x

Mines Cullinan Mine x Jagersfontein Mine x

Resources Select Resources...

Groups Select Groups...

Date Group Post 2014 ▾

Deposit Type Primary x

Geology Kimberlite x Aeolian Placer x Beach Placer x Dyke x Deep-Water Marine Placer x

Status Ratified ▾

Card Geology ▾

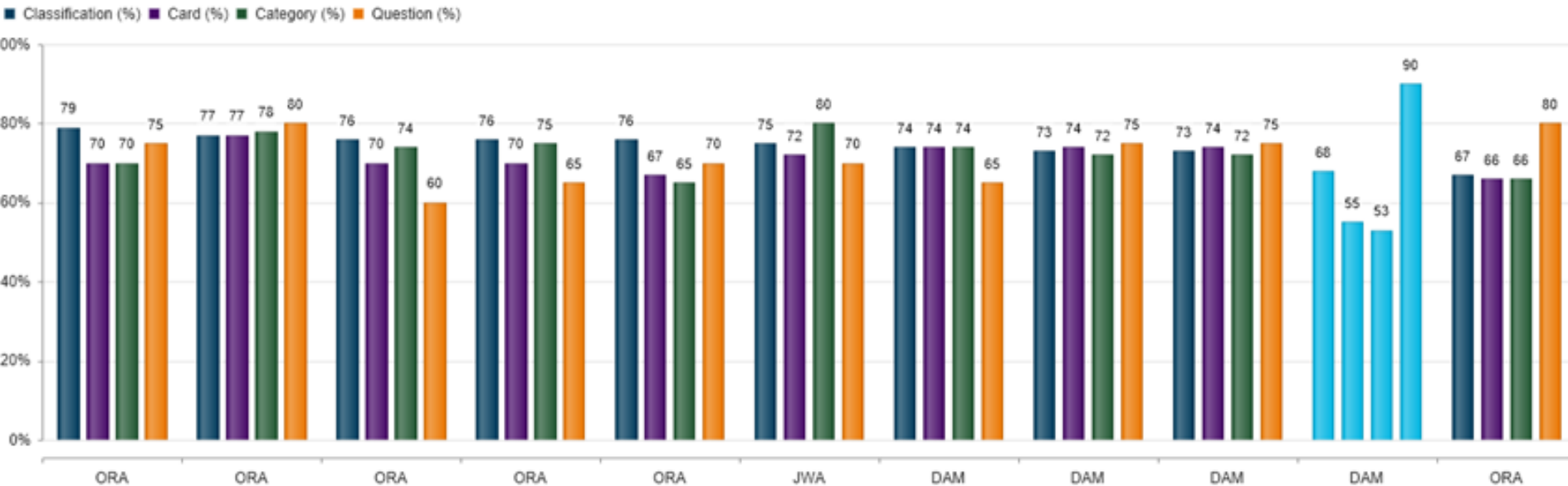
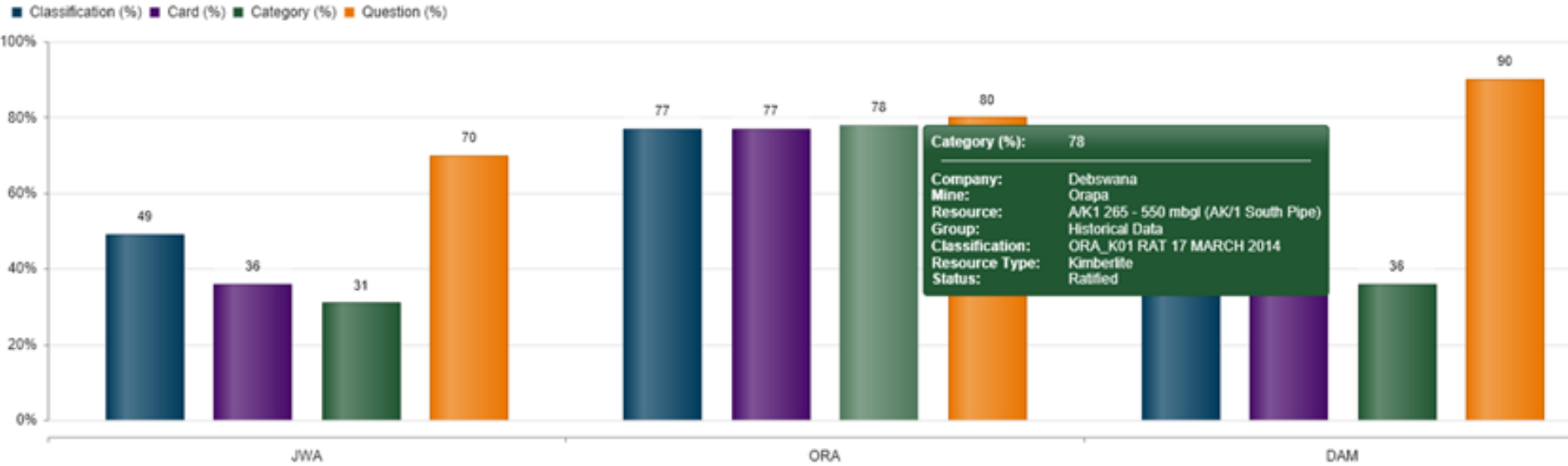
Category Knowledge Techniques ▾

Question Have applicable exploration techniques been utilised? ▾

Toggle	Company	Mine	Resource ▾	Group	Classification	Status	Classification (%)	Card (%)	Category (%)
<input checked="" type="checkbox"/>	Debswana	Jwaneng	DK2 754 - 454m amsl (N, C, S Lobes)	Historical Data	JWA_K02 RAT 11Feb2008	Ratified	64	43	52
<input checked="" type="checkbox"/>	Debswana	Jwaneng	DK2 4th Pipe 1170 - 958m amsl	Historical Data	JWA_K04 RAT 10March2008	Ratified	45	51	52
<input checked="" type="checkbox"/>	Debswana	Jwaneng	DK2 454 - 154m amsl (N, C, S Lobes)	Historical Data	JWA_K03 RAT 11Feb2008	Ratified	49	36	31
<input checked="" type="checkbox"/>	Debswana	Jwaneng	DK2 1170 - 754m amsl (N, C, S Lobes)	Historical Data	JWA_K01 RAT 11Feb2008	Ratified	75	72	80
<input checked="" type="checkbox"/>	Debswana	Orapa	AK20 0 - 260 mbgl	Historical Data	A_K20 Rat 24 June 2011	Ratified	59	55	50
<input checked="" type="checkbox"/>	Debswana	Orapa	AK1 265 - 685 mbgl	Historical Data	ORA_K03 RAT 11Feb2008	Ratified	56	42	39
<input checked="" type="checkbox"/>	Debswana	Orapa	AK1 265 - 685 mbgl	Historical Data	Orapa AK1 695 - 275 mamsl 2009	Ratified	57	43	40
<input checked="" type="checkbox"/>	Debswana	Orapa	AK1 265 - 685 mbgl	Historical Data	ORA_K01 RAT 24June2011	Ratified	63	41	40
<input checked="" type="checkbox"/>	Debswana	Orapa	AK1 0 - 265 mbgl	Historical Data	ORA_K01 RAT 11Feb2008	Ratified	75	70	74
<input checked="" type="checkbox"/>	Debswana	Orapa	AK1 0 - 265 mbgl	Historical Data	Orapa AK1 960 - 695mamsl	Ratified	76	70	75



MRCS comparative analysis





MRCS reporting

SUMMARY

Operation: Orapa
Resource: A/K1 265 - 550 mbgl (AK/1 South Pipe)
Group: Historical Data
Classification: ORA_K01 RAT 17 MARCH 2014
Status: Ratified
Report Date: 11 May 2016

Model	Recorded Score	Weighting	Weighted Score
Density	80	1	80
Geology	80	3	240
Grade	77	3	231
Revenue	74	3	222
Volume	78	2	156
Total	78		77

Mineral Resource Classification
Category:

LOW INDICATED

Signed: _____

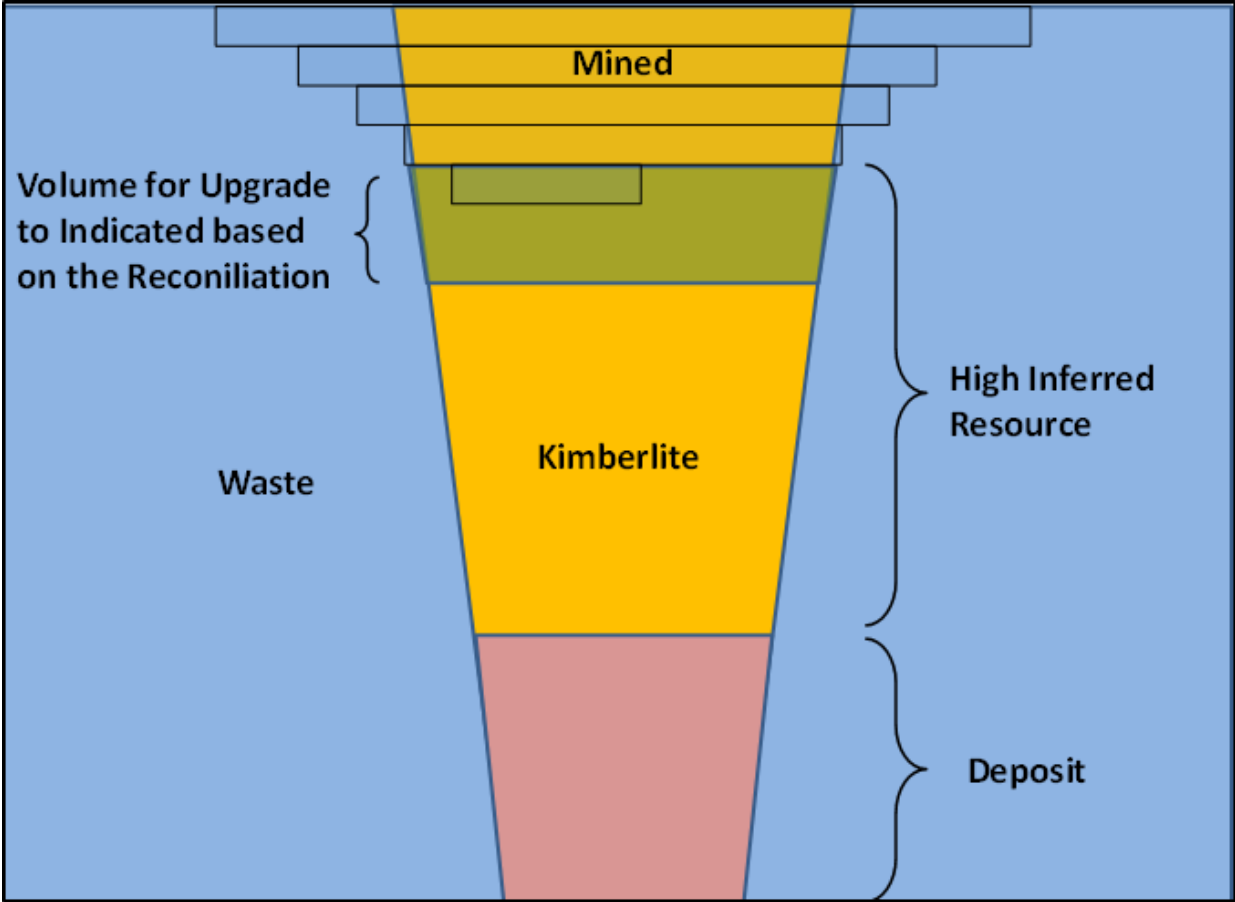
Date: _____



MRCS Performance

- Aims to review recent mining history on a specific operation, reconcile the mining results and re-assess the level of uncertainty associated with the mineral resource
- Applied to limited volume adjacent to the recent mining
- Ideally, undertaken every one or two years
- Change in geology: face mapping, blast-hole chip sampling, field observations, etc.
- RsCR, RvCR, Rv\$R

MRCs: Performance





MRCS as a predictive tool

- Complete the classification by including assumptions about geology, sampling, estimation, etc.
- For example use MRCS to establish how best to achieve an Indicated level of confidence
- Planning capital projects on an annual basis or longer term



Conclusions

- MRCS is a user-friendly and flexible system and ensures that a robust record of the classification is correctly stored
- The De Beers classification method satisfies the key components of reporting codes
 - transparency, materiality, competence
- The scorecard approach has been applied to successfully produce numerous classifications
- MRCS provides De Beers with a best practice documented and justifiable classification for all types of diamond deposits

DE BEERS
GROUP OF COMPANIES



Thank You

Our diligence is your peace of mind