



Quantitative Group  
Our Skills On *Your* Team

## CV STEPHEN COWARD

Last updated February 2009

Quantitative Group (QG) provide geostatistical, geological and resource estimation consulting services to the mining and resource sectors. QG are specialists in mining geostatistics with a strong focus on geological context and mine geology/engineering applications. QG also has additional strengths in enabling the links to be made through the value chain (sampling, geological modelling, resource estimation, mining geology, reconciliation, geometallurgy, financial risk).

### PERSONAL DETAILS

Name: Stephen John Coward  
Date of birth: 22 September 1967  
Citizenship: RSA/UK (Dual)

### CAREER SUMMARY

Stephen Coward has a background in metallurgical processing and operations management. He started his career on the diamond fields of the west coast of Southern Africa in 1986 and joined QG as principal consultant in charge of Geometallurgy in 2008.

He spent several years in production positions at several of De Beers' operations including alluvial, open pit and underground operations scattered throughout southern Africa. This experience served to identify the ubiquitous need for improved understanding of the interaction between variable and uncertain resources and the recovery efficiency of process plant (which is also variable and uncertain).

During this period he initiated several projects that led to increased use of deposit evaluation information in the optimal design and operation of mines.

At the same time he initiated research into the ways in which information generated during deposit evaluation could be improved, and to explore how it could be used for developing short term optimisation and long term processing plant configuration strategy.

This initial work led to him forming the Metred arm of the evaluation department. He was a vibrant member of the diamond value management team and was instrumental in developing a baseline measurement system for monitoring and optimising operational effectiveness that was introduced across all of De Beers' operations.

His understanding of the value drivers in group operations meant that he was well placed to contribute to the process of writing up the mining assets of De Beers for privatisation. This experience has been used subsequently in the assessment of several diamond projects and reserve valuations.

His more recent role in the UK, heading up Group Metallurgical Research has been focussed on development of tools and techniques to gather Geometallurgical data and to develop integrative practices so that the information can be used in mine planning and operational optimisation and strategy formulation.

His ongoing research interest line in the overcoming the challenges facing mineral projects that arise from the uncertainty in the rock properties that have a material impact on mineral projects value. The areas of research include destructive and non destructive property sampling, process assessment and measurement, geostatistical estimation of rock properties and system development to integrate the improved ore body understanding with operational and project value optimisation.

### QUALIFICATIONS

**MBA** - University of Witwatersrand, Johannesburg, Gauteng, South Africa,  
Awarded with Distinction 2001

**B.Comm** - University of South Africa, Pretoria, Gauteng, south Africa,  
Awarded 1995

**NHD (Ex Met)** - Technikon Witwatersrand, Johannesburg, Gauteng South Africa  
Awarded 1989



Stephen Coward  
Principal Consultant



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### PROFESSIONAL AFFILIATIONS

SAIMM - South African Institute of Mining and Metallurgy  
CIMM - Canadian Institute of Mining Metallurgy & Petroleum  
SME - The Society for Mining, Metallurgy and Exploration

### WORK HISTORY

2008 - Present

#### Principal Consultant - Quantitative Group Perth WA

Stephen has a considerable background in mineral processing. This experience combined with mathematical, sampling and estimation skills places him in a unique position to be able to evaluate opportunities that can be exploited in:

>> Sample layout and testing for ore characterisation

>> Spatial estimation of characteristics

>> Depletion modelling

>> Treatment modelling

>> Integration of treatment models with mine plan and treatment planning

>> Optimisation of the mineral resource cycle.

#### The range of Expertise provided Includes:

>> Ore sampling and characterisation programme design

>> Modelling and scale up of point and core data for spatial estimate generation

>> Block modelling and integration of ore characterisation with geological models

>> Depletion and treatment simulation

>> Financial impact assessment of geometallurgical model and associated uncertainty

>> Identification of best business opportunity in mineral projects

>> Reserve evaluation

>> Recovery factor reconciliation, system design and support

>> Technical training and on site system support



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### 2003-2008 Group Metallurgist Research

This position provided an opportunity to focus on the sampling, estimation, and analytical techniques required to quantify the impact that mineral processing has on resource constitution and reserve valuation. The aim was to reduce the total time, cost and risk of converting discoveries into operating mines.

#### *Achievements:*

The research programme developed a number of sampling, estimation and uncertainty modelling techniques, including geological uncertainty quantification, integrated rock property sampling and estimation of the metallurgical recovery factors.

These techniques are in the process of being incorporated into a framework of integrated resource evaluation, the benefits of this approach have included:

- >> Improved understanding of the range and variability of expected cash flows from projects, quantification of the impacts of uncertainty on the project value,
- >> Generation of strategies to optimise the expected value of projects given an improved forecast of the variability in tonnage, grade and recovery.
- >> Improved composition of the resource project portfolio, achieved by selectively sequencing and grouping of a range of projects to achieve a desired level of capital expenditure and product delivery variability.

### 2003-2008, De Beers Group of Companies Johannesburg, RSA Project Metallurgist - Minred

This role as head of a small team of reserve analysts was focused on provision of input into the resource estimation and reserve evaluation process, and to provide operations with data analysis capability to improve operational efficiencies. This also included the initiation of a number of projects required to develop the tools and techniques to support this function

#### *Achievements:*

- >> Utilised competencies to develop and support a strategic programme of process optimisation. Was instrumental in developing and deploying a baseline measure for Metallurgical performance across all of De Beers' operations, which was part of a programme that improved recovered dollar per ton in excess of 10%
- >> Collaborative development with the team of a number of process simulation tools, including diamond wizard, extension to the granulometry model for use in bulk sample plant monitoring, recovery factor estimation, and plant design optimisation.
- >> Development and management of a co- assurance assessment system for bulk sampling of diamond deposits that substantially improved the data quality for estimation purposes
- >> Development and deployment of a low cost web based diamond size frequency analysis package for marginal operations
- >> Was a major contributor in writing the Technical and Financial Report (TFR) circular for shareholders during the privatisation of De Beers, which unlocked substantial value for both Anglo American and the De Beers family of companies
- >> Played a major role in the justification and establishment of the MRM R&D Group which has led to a number of material improvements in the cost and time taken to evaluate Kimberlite deposits, and to take selected projects through pre-feasibility



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1998 – 1999, Anglo American Corporation of South Africa  
Ltd. Johannesburg, RSA

### Project Metallurgist - Minred

This role was established to create a link between the mineral processing and resource estimation work streams in the Diamond services division of Anglo American. He was responsible for developing the necessary capability to generate and use sample data for resource estimation and to use resource estimates for process design optimisation.

#### Achievements:

>> Established Metred arm of Minred.

>> Responsible for developing and managing information flows and facilitating liaison between mineral resource evaluation and metallurgical disciplines across group operations

>> Technical metallurgical input into evaluation projects, including the use of granulometry for process design optimisation

>> Development and design of process sampling campaigns for resource reconciliation

>> Training and development of diamond size frequency analysis skills across group operations

>> Collaborative development and deployment of Granulometry monitoring systems across several of the group operations

1997 - 1999, Namaqualand Mines Kleinzee, RSA

### Assistant Plant Superintendent - Red Area

The red area receives concentrate from several plants located on the west coast. It uses a range of technologies from pneumo-drying, magnetic separation and x-ray recovery to separate diamonds from gangue in a rich particulate concentrate. This position lead a team of 40 people and was responsible for the production output of the plant and design and development of process improvements.

#### Achievements:

>> Optimisation and management of final recovery processes which resulted in improved recovery efficiency from high 80s to low 90's.

>> Assessed sample treatment logistics and reduced sample result turn around time from in excess of 3 weeks to below three days.

>> Providing Management and direction of the metallurgical research and development portfolio, Initiated and several new projects including an upgrade of the bulk sample plant to extend the mines resources base substantially.

>> Development and implementation of new process control and optimisation system that resulted in a substantial availability improvement and reduced maintenance cost.

>> Development and implementation of Diamond size frequency monitoring system that added substantially to improved recovery efficiencies, through damage reduction and feedback to mining operations.



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1995 – 1997, De Beers – Premier Mine Cullinan, RSA  
**Plant Metallurgist, SPM , Mineral Processing Engineer**

Managerial and industrial relations experience through periods of front line supervision and management of operations. This included being accountable for the bulk sample facility, red area production and a number of research projects. This included production management, and research project development – from concept to execution. Design execution and analysis of bulk sampling programmes for both process control and ore reserve reconciliation.

*Achievements:*

>> Included adaptation of the plant to generate aggregate for underground works, at a substantial cost saving, and to accommodate revolutionary milling test work.

>> Responsible for design and implementation of innovative technologies in recovery processes, including thermo chemical dissolution and mechanised hands free feed preparation. This resulted in the mine being able to effectively recover -3+1mm stones in a process that had a payback period of less than eight weeks.

1986 - 1987, Consolidated Diamond Mines Limited  
Oranjemund, Namibia  
**Metallurgical operator**

Responsible for various process plant operations, output and availability. Extensive shift work and trouble shooting on operations.

*Achievements:*

>> Involved in the commissioning of No 4 Plant, which led to a substantial increase in the production from the West coast following a recession in the early 1980's

>> Training and experience in operating unit processes across several of the operations processing plants to develop a first hand understanding of the dynamics of plant operations.

### PUBLICATIONS

Nicholas, G., **S. Coward**, et al. (2007). *Decision making using an integrated evaluation model versus sensitivity analysis and monte carlo simulation*. CIM Conference, Montreal, Canadian Institute of Mining Metallurgy and Petroleum.

Nicholas, G. D., **S. Coward**, et al. (2006). *Integrated mine evaluation - implications for mine management*. Mine Managers Conference, Melbourne, AUSIMM.

**Coward, S.** and J. Ferreira (2005). *Development and conceptual evaluation of a methodology for sampling for diamonds in broken ore*. EMMES Conference, Johannesburg, South African Institute of Mining and Metallurgy.