THE QUANTIFICATION OF GRADE UNCERTAINTY, AND ASSOCIATED RISK, AND THEIR INFLUENCE ON PIT OPTIMISATION FOR THE SADIOLA DEEP SULPHIDE PREFEASIBILITY PROJECT

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‘A research project submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master of Science in Engineering.’

Sadiola, Mali, 2006

DECLARATION

I declare that this research report is my own, unaided work. It is being submitted in partial fulfillment of the requirements for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

(Signature of candidate)

31st day of October (year) 2006

ABSTRACT

In order to quantify the uncertainty in the grade estimate for the Sadiola Deep Sulphide Prefeasibility Project a conditional simulation model was generated using Direct Block Simulation methodology. Compared to conventional Sequential Gaussian Simulation, the Direct Block Simulation algorithm produced a reliable model in significantly less time, lending its application to a production environment.

Through application of a mining transfer function, risk pits were generated for comparison with the Deep Sulphide Prefeasibility pit. The results of this study revealed that the prefeasibility pit is optimal at the applied gold price and cost parameters, and that the risk of not achieving the project grade profile is low. Should the gold price increase, or the operating costs of the project decrease significantly, the Deep Sulphide reserve tonnage would realise significant upside potential.

The potential for using the simulation model coefficient of variation to improve the classification of the resource has been highlighted. This exercise could allow significant saving of feasibility drilling capital.

For my Wife

Theola Robins

ACKNOWLEDGEMENTS

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LIST OF SYMBOLS

Billion Years	Ga
Degrees	°
East	E
Grams per Tonne	g/t
Kilometre	km
Metre	m
Million Ounces	Moz
Million Tonnes	Mt
Minutes	‘
North	N
Ounces	oz
Percent	%
South	S
Thousand Ounces	koz
Tonnes	t
West	W
United Sates of America Dollars	US$

NOMENCLATURE

Coefficient of Variation	COV
Diamond drill core of 53mm diameter	NQ
Direct Block Simulation	DBSIM
Equal Weighted	EW
Life of Mine	LOM
Reverse Circulation Drilling	RC
Sequential Gaussian Simulation	SGS
Smallest Mining Unit	SMU
Standard Deviation	Std Dev

1 INTRODUCTION

Sadiola Hill Gold Mine is located at latitude 13°56'N, longitude 11°40'W, and altitude 125m above mean sea level, which places it approximately 500km north west of Bamako, the capital of Mali in West Africa (Figure 1.1).

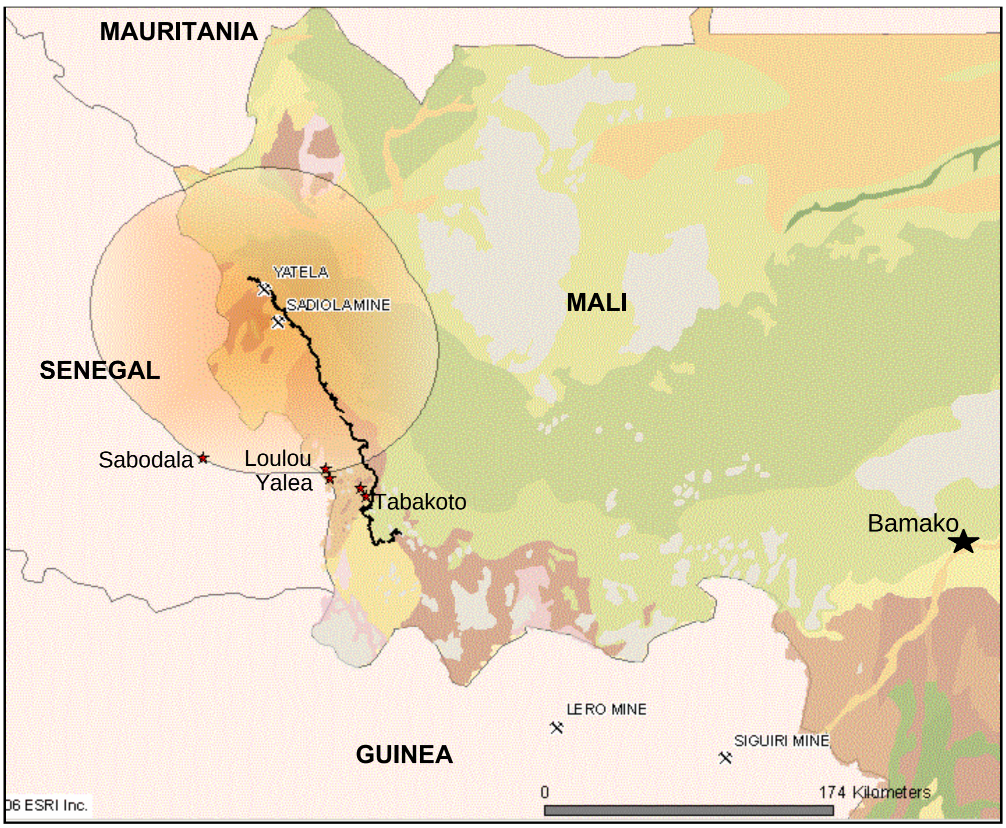

Figure 1.1: Locality map for Sadiola Mine – Mali, West Africa

The Sadiola Hill Gold Mine is mined by the Societe d'Exploration des Mines d'Or de Sadiola S.A. (SEMOS S.A.), which comprises a joint venture partnership between AngloGold Ashanti (38%), IAMGOLD (38%), the Malian Government (18%), and the IFC (6%).

Construction of the Sadiola plant began in March 1995 and was completed in June 1997. Gold production began in mid 1997 from the saprolite oxide ore body and more recently from saprolite sulphide ore as mining has progressed through the weathered profile towards the hard / soft boundary. The Sadiola ore body extends substantially below the weathered horizons into the underlying hard sulphide lithologies. However, the current Life of Mine plan (LOM) does not exploit this material because the plant is unable to treat more than 10% hard material. SEMOS S.A. has therefore commenced with a pre-feasibility study, called the 'Deep Sulphide Project' aimed at assessing the viability of upgrading the current treatment plant to facilitate the treatment of hard sulphide ore. Quantifying the grade uncertainty, related to achieving the grade profile from the design pit, would allow the project team to make a better informed decision about proceeding to the next phase of the project.

1.1 General Geology

The Sadiola Deposit is located within the Malian portion of the Kenieba-Kedougou window, a major Early Proterozoic – Birimian outlier along the NE margin of the Kenema – Man shield (Figure 1.2).

The Birimian of the window can be interpreted as a collage of at least two N-S trending terrains of different nature. To the West an older (+/- 2.2 Ga) tholeitic mafic volcanic unit with island arc type volcanics and intruded by a major calc-alkaline batholith, belongs to the Saboussire Formation. It is separated from the dominantly sedimentary sequence of the Kofi Formation by a major north to northeast trending shear zone. This sedimentary domain is significantly younger and itself intruded by calc-alkaline batholiths dated at 2.0 – 2.05 Ga. Metamorphic grade attains greenschist facies, with formation of metamorphic biotite and locally amphibolite grade near major intrusions. The Kofi Formation is obliquely cut by the approximately N-S to N10º trending Senegalo-Malian shear zone (SM) which is punctuated by several gold deposits along its splays (Loulo, Yalea, Sadiola, Yatela), (Robins, Nicholls, and De Hert, 2005).

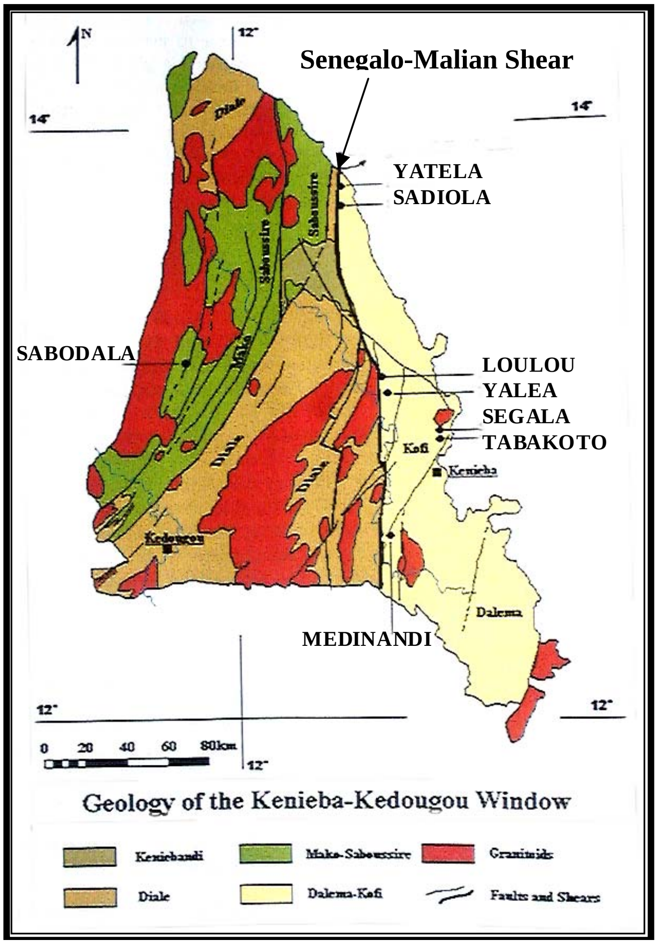

Figure 1.2: Geology of the Kenieba - Kedougou window

The Sadiola Deposit is located in the north of the window and is hosted by sediments of the Kofi Formation, which have been intruded by numerous felsic intrusives. The sediments dominantly consist of fine-grained greywacke and impure carbonates with minor tuffs and acid volcanics. At Sadiola the intensely folded impure carbonate packages comprise an alternation of limestone beds, a few millimetres to several decimetres thick, with thinner more detritic beds.

The Sadiola deposit occurs along the N10º striking Sadiola Fracture Zone (SFZ), which is thought to be a brittle-ductile splay off the SM Shear at a sinistral releasing bend. The SFZ follows the steeply westerly dipping contact between greywacke to the west and impure carbonate to the east. Along the SFZ both the greywacke and impure carbonate are transposed. The SFZ and its wall-rock are injected by discontinuous diorite dikes. Silicified quartz-feldspar-porphyry (QFP) dikes often intrude along later steep west dipping, N20º striking structures. The QFP's crosscut the diorites and may show brittle fracturing. Post mineralisation deformation has complicated structural relationships in the deposit.

Gold mineralisation at Sadiola occurs along the SFZ over a drilled strike length of approximately 2500m and remains open to the north and south. N20º trending fault splays off the SFZ are also well mineralised. The mine geological and grade block model indicates the presence of 20º to 25º south dipping ore shoots within the plane of the SFZ. Mineralisation occurs in all of the four major rock types (marble, greywacke, diorite, and quartz-feldspar porphyry) and is spatially associated with a complex alteration pattern. Drilling of the (unweathered) primary mineralisation has allowed detailed investigation of major and minor hydrothermal alteration processes that were active during the formation of the deposit. Alteration assemblages identified to date include: calc- silicate, potassic, chlorite – calcite, carbonate and silicification and have allowed the deposit to be classified as a Mesothermal-Shear Hosted deposit. Gold is associated with both arsenic and antimony dominated sulphide assemblages including arsenopyrite, pyrrhotite, pyrite, stibnite and gudmuntite (Robins, Nicholls, and De Hert, 2005).

Deposits of this type world-wide exhibit good continuity of mineralisation both along strike and extend to great depth and structurally controlled, high grade 'pay shoots' typically occur within a more pervasive lower grade halo. At Sadiola, the location and geometry of high grade mineralisation appears to be controlled by the confluence of the SFZ with the N20º splays resulting in steeply to vertically plunging zones within the plan of the SFZ.

The geometry of the extensive soft 'saprolitic' oxide deposit at Sadiola relates almost exclusively to the supergene weathering history of the primary mineralisation. The permeability of the rock formation, controlled mainly by faulting, shearing and porosity, allows the deep penetration of ground water causing oxidation of primary sulphides. Oxidation of pyrite (and other sulphide species) results in the formation of sulphuric acid further promoting the downward argillisation of the bedrock to form the clay rich assemblages present in the saprolite. The irregular, ‘karst like’ soft rock – hard rock contacts can be related to the extent of faulting and the original sulphide content of the overlying profile.

The role that supergene weathering processes have contributed to the current disposition of the Sadiola deposit cannot be underestimated. A reduction in density and relative gold enrichment caused by the iso-volumetric weathering of the primary mineralisation at Sadiola has been the principal mechanism for producing the deeply weathered saprolite deposit currently being mined. The deposit has been subjected to intense weathering in a tropical climate resulting in a series of decarbonated-argillised troughs of variable depth (up to 180m depth) along the Sadiola Fracture zone. This is the rich oxide ore body, currently being mined (Figure 1.3).

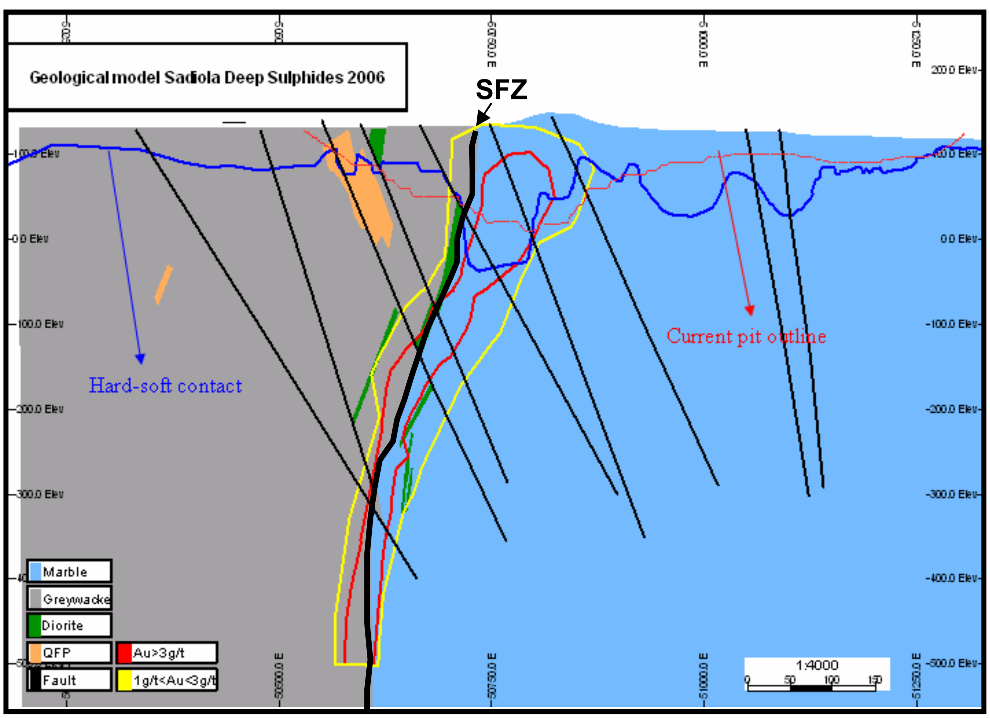

Figure 1.3: Section 5600N through Sadiola ore body.
Mineralisation sits along the greywacke-marble contact (Sadiola Fracture zone). N20º faults are indicated in black. Section compiled by Dr A. Smeesters, 2006.

2 FORMULATION OF THE PROBLEM

During 2005 Sadiola treated approximately 5.3Mt of ore at 2.83g/t accounting for a gold production of 483koz (van der Westhuizen, 2005). This material comprised almost entirely saprolite and laterite material, which the Sadiola plant with its mineral sizer, ball mill (1) and sag mills (2), and carbon in pulp (CIP) circuit is currently able to treat effectively. The current remaining Sadiola Main Pit Reserve is 21Mt at 3.35g/t accounting for 2.3Moz. This reserve is based on the optimal extraction of the saprolite and laterite ore component (at a cut-off grade of 1.42g/t) and includes a component of hard sulphide material within the LOM design pit (at 2.45g/t cut-off grade). Should Sadiola continue with its current LOM plan, mining would cease at the end of 2009, while the plant would continue to treat stockpiled material until 2015.

The oxide portion of the Sadiola Main Pit Mineral Resource at the end of 2005 was 36.4Mt at 2.08g/t accounting for 2.4Moz (at 0.70g/t cut-off grade), while the hard sulphide resource was 48.5Mt at 2.25g/t accounting for 3.5Moz (at 0.70g/t cut-off grade). The hard sulphide component of the Sadiola Mineral Resource therefore provides large upside potential for the mine. Should Sadiola be able to treat hard sulphide material, mining would continue to the end of 2015 and the LOM extended to 2024.

SEMOS S.A. is therefore completing the Deep Sulphide Prefeasibility Project to optimise the exploitation of the hard sulphide component of its Mineral Resource. The Sadiola Mineral Resource Model that was used for the Prefeasibility Study essentially comprised a grade estimate, into 30m x 30m x 10m blocks, using Ordinary Kriging, followed by a change of support calculation, using uniform conditioning, to an SMU support size of 10m x 10m x 5m. The sample information on which this model was built comprised predominantly NQ (53mm diameter) half diamond core with $4^1/_2$ inch RC pre-collars through the soft material. The final model comprised 13 independent estimation domains to honour the stationarity requirements for kriging. Refer to the 2005 year end Sadiola Mineral Resource

Statement (Robins, Nicholls, and De Hert, 2005) for detailed information on the Sadiola recoverable resource model.

The Prefeasibility project has focused on the pit expansion potential of the deposit and on the options available to upgrade the current gold treatment plant to process the hard sulphide material. As of June 2006 cost estimates indicated that a capital outlay of approximately US$145 million would be required to upgrade the treatment plant to efficiently process hard sulphide material.

Given the large capital outlay required to commence with the Deep Sulphide project, the quantification of the technical risk for exploiting the Sadiola hard sulphide resource would greatly assist the project team in their decision to proceed with the Feasibility stage of the project. Furthermore the quantification of grade uncertainty would provide focus areas that require additional drilling before a reliable Feasibility study grade modelcould be obtained.

According to Dimitrakopoulos, Farrelly, and Godoy (2002), a critical source of technical risk to a mining project is uncertainty in the expected ore grade and tonnage. Deutsch (2004), states that uncertainty exists because of incomplete data and although it cannot be avoided it can be reduced and managed by consideration of all relevant data. A method was therefore sought to measure the uncertainty in the estimated grade of the Deep Sulphide project. Unfortunately the methods that were used to provide the grade estimate only produced in a single value per mining block from which it is impossible to quantify uncertainty.

Conditional simulation, a Monte Carlo-type simulation approach, generates multiple, equally probable, realisations that provide a model of the spatial uncertainty of the grade in the insitu ore body (Dimitrakopoulos, Farelly, and Godoy, 2002). The resultant realisations are not only conditioned to the available sample data, and therefore all reasonably match the same sample statistics, but also reasonably duplicate the histogram and semi-variogram model of the sample data (Goovaerts, 1997). Spatial features are deemed “certain” if they are present in most of the simulated maps and “uncertain” if seen on a few simulated maps. According to Goovaerts (1997) – generating alternative realisations of the spatial distribution of an attribute is rarely the goal. Rather these alternative realisations serve as the input to other transfer functions, which in the open pit mining environment would comprise a mining process such as a pit optimisation algorithm.

Initial attempts at obtaining a conditional simulation model were made using the Sequential Gaussian Simulation algorithm (SGS), as proposed by Deutsch and Journel (1998). The method involves setting up simulation nodes on a regular grid, visiting each node on a random path, and simulating the grade at the node location using the conditioning data - comprising the original data and previously simulated values. The Sadiola block model is large - 1380m x 3360m x 970m (X, Y, Z) and since subsequent processes required a simulation model to SMU support (10m x 10m x 5m) the simulation grid required at least 16 nodes on 2.5m x 5m x 2.5m centres. The total number of nodes required for the simulation was thus 143.926 million and each node was simulated at least 50 times. This process proved extremely onerous regarding computational memory, and time, and was abandoned as being too impractical to implement on a mining operation.

Goovaerts (1997) suggests that when generating several realisations using sequential simulation, the computational time can be reduced considerably by keeping the same random path for all realisations. The trade-off however is the risk of generating simulations that are too similar. This approach would have defeated the final objective of achieving variable grade estimates between simulations for input into a pit optimisation transfer function. The use of a different random path for each realisation was therefore maintained.

Dimitrakopoulos, Farelly, and Godoy (2002), proposed the direct block simulation (DBSIM) method as a viable alternative to conventional SGS that considerably reduces computational time. DBSIM simulates the internal points of each block and when the simulated block is calculated the point values are discarded. The simulated block value is then added to the conditioning dataset. To integrate the block support conditioning data the algorithm has been developed in terms of a joint simulation, where the second variable relates to the block values sequentially derived through the simulation process. The algorithm simulates several hundreds of blocks per second and is considerably faster than any point conditional simulation combined with reblocking. Furthermore Dimitrakopoulos, Farelly, and Godoy (2002), show that in addition being substantially faster and more efficient in terms of computing requirements, the DBSIM method is reliable in terms of reproduction of the sample statistics.

3 CREATION OF THE SIMULATION MODEL

The DBSIM programme, which was used to create the simulation model for input into the pit optimisation transfer functions, was supplied by Mr. V.A. Chamberlain (Manager: Mineral Resources and Mine Geology, Anglo Gold Ashanti), with the permission of R. Dimitrakopoulos, the algorithm owner. The DBSIM programme was called from a Datamine Macro which simulated multiple geological domains in a loop and then compiled the simulated domains into a single block model file (Peattie, 2005). Validation of the simulations was performed by a second group of macros. The programme, as supplied, was written for a specific mine and was therefore not generic. Many of the parameters had been hard coded and it was necessary to edit the Datamine macros in order to achieve the resultant Simulation Model.

Rather than going into details of the procedures followed during the application of the DBSIM programmes, a copy of the revised user manual (Peattie 2005) has been attached for reference in Appendix A. The manual was revised as problems were encountered and solutions provided.

3.1 Simulation Methodology

Although the Deep Sulphide project has focused specifically on the hard sulphide component of the Sadiola Resource a significant amount of mineralised saprolite material occurs between the hard / soft boundary and the current LOM pit design. Since this material would contribute towards the economics of the project it was necessary to account for it in the Simulation Model.

The laterite material however only occurs close to the original ground surface and would have limited influence on the project economics since most of the ore within this zone has already been mined. To speed up the simulation process, it was therefore decided to exclude the laterite estimation domains from the study and honour all other estimation domains used in the Sadiola Recoverable Resource Model. Furthermore the same densities as per the Recoverable Resource Block Model were retained in the Simulation Model (Table 3.1).

ROCKTYPE Code	Description	Density (g/cm^3)
1	Laterite and Clay	1.97 (Average)
2	Saprolite	1.80 (Average)
3	Silicified Oxide	2.57 (Average)
4	Saprolite Sulphide	2.00 (Average)
5	Hard Sulphide	1.55 to 3.03 (Kriged)
6	Blast Oxide	2.10 (Average)
7	Blast Sulphide	2.10 (Average)

Table 3.1: Table of Rock Types and their associated densities

To facilitate manipulation of the simulation model as the process unfolded the estimation domains (KZONE in the recoverable Resource Model) were renamed ZONECODE in the Simulation Model (Table 3.2). The determination of the various estimation domains in the Recoverable Resource Model are based on trend analyses and sample statistics. This process is outlined in Robins, Nicholls, and De Hert, (2005).

KZONE	ZONECODE	Description	Project
1	1000	Far North Saprolite Ore	Main Pit - Oxide
2	2000	Saprolite Waste	Main Pit - Oxide
3	3000	North Saprolite Ore	Main Pit - Oxide
4	4000	South Saprolite Ore	Main Pit - Oxide
12	5000	Main Ore – High Grade	Deep (Hard) Sulphide
13	6000	Main Ore – Low Grade	Deep (Hard) Sulphide
14	7000	Footwall / Hangingwall Ore	Deep (Hard) Sulphide
15	8000	North Hard Ore	Deep (Hard) Sulphide
16	9000	Waste	Deep (Hard) Sulphide

Table 3.2: Table of estimation domains and their description

Conditional Simulation theory relates the conditioning data to the simulated nodes through the Conditional Cumulative Distribution Function (CCDF). As such the simulation process occurs in normal (Gaussian) space and it is necessary to perform a Gaussian transformation of the conditioning data and calculate the input variograms in normal space. Collectively the realisations should honour the statistical behaviour of the conditioning data (e.g. the mean and variance) and exhibit the same dispersion characteristics as the conditioning data. Furthermore the three dimensional spatial characteristics (semi-variogram model) of the orebody should be honoured.

Deutsch (2004) states that due to the nature of sampling ore bodies - where the objective is to define zones of economic value - higher grade material is generally sampled more than low grade zones. Since in conditional simulation the histograms and summary statistics of the conditioning data are an essential foundation for the accuracy of the resultant model they need to be representative of the volume of interest. Therefore in order to remove the influence of spatially clustered samples on the histograms and summary statistics the data for each domain should be declustered, whereby each datum is assigned a weight based on its closeness to surrounding data.

The basic steps followed during the creation of the Simulation Model are based on those proposed by Deutsch (2004) for Sequential Gaussian Simulation and are discussed under the following sub-headings.

3.1.1 Sample Data

Almost all the Deep Sulphide sample data comprised NQ diamond core at 1m sample intervals. However, since a significant amount of saprolite material – which was drilled with 125mm RC method and at 2m sample intervals - would be included in the Deep Sulphide project, all conditioning (sample) data was composited to 2m sample intervals.

A sample input file was supplied with the conditioning data zoned according to the estimation domains (ZONECODE), outlined in Table 3.2. The input data comprised raw grade information that was converted to normal space by the DBSIM programme during the simulation runs. During this process DBSIM declustered the data, and output “equal weighted” statistics for the conditioning data, simulated nodes, and blocks.

As a check, the necessity for declustering the data was tested using Isatis’ Declustering routine. During this process a series of “data windows” of various dimensions were applied to the sample data of each domain with the goal of achieving the krig mean value for that domain.

The results of the declustering exercise indicated that there was no significant spatial clustering present in the data and therefore declustering was unnecessary. This was likely a result of domaining the data and therefore achieving a relatively regular sample grid per domain.

3.1.2 Normal Score Semi-Variogram Models

Double structured, Normal Score spherical semi-variogram models were calculated per ZONECODE. As expected these differed slightly from the corresponding raw data models (also double structure spherical models), which were orientated within the dip plane (65°W) and plunge (10°S) of the deposit (Table 3.3).

ZONE CODE	C0	C1	C2	Range 1			Range 2			Search Range			Azimuth / Plunge / Dip
				X	Y	Z	X	Y	Z	X	Y	Z	
1000	2.16	2.16	3.15	12	12	10	25	35	30	40	60	28	030/00/00
2000	0.40	0.61	0.95	7	14	7	20	80	40	20	80	20	030//00/00
3000	2.49	13.74	10.32	5	9	13	18	45	30	35	75	40	010/00/00
4000	7.31	14.62	10.25	5	16	7	32	80	27	35	85	30	180/10/00
5000	10.32	11.96	9.78	6	6	6	47	60	35	35	60	40	180/10/25
6000	2.01	2.32	1.90	6	6	6	42	75	17	50	110	60	180/10/25
7000	2.17	2.57	0.97	7	7	7	30	70	30	35	90	60	030/00/00
8000	5.32	5.32	7.78	12	12	10	25	30	15	40	70	40	010/00/00
9000	0.32	0.23	0.29	8	8	8	60	60	60	50	50	30	000/00/00

Table 3.3: Raw grade semi-variogram models by ZONECODE

The normal score variogram models did not exhibit the same anisotropy as the raw variogram models. This was particularly true for ZONECODE 4000 to 6000, where the normal score experimental data provided no particular anisotropy in the plunge and dip of the ore body (Table 3.4).

The anisotropy in DBSIM follows GSLIB format (Deutsch and Journel, 1998), where for the first structure, A1 (Y) is the principle direction, A2 (X) the secondary direction and A3 (Z) the tertiary direction. Similarly for the second structure A4 is the principle direction and A6 the tertiary. As expected, and by definition for normal score variogram models, all zones had a variance of approximately one.

ZONE CODE	C0	C1	C2	Range 1			Range 2			Search Range			Azimuth / Dip
				X A2	Y A1	Z A3	X A5	Y A4	Z A6	X	Y	Z	
1000	0.190	0.510	0.300	14	35	15	50	130	30	30	30	20	030/00
2000	0.258	0.450	0.284	42	30	28	170	270	55	30	30	10	170/00
3000	0.200	0.400	0.398	10	10	12	40	50	30	25	40	15	030/00
4000	0.150	0.370	0.478	9	9	9	65	65	45	33	45	16	000/00
5000	0.300	0.370	0.328	11	11	11	35	35	23	65	65	30	000/00
6000	0.380	0.370	0.248	11	11	10	43	43	30	65	65	35	000/00
7000	0.350	0.270	0.479	9	9	8	33	33	25	120	120	60	000/00
8000	0.200	0.400	0.399	8	8	8	26	26	18	120	120	60	000/00
9000	0.231	0.301	0.467	13	13	13	132	132	105	60	60	30	000/00

Table 3.4: Normal Score semi-variogram models by ZONECODE

3.1.3 Simulation Parameters

The DBSIM programme requires an input parameter file that is similar to the GSLIB parameter file detailed in Deutsch and Journel, (1998). Table 3.5 presents the main parameters that are required by the DBSIM programme and each parameter is briefly discussed. For more detail refer to Appendix A.

- Line 1 sets up the data definition fields (columns) for the input file.
- Line 2 sets up the minimum and maximum data trimming limits below and above which data is ignored.
- Lines 3 and 4 define the interpolation parameters for the lower and upper tails of the distribution and are used for back-transformation of the data.
- Line 5 specifies whether or not to output the simulations at point support. The first 10 simulations were output at point support to validate the sample statistics and variograms models. Thereafter the process was dramatically sped up by deselecting this option.
- Line 6 defines the random number seed that is used to ensure that all locations are visited in a random order. The simulations were run in 2 batches of 25. Therefore to ensure that no overlap occurred in the random number generator, 50 (25x2) was added to the initial random number seed prior to running the second simulation batch.

- Lines 7 to 9 define the number of support sizes, the block dimensions, and the number of nodes in each direction. The programme caters for various block support sizes. All blocks in the input model were sliced to the SMU support size for the Deep Sulphides. Therefore only one support size was used. The number of nodes in each direction was set to the discretisation that the search range optimisation was based on.
- Line 10 sets up the data definition fields (columns) for the output file.
- Lines 11 to 13 set up the number of samples required for the simulation, broken down into the number of previously simulated blocks and number of conditioning data.
- Lines 14 and 15 define the minimum number of octants containing conditioning data and the search radius parameters. DBSIM uses the semi-variogram range as a basis for defining the search ellipsoid and allows the user to define a multiplier factor to the principle direction.

Line	Start of Parameters	Description
1	1 2 3 4 0 5 6	x-coordinate, y-coordinate, z-coordinate, variable to be simulated, declustering weight, zone, lode
2	-1.0e21 1.0e21	Minimum and maximum data trimming limits
3	2 2.5	lower tail option, parameter
4	4 5.0	upper tail option, parameter
5	0	1 = output point grades, 0 = do not
6	567983	random number seed
7	1	number of block support sizes
8	10 10 5	block dimensions type 1: dx, dy, dz
9	5 5 4	block discretisation (number of nodes): ndx, ndy, ndz
10	1 2 3 4 5 6	xc, yc, zc, domain, support, lode
11	8 32	min,max samples for simulation (max=24 for saprolite & waste and 32 for hsulph)
12	8	max simulated blocks to use (6 for sap and 8 for hard sulphide)
13	16	max number of conditioning data per octant (12 for saprolite; 16 for hard sulphide)
14	2	minimum number of octants with conditioning data
15	2.30, 4.62, 1.86	search radius multiplier (2.30 for zones 5000 and 6000; 4.62 for zones 7000 and 8000; 1.86 for the rest)

Table 3.5: DBSIM Parameter File

Problems encountered

Attempts were made to use the DBSIM programme to simulate successive domains in a loop, as it had been set up to do, but problems were encountered when different search parameters were required for different domains. The method for defining the search ranges in Table 3.5 was inflexible and it was necessary to redo the simulations in groups of similar search range in order to optimize simulation time and still obtain sufficient simulated blocks per domain.

The "waste" zones (ZONECODE 2 and 9) with their proportionally larger volume took a long time to simulate - with ZONECODE 9 taking one week to simulate 25 realisations. This time could have been reduced by simulating this domain separately using a 5 x 5 x 2 discretisation and a smaller multiplying factor in the order of 0.5. Based on the study in Section 3.1.5 below however, it was decided that 25 realisations were sufficient to determine the uncertainty for this domain and no further work was performed.

3.1.4 Initial Validations on Point Data

The internal nodes were estimated on 2.0m x 2.0m x 1.25m centres for each simulation totalling 100 nodes per regularised (SMU) block. These were only output for the first 10 simulations in order to check that the results honoured the conditioning data, the histogram of the normal score and raw data, and the variograms of the normal score and raw data. For the remaining simulations only the block values were retained. Raw grade values were input into the programme. The DBSIM algorithm transformed them to normal score values, for simulation, and then back-transformed the resultant normal score values to raw grade values. Both the raw and normal score data sets were output.

Statistical validation

The base statistics (both the raw grade and the normal score data) are summarised in Tables 3.6 and 3.7 respectively and presented in more detail in Appendix B for the first 10 realisations and the conditioning data.

ZONE CODE	Conditioning Data		Simulation Range in Mean Value		Simulation Range in Variance	
	Mean	Variance	Minimum	Maximum	Minimum	Maximum
1000	1.65	7.27	1.44	1.62	4.87	6.55
2000	0.36	1.69	0.31	0.33	0.72	1.21
3000	2.03	25.74	1.86	2.02	17.01	23.36
4000	2.93	32.18	2.62	2.71	19.99	25.13
5000	2.84	8.73	2.82	3.03	8.84	16.43
6000	1.36	6.26	1.35	1.44	5.68	7.27
7000	1.14	6.94	1.17	1.33	6.24	10.65
8000	2.09	28.49	2.16	2.54	19.30	47.66
9000	0.26	0.54	0.50	0.54	0.54	0.73

Table 3.6 Summary Base statistics for raw grade point data

ZONE CODE	Conditioning Data		Simulation Range in Mean Value		Simulation Range in Variance	
	Mean	Variance	Minimum	Maximum	Minimum	Maximum
1000	0.00	1.00	-0.07	0.01	0.91	1.01
2000	0.00	0.99	-0.13	-0.09	1.05	1.13
3000	0.00	1.00	-0.01	0.02	0.95	1.01
4000	0.00	1.00	-0.07	-0.04	0.93	0.96
5000	0.00	1.00	-0.03	0.02	1.06	1.10
6000	0.00	1.00	-0.03	0.03	1.03	1.08
7000	0.00	1.00	-0.04	0.06	1.07	1.12
8000	0.00	1.00	-0.05	0.06	1.09	1.17
9000	0.00	1.00	-0.19	-0.13	2.24	2.36

Table 3.7 Summary Base statistics for normal grade point data

From Tables 3.6 and 3.7, the base statistics indicated that the mean grades and variances for ZONECODE 1000 to 4000 were generally slightly under-estimated with the conditioning data exhibiting values slightly higher than the simulated values. Though the mean grades for ZONECODE 2000 and 3000 were only marginally lower, the mean grade and variance for ZONECODE 4000 were significantly lower than the corresponding conditional data values. This was initially a cause for concern for the pit optimisation phase of the project because the South Saprolite ore (ZONECODE 4000) comprises the majority of the saprolite material below the current LOM pit. The total saprolite ore however only comprises 16% of the total ore tonnes between the current LOM and Deep Sulphide pit designs. ZONECODE 1000 (Far North Saprolite) is relatively insignificant regarding its ore tonnage contribution towards the Deep Sulphide project.

From the base statistics the simulation mean and variance for ZONECODE 5000 (Main High Grade) and 6000 (Main Low Grade) –the primary drivers for the Deep Sulphide project – though marginally high, are reasonably close to the mean and variance of the conditioning data, which fall within the range of values of the 10 realisations. Similarly the ZONECODE 7000 (Hangingwall and Footwall mineralisation) conditioning data mean and variance are within acceptable limits of the corresponding 10 realisation values.

The simulated mean and variance values for ZONECODE 8000 (Northern Hards) are significantly higher than the corresponding conditioning data. A poor result is however to be expected since this domain has been insufficiently sampled. ZONECODE 8000 comprises a relatively insignificant proportion of the total Deep Sulphide ore and therefore is not expected to have significant influence on the pit optimisation runs.

For the hard sulphide waste zone (ZONECODE 9000) the simulated mean grade (0.50g/t to 0.54g/t) was significantly higher than the mean of the conditioning data (0.26g/t) though the variance is similar. This zone was expected to remain largely sub-economic and was therefore unlikely to impact significantly on the pit optimisation runs.

The normal score and raw grade base statistics showed similar trends.

Histogram validation

Histograms were generated for the first 10 realisations of both the raw grade and normal score simulation nodes. The results are presented per domain in Appendix C and confirm the deductions made from the corresponding base statistical data.

Both the raw grade and normal score histograms for ZONECODE 1000 to 4000 indicated that, except for ZONECODE 3000, the simulated grade for the saprolite material has been understated. ZONECODE 1000 and 4000 marginally so, but the grade for ZONECODE 2000 has been significantly understated. ZONECODE 2000 is however a “waste” domain with only 5% of the conditioning data above an economic cut-off grade to begin with, therefore this grade understatement is not expected to have a significant impact on the pit optimisation runs.

For the primary drivers of the Deep Sulphide project (ZONECODES 5000 and 6000) the raw grade and normal score histograms show good correlation between the 10 realisations and the conditioning data. Figures 3.1 and 3.2 illustrate this deduction for ZONECODE 5000, the Main high-grade mineralised zone.

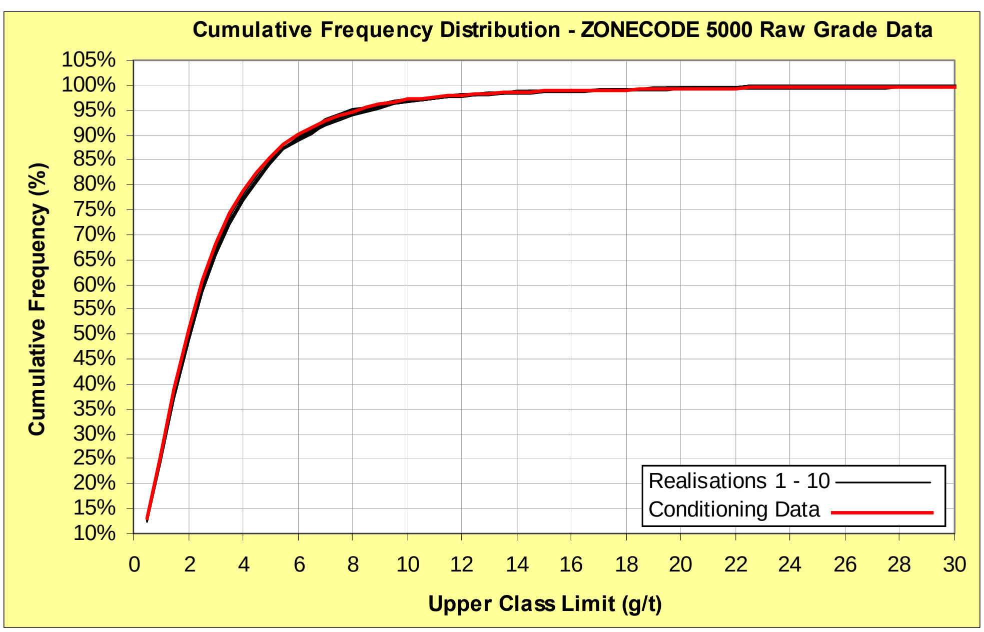

Figure 3.1 Cumulative frequency distribution for ZONECODE 5000 raw grade data

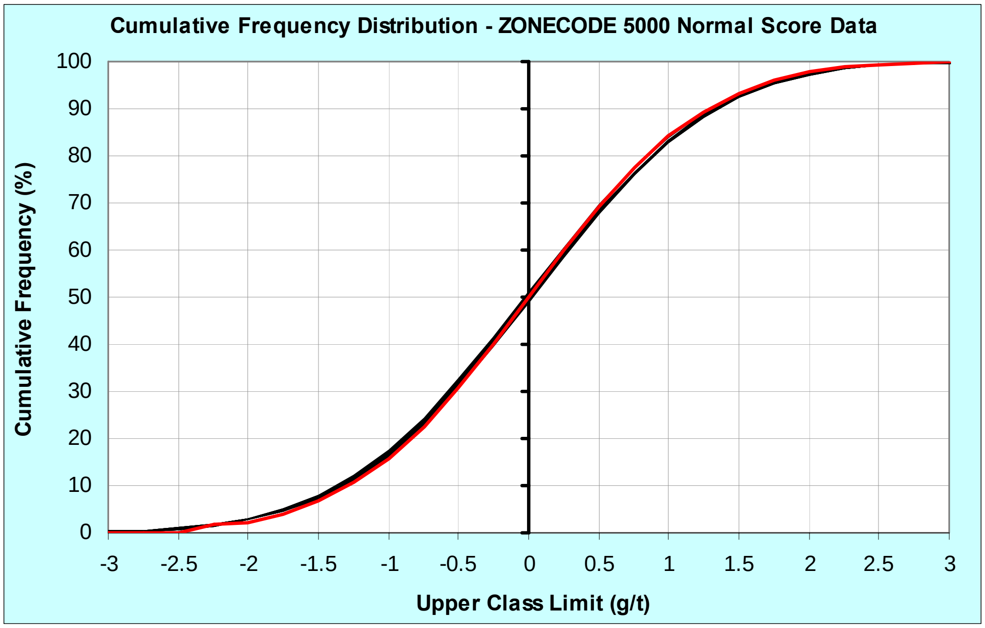

Figure 3.2 Cumulative frequency distribution for ZONECODE 5000 normal score data

For ZONECODE 7000 (Deep Sulphide Hangingwall and Footwall mineralisation) the simulated grade appears to be marginally overstated between 3g/t and 5g/t in the raw grade histograms, while the normal score histograms show acceptable correlation. The same is evident for ZONECODE 8000 (the Northern Hards) between 5g/t and 7g/t. Both these latter domains require additional drilling to ensure that they are representatively sampled.

The histograms for the Deep Sulphide “waste” domain (ZONECODE 9000) show that the grade is significantly overstated up to about 2.5g/t, however 94% of the conditioning data are below the lower marginal cut-off grade of 1.20g/t. The overstatement of grade is therefore unlikely to have a significant impact on the pit optimisations.

From a statistical perspective the Sadiola Simulation Model can be considered to be representative of the conditioning data.

Semi-variogram validation

The final test to determine the validity of the Simulation Model was to test the reproduction of the spatial correlation between the simulated results and the conditioning data. Experimental variograms were calculated for the first 10 realisations and plotted against the semi-variogram model that was input into the simulation process. To facilitate this process the DBSIM program converted the input semi-variogram models to block support and output the results. For the raw grade variogram models the regularised models were output scaled to a variance of 1, therefore these models were scaled to the variance of the block grade data. The semi-variogram model reproductions are presented in Appendix D for both the raw grade and normal score data; and discussed below.

ZONECODE 1000 – The raw grade variogram model is reproduced reasonably well with only the secondary horizontal direction (Azimuth/Dip - 120/00) experimental data showing a sill significantly less than the regularised model. The normal score simulated experimental data compares reasonably well in all directions.

ZONECODE 2000 – The raw grade experimental variogram data compare well with the regularised model, while the normal score data compare less favourably but are nevertheless considered acceptable.

ZONECODE 3000 – The experimental variogram data compare reasonably well in all directions for both the raw grade and normal score data.

ZONECODE 4000 – The experimental variogram data compare reasonably well in all directions for the raw grade data. The normal score data does not compare as favourably having a significantly lower sill than the regularised model. An acceptable correlation can however be achieved when the model is scaled to a variance of 0.40.

ZONECODE 5000 to ZONECODE 8000 – The experimental variogram data compare well with the regularised models for both the raw grade and normal score data.

ZONECODE 9000 – A reasonably good correlation exists between the raw grade experimental variogram data and the corresponding regularised model. The sill for the normal score experimental data is low compared to the regularised model, however scaling the model to a variance of 0.45 provides a reasonable fit.

3.1.5 Representative Number of Realisations

Various authors have used different numbers of realisations to model uncertainty. Dimitrakopoulos, Farelly, and Godoy (2002), considered that 50 realisations were sufficient for their purposes while Goovaerts (1997) makes reference to 100 realisations. As with any simulation study a balance was required between reducing the number of realisations, and thus the computing time, without compromising the validity of the simulated model.

The DBSIM programme outputs a file that allows the user to check the statistical results for each realisation per simulation domain – such as number of data, equal weighted average, and equal weighted variance for the conditioning data, simulated nodes and simulated blocks. This data was processed for the first 25 realisations. To determine the number of realisations that would be required to obtain a reliable uncertainty model, the number of realisations were plotted against the progressive mean and progressive coefficient of variation (COV) for each simulated domain (Appendix E). Note that where the difference between the number of simulated blocks and the total number of blocks for that domain was greater than 5%, the domain was re-estimated using more appropriate search parameters. This was necessary for ZONECODES 5000 to 8000. The final number of simulated blocks for each domain was greater than 95% of the total number of available blocks.

For the first few realisations the mean and COV values in the plots “bounced around” but as the progressive values included more realisations they stabilised, and where they levelled sufficient realisations were considered to have been used to model the variability. In this study the grade for 5 out of the 9 simulation domains could have been considered sufficiently simulated with up to 25 realisations. The remaining 4 domains however required additional realisations. Since it was easier to deal with 50 realisations than 25 realisations in the probability calculations, and most of the Deep Sulphide “ore” zones required more than 25 realisations, it was decided to use 50 realisations for all the mineralised domains and 25 realisations for the “waste” domains. Thus the 25 realisations for ZONECODE 2000 and 9000 were repeated for the second 25 (26 to 50) mineralised domain realisations. In this way the simulation time was reduced by not performing unnecessary simulations on the “waste” domains while simultaneously achieving sufficient variability in the “ore” domains, which were relatively quick to simulate.

3.2 Post Simulation Processes

The DBSIM program has a post simulation process that combines up to 4 batches of 25 realisations (for this study 2 batches) into one simulation model and calculates the base statistics per block for all the realisations. The program also calculates the probability of a block being above a certain user defined cut-off grade. For the Deep Sulphide project the economic cut-off grade is approximately 2.0g/t, therefore this cut-off grade was selected for the probability calculations.

Since it was necessary to simulate certain domains individually the post simulation process was only used as far as generating the simulated realisations in Datamine block model format. The domains were combined into a final simulation model, containing all 50 realisations, outside the DBSIM program. The mean, variance, standard deviation, and coefficient of variation were calculated for each block using Datamine's "EXTRA" routine.

Mean, **m** $= \dfrac{\Sigma AU_{(1 \text{ to } n)}}{n}$ where n is the number of realisations.

Variance, $\mathbf{s^2} = \dfrac{\Sigma(AU - m)^2}{(n - 1)}$

Standard Deviation, **s** $= \sqrt{s^2}$

Coefficient of variation, **COV** $= \dfrac{s}{m}$

Similarly the probability of each block grade being above 2.0g/t was calculated.

Probability, $\mathbf{P_{(AU>2.0g/t)}} = \dfrac{\text{No. of realizations > 2.0g/t}}{\text{Total no. of realizations } (\mathbf{n})}$

To overcome the limitations imposed on the allowable number of fields by the Datamine® Single Precision format, this post processing routine required working with the Datamine® Extended Precision format.

The simulation of the model blocks was controlled by the presence of sufficient conditioning data (greater than 8) and by the search parameters applied. A small proportion of the blocks (less than 5% per domain) were not simulated and where these blocks occurred the realisation grade of the block was set to the estimated

Krig grade. Where there was no corresponding estimated grade the realisation grade was set to zero for pit optimisation purposes - but only after the base statistics had been calculated.

Similarly for pit optimisation purposes the laterite domains were added to the simulation model with each realisation adopting the estimated grade for the laterite model blocks. The final simulation model was depleted by the saprolite life of mine volume.

3.3 Presentation of the Final Simulation Model

The final simulation model contained primary fields for 50 grade realisations, Coefficient of Variation (providing an indication of uncertainty in the grade value), and Probability that the grade would be greater than 2.0g/t. Secondary fields were the remaining base statistics, the initial classification and rock type fields, and the ZONECODE field.

A representative section (EW-5550) is presented to illustrate the primary fields of the final simulation bock model (Figure 3.3 to Figure 3.5). The $475/oz prefeasibility pit shell is shown in white and the current “oxide” LOM design is shown in green. The models have been depleted to this latter pit.

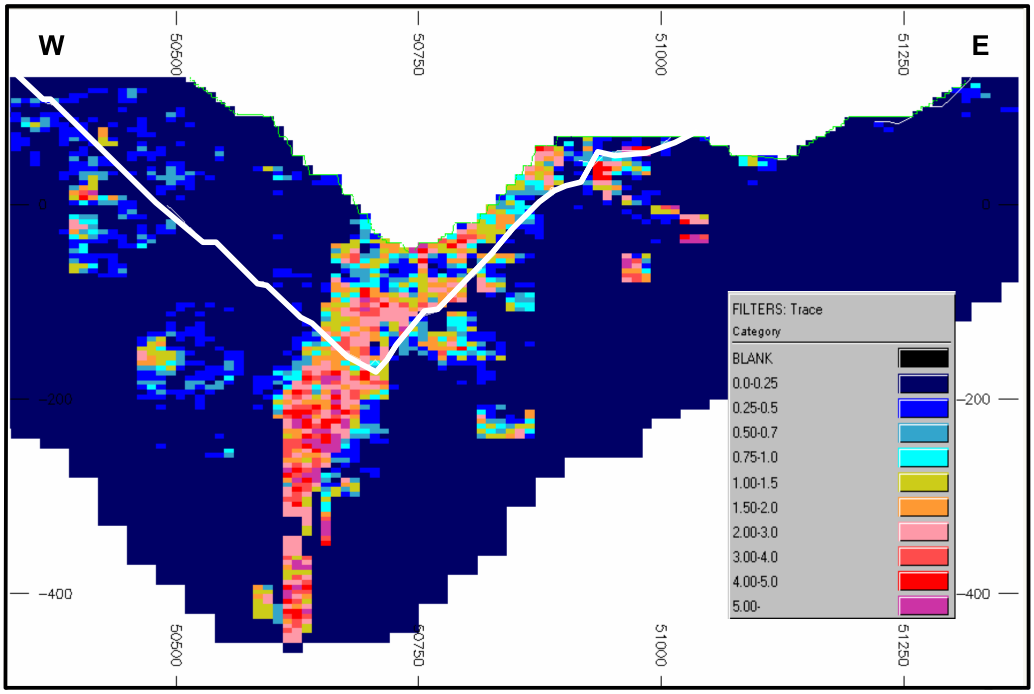

Figure 3.3: Simulated block grade for realisation 1 on Section EW-5550

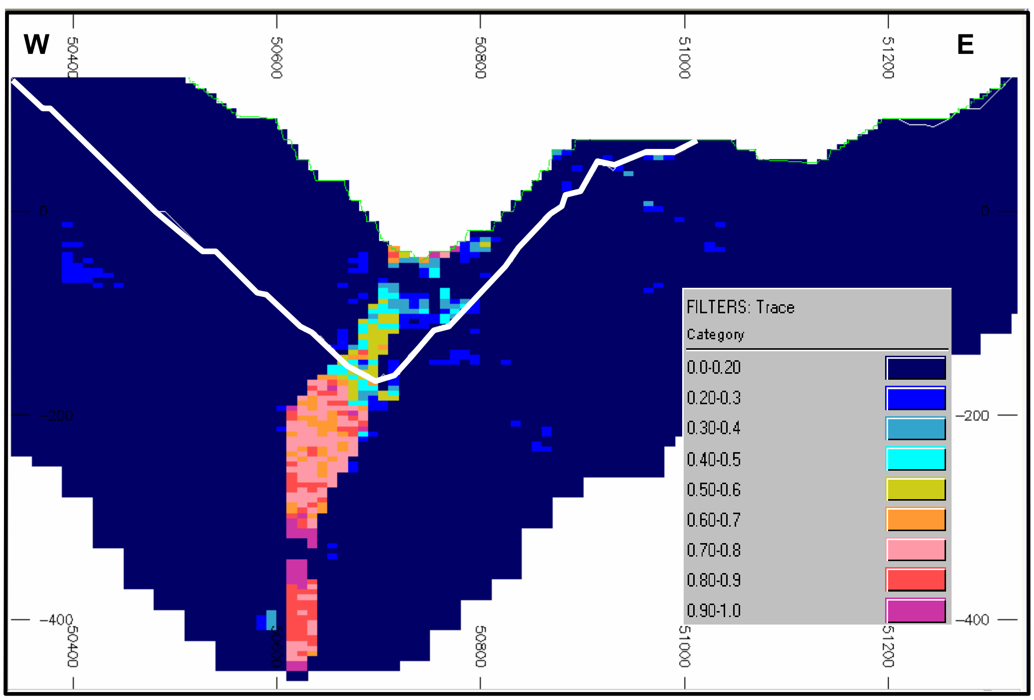

Figure 3.4: Probability of grade greater than 2.0g/t on Section EW-5550

From Figures 3.3 and 3.4 it is evident that although realisation one shows significant material within the prefeasibility pit shell above 2.0g/t, the probability of the actual grade being above 2.0g/t is in fact low. For this reason one shouldn't place too much emphasis on the grade of a single realisation but rather consider a number of realisations simultaneously. The use of probability calculations provides a good overview of the results of all the realisations simultaneously.

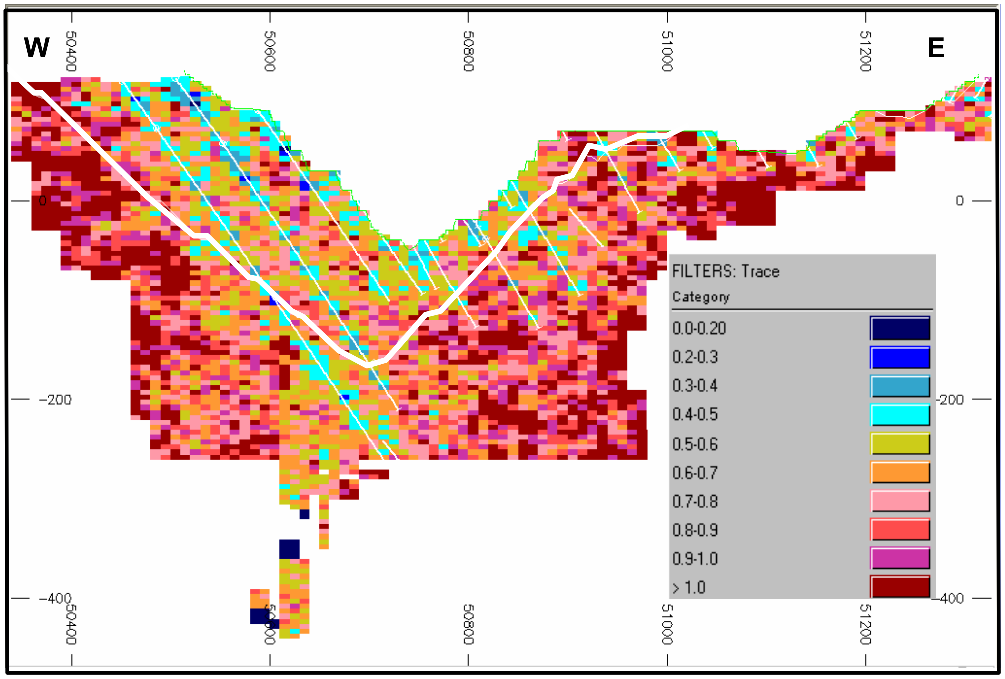

Figure 3.5: Block coefficient of variation on Section EW-5550

Figure 3.5 illustrates how the coefficient of variation calculation provides an indication of uncertainty in the simulated block grade. The diagonal white lines are borehole traces and it is evident that zones of high confidence (low uncertainty) correspond well with the borehole traces, while zones of high uncertainty correspond with zones that have been insufficiently sampled. Since the coefficient of variation provides a reliable indication of uncertainty in the simulated grade it can also be used as a tool for confirming, or even improving, the classification of the Deep Sulphide mineralisation. Furthermore it has potential to direct drilling programmes in zones that require additional sample information.

In order to asses the effect of using the coefficient of variation (COV) for improving the classification of the Deep Sulphide resource; statistics were generated for the COV per recoverable resource classification category and by estimation domain (Table 3.8). Only the mineralised domains were considered in this exercise. Histograms were furthermore generated to show the distribution of COV values by recoverable resource category (Appendix I). Figure 3.6 and Figure 3.7 illustrate the histogram of COV distributions for the primary Deep Sulphide mineralised domains.

		ZONECODE						
Class	**Statistic**	**1000**	**3000**	**4000**	**5000**	**6000**	**7000**	**8000**
MEASURED	Mean			0.69				
	Median			0.69				
	Mode			NA				
	Standard Deviation			0.15				
	Sample Variance			0.02				
	Minimum			0.34				
	Maximum			1.11				
	Number of Samples			92				
INDICATED	Mean	0.86	0.97	0.78	0.61	0.65		
	Median	0.83	1.06	0.74	0.59	0.63		
	Mode	NA	NA	NA	0.65	0.68		
	Standard Deviation	0.23	0.28	0.23	0.13	0.12		
	Sample Variance	0.05	0.08	0.05	0.02	0.02		
	Minimum	0.33	0.58	0.27	0.23	0.30		
	Maximum	2.46	2.27	2.10	1.49	1.66		
	Number of Samples	2,540	168	4,583	13,307	13,030		
INFERRED	Mean	0.94	1.12	0.93	0.66	0.70	0.98	0.85
	Median	0.92	1.06	0.90	0.64	0.69	0.94	0.81
	Mode	NA	NA	NA	0.59	0.72	1.00	0.76
	Standard Deviation	0.22	0.28	0.25	0.14	0.13	0.22	0.21
	Sample Variance	0.05	0.08	0.06	0.02	0.02	0.05	0.04
	Minimum	0.47	0.58	0.37	0.28	0.31	0.36	0.36
	Maximum	1.77	2.27	1.76	1.71	1.99	3.00	2.40
	Number of Samples	293	168	455	11,227	31,087	33,356	5,603

Table 3.8: Base statistics for COV by classification category

From Table 3.8 it is evident that only the South Saprolite mineralised zone (ZONECODE 4000) has material classified as Measured and the Deep Sulphide zones 7000 (Hangingwall and Footwall mineralisation) and 8000 (Far North mineralisation) only comprise Inferred material. These latter two zones will require additional sample information to convert them to Indicated status. There is however definite potential to convert Inferred material to Indicated status for the remaining zones.

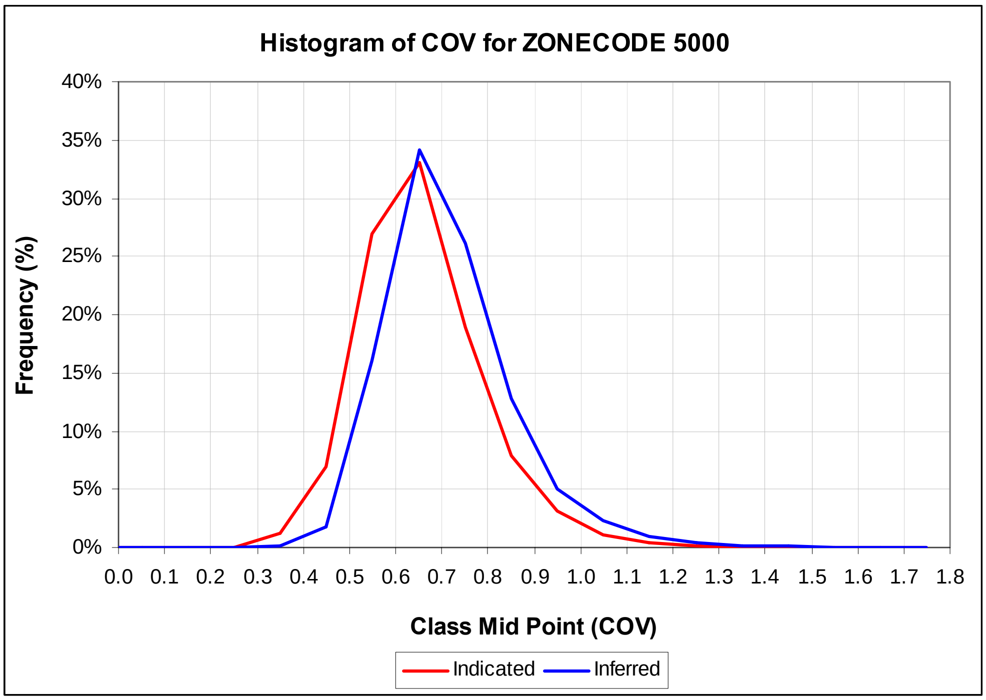

Figure 3.6: Histogram of COV by resource category for ZONECODE 5000

From Figure 3.6 and Figure 3.7 it is evident that a high proportion of Inferred material from ZONECODE 5000 and ZONECODE 6000 could be converted to Indicated status by using the simulation COV values for re-classification. Unfortunately no distinct COV threshold value could be associated with the Indicated category and a full classification study using uncertainty would be required. A method for using uncertainty (COV) to classify resources with 15% error at 90% confidence (Anglogold Ashanti resource reporting criteria) has been proposed by Dohm (2005).

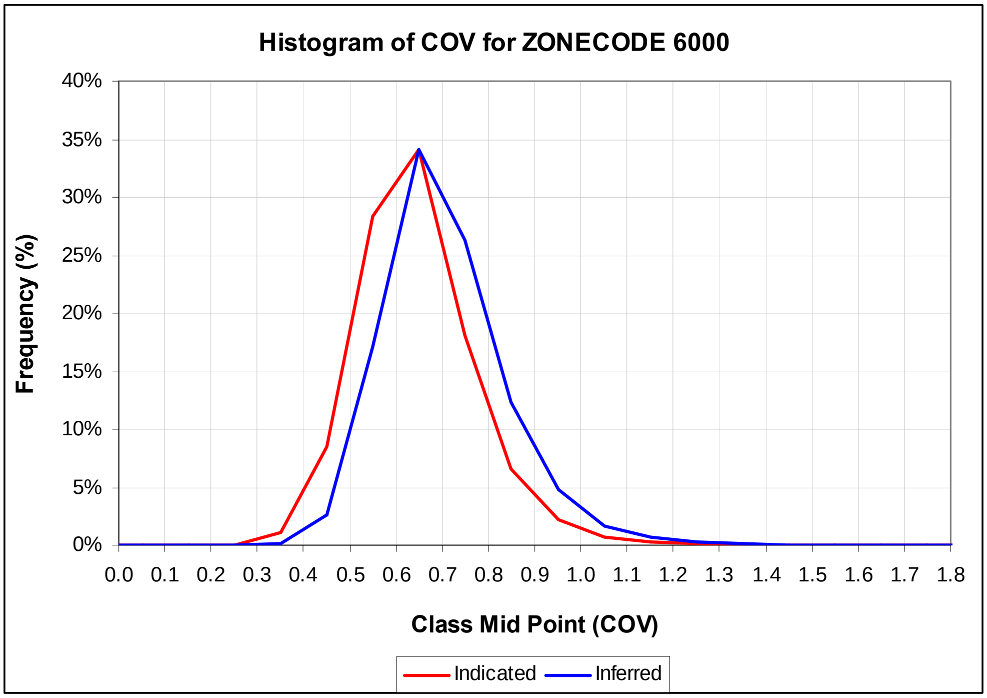

Figure 3.7: Histogram of COV by resource category for ZONECODE 6000

The Deep Sulphide project geologist has been supplied with the uncertainty model to assist with the planning of additional drilling - aimed at converting Inferred material to Indicated status for the project Feasibility study. The first additional drilling phase (Phase 8) has been planned primarily to target the Footwall and Hangingwall mineralisation. The Northern Hards will be drilled as a secondary target. These two zones are currently drilled on a 50m x 50m sample grid and will need to be in-filled to 25m x 25m in order to upgrade the resource to Indicated status. Little benefit will be gained from a revision of the classification in these two zones other than to confirm the planned sampling grid.

The last phase of the planned Deep Sulphide drilling programme (Phase 9) has been planned to convert a significant amount of gold from Inferred to Indicated status within the Main High-Grade and Low-Grade mineralised zones. The classification of these zones will be optimised using the method suggested by Dohm (2005) prior to the commencement of any additional drilling. Figures 3.6 and 3.7 indicate that a significant amount of material could be converted to

Indicated status by a revision of the classification alone. At the very least a revision of the classification will assist with the optimised planning of the final drilling phases.

4 PIT OPTIMISATIONS AND DATA PROCESSING

To maximise the use of the final simulation model each realisation was passed through a mining function using Datamine's Maxipit software. Maxipit utilises the Lerch-Grossmann algorithm to assign an economic value to each model block thereby generating an ultimate pit shell, or maximum cash flow pit. The optimiser essentially begins at the model surface and "mines down" into the model making two basic decisions for each block:

1. Should the block be mined or not?
2. Does the material go to the treatment plant or to the waste dump?

These two decisions are essentially based on the revenue generated by the block at a defined gold price, which is offset against the cost of mining the block and the cost of processing the material. Although valued individually the decision to mine a block or not is determined by considering the surrounding blocks in conjunction with the block in question. For example mining a high grade block below waste blocks may in fact pay for the cost of mining the waste blocks and still generate a profit. The ultimate pit is thus generated from all the blocks that the optimiser decides to mine.

The same pit optimisation parameters as those used in the 2005 end of year Mineral Resource Statement Report were used for the optimisation of the simulation realisations (Appendix F). The 50 Net Present Value (NPV) results for the various realisation ultimate pits were plotted with the NPV for the recoverable resource model (Figure 4.1).

From Figure 4.1 it is evident that the NPV's for all the simulation realisations are greater than the NPV for the recoverable resource model and that most of them are significantly greater. This indicates significant upside potential exists for the Deep Sulphide project. Although this is indicative of upside potential it would be more useful to take this information a step further and calculate probability or risk pits from the individual realisation pits.

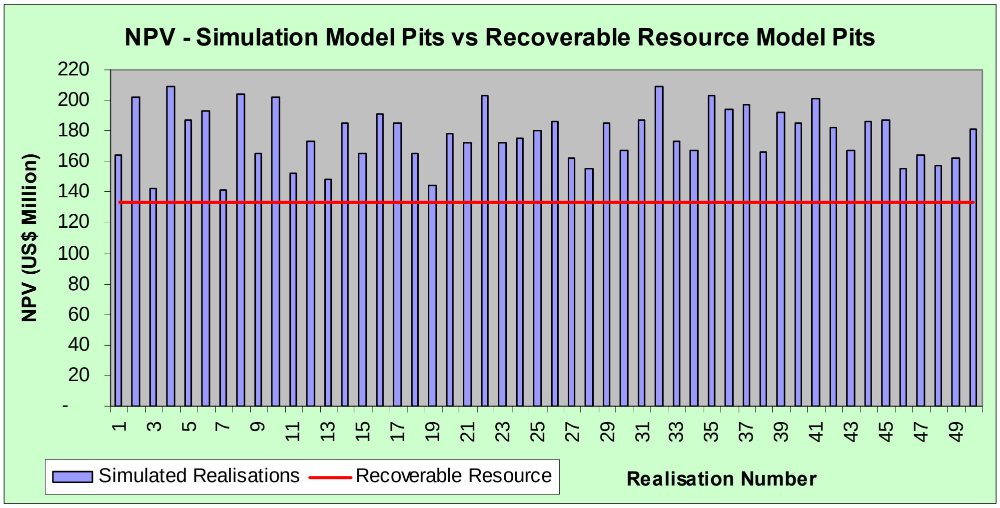

Figure 4.1: NPV for simulation realisations and recoverable resource model

4.1 Calculation of Probability / Risk Pits

The probability of mining each block was determined from the number of times it was mined in each of the 50 ultimate pits. Each block was then flagged in the simulation model based on its probability of being mined, and risk pit shells were generated at 5% probability intervals from 5% to 95% (Figure 4.2 and Figure 4.3).

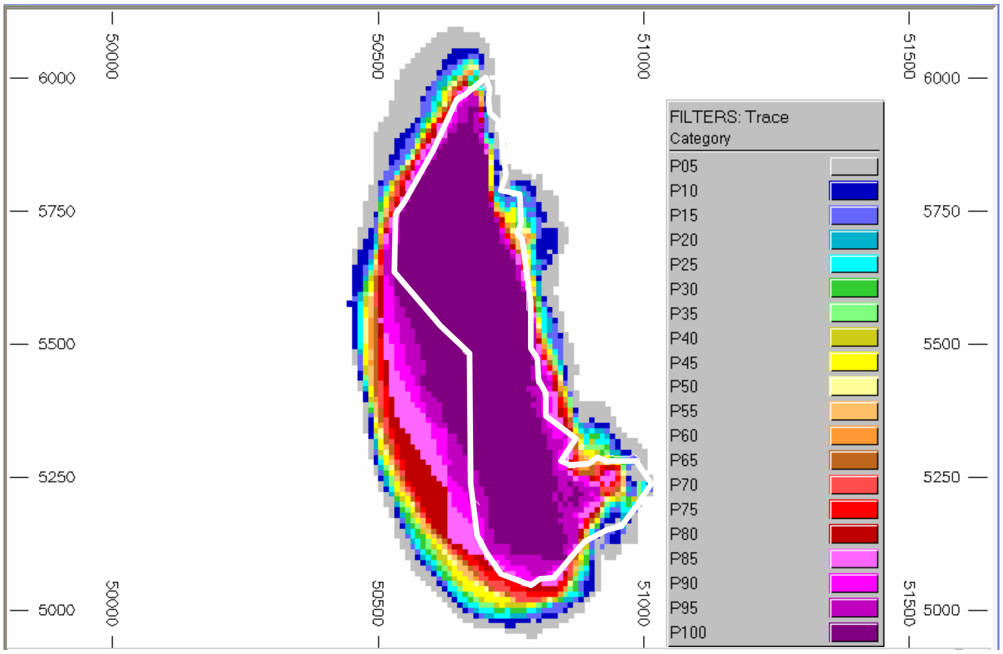

Figure 4.2: Plan view (elevation -90m) showing the probability of mining

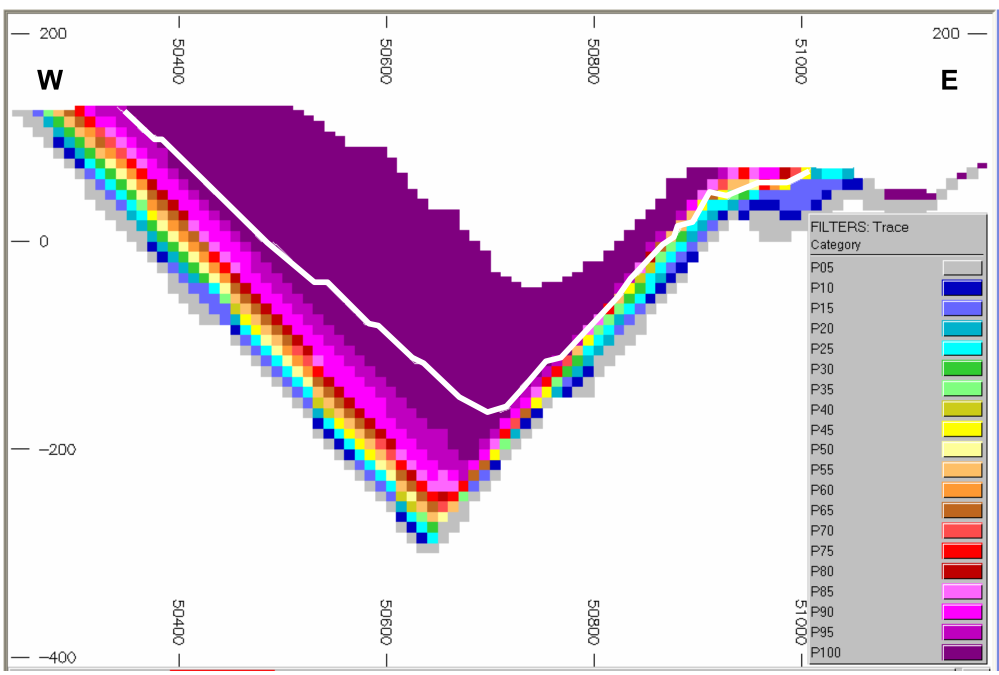

Figure 4.3: Section EW-5550 showing probability of mining.

The $475/oz prefeasibility pit shell is shown as a white line in Figures 4.2 and 4.3. It is evident in both figures that the prefeasibility pit does not fetch a significant amount of high probability / low risk material, and that in the east (Figure 4.2) it mines low probability / high risk Footwall material. The Footwall is known to be under-drilled and is the target for the Phase 8 Deep Sulphide drilling programme.

4.2 Generation of Grade Tonnage Curves

For each of the 50 realisations and the recoverable resource (SMU) model, grade tonnage curves were generated for the P05, P50, P80, P95, and Prefeasibility probability pit shells (Appendix G). Less variability than expected was achieved in each of the grade tonnage curves.

- **P05** – At the approximate economic cut-off grade of 2.0g/t the SMU model grade was 3.70g/t while the simulated realisation grades varied between 3.65g/t and 3.87g/t. The realisations indicated significant upside potential for both grade and tonnage above cut-off.
- **P50** – At 2.0g/t cut-off the SMU grade of 3.76g/t falls in the middle of the realisation grade distribution (3.65g/t to 3.93g/t), though the tonnes above cut-off show significant upside potential.
- **P80** – The grade tonnage curve is similar to that of P50 at 2.0g/t cut-off with the SMU grade of 3.79g/t falling in the middle of the realisation grade distribution of 3.67g/t to 3.93g/t. Upside tonnage potential is indicated above cut-off.
- **P95** – similarly indicates significant upside potential to the tonnage above 2.0g/t with the SMU grade of 3.83g/t midway between the realisation grade limits of 3.74g/t and 4.0g/t.

Except for P05 - for which the average grade above 2.0g/t cut-off is marginally low - the above probability pit shells indicate that the SMU grade has been estimated with reasonable accuracy. However, within all the shells the tonnes above cut-off have been understated in the SMU model. Since the density and volume have been kept constant between the two models (SMU and Simulation) this difference could only be attributed to a shift in the grade tonnage curve.

Closer examination of the grade curves indicates that generally, from about 2.5g/t, the SMU model grade shifts to the upper limit of the realisation grade distribution, indicating that it is marginally more selective than the simulation model.

Within the Prefeasibility pit shell a comparison of the simulation and SMU model grade tonnage curves indicates, that at 2.0g/t cut-off, both the SMU grade and tonnage curves lie within the range of the realisation distribution. This is illustrated in Figure 4.4 below, where the tonnage curve has been re-scaled to a maximum of 70 million tonnes. Although one may argue that the SMU model is marginally too selective, Figure 4.4 indicates that this selectivity is acceptable. Above 2.0g/t cut-off grade the average grade above cut-off for the SMU model is 3.82g/t, while the realisation grade ranges from 3.75g/t to 3.99g/t. At the same cut-off grade the SMU tonnage of 19.5Mt falls within the realisation distribution range of 19.0Mt to 21.0Mt.

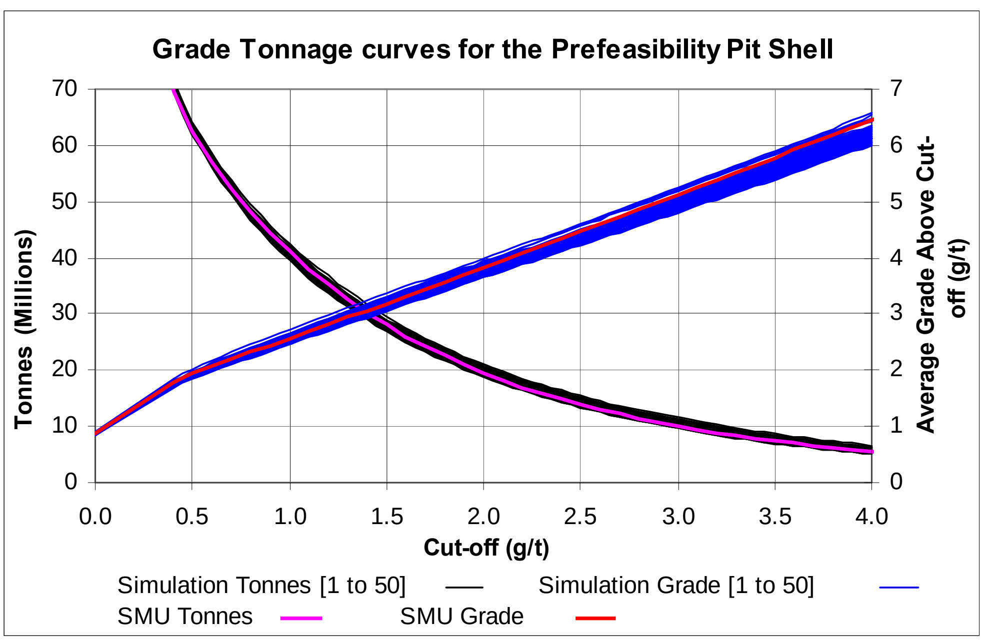

Figure 4.4: Grade Tonnage Curves within the prefeasibility pit shell

4.3 Valuation of the Pit Shells

A pit value was calculated for each of the probability pits (P05 to P95 at 0.5 intervals) using the recoverable resource model. Since the extraction of the resource within these shells was not scheduled it was not possible to calculate an NPV for each pit. An open pit value was however obtained for each scenario based on the cost of mining ore and waste, the cost of treating the different material types, and the revenue generated at a gold price of $475/oz. The 2006 grade control cut-off grades were used to define ore and waste material for the various rock types (Table 4.1) with material above the cut-off categorised as ore. The cut-off grades correspond with “break-even” Upper Marginal grade material.

Rock Type	Cut-off (g/t)	Rock Type	Cut-off (g/t)
Laterite	1.10	Hard Sulphide	1.90
Saprolite	1.00	Intermediate Oxide	1.10
Siliceous Oxide	1.50	Intermediate Sulphide	1.60
Saprolite Sulphide	1.60		

Table 4.1: Ore / Waste cut-off grades

The various recovery, cost, and revenue parameters that were used in the pit valuation calculations are presented in Table 4.2. The cost values are those calculated by the Sadiola long-term mine planner in February 2006. The rehabilitation (Rehab.) costs had been included in the variable process costs and were therefore set to zero.

Item	Material Type	Value
Mine Call Factor		100%
Recovery Saprolite Oxide		93%
Recovery Saprolite Sulphide		80%
Recovery Hard Sulphide		80%
Fixed Mining ($/tonne treated)		2.40
Fixed Process Costs ($/tonne)		1.07
Variable Process Costs ($/tonne)	Laterite (oxide)	9.84
	Saprolite Oxide - Soft	9.09
	Siliceous Oxide- Hard	15.46
	Saprolite Sulphide - Soft	13.80
	Hard Sulphide - Hard	15.58
	Intermediate Oxide	9.84
	Intermediate Sulphide	14.56
Admin Costs ($/tonne)		3.59
Capital Replacement ($/tonne)		0.46
Rehab. Costs ($/tonne)		0.00
Variable Ore ($/tonne)	Laterite (oxide)	2.089
	Saprolite Oxide - Soft	2.058
	Siliceous Oxide- Hard	1.938
	Saprolite Sulphide - Soft	1.852
	Hard Sulphide - Hard	1.825
	Intermediate Oxide	1.960
	Intermediate Suplhide	1.960
Variable Waste ($/tonne)	Laterite (oxide)	2.083
	Saprolite Oxide - Soft	2.051
	Siliceous Oxide- Hard	1.933
	Saprolite Sulphide - Soft	1.846
	Hard Sulphide - Hard	1.820
	Intermediate Oxide	1.954
	Intermediate Sulphide	1.954
Gold Price ($/oz)		475

Table 4.2: Cost parameters applied during pit valuation

The calculated open pit values using the recoverable resource model for each of the probability pits (P05 to P95 at 0.5 intervals) are presented below in Figure 4.5. Not much could be gained from this exercise other than to see the expected inverse relationship between pit value and stripping ratio with increasing mining volume and the interesting kink that occurred in both curves for probability pit P80, which lead to its inclusion in further pit value analyses. These additional analyses involved comparing the values for each of the simulation model realisations with the SMU model value within selected probability pits.

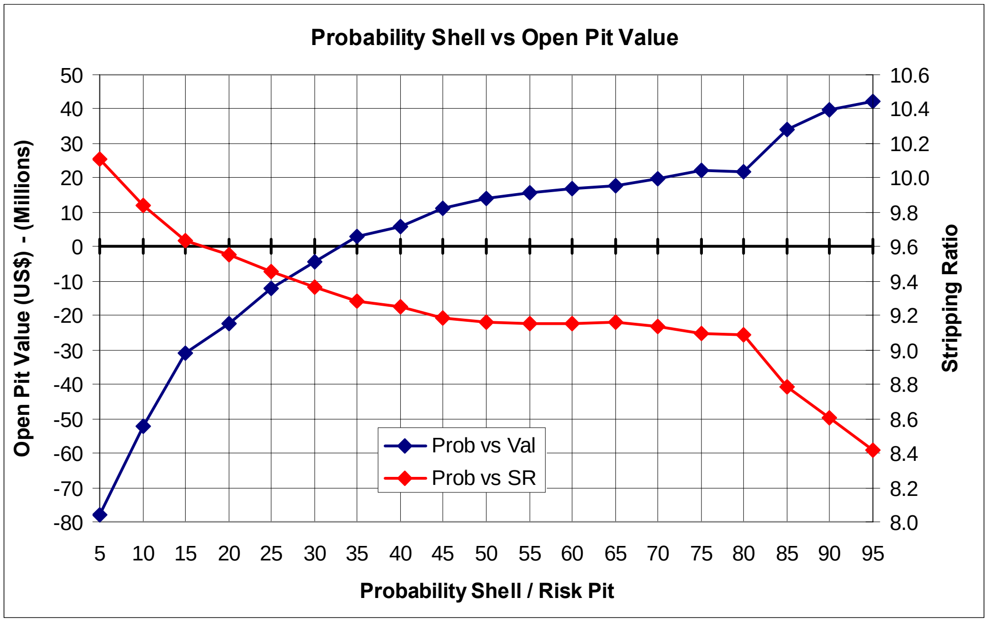

Figure 4.5: Open pit values for the probability pits

Open pit values were calculated for selected probability / risk pits (P05, P50, P80, P95) and the $475/oz Prefeasibility pit using all 50 simulated realisations and the recoverable resource (SMU) model. The results of this exercise, showing the stripping ratio, pit value for each simulation, and the SMU pit value, are presented in Appendix H. Table 4.3 summarises the pit value base statistics for the 50 realisations and SMU model per pit shell and Figure 4.6 illustrates the distribution of the realisation pit values.

Pit	SMU Profit ($ Million)	Mean Profit ($ Million)	Std Dev ($ Million)	Max Profit ($ Million)	Min Profit ($ Million)
P05	-78.010	-2.621	34.782	86.379	-67.288
P50	14.011	85.385	31.119	160.421	30.655
P80	21.745	82.204	24.921	139.124	37.691
P95	42.085	89.025	21.389	136.528	47.883
P-PF	112.889	108.036	24.400	179.400	60.870

Table 4.3: Base statistics for the realisation pit values per pit shell

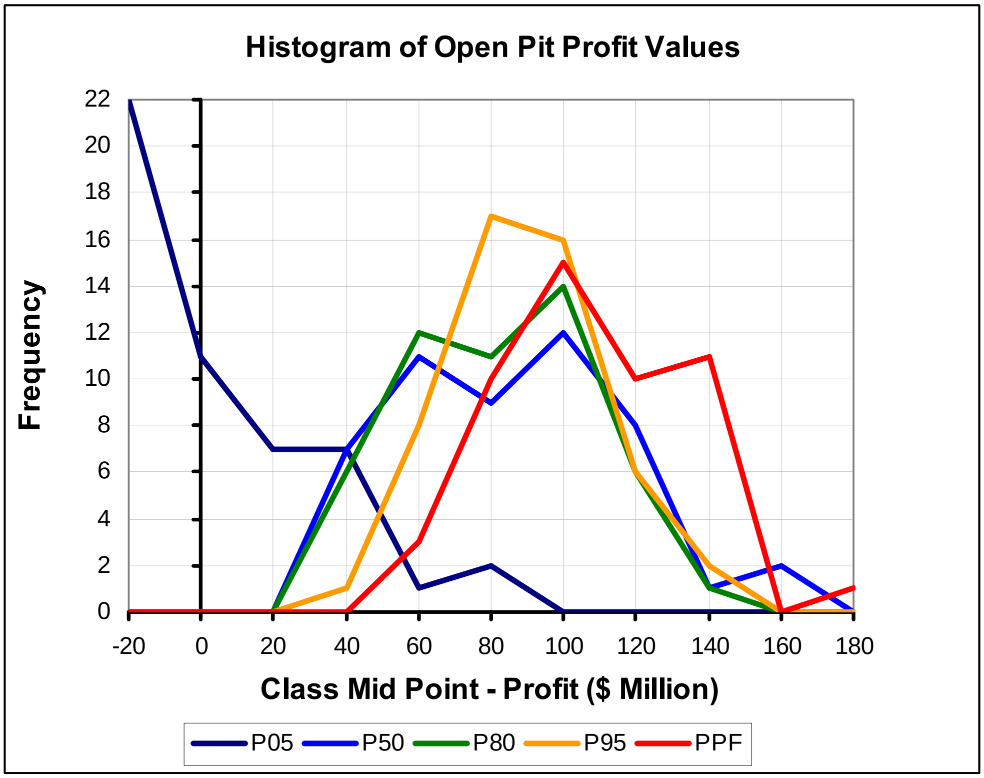

Figure 4.6: Histogram of the Open Pit Values for the 50 Realisations

From Figure 4.6 and Table 4.3 it is evident that the $475/oz Preafeasibility pit offers the greatest profit margin but not the least risk. Probability pit P95, not surprisingly, has the tightest distribution about the mean and would therefore offer the least risk to achieving the indicated profit. Considering the respective mean profit values for the preafeasibility and P95 pits however, the value offered by P95 is significantly lower than that of the prefeasibility pit and given the relatively minor additional risk, the prefeasibility pit may be the preferred pit option.

Figure 4.7 confirms that the prefeasibility pit is the optimal pit for the Deep Sulphide project - given the $475/oz gold price and cost parameters. The SMU model produces a profit of $112 million and falls in the middle of the distribution of the simulated realisations. The risk does exist that a profit of only $64 million may be realised, however a profit of $179 million is also possible, with the most likely profit ranging between $87 million and $148million.

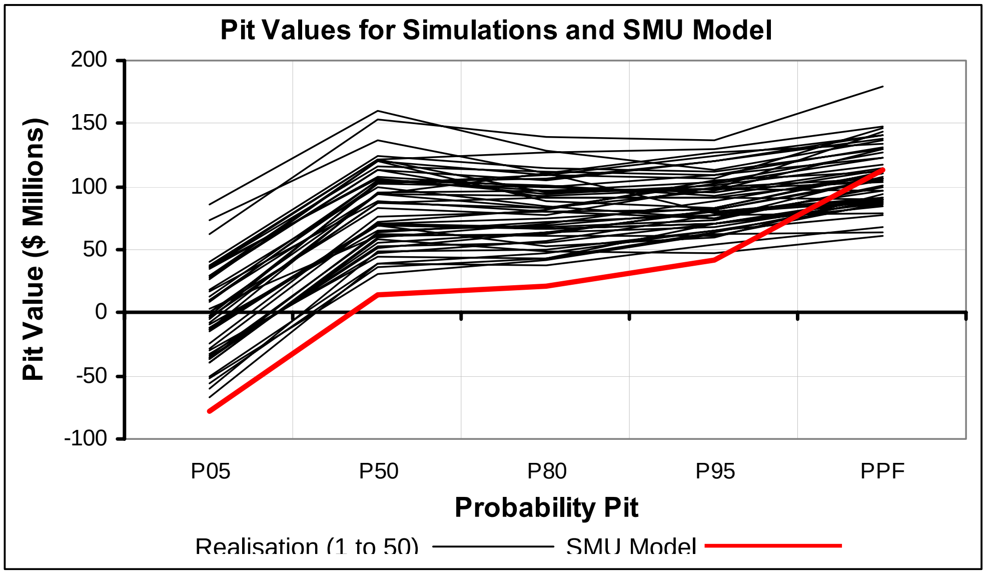

Figure 4.7: Pit Value per probability pit for the Simulation and SMU models

It is evident from Figure 4.7 that the profit curves flatten off significantly from the P50 to the P95 risk pit and that there is no insignificant difference in their mean profit (Table 4.3). Though a marginal decision at a gold price of $475/oz, mining an equivalent of the P80 or P50 pits could dramatically improve the Deep Sulphide reserve ounces, and the P50 pit would most probably become a real option should the gold price increase significantly.

Subsequent to the generation of the pit shells for this study the gold price has increased significantly and Anglogold Ashanti has increased its reserve reporting gold price to $550/oz, while at $650/oz the resource reporting gold price is closer to reality of $624/oz, (on 21 August 2006). The pit optimisation part of this study should therefore be repeated at a higher gold price (and using the latest prefeasibility study cost parameters).

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The Sadiola Deep Sulphide Project offers considerable upside potential for the Sadiola Mineral Reserve. Given the enormity of the capital outlay required to upgrade the treatment plant to process hard sulphide material, the decision was made to quantify the uncertainty in the grade estimate of the deposit's recoverable resource model. Conditional simulation, and particularly Sequential Gaussian Simulation (SGS), currently offers the most reliable method for quantifying grade uncertainty for a deposit. However despite improvements in computing technology, the application of SGS to large three dimensional deposits remains impractical because of the computing time involved. Direct Block Simulation (DBSIM) provides an enhancement to the SGS algorithm that allows simulation directly at block support. It therefore offers a more practical alternative to conventional SGS in that the algorithm can be run through standard industry software (Datamine®), and it dramatically improves computer processing time.

DBSIM was used to simulate 50 grade realisations for the Sadiola Deep Sulphide project. Conventional validation routines performed on the resultant model showed that it was reliable for quantifying the uncertainty in the grade estimate. Obtaining multiple grade realisations for each model block was however not the final objective and additional post processing of the data was required to make a meaningful assessment of the uncertainty in the grade. This involved the calculation of base statistics for the 50 realisations reporting to each block and the determination of probability, or risk, pits by passing the simulation model through a mining transfer function.

Of the calculated base statistics, the coefficient of variation (COV) was the most useful for providing an indication of the uncertainty in the grade estimate. Furthermore it had potential for practical implementation beyond the scope of this study. The correlation between COV and the current sample information has shown its potential to guide the planning of additional drilling programmes. Colouring the simulation model on COV would allow the project geologist to target specific zones of high COV and place lower importance on zones with lower COV. Expenditure on future drilling programmes would thus be optimised to gain maximum benefit. Of even greater significance to the Deep Sulphide project is the fact that the COV values have highlighted the potential to convert Inferred material to Indicated status through re-classification alone. This is particularly applicable in the Main grade zones where the current classification appears to be too stringent. Post re-classification drilling campaigns could thus target only zones that require additional sample information.

The ultimate objective of creating the simulation model was to generate optimised pit shells for each of the 50 realisations in order to assess the risk involved in mining the $475/oz prefeasibility pit. Probability shells were generated at 5% intervals for comparison with the prefeasibility shell. These risk pits indicated that the prefeasibility pit is generally conservative, corresponding with the 100% probability shell. There is however a certain amount of risk involved with mining the Footwall mineralisation, where the prefeasibility pit digs on high-risk / low-probability material. This is confirmed by the COV values in this zone, which indicate high uncertainty in the grade estimate. The Footwall mineralisation has currently been drilled to a 50m x 50m sampling grid and the pending Phase 8 drilling has been planned to infill this grid to 25m x 25m to convert it to Indicated status.

At the current economic cut-off grade of 2.0g/t, grade tonnage curves generated for selected risk pits have shown that although upside tonnage potential exists for the Deep Sulphide project the recoverable resource (SMU) model grade estimate is reliable. This indicates that the SMU model is perhaps too selective. This selectivity issue is not as pronounced within the prefeasibility pit and with the current cost information and a gold price of $475/oz the Prefeasibility pit is probably optimal.

The calculation of economic pit values for the realisations within the same selected risk pits indicated that the P50 to P95 pits, and the prefeasibility pit, are not significantly different. There is therefore potential to add reserve ounces to the project without significantly decreasing its value. An increase in gold price, or decrease in operating costs, would most likely make this additional material available to the project. The positive year to date trend in the gold price therefore presents significant upside potential for the Deep Sulphide project and the latter part of this study should be run at a gold price of between $550/oz and $650/oz. The pit value calculations confirm the conclusion made from the grade tonnage data - that at a gold price of $475/oz, and with current cost parameters, the prefeasibility pit shows maximum value for the project with no significant additional risk.

5.2 Recommendations for Future Work

The additional information gained from assessing the uncertainty in the grade estimate for the Deep Sulphide project has indicated that this is a worthwhile exercise to run on any mining related prefeasibility project. Furthermore it would be relatively easy to rerun this exercise including the additional sample information gained at the feasibility stage of the project. Though to facilitate this process it would be beneficial to develop a scripted interface between Datamine and the DBSIM executables thus enabling more user friendly interaction with the system.

Generating meaningful data from the simulation model - particularly the generation of open pit values and grade tonnage curves from the risk pits - was extremely laborious and required running processes in multiples of 51. For future work it is recommended that these processes are automated, and that the risk pits are run through a scheduling package to provide actual NPV values rather than indicative open pit values.

The most profound conclusion from this exercise has perhaps been that the classification applied to the recoverable resource model was too stringent. It is therefore recommended that the classification is re-run using the simulation COV information - as proposed by Dohm (2005). This exercise would eliminate unnecessary drilling and potentially save drilling costs.

The gold price used for this project was $475/oz (the recommended Anglogold Ashanti resource reporting gold price for 2005). Anglogold Ashanti has since increased their resource reporting gold price to $650/oz, and at $550/oz their reserve reporting gold price is significantly greater than the gold price used for this project. Since the current bullish gold price provides significant upside potential for the Deep Sulphide project, it is recommended that the pit shell work is rerun using a suggested gold price of $600/oz and the latest mining and processing costs derived from the prefeasibility project.

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DBSIM - DIRECT BLOCK SIMULATION ALGORITHM

USER'S MANUAL (*Draft 1*)

Updated December 2005

Warning not for the faint hearted - March 2005

Adapted from the DBSIM MAF manual (Richard Peattie)

Updated by Steven Robins following application of the software

(Essential user defined files have red font)

CONTENTS

1. INTRODUCTION

The DBSIM Algorithm implements the procedure to generate direct block simulation as described in the confidential progress report N-5003-1. The program is called from a Datamine Macro which simulates multiple geological domains in a loop and then compiles the simulated domains into a single block model file. Included in the programs is a group of macros and programs that perform the validation of the simulations.

1.1 Problems

This program was written specifically with one mine in mind therefore it is not generic. The main issue of DBSIM is that the majority of the parameters have been hard coded, therefore it is not user friendly for a once off projects, the large effort in setting up dbsim to run is a suited to a long term production environment. However a user friendly datamine interface could be fairly easily constructed.

Point histograms are now calculated during the simulation which eliminates the need to output internal node values for validation purposes. However the output class interval is hard coded in the executable and would require the code to be able to change. As is the size of the model and number of samples that can be utilized.

2. DBSIM RECIPE

The DBSIM procedure is shown on the flowchart presented in Figure 1. The program is run through datamine using the Datamine macro **menu_sim.mac**.

There are four inputs required consisting of:

1. A Block model called ZONEMOD.dm. It is recommended to regularise/slice your model to the block size you will finally be simulating into up front (NB monitor that integrity of required fields is maintained).
2. A borehole file called INTSAMP.dm. Set up by **zone_bh.mac**
3. A parameters file containing model definitions called DBSIM.dm. This file is not essential, you can edit this portion out of the macro so that it runs with no errors.
4. A DBSIM parameter file called DBSIM.par. This file is essential and is basically a GSLIB simulation parameter file.

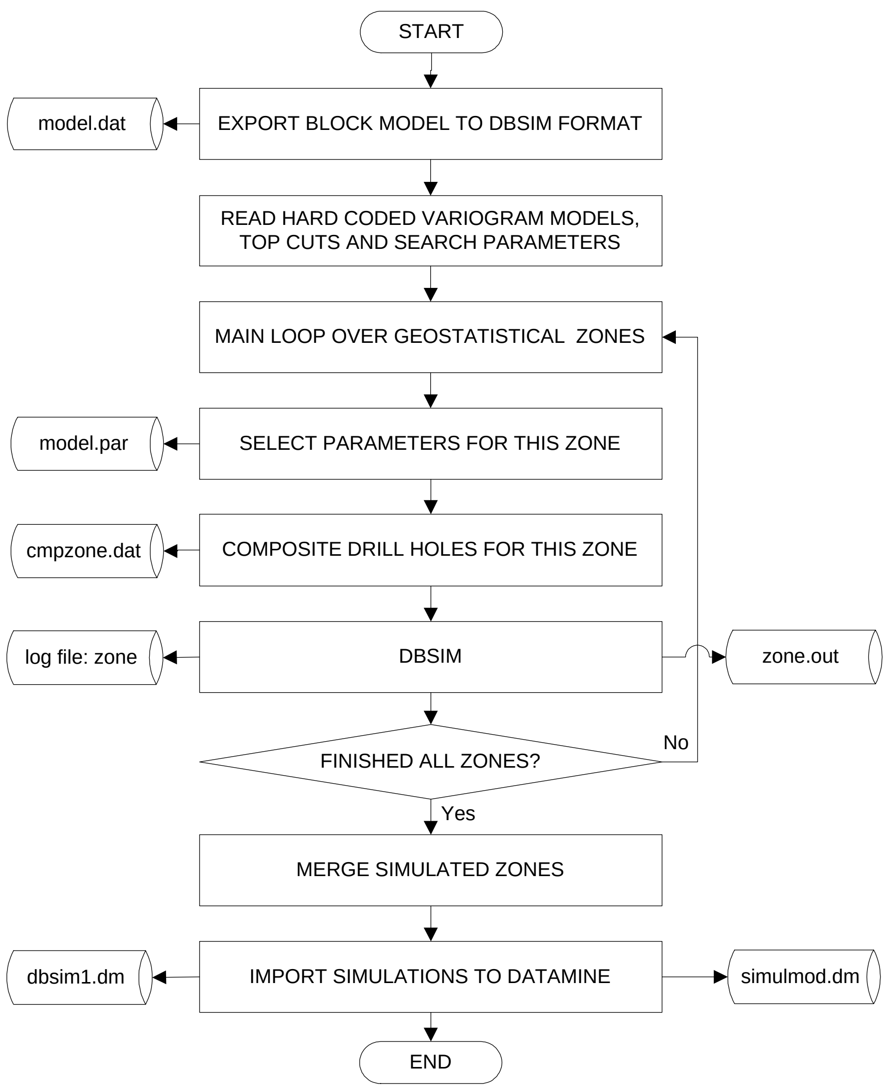


Figure 1. Flowchart of the simulation procedure.

From the menu options, (1) is selected with runs the mod_sim.mac datamine macro. **Warning hard coded in the macro is the block size to be used in the simulation and the variogram information to be used.** The macro first outputs a block listing of the number of blocks to be simulated by zone (*blocklst.dat*) and the block model for use in the DBSIM executable (*model.dat*) and then the parameters related to spatial search, variogram models and top-cuts in **normal space** *(xxvarpar.dm)*. **NOTE: The variogram models must be Normal Score (Gaussian) variograms.**

The program then calls another Datamine macro **zone_bh.mac** which selects the sampling data per zone and composites the samples and creates the INTSAMP.dm file required for the simulation it then returns you to the **mod_sim.mac**. The macro **zone_bh.mac** is all hard coded and will have to be rewritten for each mine or performed outside of the **mod_sim.mac** macro.

The macro then loops over the geostatistical domains goes through the model, zone by zone **(Zone fieldname identifier is hard coded to ZONECODE)**, selects the relevant parameters and performs the conditional simulation. After all zones have been simulated they are merged back together and imported to the file DBSIMX. The output file is ordered according to *model.dat* and contains the fields corresponding to each simulation.

NOTE: The program has been hard coded to perform simulations using ZONECODE and LODENAME (geozones and lodes), a workaround is just to create a field called LODENAME and give the field the same attributes as is in LODENAME.

3. DESCRIPTION OF PARAMETERS

3.1 Input Files for DBSIM.exe

The input to the **dbsim.exe** consists of 4 files:

(a) the conditioning data set,

(b) the model file containing the blocks to simulate,

(c) the parameter file with user defined parameters, and

(d) the temporary parameter file generated by the simulation macro.

3.1.1 Conditioning Data set

The file with the composited drill hole data. This file is automatically generated by the simulation macro. The name of the file is *cmpZONE.dat* where *ZONE* corresponds to the ZONECODE value. It is a comma-delimited ascii file formatted according:

SAMPLE_FL		
Variable	**Type**	**Description**
X	Float	X coordinate
Y	Float	Y coordinate
Z	Float	Z coordinate
GRADE	Float	Variable to be simulated
ZID	Float	Zone code
LODENAM	Float	Lode name

3.1.2 Model File

Prototype model file. This file has a list of the blocks discretising the three-dimensional envelopes where the simulation will take place. The model file is automatically generated by the simulation macro as *model.dat***.**

MODEL_FL		
Field Name	**Type**	**Description**
XC	Float	X coordinate
YC	Float	Y coordinate
ZC	Float	Z coordinate
ZID	Float	Zone code
SUPP	Float	Support code
LODENAM	Float	Lode name

3.1.3 Main Parameter File

Figure 2 shows an example of the main parameter file (*dbsim.par*). **It is user defined not automatically generated.** The file is similar to the GSLib SGS parameter file.

```
Parameters for DBSIM
*******************
START OF PARAMETERS:
1 2 3 4 0 5 6 7 8 9          \x,y,z,vr,wt,zone,lodnam
-1.0e21    1.0e21                \data trimming limits
2       2.5                  \lower tail options, parameter
4       5.0                  \upper tail options, parameter
0                            \1=output point simulation, 0=don't
657352                           \random number seed
1                                \number of block support sizes (1 if
regularized model)
5   10   5                   \ block dimensions type 1: dx,dy,dz
2    5    2                  \ block discretization: ndx,ndy,ndz
1  2  3  4  5  6             \xc,yc,zc,domain,supp,lodnam
8    24                      \min, max data for simulation
6                            \max simulated blocks to use
12                           \max numbers of cond. data per octant
2                            \min numbers of octants with cond. data
3.34                         \multiplier for the search radius (NB – explained
below)
```

Figure 2. Main parameter file (*dbsim.par*)

Broken down into there components the inputs required are.

DATA_DEF		
Field Name	**Type**	**Description**
IXL	Int	Column for X coordinate
IYL	Int	Column for Y coordinate
IZL	Int	Column for Z coordinate
IVRL	Int	Column for variable to be simulated
IWT	Int	Column for declustering weight
IZONE	Int	Column for zone code
ILOD	Int	Column for lode name

TMIN and **TMAX**: All values strictly less than **TMIN** and strictly grater than **TMAX** are ignored.

TRANF_DEF: Interpolation parameters for the lower and upper tail of the distribution used to perform the back-transformation:

TRANSF_DEF		
Field Name	**Type**	**Description**
LTAIL	Int	Interpolation type of for the lower tail
LTPAR	Float	Power model for lower tail interpolation
UTAIL	Int	Interpolation type of for the upper tail
UTPAR	Float	Power model for lower upper Interpol.

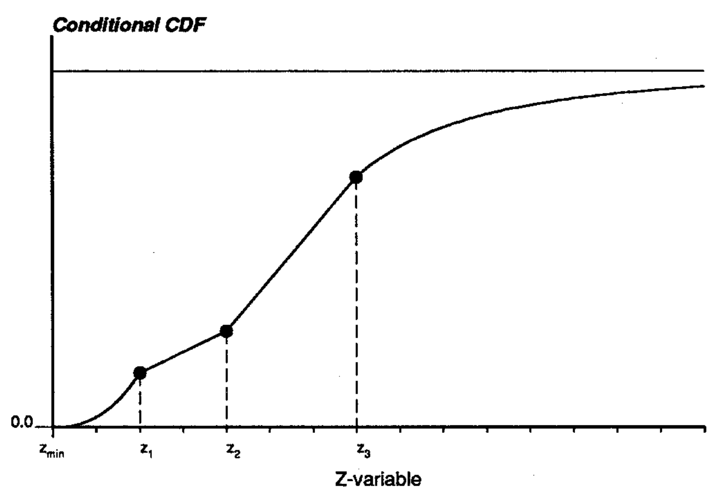


Figure 3. Conditional CDF

In cases where there is a lack of resolution of the cdf the extrapolation beyond the two extreme cdf values is critical. The program provides three types of models for the interpolation and extrapolation of cdf (refer to Deutsch and Journel, 1992 for more clarity):

1) **Linear:** used with normally distributed variables, equivalent to a power model with ω = 1

2) **Power Model**: requires ω parameter, distributions with ω < 1 are positively skewed and distributions with ω > 1 are negatively skewed. If ω = 1 the distribution is uniform. The figure below shows some power models for various ω's.

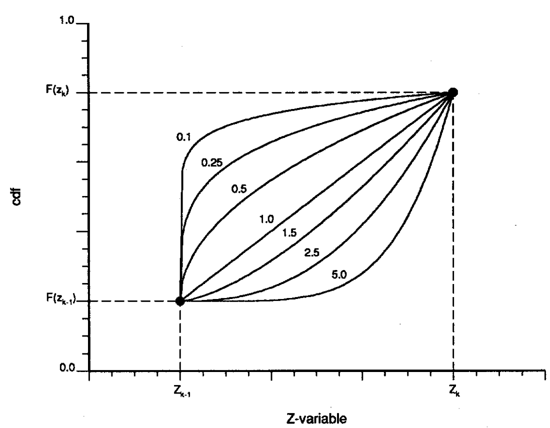


Figure 4. Power model

3) **Hyperbolic Model:** only for the upper tail of a positively skewed distribution requires ω parameter Some power models for various ω's are shown in the Figure below:

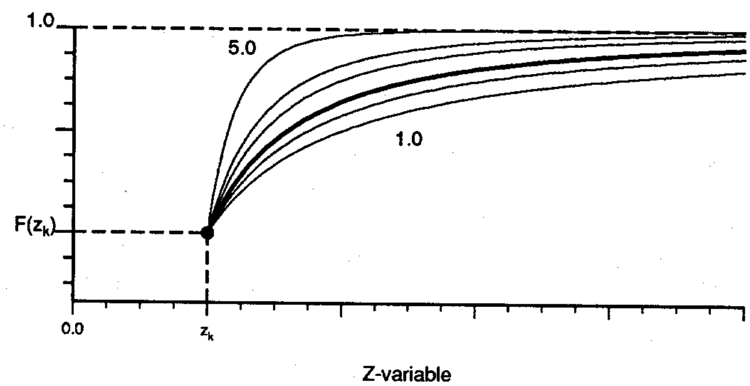


Figure 5. Hyperbolic model

IDBG: If 1=output point simulation, 0=don't. The output file containing the simulations at point support is used for validation purposes. The file will have the same name as the OUTPUT_FL but with extension DBG.

SEED: Seed for the random number generator. The program implements a linear congruential random number generator. One usually runs the simulations in batches of 25. Change this number when running successive batches (eg current # + 2xNo. of simulations in the batch).

NSUP: Number of different block sizes

SUPP_DEF: Block dimensions and discretisation (***1,...,NSUP***). The support ID attributed to each block size must be coordinated with the definitions in the **mod_sim** macro.

SUPP_DEF		
Field Name	**Type**	**Description**
SUPP	Int	Support ID
DBX:DBY:DBZ	Float	Block dimensions
NDX:NDY:NDZ	Float	Number of nodes in each direction

MODEL_DEF: Definition of columns for the variables in the model file

MODEL_DEF		
Field Name	**Type**	**Description**
IXC	Int	Column for XC coordinate
IYC	Int	Column for YC coordinate
IZC	Int	Column for ZCcoordinate
IZO	Int	Column for zone code
ISU	Int	Column for block support code
ILD	Int	Column for lode name

DATA_NUM: Minimum and Maximum number of samples for simulation

DATA_NUM		
Field Name	**Type**	**Description**
NDMIN	Int	Minimum number of samples
NDMAX	Int	Maximum number of samples

BLKMAX: Maximum number of previously simulated blocks to use

OCTMAX: Maximum number of conditioning data per octant

MINOCT: Minimum number of octants with conditioning data.

RADMUL: Multiplier for the search radius

5.2.13.1.4 Temporary Parameter File

Temporary parameter file (*model.par*). The temporary parameter file is generated by the simulation macro (mod_sim.mac) for the simulation of each zonecode. File contains the following parameters separated by comma:

TMP_FL		
Field Name	**Type**	**Description**
ZID	Float	Zonecode
ESTYPE	Float	Estimation type
ANG1	Float	Azimuth of principal direction
ANG2	Float	Dip of principal direction
TCUT	Float	Topcut
XSRADIUS	Float	Search radius in the main dir. (obsolete)
SRC1	Float	Search anisotropy ratio 2nd dir. (obsolete)
SRC2	Float	Search anisotropy ratio 3rd dir. (obsolete)
C0	Float	Nugget contribution to the sill
CC(1)	Float	Contribution of 1st structure to the sill
ANIS1(1)	Float	Anisotropy ratio in the 2nd direction
ANIS2(1)	Float	Anisotropy ratio in the 3rd direction
CC(2)	Float	Contribution of 2nd structure to the sill
ANIS1(2)	Float	Anisotropy ratio in the 2nd direction
ANIS2(2)	Float	Anisotropy ratio in the 3rd direction
NSIM	Float	Number of simulations
AA(1)	Float	range of structure 1 in the 1st direction
AA(2)	Float	range of structure 2 in the 2nd direction

DBSIM uses GSLIB conventions for the specification of the variogram model and spatial anisotropy. For detailed explanation see Deutsch and Journel, 1992. **The variogram type (IT) is hard coded to the spherical model**. The Spherical model is defined by an actual range *a*, and a positive variance contribution *c*. **The search ranges are obsolete as DBSIM has been set up to use the variogram range as a basis for the definition of the search ellipsoid**. A multiplier for the search radius in the principal direction is provided in the main parameter file (*dbsim.par*). Where your ranges for each zone are significantly different you may have to run DBSIM per ZONECODE – (change the input model so that it runs ZONECODEs with similar ranges simultaneously). You specify in the macro if you want the factor to apply to the first (a1) or second (a4) primary range. The search range will then be the {primary variogram range (either a1 or a4) x multiplying factor}.

3.2 Output Files of DBSIM

There are 3 output files generated by the program:

(a) The output file with the simulated block values,

(b) an optional output file with simulated values at point support **(Make sure you have lots of hard drive space),** and

(c) the log file containing summary information about the simulation runs and point histogram values.

3.2.1 Output Block File

Output file with the simulated block grades. This file is ordered according to the input model file **model.dat**. This file is named *ZONE.out* where *ZONE* corresponds to the ZONECODE. *ZONE.out* is ASCII comma separated with the following fields:

OUTPUT_FL		
Field Name	**Type**	**Description**
XC	Float	X coordinate of block centre
YC	Float	Y coordinate of block centre
ZC	Float	Z coordinate of block centre
SIMB	Float	Simulated block normal score
SIM	Float	Simulated block value
LODENAM	Float	Lode name
SUP	Float	Support code

3.2.2 Output Point File

Output file with the simulated internal points of each block. Generated if **IDBG**=1 is selected in the **dbsim.par**. This file is named *ZONE.dbg* where *ZONE* corresponds to the ZONECODE. *ZONE.dbg* is ASCII comma separated with the following fields:

DBG_FL		
Field Name	**Type**	**Description**
XDP	Float	X coordinate of the int. point
YDP	Float	Y coordinate of the int. point
ZDP	Float	Z coordinate of the int. point
TRVAL	Float	Simulated nscore value
GRADE	Float	Simulated grade value
LODE	Int	Lode name

3.2.4 Log File

Log file with a report summary of the simulation runs. This file is named *ZONE (with no extension)*, where ZONE corresponds to the ZONECODE. It contains the following information:

The initial statistics presented in this report are for the whole zone and not by lode as the simulation is performed. Some key information as the total number of simulated nodes, total number of blocks and total number of simulated blocks are useful as a validation check for the user.

The point histograms are added at the end of the realisation's logging information. The histograms are presented for each lode with more than 50 conditioning samples. The first column corresponds to the upper limit of the histogram bin; the second column corresponds to the frequency values of the conditioning data set; and the remaining columns are the frequency values for each one of the realisations. Two separated rows are presented at the end of *histogram data which correspond to the mean and variance of the each histogram.*

The log file includes the starting and finishing time of the simulation run. All error messages are also written to the log file.

4. POST PROCESSING MACROS

Two post processing macros are provided to enable the DBSIM user to carry out validation studies on the simulated models as well as to derive grade uncertainty measures from multiple simulations, these are **gam_sim.mac** and **post_sim.mac** respectively, both of which can be called from the **menu_sim.mac** datamine macro.

The first (**gam_sim.mac**) calculates the experimental block support variograms for each one of the simulated models, and performs the regularisation of the input point support normal score variogram model to the block support used in the simulation Note it only does this for the normal score model. The second (**post_sim.mac**) calculates uncertainty measures such as e-type estimate, probability above a user defined cutoff, conditional variance, range for a user defined probability interval, probability below the e-type estimate, grades corresponding to user defined probability values, and conditional coefficient of variation.

4.1 Variogram Model Validation

The variogram validation data is calculated by the **gam_sim** macro, which can be started by selecting option 2 in the main menu. The user must enter via keyboard the number of realisations, zonecode, azimuth, dip, lag distance, and number of lags for the variogram calculation. Due to Datamine limitations the calculation of the experimental variograms can only be carried out for a maximum of 23 simulated models in a single run. The process requires an external parameter file, named *blkconv.par*, describing the block size and number of discretisation points to be used in the regularisation of the point variogram model. *blkconv.par* is a comma separated ASCII file of the following format:

Blkconv.par		
Field Name	**Type**	**Description**
DBX,DBY,DBZ	Float	Block dimensions
NDX,NDY,NDZ	Float	Number of nodes in each direction

The remaining files required by the **gam_sim** are automatically generated by the previous step of conditional simulation (**mod_sim**): INVARPAR, SIMULMOD, *model.par*, *blocklst.dat* and the output files **OUTPUT_FL.** The output file with the multiple variograms is named GAMSIM. The user can run Datamine's VARFIT to visualise the variograms. A file named GAMAMOD is also generated and contains the normal score block values imported from the DBSIM's output files. GAMAMOD can be used reused to speed up subsequent variogram calculations for different zones. More information about the process can be found directly in **gam_sim**. **NB – DBSIM flags absent values as -999. This plays havoc with the variance/sill of the experimental variogram so check GAMAMOD simulations and set -999's to absent before running VGRAM.**

4.2 Uncertainty Measures

The calculation of uncertainty measures is carried out by **post_sim,** which can be started by selecting option 3 in the main menu. The only parameters required by **post_sim** are entered interactively by the user and consist of the number of realisations, up to four file names with 25 realisations each, and a cutoff grade. INTEV# = 0.9 is hard-coded up front and specifies the 90% confidence interval will be used for probability calculations.

The process requires SIMULMOD and up two four DBSIMX files. The uncertainty measures are written to an output file named UNCERT. The following measures and respective fields are: e-type estimate (**MEAN**), probability above a given cutoff (**PROB**), conditional variance (**CVAR**), range for a user defined probability interval (**IRANGE**), probability below the e-type estimate (**ZPROB**), grades corresponding to user defined probability values (**ZLOW** and **ZUPP**), and conditional coefficient of variation (**CCV**).

A script file named view_sim.htm is provided to facilitate the visualisation of the simulations and related uncertainty measures. The script contains pre-defined colour coding for the legends to be used in the visualisation of **PROB**, **CCV**, and any user defined field. The latter is set to be used with the block grades. The user can change the colour coding by editing the file on any text editor program.

5. TROUBLESHOOTING

5.1 Error Messages

If an error occurs during processing the error message is printed to the screen and to the log file. The following table describes the errors and their respective solutions. Some of the program limits have changed all are hard coded in the executable and cannot be changed without the code.

ERROR MESSAGES		
Error	**Description**	**Solution**
1	Error in parameter file	Check parameter file *dbsim.par*
2	Error in data file	Check data file *cmp<LODE>.dat*
3	Exceeded MAXDAT	Redefine MAXDAT or decrease sample set
4	Error in model file	Check model file – *model.dat*
5	Invalid **TRANSF_DEF** option	Check **TRANSF_DEF** parameters
17	Exceeded MAXLOD	Redefine MAXLOD or decrease number of lodes in model file
30	Exceeded max. number of samples	Redefine MAXSAM or decrease **NDMAX**
31	Nscore critical error	- No data to transform - Unacceptable cdf value - Despiking is necessary
40	Exceeded max. number of blocks	Redefine MAXB or decrease number of blocks in the model
43	Exceeded max. number of sizes	Redefine MAXSIZ or decrease **NSUP**
44	Exceeded max. discr. points in X	Redefine MAXX or decrease **NDX**
45	Exceeded max. discr. points in Y	Redefine MAXY or decrease **NDY**
46	Exceeded max. discr. points in Z	Redefine MAXZ or decrease **NDZ**
47	Exceeded max. number of conditioning blocks	Redefine MAXBLK or decrease **BLKMAX**
50	chol **-** not positive definite	Check variogram model

5.2 Hard Coded Parameters

Some DBSIM parameters are hard coded. The following table presents the hard coded parameters with their respective values:

HARD CODED PARAMETERS		
Constant	**Value**	**Description**
MAXB	500,000	Maximum number of blocks in a single zone
MAXX	10	Maximum number of discretization points in X
MAXY	10	Maximum number of discretization points in Y
MAXZ	10	Maximum number of discretization points in Z
MAXDAT	200,000	Maximum number of data altogether
MAXSAM	32	Maximum number of conditioning samples
MAXBLK	16	Maximum number of conditioning blocks
MAXNST	2	Max. number of nested structures for variogram
MAXSIZ	20	Maximum number of block sizes
MAXLOD	100	Maximum number of lodes

APPENDIX B REPRODUCTION OF BASE STATISTICS

Zone Code	Realisation Number	Raw Grade Data Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
1000	1	1.54	6.40	32.48	0.01	503,800
1000	2	1.45	4.87	32.48	0.01	503,300
1000	3	1.55	6.39	32.48	0.01	503,300
1000	4	1.53	6.43	32.48	0.01	503,300
1000	5	1.49	5.59	32.48	0.01	503,300
1000	6	1.56	6.31	32.48	0.01	503,300
1000	7	1.52	5.85	32.48	0.01	503,300
1000	8	1.44	5.33	32.48	0.01	503,300
1000	9	1.62	6.55	32.48	0.01	503,300
1000	10	1.54	5.79	32.48	0.01	503,300
1000	**Cond. Data**	**1.65**	**7.27**	**39.24**	**0.00**	**1,924**
2000	1	0.32	1.06	87.32	0.00	16,777,000
2000	2	0.33	1.09	87.32	0.00	16,777,000
2000	3	0.33	0.99	87.32	0.00	16,777,000
2000	4	0.31	0.76	87.32	0.00	16,777,000
2000	5	0.33	1.21	87.32	0.00	16,777,000
2000	6	0.31	0.72	87.32	0.00	16,777,000
2000	7	0.32	0.93	87.32	0.00	16,777,000
2000	8	0.31	0.83	87.32	0.00	16,777,000
2000	9	0.32	0.86	82.10	0.00	16,777,000
2000	10	0.31	0.85	87.32	0.00	16,777,000
2000	**Cond. Data**	**0.36**	**1.69**	**0.00**	**122.00**	**46,868**
3000	1	1.97	18.67	107.34	0.00	1,614,100
3000	2	1.86	17.01	139.01	0.00	1,610,500
3000	3	2.01	23.36	139.01	0.00	1,610,500
3000	4	2.00	21.31	139.01	0.00	1,610,500
3000	5	2.02	22.59	139.01	0.00	1,610,500
3000	6	1.95	19.83	139.01	0.00	1,610,500
3000	7	1.99	22.14	139.01	0.00	1,610,500
3000	8	1.97	21.49	139.01	0.00	1,610,500
3000	9	1.99	21.82	139.01	0.00	1,610,500
3000	10	1.96	21.07	139.01	0.00	1,610,500
3000	**Cond. Data**	**2.03**	**25.74**	**154.00**	**0.00**	**6,273**
4000	1	2.65	20.71	203.00	0.00	6,344,100
4000	2	2.63	19.99	281.00	0.00	6,326,400
4000	3	2.71	25.13	281.00	0.00	6,326,400
4000	4	2.66	21.03	281.00	0.00	6,326,400
4000	5	2.65	23.20	281.00	0.00	6,326,400
4000	6	2.64	22.08	281.00	0.00	6,326,400
4000	7	2.66	21.77	281.00	0.00	6,326,400
4000	8	2.62	20.23	281.00	0.00	6,326,400
4000	9	2.66	20.83	183.00	0.00	6,329,100
4000	10	2.69	21.92	281.00	0.00	6,326,400
4000	**Cond. Data**	**2.93**	**32.18**	**281.00**	**0.00**	**24,826**

Table B.1 Raw grade data statistics for ZONECODE 1000 to 4000

Zone Code	Realisation Number	Raw Grade Data Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
5000	1	3.03	16.43	55.40	0.01	1,922,200
5000	2	2.91	9.57	31.85	0.00	1,871,000
5000	3	2.92	9.75	31.85	0.00	1,871,000
5000	4	2.93	9.42	31.85	0.00	1,871,000
5000	5	2.90	9.47	31.85	0.00	1,871,000
5000	6	2.82	8.84	31.85	0.00	1,871,000
5000	7	2.95	9.88	31.85	0.00	1,871,000
5000	8	2.82	9.04	31.85	0.00	1,871,000
5000	9	2.90	9.67	31.85	0.00	1,871,000
5000	10	2.96	10.14	31.85	0.00	1,871,000
5000	**Cond. Data**	**2.84**	**8.73**	**234.23**	**0.00**	**3,846**
6000	1	1.40	5.68	43.75	0.00	3,801,000
6000	2	1.40	6.80	60.60	0.00	3,770,200
6000	3	1.38	6.44	60.60	0.00	3,770,200
6000	4	1.43	7.07	60.60	0.00	3,770,200
6000	5	1.36	6.42	60.60	0.00	3,770,200
6000	6	1.35	6.23	60.60	0.00	3,770,200
6000	7	1.41	7.01	60.60	0.00	3,770,200
6000	8	1.36	6.48	60.60	0.00	3,770,200
6000	9	1.44	7.27	60.60	0.00	3,770,200
6000	10	1.36	6.39	60.60	0.00	3,770,200
6000	**Cond. Data**	**1.36**	**6.26**	**88.15**	**0.00**	**7,017**
7000	1	1.19	6.24	33.40	0.00	2,890,200
7000	2	1.22	8.33	67.70	0.00	2,421,200
7000	3	1.23	8.45	67.70	0.00	2,421,200
7000	4	1.17	7.03	67.70	0.00	2,411,600
7000	5	1.26	10.65	67.70	0.00	2,421,200
7000	6	1.24	8.41	67.70	0.00	2,421,200
7000	7	1.25	8.71	67.70	0.00	2,421,200
7000	8	1.19	7.68	67.70	0.00	2,421,200
7000	9	1.33	10.46	67.70	0.00	2,421,200
7000	10	1.27	9.14	67.70	0.00	2,421,200
7000	**Cond. Data**	**1.14**	**6.94**	**67.70**	**3.63**	**3,626**
8000	1	2.16	19.30	54.81	0.01	568,200
8000	2	2.34	38.38	89.71	0.01	409,200
8000	3	2.54	47.66	89.71	0.01	409,200
8000	4	2.52	44.23	89.71	0.01	409,200
8000	5	2.36	36.35	89.71	0.01	409,200
8000	6	2.32	40.06	89.71	0.01	409,200
8000	7	2.29	38.49	89.71	0.01	409,200
8000	8	2.24	36.91	89.71	0.01	409,200
8000	9	2.40	38.68	89.71	0.01	409,200
8000	10	2.27	33.87	89.71	0.01	409,200
8000	**Cond. Data**	**2.09**	**28.49**	**89.71**	**0.01**	**828**

Table B.2 Raw grade data statistics for ZONECODE 5000 to 8000

Zone Code	Realisation Number	Raw Grade Data Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
9000	1	0.51	0.64	31.91	0.00	16,777,000
9000	2	0.54	0.69	31.91	0.00	16,777,000
9000	3	0.53	0.60	31.91	0.00	16,777,000
9000	4	0.52	0.57	31.91	0.00	16,777,000
9000	5	0.53	0.73	43.39	0.00	16,777,000
9000	6	0.51	0.63	43.39	0.00	16,777,000
9000	7	0.52	0.64	31.91	0.00	16,777,000
9000	8	0.50	0.57	43.39	0.00	16,777,000
9000	9	0.54	0.68	31.91	0.00	16,777,000
9000	10	0.52	0.54	31.91	0.00	16,777,000
9000	**Cond. Data**	**0.26**	**0.54**	**106.00**	**0.00**	**47,048**

Table B.3 Raw grade data statistics for ZONECODE 9000

Zone Code	Realisation Number	Normal Score Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
1000	1	-0.07	1.01	4.43	-5.04	503,800
1000	2	-0.05	0.91	4.19	-4.39	503,300
1000	3	-0.04	0.96	5.03	-4.45	503,300
1000	4	-0.06	0.99	4.96	-5.39	503,300
1000	5	-0.05	0.94	4.15	-4.82	503,300
1000	6	-0.03	0.97	4.64	-5.27	503,300
1000	7	-0.05	0.96	4.44	-4.62	503,300
1000	8	-0.07	0.93	4.53	-4.53	503,300
1000	9	0.01	0.95	4.35	-4.52	503,300
1000	10	-0.02	0.93	4.21	-4.44	503,300
1000	**Cond. Data**	**0.00**	**1.00**	**3.54**	**-3.16**	**1,924**
2000	1	-0.12	1.10	5.40	-5.60	16,777,000
2000	2	-0.12	1.13	5.04	-5.45	16,777,000
2000	3	-0.09	1.11	5.02	-5.68	16,777,000
2000	4	-0.13	1.09	4.91	-5.68	16,777,000
2000	5	-0.11	1.12	5.08	-5.78	16,777,000
2000	6	-0.10	1.05	4.69	-5.60	16,777,000
2000	7	-0.13	1.12	4.63	-5.86	16,777,000
2000	8	-0.13	1.09	4.80	-5.61	16,777,000
2000	9	-0.11	1.10	4.94	-5.45	16,777,000
2000	10	-0.11	1.09	4.94	-5.57	16,777,000
2000	**Cond. Data**	**0.00**	**0.99**	**4.31**	**-3.21**	**46,868**

Table B.4 Normal score statistics for ZONECODE 1000 to 2000

Zone Code	Realisation Number	Normal Score Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
3000	1	-0.01	1.01	4.60	-4.73	1,614,100
3000	2	-0.01	0.95	4.67	-5.07	1,610,500
3000	3	0.01	0.99	4.92	-4.81	1,610,500
3000	4	0.01	0.99	4.78	-5.03	1,610,500
3000	5	0.02	0.99	4.83	-5.14	1,610,500
3000	6	0.00	0.97	4.24	-4.50	1,610,500
3000	7	0.01	0.97	5.14	-4.55	1,610,500
3000	8	-0.01	1.00	4.48	-4.95	1,610,500
3000	9	0.02	0.95	4.57	-4.84	1,610,500
3000	10	0.00	0.99	4.74	-5.22	1,610,500
3000	**Cond. Data**	**0.00**	**1.00**	**3.84**	**-3.57**	**6,273**
4000	1	-0.05	0.95	5.35	-5.10	6,344,100
4000	2	-0.05	0.94	4.65	-5.42	6,326,400
4000	3	-0.04	0.95	4.82	-5.46	6,326,400
4000	4	-0.05	0.93	4.90	-5.17	6,326,400
4000	5	-0.06	0.94	4.96	-5.16	6,326,400
4000	6	-0.06	0.94	4.89	-5.32	6,326,400
4000	7	-0.05	0.95	4.67	-5.11	6,326,400
4000	8	-0.07	0.96	4.45	-5.29	6,326,400
4000	9	-0.04	0.95	4.71	-5.06	6,329,100
4000	10	-0.04	0.94	4.55	-5.16	6,326,400
4000	**Cond. Data**	**0.00**	**1.00**	**4.17**	**-3.01**	**24,826**
5000	1	0.00	1.10	5.05	-5.12	1,922,200
5000	2	0.00	1.08	4.59	-5.55	1,871,000
5000	3	0.00	1.09	4.98	-5.14	1,871,000
5000	4	0.01	1.07	4.81	-5.55	1,871,000
5000	5	0.00	1.07	5.10	-5.02	1,871,000
5000	6	-0.03	1.06	4.72	-5.23	1,871,000
5000	7	0.02	1.08	4.67	-5.24	1,871,000
5000	8	-0.03	1.07	4.66	-5.73	1,871,000
5000	9	0.00	1.08	5.05	-5.16	1,871,000
5000	10	0.01	1.10	5.22	-5.80	1,871,000
5000	**Cond. Data**	**0.00**	**1.00**	**3.72**	**-2.47**	**3,846**
6000	1	0.00	1.08	5.34	-5.34	3,801,000
6000	2	0.00	1.05	4.83	-5.28	3,770,200
6000	3	0.00	1.03	5.02	-5.18	3,770,200
6000	4	0.02	1.05	4.77	-4.99	3,770,200
6000	5	-0.01	1.04	4.70	-5.25	3,770,200
6000	6	-0.03	1.04	5.69	-4.92	3,770,200
6000	7	0.00	1.07	4.74	-5.48	3,770,200
6000	8	-0.02	1.05	4.90	-6.10	3,770,200
6000	9	0.03	1.04	5.10	-4.89	3,770,200
6000	10	-0.01	1.03	5.14	-5.08	3,770,200
6000	**Cond. Data**	**0.00**	**1.00**	**3.87**	**-3.87**	**7,017**

Table B.5 Normal Score statistics for ZONECODE 3000 to 6000

Zone Code	Realisation Number	Normal Score Statistic				
		Mean	Variance	Maximum	Minimum	Number of samples
7000	1	-0.04	1.12	5.14	-5.77	2,890,200
7000	2	-0.01	1.10	4.87	-5.48	2,421,200
7000	3	0.01	1.09	5.37	-5.11	2,421,200
7000	4	-0.01	1.10	4.77	-5.46	2,411,600
7000	5	-0.01	1.11	6.26	-5.44	2,421,200
7000	6	0.02	1.08	5.42	-5.80	2,421,200
7000	7	0.01	1.11	5.67	-5.37	2,421,200
7000	8	0.00	1.07	5.23	-4.95	2,421,200
7000	9	0.06	1.08	5.34	-4.75	2,421,200
7000	10	0.03	1.09	5.34	-5.13	2,421,200
7000	**Cond. Data**	**0.00**	**1.00**	**3.71**	**-3.22**	**3,626**
8000	1	0.02	1.11	5.02	-4.62	568,200
8000	2	0.01	1.11	5.41	-4.76	409,200
8000	3	0.03	1.16	5.01	-4.94	409,200
8000	4	0.06	1.13	5.25	-4.85	409,200
8000	5	0.03	1.13	5.02	-4.95	409,200
8000	6	-0.04	1.17	4.74	-4.74	409,200
8000	7	-0.04	1.17	4.64	-4.90	409,200
8000	8	-0.05	1.15	4.67	-4.65	409,200
8000	9	0.03	1.13	4.95	-5.16	409,200
8000	10	0.01	1.09	4.40	-4.86	409,200
8000	**Cond. Data**	**0.00**	**1.00**	**3.31**	**-3.31**	**828**
9000	1	-0.19	2.29	5.27	-5.68	16,777,000
9000	2	-0.15	2.36	5.32	-5.82	16,777,000
9000	3	-0.15	2.28	4.96	-5.30	16,777,000
9000	4	-0.15	2.29	5.01	-5.42	16,777,000
9000	5	-0.16	2.35	5.08	-5.40	16,777,000
9000	6	-0.16	2.26	5.09	-5.42	16,777,000
9000	7	-0.16	2.32	5.03	-5.57	16,777,000
9000	8	-0.17	2.24	5.55	-5.20	16,777,000
9000	9	-0.13	2.35	5.30	-5.71	16,777,000
9000	10	-0.14	2.24	4.98	-5.72	16,777,000
9000	**Cond. Data**	**0.00**	**1.00**	**4.31**	**-3.14**	**47,048**

Table B.6 Normal Score statistics for ZONECODE 7000 to 9000

APPENDIX C REPRODUCTION OF THE HISTOGRAMS

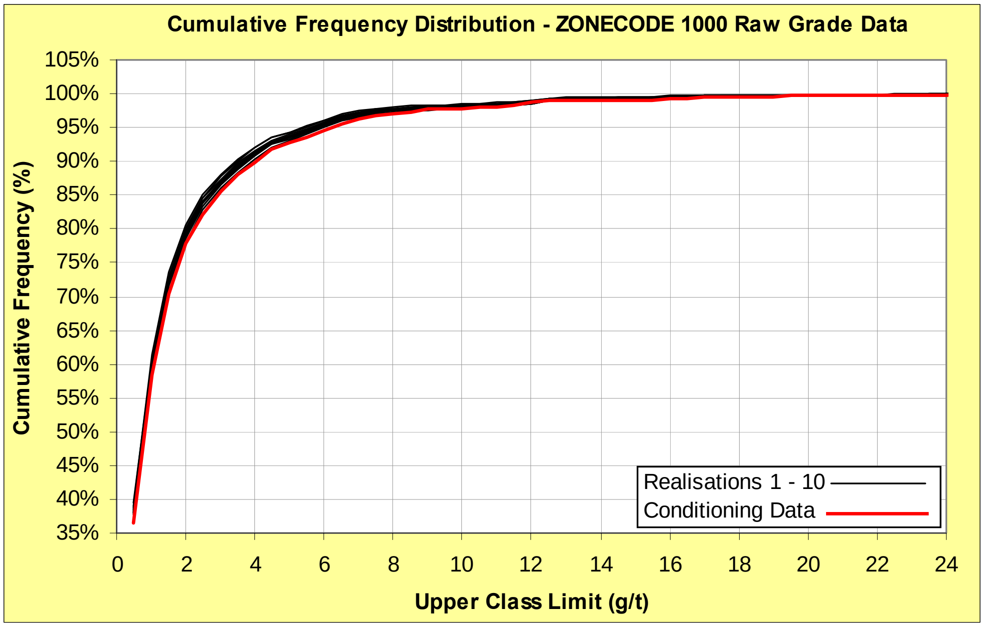


Figure C.1 Cumulative Frequency Distribution Zonecode 1000 Raw Data

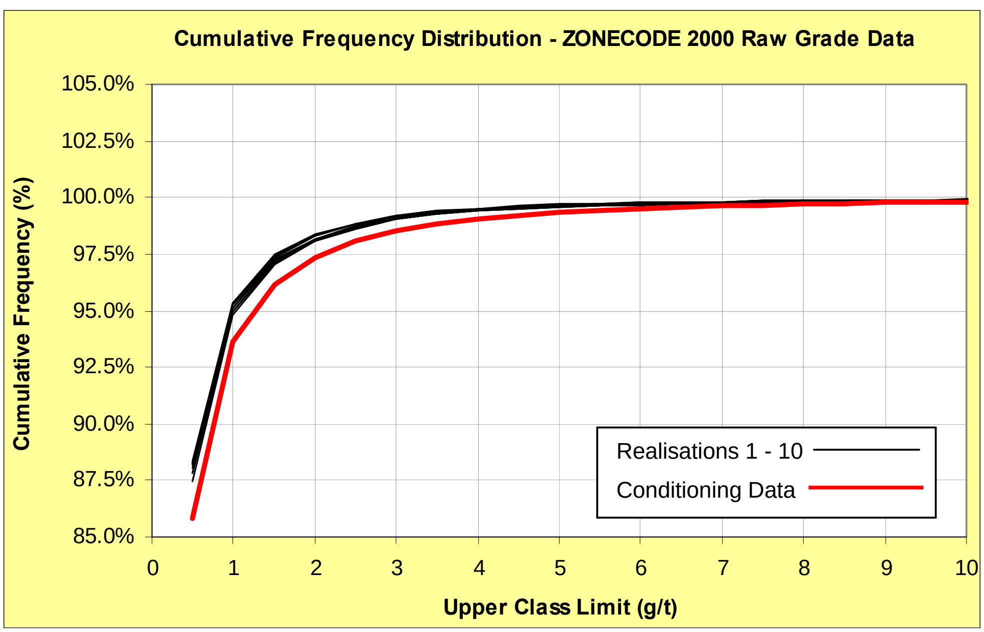


Figure C.2 Cumulative Frequency Distribution Zonecode 2000 Raw Data

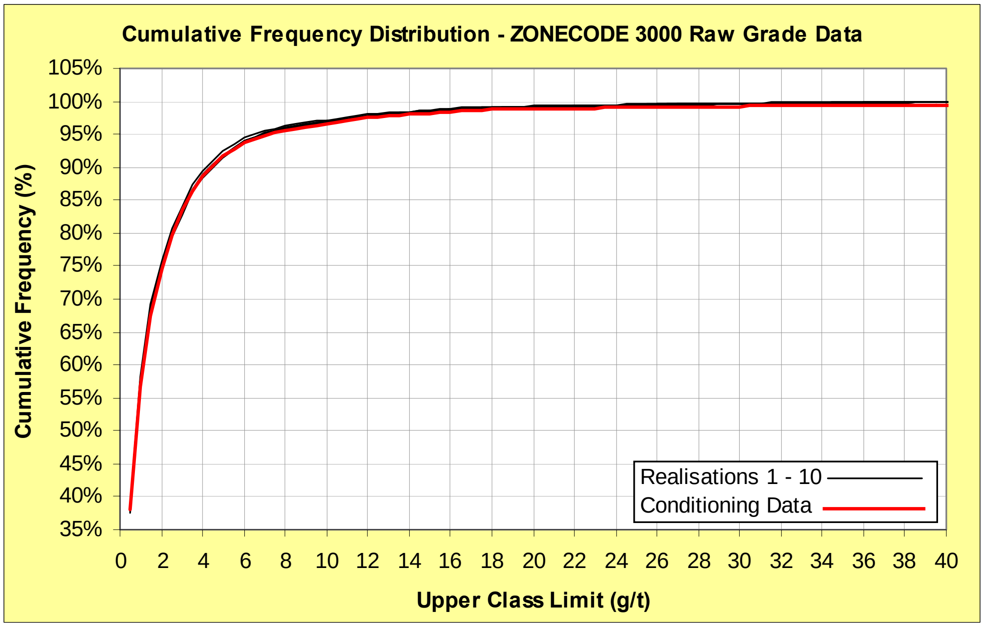


Figure C.3 Cumulative Frequency Distribution Zonecode 3000 Raw Data

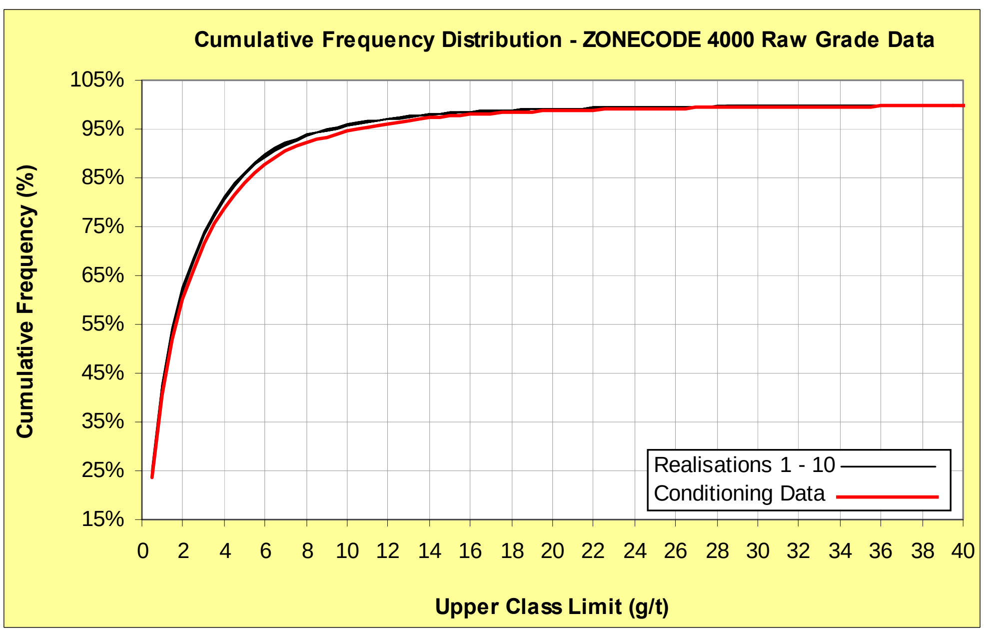


Figure C.4 Cumulative Frequency Distribution Zonecode 4000 Raw Data

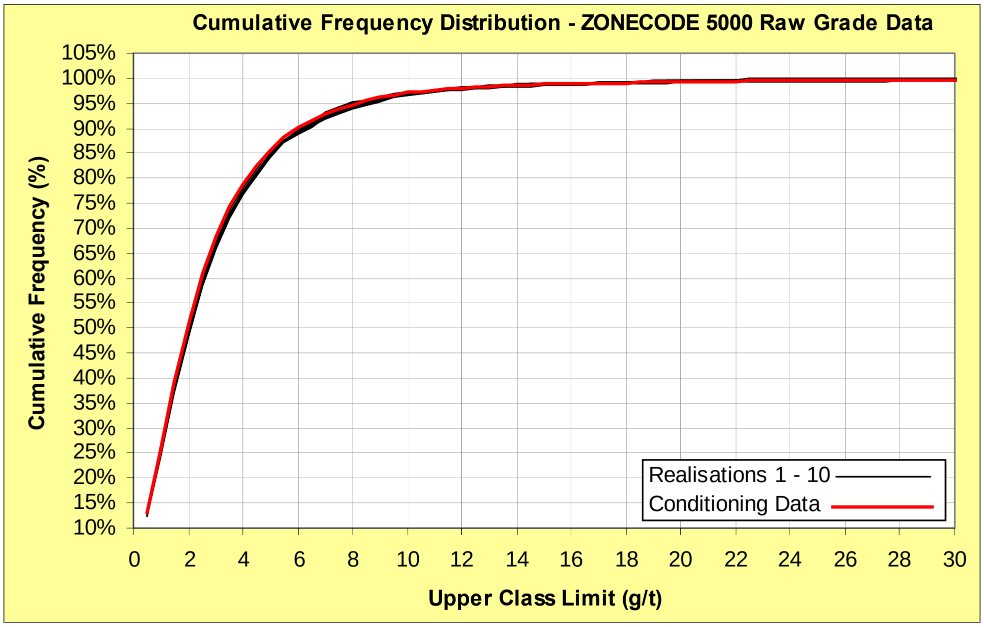


Figure C.5 Cumulative Frequency Distribution Zonecode 5000 Raw Data

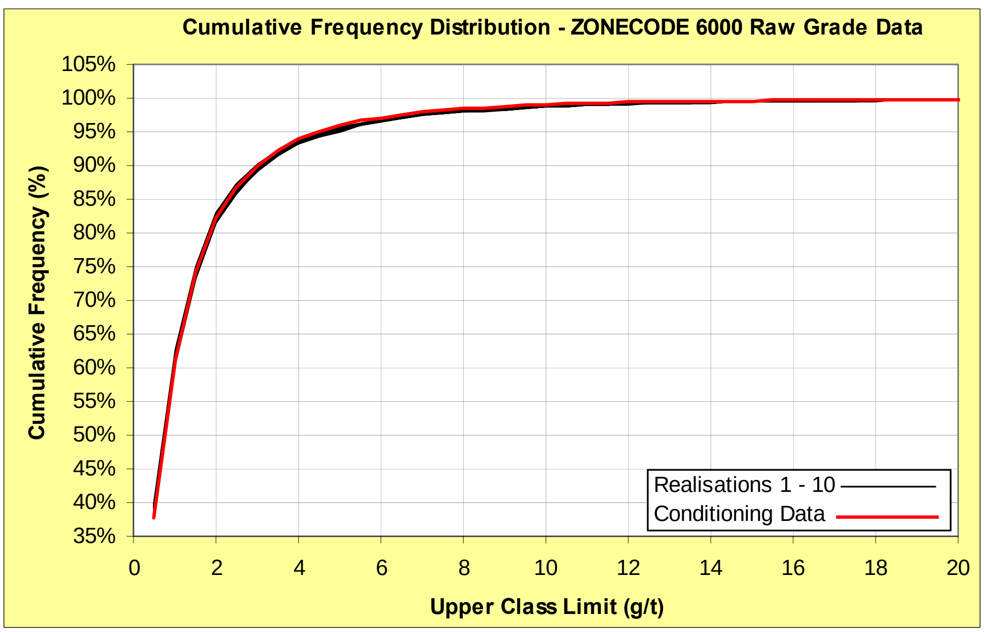


Figure C.6 Cumulative Frequency Distribution Zonecode 6000 Raw Data

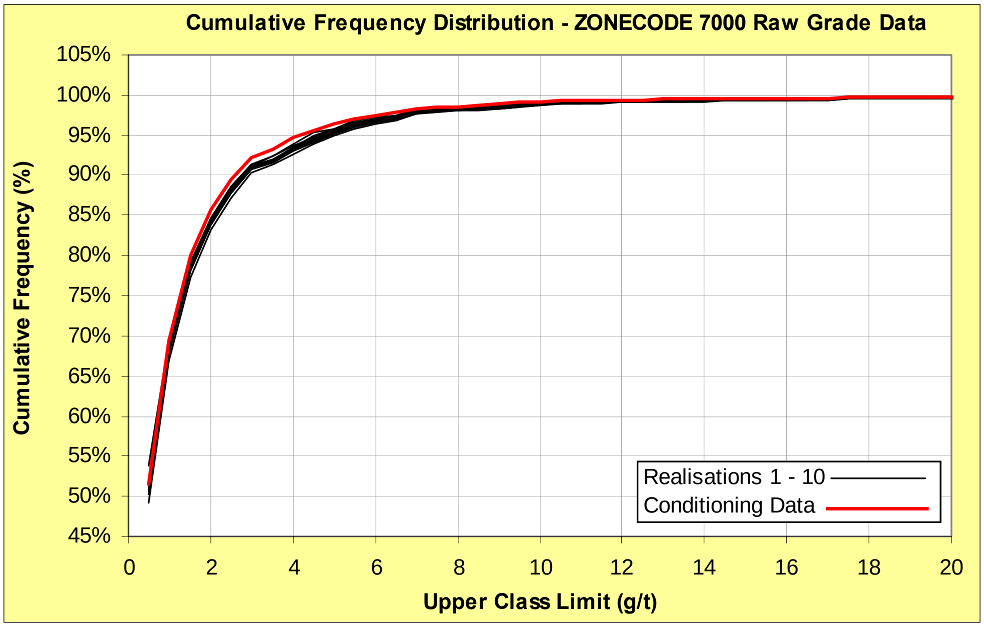


Figure C.7 Cumulative Frequency Distribution Zonecode 7000 Raw Data

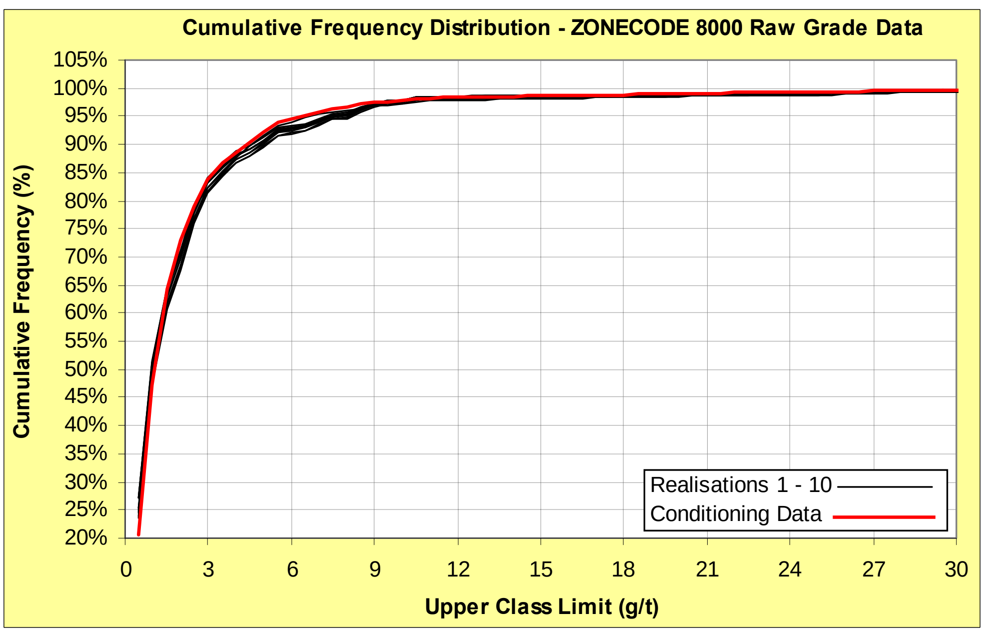


Figure C.8 Cumulative Frequency Distribution Zonecode 8000 Raw Data

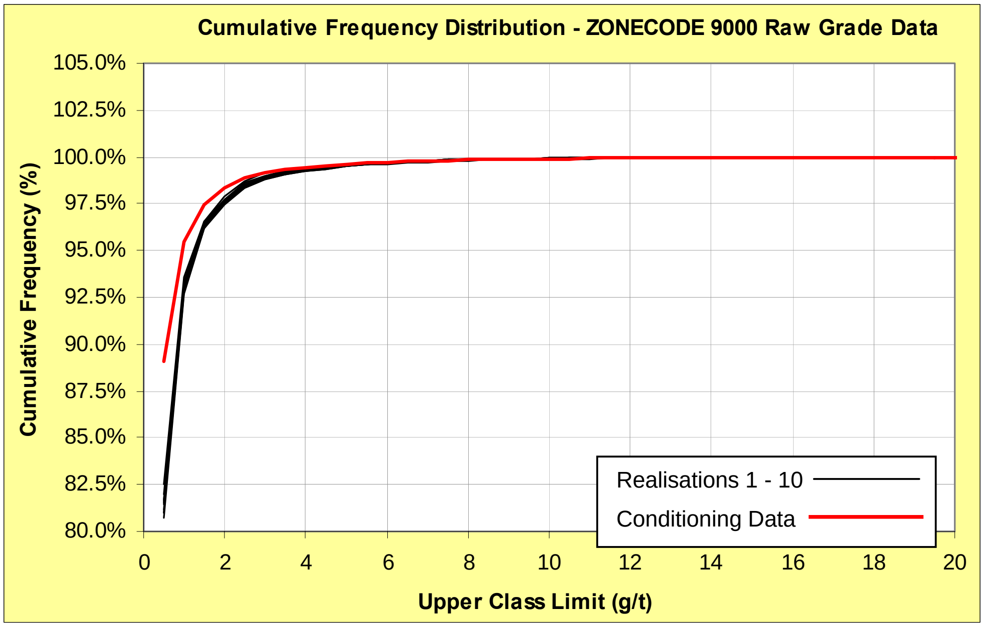


Figure C.9 Cumulative Frequency Distribution Zonecode 9000 Raw Data

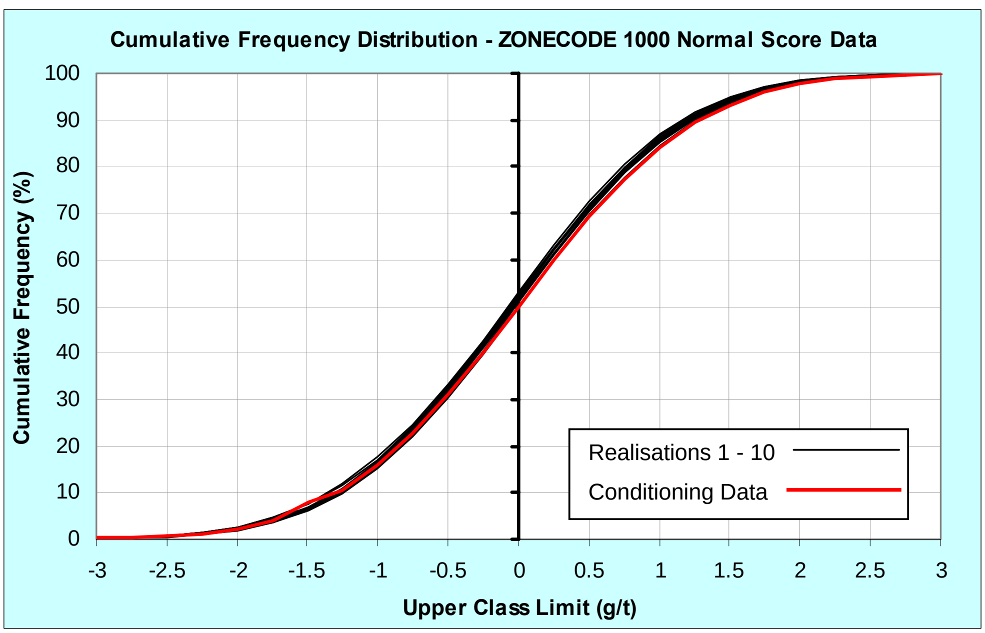


Figure C.10 Cumulative Frequency Distribution Zonecode 1000 NSC Data

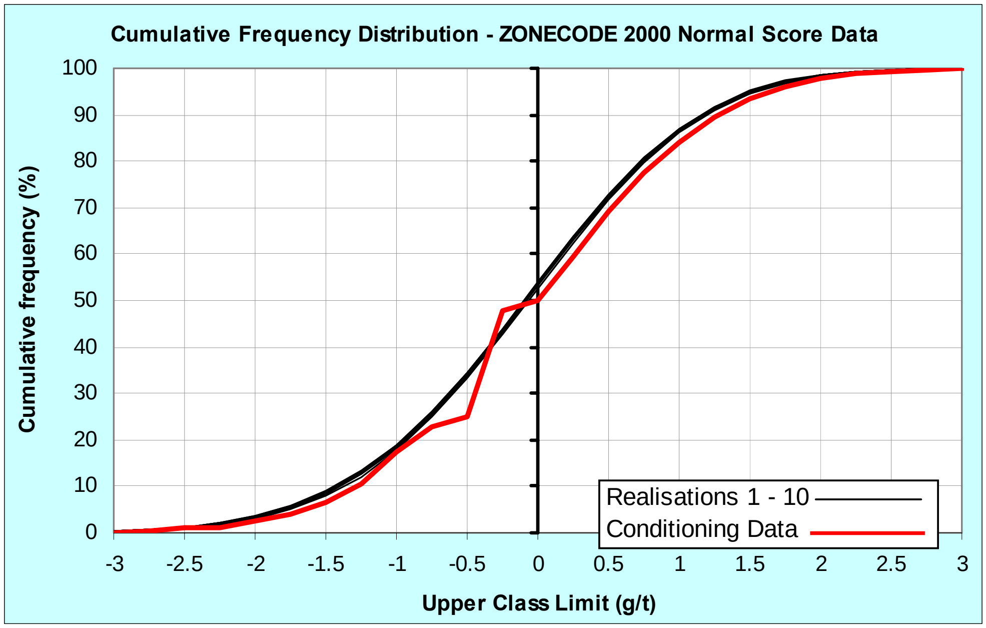


Figure C.11 Cumulative Frequency Distribution Zonecode 2000 NSC Data

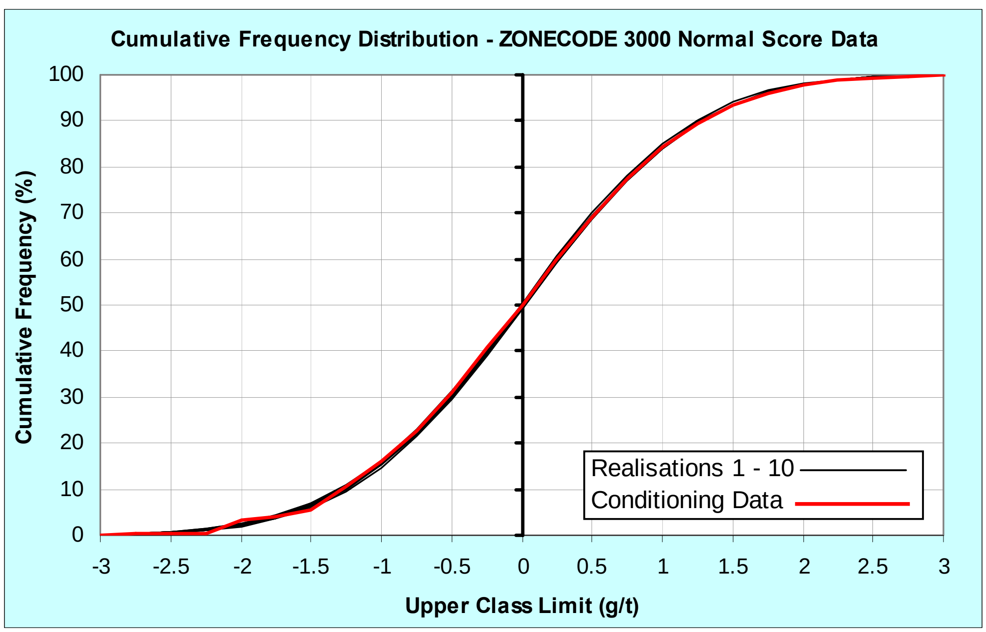


Figure C.12 Cumulative Frequency Distribution Zonecode 3000 NSC Data

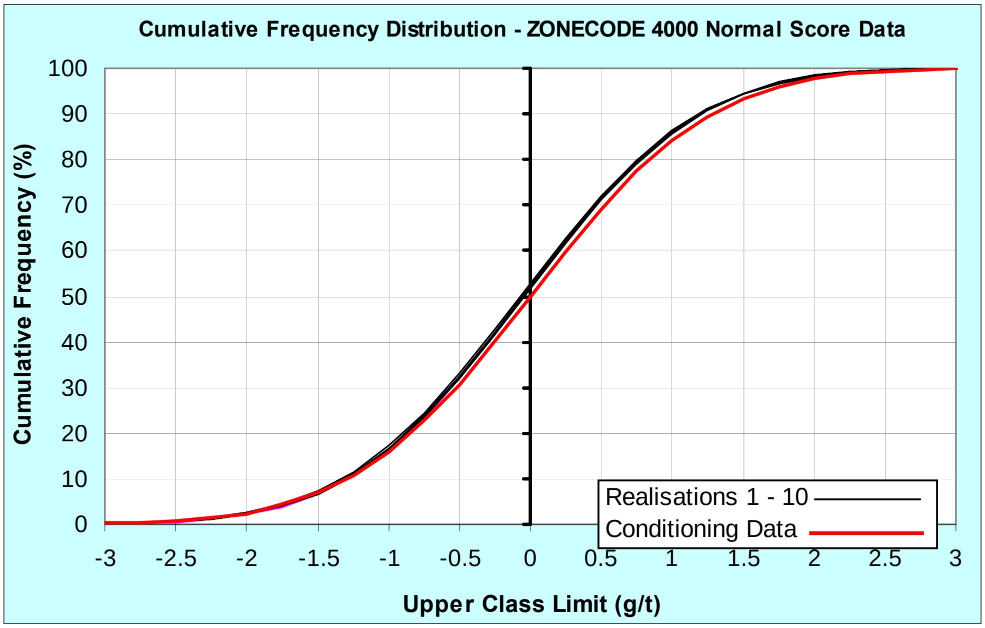


Figure C.13 Cumulative Frequency Distribution Zonecode 4000 NSC Data

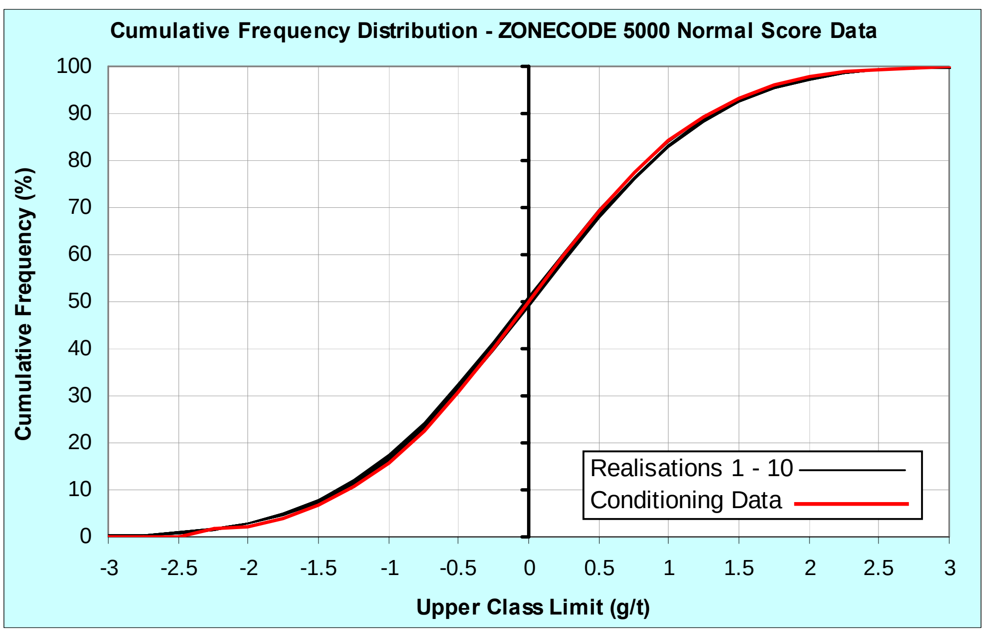


Figure C.14 Cumulative Frequency Distribution Zonecode 5000 NSC Data

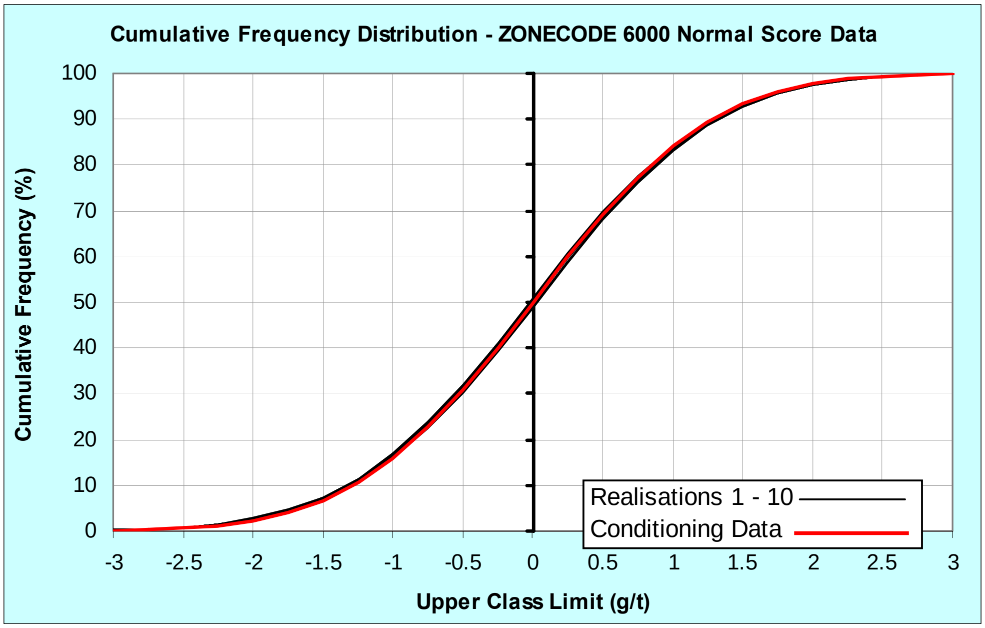


Figure C.15 Cumulative Frequency Distribution Zonecode 6000 NSC Data

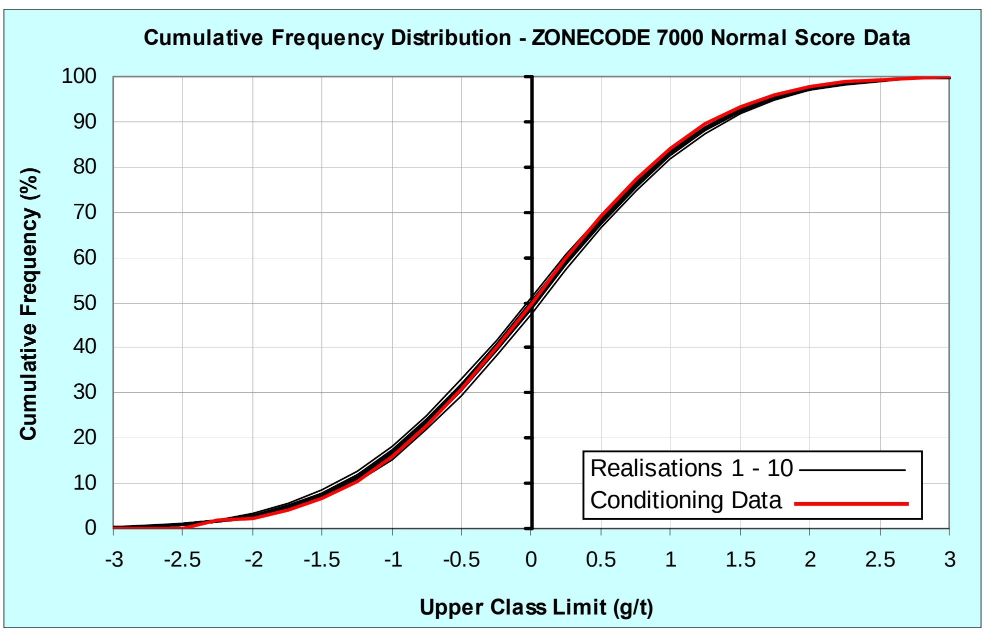


Figure C.16 Cumulative Frequency Distribution Zonecode 7000 NSC Data

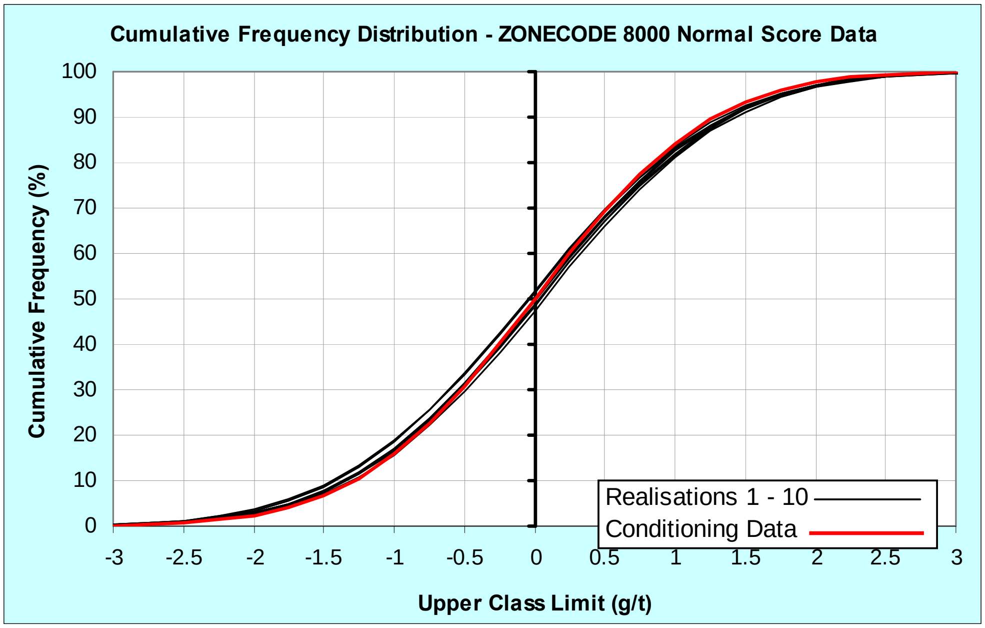


Figure C.17 Cumulative Frequency Distribution Zonecode 8000 NSC Data

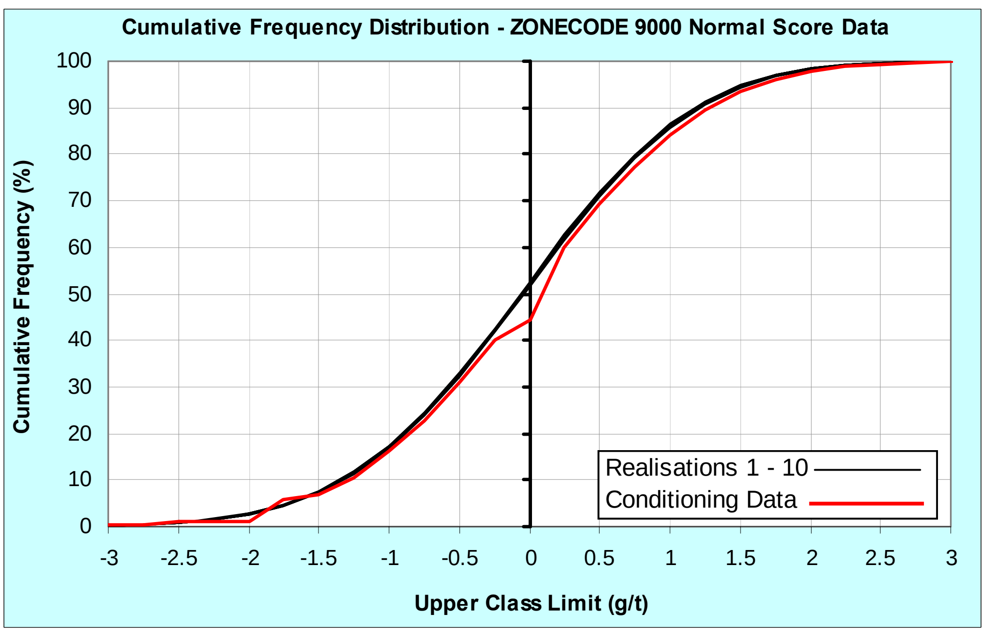
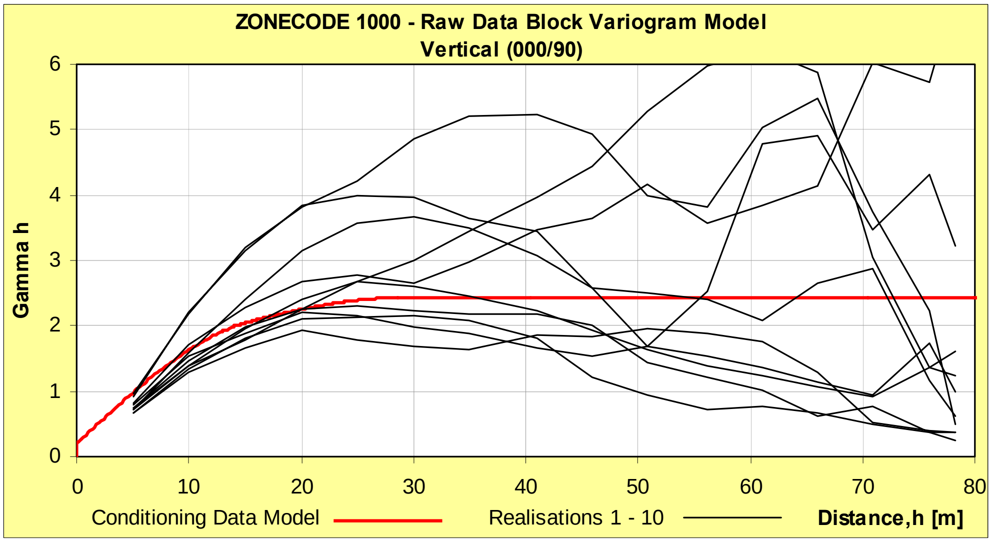
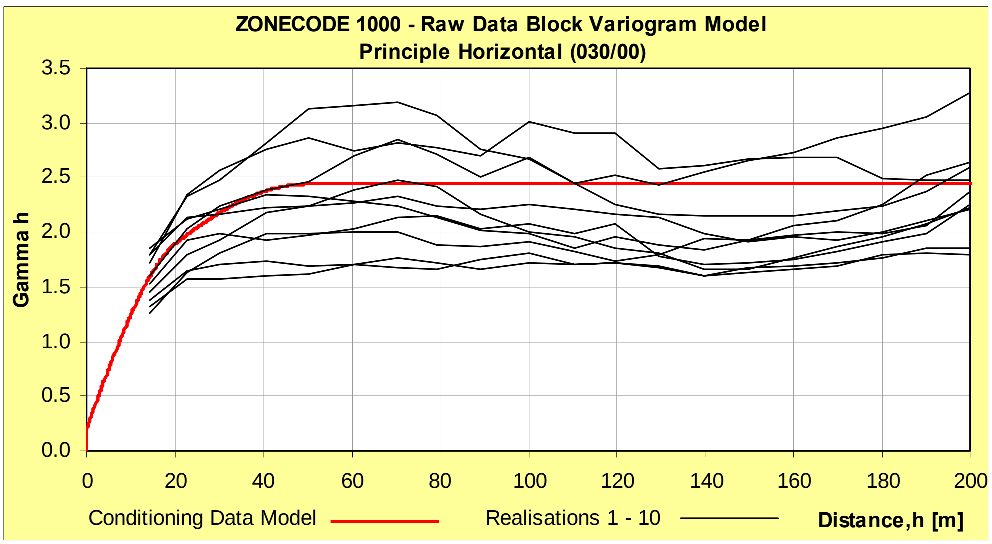


Figure C.18 Cumulative Frequency Distribution Zonecode 9000 NSC Data

APPENDX D REPRODUCTION OF SEMI-VARIOGRAM MODELS





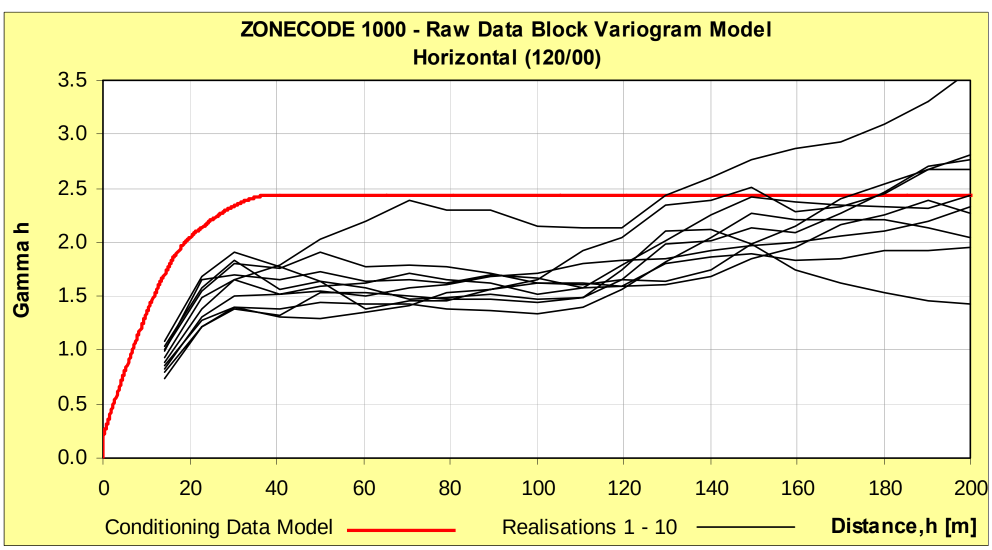
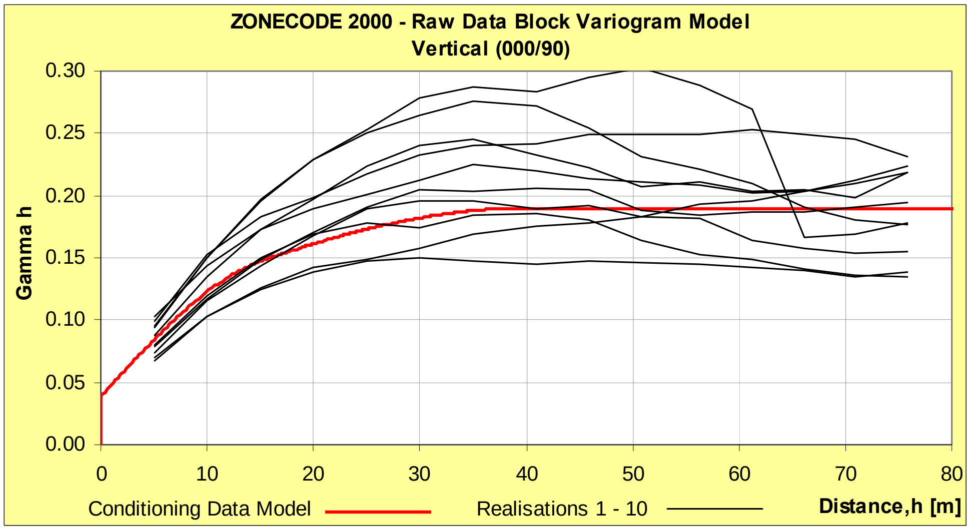
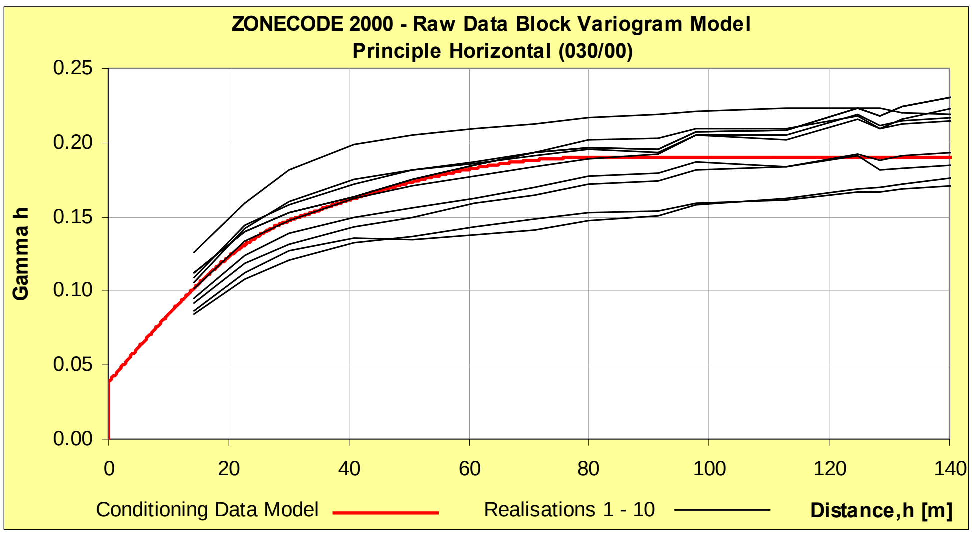


Figure D.1 Variogram reproduction Zonecode 1000 Raw Data





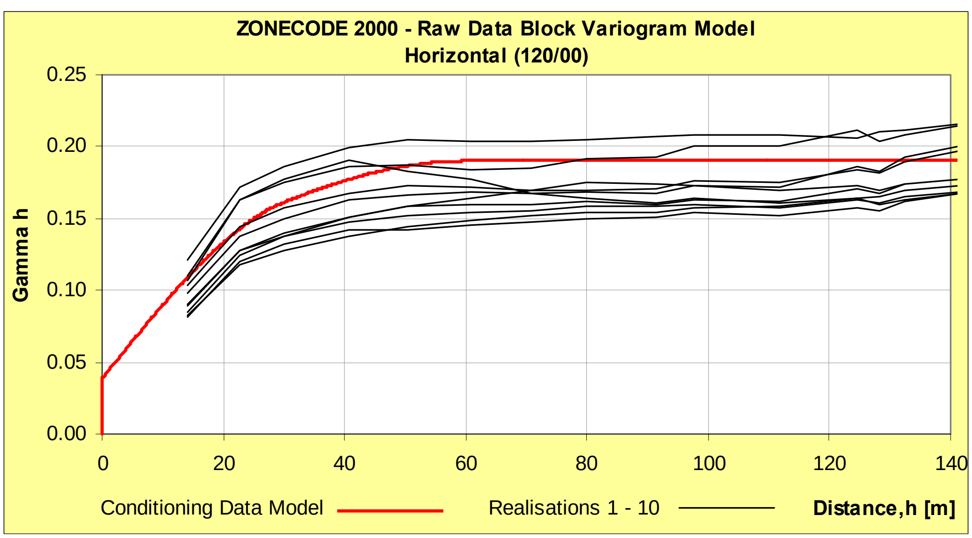
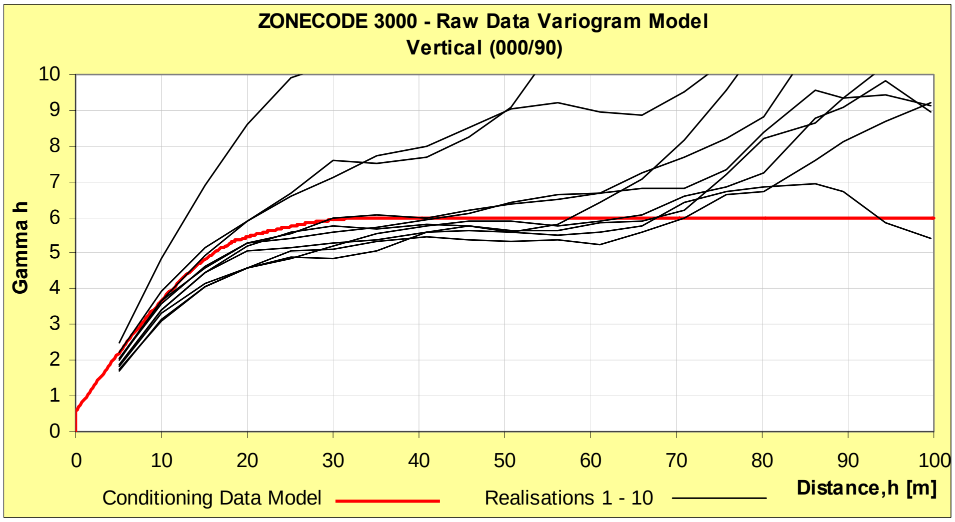
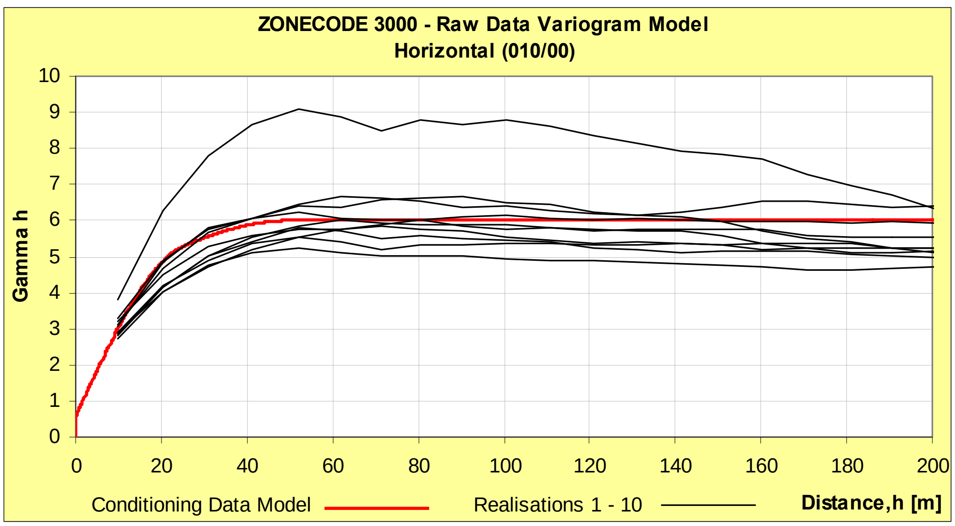


Figure D.2 Variogram reproduction Zonecode 2000 Raw Data





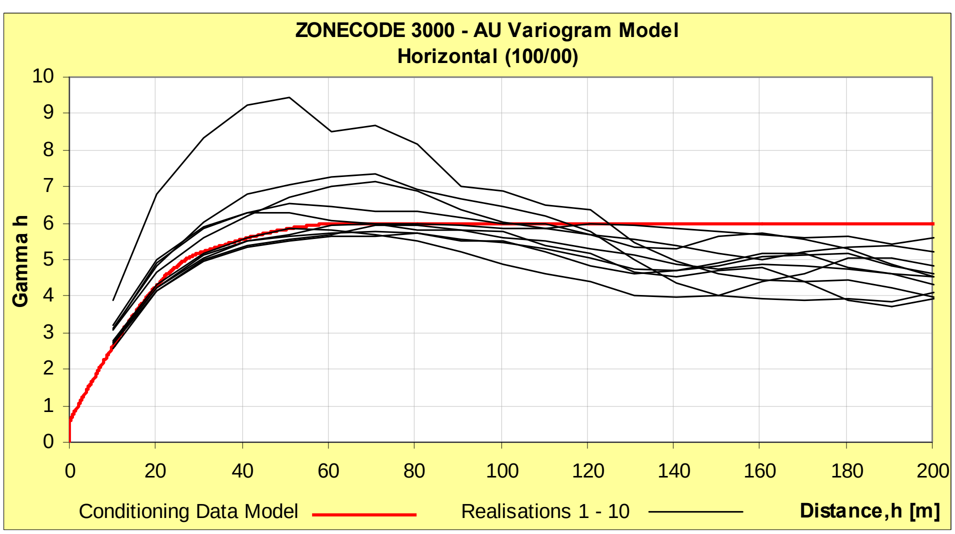


Figure D.3 Variogram reproduction Zonecode 3000 Raw Data

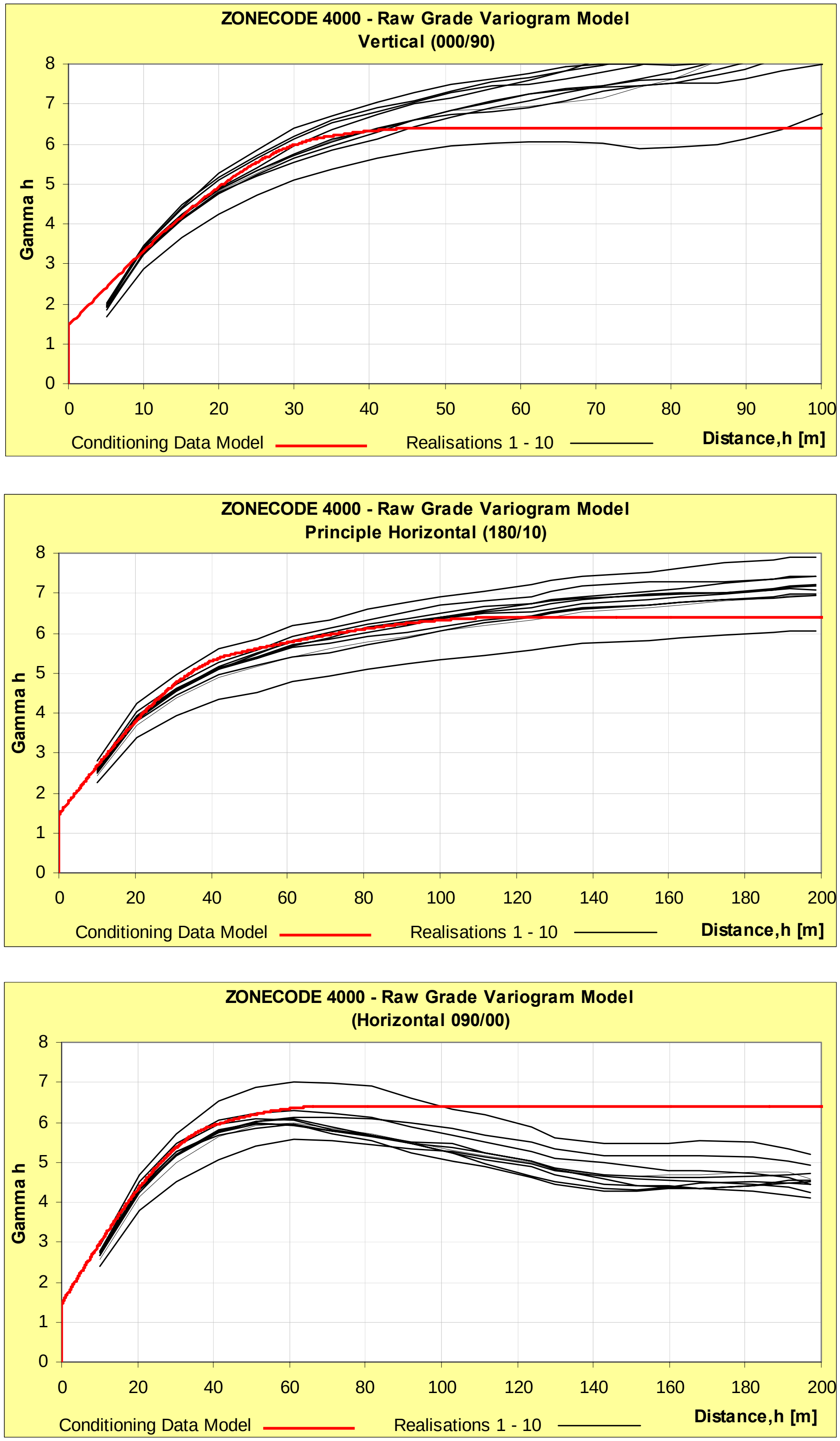
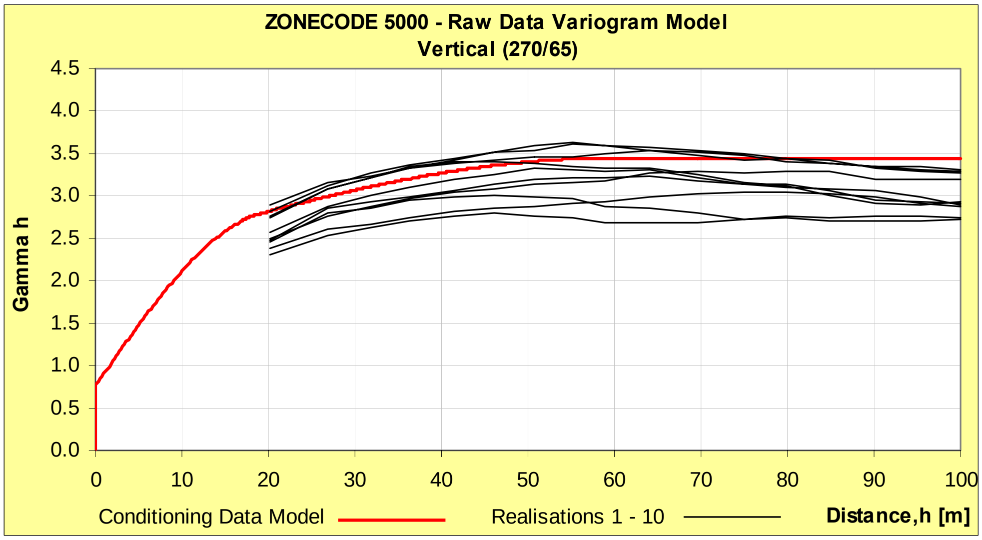
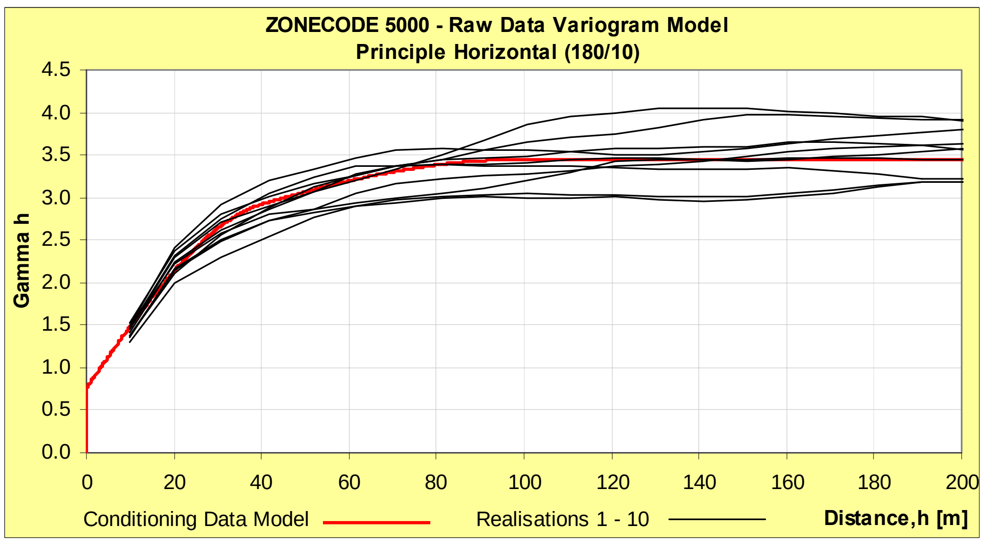


Figure D.4 Variogram reproduction Zonecode 4000 Raw Data





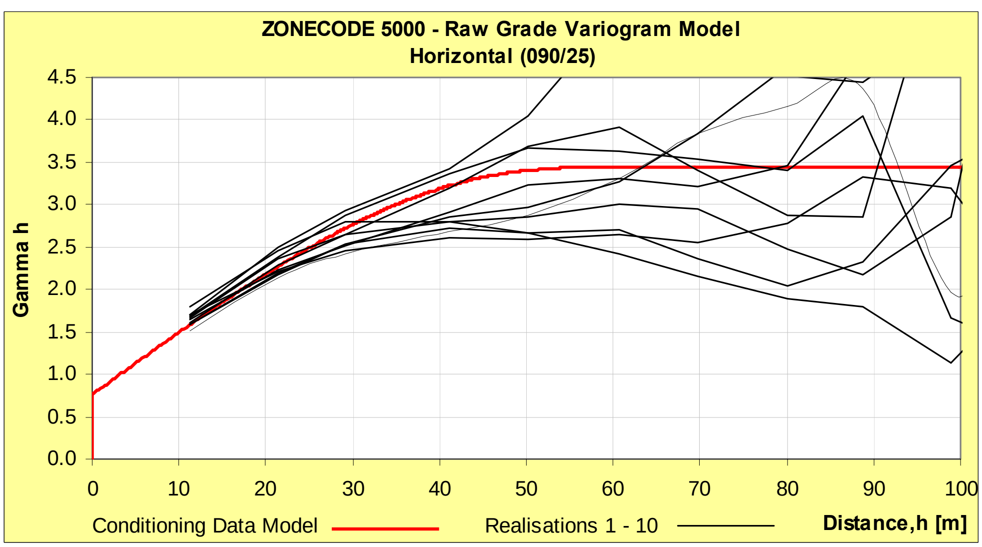
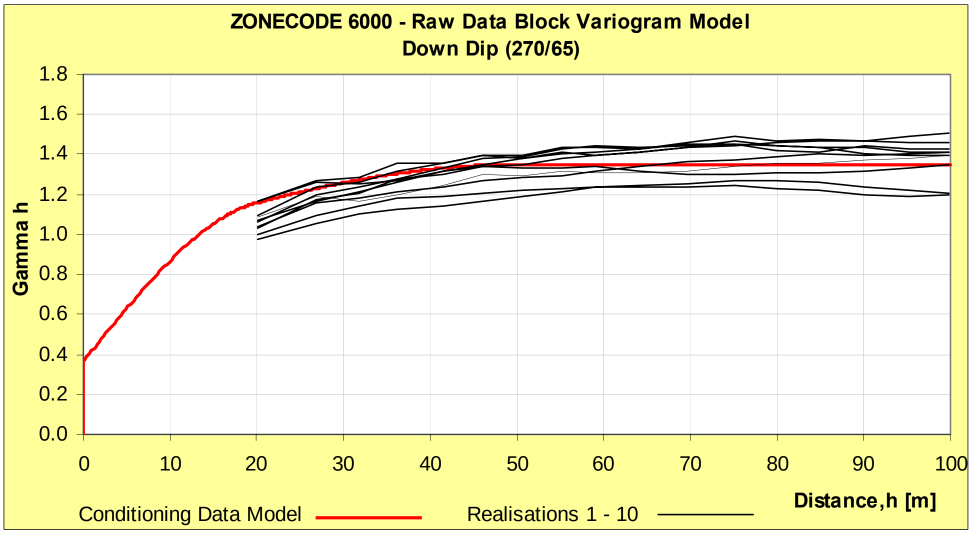
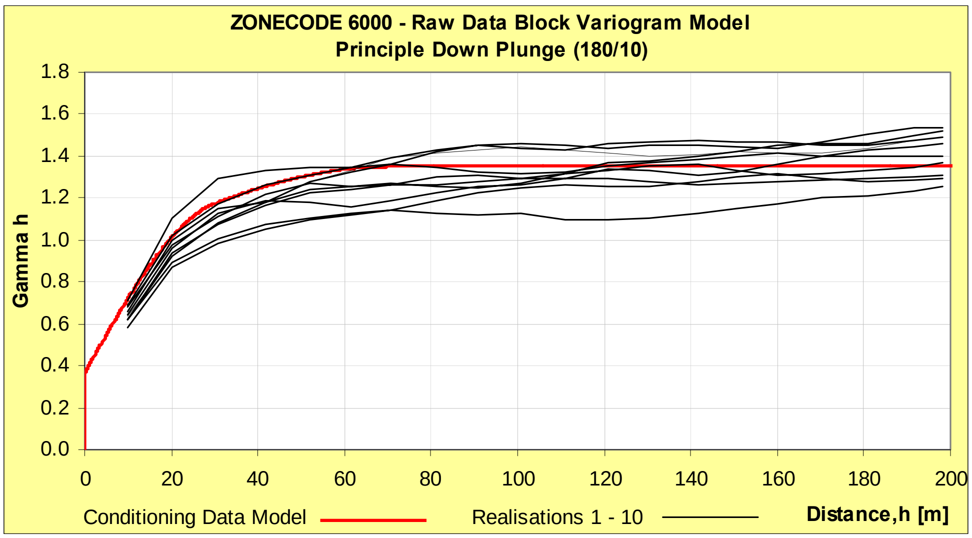


Figure D.5 Variogram reproduction Zonecode 5000 Raw Data





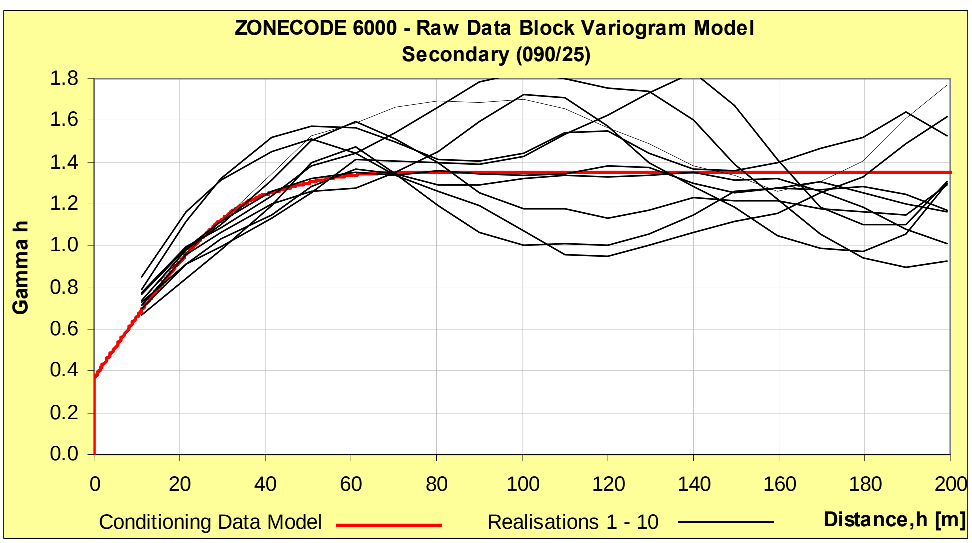
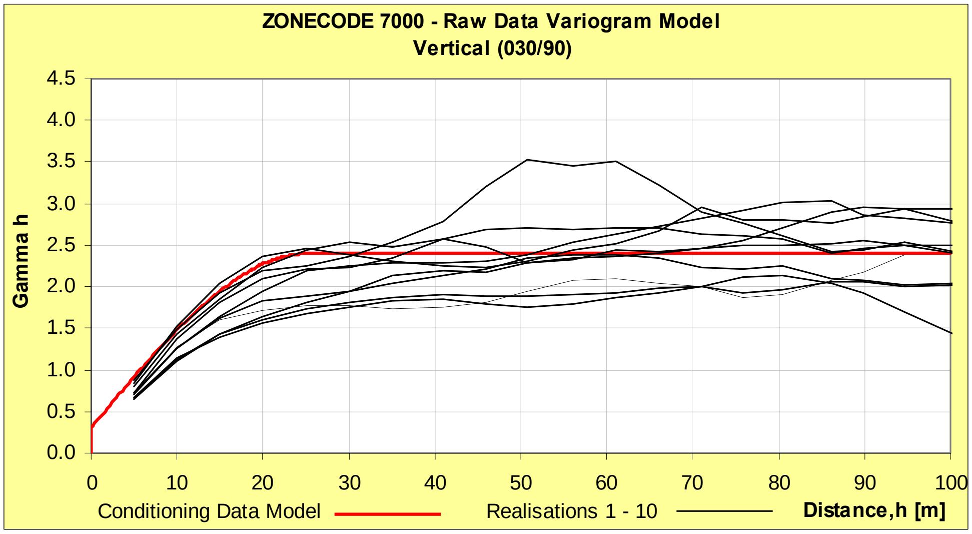
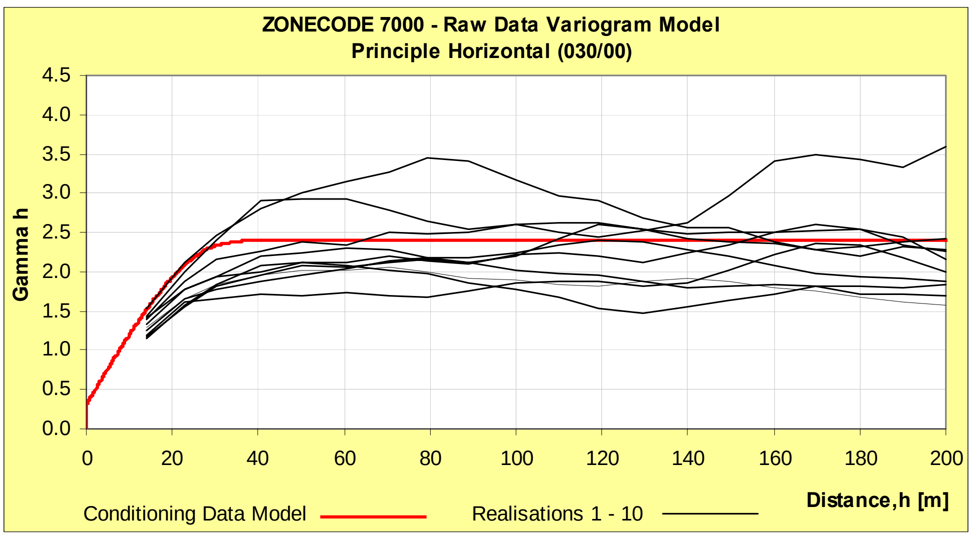


Figure D.6 Variogram reproduction Zonecode 6000 Raw Data





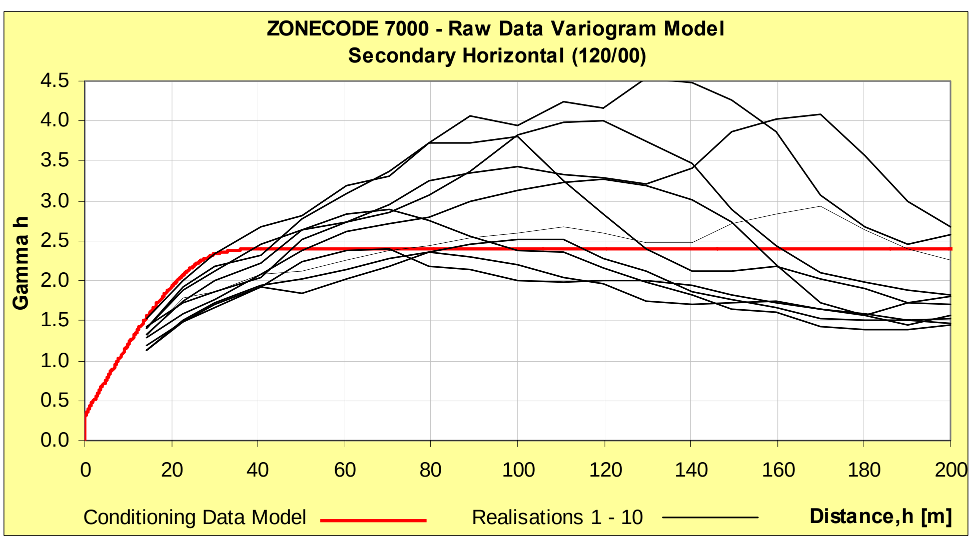


Figure D.7 Variogram reproduction Zonecode 7000 Raw Data

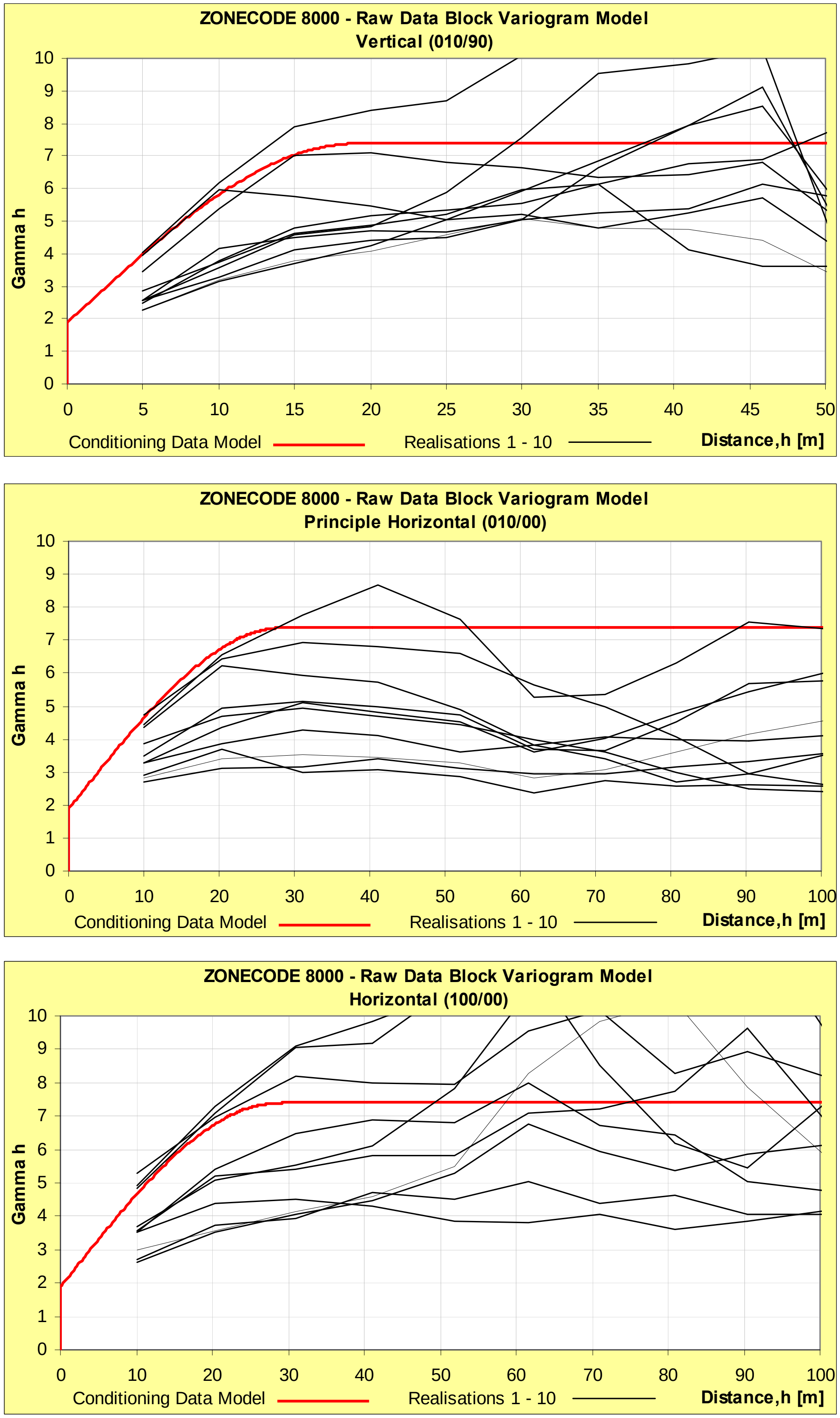


Figure D.8 Variogram reproduction Zonecode 8000 Raw Data

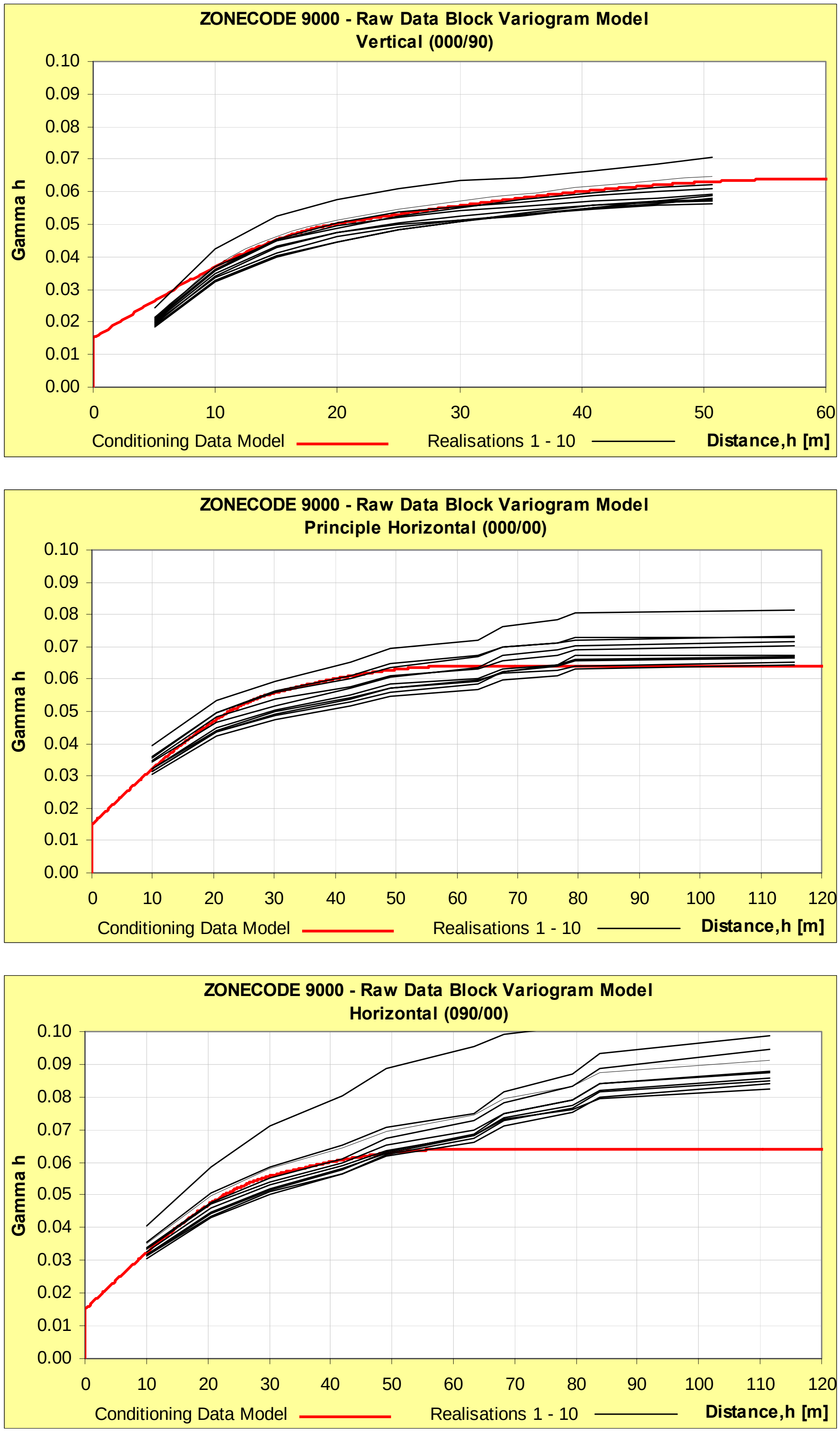
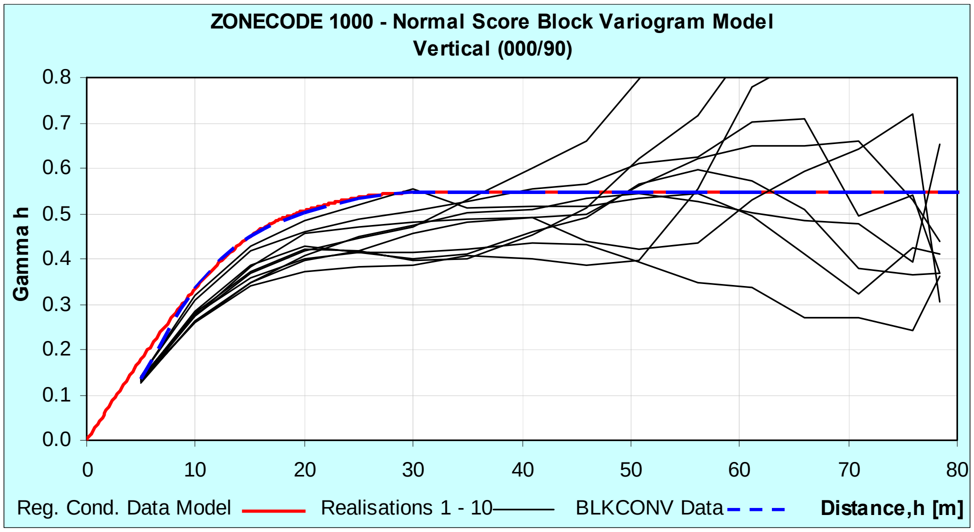
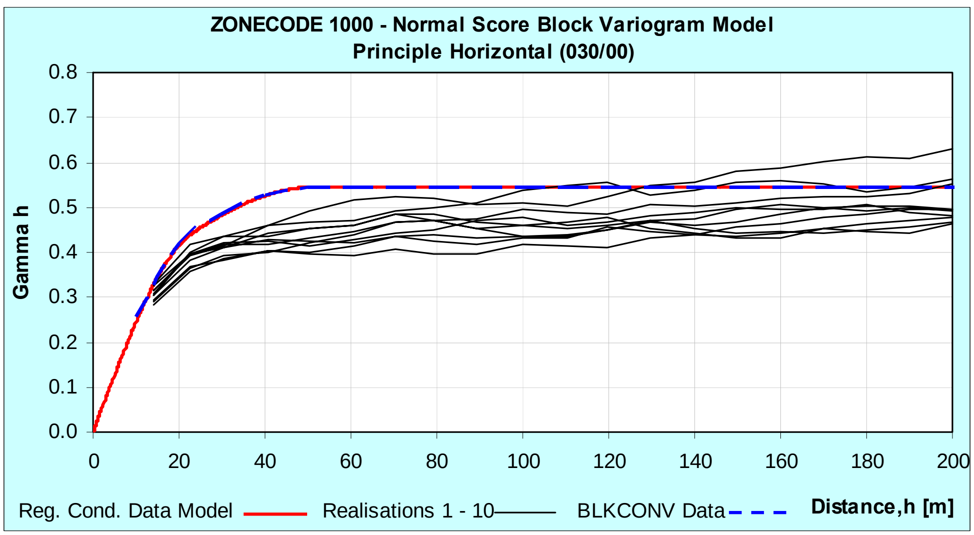


Figure D.9 Variogram reproduction Zonecode 9000 Raw Data





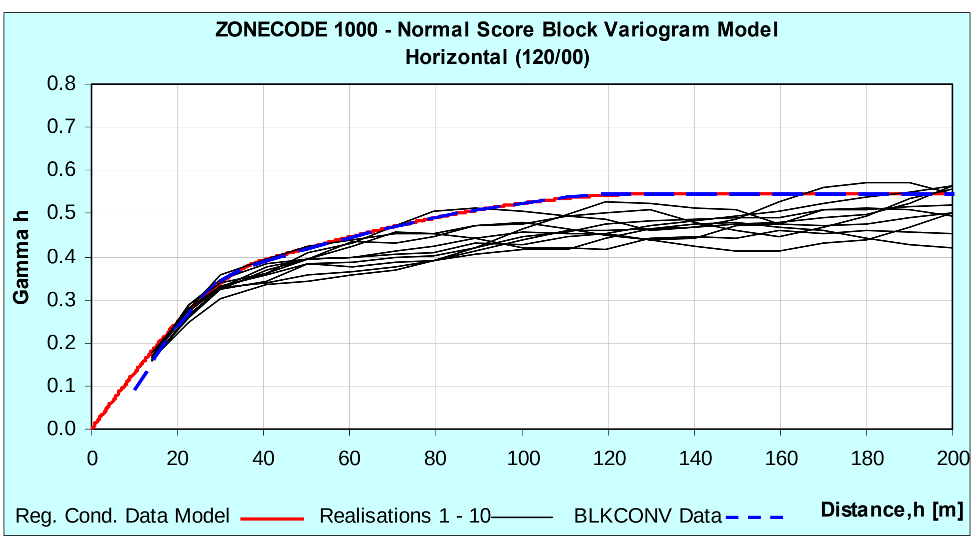
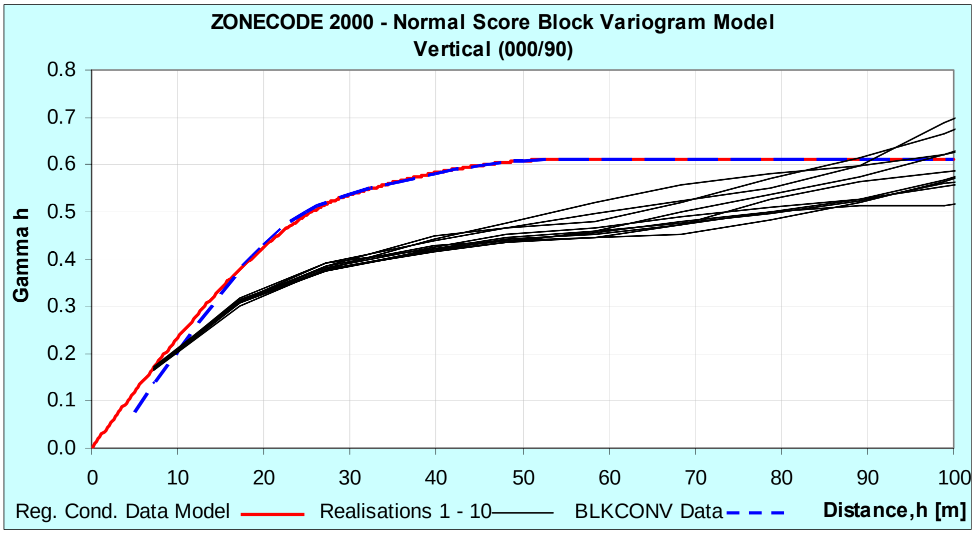
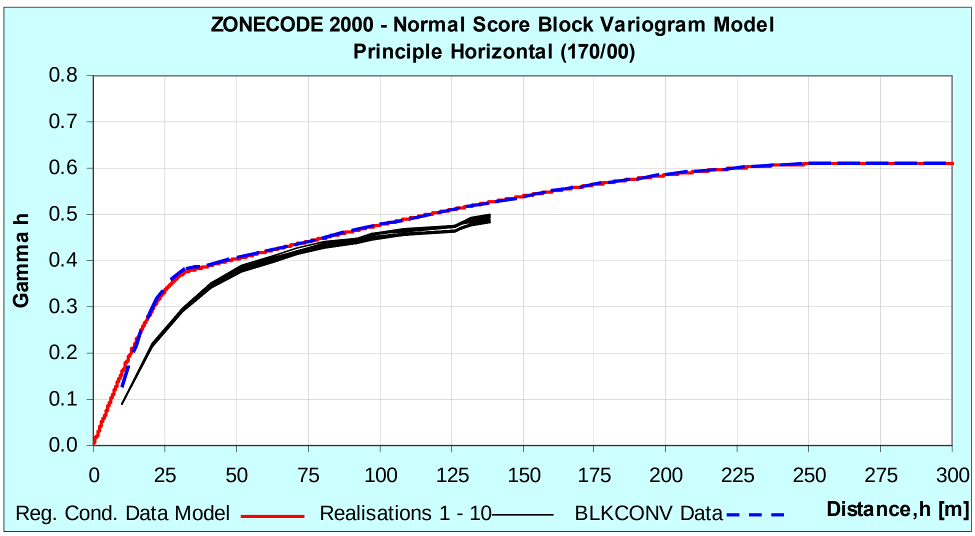


Figure D.10 Variogram reproduction Zonecode 1000 NSC Data





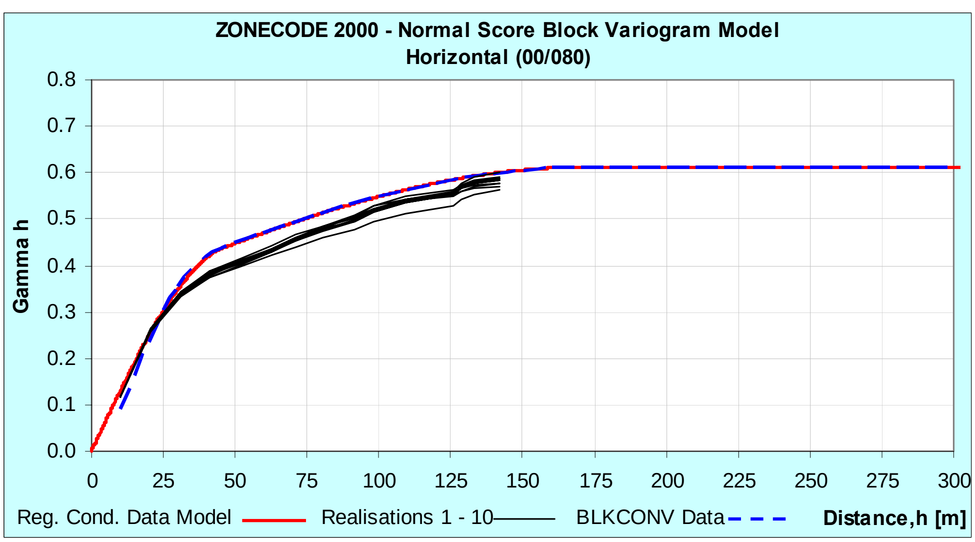


Figure D.11 Variogram reproduction Zonecode 2000 NSC Data

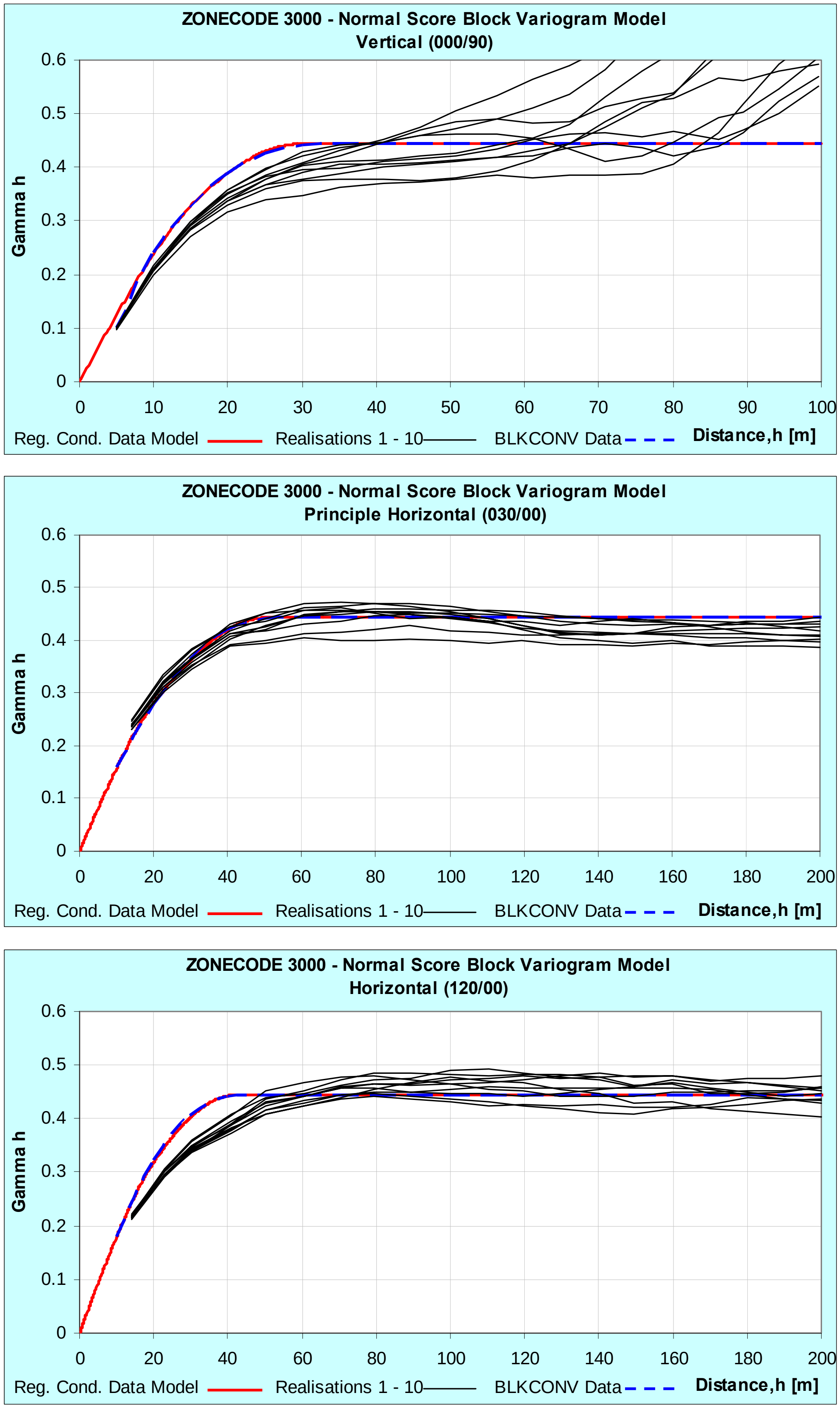


Figure D.12 Variogram reproduction Zonecode 3000 NSC Data

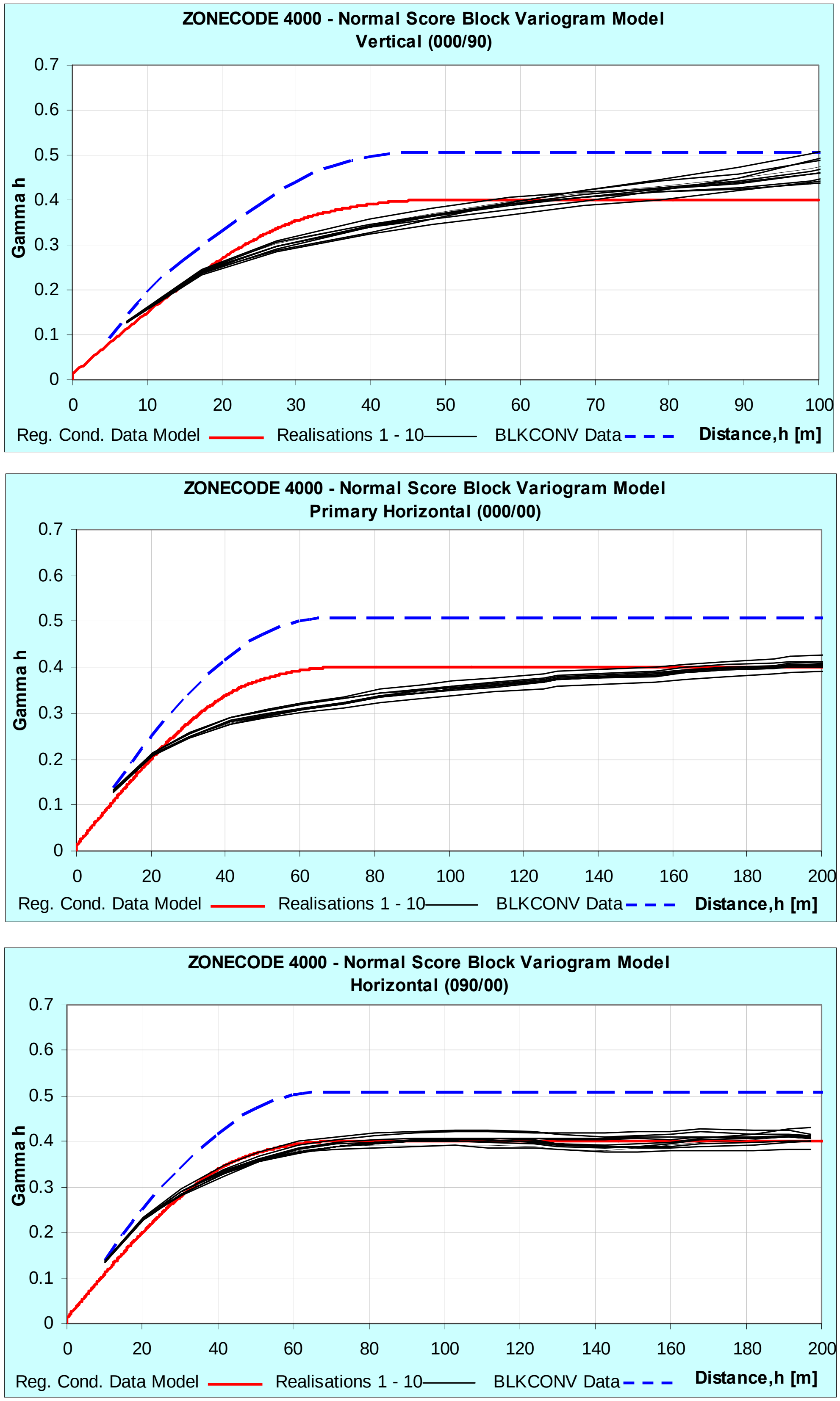


Figure D.13 Variogram reproduction Zonecode 4000 NSC Data

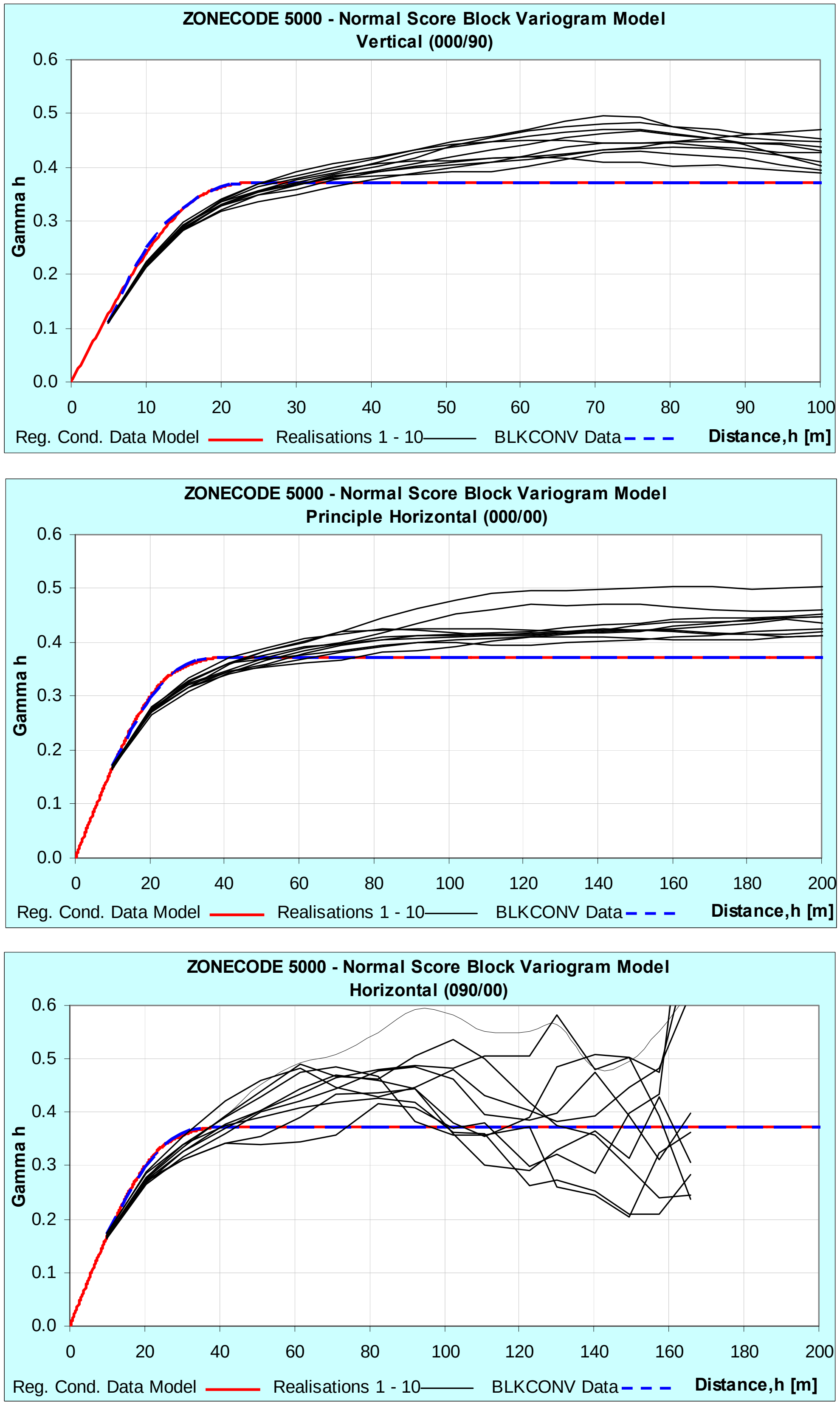


Figure D.14 Variogram reproduction Zonecode 5000 NSC Data

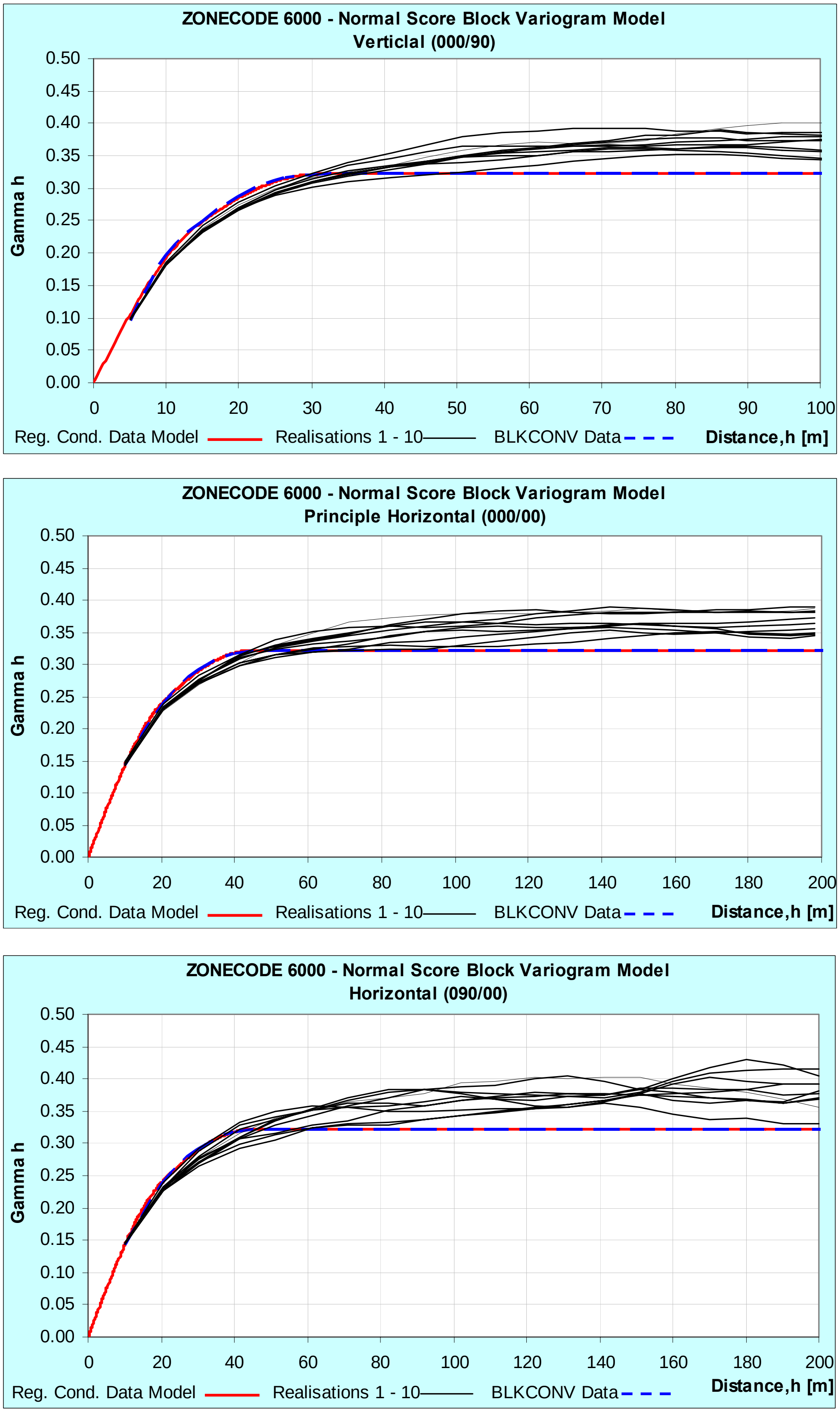


Figure D.15 Variogram reproduction Zonecode 6000 NSC Data

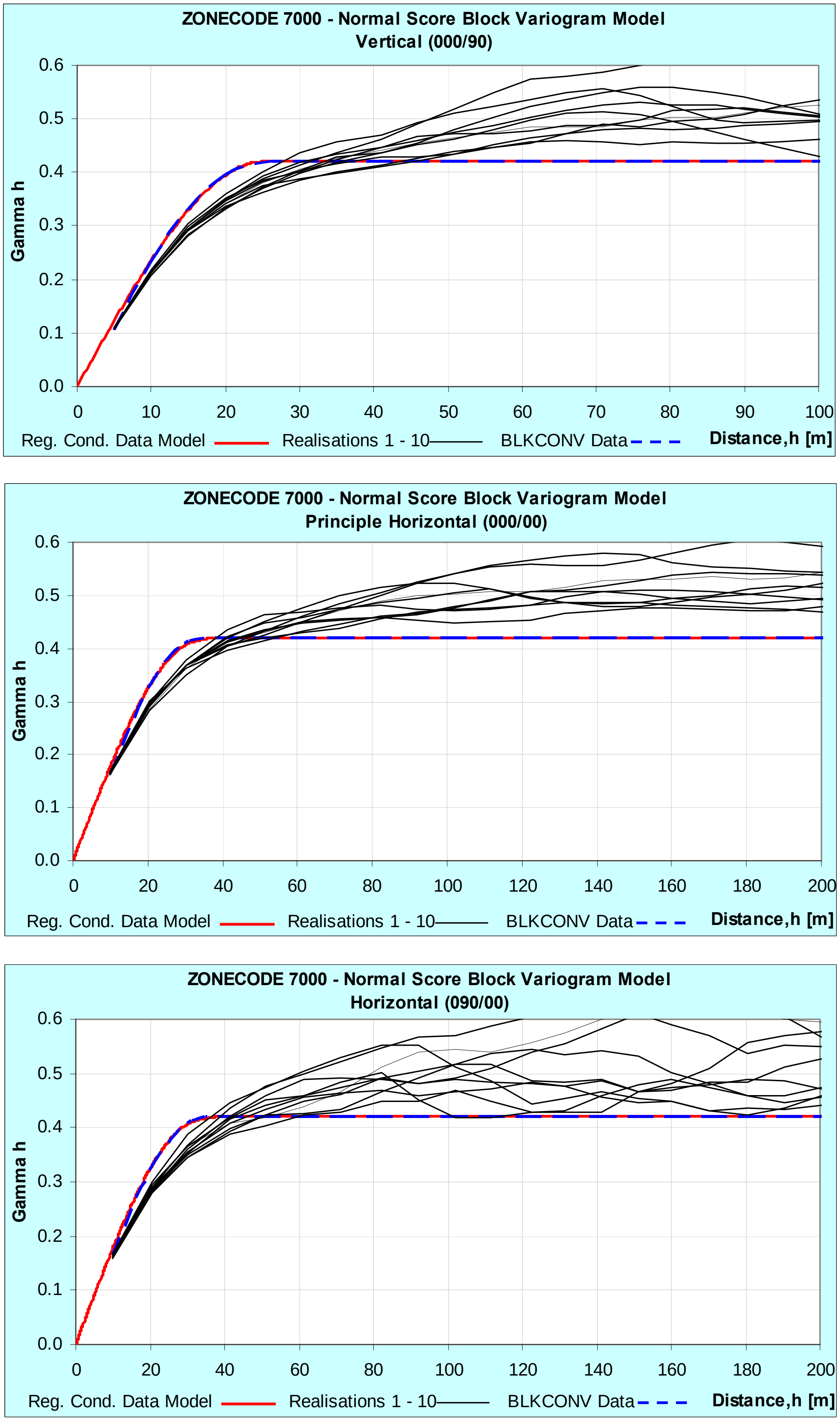


Figure D.16 Variogram reproduction Zonecode 7000 NSC Data

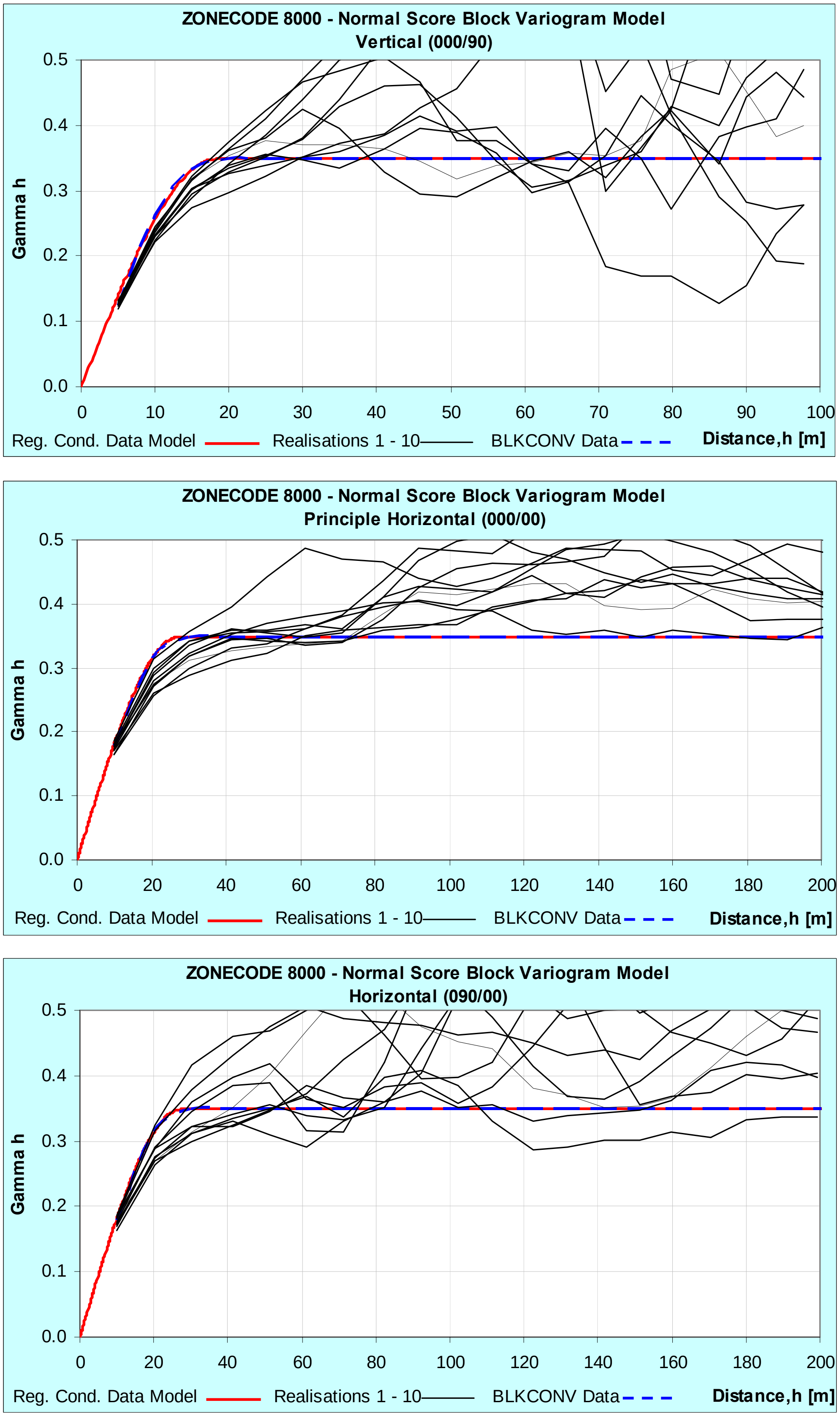


Figure D.17 Variogram reproduction Zonecode 8000 NSC Data

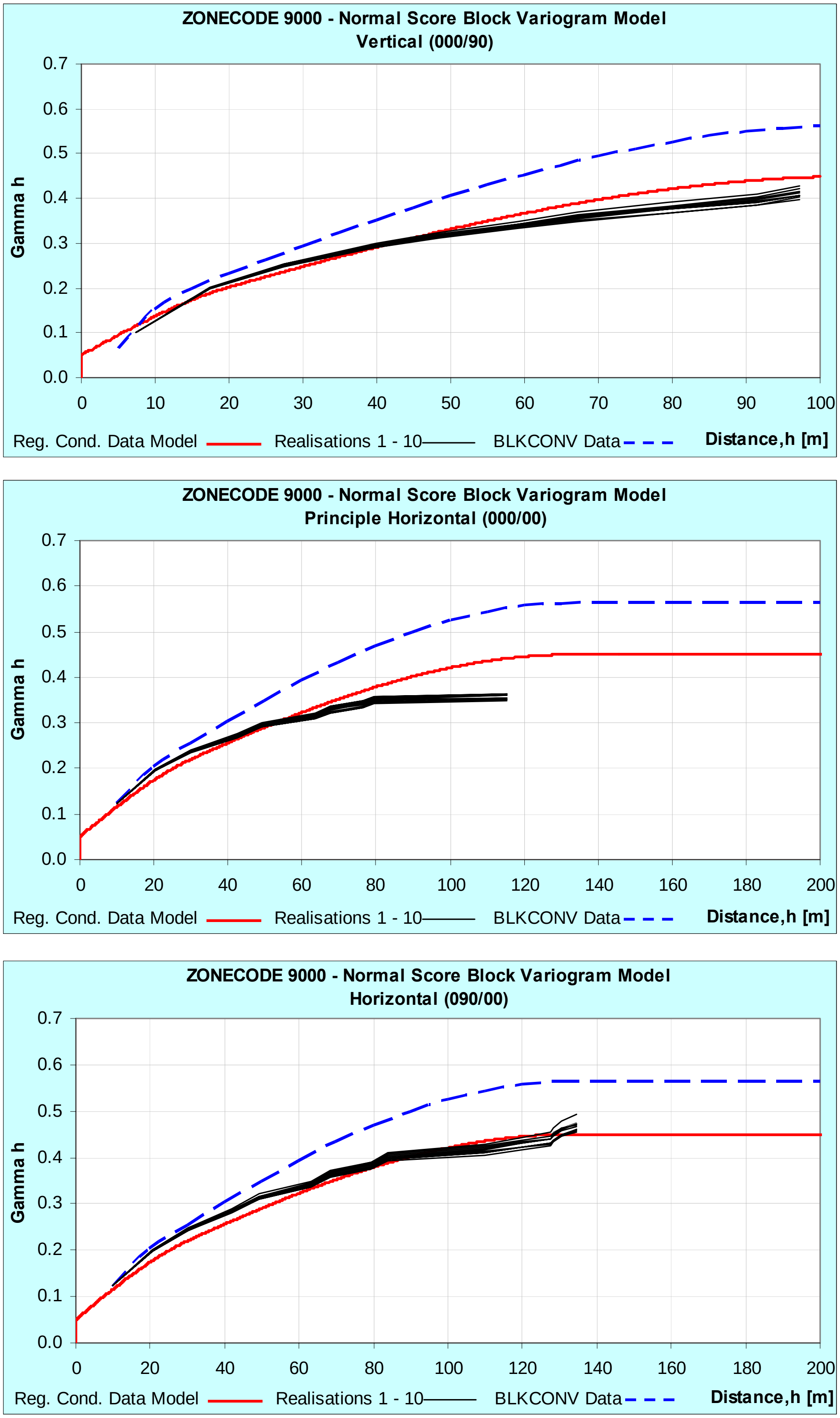


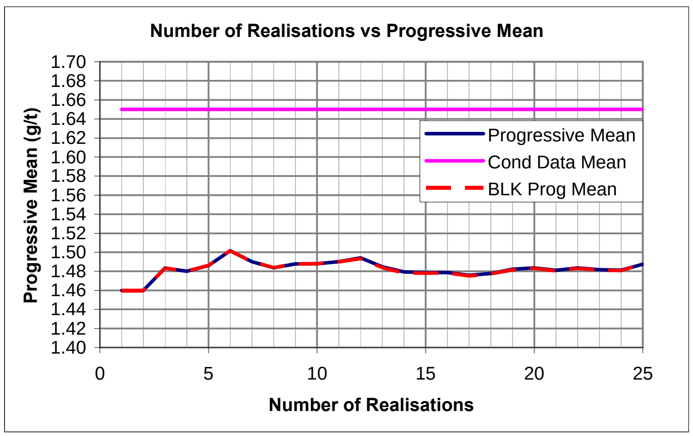
Figure D.18 Variogram reproduction Zonecode 9000 NSC Data

APPENDIX E PROGRESSIVE STATISTICAL DATA

ZONECODE 1000

FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	Conditioning Data EW Average	Conditioning Data EW Variance	Conditioning Data EW Std Dev	Conditioning Data EW COV	Points EW Average	Points EW Variance	Points EW Std Dev	Points EW COV	Blocks EW Average	Blocks EW Variance	Blocks EW Std Dev	Blocks EW COV
AU1	503100	5038	5031	1.65	7.27	2.70	1.63	1.46	5.43	2.33	1.60	1.46	2.15	1.47	1.00
AU2	503100	5038	5031	1.65	7.27	2.70	1.63	1.46	5.81	2.41	1.65	1.46	2.43	1.56	1.07
AU3	503100	5038	5031	1.65	7.27	2.70	1.63	1.53	6.14	2.48	1.62	1.53	2.55	1.60	1.04
AU4	503100	5038	5031	1.65	7.27	2.70	1.63	1.47	5.12	2.26	1.54	1.47	1.91	1.38	0.94
AU5	503100	5038	5031	1.65	7.27	2.70	1.63	1.51	5.48	2.34	1.55	1.51	2.08	1.44	0.96
AU6	503100	5038	5031	1.65	7.27	2.70	1.63	1.58	6.04	2.46	1.56	1.58	2.33	1.53	0.97
AU7	503100	5038	5031	1.65	7.27	2.70	1.63	1.42	4.88	2.21	1.56	1.42	1.82	1.35	0.95
AU8	503100	5038	5031	1.65	7.27	2.70	1.63	1.44	5.21	2.28	1.59	1.44	2.02	1.42	0.99
AU9	503100	5038	5031	1.65	7.27	2.70	1.63	1.52	5.94	2.44	1.60	1.52	2.43	1.56	1.03
AU10	503100	5038	5031	1.65	7.27	2.70	1.63	1.49	6.24	2.50	1.68	1.49	2.67	1.63	1.10
AU11	503100	5038	5031	1.65	7.27	2.70	1.63	1.51	5.24	2.29	1.52	1.51	1.91	1.38	0.92
AU12	503100	5038	5031	1.65	7.27	2.70	1.63	1.54	5.31	2.30	1.50	1.53	1.95	1.40	0.91
AU13	503100	5038	5031	1.65	7.27	2.70	1.63	1.37	4.46	2.11	1.54	1.37	1.61	1.27	0.93
AU14	503100	5038	5031	1.65	7.27	2.70	1.63	1.41	4.74	2.18	1.54	1.41	1.77	1.33	0.94
AU15	503100	5038	5031	1.65	7.27	2.70	1.63	1.47	5.64	2.37	1.62	1.47	2.24	1.50	1.02
AU16	503100	5038	5031	1.65	7.27	2.70	1.63	1.48	5.46	2.34	1.58	1.48	2.12	1.46	0.98
AU17	503100	5038	5031	1.65	7.27	2.70	1.63	1.43	5.02	2.24	1.57	1.43	1.86	1.36	0.95
AU18	503100	5038	5031	1.65	7.27	2.70	1.63	1.51	5.53	2.35	1.56	1.51	2.09	1.45	0.96
AU19	503100	5038	5031	1.65	7.27	2.70	1.63	1.56	5.85	2.42	1.55	1.56	2.26	1.50	0.96
AU20	503100	5038	5031	1.65	7.27	2.70	1.63	1.51	5.27	2.30	1.52	1.51	1.97	1.40	0.93
AU21	503100	5038	5031	1.65	7.27	2.70	1.63	1.43	5.4	2.32	1.63	1.43	2.23	1.49	1.04
AU22	503100	5038	5031	1.65	7.27	2.70	1.63	1.54	6.21	2.49	1.62	1.54	2.54	1.59	1.03
AU23	503100	5038	5031	1.65	7.27	2.70	1.63	1.44	5.4	2.32	1.61	1.44	2.17	1.47	1.02
AU24	503100	5038	5031	1.65	7.27	2.70	1.63	1.47	5.17	2.27	1.55	1.47	1.95	1.40	0.95
AU25	503100	5038	5031	1.65	7.27	2.70	1.63	1.64	6.22	2.49	1.52	1.64	2.34	1.53	0.93

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



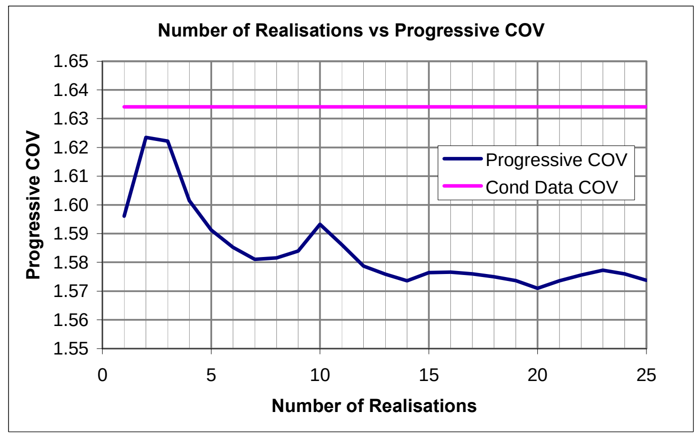
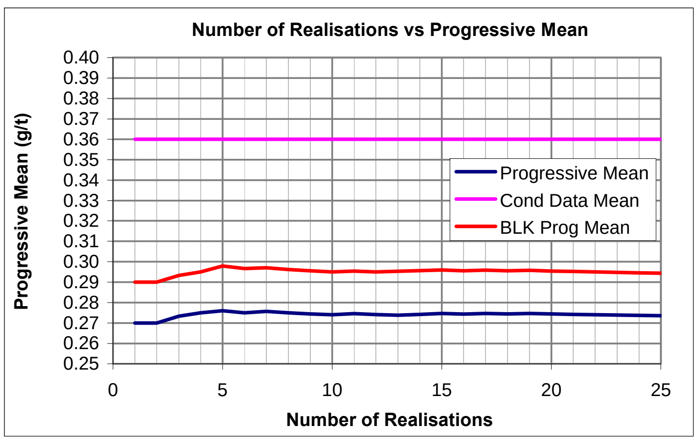


Figure E.1 Progressive statistical data for Zonecode 1000

ZONECODE 2000

				Conditioning Data				Points				Blocks			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV
AU1	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.79	0.89	3.29	0.29	0.22	0.47	1.62
AU2	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.72	0.85	3.14	0.29	0.19	0.44	1.50
AU3	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.9	0.95	3.39	0.3	0.26	0.51	1.70
AU4	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.87	0.93	3.33	0.3	0.25	0.50	1.67
AU5	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	1.02	1.01	3.61	0.31	0.3	0.55	1.77
AU6	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.74	0.86	3.19	0.29	0.2	0.45	1.54
AU7	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.89	0.94	3.37	0.3	0.27	0.52	1.73
AU8	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.89	0.94	3.49	0.29	0.25	0.50	1.72
AU9	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.71	0.84	3.12	0.29	0.19	0.44	1.50
AU10	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.77	0.88	3.25	0.29	0.21	0.46	1.58
AU11	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.94	0.97	3.46	0.3	0.27	0.52	1.73
AU12	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.8	0.89	3.31	0.29	0.22	0.47	1.62
AU13	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.82	0.91	3.35	0.3	0.23	0.48	1.60
AU14	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.89	0.94	3.37	0.3	0.25	0.50	1.67
AU15	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.85	0.92	3.29	0.3	0.24	0.49	1.63
AU16	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.84	0.92	3.39	0.29	0.24	0.49	1.69
AU17	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	1.01	1.00	3.59	0.3	0.32	0.57	1.89
AU18	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.75	0.87	3.21	0.29	0.21	0.46	1.58
AU19	18315700	183157	183157	0.36	1.69	1.30	3.61	0.28	0.89	0.94	3.37	0.3	0.26	0.51	1.70
AU20	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.8	0.89	3.31	0.29	0.22	0.47	1.62
AU21	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.78	0.88	3.27	0.29	0.22	0.47	1.62
AU22	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.81	0.90	3.33	0.29	0.23	0.48	1.65
AU23	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.8	0.89	3.31	0.29	0.22	0.47	1.62
AU24	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.78	0.88	3.27	0.29	0.22	0.47	1.62
AU25	18315700	183157	183157	0.36	1.69	1.30	3.61	0.27	0.78	0.88	3.27	0.29	0.21	0.46	1.58

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



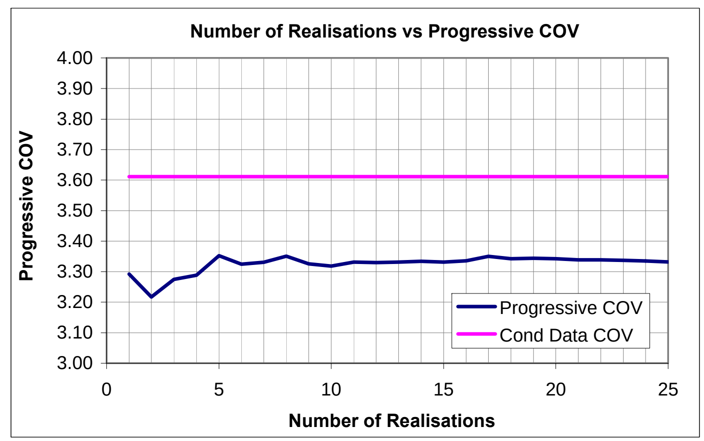
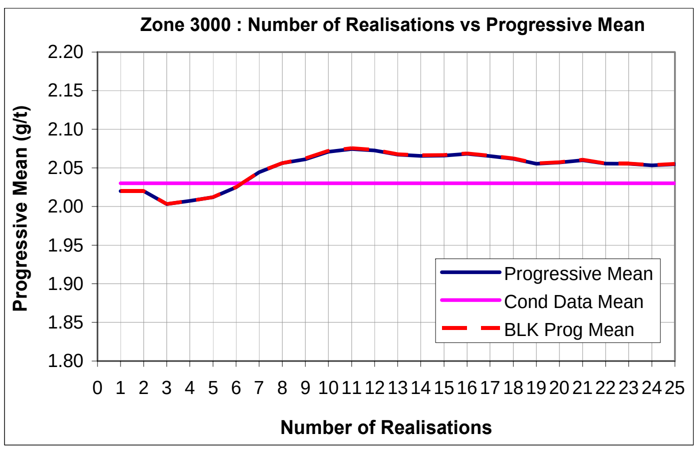


Figure E.2 Progressive statistical data for Zonecode 2000

ZONECODE 3000

				Conditioning Data				Points				Blocks			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV
AU1	1613600	16143	16136	2.03	25.74	5.07	2.50	2.02	23.2	4.82	2.38	2.02	5.43	2.33	1.15
AU2	1613600	16143	16136	2.03	25.74	5.07	2.50	2.02	23.3	4.83	2.39	2.02	5.36	2.32	1.15
AU3	1613600	16143	16136	2.03	25.74	5.07	2.50	1.97	22.52	4.75	2.41	1.97	5.41	2.33	1.18
AU4	1613600	16143	16136	2.03	25.74	5.07	2.50	2.02	22.44	4.74	2.35	2.02	5.06	2.25	1.11
AU5	1613600	16143	16136	2.03	25.74	5.07	2.50	2.03	24.58	4.96	2.44	2.03	6.15	2.48	1.22
AU6	1613600	16143	16136	2.03	25.74	5.07	2.50	2.09	26.28	5.13	2.45	2.09	6.26	2.50	1.20
AU7	1613600	16143	16136	2.03	25.74	5.07	2.50	2.16	27.27	5.22	2.42	2.16	6.51	2.55	1.18
AU8	1613600	16143	16136	2.03	25.74	5.07	2.50	2.14	28.91	5.38	2.51	2.14	7.69	2.77	1.30
AU9	1613600	16143	16136	2.03	25.74	5.07	2.50	2.1	23.51	4.85	2.31	2.11	5.15	2.27	1.08
AU10	1613600	16143	16136	2.03	25.74	5.07	2.50	2.16	26.89	5.19	2.40	2.16	6.33	2.52	1.16
AU11	1613600	16143	16136	2.03	25.74	5.07	2.50	2.11	24.87	4.99	2.36	2.11	5.73	2.39	1.13
AU12	1613600	16143	16136	2.03	25.74	5.07	2.50	2.05	23.35	4.83	2.36	2.05	5.59	2.36	1.15
AU13	1613600	16143	16136	2.03	25.74	5.07	2.50	2	22.66	4.76	2.38	2	5.33	2.31	1.15
AU14	1613600	16143	16136	2.03	25.74	5.07	2.50	2.05	22.86	4.78	2.33	2.05	5.1	2.26	1.10
AU15	1613600	16143	16136	2.03	25.74	5.07	2.50	2.07	26.76	5.17	2.50	2.07	6.81	2.61	1.26
AU16	1613600	16143	16136	2.03	25.74	5.07	2.50	2.1	24.49	4.95	2.36	2.1	5.58	2.36	1.12
AU17	1613600	16143	16136	2.03	25.74	5.07	2.50	2.02	23.65	4.86	2.41	2.02	5.45	2.33	1.16
AU18	1613600	16143	16136	2.03	25.74	5.07	2.50	2	22.96	4.79	2.40	2	5.48	2.34	1.17
AU19	1613600	16143	16136	2.03	25.74	5.07	2.50	1.94	19.39	4.40	2.27	1.94	4.2	2.05	1.06
AU20	1613600	16143	16136	2.03	25.74	5.07	2.50	2.09	24.87	4.99	2.39	2.09	5.79	2.41	1.15
AU21	1613600	16143	16136	2.03	25.74	5.07	2.50	2.12	26.09	5.11	2.41	2.12	6.16	2.48	1.17
AU22	1613600	16143	16136	2.03	25.74	5.07	2.50	1.96	21.2	4.60	2.35	1.96	4.74	2.18	1.11
AU23	1613600	16143	16136	2.03	25.74	5.07	2.50	2.05	24.36	4.94	2.41	2.05	5.83	2.41	1.18
AU24	1613600	16143	16136	2.03	25.74	5.07	2.50	2.01	22.6	4.75	2.37	2.01	5.2	2.28	1.13
AU25	1613600	16143	16136	2.03	25.74	5.07	2.50	2.09	25.46	5.05	2.41	2.09	6.04	2.46	1.18

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



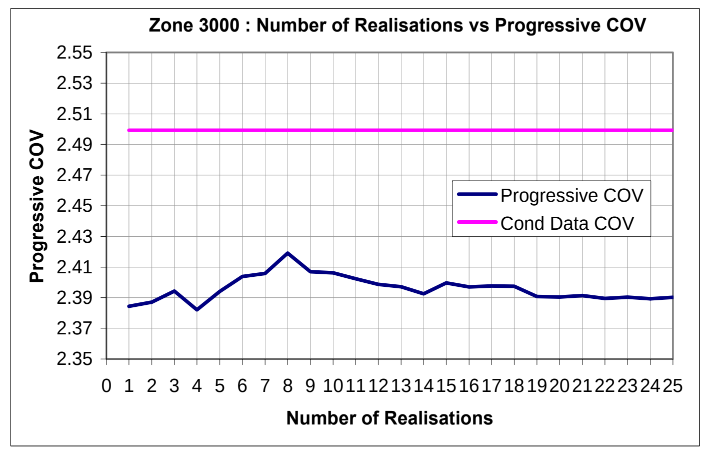
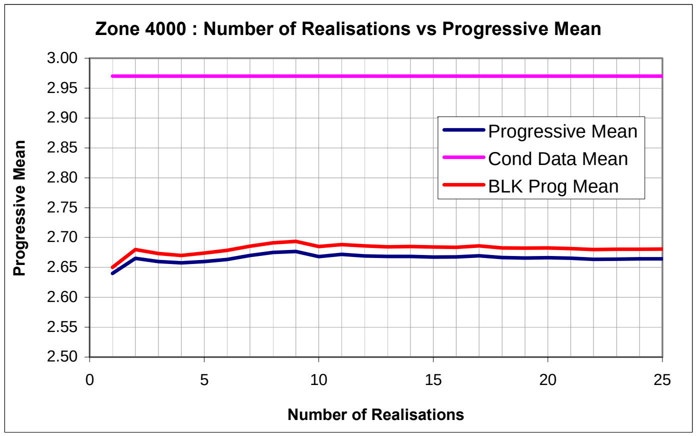


Figure E.3 Progressive statistical data for Zonecode 3000

ZONECODE 4000

FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	Conditioning Data				Points				Blocks			
				EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV
AU1	6326400	63441	63264	2.97	35.74	5.98	2.01	2.64	22.11	4.70	1.78	2.65	6.53	2.56	0.96
AU2	6326400	63441	63264	2.97	35.74	5.98	2.01	2.69	23.25	4.82	1.79	2.71	6.86	2.62	0.97
AU3	6326400	63441	63264	2.97	35.74	5.98	2.01	2.65	22.09	4.70	1.77	2.66	6.43	2.54	0.95
AU4	6326400	63441	63264	2.97	35.74	5.98	2.01	2.65	21.86	4.68	1.76	2.66	6.42	2.53	0.95
AU5	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	22.89	4.78	1.79	2.69	6.76	2.60	0.97
AU6	6326400	63441	63264	2.97	35.74	5.98	2.01	2.68	23.08	4.80	1.79	2.7	6.83	2.61	0.97
AU7	6326400	63441	63264	2.97	35.74	5.98	2.01	2.71	24.02	4.90	1.81	2.73	7.21	2.69	0.98
AU8	6326400	63441	63264	2.97	35.74	5.98	2.01	2.71	24.42	4.94	1.82	2.73	7.13	2.67	0.98
AU9	6326400	63441	63264	2.97	35.74	5.98	2.01	2.69	23.53	4.85	1.80	2.71	6.93	2.63	0.97
AU10	6326400	63441	63264	2.97	35.74	5.98	2.01	2.59	19.66	4.43	1.71	2.61	5.68	2.38	0.91
AU11	6326400	63441	63264	2.97	35.74	5.98	2.01	2.71	23.81	4.88	1.80	2.72	6.94	2.63	0.97
AU12	6326400	63441	63264	2.97	35.74	5.98	2.01	2.64	21.94	4.68	1.77	2.66	6.45	2.54	0.95
AU13	6326400	63441	63264	2.97	35.74	5.98	2.01	2.66	20.53	4.53	1.70	2.67	5.91	2.43	0.91
AU14	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	21.67	4.66	1.74	2.69	6.4	2.53	0.94
AU15	6326400	63441	63264	2.97	35.74	5.98	2.01	2.65	21.24	4.61	1.74	2.67	6.01	2.45	0.92
AU16	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	22.79	4.77	1.79	2.68	6.67	2.58	0.96
AU17	6326400	63441	63264	2.97	35.74	5.98	2.01	2.7	22.84	4.78	1.77	2.72	6.71	2.59	0.95
AU18	6326400	63441	63264	2.97	35.74	5.98	2.01	2.62	21.19	4.60	1.76	2.63	6.23	2.50	0.95
AU19	6326400	63441	63264	2.97	35.74	5.98	2.01	2.65	21.69	4.66	1.76	2.67	6.24	2.50	0.94
AU20	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	20.86	4.57	1.71	2.69	6.04	2.46	0.91
AU21	6326400	63441	63264	2.97	35.74	5.98	2.01	2.65	20.35	4.51	1.70	2.66	5.86	2.42	0.91
AU22	6326400	63441	63264	2.97	35.74	5.98	2.01	2.63	20.48	4.53	1.72	2.65	5.96	2.44	0.92
AU23	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	22.98	4.79	1.80	2.69	6.81	2.61	0.97
AU24	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	22.94	4.79	1.79	2.68	6.79	2.61	0.97
AU25	6326400	63441	63264	2.97	35.74	5.98	2.01	2.67	21.81	4.67	1.75	2.69	6.39	2.53	0.94

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



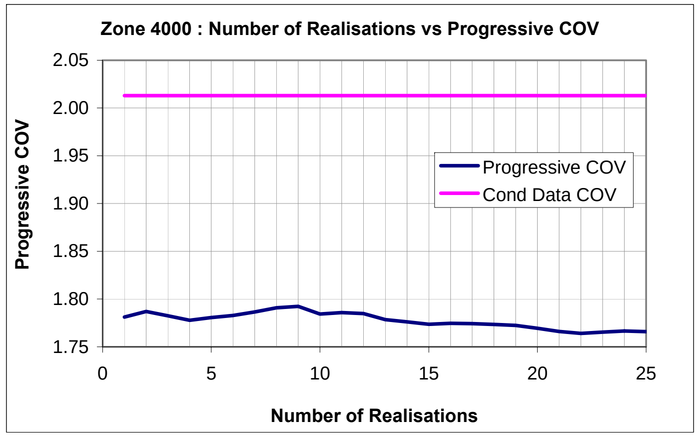
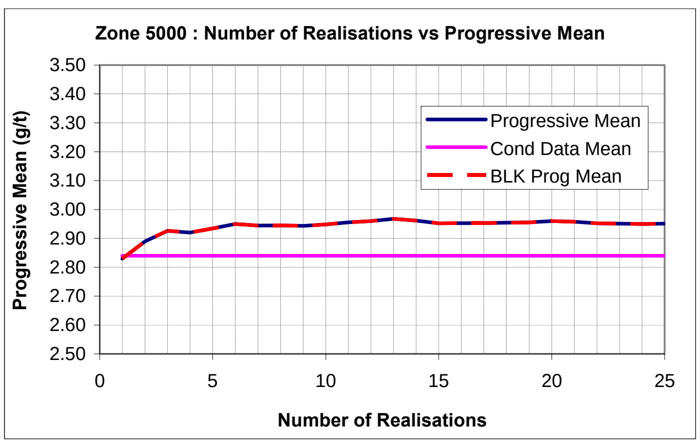


Figure E.4 Progressive statistical data for Zonecode 4000

ZONECODE 5000

FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	Conditioning Data EW Average	EW Variance	EW Std Dev	EW COV	Points EW Average	EW Variance	EW Std Dev	EW COV	Blocks EW Average	EW Variance	EW Std Dev	EW COV
AU1	1871000	19369	18710	2.84	8.73	2.95	1.04	2.83	9.3	3.05	1.08	2.83	3.2	1.79	0.63
AU2	1871000	19369	18710	2.84	8.73	2.95	1.04	2.95	10.27	3.20	1.09	2.95	3.67	1.92	0.65
AU3	1871000	19369	18710	2.84	8.73	2.95	1.04	3	10.42	3.23	1.08	3	3.62	1.90	0.63
AU4	1871000	19369	18710	2.84	8.73	2.95	1.04	2.9	9.5	3.08	1.06	2.9	3.17	1.78	0.61
AU5	1871000	19369	18710	2.84	8.73	2.95	1.04	2.99	10.19	3.19	1.07	2.99	3.49	1.87	0.62
AU6	1871000	19369	18710	2.84	8.73	2.95	1.04	3.03	10.47	3.24	1.07	3.03	3.62	1.90	0.63
AU7	1871000	19369	18710	2.84	8.73	2.95	1.04	2.91	9.51	3.08	1.06	2.91	3.16	1.78	0.61
AU8	1871000	19369	18710	2.84	8.73	2.95	1.04	2.95	9.87	3.14	1.06	2.95	3.32	1.82	0.62
AU9	1871000	19369	18710	2.84	8.73	2.95	1.04	2.93	10.05	3.17	1.08	2.93	3.53	1.88	0.64
AU10	1871000	19369	18710	2.84	8.73	2.95	1.04	2.99	10.52	3.24	1.08	2.99	3.76	1.94	0.65
AU11	1871000	19369	18710	2.84	8.73	2.95	1.04	3.03	10.96	3.31	1.09	3.03	3.97	1.99	0.66
AU12	1871000	19369	18710	2.84	8.73	2.95	1.04	3.01	10.03	3.17	1.05	3.01	3.31	1.82	0.60
AU13	1871000	19369	18710	2.84	8.73	2.95	1.04	3.06	10.99	3.32	1.08	3.06	3.93	1.98	0.65
AU14	1871000	19369	18710	2.84	8.73	2.95	1.04	2.88	9.17	3.03	1.05	2.88	2.97	1.72	0.60
AU15	1871000	19369	18710	2.84	8.73	2.95	1.04	2.82	9.14	3.02	1.07	2.82	3.08	1.75	0.62
AU16	1871000	19369	18710	2.84	8.73	2.95	1.04	2.96	10.08	3.17	1.07	2.96	3.47	1.86	0.63
AU17	1871000	19369	18710	2.84	8.73	2.95	1.04	2.96	10.45	3.23	1.09	2.96	3.77	1.94	0.66
AU18	1871000	19369	18710	2.84	8.73	2.95	1.04	2.98	9.99	3.16	1.06	2.98	3.38	1.84	0.62
AU19	1871000	19369	18710	2.84	8.73	2.95	1.04	2.97	10.05	3.17	1.07	2.97	3.41	1.85	0.62
AU20	1871000	19369	18710	2.84	8.73	2.95	1.04	3.04	10.44	3.23	1.06	3.04	3.57	1.89	0.62
AU21	1871000	19369	18710	2.84	8.73	2.95	1.04	2.91	9.52	3.09	1.06	2.91	3.18	1.78	0.61
AU22	1871000	19369	18710	2.84	8.73	2.95	1.04	2.84	9.43	3.07	1.08	2.84	3.24	1.80	0.63
AU23	1871000	19369	18710	2.84	8.73	2.95	1.04	2.94	10.16	3.19	1.08	2.94	3.6	1.90	0.65
AU24	1871000	19369	18710	2.84	8.73	2.95	1.04	2.91	9.72	3.12	1.07	2.91	3.31	1.82	0.63
AU25	1871000	19369	18710	2.84	8.73	2.95	1.04	3	10.33	3.21	1.07	3	3.57	1.89	0.63

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



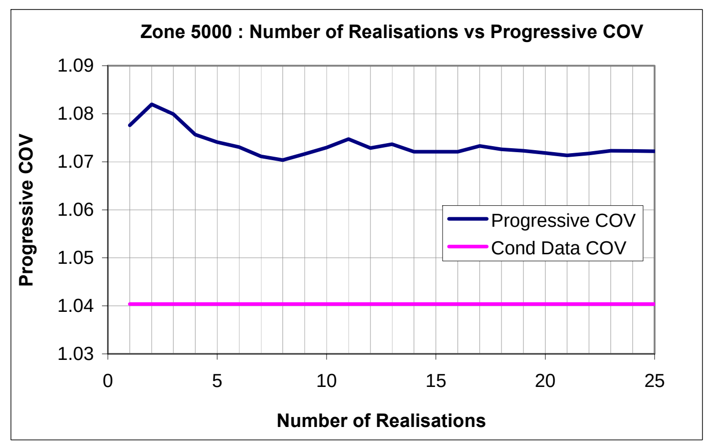
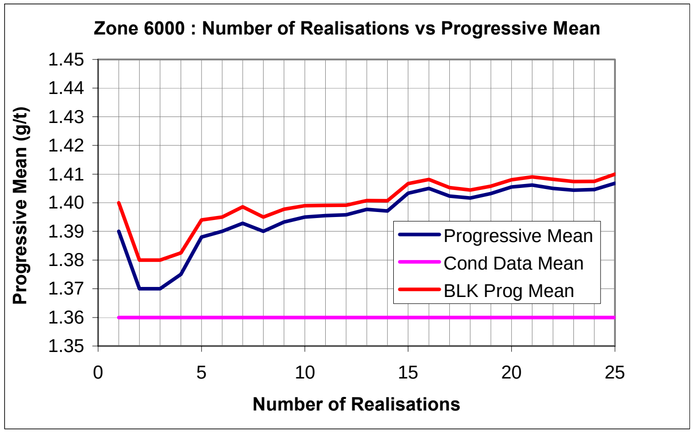


Figure E.5 Progressive statistical data for Zonecode 5000

ZONECODE 6000

				Conditioning Data				Points				Blocks			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV
AU1	3770200	38025	37702	1.36	6.26	2.50	1.84	1.39	7.08	2.66	1.91	1.40	1.45	1.20	0.86
AU2	3770200	38025	37702	1.36	6.26	2.50	1.84	1.35	6.64	2.58	1.91	1.36	1.36	1.17	0.86
AU3	3770200	38025	37702	1.36	6.26	2.50	1.84	1.37	6.88	2.62	1.91	1.38	1.44	1.20	0.87
AU4	3770200	38025	37702	1.36	6.26	2.50	1.84	1.39	6.70	2.59	1.86	1.39	1.31	1.14	0.82
AU5	3770200	38025	37702	1.36	6.26	2.50	1.84	1.44	7.51	2.74	1.90	1.44	1.57	1.25	0.87
AU6	3770200	38025	37702	1.36	6.26	2.50	1.84	1.40	7.08	2.66	1.90	1.40	1.42	1.19	0.85
AU7	3770200	38025	37702	1.36	6.26	2.50	1.84	1.41	7.11	2.67	1.89	1.42	1.43	1.20	0.84
AU8	3770200	38025	37702	1.36	6.26	2.50	1.84	1.37	6.43	2.54	1.85	1.37	1.24	1.11	0.81
AU9	3770200	38025	37702	1.36	6.26	2.50	1.84	1.42	7.35	2.71	1.91	1.42	1.56	1.25	0.88
AU10	3770200	38025	37702	1.36	6.26	2.50	1.84	1.41	7.00	2.65	1.88	1.41	1.41	1.19	0.84
AU11	3770200	38025	37702	1.36	6.26	2.50	1.84	1.40	7.09	2.66	1.90	1.40	1.45	1.20	0.86
AU12	3770200	38025	37702	1.36	6.26	2.50	1.84	1.40	6.81	2.61	1.86	1.40	1.36	1.17	0.83
AU13	3770200	38025	37702	1.36	6.26	2.50	1.84	1.42	7.38	2.72	1.91	1.42	1.55	1.24	0.88
AU14	3770200	38025	37702	1.36	6.26	2.50	1.84	1.39	6.79	2.61	1.87	1.40	1.35	1.16	0.83
AU15	3770200	38025	37702	1.36	6.26	2.50	1.84	1.49	8.33	2.89	1.94	1.49	1.80	1.34	0.90
AU16	3770200	38025	37702	1.36	6.26	2.50	1.84	1.43	7.72	2.78	1.94	1.43	1.68	1.30	0.91
AU17	3770200	38025	37702	1.36	6.26	2.50	1.84	1.36	6.51	2.55	1.88	1.36	1.30	1.14	0.84
AU18	3770200	38025	37702	1.36	6.26	2.50	1.84	1.39	6.74	2.60	1.87	1.39	1.33	1.15	0.83
AU19	3770200	38025	37702	1.36	6.26	2.50	1.84	1.43	7.29	2.70	1.89	1.43	1.48	1.22	0.85
AU20	3770200	38025	37702	1.36	6.26	2.50	1.84	1.45	7.58	2.75	1.90	1.45	1.54	1.24	0.86
AU21	3770200	38025	37702	1.36	6.26	2.50	1.84	1.42	7.14	2.67	1.88	1.43	1.40	1.18	0.83
AU22	3770200	38025	37702	1.36	6.26	2.50	1.84	1.38	6.89	2.62	1.90	1.39	1.39	1.18	0.85
AU23	3770200	38025	37702	1.36	6.26	2.50	1.84	1.39	6.86	2.62	1.88	1.39	1.39	1.18	0.85
AU24	3770200	38025	37702	1.36	6.26	2.50	1.84	1.41	7.82	2.80	1.98	1.41	1.91	1.38	0.98
AU25	3770200	38025	37702	1.36	6.26	2.50	1.84	1.46	7.93	2.82	1.93	1.47	1.67	1.29	0.88

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



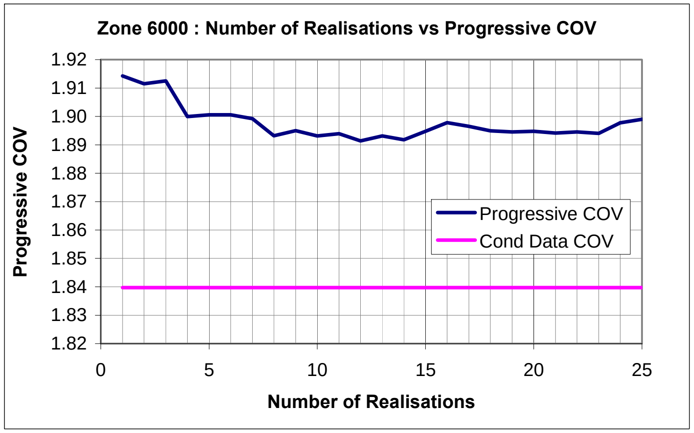
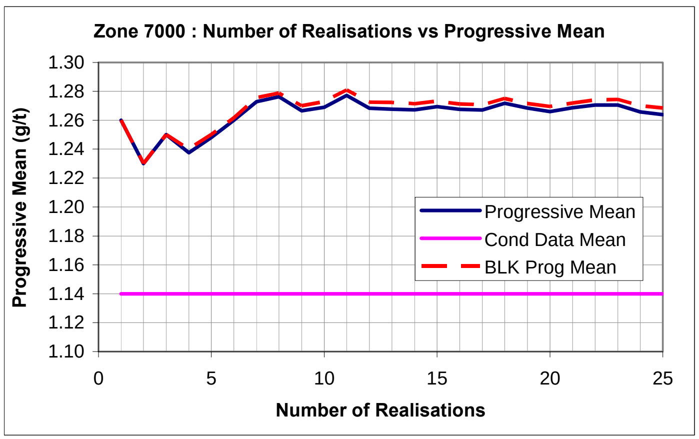


Figure E.6 Progressive statistical data for Zonecode 6000

ZONECODE 7000

				Conditioning Data				Points				Blocks			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Mean	EW Variance	EW Std Dev	EW COV	EW Mean	EW Variance	EW Std Dev	EW COV	EW Mean	EW Variance	EW Std Dev	EW COV
AU1	2421200	30598	24212	1.14	6.94	2.63	2.31	1.26	8.96	2.99	2.38	1.26	2.39	1.55	1.23
AU2	2421200	30598	24212	1.14	6.94	2.63	2.31	1.2	8.06	2.84	2.37	1.2	2.04	1.43	1.19
AU3	2421200	30598	24212	1.14	6.94	2.63	2.31	1.29	9.69	3.11	2.41	1.29	2.62	1.62	1.25
AU4	2421200	30598	24212	1.14	6.94	2.63	2.31	1.2	8.16	2.86	2.38	1.21	2.08	1.44	1.19
AU5	2421200	30598	24212	1.14	6.94	2.63	2.31	1.29	9.05	3.01	2.33	1.29	2.3	1.52	1.18
AU6	2421200	30598	24212	1.14	6.94	2.63	2.31	1.32	9.21	3.03	2.30	1.32	2.27	1.51	1.14
AU7	2421200	30598	24212	1.14	6.94	2.63	2.31	1.35	11.3	3.36	2.49	1.36	3.2	1.79	1.32
AU8	2421200	30598	24212	1.14	6.94	2.63	2.31	1.3	9.86	3.14	2.42	1.3	2.72	1.65	1.27
AU9	2421200	30598	24212	1.14	6.94	2.63	2.31	1.19	8.12	2.85	2.39	1.2	2.09	1.45	1.20
AU10	2421200	30598	24212	1.14	6.94	2.63	2.31	1.29	9.6	3.10	2.40	1.3	2.55	1.60	1.23
AU11	2421200	30598	24212	1.14	6.94	2.63	2.31	1.36	10.83	3.29	2.42	1.36	2.9	1.70	1.25
AU12	2421200	30598	24212	1.14	6.94	2.63	2.31	1.17	7.25	2.69	2.30	1.18	1.8	1.34	1.14
AU13	2421200	30598	24212	1.14	6.94	2.63	2.31	1.26	9.33	3.05	2.42	1.27	2.55	1.60	1.26
AU14	2421200	30598	24212	1.14	6.94	2.63	2.31	1.26	8.1	2.85	2.26	1.26	1.99	1.41	1.12
AU15	2421200	30598	24212	1.14	6.94	2.63	2.31	1.3	9.41	3.07	2.36	1.3	2.37	1.54	1.18
AU16	2421200	30598	24212	1.14	6.94	2.63	2.31	1.24	9.11	3.02	2.43	1.24	2.45	1.57	1.26
AU17	2421200	30598	24212	1.14	6.94	2.63	2.31	1.26	9.06	3.01	2.39	1.26	2.38	1.54	1.22
AU18	2421200	30598	24212	1.14	6.94	2.63	2.31	1.35	11.41	3.38	2.50	1.35	3.31	1.82	1.35
AU19	2421200	30598	24212	1.14	6.94	2.63	2.31	1.21	8.27	2.88	2.38	1.21	2.13	1.46	1.21
AU20	2421200	30598	24212	1.14	6.94	2.63	2.31	1.22	8.03	2.83	2.32	1.23	1.98	1.41	1.14
AU21	2421200	30598	24212	1.14	6.94	2.63	2.31	1.32	9.89	3.14	2.38	1.32	2.66	1.63	1.24
AU22	2421200	30598	24212	1.14	6.94	2.63	2.31	1.31	9.58	3.10	2.36	1.32	2.46	1.57	1.19
AU23	2421200	30598	24212	1.14	6.94	2.63	2.31	1.27	9.48	3.08	2.42	1.28	2.54	1.59	1.25
AU24	2421200	30598	24212	1.14	6.94	2.63	2.31	1.16	7.97	2.82	2.43	1.17	2.09	1.45	1.24
AU25	2421200	30598	24212	1.14	6.94	2.63	2.31	1.22	8.61	2.93	2.41	1.23	2.25	1.50	1.22

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



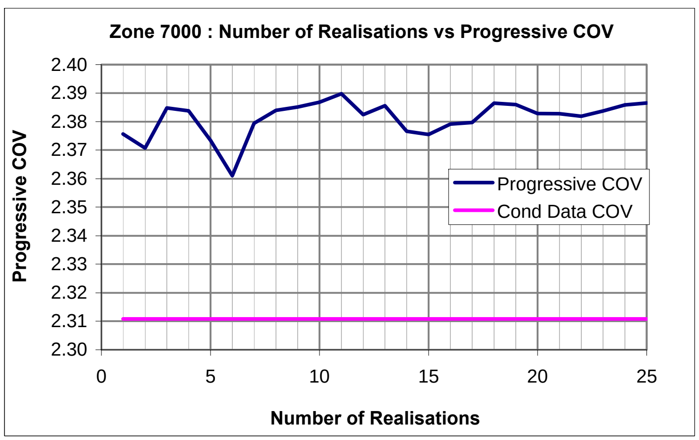


Figure E.7 Progressive statistical data for Zonecode 7000

ZONECODE 8000

				Conditioning Data				Node Estimate				Block Estimate			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Mean	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV	EW Average	EW Variance	EW Std Dev	EW COV
AU1	409200	6143	4092	2.09	28.49	5.34	2.55	2.26	33.38	5.78	2.56	2.26	5.9	2.43	1.07
AU2	409200	6143	4092	2.09	28.49	5.34	2.55	2.35	37.55	6.13	2.61	2.35	7.24	2.69	1.14
AU3	409200	6143	4092	2.09	28.49	5.34	2.55	2.13	29.51	5.43	2.55	2.13	5.41	2.33	1.09
AU4	409200	6143	4092	2.09	28.49	5.34	2.55	2.48	43.77	6.62	2.67	2.48	9.2	3.03	1.22
AU5	409200	6143	4092	2.09	28.49	5.34	2.55	2.11	29.72	5.45	2.58	2.11	5.78	2.40	1.14
AU6	409200	6143	4092	2.09	28.49	5.34	2.55	2.42	40.47	6.36	2.63	2.42	8.02	2.83	1.17
AU7	409200	6143	4092	2.09	28.49	5.34	2.55	2.38	35.76	5.98	2.51	2.38	6.56	2.56	1.08
AU8	409200	6143	4092	2.09	28.49	5.34	2.55	2.66	48.33	6.95	2.61	2.66	10.41	3.23	1.21
AU9	409200	6143	4092	2.09	28.49	5.34	2.55	2.24	33.09	5.75	2.57	2.24	6.59	2.57	1.15
AU10	409200	6143	4092	2.09	28.49	5.34	2.55	2.74	51.91	7.20	2.63	2.74	10.13	3.18	1.16
AU11	409200	6143	4092	2.09	28.49	5.34	2.55	2.47	41.68	6.46	2.61	2.47	8.58	2.93	1.19
AU12	409200	6143	4092	2.09	28.49	5.34	2.55	2.43	41.09	6.41	2.64	2.43	8.1	2.85	1.17
AU13	409200	6143	4092	2.09	28.49	5.34	2.55	2.49	46.05	6.79	2.73	2.49	10.24	3.20	1.29
AU14	409200	6143	4092	2.09	28.49	5.34	2.55	2.5	43.26	6.58	2.63	2.49	8.4	2.90	1.16
AU15	409200	6143	4092	2.09	28.49	5.34	2.55	2.1	27.37	5.23	2.49	2.1	4.66	2.16	1.03
AU16	409200	6143	4092	2.09	28.49	5.34	2.55	2.62	50.14	7.08	2.70	2.62	10.03	3.17	1.21
AU17	409200	6143	4092	2.09	28.49	5.34	2.55	2.21	32.52	5.70	2.58	2.21	6.36	2.52	1.14
AU18	409200	6143	4092	2.09	28.49	5.34	2.55	2.45	48.23	6.94	2.83	2.45	11.93	3.45	1.41
AU19	409200	6143	4092	2.09	28.49	5.34	2.55	2.23	36.18	6.01	2.70	2.23	7.6	2.76	1.24
AU20	409200	6143	4092	2.09	28.49	5.34	2.55	2.44	39.02	6.25	2.56	2.44	7.17	2.68	1.10
AU21	409200	6143	4092	2.09	28.49	5.34	2.55	2.36	40.33	6.35	2.69	2.36	8.1	2.85	1.21
AU22	409200	6143	4092	2.09	28.49	5.34	2.55	2.68	49.49	7.03	2.62	2.68	9.91	3.15	1.17
AU23	409200	6143	4092	2.09	28.49	5.34	2.55	2.29	35.57	5.96	2.60	2.29	6.44	2.54	1.11
AU24	409200	6143	4092	2.09	28.49	5.34	2.55	2.53	46.05	6.79	2.68	2.53	9.83	3.14	1.24
AU25	409200	6143	4092	2.09	28.49	5.34	2.55	2.17	31.93	5.65	2.60	2.17	6.43	2.54	1.17

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation

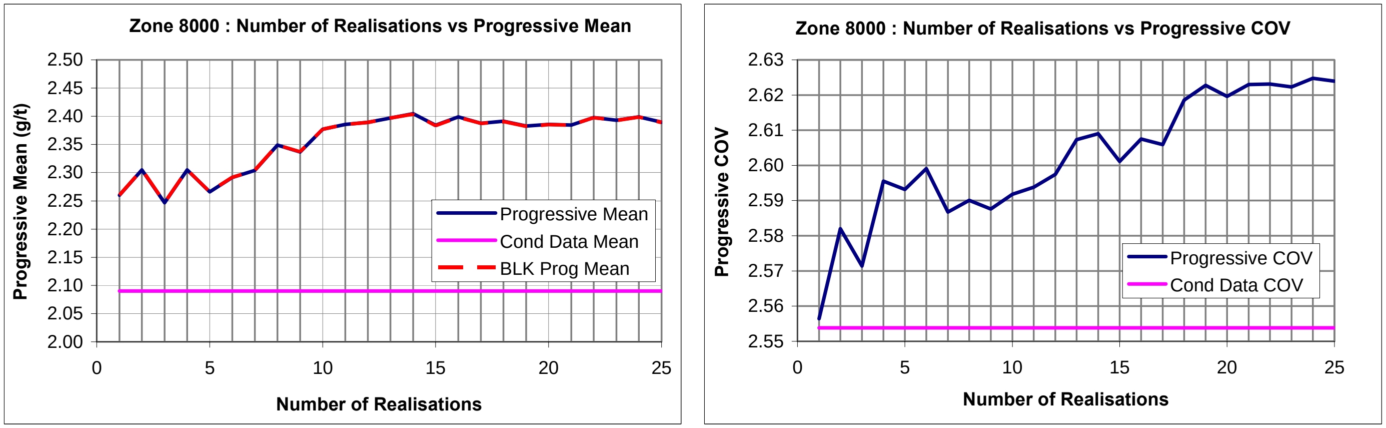
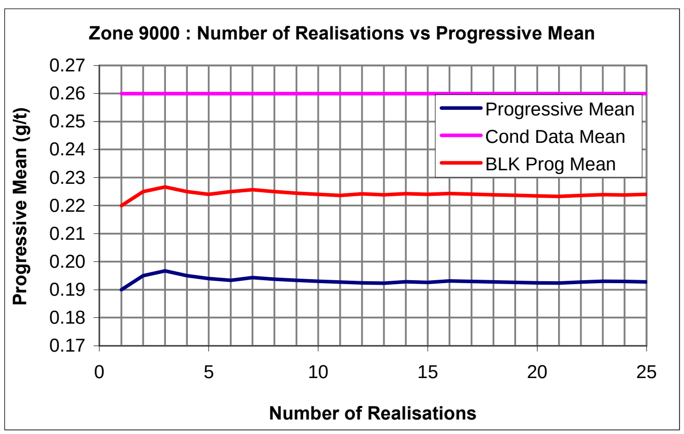


Figure E.8 Progressive statistical data for Zonecode 8000

ZONECODE 9000

				Conditioning Data				Estimated Nodes				Estimated Blocks			
FIELD	Number of Nodes	Number of Blocks	Blocks Estimated	EW Mean	EW Variance	EW Std Dev	EW COV	EW Mean	EW Variance	EW Std Dev	EW COV	EW Mean	EW Variance	EW Std Dev	EW COV
AU1	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.33	0.57	3.02	0.22	0.1	0.32	1.44
AU2	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.32	0.57	2.83	0.23	0.1	0.32	1.37
AU3	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.34	0.58	2.92	0.23	0.1	0.32	1.37
AU4	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.3	0.55	2.88	0.22	0.09	0.30	1.36
AU5	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.22	0.09	0.30	1.36
AU6	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.33	0.57	3.02	0.23	0.1	0.32	1.37
AU7	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.38	0.62	3.08	0.23	0.12	0.35	1.51
AU8	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.29	0.54	2.83	0.22	0.09	0.30	1.36
AU9	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.3	0.55	2.88	0.22	0.09	0.30	1.36
AU10	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.3	0.55	2.88	0.22	0.09	0.30	1.36
AU11	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.31	0.56	2.93	0.22	0.09	0.30	1.36
AU12	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.35	0.59	3.11	0.23	0.11	0.33	1.44
AU13	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.22	0.09	0.30	1.36
AU14	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.35	0.59	2.96	0.23	0.1	0.32	1.37
AU15	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.34	0.58	3.07	0.22	0.1	0.32	1.44
AU16	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.32	0.57	2.83	0.23	0.09	0.30	1.30
AU17	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.31	0.56	2.93	0.22	0.09	0.30	1.36
AU18	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.22	0.1	0.32	1.44
AU19	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.33	0.57	3.02	0.22	0.1	0.32	1.44
AU20	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.22	0.1	0.32	1.44
AU21	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.33	0.57	3.02	0.22	0.1	0.32	1.44
AU22	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.34	0.58	2.92	0.23	0.1	0.32	1.37
AU23	40018300	400183	400183	0.26	0.54	0.73	2.83	0.2	0.35	0.59	2.96	0.23	0.1	0.32	1.37
AU24	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.22	0.09	0.30	1.36
AU25	40018300	400183	400183	0.26	0.54	0.73	2.83	0.19	0.32	0.57	2.98	0.23	0.09	0.30	1.30

EW: Equal Weighted
Std Dev: Standard Deviation
COV: Coefficient of Variation



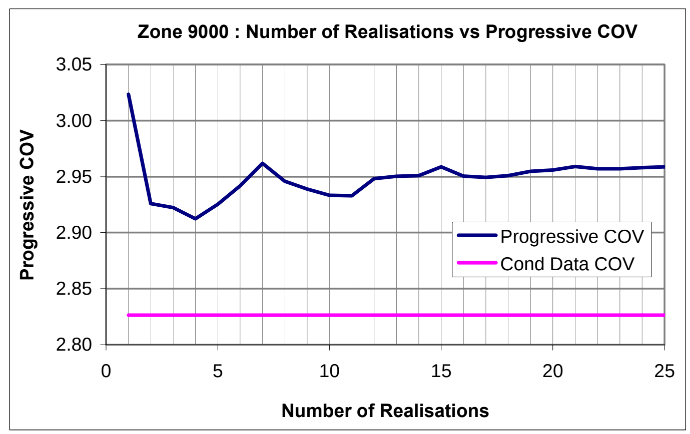


Figure E.9 Progressive statistical data for Zonecode 9000

APPENDIX F PIT OPTIMISATION PARAMETERS

Parmeter	Unit	Description	Value
Gold Price	$/ounce		475
Tonnes Treated	tonne/annum		5,255,778
Metallurgical Recovery	%	Laterite (ox)	93
		Saprolite Oxide - Soft	93
		Siliceous Oxide- Hard	93
		Saprolite Sulphide - Soft	80
		Hard Sulphides - Hard	80
		Intermediate Oxide	93
		Intermediate Suplhide	80
Total Processing Cost	$/tonne	Laterite (ox)	17.04
		Saprolite Oxide - Soft	16.29
		Siliceous Oxide- Hard	22.66
		Saprolite Sulphide - Soft	21.00
		Hard Sulphides - Hard	20.53
		Intermediate Oxide	17.04
		Intermediate Suplhide	21.76
Mining Cost	$/tonne	Laterite (ox)	1.67
		Saprolite Oxide - Soft	1.67
		Siliceous Oxide- Hard	1.67
		Saprolite Sulphide - Soft	1.67
		Hard Sulphides - Hard	1.67
		Intermediate Oxide	1.67
		Intermediate Suplhide	1.67
Mining Cost Adjustment Factor (CAF) by Rock Type		Laterite (ox)	1.02
		Saprolite Oxide - Soft	1.00
		Siliceous Oxide- Hard	0.95
		Saprolite Sulphide - Soft	0.91
		Hard Sulphides - Hard	0.81
		Intermediate Oxide	0.96
		Intermediate Suplhide	0.96
Applied Depth for Mining Cost	Mining Elevation		160
Cost adjustment factor for increase in Depth	$/per 10m bench		0.01594
Gold Price in $ per Gram	$/g		15.27160
Selling Cost (6% royalty + 1% management fee)	$/g		1.06901
Pit Slopes	Degrees	Domain 1 (East Oxides)	35
		Domain 1 (West Oxides)	40
		Domain 2 (East Sulphides)	52
		Domain 2 (West Sulphides	48

Table F.1 Pit optimization Parameters

APPENDIX G RISK SHELL GRADE TONNAGE CURVES

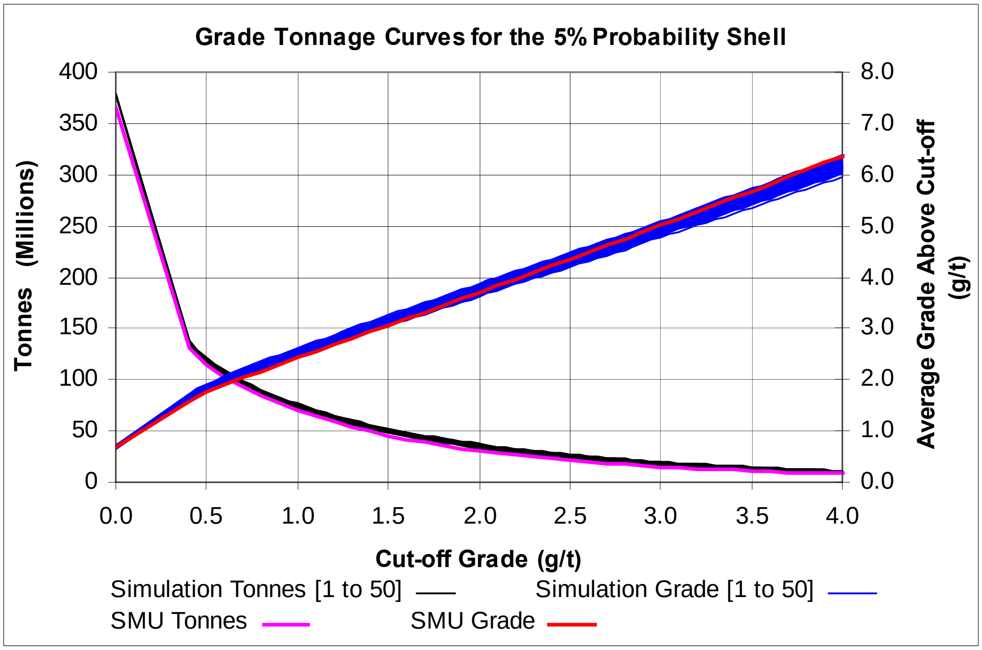


Figure G.1…Grade tonnage curves for the P05 risk shell

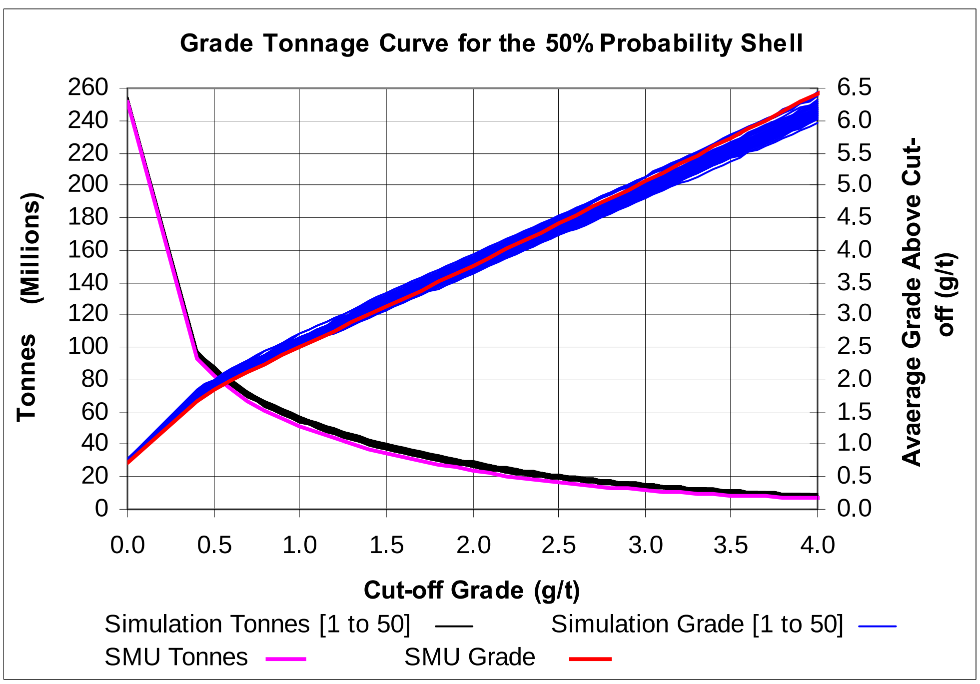


Figure G.2…Grade tonnage curves for the P50 risk shell

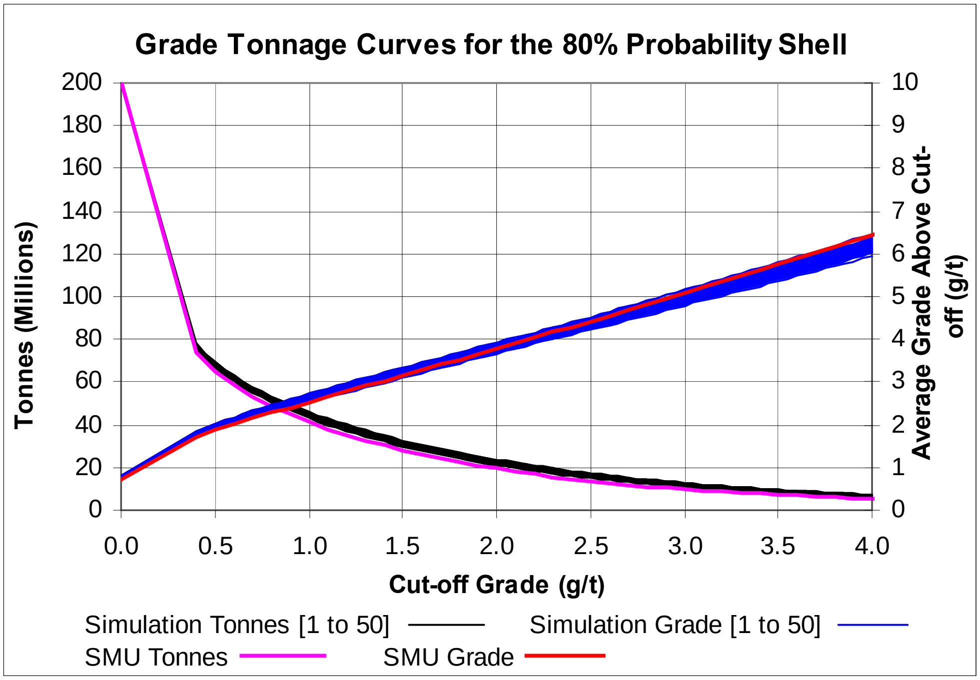


Figure G.3…Grade tonnage curves for the P80 risk shell

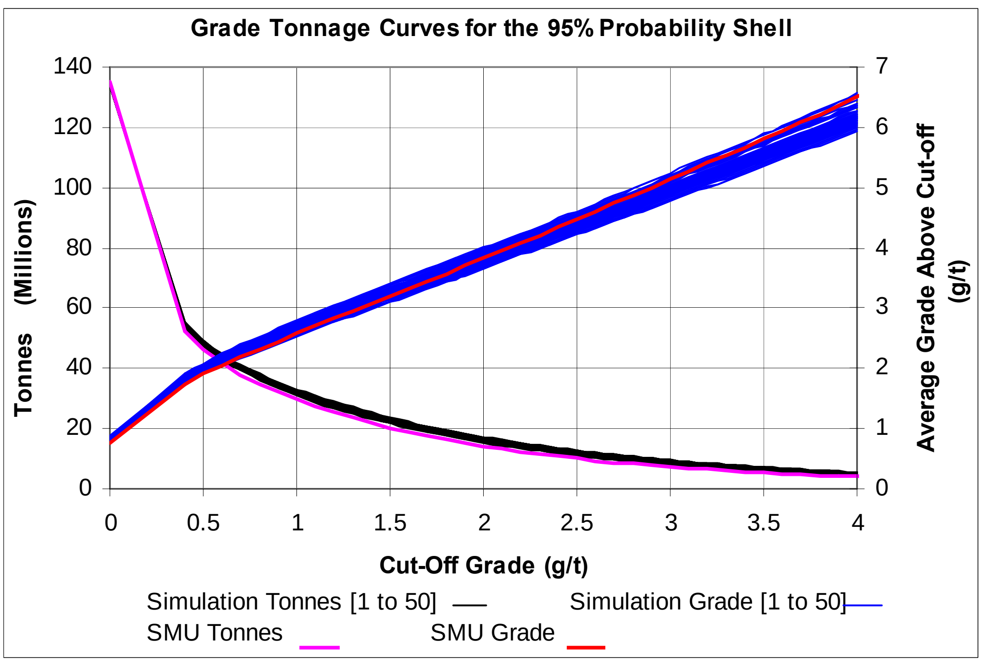


Figure G.4…Grade tonnage curves for the P95 risk shell

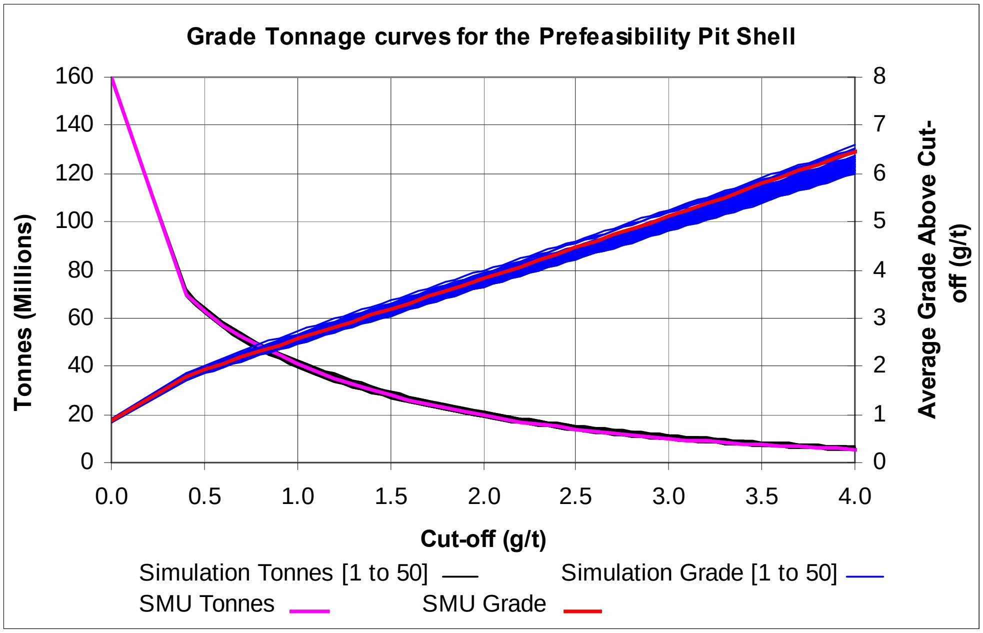


Figure G.5…Grade tonnage curves for the $475/oz Prefeasibility risk shell

APPENDIX H OPEN PIT VALUATIONS

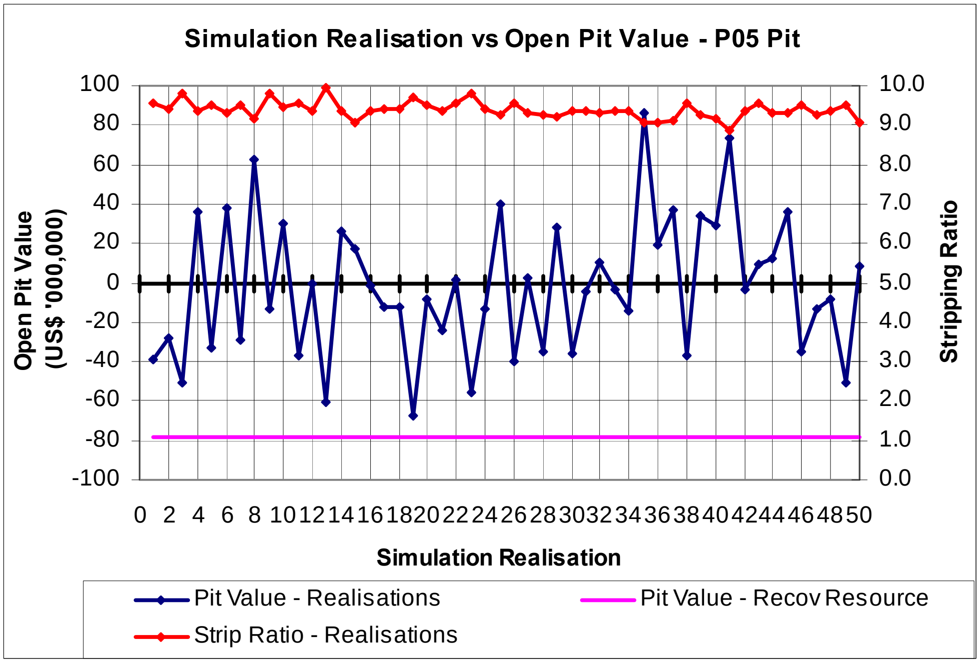


Figure H.1…Open pit values for the P05 risk pit

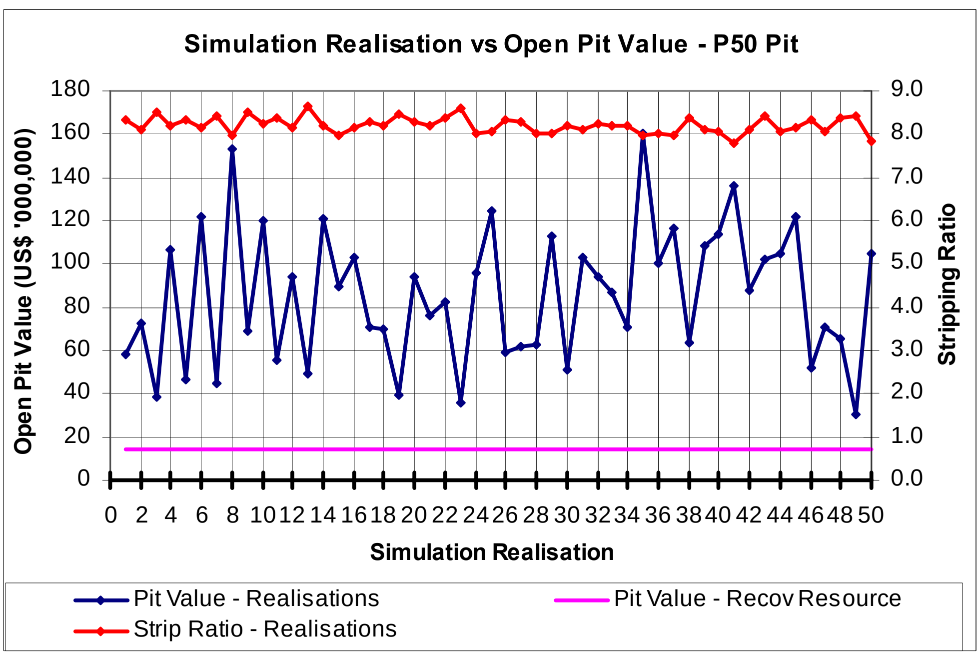


Figure H.2…Open pit values for the P50 risk pit

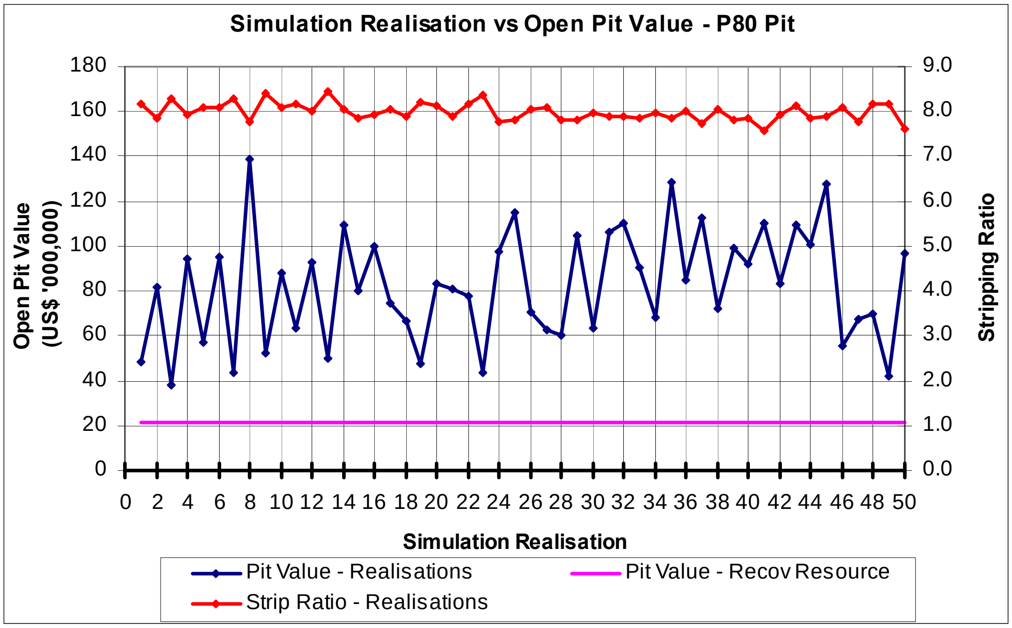


Figure H.3…Open pit values for the P80 risk pit

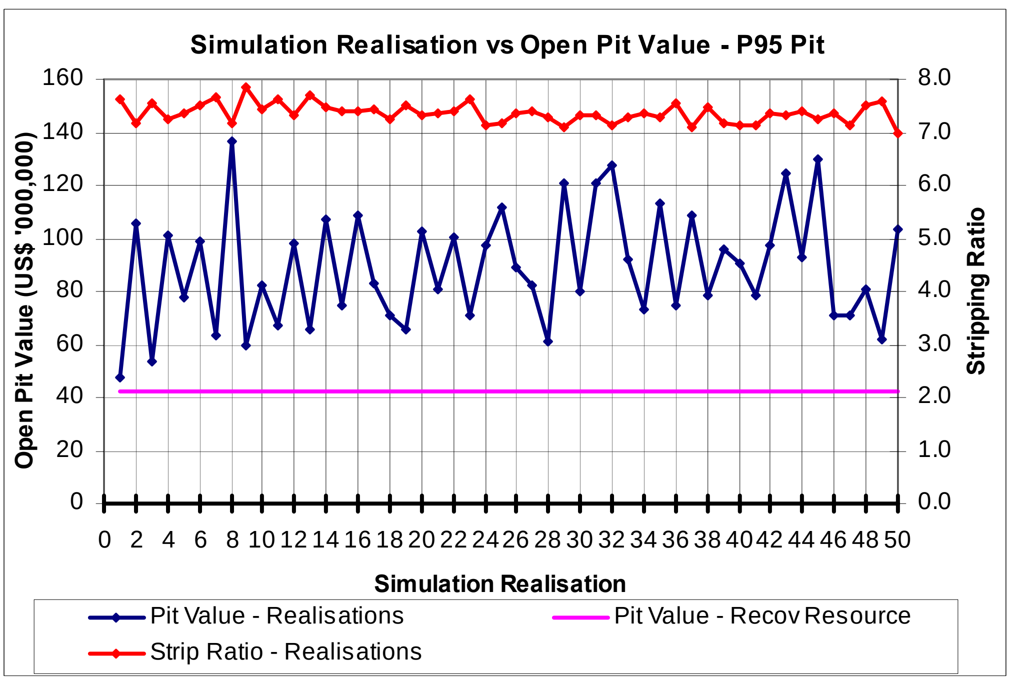


Figure H.4…Open pit values for the P95 risk pit

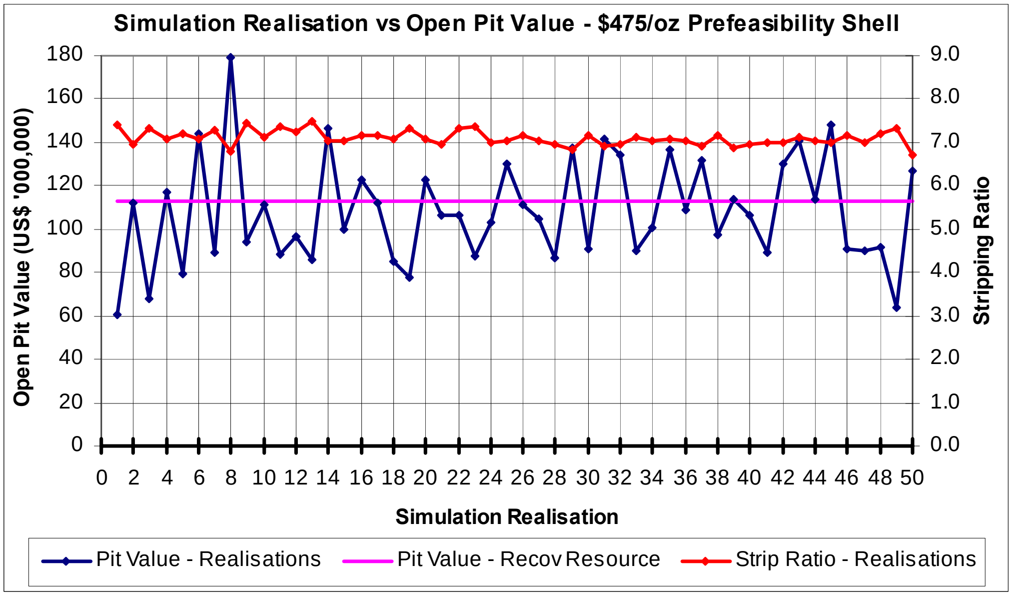


Figure H.4…Open pit values for the $475/oz Prefeasibility risk pit

APPENDIX I HISTOGRAMS FOR COV BY RESOURCE CATEGORY

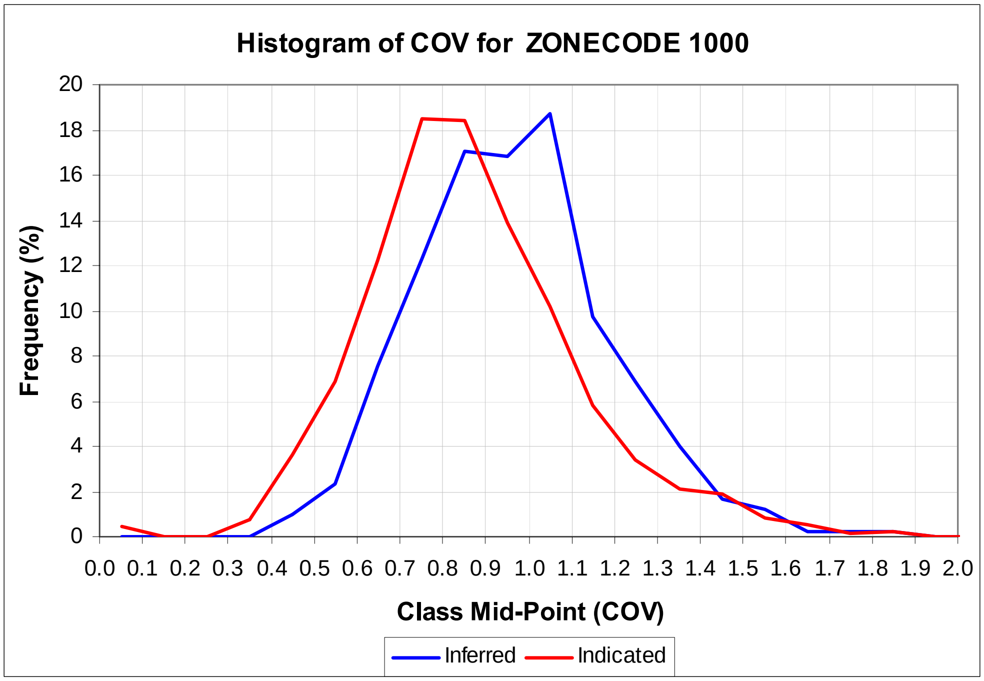


Figure I.1…Histogram of COV by resource category – Zonecode 1000

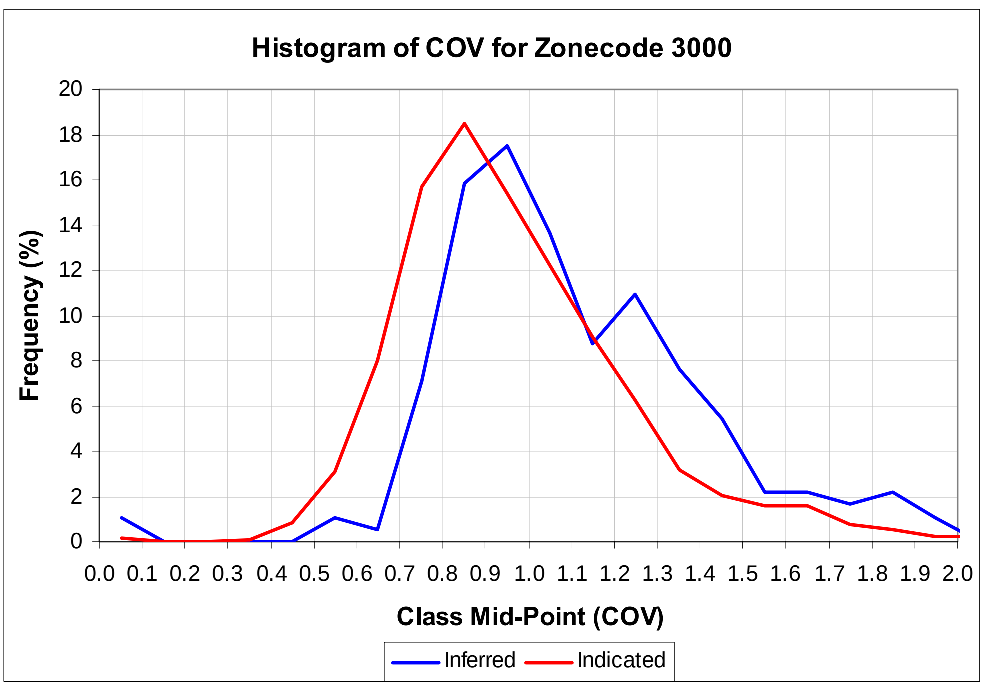


Figure I.2…Histogram of COV by resource category – Zonecode 3000

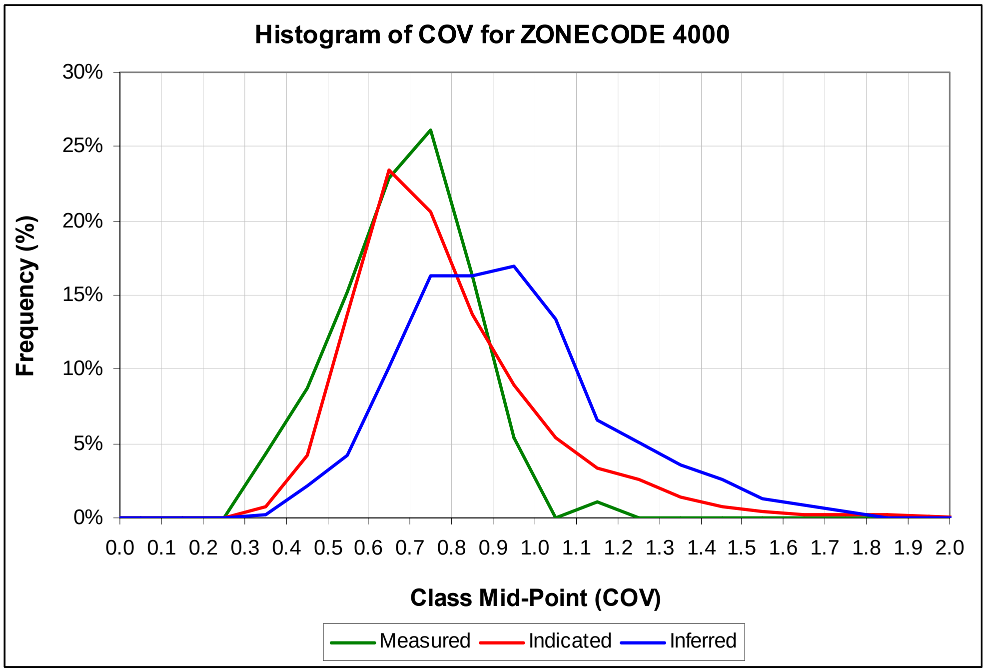


Figure I.3…Histogram of COV by resource category – Zonecode 4000

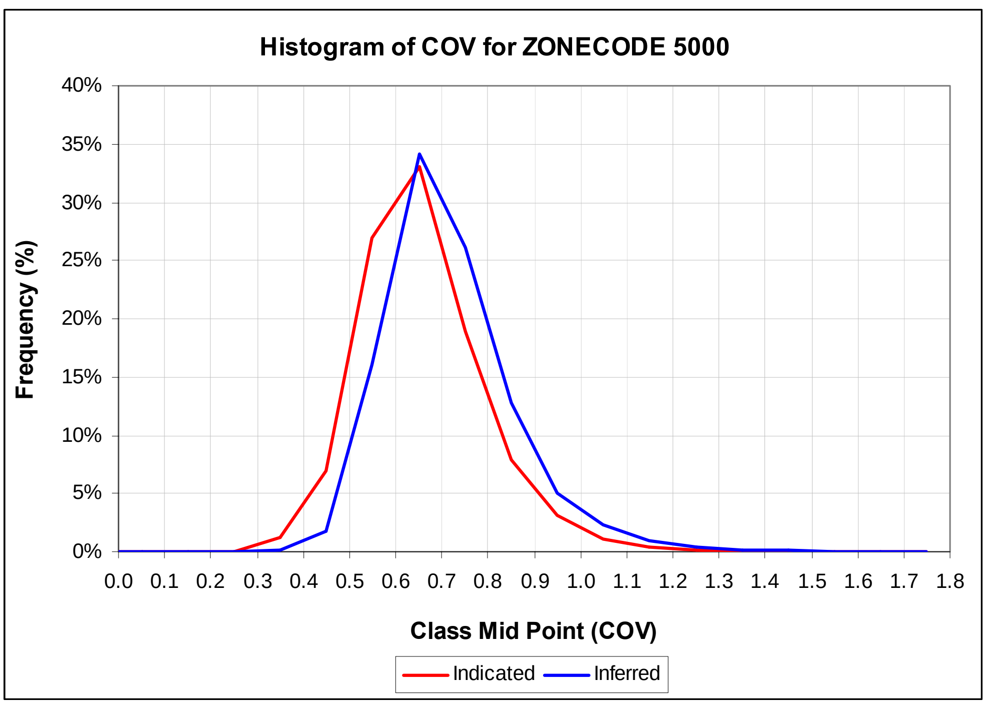


Figure I.4…Histogram of COV by resource category – Zonecode 5000

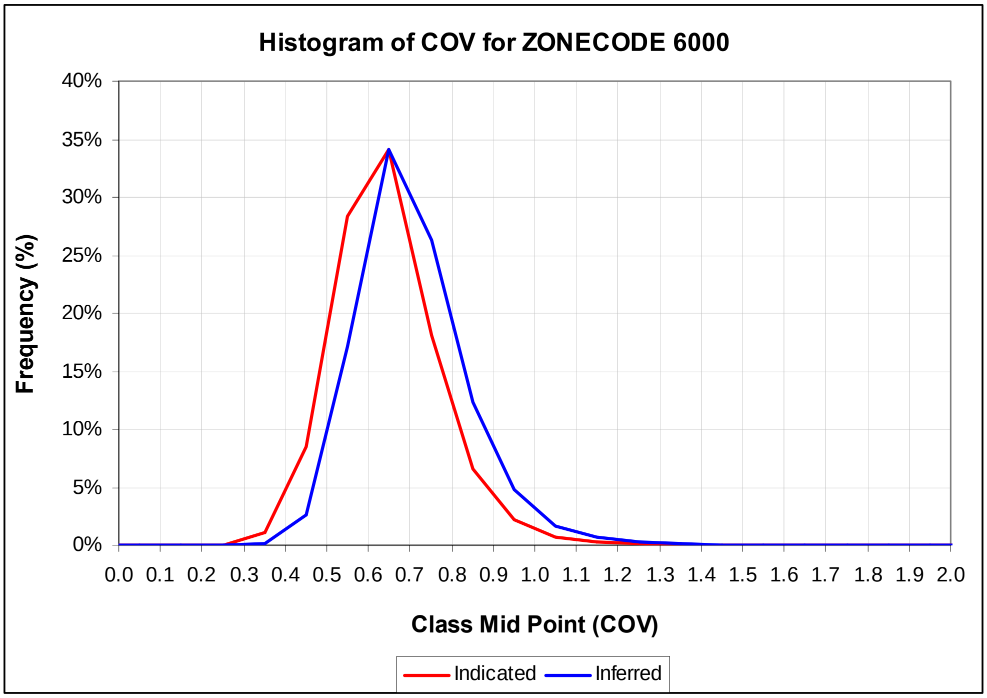


Figure I.5…Histogram of COV by resource category – Zonecode 6000

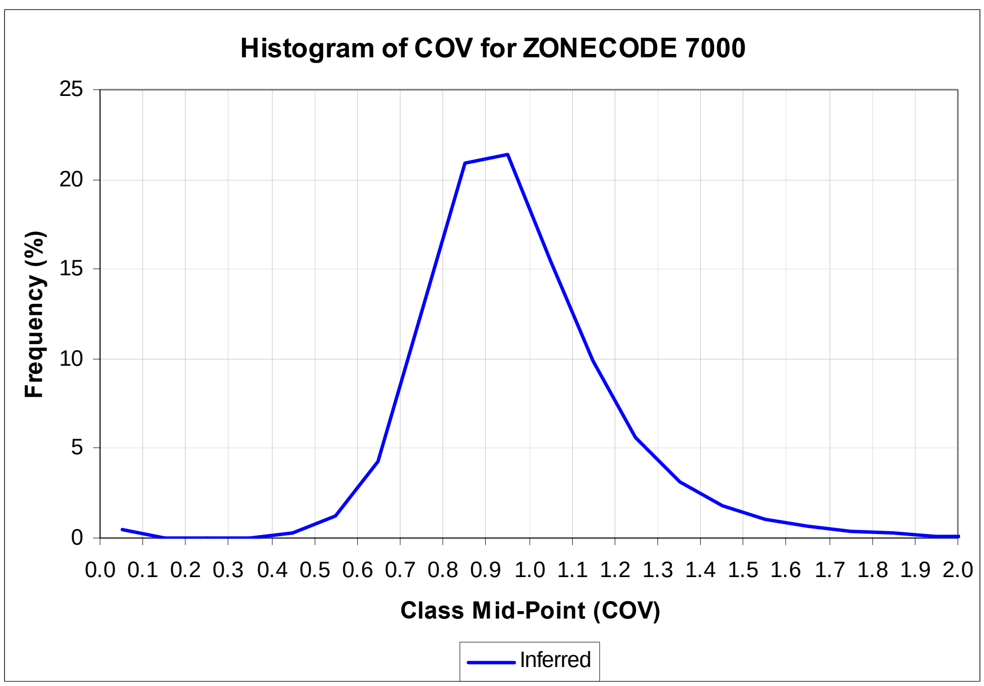


Figure I.6…Histogram of COV by resource category – Zonecode 7000

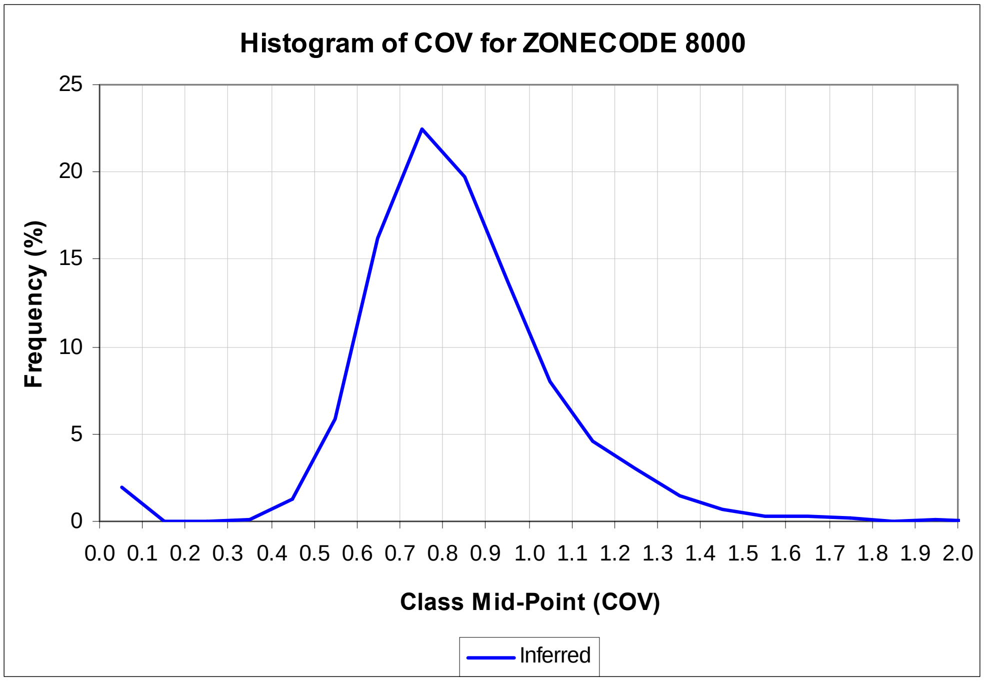


Figure I.7…Histogram of COV by resource category – Zonecode 8000