



**Orebody Modelling for Exploration:
The Western Mineralisation, Broken Hill**

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Table of Contents

Table of Contents	II
Abstract.....	X
Declaration.....	XI
Acknowledgements	XII
List of Figures.....	XIV
List of Tables	XXIV
Definition of abbreviations and acronyms.....	XXIX
CHAPTER 1: Regional and Local Geology and the Aims of this Study	1
1.1 Introduction	1
1.2 Curnamona Province	2
1.3 The Willyama Supergroup	6
1.4 The Broken Hill ore deposit.....	7
1.4.1 Mine sequence stratigraphy	9
1.4.2 Rock types of the Broken Hill ore deposit	13
1.4.2.1 Metasediments	13
1.4.2.2 Pegmatite.....	13
1.4.2.3 Lode horizon rocks.....	14
1.4.2.4 Amphibolite	14
1.4.2.5 Potosi Gneiss.....	14
1.5 Tectonism	15
1.5.1 Olarian Orogeny	15
1.5.2 Delamerian Orogeny.....	18
1.6 Characteristics of the Broken Hill orebodies	19
1.6.1 Partial melting.....	19
1.6.1.1 Orebody.....	19
1.6.1.2 Wall rocks	19
1.6.2 The Eastern Mineralisation.....	20
1.6.3 The Western Mineralisation	20
1.6.4 Mineral chemistry and alteration.....	22
1.7 Unsolved problems and research questions of the Broken Hill orebodies.....	23

CHAPTER 2: Quantitative Core Logging in the Western Mineralisation	27
2.1 Introduction	27
2.2 Maps	28
2.2.1 Drill collar locations	28
2.2.2 Three-dimensional visualisation of the analysed sample locations.....	31
2.3 Geological information resulted from core logging in the Western Mineralisation...	33
2.3.1 The conventional core logging	33
2.3.2 The quantitative core logging	35
2.3.3 Quantification of minerals and rock types	36
2.3.3.1 Quantification of minerals and rock types in group one.....	36
2.3.3.2 Quantification of minerals in group two.....	37
2.3.3.3 Quantification of minerals in group three.....	38
2.3.4 Some effective parameters and considerations in the quantitative core logging.....	39
2.3.5 Quantification of textures for sulphide minerals of the Western Mineralisation.....	40
2.3.6 Previous visual quantification methods in geosciences	41
2.4 Geochemical data of the Western Mineralisation	41
2.4.1 Sample size reconciliation	42
2.4.1.1 Equivalent core diameter	42
2.4.1.2 Equivalent length of core	46
2.4.2 Inclination of drill core.....	46
2.4.3 Recovery percentage	48
2.5 Data Compositing.....	49
2.6 Discussion about the conventional core logs 4003, 4004 and 4031	50
2.6.1 The conventional core log 4003	51
2.6.2 The conventional core log 4004	52
2.6.3 The conventional core log 4031	53
2.7 Discussion about the quantitative core logs 4003, 4004 and 4031	53
2.7.1 The quantitative core log 4003	54
2.7.2 The quantitative core log 4004.....	57
2.7.3 The quantitative core log 4031	60
2.8 Summary	63

CHAPTER 3: Quantitative Core-Log Analysis in the Western Mineralisation	64
3.1 Introduction	64
3.2 Descriptive statistics.....	65
3.3 Bar diagram	67
3.4 Statistical results for element concentrations of the Western Mineralisation	67
3.4.1 Interpretation of the bar diagrams of elements for the surface drill cores.....	74
3.4.2 Interpretation of the bar diagrams of elements for the underground drill cores..	81
3.4.3 Discussion of the statistical results and the bar diagrams of elements.....	85
3.5 Statistical results for sulphide and silicate minerals of the Western Mineralisation..	86
3.5.1 Discussion of the statistical results and the bar diagram of minerals	91
3.6 Evaluating the precision of the variation of galena+sphalerite against the variation of Pb+Zn	92
3.6.1 Comparison of the variation of Pb+Zn with variation of galena+sphalerite	95
3.6.2 Probability plot	98
3.6.3 The results of correlation coefficients	99
3.6.4 Interpretation of the correlation coefficients	100
3.7 Exploration signature of lithologies in the Broken Hill Domain	100
3.7.1 Statistical results for rock types of the Western Mineralisation	101
3.7.2 Discussion of the correlation coefficient of the rock types with Pb+Zn	103
3.8 Summary	103
CHAPTER 4: The Relationship of Magnetic Pyrrhotite with the Orebody of the Western Mineralisation	105
4.1 Introduction	105
4.2 Characteristics of pyrrhotite	107
4.3 Pyrrhotite in the Broken Hill Domain	109
4.3.1 Evaluation of chemical properties of pyrrhotite among the Broken Hill orebodies.....	111
4.3.1.1 Variation of Fe and S in pyrrhotite samples of the Broken Hill orebodies	111
4.3.1.2 Correspondence analysis for pyrrhotite samples of the Broken Hill orebodies	113
4.3.1.3 Correspondence maps for pyrrhotite samples	118
4.4 Magnetic susceptibility measurements in the Western Mineralisation	120

4.4.1 Average magnetic susceptibility (AMS)	121
4.4.2 Maximum magnetic susceptibility (MMS)	121
4.5 Descriptive statistics for magnetic susceptibility, pyrrhotite, Pb+Zn and galena+sphalerite.....	122
4.5.1 Statistical tests	122
4.5.1.1 Hypothesis of the non-parametric statistical tests	125
4.5.1.2 P value or significance level (1-tailed or 2-tailed).....	125
4.5.2 Wilcoxon Mann-Whitney U Test	126
4.5.3 Kolmogorov-Smirnov Z Test.....	127
4.5.4 Moses Test of Extreme Reactions	127
4.6 Bar diagrams of magnetic susceptibility and pyrrhotite	129
4.7 Results of correlation coefficient.....	132
4.7.1 Interpretation of the correlation coefficients.....	133
4.8 Appraisal of internal relationships among magnetic susceptibility, pyrrhotite, galena+sphalerite and Pb+Zn relative to depth	133
4.9 Contour plots.....	140
4.1 Summary	142
CHAPTER 5: Multi-Element Relationships: The Western Mineralisation.....	144
5.1 Introduction	144
5.2 The comparison of mineral chemistry of galena and sphalerite samples.....	145
5.2.1 Correspondence analysis for galena samples within the Broken Hill orebodies	147
5.2.2 Correspondence maps for galena samples.....	149
5.2.2.1 Interpretation of Figure 5.1.....	149
5.2.2.2 Interpretation of Figure 5.2.....	150
5.2.2.3 Interpretation of Figure 5.3.....	150
5.2.2.4 Interpretation of a combination of Figures 5.1 to 5.3	151
5.2.3 Correspondence analysis for sphalerite samples	151
5.2.4 Correspondence maps for sphalerite samples	153
5.2.4.1 Interpretation of Figure 5.4.....	153
5.2.4.2 Interpretation of Figure 5.5.....	154
5.2.4.3 Interpretation of Figure 5.6.....	154
5.2.4.4 Interpretation of a combination of Figures 5.4 to 5.6	155

5.3 Assay data used for multivariate statistical analysis	156
5.3.1 Statistical distributions of assay values	156
5.3.2 Compositional data analysis	159
5.3.3 Data preparation	161
5.4 Results of bivariate analysis	164
5.4.1 Interpretation of the PCC results	165
5.5 Linear multivariate regressions (LMR)	166
5.5.1 Results of LMR for Pb	167
5.5.2 Interpretation of LMR results for Pb	168
5.5.3 Results of LMR for Zn	168
5.5.4 Interpretation of LMR results for Zn	169
5.6 Cluster analysis	169
5.6.1 Distance measures for cluster analysis	170
5.6.2 Cluster algorithm	171
5.6.3 Result of cluster analysis for the 1059 clr-transformed data	171
5.7 Principal Component Analysis (PCA)	172
5.7.1 Result of PCA	173
5.7.2 The amount of PC loadings	175
5.7.3 The sign of PC loadings of the elements	176
5.7.4 Interpretation of PCs	177
5.7.5 Interpretation of elements within PCs	178
5.7.6 Maps of PC loadings	180
5.7.6.1 Map of PC ₁ loading and PC ₂ loading (Figure 5.14)	181
5.7.6.2 Map of PC ₁ loading and PC ₃ loading (Figure 5.15)	182
5.7.6.3 Map of PC ₁ loading and PC ₄ loading (Figure 5.16)	183
5.7.6.4 Map of PC ₂ loading and PC ₃ loading (Figure 5.17)	184
5.7.6.5 Map of PC ₂ loading and PC ₃ loading (Figure 5.18)	184
5.7.6.6 Map of PC ₃ loading and PC ₄ loading (Figure 5.19)	186
5.7.7 Map of PC scores	186
5.7.8 Biplots of PC loadings and PC scores for 1059 samples of the Western Mineralisation	188
5.8 Three-dimensional biplots for chemical composition of galena and sphalerite samples of the Western Mineralisation	190

5.8.1 Procedure for preparation of data for the CoDaPack3D	190
5.8.2 Galena.....	191
5.8.3 Sphalerite.....	195
5.9 Summary	198
CHAPTER 6: Variogram Analysis for the Western Mineralisation	200
6.1 Introduction.....	200
6.2 Variography.....	201
6.2.1 Variogram model-spherical scheme	202
6.2.2 The range of influence.....	203
6.2.3 Advantages of application of geostatistics versus classic statistics	204
6.2.4 Variogram calculations.....	204
6.2.4.1 Down-hole variogram	206
6.2.4.2 Three-dimensional variograms in different directions.....	206
6.2.4.3 Problem with raw data of the Western Mineralisation for calculation of variogram models	207
6.2.4.4 Logarithmic transformation of data	209
6.2.4.5 Back-transformation	209
6.3 The strike, plunge and dip of the orebody in the Western Mineralisation	210
6.4 The use of variogram ranges for the design of the optimal sampling grid	212
6.5 Comparison of variogram parameters of the Western Mineralisation with other Pb and Zn deposits	215
6.6 Variogram anisotropy of different elements in the Western Mineralisation.....	216
6.7 Evaluation of similarity levels among 10 elements of the Western Mineralisation based on their radii in Figure 6.14	220
6.8 Variogram validation (cross-validation) of the Western Mineralisation	221
6.9 Final variogram parameters used for estimation of a block model for the Western Mineralisation	222
6.9.1 Nugget variance (C_0) and other structural components of variance.....	223
6.9.2 The longest ranges of influence (a) for each variogram structure.....	223
6.9.3 The rotation angles of the three main axes against the coordinate system used.....	223
6.9.4 Two anisotropy ratios	223
6.10 Block Model.....	224

6.10.1 Orebody outline	224
6.10.2 Kriging parameters	224
6.10.3 Block size determination	225
6.10.4 Optimal number of samples for kriging estimation.....	226
6.10.5 The univariate ordinary kriging.....	227
6.11 Summary	227
CHAPTER 7: Spatial Geochemical Models for the Western Mineralisation.....	229
7.1 Introduction	227
7.2 Construction of cross-sections for evaluating geochemical halo patterns	230
7.3 Separation of threshold values from anomalous and background levels	233
7.3.1 Procedure of separating threshold from background in the Geostatistics for Windows software	235
7.4 Quantitative comparison of the geometrical characteristics of the geochemical halo patterns at different cross-sections of the Western Mineralisation	240
7.4.1 Geometrical characteristics of transverse (horizontal) zoning haloes at different elevations (or depths of the orebody)	241
7.4.2 Geometrical characteristics of the axial zoning haloes	246
7.4.3 Geometrical characteristics of the longitudinal zoning haloes.....	249
7.5 Evaluation of similarity levels among the geometrical patterns of haloes	252
7.6 Summary	253
CHAPTER 8: Spatial Models for Geochemistry, Geology and Geophysics data of the Western Mineralisation	254
8.1 Introduction	254
8.2 Appraisal of sequence of the element concentrations in the axial halo zoning	255
8.2.1 Calculations of ZI for the 10 geochemical haloes on the E-W axial sections at N= 2109 m.....	258
8.2.2 Calculations of ZI for 10 geochemical haloes on the E-W axial sections at N=1639 m.....	263
8.2.3 Comparison of the ZIs between the E-W axial sections at N=2109 m and N=1639 m.....	266
8.3 Exploration significance of the axial (vertical) zoning sequence.....	268
8.4 Classification of anomalous concentrations	273

8.5 Spatial variations of the sulphide minerals, magnetic susceptibility and specific gravity in the Western Mineralisation.....	281
8.6 Correspondence analysis for garnet samples of the Broken Hill orebodies	289
8.6.1 Correspondence map for garnet samples of the Broken Hill orebodies.....	293
8.7 The 3D biplot of garnet types and samples of the Western Mineralisation	293
8.8 Spatial variations of the silicate minerals in the Western Mineralisation.....	297
8.9 Spatial variations of the rock types in the Western Mineralisation	306
8.10 Spatial variations of the sulphide textures in the Western Mineralisation.....	310
8.11 Summary	315
CHAPTER 9: Conclusions	317
9.1 Introduction	317
9.2 Responses to research questions of this dissertation	317
9.2.1 Maximizing information of core logging	317
9.2.2 Characteristics of the quantitative core logs data of the Western Mineralisation.....	318
9.2.3 Application of classic statistics for the Western Mineralisation	319
9.2.4 Application of geostatistics for the Western Mineralisation	320
9.3 Significance of this kind of research study	322
9.4 Suggestions for future research	324
References.....	325
Appendix A.....	349
Appendix B	354
Appendix C	367
Appendix D.....	376
Appendix E	379

Abstract

The Broken Hill Zn-Pb-Ag deposit (Australia) is the largest base metal deposit in the world (Large et al. 2005)¹. Despite almost 130 years of mining, core logging is still undertaken qualitatively. Most old core has disappeared. The Western Mineralisation is the subject of this study and it is soon to be exploited in the Rasp Mine. The 77 Western Mineralisation drill cores provided an opportunity to statistically evaluate 3,215 surface and underground samples. In this process, 61,696 data were acquired from magnetic susceptibility measurements and quantitative mineralogical, lithological and textural core logging. These data sets were integrated with assay, specific gravity, collar and survey data. The large data sets² (93,192) were treated by statistical methods such as univariate and bivariate analyses, compositional data analysis, statistical test, linear multivariate regression, cluster analysis, principal component analysis, variogram analysis and univariate ordinary kriging estimation. Moreover, the previous data set of mineral chemistry was evaluated by correspondence analysis, compositional data analysis and principal component analysis. The statistical results were demonstrated in variety of diagrams such as bar diagrams, core log diagrams, contour plots, correspondence map, map of PC loading and PC score, biplot, 3D biplot and 424 cross-sections of the orebody. It was shown that Bi and Sb are pathfinder elements for the Western Mineralisation and that these elements form a broader halo around sulphide masses whereas Ag, As and Cd form a small halo. Galena-sphalerite rich ores have a higher proportion of magnetic pyrrhotite and magnetic susceptibility can be used to evaluate proximity to sulphide masses. Statistical studies suggest that Broken Hill might not be an isolated deposit and that the "next" Broken Hill may not be identical. Predictor elements for Pb are Fe, Ag and Bi and for Zn are Cd, Sb and Ag. Optimal sampling is on 22 m and 10 m along and across strike respectively and a 20 × 20 × 10 m polygon is the optimum size for block model analysis. The Western Mineralisation at Broken Hill is zoned from a Pb-Zn-S-Cd rich upper portion to a Cu-Ag-As-Bi rich lower portion. Variations within the Western Mineralisation may be primary features but are more likely to derive from intense tectonism.

¹ Harvard (UTS) Style - 6th edition (version 2004) has been used for the purpose of citation and referencing. <<http://www.lib.uts.edu.au/students/discover-your-library/referencing-and-writing/endnote/styles>>

² The data base (Excel Format), additional diagrams and satellite maps of this thesis are provided in supplementary files included on a CD to this thesis.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available for photocopying, subject to the provisions of the Copyright Act 1968.

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³ **Consolidated Broken Hill Limited**

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⁴ **The Integrated Bridging Program Research**

List of Figures

- Figure 1.1.** Contained grade and tonnage of metals for stratiform Zn-Pb deposits. The Broken Hill deposit is the largest Zn-Pb known deposit in the world (redrawn from Large et al. 2005). 2
- Figure 1.2.** The eight Domains of the Curnamona Province (from Conor et al. 2006) 3
- Figure 1.3.** Stratigraphy and geochronology of the exposed Willyama Supergroup in the Broken Hill Block, Euriowie Block and Redan Sub-Block. The Parnell Metadolerites are dated at 1686 Ma (from Stevens 2009). 4
- Figure 1.4.** Open pits on CML7 from which carbonate, sulphate and sulphide ores were extracted from 1883-2001 (from CBH Resources Ltd). 9
- Figure 1.5.** Cross-section shows the Western Mineralisation, the Centenary Mineralisation and their stratigraphic positions (redrawn from Haydon & McConachy 1987). 21
- Figure 2.1.** Collar locations of the surface drill holes and relative surface levels of the Western Mineralisation 30
- Figure 2.2.** A 3D visualisation of the sulphide mineralised sample locations in the Western Mineralisation 32
- Figure 2.3.** Coarse sulphide minerals including galena (grey), sphalerite (black), chalcopyrite (yellow) and white quartz in a cataclastic massive sulphide rock of the Western Mineralisation (drill hole 4033 at 353.2 m). The structural position of cataclastic ore is unknown and may well remain so until further underground mining commences. 36
- Figure 2.4.** Distribution of pink garnet (red crystals) within garnet quartzite in drill hole 4003, between 287.6 m and 287.75 m 37
- Figure 2.5.** Comparison charts for estimating volume percentage of minerals based on their grain size and abundance (from Terry & Chilingar 1955). 38
- Figure 2.6.** Low grade veins of chalcopyrite and other sulphide minerals within garnet quartzite in drill hole 4003 at 317.9 m 38
- Figure 2.7.** The VVC line for comparing the variances of an element concentration between HQ and NQ samples support (redrawn from Wellmer 1998). S_x and S_y are standard deviations of concentrations for NQ and HQ samples support respectively. \bar{X} and \bar{Y} are the mean concentrations for NQ and HQ samples support respectively 45

Figure 2.8. The quantitative core log of 18 parameters (rock types, minerals content, elements concentrations and magnetic susceptibility) for the investigated samples of drill hole 4003.....	55
Figure 2.9. The quantitative core log of 26 parameters (sulphide textures, minerals content, elements concentration and specific gravity) for the investigated samples of drill hole 4003.....	56
Figure 2.10. The quantitative core log of 18 parameters (rock types, minerals, elements and magnetic susceptibility) for the investigated samples of drill hole 4004.....	58
Figure 2.11. The quantitative core log of 26 parameters (sulphide textures, minerals content, elements concentration and specific gravity) for the investigated samples of drill hole 4004.....	59
Figure 2.12. The quantitative core log of 18 parameters (rock types, minerals content, elements and magnetic susceptibility) for the investigated samples of drill hole 4031.....	61
Figure 2.13. The quantitative core log of 26 parameters (sulphide textures, mineral content, elements and specific gravity) for the investigated samples of drill hole 4031	62
Figure 3.1. Descriptive statistics of Zn, Fe, Pb and S. The scale of horizontal axes is based on the percentage, and the number of samples of each element contributing in each graph has been given in Table 3.2.	70
Figure 3.2. Descriptive statistics for Bi, Ag, Sb and As. The scale of horizontal axes is based on ppm and the number of samples of each element contributing in each graph has been given in Table 3.2.	71
Figure 3.3. Descriptive statistics for Zn, Pb and Ag within the analysed samples of each surface drill core	75
Figure 3.4. Descriptive statistics for S, Fe and Cu within the analysed samples of each surface drill core	77
Figure 3.5. Descriptive statistics for Cd and As within the analysed samples of each surface drill core	78
Figure 3.6. Descriptive statistics for Bi and Sb within the analysed samples of each surface drill core	80

Figure 3.7. Descriptive statistics for Zn, Pb and Fe within the analysed samples of each underground drill core.....	82
Figure 3.8. Descriptive statistics for S, Ag and As within the analysed samples of each underground drill core.....	83
Figure 3.9. Descriptive statistics for Sb and Bi within the analysed samples of each underground drill core.....	84
Figure 3.10. Descriptive statistics for sulphide and silicate minerals. The scale of horizontal axes is based on volume percentage.	89
Figure 3.11. Descriptive statistics for galena and sphalerite within the analysed samples of each surface drill core.	90
Figure 3.12. Descriptive statistics for galena and sphalerite and Pb+Zn within the analysed samples of each surface drill core	96
Figure 3.13. Comparison of the COV of Pb+Zn, Zn and Pb with the COV of galena+sphalerite, sphalerite and galena respectively	97
Figure 3.14. (a) and (b) are related to the original data of Pb+Zn and galena+sphalerite. The red curves show the experimental percentage of Pb+Zn concentrations and the volume percentage of galena+sphalerite against their respective estimated values of cumulative probability. The straight blue lines show the theoretical percentage of cumulative probability for near-normal distribution of the variables. (c) and (d) are related to the logarithmic data of Pb+Zn and galena+sphalerite	98
Figure 3.15. Descriptive statistics for rock types within the 1928 investigated samples. The scale of horizontal axes is based on volume percentage.....	102
Figure 4.1. Aeromagnetic map of the Broken Hill Mine site and its surrounding area Scale: 3.8 km length (from New South Wales Department of Primary Industries 1995)	106
Figure 4.2. Different phases of Fe-S system in relation to variation of temperature and atomic percentage of Fe. (redrawn from Scott, Both & Kissin 1977).	110
Figure 4.3. Atomic percentage of S in pyrrhotite samples of the Broken Hill orebodies	112
Figure 4.4. Atomic percentage of Fe in pyrrhotite samples of the Broken Hill orebodies	112
Figure 4.5. Correspondence map in relation to dimensions 1 and 2 for pyrrhotite.....	118

Figure 4.6. Correspondence map in relation to dimensions 1 and 3 for pyrrhotite	119
Figure 4.7. Correspondence map in relation to dimensions 2 and 3 for pyrrhotite	119
Figure 4.8. A Magnetic Susceptibility Metre model Digital Fugro GMS-2.....	121
Figure 4.9. Positive skewed distributions for original data of MMS, AMS, pyrrhotite, Pb+Zn and galena+sphalerite. The red areas show the experimental distributions of MMS, AMS, pyrrhotite and galena+sphalerite and the blue curves are their respective theoretical (estimated) normal distributions.	124
Figure 4.10. Probability graphs for logarithmic data of MMS, AMS, pyrrhotite and galena+sphalerite. The red curves show the experimental percentage of the variables against their respective estimated percentage of cumulative probability and the straight blue lines show the theoretical percentage of cumulative probability for near-normal distribution of the variables.....	125
Figure 4.11. Statistical parameters of pyrrhotite and AMS and MMS within the investigated samples of surface drill holes	130
Figure 4.12. Comparison of the COV of pyrrhotite, Zn+Pb and AMS with that of MMS, sphalerite+galena and specific gravity.....	131
Figure 4.13. The quantitative core log for the investigated samples of drill hole 4033 ...	135
Figure 4.14. The quantitative core log for the investigated samples of drill hole 4018 ...	136
Figure 4.15. The quantitative core log for the investigated samples of drill hole 4014 ...	137
Figure 4.16. The quantitative core log for the investigated samples of drill hole 4005 ...	138
Figure 4.17. The quantitative core log for the investigated samples of drill hole 4044 ...	139
Figure 4.18. (a) and (b) show the contour plots of galena+sphalerite (vol. %) and Pb+Zn (%) respectively within the parameter space of AMS (SI) and pyrrhotite (vol. %). (c) and (d) show the contour plots of galena+sphalerite (vol. %) and Pb+Zn (%) respectively within the parameter space of MMS (SI) and pyrrhotite (vol. %)......	141
Figure 5.1. Correspondence map in relation to dimensions 1 and 2 for galena	149
Figure 5.2. Correspondence map in relation to dimensions 1 and 3 for galena.....	150
Figure 5.3. Correspondence map in relation to dimensions 2 and 3 for galena.....	151
Figure 5.4. Correspondence map in relation to dimensions 1 and 2 for sphalerite.....	153
Figure 5.5. Correspondence map in relation to dimensions 1 and 3 for sphalerite.....	154
Figure 5.6. Correspondence map in relation to dimensions 2 and 3 for sphalerite.....	155

Figure 5.7. Statistical distributions for 1059 samples of each element. The red area shows the experimental histogram for percentages of each element concentration and the blue curve shows the theoretical normal distribution model for each percentage of element concentration.....	157
Figure 5.8. Probability graphs for 1059 samples of each element. The red curve shows the experimental cumulative percentage of each element concentration and the straight blue line shows the theoretical percentage of cumulative probability for near-normal distribution of the elements	158
Figure 5.9. Contribution of 4 element concentrations within 1059 samples of the Western Mineralisation in a tetrahedron model.....	159
Figure 5.10. Histograms of the 1059 clr-transformed data for each element. The red areas show the experimental histogram of the elements and the blue curves shows the theoretical normal distribution models for the elements.....	162
Figure 5.11. Probability graphs of the 1059 clr-transformed data for each element. The red curves show the experimental percentage of cumulative probability for each element and the straight blue lines show the theoretical percentage of cumulative probability for near-normal distribution of the elements	163
Figure 5.12. Hierarchical horizontal cluster algorithm with three main groups for 1059 clr-transformed data of each element.....	172
Figure 5.13. The scree plot of eigenvalues versus number of PCs	174
Figure 5.14. Map of PC ₁ loading, PC ₂ loading and the legend of 10 elements	182
Figure 5.15. Map of PC ₁ loading and PC ₃ loading	183
Figure 5.16. Map of PC ₁ loading and PC ₄ loading	184
Figure 5.17. Map of PC ₂ loading and PC ₃ loading	184
Figure 5.18. Map of PC ₂ loading and PC ₄ loading	185
Figure 5.19. Map of PC ₃ loading and PC ₄ loading	186
Figure 5.20. Map of PC scores for 1059 clr-transformed sample data of each element using SPSS	187
Figure 5.21. Biplot for 10 element concentrations of the Western Mineralisation in relation to PC ₁ loading and PC ₂ loading	189
Figure 5.22. Biplot for a combination of 1059 samples (Figure 5.20a) and 10 element concentrations (Figure 5.21) in relation to PC ₁ loading and score and PC ₂ loading and score	189

Figure 5.23. (a) the 3D biplot of galena samples of the Western Mineralisation and (b) the axes of the 3D biplot in relation to three PCs	193
Figure 5.24. (a) the same plot as that of Figure 5.22a, but viewing from a different angle and (b) the axes of the 3D biplot in relation to three PCs.	194
Figure 5.25. (a) the 3D biplot of sphalerite samples of the Western Mineralisation and (b) the axes of the 3D biplot in relation to three PCs.....	196
Figure 5.26. (a) the same plot as that of Figure 5.25a but viewing from a different angle and (b) the axes of the 3D biplot in relation to three PCs.....	197
Figure 6.1. An experimental variogram ("+") and a fitted spherical model (red dashed curve) for Zn concentration of the Western Mineralisation and its variogram parameters.....	202
Figure 6.2. The change of variance (the red line) versus distance in (a) classic statistics and in (b) geostatistics	204
Figure 6.3. Conical search volume and effect of direction approximation in a cone	205
Figure 6.4. The histograms of raw element concentration. The red areas show the experimental histograms of the element concentrations and the blue curves show the theoretical normal distribution fitted for those elements.....	207
Figure 6.5. The probability plots of the raw element concentrations versus the percentage of cumulative probability of the element concentrations (red curves). The discrepancy from straight lines (blue lines) means the departure from normal distribution.....	208
Figure 6.6. Some examples of the erratic experimental variograms that were produced by the strike-plunge variogram of the raw data of Zn, S, Pb, Fe, Ag and Bi.	208
Figure 6.7. The possible ranges of strike, plunge and dip for the Western Mineralisation	211
Figure 6.8. The Western Mineralisation is characterised by a strike direction of 15° , a plunge of 25° and a plunge direction of 195° (in structural geology, it is defined by $25^\circ \rightarrow 195^\circ$) and a dip of 40° and a dip direction of 285° (in structural geology, it is defined by $40^\circ / 285^\circ$).....	211
Figure 6.9. (a) shows a horizontal plane ellipse that is used for displaying the strike- direction of the strike-plunge variogram and dip-direction of the down-dip variogram (b) shows the vertical plane ellipse for the dip angles of the down- dip (-40°) variogram and strike-direction of the strike-plunge variogram and	

(c) displays the vertical plane ellipse for the dip angles of the cross-dip (50°) and the down-dip (-40°) variograms	212
Figure 6.10. A schematic geochemical sampling grid for detection of Zn concentration	214
Figure 6.11. The percentage of similarity among elements of the Western Mineralisation based on their variogram parameters of three dimensional variogram models	213
Figure 6.12. The nugget effect ($\frac{C_0}{Sill}$) versus the full range of variogram for Zn and Pb concentrations (modified from Wellmer 1998).	216
Figure 6.13. The anisotropy ellipsoid (Rose diagram) with three directional and dimensional ellipses	217
Figure 6.14. Comparison of geometrical ellipsoids (Rose diagrams) of compositional parameters, their radii and anisotropy ratios	218
Figure 6.15. The similarity levels among 10 elements based on their radii of a, b and c within their Rose diagrams	220
Figure 6.16. A scatter plot of the pairs of estimated values and actual values, the linear regressions and the statistical calculations for the example of Zn concentration of the Western Mineralisation	221
Figure 6.17. Visualisation of the mean value of kriging variance estimation versus different block volumes for Zn, Pb and Bi	226
Figure 6.18. Average estimation errors versus the number of samples used for kriging for the elements of Cd, Cu and Pb.	227
Figure 7.1. The position of four transverse (horizontal) sections (dashed red rectangles) and locations of the mineralised drill core intersections.....	231
Figure 7.2. The mineralised sample locations and the position of two longitudinal sections (dashed orange rectangles).....	232
Figure 7.3. The position of two axial cross-sections and the locations of intersection of mineralisation (dashed violet rectangles).....	232
Figure 7.4. The transverse sections of 10 geochemical haloes between background and local threshold levels (elevation=10218 m and elevation=10078 m)	236
Figure 7.5. The transverse sections of 10 geochemical haloes between background and local threshold levels (elevation=9958 m and elevation=9848 m)	237

Figure 7.6. The E-W axial sections of 10 geochemical haloes between background and local threshold levels at N=2109 m and N=1639 m	238
Figure 7.7. The N-S longitudinal sections of 10 geochemical haloes between background and local threshold levels at E=9467 m and at E=9357 m	239
Figure 7.8. Comparison of the maximum lengths, maximum widths and anisotropy ratios on the transverse sections at different elevations.....	245
Figure 7.9. Comparison of maximum lengths, maximum widths and anisotropic ratios on the E-W axial sections at N=2109 m and N=1639 m	248
Figure 7.10. Comparison of maximum lengths, maximum widths and anisotropic ratios on the N-S longitudinal sections at E=9357 m and E=9467m.....	251
Figure 7.11. The percent of similarity among 10 elements based on the maximum lengths and the maximum widths of their geochemical haloes.....	252
Figure 8.1. Location of the mineralised samples on the E-W axial section at N=2109 and their intersections with the selected elevations (blue lines).....	256
Figure 8.2. The intersections of halo of Pb with the blue lines at the selected elevations on the E-W axial section at N=2109 and calculations of the LP for the elevations.	257
Figure 8.3. Variation of the ZIs for 10 elements at different elevations and their maximum ZI	267
Figure 8.4. Cluster analysis for ZI values of 10 elements	268
Figure 8.5. The longitudinal sections of 10 geochemical haloes between local threshold and anomalous levels at E=9467 m.	274
Figure 8.6. The longitudinal sections of 10 geochemical haloes between local threshold and anomalous levels at E= 9357 m.	275
Figure 8.7. The E-W axial sections of 10 geochemical haloes between local threshold and anomalous levels at N=2109 m. (Colour indices of Figure 8.7 are the same as those shown in Figures 8.5 or 8.6).....	276
Figure 8.8. The E-W axial sections of 10 geochemical haloes between local threshold and anomalous levels at N=1639 m. (Colour indices of Figure 8.8 are the same as those shown in Figures 8.5 or 8.6).....	276
Figure 8.9. The transverse sections of 10 geochemical haloes between local threshold and anomalous levels at elevation=10218 m. (Colour indices of Figure 8.9 are the same as those shown in Figures 8.5 or 8.6).....	277

Figure 8.10. The transverse sections of 10 geochemical haloes between local threshold and anomalous levels at elevation=10078 m. (Colour indices of Figure 8.10 are the same as those shown in Figures 8.5 or 8.6).....	277
Figure 8.11. The transverse sections of 10 geochemical haloes between local threshold and anomalous levels at elevation=9958 m. (Colour indices of Figure 8.11 are the same as those shown in Figures 8.5 or 8.6)	278
Figure 8.12. The transverse sections of 10 geochemical haloes between local threshold and anomalous levels at elevation=9848 m. (Colour indices of Figure 8.12 are the same as those shown in Figures 8.5 or 8.6)	278
Figure 8.13. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the E-W axial sections at N=2109 m	282
Figure 8.14. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the E-W axial section at N=1639 m	282
Figure 8.15. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the N-S longitudinal sections at E=9467 m	283
Figure 8.16. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the N-S longitudinal cross-sections at E=9357m.....	284
Figure 8.17. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the transverse sections at elevation=10218 m	285
Figure 8.18. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the transverse sections at elevation=10078 m	286
Figure 8.19. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the transverse sections at elevation=9958 m	287
Figure 8.20. Variations of the sulphide minerals, magnetic susceptibility and specific gravity on the transverse sections at elevation=9848 m.....	288
Figure 8.21. Correspondence map in relation to dimensions 1 and 2 for garnet	293
Figure 8.22. (a) the 3D biplot of garnet samples of the Western Mineralisation and (b) the axes of the 3D biplot in relation to three PCs.....	295
Figure 8.23. (a) the same plot as that of Figure 8.22, but viewing from a different angle and (b) the axes of the 3D biplot in relation to three PCs	296
Figure 8.24. Variations of the silicate minerals on the E-W axial sections at N=2109 m	298
Figure 8.25. Variations of the silicate minerals on the E-W axial sections at N=1639 m	299

Figure 8.26. Variations of the silicate minerals on the N-S longitudinal sections at E=9467 m.....	300
Figure 8.27. Variations of the silicate minerals on the N-S longitudinal sections at E=9357 m.....	301
Figure 8.28. Variations of the silicate minerals on the transverse sections at elevation=10218 m.	302
Figure 8.29. Variations of the silicate minerals on the transverse sections at elevation=10078 m	303
Figure 8.30. Variations of the silicate minerals on the transverse sections at elevation=9958 m	304
Figure 8.31. Variations of the silicate minerals on the transverse sections at elevation=9848 m	305
Figure 8.32. Variations of the rock types on the N-S longitudinal sections at E=9467 m.....	306
Figure 8.33. Variations of the rock types on the N-S longitudinal sections at E=9357 m.....	307
Figure 8.34. Variations of the rock types on the E-W axial sections at N=2109 m and N=1639 m	308
Figure 8.35. Variations of the rock types on the transverse sections at elevation=10218 m and elevation=10078 m.....	309
Figure 8.36. Variations of the rock types on the transverse sections at elevation=9958 m and elevation=9848 m.....	310
Figure 8.37. Probability of occurrence of sulphide textures on the E-W axial sections at N=2109 m and N=1639 m	312
Figure 8.38. Probability of occurrence of sulphide textures on the N-S longitudinal sections at E=9467 m.....	313
Figure 8.39. Probability of occurrence of sulphide textures on the N-S longitudinal sections at E=9357 m.....	313
Figure 8.40. Probability of occurrence of sulphide textures on the transverse sections at elevation=10218 m and elevation=10078 m.....	314
Figure 8.41. Probability of occurrence of sulphide textures on the transverse sections at elevation=9958 m and elevation=9848 m.....	315

List of Tables

Table 1.1. Size and grades of the Broken Hill orebodies and the Western Mineralisation (Plimer 2006b; Stevens 2003).....	8
Table 1.2. Regional and mine stratigraphic subdivisions of the Willyama Supergroup (from CBH Resources Ltd).....	10
Table 1.3. Summary of Units 4.8, 4.7 and 4.6 in Suite 4, average unit thickness and range of unit thickness (simplified from Haydon & McConachy 1987).	11
Table 1.4. Summary of the major deformation (D), metamorphism (M), schistosity (S) and P-T conditions during D ₁ and D ₂ of the Olarian Orogeny.	15
Table 1.5. Summary of the major deformation (D), metamorphism (M), schistosity (S) and P-T conditions during D ₂ of the Olarian Orogeny	16
Table 1.6. Summary of the major deformation (D), metamorphism (M), schistosity (S) and P-T conditions during D ₃ of the Olarian Orogeny	17
Table 1.7. Summary of the major deformation (D), metamorphism (M), schistosity (S) and P-T conditions during D ₅ and D ₆ of the Delamerian Orogeny.....	18
Table 2.1. An example of the conventional core log for drill hole 4008 from surface to 56.5 m. This drill core was logged by a senior geologist (Blampain)	34
Table 2.2. Effective parameters in quality of the quantitative core logging	39
Table 2.3. Useful considerations for quantification of minerals and rock types.....	40
Table 2.4. Calculation of standard deviation of an equivalent NQ core sample from standard deviation of the HQ and the LTK60 core size.....	44
Table 2.5. Formulae used for calculation of the easting, northing and elevation of the samples of the Western Mineralisation.....	48
Table 2.6. Formulae used for calculation of the real and estimated depth of the samples in the Western Mineralisation.	48
Table 2.7. Lithological codes used in the conventional core logs.....	50
Table 2.8. Mineralogical codes used in the conventional core logs.....	51
Table 2.9. The conventional core log of the sulphide rich segment of drill hole 4003 from 308.1 to 364.5 m. This drill core was logged by Blampain and a new graduate (Collier).....	51
Table 2.10. The conventional core log of the sulphide rich segment of drill hole 4004 from 123.7 to 177 m. This drill core was logged by Collier.....	52

Table 2.11. The conventional core log of the sulphide rich segment of drill hole 4031 from 292.6 to 332.3 m. This part of drill core was logged by a Director of CBH Resources Ltd (Plimer).	53
Table 3.1. A summary of descriptive statistics used in this chapter	66
Table 3.2. Descriptive statistics for element concentrations within the total analysed samples.....	69
Table 3.3. Descriptive statistics for 10 element concentrations within the analysed samples of surface drill holes	72
Table 3.4. Descriptive statistics for 10 element concentrations within the analysed samples of underground drill holes.....	72
Table 3.5. Descriptive statistics for sulphide minerals	86
Table 3.6. Descriptive statistics for silicate minerals.....	86
Table 3.7. Different types of correlation coefficients and their statistical terms	94
Table 3.8. The results of PCC for logarithmic (data+0.000,1).	99
Table 3.9. The results of SCC for the original data	99
Table 3.10. The results of Cronbach's alpha for the original data.....	100
Table 3.11. A summary of SCC results, significance levels (2-tailed) and abundance of rock types.....	101
Table 4.1. Atomic percentage of Fe in pyrrhotite polytypes (from Carpenter & Bailey 1973; Clark 1997; Kontny et al. 2000; Kruse & Ericsson 1988; Yund & Hall 1969).	108
Table 4.2. EMPA analyses of pyrrhotite from the Western Mineralisation and the Line of Lode from CML7.....	111
Table 4.3. A contingency table of the average percentage of elements in pyrrhotite samples within the Broken Hill orebodies.....	113
Table 4.4. The z-transformed values of Table 4.3.	115
Table 4.5. The z-transformed values+2 of Table 4.4	115
Table 4.6. A summary of statistical terms used in correspondence analysis	116
Table 4.7. Chi-square distances of Table 4.5	117
Table 4.8. The results of decomposition of Table 4.5 into six dimensions.....	117
Table 4.9. Descriptive statistics for magnetic susceptibility, pyrrhotite, Pb+Zn and galena+sphalerite within the analysed samples of surface drill holes	123

Table 4.10. Two groups of samples used in this study.....	123
Table 4.11. Descriptive statistics for magnetic susceptibility, pyrrhotite, Pb+Zn and galena+sphalerite in barren (B) and productive (P) samples	123
Table 4.12. The mean rank of AMS, MMS and pyrrhotite between the barren and the productive groups using the Mann-Whitney Test.....	126
Table 4.13. Test statistics results of the Mann-Whitney Test	127
Table 4.14. Two-Sample Kolmogorov-Smirnov Frequencies Test	127
Table 4.15. Moses Extreme Reactions Test Frequencies at the 99 % confidence level ...	128
Table 4.16. The results of SCC for 790 samples.....	132
Table 4.17. The results of KCC for 790 samples	132
Table 5.1. Average atomic percentage of elements in galena samples of the Broken Hill orebodies	146
Table 5.2. Average atomic percentage of elements in sphalerite samples of the Broken Hill orebodies	146
Table 5.3. The z-transformed values of Table 5.1.....	148
Table 5.4. The z-transformed values+2 of Table 5.3.	148
Table 5.5. The results of decomposition of Table 5.4 into six dimensions.....	149
Table 5.6. The z-transformed values of Table 5.2.....	152
Table 5.7. The z-transformed values+2 of Table 5.6	152
Table 5.8. The results of decomposition of Table 5.7 into six dimensions.....	153
Table 5.9. The results of PCC for the 1059 clr-transformed data	164
Table 5.10. R ² % for some elements of the Western Mineralisation.....	164
Table 5.11. Significant predictor elements of Pb in the third model of LMR analysis.....	167
Table 5.12. Significant predictor elements of Zn in the third model of LMR analysis	169
Table 5.13. Summary of PCs in the Western Mineralisation.....	173
Table 5.14. PC loadings of 10 elements for each PC (Table 5.13) of the Western Mineralisation	175
Table 5.15. Summary of decomposition galena samples into seven PCs based on variation of eleven elements	192
Table 5.16. Summary of decomposition sphalerite samples into seven PCs based on variation of eleven elements	195

Table 6.1. Formulae for calculation of variogram models with three structural components	203
Table 6.2. The approximate variogram model of Pb in raw data scale for the strike-plunge direction resulted from the variogram model of the logarithms of the data....	210
Table 6.3. An appropriate surface geochemical sampling grid for Pb, S, Bi, Fe and Zn when the real dip of orebody is not clear for the Western Mineralisation.....	213
Table 6.4. An appropriate surface geochemical sampling grid for Cd, Cu, Sb, As and Ag when the real dip of orebody is not clear for the Western Mineralisation.....	214
Table 6.5. Formula used for calculation of the anisotropy ratios and its results for Zn concentration of the Western Mineralisation.....	219
Table 6.6. Calculation of the anisotropic ratios 1 and 2 for Pb concentration.....	224
Table 6.7. The selected discretisation grid, the corresponding volume and the mean value of kriging variance for three elements of Pb, Zn and Bi.....	225
Table 7.1. Maximum lengths, maximum widths and anisotropy ratios on the transverse sections at different elevations (Figures 7.4 and 7.5)	242
Table 7.2. The sequence of geochemical haloes based on their maximum lengths, maximum widths and anisotropy ratios resulted from Table 7.1	243
Table 7.3. Maximum lengths, maximum widths and anisotropy ratios on on the E-W axial sections at N = 2109 m and N = 1639 m (Figure 7.6)	246
Table 7.4. The sequence of geochemical haloes based on maximum lengths, maximum widths and anisotropy ratios resulted from Table 7.3.....	247
Table 7.5. Maximum lengths, maximum widths and anisotropy ratios on the N-S longitudinal sections at E = 9467 m and E = 9357 m (Figure 7.7).....	249
Table 7.6. The sequence of geochemical haloes based on maximum lengths, maximum widths and anisotropy ratios resulted from Table 7.5.....	249
Table 8.1. LP values of 10 element concentrations at the selected elevations and maximum LP values for each element shown in red text (Appendix E).	259
Table 8.2. Selective Cn values for maximum LP values of each element and their normalised LP results.....	259
Table 8.3. Normalised LP values for 10 element concentrations at the selected elevations	260

Table 8.4. ZI values for 10 element concentrations and maximum ZI values highlighted in red text	260
Table 8.5. Calculation of the G for Cu, Ag and Sb	261
Table 8.6. Calculations of the ΔG for pairs S, Zn and pairs Fe and Bi	262
Table 8.7. The zonation sequence of geochemical haloes on the E-W axial sections at N=2109 m (from top to bottom of orebody)	263
Table 8.8. LP values of 10 element concentrations at the selected elevations and maximum LP values for each element shown in red text (Appendix E).....	263
Table 8.9. Selective Cn values for maximum LP values of each element and their normalized LP results.....	263
Table 8.10. The normalised LP values* for the 10 element concentrations at the selected elevations.	264
Table 8.11. The values of ZI for 10 element concentrations and maximum ZI values highlighted in red text	264
Table 8.12. Calculations of the ΔG for (a): S, Pb and Cd, (b): for Sb, Bi and Fe	265
Table 8.13. Calculations of the ΔG for Ag, Cu and Zn.	266
Table 8.14. The zonation sequence of geochemical haloes on the E-W axial section at N=1639 m.	266
Table 8.15. The zonation sequence of geochemical haloes on the E-W axial sections from 10178 to 9840 m in the Western Mineralisation.....	267
Table 8.16. Variations of ZC_2 and ZC_3 at different elevations for the mean percentage of 10 element concentrations of the Western Mineralisation.....	271
Table 8.17. The range of concentrations for anomaly, threshold and background for 10 elements of the Western Mineralisation.....	280
Table 8.18. Variation model for sulphide minerals.....	289
Table 8.19. Variation model for magnetic susceptibility	289
Table 8.20. Average percentage of garnet types in garnet samples collected from the Broken Hill orebodies	291
Table 8.21. The z-transformed values of Table 8.20.....	291
Table 8.22. The z-transformed values+2 of Table 8.21	292
Table 8.23. The results of decomposition of Table 8.22 into five dimensions	292
Table 8.24. A summary of decomposition garnet samples of the Western Mineralisation into three PCs based on chemical composition of six garnet types.....	294
Table 8.25. Variation models for silicate minerals.	297

Definition of abbreviations and acronyms

@: At

Å : Ångstrom [One ten-billionth of a meter (10^{-10} m or 0.0000000001 m) or $1/10^{\text{th}}$ of a nanometre].

3D: Three Dimensions

AAS: Atomic Absorption Spectrophotometry

AI: Additive Index

ALR: Additive Log-Ratio

AMS: Average Magnetic Susceptibility

B: Barren

BHT: Broken Hill Type deposit

BIF: Banded Iron Formation

BLUE: Best Linear Unbiased Estimator

CBH: Consolidated Broken Hill

CRA: Conzinc Riotinto of Australia Limited

CLR: Centred Log-Ratio

CML7: Consolidated Mining Lease Number 7

Cn: Normalization Coefficient

COV: Coefficient of Variation

DI: Denudation Index

EMPA : Electron Microprobe Analysis

F: Fisher test

G: Variability Gradient or Variability Index

HFSE: High Field Strength Elements

HiP: High (95 %) Probability

IBP-R: The Integrated Bridging Program Research

ICP-MS: Inductively Coupled Plasma Mass Spectrometry

ICP-OES: Inductively Coupled Plasma-Optical Emission Spectrometry

ILR: Isometric Log-Ratio

LMR: Linear Multivariate Regressions

LoP: Low (5 %) Probability

LP: Linear Productivity

m: Metre

Max: Maximum

Min: Minimum

MMS: Maximum Magnetic Susceptibility

MM&M: Minerals, Mining and Metallurgy Limited

Mean of K.Var: Mean Kriging Variance

Mean sq. error: Mean Squared Error

MVT: Mississippi Valley-type deposits

N: Number

NBHC: New Broken Hill Consolidated

OZ: Ounces

P: Productive

PCA: Principal Component Analysis

PC: Principal Component

PCV: Percentage of Cumulative Variance

ppm: Part per Million

ppb: Part per Billion

PPI: Percentage of Proportional Inertia

PPV: Percentage of Proportional Variance

P-T: Pressure-Temperature

Q: Quartile

R^D: Real Dimension

REE: Rare Earth Element

RL: Relative level

RQD: Rock Quality Designation

SI: International System of Units (metric system)

S^D: Simplex Dimension

SEDEX: Sedimentary Exhalative Deposits

VB: Vertical Bar

VBA: Visual Basic for Applications

VCC: Volume Variance Comparison

VIF: Variance Inflation Factor

vol. %: Volume Percentage

WestMin: The Western Mineralisation

WMDD: Western Mineralisation Diamond Drill core

X: Element Concentration

XRF: X-Ray Fluorescence

ZC Ltd. Zinc Corporation limited

ZC: Zonality Coefficient

ZI: Zonality Index