

# ResearchOnline@JCU

This file is part of the following reference:

**Pietrass, Bianca (2005) *The geological and grade continuity of the Pajingo epithermal gold system*. Masters (Research) thesis, James Cook University.**

Access to this file is available from:

<http://eprints.jcu.edu.au/1319/>

*The author has certified to JCU that they have made a reasonable effort to gain permission and acknowledge the owner of any third party copyright material included in this document. If you believe that this is not the case, please contact [ResearchOnline@jcu.edu.au](mailto:ResearchOnline@jcu.edu.au) and quote <http://eprints.jcu.edu.au/1319/>*

---

# THE GEOLOGICAL AND GRADE CONTINUITY OF THE PAJINGO EPITHERMAL GOLD SYSTEM

---

Thesis Submitted By

**BIANCA PIETRASS**

Bachelor of Science (First Class Honours) – Curtin University (W.A.S.M)

For the degree of **MASTERS BY RESEARCH**  
in the School of Earth Sciences  
James Cook University – Townsville

Supervisor: Dr. Thomas Blenkinsop

Submitted in March 2005

# Statement of Access

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and;

I do not wish to place any further restriction on access to this work.

---

Signature

Date

# Statement of Sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

---

Signature

Date

# Statement of Contributions

A number of persons from the Newmont Mining Corporation were involved in the development of this project, namely Mr Ian Bulter and Mr Andrew Aitchison. Mr Steve Harrison and Mr Geoff Phillips provided ongoing support and cooperation for the extent of the project.

The Newmont Mining Corporation generously granted \$6650 towards the funding of the project, and provided accommodation and transport to the Pajingo Mine Site during site visits. An outline of the funding supplied is given in the table below.

Student Travel Expenses	\$200
Supervisor Travel Expenses	\$1,000
School Overhead (e.g. software licenses)	\$1,000
Laboratory Costs	\$1,000
Student Computer Hire	\$1,500
Student Training Support (e.g. Conference attendance)	\$1,000
GST	\$950
<b>TOTAL (incl. GST)</b>	<b>\$6,650</b>

This project was originally founded and supervised by Dr. Simon Dominy prior the transferral of supervision to Dr. Thomas Blenkinsop from the James Cook University, Townsville. Dr. Thomas Blenkinsop also provided invaluable research and editorial assistance. Dr. John Vann also provided editorial assistance with regards to geostatistical methods and mineral resource and ore reserve estimations.

---

Signature

Date

# ACKNOWLEDGMENTS

---

A number of people have contributed greatly to this project, such that I would like to acknowledge the following people for their help and support during the course of this Masters Degree:

1. Mr. Andrew Aitchison and Mr. Ian Butler for giving me the opportunity to conduct my Masters research project on the Vera South ore body.
2. My supervisor Dr. Thomas Blenkinsop for his unwavering support and endless vision. Were it not for his help and support this project could not have been completed.
3. Mr John Vann for his incredibly detailed editing of my resource estimation chapter.
4. Miss Lucy Roberts for all the time and energy she expended explaining the principals of geostatistics and ore reserve estimation. She has been a wonderful friend and a great office mate.
5. Mr. Matthew Raine for his guidance and advice with regards to ore reserve estimation, and also for the endless times we spent together puzzling over the software programme Vulcan.
6. Mr. Steve Harrison from the Pajingo Underground Geology department for his consistently forthcoming help. I thank him for always being only a phone call away and for his assistance whilst I was on site.
7. Mr. Geoff Phillips for his guidance and advice whilst I was conducting my field research. His insight and assistance was also invaluable during a difficult and complicated period during the course of my project.
8. The staff and post-graduate students from the Earth Sciences Department at James Cook University for sharing their knowledge and for their guidance with respect to their research experience.
9. My parents for their understanding and unprecedented support through a very trying period, and also my partner Jimmy for his constant encouragement and faith in me.

# ABSTRACT

---

The aim of this project was to define the geological and grade continuity of the Vera South gold deposit, and to use this knowledge to apply geostatistical resource estimation techniques to the deposit. The deposit occurs within the Pajingo Epithermal System (PES), 72km south of Charters Towers in northeast Queensland, Australia (Porter 1990). The PES deposits are classified as volcanic hosted low-sulphidation epithermal quartz vein systems, and a thorough literature review of epithermal style deposits showed that the characteristics of the Vera South deposit are almost identical to those of the classic low sulphidation model. The PES deposits are currently owned by the Newmont Mining Corporation, and the Vera South deposit is still actively being mined. Current proven and probable resources for the deposit are 75,000mt @ 16.4g/t and 1,229,000mt @ 11.6g/t.

The geological continuity of the main mineralised quartz vein (V1) was first investigated through the application of vein characteristic correlations using parametric and non-parametric statistical tests. The results showed that the highest gold grades occur in association with the widest sections of V1 that dip between 70°–80°, have dip directions between 140°–190°, and where V1 is slightly concave in shape. The comparison of these associations with mapping of V1 and grade contouring showed that higher gold grades are associated with andesitic inclusions in the hangingwall of V1, and with brecciated zones in the hangingwall and around faults. The high grades in the hangingwall occur in small pods that extend from the hangingwall to the centre of V1, particularly in areas where V1 thickens and changes strike direction. High grades are also constrained by the Crown and smaller cross-cutting faults. High grade trends also straddle the ridges of the concave structures, where greatest dilation and thus highest fluid flow is believed to have occurred. V1 is believed to be an accumulation of multiple veins up to 50cm wide that have coalesced to form a single structure up to 16.4m in these zones.

A preliminary attempt was then made to try and determine what constraints the geometry of the host structure placed on mineralisation. Linear elastic fracture mechanics theory found that the theoretical driving stresses and pore fluid pressures required to dilate the Vera-Nancy Structure to 16.4m at a depth of 2km would be ~245MPa and ~260MPa respectively. To obtain such pore fluid pressures, hydrostatic mineralising fluids would have to have been derived from depths of ~13.2km. This depth is considered unrealistic, such that the deposit probably formed within a regional extensional environment and/or from over-pressured fluids.

Numerical models by Zhang *et al* (1995) that describe the flow of fluids along a normal fault were then compared to the Vera South deposit. The number of similarities between the two models indicates the concentration of fluid flow in the fault zone and hangingwall of a host structure due to the opening of sub-vertical fracture sets in shallow environments could have occurred in the Vera South deposit in response to fault movement. This theory explains the concentration of higher gold grades in the hangingwall of V1 and the concentration of quartz stringer veins in restraining bends.

The grade continuity of V1 was investigated using autocorrelation and variography. Variography was utilised to determine whether the distribution of gold in the various domains was showing a preferred spatial continuity, while autocorrelation was utilised using specific grade intervals to determine whether samples over or between certain gold grades were localised in specific spatial orientations. Four domains were created where the first constrained the Vera South Deeps ore body which is physically separated from the Vera South Upper ore body, and then the Vera South Upper ore body was divided into three domains based on the orientation of V1. The autocorrelation and variography results showed that continuous high grade trends occur within the Vera South ore body. Autocorrelation showed these trends have plunges and plunge bearings of 45°–65° and 215°–255°, while variography showed they have plunges and plunge bearings of 22°–68° and 237°–271°. These high grade trends are interpreted to represent the main fluid flow channel ways in which gold was deposited during mineralisation.

Fractal analysis of the gold sample populations were then performed and the results were found to be compatible with the hypothesis that more than one mineralising event and/or mechanism was active during the formation of the Vera South deposit and along the extent of the Vera-Nancy Structural Corridor at the same time, as proposed by Mustard *et al* (2003). Scatter plots of the samples from each fractal grade range population showed that the samples that comprise the lower fractal grade populations are evenly distributed across the entire width and depth of the Vera South deposit, while the samples that comprise the higher fractal grade populations are evenly distributed within the central region of the deposit and individual domains.

The geological and grade continuity interpretations were then integrated into geostatistical resource estimations for the deposit, to optimise the resource estimates and determine whether geostatistical resource estimation techniques can be applied successfully to the deposit. It was found face chip sample data should not be used for resource estimations, due to unreliable results that were subject to large biases. Reliable resource estimates were able to be created through the ordinary kriging of diamond drill sample data. Directional variography produced

plots that adequately described the spatial continuity between the samples, and block models with 10m x 10m cell dimensions produced mean kriged grade estimates that closely resembled the raw mean input grades.

The high grade trends identified during autocorrelation and variography were also observed in the block models. The highest grades occur in pods that are continuations of each other, and which occur within zones in the ore body hypothesized by Davis (2003c) to represent releasing bends. The plunges and plunge bearings of the trends in the directional and omni-directional block models were between 35°–60° and 237°–271°, and 30°–55° and 237°–271° respectively.

# TABLE OF CONTENTS

---

CHAPTER ONE. INTRODUCTION .....	1
1.1 PROJECT AIMS AND OBJECTIVES.....	2
1.2 LOCATION OF THE PAJINGO EPITHERMAL GOLD DEPOSITS.....	2
1.3 EXPLORATION HISTORY .....	3
1.4 MINING HISTORY .....	7
CHAPTER TWO. GEOLOGY OF THE PAJINGO EPITHERMAL GOLD SYSTEM.....	9
2.1 REGIONAL GEOLOGY .....	10
2.1.1 NORTH QUEENSLAND GEOLOGICAL PROVINCES .....	10
2.1.2 GOLD MINERALISATION STYLES .....	11
2.1.3 THE DRUMMOND BASIN.....	12
2.1.4 EPITHERMAL STYLE GOLD DEPOSITS .....	20
2.2 THE PAJINGO EPITHERMAL GOLD SYSTEM .....	21
2.2.1 EVOLUTION OF THE PAJINGO EPITHERMAL GOLD SYSTEM .....	21
2.2.2 THE SCOTT LODGE AND CINDY DEPOSIT .....	27
2.2.3 THE NANCY, NANCY NORTH AND VERA DEPOSITS .....	34
2.2.4 THE TOBY TREND.....	38
2.3 THE VERA SOUTH DEPOSIT .....	39
2.4 ALTERATION .....	45
2.5 VEIN TEXTURES.....	47
2.6 GOLD GRADES AND VEIN TEXTURES .....	48
CHAPTER THREE. EPITHERMAL GOLD DEPOSITS.....	52
3.1 EPITHERMAL GOLD DEPOSITS.....	53
3.1.1 CLASSIFICATION .....	53
3.1.2 THE GEOLOGICAL AND STRUCTURAL SETTING.....	53
3.1.3 ALTERATION .....	59
3.1.4 MINERALOGY AND TEXTURES .....	64
3.1.5 GOLD TRANSPORT AND DEPOSITION PROCESSES .....	65
3.2 LOW AND HIGH SULPHIDATION TYPE EPITHERMAL DEPOSITS.....	68
3.3 MINERAL RESOURCES AND ORE RESERVES OF EPITHERMAL DEPOSITS.....	75
3.4 THE PAJINGO EPITHERMAL SYSTEM COMPARED TO THE CLASSIC EPITHERMAL MODEL .....	80

CHAPTER FOUR. GEOLOGICAL CONTINUITY OF THE VERA SOUTH DEPOSIT .....	82
4.1 GEOLOGY AND GRADE DISTRIBUTION WITHIN THE MAIN VEIN.....	83
4.1.1 GRADE CONTOURING AND WIREMESHING.....	83
4.1.2 UNDERGROUND BACKS MAPPING.....	84
4.1.3 GENESIS OF THE MAIN VEIN .....	86
4.2 ANALYSIS OF THE GEOMETRY OF THE VERA SOUTH MAIN VEIN.....	94
4.2.1 CONCLUSIONS AND RECOMENDATIONS .....	97
4.3 ANALYSIS OF THE WIDTH OF THE VERA SOUTH MAIN VEIN.....	99
4.3.1 CONCLUSIONS AND RECOMMENDATIONS.....	101
CHAPTER FIVE. GRADE CONTINUITY OF THE VERA SOUTH DEPOSIT .....	102
5.1 FRACTAL ANALYSIS.....	103
5.1.1 FRACTAL THEORY .....	104
5.1.2 FRACTAL DISTRIBUTION OF GOLD GRADES.....	105
5.1.3 FRACTAL DISTRIBUTION OF GOLD GRADES IN ORE BODY'S ALONG THE VERA-NANCY STRUCTURAL CORRIDOR.....	109
5.1.4 RECOMMENDATIONS .....	110
5.2 AUTOCORRELATION (FRY ANALYSIS) .....	111
5.2.1 AUTOCORRELATION OF GOLD GRADES .....	112
5.2.2 RECOMMENDATIONS .....	114
5.3 VARIOGRAPHY.....	114
5.4 CONCLUSIONS.....	117
CHAPTER SIX. RESOURCE ESTIMATION.....	119
6.1 CURRENT PRACTICES.....	120
6.2 DATA ANALYSIS AND REVIEW.....	120
6.2.1 SAMPLE TYPE.....	121
6.2.2 SAMPLE SUPPORT .....	121
6.2.3 ANALYTICAL PRECISION AND ACCURACY.....	125
6.2.4 SAMPLE QUALITY .....	129
6.2.5 TREATMENT OF EXTREME VALUES (OUTLIERS).....	130
6.2.6 SAMPLE COVERAGE .....	132
6.2.7 DATA VALIDATION.....	133
6.3 DOMAIN DEFINITION.....	133
6.3.1 STATIONARITY .....	134
6.3.2 DOMAINING OF THE VERA SOUTH ORE BODY .....	135
6.4 STATISTICAL ANALYSIS.....	136
6.4.1 DOMAIN STATISTICS .....	136

6.4.2	FREQUENCY HISTOGRAMS.....	140
6.4.3	DISTRIBUTION FITTING .....	141
6.4.4	3-PARAMETER LOG TRANSFORMATIONS .....	141
6.5	VARIOGRAPHY.....	141
6.5.1	THE EXPERIMENTAL VARIOGRAM.....	142
6.5.2	SAMPLE DATA MODIFICATION.....	143
6.5.3	VERA SOUTH EXPERIMENTAL VARIOGRAM .....	144
6.5.3.1	VARIOGRAM PARAMETERS .....	144
6.5.3.2	VARIOGRAM MODELLING .....	148
6.5.3.3	ANISOTROPY.....	151
6.6	KRIGING.....	152
6.6.1	INTRODUCTION.....	153
6.6.2	ORDINARY KRIGING.....	154
6.6.3	ORDINARY KRIGING PARAMETERS.....	155
6.6.4	ORDINARY KRIGING RESULTS.....	156
6.6.4.1	BLOCK MODEL REPRESENTATION .....	157
6.6.4.2	HIGH GRADE ZONES IN THE BLOCK MODELS.....	157
6.6.4.3	MARGINAL BLOCK GRADES.....	158
6.6.4.4	ANISOTROPY.....	160
6.6.4.5	MEAN BLOCK MODEL GRADES.....	160
6.6.4.6	VARIANCE	161
6.6.4.7	GRADE-TONNAGE CURVES .....	163
6.7	CONCLUSIONS.....	165
6.8	RECOMENDATIONS.....	167
6.8.1	DATA CLUSTERING.....	167
6.8.2	GY'S SAMPLING THEORY .....	168
6.8.3	SPECIFIC GRAVITY .....	168
6.8.4	STATIONARITY .....	169
6.8.5	VARIOGRAPHY.....	169
6.8.6	POINT KRIGING .....	170
6.8.7	BLOCK MODELLING.....	170
6.8.8	KRIGING.....	171
6.8.9	BLOCK MODEL VALIDATION .....	172
6.8.10	EXTENSIONAL VARAINCES OF A 3D BLOCK MODEL.....	172
6.8.11	GRADE-TONNAGE CURVES.....	172

## **BIANCA PIETRASS MASTERS THESIS**

---

CHAPTER SEVEN. CONCLUSIONS.....	174
7.1 CONCLUSIONS.....	175
7.2 GEOLOGICAL CONTINUITY .....	175
7.3 GRADE CONTINUITY .....	176
7.4 GENERAL CONTROLS ON THE FORMATION OF THE VERA SOUTH ORE BODY .....	179
7.5 RESOURCE ESTIMATION .....	179
7.6 OPTIMISATION OF RESOURCE ESTIMATION .....	185
7.7 SUMMARY OF MAIN OUTCOMES .....	186
REFERENCES.....	189
APPENDIX 4.1 .....	195
APPENDIX 4.2.....	204
APPENDIX 4.3.....	226
APPENDIX 4.4.....	229
APPENDIX 4.5.....	230
APPENDIX 4.6.....	231
APPENDIX 5.1.....	231
APPENDIX 5.2.....	235
APPENDIX 5.3.....	241
APPENDIX 5.4.....	243
APPENDIX 5.5.....	268
APPENDIX 6.1.....	276
APPENDIX 6.2.....	277
APPENDIX 6.3.....	281
APPENDIX 6.4.....	282
APPENDIX 6.5.....	282
APPENDIX 6.6.....	283
APPENDIX 6.7.....	285
APPENDIX 6.8.....	291
APPENDIX 6.9.....	295
APPENDIX 6.10.....	308
APPENDIX 6.11.....	315
APPENDIX 6.12.....	316
APPENDIX 6.13.....	328
APPENDIX 6.14.....	339

# LIST OF TABLES

---

- Table 1.1 The proven and probable ore reserves and mineral resources as at January 2003 for Nancy, Nancy North, Vera and Vera South.
- Table 1.2 The gold and silver production figures for the Scott Lode.
- Table 1.3 Production figures for the year ended 30<sup>th</sup> June 2001.
- Table 2.1 The mineralisation styles and geochemical associations of the major gold deposits of northeast Queensland.
- Table 2.2 The stratigraphy of the Drummond Basin.
- Table 2.3 The main characteristics of the Scott Lode and Cindy deposit, neither of which occur along the Vera-Nancy structural corridor.
- Table 2.4 The main characteristics of the Nancy, Vera North and Vera South deposits, which all occur along the Vera-Nancy structural corridor.
- Table 2.5 The characteristics of the five main alteration styles recognised in the Vera North and Nancy deposits.
- Table 2.6 The alteration sequence associated with quartz veins in the PES.
- Table 3.1 Nomenclature used for the two main epithermal environments.
- Table 3.2 The main alteration types of epithermal environments.
- Table 3.3 Silicic alteration types that may occur in epithermal deposits.
- Table 3.4 The depth and temperature controls on the alteration assemblages of high sulphidation type epithermal deposits.
- Table 3.5 The depth and temperature controls on the alteration assemblages of low sulphidation type epithermal deposit.
- Table 3.6 Characteristics of low sulphidation (adularia-sericite) epithermal deposits.
- Table 3.7 Characteristics of low sulphidation (adularia-sericite) epithermal deposits.
- Table 3.8 The mineralisation style of some low and high sulphidation epithermal deposits.
- Table 3.9 The general parameters used at 6 epithermal vein and stockwork style gold deposits for deposit modelling.
- Table 3.10 The general parameters used at 6 epithermal disseminated and breccia style gold deposits for deposit modelling.
- Table 4.1 The material properties used for modelling by Zhang *et al* (1995).
- Table 4.2 A summary of numerical modelling methods.
- Table 4.3 The parameters used by Zhang *et al* (1996) in their studies on the effects of fluid flow and faulting compared to the characteristics of the Vera South deposit.
- Table 4.4 The results achieved by Zhang *et al* (1996) for their models on the effects of fluid flow and faulting.
- Table 4.5 The Shapiro-Wilk normality test results for the vein characteristics from the Vera South Upper and Deeps domains, where a value of 1 represents a perfect normal distribution.
- Table 4.6 The descriptive statistics of the Vera South vein grade and width sample populations.
- Table 4.7 The Vera South vein dip & dip direction sample population's descriptive statistics.
- Table 4.8 The Pearson, Spearman, Kendall and linear regression correlation coefficients achieved for the Vera South vein characteristics.
- Table 5.1 The properties of the diamond drill and face chip sample fractal populations for the Vera South ore body and domains.
- Table 5.2 The fractal dimensions and associated fractal gold grade ranges obtained for the Vera South deposit compared to the results obtained by Sanderson *et al* (1994).
- Table 5.3 The fractal gold grade ranges observed for the face chip sample populations of the deposits along the Vera-Nancy structural corridor.
- Table 5.4 The fractal dimensions of the different fractal grade ranges obtained for the Vera South ore body face chip sample populations, compared to those of the deposits along the Vera-Nancy structural corridor.

- Table 5.5. The plunges and plunge bearings of the high grade trends observed in the Vera South ore body and each domain.
- Table 5.6. The azimuths and plunges used in the variographic analysis of the Vera South ore body and domains.
- Table 5.7. The most dependable lag spacings and distances achieved for the diamond drill sample populations.
- Table 5.8. The directional variogram parameters for the Vera South diamond drill sample populations.
- Table 5.9. The plunge and plunge bearing of the high grade trends in the Vera South domains.
- Table 6.1. The Vera South mineral resources/ore reserves as of May 2003.
- Table 6.2. The ranges and variances of the diamond drill and face chip sample populations from the Vera South ore body.
- Table 6.3. The standards used at Pajingo, their expected grades and the frequency at which each standard has been used.
- Table 6.4. The percentage difference between each standard's expected and achieved mean gold values.
- Table 6.5. The variance, skewness and kurtosis of the original and duplicate sample populations from the Vera South Upper and Deeps Ore Body's.
- Table 6.6. Summary of the statistical test results achieved for the primary and duplicate face chip samples.
- Table 6.7. The coordinates and the average dip and strike of the four Vera South domains from eigenvector analysis.
- Table 6.8. The descriptive statistics of the diamond drill-hole sample data for the Vera South ore body.
- Table 6.9. The descriptive statistics of the diamond drill-hole sample data for the Vera South ore body.
- Table 6.10. The most dependable lag spacings and distances achieved for the diamond drill and face chip sample populations.
- Table 6.11. A table showing the minimum number of sample points, and the number of sample points available to produce reliable variograms for the four Vera South domains.
- Table 6.12. The omni-directional and directional variogram parameters for the diamond drill sample populations.
- Table 6.13. The omni-directional variogram parameters for the face chip sample populations.
- Table 6.14. The length of the axes of the anisotropic and isotropic search volumes for the Vera South diamond drill sample populations.
- Table 6.15. The isotropic search volume radii for the Vera South face chip sample populations.
- Table 6.16. The limits of the Vera South ore body block models for each domain.
- Table 6.17. The Vera South domain block models and their corresponding EXCEL file names.
- Table 6.18. The extent of the high grade trends in the diamond drill & face chip block models.
- Table 6.19. The plunges of the high grade zones in the Vera South ore body block models.
- Table 6.20. The mean grades of the Vera South diamond drill raw samples and block models.
- Table 6.21. The mean grades of the Vera South face chip raw samples and block models.
- Table 6.22. The variance block models for the Vera South domains and their corresponding EXCEL file names.
- Table 6.23. The minimum, maximum & average variances of the diamond drill block models.
- Table 6.24. The minimum, maximum and average variances of the face chip block models.
- Table 6.25. The total tonnes and grade of the diamond drill block models.
- Table 6.26. The total tonnes and grade of the face chip block models.
- Table 6.27. The extent and orientation of the high grade trends and search ellipses identified/used in the diamond drill and face chip block models.
- Table 6.28. The mean grades of the Vera South diamond drill and face chip raw samples and block models.

# LIST OF FIGURES

---

- Figure 1.1. The location of the Pajingo Gold Mine in Australia.  
Figure 1.2. The location of the Pajingo Gold Mine in northeast Queensland.  
Figure 1.3. The Pajingo Gold Mine mine-grid in relation to magnetic north and AMG north.  
Figure 1.4. Regional aero-magnetic and gradient array resistivity data.  
Figure 1.5. A longitudinal section of the Pajingo gold deposits along the Vera-Nancy structural corridor.  
Figure 1.6. The location of the Pajingo mining infrastructure and open pits.  
Figure 2.1. Northeast Queensland's geological provinces and sub-provinces.  
Figure 2.2. The location of the geological provinces and inliers of northeast Queensland, including the Lolworth-Ravenswood Block.  
Figure 2.3. A model illustrating the strike directions in which listric and subsequent strike slip faults developed during the extensional tectonic regimen that created the Drummond Basin.  
Figure 2.4. A model illustrating the strike directions in which listric and strike dip-slip faults developed during the Drummond Basins compressional tectonic regimen.  
Figure 2.5. The distribution of volcanics for the Late Devonian-Early Carboniferous sequences from the northern New England Orogen.  
Figure 2.6. The lateral extent of the Drummond Basin and the location of the Pajingo Epithermal Deposit within the basin.  
Figure 2.7. The location of the Pajingo gold deposits along the Vera-Nancy Structural Corridor.  
Figure 2.8. The interpreted structure of the PES with the location of the host rocks and quartz veins shown.  
Figure 2.9. A sectional view of the Vera-Nancy Structural Corridor showing the location of the host rocks and Vera South deposit.  
Figure 2.10. Geology of the Charters Towers district and the location of the PES.  
Figure 2.11. The Vera-Nancy Structural Corridor and the location of the gold deposits and prospects in relation to Mt Janet.  
Figure 2.12. The Drummond Basin's structure during extension, and the location of the Vera-Nancy Structural Corridor in relation to early listric and strike slip faults.  
Figure 2.13. A cross section of the Scott Lode.  
Figure 2.14. A zoning model of the Scott Lode based on quartz vein types and textures.  
Figure 2.15. Distribution of gold (ppm) in the ore zone.  
Figure 2.16. Distribution of silver (ppm) in the ore zone.  
Figure 2.17. Location and geological plan showing the position of the Nancy, Vera North and Vera deposits.  
Figure 2.18. A cross section of the Nancy deposit showing the N1 structure.  
Figure 2.19. Cross section of the Vera North deposit showing V1 and V2.  
Figure 2.20. Schematic diagram of dilational jogs and bends on a sinistral strike slip fault.  
Figure 2.21. Hypothetical plot of fluid pressure versus time between successive earthquake ruptures for the suction-pump and fault-valve mechanisms.  
Figure 2.22. Dilational fault jogs causing rupture perturbation and arrest along a sinistral strike-slip fault.  
Figure 2.23. The position of the Crown, Redback and Guinness Faults in longitudinal section.  
Figure 2.24. A longitudinal section looking east showing the position of the Redback and Guinness Faults in relation to the position of the main vein.  
Figure 2.25. The location of releasing and restraining bends on a normal fault.  
Figure 2.26. A model of the Vera South deposit showing how two ore body's formed separately.  
Figure 2.27. Cross section through the Vera South ore body.  
Figure 2.28. The textures observed at different depths in V1.

- Figure 2.29. The quartz textures and associated gold grades of surface samples from the Janet Ranges.
- Figure 3.1. Volcanic-hydrothermal and geothermal system processes and the respective environments of high- and low-sulphidation style epithermal deposits.
- Figure 3.2. Examples of epithermal ore body form controlled by host rock lithology, structure and hydrothermal processes.
- Figure 3.3. The temperature and pH ranges of epithermal alteration styles.
- Figure 3.4. The vein and wall rock alteration minerals associated with the Acid Sulphate and Adularia-Sericite epithermal type deposits.
- Figure 3.5. Log  $a_{S_2} - a_{O_2}$  diagram showing the mineral stability fields for significant minerals in epithermal systems at 250°C.
- Figure 3.6. Log  $a_{O_2} - pH$  diagram showing the mineral stability fields for significant minerals in epithermal systems at 250°C.
- Figure 3.7. The thermal stability of various hydrothermal minerals under different pH conditions.
- Figure 3.8. A schematic diagram of mineral zoning in low and high sulphidation epithermal deposits.
- Figure 3.9. The alteration, ore and gangue mineralogy and textures of a typical boiling epithermal vein at different depths and temperatures.
- Figure 3.10. Occurrence model for a low-sulphidation type epithermal deposit.
- Figure 3.11. Occurrence model for a high-sulphidation type epithermal deposit.
- Figure 3.12. A combined magmatic (early or late fluids) and meteoric fluids model.
- Figure 3.13. A section through the alteration assemblage of a typical high sulphidation ore body.
- Figure 3.14. Grade-tonnage plot of high and low sulphidation epithermal ore deposits including both production and reserves.
- Figure 3.15. A schematic representation of the geological and grade variability of different style deposits.
- Figure 4.1. The orientation of the elliptical search area used to grid each production level.
- Figure 4.2. The apertures around the fault before and after fault slip.
- Figure 4.3. Histograms displaying the percentage porosity and the fluid flow rates before and after fault slip in different areas.
- Figure 4.4. The migration of fluids from a fault zone into the hangingwall at shallow depths around restraining bends.
- Figure 4.5. An idealized diagram of the Vera-Nancy Structural Corridor represented as a mode I crack with maximum dilation  $\Delta u_1^0$ .
- Figure 5.1. The “Sierpinski Gasket” fractal, illustrating the principle of self-similarity.
- Figure 5.2. The location of the individual samples in *A*: Vera South Deeps and *B*: Vera South Upper.
- Figure 5.3. The minimum and maximum ranges and the plunges of the high grade trends observed in *A*: Vera South Deeps, *B*: domain 1, *C*: domain 2 and *D*: domain 3.
- Figure 6.1. The influence of support on grade distribution, as illustrated by a relative frequency graph of kriged block grades from a 10m x 10m block model compared to a 20m x 20m block model from the Vera South Deeps domain.
- Figure 6.2. A histogram showing the usage frequency of the standards.
- Figure 6.3. The assay results received for the standards plotted versus their expected grades.
- Figure 6.4. Scatter plots of Au versus Au1 for Vera South Upper and Deeps, showing the linear regression trend line and equation.
- Figure 6.5. The Vera South ore body domains and their related dips and strikes as seen in plan view.
- Figure 6.6. The Vera South ore body domains as seen in sectional view when looking north.
- Figure 6.7. The variogram and its main components.
- Figure 6.8. The methodology behind sample coordinate rotation.
- Figure 6.9. The azimuths and dips used for the variographic analysis of Vera South Deeps. The 22.5° search tolerance angle is also shown.

- Figure 6.10. The azimuths and dips used for the variographic analysis of domain 1.  
Figure 6.11. The azimuths and dips used for the variographic analysis of domain 2.  
Figure 6.12. The azimuths and dips used for the variographic analysis of domain 3.  
Figure 6.13. A figure illustrating the geometry of variographic sector searches.  
Figure 6.14. Behaviour of the variogram near the origin.  
Figure 6.15. Polar plots of the experimental variograms ranges determined for the Vera South Deeps and Domain 1 diamond drill samples.  
Figure 6.16. Polar plots of the experimental variograms ranges determined for the Domain 2 and Domain 3 diamond drill samples.  
Figure 6.17. An illustrated example of the application of kriging equations for ordinary kriging.  
Figure 6.18. The high grade trends in the diamond drill and face chip block models of *A*: Vera South Deeps and *B*: Domain 1.  
Figure 6.19. The high grade trends in the diamond drill and face chip block models of *C*: Domain 2 and *D*: Domain 3.

## LIST OF PLATES

---

- Plate 1. The main vein as seen in the VSD735E ore drive.  
Plate 2. The main vein as seen in the VSD765W ore drive.  
Plate 3. A larger individual quartz vein bounded by colloform banding.  
Plate 4. Quartz stringers in the andesitic hangingwall of the VSD735E ore drive.  
Plate 5. Colloform banding surrounding a small andesitic clast.  
Plate 6. Colloform and fine-grained sulphide banding in the main vein.