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A study on internal dilution in the orapa 2125 A/K1 kimberlite based on 2D quantitative textural analysis data

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2016

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Responses to Re-Examination Report (T.B. Chiomba – Student Number: 311463)

Examiners Report Section	Examiner's Finding	Student's Response
Factual Errors (Bullet 1)	Page 31, paragraph 1 – The mida samples were located thirty meters apart, as per resource estimate report, not fifteen.	The word "fifteen" was replaced by "thirty" to match the resource estimate report
Factual Errors (Bullet 2)	Page 74, points 1 and 2 – the null hypothesis refers to variance, not standard deviation: $\sigma_1^2 = \sigma_2^2$	$\sigma_1 = \sigma_2$ replaced by $\sigma_1^2 = \sigma_2^2$ to reflect the hypothesis of equality of variances
Factual Errors (Bullet 3)	Page 76, point 14 – the standard deviations in the denominator for the unequal variance formulation should be changed to variances – s_1^2 and s_2^2 In addition, the remainder of the denominator for the equal variance formulation should probably also be under a square root as well – please check literature sources	$t_{\bar{z}_1-\bar{z}_2} = \frac{\bar{z}_1-\bar{z}_2}{\sqrt{s_1/n_1+s_2/n_2}}$ replaced with $t_{\bar{z}_1-\bar{z}_2} = \frac{\bar{z}_1-\bar{z}_2}{\sqrt{s_1^2/n_1+s_2^2/n_2}}$ $\left(\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}\right)$ replaced with $\sqrt{\left(\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}\right)}$
Factual Errors (Bullet 4)	Section 7.2.2, line 1 – The candidate states that the Mann-Whitney test assumes that the distributions have the same shape. However, nowhere in the document is there any evidence that similarity of distributions was tested for the OREP1/2 data sets in each of the lithologies as a pre-requisite testing the medians. The only data set provided in the appendices was that of the NPK_GG and testing of these distributions revealed that the OREP1/2 datasets are not identical in shape (see Appendix to this document). The univariate statistics and the results of the t-test could, however, be reproduced. The Mann-Whitney test should also not be used for Gaussian data, which the OREP2 NPK_GG data in fact is. The statement in Section 7-2 that the choice of statistical test could be either parametric or non-parametric, is therefore not correct for all lithologies – this has to be determined using appropriate test(s).	This statement together with most of the theoretical sections of Chapter 7 have been re-written to remove ambiguity. It has been made clear that the application of the Mann-Whitney test depends on whether the distributions have the same shape or not (i.e. instead of assuming that they have the same shape). Q-Q plots have been added and used to determine whether distributions are normal or non-normal. Histograms, box plots and Q-Q plots have been used to determine if compared distributions have the same shape. Whether distributions are normal or not has been used to decide whether Welch's t-test or Mann-Whitney test applies. Whether distributions have the same shape or not has been used to determine the null hypothesis for the Mann-Whitney test cases. This statement was only included for theoretical purposes in the previous version. However since it caused confusion it has been refined to reflect that the use of parametric or non-parametric tests is subject to the right conditions being met.

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Factual Errors (Bullet 5)	Section 9.4, paragraph 1 – The existence of outlier dilution measurements may not necessarily be due to lithological misclassification. Localised wall-rock failures, both syn- and immediately post-emplacement may have resulted in the introduction of up to 100% country rock debris on a very localised scale. It would, however, be prohibitive from both a time and a cost perspective to attempt to include such small areas into a resource model and these small zones may be rolled up and included in a lithology with much lower average dilution. This is therefore a calculated trade-off between cost and model quality and not a failure of the geology workstream.	The section was updated to include the possibility that wall-rock failures may contribute to outliers. Nowhere in the text is there a proposal to model such localised phenomena. However, the proposal to check lithological logging for dilution outliers still stands, just in case a specimen has been wrongly assigned to a low-dilution or high-dilution lithology. If the original lithologies are confirmed then wall-rock failures may be used to explain them in case of low-dilution lithologies with high-value outliers. If logging errors are found then the re-classification would definitely help the statistical analysis by removing spurious outliers from particular kimberlite lithofacies.
Grammar and/or spelling (Bullet 1)	Page 2, paragraph 3, line 7 – "comminution"	"communition" replaced by "comminution" which as intended refers to the reduction of particle size by crushing
Grammar and/or spelling (Bullet 2)	Page 5, paragraph 1, line 2 – "….refer to a piece <u>of</u> kimberlitic drillcore……."	Missing "of" added between "piece" and "kimberlitic"
Grammar and/or spelling (Bullet 3)	Page 6, paragraph 4, last line – "Cas et al. (2009)."	Missing full stop (.) added immediately after "et al"
Grammar and/or spelling (Bullet 4)	Page 32, paragraph 2, line 3 – "…..A/K1 varies between and within kimberlite facies."	"with" replaced by "between"
Grammar and/or spelling (Bullet 5)	Page 35, paragraph 3, line 1 – "…..thousands <u>of</u> meters of OREP kimberlitic drillcore	Missing "of" added between "thousands" and "meters"
Grammar and/or spelling (Bullet 6)	Page 73, paragraph 1, line 5 – "cognisant"	American English spelling "cognizant" replaced with UK English spelling "cognisant"
Grammar and/or spelling (Bullet 7)	Page 76, point 13 – "……freedom <u>of</u> the t-statistic"	Missing "of" added between "freedom" and "the"
Grammar and/or spelling (Bullet 8)	Page 95, paragraph 2, line 3 – replace "contributed'' by "dominated"	"contributed'' replaced by "dominated"

Examiners Report Section	Examiner's Finding	Student's Response
Omissions (Bullet 1)	The following references appear in the reference list at the back of document but do not appear in the text and should therefore be removed, or text added where they are mentioned: Bush (2010) and Gernon et al. (2009).	Text referencing the two publications in earlier versions had been removed from the main document previously so Bush (2010) and Gernon et al. (2009a) were duly deleted from the reference list.
Omissions (Bullet 2)	The following references have been referenced to in the text, but do not appear in the reference list. The majority appear due to apparent errors in the date of publication when compared to the content of the reference list: Nowicki et al. (1007); McCourt (2004) – McCourt et al. (2004)?; Johnson et al. (2006) – Johnson et al. (1996)?; Stonehouse and Forrester (1998) – Stonehouse and Forrester (1988)?; Carrol and Schneider (1974) – Carrol and Schneider (1985)?	Nowicki et al. (2007) reference was added to the reference list. McCourt (2004) was changed to McCourt et al. (2004) in the text. The date discrepancies between the text and the reference list were rectified either in the text or reference list to match the following: Stonehouse and Forrester (1998); Johnson et al. (1996); Carrol and Schneider (1985).
Omissions (Bullet 3)	Include the name and version number of the software which was used to run the statistical tests. This is essential since not all packages produce consistent (or even correct) results and sometimes even different versions of the same product produces different results. Judging by the figures, the candidate presumably used SAS-JMP and Excel 2010/2013 It is a pity that the electronic input, JMP session script and output files were not attached to the thesis. This would have greatly simplified the verification of the output and analytical techniques. The use of proper statistical package such as JMP rather than Excel by the candidate is commendable, since the later contains errors in some statistical tests, e.g. Pottel – *Statistical flaws in Excel*, Cryer – *Problems with using MS-Excel for statistics*, as well as McCullough – *The unreliability of Excel's statistical procedures*, to name only three.	The software and versions of the software were added to Chapter 7. Significance tests were done in Statistica version 11. These were confirmed using JMP version 11. The modified Levene's test was done in Excel 2013 using validated formulae. I wasn't aware that the electronic files used in the statistical analysis needed to be handed in with the research report for marking. However I can see how that would have helped if the examiner wanted to verify everything.
Omissions (Bullet 4)	Page 31, paragraph 2 – although no individual sample size optimisation was undertaken for the Orapa Resource extension, there was collective sample optimisation undertaken to ensure that the sampling would meet the requirement for an indicated resource. This should be added to the text.	The statement was added to the second paragraph of Section 4.3.5.
Omissions (Bullet 5)	Page 74, 76 – the source of equations should be referenced.	The workflows and formulae for the significance tests in the text are generalised and included as background. The actual tests were done using commercial software and the formulae used in these packages might differ from the generalized ones.

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Comments (Bullet 1)	Where depth below surface are referred to in the text, e.g. Fig 6-18 to 6-20, the actual depth below surface or meters above sea-level should be quoted, rather than bench numbers. If bench numbers must be used, then include a table with corresponding depths in the document such that the readers can attach more meaning to the data.	A table mapping bench numbers to both the actual depth below surface (i.e. m.b.g.l) and meters above sea-level (i.e. m.a.m.s.l.) was added to section 6.4.4.
Comments (Bullet 2)	Page 102, paragraph 2 – The question confronting the teams responsible for the design of the OREP geology workflow and data capture and current face mapping are the same: will the cost and effort that will undoubtedly be expended in 100% accurate dilution data add material value to the mining process, and will I allow for faster mining? At this point it is not clear that this will indeed be the case.	The report does not recommend a change to the current dilution data collection process as it provides a good balance between cost and effort as stated in Section 5.2. However it recommends a once-off "study" to determine how far the current process underestimates dilution levels in A/K1. If the underestimation is significant then the current process will still be used but valid factors applied to correct for the underestimation.
Comments (Bullet 3)	The only primary data set included with the dissertation document, that of NPK_GG was validated by this author and the and the univariate statistics stated in the text could be reproduced from the from the data in Appendices A – D, as well as the results of the t-test.	Adding all datasets used in the study to the appendices would increase the report size to over a thousand pages as there were over 20,000 records in all the datasets. The NPK_GG data was added just as an example so that readers see the nature of the data and if necessary replicate the calculations using it.
Recommendations	If the candidate did perform equivalence of distribution test as a precursor to the Mann-Whitney test as a precursor to the Mann-Whitney test implementation, then evidence of that should be presented in the form of a table in the text. As stated by the candidate in his text well, it is clear from histograms in Figures 6-13, to 6-17 that there are other lithologies with non-similar distributions, e.g. PKBR, SPK as the most obvious for single line-scan data, and PBR, PKBR and possibly SDVK for multiple line-scan data. It is recommended that the omission regarding the distribution shape requirements for the Mann-Whiney test be rectified and the test removed from those lithologies where it is used incorrectly due to non-matching distributions. Alternatively include a statement for the relevant problem lithologies, stating that the distributions are dissimilar and the Mann-Whitney test could not be applied successfully.	The histograms, box plots and Q-Q plots were used to determine distributions that had same shape, different shapes and those that were completely different (e.g. normal versus skewed). The Mann-Whitney test was used to test for equality of medians for pairs of distributions that had the same shape. The Mann-Whitney test was used to test for equality of distributions for pairs of distributions in one class but with different shapes. The Mann-Whitney test was not used where normal distributions were involved.