Mount Nansen Mines Limited

STATISTICAL ANALYSES OF MINE ASSAY DATA

by

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1. INTRODUCTION

During recent calculations of the Mount Nansen ore-reserves the question arose, how many channel samples per drift face are needed in order to obtain optimal dependability for delineating ore-shoots and calculating ore-reserves. Similar considerations were already carried out by Campbell (1965) who writes in his review report on the geology and ore-reserves "Initially, each face was sampled wall to wall by three channels cut at 6, 4 and 2 feet above track. Also every round was muck sampled by taking a random handful from the top of every second or third car so that about a powderbox of samples was garnered to represent the round. After 200 feet of ore (Webber) it was found that the erratics expected in the ore did not occur and that for most faces the three channels would be about the same." Sampling was subsequently reduced from three to two channels per face at 2.5 and 5 feet above rail. It is obvious that the assaying expences incurred during drifting could be lowered considerably if only one instead of two channels per face can be sampled without markedly changing the endresults.

The numerous and detailed silver and gold values which are available from the assay plans of the Huestis 4300 and 4100 level and from the Webber workings presented a unique opportunity to study the distribution of the two precious metals in three different parts and elevations of the Mount Nansen ore-body. The data furthermore allowed to investigate if the assay values correspond with the observed mineralogical and geological features and if depth has an influence on the ore-grade. It was found that graphical methods provide the most convenient way to accomplish such statistical analyses.

2. SAMPLING, ASSAYING AND MEASURING METHODS

The samples were obtained from two, three to five inches wide channels, cut horizontally across the face of exposed ore, at 2.5 and 5 feet above track. Customarily, the samples are spaced 5 to 7 feet apart along the strike of the vein, depending on the length of the round. Each channel consists at least of three different samples, taken from the hanging wall and footwall of the mineralized vein and from the mineralization itself. Commonly, each of the fractions which together constitute one channel sample, possess a different width, a fact which had to be considered when calculating a standard base for the channel samples. The fractions were analysed separately by the conventional fire assay method. All the fire assays were carried out at the mine laboratory by the mine assayer and check samples were run by a commercial assaying office in Whitehorse.

According to the assay plans the limits of detection were 0.01 oz/ton for gold and 0.1 oz/ton for silver. The precision generally was within 5 per cent, however, for low grade ore it was considerably worse.

The different assay values obtained from the individual fractions of the channels together with their particular width are given on the assay plans of the mine. For the present study as well as for the ore reserves calculations a standard channel width of 4 feet was chosen since it corresponds with the minimal stoping width feasible at the Mount Nansen ore-body. The channels were reduced in such a way that they contain the entire mineralized portion of the vein, plus the adjacent barren or weakly mineralized country rock, making up the balance to the 4 feet. Therefore, it is obvious that for the calculated reduced 4 feet channels the weight of the mineralized vein is of far greater influence than for the actual sample channels. It is also important to note that a homogeneous gold and silver mineralization is assumed for the country rock adjoining the mineralized vein when calculating the 4 feet standard channels.

The reduction to 4 feet of a 7 feet wide channel consisting of three individual samples is given in the following example.

Actual 7 feet channel:

	width	Au	Ag
Country rock, hanging wall	3.5	0.05 oz/ton	1.2 oz/ton
Mineralized vein	1'	0.8 oz/ton	9.4 oz/ton
Country rock, foot wall	2.5'	Nil	Trace

Reduced 4 feet standard channel:

	width	Au	Ag
Country rock, hanging wall	1.5'	0.05 oz/ton	1.2 oz/ton
Mineralized vein	1'	0.8 oz/ton	9.4 oz/ton
Country rock, foot wall	1.5	Nil	Trace
	4'	0.22 oz/ton	2.35 oz/ton

3. INVESTIGATION ON THE REDUCTION OF THE NUMBER OF SAMPLE CHANNELS PER FACE.

As mentioned earlier the possibility of reducing the number of sample channels has already been studied by Campbell (1965) who recommended to decrease the sampling to two channels per face at 2.5 and 5 feet above track. The present work was undertaken to investigate if a further reduction of the sample channels is feasible. For this reason, channels from a number of ore-shoots from the Huestis 4300 and 4100 levels and from the Webber mine were chosen and their gold and silver assay values analysed. Of each investigated ore-shoot the means, standard deviations and coefficients of variations were separately computed for the gold and silver values of the upper and lower 4 feet wide standard channels (Table 1).

TABLE 1: Statistical parameters of gold and silver values.

		Gold			Silver		
	N	$\bar{x}$ oz/t	S_x oz/t	V_x	$\bar{y}$ oz/t	S_y oz/t	V_y
HUESTIS 4100							
H 41 - 12 - 593							
upper channels	31	0.33	0.18	0.53	7.1	5.0	0.71
lower channels	31	0.32	0.19	0.60	8.1	6.7	0.82
H 41 - 12 - 588							
upper channels	33	0.56	0.39	0.69	8.8	8.9	1.01
lower channels	33	0.64	0.55	0.86	10.9	13.4	1.22
H 41 - 12 - 585							
upper channels	42	0.87	0.68	0.78	13.6	10.1	0.7
lower channels	42	0.87	0.58	0.67	10.5	7.7	0.73
HUESTIS 4300							
H 43- 12 - 595							
upper channels	11	0.55	0.50	0.91	15.6	19.7	1.25
lower channels	11	0.56	0.55	0.98	13.2	15.3	1.16
H 43 - 12 - 594							
upper channels	35	0.63	0.48	0.76	24.0	45.6	1.90
lower channels	35	0.72	0.55	0.76	23.9	23.4	0.98
H 43 - 12 - 585							
upper channels	26	0.43	0.27	0.61	18.3	21.5	1.17
lower channels	26	0.49	0.42	0.86	15.7	12.9	0.82
WEBBER							
119							
upper channels	11	0.13	0.10	0.76	8.4	8.7	1.04
lower channels	11	0.19	0.14	0.73	10.8	9.6	0.89
121							
upper channels	8	0.24	0.11	0.45	25.5	21.7	0.85
lower channels	9	0.34	0.21	0.63	46.5	38.1	0.82
W 43 - 1-588							
upper channels	12	0.70	0.36	0.51	52.1	31.8	0.61
lower channels	12	0.64	0.54	.85	40.2	24.7	0.62

N = Number of channels per ore-shoot; $\bar{x}$, $\bar{y}$ = Mean value, S_x, S_y = Standard deviation; V_x, V_y = Variation coefficient.

From Table I it is apparent that the mean values for the upper and lower channels are remarkably similar. Great discrepancies occur only in the Webber ore-shoots where the gold grade is low and thus the influence of analytical errors great. One has also to consider that the Webber ore was affected by supergenic alteration which resulted in some chemical redepositions. The standard deviations usually are large, especially for silver, which indicates wide dispersion for this metal in the Mount Nansen ore-body. The distribution of gold was found to be somewhat more homogeneous. These features are even better demonstrated by the coefficients of variation which enable to compare the different distributions independent of their respective quantities. For gold, the coefficients of variations are always smaller than 1.00, that is the standard deviation is always smaller than the mean. For silver, the coefficients of variation are in almost half of the cases larger than 1.00, i.e. the standard deviations in these cases are larger than the mean values.

The large coefficients of variation obtained indicate that laterally - the direction in which the samples were collected - the gold and silver grades of the ore are rather inhomogeneous. It seems therefore possible that more reliability could be added to ore-grade calculations and ore-shoot delineation by spacing the channels in 3 feet intervals along the vein instead of the presently used 6 feet distance. The introduction of three feet channel intervals implies that during exploratory drifting face and back channels must be alternated.

As shown on Table I the mean values of the lower and upper channels from one particular ore-shoot are in most cases reasonably similar, both for gold and silver. The deviations from the average value of the upper and lower channels usually lie between 5 per cent and 10 per cent of the average value and never exceed 20 per cent. Since the lower and upper channels deviate so little from their average it seems appropriate to assume that no real improvement is achieved by using two channels instead of one. For this reason it is suggested that only one channel per face is sampled, preferably at 3 feet above rail.

One furthermore must consider that in exploratory drifting no assay values are available between levels, a distance which at Mount Nansen amounts to 200 feet. It is therefore statistically extremely unprobable that 2 channels per drift face situated vertically 2.5 feet apart and with a vertical interval of 200 feet to the next sample pair would improve the results of ore estimations. It is however suggested that a closer sample spacing along the vein in the drifts could lead to improved results of such calculations.

4. THE DISTRIBUTION OF GOLD AND SILVER IN THE MOUNT NANSEN ORE-BODY.

The gold and silver assay values were also studied to determine the distribution of the two elements within the Mount Nansen ore-body and to investigate the influence of the supergenic alteration, the geological setting and the mineralogy on the abundance of the two precious metals. To obtain information on the relative abundance of gold and silver in respect with each other the Ag/Au ratio of the individual gold and silver values was computed and the resulting ratios statistically treated in the same way as the individual gold and silver values.

Figure I shows the "total" arithmetic frequency histogram of all the 443 gold, silver and Ag/Au values investigated in the Mount Nansen ore-body. The histogram for gold indicates an asymmetrical curve possessing positive skewness, whereas for silver and Ag/Au reverse J-shaped curves were obtained. Since the distributions are essentially non-parametric and according to Ahrens (1957) lognormal distribution patterns appear to be the most applicable to the results of most geochemical surveys the arithmetic distributions were plotted on arithmetic-logarithmic graph paper where they approach lognormal distributions (Fig.2). A lognormal distribution is defined by two parameters, one is dependent on the mean value, the other on the character of value distribution. The latter indicates the range of the distribution. According to Matheron (1962) it seems that the lognormal law fits usually very well in the case of low-grade deposits like gold but for high-grade deposits the experimental distributions are generally negatively skewed because of the limitations towards the high values.

Grouping of values.

A correct grouping of the assay values into an adequate number of classes is necessary if same precision is to be attained in the statistical analyses. The modulus of the intervals should be directly proportional to the precision of the analyses, i.e. a more precise analyses requires a smaller modulus. Lepeltier (1969) who discusses the method, uses for statistical work 15 to 25 intervals, with the restriction that the width of a class, expressed logarithmically - must be kept equal to or smaller than half of the standard deviation (Shaw, 1964).

3 variables are important: n = number of points necessary to draw the curves; R = range of distribution of the values as expressed by the ratio of the highest to the lowest value present in the population and log. int. = the width of the classes expressed logarithmically. log.int. is linked with n and R as follows:

$$\text{log.int.} = \frac{\log R}{n}$$

$$R = \frac{\text{highest value}}{\text{lowest value}}$$

n lies between 15 and 25.

For the present study the variable n has been selected as 17 for gold, 17 for silver and 16 for Ag/Au, the resulting width of the logarithmic intervals (log.int.) being 0.150, 0.180 and 0.200.

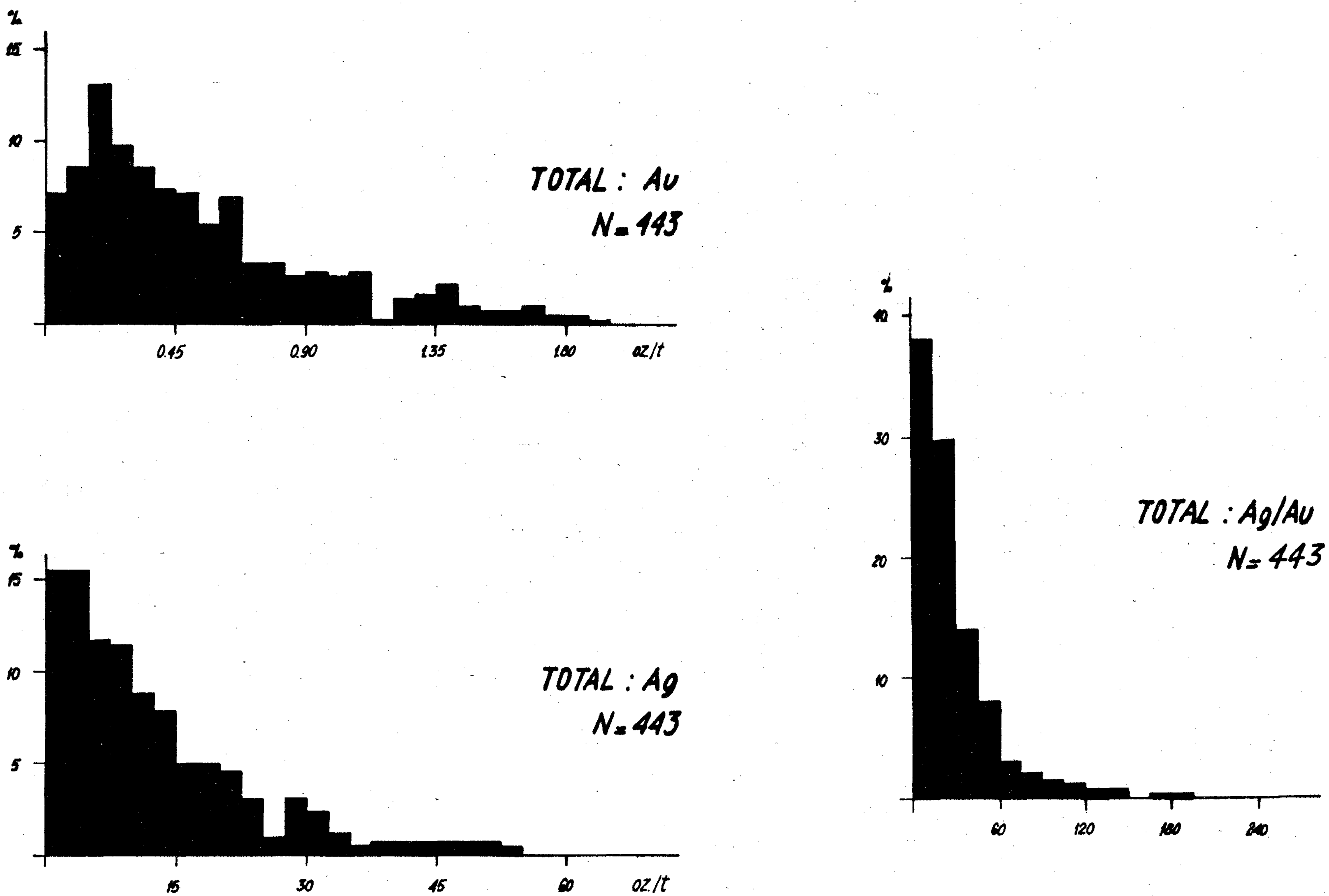
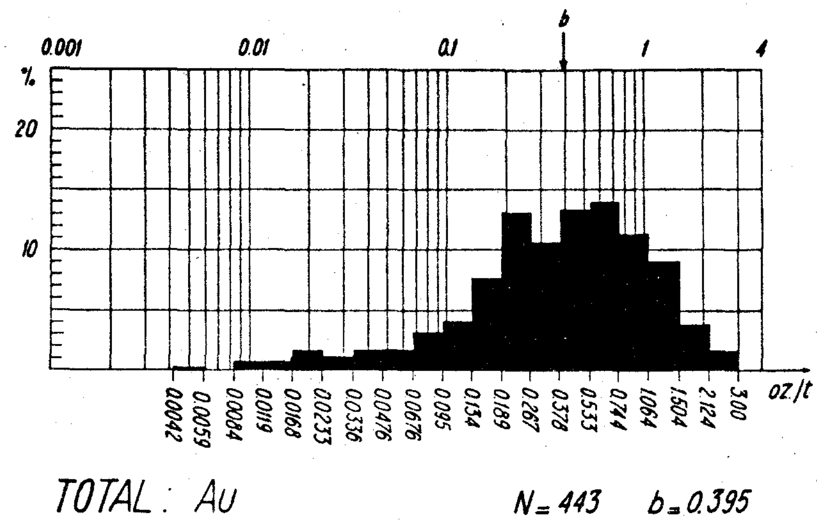
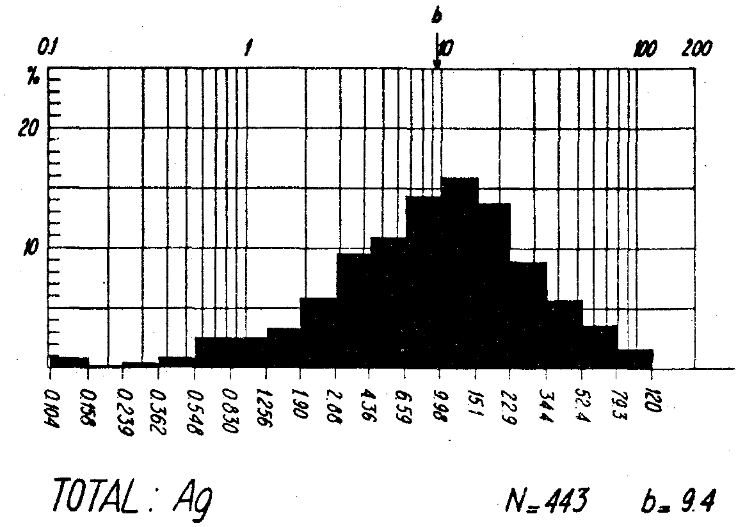


Fig. 1. Relative frequency histograms on arithmetic graph paper of all the investigated gold, silver, and Ag/Au values from the Mt. Nansen orebody





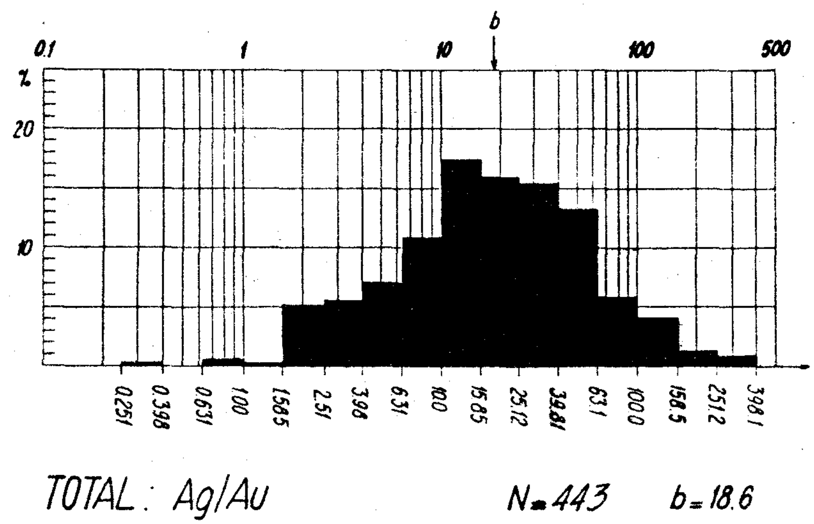


Fig. 2. Relative frequency histograms on logarithmic graph paper of all the investigated gold, silver, and Ag/Au values from the Mt. Nansen orebody

After determining the logarithmic intervals, the arithmetic class limits for gold, silver and Ag/Au were calculated and listed on tables and the histogram subsequently constructed on logarithmic-arithmetic graph paper (Fig.2). All the histograms on arithmetic-logarithmic paper indicate bell-shaped curves which - although for gold and silver displaying a weak negative skewness - approach lognormal distributions.

The fit of the distribution with a lognormal pattern can be checked graphically by plotting the cumulative frequency curve of the distribution on logarithmic probability paper. On such graph paper the cumulative frequency curve of a lognormal distribution has the form of a straight line. As can be seen on Figure 4 where the distributions are plotted on logarithmic probability paper, the points for Ag/Au fit extremely well a straight line. The line for silver is broken at about 80 per cent and the line for gold is broken twice at approximately 80 per cent and 20 per cent. Employing the graphical method given by Liozon (1961), a confidence check was carried out to test the hypothesis H_0 that the straight line or the respective segments in the case for silver and gold lie within the channel delineated by the 0.95 level of confidence. The confidence channels are inversely proportional to the size of the population considered, i.e. large population have a narrower channel than small populations. Actually, the Pearson's test should be employed to check that a distribution fits a lognormal pattern. This however is an involved operation and it is felt that the graphical method used is not only much faster but also accurate enough for the present type of study.

In this context, the following problems also had to be considered; at which value to start the cumulative frequencies and at which value to plot them, since on the probability scale the values for 0 per cent and 100 per cent are rejected. This means that the frequency value for 100 per cent cannot be plotted, the value for 0 per cent never occurs and therefore can be neglected. As low values possess a low precision the procedure of Lepeltier (1969) was followed and the frequency cumulated from the highest to the lowest values. The lowest class therefore corresponds with the frequency 100 per cent which, as discussed above, in the probability scale is rejected.

For plotting the cumulative frequencies the lower class limits were used. This allows to compare directly and without corrections curves constructed from different log.int. classes. Using the class centres for plotting the curves would have entailed an error of excess on the control tendency parameters (Lepeltier, 1969).

As earlier shown the main purpose for plotting the cumulative frequency curve for the various populations is to check how they fit lognormal distributions. In addition, the curves allow us to find graphically b-values (background) and s-values

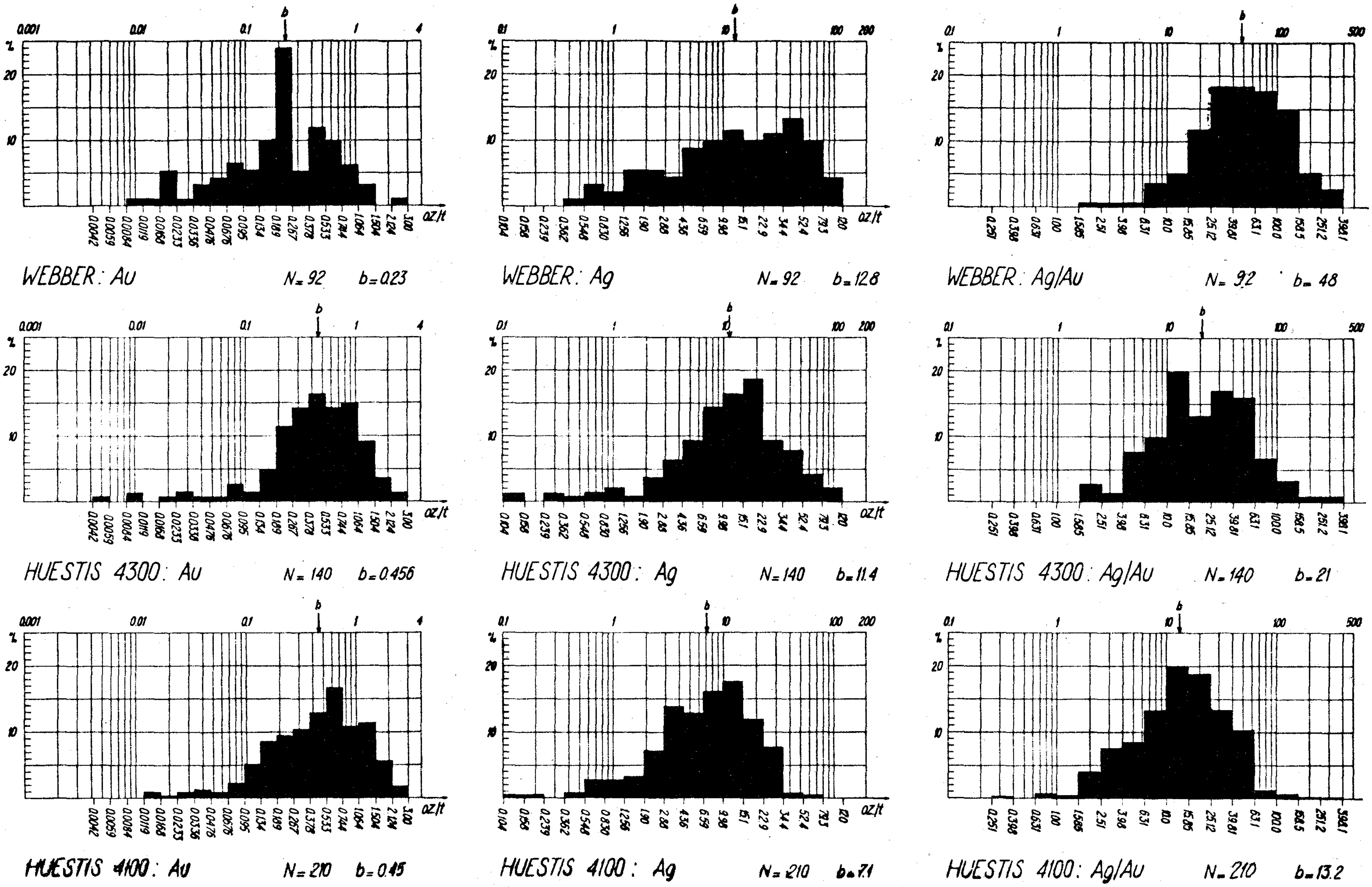
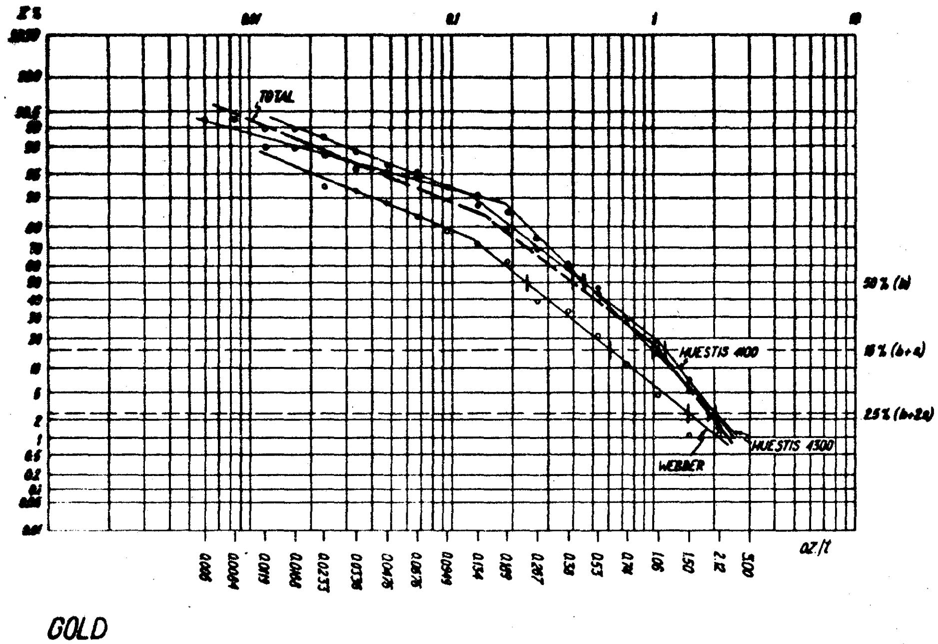
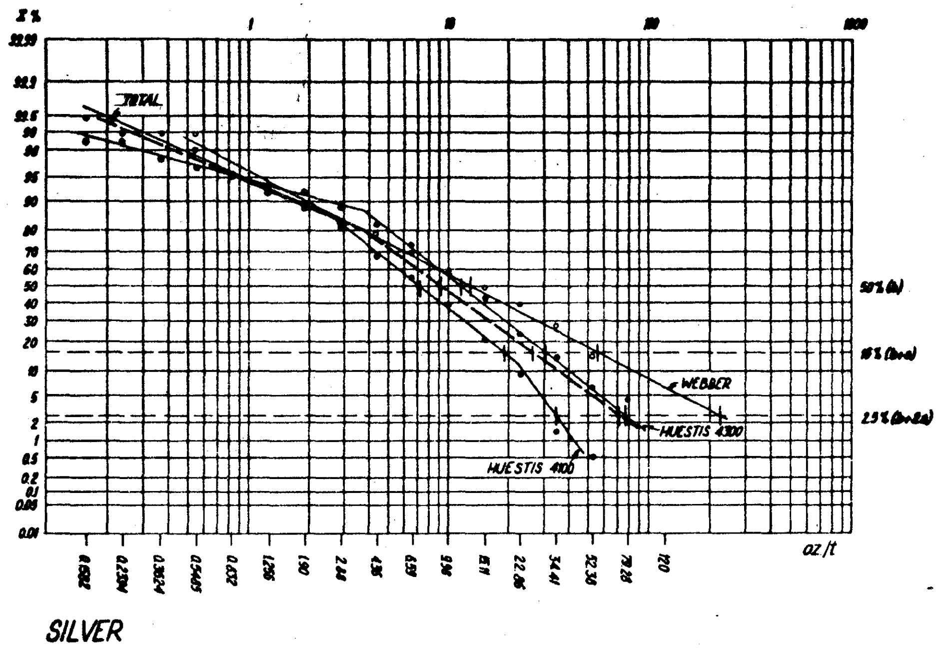


Fig. 3. Relative frequency histograms on logarithmic graph paper of the investigated gold, silver, and Ag/Au values from the individual sections of the Mt. Nansen orebody





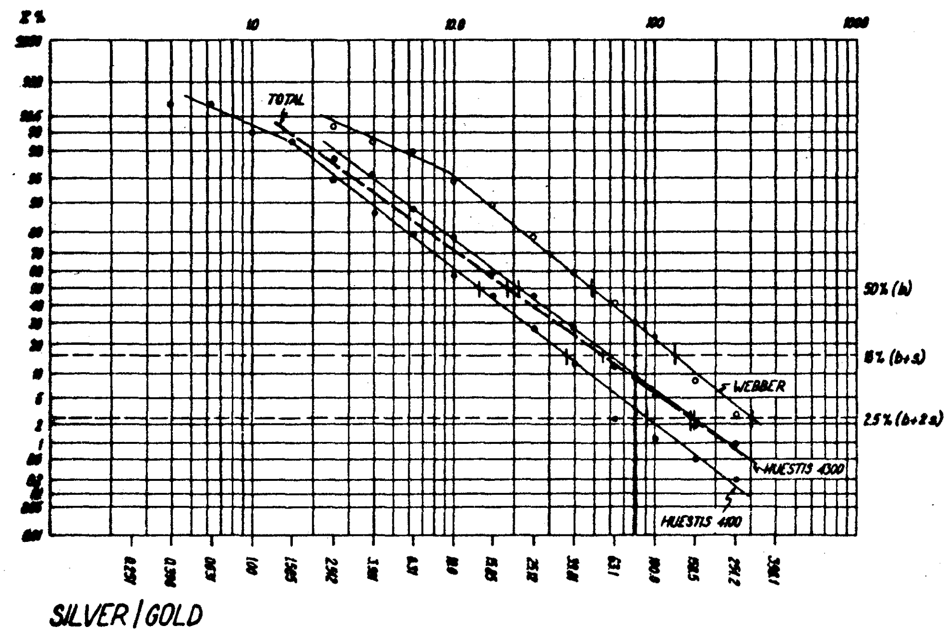


Fig. 4. Cumulative frequency distribution on logarithmic-probability paper of the gold, silver, and Ag/Au values from the three individual sections (——) and of the "total" (----) Mt. Nansen orebody.

- o Webber
- ● Huestis 4300
- ⊖ Huestis 4100

(standard deviation) of each particular distribution.

The b-value is given by the intersection of the cumulative frequency curve with the 50 per cent ordinate. In the case of a perfect lognormal distribution b corresponds with the mean, the mode (most frequent value), the median (halfway point of the readings when they have been arranged in order of size), and the geometric mean. As seen on Figure 2, none of the b-values coincide with the most frequent value class, this already is an indication that we do not deal with perfect lognormal distributions.

The s-values (standard deviation) are also obtained from the probability graph as the abscissa of the intersection of the cumulative frequency curve with the 16 per cent ordinate, since for a normal distribution b is the mean and 68.27 per cent of the population fall between b + s and b - s, i.e. one standard deviation on either side of the mean. Accordingly, 95.45 per cent of the points fall within b + 2s and b - 2s, and the value of b + 2s therefore is given at the intersection of the cumulative frequency curve with the 2.5 per cent ordinate. Since we deal with logarithms we have to consider the ratios and not the absolute values established:

In other words, the geometric deviation s' is calculated as follows:

for the upper limit:
$s' = (b + s) / b$ or $\log s' = \log (b+s) - \log b$

for the lower limit:
$s' = b / (b - s)$ or $\log s' = \log b - \log (b-s)$

Multiplying or dividing the background by the square of the geometric deviation gives for the same reason a range which includes 95.45% of the values or two standard deviations on either side of the mean (b + 2s), (b - 2s).

Since all reasoning is carried out on logarithms, the deviation has to be expressed by a logarithm $S = \log s'$ and is called the coefficient of deviation. The background b and the coefficient of deviation S are the two statistical parameters which define a lognormal distribution.

i) Gold

The relative frequency distribution on arithmetic-logarithmic graph paper for gold values obtained from Webber, Huestis 4100 and Huestis 4300 is shown on Figure 3. For all the three localities the distributions are bell-shaped and fit reasonably well lognormal populations, as indicated by the shape of the cumulative frequency curves on Figure 4.

The histogram clearly show the different gold contents found in the two sections of the Mount Nansen Mine. For the two Huestis levels the distributions are somewhat similar and possess identical b-values (see Table 2). In our case, where the distribution is not perfectly lognormal, b corresponds only with the median and thus is not identical with the mean, modus and geometric mean. Furthermore, Huestis 4300 and Huestis 4100 possess relatively similar mean values and coefficients of deviation. For Webber, the b-value as well as the mean are substantially lower, whereas the coefficient of deviation is identical to the one of the Huestis 4100 level (Table 2).

TABLE 2: Statistical parameters of gold, silver and Ag/Au values from the Mount Nansen ore-body.

	Gold				Silver				Ag/Au		
	$\bar{x}$ oz/t	b oz/t	s'	S	$\bar{x}$ oz/t	b oz/t	s'	S	b	s'	S
Huestis 4300	0.53	0.45	2.15	0.33	20.0	11.4	2.63	0.42	21.0	2.79	0.45
Huestis 4100	0.58	0.45	2.62	0.42	10.1	7.1	2.66	0.43	13.2	2.65	0.42
Webber	0.35	0.23	2.61	0.42	24.6	12.8	4.30	0.63	48.0	2.63	0.42

x: mean; b: background (median); s': geometric deviation;
S: coefficient of deviation.

The parameters indicate that the dispersion of the gold values is relatively constant within the Mount Nansen ore-body. However, a distinct difference in grade is apparent between the Huestis and the Webber mine, the ore from the latter carrying only about half the amount of the gold found in the Huestis ore. This corresponds well with the mineralogical observations where gold was detected only in extremely minute amounts in sections prepared from Webber ore. The ore-reserve calculations which indicate an overall grade of 0.25 oz/ton gold for Webber and 0.39 oz/ton gold for Huestis seem to agree with these observations.

The cumulative frequency curves for gold shown on Figure 4 also indicate the higher gold grade of the Huestis ore compared with the grade of the Webber ore. Both frequency lines of the Huestis ore coincide to a large extent and no actual trend along the dip of the vein could be observed in the Huestis mine. Interesting is the fact that all cumulative frequency curves display a negative break in the vicinity of the 0.15 oz/ton abscissa and 80 per cent ordinate (Figure 4). This break is also manifested by the distinctly negative skewness of the gold frequency distributions on Figure 3, which is caused by an excess of low values in essentially lognormal distributions. This almost regular behaviour of the gold values might be caused by the presence of 2 generations of gold in the Mount Nansen ore-deposit. Ore-microscopical observations revealed that the first generation occurs in the form of "true" gold inclusions in pyrite and arsenopyrite grains. They are relatively common but possess always extremely minute diameters and therefore contribute only subordinate amounts to the total gold present, even if their distribution is extensive. The second and younger gold generation is formed by relatively scarce but large aggregates

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of "free" gold which were emplaced late during the mineralization period of galena, freibergite and the hypogene sulphosalts. The "free" gold forms by nature of its occurence the bulk of the gold present in the ore although it is far less encountered than the small gold-inclusions of the first generation.

ii) Silver

All the frequency distributions of silver are bell-shaped and display a more or less pronounced negative skewness. For the two Huestis levels the fit with a lognormal distribution is worse than for gold which is distinctly revealed by the more complex cumulative frequency curves (Figure 3 and 4). The population of Webber, however, exhibits a much better fit and plots as straight line in the cumulative frequency distribution on Figure 4. The means and b-values for Webber and Huestis 4300 are relatively similar, whereas for Huestis 4100 the two parameters are only about half as large. The coefficients of deviation S are identical for the two Huestis levels and about 50 per cent larger for the Webber mine (Table 2).

For the Webber ore the mean-, b- and s'-values indicate a high but relatively inhomogeneous and strongly deviated silver content. The close fit with a lognormal distribution as revealed by the cumulative frequency curve indicates that the population is relatively homogeneous. From the mineralogical observations it can be deduced that the high silver content of the oxide Webber ore is primary and not caused by supergenic enrichments. That the alteration took place in situ without involving large transportation distances seems to be underlined by the almost ideal lognormal distribution of the silver values at Webber which indicate that the original (one generation?) pattern of the silver distribution is still preserved in the altered ore.

For the two Huestis levels the coefficients of deviation S of silver are identical, indicating the same degree of homogeneity throughout the developed portion of the mine. Webber on the other hand has a far greater coefficient of deviation and thus a worse homogeneity. The means and b-values obtained for the two Huestis levels, however, are vastly different. The 4300 level possesses for both variables much higher values which are relatively similar to the ones of Webber. The high silver-grade of the upper Huestis level cannot be explained by irregular silver enrichments in the upper portions of the veins, since mineralogical observations revealed no significant amounts of supergenic ore-minerals in this level. The identical coefficients of deviation found in the two Huestis levels seem to underline the mineralogical findings. The higher silver values encountered in the 4300 level therefore is regarded as a primary feature. In the Huestis mine a downdip decrease of the silver content has to be considered as probable if the observed gradient continues further downwards.

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The cumulative frequency curves for the two Huestis levels are relatively complex, both curves have a break in the vicinity of the 3 oz/ton abscissa and 85 per cent ordinate, a second break occurs in the Huestis 4100 curve at the 22 oz/ton abscissa and 10 per cent ordinate. The reason why the unaltered sulphides ore of the Huestis mine displays more complicated frequency curves than the strongly and variably altered Webber ore, which possesses a straight cumulative frequency line, is not understood. It might be explained as follows; in the Webber mine only one major period of silver mineralization took place, whereas in the Huestis mine two such periods occured, resulting in the negative break of the frequency curves at about 3 oz/ton. The excess of low values can possibly be attributed to an early generation of silver-bearing jamesonite which has been found in polished sections from Huestis ore, where jamesonite occurs as disseminated grains together with pyrite and arsenopyrite. In the Webber ore the early jamesonite generation seems to be missing.

iii) Ag/Au ratio

The ratio of the gold and silver values has been investigated in order to find out the variation of the two precious metals with respect to each other. The silver values were divided by the gold values to receive ratios larger than 1. All the Ag/Au ratios form bell-shaped curves which fit remarkably well lognormal distributions as can be seen from Figure 4, where all cumulative frequency curves plot as straight lines over a wide range of the frequency. The b-values of the distribution histograms (Table 2) demonstrate clearly the already discussed features i.e. highest relative silver grade in the Webber ore, and in the Huestis mine a trend indicating a relative decrease of the silver-content down-dip from the 4300 level to the 4100 level. S-values for the three distributions are almost identical which is also graphically demonstrated by the almost parallel development of the cumulative frequency lines in Figure 4. The 3 lines are parallel but displaced according to their Ag/Au ratios with Webber possessing the highest and Huestis 4100 the lowest values.

All the cumulative frequency curves for gold and for the two Huestis levels,also the cumulative frequency curves for silver possess negative breaks close to the 80 per cent ordinate. Accordingly, the 3 cumulative frequency curves of the Ag/Au ratios must plot as straight lines. This means that the excess of low silver values correspond with excesses of low gold values; or in other words, a relatively high correlation between gold and silver values must be assumed. This fact has been investigated in Figure 5 from which also the correlation coefficient r was obtained by using the graphical method given by Lepeltier (1969). The correlation coefficient r, gives a rigorous measure of the degree of dependency. It is found by constructing a correlation cloud in

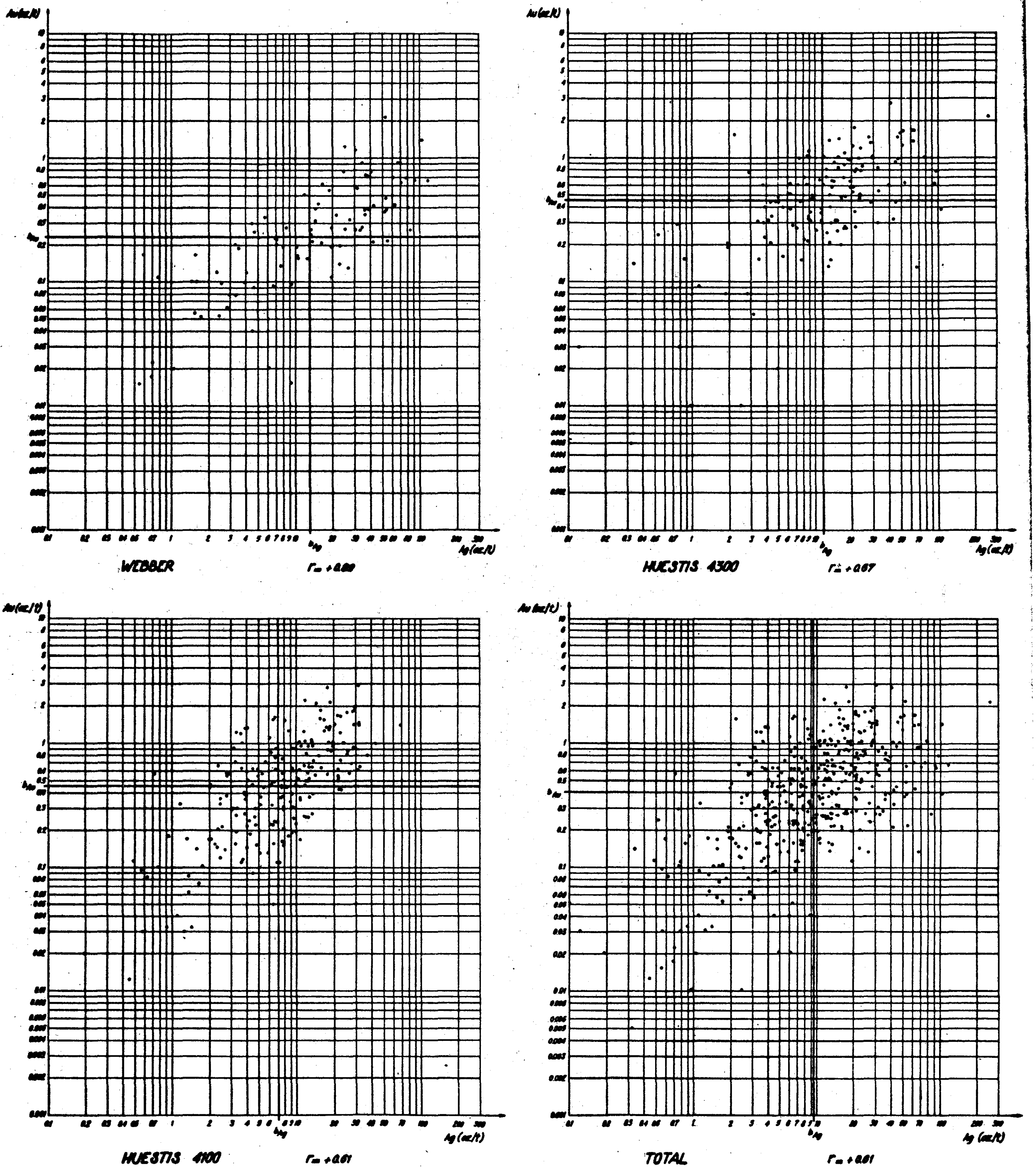

Fig. 5. Scatter diagrams of the investigated silver and gold values of the three individual sections and of the "total" Mt. Nansen orebody

full logarithmic coordinates, the cloud is then divided into four sections n_1, n_2, n_3, and n_4 by plotting the b-values of the two elements as abscissa and ordinate respectively. The number of points in each sector are counted and the coefficient of correlation calculated using the formula:

$$r = \sin \left[\frac{\pi}{2} \cdot \frac{N_1 - N_2}{N_1 + N_2} \right]$$

where N_1 = number of points in n_1 and n_3

N_2 = number of points in n_2 and n_4

The following correlations were obtained:

Webber	r = + 0.89
Huestis	r = + 0.61
Huestis	r = + 0.67
Total	r = + 0.61

All the correlation clouds have elleptical shapes with the main axes sloping + 45° (Fig.5). Since ± 1 represents perfect correlation and 0 no correlation, the correlation at Webber is much better than the one at Huestis which for both levels is almost identical. The high correlation of silver and gold found in the largely oxidized Webber ore can be considered a further indication that the chemical transport caused by the supergenic alteration of the ore occured only over small distances and that no secondary enrichment zones were formed. Primary features of the gold-silver distribution are therefore still reasonably well preserved.

5. SUMMARY AND RESULTS

The statistical analyses of the available assay data from the Mount Nansen ore has been treated separately for the Webber mine, consisting to a large extent of altered oxide ore and the two levels of the Huestis mine consisting of sulphide ore. The investigation revealed the following results:

A. The number of sample channels per face during exploratory or development drifting can safely be reduced from 2 to 1 channel without seriously influencing ore-reserve calculations or ore-shoot delineations, for the mean values of the upper and the lower channels deviate from their average usually only 5 to 10 per cent and in extreme cases never more than 20 per cent. Since horizontally the distribution of gold and silver seems to be far less homogeneous than vertically, an improvement of the results can possibly be obtained if the sample channels are spaced along the vein in 3 feet intervals instead of the 6 feet intervals used in the past.

B. From the analyses of the gold and silver distributions in the Webber and Huestis ore various observations made during ore-reserve calculations and mineralogical and geological investigations were confirmed.

a) Webber possesses the highest silver content followed by Huestis 4300 and 4100 (Table 2, Figure 3 and 4). The latter indicates the existence of a down-dip silver gradient from Huestis 4300 to 4100. If such a decrease continues to further depths is presently unknown.

b) The redistribution of silver during the supergenic alteration of the Webber ore occured only over extremely limited distances. The high correlation between gold and silver found in the Webber ore indicates that no supergenic enrichments took place and that the primary gold-silver distribution is still preserved to a large extent. It must therefore be assumed that originally the Webber ore carried more silver than the Huestis ore.

c) Huestis has a distinctly higher gold content than Webber with both Huestis levels having almost identical values (Table 2, Figures 3 and 4).

d) The absolute deviation of gold has in all cases been found to be smaller than that for silver indicating a less homogeneous distribution for the latter metal (Table 2).

e) The cumulative frequency curves of the silver and gold values and of the Ag/Au ratios indicate a relative high degree of dependency which was confirmed by the correlation analyses (Figures 4 and 5). A substantial genetical relationship of the two metals must therefore be considered.

f) The negative skewed distributions of gold (Figure 3) as well as the negative breaks in the cumulative frequency curves (Figure 4), indicate an excess of low gold values which possibly can be attributed to the first generation gold inclusions which occur within the first generation of pyrite and arsenopyrite as opposed to the second generation "free gold" which was emplaced during a relatively late stage of the mineralization and forms the bulk of the gold present.

g) The negative breaks observed for the silver cumulative frequency curves of the two Huestis levels (Figure 4) indicate that possibly two periods of silver mineralizations occured. A subordinate older phase during the emplacement of silver-bearing jamesonite and a younger main phase during the emplacement of freibergite, silver-bearing galena and the hypogene silver-bearing sulphosalts. For Webber the cumulative frequency curve for silver is a straight line indicating only significant period of silver mineralization (Figure 4).

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