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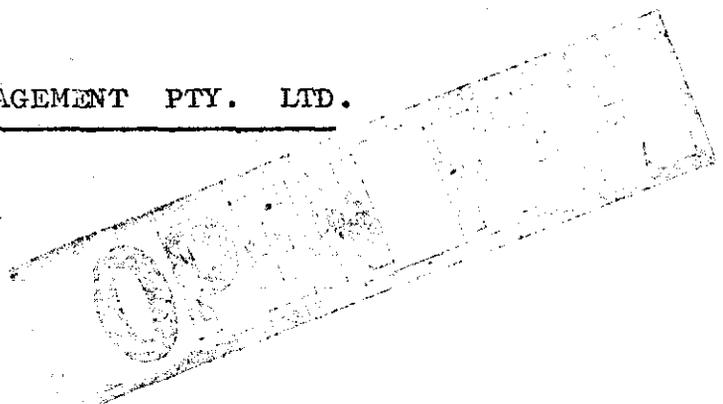
The Application of Statistical Analysis in
Mineral Evaluation, utilising data from Hall's
Lode, Lenses "A", "B" and "C",   Cleveland Mine
Tasmania

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C O N T E N T S

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1. ABSTRACT

The results of statistical analysis based on studies
of the frequency distributions of tin and copper assays
of the lode bands of Hall's Lode, Lenses "A", "B"
and "C" at Cleveland Mine are presented, and their
applications to mineral evaluation are discussed.

These analyses allow confidence limits to be placed
on the tin and copper ore-reserve grade estimates and
indicate the number of lode samples, and the approxi-
mate number of intersections required in an ore-body
in order that the mean grade may be estimated with a
known degree of reliability.

2. INTRODUCTION

In the evaluation of mineral bodies, whether one is
dealing with a completely virgin area, a new mineral
body within an area of known mineralisation, or an
extension of a known ore-body, geological and sample
data are collected with the object of obtaining
continually more accurate and reliable geological
interpretations and mineral grade and tonnage estimates.
With the availability of additional data, earlier
interpretations and estimates are continually modified
and/or extended until a stage is reached where
sufficient data has been obtained to satisfy the degree
of reliability required of such an interpretation and/
or estimate.   The reliability required will vary
considerably depending on the use to which the results
are to be put, be it a general interpretation and
mineral grade/tonnage estimate during an exploration
programme or, at the other end of the scale, detailed
stope-control and ore-reserve block grade/tonnage
estimates during mining operations.

The degree of reliability of a geological interpretation
may be expressed as poor, fair or good, depending on the
adequacy of the exposure/drilling pattern.   In dealing
with mineral grade estimates, however, the degree of
reliability of the mean grade may be expressed quantita-
tively subject to certain limitations by employing the
techniques of statistical analysis based on a study of
frequency distributions.   When sufficient data are
available, such analyses may be employed to estimate the
number of samples and the approximate number of inter-
sections required in a mineral body to compute the
average grade with selected fiducial intervals at
specified confidence levels.

This report presents the results, and evaluates the
applications of statistical analysis based on studies
of the frequency distributions of tin and copper assays
from the lode (sulphide) bands of Hall's Lode, Lenses
"A", "B" and "C" at Cleveland Mine, Tasmania.   These
three ore-bodies contain more than 80 percent of the
presently known ore reserve tonnage (viz. March 1966
estimates).

The reader is assumed to be familiar with the
geological setting and the sampling and drilling
investigations undertaken at Cleveland Mine to date or,
at least, to have access to the necessary information;
(see References 4, 6, 7 and 9).

3. **COMPUTATION OF ORE RESERVES BY THE
CROSS-SECTION / HORIZON PLAN METHOD**

The most commonly used methods of computing ore reserve
estimates (Reference No. 2) are the cross-section,
polygon and triangle methods. These methods allow the
grade and tonnage to be determined with acceptable
accuracy providing a sufficient number of intersections
are obtained. By employing the techniques of statis-
tical analysis in conjunction with one or more of these
three methods it is possible to determine the average
grade of a mineral deposit within a specified degree of
confidence.

The latest ore-reserve estimates at Cleveland Mine
(Reference No. 7) were computed by the cross-section/
horizon plan method, although the polygon and triangle
methods would also have been suitable. Split diamond
drill core, groove and channel samples (Reference 9)
were employed. A geological interpretation of the
drilling results, combined with surface and underground
mapping, was made (Reference 6) employing cross-sections
at approximately 120 ft. centres along strike and
horizon plans at 100 ft. vertical intervals. On a
longitudinal section showing all sample intersections,
each ore-body was divided up into a series of rectangular
blocks defined by the various cross-sections and
horizon plans. The tonnage of each block was calculated
as the product of the average width of the block, the
area on longitudinal projection and a constant density
factor. The grade of each block was determined by
weighting the grade of all intersections within the
block by their respective true widths. The average
ore reserve grade of a whole ore-body or lens was
determined by weighting the grades of all blocks by
their respective tonnages.

In the cross-section/horizon plan method of computing ore reserves an attempt is made to recognise differences in (1) true lode width and (2) areas of influence for each intersection, by weighting the results.   The method of selecting boundaries for each ore reserve block is, however, subject to personal judgement on the part of the individual undertaking the computations. The choice of different block boundaries will result in slightly different estimates.

In the case of Hall's Lode, Lens "A", for example, the ore reserve estimates by the cross-section/horizon plan method, as at March 1966 (Reference No. 7) were as follows :-

    Indicated Ore = 1,038,075 tons at 0.89% Sn, 0.31% Cu.
    Inferred Ore =   62,930 tons at 0.94% Sn, 0.34% Cu.
    Total Ore   = 1,101,005 tons at 0.90% Sn, 0.32% Cu.

This estimate includes interbanded chert horizons which form approximately 30 percent volume (or 25 percent weight) of the ore-body (Reference 5).   The chert horizons contain negligible tin and copper mineralisation (References 4 and 9) and the aggregate lode (sulphide) bands,   which form the remaining 75 per cent weight of the ore body would have a weighted average grade of 1.20% Sn and 0.43% Cu.

4. QUANTITATIVE STATISTICAL ANALYSIS

4a LIMITATIONS

By employing the techniques of quantitive statistical analysis, (References 1, 2 and 3), based on a study of the frequency distributions of tin and copper assays from lode (sulphide) bands, it is possible to compute fiducial intervals and confidence limits for the average grade of ore at selected confidence levels. Further, it is possible to estimate the number of lode samples, and the approximate number of lode inter-- sections, required in an ore body in order that the mean grade may be determined with a known degree of reliability.

However, these methods of statistical analysis have several limitations which must be constantly borne in mind when interpreting the results. The most important limitations are discussed below.

1. The reliability of the results can be stated mathematically only if RANDOM sampling data are employed. Random data are secured with non-random sampling of a random distribution, or random sampling of a non-random distribution. Random sampling requires that each item to be sampled have an equal chance with every other item of being selected in any sample. In practice most mineral evaluation sampling is done on a grid pattern with sampling design arranged to give each inter-section an equal "area of influence". The only thing random is the choosing of the initial reference plane and cross-section planes. Systematic sampling of this type may or may not yield random data, depending in particular on the presence of trend. At Cleveland Mine distinct trends exist as evidenced by the spatial distribution patterns for tin, copper and zinc grades (Reference 8). Also, the effects of steeply inclined ore-bodies and steep topographic relief preclude each intersection in an ore-body having an equal area of influence. It is not known, therefore, whether the sample data employed in this report are random data, and this limitation should be appreciated.

2. The samples should all be of equal volume, since it is recognised that sample size influences the magnitude of fluctuations of assays. In practice at Cleveland Mine this is difficult to obtain. Sample lengths vary considerably from 4 in. to 60 in. (see Appendices 2, 3 and 4) due to the complicated minor structures within the ore-body and the existence of two populations (viz, lode and chert bands) which, due to marked differences in physical nature and minerals content, had to be sampled separately. Furthermore, due to the effects of steeply dipping ore-bodies and steep topographic relief, the various drill intersections penetrate the ore-bodies at varying angles to the true dip. Thus equal sample lengths in different intersec-tions may represent unequal true widths.

To minimise the effects of unequal sample volumes to some extent, the majority of data employed in this report (see Appendices 2, 3 and 4) are from split diamond drill core samples, whereas in the ore-reserve calculations by the cross-section method a larger proportion of the samples used were from channel and groove cuts. The majority of the split-core samples are from AXT size drill holes. It is to be noted, however, that earlier

investigations (Reference 9) have shown a good degree of correlation between assays from samples of different sizes, (viz, groove and channel samples).

It would be opportune to state here that core recovery in the Cleveland ore-bodies has been excellent and little error would be introduced into the sample data from this source.

However, the problem of unequal sample lengths representing varying true widths cannot be overcome and constitutes a major limitation to the application of statistical techniques on the Cleveland sample data.

3. The sample population should be homogeneously distributed. The sample populations employed in this report (viz. tin and copper grades from the lode bands) are heterogeneously distributed within Lenses "A" and "B", displaying distinct spatial patterns, (Reference No. 8.). The same is probably true in the case of Lens "C" although lack of sufficient data at present precludes a detailed investigation. Such spatial distribution patterns are, of course, quite a common feature of mineral bodies, but they can introduce errors into the sample data, especially if the sample data is not random data. This limitation should be appreciated.

4. The analysed element should be present in only one mineral, under ideal conditions. At Cleveland Mine tin occurs essentially in the form of cassiterite, with only very minor amounts in the form of stannite. Also, copper occurs essentially in the form of chalcopyrite, with minor (and widespread spatially) amounts in the form of tetrahedrite, and only very minor amounts in the form of chalcocite and stannite. Errors introduced due to this source are, therefore, considered to be small.

5. Experimental errors, such as those involved in the physical tasks of sampling and sample preparation, and in assaying, all contribute to bias in sampling, that is they tend to produce an estimate that is different from the true value. Meticulous attention has been paid to sampling and sample preparation at Cleveland Mine (References 4 and 9) with a view to keeping such errors to the absolute practical limit.

6. If normal curve analysis techniques are to be applied the sample items should show an approximately 'normal' distribution. However, according to Hazen (Reference 2, p.54) "It is expected that population distributions are more nearly normal than sample distributions. For this reason normal-curve analysis is often employed to infer conditions of a population, even though the sample that represents the population is appreciably skewed".

The sample populations employed in this report (viz. tin and copper assays) are all positively skewed.

4b THE FREQUENCY DISTRIBUTION

A frequency distribution is a method of organising and summarising statistical data in which the various items of a sample population are classified into groups and the number of items falling into each group is stated. Thus a frequency distribution usually represents a sample population drawn from a much larger population and, although the sample population may contain only a few hundred items or less, it may be reasonably representative of the larger population from which it was drawn.

In this report the raw sample data given in Appendices 2, 3 and 4 have been arranged into seven frequency distributions (Appendix 1) as follows :-

1. Frequency Distribution No. 1 = 357 tin assays from 37 intersections of Lens "A", covering all ore reserve blocks (March 1966), and grouped in 0.20%Sn. grade intervals.

2. Frequency Distribution No. 1A = 156 tin assays from 16 intersections (early drill holes) of Lens "A", covering all ore reserve blocks (March 1966) and grouped in 0.2% Sn. grade intervals.

3. Frequency Distribution No. 2 = 277 copper assays from 31 intersections of Lens "A", covering all ore reserve blocks (March 1966) and grouped in 0.1% Cu. grade intervals.

4. Frequency Distribution No. 3 = 156 tin assays from 22 intersections of Lens "B", covering all the ore reserve blocks (March 1966) and grouped in 0.4% Sn. grade intervals.

5. Frequency Distribution No. 4 = 154 copper assays from 21 intersections of Lens "B", covering the same area as F.D. No. 3 and grouped in 0.1% Cu. grade intervals.

6. Frequency Distribution No. 5 = 92 tin assays from 18 intersections of Lens "C", covering an area a little in excess of all the ore-reserve blocks (March 1966) and grouped in 0.2% Sn. grade intervals - i.e. including block Nos. C7, C10, and C11 excluded from the ore reserve estimates.

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7. Frequency Distribution No. 6 = 73 copper assays from 13 intersections of Lens "C", covering the same area as F.D. No. 5 and grouped in 0.1% Cu. grade intervals.

These seven frequency distributions are shown diagrammatically as column diagrams in Figures 1 to 7. It should be noted that the raw data are the assays of the lode (sulphide) bands only.

4c. MEASURES OF CENTRAL TENDENCY

1. Arithmetic Mean

The arithmetic mean is the summation of all the items or numbers in a group divided by the number of items. For grouped data in a frequency distribution, the arithmetic mean is determined from the summation of the products of the midpoint of each grade interval and the frequency divided by the total number of items in the distribution, thus

$$ Ma \ = \ \frac{\Sigma(f \times mb)}{N} $$

The arithmetic mean is a calculated value and depends upon every item in the frequency distribution. The sum of the deviations about the arithmetic mean equals zero, and the sum of the squares of the deviations is less than those calculated about any other point.

One disadvantage of the arithmetic mean is that it is affected by extreme values. For example, the arithmetic mean of 1.45 for frequency distribution No . 3 may be misleadingly high due to 3 extreme assays (9.48, 12.40 and 18.4).

2. Median

The median is the value of the middle item of a number of items when the latter are arranged in order or according to size. It is an average of position and is affected by the number of items and not by the size of the individual items (e.g. extreme values). The median is calculated for grouped data in a frequency distribution from :-

MEDIAN= Lower limit of median G.I. +
$$ \frac{\left(\frac{N}{2} - \text{Cum. frequency of preceding G.I.}\right)}{\text{frequency of median G.I.}} \times G.I. $$

where G.I. = grade interval.

3. Mode

The mode is the most common or most frequently occurring value. It is an average of position and is independant of extreme values. The value of the mode will be that of the highest position on a frequency distribution curve if there is a sufficient number of items to **form** a smooth curve.

For grouped data in a frequency distribution, the mode is determined from :-

MODE=Lower limit of modal G.I. $+ \dfrac{D1}{D1+D2}$ x Grade Interval

Where D1 = frequency of modal grade interval minus frequency of proceeding grade interval, and D2 = frequency of modal grade interval minus frequency of next larger grade interval.

4. Effect of Skewness

For a symmetrical distribution the arithmetic mean, median and mode are identical. If the distribution is positively skewed, as is the case with frequency distribution Nos. 1-6, then the median is larger than the mode, and the arithmetic mean is larger than the median.

When skewness is not general but is due to a few items deviating a great deal from the mode, the median will only be slightly affected. The arithmetic mean, however, is affected by the value of every item in the series, and the **presence** of one or a few extremely high (or low) values in a series may result in a mean which is very misleading.

4d. MEASURES OF DISPERSION AND SKEWNESS

Measures of central tendency may have little value unless the amount of variation or dispersion of the data about these averages can be expressed quantitively.

Disperson of values about the measures of central tendency may be expressed in absolute terms (e.g. range and standard deviation) or in relative terms (e.g. coefficient of variation), independant of the units in which the raw sample data are expressed.

1. Range

The range is a simple measure of dispersion, the value of which depends on only two items - the lowest and highest - in a series. The difference between these two values gives some notion of the spread of data but can be misleading if the two values are irregular or unusual.

2. Standard Deviation

The standard deviation is the square root of the mean of the squares of the deviations about the arithmetic mean, thus :-

$$S = \sqrt{\frac{\sum d^2}{N}}$$

For grouped data in a frequency distribution, the standard deviation is determined from :-

$$S \sqrt{\frac{\sum fx(mp)^2}{N} - \frac{(\sum fxm)^2}{N}}$$

Where mp = mid point of each grade interval
     f = frequency of each grade interval
     N = total number of items in the distribution

The standard deviation is the most important measure of absolute disperson. It is one of the factors involved in the equation for the normal curve and for various skewed curves, and is used for testing for reliability and correlation. For a normal distribution 68.27 percent of all items are included in the range of $Ma \pm S$; 95.45 percent in the range $Ma \pm 2S$; and 99.73 percent in the range $Ma \pm 2S$ If the distribution is skewed these percentages will be only approximately realised.

3. Coefficient of Variation

The coefficient of variation is given by :-

$$V = \frac{S}{Ma}$$

Where S = standard deviation and Ma = arithmetic mean. The coefficient of variation is a measure of relative dispersion, and is used for comparing the dispersions of distributions having different mean values.

4. Pearsonian Measure of Skewness

A distribution which is asymmetrical is said to be skewed. Measures of skewness indicate the amount and also the direction. A series is said to be skewed in the direction of the extreme values. Thus positive skewness, or skewness to the right, indicates the extreme values are high.

The pearsonian measure of skewness is given by :-

$$Sk = \frac{3(Ma - Median)}{S}$$

This measure varies between the limits ± 3, but values as large as ± 1 are rather unusual (see Reference 1, p.228). The skewness of frequency distributions 1-6 is positive in all cases and varies between +0.560 and +1.010 (see Table 1).

4.e. FIDUCIAL INTERVAL AND CONFIDENCE LIMITS

Frequency distributions may be used to compute fiducial intervals and confidence limits about the arithmetic mean, at selected levels of confidence.

At the 95 percent confidence level, for example, we may state (assuming that the data are normally distributed) with only 5 chances in 100 of being incorrect, that the fiducial interval, or the interval between the confidence limits, covers the true arithmetic mean of the population.   The fiducial interval is determined from :-

$$F.I. = Ma \pm t_{0.05} \cdot S_{\bar{x}},$$

where Ma = arithmetic mean, $t_{0.05}$ is the "t" value for the 95 percent level of confidence and $S_{\bar{x}}$ is the standard error of the mean.   The standard error of the mean is given by :-

$$S_{\bar{x}} = \frac{S}{\sqrt{N}}$$

where S = standard deviation and N = total number of items in the distribution.   The formula for the standard error of the mean was originally derived for a normal distribution, but gives a good approximation when used with moderately skewed distributions

In mineral evaluation it is desirable to know the degree of reliability or confidence that may be placed in the estimate of the average grade, which is determined from the available sample analyses. To this end, computations have been undertaken in Appendix 1 to determine the fiducial interval at the 95 percent confidence level for frequency distributions 1-6.

The size of the fiducial interval may be decreased by decreasing the standard deviation or increasing the number of samples.   Reduction of the standard deviation (which is a function of the ore-body, combined with the physical acts of drilling, sampling, sample preparation and assaying) will become

insignificant after a reasonable number of holes has been drilled in an ore-body. Beyond this point the fiducial interval may be reduced by additional drilling and sampling, but here it is reduced solely on the basis of the increase in the total number of sample analyses and not by any reduction in the standard deviation.

To illustrate this point we may compare frequency distributions 1 and 1A for tin assays from the total ore-reserve blocks in Lens "A". Frequency distribution No. 1A contains 156 assays from 16 early (pre-1964) diamond drill holes. Frequency distribution No. 1 contains 357 assays from 37 drill hole inter-sections (as at March 1966). The additional data was obtained from underground pattern drilling on the RL. 1300 ft. horizon and from some deep drilling on "Qa" section. Frequency distributions 1A and 1 have arithmetic means of 1.12 and 1.14 respectively and similar standard deviations 0.77 and 0.75 respectively. More than doubling the number of samples and inter-sections has had little effect on the arithmetic mean and standard deviation, therefore. However, it has had the effect of reducing the fiducial interval from $\pm$ 0.12 to $\pm$ 0.08 (see Table 1).

4f. NUMBER OF LODE SAMPLE ANALYSES REQUIRED FOR SELECTED FIDUCIAL INTERVALS

The number of lode sample analyses required for selected fiducial intervals at a 95 percent confidence level may be determined from frequency distributions 1-6, (see Appendix 1).

The required value of $(S^1_{\bar{x}})$ may be determined as the arithmetic mean, Ma, and $t_{0.05}$ remain the same. Thus :-

$$S^1_{\bar{x}} = \frac{F.I.}{t_{0.05}}$$

If it is assumed that the same standard deviation will prevail, then from $S^1_{\bar{x}} = \frac{S}{\sqrt{N}}$ it is possible to

determine the number of analyses, (N^1), required.

Obviously the standard deviation will change, such
that it will be larger for smaller numbers of sample
analyses. Such changes should not be great, however,
as evidenced by frequency distribution Nos. 1 and 1A
which have standard deviations of 0.75 and 0.77 for
357 and 156 samples respectively, (see Table 1).

4g. NUMBER OF LODE INTERSECTIONS REQUIRED FOR SELECTED FIDUCIAL INTERVALS

The number of lode intersections, N_I required for
selected fiducial intervals at a 95 percent confidence
level may be determined approximately by dividing the
number of samples required, N^1 by the average number
of samples per intersection. In the case of frequency
distribution No. 1, for example, $N_I = \dfrac{N^1}{10}$ as there are
357 lode samples from 37 drill hole intersections or
approximately 10 samples per intersection.

4h. SAMPLING GRIDS REQUIRED FOR SELECTED FIDUCIAL INTERVALS

In mineral evaluation it is common practice to drill
or sample a mineral body on a systematic grid. In
this respect it is particularly instructive to ascertain
the number of intersections that would be obtained from
Hall's Lode, Lenses "A", "B" and "C", (employing the
same ore-body dimensions as used in the various
frequency distributions, Nos. 1-6) by employing various
sampling grids. Six grids have been chosen with the
following details :-

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Grid No. 1 = 100 ft x 100 ft. rectangular grid
Grid No. 2 =  50 ft x  50 ft. rectangular grid
Grid No. 3 = cross-sections at 60 ft centres x 50 ft
                          vertical intervals
Grid No. 4 = cross-sections at 120 ft centres x 100 ft
                          vertical intervals
Grid No. 5 = 150 ft x 150 ft. rectangular grid
Grid No. 6 = 200 ft x 200 ft. rectangular grid.
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The number of intersections within each of the three
ore-bodies, Lenses "A", "B" and "C", from these six
sampling grids is given in Tables 2, 3 and 4 res-
pectively. From a study of the respective frequency
distributions in Appendix 1, the probable fiducial
intervals for tin and copper grade may be determined

at the 95 percent confidence level, for the number of intersections given by each of the six sampling grids.

4i. SUMMARY

Frequency distributions have been set up for the tin and copper assays of the lode (sulphide) bands obtained from diamond drill hole, and a few groove and channel samples of Hall's Lode, Lenses "A", "B" and "C". **The** raw data are presented in Appendices 2, 3 and 4 respectively. The frequency distributions, together with computations (based on normal curve analysis) for arithmetic mean, median, mode, standard deviation, standard error of the mean, coefficient of variation, Pearsonian measure of skewness, fiducial interval at a 95 percent confidence level and number of lode samples and intersections required (at a 95 percent confidence level) for selected fiducial intervals are presented in Appendix 1.

Table 1 presents a summary of the results of these statistical analyses and Tables 2, 3 and 4 present a summary of the fiducial intervals expected from various sampling grids (at the 95 percent confidence level) for Lenses "A", "B" and "C" respectively.

5. APPLICATIONS OF STATISTICAL ANALYSIS TO MINERAL EVALUATION

The studies embodied in this report have been undertaken with the object of applying the results to mineral evaluations during the exploration, developmental and mining stages at Cleveland Mine.

In mineral evaluation studies it is desirable to ascertain :-

1. the average grade of deposit with the greatest possible degree of accuracy consistent with a practical limitation on budget expenditure, and

2. the number of samples required to determine the average grade of a deposit with a pre-determined degree of confidence.

The applications of the results to ore-reserve
computations and the design of suitable sampling
grids are considered in this section.

5a. ORE-RESERVE COMPUTATIONS

It is desirable that the normal weighted methods of
ore-reserve computations by the cross-section, polygon
or triangle methods be supplemented by a statistical
analysis of the sampling data.   Such an approach
provides the only practical method of ascertaining the
degree of relaibility or confidence that may be placed
in the average grade of a deposit.

In the case of Hall's Lode, Lens "A", for example, the
total indicated and inferred ore at March 1966
(Reference 7), as determined by the cross-section/
horizon plan method employing split core, channel and
groove samples, was 1,101,005 tons with an average
grade of 0.90% Sn. and 0.32% Cu.   Allowing for a chert
(mullock material containing negligible mineralisation)
content of approximately 25 percent by weight, the
average grade of the lode bands within the ore-body
would be 1.20% Sn. and 0.43% Cu. (see Section 3 of
this Report).

From a statistical analysis based on a study of
frequency distributions Nos. 1 and 2 (which cover an
area of the ore-body identical to that included in
the ore-reserve blocks of March 1966, but which
employ split core samples almost exclusively) the
average grade of the lode (sulphide) bands is 1.14
$\pm$ 0.08% Sn. and 0.46 $\pm$ 0.04% Cu. at a 95 percent
confidence level.   The 95 percent confidence limits
(see Table 1) are, therefore, 1.06 to 1.22% Sn. and
0.42 to 0.50% Cu.

It is opportune to mention again the limitations of
the statistical methods.   In spite of these,
particularly the unequal sample lengths and the
marked positive skewness of the distributions, there
is a reasonable degree of agreement between the

average grade as determined by the two methods.
The fiducial intervals of $\pm$ 0.08% Sn, $\pm$ 0.04% Cu. for
Lens "A", $\pm$ 0.35% Sn, $\pm$ 0.11% Cu. for Lens "B" and
$\pm$ 0.20% Sn, $\pm$ 0.25% Cu. for Lens "C" give, therefore,
measures of confidence for the average tin and copper
grades of the lode bands occurring within the combined
indicated and inferred ore-reserve blocks[*] of these
lenses.

5b. SAMPLING GRID DESIGN

In the evaluation of mineral bodies it is desirable to
know when sufficient sample data have been obtained
for the average grade of the deposit to be determined
with a specified degree of confidence.   When a stage
is reached in the drilling and sampling where the
standard deviation is no longer reduced by the addition
of more intersections, then the average grade has been
estimated within practical limits of accuracy for the
methods being used.   Additional drilling and sampling
beyond this point during exploration would be a waste
of funds from the point of view of grade estimation,
and should be undertaken only if geological conditions
(such as structiral complexities, for example) and/or
mining requirements warrant it.

The number of sample analyses, and therefore, the
approximate number of intersections, required in a
mineral body for the average grade to be estimated
within selected fiducial intervals at given confidence
levels may be determined from statistical analysis.
In the exploration stage, for example, relatively large
fiducial intervals may be acceptable whereas during
mining operations, on the other hand, smaller fiducial
intervals are likely to be required.   In both cases a
sampling grid can be designed to obtain the necessary
number of sample analyses to satisfy the individual
requirements.

[*]   See Section 4b for details of ore-reserve blocks
     covered by the various frequency distributions.

The reliability of these estimates may be checked in
the case of the tin assays for Lens "A". From
frequency distribution No. 1, which employs 357
samples, it was estimated (Appendix 1, Section 1-7c)
that if only 150 samples were taken (from approximately
15 intersections) the fiducial interval at the 95 per-
cent confidence level would be $\pm$ 0.12% Sn. Frequency
distribution No. 1A has been set up using 156 samples
from 16 early intersections. The arithmetic mean
and standard deviation are similar to those of frequency
distribution No. 1, and the fiducial interval is $\pm$0.12% Sn
(see Table 1).

In considering various sampling grid designs for
Cleveland Mine, the selection of the most suitable grid
for the various phases of exploration, development and
mining must be governed by the degree of reliability
required of the tin grade, rather than the copper
grade. In the exploration phase it is considered that
a fiducial interval of the order $\pm$ 0.15 to 0.20 % Sn.
would be acceptable for an ore-body with a mean grade
of 1.00% Sn. For a higher grade ore-body, say 1.50%
Sn. then a larger fiducial interval of the order
$\pm$ 0.40% Sn. would likewise be acceptable. Referring
to Tables 2, 3 and 4, we may conclude that sampling
grid Nos. 5 and 6 (i.e. 150 ft.x 150 ft. and 200 ft.
x 200 ft. rectangular grids respectively) satisfy these
requirements for Lenses "A", "B" and "C".

In actual mining operations a smaller fiducial
interval is usually demanded by the mining, mineral
dressing and geological departments. Again for an
ore-body with a mean grade of 1.00% Sn. or 1.50% Sn,
fiducial intervals of the order $\pm$ 0.05 to 0.10%Sn.
and $\pm$ 0.07 to 0.15% Sn. respectively would be accep-
table. Referring to Tables 2, 3 and 4 we may
conclude that sampling grid No. 3 (cross-sections
at 60 ft. centres x 50 ft. vertical intervals)
satisfies these requirements for Lenses "A", "B" and
"C". Actually sampling grid No. 4 (cross-sections

at 120 ft. centres x 100 ft. vertical intervals would
satisfy these requirements in the case of Lens "A"
but not for Lenses "B" and "C".

It is opportune to point out here that sampling grid
design is influenced by geological factors, such as
structural complexities and mining requirements, such
as stope control, in addition to those related to
grade estimation.   In most instances at Cleveland
Mine, certainly in the ground investigated in this
report, sampling grids Nos. 5 or 6 and No. 3 would
satisfy the geological requirements of such grids.
For mining purposes grid No. 3 would provide the ideal
amount of sampling and geological data to allow
effective and reliable stope control and sample data
trend analysis, (see Reference 8).   In fact, an
analysis of the spatial distribution patterns of
various populations of sample values, (such as
overall lode tin and copper grade, overall lode
width and bulk percentage chert and aggregate sulphide
bands tin and copper grade) for each ore-body based on
sampling grid No. 3 would provide invaluable data for
accurate and reliable estimations, allowing stope
control and grade control to be planned in advance.

6. CONCLUSIONS

Statistical analysis based on a study of frequency distributions of the tin and copper assay populations of the lode (sulphide) bands within the ore-bodies at Cleveland Mine provides, subject to certain limitations :-

(1) The only method of applying quantitive fiducial intervals for the average grade of ore. Because of these limitations this method should be used in conjunction with other weighting methods of ore-reserve computation (such as the cross-section, polygon and triangle methods). The average grade of the lode bands in the indicated and inferred ore-reserve blocks of March 1966 in Lenses "A", "B" and "C" are computed as $1.14 \pm 0.08\%$ Sn, and $0.46 \pm 0.04\%$ Cu ; $1.45 \pm 0.35\%$ Sn and $0.62 \pm 0.11\%$ Cu ; and $0.91 \pm 0.20\%$ Sn and $0.64 \pm 0.25\%$ Cu. respectively.

(2) A method of calculating the number of sample assays, and, therefore, the approximate number of intersections required in each ore-body for selected fiducial intervals, about the arithmetic mean, at given levels of confidence. This allows the design of sampling grids to meet the requirements of grade estimation during exploration, development and mining operations. For exploration purposes a 150 ft. x 150 ft. or 200 ft. x 200 ft. rectangular grid is considered adequate for grade estimation purposes. For mining operations a rectangular grid with cross-sections at 60 ft. centres x 50 ft. vertical intervals is considered adequate for all mining, milling, geological and grade estimation purposes.

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8. TABLES

TABLE NO. 1

CONSOLIDATED STATISTICAL RESULTS FROM FREQUENCY
DISTRIBUTION NOS. 1-6

Frequency Distribution	1	1A	2	3	4	5	6
No. of Samples N	357	156	277	156	154	92	73
No. of Inter-sections N_I	37	16	31	22	21	18	13
Arithmetic Mean, Ma	1.14	1.12	0.46	1.45	0.62	0.91	0.64
Median	1.00	0.96	0.37	0.76	0.41	0.58	0.38
Mode	0.89	0.89	0.39	Not Determined	0.32	0.14	0.27
Standard Deviation, S	0.75	0.77	0.37	2.24	0.70	0.98	1.07
Standard Error of Mean, $S_{\bar{x}}$	0.0397	0.0616	0.0222	0.0179	0.0566	0.1022	0.1253
Pearsonian Measure of Skewness	+0.560	+0.623	+0.730	+0.924	+0.900	+1.010	+0.729
F.I. at t0.05	$\pm$0.08	$\pm$0.12	$\pm$0.04	$\pm$0.35	$\pm$0.11	$\pm$0.20	$\pm$0.25
Confidence Limits at t0.05	1.06 to 1.22	1.00 to 1.24	0.42 to 0.50	1.10 to 1.80	0.51 to 0.73	0.71 to 1.11	0.39 to 0.89
Coefficient of Variation, V	0.658	0.688	0.804	1.545	1.129	1.077	1.672

TABLE NO. 2

HALL'S LODE, LENS "A" – FIDUCIAL INTERVALS FOR SAMPLING GRIDS

1. The six sampling grids for Lens "A" cover the known extent of the ore-body as at March 1966. This is approximately a rectangular area between cross-sections "G" and "V" inclusive, and between RL. 1,000 ft. and 1,500 ft. inclusive (strike length = 1,200 ft. vertical height = 500 ft). This area is covered by ore-reserve block Nos. A1 to A26 inclusive (Reference No.7), and by frequency distribution Nos. 1 and 2.

2.

Grid No.	Dimensions of Sampling Grid	No. of Grid Inter- sections	F. I. %Sn.	F. I. %Cu.
1	100 ft.x 100 ft.rectangular grid, giving (13x6)= 78 intersections	78	± 0.06	± 0.03
2	50 ft.x 50 ft. rectangular grid, giving (25x11)= 275 intersections	275	± 0.03	± 0.02
3	19 cross-sections(@ 60'centres) by 50 ft. vertical intervals, giving (19x11)= 209 intersections	209	± 0.04	± 0.02
4	9 cross-sections (@120'centres) by 100 ft. vertical intervals, giving (9x6) = 54 intersections	54	± 0.07	± 0.04
5	150 ft.x150 ft. rectangular grid, giving (9x4)= 36 intersections	36	± 0.08	± 0.04
6	200 ft.x200 ft. rectangular grid, giving (7x3)= 21 intersections	21	± 0.11	± 0.06

3. Ma = 1.14% Sn. and 0.46% Cu.

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TABLE NO. 3

HALL'S LODE, LENS "B" – FIDUCIAL INTERVALS FOR SAMPLING GRIDS

1. The six sampling grids for Lens "B" cover most of the
    known extent of the ore-body as at March 1966.   This
    is approximately a rectangular area between cross-sections
    "L" and "V" inclusive, and between RL. 800 and 1,400 ft.
    inclusive, (strike length = 800 ft. vertical height =
    600 ft.).   This area approximates to that covered by
    frequency distribution Nos. 3 and 4.   This latter includes
    ore-reserve block Nos. B3 to B8, B11, B13 to B18 and
    B21 to B23 inclusive (see Reference No. 7).

2.

Grid No.	Dimensions of Sampling Grid	No. of Grid Inter- sections	F. I.	
			%Sn.	%Cu.
1	100 ft.x 100 ft. rectangular grid, giving (9x7)= 63 intersections	63	$\pm$0.21	$\pm$0.07
2	50 ft.x 50 ft. rectangular grid/giving, (17x13)= 221 intersections	221	$\pm$0.12	$\pm$0.04
3	13 cross-sections (@ 60'centres) by 50 ft.vertical intervals, giving (13x13)= 169 intersections	169	$\pm$0.13	$\pm$0.04
4	7 cross-sections (@ 120'centres) by 100 ft.vertical intervals = (7x7)= 49 intersections	49	$\pm$0.24	$\pm$0.08
5	150ft.x 150 ft.rectangular grid, giving (6x5)= 30 intersections	30	$\pm$0.30	$\pm$0.10
6	200 ft.x 200 ft. rectangular grid, giving (5x4) = 20 intersections	20	$\pm$0.37	$\pm$0.12

3. Ma = 1.45% Sn. and 0.62% Cu.

170027

TABLE NO. 4

HALL'S LODE, LENSE "C" – FIDUCIAL INTERVALS FOR SAMPLING GRIDS

1. The six sampling grids for Lens "C" cover most of the known extent of the ore-body as at March 1966. This is approximately a rectangular area between cross-sections "H" and "W" inclusive, and between RL. 900 ft. and 1,300 ft. inclusive, (strike length = 1,300 ft. vertical height = 400 ft.). This area approximates to that covered by frequency distribution Nos. 5 and 6. This latter includes ore-reserve block Nos. C1 to C18 inclusive. Inferred ore-reserves at March 1966 (see Reference 7) includes block C1-C18, excluding C7, C10 and C11.

2.

Grid No.	Dimensions of Sampling Grid	No. of Grid Inter-sections	F. I. %Sn.	%Cu.
1	100 ft.x 100 ft.grid (rectangular) giving (14x5)= 70 intersections	70	$\pm$0.11	$\pm$0.11
2	50 ft.x 50 ft. rectangular grid, giving (27x9)=243 intersections	243	$\pm$0.06	$\pm$0.06
3	20 cross-sections (@60ft.centres) x 50 ft.vertical intervals, giving (20x9)= 180 intersections	180	$\pm$0.07	$\pm$0.07
4	10 cross-sections (@ 120ft.centres) x 50 ft. vertical intervals giving (10x5)= 50 intersections	50	$\pm$0.12	$\pm$0.13
5	150 ft.x150 ft. rectangular grid, giving (9x3)= 27 intersections	27	$\pm$0.17	$\pm$0.17
6	200 ft.x 200 ft. rectangular grid, giving (7x3)= 21 intersections	21	$\pm$0.19	$\pm$0.20

3. Ma = 0.91% Sn. and 0.64% Cu.

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9. FIGURES

170029

26A

CAPTIONS FOR FIGURES 1-4

(A) Figure 1. Column diagram of frequency distribution
     No. 1.   357 tin assays from 37 intersections of
     Lens "A", covering all ore reserve blocks
     (March 1966), and grouped in 0.20% Sn. grade intervals.

(B) Figure 2. Column diagram of frequency distribution
     No. 1A.   156 tin assays from 16 early D.D.H.
     intersections of Lens "A", covering all ore reserve
     blocks (March 1966) and grouped in 0.20% Sn. grade
     intervals.

(C) Figure 3. Column diagram of frequency distribution
     No. 3.   156 tin assays from 22 intersections of
     Lens "B", covering all ore reserve blocks (March 1966)
     and grouped in 0.40% Sn. grade intervals.

(D) Figure 4. Column diagram of frequency distribution
     No. 5.   92 tin assays from 18 intersections of
     Lens "C", covering an area a little in excess of all
     the ore reserve blocks (March 1966) and grouped in
     0.20% Sn. grade intervals.

(A)

(B)

(C)

(D)

5 cm

170030

26B
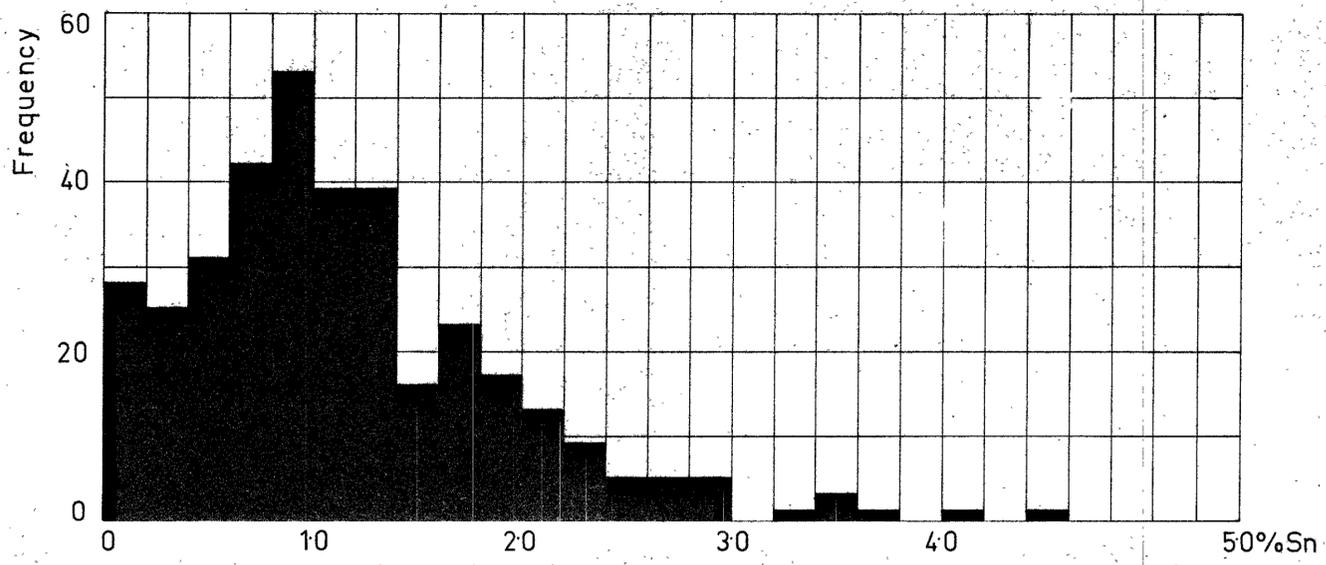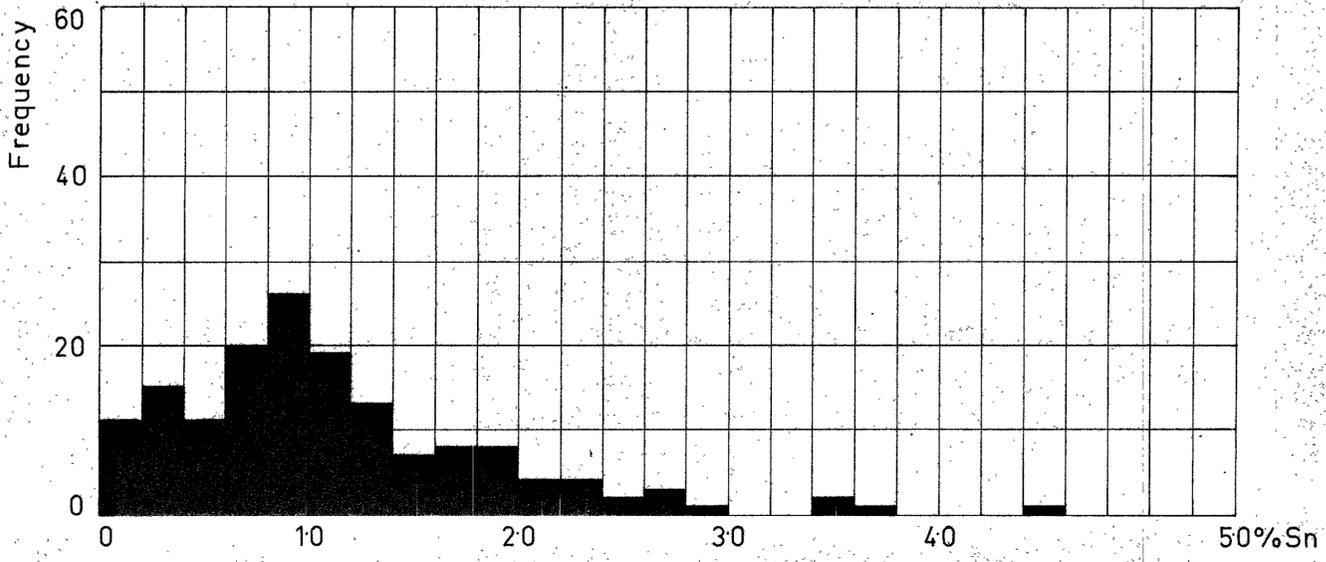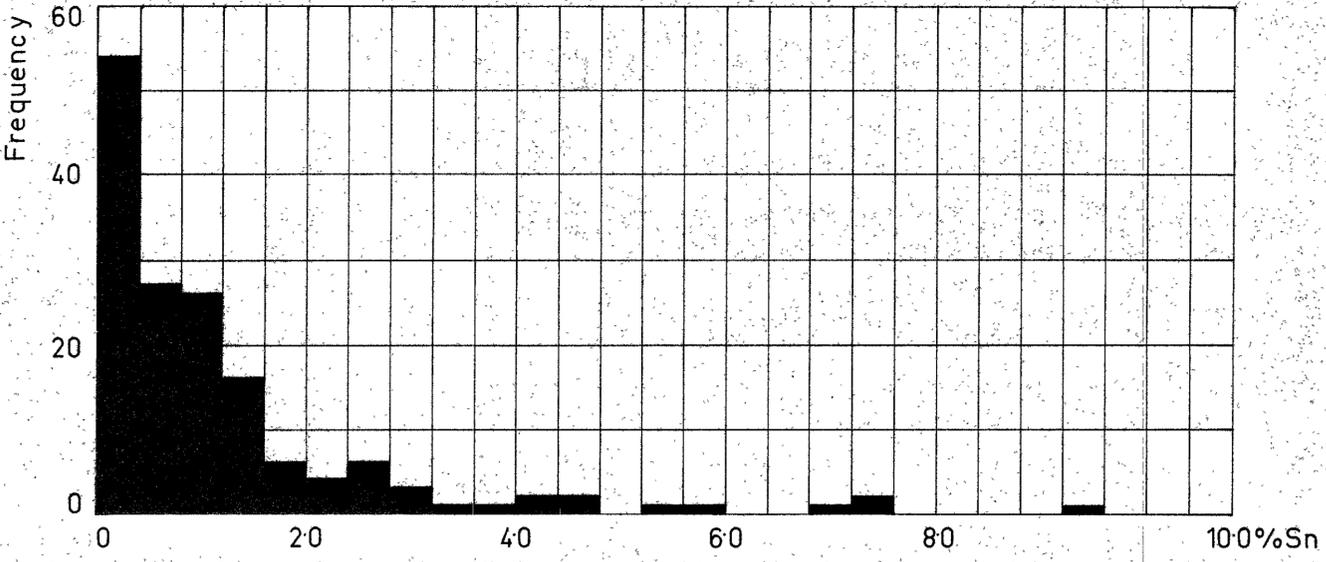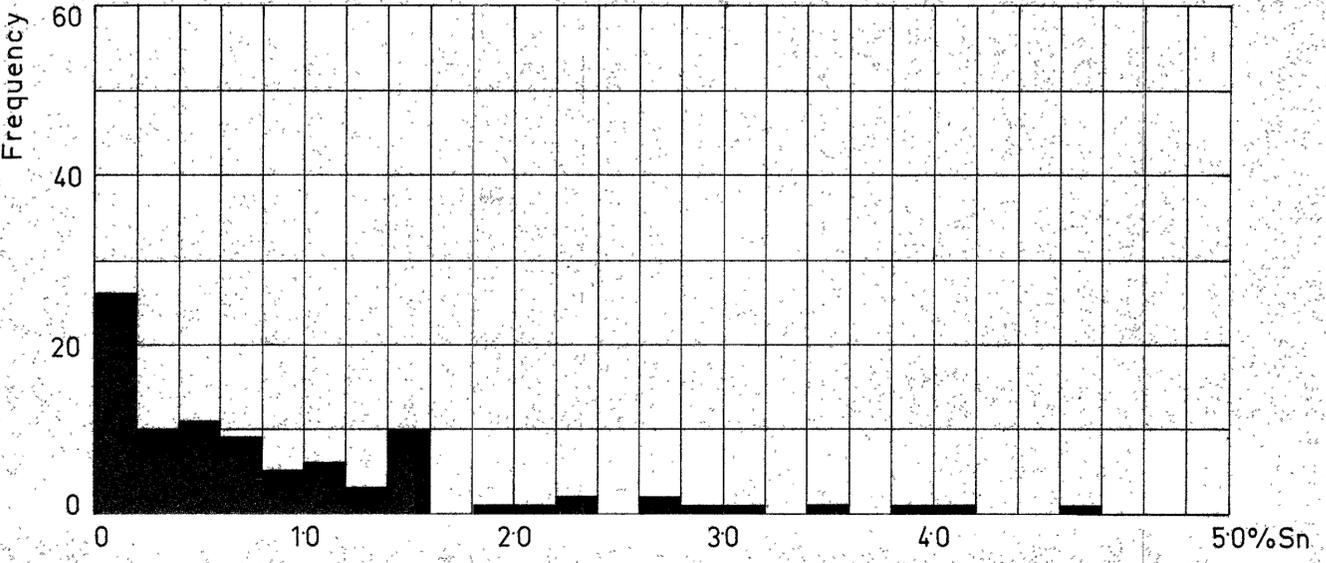
CAPTIONS FOR FIGURES 5-7

(A)   Figure 5.   Column diagram of frequency distribution
      No. 2.   277 copper assays from 31 intersections of
      Lens "A", covering all ore reserve blocks (March 1966)
      and grouped in 0.10% Cu. grade intervals.

(B)   Figure 6. Column diagram of frequency distribution
      No. 4.   154 copper assays from 21 intersections of
      Lens "B", covering all ore reserve blocks (March
      1966) and grouped in 0.10% Cu. grade intervals.

(C)   Figure 7.   Column diagram of frequency distribution
      No. 6.   73 copper assays from 13 intersections of
      Lens "C", covering the same area as frequency
      distribution No. 5 and grouped in 0.10% Cu. grade
      intervals.
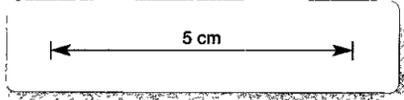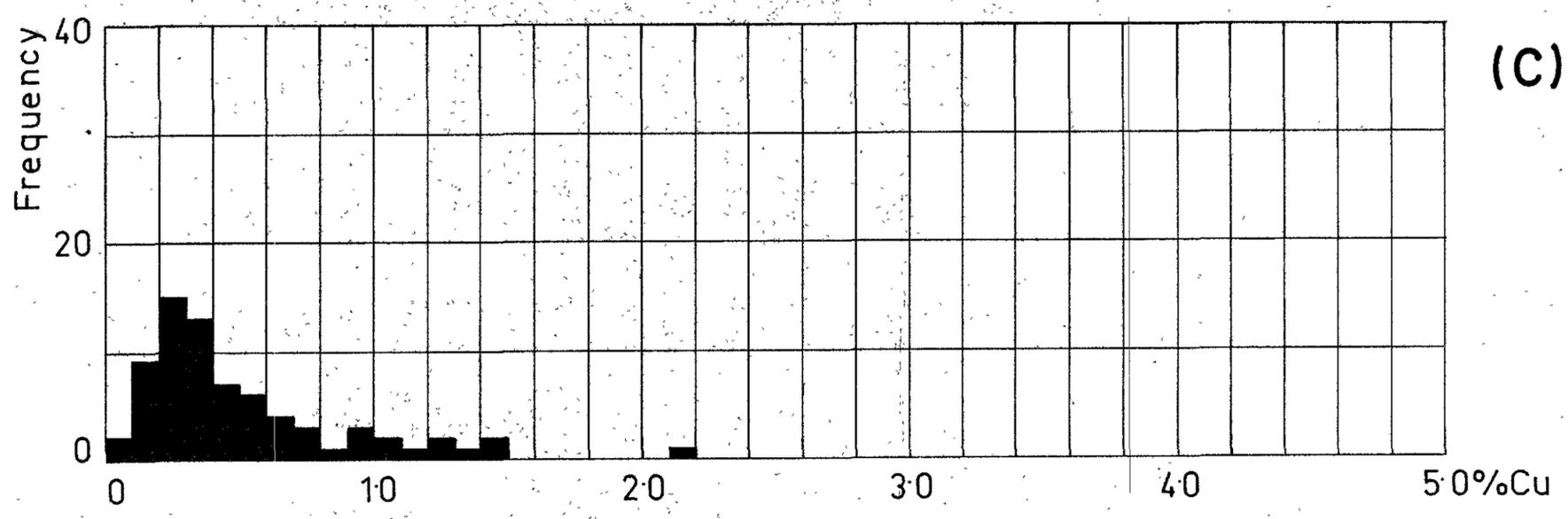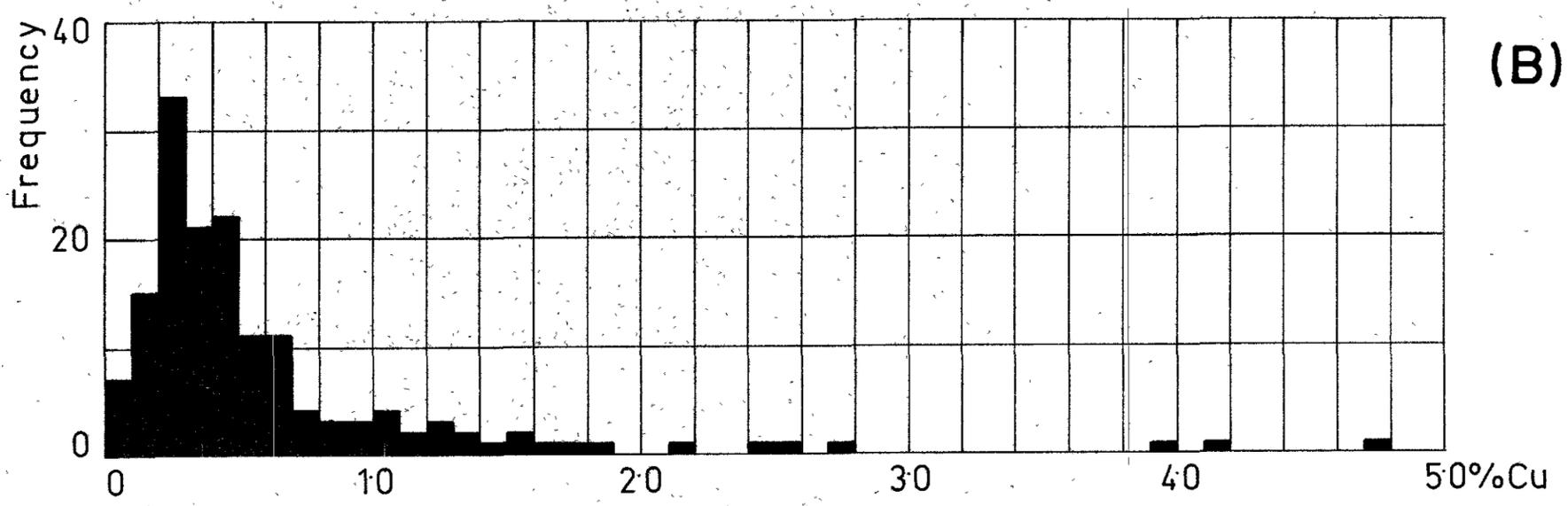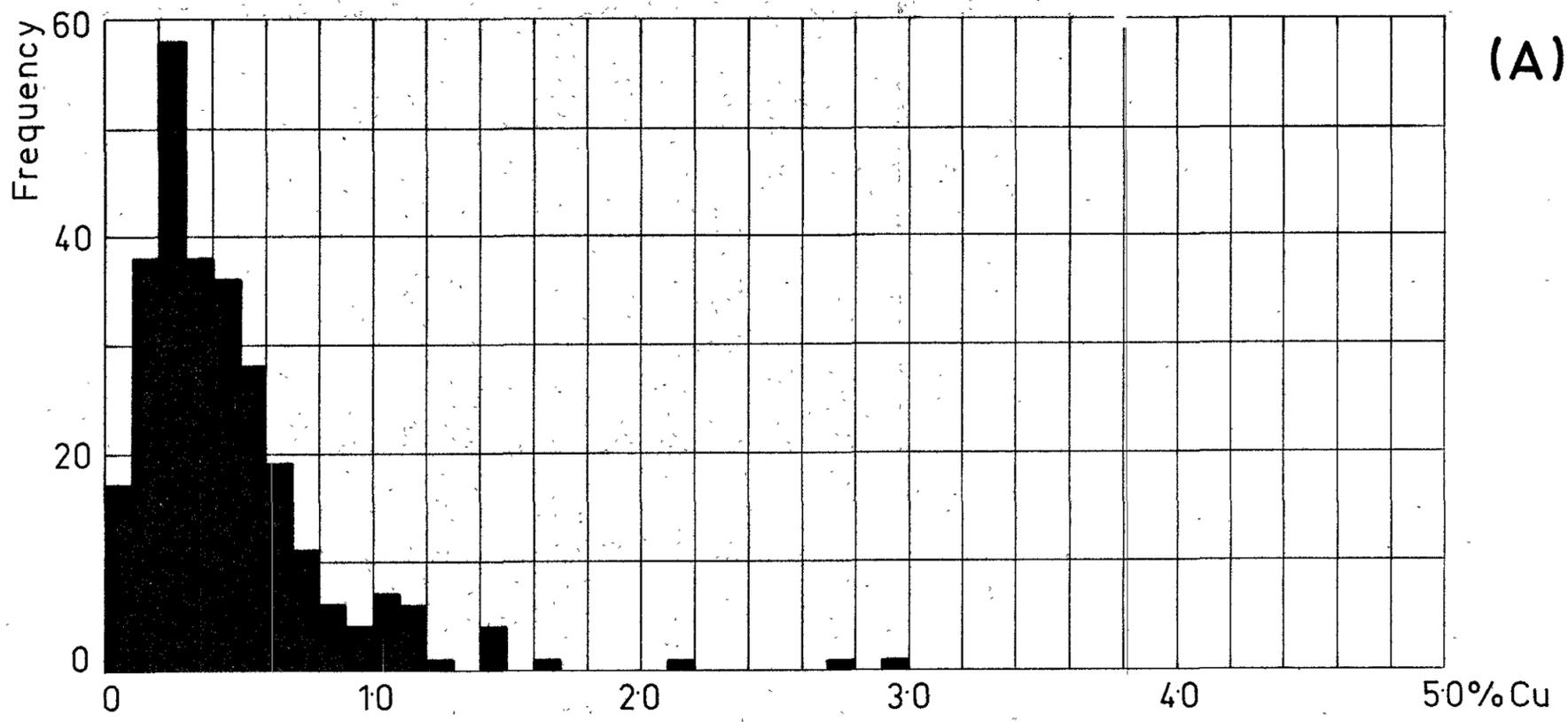
APPENDIX 1 — SECTION 1

FREQUENCY DISTRIBUTION NO.1 - HALL'S LODE, LENS "A", TIN ASSAYS

357 LODE SAMPLES FROM ALL 37 D.D.H. INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency x Midpoint	Frequency x (Midpoint)^2
	f		m p	fx m p	fx m p^2
0.00-0.19	28	28	0.10	2.8	0.28
0.20-0.39	25	53	0.30	7.5	2.25
0.40-0.59	31	84	0.50	15.5	7.75
0.60-0.79	42	126	0.70	29.4	20.58
0.80-0.99	53	179	0.90	47.7	42.93
1.00-1.19	39	218	1.10	42.9	47.19
1.20-1.39	39	257	1.30	50.7	65.91
1.40-1.59	16	273	1.50	24.0	36.00
1.60-1.79	23	296	1.70	39.1	66.47
1.80-1.99	17	313	1.90	32.3	61.37
2.00-2.19	13	326	2.10	27.3	57.33
2.20-2.39	9	335	2.30	20.7	47.61
2.40-2.59	5	340	2.50	12.5	31.25
2.60-2.79	5	345	2.70	13.5	36.45
2.80-2.99	5	350	2.90	14.5	42.05
3.00-3.19	Nil	350	3.10	Nil	Nil
3.20-3.39	1	351	3.30	3.3	10.89
3.40-3.59	3	354	3.50	10.5	36.75
3.60-3.79	1	355	3.70	3.7	13.69
3.80-3.99	Nil	355	3.90	Nil	Nil
4.00-4.19	1	356	4.10	4.1	16.81
4.20-4.39	Nil	356	4.30	Nil	Nil
4.40-4.59	1	357	4.50	4.5	20.25
Totals	357			406.5	663.81

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 1

(1) $\quad Ma = \dfrac{\Sigma fxm}{N} p = \dfrac{406.5}{357} = 1.14$

(2) $\quad S = \sqrt{\dfrac{\Sigma fx(mp)^2}{N} - \left(\dfrac{\Sigma fxm p}{N}\right)^2} = \sqrt{\dfrac{663.81}{357} - \left(\dfrac{406.5}{357}\right)^2}$

$\qquad = \sqrt{1.86 - 1.30} \quad \sqrt{0.56} = 0.75$

(3) $\quad S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{0.75}{\sqrt{357}} = \dfrac{0.75}{18.89} = 0.0397$

(4) $\quad$ F.I. $= Ma \overset{+}{-} t_{0.05} S_{\bar{x}}$ at 95 percent confidence level

$\qquad = 1.14 \overset{+}{-} 1.96 \times 0.0397 = 1.14 \overset{+}{-} 0.08$

(5) $\quad$ Median $\dfrac{N}{2} = \dfrac{357}{2} = 178.5$; (178.5 is in the 5th grade interval)

Median $=$ L.L. median G.I. $+ \dfrac{(N/2 - (\text{Cum. frequency for preceeding G.I.}) \times \text{G.I.}}{\text{frequency of median G.I.}}$

$\qquad = 0.80 + \dfrac{178.5 - 126}{53} \times 0.20 = 0.80 + 0.20 = 1.00$

(6) $\quad$ Mode $=$ L.L. modal G.I. $+ \dfrac{D_1}{D_1 + D_2} \times$ G.I.

$\qquad = 0.80 + \dfrac{(53 - 42)}{(53 - 42) + (53 - 39)} \times 0.20 = 0.80 + 0.09 = 0.89$

(7) Number of sample analyses and drill hole intersections required for selected fiducial intervals at a 95 percent confidence level

(a) New required value of $(S_{\bar{x}}^{1}) = \dfrac{\text{F.I.}}{t_{0.05}} = \dfrac{\text{F.I.}}{1.96}$ where (Ma) remains the same.

(b) Assuming standard deviation (S) remains the same the number of sample analyses required (N^1) is obtained from $\quad S_{\bar{x}}^{1} = \dfrac{S}{\sqrt{N^1}} = \dfrac{0.75}{\sqrt{N^1}}$

(c) 357 lode samples were obtained from 37 intersections, this approximates to 10 lode samples per intersection. The number of intersections required for selected fiducial intervals, $\quad N_I = \dfrac{N^1}{10}$

F.I.	$S\frac{1}{x}$	$\sqrt{N^I}$	N^1	N_I	Sampling Grid
0.20	0.1020	7.35	54	5	
0.15	0.0765	9.80	96	10	
0.12	0.0612	12.25	150	15	
0.10	0.0510	14.71	216	22	(6)= 21
0.09	0.0459	16.34	267	27	
0.08	0.0408	18.38	338	34	(5)= 36
0.07	0.0357	21.01	441	44	(4)= 54
0.06	0.0306	24.51	601	60	(1)= 78
0.05	0.0255	29.41	865	87	
0.04	0.0204	36.77	1352	135	(3)=209
0.03	0.0153	49.02	2403	240	(2)=275
0.02	0.0102	73.53	5407	541	

(8)   Frequency Distribution No. 1 employs all lode (sulphide) samples from all 37 intersections (D.D.H. Nos. C94, C33, C40, C55, C42, C43, C81, C13, C53, C17, C80, C38, C47, C95, C36, C37, C39, C23, C25, C48, C9, C84, C50, C10, C83, C51, C18, C31, C82, C54, C24, C86, C30, C57, C92, C87 and C93).

(9)   Degree of Skewness $= \frac{3(Ma-Median)}{S} = \frac{3(1.14-1.00)}{0.75} = \frac{+0.42}{0.75}$

$= + 0.560$

170036

APPENDIX 1 — SECTION 2

FREQUENCY DISTRIBUTION NO.1A — HALL'S LODE, LENS "A", TIN ASSAYS

156 LODE SAMPLES FROM 16 EXPLORATION D.D.H's

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency X Midpoint	Frequency (Midpoint)^2
	f		mp	$fx\ mp$	$fx(mp)^2$
0.00-0.19	11	11	0.10	1.10	0.11
0.20-0.39	15	26	0.30	4.50	1.35
0.40-0.59	11	37	0.50	5.50	2.75
0.60-0.79	20	57	0.70	14.00	9.80
0.80-0.99	26	83	0.90	23.40	21.06
1.00-1.19	19	102	1.10	20.90	22.99
1.20-1.39	13	115	1.30	16.90	21.97
1.40-1.59	7	122	1.50	10.50	15.75
1.60-1.79	8	130	1.70	13.60	23.12
1.80-1.99	8	138	1.90	15.20	28.88
2.00-2.19	4	142	2.10	8.40	17.64
2.20-2.39	4	146	2.30	9.20	21.16
2.40-2.59	2	148	2.50	5.00	12.50
2.60-2.79	3	151	2.70	8.10	21.87
2.80-2.99	1	152	2.90	2.90	8.41
3.00-3.19	Nil	152	3.10	Nil	Nil
3.20-3.39	Nil	152	3.30	Nil	Nil
3.40-3.59	2	154	3.50	7.00	24.50
3.60-3.79	1	155	3.70	3.70	13.69
3.80-3.99	Nil	155	3.90	Nil	Nil
4.00-4.19	Nil	155	4.10	Nil	Nil
4.20-4.39	Nil	155	4.30	Nil	Nil
4.40-4.59	1	156	4.50	4.50	20.25
Totals	156			174.40	287.80

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 1A

(1) $Ma = \dfrac{\sum fxm}{N} = \dfrac{174.40}{156} = 1.12$

(2) $S = \sqrt{\dfrac{\sum fx(m)^2}{N} - \left(\dfrac{\sum fxm}{N}\right)^2} = \sqrt{\dfrac{287.80}{156} - \left(\dfrac{174.40}{156}\right)^2}$

$= \sqrt{1.84 - 1.25} = \sqrt{0.59} = 0.77$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{0.77}{\sqrt{156}} = \dfrac{0.77}{12.49} = 0.0616$

(4) F.I. $= Ma \pm t_{0.05} \, S_{\bar{x}}$ at 95 percent confidence level

$= 1.12 \pm 1.96 \times 0.0616 = 1.12 \pm 0.12$

(5) Median $\dfrac{N}{2} = \dfrac{156}{2} = 78$; (78 is in the 5th grade interval)

Median$= $ L.L. median G.I. $+ \dfrac{\frac{N}{2} - (\text{Cum. frequency for preceeding G.I.}) \times \text{G.I.}}{\text{Frequency for median G.I.}}$

$= 0.80 + \dfrac{(78-57)}{26} \times 0.20 = 0.80 + 0.16 = 0.96$

(6) Mode $=$ L.L. modal G.I. $+ \dfrac{D_1}{D_1 + D_2} \times$ G.I.

$= 0.80 + \left(\dfrac{(26-20)}{26-20+(26-19)}\right) \times 0.20 = 0.80 + 0.09 = 0.89$

(7) Frequency Distribution No. 1A employs all lode samples from 16 intersections (D.D.H. Nos. C33, C40, C42, C43, C13, C38, C39, C37, C25, C36, C10, C18, C31, C24, C30 and C87).

(8) Degree of Skewness $= 3 \dfrac{(Ma - Median)}{S} = \dfrac{3(1.12-0.96)}{0.77} = \dfrac{+0.48}{0.77}$

$= + 0.623$

APPENDIX I — SECTION 3

FREQUENCY DISTRIBUTION NO.2 — HALL'S LODE, LENS "A" COPPER ASSAYS

277 LODE SAMPLES FROM 31 D.D.H. INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency $\times$ Midpoint	Frequency $\times$ (Midpoint)^2
	f		mp	fx mp	fx(mp)^2
0.00–0.09	17	17	0.05	0.85	0.0425
0.10–0.19	38	55	0.15	5.70	0.8550
0.20–0.29	58	113	0.25	14.50	3.6250
0.30–0.39	38	151	0.35	13.30	4.6550
0.40–0.49	36	187	0.45	16.20	7.2900
0.50–0.59	28	215	0.55	15.40	8.4700
0.60–0.69	19	234	0.65	12.35	8.0275
0.70–0.79	11	245	0.75	8.25	6.1875
0.80–0.89	6	251	0.85	5.10	4.3350
0.90–0.99	4	255	0.95	3.80	3.6100
1.00–1.09	7	262	1.05	7.35	7.7175
1.10–1.19	6	268	1.15	6.90	7.9350
1.20–1.29	1	269	1.25	1.25	1.5625
1.30–1.39	Nil	269	1.35	Nil	Nil
1.40–1.49	4	273	1.45	5.80	8.4100
1.50–1.59	Nil	273	1.55	Nil	Nil
1.60–1.69	1	274	1.65	1.65	2.7225
1.70–1.79	Nil	274	1.75	Nil	Nil
1.80–1.89	Nil	274	1.85	Nil	Nil
1.90–1.99	Nil	274	1.95	Nil	Nil
2.00–2.09	Nil	274	2.05	Nil	Nil
2.10–2.19	1	275	2.15	2.15	4.6225
2.20–2.29	Nil	275	2.25	Nil	Nil
2.30–2.39	Nil	275	2.35	Nil	Nil
2.40–2.49	Nil	275	2.45	Nil	Nil
2.50–2.59	Nil	275	2.55	Nil	Nil
2.60–2.69	Nil	275	2.65	Nil	Nil
2.70–2.79	1	276	2.75	2.75	7.5625
2.80–2.89	Nil	276	2.85	Nil	Nil
2.90–2.99	1	277	2.95	2.95	8.7025
Totals	277			126.25	96.3325

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 2

(1) $Ma = \dfrac{\sum fxmp}{N} = \dfrac{126.25}{277} = 0.46$

(2) $S = \sqrt{\dfrac{\sum fx(mp)^2}{N} - \left(\dfrac{\sum fxmp}{N}\right)^2} = \sqrt{\dfrac{96.33}{277} - \left(\dfrac{126.25}{277}\right)^2}$

$= \sqrt{0.35 - 0.21} = \sqrt{0.14} = 0.37$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{0.37}{\sqrt{277}} = \dfrac{0.37}{16.64} = 0.02224$

(4) $F.I. = Ma \overset{+}{\underset{-}{}} t_{0.05} \, S_{\bar{x}}$ at 95 percent confidence level

$= 0.46 \pm 1.96 \times 0.02224 = 0.46 \pm 0.04$

(5) Median $\dfrac{N}{2} = \dfrac{277}{2} = 138.5$; (138.5 is in the 4th grade interval)

Median $= L.L.$ median $G.I. + \dfrac{\left(\dfrac{N}{2} - Cum.\,Frequency\ for\ preceeding\ G.I.\right) \times G.I.}{Frequency\ of\ median\ G.I.}$

$= 0.30 + \dfrac{138.5 - 113}{38} \times 0.10 = 0.30 + 0.07 = 0.37$

(6) Mode $= L.L.$ modal $G.I. + \dfrac{D1}{D_1 + D_2} \times G.I.$

$= 0.30 + \dfrac{38 - 58}{(38 - 58) + (38 - 36)} \times 0.10 = 0.30 + 0.09 = 0.39$

(7) Number of sample analyses and drill hole intersections required for selected fiducial intervals at a 95 percent confidence level.

(a) New required value of $(S^1{}_{\bar{x}}) = \dfrac{F.I.}{t_{0.05}} = \dfrac{F.I.}{1.96}$ where (Ma) remains the same.

(b) Assuming standard deviation (S) remains the same, the number of sample analyses required (N^1) is obtained from $S^1{}_{\bar{x}} = \dfrac{S}{\sqrt{N^1}} = \dfrac{0.37}{\sqrt{N^1}}$

(c) 277 lode samples were obtained from 31 intersections; this approximates 9 lode samples per intersection. The number of intersections required for selected fiducial intervals $N_I = \dfrac{N^1}{9}$

F.I.	$S\frac{1}{x}$	$\sqrt{N^1}$	N^1	N_I	Sampling Grid
0.20	0.1020	3.63	13	2	
0.15	0.0765	4.84	23	3	
0.10	0.0510	7.26	53	6	
0.06	0.0306	12.09	146	16	
0.05	0.0255	14.51	211	23	(6)= 21
0.04	0.0204	18.14	329	37	(5)= 36
0.03	0.0153	24.18	585	65	(4)= 54
0.02	0.0102	36.27	1316	146	(1)= 78 (3)=209
0.01	0.0051	72.55	5263	585	(2)=275

(8)   Frequency Distribution No. 2 employs all lode samples
from 31 intersections (D.D.H. Nos. C94, C33, C40, C55,
C42, C43, C81,C13, C53, C80, C38, C47, C95, C36, C37,
C39, C48, C84, C50, C83, C51, C31, C82, C54, C24, C86,
C30, C57, C92, C87 and C93).

(9)   Degree of Skewness $= \frac{3(Ma-Median)}{S} = \frac{3(0.46-0.37)}{0.37} = +\frac{0.27}{0.37}$

$= + 0.730$

APPENDIX 1 — SECTION 4

FREQUENCY DISTRIBUTION NO.3 — HALL'S LODE, LENS "B", TIN ASSAYS
156 LODE SAMPLES FROM 22 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency $\bar{x}$ Midpoint	Frequency $\bar{x}$ (Midpoint)^2
	f		m ρ	fxm ρ	fx(mρ)^2
0.00-0.79	81	81	0.40	32.4	12.96
0.80-1.59	42	123	1.20	50.4	60.48
1.60-2.39	10	133	2.00	20.0	40.00
2.40-3.19	9	142	2.80	25.2	70.56
3.20-3.99	2	144	3.60	7.2	25.92
4.00-4.79	4	148	4.40	17.6	77.44
4.80-5.59	1	149	5.20	5.2	27.04
5.60-6.39	1	150	6.00	6.0	36.00
6.40-7.19	1	151	6.80	6.8	53.04
7.20-7.99	2	153	7.60	15.2	115.52
8.00-8.79	Nil	153	8.40	Nil	Nil
8.80-9.59	1	154	9.20	9.2	84.64
9.60-10.39	Nil	154	10.00	Nil	Nil
10.40-11.19	Nil	154	10.80	Nil	Nil
11.20-11.99	Nil	154	11.60	Nil	Nil
12.00-12.79	1	155	12.40	12.4	153.76
12.80-13.59	Nil	155	13.20	Nil	Nil
13.60-14.39	Nil	155	14.00	Nil	Nil
14.40-15.19	Nil	155	14.80	Nil	Nil
15.20-15.99	Nil	155	15.60	Nil	Nil
16.00-16.79	Nil	155	16.40	Nil	Nil
16.80-17.59	Nil	155	17.20	N il	Nil
17.60-18.39	Nil	155	18.00	Nil	Nil
18.40-19.19	1	156	18.80	18.8	353.44
Totals	156			226.4	1110.80

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 3

(1) $Ma = \dfrac{\Sigma fxm}{N} = \dfrac{226.4}{156} = 1.45$

(2) $S = \sqrt{\dfrac{\Sigma fx(m)^2}{N} - \left(\dfrac{\Sigma fxm}{N}\right)^2} = \sqrt{\dfrac{1110.80}{156} - \left(\dfrac{226.4}{156}\right)^2}$

$= \sqrt{7.12 - 2.10} = \sqrt{5.02} = 2.24$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{2.24}{\sqrt{156}} = \dfrac{2.24}{12.49} = 0.1793$

(4) $F.I. = Ma \pm t_{0.05}\, S_{\bar{x}}$ at 95 percent confidence level

$= 1.45 \pm 1.96 \times 0.1793 = 1.45 \pm 0.35$

(5) Median and Mode both occur within first grade interval, and therefore, cannot be calculated.
Frequency distribution No. 3A utilises the same sample data as frequency distribution No. 3, but employs a grade interval of 0.40 in order that the median can be calculated.

(6) Number of sample analyses and intersections required for selected fiducial intervals at a 95 percent confidence level.

(a) New required value of $(S^1_{\bar{x}}) = \dfrac{F.I.}{t_{0.05}} = \dfrac{F.I.}{1.96}$

where (Ma) remains the same.

(b) Assuming standard deviation (s) remains the same, the number of sample analyses required (N^1) is obtained from $S^1_{\bar{x}} = \dfrac{S}{\sqrt{N^1}} = \dfrac{2.24}{\sqrt{N^1}}$

(c) 156 lode samples were obtained from 22 intersections, this approximates 7 lode samples per intersection. The number of intersections required for selected fiducial intervals, $N_I = \dfrac{N^1}{7}$

F.I.	$S\frac{1}{x}$	$\sqrt{N^1}$	N^1	N_I	Sampling Grid
0.50	0.2551	8.78	77	11	
0.40	0.2041	10.98	121	17	(6)= 20
0.35	0.1786	12.54	157	22	(5)= 30
0.30	0.1531	14.63	214	31	
0.25	0.1276	17.55	308	44	(4)= 49
0.20	0.1020	21.96	482	69	(1)= 63
0.15	0.0765	29.28	857	122	
0.12	0.0612	36.60	1340	191	(3)=169
0.10	0.0510	43.92	1929	276	(2)=221
0.05	0.0255	87.84	7716	1102	

(7) Frequency Distribution No. 3 employs all lode samples obtained from 22 intersections (D.D.H. Nos. C27, C31, C64, C35, C10, C23, C25, C62, C39, C88, C67, C76, C43, C42, C55, C94, C33, C40, C96, and C44, together with 1,300 ft. R.L. cross-cuts "L" (S.W. wall groove samples) and "Qa" (N.E. wall, groove samples).

(8) Degree of Skewness $= \dfrac{3(Ma-Median)}{S} = \dfrac{3(1.45-0.76)}{2.24} = +\dfrac{2.07}{2.24}$

$= + 0.924$

APPENDIX 1 — SECTION 5

FREQUENCY DISTRIBUTION NO.3A-HALL'S LODE, LENS "B", TIN ASSAYS

PART OF FREQUENCY DISTRIBUTION NO.3, UTILISING A GRADE INTERVAL OF 0.40   156 SAMPLES FROM 22 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency $\times$ Midpoint	Frequency $\times$ (Midpoint)^2
	f		m $\flat$	fxm $\flat$	fx(m$\flat$)^2
0.00–0.39	54	54	0.2	10.8	2.16
0.40–0.79	27	81	0.6	16.2	9.72
0.80–1.19	26	107	1.0	26.0	26.00
1.20–1.59	16	123	1.4	22.4	31.36
1.60–1.99	6	129	1.8	10.8	19.44
2.00–2.39	4	133	2.2	8.8	19.36
2.40–2.79	6	139	2.6	15.6	40.56
2.80–3.19	3	142	3.0	9.0	27.00
3.20–3.59	1	143	3.4	3.4	11.56
3.60–3.99	1	144	3.8	3.8	14.44
4.00–4.39	2	146	4.2	8.4	35.28

Continued : 10 samples omitted

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 3A

(1)   Median $\frac{N}{2} = \frac{156}{2} = 78$ (78 is in the second grade interval)

Median = L.L. grade interval $+\left(\dfrac{\frac{N}{2} - \text{Cum. frequency for proceding G.I.}}{\text{frequency of median G.I.}}\right) \times \text{G.I.}$

$= 0.40 + \dfrac{78-54}{27} \times 0.40 = 0.40 + 0.36 = 0.76$

(2)   Mode cannot be calculated as it falls in first G.I.

39

APPENDIX 1 — SECTION 6

FREQUENCY DISTRIBUTION NO.4 - HALL'S LODE, LENS "B", COPPER ASSAYS
154 LODE SAMPLES FROM 21 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency X Midpoint	Frequency X (Midpoint)^2
	f		m	fxm	fx(m)^2
0.00-0.19	22	22	0.1	2.2	0.22
0.20-0.39	54	76	0.3	16.2	4.86
0.40-0.59	33	109	0.5	16.5	8.25
0.60-0.79	15	124	0.7	10.5	7.35
0.80-0.99	6	130	0.9	5.4	4.86
1.00-1.19	6	136	1.1	6.6	7.26
1.20-1.39	5	141	1.3	6.5	8.45
1.40-1.59	3	144	1.5	4.5	6.75
1.60-1.79	2	146	1.7	3.4	5.78
1.80-1.99	1	147	1.9	1.9	3.61
2.00-2.19	1	148	2.1	2.1	4.41
2.20-2.39	Nil	148	2.3	Nil	Nil
2.40-2.59	2	150	2.5	5.0	12.50
2.60-2.79	1	151	2.7	2.7	7.29
2.80-2.99	Nil	151	2.9	Nil	Nil
3.00-3.19	Nil	151	3.1	Nil	Nil
3.20-3.39	Nil	151	3.3	Nil	Nil
3.40-3.59	Nil	151	3.5	Nil	Nil
3.60-3.79	Nil	151	3.7	Nil	Nil
3.80-3.99	1	152	3.9	3.9	15.21
4.00-4.19	1	153	4.1	4.1	16.81
4.20-4.39	Nil	153	4.3	Nil	Nil
4.40-4.59	Nil	153	4.5	Nil	Nil
4.60-4.79	1	154	4.7	4.7	22.09
Totals	154			96.2	135.70

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 4

(1) $Ma = \dfrac{\sum fxm}{N} = \dfrac{96.2}{154} = 0.62$

(2) $S = \sqrt{\dfrac{\sum fx(m)^2}{N} - \left(\dfrac{\sum fxm}{N}\right)^2} = \sqrt{\dfrac{135.70}{154} - \left(\dfrac{96.2}{154}\right)^2}$

$\quad = \sqrt{0.88 - 0.39} = \sqrt{0.49} = 0.70$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{0.70}{\sqrt{154}} = \dfrac{0.70}{12.37} = 0.05659$

(4) $F.I. = Ma \overset{+}{-} t_{0.05}\, S_{\bar{x}}$ at 95 percent confidence level

$\quad = 0.62 \overset{+}{-} 1.96 \times 0.05659 = 0.62 \overset{+}{-} 0.11$

(5) Median $\dfrac{N}{2} = \dfrac{154}{2} = 77;$ (77 is in the 3rd grade interval)

Median = L.L. median G.I. $+ \dfrac{(\frac{N}{2} - \text{Cum. frequency of preceeding G.I.})}{\text{frequency of median G.I.}} \times$ G.I.

$\quad = 0.40 + \dfrac{77-76}{33} \times 0.20 = 0.40 + 0.01 = 0.41$

(6) Mode = L.L. modal G.I. $+ \dfrac{D1}{D_1 + D_2} \times$ G.I.

$\quad = 0.20 + \dfrac{(54-22)}{(54-22)+(54-33)} \times 0.20 = 0.20 + 0.12 = 0.32$

(7) Number of sample analyses and intersections required for selected fiducial intervals at a 95 percent confidence level.

(a) New required value $(S_{\bar{x}}) = \dfrac{F.I.}{t_{0.05}} = \dfrac{F.I.}{1.96}$, where (Ma) remains the same.

(b) Assuming standard deviation (S) remains the same, the number of sample analyses required (N^1), is obtained from $S^1_{\bar{x}} = \dfrac{S}{\sqrt{N'}} = \dfrac{0.70}{\sqrt{N^1}}$

(c) 154 lode samples were obtained from 21 intersections, this approximates 7 samples per intersection. The number of intersections required for selected fiducial intervals $N_I = \dfrac{N^1}{7}$

F.I.	$S\frac{1}{x}$	$\sqrt{N^{1}}$	N^{1}	N_{I}	Sampling Grid
0.20	0.1020	6.86	47	7	
0.15	0.0765	9.15	84	12	
0.12	0.0612	11.44	131	19	(6)= 20
0.10	0.0510	13.73	189	27	(5)= 30
0.09	0.0459	15.25	233	33	
0.08	0.0408	17.16	295	42	(4)= 49
0.07	0.0357	19.61	385	55	(1)= 63
0.06	0.0306	22.88	523	75	
0.05	0.0255	27.45	754	108	
0.04	0.0204	34.31	1177	168	(3)=169
0.03	0.0153	45.75	2093	299	(2)=221
0.02	0.0102	68.63	4710	673	

(8) Frequency Distribution No. 4 employs all lode samples
     obtained from 21 intersections (D.D.H. Nos. C27, C31,
     C64, C35, C10, C25, C62, C39, C88, C67, C76, C43, C42,
     C55, C94, C33, C40, C96 and C44, together with 1,300
     ft. R.L. cross-cuts "L" (S.W. wall, groove samples) and
     "Qa" (N.E. wall, groove samples).

(9) Degree of Skewness $= \frac{3(\text{Ma}-\text{Median})}{S} = \frac{3(0.62-0.41)}{0.70} = +\frac{0.63}{0.70}$

          $= + 0.900$

APPENDIX 1 — SECTION 7

FREQUENCY DISTRIBUTION NO.5 — HALL'S LODE, LENS "C" TIN ASSAYS

92 LODE SAMPLES FROM 18 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency x Midpoint	Frequency (Midpoint)^2
	f			mp	fx mp	fx(mp)^2
0.00–0.19	26	26	0.1	2.6	0.26
0.20–0.39	10	36	0.3	3.0	0.90
0.40–0.59	11	47	0.5	5.5	2.75
0.60–0.79	9	56	0.7	6.3	4.41
0.80–0.99	5	61	0.9	4.5	4.05
1.00–1.19	6	67	1.1	6.6	7.26
1.20–1.39	3	70	1.3	3.9	5.07
1.40–1.59	10	80	1.5	15.0	22.50
1.60–1.79	Nil	80	1.7	Nil	Nil
1.80–1.99	1	81	1.9	1.9	3.61
2.00–2.19	1	82	2.1	2.1	4.41
2.20–2.39	2	84	2.3	4.6	10.58
2.40–2.59	Nil	84	2.5	Nil	Nil
2.60–2.79	2	86	2.7	5.4	14.58
2.80–2.99	1	87	2.9	2.9	8.41
3.00–3.19	1	88	3.1	3.1	9.61
3.20–3.39	Nil	88	3.3	Nil	Nil
3.40–3.59	1	89	3.5	3.5	12.25
3.60–3.79	Nil	89	3.7	Nil	Nil
3.80–3.99	1	90	3.9	3.9	15.21
4.00–4.19	1	91	4.1	4.1	16.81
4.20–4.39	Nil	91	4.3	Nil	Nil
4.40–4.59	Nil	91	4.5	Nil	Nil
4.60–4.79	1	92	4.7	4.7	22.09
Totals	92			83.6	164.76

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 5

(1) $Ma = \dfrac{\sum fxmb}{N} = \dfrac{83.6}{92} = 0.91$

(2) $S = \sqrt{\dfrac{\sum fx(mb)^2}{N} - \left(\dfrac{\sum fxmb}{N}\right)^2} = \sqrt{\dfrac{164.76}{92} - \left(\dfrac{83.6}{92}\right)^2}$

$= \sqrt{1.79 - 0.83} = \sqrt{0.96} = 0.98$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{0.98}{\sqrt{92}} = \dfrac{0.98}{9.59} = 0.1022$

(4) $F.I. = Ma \pm t_{0.05}\, S_{\bar{x}}$ at 95 percent confidence level

$= 0.91 \pm 1.96 \times 0.1022 = 0.91 \pm 0.20$

(5) Median $\dfrac{N}{2} = \dfrac{92}{2} = 46$; (46 is in the 3rd grade interval)

Median = L.L.Median G.I. $+\dfrac{\left(\frac{N}{2} - Cum.frequency\ for\ preceeding\ G.I.\right) \times G.I.}{frequency\ for\ median\ G.I.}$

$= 0.40 + \dfrac{46-36}{11} \times 0.20 = 0.40 + \dfrac{2.00}{11} = 0.40 + 0.18$

$= 0.58$

(6) Mode occurs within the first grade interval and cannot, therefore, be calculated. Frequency distribution No. 5A utilises the same sample data as frequency distribution No. 5, but employs a grade interval of 0.10 in order that the mode can be calculated.

(7) Number of sample analyses and intersections required for selected fiducial intervals at a 95 percent confidence level.

(a) New required value of $(S^1_{\bar{x}}) = \dfrac{F.I.}{t_{0.05}} = \dfrac{F.I.}{1.96}$ where Ma remains the same.

(b) Assuming standard deviation (S) remains the same, the number of sample analyses required (N^1), is obtained from $S^1_{\bar{x}} = \dfrac{S}{\sqrt{N^1}} = \dfrac{0.98}{\sqrt{N^1}}$

(c) 92 lode samples were obtained from 18 intersections; this approximates to 5 samples per intersection. The number of intersections required for selected fiducial intervals $N_I = \dfrac{N^1}{5}$

F.I.	$S\frac{1}{\bar{x}}$	$\sqrt{N^1}$	N^1	N_I	Sampling Grid
0.20	0.1020	9.61	92	18	
0.19	0.0969	10.11	102	20	(6)= 21
0.17	0.0867	11.30	128	26	(5)= 27
0.15	0.0765	12.81	164	33	
0.12	0.0612	16.01	256	51	(4)= 50
0.10	0.0510	19.22	369	74	(1)= 70
0.07	0.0357	27.43	754	151	
0.06	0.0306	32.03	1026	205	(3)=180
0.05	0.0255	38.43	1477	295	(2)=243

(8) Frequency Distribution No. 5 employs all lode samples obtained from 18 intersections (D.D.H. Nos. C92, C57, C27 C79 C65, C31, C62, C39, C88, C38, C90 , C67, C34, C96, C72 and C44, together with 1,300 ft. R.L. cross-cuts "Qa" (S.W. wall, channel) and "V" (N.E. wall, channel).

(9) Degree of Skewness = $\dfrac{3(\text{Ma}-\text{Median})}{S}$ = $\dfrac{3(0.91-0.58)}{0.98}$

$= \dfrac{+3(0.33)}{0.98}$ = $\dfrac{+0.99}{0.98}$ = + 1.010

APPENDIX 1 – SECTION 8

FREQUENCY DISTRIBUTION NO. 5A – HALL'S LODE, LENS "C", TIN ASSAYS

PART OF FREQUENCY DISTRIBUTION NO. 5 UTILISING A GRADE INTERVAL
OF .10. 92 SAMPLES FROM 18 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency
	f	
0.00-0.09	9	9
0.10-0.19	17	26
0.20-0.29	4	30
0.30-0.39	6	36
etc.		

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION
NO. 5A

(1) Mode = L.L. modal G.I. + $\dfrac{D_1}{D_1 + D_2}$ x G.I.

$$= 0.10 + \frac{(17-9)}{(17-9)+(17-4)} \times 0.10 = 0.10 + \frac{8}{21} \times 0.10$$

$$= 0.10 + 0.04 = 0.14$$

APPENDIX 1 — SECTION 9

FREQUENCY DISTRIBUTION NO.6 — HALL'S LODE, LENS "C", COPPER ASSAYS
73 LODE SAMPLES FROM 13 INTERSECTIONS

Grade Interval	Frequency	Cumulative Frequency	Midpoint of Grade Interval	Frequency x Midpoint	Frequency (Midpoint)^2
	f		m	fx m	fx (m)^2
0.00-0.09	2	2	0.05	0.10	0.0050
0.10-0.19	9	11	0.15	1.35	0.2025
0.20-0.29	15	26	0.25	3.75	0.9375
0.30-0.39	13	39	0.35	4.55	1.5925
0.40-0.49	7	46	0.45	3.60	1.6200
0.50-0.59	6	52	0.55	3.30	1.8150
0.60-0.69	4	56	0.65	2.60	1.6900
0.70-0.79	3	59	0.75	2.25	1.6875
0.80-0.89	1	60	0.85	0.85	0.7225
0.90-0.99	3	63	0.95	2.85	2.7075
1.00-1.09	2	65	1.05	2.10	2.2050
1.10-1.19	1	66	1.15	1.15	1.3225
1.20-1.29	2	68	1.25	1.50	3.1250
1.30-1.39	1	69	1.35	1.35	1.8225
1.40-1.49	2	71	1.45	2.90	4.2050
1.50-1.59	Nil	71	1.55	—	—
1.60-1.69	Nil	71	1.65	—	—
1.70-1.79	Nil	71	1.75	—	—
1.80-1.89	Nil	71	1.85	—	—
1.90-1.99	Nil	71	1.95	—	—
2.00-2.09	Nil	71	2.05	—	—
2.10-2.19	1	72	2.15	2.15	4.6225
2.20-8.99	Nil	72	—	—	—
9.00-9.09	1	73	9.05	9.05	81.9025
	73			46.40	112.1850

COMPUTATIONS TO ACCOMPANY FREQUENCY DISTRIBUTION NO. 6

(1) $Ma = \dfrac{\Sigma fxmp}{N} = \dfrac{46.40}{73} = 0.64$

(2) $S = \sqrt{\dfrac{\Sigma fx(mp)^2}{N} - \left(\dfrac{\Sigma fxmp}{N}\right)^2} = \sqrt{\dfrac{112.185}{73} - \left(\dfrac{46.4}{73}\right)^2}$

$= \sqrt{1.54 - 0.40} = \sqrt{1.14} = 1.07$

(3) $S_{\bar{x}} = \dfrac{S}{\sqrt{N}} = \dfrac{1.07}{\sqrt{73}} = \dfrac{1.07}{8.54} = 0.1253$

(4) F.I. $= Ma \pm t_{0.05} S_{\bar{x}}$ at 95 percent confidence level

$= 0.64 \pm 1.96 \times 0.1253 = 0.64 \pm 0.25$

(5) Median $\dfrac{N}{2} = \dfrac{73}{2} = 36.5$; (36.5 is in the 4th grade interval)

Median $= L.L.$ Median G.I. $(+\dfrac{N}{2} -$ Cum. Frequency for proceeding G.I.)

$$\dfrac{x\ G.I.}{\text{frequency for median G.I.}}$$

$= 0.30 + \dfrac{36.5 - 26}{13} \times 0.10 = 0.30 + 0.08 = 0.38$

(6) Mode $= L.L.$ modal G.I. $+ \dfrac{D1}{D_1 + D_2} \times G.I.$

$= 0.20 + \dfrac{(15-9)}{(15-9)+(15-13)} \times 0.10 = 0.20 + 0.07 = 0.27.$

(7) Number of sample analyses and intersections required for selected fiducial intervals at a 95 percent confidence level,

(a) New required value of $(S^1_{\bar{x}}) = \dfrac{F.I.}{t_{0.05}} = \dfrac{F.I.}{1.96}$ where (Ma) remains the same.

(b) Assuming standard deviation (S) remains the same, the number of sample analyses required (N[1]) is obtained from $S^1_{\bar{x}} = \dfrac{S}{\sqrt{N^1}} = \dfrac{1.07}{\sqrt{N^1}}$

(c) 73 lode samples were obtained from 13 intersections; this approximates to $5\frac{1}{2}$ lode samples per intersection. The number of intersections required for selected fiducial intervals, $N_I = \dfrac{N^1}{5\frac{1}{2}}$

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F.I.	$S\frac{1}{x}$	$\sqrt{N^1}$	N^1	N_I	Sampling Grid
0.30	0.1531	6.99	49	9	
0.25	0.1276	8.39	70	13	
0.20	0.1020	10.49	110	20	(6)= 21
0.18	0.0918	11.66	136	25	(5)= 27
0.15	0.0765	13.99	196	36	
0.13	0.0663	16.14	260	47	(4)= 50
0.12	0.0612	17.48	306	56	
0.11	0.0561	19.07	364	66	(1)= 70
0.10	0.0510	20.98	440	80	
0.07	0.0357	29.97	898	163	(3)=180
0.06	0.0306	34.97	1223	222	(2)=243
0.05	0.0255	41.96	1761	320	

(8) Frequency Distribution No. 6 employs all lode samples obtained from 13 intersections (D.D.H. Nos. C92, C57, C79, C65, C62, C88, C90, C67, C34, C96, C72, together with 1,300 Ft. RL. cross-cuts "Qa" (S.W. wall, channel samples) and "V" (N.E wall, channel samples).

(9) Degree of Skewness $= \dfrac{3(Ma-Median)}{S} = \dfrac{3(0.64-0.38)}{1.07}$

$= +(\dfrac{3 \times 0.26}{1.07}) = + \dfrac{0.78}{1.07} = + 0.729$

APPENDIX 2

HALL'S LODE, LENS "A" – CONSOLIDATED SAMPLING DATA

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins	Grade % Sn.	% Cu.
(1) D.D.H. No. C94				921	20	1.04	0.15
QN177	36	0.70	0.32	923	15	2.28	0.25
QN178	32	1.31	0.31	925	13	1.02	0.35
1443	37	1.13	0.38	927	30	4.06	0.35
1446	37	1.35	0.35	**(5) D.D.H. No. C42**			
1447	12	0.11	0.23	740	36	1.03	0.10
1448	34	0.32	0.17	741	36	2.68	0.34
1449	19	2.59	0.92	742	36	0.18	0.11
1450	34	2.22	0.42	743	36	1.01	0.50
1451	20	0.19	0.52	**(6) D.D.H. No. C43**			
1452	27	1.32	0.30	752	36	1.01	0.13
1453	18	0.43	0.37	753	36	1.45	0.65
1455	30	0.92	0.30	754	36	1.17	0.54
1456	12	Tr	1.02	755	36	0.53	0.76
1457	24	0.50	0.13	756	48	3.60	0.89
(2) D.D.H. No. C33				759	36	0.34	1.00
558	36	0.81	Tr	760	42	Tr	0.37
559	36	0.32	0.20	762	18	Tr	0.58
560	36	0.24	0.30	**(7) D.D.H. No. C81**			
562	36	0.48	0.62	QN112	34	0.57	0.52
563	36	0.19	1.03	QN127	21	0.64	0.59
564	36	0.67	0.40	1195	31	1.28	0.51
565	36	0.42	0.23	1197	33	1.60	0.86
566	36	0.97	0.28	1198	31	1.73	0.49
567	36	1.09	0.27	1199	21	1.17	0.29
568	36	0.86	0.28	1201	32	1.07	0.22
569	42	0.22	0.25	1202	9	0.87	0.45
(3) D.D.H. No. C40				1203	33	0.56	0.43
602	36	1.46	0.43	1204	33	0.84	0.65
603	36	1.08	1.00	1205	19	0.53	0.61
(4) D.D.H. No. C55				1207	26	2.07	0.44
QN155	21	0.64	0.25	1208	27	0.71	0.21
915	18	2.07	0.23	1209	31	1.04	0.33
917	19	0.27	0.10				
919	15	2.90	0.20				

HALL'S LODE, LENS "A" – CONSOLIDATED SAMPLING DATA (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(8) D.D.H. No. C13				78–81	36	1.13	
147	36	1.81	0.42	81–84	36	1.03	
148	36	0.39	Tr	84–87	36	1.46	
149	36	1.25	0.19	97–100	36	1.53	
150	36	0.61	1.10	100–103	36	1.21	
151	36	0.95	0.32	103–106	36	0.82	
152	36	1.13	0.27	106–109	36	0.13	
153	48	0.59	1.40	109–112	36	0.14	
154	36	0.87	0.38	112–115	36	0.14	
155	36	0.73	0.21				
156	36	0.63	0.23	(11) D.D.H. No. C80			
157	36	0.95	0.56	1176	29	3.54	0.31
158	36	0.85	0.24	1178	16	0.57	0.14
159	36	0.15	0.14	1180	27	1.04	0.15
160	36	1.07	Tr	1181	43	1.64	0.41
161	36	1.09	0.22	1183	33	0.81	0.46
162	36	0.98	0.12	1184	32	0.60	0.48
163	36	0.22	0.16	1185	34	1.30	0.57
164	36	0.62	0.24	1188	12	0.86	0.46
(9) D.D.H. No. C53				1190	28	1.31	0.58
QN86	24	0.69	0.17	1192	22	0.98	0.28
883	4	0.46	Tr	1194	33	1.11	0.29
885	38	0.72	0.29	1238	31	0.74	0.45
886	36	0.65	0.19	1240	16	0.97	0.41
887	41	2.09	0.29	(12) D.D.H. No. C38			
889	5	Tr	0.35	648	42	0.87	0.68
891	13	1.47	0.25	679	36	1.03	0.56
893	4	Tr	Tr	680	36	0.81	0.28
894	18	2.15	0.94	681	36	1.80	0.62
896	15	1.08	0.23	682	36	1.25	0.41
898	40	2.25	0.57	684	36	0.17	0.30
(10) D.D.H. No. C17				685	36	0.89	0.38
60–63	36	0.30		686	36	2.68	0.84
63–66	36	0.86		687	36	2.69	0.68
66–69	36	1.97		688	36	0.79	0.28
69–72	36	0.92		690	24	0.78	0.22
72–75	36	1.00		692	36	1.15	0.45

HALL'S LODE, LENS "A" – CONSOLIDATED SAMPLING DATA (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(13) D.D.H. No. C47				629	36	0.50	0.22
QN49	50	0.71	0.59	630	36	0.98	1.10
QN36	8	0.97	0.45	631	36	2.23	1.10
QN38	30	1.36	0.45	632	36	1.64	0.44
QN39	30	1.68	0.65	633	18	1.31	0.45
807	36	1.84	0.53	635	36	1.98	1.42
808	36	1.74	0.55	636	36	1.23	0.50
809	23	1.36	0.72	637	36	0.97	0.34
811	36	1.60	0.43	638	36	1.37	0.42
812	34	1.32	0.40	639	18	0.98	0.48
813	28	0.97	0.33	**(17) D.D.H. No. C39**			
815	21	1.56	0.97	674	36	0.21	0.14
817	36	0.95	0.52	675	36	1.07	0.20
819	9	0.65	0.71	676	36	0.91	0.14
821	21	1.81	0.35	677	36	4.43	0.18
823	10	0.91	0.18	**(18) D.D.H. No. C23**			
825	9	1.95	0.25	335	36	0.61	
(14) D.D.H. No. C95				336	36	0.34	
QS6	27	1.22	0.62	337	36	1.53	
QS5	30	0.62	0.63	338	36	0.88	
1458	43	0.82	0.43	339	36	0.85	
1459	25	2.13	0.72	340	36	0.78	
1460	28	2.65	1.17	341	36	0.80	
1461	27	1.30	0.90	342	36	1.04	
(15) D.D.H. No. C36				343	36	0.22	
615	36	0.55	0.15	344	36	0.48	
617	36	0.70	0.23	345	36	1.27	
618	36	0.66	0.20	346	36	0.11	
619	36	0.82	0.10	347	36	0.19	
620	36	1.26	0.19	348	36	0.70	
(16) D.D.H. No. C37				349	36	1.05	
622	36	0.94	1.20	350	36	0.66	
623	36	2.27	0.62	351	36	0.79	
624	36	1.96	0.60	353	36	0.57	
625	36	1.10	0.29	354	36	0.48	
626	36	1.78	0.56				
627	36	0.80	0.23				
628	36	0.55	0.15				

HALL'S LODE LENS "A" – CONSOLIDATED SAMPLING DATA   (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	%Cu.
(19) D.D.H. No. C25				1259	46	0.83	0.54
402	36	2.11		1260	24	0.29	Tr
389	36	0.32		1261	28	0.99	1.49
390	36	1.45		1262	18	1.26	0.34
391	36	0.64		**(23) D.D.H. No. C50**			
392	36	0.77		QS145	22	1.58	0.37
393	36	1.17		QS144	17	0.69	Nil
394	36	1.15		857	24	0.92	0.43
395	36	2.24		859	12	0.56	0.55
396	36	1.26		861	27	1.37	1.01
397	36	0.69		**(24) D.D.H. No. C10**			
398	36	0.84		70–72	24	1.82	
399	36	0.29		72–74½	30	1.71	
400	36	0.67		77–80	36	0.16	
401	36	0.76		80–83	36	1.44	
(20) D.D.H. No. C48				83–86	36	1.41	
QS41	31	2.16	1.05	86–89	36	1.39	
QS39	6	1.28	1.11	89–92	36	0.90	
849	14	1.68	0.72	92–95	36	1.68	
851	26	Tr	0.62	95–98	36	1.90	
853	33	2.50	1.13	98–101	36	1.71	
855	36	1.83	2.15	101–104	36	0.97	
(21) D.D.H. No. C9				104–106	24	0.62	
69'3"– 72'3"	36	0.92		**(25) D.D.H. No. C83**			
72'3"– 75'3"	36	1.10		1224	28	1.94	0.72
75'3"– 77'3"	24	0.67		1225	33	1.83	1.03
79'9"– 81'9"	24	0.53		1226	31	1.27	0.39
(22) D.D.H. No. C84				1228	24	1.75	0.23
QS106	19	0.57	0.19	1229	22	1.17	0.22
1252	44	1.29	0.48	1230	26	0.47	Tr
1253	45	2.05	0.46	1231	28	0.32	0.30
1255	34	0.12	0.24	1232	19	1.88	0.54
1257	34	2.49	0.73	1233	43	1.40	0.79
1258	44	0.95	0.42	1234	33	2.81	0.35
				1235	38	1.67	0.41
				1237	10	0.98	0.24

HALL'S LODE, LENS "A" – CONSOLIDATED SAMPLING DATA (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(26) D.D.H. No. C51				(29) D.D.H. No. C82			
QS198	15	1.24	0.35	QS234	30	0.91	0.25
QS197	42	1.74	0.46	QS231	36	0.48	0.27
864	31	3.24	0.33	1210	37	1.52	0.62
865	14	2.13	0.35	1211	30	1.22	0.23
867	57	1.76	0.35	(30) D.D.H. No. C54			
869	46	0.65	0.33	QS258	21	0.14	1.40
870	33	0.58	0.45	QS257	45	2.27	0.19
871	16	0.67	0.43	900	12	2.68	0.16
873	30	1.61	0.33	901	18	0.56	0.32
874	27	1.36	0.58	904	36	0.11	0.12
(27) D.D.H. No. C18				905	36	0.84	0.25
314	36	0.33		906	36	1.33	0.24
315	36	1.12		907	27	1.39	0.17
316	36	0.28		909	45	0.43	0.37
317	36	0.97		(31) D.D.H. No. C24			
318	36	0.87		377	36	0.27	0.33
319	36	1.04		378	36	0.82	0.10
320	36	1.31		379	36	1.78	Tr
321	36	1.38		380	36	0.76	Tr
322	36	0.37		381	24	0.31	Tr
323	36	2.03		382	36	1.84	0.29
324	36	1.46		383	36	0.27	0.32
325	36	1.96		384	36	0.98	0.74
326	36	2.49		385	36	1.11	0.77
327	36	0.75		386	36	1.21	0.22
328	36	0.56		(32) D.D.H. No. C86			
329	36	0.86		QS264	31	1.87	0.58
330	36	1.42		QS263	33	1.64	0.64
(28) D.D.H. No. C31				1414	22	0.27	0.56
549	36	0.79	0.22	1416	16	0.35	1.63
550	36	1.69	0.84	1418	34	0.45	0.23
551	36	2.24	0.60	1419	32	0.24	0.38
552	36	2.09	0.58	1420	50	2.82	0.42
553	36	1.63	0.65	1422	24	0.44	0.47
554	36	0.18	0.29				

HALL'S LODE, LENS "A" – CONSOLIDATED SAMPLING DATA (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(33) D.D.H. No. C30				(37) D.D.H. No. C93			
498	36	2.14	0.22	QS363	10	2.23	0.15
499	36	0.75	0.18	QS362	13	0.60	0.46
500	36	0.78	Tr	1437	32	0.84	0.67
502	36	0.48	Tr	1438	5	Tr	0.32
503	36	Tr	Tr	1439	8	1.26	0.20
504	36	Tr	Tr	1440	23	1.72	0.82
505	36	0.52	Tr	1441	8	1.23	0.52
506	36	0.17	0.10	1442	13	2.81	0.58
507	36	0.43	0.19				
508	36	1.28	0.17				
509	36	1.32	0.19				
510	36	2.48	0.29				
(34) D.D.H. No. C57							
QS302	44	1.35	0.14				
QS301	44	1.10	0.25				
936	8	1.03	0.27				
938	49	1.61	0.17				
939	33	2.08	0.20				
940	36	Tr	0.25				
941	30	0.14	0.15				
(35) D.D.H. No. C92							
QS330	35	1.01	0.72				
1429	7	1.58	0.23				
1430	13	1.13	Nil				
(36) D.D.H. No. C87							
QS345	30	2.84	0.69				
1297	21	3.44	2.91				
1299	16	1.08	0.58				
1301	9	3.52	2.74				

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APPENDIX 3

HALL'S LODE, LENS "B" – CONSOLIDATED SAMPLING DATA

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(1) D.D.H. No. C27				518	36	Tr	0.57
450	36	0.65	0.05	519	36	3.51	0.52
451	36	1.03	0.36	520	24	0.56	0.28
452	36	1.69	0.42	(4) D.D.H. No. C64			
453	36	0.67	0.28	1017	31	0.89	0.37
454	36	2.10	0.18	1018	29	1.18	0.27
456	36	0.14	0.42	(5) D.D.H. No. C35			
457	36	0.19	0.27	606	36	1.43	1.54
460	36	0.37	0.24	607	36	1.11	0.80
461	36	0.67	0.40	608	36	1.41	0.25
462	36	0.41	0.22	609	36	9.48	1.36
463	36	0.18	0.16	610	36	0.94	0.65
464	36	0.14	0.22	611	36	0.11	0.82
465	42	0.14	0.18	612	36	3.13	0.67
467	18	Nil	Tr	613	36	0.42	1.60
470	36	Tr	0.04	(6) D.D.H. No. C10			
471	36	0.15	0.13	75	36	1.73	0.22
472	36	Tr	0.22	76	33	2.32	0.21
473	36	0.14	0.27	(7) D.D.H. No. C23			
474	36	0.38	0.42	332	36	0.29	
475	36	0.19	0.32	333	36	0.48	
476	36	0.74	0.46	(8) D.D.H. No. C25			
477	36	1.94	0.42	387	48	0.95	0.29
478	36	0.44	0.46	(9) D.D.H. No. C62			
479	36	0.13	0.49	955	43	1.45	0.49
480	36	Tr	0.40	956	5	Tr	Tr
481	36	0.11	0.36				
482	36	0.34	0.31				
(2) Lx-Cut, Groove Samples S.W. Wall				(10) Qa x-Cut, N.E. Wall Groove Samples			
Q69	37	0.24	Tr	Q10	10	Tr	0.65
Q70	43	0.26	0.22	Q12	9	0.36	0.38
(3) D.D.H. No. C31							
515	36	Tr	0.49				
516	36	Tr	0.24				
517	36	0.23	0.26				

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HALL'S LODE, LENS "B" - CONSOLIDATED SAMPLING DATA   (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(11) D.D.H. No. C39				(14) D.D.H. No. C76			
654	36	1.84	1.88	1119	15	0.33	0.46
655	24	2.42	1.21	1121	9	7.30	0.18
705	36	0.22	Tr	1123	6	0.98	0.56
656	42	4.55	1.43	(15) D.D.H. No. C43			
657	36	2.92	1.14	746	36	0.16	0.63
658	36	0.93	0.69	747	36	0.82	0.11
659	36	1.77	1.28	748	36	0.83	0.40
660	36	0.95	0.29	(16) D.D.H. No. C42			
662	36	4.54	1.03	734	36	1.37	4.14
663	36	1.13	1.19	736	36	1.57	4.71
665	36	0.11	0.57	737	36	0.59	1.77
666	36	4.37	0.40	(17) D.D.H. No. C55			
667	36	1.16	0.18	930	29	2.51	0.18
668	36	Tr	1.05	932	10	1.06	0.23
669	36	18.40	1.31	(18) D.D.H. No. C94			
670	36	0.80	0.65	QN177	36	0.70	0.32
(12) D.D.H. No. C88				QN178	32	1.31	0.31
1344	60	C.37	3.91	1443	37	1.13	C.38
1345	29	0.14	2.16	1446	37	1.35	0.35
1347	33	1.64	1.27	1447	12	0.11	0.23
1348	28	2.53	0.92	1448	34	0,32	0.17
1 351	31	1.51	2.59	1449	19	2.59	0.92
1352	33	Tr	0.49	1450	34	2.22	0.42
1353	33	0.17	0.23	1451	20	0.19	0.52
1355	44	3.67	2.75	1452	27	1.32	0.30
1357	10	Tr.	0.79	1453	18	0.43	0.37
1359	7	7.46	1.53	1455	30	0.92	0.30
1361	23	1.42	0.98	1456	12	Tr	1.02
1363	13	1.29	0.53	1457	24	0.50	0.13
1 365	10	0.23	0.25	(19) D.D.H. No. C33			
1367	12	1.27	0.63	558	36	0.81	Tr
1369	11	2.59	0.51	559	36	0.32	0.20
1371	28	5.97	2.43	560	36	0.24	0.30
1372	33	7.03	0.14	562	36	0.48	0.62
(13) D.D.H. No. C67				563	36	0.19	1.03
1026	11	2.46	0.43				
1027	7	3.14	0.87				

HALL'S LODE, LENS "B" – CONSOLIDATED SAMPLING DATA   (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	%Cu.
564	36	0.67	0.40	(22) D.D.H. No. C44			
565	36	0.42	0.23	778	36	0.58	0.22
566	36	0.97	0.28	780	36	0.75	0.57
567	36	1.09	0.27	781	36	Tr	0.30
568	36	0.86	0.28	782	36	0.60	0.17
569	42	0.22	0.25	784	36	Tr	0.17
(20) D.D.H. No. C40				785	36	0.16	0.28
580	36	0.63	0.43				
581	48	0.17	0.17				
583	36	0.56	0.30				
584	36	0.45	0.70				
585	36	2.02	0.70				
586	36	0.50	0.35				
587	36	0.72	0.47				
588	36	1.00	0.60				
589	36	0.51	0.75				
590	36	1.57	0.63				
592	36	1.02	0.50				
593	36	0.36	0.35				
594	36	12.40	0.48				
595	36	1.38	0.55				
596	36	0.99	0.35				
597	36	0.39	0.22				
598	36	1.41	0.25				
600	36	0.97	0.34				
(21) D.D.H. No. C96							
1467	12	0.67	0.22				
1469	29	0.77	0.34				
1470	16	Tr	0.51				
1471	29	4.28	0.69				
1472	22	0.57	0.40				
1473	11	1.28	0.17				
1474	5	5.37	0.27				

APPENDIX 4

HALL'S LODE, LENS "C" – CONSOLIDATED SAMPLING DATA

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(1) D.D.H. No. C92				(5) D.D.H. No. C65			
1431	6	0.51	1.17	1019	22	0.33	0.20
1432	17	4.17	1.48	1020	39	1.31	0.74
1433	6	3.13	0.68	(6) D.D.H. No. C31			
(2) D.D.H. No. C57				512	36	0.50	
942	22	0.44	Tr	513	36	0.11	
(3) D.D.H. No. C27				(7) D.D.H. No. C62			
437	36	0.52		958	20	0.69	0.39
438	36	1.52		960	25	0.57	0.52
439	36	0.82		962	13	1.43	0.65
440	36	0.11		964	46	0.68	1.29
441	36	0.12		966	46	0.79	0.53
443	36	0.29		968	8	0.60	9.0
444	36	2.66		(8) Qa x-Cut 1300' RL			
446	36	0.82		Q2A	14	0.22	0.18
(4) D.D.H No. C79				(9) D.D.H. No. C39			
1245	34	1.26	0.40	649	36	2.63	
1246	45	0.35	0.57	650	36	2.83	
1247	35	0.16	0.41	651	36	0.25	
1248	32	0.12	0.26	652	54	1.00	
1249	33	0.18	0.45	(10) D.D.H. No. C88			
1251	27	0.19	0.41	1325	14	1.10	1.35
1263	37	Tr	1.01	1327	9	1.83	0.67
1264	44	0.12	0.37	1328	15	2.30	2.18
1 265	43	Tr	0.37	1330	5	3.93	1.06
1266	33	0.10	0.41	1332	15	2.16	0.74
1267	31	Tr	0.29	1334	34	1.47	0.56
1269	29	0.12	0.20	1335	34	0.79	0.96
1 271	9	1.51	0.34	1336	35	0.50	0.75
1273	26	Tr	0.17	1337	33	1.47	0.99
1274	38	0.26	0.17	1339	32	3.54	1.23
1275	37	Tr	0.25	1340	33	2.33	1.46
1276	42	0.11	0.34				
1277	42	Tr	0.27				
1278	7	Tr	0.27				

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HALL'S LODE, LENS "C" – CONSOLIDATED SAMPLING DATA (Cont.)

Sample No.	Length ins.	Grade % Sn.	% Cu.	Sample No.	Length ins.	Grade % Sn.	% Cu.
(11) D.D.H. No.C38				1065	36	1.03	0.26
?	36	0.69		1066	13	0.99	0.16
(12) D.D.H. No. C90				1068	21	0.70	0.15
1394	26	0.99	0.35	**(18) D.D.H. No. C44**			
1395	32	0.14	0.16	772	36	0.18	
1396	34	0.84	0.81	773	36	0.48	
1397	29	Tr	0.33	775	36	0.75	
1398	34	4.64	0.98	776	24	0.14	
(13) D.D.H. No. C67							
1029	30	0.68	0.61				
1031	20	Tr	Tr				
1032	25	0.13	0.48				
1033	27	0.11	0.12				
(14) V x-Cut,1300' RL Adit							
Q72A	36	1.03	0.53				
Q73A	36	1.57	0.33				
Q74A	36	1.40	0.29				
Q75A	36	1.57	0.41				
Q76A	22	1.39	0.25				
(15) D.D.H. No. C34							
572	36	0.52	0.12				
573	36	1.56	0.32				
574	36	1.11	0.38				
575	36	1.05	0.27				
576	36	0.39	0.58				
577	36	0.32	0.23				
(16) D.D.H. No. C96							
1462	36	0.40	0.19				
1463	32	1.55	0.33				
1464	9	0.35	0.25				
1465	15	0.14	0.21				
(17) D.D.H. No. C72							
1062	23	0.35	0.24				
1063	36	0.49	0.31				
1064	36	0.43	0.32				

4.e. FIDUCIAL INTERVAL AND CONFIDENCE LIMITS

Frequency distributions may be used to compute fiducial intervals and confidence limits about the arithmetic mean, at selected levels of confidence.

At the 95 percent confidence level, for example, we may state (assuming that the data are normally distributed) with only 5 chances in 100 of being incorrect, that the fiducial interval, or the interval between the confidence limits, covers the true arithmetic mean of the population. The fiducial interval is determined from :-

$$F.I. = Ma \pm t_{0.05} \cdot S_{\bar{x}} ,$$

where Ma = arithmetic mean, $t_{0.05}$ is the "t" value for the 95 percent level of confidence and $S_{\bar{x}}$ is the standard error of the mean. The standard error of the mean is given by :-

$$S_{\bar{x}} = \frac{S}{\sqrt{N}}$$

where S = standard deviation and N = total number of items in the distribution. The formula for the standard error of the mean was originally derived for a normal distribution, but gives a good approximation when used with moderately skewed distributions

In mineral evaluation it is desirable to know the degree of reliability or confidence that may be placed in the estimate of the average grade, which is determined from the available sample analyses. To this end, computations have been undertaken in Appendix 1 to determine the fiducial interval at the 95 percent confidence level for frequency distributions 1-6.

The size of the fiducial interval may be decreased by decreasing the standard deviation or increasing the number of samples. Reduction of the standard deviation (which is a function of the ore-body, combined with the physical acts of drilling, sampling, sample preparation and assaying) will become