

THE APPLICATION OF PROBABILITY THEORY TO SEDIMENT SAMPLING

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ABSTRACT

The question of how large a sample should be collected to determine the average sphericity or roundness of a sedimentary deposit has long been unanswered. Tentative answers to this question have ranged from 50 pebbles or sand grains to 150. An attempt is made in this paper to develop a method of sampling which will answer this question from a rigorous mathematical standpoint.

The theory of sampling which is applied in this paper is based on the equation of the standard error of the mean. This equation states that the standard error of the mean of a sample is directly proportional to the standard error of any one observation and inversely proportional to the square root of the number of observations in the sample. From this fundamental expression, it is shown that the number of sedimentary particles required to obtain a tolerated per cent error of the mean of a sample is dependent on two quantities, (a) the true average or mean of the sampled population, and (b) the spread or standard deviation of the population's frequency distribution. The foregoing relations are only true if the sphericity and roundness distributions of the population follow the bell-shaped distribution of a normal curve.

To test this prime requisite, 500 pebbles were collected at random from a glacial outwash deposit. The resulting frequency distributions of roundness and sphericity were found to be essentially normal. The

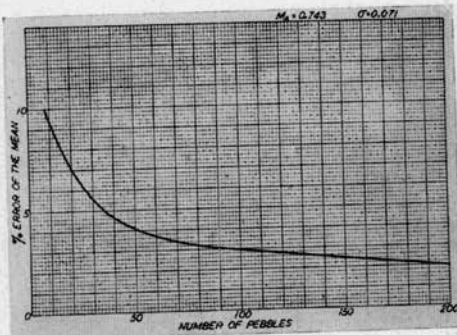


Fig. 1.—Graph illustrating the inverse relationship between sample size and per cent error of the mean.

choice of glacial outwash assured a large spread of the frequency distributions. This is desirable because results obtained from this type of deposit may now be applied to most other types of sediments. Fig. 1 is based on the equation for the standard error of the mean. It illustrates the inverse relationship between sample size and per cent error of the mean. A method of approximation, based on graphs similar to Fig. 1, has been devised by which the true mean of the sampled population is estimated. From this value the sample size is then determined for any tolerated error of the mean.

In general, a sample of 50 particles is more than adequate for roundness and sphericity determinations.