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A CHART FOR JUDGING THE RELIABILITY OF POINT COUNTING RESULTS

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ABSTRACT. The chart presented here, for judging the reliability of point-counting results, is based on twice the standard deviation. For its use, the point distance should be larger than the largest grain size included in the modal analysis.

INTRODUCTION

In petrographic publications there is a growing tendency to give modal analyses of the investigated rocks. In too many cases, however, no information at all is given on their expected reliability, even where the results are specified after the decimal point. This practice is comparable to that of giving chemical analyses in two decimals without raising the question of reliability. Such analyses may be regarded with some mistrust.

We will not deal here with the problem of whether or not a certain hand specimen is representative of a formation or a batholith. As a rule it is not, and since modern analyzing methods are quicker in operation than previous ones, a large number of analyses is usually given nowadays to represent the composition of a greater rock unit. In point counting we also have the question of whether or not a certain thin section may be considered representative of the rock (specimen) from which it was taken. We will touch upon this problem later.

When a modal analysis of a thin section is made, there is obviously a relationship between the number of points counted and the accuracy of the result. In the following section this relationship will be discussed in terms of the standard deviation. The operator's error, usually much smaller than the counting error, will not be considered.

A CHART BASED ON THE STANDARD DEVIATION

When a large number of modal analyses is needed, we should count as many points as are required to reach a predetermined reliability—and no more. This reliability will here be expressed by the standard deviation. For our purpose, a homogeneous rock can be considered as a population of mineral grains with random distribution. In such a case, the standard deviation is given by:

$$\sigma = \sqrt{\frac{p(100-P)}{n}},$$

where: p = the real content of a mineral in percent by volume,
n = the total number of points counted.

This means that our estimate will lie between $p + \sigma$ and $p - \sigma$ in about 68 out of 100 cases, between $p + 2\sigma$ and $p - 2\sigma$ in about 95 out of 100 cases, and between $p + 3\sigma$ and $p - 3\sigma$ in about 99.7 out of 100 cases. The chart presented here gives the values of 2σ for different values of p and n.[1]

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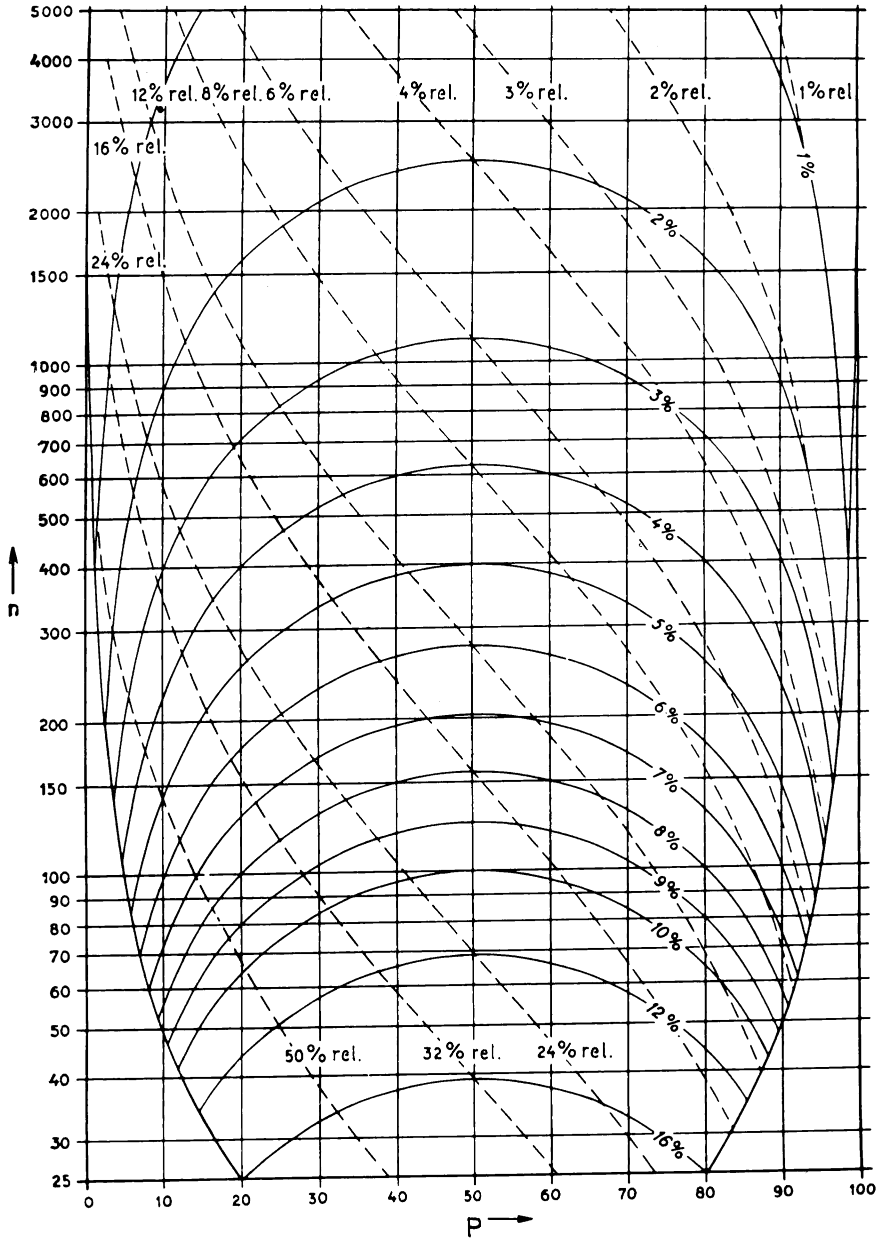
[1] In some cases (see for instance, Nomogramm G-40-195 provided with the Zeiss counting ocular; also Hennig, 1958) charts have been based on the value 0.6745σ, equivalent to a 50 percent probability. This implies that the deviation thus indicated may be exceeded as likely as not. Its use should therefore be discouraged (compare Moroney, 1956, p. 114).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50% rel.
32% rel.
24% rel.

Its use can best be illustrated by an example. If we count 500 points in a thin section of a granite and 140 points fall on plagioclase, the count leads to an estimated content of 28 percent by volume. When we plot these values on the chart, the corresponding 2σ is seen to be 4 percent. This means that the plagioclase content of that thin section lies between 24 percent and 32 percent by volume, with a 95 percent confidence. Similarly, if the biotite content of a rock is roughly estimated to be about 15 percent, we know that we will have to count about 1500 points in order to know the right value within about 2 percent on each side, again with a 95 percent confidence. The relative values of 2σ (where 2σ is expressed as a fraction of p) are indicated by dashed curves. The fields where n times p and n times (100–p) are smaller than 500 are left white, because the type of statistics used here is not valid in these cases. It will be noted that instead of the real content the estimated content is used in the chart. It can be shown that this does not cause seriously different results.

POINT DISTANCE AND GRAIN SIZE

It has been argued that there is no simple relation between the grain size of a rock and the point distance chosen for its modal analysis (Chayes, 1956). This is a curious statement, because obviously in analyzing a pegmatite with a grain size of several cms it would be a waste of time to count with a point distance of say 0.2 mm. When using our chart the relation is clear, because a correct use of the standard deviation as defined above presupposes that successive points do not lead to correlated observations. *This means that the point distance chosen should be larger than the largest grain fraction that is to be included in the analysis.* Van der Plas (1959) arrived at the same conclusion.

Earlier we raised the question whether a thin section could be considered representative of a hand specimen. From the above we may conclude that in a homogeneous rock this is primarily a question of grain size. The rock surface needed for counting depends on the number of points and the point distance, and these in their turn depend on the desired reliability and the grain size. When the needed rock surface is larger than a thin section, one can use several thin sections or a polished, etched, or stained rock surface. In the latter case we need a "macro grid" (Fitch, 1959) or a point counter adapted to that purpose (Smithson, 1963). Finally it should be pointed out that a modal analysis can also be carried out in two or more steps at different scales. For instance, the megacrysts of a megacryst-granite can be determined with a macro method, whereas the components of the matrix are measured in a thin section. In such cases care should be taken that the reliabilities are of the same order in the various steps.

Fig. 1. Chart for judging the reliability of point counting results.
n: total number of points counted.
p: the estimated percentage by volume of a mineral.
full curves: 2σ values.
dashed curves: relative 2σ values.

Example: When, after counting 900 points, the estimated content of a mineral is 10 percent, the real content must be between 8 and 12 percent. For further explanations and limitations, see text.

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