As numerous readers in other countries are not very familiar with the French language, we have thought it desirable for their sake to publish English abstracts of the principal original articles.

Minerals sampling

by Pierre GY

VOL. 1. — GENERAL THEORY

Synopsis by G. MATHERON

The first part of the work is a general introduction. It may be appropriate to read with particular attention Chapter 2, where a certain number of terms which in common use may sometimes be mistaken (accuracy and precision, bias and random error, etc...) are defined and clearly differentiated and where the concept of heterogeneity appears. GY observes that this is an essential concept since all sampling errors result directly or indirectly from the heterogeneity of the sampled substance. We must distinguish the heterogeneity of constitution, which is attributable solely to the fact that the elementary pieces have different compositions, and the heterogeneity of distribution, reflected on the scale of greater volumes which are likely to contain several pieces. Stirring or mixing of the batch have no effect on the first heterogeneity, but can, on the other hand, greatly lessen the second.

With Chapter 4 we approach the core of the subject. This first fundamental theoretical chapter (the other is Chapter 7) is devoted to the « equiprobable » sampling theory. The problem is posed in the form of calculating the variance of the error associated with the taking of a sample containing a number of pieces given in advance under the assumption that all possible samples have at the outset the same probability of being drawn. Some may feel surprised to find here a theory of sampling by constant number of pieces, whilst the actual sampling processes operate in general by constant mass or by constant loose volume. GY indicates, however, that these two processes lead to the same variance of sampling, and it has been possible to demonstrate this point as strictly correct in an article also published in the Revue de l'Industrie Minérale (August 1966). The author has therefore preferred to explain the theory of sampling by constant

number of pieces, which is plainly much easier and does not require the introduction of a complicated mathematical apparatus. The fundamental formula (4,74) established by GY shows that this variance of sampling, as was to be expected, stands in an inverse proportion to the number p of pieces in the sample taken. The coefficient of this term of 1/p presents itself in a remarkable form. It is the variance of a variable Z_i if we take for each piece the value

$$Z_i = \frac{m_i}{\bar{m}_i} - \frac{m'_i}{\bar{m}'_i}$$

where m_i and m'_i designate the mass of the piece and the quantity of useful substance it contains, and $\bar{m}_i$ and $\bar{m}_i'$ represent the average value of the same quantities in the batch.

GY transforms the expression obtained and puts it into a form (4,98) which is infinitely more convenient for practical calculations. He then examines a certain number of applications and of experimental check tests and quotes especially results obtained by BECKER which confirm his theoretical analysis fairly well. He indicates finally in Chapter 5 how the calculations can be carried out in practice. Thanks to his sampling slide rule these can be reduced to a few elementary operations.

This theoretical analysis is naturally adequate only to the degree to which the fundamental theory on which it is built (the equiprobability) has been verified. GY indicates in Chapter 6 in what cases one can expect this hypothesis to be satisfied. In practice it is necessary either that the sample should be constituted of pieces chosen independently of each other in such a way that each of the pieces of the batch has the same probability of being drawn or that the batch itself should have, starting from its initial state, been subjected to blending such that each of the pieces can with equal probability be found to be next to any of the others.

However, such conditions are only exceptionally met with in practice. The variance of the equiprobable sampling thus appears to be a minimum below which one will never go and which will, on the contrary, be most often raised by complementary terms as a result of the heterogeneity of distribution. Chapter 7, which

is the second fundamental theoretical chapter of the work, is devoted to a study of this phenomenon. The heterogeneity is defined in an exact manner by means of the same variable

$$Z_i = \frac{m_i}{\bar{m}_i} - \frac{m'_i}{\bar{m}'_i}$$

which intervened already in the study of the « equiprobable » sampling. As defined by GY, the heterogeneity possesses properties of additivity similar to those of entropy. The heterogeneity of constitution of a batch is actually the sum of the heterogeneity of constitution of the pieces in the fractions of the batch and of the heterogeneity of distribution of the fractions themselves in the batch. GY deduces from that the expression of the term « grouping » which raises the variance of equiprobable sampling and then analyses from a more specific angle the various forces of segregation which are likely to bring about this supplementary term and the way in which these always present forces show up in different types of equipment.

The third part is finally devoted to practical sampling methods. It contains almost no mathematics (except in Chapter 10 where the examination of systematic sampling necessitates a few excursion into the theory of « regionalised variables »), but very specific analytical procedures where the personal experience of the author, enriched by the theoretical analysis of the preceding chapters, finds expression in the form of practical recommendations which the most exacting judgment will not fail to approve (whilst acknowledging perhaps that one would not have succeeded in stating them as clearly). In comparing the sampling methods, i.e , random, systematic and stratified random, GY rejects random sampling as clearly less good than the two others and finally gives preference to stratified random sampling, in spite of a slight theoretical superiority of the systematic method, because of grave dangers which the latter may incur when periodical variations are present.

This much too summary analysis has merely the object of underlining the scientific interest of P. GY's work. The reader, may he be practically or theoretically inclined, must now delve into the work itself and form his own opinion.