

Sampling of discrete materials

III. Quantitative approach—sampling of one-dimensional objects

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Abstract

Part III delineates the close relationships which exist between zero- and one-dimensional objects. The one-dimensional model of flowing streams of matter is presented in sufficient detail to appreciate how on this basis it is possible to perform a complete characterisation of the various heterogeneity components involved. This is achieved by the *variogram*, which forms the central one-dimensional TOS tool for practical sampling purposes. The *variogram* and its features and properties are introduced in detail. The three principal sampling selection modes of one-dimensional systems are delineated. Lastly it is explained how a *variographic experiment* allows estimation of the sampling errors involved in a particular sampling strategy.

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1. Interrelationship between zero- and one-dimensional objects

From a theoretical standpoint, the difference between zero- and one-dimensional objects concerns a difference in *internal correlation*—“autocorrelation”—and in *observation scale*.

According to the strict definition of a zero-dimensional object there is, or there should be, no correlation between its constituents. However, the concept of autocorrelation is not binary (0 or 1): it can take any value between these two limits. Autocorrelations of zero or one are practically inaccessible limits that suppose a *complete distributional homogeneity* of the material in the first case¹ a *complete segregation* of the constituents in the second. A very powerful analysis tool, the *variogram*, will be defined in Section 3. A variogram detects and quantifies the autocor-

relation between the compositions of the materials to be found on two points of the time axis. It shows the quantified autocorrelation as a function of the *distance* between these two points, in fact it depicts the autocorrelation for an entire *range* of inter-distances. Usually, the smaller the distance, the larger is the autocorrelation between them.

Consider a lot L which flows from time $t=0$ to time $t=T_L$. On the time axis, this lot L can be broken up into a sequence of adjacent segments of uniform length T_I . Each of these segments supports a *potential increment*, I , which could be used for sampling the flow. The autocorrelation of the time series is perceptible at the scale of the total time interval $[0, T_L]$, but is usually imperceptible at the scale of the individual time segments.² To all practical intents and purposes, each time segment T_I can be regarded as a zero-dimensional object. Hence the practical conclusion that for our sampling purposes, a one-dimensional object L can be regarded as a time series of adjacent zero-dimensional

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¹ Bed-blending. The author proposed the theory and associated practice of this technique in [18]. This technique *reduces* the autocorrelation of a one-dimensional object (e.g. a flowing stream) to a *natural minimum* which is a function of the material properties.

² The great French fabulist *La Fontaine* did certainly not have the autocorrelation of a time series in mind when he wrote: *De loin c'est quelque chose mais de pres ce n'est rien* (*Seen from afar it is something but at close range it is nothing*)—but his observation fits wonderfully.