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# Standard Guide for Selection of Simulation Approaches in Geostatistical Site Investigations<sup>1</sup>

This standard is issued under the fixed designation D5924; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

Geostatistics is a framework for data analysis, estimation, and simulation in media whose measurable attributes show erratic spatial variability yet also possess a degree of spatial continuity imparted by the natural and anthropogenic processes operating therein. The soil, rock, and contained fluids encountered in environmental or geotechnical site investigations present such features, and their sampled attributes are therefore amenable to geostatistical treatment. Geostatistical simulation approaches are used to produce maps of an attribute that honor the spatial variability of sampled values. This guide reviews criteria for selecting a simulation approach, offering direction based on a consensus of views without recommending a standard practice to follow in all cases.

### 1. Scope

1.1 This guide covers the conditions that determine the selection of a suitable simulation approach for a site investigation problem. Alternative simulation approaches considered here are conditional and nonconditional, indicator and Gaussian, single and multiple realization, point, and block.

1.2 This guide describes the conditions for which the use of simulation is an appropriate alternative to the use of estimation in geostatistical site investigations.

1.3 This guide does not discuss the basic principles of geostatistics. Introductions to geostatistics may be found in numerous texts including Refs (1-3).<sup>2</sup>

1.4 This guide is concerned with general simulation approaches only and does not discuss particular simulation algorithms currently in use. These are described in Refs (4-6).

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>3</sup>

**D653 Terminology Relating to Soil, Rock, and Contained Fluids**

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

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<sup>2</sup> The boldface numbers in parentheses refer to a list of references at the end of the text.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[D5549 Guide for The Contents of Geostatistical Site Investigation Report \(Withdrawn 2002\)](#)<sup>4</sup>

[D5922 Guide for Analysis of Spatial Variation in Geostatistical Site Investigations](#)

[D5923 Guide for Selection of Kriging Methods in Geostatistical Site Investigations](#)

### 3. Terminology

#### 3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *conditional simulation, n*—a simulation approach where realizations of the random function model are constrained by values at sampled locations.

3.1.2 *drift, n—in geostatistics*, a systematic spatial variation of the local mean of a variable, usually expressed as a polynomial function of location coordinates.

3.1.3 *field, n—in geostatistics*, the region of one-, two- or three-dimensional space within which a regionalized variable is defined.

3.1.4 *indicator variable, n*—a regionalized variable that can have only two possible values, zero or one.

3.1.5 *kriging, n*—an estimation method where sample weights are obtained using a linear least-squares optimization procedure based on a mathematical model of spatial variability and where the unknown variable and the available sample values may have a point or block support.

3.1.6 *nonconditional simulation, n*—a simulation approach where realizations of the random function model are unconstrained by sample data.

3.1.7 *nugget effect, n*—the component of spatial variance unresolved by the sample spacing and the additional variance due to measurement error.

3.1.8 *point, n—in geostatistics*, the location in the field at which a regionalized variable is defined. It also commonly refers to the support of sample-scale variables.

3.1.9 *realization, n*—an outcome of a spatial random function or a random variable.

3.1.10 *regionalized variable, n*—a measured quantity or a numerical attribute characterizing a spatially variable phenomenon at a location in the field.

3.1.11 *simulation, n—in geostatistics*, a numerical procedure for generating realizations of fields based on the random function model chosen to represent a regionalized variable.

3.1.12 *smoothing effect, n—in geostatistics*, the reduction in spatial variance of estimated values compared to true values.

3.1.13 *spatial average, n*—a quantity obtained by averaging a regionalized variable over a finite region of space.

3.1.14 *support, n—in geostatistics*, the spatial averaging region over which a regionalized variable is defined, often approximated by a point for sample-scale variables.

3.1 *Definitions of Other Terms—Definitions:* For definitions of other terms used in this guide, refer to Terminology [D653](#) and Guides [D5549](#), [D5922](#), and [D5923](#). A complete glossary of geostatistical terminology is given in Ref (7).

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology [D653](#).

#### 3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *conditional simulation, n*—a simulation approach where realizations of the random function model are constrained by values at sampled locations.

3.2.2 *drift, n—in geostatistics*, a systematic spatial variation of the local mean of a variable, usually expressed as a polynomial function of location coordinates.

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3.2.8 *point, n—in geostatistics*, the location in the field at which a regionalized variable is defined. It also commonly refers to the support of sample-scale variables.

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).