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Standard Guide for Contents of Geostatistical Site Investigation Report[1]

This standard is issued under the fixed designation D5549; 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 (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Geostatistics is a framework for data analysis and estimation in media whose measurable attributes show erratic spatial variability yet also possess a degree of spatial continuity imparted by the natural and anthropogenic process 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. This guide is concerned with the reporting of such investigations.

1. Scope

1.1 This guide covers the contents required for a complete report of a geostatistical site investigation. A complete report is understood here to be one that contains all the information necessary to the understanding and evaluation of the geostatistical site investigation by other geostatisticians.

1.2 This guide does not discuss the reporting of supplementary information that may assist evaluation of the report.

1.3 While geostatistical methods are used in many fields, this guide is primarily intended for the reporting of environmental and geotechnical applications.

1.4 The basic geostatistical methods referred to in this guide are fully described in texts by David (**1**),[2] Journel and Huijbregts (**2**), Clark (**3**), and Isaaks and Srivastava (**4**). Olea (**5**) gives a thorough compilation of geostatistical terminology as well as (**6**) a practical description of the subject for engineers and earth scientists. Chiles (**7**) and Goovaerts (**8**) provide material on how to deal with spatial uncertainty and how to use geostatistics for the evaluation of natural resources.

1.5 This guide does not discuss the reporting of multivariate, space-time, and other less-frequently used geostatistical methods; however this is not intended to reflect any judgment as to the validity of these methods.

1.6 Geostatistics is but one approach that can be used to understand and describe site conditions. Investigations should incorporate whatever supplementary knowledge of the site that may be available from other sources. As with classical statistical approaches, geostatistics is not intended to establish cause-and-effect relationships.

1.7 *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.*

1.8 *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:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

3. Terminology

3.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

[1] This test method 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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[2] The boldface numbers in parentheses refer to a list of references at the end of the text.

[3] 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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *additivity, n*—a mathematical property of a regionalized variable stating that it can be combined linearly in order to define a similar variable on a larger support.

3.2.2 *correlogram, n*—a measure of spatial continuity expressing the coefficient of correlation between two variables as a function of the lag distance separating their locations.

3.2.3 *covariance, n*—a measure of similarity between two variables defined as the expected value of their product minus the product of their expected values and often used to measure spatial continuity between two variables as a function of the lag distance separating their locations.

3.2.4 *cross validation, n—in geostatistics*, a procedure by which the suitability of an estimation method is assessed by sequentially removing and estimating sample data, and comparing the resulting pairs of true and estimated values.

3.2.5 *drift, n—in geostatistics*, a systematic spatial variation that is usually expressed as a polynomial function of location coordinates.

3.2.6 *estimation, n—in geostatistics*, a procedure by which the value of a variable at an unsampled location is predicted using a weighted average of available sample values from the neighborhood of that location.

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

3.2.8 *geostatistics, n*—the application of random function theory to the analysis and estimation of natural phenomena characterized by the erratic spatial variability of their measurable attributes.

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

3.2.10 *kriging variance, n*—the expected value of the squared difference between the value of an unknown variable and its kriging estimate, sometimes used as a measure of kriging precision.

3.2.11 *lag, n—in geostatistics*, the distance vector separating the locations of two variables, as used in measures of spatial continuity.

3.2.12 *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.

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

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

3.2.15 *search neighborhood, n*—the region over which samples are considered for inclusion in the kriging process.

3.2.16 *simulation, n—in geostatistics*, a Monte-Carlo procedure for generating realizations of fields based on the random function model chosen to represent a regionalized variable. In the case of conditional simulation, the realizations are constrained to honor data values measured at sampled locations.

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

3.2.18 *variogram, n*—a measure of spatial continuity defined as one half the variance of the difference between two variables and expressed as a function of lag distance. It is also sometimes referred to as the semi-variogram.

4. Summary of Guide

5. Significance and Use

5.1 This guide is intended to encourage consistency and thoroughness in the reporting of geostatistical site investigations by describing the basic information required in a complete report.

5.2 Referring to the table of contents suggested in Table 1, this guide may be used as a template by those preparing reports or as a checklist for review and auditing purposes by qualified nonparticipants in the study.

6. Contents of a Geostatistical Site Investigation Report

TABLE 1 Suggested Table of Contents for a Geostatistical Site Investigation Report

Report Heading	Section
Objectives	6.2
Site Description	6.3
Data Sources	6.4
Definition of Field	6.5
Choice of Regionalized Variable	6.6
Exploratory Data Analysis	6.7
Spatial Continuity Analysis	6.8
Estimation	6.9
Simulation	6.10
Conclusions and Recommendations	6.11
References	6.12
Computer Software	6.13

6.1 Table 1 shows the suggested table of contents for a geostatistical site investigation report and the corresponding sections of the standard that apply to each heading.

6.2 *Objectives*—The report of a geostatistical site investigation should contain a section stating study objectives. Throughout the report, selected procedures, assumptions, and approximations should be justified in terms of these objectives. Objectives must be shown to be consistent with the data quality, sample spacing, and site coverage available.

6.3 *Site Description*—The report of a geostatistical site investigation should contain a section summarizing site history and conditions, both physical and chemical, relevant to the study.

6.3.1 Maps should be used to show the location of the site relative to country, state, province, county or similar boundary lines; roads; population centers; bodies of water, and other physiographic features.

6.3.2 Detailed site plans should be provided if the site has numerous cadastral, physical, or biological features that influence access to sample data locations or future survey locations related to the geostatistical study. Plans should be provided at