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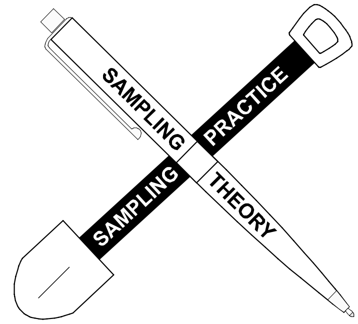
OFFICE OF RESEARCH AND DEVELOPMENT — TECHNOLOGY SUPPORT PROJECT

EPA

Correct Sampling Using the Theories of Pierre Gy



Introduction

The Environmental Sciences Division (ESD) of the National Exposure Research Laboratory is interested in the optimization of sampling protocol, sampling tools, subsampling techniques, and sample analysis. The importance of obtaining representative samples in the field and retaining their integrity throughout the analytical procedures is fundamental to the generation of meaningful data. Because sampling correctness and representativeness is critical to the collection and handling of environmental samples, the ESD has hosted short courses presented by Francis Pitard to explain and enforce the theories of Pierre Gy relating to the sampling practice of particulate solids. The inherent heterogeneity of soils presents a particular challenge to field personnel who are responsible for sampling hazardous waste sites. This heterogeneity is also a factor that must be addressed by statisticians, geostatisticians, and chemometricians as they develop sampling plans for the location and frequency of sampling. It affects the manner in which analytical chemists subsample in the laboratory. Finally, heterogeneity influences the interpretation of data and the decisions made about the actions taken to remediate contamination at a site. The theories of Pierre Gy present practical sampling and subsampling methods that can be applied for little or no added expense. Careful attention to these techniques can result in samples that better represent the site and data that more truly represent the sample.

True and complete homogeneity is a meter of scale and is impossible to achieve for particulates because many factors, including gravity, work against it. But the extent of heterogeneity and its effect on environmental sampling can be minimized. Established methods from the mining industry are applicable to the sampling of soils. The work of George Matheron, father of geostatistics, and Pierre Gy, sampling expert, can provide useful insights for environmental scientists who are faced with sampling a complex matrix for trace contaminants.

Types of Error

Pierre Gy's theory addresses seven types of sampling error and offers proven techniques for their minimization. The seven major categories of sampling error cover differences within samples. Other differences can exist, such as, within space (covered by geostatistics) and within time (covered by chronostatistics). The internal sample errors are:

Fundamental Error: This is loss of precision inherent in the sample due to chemical and physical composition and includes particle size distribution. It can be reduced by decreasing the diameter of the largest particles or by increasing the sample mass.

Grouping and Segregation Error: Error due to non-random distribution of particles, usually by gravity. It can be minimized by compositing an analytical sample from many randomly selected increments or by properly homogenizing and splitting the sample.

Long-range Heterogeneity Error: This is fluctuating and non-random. It is spatial and may be identified by variographic experiments and can be reduced by taking many increments to form the sample.

Periodic Heterogeneity Error: This fluctuation error is temporal or spatial in character and can be minimized by compositing samples correctly.

Increment Delimitation Error: Error tied to inappropriate sampling design and the wrong choice of equipment.

Increment Extraction Error: This error occurs when the sampling procedure fails to precisely extract the intended increment. Well-designed sampling equipment and good protocols are crucial.

Preparation Error: This error is the expression of loss, contamination, and alteration of a sample or subsample. Field and laboratory techniques exist to address this problem.

To truly represent a lot (or a hazardous waste site) a sample must be both accurate and precise. Obviously, 100% accuracy and precision cannot be obtained. It is important to minimize the error that is introduced in that sample-taking and in the subsequent handling, subsampling, and preparation. If large-scale heterogeneity is ignored in a sampling design, data generated from the preferentially sampled material will never truly reflect the character of the site.

Devices

Correct sampling devices are essential to good sampling protocol and to good laboratory practice. Pierre Gy recommends scoops and spatulas that are flat, not spoon-shaped, and have parallel sides, to avoid the preferential sampling of coarse particles. Additional care must be taken at the analytical laboratory, where error can be introduced by poorly designed riffle splitters, spatulas, and vibrating tools. It is recommended that the sample be subsampled using a system of exhaustive alternate shovelling wherein a large sample is "dealt out" into several smaller piles. One of these subsamples is chosen for the analysis. This method avoids preferential

Summary

Methods developed for the mining industry can provide environmental scientists with guidance for the correct sampling and subsampling of soils. The sampling theories of Pierre Gy are applicable to some sampling events at hazardous waste sites and to the successful subsampling of those samples at the analytical laboratory. Careful use of practices suggested by Pierre Gy will result in samples that better represent the site and higher quality data for little or no added expense.

References

Pitard, F. F., *Pierre Gy's Sampling Theory and Sampling Practice*, 2 Volumes, CRC Press, Inc., Boca Raton, Florida. 1989.

For Further Information

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