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Representative sampling of soil for environmental analysis: application of the principles of Gy's theory of sampling to the analysis of heavy metals in soil samples

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During environmental site assessment and soil studies, concentrations of contaminants in the soil are determined following a sequential procedure which includes sampling pattern definition, field sampling, mass reduction, laboratory sub-sampling, analytical sampling and analysis. Each step in the procedure produces some amount of variability (or uncertainty) which is cumulated and ultimately associated with the final analytical result, i.e. the concentration of the contaminants of interest. Maintaining this uncertainty under established threshold values is critical for data quality as well as for any subsequent use of the data (e.g. modeling, ecotoxicological studies).

It is assumed that the uncertainty associated with all steps pertaining to sampling amounts to more than 95% of the total uncertainty, while less than 5% is normally attributed to the analytical procedure. Gy's theory of sampling makes it possible to identify, quantify and control sources of uncertainty in the sampling and analysis process. Nevertheless, this process is still performed without using prescriptions from Gy's theory and in many situations simply ignores them.

Environmental soil sampling and analysis is a very recent field of application of Gy's theory. Based on the work of Gy and his collaborators, as well as on recent guidance from the US EPA, the basic principles of the theory will presented as they could be applied to environmental assessment. Results from the literature and from experiments conducted at the École de technologie supérieure will be used to exemplify the application of the theory to the sampling and analysis of soils contaminated with

metals. Sources of uncertainty related to sampling and sample preparation for analysis will be discussed. The influence of specific parameter on the total uncertainty will be investigated. Such parameters will include sample mass, particle size, the analyte's liberation factor, and soil humidity. Sampling and mass reduction methods as well as sample grinding will also be discussed at the field and laboratory scales.

Key words : contaminated soils, heavy metals, sampling theory, uncertainty, field sampling, laboratory sampling, mass reduction, grinding.