Contribution ID: **137** Type: **Oral Poster**

Geostatistics for radiological characterization: Sampling optimisation, data interpretation and risk analysis

Wednesday 25 May 2016 10:40 (5 minutes)

Need for proper characterisation
Dismantling and decommissioning of nuclear facilities or remediation of contaminated sites are industrial projects with huge challenges. Precise knowledge of the contamination state is required. Radiological evaluations have multiple objectives to be considered: determination of average activity levels, to allow the categorization of surfaces or volumes (sorted into different radioactive waste categories); location of hot spots (small areas with significant activity levels); and estimation of the source term (total activity) contained in soils or building structures. In addition there are radiation protection and other logistics considerations.
Estimates are essential for the proper management of these projects. Currently, characterization remains relatively empirical. Accumulated approximations often have serious consequences that threaten the project's successful completion, for example through over-categorization or unexpected contamination.
Radioactive contamination is generally complex and involves numerous parameters: radiological fingerprint, transfer path, type of contaminated materials, presence of different matrices (soils, concrete), and so on. Numerical modelling often turns out to be very difficult.
The characterization phase should be efficient and the sampling strategy has to be rational. However, investigations also represent capital expenditure; the cost of radiation protection constraints and laboratory analysis can represent a large amount of money, depending on the radionuclide. Therefore the entire sampling strategy should be optimized to reduce useless samples and unnecessary measures.

Geostatistics methodology
The geostatistical approach, which provides consistent estimates and reliable maps, is an appropriate solution for data analysis. Geostatistics aims to describe structured phenomena in space, possibly in time, and to quantify global or local estimation uncertainties. Estimates are calculated from a partial sampling and result in different representations of the contamination, including interpolation mapping ('kriging'). But the added value of geostatistics goes beyond this. Its benefit is its ability to quantify estimation uncertainty and provide risk analysis for decision making. More advanced and sophisticated geostatistical methods, such as conditional expectation or geostatistical simulations, can be used to quantify risk of exceeding the threshold, for instance. These estimates are powerful decision-making aids when classifying surfaces and volumes before decontamination starts (based on different thresholds as well as considering the remediation support impact).
Finally, multivariate geostatistics allows different kinds of information to be combined to improve estimates, using the spatial correlations between variables. Physical and historical data and non-destructive measurement results (for example dose rate or in situ gamma spectrometry) are integrated to improve understanding and prediction of the main variable (results of laboratory analysis, for example) while reducing the estimation uncertainty.

Data consolidation and sampling optimisation
To use geostatistics, datasets must be consistent for correct data processing: the same sampling protocol must be used, measurement or analysis must be performed in a short period if the decay rate is sensitive; data of the same type must be expressed in the same unit, and so on. This may seem obvious, but a lot of time can be lost in correcting errors and ensuring that the data are really consistent: coordinates, dates, units, physical and radiological heterogeneities, odd correlations⋯
In addition, the spatial structure of radioactive contamination makes the optimization of sampling (number and position of data points) particularly important. Geostatistics methodology can help determine the initial mesh size and reduce estimation uncertainties.

Application cases and lessons learned
Geostatistics can be applied to a range of radiological characterization. The only limitation is the quality of the input data, since they are fundamental to describing spatial structure of the phenomenon. Geostatistics maps can cover very small areas (a few m^2 or a few m^3) or very large sites (at a country scale) as presented in several application cases: characterization of a legacy site, post-accidental mapping, building structure categorization⋯
To conclude, geostatistics is a very powerful tool to analyze, consolidate and give value to collected pieces of in-

formation. The exploratory data analysis, in combination with the spatial structure interpretation (variogram) is probably the most interesting part of the characterization. It results in mapping outputs, risk analysis and sampling optimization.

Country or International Organization

GEOVARIANCES

Type "YES" to confirm submission of required
 Forms A and B via the official channels

YES

Primary author: Dr DESNOYERS, Yvon (Geovariances)

Presenter: Dr DESNOYERS, Yvon (Geovariances)

Session Classification: Session 4B - 1

Track Classification: Technical and Technological Aspects of Implementing Environmental Remediation Programmes