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Analysis on Data Uncertainty of HLW Disposal Process

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Abstract. HLW disposal process includes many uncertainties, such as scenario uncertainties, model uncertainties and data and parameter uncertainties and so on. However, the uncertainty of data is the source of all other uncertainties. Regarding addressing the data uncertainties in HLW disposal process, the paper focus on analyzing the concrete performing form of spatial uncertainties, and figure out the reason of producing the data uncertainties. Meanwhile, the paper points out the influence of the uncertainties and the solution of addressing and eliminating the spatial uncertainties.

1. Introduction

High-level radioactive waste (HLW) contains quite toxic, long half-life and high-level radionuclide, which has enormous impacts on our environment and society. Until now, "deep geological disposal" is generally acknowledged as a feasible method for regulations and international related researches, it is noticeable that uncertainties from different stages of the disposal process are the serious challenges we are facing now^[2,3]. The various uncertainties contain parameter uncertainties, scenario uncertainties, variation uncertainties and model uncertainties and so on. Thereinto, data uncertainties are the main source of resulting all the uncertainties. So recognizing the data uncertainties, analyzing the impact of uncertainties and controlling the uncertainties factors are significant to long-term stability of URL repository and the reliability of safety assessment.

2. The phenomena of data uncertainties

Earlier studies concluded that uncertainties of data mainly refer to the error of data, however, now the uncertainty is regarded as a wide conception about data, including error, accuracy, precision, vagueness and so on^[4]. The academic world focus on the uncertainties of spatiotemporal data, there are amounts of relevant researches. In the light of spatial data, Shi Wenzhong, Wu Lun, and other scholars pointed out systematic error is inevitable, but can be measured by accuracy indexes and uncertainty results. In addition, abnormal data, wrong spatial topology and various problems of data quality, can be detected and solved by SDT standard and mathematical analyses to control the spread of uncertainties in the whole procedure^[5,6]. Since 1985, we have already collected large amounts of data. Based on the requirements of site-selected norms, the geoscientific information database for HLW pre-selected sites has been built already, the database includes ten thematic data sets, such as the data sets about geology, hydrology, rock mechanics, but there are the prevailing problems in the integrality, consistency and topology of data. In the future work of building underground research laboratory, we must face the same problem about data uncertainty. According to the analysis of available data, the phenomena of site-selected data uncertainties are as follows.

2.1 Deficiency of meta data



Over the past 30 years, a part of the recorded data in the pre-site geoscientific information database lack complete meta data. The phenomena are obvious in earlier geophysical prospecting, for example the lack of recording the environmental conditions and instrument accuracy when collecting the data, the deficiency influence later use of the data.

2.2 Ambiguity of attribute description

Ambiguity is caused by definitions with different meaning under varying classification schemes or weak definitions without consideration of environment. For example, there exist using “granite” to describe the rock of repository, rather than " monzonitic granite ", a more accurate term.

2.3 Vagueness of spatial elements

Vagueness arises due to overlapping definitions and a lack of distinctness between ill-defined or fuzzy classes of objects or individual objects. For example, when distinguishing the categories of rock, due to the limit of density and the distribution pattern, it is difficult to ensure the spatial data.

2.4 Inaccuracy and imprecision of location

Accuracy means difference between a recorded value and true value; precision means the detail with which a measurement is reported. For example, there are deviations of truth about geometric position of drill holes.

3. The effect of data uncertainties

HLW disposal process includes many uncertainties, such as scenario uncertainties, model uncertainties and data and parameter uncertainties and so on. However, the uncertainty of data, whose effects transmit to the intended application, is the source of all other uncertainties, On the procedure of processing, analyzing and applying data, due to the transformations, the uncertainties are amplified to affect the result of safety evaluation and long-term stability of URL site.

3.1 Effect on scenario description

The descriptions about the natural barrier scene request the objective, scientific and accurate geoscientific traits. All the existing uncertainties result in that we cannot truly reflect spatial pattern and attribute traits, result in the imprecision of depicting systematical scenes.

3.2 Effect on result of evaluation

Applying data for evaluating long-term stability and safety of repository, through the application models (such as radionuclide migration model) and numerical simulation (such as seismic numerical simulation).The uncertainty dependent on the application, the uncertainty caused by data processing and the uncertainty inherent in data will seriously affect the reliability of result.

3.3 Effect on support and confidence

These data are very important for predicting the sorption, diffusion and migration behaviors of these radionuclides in different hydro-geological conditions, and in scientific community, more uncertainties have been existed, lower confidence existed in the public. Detailed and accurate data will take the geologic repository to be widely accepted not only by science, but also by public.

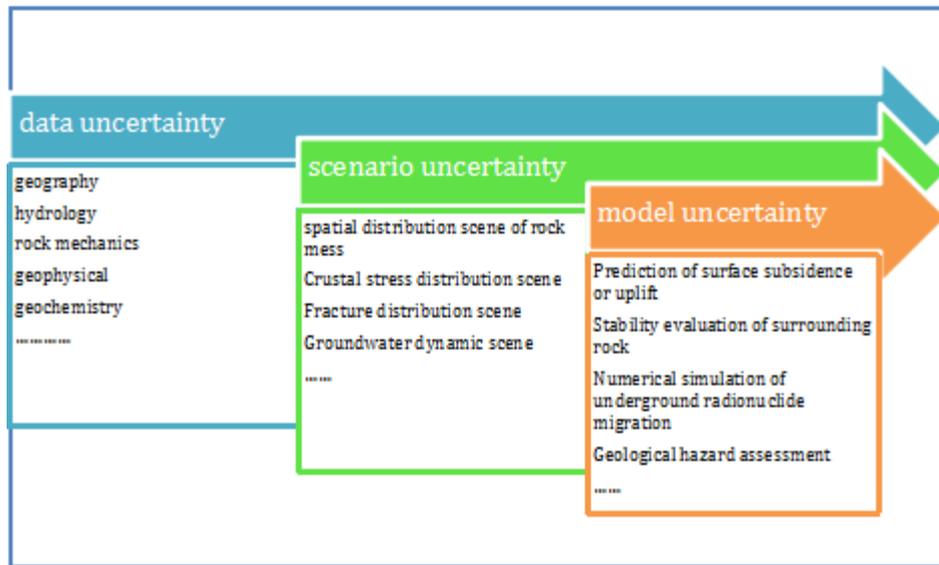


Figure 1. Effect of data uncertainties.

According to the studies on HLW geological disposal by international research institute, uncertainties are the fundamental issue of the research. The uncertainties inherent on the data may induce the emerging of scenario or model uncertainties through the transmission (as picture). Finally, all the uncertainties will directly affect the management of researching the repository system and reliability of evaluation.

4. The plan for controlling uncertainties

There have already been some scholars who propose probability theory and fuzzy mathematics to solve the uncertainty problem. These existing data quality control methods will help the future data processing to test and minimize and quantitative assess the uncertainties, which will be one of the most important R&D directions in various assessments.

Aimed to the available data, we can use the methods to detect and control the following three types of uncertainties.

4.1 Incompleteness of data:

In the database, meta data is used to record the content, quality and relevant information of spatial data. The users or managers can decide whether the data is suitable for the intended application by the meta data. Based on the meta data standards built by FGDC, we can avoid the misuse and incompleteness of data.

4.2 Inconsistency of spatial topological relations:

In geological information system, topology is used to describe the correlations of point, line and polygon, so the accuracy of spatial data can be tested by topology. If we detect unreasonable overlap of spatial elements through the topological test, we can check the certain unsure district again by field verification, and redistrict the range of zone.

4.3 Inaccuracy of monitoring data:

When we research on the hydrogeology of pre-site region, we have to monitor the crustal stress, water level of drills and temperature value. Due to the interferences of external factors, there may be noise, jump point and other unreasonable value. Aimed at the problem, we can apply Kalman filter to denoising.

5. Conclusions

This paper points out the phenomena of data uncertainty during the data collection, introduces the harmful effect of data uncertainty in the HLW programs, and proposes the scheme of controlling data uncertainty. All these researches about data uncertainties are meaningful to the R&D results of HLW geological disposal. However, due to the complication of HLW geological disposal process, there are more than ten types of subject fields, including geology, hydrology, rock mechanics and so on. Every subject field has different uncertainties. We need to explore and research thoroughly from the following aspects, phenomena, factors, test methods, subtractive technologies of uncertainties. Thus we can effectively prevent the uncertainties of R&D results of HLW geological disposal from the resources of uncertainties.

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