A Case Study on Suggestion of Relative Weighting Values of Geologic Safety Elements for HLW Disposal

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1. Introduction

It is necessary to evaluate geological elements and their characteristics for HLW disposal in quantitative manner. In especial, long term geologic characteristics are directly related to the stable operation of disposal system for long periods. Geologic elements are evaluated qualitatively in general geologic fields, while they should be characterized quantitatively to acquire accurate results for radioactive wastes disposal. Quantitative evaluation of geologic characteristics is very effective in case of complex analyses of multiple geologic elements. Therefore, the authors conducted a case study to decide geologic elements which should be evaluated for HLW disposal and to assign their relative weighting values using an applied statistical method. In this study, the weighting values are assigned only for the geologic elements which are evaluated for the first stage of geologic safety evaluation.

2. Analysis of Relative Weighting Values of Geologic Safety Elements by AHP Method

In order to assess geologic safety of a candidate site for HLW disposal, this study assumed three stages of site evaluation. The first evaluation stage recommends several preferred areas for HLW disposal in the regional scale. On the second stage, candidate sites can be designated based on the results of field survey and evaluation on the preferred areas. One or two proposed sites are selected on the third stage considering geologic safety and site suitability. This study listed geologic factors for evaluation of geologic safety and site suitability.

Table 1. Geologic factors to be considered for geologic safety of a candidate site

Functions	Items	Parameters	Functions	Items	Parameters
Geology and Topography			**Geology and Topography**		
	Lithology	Rock type		Neotectonics	Volcano
		Diversity			Uplift / Subsidence / Erosion
		Homogeneity		Weathering (exposed rock)	Soil cover
		Volume			Depth
		Ore		Topography	Topographical gradient
	Ductile structures	Mylonite zone			Quaternary deposits
		Fold	**Rock mechanics**		
		Foliation		Mechanical & Thermal properties	Strength
	Brittle structures	Joint			Deformation modulus
		vein / dyke			Fracture geometry
		Fault zone			Rock mass quality
	Neotectonics	Active fault			Coeff. thermal expansion
		Earthquake			

Functions	Items	Parameters	Functions	Items	Parameters
Rock mechanics					Eh
	Mech.& Therm. properties	Thermal conductivity			Fe^{2+}, HS^-
		Geothermal gradient			TDS
	Initial rock stress	In-situ stresses			DOC
Hydrogeology & Geochemistry					Organic and others
	Hydrogeology	Hydrogeologic unit		Geochemistry	Retardation factor
		Hydraulic conductivity			Isotopes
		Transmissivity			Groundwater age
		Hydraulic gradient			Ca^{2+}, Mg^{2+}
		Groundwater flow			Radionuclides(Ra, Rn)
		Gas transport properties			Pyrite, Biotite
		Diffusion	**Meteorology & Natural Hazards**		
		GW body types		Meteorology	Precipitation
		GW pathway			Storm
		pH		Natural Hazards	Landslides
		Eh			Flood

This study suggests relative significance of each geologic parameter to evaluate geologic safety quantitatively using the AHP analysis method. Relative significance of six items which would be considered on selection stage of the preferred areas was calculated on the first step, and then, the significance of each parameter was decided based on the results of items significance.

Table 2. Analysis result of relative significance of each geologic parameter

Item	Score	Parameter	Score	Item	Score	Parameter	Score
Lithology	18	Rock type	7	Neotectonics	35	Active fault	15
		Diversity	4			Earthquake	13
		Homogeneity	3			Volcano	5
		Volume	4			Uplift/Subsidence/Erosion	2
		Ore	2	Weathering	5	Soil cover	1
Ductile structures	10	Mylonite zone	2			Depth	4
		Fold	2	Topography	7	Topographical gradient	2
		Foliation	6			Quaternary deposits	5
Brittle structures	25	Fault zone	15	Total	100		100
		Joint	7				
		vein / dyke	3				

3. Conclusion

The suggested relative significance of parameters can be used to understand importance of geologic factors for site evaluation. However, the result should be reviewed on the real stage of site selection and modified with consideration of deep geologic environment.