GEOLOGICAL INVESTIGATION FOR HIGH LEVEL RADIOACTIVE WASTE ISOLATION IN JAPAN

K. DOI AND M. YAMAKAWA

Power Reactor and Nuclear Fuel Development Corporation
1-Chome, 9-13, Akasaka, Minato-ku
Tokyo, Japan

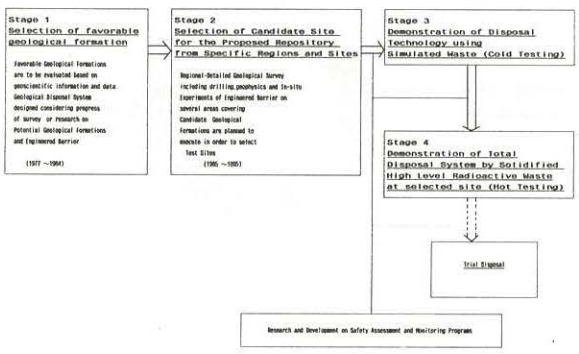
INTRODUCTION

The concept of geological disposal is to isolate the high level radioactive waste in a repository constructed at a depth of several hundred metres in a selected geological environment in Japan.

Such waste material should undergo vitrification with Boro-Silicate Glass for immobilization and be stored under control for a period of thirty to fifty years for cooling down prior to geological isolation.

As shown in Table 1, the national program of research and development for geological disposal of the high level radioactive waste has been carried on since 1977. There are four major stages in this program.

(Table 1) General Scheme for geological Disposal Program in Japan



The first stage is called Selection of Favourable Geological Formation and is based mainly on geological evaluation by means of utilizing various existing geoscientific information and data. This stage was completed in 1984.

The second stage is called Selection of the Candidate Site for the proposed repository from specific regions and sites. We are currently in the second stage of the project, which will be completed by 1995.

The third stage is called Demonstration of Disposal Technology using Simulated Waste (Cold Testing)

The fourth, which is the final stage of the project, consists of demonstration of the total disposal system using solidified high level radioactive waste at the selected site (Hot Testing).

Authorized by the Japanese government, the Power Reactor and Nuclear Fuel Development Corporation (PNC) has been performing the Research and development of geological disposal for high level radioactive waste under the national program since 1977.

GEOLOGICAL INVESTIGATION IN THE FIRST STAGE (1977-84)

During the period between 1977 and 1984, we have been investigating the possibilities for the construction of a repository and the selection of a favourable geological formation for radioactive waste isolation.

Simultaneously, we have been continually reviewing the concept of a geological disposal system within the context of our findings during stage one.

As shown in Figure 1, the Japanese islands are divided into three tectonic blocks which are bounded by two major fault zones. One is the Fossamagna and the other is the Median Dislocation Line (Median Tectonic Line). Geoscientific data indicate that geotectonic and volcanic activities have occurred since the Paleozoic Era, and they were particularly active in the Neogene. For instance, more than seventy active volcanoes and more than fifty earthquakes measuring over the magnitude of seven on the Richter Scale have been reported in the past hundred years. This is a result of the fact that Japan is located right on the Circum Pacific Island Arc.

Table 2 summarizes the distribution of all geological formations. According to Table 2, sedimentary and igneous rocks have distribution ratios of 58% to 42% respectively, and approximately 80% of granitic rocks described as acidic intrusives were intruded in the Cretaceous and early Tertiary.

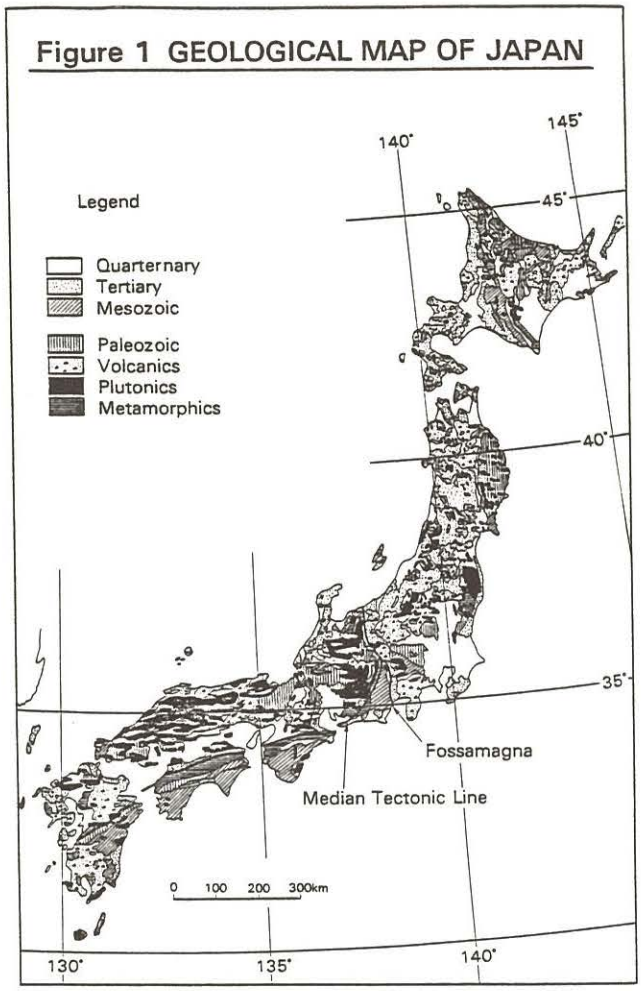
Based on the geological features mentioned above, we have evaluated several predominant geological formations such as intrusives or effusives and sedimentary rocks as to their favourability for waste isolation, while paying special attention to the effect of migrating ground water within such formations.

As a result of geological and geochemical evaluation in stage one, it has been recognized that the potential for the selection of a favourable geological formation for geological disposal is very high and this evaluation has been completed with due regard to the capacity of engineered barriers.

However, lithological rankings have not been made due to the differences of rock types encountered during site selection for geological disposal. That is, fairly diverse lithologies have been observed in each geological formation, even though it is one geological unit or one rock mass.

Furthermore, it is clear that characterization of hydrogeology and geological environment including

geotectonism such as earthquakes and volcanism are very important factors for the process of geological evaluation of each specific site.



GEOLOGICAL PROGRAM OF FUTURE INVESTIGATION FOR RESEARCH AND DEVELOPMENT FOR WASTE ISOLATION IN THE SECOND STAGE (c. 1995)

The second stage of geological investigation, to select a candidate repository for geological disposal of the high level radioactive waste, began in 1985, as shown in Table 3. This procedure is scheduled to be performed over the next ten years. Also, geological and hydrogeological studies are being performed in the laboratories and the field at the present time. Simultaneously, experimental research in an underground laboratory is considered very necessary to the development of a geological isolating system. Therefore, we are planning to construct underground laboratories in the near future.

Now, we shall outline the research and development program in the first five years of the second stage. The main target for the research program is the selection of a candidate repository site, and to establish the technology to collect the site-specific data (hydrogeology, heat transfer and rock dynamics in rock mass, lithology, physical properties, water permeability, geochemistry, etc.) which are necessary for the different evaluations at each potential site.

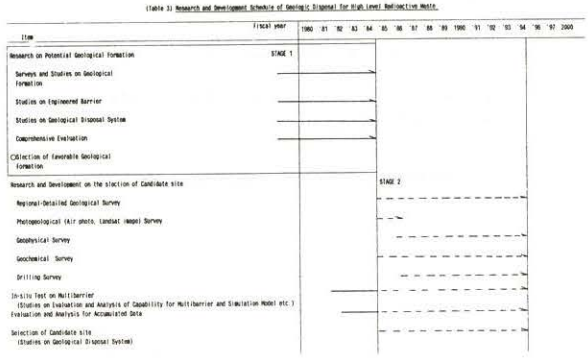
(Table 2) General geology of Japan

Geology			Distribution km²	Distribution %	Lithology (*)
Sedimentary rocks	Cenozoic	Quarternary	73,112	19.3	ss, m, c, s, ga
		Tertiary	73,269	19.4	ss, m, c, sh
	Mesozoic		30,270	8	ss, sh, sl, c
	Palaeozoic		43,869	11.6	ss, sl, t, l, c
Cenozoic volcanic rock			82,769	21.9	a, b, r, t
Acidic effusive rocks (Cretaceous)			15,708	4.2	r, t
Acidic intrusive rocks			39,408	10.4	gr, q
Basic intrusive rocks			4,517	1.2	g, d
Metamorphic rocks			15,640	4.1	gn, sc
Total			378,562	100.1	

(*) a ; andesite
b ; basalt
c ; conglomerate
d ; diabase
g ; gabbro
ga ; gravel
gn ; gneiss
gr ; granite
l ; limestone
m ; mudstone
q ; quartz porphyry
r ; rhyolite
s ; sand
sc ; crystalline schist
sh ; shale
sl ; slate
ss ; sandstone
t ; tuff and tuff breccia

Also, the barrier effect of geological formations such as rock characteristics, water permeability and basic nuclide sorption shall be investigated to evaluate the natural barrier potential of the formations. For instance, systemic studies for the characterization of sorption to the radioactive nuclides in Neogene sediments such as pyroclastic materials are very important to evaluate the geological isolating system of the high level radioactive waste. However, the geochemical relationship between the absorbents and radioactive nuclides is not yet clear, and further study should be performed in in-situ experiments.

Furthermore, it is being planned to take into particular consideration the research and development of the safety assessment model and data files based on actual geoscientific characterization of our country.



Also, several important problems are assumed to exist in the field of hydrology and geology.

Furthermore, in Japan, we cannot ignore the effect of earthquakes on the construction of a geological repository. Therefore, we shall develop a quantitative evaluation system which is closely related to seismic characterization and rock dynamics in the deep geological environment. However, according to the historical records of earthquakes, it is apparent that the effect of earthquakes result in less damage in the deep environment than the surface.

Also, the technology in the field of civil engineering and others, which are based on many years experience of large scale constructions such as nuclear power stations in Japan, will be utilized for this issue.

Nevertheless, as our selection of candidate site and geological investigations progress, we shall examine and carefully evaluate the geological environment such as rock characteristics, hydrological and geochemical aspects, volcanic activities, earthquakes, and so on.

Finally, Japan is very much interested and willing to participate in international joint research programs such as in-situ experimental study for geological disposal of high level radioactive waste.

SUMMARY

Based on the results of data from geological investigations during the progress of the selection of the specific regions and sites as well as data which will be gained from underground testing or other studies for waste isolation in addition to the national program, candidate disposal sites will be selected by PNC within about ten years.

Finally, after the selection of a candidate repository site for geological disposal and the period of technical operation using simulated waste have been sufficiently performed, experimental geological disposal will be undertaken using the solidified high level radioactive waste for hot testing around the year 2000.

REFERENCES

(1) Takash: Yoshida (1975)

An outline of the geology of Japan
(Geological survey of Japan)

(2) Atomic Energy Commission of Japan (1984)

Long term program for the Development and Utilization of Nuclear Energy.