Options for Radioactive and Other Hazardous Waste Siting within the U.S. Exclusive Economic Zone

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Technical Report

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OPTIONS FOR RADIOACTIVE AND OTHER HAZARDOUS WASTE SITING WITHIN THE U.S. EXCLUSIVE ECONOMIC ZONE

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Frank T. Manheim* and Allyn Vine**
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ABSTRACT

Some areas of the E.E.Z. (Exclusive Economic Zone) offer technical, political and economic options that may complement existing approaches to hazardous waste storage and disposal.

NOTES AND ADDENDA

A shortened version of this report, edited for a wide audience, but without references was published in Geotimes, v. 31, December, 1986, (p. 8-10) under the title "E.E.Z. may have waste-disposal options".

As stated in Geotimes, this earlier draft with references is hereby made available to interested individuals.

Appendix I is an additional list of references that may be of interest.

Appendix II is a copy of the two pages of references from the May 1986 Office of Technology Assessment Staff Paper on the Sub-seabed Disposal of High-Level Radioactive Waste.

Again the authors would like to thank the many people who have contributed ideas, criticism, and references.

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Introduction

The long-term storage and disposal of concentrated, high-level radioactive and other highly toxic wastes remains a difficult and controversial issue. Over 300,000 and 19,000 m$^3$ (over 1,300 and 35,000 million curies) of defense and commercial high-level radioactive waste, respectively, are projected to require disposal by the end of 2000 (Office of Technology Assessment, 1985). In the United States most of the funded effort applied to disposal siting has been on land sites, with only a small scientific effort devoted to research and development on disposal beneath the deep ocean bottom. As a part of a continuing effort to find reliable and politically and economically satisfactory solutions for the disposal problem, we suggest that some geographic segments of the new U.S. Exclusive Economic Zone (EEZ) offer technical and political options that may complement constructively the existing approaches to waste storage final disposal.

Present status for land storage and disposal

In the United States, most research and development on high-level radioactive-waste disposal in deep geological repositories has been focused on nine potential sites, distributed in six States, for the first repository, Washington, Nevada, Utah (two), Texas (two), Louisiana, and Mississippi (two) (Fig. 1a). Of these sites, seven are in salt and one each in tuff and basalt. Very recently Nevada, Washington, and Texas have been given priority by the Department of Energy (DOE, 1986). Following provisions of the Nuclear Waste Policy Act of 1982, four additional regions in the north-central and
eastern part of the United States were considered for the second repository (Fig. 1b). However, the apparent growing opposition of State governments to any nuclear waste sites within their borders poses at least temporary political barriers to permanent emplacement of wastes in geological repositories within the continental United States.

Present status of subseabed storage and disposal

Another seriously considered disposal option is permanent disposal within unconsolidated sediments (pelagic clays) under the central deep ocean bed far from land. Research on this option by the United States and several other nuclear nations has focused on international waters for technical and cooperative reasons (Office of Technology Assessment, 1986), and a rewarding international cooperation among principal user nations has been achieved (Sandia Laboratories, 1983; International Atomic Energy Agency, 1983). The main study areas for the Deep Ocean Nuclear Waste Disposal Program are shown in Fig. 2. Efforts were made to find standards and methodologies acceptable to all users of nuclear power and to nonusers and other coastal nations. However, this international program is threatened by existing and potential new restrictions on nuclear waste disposal in international areas of the ocean. Blanket restrictions against nuclear waste disposal in international waters, and even against research involving radionuclides, are being proposed for the London Dumping Convention, to which the United States is a signatory.

Implications of the EEZ for disposal options

The EEZ may offer a third geographic option. The offshore EEZ areas constitute about 15,800,000 km², compared with 9,370,000 km² of U.S. land territory (McGregor and Offield, 1984). A part of this area is shown in
Figs. 3 and 4. The EEZ covers a wide choice of geological substrates, including salt domes, igneous rock bodies, relatively flat-lying extensions of coastal plain strata, and such deep-water pelagic sediments as those considered for deep-ocean waste emplacement. As with site selections on land or in the deep sea, choices would trend toward areas of minimal commercial, resource, and tectonic activities.

Some segments of the EEZ, beyond the State territorial seas but within the 200-nm limit, offer logical areas for research and development, training, storage and perhaps permanent disposal systems. Initially, these may be considered backup or complementary sites to principal on-land sites in the context of the Nuclear Waste Policy Act of 1982. We suggest the following opportunities for these purposes: (1) sediment areas that display the main pelagic clay characteristics of deep ocean disposal sites but occurring within 200 nm of U.S. coasts, (2) low permeability rocks which may include granites, basalts, and, especially, rock salt, (3) bedded strata into which caverns or lined shafts might be placed for temporary (decades to centuries) monitoring and storage by drilled emplacement beneath the sea floor (Bury, 1985), and (4) development and training sites.

Deep-water hemipelagic and pelagic clay sites are especially well developed within the EEZ off the coast of California and Oregon (Fig. 3) and off the Pacific Islands Trust Territory. Although igneous rocks like granite and basalt are found off the Atlantic and the Pacific coasts, the rock type least permeable through fracturing is rock salt. Among the most extensive offshore salt deposits in the world are those in the northern Gulf of Mexico in the form of salt domes and ridges (Fig. 4); other deposits exist off the Atlantic margin. Many domes are well studied because some serve as traps for petroleum hydrocarbons. Training sites might be located reasonably close to
logistic ports. They would simulate more remote sites for the purpose of testing investigatory, emplacement, monitoring, and retrieval systems. Of particular importance, they could serve to better train crew and engineers to conduct operational and engineering functions at sea more easily, reliably, and cheaply than at more remote (including midocean) final repositories.

Discussion

Development of engineering expertise for EEZ disposal systems would draw upon both land and deep-ocean (including offshore petroleum) technology, as well as new scientific and technological approaches. Normally, it is assumed that offshore operations are more difficult than those on land. However, the constraints of work with hazardous materials in inhabited areas complicate and add to the expense of land activity. In addition, some aspects of the EEZ geological and physical environments will be more favorable than those of land environments for waste disposal in comparable substrates; for example, the artesian systems that drive meteoric water circulation through land aquifers are believed to be largely absent offshore (Manheim and Sayles, 1974). With ion movement largely limited to diffusive gradients, salt domes under the ocean should be far less erodible and leachable than comparable land forms. In addition, submarine salt domes do not present a hazard to ground-water systems in areas of human habitation. Uncommon systems, such as possible upward hydrothermal circulation in rift zones (Sleep, 1985) or aquifers that are continuous between land and sea (Kohout et al., 1986) would be excluded from consideration.

Criteria for disposal/storage areas: first, we have limited consideration to storage or disposal and training sites within the U.S. EEZ and outside State waters*. Second, we assume that sites and methods will
allow for monitoring, retrieval, and, if need be, relocation of waste. The first criterion corresponds to the Federal responsibility and legal authority for nuclear waste disposal projected for 1998 by the Nuclear Policy Act of 1982. Temporary placement of waste within sediment or rocks beneath the U.S. territorial waters will reduce, though perhaps not wholly eliminate, potential foreign opposition to waste siting in the ocean. States retain input into decision-making regarding areas off their coasts through the Coastal Zone Management Act and other statutes.

The monitoring-retrieval criterion was mandated already by the Nuclear Regulatory Commission in the final rules for geologic repositories issued in 1983. We believe that with the evolution and practice of specific techniques retrievability is as feasible under the seabed as on land. Monitorability and retrievability can allow for early detection of potential problems and transfer of waste products should on-site problems be identified or should better sites be developed. These safeguards are likely to increase public acceptability of waste sites. Variable storage time frames (decades to centuries) provide a variety of options, such as special EEZ site or sites developed for extended cooling periods, to supplement special land cooling or storage areas, to provide more time to study "permanent" sites that have optimum storage properties. Finally, in addition to high-level nuclear waste, we suggest that with modified or other less costly techniques, the EEZ could serve as a safe repository or storage area for nonradioactive hazardous wastes having lesser hazard.

*For international claim purposes the EEZ is taken from the coast to 200 nm seaward, according to the proclamation of March 10, 1983, by President Reagan. State waters usually extend to 3 nm from shore.
Conclusion

In the past, the geographical equivalents of the EEZ were considered less attractive than land or the central deep ocean for high level radioactive waste disposal. However, selected areas of the huge U.S. EEZ now offer more attractive options for radioactive waste disposal and storage.

The storage and disposal concepts discussed above should be applicable to hazardous waste of either nuclear or non-radioactive type. For example, successful storage/disposal in the EEZ might aid in solution of land disposal programs, especially toxic or corrosive chemical wastes that might cause ground water contamination. The information and experience gained in this effort might be helpful in assessing applicability of EEZ areas to the placement of high-level radioactive waste. However, the non-nuclear hazardous waste program might be a separate and distinct program, not necessarily involving commitment to nuclear waste programs.

Appropriate investigation of these options requires a multidisciplinary research program to which Federal agencies and private and commercial organizations could contribute. We assume that the next few decades will continue to bring forward new physical data and changing political-economic emphases. The authors hope that this short report will stimulate discussion and broaden the field of possible alternatives to solve our waste disposal problems.
References


Department of Energy, 1986a, Area recommendation report for the crystalline repository project, Volumes I and II, DOE-CH-15(1) prepared for the crystalline repository project by the Office of Crystalline Repository Development, Battelle Project Management Division, Argonne Ill.


List of Figures

Fig. 1. Location of candidate sites for the first deep geologic repository for high-level radioactive waste (from Office of Technology Assessment, 1985) "Sites" are named.

Fig. 1b. Location of study areas for a second deep-ocean high-level radioactive waste disposal site (from U.S. Dept. Energy, 1986a).

Fig. 2. Areas selected for the Deep Ocean Nuclear Waste Disposal Program (from Sandia Laboratories, 1983).

Fig. 3. Hemipelagic and pelagic clay areas in the U.S. West Coast EEZ. Heavy stippling denotes gravel, sand, and silty deposits. Light stippling indicates other terrigeneous sediments, including sediments in southern California offshore basins. Area shaded with irregular subparallel oblique lines refers to hemipelagic and pelagic sediments having accumulation rates of less than 150 mm/1000 years. Vertical shading refers to pelagic sediments having accumulation rates of less than 50 mm/1000 years. Heavy line denotes EEZ boundary. Map modified largely from Addicott (1985).

Fig. 4. Distribution of salt domes in northern Gulf of Mexico area. Black areas represent salt domes and ridges. Hollow areas offshore represent possible deep salt "pillows." Diagram modified from Martin (1980), by K. Klitgord, U.S. Geological Survey, Woods Hole, MA 02543. Heavy line denotes EEZ boundary.

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Appendix I

Selected Supplementary References for Hazardous Waste Disposal in U.S. EEZ


Appendix II

Staff Paper on the
Subseabed Disposal of High-Level Radioactive Waste


REFERENCES


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