1984

The National and International Legal Complications of Subseabed Emplacement of High-Level Nuclear Waste

Lynn Carlson
University of Rhode Island

THE NATIONAL AND INTERNATIONAL LEGAL COMPLICATIONS OF SUBSEABED EMPLACEMENT OF HIGH-LEVEL NUCLEAR WASTE

BY

LYNN CARLSON

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND

1984

MASTER OF ARTS THESIS

OF

LYNN CARLSON

APPROVED:

Thesis Committee

Major Professor Lewis M. Alexander

K. H. Burroughs

Nelson Marshall

A. A. Michel

Dean of the Graduate School

UNIVERSITY OF RHODE ISLAND
1984

ABSTRACT

High-level radioactive waste produced by nuclear power generation, weapons production, and medical research has been accumulating in temporary storage pools in many countries. A permanent method of disposal will soon be necessary to ensure against contamination of man and the environment.

Land-based geologic formations, such as salt domes, are the preferred sites for disposal at this time in the United States. However, political constraints in the United States and the lack of proper geologic formations within the boundaries of other nations are resulting in consideration of alternative waste management options.

Subseabed emplacement is one option under consideration and the technological aspects of this method are currently being studied. If the method is found to be feasible upon completion of oceanographic experimentation, national and international political and legal issues may arise to prevent its use.

In order to resolve these issues, it is proposed that relevant laws be conditionally amended to legalize subseabed emplacement, but only after all experimentation and observation has been completed, an international management system is operational, arguments by all actors have been considered, and international laws have been altered to explicitly cover emplacement.

It is further proposed that the international management system be developed within the framework of the convention on the Law of the Sea, in order to take advantage of an existing institution, and minimize conflicts with the International Seabed Authority.

ACKNOWLEDGEMENTS

I wish to express my thanks to my major professor, Lew Alexander, for his patience and assistance in the preparation of this thesis.

I also thank my parents for enabling me to pursue this degree, as well as for the many opportunities to learn about the sea.

I also thank Sue Lavallee and Gail Beaumont, who provided me with friendship, support and encouragement.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The ocean environment has many roles, providing man with food, minerals, energy, and recreation, in addition to being a medium for transportation, and the major climate balancing system of the world. Another role which has in some cases been abused by man, is the ocean's waste assimilative capacity (its ability to take up waste material without experiencing deleterious effects). This concept of waste assimilative capacity has been undergoing a great deal of discussion in the past ten years. At the present time, it is felt that the ocean can and should be allowed to assimilate certain waste products generated by man, but disagreement on the types and quantities of waste to be disposed of in the ocean remains among scientists, politicians, and the public. High-level radioactive waste is one type of waste product under discussion for ocean disposal.

Since the atomic energy age began some forty years ago, a large amount of high-level nuclear waste has accumulated in storage pools as nuclear power plants and weapons have proliferated. By the year 2000, there may be as much as 300,000 metric tons of spent nuclear fuel from approximately 500 commercially operating power plants around the world.[1,2] This high-level radioactive waste is

one of man's largest waste dilemmas because it is highly dangerous to life and its ability to cause harm can be very long-lived. Exposure to high-level waste can cause a variety of biological ailments, from genetic abnormalities to radiation sickness, cancer and death. Therefore, it is necessary to isolate this waste from man and his environment for many thousands of years.

The type of isolation required has proven very difficult for man to achieve. There are few places on earth which can completely isolate this waste from occurrences, either natural or man-made, that would reintroduce the radioactive material into the environment. Therefore, the waste from power plants has been stored in temporary holding ponds until a permanent solution can be found.

In 1982, the Nuclear Waste Policy Act was passed in an attempt to provide the permanent solution. This act was the first legislation in the United States to identify landbased geologic disposal sites as the method of isolation to be used. It also created a calendar establishing the dates by which these disposal sites were to be in operation. However, two factors have already caused delays in meeting the specified schedule. At the present time, the technical development of these land-based geologic formations is behind by some three years and the schedule falls behind further with each passing day.[3]

One of the major factors causing delay is public outcry. People do not wish to have hazardous nuclear waste buried anywhere near their homes or within their state. A particularly difficult problem is one of equity. Of the seventy-nine nuclear power plants commercially operating in the United States, fifty are located on the eastern seaboard, twenty-three are in the mid-west, and six are located in the western states.[4] To date, the most geologically acceptable sites for land-based disposal are in the states of Washington and Nevada. One of these two sites may receive the wastes of the entire nation, and yet Washington has only one nuclear power plant and Nevada has none. These sites are appropriate primarily because they are already contaminated, and because they are owned by the federal government, not because they are geologically perfect. Thus, the people of these states will be receiving the risks of nuclear power without the benefits, which is situation they do not wish to accept.[5,6]

A second factor causing delay in the schedule is that these land-based sites have yet to be proven acceptable from the complete isolation standpoint. Salt domes, basalt, and tuff are the three types of environments presently under consideration as disposal sites, and each has its own set of unsatisfactory characteristics. A site will not be utilized until it can be proven to be the best

option that is technologically available. The proof that one of these sites is acceptable in terms of risk appears to be far into the future.

Fortunately, in writing the Nuclear Waste Policy Act, Congress recognized that new options to the radioactive waste disposal problem might be forthcoming; therefore, the act includes a section allowing future options to be considered and evaluated.[7]

Subseabed emplacement is one such option. Viewed by policy-makers as a possible supplement to the land-based disposal sites, this method has been under study for approximately ten years. At the present time, scientists cannot advocate its use because a great deal of oceanographic experimentation needs to be completed prior to confirming its feasibility. If the experimentation can show that the method is an acceptable solution from the scientific standpoint, many other complications are expected to develop, possibly resulting in discontinuance of the idea together, or at the very least, slowing its implementation.

One such complication will be public response. To the majority of people, the idea of disposing of radioactive waste in the oceans is probably distasteful. However, those who advocate ocean disposal point out that sea water already contains a large amount of radioactivity. Natural sources contribute 5×10^{11} curies, while nuclear

explosions have added 1 X 10^8 megacuries, with 1 X 10^6 megacuries added by nuclear power operations (1 megacurie = 1000 curies). The subseabed method will not add concentrations of radioactivity greater than natural background levels at any one place, and is expected to add less. Thus, the natural sources of radiation far outweight anything that has been added by man's activities, but this fact does not create public acceptance.[8,9]

Two other complications will be national and international political and legal issues. These arise because ramifications of carrying out subseabed emplacement will be felt globally. The sites presently under consideration for subseabed disposal are located in international waters; if an accident were to occur (a leakage of radiation into the ocean) many countries might suffer severe consequences, because oceanic waters do not comply with national boundaries. For example, if a vessel being used to transport radioactive waste were to have a collision at sea, many miles of coastline, which could include several countries, might be contaminated. One need only examine the pathways of oil spilled in the oceans to understand how far-reaching the effects of pollutants can be.

These complications will certainly appear as soon as one nation or a group of nations begins the process. In

fact, the experimentation phase of subseabed disposal, occurring now, has already resulted in debates within the international arena with regard to its legality. These debates will become more frequent, and more hotly contested if the emplacement method is accepted by the scientific community because the process will be closer to becoming an actual event.

If any ocean disposal of high-level radioactive waste is to occur in the future, it is most likely to occur via the subseabed mechanism.[10] There are several reasons why this is felt to be true. First, scientific knowledge about oceanic processes increases daily, and with this knowledge comes greater security in assessing the effects of this disposal method. Also, technology has advanced so rapidly, that the methods involved in the emplacement process are now available. Thirdly, the ocean floor meets the criteria of resisting future human intrusion and possible subsequent release of the radioactive elements; and finally, a repository in the ocean would possibly decrease the political arguments that have occurred with regard to land-based disposal sites.[11]

Activities that take place in international waters are governed by a variety of treaties and customary laws. Currently, United States and international law either restricts (in the case of low-level nuclear waste) or prohibits (in the case of high-level nuclear waste)

disposal of radioactive waste in the oceans. Relevant law includes: the United States Marine Protection, Research, and Sanctuaries Act of 1972, the regulations of the International Atomic Energy Agency, the 1958 Convention of the High Seas, the London Ocean Dumping Convention of 1972, the new Law of the Sea Convention, and customary international law that a sovereign state will not use its territory to the detriment of another sovereign state.

In addition, United States law previously allowed ocean dumping of low-level radioactive waste to occur in the U.S. territorial sea, if the Environmental Protection Agency granted a permit authorizing such activity. No dumping has occurred since 1972, but regardless of this fact, several national environmental groups have pressed Congress to change this aspect of the law. As a result, a rider was attached to President Reagan's nickel-a-gallon gas tax legislation on January 6, 1983. This rider introduced a two year moratorium on approval of any permits for ocean dumping of radioactive waste. Once the moratorium ends in 1985, anyone wishing to dump radioactive waste will be required to submit an impact assessment with the permit application. If the EPA approves the permit, both houses of Congress must pass a resolution in support of the EPA approval.[12]

This legislation will make it very difficult for the

United States to dispose of radioactive waste within the oceans. However, this law, and the others mentioned above, can be withdrawn, amended, or interpreted in such a way as to allow for disposal of radioactive waste. It is within these laws that the fate of subseabed emplacement, if determined to be scientifically feasible, will become a reality or be dismissed.

The purposes of this study are: 1) to review the impacts of radiation on the environment; 2) to review the basic technology of subseabed emplacement and the organizations presently investigating the method; 3) to examine the existing and emerging national and international law standards which affect subseabed disposal, as well as the institutions presently involved in these matters; 4) to interpret and evaluate these laws and institutions with respect to possible weaknesses and foreseeable problems; and, 5) to present proposals on how these identified problems might be addressed.

CHAPTER 2
ENVIRONMENTAL IMPACTS OF RADIATION

Radiation is a term used to describe energy which is released when an atom (a single unit of an element consisting of protons, neutrons, and electrons) is broken apart. This energy has the ability to penetrate many different types of biological entities, such as the cells which make up plant and animal tissues. When such penetration occurs, the excess energy interferes with the normal functioning of the cell. The amount of interference, and therefore the degree of harm done to the organism, is dependent upon the amount of energy which is able to penetrate the cell.

At every level of production within the nuclear fuel cycle, radioactive waste materials are generated. During the mining and processing of the nuclear fuel itself, there is radioactive contamination of all materials used, plus non-usable, leftover fuel. These waste products have different names, depending upon the amount of radiation they contain. Clothing, construction debris, tools, etc. that have been contaminated are termed low-level waste and are disposed of primarily by burial in the ground. High-level waste is the spent fuel used in a nuclear reactor to generate electricity, along with the cylinders which contain this fuel.

High-level nuclear wastes contain amounts of radiation (energy) that are in great excess of the radiation that is naturally found in the environment. When exposed to this energy, a variety of ailments occur as a result of interference with the organism's cells.

When humans are exposed to high amounts of radiation, there can be damage to the respiratory track, central nervous system, digestive track, bone marrow, blood cells, and chromosomes resulting in immediate death, or a slow death due to radiation-caused cancers. If the chromosomes of an individual are damaged, genetic abnormalities may be passed on to future generations.[13]

Although scientific studies are far from complete on the effects of radioactivity in the marine environment, existing information shows that its presence can be highly detrimental. For example, the eggs of many species of fish indicate abnormal development resulting in death when exposed to radiation. filter feeding organisms such as clams are able to concentrate radioactivity within their tissues. Remarkably, this concentration does not seem to cause these organisms direct harm; however, the danger lies in utilization of these organisms by man as a food source.[14]

Radiation from spent and reprocessed fuel does not dissipate immediately upon release into the environment. The occurrence of one atom releasing its energy is completely independent of all the other atoms around it;

therefore, an individual atom may not release its energy for many years. However, scientists have calculated the amount of time it takes for each type of radioactive element (made up of several atoms) to release energy, or "decay." In other words, there is a constant probability that an atom of a particular radioactive element will decay at a constant rate, and last a certain amount of time. For some high-level wastes, the amount of time is on the order of thousands of years.[15]

Since the radiation from high-level waste is so harmful to living organisms, it must be isolated from them until the energy has dissipated. This means confining the waste to a location that will not allow exposure for several thousands of years. So far, such a location has elluded scientists. The first areas to be considered were those on continental land masses; however, as mentioned previously, public outcry and the threat of a natural or man-made occurrence which would re-introduce the radiation to the environment has delayed the use of land-based geologic formations. The next areas for consideration were those found under the oceans. If these underwater geologic formations were to be used, a new type of disposal would have to be created, and thus, the subseabed emplacement method began to take shape.

CHAPTER 3

GEOLOGY AND TECHNOLOGY OF SUBSEABED EMPLACEMENT

The ocean floor is very diverse in its geology, characterized by fault lines, spreading centers, trenches, volcanoes, and sea mounts. However, portions of the floor, known as mid-plate or mid-gyre regions, have not exhibited any of the geologic activities which create these features for millions of years, and are therefore considered inactive.

Mid-plate regions are approximately 4 km beneath the surface of the ocean. The lack of light and food, with the low temperatures in these regions make them inhospitable to the majority of life forms, so that they are considered biologically unproductive. A steady supply of small particles from oceanic processes has been accumulating on the sea floor of the mid-plates at a rate of 0.1 - 10 mm every 1000 years. At the present time, it is estimated that thirty percent of the ocean floor is covered by approximately 100 meters of these particles, creating a fine grained, dark brown sediment known as abyssal clay.[16]

The thickness, adsorptivity, and biological barreness of this sediment, along with its distance from human activity and areas of geologic instability combine to create an environment that, to date, appears ideal for the disposal of high-level waste.

There are presently four sites which exhibit the necessary combination of characteristics. In the Pacific Ocean, the MPG 1 site is approximately 900 miles north of Hawaii and E2 site is east of Japan. In the Atlantic Ocean, the GME site is off the northwest coast of Africa, and the NAP site north of Puerto Rico (Figure 1).[17]

The technology for the emplacement method is available at the present time. It consists of a multi-barrier concept, involving a man-made barrier, the canister containing the radioactive waste, and a natural barrier, the sediments of the mid-plate regions.

When spent fuel is removed from a nuclear reactor, it will be stored for twenty to thirty years in existing pools, allowing some heat to dissipate. The waste will then be solidified into a glass matrix by highly technical processes and packaged in man-made canisters. Each canister, referred to as a penetrometer, is expected to be approximately five meters long and four-tenths of a meter in diameter. The penetrometers will be transported over land by conventional means to a shipping port designed specifically for emplacement vessels. The penetrometers will be loaded aboard a vessel, then transported to the ocean disposal site.

The vessel would hold its position over a particular location on the sea floor, and allow the penetrometer to

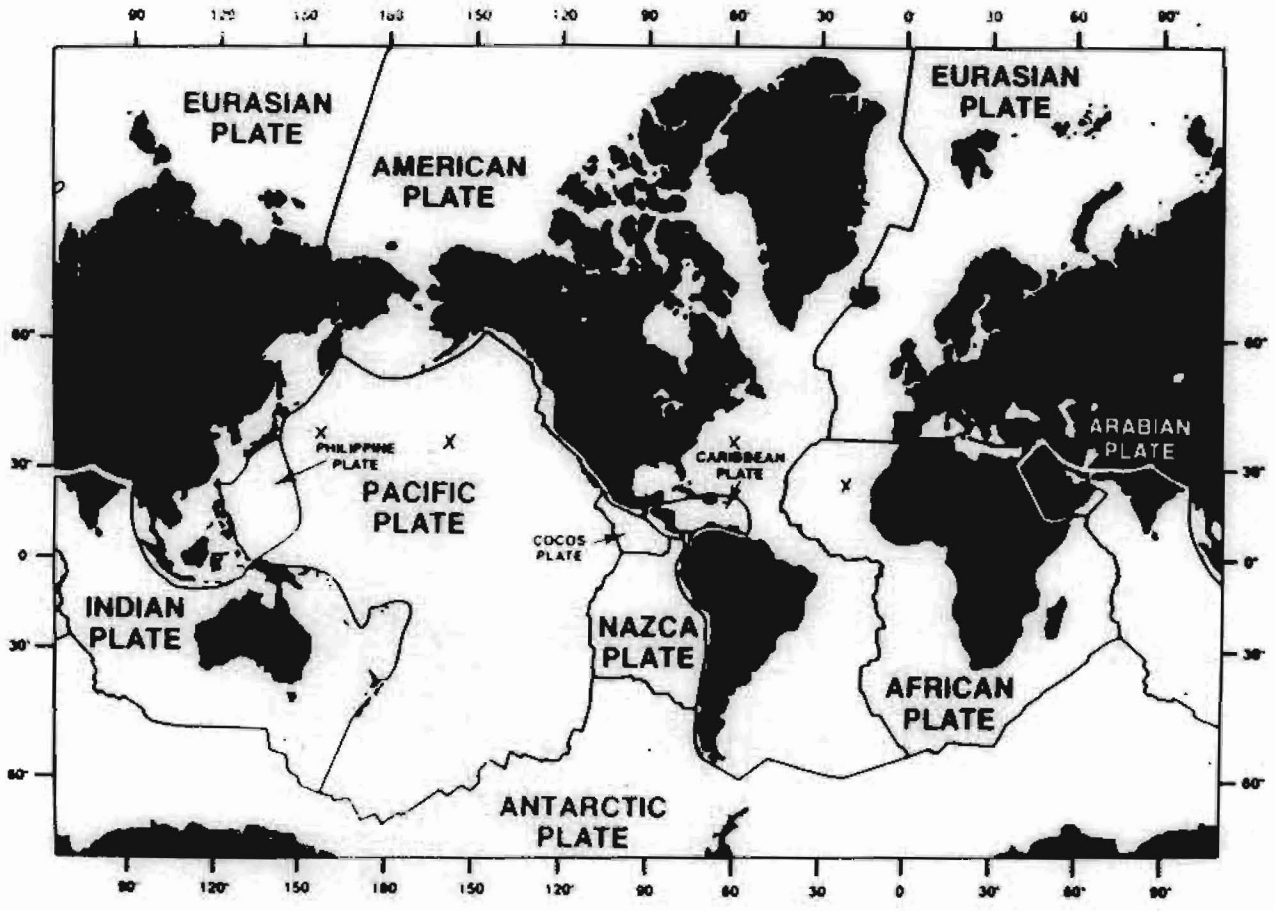

Figure 1: Approximate Sites of Mid-Plate Regions Suitable for Subseabed Emplacement.
Source: Hollister, Charles. "The Seabed Option." Oceanus 20 (1977):18-25.

free-fall through the water column. By the force of its momentum, the penetrometer will bury itself in the deep sea sediments to a depth of some thirty meters. At this point the multi-barrier concept takes effect (Figure 2).[18,19]

The penetrometer itself is one type of barrier, because the radioactive waste is sealed inside. However, this barrier is not expected to withstand the corrosive powers of the ocean's salt water for more than three to five hundred years. This is not enough time for the waste to decay to levels that would normally be found in the marine environment. As a result, a second barrier is necessary, and the deep sea sediments provide a seemingly excellent one.[20]

Once the pentrometer has corroded, slow leakage of the radioactive elements into the sediments immediately surrounding the penetrometer is expected to occur. The low temperatures at this location cause any chemical reactions to happen more slowly, giving an added advantage. However, the main attraction of the sediments is their adsorptive capability.

As the radioactive elements escape, they are adsorbed onto the surfaces of the sedimentary particles and are essentially trapped there. The tectonic stability of the mid-plate region, slow current rate, and low temperatures combine with the adsorptive capability of these sediments

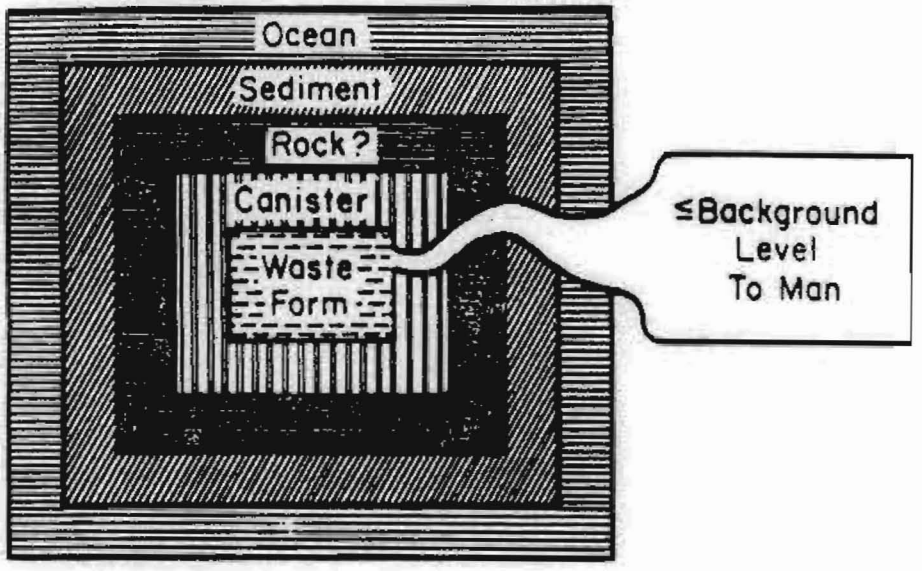

Figure 2: The Multi-barrier Concept of Subseabed Emplacement.
Source: Hollister, Charles. "The Seabed Option." Oceanus 20 (1977): 18-25.

to retain radioactive elements within a localized area, which is far from man's activities and biologically less productive than other ocean areas (Figure 3).[21]

Other variations of this method with regard to the penetrometer itself have been considered. For instance, rather than letting the penetrometer free-fall, some scientists have envisioned a propulsion device to drive the penetrometer into the sediments, or drilling down into the sediments with a coring device, and actually dropping the pentrometer through the corer. However, the free-fall method is the most preferred at this time (Figure 4).[22]

Four areas of concern to scientists studying subseabed emplacement are now being examined to determine whether or not the possibility of using this isolation technique must be dismissed. These areas are pore water movement, heat transfer, retrieval, and alteration of the waste form.

The sediments of the ocean floor undergo a natural cooling process, in which sea water moves through spaces in between each sedimentary particle. This is known as pore water movement. In some areas, the water moves through the sediments relatively rapidly. If the pore water movement of the mid-plate regions is greater than 0.1 mm per year, radioactive elements leaking out of corroded penetrometers would be carried through the sediments and out of the localized area before decaying to natural background levels

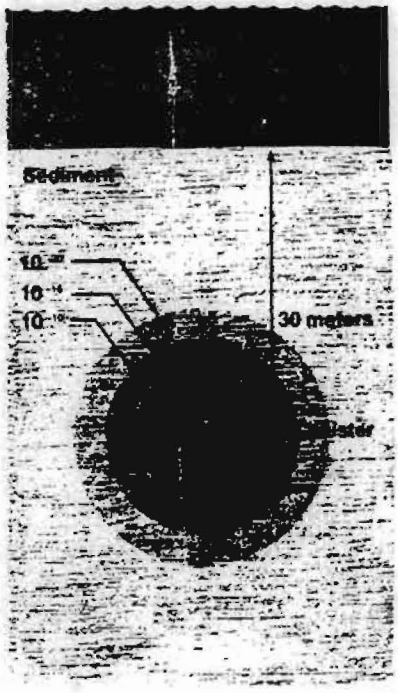

Figure 3: Area of Concentration Around Adsorptive Sediments.
Source: Hinga, K.R. et al. "Disposal of High-level Radioactive Wastes by Burial in the Sea Floor." Environmental Science and Technology 16 (1982):28A-37A.

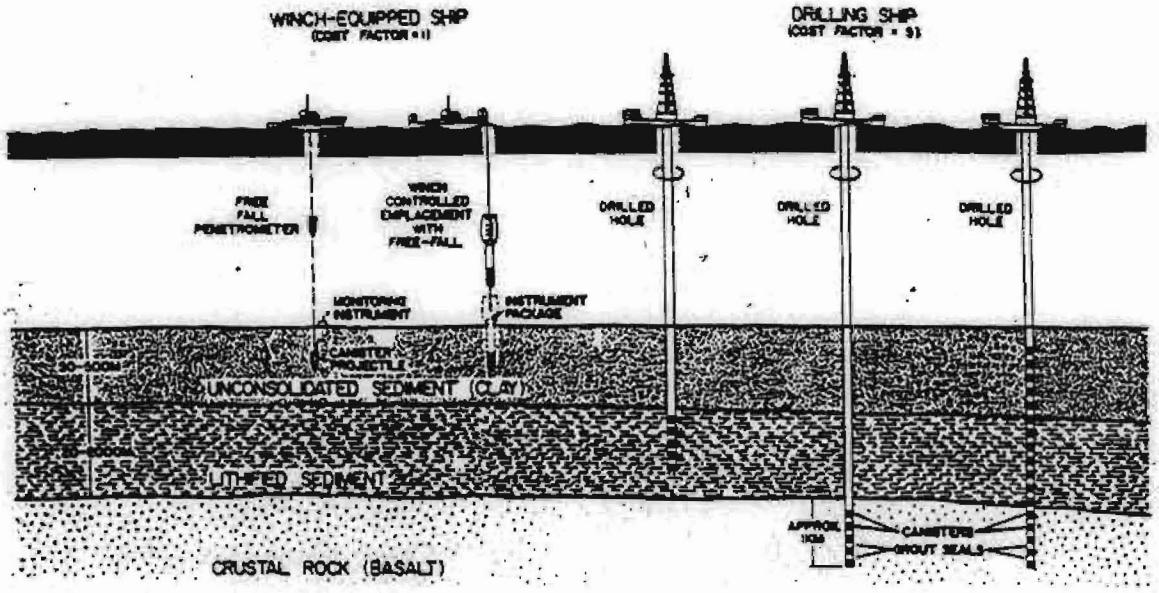

Figure 4: Emplacement Methodologies
Source: Silva, Armand. "Physical Processes in Deep Sea Clays." Oceanus 20 (1977): 31-40.

(the level of radioactivity considered permissable by policy-makers). However, measuring the rate of pore water movement is a very difficult process, and it will take many years of experimentation to determine whether or not this factor will render subseabed emplacement inpermissiable.

Whether the penetrometer is first emplaced in the sediments, it will be very hot due to the release of energy from radioactive elements within. This heat is of concern to scientists because there is the possibility that introducing high temperatures to the sediments will disrupt their natural adsorption capabilities. Since the emplacement method relies so heavily on this adsorptive capability, anything which would alter it would also result in dismissal of the method. Experimentation is now under way to determine the effects of this heat transfer to the sediments.

It is felt that any isolation method must maintain a retrieval capability. In other words, if the method is found to be inadequate for some reason after radioactive waste has already been stored in a geologic formation (land-based of any other option), the ability to remove the waste from the formation must be available. Subseabed emplacement was thought to be deficient in this requirement; however, it is now believed that penetrometers can be fitted with devices which will mark their location, enabling them to be retrieved by a vessel such as the

Glomar Challenger. This vessel has been equipped with devices that allow it to pinpoint locations on the sea floor for drilling exploratory holes, and this equipment can be modified such that the vessel could retrieve penetrometers.

Prior to scientific acceptance of subseabed emplacement, experimentation on the alteration of the waste form must also be completed. When the radioactive elements escape from the penetrometer and interact with the sediments, there is a possibility that the elements will be chemically altered in such a way that they will be more soluble in the sea water, thus having a greater chance of being transported by currents to locations of biological productivity and/or human contact. On the other hand, the elements may become less soluble upon interaction, and this would be an added advantage to the barrier properties of the sediment.[23]

Thus, the opinion of the scientific community is that, at the present time, nothing has been found to exclude subseabed emplacement from the list of options available for high-level radioactive waste disposal. However, the process cannot be advocated until more extensive experimentation has been done to discount the possible problems mentioned above. There are two organizations currently involved in analyzing subseabed emplacement: the United

States Subseabed Disposal Program of the Department of Energy, and the Subseabed Working Group, part of the Organization for Economic Cooperation and Development's Nuclear Energy Agency (OECD/NEA).[24]

The OECD is a multi-national organization which promotes policies designed to achieve economic growth, employment and a high standard of living within its member countries. The NEA is an agency within the OECD dedicated to promoting co-operation between member countries on the safety and regulatory aspects of nuclear development, and the assessment of nuclear energy as a contributor to economic progress.[25]

CHAPTER 4

INVESTIGATING ORGANIZATIONS

In the United States, the Department of Energy has a contract with Sandia National Laboratories in New Mexico to operate the Subseabed Disposal Program (SDP). Sandia, in turn, delegates funds to a variety of research groups at universities and laboratories around the country.

The primary objective of the United States program is to

> assess the scientific, environmental, and engineering feasibility of disposing of processed and packaged high-level nuclear waste in geologic formations beneath the world's oceans.[26]

The secondary objective is to maintain the ability to evaluate the plans and technologies of other countries interested in subseabed disposal. In the event that the United States finds subseabed disposal an unacceptable option, it is still possible that other countries which have fewer, if any, land-based options will decide to utilize the method. This fact makes continuance of the SDP a fairly important committment for the United States, because the U.S. will be affected by the process regardless of whether or not it is actually involved.[27]

> A strong U.S. program is necessary to maintain international leadership, to ensure that the option is fully and rigorously investigated, and to protect the marine environment.[28]

There are four phases to the United States program.

The first phase was completed in 1976, and involved estimating the technical and environmental feasibility of subseabed emplacement on the basis of historical data. The second phase, occurring at the present time, considers the scientific and environmental feasibility from newly acquired oceanographic data. This is expected to take until 1988, but the completion date will depend upon funding. Phase three, expected to take seven to ten years, is to determine the engineering and legal acceptability, while the fourth phase consists of demonstrating the disposal facilities for a period of ten to twelve years. It is estimated that a completed disposal facility could be ready for use by the year 2000 if extensive delays are not encountered.[29]

The OECD became involved in radioactive waste disposal because several member states had a joint problem; where to dispose of their low and high-level wastes. The OECD assigned the task of solving the problem to the Nuclear Energy Agency. The NEA developed an ocean disposal program, in which packaged low-level wastes were dumped at certain sites in the northeast Atlantic. High-level wastes were stored in holding ponds within each nation.

The first low-level waste disposal operation took place in 1967, and these operations have continued on an almost annual basis ever since. Eight countries have

participated at one time or another, but since 1971, only Belgium, Switzerland, the Netherlands, and the United Kingdom have used the NEA mechanism.[30,31]

In 1977, the NEA organized the Subseabed Working Group (SWG) which, as of 1982, consists of representatives from the United States, Belgium, Canada, West Germany, France, Italy, Japan, the Netherlands, Spain, Switzerland, and Britain.[32] It is divided into subgroups which specialize insuch areas as biological oceanography, sedimentary geology, waste forms, canister form, international policy issues, etc.[33]

> The SWG provides a forum for exchanging data among the participating nations' research programs, exploring ideas, and coordinating the use of research vessels and other specialized facilities. In 1982, the SWG established a task group to study the institutional issues surrounding subseabed disposal.[34]

The SWG and SDP are important because they are ensuring that the subseabed method is receiving the proper attention from scientists and policy-makers. However, these programs are deficient in one very important area, that of international involvement. The SDP is completely within the realm of the United States, while the SWG is regional and only involves those countries which have a high-level waste disposal problem and/or are interested in alternatives to land-based options.

As the amount of scientific and political attention towards emplacement grows, so do the arguments about its

legality. There are obstacles to be overcome within the realm of existing and emerging United States and international laws which govern the use of the high seas and the seabed below.

CHAPTER 5

EXISTING AND EMERGING UNITED STATES LAW

In 1972, the United States Congress passed the Marine Protection, Research and Sanctuaries Act, also known as the Ocean Dumping Act. Section 101(a) of this act has effectively prohibited ocean disposal of high-level radioactive waste by the United States:

> No person shall transport from the United States any radiological, chemical, or biological warfare agent or any high-level radioactive waste... for the purpose of dumping it into ocean waters.[35]

Another section of the Act provides the United States Environmental Protection Agency (EPA) the power to grant permits for ocean disposal of low-level radioactive waste. Although this power has been temporarily dissolved due to the moratorium rider mentioned previously, the EPA remains the governing body which develops regulations for ocean disposal of all wastes not expressly prohibited at the Act. Recently, EPA has started a program to develop regulations specifically directed towards the ocean disposal of radioactive waste, and is carrying out site-characterization studies to look at the biological, chemical, and physical characteristics of marine radioactivity.[36]

Within the past eleven years, many scientific studies have been done to try and determine just how degraded the ocean is, and what its limits are in accepting man's waste. These studies have shown that the waste assimilative capa-

city of the ocean is highly dependent upon location. For example, the New York Bight, an enclosed area of the Atlantic Ocean, has been severely degraded by man's waste products. However, the Southern California Bight, because it is not enclosed, does not show signs of being over-taxed by man's wastes.

These studies have prompted reconsideration of the Ocean Dumping Act. It appears that the United States can now relax the regulations to a certain degree, allowing particular ocean locations around the country to accept some of man's wastes while the effects are monitored.

However, radioactive waste is one product that is highly controversial. Scientific experiments on radiation in the marine environment are incomplete, and in the case of this waste product, extreme caution needs to be advocated rather than submission to public pressure when there is incomplete data.

In an effort to emphasize this caution, the rider to President Reagan's 1983 gas tax legislation placing a two year moratorium on ocean disposal of any radioactive waste is now in effect. It would appear that the emerging law with regard to radioactive waste dumping by the United States is very restrictive. However, the fact that this moratorium was induced by a rider rather than an individual bill may indicate otherwise. Of course the rider is no

less legal than a separate document, but it does indicate that a certain amount of game-playing may have been going on by "hiding" the legislation behind the skirts of a more immediate problem. In other words, the majority of Congress may have wanted to leave the discussion of ocean disposal open for future negotiation, but did not wish to jeopardize the enactment of the gas tax legislation by arguing over a rider which could be amended at another time.

The theory that Congress really wished to leave the question open is based on two factors. First of all, when the Nuclear Waste Policy Act was signed it did include the section allowing other options to be studied. In an attempt to clarify what these other options might be, it was asked whether or not the Subseabed Program of the United States Department of Energy was included, and the answer was yes.[37] The very existence of the subseabed program indicates that the government is not completely devoted to continuing the restrictions of the moratorium and the Ocean Dumping Act.

The second factor is the consideration given to the possibility of disposing of decommissioned nuclear submarines in the ocean. If Congress were united in an anti-dumping stance, the arguments over this possibility would have been less intense or non-existent.[38]

In addition, some scientists and policy-makers have

put forth the argument that subseabed "emplacement" is not really "dumping." The Ocean Dumping Act defines dumping as:

> The disposition of material... provided that it does not mean... the intentional placement of any device... on or in the submerged land beneath ocean waters, for a purpose other than disposal...[39]

When the definition alone is strictly interpreted, subseabed emplacement appears to escape the prohibition. However, the wording of section 101(a) is based on the transport of radioactive waste, and if the waste cannot be transported to a disposal site, the method is not usable. Also, due to this weakness of the dumping definition and subsequent questioning of its relevance to emplacement, the EPA issued a statement that subseabed emplacement is considered by them to be a prohibited action.

Thus, the existing United States law currently prohibits all ocean disposal of high-level radioactive waste, but there are indications that ocean dumping will not continue to be ruled out in the future if found to be scientifically acceptable; the laws could be amended some time in the future if the pressures against land-based options become too large.

CHAPTER 6

EXISTING AND EMERGING INTERNATIONAL LAW AND INSTITUTIONS

International law has always been a rather uncertain system, even on land where boundaries between nations are defined. Each nation has its own rules and regulations, religion, language, political system, would like to maximize it sovereignty, and be completely independent from those nations which differ in their values. However, as the world has become more crowded, and as resources have become depleted, interdependence becomes impossible to avoid. Every nation is tied to its neighbors. Whether it be due to importing and exporting material goods, food or oil, nations can no longer be reliant upon themselves for all their needs.

Hence, the need for a growing body of international law to govern these interdependent activities. Until recently, there has been a definite lack of international law to govern the world's environment, primarily because one nation's use of the environment had no noticeable effect upon another nation. However, the ever-increasing rate of resource development and use has resulted in conflicts of interest, particularly with regard to pollution.

In much of the world, people have utilized the dispersal capabilities of the air and water to solve the problem of how to manage their wastes. This capability has been

over-used, however, so that one nation's waste problem affects several other nations, and the potential for argument arises.

The ocean is one environmental system which seems to have escaped disaster, not because it is any less utilized, but merely because of its vastness. The international community now recognizes that the waste assimilative capacity of the oceans is finite, and that the types of waste being placed there affect all nations to a certain degree. For example, oil spilled in the North Sea may damage the beaches of Spain, France, and England regardless of whose flag a super tanker was flying at the time of an accident.

In response, international laws have slowly been developed to govern the use of the ocean environment as a waste disposal medium. These are either in the form of customary laws of specific treaty laws, and they continue to evolve over time as new issues arise. Subseabed emplacement is an international issue which falls within the scope of these laws.

A long-standing customary international law is that a sovereign state reigns supreme over its territory and does not have to explain its actions to any other entity; however, this right has become burdened with the responsibility of non-interference. Each state has an obligation to ensure that activities which take place

within its jurisdiction do not pollute the waters or air of another sovereign.[40]

This is exemplified in the Trail Smelter case. A smeltering plant in British Columbia, Canada, released fumes into the atmosphere. The United States claimed that these fumes were doing damage to the state of Washington. After arbitration, it was found that Canada was responsible under international law for the emissions of the industry because:

> No state has the right to use or to permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another state.[41]

Thus, the existing customary international law that a sovereign state is supreme and not required to answer to anyone else has become burdened with a restriction when matters of the international environment are in question:

> Emerging principles of international environmental law suggest some international constraints on a nation's freedom to pursue any resource policy it chooses, at least if those policies degrade the environment of other nations. In principle, a nation may not pollute if the discharges threaten severe environmental damage to the international community.[42]

Subseabed emplacement of high-level nuclear waste is a disposal option which may be restricted by this rule of non-interference if members of the international community feel the process conflicts with sovereign rights, or threatens to cause severe environmental damage.

It is unlikely that subseabed emplacement will interfere with any high seas freedoms. Emplaced canisters will

not hinder the traditional rights of navigation or fishing, nor will they hinder the more recently acknowledged rights of resource exploration or exploitation. The criteria used to select sites for emplacement have caused dismissal of areas that have profitable amounts of resources, particularly manganese nodules. Even if the limited resources at emplacement sites were to become profitable in the future:

> ...and deep ocean mining were to expand to all the module covered areas of the ocean, the area occupied by a repository would amount to a trivial loss in mining operation area, about 0.0005%. Should for any reason a nodule mining operation be conducted in the area of a repository, it would not impair the containment capabilities of the repository.[43]

The major problem under this customary law is the risk to the environment. Scientific experimentation taking place at the present time is being carried out in order to discount the possibility that radioactive pollution of the ocean will occur. This experimentation will continue until every foreseeable event is examined. Subseabed emplacement will not become a reality until this has been completed. However, models are not always accurate, and the possibility for contamination due to an unforeseen event does exist. If the emerging customary international law of non-interference is applied, the nations utilizing subseabed emplacement will have to decide whether or not they wish to accept its inherent risks as well as its benefits.

A weakness of the non-interference rule can be found

in the fact that it is not binding on all nations. For a customary law to be binding, it must have been acquiesced in for several years by many nations. Several countries continue activities that cause international pollution. For example, the acid rain problem in the United States is now affecting the Canadian environment. Therefore, the ability of this customary law to restrict nations in the use of subseabed emplacement may be questioned. However, the obligations and responsibilities of states in regard to ocean disposal of high-level radioactive waste have been coeified in four treaties which are somewhat more forceful.

The first treaty to recognize high-level waste as a potential problem was the 1958 Convention of the High Seas. Article 25(1) reads:

> Every state shall take measures to prevent pollution of the seas from the dumping of radioactive wastes, taking into account any standards and regulations which may be formulated by the competent international organizations.[44]

This treaty was important in two ways. It was the first time that marine pollution via radioactive waste was singled out as a real threat, and it emphasized the significance of any regulatory actions taken by international organizations in accordance with their authority.[45]

However, the Convention was written at a time when a technological advancement such as subseabed emplacement was unforeseen, and as a result the treaty is vague with regard to the legality of the process. This treaty is ambiguous

because it does not provide an actual ban on all disposal methods, it does not distinguish between high and low-level radioactive waste, and it sets no international standards. Because it does not specifically prohibit ocean dumping, it may be inferred that if the dumping does not actually result in pollution, then it is a reasonable and legal activity.[46]

Since subseabed emplacement will not be carried out until there is reasonable assurrance that pollution will not occur, the method would be legal under this Convention. If any portion of this treaty is likely to hinder the method's advance it is the authorization of international organizations to formulate regulations which could prohibit use of the method by member states.

To clarify "competent international organizations" the Conference adopted a special resolution identifying the International Atomic Energy Agency (IAEA) as the organization which should conduct studies, set standards and regulations.[47]

To date, the IAEA has not used its authority to create any regulations which would rule out subseabed emplacement, and it is not likely to do so. The IAEA was originally developed to provide a forum for the international promotion of nuclear energy and its uses. If the nuclear energy industry is to be promoted, the waste disposal problem must

be resolved. Therefore, the IAEA will not do anything to interfere with a disposal strategy that has the slightest possibility of reducing the problem. It would rather encourage the idea, as long as member states continued their support of the organization's goals.

Thus, the 1958 Convention's identification of the IAEA as the regulatory agency has been seen as a potential problem because there may be a conflict of interest. The IAEA is to promote the peaceful uses of nuclear energy, which conflicts with the idea that they are to regulate those uses. An entity trying to maintain security in its existence will not produce regulations which limit its purpose.[48]

The second treaty to define the responsibilities and obligations of the international community with regard to radioactive waste is the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter into the Oceans (the London Dumping Convention or LDC).

The LDC went beyond the 1958 Convention on the High Seas by distinguishing between high-level and low-level radioactive wastes, and expressly prohibiting any dumping at sea of the former. Article IV reads:

> Contracting parties shall prohibit the dumping of any wastes or other matter in whatever form or condition...the dumping of wastes or other matter listed in Annex 1 (which includes) high-level radioactive waste or other high-level radioactive matter, defined on public health, biological, or other grounds, by the competent international body in

> this field, at present the International Atomic Energy Agency, as unsuitable for dumping at sea.[49]

The initial weakness of the LDC is that, like the 1958 Convention on the High Seas, it involves the IAEA as the competent international organization for creating recommendations and defining high-level waste. As mentioned previously, this international organization has a conflict of interest, and therefore may not be the appropriate body to rely on for these duties when it comes to the subseabed waste disposal strategy.

A second weakness is that the wording of the LDC is almost ambiguous with regard to the subseabed method. Although dumping of high-level waste is prohibited, the LDC can be interpreted in such a way so as to allow emplacement. Once again, the argument has been put forth that "emplacement" is not "dumping". The Convention defines dumping as:

> Any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms, or other man-made structures at sea.[50]

Emplacement is certainly deliberate disposal, but is it disposal "at sea"? If the term "at sea" applies to the location of the vessel that is doing the dumping, then subseabed emplacement is illegal under the LDC. On the other hand, if the term "at sea" means discharge of wastes into the water, then subseabed emplacement is not illegal.[51]

This interpretation problem has generated a conflict of opinion between member states over the application of the LDC with regard to emplacement. In December of 1983, a special meeting was held by states party to the LDC. One purpose was to determine the Convention's jurisdiction over subseabed emplacement and make recommendations to the 8th Annual Consultative Meeting taking place in February of 1984. The issue was not resolved because too much time was spent arguing over other matters.[52]

During the 8th Annual Meeting, a proposal was made for the LDC to begin research on subseabed emplacement. The delegates from Canada, West Germany, Argentina, Norway, Ireland, and Nauru tried to block this proposal, indicating they felt it was an unsafe procedure and morally wrong. They felt that those countries which benefit from nuclear power (including themselves) should not export the risks of this energy source to the international community. The proposal passed despite this opposition.[53]

In addition to the difference of opinion among member states, there is also conflict within nations themselves. The United States National Oceanic and Atmospheric Administration has taken the position that subseabed emplacement would not be an illegal act by the U.S., while the EPA has said that it would be illegal.[54] Both West Germany and Canada also seem to have an intranational conflict over the appropriateness of subseabed emplacement,

as they are each members of the Subseabed Working Group of the OECD/NEA, and yet both countries wish to block the proposal for the LDC to begin research.

This could be purely economical, neither country wishing to have more funds going to research. But, it could also represent an internal division of opinion over whether or not to support the emplacement idea.

Regardless of these international and national conflicts, the ultimate passage of the proposal for research certainly indicates that emplacement will continue to be discussed in future meetings of the LDC, generating exposure to and knowledge of the method's intricacies, which is the first step towards acceptance.

A second international body, the International Marine Organization (IMO) become involved in ocean dumping matters because it is the Secretariat of the LDC. IMO's responsibilities have been limited to notifying all states party to the LDC when one member has issued a permit for dumping those wastes which are not prohibited, and thus far has not established any recommendations regarding subseabed emplacement.[55]

Perhaps the major weakness of the LDC is that there is no enforcement mechanism. Like all international treaties, the compliance of a member state with the LDC's prohibition, however defined or regulated, is up to an individual

nation. A state initially signs a treaty because it is in its best interest to do so. However, if a country's waste disposal problem becomes too large, and the legality of subseabed emplacement is not properly determined, the states best interest may lie in a unilateral action outside the LDC.

The final and most recent international treaty likely to have an effect on subseabed emplacement is the Law of the Sea Treaty (LOS), opened for signature in December of 1982. The United States has not yet signed this treaty and is not expected to do so until revisions are made with regard to seabed mining activities or there is a change in the federal administration. However, a majority of nations (131 or 169) have signed, indicating that this treaty will be the governing body of ocean law for the future. The LOS has several portions that could directly pertain to the use of subseabed emplacement; of greatest significance with respect to its legality are the definitions of dumping and pollution, and Articles 136, 140, 145, 209, and 210.

Article 1(5) of the LOS defines dumping in a manner consistent with the LDC:

> Any deliberate disposal of wastes or other matter from vessels, aircraft, platforms, or other man-made structures at sea...any deliberate disposal of vessels, aircraft, platforms, or other man-made structures at sea.[56]

Once again, a weakness is whether or not subseabed emplacement constitutes dumping "at sea". If "at sea"

includes "within the sea floor", and emplacement is therefore a type of dumping, then member states might be prevented from using the method due to Article 210:

> States shall adopt laws and regulations to prevent, reduce, and control pollution of the marine environment by dumping.[57]

The next question to be raised is whether or not emplacement is a form of "pollution" of the marine environment by dumping, in which case Articles 209 and 145 will apply:

> International rules, regulations and procedures shall be established in accordance with Part XI to prevent, reduce, and control pollution of the marine environment from activities in the Area...States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by vessels...operating under their authority.[58]

The LOS defines the Area as the seabed, ocean floor and subsoil which is beyond national jurisdiction. Therefore, the Area includes those mid-plate regions which are being considered for subseabed disposal, and all of the portions of the LOS treat pertaining to the Area (Part XI) apply to subseabed emplacement.

Article 145 is included in Part XI, and informs member states that:

> Necessary measures shall be taken with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects of such activities...the Authority shall adopt appropriate rules, regulations and procedures for...the prevention, reduction and control of pollution...to the marine environment...particular

> attention being paid to the need for protection from harmful effects of such activities as...disposal of waste....[59, 60]

However, even if subseabed emplacement is dumping "at sea", and is an activity regulated by those Articles of Part XI regarding the Area, then it becomes necessary to define whether or not emplacement is a form of pollution that will harm the marine environment and therefore be subject to those laws and regulations designed to prevent, reduce, and control said pollution.

Article 1(4) of the LOS defines pollution as:

> The introduction by man, directly or indirectly, of substances or energy into the marine environment which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.[61]

Subseabed emplacement will probably not result in excessive harm to marine life because the mid-plate regions are less biologically productive than other ocean areas. The method is intended to be an activity which reduces the hazard to human health; and once again, emplaced canisters are not likely to hinder marine activities, impair the quality of sea water, or reduction of amenities. Scientists studying the process have given every indication of attempting to avoid these outcomes, and if they did not feel they could avoid them, the studies would have been discontinued.

In addition, this definition of pollution could be

interpreted as requiring an actual release of the substances or energy, not just a risk of their release, which would be the case in subseabed emplacement.[62]

Since the LOS defines the Area as the "common heritage of mankind" (Article 136) and says that "activities in the Area shall be carried out for the benefit of mankind as a whole" (ARticle 140), a second weakness in interpretation arises...is subseabed emplacement an activity which will benefit mankind? Different nations will have different opinions on whether or not this disposal method is such an activity. Arguments over ocean disposal of radioactive waste in general have already occurred and show the potential for deepening the north-south dispute.[63]

Developing nations seem to be of the opinion that any ocean disposal of radioactive waste, and therefore subseabed emplacement, is not beneficial. This attitude was reflected in discussions at the 7th Annual Consultative Meeting of the LDC (1983) in which the nations of Kiribati and Nauru proposed that the Convention be amended to prohibit dumping of all radioactive waste, regardless of level, form, content, or method of containment (this proposal was eventually withdrawn due to opposition from other member states). Also, in 1982, the 13th South Pacific Forum (consisting of representatives from the Cook Islands, Micronesia, Fiji, Kiribati, Nauru, Nive, Tonga, Tuvalu, Vanuatu, Western Samoa, the Solomon Islands, and Papua New

Guinea) called on all nations to refrain from storing or dumping nuclear wastes in the Pacific.[64, 65]

A fourth weakness of the LOS is that, like all international treaties, it is only binding upon those nations which have become signatory states. The United States, United Kingdom, West Germany, and Italy are four influential countries interested in subseabed emplacement (as shown by their participation in the SWG) which have not signed the LOS treaty, and therefore the provisions mentioned above are not presently binding upon them.

Thus, even the most recent and comprehensive body of international law governing uses of the ocean is not going to assist its member states in determining whether or not emplacement is a legal use. In summary, the four major weaknesses of the LOS are 1) whether or not the method is dumping at sea 2) whether or not the method is a form of marine pollution 3) whether or not emplacement is an activity which will benefit mankind and 4) the fact that not all nations interested in emplacement are states party to the convention.

CHAPTER 7

PROPOSED ACTIONS NEEDED FOR A FUTURE IN SUBSEABED EMPLACEMENT

At the present time, a major impediment to an acting, technically proven subseabed repository, is the existing ambiguity in interpreting national and international law. Perhaps the most obvious action to alleviate this impediment would be to amend the U.S. Marine Protection, Research and Sanctuaries Act, London Dumping Convention, Convention of the High Seas and Law of the Sea Treaty to completely exclude subseabed emplacement from their various prohibitions, in other words, legalize the method.

Realistically however, this does not seem to be a viable option, because of the pressures from various political actors. Members of public, governmental, industrial, and scientific institutions would certainly object to such amendments on a national and international basis. Their objections could range from the lack of methods with which to prove the reliability of emplacement, to moral arguments that the oceans are somehow sacred and to be used as a disposal medium, the latter of which are not going to be easily swayed by qualitative or quantitative descriptions.

Even if these objections were not raised, it would not be in the best interest of the international community to

alter the laws in such a manner, because it could lead to unilateral decisions to proceed with an inadequately tested process.[66]

Thus, rather than amending the laws in such a way as to make subseabed emplacement completely illegal by including it as "dumping at sea", or totally unregulated by excluding it from the laws, it is proposed that these laws be amended to make emplacement conditionally legal. In other words, emplacement would only become legal once all scientific and technical experimentation has been completed, there is an operational international management system, arguments by all actors have been taken into account by experts within the system, and subsequently, the laws have been altered to explicitly cover emplacement.[67]

This type of amendment would have the effect of clarifying the legality of the method, restraining unilateral actions, and at the same time, acknowledging that the method exists and may be future option. If experimentation is able to provide tangible proof of the technique's feasibility under the rational management system, it will be easier to respond to objections with valid arguments, and emplacement will have a greater chance for success.

The United States, as the past leader in bringing ocean dumping issues to the international community via the Marine Protection, Research and Sanctuaries Act (MPRSA)

should explicitly define its position on emplacement, and ocean disposal of radioactive waste in general. Only after the U.S. has done this, through amending the MPRSA in the above manner, and discontinuing delay tactics such as moratoriums and debates over exceptions for military waste, can it expect to maintain leadership and re-establish its committment to protection of the marine environment. If the United States has any hope of using subseabed emplacement in the future, it should eliminate international conflict, then propose actions to redefine international laws.

Since the first condition of the proposed amendment, scientific and technical experimentation, is currently underway, it is further proposed that experts in this field begin to develop the second condition of such an amendment...creating the international management system. This can be done in one of two ways: negotiate a new international treaty which develops the system, or rely on existing institutions.[68]

Creating an international treaty is an extremely difficult process. Countries often feel that their sovereignty is being limited by entering into an agreement which requires them to behave in a specific way. As a result, negotiation of international law involves the same type of political game-playing and compromise that occurs within a country; and the more nations involved, the more

complicated the game. In addition, states are unwilling and/or unable to divert the additional funds necessary to run any resulting international organizations.

Given the difficulties that were and continue to be experienced in negotiating the Law of the Sea Treaty, attempting to create a new treaty for a subseabed regime is unlikely to be successful, particularly since there is an existing dispute between developed and developing nations over the very idea of putting high-level radioactive waste in the oceans.

Thus, attempts to develop an international management system for subseabed emplacement would probably have a greater chance for success within an existing institution. The next question becomes which institution is best suited to govern subseabed emplacement, the Subseabed Working Group of the NEA, the International Atomic Energy Agency of the High Seas Convention and the London Dumping Convention, or the International Seabed Authority of the Law of the Sea Treaty?

Since the Subseabed Working Group currently has the greatest expertise, it would probably be the best institution for extension as a management body if scientific and technical work were the only considerations in creating a respository. However, the fact that it is a multi-national group rather than an international group would probably eliminate it from consideration as the sole management

institution.

The Subseabed Working Group has been likened to the Antarctic treaty regime, in that control and management is carried out only by those nations which have a stake in avoiding a particular conflict (determining territorial claims). The SWG is composed of nations which have a stake in avoiding conflict over nuclear waste disposal, and if it were the regime used to manage subseabed disposal, some of the same problems that have developed in the Antarctic can be predicted to cause trouble for the SWG. For example, the seabed, like Antarctica, is now considered to be the "common heritage of mankind", and should be managed for the benefit for all people. Developing countries are doubtful that nations with a nuclear waste disposal problem will manage the seabed to their benefit.[69]

> From the point of view of the subseabed disposal option, a restrictive regime is likely to face a much greater challenge from the international community as a result of concern with the potential effects of accidents combined with growing and sometimes strident antinuclear movement.[70]

Thus, although the SWG may have the greatest expertise with scientific and technical matters, and therefore, could make the greatest contribution to a regime, the fact that it is limited in national involvement would probably result in its ultimate failure.

As mentioned previously, the International Atomic Energy Agency is defined by the London Dumping Convention as the

international body competent to define what types of radioactive waste are prohibited from being dumped in the oceans. However, the international community is unlikely to accept this organization as the best institution to house a subseabed disposal regime because of its inherent conflict of interest. It is doubtful that an organization designed to promote the nuclear energy industry would be allowed to regulate a waste disposal strategy, when international opposition to the use and existence of nuclear energy and weapons grows daily.

Another option is to develop a subseabed disposal regime within the new Law of the Sea Treaty. One reason for discounting the LOS is that not all nations interested in subseabed emplacement are signatories at the present time. However, there are several other reasons which point to this treaty as the best alternative in which to develop an international management system.

First of all, the LOS and subseabed disposal are both products of the past thirty years. Both have been and continue to develop in a world of technological and sociological change. Therefore, the opportunity for them to grow in conjunction with each other, one as a use of the ocean and the other as the regulator of such use, is available to be taken advantage of.

Secondly, because a majority of the world's sovereign

nations have signed this treaty, and are therefore bound by its provisions, there will be a great deal of pressure on those non-signatory states interested in subseabed emplacement to comply with, or at least work within those provisions regarding environmental protection and seabed uses.

Third, the possibility still exists that the nations comprising the OECD's Subseabed Working Group, including the United States, may become signatories before the year 2000, when scientific experimentation is expected to be complete. In this case, the SWG could work in association with the International Seabed Authority of the LOS, and the international community as a whole, providing the scientific and technical expertise in a forum that includes input from all sectors of the globe. Once the management regime has been developed, the LOS could be amended to explicitly apply to subseabed emplacement.[71]

CHAPTER 8

CONCLUSION

Scientists and policy-makers are gradually changing their opinions regarding use of the oceans for waste disposal purposes, and proper utilization of ocean systems could solve many disposal dilemmas. Technological advancements will undoubtedly continue to provide methodologies which enable man to maximize his use of the ocean's assimilative capacity.

Subseabed emplacement is one technologically advanced methodology presently under consideration for maximizing the geologic resources of the seabed as a disposal medium for high-level radioactive wastes.

Scientific investigations are now underway to determine the impacts of radiation on the marine environment, as well as the oceanographic and technical feasibility of subseabed emplacement. However, the existing environmental protection movement, and rising opposition to the use of nuclear energy and weapons are factors which will influence whether or not use of such technology is eventually considered to be a legal and reasonable use of an international commons.

Despite much discussion in the past few years, the legal status of subseabed emplacement remains ambiguous. Both United States and international laws exist which may

or may not prohibit the use of the emplacement method, depending on how different agencies and nations interpret these laws. The point of disagreement appears to be whether or not emplacement is "dumping at sea". This ambiguity could be resolved by amending the laws, and this must be the first step taken by the United States and the international community if an actual repository is to be utilized.

However, an amendment which completely excludes subseabed emplacement form prohibitions is not in the best interest of the United States or other nations, since it would allow for unilateral, hasty decisions to proceed with an insufficiently tested process. Therefore, it is suggested that the laws be amended to legalize subseabed emplacement on a conditional basis; the conditions being that scientific and technical experimentation is completed, an international management system is operating and the opinions of all actors (public, industrial, environmental, political, etc.) have been discussed.

It is also suggested that, because subseabed emplacement and the Law of the Sea Treaty have both been a product of the past thirty years with the capability of growing in conjunction with each other, the international management regime be developed within the Law of the Sea forum, which includes the International Seabed Authority.

The idea of placing high-level radioactive waste beneath the sea floor is initially alarming, especially to those who know little of oceanic systems and capabilities. If subseabed emplacement is ever to become a reality, a great deal of public education will be necessary in order to sway people's initial distrust and moral convictions against the oceans being used as a dumping ground.

The oceans should not be looked upon as the ultimate answer for man's wastes, but rather as one piece of the entire world environment which can be used, enjoyed, and protected with rational management based on a sound education.

ENDNOTES

1. Sonja Boehmer-Christiansen, "Nuclear Waste in the Marine Environment," Marine Policy Reports 6 (1983): 1.

2. "World List of Nuclear Power Plants," Nuclear News 27 (1983): 71-90.

3. "Selection of Nuclear Dump Expected to be Three Years Late," Rocky Mountain News, 28 December 1983, p. 40.

4. The eastern seaboard states are comprised of Md, Ma, Ct, N.Y., Pa, N.J., Me, N.H., Vt, R.I., Dl, Ar, La, Ms, Al, Fl, Ga, S.C., N.C., Va, WVa, Ky, Tn. Mid-western states are comprised of Il, In, Io, Ka, Mi, Mn, Mo, Ne, N.D., Oh, S.D., Wi. The western states are comprised of Ca, Co, Id, Nv, Or, Ut, Wa, Wy, Mt. Az, N.M., Ok, Tx.

5. "World List of Nuclear Power Plants," Nuclear News 27 (1983): 71-90.

6. Edward Laine, personal communciation, 1983.

7. Ibid.

8. Boehmer-Christiansen, "Nuclear Waste in the Marine Environment," p. 1.

9. Charles D. Hollister, "The Seabed Option," Oceanus 20 (1977): 21.

10. Daniel Finn, "The Obligation of International Cooperation to Protect the Marine Environment," Virginia Journal of International Law 21 (1981): 673.

11. Daniel Finn, "International Law and Scientific Consultation on Radioactive Waste Disposal in the Ocean," in Wastes in the Ocean vol. 3, ed. Kilho Park, et al., (New York: John Wiley and Sons, 1983), p. 81.

12. "New Radioactive Waste Law," Oceans 16 (1983): 70.

13. R.J. Pentreath, Nuclear Power, Man, and the Environment, (London: Taylor and Francis Ltd., 1980), pp. 1-73.

14. International Atomic Energy Agency, Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems, (Vienna; International Atomic Energy Agency, 1976), p. 62-63.

15. Pentreath, p. 6.

16. Charles D. Hollister, et al., "Subseabed Disposal of Nuclear Wastes," Science 213 (1981): 1322.

17. Armand Silva, personal communication, 1984.

18. Hollister, et al., "Subseabed Disposal of Nuclear Wastes," p. 1325.

19. John E. Kelly, Subseabed Disposal Program for High-level Radioactive Waste Briefing Book Draft 5, (Complex Systems Research Center, University of New Hampshire, undated): Section 8.

20. Kenneth R. Hinga and Joel Lipkin, "High-level Radioactive Waste Disposal in the Ocean Floor: An Introduction," Sea Technology 24 (1983): 38.

21. Edward Laine, personal communication, 1983.

22. Hollister, et al., "Subseabed Disposal of Nuclear Wastes," p. 1324.

23. Laine, personal communication, 1983.

24. William H. MacLeish, "Burying Faust," Oceanus 20 (1977):3.

25. Nuclear Energy Agency/Organization for Economic Cooperation and Development, Marine Radioecology, (Tokyo: NEA/OECD, 1980): p. 2.

26. John Kelly and Cordelia Shea, "The Subseabed Disposal Program for High-level Radioactive Waste," Oceanus 25 (1982): 44.

27. Ibid., p. 45.

28. Kelly, Section 6.

29. Kelly and Shea, pp. 44-45.

30. David A. Deese, "Seabed Emplacement and Political Reality," Oceanus 20 (1977): 51-52.

31. Finn, "The Obligation of International Cooperation to Protect the Marine Environment," p. 633.

32. Kelly and Shea, p. 45.

33. Sandia National Laboratory, Subseabed Disposal Program Plan Volume 1: Overview, (New Mexico: Sandia National Laboratory, 1980), p. 20.

34. J. Kelly, Section 6.

35. The Marine Protection, Research and Sanctuaries Act of 1972, Public Law 92-532.

36. P. Columbo, et al., Analysis and Evaluation of a Radioactive Waste Package Retrieved from the Atlantic 2800m Disposal Site, (Washington D.C.: Environmental Protection Agency, 1982), p. ix.

37. Edward Laine, personal communication, 1983.

38. "Navy Eyes Dumping Radioactive Subs at Sea," The Providence Sunday Journal, 15 May 1983, p. A-14.

39. The Marine Protection, Research and Sanctuaries Act of 1972, Public Law 92-532, Section 3(f).

40. Gerhard von Glahn, Law Among Nations, (New York: Macmillan Publishing Co., Inc., 1981), p. 175.

41. Ibid, p. 176.

42. Richard B. Bilder, "International Law and Natural Resources Policies," Natural Resources Journal 20 (1980): 469.

43. Edward Miles, et al., Subseabed Disposal of High-level Nuclear Waste: An Assessment of Policy Issues for the United States, (Seattle: Institute for Marine Studies, 1983), p. 109.

44. The Geneva Convention on the High Seas, Article 25(1), 1958.

45. J. Paul Lomio, "International Law and Disposal of Radioactive Wastes at Sea," New England Law Review 15 (1980): 266-267.

46. Finn, "The Obligation of International Cooperation to Protect the Marine Environment," p. 647

47. A. Ostrovskii, "International Legal Protection of the Seas from Pollution," Ocean Development and International Law 3 (1976):299.

48. P.J. Taylor, The Impact of Nuclear Waste Disposal to the Marine Environment, (Oxford: Political Ecology Research Group, 1982), p. 51.

49. The Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter into the Oceans of 1972, Article IV.

50. Kelly and Shea, p. 51.

51. Deese, p. 55

52. David Tarnas, personal communication, 1984.

53. John Botzum, ed., Ocean Science News 26 (1984): 1.

54. Kelly and Shea, p. 51.

55. Finn, "International Law and Scientific Consultation on Radioactive Waste Disposal in the Ocean," p. 73.

56. Third United Nations Conference on the Convention on the Law of the Sea, Draft of 30 April 1982, Article 1(5).

57. Ibid, Article 210.

58. Ibid, Article 209.

59. The Authority is the International Sea-bed Authority established by Article 156 of the Law of the Sea Treaty. States party to the Law of the Sea are to organize and control activities in the Area through this organization (Article 157).

60. Convention on the Law of the Sea, Article 145.

61. Ibid, Article 1(4).

62. Finn, "International Law and Scientific Consultation on Radioactive Waste Disposal in the Ocean," p. 87.

63. Bilder, pp. 465-466.

64. Environmental Policy and Law 10 no. 3 (1983): 83-85.

65. Environmental Policy and Law 10 no. 1 (1983): 3 & 26.

66. Miles, et al., p. 107.

67. Ibid, p. 128.

68. Ibid, p. 128.

69. Ibid, p. 101.

70. Ibid, p. 102.

71. Ibid, p. 128.

SELECTED BIBLIOGRAPHY

Bilder, Richard B. "International Law and Natural Resources Policies." Natural Resources Journal 20 (1980): 451-486.

Boehmer-Christiansen, Sonja. "Nuclear Waste in the Marine Environment." Marine Policy Reports 6 (1983): 1-5.

Botzum, John ed. Ocean Science News. Washington, D.C.: Nautilus Press, 1984.

Brown,E.D. "International Law and Marine Pollution: Radioactive Waste and Other Hazardous Substances." Natural Resources Journal 11(2), (1971): 221-248.

Colglazier, E. William, ed. The Politics of Nuclear Waste. New York: Pergamon Press, 1982.

Columbo, P., et al. Analysis and Evaluation of a Radioactive Waste Package Retrieved from the Atlantic 2800m Disposal Site. Washington, D.C.: Environmental Protection Agency, 1982.

The Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter into the Oceans, Article IV. 1972.

Convention on the Law of the Sea, Article 145. 1982.

Daugherty, Michael Lee. "Disposal of High Level Nuclear Waste: An Abdication of Responsibility." University of Illinois Law Forum. (1979): 915-941.

Deese, David A. Nuclear Power and Radioactive Waste. Lexington, MA: D.C. Heath and Company, 1978.

Deese, David A. "Subseabed Emplacement and Political Reality." Oceanus 20 (1977): 47-63.

Egami, Nobuo, Ed. Radiation Effects on Aquatic Organisms. Baltimore, MD: University Park Press, 1979.

Environmental Policy and Law. 10 no. 1 (1983).

Finn, Daniel. "International Law and Scientific Consultation on Radioactive Waste Disposal in the Ocean." In Wastes in the Ocean vol. 3. pp. 68-95. Edited by Kilho Park, et al. New York: John Wiley and Sons, 1983.

Finn, Daniel. "The Obligation of International Cooperation to Protect the Marine Environment." Virginia Journal of International Law 21 (1981): 621-690.

Flax, Susan Jo. "Radioactive Waste Management." Harvard Environmental Law Review 5 (1981): 259-295.

The Geneva Convention on the High Seas, Article 25 (1), 1958.

Glahn, Gerhard von. Law Among Nations. New York: MacMillan Publishing Co., 1981.

Haimbaugh, George D. "Protecting the Seas from Nuclear Pollution." South Carolina Law Review 33 (1981) : 197-225.

Handl, Gunther. "Managing Nuclear Wastes: The International Connection." Natural Resources Journal 21 (1981): 267-314.

Hinga, Kenneth R. et al. "Disposal of High Level Radioactive Wastes by Burial in the Sea Floor." Environmental Science and Technology. 16(1) (1982); 28a-36a.

Hinga, Kenneth R., and Lipkin, Joel. "High-Level Radioactive Waste Disposal in the Ocean Floor: An Introduction." Sea Technology 24 (1983): 36-39.

Hodges, Jack W. "International Law and Radioactive Pollution by Ocean Dumping: With All Their Genius and With All Their Skill..." San Diego Law Review 11(757), (1974): 757-775.

Hollister, Charles D. "The Seabed Option." Oceanus 20 (1977): 18-25.

Hollister, Charles D., et al. "Subseabed Disposal of Nuclear Wastes." Science 213 (1981): 1321-1326.

International Atomic Energy Agency. Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems. Vienna; International Atomic Energy Agency, 1976.

Jackson, Thomas D., ed. Nuclear Waste Management, The Ocean Alternative. New York: Pergamon Press, 1981.

Kelly, John E. Subseabed Disposal Program for Highlevel Radioactive Waste Briefing Book Draft 5. See note 19.

Kelly, John, and Shea, Cordelia E. "The Subseabed Disposal Program for High-level Radioactive Waste." Oceanus 25 (1982): 42-53.

Laine, Edward. University of Rhode Island, Kingston, R.I. Personal Communication, November 1983.

Lipschutz, R.D. Radioactive Waste: Politics, Technology, and Risk. Cambridge: Ballinger Publishers, 1980.

Lomio, Paul J. "International Law and Disposal of Radioactive Wastes at Sea." New England Law Review 15 (1980): 253-286.

Macleish, William H. "Burying Faust." Oceanus 20 (1977): 3.

The Marine Protection, Research and Sanctuaries Act of 1972, Public Law 92-532, Section 3(f).

Miles, Edward, et al. Subseabed Disposal of Highlevel Nuclear Waste: An Assessment of Policy Issues for the United States. Seattle: Institute for Marine Studies, 1982.

"Navy Eyes Dumping Radioactive Subs as Sea." The Providence Sunday Journal, 15 May 1983, p. A-14.

Needler, G.T. and Templeton, W.L. "Radioactive Waste: The Need to Calculate an Oceanic Capacity." Oceanus 24 (1981) : 60-67.

"New Radioactive Waste Law." Oceans 16 (1983) : 1-72.

Nuclear Energy Agency/Organization for Economic Cooperation and Development. Marine Radioecology. Tokyo: NEA/OECD, 1980.

"Old Atomic Subs Never Die - There's No Place To Go." The Evening Bulletin, 12 January 1984, p. A-1.

Ostrovskii, A. "International Legal Protection of the Seas From Pollution" Ocean Development and International Law 3 (1976) : 287-302.

Pentreath, R.J. Nuclear Power, Man, and the Environment. London: Taylor and Francis Ltd., 1980.

Sandia National Laboratory. Subseabed Disposal Program Plan Volume 1: Overview. New Mexico: Sandia National Laboratory, 1980.

"Selection of Nuclear Dump Expected to be Three Years Late." Rocky Mountain News, 28 December 1983, p. 40.

Silva, Armand. University of Rhode Island, Kingston, R.I. Personal communication, March 1984.

Springer, Allen L. "Towards a Meaningful Concept of Pollution in International Law." International and Comparative Law Quarterly 26 (1977) : 531-557.

Tarnas, David. University of Washington, Seattle, Washington. Personal communication, February, 1984.

Taylor, P.J. The Impact of Nuclear Waste Disposal to the Marine Environment. Oxford: Political Ecology Research Group, 1982.

Templeton, W.L. "Dumping of Low Level Radioactive Waste in the Deep Ocean." In Impacts of Radionuclide Releases into the Marine Environment. (1981) : 451-464.

Third United Nations Conference of the Convention on the Law of the Sea, Draft of 30 April 1982.

Von Glahn, Gerhard. Law Among Nations. New York: MacMillan Publishing Co., Inc., 1981.

"World List of Nuclear Power Plants." Nuclear News 27 (1983) : 71-90.