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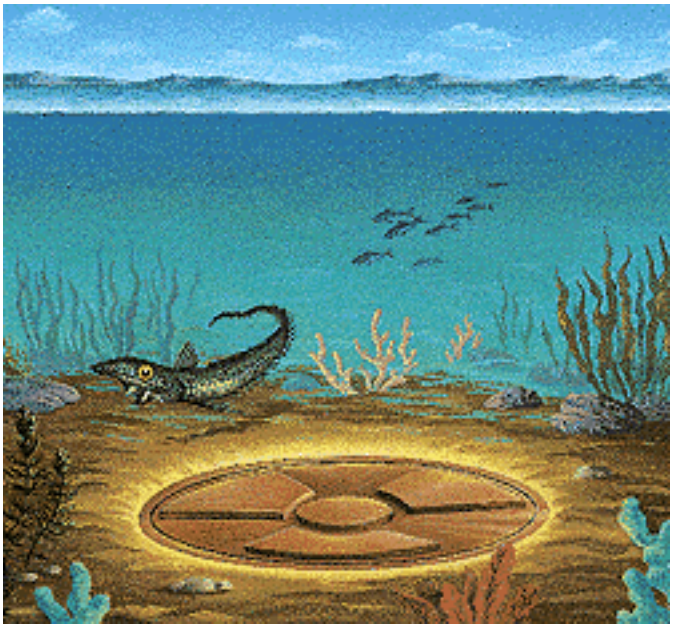
The Sub-Seabed Solution

Far from being embraced, a promising solution to the radioactive-waste problem faces stiff opposition from the federal government, the nuclear industry, and environmental interests

by Steven Nadis



IN 1976 a giant coring device mounted to a ship plunged repeatedly into the bottom of the Pacific Ocean, three miles below the surface, bringing up 100-foot-long tubes of mud and clay with the consistency of peanut butter. The primeval muck told a tale of geologic serenity. Sediment records from the cores indicate that the region -- roughly 600 miles north of Hawaii and spanning an area four times the size of Texas -- has been tranquil for 65 million years, unperturbed by volcanic activity or by shifting of the earth's tectonic plates. Charles Hollister, a geologist and senior scientist at the Woods Hole Oceanographic Institution, saw even more when he gazed at the thick dark ooze. He saw what might prove to be the perfect place to sequester our high-level nuclear waste -- the most potent and intensely radioactive by-products of military or civilian

enterprise.

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It's an intriguing vision, and one that in principle still holds great promise. Yet the concept of "sub-seabed disposal," first suggested by Hollister in 1973, has been undercut by a series of political blunders. A decision later this fall at a meeting in London sponsored by the International Maritime Organization, and a bill before Congress at this writing, may kill the idea -- possibly the best solution yet advanced to the nuclear-waste problem -- before society has had a chance to judge its true potential.

Hollister first hit upon the notion of sub-seabed burial twenty-three years ago, at a small social gathering in Washington, D.C. There he met William Bishop, a chemist at the Sandia National Laboratories, in New Mexico, who described the problems associated with a proposed nuclear-waste repository in Lyons, Kansas. "I immediately thought of the clays in the deep-sea floor, which I knew, from previous studies, clung tenaciously to the radioactive particles that had settled there as a result of atmospheric nuclear testing," Hollister recalls. He and Bishop stayed up all night discussing the idea, and a month later Hollister made a pitch to officials at Sandia, whose interest was piqued.

Next Hollister brought biologists, physicists, and oceanographers to Sandia to see if they could "destroy" the idea in what he calls the "biggest shootout since the OK Corral." He says, "If we could find out it was a stupid idea at the outset, it would save us a lot of time and money." But rather than shooting down the concept, many of the scientists told Hollister they'd like to work with him on it. A sub-seabed research program was initiated in 1974, with financial backing from Sandia; within a few years it had grown into an international effort involving ten countries and 200 scientists, under the auspices of the Paris-based Organization for Economic Cooperation and Development. This collaboration led to the core-sampling expedition that demonstrated the stability of the region underlying the North Pacific floor. Hollister points out that the Pacific site he and his colleagues explored twenty years ago is not unusual, geologically speaking. "About a quarter of this planet is covered with geology that is appropriate for this solution," he says.

Experiments conducted by this international team of scientists

from 1974 to 1986 support Hollister's opinion that the sticky mud and clays that blanket the mid-ocean basins may provide the best burial grounds yet proposed for nuclear waste. These tests suggest that if waste canisters were deposited just ten meters below the ocean floor, any toxic substances that leaked out would be bound up by the clays for millions of years. Deeper interment, at 100 meters or more, could easily be managed, providing an even greater margin of safety. "The stuff sticks to the mud and sits there like heavy lead," Hollister maintains. "Nothing's going to bring it into the biosphere, unless we figure out how to reverse gravity."

If he's right, and the proposed technique could end the worldwide radioactive-waste problem that has been building up for the past fifty years, why has almost nobody in this country heard about it? The answer to this question -- along with the roots of many of the problems plaguing current U.S. nuclear-waste-disposal efforts -- can be traced to a 1986 decision by the Department of Energy which cut off research funds for sub-seabed and other disposal alternatives, so that the agency could focus exclusively on developing a land-based geologic repository for high-level wastes; a year later it settled on Yucca Mountain, Nevada. The timing was unfortunate: ongoing sub-seabed experiments were canceled in spite of encouraging results and after much experimental apparatus had already been built.

The federal government had a change of heart in 1987, when Congress passed amendments to the Nuclear Waste Policy Act which, among other things, established the Office of Subseabed Disposal Research within the DOE. The director of this office, Walter L. Warnick, was asked to create a consortium of university investigators and devise a long-range research plan. But a couple of months after Warnick had enthusiastically begun, the congressional committee that controlled appropriations strongly discouraged the Energy Department from spending any money on the program. With access to sub-seabed research funds blocked, Warnick shifted his attention to acid rain and global-warming issues. The Office of Subseabed Disposal existed in name only until this year, when it was abolished altogether.

Warnick was disappointed by the final decision, although he recognizes that it was effectively made about a decade ago, when the DOE and Congress chose the Yucca Mountain alternative and

"put all their eggs in that basket." The judgment, he adds, was made on pragmatic, rather than technical, grounds. "It merely reflected the feeling that land-based-disposal technology was more advanced at the time." But from a technological point of view, he says, "sub-seabed disposal is a fascinating concept that offers many advantages, perhaps the foremost being that wastes would be deposited at some of the most geologically stable places on earth." What's more, "all the research that has been done on this option since 1974 points to no insurmountable obstacles" -- an assessment, Warnick says, that is widely accepted within the Energy Department.

The sub-seabed approach has been the subject of peer-reviewed research, and the program generated dozens of articles in prominent international scientific journals. Henry Kendall -- a Nobel laureate in physics, a professor at the Massachusetts Institute of Technology, and the chairman of the Union of Concerned Scientists -- calls sub-seabed disposal a "sweet solution" and a "winner," labeling it the best of the alternatives from a technical standpoint. A National Academy of Sciences panel called for further study of the sub-seabed approach, and a report last year by Robert Klett, a systems analyst at Sandia, concluded that "[all] analyses to date indicate that sub-seabed disposal would be a safe and economical method of [high-level waste] disposal and that predictions could be made with a high degree of confidence." In light of these endorsements, why isn't the idea being pursued, if only through research? Why won't this country make the modest investment -- about ten years and $250 million, according to Hollister -- required to find out if it would really work?

THE reasons are varied, though they are woven together in a familiar pattern. The Department of Energy killed the program partly for political reasons and partly because the sub-seabed researchers never really fit in with mainstream DOE culture. "It was a clear case of 'not invented here,'" Hollister says. Many environmentalists -- acting as narrow-mindedly as their traditional opponents in government and the nuclear industry -- dismissed the idea before learning the details, assuming that the approach involved little more than wholesale ocean dumping. The nuclear utilities lobbied against it for pecuniary reasons: the waste-disposal

effort is largely subsidized by a tax on nuclear-generated electricity that the utilities have been paying (they pass the cost on to consumers) since 1982, and they have seen little tangible return on their $12 billion investment. Industry officials -- concerned that the DOE would be unable to meet its obligation to start accepting nuclear waste by 1998 -- surmised that the sooner the Yucca Mountain facility opened, the sooner they could divest themselves of their spent nuclear fuel and the waste issue in general. "Their position was extremely superficial," says John Kelly, who heads JK Research Associates, a consulting firm specializing in nuclear- and hazardous-waste disposal issues. "They decided the only way to succeed in building a repository in Nevada was to cut off all alternatives." This position was shared by Louisiana Senator J. Bennett Johnston, then the chairman of the Energy and Natural Resources Committee and a leading opponent of sub-seabed disposal.

The shortcomings of the resultant program are now widely apparent. After spending almost $2 billion on technical studies and preliminary excavation at Yucca Mountain, the DOE still hasn't demonstrated the geologic suitability of the site. The mountain lies near active seismic faults and a volcano that erupted less than 10,000 years ago. There is concern that the water table beneath the proposed burial grounds could rise and seep into the repository, contaminating groundwater and allowing radioactivity to escape. Two scientists, holding a decidedly minority view, have even suggested that the buried wastes might "go critical" and explode because of the large amounts of fissionable material packed into a relatively small space. Meanwhile, political opposition is growing: Nevada's governor and senators, along with local environmental groups, have declared war on the venture. Even if the project can withstand these challenges and move forward, the facility will be seriously undersized the day it opens its doors (2015 is considered the earliest possible date), able to accommodate just a fraction of the high-level waste that will have accumulated by then in the United States.

The government's unwillingness to prepare a good fallback position in the face of mounting difficulties seems like sheer folly. Although the DOE is not supporting any work on alternative disposal concepts at present, Hollister has not given up. While the ambitious research program he helped to fashion is on hold, he continues to explore the sub-seabed concept in indirect ways. In

1993, for example, he spent six weeks in the Norwegian Sea studying a Soviet nuclear sub that had sunk years before in the middle of an active fishing ground. "The scientific evidence to date points to zero impact if the nuclear material sits beneath the bottom of the sea or even on the bottom," he says. Other analyses of radioactive spills in the marine environment have reached a similar conclusion: high-level radioactive materials tend to stay put if they are placed in or on a clay-rich sea floor, Hollister claims. Vertical migration rates are so slow that it is "virtually impossible" for measurable concentrations of radioactivity to reach the surface from deep water. "Many people don't like this conclusion," he adds, "but I've never seen any data in the oceanographic literature that refute it."

He concedes that the sub-seabed-disposal concept requires additional scrutiny. Several questions, all fairly straightforward, still need to be addressed. For instance, is it better to put the waste in torpedo-shaped canisters that will penetrate the sea floor on their own after being dropped from the surface, or should it be implanted by means of drilling? How deep should the canisters be buried? How will the heat generated by radioactive waste affect the muds lying beneath the ocean? And how strongly will negatively charged clay particles latch on to positively charged ions of uranium, plutonium, cesium, and strontium? "We know exactly what to do to answer these questions," Hollister says, citing field experiments that have already been designed to determine, for instance, how securely the holes close up around the waste canisters and whether radioactive material moves through ocean-floor clays at the same rates measured in the lab.

Arrangements would have to be made, of course, to ensure the safe transport of waste to the seabed. International laws governing the use of the seas would also have to be addressed, although this might be done while research is under way.

A FORUM already exists that can resolve issues related to sub-seabed disposal: the annual meetings of the contracting parties to the London Dumping Convention, the only international treaty that directly addresses the subject. Should sub-seabed nuclear-waste disposal ever be implemented, the program could be administered and regulated worldwide by the International Maritime

Organization, the agency that oversees the functions of the LDC. This prospect may be especially attractive to countries like the Netherlands and Japan, which have little room and no favorable geology for land-based disposal methods.

Yet the treaty may pose the biggest hurdles for this waste-disposal option. Although the dumping of any radioactive waste at sea has been prohibited by international law since 1994, the status of sub-seabed disposal has been ambiguous. This may change very soon: a resolution to be taken up at an LDC meeting at the end of this month would extend the definition of "dumping" to include "any deliberate disposal or storage of wastes or other matter in the sea-bed and the subsoil thereof." If the measure passes (and indications are that it will), sub-seabed disposal will be prohibited, and the decision may not be appealed for twenty-five years.

The resolution makes no sense to Edward Miles, an expert on international marine policy at the University of Washington. "On objective grounds, there is no way one can argue that sub-seabed burial is dumping," he says, pointing out that the United Nations' International Atomic Energy Agency considers it a "variation of deep geologic disposal on land." The United States, which lobbied for the sub-seabed approach at the 1984 LDC meeting, has since "flip-flopped" on the issue, he says, and now supports the resolution. "It's not a position based on any scientific or legal matters. It's just a political decision attributable to the fact that the environmental community has access to Al Gore and, through him, to President Clinton."

Clifton Curtis, a political adviser to Greenpeace International, has fought against sub-seabed disposal since 1978, at LDC meetings and elsewhere, in his campaign to "protect the ocean from potentially harmful activities." He favors land-based disposal options, arguing that "the people who produce nuclear waste should deal with it in their own territory -- that would force everyone to pay more attention to what they're producing." Terrestrial methods are also superior on the grounds of "monitorability" and "retrievability," he says. "If there's ever the need to retrieve the wastes because of a problem, it's much easier to do so on land."

Hollister disputes this contention, asserting that the technology

exists for both monitoring and recovery at sea. What's more, he says, sub-seabed retrieval would probably be easier and cheaper than digging vast tunnels into the earth. Yet Curtis remains unconvinced and would like to see the impending ban on sub-seabed disposal apply to research as well -- a viewpoint, he claims, that is shared by all major environmental organizations. "There is a broad consensus that ocean dumping of radioactive wastes, including sub-seabed burial, should be prohibited," he says. "In light of that, it makes more sense to focus our research on terrestrial options."

The London treaty takes no formal position regarding experiments that would involve putting small amounts of radioactive material in the ocean floor. But even if such studies are not explicitly forbidden, Miles argues, the U.S. government is highly unlikely to fund such research in the face of an international (and national) disposal ban. "A decision to classify sub-seabed disposal as dumping would effectively kill the idea by cutting off any motivation to continue the research," he says. "And without any additional research there will be nothing to reconsider twenty-five years from now."

Another assault on sub-seabed disposal comes in the form of a House bill,HR 1020, that at the time of this writing was scheduled for a vote in September. It contains a section written by Frank Pallone Jr., a New Jersey congressman, that would prohibit the funding of research related to the sub-seabed disposal of radioactive waste. Sub-seabed disposal "is something that shouldn't even be considered," says Rick Kessler, an aide to Pallone, by way of explaining the motivation behind the bill. "Why should the U.S. taxpayer spend a penny researching something that will never happen?"

Hollister is puzzled by the flurry of attacks on a field that has been unfunded and dormant for a decade. "I have no problem with a ban on sub-seabed disposal," he says. "I think it should be banned until we do more experiments. What troubles me is people who are trying to ban *research* on the subject." Rather than discouraging inquiry to meet short-term political objectives, he says, we should be actively exploring all reasonable disposal options. He suspects that the opposition to sub-seabed disposal is part of a broader opposition to nuclear energy in general. "Some people don't want to hear about anything nuclear, even solutions," he says.

Paul Slovic, a psychologist at Decision Research, in Eugene, Oregon, who serves on the National Academy of Sciences Board on Radioactive Waste Management, believes that many people are opposed to doing anything with high-level nuclear waste. "They don't have any position except to not deal with it. Any suggestion you could make would be considered unacceptable." This attitude, which is compounded by a widespread mistrust of government and the nuclear industry, makes the problem "quite intractable," Slovic says. "We still haven't figured out as a society how to make decisions about high-level radioactive wastes."

John Kelly, the consultant, has a more optimistic outlook. "Some say that it's institutionally impossible to find a solution, and I think that's right if we don't have an active research-and-education program," he says. "On the other hand, you have to believe that people can change their opinions in the face of new scientific findings." This process could take a while, possibly a generation, but he considers that a reasonable time frame for developing a sound waste-disposal system.

Decisions should not be made hastily; nor should they be postponed indefinitely. The status quo is not an attractive option, because it entails considerable risks and costs. U.S. nuclear-weapons-production facilities alone have generated millions of gallons of high-level wastes whose careless handling has led to extensive contamination of the sites and in some cases the areas around them. Now the government is paying about $5.5 billion a year to contractors -- as part of the biggest and costliest environmental cleanup effort ever undertaken -- to try to contain this radioactive mess until permanent waste repositories become available. (Some $400 million a year is being spent on getting such repositories ready.) Over the next century the price tag for the cleanup may be anywhere from a quarter of a trillion to a trillion dollars, a staggering sum that makes most congressional cost-cutting efforts look trivial.

The cleanup program has become a boondoggle, partly owing to bureaucratic mismanagement and partly because the task of environmental remediation has been complicated by the lack of a permanent disposal method. That's why a safe, secure, and long-term solution is so important. If we investigate thoroughly, we just might find that the best place to deposit our high-level nuclear

trash is in the low-level abyssal clays beneath the ocean. It's possible, of course, that we'll conclude after further study that sub-seabed disposal is not the answer, but we ought to spend the time and money to find out. Charles Hollister's estimate of the necessary investment, $250 million, equals the budget for about two weeks of the current, and faltering, nuclear cleanup and waste-disposal operation.

Illustration by Doug Martin

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