Deep-Sea Salvage: Did CIA Use Mohole Techniques to Raise Sub?

The CIA's recent attempt to salvage a sunken Russian submarine has opened up a new technological arena for strategic skirmishing between the great powers. If parts of a submarine can be recovered from the deep-sea bed, so too can smaller objects, such as hydrophones and the reentry vehicles from ICBM tests. But the technology may not be as new or unprecedented as it was made to appear in the first enthusiastic accounts of the *Glomar Explorer*'s deep-sea escapade. One of the pioneers of deep-sea recovery suggested to the CIA 12 years ago a mission so similar to the *Glomar Explorer*'s that he is now reviewing his patent rights. There is also some reason to doubt that the *Glomar Explorer*'s task was quite as large as has been portrayed.

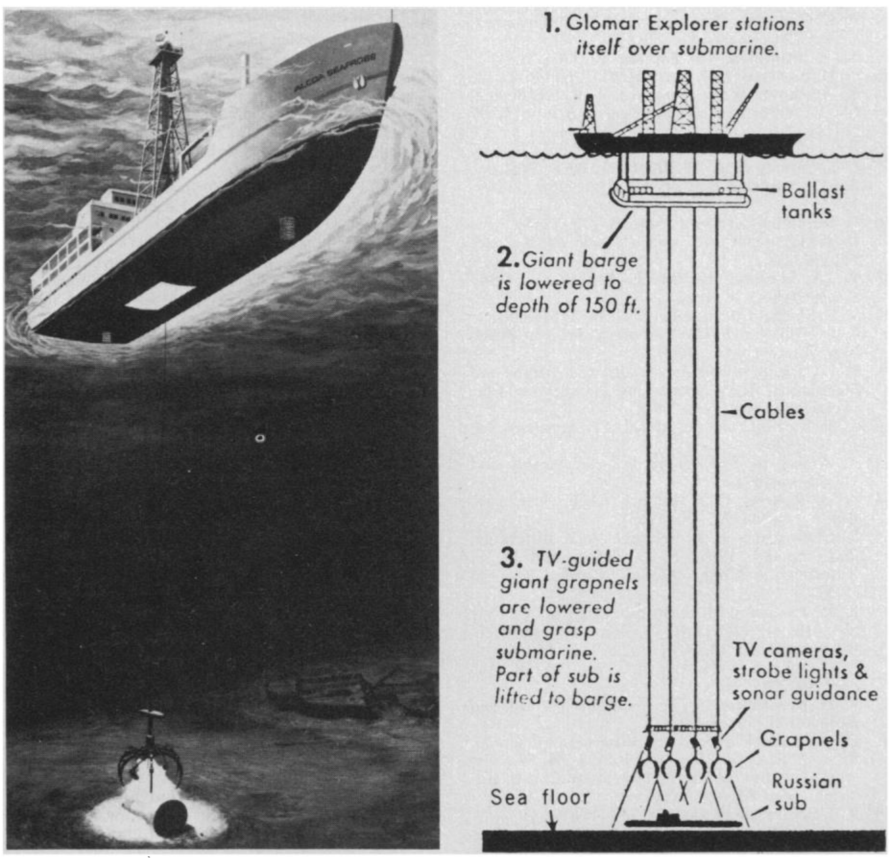
A proposal to retrieve missile nose cones, and maybe submarines also, was presented to the CIA in the early 1960's by Ocean Science and Engineering Inc., a small but adventurous company whose members designed the basic systems for Project Mohole, the plan to drill a hole through the sea bed to the Mohorovicic discontinuity. According to a former OSE employee, the proposal was stimulated by the sinking of the American nuclear-powered submarine *Thresher* in 1963. The employee told *Science* that the proposal envisaged deployment of a drill pipe with a terminal claw from a dynamically positioned surface ship. Both the technique and purpose of the OSE proposal, which the CIA turned down, were the same as that of the *Glomar Explorer*, he says. The president of OSE, Ed Lawlor, confirmed the account but said that the proposal was "too sensitive" to discuss further over the telephone. Another former OSE employee says the proposal was initiated before the sinking of the *Thresher*, the original purpose being to recover missile nose cones from off Palmyra, one of the Line Islands in the Pacific.

Willard N. Bascom, an engineer with genius but no degree, founded OSE when he resigned from Project Mohole. Though the project went on to political disaster, the techniques evolved by Bascom and his team later became the basis of the highly successful deep-sea drilling program carried out by the oceanographic research ship *Glomar Challenger*. Were Bascom's ideas also the basis of the *Glomar Explorer*, the CIA ship operated by Howard Hughes' Summa Corporation under the guise of mining for deep-sea nodules until its cover was blown 2 months ago?

The two ships bear the name *Glomar* because both were designed by the Global Marine Corporation of Los Angeles. Global Marine officials decline to discuss the *Glomar Explorer*, but the accounts that appeared during March and April purport to describe the principal operating features of the ship. To the extent that these accounts can be relied on, the ship would appear to incorporate the main techniques described by Bascom over the last 10 years, such as dynamic positioning to keep the ship in one spot, use of a tapered drill pipe to recover the object, and deployment of powered tongs to grapple it.

Bascom, now director of the Southern California Coastal Water Research Project, declines to comment on OSE's proposal to the CIA or its similarity to the techniques used by the *Glomar Explorer*. His attorney, George Wise of Long Beach, California, says only that "a review of his rights is being undertaken." According to Global Marine's secretary and treasurer, Taylor Hancock, the *Glomar Explorer*'s technology is "vastly different" from Bascom's conceptions, but neither he nor Curtis Crooke, head of the company's *Glomar Explorer* program, is willing to describe what the differences may be.

The *Glomar Explorer*, *Time* magazine announced last March, "pushed the limits of engineering and technology almost as far as Project Apollo." The Los Angeles *Times* praised the ship as a "revolutionary" craft designed to reach to "unheard of ocean depths" (the Russian submarine reportedly lay in 16,500 feet of water). Such publicity may have been a welcome change for the CIA, which engendered it. But, remarkable as the *Glomar Explorer*'s achievement—whatever it was—may have been, its operating depth was not precisely "unheard of." A patent filed by Bascom in 1962 and granted in 1965 (U.S. Patent No. 3,215,976) describes a method for searching and recovering objects with drill pipe



Artist's conception (left), drawn in 1969, of a search and recovery operation by the Alcoa Seaprobe, *a vessel using the dynamic positioning and drill pipe recovery technique devised by Willard Bascom. The vessel was completed in 1971. [Picture credit: Alcoa] Diagram from* Time Magazine *(right), showing* Glomar Explorer's *mode of recovery. [Reprinted by permission from* Time, *the weekly magazine; copyright Time Inc.]*

and pick-up tongs "at depths of the order of 20,000 feet."

Bascom's patent is no mere pipe dream. A ship has been built according to its specifications by the Alcoa Marine Corporation. Called the *Alcoa Seaprobe*, it was built in 1971 and is designed to lift weights of 200 tons from 6000 feet and 50 tons (using high-strength drill pipe) from 18,000 feet. *Glomar Explorer*, according to *Time*, used bottom placed instruments to maintain "an almost impossible stationary position, straying no more than 50 feet in any direction." The *Alcoa Seaprobe*, according to her former chief engineer, can hover with an accuracy of about 20 feet. George G. Scholley, president of the Alcoa Marine Corporation, says he has "the utmost respect" for the *Glomar Explorer*'s achievement but notes that it would seem to be "just an upscaling from what we are doing —the technology is basically the same, the basic concept is the same."

The deep-sea search and recovery capability of the *Glomar Explorer* and *Alcoa Seaprobe* in effect make it technically feasible to retrieve a large variety of objects, provided that the cost is worthwhile. Four classes of objects with strategic implications are submarines, missiles, satellites, and hydrophones.

• *Submarines*. Two American nuclear submarines are known to have sunk in the Atlantic, the *Thresher* in 1963 and the *Scorpion* in 1968. Both were nuclear-powered attack submarines and carried no missiles. The *Thresher* lies in 8,000 feet of water, the *Scorpion* in about 12,000 to 14,000 feet. The two submarines are in pieces, but there is no detectable leakage from their nuclear power plants. A few small objects have been recovered with a magnetic trawl towed from the *Mizar*, a Navy deep-sea reconnaissance ship which is said to have made the initial survey of the Russian submarine site in the Pacific.

Besides the *Thresher* and the *Scorpion*, two Russian submarines are reported to have sunk in the Atlantic. A November class nuclear-powered attack submarine sank off Portugal in April 1970, and another nuclear submarine, equipped to carry three nuclear missiles, foundered 900 miles northeast of Newfoundland in March 1972, and may have been lost. The Los Angeles *Times*, in its initial story on the *Glomar Explorer*, reported that the Atlantic Ocean was the site of the ship's operation. The *Glomar Explorer* is known at least to have conducted tests in the Atlantic after being completed in 1973 at a Pennsylvania shipyard.

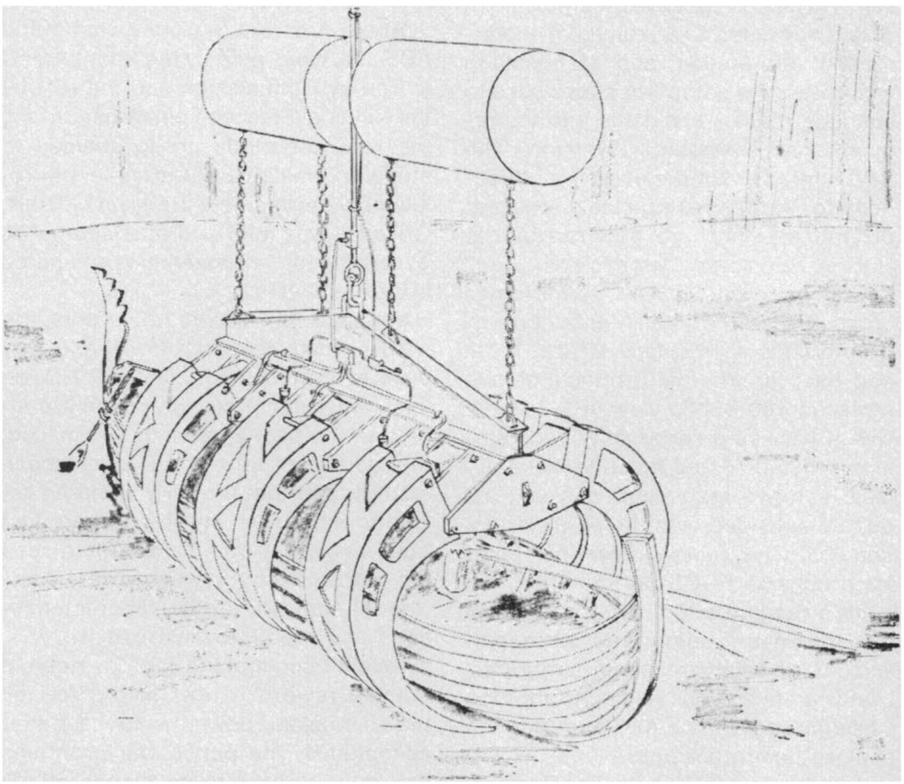
• *Missiles*. The Soviet Union has to test its longest range ICBM's over water because its overland range is slightly too short for their full flight path. The initial propulsion stages of such a missile would fall back in the general vicinity of the launch point and the final stage of the order of 100 miles further on. The reentry vehicle, however, would be designed to survive the flight down to the intended explosion point and maybe to sea level.

Most reentry vehicles used on Soviet ICBM tests over the Pacific would not contain real warheads, or anything resembling them. But, according to an expert who declines to be identified, "if you think about how engineers go about convincing themselves their designs will work, you would expect that at some time in a flight test program a reasonable facsimile of an actual bomb would be flown." The same source adds that the Russians "have taken a more empirical approach to these things than we have—they want to see things actually done in a test rather than rely on calculations and extrapolations."

A reentry vehicle containing a "reasonable facsimile of a bomb" might well be designed to explode at the end of its flight so as to prevent recovery. Should it survive, however, its point of impact could be calculated from its trajectory to within a few square miles. In favorable conditions, such an object should be recoverable by a ship such as the *Alcoa Seaprobe*, whose bottom-scanning sonar can resolve targets of 2 feet at a distance of 300 feet.

• *Satellites*. Most satellites burn up in the atmosphere, and such fragments as survive are of only metallurgical interest. Reconnaissance satellites may be programmed to release packages designed for recovery, and on five or six occasions, according to a source who declines to be named, Soviet satellites have released such packages while not over the Soviet Union. Unfortunately the packages are also designed to explode in this eventuality, and no instance is known of such an object reaching the ocean intact.

• *Hydrophones*. Hydrophone arrays can be deployed strategically for detecting the other side's missile submarines or, tactically, for defending particular targets. The distinction is important because of the SALT (Strategic Arms Limitation Talks) agreement banning interference with the other side's "national means of verification." The phrase, usually understood to refer to satellites, has not been publicly defined but, according to a State Department official, it probably includes strategic hydrophones. The United States maintains a strategic hydrophone network, SONUS, which covers about a third of the Atlantic and Pacific oceans. (It was apparently through SONUS that the collapse of the salvaged Russian submarine was detected and pinpointed.) The Soviet Union does not have a strategic network and all its hydrophones, being tactical, are therefore fair game. Recovery of a deep-sea hy-



Conception by Willard Bascom for recovery of a vessel from deep water. The tongs weigh 50 metric tons and, like those used with the Glomar Explorer, *would be towed independently to the salvage site. The tongs are attached to a drill pipe and their weight is offset by buoyant cylinders. [From an article by Bascom in* Science, *15 October 1971, pp. 261–69]*

APS Critiques Nuclear Safety R & D

This May marks the fourth anniversary of the great debate over an arcane but important piece of plumbing in nuclear power plants called the emergency core cooling system. The ECCS issue has been overshadowed lately by new concerns over the possibility of nuclear theft and sabotage. But a noteworthy study released by the American Physical Society on 28 April is a reminder that the argument over reactor accidents—and the adequacy of systems that are supposed to mitigate them—is still not resolved.

The APS report is the product of a year-long examination of the government's nuclear safety research programs. In brief, the society's 12-man study group found no reason for "substantial short-range concern" about nuclear accidents. And the group said that emergency cooling systems probably would prevent a catastrophic meltdown of a reactor core if called upon "under most circumstances."

Nevertheless, the APS group said, there is a general lack of "well-quantified understanding" about such backup safety systems as emergency cooling. This it attributed to a paucity of experimental information and to resulting weaknesses in computer codes used to simulate reactor accidents and the response of emergency systems. The APS offered a number of recommendations for strengthening safety research programs, which are now run by the Nuclear Regulatory Commission.

Concern over ECCS performance arose within the old Atomic Energy Commission in the late 1960's. What had been an internal technical debate surfaced into public view in 1971 and, with a year-long series of public hearings in 1972–73, did much to make nuclear safety a major public issue. The debate subsided with the AEC's adoption of stricter, more conservative rules for predicting ECCS performance. But it left a residue of questions about the management, funding, and basic philosophy of safety research programs. Last year, in an unusual departure for a scientific society, the APS undertook to explore these questions.

Among its other main conclusions, the APS study group said:

- ▸ A major AEC analysis of reactor accidents, called the Rasmussen report, had underestimated the number of deaths and illnesses that would result from a major release of radioactivity in a reactor accident by a factor of 25 to 50. Rather than the 310 cancer deaths predicted to result from a large release of fission products, the APS group set the number between 10,000 and 20,000 in a densely populated area.
- ▸ The engineering sophistication of reactor control rooms, as well as the training of reactor operators, is below standards maintained for military commands and air-traffic control centers.
- ▸ Much more could be done to measure objectively the success or failure of quality control programs in the nuclear industry.
- ▸ Research on recovery from nuclear reactor accidents is not being done now, but should be.

Outside review of the safety research program "has probably not been sufficient." Small outside review groups, preferably with no other connection to the nuclear community, should monitor experimental and theoretical programs, and results should, to the extent possible, be published in refereed journals.

About one-quarter of the cost of the APS study was paid by the (then) Atomic Energy Commission and the rest by the National Science Foundation. Along the way, the study group seemed to strike an amicable but arms-length relationship with safety program officials. Criticism was mild and often tempered by praise for improvements instituted in the past 2 years.

In response, Herbert J. C. Kouts, the NRC's safety research chief, told *Science* that money for safety R & D on light-water reactors has roughly doubled in the past 2 years to $70 million, that scores of new projects had been started, and that formerly withered relations with university researchers had been revived. Kouts said he had read the APS study, agrees with many (though not all) of its recommendations, and intends to make use of it.

"We'd been looking for a competent outside review," Kouts said. "We felt that if nuclear power is to be better accepted by the public, our programs are going to have to be 'signed off' on by the larger technical community."

—R. G.

drophone might not be worthwhile, since the individual sensors are less important than the way their information is processed. On the other hand, ability to locate and reach the other side's hydrophones might open up various possibilities for interfering with his network.

Just how far the *Glomar Explorer* has contributed to opening up the deep ocean floor is hard to say because, despite the profusion of material about the ship's exploits, its actual capabilities are far from clear. CIA officials disseminated a lot of information on a semi-official basis for a brief period in March, but are now unwilling to comment. "That's a non-starter around here," a CIA man told *Science*, saying by way of explanation that the Russians had tolerated the U-2's overflights up until the first official confirmation by the United States government.

Some newspapers gained the impression that the CIA, while ostensibly trying to bottle up the story of the *Glomar Explorer*, had actually been helpful all along in getting it out. There is room for endless speculation, but the account best suited to the agency's purposes might be one that would justify the cost of Project Jennifer on the one hand, and not humiliate the Russians on the other.

As it happens, the general version that emerged in public last March fulfills both objectives. The Russian submarine was raised intact from the ocean floor some 750 miles northwest of Oahu, the story goes. About half way up the 16,500 foot ascent, a rattling of cables was heard on the *Glomar Explorer*'s deck and two thirds of the captured submarine broke away, damaging the claws and sinking back to the bottom. The third that was recovered contained no missiles, no code room, and maybe, but not definitely, either two nuclear tippable torpedoes or the evidence for their existence. Reports that the whole submarine, or two of its nuclear torpedo warheads had been recovered, were specifically denied.

While this version of events may be accurate, it contains a number of implausibilities that raise questions about the semi-official version. For one thing, the ability to raise the total bulk of a submarine from a depth of 16,500 feet would be an advance of some two orders of magnitude beyond the current state of the art (*Alcoa Seaprobe* can raise 50 tons from 18,000 feet.) Scholley, Alcoa Marine's president, says flatly that "There is no way on God's green earth that they could have lifted the whole submarine up."

For another, the chances that the CIA found the submarine in one piece seem in fact to be less than overwhelming. Unlike surface ships which tend to maintain their structural integrity on sinking, submarines get badly broken. On passing their design depth, they implode and the hull either breaks at that point or is gravely weakened. The submarine then accelerates downward, crashing into the sea bottom at sometimes remarkable speeds. The *Thresher*, for example, is held by some estimates to have impacted at a speed of 100 knots (115 miles per hour). Others, however, believe that 25 to 30 knots is the maximum descent speed a sinking sub can attain.

Whatever its exact impact velocity, the structure is almost certain to break up, if the accidents with American submarines are anything to go by. According to Captain William Walker, an engineer in the Office of the Oceanographer of the Navy, the *Scorpion* lies with its bow and stern ends broken off, although the midship section is fairly intact. The *Thresher* broke into a greater number of pieces and is surrounded by a field of debris about half a mile in radius. Asked about the apparent raising of the Soviet submarine in one piece Walker said: "That was quite remarkable to me considering our experience with the *Thresher* and *Scorpion*. I would have expected at least the bow and stern sections to have been fractured off."

If the submarine was indeed in one piece, it is hard to reconcile such figures as have been published with the magnitude of the operation required. The Russian submarine is reported to belong to a category, the Golf class, which has a displacement weight of 2800 tons. Estimates obtained by *Science* for the submarine's likely deadweight range from 2000 to 8000 tons, and several newspapers cite a figure of 4000 tons. But the lifting capacity of the *Glomar Explorer* is usually quoted as 800 tons, attributed either to the ship's main derrick or its submersible barge, which is clearly insufficient to raise an entire submarine.

Almost all accounts mention that a drill pipe with a large claw at the end was used to raise the submarine. (*Time*, in its diagram, shows four cables, but its text describes the use of piping.) According to the Los Angeles *Times*, the *Glomar Explorer*'s drill pipe had walls 4 inches thick with a hollow core 3 inches in diameter. Rough calculation suggests that a drill pipe of these dimensions, if made of the strongest steel used in commercially available drill pipes, could lift some 3400 tons before it started to deform. If the submarine weighed 4000 tons, it is hard to see how the Los Angeles *Times*' drill pipe could have lifted it in one piece.

Rumor in the ocean mining world, however, has it that the drill pipe was a massive 16 inches in diameter. Both this and the figures quoted above are reconciled in the version given by a mining engineer close to one of the contractors for the *Glomar Explorer*. The engineer, who declines to be identified, says that the ship used different thicknesses of pipe to construct a tapered drill string, with the pipe at the top having walls as thick as 6 inches. He states that the *Glomar Explorer*'s derrick had a total lifting capacity of about 5000 tons. If its drill string weighed 1500 tons, the ship would have a lifting capacity of 3500 tons with which to overcome suction effects and raise its payload. Another mining engineer, John Miro of Ocean Resources Inc., San Diego, believes that ship may have used steel cables to assist the drill pipe.

It is hard to distinguish whether a lifting capacity of this order would have been designed to lift the whole submarine, or just a single large fragment of it. (If the Russian submarine broke into three pieces, like the *Scorpion*, with its midships intact, this section might amount to a large fraction of its total tonnage.)

If the submarine was indeed in pieces, it would have been much easier to salvage, and has quite possibly been retrieved in its entirety. If, on the other hand, the *Glomar Explorer* succeeded in lifting the entire submarine, as the semi-official version claims, the ship should have little trouble in recovering the two thirds which dropped back, especially since the second descent of the stricken submarine would almost certainly shatter it into easily retrievable fragments.—NICHOLAS WADE

Privacy: Congressional Efforts Are Coming to Fruition

The issue of privacy is finally having its day in Congress. The last Congress (93rd) saw the introduction of scores of bills designed to protect individuals from surveillance and record-keeping activity of government and government-funded agencies.

Two of them passed. One was the so-called Buckley amendment to the Elementary and Secondary Education Amendments of 1974, which increases access to student records by students and their parents, and inhibits it for others. The other, more far-reaching law represents the first attempt to set government-wide standards regulating data banks containing records on individuals held by most agencies in the federal government. Called the Privacy Act of 1974, it is the final legacy of Senator Sam J. Ervin (D–N.C.) who retired from Congress last December. The law goes into effect on 27 September.

These two measures are the early blossomings of what promises to be an entirely new family of legislation designed to stem the real or potential erosion of personal liberty caused by massive and promiscuous data collection, use, and dissemination by all levels of government as well as the private sector.

The Privacy Act is couched in fairly general terms—what it does is articulate a set of principles to ensure that information is only used for the purpose for which it was collected and to let members of the public know what the government knows about them. It lays a basis for future, more specific legislation governing the handling of various categories of information. The law is actually one of the federal government's first steps in building a theoretical framework for achieving a balance, in both the public and private sectors, between the individual's right to privacy and society's "need to know." The latter concept is already formalized in the Freedom of Information Act; one intended effect of the privacy measure is to clarify one of the exemptions in the FOI act that prohibits the dispensation of information when that involves a clearly unwarranted invasion of privacy.

There is a fair amount of stabbing in the dark involved in privacy legislation, and it is case law that will eventually determine its substance. Meanwhile, as Ruth M. Davis, director of the Institute for Computer Sciences and Technology at the National Bureau of Standards, observes, one inevitable spinoff will be the development and revival of good information management practices. (NBS has been deeply involved in developing standards for confidentiality and security in automated data systems.) The government has been in possession of files it didn't even know about, as was revealed in a 3-year study completed in 1974 by the Ervin subcommittee of the Senate Judiciary Committee. That study found 858 data banks in 54 agencies, all of which contained more than 1.25 billion files on individuals. The Privacy Act