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Mining: A Naval Strategy

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MINING: A Naval Strategy

The potential significance and utility of the mine in naval warfare has seldom been appreciated since its invention at the time of the American Revolution. The following historic narrative and analysis offer the reader not only a valuable review of past successes and failures of mine campaigns, but also a series of unique insights into possible roles for the mine in contemporary warfare.

A lecture delivered at the Naval War College

by

Professor Andrew Patterson, Jr.

The constraints of time require that my talk deal with the major considerations of mining as a naval strategy. I shall therefore limit my observations to an outline of the history of mine warfare and mention certain specific engagements of great naval significance, then comment on the mine and strategic materials, and conclude by summarizing some generalizations which become evident to one who has had the opportunity to study mining extensively. These generalizations will tell us a good deal about how the mine has been employed and how it might better be employed in the future. Although this approach is not exhaustively academic, I think it will provide a summary look at the subject.

If we define a mine as an instrument of warfare which is placed on or near a ship under the waterline to cause damage by the effect of its explosion alone, then we can clearly place the origin of mine warfare with one of my fellow Yale men, David Bushnell of Connecticut, class of 1775. Bushnell demonstrated to his fellow students and his professors that gunpowder could be exploded under water and then postulated and demonstrated experimentally that the bottom or side of a ship is more vulnerable to explosions under water than are sections above the waterline. He spent a considerable portion of his undergraduate years, even as Yale students do today, on something other than his studies, for by 1775 he had built and tested an operational one-man submarine and an explosive magazine or mine to be emplaced by it. His inventions were used in the War of Independence by the United States, but they had no notable success.

Robert Fulton, whom Americans credit with the invention of the steamboat, made the next major advances in the technology of mining. A

man of innumerable mechanical schemes and unbelievable energy, he first designed mines and then persuaded Napoleon to use them against the British. However, after losing the confidence of the French, he went to England and convinced the British to use his mines against the French. After leaving Britain, he tried to sell his idea for the defense of New York harbor to the American Government but failed, despite his strikingly modern McNamara-style cost analysis entitled "Torpedo War."* [1] He calculated that a third-rate ship of the line (one of 80 guns and 600 men) would cost $400,000 to build and equip, while the same 600 men placed 12 at a time in torpedo boats, would cost, for the craft plus outfitting with torpedoes, only $24,300, resulting in a saving of $375,700. He also assessed the relative safety in a major battle of those in a defending ship of the line *vs.* those in the torpedo craft and concluded the latter would be better off. Fulton's ideas, while definitely sound, were ahead of the technological level of his weapons.

Samuel Colt, also of Connecticut and famous for his invention of the revolver pistol, began to experiment with mines at the age of 15. In 1842 he adapted an electrical firing device to his mine designs, developed and built a successful sheathed underwater cable, and conducted numerous spectacular and successful demonstrations of his system, some of which were against moving craft at considerable distances from the firing point. Again, the U.S. Navy could not be sold on the idea of mines, in spite of the public and political popularity of Colt's devices and system.

Further developments took place then on the Continent, leading to the planting of electrically detonated wine-cask mines at Kiel during the Schleswig-Holstein War of 1848-1850. Mines were planted by the Russians in the Crimean War of 1854-1856 at Sevastopol, Sveaborg, and Kronstadt. These utilized the Jacobi fuse, a kind of chemical horn firing device. In the French-Austrian War of 1859, the harbor of Venice was protected by mines containing up to 450 pounds of guncotton rigged to be fired electrically. Finally, these European developments were also recognized in Asia where the Chinese used mines in their war of 1857-1858 with the English.

None of these installations entailed any actual battle experience, however. It was not until our Civil War that mines were seriously and effectively employed. Matthew Fontaine Maury, the noted American oceanographer, concluded early in the war that the vast shoreline and river systems of the South could not be protected by a new nation which had no navy to speak of, except by the use of mines. If we define tactical to mean operations within an engagement limited in space and in time and strategic to mean the deployment of forces and materiel on a large scale—often in advance or over a protracted period—the South was unable to develop any overall strategic concept for the use of mines. It had no time for advance preparation and was lacking in both resources of men and material and, therefore, could do little other than meet immediate threats. Nevertheless, the events of the obviously successful Southern mine and spar torpedo campaign speak for themselves. By the end of the war, 29 Federal vessels were sunk and 14 damaged in major degree. Certainly, considerable planning went into the installation of several electrically

*Bushnell who first used the term, chose to call his weapon a torpedo, after the electric torpedo fish found off European coasts; the root Latin verb, torpere, means to stun. This name was used for the weapon we now call the mine through most of the 19th century when the advent of the self-propelled torpedo caused the named stationary device to be called the mine.

controlled minefields in strategic rivers, but the majority of the efforts were in the form of improvised but ingenious tactical maneuvers in the face of a vastly better equipped and numerous enemy. These efforts created stalemates in nearly all the major rivers, notably the James, prolonging the war not just for months, but for years.

I should like now to pass rather rapidly through the years 1865 until the present, picking out some engagements involving mines which were decisive in establishing the strategic and tactical uses to which mines could be put.

In the Russo-Turkish War of 1877-1878, the Russians wished to keep the elements of the Turkish Fleet separated and immobilized. They did so by planting mines at strategic spots in the Danube, spots so well chosen that the British planted aerial-laid mines at the exact same places in WW II. Although only one sinking is credited, the Turkish battleship *Suna*, the combined Russian effort with spar torpedoes and mines reduced the effective strength of the Turks to zero and transferred the initiative into Russian hands.

You will recall that this was the period during which the iron navies were developing and replacing sailing ships. It is curious to us today that developments in ships and armament, particularly including mines, were widely publicized and discussed. The Austrians, for example, displayed their mining system at the Paris exhibition of 1867, and Maury would give instruction in mining systems to the representatives of any government which could pay his substantial fee. This openness continued to the turn of the century.

Then the Russo-Japanese War of 1904 and a new climate of international mistrust changed things. The Russo-Japanese War constituted the first major confrontation between world powers using modern mines, a confrontation which warfare theorists had been calling for if mines were to be tested in the heat of battle as a system of weaponry. The Japanese mined offensively, placing fields across Russian harbors with considerable daring and then enticing the Russian Fleet out with a show of inferior forces. The Russians mined defensively, managing thus to extend their shorelines effectively to seaward, making it impossible for the Japanese Fleet to bombard the shore defenses. Six Russian ships were sunk by Japanese mines, one by a Russian mine. Eleven Japanese ships were sunk by Russian mines. Many ships and small craft of several nations fell victim to floating mines after the war was over, giving rise to the Hague Convention on mines of 1907.

Perhaps the most classic and history-making strategic action employing mines was by the Turks, possibly with aid from the Germans, in the Dardanelles in 1914. Using a mixed bag of mines and nets of uncertain origin and quality, the Turks mined the straits, employing an inspired combination of shore and naval weaponry, and undoubtedly changed the course of history. The minefields, at first rudimentary but later expanded, were guarded by shore batteries and searchlight installations, making it impossible for the British to sweep the fields. Attempts to do so were abandoned after the British lost four dreadnoughts to mines and shore fire. As a result of the blockade, Russian wheat did not leave the Ukraine, Turkey was not surrounded from the north, Turkey and Bulgaria were not separated by the naval wedge that Britain hoped to drive between them; but, most of all, the British suffered a major psychological defeat as well as a significant loss of ships and men.

The campaign by Russian Adm. Nikolai von Essen against the Germans in the Baltic was well planned in advance and brilliantly executed. Unfortunately, it was terminated by the

admiral's death in 1915. A concerted effort went into training elements of the Baltic Fleet in minelaying, and many destroyer hulls were converted to or developed as minelayers. Owing to the long 6-week period between the precipitating assassination and the declaration of hostilities, there was plenty of time to lay mines during the period of mobilization. While the Russians laid mines mostly for defensive protection of their own harbors and shore areas, they also mined offensively to interdict traffic on the Scandinavian-German iron ore routes. After the Germans laid minefields, von Essen expanded them and converted them into his own, creating havoc in the German Fleet. He then made fast runs into German harbors with minelaying destroyers, virtually cutting off the flow of iron ore, and preventing the German Fleet from giving fire support to shore-based forces. On one occasion alone, the Germans lost seven of 11 ships in the 10th Destroyer Flotilla.

A mine barrage of major proportions had been planned by the British Admiralty in WW I against the German concentrations at Heligoland, but its cost caused Churchill to turn it down as impossible. Furthermore, in 1914-1915, the British did not have a reliable mine to use, much less the numbers necessary to mount such a barrage. It was not until the United States entered the war and made its technological and production facilities available that it was possible to mount this offensive. By this time the British had developed the successful H2 mine, which was embodied into the Mk 6 mine, with float, antenna, et cetera. These made the mine barrage possible since they were able to watch over a much greater volume of ocean. Thus the decision was made to close off the entrance for German subs into the North Sea; by the end of the war, 70,117 mines had been laid. Not many sinkings can be attributed to the barrage (Roskill in his British report claims five, and Admiral Scheer says none. However, the barrage did force the Germans to traverse a greater distance to open water, with consequent delay, and the morale effect for the beleaguered British and the anxious Americans probably was significant. The cost of the barrage has been reckoned as equal to the cost of running the war for 1 day. Hence, if it shortened the war by 1 day, which it may well have done through its morale (if not ship sinking) effects, it was a good investment.

During WW II the United States conducted two major mining operations in the Pacific. The initial campaign was in the southern and outer reaches, and this was followed by a close-in operation around the Japanese home islands in what has come to be known as Operation Starvation. These campaigns were singularly successful in spite of the fact that

> There was at no time in the past war an over-all plan for a mining campaign against the Japanese, and as a consequence offensive mining was not included in the major strategy of the war. . . . Mines perhaps more than any other weapon of equal accomplishment, were orphans during the war. Even though approval and encouragement were received from the high commands, much of the initiation and promotion of the mine laying campaign can be traced to the relatively small group of enthusiasts engaged in the work.[2]

During the last 5 months of the war, more than 1,250,000 tons of Japanese shipping were sunk or damaged by mines, and a virtual blockade of the Shimonoseki Straits and of the inland sea was affected. The aerial mining campaign is credited by Prince Konoye (and other knowledgeable Japanese officers) with having an overall

economic effect comparable to all the other bombing and incendiary raids conducted. Thus an effort in mining requiring 5.7 percent of the XXI Bomber Command's flying time was comparable to all of the remaining 94.3 percent given to strategic bombing. Mines sank and damaged more shipping than any other agent, whether it was submarines, Army or Navy air forces. Despite this phenomenal success, the attack was very nearly too little and too late, as had decidedly been the case with the North Sea barrage. The bulk of the mining was of a strategic nature, although a number of tactical mining campaigns were mounted in support of amphibious operations when it was desired to interfere temporarily with movements of enemy ships; examples of tactical employment of mines would be in the Solomons, Rangoon, the Marshall Islands, Palau Atoll, Truk, Wolcai, and the Shimonoseki Straits.

I cannot end this brief historical recital without mentioning the incident at Wonsan, Korea. There was plenty of evidence that mines were being used by the North Koreans, for there had been sightings of drifting mines and of minefields on both coasts. Accordingly, plans were made to sweep for 10 days before the planned landing at Wonsan. What was not perhaps fully anticipated was that the Russians had given the North Koreans mines, torpedoes, and depth charges as well as technical training and direct supervision in planning and laying the fields at Wonsan. In the first 3 days of sweeping, American forces lost two large steel minesweepers and were so demoralized that the following message was sent to the Pentagon: "The U.S. Navy has lost command of the sea in Korean waters . . . ." Sweeping was abandoned and searching for mines instituted for 2 days. Then as the sweepers had cleared a channel and neared the shore, influence mines were encountered. Seven more days were required to complete the sweep, and the commanding officer of the landing force wisely concluded that, because of ROK advances on land, the landing was not required until the sweep could be completed. Of the estimated 3,000 mines laid, only 225 were swept and destroyed. The remainder lay outside swept channels.

In retrospect, the major result of the Wonsan encounter was a revitalization of U.S. Navy mine countermeasure activity. One cannot view the Wonsan incident as anything but a major victory for the Russians. In exchange for 3,000 obsolete mines, many of WW I vintage, a majority of pre-WW II style, the United States, aside from losses of ships and men, was committed to a continuing program of mine countermeasure expenditures extending into the multimillion dollar range. While this was good for the United States, it was a cheap trade-off for the Russians to force us to spend that kind of money.

Turning to some selected historical observations carefully picked from the panorama outlined above, significant conclusions can be reached. It is a surprising fact that *all* ship sinkings in the European theater in WW II were in depths of less than 600 feet, while in WW I the bulk of ships were sunk in similar inshore waters. During the 3 winter months of 1917-1918, 200 ships were sunk within 10 miles of shore (63 percent) while within 50 miles of shore an additional 35 percent were sunk, for a total of 98 percent ships sunk, all in waters not more than 50 miles from shore. From February 1917 to October 1918, 2,000 ships were sunk; 43 percent 10 miles from shore, 29 percent within 50 miles, for a total of 72 percent sunk within 50 miles of shore. In a similar way, during WW II every British battleship, fleet carrier, and cruiser sunk or damaged; every British submarine sunk in enemy action; every German warship, cruiser sized or greater; every German warship torpedoed by Soviet submarines; every Italian surface ship or

warship damaged by submarine action; every Soviet warship sunk by submarines; *all of these* were sunk in waters of less than 600-foot depth.

The reason why these sinkings, a significant number of which must have resulted from mines, took place in comparatively shallow waters near shore is quite evident. Transiting upon the ocean's surface takes place between a comparatively limited number of ports, whose location is determined by favorable conditions both ashore and offshore, as well as by historical accident. These ports are quite commonly approached through waterways which are restricted in one way or another by local or distant geography. The economic health and survival of these ports hinges on access to and need for various commodities and strategic materials. Minefields have characteristically been placed at points where ship traffic is expected, and attack submarines or surface ships would hunt their prey in similar waters.

An obvious implication of these data is that very little mining has been done in deep waters and that, hence, there is an unfulfilled need for a good deep-water mining capability. Except for those areas where the Continental Shelf extends far to sea, as it does on the east coast of the United States, there are uses for deep-water moorable mines near shore. In addition, the paths of much ocean traffic in deep water are still fairly narrowly defined by the desire to sail the minimum possible distance between established ports, modified only by intervening geographical features or by wind or weather.

Three charts emphasize what I mean. First is a depiction of the narrow waters of the world. Places marked 1 are 25 fathoms or less; 2, 25 to 200 fathoms; and 3, greater than 200 fathoms. Much traffic seems to go through narrow waters. Next is shown the major ports of the world. If this were overlaid with the preceding chart, most of these would be within narrow, shallow waters. Finally there is a track chart of the world showing selected tracks between these major ports. It is here where most of the world's trade is funneled, eventually through the narrow, shallow waters previously depicted.

I leap to a conclusion from these figures, and the history of mining seems to convey this point in general, that it is the ships and men themselves, more than the cargoes, which are the prime strategic materials. I leap also from strategy to strategic waterways. This was certainly Fulton's idea when he wrote *Torpedo War* in 1810. It was likewise the motivation for the use of torpedoes (that is, mines) during the Civil War, since the South could not blockade the North's sources of strategic materials. Only in WW I and WW II did the attack on cargo ships begin in a concerted way, and then, again, it was the ships and their generalized contents that were the targets, rather than attempts to control any particular materials. In both of these wars the attempts to establish the North Sea barrage or the Scotland-Iceland barrier were for general strategic and political objectives rather than for the control of specific strategic materials. Not the least of the objectives of mining is to cause the adversary to expend relatively large amounts of his substance on minesweeping and countermeasures; large amounts of this substance consist of ships and men, to which a few strategic materials, like copper, are added. There are clearly notable exceptions to mining in this generalized strategic sense: the classic examples are the Russian and British use of mines in both World Wars to deny high-quality Scandinavian iron ore to Germany, both of which were singularly successful. These exceptions do not alter the conclusion, however, that in a large majority the targets of mining have not been specific strategic materials, but more generalized

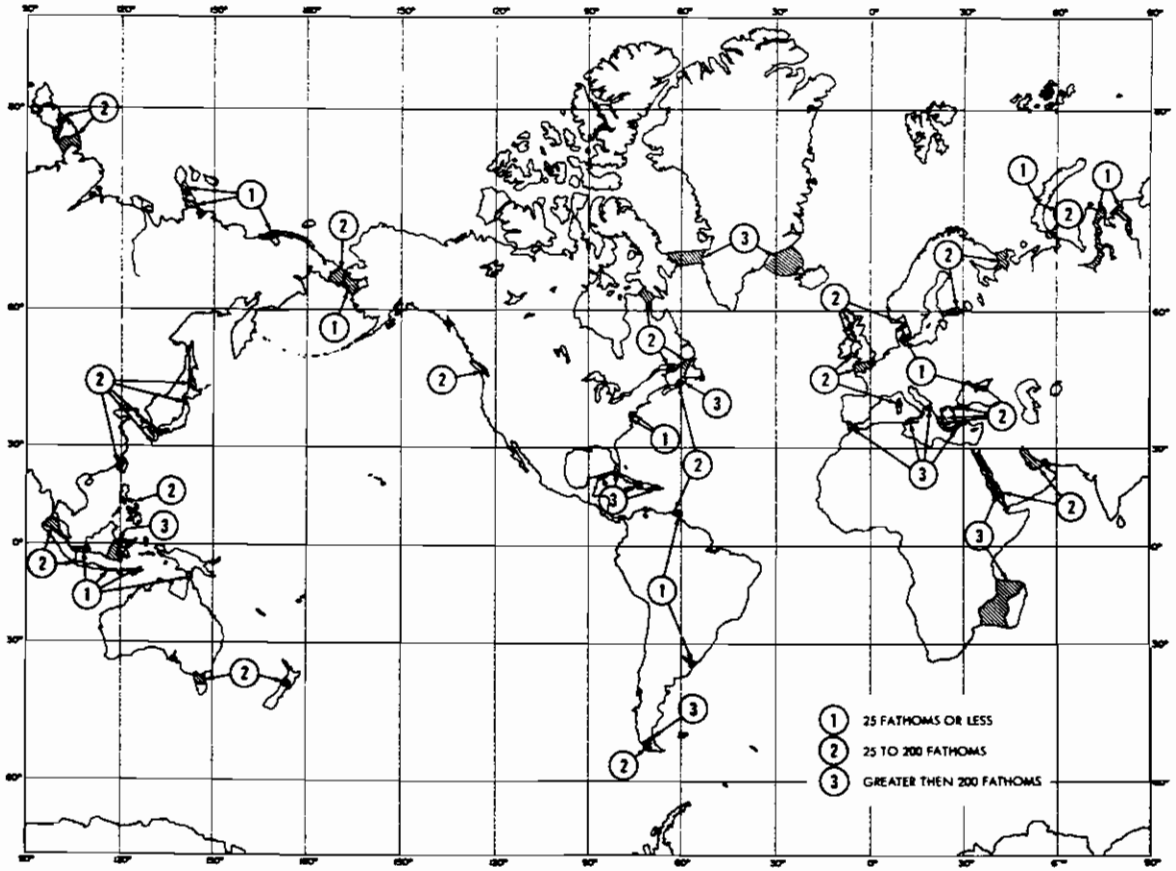

Fig. 1—Depths of Narrow Waters

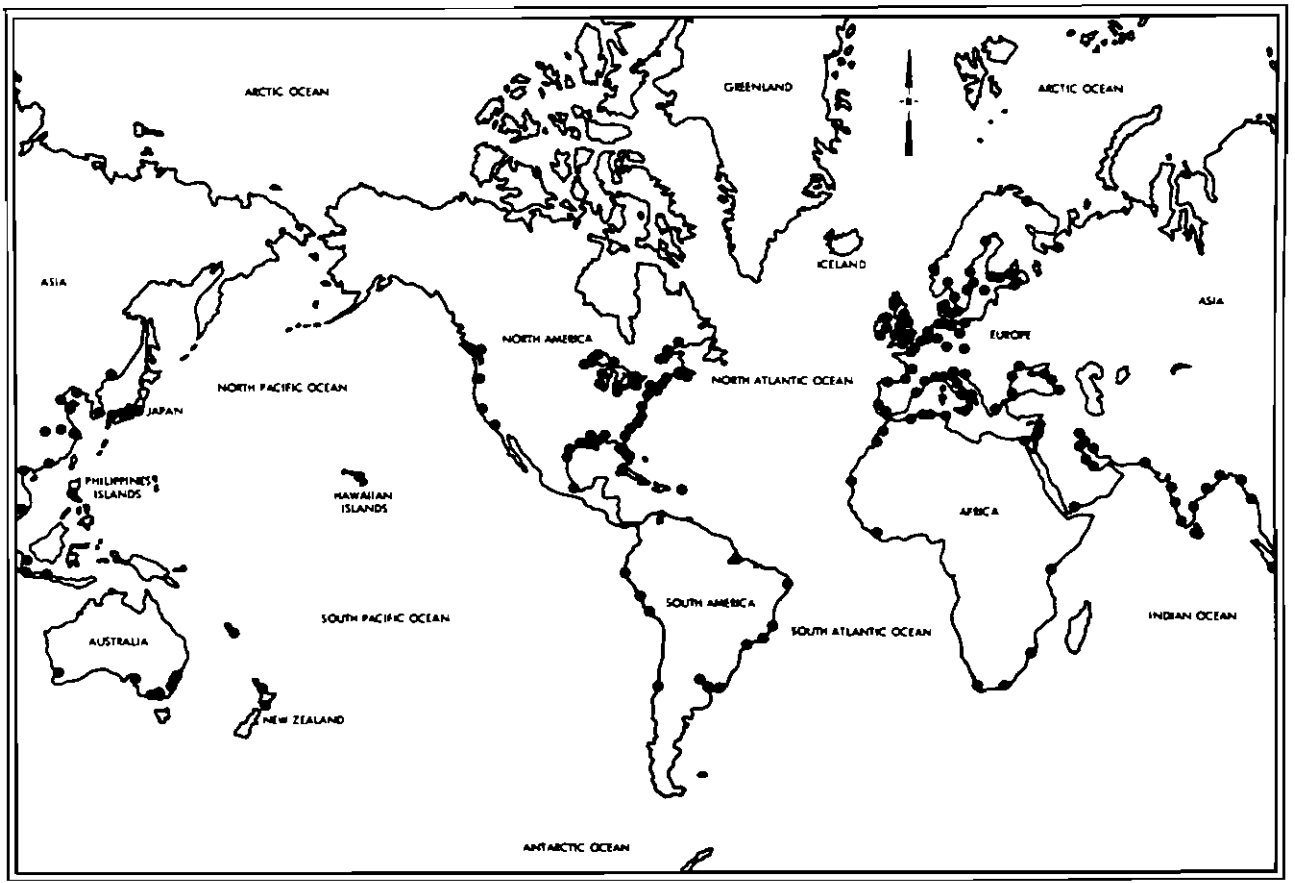

Fig. 2—Major Ports of the World

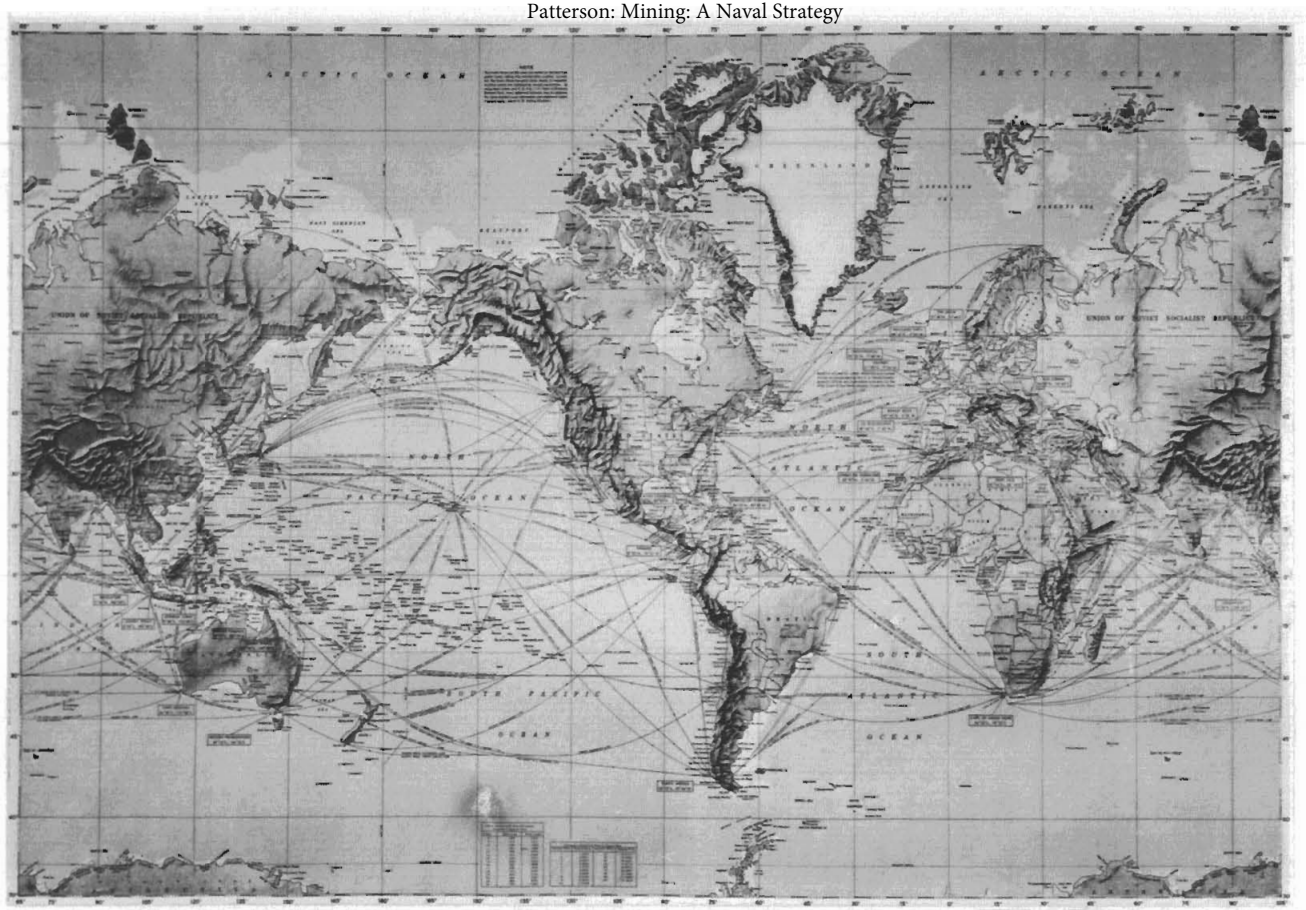

Fig. 3—Track Chart of the World (Showing selected tracks, within distances from place to place in nautical miles)

objectives. When these have not been men and ships, they have been political. Although in WW I the Allied Powers were anxious to get arms to Russia in exchange for her wheat, the Central Powers and Turkey undertook the mining of the Dardanelles not because of these materials, however strategic they might have been, but for political reasons. The targets sunk by those 20 mines at Erenköi were British battleships, British seamen, and British national prestige and pride. Brittania no longer ruled the waves!

To rephrase the historical lesson another way, few mining episodes or campaigns have been undertaken with specific raw materials as their goals. The goals have been larger: political and strategic and directed against ships and men themselves. These I deem to be the prime strategic materials.

Why this should be so is puzzling. It would seem to indicate lack of foresight on the part of strategic planners. It is certainly true that the strategic materials we depend upon—food, fuel, and certain minerals—often come from a few limited places. Nickel is a good example. Until WW II nearly all came from Canada. Cuba is now a significant producer, ironically from mines developed by the United States during WW II. There are numerous other strategic materials which come from only a few places, Persian Gulf oil being a particularly significant example.

I would go so far as to venture that, except in extended wars of the WW I and WW II types, it is not permissible to speak of the strategic uses of mining. The uses which have been made of mining lie elsewhere—in the political and psychological realms—a topic I shall defer to a subsequent part of this talk.

A second item which stands out in the historical record is the degree in which proponents and opponents of mining have been "true believers" in the Eric Hoffer sense of the term. From the times of Bushnell, Fulton, and Colt, mine developers have pressed and fought enthusiastically for the adoption of their ideas against others even more passionately opposed. Thus, when Fulton proposed mines first to the French, Admiral le Pelley, who was of the old school, refused to be interested because he had "conscientious scruples against such a terrible invention."[3] Fulton's encounter with Commodore Rodgers was not very much different, the commodore finding Fulton's torpedoes to be "comparatively of no importance at all; consequently they ought not to be relied on as a means of national defense."[4] While the proponents of mining have evidently believed in the efficacy of their weapons, their opponents have been motivated by a variety of very human emotions. The Earl St. Vincent, First Lord of the Admiralty, feared he would soon be out of a job when he said to Fulton, "Pitt" [who had supported Fulton's experiments in England] was the greatest fool that ever existed, to encourage a mode of war which they who commanded the seas did not want, and which, if successful, would deprive them of it."[5] This polarization of true believers is no doubt connected with the quote given above from the Strategic Bombing Survey which found that at no time was mining a part of the grand strategy of WW II. I raise the issue to indicate that among the arguments which are necessary if mining is to be used effectively as a weapon of war are those against prejudices of a number of different types.

A third feature of mines, which is of paramount importance in their tactical and strategic use, is their characteristically high degree of cost effectiveness. A string of 20 very ordinary mines off Erenköi in the Dardanelles probably altered the course of history in the Middle East. But of the mining expeditions which have been conceived on a large scale and postmortemed in detail, none is a better example than Operation

Starvation around Japan at the end of WW II. Sherwood Frey has taken data from the 1946 survey [referred to above] and converted them into a modern cost-effective format, using contemporaneous dollar figures. Among the conclusions are: Mines laid by aircraft and submarines produced from 2 to 10 times the merchant ship sinkings yielded by submarine torpedoes per unit of cost. Air-laid mines, producing about eight sinkings per million dollars of cost, were about 50 percent more effective per unit of cost than were submarines laying mines. However, there were *no* casualties to submarines on minelaying missions. It thus appears that submarines achieved a greater cost effectiveness using mines than they did using torpedoes. The effectiveness-cost ratio for submarines using mines is 4.7 casualties per million dollars of cost, while for submarines using torpedoes it is only 1.1 to as low as 0.36 sinkings per million dollars of cost, depending on how the initial investment in the submarines is handled. A reverse datum which would be instructive is the expenditure the United States has made on mine countermeasure activity divided by the cost to the Russians and Koreans of the mining at Wonsan. The figure, indeterminate for the present, is undoubtedly very large; it would affirm again and with vigor the statement that mining is cost effective not only in targets sunk, but also in expenditures made by the reacting opponent.

One can, of course, quote less favorable data. The North Sea barrage was singularly ineffective in terms of the sinkings it achieved for the costs it entailed. This may suggest, as do other experiences, that we should devise more comprehensive methods of measuring costs to the opponent other than simply the number of ships sunk. We need to quantify how much a delay or a longer route costs him. How much is it worth to demoralize his seamen or strike fright in the heart of his populace? On these scores we know mines have been singularly effective also.

I would like to emphasize the obvious point that mines should not be utilized as a sole element in a strategy, as the figures quoted above may seem to indicate they have been. They should be used as a part of an integrated or coordinated strategic or tactical plan. In the Pacific,

> on 30 and 31 March 1944, prior to the planned US landings at Hollandia in North New Guinea, carrier aircraft attacked Palau (Atoll) with mines and bombs in order to reduce its effectiveness as a base from which the Japanese could launch a possible counterattack. The attack consisted essentially first of mining all exit passages to prevent the escape of enemy ships, then a direct bombing attack in which all the trapped ships were either sunk or beached, and finally the mining of the anchorage and the bombing of installations to prevent the further use of the Atoll by enemy vessels. The operation was completely successful, and Palau was abandoned as a forward enemy base shortly afterward.[6]

Thirty two ships were bottled up in the harbor; three were damaged by mines, and the rest would not risk trying the mined channels. All the ships were destroyed by bombing. A more successful combined tactical strike is hard to imagine.

But of all the factors which stand out when one contemplates the history of mine warfare, none is as noteworthy as the profound psychological and political impact of their use. Almost invariably the danger of mines is subjectively judged to be vastly greater than the actual or real threat the mines may present. Acknowledging that the "effect of mines" and "actual threat" are not

easily quantifiable—or indeed as a very consequence of this unquantifiability—this general statement will stand unchallenged.

The simple mention of the word *mine* by governments has closed seaways and precipitated wars. It is interesting that the Egyptians seem especially prone to the use of verbal minefields: at least three historic instances bear recalling. In the Israeli 6-day war of 1967, Egypt announced a blockade of the Gulf of Aqaba, stating mines had been laid. In the Suez incident of 1956, Egypt stated the approaches to Alexandria had been mined and that the Gulf of Suez was dangerous to navigation. In both cases these statements were major factors in precipitating the crises into armed conflict. A much earlier incident throws illuminating commentary on the latter two. During the Arab-Pasha uprising of 1882, hundreds of steamers were tied up outside the Suez Canal because of the reported planting of mines. As an Italian warship steamed up, its captain, the future Vice Admiral Morin, inquired the cause of the congestion and was told of the mines. He reportedly replied that the Egyptians had hardly the skill to lay mines properly, and if they had been laid as long as claimed they were probably ineffective, and steamed through the canal. His calculated risk broke the verbal blockade.

To repeat, the use of mines, or on occasion just the statement that mines had been planted, has most often resulted in extreme political reaction or overexaggerated psychological and emotional reaction. As Lott puts it, speaking of Farragut's fleet during the Civil War, "Sailors hardened to the smoke, noise, and pandemonium of close-range cannonading were stunned and demoralized by the sudden and unexpected mine blasts."[7] The fact that the mine threat usually remains hidden, unknown, uncalculated, and unassessed leads to the necessity to make decisions on what are emotional rather than rational grounds. I am indebted to Vice Adm. E.P. Aurand for a perceptive interpretation of this point. As he puts it, the important thing is not your calculation of the minefield's effectiveness or threat, but the enemy's *guess* of its threat. Historically, though with the usual exceptions (Damn the torpedoes, full speed ahead!), the tendency has been to overestimate the threat. The very great payoff rate of mines (a $350 mine can sink a $1 million ship) surely adds to this effect, since the risk is emotionally felt to be very great.

It is not going too far to say that the potential of mines excites a different sort of fear than ordinary weapons. Vice Adm. Friedrich Ruge puts his finger on this source of fear when he comments,

> The mine is the only weapon of naval warfare that is to some extent capable of altering geographical circumstances by making certain areas unpassable to ships. Thus an area which has been declared dangerous because of the use of mines is usually treated with great respect and is avoided as though it were land.[8]

It is also true that mines have *not* been used on numerous occasions because of the political and emotional impact their use would entail. The rules of the game in Vietnam are so strange it is not easy to say much about it, but it is probably fair to say that political considerations have strongly guided military actions, including the use and nonuse of mines.

Mines possess a number of unique qualities as weapons which are significant in any consideration of how they might be used strategically.

Mines are versatile; they can do direct damage to military logistic units, but they can also attack broad facets of the enemy's economy. Because ships typically carry a large bulk of goods, they are much more vulnerable to

attack than other modes of transport, especially on land. Mines can destroy and disrupt the enemy's merchant marine. They can increase the damage inflicted by other weapon systems by channeling traffic into positions favorable for attack. They can saturate ports, disrupt storage and loading as well as shore-based transport, and force diversion of traffic to decrease or even stop cargo flow. They have deterrent effects which weigh heavily in the political and psychological realms.

Mines are waiting weapons. The target must come to the mine. While this might at first be thought a disadvantage, it actually has a number of positive attributes. The mine maintains vigilance, possibly over a long period, without continued commitment of forces. The initiative or aggression must come from the enemy. A direct face-to-face confrontation can be avoided.

Mines usually are invisible weapons. If mines are laid surreptitiously, they can inflict maximum damage because of surprise. If they are announced, the psychological impact is maximized because of the ignorance of the size and nature of the threat.

Mines are selective weapons. Few other weapons can be made to select a very specific size or class of target or be selective in depth or range—clearly mines are vastly more selective than bombs.

Mines are flexible in duration and times of activeness.

Mines are ideally suited to providing graduated response in intensity, area, and time of attack. The minimum response required to attain a military goal can be chosen.

Mines change the geography of the battlefield.

Conclusions. Mining strategy and its planning must be started in advance—it is not adequate to wait until later to decide that mining might be useful. The amount of logistic preparation is too great. This mistake was made by the United States in WW I and WW II and again—with respect to countermeasures—in the Korean war.

Offensive mining should be considered a complementary effort, not a competitor, to other forms of attack systems—submarine torpedoing, aircraft bombing, or whatever modern technique may be employed. Mining should be assessed on a cost-effectiveness basis, as with any other system, but in doing so it is necessary to be both honest and realistic about the assumptions put into the calculation. When mining is used, planners should endeavor to coordinate their mining effort with other modes of attack to gain maximum effectiveness.

Mine warfare has always been considered a contest between the mine designers on the one hand and the countermeasures experts on the other. Experience indicates, however, that mines can be made so difficult to sweep or hunt that practical countermeasures may take some time to develop, thereby assuring that the opponent will have suffered time-consuming delay and attrition of his valuable resources.

Since a mine campaign is closely related to the entire war strategy, the first task at hand is to convince strategists and tacticians that mines have any role at all to play in a modern conflict. Mine technology, to a greater degree than that of any other weapons system, exponentially decays after a conflict has been finished. Consequently, the planners of the current generation:

- assume mines are available and ready to use if they should want them, when in fact they are not,
- know nothing about how to use them and assume they can be employed only in long, drawn-out major strategic standoffs, when exactly the opposite should be true,
- fail to realize that mines are specialized weapons with requirements which demand training and preparation to use them advantageously.

Minelaying, as a general rule, should commence with a large initial attack—hence the need for advance preparation— and be continued by frequent moderate-sized attacks rather than occasional large-scale attacks. Minelaying should be so dispersed as to put the maximum burden on the enemy's mine clearance forces.

Much of the value of a new weapon—e.g., a new firing mechanism—lies in its unexpected introduction and large-scale use before the enemy can develop countermeasures or adopt alternative courses of action.

One must also realize that there are values other than sinking ships that the miner desires and with which he is concerned because they redound to the benefit of the minelaying side:

- sinking ships is fine, but damaging a ship may be better—forcing the enemy to expend men and materiel on repairing damaged ships is advantageous;
- forcing the enemy to engage in mine countermeasures uses up men and resources at little cost to the miner;
- delay of shipping and disruptions of cargo handling at ports on both ends of a supply line are valuable byproducts of mining even if no ship is sunk;
- demoralization of both ship and shore crews is also a valuable byproduct; if the crew can be prodded to jump ship, so much the better.

Simplification of mine preparation in the field would make the mine a much more useful weapon as would relaxing some of the earlier strictures which I have noted above.

Every effort should be made to accumulate intelligence information on how and where best to use mines before and during hostilities. An equal and perhaps even greater effort should be made to determine the effects of mines on the enemy's war effort while they are being used as well as after the end of hostilities. One needs to receive feedback on the effects of mine weapon systems as quickly as possible if the minelayer is to get credit for what he has accomplished in his effort and if mines are to be credited with what they have done; otherwise, cost effectiveness will not be assessed correctly, thus reducing the chances of their intelligent and effective use.

The possible future use of mines in affecting and possibly settling international disputes should not be overlooked. Mines can be dropped so as to produce a blockade without actually resulting in direct harm or bloodshed to the local populace. The economic effects of such blockade might well assist the settlement of disputes without actual combat. It should be noted, however, that one must maintain a cadre of trained officers and men if one desires to have the option of a mine campaign open at any time to deal with international disputes.

In using mines we have erred in thinking of them as only long-term attrition weapons instead of using them as tactical weapons. We have failed to use them for their psychological and political effects by insisting that only a ship sunk is a valid test of whether the mine has accomplished its mission.

We have not devised a sufficiently evangelical approach to the conversion of true nonbelievers in that we have not convincingly shown that mines are important parts of overall oceanic and riverine naval strategy. We have not recognized or, more properly, minefield planners have not properly recognized the strategic character of ships and men themselves, but rather have preferred to consider such products as petroleum or platinum as the ultimate targets of mine warfare.

Many persons in the position to make decisions of military importance do not understand the characteristics of mine warfare or its underlying principles, so the potential of the minefield as a military weapon system is not well appreciated. Why does this situation exist?

• Military people are vehicle oriented, not weapon oriented. It is the Polaris submarine that claims the allegiance, not the Polaris rocket. Mines have the disadvantage of being even less dependent on a particular vehicular delivery sytem than are most other weapons.

• Mines lack bang appeal. The layer seldom gets to see one go off, and, as a consequence, his battle ribbons record few or no sinkings compared to the usual aviator, say, who gets to drop a bomb.

• Mines have commonly been the chosen weapon of inferior nations because of their cost effectiveness. This leaves the stigma that somehow it is beneath the dignity of the great nation to use such a weapon. There is the feeling, expressed ever since the time of Bushnell and Fulton, that the mine is somehow an ungentlemanly weapon.

• Mine service is often thought not to contribute to professional advancement.

• The mine is a basic and ancient weapon, one for which it is not easy to devise novel innovations or arrive at a breakthrough.

In conclusion, it can be fairly said that the military has failed historically to appreciate the significant role the mine is capable of playing in naval warfare and continues to do so for a variety of reasons. It is only by dispassionate critical analysis of past successes and failures that we can hope to overcome the traditional prejudices against this useful weapon.

BIOGRAPHIC SUMMARY

Professor Andrew Patterson, Jr., did both his undergraduate and graduate work at the University of Texas, gaining his Ph.D. there in 1942. He has been actively associated with the Harvard Underwater Sound Laboratory (1943-1945), the U.S. Navy Underwater Sound Laboratory as a physicist and research consultant (1945-1951), and served as the Director of the Office of Naval Research at the Edwards St. Laboratory, Yale University (1951-1956). Professor Patterson was the Chairman of the Mine Advisory Committee, National Academy of Sciences of the National Research Council for 1958-1962. Since 1962 he has served as a consultant to the Mine Advisory Committee and presently is Professor of Chemistry, Yale University.

FOOTNOTES

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