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STRATEGIC IMPLICATIONS OF CONTINENTAL SHELVES

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INTRODUCTION

The history of humanity has been closely associated with the sea. Even disregarding the theory that attributes the birth of organic life to that salty environment, one cannot deny that through the blue and green expanses of water, different streams of civilizations marked the road of history along the centuries. But man's primary interest in the ocean has been as a means of transportation or communication.

Scientific knowlege of the sea began as recently as a century ago ("Challenger" expedition, 1872-76). After such a relatively recent start, interest in the importance of the oceans grew greatly as funds were invested in better knowledge of them. That is particularly true among the main world powers. Though exploration gave varied results, increased knowledge raised new questions and indicated newer and heavier demands. Later, a real tridimensional scientific scope posed new challenges, as indicated by recent views of the oceans as a "world granary."

Advances in outer and inner space (or hydrosphere) are closely related to scientific and technological progress. Also, both involve difficult operational environments. They both require careful planning. Inefficiencies and errors are not tolerated. Research is very expensive. Sophisticated instrumentation is needed. Also, both require highly qualified personnel on a comparatively large scale of the total of persons employed.

The conquest of both spaces began after the "population explosion" was noted. This latter phenomenon added an increasing amount of tensions all over the world. The need for vital space and the search for supremacy in the world opened areas for friction or major disputes in this tense world. Countries with the most advanced operational know-how are in the best position for achieving success. It is not surprising, then, to find reasons to conquer new environments other than the reasons of humanitarian wishes for more food, more space, and water for every human being or the intellectual reasons in search of scientific knowledge.

Five-sevenths of the world's surface is covered by the oceans. In character, two ocean environments can be distinguished. One is that extension of the mainland sloping under water to a relatively abrupt change in bottom slope; the other extends beyond that boundary and encompasses the larger and abyssal oceanic depths. The first area is the Continental Shelf; the latter is the pelagic zone.

Of these two, because of the lesser depths and nearness to the coast, the Continental Shelf will be increasingly important. The open seas will continue to be primary areas for ocean transportation of goods between continents and, therefore, areas of military dispute for their protection.

The discussion of factors affecting the Continental Shelf and elucidation of its importance from a strategic viewpoint are the main purposes of this research. In the present world, strategy embraces several aspects that involve the projection of efforts from fields apparently disconnected from the specific military one. Hence, our discussion will have to cover several areas other than that of our primary concern prior to any attempt to draw conclusions.

I—THE CONTINENTAL SHELVES: THEIR PHYSICAL CHARACTERISTICS

The advent of modern devices of sounding permitted a better understanding of the sea relief in this century with the introduction of echo sounds. With these means, better than ever before, it was seen that when approaching the coasts from the deep sea an area of rapidly decreasing depths and a following comparatively flat bottom preceded the immediate beach or coastline. The latter flat area was mentioned in 1887 by Hugh R. Mill as the Continental Shelf.[1] The abrupt transition of depths is the area named Continental Slope; its inner limit is about the 100-fathom or 200-meter isobath.

The International Hydrographic Bureau, through its International Committee on the Nomenclature of Ocean Bottom Features (22 September 1952), defines the Continental Shelf as the zone bordering continents from the low waterline to a depth at which a relatively steep slope towards the deep regions is found. It locates that sharper increase in depth around 100 fathoms or 200 meters but recognizes that it can occur at more than 200 or less than 65 fathoms. It also recognizes the continental borderland where the marginal area is irregular and has much larger depths than those mentioned for a Continental Shelf.[2]

The Continental Shelf was found to vary in width and depth in different areas of the world, but it shows some limited confined range of variation. Also, shores of young elevated mountainous regions have a narrow shelf or lack it. Those differences make it difficult to establish an accurate and comprehensive definition of the morphological phenomenon.

The area significance of the Continental Shelves is indicated by the fact that they represent 7.6 percent of the total ocean surface,[3] or about 20 percent of all the continental land masses (excluding Antarctica).[4]

The area dimension of the Continental Shelves, compared to the continental land, varies for various regions as follows:[5]

Continental United States	16.5%
The Americas (excluding Continental United States)	20 %
Europe	38 %
Africa	5 %
Asia (excluding China)	30 %
U.S.S.R. and China	25.5%
Australia and New Zealand	24 %

Accordingly, some specific areas have very extensive Continental Shelves, i.e., Java, Sumatra, Malacca, Borneo, south of Bering Strait, east of Siberia, Australia, Guinea, east of Argentina, Korea, and the North Sea.[6] Other areas lack the Continental Shelf, like Chile and Peru, though Birot[7] mentions that often there is a Continental Shelf about 20 kilometers wide in a transitional zone from the submarine bottom to the aerial relief off the mountainous coasts.

A comparison of sources shows different estimates of the dimension of shelves. To illustrate, Shepard,[8] Kuenen,[9] and Carsey[10] indicate that the maximum width reaches to 800 miles, the average width is about 42 miles, the average depth is of 72 fathoms but may reach 270 fathoms, and the average slope of the Continental Shelf is about 0°07′. The slope mentioned is not uniform, the inner half of the shelf being steeper than the outer shelf. The flatness of the shelf or its uniform slope is a general description since hollows and hills of 20 meters and larger are frequently observed.

The predominant sediment of Continental Shelves is sand. Pebbles, cobbles, and rock bottoms are also common in the outer parts. The proximity to large rivers is shown by a change of the predominant sediment towards mud.[11] Studies on the geological structure have shown unconsolidated sediment overlying wedges of semiconsolidated sediment.[12] In some of those Continental Shelves the layer of sediment could be as much as 6 to 12 kilometers.[13]

The formation of Continental Shelves is not clearly understood so far, although various theories have been advanced. Some investigators support a depositional origin, but others think wave erosion played a major role. Also, there are supporters of the theory that both processes could have acted together.[14] Geophysical studies showed the origin of shelves have not been the same everywhere. For example, the subsidence of sediments formed the shelf off the eastern U.S. coast.[15] The lowering of the sea level during glacial periods is of particular importance to the possible development of shelves, but there is a broad divergence of opinion regarding the estimation of maximum sea lowering in the Pleistocene era.[16] Research on submarine canyons could be useful for a better explanation of the phenomenon.[17]

Waters covering the Continental Shelves are differentiated from the waters beyond at greater depths. These waters represent a biological province—the neritic—in the habitats of marine life.[18] Dilution, contamination by terrigenous sediments, penetration of natural light, and ease of development of a nutrition chain give specific character to the Continental Shelves.[19]

Influencing transmission of light in the sea, material in suspension plays an important role. Coastal waters can be so densely contaminated with suspended material that almost 50 percent of the total light intensity received on the surface can be absorbed in a meter below the sea level. The reflectivity of the suspended particles also affects the waters, altering their color. It is not strange, then, to see that from the deep blue of the "oceanic desert" the color changes in the marginal areas of the shelves to a greenish blue or a green or at times to shades of gray, brown, red, or yellow.[20]

The proximity of nutrients—phosphates, nitrates, and nitrites—to the euphotic area and the more favorable conditions for vertical movements in the water masses account for a rich coastal life.[21] Therefore, the Continental Shelves are fertile areas for productive fishing or abundant animal life and are more valuable in this respect than the deeper oceans. The influence of that environment is not confined only to the geographical limits of the shelves themselves.

II–CURRENT JURISPRUDENCE: LEGAL TRENDS REGARDING CONTINENTAL SHELVES

International legislation of sovereignty of a coastal state's marginal waters was born, probably, as a need for safety. When limitation was first thought of, naval guns of short range were the only possible threat to land from offshore waters. The only extractive activities were fishing and the search for valuable raw materials. Other than these, exploitation was not practical. Within this century the laying of submarine cables and development of offshore oil extraction created needs for a new definition of sovereignty. However, no definite declaration was made previous to the 1940's regarding national rights to resources on Continental Shelves.

The first specific precedent goes back to 26 February 1942 with the bilateral treaty between the United Kingdom and Venezuela regarding exploitation of submarine oilfields in the Gulf of Paria.[1] A major event was the proclamation of the United States by President Truman on 28 September 1945 reserving for the United States, sovereignty on the seabed and subsoil resources of the Continental Shelf offshore to a depth of 100 fathoms.[2] Though there had been an earlier international act (2 September 1947), the declaration of the Inter-American Defense Zone considered more than the Continental Shelf area and was restricted to defense purposes.[3] No claim was made, at that time, of economic implication, but Truman's proclamation aroused a series of later declarations of similar nature.

Differences in declarations on sovereignty on Continental Shelves are noted as follows: (a) the maximum depth to which the claim was made, (b) the nature of the area. For example, on 29 October 1945, Mexico reserved all natural riches of the adjacent Continental Shelf delimited by the 200-meter isobath.[4] Argentina, on 9 October 1946, declared sovereignty over the Argentine epicontinental sea and Continental Shelf but previously (24 January 1944) had declared those areas to be zones of mineral reserves.[5] Costa Rica and Honduras, on different dates, refer to the submarine platform with no indication of depth. Other nations followed: for example, the Kingdom of Saudi Arabia on 29 May 1949 extended claims to areas in the Persian Gulf contiguous to its coasts. A 19 May 1949 Iranian Bill refers to the Continental Shelf without indicating a depth.[6] Brazil, on 8 November 1950, established her exclusive jurisdiction over the natural resources of the Continental Shelf as well as for fishing in that area, differing from Argentina only in the method.[7]

The growing importance of fishing operations led some countries to new declarations of sovereignty of the waters up to limits of 200 miles offshore but without restraining freedom of navigation by ships of other nations. Countries without Continental Shelves made related claims. For example, Chile and Peru made proclamations on 25 June 1947 and 1 August 1947, respectively.[8]

In the midst of those and other claims, and under the pressure of new marine technological advances, the United Nations celebrated the International Law Commission meetings of 1951, 1953, 1956[9] and the Geneva Convention of the Continental Shelf of 1958.[10] Draft articles were prepared with some changes which gave the scheme of the Geneva Convention of 1958, currently the latest international codification on the Continental Shelf.[11]

In that conference a legal definition of the shelf was established, and rights of the coastal states were defined. Regarding the definition, the criterion has been to leave a flexible margin of adjustment to technological developments that is to interpret the Continental Shelf as the submarine bottom to 200 meters or beyond that limit if exploitation of natural resources was feasible (article 1). In defined areas, the right of exploitation by the coastal states is exclusive, but sovereignty applies only to exploring and exploiting natural resources (article 2.1). The convention clearly defines the term "natural resources" as those minerals, nonliving resources of the seabed and subsoil, as well as the living animals that at the harvestable stage are immobile or under the seabed or move in constant physical contact with the bottom or subsoil (article 2.4). The idea of sovereignty does not imply the superjacent waters, where the concept of freedom of the seas prevails (article 3). Also, no coastal state may impede another nation's laying of submarine cables or pipelines across its Continental Shelf (article 4). The exclusive right to exploitation does not interfere with oceanographic or scientific research by other parties whenever those are done with the intention of open publication (article 5.1). A safety zone of only 500-meter radius around structures erected for exploitation purposes is allowed. Those structures are not to be put up in disregard of the needs of navigating international sealanes (article 5.2, 5.3). The codification explicitly indicates that the opportunity for research by the coastal state is necessary (article 5.8).

In spite of its remarkable achievement, the Geneva codification offers broad areas of potential disagreement. The first of them is the delimitation of the Continental Shelf. Other questions include: What is an unjustifiable interference? What are essential sealanes to international navigation?[12]

The convention failed to provide for compulsory settlement of disputes, thus settlement is left to the states themselves. The majority of the participants opposed mandatory use of the International Court of Justice or other suggested means of settlement.[13]

The convention of Geneva came into force on 10 June 1964 (article 11.1).[14] After June 1969 a revision is possible on the request of the signing countries (article 13.1).

In recent years, legislation and peaceful use of the ocean floors have become the concerns of several countries represented in the United Nations.[15] Since new ideas on those matters are connected with the use of Continental Shelves, it is desirable to mention possible legal trends. We can distinguish the following possible attitudes: (a) to call a new United Nations convention, (b) to adopt the "wait and see" position expecting that conflicts will show future courses of action, (c) the "national lake" attitude, and (d) the "flag state approach."[16] Those policies have been discussed relating to the high seas. But, so far, the limit of the Continental Shelf has been flexibly defined. Therefore, a redefinition of the outer limit of the Continental Shelf is involved in discussion of the high seas legal status.

There is disagreement among nations regarding the status of the high seas beyond the Continental Shelf and over it. For the Continental Shelf, exploitation of defined resources is a recognized national right. For the high seas, some less powerful states desire instruments of international control. The extent of territorial waters is not agreed upon. Interests of different states are in conflict. The big powers, like the United States, prefer (under the principle of freedom of the seas) to retain a concept of narrow territorial seas (equal to or less than 12 miles, preferably 3 miles) to restrain exclusive fishing rights to a narrow fringe (12 miles),[17] and to have the United Nations redefine the rights of countries to the Continental Shelves, not going beyond the 200-meter depth.[18] Small powers, such as some of the Latin American countries, tried to extend their sovereignty, not only to the soil and subsoil of their Continental Shelves, but also to waters as far as the extent of the shelf or even to a fixed large distance offshore, invoking the principle of conservation of resources (fisheries included) and economic development.[19]

The latest concern regarding the use of the seabed in the United Nations meetings reflects a division in opinion between the two major world powers and the smaller countries. These concerns are in the sphere of the security field. Developing countries feel that that policy must be established to prevent the growth of a new colonialism. The major powers emphasize military differences. The United States advocates prohibition of emplacement of weapons of mass destruction on the seabed and deep ocean floor. The U.S.S.R. wants use of the seabed beyond the territorial waters to be reserved only for peaceful purposes.[20]

A proposal made by the Ambassador of Malta to the United Nations, Mr. A. Pardo, tried to solve the problem of the seabed and deep ocean floors through international juridical mechanisms.[21]

III–ECONOMIC IMPORTANCE OF CONTINENTAL SELVES: CURRENT POSSIBILITIES AND IMPLICATIONS ON NATIONAL OR WORLDWIDE ECONOMY

The resources of the sea have been heavily emphasized in the last decade. Most of the frequently listed "marine riches" exist on all Continental Shelves. Comparing possibilities with the deep oceans, the shelves have the advantages of shallower depths than the depths of the sea and of nearness to populated areas.

One way to judge the economic value of sea resources could be through the estimated $9 billion worth of ocean activities which took place in 1963. This amount is estimated to increase by 8 to 15 percent yearly. If we analyze those figures for the current value of different resources, we observe that fishing, petroleum exploitation, mining and mineral extraction, and seaweed farming are the most significant.[1] Also, heavy government expenses in research for defense purposes reveals the double importance of the marine environment.

From the items previously mentioned, fishing is one of the outstanding economic activities, followed by petroleum extraction. All other commodities, in general, run in a lower scale of value, if military and paramilitary expenses are excluded.

The importance of fishing for human nourishment is well known, especially in relation to the population explosion. Fifty percent of the current world's inhabitants have a protein deficiency. Fish protein compares in protein content to that of meat, eggs, or milk. Also, the unsaturated fats of fish oils have dietary advantages.[2] If the lack of protein is critical now, the possibilities of malnutrition in the future, unless tremendous technical developments in farming on land are achieved, will be huge. Theoretical studies indicate the production capacity of animal protein from the seas could be large enough to satisfy the diet of 30 billion people.[3]

Estimates, based on studies off southern California, indicate that the production of zooplankton is 7.5 percent of the total phytoplankton production and that fish, sea mammals, and benthic animals reach only 3.4 percent of the total phytoplankton production.[4] Therefore, one solution for more efficient use of food from the sea would be to shorten the feeding chain, trying to make phytoplankton or zooplankton edible for humans. To illustrate, 1,000 grams of phytoplankton convert into 100 grams of copepods. This, in turn, means 10 grams of herring, implying finally one gram for man.[5] The Russians were experimenting with krill as a food for man. Other possible uses are as food for domestic and other animals.[6]

Continental Shelves are the areas of most productive fishing. Almost 80 percent of the world catch comes from those areas and nearby zones.[7] The Continental Shelves of the Northern Hemisphere are about three times the area of the Southern Hemisphere Continental Shelf areas, and top production has been reached. Hence, the shelf areas of the "oceanic hemisphere" will become more important in future efforts to increase the world catch of fish. It is interesting to note the most spectacular jump in fish catch made by Peru is precisely in the area of the Continental Shelf, in regions benefited by convenient currents and nutrients. This brings forth the question of the future possibilities of increasing the world catch through pelagic fishing. For a better catch, equipment will have to be improved.[8] It is reasonable to expect that Continental Shelves will keep their importance as the main fishing grounds. Therefore, we can forecast a pressure towards research and exploratory fishing in the probably fertile areas of the Southern Hemisphere. This will require the development of large new fishing fleets with the capability of processing their catches through factory mother ships. The Russians already showed this trend in their operation in the Argentine Continental Shelf in the last few years.

As was mentioned, the coastal areas of the less developed countries will be the new grounds for fishing. Those countries generally lack the means required for the best methods and they will be, therefore, out of competition. We can foresee that those activities may generate areas of conflict. The maladies of probable overfishing in those regions is a real danger. Consequences of overfishing have been proven with the forced interruptions of World Wars I and II in Europe[9] and in the halibut fishing in the northeastern Pacific and on the Grand Banks.[10] That fear is the cause of disagreement in the current juridical status of sovereignty on Continental Shelves legislated unilaterally by different countries.

Current exploitation of minerals at sea, compared with the potential, is meager. The reasons for the small-scale exploitation include a lack of convenient information, lack of appropriate technology, and a nonurgent need to resort to that source of minerals.[11] A good proof of the last is the case of petroleum exploitation. Even offshore mining of that material, which started in 1899, developed only after World War II. In a period of 10 years, ending in 1967, offshore oil production reached 16 percent of the total world production.[12] In the United States alone, offshore natural gas production reached 977 billion cubic feet.[13] Offshore oil production of the United States equals that of the rest of the world, with the Persian Gulf accounting for 75 percent of the production outside the United States.[14] The potential oil exploitation in the North Sea is well revealed by the interest shown in the 5-year exploration period begun by 23 groups of different oil companies. The possibilities of natural gas supplies discovered in the same area seem to be able to replace the coal gas used in the area within the next 20 years.[15]

Estimates of reserves for the next 10 years indicate that offshore oil production will account for 40 percent of the world's extraction. Estimates for the Arctic Continental Shelf in the Tyumen region show that by 1980 oil production there will equal the current production of the Union of Soviet Socialist Republics.[16] Other shelf areas of the world in the Southern Hemisphere seem ready to start offshore oil exploitation on a large scale. In some places close to the coast, offshore exploitation began in 1932.[17] Other estimates by W.E. Pratt (1951) indicate Continental Shelf oil reserves are approximately 1,000 billion barrels, equaling oil reserves of continental areas.[18]

Rights to petroleum exploitation from the shelf are clearly defined in the last Geneva Convention already discussed. The convention assures benefits for the coastal state. A nation's profit, however, will depend upon its technology and the feasibility of extraction.

Mining and extractive activities from the Continental Shelves can be divided into two categories: exploiting the riches of the soil and subsoil and extraction of minerals and salts from the sea water, which includes the conversion of salt water into fresh water. We shall discuss at more length the first type of exploitation, since extraction of salts and minerals is easily accomplished from territorial waters. Though we shall mention mining operations, some of them are done also in the beaches.

Continental Shelves are about 20 percent of the continental lands. As the rocks of Continental Shelves do not differ basically from rocks on land, one can expect the same average mineral potential in those submarine soils. On beaches, due to the mechanical forces of the ocean surf, mining and processing are relatively simple. The sea level variations of the Pleistocene age, during presumed stabilization periods, give good mining possibilities for old offshore beaches, now submerged.[19]

Glauconite, a possible source of potassium, is found in various offshore locations. Phosphorite is found off Peru, Mexico, Chile, the United States, Argentina, Japan, South Africa, and certain submerged areas off islands in the Indian Ocean. Tin is found in drowned river valleys offshore in Thailand and Indonesia. Also in drowned river valleys are deposits of gold, platinum, and diamonds. Some of those areas are off Nome and Good News Bay in Alaska and the Orange River in South-West Africa.[20]

Iron ore and coal have been mined from the subsea floor for a long time, but the mines were entered from the coast, as is done in England, Japan, Newfoundland, and Finland.[21] Sulphur is also found in the caps of salt domes. Large concentrations of those domes have been surveyed in the offshore areas of the Gulf of Mexico. Also, in the Gulf of Mexico, as well as offshore Iceland, notable calcareous shell deposits exist, used as raw material for the manufacture of portland cement. From the offshore areas of eastern Texas alone, 45 million tons of shells have been obtained in the last 20 years.[22] Also, there are deposits of magnetite, columbite, ilmenite, zircon, rutile, monazite, and silica in different areas of the world.[23]

Extraction from sea water of salts and minerals with concentrations smaller than those of boron is not economical, using current methods. Of some of those economically feasible to exploit, offshore minerals for which there are adequate land reserves are not practically extracted. However, magnesium, sodium chloride, potassium compounds, bromine, and chemicals used in the manufacture of gypsum are obtained from sea water, mostly in the United States.[24]

Extraction of fresh water from salt water has been performed only in limited coastal areas due to its high cost. Therefore, we shall not discuss that activity. We also shall leave aside the possibilities of using the physical phenomena of the ocean as a source of energy, which, except in one case, is in the project stage and of strict coastal interest.[25]

Seaweed is farmed mostly in territorial waters, though it could be harvested in some areas outside of those. Seaweed is economically important and can have several uses: food for men and cattle and as a source of iodine, potash, alginic acids, alginates, agar-agar, and fertilizer.[26]

Comparing future possibilities to the reality of Continental Shelf mining, it is worth noting a recent 1-year study was conducted by Economic Associates, Inc., with support of Ocean and Engineering, Inc. and some University of Maryland consultants. The study aims primarily at nonliving resources on the

U.S. shelves. The published conclusion states that of the 50 materials existing on the shelves, only a handful are vital for the U.S. economy in case of shortage or price rise. Oil and gas are mentioned as worthwhile mining resources. Recommendations of the report emphasize the need for more comprehensive studies of the U.S. continental margins.[27]

Such a declaration by a major user of natural resources in the most advanced economy is worthy of special consideration. However, it is dangerous to generalize, since the land resources in the United States are seldom found in other countries. Also, it is worth considering that exploitation of mineral resources at sea, even at moderate depths, requires a solid technology; therefore, in most cases, advanced countries will play an active role in seabed exploitation wherever it is done. Moreover, a detailed scientific knowledge of the areas of Continental Shelves intended for exploitation is essential.

IV–MARINE TECHNOLOGY: ITS CURRENT POSSIBILITIES ON CONTINENTAL SHELVES

Operations on the Continental Shelves, as well as on the deep sea bottom, depend on oceanographic knowledge, engineering techniques, and an understanding of man's physiology.[1] Development of new materials, reliable and resistant to tremendous pressures, although light, implies great progress in the capability for deep sea operation. It is easily understandable that the attainment of that commitment will involve—and has involved—multiple technology proficiency.

After the Truman proclamation, activities and technology interacted in a continuous and more intense yearly trend. All those activities have been directed usually towards: (a) increasingly deeper and freer individual human operations in the sea;[2] (b) development of more versatile vehicles capable of reaching deeper ranges, of manned, unmanned, and robot forms;[3] and (c) development of techniques for direct and indirect knowledge of the sea and its boundaries.[4]

The development of the aqualung by Jacques Yves Cousteau in 1943 was a milestone for future progress in the exploration of Continental Shelves. The Krasberg lung with a controlled amount of oxygen and the use of a closed breathing system of a helium and oxygen atmosphere was another important advance for reaching increasing depths in diving.[5] Other major steps were established through operations "Continental Shelves," "Sealab," and the project "Man-in-the-Sea." The first operation began in 1962 and proved the ability of man to live and work for long periods of time in the sea. Those first trials were surpassed by the achievements of Sealabs I and II. New shelters were tested, longer numbers of days and men were involved, and flexible structures like the SPID (Submersible Portable Inflatable Dwelling) were tried successfully.[6] Experiences of Sealab II showed aquanauts were able to stay 15 to 30 days continuously under 205 feet of water.[7] Sealab III, scheduled for the autumn of 1968, planned to advance the previous experiments in the field of oceanography, engineering, salvage and construction, biology, and use of trained mammals for helping aquanauts.[8] Unfortunately the death of one of the aquanauts, Mr. Berry L. Gannon, the cause of which was not clear, interrupted the experiment.[9]

A group of divers from California, working with specially designed gear, were able to perform tasks at 600 feet. Another system, the "Cachalot," developed by Westinghouse, allows uninterrupted diving and living in a high-pressure atmosphere of oxygen-helium-nitrogen. With that system, longer periods of useful operation, greater safety, and savings of time are obtained.[10]

"Bathysphere," "benthoscope," "bathyscaph" and "Trieste" are pioneers in reaching great depths. Since 23 January 1960, when the last reached 35,800 feet in the deepest part of the Marianas Trench, several submersibles have been launched. After the diving saucers created by Cousteau, other inventors increased the capabilities of earlier vehicles. Among those, we can mention "Deep Quest," which is 40 feet long and carries 7,000 pounds of equipment for special use for prospecting for minerals on Continental Shelves. The PX-15, because of its capabilities of floating freely, is of special value for biological and acoustical observations.[11]

Besides specific oceanographic instrumentation, photography, television, seismic refraction and reflection, sound transmission, and magnetometry have been powerful means for extending man's knowledge of the bottom of the Continental Shelves. Submarine photography was attempted in 1895 by Boutan, but it took several years before the proper lighting and gear were obtained.[12] Underwater television combined with sonar and lifting gear assembled in special devices like CURV (Cable Controlled Underwater Recovery Vehicle) is able to locate and recover objects from the bottom, such as the hydrogen bomb lost at Palomares, Spain. Some underwater television systems, like the one developed by the U.S. Fish and Wildlife Service, can work at 1,000 feet and obtain clear images with as little light as one foot-candle.[13]

Present capabilities to deploy instruments and equipment in floating or fixed platforms required long years of engineering experience. Now, large buoys like the Nomad can be safely anchored in the deep ocean. Also platforms, essential for drilling offshore, have grown considerably in size. The state of the art ,that allowed, until only recently, 200 feet as a maximum depth of extraction began to make further progress with different modes of operation. Since 1963 the introduction of floating platforms permitted hopes of not only greater exploitable depths but reduced costs and gave greater mobility and better seaworthiness.[14] In 1967 a huge floating platform built in the United States and towed to Africa began to operate in 300 feet of water. The *Submarex*, a converted patrol ship, could drill in 1,500 feet of water. Records of a 242 foot barge, the *Blue Water*, showed an aptitude for withstanding waves of 28 feet and winds of 65 miles per hour without suspending drilling operations.[15]

The mining of most minerals from the sea is not as advanced as the techniques for the exploitation of oil. Hydraulic or bucket dredge is used for most minerals.[16] The situation has changed with new Deep Submersible Vehicles (DSV) like the Quest and the abilities of man to dive to the bottom of Continental Shelves.

The high reliability of automatic systems and the natural advantages of the Continental Shelf seem to open wide hopes for the installation of nuclear plants on the seabed. The almost infinite radiation shield and infinite isothermal sink, a naturally pressurized environment, and isolation in the event of disaster are the main advantages of that location, In that case, Continental Shelves adjacent to populated areas would be suitable "service areas."[17]

The above review has shown that the progress of technology allows us small-scale operations to all depths of almost all Continental Shelves. The feasibility of enlarging that potential depends on industrial developments such as super-strength plastics, power packages, deep mooring devices,[18] better knowledge of the composition and soil mechanics of the bottom floors, better structure foundations,[19] and tests on the aptitude of man to withstand high-pressured special atmospheres.[20] The success of operating automatic systems is also of major importance for special tasks where man cannot be exposed. It is also clear that any of those operations will require high technological standards, expensive devices, and big groups of qualified personnel able to work as teams. Therefore, this sort of operation will be restricted in the immediate future to a few nations of the world.

V—NAVAL APPLICATIONS: POSSIBLE MILITARY EXPLOITATION OF CONTINENTAL SHELVES

Land bases have been and probably will continue to be the main support for naval forces. Navies must cross Continental Shelves where much effort has been put into offensive and defensive weapon systems which have greatly changed with time. Before the development of the submarine, coastal batteries, rudimentary mines, and naval forces were the main threats to other naval forces transiting the Continental Shelves. Submarines and aviation have changed the scene. Developments in mine devices converted the shelves into areas of greater danger before World War I, but achievements in underwater vehicles and techniques have created a revolution since World War II.

To estimate the new possibilities open, it is convenient to focus the discussion on mobility, weapons operations, and related problems.

Nuclear submarines led to operational capabilities difficult to conceive before the 1950's. Currently they can reach the maximum depths of the Continental Shelves, manoeuver at very high speeds,[1] and operate for long periods of time. Special submersible vehicles can also reach all depths of Continental Shelves, with limited purposes. A military submarine, the USS *Dolphin*, launched on 8 June 1968 and operational now, represents a new asset in the deep submergence submarine vehicles list. Her research equipment weighs more than 12 tons, and she has more sonar devices than any other submarine. The *Dolphin* is engaged in classified research, and her capabilities are currently evaluated.[2] With the latest experiences of the Man-in-the-Sea Project, the mobility of man himself on the bottom of the shelves has been tested. That implies the possibility of laying implements on the bottom of the shelves and attending them or performing other tasks. Manipulation capabilities of special vehicles, manned or unmanned, have been provided and improved, as has the knowledge of divers, which can be combined with a great uplifting power, i.e., with "Hardiman" (Human Augmentation Research and Development Investigation).[3]

Deployment of weapon systems on the Continental Shelves and in the superjacent waters can encompass planting of mines, establishing of static Subroc launchers, establishing fixed or mobile ballistic missile launching platforms, operation of guided underwater systems, and conventional operations in antisubmarine warfare.

The feasibility of placing fixed or mobile weapons systems on the bottom depends heavily on the nature of both the bottom and the structure. Knowledge of soil mechanics is important. The U.S. Bureau of Docks has been conducting studies of deep ocean installations. One author, a participant in those studies, concludes that loads up to 10,000 pounds can be placed with current techniques,[4] but undoubtedly the knowledge of the constitution of the bottom is essential.[5] Areas of loose sediment, and especially ooze, will be difficult or inconvenient zones, even for landing submersible vehicles, and could act as traps.[6] Besides knowledge of the soil mechanics, a detailed survey of the relief of the bottom will be important for picking out possible emplacement sites.

The manned operation of those stations will be closely linked to developments in power packages and in resupply facilities. The importance of both features is evident; the lesser the frequency of visits to those stations the better will be their secrecy of location. The loss of concealment is a serious detriment for an underwater offensive-defensive system, and the discovery of an offensive system installed on the enemy's Continental Shelf implies its almost sure destruction.

Some people envisage the fruits of current experiences like Sealab as the foundation for more ambitious projects of underwater nuclear submarine bases. They would make it possible to service, to resupply, and to change crews for military submarines without having them surface or go back to their land bases so frequently.[7] Although to discuss this seems premature, it is worth while to note the concern about the use of seamounts for that and other purposes.[8]

One way to improve the concealment of underwater missile stations is to place them underground. If engineers could afford this type of construction, at least at the depths of the Continental Shelves, the task of identifying and locating them would be considerably more difficult than for stations resting on the bottom.[9]

The use of underwater missile stations for defensive operations against submarines or surface forces does not seem to be practical. The advantage of mobility, if the first firing is not a kill, is missing. The system is expensive and for attacking surface forces can be substituted with other mobile weapon systems. Regarding submarine counterattacks, a combination of guided systems with surface and submarine ships seems to be more advantageous.

Usually all defensive systems put up on the shelves will need systems for detection and classification, except those weapon systems functioning under the specified premise of automatic firing. For the purpose of detection, the Continental Shelf will provide a lengthened warning analogous to that obtained by the DEW line. Advantages gained through the SOFAR studies,[10] transducers able to perform reliably at great pressures,[11] and methods of antisubmarine warfare environmental prediction[12] let us conceive of outer shelf detection systems that could efficiently alert us of possible intruders on the Continental Shelf.

The use of previously described means would imply new demands on geophysical detailed surveys of the Continental Shelves where operations are planned, especially navigation aids and efficient underwater communications systems.

VI–STRATEGIC IMPLICATIONS: FORMER FACTORS IN THEIR GLOBAL INTERACTION AND THE PROJECTION OF FORCE FROM THE SEA

We have seen how the riches of the Continental Shelves are open to exploitation and also how those zones are useful for military applications. Both features widen the spectrum of possible conflicts, frictions, and areas of possible dispute in war. Economic incentives and economic objectives are essential for nations' progress. The protection and expansion of those objectives include an important body of peacetime strategies. Our world does not have true peace, and the opposition of two major blocs is forcing a deployment of military means through strategies that look for favorable relative positions. The areas under study fall within two main spheres of action: economy and war. Therefore, their connections with politics and a recourse to force have to be looked for in both fields.

The current economic importance of the shelves can be summarized in their riches as world fishing grounds and sources for petroleum exploitation and mineral extraction. Of those activities, the first two are of paramount importance. Mineral extraction will increase if economic incentives or want of important materials surpasses the current technological and economic drawbacks. But the need for those materials is easy to conceive if man continues in a "dispendious mood" (extravagant and wasteful) regarding natural resources. It can be argued that intensive extraction has stimulated new developments and that substitutes have been found in the history of economic and industrial development. Anyway, that optimistic theory that rests on unlimited possibilities, although hopeful, is not always real. The highly industrialized countries, unless the trend is changed, will be the ones most in need of those sea reserves.

Legal possession of soil and subsoil Continental Shelf riches is clearly defined by the Geneva Convention, in spite of its imperfections. However, the entitlement to those riches does not mean the feasibility of direct exploitation, since the ability to exploit is limited to less than a handful of countries. Exploitation is always possible, using another's techniques through contracts or concessions, with some of the benefits, wishes, and interest of bilateral or multilateral parties involved, even though these might not always coincide. On that occasion, indirect pressures or political actions, the pursuing of one's national interests, could give place to frictions or conflicts of different magnitude. Those conflicts will usually encompass one or more countries of a well-developed stage and one of those in the developing stage, most frequently the legal owner of the prospected riches.

Exploitation is generally preceded by the exact knowledge of what is worth exploiting. Previous surveys are always necessary to assure success. Prospecting is an expensive activity and requires in its exploratory phases a great deal of scientific and technical skills. In these cases the pattern of conflict between the possible explorers and owners of the shelves is repeated. Differences or conflicts regarding knowledge of another's Continental Shelf can well precede other conflicts. It is worth noting that scientific enterprises can cover, at times, some of those operations. Article 5.8 of the Geneva Convention on Continental Shelves states:

> Nevertheless the coastal state shall not normally withhold its consent if the request to research is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf subject to the proviso that the coastal state shall have the right, if it so desires, to participate or to be represented in the research and that in any event the results shall be published.[1]

That restriction of rights is made with the open intention of preventing a state from hampering the development of scientific knowledge. On the other hand, how can one be assured that scientific data is to be used only for scientific purposes and that the published results are the only results? That does not happen in marine research at least. Although the participation of the coastal country is afforded in the convention, great disparity of technological levels cannot assure that the supervision is effective.

Therefore, we can conclude that when the exploitation of the resources of the Continental Shelves would involve high interests and the resources would not appertain to the advanced countries making the exploitation itself, frictions and conflicts—natural or provoked—might be abundant.

Although conflicts are possible, more immediately important are conflicts on the Continental Shelves involving fishing activities. Several examples in the past showed that in those cases not only political, but military, action has been used as a means of enforcing a determined course of action. The difficulty in a successful definition of the area of exclusive fishing rights is another proof of the clash of national interests.[2] Fishing is the oldest sea resource exploited and also of the most importance. It is then natural that this field contains the largest record of frictions.

Again, technology and economic development present opposing interests for developed and developing countries. The superpowers and big fishing nations want no territorial restrictions beyond a narrow fringe of coastal waters. Meanwhile, the smaller and less-developed powers look for wide margins of exclusive fishing rights. The Soviet Union, due to security reasons, does not share the opinion of the United States.[3]

The ambiguity of the Geneva Convention regarding sedentary species, mentioned in article 2.4,[4] brought about other conflicts, due to its interpretation, such as the one between Brazil and France.[5]

The effects of overfishing in traditional areas and the desire to increase the catch make countries with growing economies or those depending on fishing to direct their eyes towards new areas. Continental Shelves and slopes of remote places are suitable places for fishing when adequate fishing fleets and techniques are available. In that position, the freedom to fish in the most profitable regions is a logical policy to sustain. The less-developed countries, which lack modern techniques, emphasize the danger of overfishing and the need for conservation of the natural resources in front of their coasts. In some countries, for example, the balance of fishing captures has implications for other industries such as the guano industry in Peru.

The need for greater animal protein would justify operations that are also economically advantageous. Also, paradoxically, most of those starving nations are in front of the sea with good prospects of abundant fish, but they lack the human and material resources to make fishing operations economically successful.

Looking at the subject from the other side, is it illogical not to harvest the seas where fishing is convenient? That is a waste of resources offered by nature. That harvest will fulfill its cycle of life anyhow. The key is really to determine the correct level of the catch and how to make sure that that level is respected. For that, a good knowledge of population dynamics is essential, and, in most cases, for the probably new fishing grounds those studies are missing.

Solutions to these situations could be sought through multilateral, bilateral, or unilateral means. Multilateral efforts have not always been successful. Unilateral enforcement usually leads to naval action as a means of enforcing the regulations on intruders.[6] Previously it was pointed out the probable difference in power among prospective litigants regarding sea exploitation conflicts; therefore, enforcement of unilateral declarations of exclusive rights very frequently, if preceded by a naval action, would be followed by political action in one of the several international forums or in the United Nations. Conciliation of opposing interests cannot be easily seen at the present unless enforcement is found through multilateral agreement on the basis of mutual conveniences. Those agreements will not be easily carried out. Therefore, Continental Shelf waters would be areas of intense naval deployment and patrolling by some countries.

Partial or large damage to a country's economy done by overfishing in its coastal waters depends upon the extent those waters are used as fishing grounds and to the importance of fishing to its economy. The magnitude of the operations and the period for which they have to be sustained would depend on specific situations. This cold war operation is feasible in a tense world. To be ignorant of what is happening and to resort to political or military ways of counteraction for a relatively extended period of time diminishes the expectancy of this conflict. In any case, knowledge of the resources and their natural dynamics and reconnaissance through naval or other paramilitary units would be some of the means of assuring some validity to claims towards pretended "aggressors."

In spite of the previously mentioned conflicts involving the Continental Shelf areas, naval hostilities of a cold or hot war will provide the broadest use of them. The two major political and military blocs of the world show a different dependence on sea operations. The free world counts on the unrestricted use of the sea for transportation of goods and men. The Communist world, on the other hand, has a growing interest in the sea as a means of defeating the enemy by annihilation of those streams of trade and logistics vital to the maritime nations. As a new trend today, the Communist nations seem to be aware of the economic benefits of controlling the sea through shipping and new courses of action which shape what is difficult to define as merely an economic strategy.[7]

Within that frame a considerable deployment of military force at sea provides offensive and defensive systems by both blocs. Those forces keep an almost equal value, either in conventional or nuclear war, since they partially participate at length in the latter.

The Continental Shelves, as we have seen, provide alternately for aggression and defense. However, to make their use feasible requires high technology and a good knowledge of the areas concerned. For the free world, the United States, the United Kingdom, Japan, and France lead in marine technology, being the first countries prominent in all fields of that technology. On the other hand, the Soviet Union has shown a tremendous increase in her capabilities and interest in ocean sciences. Her buildup on an important research fleet and of a large fishing fleet, which undoubtedly acts as a simultaneous collector of data intelligence, has spread Communist maritime operations worldwide. Some scientists speculate the Soviets are behind the United States in marine science. Their knowledge of some areas, however, such as the Arctic, is better. There is evidence that they apply great effort to military oceanographic research.[8]

Information on Soviet underwater experience is scarce. However, we can presume a rising effort, since in June 1968 an underwater laboratory, the "Chernomov," was being tested in the Black Sea. The design of that laboratory seems to be below the Sealab III level, but it is known that new underwater vehicles are being developed.[9]

Both major blocs have nuclear submarines capable of delivering nuclear weapons from ranges of about 2,500 nautical miles for the United States and an assumed range of 400 nautical miles for the Soviet Union. The latter range estimate is an approximation. It was estimated that the Soviets lag 10 years behind the submersible capabilities of the United States. Let us assume for both about equal ranges as well as comparable aptitude for underwater launching.[10] Even with their respective differences, both weapons systems are capable of inflicting tremendous damage to industrial complexes as well as a heavy number of casualties.

Usually a Fleet Ballistic Missile Submarine (SSBN) will attack as far as possible from the enemy shoreline and the border of the Continental Shelf. However, the selection of inland targets or the particular needs of increasing failures in the navigation systems could oblige the attacking submarine to cross the Continental Shelf. In both cases, detection of the intruder as far as possible is vital for his destruction before his weapons can be launched.

The surveillance system installed on the Continental Shelf and complemented by a deep ocean system, fixed or mobile, would be invaluable. Such a surveillance system combined with a guided weapons system could provide one apt response in the short amount of reaction this sort of attack allows. Probably it is within that frame that projects Trident and Artemis merged[11] and the Atlantic Underwater Tactical Evaluation Center operations are tested.[12]

Other strategic shelves where the probable Fleet Ballistic Missile Launchers exit may provide installations of complementary detection systems, that through convenient communications allow better intelligence of the enemy's movements.[13] Those systems will require considerable expense, a good level of secrecy for keeping the efficiency of the system, and a good display of technology.

The use of underwater mobile or fixed platforms for offensive purposes from the enemy's Continental Shelf is difficult to conceive as convenient. The advantage of such a strategic deployment could be for launching missiles or as a base for underwater operations. The first use would be elaborate, expensive, and consequently aimed only towards important objectives that cannot be reached by other means and where surprise is important. But there are serious adverse factors; primary objectives usually would be in areas of highly sophisticated defense systems, operations for laying the necessary devices will be seriously impaired at times or impossible to execute. The use of the Continental Shelf for putting up small underwater bases, easy to construct and with limited objectives, is a more feasible method.

Underwater antiballistic missile stations on a shelf could imply a convenient defensive deployment for destruction of multiple warhead missiles before the separation point. Those stations would enjoy concealment within the premises commented upon in the previous chapter.

Continental Shelves are suitable grounds for mine and countermine warfare operations. Mobile underwater stations could operate for both types of actions within a reasonable radius, depending on tasks, weapons, and levels of risks admitted. The laying of special weapons of large destructive force on determined spots of the ocean bottom is conceivable with current technology. If those weapons can be rendered active at will a long time after being laid, operations in strategic areas of the world by one of the major blocs in belligerence could achieve a military advantage and could be expected. Do those weapons exist, and have some of them already been deployed? Secrecy on modern developments make that a difficult question to answer with reasonable accuracy.

The natural characteristic granted to objects laid on the Continental Shelves, concealment, led us to one of the most immediate uses of Continental Shelves, in the case of needing secrecy for some undetermined reasons. Those areas are available for hiding weapons or devices, provided surveillance of the zone is possible or intruders are discarded. Exploitation of this course of action is varied and reaches different scales of operations, covering from peacetime operations to insurgency, espionage, or conventional actions. Coastal or shelf areas of underdeveloped countries could be sanctuaries for these types of operations, since their surveillance is deficient.

So far, our discussion has put us on the verge of utopia, at least for some skeptical people who have not witnessed the current pace of underwater operations. Unfortunately, when these matters are discussed from a public information viewpoint, the elements of proof are scarce. It is natural that high military developments are subjected to a level of secrecy directly proportional to the amount of innovation that the weapon or development implies. Anyway, our review of underwater activities can show us that progress made in this area lets us be suspicious that new possibilities in maritime warfare can complicate severely the currently known status.

How does all that affect different countries? Evidently, for conflicts of a small scale, the implications are not so large; but for large-scale conflicts the efforts will have to be redoubled since the three dimensional frame achieved in World Wars I and II has been enlarged considerably through the action of more capable submersible vehicles and a man less restricted on water. The Continental Shelves emerge within that scene as a double source of effect and conflicts—economic and military. Both are important factors either in peace, cold war, or hot war situations. Of course, the Continental Shelves of both superpowers and immediate areas will be the most vital areas. There, the systems of attack and defense will compete heavily. The surveillance of those areas appears critical, and that task will impose arduous work.

The current technology and high interest involved in worldwide strategies lets us say that those uses analyzed, and probably other uses of the Continental Shelves, pose a real danger of a complex escalation of a cold war game on the continental margins.

Since the economic side should not be neglected as a source of pressure and friction, an early agreement on a juridical and more complete status of the bottom of the shelves, seabed, and the waters superjacent should prevent further complexities of the world's political-military situation.[14]

To reach that reliable status will involve tremendous difficulties due to the differences in opinion because of strong national interests. The unrestricted principle of freedom of the seas probably can no longer be held if the balance of power is to be kept in its current status. Even the principles of freedom of navigation and unimpeded scientific and economic research will have to be revised.

In any case, the surveillance of Continental Shelves and assurance of fulfillment of agreements will involve an effort impossible[15] or very difficult to perform with current means. However, those coastal nations which do not or can not develop underwater technology and operational capabilities to operate at the levels of the Continental Shelves will be economically and militarily inferior in the face of future changes affecting maritime areas.

VII—CONCLUSIONS

The Continental Shelves have considerable natural wealth. They are important for fishing, petroleum exploitation, and some mineral extraction. If more emphasis were put on mining certain materials, these resources of wealth could play an even more significant role.

The feasibility of operations on Continental Shelves is presently restricted to small-scale operations, but, with experience, the field is expanding for some of the most advanced countries. The impact of those advancements is felt in both economic and military fields. Major progress is noted, not only in diversity of operations, but also in the accuracy and range of action of the whole field. The ability of man to work at increasingly greater depths has multiple implications in that progress.

The increase of new capabilities complicates remarkably any major war in which the leading countries would be involved, since the military use of the Continental Shelves would be of great advantage. In general, we can say that new technologies are broadening the area of naval concern. Detection and surveillance are enlarged to a great extent through the use of the Continental Shelves. General surveillance will be necessary for each country's security. Offensive-defensive systems which can be installed on the Continental Shelves within the present state of the art or in the near future enlarge the spectrum of current strategies. Either deterrence or retaliation will have new systems entering the stage in the near future, unless current trends are changed.

The possibilities mentioned indicate that early and worldwide agreement about the use of Continental Shelves and deep ocean soils would be wise. To reach agreements will be arduous, but agreements may be one means of preventing an escalation of underwater warfare.

Whether that aim is reached or not, the nations with better marine technologies, knowledge of the oceans, and know-how will have a great advantage in the strategic use of the Continental Shelf in war as well as for immediate exploitation of natural resources.

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