

THE SOUTH AFRICAN INSTITUTE
OF
INTERNATIONAL AFFAIRS

OIL FROM THE SEA: TRENDS AND PORTENTS

by

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UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG.

8 May, 1968.

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OIL FROM THE SEA: TRENDS AND PORTENTS

The curious thing about the exploitation of petroleum beneath the seas is that it is only in the last few years the public has come to realise that oil is increasingly being extracted from the seabed.

In South Africa there are also those who probably never knew that this was done until the Government decided to encourage oil prospection, not merely on South Africa's mainland but off-shore.

Such a belated awakening is curious since petroleum has been sought and found in the seabed for more than a quarter of a century - ever since offshore rigs were put to work near the Louisiana coast. From there the technique of drilling for oil or natural gas in the shallow bed of the continental shelf has spread to all continents - including Africa.

I suggest that the main reason for this public lack of awareness, in what is now seen to have been the start of a far-reaching development, was (as I had begun to suspect after my visit to the North Sea last year) that tapping oil reservoirs in the shallow seabed off a coast and always relatively near an existing productive oilfield on dry land, was still regarded by promoters and public alike, a few years ago, as merely an extension of an essentially land venture - nothing qualitatively new.

Such an interpretation of mine helps to explain why the conventional self-elevating drilling platform still possesses so very few adaptations to a marine environment. It is the product - the technological consequence - of what I call, ... of what I like to call in a wider context, the "onshore mentality". I say this without any pejorative undertones since I remain convinced that the offshore, self-elevating drilling rig is a wonderful engineering creation; but that is how the mind works, as a rule, and any history of science provides many precedents.

The point I am trying to make because it is central to my theme is that, only after a quarter of a century of marine oil

exploration, is it becoming clear - not only in the abstract but on the evidence of new techniques not necessarily associated with the oil industry - that offshore oil exploration is not just a slightly unorthodox adjustment of an old boundary - the seashore - but the long unrecognised beginning of the conquest of a new milieu: not so much the sea per se - the sea, whose pelagic resources (+) have been exploited for a long time from the surface - but the new milieu of the seabed and its sub-soil. This exploitable seabed is, for a little while, still the continental shelf but soon it will also be the seabed in the deeper reaches of the ocean: according to one authority, to at least a depth of 3000 feet, within a decade from now; and not only for the acquisition of petroleum or diamonds but also for the exploitation of a whole, already sampled, range of minerals and chemicals; and it is the population explosion - already with us - which will quicken the trend.

While in the North Sea gas concession area in September last year I saw clear evidence of a change, if not of outlook, then in technique. The old technique was coming to the end of its tether and the new, which eventually would be as well adapted to the marine environment as the dolphin and the crab, had made its appearance.

This is why the impressions I gathered during a four-day stay on the back of a Wellsian monster with stilt-like legs the height of a 32-storey building have a place in this talk; and as such giant structures are likely to be among those to be used off the Cape coast, in the not too distant future, when the present programmes of geophysical prospection have been implemented, that visit is of interest to a South African audience.

The rig I visited was under charter to the Total Group: that is, to its British oil exploration subsidiary company. It stood in something like 200 feet of water, near the entrance to the Moray Firth, 25 miles from the coast of Scotland. I reached it by helicopter from Aberdeen. It was a self-elevating platform: still the most widely used model all over the world and I was told that there were 11 such rigs of various makes in the North Sea at the time. There were also three or four semi-submersible rigs in the concession area and one drillship: a converted tanker which could only operate when the sea was relatively calm.

The rig I visited - with its tremendously long lattice - girder legs planted on the seabed and its platform jacked up some 50 feet above the water; its tall derrick and its three big cranes - is, I repeat, a remarkable engineering creation: not only because of its size but because of the ingenuity displayed in achieving, in a mobile element ... nay, two mobile elements, the stability of an onshore derrick: if not stability all the time, then most of the time.

(+) Pelagic: free swimming, near the surface, in the open sea.

Over the decades it has been gradually modified without the principle being affected: to stand while at work, to stand on that part of the continental landmass which happens to be submerged. It has been modified to enable it to operate in slightly deeper waters and to stand up better to winds of gale force - though not the worst - without losing its footing; but it remains, nonetheless, a structure whose precarious stability demands perpetual vigilance.

Drilling procedure and equipment are the same as on land but since the rigid drill pipes have to pass through sea water before entering the rocks in the seabed, a tubular casing is provided which links the base of the derrick with the rock under the sandy bottom. In this way the sea is excluded from the system.

The average cost of a self-elevating platform is high: about R7 million and as the rig is further adapted to deeper waters on the continental shelf by being provided with longer legs and also elaborate engineering gimmicks capable of providing additional stability, it is costing more and approaching its economic limit. (+)

That limit, according to a recent issue of a technical journal devoted to the petroleum industry, is 460 feet for the length of the legs and 300 feet for the depth of the water. (++) When the self-elevating rig reaches that limit it will cost as much as a semi-submersible rig, which has a much wider range of action.

The semi-submersible is destined to take over where the self-elevating rig leaves off. In relatively shallow water it stands on the seabed but in deeper waters (though still on the continental shelf) it can be made to float, when the water in the tanks below the pillars of the platform is expelled. A certain stability is then achieved with the assistance of a dozen or more anchors of about 13 tons each.

The semi-submersible paves the way for the true drilling ship, to be provided with computer-actuated propellers: one fore and one aft. I know that the French have an experimental vessel of that kind called "Cerebel" and other nations may have too.

An even further stage in offshore drilling technique is already being envisaged. At the French Petroleum Institute near Paris, a research centre I visited for the first time in 1959, I was shown last year some photographs of a drilling system which is a complete breakaway from the mainland tradition - a system adapted to a marine milieu. Called flexoforage because the

(+) One gimmick on the rig "Endeavour" I visited and also on France's most recently-built rig "Neptune-Gascogne" is an electrically-operated apparatus making it possible for the three legs of these platforms to be slanted so as to give the rigs a wider and thus a firmer base.

(++) "L'Industrie du Pétrole en Europe", Jan.-Feb. 1968.

succession of drilling pipes of the conventional system is replaced by a continuous steel drilling "cable", flexible enough to be wound round a winch drum as wide as the ship that carries it; this original apparatus also accepts the full implications of another new outlook: that more and more equipment, power units and other such-like machinery should be placed on the seabed and not on or above the surface of the sea. Eventually some of the personnel would also be established on the seabed.

The placing of the production oil well head (what is familiarly called the "christmas tree") on the seabed is already operational; and for the keeping of personnel in permanent bases on the seabed for long uninterrupted periods there exists already a whole range of experimental submarine chambers, vehicles and workshops.

In this pioneer work several nations have something of value to offer. Some of these machines have long articulated arms with claws making it possible to pick up samples from the seabed: arms controlled from the interior of the chamber or vehicle. Such vehicles can operate in the deeper reaches of the ocean, well beyond the continental shelf - down to 6000 feet or so. One advanced model, DOWB, has a two-man life support endurance of 65 hours and a range of about 25 miles. The average speed is 3 m.p.h. The arm or manipulator has a TV viewing system and can lift and store away objects weighing up to 50 pounds.

What is there to exploit or mine in the seabed? As far as we know - and that cannot be all - cassiterite (the most common ore of tin) and other tin ores, manganese (so far found in abundance in the form of nodules lying on the sea-floor), iron ore, phosphorite, coal. (+)

Of course, all this and particularly the production of petroleum has geopolitical and strategic implications. Petroleum, as a major provider of energy, is hot political stuff. I propose to touch upon some of these implications and also on the legal aspect; but before doing so I am going to say something about oil in our own continent: Africa.

The petroleum picture in Africa has drastically changed in a few years. I remember with fair precision the time when Africa produced hardly any oil at all. In 1951 (when I was still General Secretary of this Institute) the society produced a book, the fruit of the labours of a panel of experts under the chairmanship of Sir Francis de Guingand, on the resources of Africa south of the Sahara - with certain oblique references to Africa as a whole. In that book, on page 229, there is a meaningful sentence: "Crude oil has not yet been discovered in Africa".

(+) According to Tony Loftas in his book "Wealth from the Oceans" (J.M. Dent, London, 1967) such nodules may also contain cobalt, lead, nickel, vanadium or zinc. Apparently such nodules are found on the deep sea floor, not on the continental shelf.

Incidentally, it produced a little at that time (a mere two million tons in Egypt) but so little that it was next to nothing.

What is the position now? The 1966 figure for all Africa (that is, 15 years after the publication of that book) was 137 million tons a year. The deserts of Algeria and Libya account for a little more than 100 million tons and the remainder is produced by a string of countries bordering on the South Atlantic.

West Africa is growing into an important oil-producing region, with Nigeria in the lead with an annual production of 21 million tons, much of it from offshore sedimentary rocks; and, nearer home, in the southern hemisphere, there is, not only Angola, with its mainland oilfield, but Cabinda, a Portuguese enclave in Congo (Brazzaville) where, close to the sea shore, an economic oil accumulation was revealed by the drill-bit of a semi-submersible rig at a total depth of less than 2000 feet. This happened towards the end of last year.

Apart from what has already been found there is the search, much of it offshore, in other West African countries, such as Senegal, Dahomey, Camerouns and Gabon, where prolonged programmes of geophysical prospection have conjured up promising evidence of oil-trap structures. Whether some still contain their original accumulations of oil, only actual drilling can tell.

What of South Africa?

If the answer is to have any meaning at all, certain things must be recalled. One is, with regard to offshore prospects, that, so far, all the offshore discoveries made to date, in the world, have been extensions, in the continental shelf, of known oil-bearing sedimentary strata on land. This goes even for the oil basin off Cabinda which is not far from the mainland oilfield of North Angola; and it is also true of the North Sea whose gas-filled stratum of porous sandstone is in a geological formation similar to that of the "onshore" gas fields of Groningen in North Holland - not very far away.

In South Africa, on the other hand, international oil companies have agreed to spend a lot of money in offshore geophysical surveys and these surveys may be followed by exploratory drilling: all this, although there are no known accumulations of oil on the mainland. This is a new sort of risk.

With regard to the mainland of the Republic, where sporadic drilling at long intervals had been undertaken for half a century with no positive results, it should be recognised that this onshore drilling was done before the era of geophysical prospection. Modern prospection methods - magnetic, seismic, gravimetric - eliminate, to a large extent, the hit-and-miss approach. They pin-point likely oil traps in the right kind of geological formations.

Thus the failure of earlier oil searches onshore in South

Africa does not mean much by itself and Soekor (+) was quite right to start from scratch with modern geophysical survey methods, to be followed with exploratory drilling.

What makes the mainland of South Africa less promising than the offshore areas is that the mainland possesses, in lesser measure, the pre-requisites for the existence of economic accumulations of oil.

Oil is formed by the decay of marine organisms - micro-organisms such as plankton - trapped in seabed sediments: that is, sedimentary rocks such as sandstone or limestone ... porous or permeable rocks which, many millions of years ago, were the ooze of the seabed. As a result of physical and chemical action some of this decayed matter became transformed into molecules of crude oil hydro-carbons, but these would not have endured until now unless trapped in strata of porous or permeable stone and, since the tendency of oil is to move upwards the usual trap is a layer of another type of rock, as long as it is non-porous: rock-salt for instance as is the case in the North Sea. This kind of non-porous or impermeable ceiling is called a "cap-rock".

But there are further pre-requisites. To be an economic or practical proposition the oil must be concentrated in one spot. Such concentration takes place where the sedimentary layer has developed a fold - arch-shaped or dome-shaped. Such a fold called a syncline can be many miles wide and, if it is a rather pronounced fold, there is a promise of a large accumulation of trapped oil. Such signs can be detected by geophysical surveys: but geophysical prospection cannot tell whether there is still oil in a particular reservoir. That can only be determined by drilling. Periodical, sporadic movements of the earth's crust in the course of millions of years may have finally caused cracks in a particular oil trap or reservoir and the oil would then have percolated upwards and vanished.

Now, the older the sedimentary rocks, the greater the likelihood that a particular reservoir has suffered a crack or cracks and lost its oil; and the thinner the sedimentary rock stratum the greater the likelihood that the oilfield in it will not be a rich one.

Thus, very thick, youngish deposits (that is less than 100 million years) of sedimentary rocks hold more promise.

South Africa has, apparently, more of that promising kind offshore than on the mainland.

(+) Southern Oil Exploration Corporation (Pty.) Ltd., a government sponsored organisation whose main term of reference is to find oil in the Republic by undertaking exploration itself and by assisting other oil prospecting lease holders.

With regard to the mainland it is only fair to add that certain unspecified discoveries made recently in the Southern Karroo have led Professor E.S.W. Simpson, Professor of Geology at the University of Cape Town, to revise the pessimistic views he had expressed a year ago about the prospects of the country's mainland. He said that oil might well be found in useful accumulations on dry land.

As you probably know from newspaper reports, drilling is proceeding on the mainland of the Republic but, offshore, we are still at the geophysical prospection stage. In the Agulhas Bank this is being undertaken by half a dozen companies, each with its own concession area; and, in the continental shelf of the Eastern Cape by Total on behalf of a consortium consisting of B.P., Mobil, Shell and Total. (+)

I might interpolate here that, today, the discovery of an oilfield in or near a country - any country - does not only hold the firm promise of a steady home supply of energy for industry and transport but also of edible protein - for domestic animals for some time to come and eventually, when made more sophisticated, for human consumption. Such protein is obtained by cultivating yeast on the waxy part of gas-oil. Crude oil generally contains one per cent of such wax.

The legal aspect of the conquest of a new environment like the seabed is already a complex subject but, in this talk I can do no more than touch upon it.

The international lawyers recognised as early as the start of the post-war that the law of the seabed should be quite different from the Law of the Sea. They saw - possibly because of the emergence of offshore oil exploitation at that time - that the resources of the sub-soil of the continental shelf would soon become the prizes of a new scramble beyond the limit of territorial waters which, incidentally, have in the Republic a breadth of six miles as against the traditional three miles still adhered to by many though, by no means, all nations.

The legal definition of the continental shelf (geographically, that shallow portion of the submerged section of the landmass near the shoreline) is restrictive and has little in common with the definition of territorial waters. The standard of measure is different too.

This is what the Convention on the Continental Shelf adopted in Geneva on 24th April, 1958, lays down: it concedes a nation's sovereignty over the benthic resources (those of the sea floor) of its entire continental shelf, without any regard to territorial limitations, to a depth of 200 meters (656 feet) or "beyond that

(+) A few days after the delivery of this address, it was learned that a seismic survey was also being carried out in an Atlantic offshore area extending as far North as the Orange River.

limit to where the depth of the superjacent waters admits to the exploration of the natural resources of the said areas".

According to an article in "Foreign Affairs" (+) the implication here is that benthic sovereignty may be exercised over a continuous stretch of sea floor starting with the beach and extending outwards and downwards to whatever depth the nation is able to work its benthic resources. Beyond that point sovereignty ceases and there is nothing in the Convention suggesting that jurisdiction may again be claimed at some point farther in the ocean where it is once again shallow.

This is not a fine point of law. Already the 1958 Convention appears to be inadequate and in need of supplementary conventions. The North Sea is a case in point. It is almost entirely "continental shelf" by the simple 200-metre definition. The exception is a deep trench bordering the southern tip of Norway. Legally this should have cut off Norway from participating in the North Sea petroleum bonanza but only by the willingness of the other riparian states simply to ignore this trench Norway got its share of the cake.

What would have occurred if an anti-Western state had been on the other side of a similar trench? We can only suggest that a complex legal tussle would have ensued.

This relatively young convention (young because only fully ratified as recently as 1964) ... this convention about what could be called the domestication of the seabed obviously opens legal vistas without end. As I see it, technological advances are likely to be so rapid from this day forward that they may well bring about situations conducive to quarrels between nations because of conflicting interests and, probably more frequently, because of the depredations of the few.

It should not be forgotten that, beyond the not very well defined frontier or boundary of the legally defined continental shelf under the sovereignty of the state bordering it, there is the ocean, open to all nations. The ocean is still the property of all mankind. This, to a layman like myself, seems strange considering that other environments are dominated by the principle of national sovereignty; not Antarctica, it is a special case. One might have surmised that the air, the milieu conquered in our lifetime, would have been the last to remain the common property of all the peoples. It was Mr. Gideon Roos, our Chairman this evening, who, in a learned address to this Society, on legal matters, more than 15 years ago, reminded his audience that a nation's sovereignty extended to the air space above its soil.

(+) "The Political Ocean" by E.W. Seabrook Hull, April, 1967.

In this respect, I think it will be of particular interest to Mr. Roos to hear of a likely development, in certain circumstances. It is suggested by an American expert of underwater technology that the "water space" above that portion of the continental shelf to which a state has sovereign rights might well be given the same legal status as "air space". The writer adds, however, that what is more likely to happen in the near future - something less drastic, is that "the right to regulate the jettison of material over occupied areas of the sea bed, the right to regulate traffic above and around occupied areas of the sea bed, and the right to discriminate between peaceable and belligerent transit over occupied areas of the sea bed may well result, as emoluments of sovereignty". (+)

Lest I should be suspected of riding a private hobby-horse in my emphasis on the coming exploitation of benthic resources, in addition to the search for oil in the continental shelf and beyond, I should like to mention the views expressed in a leading article by the American monthly "World Petroleum" in its November 1967 issue.

"The big question of the future of natural resources under the sea, in the seabed and on the ocean floor has suddenly moved into the political limelight....

"The spark that seems to have ignited this newest potential powder keg was generated by a request submitted by the Government of Malta to the current session in the General Assembly of the United Nations. This was a request to include, as a supplementary item on the agenda, a 'Declaration and Treaty concerning the reservation exclusively for peaceful purposes of the seabed and the ocean floor underlying the seas beyond the limits of present national jurisdiction and the use of their resources in the interest of mankind".

A particularly significant comment by the leader-writer is that "co-operation of private and public capital of many nations will be an absolute necessity in the mobilisation of all possible weapons to conquer the hidden treasures of the sea....." To reach such a goal, the writer goes on, a clear status of the areas in question is to be established. The "right of free capture" of the natural resources in a "no-man's land under the seabed" could not be carried out in an unlimited way "without creating international conflicts with considerable dangers."

In all this, let us remember or accept that a powerful spur will be given to the exploitation of the resources of the seabed by the threatening population explosion, not immediately in Africa but, soon, it will affect Africa too. It is an awesome thought that the population of the planet is likely to be doubled before the year 2,000.

(+)

John P. Craven, "Seapower and the Sea-bed",
U.S. Naval Institute Proceedings, April 1966.

10/ I should ...

I should like to end with a few words about the naval implications of the exploitation of the resources of the continental shelf, for a small naval power like the Republic.

If we confine ourselves, for argument's sake, to marine petroleum, I can see that the setting of an "incident" might be provided, one day, by the Agulhas Bank, if it proved to be a rich and extensive oil area.

The Agulhas Bank which juts forth into the high seas for a considerable distance - about 170 miles - is all or nearly all continental shelf in the legal sense of the expression and South Africa has the right to exploit its oil deposits for its own benefit. This would be a right but, like all rights of such a nature, it may have to be supported by the country's naval power, purely for purposes of deterrence and this, in the peculiar modern context, would probably achieve the required result. In the contemporary international climate there is little indication of any eagerness, even on the part of a big power bent on acquiring new sources of valuable raw materials, to use armed force, far from its base, merely to achieve an economic advantage. Besides, as was implied in what the article "Seapower and the Seabed" said about a state's possible "emoluments of sovereignty" in the water space over occupied areas of the seabed, small naval units might well be needed and suffice to warn intruders that trespassing is forbidden.

In fact, according to a recent British book on "The Sea in Modern Strategy" by L.W. Martin, even a merchant fleet can generate a subtle and effective influence in this regard - a kind of indirect form of deterrence, by showing its country's flag on the seven seas and thus conferring prestige on the nation that owns that merchant marine. "It is clear" concludes the writer, "that merchant shipping can, in the right circumstances, serve political purposes".

If this is a role a national merchant fleet could be expected to play in the world of tomorrow, then my feeling is that Safmarine would play it extremely well.

All this may appear a bit nebulous to us today but all I wished to convey in these last remarks was the need for the Government and for responsible citizens to realise IN GOOD TIME the logical consequences, in naval strategy or naval police work and thus in geopolitics too, of the exploitation of benthic resources - and of oil in particular.

Should the assumptions I made at the beginning of this talk be valid then the most effective and successful response to the challenge of the coming economic revolution (that is, the opening of the seabed to human enterprise and the rational harvesting of sea foods) might well be an attempt by South Africans to be more conscious of the new dimension the all too familiar ocean is assuming.

It may well be that this country's elite has been dominated too long by Rhodes' famous injunction, perpetuated in the orientation of his statue in Cape Town's Adderley Street. The injunction lingers on although it has lost much of its validity.

After all, this country, being a peninsula, has, even without South-West Africa, more coastline mileage than land frontiers. If, as I have tried to show, the sea is going to provide a new dimension of value - whether oil is found off our coasts or not -- then the Republic will be served with more opportunities than many other nations and should prepare herself to cultivate them.