OIL SHALE IN FOCUS

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I know of no topic on the public scene, unless it be Viet Nam, on which there is more ignorance, confused thinking and dogmatic opinion than oil shale - thus the title for my presentation. Maybe the title should be "Oil Shale Out of Focus" because there is no assurance that I can clarify the subject for you. One of the frustrations of those who deal with oil shale every day, is that its problems are many sided and so involved, that we so-called experts may be the most confused among you.

I might add that the confusion in the public mind is greatly compounded by all sorts of uninformed individuals and organizations joining the fray, each with some axe to grind or some real or imaginary dragon to kill.

As an example, on April 7, 1967, a press release from the office of the Senate Antitrust and Monopoly Subcommittee began as follows:

"How and when to sell a national treasure -- worth almost 20 times the annual federal budget -- will be the topic of Senate hearings opening April 18.

"'The government owns more than 80 percent of the 10 million acres of this land in Colorado, Wyoming and Utah,' said Hart. 'It contains two trillion barrels
of shale oil which conservatively is estimated to be worth $2.5 trillion -- or enough for $40,000 for each American household. Its market value may be twice that."

It is this type of sensationalism that needs to be brought into focus.

GEOLOGY AND RESERVES

The oil shales of importance in the United States are found in the Parachute Creek member of the Green River formation, and were formed as sediments in brackish lakes about 50 million years ago. The organic matter in the oil shale is called kerogen and is not an oil nor is the rock a shale, it is a marlstone. Oil is formed by heating the rock to about 800°F. The kerogen decomposes to an oil, gas and a coke-like residue that remains in the spent shale. About 30 percent by volume of average grade oil shale is organic matter.

Our major oil shale reserves are in Colorado, Utah and Wyoming. The areas are well defined and we are confident that the largest reserve is in Colorado's Piceance Creek Basin. Utah has some areas that may be developed at reasonable cost by open-pit mining but much of its oil shale is deeply-buried and cannot be economically produced with technology now available.

Wyoming has only marginal oil shale prospects despite a large area of Green River formation, but additional exploration is needed especially with regard to associated minerals. I will have more to say on these other minerals later.
A figure of 1.744 trillion barrels was given recently for the oil shale potential of Colorado, Utah and Wyoming. This estimate is based on the 15-15 definition (at least 15 gallons per ton in beds at least 15 feet thick) but such a figure is meaningless since much of this oil is not now nor is likely ever to be economically recoverable. Dr. Wayland pointed out in his testimony that only "about 80 billion barrels of shale oil is considered recoverable by demonstrated mining and retorting methods", or less than 10% of the total reserve. According to Dr. Wayland's figures, 21.1% of the reserve is in private hands or a recoverable reserve of about 16 billion barrels.

Eighty billion barrels or even 16 billion barrels is a lot of oil, well worth going after, but these numbers are a far cry from the trillions of barrels that lead people to think in terms of paying off the national debt with oil shale royalties or of the oil shale owners hoarding hundreds of years of oil supply. I am confident that ultimate recoveries of shale oil will be higher than Dr. Wayland's figures but decades will pass before the leaner, less-accessible oil shales become a part of the "recoverable" reserve. Any figures that do not take into account losses and uneconomic low-grade zones are misleading and have done much to confuse the real issues of the oil shale problem.

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THE TECHNOLOGY

I would like to dispose of the subject of technology without involving you in details of the various techniques for producing the oil. The two suggested approaches for the recovery of shale oil are (1) mining/aboveground retorting and (2) retorting in place or in situ.

Shale oil has been produced for more than 100 years by mining/retorting and this is the only production method in use today. Russia and China both have sizeable industries. Current research and development in the USA is aimed mainly at improving these earlier mining/retorting techniques and applying modern engineering concepts and equipment to the job. Good results have been achieved, a sound technology is available and we are now in the prototype phase of testing some of our new ideas. This technology can and probably will be applied commercially by the early 1970's.

The in situ technique has many proponents, among them:

- Oil people who would like to apply their background and experience to shale oil production.
- Naturalists who look on mining as a despoiler of the aesthetic value of the landscape.
- Proponents of nuclear technology who would like to develop peaceful uses for atomic explosions.
- Engineers who think there ought to be a better way to get the oil from oil shale than to move hundreds of thousands or even millions of tons of rock every day.
All have some logic to support their position, but unfortunately research has not yet come up with a feasible in situ production method. The reasons are several but prominent among them are:

. Oil shale has no permeability or porosity and in most areas little or no communication exists between holes even a few feet apart.

. The rock must be brought to a high temperature to form oil before it can be produced.

. The oil is waxy, viscous and flows with difficulty at ambient rock temperatures.

The nuclear concept that seeks by a massive explosion to create a rubble zone of broken oil shale is no cinch to work and the efficiency of oil recovery by a subsequent combustion phase is a question mark. There is a general misunderstanding of the $0.29 per barrel cost for the nuclear approach estimated by Dr. M. A. Lekas of the AEC.\(^2\) Lekas took some highly optimistic assumptions and applied them to hypothetical situations to get some idea of the comparative economics of shale oil production by the nuclear method under various conditions. The lowest conceivable figure was $0.29 and even if achievable could be applied only to a limited part of the shale reserve in Colorado and not at all in Utah.

\(^2\) Lekas, M. A., "Economics of Producing Shale Oil by the Nuclear In Situ Retorting Method", Third Annual Oil Shale Symposium, April, 1966.
or Wyoming. Furthermore the costs would likely be considerably higher because ideal conditions are almost never encountered. This figure ($0.29/bbl) was used in congressional testimony to support the idea that oil shale royalties should be as high as possible, a classic example of the misuse of information by those with inadequate background in the subject.

Before dismissing in situ retorting entirely let me make clear that an efficient economic in situ shale oil production method is a desirable objective and worthy of research effort. I have confidence that such a method can be developed but I am not optimistic that one will be available by the time we need shale oil. Therefore, it is my belief that shale oil will be produced first by mining and retorting using techniques already in an advanced stage of development and that these methods will be improved still further through commercial application. In situ methods of production may be in use within 20 years but they will not likely be more economical than the mining/retorting systems of that day.

THE NEED AND THE MARKET

Do we need shale oil now? Obviously with imports of 2,500,000 barrels a day, we have an adequate supply of oil for the present. The fact is that we cannot have shale oil in any significant quantity for at least 10 years. The more

3/ Paul H. Douglas, testimony before the Subcommittee on Antitrust and Monopoly of the Senate Judiciary Committee April 19, 1967.
pertinent question is whether or not we will need shale oil by 1975 or 1980.

Take almost anyone's appraisal and you will find a prediction that domestic oil supply will fall short of demand by a wide margin by 1980 or thereabouts. Since we are now supplementing domestic supply with imports amounting to 20% of demand we obviously are going to have to find much greater quantities of oil, to increase imports or develop synthetic oil. Most likely we will do all three.

In this light, let me focus your attention on a regional situation. The Rocky Mountain area now produces about 1,000,000 barrels of oil per day from a proven reserve of less than 3 billion barrels. Both production and reserves have been static or declining in most of the producing states. Exploration also has declined significantly. Colorado is a striking example of production declining, with a decrease in 10 years from 160,000 to 90,000 barrels per day.

It seems to me that shale oil first will become a regional supply of oil making up the decline in production of conventional oil in the Rocky Mountains and this combined with increased demand for petroleum products in the area may take all the shale oil that can be produced for the next 10 to 15 years.

TIMING AND COST

Contrary to some expressed thought, oil shale will not emerge in a flood to drown the domestic oil industry. Many
factors will see to this, not the least of which is the time required to build an industry and its cost. By the time the technology is proven to the degree needed to justify the large expenditures that are inevitable we may be into the 1970's. It has been stated that a 58,000 B/D oil shale plant using the TOSCO II system will cost $130 million.4/

If we round this off to $2000 per daily barrel, simple arithmetic tells us that 1,000,000 barrels per day will cost $2 billion. If we add the power plants, pipelines and other similar industrial installations, and the expansion of highways, schools, hospitals, and municipal facilities, this cost could double. To build a 1,000,000 B/D industry by the end of the 1970's will be a monumental task requiring that no time be lost at any step. To build the industry faster probably is out of the question owing to the physical size of the effort and the political, technical and financial barriers to be surmounted. It seems likely that there will be a need for the oil about as fast as it can be developed.

COMPETITORS OF SHALE OIL

The importation of overseas oil is the most serious competitor of a shale oil industry as well as the domestic producer. Shale oil can no where near attain the present dollar cost of a barrel of imported Persian Gulf oil nor

4/ Morton M. Winston, Executive Vice President, The Oil Shale Corporation, testimony before the Subcommittee on Antitrust and Monopoly of the Senate Judiciary Committee April, 1967.
can any oil being found in North America today. I need not dwell on this point in a talk to oil men but it is worth mentioning in the following context.

There is, in my opinion, an urgency to bring oil shale, coal and tar sands into production as suppliers of a part of our North American oil needs. First, we must protect against interruption of overseas supplies. The current Egyptian-Israel controversy is another example of the constant threat to mid-east oil. Second, but not less important, we should keep a strong bargaining position in the market for world oil. We may find Arabian oil much more expensive when we no longer have productive capacity in excess of normal demand. I would advance the thought that we should keep some of our shut-in capacity available for emergencies and use oil shale, coal and tar sands as a part of the "base-load" supply.

In respect to coal and tar sands, it seems to me that all will fit into our future oil supply, first as regional sources, later in the national oil mix of Canada and the United States. The technologies are remarkably similar, in that mining and materials handling and the up-grading of hydrogen-deficient hydrocarbons are involved in each. There is no reason that favorably situated "high-grade" deposits of all three sources -- oil shale, tar sands and coal -- will not be competitive with each other and with conventional petroleum.
OTHER MINERALS

The discovery of other potentially valuable minerals in some of the oil shale formations, while adding to the legal and administrative problems of the Federal government, already has had a beneficial influence. The minerals to which I refer are nahcolite (sodium bicarbonate), dawsonite (a sodium aluminum carbonate) and halite (sodium chloride). The more interesting of these may be dawsonite since if economically recoverable it could be a new source of aluminum. Bauxite, 90% of which is imported, is now our sole raw material for this strategically important commodity.

Will these other minerals be economically recoverable? How will they influence the shale oil future? These and other questions must await the detailed evaluation always necessary for nearly discovered minerals. Like oil shale itself there is no question but what the quantities are large - zones several hundred feet thick covering thousands of acres - but also like oil shale the economics of recovery must be established. At this time the potential is exceedingly interesting but no definite answer can be given. A number of companies, including chemical and aluminum companies, are making evaluations and will accelerate their efforts if lands containing these minerals can be obtained on a reasonable basis from the Federal government.

THE FEDERAL OIL SHALE LEASING POLICY

I was tempted, because this topic is in the news, to devote my whole presentation to it. The reason I have refrained is that its importance can be overstated.
There is no assurance at the present time, although we are hopeful, that the leasing regulations will be acceptable to industry when issued in final form. Certainly they are not workable in their present form. Another thing, an important fact that often escapes notice, is that shale development is proceeding on private lands, will continue to do so, and may even accelerate if development on public lands is discouraged by oppressive regulation.

I sincerely hope that Secretary Udall will modify his proposed leasing regulation to the extent that a healthy, competitive and ultimately profitable private industry can be developed on the public oil shale lands. This is his stated aim but in my opinion the regulations as written will not achieve the objectives he seeks.

While there are other questionable provisions of the regulations, it is basically unsound to require that a lessee make public all the know-how, and give up title to any patents, resulting from his research on public lands. Not only is this stipulation likely to discourage qualified applicants for leases but if followed would surely result in a mediocre technology. I cannot visualize a company using its always limited research budget and its top personnel to do research on this basis when there are always more opportunities than resources available for proprietary research.

I look at those parts of the regulation relating to patents and disclosure as essentially a negation of the
patent system, which is in large measure responsible for the industrial and scientific progress of our country. As a reward for innovation, and for disclosing the nature of his invention to others by publication of a patent, the inventor is given a limited monopoly (17 years) on its use. In practice the inventor almost always has been willing to license his technology, under the patent system, but the chance that a competitor may devise a better mousetrap usually has spurred others on to research and innovation. Requiring that patents be assigned to the Federal government and that all results of research be immediately made public will remove the most powerful competitive force that can be brought into oil shale development.

It is suggested by the regulation, and by public expressions of the Secretary, that granting ownership of the technology to the public is a necessary compensation for the opportunity to use the publically-owned oil shale resource. I submit that royalties commensurate with the value of the product and its cost of production should be the means of direct compensation to the public.

I further submit that every means should be taken to insure the maximum degree of technological competition, for from this competition will flow the greatest benefit of all to the public -- an ample supply of products at the lowest possible cost.