

improve now envisioned methods. The cost of the program for the 10-year period is estimated at \$15.0 million. The proposed research will complement other research on above-ground methods of converting kerogen to shale oil and will utilize data derived from proposed basic research.

Work Plan

A. Determine the nature of oil shales of the Green River formation, by laboratory and field measurements and analyses, to establish the conditions in the deposit and to relate results of an in situ experiment at a given location to the entire deposit. The study will include:

(1) Core sampling of oil shales believed to have different characteristics in four intervals in Colorado deposits, in three different beds and one unexplored deposit in Wyoming, and in one interval in Utah. Core sampling will be done largely during the first two years of the program. It will involve drilling boreholes and recovering about 6-inch-diameter cores of oil-shale intervals and adjacent intervals that may affect the in situ process. The following holes will be required in the three States:

Colorado: Core mahogany zone, poor core-recovery zone, nacholite zone, and basal Parachute Creek formation. This will require at least three holes, each of which will be 3,000 feet deep, with some 2,000 feet of core.

Utah: Core mahogany zone. This will require a 1,000-foot hole and 500 feet of core.

Wyoming: Drill two coreholes to sample the Laney member and two coreholes to sample the Wilkins Peak and Tipton members. These holes will total 7,000 feet, including some 3,000 feet of core.

This work will be fully correlated with coring, sampling, and resource-appraisal work proposed under other projects of this program.

(2) Conduct laboratory analyses and research on representative cores to determine richness, composite (organic content), lithology, and physical (mechanical) rock properties. Use holes from which these cores are obtained to conduct selected rock-property determinations on oil shales in place where they are affected by depth of burial and other formation conditions.

(3) Based on the determined properties of rock specimens and rocks in place, use statistical and other techniques to design experiments to select rock parameters and conditions that appear the most promising for creating desired permeability and in situ combustion conditions at different locations in the Green River formation. This work will start as soon as data are available and will continue for the remainder of the program.

B. Conduct a field experiment, or experiments, to develop an in situ technique utilizing methods of fracturing and underground combustion considered to be the most promising.

The steps involved in such an experiment are to select a suitable site, conduct controlled fracturing tests, set up necessary surface facilities for conducting and controlling an in situ combustion experiment, conduct the experiment, and evaluate the results obtained. Site selection and establishing the characteristics of the deposit will be largely handled through phase "A" of this program so that only rather minor preparatory work will be done during the first year under this phase of the program. Development of an efficient recovery experiment may require 4 to 8 years, with much of the work being done during the fourth to seventh years of the program.

C. Perform laboratory and field research on novel methods of fracturing oil shale in place such as electrical fracturing and the use of chemical high explosives in preinduced fractures to develop techniques applicable to shallow or thin oil-shale beds.

D. Determine the feasibility of using nuclear explosives for fracturing large quantities of shale preparatory to in situ retorting for use in deep, thick sections of the deposit amenable to the required scale of operation. This investigation consists of four parts:

(1) Based on laboratory and bench-scale results, design and conduct simulated nuclear experiments to approximate the known and expected conditions that will exist in a nuclear chimney following fracturing by a nuclear explosive. The primary purpose of the experiments will be to develop retorting and recovery methods applicable to large quantities of ungraded shale. The advantages of such experiments, rather than proceeding directly to a nuclear blast, are that extensive analyses of the shale are possible and instrumentation for following