industry of a small part of the approximately 80% of the oil shale resources which are Federally owned. Four years of study and planning and the completion of a six-volume Environmental Impact Statement have preceded this action. If this program is successful the production from the six Federal leases combined with production from private lands could reach an estimated 400,000 bbl per day by the early 1980s and one million bbl per day before the close of that decade.

The first lease offering under the prototype program of a single 5,100-acre tract in northwestern Colorado was on January 8, 1974. Eight offers were received with a high bid of $210,305,600 submitted by a combination of Standard Oil Company of Indiana and the Gulf Oil Corporation. This appears to be the highest per acre bid ever received by the Federal government for the leasing of any mineral deposit. The total of all bonus bids received was $641,126,463.09.

BARANOWSKI, F. P., Atomic Energy Comm., Washington, D.C.

NUCLEAR FUEL—AN ASSESSMENT

No abstract available.

BURTON, GUY, and ROBERT WELLBORN, Burton and Hawks, Inc., Casper, Wyo.

LONE PINE FIELD—EXERCISE IN STRUCTURAL GEOLOGY

Lone Pine field, in the northwest part of North Park basin, Colorado, lies between the Park Range on the west and the Sheep Mountain-Delaney Butte thrust on the east. The oil field underlies a surface anticline mapped by Hale in 1965. Seismic work by a major oil company condemned this prospect, and it was farmed out to Burton-Hawks Exploration Company, who drilled the discovery well in November 1971. In general, the structural configuration and drilling depths conformed closely with Hale's cross section interpretation. The discovery well had a gas blowout from the Dakota Sandstone while coming out of the hole for a drill-stem test. After the well was controlled the Lakota Formation was drilled and completed as an oil producer with an I.P.F. of 515 BOPD. Subsequent drilling has found nine more oil wells and one gas well, all south of the discovery. The northern productive limit appears to have been found, with two dry holes just north of the discovery; however, the southern extent of the field remains to be determined. Present oil production extends 1.25 mi along both flanks of the structure, with a gas cap separating the two flanks. Some minor oil production is obtained from the Dakota Sandstone oil ring in two wells.

The Lone Pine structure is a tightly folded, complexly faulted anticline, with 25-45° dips on the east flank and 45-60° dips on the west flank in the oil column. An oil column of approximately 300 ft has been established. Stratigraphic thickness of the Lakota is 70-75 ft, with 60-65 ft of effective pay. Average porosity of the Lakota is 18 percent. Drilling depths range from 2,400 to over 3,000 ft depending on topography and hole deviation. Wells are spaced about 800 ft apart along the east flank; optimum spacing on the west flank is yet to be determined. Each east-flank well proves up an estimated 300,000 bbl of recoverable oil, and west flank wells approximately 150,000-200,000 bbl of oil. A strong water drive hopefully will assure flowing wells throughout the life of the field.

Detailed structural analysis has been essential in guiding development drilling. Large scale, precise structural cross sections are built through each well. Logs are examined closely to determine even the smallest faults. All possible surface data are utilized. Concentric fold form, constant bed thickness and bed length, and a detailed analysis of fault behavior are combined to map as closely as possible the structural attitude in development wells while drilling. The target area for each well is a bank of production (oil ring) only 300-500 ft wide, and attempts are made to penetrate the oil ring near its midpoint to avoid water fingering from below and gas fingering from above. In addition, because of strong tendency for hole deviation in the steeply dipping strata, and the desire to penetrate the Lakota pay "broadside" where possible, the wells must be located at the surface (away from the axis) about 400 ft from the desired location at total depth. Frequent directional surveys while drilling have been necessary, particularly in the early development where unpredictable structural complexities were found.

Despite the problems and additional expense of this type of development drilling, Lone Pine field should prove very profitable. Some of the wells are capable of flowing over 1,000 BOPD; however, all wells are choked back to 100-150 BOPD to prevent premature water fingering, or possible gas fingering.

BUTLER, JOHN, JR., GeoQuest Int., Ltd., Houston, Tex.

MODEL WHICH PRODUCES SYNTHETIC SEISMIC CROSS SECTION

No abstract available.

GARRETT, DONALD E., and RICHARD D. RIDLEY, Garrett Research and Development Co., Inc., La Verne, Calif., and RANDALL T. CHEW, III, Garrett Research and Development Co., Inc., Grand Junction, Colo.

DEVELOPMENT IN *IN SITU* PROCESSING FOR SHALE OIL RECOVERY

"Oil Shale" is a kerogenous marlstone found in the Eocene Green River Formation over wide areas of Colorado, Utah, and Wyoming. Oil content averages about 20 gal per ton. Over the past 20 years experimentation in the *in situ* processing has been largely in the direction of downhole fracturing techniques. Nuclear fragmentation also has been considered. U.S. Bureau of Mines experiments on mine-run rock in surface retorts at the Laramie Research Station demonstrated the feasibility of *in situ* retorting once the necessary void volume had been created.

In the Occidental process a volume sufficient to create the required void space is mined beneath the ore which is then fragmented using conventional explosives to form a retort. Heat introduced at the top of the retort initiates retorting which then proceeds downward ahead of the advancing flame front. The oil produced is pumped from a sump at the bottom of the fragmented rock pile.

The Occidental process is not limited by room and pillar mining thicknesses and thus can exploit thicker

oil-shale sections than other methods. Much less rock per barrel of oil is mined by the Occidental process than in other processes. The process is environmentally attractive in that surface installations are kept to a minimum because a surface retort is not required. Rock mined is readily revegetated raw oil shale.

CURTIS, GRAHAM, Gulf Minerals Resources Co., Denver, Colo.

ENVIRONMENTAL GEOLOGY AND LEGISLATION AND EFFECT ON EXPLORATION AND PRODUCTION

No abstract available.

DOLE, HOLLIS M., Colony Development Operation—Atlantic Richfield Co., Denver, Colo.

TITLE TO BE ANNOUNCED

No abstract available.

DUNN, C. E., Saskatchewan Dept. Mineral Resources, Regina, Sask.

UPPER DEVONIAN DUPEROW SEDIMENTARY ROCKS IN SOUTHEASTERN SASKATCHEWAN—WHY NO OIL YET?

Although oil shows are common in the 500 to 700 ft thick Duperow Formation (Frasnian) of southernmost Saskatchewan, no commercially viable accumulations have been found. However, a few miles south of the Canadian border producing fields are present in Montana.

The sedimentary rocks comprise more than 20 carbonate/evaporite cycles with potentially good reservoir rocks—sucrosic dolomites, oolites, and vuggy carbonates. The inhibiting factors to hydrocarbon accumulation are: (1) extensive anhydritization plugging pore spaces; (2) halite plugging vuggy carbonates in the upper Duperow; (3) many vertical fractures, now plugged by anhydrite, but good potential escape routes for fluids in the past; (4) absence of oolite developments more than 2 ft thick.

These factors explain the lack of success to date. However, the Duperow still is considered a good prospect because: (1) good porosity and oil staining are common in two zones near the middle of the Duperow section; (2) only 180 wells have penetrated the Duperow over an area of 15,000 sq mi—35% of these have terminated above the porous zones, sometimes on seismic highs where the prospect was obviously the overlying Birdbear Formation, a known producer; (3) vuggy carbonate rocks may not always be halite plugged in an area southwest of a major halite body; (4) isopach maps show that extensive solution of Middle Devonian Prairie Evaporite salts took place in Duperow deposition causing locally anomalous accumulations of Duperow sediments. Structure contour maps indicate northwest and northeast trends of the anomalies. These trends are strongly emphasized in a computer-plotted third-degree residual trend surface analysis map. A major northeast lineament lines up with the Duperow fields in north Montana. Conjugate sets of weakness in the Precambrian basement may have caused these trends, and their intersections are the most likely prospects for Duperow oil.

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GEOLOGY AND HYDROCARBON POTENTIAL OF WINNEPEGOSIS FORMATION IN SOUTHERN SASKATCHEWAN

No abstract available.

GEORGE, GENE R., Runge, Campbell & George, Casper, Wyo.

POISON DRAW FIELD, CONVERSE COUNTY, WYOMING

Oil and gas production in Poison Draw field, discovered in 1972, is from the lower sand bed of the Teckla sand member of the Lewis Shale (Late Cretaceous). Oil production has passed the one-million-bbl mark and is expected to exceed eight million bbl of primary production.

The pool is contained in a stratigraphic trap formed in a delta-front environment where strong long-shore currents and wave action formed a northwest-southeast trending system of beaches and delta-front bars. The Poison Draw Teckla pool produces from an undersaturated, underpressured sandstone reservoir.

Development drilling on the east updip margin and in the northern part of the field is still active. The recent increases in crude oil prices have greatly enhanced the economic potential of the field.

One other Teckla sand pool already has been found and further exploration drilling may find additional Teckla sand pools in the southern Powder River basin.

GLASS, GARY B., Wyoming Geol. Survey, Laramie, Wyo.

USE OF PUBLISHED WYOMING COAL ANALYSES

Published proximate analyses, heat values, and sulfur contents of representative Wyoming coals were compared by sample types (face, tipple, and delivered) and by mining methods (underground and strip). These comparisons suggest that the quality of thick, potentially strippable Wyoming coals should not be characterized too stringently from published proximate analyses and heat values without consideration of detailed background information on each analysis. Minimally, the type of sample, date of analysis, sizes sampled, description of coal, thickness and part of coal sampled and/or discarded, type of mine, mining equipment, preparation facility, processing, and even customer identification should be known.

This precaution is deemed necessary for the following reasons.

1. Although analyses of face samples best characterize a coal bed in its natural state, most published analyses of Wyoming coals are either very old face samples from abandoned underground mines or they are tipple and delivered samples.

2. Most available face, tipple, and delivered samples of thick coals (35-118 ft thick) are only representative of one fourth to one half of the entire thickness of such beds.

3. For a given coal bed, there are not enough surface mines for which analyses are available to charac-