Oil and Gas; and Helium Production Potential of Oil and Gas Assets in Navajo County, Arizona

On behalf of

Blackstone Exploration Company Inc.

By

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Summary

Navajo and Apache counties in Northeastern Arizona are within the Colorado Plateau and close to the Four Corner Region – the border Arizona shares with Utah, New Mexico and Colorado. This area has been extensively studied by geologists over the years. It is characterized by complex geological features due to the fact that it is an area of relatively high volcanic activity. There are complex geological features arising from the volcanic activity such as sills, dikes, diatremes, laccoliths that are both visible on the subsurface and these features, along with natural fractures give rise to even more complex geologic features in the subsurface. The evidence supports the fact that the volcanic activity adds to the complexity of the deposition environment in this area. This then influences the occurrence of minerals and resources (such as uranium, potash, and helium to name a few) in this region and as occur in other regions in the world with similar volcanic activity. Therefore, it is imperative that a thorough understanding of the type of rocks deposited by magma flow and the features created such as intrusive igneous rocks as well as the complex fractures created be fully accounted for and geologically modeled when exploring for hydrocarbons in this region. The evidence also supports the fact that reservoir rocks exist extensively in this region as there are numerous shows of oil and gas at various stratigraphic intervals that have been reported. However, the fact that only a few commercial fields have been discovered is most likely due to the compartmentalization of hydrocarbons within these reservoir rocks. This makes it important to gather as much reservoir data such as cores, well logs and tests as possible and to correctly interpret them to reveal these hidden non-conventional reservoir rocks.

This study is made of the producing fields in this area – the Pinta Dome and the Dineh bi Keyah fields that have produced over 6.5Bcf of gas with an average of 8% helium and 20 Million barrels of oil equivalent respectively. It is an integrated study of the geology, petrophysical, and well completion techniques, as well as core data and production data that have been collected since 1945 to date to determine the productive reservoir rocks- carbonate rocks, igneous intrusive sills, and sandstones; possible source of hydrocarbons and helium gas –basement granite; carbonates and shale rocks; and the production drivers for the wells – well stimulation. These serve as analogs to guide the field development for the new wells currently being drilled in Apache and Navajo counties by Blackstone Exploration Company Inc. (BECI).

The results reveal that there are consistently three reservoir rocks with oil and gas shows that are of primary interest: the deep Devonian; the Permian Fort Apache limestone and the Coconino sandstone with oil or gas shows. Also, the Pennsylvanian carbonates and shales with intrusive igneous rocks are an additional target for exploration. The sandstones with shows can be placed on primary production, while the carbonates, dolomites, anhydrites, shales and igneous rocks with shows must be acidized and fractured to produce economic quantities of oil and gas.

Four wells drilled by BECI were evaluated and based on the well log response for these wells and possible productive reservoir rocks were identified. A total of 28 formation intervals or zones indicated possible hydrocarbon bearing zones. The formation thickness ranged from 6 feet to 150 feet for these

individual zones. This raises the expectation of commercial hydrocarbons as well as helium gas from the multiple reservoir rocks in these wells.

Introduction

Arizona is known for its huge potential for exploration and production of hydrocarbons and industrial gases. The significant geologic features in Arizona include the Grand Canyon, Kaibab Arch; Mogollon Highlands transition zone; Monument Uplift; Defiance Uplift; Black mesa Basin; Holbrook Basin, and Southern edges of the Kaiparowits and Blanding Basins (Figure.1).

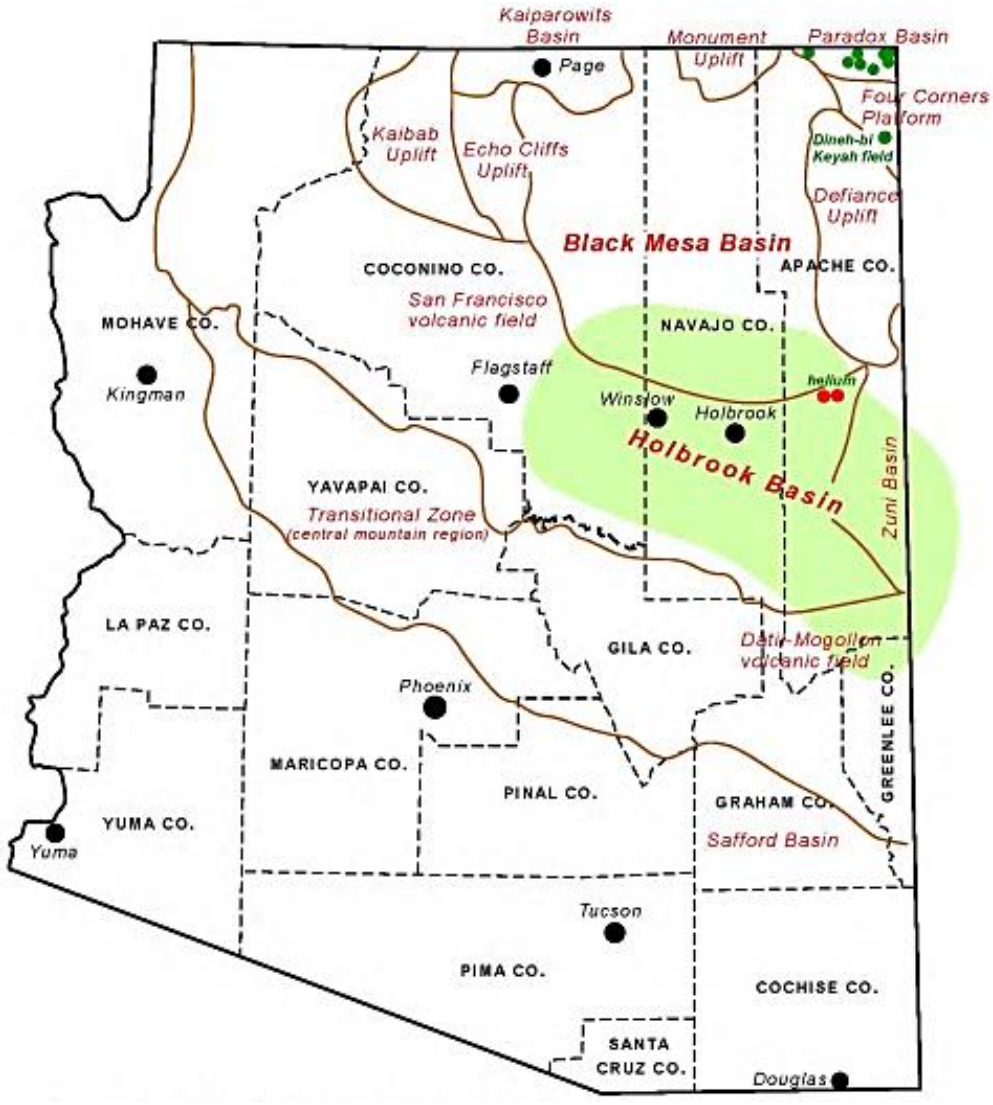

Figure 1: Location of the Holbrook Basin and adjoining Black Mesa Basin in northeastern in Arizona (Ryder, 1983).

The Holbrook Basin in east-central Arizona is one of the eight areas within Arizona considered to have the best potential for additional oil, natural gas and helium based on the fact that these areas contain

potential source and reservoir rocks, seeps or petroliferous rocks, or wells with shows of oil or gas. The others include the Cordilleran shelf in northwestern Arizona; Chuar Basin in north-central Arizona; Paradox Basin and Black Mesa Basin in northeastern Arizona; the Pedregosa and Bisbee Basins in south-eastern Arizona and the Yuma Basin (Salton Trough) in southwestern Arizona (Rauzi, 2001).

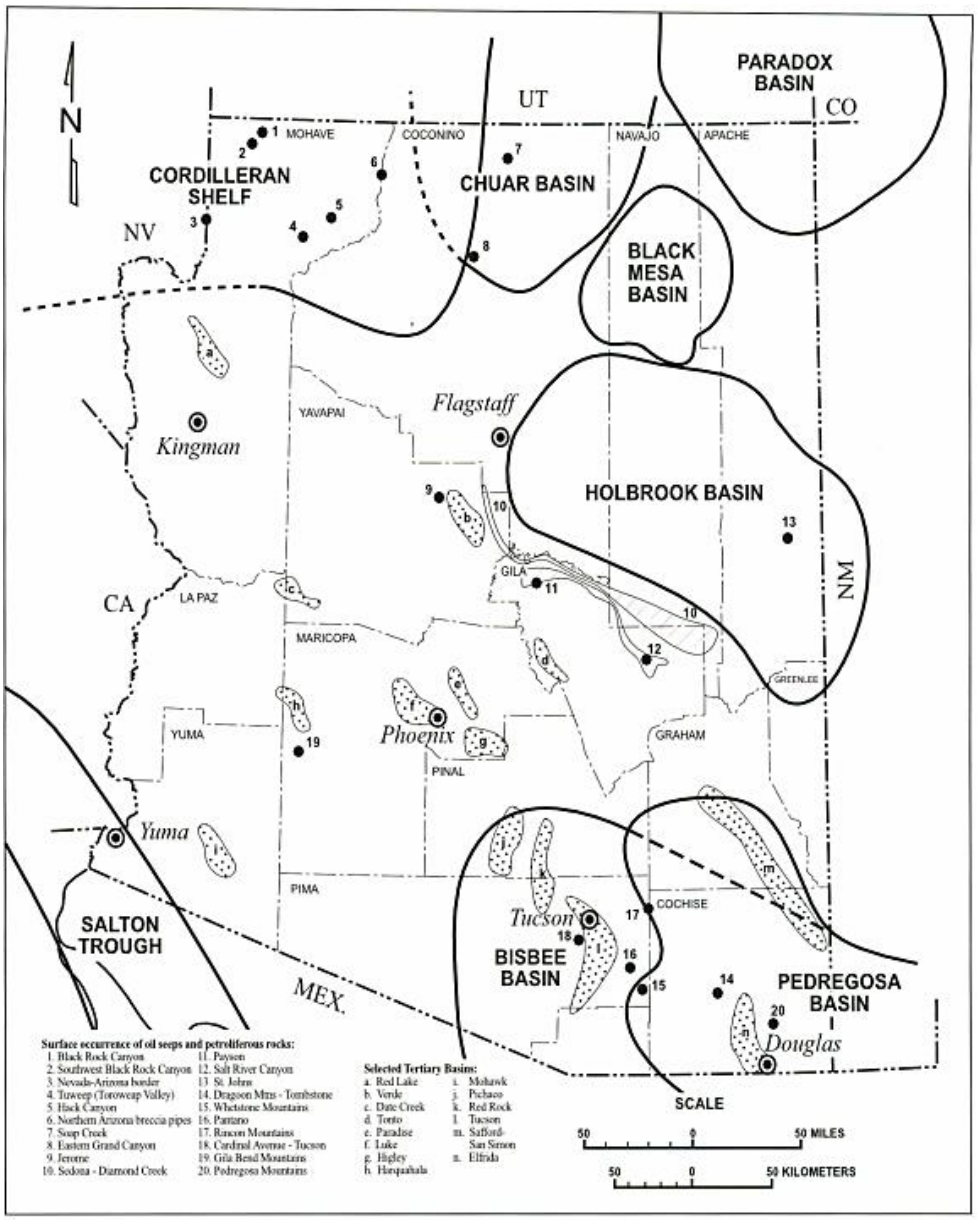

Figure 2: Areas with oil and gas potential and surface occurrence of oil seeps and petroliferous rocks in Arizona. Numbers refer to locations with surface occurrence of oil seeps and petroliferous rocks (Rauzi,2003).

These areas have been sparsely drilled, with drilling density in the Holbrook Basin particularly, being one well per 100 square miles. Most of the wellbores drilled in the northeastern and east- central Arizona were for other mineral resources such as potash and uranium. Most of the wells drilled were shallow vertical wells and deeper horizons with reported oil and gas shows went largely untested. This creates an opportunity for further exploration and production employing modern exploration, completion and production principles to uncover the best potential reservoirs and strategically unlock the production potential within these areas.

Blackstone Exploration Company Inc. (BECI) is a leading operator that has recognized the opportunity to drill and explore for oil and gas; as well as helium in the Holbrook basin in Navajo County, Arizona by employing modern exploration, drilling completion and production principles.

BECI has leased about 400,000 acres covering both the Coconino and Navajo counties. The company is a pioneering the resurgence in drilling activities in the Holbrook basin and Black Mesa basin, and is actively engaged in expanding its leasehold area in Arizona State.

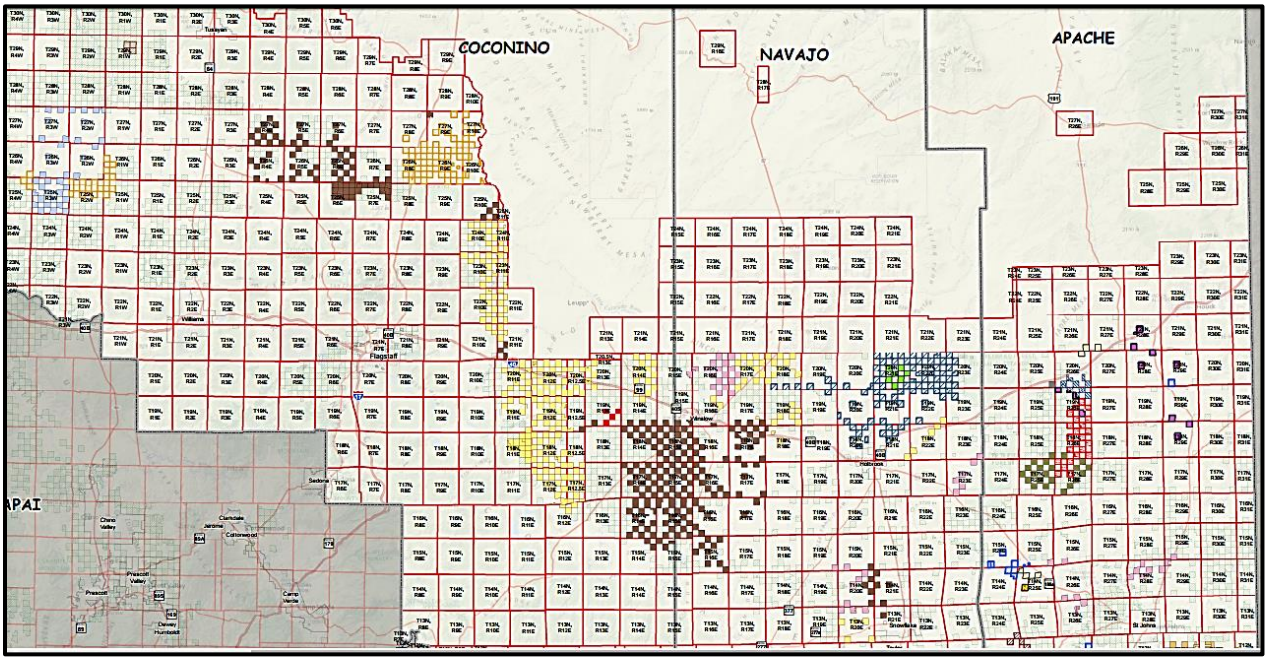

Figure 3: Blackstone Exploration Company Inc. Leasehold area (shaded dark brown) among other operators

Geology of the Area

BECI leasehold area in Coconino and Navajo counties, Arizona are in the central and western parts of the Holbrook basin and the adjoining southern part of the Black Mesa basin. Rauzi (2001) describes the Holbrook Basin as a structural and stratigraphic basin between the Defiance uplift to the northeast and the Mogollon Rim to the south. The basin is connected on the northwest to the Oraibi trough that extends northeastward through the Black mesa Basin area (Figure 4). The southern part of the Holbrook basin consists of north-northeast dipping Palezoic strata that form the Mogollon slope. There are more than 4,000 feet of Paleozoic rocks in the area. Also, some Triassic rocks, which have produced helium, are present in the central and northern parts of the basin. The Paleozoic strata include 500 feet of shelf and shallow marine deposits of Cambrian, Devonian, and Mississippian age that wedge out to the east (Rauzi, 1996a), 500 feet of largely marginal marine deposits of Pennsylvanian age that pinch out to the east, and sabkha and salt deposits of Permian age that form the Holbrook salt basin (Rauzi, 2000). The sabkha deposits consist principally of fine-grained red beds that are locally interbedded with limestone, dolomite, anhydrite, and salt. This sequence, which attains a maximum thickness of more than 3,000 feet in the subsurface near Holbrook, grades laterally into continental eolian deposits along the Sedona arch to the west and shallow marine deposits of the Central Arizona shelf to the south (Blakey and Knepp, 1989).

The sabkha and salt-pan deposits in the Holbrook Basin are similar in age and character to deposits in the Permian Basin of West Texas, which has had prolific hydrocarbon production. The Holbrook Basin, like the Paradox and Permian basins, contains extensive evaporite deposits, which are commonly associated with major hydrocarbon reserves and production in many parts of the world. Kirkland and Evans (1981) showed that this association is due to the high organic productivity of evaporite environments. Permian strata are also considered to have hydrocarbon potential south of the Holbrook Basin beneath the volcanic rocks of the White Mountains. In that area, sabkha and salt-pan deposits may fill additional salt basins and form stratigraphic and structural traps along the northern margin of the Central Arizona shelf (Rauzi, 1996b).

At least four regionally extensive carbonate beds of Permian age are present in the Holbrook Basin. The lowest of these, the Fort Apache Member, crops out in the steep escarpment all along the southern edge of the Holbrook Basin. Freshly broken pieces from outcrops of the Fort Apache are reported to have a strong petroliferous odor. The entire Fort Apache Member was cored in the Tonto Drilling #1 Alpine Federal hole south of Springerville in Sec. 23, Twp. 6 N., R. 30 E (Figure 4). There, it is a fossiliferous, vuggy-to-cavernous dolomite. Dead oil is present in the vugs and along fractures (Figure 5). The application of acid resulted in brown bubbles and a strong smell of crude oil. The author observed and reported free oil bleeding from vertical fractures in carbonate beds just above the Fort Apache Member in the Alpine well (Figure 5; Rauzi, 1994a; 1994b). The presence of bioherms in the Fort Apache Member in the eastern part of the Holbrook Basin is suggested by the fossils, vugs, and pin-point porosity in the Alpine well and good permeability and porosity (up to 30 percent) that were recorded in several wells southeast of St. Johns between 1994 and 1997 (Rauzi, 1999, p. 5).

In 1997, PetroSun Exploration and Production encountered a pocket of methane gas in Permian rocks that had sufficient pressure to blow the drill string out of the hole in its NMAL #15-1 between Concho and Holbrook (Sec. 15, T. 14 N., R. 25 E.). Gas shows were also reported in granite wash in that well. Strong gas shows were reported in Pennsylvanian and Mississippian strata in the Resource Operating #1 Federal north of Show Low (Sec. 29, T. 11 N., R. 22 E.) and the Sumatra Energy Company #1-17 Santa Fe near Concho (Sec. 17, T. 12 N., R. 26 E.). The Martin Formation (Devonian) has a strong petroleum odor on fresh breaks and commonly yields a faint milky-white cut fluorescence in 111-trichloroethane throughout its outcrop south of the Holbrook Basin between Payson and Salt River Canyon. A seep of high-gravity oil was reported northwest of Payson (Petzet, 1997, p. 85). Amstrat reported oil stains on a conventional core of Devonian carbonate in the Wichita Industries #1-11 Federal well in the western part of the basin near Mormon Lake (Sec. 11, T. 17 N., R. 9 E.). Amstrat noted that when carbonate rock in the Wichita well was dissolved in acid an oily scum covered the insoluble residue. Fair to heavy oil stain, good fluorescence, and trace cut were reported in Devonian strata west of Winslow in the Gus Berry #26-1 State (Sec. 26, T. 19 N., R. 13 E.). Shows in the Berry well are coincident with good drilling breaks. Two of the shows are also coincident with good crossover (gas effect) on the neutron-density curves. The Gus Berry well, drilled in late 1999 and currently shut-in, is within the trend of the Oraibi trough in the northwestern part of the Holbrook Basin.

The petroliferous outcrops of the Martin Formation and Fort Apache Member along the Mogollon Rim south of the basin, together with shows of oil and gas in wells, document the presence of hydrocarbon source rocks and migration of oil and natural gas in the Holbrook Basin. Shows of oil and gas in other wells in the sparsely drilled Holbrook Basin were tabulated and described by Bahr (1962), Peirce and Wilt (1970), Peirce and Scurlock (1972), and Petzet (1997).

Production of more than 700 million cubic feet of 99.9% pure helium from Permian and Triassic strata northwest of Holbrook in the Pinta Dome area (Figure 4) and the recent discovery of carbon dioxide in Permian strata between St. Johns and Springerville (Rauzi, 1999) demonstrate that subsurface conditions are favorable for the generation and entrapment of industrial gas in the Holbrook Basin. The gas that was produced from the Holbrook Basin between 1960 and 1976 contained 8 to 10% helium, which was mixed largely with nitrogen. This is the richest known concentration of helium gas in the world (Dean and Lauth, 1961; Spencer, 1983). Gas, in the carbon dioxide discovery well drilled near St. Johns in 1994, analyzed by the U.S. Bureau of Mines, contained 90 percent carbon dioxide and 0.52 to 0.81 percent helium.

Several stratigraphic wells drilled to delineate potash in the Holbrook Basin encountered pressure within the sabkha-salt deposits of Permian age that was sufficient to blow gas containing 2.4 to 4.09% helium out of the hole. The Kern County Land #1 State (See. 2, T. 18 N., R. 24 E.), most notable for encounter of helium, blew gas containing 0.22% methane, 4.09% helium, and 95% nitrogen for 26 hours before it was brought under control. Other wells that encountered helium include:

- New Mexico and Arizona Land Company (NMA) #3 Fee (See. 28, T. 17 N., R. 22 E.),
- Arkla Exploration #22 NMA (See. 23, T. 17 N., R. 23 E.),

- Arkla Exploration #37 NMA (See. 25, T. 16 N., R. 22 E.),
- Arkla Exploration #68 NMA (See. 19, T. 16 N., R. 23 E.),
- Arkla Exploration #7 State (See. 10, T. 15 N., R. 23 E.), and
- The Arkla Exploration #10 NMA (See. 27, T. 16 N., R. 23 E.).

The latter well blew gas that tested 2.4% helium at the Kerr-McGee lab at Navajo, Arizona. The helium-rich gas in these wells provides evidence of the migration of helium through this area and points to the potential for additional untapped reserves of helium in the Holbrook Basin. The potential for hydrocarbons and industrial gases in the Holbrook Basin is considered good to very good. Evidence for this potential includes past and current production of hydrocarbons north of the basin in the Four Corners area, past production and recent discovery of industrial gas within the basin, shows of oil and gas in wells drilled throughout the basin, a surface seep of high-gravity oil south of the basin near Payson, and outcrops of petroliferous rocks of Devonian and Permian age all along the Mogollon Rim at the southern edge of the basin. Geologic conditions in the Holbrook Basin are favorable for a variety of stratigraphic and structural traps including buried ridges and bioherms throughout the basin and in the Oraibi trough in the northwestern part of the area, zones of well-developed porosity and up-dip pinch outs all along the Mogollon slope, and bioherms, reefs, clastic buildups, and sand-lens development in proximity to buried topography throughout the basin and along the trend of buried shorelines to the east and west. Wells drilled in the southeastern part of the basin between Concho and Alpine, along the southwestern margin or shoreline of the late Paleozoic land mass, may encounter oil and gas trapped in bioherms, reefs, and clastic buildups associated with the buried shoreline. Strata in the Holbrook Basin are essentially flat lying and largely under-pressured.

Exploration opportunities have not been exhausted in the Mogollon slope region. Although much exploration effort has been expended in the vicinity of the Holbrook "anticline" there is reason to question the subsurface extent of the anticlinal aspect. Of much greater potential significance is the structural condition imposed by subsidence associated with the development of upper Supai evaporites. It is suggested that the Fort. Apache Member and all older Paleozoic strata are deflected downward on the order of 600-700 feet along a narrow zone parallel to but southwest of the Holbrook "anticline." The zone may have stratigraphic importance in that a Fort. Apache Member dolomitization and porosity trend may be associated with the edge of the saline basin. Numerous dark dolomitic zones are interbedded with the evaporites and may constitute some potential in zones of structure. Devonian strata are apparently preserved in northwest trending narrow troughs, one of which partly underlies the subsidence zone mentioned above. Helium occurs at the north end of the Defiance uplift in Devonian and Mississippian strata, but its principal occurrence is at the south end in the Permian Coconino sandstone. Helium is believed to have been derived from Precambrian granitic rocks of the Defiance positive mass. These data suggest that the entire west flank of the Defiance uplift is a likely helium exploration province, one that is untested. If the Pinta Navajo Springs helium has moved laterally from

beneath the Black Mesa basin, additional concentrations may occur to the north and northwest, providing trapping conditions, stratigraphic or structural, are present.

Arizona has oil, gas and helium potential that is largely untested. There are extensive regions of favorable country in the Plateau region within which to search for detailed prospects. Much of the potential is likely to be stratigraphic in nature such that random drilling on an isolated anticline may not prove to be a conclusive test. The overall geologic setting is sufficiently complex to require a careful examination of the significance and interrelationships between all forms of available geologic data (Pierce, et al; 1970).

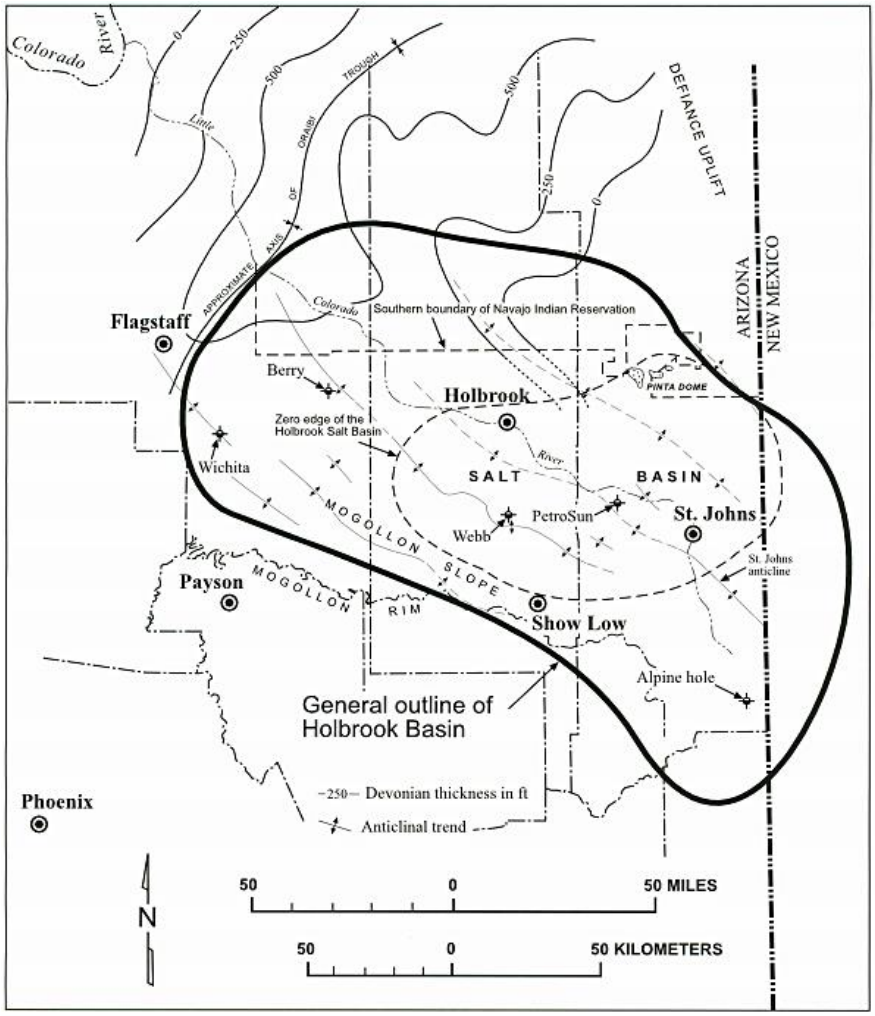

Figure 4: Holbrook Basin features (Rauzi, 2001).

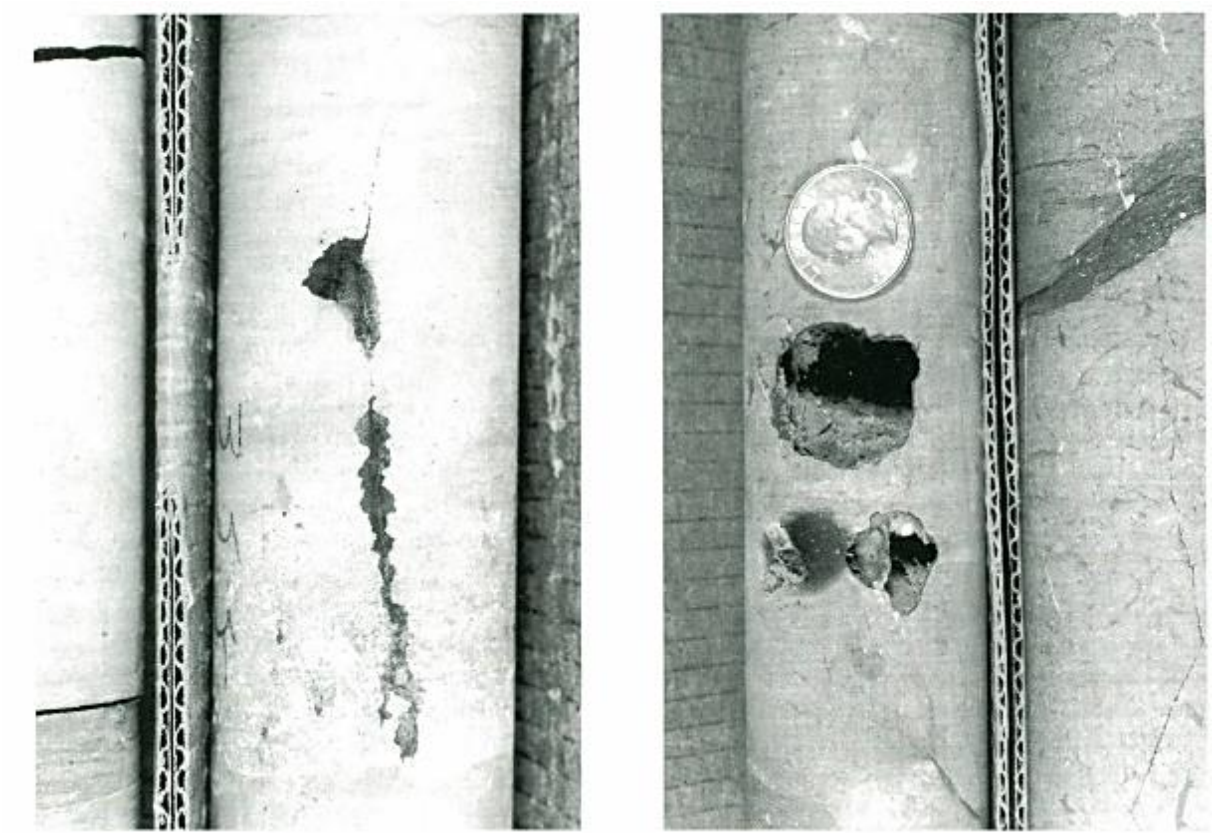

Figure 5: Core from the Fort Apache Limestone Member in the #1 Alpine Federal hole south of Springerville in southern Apache County. Note distinct fossil hash and oil bleeding from vertical fractures in the left photo and vugs and wispy dark laminae in the right photo. (Quarter for scale). The core is 2 inches in diameter. See Figure 4 for location of the Alpine hole.

Helium Source Rocks

Helium, although present in the immediate Four Corners area, is currently being produced commercially only in the southeastern corner of the Black Mesa basin southwest of the Defiance uplift just to the south of the Reservation boundary. This helium production is about 100 miles south of the nearest oil production established in 1967 at the Dineh-bi-Keyah field at the north end of the Defiance uplift, Apache County

Ultimately, helium is believed to be derived by radioactive disintegration of uranium and thorium bearing minerals, an origin quite dissimilar from that generally postulated for the organic compounds that combine to form oil and natural gas. The geologic habitat of helium varies from that of oil and natural gas in all of the factors that relate to contrasting sources. Whereas it is common to associate oil and gas with marine environments rich in organic matter, helium is commonly considered to be influenced by the proximity of a radioactively disintegrating source such as a basement granitic mass. Subsequent concentration by migration and accumulation might take place in any rock, regardless of initial origin. Sedimentary rocks of marine origin need not be an intervenor as regards source, but may provide reservoir space

The Supai Formation of Pennsylvanian-Permian age occurs over a large area in northern Arizona, but much of its extent is covered by younger formations. It consists essentially of red, flat-lying, interbedded clastic sediments (sandstone, siltstone, mudstone, and claystone) of deltaic or flood-plain origin, and limestone. The uranium occurrences have only been found along or close to the face of the Mogollon Rim and in the lower part of the formation approximately 800 feet below the Ft. Apache Limestone member. At both Fossil Creek and at Promontory Butte, which are some thirty miles apart, the mineralization appears to be closely associated with a twelve foot thick limestone pebble conglomerate, and with a gray shaly mudstone above, below or on both sides of the conglomerate. Fragments of coaly material, carbonized wood fragments and carbonaceous trash are scattered in the conglomerate and along some horizontal bedding planes in the mudstone. Uraninite, copper carbonates and copper, iron and other metallic sulfides have been identified in the mineralized zone at Promontory Butte but other uranium minerals have not been observed. The Cibecue occurrence is less well exposed but appears to have a similar geologic setting.

Another possible source yet to be evaluated is the recently prospected uranium occurrence in the Supai Formation along the Mogollon Rim. At present this can only be considered as a marginal possibility but one that deserves close examination.

Stratigraphic Section

The stratigraphy of the Holbrook and Black Mesa Basins is shown in Figure 6. Each major period of deposition during the Paleozoic Era, with the exception of the Permian System, shows a general thickening from east toward the west and northwest (Figure.7). Stratigraphic traps formed as pinch-out zones on anticlinal trends, and localized areas showing good permeability and porosity, are possible in various formations. Pinch-out or overlap type of stratigraphic traps are possible throughout most of the Black Mesa basin area. The best possibilities for this type of trap are expected along the west flank of the Defiance uplift and on the flanks of a buried granite ridge in the vicinity of Holbrook, Arizona. Paleozoic carbonate units provide the best oil and gas reservoirs in the Colorado Plateau province and transitional zone. Good reservoir rocks which are in proximity to possible source rock units include the dolomite of the Devonian Martin and Elbert Formations, Mississippian Red wall Limestone, Pennsylvanian shelf carbonate rocks, and Fort Apache Member of the Permian-Pennsylvanian Supai Formation (Brown and Lauth, 1957; Lessentine, 1965; Barwin and others, 1971).

Cambrian: The Cambrian sediments range in thickness from zero feet on the flanks of the Defiance uplift to about 2500 feet in the extreme northwestern corner of Arizona. These rocks transgress time lines and become progressively younger to the east. Small shows of oil have been reported in wells drilled in the northwestern part of the State while no shows have been reported near the center of the Black Mesa basin. Because of the thick section of dolomites, limestones, shales and sandstones present in the northwestern part of the State, the Cambrian rocks are considered an objective in that area.

Devonian: The Devonian section ranges in thickness from zero feet on the flanks of the Defiance uplift to about 1500 feet in the northwest corner of the state (Brown et al, 1958). The section overlays the Cambrian section unconformably. It consists of the Martin formation and its lithologic equivalents (the Temple Butte Formation or the Elbert formation). The section consists of medium to dark gray limestones and dolomites, green, red and gray shales and minor sandstone beds. In places the Martin Formation is underlain by a thin section of the Devonian Aneth Formation. Outcrops of limestone and dolomite along the Mogollon Rim from the Salt River Canyon south of Showlo w, to Chino valley north of Prescott, give a petroliferous odor on fresh fracture. Oil shows in the Devonian were recorded in wells drilled on the Boundary Butte anticline immediately north of the Arizona-Utah state line. Most of the wells drilled in the Black Mesa basin, many of which were drilled on the younger structural trends, recorded no shows of oil or gas in the Devonian. The Devonian rocks are considered a good objective horizon for oil and gas in northern Arizona where the proper structural and stratigraphic conditions exist.

Mississippian: The Mississippian age Redwall Limestone overlays the Devonian unconformably in this area. The Mississippian section ranges in thickness from zero feet along the flanks of the Defiance uplift to about 1600 feet in the northwest corner of the State. These rocks consist of white to buff, chalky to crystalline limestone with chert nodules; thin beds of gray to tan, crystalline dolomite, and gray to red-brown shale. Good to excellent porosity has been recorded almost everywhere in the Paradox basin and in many parts of the Black Mesa basin. Some low B. T. U. gas has been found in the Mississippian at East

Boundary Butte. Oil, helium and carbon dioxide gas has been found in this section in southeastern Utah and in northwestern New Mexico. Because of the good porosity and numerous oil and gas shows, the Mississippian formations are considered good objectives. However, the formation is locally absent due to pre-Pennsylvanian erosion.

Pennsylvanian: Pennsylvanian strata are, at the present time, apparently the most important sources of petroleum products in southern Utah and northern Arizona with approximately 95% of Arizona's production associated with Pennsylvanian strata, the remaining 5% coming from Devonian and Mississipian reservoir rocks. The Pennsylvanian-age Naco Formation overlies either the Devonian or Mississippian depending on the extent of later Devonian to early Mississippian and pre-Pennsylvanian erosion. The Hermosa formation, ranges in thickness from zero feet on the flanks of the Defiance uplift to about 1800 feet in the northeastern corner of the state. At the extreme northwestern part of Arizona, the Hermosa reaches a maximum thickness of about 1600 feet. The Hermosa formation is the only commercial oil and gas producing horizon in the state. The Hermosa formation consists of black shales; medium to dark gray, dense to crystalline limestones and dolomites; white to light gray anhydrite - and salt. The upper and lower Hermosa are predominantly gray, dense to crystalline limestones with minor dolomite, sandstone and shale beds. The upper Hermosa has had many good shows and is considered an objective. Many good shows have been recorded in wells drilled on the Holbrook Anticline along the southern edge of the Black Mesa basin. The Naco fomation from the south may interfinger with the Hermosa giving rise to possible facies-change type of reservoirs in that area. The Pennsylvanian formations are considered very good objectives for commercial oil and gas production.

Permian: The Permian rocks range in thickness from less than 250 feet on the Defiance uplift to more than 3500 feet in the Holbrook area. In the southern part of the Black Mesa basin, the Permian strata include in descending order: the Kaibab, Coconino and Supai formations.

The Kaibab is predominantly a buff, gray to bluish gray, cherty and fossiliferous, crystalline limestone. Minor sandstones and shale beds are present throughout the section. The Kaibab ranges from zero feet in the Holbrook area to about 800 feet in thickness in the Kaibab Plateau area in the northwestern part of the state. Since the Kaibab crops out or is near the surface throughout its depositional limits, it is considered a very limited objective for oil and gas. Oil is present in geodes found in a Kaibab outcrop on the east flank of the San Rafael swell in Utah.

The Coconino sandstone varies in thickness from about 80 feet to over 750 feet. It is a white to buff, highly crossbedded, fine to medium-grained sandstone. Core analyses of the Coconino sandstone show 19 to 21 percent porosity in its upper part. Sample studies indicate excellent porosity throughout its entire section. Minor dead oil stain was noted in wells near Holbrook. Helium was produced in the Coconino on the Pinta structure near Navajo, Arizona. Where the Coconino has proper cover, helium, low B. T. U. gas and limited oil reserves may be found, particularly in the Pinta dome area.

The Supai formation ranges in thickness from less than 1500 feet to approximately 3000 feet in the Holbrook area. It consists predominantly of alternating red sandstones and shales, abundant salt locally and minor limestone beds. The most prominent limestone horizon is the Fort Apache member. The Fort

Apache, which is nearly 200 feet thick at its type section near the Fort Apache Indian Agency south of Showlow, thins westward to zero feet at Sycamore Canyon southwest of Flagstaff. The northern limit is unknown due to lack of subsurface data. Many wells along the Holbrook Anticline recorded good shows in the Fort Apache horizon. The limestones and dolomites of the outcrop areas along the Mogollon Rim have a good petroliferous odor. Where the Fort Apache member attains a reasonable thickness, it is considered a good objective horizon for commercial oil and gas production. Helium gas shows have been reported about 1000 feet below the top of the Fort Apache member. A thick section of salt is present in the Supai formation. Exploration directed toward the Fort Apache member should be influenced in large part by its relationship to evaporites and the factors that control facies distribution.

Live Oil Shows in the 1 Alpine Federal

Stratigraphic traps in Paleozoic rocks may involve mafic dikes or sills. These would induce fracture porosity and permeability in Paleozoic carbonates during intrusion and may become reservoir rock themselves after cooling. Although igneous rock does not seem compatible with accumulation of hydrocarbons, more than 17 million barrels of oil have been produced from igneous rock at the Dineh-bi-Keyah Field in northeast Arizona (about 180 miles north of the Alpine hole). This igneous reservoir rock of Tertiary age intruded white to light tan carbonates and black shales of the Pennsylvanian Hermosa Formation and has yielded more oil than any reservoir rock in Arizona. Probable Pennsylvanian petroleum in a Tertiary volcanic reservoir rock raises many interesting questions and implications.

The 1 Alpine-Federal penetrated potentially important hydrocarbon source rocks in east-central Arizona and showed that Precambrian rocks are deeper than projected by the operator at this location. Live oil shows in Permian carbonate units in the Alpine hole (Figure 5) and regional studies suggest that petroleum potential exists in Permian and pre-Permian rocks yet to be explored in east-central Arizona and west-central New Mexico.

Hydrocarbon source rocks in the 1 Alpine-Federal include upper Supai Group, San Andres 14 Limestone, and possibly Cretaceous strata. Bleeding oil in the upper "Supai" in the Alpine hole indicates that these rocks are in the oil-generating window at this location suggesting that the extensive basaltic volcanism in east-central Arizona may have helped mature the Paleozoic units. San Andres Limestone contains organic-rich stylolites and dark gray to black shales and may be an effective hydrocarbon source (and reservoir) rock where matured (and fractured), perhaps, by volcanism. Cretaceous strata contain coaly laminations and grain-sized pieces of coal and may be a source for coalbed methane or natural gas.

The region, therefore, offers opportunities for hydrocarbon accumulations beneath the extensive surface cover of volcanic rock in east-central Arizona. Given that (1) live oil shows are present in close proximity to volcanic rock in the 1 Alpine-Federal, (2) volcanism may have enhanced the hydrocarbon maturity and potential of Paleozoic rocks, (3) favorable Paleozoic paleogeography exists near and along the southwest margin of the Defiance Positive, and (4) interbedded clastic, carbonate, and organic-rich

deposits are likely along this margin of Pennsylvanian and earlier onlap, the region deserves further evaluation for oil and gas (Rauzi, 2009).

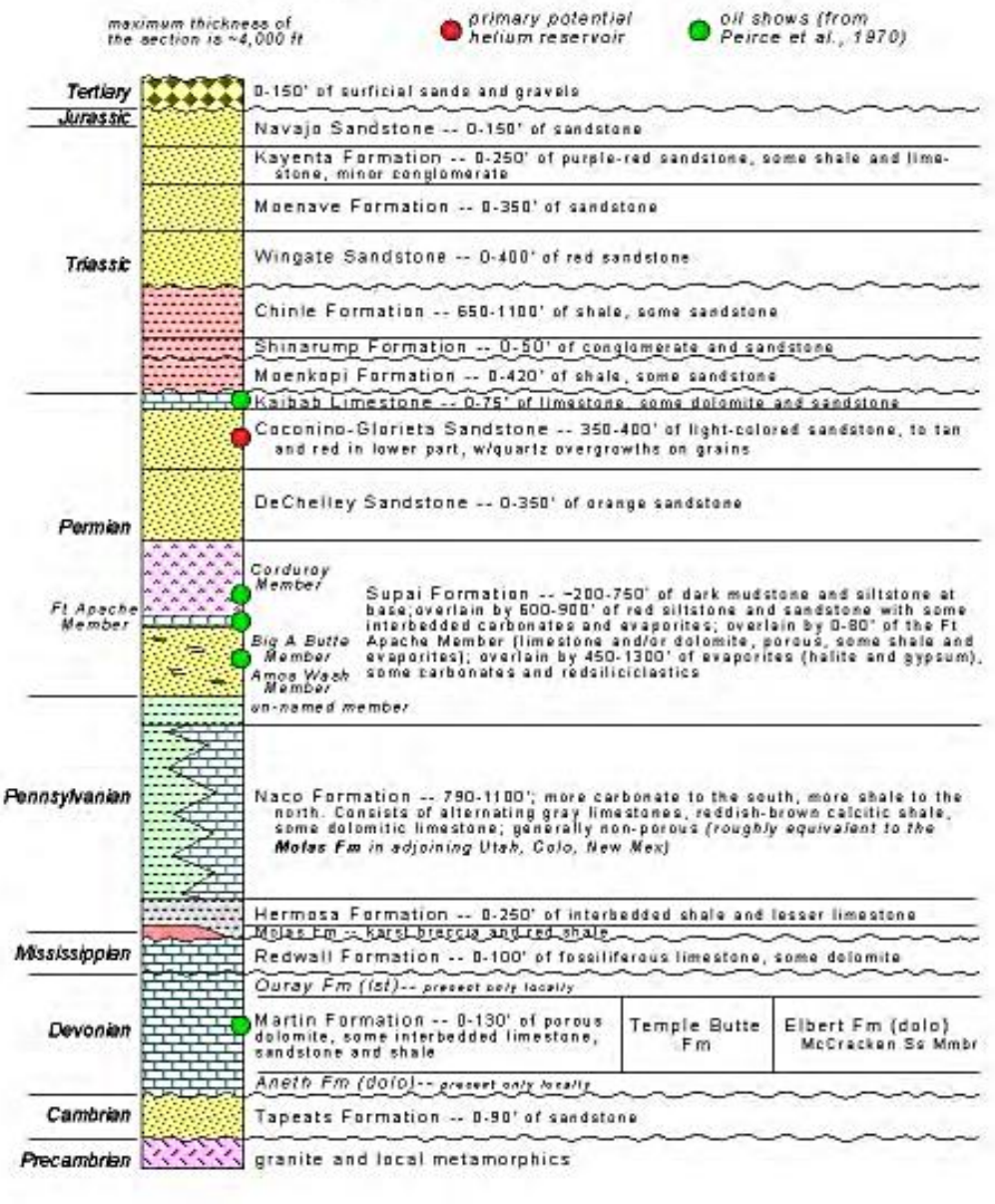

Figure 6: Stratigraphy of the Holbrook and Black Mesa Basins (Mazzullo, 2014).

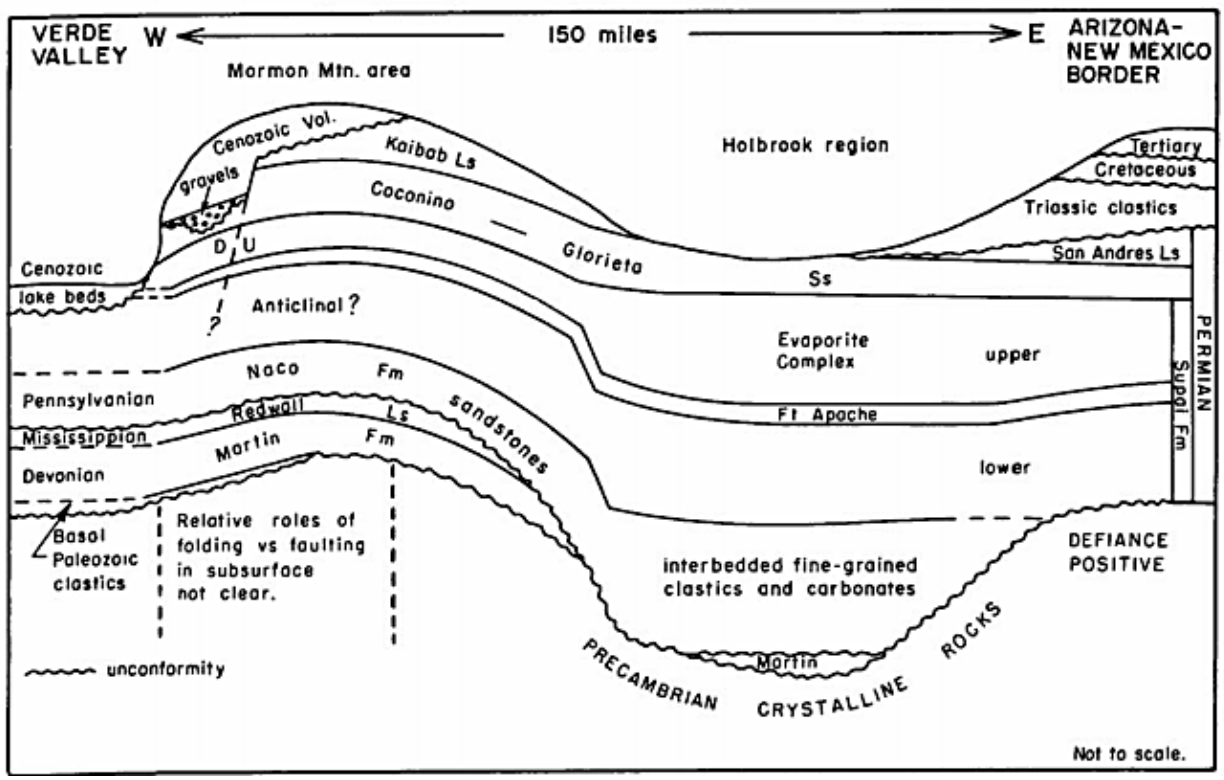

Figure 7: East – west geologic section across Mogollon slope region – Verde Valley through Holbrook basin to Arizona – New Mexico Border (Pierce, et al; 1970).

Diagrammatic representation of the general subsurface geology of the Mogollon slope region along a generally east-west direction is shown in Figure 7. Although not to scale, thickness aspects have been qualitatively indicated.

Helium Gas in Arizona

Some of the richest helium-bearing gas in the world was produced from fields completed specifically for helium in northeastern Arizona in the 1960s and 1970s. All production came from fields in Apache County (Figure 1). Three fields were located in the Holbrook Basin south of the Defiance uplift about 35 miles northeast of Holbrook. One field was located in the Four Corners area north of the Defiance uplift near the small community of Teec Nos Pos. Helium-rich gas was discovered in the Dineh-bi-Keyah oil field on the northeastern flank of the Defiance uplift in the late 1960s but was not produced until 2003. Helium concentrations range from trace amounts up to 10% in the Holbrook Basin and Four Corners area. Both areas have good potential for additional discovery and production of helium (Rauzi, 2003)

Most of the helium produced in the United States is extracted from natural gas from fields in Wyoming, Utah, Colorado, New Mexico, Kansas, Oklahoma, and Texas (Pacheco, 2003, p. 80). The extracted helium is processed into a crude helium product, which varies from 50% to 80% helium, and is ultimately purified to a Grade-A helium product, which is 99.995% or better.

Due to increasing demand for helium, Oil and gas operators are developing helium prospects near the old helium fields in the Holbrook Basin in central Apache County and are starting to produce the helium-rich gas at the Dineh-bi-Keyah field in northern Apache County as well as the Beautiful Mountain Field just across the state line in New Mexico.

Geology

Northeastern Arizona is part of the Colorado Plateau Physiographic province. The Colorado Plateau is characterized by flat-lying, relatively undisturbed, largely marine sedimentary rocks of Paleozoic and Mesozoic age that are covered by Tertiary to recent volcanic flows near Flagstaff and Springerville. Permian strata truncate Cambrian, Devonian, Mississippian, Pennsylvanian, and Proterozoic rocks along the margins of the Defiance uplift. Maximum submergence of the Defiance uplift may have occurred during the Mississippian but the Mississippian rocks were subsequently eroded back, probably by renewed, slow emergence of the uplift in Pennsylvanian through Permian time. As much as 2000 feet of Permian strata were eventually deposited on the Proterozoic basement rocks of the Defiance uplift. All past production of helium and current production of oil, natural gas and carbon dioxide (CO_2) are from rock formations of Paleozoic age in the Plateau province. The major tectonic features in northeastern Arizona include the Defiance and Kaibab uplifts in the northern part of the area (Figure 1). The Black Mesa Basin is situated between the Kaibab and Defiance uplifts. The Holbrook Basin lies between the Defiance uplift on the north and the Mogollon Slope on the south. A prominent escarpment known as the Mogollon Rim defines much of the southern edge of the Plateau province. Numerous diatremes (volcanic pipes that consist mainly of breccia) and dikes including Agathla Peak in northeastern Arizona and Ship Rock in northwestern New Mexico are present throughout the Four Corners region (Fitzsimmons, 1973). To the south, the Hopi Buttes volcanic field, which includes many necks and diatremes with related flows, covers an area of approximately 1500 square miles in the northern part of the Holbrook Basin (Figure 1). There appears to be a correlation between the diatremes and other deep-seated intrusive rocks and the presence and production of helium.

Helium Production in the Holbrook Basin

The Pinta Dome, Navajo Springs, and East Navajo Springs fields are relatively small anticlinal structures located in the Holbrook Basin in Townships 19 and 20 North, Ranges 26, 27, and 28 East (Figures 8). Wells in the Pinta Dome and Navajo Springs fields produced helium from the Permian Coconino Sandstone. Several wells in the East Navajo Springs field produced helium from the Shinarump Conglomerate at the base of the Triassic Chinle Formation. Figure 6 shows the generalized stratigraphy

in the PintaDome-Navajo Springs area. A composite well log of the Pinta Dome, Navajo Springs, and East Navajo Springs fields is shown in Figure 9.

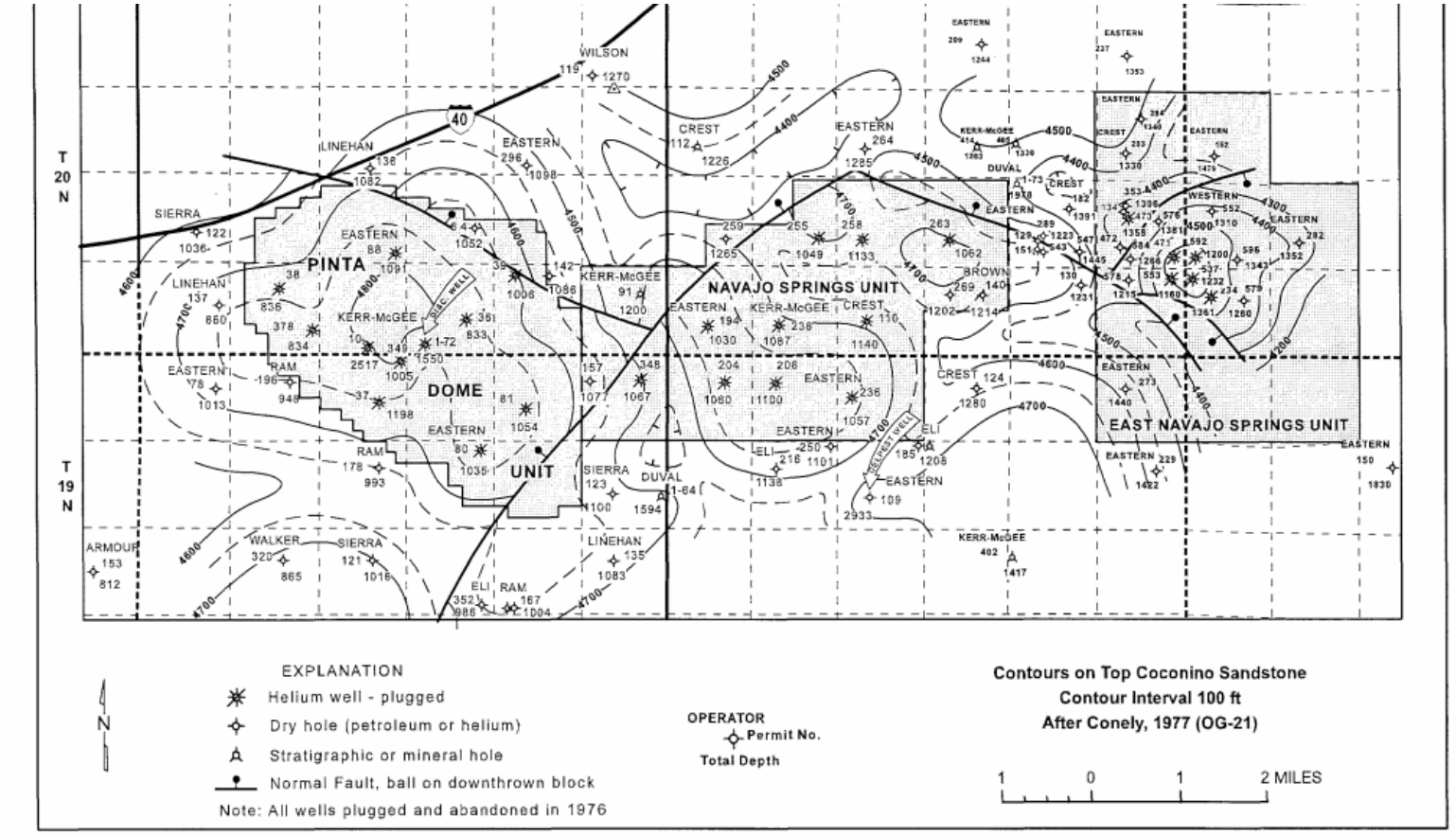

Figure 8: Structural contour map of the Pinta Dome, Navajo Springs and East Navajo Springs helium fields in the Holbrook Basin, Apache County, Arizona (Modified from Conely, 1974).

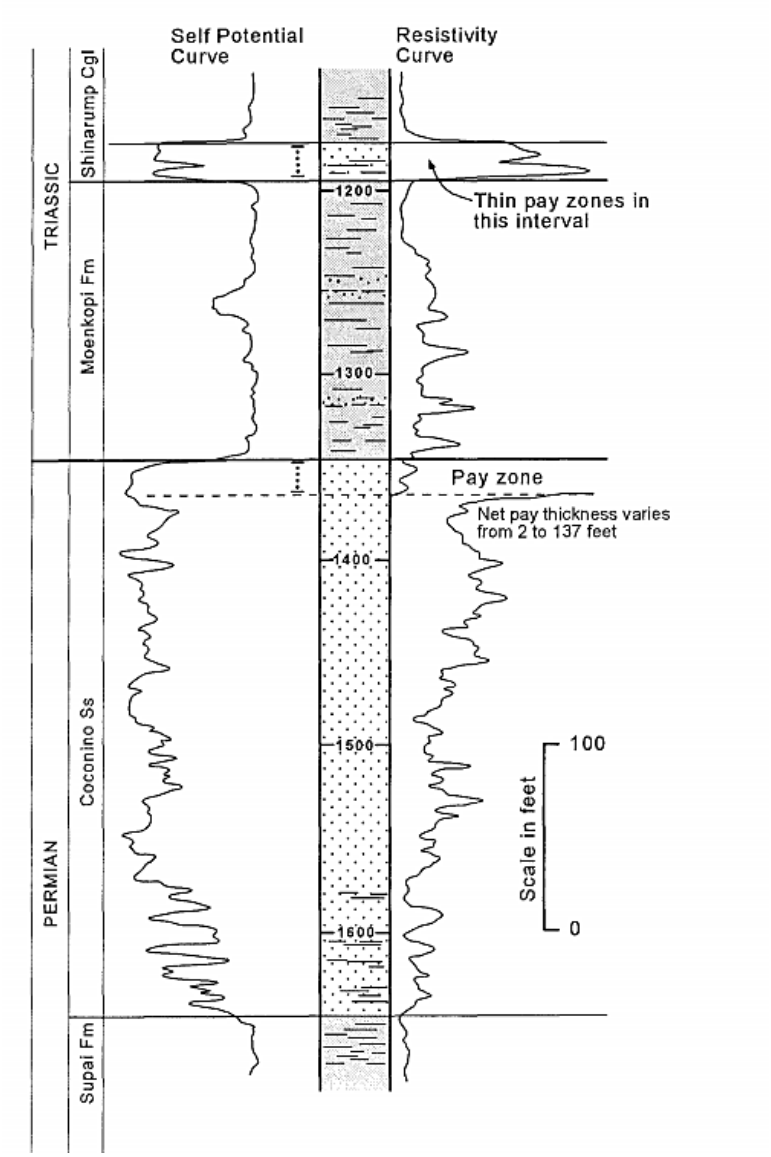

Figure 9: Composite log of Pinta Dome-Navajo Springs-East Navajo Springs pools, showing stratigraphic position of the two gas-productive reservoirs. The Coconino Sandstone produced in all three pools; the Shinarump Conglomerate was productive only in the East Navajo Springs pool. (Allen, 1978).

History of Helium Production in Arizona

Masters (1960) and Dean (1960) published the history of the exploration and development of the helium resources in the Navajo-Chambers area. The Navajo-Chambers region represented the only area in the history of the helium industry that had experienced sustained exploration and development for helium gas alone (Dean, 1960,). Kipling Petroleum Company discovered helium on Pinta Dome in 1950 when it drilled the #1 Macie in search of oil. No oil was found but the test initially encountered helium bearing, non-flammable gas in the lower Chinle conglomerate and a large flow of gas in the upper part of the Coconino Sandstone at a depth of 1032 to 1054 feet. The gas did not burn so it was allowed to flow unrestricted from the wellbore for about eight weeks (Dean, 1960; Dean and Lauth, 1961). Contemporaneous reports indicated that the gas escaping from the open well "roared like a jet engine" at an estimated initial rate of 24 million cubic feet per day (Heindl, 1952; Beaumont, 1959). The operator shut the well in after testing by the U.S. Bureau of Mines (USBM) showed that the gas was rich in helium (Masters, 1960).

In 1951, Kipling Petroleum Company drilled the #2 Macie, which was abandoned because of stuck pipe. In 1955, the Apache Oil and Helium Corporation took over development of the field, reworked the #2 Macie, which blew out, and drilled the #3 Macie, which it abandoned before penetrating the Coconino sand. In 1956, Kerr-McGee Oil Industries made an agreement with Apache Oil and Helium to complete the development of the field. Kerr-McGee completed the #2 and #3 Macie wells and drilled three more gas wells and two dry holes. In 1959, Eastern Petroleum Corporation drilled three gas wells and extended the area of helium production to the southeast. Kerr-McGee constructed a helium-extraction plant at Navajo and started processing helium from the Pinta Dome field in 1961, the Navajo Springs field in 1964, and the East Navajo Springs field in 1969. Some of the wells completed in the Navajo Springs and East Navajo Springs fields were not produced because of unitization. Kerr-McGee's helium plant was the first privately financed helium plant in the world producing Grade-A helium (Smith and Pylant, 1962). Average surface shut-in pressure at the Pinta Dome field was 99.3 pounds per square inch in 1961. The average pressure was down to 60.3 pounds per square inch in 1968. Production in the Pinta Dome area had declined to such an extent that the plant was closed in early 1976 and the fields were abandoned. Nearly 9 billion cubic feet of gas containing more than 700 million cubic feet of Grade-A helium were produced from the Pinta Dome and adjacent Navajo Springs and East Navajo Springs fields. Gas produced from the Coconino Sandstone averaged 90% nitrogen, 8-10% helium, and 1 % carbon dioxide.

Shows of Helium in Wells in the Holbrook Basin

The first recorded report of helium-bearing gas in Arizona was from the Great Basin Oil Company #1 Taylor-Fuller, a non-productive oil test drilled to a depth of 4675 feet a few miles southwest of Holbrook in 1927 (Beaumont, 1959). A test of the Cambrian Tapeats Sandstone at a depth of 3 500 feet was reported to have flowed 100,000 cubic feet of gas containing 1.12% helium a day (Turner, 1968).

Helium production is associated with carbon dioxide (CO_2) production that is currently carried out by Ridgeway Arizona Oil Corporation between St. Johns and Springerville in southern Apache County. All production is from the Supai Formation of Permian age. Ridgeway drilled the discovery well, the #1 Plateau Cattle, near St. Johns in 1994 and a follow-up well, the #3-1 State, 4 miles south of the #1 Plateau Cattle well in 1995. The only determination that Ridgeway was able to make at the well site was that the gas from the discovery well would not burn. Ridgeway sent samples of the nonflammable gas from the discovery well, and subsequently from the follow up well, to the USBM [The USBM was eliminated and its minerals information and analysis functions were transferred to the U.S. Geological Survey in January 1996] in Amarillo, Texas, for analysis. The USBM analysis indicated 90% CO_2, 6% nitrogen, and 0.5 to 0.8% helium in the #1 Plateau Cattle well and 89% CO_2, 10% nitrogen, 0.7% helium, and 0.1% each of methane and argon in the #3-1 State well. Ridgeway drilled six additional wells south of the #3-1 State well in 1997. In July 2002, Ridgeway started producing CO_2 from one of the wells, the #10-22 State, for a liquid plant located near the Tucson Electric Power Company's electric generating station. No helium is currently being produced for commercial use but Ridgeway plans to eventually extract helium from the CO_2 gas stream. Shows of oil and gas have been reported in numerous wells drilled in the Holbrook Basin (Bahr, 1962; Turner, 1968; Peirce and Wilt, 1970; and Conley and Giardina, 1979). Gas analyses report that helium is present in many of the wells. High concentrations of helium were reported in at least three oil tests and in several of the stratigraphic wells drilled to delineate potash deposits in the Holbrook Basin in the 1960s and 1970s. These are included in the following list.

- The James G. Brown & Associates #2 Chambers-Sanders in Sec. 27, T. 21 N., R. 28 E. Encountered a show of nonflammable gas in the Permian Coconino Sandstone at a depth of 542 feet. Analysis showed the gas contained 93.6% nitrogen, 1.2% argon, 2.3% helium, and 2.8% CO_2.
- The Kern County Land #1 State in Sec. 2, T. 18 N., R. 24 E. Gas blew out of the hole for 26 hours from the Permian Supai Formation at 965 feet. Analysis showed the gas contained 0.22% methane, 4.09% helium, and 95.10% nitrogen.
- The Great Basin Oil Company # 1 Taylor-Fuller in Sec. 16, T. 17 N., R. 20 E. A gas flow was reported from the Cambrian Tapeats Sandstone at a depth of 3500 feet. The gas was reported to contain 18.98% nitrogen, 79.5% CO_2, and 1.12% helium.
- The New Mexico and Arizona Land Company #3 Fee in Sec. 28, T. 17 N., R. 22 E. Gas blew out of the hole while coring at a depth of 1040 feet in the Supai Formation. The gas was reported to contain helium.
- The Arkla Exploration #22 NMA in Sec. 23, T. 17 N., R. 23 E. Air blew out of the hole while coring below a depth of 1367 feet in the Supai Formation. A strong blow was reported in a drill stem test of the interval 1342-1523 feet. No analysis of the gas is available.

- The Arkla Exploration #37 NMA in Sec. 25, T. 16 N., R. 22 E. Gas blew out of the hole from the Supai Formation at 821 feet in the straight hole and at 816 feet and 818 feet in the side track hole. A drill stem test of the interval 779-819 feet measured an initial and final flowing pressure of 175 pounds. Initial shut-in pressure was 240 pounds and final shut-in pressure was 175 pounds. No analysis of the gas is available.
- The Arkla Exploration #68 NMA in Sec. 19, T. 16 N., R. 23 E. Gas blew out of the hole from the Supai Formation at 896 feet and 970 feet. All drill fluid was lost both times.
- The Arkla Exploration #10 NMA in Sec. 27, T. 16 N., R. 23 E. Gas and fluid blew out of the hole from the Supai Formation at 940 feet, 959 feet, and 1007 feet. The gas tested 2.4% helium at the Kerr McGee lab at Navajo, Arizona.
- The Arkla Exploration #7 State in Sec. 10, T. 15 N., R. 23 E. Gas blew out of the hole out while drilling - no depth interval was given.
- The L.M. Lockhart #1 Aztec Land & Cattle Company in Sec. 33, T. 14 N., R. 20 E. Gas blew out of the hole for 18 minutes during a drill stem test of the Fort Apache limestone from 1678-1742 feet. Analysis of the gas indicated 23.8% methane, 3.2% ethane, 70.7% nitrogen, and 0.267% helium.

No gas analyses are available for some of the wells. However, the nonflammable gas reported in these wells may have contained helium, especially in light of the high helium concentrations reported in the wells with a gas analysis. The location of the wells in the Holbrook Basin with reported shows of helium or nonflammable gas is shown in Figure 10.

Helium Production in the Four Corners Area

The Texaco #1 Navajo-Z produced helium from the Mississippian Leadville Limestone in the late 1960s. The #1 Navajo-Z is located in sec. 36, T. 41 N., R. 30 E. in the Tohache Wash area near Teec Nos Pos in northern Apache County (Figures 10 and 11). A composite gamma ray-neutron and graphic lithologic log of the #1 Navajo-Z well is shown in Figure 13. The Leadville is equivalent to the Redwall Limestone in Grand Canyon. Texaco originally completed the well as an oil producer in the Devonian Aneth Formation. Texaco plugged the Devonian interval in 1961 after less than a year of poor production and recompleted the well as a helium producer in the overlying Mississippian Leadville Limestone (Figure 14). Gas in the Mississippian reportedly contained approximately 6% helium mixed mostly with nitrogen, methane, and CO_2. Texaco abandoned the Tohache Wash field in 1969 after producing more than 385 million cubic feet of helium-rich gas from the Mississippian. Kerr-McGee discovered oil in an igneous sill of Tertiary age at the Dineh bi Keyah field in 1967 (Figures 1 and 12). Gas associated with the oil in the igneous sill, which intruded strata of Pennsylvanian age, averaged 4.2% helium. Gas in the underlying Devonian McCracken Sandstone ranged from 4.8% to 5.6%. Kerr-McGee completed two gas wells, the #2 Navajo-B and the #2 Navajo-C, in the deeper Devonian strata but shut-in both wells in 1967 for lack of a market and pipeline. A composite gamma ray-sonic and graphic lithologic log of the #2 Navajo-C well is shown in Figure 15.

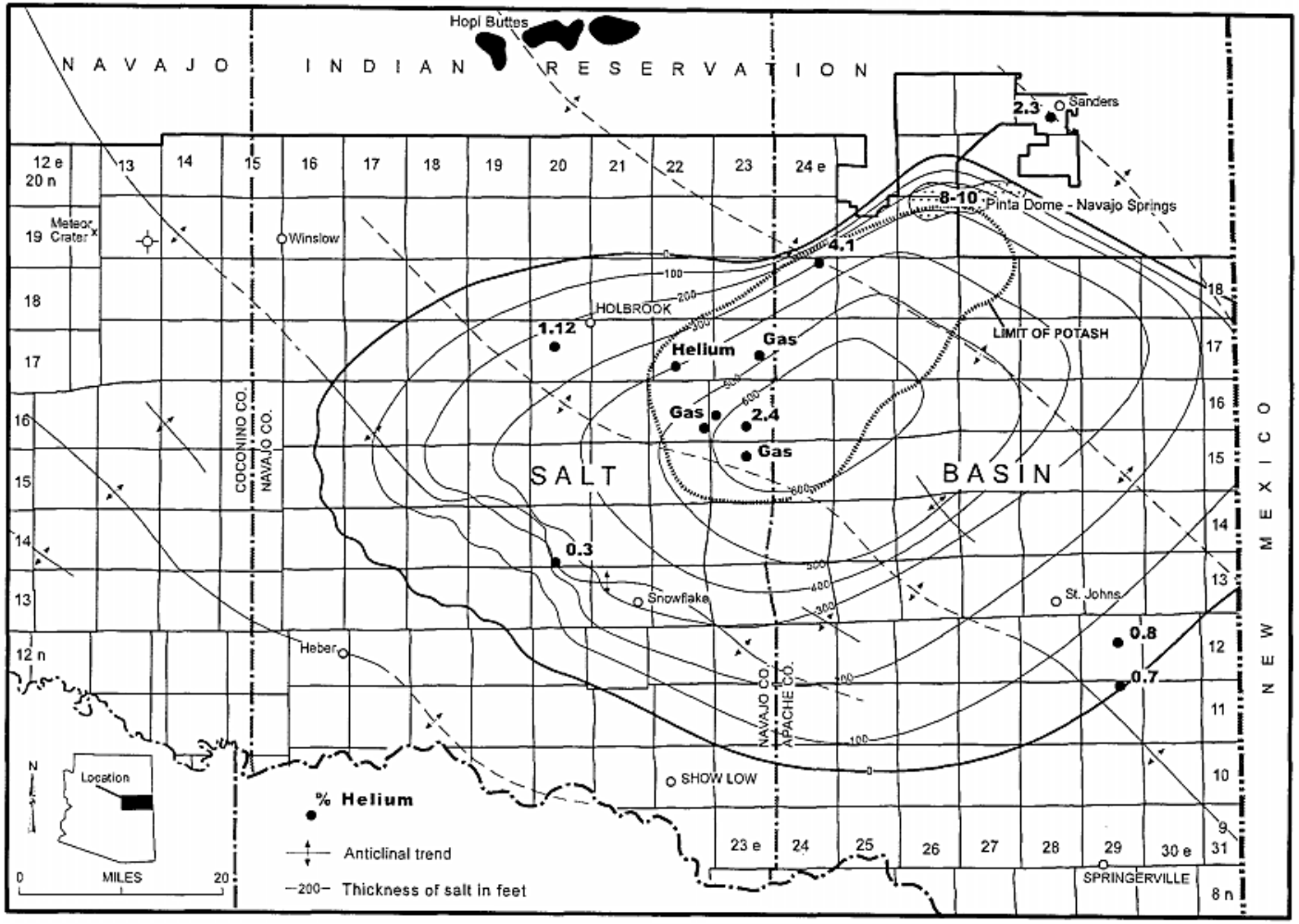

Figure 10: Map showing extent of Holbrook salt basin, aggregate thickness of Permian salt, regional structural trends, and helium content of selected wells in the Holbrook Basin (Rauzi, 2000).

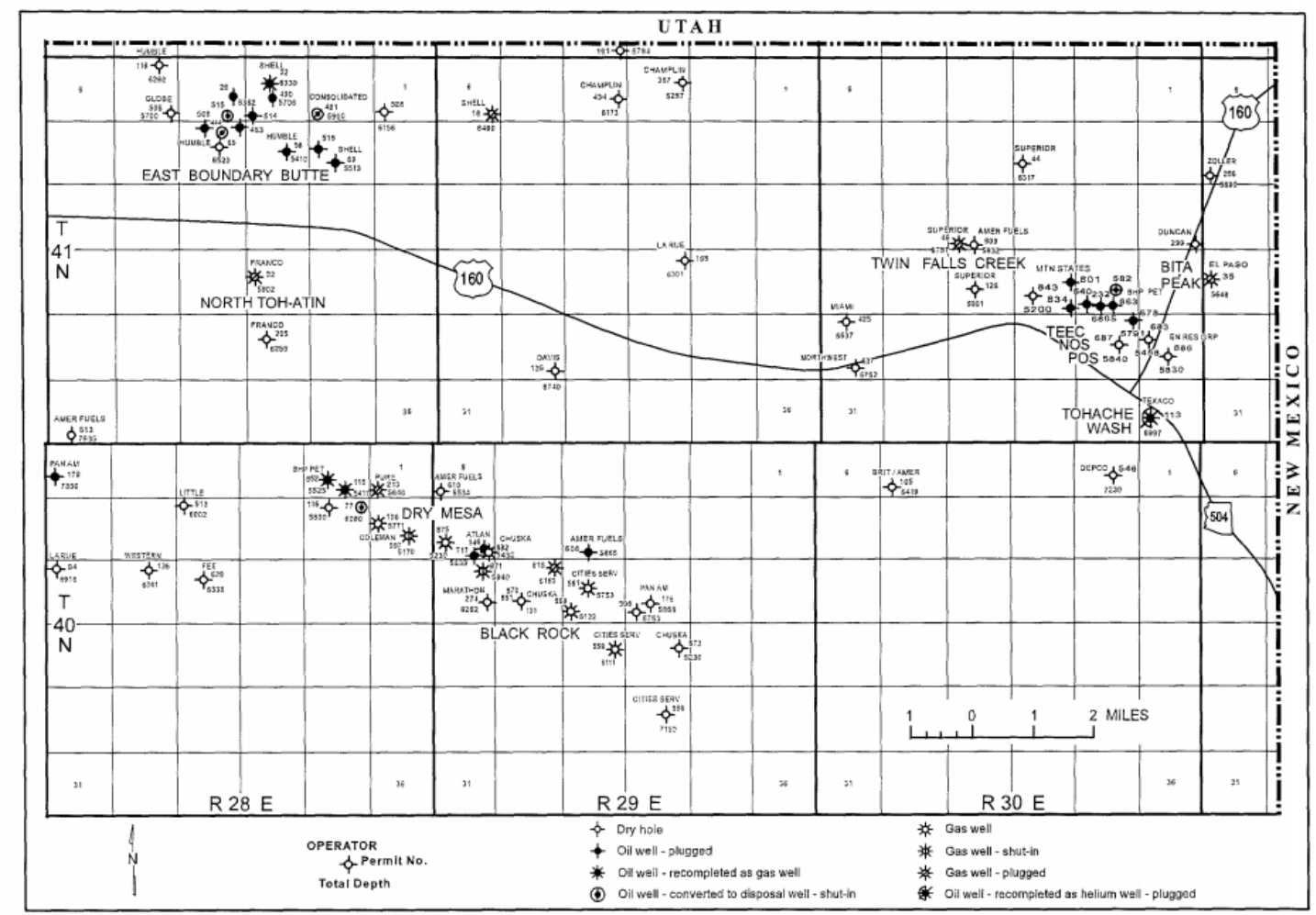

Figure 11: Oil, natural gas, and helium development map, Four Corners area, Arizona (Rauzi, 2003).

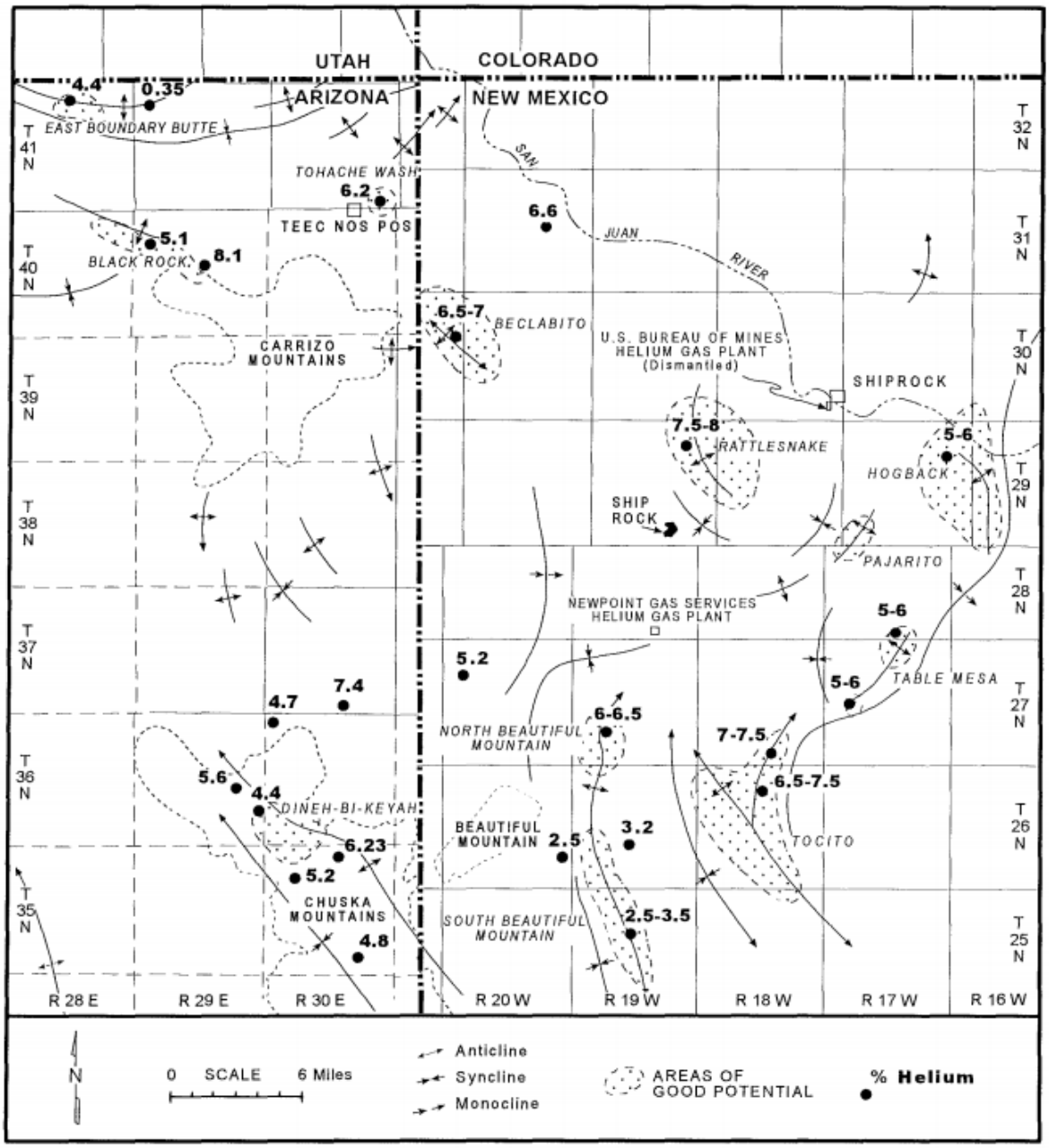

Figure 12: Map showing areas with helium potential and helium content of wells in the Four Corners area of Arizona and New Mexico (Modified after Casey, 1983).

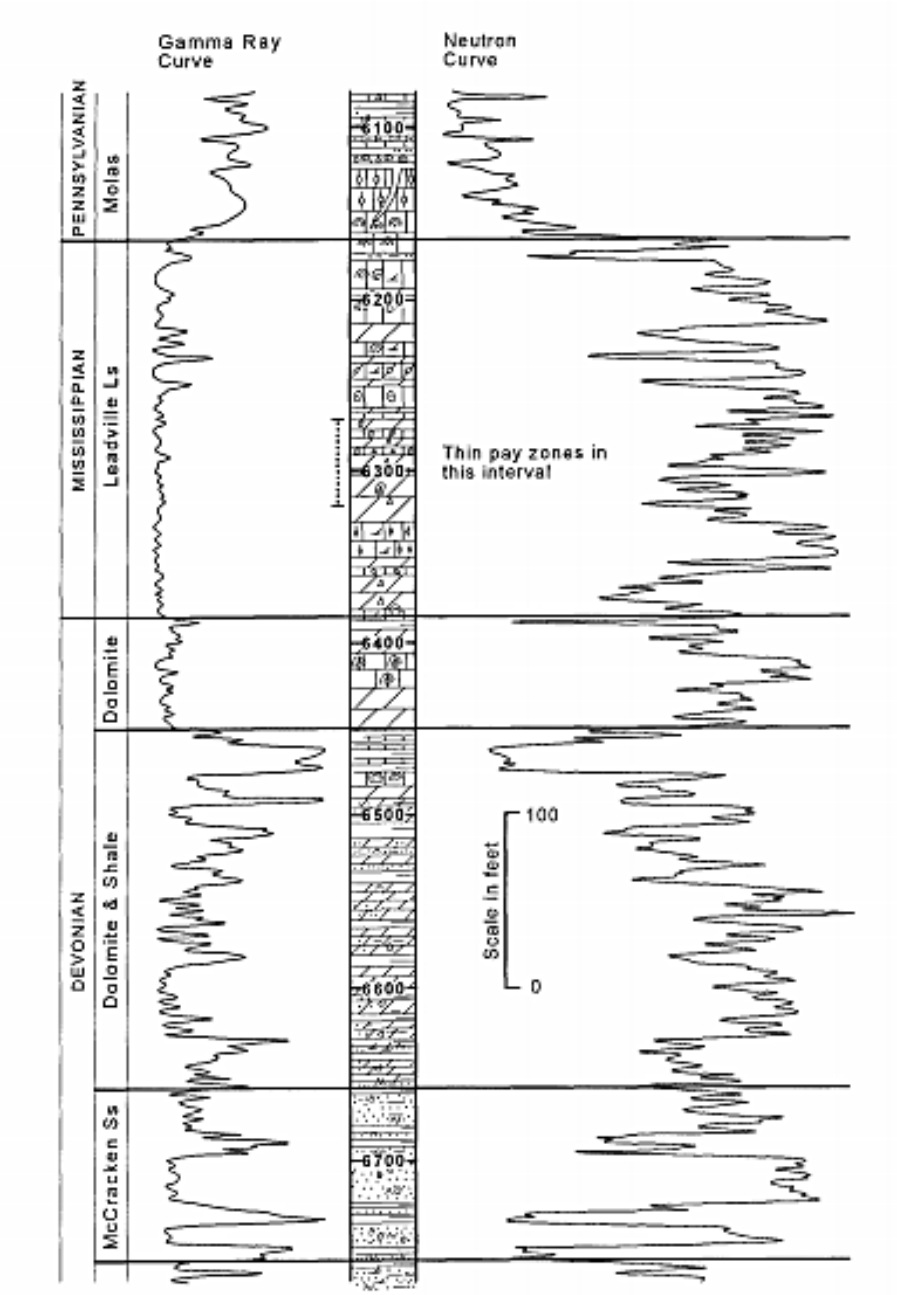

Figure 13: Log of the Texaco Inc. #1 Navajo-Z well showing the stratigraphic position of the helium-bearing reservoir in the Tohache Wash Field. Gas in the Mississippian was 6.03% helium. Cumulative production was 385,774 Mer. Lithology from Amstrat. See Figure 11 for location of well.

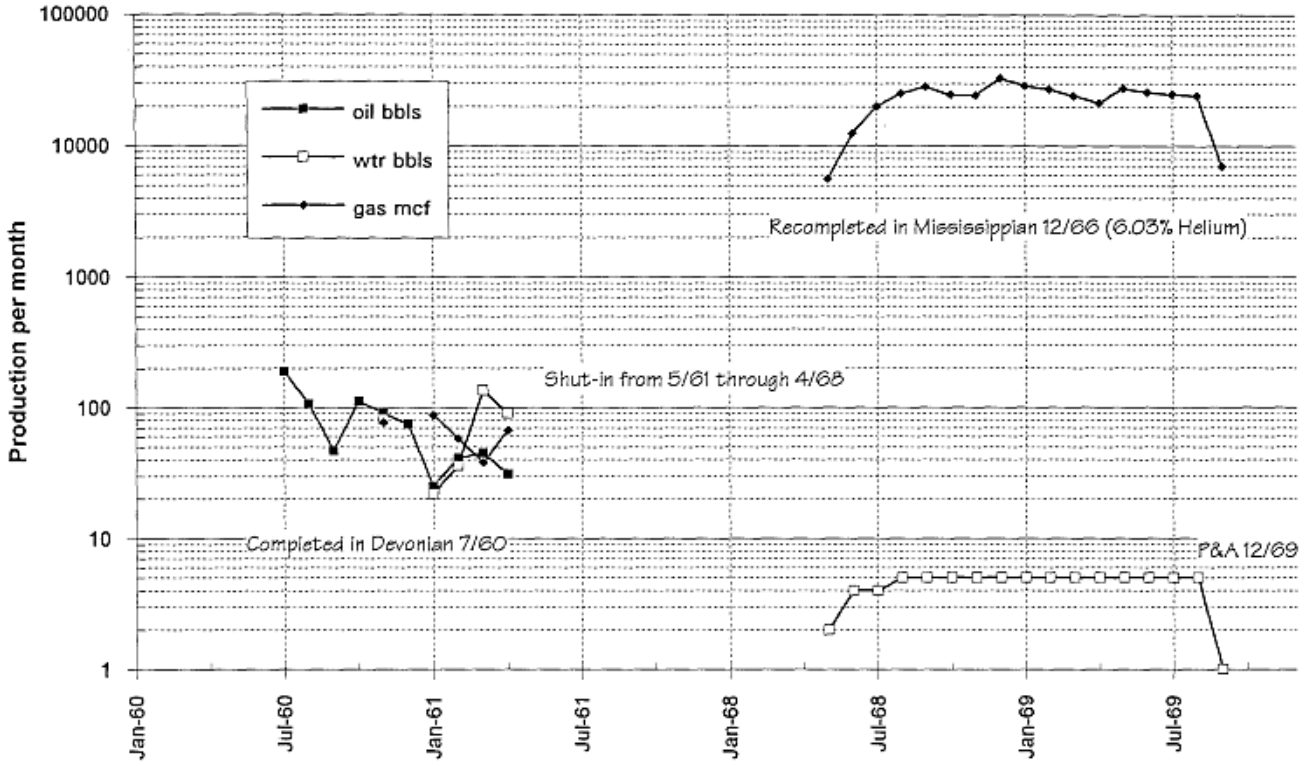

Figure 14: Monthly production at the Texaco 1 Navajo-Z (Permit 113) in the Tohache Wash field.

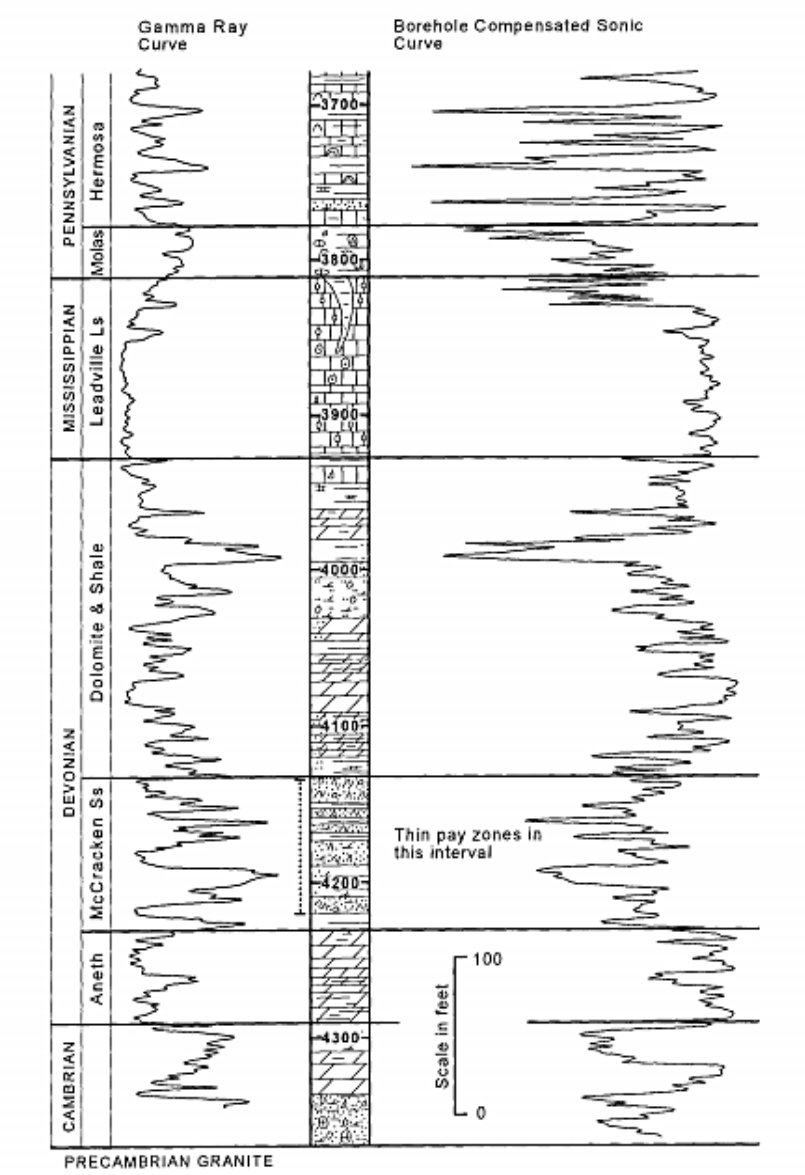

Figure 15: Log of the Kerr-McGee #2 Navajo-C well showing the stratigraphic position of the helium-bearing reservoir in the Dineh bi Keyah Field. Gas in the Devonian ranges from 3.11% to 6.23% helium and averages 4.83% helium. Lithology from Amstrat.

Shows of helium in wells in the Four Corners area

Peirce and Wilt (1970) tabulated wells with shows of oil, gas, and helium in the Four Corners area of Arizona. Casey (1983) described wells that encountered helium in the Four Corners area of New Mexico and Arizona. Turner (1968, Table II) listed several wells in the East Boundary Butte field with high concentrations of helium. The highest concentrations were in the Mississippian Leadville limestone but helium in the Pennsylvanian strata ranged from 0.34% to 1.10%. Helium rich gas is commonly found in strata of Devonian and Mississippian age but is also found in strata of Pennsylvanian, Permian, and Triassic age. Wells that encountered helium-rich gas in the Four Corners area of Arizona are listed below. Location of wells is shown in Figures 11 and 12.

- The Shell #2 Navajo in Sec. 3, T. 41 N., R. 28 E. Shut-in gas well at the East Boundary Butte field. Gas from different intervals in the Pennsylvanian was reported to range from 0.34% to 1.10% helium. Well has been shut-in since October 1998.
- The Humble #1 Navajo in Sec. 4, T. 41 N., R. 28 E. Shut-in gas well at the East Boundary Butte field. Gas in the Pennsylvanian was reported to contain 1.0% helium. Gas in the Mississippian tested at 4.4% helium. Well has been shut-in since December 1998.
- The Shell #1 Navajo in Sec. 6, T. 41 N., R. 29 E. Gas in the Pennsylvanian was reported to contain 0.35% helium.
- The Atlantic Refining #7-1 Navajo in Sec. 7, T. 40 N., R. 29 E. Gas in the Mississippian tested at 5.1 % helium.
- The Kenai Oil & Gas #34-7 Navajo in Sec. 7, T. 40 N., R. 29 E. Gas in the Mississippian tested at 4.92% helium.
- The Pan American Petroleum # 1 Moko-Navajo in Sec. 15, T. 40 N., R. 29 E. Gas in the Pennsylvanian tested at 0.73% helium. Gas in the Mississippian tested at 8.07% helium.
- The Universal Resources #1-15 Navajo in Sec. 15, T. 40 N., R. 29 E. Gas in the Pennsylvanian ranged from 0.51 % to 0.53% helium. Gas in the Mississippian ranged from 0.24% to 0.28% helium.
- The Socony Mobil Oil #1 Navajo-155 in Sec. 28, T. 39 N., R. 25 E. Gas in the Pennsylvanian contained 15 units of helium by chromatograph.
- The Gulf#1 Navajo-CS in Sec. 34, T 37 N., R. 30 E. Gas in the Pennsylvanian contained 7.4% helium.
- The Humble Oil & Refining #1 Navajo-87 in Sec. 23, T. 36 N., R. 29 E. Gas in the Devonian tested at 5.6% helium.
- The Humble Oil & Refining #1 Navajo-88 in Sec. 25, T. 36 N., R. 29 E. Gas in the Devonian ranged from 4% to 4.4% helium.
- The Humble Oil & Refining #2 Navajo-88 in Sec. 25, T. 36 N., R. 29 E. Gas in the igneous sill of Tertiary age ranged from 3.5% to 5.2% helium.
- The Union Texas Petroleum #1-6 Navajo in Sec. 6, T. 36 N., R. 30 E. Gas in the Pennsylvanian tested at 4.7% helium.
- The Anadarko #1 Navajo-135 in Sec. 3, T. 35 N., R. 30 E. Gas in the Devonian tested at 6.23% helium.

- The Humble Oil & Refining #1 Navajo-140 in Sec. 8, T. 35 N., R. 30 E. Gas in the Devonian averaged 5.2% helium.
- The Humble Oil & Refining #151-1 Navajo in Sec. 35, T. 35 N., R. 30 E. Gas in the Devonian ranged from 3.1 to 4.8% helium.

Origin of helium

Two sources of terrestrial helium are described by Spencer (1983):

(1) Primordial helium derived from sources deep within the earth, and

(2) Radioactive decay of uranium and thorium that is concentrated in the earth's crust.

The helium 3 isotope signifies primordial helium whereas the helium 4 isotope signifies helium from radioactive decay. Low ratios of helium 3 to helium 4 indicate that helium in most natural gas fields was primarily derived from radioactive decay. Two possible sources for the helium in Arizona are the Precambrian crystalline rocks beneath the helium reservoir rocks (primordial helium) or sediments containing significant amounts of radioactive material overlying the helium reservoir rocks (radioactive decay). The current lack of information about the isotopic ratios prevents a definitive conclusion as to the source of helium encountered as shows or produced in Arizona. In either case, stratigraphic thinning, fracturing, faulting, or volcanic activity would be a necessary component in bringing the potential helium-source rocks into contact with the reservoir rocks.

Helium Producing Wells in Arizona

Permit	TWP	RGE	SE	OPERATOR	LEASE NAME	FLD	CUMGAS_Mcf
194	20N	27E	31	Eastern Petroleum	13 Santa Fe	NS	1,783,968
1-72	20N	26E	34	Kerr-McGee	01 Macie-State	PD	1,779,460
36	20N	26E	34	Kerr-McGee	02 State	PD	1,442,149
81	19N	26E	02	Kerr-McGee (Eastern)	1-02 State	PD	1,100,253
88	20N	26E	28	Kerr-McGee (Eastern)	1-28 State	PD	804,961
10	20N	26E	33	Kerr-McGee	01 Fee	PD	531,292
39	20N	26E	35	Kerr-McGee	02 Fee	PD	513,646
113	41N	30E	36	Texaco	1 Navajo-Z	PD	385,774
238	20N	27E	32	Eastern (KerrMcGee)	1 Barefoot State	NS	276,907
349	19N	26E	04	Kerr-McGee	03A State	PD	266,127
236	19N	27E	04	Eastern Petroleum	17 Santa Fe	NS	86,878
038	20N	26E	32	Kerr-McGee	04 State	PD	48,233
206	19N	27E	05	Eastern Petroleum	14 Santa Fe	NS	47,141
080	19N	26E	10	Eastern Petroleum	01-10 State	PD	43,387
471	20N	27E	25	Crest-Ariz Helium	01 Santa Fe	ENS	42,073
263	20N	27E	27	Eastern Petroleum	35 Santa Fe	NS	25,388
553	20N	27E	36	W. Heli. Connelly	1 KM State	ENS	23,337
234	20N	28E	31	Apache Drlg, E. Pet.	21 Ancon-SntaFe	ENS	22,007
537	20N	28E	31	Eastern Petroleum	21-1A Santa Fe	ENS	8,299
037	19N	26E	04	Kerr-McGee	03 State	PD	6,186
592	20N	28E	30	Eastern Petroleum	01 Merde-Indian	ENS	991
378	20N	26E	32	Kerr-McGee	04A State	PD	282
TOTALS:		CUMGAS IN MCF:					9,238,739

Note: FLD=Fields; PD=Pinta Dome; NS=Navajo Springs; ENS=East Navajo Springs

Table1: Cumulative Production of Wells in the Pinta Dome, Navajo Springs and East Navajo Springs Fields

Field Study

The wells drilled in surrounding fields to the BECI leasehold area in Apache and Navajo counties will be investigated. Primarily this study will examine the pertinent well historical data, including drilling and completion techniques employed to determine the reservoir characteristics and also production drivers that affect the well performance for these wells. The two prominent fields in Arizona, the Pinta Dome field – for helium gas production; and the Dineh-bi-Keyah – for oil and natural gas; will be investigated, as well as wells in adjacent to those being currently drilled by BECI.

Pinta Dome Field

The Pinta Dome field in Apache County, Arizona is a known Helium producing field with 6.5 Bcf of Helium gas produced from 1961 to 1976. The amount of Helium produced in this field represents about 71% of total Helium production in Arizona State. This field therefore represents a good reference for Helium exploration in Arizona State.

Helium production in the Pinta Dome area is primarily from the Coconino Sandstone and Permian formations. The Coconino sandstone is a fractured eolian and fluvial sandstone with a gross thickness of 70 feet and is continuous within fault blocks in the area. Porosity of the Coconino sands is reported to be 14%; average permeability is approximately 110 millidarcies; with water saturation of 29%. These outstanding reservoir characteristics of the Coconino sandstone, combined with an average net pay of 61 feet and an average helium concentration of 8%, resulted in one of the most prolific helium production gas fields in the world. There have been eleven wells reported to produce Helium gas in the Pinta Dome field. The well permit numbers and names are:

- 1-72 Kerr-McGee 1 State
- 36 Apache Oil & Helium 3 Macie State
- 81 Eastern 1-2 State
- 88 Eastern 1-28 State
- 39 Kerr-McGee 2 Fee
- 10 Colgrove 2 Macie-Hortenstine
- 349 Kerr-McGee 3A State

- 80 Eastern 1-10 State
- 38 Kerr- McGee 4 State
- 37 Kerr-McGee 3 State
- 378 Kerr-McGee 4A State

Based on reported individual yearly production for each well, the daily production rates were determined and average production rates were calculated. The average production rate for each well is as follows:

- 1-72 Kerr-McGee 1 State 304.7 Mcf/D
- 36 Apache Oil & Helium 3 Macie State 246.8 Mcf/D
- 81 Eastern 1-2 State 201.0 Mcf/D
- 88 Eastern 1-28 State 200.4 Mcf/D
- 39 Kerr-McGee 2 Fee 192.8 Mcf/D
- 10 Colgrove 2 Macie-Hortenstine 90.8 Mcf/D
- 349 Kerr-McGee 3A State 72.9 Mcf/D
- 80 Eastern 1-10 State 19.8 Mcf/D
- 38 Kerr- McGee 4 State 18.8 Mcf/D
- 37 Kerr-McGee 3 State 2.8 Mcf/D
- 378 Kerr-McGee 4A State 0.7 Mcf/D

This field averaged about 1,400 Mcf/d from 1961 to 1976.

Kerr-McGee 2 State - Permit 036

The Kerr-McGee State #2 well is located in Sec. 34, Twp 20N, Range 26E NW SE in Apache County, Arizona.

This well was initially permitted in September 1955 as the Macie #3 well, and was drilled to a depth of 2500 feet. Kerr-McGee then took over the well, completing it in 1956 with perforations in the Coconino sandstone interval of 1000 - 1020 feet, and 1120 – 1124 feet.

The well test flowed 2,400Mcf gas and production commenced in 1961 till 1976 when production was halted in the Pinta Dome area. During this 15 year production period, the well achieved cumulative total production of 1,441,149 Mcf (1.4 Bcf) of helium gas.

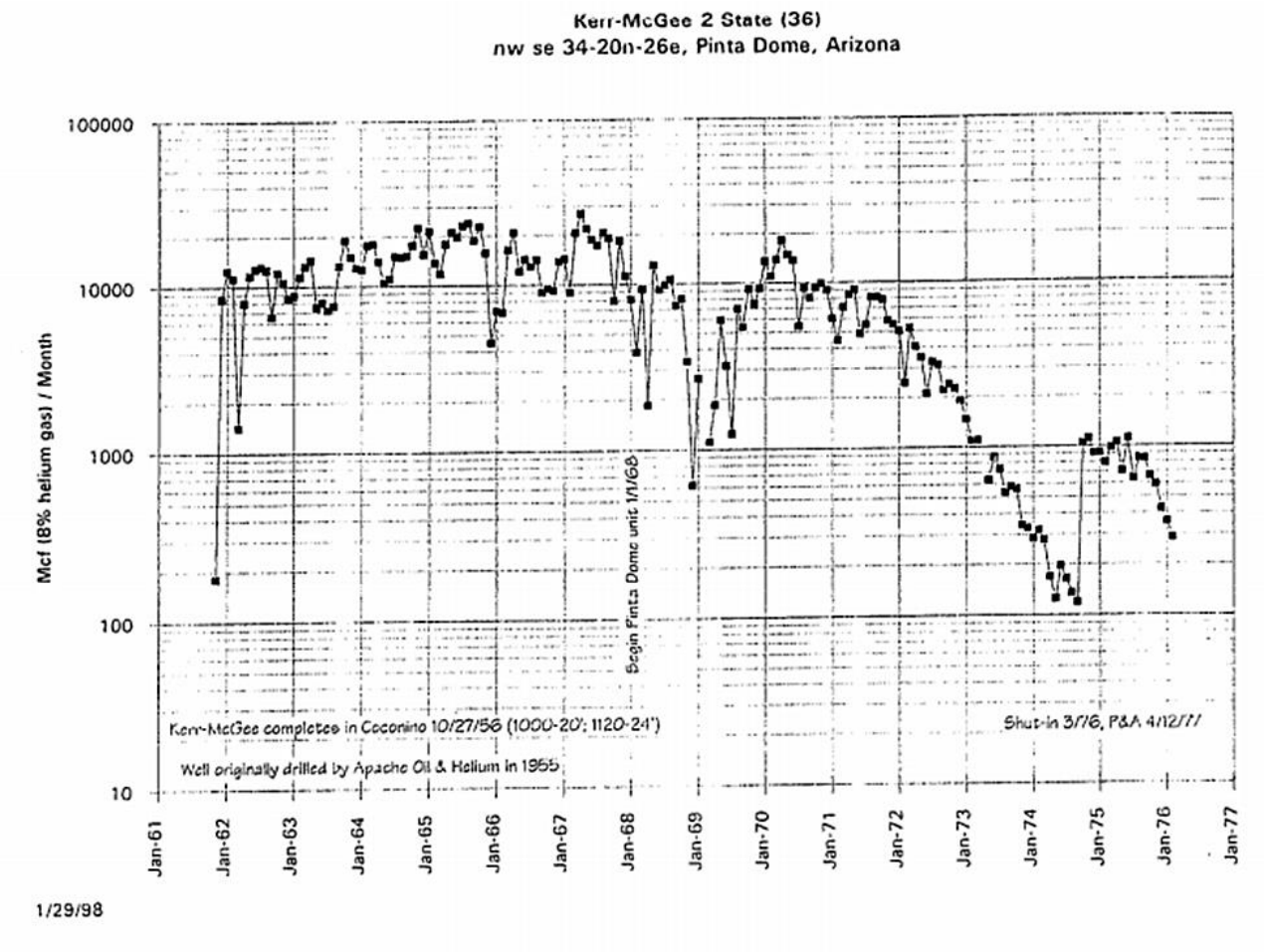

Figure 16: Production profile for Kerr-McGee 2 State (Permit 36). Total Cumulative Production was 1.4 Bcf of gas.

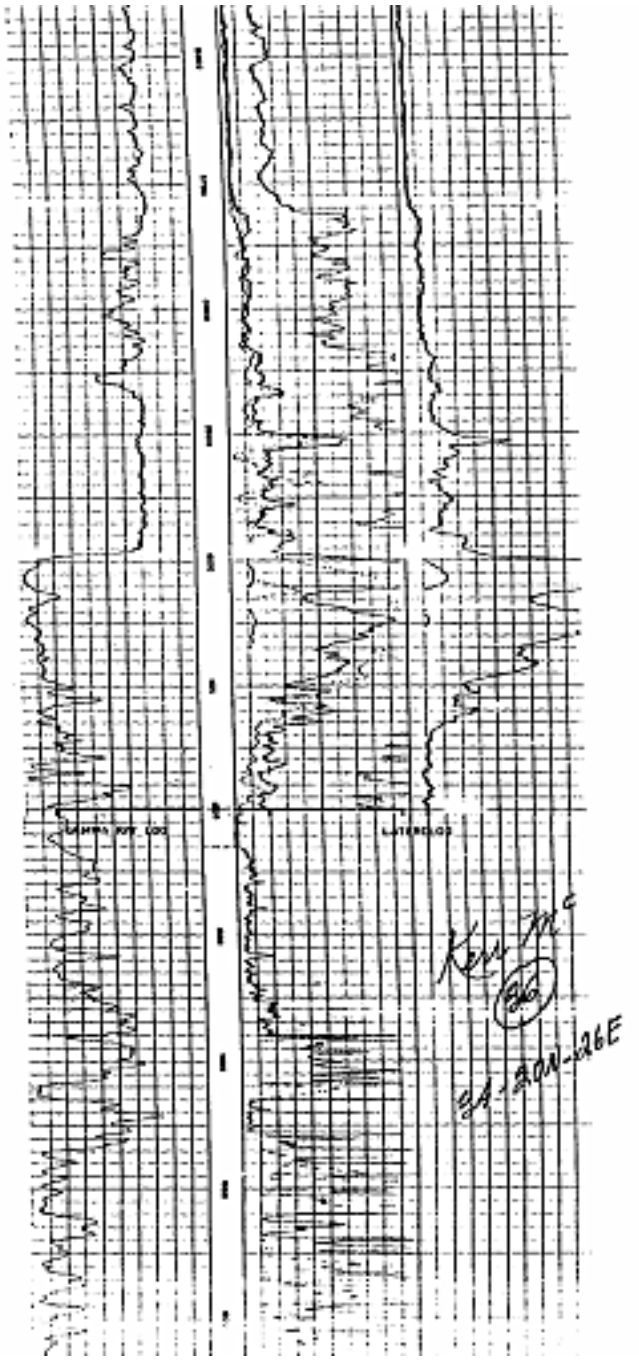

Figure 17: Induction Log for Kerr-McGee 2 State well showing the productive Coconino gas zone at 1000 – 1124 feet.

Eastern Petroleum 1-2 State

The Eastern Petroleum 1-2 State well is located NE SW; Sec 2, Twp 19N, Range 26E Apache County, Arizona. It was drilled to a total depth of 1054 feet in June 1959. The following formations were encountered at these depths:

Chinle Conglomerate: 711 feet

Shinarump: 811 feet

Moenkopi: 819 feet

Coconino: 973 feet

The Chinle conglomerate section was observed to be completely water wet in this well.

The Coconino sandstone was discovered to be 81 feet thick massive sandstone, buff in color, with cross bedding exhibited in the cores. A transition zone composed of dark red silty shales of the Moenkopi streaked with buff and tan colored sandstones of the Coconino was encountered from 954 feet to 973 feet. This transition zone overlaid the Coconino sandstones which occur from 973 feet to 1054 feet.

Perforations were made within the Coconino sandstones at the following intervals: 974 – 991 feet, 995-1000 with 2 shots per feet; abrasive jet with 2 holes each at 977, 982, and 999.5 feet. This well was then further sand water fractured.

The well was tested on a 1” choke for 1 hour, with casing pressure of 71#, and it flowed at an initial flow rate of 2002 Mcfpd.

Cores:

No. 1	987 feet to 991 feet	Cut 4 feet, recovered 4 feet
	2 feet Sandstone,	buff, fine grained, subround to sub-angular, firm, good porosity, fair permeability.
	2 feet Sandstone, white, very fine grained, subround to subangular, very firm, fair porosity, poor permeability.	
	Entire core was bubbling gas.	
No. 2	991 feet to 1017 feet	Cut 26 feet, recovered 26 feet.
	2 feet Sandstone,	buff, fine grained, subround to subangular, firm, fair porosity and permeability.
	11 feet Sandstone,	buff to brown, fine to medium grained, subround to subangular,

good porosity and permeability.

7 feet Sandstone, buff to white, fine grained, subround to subangular, fair porosity and permeability

6 feet Sandstone, buff, fine to medium grained, subround to subangular, few red fine to coarse round grains, some red clay on cross beds.

Entire core is bleeding gas.

Sandstone is crossbedded.

No. 3 1017 feet to 1044 feet cut 26 feet, recovered 27 feet.

1 foot Sandstone, tan fine grained, round to subround, very firm, low permeability fair porosity.

10 feet Sandstone, buff, fine grained, round to subround, firm.

7 feet Sandstone, buff, fine to medium grained, subround to subangular.

9 feet Sandstone, ditto with small red oxide stains. Some green shale intercalated on bedding plans.

Appears by tasting to be a salt water level at 1018 feet.

Drill Stem Tests:

No. 1 970 feet to 991 feet (Coconino sandstone)

Open 30 minutes, helium-nitrogen gas to surface immediately;

Flowed at the following rate:

5 minutes – 250 MCF/D

15 minutes – 286 MCF/D

25 minutes – 323 MCF/D

30 minutes – 552 MCF/D

Surface Pressure: 93 psig

Initial flowing pressure: 63 psig

Final flowing pressure: 63 psig

Initial shut-in pressure: 108 psig

Final shut-in pressure: 104 psig

Initial hydrostatic pressure: 477 psig

Final hydrostatic pressure: 459 psig

Perforations:

973 to 1010 feet – 37 feet thickness

Reservoir characteristics from core and log analysis:

Average Porosity: 14.8%

Average Permeability: 171 md

Average Water Saturation: 47.8%

1010 to 1019 feet – 9 feet thickness

Reservoir characteristics from core and log analysis:

Average Porosity: 14.2%

Average Permeability: 93.4 md

Average Water Saturation: 68.1%

A commercial helium-nitrogen producer was predicted to be possible from the upper 37 feet of Coconino sandstone. A forecast of initial potential of 2 – 2.5 million cubic feet per day was determined. This well actually had an initial potential of 2.4 million cubic feet of gas per day on primary production.

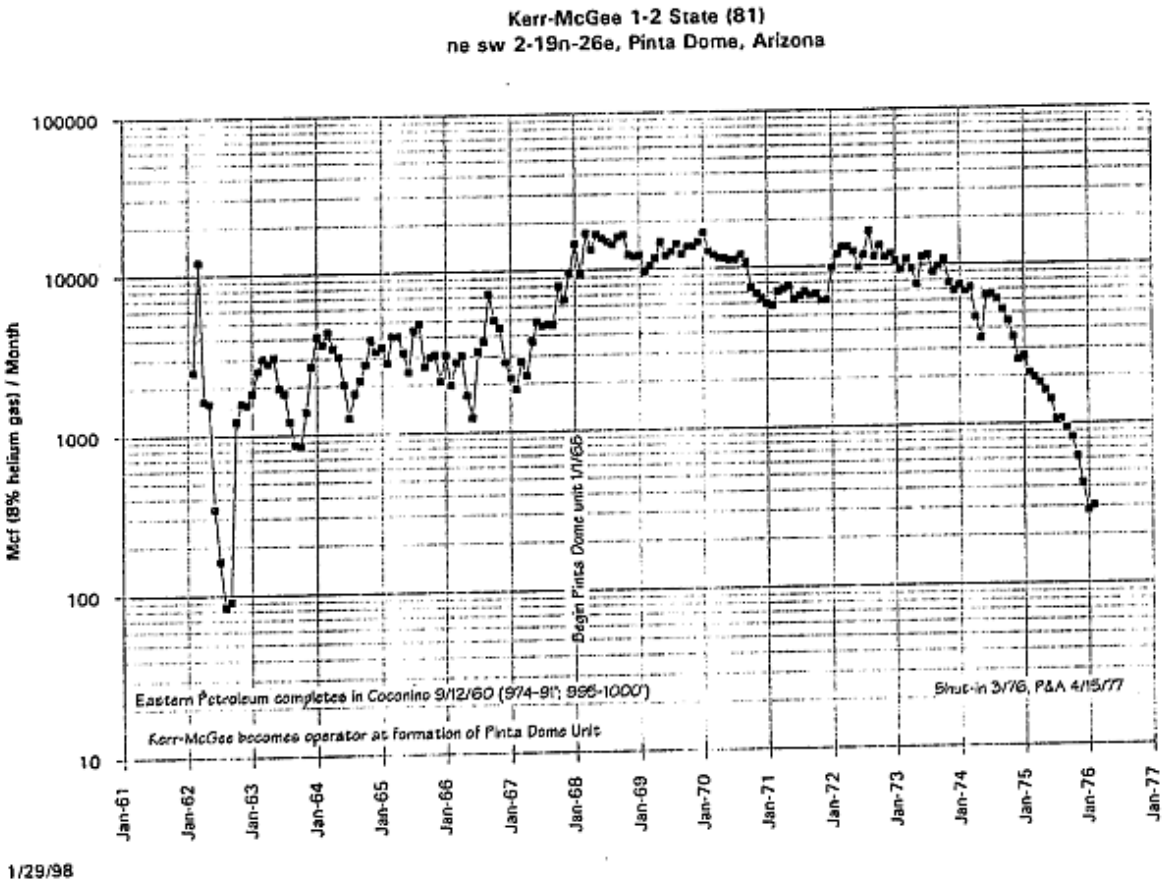

Figure 18: Production profile for Eastern 1-2 (Permit 81) with cumulative total production of 1.1 Bcf of gas.

Eastern Petroleum 1-28 State - Permit 88

The Eastern Petroleum 1-28 State well is located SE SE; Sec 28, Twp 20N, Range 26E Apache County, Arizona. It was drilled to a total depth of 1091 feet in June 1959. The following formations were encountered at these depths:

Chinle Conglomerate: 711 feet

Shinarump: 761 feet

Moenkopi: 801 feet

Coconino: 935 feet

The Chinle conglomerate section was observed to be completely water wet in this well.

The Coconino sandstone was discovered to be 156 feet thick massive sandstone, buff in color, with cross bedding exhibited in the cores. A transition zone composed of dark red silty shales of the Moenkopi streaked with buff and tan colored sandstones of the Coconino was encountered from 911 feet to 935 feet. This transition zone overlaid the Coconino sandstones which occur from 935 feet to 1091 feet.

Perforations were made within the Coconino sandstones at the following intervals: 937 – 1000 feet with 2 shots per feet. This well was then further sand water fractured.

Cores:

No. 1 940 feet to 956 feet Cut 16 feet, recovered 16 feet

2 feet Sandstone, red to tan, streaked with light green and red sandy shale

1 foot Sandstone, tan to brown, fine grained, hard, sub-round to subangular streaked with thin green shale.

13 feet Sandstone, buff to brown, fine grained, hard, sub-round to subangular, good porosity and permeability becoming medium grained towards the base.

Entire core was bubbling gas.

Vertical fractures from 943 to 946.

No. 2 956 feet to 969 feet Cut 13 feet, recovered 13 feet.

4 feet Sandstone, buff, fine to medium grained, subround good porosity and permeability.

5 feet Sandstone, buff, fine to medium grained, subround, very much cross bedding

4 feet Sandstone, ditto, some Aeolian fluting in the sandstone.

Entire core bubbling gas, vertical fractures 956 – 960 and 968 - 969

No. 3 969 feet to 978 feet cut 9 feet, recovered 9 feet.

4 feet Sandstone, buff, fine to medium grained, subround to subangular, firm, fair porosity and permeability; very slight oil stain.

5 feet Sandstone, buff, ditto, good porosity and permeability.

Drill Stem Tests:

No. 1 940 feet to 956 feet (Coconino sandstone)

Open two hours, helium-nitrogen gas to surface immediately;

Immediately; flowed at the following rate:

30 minutes – 83 MCF/D

60 minutes – 105 MCF/D

90 minutes – 118 MCF/D

120 minutes – 118 MCF/D

Recovered: 35 feet Gas cut drilling mud.

Surface Pressure: 50 psig

Initial flowing pressure: 15#

Final flowing pressure: 30#

Initial shut-in pressure: 93#

Final shut-in pressure: 93#

Initial hydrostatic pressure: 468#

Final hydrostatic pressure: 468#

Perforations:

38 feet of the Coconino was cored

Reservoir characteristics from core and log analysis of the upper 78 feet of pay:

Average Porosity: 13.8%

Average Permeability: 87 md

Average Water Saturation: 39.9%

There is an additional 20 feet of pay with slightly higher water saturation in the gas-water transition zone.

Analysis of the gas sample taken on the drill stem test in the upper 16 feet of this section and sent to the Bureau of Mines in Amarillo, Texas had the following analysis:

Helium…….8.6%

Nitrogen……..89.9%

CO2…….0.8%

Methane……0.1%

Argon……..0.6%

Total 100%

The upper 78 feet thick Coconino sandstone is forecasted to produce helium-nitrogen gas with an initial production potential greater than five million cubic feet of gas per day.

The actual initial production rate for this well was 2.14 Million cubic feet of gas per day. The cumulative total production was reportedly 804 Million cubic feet of gas from 1962 to 1972 (10 year production period).

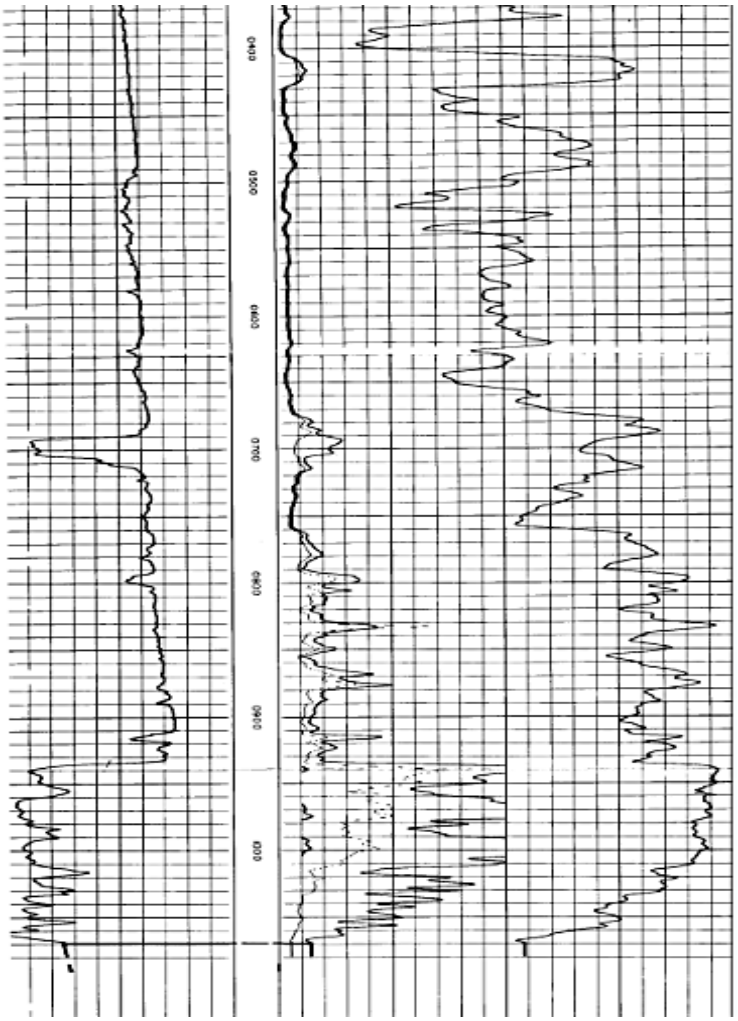

Figure 19: Induction Log for Eastern State 1-28 (Permit 88) showing perforations at 937 – 1000 feet.

Kerr- McGee 2 Fee - Permit 039

The Kerr-McGee 2 Fee well is located Sec 35, Twp 20N, Range 26E Apache County, Arizona. It was drilled to a total depth of 1011 feet in June 1957.

The following formations were encountered at these depths:

Chinle Conglomerate: 711 feet

Shinarump: 761 feet

Moenkopi: 801 feet

Coconino: 935 feet

The Chinle conglomerate section was observed to be completely water wet in this well.

The Coconino sandstones occur from 959 feet to 1011 feet in this well.

Perforations were made within the Coconino sandstones at the following intervals: 959 – 1011 feet with 2 shots per feet. The initial production rate was reported to be 10,000 Mcfd of gas and the cumulative total production for this well is 513 MMcf of gas.

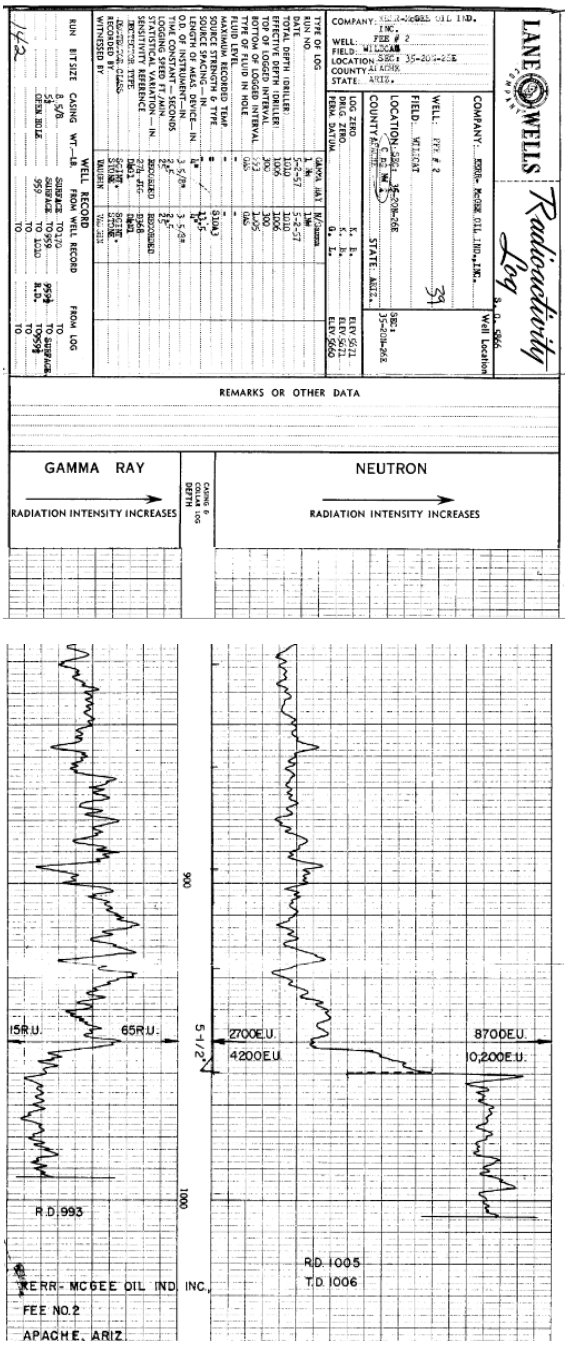

Figure 20: Induction log for the Kerr-McGee 2 Fee (Permit 39) showing perforation interval at 959 – 1011 feet.

Kerr-McGee #1 Barfoot-State (Permit 238)

The Kerr-McGee #1 Barfoot-State was drilled and completed in 1963 to a total depth of 1087 feet, with float collars set at 1052 feet. The formations were encountered and the depths are:

- Shinarump 714 feet
- Monekopi 805 feet
- Coconino 984 feet

A 50 feet gas zone was encountered at depth of 984 – 1034 feet.

Perforations of 4 spf shot between 986 and 1008 feet.

Casing Pressure: 107.3#

Temp. at wellhead: 60^{o}F

Porosity: 12%

Water Saturation: 38%

Helium: 8.24%

Rate Flow on Test:

2” tubing	Orifice .25	Casing Pres – 103.3 – 136MCF
	Orifice .50	Casing Pres - 86.8 – 449MCF
	Orifice .75	Casing Pres - 61.2 – 732MCF
	Orifice 1.00	Casing Pres - 40.0 – 933MCF

Produced a total of 95MCF gas in a 4-hour test.

Water table: 1034 feet

Calculated Open Flow: 1160 MCF

Kerr-McGee #1 Barfoot-State Monthly Gas Production

Monthly Gas (MCF) Production – Kerr-McGee #1 Barfoot State, Permit #238

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
January			4,094	4,278	4,663	3,563	2,427	1,794	2,271	872	656
February			2,148	3,799	4,068	2,602	1,406	1,222	1,768	721	459
March			3,354	4,778	4,237	3,409	1,638	1,279	2,148	1,005	452
April		4,130	3,917	4,745	1,385	3,429	2,068	1,119	1,907	957	414
May		5,506	4,272	5,125	469	3,698	1,711	966	1,719	892	77
June		2,943	4,568	5,149	1,915	3,562	1,962	824	1,567	446	170
July			5,056	5,042	1,754	6,264	2,518	752	1,335	796	332
August	95*		4,660	5,240	2,863	6,381	2,379	845	814	963	132
September			5,190	4,880	3,154	4,440	1,818	787	1,490	863	0
October			4,538	4,737	2,255	3,674	1,414	820	903	838	0
November			4,260	4,620	2,418	2,557	1,299	1,385	748	727	0
December		10,027	4,119	3,751	2,123	2,529	1,543	2,664	723	453	0
Total	95	22,606	50,131	56,144	31,304	45,108	22,228	14,457	17,393	9,533	2,692

* - Gas produced during test

The Kerr-McGee #1 Barfoot State well attained a total cumulative helium gas production of 276,812 MCF over a 13 year period from the Coconino sandstone. Records indicate that this well was not treated or stimulated and production was based on primary recovery alone, exceeding projected calculated reserves by over 500%.

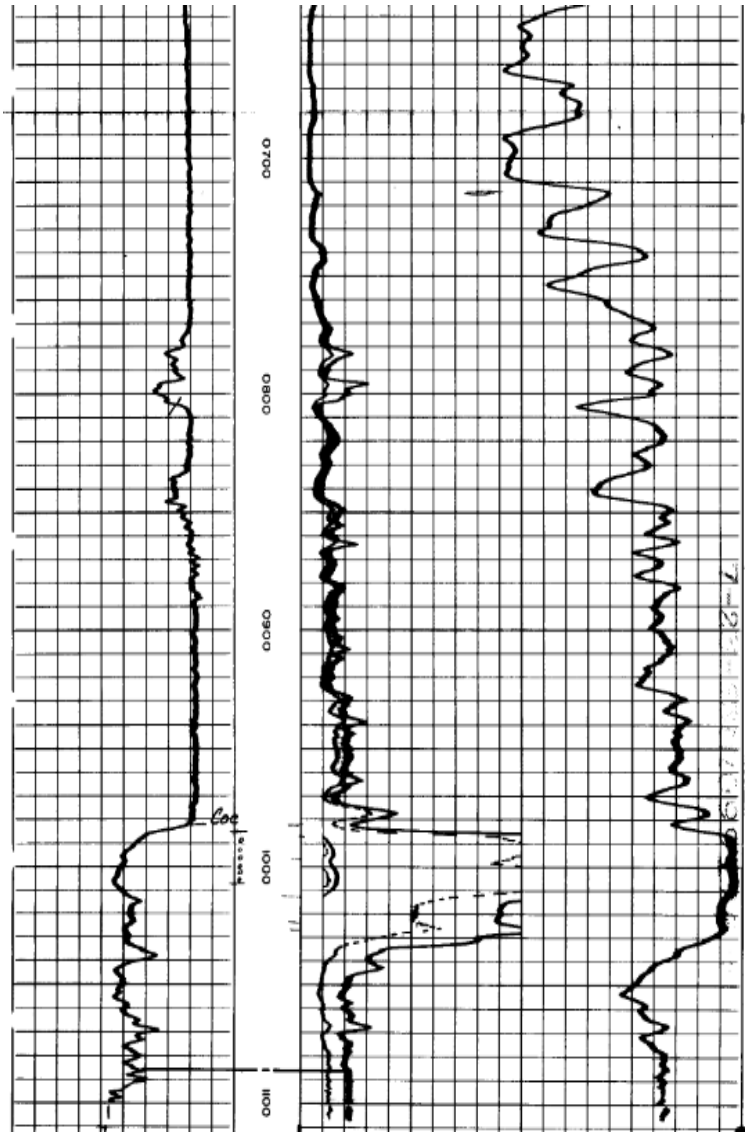

Figure 21: Induction Log for Kerr-McGee #1 Barfoot (Permit 238) showing 50 feet Coconino sandstone productive helium reservoir and the 22 feet perforation interval that resulted in cumulative production of 270MMCF of helium gas.

Kerr-McGee 1 Fee - Permit 10

The Kerr-McGee 1 Fee well is located SW SE; Sec 33, Twp 20N, Range 26E Apache County, Arizona. It was drilled to a total depth of 2500 feet and completed as a helium producer in October 1956.

Perforations were made within the Coconino sandstones at the following intervals: 956 – 980 feet. The initial production rate was 480 Mcfgd . The cumulative gas production is reportedly 530 MMcf of gas.

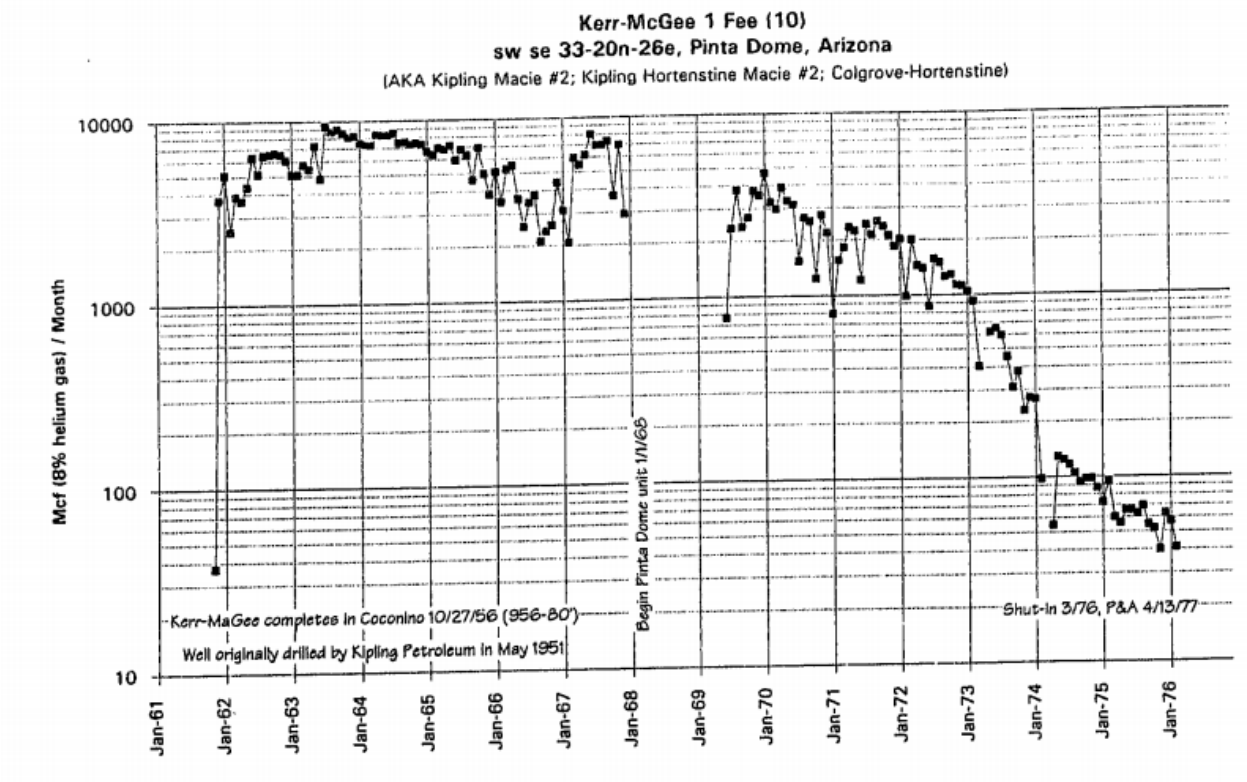

Figure 22: Production profile for Kerr-McGee Fee#1 (Permit 10) with cumulative total production of 530 MMcf of gas.

Kerr McGee 3A State – Permit 349

The Kerr-McGee 3A State well is located SE SW; Sec 4, Twp 19N, Range 26E Apache County, Arizona. It was drilled to a total depth of 1198 feet in June 1959. The following formations were encountered at these depths:

Chinle Conglomerate: 0 feet

Shinarump: 782 feet

Moenkopi: 864 feet

Coconino: 985 feet

Perforations were made within the Coconino sandstones at the following intervals: 1010 – 1016 feet. The initial production rate was 140 Mcf and the cumulative total gas production was 266 MMcf.

Kerr-McGee 4 State – Permit 38

The Kerr-McGee 4 well is located NW SE NE; Sec 32, Twp 20N, Range 26E Apache County, Arizona. It was drilled to a total depth of 836 feet in May 1957. The following formations were encountered at these depths:

Coconino: 828 feet

The Coconino was encountered from 828 feet to 836 feet.

Perforations were made within the Coconino sandstones at the following intervals: 828 – 836. The initial production rate was 420 Mcfgpd and the cumulative total production over a 6 year period was 48 MMcf of gas.

Kerr-McGee 3 State - Permit 37

The Kerr-McGee 3 State well is located in NE NW SE; Sec 4, Twp 19N, Range 26E Apache County, Arizona. It was drilled to a total depth of 1198 feet in May 1957. The following formations were encountered at these depths:

Chinle Conglomerate: 711 feet

Shinarump: 761 feet

Moenkopi: 801 feet

Coconino: 1010 feet

The Chinle conglomerate section was observed to be completely water wet in this well.

Perforations were made within the Coconino sandstones at the following intervals: 1010 – 1016, 1088-1100; 1138-1145 feet with 4 shots per feet. The initial production rate of this well was 140 Mcfgpd, with cumulative production of 6 MMcf of gas from 1961 to 1966 (5 years).

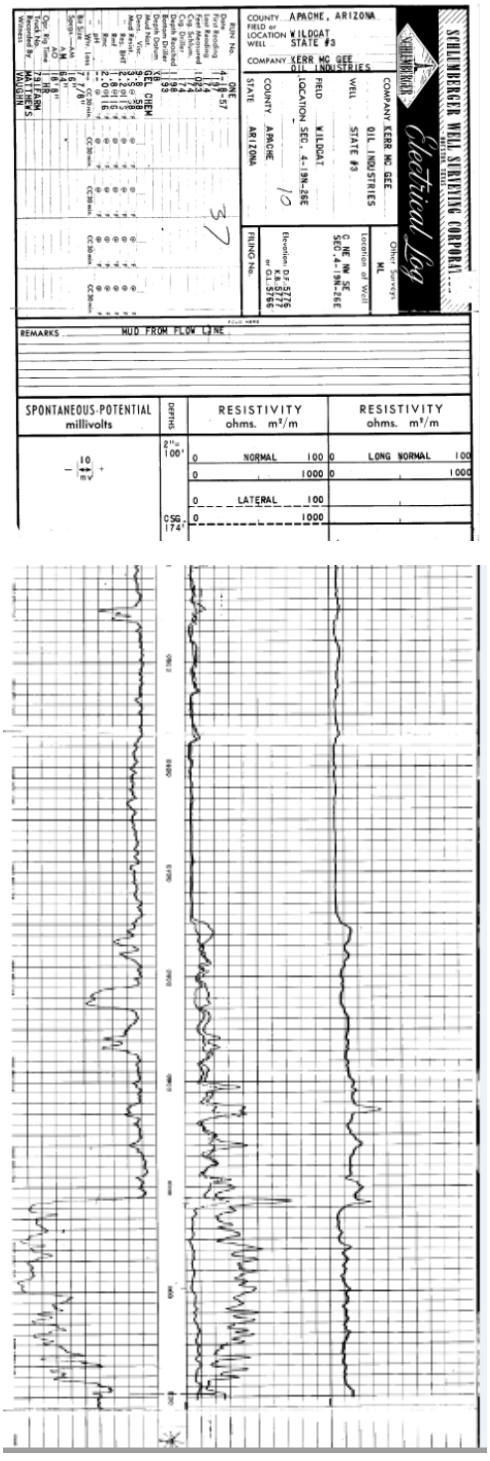

Figure 23: Induction Log for Kerr-McGee 3 State showing Coconino Sandstone from 1010 – 1145 feet.

Kerr-McGee 4A State – Permit 378

The Kerr-McGee 4A State well is located NE SE; Sec 32, Twp 20N, Range 26E Apache County, Arizona. It was drilled to a total depth of 804 feet in February 1967. The following formations were encountered at these depths:

Chinle Conglomerate: 550 feet

Shinarump: 632 feet

Moenkopi: 770 feet

Coconino: 793 feet

Perforations were made within the Coconino sandstones at the following intervals: 793 – 796 feet with 4 shots per feet. Initial production rate was 42 Mcfgpd.

Dineh Bi Keyah (DBK) Field

Dineh bi Keyah, "The People's Field" (or pasture) was discovered by the Kerr-McGee Corporation on top of the Toadlena anticline in the Chuska Mountains of Apache County, Arizona. The center of Dineh bi Keyah is approximately 5 miles due east of the Arizona–New Mexico boundary, and about 52 miles southwest of Farmington, New Mexico. Shiprock, New Mexico, lies 33 miles northeast from the discovery. This is high country with prominent volcanic geologic features covering the landscape. Kerr-McGee's discovery well is 7,560 feet above sea level and their Navajo No. 14 is at 8,555 feet.

The Discovery Well

Kerr-McGee's Navajo No. 1 (Fig. 1) was spudded January 22, 1965. Seven-inch casing was cemented at 3,159 feet on February 13, 1965. Early June of 1965 the shallow Coconino interval (starting at 590 feet) was thoroughly tested. Gas containing helium was found, but pressure and volume remained too low for commercial interest. The presently producing igneous interval was not tested at this time. Kerr-McGee formally abandoned the well on June 22, 1965. The first notice of new interest came via a U. S. Geological Survey notice dated January 17, 1967. The notice stated that Kerr-McGee wanted to re-enter No. 1, clean out the cement plugs, perforate from 2,860 feet to 2,885 feet and test that interval.

The following account of the lead geologist- John Masters who discovered the Dineh-bi-Keyah field for Kerr-McGee:

“In 1967, I found Dineh-bi-keyah, Field of the People, on the Navajo Reservation, right in the uranium area I had worked so intensively. I did this by myself, with an idea that came to me alone on a Saturday afternoon in the Kerr-McGee office in Oklahoma City. I had left Arizona 14 years before and hadn’t thought much about the area since then. But that Saturday afternoon, my subconscious mind finally put together a geologic picture it had probably been wrestling with for the whole 14 years. Suddenly, in a single flash, I saw all the data in my memory rearranged into a convincing regional structural picture. It formed a huge buried anticline 35 miles long under most of the uranium area I had worked so long ago. It was probably the largest undrilled anticline left in the United States. It was virtually invisible to anyone who had not walked and jeeped over nearly every mile of that structure. Indeed, it had stayed invisible to me for 14 years. On that Monday, I went to Mr. McGee. He asked me about 20 serious, probing questions and then said, “OK.” He was the clearest-thinking, most decisive man I’ve ever known. We drilled it and found no conventional reservoir rock, but it did have an igneous sill at 2800 feet — with good oil shows. Everyone wanted to plug it. McGee had sat a lot of wells as a young geologist for Phillips. This time, he didn’t pay much attention to the rock type, the correlations, or the structural position. He was fixated on the oil show. He said, “Test it.” No oil. He said, “Acidize it.” No oil. Then he said, “Frac it.” The well came in for 648 BOPD of 45° API gravity oil. We drilled 31 wells which produced an average of more than 500,000 barrels each from 2800 feet. Total production was nearly 20 million barrels. That was my igneous intrusive field, mine and Mr. McGee’s — a screwball, one of a kind. The rule learned from that was that you don’t have to be entirely right — just right enough, and ahead of everyone else”.

The following account of subsequent operations will be of interest:

1-26-67: Spotted 1,000 gallons of 10 percent acetic acid at 3,020' Perforated from 2,860'-2,885' with 4 jets per foot. Swabbed well dry. No fill up.

1-27-67: Acidized with 358 gallons of 10 percent acetic acid. Recovered 4 barrels of new oil in 5 hours of swabbing.

1-28-67: Swabbed 6.75 barrels of new oil in 8 hours.

1-29-67: Fractured well with 10,000 gallons of crude oil and 10,000 pounds of 20-40 sand.

1-30 and 31-67: Swabbed back all of frac oil and 137 barrels of new oil.

2- 1-67: Tested well at rate of 611 B/D (barrels per day).

The discovery well ultimately settled at 1,400 B/D until July 19, 1967 when an additional interval was opened. After the additional zone (2,885'-2,942') was introduced, production climbed. The production on July 23, 1967 was 1,851 B/D of 43.3° oil, 135 MCF/D (thousand cubic feet per day) gas, and 0 B/D water. The GOR (gas-oil ratio) was 73 cu. ft./barrel (see Figure 24 for electric log cross section).

Several very important and now obvious points were demonstrated by the action that took place in the discovery well. First, any igneous rock with some indication oil or gas saturation should be considered a potential reservoir rock. Second, a negative drill stem test (or swab test) of untreated but potentially productive igneous rock does not render the rock unproductive. The same kind of rock can be acidized and results may still remain poor. A frac job in Dineh bi Keyah obviously resulted in unlocking the hydrocarbons in the igneous rock. The intrusive tertiary sill in the field is considered an unconventional reservoir that required application of appropriate completion techniques to make it a productive reservoir despite oil shows indicated at this formation depth. Therefore the challenge to operators is to explore for similar unconventional reservoir rocks and unlock the oil and gas contained in these rocks.

Rocks

The Chuska Sandstone underlies most of the surface of the Chuska and Lukachukai Mountains. The standard northeastern Arizona geologic section lies beneath the Chuska, and all of the common rock units are present. The main rock formation is the intrusive syenite sill—a biotite-rich vogesite and belonging to the syenite lamprophyre group of igneous rocks. The rock consists of diopside, biotite, apatite, rutilc, and ores enclosed in sanidine. Chlorite, calcite, and some of the ores are also present, with glass being a cementing material.

The porosity, permeability, and oil-saturation values measured in the igneous rock are similar to the reservoir parameters of many oil-producing carbonate rocks. By core analysis, porosity ranges from 5 to 17 percent and averages 10 percent; permeability ranges from less than 0.01 to 25 millidarcies; residual oil saturation ranges from zero to 25%, and water saturation from 25% in permeable sections to 93% in zones of very low permeability. The oil saturation at various levels in the sill generally is related to

porosity, permeability, and fracturing. In some wells, intervals up to 60 feet thick have no saturation, apparently because of low permeability. There is no significant alteration of minerals surrounding the cavities and this suggests the cavities formed during cooling of the magna and not by subsequent leaching." This rock has obvious primary porosity, but the degree and type of fracture system also must play an important role. Section 32 of T. 36 N., R. 30 E., probably is underlain by a highly complex fracture system. All wells in this section are outstanding producers. These high performing wells in this section will be investigated in subsequent pages.

The sill is comparable in general appearance and mineral composition with plugs, dikes, and sills that crop out in the area. However, the igneous rocks exposed at the surface in the area are very fine grained and dense and have little, if any, porosity. Samples from the two igneous plugs which crop out at Roof Butte, 1 mile southeast of the No. 1 Navajo well, are difficult to distinguish from core chips from the dense parts of the producing sill.

The intrusive rock has been determined to be about 31,000,000 years old which indicates probably emplacement during the Oligocene. The host rock is approximately 300,000,000 years old and thus was deposited during Pennsylvanian time.

A secondary target in Dineh bi Keyah is helium. Helium has been found in commercial quantities in the deeper horizons - Devonian (McCracken and Aneth intervals)

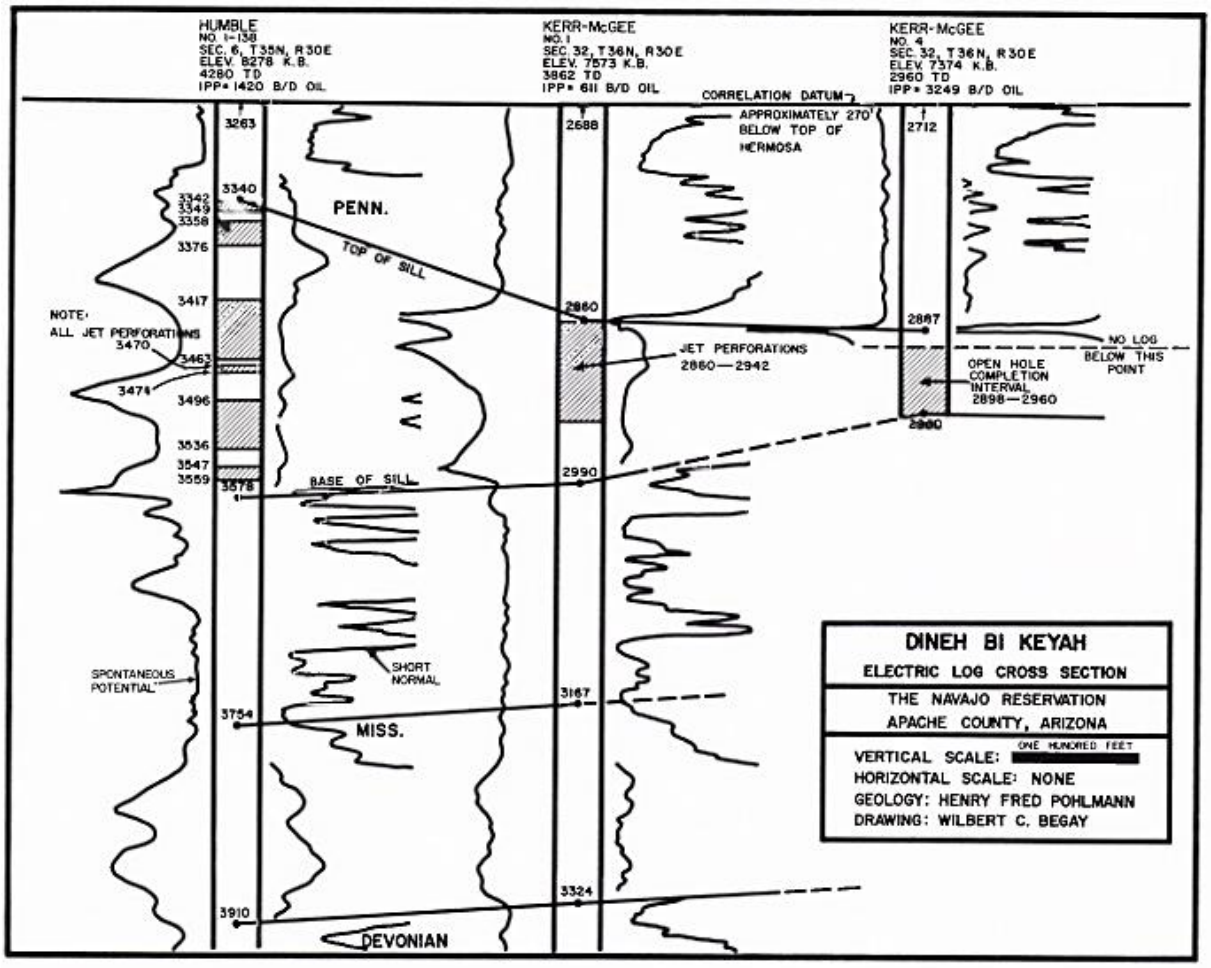

Figure 24: Log Correlation of Wells in the Dineh-bi-Keyah field showing the intrusive rock (Pohlmann, 1967)

Kerr-McGee #1 Navajo: Permit 377

SE SW Sec. 32 T 36N R 30E

Elevation 7564

Spud Date: 1-22-65 Comp Date: 2-1-67

TD: 3864 IP 634, 851 BOPD (Reworked) with Redda pump

Formation Tops:

Triassic	0
Permian	573
Pennsylvanian	1305
Mississippian	3127
Devonian	3325
Cambrian	3690

Perfs: 2860 – 2942 Reworked in 7-19-67 in Hermosa formation (Tertiary syenite – igneous sill)

4 spf ,

11-16-74: Acidized perfs with 5000 gals of 7.5% HCL Acid. Max Pressure 1100psi.

Average Injection rate 10 BPM at 600 psi. ISIP – 0 psi

11-18-74: Reperfd 2885 – 2942 with 2HPF

Fractured with 90,000 gals Gel (lease crude) and 90,000# 10-20 sand

Average Injection rate – 36BPM. Max Pressure 3000psi. ISIP 550 psi

Pumping with 1.50” Bore Rod Pump

Date of first production: 1-27-67

Date of Test: 12-2-74 250 bbls oil 56.8 Mcf Water 3 bbls GOR: 227

Gravity of oil: 41.7 ^{o}API

Reworked:

4 spf with 0.46”@ 2860 – 2885

1 spf with 0.50”@ 2885 – 2942

Treatment: 62,000 gal oil, 30,000# sand, 3,000 adomite, 146 ball sealers

Max pressure: 3000 psi. Ave treating pressure: 2500 psi. Ave injection rate: 58.3BPM

7-23-67 1851 BO, 135 Mcf, 43.3°API, 0 bbls Water GOR: 73 cu/bbl

Acres: 160

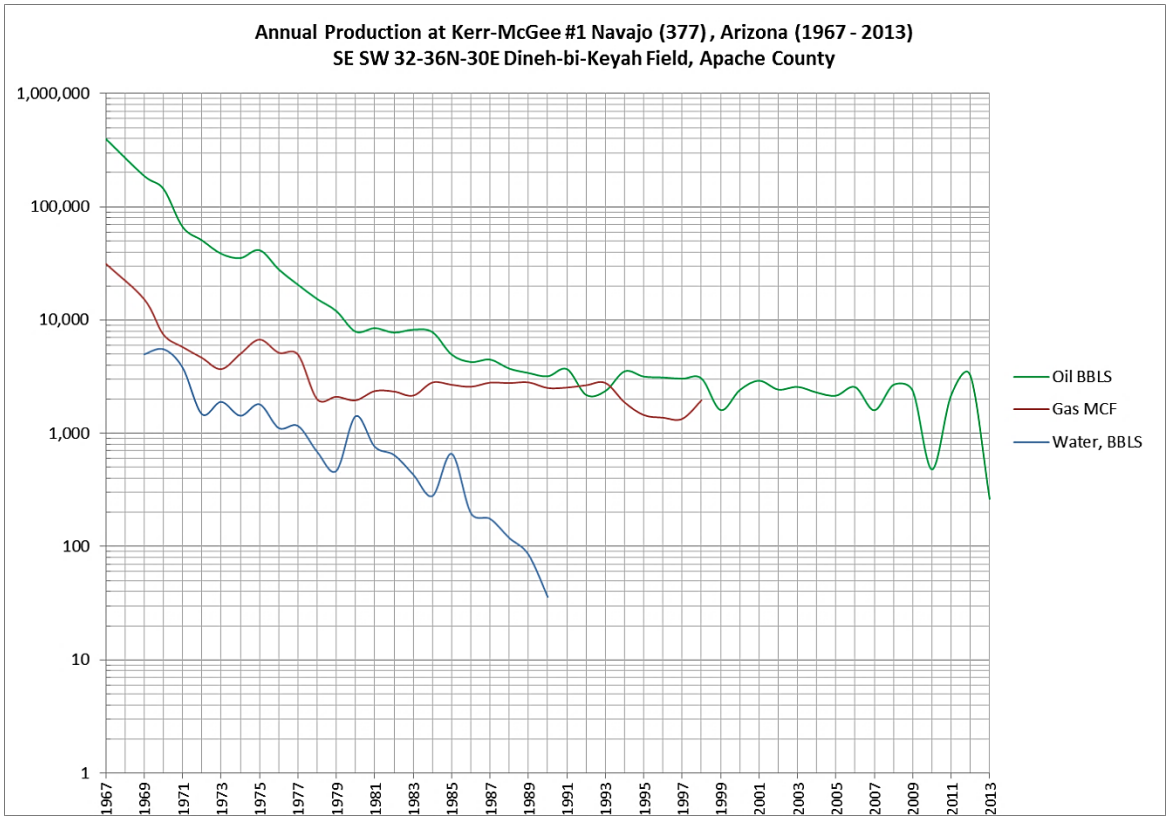

Figure 25: Annual Production at Kerr-McGee #1 Navajo (Permit 377), Arizona (1967-2013)

Cum Oil: 1,156,785 BBL

Cum Gas: 137,928 MCF

Cum Water: 31,229 BBL

Kerr McGee #2 Navajo: Permit 379

SE NW Sec. 32 T 36N R 30E

Elevation 7604

Spud Date: 2-15-67 Comp Date: 3-12-67

TD: 3275 IP: 2865.5 BOPD , 43.5 ^{o}API with Redda pump

Formation Tops:

Triassic	0
Coconino	705
Supai	1440
Pennsylvanian	2494 (Hermosa) 3059 - 3157

Perfs: 3060 –3130 Reworked in 7-19-67 in Hermosa formation (Tertiary syenite – igneous sill)

4 spf ,

11-16-74: Acidized 3060 - 3114 with 500 gals of acetic acid. Max Pressure 1100psi.

11-18-74: Fractured with 22,000 gals oil and 20,000# sand

. Max Pressure 3000psi.

Pumping with Reda Pump

Reworked:

12/7/72 2 HPF @ 3060 –3130

Treatment: 80,000 gal crude, 80,000# 10-20 sand

Max pressure: 3000 psi. Ave treating pressure: 2500 psi. Ave injection rate: 58.3BPM

12-1-72 332 BO, 33 Mcf, 41^{o}API, 14 bbls Water GOR: 104 cu/bbl

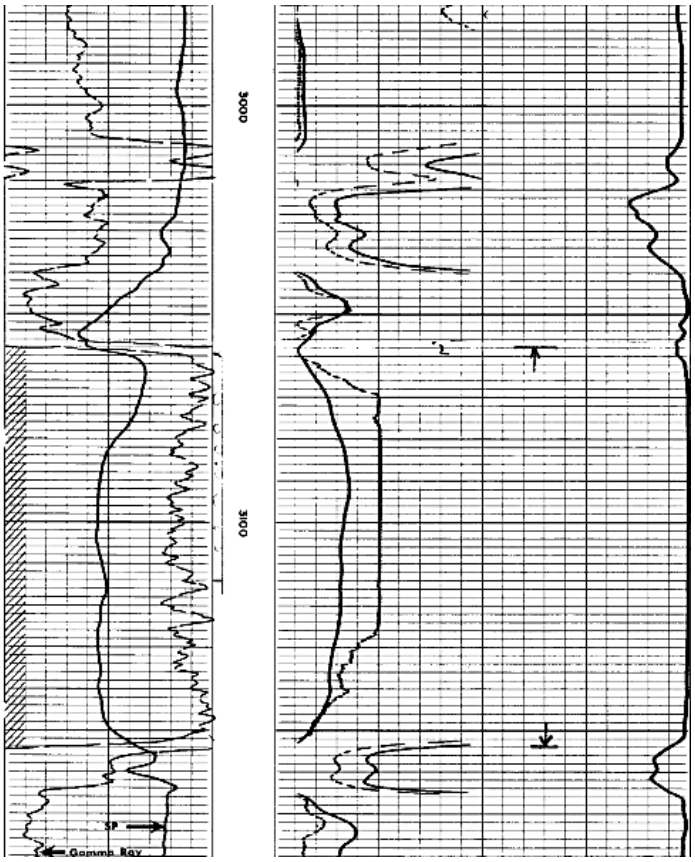

Figure 26: Induction log for Kerr-McGee #2 Navajo (Permit 379) showing perforation interval - 3060-3114

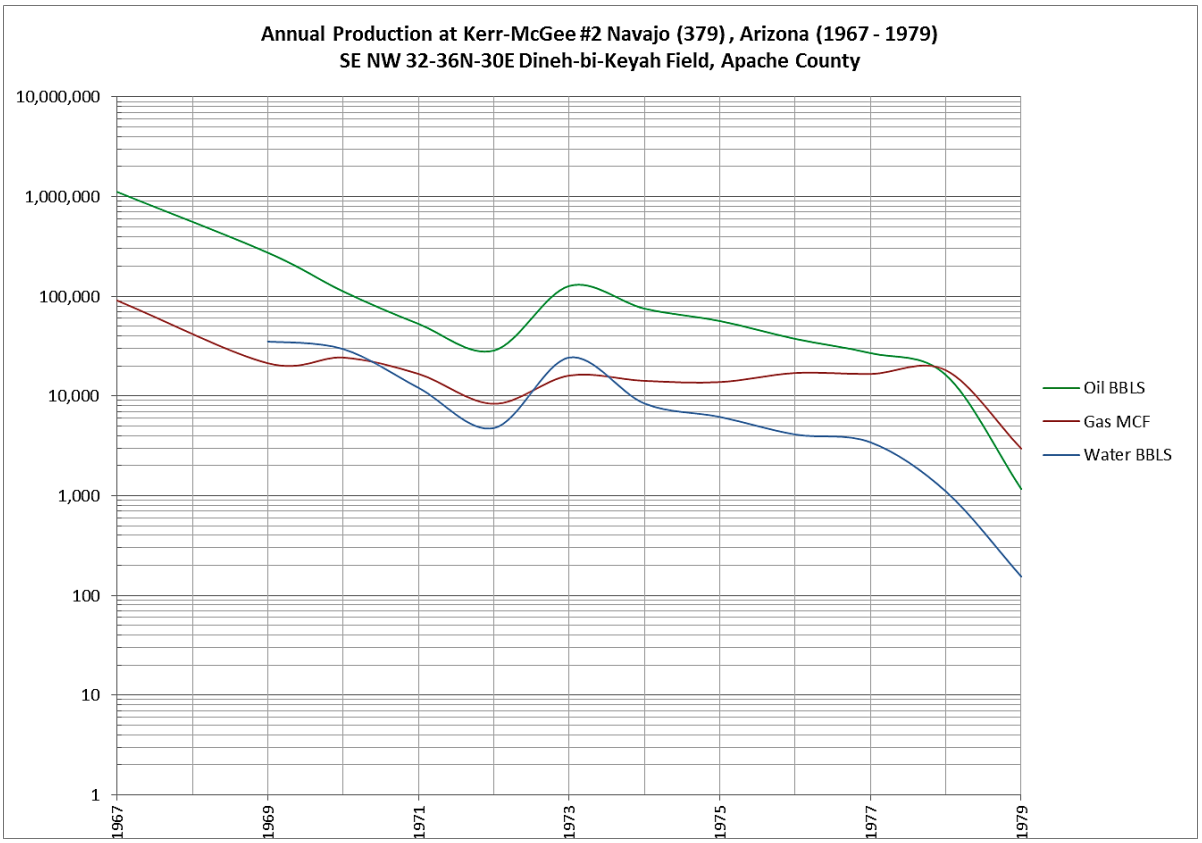

Figure 27: Annual Production at Kerr-McGee #2 (Permit 379) Navajo, Arizona (1967-1979)

Cum Oil: 1,925,770 BBL

Cum Gas: 260,710 MCF

Cum Water: 129,654 BBL

Kerr McGee #4 Navajo: Permit 384

SE NE Sec. 32 T 36N R 30E

Elevation 7353

Spud Date: 6-27-67 Comp Date: 7-23-67

TD: 2960 IP: 3249 BOPD , 43°API with Redda pump

Formation Tops:

Chinle	0	Red Shale with thin SS stringers
Coconino	565	Massive SS w/ shaly stringers in Lower 250
Cutler	1294	Sh, SS, LMS
Pennsylvanian	2408	LMS, Pred dense & tite w/ red & gray sh., some thin Sd stringers
Igneous	2887	Syenite
Hermosa	2959	LMS – dense and tite

Perfs: 2898 –2960

4 spf ,

Acidized 2898 - 2960 with 500 gals of acetic acid. Max Pressure 1100psi.

Fractured with 60,000 gals oil and 30,000# sand, 3000# adomite

Max Pressure 900psi. Ave. Treating Pressure 700 psi, Ave. Treating Rate: 70 BPM.

Pumping with Reda Pump

3249 BO, 189 Mcf, 43°API, 0 bbls Water GOR: 58 cu/bbl

Rework : 12-8-77

2 HPF,

Acidized 2898 - 2960 with 1000 gals of Resi-sol and 100 gal of crude oil. Max Pressure 1100psi.

Fractured with 500 gal of scale preventative, 96,400 gals crude oil and 81,000# 10 – 20 sand and 7800# of 100 mesh sand at 120 BPM

Pumping with Reda Pump

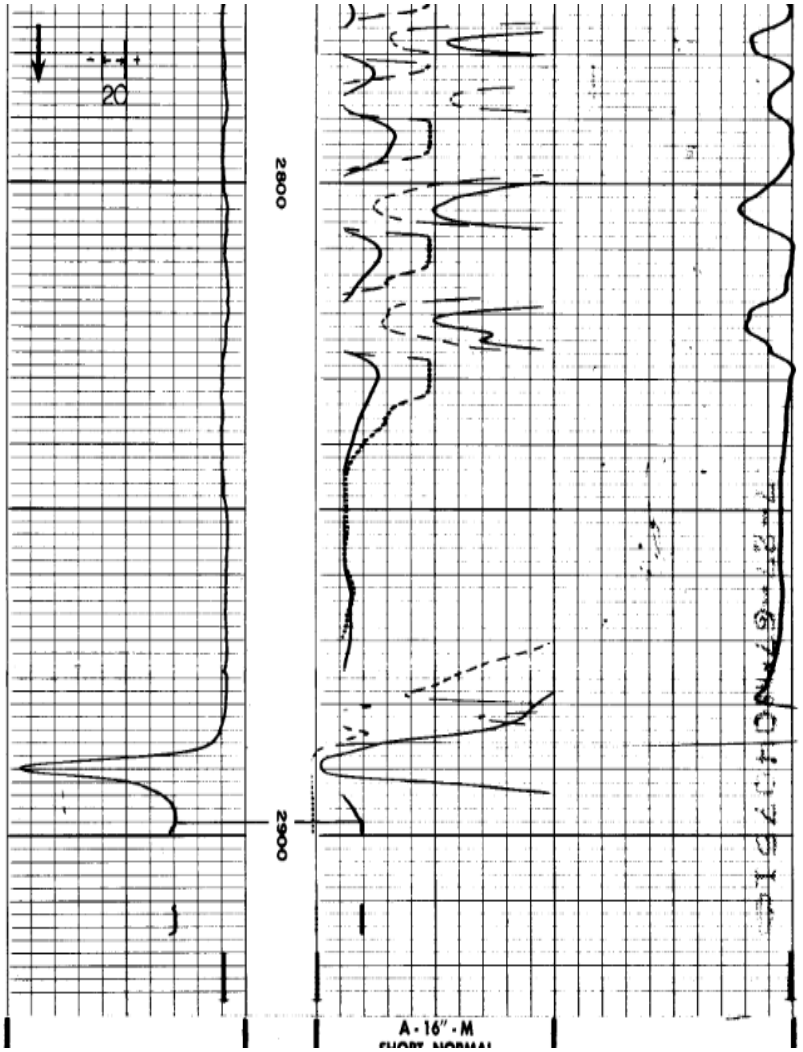

Figure 28: Induction log for Kerr-McGee #4 Navajo (Permit 384) showing productive section at 2892 feet

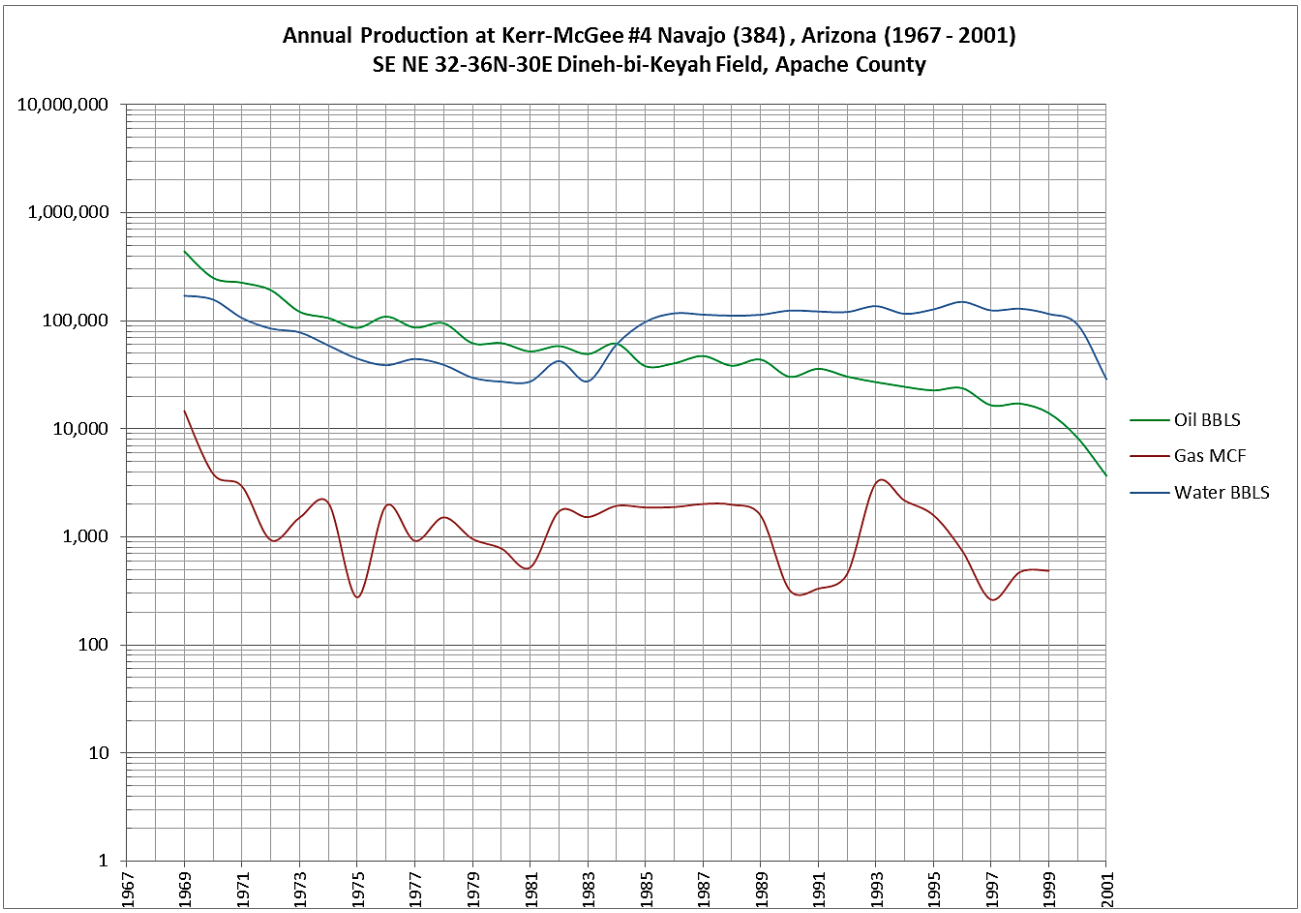

Figure 29: Annual Production at Kerr-McGee #4 Navajo (Permit 384), Arizona (1967-2001)

Cum Oil: 3,624,310 BBL

Cum Gas: 110,968 MCF

Cum Water: 2,984,635 BBL

Kerr McGee #3X Navajo: Permit 386

SE SE Sec. 32 T 36N R 30E

Elevation 8017

Spud Date: 3-11-67 Comp Date: 4-07-67 Recompletion Date: 10-8-73

TD: 3600 IP: 3249 BOPD , 43°API with Reda pump

Formation Tops:

Triassic	0	
Coconino	1095	SS, shale, and chert streaks
Supai	1840	Sh, and SS
Pennsylvanian	2894	LMS, Pred dense & tite w/ red & gray sh., some thin Sd stringers
Igneous	3422	Syenite
Hermosa	3480	LMS – dense and tite

Perfs: 3457 –3477

4-7-67

5 spf 0.47" Jet,

Acidized 3427 - 3457 with 250 gals of acetic acid. 1500 gals 3% hydrofluoric acid and 30 ball sealers..

Fractured with 30,000 gals oil and 15,000# sand. Max Pressure 1700#.

Pumping with Reda Pump

2865 BO, 367 Mcf, 43.5°API, 0 bbls Water GOR: 128 cu/bbl

Rework : 6-19-73

2 HPF,

Acidized 3437 - 3477 with 500 gals of acetic acid. Max Pressure 1100psi.

Fractured with 77,674 gals oil and 80,000# 10 – 20 sand

Max Pressure 1600psi. Ave. Treating Pressure 1500 psi, Ave. Treating Rate: 89.6 BPM.

Pumping with Reda Pump

320 BO, 138 Mcf, 40°API, 75 bbls Water GOR: 432 cu/bbl

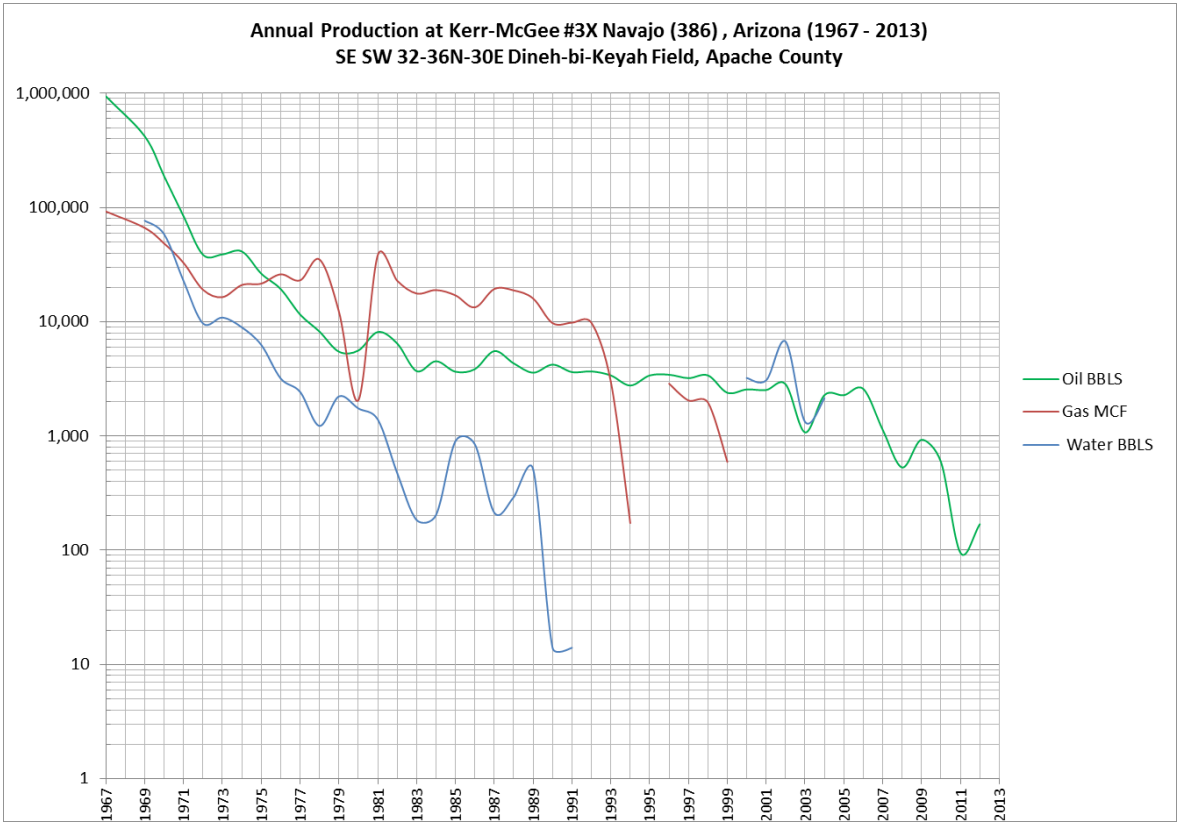

Figure 30: Annual Production at Kerr-McGee #3X Navajo, Arizona (1967-2013)

Cum Oil: 1,926,637 BBL

Cum Gas: 639,529 MCF

Cum Water: 226,003 BBL

Kerr McGee #11 Navajo: Permit 506

NW SE Sec. 32 T 36N R 30E

Elevation 7402

Spud Date: 7-8-69 Comp Date: 8-09-69 Recompletion Date: 12-15-77

TD: 2893 IP: 456 BOPD , 167 Mcfd, 43°API with Reda pump

Formation Tops:

Chinle (Triassic)	0	Red Shale with thin stringers of sand
Coconino (Permian)	482	Massive sandstone with shaly stringers
Hermosa (Penn)	2328	Limestone, predominantly dense and tite
		with red and gray shale, some thin sandstone stringers
Black Shale	2792	Shale, dolomitic, dense
Intrusive	2800	Syenite

Perfs: 2831 –2893

8-9-69

Open hole

Fractured 2831 – 2893 with 60,060 gals oil, 37,500# sand and 3000# Adomite.

Max Pressure 1350 psi; Ave. Pressure 1200 psi; Ave. Injection Rate: 79 BPM

Tubing pump

456 BO, 167 Mcf, 42.8°API, 0 bbls Water GOR: 366 cu/bbl

Rework : 12-15-77

2 HPF,

Acidized with 1000 gals of Resi-Sol and 400 gals crude oil.

Fractured with 500 gals scale inhibitor; 95,900 gals crude oil; 7,350# 100 mesh sand; 81,0000 80,000# 10 – 20 sand. Ave. Treating Pressure 1616 psi, Ave. Treating Rate: 115 BPM.

Pumping with Reda Pump

320 BO, 138 Mcf, 40°API, 75 bbls Water GOR: 432 cu/bbl

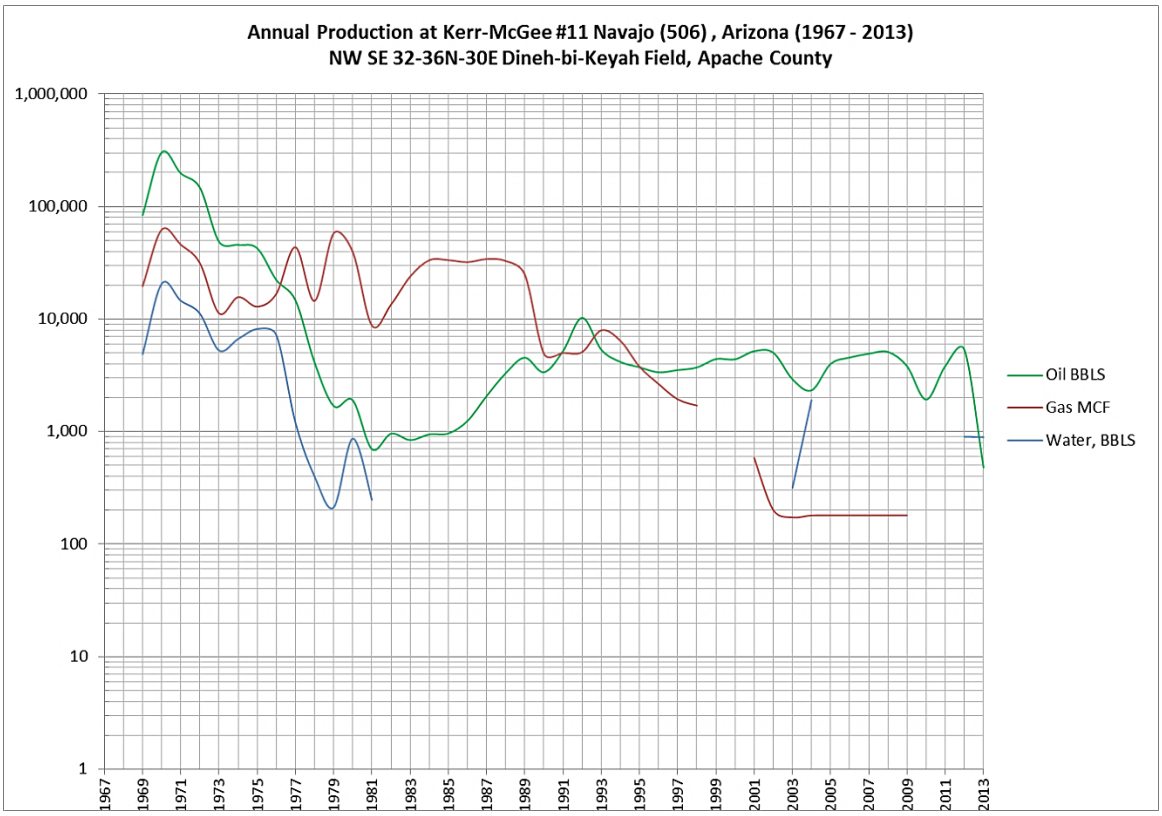

Figure 31: Annual Production at Kerr-McGee #11 (Permit 506) Navajo, Arizona (1967-2013)

Cum Oil: 1,028,505 BBL

Cum Gas: 649,482 MCF

Cum Water: 85,464 BBL

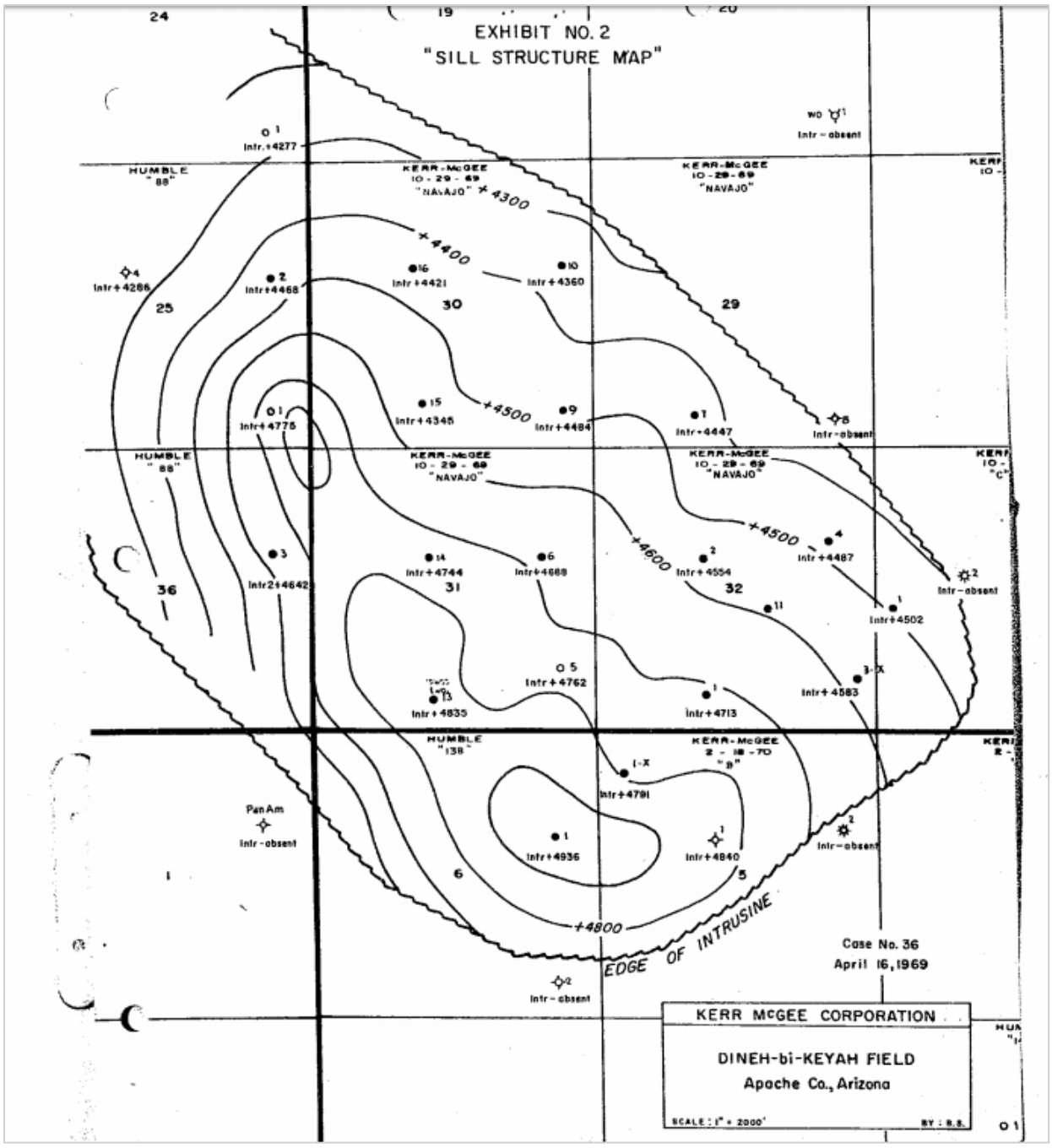

Figure 32: Map showing extent of intrusive tertiary sill at the Dineh-bi-Keyah Field, Apache County, Arizona

Kerr McGee #24 Navajo: Permit 695

NW/NW Sec. 32 T 36N R 30E

Elevation 7402

Spud Date: 9-24-78 Comp Date: 11-07-78

TD: 3515 IP: 85 BOPD, 60.8 Mcfd, 197 BW, 43^{o}API with Reda pump

Formation Tops:

Chinle (Triassic)	0	Red Shale w/thin stringers of sand
Coconino (Permian)	1045	Massive sandstone w/shaley stringers
Hermosa (Penn)	2885	Gray, dense limestone w/shaley stringers
Black Shale	3365	Black Shale
Intrusive	3412	Syenite

Perfs: 3413 –3515

11-7-78

Open hole

Fractured 3413 – 3515 with 76,000 gals crude, 120,000# sand.

Max Pressure 1350 psi; Ave. Pressure 310 psi; Ave. Injection Rate: 54 BPM

Tubing pump

85 BO, 60.8 Mcf, , 197 bbls Water GOR: 715 cu. ft/bbl

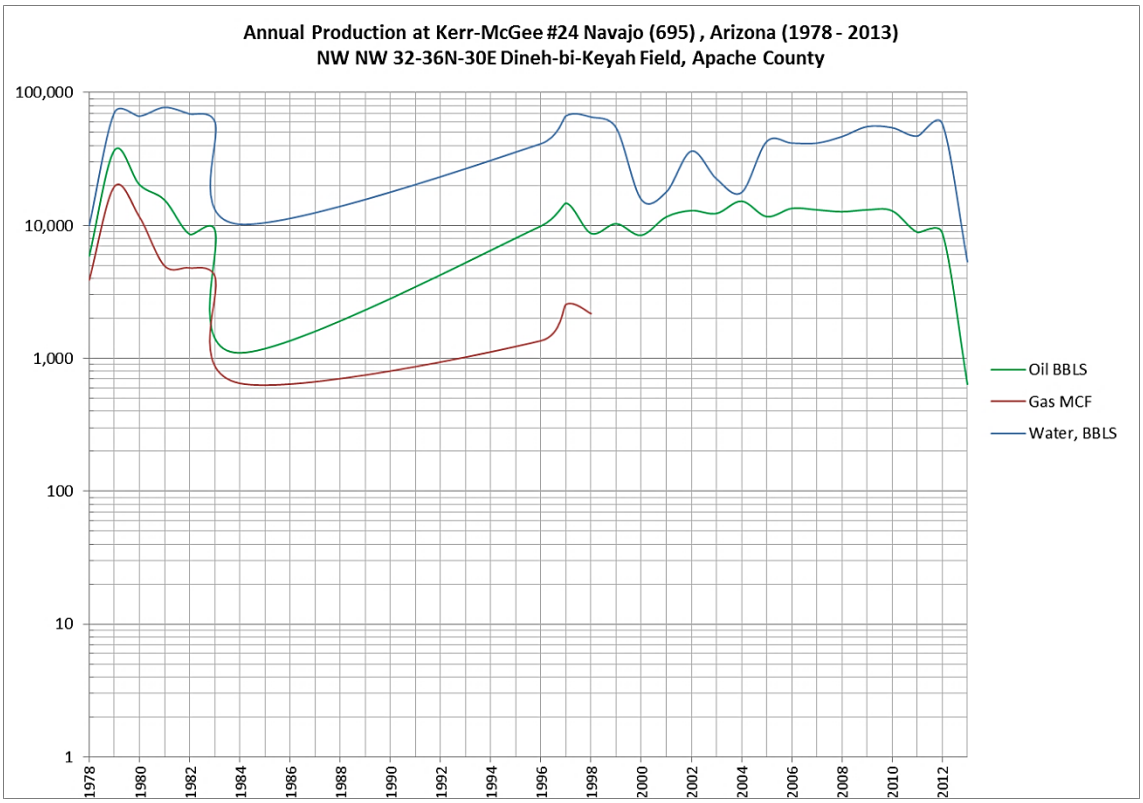

Figure 33: Annual Production at Kerr-McGee #24 Navajo (Permit 695), Arizona (1978-2013)

Cum Oil: 296,949 BBL

Cum Gas: 55,775 MCF

Cum Water: 1,095,988 BBL

WELLS IN CLOSE PROXIMITY

The wells drilled in close proximity to the BECI wells in Navajo county will also be investigated. Primarily this study will examine the pertinent well historical data, including drilling and completion techniques employed to determine the reservoir characteristics and also production drivers for these wells.

Lydia Johnson Trustee #2 – Permit 097

The Lydia Johnson Trustee #2 well is located in SW NE; Sec 33, Twp 14N, Range 20E Navajo County, Arizona. It was drilled to a total depth of 1540 feet in 1959. The following formations were encountered at these depths:

Chinle Conglomerate: Surface

Top of Coconino: 315 feet

Base of Coconino: 555 feet

Salt Section: 715 feet

Fort Apache: 1510 feet

Perforations were made within the Fort Apache at the following interval: 1517 – 1523 with 4 shots per feet. The well was acidized with 2000 gals acid. Oil shows were reported in the Fort Apache as well as slight gas and distillate. This well was plugged and abandoned in December, 1963.

Lockhart Aztec #1

The Lockhart Aztec #1 well is located in Sec 33, Twp 14N, Range 20E Navajo County, Arizona. The elevation at the well site is about 6000 feet above sea level. The well was drilled to a total depth of 3734 feet in June 1949 where it reached the base of the granite formation.

This well was drilled by L.M Lockhart of Los Angeles. It was cored continuously from 1678 feet to 2181 feet, and from 3492 feet to the bottom. Core recovery was nearly 90% and an unusually accurate picture of the encountered formations is available. The following formations were encountered at these depths:

Coconino: Surface

Supai:	550 feet
Fort Apache Zone of Upper Supai:	1520 feet
Bottom Fort Apache:	1750 feet
Middle Supai:	2160 feet
Lower Supai	2480 feet
Intra-formation conglomerate	3015 feet
Pennsylvanian Formation	3024 feet
Mississippian Formation	3650 feet
Devonian Formation	3685 feet
Total Depth	3734 feet

Electric resistivity and gamma ray logs were run after the completion of the well. A drill stem test was run from 1678 to 1742 feet with negative results. The well was plugged and abandoned without any thorough formation tests made.

The marine formations of the Permian, Pennsylvanian, Mississippian and Devonian age are all considered as source beds for petroleum because of their high content of organic material. Many small oil shows were reportedly encountered from 1500 to about 3700 feet. There were also indications of gas and some smell of distillate.

Core analyses were reported to show two zones with petroliferous possibilities: One from 1540 to 1750 feet and the second from 3590 to 3700 feet. Both zones are in “tight” limestone formations, i.e. formations which will give up their petroleum content only upon the application of heavy dosages of acid. The drill stem test run from 1678 to 1742 feet was in the first possible aforementioned zone. It showed an 18 minute blow of air and a strong distillate smell but nothing more. Core analyses of this

zone show a low porosity and low permeability zone –"tight", however the oil saturation of the pore space is over 25%. Similar oil saturation exists in the second zone at 3590 to 3700 feet.

While the formations penetrated in these two zones are admittedly "tight", the percentage of saturation of the available pore space warrants the thorough testing of these two sections with adequate shooting and intense acidization.

The electric log of this well is reported to be very similar to the Dove Cree Field and the Boundary Butt Field discovery well electric logs. The discovery well in Boundary Butte Field was initially abandoned as a dry hole because of the "tight" appearance of the limestones. Subsequent shooting and heavy acidization made this an excellent producing well and opened up a new field.

Recommendations were made to test the two zones by shooting and heavy acidizing. However, the well was never shot and acidized to test the identified possible petroleum zones. The well was plugged and abandoned on June 6th, 1949 – three days after completion (Heindl, 1949).

Core Analysis of Lockhart Aztec #1 Well

Core analyses, electric log, solubility tests were employed to identify important zones that have the possibility of oil and gas production in this well.

Three potential oil and gas horizons were indicated by these tests as follows:

Zone 1: The top of the Fort Apache zone of the Upper Supai formation at 1520 feet. The cuttings from 1520 – 1628 feet showed oil stains however, this section was not cored. Core samples were taken from 1678 to 1741 feet with 100% core recovery of the 63 feet core. Core analysis of this section shows a dolomitic limestone with a weighted average porosity of 3.5%; average oil saturation of 32.6% and 70% solubility in acid. Permeability tests indicated a high capacity of the section.

Zone 2: Within the Pennsylvanian zone, from 3150 to 3600 feet there is an interval the upper part of which consists of lime showing only minor fractures with local zones of saturation. From 3452 to 3513 feet, laboratory tests indicate a saturation ranging between 0 to 12.8% and acid solubility range of 57% to 92%, with an average of 70%. From 3513 to 3600 feet alternating shales, limestones and sandstones show minor fracturing and a small saturation in the cores. It was recommended that the whole zone, an aggregate of 400 feet may be worth a test in future wells.

Zone 3: Major fracturing was noted within the Mississippian formation – a brecciated, hard, red, gritty conglomerate from 3610 to 3640 feet.

Core analysis from 3657 to 3685 feet shows continuous oil saturation ranging from 3.6% to 41.4%; and an acid solubility from 76.5% to 89.5%. Effective porosity of this zone ranges from 1.1% to 5.5% and major fracturing is plainly visible.

Core analyses of Devonian cores from a depth of 3685 to 3708 feet indicate oil saturation ranging from 0 to 14.5% with a weighted average of 9.6%; acid solubility from 38.9% to 89.4% with a greater portion of the zone averaging better than 74.3%.

The high porosity and saturation indicated by core analyses in zones 1 and 3, together with the high solubility of the formations in each zone and the presence of major fractures give these two zones a high potential value as oil and gas horizons. With modern methods of well completion and development no well having the indications shown by this well should be abandoned, without a proper well treatment with acid and, as indicated in this case, implemented by shooting to loosen the formation and make it more susceptible to acid.

From the foregoing facts it is obvious that acidizing offers excellent possibilities of developing commercial production of oil and gas in at least two horizons in the Lockhard No. 1 well. It is therefore recommended that after drilling out the plug and cleaning the well the following steps be taken:

Zone 3:

It is suggested that 5.5 inch casing be set at 3605 feet and cemented with at least 250 sacks of cement and preferably 300 sacks. It is then desirable to shoot the formation with 250 quarts of nitroglycerin. The well should then be thoroughly cleaned out and a production test made. If the shot fails to develop commercial production of oil or gas it will serve to form lines of fracturing in a deep zone surrounding the borehole which will permit the acid to penetrate deeper into the formation. This should be applied in at least two or preferably three stages. The first should be no more than 1,000 gallons. After that the well should be thoroughly cleaned out and a production test made. The second stage should be with 3,000 gallons. If a third stage is necessary then 10,000 gallons should be applied, cleaned out and tested.

Zone 1:

This zone, from 1520 to 1741 feet, is also a most attractive one. If zone 3 should fail to develop into a commercial zone after acid treatment the same procedure should be followed with zone 1.

After recovering as much casing as possible above the cemented section a bridge plug should be set at 1750 feet. The casing should be set at 1520 feet and cemented with 250 sacks of cement. There will then remain 230 feet of open hold which should be shot with 350 quarts of nitroglycerin, cleaned out and tested. If results are negative or unsatisfactory then a three stage acid treatment should be applied with the first stage being 1,000 gallons; the second 5,000 gallons and the third if necessary not more than 10,000 gallons. It is important that the well be cleaned out and tested after each stage. Then if the results of any one stage are satisfactory the others can be eliminated.

Even should the results of the third and deepest zone prove satisfactory it may be found desirable to treat the zone 1 interval. In such case the casing should be perforated with from 300 to 400 perforations opposite the interval from 1520 to 1741 feet. Then the recommended acid treatment should be applied.

Although carbonate rocks, such as limestones, are not all equally soluble in acid, where properly applied, the acid produces amazing results even where the formations have as barely a color of oil or a faint gas odor while drilling. Acid enlarges the pores and creates cavities in limestone, especially where major fracturing exists. The deeper the acid penetrates the formations away from the bore hole the greater the pores become permitting a freer flow of oil and gas. Hence the advisability of acidizing in two or three stages, each stage with a greater amount of acid than the preceding one.

It is not possible to estimate the amount of oil or gas that acid treatment will develop on relatively similar formations in widely separated areas. Comparisons may prove unsatisfactory. In order to point out what the proper application of acid can do, however, it may not be amiss to cite the development of

a well in the Boundary Buttes area of Northeastern Arizona and Southeastern Utah which is now producing from Hermosa limestone, the geological equivalent of the formation in the lower zone of the Lockhart well.

Byrd-Frost's English #1, located in C NE1/4 NW1/4 Section 22 Twp 43S Range 22E, San Juan County, Utah, topped the Hermosa formation of the Pennsylvanian at 3790 feet. The lime core showing oil and gas. Laboratory tests of the core did not show good porosity. A drill stem test, however, from 4625 to 4677 feet, open 1.5 hours, had gas at the surface in ten minutes estimated at 250,000 cubic feet per day.

The zone was treated with acid through 200 perforations in the casing. The first stage of 1,000 gallons did not produce any additional gas. The second treatment with 2,000 gallons increased the flow of gas from 8 million to 10 million cubic feet per day. The last stage of 10,000 gallons developed the flow of gas to an actual measurement of 20 million cubic feet per day with a small amount of high gravity oil. (Further discussion of the English #1 is carried out in subsequent pages).

Laboratory tests of the cores from the two horizons (Zones 3 and 1) mentioned above in the Lockhart #1 well indicate that the three stage acid treatment recommended has better than an average chance of developing commercial production. Both zones are equally important and both should be tested (Larrazolo Jr., 1949)

Gas Analysis

The gas show from 1635 – 1735 feet in the Lockhart #1 well was collected and sampled. The results of the analysis indicated the gas composition to be helium (0.28%); methane (24.6%); nitrogen (69.9%); and the dry gas - 372 BTU/CU.FT. This gas analysis was performed in June, 1949.

A second gas analysis was carried out in October 1962. This yielded comparable gas composition results 13 years later. The gas composition was reported to be helium (0.267%); methane (23.8%); nitrogen (70.7%) and dry gas – 357 BTU/CU.FT.

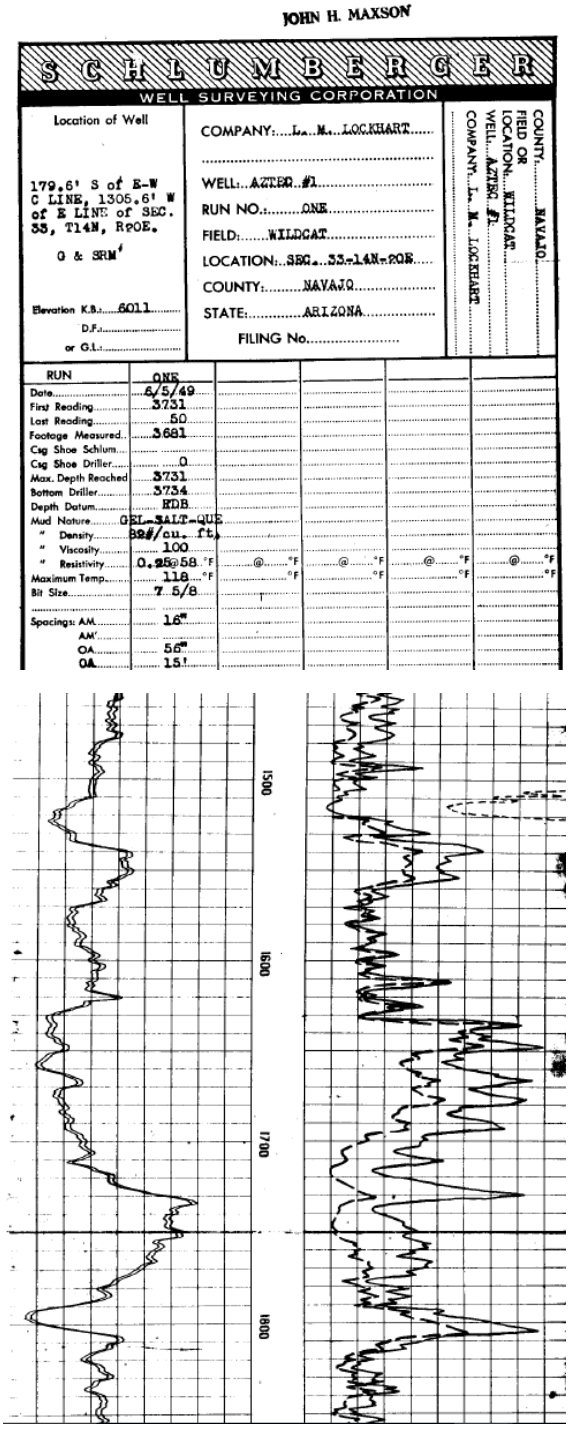

Figure 34 (a): Induction log for Lockhart Atzec #1 showing Zone 1: 1520 – 1741; core samples obtained from 1678 - 1741

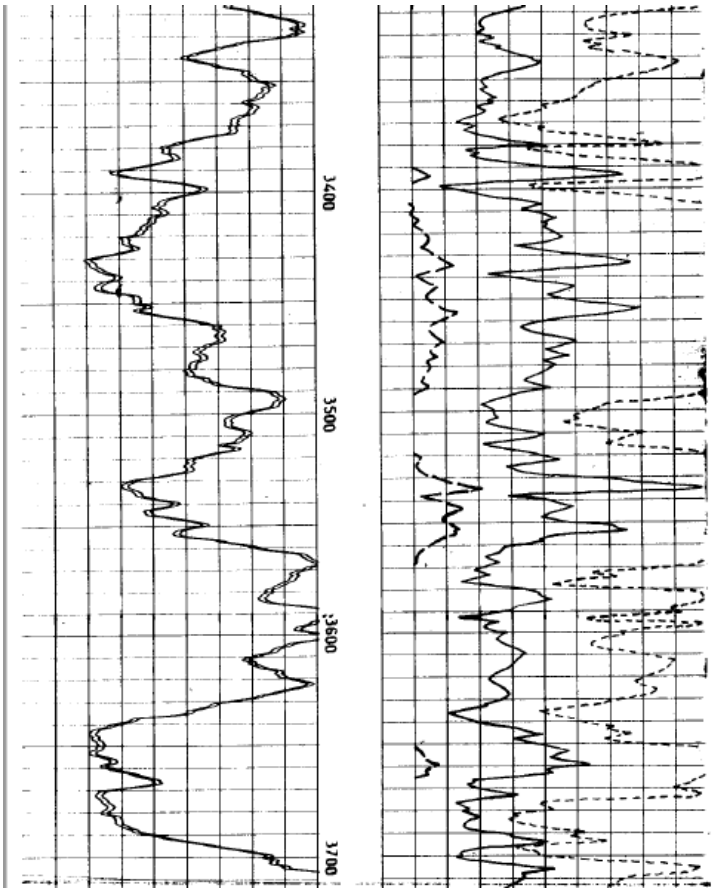

Figure 34 (b): Induction log for Lockhart Atzec #1 showing Zone 2: 3150 – 3600, core samples obtained from 3452 – 3519; and Zone 3: 3610 – 3640, core samples obtained from 3657 – 3685

Figure 34 (a) and (b) showing the induction logs for Lockhart Atzec #1 indicating Zones 1, 2 and 3 from which cores were obtained and analyzed.

An earlier report on the Lockhart #1 Aztec well was also discovered in the well file for this well. This report, dated August 1949 was prepared by Ed D. Mckee, a Geologist based in Phoenix, Arizona.

Mckee (1949) reported on the stratigraphic geology of L.M. Lockhart #1 Aztec Well. Sec. 33, T 14 N, R 20 E., Navajo County, Arizona, Elevation 6011 feet.

Also, Mckee described the stratigraphic column of the well based on well log, and examination of well cores and samples as follows:

Feet to Top	Rock Description	Formation
0	Sandstone, white, quartzitic, fine-grained	Coconino
550	Shale, red brown, slity, calcareous, in sandstone	
620	Anhydrite and gypsum in shale	Supai
820	Sandstone, alternating with gypsum, anhydrite, halite	
1070	Shale, gray and brown, silty, dolomitic, massive	
1110	Anhydrite, mottled to white, hard, dense	
1250	Shale, gray brown, calcareous	
1270	Shale, red brown, halite inclusions; grading sown to anhydrite, halite, sandstone, red shale	
1540	Dolomite, dark gray to black, silty, some black organic matter	Fort Apache
1570	Shale, gray, alternating with dolomite	
1678	Dolomite, brownish gray	Base Ft. Apache
1750	Shale, red brown, dolomitic	
1770	Halite, with beds of sandstone and anhydrite	Base Up. Supai
2160	Anhydrite, gray, massive with halite	
2175	Shale, red to chocolate brown, sandy, includes gypsum and minor beds of sandstone	
2620	Shale, gray, highly micaceous, dolomitic	
2755	Dolomite, brown to gray brown, silty	
2780	Shale, gray, dolomitic, and some dolomite	
2860	Limestone, gray brown, shaly, dolomitic, with minor streaks of brown, calcareous shale	
2904	Shale, brown, calcareous, hard, dense; some gypsum	
2930	Shale, brown, calcareous; streaks of brown limestone	
2938	Limestone, cherty, hard, silty, interbedded with calcareous, mottled green shale	
2995	Shale, brown, calcareous, fractured, with anhydrite inclusions	

3015	Limestone conglomerate; smooth brown limestone pebbles in lime matrix	Base of Middle Supai
3020	Shale, blue gray, calcareous, slity	
3040	Shale, brown, calcareous, small line pebbles	
3090	Limestone, brown, silty, some fractures	
3107	Shale, brown, calcareous	
3121	Limestone, gray, very shaly	
3127	Shale, brown, calcareous	
3132	Limestone, dark gray, silty	
3138	Shale, brown gray, calcareous	
3141	Limestone, gray, very silty, nodular	
3147	Limestone, aphanitic, gray, cherty, fractured	
3156	Shale, dark brownish gray, calcareous	
3166	Limestone, gray, silty, cherty	
3175	Shale, dark gray to black, fossiliferous, calcareous, with minor fractures	
3184	Limestone, gray, massive, coarse grained, fossiliferous	
3216	Shale, micaceous, silty, calcareous, minor fractures	
3273	Shale, gray, silty, bentonitic, calcareous, with lime pebbles	
3296	Limestone, gray, alternating with gray shale	
3385	Shale, mottled, red brown, calcareous, nodular; and limestone, thin, granular, shaly	
3424	Limestone, gray, granular, silty, fossiliferous; some chert, minor fractures	
3471	Sandstone, very fine grained, fractured, calcareous	
3479	Limestone, gray, cherty, granular, minor fractures; grades down into shaly limestone	
3505	Shale, red brown, calcareous, micaceous, with beds of fossil limestone	
3539	Sandstone, dark gray, hard, fine-grained, with purple shale partings	

3544	Limestone, light gray, coarse-grained, silty, with shaly partings and gray brown nodular shale	
3575	Shale, red brown, calcareous, fossiliferous	
3610	Shale, red, silty, mottled, with subangular granite fragments	
3641	Sandstone, very shaly, fine to medium-grained, calcareous; some limestone inclusions	
3650	Limestone, dolomitic, silty, massive, with minor fractures	
3657	Limestone, dolomitic, granular, sandy, with vugs of white crystalline limestone, major fractures	
3685	Limestone, dolomitic, gray green, with thin gnarly beds of sandy shale	
3708	Sandstone, fine-grained, calcareous	
3724	Granite, biotite, weathered	Pre-Cambrian

Most if not all of the sedimentary strata encountered in the well are of Pennsylvanian and Permian age. Pre-Cambrian granite was encountered at the bottom and a small thickness of Devonian and Mississippian strata may possibly rest upon it, though the writer believes that Pennsylvanian beds extend down to the granite. It is important to note that this well is located on the margin of a basin of Pennsylvanian age and near the center of the deepest basin of Permian age (3200 feet) in Arizona.

Zones that show Oil Concentrations

According to core analysis by Stanolind Oil and Gas Company the following zones were found to contain oil (Analysis made by the research department in Tulsa):

1678 – 1741

2873 – 3129

3175 – 3449

3452 – 3515

3657 - 3708

Zones of Porosity and High Resistivity from Electric Log

The induction log prepared by Schlumberger indicates the following:

1. Porous zone in limestone with high resistivity from 1510 to 1730 feet.
2. Various zones if porosity and high resistivity in limestone indicated between 2873 and 3565 feet,
3. Zone in limestone between 3657 and 3708 indicates a porous zone of high resistivity related to area of major fracturing observed in the cores.

Zones of Observed Fracture:

Based on physical observation, the following zones of fracture in limestone were noted:

1. Minor fracturing in limestone 1678 – 1741 feet.
2. Minor fracturing in limestone and shale 2873 – 3515 feet.
3. Major fracturing in limestone 3657 – 3704 feet.

Conclusions: The most favorable zone for testing based on field examination of cores, cuttings, induction well log and lab analysis of core appears to be between 3600 – 3708 feet. A second favorable zone for testing is indicated between 1510 and 1730 feet. Third zone is between 2873 – 3565 feet.

English #1, S22 T43S R22E

The English 1 is located in Sec 22, Twp 43S, R 22 E in San Juan County, Utah with 5415 feet elevation. This well was completed June 10, 1948.

Formation Record for this well:

Depth	Thickness	Formation
0 – 525′	525′	Sandstone; white, med to crs
525′ – 740′	215′	Sandstone with red shale
740′ – 930′	190′	Shale; sandy, with traces pink limestone
930′ – 1340′	410′	Shale; red to purple
1340′ – 1405′	165′	Sand; red and white, v. crs.
1405′ – 1645′	240′	Shale, red, with some sand
1645′ – 1770′	125′	Sand, white, to grey med.
1770′ – 2040′	270′	Shale, red and sand lenses
2040′ – 3055′	1015′	Shale; red-green, with minor amounts of limestone, anhydrite and chert
3055′ – 4480′	1425′	Limestone; grey to red, silty, with heavy beds of fine micaceous sandstone
4480′ – 5270′	790′	Limestone; tan to brown, med grained to fine, fossiliferous in part. Some beds of black calcareous shale. Nodules of black and orange chert
5270′ – 5510′	240′	Limestone; tan f. xtln, with considerable green and red shale
5510′ – 5870′	360′	Limestone; white, med. to crs. xtln, cherty
5870′ – 6055 ′	185′	Limestone; shaley with some beds white sandstone
6055′ – 6090′	35′	Limestone; brn, with increasing amts of quartz

The following potential productive zones were encountered in this well:

1. 4620 to 4675 feet
2. 4780 to 4825 feet
3. 5100 to 5150 feet
4. 5200 to 5300 feet
5. 5150 to 5650 feet

Well Treatment performed on February 1, 1949:

The well was acidized with 20,000 gallons in zones below 4670 feet

Well plugged back to 4670 feet.

Further acidizing with 13,000 gallons through perforations 4620 to 4670 feet.

Production: 25,000 Mcf/d

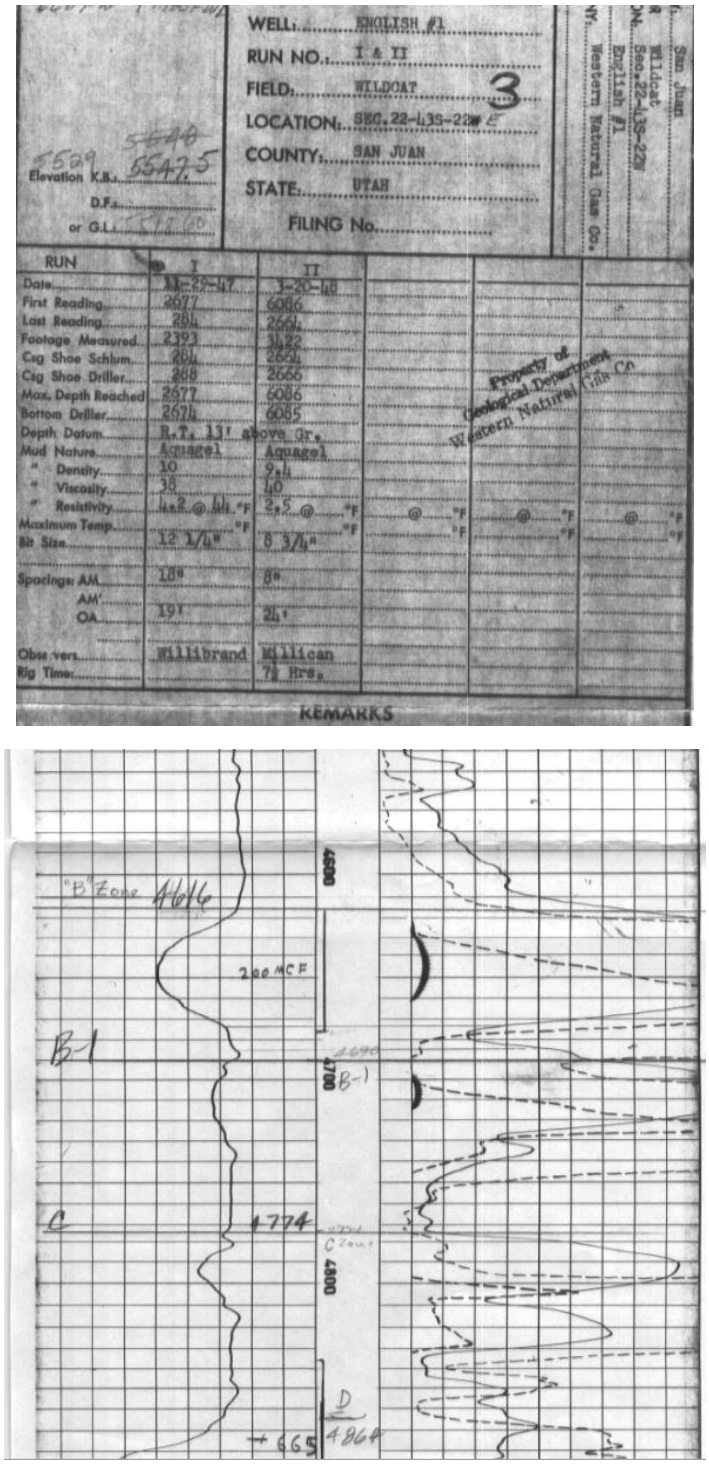

Figure 35: Induction Log for English #1, San Juan County, Utah showing perforation depth at 4620 to 4670 feet.

BECI Wells

The report will now focus on the four wells currently drilled by Blackstone Exploration Company Inc. These wells include the:

Rocking Chair Ranch #1,

Rocking Chair Ranch #2,

Rocking Chair Ranch #3 and

Rocking Chair Ranch #4.

These wells have been drilled and logged with both mud logs and electrical induction logs.

The well logs for each well will be evaluated and possible hydrocarbon zones will be identified and recommended for completion.

ROCKING CHAIR #1

Location: SEC 5-T13N-R23E

NAVAJO COUNTY, ARIZONIA, USA

Drilling Completed: 3-06-2016

API#: 02-017-20109

Ground Elevation (ft): 5826.9 K.B. Elevation (ft): 5827

Total Depth: 2218 (ft)

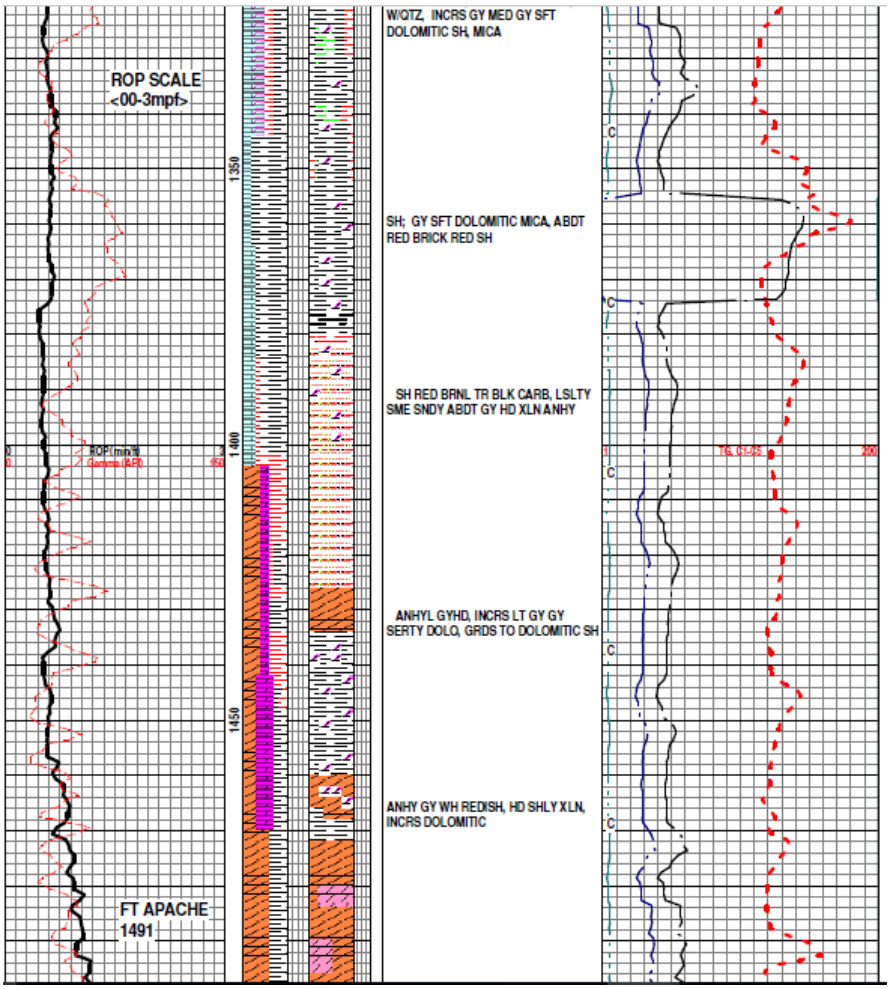

Figure 36 (a): Mud log for Rocking Chair Ranch #1 showing possible reservoir – Zone 1 (1336 – 1374 feet).

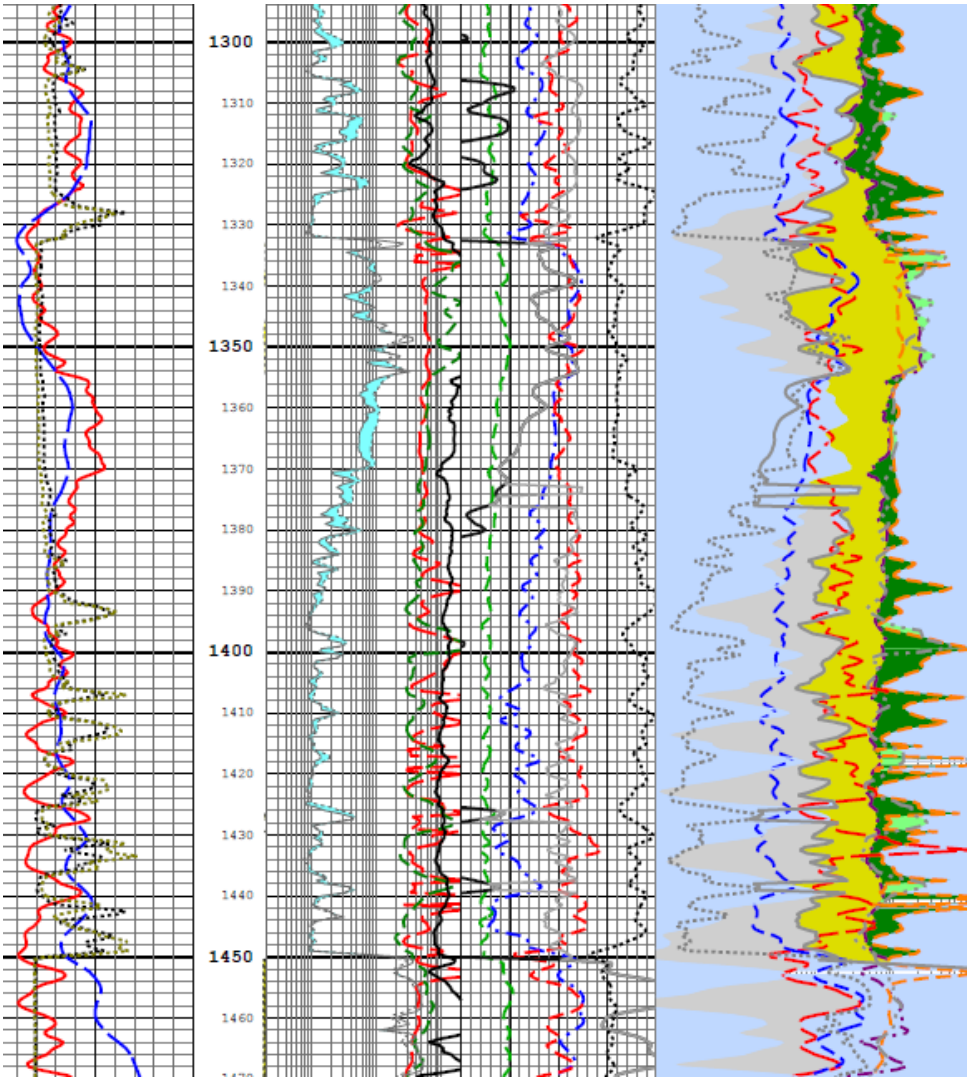

Figure 36 (b): Induction log for Rocking Chair Ranch #1 showing possible reservoir – Zone 1 (1336 – 1374 feet).

Possible productive zone indicated at 1336 – 1374 feet. Formation thickness is 38 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 36 (a) and (b) above.

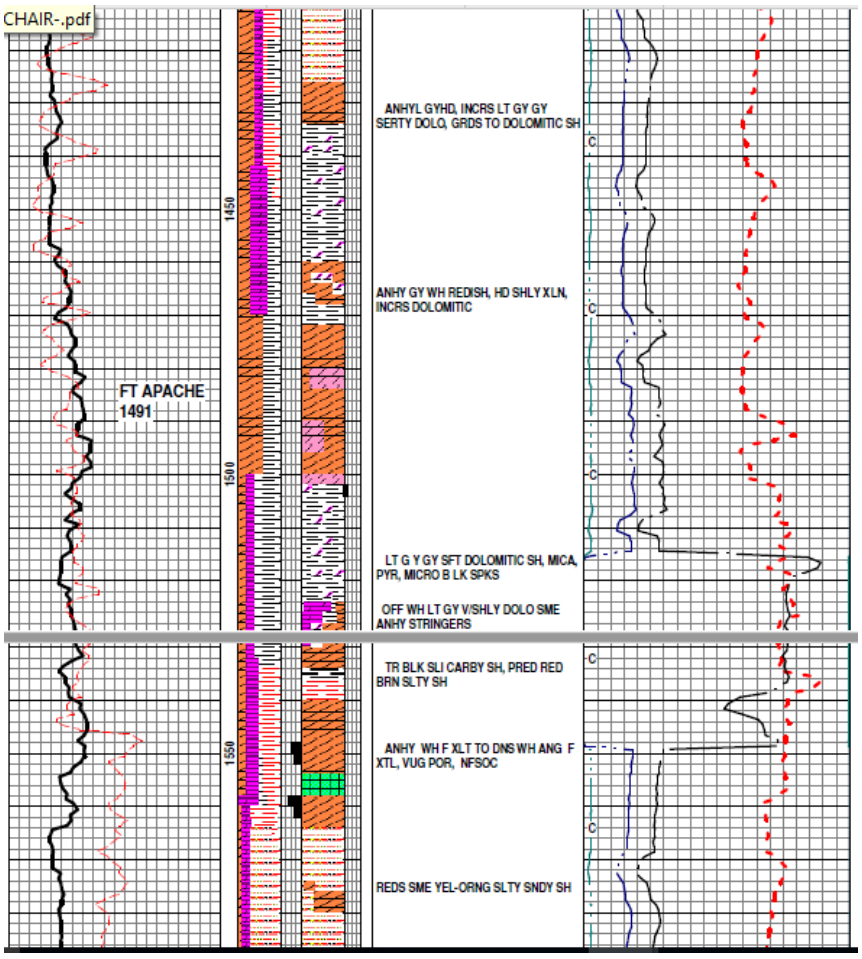

Figure 37 (a): Mud log for Rocking Chair Ranch #1 showing possible reservoir – Zone 2 (1450 – 1500 feet).

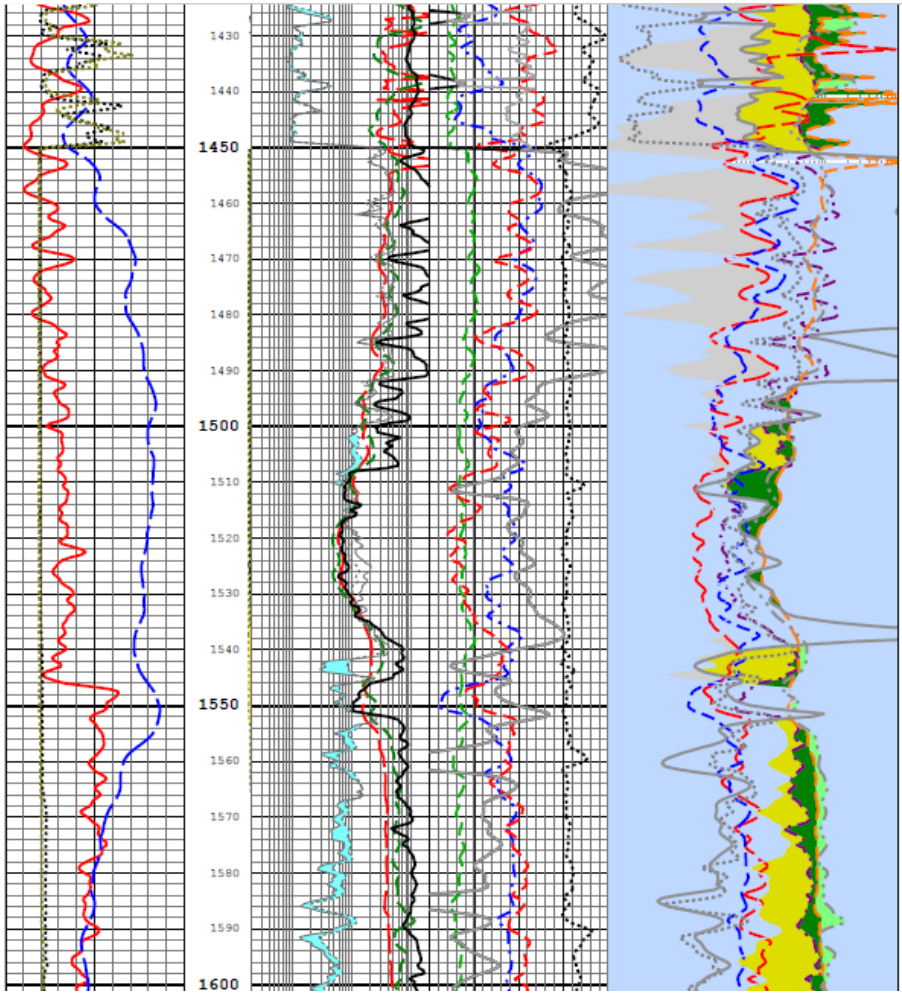

Figure 37 (b): Induction log for Rocking Chair Ranch #1 showing possible reservoir – Zone 2 (1450 – 1500 feet).

Possible productive zone indicated at 1450 – 1500 feet. Formation thickness is 50 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 37 (a) and (b) above.

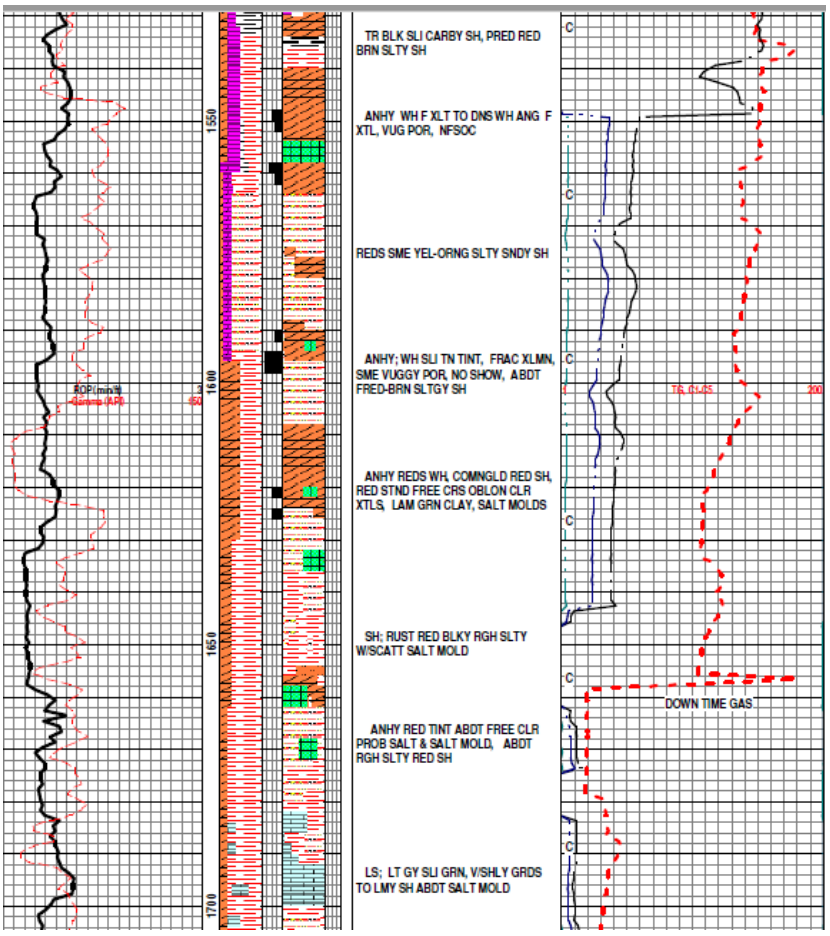

Figure 38 (a): Mud log for Rocking Chair Ranch #1 showing possible reservoir – Zone 3 (1610 – 1626 feet).

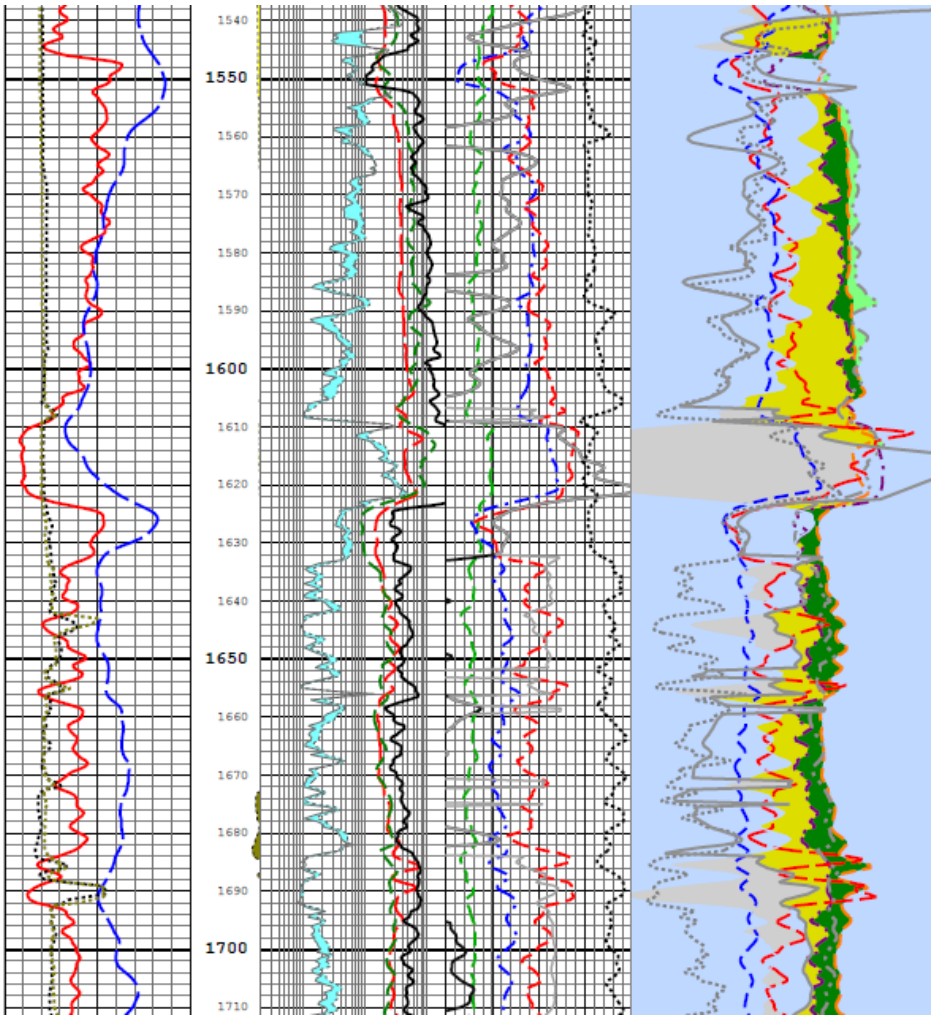

Figure 38 (b): Induction log for Rocking Chair Ranch #1 showing possible reservoir – Zone 3 (1610 – 1626 feet).

Possible productive zone indicated at 1610 – 1626 feet. Formation thickness is 16 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 38 (a) and (b) above.

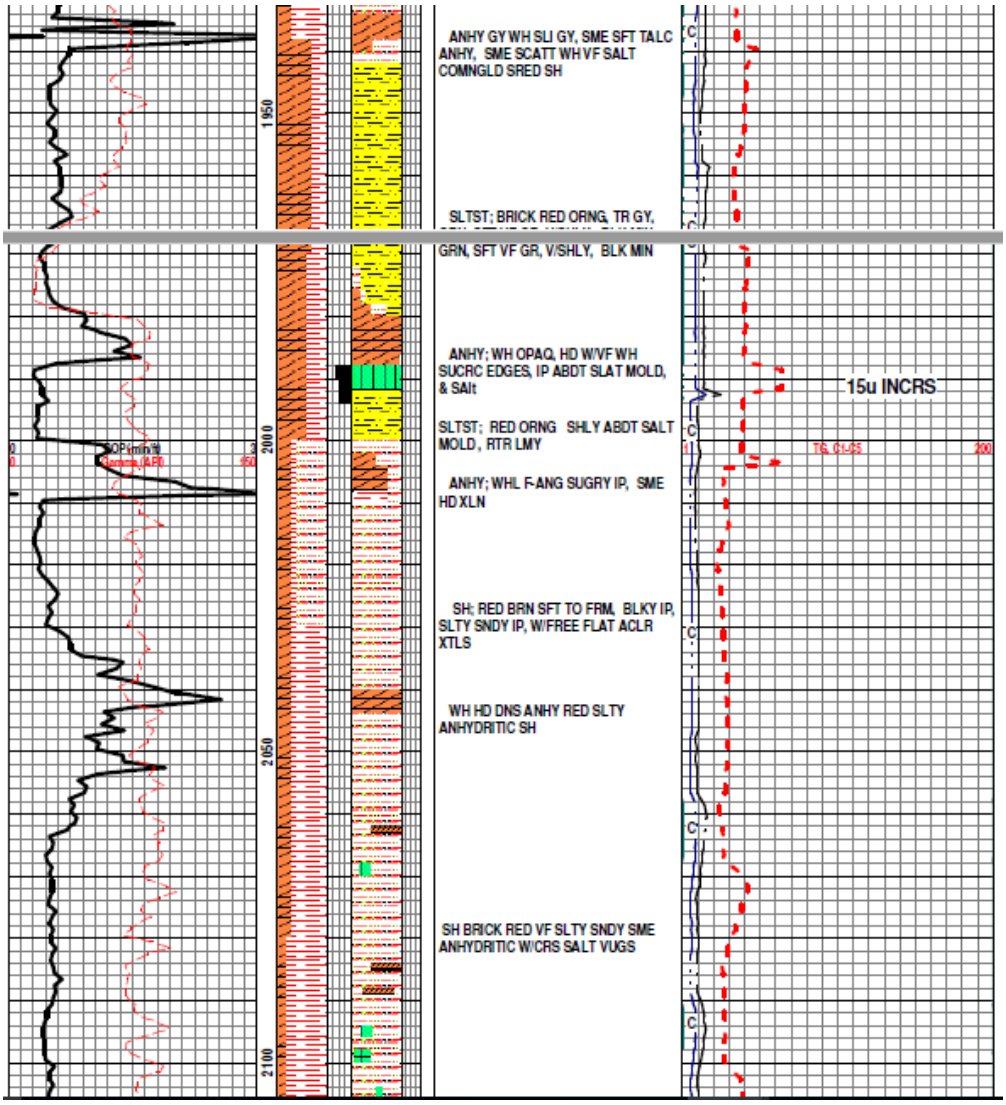

Figure 39 (a): Mud log for Rocking Chair Ranch #1 showing possible reservoir – Zone 4 (1970 – 1992 feet).

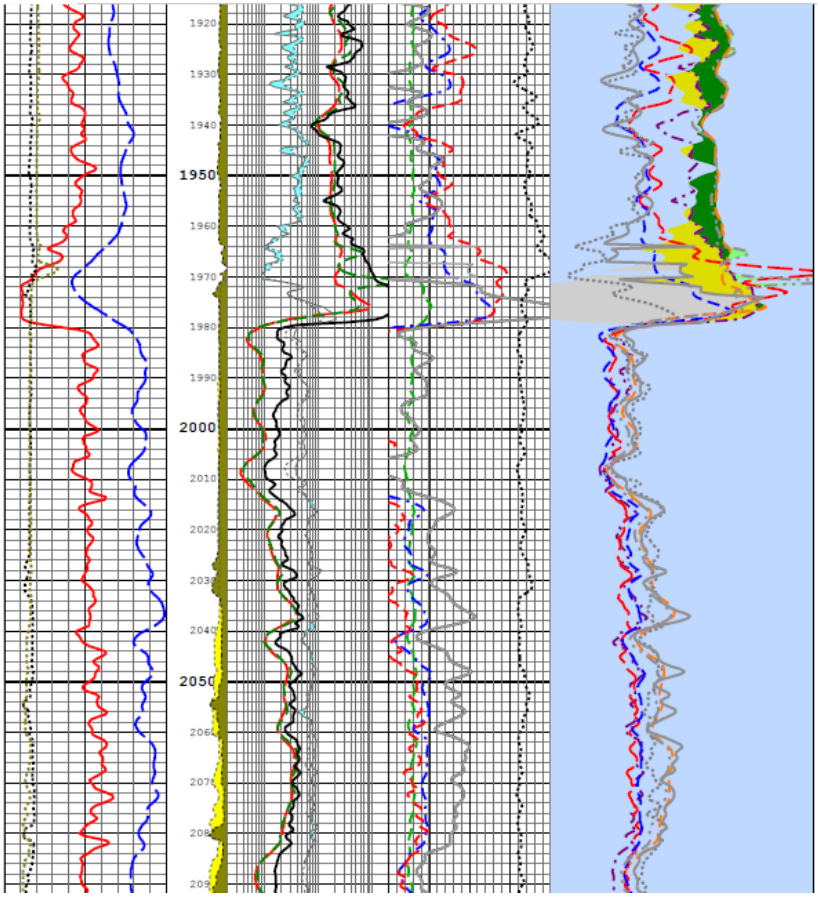

Figure 39 (b): Induction log for Rocking Chair Ranch #1 showing possible reservoir – Zone 4 (1970 – 1992 feet).

Possible productive zone indicated at 1970 – 1992 feet (based on mud log readings). Formation thickness is 22 feet

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 39 (a) and (b) above.

ROCKING CHAIR RANCH #2
SECTION: 13-T14N-R19E

NAVAJO COUNTY, ARIZONA

API# 02-017-20110

ELEVATIONS: KB: 5854’ GL: 5845’

(DRILLING MEASURED FROM KB)

TOTAL DEPTH: RTD: 2689’ LTD: 2684’ Drilling Completed: January 6, 2016

05-03-2016: Perforating the upper-Supai zones in the RCR02.

1451’-1457’

1438’-1444’

1353’-1363’

1336’-1344’

1175’-1179’

1089’-1095’

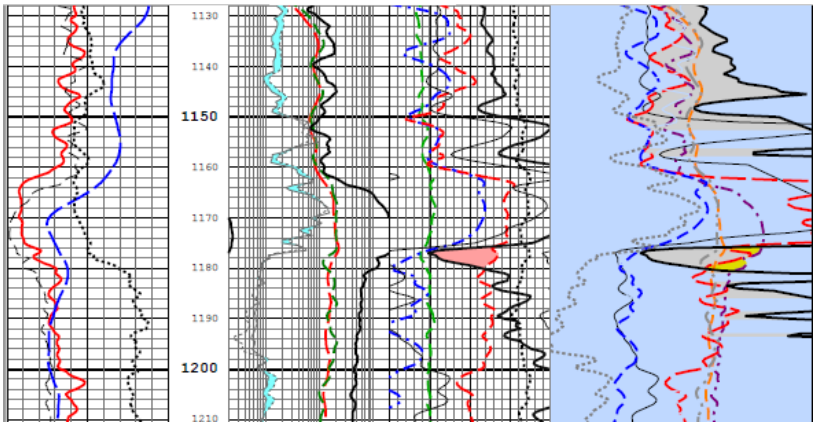

Figure 40 (a): Induction log for Rocking Chair Ranch #2 showing possible reservoir – Zone 1 (1170 – 1179 feet).

Possible productive zone indicated at 1170 – 1179 feet. Formation thickness 9 feet.

This is a zone showing high resistivity on the electric log in Figure 40 (a) above.

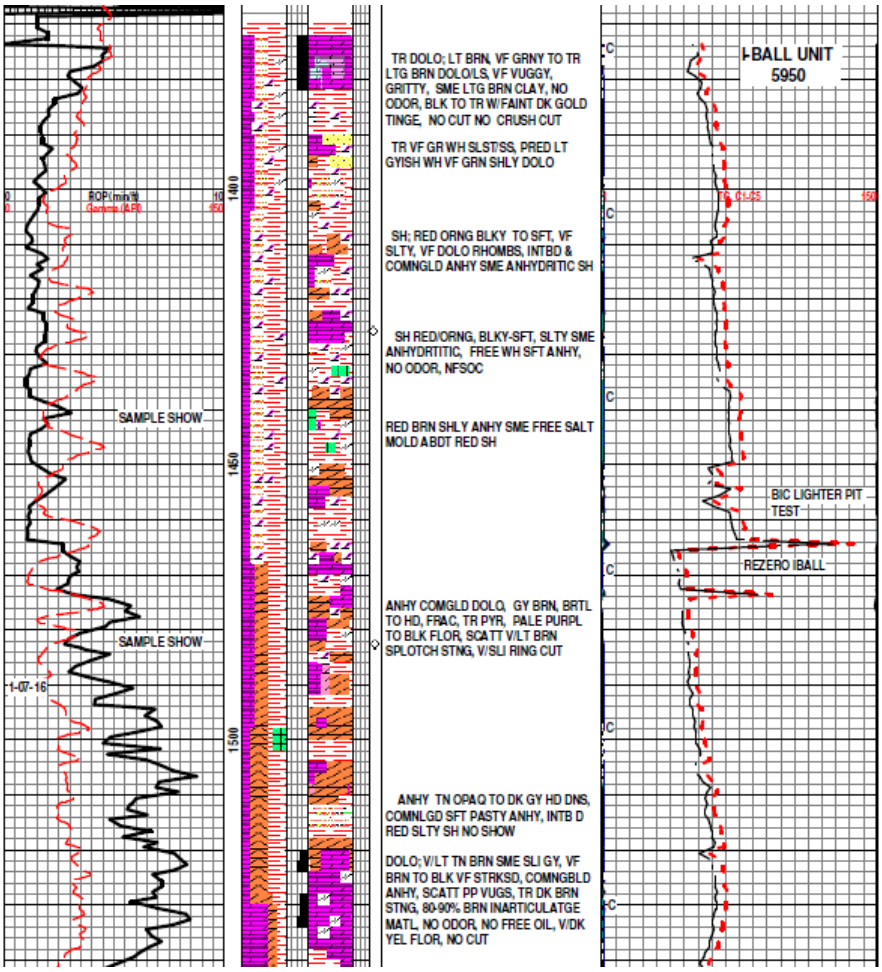

Figure 41 (a): Mud log for Rocking Chair Ranch #2 showing possible reservoir – Zone 2 (1344 – 1360 feet).

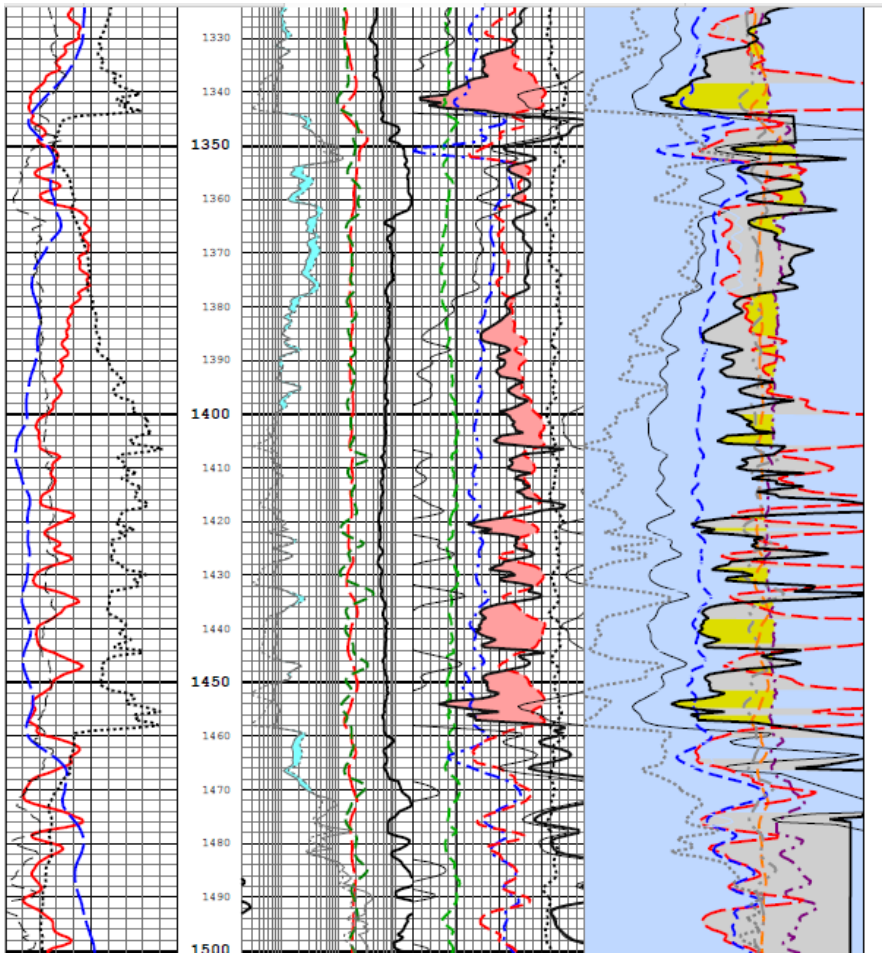

Figure 41 (b): Induction log for Rocking Chair Ranch #2 showing possible reservoir – Zone 2 (1344 – 1360 feet).

Possible productive zone indicated at 1344 – 1360 feet. Formation thickness is 16 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 41 (a) and (b) above.

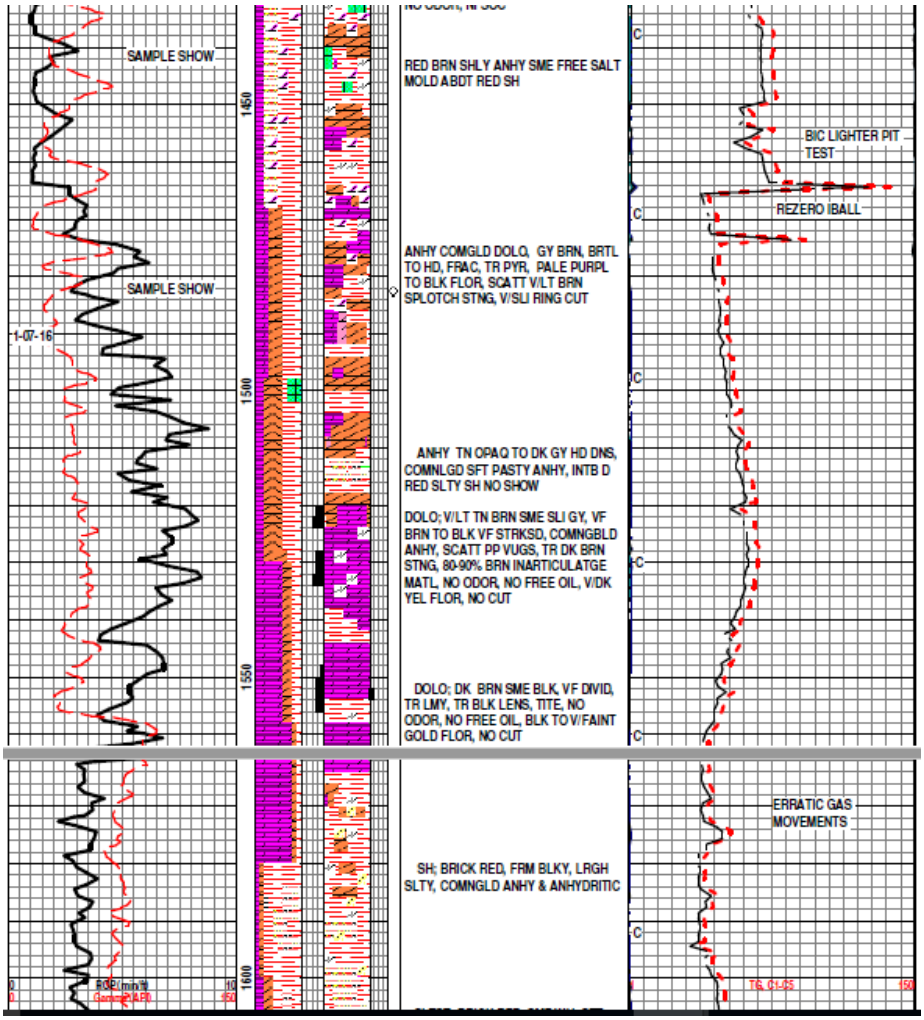

Figure 42 (a): Mud log for Rocking Chair Ranch #2 showing possible reservoir – Zone 3 (1450 – 1550 feet).

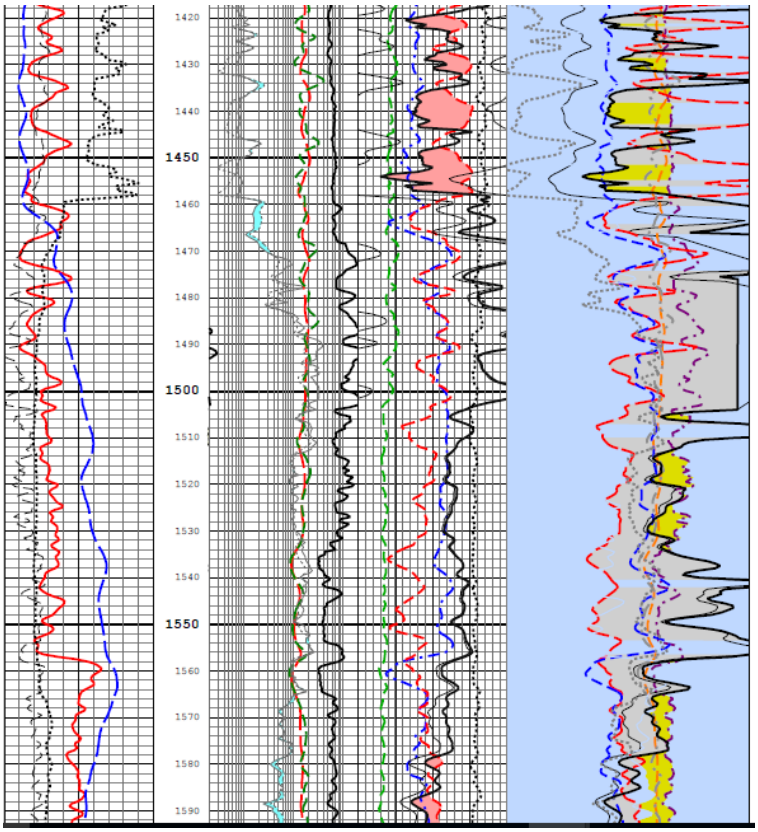

Figure 42 (b): Induction log for Rocking Chair Ranch #2 showing possible reservoir – Zone 3 (1450 – 1550 feet).

Possible productive zone indicated at 1450 – 1550 feet. Formation thickness is 100 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 42 (a) and (b) above.

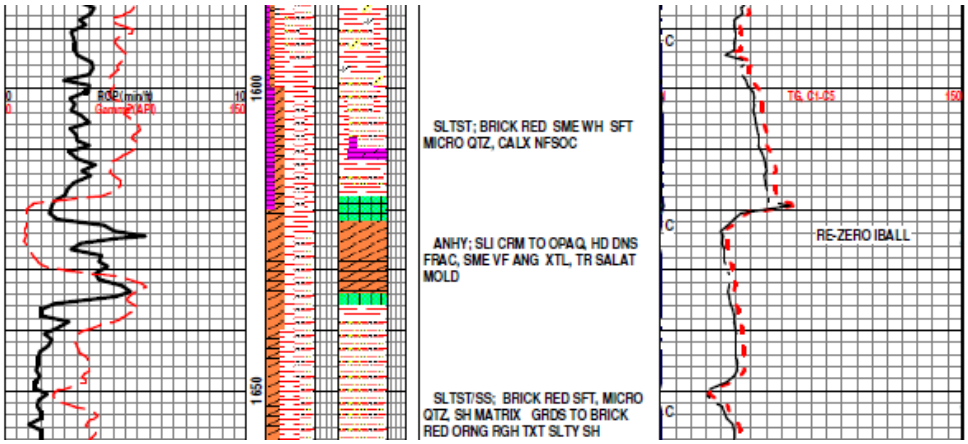

Figure 43 (a): Mud log for Rocking Chair Ranch #2 showing possible reservoir – Zone 4 (1620 – 1632 feet).

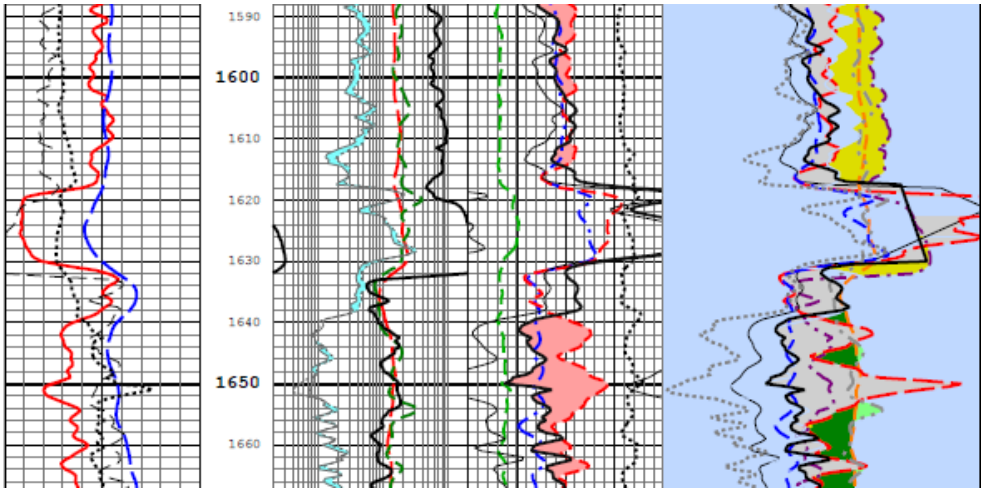

Figure 43 (b): Induction log for Rocking Chair Ranch #2 showing possible reservoir – Zone 4 (1620 – 1632 feet).

Possible productive zone indicated at 1620 – 1632 feet. Formation thickness is 12 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 43 (a) and (b) above.

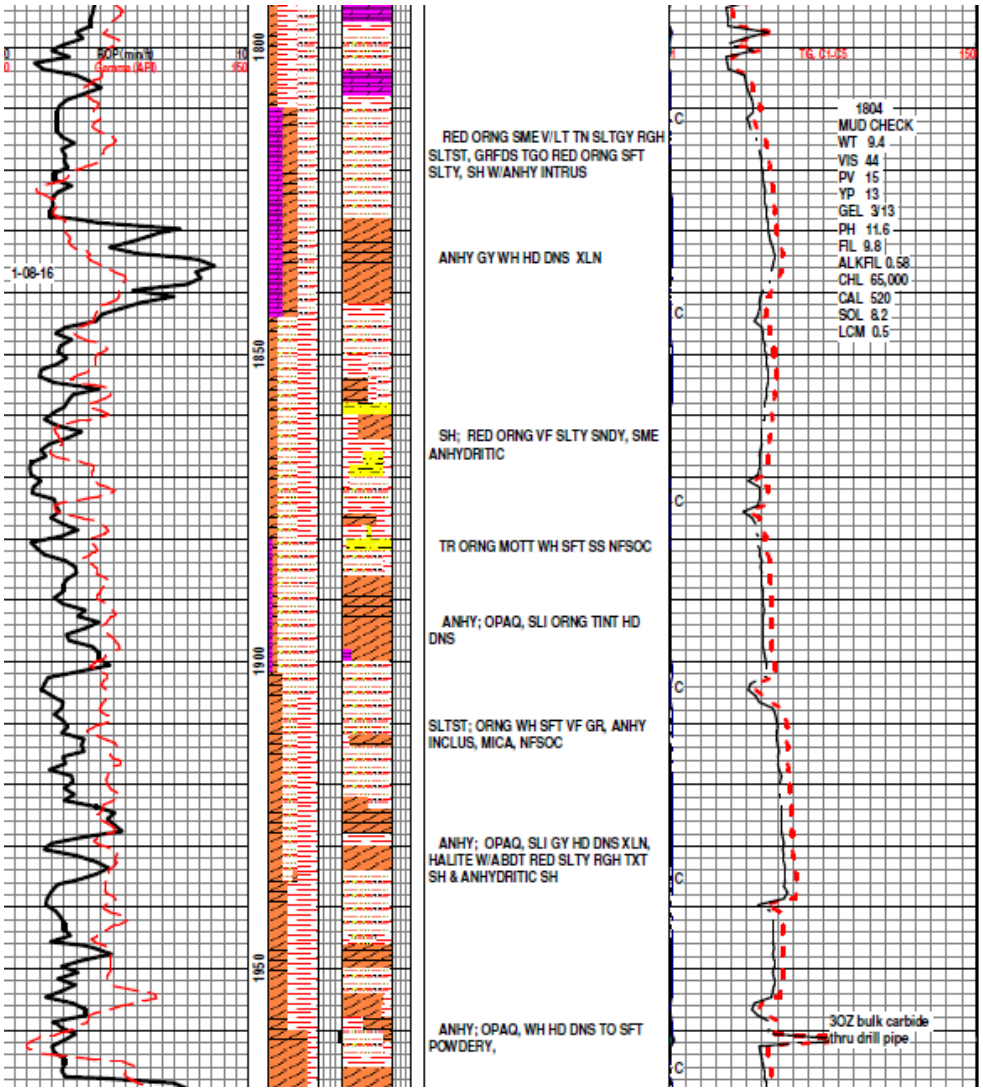

Figure 44 (a): Mud log for Rocking Chair Ranch #2 showing possible reservoir – Zones 5 and 6 (1820 – 1836 feet; 1940 – 1966 feet).

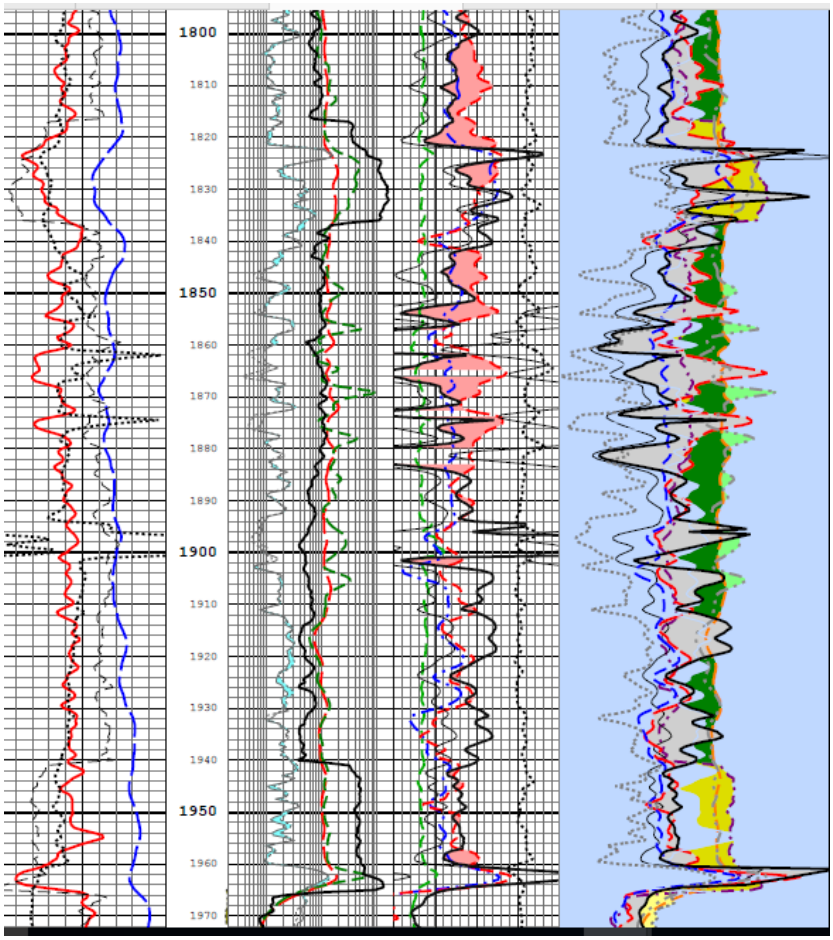

Figure 44 (b): Induction log for Rocking Chair Ranch #2 showing possible reservoir – Zones 5 and 6 (1820 – 1836 feet; 1940 – 1966 feet).

Possible productive zones indicated at 1820 – 1836 feet; and 1940 – 1966 feet. Formation thicknesses are 16 and 26 feet respectively.

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 44 (a) and (b) above. It is important to note that the mud logs have high readings throughout the interval (1820 to 1966 feet). The lithologies through these intervals are predominantly anhydrite, shale and limestone. These intervals can be acidized and fractured.

ROCKING CHAIR RANCH #3

SECTION 21-14N-R19E

Location: Navajo County, Arizona

Drilling Completed: 4-27-2016.

Total Depth (TD): 2223’.

Perforations:

1559’-1565’

1546’-1554’

1532’-1542’

1526’-1532’

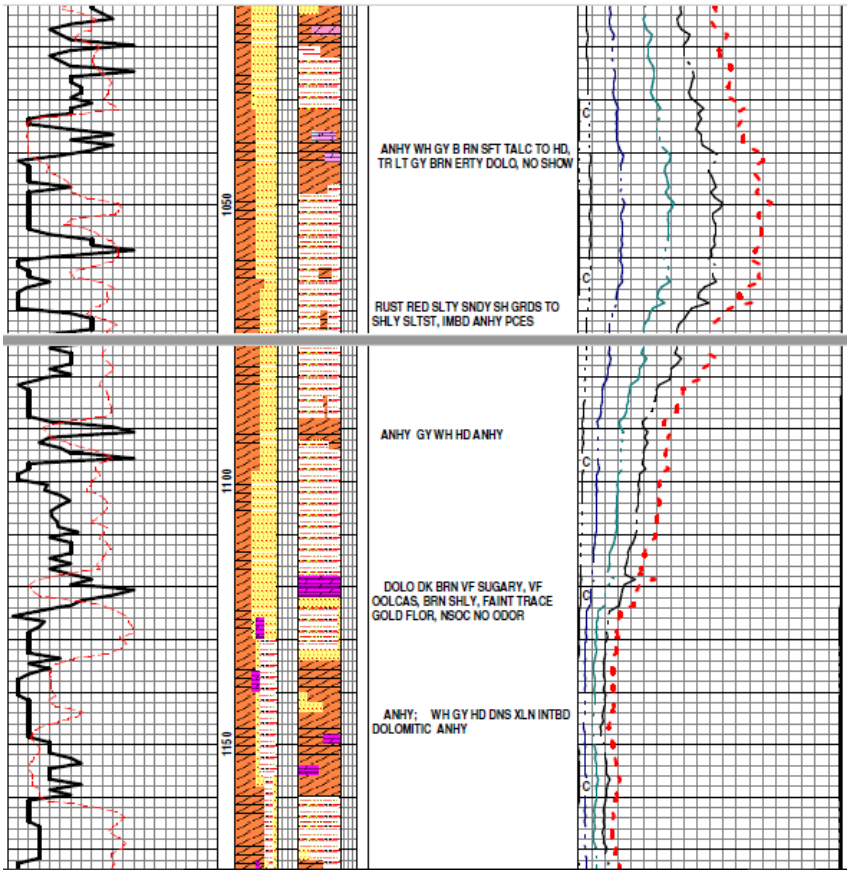

Figure 45 (a): Mud log for Rocking Chair Ranch #3 showing possible reservoir – Zones 1 and 2 (1030 – 1050 feet; and 1148 – 1162 feet).

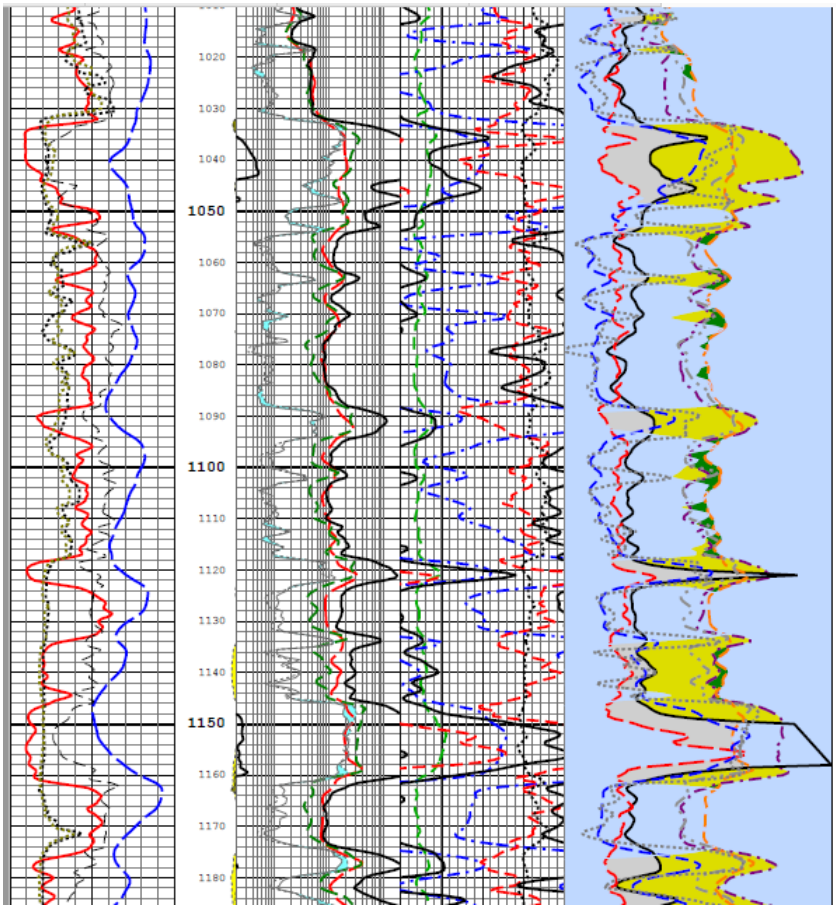

Figure 45(b): Induction log for Rocking Chair Ranch #3 showing possible reservoir – Zones 1 and 2 (1030 – 1050 feet; and 1148 – 1162 feet).

Possible productive zones indicated at 1030 – 1050 feet; and 1148 – 1162 feet. Formation thicknesses are 20 and 14 feet respectively.

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 45 (a) and (b) above.

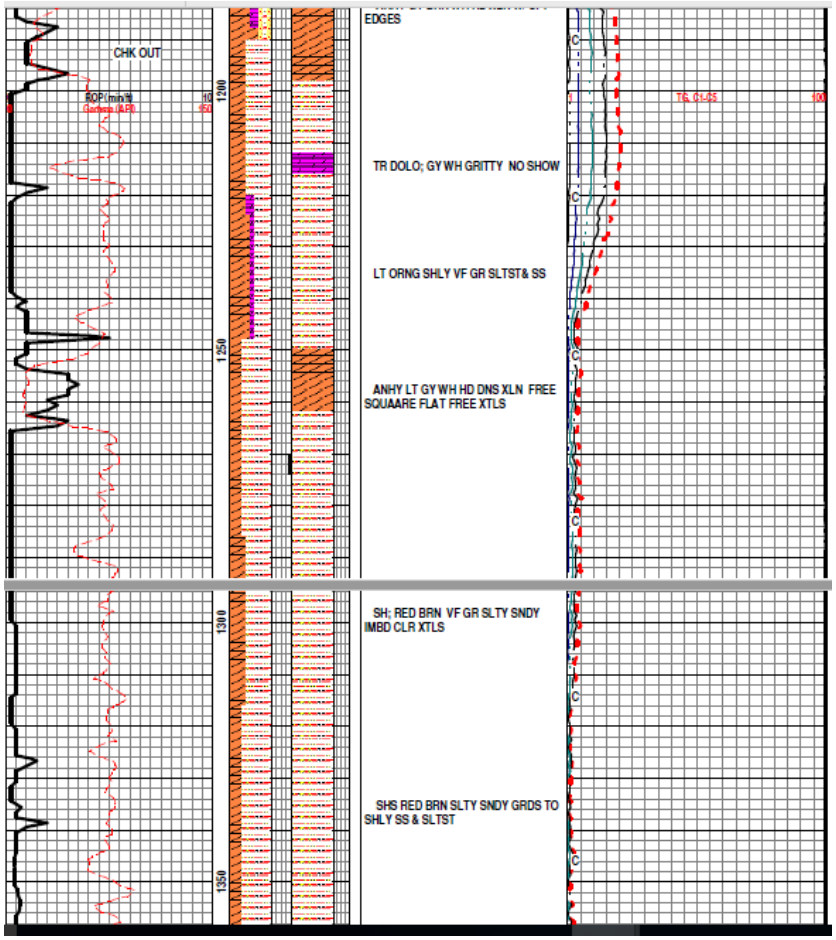

Figure 46 (a): Mud log for Rocking Chair Ranch #3 showing possible reservoir – Zones 3 and 4 (1212 – 1220 feet; and 1250 – 1268 feet).

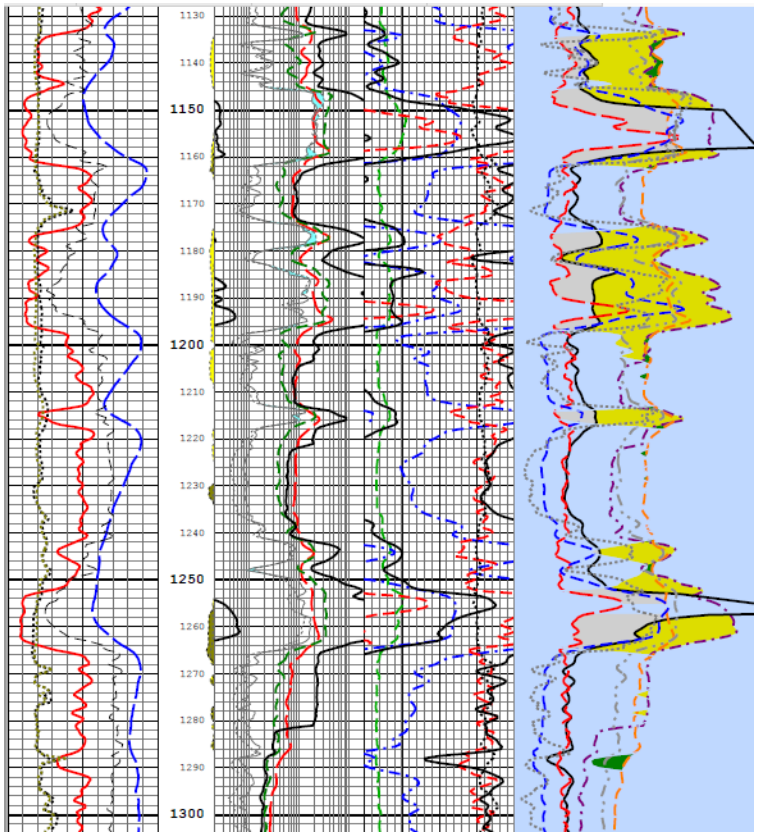

Figure 46(b): Induction log for Rocking Chair Ranch #3 showing possible reservoir – Zones 3 and 4 (1212 – 1220 feet; and 1250 – 1268 feet).

Possible productive zones indicated at 1212 – 1220 feet; and 1250 – 1268 feet. Formation thicknesses are 8 and 18 feet respectively.

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 46 (a) and (b) above.

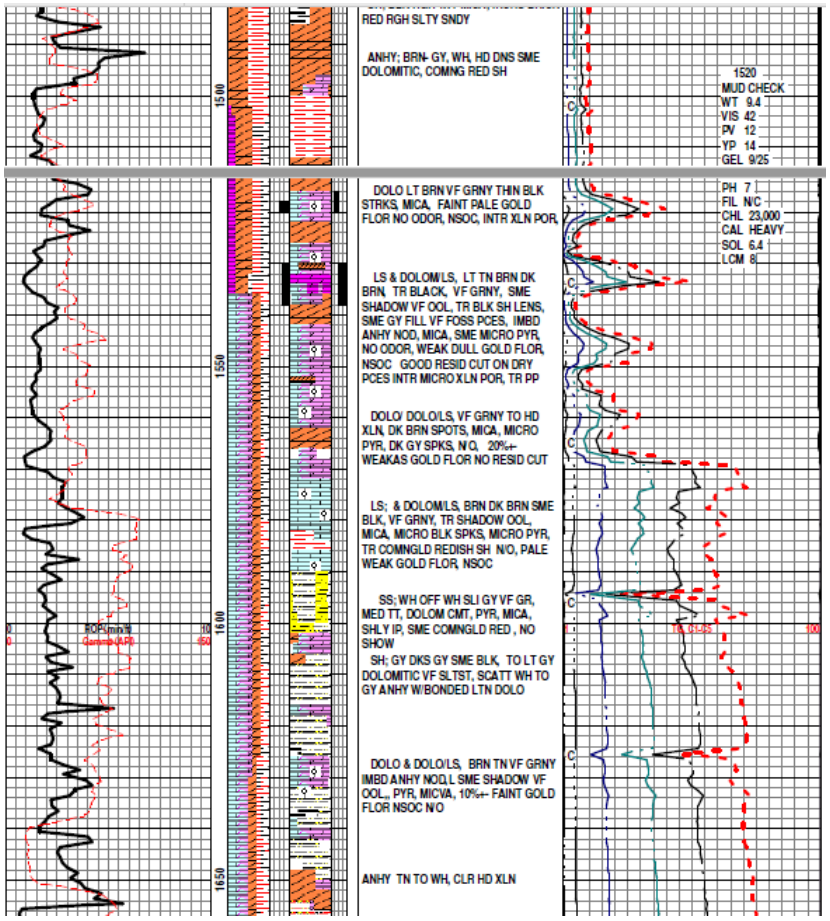

Figure 47 (a): Mud log for Rocking Chair Ranch #3 showing possible reservoir – Zones 5 and 6 (1488 – 1496 feet; and 1506 – 1674 feet).

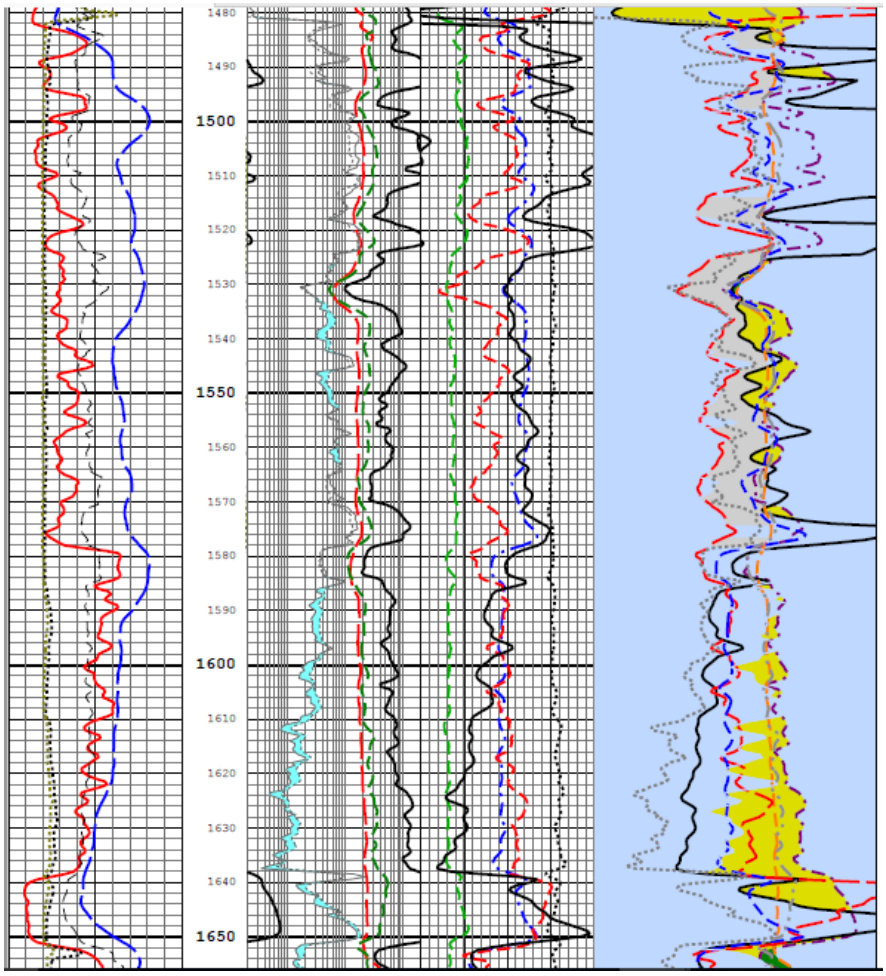

Figure 47 (b): Induction log for Rocking Chair Ranch #3 showing possible reservoir – Zones 5 and 6 (1488 – 1496 feet; and 1506 – 1674 feet).

Possible productive zones indicated at 1488 – 1496 feet; and 1506 – 1674 feet. Formation thicknesses are 8 and 168 feet respectively

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 47 (a) and (b) above.

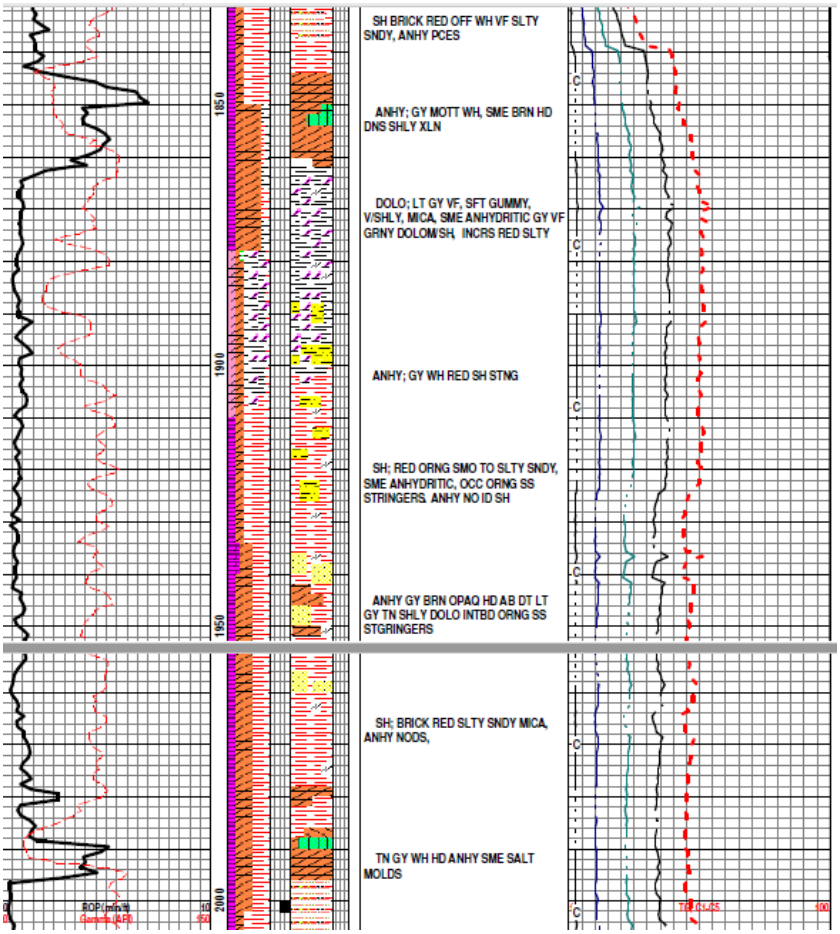

Figure 48 (a): Mud log for Rocking Chair Ranch #3 showing possible reservoir – Zones 7 and 8 (1840 – 1856 feet; and 1980 – 1992 feet).

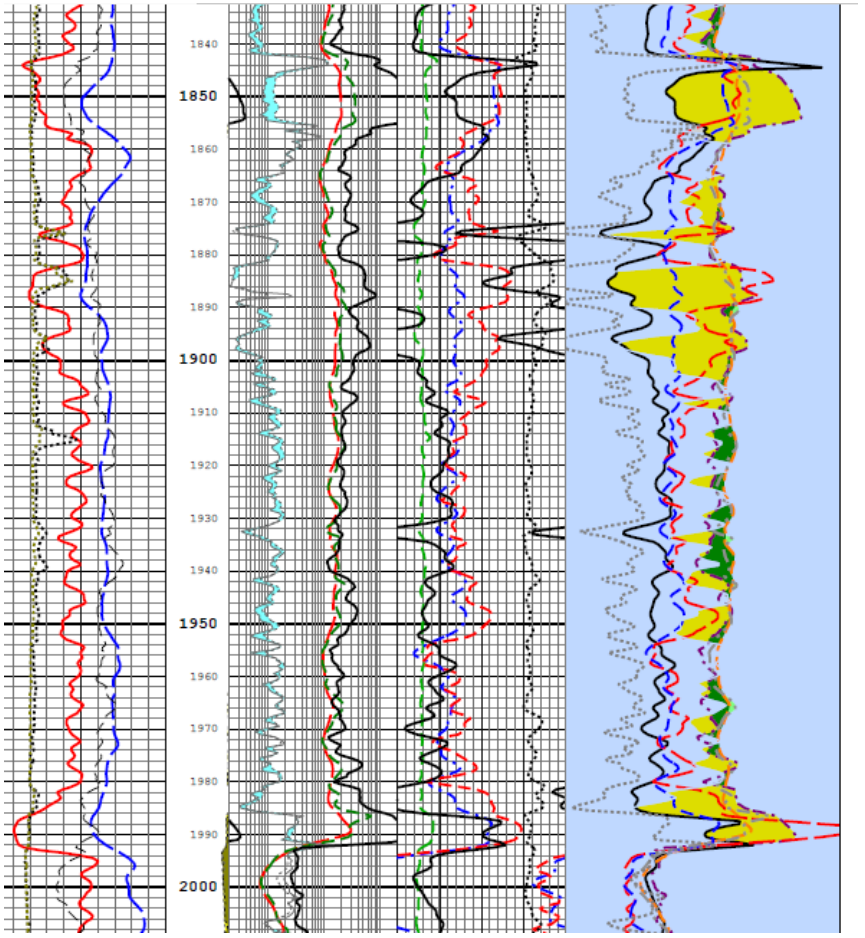

Figure 48 (b): Induction log for Rocking Chair Ranch #3 showing possible reservoir – Zones 7 and 8 (1840 – 1856 feet; and 1980 – 1992 feet).

Possible productive zones indicated at 1840 – 1856 feet; and 1980 – 1992 feet. Formation thicknesses are 16 and 12 feet respectively

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 48 (a) and (b) above. Note the gas show from the top (1840 feet) to the bottom (1992 feet) of the mud log section.

ROCKING CHAIR RANCH #4
SECTION-27-T14N-R19E

Total Depth of 1853’

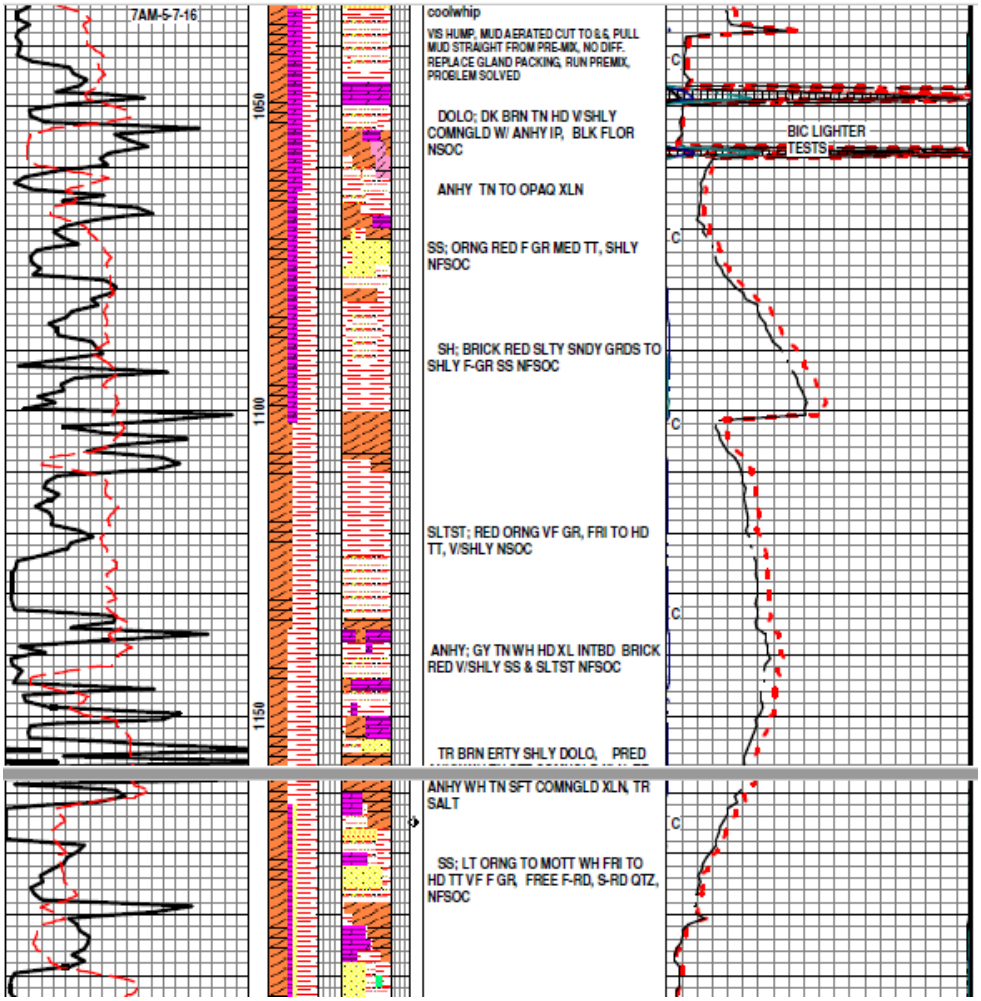

Figure 49 (a): Mud log for Rocking Chair Ranch #4 showing possible reservoir – Zones 1; 2; 3 and 4 (1052 – 1070 feet; 1106 – 1112 feet; 1140 – 1150 feet; and 1160 – 1190 feet).

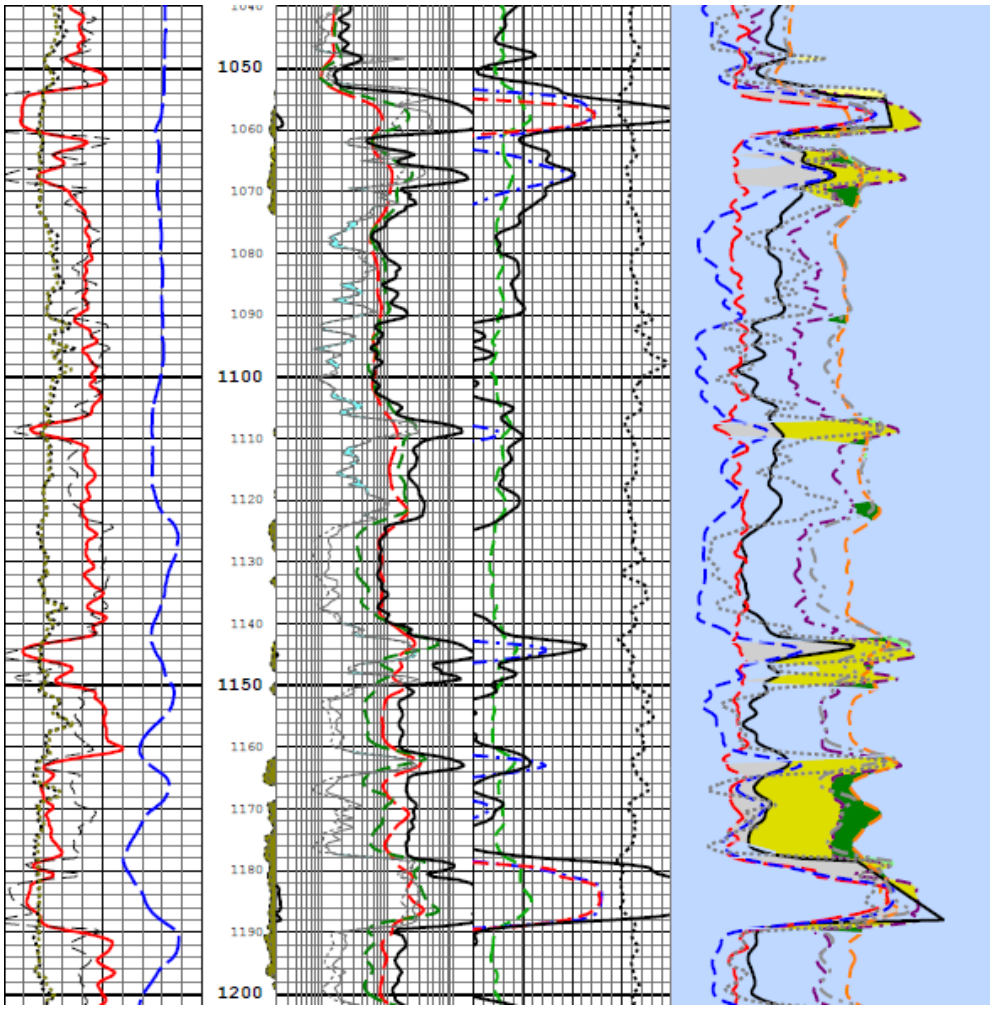

Figure 49 (b): Induction log for Rocking Chair Ranch #4 showing possible reservoir – Zones 1; 2; 3 and 4 (1052 – 1070 feet; 1106 – 1112 feet; 1140 – 1150 feet; and 1160 – 1190 feet).

Possible productive zones indicated at 1052 – 1070 feet; 1106 – 1112 feet; 1140 – 1150 feet; 1160 – 1190 feet. Formation thicknesses are 18; 6; 10 and 30 feet respectively

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 49 (a) and (b) above. Note the gas show from the top (1052 feet) to the bottom (1190 feet) of the mud log section.

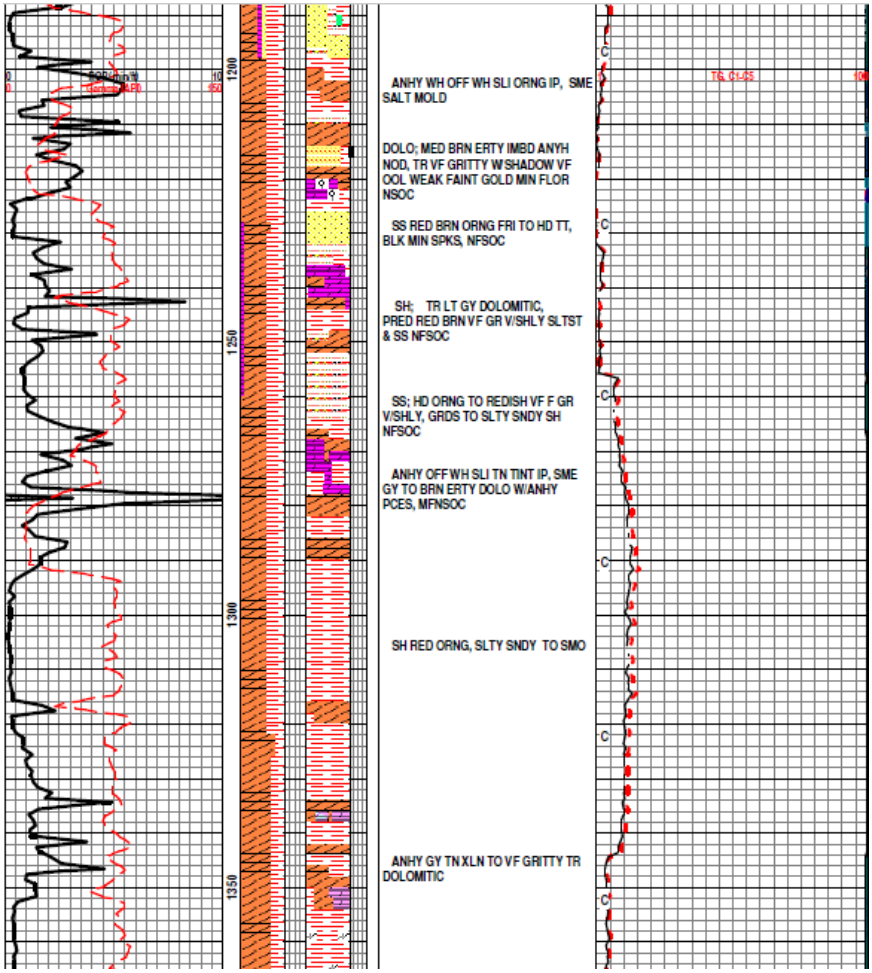

Figure 50 (a): Mud log for Rocking Chair Ranch #4 showing possible reservoir – Zones 1and 2 (1200 – 1224 feet; and 1264 – 1290 feet).

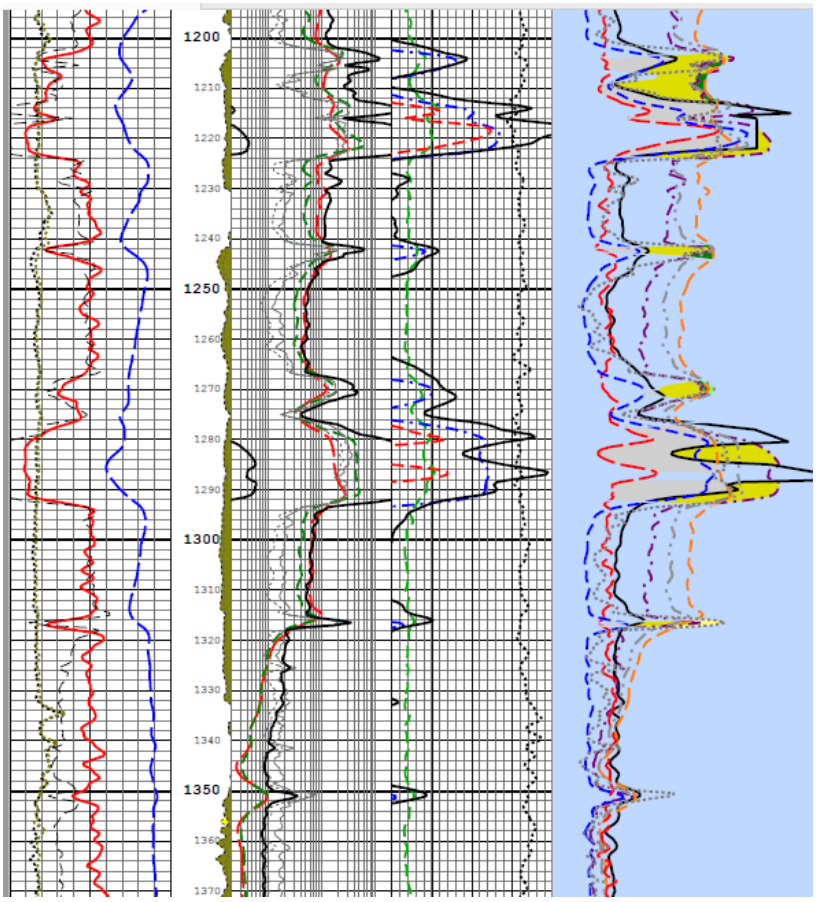

Figure 50 (b): Induction log for Rocking Chair Ranch #4 showing possible reservoir – Zones 1and 2 (1200 – 1224 feet; and 1264 – 1290 feet).

Possible productive zones indicated at 1200 – 1224 feet; and 1264 – 1290 feet. Formation thicknesses are 24 and 26 feet respectively

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 50 (a) and (b) above.

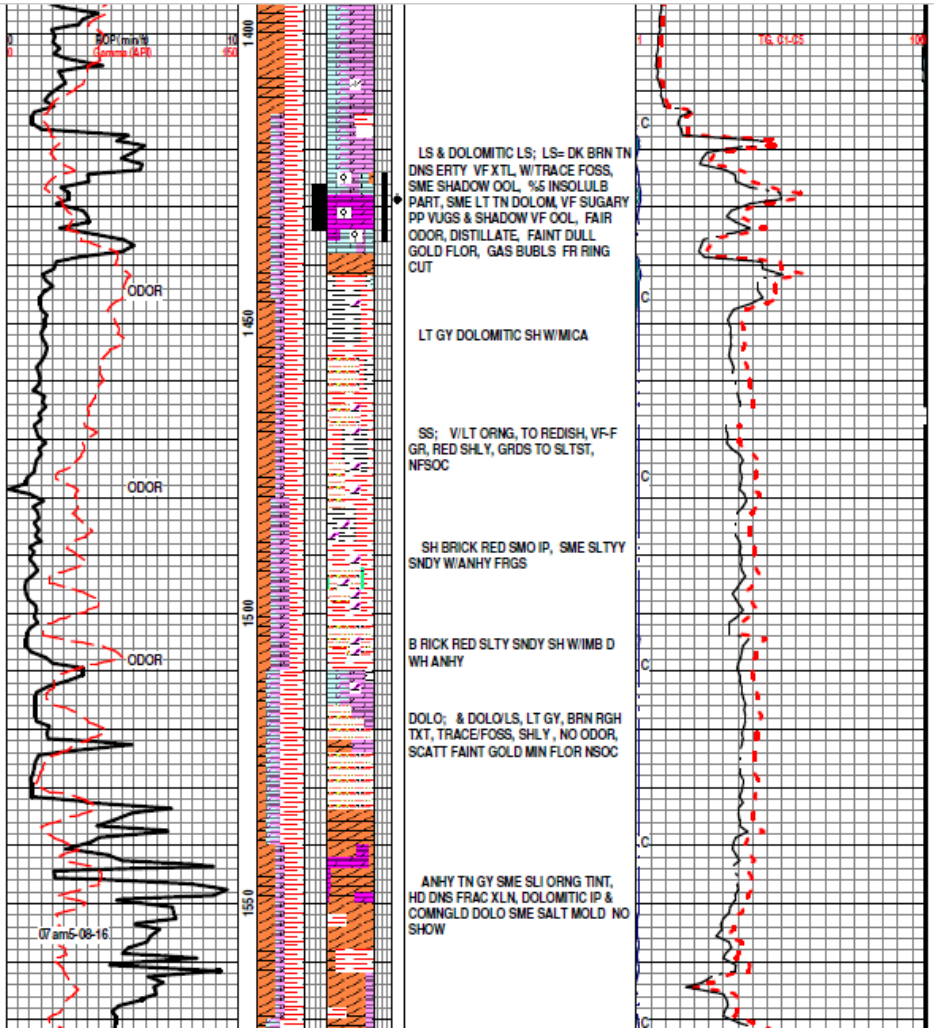

Figure 51 (a): Mud log for Rocking Chair Ranch #4 showing possible reservoir – Zone 3 (1400 – 1550 feet).

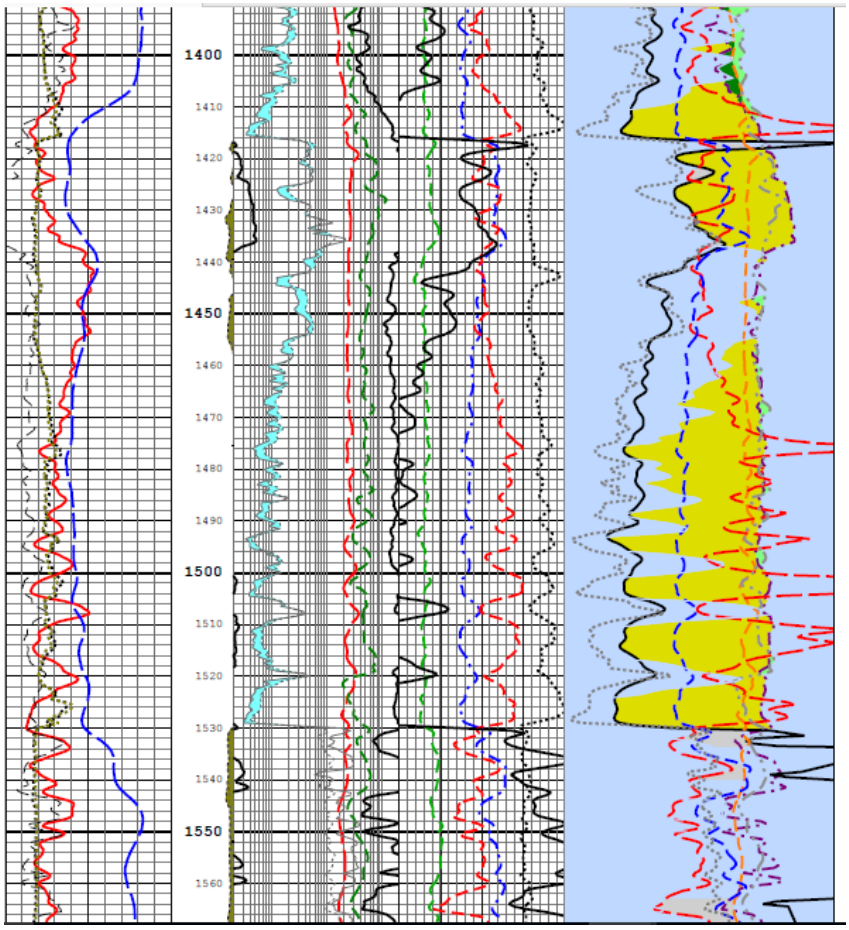

Figure 51 (b): Induction log for Rocking Chair Ranch #4 showing possible reservoir – Zone 3 (1400 – 1550 feet).

Possible productive zone indicated at 1400 – 1550 feet. Formation thickness is 150 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 51 (a) and (b) above.

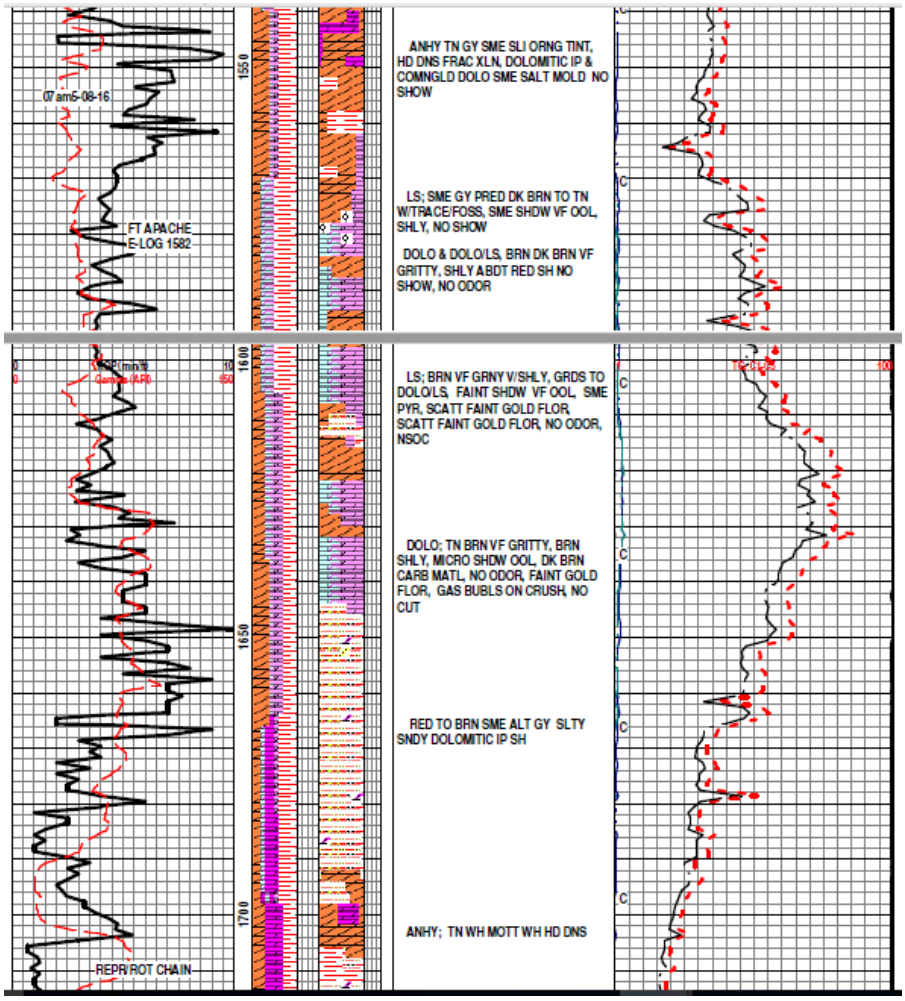

Figure 52 (a): Mud log for Rocking Chair Ranch #4 showing possible reservoir – Zones 4 and 5 (1550 – 1570 feet, and 1580 – 1704 feet).

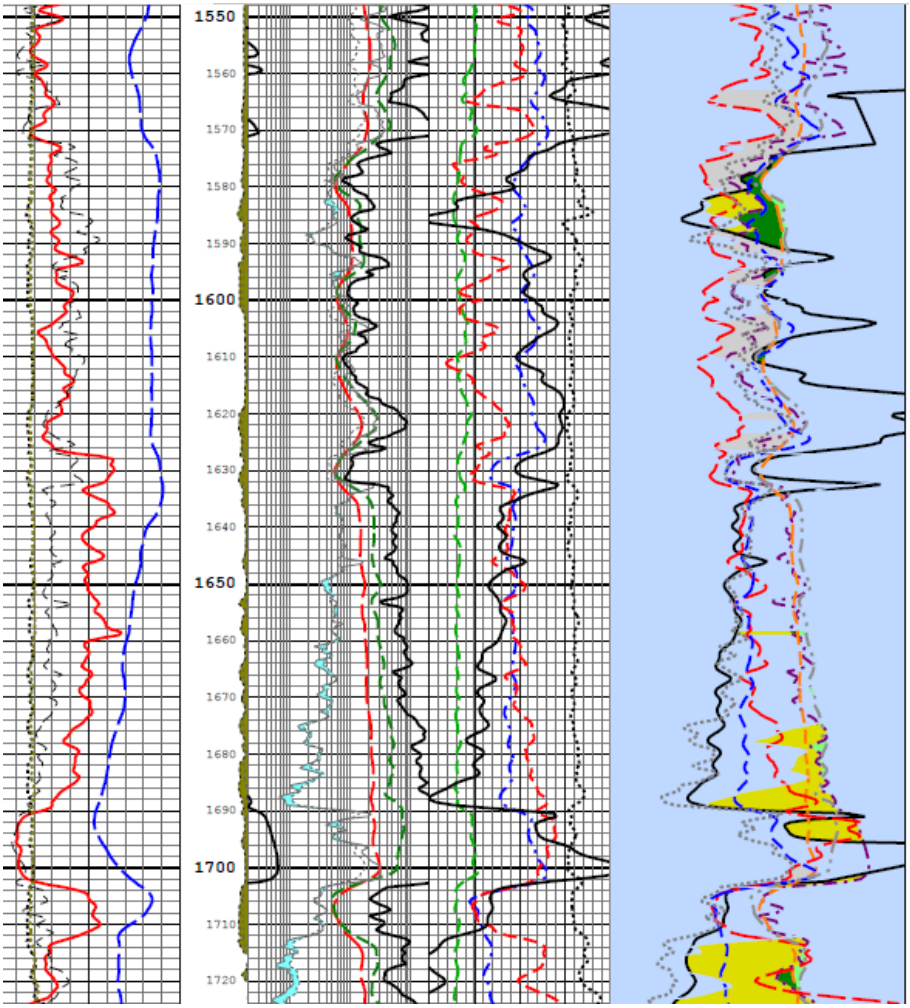

Figure 52 (b): Induction log for Rocking Chair Ranch #4 showing possible reservoir – Zones 4 and 5 (1550 – 1570 feet, and 1580 – 1704 feet).

Possible productive zones indicated at 1550 – 1570 feet, and 1580 – 1704 feet. Formation thicknesses are 20 and 124 feet respectively

These zones show high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 52 (a) and (b) above.

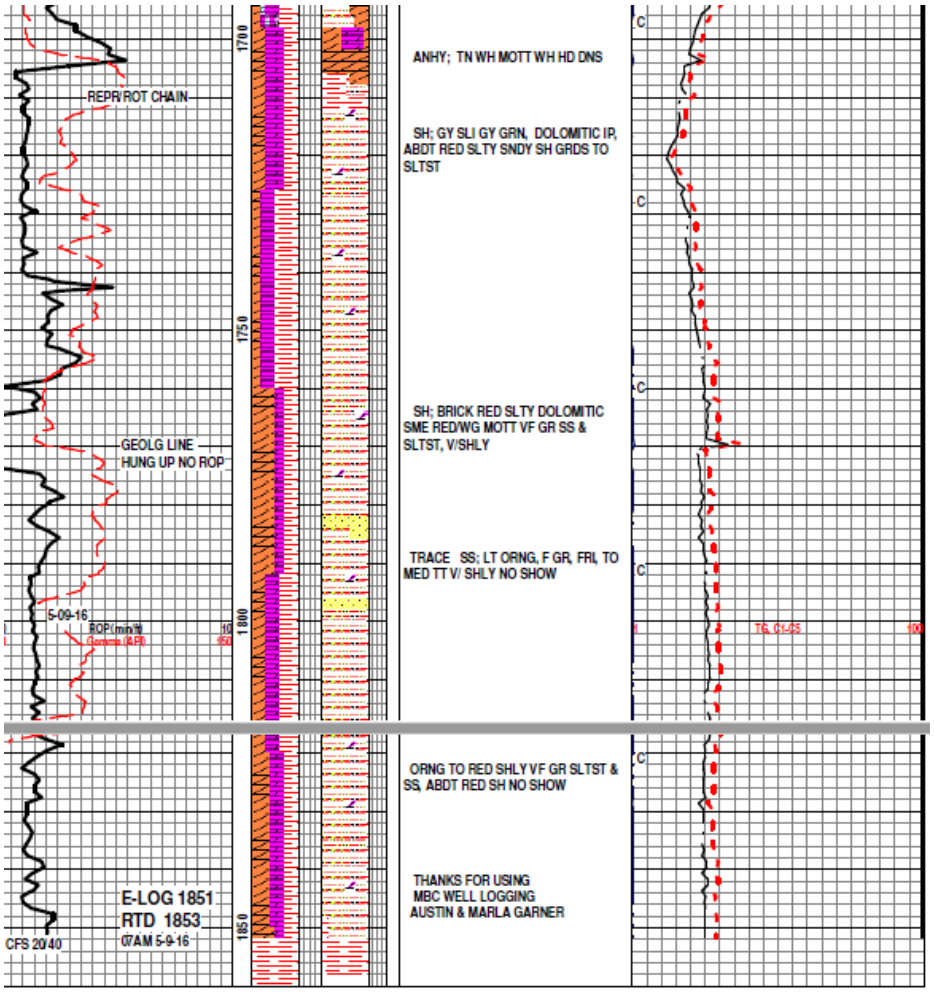

Figure 53 (a): Mud log for Rocking Chair Ranch #4 showing possible reservoir – Zone 6 (1716 – 1820 feet).

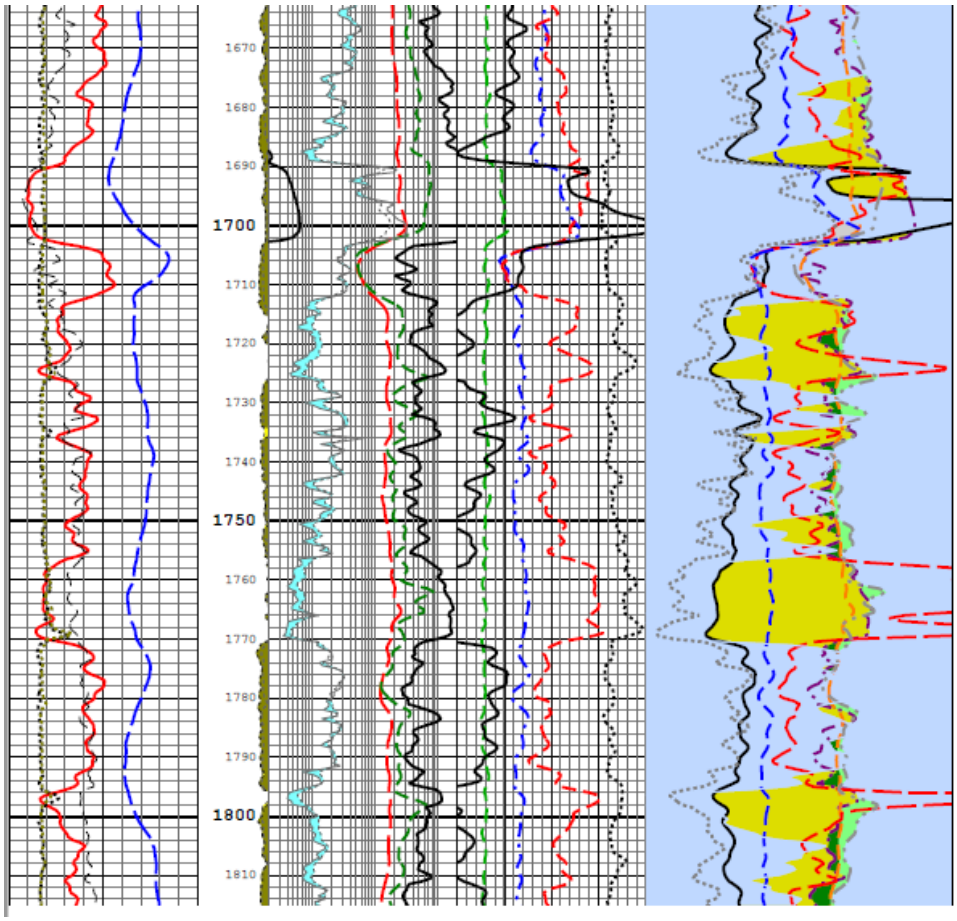

Figure 53 (b): Induction log for Rocking Chair Ranch #4 showing possible reservoir – Zone 6 (1716 – 1820 feet).

Possible productive formation indicated at 1716 – 1820 feet. Formation thickness is 104 feet.

This zone shows high resistivity on the electric log and high gas readings on the mud log as indicated in Figure 53 (a) and (b) above.

Summary of Well Evaluation

The following wells drilled by Blackstone Exploration Company Inc. (BECI); -Rocking Chair Ranch #1, #2 ,#3 and #4 were evaluated. The mud log and induction logs for each well indicated multiple zones in each well that can potentially be hydrocarbon bearing reservoir rocks. Each identified zone will need to be isolated and tested to determine the production performance of each zone. The dominant lithology in these wells is limestone or carbonate, with shales; and evaporites including anhydrite, gypsum. These identified zones will need to be stimulated with acid and fractured to recover the oil and gas (including helium) that are contained in these tight reservoir rocks.

Rocking Chair Ranch #1

- Zone 1: 1336 – 1374 feet. Formation thickness is 38 feet.
- Zone 2: 1450 – 1500 feet. Formation thickness is 50 feet.
- Zone 3: 1610 – 1626 feet. Formation thickness is 16 feet.
- Zone 4: 1970 – 1992 feet. Formation thickness is 22 feet

This well has 4 possible productive zones with a total thickness of 126 feet.

Rocking Chair Ranch #2

- Zone 1: 1170 – 1179 feet. Formation thickness 9 feet.
- Zone 2: 1344 – 1360 feet. Formation thickness is 16 feet.
- Zone 3: 1450 – 1550 feet. Formation thickness is 100 feet.
- Zone 4: 1620 – 1632 feet. Formation thickness is 12 feet.
- Zone 5: 1820 – 1836 feet. Formation thickness is 16 feet.
- Zone 6: 1940 – 1966 feet. Formation thickness is 26 feet

This well has 6 possible productive zones with a total thickness of 179 feet.

Rocking Chair Ranch #3

- Zone 1: 1030 – 1050 feet. Formation thickness is 20 feet.
- Zone 2: 1148 – 1162 feet. Formation thickness is 14 feet.
- Zone 3: 1212 – 1220 feet. Formation thickness is 8 feet.
- Zone 4: 1250 – 1268 feet. Formation thickness is 18 feet.
- Zone 5: 1488 – 1496 feet. Formation thickness is 8 feet.
- Zone 6: 1506 – 1674 feet. Formation thickness is 168 feet.
- Zone 7: 1840 – 1856 feet. Formation thickness is 16 feet.
- Zone 8: 1980 – 1992 feet. Formation thickness is 12 feet.

This well has 8 possible productive zones with a total thickness of 264 feet.

Rocking Chair Ranch #4

- Zone 1: 1052 – 1070 feet. Formation thickness is 18 feet.
- Zone 2: 1106 – 1112 feet. Formation thickness is 6 feet.
- Zone 3: 1140 – 1150 feet. Formation thickness is 10 feet.
- Zone 4: 1160 – 1190 feet. Formation thickness is 30 feet.
- Zone 5: 1200 – 1224 feet. Formation thickness is 24 feet.
- Zone 6: 1264 – 1290 feet. Formation thickness is 26 feet.
- Zone 7: 1400 – 1550 feet. Formation thickness is 150 feet.
- Zone 8: 1550 – 1570 feet. Formation thickness is 20 feet.
- Zone 9: 1580 – 1704 feet. Formation thickness is 124 feet.
- Zone 10: 1716 – 1820 feet. Formation thickness is 104 feet.

This well has 10 possible productive zones with a total thickness of 512 feet.

Vertical wells will need to be drilled to determine the extent of the lateral extent of the identified reservoir rocks in the area. Horizontal wells that will result in improved contact with the reservoir rocks and an increase in recoverable reserves can then be subsequently drilled to develop the field.

Gas Analysis for BECI wells

The gas produced from the Rocking Ranch #1 and Rocking Ranch #4 wells were collected and sent to the lab and analyzed to determine their respective compositions. Two sets of samples for each well were collected and analyzed. Both samples for each well confirm the presence of helium gas in each well. The two samples from the Rocking Ranch #1 have helium concentration of 0.186% and 0.163% respectively. Also, both samples from the Rocking Ranch #4 show concentrations of 0.157% and 0.184% respectively. The gas samples also exhibit low dry gas content of 177.2 and 199.3 BTU for both Rocking Ranch #4; and 321.2 and 286.5 BTU for the Rocking Ranch #1.

This confirms the presence of helium gas in the shallower Permian rocks in the leasehold area.

It is anticipated from core reports of wells in the surrounding vicinity that higher concentrations of helium will be encountered in the deeper Devonian zones.

OXYGEN

NATURAL GAS ANALYSIS REPORT
GPA 2145-09

Sampled by:	Analyzed by:
Blackstone Exploration	Caraway Analytical, Inc
PO Box 940	P. O. Box 2137
Holbrook, Arizona 86025	Liberal, Kansas 67905
Phone:	Phone: 620-482-2371
Fax:	Fax: 620-626-7108

Lab Number: 20160800 Analyzed: 05/02/16

Sample From:	ROCKING CHAIR RANCH #1	Pressure:	
Producer:	BLACKSTONE EXPLORATION	Temperature:	
Date:		Location:	5-13-20
Time:		County:	NAJAVO
Sampler:	ROGER MARTIN	State:	ARIZONA
Source:	#3	Formation:	FT APACHE

		Mole %	GPM
Helium	He:	0.186	0.000
Hydrogen	H2:	0.053	0.000
Oxygen	O2:	3.369	0.000
Nitrogen	N2:	63.933	0.000
Carbon Dioxide	CO2:	6.576	0.000
Methane	C1:	21.485	0.000
Ethane	C2:	2.600	0.975
Propane	C3:	1.240	0.465
Iso Butane	iC4:	0.148	0.045
Normal Butane	nC4:	0.227	0.072
Iso Pentane	iC5:	0.056	0.015
Normal Pentane	nC5:	0.044	0.012
Hexanes Plus	C6+:	0.083	0.019
	TOTAL:	100.000	1.604
	Z Fact:	0.9999	
	SP.GR.:	0.9338	
	BTU (SAT):	315.6 @ 14.73 psia	
	BTU (DRY):	321.2 @ 14.73 psia	
	OCTANE RATING:	32.2	

COMMENTS: HIGH CO2
ANALYZED TWICE

Oxygen 3.369

OXYGEN

NATURAL GAS ANALYSIS REPORT
GPA 2145-09

Sampled by:	Analyzed by:
Blackstone Exploration	Caraway Analytical, Inc
PO Box 940	P. O. Box 2137
Holbrook, Arizona 86025	Liberal, Kansas 67905
Phone:	Phone: 620-482-2371
Fax:	Fax: 620-626-7108

Lab Number: 20160801 Analyzed: 05/02/16

Sample From:	ROCKING CHAIR RANCH #1	Pressure:	
Producer:	BLACKSTONE EXPLORATION	Temperature:	
Date:		Location:	5-13-20
Time:		County:	NAJAVO
Sampler:	ROGER MARTIN	State:	ARIZONA
Source:	#3	Formation:	FT APACHE

		Mole %	GPM
Helium	He:	0.163	0.000
Hydrogen	H2:	0.050	0.000
Oxygen	O2:	5.280	0.000
Nitrogen	N2:	65.743	0.000
Carbon Dioxide	CO2:	5.567	0.000
Methane	C1:	19.353	0.000
Ethane	C2:	2.274	0.853
Propane	C3:	1.087	0.407
Iso Butane	iC4:	0.130	0.040
Normal Butane	nC4:	0.198	0.063
Iso Pentane	iC5:	0.049	0.013
Normal Pentane	nC5:	0.038	0.011
Hexanes Plus	C6+:	0.068	0.016
	TOTAL:	100.000	1.403
	Z Fact:	0.9999	
	SP.GR.:	0.9378	
	BTU (SAT):	281.5 @ 14.73 psia	
	BTU (DRY):	286.5 @ 14.73 psia	
	OCTANE RATING:	28.9	

COMMENTS: HIGH CO2
ANALYZED TWICE

Oxygen 5.280

NATURAL GAS ANALYSIS REPORT
GPA 2145-09

Sampled by:	Analyzed by:
Blackstone Exploration	Caraway Analytical, Inc
PO Box 940	P. O. Box 2137
Holbrook, Arizona 86025	Liberal, Kansas 67905
Phone:	Phone: 620-482-2371
Fax:	Fax: 620-626-7108

Lab Number:	20161231	Analyzed:	06/23/16
Sample From:	ROCKING CHAIR RANCH #4	Pressure:	
Producer:	BLACKSTONE EXPLORATION	Temperature:	
Date:		Location:	27-14-19
Time:		County:	NAJAVO
Sampler:	ROGER MARTIN	State:	ARIZONA
Source:	#1	Formation:	FT APACHE

		Mole %	GPM
Helium	He:	0.157	0.000
Hydrogen	H2:	0.000	0.000
Oxygen	O2:	0.000	0.000
Nitrogen	N2:	39.675	0.000
Carbon Dioxide	CO2:	45.413	0.000
Methane	C1:	12.775	0.000
Ethane	C2:	1.180	0.443
Propane	C3:	0.502	0.188
Iso Butane	iC4:	0.073	0.022
Normal Butane	nC4:	0.109	0.035
Iso Pentane	iC5:	0.035	0.010
Normal Pentane	nC5:	0.029	0.008
Hexanes Plus	C6+:	0.052	0.012
	TOTAL:	100.000	0.717
	Z Fact:	0.9998	
	SP.GR.:	1.1722	
	BTU (SAT):	174.1 @ 14.73 psia	
	BTU (DRY):	177.2 @ 14.73 psia	
	OCTANE RATING:	18.5	

COMMENTS: HIGH CO2 0.000

NATURAL GAS ANALYSIS REPORT
GPA 2145-09

Sampled by:	Analyzed by:
Blackstone Exploration	Caraway Analytical, Inc
PO Box 940	P. O. Box 2137
Holbrook, Arizona 86025	Liberal, Kansas 67905
Phone:	Phone: 620-482-2371
Fax:	Fax: 620-626-7108

Lab Number:	20161232	Analyzed:	06/23/16
Sample From:	ROCKING CHAIR RANCH #4	Pressure:	
Producer:	BLACKSTONE EXPLORATION	Temperature:	
Date:		Location:	27-14-19
Time:		County:	NAJAVO
Sampler:	ROGER MARTIN	State:	ARIZONA
Source:	#2	Formation:	FT APACHE

		Mole %	GPM
Helium	He:	0.184	0.000
Hydrogen	H2:	0.021	0.000
Oxygen	O2:	0.000	0.000
Nitrogen	N2:	44.764	0.000
Carbon Dioxide	CO2:	38.601	0.000
Methane	C1:	14.050	0.000
Ethane	C2:	1.418	0.532
Propane	C3:	0.616	0.231
Iso Butane	iC4:	0.088	0.027
Normal Butane	nC4:	0.131	0.042
Iso Pentane	iC5:	0.040	0.011
Normal Pentane	nC5:	0.031	0.009
Hexanes Plus	C6+:	0.056	0.013
	TOTAL:	100.000	0.864
	Z Fact:	0.9999	
	SP.GR.:	1.1303	
	BTU (SAT):	195.9 @ 14.73 psia	
	BTU (DRY):	199.3 @ 14.73 psia	
	OCTANE RATING:	20.6	

COMMENTS: HIGH CO2 0.000

Observations from Pinta Dome field Drilling, Completion and Production

The Pinta Dome field is the field that produced the highest concentration of Helium in the United States. The wells in the Pinta Dome area were drilled into the Coconino Sandstone. This sandstone body is stratigraphically present in the Pinta Dome area of production at a depth ranging from 945 – 1000 feet. The wells were vertical wells that were perforated and the gas was produced without further well treatment.

Observations from DBK field Drilling, Completion and Production

The DBK field is the most productive oil and gas field in Arizona, accounting for over 75% of the State's total production. The wells that were drilled in the late 1960s and early 1970s were vertical wells that targeted the intrusive igneous syenite sill within the Hermosa limestone and shale formation. These wells were drilled and perforated at a depth ranging from 2800 – 2900 feet. It is reported that there had been recorded oil and gas shows in cuttings when drilling through this formation earlier times. However, as reported by the Geologist in charge of this discovery, it was further treatment of this zone with three stage treatment (an initial acidizing and subsequent bigger frac) that unlocked commercial quantities of hydrocarbons. This well completion technique was applied to all the thirty-one (31) wells drilled in the DBK and resulted in an average well production of 500,000 barrels each. Basically the good oil shows in the formations at 2800 feet depth required appropriate well completion techniques of acidizing and fracturing to unlock about 20 million barrels of oil.

More recently 2003, operators are deepening the wells in the DBK field to target the deeper Devonian and Mississippian formations. The helium concentrations at this depth are reported to be higher than those produced along with the oil and gas at shallower depths.

Recommendations for BECI Wells

Implementation of the observations from drilling and completions of wells in the vicinity; particularly the completion techniques applied to the DBK field have to be employed in the BECI drilling area.

Also, the possible productive zones identified in each of the wells drilled and subsequent wells will have to be acidized and fractured to unlock the oil and gas reserves in these tight rocks.

The extent of the reservoir rocks in the field will need to be determined to understand rock compartmentalization in this area

The influence of the volcanism (which makes this region a complex geological one) in this area will need to be understood to aid in the exploration for oil, natural gas and helium gas reserves in the area and the region as a whole.

There is reportedly a correlation between volcanism and helium reserves. This need to be further investigated and understood in this area as observed both in the DBK field and Pinta Dome area (See Figure 54 for an illustration of an earth model that can be applied to this area).

Incorporating seismic data, regional studies, 3-d earth and reservoir modeling will greatly improve the knowledge of rock compartmentalization and uncover other intrusive igneous rocks in the area that maybe productive reservoirs.

On-going data gathering, gas sampling while drilling, record of drilling activities, well logging, mud logging, core samples and core data analysis must continue to be carried out to aid in the exploration and production of oil and gas in the area.

Intrusive or Plutonic, Processes and Bodies

The generic term for an intrusive igneous body is a pluton, and the rocks outside the pluton are called the country rocks. The size and shape of plutons is generally somewhat speculative because erosion exposes only a small portion of most bodies. Nonetheless, we have managed to accumulate considerable data from more deeply eroded plutons, geophysical studies, and mining works. From these we have classified plutonic bodies into a few common forms. These forms are grouped into tabular, or sheet-like, bodies and non-tabular ones. Further classification is based on specific shapes and whether a body cuts across the fabric (usually bedding) of the country rocks or whether it follows the external structures. Crosscutting bodies are called discordant, and those that are intruded parallel to the country rock structure are called concordant.

Tabular Intrusive Bodies Tabular intrusive bodies are simply magma that has filled a fracture. A concordant tabular body is called a sill, and a discordant one is called a dike.

A sill occurs when magma exploits the planar weaknesses between sedimentary beds or other foliations, and is injected along these zones (Figure 54).

A dike is a magma-filled fracture that cuts across bedding or other country rock structures.

A fracture is an ideal conduit for magma because fractures can penetrate deeply and form easily, particularly in areas affected by extension or the force of a rising magma diapir. Clearly, magma could not have been generated between two bedding layers, so a sill must be fed by a dike somewhere along its length (unless the bedding dips steeply, and the sill is nearly vertical).

Dikes and sills are typically shallow and thin, occurring where the rocks are sufficiently brittle to fracture. Although most dikes and sills are emplaced in a single event, some may have a history of multiple injections. More than one stage of injection may occur because the dike or sill contracts as it cools, leaving a weakened zone for later magmas. Alternatively, the ductility contrast between a dike or sill and the country rock might make the contacts susceptible to localized deformation and later magmatic injection. A body is described as multiple if all phases of injection are of the same composition and composite if more than one rock type is represented. Dikes and sills can occur as solitary bodies, but dikes, at least, more typically come in sets, reflecting the tendency for fractures to form in sets as a brittle response to imposed stresses over an area.

Genetically related sets of numerous dikes or sills are called swarms. Dike swarms can consist of very large numbers of individual dikes.

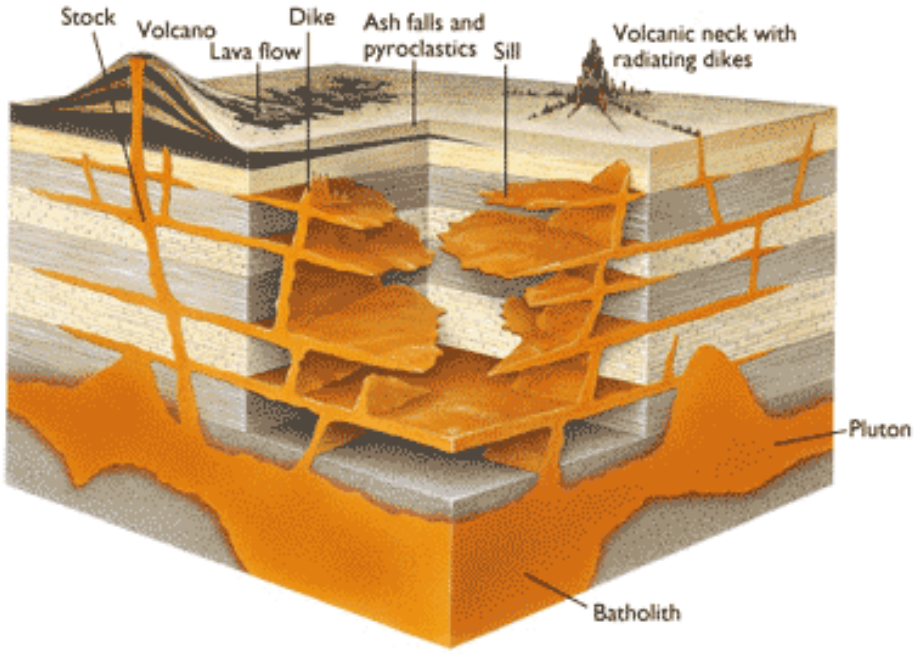

Figure 54: Illustration of an earth model showing volcanic rock features (Winter, 2014).

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APPENDIX

Eastern Petroleum 1-2 State Well Files

County Apache

Area Pinta Dome

Lease No. State 2089

Well Name Eastern Petroleum Company 1-2 State

Location NE SW Sec 2 Twp 19N Range 26E Footage 1980 FSL 1980 FWL

Elev Gr 5740 KB Spud Date 6-8-59 Complete Abandon 6-16-59 Total Depth 1084

Contractor: Approx. Cost $

Drilled by Rotary X
Cable Tool

Casing Size	Depth	Cement
8 5/8	76'	75sx
4 ½	1041.4	100sx

Interval
Production Horizon 974-1000 Coconino

Initial Production Coconino Grd. 4006 MCF

Helium Well

REMARKS: (OW WO)

River Frac 5000 GLNS/50001bs. from 974'-1000'

See file for three cores & 1 DST.

1-18 Sheet-in

Elec. Logs IE; Micrplog

Applic to Plug Plugging Record ✓ Completion Report X

Sample Log
Sample Descript
Sample Set 1-100 P-621
Cores

Water well - accepted by

Bond Co. & No. U. S. Fidelity & Guaranty Company 97716-13-3773-6%

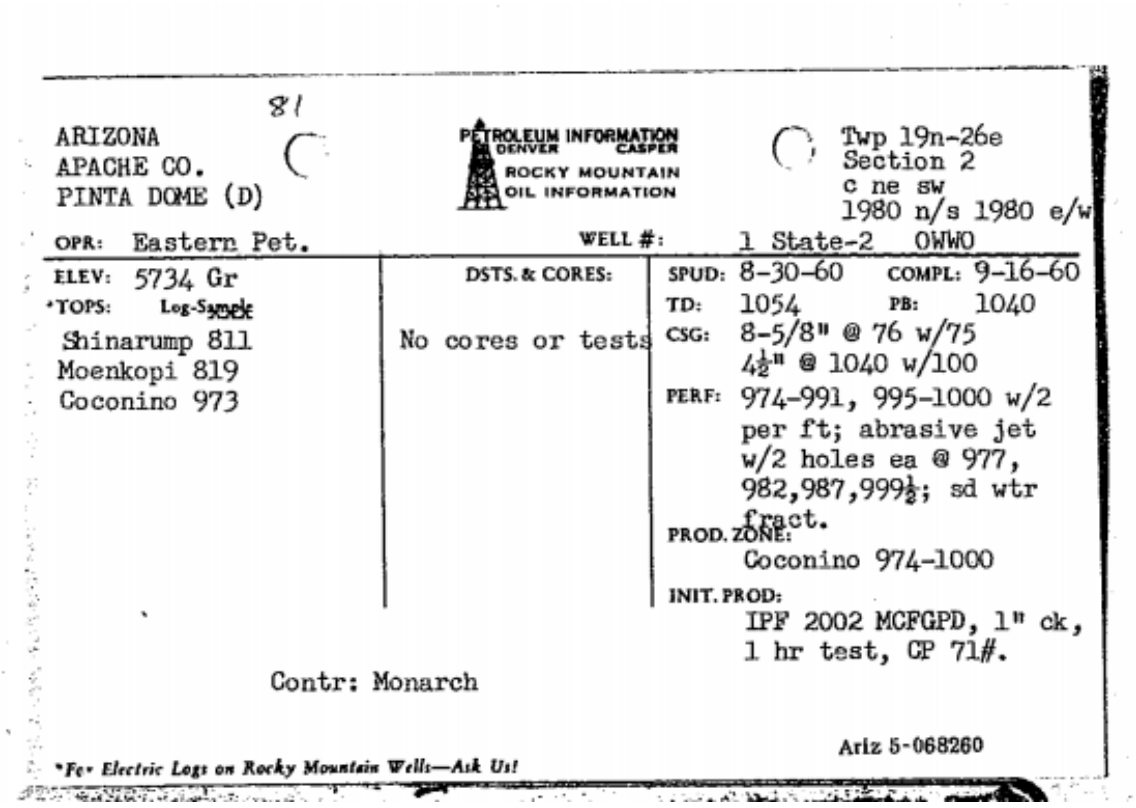
Bond Am't $ 15,000 Cancelled 7-22-65 Date Organization Report X

Filing Receipt 62024 dated 5-14-59 Well Book X Plat Book X

API # 02-001-05123 Loc. Plat X Dedication All Section 2

Sample 621

PERMIT NO. 81 Date Issued 5-19-59



81

ARIZONA
APACHE CO.
PINTA DOME (D)

PETROLEUM INFORMATION DENVER CASPER
ROCKY MOUNTAIN OIL INFORMATION

Twp 19n-26e
Section 2
c ne sw
1980 n/s 1980 e/w

OPR: Eastern Pet. WELL #: 1 State-2 OWWO

ELEV: 5734 Gr
*TOPS: Log-Sample
Shinarump 811
Moenkopi 819
Coconino 973

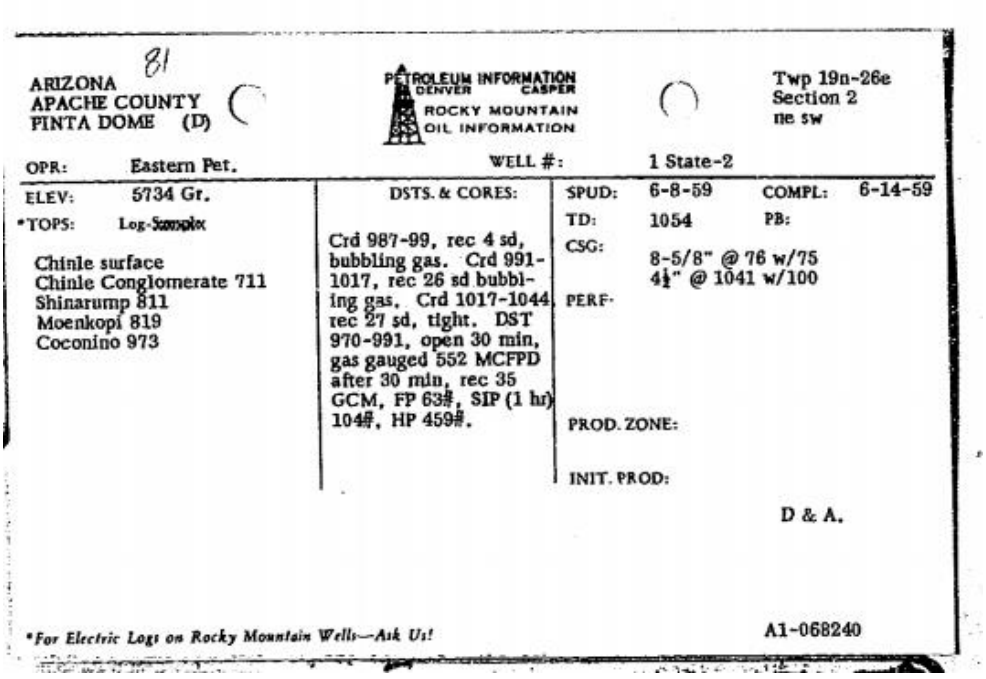
DSTS. & CORES:
No cores or tests

SPUD: 8-30-60 COMPL: 9-16-60
TD: 1054 PB: 1040
CSG: 8-5/8" @ 76 w/75
4½" @ 1040 w/100
PERF: 974-991, 995-1000 w/2 per ft; abrasive jet w/2 holes ea @ 977, 982,987,999½; sd wtr fract.
PROD. ZONE:
Coconino 974-1000
INIT. PROD:
IPF 2002 MCFGPD, 1" ck, 1 hr test, CP 71#.

Contr: Monarch

Ariz 5-068260

*For Electric Logs on Rocky Mountain Wells—Ask Us!



81

ARIZONA
APACHE COUNTY
PINTA DOME (D)

PETROLEUM INFORMATION DENVER CASPER
ROCKY MOUNTAIN OIL INFORMATION

Twp 19n-26e
Section 2
ne sw

OPR: Eastern Pet. WELL #: 1 State-2

ELEV: 5734 Gr.

*TOPS: Log-Sample

Chinle surface
Chinle Conglomerate 711
Shinarump 811
Moenkopi 819
Coconino 973

DSTS. & CORES:

Crd 987-99, rec 4 sd, bubbling gas. Crd 991-1017, rec 26 sd bubbling gas. Crd 1017-1044 rec 27 sd, tight. DST 970-991, open 30 min, gas gauged 552 MCFPD after 30 min, rec 35 GCM, FP 63#, SIP (1 hr) 104#, HP 459#.

SPUD: 6-8-59 COMPL: 6-14-59
TD: 1054 PB:
CSG: 8-5/8" @ 76 w/75
4½" @ 1041 w/100
PERF:

PROD. ZONE:

INIT. PROD:

D & A.

*For Electric Logs on Rocky Mountain Wells—Ask Us!

A1-068240

[illegible] TO JANUARY [illegible]

STATE OF ARIZONA

OIL AND GAS CONSERVATION COMMISSION

PHOENIX, ARIZONA

FORM O&G 53

Form Prescribed Under Oil and Gas Conservation Act of 1951

WELL COMPLETION REPORT

(File in Duplicate)

Operator [illegible] Petroleum Company Field [illegible]

Street 2120 First National Bank Building Pool

City Denver 2 State Colorado County Apache

Lease Name State of Arizona [illegible] Well No. 1-2 Acres in Unit

Location [illegible]

Sec. 2 Twp. [illegible] Rge. [illegible]

Elevation DF [illegible] GR Electric Log Run June [illegible] 19

Number of [illegible] Producing Wells on this Lease, including this well 2

Has Authorization to Transport Oil or Gas From Well, Form O&G 47 been filed? No

OFFICIAL COMPLETION GAUGE

Date Test Commenced [illegible] 19 [illegible] Hour [illegible] M. Date Test Completed [illegible] 19 [illegible] Hour [illegible] M.

Length of Test 4 Hours Minutes

For Flowing Well: For Pumping Well:

Flowing pressure on Tbg. lbs./sq. in. Length of stroke used inches

Flowing pressure on csg. [illegible] lbs./sq. in. Number of strokes per min.

Size tbg. in. No. ft. run Size of working barrel inches

Size choke 4 points in. Type choke Size tubing in. No. ft. run

Length in. Shut in pressure

If flowing well, was this well flowed for the entire duration of this test without the use of swab or other artificial flow device? Yes If jetted, used cu. ft. gas per bbl. oil. Result of this test [illegible] 2,450 MCFPD.

Gas-oil ratio of this well is cu. ft. of gas per bbl. of oil.

Per cent water produced during this test

Gravity of oil produced during this test (Corrected to A.P.I. 60° F)

Name of Pipe Line or other carrier

If perforated: No. Shots [illegible] From [illegible] To [illegible] Date Perforated

Date well Spudded June [illegible] 19 [illegible] Date Well Completed September [illegible] 19 [illegible]

Top Pay 973 Ft. Total depth of well [illegible] Ft.

CASING LINER AND TUBING RECORD

String	Size	Wt./Ft.	Name and Type	Amount Ft. In.	Depth Set at	Perforated From	To

CEMENT AND TESTING RECORD

Size of Hole	String	Where Cement Placed	No. Sacks Cement	Method Used	Pressure Applied in Testing	Hardness of Cement Drilled	Type of Cement
[illegible] 3/4	4 1/2	T.D.	[illegible]	[illegible]	[illegible] lbs.		No Record

CHEMICAL OR SHOOTING RECORD BEFORE COMPLETION

Size	Chemical or	Quantity	Date	Depth From	To
	[illegible]	[illegible] gals/[illegible] lbs.	[illegible]	[illegible]	[illegible]

AFFIDAVIT

I, J. Steiner, being first duly sworn on oath state that I have knowledge of the facts and matter herein set forth and that the same are true and correct.

[illegible signature]

Representative of Company

STATE OF COLORADO)
COUNTY OF DENVER) ss.

Subscribed and sworn to and before me this [illegible] day of September 19 [illegible]

by J. Steiner [illegible] [illegible signature] Notary Public

My Commission expires April [illegible], 196[illegible]

[illegible] STATE O & G CONS. COMM.

8 | 9

Eastern Petroleum No. 1-2 State (continued)

Present Status: Shut-In

Cores:

No. 1 987 feet to 991 feet Cut 4 feet, recovered 4 feet.
2' Sandstone, buff, fine grained, subround to subangular, firm, good porosity, fair permeability.
2' Sandstone, white, very fine grained, subround to subangular, very firm, fair porosity, poor permeability.
Entire core was bubbling gas.

No. 2 991 feet to 1017 feet Cut 26 feet, recovered 26 feet.
2' Sandstone, buff, fine grained, subround to subangular, firm, fair porosity and permeability.
11' Sandstone, buff to brown, fine to medium grained, subround to subangular, good porosity and permeability.
7' Sandstone, buff to white, fine grained, subround to subangular, fair porosity and permeability.
6' Sandstone, buff, fine to medium grained, subround to subangular, few red fine to coarse round grains, some red clay on cross beds.
Entire core is bleeding gas.
Sandstone is crossbedded.

No. 3 1017 feet to 1044 feet Cut 26 feet, recovered 27 feet.
1' Sandstone, tan, fine grained, round to subround, very firm, low permeability, fair porosity.
10' Sandstone, buff, fine grained, round to subround, firm.
7' Sandstone, buff, fine to medium grained, subround to subangular.
9' Sandstone, ditto with small red oxide stains. Some green shale intercalated on bedding planes.
Appears by tasting to be a salt water level at 1018 feet.

Drill Stem Tests:

No. 1 970 feet to 991 feet (Coconino sandstone)
Open 30 minutes, helium-nitrogen gas to surface immediately;

Eastern Petroleum No. 1-2 State (continued)

Flowed at the following rate:
5 minutes - 250 MCF/D
15 minutes - 286 MCF/D
25 minutes - 323 MCF/D
30 minutes - 552 MCF/D
Started unloading mud which was previously lost in the formation at the end of 27 minutes. The gas volume was increasing at the end of the test. Surface pressure when gas analysis sample taken was 93 psig.
Recovered 35 feet of gas cut mud.
Shut-in time, initial and final: 60 minutes.
Initial flowing pressure: 63 psig.
Final flowing pressure: 63 psig.
Initial shut-in pressure: 108 psig.
Final shut-in pressure: 104 psig.
Initial hydrostatic pressure: 477 psig.
Final hydrostatic pressure: 459 psig.

EASTERN PETROLEUM CO. No. 1-2 State

973 to 1010' - 37 feet.

with the following characteristics worked out from core and log analysis:

Average Porosity 14.8%
Average Permeability..... 171 md.
Average Water Saturation..... 47.8%

1010 to 1019' - 9 feet.

with the following characteristics derived from core analysis:

Average Porosity..... 14.2%
Average Permeability..... 93.4 md.
Average Water Saturation..... 68.1%

ROBERT E. LAUTH
Consulting Geologist

GEOLOGICAL COMPLETION REPORT
Eastern Petroleum Company
State No. 1-2
Section 2, T19N, R26E
Apache County, Arizona

WELL DATA

Rotary: Surface to total depth - mud drilled
Spud date: June 8, 1959
Date drilling completed: June 14, 1959
Initial production: Testing
Surface casing: 8 5/8" @ 76 feet with 75 sacks
Production casing: 4½" @ 1041.40 feet with 100 sacks
Contractor: Eastern Drilling Company
Leased rig of Apache Drilling Company, Denver, Colorado
Well location: NE - SW; 1980' FSL & 1980' FWL, Section 2, Township 19 North, Range 26 East, Apache County, Arizona
Elevation: 5734' ground
5740' rotary bushing
Total depth: 1054 feet
Plug back: 1019 feet

FORMATION TOPS

Formation	Depth	Elevation	Thickness
Chinle	Surface	+5740	811'
Chinle congl.	711'	+5029	50'
Shinarump congl.	811'	+4929	8'
Moenkopi	819'	+4921	154'
Coconino	973'	+4767	–

CORRELATION

Formation	Eastern Petr. 1-2 State SW 2-19N-26E	Eastern Petr. 1-10 State NE 10-19N-26E	Eastern Petr. 1-6 State NE 6-19N-26E
Chinle congl.	+5029	+5044	+4991
Coconino	+4767	+4768	+4713

Formation	Kerr McGee No. 1 State SW 34-20N-26E	Kerr McGee No. 2 State SE 34-20N-26E	Kerr McGee No. 3 State SE 4-19N-26E
Chinle congl.	+5040	+5052	+5031
Coconino	+4773	+4782	+4766

DISCUSSION

The purpose of this report is to present geological information and basic data concerning the Eastern Petroleum Company, State No. 1-2 well located in the NE SW of Section 2, Township 19 North, Range 26 East, Apache County, Arizona.

Under surface pipe the hole was drilled to a depth of 1054 feet with a 6 3/4 inch bit. A fresh water sand was noted from 224 to 251 feet. Lost circulation was minor. Some mud was lost at a depth of 367 feet and approximately 100 barrels of mud was lost in the Coconino sandstone when total depth was reached.

Four and one-half inch casing was set and cemented at 1041.4 feet with 100 sacks of cement. Three cores and one drillstem test were taken in the Coconino sandstone. Details of these will be given in the report. Careful examination of the sample cuttings were made at the wellsite at the time of drilling.

A Schlumberger Electrical-Induction log was run from under surface casing to a depth of 1051 feet. A microlog was run from 86 to 1051 feet.

Final formation tops have been adjusted and picked from electrical log curves related to sample cutting examination and stratigraphic correlation.

STRATIGRAPHY

Attached to this report is the sample description made by the writer from 10 foot and 5 foot sample cuttings for the interval 210 to 1054 feet.

The lithology and correlation of the possible producing horizon (the Coconino sandstone) is discussed in the following paragraphs.

The Chinle conglomerate section is completely water wet, and, hence, will not be discussed.

Coconino sandstone 973' to 1054' (penetrated 81 feet)

The Coconino sandstone is massive, buff in color, and exhibits cross bedding in the cores. A transition zone exists which is composed of dark red silty shales of the Moenkopi streaked with buff and tan colored reworked sandstones of the Coconino. This zone is present from 954 feet to 973 feet.

-3-

By log analysis and core analysis there is a maximum of 46 feet which will be productive of helium-nitrogen gas. Of this, nine feet is in the gas-water transition zone.

The upper thirty-seven foot zone has the following characteristics which are averaged from core and electrical-microloganalysis:

973 to 1010 feet - 37 feet

Average Porosity 14.8%
Average Permeability . . . 171 millidarcies
Average Water Saturation . 47.8%

The lower nine foot zone has the following characteristics averaged from core analysis:

1010 to 1019 feet - 9 feet

Average Porosity 14.2%
Average Permeability . . . 93.4 millidarcies
Average Water Saturation . 68.7%

A commercial helium-nitrogen producer can be made in the upper 37 feet of Coconino sandstone. An initial potential of two to two and a half million cubic feet per day would be reasonable to expect.

RECOMMENDED COMPLETION PROCEDURE

Four and one-half inch (OD), J-55, 9.5 lb. and P-110, 15.10 lb. used casing was set and cemented at 1041.40 feet with 100 sacks of cement. The top of the float collar is at 1019 feet. Centralizers were placed on the shoe joint and just above the pay zone. The plug was pumped to a depth of 510 feet with clear water. It is thought that the plug stopped at this point because of the mixed weight of casing and the amount of gel used in the cement rather than a leak in the pipe.

The different weight of pipe changes its internal diameter in the following dimensions:

J-55, 9.5 lb = 4.090" ID
P-110, 151 lb = 3.826" ID

The mixed weights of pipe appear to be scattered throughout the hole rather than in any one spot. In drilling cement and swabbing, caution must be used.

The following procedure is recommended in completing the Coconino sandstone zone:

1) Drill out the cement to the top of the float collar (1019'); there is 509 feet of cement to drill out. The bit size in drilling the cement must be under the smallest internal diameter of the pipe, namely, 3.826 inches to avoid hanging up.
2) Perforate with 2 shots per foot the intervals 974 to 991 and 995 to 1004 feet.
3) Wash with mud acid sufficient to cover completely all perforations plus an additional amount to penetrate back into the mud invaded zone, approximately 50 gallons.
4) Load the hole with water to help push the acid back into the formation. Allow to set for 4 to 8 hours.
5) Swab water and acid back using a Mission type swab rubber which will be flexible in the mixed string of pipe. Allow the well to blow dry.

From the characteristics of the electrical-induction and microlog core analysis and drillstem test data, the completion should be a natural one.

CONCLUSIONS

This test is considered to have adequately tested all the formations penetrated.

The Coconino sandstone from 973 to 1019 feet contains helium-nitrogen gas.

It is recommended that the intervals 974 to 991 and 995 to 1004 feet be perforated. The completion should be a natural one.

An initial potential of 2 to 2½ million cubic feet of gas per day is reasonable to expect.

The writer expresses his appreciation for the opportunity of making this well study and respectfully submits this report.

Robert E. Lauth

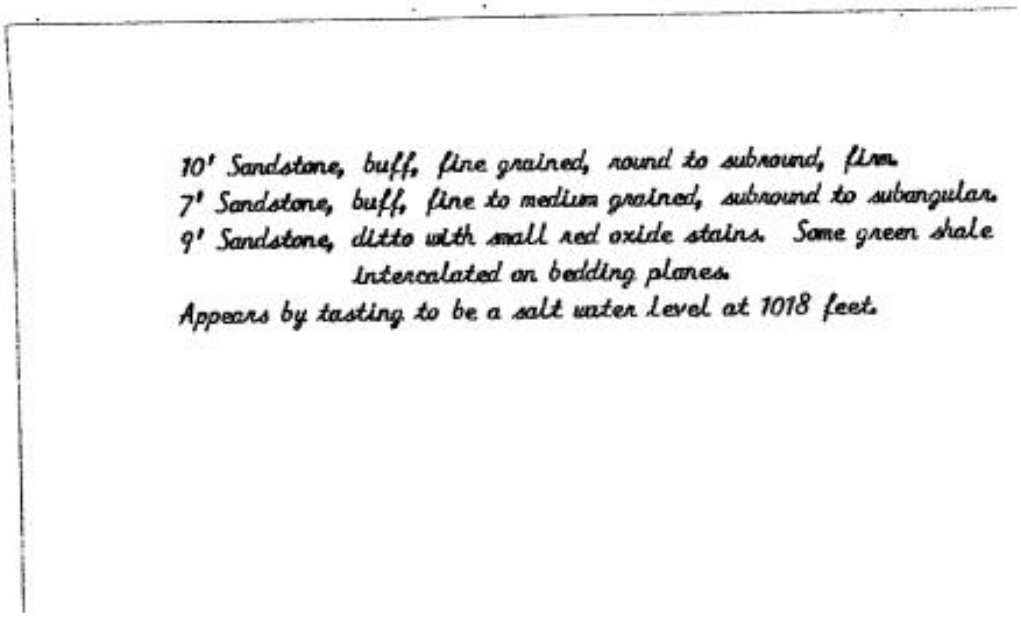
Robert E. Lauth
Geological Consultant
Durango, Colorado
August 7, 1959

CORE DESCRIPTION
Eastern Petroleum Company
State No. 1-2
Section 2, T19N, R26E
Apache County, Arizona
Elevation 5740' rotary bushing

Core No. 1 987 - 991 Cut 4 feet, recovered 4 feet.
Coring time (minutes per foot), 1, 2, 2, 2.
2' Sandstone, buff, fine grained, subround to subangular, firm, good porosity, fair permeability.
2' Sandstone, white, very fine grained, subround to subangular, very firm, fair porosity, poor permeability.
Entire core was bubbling gas.

Core No. 2 991 - 1017 Cut 26 feet, recovered 26 feet.
Coring time (minutes per foot), 2, 3, 3, 2, 2, 1, 2, 1, 2, 2, 3, 2, 2, 1, 2, 2, 2, 2, 2, 2, 3, 4, 3, 2, 3, 1.
2' Sandstone, buff, fine grained, subround to subangular, firm, fair porosity and permeability.
11' Sandstone, buff to brown, fine to medium grained, subround to subangular, good porosity and permeability.
7' Sandstone, buff to white, fine grained, subround to subangular, fair porosity and permeability.
6' Sandstone, buff, fine to medium grained, subround to subangular, few red fine to coarse round grains, some red clay on cross beds.
Entire core is bleeding gas.
Sandstone is crossbedded.

Core No. 3 1017 - 1044 Cut 26 feet, recovered 27 feet.
Coring time (minutes per foot), 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 2, 2, 3, 2, 2, 3, 3, 4, 3, 3, 3, 3, 3.
1' Sandstone, tan, fine grained, round to subround, very firm, low permeability, fair porosity.



10' Sandstone, buff, fine grained, round to subround, firm.
7' Sandstone, buff, fine to medium grained, subround to subangular.
9' Sandstone, ditto with small red oxide stains. Some green shale
intercalated on bedding planes.
Appears by tasting to be a salt water level at 1018 feet.

SAMPLE DESCRIPTION
Eastern Petroleum Company
State No. 1-2
Section 2, T19N, R26E
Apache County, Arizona
Elevation 5740' rotary bushing

Samples start at 210 feet in the Chinle formation.

210 - 220	100 siltstone and shale brick-red, trace of limestone nodules and coarse grained sandstone.
220 - 230	100 shale red, gray, some light green, in part silty, trace of white fine grained sandstone.
230 - 240	100 shale ditto, trace of white crystalline limestone.
240 - 250	40 sandstone white, fine grained, well cemented, micaceous, calcareous. 60 shale ditto.
250 - 260	60 sandstone ditto, hard and tight, trace of white crystalline limestone. 40 shale ditto, some brown silty.
260 - 270	70 sandstone white, clear, fine to coarse grained, loose, subround to angular. 30 limestone white, red, crystalline.
270 - 280	100 sandstone white to tan, predominately fine grained, loose, calcareous.
280 - 290	100 sandstone ditto. Some brown red chert.
290 - 300	Sample missing.
300 - 310	50 sandstone ditto. 50 shale light green, gray with limestone nodules.
310 - 320	Sample ditto.
320 - 330	50 sandstone ditto, medium grained. 30 limestone white crystalline. 20 shale ditto.
330 - 340	80 sandstone ditto. 10 limestone white crystalline. 10 shale ditto.
340 - 350	100 shale light green, in part micaceous, sandy, some gray and red, also calcareous.

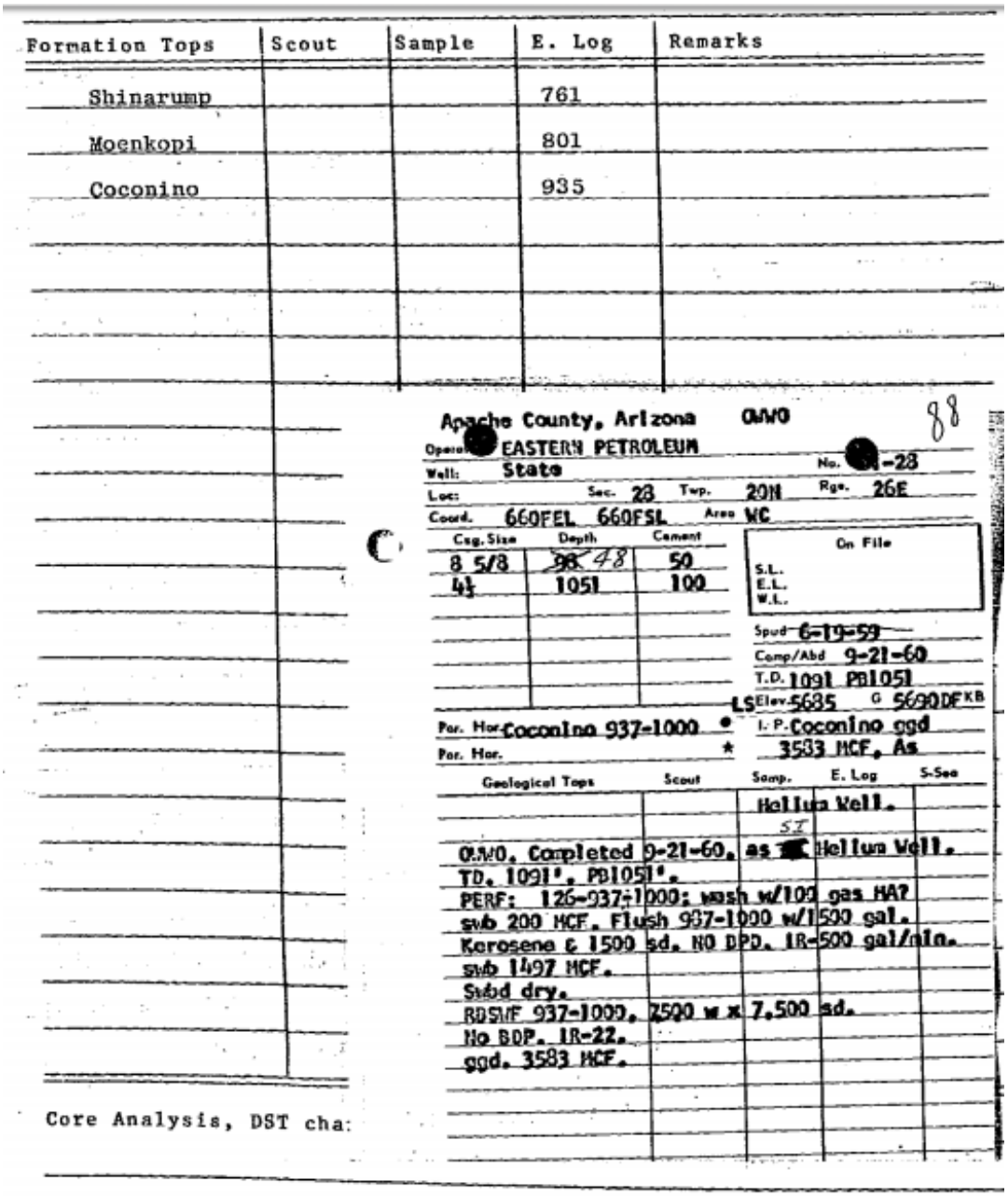
350 - 360	100 shale as above, in part sandy.
360 - 370	100 shale ditto.
370 - 380	60 sandstone white to tan, fine to medium grained, predominately medium grained, loose. 40 shale ditto. Trace of limestone white crystalline.
380 - 390	100 sandstone ditto, predominately fine grained, subround to subangular. Trace of limestone.
390 - 400	Trace of sandstone. 100 shale brick red and light green, some limestone nodules.
400 - 410	30 sandstone clear, fine to medium grained, loose, some very fine grained, some red and brown chert. 70 shale ditto, also lavender.
410 - 420	Trace of sandstone ditto. 100 shale as above.
420 - 430	100 shale ditto. Trace of red chert.
430 - 440	Trace of sandstone white, medium gained. 100 shale chocolate red, light green, slightly silty.
440 - 450	100 shale ditto, chocolate red, in part finely micaceous.
450 - 460	10 sandstone clear, fine to medium grained, loose, round to subround to subangular, some red and brown chert. 90 shale ditto.
460 - 470	20 sandstone ditto. 80 shale ditto.
470 - 480	30 sandstone ditto. 70 shale ditto.
480 - 490	10 sandstone ditto. 90 shale ditto.
490 - 500	30 sandstone clear, fine to coarse grained, subround to subangular, loose. Trace of gypsum. 70 shale gray, red, and lavender.
500 - 510	30 sandstone ditto. 70 shale ditto, light green.
510 - 520	20 sandstone ditto, some brown chert. 80 shale ditto, light green.
520 - 530	20 sandstone ditto, some very fine grained, white, well cemented. 80 shale ditto, light green.
530 - 540	10 sandstone ditto. 90 shale ditto, light green.
540 - 550	30 sandstone red, clear, fine to medium grained, loose, angular. 70 shale ditto, much red chert.
550 - 560	20 sandstone white to light green, fine grained, bound by clay cement. 80 shale ditto.

770 - 780	100 sandstone tan to clear, fine to coarse grained, angular, loose.
780 - 790	100 sandstone ditto, some pebbles. Some red chert.
790 - 800	100 sandstone ditto, becoming fine grained. Some red chert.
800 - 810	100 sandstone ditto, clear, predominately coarse grained, subround to angular.
810 - 820	80 sandstone ditto. 20 shale red, finely grounded.
820 - 830	60 sandstone ditto. 40 shale red, gray, chocolate red, some yellow chert.
830 - 840	40 sandstone as above, predominately coarse grained. 60 shale chocolate brown, red, lavender, light green, some chert.
840 - 850	30 sandstone ditto, much pebbles, subround, also red, and white, fine grained, sandy, micaceous. 70 shale ditto.
850 - 860	80 sandstone red, white, fine grained, micaceous, cement. 20 shale red, gray, green.
860 - 870	80 sandstone ditto. 20 shale ditto - trace of chocolate brown, finely micaceous, and finely sandy.
870 - 880	50 sandstone ditto. 50 shale chocolate brown, finely micaceous, finely sandy.
880 - 890	30 sandstone ditto, some white fine grained. 70 shale ditto, very sandy.
890 - 900	Trace of sandstone. Trace of white crystalline limestone. 100 shale as above.
900 - 910	Trace of white, fine grained sandstone. 100 shale as above - chocolate brown, finely micaceous.
910 - 920	20 sandstone white to light green, fine grained, and well cemented. 80 shale ditto, chocolate brown and finely micaceous.
920 - 930	10 sandstone ditto. 90 shale ditto, chocolate brown, and finely micaceous.
930 - 935	30 sandstone light green and gray, fine grained, micaceous. 70 shale ditto - chocolate brown, finely micaceous.
935 - 940	40 sandstone ditto, also red and very fine grained. 60 shale ditto.

940 - 945	30 sandstone ditto. 70 shale ditto, some lavender, some chert.
945 - 950	10 sandstone ditto. 90 shale chocolate brown, micaceous.
950 - 955	10 sandstone red, very fine grained, micaceous. 90 shale ditto.
955 - 960	30 sandstone as above, some tan and very fine grained. 70 shale ditto.
960 - 965	50 sandstone ditto. 50 shale ditto.
965 - 970	10 sandstone white to buff, fine grained, subround to subangular. 60 sandstone red, very fine grained. 30 shale red to brown.
970 - 975	Trace of white sandstone. 10 sandstone brown, red, very fine grained. 90 shale chocolate brown, gray, green.
975 - 980	30 sandstone buff, fine grained, subround to subangular. 70 shale red, also chocolate brown, in part very sandy, micaceous.
980 - 985	60 sandstone clear, buff, medium grained, subround to subangular. 40 shale red as above.
Circ. sample @ 985	80 sandstone ditto. 20 shale red as above.
987 - 991	See Core No. 1.
991 - 1017	See Core No. 2.
1017 - 1044	See Core No. 3.
1044 - 1054	100 sandstone buff, fine to medium grained, subround to subangular.

Note: When the core point at 987' was reached, it was found that a joint of pipe was in the string which was not tallied in. All sample records and drilling time records have been corrected for this depth discrepancy.

Eastern Petroleum 1-28 State - Permit 88 Well Files



Formation Tops	Scout	Sample	E. Log	Remarks
Shinarump			761	
Moenkopi			801	
Coconino			935	

Apache County, Arizona OWO

Oper. EASTERN PETROLEUM

Well: State No. -28

Loc: Sec. 28 Twp. 20N Rge. 26E

Coord. 660FEL 660FSL Area WC

Csg. Size	Depth	Cement
8 5/8	~~98~~ 48	50
4½	1051	100

On File: S.L. E.L. W.L.

Spud 6-19-59

Comp/Abd 9-21-60

T.D. 1091 PB1051

LS Elev. 5685 G 5690 DF KB

Por. Hor. Coconino 937-1000 •

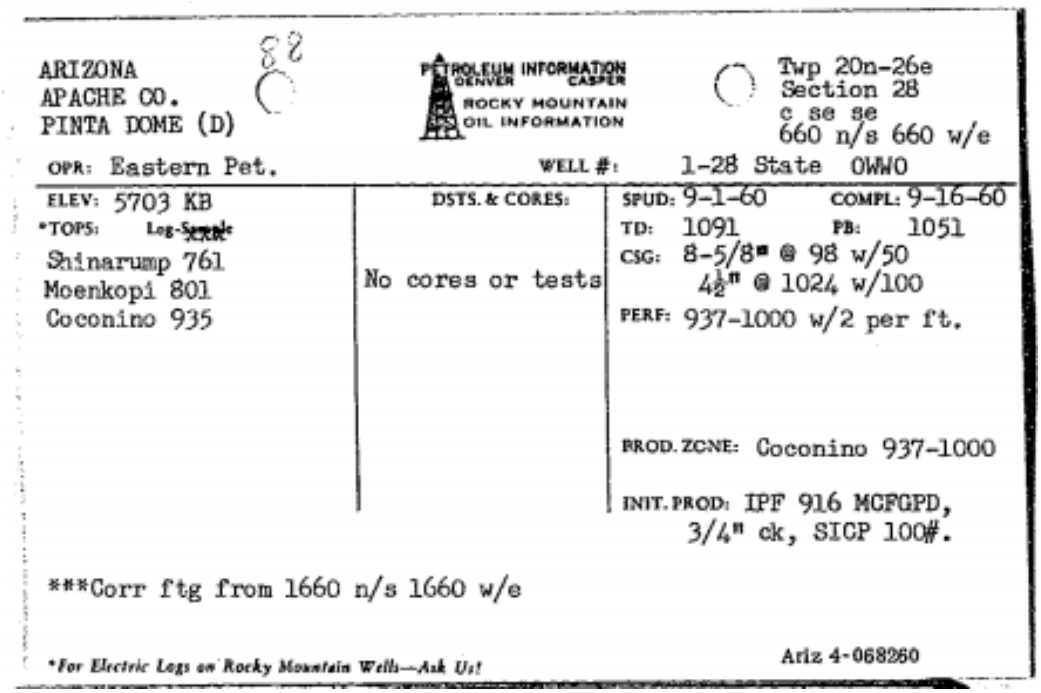
Por. Hor. *

I. P. Coconino ggd 3533 MCF, As

Geological Tops	Scout	Samp.	E. Log	S-Sec
		Helium Well.		

OWO. Completed 9-21-60, as Helium Well.
TD. 1091', PB1051'.
PERF: 126-937-1000; wash w/100 gas HA?
swb 200 MCF. Flush 937-1000 w/1500 gal.
Kerosene & 1500 sd. NO BDP. IR-500 gal/min.
swb 1497 MCF.
Swbd dry.
RDSWF 937-1000. 7500 w x 7,500 sd.
No BDP. IR-22.
ggd. 3583 MCF.

Core Analysis, DST cha:



ARIZONA
APACHE CO.
PINTA DOME (D)

PETROLEUM INFORMATION DENVER CASPER
ROCKY MOUNTAIN OIL INFORMATION

Twp 20n-26e
Section 28
c se se
660 n/s 660 w/e

OPR: Eastern Pet. WELL #: 1-28 State OWWO

ELEV: 5703 KB
*TOPS: Log-Sample
Shinarump 761
Moenkopi 801
Coconino 935

DSTS. & CORES:
No cores or tests

SPUD: 9-1-60 COMPL: 9-16-60
TD: 1091 PB: 1051
CSG: 8-5/8" @ 98 w/50
4½" @ 1024 w/100
PERF: 937-1000 w/2 per ft.

PROD. ZONE: Coconino 937-1000

INIT. PROD: IPF 916 MCFGPD,
3/4" ck, SICP 100#.

***Corr ftg from 1660 n/s 1660 w/e

*For Electric Logs on Rocky Mountain Wells—Ask Us!

Ariz 4-068260

FIELD Pinta Dome

OPERATOR Kerr-McGee Corporation ADDRESS P. O. Box 250, Amarillo, TX 79105

Federal, State, or Indian Lease Number or Lessor's Name if Fee Lease State WELL NO. 1-28

SURVEY T-20N, R-26E SECTION 28 COUNTY Apache

LOCATION

TYPE OF WELL Gas (Helium) (Oil, Gas or Dry Hole) TOTAL DEPTH 1091'

ALLOWABLE (If Assigned) None

LAST PRODUCTION TEST OIL 0 (Bbls.) WATER 0 (Bbls.)

GAS 68 (MCF) DATE OF TEST 2-5-72

PRODUCING HORIZON Coconino Sand PRODUCING FROM 937' TO 1000'

1. COMPLETE CASING RECORD

8-5/8" - cemented with 50 sx at 48'.

4-1/2" - cemented with 150 sx at 1051'.

PBTD 1051'.

2. FULL DETAILS OF PROPOSED PLAN OF WORK

1. Set cement retainer at 880'.
2. Squeeze 50 sx cement below retainer. Equalize 20 sx cement from 880-680'.
3. Pull tubing.
4. Fill casing to surface with cement.
5. Erect 4" pipe marker as per Rule 202-A7.

If well is to be abandoned, does proposed work conform with requirements of Rule 202? yes If not, outline proposed procedure above.

DATE COMMENCING OPERATIONS Upon approval.

NAME OF PERSON DOING WORK ADDRESS

CORRESPONDENCE SHOULD BE SENT TO C. J. Breeden (Name) C J Breeden

District Manager (Title)

P. O. Box 250, Amarillo, TX 79105 (Address)

March 1, 1977 (Date)

Date Approved 3-7-77

STATE OF ARIZONA

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Application to Abandon and Plug

Eastern Petroleum No. 1-28 State (continued)

Present Status: Shut-In

Cores:

No. 1 940 feet to 956 feet Cut 16 feet, recovered 16 feet
2' Sandstone, red to tan, streaked with light green and red sandy shale.
1' Sandstone, tan to brown, fine grained, hard, sub-round to subangular streaked with thin green shale.
13' Sandstone, buff to brown, fine grained, hard, sub-round to subangular, good porosity and permeability becoming medium grained towards the base.
Entire core was bubbling gas.
Vertical fractures from 943 to 946.

No. 2 956 feet to 969 feet Cut 13 feet, recovered 13 feet
4' Sandstone, buff, fine to medium grained, subround, good porosity and permeability.
5' Sandstone, buff, fine to medium grained, subround, very much cross bedding.
4' Sandstone, ditto, some aeolian fluting in the sand-stone.
Entire core bubbling gas, vertical fractures 956 - 960 and 968 - 969.

No. 3 969 feet to 978 feet Cut 9 feet, recovered 9 feet
4' Sandstone, buff, fine to medium grained, subround to subangular, firm, fair porosity and permeability; very slight oil stain.
5' Sandstone, buff, ditto, good porosity and perm-eability.

Drill Stem Tests:

No. 1 940 feet to 956 feet (Coconino sandstone)
Open two hours, helium-nitrogen gas to surface immediately; flowed at the following rate:
30 minutes - 83 MCF/D
60 minutes - 105 MCF/D
90 minutes - 118 MCF/D
120 minutes - 118 MCF/D
This test would probably have been much better, but approximately 60 barrels of mud with about 18% lost circulation material was lost in the formation just prior to testing. Surface pressure, when gas analysis sample taken, was 50 psig.

EASTERN PETR. 1-28 State

D.S.T. No. 1 940 to 956 Open 2 Hours
Good blow Immed. Gauged: 30 Minutes - 83 MCFG/D
60 " - 105 MCFG/D
90 " - 118 MCFG/D
120 " - 118 MCFG/D

Recovered: 35' Gas cut drlg mud.

IHP - 468#
FHP - 468#
ISIP (1 hr) - 93#
FSIP (1 hr) - 93#
IFP - 15#
FFP - 30#

Note: This test would probably have been much better but there was lost approximately 60 bbls of mud in the formation and the mud had approximately 20% lost circulation material in it.

38 feet of the Coconino was cored.

It had an average Porosity of 13.8%
Average Permoability of 87 Millidarcys
Average Water Satur. of 39.9 %

The log shows 78 feet of pay with these characteristics:

There is an additional 20 feet of pay with slightly higher water saturation.

GEOLOGICAL COMPLETION REPORT
EASTERN PETROLEUM COMPANY
STATE NO. 1-28
Section 28, T20N, R26E
Apache County, Arizona
PN 88

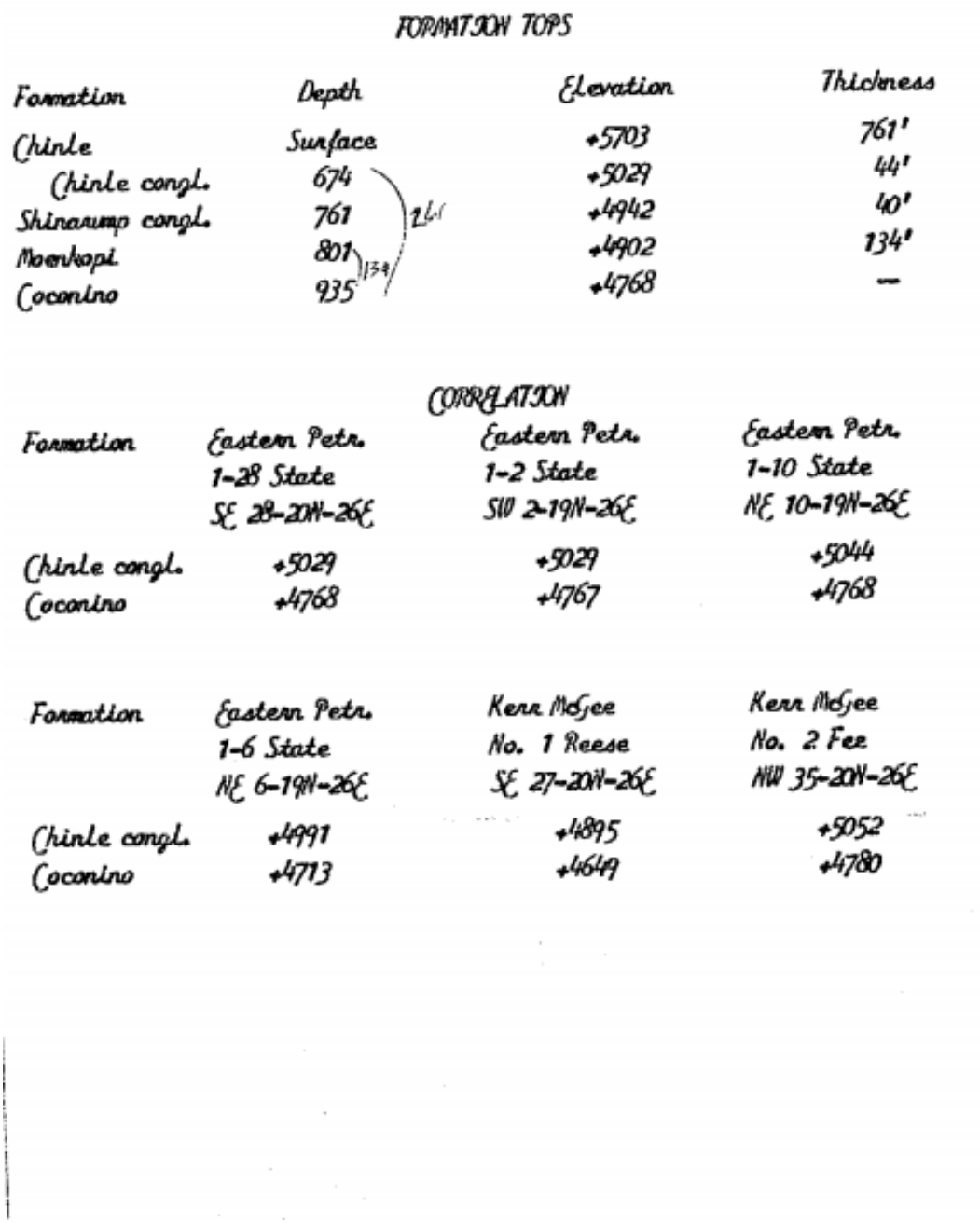
By: Robert E. Lauth
Geological Consultant
Durango, Colorado

ROBERT E. LAUTH
Consulting Geologist

GEOLOGICAL COMPLETION REPORT
Eastern Petroleum Company
State No. 1-28
Section 28, T20N, R26E
Apache County, Arizona

WELL DATA

Rotary: Surface to total depth - mud drilled
Spud date: June 17, 1959
Date drilling completed: June 24, 1959
Initial production: Testing
Surface casing: 8 5/8" @ 48 feet with 50 sacks
Production casing: 4½" @ 1051.2 feet with 100 sacks
Contractor: Eastern Drilling Company
Leased rig of Apache Drilling Company, Denver, Colorado
Well location: SE - SE; 660' FSL & 660' FEL,
Section 28, Township 20 North, Range 26 East,
Apache County, Arizona
Elevation: 5696' ground
5703' rotary bushing
Total depth: 1091 feet
Plug back: 1051 feet



FORMATION TOPS

Formation	Depth		Elevation	Thickness
Chinle	Surface		+5703	761'
Chinle congl.	674		+5029	44'
Shinarump congl.	761	127	+4942	40'
Moenkopi	801	134	+4902	134'
Coconino	935		+4768	—

CORRELATION

Formation	Eastern Petr. 1-28 State SE 28-20N-26E	Eastern Petr. 1-2 State SW 2-19N-26E	Eastern Petr. 1-10 State NE 10-19N-26E
Chinle congl.	+5029	+5029	+5044
Coconino	+4768	+4767	+4768

Formation	Eastern Petr. 1-6 State NE 6-19N-26E	Kerr McGee No. 1 Reese SE 27-20N-26E	Kerr McGee No. 2 Fee NW 35-20N-26E
Chinle congl.	+4991	+4895	+5052
Coconino	+4713	+4649	+4780

Formation	Kerr McGee No. 1 State SW 34-20N-26E	Kerr McGee No. 2 State SE 34-20N-26E	Kerr McGee No. 3 State SE 4-19N-26E
Chinle congl.	+5040	+5052	+5031
Coconino	+4773	+4782	+4766

Formation	Kerr McGee No. 4 State NE 32-20N-26E	Kerr McGee No. 1 Fee SE 33-20N-26E
Chinle congl.	+5006	+5061
Coconino	+4735	+4787

Note: On Kerr McGee No. 2 Fee in Sec 35-20N-26E there is a discrepancy in elevations. The one used here is 5732'KB. The other elevation given by Kerr-Mcgee is 5671'KB.

DISCUSSION

The purpose of this report is to present geological information and basic data concerning the Eastern Petroleum Company, State No. 1-28 well located in the SE - SE of Section 28, Township 20 North, Range 26 East, Apache County, Arizona.

Under surface pipe the hole was drilled to a depth of 1091 feet with a 6 3/4 inch bit. A fresh water sand was noted from 262 to 283 feet. Considerable mud, approximately 400 barrels, was lost in the Coconino pay zone while coring and drilling.

Four and one-half inch casing was set and cemented at 1051.2 feet (ground level measurements) with 100 sacks of cement. Three cores and one drillstem test were taken in the Coconino sandstone. The entire pay zone was not cored due to excessive loss of mud while coring. Details of the cores and drillstem test will be given in the report. Careful examination of the sample cuttings was made at the wellsite at the time of drilling.

A Schlumberger Electrical-Induction log was run from under surface casing to a depth of 1075 feet. A microlog was run from 750 to 1073 feet.

Final formation tops have been adjusted and picked from electrical log curves related to sample cutting examination and stratigraphic correlation.

STRATIGRAPHY

Attached to this report is the sample description made by the writer from 10 foot and 5 foot sample cuttings for the interval 50 to 1090 feet.

The lithology and correlation of the possible producing horizon (the Coconinosandstone) is discussed in the following paragraphs.

The Chinle conglomerate section is completely water wet and will not be discussed.

Coconino sandstone 935 to 1091' (penetrated 156 feet)

The Coconino sandstone is massive, buff in color, and exhibits cross-bedding in the cores. A transition zone exists which is composed of buff and tan colored fine grained sandstones of the Coconino streaked with dark red silty and micaceous shales of the Moenkopi formation. This zone is present from 977 to 935 feet.

By log analysis and core analysis there is a maximum of 98 feet of sandstone which will be productive of helium-nitrogen gas. Of this, twenty feet is in the gas-water transition zone.

The upper seventy-eight foot zone has the following characteristics which are averaged from core and electrical-micrelog analysis.

935 to 1013 feet - 78 feet

Average Porosity	13.8%
Average Permeability	87 millidarcies
Average Water Saturation	39.9%

The lower twenty foot gas-water transition zone has essentially the same porosity; a little higher permeability and approximately 60% water saturation.

An analysis of the gas sample taken on the drillstem test in the upper 16 feet of this section and sent to the Bureau of Mines in Amarillo, Texas, had the following analysis:

Helium	8.6%
Nitrogen	89.9%
CO_2	0.8%
Methane	0.1%
Argon	0.6%
Total	100.0%

A commercial helium-nitrogen producer can be made in the upper 78 feet of Coconino sandstone. An initial potential in excess of five million cubic feet of gas per day would be reasonable to expect.

RECOMMENDED COMPLETION PROCEDURE

Four and one-half inch (OD), J-55, 9.5 lb and P-110, 15.10 lb used casing was set and cemented at 1051.2 feet with 100 sacks of cement. Only one joint 25.58 feet in length of P-110, 15.10 lb casing was used. It is the bottom joint and below the lowest possible pay zone. The remainder of the pipe is J-55, 9.5 lb. A float shoe was used. The top of the float is at 1051 feet. Centralizers were placed at 1026, 954, and 938.55 feet respectively. The plug was pumped down to the top of the float shoe with clear water.

The following procedure is recommended in completing the Coconino sandstone zone:

1) Perforate with 2 shots per foot the interval 937 to 1005 feet (68 feet).
2) Wash with mud acid sufficient to cover completely all perforations plus an additional amount to penetrate back into the mud invaded zone, approximately 160 gallons.
3) Load the hole with water to help push the acid back into the formation. Allow to set for 8 to 12 hours.
4) Swab water and acid back. Allow the well to blow dry.

From the characteristics of the electrical-induction and micrelog, core analysis and drillstem test data, the completion should be a natural one.

Because 400 barrels of mud with cotton seed hulls and fibers were lost in the Coconino sandstone, much washing and cleaning with mud acid might be necessary.

CONCLUSIONS

This test is considered to have adequately tested all the formations penetrated.

The Coconino sandstone from 935 to 1033 feet contains helium-nitrogen gas.

It is recommended that the interval 937 to 1005 feet be perforated. The completion should be a natural one.

An initial potential in excess of 5 million cubic feet of gas per day is reasonable to expect.

The writer expresses his appreciation for the opportunity of making this well study and respectfully submits this report.

Robert E Lauth

Robert E. Lauth
Geological Consultant
Durango, Colorado
August 13, 1959

CORE DESCRIPTION
Eastern Petroleum Company
State No. 1-28
Section 28, T20N, R26E,
Apache County, Arizona
Elevation 5703' rotary bushing

Core No. 1 940 - 956 Cut 16 feet, recovered 16 feet.
Coring time (minutes per foot) 6, 3, 5, 5, 5, 3, 4, 6, 4, 5, 5, 3, 3, 4, 4, 4. Lost circulation, pulled core barrel.
2' Sandstone, red to tan, streaked with light green and red sandy shale.
1' Sandstone, tan to brown, fine grained, hard, subround to subangular streaked with thin green shale.
13' Sandstone, buff to brown, fine grained, hard, subround to subangular, good porosity and permeability becoming medium grained towards the base.
Entire core was bubbling gas.
Vertical fractures from 943 to 946.

Core No. 2 956 - 969 Cut 13 feet, recovered 13 feet.
Coring time (minutes per foot) 7, 7, 7, 4,3, 3, 5, 4, 4, 4, 4, 5, 3, 3. Core barrel jammed.
4' Sandstone, buff, fine to medium grained, subround, good porosity and permeability.
5' Sandstone, buff, fine to medium grained, subround, very much cross bedding.
4' Sandstone, ditto, some aeolian fluting in the sandstone.
Entire core bubbling gas, vertical fractures 956 - 960 and 968 - 969.

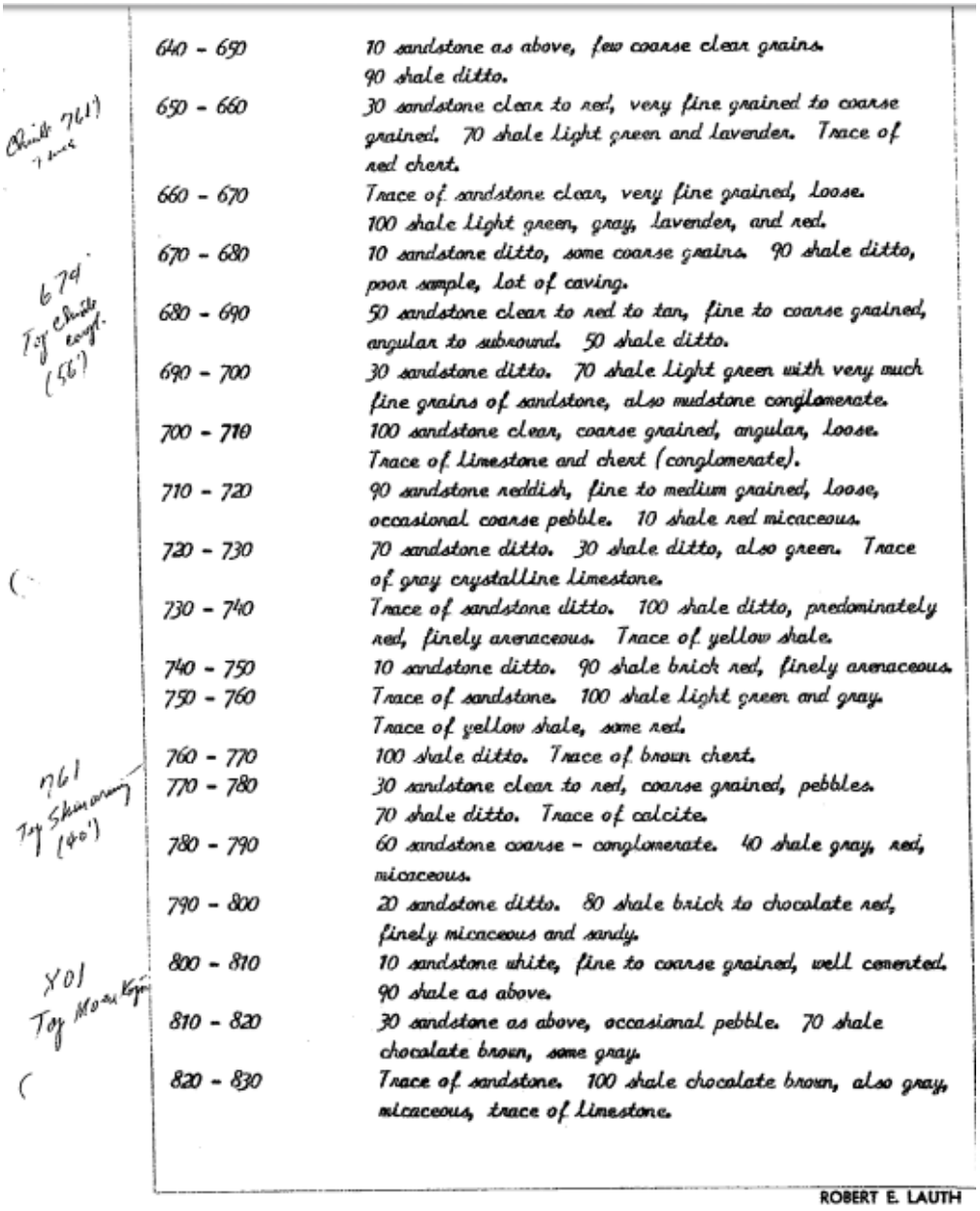
Core No. 3 969 - 978 Cut 9 feet, recovered 9 feet.
Coring time (minutes per foot) 4, 5, 4, 5, 6, 4, 4, 13, 14. Lost circulation, pulled core barrel.
4' Sandstone, buff, fine to medium grained, subround to subangular, firm, fair porosity and permeability; very slight oil stain.
5' Sandstone, buff, ditto, good porosity and permeability.

DRILLSTEM TEST RECORD
Eastern Petroleum Company
State No. 1-28
Section 28, T20N, R26E
Apache County, Arizona
Elevation 5703' rotary bushing

DST No. 1 940 - 956 (Coconino sandstone)
Open two hours, helium-nitrogen gas to surface immediately; flowed at the following rate:

30 minutes - 83 MCF/D
60 minutes - 105 MCF/D
90 minutes - 118 MCF/D
120 minutes - 118 MCF/D

This test would probably have been much better, but approximately 60 barrels of mud with about 18% lost circulation material was lost in the formation just prior to testing. Surface pressure, when gas analysis sample taken, was 50 psig.
Recovered 35 feet of gas cut mud.
Shut-in time, initial and final: 60 minutes.
Initial flowing pressure: 14 psig.
Final flowing pressure: 16 psig.
Initial shut-in pressure: 59 psig.
Final shut-in pressure: 89 psig.
Initial hydrostatic pressure: 458 psig.
Final hydrostatic pressure: 453 psig.



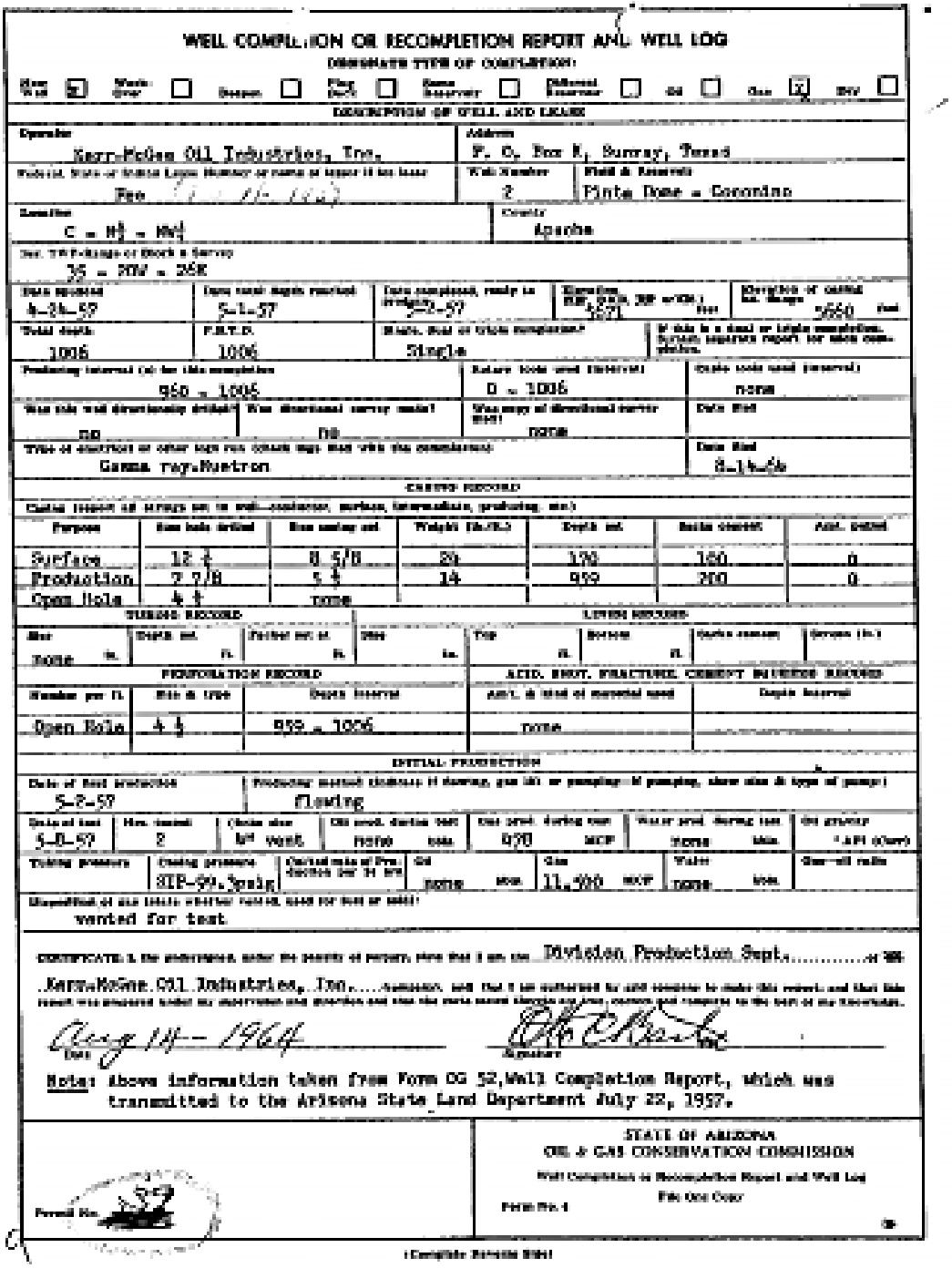
640 - 650	10 sandstone as above, few coarse clear grains. 90 shale ditto.
650 - 660	30 sandstone clear to red, very fine grained to coarse grained. 70 shale light green and lavender. Trace of red chert.
660 - 670	Trace of sandstone clear, very fine grained, loose. 100 shale light green, gray, lavender, and red.
670 - 680	10 sandstone ditto, some coarse grains. 90 shale ditto, poor sample, lot of caving.
680 - 690	50 sandstone clear to red to tan, fine to coarse grained, angular to subround. 50 shale ditto.
690 - 700	30 sandstone ditto. 70 shale light green with very much fine grains of sandstone, also mudstone conglomerate.
700 - 710	100 sandstone clear, coarse grained, angular, loose. Trace of limestone and chert (conglomerate).
710 - 720	90 sandstone reddish, fine to medium grained, loose, occasional coarse pebble. 10 shale red micaceous.
720 - 730	70 sandstone ditto. 30 shale ditto, also green. Trace of gray crystalline limestone.
730 - 740	Trace of sandstone ditto. 100 shale ditto, predominately red, finely arenaceous. Trace of yellow shale.
740 - 750	10 sandstone ditto. 90 shale brick red, finely arenaceous.
750 - 760	Trace of sandstone. 100 shale light green and gray. Trace of yellow shale, some red.
760 - 770	100 shale ditto. Trace of brown chert.
770 - 780	30 sandstone clear to red, coarse grained, pebbles. 70 shale ditto. Trace of calcite.
780 - 790	60 sandstone coarse - conglomerate. 40 shale gray, red, micaceous.
790 - 800	20 sandstone ditto. 80 shale brick to chocolate red, finely micaceous and sandy.
800 - 810	10 sandstone white, fine to coarse grained, well cemented. 90 shale as above.
810 - 820	30 sandstone as above, occasional pebble. 70 shale chocolate brown, some gray.
820 - 830	Trace of sandstone. 100 shale chocolate brown, also gray, micaceous, trace of limestone.

ROBERT E. LAUTH

830 - 840	Trace of sandstone. 100 shale ditto.
840 - 850	100 shale ditto.
850 - 860	10 sandstone green, fine grained, cemented with calcareous cement. 90 shale ditto.
860 - 870	Trace of sandstone ditto. 100 shale chocolate red.
870 - 880	30 sandstone red, very fine grained, shaly and silty, occasional pebble. 70 shale ditto, some gray and green.
880 - 890	40 sandstone ditto, in part micaceous. 60 shale ditto.
890 - 900	10 sandstone ditto, some clear, fine grained, and loose. 90 shale ditto. Trace of yellow shale.
900 - 905	100 shale chocolate brown and gray. Trace of red chert.
905 - 910	10 sandstone white, medium grained with much clay cement. Trace of white, fine grained, micaceous. 90 shale ditto.
910 - 915	10 sandstone ditto. 10 limestone white crystalline. 80 shale as above.
915 - 920	10 sandstone ditto. Trace of root beer, fine grained, and hard sandstone. 90 shale red and gray, in part very sandy.
Root Beer sand. 920 - 925	70 sandstone tan to root beer color, very fine grained to hard and tight. 30 shale varicolored.
925 - 930	70 sandstone ditto. 30 shale red to chocolate to micaceous.
930 - 935	10 sandstone ditto, red. 90 shale red, micaceous, and sandy.
935 Top Cavings 935 - 940	30 sandstone ditto, tan. 70 shale red, micaceous, and sandy.
15 min. cic. sample @ 940	30 sandstone fawn colored to buff, fine grained, and well cemented. 70 shale red, micaceous, and sandy, sandstone is probably in streaks in shale.
940 - 956	See Core No. 1.
956 - 969	See Core No. 2.
969 - 978	See Core No. 3.
978 - 985	100 sandstone buff, fine to medium grained, and firm. Lot of cavings.
985 - 990	100 sandstone ditto. Lot of cavings.
990 - 995	100 sandstone ditto, becoming firmer and compact. Lots of cavings.

995 – 1000	100 sandstone ditto. Lot of cavings.
1000 – 1005	Trace of sandstone. 100 green chloritic material.
1005 – 1010	20 sandstone. 30 green chloritic material. 50 shale, cavings.
1010 – 1015	80 sandstone buff, fine to medium grained, good porosity and permeability. 20 green chloritic material (basalt?).
1015 – 1020	100 sandstone ditto.
1020 – 1025	100 sandstone ditto, firm, fair porosity and permeability.
1025 – 1030	20 sandstone very fine grained to reground. 80 shale light pale green (cavings).
1030 – 1035	30 sandstone ditto, same buff, fine to medium grained, subround to angular with iron stains. 70 shale as above (cavings).
1035 – 1040	100 sandstone ditto, much cavings.
1040 – 1045	100 sandstone buff, fine to medium grained, subround to subangular, looks wet. Much cavings.
1045 – 1050	100 sandstone ditto, looks wet, much cavings.
1050 – 1055	100 sandstone ditto, looks wet, much cavings.
1055 – 1060	100 sandstone ditto, looks wet, slight salty taste, much cavings.
1060 – 1065	100 sandstone ditto, looks wet, much cavings.
1065 – 1070	100 sandstone ditto, in part iron stained, looks wet, still much shale cavings.
1070 – 1075	100 sandstone ditto, much iron stain, looks wet, and tastes salty, much cavings.
1075 – 1080	100 sandstone ditto, much iron stain, looks wet, and tastes salty, much cavings.
1080 – 1085	100 sandstone ditto, much iron stain, looks wet, tastes salty, and much cavings.
1085 – 1090	100 sandstone ditto, still much cavings, some red shale.
Total depth	1091'

Kerr- McGee 2 Fee - Permit 039 Well Files



WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

DESCRIPTION OF WELL AND LEASE

Operator: Kerr-McGee Oil Industries, Inc.	Address: P. O. Box E, Sunray, Texas
Well No.: 2	Field & Reservoir: Pinta Dome - Coconino
Location: C - N½ - NW¼	County: Apache
Sec. TWP-Range or Block & Survey: 35 - 20N - 26E	
Date Received: 4-24-57	Date completed, ready to produce: 5-2-57
Elevation: 5671	Elevation of casing hd. flange: 5660
Total depth: 1006	P.B.T.D.: 1006
Single, Dual or Triple Completion?: Single	
Producing interval (s) for this completion: 960 - 1006	Rotary tools used (interval): 0 - 1006
Cable tools used (interval): none	
Was this well directionally drilled?: no	Was directional survey made?: no
Was copy of directional survey filed?: none	Date filed:
Type of electrical or other logs run (check logs filed with the commission): Gamma ray-Neutron	Date filed: 8-14-57

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lbs./ft.)	Depth set	Sacks cement	Amt. pulled
Surface	12 ¼	8 5/8	24	170	150	0
Production	7 7/8	5 ½	14	959	200	0
Open Hole	4 ½	none				

TUBING RECORD				LINER RECORD			
Size	Depth set, ft.	Packer set at, ft.	Size, in.	Top, ft.	Bottom, ft.	Sacks cement	Screen (ft.)
None							

PERFORATION RECORD			ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD	
Number per ft.	Size & type	Depth interval	Amt. & kind of material used	Depth interval
Open Hole	4 ½	959 - 1006	none	

INITIAL PRODUCTION

Date of first production	Producing method (flowing, gas lift, or pumping—if pumping, show size & type of pump)
5-2-57	flowing

Date of test	Hrs. tested	Choke size	Oil prod. during test	Gas prod. during test	Water prod. during test	Oil gravity
5-8-57	2	64ths	none bbls.	870 MCF	none bbls.	°API (Corr.)

Tubing pressure	Casing pressure	Cal'ted rate of Prod. during test for 24 hrs.	Oil	Gas	Water	Gas-oil ratio
	SIP-99.3psig		none bbls.	11,500 MCF	none bbls.	

Disposition of gas (sold, vented, used for fuel or lease): vented for test

CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the Division Production Supt. of the Kerr-McGee Oil Industries, Inc. (company), and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

Date: Aug 14 - 1964 Signature: Otto C Banks

Note: Above information taken from Form OG 52, Well Completion Report, which was transmitted to the Arizona State Land Department July 22, 1957.

Permit No. 52

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Well Completion or Recompletion Report and Well Log
File One Copy
Form No. 4

(Complete Reverse Side)

July 10, 1957

Kerr-McGee Oil Industries, Inc.

Legal Subdivision Sec. T. & Rge.	Total Depth	Diameter	Casing	Production	Pay Zone	Your Designated Name
NENWSE; 34-20N-26E	2502' TD 1174' PBTD	8 5/8" 7"	286' 1227'	SIP 99.3 Est. 2400 MCF	1000'-1020' 1120'-1124'	State #2
SESWSW; 34-20N-26E	1550' TD 1200' PBTD	12" 10" 8 5/8" 6 5/8"	15' 640' 840' 1530'	SIP 99.1 Est. 10,800 MCF	1027'-1100'	State #1
; 33-20N-26E	2500' TD 1222' PBTD	10 3/4" 7"	118' 1253'	SIP 99.3 Est. 400 MCF	956'-980'	Fee #1
; 4-19N-26E	1198' TD 1062' PBTD	8 5/8" 5 1/2"	174' 1192'	SIP 99.3 Est. 140 MCF	1010'-1016'	State #3
; 32-20N-26E	836' TD 832' PBTD	8 5/8" 5 1/2"	167' 828'	SIP 96.5 Est. 420 MCF	832'-836'	State #4
; 35-20N-26E	1006' TD	8 5/8" 5 1/2"	170' 959'	SIP 99.3 Est. 10,000MCF	960'-1006'	Fee #2

Completion reports filed November 17, 1956, on the State #1, 2 and Fee #1, formerly called Macie #1, 2 and 3. State #3, 4 and Fee #2 filed on July 20, 1957.

These reports should give you more complete information.

Kerr-McGee #1 Barfoot-State Well Files

Kerr-McGee #1 Barfoot-State
32-20N-27E

T. D. - 1087' Float Collar @ 1052'

Tops	Ker-McGee	B. Brown
Shinarump	714	781
Moenkopi	805	805
Coconino	984	984

Gas zone: 984 to 1034 - 50'
Perfs: 4 per foot Super Dyna Jets between 986 and 1008'

Casing pressure: 107.3#

Temp. at well head - 60°F.

Rate Flow on test:

2" tubing	Orfice .25	Casing pres -	103.3 -	136MCF
	" .50	" -	86.8 -	449 MCF
	" .75	" -	61.2 -	732 MCF
	" 1.00	" -	40.0 -	933 MCF

Porosity - 12%

Water Saturation - 38%

Helium - 8.24%

Casing record: 7 5/8" (24.4#) @ 195.08' w/70 sx.
4½' (9.5#) @ 1076.29' w/140 sx.

Produced a total of 95 MCF gas in a 4-hour test.

Water table - 1034'

Calculated open flow rate - 1160 MCF

PN 238

P

Reserve Report for the Kerr-McGee Barfoot State 1

Sept. 19, 1963

Spector and Johnson
705 Guaranty Bank Bldg.
Phoenix 12, Arizona
Atten: Mr. A. B. Spector

Re: Volumetric reserve helium study of the Barfoot property in Apache County, Arizona

Dear Sir:

The volumetric reserves of net recoverable helium under Section 32-T20N-R27E., Apache County, Arizona is calculated to be 48,000 MCF. The present well head price for pure helium averages $8.12 per MCF. Based on these figures, the total recoverable helium value is placed at $390,000.00. This breaks down into the following: (Rounded out to nearest 1000)

Barfoot interest	- 40%	- $156,000
Kerr-McGee "	- 40%	- 156,000
State Royalty	- 12½%	- 49,000
S & J "	- 7½%	- 29,000

Many factors were used to arrive at these conslusions. Geologic structure and hydrologic data had to be used to arrive at the amount of productive acreage in the lease.

A short, general discussion on the data used in these conclusions are discussed below:

Porosity" The reported porosity of the Barfoot well was 12%. Eastern #13 Santa Fe had 13.5% and the #14 Santa Fe had 14.5%. Other wells in the field ranged up to 17% porosity. The 13.5% figure used in these calculations are considered relatively conservative by field-wide averages.

Conate water: Cores of the Barfoot well showed an average of 38% water saturation. This is higher than average due to core analysis below the 1032 foot level. Field wide water saturation about 30% at Pinta and Navajo Springs and this value was used.

Acreage: A total acreage in the lease is 640 acres. A total of 380 acres was used in the evaluation as being productive. By applying hydrologic data with the structural features, the northeastern part of Sectinn is not expected to be productive.

Recovery factor: A recovery factor of 85% was used, however, it is believed that about all of the gas will be recovered by water drive and the use of a compressor. If all of the gas is recovered the value of this lease will increase by 15%.

Nitrogen & Argon: The total gas is composed of about 90% Nitrogen and 0.6% Argon. Although they have commercial value, these gasses are not being processed at the Kerr-McGee plant. The Nitrogen is being used as a coolant in the helium recovery process and a value should be placed on it.

The volumetric reserves given are believed to be reasonable and accurate with present geological and engineering data. More control to the north of the Barfoot well may indicate more productive acre than was used in the evaluation. An increase in the price of helium at the well head will also increase the value of the property.

Reservoir data and pertinent values are shown on the following data sheet. These data were used in the calculations.

Very truly yours,

Silas C. Brown
Registered geologist

SCB:b

DATA SHEET

RESERVOIR DATA & ESTIMATES

OF HELIUM RESERVES

Field: Navajo Springs Reservoir: Coconino SS. Interval 986-1034

County: Apache State: Arizona

Company: Korr-McGee & Barfoot Location: Section 32-T20N-R27E.

1. Total area of lease	640	acres.
2. Total productive area	380	acres.
3. Thickness of pay	48	feet.
4. Volume of pay	15,000	Acre/ft.
5. Net helium per acre-foot	3.2	MCF
6. Net helium under lease	48,000	MCF
7. Average productive porosity	13.5%	
8. Conate Water	30%	
9. Reservoir Temperature	89°F	
10. Present Casing pressure	103.3	psig.
11. Specific gravity of gas	0.907	
12. Original gas in reservoir	590,000	MCF
13. Net Helium @ 8.24%	48,000	MCF
14. Recovery factor	85%	
15. Value of recoverable helium @ $8.12 per MCF	$390,000	
16. Value of Barfoot interests - 40%	$156,000	

Note: all values and volumes are at 15.025 psig and 60°F.
Most values were rounded to nearest 1000.

Kerr-McGee 1 Fee - Permit 10 Well Files

COUNTY Apache Field Plata Dome LEASE NO. Hortenstine-Macie Fee

WELL NAME Kerr-McGee Oil Industries, Inc. #1 Fee

LOCATION SW SE SEC 33 TWP 20N RANGE 26E FOOTAGE 330' FSL 2310' FEL

STATUS Hole TOTAL DEPTH 2513'

ELEV 5263' GR KB SPUD DATE 5-18-56? COMP. DATE 10-27-56 1222 PB

CONTRACTOR

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH
10 3/4"	138'	60 sx	
7	1260'	275 sx	

DRILLED BY ROTARY x

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR 950-1150+ Coconi

INITIAL PRODUCTION 216 MCF Helium
480 MCF AOF

FORMATION TOPS	DEPTHS	SOURCE E.L.	SOURCE S.L.	REMARKS

OPERATIONS AND COMPLETION ASSUMED BY KERR-MCGEE APPROX 10-17-56?

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS
Radio-Activity		
GRN		

(sent to Utah)
SAMPLE LOG Am Strat
SAMPLE DESCRIP.
SAMPLE NO. 2 212, 2-1663
CORE ANALYSIS
DSTs

REMARKS Permit originally (producing well) filed by Kirling Pet. Company. The well is referred to by various names in the files: Horenstine Macie #2; Apache Oil & Helium Lease-Macie #2; Kirling Well, Colorado-Horenstine, KerrMcGee Fee #1, etc.

APP. TO PLUG x
PLUGGING REP.
COMP. REPORT x

WATER WELL ACCEPTED BY

BOND CO. Firemens Ins. Co. BOND NO. 188 78 10-328

BOND AMT. $ 25,000 CANCELLED DATE ORGANIZATION REPORT 6-27-60

FILING RECEIPT none LOC. PLAT x WELL BOOK x PLAT BOOK x

API NO. 02-001-05375 DATE ISSUED 5-15-62 DEDICATION All

PERMIT NUMBER 10

(over)

Kerr McGee 3A State – Permit 349 Well Files

COUNTY Apache AREA 5' SW Navajo LEASE NO. State 3120

WELL NAME KERR MCGEE #3A STATE [redacted]

LOCATION NE NE SEC A TWP 19N RANGE 26E FOOTAGE 330' FSL 330 FEL

STATUS Completed TOTAL 997 PETD

ELEV 5765 GR KB SPUD DATE 4-17-66 COMP. DATE 4-23-66 DEPTH 1005'

4-28-667 SOLD' AM Stn

CONTRACTOR Stewart Brothers

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH
7 5/8"	200'	125 SKS	
6 3/4	1004	100 SKS	

DRILLED BY ROTARY X

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR Coconino

INITIAL PRODUCTION 586 MCFPD Helium

FORMATION TOPS	DEPTHS	SOURCE E.L.	REMARKS
Chinle	0	X	
Shinarump	780'		
Moenkopi	894'		
Coconino	965'		

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS
IE/Perforating Log/GR	965-980	965-980

SAMPLE LOC AB Strat

SAMPLE DESCRP. Four Corn

SAMPLE NO. 1373*

CORE ANALYSIS

DSTs

Tucson 2067*

REMARKS Samples turned in to Four Corners Samples Cuts. Helium producing.

APP. TO PLUG

PLUGGING REP.

COMP. REPORT X

WATER WELL ACCEPTED BY

BOND CO. Firemen's Ins. Co. BOND NO. BND IBS 98-10-52B

BOND AMT. $ 25,000 CANCELLED DATE ORGANIZATION REPORT 7-14-66

FILING RECEIPT 9447 LOC. PLAT X WELL BOOK X PLAT BOOK X

API NO. 02-001-05265 DATE ISSUED 3-31-66 DEDICATION N/2 N/2 SW/4,SE/4SW/4SE/4 Sec 4 E/2 NE/4 Sec 5

PERMIT NUMBER 349

(over)

Kerr-McGee 4 State – Permit 38 Well Files

COUNTY Apache FIELD: Pinta Dome LEASE NO. State 2113

WELL NAME Kerr-McGee State #4

LOCATION NW SW NE SEC 32 TWP 20N RANGE 26E FOOTAGE 1650 FNL 2310 FEL

ELEV 5564' GR 5575~~DF~~* SPUD DATE 5-4-57 STATUS ~~Completed~~ P & A 4-14-57 TOTAL COMP. DATE 5-10-57 DEPTH 836'

* per logs & completion report

CONTRACTOR

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH
8 5/8"	167'	100 sx	NA
5 1/2"	828'	200 sx	

DRILLED BY ROTARY x

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR

INITIAL PRODUCTION Coconino

IPF 420 MCFPD (Helium) open flow

FORMATION TOPS	DEPTHS	SOURCE L.L.	SOURCE E.L.	REMARKS

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS
GRN; Radioactivity (cannot locate log file)		828-832

SAMPLE LOG

SAMPLE DESCRP.

SAMPLE NO.

CORE ANALYSIS

DSTs

REMARKS Producing Helium Well. Shut in pressure 96.5#

APP. TO PLUG ✓

PLUGGING REP. ✓

COMP. REPORT x

WATER WELL ACCEPTED BY

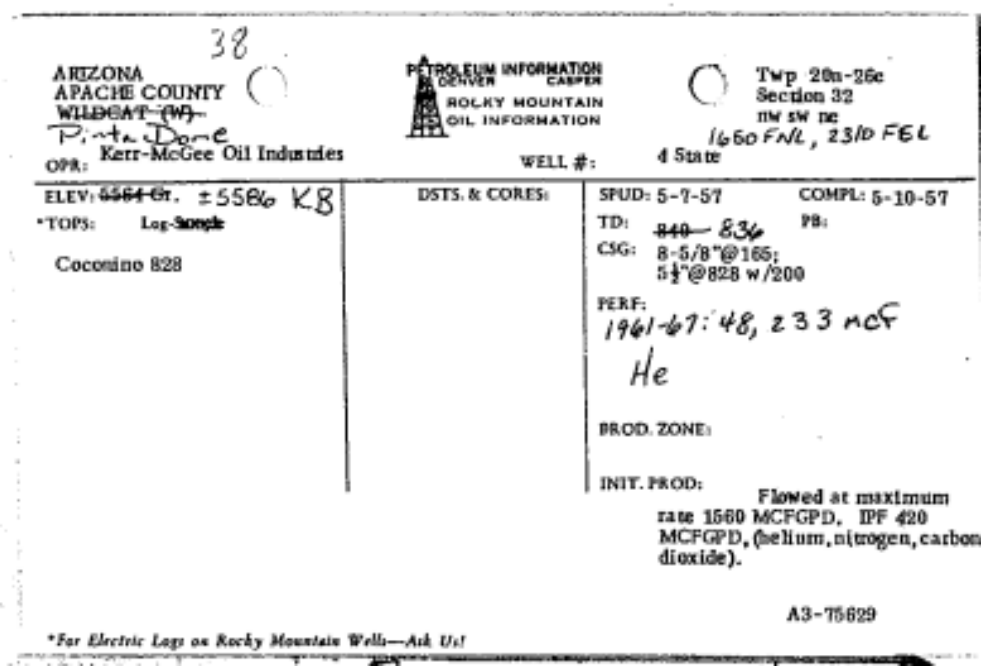
BOND CO. Firemen's Ins. Co. BOND NO. 188 98 10-528

BOND AMT. $ 25,000 CANCELLED DATE ORGANIZATION REPORT x

FILING RECEIPT ~~XXXXXX~~ none LOC. PLAT x WELL BOOK x PLAT BOOK x

API NO. 02-001-05136 DATE ISSUED 4-1-57 DEDICATION All

29



38

ARIZONA
APACHE COUNTY
~~WILDCAT (W)~~
Pinta Dome
OPR: Kerr-McGee Oil Industries

PETROLEUM INFORMATION DENVER CASPER
ROCKY MOUNTAIN OIL INFORMATION

WELL #: 4 State

Twp 28n-26e
Section 32
nw sw ne
1650 FNL, 2310 FEL

ELEV: ~~4564 Gr.~~ ±5586 KB
*TOPS: ~~Log~~
Coconino 828

DSTS. & CORES:

SPUD: 5-7-57 COMPL: 5-10-57
TD: ~~849~~ 836 PB:
CSG: 8-5/8"@165;
5½"@828 w/200

PERF:
1961-67: 48, 233 mcf
He

PROD. ZONE:

INIT. PROD: Flowed at maximum rate 1560 MCFGPD, IPF 420 MCFGPD, (helium, nitrogen, carbon dioxide).

A3-75629

*For Electric Logs on Rocky Mountain Wells—Ask Us!

July 10, 1957 Kerr-McGee Oil Industries, Inc.

Legal Subdivision Sec. T. & Rge.	Total Depth	Diameter	Casing	Production	Pay Zone	Your Designated Name
NENWSE; 34-20N-26E	2502' TD 1174' PBTD	8 5/8" 7"	286' 1227'	SIP 99.3 Est. 2400 MCF	1000'-1020' 1120'-1124'	State #2
SESWSW; 34-20N-26E	1550' TD 1200' PBTD	12" 10" 8 5/8" 6 5/8"	15' 640' 840' 1530'	SIP 99.1 Est. 10,800 MCF	1027'-1100'	State #1
; 33-20N-26E	2500' TD 1222' PBTD	10 3/4" 7"	118' 1253'	SIP 99.3 Est. 400 MCF	956'-980'	Fee #1
; 4-19N-26E	1198' TD 1062' PBTD	8 5/8" 5 1/2"	174' 1192'	SIP 99.3 Est. 140 MCF	1010'-1016'	State #3
; 32-20N-26E	836' TD 832' PBTD	8 5/8" 5 1/2"	167' 828'	SIP 96.5 Est. 420 MCF	832'-836'	State #4
; 35-20N-26E	1006' TD	8 5/8" 5 1/2"	170' 959'	SIP 99.3 Est. 10,000MCF	960'-1006'	Fee #2

Completion reports filed November 17, 1956, on the State #1, 2 and Fee #1, formerly called Macie #1, 2 and 3. State #3, 4 and Fee #2 filed on July 20, 1957.

These reports should give you more complete information.

Yours truly,

Otto C. Barton

Kerr-McGee 3 State - Permit 37 Well Files

COUNTY Apache Field Pinta Dome LEASE NO. State 2114

WELL NAME Kerr-McGee State 3

LOCATION NW SE SEC 4 TWP 19N RANGE 26E FOOTAGE 2310 FSL 1650 FEL

ELEV 5766' GR 5777' RB SPUD DATE 4-10-57 STATUS P&A 1-13-77 TOTAL COMP. DATE 4-23-57 DEPTH 1198'

CONTRACTOR Ble Weel

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH
8⅝"	174		
4½	1192		

DRILLED BY ROTARY x

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR

INITIAL PRODUCTION 140 MCF & 2 BWPD on 24 hr basis

FORMATION TOPS	DEPTHS	SOURCE L.L.	SOURCE E.L.	REMARKS
Coconino	954'		x	

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS	
Elec.	1138-1145'	1010-1145	SAMPLE LOG
	1088-1100'	Coconino	SAMPLE DESCRP.
	1010'1016'		SAMPLE NO.
			CORE ANALYSIS
			DSTs

REMARKS ~~This well is shut in and has been since completion 9-1-570~~

APP. TO PLUG ✓

PLUGGING REP. ✓

COMP. REPORT x

WATER WELL ACCEPTED BY

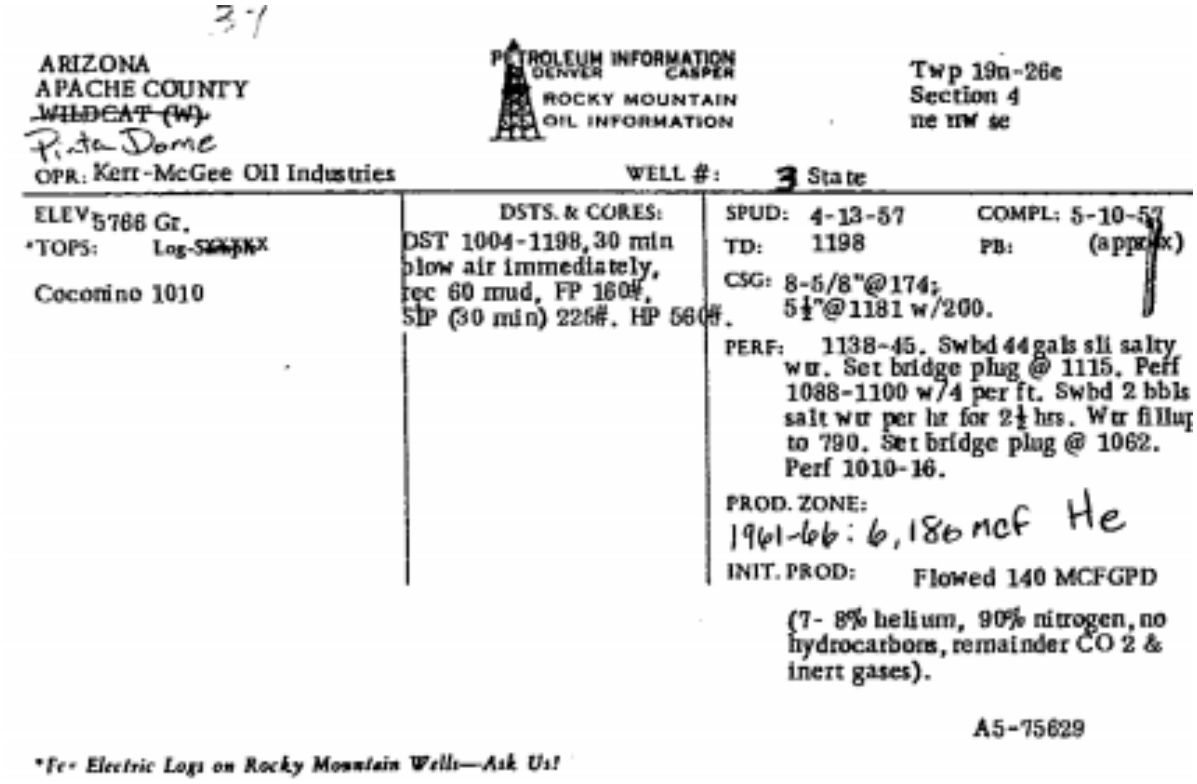
BOND CO. Firemen's Ins. Co. BOND NO. 188 98 10-528

BOND AMT. $ 25,000 CANCELLED DATE ORGANIZATION REPORT x

FILING RECEIPT LOC. PLAT x WELL BOOK x PLAT BOOK x

API NO. 02-001-05125 DATE ISSUED 4-1-57 DEDICATION All

PERMIT NUMBER 37



3-1

ARIZONA
APACHE COUNTY
~~WILDCAT (W)~~
Pita Dome
OPR: Kerr-McGee Oil Industries

PETROLEUM INFORMATION
DENVER CASPER
ROCKY MOUNTAIN
OIL INFORMATION

Twp 19n-26e
Section 4
ne nw se

WELL #: 3 State

ELEV 5766 Gr.
*TOPS: Log-~~Sample~~
Coconino 1010

DSTS. & CORES:
DST 1004-1198, 30 min blow air immediately, rec 60 mud, FP 160#, SIP (30 min) 226#. HP 560#.

SPUD: 4-13-57 COMPL: 5-10-57
TD: 1198 PB: (approx)
CSG: 8-5/8"@174; 5½"@1181 w/200.
PERF: 1138-45. Swbd 44 gals sli salty wtr. Set bridge plug @ 1115. Perf 1088-1100 w/4 per ft. Swbd 2 bbls salt wtr per hr for 2½ hrs. Wtr fillup to 790. Set bridge plug @ 1062. Perf 1010-16.
PROD. ZONE:
1961-66: 6,186 mcf He
INIT. PROD: Flowed 140 MCFGPD
(7- 8% helium, 90% nitrogen, no hydrocarbons, remainder CO 2 & inert gases).

A5-75629

*For Electric Logs on Rocky Mountain Wells—Ask Us!

PLUGGING RECORD

Operator: Kerr-McGee Corporation		Address: P. O. Box 250, Amarillo, TX 79105	
Federal, State, or Indian Lease Number, or lessor's name if fee lease: State	Well No.: 3	Field & Reservoir: PINTA DOME/Coconino Sand	
Location of Well: C-NE-NW-SE Section 4 Twp 19N-Rge 26E		Sec-Twp-Rge or Block & Survey	County: Apache
Application to drill this well was filed in name of: Apache Oil & Helium Co.	Was this well ever produced oil or gas: Yes - Helium	Character of well at completion (initial production): Oil (Bbls/day): N/A	Gas (MCF/day): 140 (9.08?Hz)
			Dry? No
Date plugged: 4/13/77	Total depth: 1198'	Amount well producing when plugged: Oil (Bbls/day): -0-	Gas (MCF/day): 93
			Water (Bbls/day): 0

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used. Indicate zones squeeze cemented, giving amount cement
N/A			

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped, etc.)	Packers and shoes
8 5/8"	[illegible]174	0	[illegible]174	---	EZSV Retainer at 968'
5 1/2"	[illegible]1172	0	[illegible]1172	---	------

Was well filled with mud-laden fluid, according to regulations? Yes

Indicate deepest formation containing fresh water.

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well:
Kerr-McGee Corporation	P. O. Box 250 Amarillo, TX 79105	All

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval in fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Well was P & A by setting 5 1/2" EZSV cement retainer at 968' with 60 sxs. Class "B" Cement pumped below retainer and 117 sxs. Class "B" Cement from retainer to surface.

Use reverse side for additional detail.

CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the Engineering Assistant of the Kerr-McGee Corporation (company) and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

April 22, 1977
Date

RECEIVED
APR 25 1977
O & G CONS. COMM.

Lynn Kelley
Signature

Lynn Kelley

Permit No. 37

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Plugging Record
File One Copy

Form No. 10

Kerr-McGee 4A State – Permit 378 Well Files

COUNTY Apache AREA Pinta Dome LEASE NO. State 2088-1 7 2113

WELL NAME Kerr-McGee #4A State

LOCATION NE SE SEC 32 TWP 20N RANGE 26E FOOTAGE 1400 FSL and 330 FEL

STATUS [illegible] TOTAL 804'

ELEV 5555' GR KB SPUD DATE 2-15-67 COMP. DATE 3-6-67 DEPTH 836'

CONTRACTOR

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH
7 5/8	207'	125 SKS	NS
4 1/2	836'	150 SKS	

DRILLED BY ROTARY x

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR Coconino 793-96'

INITIAL PRODUCTION

FORMATION TOPS	DEPTHS	SOURCE L.L.	SOURCE E.L.	REMARKS
Chinle	0		x	
Chinle-Conglomerate	550'			
Shinarump	632'			
Moencopi	770'			
Coconino	793'			

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS
IES	793-796	793-796

SAMPLE LOG

SAMPLE DESCRP.

SAMPLE NO. 1416/*

CORE ANALYSIS

DSTs

*Tucson 2084

REMARKS Existing State #4 Well (Permit 38 to be shut-in upon successful completion of this well.

APP. TO PLUG x

PLUGGING REP. x

COMP. REPORT x

WATER WELL ACCEPTED BY

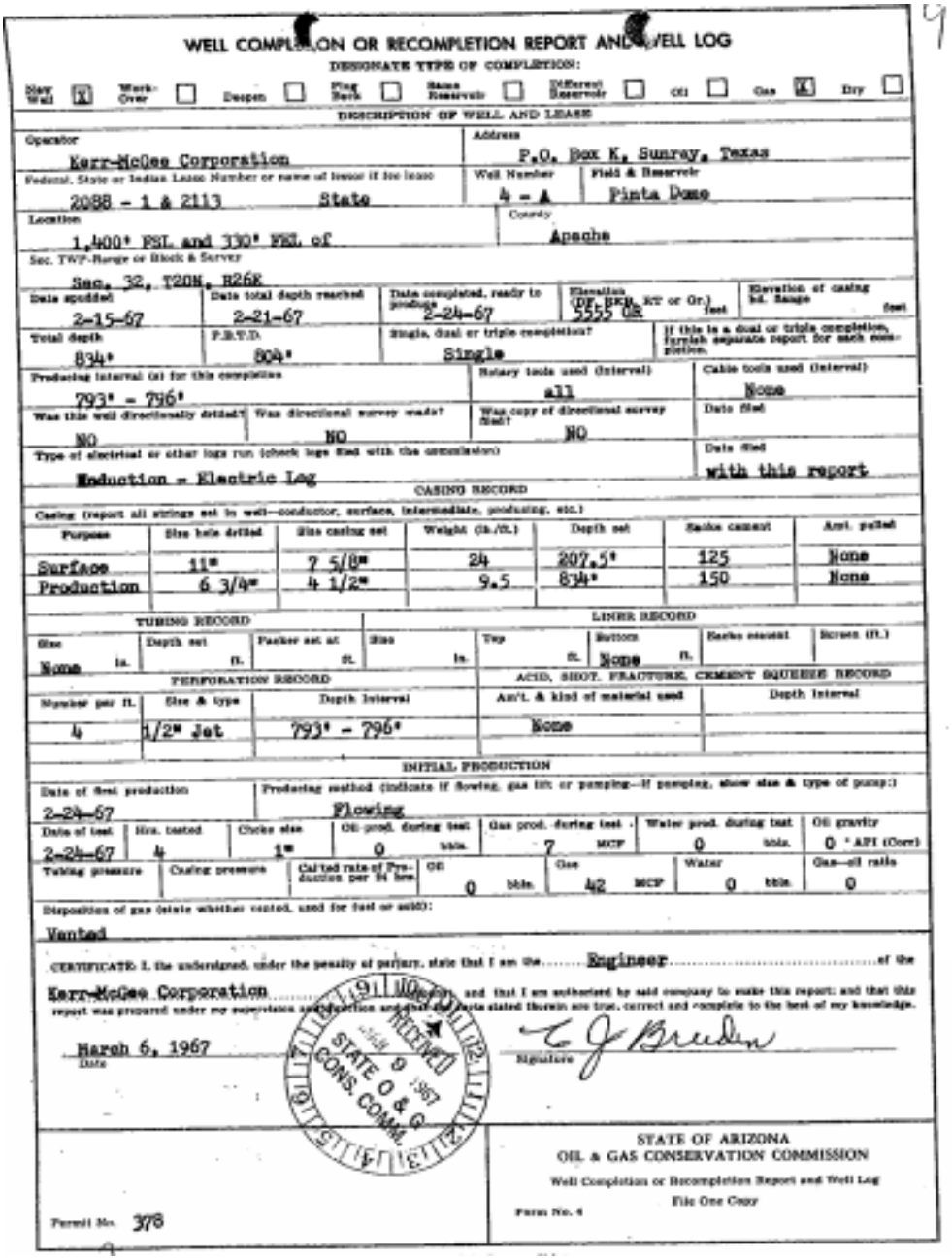
BOND CO. Firemen's Ins. Co. BOND NO. 188 98 10-528

BOND AMT. $ 25,000 CANCELLED DATE ORGANIZATION REPORT 7-14-60

FILING RECEIPT 9472 LOC. PLAT x WELL BOOK x PLAT BOOK x

API NO. 02-001-20003 DATE ISSUED 2-6-67 DEDICATION E/2 NW/4 NE/4 SW/4 of Sec 32; SE/4 SW/4 E/2 SW/4 of Sec 29

PERMIT NUMBER 38



WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

DESIGNATE TYPE OF COMPLETION:

New Well [X] Work-Over [ ] Deepen [ ] Plug Back [ ] Same Reservoir [ ] Different Reservoir [ ] Oil [ ] Gas [X] Dry [ ]

DESCRIPTION OF WELL AND LEASE

Operator: Kerr-McGee Corporation	Address: P.O. Box K, Sunray, Texas
Federal, State or Indian Lease Number or name of lessor if fee lease: 2088 - 1 & 2113 State	Well Number: 4 - A
Field & Reservoir: Pinta Dome	
Location: 1,400' FSL and 330' FEL of	County: Apache
Sec., TWP-Range or Block & Survey: Sec. 32, T20N, R26E	

Date spudded	Date total depth reached	Date completed, ready to produce	Elevation (DF, RKB, RT or Gr.) feet	Elevation of casing hd. flange feet
2-15-67	2-21-67	2-24-67	5555 GR	

Total depth	P.B.T.D.	Single, dual or triple completion?	If this is a dual or triple completion, furnish separate report for each completion.
834'	804'	Single	

Producing interval (s) for this completion	Rotary tools used (interval)	Cable tools used (interval)
793' - 796'	all	None

Was this well directionally drilled?	Was directional survey made?	Was copy of directional survey filed?	Date filed
NO	NO	NO	

Type of electrical or other logs run (check logs filed with the commission): Induction - Electric Log — Date filed: with this report

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amt. pulled
Surface	11"	7 5/8"	24	207.5'	125	None
Production	6 3/4"	4 1/2"	9.5	834'	150	None

TUBING RECORD

Size	Depth set	Packer set at	Size	Top	Bottom	Sacks cement	Screen (ft.)
None in.	ft.	ft.	in.	ft.	None ft.		

LINER RECORD

PERFORATION RECORD

Number per ft.	Size & type	Depth interval
4	1/2" Jet	793' - 796'

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

Amt. & kind of material used	Depth interval
None	

INITIAL PRODUCTION

Date of first production: 2-24-67 — Producing method (indicate if flowing, gas lift or pumping—if pumping, show size & type of pump): Flowing

Date of test	Hrs. tested	Choke size	Oil prod. during test	Gas prod. during test	Water prod. during test	Oil gravity
2-24-67	4	1"	0 bbls.	7 MCF	0 bbls.	0 ° API (Corr.)

Tubing pressure	Casing pressure	Calculated rate of Production per 24 hrs.	Oil	Gas	Water	Gas—oil ratio
			0 bbls.	42 MCF	0 bbls.	0

Disposition of gas (state whether vented, used for fuel or sold): Vented

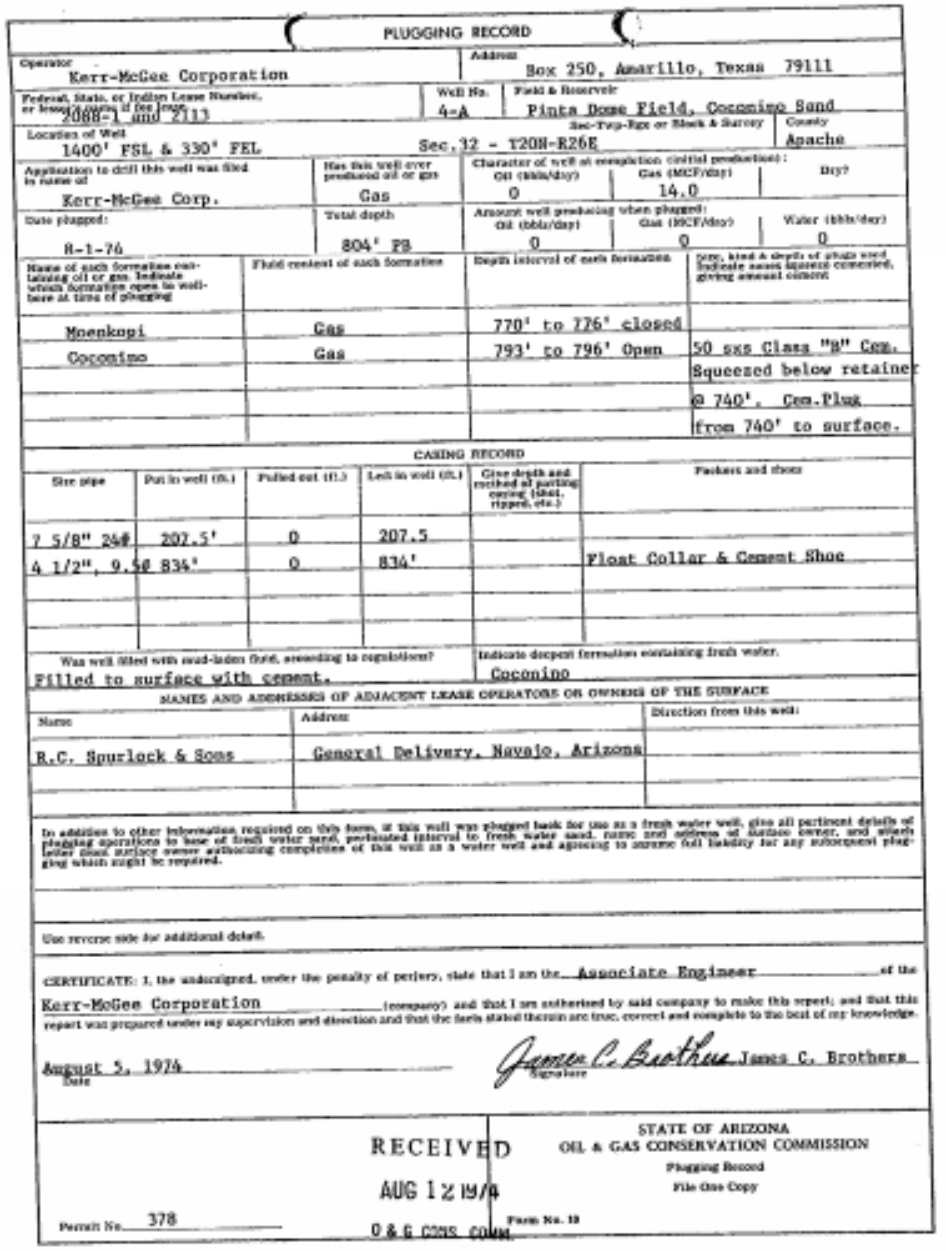
CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the Engineer of the Kerr-McGee Corporation, and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

March 6, 1967 (Date) — T J Breeden (Signature)

RECEIVED MAR 9 1967 STATE O & G CONS. COMM.

Permit No. 378

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Well Completion or Recompletion Report and Well Log
File One Copy
Form No. 4



PLUGGING RECORD

Operator: Kerr-McGee Corporation
Address: Box 250, Amarillo, Texas 79111
Federal, State, or Indian Lease Number, or lease name if fee lease: 2088-1 and 2113
Well No.: 4-A
Field & Reservoir: Pinta Dome Field, Coconino Sand
Location of Well: 1400' FSL & 330' FEL
Sec.-Twp.-Rge or Block & Survey: Sec. 12 - T20N-R26E
County: Apache
Application to drill this well was filed in name of: Kerr-McGee Corp.
Has this well ever produced oil or gas: Gas
Character of well at completion (initial production): Oil (bbls/day): 0; Gas (MCF/day): 14.0; Dry?
Date plugged: 8-1-74
Total depth: 804' PB
Amount well producing when plugged: Oil (bbls/day): 0; Gas (MCF/day): 0; Water (bbls/day): 0

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Sacks, kind & depth of plugs used. Indicate amount squeezed cemented, giving amount cement
Moenkopi	Gas	770' to 776' closed	
Coconino	Gas	793' to 796' Open	50 sxs Class "B" Cem. Squeezed below retainer @ 740', Cem.Plug from 740' to surface.

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped, etc.)	Packers and shoes
7 5/8" 24#	207.5'	0	207.5		
4 1/2", 9.5#	834'	0	834'		Float Collar & Cement Shoe

Was well filled with mud-laden fluid, according to regulations? Filled to surface with cement.
Indicate deepest formation containing fresh water: Coconino

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well:
R.C. Spurlock & Sons	General Delivery, Navajo, Arizona	

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Use reverse side for additional detail.

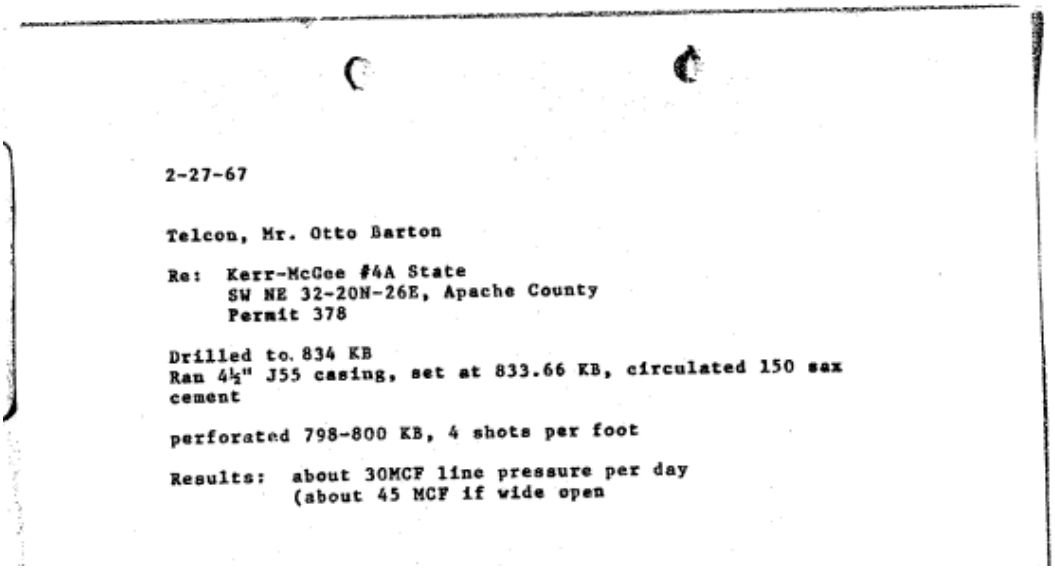
CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the Associate Engineer of the Kerr-McGee Corporation (company) and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

August 5, 1974 (Date)
James C. Brothers (Signature) James C. Brothers

RECEIVED
AUG 12 1974
O & G CONS COMM

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Plugging Record
File One Copy

Permit No. 378
Form No. 10



2-27-67

Telcon, Mr. Otto Barton

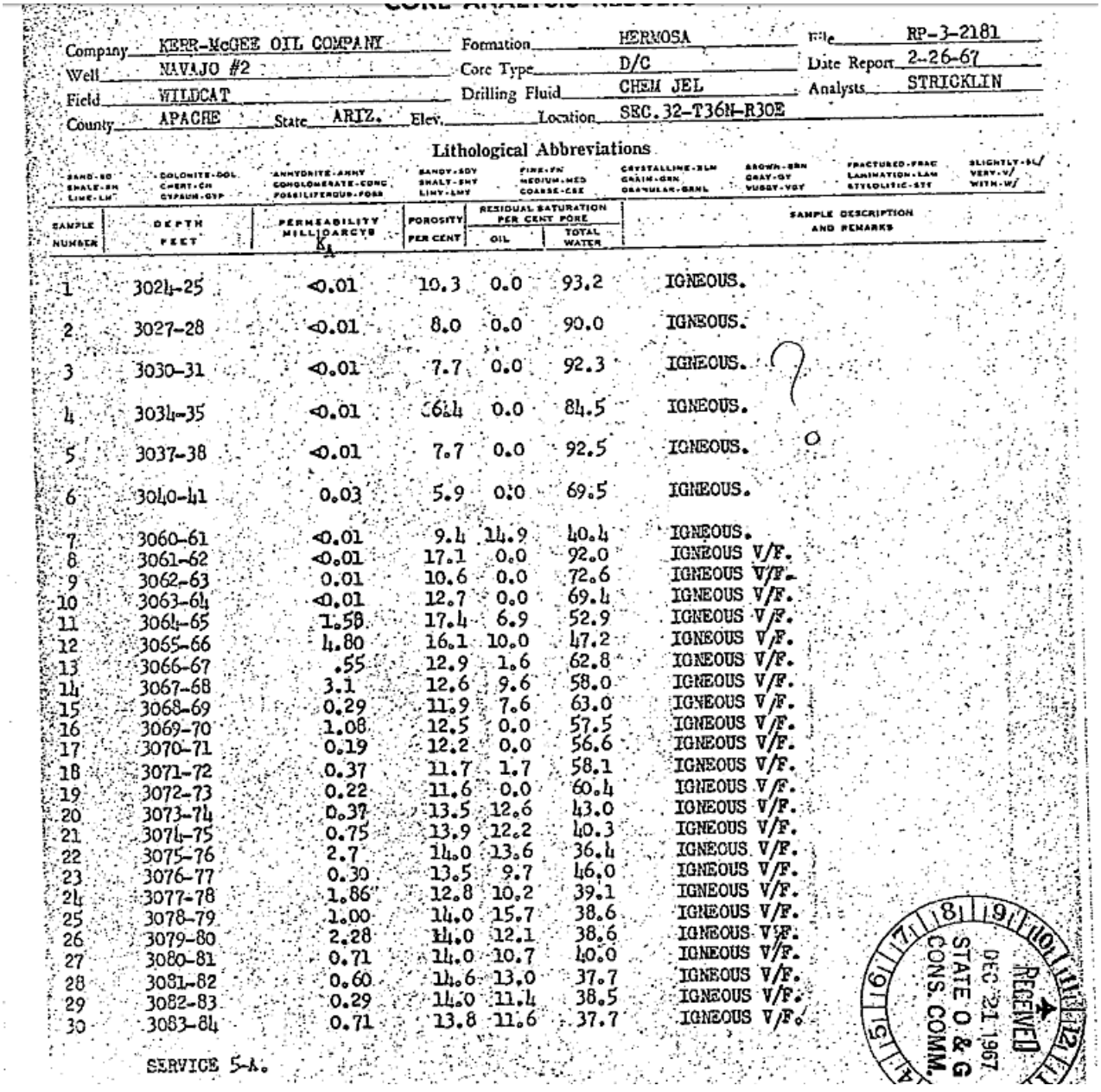
Re: Kerr-McGee #4A State
SW NE 32-20N-26E, Apache County
Permit 378

Drilled to 834 KB
Ran 4½" J55 casing, set at 833.66 KB, circulated 150 sax cement

perforated 798-800 KB, 4 shots per foot

Results: about 30MCF line pressure per day
(about 45 MCF if wide open

Kerr McGee #2 Navajo: Permit 379 Well Files



CORE ANALYSIS REPORT

Company KERR-McGEE OIL COMPANY Formation HERMOSA File RP-3-2181
Well NAVAJO #2 Core Type D/C Date Report 2-26-67
Field WILDCAT Drilling Fluid CHEM JEL Analysts STRICKLIN
County APACHE State ARIZ. Elev. Location SEC. 32-T36N-R30E

Lithological Abbreviations

SAND-SD SHALE-SH LIME-LM · DOLOMITE-DOL CHERT-CH GYPSUM-GYP · ANHYDRITE-ANHY CONGLOMERATE-CONG FOSSILIFEROUS-FOSS · SANDY-SDY SHALY-SHY LIMY-LMY · FINE-FN MEDIUM-MED COARSE-CSE · CRYSTALLINE-XLN GRAIN-GRN GRANULAR-GRNL · BROWN-BRN GRAY-GY VUGGY-VGY · FRACTURED-FRAC LAMINATION-LAM STYLOLITIC-STY · SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
1	3024-25	<0.01	10.3	0.0	93.2	IGNEOUS.
2	3027-28	<0.01	8.0	0.0	90.0	IGNEOUS.
3	3030-31	<0.01	7.7	0.0	92.3	IGNEOUS.
4	3034-35	<0.01	6.4	0.0	84.5	IGNEOUS.
5	3037-38	<0.01	7.7	0.0	92.5	IGNEOUS.
6	3040-41	0.03	5.9	0.0	69.5	IGNEOUS.
7	3060-61	<0.01	9.4	14.9	40.4	IGNEOUS.
8	3061-62	<0.01	17.1	0.0	92.0	IGNEOUS V/F.
9	3062-63	0.01	10.6	0.0	72.6	IGNEOUS V/F.
10	3063-64	<0.01	12.7	0.0	69.4	IGNEOUS V/F.
11	3064-65	1.58	17.4	6.9	52.9	IGNEOUS V/F.
12	3065-66	4.80	16.1	10.0	47.2	IGNEOUS V/F.
13	3066-67	.55	12.9	1.6	62.8	IGNEOUS V/F.
14	3067-68	3.1	12.6	9.6	58.0	IGNEOUS V/F.
15	3068-69	0.29	11.9	7.6	63.0	IGNEOUS V/F.
16	3069-70	1.08	12.5	0.0	57.5	IGNEOUS V/F.
17	3070-71	0.19	12.2	0.0	56.6	IGNEOUS V/F.
18	3071-72	0.37	11.7	1.7	58.1	IGNEOUS V/F.
19	3072-73	0.22	11.6	0.0	60.4	IGNEOUS V/F.
20	3073-74	0.37	13.5	12.6	43.0	IGNEOUS V/F.
21	3074-75	0.75	13.9	12.2	40.3	IGNEOUS V/F.
22	3075-76	2.7	14.0	13.6	36.4	IGNEOUS V/F.
23	3076-77	0.30	13.5	9.7	46.0	IGNEOUS V/F.
24	3077-78	1.86	12.8	10.2	39.1	IGNEOUS V/F.
25	3078-79	1.00	14.0	15.7	38.6	IGNEOUS V/F.
26	3079-80	2.28	14.0	12.1	38.6	IGNEOUS V/F.
27	3080-81	0.71	14.0	10.7	40.0	IGNEOUS V/F.
28	3081-82	0.60	14.6	13.0	37.7	IGNEOUS V/F.
29	3082-83	0.29	14.0	11.4	38.5	IGNEOUS V/F.
30	3083-84	0.71	13.8	11.6	37.7	IGNEOUS V/F.

SERVICE 5-A.

RECEIVED DEC 21 1967 STATE O & G CONS. COMM.

Company: KERR-McGEE OIL COMPANY Formation: HERMOSA File: RP-3-2181
Well: NAVAJO #2 Core Type: D/C Date Report: 2-26-67
Field: WILDCAT Drilling Fluid: CHEM JEL Analysts: STRICKLIN
County: APACHE State: ARIZ. Elev. Location: SEC. 32-T36N-R30E

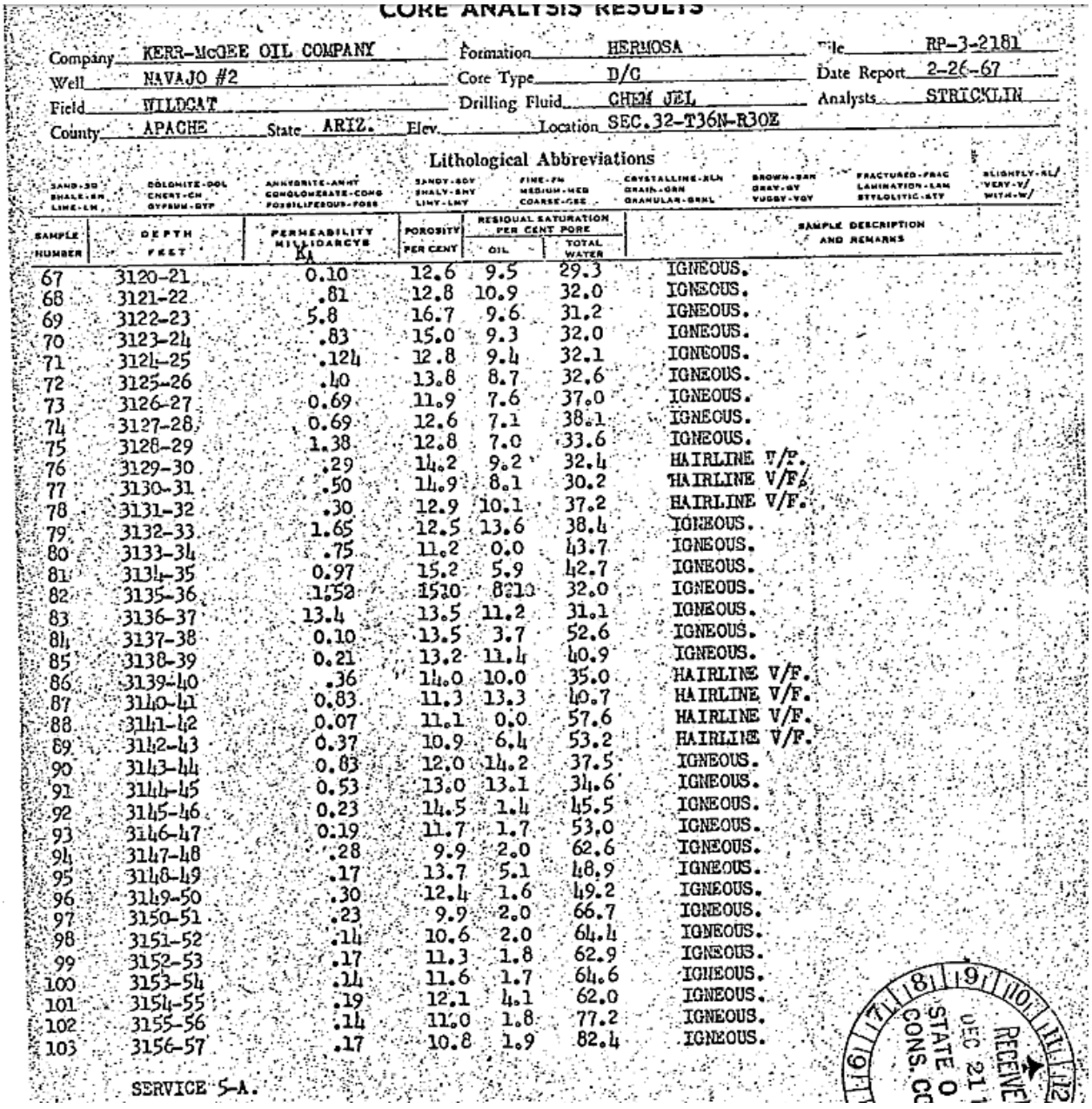
Lithological Abbreviations

SAND-SD SHALE-SH LIME-LM | DOLOMITE-DOL CHERT-CH GYPSUM-GYP | ANHYDRITE-ANHY CONGLOMERATE-CONG FOSSILIFEROUS-FOSS | SANDY-SDY SHALY-SHY LIMY-LMY | FINE-FN MEDIUM-MED COARSE-CSE | CRYSTALLINE-XLN GRAIN-GRN GRANULAR-GRNL | BROWN-BRN GRAY-GY VUGGY-VGY | FRACTURED-FRAC LAMINATION-LAM STYLOLITIC-STY | SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS Ka	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
31	3084-85	0.22	13.0	11.8	37.7	IGNEOUS V/F.
32	3085-86	1.45	11.2	8.0	32.1	IGNEOUS.
33	3086-87	5.6	12.1	11.5	37.2	IGNEOUS.
34	3087-88	.62	15.5	9.7	34.8	IGNEOUS.
35	3088-89	3.9	12.9	9.3	39.5	IGNEOUS.
36	3089-90	3.3	13.0	10.0	30.8	IGNEOUS.
37	3090-91	5.6	11.4	11.4	36.8	IGNEOUS.
38	3091-92	1.04	11.7	10.3	35.0	IGNEOUS.
39	3092-93	1.24	11.4	9.7	29.8	IGNEOUS.
40	3093-94	2.07	12.2	10.6	30.3	IGNEOUS.
41	3094-95	2.9	12.4	9.7	33.0	IGNEOUS.
42	3095-96	6.8	12.5	9.6	32.8	IGNEOUS.
43	3096-97	3.7	12.4	11.3	36.2	IGNEOUS.
44	3097-98	14.9	12.0	1.7	41.7	IGNEOUS.
45	3098-99	1.66	10.9	1.8	36.7	IGNEOUS.
46	3099-3100	4.1	15.6	10.3	30.8	IGNEOUS.
47	3100-01	25.3	14.6	11.0	27.4	IGNEOUS.
48	3101-02	4.5	13.8	11.6	36.2	IGNEOUS.
49	3102-03	20.0	14.0	10.0	35.0	IGNEOUS.
50	3103-04	4.1	13.6	10.3	29.4	IGNEOUS.
51	3104-05	3.7	15.3	10.5	26.2	IGNEOUS.
52	3105-06	.83	13.0	12.3	33.0	IGNEOUS.
53	3106-07	19.5	15.8	10.1	38.0	IGNEOUS.
54	3107-08	3.9	14.2	9.9	31.0	IGNEOUS.
55	3108-09	11.1	14.3	12.6	30.8	IGNEOUS.
56	3109-10	4.3	14.5	11.0	28.2	IGNEOUS.
57	3110-11	2.28	13.1	10.7	23.7	IGNEOUS.
58	3111-12	5.8	13.4	10.4	32.0	IGNEOUS.
59	3112-13	13.4	10.9	7.3	24.0	IGNEOUS.
60	3113-14	2.7	12.3	12.2	37.4	IGNEOUS.
61	3114-15	.83	13.9	10.1	31.0	IGNEOUS.
62	3115-16	.62	13.2	9.1	26.5	IGNEOUS.
63	3116-17	1.04	13.0	9.3	28.5	IGNEOUS.
64	3117-18	.33	12.5	9.6	32.8	IGNEOUS.
65	3118-19	.83	11.9	10.1	37.8	IGNEOUS.
66	3119-20	.069	10.8	7.4	42.6	IGNEOUS.

SERVICE 5-A.

RECEIVED DEC 21 1967 STATE O & G CONS. COMM



CORE ANALYSIS RESULTS

Company KERR-McGEE OIL COMPANY Formation HERMOSA File RP-3-2181
Well NAVAJO #2 Core Type D/C Date Report 2-26-67
Field WILDCAT Drilling Fluid CHEM GEL Analysts STRICKLIN
County APACHE State ARIZ. Elev. Location SEC.32-T36N-R30E

Lithological Abbreviations

SAND-SD SHALE-SH LIME-LM DOLOMITE-DOL CHERT-CH GYPSUM-GYP ANHYDRITE-ANHY CONGLOMERATE-CONG FOSSILIFEROUS-FOSS SANDY-SDY SHALY-SHY LIMY-LMY FINE-FN MEDIUM-MED COARSE-CSE CRYSTALLINE-XLN GRAIN-GRN GRANULAR-GRNL BROWN-BRN GRAY-GY VUGGY-VGY FRACTURED-FRAC LAMINATION-LAM STYLOLITIC-STY SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS Ka	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
67	3120-21	0.10	12.6	9.5	29.3	IGNEOUS.
68	3121-22	.81	12.8	10.9	32.0	IGNEOUS.
69	3122-23	5.8	16.7	9.6	31.2	IGNEOUS.
70	3123-24	.83	15.0	9.3	32.0	IGNEOUS.
71	3124-25	.124	12.8	9.4	32.1	IGNEOUS.
72	3125-26	.40	13.8	8.7	32.6	IGNEOUS.
73	3126-27	0.69	11.9	7.6	37.0	IGNEOUS.
74	3127-28	0.69	12.6	7.1	38.1	IGNEOUS.
75	3128-29	1.38	12.8	7.0	33.6	IGNEOUS.
76	3129-30	.29	14.2	9.2	32.4	HAIRLINE V/F.
77	3130-31	.50	14.9	8.1	30.2	HAIRLINE V/F.
78	3131-32	.30	12.9	10.1	37.2	HAIRLINE V/F.
79	3132-33	1.65	12.5	13.6	38.4	IGNEOUS.
80	3133-34	.75	11.2	0.0	43.7	IGNEOUS.
81	3134-35	0.97	15.2	5.9	42.7	IGNEOUS.
82	3135-36	1.52	1520	8210	32.0	IGNEOUS.
83	3136-37	13.4	13.5	11.2	31.1	IGNEOUS.
84	3137-38	0.10	13.5	3.7	52.6	IGNEOUS.
85	3138-39	0.21	13.2	11.4	40.9	IGNEOUS.
86	3139-40	.36	14.0	10.0	35.0	HAIRLINE V/F.
87	3140-41	0.83	11.3	13.3	40.7	HAIRLINE V/F.
88	3141-42	0.07	11.1	0.0	57.6	HAIRLINE V/F.
89	3142-43	0.37	10.9	6.4	53.2	HAIRLINE V/F.
90	3143-44	0.83	12.0	14.2	37.5	IGNEOUS.
91	3144-45	0.53	13.0	13.1	34.6	IGNEOUS.
92	3145-46	0.23	14.5	1.4	45.5	IGNEOUS.
93	3146-47	0.19	11.7	1.7	53.0	IGNEOUS.
94	3147-48	.28	9.9	2.0	62.6	IGNEOUS.
95	3148-49	.17	13.7	5.1	48.9	IGNEOUS.
96	3149-50	.30	12.4	1.6	49.2	IGNEOUS.
97	3150-51	.23	9.9	2.0	66.7	IGNEOUS.
98	3151-52	.14	10.6	2.0	64.4	IGNEOUS.
99	3152-53	.17	11.3	1.8	62.9	IGNEOUS.
100	3153-54	.14	11.6	1.7	64.6	IGNEOUS.
101	3154-55	.19	12.1	4.1	62.0	IGNEOUS.
102	3155-56	.14	11.0	1.8	77.2	IGNEOUS.
103	3156-57	.17	10.8	1.9	82.4	IGNEOUS.

SERVICE 5-A.

RECEIVED DEC 21 1 STATE O CONS. CO

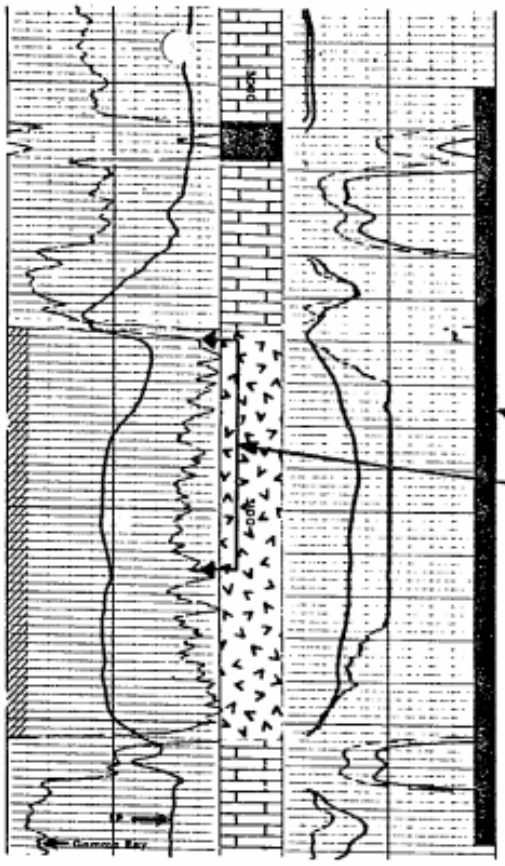


EXHIBIT NO. 3
"LOG & COMPLETION
FOR TYPICAL WELL"

KERR-McGEE

NAVAJO NO. 2

CORE 3000-3178

Pf 3060-3114

IPP 2856 BOPD

March 2 to 12, 1967

Perforated 3060' to 3114' with 2 JSPF. Pumped 500 gals 10% acetic acid into formation.

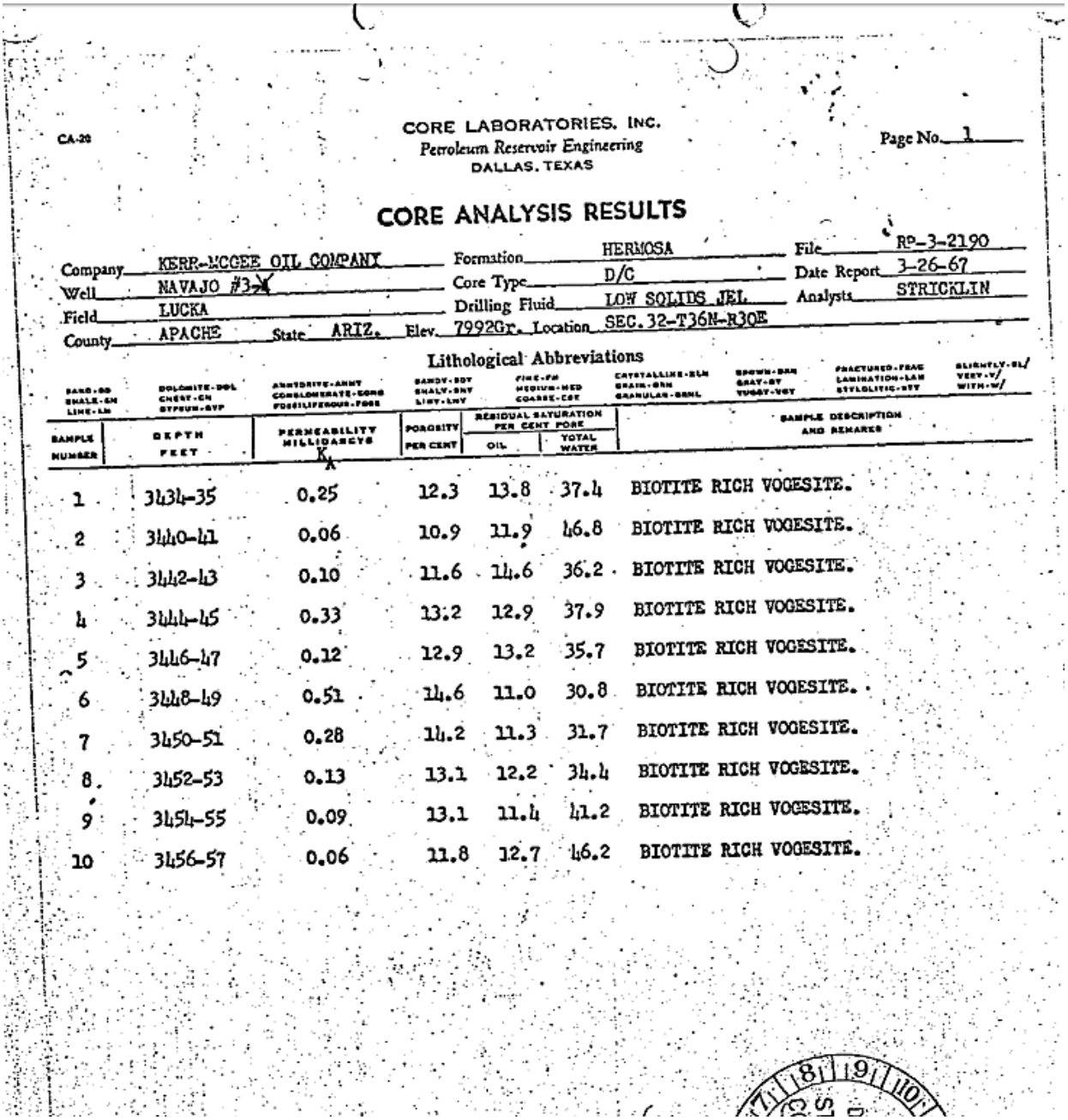
Recovered 105 barrels load oil and acid water in 6½ hours swabbing. Recovered only four barrels during last two hours swabbing off bottom. Had 35 barrels acid water and load oil to recover. Shut in overnite.

Swabbed nine barrels of oil. Loaded hole with oil and fraced well with 22,000 gallons crude oil and 20,000# of 20-40 sand.

Ran tubing to 3084'. Swabbed back 865 barrels load oil in three days.

Ran Reda pump. Produced 2857 barrels of oil in 24 hours. Fluid standing 1100' above pump.

Kerr McGee #3X Navajo: Permit 386 Well Files



CA-20

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Page No. 1

CORE ANALYSIS RESULTS

Company KERR-MCGEE OIL COMPANY Formation HERMOSA File RP-3-2190
Well NAVAJO #3-X Core Type D/C Date Report 3-26-67
Field LUCKA Drilling Fluid LOW SOLIDS GEL Analysts STRICKLIN
County APACHE State ARIZ. Elev. 7992Gr. Location SEC. 32-T36N-R30E

Lithological Abbreviations

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS K_A	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
1	3434-35	0.25	12.3	13.8	37.4	BIOTITE RICH VOGESITE.
2	3440-41	0.06	10.9	11.9	46.8	BIOTITE RICH VOGESITE.
3	3442-43	0.10	11.6	14.6	36.2	BIOTITE RICH VOGESITE.
4	3444-45	0.33	13.2	12.9	37.9	BIOTITE RICH VOGESITE.
5	3446-47	0.12	12.9	13.2	35.7	BIOTITE RICH VOGESITE.
6	3448-49	0.51	14.6	11.0	30.8	BIOTITE RICH VOGESITE.
7	3450-51	0.28	14.2	11.3	31.7	BIOTITE RICH VOGESITE.
8	3452-53	0.13	13.1	12.2	34.4	BIOTITE RICH VOGESITE.
9	3454-55	0.09	13.1	11.4	41.2	BIOTITE RICH VOGESITE.
10	3456-57	0.06	11.8	12.7	46.2	BIOTITE RICH VOGESITE.

Blackstone Exploration Company Inc.

Olufela Olukoga, Reservoir Engineering Consultant

CORE ANALYSIS RESULTS

Company KERR-MCGEE OIL COMPANY Formation HERMOSA File RP-3-2190
Well NAVAJO #3-X Core Type D/C Date Report 3-26-67
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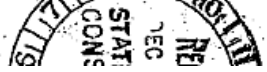
Lithological Abbreviations

SAND-SD SHALE-SH LIME-LM	DOLOMITE-DOL CHERT-CH GYPSUM-GYP	ARKOSITE-ARKY CONGLOMERATE-CONG FOSSILIFEROUS-FOSS	SANDY-SDY SHALY-SHY LIMY-LMY	FINE-FN MEDIUM-MED COARSE-CAS	CRYSTALLINE-XLN GRAIN-GRN GRANULAR-GRNL	BROWN-BRN GRAY-GY VUGGY-VGY	FRACTURED-FRAC LAMINATION-LAM STYLOLITIC-STY	SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS MAX.	K 90°	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
1	3427-28	<0.01	<0.01	9.4	4.1	76.5	THIS ROCK IS A BIOTITE RICH VOGESITE,
2	3428-29	<0.01	<0.01	9.3	1.3	81.5	AND BELONGS TO THE SYENITE LAMPROPHYRE
3	3429-30	<0.01	<0.01	8.2	5.7	75.0	GROUP OF IGNEOUS ROCKS.THIS ENTIRE CORE
4	3430-31	<0.01	<0.01	9.4	10.5	73.6	IS ROCK OF THIS TYPE.
5	3431-32	<0.01	<0.01	9.8	11.4	67.7	*SAMPLES #2&3 ARE BOTH FRACTURED VERTICALL
6	3432-33	<0.01	<0.01	10.0	12.3	72.5	& SAMPLE #5 HAS HORIZ. PARTING PLANES,
7	3433-34	<0.01	<0.01	9.7	17.7	64.3	PROBABLY SANIDINE XLYIZATION.
8	3434-35	<0.01	<0.01	8.3	15.3	63.7	VERT. FRACTURE.
9	3435-36	0.89	<0.01	9.9	8.1	71.8	HAIR LINE V/F.
10	3436-37	<0.01	<0.01	8.5	3.2	76.5	HORIZ. PARTING PLANE.
11	3437-38	<0.01	<0.01	9.0	2.6	81.8	HORIZ. PARTING PLANE.
12	3438-39	<0.01	<0.01	7.4	3.2	82.0	HORIZ. PARTING PLANE.
13	3439-40	<0.01	<0.01	7.6	7.1	77.7	HORIZ PARTING PLANE.
14	3440-41	<0.01	<0.01	8.1	12.1	70.5	V/F.
15	3441-42	<0.01	<0.01	9.1	12.9	64.3	V/F.
16	3442-43	0.58	<0.01	8.7	14.8	62.3	HAIR LINE V/F.
17	3443-44	<0.01	<0.01	9.2	12.3	58.5	HAIR LINE V/F.
18	3444-45	<0.01	<0.01	8.0	11.9	51.9	HORIZ. PARTING PLANE.
19	3445-46	<0.01	<0.01	8.8	12.6	52.8	
20	3446-47	<0.01	<0.01	9.2	20.2	48.1	
21	3447-48	<0.01	<0.01	11.2	13.6	48.2	
22	3448-49	<0.01	<0.01	12.3	13.6	45.6	
23	3449-50	0.70	<0.01	10.8	12.5	42.2	HAIR LINE V/F.
24	3450-51	<0.01	<0.01	12.1	11.4	46.6	HORIZ. PARTING PLANE.
25	3451-52	<0.01	<0.01	10.4	12.3	54.5	
26	3452-53	<0.01	<0.01	10.4	11.3	54.3	
27	3453-54	<0.01	<0.01	10.6	15.6	53.3	
28	3454-55	<0.01	<0.01	11.5	13.6	53.4	
29	2455-56	<0.01	<0.01	9.5	10.2	68.3	
30	3456-57	<0.01	<0.01	9.2	7.4	69.5	HORIZ. PARTING PLANE.
31	3457-58	<0.01	<0.01	9.7	8.8	73.2	
32	3458-59	<0.01	<0.01	9.3	2.8	76.5	HORIZ. PARTING PLANE.
33	3459-60	0.44	<0.01	9.3	2.5	80.5	HAIR LINE V/F, & HORIZ PARTING PLANE.
34	3460-61	<0.01	<0.01	9.7	2.5	83.4	V/F, & HORIZ. PARTING PLANE.
35	3461-62	<0.01	<0.01	10.2	3.7	81.3	
36	3462-63	<0.01	<0.01	9.6	7.6	74.4	HORIZ. PARTING PLANE.
37	3463-64	<0.01	<0.01	10.0	6.6	77.0	
38	3464-65	<0.01	<0.01	10.8	5.6	77.6	
39	3465-66	<0.01	<0.01	11.2	0.2	83.5	



Blackstone Exploration Company Inc.

Olufela Olukoga, Reservoir Engineering Consultant

CA-20

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Page No. 2

CORE ANALYSIS RESULTS

Company KERR-MCGEE OIL COMPANY — Formation HERMOSA — File RP-3-2190
Well NAVAJO #3-X — Core Type D/C — Date Report 3-26-67
Field LUCKA — Drilling Fluid LOW SOLIDS JEL — Analysts STRICKLIN
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SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS		POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
		MAX	90°				
40	3466-67	0.14	<0.01	10.2	0.2	82.0	HAIR LINE V/F, HORIZ PARTING PLANE.
41	3467-68	<0.01	<0.01	9.6	0.2	78.5	
42	3468-69	<0.01	<0.01	9.7	2.8	75.0	
43	3469-70	<0.01	<0.01	7.3	0.3	74.0	
44	3470-71	<0.01	<0.01	10.0	0.2	75.8	
45	3471-72	<0.01	<0.01	9.1	0.2	73.5	HORIZ. PARTING PLANE.
46	3472-73	<0.01	<0.01	10.1	3.4	68.7	HORIZ. PARTING PLANE.
47	3473-74	<0.01	<0.01	10.1	0.2	79.0	HORIZ. PARTING PLANE.
48	3474-75	<0.01	<0.01	8.4	0.2	77.5	HORIZ. PARTING PLANE.
49	3475-76	<0.01	<0.01	8.8	0.0	85.4	V/F.
50	3476-77	<0.01	<0.01	9.5	0.3	75.3	V/F.
51	3477-78	<0.01	<0.01	8.1	0.2	76.9	
52	3478-79	<0.01	<0.01	9.3	0.3	86.5	
53	3479-80	<0.01	<0.01	7.6	0.0	79.3	

Lydia Johnson Trustee #2 – Permit 097 Well Files

County Navajo

Area Snowflake Anticline

Lease No. Aztec Land & Cat. Co

Well Name Lydia Johnson #2 Aztec Land & Cattle Co. Trustee

Location SW NE Sec 33 Twp 14N Range 20E Footage 1650 FEL; ~~2450~~ FNL 2540 (as attached)

Elev 6023 ±GL Gr 6012 KB Spud Date 1959 Complete Abandon 12-16-63 Total Depth 1540

from USGS 7½' quad [illegible] per CES

Contractor: Approx. Cost $

Drilled by Rotary ___ Cable Tool ✓

Casing Size	Depth	Cement
10	10	
4 ½	1500	

Production Horizon

Initial Production P & A

See report by L.H. Bells Associates

REMARKS: Ft. Apache 1510 (show oil reported in Ft. Apache) Perf 24/1517-23; acid w/2000 R. A. rec sli gas & distill. (gas TSTM; would not burn)

Gas analysis in file

Elec. Logs

Applic to Plub X Plugging Record X Completion Report

Sample Log

Sample Descript

Sample Set

Cores

Water well - accepted by

Bond Co. & No. Stuckey Insurance Agency 59192

Bond Am't $ 2,500 Cancelled Date 12-31-63 Organization Report X

WELL HISTORY

In the drilling of this well, caverns and fissures were encountered from the surface to a depth of approximately 315 feet. The base of the Coconino sand occurred at a depth of approximately 555 feet; and the top of the salt section occurred 715 feet. It was necessary to drill a 10" diameter hole and 7" casing was placed to a depth of 200' to prevent the losing of the drilling fluid into the Coconino sand.

A 6 1/4" diameter hole was drilled to total depth and new 4 1/2" O.D., 9.5 lbs. J-55 casing was run to total depth and cemented with 100 sacks of Portland cement. The one hundred sacks used to cement the 4 1/2" casing would reach from the bottom of the hole to a point approximately 700 feet from the surface of the ground.

Prior to the running and cementing of the 4 1/2" casing, the 7" casing was pulled from the well. At some later date, approximately 3 joints of 7" casing was placed in the well outside the 4 1/2" casing and three or four sacks of cement were placed around it at the top.

In the drilling of this well, no water bearing formation was encountered until a depth of 595 feet. A very small amount of water was logged as 2 bailers, which would be something less than 100 gallons.

The mechanical completion and formations drilled are graphically represented in Figure 1.

DUPLICATE
REPORT

TRUESDAIL LABORATORIES, INC.

CHEMISTS - BACTERIOLOGISTS - ENGINEERS

4101-4107 N. FIGUEROA STREET
LOS ANGELES 65
CAPITOL 5-4148

CLIENT L. H. Bell & Associates
1505 East Thomas Road
Phoenix, Arizona

DATE October 3, 1960

RECEIVED September 28, 1960

SAMPLE Two bottles of gas as submitted by the Client.

LABORATORY NO. 49468

INVESTIGATION

Gas chromatographic analysis of each.

RESULTS

Analysis by gas chromatography on a silica gel column at 51°C. shows the following organic constituents:

	Sample 1	Sample 2
Methane	4.6%	3.6%
Ethane	1.1%	1.0%
Propane	1.9%	1.6%
Carbon Dioxide . . .	1.1%	1.0%

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Carbon Dioxide . . .	1.1%	1.0%

Lockhart Aztec #1 Well Files

REPORT OF ANALYSIS

F. S. - 11518 M.S. N-39694 ,H .30 OBS. PRES. 66.5 CAL. PRES. 65.6

STATE- ARIZONA COUNTY- NAVAJO

FIELD- WILDCAT WELL NAME- LOCKHART AZTEC NO. 1

LOCATION- SEC. 33, T14N, R20E OWNER- ARK-LA EXPLORATION CO.

DATE COMPLETED- 06/03/49 DATE SAMPLED- 3734

9-3

SAMPLED BY- LOREN HUGHES

NAME OF PRODUCING FORMATION-

DEPTH IN FEET- THICKNESS IN FEET-

SHUT IN WELLHEAD PRES., PSIG- OPEN FLOW, MCF/D-

CHECK OF DATA-
THE WELL DATA ARE ACCURATE, (_____) WITHOUT CORRECTION, (_____) AS CORRECTED ABOVE.

REMARKS-

ANALYSIS-

METHANE	24.6 %	NORMAL PENTANE	.1 %	OXYGEN	0.0 %
ETHANE	3.2 %	ISOPENTANE	0.0 %	ARGON	.1 %
PROPANE	1.5 %	CYCLOPENTANE	TRACE %	HYDROGEN	.1 %
NORMAL BUTANE	.3 %	HEXANES PLUS	.1 %	H2S	0.0 %
ISOBUTANE	.2 %	NITROGEN	69.6 %	CO2	TRACE %
SPECIFIC GRAV	.884			HELIUM	.28 %
				TOTAL	100.1 %

CALCULATED GROSS BTU/CU. FT., DRY AT 60 DEG. F AND 30 IN. MERCURY- 372.

PERMISSION FOR RELEASE:
Permission is hereby granted for the Bureau of Mines to release the above data, together with similar data released by other operators as public information and as parts of a series of papers on analyses of gases from various fields, states, or regions.

Apparently gas was sampled from 1635-1735'

RECEIVED JUL 21 1969 STATE O & G CONS. COMM.

COMPANY_____

BY_____

HA-1 Revised 6-26-58

REPORT OF ANALYSIS

State Arizona F.S No. 8670

County Navajo Field

Well Owner Aztec Land & Cattle Co. Name L. M. Lockhart No. 1

Location: Sec. 33 T. 14N R. 20E Date Completed

Open Flow MCF/D Wellhead Pressure p.s.i.g.

Producing Stratum:

Depth to (feet): Thickness (feet):

Stratigraphic Position of Producing Formation

Sampled: Date: By:

Mass Spectrometer Run No. 7766 Date of Run 10/3/62

Analysis:

Methane	23.8 %	Normal Penthane	Trace %	Oxygen	Trace %
Ethane	3.2 %	Isopentane	0.1 %	Argon	0.1 %
Propane	1.1 %	Cyclopentane	Trace %	Helium	0.267 %
Normal Butane	0.3 %	Hexanes Plus	0.1 %	Hydrogen	0.0 %
Isobutane	0.3 %	Nitrogen	70.7 %	H_2S	0.1 %
				CO_2	0.1 %

Calculated gross B.t.u./cu. ft., dry at 60°F. and 30" mercury 357 Total

CHECK OF DATA: The well data are accurate:
( ) Without correction ( ) As corrected above

PERMISSION FOR PUBLICATION:
Permission is hereby granted for the Bureau of Mines to publish the above data, together with similar data released by other operators, as parts of a series of papers on analyses of gases from various fields, states, or regions.

Company

Oil and Gas; and Helium Production Potential of Oil and Gas Assets in Navajo County, Arizona.

Blackstone Exploration Company Inc.

Olufela Olukoga, Reservoir Engineering Consultant

O. A. LARRAZOLO, JR.
Petroleum Geologist
Phone 2-8459 254 Korber Bldg.
Albuquerque, N. M.

September 6, 1949

Mr. W. B. Weast
513 W. Latham St.,
Phoenix, Arizona.

Dear Sir:

Pursuant to your request made through Mr. D. M. Ferebee, of the Stanolind Oil and Gas Co., I went to Winslow, Arizona on August 28th., and there, through the courtesy of Mr. Ferebee, examined cores, logs, laboratory tests, etc., from the Lockhart No. 1 Aztec well drilled in section 33 T 14 N R 20 E., Navajo County, Arizona. I returned to Albuquerque the same afternoon bringing with me all the documentary evidence concerning the well which was kindly furnished me by Mr. Ferebee.

Although time has not permitted an examination of the area in which the well was drilled it is evident from structure maps and regional geology that the test was drilled on adequate geological structure. The stratigraphy of the area as described by Mr. Charles S. Lavington in his report of the region and by Mr. Ferebee personally to me, coupled with the structural features as mapped, certainly merited the test. The results of the Lockhard No. 1 well amply confirmed the opinions of these two gentlemen.

The well started in the Coconino sandstone of Permian age. The succeeding underlying formations were topped at the following depths:

Supai formation	550 ft.
Fort Apache Zone of Upper Supai	
(from samples)	1540 "
(from Electric Log)	1520 "
Bottom Fort Apache	1750 "
Middle Supai	2160 "
Lower Supai	2480 "
Intra-formations conglomerate	3015 to 3024 ft.
Pennsylvanian formation	3024 ft.
Mississipian "	3650 "
Devonian "	3685 "
Total Depth	3734 "

It is hardly necessary to describe the log of the well in detail. The important features of the well are the zones which the core analyses, electric log, solubility tests, etc., are worthy off further treatment to test the possibility of oil and gas production.

There are three potential oil and gas horizons indicated by these tests, as follows:

Zone 1. The electric log picked up the top of the Fort Apache zone of the upper Supai formation at 1520 ft. from 1520 feet to 1628 feet the cuttings showed oil stains- this section was not cored. From 1678 to 1741, a thickness of 63 feet, the section was cored and a core recovery of 100% was obtained. The core analysis of this section, copy of which you have, shows a dolomitic limestone with a weighted average porosity of 1.5%-average oil saturation of 32.6% and 70% solubility in acid. Permeability tests indicated a high capacity of the section.

Zone 2. From 3150 to 3600 feet there is a zone the upper part of which consists of lime showing only minor fractures with local zones of saturation. From 3452 to 3513 feet laboratory tests indicate a saturation of from 0 to 12.8% and a solubility in acid of from 57% to 92%, with an average of 70%. From 3513 to 3600 feet alternating shales, limestones and sandstones show minor fracturing and a small saturation in the cores.

The whole zone, an aggregate of 400 feet, may be worth a test in future wells if contemplated tests in the Lockhart No 1 well are successful. In this well however, the zone does not seem of enough importance to justify the cost of a thorough test.

Zone 3. from 3610 to 3640 feet a brecciated, hard, red, gritty conglomerate, in which no core recovery was obtained, may contain major fracturing.

From 3657 to 3685 feet the core analysis shows continous oil satiration ranging from 3.6% to 41.4% and a solubility in acid of from 76.5% to 89.5%. Effective porosity of this zone ranges from 1.1% to 5.5% and major fracturing is plainly visible.

From 3685 to a depth of 3708 feet core analyses indicate oil saturation of from 0 to 14.5% with a eighted average of 9.6%; solubility in acid of from 38.9% to 89.4% and the greater portion of the zone averaging better than 74.3%.

The high porosity and saturation indicated by core analyses in zones 1 and 3, together with the high solubility of the formations in each zone and the presence of major fracturgive these two zones a high potential value as oil and gas horizons. With modern methods of well completion and development no well having the inidations shown by this well should be abandoned without a proper treatment with acid and, as indicated in this case, implemented by shooting to loosen the formation and make it more susceptible to acid.

From the foregoing facts it is obvious that acidizing offers excellent possibilities of developing commercial production of oil and gas in at least two horizons in the Lockhard No. 1 well. It is therefore recommended that after drilling out the plug and cleaning the well the following steps be taken:

Zone 3.

It is suggested that 5½ inch casing be set at 3605 feet and cemented with at least 250 sacks of cement and preferably 300 sacks. It is then desirable to shoot the formation with 250 quarts of nitro-glycerine. The well should then be throughly cleaned out and a production test made. If the shot fails to develop commercial production of oil or gas it will serve to form lines of fracturing in a deep zone sorrounding the bore hole which will permit the acid penetrate deeper. This should be applied in

at least two and preferably three stages. The first should be no more than 1000 gallons. After that the well should be thoroughly cleaned out and a production test made. The second stage should be with 3000 gallons. If a third stage is necessary then 10,000 gallons should be applied, cleaned out and tested.

Zone 1.

This zone, from 1520 to 1741 feet, is also a most attractive one. If zone 3 should fail to develop into a commercial zone after acid treatment the same procedure should be followed with zone 1.

After recovering as much casing as possible above the cemented section a bridge plug should be set at 1750 feet. The casing should be set at 1520 feet and cemented with 250 sacks of cement. There will then remain 230 feet of open hole which should be shot with 350 quarts of nitro-glycerine, cleaned out and tested. If results are negative or unsatisfactory then a three stage acid treatment should be applied with the first stage being 1000 gallons; the second 5,000 gallons and the third if necessary not more than 10,000 gallons. It is important that the well be cleaned out and tested after each stage. Then if the results of any one stage are satisfactory the others can be eliminated.

Even should the results of the third and deepest zone prove satisfactory it may be found desireable to treat the zone 1 interval. In such case the casing should be perforated with from 300 to 400 perforations opposite the interval from 1520 to 1741 feet. Then the recommended acid treatment should be applied. Shooting, of course, would be eliminated in such a case.

Although carbonaterocks, such as limestones, are not all equally soluble in acid, where properly applied, the acid produces amazing results even where the formations have has barely a color of oil or a faint gas odor while drilling. Acid enlarges the pores and creates cavities in limestone, especially where major fracturing exists. The deeper the acid penetrates the formations away from the bore hole the greater the outlets, or pores, become permitting a freer flow of oil and gas. Hence the adviseability of acidizing in two or three stages, each stage with a greater amount of acid than the preceding one.

It is not possible to estimate the amount of oil or gas that acid treatment will develop on relatively similar formations in widely separated areas. Comparisons may prove unsatisfactory. In order to point out what the proper application of acid can do, however, it may not be amiss to city the development of a well in the Boundary Buttes area or northeastern Arizona and southeaster Utah which is now producing from Hermosa limestone the gelogical equivalent of the formation in the lower zone of the Lockhart well.

Byrd-Frost's English No. 1, located in C NE¼ NW¼ Section 22 T 43 S R 22 E., San Juan County, Utah, topped the Hermosa formation of the Pennsylvanian at 3790 feet. The lime core showing gas and oil. Laboratory tests of the core did not show good porosity. A drill stem test, however, from 4625 to 4677, open 1½ hours, had gas at the surface in ten minutes estimated at 250,000 cubic feet per day.

The zone was treated with acid through 200 perforations in the casing. The first stage of 1,000 gallons did not produce any additional gas. The second treatment with 2,000 gallons increased the flow of gas to from eight million to ten million cubic feet per day. The last stage of 10,000 gallons developed the flow of gas to an actual measurement of 20 million cubic feet per day. At the time of completion it was also making a small amount of high gravity oil.

Laboratory tests of the cores from the two horizons mentioned above in the Lockhard No. 1 well indicate that the three stage acid treatment recommended has better than an average chance of developing commercial production. Both zones are equally important and both should be tested, zone No. 1 even if the acid has to be applied through casing perforations.

Respectfully submitted,

signed O. A. Terrazolo, Jr.

Report to Messrs. J. M. Kellogg and W. H. Weast,

Phoenix, Arizona 8-27-49

by Ed D. McKee

I SUBJECT: Stratigraphic geology of L. M. Lockhart, No. 1 Aztec Well, Sec. 33, T 14 N, R 20 E, Navajo County, Arizona, Elevation 6011 ft.

II INTRODUCTION TO STRATIGRAPHIC COLUMN AT WELL: The following condensed description of the geologic strata represented has been compiled from the log of Stanolind Oil and Gas Company and from examination of well cores and samples.

Feet to Top	Rock Description	Formation
0	Sandstone, white, quartzitic, fine-grained	Coconino
550	Shale, red brown, silty, calcareous, in sandstone	Supai
620	Anhydrite and gypsum in shale	
820	Sandstone, alternating with gypsum, anhydrite, halite	
1070	Shale, gray and brown, silty, dolomitic, massive	
1110	Anhydrite, mottled to white, hard, dense	
1140	Halite, grading down into anhydrite and shale	
1250	Shale, gray brown, calcareous	
1270	Shale, red brown, halite inclusions; grading down to anhydrite, halite, sandstone, red shale	
1540	Dolomite, dark gray to black, silty, some black organic matter	Fort Apache
1570	Shale, gray, alternating with dolomite	memb.
1678	Dolomite, brownish gray	Base Ft. Apache
1750	Shale, red brown, dolomitic	
1770	Halite, with beds of sandstone and anhydrite	Base Up. Supai
2160	Anhydrite, gray, massive with halite	
2175	Shale, red to chocolate brown, sandy, includes gypsum and minor beds of sandstone	
2620	Shale, gray, highly micaceous, dolomitic	
2755	Dolomite, brown to gray brown, silty	
2780	Shale, gray, dolomitic, and some dolomite	
2860	Limestone, gray brown, shaly, dolomitic, with minor streaks of brown, calcareous shale	
2904	Shale, brown, calcareous, hard, dense; some gypsum	

Feet to Top	Rock Description	Formation
2930	Shale, brown, calcareous; streaks of brown limestone	
2938	Limestone, cherty, hard, silty, interbedded with calcareous, mottled green shale	
2995	Shale, brown, calcareous, fractured, with anhydrite inclusions	
3015	Limestone conglomerate; smooth brown limestone pebbles in lime matrix	Base of Middle Supai //
3020	Shale, blue gray, calcareous, silty	
3040	Shale, brown, calcareous, small lime pebbles	
3090	Limestone, brown, silty, some fractures	
3107	Shale, brown, calcareous	
3121	Limestone, gray, very shaly	
3127	Shale, brown, calcareous	
3132	Limestone, dark gray, silty	
3138	Shale, brown gray, calcareous	
3141	Limestone, gray, very silty, nodular	
3147	Limestone, aphanitic, gray, cherty, fractured	
3156	Shale, dark brownish gray, calcareous	
3166	Limestone, gray, silty, cherty	
3175	Shale, dark gray to black, fossiliferous, calcareous, with minor fractures	
3184	Limestone, gray, massive, coarse grained, fossiliferous	
3216	Shale, micaceous, silty, calcareous; minor fractures	
3273	Shale, gray, silty, bentonitic, calcareous, with lime pebbles	
3296	Limestone, gray, alternating with gray shale	
3385	Shale, mottled, red brown, calcareous, nodular, and limestone, thin, granular shaly	
3424	Limestone, gray, granular, silty, fossiliferous; some chert, minor fractures	
3471	Sandstone, very fine grained, fractured, calcareous	
3479	Limestone, gray, cherty, granular, minor fractures; grades down into shaly limestone	
3505	Shale, red brown, calcareous, micaceous, with beds of fossil limestone	
3539	Sandstone, dark gray, hard, fine-grained, with purple shale partings	
3544	Limestone, light gray, coarse-grained, silty, with shaly partings and gray brown nodular shale	
3575	Shale, red brown, calcareous, fossiliferous	
3610	Shale, red, silty, mottled, with subangular granite fragments	
3641	Sandstone, very shaly, fine to medium-grained, calcareous; some limestone inclusions	

Feet to Top	Rock Description	Formation
3650	Limestone, dolomitic, silty, massive, with minor fractures	
3657	Limestone, dolomitic, granular, sandy, with vugs of white crystalline limestone, major fractures	
3685	Limestone, dolomitic, gray green, with thin gnarly beds of sandy shale	
3708	Sandstone, fine-grained, calcareous	
3724	Granite, biotite, weathered	Pre-Cambrian

III AGE OF STRATA AND RELATION TO SEDIMENTARY BASIN: Most, if not all, of the sedimentary strata encountered in the well are of Pennsylvanian and Permian age. Pre-Cambrian granite was encountered at the bottom and a small thickness of Devonian and Mississippian strata may possibly rest upon it, though the writer believes that Pennsylvanian beds extend down to the granite. It is important to note that this well is located on the margin of a basin of Pennsylvanian age and near the center of the deepest basin of Permian age (3200 feet) in Arizona.

IV ZONES THAT SHOW OIL CONCENTRATIONS: According to core analysis by Stanolind Oil and Gas Company the following zones were found to contain oil (Analyses made by research department in Tulsa) as per attached enclosure.

1678 - 1741
2873 - 3129
3175 - 3449
3452 - 3515
3657 - 3708

V ZONES OF POROSITY AND HIGH RESISTIVITY FROM ELECTRIC LOG:

An electric log prepared by Slumberger Well Surveying Corporation (see attached) indicates the following:

(1) Porous zone in limestone with high resistivity from 1510 to 1730 feet.

(2) Various zones of porosity and high resistivity in limestone indicated between 2873 and 3565 feet.

(3) Zone in limestone between 3657 and 3708 indicates a porous zone of high resistivity related to area of major fracturing observed in the cores.

VI ZONES OF OBSERVED FRACTURE: According to D. M. Ferebee, who was geologic observer for Stanolind Oil and Gas Company, the following zones of fracture in limestone were noted.

(1) Minor fracturing in limestone 1678 - 1741 feet.

(2) Minor fracturing in limestone and shale 2873 - 3515 feet.

(3) Major fracturing in limestone 3657 - 3704 feet.

VII GENERAL CONCLUSIONS: Most favorable zone for testing, based on field examination of cores and cuttings, on Slumberger log of well and on lab analysis of core appears to be between 3600 - 3708 feet. A second favorable well for testing is indicated between 1510 and 1730 feet. Should a successful completion be made in either or both of these zones, further testing would seem to be warranted in the porous sections of the zone between 2873 - 3565 feet.

VIII INCLOSURES:

(1) Slumberger detail log of Lockhart No. 1 Aztec Well.

(2) Slumberger general log " " " " " "

(3) Core analysis summaries " " " " " " by

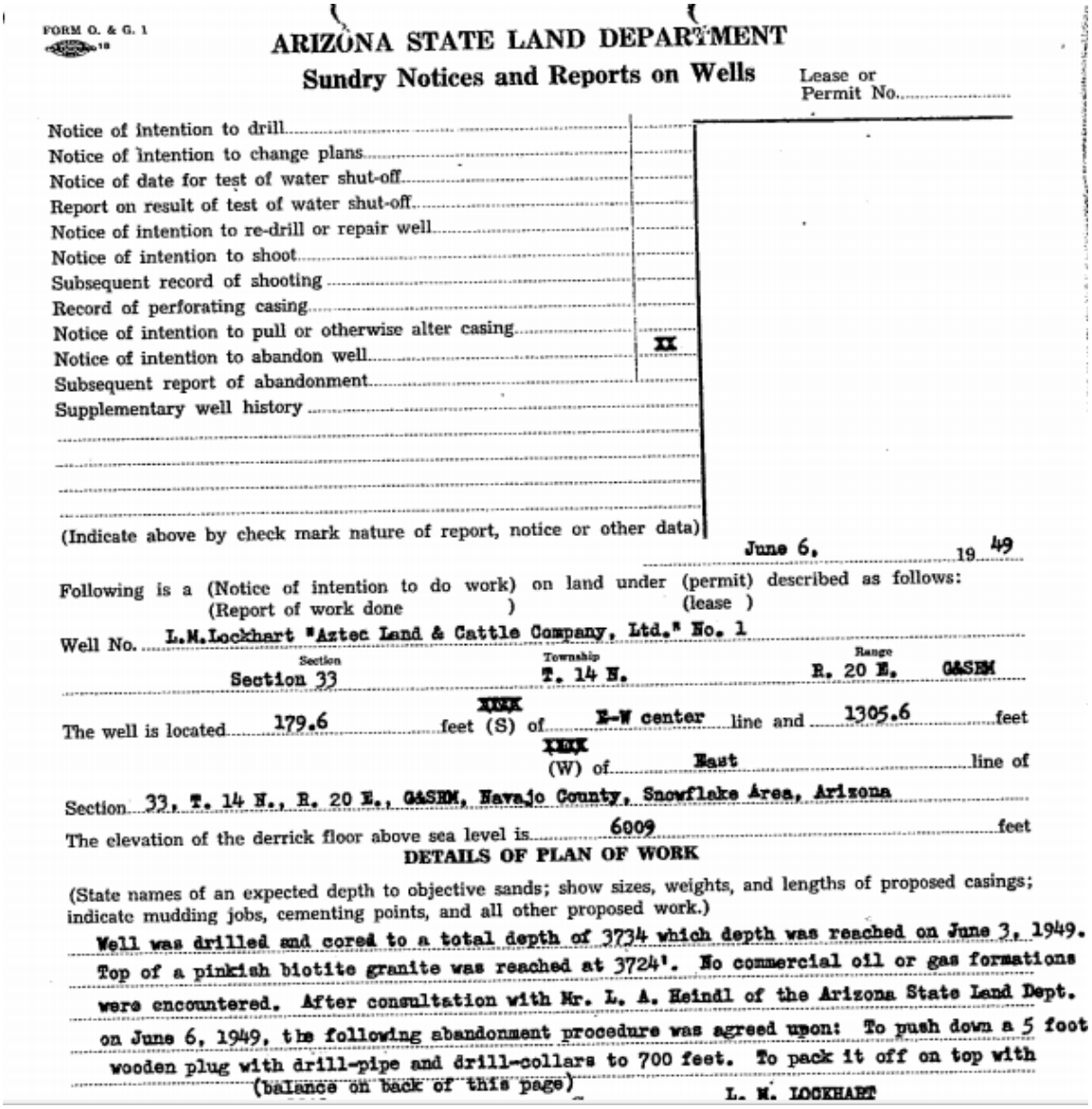
Stanolind Oil and Gas Company.

Report submitted August 27, 1949

Edwin D. McKee

Edwin D. McKee,
Geologist

Postoffice Box 554
Flagstaff, Arizona



FORM O. & G. 1

ARIZONA STATE LAND DEPARTMENT

Sundry Notices and Reports on Wells

Lease or Permit No.

Notice of intention to drill	
Notice of intention to change plans	
Notice of date for test of water shut-off	
Report on result of test of water shut-off	
Notice of intention to re-drill or repair well	
Notice of intention to shoot	
Subsequent record of shooting	
Record of perforating casing	
Notice of intention to pull or otherwise alter casing	
Notice of intention to abandon well	XX
Subsequent report of abandonment	
Supplementary well history	

(Indicate above by check mark nature of report, notice or other data)

June 6, 19 49

Following is a (Notice of intention to do work) (Report of work done) on land under (permit) (lease) described as follows:

Well No. L.M.Lockhart "Aztec Land & Cattle Company, Ltd." No. 1

Section 33 | Township T. 14 N. | Range R. 20 E. | G&SRM

The well is located 179.6 feet (S) XXX of N-W center line and 1305.6 feet (W) XXX of East line of

Section 33, T. 14 N., R. 20 E., G&SRM, Navajo County, Snowflake Area, Arizona

The elevation of the derrick floor above sea level is 6009 feet

DETAILS OF PLAN OF WORK

(State names of an expected depth to objective sands; show sizes, weights, and lengths of proposed casings; indicate mudding jobs, cementing points, and all other proposed work.)

Well was drilled and cored to a total depth of 3734 which depth was reached on June 3, 1949. Top of a pinkish biotite granite was reached at 3724'. No commercial oil or gas formations were encountered. After consultation with Mr. L. A. Heindl of the Arizona State Land Dept. on June 6, 1949, the following abandonment procedure was agreed upon: To push down a 5 foot wooden plug with drill-pipe and drill-collars to 700 feet. To pack it off on top with

(balance on back of this page)

L. M. LOCKHART

Continued from Front Page

sawdust in sacks. To then place 26 sacks of cement on top of sawdust which will fill hole to 650 feet. To cut off the 20" conductor pipe one foot above bottom of cellar. To weld a 3/8" steel plate over top of 20" conductor pipe. To weld a 2" pipe to above plate which will extend above ground level as a marker for well when cellar filled. To fill cellar to ground level and level off location. The well to be abandoned in accordance with the above described program.

Lockhart Aztec Core Report on the Fort Apache Formation

STANOLIND OIL+GAS CO.
Research Dept.

9-3

L. M. Lockhart
Aztec #1
Wildcat Navajo County, Arizona
Lo cation Sec. 33 T14NR 20 E Da
Formation Analyzed Ft. Apache Zone upper Supai

Lab. No . 2708
Date Reported 4-18-49
Date Received 4-12-49

Coring Data

Zone 1678-1741
Start Coring 1678
Top o f Sand 1540
Bottom of Sand 1750
Stopped Coring1741
Total Feet Cored 63
Total Feet Formation 210
Recovery, Feet of Formation 63
Recover % of Formation 30.0

Type of Drilling Fluid (Oil o r water Base muc) Jel Nase with Sawdust
Filtrate Loss (CC. Per Min. Api) ---

Summary of Core Analysis

Oil Content (By Extraction) Zo ne	Feet of Sand	Po ro sity Max.	Min.	Wtd. Avg.	Av. Sa
1678-1741	63	10.2	.7	3.5	3:

* For comparative purposes o nly. Not to be used in estimating oil in place.

Permeability*

Zone	Feet of Sand	Millidarcys Max.	Min.	Wtd. Avg.	Capacity Ft. XMD
1678-1741	63	22.80	<.05	.65	40.95

*Unless Noted Otherwise Permeabilityes are Parallel To Bedding Planes
< Indicates "Less than" > Indicates "Greater Than"
Letter o f transmittal by D.M.Firebee, no date no file
With graphical core analysis lo g.
Acid response test to follow as supplement to this report.
cc: Lewis Finch, Jr., H. T. Mo rley (2), C. F. Bedford,
D. M. Firebee

Lockhart Aztec Core Report on the Lower Supai Formation

L. M. Lockhart
Aztec # 1
Wildcat Navajo County Arizona
Location Sec. 33 T14NR20E
Formation Analyzed Lower Supai Marine Penn (Naco?)
Mississippian (Redwall Elev. 5990'

Lab. No. 2708
Date Reported 5-24-49
Date Received 5-20-49

Coring Data

Zone	2873-3129	3175-3449	3452-3513
Start Coring	2873	3175	3452
Top of Sand	2480	3175	3452
Bottom of Sand	3175?	3452	[illegible]
Stopped Coring	3129	3452	3513
Total Feet Cored	54*	100**	61
Total Feet of Formation	696	277	-----
Recovery Ft. of Formation	51	86	61
Recovery % of Formation	7.3	31.0	------

Type of Drilling Fluid (oil or water base mud) Jel and Sawdust
Filtrate Loss (CC per 30 min API) High
* Does not include drilling interval of 202'
** Does not include drilling interval of 177'

Summary of Core Analysis

Oil Content (By Extraction)

Zone	Feet of Net Sand	Porosity Mx.	Porosity Min.	Porosity Wtd. Avg.	Avg. Oil Sat. %
2873-3129	51	5.0	< .5	1.6	2.0
3175-3449	76	1.8	< .5	.8	11.9
3452-3513	61	3.7	< .5	1.2	5.3

* For comparative Purposes only, Not to be used in estimating oil in place

Permeability*

Zone	Feet of Net Sand	Millidarcys Mx.	Min.	Wtd Avg.	Cap. Ft. MD
2873-3129	51	4.45	< .05	.41	20.91
3175-3449	76	<.05	< .05	<.05	3.80
3452-3513	61	< .05	<.05	<.05	2.75

Unless noted otherwise Permeabilities are parallel to Bedding Planes
< Indicates "Less Than" > Indicates "Greater Than"
Letters of transmittal by D.M.Perebee, 5-12-49 no file.
With graphical core analysis log.
Please attach to Report #2708 dated 4-18-49
Acit Solubility test to follow as a supplement
CCLewis Finch, Jr., H.T.Morley (2), C.F.Bedford, D.M.Perebee

By J. V. Spurlock

Lockhart Aztec Core Report on the Mississipian/Devonian Formation

9-3

L.H. Lockhart
Aztec Unit #1
Field Wildcat Navajo Co . Arizona
Location Sec. 33 T14N R20E
Formation Analyzed Mississippian? Devonian? El. 5990'

Lab. No. 2708
Date Reported 6-3-49
Date Received 6-3-49

Coring Data

Zone	3657-3685	3685-3708
Start Coring	3657	3685
Top o f sand	3452	3685
Stopped Coring	3685	-----
	3685	3708
To tal Feet Cored	21 *	23
Total Feet Formation	33	###
Recovery Feet of Formation	16	21
Recovery % o f Formation	48.5	----

Type of Drilling Fluid Gel and Sawdust
Piltrate Loss9CC per 30 min. API) High

*Does not include drilling interval o f 7'

Summary o f Core Analysis

Oil content (By Extraction)

Zone	Ft. of Net Sand	Porosity Max.	Min.	Wtd. Avg.	Averag Oil Dat
3657-85	16	5.7	1.1	2.9	23.9
3685-3708	21	1.6	< .5	.9	9.6

* For comparative purposes only, Not to be used in estimating oil in place.

Permeability*

Millidarcys

Zone	Ft. of Net Sand	Max.	Min.	Wtd. Av.	Capacity Ft XMD
3657-85	16	.85	<.05	.10	1.60
3685-3708	21	<.05	<.05	<.05	1.05

Letter transmittal by D.M.Perebee, dated 6-1-49 no file.
With graphical core analysis log.
Other test to follow as supplements.

Lockhart Aztec Core Report Summary on the Fort Apache Formation

FORM 621 5-48

NOLIND OIL AND GAS COMPANY
RESEARCH DEPARTMENT
CORE ANALYSIS SUMMARY

WELL L. M. Lockhart Aztec #1 LAB. NO. 2708
FIELD Wildcat, Navajo County, Arizona DATE REPORTED 4-18-49
LOCATION Sec. 33 T14NR 20E DATE RECEIVED 4-12-49
FORMATION ANALYZED Ft. Apache Zone upper Supai ELEV. ——

CORING DATA

ZONE	1678-1741
START CORING	1678
TOP OF SAND	1540
BOTTOM OF SAND	1750
STOPPED CORING	1741
TOTAL FEET CORED	63
TOTAL FEET OF FORMATION	210
RECOVERY, FEET OF FORMATION	63
RECOVERY, % OF FORMATION	30.0

TYPE OF DRILLING FLUID (OIL OR WATER BASE MUD) Jel Base with Sawdust
FILTRATE LOSS (CC. PER 30 MIN. API) ——

SUMMARY OF CORE ANALYSIS

OIL CONTENT (BY EXTRACTION)

ZONE	FEET OF NET SAND	POROSITY MAX.	POROSITY MIN.	POROSITY WTD. AVG.	AVERAGE OIL SAT. %
1678-1741	63	10.2	.7	3.5	32.6

*For Comparative Purposes Only. Not To Be Used In Estimating Oil In Place.

PERMEABILITY*

ZONE	FEET OF NET SAND	MILLIDARCYS MAX.	MILLIDARCYS MIN.	MILLIDARCYS WTD. AVG.	CAPACITY FEET X M. D.
1678-1741	63	27.00	<.05	.65	40.95

*Unless Noted Otherwise, Permeabilities Are Parallel To Bedding Planes
"<" Indicates "Less Than"; ">" Indicates "Greater Than"

Letter of transmittal by D. M. Firebee, no date, no file
with graphical core analysis log.
Acid response test to follow as supplement to this report.

cc: Lewis Finch, Jr.
H. T. Morley (2)
C. F. Rutford

Lockhart Aztec Core Report Summary on the Mississipian/Devonian Formation

STANOLIND OIL AND GAS COMPANY
RESEARCH DEPARTMENT
CORE ANALYSIS SUMMARY

L. H. Lockhart
WELL: Aztec #1 LAB. NO.: 2708
FIELD: Wildcat, Navajo County, Arizona DATE REPORTED: 5-20-49
LOCATION: Sec. 33 T14N R20E DATE RECEIVED: 5-20-49
FORMATION ANALYZED: Lower Supai, Marine Penn (Naco?) Mississippian (Redwall?) ELEV.: 5950'

CORING DATA

ZONE	2873-3129	3175-3449	3452-3513
START CORING	2873	3175	3452
TOP OF SAND	2480	3175	3452
BOTTOM OF SAND	3175 ?	3452	----
STOPPED CORING	3129	3452	3513
TOTAL FEET CORED	54 *	100 **	61
TOTAL FEET OF FORMATION	695	277	----
RECOVERY, FEET OF FORMATION	51	86	61
RECOVERY, % OF FORMATION	7.4	31.0	----

TYPE OF DRILLING FLUID (OIL OR WATER BASE MUD): Gel and sawdust
FILTRATE LOSS (CC. PER 30 MIN. API): High

* Does not include drilling interval of 202'
** Does not include drilling interval of 177'

SUMMARY OF CORE ANALYSIS

OIL CONTENT (BY EXTRACTION)

ZONE	FEET OF NET SAND	POROSITY MAX.	POROSITY MIN.	POROSITY WTD. AVG.	AVERAGE OIL SAT. %
2873-3129	51	5.0	<.5	1.6	2.0
3175-3449	76	1.8	<.5	.8	11.9
3452-3513	61	3.7	.5	1.2	5.3

*For Comparative Purposes Only. Not To Be Used In Estimating Oil In Place.

PERMEABILITY*

ZONE	FEET OF NET SAND	MILLIDARCYS MAX.	MILLIDARCYS MIN.	MILLIDARCYS WTD. AVG.	CAPACITY FEET X M. D.
2873-3129	51	4.45	.05	.41	20.91
3175-3449	76	<.05	.05	<.05	3.80
3452-3513	61	<.05	.05	<.05	2.75

*[illegible]
"L" Indicates "Less Than"; "P" Indicates "Greater Than"

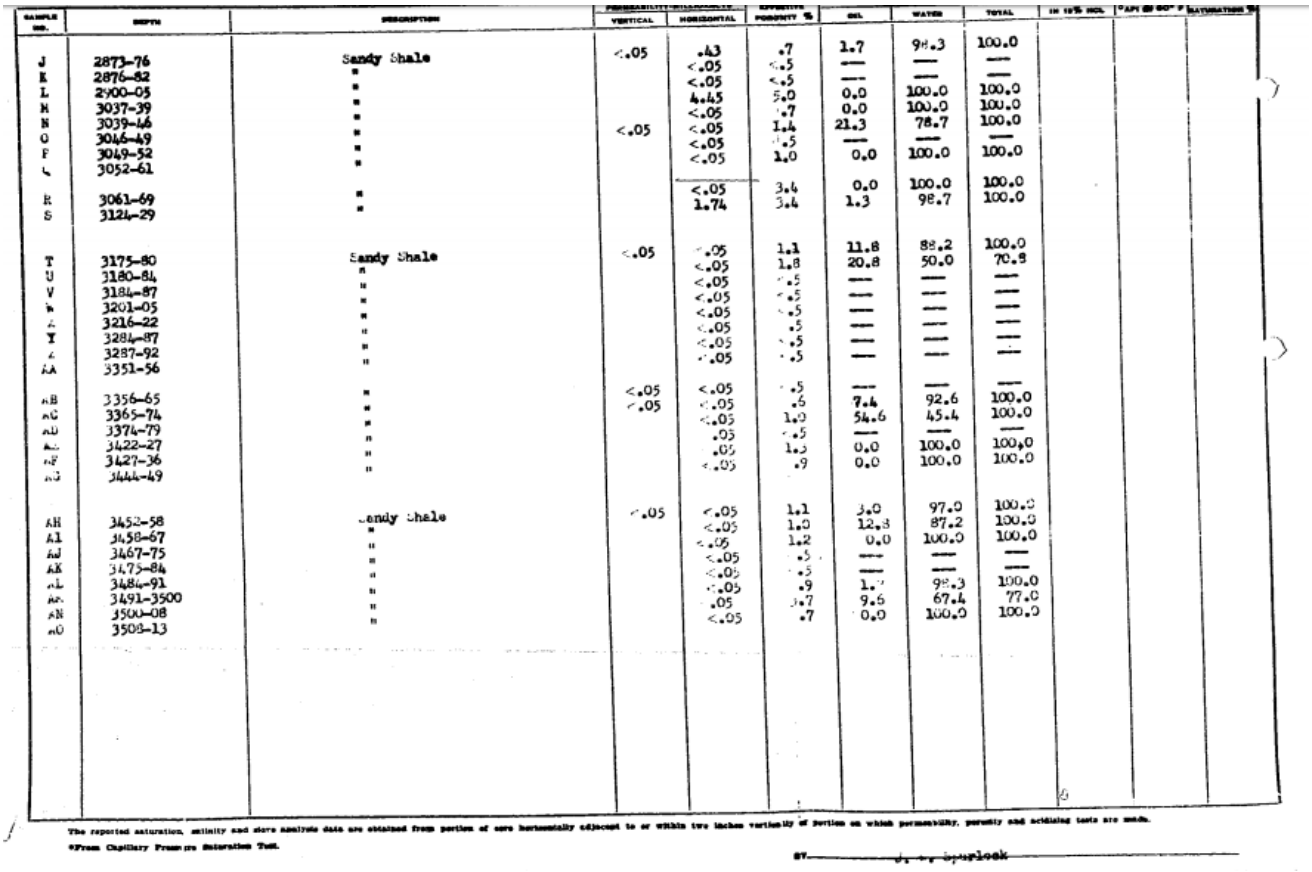
Letters of transmittal by W. H. Forsbee, 5-12-49, on file, with graphical core analysis log.
Please attach to Report 2708, dated 5-18-49.
Acid solubility test to follow as a supplement

cc: Louis Fine, Jr.
[illegible]
[illegible] Bedford
W. H. Forsbee

BY [illegible]

Blackstone Exploration Company Inc.

Olufela Olukoga, Reservoir Engineering Consultant



SAMPLE NO.	DEPTH	DESCRIPTION	PERMEABILITY MILLIDARCYS VERTICAL	PERMEABILITY MILLIDARCYS HORIZONTAL	EFFECTIVE POROSITY %	OIL	WATER	TOTAL	IN 15% HCL	°API @ 60° F	SATURATION %
J	2873-76	Sandy Shale	<.05	.43	.7	1.7	98.3	100.0			
K	2876-82	"		<.05	<.5	—	—	—			
L	2900-05	"		<.05	<.5	—	—	—			
M	3037-39	"		4.45	5.0	0.0	100.0	100.0			
N	3039-46	"		<.05	.7	0.0	100.0	100.0			
O	3046-49	"	<.05	<.05	1.4	21.3	78.7	100.0			
P	3049-52	"		<.05	<.5	—	—	—			
Q	3052-61	"		<.05	1.0	0.0	100.0	100.0			
R	3061-69	"		<.05	3.4	0.0	100.0	100.0			
S	3124-29	"		1.74	3.4	1.3	98.7	100.0			
T	3175-80	Sandy Shale	<.05	<.05	1.1	11.8	88.2	100.0			
U	3180-84	"		<.05	1.8	20.8	50.0	70.8			
V	3184-87	"		<.05	<.5	—	—	—			
W	3201-05	"		<.05	<.5	—	—	—			
X	3216-22	"		<.05	<.5	—	—	—			
Y	3284-87	"		<.05	.5	—	—	—			
Z	3287-92	"		<.05	<.5	—	—	—			
AA	3351-56	"		<.05	<.5	—	—	—			
AB	3356-65	"	<.05	<.05	<.5	—	—	—			
AC	3365-74	"	<.05	<.05	.6	7.4	92.6	100.0			
AD	3374-79	"		<.05	1.0	54.6	45.4	100.0			
AE	3422-27	"		.05	<.5	—	—	—			
AF	3427-36	"		.05	1.0	0.0	100.0	100.0			
AG	3444-49	"		<.05	.9	0.0	100.0	100.0			
AH	3452-58	Sandy Shale	<.05	<.05	1.1	3.0	97.0	100.0			
AI	3458-67	"		<.05	1.0	12.8	87.2	100.0			
AJ	3467-75	"		<.05	1.2	0.0	100.0	100.0			
AK	3475-84	"		<.05	<.5	—	—	—			
AL	3484-91	"		<.05	.9	1.7	98.3	100.0			
AM	3491-3500	"		.05	1.7	9.6	67.4	77.0			
AN	3500-08	"		<.05	.7	0.0	100.0	100.0			
AO	3508-13	"									

The reported saturation, salinity and core analysis data are obtained from portion of core horizontally adjacent to or within two inches vertically of portion on which permeability, porosity and acidizing tests are made.

*From Capillary Pressure Saturation Test.

BY: [illegible]

FORM 601 5-48

STANOLIND OIL AND GAS COMPANY
RESEARCH DEPARTMENT
CORE ANALYSIS SUMMARY

L. N. Lockhart
WELL Aztec Unit #1 LAB. NO. 2708
FIELD Wildcat, Navajo County, Arizona DATE REPORTED 6-3-49
LOCATION Sec. 33 T14N R20E DATE RECEIVED 6-3-49
FORMATION ANALYZED Mississippian? Devonian? ELEV. 5990'

CORING DATA

ZONE	3657-3685	3685-3708
START CORING	3657	3685
TOP OF SAND	3452	3685
BOTTOM OF SAND	3685	——
STOPPED CORING	3685	3708
TOTAL FEET CORED	21 *	23
TOTAL FEET OF FORMATION	33	——
RECOVERY, FEET OF FORMATION	16	21
RECOVERY, % OF FORMATION	48.5	——

TYPE OF DRILLING FLUID (OIL OR WATER BASE MUD) Jel & Sawdust
FILTRATE LOSS (CC. PER 30 MIN. API) High

* Does not include drilling interval of 7'

SUMMARY OF CORE ANALYSIS

OIL CONTENT (BY EXTRACTION)

ZONE	FEET OF NET SAND	POROSITY			AVERAGE OIL SAT. %
		MAX.	MIN.	WTD. AVG.	
3657-85	16	5.7	1.1	2.6	23.9
3685-3708	21	1.6	<.8	.9	9.6

*FOR COMPARATIVE PURPOSES ONLY. NOT TO BE USED IN ESTIMATING OIL IN PLACE.

PERMEABILITY*

ZONE	FEET OF NET SAND	MILLIDARCYS			CAPACITY FEET X M. D.
		MAX.	MIN.	WTD. AVG.	
3657-85	16	.85	<.05	.10	1.60
3685-3708	21	<.05	<.05	<.05	1.05

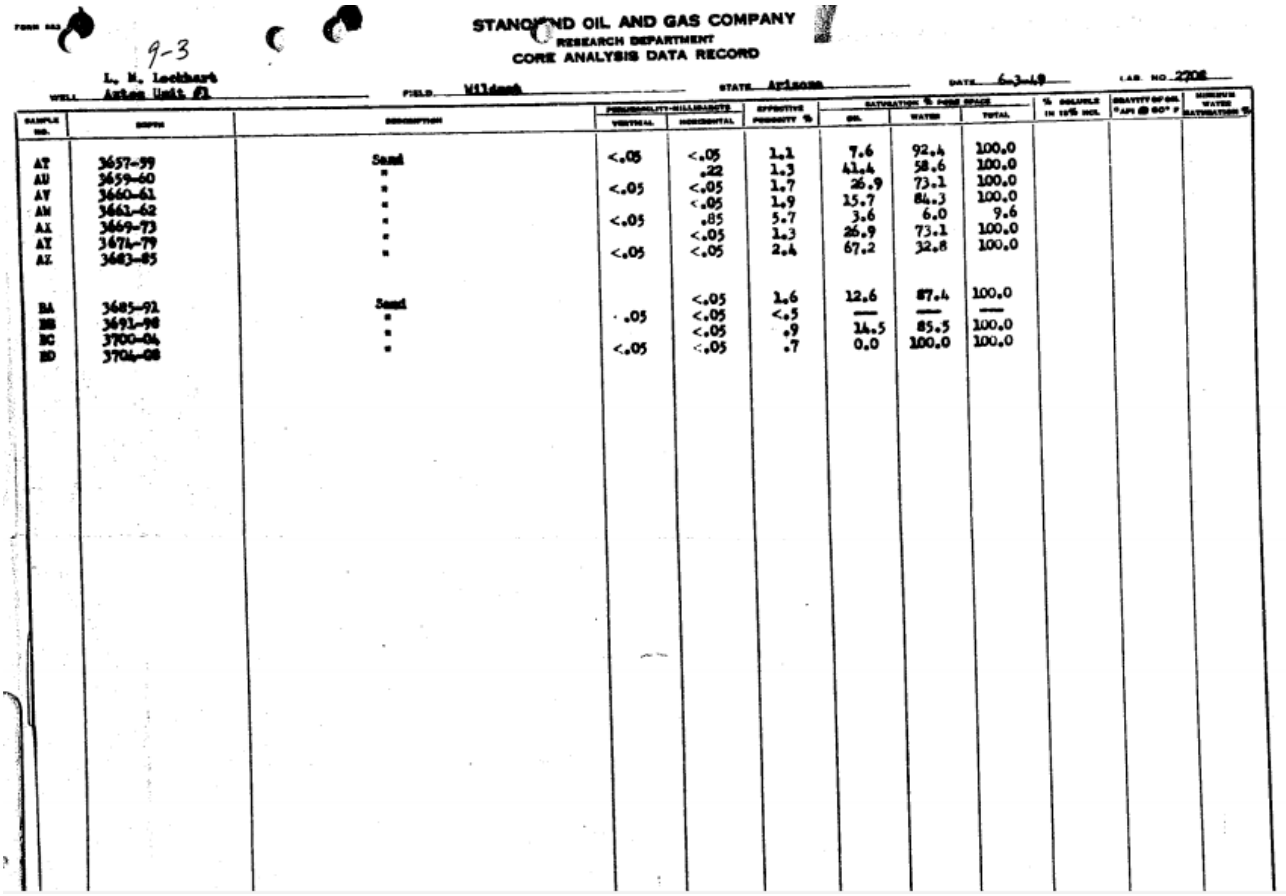
*UNLESS NOTED OTHERWISE, PERMEABILITIES ARE PARALLEL TO BEDDING PLANES
"<" INDICATES "LESS THAN"; ">" INDICATES "GREATER THAN".

Letter of transmittal by D. N. Forebee, dated 6-1-49, no file with graphical core analysis log.
Other tests to follow as supplements.

cc: Lewis Finch, Jr.
H. T. Morley (2)
C. F. Bedford

Blackstone Exploration Company Inc.

Olufela Olukoga, Reservoir Engineering Consultant



STANDARD OIL AND GAS COMPANY
RESEARCH DEPARTMENT
CORE ANALYSIS DATA RECORD

9-3

WELL L. M. Lockhart Aztec Unit #1 FIELD Wildcat STATE Arizona DATE 6-3-49 LAB. NO. 2206

SAMPLE NO.	DEPTH	DESCRIPTION	PERMEABILITY-MILLIDARCYS VERTICAL	PERMEABILITY-MILLIDARCYS HORIZONTAL	EFFECTIVE POROSITY %	SATURATION % PORE SPACE OIL	SATURATION % PORE SPACE WATER	SATURATION % PORE SPACE TOTAL	% SOLUBLE IN 10% HCL	GRAVITY OF OIL °API @ 60° F	MINIMUM WATER SATURATION %
AT	3657-59	Sand	<.05	<.05	1.1	7.6	92.4	100.0			
AU	3659-60	"		.22	1.3	41.4	58.6	100.0			
AV	3660-61	"	<.05	<.05	1.7	26.9	73.1	100.0			
AW	3661-62	"		<.05	1.9	15.7	84.3	100.0			
AX	3669-73	"	<.05	.85	5.7	3.6	6.0	9.6			
AY	3674-79	"		<.05	1.3	26.9	73.1	100.0			
AZ	3683-85	"	<.05	<.05	2.4	67.2	32.8	100.0			
BA	3685-92	Sand		<.05	1.6	12.6	87.4	100.0			
BB	3692-98	"	.05	<.05	<.5	—	—	—			
BC	3700-04	"		<.05	.9	14.5	85.5	100.0			
BD	3704-08	"	<.05	<.05	.7	0.0	100.0	100.0			

FORM O. & G. 1

ARIZONA STATE LAND DEPARTMENT

Sundry Notices and Reports on Wells

Lease or Permit No.

Notice of intention to drill	X
Notice of intention to change plans	
Notice of date for test of water shut-off	
Report on result of test of water shut-off	
Notice of intention to re-drill or repair well	
Notice of intention to shoot	
Subsequent record of shooting	
Record of perforating casing	
Notice of intention to pull or otherwise alter casing	
Notice of intention to abandon well	
Subsequent report of abandonment	
Supplementary well history	

(Indicate above by check mark nature of report, notice or other data)

February 18, 19 49

Following is a (Notice of intention to do work) on land under (permit) described as follows:
(Report of work done) (lease)

Well No. L.M.Lockhart "Aztec Land & Cattle Company, Ltd." No. 1

Section 33 (2460' fsl) T. 14 N. R. 20 E. G&SRM

The well is located 179.6 feet (S) of E - W center line and 1305.6 feet (NW NW NE SE) (W) of East line of

Section 33 - T.14N. - R.20 E. - G&SRM - Navajo County, Snowflake Area, Arizona

The elevation of the derrick floor above sea level is 5990 feet

DETAILS OF PLAN OF WORK

(State names of an expected depth to objective sands; show sizes, weights, and lengths of proposed casings; indicate mudding jobs, cementing points, and all other proposed work.)

Expect to encounter objective formations from approx. 2000' and will drill with rotary tools to basement or to a depth at which further drilling, in the judgment of the operator, would be unwarranted. Will set and cement approx. 100' of 12 3/4" O.D. H-3, 45# surface casing; and if justified by oil or gas formations encountered, will set and cement a string of 7", 23# new seamless casing. Mud of sufficient weight and substance to prevent blowouts will be used at all times and adequate blow-out prevention equipment will be installed and kept ready for immediate operation.

Approved February 23, 1949
Date

P. T. Williams

Arizona State Land Department

Company L. M. LOCKHART

By L. M. Lockhart

301-303 Subway Terminal Bldg.
417 South Hill Street

Address Los Angeles 13, California

Phone: MIchigan 3697

OG # 9-3

KELLOGG-WEAST-AZTEC #1
(s/a Lockhart-Aztec #1)

Location: Sec. 33, T. 14 N., R. 20 E. Navajo County
Elevation: 6011 ft. (NW¼NE¼SE¼)
TD: 3724'

Commenced: February 1949
Completed: 1949 (?)

Feet to Top	Rock Description	Formation
0	Sandstone, white quartzitic, fine-grained	Coconino
550	Shale, red brown, silty, calcareous, in sandstone	Supai
620	Anhydrite and gypsum in shale	
820	Sandstone, alternating with gypsum, anhydrite, halite	
1070	Shale, gray and brown, silty, dolomitic, massive	
1110	Anhydrite, mottled to white, hard, dense	
1140	Halite, grading down into anhydrite and shale	
1250	Shale, gray brown, calcareous	
1270	Shale, red brown, halite inclusions; grading down to anhydrite, halite, sandstone, red shale	
1540	Dolomite, dark gray to black, silty, some black organic matter	Fort Apache
1570	Shale, gray, alternating with dolomite	/memb.
1678	Dolomite, brownish gray	Base Ft. Apache
1750	Shale, red brown, dolomitic	
1770	Halite, with beds of sandstone and anhydrite	Base Up. Supai
2160	Anhydrite, gray, massive with halite	
2175	Shale, red to chocolate brown, sandy, includes gypsum and minor beds of sandstone	
2620	Shale, gray, highly micaceous, dolomitic	
2755	Dolomite, brown to gray brown, silty	
2780	Shale, gray, dolomitic, and some dolomite	
2860	Limestone, gray brown, shaly, dolomitic, with minor streaks of brown, calcareous shale	
2904	Shale, brown calcareous, hard, dense; some gypsum	
2930	Shale, brown, calcareous; streaks of brown limestone	
2938	Limestone, chert, hard, silty, interbedded with calcareous, mottled green shale	
2995	Shale, brown, calcareous, fractured, with anhydrite inclusions	
3015	Limestone conglomerate; smooth brown limestone pebbles in lime matrix	Base of Middle Supai
3020	Shale, blue gray, calcareous, silty	
3040	Shale, brown, calcareous, small lime pebbles	
3090	Limestone, brown, silty, some fractures	
3107	Shale, brown, calcareous	
3121	Limestone, gray, very shaly	
3127	Shale, brown, calcareous	
3132	Limestone, dark gray, silty	
3138	Shale, brown gray, calcareous	
3141	Limestone, gray, very silty, nodular	
3147	Limestone, aphanitic, gray, cherty, fractured	
3156	Shale, dark brownish gray, calcareous	
3166	Limestone, gray, silty, cherty	
3175	Shale, dark gray to black, fossiliferous, calcareous, with minor fractures	
3184	Limestone, gray, massive, coarse grained, fossiliferous	
3216	Shale, micaceous, silty, calcareous; minor fractures	
3273	Shale, gray, silty, bentonitic, calcareous, with lime pebbles	
3296	Limestone, gray, alternating with gray shale	
3385	Shale, mottled, red brown, calcareous, nodular, and limestone, thin, granular shaly	
3424	Limestone, gray, granular, silty, fossiliferous; some chert, minor fractures	
3471	Sandstone, very fine grained, fractured, calcareous	
3479	Limestone, gray, cherty, granular, minor fractures; grades down into shaly limestone	
3505	Shale, red brown, calcareous, micaceous, with beds of fossil limestone	
3539	Sandstone, dark gray, hard, fine-grained, with purple shale partings	
3564	Limestone, light gray, coarse-grained, silty, with shaly partings and gray brown nodular shale	

3/21/58

KELLOGG-WEAST-AZTEC #1
(n/a Lockhart-Aztec #1) Sec. 33, T. 14 N., R. 20 E. Navajo County

Feet to Top	Rock Description	Formation
3575	Shale, red brown, calcareous, fossiliferous	
3610	Shale, red, silty, mottled, with subangular granite fragments	
3641	Sandstone, very shaly, fine to medium-grained, calcareous; some limestone inclusions	
3650	Limestone, dolomitic, silty, massive, with minor fractures	
3657	Limestone, dolomitic, granular, sandy, with wags of white crystalline limestone, major fractures	
3685	Limestone, dolomitic, grey green, with thin gnarly beds of sandy shale	
3708	Sandstone, fine-grained, calcareous	
3724	Granite, biotite, weathered	Pre-Cambrian

Report submitted August 27, 1949.

9-112.

COUNTY	STATE	TOOLS	INFO. O/H
Navajo	Arizona	Rotary	

WELL
L.W.Lockhart-Aztec Land and Cattle Co. #1 (See K-W All Co. card).

LOC. 180' S of EW center line & 1306' W of E line, SE 33 11N-20E (NWNESE) (2478 FSL & 1306 WEL)

ELEV. 6000' ground
6011' Kelly bush

CONTRACTOR
Dunlap and Graham, Long Beach. Harry Failing, tool pusher

COMM.	COMP.	T. D.	I. P.
March 7, 1949	June 5, 1949	3734'	P & A

FORMATION RECORD
(see reverse side)

CASING
0-4' 20" conductor
4'is below cellar floor.

ACID

SHOT

REMARKS Drill stem test 1678'-1742' in Ft. Apache series of Supai formation. Air blow for 18 minutes, some smell of distillate. Good shut-off.

Adjoining water well TD 583', water sand from 555'-565', water raises to 545', makes about 10 gpm. No sample for analysis taken but water is potable.

(SCOUT REPORTS ON REVERSE SIDE)

no Kennedy

13 Mar 49 Spudded Mar 7. Drlg @ 325. Kaibab on surface to 138', sandy silty phase. Lost circulation @ 138' and again twice above 300'.

5 Apr 49 Drlg @ 1880 in brown maroon shales (supai) Base of Coconino at 480'. See remarks on front re: drill stem test.

28 Apr 49 Drlg @ 3028. Tough purple-black gritty shale, lime cement. No shows since drill stem test.

20 May 49 Drlg w/ almost continuous wire-line cores at 3600'. Maroon limey shales with few questional oil stains. Core showed a few gas bubbles. Ferebee (Stanlind geologist sitting on well) reports Penna? marine phase 3150'-3450'. His residue examinations show much higher % sol. materials than previously reported. Much over 50% sol.

26 May 49 Coring @ 3659'. 3608-33, very hard chert & cgl. 3622-23 completely dulled one hard-faced bit. 3633-41-50, maroon sandy shales with lime streaks. Considerable slickensides. 3650-57 Coarse recrystallized? limestone w/ shaley streaks.

6 Jun 49 Completed June 5, 1949. Granite @ 3724'. TD 3734'. Schlumberger gamma ray run June 5.

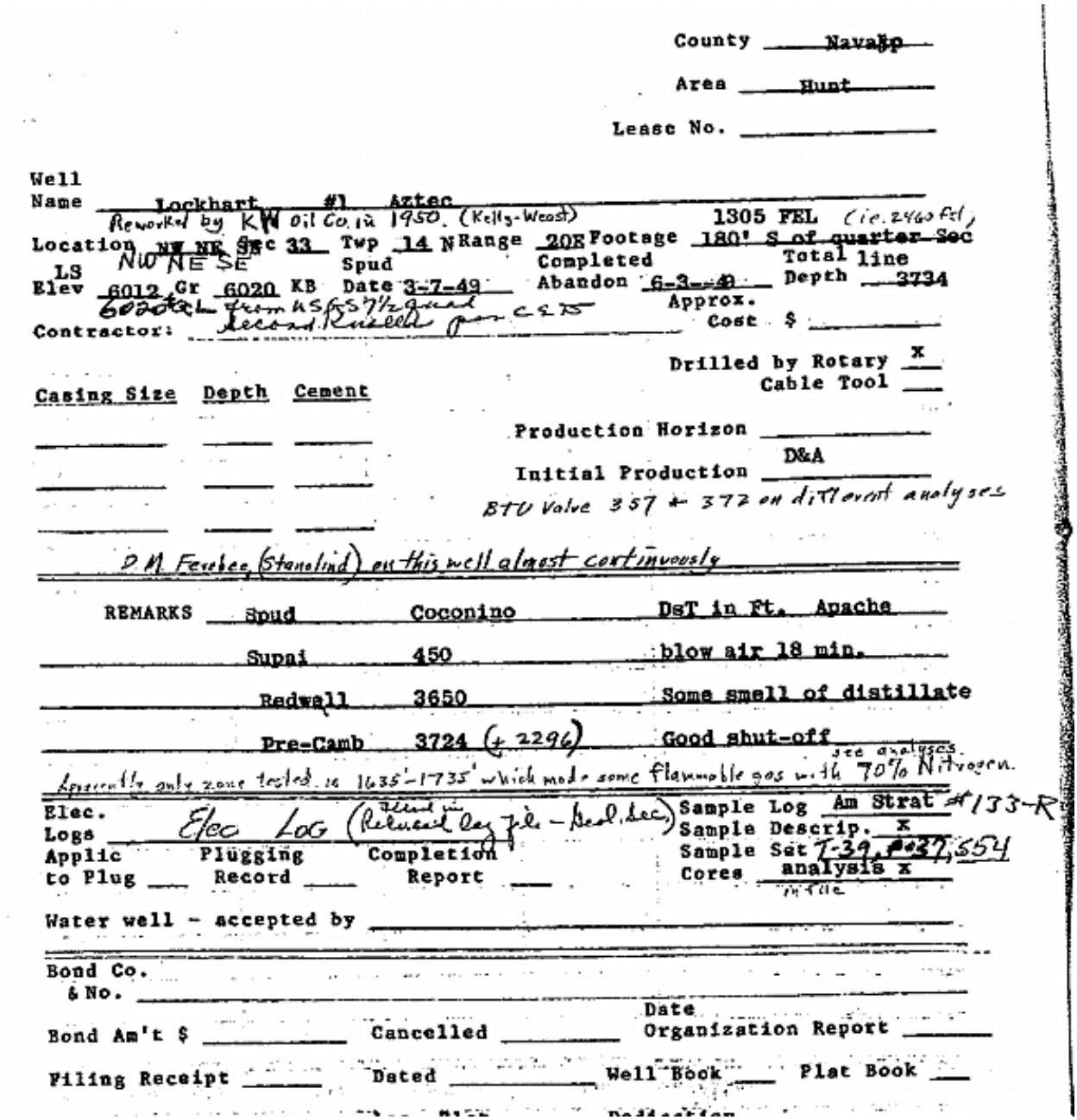
8 Jun 49 Cuttings and cores to MNA.

Hole 20' off vertical at 3400'.

4 feet of 20" conductor casing set at bottom of cellar; bottom of the 4' is 21' below kelly bushing, elevation 6011'.

to 60' 16" hole
60 - 1918' 11" hole
1918 - 3731' 9 5/8" hole
3731 - 3734' 7 5/8" hole (core hole).

Well plugged from 750'-650' in hard shale



County Navajo

Area Hunt

Lease No.

Well Name Lockhart #1 Aztec
Reworked by KW Oil Co. in 1950. (Kelly-Weast)

Location NW NE Sec 33 Twp 14 N Range 20E Footage 1305 FEL (i.e. 2460 fel), 180' S of quarter Sec line
LS NW NE SE
Elev 6012 Gr 6020 KB Date Spud 3-7-49 Completed Abandon 6-3-49 Total Depth 3734
6020 KB from USGS 7½ quad
Contractor: Record Russell Approx. Cost $

Drilled by Rotary X
Cable Tool

Casing Size	Depth	Cement

Production Horizon
Initial Production D&A

BTU Value 357 + 372 on different analyses

D M Forshee, (Stanolind) on this well almost continuously

REMARKS

Spud	Coconino	DST in Ft. Apache
Supai	450	blow air 18 min.
Redwall	3650	Some smell of distillate
Pre-Camb	3724 (+ 2296)	Good shut-off

see analyses
Apparently only zone tested is 1635'-1735' which made some flammable gas with 70% Nitrogen.

Elec. Logs Elec Log (Filed in Released Log file - Dept. Sec.)
Applic to Plug ___ Plugging Record ___ Completion Report ___
Sample Log Am Strat #133-R
Sample Descrip. X
Sample Set 7-39, 8037, 554
Cores analysis X in file

Water well - accepted by

Bond Co. & No.
Bond Am't $ Cancelled Date Organization Report
Filing Receipt Dated Well Book Plat Book

August 3, 1949

Mr. J. M. Kellogg
Mr. W. H. Keast
Phoenix, Arizona

Gentlemen:

At your request the following letter report is submitted regarding your proposal to test the L. M. Lockhart-Astec #1 well on Section 33, Township 14 North, Range 20 East, Navajo County, Arizona:

Geology-Structure

The well is located on the Snowflake anticline which is superimposed on the larger Holbrook anticline. The closure on the Snowflake anticline itself is from 120 to 130 feet and the closure on the Holbrook anticline increases this closure to over 300 feet. The Snowflake anticline covers an area of about 11 square miles. The elevation at the well site is about 6000' above sea level. The structural location of the well was based on a geological report by Mr. Silas C. Brown, formerly with the U. S. Geological Survey and now with the General Petroleum Corporation.

Geology-Stratigraphy

The surface formation at the well site is the Kaibab limestone of Permian age and the well successively penetrated the Coconino sandstone (Permian), the Supai formation (Permian), the Naco(?) limestone (Pennsylvanian), the Redwall limestone (Mississippian) and the Martin limestone (Devonian). The well reached granite at 3724' and bottomed at 3734'.

Drilling History

This well was drilled by L. M. Lockhart of Los Angeles. It was cored almost continuously from 1678' to 2181' and from 2492' to the bottom. Core recovery was nearly 90% and an unusually accurate picture of the encountered formations is available. The Standard Oil and Gas Company, on agreement with L. M. Lockhart, had its geologist, Mr. D. M. Forbes, on the well almost continuously and in addition ran a series of cutting and core analyses. Electric resistivity and gamma ray logs were run after the completion of the well. A drill stem test was run from 1678' to 1742' with negative results. The well was plugged and abandoned without any thorough formation tests being made.

Petroliferous Possibilities

The marine formations of the Permian, Pennsylvanian, Mississippian and Devonian age are all considered as source beds for petroleum because of their high content of organic material. Many small oil shows were encount-

ered from 1500' to about 3700'. There were also indications of gas and some smell of distillate.

Core analyses prepared by the Stanolind Company laboratories show two zones with petroliferous possibilities: One from 1540' to 1750' and the second from 3590' to 3700'. Both are in "tight" limestone formations, i.e. formations which will give up their petroleum content only upon the application of heavy dosages of acid. The drill stem test run from 1678' to 1742' was in the first possibility mentioned above. It showed an 18 minute blow of air and a strong distillate smell but nothing more. Core analyses of this zone show the porosity and permeability to be low, i.e. "tight", but the oil saturation of the pore space is over 25%. In the second zone, 3590' to 3700', a similar condition exists.

While the formations penetrated in these two sections are admittedly "tight", the percentage of saturation of the available pore space warrants the thorough testing of these two sections with adequate shooting and intense acidization.

The electric log of this well is reported to be very similar to the Dove Creek Field and Boundary Butte Field discovery well electric logs. The discovery well in Boundary Butte Field was initially abandoned as a dry hole because of the "tight" appearance of the limestones. Subsequent shooting and heavy acidization made this an excellent producing well and opened up a new field.

Proposed Development

The following is an outline of the proposed testing of the Lockhart-Aztec #1 well:

Both horizons will be tested.

The bottom of the well is to be cemented with 250 to 300 sacks of cement from 3590' to 3710' and then drilled out to 3700'. The well will then be shot from 3590' to 3650' and heavily acidized to make a thorough test.

If the bottom horizon becomes a producer, it is proposed to drill a second well in the immediate vicinity to test the upper horizon between 1540' and 1750' in a similar manner.

If the bottom horizon does not produce, the upper horizon will be tested in a similar manner in the same hole.

The work will be done by reputable firms and supervised by Stanolind Oil and Gas Company representatives.

Comments

In that this well was never shot and acidized, the State Land Depart-

ment feels that the Lockhart-Astec #1 well has not yet received a thorough test. The information contained in the core and sample analyses, the electric log, and in both written and oral communication with geologists and production men concerned, emphasizes the fact that there is adequate geologic justification for making a thorough test of the oil and gas possibilities of this well.

The plan of shooting and acidizing the well, as outlined above, is adequate to thoroughly test the petroleum possibilities of the Lockhart-Astec #1 well.

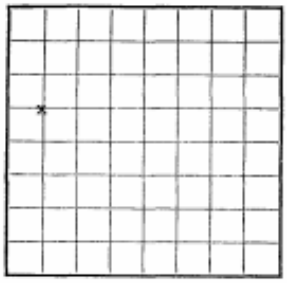
Very truly yours,

L. A. Heindl
Geologist

LAH:ld

English #1 , S22 T43S R22E Well File

Form 9-330



LOCATE WELL CORRECTLY

Navajo Indian Agency
U. S. Land Office Window Rock, Ariz.
Serial Number I-149-Ind-7180
Lease or Permit to Prospect English

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COPY

LOG OF OIL OR GAS WELL

Company Western Natural Gas Company Address 823 Midland Tower, Midland, Texas

Lessor or Tract English Field Wildcat State Utah

Well No. 1 Sec. 22 T. 43S R. 22E. Meridian SLBM County San Juan

Location 660 ft. [N./S.] of N Line and 1980 ft. [E./W.] of W Line of 22-43S-22E Elevation 5415
(Derrick floor relative to sea level)

The information given herewith is a complete and correct record of the well and all work done thereon so far as can be determined from all available records.

Signed

Date February 1, 1969 Title Petroleum Engineer

The summary on this page is for the condition of the well at above date.

Commenced drilling 10-30, 19 47 Finished drilling 6-10, 19 48

OIL OR GAS SANDS OR ZONES

(*Denote gas by G*)

No. 1, from 4620 to 4675 G No. 4, from 5200 to 5300 G

No. 2, from 4780 to 4825 G No. 5, from 5510 to 5650 G

No. 3, from 5100 to 5150 G No. 6, from to

IMPORTANT WATER SANDS

No. 1, from 1640 to 1680 No. 3, from to

No. 2, from to No. 4, from to

CASING RECORD

Size casing	Weight per foot	Threads per inch	Make	Amount	Kind of shoe	Cut and pulled from	Perforated From—	Perforated To—	Purpose
13 3/8	32#	8 Round	Naylor	288	Texas Pattern				Water
9 5/8	36#	8 Round	Nat'l	2675	Halliburton				
7	20#	8 Round	Nat'l	6090	Halliburton				Production
2 1/2	6.50#	8 Round	Nat'l	4652					

MUDDING AND CEMENTING RECORD

Size casing	Where set	Number sacks of cement	Method used	Mud gravity	Amount of mud used
13 3/8	288	200	Halliburton		
9 5/8	2675	500	"		
7	6090	325	"		

FOLD | MARK

PLUGS AND ADAPTERS

Heaving plug—Material Length Depth set

Adapters—Material Size

13 3/8	288	200	Hallibmrton		
9 5/8	2675	500	"		
7	6090	325	"		

FOLD | MARK

PLUGS AND ADAPTERS

Heaving plug—Material ..... Length ..... Depth set .....

Adapters—Material ..... Size .....

ACID RECORD — SHOOTING RECORD

Size	Shell used	Explosive used	Quantity	Date	Depth shot	Depth cleaned out
20,000 gallons in zones below 4670.						
Well plugged back to 4670						
13,000 gallons thru perforations 4620-70. Well completed						

TOOLS USED

Rotary tools were used from 0 feet to 6090 feet, and from ..... feet to ..... feet

Cable tools were used from ..... feet to ..... feet, and from ..... feet to ..... feet

DATES

February 1, 19 49. Put to producing Well shut in, 19.....

The production for the first 24 hours was ..... barrels of fluid of which .....% was oil; .....% emulsion; .....% water; and .....% sediment. Gravity, °Bé. .....

If gas well, cu. ft. per 24 hours 25,000 MCF Gallons gasoline per 1,000 cu. ft. of gas 1,161

Rock pressure, lbs. per sq. in. 1124

EMPLOYEES

Jim Reeves, Driller M. P. Cooper, Driller

J. W. McClinton, Driller Rudy Poteet, Driller

FORMATION RECORD

FROM—	TO—	TOTAL FEET	FORMATION
0	525	525	Sandstone; white, med to crs.
525	740	215	Sandstone with red shale
740	930	190	Shale; sandy, with traces pink limestone
930	1340	410	Shale; red to purple
1340	1405	165	Sand; red & white, v. crs.
1405	1645	240	Shale, red, with some sand
1645	1770	125	Sand, white, to grey med.
1770	2040	270	Shale, red & sand lenses
2040	3055	1015	Shale; red & green, with minor amounts of limestone, anhydrite & Chert
3055	4480	1425	Limestone; grey to red, silty, with heavy beds of fine micaceous sandstone
4480	5270	790	Limestone; tan to brown, med grained to fine, fossiliferous in part. Some beds of black calcareous shale. Nodules of black & orange chert.
5270	5510	240	Limestone; tan f. xtln, with considerable green & red shale
5510	5870	360	Limestone; white, med. to crs. xtln, cherty
5870	6055	185	Limestone; shaley with some beds white sandstone
6055	6090	35	Limestone; brn, with increasing amts of quartzi