NORTH DAKOTA GEOLOGICAL SURVEY CIRCULAR N0. 252

Summary of the McAlester Fuel Company - Christenson No. A-1
Bottineau County, North Dakota
Well No. 2224 - Permit No. 2236

By William P. Eastwood
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McAlester Fuel Company - Christenson #A-1 is located in the NE 1/4, NW 1/4, Section 1, Township 160 North, Range 79 West (1977 FWL, 660 FNL), Bottineau County, North Dakota. Elevation of KB 1463, GL 1452. Contractor: Cardinal Drilling Company.

The drilling permit was issued on March 6, 1959, with the well being classed as a wildcat. The well was drilled to a total depth of 3480 and completed on April 9, 1959, as a producer from the middle part of the Ratcliffe interval of the Madison group and was the discovery well of the Southwest Starbuck field. Production declined rapidly and, after the failure of an attempted recompletion in the Midale subinterval, the well was plugged and abandoned on December 2, 1960.

Drill Stem Tests:

1. 3321-3337 (Spearfish formation). Open 45 minutes, recovered 40 feet of mud.

IFP	0
FFP	25
SIP	50

2. 3341-3352 (Ratcliffe interval). Open 2 hours, shut in 45 minutes, recovered 1800 feet of gas, 40 feet of slightly oil and heavily gas cut mud, 400 feet of slightly mud cut gassy oil.

IHP	1890	
IFP	35	
FFP	185	
SIP	1470	and still increasing
FHP	1830	

Casing and Tubing Record:

213 feet of 8-5/8 inch surface casing cemented with 150 sacks.
3471 feet of 5-1/2 inch production casing cemented with 225 sacks.
3372 feet of 2-7/8 inch tubing.

Completion Data:

1. April 9, 1959. Perforated 3343-3353 (Ratcliffe interval) with 4 holes per foot. Acidized with 3,000 gallons. Well pumped 75 barrels oil per day, 12% water. Gravity 36^0 API. SIP 80 psi in 12 hours.

2. March 30, 1960. Prior production 18 BOPD. Abrasijeted 2 holes at 3348. Fraced through perforations (3343-3353) and abrasijet holes with 10,000 gallons acid petrofrac and 10,000 pounds sand. Breakdown pressure 1600 pounds, maximum pressure 3400 pounds, average injection rate 5 BPM. After recovery load oil, well flowed salt water.

Squeezed perforations 3343-3353 with 185 sacks. Breakdown at 800 pounds, final pressure 3500 pounds.

After drilling out cement well pumped 4 barrels oil per day, 35% basic sediment and water from above perforations.

3. October 31, 1960, Prior production 3 BOPD, 45% water. Perforated 3408-3412 (Midale subinterval) and acidized with 500 gallons MCA. After recovering acid water, well swabbed 100% salt water from Midale.

Set bridge plug at 3402 and perforated 3335-3340 (Ratcliffe). Vibrofraced 3335½-3339½, acidized with 4,000 gallons retarded acid. Swabbed acid water and put well on pump, production 0 to 7 BOPD, 80% water.

Plugging Data:

Set bridge plug at 3300, dumped 4 sacks cement on top. Loaded hole with mud. Shot off and pulled 5-1/2 inch casing from 1840, set 20 sacks cement plug at 1840. Set 20 sacks cement plug at 215 at base of surface casing and 5 sacks cement plug in top of surface casing. Welded cap on top of surface casing. Top of surface casing is well below plow depth.

Mechanical Logs:

Induction - Electrical (222-3474)
Microcaliper - Microlaterolog (2140-3479)

Core Record:

3318-3366 and 3422-3427

The formation tops were determined from samples and mechanical logs. Color names are those used in the Rock Color Chart of the National Research Council. Limestone petrography terms are those proposed by Folk (1959), Bulletin of the American Association of Petroleum Geologists, vol. 43, no. 1, pp. 1-38.

FORMATION TOPS

Cretaceous System	
Niobrara formation	1380
Greenhorn formation	1694
Mowry formation	1966
Fall River formation	2160
Jurassic System	2427
Piper formation	2889
Triassic System	
Spearfish formation	3144
Mississippian System	3333
Ratcliffe interval	3333
Midale subinterval	3404
Frobisher-Alida interval	3440
Rival subinterval	3440
Top “Massive Anhydrite”	3465

225-375 Shale, light gray (N7), blocky. Rare pieces of yellowish gray (5Y7/2) siltstone.

375-765 Shale, light gray, as above, with common to rare, medium gray (N5), subfissile, dark shale. Rare, medium sized aggregates of pyrite crystals. Rare, moderate red (5R4/6) siltstone at 495-510. Rare, grayish red siltstone (5R4/2) at 595-605 and 645-655.

765-955 As above, with very rare pieces of black, fissile shale, common, medium gray shale.

955-1300 Common, light gray, blocky shale; common, medium dark gray, blocky to subfissile shale.

1300-1330 Very abundant, dark gray to black, soft shale.

1330-1360 Abundant, medium gray, soft shale; common, pale reddish brown (10R5/4) siltstone.

1360-1400 Abundant, black, subfissile shale, slightly calcareous. Common to rare, dark gray, calcareous shale containing white specks.

1380 Top of Niobrara formation

1400-1420 Abundant, calcareous shale with white specks as above; common black shale as above.

1420-1460 Abundant, black, subfissile shale; common speckled shale as above.

1460-1530 Abundant, black, subfissile shale; common, medium gray, calcareous shale; rare speckled shale.

1530-1640 Abundant, black, fissile, soft shale; rare calcareous shale. Rare mollusk fragments. Rare to common, medium gray shale.

1640-1700 Black shale as above. Very rare, coarse sized, iron-stained calcite fragments.

1694 Top of Greenhorn formation

1700-1780 Shale, very calcareous, black, hard, subfissile, containing abundant white specks. Rare mollusk fragments.

1780-2020 Abundant, black, soft, fissile, non-calcareous shale. Common to rare, calcareous, speckled shale as above. Rare mollusk fragments. Very rare, brown, chitinous (?) spines or fins at 1880-1900.

2020-2140 Abundant, black to medium dark gray, fissile shale. Rare, medium light gray to pale yellowish brown siltstone.

2160 Top of Fall River formation

2140-2170 Abundant, coarse to medium, rounded to subangular, loose quartz sand grains, some cemented together with silica and pyrite. Common shale as above. The loose grains are of medium to coarse size. Slightly smaller grains are abundant in the pyrite cemented fragments. The smaller grains in the uncemented portion were probably lost during the washing of the samples.

2170-2200 As above, with rare fragments of white, fine grained, friable quartz sandstone.

2200-2210 Common, grayish pink (5R8/2), fine crystalline gypsum; common, white, fine grained sandstone; abundant black and gray shale cavings.

2210-2240 Quartz grains, sandstone fragments, and shale cavings as in 2170-2200 above.

2240-2260 Abundant shale cavings as above; common moderate red (5R5/4) shale and fine grained, shaly sandstone; common quartz grains and white sandstone fragments as above. Rare, moderate red fragments of fine crystalline gypsum.

2260-2340 Shale and sandstone fragments as above. Common pyrite aggregates. Common, white to light gray, very fine grained sandstone or siltstone. Very rare, moderate red shale. Sandstone fragments have a calcite cement.
2340-2400 Common, white to pink, fine crystalline gypsum. Common to rare sandstone as above. Abundant shale as above.
2400-2410 Black shale and abundant, coarse, rounded quartz grains. Common to rare pyrite aggregates. No gypsum seen.

2427 Top of Jurassic system
2410-2490 Abundant black shale; common, light gray, fine grained sandstone; very common, fine crystalline gypsum; very raresiderite pellets.
2490-2560 Shale and gypsum as above; rare to common, pale olive (10Y6/2), very fine grained, calcareous, silty sandstone; very rare, light olive (10Y5/4) shale.
2560-2580 As above, with very rare fragments of white sparite to micro-sparite limestone containing black fragments.
2580-2650 Common limestone as above; shale, gypsum, and sandstone as above. Limestone appears to be slightly sandy. Amount of gypsum variable; probably cavings.
2650-2670 Very common limestone and shale as above; rare gypsum and sandstone.
2670-2680 Abundant, black, fissile shale; rare limestone, sandstone, and gypsum. Rare, light olive shale.
2680-2740 As above, with common, light olive shale.
2740-2750 Black and olive shale as above; common moderate red (5R4/6) shale.
2750-2800 Abundant, white, sparite to microsparite limestone. Abundant shale as above. Rare sandstone and gypsum.
2800-2900 Abundant black shale, common light olive shale, and moderate red shale. Rare limestone, sandstone, and gypsum.

2889 Top of Piper formation
2900-2930 Common, white, microsucrosic, dolomitic limestone. Abundant shale as above.
2930-2960 As above, with common pale yellowish brown micrite limestone. Badly caved.
2960-3030 Abundant, very pale orange (10YR8/2) to white, micrite to microsparite limestone. Common shale cavings as above. Limestone seems to be mainly micrite.
3030-3060 Limestone, pale yellowish brown (10YR6/2), pelmicrite; scattered very small pellets in a sublithographic matrix. Common to rare, black shale cavings. Common, pale yellowish brown, microsparite limestone. Pelmicrite contains rare ostracodes.
3060-3080 Pale yellowish brown limestone as above. Common, white, fine crystalline gypsum.
3080-3120 Limestone and gypsum as above. Abundant black shale cavings.

3144 Top of Spearfish formation
3120-3190 Common, white to pink, fine crystalline gypsum; common olive and red shale; rare limestone as above. Abundant black shale cavings. Interval badly caved.
3190-3210 Common, moderate red to moderate brown (5YR4/4) shale. Badly caved.

3210-3270 Common, moderate red, fine grained quartz sandstone. Some fragments contain a few medium-sized quartz grains. Rare red shale. Badly caved. Common, loose, medium sized, rounded quartz grains.

3270-3280 Common, pale green (10G6/2) shale, rare sandstone and shale. Very common black shale cavings.

3280-3290 Common moderate red sandstone as above, and loose quartz grains as above. Black shale cavings.

3290-3300 Abundant olive and black shale and rare sandstone. Common loose quartz grains.

3300-3315 Shale cavings as above; very rare loose quartz grains.

3318-3320 Sandstone, moderate red, very fine grained, silty, calcareous. Fair oil stain, good cut in carbon tetrachloride. Fair intergranular porosity and permeability.

3320-3321 Sandstone as above, but containing rare to common, medium sized, rounded quartz grains. Scattered oil stain, fair cut.

Drill stem test #1 (3321-3337). Open 45 minutes, recovered 40 feet of mud.

3321-3325 Sandstone, moderate red, very fine grained, with scattered medium sized, rounded quartz grains concentrated in indistinct laminae. Silty and slightly calcareous. Contains small irregular inclusions of clear and white anhydrite. Good porosity and permeability. Scattered stain, weak cut. The finer parts of the rock are the ones containing the oil staining.

3325-3326 Sandstone, very fine grained, moderate red to pale red (10R6/2), friable, silty. Good stain and good cut. No medium sized quartz or anhydrite inclusions seen. Good intergranular porosity and permeability.

3326-3327 Sandstone as above, interlaminated with moderate red (5R4/6), slightly more silty and less friable, unstained sandstone.

3327-3329 Unstained sandstone as above.

3329-3330 Sandstone, fine grained, slightly calcareous. Relatively clean and not as silty as above. No oil stain.

3330-3332 As above, containing common, medium sized, rounded quartz grains and irregular inclusions of white, fine crystalline anhydrite. Scattered slight stain. Fair intergranular porosity and permeability.

3332-3333½ Sandstone, white to moderate red, fine grained with very common, medium to coarse, rounded quartz grains. Abundant, medium to large inclusions of white to moderate red, fine crystalline anhydrite. No stain. Sandstone has a dolomitic cement. The chip from 3233-3333½ could be called a very sandy and anhydritic dolomite.

3333 Top of Ratcliffe interval.

3333½-3334 Missing.

Core #2

3334-3335 Dolomite, very pale orange to white, fine crystalline to cryptocrystalline. Common, medium to fine quartz grains and very common inclusions and bands of anhydrite. Tight, dense. No oil stain.

3335-3336 Dolomite, pale yellowish brown, fine crystalline, very anhydritic, no quartz grains seen. No oil stain.

3336-3338 Limestone, very pale orange, pelmicrite and pelmicrosparite. Very small pellets tightly packed in a sublithographic to fine crystalline cement. Rare fossil fragments. Common, light brown (5YR6/4), translucent, medium sized anhydrite crystals. Fair to poor intercrystalline porosity and permeability. No stain.

3338-3339 Limestone, very pale orange, fine crystalline, microsparite. Common ostracode shells and fragments. Some of the shells filled with clear calcite. Rare, fine brown anhydrite crystals.

3339-3340 Limestone as above. Abundant ostracode shells and fragments. No oil stain.

3340-3341 Limestone as above; interbedded pale yellowish brown, anhydritic, pelsparite limestone consisting of abundant pellets or small intraclasts closely packed in a sparry calcite cement; rare ostracode fossils. Veins of brown anhydrite crystals are present along the contact between the two types of limestone.

Drill stem test #2 (3341-3352). Recovered 1800 feet of gas, 40 feet of slightly oil and heavily gas cut mud, 400 feet of slightly mud cut gassy oil.

3341-3342 Dolomite, limy, very pale orange, fine crystalline, very anhydritic. Good intercrystalline porosity and permeability. No oil stain.

3342-3343 Dolomite, very light gray, very fine crystalline. Moderate red, clayey and calcareous material filling fractures and vugs. No oil stain. Low porosity and permeability.

Perforated interval 4343-4353. Initial production 75 barrels of oil, 12% water per day.

3343-3344 Limestone, pale to moderate yellowish brown. Intrapelmicro-sparite, small intraclaats and pellets in a fine crystalline matrix. Heavy oil stain and good cut in carbon tetrachloride. Good pinpoint and intercrystalline porosity. Common, medium to large, brown, translucent anhydrite crystals, some of which have inclusions of small intraclasts.

3344-3345 Limestone, pale yellowish brown, microaparite. Rare to no pellets or intraclasts, common veins of white anhydrite. Scattered stain and fair cut. Low porosity and permeability.

3345-3349 Limestone, intrapelmicrosparite, as in 3343-3344 above. Rare to common ostracode valves. Good stain and cut. Common anhydrite crystals and masses at 3346-3347.

3349-3350 Dolomite, pale yellowish brown, fine crystalline, common large anhydrite masses. Good stain and cut. Low porosity and permeability.

3350-3352 Limestone, pale to moderate yellowish brown, as in 3345-3349 above, good stain and cut, good pinpoint and intercrystalline porosity and permeability.

3352-3353 Limestone as above with very fine crystalline dolomite containing common disseminated anhydrite, tight and dense, no stain.

3353-3355 Anhydrite, dolomitic, very pale orange, fine crystalline. No stain. Tight and dense.

3355-3356 Dolomite, very pale orange, fine crystalline. Common inclusions of clear to pale brown anhydrite crystals. No stain. Good inter-crystalline porosity probably low effective permeablility.

3356-3357 Light gray shaly dolomite.
3357-3359 Anhydrite, moderate red, cryptocrystalline, with common small lenses and irregular laminae of moderate red argillaceous dolomite.
3359-3362 Anhydrite, moderate red, cryptocrystalline, no inclusions of dolomite.
3362-3364 Anhydrite, slightly dolomitic, cryptocrystalline a large vertical vein of moderate red shaly dolomitic anhydrite at 3362-3363.
3364-3365 Dolomite, moderate red, argillaceous, containing abundant irregular inclusions of moderate red fine crystalline anhydrite.
3365-3366 Dolomite, moderate red, fine crystalline to cryptocrystalline, not argillaceous, no anhydrite inclusions seen. End of core.
3366-3370 Abundant anhydrite, white with pink tinge, fine crystalline, common black shale cavings.
3370-3375 Abundant pale yellowish brown fine crystalline limy dolomite, common to rare moderate pink fine crystalline limy slightly anhydritic dolomite. Both types have low porosity and permeability.
3375-3405 Abundant white anhydrite as in 3366-3370 above, rare limy dolomite as above. Common black shale cavings.

Perforated interval 3408-3412. Initial production 7 barrels of oil per day, 80% water.

3404 Top of Midale subinterval
3405-3415 Abundant very pale orange, fine crystalline dolomitic limestone, rare pale yellowish brown pelmicrite limestone (cavings ?). Rare white anhydrite as above. Common black shale cavings.
3415-3422 As above but with some of the dolomitic limestone fragments containing medium sized pale brown anhydrite crystals. Circulated at 3417.
3422 Circulation sample. Dolomitic limestone as above with rare moderate brown micrite limestone.
3422-3423 Limestone very pale orange to very light gray. Pelmicrosparite, small to medium pellets is a very pale fine crystalline matrix. Common ostracode valves, rare pelecypod fragments. Fair inter-crystalline porosity, very low permeablility.
3423-3424 As above but with common pale brown medium sized anhydrite (?) crystals and with a slight oil stain and good cut in carbon tetrachloride. Common pinpoint porosity, good intercrystalline porosity, fair to poor permeability.
3424-3425 Limestone, as in 3422-3423 above. No oil stain or cut. Rare brown anhydrite crystals.
3425-3427 Limestone, very pale yellowish brown to very pale orange. Avery fine crystalline microsparite, almost a micrite, containing common small pellets and very small brown dolomite crystals. Fair inter-crystalline porosity, low permeability, no oil stain. Contains laminae where the pellets are more common and more closely packed and veins of large pale brown translucent anhydrite crystals. End of core.

3440 Top of Frobisher-Alida interval
3427-3480 Samples missing.
3480 Total Depth.