

NORTH DAKOTA GEOLOGICAL SURVEY CIRCULAR NO. 250

Summary of the Cardinal, Great Plains, W. C. Kaufman, Jr.
Anna Kaeding No. 1
Well No. 2292 - Permit No. 2304

by William P. Eastwood
April 1961

The Cardinal, Great Plains, W. C. Kaufman #1 Anna Kaeding is located in NE 1/4, SE 1/4, Section 34, Township 161 North, Range 78 West, Bottineau County, North Dakota. Elevation of K.B. 1472, G.L. 1463.

The drilling permit was issued April 17, 1959. The well was drilled to a total depth of 3276 (driller), plugged back to 3265, and completed as a producer from the Midale subinterval of the Ratcliffe interval of the Madison group on May 14, 1959. This is the discovery well of the South Starbuck field.

Drill Stem Tests:

1. 3231-3272. (Spearfish and Midale)
Open 2-1/2 hours, shut in 30 minutes.
Recovered: 30 feet highly gas cut mud
300 feet oil cut, highly gas cut mud
60 feet slightly mud cut, highly gas cut oil
55 feet gassy oil
445 feet total fluid recovery

Pressures:

IHP	1842
IFP	47
FFP	186
FHP	1812
SIP	1529 (not stabilized)

Casing and Tubing Record:

- 182 feet of 8-5/8 inch surface casing cemented with 125 sacks.
- 3276 feet of 5-1/2 inch production casing cemented with 150 sacks.
- 3251 feet of 2-3/8 inch tubing.

Completion Data:

1. Plugged back to 3265.
2. Vibrofraced 3251-3261 with two No. 5 charges.
3. Perforated 3251-3261 with 8 holes per foot.
4. Acidized with 2,000 gallons.
5. 24-hour pump test. Pumped 75 barrels net oil, gravity 37.6° API, 50% water, GOR not taken in.

Core Record:

1. 3252-3272. Full recovery. Core chips listed as being from 3246-3266.

Mechanical Logs:

Electrical (183-3267)

Microlaterolog-Microcaliper (2266-3266)

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, p. 1-38.

FORMATION TOPS

Cretaceous

Niobrara formation	1352
Greenhorn formation	1661
Mowry formation	1940
Fall River formation	2118

Jurassic 2365 (?)

Piper limestone	2805
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Triassic (?)

Spearfish formation	3088
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Mississippian

Ratcliffe interval	3245
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Total depth	3276
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180-270	Shale, light gray (N7), soft, fissile, contains rare small mica flakes. Slightly silty, but mostly clay shale. Non-calcareous.
270-420	Shale, light gray, micaceous. As above, but blocky and not as soft or as fissile.
420-510	Shale, medium light gray (N6), blocky, subfissile, hard, no mica flakes. Rare, light gray, soft shale at 480-510.
510-600	Common, medium light gray, hard shale as above; common, light gray, soft shale as above.
600-750	Abundant, light gray, blocky, subfissile, non-micaceous shale. Rare fragments of pale yellowish brown, very fine grained sandstone (cavings?).
750-780	Abundant, light gray shale as above. Common, medium gray (N5) to medium dark gray (N4), blocky, subfissile shale.
780-810	Abundant, light gray shale as above.
810-840	As above, rare white bentonite particles.
840-960	Common, light gray shale as above; common to rare, white to very light gray (N8), hard, blocky shale.
960-1020	Shale as above; rare white bentonite (?) particles.
1020-1170	Shale, blocky, subfissile, medium light gray to brownish gray (5YR4/1). Very rare fragments of light brownish gray (5YR6/1) siltstone.
1170-1260	Shale, black, moderately soft, fissile.
1260-1320	Shale, medium light gray, with rare black fissile shale as above.
1320-1410	Abundant, dark gray to black, soft, fissile shale as above.
1410-1500	Shale as above, with rare to common, black, calcareous shale containing rare, small, pinkish, calcareous fragments.
1500-1620	Abundant, dark gray to black, calcareous, blocky shale containing very abundant, small, pink to white, calcareous "specks." Rare, black, fissile shale.

1620-1800 Abundant, medium gray, soft, limy shale. Rare, black, speckled shale as above. Common to rare inoceramus fragments.

1800-1830 Shale as above. Rare pieces glauconitic, calcareous sandstone and rare, pale yellowish brown, sparite limestone.

1830-1890 Common to abundant, black shale containing very abundant, white, calcareous specks. Common, dark gray to medium gray shale.

1890-1920 Shale, black to dark gray, fissile. Contains rare, small, pale brown, chitinous (?) fins or spines.

1920-2010 Shale, black, as above. Common speckled shale as above. Rare chitinous spines as above. Very rare calcareous sandstone.

2010-2170 Shale, black, fissile, soft. Very rare speckled shale cavings. Very rare white siltstone.

2170-2200 Shale as above; rare ironstained siltstone and very fine grained sandstone.

2200-2230 As above, common, coarse, rounded to subangular quartz grains.

2230-2270 Siltstone as above; common moderate red (5R5/4), soft, silty shale. Abundant black shale. Rare, moderate red, fine grained, silty sandstone. Rare, large, rounded quartz fragments. Rare brown siderite pellets.

2270-2290 Abundant, white, fine to medium grained, friable, calcareous quartz sandstone consisting of angular to rounded quartz fragments with calcareous cement. Common white siltstone as above. Black shale cavings.

2290-2300 Siltstone and shale as above; rare sandstone as above.

2300-2310 Common, white to pale greenish yellow (10Y8/2), iron stained siltstone, slightly calcareous. Rare, moderate red, silty sandstone; black shale cavings.

2310-2350 Common, very light grayish pink, fine crystalline gypsum. Siltstone and shale as above. Rare small pyrite aggregates.

2350-2370 Common gypsum as above; abundant black fissile shale; common medium gray shale; rare siltstone as above.

2370-2390 Abundant, medium gray, blocky, soft shale; very common black fissile shale; rare gypsum.

2390-2450 Rare gray shale and pink gypsum. Abundant black shale, probably cavings because it contains brown chitinous (?) spines.

2450-2500 Abundant, black, fissile shale; very rare siltstone and gypsum. Rare pale olive (10Y6/2) shale. Rare, very fine grained, silty sandstone.

2500-2520 Abundant, black, fissile shale; common to rare pink gypsum; rare, pale olive shale.

2520-2540 Common pale olive shale, black shale and gypsum as above.

2540-2550 As above, with very rare, calcareous, very fine grained sandstone.

2550-2570 Common sparite limestone, white with abundant black linear fragments. Common, white, calcareous, fine grained sandstone. Shale and rare gypsum as above.

2570-2700 Black and olive shale as above. Rare limestone and sandstone as above. Interval appears to be badly caved. Rare mollusk fragments. Rare large fragments of white selenite at 2630-2640. Rare pink gypsum cavings.

2700-2780 Common pale olive shale, common black shale, rare, moderate red, silty shale. Rare limestone as in 2550-2570. Common gypsum cavings.

2780-2800 Shale as above. Rare, pale yellowish brown, micrite limestone.

2800-2810 Shale as above; common, white, very fine grained, slightly calcareous sandstone. Common pink gypsum.

2810-2820 Shale, sandstone and gypsum as above. Common, white to very pale orange, microsucrosic dolomite.

2820-2840 Shale and gypsum as above. No sandstone or dolomite.

2840-2850 As above, rare sandstone.

2850-2890 As above, with rare to common, very pale yellowish brown, limy dolomite.

2890-2910 Shale and gypsum cavings as above. Rare, pale yellowish brown, micrite limestone.

2910-2920 Rare, white to pale yellowish brown, micrite limestone; rare, white, microsucrosic, limy dolomite. Shale and gypsum cavings as above.

2920-2960 Abundant, white, micrite limestone. Common black shale and pink gypsum cavings.

2960-2970 Limestone as above, with common fragments of intramicrosparticle composed of rounded small intraclasts or pseudo-oolites closely packed in a white microsparticle matrix; may also contain quartz sand grains.

2970-2990 Common micrite limestone as above; rare fragments of sandy intramicrosparticle as above. Abundant black shale, common moderate red shale cavings, rare pink gypsum.

2990-3090 Rare limestone as above; very common, white, fine crystalline gypsum. Shale as above. Badly caved. Common, medium gray to olive gray, calcareous shale cavings.

3090-3100 Black fissile shale and medium gray, blocky shale. Probably cavings.

3100-3140 Abundant, light red (5R6/6), very fine grained sandstone. Common, pink to white, fine crystalline gypsum. Limestone and black shale cavings.

3140-3190 As above, but the very fine grained sandstone contains common, medium sized, rounded quartz fragments.

3190-3240 Sandstone, light red, medium grained to very fine grained, gypsiferous. Badly caved.

3240-3246 Abundant, fine to medium crystalline, pale yellowish brown, limy dolomite with anhydrite gypsum fillings. Slight oil staining. Rare small pores.

Core #1 (3246-3266). Description of core chips.

3246-3247 Limestone, probably slightly dolomitic, pale yellowish brown. Pelmicrosparticle. Small pellets and rare fossil fragments tightly packed in a matrix of very pale yellowish brown microsparticle which may be slightly dolomitic. Medium to large sized, brown, sub-rectangular anhydrite crystals, some of which have irregular borders. Common, very small pinpoint pores. Good oil stain and good cut in carbon tetrachloride. Low pinpoint and matrix porosity, low permeability.

3247-3248 Pelmicrosparticle limestone as above in contact with slightly darker intrapelmicrite limestone consisting of large intraclasts and small pellets very tightly packed in a sublithographic to microsparticle cement. Both types of rock have fair pinpoint and intergranular porosity, slight oil stain, and weak cut. Fair porosity, but probably low permeability. Common large brown anhydrite crystals in both lithologies. Contact between the two lithologies is sharp and not gradational.

- 3248-3249 Limestone, medium light gray, micrite, containing common small rounded inclusions of pale yellowish brown, porous microsparite (microsucrosic) oil stained limestone. Inclusions increase in number toward one side of the chip until the whole rock is composed of oil stained microsparite with good to fair inter-crystalline porosity.
- 3249-3250 Limestone, pale yellowish brown, microsparite as above. Common, medium sized, brown anhydrite crystals. Good oil stain and good cut. Fair to good intercrystalline porosity and permeability. The oil stained chips have the fine carbonate crystals loosely cemented with a very pale yellowish brown, very fine crystalline to microcrystalline carbonate matrix. One chip that is unstained has more matrix and less porosity and permeability than the oil stained ones. The unstained chip also does not contain anhydrite crystals.
- 3250-3251 Limestone, very light gray to white, micrite. Sublithographic to microcrystalline limestone containing common, very fine dolomite crystals. More porous parts of the rock (microsparite) are oil stained and have common, medium sized, brown anhydrite crystals and large, white, with brownish border, anhydrite crystals. Rock also has a thin (2/10 inch) vein of anhydrite which in places is bordered by a thin zone of oil stained microsucrosic limestone. Scattered oil stain. Generally poor porosity and permeability.
- Perforated zone 3251-3261. Potential test 75 barrels net oil per day, 50% water.
- 3051-3052 Limestone, very pale yellowish brown, microsparite. Contains abundant small brown anhydrite crystals and common large masses of white microcrystalline anhydrite. Low porosity and permeability. No stain.
- 3252-3253 Limestone, pale yellowish brown, microcrystalline microsparite containing common, very small dolomite (?) crystals and associated with a very large mass of white microcrystalline anhydrite. Contact between the anhydrite and limestone is sharp, but with a few small inclusions of limestone within the anhydrite no farther than 1/10 inch from the contact. The limestone also contains a thin band of brown anhydrite crystals about 1/10 inch from the contact. No stain. Low porosity and permeability.
- 3253-3256 White anhydrite with irregular veins and inclusions of limestone as above. Limestone contains small brown anhydrite crystals and ghosts of pellets or small intraclasts. Some of the limestone is a tight, dense micrite.
- 3256-3258 Limestone, pale to moderate yellowish brown, micrite. Contains common, small, brown to colorless anhydrite crystals and large masses of fine crystalline, white anhydrite. Contact between the anhydrite and limestone is very sharp. Vary low porosity and permeability, no stain or cut.
- 3258-3259 Anhydrite, white, fine crystalline, with irregular veins or laminae of pale yellowish brown, microcrystalline, microsucrosic, limy dolomite.

3259-3260 Limestone, pale yellowish brown. Pelospirite consisting of pellets and abundant algal (?) tubes in a clear calcite cement with laminae of pale yellowish brown micrite. Abundant brownish dolomite or limy anhydrite crystals with the crystal masses arranged subparallel to the laminations.

3260-3261 Limestone, very pale yellowish brown, microspirite, composed of very fine carbonate crystals. Numerous small laminae of slightly darker carbonate. Good intercrystalline porosity, probably low permeability. No stain or cut.

3261-3262 Dolomite, pale yellowish brown, microcrystalline. Fair intercrystalline porosity, probably very low effective permeability.

3262-3263 Dolomite, moderate pink (5R7/4), microcrystalline to sub-lithographic, tight, dense.

3263-3264 Anhydrite, pale red (5R6/2), cryptocrystalline with rare small inclusions of moderate red (5R5/4), microsugrosic dolomite.

3264-3266 Dolomite, moderate pink to moderate red, as above.
End of core chips.

3266-3270 Missing.

3270-3276 Rare, pink to white gypsum and anhydrite. Very badly caved.

3276 Total depth - driller.

3265 Plugged back depth.