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Correlation of the Amerada Petroleum Company Well Drilled near Nehawka, Nebraska


E. C. Reed

University of Nebraska-Lincoln

G. E. Condra

University of Nebraska-Lincoln

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NEBRASKA GEOLOGICAL SURVEY

Paper Number 14

Correlation of the Amerada
Petroleum Company Well,
Drilled Near Nehawka,
Nebraska



February, 1939

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G. E. CONDRA, State Geologist

E. C. REED, Assistant State Geologist

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NEBRASKA GEOLOGICAL SURVEY

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Correlation of the Amerada Petroleum Company Well, Drilled Near Nehawka, Nebraska

By G. E. CONDRA

INTRODUCTION

This core-drilled well, known as Shroeder No. 1, is located on the Nehawka anticline about four miles north and two miles west of Nehawka, in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 11 N., R. 12 E., Cass County, Nebraska. It was spudded in March 1, 1924, and abandoned October 15, 1924.

According to Mr. O. J. Scherer, who did the levelling, the altitude of the surface at the well is 1128 feet. The well reached a depth of 1828 feet. Its core diameter is 6 inches from 0 to 515 feet, 3 $\frac{1}{2}$ inches from 515 to 805 feet; and 2 $\frac{1}{2}$ inches from 805 feet to 1828 feet.

The core was boxed and trucked to the State Geological Survey of the University of Nebraska where it has been preserved and studied quite closely by geologists, paleontologists, and a chemist. Although many genera and species of fossils have been identified in the core of the well, they are not listed in this report nor are any of the chemical analyses, which were made at various intervals, included.

The log was published first in 1927 (see pp. 246-260, Bull. 1, 2d ser., Nebraska Geol. Survey), and second in 1931, with some changes in correlation (see pp. 71-86, Bull. 4, 2d ser., Nebraska Geol. Survey). The log has been of interest to many oil geologists and others.

The several wells drilled in eastern Nebraska and western Iowa the past few years have afforded new data which contribute much to an understanding of the formations encountered in the Amerada well and since certain recent changes have been made in the correlation of formations drilled in the well, this paper is published in the hope of bringing the knowledge of the conditions up-to-date. The main points to be covered in this report relate to the cut-outs at unconformities, to the problem of the presence or absence of Mississippian beds, and to the boundaries of the Mississippian, Devonian, Silurian, and Ordovician systems.

REVISED LOG OF THE AMERADA WELL

I. Quaternary system, largely loess and glacial till, 27'

Unconformity.....

II. Carboniferous system, 606' 6":

(1) Upper Carboniferous series, 343' 8":

A. Virgil subseries, 99' 4":

(A) Shawnee group, 37':

1. Oread limestone formation, 37':
 - (1) Plattsmouth limestone, top eroded, 9' 5" remaining:
 - a. Limestone, gray, massive, part weathered buff, 2' 7"
 - b. Limestone, dark gray, dense, with large *Triticites*, 4' 10"
 - c. Limestone, dark gray, soft, impure, 2'
 - (2) Heebner shale, upper portion bluish gray, lower portion black and fissile, 3' 7"
 - (3) Leavenworth limestone, bluish gray, dense, 2'
 - (4) Snyderville shale, 14':
 - a. Shale, bluish gray, massive, indurated, calcareous, 8' 6"
 - b. Shale, massive, top brownish, middle maroon, lower portion mottled blue-brown, 5' 6"
 - (5) Weepingwater limestone, gray, shaly at top and base, middle massive, all fossiliferous, 8'; depth of base, 64'
- (B) Douglas group, 62' 4':
 1. Lawrence shale formation, 44':
 - (1) Shale, gray, argillaceous, indurated, very fossiliferous, 2'
 - (2) Shale, red and yellowish, with blue mottling, argillaceous, 7'
 - (3) Shale, reddish, weathered yellowish, bedded, argillaceous-arenaceous, with some flakes of mica, 4' 6"
 - (4) Shale, bluish to gray, argillaceous to calcareous, with thin limy seams (*Amazonia*? near top) and coal-like bands, 30' 6"; depth, 108'. Most of the core of this subdivision was poorly recovered.

Unconformity: several feet of the normal section missing

2. Stranger formation, top eroded, 18' 4" remaining:
 - (1) Cass (Haskell?) limestone, top eroded, 7' 6" remaining:
 - a. Limestone, dark gray, massive, fossiliferous, 5'
 - b. Shale, dark gray, 6"
 - c. Shale, black, finely bedded, fossiliferous, 1' 2"
 - d. Shale, dark gray, calcareous, 6"
 - e. Limestone, dark gray, dense, 4"; depth, 115' 6"
 - (2) Shale, unnamed, 6':
 - a. Shale, dark gray, 6"
 - b. Shale, bluish gray, calcareous, 3' 6"
 - c. Shale, bluish gray, limy, 2'; depth, 121' 6"
 - (3) Nehawka limestone, dark gray, irregular, conglomeratic, with "pellet structure," 4' 10"; depth, 126' 4"

Unconformity: the Iatan limestone and Weston shale of the Pedee group, and the cherty zone at the top of the South Bend limestone missing, due to erosion

B. Missouri subseries, 244' 4":

(C) Lansing group, 52' 8":

1. Stanton limestone formation, 37' 4":
 - (1) South Bend limestone, the chert-bearing top zone missing; 5' 10" remaining of middle and lower zones:
 - a. Shale, gray, calcareous, with many *Triticites*, 1' 2"
 - b. Limestone, dark gray, massive, fossiliferous, many *Triticites*, 1' 10"
 - c. Shale, bluish gray, argillaceous-calcareous, 1' 10"
 - d. Limestone, gray, dense, massive, with *Triticites*, about 1'; depth, 132' 2"

- (2) Rock Lake shale, gray, calcareous, 4'; depth, 136' 2"
- (3) Stoner limestone, medium dark gray, massive, dense, fossiliferous, with a 3' 4" shaly zone near base, all quite fossiliferous, with *Triticites* and *Cyclotrypa barberi*, 19' 10"; depth, 156'
- (4) Eudora shale, 6' 10":
 - a. Shale, bluish gray above, dark below, bedded, 4' 6"
 - b. Limestone, bluish gray, dense, 6"
 - c. Shale, gray, limy, 6"
 - d. Shale, bluish above, dark and very fossiliferous below, with *Ambocoelia*, *Wellerella*, *Orbiculoidea*, *Myalina swallowi*, etc., 1' 4"; depth, 162' 10"
- (5) Captain Creek limestone, very dark gray, 10"; depth, 163' 8"
- 2. Vilas shale formation, 7' 6":
 - (1) Shale, dark gray, fossiliferous, 1' 9"
 - (2) Shale, bluish gray, massive, with calcareous concretions near top and pyritiferous, 5' 9"; depth, 171'
- 3. Plattsburg limestone formation, 8':
 - (1) Spring Hill limestone, gray, nodular, irregular, about 3'
 - (2) Hickory Creek shale, bluish, argillaceous, 2'
 - (3) Meadow limestone, gray, massive, very fossiliferous, 3'; depth, 179'
- (D) Kansas City group, 111' 8":
 - 1. Bonner Springs shale formation, gray and dark gray, argillaceous, very fossiliferous, with bryozoa, pelecypods, brachiopods, etc., 8' 10"; depth, 187' 10"
 - 2. Wyandotte limestone formation, 30':
 - (1) Farley limestone, light gray, massive, dense, 6' 8"; depth, 194' 6"
 - (2) Island Creek shale, 2' 6":
 - a. Shale, bluish gray, limy, massive, fossiliferous, 1' 6"
 - b. Shale, dark bluish gray, massive, limy, pyritiferous, fossiliferous, 1'; depth, 197'
 - (3) Argentine limestone, 20' 10":
 - a. Limestone, medium light gray, largely massive and dense, fossiliferous, 15' 10"
 - b. Limestone, medium dark gray, argillaceous, with thin shale seams and many fossils, 5'; depth, 217' 10"
 - (4) Quindaro shale and Frisbie limestone, missing
 - 3. Lane shale formation, dark gray, limy, fossiliferous, 1'; depth, 218' 10"
 - 4. Iola limestone formation, 3' 4":
 - (1) Raytown limestone, dark gray, fossiliferous, 8"
 - (2) Muncie Creek shale, 1' 9":
 - a. Shale, dark gray and black, calcareous-arenaceous, fossiliferous, 1'
 - b. Shale, black, with gray specks, 9"
 - (3) Paola limestone, dark gray, very fossiliferous, 11"; depth, 222' 2"
 - 5. Chanute shale formation, 14' 10":
 - (1) Shale, bluish gray, indurated, fine textured, brittle, with pyrite and fossil fragments, 10' 4"

- (2) Mudstone, dark gray, 2"
- (3) Shale, dark gray, carbonaceous-argillaceous, 4"
- (4) Limestone, gray, impure, 2"
- (5) Shale, dark gray, with limy seams, and many fossils, 5"
- (6) Shale, bluish gray, argillaceous, 3' 5"; depth, 237'
- 6. Drum limestone formation, 9' 6":
 - (1) Limestone, dark gray, yellowish at top, largely massive, with fossil fragments, 8'
 - (2) Shale, gray, limy, 6"-1'
 - (3) Limestone, gray, fossiliferous, 1'; depth, 246' 6"
- 7. Quivira shale formation, 7':
 - (1) Shale, gray, argillaceous, crumbly, 1' 9"
 - (2) Shale, black, coal-like, 9"
 - (3) Shale, bluish gray, argillaceous, calcareous at base, 4' 6"; depth, 253' 6"
- 8. Westerville limestone formation, 24':
 - (1) Limestone, gray, part oölitic, part dense, quite fossiliferous, with *Triticites* and small gastropods common, 8' 6"
 - (2) Limestone, gray, earthy, with *Triticites*, 2' 5"
 - (3) Limestone, gray, massive, firm, with *Triticites*, 1' 7"
 - (4) Shale, bluish gray, argillaceous, quite fossiliferous, 1' 9"
 - (5) Limestone, light gray, silty, with small limy lumps, like lithographic stone at base, quite fossiliferous, 1' 3"
 - (6) Shale, dark gray, argillaceous-calcareous, with small limy lumps, and fossiliferous, 2' 8"
 - (7) Limestone, light gray, part oölitic, massive, with scattered small *Triticites*, 5' 10"; depth, 277' 6"
- 9. Cherryvale shale formation, 13' 2":
 - (1) Siltstone, gray, limy, massive, 5'
 - (2) Shale, bluish gray, argillaceous, fossiliferous, 1' 2"
 - (3) Shale, black, coal-like, 6"
 - (4) Shale, bluish gray, argillaceous, part nodular, with some fine mica and many fossils, 6' 6"; depth, 290' 8"
- (E) Bronson group, 62' 4":
 - 1. Dennis limestone formation (Winterset to Canville), 24':
 - (1) Limestone, dark gray, massive, part oölitic, fossiliferous, 10'
 - (2) Shale, upper portion gray, massive; lower portion dark and finely bedded, 1' 10"
 - (3) Limestone, bluish gray, dense, quite fossiliferous, with *Osagia*, *Meekella*, *Ambocoelia*, *Juresania*, *Derbya*, etc., 3'
 - (4) Limestones and interbedded shales; dark gray, 9' 2"; depth, 314' 8"
 - 2. Galesburg shale formation, 7' 4"
 - (1) Shale, gray, limy, massive, with *Marginifera*, *Ambocoelia*, *Orbiculoidea*, *Chonetes*, etc., 1' 8"
 - (2) Shale, black, bedded, with *Lingula*, *Wellerella*, etc., 2' 2"
 - (3) Limestone, dark gray, dense, fossiliferous, 6"
 - (4) Shale, bluish gray, argillaceous, massive, 3'; depth, 322'
 - 3. Swope limestone formation, 21':
 - (1) Bethany Falls limestone, 14' 10":
 - a. Limestone, dark gray, dense, nodular, earthy, stylolitic, with algal growth, some pyrite and poorly preserved fossils, 6'

- b. Limestone, light gray to dark gray, clouded, fine texture, brittle, dense, fractures with sharp edges, contains some unfossiliferous shale in upper portion, 8' 10"; depth, 336' 10"
- (2) Hushpuckney shale, 4' 7":
 - a. Shale, dark gray, with some calcareous material, *Lingula*, *Wellerella*, and *Orbiculoidea*, 1' 2"
 - b. Limestone, dark gray, dense, 2"
 - c. Shale, gray, argillaceous, massive, lumpy, 3' 3"; depth, 341' 5"
- (3) Middle Creek limestone, dark gray, fine textured, with some pyrite, fossil fragments and algal growth, 1' 7"; depth, 343'
- 4. Ladore shale, bluish gray to dark gray, calcareous, with pyrite, fine light colored mica, and small limy concretions, 5'; depth, 348'
- 5. Hertha limestone formation, 5':
 - (1) Limestone, dark gray, part with brownish tinge, massive, cavernous, reticulate, stylolitic, fossiliferous, 3'
 - (2) Shale, bluish gray, with *Orbiculoidea* and *Composita*, 8"
 - (3) Limestone, upper portion dark gray to brownish gray, semi-crystalline, stylolitic, with some pyrite, scattered fine mica and brachiopoda fragments; lower portion dark gray, with *Ambo-coelia*, crinoid joints, and some fusulines; thickness, 1' 4"; depth, 353'
- (F) Bourbon group, 17' 8":
 - 1. Shale, bluish, argillaceous, massive, with many small calcareous concretions, 3' 6"
 - 2. Shale, bluish to reddish, silty or sandy, lumpy, 9' 6"
 - 3. Shale, dark gray, argillaceous-arenaceous, 1'
 - 4. Shale, reddish, arenaceous-argillaceous, with small flakes of mica, 3' 8"; depth, 370' 8"

Unconformity: the basal Bourbon and upper beds of the Marmaton group missing

(II) Middle Carboniferous series, 91' 10":

A. Des Moines subseries, 91' 10":

(A) Marmaton group, 65' 4" or more:

- 1. Pawnee limestone (?), 3' 10":
 - (1) Limestone, dark gray, porous, filled-in with bluish gray shale, quite fossiliferous; upper 6" massive; middle and lower portions shaly, with fusulines, crinoid joints, *Chonetes*, *Mesolobus*, *Composita*, *Ambocoelia*, etc.; thickness, 2' 6"
 - (2) Shale, bluish gray, argillaceous, with fusulines, *Orbiculoidea missouriensis*, *Composita subtilita*, *Mesolobus mesolobus*, fish scales, and a shark tooth, 8"
 - (3) Limestone, gray, with many fusulines at base, 8"; depth, 374' 6"
- 2. Labette shale (?), 45' 6":
 - (1) Shale, reddish, mottled-bluish-gray, with calcareous lumps and some fine mica, 6'
 - (2) Shale, red, composed of silt and fine sand, 5' 6"
 - (3) Sandstone, gray, reddish at top, with lime induration and some very fine mica, 1'

- (4) Shale, reddish to grayish, even grained, mostly silt, with some fine sand and clay, 3' 5"
 - (5) Limestone, dark gray, porous, filled-in with blue and red shale, 7"
 - (6) Shale, bluish gray, silty to clayey, breaks along bedding planes, 1'
 - (7) Limestone, dark gray, fragmentary, brecciated, 2"
 - (8) Shale, bluish gray, argillaceous-sandy, irregular induration, massive except top which is poorly bedded with small brownish concretions and fossil fragments, 3' 4"
 - (9) Shale, red, silty to sandy, massive, with bluish splotches near top, 4' 6"
 - (10) Shale, yellowish brown to reddish, irregular, lumpy, with crinoid joints, *Composita*, *Chonetes*, *Ambocoelia*, *Derbya*, *Wellerella*, etc., 2' 8"
 - (11) Shale, bluish gray with reddish zones, essentially a micaceous bedded sandstone, 11' 10"; depth, 414' 6"
 - (12) Limestone, dark gray, dense, 4"
 - (13) Shale, dark gray, reddish tinge, slabby, argillaceous, 1"
 - (14) Shale, bluish gray, sandy, 3"
 - (15) Shale, gray, mottled with some red, massive, 3'
 - (16) Shale, grayish, limy, quite argillaceous at top with large yellowish and reddish splotches; fossiliferous in lower portion, with crinoid fragments, a ramose bryozoan, *Composita*, *Punctospirifer*, *Lingula*, *Marginifera*, etc.; lithographic at base; thickness, 1' 10"; depth, 420'
3. Fort Scott limestone (?), 16':
- (1) Limestone, bluish gray, part weathered yellowish, soft, earthy, with crinoid joints and brachiopod fragments, 1' 6"
 - (2) Shale, bluish gray, argillaceous, crossed by thin sandy seams, 1' 2"
 - (3) Limestone, dark gray to brownish gray, fragmental, brecciated, with fusulines, 10"
 - (4) Shale, bluish gray and some red, lumpy, 1' 6"
 - (5) Shale, reddish to bluish gray, massive, argillaceous-arenaceous, with small concretions in lower portion, 3'
 - (6) Shale, dark gray, argillaceous, indurated, calcareous, 1' 2"
 - (7) Limestone, dark gray, dense, semi-crystalline, filled-in with bluish gray shale, 1'
 - (8) Shale, bluish gray, massive, with *Linoproductus* at top, 6"
 - (9) Limestone, dark gray, dense, massive, semi-crystalline below, with fossil fragments, 6"
 - (10) Shale, bluish gray, fine grained, argillaceous, darker gray and somewhat earthy at top, with *Lingula* sp., 8"
 - (11) Shale, bluish gray, argillaceous, 2'
 - (12) Shale, bluish argillaceous, massive, reddish-mottled at top, 6"
 - (13) Limestone, dark gray, semi-crystalline, rather dense, arenaceous, part weathered brownish, with small flakes of mica and pelecypodal fragments; 6" of white arenaceous to shaly material at top; thickness, 1' 8"; depth, 436'

- (B) Cherokee shale (?) Marmaton (?), 22' 2":
1. Shale, reddish, mottled yellowish-green, argillaceous, indurated, lumpy, brachiopodal, 5'
 2. Shale, argillaceous, buff in upper portion; lower 4" red, with carbonaceous seam at 442' 6", nodular limy concretionary bodies at 443', and some very fine mica, *Lingula* sp., and small pelecypods in upper portion, 3'
 3. Limestone, dark gray, semi-crystalline, porous, weathered brownish, brachiopodal, 8"
 4. Shale, dark gray at base, reddish in middle and upper portions, weathered buff at top, arenaceous, fine texture, micaceous, separates along bedding, 10' 4"
 5. Shale, dark bluish gray, silty throughout, massive, 2' 8"
 6. Limestone, bluish gray to dark gray, quite firm, 6"; depth, 458' 2"
- (B') Cherokee shale, 4' 6":
1. Shale, bluish gray, massive, filled with nodular calcareous material, 1' 4"
 2. Re-worked material, mostly dark gray and limy; cut across by bluish gray shale seams; basal 8" firmly indurated and conglomeratic; thickness, 2'
 3. Shale, gray, argillaceous, with scattered pebbles, 1'; depth, 462' 6"

Unconformity: part of the Cherokee and top of the Mississippian series missing

(III) Lower Carboniferous (Mississippian) series, 171':

A. Osage group, 111' 6":

1. Limestone, brownish, fine-grained, cherty, 1'
2. Limestone, cavernous, filled-in with shale, 6"
3. Limestone, brownish, fine-grained, cherty, 2'
4. Limestone, porous, gray to brownish, fine-grained, filled in with bluish to reddish shales, 6'
5. Limestone, dark gray, massive, 1' 8"
6. Limestone, cavernous, filled in with bluish clay shale, 2' 4"
7. Dolomite, buff, fine textured, 6"
8. Shale, in cavities, mostly massive, bluish, with a few small pebbles, 1' 8"
9. Limestone, brownish, cherty, arenaceous, magnesian, 8' 10"
10. Clay-shale filling, 6"
11. Limestone, brownish, dolomitic and cherty above, weathered buff below, 2' 8"
12. Shale in cavities, reddish or bluish, argillaceous, pebbly, 2' 4"
13. Limestone, bluish, gray, cherty, 1'
14. Shale, argillaceous, 1'
15. Limestone, bluish gray, cherty, 2' 1"
16. Limestone, porous, with clay-filling, 1' 11"
17. Dolomite, siliceous, crystalline, dark gray, part vitreous, 8' 6"
18. Shale in fissures, 2'
19. Limestone, gray to brownish, nearly solid, pyritiferous, clay shale at 517' 5" to 518' 4"; thickness, 22' 6"
20. Limestone, light gray, fine grained, pyritiferous, 2' 6"
21. Limestone, brownish, cherty, with pyrite and small crystals of galena, 6'
22. Limestone, medium dark gray, some calcite in veins, 2'

23. Limestone, brownish, cherty, with pyrite and small crystals of galena, 8'
24. Dolomite, brownish, fine grained, with some shale, 19' 6"
25. Limestone, dark gray, shaly, 1' 3"
26. Limestone, gray, magnesian, pyritiferous, cherty at top, 3' 3"; depth, 574'

B. Kinderhook group, 59' 6":

1. Chouteau formation, 53':

- (1) Dolomite, light gray, fine grained, 3' 3"
- (2) Shale, dark gray, 6"
- (3) Dolomite, buff, base disintegrated, 2' 5"
- (4) Shale, gray, indurated, 1' 10"
- (5) Dolomite, vitreous, crystalline, 8"
- (6) Dolomite, light gray, fine grained, 4"
- (7) Shale, gray, with layers of dolomite, 7' 8"
- (8) Dolomite, brownish, arenaceous, crystalline, 11' 10"; depth, 602' 6"
- (9) Shale, gray, and dolomite, weathered buff or dark gray, pyritiferous, 4' 6"
- (10) Dolomite, brownish, siliceous, 1' 6"
- (11) Shale, gray, indurated, sandy, mottled gray above, argillaceous below, 2' 9"
- (12) Limestone, medium dark gray, very fine grained to nearly amorphous, magnesian, rather impure, 1' 3"
- (13) Dolomite, brownish, granular, siliceous, 1' 2"
- (14) Shale, greenish blue, argillaceous, crumbly, 7"
- (15) Dolomite, dark gray to medium gray, fine grained, with some clay, 3' 3"
- (16) Dolomite, brownish at top; light gray, vitreous and pitted from 621' to 627' except in lower 1' which is fine-grained; pyrite at 618'-621'; thickness, 9' 6"; depth, 627'

2. Kinderhook shale formation, 6' 6":

- (1) Shale, bluish gray, crumbly, argillaceous, pyrite at base, 1'
- (2) Shale, dark gray, massive, 2' 4"
- (3) Dolomite, fine-grained, 2"
- (4) Shale, dark gray to nearly black, 3'; depth, 633' 6"

III. Devonian system, 168'

1. Dolomites, 90' 6":

- (1) Dolomite, largely grayish and vitreous, upper 1' brownish, next 2' crystalline, with clay in thin seams; thickness, 8'
 - (2) Dolomite, light gray, fine-grained, 22' 2"
 - (3) Shale, gray, indurated, 5"
 - (4) Dolomite, light gray and darker zones, fine-grained, 4" shale in an oblique seam at 672'; thickness, 21' 11"
 - (5) Dolomite, light gray, part brownish-mottled, dense to pitted, filled in with bluish shale, 29' 4"
 - (6) Dolomite, light gray, fine-grained, with shale seams between 718' and 718' 8"; thickness, 8' 8"; depth, 724'
2. Dolomites and shales, 45' 5":
- (1) Dolomite, light gray to dark gray, irregular, with shale seams, part weathered buff, pyritiferous, 9' 6"

- (2) Shaly, dark gray or weathered, with some dolomite, 1' 4"
- (3) Dolomite, massive, granular, part vitreous, pyritiferous, 5' 2"
- (4) Shale, dark gray, indurated, 1' 4"
- (5) Dolomite, light gray, fine to coarse, part vitreous, 8' 10"
- (6) Shale, dark gray to black, 4"
- (7) Dolomite, light gray to dark gray, partly earthy, with seams of shale, 3' 6"
- (8) Dolomite, brownish, with some quartz vugs, and dark gray shale layers, part light gray, pyritiferous, 8' 6"
- (9) Shale, gray, massive, argillaceous, 3' 4"
- (10) Dolomite, light gray, part fine-grained, 2' 5"
- (11) Shale, bluish gray, argillaceous, 1' 2"; depth, 769' 5"
- 4. Dolomite, 32' 1":
 - (1) Dolomite, light gray, part crystalline, 6' 7"
 - (2) Dolomite, brownish, dark gray, vitreous, fine-grained, dense, with pyrite, and broken-down silica, some embedded rounded and frosted sand, 25' 6"; depth, 801' 6"

Unconformity; not well marked

IV. Silurian system, 377' 11":

- 1. Dolomite, grayish, part brownish-mottled, crystalline, mostly vitreous, pyritiferous, pitted, shale-filled cavities, with *Favosites favosus* (?), *Favosites niagarensis*, and *Halysites catenulatus*, 187' 6"; depth, 989'
- 2. Dolomite, light gray, fine-grained to amorphous, with small scattered bodies of broken-down silica, some pyrite, and clay fillings in fissures, 28' 6"; depth, 1017' 6"
- 3. Dolomite, light gray and light bluish gray, amorphous to fine-grained, with some broken-down silica, and pyrite, 38'
- 4. Broken-down silica, nearly white, soft, 1' 1"
- 5. Chert, bluish to brownish, 5"
- 6. Broken-down silica, nearly white, soft, 7' 6"
- 7. Shale, light bluish gray, indurated, grading into dolomite at top, 21' 6"
- 8. Core not well recovered, 4'
- 9. Dolomite, light gray to brownish, fine-grained, coarse at places, 26' 6"; depth, 1116' 6"
- 10. Dolomite, gray and brown-mottled, crystalline, part pitted, with *Conchidium occidentalis* (?) and *Favosites niagarensis*, 51' 6"; depth, 1168'
- 11. Core not recovered in good condition, 11' 5"; depth, 1179' 5"

Unconformity, Maquoketa shale missing

V. Ordovician system, 387' 7":

(A) Trenton group, 271' 7":

1. Prosser formation, 233' 1":

- (1) Dolomite, medium dark gray, largely crystalline, fine-grained, pyritiferous, with clay in cavities, some broken-down silica at places, coquina-like and yellowish between 1246' 6" and 1249'; ostracods at 1200'; thickness, 74' 7"; depth, 1254'
- (2) Dolomite, medium dark gray, argillaceous, with *Escharopora*, 21'

- (3) Dolomite, grayish, crystalline, part pitted, with *Escharopora*, 16'
 - (4) Dolomite, medium light gray, fine texture, with some light siliceous material, 51'
 - (5) Dolomite, gray to brownish, vitreous, pitted in places, pyritiferous, 70' 6"; depth, 1412' 6"
 - 2. Ion shale formation, dark gray, generally sandy but argillaceous in middle and top, dolomitic layers between 1426' 6" and 1427' and 1420' and 1423' 4", with *Isotelus* sp. and *Plectambonites sericeus* and *Dalmanella* sp., 23' 10"; depth, 1436' 4"
 - 3. Guttenberg limestone formation, brownish limestone or dolomite, grading into dark gray shale at top and bottom, 14' 8"; depth, 1451'
 - (B) Black River group, 67':
 - 1. Spechts Ferry formation, 17':
 - (1) Shale, dark, sandy, some calcareous material, with *Rhinidictya*, *Homotrypa*, *Monticulipora*, *Rhynchotrema*, *Plectambonites*, etc., 3' 4"
 - (2) Limestone, dark gray to brownish, shaly at base, 5' 1"
 - (3) Shale, dark gray, argillaceous, with thin bands of gray limestone at top and base, 8' 7"; depth, 1468'
 - 2. McGregor limestone (Platteville) formation, brownish, fine-grained, dense, with *Rafinesquina* sp., *Trematis ottawaensis*, 7' 2"; depth, 1475' 2"
 - 3. Glenwood shale formation, 42' 10":
 - (1) Shale, dark gray to bluish gray, argillaceous, with light gray bodies of limestone, *Rafinesquina*, *Dalmanella* sp., and *Pionodema subaequata*, 9' 4"
 - (2) Shale, dark gray, sandy, with small limestone bodies in lower two-fifths, 33' 6"; depth, 1518'
 - (C) Chazyan (St. Peter) group, 49':
 - 1. Sandstone, dark gray to light mottled, pyritiferous, 18'
 - 2. Sandstone, gray, fine-textured, friable, pyritiferous, weathers buff, 22' 10"
 - 3. Shale, dark gray, sandy, 1' 4"
 - 4. Shale, dark gray, argillaceous, 6"
 - 5. Conglomerate, dark pebbles in gray sand, 2'
 - 6. Conglomerate, like above, with fragments of oboloid brachiopods and some petroleum residue, 6"
 - 7. Sandstone and sandy shale, dark gray-mottled, with some poorly preserved fossil fragments, 1' 3"
 - 8. Shale, dark, indurated, argillaceous, 10"
 - 9. Conglomerate, with dark pebbles and fragments of oboloid brachiopods, 1' 3"
 - 10. Sand or sandy shale, dark gray, 2½"
 - 11. Conglomerate, with dark pebbles and fragments of oboloid brachiopods, 3½"; depth, 1567'
- Unconformity: the Prairie du Chien and Cambrian rocks missing, due to non-deposition or erosion, but more likely to the latter.
- VI. Pre-Cambrian rocks, represented by the reddish to grayish brown Sioux quartzite, 261'; depth, 1828'

DISCUSSION OF CORRELATION

Missouri Subseries. The classification of the Missouri subseries in the Amerada well is now made without much reservation, because most of this part of the section crops out in the Weepingwater and Platte valleys and it has been possible to compare the exposed beds with the units found in the well. However, it would not have been possible to closely correlate the Missouri formations of this well prior to the completion of regional studies made on outcrops in the Platte Valley, Weepingwater Valley, and in southwestern Iowa, northwestern Missouri, and northeastern Kansas. The first problem was to classify the exposed rocks in this area, in which two troublesome unconformities delayed progress for several years. The second problem, *i.e.*, the correlation of the Upper Carboniferous units in this well, was comparatively easy after the classification of the exposed rocks was accomplished.

The base of the Missouri subseries, as defined by Dr. R. C. Moore, and now recognized by the Kansas, Missouri, Iowa, and Nebraska surveys, is not at the Hertha limestone, but at an unconformity several feet lower. The beds between the Hertha and this unconformity were given the name Bourbon group by Moore, but in a recent report of the Missouri Survey, most of the section referred to the Bourbon group by Moore is classed as the Pleasanton as now recognized in Missouri. But, even so, it will require a redefinition of the Pleasanton to make it correlative with the Bourbon. Consequently, the Nebraska Survey uses Moore's name Bourbon.

Des Moines Subseries. The Des Moines subseries is comparatively thin in the Nehawka anticline, in the vicinity of the Amerada well where much of its upper and lower portions are missing, the contact between the Marmaton and the Cherokee groups is not well defined, and the thickness recorded for the latter is questionable. The correlation of the Pawnee, Labette, and Fort Scott in this well, though tentative, is supported by the logs of other deep wells of the region, and no other classification of this interval could be made with any degree of assurance. The Cherokee thickens quite rapidly southeastward, in the Forest City basin.

Mississippian Series. The logs of the Amerada well, published in 1927 and 1931, recognize the presence of the Mississippian beds, however, some geologists have claimed that the Mississippian is missing here. Recently Mr. R. A. Carmody, geologist of the Gulf Oil Company, examined parts of the core that had been referred to the Mississippian and concluded that they are of Devonian age. Also, Professor E. C. Reed, who examined rather closely all of this part of the core, was at first in provisional agreement with Mr. Carmody, but now reports as follows:

"There is a difference of opinion among geologists concerning the section Dr. Condra correlates as Mississippian in the Nehawka core. Some hold that all of the interval from 462' 6" to 724' is Mississippian in age and, in the

opinion of others, this interval is Devonian. There is strong possibility, however, that a part of this interval is Mississippian and a part is Devonian. If this interval is carried eastward and southeastward into areas where the Kinderhook shale is well developed and serves to separate clearly the Mississippian from the Devonian, it appears that the section from 462' 6" to 633' 6" is Mississippian and that the upper 111' 6" (462' 6" to 574') should be referred to the Osage group, in large part, and that the next underlying 59' 6" (574' to 633' 6") represents the Kinderhook group, probably largely correlative with the Chouteau and in very small part true Kinderhook shale. The dark gray to nearly black shale immediately above 633' 6" is very suggestive of the Kinderhook shale which correlates with the Chattanooga.

"A suggested correlation of the part of the section in question is as follows:

1. Osage group, depth 462' 6"-574'
2. Kinderhook group, depth 574'-633' 6":
 - (1) Chouteau formation, 574'-627'
 - (2) Kinderhook shale formation, 627'-633' 6" "

In a correlation made prior to the receipt of the above statement from Professor Reed, the writer recognized the Osage group in the Amerada well, placed the base of the Mississippian at a depth of 574', and classed the section between 574' and 633' 6" as Mississippian (?) Devonian (?). However, he now concurs in Reed's conclusions regarding the Mississippian in this well and places its base at 633' 6" as shown in the revised log.

In the correlation of Mississippian rocks, most geologists expect to find considerable chert, and some of them may expect the chert to occur generally in the system. Especially is this true of those who have logged the Boone formation. But in the Northern Mid-Continent region the chert is not so conspicuous, as is true of the Osage beds. For example the Osage group, in the Amerada well has chert in only nine of its twenty-six subdivisions and in a total thickness of about thirty feet of the 111' 6" section. Certainly, this rather low content of chert should not cause one to correlate this part of the section as Devonian as has been done.

Devonian System. The upper boundary of this system in the well is now placed at a depth of 633' 6" and the lower boundary is thought to be at about 801' 6". The thickness of the system here is about 168' with no established basis for separating it into groups or formations.

Silurian System. Paleontologic studies made the past few years show that the Silurian is thinner in the Amerada well than was formerly supposed and that its thickness is about 377' 11", represented by the core found between depths 801' 6" and 1179' 6". The boundaries of the system, as now placed, were established by the occurrence of *Favosites niagarensis* and other diagnostic fossils and should be approximately correct.

Ordovician System. Fortunately, a number of key fossils occur in the core now assigned to the Ordovician. These fossils have been studied by Dr. C. O. Dunbar, Dr. R. S. Bassler, Dr. Eula D. McEwan, Professor E. C. Reed, the author, and others, and they show that the top of the Ordovician is at 1200' or higher, probably at 1178' 5". Also, some of these fossils occur quite low in the section, near the base of the system as corrected.

The Ordovician section of this well compares quite closely with the well-known section exposed in northeastern Iowa, except that the topmost and basal beds of the system are absent here, due to non-deposition or more likely to erosion. Dr. G. Marshall Kay, who is quite conversant with the Ordovician of Iowa, assisted with our correlation. It was he who first noted that the Prairie du Chien is missing here. However, it is known to occur in the basins bordering this area.

In the original examination of the core of this well Dunbar and Condra observed a yellowish zone between the depths 1246' 6" and 1249' and at first were inclined to use the zone to mark the boundary between the Silurian and Ordovician, but on further examination they found the zone to be only mud-stained. Recently, Professor Reed studied this zone and made the following report: "The section of core from 1179' 5" to 1265' has been re-examined with the intention of attempting to locate the Silurian-Ordovician boundary. On first examination it appeared that there was a weathered zone from 1246' 6" to 1249', but a microscopic examination of the dolomite both above and below this point shows absolutely no lithologic change and it was found that the weathered appearance of this part of the core is due to the fact that it is mud-stained, caused by the penetration of circulating yellowish mud into porous dolomite."

The 11' 5" of core between depths 1168' and 1179' 5" was not recovered in good form, but it was observed that this part of the section is soft, crumbly, and probably reworked material which may mark the location of an unconformity and the contact of the Silurian and Ordovician. We found Ordovician fossils just below but none above this zone. Consequently, the top of the Ordovician is thought to be at a depth of 1179' 5".

That part of the core which is assigned to the Ordovician contains some fossils which range upward into the Silurian and others which are thought to occur only in the Ordovician, as for example, *Escharopora*. The fossils which are diagnostic of the Ordovician are quite well distributed in the section correlated as Ordovician.

A personal communication received from Dr. R. S. Bassler of the United States National Museum, Washington, D. C., under date of January 17, 1936, includes the following statement: "The specimens of bryozoa which you sent from the Amerada well at Nehawka, Nebraska, at depth of 1290 feet, although poorly preserved, are almost like *Escharopora subrecta* Ul-

rich of the Decorah shales. This genus does not go into the Silurian and it appears to me that these specimens indicate the age as not younger than Platteville."

Cambrian System. Although rocks of Cambrian age occur in the basin bordering the Nehawka anticline, they were not found in the Amerada well.

Pre-Cambrian Rocks. There is no doubt about the correlation of the Pre-Cambrian in this well because all of the 261 feet of the lower core has been found to be Sioux quartzite, the full thickness of which is not yet known at this place.

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