The Marmaton of Western Kansas and Eastern Colorado

SIPES Luncheon
January 28, 2016

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Outline

• Where are the Marmaton Fields?
• Production Expectations
• Stratigraphy
• Lithology
• Porosity
• Oil Traps
• Field Examples
• Exploration Considerations
Where are the Marmaton Fields?
There are approximately 1164 fields in Western Kansas and 57 fields in Eastern Colorado with Marmaton production.
Since early 2014, there have been approximately 55 new Marmaton discoveries in Western Kansas and Eastern Colorado.

Ancient Oceans Energy, Ltd.
Production Expectations
Western Kansas

Most productive Marmaton Field - Novinger Field (7.3 million BBLs). Marmaton Fields > 500,000 BBLs are rare. Typical Marmaton Production ~ 250,000 BBLs per field. Most Marmaton Fields are made up of between 1 to 6 wells; there are several 1 well fields. Best Marmaton wells produce between 60,000 and 100,000 BBLs; a few have produced > 100,000 BBLs. Commonly part of multipay fields; combined with other formations many of these fields > 1 million BBLs.

Eastern Colorado

Most productive Marmaton Field – Bledsoe Ranch Field (249,731 BBLs). Marmaton Fields > 100,000 BBLs are rare. Typical Marmaton Production ~ 40,000 – 70,000 BBLs per field. Most Marmaton Fields are 1 or 2 well fields, occasionally 4 or 5 well fields are observed. Best Marmaton Wells produce on the order of 60,000 - 80,000 BBLs per well; a few have produced > 100,000 BBLs. Commonly part of multipay fields; combined with other formations many of these fields > 1 million BBLs.
Marmaton Production with Multiple Pay Zones in Western Kansas

Approximately 66% of the Fields that produce from the Marmaton in Western Kansas, also produce from Other Groups/Formations.
Approximately 85% of the Fields that produce from the Marmaton in Colorado, also produce from other Groups/Formations.
Stratigraphy
Marmaton Outcrop
Southeastern Kansas

From Jewett, 1941, Classification of the Marmaton Group, Pennsylvanian, In Kansas
Osborn’s Correlations

- Masters thesis under Jewett
- Made correlation from outcrop area to SW Kansas (A-A’)
- Reported that the Lenapah LS was absent in SW Kansas
Porosity in all 3 Limestone Zones

Perf: 5079-81
Produced 239,479 BO
and 315,941 mcf of gas
from the Marmaton (1988-2012).

Local names such as
Novinger (Pawnee) and Beymer
(Pawnee?) Zones are also used.
Marmaton Type Log – Cheyenne County, Colorado

Top of Marmaton

Cored Top of Marmaton

IP 35 BOPD, 6 BWPD

Local names such as the Torch (Altamont?) are also used.

This shale is usually picked as Top of Cherokee Shale in Kansas

Bledsoe Ranch 14-30, SSW 30-12S-50W

Neutron Density Log

Dual Induction Log
Basic Kansas Cyclothem

Modified From Heckel, 1977

Water Depth
Kansas Marmaton Megacyclothem

Defined by Jewett, 1958, Classification of the Marmaton Group, Pennsylvanian, In Kansas, KGS Bulletin 58
Daniels’ Eastern Colorado Desmoinesian Cycles

Compared Log Signatures to Core Data in Eastern Colorado and identified 5 major cycles in the Marmaton + Cherokee which were designated A, B, C, D, and E.

Used Heckel’s terminology to describe depositional environment, rock type, and water depth:

- Upper Limestone A Unit
- Upper Limestone B Unit
- Core Shale Unit
- Middle Limestone Unit
- Outside Shale Unit

The good reservoir rock is usually at the top of the cycle. In the Upper Limestone A Unit where local deposits of fossiliferous, oolitic lime grainstones were deposited in high energy shallow waters.

Lithology
Altamont LS
Cream to buff or gray, dense to fine crystalline, fossiliferous limestone. At some locations, it is dolomitic, and occasionally oolitic.

Pawnee LS
Cream to light gray to buff, dense to fine crystalline limestone, described as a grainstone in some areas, oolitic, occasionally dolomitic.

Fort Scott LS
Cream to gray, mottled, cryptocrystalline, dense, slightly fossiliferous, slightly oolitic. Chaetetes fossil corals are observed in the Higginsville Member.
Porosity
Porosity Example - Cuttings Samples, Great Plains Field, Colorado

Intergranular oolitic and moldic porosity

Chaetetes coral framework porosity

Photos: Wiepking-Fullerton Energy, LLC.
Porosity Examples – Howard Dirks No. 2 Core, Logan County, Kansas

Moldic Leached Bioclasts (m)

Altamont LS

Enlarged Moldic Porosity (em)

Modified from Caldwell, 1983, Kansas-Type Cyclothems and Porosity Development in the Middle Pennsylvanian Marmaton Group, Dirks Field Logan Co, KS
Porosity Example - Cuttings Sample, Western Kansas

Altamont LS

Porosity

Marmaton

Cherokee

Vuggy Intercrystalline Porosity

Oomoldic Porosity

Samples examined by J. MIke on October 18, 2010

Source: Ancient Oceans Energy, Ltd.
Oolitic Grainstone with oomoldic porosity (black); Sparry calcite cement also exhibits intercrystalline porosity.

From Baab, P., 1971, The Pawnee Limestone Formation, Novinger Field, Meade Co, KS
Porosity Example - Wilkinson 2-18 Cuttings, Scott County, KS

Intergranular, Pinpoint, and Vugular Porosity
(no mention of oomoldic).

Pawnee LS?

MARM C: Tr Grains, crm (brm-sat stn), p srtd grains; smll-md sub-rdd to lg oblong, intr-bdd iso loss in fn-xln matrix, p intr-gran por, iso p ppt's betwn grns, evn stn, full sat, FSFO (live-It brn & flky dd oil), VSSG bbls in por. Much Packstn, grn-sb grn, crm, arg., scat p-intr-gran por, iso p, pt-vug por, lt ln-brm evn to mstly unevn stn, p-no fluor, gd swf odr. W/Depth Ls, crm, p intr-xln por, no stn, less por, diminished shows/odr. Tr's of Bryozoans, & lg xl growths.
Porosity Example - Tradewinds 1-28, Cuttings, Kiowa County, Colorado

Interconnected Pinpoint Porosity and Fracture Porosity

Pawnee LS

LS cm-tigy-tan gran-xbd fr-firml v tł-oool w/ooc calc infill & mocc cin, chky & arg mtxx; vf
dissem pyr; por-frs [interconn pinpoint por-ooc evid of frac por]; pilstn-30% dkgrn-bk-ooc tay
oilstn, asph-ooc lve tay strm oil from crushed cuttings; flr-30% m-biøyel esp on oilstn ctgs;
cut-30% immed myel-mky strm on oilstn ctgs-slow mky diffuse on xcline ctgs; res-v-vittan
res in dish from oil ring

Marmaton

Cherokee

Neutron-Density Log
Oil Traps
Traps – Structural

Large Structures

Structure Map - Top of Marmaton, Kismet Dome, Seward County, Kansas, Blue circles are Marmaton Wells. (Source: KGS Digital Petroleum Atlas)

Small Structures

3-D Seismic Time Structure Map on the Pawnee, Western Kansas. The single well at intersection of red lines has produced 100,000+ BO from the Pawnee LS. (Source: Ancient Oceans Energy, Ltd.)

3-D Seismic Isochron Map – Anhydrite to Mississippian, Wesley Field, Ness County, Kansas. The 2 wells have produced 81,685 BO from the Altamont LS. (Source: Trans Pacific Oil, Wichita, KS)
Porosity Zone “pinches out” at updip location.
Novinger Field
Meade County, Kansas
Top of Marmaton

Pawnee LS
(“Novinger Zone”)

According to Renfroe, this is a clastic deposit of organic fragments formed under turbulent conditions of waves and currents, similar to a sand bar.
Produced 7.3 Million BBLs of Oil from 34 wells.

Discovered in 1950, 2 years after the Kismet Field discovery.

Largest Continuous Marmaton Field in Western Kansas and Eastern Colorado.

No obvious signs of significant structure on the Mississippian surface like that of the Kismet Dome.
4 mile long deposit of porous limestone.

No obvious indication of deposit or structure on the Cherokee surface.

Oil stratigraphically trapped within up dip half of the field.

From Renfroe, 1959, Novinger Field, Oil and Gas Fields of Kansas, Volume 2

From Renfroe, 1954, World Oil, October 1954
Novinger Field- continued.

Porosity Zone “pinches out” at up dip location.

Modified from Renfroe, 1959, Novinger Field, Oil and Gas Fields of Kansas, Volume 2
White Woman Field
Wichita and Kearny Counties, Kansas
White Woman Field- Wichita and Kearny Counties, Kansas

Discovered in 1962, Developed in the 1980s
Produced 500,000+ BBLs of Oil from the Marmaton

Green = Marmaton Oil Wells; Blue = Disposal Wells

Ancient Oceans Energy, Ltd.
Good Production on Structural Highs; Water-Wet in low areas.

Field discovered by mediocre well (4891 BBLs) in 1962, yet good offset wells in the SE/4 of Section 33 were not drilled until the early 1980’s.

Blue circles are Marmaton Producing Wells; all are completed in the Altamont B zone except for the well in the SE SW of Sec. 34; this well is an Altamont A well.
Description from the Alyce McMichael No. 1 (E2SESE 33-T20S-R35W):
Limestone: tan, fine crystalline, oolitic, sucrosic texture, bioclastic, some loose oolites, free oil, vugular and interoolitic porosity.
Cowdery West Field
Scott County, Kansas
Cowdery West Field, Scott County, Kansas

Single Well Marmaton Field

Snyder 1- SW/4 Sec 24-T18S-R31W
Produced 158,550 BBLs of oil since 1983.

Porosity zone not present in offsets.

Structure Map- Base of the Altamont Pay Zone, Red numbers= feet of porosity > 6%

Source: Ancient Oceans Energy, Ltd.
Cowdery West Field continued.

Snyder 1 NWSESW 24-18S-31W

Altamont B Pay Zn.
Perf: 4360-70
IP: 130 BOPD

Density Log
Porosity 10% 20%

Cherokee

Eitel 1-23 NENESE 23-18S-31W

Density Log
Porosity 10% 20%
Clifford Field
Lincoln County, Colorado
Clifford Field, Lincoln County, Colorado

2.4 Million BBL Oil Field; Produced 243,497 BBLs from 4 Marmaton Wells.

Most of the production is from the Morrow.

Discovered in 1982 by drilling a seismic anomaly (Thin Stone Corral to Morrow Isochron) in Section 1-T12S-R53W.

Modified from Shannon, L., 1990, Clifford Field: a Fluvial Valley-Fill Reservoir, Lincoln County, Colorado, RMAG Morrow Sandstones
Clifford Field continued...

Porosity Zone developed in the Pawnee. Described as a fossiliferous and oolitic LS in core.

Modified from Shannon, L., 1990, Clifford Field: a Fluvial Valley-Fill Reservoir, Lincoln County, Colorado, RMAG Morrow Sandstones
Clifford Field continued.

Marmaton (Pawnee) Production on structural highs.

Discontinuous porosity development.

Several dry holes adjacent to Marmaton Production.

Modified from Shannon, L., 1990, Clifford Field: a Fluvial Valley-Fill Reservoir, Lincoln County, Colorado, RMAG Morrow Sandstones
Great Plains Field
Lincoln County, Colorado
Produced > 1.7 Million BBLs from Lansing, Cherokee, Marmaton, Morrow, and Osage.

Discovered in 2007 by re-entry of Forristal Ranch State 22-30 which was abandoned as a dry hole in 1991. Subsequent drilling and a 3-D seismic survey revealed a large structure to the north.

Still developing Field today and limits of the field are to be determined.
Great Plains Field continued...

Multiple Pay Zones: Lansing, Marmaton (Torch, Pawnee A, Pawnee B), Cherokee, Morrow, and Osage.

Large structure discovered by drilling and 3-D seismic in Sections 23, 24, 19, and 20. 3-D seismic also revealed some faulting in the field.

Additional development ongoing.

Cross Section by Sapp, S., 2013, Great Plains Field, RMAG Oil and Gas Fields of Colorado, 2014
Great Plains Field continued...

Three Marmaton Zones produce on the structural high:
1. Torch
2. Pawnee A
3. Pawnee B

The Pawnee B is by far the thickest and most continuous deposit of porous limestone.

Marmaton production to date (yellow area below) seems to coincide with the structural high.

Base Map: COGCC Website, yellow dots= producing wells, open circles= permits, diagonal lines = abandoned permits

Isopach Map- Marmaton Pawnee B Zone (Feet of porosity > 6%)

= Marmaton Producers
Produced ~ 49,000 BBLs since 2010

Source: Ancient Oceans Energy, Ltd.
Great Plains Field continued.

Aloha Mula #1
SESW 19-10S-55W

Marmaton
Torch
Pawnee
Fort Scott
Cherokee

Perf: 7110-7118 (Cherokee A)
IP: 634 BOPD, 55 BWPD, 370 MCFGPD

Perf: 6954-6966 (Torch)
IP: 24 BOPD, 90 BWPD
Perf: 7014-7030 (Pawnee B)
IP: 12 BOPD, 105 BWPD, 21 MCFGPD

Aloha Mula #9
NESE 19-10S-55W

Perf: 6928-6942 (Torch)
IP: 162 BOPD, 81 MCFGPD

Perf: 6928-6942 (Torch)
IP: 162 BOPD, 81 MCFGPD

Bubba State #2
SWNW 20-10S-55W

Perf: 6980-6992 (Pawnee B)
IP: 114 BOPD, 171 BWPD

Bubba State #4
NENW 20-10S-55W

Perf: 6964-6974 (Pawnee A)
IP: 135 BWPD

All logs are Neutron-Density Logs

Source: Ancient Oceans Energy, Ltd.
Exploration Considerations
Exploration Considerations

1. Marmaton Fields are usually relatively small targets, with a few exceptions. 3-D Seismic is essential to help identify targets.
2. In many cases, Marmaton production has been discovered as a secondary target, or as a “surprise” while exploring for other groups/formations like the Lansing/KC, Cherokee, Morrow, and/or Mississippian.

Always map the Marmaton zones to see if an ideal drilling location can be selected that will test the primary target(s) and the Marmaton, if possible.

Also, watch the Marmaton closely during drilling for shows and consider DSTs.

The Bubba State #2 was a Cherokee test. Marmaton Torch zone was a nice surprise in this well. IP: 162 BOPD + 81 MCFGPD
3. Although good porosity zones in all 3 Marmaton Limestone intervals are widespread, predictions of the porosity trends are difficult. There are many dry holes around good Marmaton producers that demonstrate this issue.

Cowdery West Field Example: There were five unsuccessful attempts to offset a good 158, 550 BBL Marmaton Well.
Exploration Considerations continued...

4. Isopach maps of the individual cycles may reveal thick zones with deposits of high quality, oolitic grainstone reservoir rock.
5. There is plenty of space between Marmaton Fields for the next half-million BBL White Woman Field. An undiscovered 7-million BBL Novinger Field may also be waiting somewhere out there.
Thank You.

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