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WHY MODELERS NEED TO LOOK AT THE ROCKS!

EXAMPLES FROM THE ANETH OIL FIELD, SOUTHWEST REGIONAL PARTNERSHIP ON CARBON SEQUESTRATION DEMONSTRATION SITE FOR GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE, SOUTHEASTERN UTAH

ACKNOWLEDGMENTS

This ongoing research is performed under the direction of the New Mexico Institute of Mining and Technology, Bryan McPherson, Project Manager and Principal Investigator, as part of the Southwest Regional Partnership on Carbon Sequestration – Phase II: Field Demonstrations Project. This project is funded by the U.S. Department of Energy through the National Energy Technology Laboratory, Contract No. DE-FC26-05NT42591.

Liz Paton, Cheryl Gustin, Jim Parker, Mike Laine, and Brad Wolverton of the Utah Geological Survey, designed displays, drafted figures, and photographed core.

Location Map of the Paradox Basin and Major Oil and Gas fields

SUMMARY

Greater Aneth oil field, Utah's largest oil producer, was discovered in 1956 and has produced over 440 million barrels of oil. Because it represents an archetype oil field of the western U.S., Greater Aneth was selected to demonstrate combined enhanced oil recovery (EOR) and CO_2 sequestration under the auspices of the Southwest Regional Partnership on Carbon Sequestration, sponsored by the U.S. Department of Energy. Greater Aneth field is divided into four units. The Aneth Unit in the northwestern part of Greater Aneth field has not had significant CO_2 injection and therefore provides an opportunity to inject a relatively large volume of CO_2 from a nearby pipeline, and to extensively monitor the effects of injection from reservoir to surface. Thus, the Southwest Regional Partnership field demonstration is taking place in the 66-km² Aneth Unit, operated by Resolute Natural Resources and Navajo Nation Oil & Gas Co., Inc.

Located in the Paradox Basin of southeastern Utah, Greater Aneth is a stratigraphic trap, with fractures and minor faults. The primary reservoir is the Desert Creek zone sealed by the overlying Gothic shale, both within the Pennsylvanian Paradox Formation. Past geophysical well-log interpretations and published cross sections divide the Desert Creek into several correlatable reservoir subzones and units, as well as a few seals, across the field. However, caution is urged when using this type of information alone to generate reservoir models for CO_2 sequestration and movement over time at Aneth and other fields.

Examination of available slabbed conventional cores from Aneth unit wells reveals a complex reservoir consisting of limestone (oolitic, peloidal, and skeltal grainstone and packstone, and algal boundstone/bafflestone) and finely crystalline dolomite. These lithotypes represent a variety of depositional environments (open-marine shelf, shallow-marine beach and shoals, algal mounds, low-energy restricted shelf, etc.) that produce reservoir heterogeneity beyond what is determined from well logs. Fractures in cores are relatively common and there is evidence (hydrothermal dolomite, brecciation, etc.) of minor but important faults that may affect fluid flow. Cores reveal additional potential seals within the Desert Creek (mudstone and very fine grained sandstone units). Finally, several units containing the bryozoan Chaetetes have good porsity on well logs, but core observations show the porosity is ineffective.

GENERAL FIELD OVERVIEW

Discovery Well

- Texaco #1 Navajo C
- T.D. – 5923 ft.
- Completed February 6, 1956
- IPF – 568 barrels of oil per day
- Initial Pressure – 2170 psia
- GOR Gas – 3448:1

Reservoir Data

- Productive Area – 48,260 acres
- Net Pay – 50 ft
- Porosity – 10.2%
- Permeability – 10 md, range 3-30 mD
- Water Saturation – 24%
- Bottom-hole Temperature – 125°F
- Type of Drive – Fluid Expansion and Solution Gas
- Lithology – Limestone (algal boundstone & oolitic-, peloidal-, & skeletal grainstone & packstone), as well as finely crystalline dolomitic limestone

Production Data (as of Janauary 1, 2007) and Reserves

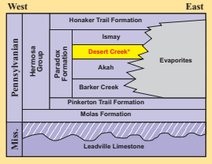
- Cumulative Oil – 443,787,714 barrels
- Cumulative Gas – 388,043,004 mcf
- Cumulative Water – 1,447,923,351 barrels
- Active Wells – 460
- In Place Total Reserves – 1100 million barrels
- Type of Secondary Recovery – Waterflood and CO_2 Flood, Horizontal Drilling

Oil Characteristics

- Type – Paraffinic
- Color – Dark Green
- API Gravity – 40-42°
- Viscosity, SUS – 0.53-0.54 cp
- Pour Point – 10°F (-12°C)
- Sulfur, wt% – 0.20%
- Nitrogen – 0.04%

Aneth Unit

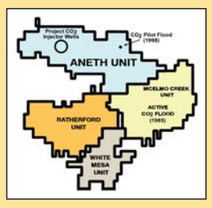
- 16,320 acres
- 421 Million Barrels of Oil in Place
- Over 135 Million Barrels Recovered (33% Recovery)
- Waterflood, 1962
- Infill Drilling to 40 acres, 1982; Infilling to 20 acres, 1988
- Horizontal Drilling Program, 1994



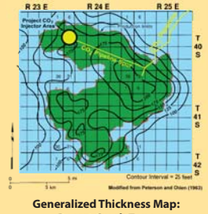
Pennsylvanian Stratrigraphy of the Paradox Basin

*Reservoir Unit at Greater Aneth field

Location of Greater Aneth and Surrounding Oil Fields, Paradox Basin

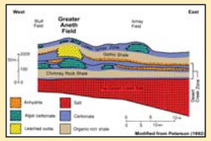


Units within Greater Aneth Field



Generalized Thickness Map: Desert Creek Zone

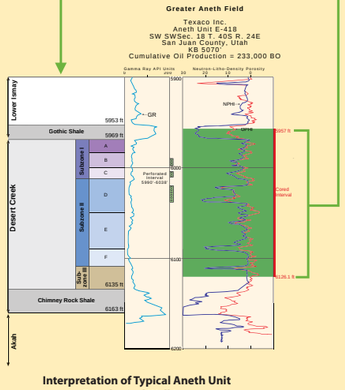
Published Schematic Interperetation



Diagrammatic Lithofacies Cross Section

Interpretation Based on Field Well-Log Correlation

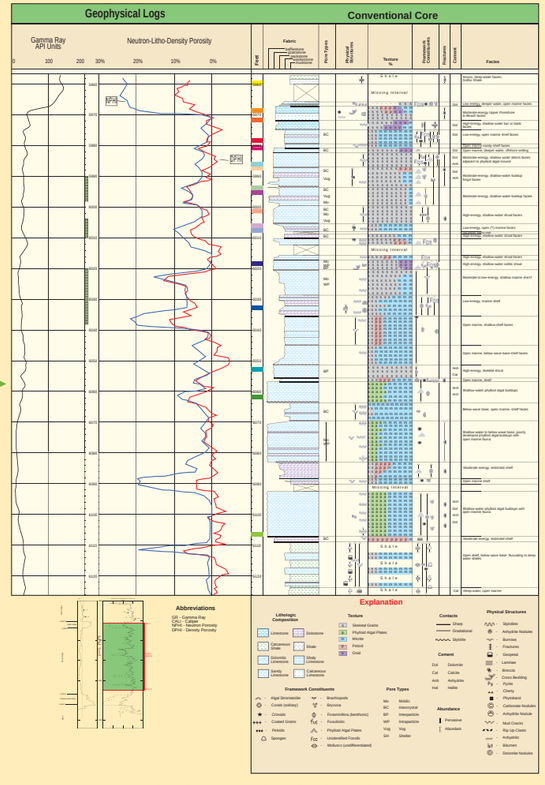
North-Northwest to Southeast Stratigraphic Cross Section



Interpretation of Typical Aneth Unit Geophysical Well Log

ANETH RESERVOIR SUBZONES AND UNITS

Reality! Based on Interpretation of Conventional Core



Core Description from Aneth Unit E-418

Reservoir Heterogeneity: Seals, Baffles, and Flow Units

5960 ft.
- Gothic Shale - Black Siliceous, Calcareous Shale
- Anaerobic Deep Water Marine
- No Porosity, No Permeability
- Major Reservoir Seal

5969 ft.
- Quartz Sandstone/ Dolomitic/Calcarenite with Cross-Bedding and Desiccation Cracks
- Upper Foreshore to Beach
- Low Porosity and Low Permeability
- Potential Seal/Barrier

5972 ft.
- Oolitic/Skeletal Grainstone,
- Shallow Marine Shoal,
- Low Porosity and Low Permeability,
- Baffle

5979 ft.
- Skeletal Crinoidal Wackestone
- Deeper Water Open Marine
- Low Porosity , Low Permeability
- Potential Seal/Baffle

5981 ft.
- Pisolitic/Oolitic/Skeletal Grainstone with Anhydrite Plugging, Dolomitic
- Peritidal Evaporite
- Low Porosity and Low Permeability
- Seal/Baffle

5996 ft.
- Chaetetes Skelatal Framestone with Replacement Saddle Dolomite and Anhydrite
- Deep Water, Agitated Marine
- High "Heartbreak" Porosity, Low Permeability
- Baffle to Very Poor Flow Unit

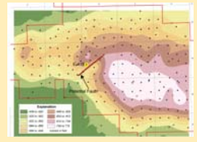
6019 ft.
- Skeletal Coated Grain, Grainstone
- Storm-Dominated Shallow Marine
- High Porosity, High Permeability
- Best Reservoir Flow Unit within the Section (Perforated)

6033 ft.
- Dolomitized Skeletal Hard Peloidal Packstone to Wackestone
- Low-Energy Open Marine
- High Porosity, Low Permeability
- Baffle to Poor Quality Flow Unit (Perforated)

6053 ft.
- Foram (Fusulinid)/ Skeletal Grainstone
- Shallow Water Foram Bank
- High Porosity, Low Permeability
- Baffle to Poor Flow Unit

6062 ft.
- Phylloid-Algal Bafflestone with Kansas Phyllum
- Shallow Water Algal Buildup
- Low Porosity, Low Permeability
- Baffle

6107 ft.
- Dolomitized Peloidal Mudstone/Wackestone with Anhydrite Plugging
- Restricted Shallow Marine
- High Porosity, Low Permeability
- Baffle to Poor Flow Unit



Structure Contour Map of the Top of the Desert Creek Zone, Aneth Unit

Evidence of Faulting

5988 ft.
Vertical Fractures

6002 ft.
Dolomite Replacement Bounded by Stylolites and Fracture Swarms

6006 ft.
Breccia with Limestone Clasts Surrounded by Stylolites and Dolomite

6007 ft.
Thin Section Photomicrograph, Breccia with Limestone Clasts and Dolomite

5987 ft.
Saddle Dolomite Replacement (Hydrothermal Alteration) and Vugs Lined with Saddle Dolomite, Well-Terminated Quartz, and Bitumen

5995 ft.
Saddle Dolomite (Hydrothermal Alteration) and Small Vugs (Upper Perforated Zone)