Placid Oil Company WXC-State 1 well. Southwest view of Penrod rig 20 on location in central Utah. The Canyon Mountains are in distance where Neoproterozoic strata are thrusted over Cambrian through Devonian strata. Photograph by Doug Sprinkel, winter 1978.
Oil and gas fields in Utah showing geologic provinces, sedimentary basins, and principal structural boundaries (modified from Chidsey and others, 2005).
Central thrust belt Utah play in the late 1970s was pursued based on the success in the northern Utah sector of the Sevier thrust belt.
Oil and gas map showing leading edge of Sevier thrust belt and location of the Covenant field.
The map area represents about 276 square townships. The map area has had fewer than 120 wells drilled since 1918, which means one well has been drilled per every two townships or one well per about 72 square miles. The increase in drilling in the 1970s and early 1980s was due to significant increase in oil prices from the Arab oil embargo, the discovery of the Pineview field in northern Utah, and the Iranian revolution (thrust fault locations modified from Willis, 1999).
Several wells had shows that may be key to future exploration. These wells highlight the potential targets in the Twin Creek Limestone, Navajo Sandstone, Sinbad Limestone (Moenkopi Formation), and Permian section.
The WXC-State 1 well penetrated a repeated Twin Creek and Arapien section with gas shows in the hanging wall (HW) section of Arapien and footwall section of Twin Creek and Navajo. Three cores were taken from the Navajo in which oil stain along fractures were noted. Swab test in the Navajo yielded a small flare of gas. The Twin Creek was not swabbed. The dipmeter analysis suggested this well was on the west flank of the structure. Data are from mud log and personal notes of Doug Sprinkel.
The WXC-Howard 1A well had no apparent thrusted sections, and had multiple gas and oil shows in the Twin Creek. No oil or gas shows were visible in the Navajo but trip gas was abundant and increased on subsequent trips. Swab tests through casing in multiple zones of the Twin Creek and Navajo yielded some gas. Data are from mud log and personal notes of Doug Sprinkel.
Reason to Drill WXC-Howard 2

• Drilled to evaluate the Twin Creek Limestone and Navajo Sandstone in a structurally higher position.
• Average dip of Twin Creek in WXC-Howard 1A was 12-15° west dips.
• Placid Oil Company hoped to get 600 to 800 ft higher at the Navajo level.
• Similar to the Pineview discovery of moving a short distance to get up dip to shows.

The WXC-Howard 2 well was drilled to evaluate shows tested and described in the WXC-Howard 1A well in an up-dip position. A similar argument led American Quasar to Pineview discovery in 1975.
This well gained structural elevation and had shows in several of the key reservoirs of the Twin Creek Limestone and Navajo Sandstone. The Navajo was tested with a gas flare that was snuffed out by a strong fresh-water flow. The Twin Creek was not tested. Data are from mud log and personal notes of Doug Sprinkel.
Other Notable Wells

- **Placid WXC-Barton 1**
  - Gas shows in faulted section of Moenkopi Formation
  - Switch to oil base mud at 16,580 ft
  - H₂S gas at 18,429 ft
  - BHT > 450°F

- **Williams Expl. Monroe Fee 1**
  - Penetrated Pavant thrust
  - Reported recovered gas from Sinbad Limestone Mbr., Moenkopi Formation

- **Phillips US-E 1**
  - Recovered oil from Sinbad
  - Could not complete after being shut-in for winter

The Placid WXC-Barton 1, Williams Exploration Monroe Fee 1, and Phillips Petroleum US-E 1 are other wells with key shows in reservoirs older than the Jurassic Navajo Sandstone, most commonly in the Triassic Sinbad Limestone Member of the Moenkopi Formation. The Barton well is also noted for being the only well in central Utah to contain deadly concentrations of hydrogen sulfide gas and very high down-hole temperatures. Data are from mud log and personal notes of Doug Sprinkel.
Conclusions From Drilling

• Structural geometries similar to northern Utah thrust belt
• Jurassic Twin Creek and Navajo reservoirs
• No marine Cretaceous source rocks in subthrust position
• What was source of oil and gas shows?
  – Jurassic Arapien Shale
  – Permian Park City-Phosphoria Formation
  – Permian Toroweap Formation
  – Mississippian strata

As the result of Placid’s drilling program and wells drilled by other operators, we could not demonstrate marine Cretaceous source rocks in a subthrust position. Placid began investigating other possible source rocks in Mississippian, Permian, and Jurassic strata.
Stratigraphic correlation chart showing potential source and reservoir rocks of each stratigraphic region.
Collecting oil from the Covenant field and the gas chromatograph (GC) analysis of oil (Baseline DGSI, 2005).
Basic Oil Characteristics

• Color – Dark brown
• Gravity – 40.5° API
• Pour Point – 2.2°F
• Viscosity – 4 cst @ 77°F
• Sulfur – 0.48%
• Nitrogen – 474 ppm

Basic geochemical characteristics of the oil from the Covenant field. Production is from the Navajo Sandstone but the source of the oil is Mississippian.
C13 aromatic versus saturated hydrocarbons plot shows the oil from the Covenant field is geochemically different from the well-known Phosphoria source of Rangely field, Colorado, the Cretaceous source of fields in northeastern Utah, and the mixed Cretaceous-Phosphoria source of Ashley Valley field in eastern Utah. The age of the oil is likely Mississippian.
Potential Mississippian Source Rocks for Central Utah

- **Doughnut Formation**
  - 0.8-16.5% TOC (total organic carbon)
  - Low HC values
  - Favorable thermal maturity
  - Swetland and others, 1978

- **Manning Canyon Shale**
  - 0.66-4.14% TOC
  - Low HC values
  - High thermal maturity
  - Poole and Claypool, 1984

- **Delle Phosphatic Member of Deseret Limestone**
  - 1-3% TOC in central Utah
  - Moderate HC values
  - Favorable thermal maturity
  - Sandberg and Gutschick, 1984

The possible source rocks for the Covenant field is likely one of these three Mississippian formations.
The Doughnut Shale is the principal source rock for this time slice; however, the Manning Canyon Shale could be a significant source rock if it is preserved in a subthrust position along the edge of the Oquirrh Basin where much thinner Oquirrh Formation would have been deposited.
Delle Phosphatic Member of the Deseret Limestone could be the dominant source rock during this time slice. The Delle on the hanging wall of the Nebo thrust would likely be “over cooked” but should be in an optimum thermal regime in the central area. Note that the Chainman Shale is restricted to western Utah and eastern Nevada, and is not likely a viable source for the Mississippian oil in central Utah.
The Navajo Sandstone is the main reservoir for the Covenant field. The Navajo is dominantly a quartz sandstone but the reservoir is likely heterogeneous with varying porosities and fine-grained baffles that could affect production. Detailed reservoir characterization studies are needed to understand better the reservoir characteristics.
Isopach map of the Navajo/Nugget Sandstone. Arrows indicate paleowind directions.
Interdune oasis and wadi deposits are potential baffles to production within the Navajo Sandstone.
The principal seal is likely the Jurassic Arapien Shale as oil migrated along thrust faults.
Structural history of the central Utah thrust belt. The key items include thrusting that was sequential and began in Late Jurassic to late Early Cretaceous. Thrusting ended in Eocene and was likely coincident with Laramide deformation. Neogene extension is also a part of the structural history.
Central Utah Thrust Belt Play Area

- Thrust-related anticlines
- Multiple reservoirs
  - Twin Creek Limestone
  - Navajo Sandstone
  - Sinbad Limestone Member of Moenkopi Formation
- Arapien is main seal
  - Twin Creek
  - interdunal zones in Navajo
  - shale zones in Moenkopi

Exploration summary of central Utah play.
Cross section showing the structural style of traps and relation to source rocks and seals.
Key to central Utah is understanding the location and maturation of the source rocks. That information combined with timing and migration pathways will lead to additional discoveries.
The Utah Geological Survey (UGS) source-rock assessment will sample surface exposures and collect cuttings from wells in the UGS Core Research Center for geochemical biomarker analysis.
The Utah Geological Survey is planning to conduct detail reservoir characterization studies of the Navajo Sandstone.
References


Baseline DGSU, 2005, Basic crude oil characteristics and biomarker analysis from the Kings Meadow Ranches no. 17-1 well, covenant field, Sevier County, Utah: Utah Geological Survey Open-File Report 467, 15 p.


