Geologic Evaluation of Yuma Basin for Carbon Dioxide Sequestration Potential

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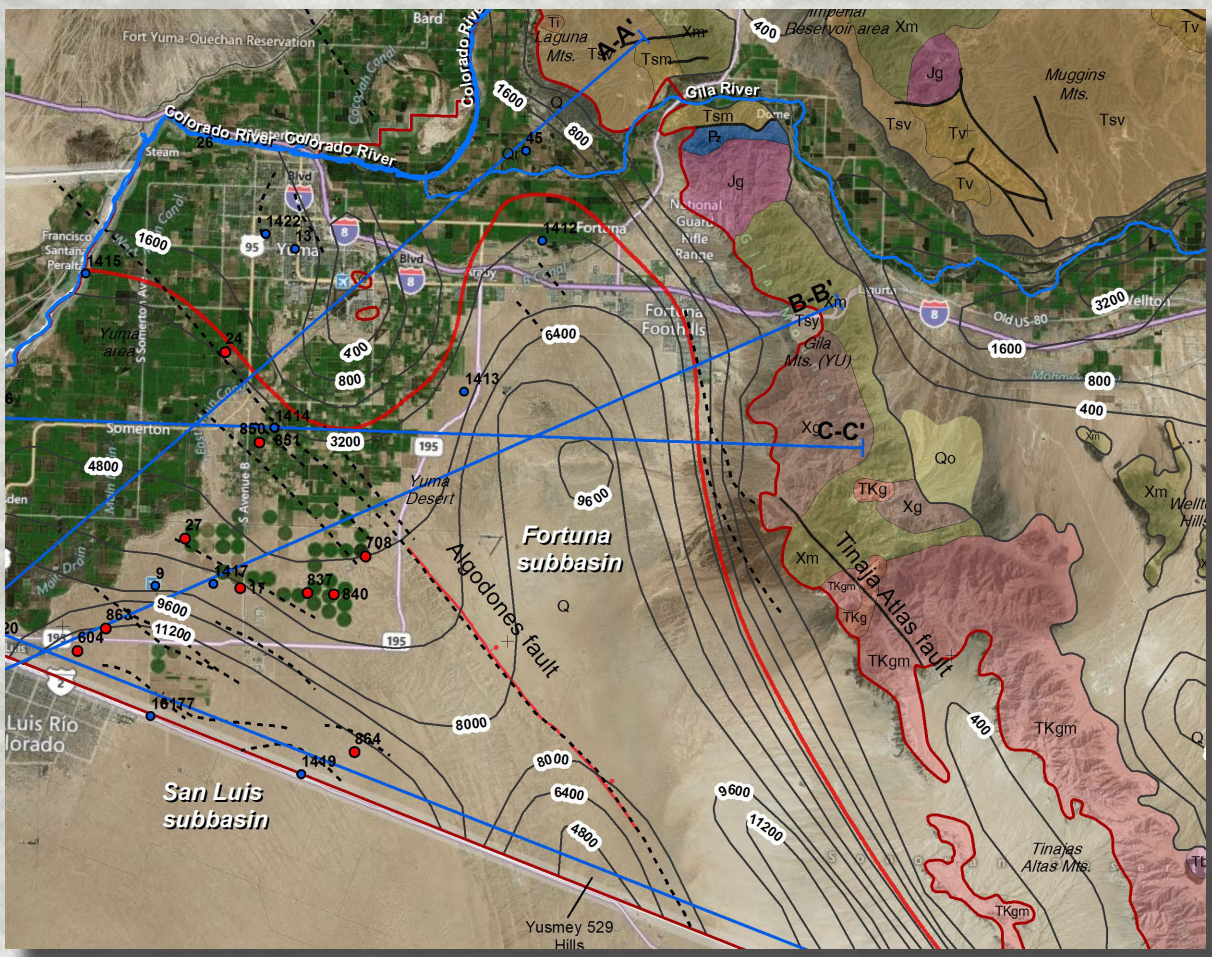

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by

Brian F. Gootee

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Arizona Geological Survey Open-File Report 13-04

April 2013

Arizona Geological Survey

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1.0 Introduction

The Department of Energy (DOE), including its National Energy Technology Laboratory and West Coast Regional Carbon Sequestration Partnership (WESTCARB), have established national programs to evaluate the technical feasibility of long-term subsurface geologic storage of carbon dioxide (CO_2) produced by industrial activity. The WESTCARB is a consortium of seven western U.S. States and one Canadian Province that is one of seven regional North American partnerships established to evaluate technical aspects of high-volume CO_2 capture and sequestration. Collaborative WESTCARB research programs have included more than 90 public agencies, private companies, and non-profit organizations. The Arizona Geological Survey (AZGS) began work in 2010 on *WESTCARB Phase III – Arizona Geological Characterization* (California Energy Commission Agreement Number 500-10-024).

As part of *WESTCARB Phase III*, the AZGS is evaluating the potential for CO_2 sequestration in geologic formations that are below a level of 800 meters (m) depth below land surface (bls). This evaluation is directed at porous and permeable geologic formations with impermeable sealing strata in Cenozoic sedimentary basins in the Basin and Range Province, and Paleozoic sedimentary formations in the Colorado Plateau. An initial screening of Cenozoic sedimentary basins with significant depth and volume below the 800 m bls level resulted in ten candidate basins from a total of 88 basins (Spencer, 2011). This report represents ongoing WESTCARB assessment of CO_2 storage potential in the Yuma basin, one of ten Cenozoic basins in Arizona identified during the preliminary evaluation, and is part of Tasks 2 and 3 of Arizona WESTCARB Phase III. Task 2 consists primarily of characterizing basin structure, stratigraphy, lithology, and the nature of seals or a cap rock. This task also includes determining the storage capacity of permeable sediments below 800 depth (Spencer, 2011). Task 3 is to determine if, and at what depth, saline groundwater approaches 10,000 milligrams per liter (mg/L) of total dissolved solids (TDS), characterized in a separate study (Gootee and others, 2012). This concentration represents the threshold above which water is considered non-potable and unsuitable as drinking water (United States Environmental Protection Agency). Individual-basin studies such as this study are intended to provide estimates of the volume of permeable strata that are capped by impermeable strata (with an interface at depths greater than 800m), and that are saturated with saline groundwater (>10,000 mg/L TDS).

The Yuma basin is located in the southwestern Basin and Range Province of Arizona adjacent to the San Andreas Transform boundary and the Gulf of California. The Colorado River marks the western boundary of the Yuma basin for the purposes of this study, although it has no subsurface significance (Plate 1). Similarly, the Arizona-Sonora border marks the southern boundary of the Yuma basin for the purposes of this study, but also has no subsurface significance. The southwestern part of the Yuma basin is, geologically, part of the Salton Trough (Plate 1). Along the flanks of the basin are the northwest-trending Chocolate Mountains in California to the northwest, Laguna and Gila Mountains to the north and northeast, and Tinajas Atlas Mountains to the east and southeast. The Colorado and Gila rivers pass through the northern mountain ranges and converge in the Yuma Valley with the Colorado River continuing southward. . The Yuma Desert and Luke Air Force Range make up a large portion of the Yuma basin. The Yuma basin is separated into two subbasins by a northwest trending bedrock ridge that is buried in most places, forms several low hills, and connects the Cargo Muchacho Mountains in California with the Tinajas Atlas Mountains in northwestern Sonora. This ridge separates the Yuma basin into two subbasins, referred to as the San Luis subbasin in the southwest and the Fortuna subbasin in the northeast (Mattick and others, 1973).

The Yuma basin as defined above is the second largest Cenozoic basin in Arizona, with an estimated volume of 2,497 km^3 underlain by Cenozoic basin-fill sediments, 1,437 km^3 of which lie below 800 m (2,625 ft) depth (Spencer, 2011). A maximum depth of approximately

3,795 m (12,450 ft) is modeled from gravity by Oppenheimer and Sumner (1981). Basin-fill sediments in the Yuma basin occupy an area of approximately 1,780 square kilometers (km^2) (690 square miles (mi^2)). Basin-fill sediments below a depth of 800 m occupy an area of approximately 1,130 km^2 (435 mi^2), or 63% of the Yuma basin.

2.0 Approach and Methods

The DOE National Energy Technology Laboratory and Regional Carbon Sequestration Partnerships have developed methodologies for characterizing CO_2 sequestration potential in major geological systems, in particular saline formations, which are the focus of this study (DOE, 2010). In this report I present, analyze, and interpret data that meet basic criteria for characterizing the potential for carbon dioxide sequestration in saline aquifers. Although basalt is being considered for CO_2 sequestration, and basalt is present at depth in the Yuma basin, basalt is not the focus of this study. Furthermore no attempt was made to establish criteria based on vicinity to population or infrastructure as part of this assessment.

Collection, compilation and quality assurance/quality control of well-log databases and relevant water-quality data were a major effort in this assessment. In addition, numerous published and unpublished previous works were screened for applicability, acquired, scanned to PDF, georeferenced, and incorporated into ArcMap projects. These data sets were used to evaluate depth-to-bedrock contours in previous publications (e.g., Richard and others, 2007) and build two- and three-dimensional datasets for constructing geologic cross-sections and three-dimensional geologic models. Subsurface geologic data were incorporated into cross-sections, which aided in the analysis of basin stratigraphy at target depths near and below 800 m bls. A more detailed discussion of approach and methodology is presented in a previous study of the Safford basin, the first basin evaluated for the WESTCARB Phase III project (Gootee, 2012).

3.0 Subsurface Data

4.1 Well Data

The 28 shallow and deep wells used to evaluate the subsurface stratigraphy of the Yuma basin are listed in Appendix A and shown in Plate 1. A well depth greater than 1,700 ft-bls was chosen as initial screening criteria (i.e., shallower wells were not necessarily included in this review and analysis). Nine wells with a total depth shallower than 1,700 ft-bls were associated with high-quality geologist's logs and geophysical data. These wells are also included in this analysis and are particularly valuable for areas devoid of deep well data. The majority of well data was derived from the Arizona Oil and Gas (OG) database, with other sources from the Arizona Department of Water Resources (ADWR), US Geological Survey (USGS) and the Department of Interior Bureau of Reclamation (BOR). Many deep wells were drilled in California and Mexico and are referenced, but not thoroughly evaluated.

Lithologic entries from borehole logs for wells used in the evaluation are listed in Appendix B. Lithology was tabulated into individual logged depths or grouped into zones with representative lithology. Lithology data were derived primarily from driller-mud and/or geologist's logs. In some cases, geophysical logs were used with the mud logs to bracket and summarize a lithologic interval.

For the purposes of identifying lithology suitable for CO_2 sequestration, and correlating stratigraphy in the Yuma basin, lithology was grouped into eight (8) lithologic types, based on composition and texture. These are summarized in Appendix B as "HGUID" and "HGUCode", and described in Table 1. HGU-labels were used for constructing the geologic cross-sections with Aquaveo's Subsurface Analyst tools in ArcGIS 10.0. Formation tops picked by

geologists/drillers, primarily by Olmsted and others (1973) and Mattick and others (1973), were noted in an additional column, and represented by “HGUID2” and “HGUCode2”. Formations from Olmsted and others (1973) were grouped into three sequences described in this report, and coded as “HGUID3” and “HGUCode3” in Appendix B and Table 1.

In order to build a stratigraphic and structural model, all available log data were reviewed by the author, especially logs from oil and gas drilling between 1980 and 1987. Additionally, cuttings stored at AZGS were examined at specific intervals from eight of the OG wells. AZGS well-cuttings identifiers for wells in the Yuma basin are listed in Appendix A. The AZGS cuttings ID and list of cutting samples, drawer numbers, etc. are listed in Appendix C.

Table 1. Hydrogeologic fields used to construct geologic cross-sections.

HydroID	HGUCode	HGUName	Description
1	Clastics	C	Predominantly conglomeratic or gravelly sediment
2	Clastics	PC	Predominantly coarse grained sediments (sand and gravel)
3	Clastics	PF	Predominantlly fine grained sediments (silt and clay)
4	Clastics	CL	Predominantly clay deposits
5	Carbonate	LM	Predominantly limestone or lime marl
6	Volcanic	V	Volcanic rocks (andesite, basalt and tuff) and volcaniclastic-rich sediments
7	Bedrock	B	c
8	Unknown	U	Unknown rock or sediment type
HydroID2	**HGUCode2**	**HGUName2**	**Description2**
1	Colorado River Deposits	CRD	Colorado River deposits include undifferentiated young and old alluvium, coarse-gravel zone, wedge zone, and transition zone (Olmsted et al., 1973).
2	Bouse Formation	BOU	Bouse sediments
3	Pre-Colorado River Deposits	PCRT	Marine sediments underlying Bouse Formation, typically sandy
4	Pre-Colorado River Deposits	PCRM	Kinter Fm.:Red beds with volcanics (mostly tuff)
5	Tertiary volcanic and sedimentary rocks	TV	Mid-Tertiary volcanic rocks
6	Tertiary volcanic and sedimentary rocks	TVS	Mid-Tertiary volcanic and sedimentary rocks
7	Bedrock	B	Consolidated plutonic and metamorphic rocks (Vitrefax and Tumco formations)
8	Unknown	U	Unknown classification
HydroID3	**HGUCode3**	**HGUName3**	**Description3**
1	Colorado River Deposits	CR	Unconsolidated silt, sand and gravel derived from the Colorado and Gila rivers.
2	Pre-Colorado River Deposits	PCR	Semi-consolidated clay, silt and sand derived from marine and terrestrial sources. This includes the upper clay unit also referred to as the Bouse Formation.
3	Consolidated mid-Tertiary and older units	B	Consolidated 'bedrock' consisting of various igneous, volcaniclastic and metamorphic rock units.

4.2 Other Data

Depth-to-bedrock contour data for the Yuma basin were derived from Richard and others (2007) (Plate 1). Depth-to-bedrock was modeled from gravity by Oppenheimer and Sumner (1980) and gravity and seismic by Mattick and others (1973). Several oil and gas exploration wells were drilled in the early 1980's following by gravity and seismic work. Brennan (1989) used these recent OG well and seismic data to revise and update basin stratigraphy and structure following nomenclature used by Olmsted and others (1973); however, depth-to-bedrock maps by Richard and others (2007) did not include Brennan's work. Depth-to-bedrock maps were not updated in this report. At least 20 seismic-reflection surveys have been done in the Yuma basin and northern Sonora, Mexico. Analysis and interpretation of these data by various authors (Eberly and Stanley, 1978; Brennan, 1989; Pacheco, 2006) were used to discuss stratigraphy and structure within the Yuma basin.

4.0 Geologic Characterization

4.1 Geologic and Tectonic Setting

The Yuma basin lies in a transition zone between the active transtensional plate boundary that extends through the Salton Trough, and the southwestern extent of a now largely inactive part of the Basin and Range tectonic province. As a result of continuing plate motion, the Gulf of California-Salton Trough system is an actively growing rift with a large component of right-lateral slip at the southeast end of the San Andreas fault (Stone, 1981). Initial extension of the Gulf of California began approximately 12 million years ago (Ma) and continued to about 6 Ma (Henry and Aranda-Gomez, 2000). The plate boundary became localized around 7 to 6 Ma in the Gulf area and the modern transform fault system developed (Dorsey and others, 2011; Pacheco and others, 2006).

Extension and normal faulting in the Yuma area began at roughly 25 Ma (Spencer and others, 1995). Extensional faulting produced sedimentary basins that filled with syntectonic sedimentary and volcanic rocks. The basal mid-Tertiary section is typically composed of coarse-clastic sedimentary rocks, rock avalanche breccias, and interbedded mafic lava flows and overlying felsic volcanic rocks as young as a ~22 Ma (Spencer and others, 1995). Extension following this middle Tertiary episode of extension is not well understood, and its timing is poorly known. Extension in the Altar basin further south appears to have begun around 16 Ma (Pacheco and others, 2006). The topography of ranges east and north of the Yuma basin resulted from poorly defined faulting that occurred after middle Tertiary extension and basin genesis, and before the Pliocene-Quaternary opening of the Gulf of California.

Evidence for localized, significant tectonic movement in the Yuma basin since late Miocene is not recognized and Pliocene Colorado River strata are interpreted as being relatively undeformed and autochthonous (Axen and Fletcher, 1998; Olmsted and others, 1973; Mattick and others, 1973); however, significant transtensional movement and deformation during the latest Miocene into early Pliocene cannot be ruled out given the proximity to the San Andreas Fault zone and the fact that the basin is blanketed by younger strata.

The volcanic and sedimentary rocks associated with middle Tertiary extension are generally tilted, and are unconformably overlain by gently dipping sandstone and shale interpreted to represent syn- and post-tectonic nearshore marine and terrestrial deposits adjacent to a proto-Gulf of California. Tectonism appears to have ceased by approximately 6 Ma, implying that basin and range formation in the Yuma area ended by this time. This late Miocene(?) faulting produced the northwest-trending mountains and buried bedrock highs that separate the Yuma basin into two subbasins, the Fortuna subbasin to the northeast and San Luis subbasin to the southwest, separated by a bedrock high referred to as the "Yuma high".

Thick, predominantly marine shale is found in the San Luis subbasin, and may be present in the Fortuna subbasin based on the depth and geometry of depth-to-bedrock maps (Plate 1). The San Luis and Fortuna subbasins merge with the Altar basin in northern Mexico (Guzman, 1981; Pacheco and others, 2006). Early estimates of thickness of Cenozoic basin-fill by Mattick and others (1973) and Oppenheimer and Sumner (1981) indicate thickness of 3,600 to 4,500 m (12,000 to 15,000 ft). Several hundred meters of near shore, marine shale and fine sand unconformably overlapped older mid-Miocene and older strata in the Yuma basin, and are in turn overlain by Colorado River detritus deposited after ~4.8 Ma (Spencer, 2011b). When and how the Gila River arrived in the Yuma basin is less certain (Kimbrough and others, 2011). Proto-delta sand sequences derived from the Colorado River were deposited in the Yuma basin, and may have originally occupied and filled the Fortuna subbasin southeast into Bahia Adair (Kinsland and Lock, 2001), subsequently integrating with the San Luis subbasin across the Yuma high. The Colorado River's present location is associated with a thick sequence of fluvio-deltaic sand interpreted as being essentially undeformed in the Yuma area.

Recent research along the Lower Colorado River corridor supports the interpretation that the Colorado River migrated downstream from Lake Mead to Blythe by a series of lake-spillover events (Kimbrough and others, 2011; House and others, 2011; Spencer and others, 2011a), signaled by the presence of a basal sequence of fine-grained silt and clay deposits referred to as the Bouse Formation (Metzger, 1968). This top-down mechanism of lake formation, spillover, and river integration, in a fairly stable landscape may have occurred immediately north of the Laguna Mountain area near Cibola (Spencer and others, 2011b). The age and depositional relationship of the Bouse Formation to overlying Colorado River and underlying Pre-Colorado River deposits in the Yuma basin is not well understood from well data, and is beyond the scope of this work. However, the depositional setting and environment in the Yuma basin is critical for understanding basin development and evolution.

4.2 Structural Features

Quaternary faults are present in the Yuma basin and include the Tinaja Atlas and Algodones faults (Plate 1). The active Algodones fault is in the Yuma Desert is latest Pleistocene (Woodward-McNeil and Associates, 1974; Pearthree, 1998, 2011). The Algodones fault appears to be a co-linear extension of the Altar Fault to the southeast and San Andreas Fault to the northwest. The Altar, and possibly Algodones fault, is an oblique normal fault with significant dextral offset (Pacheco and others, 2006). The timing of any significant transtensional movement on the Algodones Fault is not well constrained, and may be older than normal faulting. The Algodones fault zone is associated with steep gravity anomalies adjacent to thick basin-fill sediment, interpreted to be largely due to normal faulting of mid-Miocene through the latest Pleistocene (Woodward-McNeil and Associates, 1974; Pearthree, 1998).

The majority of buried faults and tilted strata in the Yuma basin is believed to be largely restricted to early-Miocene and older rocks related to extension and detachment faulting between 20 and 30 Ma. The mid-Miocene and younger strata unconformably overlap older strata and appears to be relatively non-deformed; however, dipmeter and geophysical log data indicate minor localized faulting and folding. Olmsted and Mattick, and others (1973) identified and interpreted faults from well, gravity, and seismic data, located in Plate 1. Individual faults are inferred to have normal displacements ranging on the order of 30 to 300 m (100 to 1,000 ft), predominantly down to the southwest, and restricted to mid-Tertiary rocks (Mattick and others, 1973) (Plates 2 and 3, cross-sections AA' through DD').

Tilting of Oligocene to early-Miocene bedding is commonly significant and generally westward, consistent with exposures in the Gila and Laguna Mountains (Olmsted, 1972; Spencer and Reynolds, 1989; Lombard, 1993; Shipman and others, 2006; Youberg and others,

2011). The structural relationship between the base of the Oligo-Miocene units and crystalline-(?) basement is not well understood.

4.3 Stratigraphic Units and Physical Properties

The most extensive subsurface analyses of the Yuma basin, by Olmsted and others (1973) and Mattick and others (1973), were based on several geologic and geophysical surveys to characterize the geology of the Yuma basin. They differentiated subsurface geologic units from well data, correlated those units to surficial geology units exposed in the area, and proposed nomenclature for the Yuma basin (see H31 in Olmsted and others, 1973 and Table 1). Following their research, seven (7) deep wells were drilled in the 1980's for oil and gas exploration (Appendix A). Brennan (1989) was able to correlate geophysical logs between wells in the new well field south of Yuma, applying nomenclature used by Olmsted and others (1973).

For the purposes of characterizing stratigraphy and structure of Cenozoic deposits in the Yuma basin below 800 m depth, nomenclature used by Olmsted and others (1973) was grouped into three geologic sequences of distinctly different origin. These sequences, each of which has a wide variety of lithologic variation and lateral facies changes, unconformably overlies crystalline igneous and metamorphic basement, and consist of, from oldest to youngest, 1) mid-Tertiary volcanic and sedimentary deposits, 2) mid-Miocene-(?) to Pliocene pre-Colorado River deposits, and 3) Pliocene to Holocene Colorado River deposits. All geologic sequences are found near and below the 800-m target depth. The following descriptions of each sequence are summarized from previous works, and in some cases incorporated observations from re-examination of available well-borehole logs, geophysical logs and well cuttings at the AZGS.

4.4 Mid-Tertiary Volcanic and Sedimentary rocks

These rocks include the terrestrial red beds, breccia and conglomerate, and overlying tuffaceous sediments and fanglomerates of the Kinter Formation described by Olmsted and others (1973) and Lombard (1993). The lower part of this sequence consists of moderately to steeply-dipping coarse red beds and conglomerate, volcanic and volcaniclastic rocks. Sedimentary rocks in this sequence range from arkosic redbeds, mudstone and shale to fanglomerate and megabreccia, and are strongly to weakly indurated in outcrop and in the subsurface. Redbeds are found in the basal portion of this sequence and contain subangular to rounded clasts of quartz and feldspar, hornblende, biotite, and metamorphic and volcanic rocks. The fine-grained beds contain gypsiferous sediment and tuffaceous mudstone.

The upper part of the Kinter Formation consists primarily of arkosic breccia and conglomerate, sand and mudstone with tuffaceous portions, derived from local granitic and metamorphic sources. The Kinter Formation is generally tilted less than 35 degrees in outcrop, and includes a significant angular unconformity with the underlying sequence described above (Olmsted and others, 1973). An age of early Miocene (~23 Ma) represents the uppermost age constraint for the mid-Tertiary sequence (Olmsted and others, 1973). The Kinter Formation and correlative mid-Tertiary strata in the northern Gila Mountains and at the Yuma Territorial Prison (Shipman and others, 2006; Youberg and others, 2011) are interpreted to represent syntectonic deposits formed during regional extension between 20 and 30 Ma (Spencer and others, 1995).

Exposures of mid-Tertiary strata in the Chocolate, Gila and Laguna Mountains dip moderately to steeply to the west and southwest, and are heavily faulted (Olmsted, 1972; Olmsted and others, 1973; Lombard, 1993; Shipman and others, 2006). In the San Luis subbasin, OG well 604 penetrated of ash-flow tuff, siltstone and sandstone from 2,300 to 2,800 m (6,900 to 8,500 ft) that was moderately tilted to the southwest. Between 2,800 and 3,600 m (8,500 and 11,000 ft), alternating intervals of sandstone and basalt with occasional siltstone were encountered, dipping moderately to steeply (20 to 70 degrees to the southwest (Nations

and others, 1989) (sections BB' and DD', Plates 2 and 3). A similar sequence of steeply-dipping volcaniclastic strata was penetrated in OG well 863 approximately 2 km northeast of well 604. The total estimated thickness of the mid-Tertiary sequence is poorly constrained due to faulting and tilting, but is estimated to be between 1,800 and 2,400 m (6,000 and 8,000 ft). An angular unconformity is present at the top of the mid-Tertiary sequence exposed in outcrop. This angular unconformity is also indicated by a basal conglomerate in the lower 40 m (130 ft) at the base of the Pre-Colorado River marine sequence, and a sharp increase in dips across the contact up-section. This angular unconformity is also indicated by seismic-reflection data identified by Brennan (1989). The mid-Tertiary volcanic and sedimentary rocks are preserved in the San Luis subbasin, and perhaps throughout the Fortuna subbasin, but are absent further south in the Altar basin (Pacheco and others, 2006).

4.5 Pre-Colorado River deposits

The mid-Tertiary sequence is unconformably overlain by a sequence of predominantly marine sedimentary deposits of fine sand, silt and clay. This sequence represents the initial incursion of open-marine waters into a proto Gulf of California embayment related to the trans-tensional development of the San Andreas fault system in the Yuma area between ~ 8 and 6 Ma (Dorsey and others, 2011). These deposits are referred to as the Pre-Colorado River (PCR) deposits. This PCR sequence was identified as the Older Marine Sedimentary Rocks by Olmsted and others (1973). They divided this unit into an older, more indurated marine sedimentary unit, overlain by a younger, finer-grained unit referred to as the Bouse Formation. The PCR deposits appear to be equivalent to a widespread open-marine sequence identified in the Altar basin (Pacheco and others, 2006). The age of these deposits is poorly constrained, based on planktonic foraminiferans as Miocene/Pliocene or all Pliocene (Olmsted and others, 1979).

Lower sequence

The majority of PCR sedimentary deposits are below 800 m (2,625 ft) depth. Thickness of the PCR deposits may be as much as 2,000 m (6,500 ft) in the San Luis subbasin. In the Fortuna subbasin, the marine sequence is present below ~600 m (2,000 ft) depth, and may be as much as 3,000 m (9,800 ft) thick, although its true thickness and extent remains unknown and untested. The uppermost elevation of the PCR deposits is -400 m (-1,300 ft) in OG well 14-12 in the Fortuna subbasin, and similarly in OG well 14-22 at -374 m-elevation (-1,226 ft-elevation). Approximately 15 km southwest of OG well 604, the PCR deposits are estimated from seismic-reflection data to be about 500 m (1,600 ft) thick (Pacheco and others, 2006). PCR strata are interpreted from seismic-reflection data to be relatively non-deformed and gently onlap older early-Miocene strata between the southwestern Yuma basin and northern Altar basin, and conformable (in part) with the overlying Bouse Formation and Colorado River deposits.

The PCR deposits consist predominantly of unconsolidated to somewhat indurated, light-gray, fine-grained sandstone and medium- to dark-gray silt and mudstone, and is occasionally fossiliferous. Sandy portions range from 15 to 50 ft thick, and are generally unconsolidated, poorly cemented with a slight calcareous cement. Sands are light gray, very fine to coarse-grained, angular to well-rounded, moderate to well-sorted, and generally thinly-laminated. Grains include abundant quartz and minor granitic and volcanic grains, brown and black chert, and biotite, although downhole contamination from CR sand and gravel is evident in nearly all cutting samples. Clay-rich portions are brown to gray to black, and cohesive, firm to soft, fissile and fossiliferous. Silty portions are greenish- and bluish-gray with a slight calcareous cement. Sandy fractions increase in grain size, grain angularity, and are redder and more poorly sorting adjacent to granitic bedrock. No evaporite deposits such as halite or gypsum were

reported in logs. Fossils identified in OG well 604 within this sequence include foraminifers, scattered pelecypod and echinoid fragments, and mollusks indicative of a marine setting, including benthic fauna in the basal 10 m (33 ft) of this sequence (Smith, 1970; Olmsted and others, 1973; Eberly and Stanley, 1978). The base of this sequence is represented by a basal conglomerate overlying an angular unconformity with older early-Miocene strata.

Towards basin centers, sediment in the PCR deposits generally has lower electrical resistivity and elevated gamma radiation. Electrical resistivity logs have saw-tooth patterns indicative of meter-scale sand-shale bedding that is possibly indicative of turbidite sequences (Brennan, 1989). Neutron-porosity and compensated neutron-formation density logs indicate porosity between 20 and 50%, typical of shale with sandy portions.

PCR deposits in the Yuma basin generally lack widespread deformation. Rather, deformation appears to be localized along faults or within the Algodones fault zone. Seismic-reflection data to the southwest in the northern Altar basin indicate a relatively non-deformed marine sequence dipping generally less than 10 degrees to the southwest, between an underlying crystalline basement and overlying sequence of Colorado River deposits (Pacheco and others, 2006). Dipmeter and seismic data in the Yuma basin indicate gentle to moderately dipping beds in the PCR deposits, dipping predominantly westerly to southwesterly between 10 to 25 degrees. PCR sequence generally lacks faults and fractures, which may indicate that vertical permeability is limited by primary bedding features such as shale-sand sequences and not by faults or fractures. However, strata in OG well 864 dip progressively between 25 to 10 degrees between ~2,800 and 1,200 m (~9,100 and 4,000 ft), which suggests that deposits are juxtaposed against growth faults along the northeast margin of the San Luis subbasin. Gentle folds may be present, indicated by dipmeter data in OG 863 between 1,650 and 1,740 m (5,400 and 5,700 ft) bls. Gently dipping sand-shale sequences, growth faults and potential folding may provide ideal conditions for sealing and trapping CO_2 in the Yuma basin.

Near basin margins and along faults, the PCR deposits may be disconformable to slight angular unconformable with the overlying CR deposits, especially in OG wells 864 and 27. Otherwise, the marine pre-Colorado River deposits appear to be conformable with the overlying Bouse Formation, representing nearly continuous deposition of marine deposits.

Upper clay unit or Bouse Formation

Abruptly overlying the Pre-Colorado River deposits in the subsurface is a widespread marine deposit of greenish, bluish and light brownish gray silty clay referred to as the Bouse Formation (Olmsted and others, 1973). Olmsted and others correlated this subsurface clay-rich unit in the Yuma basin with the Bouse Formation based on a single outcrop area ~2 miles south of Imperial Dam where similar fine-grained clastic deposits directly underlie Colorado River gravels and resemble Bouse Formation siltstone observed in outcrop farther north along the Lower Colorado River corridor between Lake Mead and Blythe. Although the clay unit clearly underlies CR deposits in the Yuma basin, the clay lacks any significant or diagnostic limestone or marl at its base as observed in the Bouse sequence outside the Yuma basin (Metzger and others, 1973). Based on the lithologic similarity of the Bouse Formation in the subsurface Yuma basin to the underlying PCR deposits, and the lack of CR detritus in this clay-rich unit, the Bouse Formation is interpreted to represent an upper clay unit within PCR deposits. However, given the degree of uncertainty and ability to identify the relationship of the Bouse clay to adjacent units, it is possible that the clay is somehow related to the arrival of the CR into the Yuma basin.

The Bouse Formation appears to be thickest in the San Luis subbasin as determined from seismic-reflection data (Brennan, 1989). The maximum elevation of the Bouse Formation in the subsurface is -273 m (-969 ft) elevation in USGS well #26. The Bouse Formation is

thinnest to the north in OG well 14-12, 107 m (351 ft), gradually thickens towards the south, and appears to rapidly thicken southwest of the Yuma basement high, with a maximum thickness of approximately 430 m (1,400 ft) in OG wells 27 and 604. The Bouse Formation begins to rapidly thin to 180 m (600 ft) thick in OG well 14-20 ~3 km to the west of OG 604.

In the Yuma basin the Bouse Formation consists predominantly of greenish-bluish-brown gray, fine-grained clay and silt containing occasionally abundant marine fossils (Smith, 1970). Clay is commonly silty, light to dark gray and occasionally blue-green, and is soft to very firm, sticky, and slightly to very soluble. A micro-micaceous and arenaceous component is also present throughout. Calcareous cement is ubiquitous, ranging from light to very abundant.

Excluding contamination from overlying CR sands, occasional discontinuous thin beds of very fine-grained to coarse, moderately well-sorted, light gray sand ranging from 3 to 15 m (10 to 50 ft) thick are interbedded within the clay. A micro-micaceous and arenaceous component of biotite, muscovite and quartz grains are present, as well as unidentified dark green and black grains. Sandy units are loose to very friable, and fossiliferous, with a slightly calcareous cement. Olmsted also noted that none of the distinctive well rounded gravels in the CR alluvium are observed from well data within or below the Bouse; however, interbeds of rounded, well-sorted, fine to medium sand with occasional black chert and other lithics were noted in mud logs (OG wells 17, 27, 604, 837, 840, 863 and 864) and observed in cuttings (this study). In most cases, observation of CR detritus in cuttings were not indicated in geophysical logs, suggesting borehole contamination. In some cases, a change in lithology or permeability observed in geophysical logs was not apparent in cuttings. Thus, the presence or absence of CR detritus within the Bouse was inconclusive. Defining the depositional relationship of the Bouse from underlying and overlying strata is complicated by several factors. Overlying unconsolidated CR sand is always washed out from drilling, contaminating cuttings in underlying units. Additionally, the blue-green-gray clays diagnostic of the Bouse Formation are also lithologically similar to clay units interbedded with fine sand and silt in the underlying PCR deposits and to gray clay and silt interbedded with the overlying CR sands in the Transition Zone. The Bouse Formation is fairly well recognized in the subsurface by an increase in gamma-ray and SP values and decreased electrical resistivity (see OG well 27 in section AA' immediately underlying CR deposits, Plate 2).

Based on available well data, the Bouse Formation appears to be conformable between the underlying PCR and overlying CR deposits. Although the clay-rich deposits appear to begin and end relatively abruptly in depositional sequence, the Bouse Formation appears to be gradational and conformable with the overlying CR deposits. If so, the age of the uppermost Bouse Formation is approximately 4.8 Ma, based on the first arrival of base-load sediment from the Colorado River (Spencer and others, 2011a). Given the abundance and widespread distribution of the clay throughout the basin, it is possible that the Bouse clay in the Yuma basin was reworked from Bouse Formation silt and clay deposits upstream in one or more paleo-lakes, prior to the arrival of Colorado River sediment base-load. However, it is also possible that the Bouse Formation in the Yuma basin is a continuation and/or transgression of marine clay deposition prior to the downstream integration of the Colorado River. Nonetheless, given the scope of this project and time to review available well data, the stratigraphic relationship between the Bouse Formation and its overlying and underlying units remains inconclusive and unresolved. Given the widespread and nearly continuous clay deposit of the Bouse Formation (at least not immediately adjacent to bedrock margins) below 800 m depth, this unit may provide sealing conditions suitable for sequestering CO_2 in underlying permeable sands within the PCR deposits.

4.6 Colorado River Deposits

Colorado River (CR) deposits are widespread across the Yuma basin at the surface and in the subsurface. The CR deposits include deposits from the Gila River, although the time of first arrival of Gila River deposits, and their subsurface relationship to Colorado River deposits, is not presently understood. Recent research along the Lower Colorado river indicates that the CR arrived into the Yuma area during the early Pliocene by approximately 4.8 Ma (Dorsey and others, 2011; Spencer and others, 2011a; Kimbrough and others, 2011), following a series of basin-filling, lake-spillover, and incision events from Lake Mead to Blythe (Spencer and others, 2011b; House and others, 2011). The final lake-overflow and subsequent integration event between Blythe and the Yuma basin would have occurred near the Chocolate-Trigo area south of the Cibola area (Spencer and others, 2011b). This event would be marked by a significant increase in sediment supply and initial progradation of a delta into the Gulf of California marine embayment. The influx of CR sediment into the embayment likely outpaced subsidence, which allowed the delta to prograde. Although the position and extent of the CR delta complex outboard of the Yuma basin in the early-Pliocene is poorly constrained because of the complexities produced by tectonic activity (Pacheco and others, 2006), CR deposits appears to be autochthonous in the Yuma basin.

CR deposits consist predominantly of unconsolidated clay, silt, sand, and gravel delivered by the CR. Olmsted and others (1973) classified CR deposits into a lower Transition Zone, overlain by “older” and “younger” alluvium. For the purposes of evaluating storage potential of CO_2 in permeable strata underlying an impermeable seal (the Bouse Formation) in the Yuma basin, the sequence of Colorado River deposits are lumped into a single sequence consisting of a basal Transition Zone and overlying upper deposits. The CR sequence represents a variety of depositional environments dominated by a marine to non-marine fluvio-deltaic system that prograded into a shallow-(?), marine embayment. Both fining- and coarsening-upwards sequences are indicated from electrical resistivity logs, and may indicate turbidite and submarine fans (Brennan, 1989).

Basal Transition Zone

Olmsted and others (1973) briefly described a “Transition Zone” of deposits which abruptly grade from the underlying Bouse Formation into Colorado River sands. Olmsted and others (1973) assigned this unit, primarily for convenience, to a sequence of CR deposits that contained roughly equal portions of gray silt and clay to quartz-rich sand and silt. Deposits in the Transition Zone coarsen upwards into predominantly sands and gravels characteristic of the upper CR deposits.

Sandy portions are silt-rich and range from 3 to 15 m (10 to 50 ft) to as much as 30 m (100 ft) thick. The sands are moderately to well-sorted, angular to very well-rounded, with abundant clear and frosted quartz grains. Lithic grains of fine- to coarse sand, and occasionally pebbles, consist of distinctive black chert, granite, basalt and other mixed volcanics.

Interbedded with sands in the Transition Zone are beds of silty clay ranging in thickness from 3 to 10 m (10 to 30 ft). The clay is generally light gray to brownish-gray and occasionally greenish- and bluish-gray in color with a micro-micaceous silty component, and is occasionally fossiliferous. Clays are generally loose to firm and fissile, very soluble, but with a slight calcareous cement and occasionally a trace of pyrite mineralization.

The base of the Transition Zone is defined by coarse sand and gravel immediately overlying the fine-grained Bouse Formation. The Transition Zone coarsens upward into sand-rich deposits characteristic of CR deposits throughout the remainder of the sequence. Although the top of the Transition Zone is identified locally by a fossiliferous gray clay or silt, it is conformable with overlying sand-rich alluvium, and thus the extent and thickness of the

Transition Zone is not well defined throughout the basin. The Transition Zone appears to gradually thicken to the south, with thickness ranging from 30 m (100 ft) thick in the northwestern Fortuna subbasin, ~140 m (450 ft) near Yuma Hills, ~275 m (~900 ft) thick in OG well 604 in southwestern San Luis subbasin, and 365 m (1,200 ft) in OG well 863 in south-central San Luis subbasin. The upper part of the Transition Zone was also interpreted to be present in BOR well No. 28 in the far southeastern portion of the basin (see DD').

Pacheco and others (2006) noted a potentially similar sequence to the Transition Zone identified in well "W1" approximately 15 km (mi) south of OG 604. This sequence (Sequence B) consists of ~1,000 m (3,300 ft) of a mudstone-sandstone sequence. Mudstone and sandstone are regularly interbedded, poorly cemented, with fine-grained sandstone, siltstone and mudstone. Sandstone beds are light gray to tan-colored, quartz-rich, and poorly consolidated. Mudstone beds are gray to black, indurated to poorly indurated, and slightly calcareous, with benthic foraminiferans. This sequence transitions into an overlying sand-rich facies characteristic of Colorado River sediment. They interpreted this sequence B to represent the influx of Colorado River sands in a shallow-marine (in part) setting as part of a sub-aqueous delta apron.

Clay beds in the Transition Zone, which may represent brief incursions of marine conditions at the edge of the delta apron, grade upward into predominantly shallow deltaic sediments. The source of the greenish- and bluish-gray clays in this portion may be reworked Bouse Formation further up-dip in the Yuma basin, and/or from lacustrine clays in the Bouse Formation to the north. Olmsted and others (1973) suggested that thin beds (generally less than 2 ft. thick) of bluish- and greenish-gray clay found above the Transition Zone are boulders of marine clay reworked into the CR deposits.

Upper CR deposits

The remainder of the CR deposits overlying the Transition Zone are generally characterized as a sequence of abundant quartz-rich sand and silt in proportion to relatively minor clay and silt. CR sand can be recognized by the presence of abundant fine-grained well rounded quartz grains with hematite coatings and syntaxial quartz overgrowths that surround the hematite-coating, rounded grains, plus chert lithics, and Cretaceous microfossils, all reworked from Mesozoic deposits on the Colorado Plateau (Dorsey, 2011). However, only grain shape, composition, and texture have been evaluated in studies of Yuma basin sediments.

Sandy portions consist of very fine to medium-grained, light brown to gray, well-rounded to sub-rounded quartz grains. Quartz grains are commonly frosted and translucent with medium- to well-sorted lithic grains of mixed volcanic rocks, granite and other exotic lithics from outside the Yuma basin, including distinctive black chert. Biotite and muscovite minerals are also abundant. Shell fragments of pelecypods and gastropods are occasionally abundant. A slight calcareous cement is ubiquitous throughout CR deposits.

The CR deposits gradually thicken to the southwest towards the Gulf of California marine embayment. CR deposits have a maximum known thickness of 1,220 m (4,010 ft) in OG well 864 (section DD', Plate 3), but may be as deep or deeper in the Fortuna subbasin, where an ancestral Colorado River may have flowed through the Fortuna subbasin to the Gulf of Bahia Adair (Kingsland and Lock, 2001). Thickness of the CR deposits increase southeastward from ~600 to ~800 m (2,000 to 2,600 ft) between OG wells 14-12 and 14-13, possibly indicating progradation of the CR deposits to the southeast into deeper parts of the Fortuna subbasin. The average thickness of the CR deposits in the Yuma basin is between ~1,000 and 1,200 m (3,300 and 3,900 ft) (see sections AA through DD'). Earlier maps of the base of the Bouse Formation by (Mattick and others, 1973, Fig. 3; Nations and others, 1989, Fig. 20), and this study, indicate that the base of the Colorado River sediments originally occupied the Fortuna Basin, and

connected to the San Luis Basin through a trough between Yuma Hills and “Yusmey 529” Hills (an extension of Sierra El Rosario mountains in northern Sonora, Mexico) (Plate 1).

Bedding in the CR deposits dips gently between 0 and 6 degrees to the north in OG well 863, and gently to the southwest towards the Altar basin (Pacheco and others, 2006), and appear to be non-deformed (Brennan, 1989). Although the Algodones Fault has been active during the Pleistocene (Menges and Pearthree, 1989), seismic-reflection data show no significant offset in CR deposits (Brennan, 1989; Pacheco and others, 2006), which suggests that the CR deposits in the southwestern Yuma basin may not be significantly displaced by strike slip faulting relative to the northeastern Yuma basin.

5.0 Salinity

Fresh, brackish and saline groundwater have been reported at depths below 800 m in the Yuma basin (Gootee and others, 2012). Although deep-well salinity data are sparse, the data suggest that brackish to saline conditions predominate below 800 m (2,625 ft) depth in the lowermost Colorado River deposits and underlying units. Oil and gas showings are also present and localized to permeable sands in Colorado and Pre-Colorado sediments.

Only three salinity measurements have been reported in wells drilled deeper than 800 m depth (Gootee and others, 2012). In the far southwestern portion of the Yuma basin, OG well 14-20 reported “salt water” from a perforated interval between 1,011 and 1015 m (3,317 and 3,329 ft), estimated to have 30,000 mg/L total dissolved solids (TDS). Nearby OG well 14-18 measured fresh water of 793 mg/L TDS from an unreported interval above 898 m (2,946 ft) (TD of well), within the Colorado River deposits. In the south-central portion of the basin, OG well 840 noted brackish to fresh water between 665 and 627 m (2,180 and 2,055 ft) in the lowermost Colorado River deposits. In the same well the casing was later perforated between 683 and 684 m (2,242 and 2,245 ft) and recovered “salt water”, an estimated 30,000 mg/L TDS. OG well 850, ~5 miles to the northwest of OG well 840, reported “4,000 ppm salt” between 784 to 788 m (2,572 to 2,582 ft), interpreted to represent the basal Colorado River sequence near the contact with the marine Pre-Colorado River deposits. Subsequent perforations in the same well between 420 and 440 m (1,390 and 1,450 ft), equivalent to the Bouse Formation, resulted in a minor amount of visible gas with slight odor, and 4,150 mg/L TDS. Electrical resistivity surveys by Mattick and others (1973) in the Fortuna subbasin along cross-section CC’, revealed a high-conductivity layer at approximately 1,200 to 1,300 ft-bls of 3.6 ohms-m, interpreted to represent saline groundwater near the base of the Colorado River deposits. These salinity measurements indicate brackish to saline groundwater conditions are present above and below 800 m depth in the lower portions of the Colorado River deposits, and likely underlying porous sedimentary deposits. Due to the lack of salinity data, the depth at which salinity approaches 10,000 mg/L TDS in the Yuma basin could not be mapped.

The Yuma basin has also reported numerous oil and gas showings in many of the OG wells, especially OG well 604 (Brennan, 1989). Oil and gas have been reported as shallow as 365 m (1,200 ft) in OG well 604, and 430 m (1,400 ft) bls in OG well 850. Brennan (1989) concluded that oil and gas potential is higher in the eastern San Luis subbasin. Rauzi (2001) suggested that rich oil fields in northern Gulf of California may have migrated up-dip into stratigraphic traps within the marine sequence or older Tertiary strata in the Yuma basin.

6.0 Conclusions

Incomplete:

- Given the widespread and nearly continuous clay deposit of the Bouse Formation (at least not immediately adjacent to bedrock margins) below 800 m depth, this unit may provide sealing conditions suitable for sequestering CO_2 in underlying sand and silt strata.
- Gently-dipping sand-shale sequence-strata, growth faults and potential folding may provide ideal conditions for sealing and trapping of CO_2 in the Yuma basin.
- Within marine strata, sand facies, potential oil and gas showings, and saline groundwater indicate a favorable sequestration potential.
- Groundwater salinity data was insufficient for generating an iso-salinity map suitable for calculating volume of saline groundwater below 800 m
- Although portions of the deeply buried mid-Tertiary sequence of sedimentary and volcanic rocks may provide favorable CO_2-sequestration potential, the degree of consolidation, deformation and general lack of subsurface data make this strata sequence an unlikely candidate for further evaluation. Additional subsurface exploration (drilling and/or seismic) would be needed to evaluate the possibility of storing CO_2.

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Well Type	Well ID	Cadastral location	Other ID (2)	Year Drilled	Basin	Elev. (m)	Elev. (ft)	UTM-E NAD83 12N	UTM-N NAD83 12N	Well Depth (ft)	Well Depth (m)	Logs	AZGS well-cuttings ID (1)	Comments
OG	14-14	C(9-23)32dd	Yuma Basin Oil Company #1 Sinclair (?)	1925	Yuma	58	190	158,849	3,612,604	1,828	557	D	--	Well not found in Olmsted/Mattick. May be related to DH 15; unresolved.
OG	14-22	C(8-23)32caa1	Sinclair Oil Kryger 1 (?), DH-15	1925	Yuma	37	120	158,368	3,622,878	1,400	427	D, G, T	--	DH-15 has only interpretations that vary from Olmsted detailed log and interpretation. DH-15 may represent another well of unknown location. May be related to OG 14-14; unresolved.
OG	14-20	C(11-25)11ab	Yuma Valley Oil and Gas Musgrove #1, DH-30	1940	Yuma	27	90	143,422	3,601,308	4,868	1,484	D, L, E	37	
OG	9	C(10-24)35bb	Hickey, J.M. 1 Federal	1954	Yuma	50	165	152,538	3,604,275	940	287	L	202	Well log incomplete.
OG	17	C(10-23)31aaa.	M.P. Stewart Federal 1, DH-28	1954	Yuma	56	185	157,020	3,604,154	3,660	1,116	L	301	
OG	24	C(9-23)19bcd	CO Basin Associates Elliot No 1., DH-20	1954	Yuma	34	110	156,236	3,616,624	3,255	992	D, G, L, T, P, MUD	358	
OG	27	C(10-24)24cbb	Colorado Basin Associates, Inc. Federal No. 1, DH-27	1954	Yuma	55	180	154,113	3,606,772	6,015	1,833	D, G, E, P, MUD, SP, DIP	359, 385	Logs in Mattick et al., 1973. E-logs digitally scanned into LAS format.
OG	45	C(8-22)15dac	Gila Valley O&G Kamrath #1	1958	Yuma	46	151	172,130	3,627,272	2,140	652	L, E	1181, 1325	
OG	14-17	C(10-23)31bbb1	LCRP 1	1961	Yuma	52	172	155,598	3,604,380	1,000	305	G, L, R, T, Ha, C14, PC	1511, 1882, 2985	C14 sample.
OG	14-16	C(9-25)35cbd	LCRP 9	1962	Yuma	32	104	143,143	3,613,522	1,201	366	D, L, C, T	2992	
OG	14-10	C(7-22)14bcd	LCRP 14	1963	Yuma	46	150	172,940	3,637,085	505	154	G, L, R, T, HA, P, PC	2996	
USGS	13	C(8-23)33cdd	Stardust Hotel test well, LCRP 13, DH-14	1963	Yuma	60	197	159,910	3,622,097	1,090	332	D, L, G, T, HA	2978, 3216	Originally 830 ft, deepened to 1,090 ft.
35	16177	C(11-24)23bcb	LCRP 10	1963	Yuma	49	161	152,278	3,597,390	1,038	316	D, G, L, R, T, HA, PC	--	
OG	14-13	C(9-22)28cbb	ADWR 35-16001, LCRP 25	1964	Yuma	62	205	168,872	3,614,551	2,319	707	D, E, G, L, R, T, P	--	
OG	14-18	C(10-25)35bbd	ADWR 35-16128, LCRP 17, DH-29	1964	Yuma	27	90	142,706	3,604,583	2,946	898	C, E, L, HA	2997	
OG	14-12	C(8-22)35caa1	CH-704, LCRP 29	1965	Yuma	47	155	172,992	3,622,521	1,997	609	G, C, E, L, T, P, PC	3004a	
OG	14-15	C(9-24)8baa	LCRP 28, DH-19	1965	Yuma	36	119	148,853	3,620,785	2,466	752	C, E, G, L, T	3003a	
OG	14-19	C(11-23)34bbc	LCRP 30	1965	Yuma	50	163	160,254	3,594,334	623	190	L, T, C, E, G	3218	
USGS	26	C(16-22)29gca2	LCRP 26, DH-17	1965	Yuma	39	129	155,636	3,628,388	1,777	542	A, C, E, G, L, R, T	--	In California.
BOR	28	C(13-20)2abd1	BOR CH-28YM. GWSI 321957114164201	1966	Yuma	176	578	191,321	3,582,026	1,427	435	A, C, G, L, T, E	--	
OG	604	C(11-24)8ac	Exxon Yuma-Federal No. 1	1973	Yuma	50	163	148,413	3,600,823	11,444	3,488	L, E, BHC	3316	
OG	708	C(10-23)23ddd	An-Son 1-23 State	1980	Yuma	64	210	163,646	3,605,833	2,893	882	L, CN, I, E, G	3387	
OG	837	C(10-23)34bbc	Dowling Petroleum State No. 1	1983	Yuma	73	241	160,570	3,603,893	2,925	892	L, MUD	3398	Well abandoned at 2,925 ft. Replaced with No. 1A (OG 840). Samples collected 0 to 2,900 ft.
OG	840	C(10-23)34aad	Dowling Petroleum State No. 1A, PD-5	1983	Yuma	73	241	161,968	3,603,835	5,000	1,524	MUD, L, H, BHC, G, SW, I, DIP, FF, CN, SYGT, VDL, Co	--	Location may be only 25 ft from OG well 837. Logs 940 to 5,000 ft-bls. Upper 2,900 ft of lithology logs from OG 837.
OG	850	C(10-23)5bdd	Central Oil Co. 1 Aman	1984	Yuma	57	188	158,046	3,611,861	2,848	868	L, I, E, CN, G, SP, C, Co	--	Geology and lithology log missing. Descriptions based on core intervals and a summary of formation picks
OG	851	C(9-23)32ddb	Central Oil CO - MCP B&P #1	1984	Yuma	57	188	158,814	3,612,638	2,539	774	MUD, L, H, I, E, CN, G	--	
OG	863	C(11-24)4dbb	Petroleum Tech Services Co., Federal No 4-1	1987	Yuma	47	155	149,921	3,602,021	7,000	2,134	L, MUD, H, G, I, SW, SGR, DIP, BHC, RFT	4266	
OG	864	C(11-23)26adc	Federal "A" 26-1	1987	Yuma	52	172	163,062	3,595,480	9,135	2,784	L, H, MUD, G, I, BHC, SW, CN, SGR, DIP	4297	

Notes

1 - additional cuttings are available from shallow wells in study area (LCRP 2, 3, 18, 6, 7, 10, 11, 12, 13, 18, 19, 23, and 26) and more.

2 - DH wells from Mattick et al. (1973). Lower Colorado River Project (LCRP) wells from Olmsted et al. (1973).

Log Abbreviations

BHC = borehole compensated log
C = caliper log
CN = compensated neutron -formation density log
Co = core samples taken
D = Drillers log
DIP = dipmeter log
E = electric log (SP and resistivity)
EPT = Electromagnetic Propagation log
FF = fracture finder log
G = gamma ray log
H = hydrocarbon analysis
HA = heavy minerals analysis
I = induction log
L = cuttings reviewed by geologist
MUD = driller's mud log
P = paleontological analysis
PC = pebble count from cuttings
R = resistivity log
RFT = repeat formation tester
S = samples
SGR = spectral gamma-ray log
SP = spontaneous potential log
SW = sonic waveform log
SYGT = synergetic log
T = temperature log
VDL = variable density log

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
35	16177	16177	161	0	93	93	2	PC	1	CRD	1	CR	sand, silty, clayey, with some fine gravel	Upper, fine-grained zone	See detailed log in Olmsted (1973), p. H188-H189.
35	16177	16177	161	93	149	56	2	PC	1	CRD	1	CR	sand with gravel and few cobbles		
35	16177	16177	161	149	189	40	2	PC	1	CRD	1	CR	sand, silty		
35	16177	16177	161	189	331	142	2	PC	1	CRD	1	CR	gravel and sand, few pebbles, sandstone concretions	Coarse-gravel zone	
35	16177	16177	161	331	369	38	2	PC	1	CRD	1	CR	sand (gray), pebbly sand, sandstone concretions		
35	16177	16177	161	369	427	58	2	PC	1	CRD	1	CR	gravel and sand, few pebbles, sandstone concretions	Wedge zone	
35	16177	16177	161	427	524	97	2	PC	1	CRD	1	CR	gravel, sand and gravel		
35	16177	16177	161	524	580	56	2	PC	1	CRD	1	CR	gravel with qtz, chert, volcanic, plutonic and mets rocks, and sand		
35	16177	16177	161	580	737	157	2	PC	1	CRD	1	CR	sand, sand and gravel		
35	16177	16177	161	737	746	9	2	PC	1	CRD	1	CR	sand, silty, clayey, and sand concretions		
35	16177	16177	161	746	807	61	1	C	1	CRD	1	CR	gravel cemented (conglomerate)		
35	16177	16177	161	807	903	96	2	PC	1	CRD	1	CR	sand, silty, clayey with fine gravel		
35	16177	16177	161	903	980	77	2	PC	1	CRD	1	CR	sand, silty, clayey with few wood		
35	16177	16177	161	980	1013	33	2	PC	1	CRD	1	CR	sand, silt, sandy lay		
35	16177	16177	161	1013	1038	25	4	CL	1	CRD	1	CR	clay, pebbly, and sand		
BOR	28	BOR-28	578	0	95	95	2	PC	1	CRD	1	CR	sand, fine	Older and younger alluvium, undifferentiated	See detailed log in Olmsted (1973), p. H190.
BOR	28	BOR-28	578	95	100	5	4	CL	1	CRD	1	CR	clay, calcareous		
BOR	28	BOR-28	578	100	105	5	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	105	115	10	4	CL	1	CRD	1	CR	clay, calcareous, medium-brown; interbedded medium to coarse granitic sand		
BOR	28	BOR-28	578	115	280	165	2	PC	1	CRD	1	CR	sand, fine, predominantly quartz		
BOR	28	BOR-28	578	280	310	30	3	PF	1	CRD	1	CR	clay, silty, medium-brown; interbeds of fine to coarse granitic sand		
BOR	28	BOR-28	578	310	325	15	1	C	1	CRD	1	CR	gravel, fine		
BOR	28	BOR-28	578	325	335	10	4	CL	1	CRD	1	CR	clay, brown, silty		
BOR	28	BOR-28	578	335	380	45	2	PC	1	CRD	1	CR	sand, fine to coarse; considerable fine gravel		
BOR	28	BOR-28	578	380	385	5	4	CL	1	CRD	1	CR	clay, brown, silty		
BOR	28	BOR-28	578	385	395	10	2	PC	1	CRD	1	CR	sand and gravel, fine to coarse		
BOR	28	BOR-28	578	395	445	50	2	PC	1	CRD	1	CR	sand, fine; thin beds of light-brown sandy to silty clay		
BOR	28	BOR-28	578	445	450	5	4	CL	1	CRD	1	CR	clay, silty, light brown		
BOR	28	BOR-28	578	450	460	10	2	PC	1	CRD	1	CR	sand, coarse		
BOR	28	BOR-28	578	460	635	175	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	635	640	5	4	CL	1	CRD	1	CR	clay, light brown, silty		
BOR	28	BOR-28	578	640	675	35	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	675	680	5	4	CL	1	CRD	1	CR	clay, light-brown		
BOR	28	BOR-28	578	680	700	20	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	700	705	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	705	715	10	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	715	720	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	720	725	5	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	725	730	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	730	760	30	2	PC	1	CRD	1	CR	sand, fine; cemented layer at 755 ft		
BOR	28	BOR-28	578	760	810	50	2	PC	1	CRD	1	CR	sand, fine; clay layers, thin cemented zones and scattered fine gravel		
BOR	28	BOR-28	578	810	870	60	2	PC	1	CRD	1	CR	sand, fine; thin beds of clay; cemented layer at 810 ft		
BOR	28	BOR-28	578	870	970	100	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	970	975	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	975	1085	110	2	PC	1	CRD	1	CR	sand, fine; thin cemented layers at 1,015, 1025 and 1075 ft; little silt or clay		
BOR	28	BOR-28	578	1085	1090	5	4	CL	1	CRD	1	CR	claystone, probably calcareous		
BOR	28	BOR-28	578	1090	1160	70	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	1160	1165	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	1165	1170	5	2	PC	1	CRD	1	CR	sand, fine		
BOR	28	BOR-28	578	1170	1175	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	1175	1215	40	2	PC	1	CRD	1	CR	sand, fine; little silt or clay		
BOR	28	BOR-28	578	1215	1220	5	4	CL	1	CRD	1	CR	clay		
BOR	28	BOR-28	578	1220	1275	55	2	PC	1	CRD	1	CR	sand, fine; more indurated (higher acoustic velocity) than materials above		
BOR	28	BOR-28	578	1275	1285	10	2	PC	1	CRD	1	CR	sand, coarse		
BOR	28	BOR-28	578	1285	1305	20	2	PC	1	CRD	1	CR	sand, fine, clayey, bluish to greenish-clay	Transition zone: fine sand and blue, gray and green clay	
BOR	28	BOR-28	578	1305	1310	5	4	CL	1	CRD	1	CR	clay, gray		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
BOR	28	BOR-28	578	1310	1315	5	2	PC	1	CRD	1	CR	sand, fine gray		
BOR	28	BOR-28	578	1315	1320	5	4	CL	1	CRD	1	CR	clay, gray		
BOR	28	BOR-28	578	1320	1375	55	2	PC	1	CRD	1	CR	sand, fine, clayey, gray; thin cemented layers at 1320, 1360 to 1365 and 1370 ft		
BOR	28	BOR-28	578	1375	1385	10	4	CL	1	CRD	1	CR	clay, gray		
BOR	28	BOR-28	578	1385	1427	42	2	PC	1	CRD	1	CR	sand, fine, clayey, gray.		
OG	9	9	161	0	580	580	2	PC	1	CRD	1	CR	"volcanic debris"		
OG	9	9	161	580	660	80	1	C	1	CRD	1	CR	moderate gray varigated, rounded to polished round pebbles broken [contamination?]. Gneiss fragments. Some coarse pebbly.		
OG	9	9	161	660	680	20	2	PC	1	CRD	1	CR	volcanics 100%		
OG	9	9	161	680	720	40	2	PC	1	CRD	1	CR	few pebbles		
OG	9	9	161	720	740	20	6	V	1	CRD	1	CR	volcanics		
OG	9	9	161	740	840	100	6	V	1	CRD	1	CR	tuffaceous material and tuff		
OG	9	9	161	840	880	40	2	PC	1	CRD	1	CR	any fragments appear to be chips from large pebbles or cobbles		
OG	9	9	161	880	940	60	8	U	1	CRD	1	CR	unknown		
OG	17	17	185	0	82	82	2	PC	1	CRD	1	CR	Surface ss. Conglomerate, water sand.		Formation picks from Mattick et al., 1973
OG	17	17	185	82	375	293	1	C	1	CRD	1	CR	conglomerate and boulders. 160-170: angular fragments pink quartzite med. Granites, coarse (sp.?) round sandstone, venin quartz. At 375: angular pebble fragments quartz porphyry, frac?, hard.	Colorado River Delta deposits	
OG	17	17	185	375	900	525	1	C	1	CRD	1	CR	conglomerate		
OG	17	17	185	900	950	50	2	PC	1	CRD	1	CR	white, coarse, well round ss., clear qtz grains, coarse ang. Pebbles quartz monzonite.		
OG	17	17	185	950	1022	72	1	C	1	CRD	1	CR	conglomerate		
OG	17	17	185	1022	1042	20	2	PC	1	CRD	1	CR	hard gray sandstone		
OG	17	17	185	1042	1550	508	1	C	1	CRD	1	CR	conglomerate		
OG	17	17	185	1550	1600	50	2	PC	1	CRD	1	CR	white -pinkish c.-med. Well rounded ss., coarse pebble fragments as above.		
OG	17	17	185	1600	1931	331	3	PF	2	BOU	1	CR	red shale with grey sandstone streaks.	Bouse Fm	Possible Transition zone at 1,748 ft-bls (Mattick)
OG	17	17	185	1931	1937	6	2	PC	2	BOU	1	CR	White sandstone. Strong gas odor at about this interval.		
OG	17	17	185	1937	1952	15	5	LM	4	PCRM	2	PCR	Hard sandy limestone: White coarse clear subangular quartz sandstone as above, lot vein quartz. 15% white-cream marly limestone with fw.fn.scattered vugs	Marine underlying Bouse	
OG	17	17	185	1952	2230	278	3	PF	4	PCRM	2	PCR	Gray shale with sandy limestone. Shell fragments (littoral environment).		
OG	17	17	185	2230	2250	20	2	PC	4	PCRM	2	PCR	white coarse to medium weathered, subang. To subr. To round sandstone iron stain pcc. Bit? Frag. Of shell in very fine grained sandstone - poor sorting factor.		
OG	17	17	185	2250	2710	460	3	PF	4	PCRM	2	PCR	Gray shale with sandy limestone. Shell fragments (littoral environment).		Possible Bouse at 2,515 ft-bls (Mattick)
OG	17	17	185	2710	2720	10	1	C	3	PCRT	2	PCR	Fanglomerate: coarse pebble frags., dark gray, quartzite, seyenite and coarse round peb. Interbedded in coarse white sandstone.	Pre-Colorado River	
OG	17	17	185	2720	2800	80	1	C	3	PCRT	2	PCR	Conglomerate		
OG	17	17	185	2800	2830	30	1	C	3	PCRT	2	PCR	Frags. Cobbles as above in med. Wh. Ss.		
OG	17	17	185	2830	2900	70	1	C	3	PCRT	2	PCR	Conglomerate		
OG	17	17	185	2900	3095	195	2	PC	3	PCRT	2	PCR	Clear wh. Med. Subr. Qtz. Ss. With many scott. Round qtz. grains., 10% iron stain, rd. jasper grains. And frags. Lithology becomes coarser at base of this interval.		
OG	17	17	185	3095	3115	20	1	C	3	PCRT	2	PCR	conglomerate		
OG	17	17	185	3115	3120	5	2	PC	3	PCRT	2	PCR	coarse, exotic pebbles as above in wh. Med. Subr. Clear qtz ss., frag of shells.		
OG	17	17	185	3120	3250	130	1	C	3	PCRT	2	PCR	conglomerate		
OG	17	17	185	3250	3660	410	2	PC	3	PCRT	2	PCR	Conglomerate: coarse. Frag. Exotic peb. In wh. Med. Subr. To round clear qtz. Ss., iron stain.		
OG	24	24	110	0	160	160	2	PC	1	CRD	1	CR	surface clay and gravel		
OG	24	24	110	160	397	237	2	PC	1	CRD	1	CR	sand and gravel		
OG	24	24	110	397	618	221	3	PF	1	CRD	1	CR	sand and shale		
OG	24	24	110	618	1431	813	2	PC	1	CRD	1	CR	sand and conglomerate	Drilling rate rapidly slows down at 1,465 ft (formation change?) (BFG)	

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	24	24	110	1431	1521	90	7	B	7	B	3	B	Granite Wash		
OG	24	24	110	1521	1586	65	7	B	7	B	3	B	hard sand		
OG	24	24	110	1586	1621	35	7	B	7	B	3	B	Granite Wash and gravel		
OG	24	24	110	1621	1712	91	7	B	7	B	3	B	hard sand and Granite Wash		
OG	24	24	110	1712	1772	60	7	B	7	B	3	B	conglomerate and Granite Wash		
OG	24	24	110	1772	1800	28	7	B	7	B	3	B	hard sand		
OG	24	24	110	1800	2025	225	7	B	7	B	3	B	Granite Wash		
OG	24	24	110	2025	2249	224	7	B	7	B	3	B	Granite Wash and Shale		
OG	24	24	110	2249	2454	205	7	B	7	B	3	B	Granite Wash		
OG	24	24	110	2454	2568	114	7	B	7	B	3	B	granite		
OG	24	24	110	2568	2695	127	7	B	7	B	3	B	rock and sand		
OG	24	24	110	2695	3153	458	7	B	7	B	3	B	Granite Wash		
OG	24	24	110	3153	3277	124	7	B	7	B	3	B	granite		granitic basement
OG	27	27	170	0	18	18	2	PC	1	CRD	1	CR	sand	Colorado River Delta deposits	
OG	27	27	170	18	185	167	2	PC	1	CRD	1	CR	sand		
OG	27	27	170	185	268	83	2	PC	1	CRD	1	CR	boulders and sand breaks		To depth uncertain - report 168 ft
OG	27	27	170	268	360	92	2	PC	1	CRD	1	CR	boulders, gravel and sand		
OG	27	27	170	360	451	91	2	PC	1	CRD	1	CR	sand streaks and gravel		
OG	27	27	170	451	1450	999	2	PC	1	CRD	1	CR	sand		
OG	27	27	170	1450	1797	347	2	PC	1	CRD	1	CR	shale and sand		
OG	27	27	170	1797	2125	328	2	PC	1	CRD	1	CR	sand		
OG	27	27	170	2125	2248	123	1	C	2	BOU	1	CR	conglomerate and thin shells	Bouse Fm. (?)	
OG	27	27	170	2248	2511	263	1	C	2	BOU	1	CR	conglomerate, shale, lime and shells		
OG	27	27	170	2511	2603	92	1	C	2	BOU	1	CR	conglomerate, shells		
OG	27	27	170	2603	2859	256	1	C	2	BOU	1	CR	conglomerate, shells and shale		
OG	27	27	170	2859	2975	116	1	C	2	BOU	1	CR	conglomerate		
OG	27	27	170	2975	3073	98	1	C	2	BOU	1	CR	Conglomerate and shale and sand		
OG	27	27	170	3073	3177	104	3	PF	4	PCRM	1	CR	sticky shale	Pre-Colorado River	
OG	27	27	170	3177	3229	52	3	PF	4	PCRM	1	CR	shale	Top of Bouse at 3112 ft (Mattick and others, 1973)	
OG	27	27	170	3229	3248	19	1	C	3	PCRT	1	CR	boulders and shale		
OG	27	27	170	3248	3418	170	3	PF	4	PCRM	1	CR	shale		
OG	27	27	170	3418	3776	358	3	PF	4	PCRM	1	CR	shale		3737' 18 degree dip to S54E
OG	27	27	170	3776	3927	151	3	PF	4	PCRM	2	PCR	shale and sand	Bouse Fm. (Brennan, 1979)	3826 avg. approx. 30 deg. Dip to S30W to 5900.
OG	27	27	170	3927	4009	82	3	PF	4	PCRM	2	PCR	shale and sandy shale		
OG	27	27	170	4009	4130	121	2	PC	4	PCRM	2	PCR	sand and shale		
OG	27	27	170	4130	4256	126	3	PF	4	PCRM	2	PCR	shale and sandy shale		
OG	27	27	170	4256	4407	151	3	PF	4	PCRM	2	PCR	shale		
OG	27	27	170	4407	4443	36	3	PF	4	PCRM	2	PCR	hard shale		
OG	27	27	170	4443	4489	46	3	PF	4	PCRM	2	PCR	shale and sandy shale		
OG	27	27	170	4489	4536	47	3	PF	4	PCRM	2	PCR	shale		
OG	27	27	170	4536	4580	44	3	PF	4	PCRM	2	PCR	shale		
OG	27	27	170	4580	4617	37	3	PF	4	PCRM	2	PCR	shale and hard sand		
OG	27	27	170	4617	4652	35	3	PF	4	PCRM	2	PCR	shale		
OG	27	27	170	4652	4653	1	3	PF	4	PCRM	2	PCR	hard shale		
OG	27	27	170	4653	4670	17	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	4670	4705	35	3	PF	4	PCRM	2	PCR	shale and sand		
OG	27	27	170	4705	4724	19	3	PF	4	PCRM	2	PCR	tough shale		
OG	27	27	170	4724	4788	64	2	PC	4	PCRM	2	PCR	sand and shale		
OG	27	27	170	4788	4820	32	3	PF	4	PCRM	2	PCR	hard shale		
OG	27	27	170	4820	4866	46	3	PF	4	PCRM	2	PCR	shale and sand		
OG	27	27	170	4866	4872	6	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	4872	4919	47	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	4919	4946	27	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	4946	4974	28	2	PC	4	PCRM	2	PCR	hard sand	top of NonMarine (Breenan, 1989)	
OG	27	27	170	4974	5012	38	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	5012	5059	47	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	5059	5088	29	2	PC	4	PCRM	2	PCR	hard sand		
OG	27	27	170	5088	5126	38	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	5126	5189	63	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	5189	5214	25	3	PF	4	PCRM	2	PCR	hard shale and sand		
OG	27	27	170	5214	5295	81	3	PF	3	PCRT	2	PCR	shale and granite wash		
OG	27	27	170	5295	5362	67	2	PC	3	PCRT	2	PCR	sand and shale		
OG	27	27	170	5362	5376	14	2	PC	3	PCRT	2	PCR	granite wash and shale		
OG	27	27	170	5376	5447	71	3	PF	3	PCRT	2	PCR	hard shale and sand		
OG	27	27	170	5447	5466	19	2	PC	3	PCRT	2	PCR	granite wash		
OG	27	27	170	5466	5535	69	2	PC	3	PCRT	2	PCR	granite wash and shale		
OG	27	27	170	5535	5806	271	3	PF	3	PCRT	2	PCR	shale and sand		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	27	27	170	5806	5817	11	3	PF	3	PCRT	2	PCR	hard shale		
OG	27	27	170	5817	5867	50	3	PF	3	PCRT	2	PCR	shale and hard sand		
OG	27	27	170	5867	5883	16	1	C	3	PCRT	2	PCR	conglomerate		
OG	27	27	170	5883	6015	132	1	C	3	PCRT	2	PCR	conglomerate		
OG	45	45	173	0	1	1	3	PF	1	CRD	1	CR	soil		
OG	45	45	173	1	18	17	2	PC	1	CRD	1	CR	quick sand		
OG	45	45	173	18	119	101	2	PC	1	CRD	1	CR	sand gravel		
OG	45	45	173	119	140	21	2	PC	1	CRD	1	CR	sand gravel and boulders heavy water producing strata at 138 ft		
OG	45	45	173	140	305	165	2	PC	1	CRD	1	CR	sand gravel and boulders. Clay streaks.		
OG	45	45	173	305	315	10	2	PC	1	CRD	1	CR	Pea gravel. Water.		
OG	45	45	173	315	385	70	2	PC	1	CRD	1	CR	Sand boulders alternate clay streaks		
OG	45	45	173	385	505	120	2	PC	1	CRD	1	CR	red shale, sand streaks, boulders.		
OG	45	45	173	505	573	68	3	PF	8	U	1	CR	gray sandy shale		at 515 ft argillaceous shale w/shell fragments
OG	45	45	173	573	645	72	3	PF	8	U	1	CR	sandy shale		
OG	45	45	173	645	694	49	3	PF	8	U	1	CR	gray shale chert stringers		
OG	45	45	173	694	709	15	3	PF	8	U	1	CR	gray sandy shale		
OG	45	45	173	709	751	42	2	PC	8	U	1	CR	hard sandstone		
OG	45	45	173	751	786	35	2	PC	8	U	1	CR	sandstone and shale		
OG	45	45	173	786	800	14	5	LM	8	U	1	CR	sandstone and lime		
OG	45	45	173	800	816	16	2	PC	8	U	1	CR	hard sandstone. Producing a flow of nitrogen gas		
OG	45	45	173	816	857	41	5	LM	8	U	1	CR	shale sandstone and lime		
OG	45	45	173	857	865	8	2	PC	8	U	1	CR	sandstone show of gas and oil in mud		
OG	45	45	173	865	913	48	3	PF	8	U	1	CR	shale and sandstone gas show at 913		
OG	45	45	173	913	997	84	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	997	1024	27	5	LM	8	U	1	CR	sandstone, lime and shale		
OG	45	45	173	1024	1260	236	5	LM	8	U	1	CR	sandstone, lime stringer and shale. Gas show at 1,183 ft, oil show at 1,208 and 1,230 ft.		
OG	45	45	173	1260	1310	50	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	1310	1510	200	5	LM	8	U	1	CR	sandstone, shale and lime. Oil and gas shows at 1,411, 1473, 1,500 to 1,530.		
OG	45	45	173	1510	1530	20	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	1530	1567	37	3	PF	8	U	1	CR	sandy shale and sandstone		
OG	45	45	173	1567	1624	57	5	LM	8	U	1	CR	sandstone, lime and shale		
OG	45	45	173	1624	1664	40	2	PC	8	U	1	CR	sandstone, shale, dark rubbery mud		
OG	45	45	173	1664	1730	66	2	PC	8	U	1	CR	sandstone and shale		
OG	45	45	173	1730	1873	143	5	LM	8	U	1	CR	sandstone with lime breaks. Show of oil 1,800 to 1,830.		
OG	45	45	173	1873	1898	25	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	1898	1905	7	3	PF	8	U	1	CR	shale		
OG	45	45	173	1905	1915	10	2	PC	8	U	1	CR	sandstone oil show		
OG	45	45	173	1915	1948	33	2	PC	8	U	1	CR	sandstone, shale		
OG	45	45	173	1948	1950	2	1	C	8	U	1	CR	conglomerate. Oil show		
OG	45	45	173	1950	1960	10	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	1960	1977	17	3	PF	8	U	1	CR	sticky shale		
OG	45	45	173	1977	2004	27	5	LM	8	U	1	CR	sandstone, lime and shale		
OG	45	45	173	2004	2006	2	4	CL	8	U	1	CR	mud		
OG	45	45	173	2006	2072	66	5	LM	8	U	1	CR	sandstone, lime stringers		
OG	45	45	173	2072	2083	11	2	PC	8	U	1	CR	sandstone, oil show		
OG	45	45	173	2083	2084	1	4	CL	8	U	1	CR	mud		
OG	45	45	173	2084	2105	21	2	PC	8	U	1	CR	sandstone		
OG	45	45	173	2105	2119	14	2	PC	8	U	1	CR	alternate sandstone and light brown mud		
OG	45	45	173	2119	2123	4	1	C	8	U	1	CR	conglomerate		
OG	45	45	173	2123	2140	17	2	PC	8	U	1	CR	sandstone	Colorado River delta deposits based on amount of sand, silt and dispersed lime (BFG)	
OG	604	604	163	0	3161	3161	2	PC	1	CRD	1	CR	Gravels with minor amounts of coarse sand to 1,030'. Interbedded coarse sand and gravel with minor amounts of shale to 3,161	Colorado River Delta deposits	Colorado River Gravels. See also Eberly and Stanley (1978)
OG	604	604	163	3161	3655	494	3	PF	1	CRD	1	CR	Pelecypod fragments, first occurrence at 3,161'. Interbeds of sand and gray and tan shale grading downward into shale.	Transition Zone.	Appears to be equivalent to Sequence B in Pacheco et al. 2006.
OG	604	604	163	3655	4087	432	3	PF	1	CRD	1	CR	Shale, grey brown interbedded with few ss-sl stringers, trace shell frags	Transition Zone.	Appears to be equivalent to Sequence B in Pacheco et al. 2006.
OG	604	604	163	4087	5430	1343	3	PF	2	BOU	2	PCR	Firm massive gray shale with marine fossils. Occasional interbeds of V.f.g. sand	Bouse Fm	

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	604	604	163	5430	6800	1370	3	PF	2	BOU	2	PCR	Firm massive gray shale with marine fossils. Occasional interbeds of V.f.g. sand	Bouse Fm?	
OG	604	604	163	6800	6974	174	1	C	2	BOU	2	PCR	conglomeratic(?) fine sand and silt	Bouse Fm?	
OG	604	604	163	6974	8500	1526	6	V	6	TVS	3	B	First occurrence of volcanics, ash-flow tuff. Tuffs to 8,500 ft	Pre-Colorado River	Tuffs and volcanics
OG	604	604	163	8500	11000	2500	6	V	6	TVS	3	B	Below 8.500 ft section is composed of alternating beds of basalt flows and conglomerates		
OG	604	604	163	11000	11444	444	3	PF	6	TVS	3	B	from 11,000 ft to T.D. well penetrated fine, red, mineralized siltstone.		
OG	708	708	210	0	450	450	2	PC	1	CRD	1	CR	sands and gravel include thin clay streaks	Colorado River Delta deposits	
OG	708	708	210	450	1391	941	2	PC	1	CRD	1	CR	sands and gravel with some fluvial clay	Colorado River Delta deposits	
OG	708	708	210	1380	1391	11	4	CL	1	CRD	1	CR	lignite and clay	Colorado River Delta deposits	
OG	708	708	210	1391	1820	429	4	CL	2	BOU	1	CR	bluish gray and gray clays with some sand very soft	Bouse Fm	
OG	708	708	210	1820	2244	424	4	CL	4	PCRM	2	PCR	red clay more indurated	Marine underlying Bouse	
OG	708	708	210	2244	2440	196	2	PC	4	PCRM	2	PCR	reddish sands, med-fine, some dark maroon, some clay	Marine underlying Bouse	see logs in OG files for more detail below this interval
OG	708	708	210	2440	2460	20	2	PC	4	PCRM	2	PCR	siliceous rock with well rounded quartz sand	Marine underlying Bouse	
OG	708	708	210	2460	2830	370	2	PC	3	PCRT	2	PCR	reddish sands of maroon sand, some clay, increase fracture of large clasts	Pre-Colorado River	
OG	708	708	210	2830	2900	70	1	C	3	PCRT	2	PCR	fanglomerate with some light colored sand	Pre-Colorado River	
OG	837	837	210	0	40	40	8	U	1	CRD	1	CR	[no log data]	Colorado River Delta deposits	Pipe stuck during drilling at 2,925 ft and abandoned. Rig apparently moved over 25 ft, but location may be in NE quadrant of section. Replaced with No. 1A (OG 840). Cuttings to 2,900 ft used for 1A.
OG	837	837	241	40	1220	1180	1	C	1	CRD	1	CR	Conglomerate	Colorado River Delta deposits	
OG	837	837	241	1220	1260	40	2	PC	1	CRD	1	CR	Conglomerate with shale and sand	Colorado River Delta deposits	
OG	837	837	241	1260	1400	140	2	PC	1	CRD	1	CR	Conglomerate and shale and sand	Colorado River Delta deposits	
OG	837	837	241	1400	1580	180	2	PC	2	BOU	1	CR	Sand with shale and few conglomerate	Bouse Fm	
OG	837	837	241	1580	1600	20	2	PC	2	BOU	1	CR	sand and shale	Bouse Fm	
OG	837	837	241	1600	1650	50	4	CL	2	BOU	1	CR	Shale with sand and lime	Bouse Fm	
OG	837	837	241	1650	1780	130	2	PC	3	PCRT	1	CR	Conglomerate with sand	Pre-Colorado River	
OG	837	837	241	1780	1880	100	2	PC	3	PCRT	1	CR	Conglomerate and shale and sand	Pre-Colorado River	
OG	837	837	241	1880	2120	240	2	PC	3	PCRT	1	CR	Sand with shale and few conglomerate	Pre-Colorado River	
OG	837	837	241	2120	2380	260	3	PF	3	PCRT	1	CR	Shale and sand	Pre-Colorado River	
OG	837	837	241	2380	2500	120	2	PC	3	PCRT	1	CR	Sand with chert and shale	Pre-Colorado River	
OG	837	837	241	2500	2560	60	3	PF	3	PCRT	2	PCR	Shale with sand with chert	Pre-Colorado River	
OG	837	837	241	2560	2795	235	3	PF	3	PCRT	2	PCR	Shale with few sand and trace chert	Pre-Colorado River	
OG	837	837	241	2795	2925	130	2	PC	3	PCRT	2	PCR	conglomeritic sand, unconsolidated with volcanic and granitic frags	Pre-Colorado River	
OG	840	840	241	0	40	40	8	U	1	CRD	1	CR	[unknown]	Colorado River Delta deposits	Continued from OG 837. Log 0 to 2,900 ft is the same.
OG	840	840	241	40	1220	1180	1	C	1	CRD	1	CR	Conglomerate	Colorado River Delta deposits	
OG	840	840	241	1220	1260	40	2	PC	1	CRD	1	CR	Conglomerate with shale and sand	Colorado River Delta deposits	
OG	840	840	241	1260	1400	140	2	PC	1	CRD	1	CR	Conglomerate and shale and sand	Colorado River Delta deposits	hydrocarbon shows at 1,600 ft interval
OG	840	840	241	1400	1580	180	2	PC	2	BOU	2	PCR	Sand with shale and few conglomerate	Bouse Fm	
OG	840	840	241	1580	1600	20	2	PC	2	BOU	2	PCR	sand and shale	Bouse Fm	
OG	840	840	241	1600	1650	50	5	LM	2	BOU	2	PCR	Shale with sand and lime	Bouse Fm	
OG	840	840	241	1650	1780	130	2	PC	2	BOU	2	PCR	Conglomerate with sand	Bouse Fm	
OG	840	840	241	1780	1880	100	2	PC	2	BOU	2	PCR	Conglomerate and shale and sand	Bouse Fm	
OG	840	840	241	1880	2120	240	2	PC	2	BOU	2	PCR	Sand with shale and few conglomerate	Bouse Fm	
OG	840	840	241	2120	2380	260	3	PF	4	PCRM	2	PCR	Shale and sand	Marine underlying Bouse	Note in files say "could be transitional from 2,180 ft (tested by Redbird) to 2,055 - brackish to fresh". A perforated interval between 2,242 and 2,245 ft recovered "salt water".
OG	840	840	241	2380	2500	120	2	PC	4	PCRM	2	PCR	Sand with chert and shale	Marine underlying Bouse	SP an d GR logs similar to Bouse signature and elevation picks to OG 864.
OG	840	840	241	2500	2560	60	3	PF	4	PCRM	2	PCR	Shale with sand with chert	Marine underlying Bouse	as above
OG	840	840	241	2560	2795	235	3	PF	4	PCRM	2	PCR	Shale with few sand and trace chert	Marine underlying Bouse	as above
OG	840	840	241	2795	3400	605	2	PC	4	PCRM	2	PCR	conglomeritic sand, unconsolidated with volcanic and granitic frags	Pre-Colorado River	At 3,165 probable gastropod shell with hydrocarbon showing.
OG	840	840	241	3400	4000	600	2	PC	4	PCRM	2	PCR	sand, rounded, unconsolidated	Pre-Colorado River	

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	840	840	241	4000	5000	1000	7	B	7	B	3	B	quartz monzonite with biotite and hornblende with volcanic frags		Granite Wash
OG	850	850	188	0	1321	1321	2	PC	1	CRD	1	CR	sand, lt brown, fine to med grain, no samples.	Colorado River Delta deposits	[Transferred to BOR in 1994]
OG	850	850	188	1321	1350	29	2	PC	1	CRD	1	CR	sand, light brown, v fine medium, Silty, pebbly, slightly calcareous	Colorado River Delta deposits	Top of transition zone at 1450 ft
OG	850	850	188	1350	1410	60	2	PC	2	BOU	1	CR	sand, light brown, v fine medium, slightly calcareous	Bouse Fm	SDWL #001 1321-2848'
OG	850	850	188	1410	1504	94	2	PC	2	BOU	1	CR	sand, light grey-brown, v fine-coag, silty, pebbly, slightly calcareous	Bouse Fm	
OG	850	850	188	1504	1729	225	2	PC	2	BOU	1	CR	sand, brown, fine medium, slightly laminated, no samples.	Bouse Fm	BC Sand at 1726
OG	850	850	188	1729	1738	9	2	PC	2	BOU	1	CR	sand, gray, fine, calcareous	Bouse Fm	
OG	850	850	188	1738	1746	8	5	LM	2	BOU	1	CR	Course, gray, silty, slightly calcareous	Bouse Fm	
OG	850	850	188	1746	2390	644	3	PF	2	BOU	1	CR	Course, gray, silty, fractured, no samples	Bouse Fm	Coco Sand at 2386
OG	850	850	188	2390	2392	2	5	LM	4	PCRM	2	PCR	sand, light tan, v fine-fine, laminated, calcareous	Marine underlying Bouse. [CR/PCR pick based on logs - BFG]	
OG	850	850	188	2392	2398	6	5	LM	4	PCRM	2	PCR	sand, light gray, v fine-fine, silty, laminated, calcareous, no samples.	Marine underlying Bouse	
OG	850	850	188	2398	2604	206	5	LM	4	PCRM	2	PCR	sand, light gray, v fine, slightly calcareous	Marine underlying Bouse	Casing perforated from ~ 2,508 to 2,572 ft. Bailed water from this interval was tested as fresh. Another interval between ~ 2,390 to 2,450 was swabbed with visible gas and positive odor, later tested with 4,000 ppm TDS.
OG	850	850	188	2604	2641	37	5	LM	4	PCRM	2	PCR	Course, red-brown, slightly silty, calcareous	Marine underlying Bouse	
OG	850	850	188	2641	2680	39	5	LM	4	PCRM	2	PCR	sand, light tan, v fine-fine, slightly silty, laminated, slightly calcareous	Marine underlying Bouse	
OG	850	850	188	2680	2820	140	2	PC	4	PCRM	2	PCR	sand ,light gray, v fine-fine, v silty, crystalline, laminate	Marine underlying Bouse	
OG	850	850	188	2820	2848	28	5	LM	4	PCRM	2	PCR	Course, red-brown, slightly silty, sandy, fine, laminated, slightly calcareous, no samples		
OG	851	851	188	0	500	500	8	U	1	CRD	1	CR	[no log data]	Colorado River Delta deposits	see logs in OG files for alternative elevations of the Bouse.
OG	851	851	188	500	1140	640	2	PC	1	CRD	1	CR	Sand, conglomeratic with occasional intervals of clay, very poorly to moderately to well sorted.	Colorado River Delta deposits	
OG	851	851	188	1140	1160	20	1	C	1	CRD	1	CR	Conglomerate: pea to very coarse sand, angular, poorly sorted, predominantly quartz with biotite and dark mafics.	Colorado River Delta deposits	Top of transition zone
OG	851	851	188	1160	1345	185	2	PC	1	CRD	1	CR	Sand: predominantly quartz and biotite, angular.	Colorado River Delta deposits	
OG	851	851	188	1345	1350	5	2	PC	1	CRD	1	CR	Sand with trace dark punky shale, dark gray brown silt in gray very coarse sand.	Bouse Fm	Bouse Fm
OG	851	851	188	1350	1840	490	2	PC	1	CRD	1	CR	Sand, as above. See OG log for details.	Marine underlying Bouse. CR/PCR pick at 1835 ft-bls based on all logs (BFG)	
OG	851	851	188	1840	1850	10	4	CL	1	CRD	2	PCR	Clay: bluish green to occasionally dark red, very soft, silty.		
OG	851	851	188	1850	1890	40	3	PF	1	CRD	2	PCR	Siltstone: dark gray green, occ. Dark brown, mod. Hard to hard, occ. Very sandy, micaceous, trace calcite.		
OG	851	851	188	1890	1930	40	2	PC	1	CRD	2	PCR	Sand		
OG	851	851	188	1930	1940	10	1	C	1	CRD	2	PCR	Conglomerate	Arkosic sands (?) to TD	
OG	851	851	188	1940	2310	370	2	PC	1	CRD	2	PCR	Sand; rock fragments of granite show up around 2,270 ft		
OG	851	851	188	2310	2335	25	2	PC	1	CRD	2	PCR	Sand pred. white with occ. Clear and pink, very fine to very coarse, very poorly sorted, predom. Angular, moder. Clean with slight clayey silty matrix, with feldspar alternating to kaolin		
OG	851	851	188	2335	2539	204	2	PC	1	CRD	2	PCR	Sand, pred. quartz, clear to white with common vsl stain, coare to very coarse, moderate well sorted, very angular.	"Arkosic sandstone" and "Fractured basement" noted from 2440 to TD.	
OG	863	863	155	0	690	690	2	PC	1	CRD	1	CR	Gravels with coarse sands, clays, quartz particles	Colorado River Delta deposits	Colorado River Gravels
OG	863	863	155	690	770	80	1	C	1	CRD	1	CR	Gravel: varicolored, unconsolidated, ang. To well rounded, fair sorted, pred. granula with fine to coarse quartz sand with CR lithologies.		
OG	863	863	155	770	1500	730	2	PC	1	CRD	1	CR	Overall sand (95%)		
OG	863	863	155	1500	2755	1255	2	PC	1	CRD	1	CR	overall sand with increasing fines (clay and silt) down section. At base of this interval sand is argillaceous, gray and calcareous.		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	863	863	155	2755	2855	100	3	PF	1	CRD	1	CR	Predominantly clay and silt with ~50% sand. . Clastics still suggest Colorado input [bfg].		
OG	863	863	156	2855	3010	155	2	PC	1	CRD	1	CR	sand, brown, clayey, packed ss, angul to well rounded. Moderately well sorted, clear and frosted quartz, chert, argillaceous limestone, trace volcanics, biotite, green sticky clay, minor white kaolinite clay matrix.		
OG	863	863	156	3010	3155	145	3	PF	1	CRD	1	CR	Sand/fine mix, tan, fine to verfy fine, fine to mod. Sorted, common, tan, soft, mod. Hydratable, mod to very adhesive clay, in part white kaolinite; choesive multilithic, quartz monzonite, limestone, calc. cement ss, chert, lignite.		
OG	863	863	157	3155	3255	100	2	PC	1	CRD	1	CR	Sand	Transition Zone.	
OG	863	863	158	3255	3265	10	3	PF	1	CRD	1	CR	Clay		
OG	863	863	159	3265	3300	35	2	PC	1	CRD	1	CR	Sand		
OG	863	863	160	3300	3340	40	3	PF	1	CRD	1	CR	Clay, light brown, soft, very soluble, ttrace firm claystone, interbeds sand and sandstone		
OG	863	863	161	3340	3375	35	2	PC	1	CRD	1	CR	Sandstone: buff, light brown, gray, very fine to very coarse, ss angular to round, mod to well sorted, friable, calc. cemented, common loose coarse grains.		
OG	863	863	162	3375	3495	120	4	CL	1	CRD	1	CR	Clay: light to medium tan, tan to brown, soft, mod. Hydratable/HHR COC mod. White kaolinite, gritty, interbedded sandy lenses, trace macro fossil fragments, SOS thin firm calc. cement ss,		
OG	863	863	163	3495	3825	330	3	PF	1	CRD	1	CR	Sand and clay, similar to above with fossil fragments, pyrite clusters, firm, friable		
OG	863	863	164	3825	3855	30	2	PC	1	CRD	1	CR	Sand,gray to gray brown, firm, firable, calc cement, very fine to fin?, quartz, gray-black chert, volcan, common pyrite, abundant fossil fragments.		Marine setting? With CR clasts?
OG	863	863	165	3855	4100	245	3	PF	1	CRD	1	CR	Clay to sandy clay, fossiliferous, gray to gray-brown, firm		
OG	863	863	165	4100	4200	100	2	PC	1	CRD	1	CR	Sand, similar to above.		
OG	863	863	165	4200	4305	105	3	PF	1	CRD	1	CR	Sandy clay		
OG	863	863	165	4305	4335	30	2	PC	2	BOU	1	CR	Clayey sand/sandy clay 50/50, similar to above lithics, color and consistency	Bouse Fm. Decrease in drilling rate from sands into massive silt and clay at 4400 ft-bls may indicate non-marine overlying marine contact (BFG).	
OG	863	863	165	4335	5450	1115	3	PF	2	BOU	2	PCR	Silt and clay 50/50, calcareous, cohesive, soft to firm, slick, olive gray, occ. Fossiliferous, trace quarts sand, rounded. Trace microfauna	Bouse Fm	
OG	863	863	165	5450	5500	50	2	PC	4	PCRM	2	PCR	Sand: light to medium gray, loose, coarse, very fine to very coarse, angular to well rounded, sorted, predominantly clear and frost quartz, minor green, red and yellow volcanic grains, brown and black chert grains, biotite, trace calcite, pyrite, kaolinite, garnet, ss: light gray, firm to slightly hard, very fine to calc and calc clay CRTD DSC LAM [contorted lamina?], gray clay and siltstone.	Marine. Dipmeter suggests the interval between 5400 and 5700 ft-bls is gently tilted or folded.	Dipmeter data from 5100 to 7000 ft
OG	863	863	165	5500	5540	40	3	PF	4	PCRM	2	PCR	Clay, fossiliferous		
OG	863	863	165	5540	5555	15	2	PC	4	PCRM	2	PCR	Sand, as above sand with fossils		
OG	863	863	165	5555	5650	95	2	PC	4	PCRM	2	PCR	clayey sand, similar to above layer		
OG	863	863	165	5650	6005	355	3	PF	4	PCRM	2	PCR	Clay and silt, firm to soft, light gray, fissile. Laminated clay		
OG	863	863	165	6005	6135	130	1	C	4	PCRM	2	PCR	Clayey sand, gray soft, flakey, frost and clear quartz, dark gray chert		
OG	863	863	165	6135	6306	171	3	PF	4	PCRM	2	PCR	Sandy silt and claystone: dark gray chert, rounded to moderate well sorted, clear and frosted quartz, trace biotite, dark gray chert grains, soft. Silt calcarous.		
OG	863	863	155	6306	7000	694	6	V	5	TV	3	B	volcanic material, tuff, altered sands, interbedded siltstones & clays	Volcanic and sediments (interbedded and/or faulted?	
OG	864	864	172	0	320	320	8	U	1	CRD	1	CR	no log		
OG	864	864	172	320	370	50	1	C	1	CRD	1	CR	Predominantly gravel and caliche, variegated, multi-colored lithics, red, yellow, green jasperoid, moderately altered basalt, mineralized tuff, trace detrital granitics and dark schist.		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	864	864	172	370	1170	800	2	PC	1	CRD	1	CR	Sand: litht tan, very fine to very coarse, moderately to well-sorted, subangular to well rounded, quartz, trace lithic fragments and mica, loosley consolidated. Clear, cloudy and white quartz sand with occasional staining. Occasional light gray, calcarous, clayey, firm to hard sandstone and white		
OG	864	864	172	1170	2610	1440	2	PC	1	CRD	1	CR	Predominantly sand with increasing-downward portions of clay. Sand is approx. 60 to 70 % of fraction. Sand as above. Clay is soft, soluble matrix; minor hard TT, calcareous SS.		
OG	864	864	172	2610	2972	362	4	CL	1	CRD	1	CR	Predominantly clay: light brown, soft to very firm, sticky, silty, calcareous, thin-bedded with fine to medium, dirty, calcareous sandstone, dissemenated very coarse(?) to granule, sands rounded to well rounded ign-meta clasts, chert and basalt; fossil fragments, pelecypods and gastropods fragments.		
OG	864	864	172	2972	3260	288	4	CL	2	BOU	1	CR	as above noted in MUD log	Bouse noted from 2972 to 3730 ft	Dipmeter data from 2900 to 9100 ft
OG	864	864	172	3260	3775	515	3	PF	2	BOU	1	CR	Predominantly siltstone with abundant clay (30-40%). Silt is light to medium gray, soft to slightly firm, calcareous, micromica, fossil fragments.		
OG	864	864	172	3775	3825	50	2	PC	3	PCRT	1	CR	Pred. sand with silt and clay. Sand loose, fine to medium grained, occ. Coarse to very coarse, ang. To well rounded, moderately wel sorted, clear to cloudy quartz, dark gray, black and green rock grains, biotite, muscovite and fossil fragments.		
OG	864	864	172	3825	4010	185	3	PF	4	PCRT	1	CR	Predominantly siltstone with abundant clay (30-40%). As above.		
OG	864	864	172	4010	4375	365	2	PC	5	PCRT	2	PCR	Sand: light to medium gray, fine to coarse, loose, mod. To well sorted, pred. clear subang. To subr. Quartz, moderately cloudy quartz, minor fresh euhedral biotite, minor pyrite, trace chlorite, rare trace fossil fragments.		
OG	864	864	172	4375	4600	225	4	CL	6	PCRT	2	PCR	Clay: brown to gray-green, soft, soluble with minor firm siltstone and sand (light gray with some limonite staining, ang. to round, well sorted quartz).		
OG	864	864	172	4600	4835	235	2	PC	7	PCRT	2	PCR	Sand: rust-pink, fine to med-cse, subangular to subrounded, well sorted, limonite stained, koalinite, diorite, clumps biotite, trace fossile, and very soluble interstitial clays.		
OG	864	864	172	4835	4860	25	4	CL	8	PCRT	2	PCR	Clay: light gray, soft, soluble to sticky, minor firm siltstone, very fine to coarse, angul. Ss rounded, clear to cloudy quartz sand, trace fossils.		
OG	864	864	172	4860	7300	2440	2	PC	9	PCRT	2	PCR	Pred. loose sand with clay and silt, arkosic, rust-pink color, fine to med. Coarse, mod. To well sorted with soft red soluble clay. No fossils reported except at one interval around 5500 ft with pelycypods and other shell fragments.		
OG	864	864	172	7300	8225	925	2	PC	10	PCRT	2	PCR	As above but with increase percentage of silt and clay. Trace black chert and fossil fragments (macro). Color shift to gray-brown with moderately calcarious cement. Firm to hard.		
OG	864	864	172	8225	8300	75	2	PC	11	PCRT	2	PCR	As above with minor amount of moderate clear to white ahydrite in gray-buff, fine to medium, well cemented calcareous and silica cement.		
OG	864	864	172	8300	9135	835	2	PC	12	PCRT	2	PCR	Pred. sand and sandstone: light gray, fine to med., firm, hard to brittle, kaolinitic. Granite Wash at 8950 to TD. Fossil fragments reported at 8850 ft. See MUD log for additional details of lithology.		
OG	1410	14-10	155	0	192	192	2	PC	4	PCRM	1	CR	sand and gravel		
OG	1410	14-10	155	192	258	66	2	PC	4	PCRM	1	CR	sand, fine, with silt and clay interbedded		
OG	1410	14-10	155	258	471	213	3	PF	4	PCRM	1	CR	Silt and clay with some fine sand		
OG	1410	14-10	155	471	505	34	1	C	4	PCRM	1	CR	Gravel and conglomerate, subrounded to rounded, mostly granitic, with some fossils and volcanics		
OG	1412	14-12	55	0	48	48	4	CL	1	CRD	1	CR	clay	Upper, fine-grained zone	See detailed log in Olmsted (1973), p. H173-H174.

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1412	14-12	55	48	89	41	4	CL	1	CRD	1	CR	sand with 50% clay		
OG	1412	14-12	55	89	174	85	1	C	1	CRD	1	CR	gravel	Coarse-gravel zone	
OG	1412	14-12	55	174	187	13	2	PC	1	CRD	1	CR	sand	Wedge zone	
OG	1412	14-12	55	187	295	108	2	PC	1	CRD	1	CR	sand with scattered pebbles		
OG	1412	14-12	55	295	305	10	2	PC	1	CRD	1	CR	sand with gravel		
OG	1412	14-12	55	305	315	10	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	315	335	20	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	335	380	45	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	380	383	3	2	PC	1	CRD	1	CR	gravel with fine sand		
OG	1412	14-12	55	383	426	43	2	PC	1	CRD	1	CR	sand with pebbles		
OG	1412	14-12	55	426	430	4	2	PC	1	CRD	1	CR	sand some gravel and green to brown plastic clay		
OG	1412	14-12	55	430	445	15	2	PC	1	CRD	1	CR	sand with fine gravel		
OG	1412	14-12	55	445	463	18	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	463	490	27	2	PC	1	CRD	1	CR	sand with gravel and a few green bentonitic clay balls		
OG	1412	14-12	55	490	507	17	2	PC	1	CRD	1	CR	sand and fine pebbles		
OG	1412	14-12	55	507	515	8	2	PC	1	CRD	1	CR	gravel and sand		
OG	1412	14-12	55	515	540	25	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	540	545	5	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	545	548	3	4	CL	1	CRD	1	CR	clay		
OG	1412	14-12	55	548	570	22	2	PC	1	CRD	1	CR	gravel		
OG	1412	14-12	55	570	581	11	2	PC	1	CRD	1	CR	sand with gravel		
OG	1412	14-12	55	581	590	9	2	PC	1	CRD	1	CR	sand with gravel		
OG	1412	14-12	55	590	600	10	2	PC	1	CRD	1	CR	sand with pebbles		
OG	1412	14-12	55	600	705	105	2	PC	1	CRD	1	CR	sand and gravel		
OG	1412	14-12	55	705	714	9	4	CL	1	CRD	1	CR	clay, soft, brown		
OG	1412	14-12	55	714	728	14	2	PC	1	CRD	1	CR	gravel and sand		
OG	1412	14-12	55	728	731	3	3	PF	1	CRD	1	CR	silt, clayey, brown		
OG	1412	14-12	55	731	753	22	2	PC	1	CRD	1	CR	sand and gravel		
OG	1412	14-12	55	753	759	6	3	PF	1	CRD	1	CR	silt, clayey, brown		
OG	1412	14-12	55	759	794	35	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1412	14-12	55	794	809	15	4	CL	1	CRD	1	CR	clay, soft, grayish brown; some gray clay	Transition zone (?)	
OG	1412	14-12	55	809	816	7	2	PC	1	CRD	1	CR	sand		
OG	1412	14-12	55	816	831	15	4	CL	1	CRD	1	CR	clay, soft, gray brown		
OG	1412	14-12	55	831	885	54	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1412	14-12	55	885	944	59	4	CL	1	CRD	1	CR	clay, brown and gray, fossiliferous, interbedded sand	Transition zone	
OG	1412	14-12	55	944	969	25	2	PC	1	CRD	1	CR	gravel, somewhat cemented, and sand		
OG	1412	14-12	55	969	1045	76	2	PC	2	BOU	1	CR	sand and gravel; thin beds of fossiliferous gray silty clay	possible Bouse Fm. at 972 ft (Mattick et al., 1973)	
OG	1412	14-12	55	1045	1065	20	4	CL	2	BOU	1	CR	clay, bluish-gray and pinkish-brown, fossiliferous	Bouse Formation	
OG	1412	14-12	55	1065	1071	6	3	PF	2	BOU	1	CR	silt and fine sand, well-sorted, gray		
OG	1412	14-12	55	1071	1088	17	4	CL	2	BOU	1	CR	clay, bluish-gray and pinkish-brown, fossiliferous		
OG	1412	14-12	55	1088	1093	5	3	PF	2	BOU	1	CR	silt and fine sand, well-sorted, gray		
OG	1412	14-12	55	1093	1110	17	4	CL	2	BOU	1	CR	clay, bluish-gray and pinkish-brown, fossiliferous		
OG	1412	14-12	55	1110	1118	8	3	PF	2	BOU	1	CR	silt and fine sand, well-sorted, gray		
OG	1412	14-12	55	1118	1249	131	4	CL	2	BOU	1	CR	clay and silty clay, bluish-gray and pinkish brown, fossiliferous		
OG	1412	14-12	55	1249	1257	8	3	PF	2	BOU	1	CR	silt and clayey silt		
OG	1412	14-12	55	1257	1297	40	4	CL	2	BOU	1	CR	clay and silty clay, bluish-gray and pinkish brown, fossiliferous		
OG	1412	14-12	55	1297	1330	33	3	PF	2	BOU	1	CR	silt and clayey silt, gray, fossiliferous		
OG	1412	14-12	55	1330	1345	15	4	CL	2	BOU	1	CR	clay and silty clay, bluish-gray and pinkish brown, fossiliferous		
OG	1412	14-12	55	1345	1372	27	3	PF	2	BOU	1	CR	silt and clayey silt, gray fossiliferous		
OG	1412	14-12	55	1372	1396	24	4	CL	2	BOU	1	CR	clay and silty clay, bluish-gray and pinkish brown, fossiliferous		
OG	1412	14-12	55	1396	1435	39	2	PC	4	PCRM	2	PCR	sand, fine, gray, somewhat indurated; some medium sand and silt; fossiliferous	Older marine sedimentary rocks	
OG	1412	14-12	55	1435	1473	38	4	CL	4	PCRM	2	PCR	clay, gray		
OG	1412	14-12	55	1473	1506	33	3	PF	4	PCRM	2	PCR	silt		
OG	1412	14-12	55	1506	1529	23	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1529	1575	46	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1575	1591	16	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1591	1615	24	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1615	1632	17	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1632	1651	19	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1651	1668	17	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1668	1680	12	2	PC	4	PCRM	2	PCR	sand		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1412	14-12	55	1680	1686	6	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1686	1701	15	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1701	1706	5	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1706	1722	16	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1722	1731	9	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1731	1757	26	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1757	1768	11	4	CL	4	PCRM	2	PCR	clay		
OG	1412	14-12	55	1768	1829	61	3	PF	4	PCRM	2	PCR	silt fine sand, and clay, somewhat indurated and fossiliferous [and overlying abbreviated lithologies]		
OG	1412	14-12	55	1829	1851	22	2	PC	4	PCRM	2	PCR	sand		
OG	1412	14-12	55	1851	1937	86	3	PF	4	PCRM	2	PCR	silt, fine sand, and clay		
OG	1412	14-12	55	1937	1942	5	4	CL	4	PCRM	2	PCR	clay, gray, bentonitic		
OG	1412	14-12	55	1942	1976	34	2	PC	4	PCRM	2	PCR	sand, fine to medium, gray, somewhat indurated		
OG	1412	14-12	55	1976	1997	21	4	CL	4	PCRM	2	PCR	clay, sandy and silt, pale-greenish-gray		
OG	1413	14-13	205	0	25	25	2	PC	1	CRD	1	CR	sand	Upper, fine-grained zone	Detailed log in Olmsted (1973), p. H176-H177.
OG	1413	14-13	205	25	45	20	1	C	1	CRD	1	CR	gravel		
OG	1413	14-13	205	45	69	24	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	69	82	13	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	82	109	27	2	PC	1	CRD	1	CR	sand, silty; some gravel and brown clay		
OG	1413	14-13	205	109	142	33	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	142	160	18	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	160	165	5	1	C	1	CRD	1	CR	gravel, cemented	Coarse-gravel zone	
OG	1413	14-13	205	165	175	10	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	175	188	13	2	PC	1	CRD	1	CR	sand, fine to coarse		
OG	1413	14-13	205	188	197	9	1	C	1	CRD	1	CR	gravel		
OG	1413	14-13	205	197	207	10	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	207	210	3	4	CL	1	CRD	1	CR	clay, silty, brown		
OG	1413	14-13	205	210	245	35	2	PC	1	CRD	1	CR	sand, gravel and some silty clay		
OG	1413	14-13	205	245	249	4	4	CL	1	CRD	1	CR	clay, silty	Coarse-gravel zone (?)	
OG	1413	14-13	205	249	254	5	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	254	261	7	4	CL	1	CRD	1	CR	clay		
OG	1413	14-13	205	261	304	43	2	PC	1	CRD	1	CR	gravel and coarse sand		
OG	1413	14-13	205	304	317	13	2	PC	1	CRD	1	CR	sand, silt and clay	Wedge zone	
OG	1413	14-13	205	317	427	110	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	427	431	4	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	431	526	95	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	526	530	4	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	530	573	43	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	573	578	5	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	578	661	83	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	661	665	4	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	665	733	68	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	733	736	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	736	756	20	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	756	760	4	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	760	771	11	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1413	14-13	205	771	774	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	774	782	8	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1413	14-13	205	782	785	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	785	817	32	2	PC	1	CRD	1	CR	sand and gravel		
OG	1413	14-13	205	817	820	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	820	837	17	2	PC	1	CRD	1	CR	sand and fine gravel; some fine white sandstone		
OG	1413	14-13	205	837	841	4	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	841	891	50	2	PC	1	CRD	1	CR	sand, coarse; and gravel (chiefly metamorphic and volcanic)		
OG	1413	14-13	205	891	894	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	894	920	26	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	920	923	3	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	923	930	7	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	930	941	11	2	PC	1	CRD	1	CR	sand and gravel		
OG	1413	14-13	205	941	944	3	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	944	955	11	2	PC	1	CRD	1	CR	sand and gravel		
OG	1413	14-13	205	955	965	10	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	965	975	10	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	975	978	3	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	978	986	8	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	986	1020	34	2	PC	1	CRD	1	CR	sand		

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OG	1413	14-13	205	1020	1023	3	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	1023	1036	13	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1036	1040	4	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	1040	1043	3	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1043	1054	11	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1054	1058	4	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	1058	1066	8	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1066	1071	5	4	CL	1	CRD	1	CR	clay, gray or brownish-gray		
OG	1413	14-13	205	1071	1090	19	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1090	1127	37	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	1127	1159	32	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1159	1164	5	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1164	1188	24	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1188	1192	4	4	CL	1	CRD	1	CR	clay, gray		
OG	1413	14-13	205	1192	1254	62	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1254	1258	4	3	PF	1	CRD	1	CR	silt		
OG	1413	14-13	205	1258	1277	19	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1277	1281	4	3	PF	1	CRD	1	CR	silt, clayey		
OG	1413	14-13	205	1281	1288	7	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1288	1299	11	4	CL	1	CRD	1	CR	clay, hard, light brownish-gray		
OG	1413	14-13	205	1299	1322	23	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1322	1325	3	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1325	1350	25	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1350	1357	7	2	PC	1	CRD	1	CR	gravel and sand		
OG	1413	14-13	205	1357	1378	21	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1378	1384	6	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	1384	1420	36	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1420	1424	4	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1424	1441	17	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1441	1444	3	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1444	1454	10	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1454	1461	7	4	CL	1	CRD	1	CR	clay		
OG	1413	14-13	205	1461	1467	6	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1467	1480	13	2	PC	1	CRD	1	CR	gravel and coarse sand		
OG	1413	14-13	205	1480	1497	17	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1497	1502	5	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1502	1535	33	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1535	1539	4	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	1539	1576	37	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1576	1580	4	4	CL	1	CRD	1	CR	clay, silty		
OG	1413	14-13	205	1580	1590	10	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1590	1616	26	4	CL	1	CRD	1	CR	clay, soft, sticky, light brownish-gray		
OG	1413	14-13	205	1616	1631	15	1	C	1	CRD	1	CR	gravel (mostly plutonic, volcanic, and metamorphic rock detritus, some chert and quartzite)		
OG	1413	14-13	205	1631	1648	17	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1648	1651	3	3	PF	1	CRD	1	CR	silt, sandy, soft		
OG	1413	14-13	205	1651	1675	24	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1675	1678	3	3	PF	1	CRD	1	CR	silt, sandy, soft		
OG	1413	14-13	205	1678	1732	54	2	PC	1	CRD	1	CR	sand; beds of cemented sand and gravel		
OG	1413	14-13	205	1732	1741	9	4	CL	1	CRD	1	CR	clay, hard, light brownish-gray		
OG	1413	14-13	205	1741	1754	13	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1754	1767	13	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1767	1772	5	4	CL	1	CRD	1	CR	clay, soft, light brownish gray		
OG	1413	14-13	205	1772	1800	28	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1800	1823	23	4	CL	1	CRD	1	CR	clay, silty and sandy		
OG	1413	14-13	205	1823	1858	35	2	PC	1	CRD	1	CR	sand and gravel, somewhat indurated		
OG	1413	14-13	205	1858	1863	5	3	PF	1	CRD	1	CR	silt, sandy		
OG	1413	14-13	205	1863	1933	70	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1933	1943	10	4	CL	1	CRD	1	CR	clay, brown		
OG	1413	14-13	205	1943	1964	21	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1964	1974	10	4	CL	1	CRD	1	CR	clay		
OG	1413	14-13	205	1974	1984	10	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	1984	1997	13	4	CL	1	CRD	1	CR	clay		
OG	1413	14-13	205	1997	2101	104	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	2101	2110	9	4	CL	1	CRD	1	CR	clay, hard; or pale bluish-gray and pale brown claystone; pelecypods	transition zone	
OG	1413	14-13	205	2110	2117	7	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	2117	2122	5	4	CL	1	CRD	1	CR	clay, hard; or pale bluish-gray and pale brown claystone; pelecypods		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1413	14-13	205	2122	2131	9	2	PC	1	CRD	1	CR	sand		
OG	1413	14-13	205	2131	2144	13	4	CL	1	CRD	1	CR	clay and claystone, medium bluish-gray and brown; pelecypods		
OG	1413	14-13	205	2144	2154	10	2	PC	1	CRD	1	CR	sand and silt		
OG	1413	14-13	205	2154	2185	31	4	CL	1	CRD	1	CR	clay and claystone, medium bluish-gray and brown; pelecypods		
OG	1413	14-13	205	2185	2216	31	2	PC	1	CRD	2	PCR	sand, fine to coarse; somewhat indurated, gray	CR/PCR pick based on similar lithology, caliper and resistivity from OG 14-12 (BFG)	
OG	1413	14-13	205	2216	2219	3	4	CL	1	CRD	2	PCR	clay		
OG	1413	14-13	205	2219	2253	34	2	PC	1	CRD	2	PCR	sand		
OG	1413	14-13	205	2253	2271	18	4	CL	1	CRD	2	PCR	clay and claystone, bluish-gray, olive-gray, and brown; pelecypods; some interbedded sand and silt		
OG	1413	14-13	205	2271	2286	15	2	PC	1	CRD	2	PCR	sand		
OG	1413	14-13	205	2286	2294	8	4	CL	1	CRD	2	PCR	clay and claystone, bluish-gray, olive-gray, and brown; pelecypods; some interbedded sand and silt		
OG	1413	14-13	205	2294	2307	13	2	PC	1	CRD	2	PCR	sand		
OG	1413	14-13	205	2307	2318	11	4	CL	1	CRD	2	PCR	clay, hard; or tough sticky olive-gray claystone; some pelecypods.		
OG	1414	14-14	150	0	15	15	2	PC	1	CRD	1	CR	surface sand		
OG	1414	14-14	150	15	35	20	1	C	1	CRD	1	CR	gravel		
OG	1414	14-14	150	35	72	37	4	CL	1	CRD	1	CR	clay		
OG	1414	14-14	150	72	98	26	2	PC	1	CRD	1	CR	water sand		
OG	1414	14-14	150	98	163	65	4	CL	1	CRD	1	CR	clay		
OG	1414	14-14	150	163	291	128	3	PF	1	CRD	1	CR	sandy shale		
OG	1414	14-14	150	291	327	36	2	PC	1	CRD	1	CR	water sand		
OG	1414	14-14	150	327	419	92	3	PF	1	CRD	1	CR	grey shale		
OG	1414	14-14	150	419	678	259	1	C	1	CRD	1	CR	shale and boulders		
OG	1414	14-14	150	678	739	61	3	PF	1	CRD	1	CR	red bed		
OG	1414	14-14	150	739	744	5	5	LM	1	CRD	1	CR	lime shell		
OG	1414	14-14	150	744	789	45	2	PC	1	CRD	1	CR	sand		
OG	1414	14-14	150	789	863	74	3	PF	1	CRD	1	CR	sandy shale		
OG	1414	14-14	150	863	903	40	3	PF	1	CRD	1	CR	red bed		
OG	1414	14-14	150	903	1012	109	5	LM	1	CRD	1	CR	sandy shale with lime shells		
OG	1414	14-14	150	1012	1019	7	2	PC	1	CRD	1	CR	sand showing gas		
OG	1414	14-14	150	1019	1078	59	3	PF	1	CRD	1	CR	sandy shale		
OG	1414	14-14	150	1078	1137	59	3	PF	2	BOU	1	CR	shale	Bouse Fm	
OG	1414	14-14	150	1137	1206	69	3	PF	2	BOU	1	CR	sandy shale with lime shells	Bouse Fm	
OG	1414	14-14	150	1206	1226	20	2	PC	2	BOU	1	CR	sand - showing oil	Bouse Fm	
OG	1414	14-14	150	1226	1393	167	3	PF	2	BOU	1	CR	rotten shale	Bouse Fm	
OG	1414	14-14	150	1393	1409	16	5	LM	2	BOU	1	CR	lime shell	Bouse Fm	
OG	1414	14-14	150	1409	1481	72	3	PF	2	BOU	1	CR	brown shale	Bouse Fm	
OG	1414	14-14	150	1481	1531	50	3	PF	4	PCRM	1	CR	sandy shale with lime shells		
OG	1414	14-14	150	1531	1596	65	3	PF	4	PCRM	1	CR	red bed		
OG	1414	14-14	150	1596	1639	43	3	PF	4	PCRM	1	CR	hard shale		
OG	1414	14-14	150	1639	1683	44	3	PF	4	PCRM	1	CR	shale and shells		
OG	1414	14-14	150	1683	1756	73	2	PC	4	PCRM	1	CR	hard sand		
OG	1414	14-14	150	1756	1800	44	3	PF	4	PCRM	1	CR	sandy shale		
OG	1414	14-14	150	1800	1828	28	2	PC	4	PCRM	1	CR	oil sand: fine brown sand, strong odor	CR determination based on proximal well OG 851 (BFG)	Cored 1824-1828
OG	1415	14-15	119	0	28	28	2	PC	1	CRD	1	CR	sand, fine and silt	Upper, fine-grained zone	Detailed log in Olmsted (1973), p. H180-H182.
OG	1415	14-15	119	28	85	57	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	85	93	8	4	CL	1	CRD	1	CR	clay, silty, brown		
OG	1415	14-15	119	93	109	16	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	109	115	6	2	PC	1	CRD	1	CR	sand, some pebbles		
OG	1415	14-15	119	115	124	9	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	124	186	62	1	C	1	CRD	1	CR	gravel, coarse, predominantly subrounded to rounded; some coarse sand.	Coarse-gravel zone	
OG	1415	14-15	119	186	214	28	2	PC	1	CRD	1	CR	sand, silt, and clay; thin streaks of gravel	Wedge zone	
OG	1415	14-15	119	214	290	76	2	PC	1	CRD	1	CR	sand, fine to coarse; thin beds of clay and silt		
OG	1415	14-15	119	290	326	36	2	PC	1	CRD	1	CR	sand, fine and silt		
OG	1415	14-15	119	326	330	4	3	PF	1	CRD	1	CR	silt, pale-brown		
OG	1415	14-15	119	330	356	26	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	356	362	6	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	362	395	33	2	PC	1	CRD	1	CR	sand, fine to coarse, somewhat pebbly		
OG	1415	14-15	119	395	401	6	3	PF	1	CRD	1	CR	silt, light brown		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1415	14-15	119	401	408	7	2	PC	1	CRD	1	CR	sand, sparse small pebbles		
OG	1415	14-15	119	408	410	2	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	410	421	11	2	PC	1	CRD	1	CR	sand, fine to coarse		
OG	1415	14-15	119	421	425	4	4	CL	1	CRD	1	CR	clay, silty brown		
OG	1415	14-15	119	425	448	23	2	PC	1	CRD	1	CR	sand, fine to coarse		
OG	1415	14-15	119	448	451	3	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	451	530	79	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	530	534	4	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	534	549	15	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	549	552	3	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	552	632	80	2	PC	1	CRD	1	CR	sand, fine to medium; some coarse pebbly sand. Pebbles mostly plutonic, volcanic, and metamorphic rocks; a few are well-rounded chert and quartzite. Many fragments of plants and carbonized wood.		
OG	1415	14-15	119	632	637	5	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	637	651	14	2	PC	1	CRD	1	CR	sand, some fine to medium gravel.		
OG	1415	14-15	119	651	657	6	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	657	680	23	2	PC	1	CRD	1	CR	sand, some fine to medium gravel.		
OG	1415	14-15	119	680	710	30	2	PC	1	CRD	1	CR	sand		
OG	1415	14-15	119	710	750	40	2	PC	1	CRD	1	CR	sand, fine to medium		
OG	1415	14-15	119	750	790	40	2	PC	1	CRD	1	CR	sand, medium to coarse		
OG	1415	14-15	119	790	810	20	2	PC	1	CRD	1	CR	sand, fine to medium; some silt		
OG	1415	14-15	119	810	860	50	2	PC	1	CRD	1	CR	sand, scattered pebbles		
OG	1415	14-15	119	860	908	48	2	PC	1	CRD	1	CR	sand, fine to medium, gray; some silt		
OG	1415	14-15	119	908	918	10	2	PC	1	CRD	1	CR	sand, medium to coarse, gray		
OG	1415	14-15	119	918	923	5	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	923	975	52	2	PC	1	CRD	1	CR	sand, fine to coarse, poorly sorted; granules and small pebbles mostly of black chert and silicic volcanic rocks		
OG	1415	14-15	119	975	979	4	3	PF	1	CRD	1	CR	silt, light brown		
OG	1415	14-15	119	979	1000	21	2	PC	1	CRD	1	CR	sand, some gravel, fine to coarse, poorly sorted.		
OG	1415	14-15	119	1000	1072	72	2	PC	1	CRD	1	CR	sand, fine to medium, and silt		
OG	1415	14-15	119	1072	1078	6	2	PC	1	CRD	1	CR	sand, fine to coarse, pebbly		
OG	1415	14-15	119	1078	1168	90	2	PC	1	CRD	1	CR	sand and silt, fine to medium		
OG	1415	14-15	119	1168	1175	7	4	CL	1	CRD	1	CR	clay, brown to brownish gray		
OG	1415	14-15	119	1175	1377	202	2	PC	1	CRD	1	CR	sand and silt, fine to medium		
OG	1415	14-15	119	1377	1382	5	4	CL	1	CRD	1	CR	clay,, light-brownish gray		
OG	1415	14-15	119	1382	1462	80	2	PC	1	CRD	1	CR	sand, fine to coarse, and fine gravel		
OG	1415	14-15	119	1462	1471	9	3	PF	1	CRD	1	CR	silt, light brown, and light brownish gray clay		
OG	1415	14-15	119	1471	1480	9	2	PC	1	CRD	1	CR	sand and fine gravel		
OG	1415	14-15	119	1480	1485	5	1	C	1	CRD	1	CR	gravel, cemented		
OG	1415	14-15	119	1485	1672	187	2	PC	1	CRD	1	CR	sand, medium to coarse; scattered pebbles and thin beds of gravel		
OG	1415	14-15	119	1672	1677	5	4	CL	1	CRD	1	CR	clay, gray and brown		
OG	1415	14-15	119	1677	1699	22	2	PC	1	CRD	1	CR	sand, coarse, and gravel		
OG	1415	14-15	119	1699	1703	4	3	PF	1	CRD	1	CR	silt and grayish-white clay; possibly a few pebbles		
OG	1415	14-15	119	1703	1740	37	2	PC	1	CRD	1	CR	sand, some gravel and clay balls		
OG	1415	14-15	119	1740	1742	2	3	PF	1	CRD	1	CR	silt and clay, brown and gray		
OG	1415	14-15	119	1742	1756	14	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1415	14-15	119	1756	1760	4	4	CL	1	CRD	1	CR	clay, silty, gray		
OG	1415	14-15	119	1760	1794	34	2	PC	1	CRD	1	CR	sand, some gravel; thin cemented zones or concretions		
OG	1415	14-15	119	1794	1799	5	2	PC	1	CRD	1	CR	sand, coarse, and fine gravel, somewhat cemented		
OG	1415	14-15	119	1799	1815	16	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1415	14-15	119	1815	1820	5	4	CL	1	CRD	1	CR	clay, grayish brown		
OG	1415	14-15	119	1820	1860	40	2	PC	1	CRD	1	CR	sand, some gravel		
OG	1415	14-15	119	1860	1927	67	2	PC	1	CRD	1	CR	sand, fine to coarse		
OG	1415	14-15	119	1927	1938	11	4	CL	1	CRD	1	CR	clay, gray, fossiliferous	Transition zone	
OG	1415	14-15	119	1938	1955	17	2	PC	1	CRD	1	CR	sand and silt, gray		
OG	1415	14-15	119	1955	1976	21	4	CL	1	CRD	1	CR	clay, gray, fossiliferous		
OG	1415	14-15	119	1976	2028	52	2	PC	1	CRD	1	CR	sand, fine to coarse, gray; some fine gravel		
OG	1415	14-15	119	2028	2045	17	4	CL	1	CRD	1	CR	clay, gray and fine sand, fossiliferous		
OG	1415	14-15	119	2045	2090	45	2	PC	1	CRD	1	CR	sand, fine to coarse, gray and subangular to rounded gravel composed of chert and quartzite in addition to plutonic, volcanic and metamorphic rocks		
OG	1415	14-15	119	2090	2130	40	4	CL	1	CRD	1	CR	clay, gray, silt and fine sand, fossiliferous		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1415	14-15	119	2130	2143	13	2	PC	1	CRD	1	CR	sand, some fine gravel		
OG	1415	14-15	119	2143	2156	13	4	CL	1	CRD	1	CR	clay, silty, gray, fossiliferous		
OG	1415	14-15	119	2156	2176	20	2	PC	1	CRD	1	CR	sand, fine to medium, gray		
OG	1415	14-15	119	2176	2180	4	4	CL	1	CRD	1	CR	clay and silt, gray, fossiliferous		
OG	1415	14-15	119	2180	2218	38	2	PC	1	CRD	1	CR	sand and gravel, fine to coarse, gray, subangular to rounded; composed of chert and quartzite in addition to plutonic, volcanic and metamorphic rocks.		
OG	1415	14-15	119	2218	2223	5	4	CL	1	CRD	1	CR	clay, gray, fossiliferous		
OG	1415	14-15	119	2223	2292	69	2	PC	1	CRD	1	CR	sand and gravel, fine to coarse, gray, subangular to rounded; composed of chert and quartzite in addition to plutonic, volcanic and metamorphic rocks.		
OG	1415	14-15	119	2292	2302	10	4	CL	1	CRD	1	CR	clay, gray, and fine sand, fossiliferous		
OG	1415	14-15	119	2302	2350	48	2	PC	1	CRD	1	CR	sand and gravel, somewhat cemented		
OG	1415	14-15	119	2350	2395	45	4	CL	1	CRD	1	CR	clay, gray and fine sand, interbedded		
OG	1415	14-15	119	2395	2446	51	2	PC	1	CRD	1	CR	sand and gravel, somewhat cemented		
OG	1415	14-15	119	2446	2466	20	4	CL	1	CRD	1	CR	clay, gray, fossiliferous		
OG	1416	14-16	104	0	101	101	2	PC	1	CRD	1	CR	sand, silty, some wood	Upper, fine-grained zone	Detailed log in Olmsted (1973), p. H181-H182.
OG	1416	14-16	104	101	179	78	2	PC	1	CRD	1	CR	sand and gravel, gravel and sand	Coarse-gravel zone	
OG	1416	14-16	104	179	200	21	2	PC	1	CRD	1	CR	sand, some silt and gravel		
OG	1416	14-16	104	200	205	5	1	C	1	CRD	1	CR	gravel with boulders	Coarse-gravel zone (?)	
OG	1416	14-16	104	205	285	80	2	PC	1	CRD	1	CR	sand, silty, clayey, and gravels		
OG	1416	14-16	104	285	302	17	1	C	1	CRD	1	CR	gravel, boulders, and cobbles		
OG	1416	14-16	104	302	1024	722	2	PC	1	CRD	1	CR	sand, silty sand and gravel	Wedge zone	
OG	1416	14-16	104	1024	1032	8	4	CL	1	CRD	1	CR	clay		
OG	1416	14-16	104	1032	1153	121	3	PF	1	CRD	1	CR	sand, silt, some gravel, some carbonized wood		
OG	1416	14-16	104	1153	1158	5	4	CL	1	CRD	1	CR	white clay		
OG	1416	14-16	104	1158	1201	43	2	PC	1	CRD	1	CR	sand, silty		
OG	1417	14-17	185	0	82	82	2	PC	1	CRD	1	CR	sand	Upper, fine-grained zone	See detailed log in Olmsted (1973), p. H183-H184.
OG	1417	14-17	185	82	84	2	1	C	1	CRD	1	CR	gravel		
OG	1417	14-17	185	84	137	53	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	137	153	16	1	C	1	CRD	1	CR	gravel, pebbles, and cobbles, and about 10 percent more sand	Coarse-gravel zone	
OG	1417	14-17	185	153	170	17	1	C	1	CRD	1	CR	gravel, pebbles, and cobbles, and more sand than above		
OG	1417	14-17	185	170	178	8	2	PC	1	CRD	1	CR	sand, pebbly		
OG	1417	14-17	185	178	190	12	1	C	1	CRD	1	CR	gravel, pebbles and cobbles, and about 40 percent sand; streaks of red-brown clay		
OG	1417	14-17	185	190	196	6	2	PC	1	CRD	1	CR	sand, pebbly, grayish-brown		
OG	1417	14-17	185	196	268	72	2	PC	1	CRD	1	CR	gravel, and 10-30 % sand		
OG	1417	14-17	185	268	297	29	1	C	1	CRD	1	CR	gravel, scattered cobbles		
OG	1417	14-17	185	297	325	28	2	PC	1	CRD	1	CR	sand	Wedge zone	
OG	1417	14-17	185	325	395	70	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	395	407	12	1	C	1	CRD	1	CR	grave		
OG	1417	14-17	185	407	408	1	4	CL	1	CRD	1	CR	clay, bluish-gray		
OG	1417	14-17	185	408	416	8	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	416	420	4	2	PC	1	CRD	1	CR	gravel and 40-50 % medium gray sand		
OG	1417	14-17	185	420	433	13	2	PC	1	CRD	1	CR	Sand, fine to medium		
OG	1417	14-17	185	433	440	7	2	PC	1	CRD	1	CR	sand and 30-50 gravel		
OG	1417	14-17	185	440	472	32	2	PC	1	CRD	1	CR	sand and a few small pebbles		
OG	1417	14-17	185	472	480	8	2	PC	1	CRD	1	CR	gravel and 40 % sand; some wood embedded in bluish-gray clay		
OG	1417	14-17	185	480	497	17	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	497	500	3	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	500	542	42	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	542	555	13	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	555	575	20	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	575	590	15	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	590	604	14	2	PC	1	CRD	1	CR	Sand		
OG	1417	14-17	185	604	610	6	2	PC	1	CRD	1	CR	Gravel, subangular to well-rounded and 30 percent medium to coarse brown sand		
OG	1417	14-17	185	610	620	10	2	PC	1	CRD	1	CR	sand, well-rounded, medium to coarse, medium brown		
OG	1417	14-17	185	620	641	21	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	641	643	2	2	PC	1	CRD	1	CR	sand, poorly sorted, fine to very coarse and 15-20% gravel		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1417	14-17	185	643	686	43	2	PC	1	CRD	1	CR	Sand, fine to coarse; scattered pebbles and streaks of bluish-gray shaley clay and silt		
OG	1417	14-17	185	686	689	3	2	PC	1	CRD	1	CR	Sand, medium to very coarse and 15% well-rounded gravel, streaks of greenish-blue clay		
OG	1417	14-17	185	689	701	12	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	701	710	9	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	710	735	25	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	735	740	5	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	740	745	5	2	PC	1	CRD	1	CR	sand, medium to coarse, grayish-brown; a few pieces of broken lava rock		
OG	1417	14-17	185	745	780	35	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	780	795	15	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	795	807	12	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	807	809	2	2	PC	1	CRD	1	CR	sand, medium, gray; 20-25% gravel and a few gray clay balls		
OG	1417	14-17	185	809	818	9	2	PC	1	CRD	1	CR	sand, medium to coarse, well-rounded, gray; silt and clay at 816 ft; and a few subangular volcanics at 820 ft		
OG	1417	14-17	185	818	820	2	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	820	835	15	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	835	860	25	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	860	880	20	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	880	882	2	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	882	890	8	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	890	915	25	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	915	940	25	2	PC	1	CRD	1	CR	sand, fine, moderate-yellowish-brown, angular to rounded; contains a few rounded pebbles and some pebbles of volcanic rocks. Carbonized wood at 939 ft		
OG	1417	14-17	185	940	945	5	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	945	950	5	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	950	960	10	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	960	965	5	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	965	975	10	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	975	985	10	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	985	990	5	2	PC	1	CRD	1	CR	sand		
OG	1417	14-17	185	990	1000	10	2	PC	1	CRD	1	CR	sand		
OG	1418	14-18	90	0	71	71	2	PC	1	CRD	1	CR	Sand and silt, some clay, gastropods, and carbonized wood	Upper, fine-grained zone	
OG	1418	14-18	90	71	174	103	2	PC	1	CRD	1	CR	Sand and gravel, some silt and clay		
OG	1418	14-18	90	174	206	32	1	C	1	CRD	1	CR	Gravel, coarse, probably somewhat cemented	Coarse-gravel zone:	
OG	1418	14-18	90	206	231	25	2	PC	1	CRD	1	CR	Sand, some gravel		
OG	1418	14-18	90	231	276	45	1	C	1	CRD	1	CR	Gravel, coarse, probably cemented, at least in part		
OG	1418	14-18	90	276	306	30	2	PC	1	CRD	1	CR	Sand and gravel	Wedge zone:	
OG	1418	14-18	90	306	350	44	1	C	1	CRD	1	CR	Gravel, coarse, probably cemented in part		
OG	1418	14-18	90	350	408	58	2	PC	1	CRD	1	CR	Sand, some coarse gravel beds		
OG	1418	14-18	90	408	472	64	1	C	1	CRD	1	CR	Gravel, coarse, probably cemented in part		
OG	1418	14-18	90	472	594	122	2	PC	1	CRD	1	CR	Sand, some gravel		
OG	1418	14-18	90	594	644	50	1	C	1	CRD	1	CR	Gravel, fine to medium, cemented in part		
OG	1418	14-18	90	644	847	203	2	PC	1	CRD	1	CR	Sand, some gravel; a few thin beds of silt and cemented gravel		
OG	1418	14-18	90	847	859	12	3	PF	1	CRD	1	CR	Silt, clayey, in two thin beds, with sand between them		
OG	1418	14-18	90	859	1030	171	2	PC	1	CRD	1	CR	Sand, some gravel; a few thin beds of silt and cemented gravel		
OG	1418	14-18	90	1030	1038	8	3	PF	1	CRD	1	CR	silt		
OG	1418	14-18	90	1038	1432	394	2	PC	1	CRD	1	CR	sand, some silt and fine gravel		
OG	1418	14-18	90	1432	1434	2	4	CL	1	CRD	1	CR	clay		
OG	1418	14-18	90	1434	1990	556	2	PC	1	CRD	1	CR	sand, compact, silty and pebbly; thin clay beds at depths of 1,520, 1688, 1692, 1750, 1778, 1920, and 1934 ft		
OG	1418	14-18	90	1990	2000	10	4	CL	1	CRD	1	CR	clay		
OG	1418	14-18	90	2000	2030	30	2	PC	1	CRD	1	CR	sand, compact; and cemented gravel		
OG	1418	14-18	90	2030	2057	27	2	PC	1	CRD	1	CR	sand, silty; a few thin beds of cemented gravel		
OG	1418	14-18	90	2057	2060	3	4	CL	1	CRD	1	CR	clay, silty		
OG	1418	14-18	90	2060	2090	30	2	PC	1	CRD	1	CR	sand and thin beds of grayish-white compact silt		
OG	1418	14-18	90	2090	2147	57	2	PC	1	CRD	1	CR	sand, silty, and thin beds of cemented gravels		
OG	1418	14-18	90	2147	2150	3	3	PF	1	CRD	1	CR	Silt, clayey		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1418	14-18	90	2150	2200	50	2	PC	1	CRD	1	CR	sand, silt, and thin beds of clay and cemented gravel		
OG	1418	14-18	90	2200	2212	12	2	PC	1	CRD	1	CR	Sand, compact; and cemented gravel		
OG	1418	14-18	90	2212	2220	8	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2220	2233	13	3	PF	1	CRD	1	CR	Silt and sand		
OG	1418	14-18	90	2233	2238	5	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2238	2300	62	2	PC	1	CRD	1	CR	Sand, compact, silty; thin beds of clay		
OG	1418	14-18	90	2300	2342	42	2	PC	1	CRD	1	CR	Sand, silty		
OG	1418	14-18	90	2342	2348	6	4	CL	1	CRD	1	CR	Clay, silty		
OG	1418	14-18	90	2348	2415	67	2	PC	1	CRD	1	CR	Sand, compact; thin beds of cemented sand and gravel		
OG	1418	14-18	90	2415	2417	2	4	CL	1	CRD	1	CR	Clay, silty		
OG	1418	14-18	90	2417	2514	97	2	PC	1	CRD	1	CR	Sand, thin beds of silt and silty clay		
OG	1418	14-18	90	2514	2520	6	4	CL	1	CRD	1	CR	Clay	Transition zone (?)	
OG	1418	14-18	90	2520	2674	154	2	PC	1	CRD	1	CR	Sand, some cementation; some silt		
OG	1418	14-18	90	2674	2676	2	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2676	2728	52	2	PC	1	CRD	1	CR	Sand, silty; and thin cemented beds		
OG	1418	14-18	90	2728	2730	2	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2730	2804	74	2	PC	1	CRD	1	CR	Sand, silty; and thin cemented streaks		
OG	1418	14-18	90	2804	2806	2	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2806	2818	12	2	PC	1	CRD	1	CR	Sand, silty; and a few thin lenses of cemented gravel		
OG	1418	14-18	90	2818	2822	4	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2822	2852	30	2	PC	1	CRD	1	CR	Sand, silt, and thin beds of clayey silt		
OG	1418	14-18	90	2852	2892	40	2	PC	1	CRD	1	CR	Sand and some silt and cementation		
OG	1418	14-18	90	2892	2900	8	4	CL	1	CRD	1	CR	Clay		
OG	1418	14-18	90	2900	2946	46	2	PC	1	CRD	1	CR	Sand, silt, and thin lenses of silty clay		
OG	1419	14-19	163	0	53	53	2	PC	1	CRD	1	CR	Sand, very fine to coarse, silty; some very fine angular gravel. Few pieces brown clay.	Upper, fine-grained zone	
OG	1419	14-19	163	53	72	19	2	PC	1	CRD	1	CR	Sand, very fine to coarse		
OG	1419	14-19	163	72	130	58	1	C	1	CRD	1	CR	Gravel, very fine to coarse (pebbles and chips to 25 mm), with fine to very coarse sand. Gravel is subangular to subrounded, has relatively high percentage of tuffs and other light volcanic types. Partly cemented	Coarse-gravel zone	
OG	1419	14-19	163	130	142	12	1	C	1	CRD	1	CR	Gravel, very fine to coarse, and fine to very coarse sand. Somewhat finer and less cemented than previous interval		
OG	1419	14-19	163	142	190	48	2	PC	1	CRD	1	CR	Sand, fine to very coarse. Small amount of brown silt, silty clay, and very fine gravel.		
OG	1419	14-19	163	190	202	12	1	C	1	CRD	1	CR	Gravel, very fine to medium and fine to very coarse sand. Gravel is subangular to subrounded, to 15 mm or larger; includes chert, quartzite, tuff, andesite, and granite.		
OG	1419	14-19	163	202	209	7	2	PC	1	CRD	1	CR	Sand, fine to very coarse.		
OG	1419	14-19	163	209	232	23	1	C	1	CRD	1	CR	Gravel, very fine to medium, and small amount of medium to coarse cemented sand. Gravel is subangular to rounded pebbles and chips to 15 mm or larger. Includes granite chert, quartzite, but less andesite than above, a very little tuff. Some of the quartzitic pebbles look typical of Colorado River deposits.		
OG	1419	14-19	163	232	289	57	2	PC	1	CRD	1	CR	Sand, fine to very coarse, and very fine to medium gravel. Gravel similar to previous interval. Small amount of brown silt.		
OG	1419	14-19	163	289	301	12	1	C	1	CRD	1	CR	Gravel, very fine to medium, and small amount of medium to very coarse sand. May be partly cemented, but very permeable.		
OG	1419	14-19	163	301	310	9	1	C	1	CRD	1	CR	Gravel, very fine to medium, and fine to very coarse sand. Cemented.		
OG	1419	14-19	163	310	325	15	2	PC	1	CRD	1	CR	Sand, fine to very coarse; some very fine to medium gravel.	Wedge zone	
OG	1419	14-19	163	325	360	35	1	C	1	CRD	1	CR	Gravel, very fine to medium, and sand, medium to very coarse. Cemented.		
OG	1419	14-19	163	360	381	21	2	PC	1	CRD	1	CR	Sand, fine to very coarse; some very fine to medium gravel.		
OG	1419	14-19	163	381	409	28	1	C	1	CRD	1	CR	Gravel, very fine to medium (10 mm or larger) and medium to very coarse.		

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OG	1419	14-19	163	409	466	57	2	PC	1	CRD	1	CR	Sand, fine to very coarse and some very fine to medium gravel. Small amount of brown silty clay. Fragments of carbonized wood below 442 ft.		
OG	1419	14-19	163	466	496	30	2	PC	1	CRD	1	CR	Sand, fine to very coarse. Some very fine to medium gravel.		
OG	1419	14-19	163	496	544	48	2	PC	1	CRD	1	CR	Sand, fine to very coarse. Small amount of very fine to medium gravel		
OG	1419	14-19	163	544	623	79	2	PC	1	CRD	1	CR	Sand, fine to very coarse. Small amount of very fine to medium gravel and some brown clayey silt. Loose, uncemented.		
OG	1420	14-20	93	0	50	50	2	PC	1	CRD	1	CR	sandstone and gravel		
OG	1420	14-20	93	50	60	10	2	PC	1	CRD	1	CR	sand with streaks of clay		
OG	1420	14-20	93	60	135	75	2	PC	1	CRD	1	CR	sand with clay streaks		
OG	1420	14-20	93	135	174	39	1	C	1	CRD	1	CR	water gravel		
OG	1420	14-20	93	174	336	162	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	336	360	24	4	CL	1	CRD	1	CR	clay		
OG	1420	14-20	93	360	370	10	2	PC	1	CRD	1	CR	coarse sand		
OG	1420	14-20	93	370	407	37	2	PC	1	CRD	1	CR	fine sand		
OG	1420	14-20	93	407	465	58	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	465	470	5	4	CL	1	CRD	1	CR	sandy clay		
OG	1420	14-20	93	470	482	12	2	PC	1	CRD	1	CR	sand-gravel (?)		
OG	1420	14-20	93	482	493	11	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	493	495	2	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	495	510	15	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	510	518	8	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	518	522	4	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	522	533	11	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	533	534	1	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	534	586	52	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	586	588	2	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	588	862	274	1	C	1	CRD	1	CR	sandy shale with boulders		
OG	1420	14-20	93	862	930	68	1	C	1	CRD	1	CR	sandy shale with boulders		
OG	1420	14-20	93	930	1010	80	3	PF	1	CRD	1	CR	sand and shale		
OG	1420	14-20	93	1010	1033	23	5	LM	1	CRD	1	CR	shale and limestone		
OG	1420	14-20	93	1033	1073	40	5	LM	1	CRD	1	CR	shale with streaks of limestone		
OG	1420	14-20	93	1073	1080	7	2	PC	1	CRD	1	CR	gas sand -gas showing		
OG	1420	14-20	93	1080	1100	20	2	PC	1	CRD	1	CR	water sand with shale		
OG	1420	14-20	93	1100	1122	22	2	PC	1	CRD	1	CR	water sand		cored 1098 to1122
OG	1420	14-20	93	1122	1188	66	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	1188	1210	22	5	LM	1	CRD	1	CR	shale with streaks of limestone		cored 6 feet
OG	1420	14-20	93	1210	1254	44	5	LM	1	CRD	1	CR	shale with streaks of sand and limestone		
OG	1420	14-20	93	1254	1270	16	3	PF	1	CRD	1	CR	shale with streaks of sand		cored. Showing of oil.
OG	1420	14-20	93	1270	1300	30	1	C	1	CRD	1	CR	boulders and blue shale		
OG	1420	14-20	93	1300	1313	13	5	LM	1	CRD	1	CR	hard sand and limestone		
OG	1420	14-20	93	1313	1317	4	2	PC	1	CRD	1	CR	hard sand		
OG	1420	14-20	93	1317	1344	27	1	C	1	CRD	1	CR	conglomerate		
OG	1420	14-20	93	1344	1490	146	1	C	1	CRD	1	CR	conglomerate with hard sand		
OG	1420	14-20	93	1490	1539	49	2	PC	1	CRD	1	CR	hard sand		
OG	1420	14-20	93	1539	1541	2	2	PC	1	CRD	1	CR	gas sand		
OG	1420	14-20	93	1541	1555	14	5	LM	1	CRD	1	CR	sand and lime		
OG	1420	14-20	93	1555	1600	45	2	PC	1	CRD	1	CR	hard sand with streaks of shale		
OG	1420	14-20	93	1600	1645	45	2	PC	1	CRD	1	CR	sand and shale		
OG	1420	14-20	93	1645	1650	5	2	PC	1	CRD	1	CR	oil sand		
OG	1420	14-20	93	1650	1667	17	3	PF	1	CRD	1	CR	hard shale with streaks of sand		
OG	1420	14-20	93	1667	1798	131	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	1798	1810	12	3	PF	1	CRD	1	CR	sticky shale		
OG	1420	14-20	93	1810	1827	17	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	1827	1833	6	2	PC	1	CRD	1	CR	hard sand		
OG	1420	14-20	93	1833	1928	95	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	1928	1979	51	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	1979	1985	6	2	PC	1	CRD	1	CR	hard sand with conglomerate		
OG	1420	14-20	93	1985	1995	10	2	PC	1	CRD	1	CR	oil sand		
OG	1420	14-20	93	1995	2022	27	2	PC	1	CRD	1	CR	sand and shale		cored 1984 to 2025
OG	1420	14-20	93	2022	2065	43	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	2065	2175	110	2	PC	1	CRD	1	CR	sand and shale		
OG	1420	14-20	93	2175	2263	88	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	2263	2275	12	2	PC	1	CRD	1	CR	hard sand showing oil		
OG	1420	14-20	93	2275	2283	8	8	U	1	CRD	1	CR	missing		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1420	14-20	93	2283	2293	10	2	PC	1	CRD	1	CR	oil sand: Fine, well rounded, well sorted, uniform quartz sand with considerable amounts of magnetite. Windblown origin probable. Average size 1/2 or less (?) mm, cement calcareous.		cored
OG	1420	14-20	93	2293	2304	11	2	PC	1	CRD	1	CR	oils sand with shale at bottom		
OG	1420	14-20	93	2304	2367	63	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	2367	2410	43	3	PF	1	CRD	1	CR	sandy shale, cored		
OG	1420	14-20	93	2410	2437	27	8	U	1	CRD	1	CR	missing		
OG	1420	14-20	93	2437	2545	108	3	PF	1	CRD	1	CR	sandy shale with streaks of sand		
OG	1420	14-20	93	2545	2622	77	3	PF	1	CRD	1	CR	sandy shale		
OG	1420	14-20	93	2622	2630	8	5	LM	1	CRD	1	CR	hard shell		
OG	1420	14-20	93	2630	2635	5	2	PC	1	CRD	1	CR	sand, cored		
OG	1420	14-20	93	2635	2650	15	8	U	1	CRD	1	CR	[unknown]		
OG	1420	14-20	93	2650	2664	14	5	LM	1	CRD	1	CR	sand and shale, fault cored at 2664. A broken sand and shale zone between 2,635 and 2,675 ft with core of hard white, well-rounded calcareous sand, carrying fossils, was taken at 2,660 ft.	top of transition zone - 2,660 calcareous sand carrying fossils. Fault cored at 2,664	high-gravity oil collected here.
OG	1420	14-20	93	2664	2675	11	2	PC	1	CRD	1	CR	oils sand, cored		
OG	1420	14-20	93	2675	2770	95	1	C	1	CRD	1	CR	sandy shale with boulders		
OG	1420	14-20	93	2770	2845	75	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	2845	2920	75	2	PC	1	CRD	1	CR	sand and shale		
OG	1420	14-20	93	2920	2932	12	2	PC	1	CRD	1	CR	hard sand		
OG	1420	14-20	93	2932	3010	78	3	PF	1	CRD	1	CR	shale		
OG	1420	14-20	93	3010	3020	10	2	PC	1	CRD	1	CR	hard sand		
OG	1420	14-20	93	3020	3040	20	3	PF	1	CRD	1	CR	hard shale		
OG	1420	14-20	93	3040	3055	15	1	C	1	CRD	1	CR	conglomerate, granite wash (arkose?)		
OG	1420	14-20	93	3055	3150	95	2	PC	1	CRD	1	CR	hard sand with streaks of conglomerate		
OG	1420	14-20	93	3150	3210	60	2	PC	1	CRD	1	CR	hard sand with streaks of shale		
OG	1420	14-20	93	3210	3220	10	2	PC	1	CRD	1	CR	hard sand, gas show		
OG	1420	14-20	93	3220	3235	15	3	PF	1	CRD	1	CR	sandy shale with streaks of soft sand		
OG	1420	14-20	93	3235	3275	40	3	PF	1	CRD	1	CR	shale with streaks of soft sand		
OG	1420	14-20	93	3275	3318	43	3	PF	1	CRD	1	CR	shale		
OG	1420	14-20	93	3318	3330	12	2	PC	1	CRD	1	CR	sand ran from tester : Siltstone, silt with very few sand grains up to ? 2 subangular pebbles 2 x 1/2 cm. Pebbles cherty, cement calcareous. Some poorly defined fossil material. Colors gray tinged with green. 3322': silty to fine grained sandstone, clay with some broken shell fragments, few pelecypod fragments. Sand 90% quartz, angular, white to yellow to extremely glassy. Biotite flakes up to 1mm. Muscovite flakes too. Some unidentified black grains up to 1/4 mm.		cored 3318 to 3330
OG	1420	14-20	93	3330	3340	10	3	PF	1	CRD	1	CR	shale		
OG	1420	14-20	93	3340	3360	20	2	PC	1	CRD	1	CR	sand		
OG	1420	14-20	93	3360	3410	50	3	PF	1	CRD	1	CR	shale with streaks of sand		
OG	1420	14-20	93	3410	3450	40	3	PF	2	BOU	2	PCR	sandy shale	Top of Bouse Fm at 3,410 ft-bls (USGS)	
OG	1420	14-20	93	3450	3480	30	5	LM	2	BOU	2	PCR	shale and limestone		
OG	1420	14-20	93	3480	3550	70	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3550	3580	30	3	PF	2	BOU	2	PCR	shale with streaks of sand		
OG	1420	14-20	93	3580	3595	15	2	PC	2	BOU	2	PCR	sand		
OG	1420	14-20	93	3595	3610	15	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3610	3620	10	3	PF	2	BOU	2	PCR	shale with streaks of hard sand		
OG	1420	14-20	93	3620	3633	13	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3633	3642	9	2	PC	2	BOU	2	PCR	sand, gas shows in ditch		
OG	1420	14-20	93	3642	3672	30	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3672	3703	31	3	PF	2	BOU	2	PCR	tough shale		
OG	1420	14-20	93	3703	3730	27	3	PF	2	BOU	2	PCR	tough shale with streaks of sand		
OG	1420	14-20	93	3730	3750	20	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3750	3780	30	2	PC	2	BOU	2	PCR	shale with gravel (conglomerate?)		
OG	1420	14-20	93	3780	3785	5	1	C	2	BOU	2	PCR	gravel		
OG	1420	14-20	93	3785	3800	15	3	PF	2	BOU	2	PCR	shale		
OG	1420	14-20	93	3800	3840	40	1	C	2	BOU	2	PCR	conglomerate with sand		
OG	1420	14-20	93	3840	3860	20	1	C	2	BOU	2	PCR	conglomerate wash		
OG	1420	14-20	93	3860	3927	67	3	PF	2	BOU	2	PCR	sandy shale		
OG	1420	14-20	93	3927	3967	40	3	PF	2	BOU	2	PCR	shale with streaks of sand		
OG	1420	14-20	93	3967	4010	43	3	PF	2	BOU	2	PCR	shale with streaks of gravel and sand		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
OG	1420	14-20	93	4010	4350	340	8	U	4	PCRM	2	PCR	no further log available	Depth to top Tertiary sedimentary rocks 4,350 ft-bls noted in log - visible pick in E-log (BFG)	
OG	1420	14-20	93	4350	4868	518	8	U	4	PCRM	2	PCR	no further log available		
OG	1422	14-22	120	0	35	35	2	PC	1	CRD	1	CR	soil/sand		Mattick et al. (1973) purport "granite" below 1,398 ft. DH-15 may represent another well of unknown location.
OG	1422	14-22	120	35	50	15	2	PC	1	CRD	1	CR	sand/gravel		
OG	1422	14-22	120	50	53	3	4	CL	1	CRD	1	CR	clay		
OG	1422	14-22	120	53	80	27	2	PC	1	CRD	1	CR	clay/gravel		
OG	1422	14-22	120	80	132	52	4	CL	1	CRD	1	CR	hard clay		
OG	1422	14-22	120	132	135	3	2	PC	1	CRD	1	CR	soft sandstone		
OG	1422	14-22	120	135	188	53	1	C	1	CRD	1	CR	heavy water gravel		
OG	1422	14-22	120	158	503	345	2	PC	1	CRD	1	CR	sand/some gravel		
OG	1422	14-22	120	188	456	268	2	PC	1	CRD	1	CR	sandstone		
OG	1422	14-22	120	456	158	-298	4	CL	1	CRD	1	CR	clay		
OG	1422	14-22	120	503	551	48	1	C	1	CRD	1	CR	sand/gravel water		
OG	1422	14-22	120	551	566	15	3	PF	1	CRD	1	CR	blue shale		
OG	1422	14-22	120	566	576	10	4	CL	1	CRD	1	CR	clay		
OG	1422	14-22	120	576	590	14	2	PC	1	CRD	1	CR	sandstone		
OG	1422	14-22	120	590	594	4	4	CL	1	CRD	1	CR	clay		
OG	1422	14-22	120	594	597	3	2	PC	1	CRD	1	CR	sand		
OG	1422	14-22	120	597	617	20	4	CL	1	CRD	1	CR	hard clay		Log from 617 to 1,400 not found. Picks from well file 14-14 are apparently made by geologist.
OG	1422	14-22	120	617	972	355	8	U	1	CRD	1	CR	unknown		
OG	1422	14-22	120	972	1243	271	8	U	2	BOU	1	CR	unknown	Possible Bouse Formation at 972 (Mattick et al., 1973)	from Mattick et al., (1973)
OG	1422	14-22	120	1243	1398	155	8	U	3	PCRT	2	PCR	unknown	top of Nonmarine sedimentary rocks (?)	from Mattick et al., (1973)
OG	1422	14-22	120	1398	1400	2	7	B	7	B	3	B	"granite" (?)		from Mattick et al., (1973)
USGS	13	LCRP-13	197	0	70	70	2	PC	1	CRD	1	CR	Sand	Upper, fine-grained zone	See detailed log in Olmsted (1973), p. H175.
USGS	13	LCRP-13	197	70	75	5	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	75	105	30	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	105	135	30	3	PF	1	CRD	1	CR	clay and sand		
USGS	13	LCRP-13	197	135	170	35	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	170	200	30	1	C	1	CRD	1	CR	gravel and about 40-50 % sand	Coarse -gravel zone	
USGS	13	LCRP-13	197	200	206	6	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	206	216	10	1	C	1	CRD	1	CR	gravel		
USGS	13	LCRP-13	197	216	220	4	4	CL	1	CRD	1	CR	clay	Wedge zone	
USGS	13	LCRP-13	197	220	273	53	2	PC	1	CRD	1	CR	sand, very little gravel		
USGS	13	LCRP-13	197	273	278	5	4	CL	1	CRD	1	CR	clay, gray, hard		
USGS	13	LCRP-13	197	278	316	38	2	PC	1	CRD	1	CR	sand, small gravel		
USGS	13	LCRP-13	197	316	330	14	2	PC	1	CRD	1	CR	sand, 1/2 inch gravel and "rock"		
USGS	13	LCRP-13	197	330	360	30	2	PC	1	CRD	1	CR	sand, little gravel		
USGS	13	LCRP-13	197	360	395	35	2	PC	1	CRD	1	CR	sand, with clay balls and streaks from 372 to 392		
USGS	13	LCRP-13	197	395	410	15	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	410	425	15	2	PC	1	CRD	1	CR	sand, with clay streaks		
USGS	13	LCRP-13	197	425	430	5	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	430	465	35	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	465	474	9	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	474	500	26	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	500	515	15	3	PF	1	CRD	1	CR	clay and sand		
USGS	13	LCRP-13	197	515	520	5	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	520	525	5	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	525	567	42	2	PC	1	CRD	1	CR	sand, packed		
USGS	13	LCRP-13	197	567	575	8	4	CL	1	CRD	1	CR	clay, hard		
USGS	13	LCRP-13	197	575	585	10	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	585	600	15	2	PC	1	CRD	1	CR	sand and gravel		
USGS	13	LCRP-13	197	600	605	5	2	PC	1	CRD	1	CR	sandstone		
USGS	13	LCRP-13	197	605	625	20	2	PC	1	CRD	1	CR	clay and gravel		
USGS	13	LCRP-13	197	625	635	10	2	PC	1	CRD	1	CR	sand		
USGS	13	LCRP-13	197	635	693	58	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	693	750	57	2	PC	1	CRD	1	CR	sandstone		
USGS	13	LCRP-13	197	750	757	7	4	CL	1	CRD	1	CR	clay, hard		
USGS	13	LCRP-13	197	757	768	11	2	PC	1	CRD	1	CR	sand and sandstone		
USGS	13	LCRP-13	197	768	780	12	2	PC	1	CRD	1	CR	sand and gravel		

Well Type	Well ID	Label	Elev. (ft)	From Depth (ft)	To Depth (ft)	Thick-ness (ft)	HGUID	HGU Code	HGUID2	HGU Code2	HGUID 3	HGU Code3	Lithology	Formation Notes (Olmsted and others, 1973)	Comments
USGS	13	LCRP-13	197	780	825	45	4	CL	1	CRD	1	CR	clay		
USGS	13	LCRP-13	197	825	855	30	3	PF	1	CRD	1	CR	clay, gray sandy streaks of brown fine sand		
USGS	13	LCRP-13	197	855	857	2	2	PC	1	CRD	1	CR	sand, fine on sandstone		
USGS	13	LCRP-13	197	857	896	39	2	PC	1	CRD	1	CR	sand, gray and clay		
USGS	13	LCRP-13	197	896	899	3	3	PF	1	CRD	1	CR	clay or shale		
USGS	13	LCRP-13	197	899	905	6	2	PC	1	CRD	1	CR	sand and silt		
USGS	13	LCRP-13	197	905	910	5	3	PF	1	CRD	1	CR	clay and streaks of sand		
USGS	13	LCRP-13	197	910	920	10	2	PC	1	CRD	1	CR	sand, clay, and silt (thin layer), cemented sand and gravel at 917 ft		
USGS	13	LCRP-13	197	920	950	30	2	PC	1	CRD	1	CR	sand, with cemented streaks, and streaks of clay		
USGS	13	LCRP-13	197	950	953	3	4	CL	1	CRD	1	CR	clay, brown		
USGS	13	LCRP-13	197	953	965	12	4	CL	1	CRD	1	CR	clay, gray and sand		
USGS	13	LCRP-13	197	965	970	5	3	PF	1	CRD	1	CR	clay and sandstone		
USGS	13	LCRP-13	197	970	973	3	2	PC	1	CRD	1	CR	sand, loose		
USGS	13	LCRP-13	197	973	985	12	3	PF	1	CRD	1	CR	clay and sandstone		
USGS	13	LCRP-13	197	985	988	3	2	PC	1	CRD	1	CR	sandstone		
USGS	13	LCRP-13	197	988	1025	37	3	PF	1	CRD	1	CR	clay, silt, sand, and sandstone		
USGS	13	LCRP-13	197	1025	1068	43	4	CL	1	CRD	1	CR	sandy clay		
USGS	13	LCRP-13	197	1068	1071	3	2	PC	1	CRD	1	CR	sand, loose		
USGS	13	LCRP-13	197	1071	1085	14	3	PF	1	CRD	1	CR	clay, sandy, and sandstone		
USGS	13	LCRP-13	197	1085	1090	5	2	PC	1	CRD	3	B	granite Wash		
USGS	26	LCRP-26	129	0	120	120	3	PF	1	CRD	1	CR	sand, silt, and clay	Upper, fine-grained zone	Depth/elevation estimated from PP726-D Plate 2 figure
USGS	26	LCRP-26	129	120	180	60	1	C	1	CRD	1	CR	gravel with pebbles and cobbles of siliceous rocks, quartzite and chert	Coarse -gravel zone	
USGS	26	LCRP-26	129	180	522	342	2	PC	1	CRD	1	CR	sand and gravel, gravel and sand		
USGS	26	LCRP-26	129	522	536	14	1	C	1	CRD	1	CR	conglomerate		
USGS	26	LCRP-26	129	536	1033	497	2	PC	1	CRD	1	CR	sand, silty and gravel, gravel and sand		
USGS	26	LCRP-26	129	1033	1083	50	4	CL	1	CRD	1	CR	clay, silty, sandy	transition zone	
USGS	26	LCRP-26	129	1083	1102	19	2	PC	1	CRD	1	CR	gavel and sand, some chert and quartzite pebbles		
USGS	26	LCRP-26	129	1102	1115	13	2	PC	1	CRD	1	CR	sand, fine to medium, gray		
USGS	26	LCRP-26	129	1115	1343	228	3	PF	2	BOU	1	CR	clay, silty, and sand, fine to medium	Bouse Fm	
USGS	26	LCRP-26	129	1343	1352	9	6	V	2	BOU	1	CR	tuff (?)	Bouse Fm	
USGS	26	LCRP-26	129	1352	1380	28	2	PC	2	BOU	1	CR	calcareous sandstone	Bouse Fm	
USGS	26	LCRP-26	129	1380	1665	285	1	C	3	PCRT	2	PCR	conglomerate -- pebbles, cobbles, and boulders of gneiss, granite, pegmatite; coarse gritty sandstone	Non-marine Sedimentary rocks	Tertiary non-marine sedimentary rocks
USGS	26	LCRP-26	129	1665	1777	112	1	C	3	PCRT	2	PCR	Boulder conglomerate or mega breccia; blocks of boulders of crystalline rocks		Tertiary non-marine sedimentary rocks

AZGS ID	Book	Page	Well Name	Quad	Twn	Rng	Sec	Qtr Sec	Top interval	Bottom interval	No samples	Cabinet	Remark
37	Well Sample Log	4	Yuma Valley Musgrove	C	11	25	11		2300	3330			Samplex with 3
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	8	17	---	---	0	546			10 wells to 546 ft
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	8	18	---	---	0	546	---	---	---
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	8	19	---	---	0	546	---	---	---
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	8	20	---	---	0	546	---	---	---
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	8	21	---	---	0	546	---	---	---
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	9	18	---	---	0	546	---	---	---
61	Well Sample Log	6	Wellton - Bureau of Reclamation	C	9	19	---	---	0	546	---	---	---
202	Well Sample Log	16	J M Hickey & Son Federal #1	C	10	24	35	bb	580	880			well #63, 303-305
301	Lab Book No. 1	18	MPS Stewart et al Federal #1	C	10	23	31	aa	0	3660	214	A-21	O&G#17
358	Lab Book No. 1	20	Colorado Basin Associates Newcomer#1	C	9	23	19	bc	1030	3277	220	A-23&24	O&G#24
359	Lab Book No. 1	20	Colorado Basin Associates Federal #1	C	10	24	24	cbb	1000	6012	516	A-24&25	O&G#27
385	Well Sample Log	30	Colorado Basin Associates Federal #1	C	10	23	17		2600	6012			broken intervals
385	Lab Book No. 1	22	Colorado Basin Associates Federal #1	C	10	24	24	cbb	2600	6012	324	A-29	TD 6015 (See #359), O&G#27
397	Well Sample Log	32	Howard P Johnson	C	7	12	24	bdd	0	480	25	---	---
397	Lab Book No. 1	22	Howard P Johnson	C	7	12	24	bdd	20	480	24	C-65	O&G
399	Well Sample Log	32	Chapman & Lynch	C	6	14	27	baa	280	900	20	---	---
399	Lab Book No. 1	22	Chapman & Lynch	C	6	14	27	baa	280	900	36	C-65	O&G
400	Well Sample Log	32	Chapman & Lynch	C	6	14	22	caa	100	750	11	---	---
400	Lab Book No. 1	22	Chapman & Lynch	C	6	14	22	caa	100	750	11	C-65	O&G
420	Well Sample Log	34	Frank H Tammany	C	9	21	22	da	0	290	---	---	---
420	Lab Book No. 1	24	Frank H Tammany	C	9	21	22	da	0	290	28	C-72	O&G
639	Lab Book No. 1	36	GC Dunford Well	C	7	13	13		---	---	---	---	Water well
640	Lab Book No. 1	36	Loftus-Baird Stoval # 1	C	8	13	4	ba	---	---	---	---	TD 2630
780	Lab Book No. 1	44	Chapman et al	C	7	14	24	c	20	1380	95	C-50	---
780	Lab Book No. 1	44	Chapman et al	C	7	14	24	c	660	1010	34	C-41	---
786	Lab Book No. 1	44	Auguste Casaretto Well	C	5	11	2	b	815	1000	18	C-40	---
969	Lab Book No. 1	54	Dr. RG Barfoot Well	C	7	15	9/16		20	900	46	C-49	---
971	Lab Book No. 1	54	Max F Permenter	C	4	11	12		60	1229	40	C-50, C-51	---
977	Lab Book No. 1	54	Chapman et al	C	7	14	24	ccc	---	---	---	---	See #780
1123	Lab Book No. 1	62	Anderson Development	C	9	22	22	b	75	537	85	D-38	---
1127	Lab Book No. 1	64	Yuma High School	C	9	23	5	a	0	245	25	D-1	---
1129	Lab Book No. 1	64	Bob Morris (Yuma Valley)	C	---	---	---	---	0	300	31	D-37	---
1136	Lab Book No. 1	64	Powers #1	C	9	22	12	aad	140	400	27	D-1	---
1137	Lab Book No. 1	64	Power #2	C	9	21	9	baa	0	475	48	D-1	---
1140	Lab Book No. 1	64	Trussel Well	C	10	23	12	dcb	0	250	25	D-1	---
1141	Lab Book No. 1	64	Yuma County Fair Commission	C	9	23	2	c	50	295	18	C-56	---
1144	Lab Book No. 1	64	O.W. Balmes #1	C	8	21	23	c	0	500	50	D-47	---
1181	Lab Book No. 1	66	Gila Valley #1 Kamrath	C	8	22	15	da	0	2137	282	B-41, B-42	---
1313	Lab Book No. 1	74	Keoughan Drilling Co. State #1	C	7	13	16	aa	3250	bottom	5	D-19	---
1325	Lab Book No. 1	74	Gila Valley #1 Kamrath	C	8	22	15	dab	---	---	---	---	See #1181
1511	Lab Book No. 1	84	LCRP #1	C	10	23	31		0	807	25	D-27	---
1511	Lab Book No. 1	84	LCRP #1	C	10	23	31		860	1490		D-24, D-25	---
1575	Lab Book No. 1	88	No Name	C	7	14	24	aaa	205	685	27	D-55, D-56	---
1676	Lab Book No. 1	94	Desert Drilling State #1	C	7	13	16	aa	1300	1720	206	E-2	3 depth intervals
1676	Lab Book No. 1	94	Desert Drilling State #1	C	7	13	16	aa	2300	2400	206	E-2	3 depth intervals
1676	Lab Book No. 1	94	Desert Drilling State #1	C	7	13	16	aa	5000	6760	206	E-2	3 depth intervals
1881	Lab Book No. 1	106	Navy Well	C	10	23	20	bbb	20	315	22	I-42	---
1881	Lab Book No. 1	106	Navy Well	C	10	23	20	bbb	70	310	13	E-23	---

AZGS ID	Book	Page	Well Name	Quad	Twn	Rng	Sec	Qtr Sec	Top interval	Bottom interval	No samples	Cabinet	Remark
1882	Lab Book No. 1	106	LCRP #1	C	10	23	31	bbb	381	1000	34	E-23	---
1883	Lab Book No. 1	106	Nutt #1	C	10	23	15	aaa	0	300	25	E-23	---
1884	Lab Book No. 1	106	Nutt #2	C	10	23	15	aab	126	868	33	E-23	---
2147	Lab Book No. 1	120	John Niedfelt	C	4	11	34	abb	100	810	67	E-44	---
2163	Lab Book No. 1	120	Hyder FRMS	C	3	11	35	cbb	1003	1215	25	E-46	---
2178	Lab Book No. 1	122	Virgil Merril	C	4	11	21	bbb	205	1300	107	F-1	---
2179	Lab Book No. 1	122	Leland Archer	C	3	11	32	bbb	50	1170	39	F-1	---
2181	Lab Book No. 1	122	Olson	C	4	11	23	bbb	10	2000	193	E-53	---
2182	Lab Book No. 1	122	Virgil Merril	C	4	11	21	bcb	195	555	36	E-53	---
2295	Lab Book No. 1	128	John Niedfelt	C	4	11	34	abb	800	1495	59	F-12	---
2421	Lab Book No. 1	136	Graham & Murphree	C	10	23	23	cbd	0	496	25	G-11	---
2444	Lab Book No. 1	136	Yuma #3 Auger Hole A	C	7	21	31	dcb	0	102	7	H-15	---
2445	Lab Book No. 1	136	Yuma #4	C	7	21	31	cdb	2	102	10	H-15	---
2446	Lab Book No. 1	136	Yuma #5	C	7	21	31	cdb	1	122	9	H-15	---
2447	Lab Book No. 1	136	Yuma #6 Auger Hole C	C	7	21	31	ccb	0	112	10	H-15	---
2463	Lab Book No. 1	138	Knisely-Moore Corp	C	11	23	19	bcd	25	510	44	H-17	(?)
2464	Lab Book No. 1	138	Knisely-Moore Corp	C	11	23	20	bcd	10	515	45	H-17	(?)
2473	Lab Book No. 1	138	Cibola Test Hole #1	C	5	21	11	aba	0	540	55	---	(?)
2859	Lab Book No. 2	None	Melvin Taylor	C	9	17	3	da	400	510	21	I-36	---
2863	Lab Book No. 2	None	Del Sun Inc.	C	9	22	12	bdc	10	200	20	I-36	---
2954	Lab Book No. 2	None	LCRP (Parker)	C	11	24	10	cdd	40	490	44	I-48	---
2955	Lab Book No. 2	None	LCRP (Parker)	C	11	24	11	cdd	50	500	58	J-28	---
2956	Lab Book No. 2	None	LCRP (Parker)	C	11	24	10	ddd	29	500	45	J-28	---
2957	Lab Book No. 2	None	LCRP (Parker)	C	11	24	11	bdd	50	500	44	J-28	---
2958	Lab Book No. 2	None	LCRP (Parker)	C	11	24	9	ddd	0	500	46	J-28	---
2959	Lab Book No. 2	None	LCRP (Harrison)	C	10	23	20	ada	0	450	44	J-27, J-28	---
2960	Lab Book No. 2	None	LCRP (Espy)	C	10	23	22	bcb	0	480	23	J-27	---
2961	Lab Book No. 2	None	LCRP (Espy)	C	10	23	22	bbb	0	475	23	J-27	---
2962	Lab Book No. 2	None	LCRP (Espy)	C	10	23	29	cab	80	460	26	J-28	---
2963	Lab Book No. 2	None	USGS #1	C	10	23	31	dcd	---	---	---	---	---
2964	Lab Book No. 2	None	USGS #2	C	9	23	14	ccc	0	37	5	I-42	---
2965	Lab Book No. 2	None	USGS #3	C	10	23	20		0	450	67	J-27	---
2966	Lab Book No. 2	None	USGS #4	C	10	23	20		0	480	24	J-28	---
2967	Lab Book No. 2	None	American Legion	C	9	23	4	abd	155	205	5	J-27	---
2968	Lab Book No. 2	None	American Legion	C	10	25	2	aac	0	512	51	J-27	---
2969	Lab Book No. 2	None	American Legion	C	8	22	31	dbb	0	37	4	I-49	---
2970	Lab Book No. 2	None	American Legion	C	10	25	35	ab	0	32	8	I-42	---
2971	Lab Book No. 2	None	American Legion	C	9	23	19		0	37	4	I-49	---
2972	Lab Book No. 2	None	American Legion	C	10	23	9	aaa	0	37	6	I-42	---
2973	Lab Book No. 2	None	American Legion	C	10	25	2	bac	0	27	6	I-42	---
2974	Lab Book No. 2	None	Houck	C	9	22	11	bbb	160	180	1	I-42	---
2975	Lab Book No. 2	None	College	C	8	22	35	ccb	0	600	38	I-47	---
2976	Lab Book No. 2	None	St. Franics Church	C	8	23	33		0	318	47	I-47, I-48	---
2977	Lab Book No. 2	None	Knight Brothers	C	9	21	8	ddd	370	730	38	I-47	---
2978	Lab Book No. 2	None	Stardust	C	8	23	33	cdd	70	800	58	I-48, I-49	see 3216
2979	Lab Book No. 2	None	USBR #6	C	9	22	33	cbb	0	204	14	I-48	---
2980	Lab Book No. 2	None	Dr. Evkert	C	9	21	18	ddd	0	350	22	I-48	---
2981	Lab Book No. 2	None	Coronado	C	8	23	21	abc	---	---	---	---	---
2982	Lab Book No. 2	None	John Nutt #2	C	10	23	11	ccb	286	890	75	J-27	---

AZGS ID	Book	Page	Well Name	Quad	Twn	Rng	Sec	Qtr Sec	Top interval	Bottom interval	No samples	Cabinet	Remark
2982	Lab Book No. 2	None	John Nutt #2	C	10	23	11	ccb	0	360	35	I-48	---
2983	Lab Book No. 2	None	John Nutt #4	C	10	23	12	bad	0	683	21	I-48	---
2984	Lab Book No. 2	None	Southern Pacific Co.	C	12	16	9	a	0	1005	47	J-26	---
2985	Lab Book No. 2	None	LCRP #1	C	10	23	31	bb	0	816	75	J-26	---
2985	Lab Book No. 2	None	LCRP #1	C	10	23	31	bb	816	1000	24	I-49	---
2986	Lab Book No. 2	None	LCRP #2	C	10	23	31	bb	20	890	94	J-25	---
2987	Lab Book No. 2	None	LCRP #3	C	10	23	31	bb	10	600	63	I-47	---
2988	Lab Book No. 2	None	LCRP #6	C	10	23	31	bb	0	975	97	J-25, J-26	---
2989	Lab Book No. 2	None	LCRP #6a	C	10	23	31	bb	1050	2519	47	I-48	---
2990	Lab Book No. 2	None	LCRP #7	C	10	23	31	bb	20	1000	99	I-47	---
2991	Lab Book No. 2	None	LCRP #8	C	10	23	31	bb	0	985	99	J-25	---
2992	Lab Book No. 2	None	LCRP #9	C	9	24	35	cb	0	1201	81	J-28	---
2993	Lab Book No. 2	None	LCRP #10	C	9	24	35	cb	19	1038	132	J-26	---
2994	Lab Book No. 2	None	LCRP #11	C	9	24	35	cb	0	1140	54	I-42	---
2995	Lab Book No. 2	None	LCRP #12	C	9	24	35	cb	0	1000	49	I-48	---
2996	Lab Book No. 2	None	LCRP #14	C	7	22	14	BC	11	482	36	I-42	---
2997	Lab Book No. 2	None	LCRP #17	C	10	25	35	bbd	0	2946	112	I-48	---
2998	Lab Book No. 2	None	LCRP #18	C	10	25	35	bbd	14	729	35	I-49	---
2998	Lab Book No. 2	None	LCRP #18	C	10	25	35	bbd	729	815	4	K-37	---
2999	Lab Book No. 2	None	LCRP #19	C	10	25	35	bbd	24	679	35	I-47	---
3216	Lab Book No. 2	None	Stardust Hotel test well, LCRP 13	C	8	23	33	cdd	170	1090	47	K2	see #2978
3218	Lab Book No. 2	None	LCRP #30	C	11	23	34	bb	36	415	27	K-2	only 3 samples in this drawer.
3316	Lab Book No. 2	None	OG #604	C	11	24	8	ac	230	11444	1118	K-14 to K-17	
3387	Lab Book No. 2	None	An-Son State 1-23, OG #708	C	10	23	23	ddd	0	2890	285	N-5, 6	
3398	Lab Book No. 2	None	Dowling Petroleum 1 State, OG #837	C	10	23	34	bbc	0	5000	503	N-12, 13	State 1-A: 2900-5000
4266	Lab Book No. 3	None	Petroleum Tech Services Co., Federal No 4-1	C	11	24	4	dbb	330	7000	479	O-42, 43	
4297	Lab Book No. 3	None	Federal "A" 26-1, OG # 864	C	11	23	26	adc	317	9135	698	P-13, 14	1254' FEL, 1040 FNL
3000a	Lab Book No. 2	None	LCRP #23	C	---	---	---	---	555	704	22	I-49	---
3001a	Lab Book No. 2	None	LCRP #24	C	---	---	---	---	2	415	37	I-49	---
3002a	Lab Book No. 2	None	LCRP #27	B	7	21	31	aaa	0	881	52	J-29	---
3003a	Lab Book No. 2	None	LCRP #28	C	9	24	8	ba	0	2311	91	I-49	---
3004a	Lab Book No. 2	None	LCRP #29	C	8	22	35	ca	600	2001	59	J-29, J-30	---
3005a	Lab Book No. 2	None	---	C	8	22	31	bda	0	37	4	I-49	---
3006a	Lab Book No. 2	None	Nutt #1	C	10	23	15	aa	0	300	38	I-49	---
3007a	Lab Book No. 2	None	Nutt #5	C	---	---	---	---	38	600	144	J-27	---
3007a	Lab Book No. 2	None	Nutt #5	C	---	---	---	---	368	700	28	I-49	---
3008a	Lab Book No. 2	None	Nutt #6	C	---	---	---	---	40	694	180	J-26, J-27	---
3008a	Lab Book No. 2	None	Nutt #6	C	---	---	---	---	40	694	185	J-26, J-27	---