

# Structure contours on Abo Formation (Lower Permian)

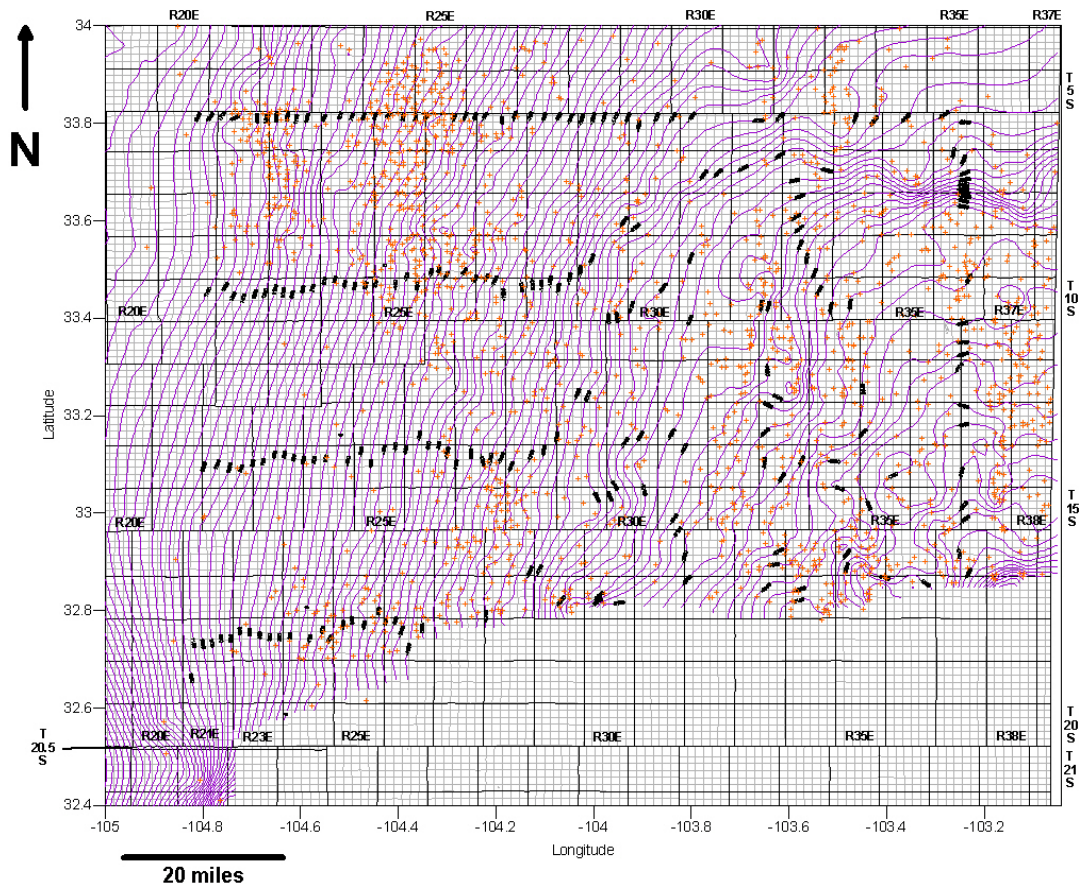
## Northwest Shelf of Permian Basin

By

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## INTRODUCTION

This open-file report contains a digital structure contour map of the upper surface of the Abo Formation: (Lower Permian) on the Northwest Shelf of the Permian Basin, southeastern New Mexico (Figures 1, 2, 3). This project was undertaken at the request of the New Mexico State Land Office and was funded by the New Mexico State Land Office.

This open-file report has three parts:

1. This pdf document that discusses the report, the digital database of well data, well location methodology, correlation of the top of the Abo Formation, contouring methods, and the various methods available to view the structure contour map.
2. A digital database of 1768 wells, including well locations, depth to the Abo in each well, surface elevation of each well, and the subsea elevation of the Abo in each well.
3. The structure contour map on the upper surface of the Abo, which is presented in four different formats: a large pdf image with a 25 ft contour interval, a small pdf image with a 100 ft contour interval, an ArcReader project, and an ArcMap project.

The structure contour map of the top of the Abo Formation was constructed using the structural elevation of the upper surface of the Abo in 1768 wells that cover a 9300 mi<sup>2</sup> area in southeastern New Mexico. Contours were made with a modern digital contouring program (*Surfer 8*, a product of Golden Software, Inc.). The database of wells and structural elevations is presented in this report in Microsoft Excel format so that the reader has the ability to plot the wells and structural data, and make contours on his/her own using different techniques and software than used for this project. The user also has the freedom to add additional well data to the database.

## THE ABO STRUCTURE DATABASE

The Abo structure database (*Abo structure data NW shelf.xls*) is presented on this CD in Microsoft Excel format. For each of the 1768 wells in the database, there are 17 data fields that pertain to the description of each well, its location, and the subsea

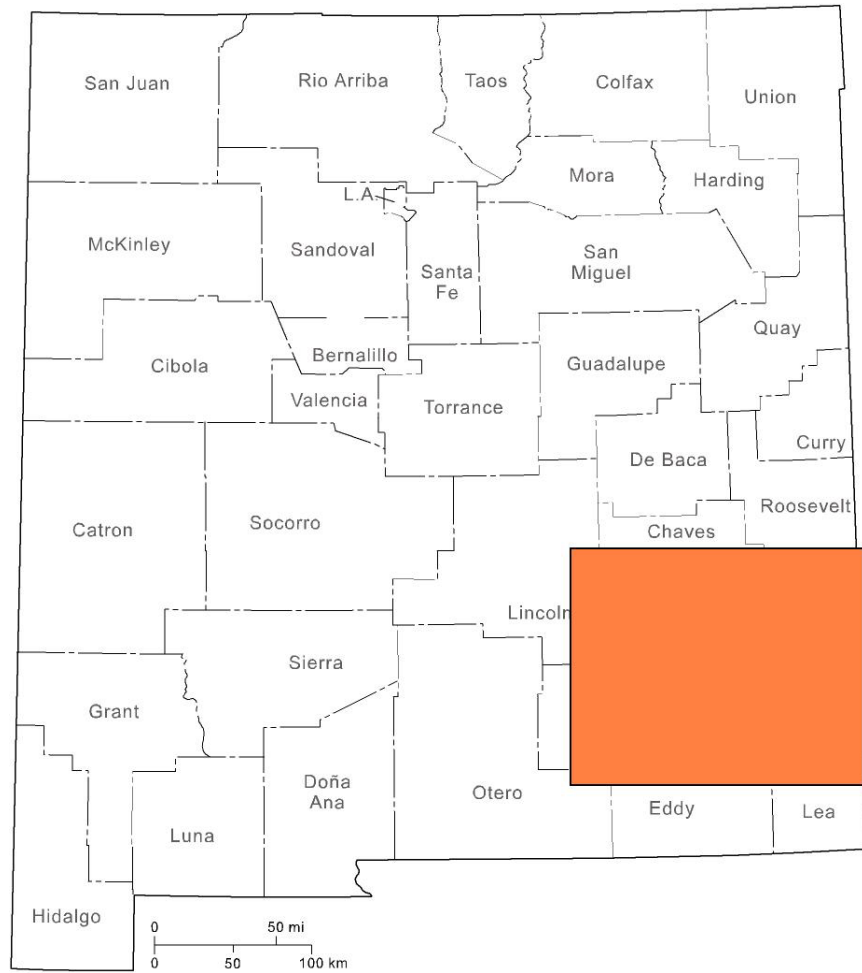


Figure 1. Location of structure contour map produced for this report.

Age		Strata	
<b>Triassic</b>		Chinle	
		Santa Rosa	
		Dewey Lake	
<b>Permian</b>	Ochoan	Rustler	
	Guadalupian	Salado	
		Artesia Group	Tansill
			Yates
			Seven Rivers
			Queen
		Grayburg	
		San Andres	
	Leonardian	Yeso	Glorieta
			Paddock
Blinebry			
Tubb			
	Drinkard		
	Abo		
Wolfcampian		Hueco ("Wolfcamp")	
<b>Pennsylvanian</b>	Virgilian	Bough	
		Cisco	
	Missourian	Canyon	
	Des Moinesian	Strawn	
	Atokan	Atoka	
Morrowan	Morrow		
<b>Miss.</b>		undivided	
<b>Dev.</b>	Upper	Woodford	
	Middle		
	Lower	Thirtyone	
<b>Sil.</b>	Upper	Wristen	
	Middle		
	Lower	Fusselman	
<b>Ord.</b>	Upper	Montoya	
	Middle	Simpson	
	Lower	Ellenburger	
		Bliss	
<b>Cambrian</b>			
<b>Precambrian</b>		igneous, metamorphic volcanics	

Figure 2. Stratigraphic column of Phanerozoic sedimentary rocks on Northwest Shelf of Permian Basin. Abo Formation shown in red.

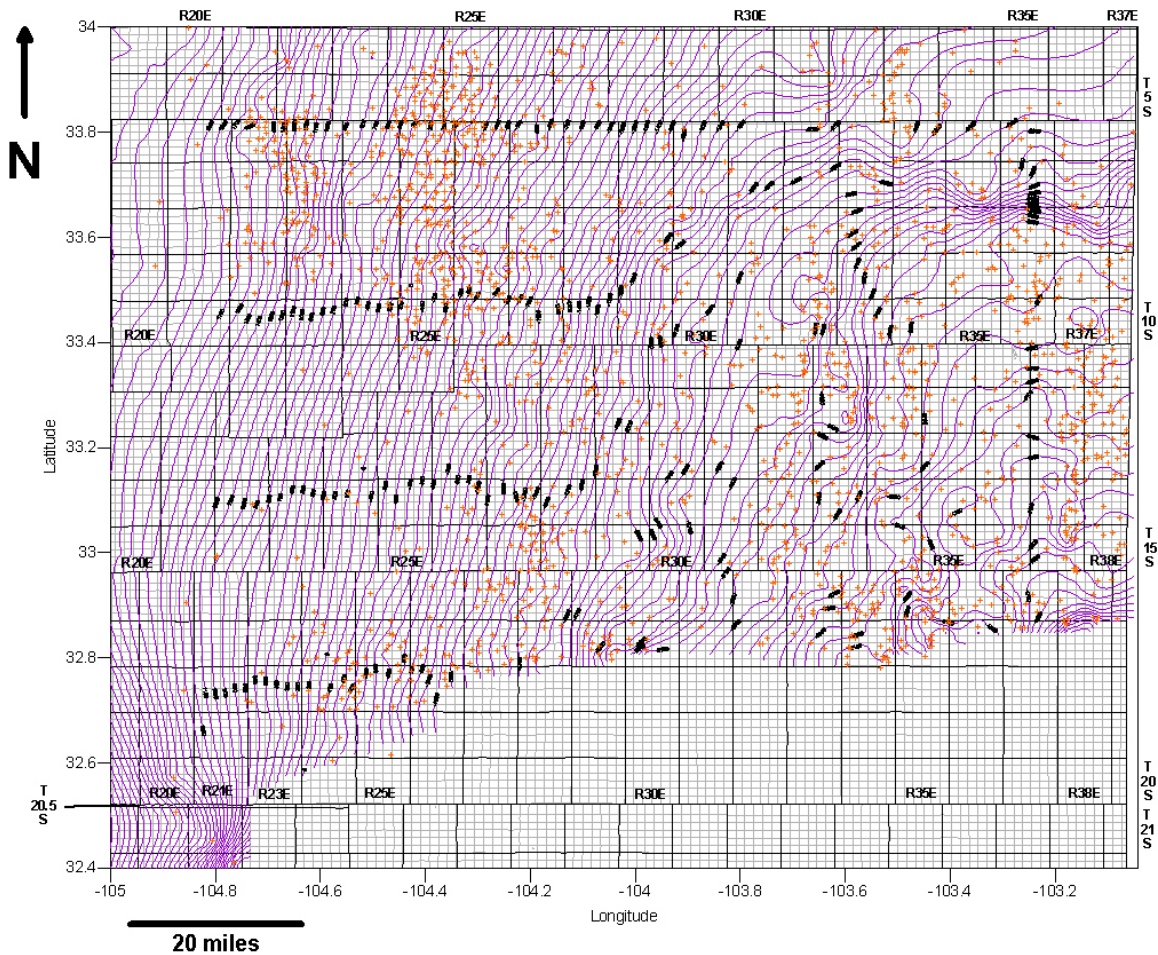


Figure 3. Structure contours on upper surface of Abo Formation, Northwest Shelf of Permian Basin.

(structural) elevation of the upper surface of the Abo Formation in each well. The data fields are described below.

**Operator:** The name of the company that drilled the well.

**Lease name:** The name of the lease the well was drilled on.

**Well number:** The number of the well in the lease.

**API number:** The unique API well number, if present in the well files of the New Mexico Bureau of Geology and Mineral Resources.

**Location (S-T-R):** The location of the well, in terms of the section, township, and range.

**Township (south):** The township, south of the regional base line, in which the well is located.

**Range (east):** The range, east of the New Mexico Principal Meridian, in which the well is located.

**Section:** The section within the township and range, specified above, in which the well is located.

**Location in section:** The location of the well in feet from the section boundaries.

**Longitude:** The longitude of the well, in decimal degrees. See section on *Well locations* in this report to find out how longitude was calculated.

**Latitude:** The latitude of the well, in decimal degrees. See section on *Well locations* in this report to find out how latitude was calculated.

**Elevation:** The surface elevation of the well in feet above sea level.

**Elevation datum:** The datum at which the surface elevation was measured.

*KB = Kelly bushing*

*DF = derrick floor*

*GL = ground level.*

**Total depth:** Total depth of the well, in feet.

**Abo top (ft):** Depth to the top of the Abo Formation, in feet.

**Abo subsea elevation:** The subsea (or structural) elevation of the upper surface of the Abo Formation was calculated by subtracting the depth to the top of the Abo Formation from the surface elevation of the well.

**Source Abo top:**

*Scout ticket* = the depth to the top of the Abo Formation was obtained from well records on file at the New Mexico Bureau of Geology and Mineral Resources.

*Log correlation* = the depth to the top of the Abo Formation was determined by correlating geophysical borehole logs and/or sample logs on file at the New Mexico Bureau of Geology and Mineral Resources.

## WELL LOCATIONS

Well locations in the Abo structure database are provided in both section-township-range format and in latitude-longitude format. Section-township-range format is the legal surveyed well location and is provided with every well record; this is the location used in every well permit. A location in latitude-longitude format is necessary to plot wells on a map using a computer and to perform contouring with a computer.

Latitude and longitude were calculated from the section-township-range coordinates at the New Mexico Bureau of Geology and Mineral Resources using the Geographix Exploration Program (a product of Landmark Graphics) and the Whitestar

Corporation digital land grid of New Mexico (1997 version). This method allows translation of section-township-range coordinates into latitude-longitude coordinates based on the 1927 North American datum. In general, wells located with our version of the Whitestar land grid appear to plot within 250 feet of the surveyed locations on a 1:24,000 topographic map. In general, these locations will be accurate to at least the nearest quarter-quarter-quarter section. This is sufficient accuracy to produce a valid structure contour map on a basinal scale with a maximum well density of one well per section.

## **DETERMINATION OF DEPTH TO TOP OF ABO FORMATION**

The database contains values for depth to the upper surface (“top”) of the Abo Formation for 1768 wells. Of these, tops for 1443 wells were obtained from well records on file at the New Mexico Bureau of Geology and Mineral Resources. Tops for 325 wells were obtained by correlating geophysical borehole logs and, where available, sample logs. Therefore, 18% of the Abo tops were the result of correlations made explicitly for this project.

The top of the Abo was correlated using logs in approximately 250 wells because preliminary structure contour maps made solely from scout tops revealed anomalous structural elevations that resulted in closed contours, structural reversals, or other deviations from the normal contour patterns in the area in which the wells are located. The depths to the top of the Abo in the 75 other wells were correlated as random spot checks throughout the project area. After examination of the preliminary contour maps, logs from selected wells were correlated in order to either confirm or correct the apparent structural anomalies. In approximately one-half of the cases, correlation revealed the scout tops were in appreciable error (more than 30 ft difference from the correlated top), resulting in false anomalies, closed contours, or structural reversals. In the other one-half of the cases, the Abo top as reported in the well records was within 30 ft of its actual depth; in these cases, the structural anomalies are real and are portrayed in the final version of the structure contour map.

There were several reasons why the reported Abo tops in the well records were different from the tops correlated for this project. Some errors are systematic and result from the placement of the top of the Abo at different stratigraphic positions than used by most workers and as defined in published research. In most places on the Northwest

Shelf, the top of the Abo is marked by a transition from the red, nonmarine to perhaps marginal marine red shales and fine-grained sandstones of the Abo Formation to the shallow marine evaporitic sediments of the overlying Yeso Formation. The lower part of the Yeso Formation consists of orange sandstones, orange shales, light gray to white dolostones (some of which are oolitic), and bedded anhydrite. In some areas, there appears to be a laterally interfingering relationship between uppermost Abo strata and lowermost Yeso strata, indicating that the correlated tops do not define a chronostratigraphic surface. In other areas, the boundary between the Abo and the Yeso is sharp and perhaps disconformable, suggesting erosion or beveling of the Abo prior to or during the relative sea level rise that led to the deposition of marine Yeso sediments above the nonmarine Abo sediments.

Where the two formations appear to laterally interfinger, Abo-like red shales in the lower Yeso have been correlated by some (but not by most) workers to be in the upper part of the Abo; this results in reported tops reported in the well records that may be 80 to 100 ft above the actual Abo tops. This project attempted to provide a uniform correlation of the Abo, thereby eliminating inconsistencies in correlations.

Errors in correlation also result from a southeastward facies transition within the Abo from clastic redbeds in the northwest part of the Permian Basin to a dominantly dolostone facies to the southeast. In the southeast where the Abo is dominantly dolostone, the uppermost 10 to 200 ft of the Abo consists of red to green shale that represent a southeastward progradation of Abo clastics over Abo carbonates. Although most workers correlate the top of the Abo at the top of the shale section, some of the well records indicate an Abo top at the base of the shale (top of the dolostone section). Wells correlated in this manner produce false anomalies on the preliminary structure contour maps.

Another common miscorrelation is mistaking the top of the Tubb sandstone member of the Yeso Formation for the top of the Abo. Both the Tubb sandstone and the Abo produce relatively high radioactive readings on gamma-ray logs relative to overlying carbonate-bearing strata. In places where the upper Abo shale overlies Abo dolostones, both the Tubb sandstone and the upper Abo shale are characterized by strata with a relatively high radioactive signature sandwiched between overlying and underlying marine strata of relatively low radioactivity. The Tubb is typically present 700 to 900 ft above the top of the Abo, so miscorrelation of the Tubb as the Abo will result in a map that portrays high-amplitude anticlines and domes that are not actually present.



## CONTOURING METHODS

The structure on top of the Abo Formation was contoured digitally using *Surfer 8*, a modern digital contouring program (*Surfer 8* is a registered trademark of Golden Software, Inc.). Gridding of the well data, provided in the Excel spreadsheet on this CD, was done in Surfer using the point kriging method with default parameters. The gridded data were then contoured at 25 ft and at 100 ft contour intervals. For both the 25 ft and 100 ft contour-interval maps, the contours were smoothed with the high smoothing option in order to remove the straight-line aspects of contours that are made without the smoothing option. Although smoothing results in contours are more rounded and look more natural, this option can locally cause contour lines to cross over each other in areas where contour spacing is very close.

One of the drawbacks to the kriging method in the gridding of data is that the method can extrapolate structural elevation values beyond the known range of values, thereby producing a map that in places may have unrealistically high or unrealistically low contours. However, kriging generally minimizes this effect compared to other gridding techniques and generally results in contours that more closely approximate a good hand-contoured map than other gridding techniques. Kriging also attempts to minimize bulls eye patterns in the data and will attempt to connect isolated high points along ridgelines, thereby expressing trends between data points (Golden Software, Inc., 2002).

## ACCESSING THE MAPS

The structure contour map of the upper surface of the Abo Formation is presented in three formats for your use.

1. **Pdf format.** This format may be viewed on any computer that has Adobe Acrobat Reader installed and is a fixed map that cannot be modified or overlain on other maps. Two versions of the pdf map are give, one with 100 ft structure contour intervals (Abo structure 100 ft contours.pdf) and one with 25 ft contour intervals (Abo structure 25 ft contours.pdf). The 25 ft contour interval map has greater resolution than the 100 ft contour interval map and therefore will produce a larger map when plotted on paper, but will also require more computer memory to

produce the map in a timely manner. Users that have older computers with limited memory and processing power may wish to use the map with the 100 ft contour intervals. Both maps were exported directly from Surfer 8. The pdf format is easy to use and a paper map may be easily plotted using a large format plotter. The pdf maps show contours and their values, a section-township-range grid, and well locations. If you do not have Adobe Acrobat Reader installed on your computer, a free copy is included on this CD in the file “Acrobat Reader” and may be downloaded and used in accordance with the license agreement provided with the software.

2. **ArcMap format.** ArcMap is a Geographic Information System (GIS) product of ESRI Corp. With this map, you can plot well locations, well data, contours, and other geologic and geographic data in a system of digital maps that may be spatially related to other geologic and geographic data that the user chooses to import from other sources. The user must have ArcMap v 8.2 from ESRI in order to view and use the contour map in ArcMap format. The files for the ArcMap version of the Abo structure contour map are located in the folder “*ArcMap*”. The structure contours in the ArcMap format were first created in Surfer 8 and then exported to ArcMap.
3. **ArcReader format.** ArcReader, a product of ESRI Corp., is a free viewer that allows the user to view the GIS version of the contour map, but not modify or change it. This format is located on this CD in the folder “*ArcReader map*”. If Arc Reader is not installed on your computer, you may download it from this CD by opening the folder “*ArcReader program*” and then by double clicking on the “license agreement” icon and accepting the terms of the license agreement. You may then double click on the “*setup*” icon in order to install ArcReader. After installation is complete, you may view the Abo structure map by clicking on the Abo-structure ArcReader project.

## **REFERENCE**

Golden Software, Inc., 2002, Surfer 8 users guide: Golden Software, Inc., Golden, CO., 640 p.