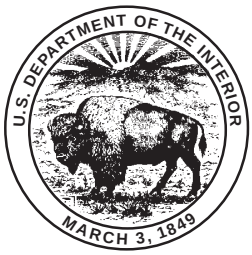
← Contents
← Previous Section

Maps Illustrating the Distribution of Deep Wells in the United States by Geologic Age

By Craig J. Wandrey *and* David K. Vaughan

GEOLOGIC CONTROLS OF DEEP NATURAL GAS RESOURCES IN THE UNITED STATES

U.S. GEOLOGICAL SURVEY BULLETIN 2146–B



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1997

CONTENTS

FIGURES

TABLE

Maps Illustrating the Distribution of Deep Wells in the United States by Geologic Age

By Craig J. Wandrey *and* David K. Vaughan

ABSTRACT

Two maps display exploration and production histories for wells from deep reservoirs (greater than 15,000 ft, 4,572 m). The first map shows producing oil and condensate or gas wells by geologic age of producing reservoir. The second map shows nonproducing wells by geologic age of the oldest rocks penetrated or investigated. The accompanying table demonstrates the relationship between structural classification of basins and commodities produced. Deep reservoirs in general are gas prone, in part due to long exposure of source rocks to higher temperatures. Younger deep basins are commonly oil prone, in part due to a shorter deep burial history and resultant shorter exposure of source rocks to higher temperatures. Continued hydrocarbon generation in these younger basins also contributes to overpressuring, which in turn contributes to suppression of thermal maturity in source rocks.

PRODUCING AND NONPRODUCING DEEP WELLS

Maps showing wells drilled deeper than 15,000 ft (4,572 m) were compiled using Petroleum Information Corporation's Well History Control System (WHCS) files as of June 1991 (Petroleum Information Corporation, 1991). These files contain geologic, engineering, and production data for more than 2.2 million exploration and production wells drilled in the United States. Figure 1 shows wells that have produced hydrocarbons from depths greater than 15,000 ft, grouped by geologic age of the producing formation. Figure 2 shows deep nonproducing wells, grouped by the age of the oldest rocks penetrated.

Parts (yellow areas) of the maps identify areas containing sedimentary rocks at depths of 15,000 ft (4,572 m) or greater in each region or basin. Sedimentary thickness data were compiled using a contour map of sedimentary rock depth of the conterminous United States (Frezon and others, 1983), an unpublished basement map of the southwestern United States (W.C. Butler, U.S. Geological Survey, 1992), and well log and seismic data for the Midcontinent Rift system (Anderson, 1990). Producing wells shown in figure 1 were color-coded by geologic age of producing formation (Cenozoic, Mesozoic, Paleozoic) using geologic age codes in the WHCS files. These data were compiled from five maps of producing wells by Wandrey and Vaughan (1992).

Although the data are current, they are not always complete or entirely accurate. Therefore, several cross checks were made to ensure that the wells shown in figure 1 did in fact produce from depths greater than 15,000 ft (4,572 m). WHCS records commonly show that a well produced petroleum and was drilled to greater than 15,000 ft, but the depth of production is not identified in the file. In these cases, the wells were cross checked against subsurface geologic maps, depth of formation top, and initial-potential files. Information on individual wells in the Gulf Coast Basin is particularly misleading or missing; in many cases, wells were drilled into salt domes created by flowage of salt from older deeper salt beds up into younger rocks, and the age of the salt rather than that of the surrounding rocks is given.

Table 1 shows a compilation of producing well categories used to prepare figure 1. Of the 6,178 wells that produce or have produced hydrocarbons from depths greater than 15,000 ft (4,572 m), 4,547 are gas or gas and condensate wells (fig. 1). The total wells column given in table 1 may not always equal the sum of the other three columns because some wells produced both oil and gas and are listed twice in the table. For some wells final well-classification information indicating the type of production is missing, and for others location information is not available with which to identify the basin. More than 200 of the wells identified in table 1 are not shown in the figures because well classification and location problems could not be resolved. For many offshore wells in the Gulf of Mexico, geologic age is not recorded in the WHCS files; in these cases, the approximate geologic age of formation at total depth of a well was determined by comparing the total depth of the well with that of neighboring wells for which there was geologic age information. For wells outside areas in which sedimentary rocks are 15,000 ft or deeper, location data may be inaccurate or the

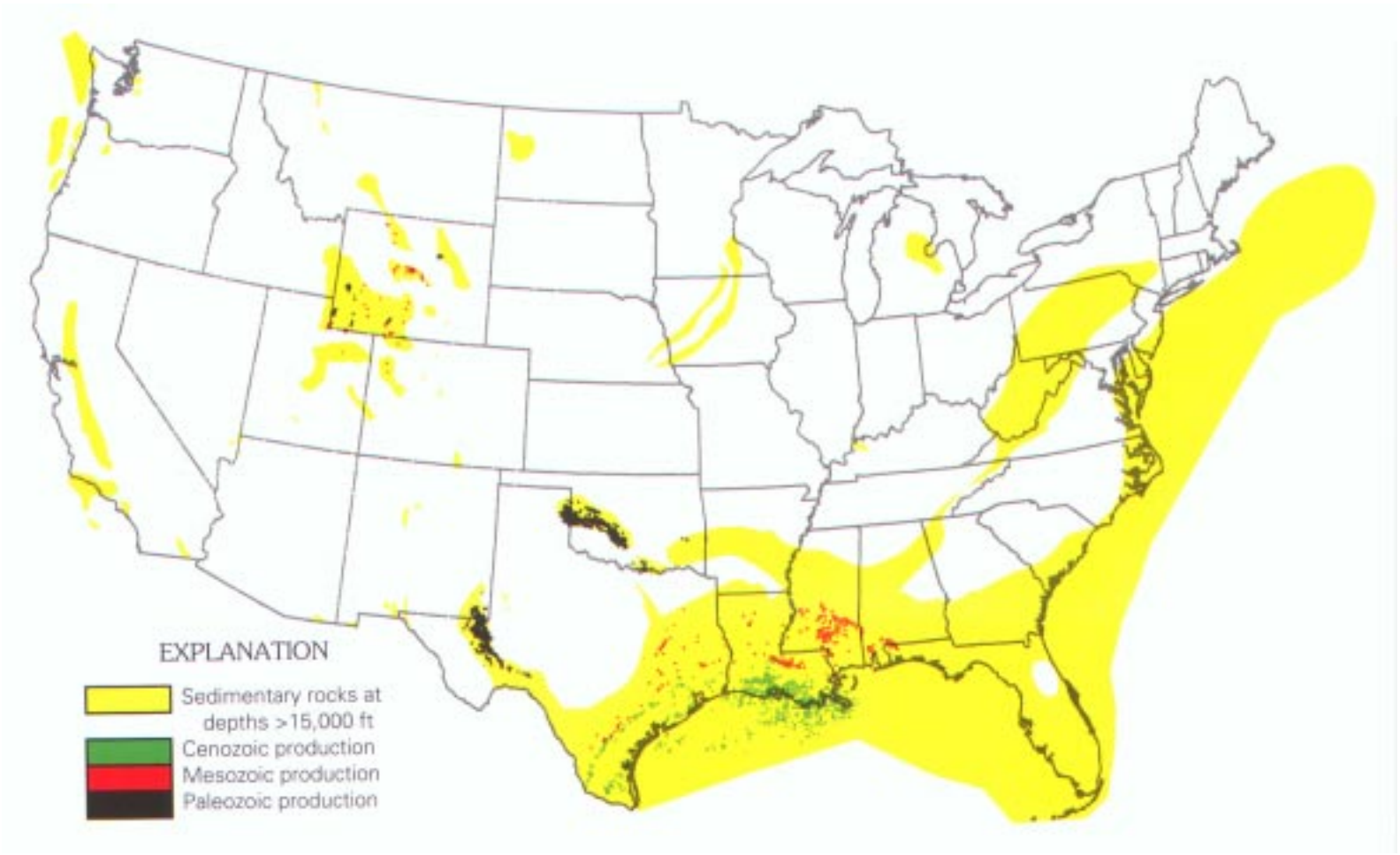


Figure 1. Map of the United States showing wells that have produced hydrocarbons from depths greater than 15,000 ft (4,572 m), grouped by geologic age of the producing formation.

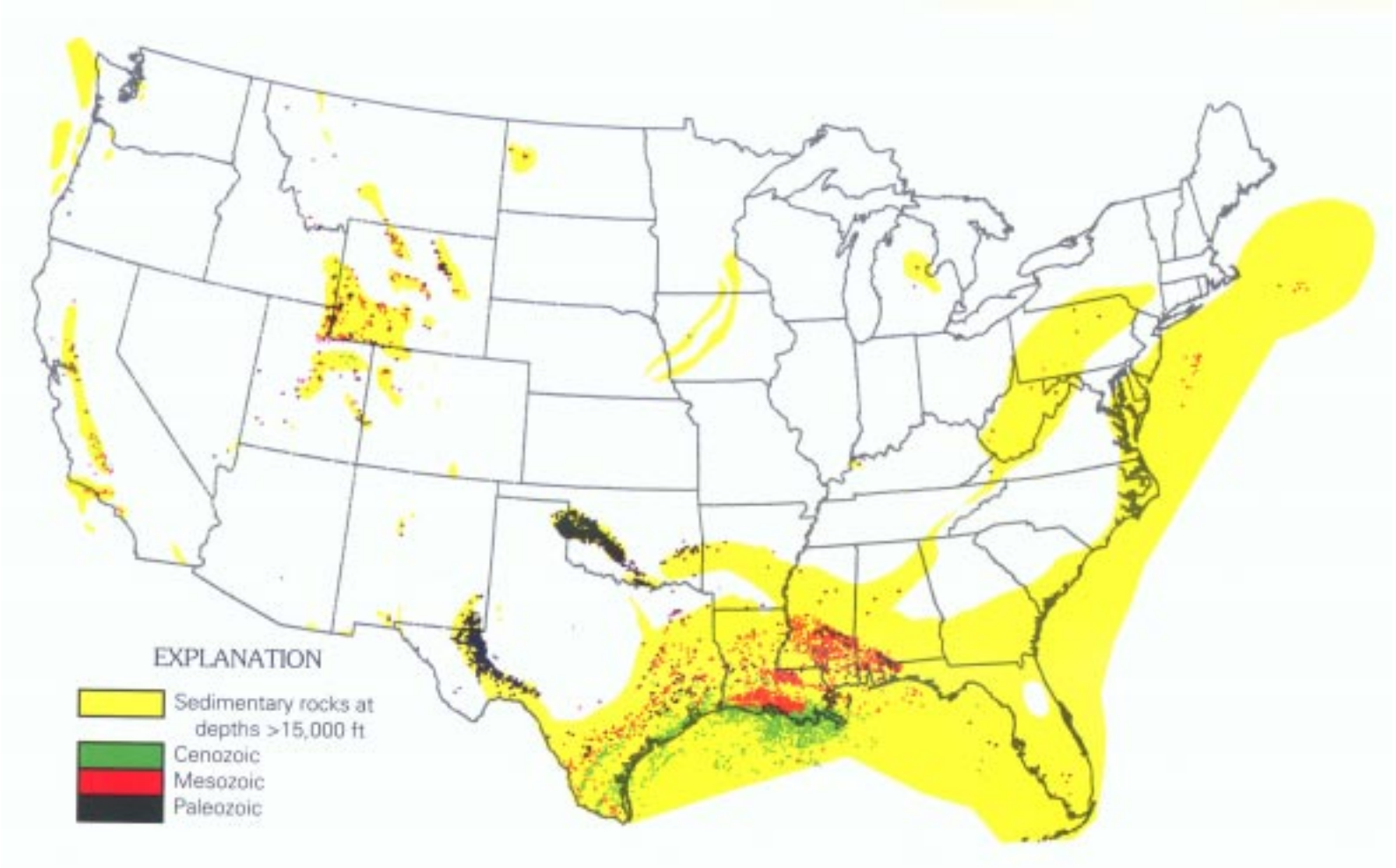


Figure 2. Map of the United States showing nonproducing, deep (greater than 15,000 ft, 4,572 m) wells, grouped by geologic age of the oldest rocks penetrated.

Table 1. Number of total wells and producing wells by production category and tectonic regime for selected basins in the United States.
[The number of total wells does not always equal the sum of the other three columns because some wells produced both oil and gas and are therefore listed twice in the table. Also, the total number of wells does not equal the 6,178 wells discussed in the text. For some wells final well-class information indicating the type of production is lacking, and for others location information was insufficient to determine the correct basin. Approximately 169 of these wells are not shown on the maps because well classification and location problems could not be resolved. Data from Well History Control System of Petroleum Information Corporation (1991)]

Basin or province	Total number of wells	Oil-producing wells	Gas-producing wells	Oil and gas producing wells	Tectonic regime
Anadarko	1,258	41	1,231	1	Foreland basin.
Ardmore	10	0	10	0	Foreland basin.
Arkoma	6	1	10	0	Foreland basin.
Bighorn	4	0	4	0	Foreland basin.
Green River	107	24	81	0	Foreland basin.
Gulf basin	3,465	999	2,411	35	Passive-margin basin.
Marietta	14	3	11	0	Foreland basin
Permian	873	22	793	2	Continental-margin rift basin.
Piceance	2	1	1	0	Foreland basin.
Powder River	32	31	0	0	Foreland basin.
San Joaquin	6	5	0	0	Foreland basin.
Uinta	154	152	2	0	Foreland basin.
Ventura	6	4	2	0	Transpressive basin.
Wind River	72	6	65	0	Foreland basin.

area of sedimentary rock at depths of 15,000 ft or more may not have been extended far enough from the basin center due to lack of data.

The Gulf Coast Basin contains most of the deep producing wells (1,895) in the United States, whereas the Rocky Mountain region contains only 265 deep producing wells. The Appalachian-Illinois-Michigan region contains 19 wells drilled deeper than 15,000 ft (4,572 m), but all wells are either dry holes or are producing from formations that are less than 15,000 ft deep.

For the majority of depth intervals below 15,000 ft (4,572 m), gas-producing wells make up more than 90 percent of the total producing wells. For all depth intervals together, the Rocky Mountain region has the smallest percentage (34 percent) of deep gas wells to total producing wells (91 deep gas wells and 265 total deep wells). This figure is somewhat misleading because it is strongly biased by deep oil production in the Uinta and Powder River Basins. The Green River, Wind River, Washakie, and Bighorn Basins and the area of the Wyoming-Utah-Idaho thrust belt are predominantly gas prone below 15,000 ft, but have fewer total wells. The deepest producing wells in the Rocky Mountain region, namely those producing below 20,000 ft (6,096 m), are gas producers from the Madison Limestone in the Wind River Basin of Wyoming. The two deepest wells in the Midcontinent region are gas producers that were drilled into the Upper Cambrian and Lower Ordovician Arbuckle Group and the Silurian and Devonian Hunton Group in the Anadarko Basin in Texas and Oklahoma.

The deepest wells in the Gulf Coast Basin are natural gas wells in Louisiana. These produce gas from Miocene strata, but no WHCS formation data are available for these wells. The deepest offshore well is on the Eugene Island block off Louisiana and produces from Miocene strata at a depth of about 21,000 ft (6,401 m).

The Uinta and Gulf Coast Basins, the two areas in which there are significant numbers of deep oil wells, are producing from relatively young rocks. It is likely that source rocks that are still producing oil at these depths have been buried deeply for only a short time or have been overpressured for the greater part of the time spent in the oil and gas windows. The success ratio of approximately 46 percent for these deep wells is high and may be due to a variety of factors: (1) greater investment is likely made in preparatory exploration of the prospect to reduce the financial risk, and (2) fewer true wildcats exist; that is, most wells are production wells drilled in proven areas resulting in a better success rate.

Figure 2 shows nonproducing wells grouped by the age of the oldest rocks penetrated. Nonproducing means that hydrocarbons could not be economically produced at the time drilling was completed. Shows of oil and (or) gas may have been identified but were insufficient to warrant production, or completion problems may have precluded production. Some of these wells may not be dry holes in the conventional sense of the term. Because WHCS uses the same code for dry holes and for abandoned producing wells, a few wells displayed as dry holes may in fact have produced in the past or may be temporarily shut-in until pipelines or production facilities are completed. Although the number of wells that produced at one time or are still producing is relatively accurate, dry-hole estimates may be high.

REFERENCES CITED

Anderson, R.R., 1990, Interpretation of geophysical data over Mid-continent rift system in the area of the M.G, Eischeid No. 1 petroleum test, Carroll County, Iowa, *in* Anderson, R.R., ed., The Amoco M.G. Eischeid No. 1 deep petroleum test, Carroll County, Iowa, preliminary investigations: Iowa Department of Natural Resources Special Report 2, p. 27–38.

Frezon, S.E., Finn, T.M., and Lister, J.H., 1983, Total thickness of sedimentary rocks in the conterminous United States: U.S. Geological Survey Open-File Report 83–920, scale 1:5,000,000.

Petroleum Information Corporation, 1991, Well History Control System (through December 1991): Available from Petroleum Information Corporation, 4100 East Dry Creek Road, Littleton, Colorado 80122.

Wandrey, C.J. and Vaughan, D.K., 1992, Maps illustrating the distribution of deep wells in the U.S. by geologic age, *in* Dyman, T.S., ed., Geologic controls and resource potential of natural gas in deep sedimentary basins: U.S. Geological Survey Open-File Report 92–524, p. 114–116, 9 plates, scale 1:5,000,000.