# Chapter 2
# **Overview**

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Chapter 2 of 13

**Petroleum Systems and Assessment of Undiscovered Oil and Gas in the Anadarko Basin Province, Colorado, Kansas, Oklahoma, and Texas—USGS Province 58**

Compiled by Debra K. Higley

U.S. Geological Survey Digital Data Series DDS–69–EE

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# Overview

By Debra K. Higley and Stephanie B. Gaswirth

## Introduction

This publication provides research results and related data in support of the U.S. Geological Survey (USGS) assessment of the undiscovered oil and gas resource potential of the Anadarko Basin Province of western Oklahoma and Kansas, northern Texas, and southeastern Colorado (fig. 1). This province area includes the Las Animas arch of southeastern Colorado, part of the Palo Duro Basin of Texas, and the Anadarko Basin. This is hereafter referred to as the 2011 assessment, which corresponds to the publication release date of the assessment results (Higley and others, 2011). Results of the geologic analysis and resource assessment (chapter 1) are based on the geologic elements of each defined total petroleum system (TPS), including hydrocarbon source rocks (source-rock maturation, hydrocarbon generation and migration), reservoir rocks (sequence stratigraphic and petrophysical properties), hydrocarbon traps (trapping mechanisms and timing), and seals. Using this geologic framework, the USGS defined 2 TPSs, the Woodford Composite TPS and Pennsylvanian Composite TPS (fig. 1) and 12 included assessment units (AU) (chapters 1 and 5–7), and quantitatively estimated the undiscovered oil and gas resources within these AUs. The assigned TPS and AU names and numeric codes follow.

Woodford Composite TPS 505801:

1. Arbuckle-Ellenburger, AU 50580101
2. Simpson Group, AU 50580102
3. Viola Group, AU 50580103
4. Hunton Group, AU 50580104
5. Mississippian, AU 50580105
6. Woodford Shale Gas, AU 50580161
7. Woodford Shale Oil, AU 50580162
8. Pennsylvanian Composite TPS 505802:
9. Morrowan-Atokan, AU 50580201
10. Desmoinesian, AU 50580202
11. Missourian-Permian, AU 50580203
12. Greater Granite Wash Composite, AU 50580204
13. Thirteen Finger Limestone–Atoka Shale Gas, AU 50580261

There are nine conventional and three continuous AUs. Continuous AUs are the (1) Devonian and Mississippian Woodford Shale Gas and (2) Woodford Shale Oil AUs of the Woodford Composite TPS, and (3) the Pennsylvanian Thirteen Finger Limestone–Atoka Shale of the Pennsylvanian Composite TPS. The stratigraphic charts show units within the Woodford Composite TPS (fig. 2) and Pennsylvanian Composite TPS (fig. 3).

## Discussion of Chapters

The 13 chapters included in DDS–69–EE cover topics that range from the oil and gas resource assessment results (chapter 1) of the Anadarko Basin Province, to background geological and geochemical research (chapters 3–11), tabular data and graphs in support of the assessment (chapter 12), and data releases of geographic information systems (GIS) shape files, zmap-format grid files that were used to build petroleum system models, and a standalone three-dimensional (3D) geologic model (chapter 13). Information on individual chapters is below.

Chapter 3. Thermal maturation history is based on one-dimensional (1D) and four-dimensional (4D) petroleum system models created as part of this study and on published research. This information was used to model hydrocarbon generation, migration, and accumulation through time for three assigned source intervals, the Ordovician Oil Creek Formation, Devonian-Mississippian Woodford Shale, and the informal Atokan Thirteen Finger limestone. Thermal maturation boundaries were also used to delineate continuous assessment units.

Chapter 4. The geochemistry of produced gases from the Anadarko Basin was analyzed with particular regard for their source and timing of generation, and this information helped to define the assessment units used in the assessment of undiscovered resources.

Chapter 5. The geology and assessment of Cambrian through Devonian stratigraphy of the Anadarko Basin Province is discussed. Included are descriptions of the units that compose the AUs: the Reagan Sandstone, the Arbuckle Group, the Simpson Group, the Viola Group, the Sylvan Shale, the Hunton Group, and the Misener sand (fig. 2).

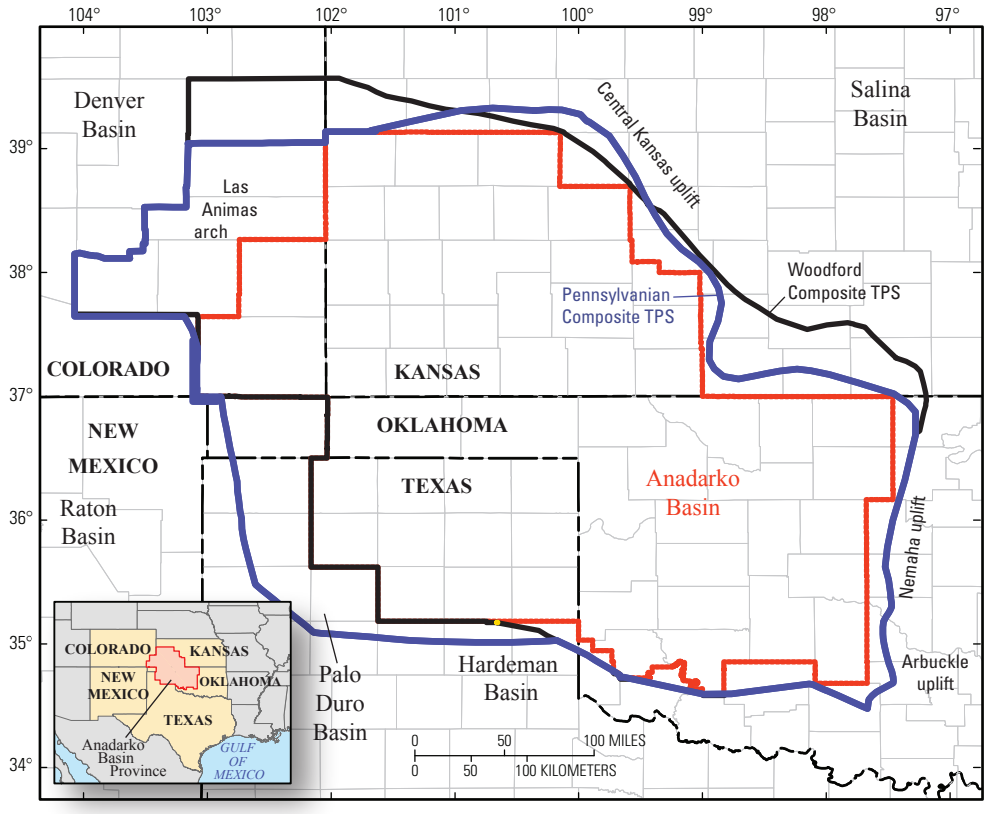


**Figure 1.** Map showing the Anadarko Basin Province is delineated by the maximum areal extent of the Woodford Composite and Pennsylvanian Composite Total Petroleum Systems (TPSs). The province includes the Anadarko Basin (red line), part of the Palo Duro Basin, and the Las Animas arch.

Chapter 6. Contained are the geology, thermal maturation history, and assessment of continuous resources of the Devonian-Mississippian Woodford Shale Gas and Woodford Shale Oil AUs (fig. 2).

Chapter 7. Conventional undiscovered resources of Mississippian through Permian AUs are discussed, as well as continuous gas resources from the Atokan Thirteen Finger limestone AU (figs. 2 and 3). Background information on these AUs includes the geologic characteristics and thermal maturation and petroleum production histories of the source and reservoir rocks.

Chapters 8 and 9. Pore pressures in Pennsylvanian strata of the greater Anadarko Basin range from overpressure in the deep basin, to normal pressure in the northeastern flank, to underpressure in the northwestern flank. The characteristics and evolution of the overpressured system are discussed in chapter 8, along with the finding of a paleo-overpressure zone more extensive than the present-day area of overpressure. The characteristics and causes of the underpressure, which grades into normal pressure along the northern flank of the basin, are discussed in chapter 9.

Chapter 10. Lithologies derived from mud logs, sample logs, and geophysical logs are presented on eight structural cross sections that cover the Oklahoma portion of the Anadarko Basin. There are three major lithologic groups: (1) the carbonate-dominated units of Mississippian age and older, (2) mostly siliciclastic units of Pennsylvanian age, and (3) evaporites and red shales of Permian age.

Chapter 11. This discussion of the tectonic and structural evolution of the Anadarko Basin is accompanied by a structural interpretation of a key two-dimensional (2D) seismic line and associated structural restoration.

Chapter 12. Contained are tabular data and graphs used in support of assessment of undiscovered oil and gas resources of the Anadarko Basin Province.

Chapter 13. Included are grid files and associated readme and metadata files used to build and document a 4D petroleum system model of the province. The 2D grid files comprise (1) 26 structural surfaces across the province, (2) estimated eroded thickness of strata in the Cenozoic, (3) total organic carbon content of the Woodford Shale, and (4) basement heat flow. Also included with this chapter is a 3D standalone geologic model of the Anadarko Basin Province that incorporates the 2D grid files.

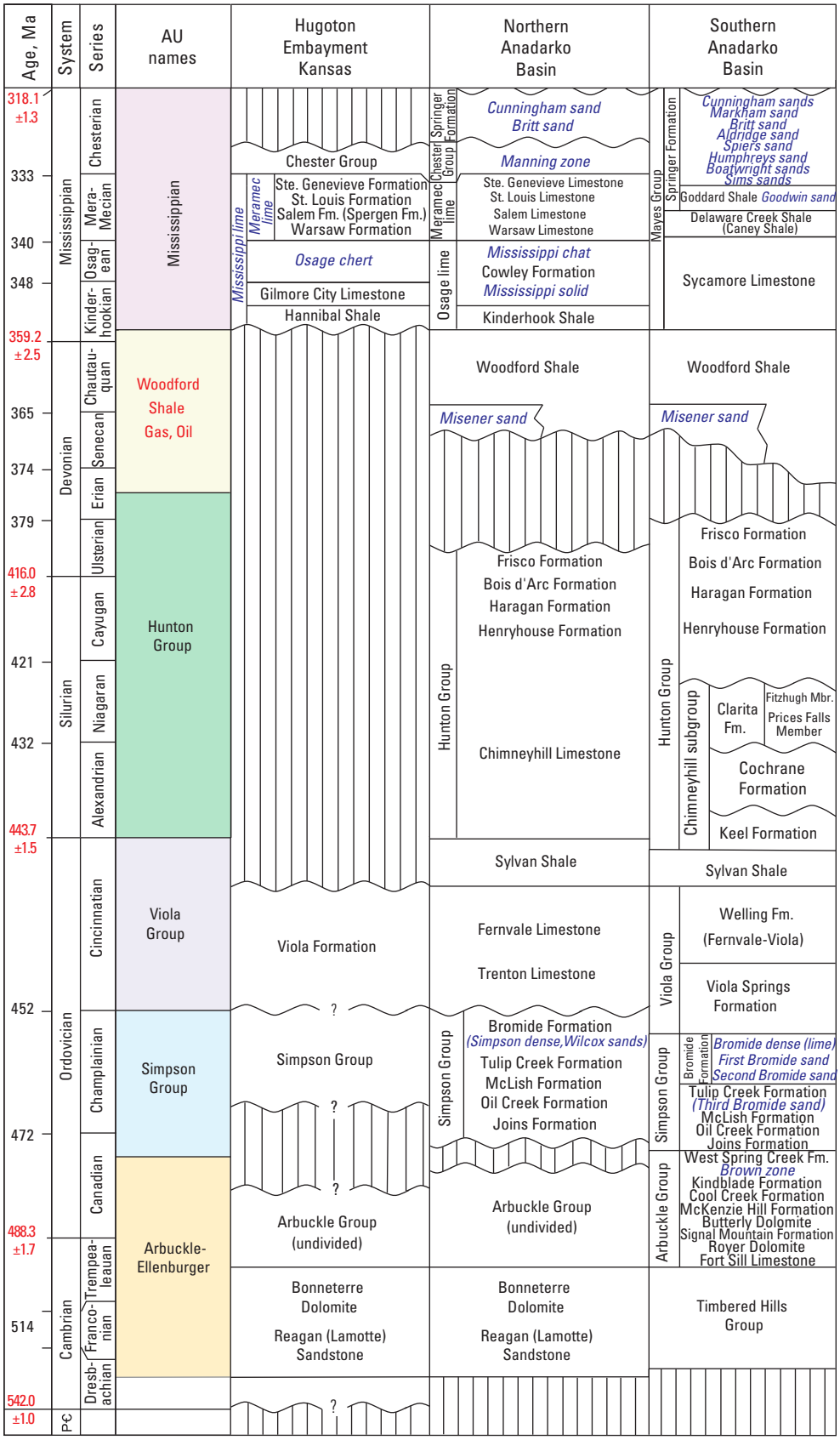


**Figure 2.** Generalized surface and subsurface stratigraphic columns for the Anadarko Basin and the Southern Oklahoma Fold Belt Provinces for the Precambrian to Mississippian. Assessment units (AU) are included in the Woodford Composite TPS. Blue text and lowercase descriptors indicate informal status. Wavy horizontal lines and vertical bars indicate unconformities and their duration. Modified from Bebout and others (1993) and Henry and Hester (1995). Ages in millions of years before present (Ma) from Haq and Van Eysinga (1998) and Gradstein and others (2004) (red text). Fm., Formation; Mbr., Member.

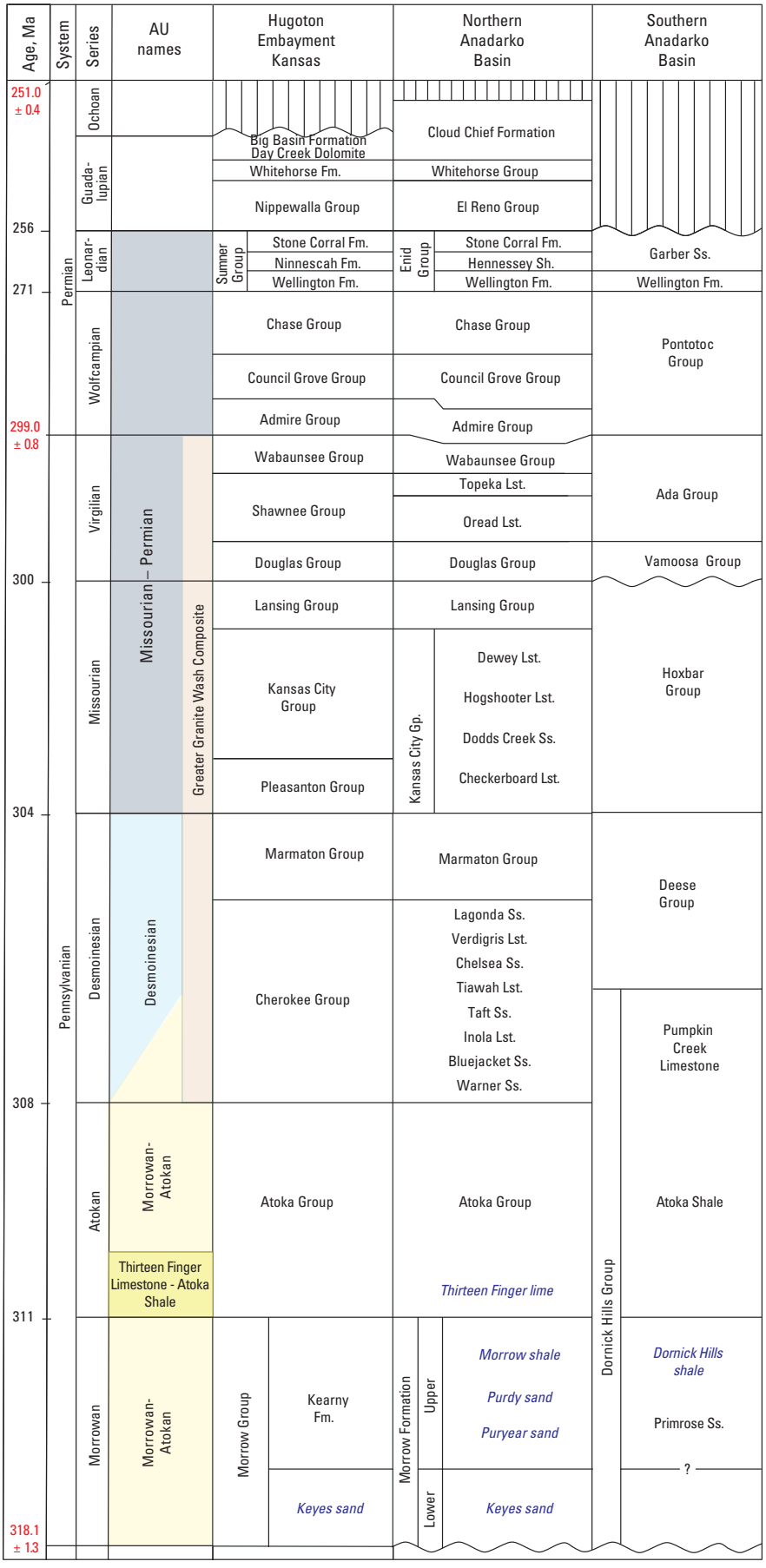


**Figure 3.** Generalized surface and subsurface stratigraphic columns for the Anadarko Basin and the Southern Oklahoma Fold Belt Provinces for the Precambrian to Mississippian. Assessment units (AU) are included in the Woodford Composite TPS. Italic (blue) text and lowercase descriptors indicate informal status. Wavy horizontal lines and vertical bars indicate unconformities and their duration. Modified from Bebout and others (1993) and Henry and Hester (1995). Ages in millions of years before present (Ma) from Haq and Van Eysinga (1998) and Gradstein and others (2004) (red text). Fm., Formation; Mbr., Member.

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## Using This CD

The descriptive and interpretive text chapters of this volume are in PDF format. Use Acrobat Reader Version 7.0 or later to access and view these chapters.

Data-table files are presented as tab-delimited text files (.tab files), usable in spreadsheet and database software. Graphical and summary-table files are presented as portable document format files (.pdf files). Zmap-format grids (.DAT) and the associated readme file include geographic coordinate data. Geographic Information System (GIS) data associated with the Anadarko Basin resource assessment can be accessed from the following website: *http://energy.usgs.gov/OilGas/AssessmentsData/NationalOilGasAssessment/USBasinSummaries.aspx?provcode=5058*.

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