National and Global Petroleum Assessment

# Assessment of Undiscovered Conventional Gas Resources in the Deep Tuscaloosa Group Sandstones of the Western Gulf Basin Province, U.S. Gulf Coast Region, 2021

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 14,785 billion cubic feet of gas resources in the Western Gulf Basin Province, U.S. Gulf Coast region.

## Introduction

The U.S. Geological Survey (USGS) completed a geology-based assessment of undiscovered, technically recoverable conventional gas resources in Upper Cretaceous deep (greater than 19,000 feet depth) Tuscaloosa Group sandstones of southern Louisiana, in the U.S. Gulf Coast region (fig. 1). One geologic assessment unit (AU) was defined, and the assessed interval is part of the Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System (TPS). The Deep Tuscaloosa Conventional Gas AU is basinward of, and independent from, the 2007 Downdip Tuscaloosa Conventional Gas AU (Pitman and others, 2007).

In the beginning of the Late Cretaceous, a relative drop in sea level, probably associated with local uplift, caused increased erosion in the northern U.S. Gulf Coast region that resulted in an eroded surface known as the mid-Cretaceous unconformity (Galloway, 2008). Following the basinward movement of the shoreline, fluvial and deltaic sediments prograded over newly exposed carbonate-dominated Lower Cretaceous strata. These progradational sediments (consisting primarily of sandstones and shales) as well as muds deposited during a period of higher relative sea level, make up the Tuscaloosa Group and are found across much of the eastern U.S. Gulf Coast region, from onshore fluvial environments to slope and basin floor deposits (Galloway, 2008). In southern Louisiana, a maximum net thickness of the sandstone of the Tuscaloosa Group is found in the center of the state near what may have been the ancestral Mississippi River (Snedden and others, 2016). Within the Deep Tuscaloosa Conventional Gas AU, the Tuscaloosa Group is found at depths below 19,000 feet among structures associated with the movement of existing or extruded Jurassic Louann Salt (Diegel and others, 1995; Schuster, 1995; McBride, 1998). These structures are integral to the geologic model used in this assessment.

## Geologic Model for Assessment

Research indicates reservoir quality, source rock maturity, and migration are all sufficient for hydrocarbon occurrence within the AU (Smith, 1981; Dubiel and others, 2003; Pitman and others, 2007; Hackley and others, 2020). The gas found in the Tuscaloosa Group, below roughly 19,000 feet, is dry and cannot be directly linked to a source rock using established methods. Work by Hackley and others (2020) shows that shallower gas of the Tuscaloosa, landward of the AU in central Louisiana and western Mississippi, is sourced from transgressive deposits of the Tuscaloosa marine shale, within the Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System (TPS) that rest conformably on top of productive sandstones of the Tuscaloosa Group.

The retention of hydrocarbons and the number and size of those traps are major components of the geologic model used in this assessment. Hydrocarbon trap types are presumed to be associated with structures generated by in-place and extruded Louann Salt. The movement of salt and the concomitant formation of structures, such as keels, welds, diapirs, and counter regional dipping feeders, that bound minibasin sediment accumulations, have been documented in the shallow to deep offshore strata (for example, see Pilcher and others, 2011; Harding and others, 2016). These features are clearly seen in offshore seismic data where the quantity and quality of data are much better than what is available onshore. However, limited onshore seismic data have indicated similar deep, salt-associated structures exist onshore (Diegel and others, 1995; Schuster, 1995; McBride, 1998).

Although onshore salt has been expelled downdip to form allochthonous basins and salt features in the Cenozoic offshore strata, the deeper salt-related structures that affect primary Mesozoic sediment accumulations are consistent between both trends (Diegel and others, 1995; Schuster, 1995; McBride, 1998). The spacing of salt expulsion structures and potential hydrocarbon traps are significant factors in determining the number of gas fields in table 1 (Merrill, 2022). The sizes of undiscovered gas fields are constrained based on known Tuscaloosa Group production within and outside the AU as well as information from regional analogs.

Fundamental geologic characteristics of the reservoir rock were also considered in this assessment. The depositional environment for the Tuscaloosa Group in the AU area (fig. 1) ranges from distal deltaic to channelized and confined intraslope. Well log analyses indicate the net thickness of porous sandstone in the assessed area ranges from 10 feet to more than 650 feet with the maximum thickness on the deltaic axis in central Louisiana and concurs with ranges reported in Snedden and others (2016). Porosity and permeability average 20 percent and 100 millidarcies, respectively, based on Dutton and others (2018) and Nehring Associates Inc. (2018). The relatively high porosity and permeability at these depths are attributed to the preservation effects of chlorite coatings that inhibit the growth of quartz cements (Dowey and others, 2012; Woolf, 2012; Dutton and others, 2018).



**Figure 1.** Map showing the location of one gas assessment unit (AU) in the Western Gulf Basin Province, U.S. Gulf Coast region.

## Assessment Unit

One conventional AU was defined for this assessment (fig. 1). The northern boundary of the Deep Tuscaloosa Conventional Gas AU abuts the southern boundary of the 2007 Downdip Tuscaloosa Gas AU (Pitman and others, 2007). The 2007 assessment focused on shallower sandstones of the Tuscaloosa Group with traps associated predominantly with growth faulting. The geologic models are different and therefore, the AU boundaries do not overlap. Consequently, this assessment is independent from the 2007 work and not an update or reassessment. The eastern boundary of the AU extends to the state water boundary. Studies by Harding and others (2016) and Snedden and others (2016) show sandstones of the Tuscaloosa Group were deposited across the eastern portion of the AU and supplied sediment to areas in the offshore eastern Mississippi Canyon. The southern boundary also extends to the state water boundary as indicated by the same sources. In southwestern Louisiana, the sandstones are thin to absent. Therefore, the western AU boundary is determined by sandstone presence. In this western area, the AU boundary is inclusive of wells with known sandstone confirmed by drill cuttings, and interpreted sandstone from well logs and seismic data, but otherwise the AU does not include much of southwestern Louisiana.

**Table 1.** Key input data for one gas assessment unit in sandstones of theTuscaloosa Group, U.S. Gulf Coast region.

[Shading indicates not applicable. AU, assessment unit; BCFG, billion cubic feet of gas]

| Assessment input data—Conventional AUs | Deep Tuscaloosa Conventional Gas AU | | | |
|---|---|---|---|---|
| | Minimum | Median | Maximum | Calculated mean |
| Number of gas fields | 1 | 90 | 360 | 99.2 |
| Size of gas fields (BCFG) | 30 | 60 | 6,000 | 149.3 |
| AU probability | 1.0 | | | |

## Undiscovered Resource Summary

The USGS quantitatively assessed one AU for undiscovered natural gas resources for the Deep Tuscaloosa Group Conventional Gas AU of the Western Gulf Basin Province, U.S. Gulf Coast region (table 2). The estimated mean total resource is 14,785 billion cubic feet of gas (BCFG). The F5 and F95 range resources are 29,104 and 5,432 BCFG, respectively. The median (F50) resource is 13,353 BCFG. There are no natural gas liquid resources.

**Table 2.** Results for one gas assessment unit in sandstones of the Tuscaloosa Group, U.S. Gulf Coast region.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Shading indicates not applicable. BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids]

| Total petroleum system and assessment units (AUs) | AU probability | Accumulation type | Total undiscovered resources | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas (BCFG) | | | | NGL (MMBNGL) | | | |
| | | | F95 | F50 | F5 | Mean | F95 | F50 | F5 | Mean |
| Upper Jurassic Cretaceous Tertiary Composite Total Petroleum System | | | | | | | | | | |
| Deep Tuscaloosa Conventional Gas AU | 1.0 | Gas | 5,432 | 13,353 | 29,104 | 14,785 | 0 | 0 | 0 | 0 |
| **Total undiscovered conventional resources** | | | **5,432** | **13,353** | **29,104** | **14,785** | **0** | **0** | **0** | **0** |

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## For More Information

Assessment results are also available at the USGS Energy Resources Program website at https://www.usgs.gov/programs/energy-resources-program.

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