Identifying the Source of the Lower Cenomanian Maness Shale of East Texas

DAVIDSON, Joshua, DENNE, Richard

Department of Geological Sciences, Texas Christian University, Fort Worth, TX 76129

Abstract

The Lower Cenomanian Maness Shale is an argillaceous mudrock that occurs between the Buda Limestone and Woodbine Sandstone in the East Texas Field, and was originally placed within the Washita Group based on its biostratigraphy. It regionally extends throughout the East Texas Basin in tandem with the overlying Woodbine Group and displays considerable thickness and facies variations. The Maness interval is significant because previous studies indicate that it may be a hydrocarbon source rock. Although this mudrock has been studied for several decades, the sediment source of the Maness remains in question. Prior studies have indicated that the sediment comprising the Maness could have come from multiple sources, one of them being the southern side of the Sabine Uplift. In the current study, I will correlate well logs through the south side of the Sabine Uplift from Polk and Tyler counties through Rusk county. I will then generate an isopach map of the study area and will compare thickness trends to those shown on the composite isopach map constructed by English (2020). Lastly, I will examine a core from Tyler or Polk counties that could potentially reveal clastic sandstones occurring within the Maness. The findings will be used to test my hypothesis that the Maness Shale is sourced from the southern portion of the Sabine Uplift.

Geologic Background

Tectonics: The area to be studied covers nine counties within the Greater East Texas Basin. This region was influenced by significant geologic features such as the Ouachita Uplift (north), the Sabine Uplift (east), the Llano Uplift and associated San Marcos Arch (southwest), Sligo and Stuart City reefs (south-southwest), and syn-depositional movement of the Louann Salt. These features are the result of tectonic events that occurred from the Late Carboniferous to the Late Cretaceous and had a strong influence on the paleoceanography and depositional patterns of the Greater East Texas Basin.

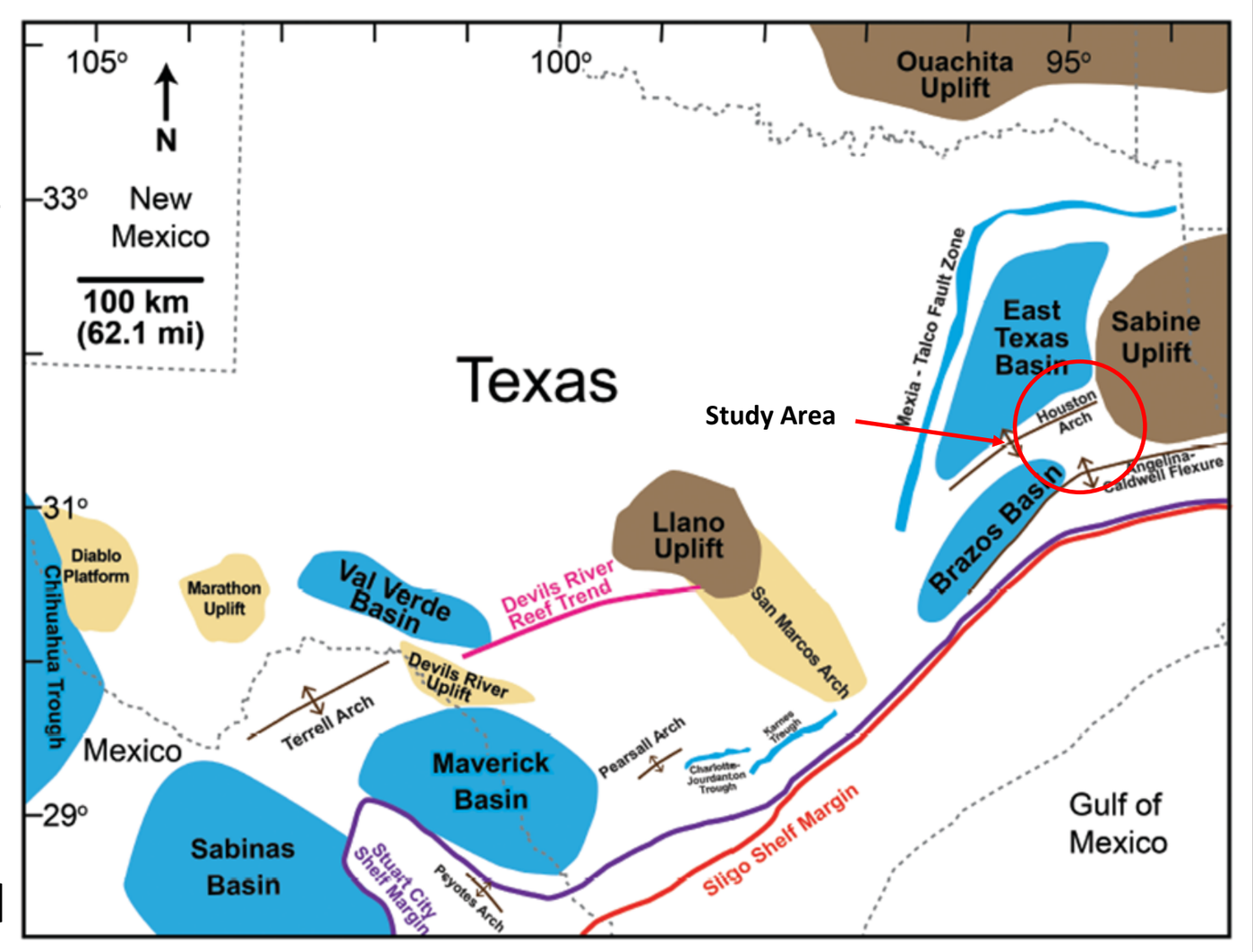

Figure 1. Map of the structural features affecting deposition on the Texas shelf during the Early Cenomanian-Turonian. Uplifts are shaded in brown, submarine platforms and arches in tan, and basins in blue. Sligo margin is in red and Stuart City margins in purple. Study area polygon outlined in red. Modified from Denne and Breyer (2016a).

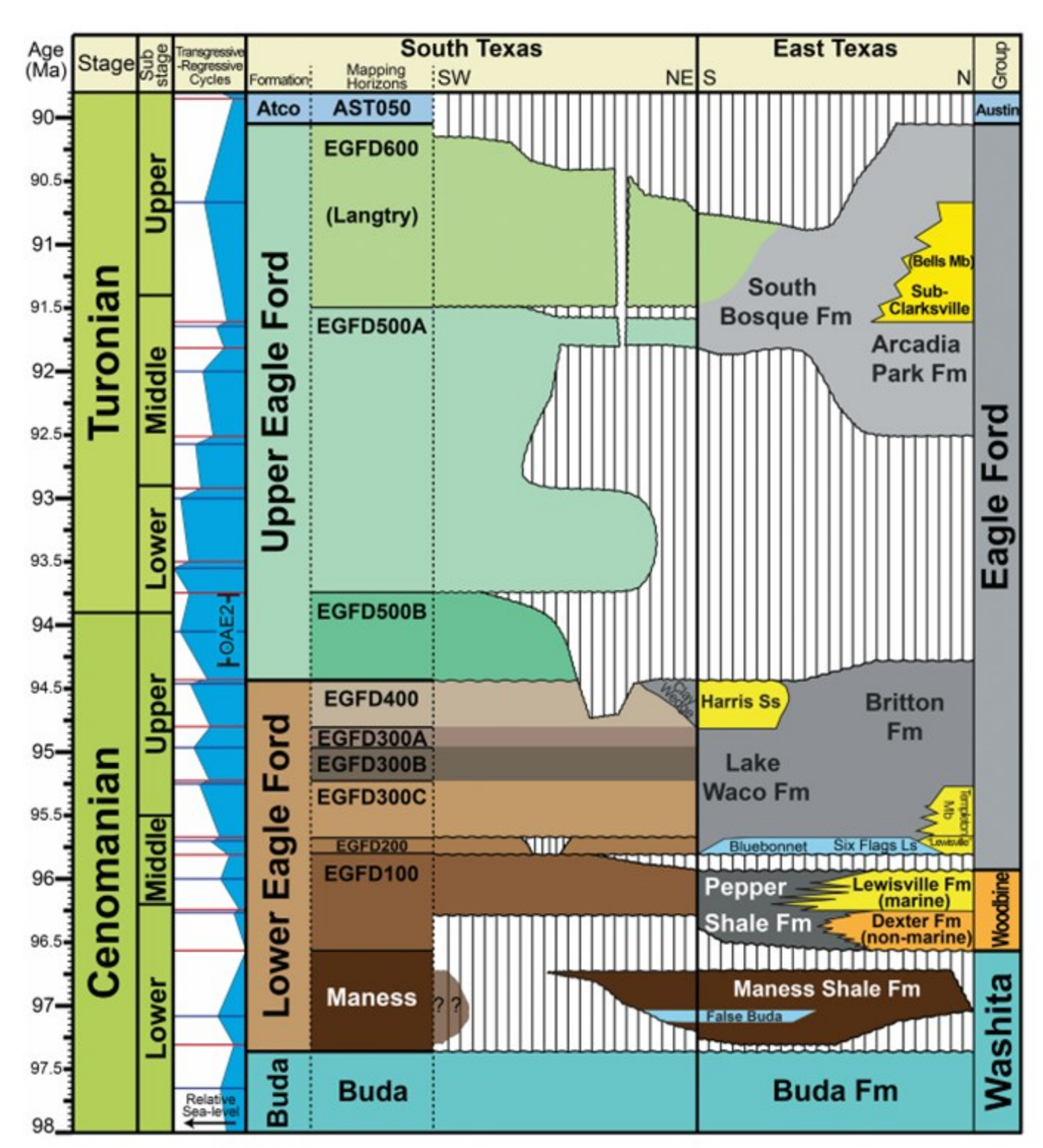

Figure 2. Stratigraphic column for this semi-regional study with Wheeler Diagrams for South and East Texas using age models developed by Denne et al. (2016). The transgressive and regressive cycles are based on Hardenbol et al. (1998), Arther and Sageman (2004), and Denne and Breyer (2016). Revised from (Denne and Breyer, 2016).

Depositional Environment: The Maness Shale occurs between the base of the Woodbine and top of the Buda at its type locality, which is Shell Oil Company's Maness Well No. 1 in Cherokee Texas (Fig. 3) (Bailey et al., 1945). The Maness is a calcareous shale and claystone that is slightly laminated to massive in its type area (Baily et al., 1945). It earned the nickname, "the bronze shale" of the East Texas Field because of its faint bronze or copper and gray splotches (Bailey et al, 1945). This can be seen in the Kinney 25 core from English (2020), which is adjacent to Maness Well No. 1 (Fig. 8). The deposition of the clay-rich Maness Shale occurred after the termination of Buda Limestone deposition (Denne and Breyer, 2016a).

Purpose

The lack of outcrop occurring in the Maness Shale has caused its sediment source and paleoenvironment to remain ambiguous in the geologic literature. Hudson (2014) characterized the Maness as a deep marine, organic rich shale, while Denne et al (2016) indicates that it consists of deltaic muds sourced from the Sabine Uplift. Nevertheless, understanding the clastic sediments of the Maness Shale and their source is critical and must be understood before further work can build an accurate sequence stratigraphic framework (Denne and Breyer, 2016). This proposed study will add to recent studies in adjacent areas by Patterson (2018) and English (2020). My study will focus on the area to the south of the East Texas Field; on the south side of the Sabine Uplift and adjacent basins, where the Maness has yet to be mapped. I will use log-generated maps to test the hypothesis that the source of the Maness Shale is most likely the southern part of the Sabine Uplift.

Previous Studies

The Lower Cenomanian Maness Shale was first identified and then named by Bailey et al. (1945) in the subsurface of the East Texas Field. It was initially identified in a core from Shell Oil Company's Maness Well No. 1 in eastern Cherokee County. At its type locality, the Maness lies between the base of the Woodbine and top of the Buda at depths of 4,705 feet to 4,766 feet (1434 m- 1453 m) (Fig. 5) (Bailey et al., 1945).

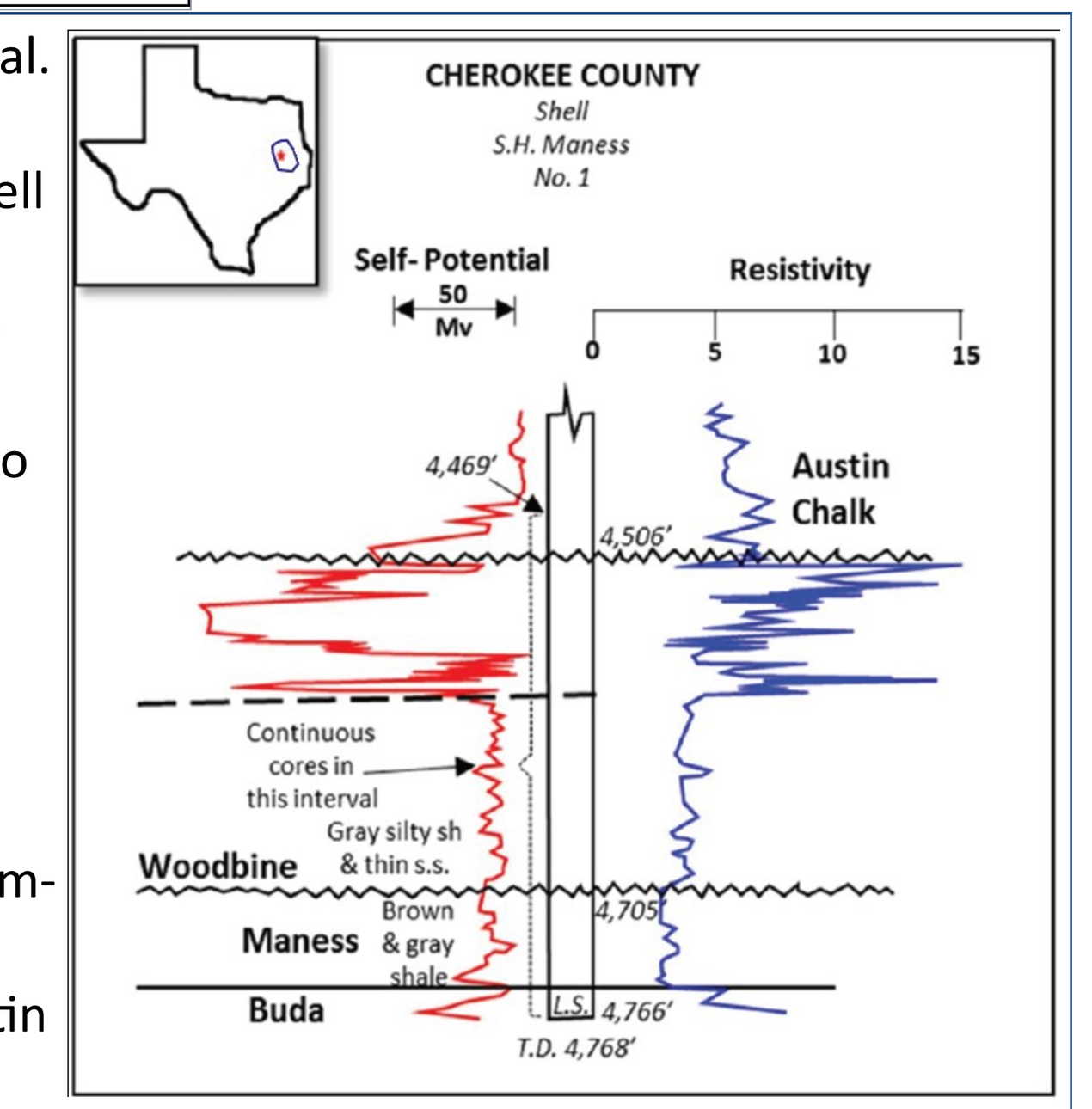

Figure 3. Well log from the S.H. Maness No. 1 that first identified the Maness Shale in Cherokee County, Texas (red star) using spontaneous potential and resistivity. The study area is outlined in royal blue. From Patterson (2018) Patterson (2018), and English (2020).

Barrett and Goodson (2006) tested the reservoir-quality of nine Eagle Ford/Woodbine sandstone wells in Tyler County, Texas. The methods in their study involved analyzing foraminiferal abundances and diversity changes in 10-ft (3 m) cuttings from the base of the Austin Chalk through the top of the Buda Limestone. Their findings show that the Maness displays fining-upward sandstone patterns, which are interpreted as distributary settings in this region (Fig. 7) (Barrett and Goodson, 2006). Hentz et al., (2014) also identified an upward-fining (retrogradational) section in the lower portion of the Maness interval. However, the upper portion of the Maness interval consistently comprises an upward coarsening (progradational) unit (Fig. 5) throughout the East Texas basin (Hentz et al. 2014). These two intervals are divided by a high gamma ray spike, which separates a lower transgressive interval from an upper regressive interval. This upper interval records the early high-stand conditions of Woodbine sedimentation within the Maness (Hentz et al., 2014).

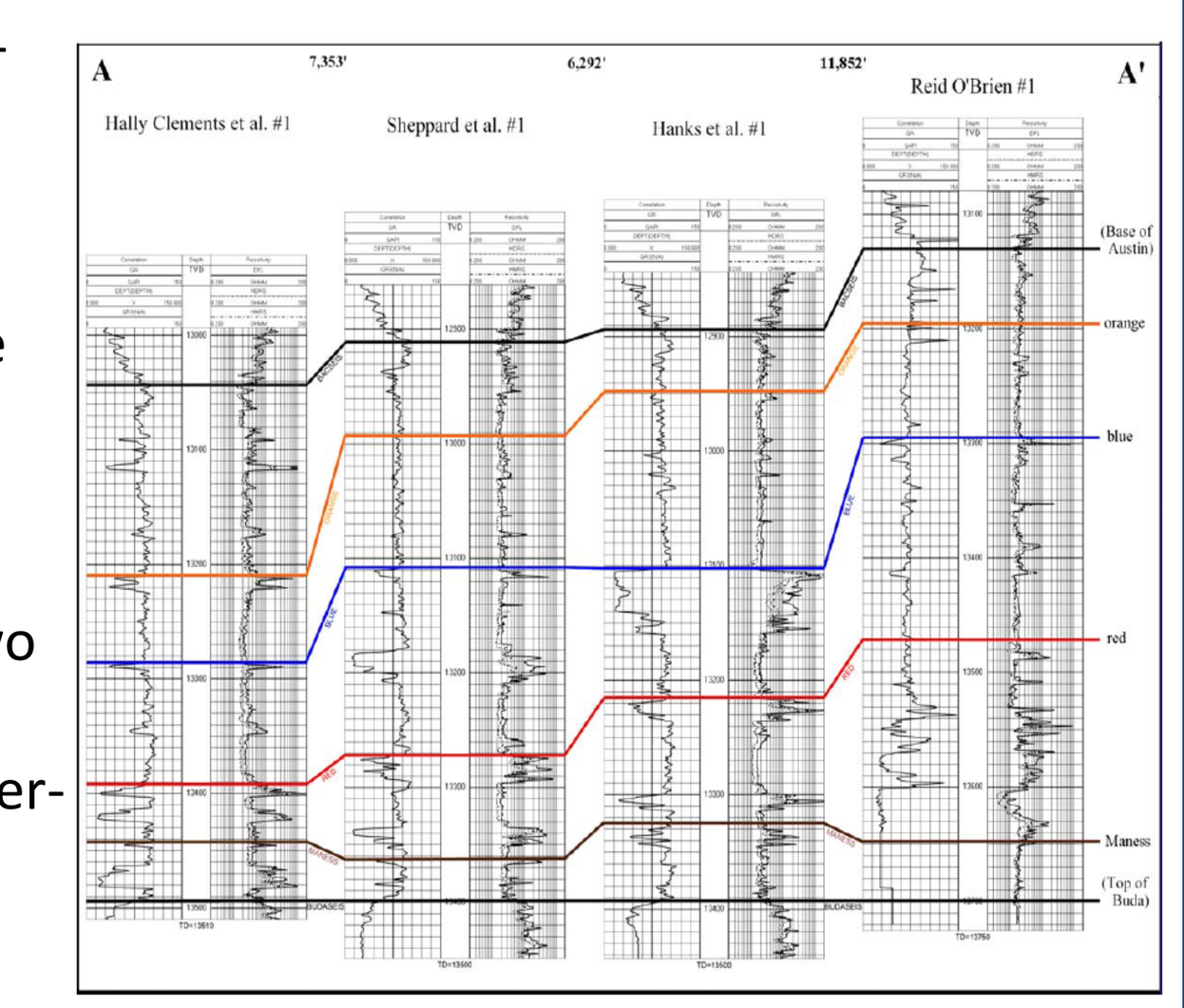

Figure 4. Representative log correlations from the base of the Austin Chalk to the top of the Maness Shale from Tyler County, Texas (Barrett and Goodson, 2006)

Denne and Breyer (2016a) were the first to create an isopach map of the Maness Shale. This isopach map illustrates a thickness trend with elongated contour lines trending from northeast to southwest (Fig. 6), indicating that the deposition of the Maness originated from a northern source (Denne and Breyer, 2016).

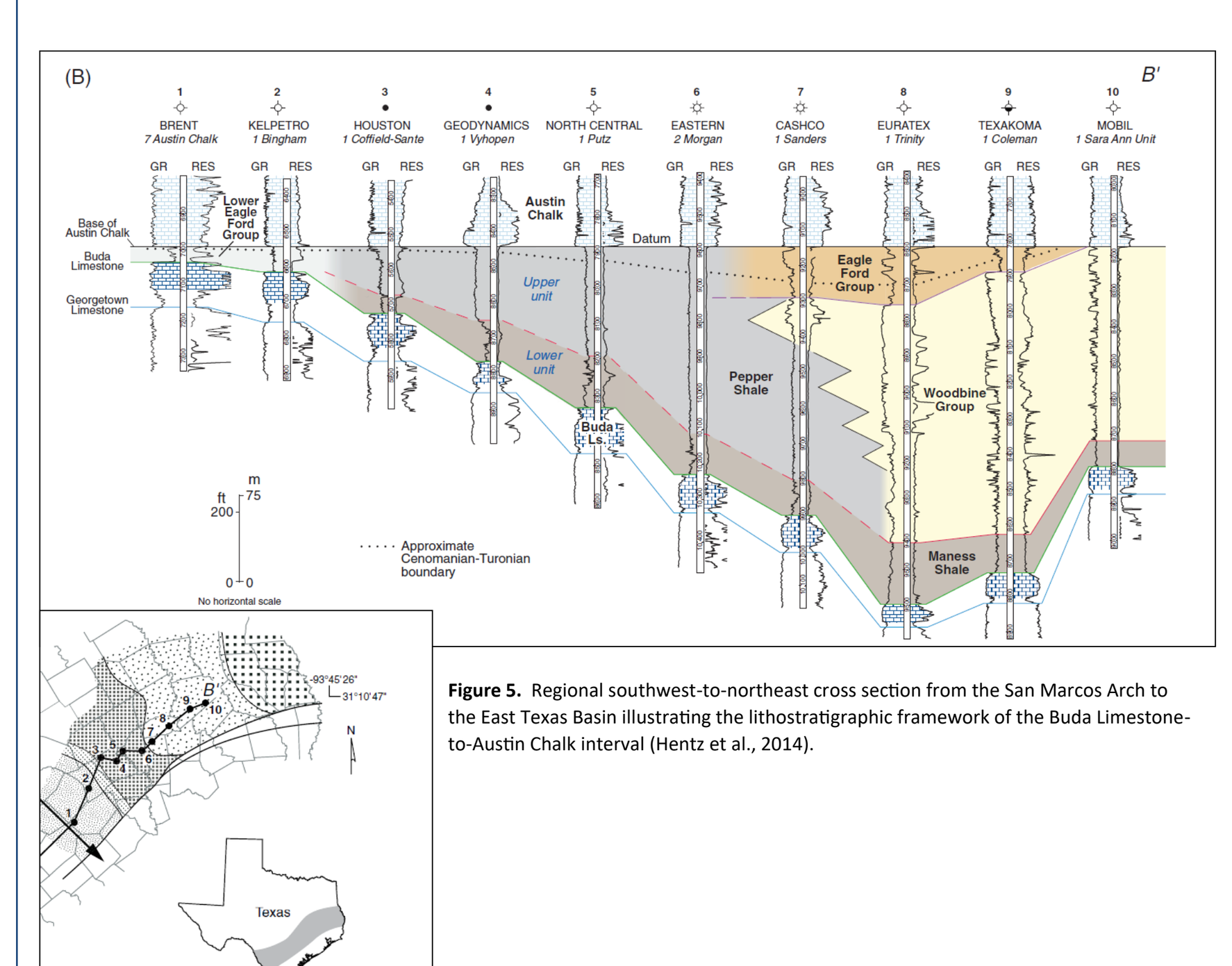

Figure 5. Regional southwest-to-northeast cross section from the San Marcos Arch to the East Texas Basin illustrating the lithostratigraphic framework of the Buda Limestone-to-Austin Chalk interval (Hentz et al., 2014).

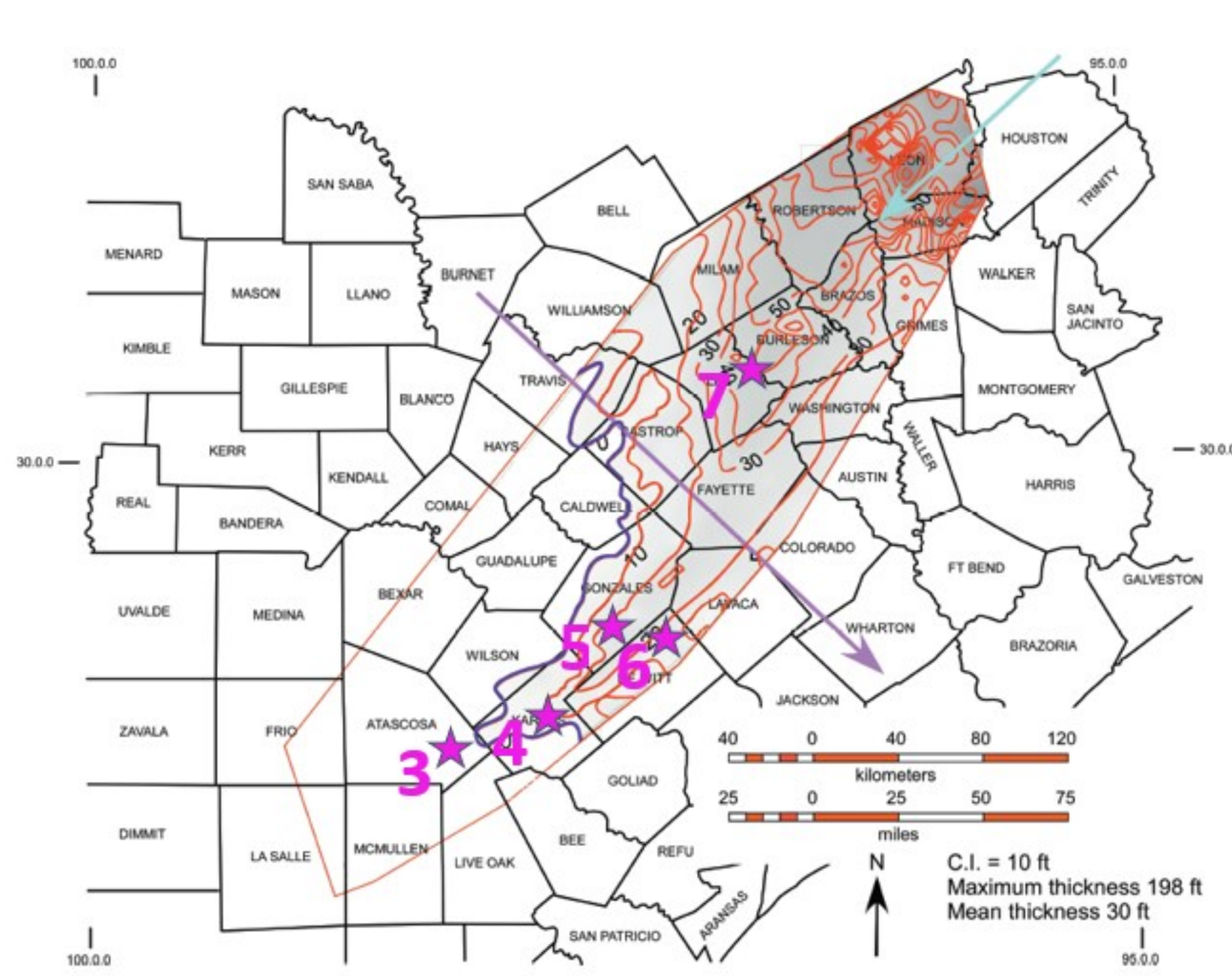

Figure 6. Isopach map of the Maness Shale from Denne and Breyer (2016a) near the San Marcos Arch. The estimated locations of the arch are illustrated by the purple arrow. Wells used for log correlation in Figure 9 are shown on the map. Blue arrow suggests the direction of sediment transportation.

Hypothesis and Methods

I will use the log patterns of the Maness that were identified by Denne and Breyer (2016), Patterson (2018), and English (2020) and extend their correlations to my study area to the east (Fig. 7). This will fill the knowledge gap between these recent studies and include the southern region of the Sabine Uplift where the Maness Shale is thickest (Anderson 1979; Hentz et al 2014). I will acquire logs for the proposed study area from several sources including Enverus, the Texas RRC, and the BEG, and will use IHS Petra® to correlate these logs to generate structure, isopach, and average gamma ray maps. Resulting maps will be used to identify the source of the Maness clastics via variations in thickness and facies trends . Data from my study will also be combined with those from prior studies to create one central, more spatially extensive database of the Maness shale.

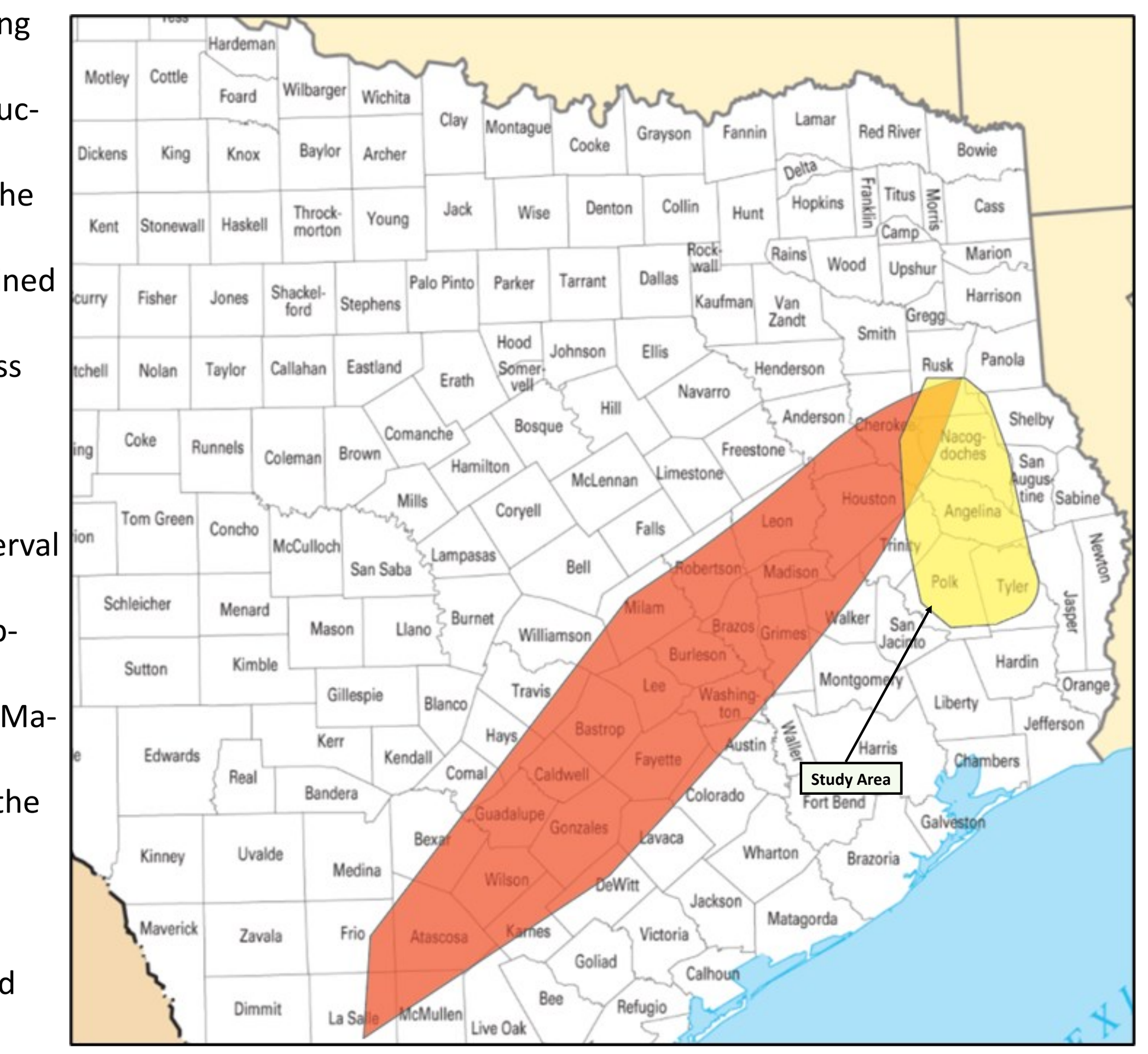

Figure 7. South and east Texas counties map showing the collective study areas of Denne and Breyer (2016), Patterson (2018), and English (2020) in the red polygon, and the current study area in the yellow polygon. Source: http://mapsof.net/texas/texas-county-map

Specifically, I will integrate data from a described core at the BEG in Austin, Texas. This cored interval will come from Tyler or Polk counties southwest of the Sabine uplift, and will be used to further substantiate the log data. This would provide visual evidence of clastic sediments occurring within the Maness and would further facilitate the testing of my hypothesis that the Maness Shale is sourced by the south side of the Sabine Uplift.

My deliverables will include one structure map and one isopach map generated from five dip and strike cross sections using raster logs. If I can definitively identify sandstones associated with the Maness Shale, then this will be a strong indicator that the source is the south side of the Sabine uplift, so in that case I will also generate sand thickness maps. In addition, I will provide a core analyses from either Tyler or Polk counties. The findings will yield further evidence to test my proposed hypothesis regarding the sediment source of the Maness Shale.

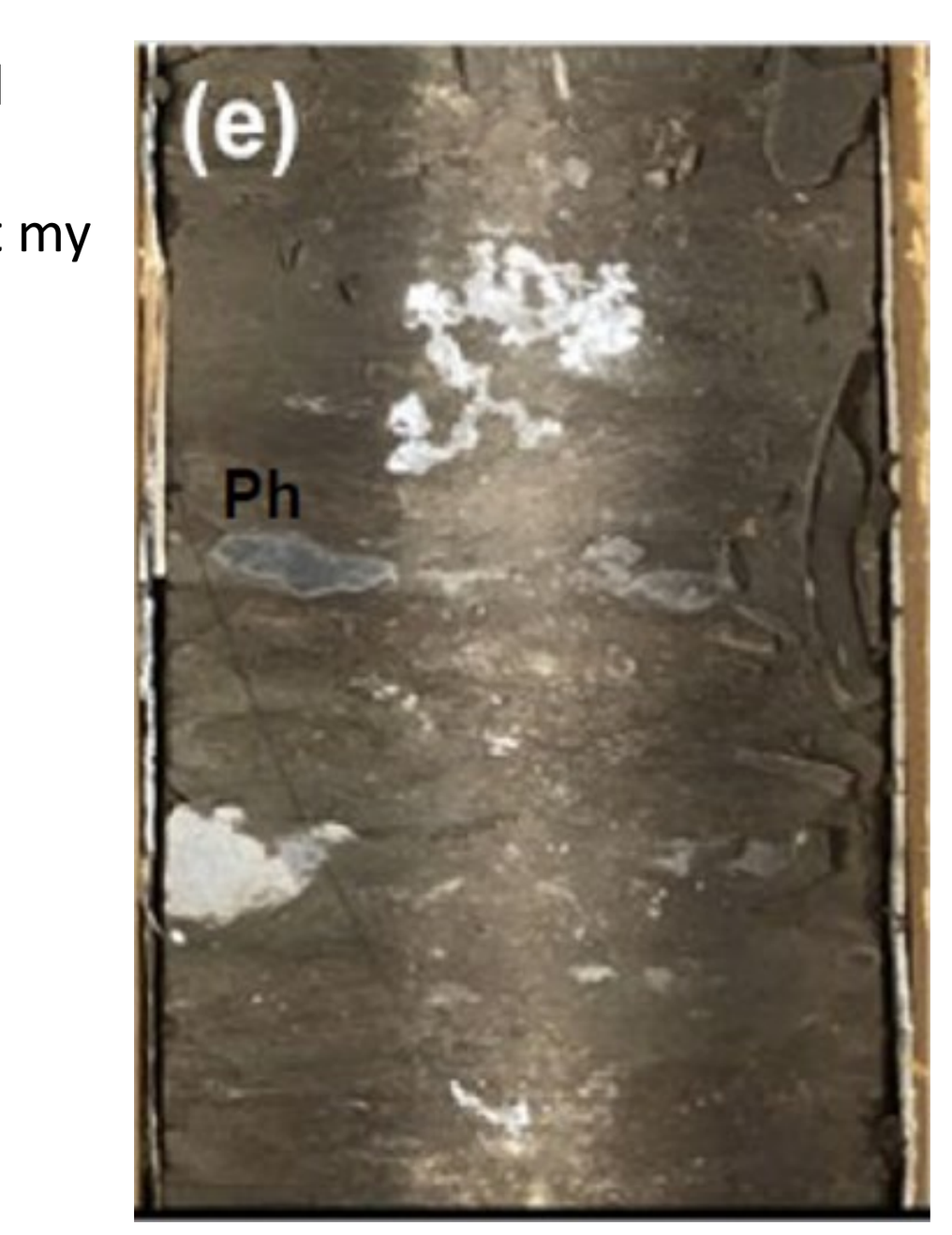

Figure 8. Core photograph of the Kinney 25 core from English (2020) displaying a phosphate concretion within the copper-colored Maness shale as described in the type location in Cherokee County (Lozo 1951).

References

- Anderson, EG, 1979, Basic Mesozoic Study in Louisiana, the North Coastal Region, and the Gulf Basin, Louisiana Geological Survey, Mineral and Energy Resource Program LSU, p. 58.
- Bailey, TL, Evans, FG, & Adkins, WS, 1945, Revision of Stratigraphy of Part of Cretaceous in Tyler Basin, Northeast, Texas, AAPG, 29(2), 170-186
- Barrett, M.L. and Goodson Jr, J.P., 2006. High-resolution foraminiferal biostratigraphy of Cenomanian and Turonian sandstones, Tyler County, Texas.
- Denne, RA, Breyer, JA, 2016a, Regional depositional episodes of the Cenomanian-Turonian Eagle Ford and Woodbine groups of Texas, in JA Breyer, ed., The Eagle Ford Shale: A Renaissance in U.S. Oil Production, AAPG Memoir 110, p. 87-113.
- English, MM, 2020, The Maness Shale: Stratigraphy and Geochemistry of the Lower Cenomanian Maness Shale of East Texas, M.S. thesis, Texas Christian University M.S. thesis.
- Hentz, TF, Ambrose, WA, Smith, DC, 2014, Eaglebine play of the southwestern East Texas Basin: Stratigraphic and depositional framework of the Upper Cretaceous (Cenomanian-Turonian) Woodbine and Eagle Ford Groups: AAPG Bull., v. 98, p. 2551-2580.
- Lozo, FE, 1951, Stratigraphic notes on the Maness (Comanche Cretaceous) Shale in FE Lozo, ed., The Woodbine and adjacent strata of the Waco area of central Texas, a symposium for the 1951 field trip sponsored by the East Texas Geological So ciety: SMU Press, Fondren Science Series 2, Dallas, Texas, p. 67-100.
- Patterson, SA, 2018, The Maness Shale: a comparison of the geomechanical and mineralogical properties within the Lower Eagle Ford Formation, South Texas, M.S. thesis, Texas Christian University, Fort Worth, TX, 97 pp.