Detailed subsurface mapping of the Edwards-Trinity (Plateau) Aquifer: Morphological features of pre-Cretaceous topography approximated from Trinity thickness, Crockett and adjacent counties, Texas

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Introduction

The Texas Water Development Board (TWDB) Brackish Resources Aquifer Characterization System (BRACS) department is conducting a study of brackish groundwater resources of the Edwards-Trinity (Plateau) Aquifer, including detailed subsurface mapping of the Edwards and Trinity groups. The overall study area and the sub-focus area for this poster is shown in Figure 1. The Edwards and Trinity groups are lower Cretaceous in age, and in the study area, the Trinity was unconformably deposited over rocks of Paleozoic to Triassic age. The pre-Cretaceous erosional surface on which the Trinity was deposited is known as the Wichita Paleoplain (Rose, 2021). The Trinity Group is comprised of sandstone and limestone or marly limestone, whereas the Edwards Group is dominantly limestone with some mudstone.

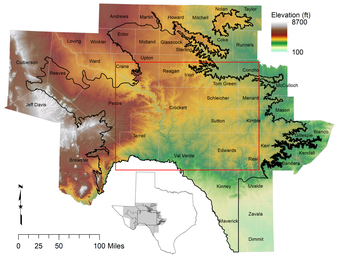

Figure 1: Map of BRACS study area (black outline) and focus area of this poster (red rectangle).

Previous work

Previous regional subsurface mapping of the Edwards-Trinity Aquifer system, which encompasses the Edwards-Trinity (Plateau) and Edwards (Balcones Fault Zone) aquifers, was conducted by Barker and Ardis (1992) who compiled base of Cretaceous control points from a variety of authors throughout the region. Barker and Ardis (1996) includes seven regional cross sections of this work. In our study area, Rose (2021) used the work of Barker and Ardis (1992) as well as his own interpretations to reconstruct the morphology of the Wichita Paleoplain.

Methods

Using publicly available geophysical logs, we correlated the top and base of the Trinity Group in 1,682 wells using the IHS Kingdom software. We started our interpretations where the Trinity Group has a consistent and easily identified pattern in the gamma ray curve, then mapped various patterns of the Trinity and its relationship to underlying formations. We checked our interpretations against an isochore (thickness) map of the Trinity, which helped ensure consistency in our interpretations. The Trinity isochore values in Figure 2 were contoured using the Topo to Raster tool in ArcMap 10.8.2. By assuming that the units overlying the Trinity were entirely horizontal at the time of their deposition (an over-simplification), the isochore map of the Trinity can be viewed as approximating the morphology of the paleotopography at the time of Trinity deposition, where thin areas of the Trinity represent topographic highs, and thick areas represent topographic lows.

Discussion

By imagining the Trinity thickness contours as representing elevation contours of the pre-Cretaceous topography (noting that the values are in reverse order from elevation values), the contours in the thinner areas of the Trinity (<400 feet thick) reveal a regional paleotopographic landscape. Our interpretations of morphological features are made more clear by imagining the time when the Cretaceous Sea initially began to transgress onto the landscape, by viewing the 200- to 250-foot thickness contours as the approximate coastline. We highlight five interpreted paleotopographic features in Figure 2, and present correlation sections through these five features in Figure 3. We note that the prominent 50-foot contours in the northeast portion of the map correspond to the Roosevelt high (Rose 1972), which is a known feature and thus not further discussed here. Additionally, on the southwest of the Roosevelt High the 350- to 100-foot thickness contours 'V' to the north and northeast (such as contours 'V' in a valley), and correspond to the Schleicher Valley identified by Rose (2021).

Future work

We plan to finish our stratigraphic interpretation by the end of 2022. Afterwards we will perform lithologic analysis, compile analyses of water quality samples, interpret water quality from resistivity logs, and map salinity classes throughout the Edwards-Trinity (Plateau) Aquifer. Our goal is to complete this project and publish our report by the end of 2024.

Our five interpreted paleotopographic features, highlighted and numbered in Figure 2, are discussed below:

1) Pandale high - a NW-SE-trending high over which the Trinity is locally not present due to non-deposition. The name Pandale comes from Barker and Ardis (1996, plate 2), who note the absence of the Trinity over the "Pandale anticline" at the southeastern corner of our mapped Pandale high. The Pandale high parallels the Marathon-Ouachita fold and thrust belt and may be structurally related, though the Trinity was deposited subsequent to any structural movement. Over this high the Trinity is deposited on Paleozoic limestones (San Andres Formation?), which may have been more resistant to erosion than the Paleozoic shales underlying the Trinity on either side of the Pandale high.

2) Terrell embayment - the 300- to 200-foot thickness contours on the southwest edge of the Pandale high can be projected northwest parallel to the Marathon-Ouachita fold and thrust belt to matching contours across the Terrell embayment, suggesting the Pandale high was a more extensive morphological trend that was subsequently eroded.

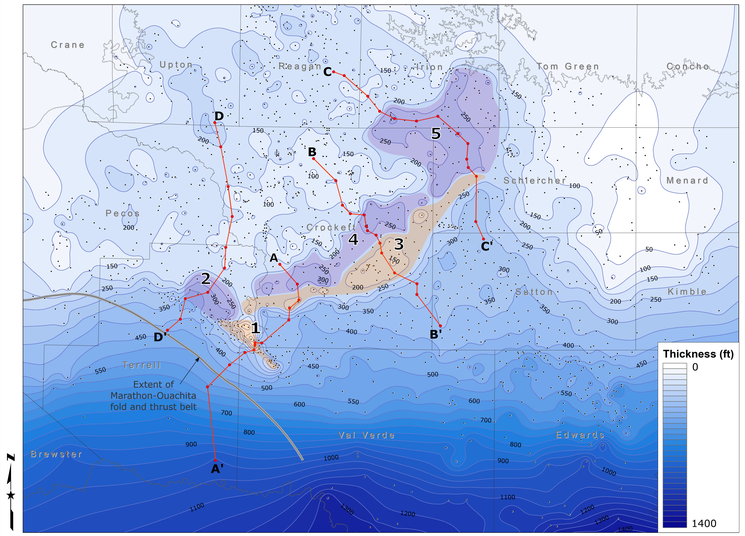

Figure 2: Isochore (thickness) map of the Trinity Group. Interpreted paleotopographic features are highlighted in orange (highs) and purple (lows). Black dots are well control with interpreted top and base of the Trinity Group (1,682 wells). Red lines are correlation sections and red dots are section wells.

3) Crockett high - an arcuate, generally NE-SW-trending high which occurs where the Trinity is in contact with the northwest-dipping San Andres Formation. We hypothesize the San Andres was relatively resistant to erosion, forming a broad paleotopographic high prior to deposition of the Trinity.

4) Crockett depression - bordering the northwestern edge of the Crockett high is a depression that is locally up to 150 feet shallower and may have been a restricted embayment during the initial flooding of the Cretaceous Sea. Within the Crockett depression, the well F.R. Henderson Jr. 2 (Figure 3, B-B', BRACS ID 55049) has a handwritten annotation at the base of the Trinity indicating "flow of sulfur water". The configuration of this depression may have resulted in the local deposition of evaporites and/or prevented recharge by meteoric water that flows southeast, perhaps bypassing the restricted water in the base of the Trinity in the depression yielding decreased water quality.

5) Irion embayment - extending north into Irion County is an embayment where the Trinity is consistently 200- to 300-feet thick. Within this embayment, the lower Trinity is easily confused with sands of the Dockum Group, which underlie the Trinity immediately to the northwest (Figure 3, C-C').

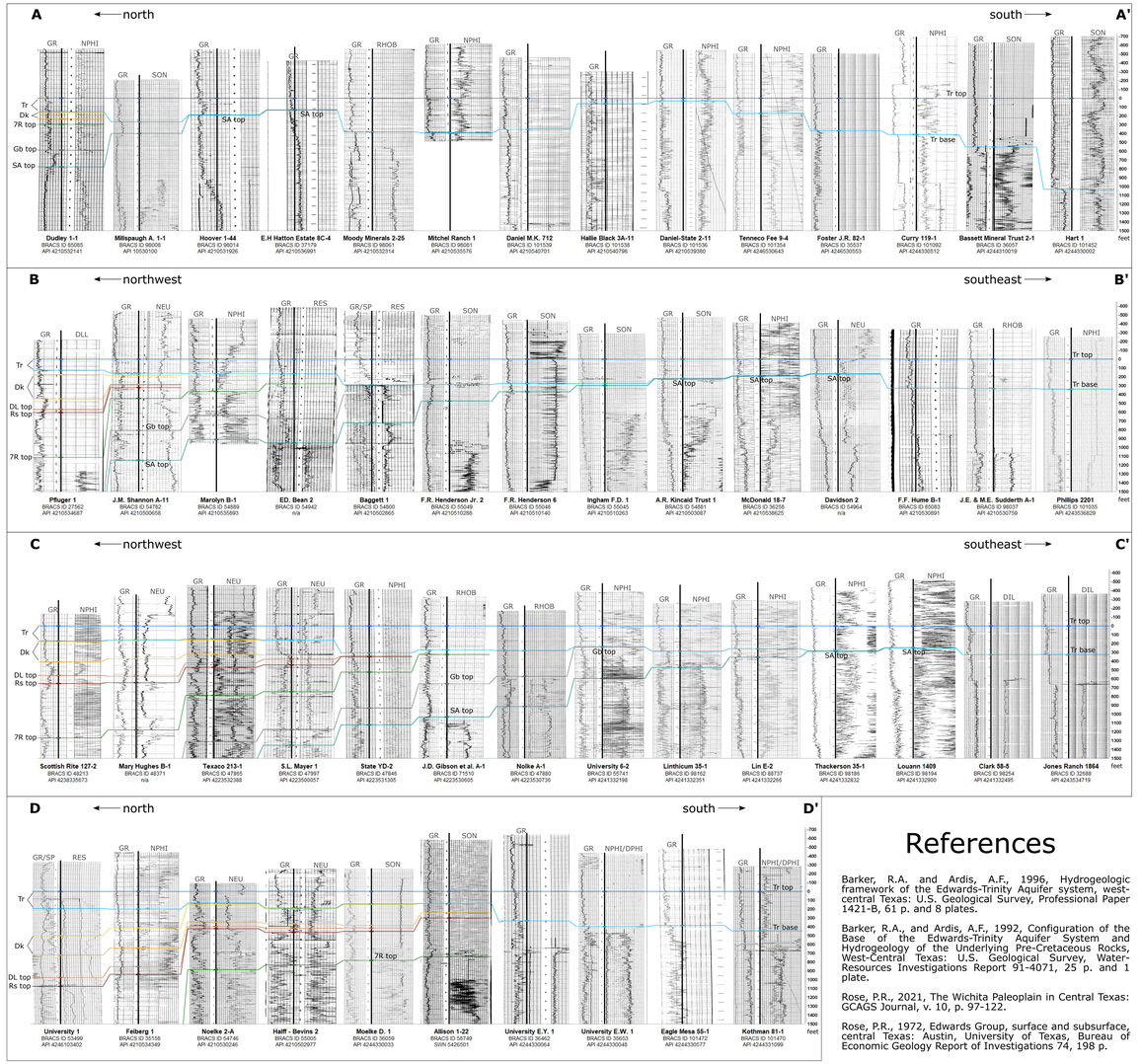

Figure 3: Correlation sections flattened on the top of the Trinity Group. The distance between wells are held constant for ease of correlation and are not to scale. Formation abbreviations: Tr = Trinity, Dk = Dockum sands, DL = Dewey Lake, Rs = Rustler, 7R = Seven Rivers, Gb = Grayburg, SA = San Andres. Log curve abbreviations: GR = gamma ray, SP = spontaneous potential, NPHI = neutron porosity, DPHI = density porosity, NEU = neutron intensity, RHOB = bulk density, SON = sonic, RES = resistivity, DIL = dual induction log, DLL = dual laterolog.

References

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