Geomechanical Relationship Between Maness Shale and Lower Eagle Ford, San Marcos Arch, Texas

Alec Burns - B.S. Geology, School of Geolgoy, Energy and the Environment
Faculty Advisor: Richard Denne, SGEE

Introduction

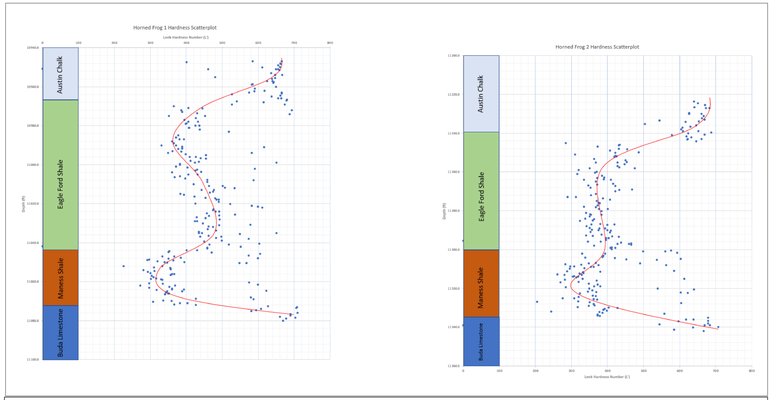
The Eagle Ford Shale in South Texas is one of the most prolific unconventional shale plays in North America, having produced both natural gas and more oil than traditional shale plays. The purpose of this project was to measure and compare the hardness properties of the basal Maness Shale unit to the surrounding members of the Eagle Ford group, as well as the overlying Austin Chalk and underlying Buda Limestone. The Maness is relatively unknown since there is no known lateral extent of the unit because it does not outcrop (Bailey, et al., 1945). Understanding the geomechanical properties of the Maness is important since this unit ultimately effects Eagle Ford production. Two wells from the San Marcos Arch in the East Texas Basin were used for the project named Horned Frog 1 and Horned Frog 2.

Figure 1. Regional depositional episodes of South Texas and coeval formations of East Texas. Section ages and hiatal surfaces are based on age models from Denne et al. (2016). The transgressive-regressive cycles are based on Hardenbol et al. (1998), Arthur and Sageman (2004), and Denne and Breyer (2016). The timescale is from Gradstein et al. (2012). The reference stable carbon isotope curve and global isotope events are from Jarvis et al. (2006) and Saltzman and Thomas (2012).

The figure above is a paleogeographic map of the Western Interior Seaway. This was the depositional environment for the Eagle Ford Shale and the Maness Shale. This occured during Ocean Anoxic Event 2 (Donne, Breyer 2016).

Background

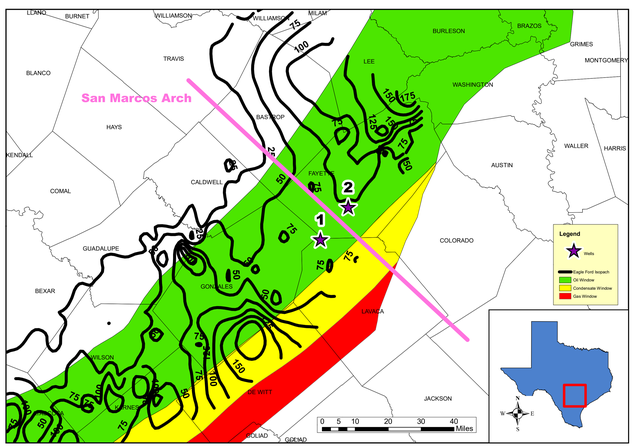
In the San Marcos region, the Eagle Ford contains a much higher carbonaceous shale percentage, which makes the rock more brittle and more conductive to hydraulic fracturing (TTRC Production Data). It was deposited during the Cenomanian (96 Ma) when there was a shallow sea between the Texas Shelf and the Western Interior Seaway, coincident with Ocean Anoxic Event 2 (Denne, Breyer 2016). The clay-rich Maness Shale is coeval with a clay-rich shale that overlies the Buda Limestone in the northern portion of the subsurface in South Texas (Denne, Breyer pg. 148). It was deposited during the Early Cenomanian at the bottom of the Western Interior Seaway in anoxic conditions and a high concentration of sulfur (Denne, Breyer 2016). The Maness Shale is believed to help act as a fracture barrier to underlying water reservoirs, however it also poses a problem for the possibility of drill bits getting stuck due to its ductile properties. This is why understanding the hardness of the Maness is important for the drilling operations in the Eagle Ford.



The Horned Frog 1 scatterplot (left) and Horned Frog 2 scatterplot (right) show the sampled data from the Proceq Bambino. On both wells, the carbonates show a high (>600 L') hardness reading on average. As seen on the graph, the Eagle Ford is significantly softer, yet the trend is to increase in hardness towards the Lower Eagle Ford. The trend line dcreases abruply in both samples when the Maness Shale is reached, indicating a more ductile geophysical properties in comparison to the other strata.

Methods

The Proceq Bambino, a hand-held rebound hammer, was used to measure the geomechanical brittleness of the rock units in readings of the Leeb hardness number (rebound velocity/impact velocity x 1000). For each well, measurements were taken at six-inch increments. The exception to this was that the Maness Shale had more measurements taken due to the purposes of this study in order to get a full understanding of its geomechanical properties. At every increment, five tests were done with the Bambino in order to get a conclusive average. The results were then computed into a scatterplot making the visualization of the hardness levels much easier to accentuate.



Results

The results for the geomechanical hardness averages are shown in the table below:

Horned Frog 1 Core

FORMATION	*L' (average)*
Austin Chalk	620
Eagle Ford Shale	454
Maness Shale	344
Buda Limestone	665

Horned Frog 2 Core

FORMATION	*L' (average)*
Austin Chalk	634
Eagle Ford Shale	417
Maness Shale	339
Buda Limestone	642

The trend lines on the scatterplots clearly show the discrepancy of hardness between the Eagle Ford and Maness. The Maness is 24% softer than the Eagle Ford in the Horned Frog 1 core, and 19% softer in the Horned Frog 2 core, indicating that the Maness is more ductile than the adjacent rocks.

Future Research

Studying the geochemistry of the Maness Shale may also produce other reasons why this unit poses problems during drilling. For example, it would be useful to study and distinguish which types of swelling clays (e.g. kaolinite, smectite, etc.) are present in the Maness unit in order to further understand the physical properties of the rock.

Conclusions

After using the Bambino to calculate the geomechanical stiffness properties of the well core, the results from this sample indicate that the Maness is more ductile than the Lower Eagle Ford. The low variability of its hardness may provide the answer why this rock unit poses problems during the drilling and completion of a well. With future research, a more comprehensive understanding of the Maness Shale can be achieved in the foreseeable future.

Denne, R. A., and J. A. Breyer, 2016, Regional depositional episodes of the Cenomanian-Turonian Eagle Ford and Woodbine groups of Texas and their relationship to Oceanic Anoxic Event 2 (OAE2): Gulf Coast Association of Geological Societies Transactions, v. 66, p. 145–158.

"Eagle Ford Shale Information." Texas Rail Road Commission, www.rrc.state.tx.us/oil-gas/major-oil-and-gas-formations/eagle-ford-shale-information/.

Bailey, Thomas L., Frank G. Evans, and Walter Scott Adkins. "Revision of stratigraphy of part of Cretaceous in Tyler Basin, northeast Texas." AAPG Bulletin 29.2 (1945): 170-186.