Abstract
Although multiple localized chemostratigraphic and strength studies have been completed on the organic-rich Barnett Shale in the Fort Worth basin (Montgomery et al., 2005; Pollastro et al., 2007; Jarvie et al., 2007; Rowe et al., 2008; Williams et al., 2016; Taylor, 2017; Alsleben, unpublished), basin-wide correlations have not been completed. Basin-wide correlation of chemostratigraphy and mechanical stratigraphy could enhance the understanding of regional variations in chemical composition and rock competence. Therefore, the proposed study is going to test multiple hypotheses to identify regional trends and correlations within the Barnett Shale, based on variations in the formulations chemical makeup and rock strength. Using the data from a total of nine cored Barnett intervals, several correlative chemofacies can be identified across the basin and grouped into zones. These zones show strong relationships between %Ca, %Si, % Clay (K, Al, Ti), and unconfined compressive strength.

Methods
ED-XRF Analyses
- Elemental composition of samples were collected by Bruker Tracer IV
- ED-XRF can transmit and receive high-energy X-ray beams.
- Emitted X-ray force an electron to be expelled from the lower-energy inner shell (K shell), resulting in electrons from the higher-energy outer shells replacing the expelled electron and releasing energy in the form of emission X-rays (Fig. 6).
- Major element analysis will consist of a run time interval of sixty seconds with a 15kV calibration and trace element analysis will consist of a run time interval of ninety seconds with a 40kV calibration.
- Data is converted to weight% and parts per million (ppm).
- Hierarchical Cluster Analysis using the Ward (1963) method is performed on data from all nine cores to determine chemofacies.

Micro-mechanical Analyses
- The Bambino (Fig. 6) is a micro-rebound hammer used to measure Leeb’s hardness number for each rock sample by measuring velocity as an impact compared to rebound velocity (Fig. 7).
- An empirical equation from Zahn and Enderlin (2010) was used to convert Leeb Hardness into UCS.
- The Dimpler (Fig. 8) is a point-load penetrometer developed after Ramos et al. (2008).
- The impression (Fig. 9) left on the rocks surface can be measured and the geometric properties can be converted to UCS using an empirical equation from Ramos et al. (2008).

Results

Discussion
Results from strength and element testing show a strong positive linear relationship between %Ca and UCS (Fig. 10), as well as a strong negative linear relationship between %Clay (Al+Ti+K) and UCS (Fig. 11). Trends in minerals composition plot very closely between all nine wells and plot below the Wiedepohl (1971) “Average Shale” (Fig. 12). Four distinct chemofacies were identified across all nine wells (Fig. 14)(Fig.15). Facies 2 is considered a calcareous facies as its made up of the well sections were there was corupt data or no data. Facies 1 and 5 are found mostly in the southern part of the basin and represent the most calcareous facies, suggesting sediment input from the Caballo- Arkansas Island Chain. Facies 4 trace elements (Mo, Ni,V, Cu, Zn, Co) suggest this facies was possibly affected by anoxic conditions (Trubovillard et al., 2006). These zonations were identified by abundances of chemofacies in distinct sections of each well (Fig 13). Zone 1 being composed of mostly facies 3, zone 2 being composed of highly interlaced facies 3 and 4, and zone 3 composed of mostly Facies 4.

Conclusions
- In the Barnett Shale, clay content appears to have the largest effect on rock strength. The strongest rock being found in the northern part of the basin and the weakest rock being found in the southern part of the basin.
- 4 distinct chemofacies were identified across the basin using a hierarchical cluster analysis and then visually grouped into 3 unique zonations.
- Zonations suggest changes in sediment input in relation to location within the basin, with more calcareous input in the northern part of the basin, and more siliceous input in the southern part of the basin.

References