TEXAS TECH UNIVERSITY
College *of* Arts & Sciences™

Department of Geosciences

Department of Geosciences
Texas Tech University
Research Day 2017
May 10th

Welcome to the 11th Annual Department of Geosciences Research Day.

The program this year presents 43 abstracts from faculty, graduate and undergraduate researchers covering a wide variety of topics highlighting ongoing research within the Department of Geosciences. Note geoscience undergraduate seniors first author 34 abstracts! Undergraduate research within the department is a priority reflected in the volume and quality of these abstracts.

The Geoscience Society is sponsoring our luncheon this year. Please thank the officers for the catered barbeque lunch. The society also provides gifts to the winning poster. The plaque is in the second floor display case, stop by and note past winners.

Lastly, I would like to thank all of the presenters for their hard work and commitment to providing quality research. Plus, a special thank you to all the undergraduate researchers; presenting on Research Day is one of the last hurdles you clear before graduation. Be proud of your accomplishments!

Let's have some fun,
Dustin Sweet

Schedule of Events
10:30-12:30 Poster Presentations
12:30-1:15 J&M Bar-B-Q Lunch
1:15 Award Presentations

Box 41053 | Lubbock, Texas 79409-1053 | T 806.742.3102 | F 806.742.0100

An EEO/Affirmative Action Institution

*Indicates undergraduate researcher

Upper mantle analysis of Northern Pacific Ocean basin

F. ABRAHA*, H. GURROLA

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (fitsum.abraha@ttu.edu)

The crust beneath the Pacific Ocean, north of the Hawaiian chain of islands (between longitude 195W-150W and latitude 16N-36N), is composed of the pacific plate. In such a region with no obvious sources or tectonic features that would cause thermal anomalies such as mid-oceanic ridges (heat) or subduction zones (cool), we would expect there to be little to no anomalous topogaphy on the upper mantle discontinuites. We test this hypothesis by using PP bounce precursor data collected for all available global broad band seismic stations. We produced a 3-D cude of stacked PdP precursors for this region and then viewd several profiles throughout the region. We produced horizon maps by picking the positve peak at 410 km depth that is considered to be the olivine to spinel phase transition (refered to as the 410 km discontinuity) and a negative phase nominally near 80 km depth that we believe is the lithosphere asthenosphere boundary (LAB). Both horizons in this area are continuous, but can vary in depths as you move beneath the islands and through the hot spot. This study implies that as expected there are no heat anomalies in the upper mantle throughout most of norhtern Pacific Ocean basin, but we find a deep 410 at the expected location for the hotspot. There is a shallow region for the 410 (by ~5 km) roughly at longitude 157W which should correspond to cooler temperatures which may be due to a localized convection cell.

Petrophysical Evaluation of the Lower Avalon Shale.

A. AL-AMERI[2], J. COE[1], D. FAN[2], I. HADDAD[2]

[1]Bob L. Herd Department of Petroleum Engineering, Texas Tech University, Box 43111, Lubbock, TX 79409-21011

[2]Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

The Avalon Shale is an active unconventional play in the Delaware Basin located in southeast New Mexico and west Texas. It is the uppermost member of the Bone Spring Formation and is stratigraphically above the 1st Bone Spring Sand and below the Brushy Canyon Formation. The thickness of the Avalon Shale ranges from 900-1700 ft. and has been subdivided into three informal intervals: the mudstone-rich Upper Avalon, carbonate-rich Middle Avalon, and the mudstone-rich Lower Avalon [1]. The Lower Avalon is the focus of this petrophysical analysis.

Systematic calculations were performed on raw log data in Microsoft Excel and subsequently exported and plotted in Schlumberger Techlog 2015. The calculations include: total organic carbon (TOC), matrix density (ρ_{ma}), total porosity (Φ_t), clay-bound water (CBW), effective porosity (Φ_e), water saturation (S_w), effective water saturation (S_{we}), permeability (k), oil porosity (Φ_{oil}), and original oil in place (OOIP). Formation fracability and brittleness are based on the geomechanical properties of Young's Modulus (E) and Poisson's Ratio (μ). Potential pay zones were then determined based on the following cutoffs: k > 1000 nD, Φ_t > 11%, TOC wt.% > 2%, ρ_b < 2.53 g/cc, Pe < 4, and GR > 75 API. Well placement plan and fracturing design are accordingly conducted to maximize production, and estimated ultimate recovery (EUR) using recovery factors of 3%, 4%, 5%, and 6% were calculated.

The results show that the Lower Avalon can be divided into three zones of interest: an upper mudstone-dominated interval at depths of 7941-8076 ft. (total thickness = 135 ft.), a cherty interval at depths of 8076-8131 ft. (total thickness = 55 ft.), and a lower mudstone-dominated interval at depths of 8131-8223 ft. (total thickness = 92 ft.). The methodology applied in this study yields estimates of OOIP within the upper and lower pay zones to be 60.3 MMbbl and 29.9 MMbbl, respectively, and the most conservative combined EUR (3%) is greater than 350 Mbbl, therefore making this a commercial prospect. Optimal lateral placement at 8060 ft. combined with multistage fracturing will maximize the conductive drainage area of the Lower Avalon reservoir.

[1] Stolz, D. (2015) SPE-178610-MS/URTeC:2154681.

Chronostratigraphic Evolution of the Eastern Shelf and Midland Basin – Schleicher, Menard, Kimble, and Concho counties.

ERIC ANDERSON*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (Eric.a.anderson@ttu.edu)

Fusulinid zonation allows for the ability to chronostratigraphically recreate the paleogeography of the Pennsylvanian and Permian time periods. The Permian Basin Archival of Biostratigraphic Zone Tops (PABZT) project uses biostratigraphic reports from wells drilled in West Texas and Eastern New Mexico. This report will focus on four counties: Schleicher, Kimble, Menard, and Concho. This report assesses the movement of the eastern shelf edge of the Midland Basin throughout the Pennsylvanian and Permian. Structural maps of the Leonardian, Wolfcamp, Cisco, Canyon, Strawn, Lower Strawn, and Atokan time periods demonstrate that the Eastern Shelf runs generally north-south through the study area. Moreover, the shelf edge aggrades during the Pennsylvanian, followed by major progradation into the Midland Basin in Permian time.

Reservoir Producibility Index [RPI] from NMR Logs in the Analysis of Tight Oil Reservoirs.

G.B. ASQUITH

[1]Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (George.Asquith@ttu.edu)

Jarvie, 2012 outlined a technique called Oil Saturation Index [OSI] based on S1 and TOC from RxEval Analysis used to determine the amount of free non-adsorbed oil in a tight oil reservoir. The equation is listed below (after: Jarvie, 2012):

OSI = S1*100/TOC

Kausik & others, 2015; and Reeder & others, 2016, determined that using NMR data a measurement similar to OSI [RPI] could be determined. RPI was designed to overcome the two limitations to the OSI Method. OSI Limitations Include: 1.) loss of free oil on cores or cuttings during depressurization, and 2.) in lean zones [i.e. both S1 and TOC low] OSI can exceed productive criteria. The equation for RPI is listed below:

Carbon Saturation Index [CSI]

CSI = Wc_oil/Wc_organic

Reservoir Producibility Index [RPI]

RPI = [CSI*W_oil]*100

RPI of 0.1 = OSI of 100

The first example is from the Devonian Woodford Shale and overlying Mississippian Limestone in Oklahoma. The main target was the Woodford, however the RPI indicates that the thickess zone of RPI greater than 0.1 is in the Mississippian Limestone. A horizontal place this zone IP for 300bopd. The second example is from the Permian Wolfcamp in the Midland Basin of Texas. Both the Wolfcamp contains thick zones of up 200 feet thick with RPI>0.1. A 7,500 foot lateral IP for 1,132bopd+ 1.0mmcfgpd+1,965bwpd. Reservoir Producibility Index [RPI] provides the geologist/engineer with an additional method to delineate zones with potentially producible free moveable hydrocarbons in tight oil reservoirs.

INFERENCE OF LAVA PROPERTIES FROM THE MORPHOLOGIES OF FLOWS ON THE SOUTHERN FLANK OF ELYSIUM MONS, MARS.

AARON AUSMUS*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (aaron.ausmus@ttu.edu)

The morphologies of lava flows can be used to estimate rheological and other properties of component magmas. In this project, the lengths, average widths, average slopes, and volumes of lava flows on the southern flank of the Elysium Mons shield volcano were measured and used to estimate lava viscosities and effusion rates. Identification of distinct digitate lava flows was initially conducted using daytime images generated by the Thermal Emission Imaging System (THEMIS), and the morphological properties of these flows were later determined from a co-registered gridded topographic database generated from Mars Orbiter Laser Altimeter (MOLA) data. Care was taken to ensure that inflated flows, the morphologies of which cannot be easily used to constrain magma properties, were not considered in this work. Measured lengths of prominent flows in the study area range from 33 to 170 km, and associated average flow widths range from 6.8 to 16 km. Flow volumes range from 8 to 185 km^3 with viscosities ranging between 3.0×10^6 Pa s and 1.3×10^7 Pa s. Estimated effusion rates for studied flows average ~2917.21 m^3/s with emplacement durations from ~121 to 595 days. As expected, magma viscosities are typical of flows associated with large Martian shields. Effusion rates are approximately comparable to those that were associated with emplacement of some units of the Columbia River Basalt Group, but are several orders of magnitude lower than those typical of emplacement of lunar mare-style flows.

Seismic Mapping and Three-dimensional Visualization of Horizons and Faults in the Matagorda Island Federal Lease Area off the Gulf of Mexico.

HALEY BAHRET* AND SEIICHI NAGIHARA

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (haley.bahret@ttu.edu)

Two-dimensional seismic reflection lines, velocity well data, and fossil well data were used for mapping major stratigraphic horizons and faults in the Matagorda Bay federal lease area off Texas. The study area lies in the continental shelf where seafloor is flat at 104 feet. The seismic data were acquired by CGG in the 1980's. They consist of a grid of seven lines running northeast to southwest and seven running southeast to northwest with shot intervals every 82 feet. Using the data collected from three velocity wells, a travel time-depth conversion graph was generated. This was necessary for converting the two-way travel time measurements on the seismic sections to depth. Three horizons were mapped based on the strength of their reflected seismic waves, one of which was the water bottom. Two normal faults were mapped, which trend northeast to southwest and almost parallel to the shoreline. This is consistent with the trend of other faults found in the continental shelf off Texas. The relative ages of the horizons and faults were determined using the fossil well data and was found to be in the Upper Miocene (Tortonian stage) era. The reflection horizons and fault surfaces were projected into a 3D subsurface perspective image using the seafloor as the reference datum in ESRI's ArcGIS software.

Petrology of the Wolfcamp Shale in Amoco #1 Chilton (Gaines County, Texas).

M. BAKER*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

A core taken from the Wolfcamp shale in #1 Amoco J.P. Chilton, near the western side of the Midland Basin, consists of an upper interval of shale and a lower interval of limestone. The shale beds are, with exception of a few bioturbated zones, well laminated and high in organic matter, indicating deposition in a deep basinal environment. The shale beds in the cored interval are highly calcareous, and consist primarily of clay (illite) with abundant silt-sized crystals of dolomite – they would be classified as mixed carbonate mudstone or marlstone. Carbonate skeletal grains are like those in the underlying limestone (crinoid columnals, bryozoans, brachiopods, and spicules) – some shale beds have grainstone laminae similar in composition to the limestone beds, but also include glauconite and more abundant phosphatic skeletal grains. A few of the larger skeletal grains have been partly or completely silicified.

Mapping from Home.

C. BLAKEMORE*

[1]Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (zack.huseth@ttu.edu)

The following paper is a research project based on digitally mapping structural features of the Arbuckle Mountains using Google Earth and ArcGIS. The purpose of this research was to map fractures in an area to the west of I-35 and between the cities of Springer and Davis Oklahoma. The problems encountered with this type of analysis is the limitations of the satellite imagery and cluster quantity of the features. The satellite imagery problems were quality of the image. The cluster quantity problems were the concentrations of fractures in only some places of the area. The basic design of this project was to take polylines hand drawn in Google Earth and save them as a file that could then be processed, converted, and measured in ArcMap. A trend that was discovered after drawing and calculating the trend of the fracture lines was that there was a dominate direction and pattern that was forming with the fractures. With the trend of the fractures known an estimation of the stress field in the region can be made and a conclusion could be reached that using a digital medium, such as Google Earth, could be used for an advanced trial mapping or first look at a field area.

Influence of the Marathon Fold and Thrust Belt on Sediment Deposition in the southern Delaware Basin denoted by depths of Fusulinid biozone tops in Pecos, TX.

RICHARD BLOOMER*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

Pecos County contains parts of the Midland Basin, the Central Basin Platform, the Delaware Basin and the Marathon Fold and Thrust Belt. Deformation along the Marathon belt resulted in subsidence in the study area that was filled with Pennsylvanian and Permian strata. This study area tests whether the Marathon Fold and Thrust Belt influenced sedimentation in southern Pecos County through the creation of fusulinid-controlled chronostratigraphic surfaces. Last appearance datums for the Leonardian, Wolfcamp and Lower Strawn time intervals were created with 102 biostratigraphic reports from wells drilled in 1930 to 1970. Results demonstrate a structurally high area in the southern part of the study area and in the NE area that correspond to the Marathon margin and the Central Basin Platform, respectively. In the south, minimal progradation occurred for the Strawn through Wolfcamp intervals, but strong progradation (52 km) during the Leonardian interval. These results suggest that activity in the Marathon Fold and Thrust Belt was progressively encroaching in the early Permian, but did not readily affect southern Pecos County until the Wolfcamp-Leonardian.

Analysis of Thunderstorm Initiation Along Dryline Events in West Texas

T. BROOKS*

Atmospheric Sciences Group, Texas Tech University, Box 42101, Lubbock, TX 79409-2101 (taylor.h.brooks@ttu.edu)

A dryline is an air mass boundary separating moist, maritime tropical air from dry, continental tropical air. This is a narrow zone with a sharp change in moisture and is often the site of confluence in the near-surface wind field. The purpose of this study is to find any correlation between the intensity of a dryline event and the development of thunderstorms. The spring months (April, May, June) for four years were reviewed for this study, 2013-2016. DIFAX maps were used to determine the dates during these years that dryline events occurred. 49 dryline events were recorded, and the data for each were retrieved from the West Texas Mesonet.

The study found that as the spring season progressed, there was a decline in the average change in temperatures associated with a dryline as well as a decrease in the confluence. The precipitation results suggest virtually no relationship between the intensity of a dryline (as measured by the surface dewpoint gradient) and the development of thunderstorms. It is possible that other factors, such as differing amounts of upper-level forcing or a cap in place, have a great influence on whether a dryline creates precipitation.

Petrophysical Analysis of the lower Avalon Shale, Eddy County, New Mexico.

J. BROTHERTON, A. JAMALI, P. MCELROY, Z. YAO

The Permian Basin is one of the most prolific and longest-producing oil basins in the United States. It accounts for approximately 18% of U.S. crude oil production and 23% of the nation's oil reserves. The Avalon Shale is the uppermost member of the Permian Bone Spring Formation, and is located throughout the interior of the Delaware Basin in west Texas and southeast New Mexico. Maps show the Avalon section can have up to 600 feet of potential reservoir within the 950 foot interval. Often there is a tight interval in the middle, leading to the designation of an "Upper and Lower" although the stratigraphic depth of that tight interval varies widely across the basin. The assigned unit of evaluation is the lower Avalon, well #1-5399. Siliciclastic mudstones in lower Avalon are considered to be of good reservoir quality and are highly productive.

In order to decide whether to complete the zone of interest, we calculated OOIP for a 107 acre well spacing. In addition, we seek to determine optimal depth for lateral placement. We used the Simpson Method for calculation of total porosity, variable matrix analysis for calculation of matrix density, and Pe-Rhob quick look method with Lewis' cutoff values for determination of preferred facies. We followed flow chart guidelines to determine CBW, minimum horizontal stress, and brittleness coefficient, and used a permeability cutoff 1 μD to calculate OOIP. The calculated OOIP is approximately 12 MMSTB. Using a 3% recovery factor and other given economic parameters, the project will yield a 1.25 profit to investment ratio and is therefore economical. Through meticulous well log analysis, we determined the optimal position for the placement of our lateral is 8,060 ft. The fracture propagation window is 280 ft. thick and contained between extensive calcite deposits, and ranges from 7,940 ft. to 8,220 ft. in depth. Approximately 60% of OOIP is located in the top portion of the reservoir, while the middle interval lacks oil and poses a potential hazard to drilling due to high chert content. Depth of lateral placement was selected because of increased calcite content at 8,060 ft with a marked decrease in gamma ray count which allows for better geo-steering. Calculations were performed using Microsoft Excel and Techlog.

Environmental Impacts of Fracking in Texas.

S. BUDHWANI*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (*shehzad.budhwani@ttu.edu)

This study aims to analyze the process of hydraulic fracturing and how it can impact the environment. There are concerns over the effects of oil and gas exploration on the environment and the community. With increased production and ever-high demands for cleaner natural gas, the application of fracking has become very popular especially in Texas. With natural gas production expected to be triple by 2030 in USA [1], there is a growing need to analyze the potential environmental threats of the process, especially in Texas, by far the largest producer of natural gas in the country. The purpose of this research is to recognize and analyze these threats and propose some solutions.

Fracking has become a very popular and economical in Texas in the recent years, but it is also known to be linked with harmful environmental impacts. The research studies the chemicals involved in hydraulic fracturing fracking, related water pollution, various sources of related air pollution and their effects on the atmosphere and human health. The study also addresses the controversial issue of induced seismicity linked with these practices. It is therefore important to conduct a thorough geologic survey of the area. Texas has been blessed with incredible resources and therefore we find that careful planning is required to protect the environment and communities that are directly affected by the industry. We consider and study the current research findings and evidences of the impacts of hydraulic fracturing on the total environment and propose some alternatives and long-term solutions that include better community management and better regulation for recycling or treating water as well as closely monitoring pipelines and tanks.

[1] Deutch, J. (2011) The good news about gas: the natural gas revolution and its consequences, 82–93.

Petrology of Wolfcamp (Early Permian) Limestones in the Gray CSL Field, Gaines County, Texas.

Z. BYARS*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

A core taken from the Wolfcamp shale in #1 Amoco J.P. Chilton, near the western side of the Midland Basin, consists of an upper interval of shale, and a lower interval of limestone. The limestone beds are graded calcarenite (grainstones) with bioclasts composed of shallow-water organisms such as crinoids, bryozoans, and brachiopods. The limestone beds are partly dolomitized, grain-supported, well-sorted, normally-graded, and laminated – indicating deposition by turbidity currents in the deep-water basinal environment of the Midland Basin.

Acrotretid Brachiopods in the Western Tennessee Shelf.

E. CARLSON*, J.E. BARRICK

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (eric.carlson@ttu.edu)

Small acrotretid brachiopods, mostly *Artiotreta parva* Ireland 1961, display a conspicuous acme in abundance in the lower part of the lower Wenlock Maddox Member of the Wayne Formation in western Tennessee. The Maddox Member represents a carbonate ramp setting that deepens from northeast to southwest. Deeper portions of the ramp towards the southwest contain higher concentrations of *A. parva*, which are restricted to a thin stratigraphic level low in the Maddox Member. The distribution of A. parva was compared with distribution of carbonate lithofacies, and insoluble residue content, conodont species, and benthic foraminifera. A strong correlation exists between the brachiopod distributions and the low-energy, deeper water mud-dominated carbonate lithofacies. A weak negative correlation is found between the brachiopod distribution and insoluble residues. Total conodont abundance and brachiopod reveal a weak positive correlation. The distribution of one conodont species, *Dapsilodus obliquicostatus* correlates most closely with the presence of *A. parva*. A very weak correlation appears to exist between *A. parva* and some benthic foraminifera (*Thuramina* species).

A correspondence between *A. parva* and carbonate mud facies is expected, for acrotretid brachiopods are common in offshore muddy settings. However, similar rocks in the higher part of the Maddox Member lack these acrotretids. The specific environmental conditions that must have existed for a rapid bloom of *A. parva* to occur are unclear, but these conditions must have disappeared. The limited stratigraphic range could represent as aspect of the early Wenlock flooding of the ramp, followed by shallowing. Or, because the acme lies just above the end of the Ireviken Event, the acme may have a short-lived response to temporary, post-extinction conditions.

Fracture Analysis of the Early Ordovician Kindblade Formation within the Arbuckle Mountains, Murray and Carter Counties, Oklahoma

STEPHEN DAVIS*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (stephen.s.davis@ttu.edu)

The Arbuckle Mountains, which reside in south-central Oklahoma, record the deformation linked to the Appalachian-Ouachita Orogen along the southern boundary of Laurentia towards the end of the Paleozoic. Several study areas within the steeply dipping carbonate rocks of the Early Ordovician Kindblade Formation were selected for fracture analysis as part of a series of studies to better understand the result of regional stresses on the Arbuckle Mountains. Study area "A," is located approximately 5 miles due west of I-35 mile marker 46 on private property and sits alongside a northeast trending fault zone.

The relationship between ductile and brittle deformation in a fold and thrust belt can be correlated to the geometries of bedded sedimentary rock under applied stress. As a formation deforms ductally, brittle deformation occurs in the form of fractures. By taking the azimuth of individual fractures remotely, using a combination of Google Earth Pro and Esri ArcMap GIS applications, fractures are mapped at an outcrop scale using the rectangular window sampling method as described by (Watkins, 2015 [1]) and grouped into fracture sets and age relationships between each fracture set can be determined. Fracture models are worked backwards to reveal any fracture sets that predate the orogenic event and might have formed under historical stress fields. Along with GIS generated data, data from surrounding sites within the Arbuckle Mountains have been used to describe the subsurface geology of the region and the Kindblade Formation itself.

Results identify three distinct fracture sets A1, A2, and B1. Fracture sets A1 and A2 crosscut each other, while B1, the youngest of the fracture sets crosscuts both of the other two. Posing questions, are the fracture sets found at site "A" consistent with other fracture sets found at other sites within the Kindblade Formation? Are the fracture sets found at site "A" consistent with other fracture sets found in similar units of the Arbuckle Mountains? If not, how do these fracture sets differ from the ones found at site "A" and what are the implications?

[1] Watkins et al. (2015) *Journal of Structural Geology* **72**, 67-82.

The Upper Mississippian Carbonate to Shale Succession, Subsurface Shackelford County, Texas.

E. DESHAIES*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 Ethan.deshaies@ttu.edu

The Fort Worth Basin formed during Mississippian as crustal downwarping and flooding dominated central Texas. Shallow marine carbonates, including carbonate mounds, of the Chappel Limestone built out into the Fort Worth Basin during the Early Mississippian. As crustal downwarping continued, shallow water Late Mississippian carbonates, the Whites Crossing Limestone, formed at the shelf edge. As the Whites Crossing was being deposited, organic-rich, siliceous mud deposition began in the deepest part of the basin, the Barnett Shale. A core of the Chappel, Whites Crossing, and Barnett Shale from Shackelford County was provided by S. Ruppel of the Bureau of Economic Geology (Austin) for petrographic and biostratigraphic analysis of the Chappel to Barnett transition. Conodont faunas from core samples confirm the Late Mississippian age of the Whites Crossing and Barnett.

Ten distinct units comprise the uppermost Chappel, and Whites Crossing through Barnett section. The bottom of the core (Unit A) is coarse-grained white skeletal grainstone interbedded with gray shale stringers that is assigned to the Chappell Limestone. The color changes from white unit A to gray Unit B, which is the base of the Whites Crossing Limestone. Units B-E (33 feet Thick) are skeletal packstone/grainstone that have been partially silicified and contain dark gray shale stringers. Unit F (3 feet thick) is a porous micrite that contains oil. Units G-I (24 feet thick) changes from a wackestone to a skeletal grainstone. Unit H is a wackestone and contains a large amount of organic-rich dark shale stringers and Unit I is a grainstone containing few shale stringers. The uppermost Unit J (41 feet thick) is dark brown to black organic-rich shale, typical Barnett Shale, and at the top of the core shale the shale is mixed with corals and skeletal grains. This facies succession represents the transition from shallow to deep marine carbonates capped by deep marine siliceous mud.

Creating Forecasting Criteria for Precipitation Type using Radiosonde and Surface Observation Data.

J.F. DUNLAP*

Atmospheric Sciences Group, Texas Tech University, Box 42101, Lubbock, TX 79409-2101

Forecasting precipitation type has been a notoriously difficult task for meteorologists since its inception. Lack of accurate forecasting can lead to loss of time and money when cities shut down due to false alarms. And worse, inaccurate forecasts can also cause damage to property, people, and even loss of life. This is particularly an important issue when concerning precipitation type.

In order to address this situation, the criteria used to predict forecasts in existing models were analyzed and compared with data from actual precipitation events that saw a variety of hydrometeors reach the surface. The diagnostic thresholds already established were tested using radiosondes and contrasted with data observed at the surface in order to determine if adjustments to the current forecasting criteria need to be made. Ultimately, the goal was to determine where the greatest sources of error in current forecasting of precipitation type lie, and to reduce the occurrence of those errors.

Simulating the unusual propogation of the 27 May 1997 tornadic thunderstorm over Jarrell, Texas.

M. ESLICK*, J. DAHL

Atmospheric Sciences Group, Texas Tech University, Box 42101, Lubbock, TX 79409-2101 (mark.eslick@ttu.edu)

The Jarrell, Texas tornado, which occurred on May 27, 1997, was a violent tornado, with F5 wind speeds (>260mph). Although environmental factors existed, such as large instability (CAPE of 6500 J kg^{-1}), weak vertical wind shear did not suggest that the environment was primed for tornadic weather. Stability and shear are needed for tornadoes, so one of the ingredients being weakly pronounced didn't seem supportive of tornadoes. The storm propagated in an unusual manner and it has been suggested that this may have altered the storm-relative winds such as to promote strong storm rotation. Complicating matters, the nearest radar site in Austin/San Antonio was unable to scan the storm due to ground clutter, and radar data had to be used from the radar from Central Texas. The mystery behind this storm is how it achieved rotation and how its unusual propogation influenced rotation. To analyze these questions, the Bryan cloud model CM1 was used and a novel 'traveling updraft nudging' technique to enforce the observed propagation of the storm. The poster will focus on preliminary results of the simulation.

Round Robin Comparison of Composition Based Mineralogical Characterization of Unconventional Reservoir Rocks.

MATT P. FISHER AND CALLUM.J. HETHERINGTON

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (matt.fisher@ttu.edu)

Understanding the mineralogical composition of reservoir rocks is a vital component of hydrocarbon recovery, especially in unconventional reservoirs, which are the main targets of hydrocarbon exploration today. Obtaining accurate mineralogical data from unconventional hydrocarbon reservoirs has its challenges though. XRD and XRF are commonly applied geochemical techniques that are used in the oil and gas industry in order to obtain mineralogical data, but these techniques have their challenges.

This project compares four geochemical techniques (PXRF, conventional XRF using WDS and Uniquant, and XRF powder analysis) for the compositional analysis of unconventional reservoir rocks. The results from the differing approaches are compared against the petrophysical log data taken from the unconventional reservoirs used in this study to test the reliability, reproducibility, accuracy and precision of the techniques and the mineralogical interpretation of logs that are used to interpret sub-surface geology. The reservoir rocks used in this study were taken from forty sidewall cores from reservoirs in the Permian Basin of Southeastern New Mexico.

This research concluded that the Matrix Identification (MID) plots, based on petrophysical data, for the three wells predict the dominant minerals present in each reservoir, especially if the correct bulk density values are used. Glass discs analyzed in WDS mode is proposed to be the most accurate and precise of the four XRF methods used in this study, particularly for calcite-poor samples, but for samples that contain >20% CaO or the presence of sulfur, WDS glass is the least accurate of the four methods of XRF. Glass discs analyzed by the Uniquant method is proposed to be the most accurate method for carbonate rich samples unless there is a high abundance of sulfur. PXRF is the most accurate of the four methods for these sulfur rich samples, as the calculated mineral abundances (via normative calculations) from the PXRF data, is the most comparable to the XRD data. And lastly, the XRD data ran in triplicate shows high reproducibility, especially for samples that contain less than 10% clay minerals.

Geochemistry and Petrology of the Ashland Pluton, Klamath Mountains, California and Oregon.

S. L. FUSTON*, C.J. HETHERINGTON, C.G. BARNES

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (spencer.fuston@ttu.edu)

The Ashland Pluton is a multi-stage magmatic complex which intruded the Klamath Mountains province (California and Oregon) in late Middle Jurassic time. The pluton ranges in composition from gabbro to tonalite, quartz monzodiorite, biotite granite followed by late dioritic dikes.

Samples collected as part of a summer research trip as well as historical collections are utilized in an ongoing geochemical study involving bulk-rock major/trace element analysis and major/trace element analysis of key mineral phases. These mineral phases include: sphene, hornblende, allanite, biotite, apatite, magnetite, and ilmenite. Mineral compositional trends are obtained in light of elemental zonation patterns identified through backscatter electron imaging. As such, a temporal record of processes impacting both magma and mineral compositions is obtained.

Upon collection of mineral major element compositions, a newly-proposed method [1] of calculating volcanic magma reservoir conditions through amphibole compositions will be applied to the Ashland Pluton. This is done in an attempt to assess the ability of the method to calculate emplacement conditions in an intrusive magmatic context.

Bulk-rock major element analyses define broadly linear compositional trends when plotted against silica with the exception of P_2O_5, which defines a compositional trend characteristic of fractional crystallization. The sample suite is calculated to be magnesian in composition with alkali-lime index trends ranging from calcic to calc-alkalic. Aluminum saturation index trends are broadly metaluminous with only the most evolved samples reaching peraluminosity.

Trace element analyses of sphene are characterized by relatively high concentrations of light rare earth elements (REE) with decreasing concentrations of middle and heavy REE. Negative europium anomalies are present inconsistently in sphene. Trace element analyses of hornblende are characterized by increased concentrations of light and middle REE with decreasing concentrations of heavy REE. Negative europium analomies are present throughout the hornblende analyses. Upon completion of additional grain analyses, more representative trends will be identified and, therefore, will allow for the process controlling magmatic evolution to be better constrained.

[1] Nahasaki et al. (2017) *Lithos* **278-281**, 153-165.

Structural Patterns and Interpretations Throughout The Arbuckle Mountains.

L. GARDE*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (Lauren.Garde@ttu.edu)

The Arbuckle Mountains expose structural deformation in the outcrops. The mountains contain Pre-Cambrian through Permain strata. Fracture patterns within the structural deformation relate to tectonic activity. A structural map of this region has not been published since 1954. An updated map is needed to convay structures and fractures that are not depicted in the previous one. Fracture patterns and road cuts, along I-35 and other nearby roads, are examined and analyzed in order to identify structures within the Arbuckle Mountains as well as the orientation and density of fractures in the area. The formations studied are Woodford shale, Viola abd Bromide limestone, Coolings Ranch Conglomerate, Royer Dolomite Ft. Sill Limestone, Colbert Rhyolite, and a study area within Murray County, northwest of Mountain Lake. Formations are analyzed through stereonets to better understand the history of how the anticline formed. Bedding structure, folds, and boundaries between the bedding are measured in order to create an updated map. There are three sets of fractures within the study area. The results show a better understanding of the structural geology within the Arbuckle Mountains. Fracture patterns piece together the series of events that show the tectonic history. The study improves the understanding of the Arbuckle Mountain Range. It models the area, allowing for a better petroleum development in Oklahoma, and assisting in other structural efforts.

Middle Pennsylvanian Conodonts from the lower Strawn on the Central Basin Platform, West Texas Permian Basin area.

Ben Grunau*

Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053 (benjamin.grunau@ttu.edu)

Conodont samples studied in this report are from the very poorly understood Atokan-Desmoinesian succession (Atoka-Strawn) on the Central Basin Platform, West Texas. Conodonts come from three wells on the eastern edge of the Central Basin Platform, the Unocal Parker wells X-1, V-7, and AD-3, from the basal 150-300 feet of the carbonate section assigned to the Strawn. The Strawn carbonates rest unconformably on Late Mississippian shales. The basal Desmoinesian unconformity is attributed to late-Pennsylvanian transgressional erosion from a general second-order eustatic progradation.

An unpublished report shows that the basal beds in these wells are earliest Desmoinesian (DS-1; Wilde, 2004) in age based on the presence of early-Desmoinesian fusulinids: *Wedekindellina euthysepta, Beedeina euryteines, Beedeina leei*, and *Wedekindellina excentrica*. The following conodont species were recovered from the the lower Strawn section: Parker V-7 - *Neognathodus colombiensis, N. asymmetricus, N. bothrops*, and *Idiognathodus* sp. HA; the Parker X-1 - *N. asymmetricus, N. colombiensis*, *I*. sp. HA, and *I*. sp. HI; and the Parker AD-3 - *N. bothrops* and *I.* sp. HI. Conodonts analyzed in this report can ultimately be referenced against previously established Desmoinesian conodont faunal interval zones of three previously published Texas Tech theses on New Mexico sections.

Petrography of the Comanche Peak Limestone (Cretaceous) near Sweetwater, Texas.

B. HARKRIDER*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

An outcrop of the Comanche Peak Limestone near Sweetwater exposes facies that differ from those typical of most of the formation. In most areas, the Comanche Peak is nodular, bioturbated, micritic wackestone or packstone interbedded with bioturbated marlstone. At the

Sweetwater outcrop, the limestone consists mostly of cross-bedded sparry grainstone with fine abraded fossil skeletal grains. While much of the Comanche Peak was deposited in a subtidal shelf environment, the Sweetwater section must represent an intertidal beach environment.

Petrophysical Analysis of the Lower Avalon Shale, Permian Basin.

HUANG SIYUAN[1], MANSOUR AHMED[1], ZARIFSADR KHALIL[1], ST-GERMAIN, DANIEL A.[2]

[1]Bob L. Herd Department of Petroleum Engineering, Texas Tech University, Box 43111, Lubbock, TX 79409-21011

[2]Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

The Permian Basin is a sedimentary basin largely contained in the western part of Texas and the southeastern part of New Mexico. The total production for Permian Basin up to the beginning of 1993 was over 14.9 billion barrels ($2.37\times109\ m^3$). The Avalon Shale is an oil and gas field that is part of the Permian Basin. It lies above the Bone Spring and above Wolfberry formation, and mainly spread across parts of Southern Eddy and Southwestern Lea counties in New Mexico, The Avalon is comprised of a series of individual sandstone zones which are separated by carbonaceous and shaley siltstones ranging in depth from 6500 to 9000 feet (Lee et al, 2000). In this study, the lower Avalon, well #1-5399 is assigned for evaluation. The main lithology in lower Avalon is shaly-siltstone, which is considered a potential zone to produce oil and gas.

A full well-log suite including geochemical data was utilized to determine whether to complete the interest zone. A series of corresponding calculations were performed by utilizing both Excel and Techlog. Factors as total porosity, matrix density, and TOC etc. were estimated. Then, the OOIP was estimated and a more conservative OOIP was corrected with a permeability cutoff of 1 μD. Also, other parameters as minimum horizontal stress and brittleness coefficient were estimated by applying the flow chart, which can help to determine the penetration location. Two potential zones were seen as 7962-8075 ft and 8090-8112 ft. However, due to the high chert content contains in the middle interval, it is difficult to build the connection for these two zones and produce from both of them. Since the upper zone has higher OOIP than the lower zone, it is decided to produce from the upper zone, and the optimal position to penetrate the well is proposed at around 8015-8030 ft. The EUR in the upper zone is estimated at 3.25 MMSTB with an OOIP of 54.23 MMSTB and a primary recovery factor of 6 %. The decision of complete the well is made based on the economic analysis of the upper zone.

Retrospective Analysis of Groundwater Levels for decades 1980−2010 of the Mississippi River Valley Alluvial Aquifer.

ZACHARY J. HUSETH*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (zack.huseth@ttu.edu)

The Mississippi River Valley alluvial aquifer (MRVA) is a unconfined aquifer that comprises the uppermost section of the Mississippi Embayment aquifer system [1]. The MRVA is located in parts of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee and resides within the greater flood plain of the Mississippi River. The MRVA has an area of approximately 32,000−33,000 square miles and ranges from 70−120 miles in width [1]. The MRVA is graded with gravel at the base fining upward into sand with considerable vertical and horizontal heterogeneity owing to complex silt and clay distributions. The MRVA is 60−135 feet thick and is almost entirely quaternary in age [1]. Since the 1950s and accelerating in the 1970s and 1980s, over-pumping for production agriculture from aquifer for crop irrigation has created a systematic decrease in water levels over the past several decades. From north to south, the water-level altitudes in the aquifer show general decrease, which is consistent with gradient towards the gulf coast; however, large regional variations attributable to pumping exist. Pumping has caused persistent decrease in water levels in the Mississippi Delta region and more restricted parts of Arkansas. To enhance scientific understanding of the spatial and temporal history of water levels, retrospective spatial analysis of the decadal mean water levels for decades 1980–2010 using a geographic information system was conducted. The results show a substantial decline in water-level altitude comparing the 1980 decade to the 2010 decade in the Mississippi Delta, farm lands east to southeast of Little Rock, Arkansas, as well as farmland to south of Jonesboro bordering Crowley's Ridge in northeastern Arkansas.

[1] Ackerman, D.J., 1996, Hydrology of the Mississippi River Valley alluvial aquifer, south-central United States: U.S. Geological Survey Professional Paper, 1416–D, 56 p.

The Petrology of the Ogallala Formation in Yoakum County, Texas.

A. E. HUTSON*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

Samples taken from drill cuttings at two water wells in the Ogallala Formation in Yoakum County are used to determine the mineralogical composition of sands in the Ogallala Aquifer. The general composition of these samples is similar to others taken from the Ogallala Formation around the High Plains; however, the abundance of quartz grains, and in particular monocrystalline straight-extinction quartz is greater here, and the abundance of lithic grains is correspondingly lower compared to average Ogallala values. Only rare chert and limestone grains are found in the coarser size fractions. These differences suggest that the well sites in Yoakum County penetrate primarily eolian facies in the Ogallala, which tend to have higher abundance of quartz compared to fluvial facies.

Structural analysis of Canon Del Trigo Manzano Mountains, Central NM.

T. JACKSON*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053, Trent.jackson@ttu.edu

Canon Del Trigo of the Manzano Mountains in central New Mexico consists of deformed Precambrian age rocks. The Monte Largo shear zone located north of Canon Del Trigo is not well understood. Assessing the multiple deformations that occurred in Canon Del Trigo may allow for further understanding of the Monte Largo shear zone. Using a Brunton compass to record measurements, a detailed field map and interpretation of the attitude of the formations was created. In addition, a new approach of computationally mapping the contacts using Google Earth was used to analyze the structures of Canon Del Trigo.

Jeffery Grambling notes that there are three differing lithologies within Canon Del Trigo that combined make up the Blue Springs Schist unit [1]. Previous work did not continue further east into the canyon, which led to a distinct rock type that was previously unmapped. Focusing on the preserved fabrics and deformational features of the Blue Springs Schist will provide a framework for understanding the temporal and kinematic relationships of the multiple deformation periods that affected the Monte Largo shear zone.

Previous work in Canon Del Trigo performed by Jeffery Grambling focused on large-scale mapping and minor structural details were not addressed. The minor structure features are important to understand the shortening of the Precambrian Stratigraphy. Mapping and analyzing the smaller scale features and correlating them to Grambling's work can help justify the accuracy of the large scale mapped features.

[1] Grambling, J. (1982). Precambrian Structures in Canon Del Trigo Manzano Mountains, Central New Mexico. pp: 217-220.

Trace element geochemistry of clinopyroxenes from the Appinite Suite, Kentallen, Scotland.

Z.R. LINDBERG*, E.L. BACKUS, C.J. HETHERINGTON

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (zach.lindberg@ttu.edu)

The Appinite Suite of the Ballachulish Igneous Complex is a series of mafic to ultramafic intrusions that range from meladiorite to hornblendite to kentallenite, which is a melanocratic variety of monzonite composed of olivine and clinopyroxene with interstitial biotite, plagioclase, and potassium feldspar. Cross-cutting relationships prove kentallenite predates the main intrusion of the Ballachulish Igneous Complex, although geochronology shows that they are indistinguishable in age. Kentallinite has largely gone unstudied and this contribution applies modern techniques to characterize the composition and magmatic evolution of samples collected at the kentallinite type-locality.

The kentallenite samples are composed of euhedral crystals of olivine (10%-15%), biotite (5%), and clinopyroxene (30%-40%) in a matrix of potassium feldspar plus plagioclase. The clinopyroxene and olivine are large, euhedral grains that occur in a finer grain matrix of plagioclase and potassium feldspar. Olivines are fractured and surrounded by chlorite rims resulting from secondary alteration. The clinopyroxene grains show well defined oscillatory zoning controlled by exchange between several elements (Fe, Mg, Si and Al). Based on the presence of olivine inclusions in the cores of the clinopyroxenes, olivine then clinopyroxene were the first to crystallize. Thereafter, subhedral-biotite crystallized, followed by interstitial, plagioclase and potassium feldspar.

Compositionally, the rocks are alkaline, with (Na_2O + K_2O) abundances > 5.0 wt% at SiO_2 abundances <50.0 wt.%; MgO abundances are >15.0 wt% and whole-rock Mg# of ~70. Trace element analysis of clinopyroxene from core-to-rim show chondrite normalized REE patterns with positive light REE slopes and negative slopes in the middle and heavy REE patterns, but a general trend of REE enrichment in grains from cores to rims. Eu anomalies are small and negative to not present.

Lineament Analysis of Surface Features at The Caprock Escarpment.

A. Nassri* & A.S. Yoshinobu

Department of Geosciences, Texas Tech University, Lubbock, TX 79409-1053

Linear features on landsat imagery and remotely sensed data and recorded in the field are used to analyze fracture traces visible on aerial photography, which are nature linear drainage and topographic alignments in order to study linear orientation relationships locally at the study are of the Caprock Escarpment and regionally. Joints were recorded using ArcGIS imagery and during field observation suggesting that the development of physiographic lineaments is influenced by tectonic activity and geologic structures. The function of joints relies on the fact that it provides paths of weakness paths which surface drainage possibly preferentially develops indicating that the lineaments are a manifestation of underlying zones of fracture concentrations. The preferred orientations of the joints recorded were 300-320°,030-050°,and 00-020° orientation. This research paper will cover the study conducted on the lineaments to further understand the relationships between local and regional tectonic activity at Caprock Canyon State Park in West Texas.

Sedimentology and Petrography of the Dean Formation in the Ackerly Field (Dawson County, Texas).

D. L. OLIVE*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

The Dean Formation is an Early Permian (Leonardian) deep water shale and fine-grained sandstone sequence in the northern Midland Basin. A 26-foot section of core taken from the Dean 'Sandstone' at a depth of 8647 to 8673 feet in Superior Oil Co. Ackerly Dean #1, consists primarily of base-cut-out Bouma sequences deposited by turbidity currents. Representative examples of Bouma A, B, C, D, and E units show that the sand and coarse silt fraction consists of quartz, muscovite, chlorite, opaque oxides, and plagioclase. The fine silt and clay fraction contains abundant organic matter, and this is concentrated in the E units, and in laminations within C and D units.

Analysis of seismic noise from three component seismic stations to try to identify standing waves between geologic layers.

J. ORTEGA*, H. GURROLA

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (juan.ortega@ttu.edu)

To try to determine if standing waves are found in the noise from a seismic station we used Autocorrelation and Fourier analysis to try to identify repeated patterns in these data. In this project we had 6 different seismic stations in which seismograms were recorded of background noise. We used Fourier transform to perform harmonic analysis to try to identify standing waves in these data. We then use an Autocorrelation function to find repeated patterns in these data.

We used data from a temporary array of seismometers located within the Muleshoe National Wildlife Refuge. We performed all analysis on the vertical component only assuming that, if there were a vertically traveling standing wave of P-wave energy in between the surface and layers in earth, that a standing P-wave would be recorded only on the vertical component.

We were able to identify some of these standing waves in stations 2, 4 and 5. The other stations do not show prominent standing waves that we could conclude that they were present.

Calculation of Total Organic Carbon in an Unconventional Permian Wolfcamp Oil Reservoir: Midland Basin Texas, Using Different Methods.

D. OYETUNJI* & G.B. ASQUITH (ADVISOR)

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (damilola.oyetunji@ttu.edu)

Petrophysical analysis were carried out on an unconventional Permian Wolfcamp Oil Reservoir to examine the total organic carbon (TOC, wt %) contained in it. This is because Shale contains different minerals such as clay, quartz, carbonates, kerogen and other heavy minerals that are all considered during analysis and interpretation. The petrophysical analysis involved the use of well logs such as nuclear magnetic resonance, gamma ray, density and resistivity logs to record different parameters like the bulk density, porosity, deep resistivity, and volume of quartz, pyrite and calcite. The well log data served as parameters to calculate the TOC using different methods. The methods include the Porosity Deficit Method, (direct method), Passey, Schmoker and Bulk Density vs. Lab Derived TOC Methods (indirect methods). From table 1, the Porosity Deficit Method yielded a TOC that ranges from 0 to 10.566 with a mean of 0.609. The Passey Method yielded a TOC that ranges from 0 to 5.879 with a mean of 1.454. The Schmoker Method yielded a TOC that ranges from 0 to 14.070 with a mean of 2.950. The Bulk Density vs. Lab Derived TOC Method yielded a TOC that ranges from 0.075 to 15.160 with a mean of 1.755.

METHODS	MEAN (wt. %)	RANGE (wt. %)	STANDARD DEVIATION (wt. %)
PASSEY	1.454	0 – 5.879	1.353
SCHMOKER	2.950	0 – 14.070	1.636
POROSITY DEFICIT	0.609	0 – 10.566	1.125
BULK DENSITY VS. TOC	1.755	0.075– 15.160	0.833

Late Pennsylvanian to Early Permian Evolution of the Ozona Arch/Pecos Arch and its Connection to the Central Basin Platform.

A. PEDRAZA*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

This paper evaluates the evolution of the geologic relationship of the Central Basin Platform and Ozona-Pecos Arch. Specifically, I used fusulinind-controlled chronostratigraphic surfaces to assess if the Central Basin Platform and the Ozona-Pecos arch were connected or separated. Using well cuttings, biostratigraphic zone depths were determined. They were interpreted between the 1940s to 1970s by R.V. Hollingsworth. Data was used to construct chronostratigraphic surfaces. The Atokan chronostratigraphic surface demonstrates that a structural low was persistent in the intervening area between the Central Basin Platform and the Ozona-Pecos Arch. However, by the end of the Lower Strawn interval, the two features appear to be a connected topographic feature along their respective southern margins, although an embayment occurs to the north in the region between the two features. By Wolfcampian time, the data here demonstrate that the two features were sitting at the same topographic level. Thus, if they were structurally segmented, the fault must have been strike-slip with litte dip slip dispalcement.

Chronostratigraphic Study of the Central Basin Platform and Delaware Basin in Loving, Ward and Winkler Counties, Texas.

K. J. PEVEHOUSE*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053. katie.pevehouse@ttu.edu

This report evaluates the evolution of the western margin of the Central Basin Platform and the eastern edge of the Delaware Basin through the use of fusulinid-controlled chronostratigraphic surfaces. The study area is within Loving, Ward and Winkler counties of west Texas. In these counties, wells utilized for data collection were drilled from 1940's through the 1970's. Depths to biostratigraphic zone tops or last appearance datums (LADs) are created for Leondarian, Wolfcampian, Cisco, Canyon and Lower Strawn intervals. The chronostratigraphic surfaces demonstrate that a relatively deep canyon formed along the western edge of the Central Basin Platform during the Canyon interval. The subsequent Cisco interval filled and annealed this canyon feature. The Wolfcampian interval demonstrates aggradation along the western margin indicating a period of margin stability for around 10 m.y. The Leonardian interval records a significant progradation of the western margin. Moreover, an isopach map of the Leonardian interval suggests that localized carbonate buildups occurred along the western margin. Presumably, these buildups are the precursor to the younger Guadalupian reef that rimmed the Delaware Basin.

Lineament Analysis in Relation to Geomorphology in Caprock Canyons State Park, Texas.

R. RUTAIVILAVAN*, A.S. YOSHINOBU

Department of Geosciences, Texas Tech University, Lubbock, TX 79409-1053

Analysis of aerial imagery reveal linear physiographic features within drainages of Caprock Canyons State Park, Texas. These lineaments within the drainages show preferred orientations of 30°-90° and 240°-300°. Lineaments drawn in GIS reflect orientations of joints measured within Caprock Canyons which suggest that linear physiographic features such as drainages are dictated by preceding geologic structures. Joints within the Permian sandstones provide paths of weaknesses that create these linear physiographic features. Percolation of water through these joints enhance dissolution of halite beds beneath Caprock Canyons. Once these beds dissolve, subsidence in the area occurs and the overlying rock will collapse in the preferred orientations

of the preexisting joints. So, joints have control on the geomorphology of Caprock Canyons State Park.

Class Team Project on Lower Avalon Shale Productivity Analysis GEOL 5399 - Advanced Petrophysics.

O. SALEH, M. YERMEKOVA, O.T. AJIBOLA, T. SPARKS

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053, TEAM #1

The Avalon shale, sometimes called the Leonard shale or the upper Bone Springs formation, is located in the Permian and Delaware Basins in Southeast New Mexico and West Texas. In the Delaware Basin, the upper Leonardian (Lower Permian) strata of the Avalon shale play (first Bone Spring carbonate) consist of hundreds of meters of dark, organic-rich siliciclastic mudstones interbedded with carbonate-rich deposits. The formation allocated for assessment in this term project is the Lower Avalon, which is lying immediately below Carbonates deposited before the Upper Avalon formation.

In this project, data file including the geochemical data for WELL #1-5399 was given for analysis. Productivity evaluation of the Lower Avalon shale was performed through analyzing petro-physical data obtained from well log analysis using Schlumberger's Techlog Wellbore Software and Microsoft Excel calculations. To determine if the shale is thermally mature enough to produce oil, the thermal maturity index was calculated to be 6.26 as well as the total organic content was calculated as TOC = 1.92 wt%. The TOC values from lab correlation equation method was then used with the Simpson and Other Method equation to determine the total porosity. Based on these calculations, oil-filled porosity and permeability of the reservoir rock as well as the Original Oil in Place (OOIP) were calculated. The estimated recoverable oil was determined based on Original Oil in Place (OOIP) with the 1000 nD permeability cut-off.

There are three zones in the Lower Avalon formation namely the upper, middle and the lower zones. The most conservative OOIP using the permeability and the effective porosity cut-offs came from the upper zone 7941.5 ft to 8075 ft and an EUR of 41.88 MMstb. The lower zone located 8112 ft to 8222 ft is less conservative OOIP with an EUR of 23.48 MMstb. It is obvious that we cannot conveniently meet up with the economic well requirement of 350Mbo for each of the six wells placed in the 640 acres assigned by producing from a single zone. Therefore, there is need to optimally select the landing point depth of the lateral that would produce from the three zones. The middle zone is a good candidate for the location of the lateral, but it can be cherty and thus cause the drilling in the rock to take longer time. The lateral section of the well was placed at 8070 ft, which provides an easy frac distance through the zones. This depth is in the upper zone with the highest recovery and better organic richness. Using Gamma Ray, accurate geolocation and geo-steering of the well bore can be achieved, while drilling the lateral in the shaly formation. Moreover, the zone has more consistence and better matrix permeability and the vertical fracs with better hydraulic fracture conductivity can easily propagates downward due to larger conductive area. There are also more quartz-calcite below the lateral as this would provide brittle and fracture prone shale. Using the most conservative recovery factor of 6%, we found the OOIP to be 70.95 MMstb, while the EUR to be 4.26 MMstb.

On the occurrence and origin of Fe-Mn nodules in the post-Würmian Alpine sediments of Geneva Basin (Western Switzerland)

B. SEGVIC[1], G. ZANONI[1], S. GIRARDCLOS[2]

[1]Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (branimir.segvic@ttu.edu)
[2]Depth. of Earth Sciences, University of Geneva, 1205 Geneva, Switzerland

The soils and surface sediments of Geneva basin located in western Switzerland are intrinsically tied to the last Alpine glaciation that reached its maximum around 20 to 22 ky BP. Colluvial and alluvial processes are considered parental to the young Holocene sediments featured by some remarkable eogenetic phenomena such as the formation of Fe-Mn nodules. Along the hillside of Grand-Saconnex in Geneva, recent archaeological excavations revealed a nicely developed ~1.5 m thick exposure of post-glacial sediments. At the interface of two colluvial units a cm-thin zone rich in Fe-Mn nodules is reported. A detailed X-ray elemental mapping coupled with XRD and XRF investigations was performed in order to understand the occurrence modes as well as the origin of such mineralization.

The nodules host layer is essentially consisted of 10Å-clays, chlorite, mixed-layer I-S, quartz and amorphous matter. In addition, a myriad of Fe-Mn concretional forms is present attaining up to 1.5 mm in diameter size. The nodules are spherical to subangular, with an onion-like internal architecture marked by selective enrichments in Fe and Mn. Mineralogy of nodules reflects the composition of the host sediment with an exception of very low crystalline Fe-Mn aggregates present solely within the studied concretional forms. The nodule-rich layer is 10 to 100 times enriched in typical ophiolite minerals. Furthermore, this layer is devoid of hydroxyl-interlayered clay minerals typical for the rest of the colluvium.

The abovementioned ophiolite mineral suite is believed to have served as a feedstock of Fe and Mn. Most probably, the morphology of terrain receptive to water retention, caused favourable pH-Eh conditions that enhanced mobilization of Fe and Mn in their soluble forms. Electron microscopy identified the exfoliated chlorite, and presumably metamorphic vermiculite, as the most evident sources of Fe. Oscillating redox conditions triggered the precipitation of Fe and Mn in the form of low-crystalline aggregates attached to the outer surfaces of illite crystallites. This process ultimately saw an end with the formation of nodules thoroughly cemented by Fe-Mn mineralization.

Hf Isotope Zircon Systematics of Archean Anorthosites: the Manfred Complex, Yilgarn Craton, Western Australia

A. K. SOUDERS AND P.J. SYLVESTER

Mineral Isotope Laser Laboratory (MILL), Texas Tech University, Box 1053, Lubbock, TX 79409-1053 (kate.souders@ttu.edu)

Archean anorthosite complexes represent a minor, yet distinct rock type found within many Archean terranes. These mantle-derived melts are commonly found in layers with associated leucogabbro, gabbro, and ultramafic units of similar origin. Most Archean anorthosites contain zircon crystals, which can be used to establish robust crystallization ages for anorthosite complexes. These minerals are also ideal targets for in-situ Lu-Hf isotopic analysis to further characterize the source of Archean anorthosites and provide insight into the formation and evolution of the continental crust during the Archean.

The ca. 3.7 Ga Manfred Complex is exposed northeast of Mount Narryer within the Narryer Gneiss Terrane, Yilgarn Craton, Western Australia. The layered anorthosite-gabbro-ultramafic intrusion outcrops in pods and lenses, engulfed by granitic gneisses [1, 2, 3]. We have sampled anorthosites, leucogabbros, and gabbros from the Manfred Complex and determined their age by LA-ICPMS U-Pb zircon geochronology. Zircon crystals separated from these rocks give ages of 3.53 Ga to 3.73 Ga. LA-MC-ICPMS Lu-Hf isotope analyses were performed by focusing the laser spot directly on top of the U-Pb analysis location of each zircon grain. Initial Hf isotope compositions of zircon grains from the Manfred complex range from ca. $\square_{Hf}$ (+3) to (-2). This range suggests contributions for both depleted mantle and more ancient crustal sources to the parent magma of the Manfred Complex.

[1] Kinny et al. (1988) Prec. Res. **38**, 325-341.
[2] Myers (1988) Prec. Res. **38**, 309-323.
[3] Williams and Myers (1987) WA Geol. Sury Rpt. 22, 32 pp.

Adsorption of Ca2+ on α-aluminum oxide in NaCl media at 25ºC with variable ionic strength, starting concentration and surface area.

E. STINSON*, M.K. RIDLEY

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053 (eric.stinson@ttu.edu)

The titration of α-aluminum oxide in a Ca2+ dispersion solution of NaCl, HCl, CaCl2, and deionized water was carried out with ionic strengths of 0.3m with 0.001m and 0.002m Ca2+ and 0.03m with 0.001m Ca2+ using two α-aluminum oxide samples with different surface areas (BET=5.906m2/g and 11.092m2/g). Samples were characterized with ICP-AES analysis and percentage of calcium ions absorbed, total number of moles of calcium ions absorbed per m2, pH values, and Al3+ solubility were calculated. The percentage of calcium ions adsorbed onto α-aluminum oxide increases with increasing pH and decreasing ionic strength of the dispersion solution. The number of moles of calcium ions absorbed per unit area increases with increasing pH and increasing starting concentration of calcium ions of the same ionic strength. Dissolution of α-aluminum oxide into Al3+ is shown to increase with increasing pH.

The base of the Ogallala Formation in Martin County, Texas.

C. C. STRAUB*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

Driller's logs for water wells, available from the Texas Water Development Board, are used to create a detailed map showing the base of the Ogallala Formation in Martin County. The Ogallala Formation here fills several deep paleo-valleys cut in underlying Cretaceous bedrock. These paleo-valleys generally follow the present course of Mustang Draw and Sulphur Spring Draw. Remnant Cretaceous bedrock 'highs' are present beneath the Ogallala in southern Martin County. Cretaceous strata are absent in eastern Martin County, where the Ogallala Formation rests directly on underlying Triassic strata, or has been removed by later erosion.

PABZT Project (Permian basin archival of biostratigraphic zone tops).

D.E. SWEET, J. GARCIA, D. ST.-GERMAIN, & 22 UNDERGRADUATE STUDENTS

In the Fall of 2011, the Department of Geosciences received a donation of biostratigraphic reports from wells drilled in the 1930's to the early 1970's within the greater Permian Basin region. These reports provide depth to the tops of numerous biostratigraphic zones and thus provide a means to spatially map out chronostratigraphic surfaces within the region. The PABZT (Permian Basin Archival of Biostratigraphic Zone Tops) Project was undertaken to digitally capture this data and provide a means to spatially manipulate with GIS.

To date, the project is approximately ~58% complete with 73 out of 126 counties completed. Total wells contributing to the current database is 3103 and largely centers on the western half of the Permian Basin province. Recently, archival efforts have focused on the Delaware Basin and surrounding counties.

Geology of the Dockum Aquifer at the Brackish Groundwater Desalinization Initiative, Seminole, Texas.

J. TANKERSLEY*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

A water-well was completed in the Dockum aquifer approximately two miles southwest of Seminole, Texas as a part of the Brackish Groundwater Desalination Initiative enacted by the city of Seminole in cooperation with Texas Tech. This initiative was made in order to determine the feasibility of using wind power to desalinate brackish groundwater from the Dockum Group for municipal water supply. Drill cuttings from the well show that four units within the Dockum Group are present here, the Cooper Canyon, Trujillo, Tecovas, and Santa Rosa formations – of these, the Trujillo and Santa Rosa are known to be aquifers around the High Plains. A lithologic log made from the drill cuttings, and a gamma ray log of the well provided by Schlumberger, show that the Trujillo Sandstone, at a depth range from 590' to 650' is likely to be the most useful interval to perforate for future brackish groundwater development in the area.

Petrology of the Walnut Formation (Cretaceous) near Fluvanna, Texas.

J. VASQUEZ*

Dept. of Geosciences, Texas Tech University, Box 41053, Lubbock, TX 79409-1053

The Walnut Formation (Comanchean – middle Cretaceous) near Fluvanna, Texas is about 6.5 m (25 ft thick), and exhibits divisions similar to those found in central Texas, but is much thinner. The formation can be divided into a lower interval of sandy shale with interbedded fossiliferous limestone (ostreid packstone and wackestone), and an upper interval of calcareous shale and nodular limestone (gastropod/bivalve wackestone and mudstone). Gamma ray spectrometry indicates that total gamma radiation is highest near the base of the Walnut, and diminishes upward. K content is also highest near the base, but U and Th contents peak in the upper part of the formation. This suggests that clay and feldspar content may be greatest in shales within the lower part of the formation, while organic matter is more abundant in the upper part of the formation. The Walnut was deposited as an initial part of a transgressive systems tract, under conditions similar to those in significant ‘shale gas’ plays, although the Walnut Formation is much thinner.