POSTER PRESENTATION ABSTRACTS

(Listed alphabetically by corresponding author, designated with an asterisk (*)

Tandis S. Bidgoli* and Wei Want -- Assessing the viability of phosphatic fossils for geo- and thermochronology

Geo- and thermochronologic dating methods are routinely used in a wide range of geologic studies; however, obtaining ages directly from marine carbonate and shales remains a major challenge. Conodonts have emerged as a possible solution to this problem. These tooth-like fossils are common in marine rocks covering a wide span of geologic time, and are made of hydroxyapatite with U and Th in suitable concentrations for the U-Pb and (U-Th)/He isotopic systems. These microfossils are already routinely used for biostratigraphic control and as geothermometers via the conodont color alteration index. Although these fossils show promise, recent investigations (Landman et al., 2016 and Bidgoli et al., 2018) suggest that open-system behavior and parent isotope loss, may limit the viability of these fossils for dating. This study investigates isotopic heterogeneities in conodonts and their potential causes through U-Pb dating and trace and rare earth element depth profiling of specimens using laser ablation-inductively coupled plasma mass spectrometry. U-Pb spot ages and concentration profiles were obtained from conodonts from five well-studied units of known age across the U.S. They include the Pennsylvanian Houx Limestone (Kansas), Mississippian Cuivre Shale (Missouri), Mississippian Pre-Weldon Shale (Oklahoma), Devonian Holt's Summit Sandstone (Missouri), and Devonian Percha Formation (Arizona). Preliminary results from 44 conodont specimens (265 spots) from these units suggest high U, Th, and Pb concentrations on the margins of the conodonts. Transects across specimens also suggest improved accuracy of dates moving from conodont margins to interiors. On-going work focuses on obtaining additional data from polished specimens to illustrate U and Pb distributions and better understand influencing factors, including the role of tissue type, microstructural heterogeneities, and color alteration index on conodont U-Pb ages.

John M. Clymer – Trace Metal Analysis of the Devonian Ohio Shale of Eastern Kentucky

The gamma-ray tool is used to infer the organic carbon content in shales due to the interaction between uranium (U) and organic carbon. However, the Cleveland Member of the Ohio Shale Group of eastern Kentucky, within the Appalachian Basin, displays a moderately low gamma-ray response relative to the Lower Huron member of the same group, despite both having similar total organic carbon (TOC) content. We hypothesize that this discrepancy between U concentration and organic carbon accumulation is related to reworking of the sediment, causing a depletion in trace metals, especially U, as a result of oxidation. In this study, U inventory of the Cleveland Shale is evaluated to determine the depositional environment and mechanisms that influence U content of organic-rich rock. The results of this study will provide better constraints on paleoceanographic conditions during Devonian time.

The U/TOC ratio in organic-rich shales is influenced by many factors such as the primary uranium content of the water body and the sedimentation rate at the time of deposition [1]. The Devonian black shales of North America provide a remarkable study area for this investigation. This discrepancy between U concentration and organic carbon accumulation in the Cleveland Shale is likely related to oxidative reworking of the sediment, causing a depletion of uranium. Results from this project will give insight into depositional conditions as well as processes that occurred post-deposition. Additionally, this study has implications for predictions of the extent of source rocks in the subsurface when gamma-logs do not detect radioactivity. Though this investigation is primarily focused on Devonian-age shales, the methods and ideas discussed throughout this project can be applied to shales of different age.

Kevin Doyle -- Gulf of Mexico "Dead Zones" as Analogs for Ancient Marine Source Rock Depositional Environments

Using modern depositional environments as analogs to explain formations in the Ancient Rock Record are a common application by geoscientists. Bridging the conceptual gap between the time scale and dimensions of modern depositional environments versus ancient units can be challenging. The timing and extent of modern Gulf of Mexico "Dead Zones" are presented as an analog for the deposition of ancient marine source rocks.

Since the 1500's, when Spanish explorers probed the Gulf of Mexico coastlines, there have been historical accounts of fish and invertebrate animal kills in this basin's shallow waters. In the last few decades, environmental studies have identified the dinoflagellate, *Karenia brevis*, as the main producer of Harmful Algal Blooms (HABs) / Red Tide outbreaks seaward of the Mississippi River Delta, offshore Texas/Louisiana and the Caloosahatchee River Estuary, offshore SW Florida. If such events occurred in geologic times, then with preservation, they are postulated to be the source of organic-rich sediment and an analog for ancient marine, algal source rocks.

In shallow water adjacent to the coastlines, HABs / Red Tide events can contribute to the creation of aerially-extensive, low-oxygen to zero-oxygen water columns as the result of *K. brevis* proliferation, resulting in asphyxiation of pelagic and benthic organisms. These "Dead Zones" seaward of the Mississippi and Caloosahatchee Rivers can cover 4000 to 8000 sq. miles (10,360 to 20,720 sq. kilometers), equivalent to ~ 220, 6x6 mile Townships or approximately 1000 Gulf of Mexico Federal Lease Blocks.

Since the 1950's, low oxygen events seaward of the Mississippi River events are enhanced by the presence of man-made nitrates in the seawater. Pre-1700 historical events and ancient events would have been supported by natural sources of nutrients, such as upwelling of the deep ocean adjacent to the continental shelf of the Gulf of Mexico.

A Gulf of Mexico Dead Zone analog is presented where 50 m of deposition/preservation in 1 My compares to a similar thickness and likely age of deposition for a single North Sea Kimmeridge Clay "hot shale" event. Other source rock analogs, such as the Bakken, are also investigated.

C. Layne Farr -- Permeability Anisotropy and Meandering Fluvial Facies Architecture of the Bartlesville Sandstone, Nowata County, Oklahoma.

Permeability anisotropy is characterized and related to the fluvial facies architecture of the Bartlesville sandstone to understand finer scale permeability variations affecting fluid flow within hydrocarbon reservoirs. Permeability anisotropy is often upscaled in reservoir models such that finer scale heterogeneities are rendered irrelevant; however, studies have demonstrated that finer scale heterogeneities pose significant consequences for hydrocarbon recovery. The Bartlesville sandstone (Boggy Formation, Desmoinesian) is represented in core from enhanced recovery injection well MF Canada I-AI (SEC. 30 T27N R16E) in Nowata County, Oklahoma from depths 802 to 849 feet. The core exhibits minimal residual hydrocarbon presence, minimal drilling mud cake, lacks telogenesis alteration, and thus it is conducive to permeametry, petrographic, and image-based rock analyses.

A meandering fluvial hierarchical facies architecture is constructed from a detailed core description utilizing the lithofacies as the foundational unit. Units in the proposed hierarchical scheme in increasing rank include the lithofacies, facies/sub-facies, storey, and storey groups. Three stacked meandering fluvial storeys consisting of channel floor, lateral accretion bar, crevasse splay, and floodplain elements are identified. Probe permeametry is sampled as a circumferential grid along the outer surface of the core with centimeter vertical spacing yielding three-dimensional permeability data fields ultimately contoured for finer-scale architectural element permeability trends. Core plugs are extracted parallel to

strike, parallel to dip, and perpendicular to stratal elements within individual lithofacies for use in core plug permeametry.

Petrographic analyses and image-based rock analyses are utilized to investigate permeability anisotropy at the microscale relative to facies architectural elements. Petrographic analysis of thin sections is employed to quantify rock components, texture, and qualitatively characterize pore systems and grain fabrics in multiple orientations. Three-dimensional qualitative analyses of micro-pore size, pore shape, pore distribution, and pore interconnectivity are evaluated utilizing micro-computed tomography (micro-CT) to image core plugs. Three-dimensional pore networks extracted from micro-CT images are used to model transport properties such as single and multiphase fluid flow.

Curtis J. Faulkner -- A New Approach to Geological Surface Mapping for the Missourian and Desmoinesian Sediments in the Tulsa Basin-Cherokee Platform of Eastern Oklahoma: The MADEOS Project

A new generation of geologic surface map has been developed by applying eustatic depositional models combined with modern technologies to improve the resolution of the current geologic maps in Eastern Oklahoma. Instead of creating and updating the standard or traditional geologic maps using historical formation definitions, this new approach uses the concepts of eustatic cyclothem basinal modeling merged with data from satellite imagery, fossil evidence, geochemistry, open-hole well logs, paleo-tectonic and seismic earthquake-fault data to produce an enhanced, more powerful, user-friendly and stratigraphic accurate digital map. Nearly 3,700 square miles in nine counties have currently been mapped with Petra IHS Markit software. The MADEOS map incorporates 500 research fossil sites, the Oklahoma Geological Survey Earthquake surface data, Heckel's 2013 regional Midcontinental correlation sea-level chart and the MADEOS correlation cross sections.

In the standard geologic maps, sediments from multiple eustatic cycles are often grouped together within a single Pennsylvanian formation's definition making it difficult at times to distinguish which part of the formation one is located. With the MADEOS map, one can plot their paleo-data and know both formational and the individual shale members within each eustatic cycle. The new, updated surface faulting data from the Oklahoma Geological Survey has been incorporated with each fault being verified from satellite imagery. In most cases these faults are easily distinguished in aerial photos and extended beyond the current Survey's fault maps. Detailed fault patterns, fault movement, cross cutting relationships and fault systems are now providing a better understanding in multiple paleo-stress fields and the timing of faulting events. Previous correlation busts are now being recognized and corrected with the new fault data interpretation and fossil evidence. This new style of integrated mapping provides a far better understanding and a greater potential for improved scientific investigation, resource development, civil construction and geohazard implications and predictions. The MADEOS map is growing into a powerful, modern geologic tool.

William K. Hagood*, Matthew Totten, Abdelmoneam Raef, Victor Cimino – Detailed Core and Log Analysis of a Producing Viola Dolomite Well in Comanche County, Kansas

The Ordovician-aged Viola Limestone of southwestern Kansas is a developing carbonate resource play with significant accumulations of hydrocarbons. The Viola surface is an unconformity, and production comes from regions of preserved dolomite on paleo-topographic highs. Evaluation of a cored interval of the upper Viola recognized several distinct facies, which were examined in conjunction with detailed well log analysis and X-Ray Fluorescence analysis to recognize facies control on Viola production. Five major facies were determined by petrographic analysis and core examination, labeled cherty dolomite, intraclastic breccia, intraclastic rudstone, bioclastic grainstone, and muddy dolostone. The depositional environments of the facies were interpreted to be a shallow marine environment, ranging from low to high energy, with the cherty dolomite and muddy dolostone facies being low energy, and intraclastic breccia, intraclastic rudstone, and

bioclastic grainstone facies as high energy. Wire-line log signatures differentiated the A, B, and C zones and cherty dolomite facies in Rich C #7 and correlate easily with other Viola-producing wells in south-central Kansas. The well log facies can be identified from NPHI, DPHI, and sonic log signatures and are discriminated by cross plots of this log data. The chemical data from the XRF machine partly discriminated well log facies and some described facies using specific elemental signatures and ratios. All the well log facies and the cherty dolomite, rudstone, and muddy dolostone petrofacies were discriminated from plotting Si versus Al, Si/Al versus Ti, Si/Al versus Zr. P-Wave velocity measurements exhibited correlations to the NPHI, DPHI, and sonic log values of Rich C #7. The B zone correlates with the P-Wave velocities, with the cherty dolomite facies being discriminated by the velocities. This study illustrates the advantages of correlating depositional facies with reservoir quality and linking specific reservoir petrofacies with well log signatures, ultimately to create a greater understanding of the controls on reservoir quality to aid in predicting new areas of exploration.

Franek Hasiuk -- 3D Printing Kansas Geology: Methods and Models for Increasing Understanding and Engagement with Kansas Geology

3D Printing as a technology has matured to the point where 3D printers are becoming more commonplace in both work and educational environments. For less than a thousand dollars, reliable 3D printers can be purchased that can serve as a passport to the non-experts making three-dimensional models. Geologists regularly use and produce three-dimensional data, and these data are becoming more and more accessible to the broader public allowing them to be used in decision making at all levels of government, in business planning, in student projects, in legal proceedings, and in art pieces.

This presentation will show example 3D printed models of Kansas geology including: topographic maps derived from a variety of spatial datasets of differing resolution (e.g., LIDAR, USGS NED, SRTM, ETOPO1) to show how 3D printed models can augment traditional mapping products; stackable models of Kansas stratigraphy (e.g., Cenozoic/Mesozoic/Paleozoic/Precambrian) to show the morphology of state-wide stratigraphic systems; models of subsurface oil and gas reservoirs to show the differing configurations of petroleum plays; a model of the high plains aquifer to show its relation to the stratigraphic cover of Kansas; and a model of Kansas aeromagnetic data to show how types of data other than topographic or stratigraphic can be 3D printed. The purpose of these models is twofold. First, the expert geologist can use them to look at their data in a new way. Second, the simple, tactile presentation of a colorful model can allow the non-expert to build familiarity with a concept in a more natural manner than first trying to interpret a topographic map or computer visualization. In this way, 3D printing is a way to both perform and communicate our science in a way that was not available in a cost-effective manner even ten years ago.

Peng Li* and Ciara Mills -- Source Rock characteristics of the Arbuckle-Knox and Elvins Groups in northeastern Arkansas

Cores and cuttings from five wells in the Reelfoot Rift of northeastern Arkansas were evaluated to determine the source rock characteristics of the Upper Cambrian-Lower Ordovician Elvins and Arbuckle-Knox Groups. Samples from the Arbuckle-Knox limestone and dolomite beds exhibit very low (less than 0.10% on average) present-day total organic carbon (TOC), suggesting that it has little potential to be an effective source rock. TOC values of the Elvins shale and siltstone beds are generally low (less than 1% on average) while some fairly good organic intervals with TOC values up to 3.95% are present. Cutting samples with TOC greater than 1.0% were analyzed by Rock-Eval. S_2 shows high variability within the samples, ranging from 0.34 to 26.05 mg/g. The average S_2 value is 4.25 mg/g. HI values vary widely from 31 to 659 mg/g TOC, with an average of 208 mg/g TOC. The ration of S_2/S_3 averages 10.42. Anomalous low T_{max} values (432 ^oC on average) imply that some of the free hydrocarbons are too heavy to be thermally extractable in S_1 peak and therefore

carried over into the S_2 peak. Visual kerogen analysis was conducted on organic-rich, calcareous shale samples from the Elvins Group. The kerogen composition consists mostly of amorphous organic matter with minor solid hydrocarbon and detrital inertinite, which characterizes Type II kerogen. Vitrinite reflectance (R_o) was measured for the samples with occurrence of representative vitrinite, ranging from 3.95% at 7,986 feet to 4.10% at 10,226 feet. Bitumen reflectance (BR_o) values range from 3.95% at 9,080 feet to 4.54% at 11,407 feet, which is equivalent to a R_o range of 4.00-4.54%. Thermal maturity values suggest that samples in the Elvins Group have reached post-mature stage, only producing dry gas. These analyses indicate that the Elvins Group may have dry gas potentials in organic-rich horizons in northeastern Arkansas.

Ciara M. Mills -- Petrographic analysis of diagenetic trends and porosity types in the upper Smackover Formation, southwestern Arkansas

In the subsurface Gulf Coastal Plain of southern Arkansas, the upper sequence of the Jurassic Smackover Formation consists primarily of ooid grainstones, which serve as substantial carbonate reservoirs for hydrocarbons and are one of the primary producers of hydrocarbons in the state. Petrographic analyses of these grainstones provide critical information for interpreting reservoir quality and therefore are useful for hydrocarbon exploration. Thin sections of the upper Smackover Formation taken from cores in seven wells from seven oil fields in Miller, Lafayette, and Columbia counties in southwestern Arkansas were analyzed for trends in primary porosity type and diagenetic features including cementation, dissolution, replacement, and compaction.

Interparticle porosity was present in all seven wells and was the dominant porosity type. However, moldic and intraparticle porosity were common in wells located in the Paup Spur, Midway, and McNeil East fields due to the dissolution of ooids and other allochems. Oomoldic porosity was the primary porosity type for many samples in these wells.

The primary mineralogy of the ooid grainstones was calcite although many samples contained dolomite. All wells contained at least trace amounts of dolomite, but samples bearing the most dolomite came from wells located in the Midway, Kress City SE, Mt. Vernon, and McNeil East fields. Calcite was most commonly found as cement in the interparticle space between grains. Carbonate rim cements were present in all wells, although thickness, grain size, and mineralogy of these rims varied at depth within each well. Coarser grained sparry calcite cement occurred in the Kress City SE, Mt. Vernon, Walker Creek, and Atlanta fields and syntaxial rim cement was found in samples from the Mt. Vernon and Atlanta fields.

Further analyses of these samples will reveal a more detailed diagenetic history of the upper Smackover Formation as well as whether differences in porosity preservation and diagenesis are related to depositional environment or post depositional processes such as cementation history.

Stephan C. Oborny*, Bradley D. Cramer, Carlton E. Brett -- Chronostratigraphic recalibration of the upper Silurian Salina Group (Big Lime) of the Appalachian and Michigan basins

Upper Silurian Salina Group strata (Big Lime) in the Appalachian Basin have undergone extensive chronostratigraphic recalibration in recent years, in some cases by more than a stage. Until now these improved calibrations remained limited to surface outcrops and/or cores that were distal from existing datasets therein preventing the coupling of these data with subsurface models and inhibiting the precise application of time-stratigraphic approaches to these strata throughout the region. Here, we combine pre-existing and new high-resolution integrated conodont and carbon isotope ($\delta^{13}C_{carb}$) biochemostratigraphic and subsurface geophysical data from the Appalachian Basin. These combined data

provide chronostratigraphic constraints for the salt-bearing units of the Appalachian and Michigan basins, units that are critical for hydrocarbon exploration. Additionally, the synthesis of new and pre-existing data provides improved temporal constraints on sedimentation rates, tectonic models, water-mass mixing, and onset of restricted circulation in the Appalachian Basin.

Oluwole Okunromade*, Eugene Holubnyak, Edward Peltier -- Preliminary Evaluation of Carbon Dioxide-Enhanced Oil Recovery (CO2-EOR) in Kansas Oil Fields

The successful use of carbon dioxide as a tertiary recovery mechanism has grown rapidly in the oil industry to combat global warming. Many mature oilfields in Kansas are currently in the late stage of water injection, making them good candidates for CO_2-EOR. However, several assessments need to be carried out to determine their suitability for this technology. The Kansas Geological Survey (KGS) online database contains a compilation of geologic and engineering resources required for the evaluation of oilfields in Kansas. This database contains well data, secondary recovery and pressure maintenance records, which is the foundation for majority of this work.

The major goal of this study is to provide preliminary assessment of various oilfields in Kansas and identifies oilfields with the potential for CO_2-EOR by applying cutoff parameters such as reservoir depth, API gravity, cumulative oil production and CO_2 miscibility. From an initial selection of 486 fields, 11 oilfields were grouped under Tier 1 because they are suitable for miscible CO_2-EOR. 16 fields are classified under Tier 2 since they contain reservoirs with pressures slightly lower than the estimated minimum miscibility pressure. All selected fields are then ranked based on production data to lay the groundwork for further screening criteria and limitations such as economics, proximity to CO_2 source, infrastructure and unitization.

Joseph Orso*, Franciszek Hasiuk, Bob Dawson -- New Approaches for Well Cutting Analysis: Rig-Site Water Intrusion Porosimetry (R-SWIP) and Dynamic Particle Size Analysis

Characterizing the petrophysical properties of reservoir facies, specifically microporosity, is essential in assessing the producibility and risk involved with individual assets. Currently, directly quantifying porosity of well cuttings requires utilization of the Gas Research Institute porosimetry method and/or mercury porosimetry methods. Both of which occur after intermediate or complete wellbore emplacement and incorporate analysis within the laboratory setting. However, due to heterogeneity of unconventional target formations such methods may not result in optimal emplacement of individual wells.

As a result, well site petrophysical methods may significantly aid in real-time drilling guidance and result in more efficient and economic execution of drilling programs. Through this study, a water intrusion porosimetry method was employed to analyze the porosity of dry well cuttings at a constant water pressure of 200 psi (1380 kPa). Through analyzing cumulative water intrusion, an effective porosity of the reservoir rock is assessed. This testing procedure is simple, quick, and non-hazardous toward cutting samples.

To determine certain constraints with this procedure (i.e., cutting angularity, shape, and size), a particle image analyzer was utilized. The Camsizer P4 particle size analyzer is capable of determining particle properties (i.e., width, length, sphericity, aspect ratio, convexity, symmetry, and roundness) of granular materials via image analysis. Not only can this device be beneficial for determining well cutting particle size for petrophysical characterization, but it may also provide information on cutting diagenesis associated with highly destructive bits, and provide an estimation on bit wear. Through combining these methods within the field, a holistic, “field capable” set of petrophysical analyses may provide

better estimations of reservoir porosity and current bit wear to ensure the most efficient and producible wellbore emplacement.

Sean Polun*, Tandis S. Bidgoli, Francisco Gomez, Esmail Ansari -- Monitoring injection-induced surface deformation in the US midcontinent with interferometric SAR (InSAR): New methods for assessing induced seismicity

Deep reservoirs are often targeted for injection of brine and hazardous/nonhazardous wastewater as well as for injection associated with enhanced oil recovery (EOR) and CO_2 storage. In Kansas and Oklahoma, the Cambrian-Ordovician Arbuckle Group saline aquifer is the primary reservoir used for injection, despite recent increases in earthquakes that have been linked to large volume injection operations. Monitoring these operations is complicated due to the large number of wells and potential for pressure communication between densely spaced injection sites. Additionally, while UIC (Underground Injection Control) Class I (hazardous and non-hazardous waste injection) wells are strictly monitored by state and federal agencies, injection volumes for Class II wells are self-reported and often rely on oil production figures and estimated oil-water ratios. Thus, the accuracy of the reported wastewater injection volumes at some sites in questionable. Interferometric Synthetic Aperture Radar (InSAR) is a powerful tool for monitoring ground deformation associated with earthquakes, volcanoes, landslides, and different anthropogenic activities, and can be utilized to for surface deformation surrounding injection sites. We are using C-band (~5.6 cm wavelength) Sentinel-1 SAR data to observe areas in central Kansas that have large numbers of Class I and II injection wells to explore for signatures of surface deformation. These observations are integrated with a comprehensive 3D reservoir-geomechanical model for the region, as well as regional seismicity to look for patterns. We are able to demonstrate coherence across multiple months and observe potential deformation signatures, despite the pitfalls that surround InSAR processing in the midcontinent (decorrelation across the growing season, severe weather, etc.). With elastic source modeling, it is possible that InSAR-based approaches will constitute a viable methodology for future monitoring of injection operations throughout the midcontinent.

Luke Rijfkogel -- Incorporating seismic attributes, well-logs, and computer tomography scan for porosity prediction of a 3D seismic survey, Wellington Field, Kansas

The dependence of elastic properties especially on litho-petrophysical properties provides tangible opportunities for seismic hydrocarbon-reservoir characterization. In the case of carbonate reservoirs, porosity is the main controlling parameter on seismic P-wave velocity. Our goal is to establish both seismic facies identification, classification, and build an understanding of the porosity in terms of both volume fraction and pore-surface area and its impact on seismic amplitude especially bandwidth, peakedness, and energy. A 3D seismic data set, well-logs and core samples, are utilized to validate an observed linear relationship of acoustic impedance and porosity from well-logs. The linear relationship that porosity has with impedance allows for porosity prediction. Core samples will be utilized for CT-scans to image and understand carbonate porosity architecture and be a proxy for the impact of petrophysical controls on seismic amplitude (impedance). We achieved a reliable porosity prediction of the reservoir facies on Mississippian carbonates that will enable improved reservoir and fluid replacement modeling.

Chanse J. Rinderknecht* and Franciszek J. Hasiuk -- Deciphering the paragenesis of the calcite microcrystals that host microporosity in limestone oil reservoirs from highly spatially resolved imaging and geochemistry

Microporosity is common in conventional and unconventional carbonate reservoirs and can host significant hydrocarbon reserves. Microporosity can complicate reservoir recovery efficiency, cause inaccurate hydrocarbon reserves estimates, and produce high-water saturation measurements on wireline logs. The microcrystals that host microporosity increase reservoir surface area and thus play an important role in fluid flow dynamics and hydrocarbon recovery.

Geochemical data suggest that these calcite microcrystals are an abiotic precipitate (i.e., cement). Over the last forty years, the paragenetic history of calcite cements has been deciphered through careful petrography and geochemical analysis of calcite macrocements. Here we endeavor to apply the same methods at the microscale using highly spatially resolved imaging (scanning electron microscopy) and geochemical analysis (energy dispersive x-ray spectroscopy). If calcite microcrystals are zoned, it could mean that bulk geochemical analyses are not reflective of the chemistry of limestone reservoir pore surfaces, which may result in inaccurate prediction of reservoir wettability as well as affect the design of the chemical compositions of water floods.

Preliminary data from a depositional chalk shows geochemical zonation with respect to the Mg/Ca ratio suggesting a multi-stage precipitation of microcrystals. Chemistries range from <1 to approximately 25 mmol/mol Mg/Ca. No evidence of aggressive dissolution textures was observed. Ongoing research is targeting several other conventional limestone oil reservoirs to test hypotheses concerning zonation in crestal (oil-leg) and flank (water-leg) wells.

Abbas Seyedolali*, FNU Suriamin, William Full, Matthew J. Pranter -- Provenance and diagenesis of the Mississippian Meramec STACK rocks in north-central Oklahoma, USA

The origin and diagenesis of mixed siliciclastic-carbonate rocks of the Mississippian Meramec STACK reservoirs are poorly known and critical to reservoir development. This study investigates these concepts relative to porosity and permeability via a combination of core and thin-section characterization, image analysis, Scanning Electron Microscope (SEM) and Electron probe micro-analyzer (EPMA)-cathodoluminescence (CL) analyses.

The above observations combined with log analysis, sedimentary structures and ichnofossils from five cores resulted in the delineation of eight major lithofacies (rock types) associated with a wave-dominated near shore system. Based on observed diagenetic features, reservoir quality is hampered extensively by calcite cement, quartz cement, clay authigenesis and Fe-dolomite. A paragenesis schema illustrates that Fe-carbonate is the latest authigenic mineral formed whereas quartz cement is attributed to earlier diagenesis. The CL characteristics of quartz silt grains suggest derivation from a complex source terrain that includes igneous, metamorphic and reworked sediments consisting of quartz primarily in the coarse silt size range. Based on healed broken volcanic quartz grains by quartz cement, the presence of metamorphic rock fragments, and abundant carbonate allochems, the hinterland was nearby. Local sources of this material include metamorphic and associated igneous rocks that are prone to alter and generate coarse silt-size quartz grains including rhyolite, andesite and dacite; plutonic rocks like granite, diorite, monzonite, or high-grade metamorphic rocks like gneiss. Multivariant analysis of XRF data from two cores indicates a statistical relationship with lithofacies. The source of the silt grains is likely the Wichita/Arbuckle Mountains which have similar mineralogic and physical characteristics as Meramec terrigenous clastics.

Valerie Smith*, R.M. Joeckel, Joel Main -- Lansing-Kansas City Correlations from Outcrop Belt to Red Willow County, Nebraska.

The Integrated Midcontinent Stacked Carbon Storage (IMSCS) Hub Project is seeking CO_2 storage opportunities in saline zones that are vertically stacked with potential EOR reservoirs in oil-bearing carbonate strata. It has renewed interest in the Pennsylvanian Lansing – Kansas City groups (LKC), a regional succession of interbedded carbonates and mudrocks. Reservoir characterization efforts are in progress along the Cambridge Arch and the Central Kansas Uplift. Lithostratigraphic correlations, however, have been confounded by the existence of two different zonal lettering conventions used by petroleum-industry operators, one in Nebraska (zones A-F), the other in Kansas (zones A-L). To address these ambiguities, a regional well section has been prepared that traces these Pennsylvanian LKC formations

eastward to their outcrop belt in eastern Kansas (and, to a lesser degree, southeastern Nebraska) where the units were formally named.

Mudrock and carbonate successions are clearly recognized in log response and generally fit into a transgressive – regressive model associated with cyclic deposition related to late Paleozoic Gondwanan ice ages and sea-level change. This research correlates named LKC formations in the study region while noting their letter designations. The well section includes wells found in the literature where formation names and letters have been used along with annotations of differences where applicable. This work serves as a valuable key for unlocking correlation challenges among existing wells and their legacy LKC top picks while facilitating reservoir characterization efforts, especially when comparing storage options across state lines.

Kevin J. Toth -- Influence of Structure on Mississippian Paleotopography and Distribution of the Pennsylvanian Red Fork and Lower Skinner Sandstones in Parts of Noble, Pawnee and Osage Counties, Oklahoma

Valley filling sandstones of the Red Fork and Lower Skinner sequences in parts of Noble and Pawnee counties, Oklahoma, have linear distribution patterns that (1) differ from regional sediment dispersal systems and (2) result in the stacking of reservoirs. Middle Pennsylvanian (Desmoinesian) Cherokee Group sandstones, including the Red Fork and Lower Skinner, are dominantly low-energy, channel-filling sandstones that have produced large volumes of oil and gas since their discovery in the early 20th century. The sandstone-bearing channels that are the focus of this study are highly elongated and narrow, contain thick accumulations of sandstone, and unexpectedly stacked, observations that prompted the hypothesis that accommodation was generated along the same trend across a span of geologic time long enough to encompass two depositional cycles. The distribution of these narrow channel-filling sandstones can be difficult to map using wireline log control. Furthermore, if the orientation of these channels was influenced by faulting, these faults are not recognized in structure and thickness maps constructed from wireline log data. A 3-D seismic volume across part of the study area provided the interwell data necessary to delineate faults that influenced paleotopography and drainage patterns during Cherokee deposition. We propose that lowstand erosion favored the fault-influenced topographic lows, generating valleys that subsequently filled during transgression. The fault trough is especially evident at the contact between the Mississippian carbonate section and the overlying Pennsylvanian siliciclastics, evidence that seismic could provide an additional exploration tool to locate lucrative, but elusive Pennsylvanian reservoirs.

Christian Tucci*, Abdelmoneam Raef, Matthew Totten -- Seismic Processing Workflow for Maximizing Quality Control of 2D and 3D Seismic Data in Ellis County, Kansas

In the acquisition of 2D and 3D, the seismic workflow builds and formats the prestack data by seeking to improve the signal-to-noise ratio and situate cables and channels correctly in three-dimensional geometry. The quality control of the seismic workflow and its inherent steps is important in assuring that this signal-to-noise ratio is optimum for seismic interpretation. By improving the seismic processing workflow and establishing valid quality controls, native seismic data will be improved in varying degrees. These steps include data input, assigning geometry, dynamic corrections, velocity modeling, statics corrections and stacking. By addressing these facets and quality controlling each one, the native data will be improved in such a way that seismic interpretation and all attribute analysis will yield more accurate results. By building each quality control iteration to be as robust as possible, many problems are mitigated and even elucidates unforeseen problems that can then be moderated. Following this built workflow, the dataset that used for this thesis was wrought with issues that were then rectified to supply a post stack solution to be interpreted. Not only can this workflow create an improved post stack from prestack, but the workflow allows for accurate correction of previously interpreted post stack data with steps that use surface static correction modelling. The impact of this research builds a

model for remedying problems built into each unique native dataset. This research seeks to further the knowledge about seismic data processing and the steps associated with improving the quality of data.

Molly Simpson Turko* and Shankar Mitra -- Regional Structural Styles in the Wichita Uplift and Anadarko Basin, Southern Oklahoma

Regional structural transects across the Wichita uplift and adjacent Anadarko Basin show the relationship between thick-skinned basement-involved structures and thin-skinned detached fold-thrust structures. Slip from the basement-involved structures in the Wichita uplift is transferred along two major detachments into the Anadarko basin. Along the southwestern margin of the Anadarko Basin, the Wichita uplift is marked by a zone of frontal imbricates forming a triangular wedge with most of the slip dissipated along the Wichita front. Paleozoic units show tight folding with overturned beds in the frontal zone. The uplift is episodic as indicated by the truncation of major faults along unconformities and their subsequent reactivation. In contrast, the southeast margin shows that a significant part of the slip is transferred into structures in the basin. These structures are tight faulted-detachment folds that formed above a major detachment within the Springer shale, cored by broader structures detaching at the base of the Arbuckle Group. Examples include the Carter-Knox, Cement-Chickasha, and Cruce structures. Oblique faults with normal and strike-slip components cut some of these structures, resulting in more complex geometries. Pre-existing normal faults of Precambrian-Cambrian age were either reactivated along the Wichita uplift, or controlled the location of the Pennsylvanian age structures in the Anadarko basin. Reorientation of regional stresses from NE-SW to a more ENE-WSW direction during the Pennsylvanian uplift may have influenced the tectonic history of the area. 2D and 3D seismic, well log data, and surface geology were used to evaluate the structural styles and development of the Wichita uplift.