TEXAS TECH UNIVERSITY
College *of* Arts & Sciences

Department of Geosciences

Department of Geosciences
Texas Tech University
Research Day 2013

Welcome to the Department of Geosciences 2013 Research Day.

This volume presents almost 50 abstracts that give a tremendous overview of the spectrum and diversity of research in the Department. It should also be noted, and point of pride, that there are contributions from >20 undergraduates, who are involved with almost every area of active research pursued within the Department. The Department's long-standing support and commitment to undergraduate research is a tremendous credit to everyone.

As with previous years we welcome a few visitors and special guests. Some guests, such as Steve Henderson (Halliburton) are returnees, and Steve's assistance in evaluating the Petrophysics posters is greatly appreciated. There are also some new guests this year and I would like to highlight the contribution from Sanders, Wiebe and Wilson, who are joining us from Whiteface Consolidated Independent School District. Their poster is part of a STEM enrichment program, which included visiting the GeoAnalytical laboratories, and under the mentorship of Dr. Melanie Barnes, preparing, processing and analyzing a series of agricultural samples for arsenic. The students have been selected to represent Texas and the Southwest Region of the United States in the National Finals of the eCYBERMISSION 2013, a web-based STEM competition for students working to solve problems in their community. I hope that Hudson, George and Brett enjoy their time with us today, and wish them well on their trip to the National Finals event. I hope that they are inspired to pursue further educational and research opportunities in science.

The Geoscience Society continues its generous sponsorship and support of Research Day through the provision of coffee and cookies in room 230, and (the now traditional) Rudy's BBQ lunch. (Served in room 201 (Structure Lab) from 12:30 onwards). Everyone who enjoys the feast is invited to make a small contribution – just a dollar or two – that will be donated to the Sigma Gamma Epsilon Geosciences Society Scholarship fund. Continuing to develop scholarship funds will help recruit and support students in the future who are the life-blood of this event.

Finally, thank you to everyone, presenters and viewers, for coming along to participate in the event. I hope that everyone enjoys the morning and is inspired for their upcoming summer of research.

Callum J Hetherington

Petrophysical Analysis of the Avalon Shale of Southeastern New Mexico.

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Applying petrophysical analysis techniques to acquired digital log data from the Avalon shale permitted the determination of intervals that were optimal for horiztontal well drilling as well as other important pretrophysical parameters. The petrophysical parameters include the thermal maturity index (MI), total organic carbon (TOC), original oil in place (OOIP), volume of kerogen (Vke), water saturation (Sw), mineral brittleness index (MBI), and effective porosity (Φe). Economic analysis was also performed where the recovery factor and gross/ net revenue were calculated. The Avalon shale is a Permian age formation located in southeast New Mexico that has produced both oil and natural gas.

The Josephine Ophiolite: A Microstructural Analysis of Chrome Ridge and Illinois River areas, Southern California and Northern Oregon.

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The Josephine Ophiolite represents Jurassic oceanic lithosphere and contains one of the largest peridotite masses in the world, exposed over 900 km^2 in northern California and southern Oregon. This research reports new structural and lithologic correlations between the Vulcan Peak region and the Illinois River section of the peridotite. Previous studies in mantle peridotites exposed in other ophiolites have shown that structures in the mantle sequence of ophiolites may represent processes associated with magma emplacement in the overlying crust, lithospheric plate separation, and drag from underlying upwelling asthenosphere. To determine the processes that generated high-temperature structures in ophiolite peridotites, geometric and kinematic associations need to be made between crustal and mantle structures. Geologic mapping and oriented samples were collected in the Klamath Mountains, Chrome Ridge region. Oriented samples of dunite and harzburgite were collected and were cut perpendicular to foliation and parallel to lineation, where apparent. The mineralogical and textural characteristics of the samples were studied by optical microscopy. The samples are dominated by inequigranular polygonal to interlobate, coarse porphyroclastic, kink-banded olivine crystals. A coarse, porphyroclastic texture is a product of asthenospheric deformation at high temperatures (≥1200°C). This, with ubiquitous kink banding, and recrystallization forming small polygonal olivine grains found throughout the samples, support the interpretation that the rocks in the Chrome Ridge and Illinois River areas underwent high-temperature penetrative deformation probably due to asthenospheric flow in the mantle beneath the Josephine ridge axis. Such a tectonic setting is consistent with the required high temperatures to create the fabrics and structures observed. Foliations and lineations in samples collected for this study, however, do not parallel those measured in previous studies in the Vulcan Peak region to the southwest. This may be due to intervening, younger faults that have rotated and or translated the Chrome Ridge and Illinois River map areas.

The Importance of Organoporosity [Φ om] versus Mineral Matrix Porosity [Φmm] in Organic-Rich "Shale" Reservoirs using the Maxwell-Garnett Equation and Shaly Sandstone Producibility [Q] Plots

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In analyzing unconventional organic "shale" reservoirs it is important to determined from conventional petrophysical logs which is the dominate pore type organoporosity (Φom) or mineral matrix porosity (Φmm). It is important because Loucks and others, 2010 have reported the following about the pore sizes of the Φom versus Φmm (InterP & IntraP): Approximate RangeInterP (Φmm): 30 – 2000nm IntraP (Φmm): 10 – 1000nm
OM (Φom): 5 – 750nm

The Maxwell-Garnett Equation is designed to model the low frequency current response in a mixture of spherical pores (vugs) imbedded in finer matrix pores. In an organic shale reservoir the kerogen (Sw in Φom = 0.0) fragments like the hydrocarbon filled vugs (Swvug = 0.0) are insulators imbedded in a conductive matrix (Φmatrix or Φmm). Remember the electro-magnetic wave can only travel through porosity containing water. In order to apply the Maxwell-Garnett Equation to a organic shale reservoir the amount of each porosity (Φom and Φmm) must be separated. The procedure is listed below: Φtotal, volume of clay (Vcl), and volume of kerogen (Vke) are obtained using the bulk density (Φb) and neutron (ΦNls) porosity logs, utilizing the simultaneous equation method developed by Rick Lewis with Schlumberger. Effective porosity (Φe) = Φtotal – CBW CBW = Vcl x Φ clay, where Φom = Vke x OM Φmm = Φe – Φom and OM = porosity in the kerogen [OM = 0.30]

Two organic shale were selected the Devonian Woodford [gas] in Oklahoma and the Permian Avalon [oil] New Mexico. In both the Woodford and Avalon the resistivity calculated by the Maxwell-Garnett Equation (Rtcalc) matched the log resistivity (Rtlog) when the water saturation (Swmm) of the mineral matrix porosity (Φmm) was calculated, however if Swmm = 1.0 was assumed Rtcalc did not match Rtlog. Which indicates that both Φom and Φmm are hydrocarbon-bearing. In the Woodford there were very few zone where Rtcalc did not match Rtlog when Smm = 1.0, which indicates Φmm is the dominate pore type. In the Avalon over most of the entire interval Rtcalc did not match RtLOG when Smm = 1.0, which indicates Φmm is the dominate pore type. Woodford OGIPscf/640acres using a 100nD permeability cut-off by pore type was Φom = 8.5BCF/sec and Φmm = 0.9BCF/sec, and the Avalon OOIPstb/160acres using a 100nD permeability cut-off by pore type was □om = 13mmbo/160acres and Φmm = 17mmbo/160acres.

How would these two organic shale reservoirs plot on a Shaly Sandstone Producibility (Q) Plot? A Q Plot is a triangle cross plot of effective porosity (Φe) X –Axis versus Q [(Φtotal –

Φe)/Φtotal] Y- Axis. Therefore Φe represents the amount of porosity free of clay (Φe) and Q represents amount of porosity filled with clay. On the Q Plot there is a line below which is shaly sandstone reservoir and above which is non-shaly sandstone reservoir. This line separating shaly sandstone reservoir from non-reservoir is based on field data from U.S. Gulf Coast, New Mexico, Colorado and Wyoming. When plotted on a Q-Plot the Woodford data plot on or above the shaly sandstone reservoir line. Much of the Avalon data when plotted on the Q-Plot, plots well below the shaly sandstone reservoir line. The very important question is why is so much of the Avalon data below the line; could it be because the Avalon contains more (Φmm) porosity with larger pores (Remember: Loucks and others, 2010).

Petrophysical Analysis of Permian Avalon Shale, Eddy County, NM

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The Permian Avalon (Leonard) Shale is an unconventional petroleum play in the Delaware Basin within the larger Permian Basin. The Avalon Shale is part of the Bone Springs Formation and is an interlayered shale and shaly-sandstone unit with a thick limestone layer separating the Upper Avalon Shale and the Lower Avalon Shale. The goal of this project was to evaluate well #1-5339 of the formation and decide where to place the first horizontal well using the provided log data for the depth interval 7500-8270 ft. The provided and calculated data was used to create plots of depth vs. resistivity, porosity, gamma ray, photoelectric factor, lithology, mineral brittleness index (MBI), and total organic carbon (TOC) in Microsoft Excel. Well placement was decided by performing an economic analysis and a log analysis using these plots.

Based on the log plot data and the economic analysis results, the Upper Avalon Shale was selected for placement of the first well. The porosity log indicates that many zones in the lower interval are below the cutoff for acceptable porosity. The upper interval also has more regions in the "very good" range of the TOC chart and past the pay cutoff of the permeability chart. The first well will placed at a depth of 7586 ft in the Upper Avalon Shale. This depth was selected because it is less shaly than other producible depths in the upper interval, based on analyses of the porosity and MBI charts.

The original oil in place (OOIP) was calculated individually for porosity in the organic matter (organoporosity) and the porosity in the mineral matrix. The maximum net revenue possible was calculated to be $23 million for the upper interval (~460,000 barrels of oil) and $20 million for the lower (~410,000 barrels of oil), using a recovery factor of 3% and assuming a price of $85/barrel of oil.

Carbonate Stable Isotopes from Soil Cores from Playa Lakes, Southern High Plains, Texas

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The Southern High Plains is a large plateau that experiences little net erosion and contains numerous playa. These playas are particularly useful in recovering paleoclimate information because of their sensitivity to changes in the precipitation and temperature due to their transitory nature and small size. Here we present isotopic data from soil carbonate recovered from buried soils within core samples from playa lakes on the Southern High Plains.

Two to three buried soils were recognized in four cores recovered from playas in Bailey and Floyd Counties. The oldest buried soil is an aridisol estimated between 30-40 ky. The second buried soil is an inceptisol estimated around 21 ky. The third buried soil is characterized as a mollisol and estimated at 11 ky. The top of the cores represents the modern mollisol common in the region.

Cores were sampled at 10 cm intervals for $CaCO_3$ contents and stable isotope analyses. The percentage of $CaCO_3$ varied throughout core samples from 0.01% to 1.0% to greater than 5.0% dependent upon the specific soil horizon. Inorganic oxygen isotopes from the Bailey Playa cores show a broad range from -4 to -13‰ whereas the Floyd Playa data ranges from -4 to -9‰. The large ranges in $\delta^{18}O$ values from individual soil horizons indicate that the soil carbonates did not form under uniform climatic conditions, but rather indicate varying meteoric water influence. $\delta^{13}C$ values of soil carbonate range from an average of -6.5‰ at the bottom of the cores to -21.1‰ in the first buried mollisol soil, such that each individual paleosol provides a lower average value than the paleosol below. This decreasing upward trend in the $\delta^{13}C$ values can be explained as an increase in contribution of carbonate from organic sources rather than atmospheric CO_2. We relate this trend to an increase in vegetation through time resulting from a decrease in aridity upward as shown by the soil progression of aridisol—inceptisol—mollisol.

West Texas and Eastern New Mexico Precambrain Basement Revealed

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Seismic interpretations, U-Pb zircon ages, and geochemical and isotopic analysis from the last decade combined with earlier information, provides a geologic framework for the Precambrian basement of west Texas and eastern New Mexico. Much of the crystalline basement documents voluminous, episodic magmatism that is a key component in the development of southern Laurentia. This complex history involves at least four major magmatic events and at least two periods of basin development from 1.49 to 1.07 Ga. The Texas Panhandle Precambrian basement consists of quartz monzonite, granite, rhyolite, and quartz syenite that can be divided into separate

periods of magmatism at ~1.47 and ~1.37 Ga and may extend as far south as the Carrizo Mountain Group near Van Horn (1.33 Ga). Sm-Nd isotopic signatures indicate that these magmas had similar source regions.

From 1.28 to 1.22 Ga, a broad, carbonate-dominated shelf, known locally as the Debaca sequence, extended throughout the region from the Llano Uplift in the southeast to the wetern Grand Canyon regions. Well log data coupled with seismic data and deep crustal reflection data image large basins with cross-cutting sill. Outcrop and well data support the presence of associated mafic magmatism, along with episodic rhyolite ash falls wich may be sourced in the Burro Mountains southwestern New Mexico.

About 1150 Ma, after the deposition of quartz-rich sandstone of the Lanoria Formation, renewed bimodal magmatism began and lasted until ~1070 Ma. This magmatic episode was characterized by tholeiitic basalt and alkaline ("A-type") rhyolite/granite, all typical of extensional settings. U-Pb (zircon) dating provides evidence of widespread, Grenville-age (1070-1110 Ma) Plutonic rocks in the Texas/New Mexico basement. Dated samples include alkali feldspar granite of the gabbroic sill in the basement of eastern New Mexico. In addition, evidence of the northwest directed Grenville collisional event is apparent in the deformed nature of rocks located in the southern most part of the Laurentian continent.

Correlation of Cyclothems between the Strawn of the Central Basin Platform, West Texas and the Desmoinesian Stage (Pennsylvanian) of the Mid-Continent Region

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In their paper, "Effects of Long Term Accommodation Change on Short Term Cycles, Upper Paleozoic Platform Limestones, West Texas", Saller et al. (2009) subdivided the Strawn facies of cores from three Unocal project wells, located in the Central Basin Platform of West Texas, into a series of cycles. Although they proposed that the Strawn cycles were eustatic in origin, no attempt was made to correlate the Strawn cycles to other regions in the United States. The purpose of this research project was to determine if the cycles of the Strawn in West Texas could be correlated to eustatic cycles in the Desmoinesian Stage of the Mid-Continent Region using fusulinid and conodont biostratigraphy, and cycle matching. Fusulinid zones of the Strawn interval of Unocal cores, reported by G. Wilde, were matched with the Midcontinent fusulinid zonation. Conodont faunas of the Strawn in the Unocal cores, collected by J. Barrick, were compared with Midcontinent conodont ranges identified in the Desmoinesian by Boardman et al. (2004). After a preliminary biostratigraphic alignment between the West Texas Strawn section and the Midcontinent Desmoinesian section was made using the conodonts, the numbers of cycles in each region were compared. The number of cycles in upper Strawn (fusulinid zones DS-3 and DS-4) is comparable with those in the lower and upper Marmaton Group (upper Desmoinesian) of the Midcontinent Region, suggesting a common eustatic origin. However, whereas the lower Strawn in the Unocal cores comprises only two major cycles the equivalent Midcontinent Cherokee Group (DS-1 and DS-2; lower Desmoinesian) of the Midcontinent Region contains as many as 20 supposedly eustatic cycles.

Use of Ensemble Sensitivity Analysis in the Forecasting of Convective Events

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The recent increase in the use of ensemble forecasts has led to new information being available to forecasters, including uncertainty statistics and probabilistic guidance. Various techniques have been used to generate ensembles, one of them being the Ensemble Kalman Filter (EnKF), which produces analyses and subsequent forecasts that represent a probability distribution of the atmosphere with flow dependent errors. Ensemble Sensitivity Analysis (ESA) is an ensemble-based method that estimates the sensitivity of a longer-range forecast to early forecast or initial time weather features. In turn, this type of sensitivity analysis provides additional information from an ensemble that can highlight important dynamical relationships and can be used to increase forecaster awareness.

Previous work in this area has been primarily focused on synoptic-scale weather which involves mostly linear perturbation evolution at the 1-2 day forecast range. This study focuses on developing ESA within a multi-scale WRF model EnKF for severe convection, which is more influenced by nonlinear perturbation evolution and has a binary nature. Three model domains are used with grid spacing of 36, 12, and 4 km. Data assimilation is performed on all three domains, and a short range ensemble forecast is produced for each. Results applying ESA to an April 2012 convective event will be shown. Through real time sensitivity products, increased forecaster awareness and objective selection of sub-ensembles with higher skill can be accomplished. Also, adaptive observing systems can be designed to best reduce forecast uncertainty. Discussed will be how these applications of convective ESA can be used in an operational setting.

Correlation of the Rogue Volcanic and Chetco Intrusive Complex in the Klamath Mountains, SW Oregon

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The Rogue-Chetco magmatic complex, SW Oregon, is a suite of extrusive and intrusive magmatic rocks in the Klamath Mountains. The Rogue Formation is a low-grade metamorphosed, succession of porphyritic lavas, pyroclastic rocks and volcanogenic sedimentary rocks that have been metamorphosed to epidote + chlorite. The Chetco Complex is a composite plutonic complex that was suggested to be the intrusive equivalent of the Rogue volcanic rocks. This hypothesis is tested using major and trace element bulk rock compositions, and comparison of trace element compositions of augite between intrusive and extrusive samples.
Whole-rock compositions of Rogue Formation lavas indicate that these rocks are tholeiitic basalts extruded in an island arc environment. Augite phenocrysts are well preserved in the rocks. Plagioclase phenocrysts (An91-72) are commonly altered to sericite.

The Chetco Complex consists of a quartz hornblende gabbro (Red Dog Creek gabbro) and a two-pyroxene gabbro troctolite (York Butte gabbro); both units are intruded by tonalitic dikes. The Red Dog Creek gabbro is characterized by hornblende, biotite, plagioclase (An50-81), quartz, and rare pyroxene. The York Butte gabbro is predominately hornblende, pyroxene, plagioclase (An96-91), and rare olivine. Major and trace element whole-rock compositions indicate that the gabbros of the Chetco Complex are derived from high-alumina arc basalt. Trace element analyses of pyroxene from the Rogue Formation and Chetco Complex are underway and will be reported and compared to test the possible correlation of the two units.

Petrology and Source Area of Pebbles from a Western Outlier of the Ogallala Formation, near Vaughn, New Mexico.

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An erosional remnant of Ogallala Formation sand and gravel is exposed near Vaughn, New Mexico. The gravel contains pebbles of varied sedimentary, metamorphic, and igneous rock types. Most abundant in the gravel are limestone pebbles which, based on their fossil assemblages and partial silicification, were probably derived from Lower Pennsylvanian limestones exposed about 100 km west of Vaughn in the Manzano Mountains. Lithic and arkosic sandstone pebbles are also common, most likely derived from Upper Pennsylvanian or Lower Permian strata, and quartzarenite pebbles are probably derived from nearby outcrops of the Permian Glorieta Sandstone. These strata are exposed in the foothills of the Manzano and Sangre de Cristo mountains, as well as in the Pedernal Hills closer to Vaughn. Metamorphic quartzite and meta-arkose pebbles are also common, and were most likely derived from outcrops of the Proterozoic Ortega Quartzite of the Hondo Group in the southern Sangre de Cristo Mountains. A single granite pebble examined probably came from a Proterozoic granitic intrusion such as the Priest or Sandia plutons exposed in the Manzano and Sandia Mountains. Although the gravel outcrop at Vaughn is one of the westernmost isolated remnants of the Ogallala, left on the western side of the Pecos River; the gravel has pebble types similar to those found in exposures of the Ogallala Formation over 300 km farther east on the Southern High Plains of Texas.

A Pennsylvanian Age for the Fountain Formation constrained by lithologic comparison of overlying eolian units

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The Fountain Formation is poorly dated, but contains basal and upper biostratigraphic control at two different locations. The basal age of early Pennsylvanian is denoted by conodonts recovered at Manitou Springs, Colorado. The upper age of latest Pennsylvanian is denoted by fusulinids recovered north of Loveland, CO. However, at localities south of Denver, CO, the Fountain Formation is often portrayed as ranging into the early Permian largely because it is overlain by an eolian unit previously mapped as Permian Lyons Formation. This lithostratigraphic correlation of the Lyons Formation occurs over approximately 200 km through discontinuous and faulted outcrop. Yet, in northern Colorado, two eolian stratigraphic units occur: earliest Permian Ingleside Formation and slightly younger Lyons Formation. Here we present petrographic, sedimentologic and stratigraphic data that suggests that the upper constraining eolian unit at Manitou Springs more closely resembles the Ingleside Formation.

Near Loveland, Colorado, eolian and fluvial strata intercalate in the upper 50 m of the Fountain Formation before giving way into the predominately eolian Ingleside Formation. This gradational transition from largely fluvial/alluvial to predominantly eolian is also observed to the south at the Manitou Springs locality. Sandstone mineralogy and grain size distributions of the Ingleside Formation mimic the Manitou Springs eolian unit, whereas similar data from the Lyons Formation does not. Therefore, at Manitou Springs, we suggest that the eolian unit atop the Fountain Formation lithologically is best characterized as Ingleside Formation. Barring a significant southerly time transgression for the Ingleside Formation, this proposed change in nomenclature further suggests age control from the north can be used to constrain a minimum age for the Fountain Formation. Thus, an entirely Pennsylvanian age for the Fountain Formation is proposed.

Relationships Between Xenoliths of the Wooley Creek Batholith and surrounding Host Rock Terranes, Klamath Mountains, California

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When considering emplacement mechanisms of igneous intrusions, a question still remains: how is space created in the crust to accommodate the magma? One possibility is that, during ascent, the magma breaks off blocks of the host rock it is intruding and that these blocks are the source of xenoliths found within an intrusion. If so, one can conclude that xenoliths should be genetically related to the host rock.

The goal of this work is to quantify a relationship between xenoliths found within the Wooley Creek batholith and host rock terranes in contact with intrusional margins. To do this, three aspects of the xenoliths and host rock terranes were analyzed. First, the mineral assemblage and how it varies between the host rocks and the xenoliths. Second, the bulk rock chemistries of a suite of samples, both xenolith and host rock were collected, using ICP-AES, and then analysed for trends and patterns that might link xenolith samples to a specific host rock region. Third, polished thin sections were used to analyze the rare earth element chemistry of clinopyroxene crystals within xenolith and host rock samples using LA ICP-MS. Again these data were plotted and analyzed for unique patterns.

This study offers a new perspective on how to relate xenoliths to host rocks around an intrusion and validates that trace elements can be useful in quantifying genetic relationships. The results of this study show that while the use of trace element data and petrographic observations can be used to determine probable relationships between xenoliths and host rocks, more information is needed to definitively conclude whether such a relationship exists.

Qualitative Uranium Analysis of Mississippian-Age High Gamma Carbonate, Bend Arch Region, Texas

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Fifty-six (56) feet of core from a productive carbonate interval of Mississippian age in the Bend Arch region of north-central Texas has occasionally higher than expected gamma ray values. Interpretation of the full spectrum gamma-ray log would be attributed to significant shale components in some intervals. However, assaying of spectral gamma-ray logs suggests that the peaks in the gamma-ray values are caused by higher than expected uranium/potassium ratios. Ten core plugs were taken from throughout the core at the approximate intervals that coincide with highest and lowest gamma-ray activity. Aliquots from the core-plugs have been prepared for a sequential leeching procedure (Tessier et al, 1979) that is designed to strip heavy metals, including uranium, from a variety of mineralogical hosts. The initial leach will liberate exchangeable metals from clay and other secondary minerals. A second leaching step will quantify any role between gamma-ray activity and metals bound to carbonates. A third step will release metals associated with iron and manganese sulfides and oxides. Finally, metals that are bound to organic matter will be brought into solution, leaving a residual portion of silicates and other stable minerals.

After each leaching step the concentration of uranium dissolved in solution will be measured by ICP-AES to qualitatively assess the portion of gamma-ray activity represented by each mineralogical category. Results from the Tessier procedure will be compared to whole-rock uranium abundances determined for individual samples by X-ray fluorescence spectrometry. This study will determine if a relationship between high uranium/potassium ratios, mineralogical species, and portion of gamma-ray activity not associated with shale minerals exists and may help guide future field development.

Surface charge and dissolution at the α-Mn_2O_3 – water interface in NaCl media

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Manganese oxides are widespread in the environment and are found in nearly all soils. They are highly reactive and participate in a variety of acid-base, sorption and redox reactions. Their adsorption capacity for heavy metals and toxic contaminants is of particular environmental importance.For example, manganese oxides are used for wastewater treatment and metal remediation. To evaluate the adsorption capacity of these phases, it is necessary to understand the solid-water interface properties of manganese-oxides.

This presentation will outline an experimental study investigating the surface charging and dissolution behavior of α-Mn2O3 in NaCl media. A synthetic α-Mn2O3, end-member bixbyite, is being used. Prior to use in experiments, the bixbyite sample was washed extensively. Washing comprised rinsing in HCl, nanopure water and hydrothermal pre-treatment. The sample was characterized by XRD and SEM, which verified the presence of crystalline bixbyite and no other phases were identified. The surface area of the sample was determined by BET measurement. The sample has a low surface area of < 1m2/g.

Potentiometric titrations are being performed using a Mettlerautotitrator and Ross combination pH electrode. All titrations are completed in NaCl media at ionic strengths of 0.03, 0.06 and 0.3 m, with the temperature controlled at 25 ºC. Titrations performed from acid-base showed considerable variation, arising from dissolution of the bixbyite. Therefore, titrations are completed from base to acid, and samples are withdrawn at acidic pH values. The withdrawn samples are filtered then analyzed by ICP to determine Mn concentrations. The bixbyitehas a pHznpc value between 7 and 8, and a high pH-dependent surface charge.

Effects of the Entrainment of the Free Atmosphere on Structure on Cloud Formation Potential

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The atmospheric boundary layer (ABL) is relatively a thin atmospheric layer that is directly influenced by the earth's surface. During the daytime, the ABL grows up to several kilometers from the ground. For most of our lifetime we stay in the ABL. Thus, many weather-related businesses, such as wind energy, air transportation, agriculture, and air quality control, always need more accurate and detailed information on the ABL. In the ABL, turbulence always exists due to the earth's surface that is spatially and temporally heterogeneous on various scales. In the surface-atmosphere interaction, a different combination of surface and atmospheric conditions results in completely different structure of the ABL, which is a critical determinant of cloud and thunderstorm development [1].

Using large eddy simulation (LES), which can explicitly resolve energy-containing turbulent eddies, we investigate the effects of the entrainment on structures of the convective atmospheric boundary layer (ABL), the daytime ABL, and further on the distribution of relative humidity (RH). Given that clouds start to form when RH reaches 100 % and condensates, a higher RH value implies a larger potential of cloud formation. LES is run with horizontal grid spacing of 50 m over a horizontal domain of 4 km x 4 km. The model top is 2 km, which is resolved with 80 grids. we visualize cloud potential defined with RH > 70 % and also analyse domain averaged ABL structure between simulated ABLs with different initial soundings of potential temperature and water vapour mixing ratio.

[1] Findell, K. L., and E. A. B. Eltahir (2003) Atmospheric controls on soil moisture-boundary layer interactions. Part I: framework development, 4:552-569.

Geologic Mapping using ERDAS and Field Methods Compared, Big Bend National Park, Texas.

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A geologic map of the San Vicente area in Big Bend National Park was created using traditional field methods, and compared with one of the same area generated with use of ERDAS remote sensing software and NAIP aerial imagery. Using the "unsupervised classification" mode of analysis in ERDAS only gross-scale bedrock geologic features were properly identified. Although this method readily discriminated some bedrock units, it did not correctly place the contacts between them. Some resistant ridge-forming units cast strong shadows or had poor image contrast and were not discriminated. Broad areas covered by Quaternary terrace gravels were not recognized as different from the low alluvial deposits; however, the alluvial floodplain areas are shown with great detail. A series of basaltic dikes was not recognized, probably because the width of their exposures was below the resolution of this method of image analysis.

Quantifying the Mineralogical and Compositional Response of Shale Oil and Gas Rocks to Matrix Acidifcation.

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Unconventional oil and gas reserves hosted in shale formations have received a great deal of interest in recent years due to their potential to greatly increase global hydrocarbon production. There are, however, technical challenges to exploiting these reserves that demand many varied techniques for hydrocarbon extraction. A significant challenge is stimulating and maintaining production from shale formations that have low to very low permeability. Hydraulic fracturing stimulation is a broadly applied technique wherein fluid and propent is forced into the rock at high pressures inducing brittle deformation in a rock, thereby increasing permeability. Hydraulic fracturing is commonly preceded by a matrix acidizing pre-flush. The acidizing pre-flush dissolves material resulting in increased porosity. Though the physical effects of the matrix acidizing pre-flush have been quantified, the mineralogical and compositional effects are less well understood. Core-plugs from several well-known shale formations have been halved, and one piece exposed to dilute HCl. Both samples were then crushed, powdered, and mineralogically characterized by X-ray diffractometery (XRD) and the patterns evaluated and quantified by Reitveld refinement. Mass loss caused by exposure to HCl was ~2 %, which based on sample effervescence, was mainly attributed to carbonate decomposition, a conclusion that was loosely corroborated by the XRD. Compositional analyses of the samples by XRF shows that abundances of CaO decreased slightly, while other major element abundances remain unchanged. Thermogravimetric analyses (TGA) will be used to monitor the compositional changes based on carbonate decomposition, as well as the impact of the acid treatment on sulfide and graphite speciation.

Fossil Resource Assessment using GIS in Big Bend National Park, Texas.

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A study was conducted to assess the use of Geographic Information Systems software for fossil resource management issues in Big Bend National Park, Texas. For this test case, a study area on Tornillo Flat in the north-central part of the Park was chosen. Half of the study area consists of exposed bedrock, and the majority of fossil collection sites here occur within the Javelina Formation. Most of the sites occur in distinct clusters at distances greater than a kilometer from paved roads, gravel roads, or primitive campsites. There appears to be a relationship between the occurrence of fossil collection sites and land surface slope angle and slope aspect. Thirty-six of the thirty-nine fossil sites located in the study area occur on slopes between 15 and 25 degrees facing a southerly direction. The southerly dip of bedrock units in the Tornillo Flat area may control this local relationship. Fossils may tend to occur more frequently on the south-facing dip slopes of inclined cuestas or hogback ridges where bedding planes are exposed over a broad area. Bedrock erosion rates, and the physical properties of soil and environmental factors in this area such as vegetation density could also control the rate of exposure and destruction of fossils and play a role in establishing this relationship.

West Texas Lightning Mapping Array Error Analysis using Aircraft Tracks

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All measurements of physical quantities are subject to uncertainty. By understanding this uncertainty, one can make meaningful conclusions regarding the data. On occasion, the West Texas Lightning Mapping Array detects the presence of aircraft. Corona discharge from the tips of the wings as the aircraft flies through cirrus clouds is located in the same manner as lightning. Unlike lightning discharges, the spread in the track is well-constrained. We are able to analyze the array's error estimates by cross-referencing the data we've collected with the data from the aircraft's flight data recorder. In their paper on the accuracy of the Lightning Mapping Array, Thomas [1] use aircraft tracks to characterize the location accuracy. Using data from February 20th, 2012, we replicate their analysis for the West Texas LMA, and compare the errors to those in the published literature for other LMA networks.

[1] Thomas et al. (2004) *JGR* **109**, D14207

Evaluating Predictability of Severe Convection using a WRF Ensemble Kalman Filter.

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While many advances have been made in Numerical Weather Prediction (NWP) over the past few decades, NWP models still often struggle with the initiation and progression of severe convective events. High resolution models are becoming more proficient in accurately predicting severe convection, but more progress can be made. The use of an ensemble Kalman filter

in NWP models is becoming an increasingly popular method of data assimilation. The main goal of this study is to implement an ensemble Kalman filter in the Weather Research and Forecasting (WRF) model to evaluate its usefulness in predicting convective initiation and the downstream progression of severe convective events. Attention will be given to the mean of the ensemble members; specifically, how useful the mean is, when it loses its usefulness in making a deterministic forecast, and how the best member should be determined if strong storm-scale nonlinearity forces the mean off the model attractor. Another area explored here is the evaluation of the ensemble when different sets of physics schemes are employed among the ensemble members. In particular, resulting forecast probabilities will be examined to understand the role of physics uncertainty in the regional-scale prediction of severe convection and convective initiation. Preliminary results and future research goals will be discussed.

Average Winds over Texas and Surrounding States in a Five Week Period.

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As wind energy is becoming more abundant, it is important to examine where the most wind occurs to find the best locations for new wind farms locally in Texas and its surrounding states. This study analyzes the winds over a five week period which starts at the beginning of January 2012 and ends in early February 2012. The wind data will be extracted from the Global Forecast System (GFS) and then run through the Weather Research and Forecasting-Advanced Research (WRF). Then the winds obtained are averaged according to time of day including the overall average, night time averages, and day time averages. These averages are then plotted at different heights, corresponding to the height of a wind turbine, and analyzed to find the best locations for new farms. Further study in this research will show the average winds over multiple years to ensure a more accurate analysis.

Evaluation and Economic Analysis of Permian Avalon Shale, South East New Mexico.

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The Avalon Shale is shale play spanning across a large section of West Texas and Southern New Mexico. The Avalon Shale sits atop the Bone Spring formation in the Delaware Basin in the Permian Basin's westernmost area. In some places, the interval is two layers of shale separated by a limestone layer. The Project was to evaluate the productivity of a well in the avalon shale. First the Maturity Index was evaluated to be 5.77 by Zhao et al.[1] method. Further, the shale above and below the carbonate layer (7751ft – 7941ft) was evaluated for the OOIP. The TOC was found with the help of Schmoker equation. The TOC was used to find the volume fraction of kerogen. And then the volume fractions of carbonate, clay and quartz was calculated. Thus inturn helped in calculating the oil filled porosity and the permiability of the two zones. And by assuming a permeability cut off of k>100nD the Original Oil in Place (OOIP) of both the zones were evaluated. An economic evaluation was performed assuming a recovery factor 3% to find the net revenue for the two zones. On the basis of the productivity evaluation and economic analysis the best zone for placing the lateral section of the horizontal well was determined.

[1] Zhao, H., Givens, N., Curtis, B., Thermal Maturity of the Barnet Shale determined by well log analysis, AAPG Bulletin, Vol. 9, Issue 4, Pages 535-549 (2007)

Properties and Formation Mechanisms of Lunar Rimae Plato

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Lunar sinuous rilles developed as surface conduits for voluminuous low-viscosity lava flows of mafic and possibly ultramafic composition. Three prominent rilles, collectively known as Rimae Plato, are located in the region surrounding Plato crater in the northeastern part of Imbrium Basin. The exposed parts of these rilles range from ~40 km to 250 km in length and ~500 m to 3500 m in width. Though rille floors are as great as 700 m beneath adjacent uplands, channel relief typically decreases with down-channel distance, and the floors of distal reaches ultimately fade into the plains of local terminal basins. As is typical of large lunar rilles, the systems of Rimae Plato are characterized by head regions marked by large topographic depressions, by longitudinal channel slopes of well under 1 degree, and by both U- and V-shaped cross-sectional profiles. Though bedrock outcrops exist along channel walls and the inner flanks of local impact craters, meter-resolution images suggest the widespread mantling of the Plato region by a layer of fine regolith of ~10 m thickness. Models suggest that the flow of lava through the rilles was fully turbulent, with corresponding Reynolds numbers as great as ~5 x 10^5. Mechanical and thermal incision rates for flows with depths of 20 m on slopes of 0.2 degrees are estimated to be ~2.5 m/day and ~1 m/day, respectively. Discharge rates well in excess of 50,000 m^3 are estimated for most of the channels that comprise the Rimae Plato systems, and formation of the largest channels here should have required peak lava discharges of at least several hundred thousand cubic meters per second.

The Source of Paleozoic Limestone Pebbles found in the Ogallala Formation of the Southern High Plains, Texas.

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Paleozoic limestone pebbles found in the Bridwell Member of the Ogallala Formation in Lubbock and Garza counties consist predominantly of wackestones and packstones with mild silicification but no dolomitization. The pebbles contain a fossil assemblage with fusulinid foraminifera, productid brachiopods, phylloid algae, rugose corals, and *Chaetetes*. This fossil assemblage indicates that the pebbles were derived from Pennsylvanian limestones. The most likely source for the pebbles

would have been in the Manzano, Sandia, or southern part of the Sangre de Cristo Mountains in northcentral New Mexico. The lower part of the Pennsylvanian Madera Group in this region consists predominantly of limestone, and may be the source of the pebbles. Detailed examination of the fusulinid foraminifera preserved in the pebbles, may help determine the exact sources within the Madera Group.

Deciphering Early Pennsylvanian Paleogeography of the Ancestral Rocky Mountains in the Taos Trough Region through Soft-Sedimentary Fold Analysis: Sangre de Cristo Mountains, New Mexico.

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The Ancestral Rocky Mountains (ARM) formed a collage of uplifted Precambrian basement rocks (highlands) with intervening sedimentary basins (troughs). Paleogeography of the ARM has been ever evolving. In northern New Mexico, the Taos trough is most commonly portrayed as a single, north-south trending basin that was filled with sediment derived from the westerly located Uncompahgre uplift. Here we present stratigraphic, structural, and sedimentologic data that indicates that portions of the earliest basin fill (early Pennsylvanian Sandia Formation) was derived from intrabasinal highs located to the east of the Taos trough depocenter.If a second paragraph is needed the pagination and structure should look like this.

Facies analysis of a measured stratigraphic section indicates two distinct facies. The mudstone facies (Ms) is comprised of both organic-rich shales and siltstones. These sediments are extremely fine grained, thinly laminated, and fissile. The sandstone facies (Sm) is distinguished by the appearance of sharp based sandstone beds of varying thicknesses. Sm facies is found sporadically throughout the measured section intercalated with the Ms facies. It is common to find fragments of marine fossils or plant material in either of these facies. Taken together, these stratigraphic data are inferred to record delta front sedimentation.

Fold axes and hinge line data were measured in thirteen syn-sedimentary folds occurring within the Ms facies. These data show a wide variance of axial plane orientations, but in general, the fold axes have a preferred eastern dip orientation (i.e. westward vergence). The unrestored data was then corrected to early Pennsylvanian orientations by restoring nearby, coeval fluvial bed attitudes to horizontal. Final paleo-corrected fold orientations were found to be similar to field measurements though slightly less consistently eastward dipping. This syn-sedimentary fold vergence indicates that the delta slope dipped to the northwest. Thus, sediments were being sourced from the east, likely near present day Mora, New Mexico. An eastern source contradicts an exclusive western source shown in most paleogeographic reconstructions.

The Role of GIS in Understanding Border Communities' Vulnurability to Narco Tunneling

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Since the early 1990's, tunneling activity under the border between Mexico and United States for smuggling narcotics has steadily become a major focus for border protection agencies such as CBP and ICE. This research uses GIS to create a framework of factors for identifying the potential risk zones along the border for narcotics tunneling. We attempted to gain an understanding of these tunnels from various different perspectives including geology/soils, correlation with types of urban zones, proximity to major outgoing roads, proximity to the border itself, and the geography of the tunnels, including their locations and proximities to each other. Archival research was used to find the tunnels in order to map them (when available). Analyses of our findings show the communities where tunneling activity is most prevalent. Within the focus communities of Nogales, AZ and south San Diego, CA we found that these tunnels are located in industrial/commercial, apartment residential zones, or any other area that provides empty, secluded space that can conceal a tunnel. There is also a strong relationship between tunnel clustering and proximity to the nearest Port of Entry into the United States. In terms of physical geography we found common soil types and geology that seem to appeal most to would-be smugglers; soils that are primarily clay and are less likely to cave in. Alluvial geology is ideal for the deeper tunnels that dig down past soil and into sediment, as more sophisticated tunnels do.

Hydrothermal remobilization of rare earth elements in a carbonatite-hosted rare earth element deposit, Bear Lodge Mountains, Wyoming.

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The Bear Lodge Mountains of northeast Wyoming is the locality of a carbonatite-hosted rare earth element (REE) deposit. The carbonatite is emplaced as subvertical, northwest trending dikes primarily situated within three diatreme structures. The carbonatite dikes are primarily composed of calcite and < 20 percent hexagonal REE-mineralized-pseudomorphs after burbankite. The secondary REE-mineralization present in pseudomorphs progresses from ancylite [$SrCe(CO_3)_2OH*H_2O$] at depth to bastnaesite group minerals [e.g. bastnaesite $(Ce,La)CO_3F$] nearer the surface. Up to three calcite textures are observed in samples: coarse-grained calcite with well-defined cleavage; fine-grained, anhedral to consertal, inclusion free calcite; and coarse-grained, consertal calcite with abundant inclusions of fluorite and calcite.

Calcite from several carbonatite samples were analyzed using laser ablation inductively-coupled mass spectrometry. The coarse-grained calcite with well defined cleavage have steep, negatively sloped, log-linear chondrite normalized REE patterns which parallel bulk rock patterns. The coarse-grained, consertal calcite with abundant inclusions have convex up, "humped" patterns whereas the fine-grained, anhedral, inclusion-free calcite have relatively flat patterns; neither of these patterns are typical of magmatic calcite and are more likely related to sub-solidus processes. The "humped" and relatively flat patterns are interpreted as the products of calcite recrystallization in the presence of a hydrothermal fluid. A hydrothermal fluid with hard ligands such as F^- and CO_3^{2-} would preferentially complex with and subsequently mobilize the light rare earth elements (LREE) producing the observed non-magmatic calcite REE patterns. The progression in REE mineralization from primary burbankite to bastnaesite group minerals is characterized by an increase rare earth oxide content which suggests that the mobilized LREE are being sequestered into the secondary REE-minerals throughout the dikes.

Sand and Gravel Petrology of the Ogallala "Slaton Channel" in Crosby County, Texas.

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The "Slaton Channel" represents the fill of a paleo-valley within the Ogallala Formation along the border of Lubbock and Crosby counties, Texas. Sand and gravel samples taken from four stratigraphic levels within the Slaton Channel were separated into size fractions, embedded in epoxy, and cut into thin-sections for point counting. The mineralogical composition of the sand and gravel is similar to other Ogallala samples collected across the Southern High Plains of West Texas and eastern New Mexico. There is strong compositional variation with grain size; the granule gravel and very coarse sand consists predominantly of lithic grains with very little feldspar, whereas the coarse to fine sand consists predominantly of quartz with slightly more feldspar. There is also some compositional variation stratigraphically within the Slaton Channel; the upper channel-fill has more chert, compared to limestone and clastic lithic grains, more feldspar (mostly microcline), and a greater proportion of metamorphic quartz compared to plutonic quartz. The abundance of limestone rock fragments among lithic grains in the Slaton Channel probably reflects the close proximity of Lower Cretaceous bedrock outcrops. In spite of the unique features of the Slaton Channel, its sand and gravel composition is similar to other samples from the southern extent of the Ogallala Formation.

Fine-scale Radar Observations of West Texas Drylines and Embedded Misocyclones from Spring of 2012.

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Predicting convective initiation (CI) along the dryline has long proven difficult to operational meteorology, and the quintessential method of improving such predictions is to advance fundamental understanding of the finescale dryline structure and processes—including those of dryline-imbedded vortices. Although these vortices, or misocyclones, are known to vary in size and propagate along dryline boundaries, only recently has radar technology improved enough to make observations in a detailed manner. Thus, little is known about their formation and evolution. Misocyclones may be caused by the intersection and tilting of convective rolls along air mass boundaries and may be regions of enhanced vertical air motion—potentially catalyzing CI. If rolls are indeed responsible for these misocyclones, the size and spacing of misocyclones may be directly related to boundary layer depth. Likewise, vertical shear would be necessary for the roll, and consequently, vortex formation. The need, if any, for cross-dryline shear will also be assessed. Using dual-Doppler methodology and data from two Texas Tech Ka band (TTUKa) radars with 0.49 deg beam width, multiple dryline events are objectively analyzed to derive 2-D wind fields and regions of enhanced convergence and vorticity. Range-height indicators (RHIs) are also utilized to record the vertical wind profile and shape of the dry front. The findings of a highly complex dryline structure, the necessity of dryline-intersecting linear structures for the existence of misocyclones, and other findings of interest will be addressed.

Surface charge development at the pyrolusite–water interface in NaCl media.

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Ion adsorption phenomena at mineral-solution interfaces are important reactions in controlling the cycling and transport of toxic contaminants and heavy metals in surficial environments. The role played by manganese oxides in adsorbing metals is of special interest to environmental scientists, because they are ubiquitous in natural soils and waters, and they have high adsorption capacities. The high adsorption capacity of manganese oxides results in them being used widely in water treatment and remediation applications. To fully understand and predict the adsorption behavior of manganese oxides, and thereby more effectively utilize their adsorption capacity, fundamental knowledge of the solid-solution interface behavior of manganese oxides is needed.

In this work, pyrolusite (β-MnO_2) was selected for study as it is the most stable and abundant polymorph of MnO_2, is commonly found in natural deposits, and is utilized for numerous technological applications. Potentiometic titrations were performed to evaluate the surface charging behavior of pyrolusite as a function of pH, temperature (25° C), and ionic strength (0.03 – 0.3 *m*). Commercially available pyrolusite samples are being studied. Prior to use, the pyrolusite samples are washed and characterized extensively. Washing comprises rinsing in HCl, nanopure water and hydrothermal pre-treatment. Sample characterization included SEM and TEM imaging, XRD, and BET surface area measurements. The samples have been confirmed to be pure, crystalline pyrolusite with a blocky habit. The samples have a low surface area of < 1 m^2/g. Potentiometic titrations show a pH_{znpc} value close to 7.5, and a high pH-dependent surface charge in NaCl media.

Fire frequency in Southern California: A Preliminary Analysis at the Census Tract Level

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There has been much discussion on the role ex-urban growth plays in wildfire vulnerability within the American West. Nowhere is this question more pressing than in Southern California where decentralized hillside sprawl has placed housing developments within seemingly pristine but fire prone landscapes. Some argue that ex-urbanites bring a new amenities based value of nature to ex-urban landscapes which may be less compatible with fire mitigation strategies which seek to reduce vegetation fuel loads through prescribed burns or clearings. The majority of this analysis is based within specific ex-urban communities where local property owner expectations can be explored. It has also tended to focus on the aftermath of a specific wildfire event. Little research has attempted to bring the findings of this work to a regional scale where repeated wildfire exposure could be determined in comparison to ex-urban growth through time. Such an analysis might better address planning policy recourse. Instead regional fire studies that do exist tend to be lacking in comparative analysis of community vulnerability and focus more on vegetation regimes and weather conditions. This paper seeks to tackle this disjuncture. It employs GIS to create an analysis of fire frequency over the past 50 years in coastal counties of Southern California and uses socioeconomic information at the census block level to better describe residential communities which face wildfire vulnerability.

Arsenic: It's What's for Dinner

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According to the World Health Organization, arsenic is a known carcinogen and is the number one environmental chemical concern for human health in the United States and worldwide. This study examined the high arsenic levels present in the farm soils, plants, and water in West Texas. Research and experiments were done which sampled and determined arsenic levels in farmlands and wetlands, as well as the local water supply.

It was discovered that the highest levels of arsenic were found in irrigated farmlands. Additionally, local wetlands were negatively affected by the presence of arsenic. Higher arsenic levels were discovered in the cold water supply compared to the hot water supply. Experiments with invertebrates showed the negative impacts of increased arsenic levels. Based on the experimental results obtained, remedial efforts were undertaken and measured. Most critical was the testing of native plants for their ability to accumulate arsenic and serve as tools in phytoremediation. A native grass, sand drop seed, was discovered to have potential in removing arsenic from the soil, and efforts to expand and implement this solution are underway.

Bone Histology of *Alamosaurus* Ribs from the Upper Cretaceous of Big Bend National Park, Texas.

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Parts of two thoracic ribs and a cervical rib were collected with the partial skeleton of the titanosaurian sauropod *Alamosaurus sanjuanensis* on Rough Run Creek in Big Bend National Park, Texas. The ribs were removed from their plaster jackets, cleaned, and prepared for this research. Cross-sections of the ribs were studied, and thin-sections were made to examine their microscopic histology. The rib heads have extensive camellate cavities and are covered by only a thin layer of lamellar cortical bone. The proximal ends of the shafts have internal camellate cavities surrounded by a thicker cortex. The distal end of the largest thoracic rib has no camellate cavities, but instead normal spongiosa bone surrounded by very thick cortex. The camellate cavities are generally thought to have enclosed air-filled extensions of the lungs. The air sacs could have served to reduce the body weight in these large animals, or to assist with thermoregulation and respiration by increasing the lung surface area for ventilation.

Petrophysical Analysis of the Avalon Shale Formation, S.E. NM

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The Avalon Shale lies above the Bone Spring formation in the Delaware Basin in the Permian Basin's westernmost area. Avalon potential has been recognized for some time even though operators have drilled through the Avalon in search of other reservoirs. In some places, the interval is two layers of shale separated by a limestone layer. Currently, numerous oil and gas companies are directing their efforts toward the exploration and exploitation of "Tight Oil" from the Avalon Shale. This new proposed study will focus on the Lower and Upper Avalon Shale intervals that are separated by the Avalon Carbonate. This unconventional oil reservoir has proved to be challenging in terms of reservoir characterization, predicting producibility potential, estimating ultimate recovery, and optimizing fracture stimulation techniques. Many companies either do not have or have limited rock property data that are crucial for understanding these reservoirs. Therefore, in order to properly evaluate and explore the Avalon Shale, appropriate types of rock property data need to be measured and integrated with log data, petrophysics and stimulation. This project consists of the characterization and evaluation of a well located in the Permian Avalon Shale in the southeast of New Mexico. Petrophysical evaluation reveals the Upper Avalon Shale to be a suitable candidate for placing the first horizontal well. Even though our evaluation suggests presence of organic matter in both the Upper and the Lower Avalon Shales, the Upper Avalon was chosen after considering the oil in place and material brittleness and the overall homogeneity or the rock in the Upper section. These factors were further integrated with the estimated rock geomechanical properties and it was concluded that 7600ft would be the optimum target depth to avoid unwanted fracture growth into the middle Avalon Carbonate while still taping into the major organic rich portion. Based on our detailed petrophysical evaluation of the Upper Avalon Shale we have estimated the original oil initially in place to be approximately 9.2

MMSTB per 160 acre horizontal drilling location. We have estimated the recoverable oil initially in place at 276 MSTB for the Upper Avalon Shale Section assuming a recovery efficiency of three percent. Based on preliminary economic assumptions we estimate the Upper Avalon Shale Section represents a profitability to investment ratio (P/I) of approximately 1.7

Variations of the Vertical Electric Field and Wind Speed on Days with Airborne Dust in Lubbock, Texas

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A station consisting of a downward-facing electric field meter and a sonic anemometer was deployed in the spring of 2012 in the Lubbock, Texas area in order to observe at 1 Hz the effect of airborne dust on the vertical electric field and how the electric field varies with the horizontal wind speed under conditions with suspended dust. The vertical electric field during blowing dust cases shows the expected reversal in sign from the fair-weather electric field. The covariance values between the electric field and the horizontal wind components differ from those observed on fair-weather days. With respect to larger time intervals under dusty conditions, the average covariance between the horizontal wind and the vertical electric field is generally large and positive, likely due to the expected overall increase in the suspension of largely negatively charged dust particles during longer periods with stronger winds, in line with past studies. However, with respect to smaller time intervals (windows less than 30 s) for which we find few observations in the literature, the average covariance in dusty conditions is either near zero, suggesting little correlation, or negative, suggesting that higher frequency gusts could carry more positively charged dust particles than found in the overall layer of airborne dust. A simple charge model for dusty conditions reproduces the observed fluctuations and confirms the role of lofted positive charge. These observations of negative covariance above the saltation layer appear to be a new result.

Thermal conductivity in deformed quartzites: the role of mineral preferred orientation

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Thermal conductivity is an important mineral and rock property because heat transfer is a factor in understanding the development of economic resources, including geothermal energy and hydrocarbon resource maturation. Quartz, one of the most abundant minerals in the Earth's crust and near-surface sediments, is thermally anisotropic with higher thermal conductivity parallel to its c-axis compared to its shorter a-axes. Quartz' anisotropy, therefore suggests, that quartz-rich lithologies with preferred orientation may have higher thermal conductivity parallel to foliation (or lineation). Quartz shape preferred orientation (SPO) and thermal conductivity of quartzites collected on a down-temperature transect in the host-rocks of the Priest Pluton in the Manzano Mountains (NM) have been measured. Quartz SPO data, measured on the basis of length to width ratios, show a systematic decrease from 2.40 ± 0.88 to 2.17 ± 0.48 with increasing distance from the pluton. Thermal conductivity was measured on discs cored parallel and perpendicular to the foliation in each sample. A consistent observation is that measured thermal conductivity in a sample is higher measured parallel to foliation compared to perpendicularly. However, comparison of data between samples is contradictory to the hypothesis that greater SPO should result in greater conductivity parallel to foliation and lower conductivity perpendicular to foliation. In samples with higher SPO (>2.3) the measured thermal conductivity was 7.1 ± 0.2 W/(m·K) and 5.7 ± 0.9 W/(m·K) parallel and perpendicular to the foliation respectively. In samples with lower SPO (<2.2) measured conductivity was 7.8 ± 0.2 W/(m·K) and 4.7 ± 0.1 W/(m·K) respectively. One explanation is the presence of muscovite in the samples. Thermal conductivity in muscovite is an order of magnitude higher when measured parallel to cleavage planes compared to across cleavage planes. Therefore, higher than expected thermal conductivities in samples with lower SPO may be caused by high muscovite abundances. However, muscovite is ~23% by volume in samples with higher SPO and <10% by volume in samples with lower SPO. Therefore, there is no observed retardation of thermal conductivity perpendicular to foliation, nor enhanced conductivity parallel to foliation in samples with abundant muscovite, and mica abundance does not explain the data. Another explanation of the unexpected data-trend may be total grain surface area. Samples with greater shape preferred orientation have lower average grain size. This corresponds with a greater surface area and a higher density of grain boundaries. Grain boundaries may represent energy barriers that retard thermal conductivity in a sample, with the consequence that finer grained samples have lower thermal conductivity that coarser grained samples, despite their greater SPO.

A Study on the Focal Mechanisms of the Snyder Seismic Events and Their Cause: Is Hydraulic Fracturing Inducing Earthquakes?

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A series of earthquakes occurred in the area of Snyder, the seat of Scurry County, from January 2010 to December 2011. Snyder is located in west Texas and is part of the Horseshoe atoll, a section of the Permian Basin. The Permian Basin is an oil rich area where Paleozoic limestone comprises the subsurface. According to the Railroad Commission of Texas, there are currently over 37,000 oil and gas records filed in Scurry County[1]. There has been much debate about the possibility of hydraulic fracturing lubricating faults and inducing earthquakes in the petroleum fields of the Permian Basin. By studying the data collected from seismic stations around the area, this research examines the processes that caused the series of seismic events. Converting the P-wave first motion polarity into focal mechanisms specifically demonstrates the motion in which the earthquake occurred. Using this method, it was found that these earthquakes are oblique-slip, which includes both vertical and horizontal components. Typically, induced earthquakes propigate parallel to

the stress field and and natural fractures occur perpendicularly. Whether the earthquakes are created by stress fractures, lubricating faults, or induced seismicity, it is imperative to obtain the facts in order to understand the cause. The purpose of this research is to accurately determine whether or not the process of hydraulic fracturing stimulates induced earthquakes.

[1] Railroad Commission of Texas. Oil and Gas Well Records. District 8A Results.

Petrophysical and Economical Analysis of Upper and Lower Avalon Shale , South East New Mexico.

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The Avalon shale for studied well is located in south east New Mexico that the thickness is 255' for upper Avalon and 284' for lower Avalon separated by a 189' carbonate layer. Following the Asquith (2009) flowchart for shale formation analysis, Thermal maturity index (MI) needs to be calculated to predict the maturity of organic matter to define the producible hydrocarbon type associated with that. For this purpose, the Zhao (2007) technique has been used and the MI for upper and lower Avalon calculated as 5.67, after plotting this value in MI-GOR correlation for Barnett shale, the hydrocarbon type defined as Wet gas and oil for Avalon.
Total Organic Carbon (TOC) is calculated from the Passey and Schmoker method. Having a more reasonable trend, the Schmoker TOC was used for kerogen volume analysis.
The main purpose of this analysis is to determine the best candidate for horizontal well completion between the lower and upper Avalon. The decision making factors for this purpose are assumed as original oil in place (OOIP) after applying permeability cutoff (K>100nD) and comparing the mineral brittleness index (MBI) for two intervals and finally the economic aspects. The results of this analysis show that OOIP, after applying the cutoff, has a more uniform pattern in the upper Avalon and no barriers are observed in this interval. On the other hand, the lower Avalon MBI is higher than the upper due to the high content of carbonate that makes it easier to fracture. Although the lower Avalon contains more producible hydrocarbons and economic analysis shows higher profit, it is thicker with several carbonate barriers which prevent it from being a better candidate for horizontal drilling than the upper Avalon. Considering the 3% recovery from the OOIP, the results for mineral matrix OOIP, organic matter OOIP and recovery after applying the permeability cutoff were plotted and the summation for each interval are provided in a table for a better comparison.

[1] G. B. Asquith (2009) *AAPG*.
[2] H. Zhao et al. (2007) AAPG Bulletin.