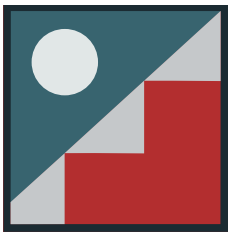

NEW MEXICO EPSCoR

2015 ALL HANDS MEETING

17 APRIL 2015 NEW MEXICO TECH

POSTER SESSION ABSTRACTS

Uranium Specific Filters for Removal from Groundwater and Drinking Water

Samantha Saville, New Mexico Tech

Uranium has a significant impact on life in several Western states including New Mexico. The EPA in 1991 proposed the uranium standard for drinking water to be 30 ppb (EPA 1991) but groundwater in uranium-rich areas can range up to 120 ppb (Langmuir 1997). This creates a large problem in New Mexico because most drinking water comes from sources that can be contaminated with high uranium concentrations. Removal of uranium by binding to a subsequently-separable solid is becoming a highly sought technology in industry and uranium research. Veliscek-Carolan et al (2013) reported that the non-functionalized titania oxide absorbed 20% uranium selectively from a mixed solution of other actinides and lanthanides and radioactive material and up to 50% selectively to uranium with other groups. In my project we will be developing uranium filters with a new proprietary material that is an inorganic-organic hybrid material on the bases of graphite developed by Dr. Frolova. This is a new material that has recently been prepared and will be patented. The goal of this new material is to create a surface which will specifically absorb uranium, thus significantly reducing uranium concentrations in drinking water as an inexpensive, reusable commercial filter. This will be accomplished by modifying carbon material with organic pendants that have binding characteristics specific to uranium. In our preliminary results we were able to concentrate 91.6% of uranium on our material and 81.98% of uranium when mixed with other common divalent cations that only absorbed less than 50% showing specificity to uranium.

The Energy-Water-Environment Nexus and Economic Efficiency: Use of System Dynamics Modeling Approach in the San Juan Basin

Janak Joshi, PhD Student, Department of Economics, UNM

Energy and water, inextricably interlinked natural resources, play a vital role in the economic and environmental health of the world. Water is the major input in the energy production system while treatment and distribution of water require energy. The increasing consumption of energy raises questions on resource sustainability and environmental pollution. This further affects economic efficiency and public health. This study uses system dynamics modeling and simulation approach to capture the complex interdependency of water, energy, environment and economy in the San Juan Basin. The objective is to observe resource optimization, minimize negative externalities and maximize social-economic benefits.

ABSTRACT

Maxwell Baymiller, New Mexico Tech

Gold nanoparticles (GNPs) are metallic gold particles with sizes ranging from several to hundreds of nanometers in diameter. Their unique surface properties – such as surface plasmon resonance (SPR) and associated optical characteristics – have made them useful for a number of applications, ranging from sensing and imaging to drug and gene delivery. GNPs are most commonly synthesized using the Turkevich method, in which dilute tetrachloroauric acid ($HAuCl_4$) is boiled and citrate or borohydride ions added to reduce the Au^{3+} to Au^0. While this method is simple and cheap, the particles it produces can have an undesirable range of sizes and aggregate at modest salinity. As such alternative GNP synthesis methods have been developed, including many which utilize cellular and extracellular extracts from various species of bacteria, fungi, or plants. In these "biosynthetic" methods the action of a reducing enzyme is often cited as the cause of Au^{3+} reduction, yet no common mechanism has ever been definitively proven. Here we present a novel synthetic method for GNPs which uses the ubiquitous biological coenzyme nicotinamide adenine dinucleotide (NADH), and postulate that the action of this molecule may be responsible for previous reports of GNP biosynthesis. We also show that the synthesis of GNPs using NADH has the advantages of being isothermal, very rapid, and producing colloids which are resistant to salt-induced aggregation.

Preferences on Energy Sources, Tradeoffs and How They Vary Across New Mexico

Janie Chermak, UNM
Jennifer Thacher, UNM
Kara Walter, UNM
Janak Joshi, UNM

There are many different technologies that have been or are being developed that can be used for energy production and New Mexico has the potential to extract and produce many of them. While New Mexico consistently ranks in the top 15 for energy production and has large reserves, little is known about how New Mexicans feel about various options and the tradeoffs between them. If the public is unwilling to switch or if they do not believe that technologies will help the economy, their community, or environment, then technologies are unlikely to gain traction. Some of these are currently economically viable, meaning that they are cost effective and can be used on a large scale, such as coal or solar while others are still being developed, such as bio-algal. To address these questions, we are conducting a statewide survey that will allow us to see how opinions across the state vary. This poster presents the research questions underlying the survey, our hypotheses, and maps specific survey questions to the hypotheses and research questions. Such questions include the perceived threat to the environment and water supply based on current production and potential. Questions about extraction and production energy on public lands are also included. We expect preferences to vary across the state, where distance to technologies and resources, beliefs about the environment, and state of their local community are important determinants.

Keywords: energy economics, survey, tradeoffs, preferences

Radical Reporters of Electronic Structure

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ABSTRACT: *Spin* is an intrinsic property of electrons and it is responsible for the vast majority of magnetic behavior in matter. Furthermore, the interaction between *unpaired* electron spins can lead to many interesting and useful molecular systems. When a molecule absorbs a photon of light, two unpaired electrons are typically formed and it is the interactions between these two electrons, and with their molecular environment, that are the dominant force in controlling excited state behaviors. Careful control of excited state behaviors is crucial to fields as diverse as solar energy and molecular electronics, and this work demonstrates one part of the toolbox that we are developing to understand these complex phenomena. In particular, this work focuses on how to use the interaction between the photogenerated, unpaired electrons and additional *pendant radicals* to understand the short lived excited states which are formed upon the absorption of light. Specifically, our work involves the development of ways to modify molecules in a way that does not change their basic properties, but allows for the use of more advanced techniques to better understand key relationships between molecular structure and their electronic behavior. This, in turn, will enable the construction of a complete molecular toolbox for the construction of new and useful molecules. These modifications allow for the use of advanced high-field magnetic techniques, and we will discuss how these are being used to understand the complex interactions between ground and excited states as the pertain to magnetic exchange interactions.

KEYWORDS: Spin, Radicals, Excited State, Magnetism, Ground State

ABSTRACT
Wenhan He, University of New Mexico

Solution processable conjugated polymers possessing low bandgaps have been the subject of intensive research in the field of organic photovoltaic (OPV) devices. Incorporation of Pt(II) complexes into conjugated polymer structures has been considered beneficial for OPV operations because these complexes are unique for intrinsically adopting square planar geometries and can serve as building blocks for linear long-chain structures, more importantly they typically show strong spin–orbital coupling effects that induce formation of long-lived triplet excitons, Thus Pt containing conjugated polymers have recently attracted signifcant attention in OPV research. Here a conjugated boron-dipyrromethene (BODIPY)–platinum polymer possessing a low bandgap of 1.7 eV has been synthesized and characterized. The bulk heterojunction solar cells employing this polymer gave high open circuit voltages up to 0.92 V and power conversion efficiencies close to 1%.

Analysis and Separation of Produced Water for Osmotic Power Development

Elizabeth Jackson, Eastern New Mexico University

The Southeast district is home to the largest oil field industry, in terms of production, in the country. When extracting oil it's common to have several byproducts being produced, one of which is known as produced water. This producible water contains enormous amounts of concentrated ions, which would make it a very viable option for the production of energy. Osmotic power or pressure retarded osmosis (PRO) is a burgeoning renewable energy source that converts the pressure differential between water with high salinity and water with lower or no salinity into hydraulic pressure. The idea of using produced water is that due to its high salinity concentration they can pair it with "tap water" and the energy output will be three times the amount produced when fresh water meets the sea. In order to further this research the particular ions and the concentrations of those said ions in the produced water must be known. Knowing the specifics will then allow for the quantitation of the highly concentrated ions to be maximized, thus leading to maximum production of energy. The method I have developed starts with a liquid-liquid extraction to separate non-polar from polar with the same principle that allows oil to float on water. With this extraction like will dissolve like leaving an aqueous layer separated from an organic layer. The organic layer will then be pipetted out and a drying agent will be administered to ensure all water molecules are absorbed. To assist in cutting down the concentration of the component a solvent extraction approach is necessary for thin layer chromatography (TLC) to be used. This step is vital because TLC will give us insight not only in a very broad understanding of the number of ions we can expect to be present in our sample but it also will allow us to visually see if our extraction of the organic layer from the aqueous layer was successful. If successful solid black dots will appear on the plate representing separation, however, if unsuccessful the plate will become smeared indicating the sample is too highly concentrated. If the steps up to this point are successful Gas Chromatography Mass Spectrometry (GC-MS) and Ion Chromatography (IC) will be used hand in hand to determine the amount of ions present and the concentrations of those said ions in our sample. Understanding the specifics will allow us to brainstorm a technique that we can employ in order to maximize the concentrated ions, which will in return maximize energy production.

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Algal Lipid Extraction and Chromatographic Analyses

Abstract

Microalgae hold promise as a sustainable source of biofuels based on their rapid growth and reportedly high concentration of lipids. In recent decades, the biotechnology of microalgae has gained considerable importance.

Microalage are cultivated on our outdoor pilot unit called Algal Turf Scrubber (ATS®). The productivity can reach 3.1-3.2 g dry weight day^{-1} m^{-2}. The Soxhlet extraction method is chosen because of its simplicity in operation, relative safety and potential for upscaling to industrial plant level. Analysis shows that ethanol, chloroform and hexane are generally more efficient in the extraction of lipids than other solvents studied. Thin layer chromatography is used to separate the lipids and chlorophyll. For best separation, we have tried mixed solvents with various compositions. We will then use high performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS) to analyze the compositions.

The Sustainability and Management of the Truth or Consequences, New Mexico Geothermal Resource

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ABSTRACT

Deterioration of geothermal resources due to overexploitation often results from the lack of a comprehensive water management system. We have investigated the sustainability and water management practices of the Truth or Consequences, New Mexico, hot-spring system in the southern Rio Grande Rift. There are currently ten commercial spa resorts and an estimated 158 geothermal production wells utilizing the relatively hot (~ 41 °C) groundwater within the town's 0.6 km^2 historic hot-springs district. Over the last seven decades there has been an estimated 285% increase in the number of geothermal wells in this area. Theis et al. (1941) provided measurements of borehole discharge temperature, water-table elevation, artesian pressure heads, water chemistry and natural hot-spring discharge. We replicated these measurements between October 1, 2012 and September 30, 2013 for comparison to gain insight into the system's response to development. We also estimated current water consumption and characterized diurnal temperature and pressure patterns to guide resource management.

We found that there has been virtually no change in water chemistry between 1941 and 2013. However, silica and cation-based geothermometry indicates that deep reservoir temperatures may have increased by 10 to 14%; this might be a result of drawing water from greater depths due to increased pumping in the area. Spatial discharge and temperature patterns have shifted, while temperature magnitudes show little change (~ 1 °C decline). The temperature decline is most likely due to changes in well depth, as current wells are typically 40% shallower than those of 1941. The spatial pattern of water-table elevation has changed very

little, while the magnitude of mean water-table elevation has declined by approximately 0.4 meters. Additionally, artesian pressures appear to have dropped, although data are very limited. The estimated amount of natural geothermal discharge has declined by approximately 13% to 7.14 x 10^{-2} m^3s^{-1}. Overall, the evidenced changes are marginal considering the aggressive development that has taken place since 1941; thereby suggesting the system is reasonably healthy. Our analysis of daily water-table elevations and discharge temperatures in the hot-springs district indicates that fluctuations of these parameters are largely controlled by human water demand. Measured values decline during periods of high demand and recover when demand diminishes. The periods of daily recovery are believed to play an important role in mitigating long-term adverse effects of development. Data on water consumption limit our ability to make inferences about future development, as only 6.3% of appropriated water is accounted for in the current reporting system regulated by the State. While evidence suggests that the system is currently not overexploited, it is imperative that a comprehensive monitoring program and water usage reporting system be emplaced before the resource is further developed.

Mix-Matrix Water Stable Thin Film MOFs for Osmotic Power Generation

Carlos Ordonez, Xu Wang, Tatiana Timofeeva, Qiang Wei

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Osmotic power generated from the osmotic pressure differences between the mixing of fresh river water and sea water through a semi-permeable membrane[1] could potentially be the answer to this elusive question: How can we develop clean renewable energy with little cost, and high efficiency? The pressure produced from the mixing of the two water solutions is capable of moving a turbine to produce clean energy without the use of fossil fuels or toxic chemicals. However, the problem with this technology is the production of highly effective, semi-permeable membranes capable of separating even the smallest solute particles from the water solvent. One of the fascinating techniques for achieving such membranes is the production of Mixed Matrix Membranes (MMMs)[2] with porous materials embedded in a polymeric matrix thin film. Often the porous materials, such as activated carbon, and zeolites, can cause poor permeability of the membranes and thus low efficiency. Metal-Organic Frameworks (MOFs) are a new class of microporous structures build from the coordination of transition metal ions with organic linkers[3]. The variability in the type of metal and organic ligands chosen to build the framework has allowed MOFs to possess a high level of functionality, as well as improve the selectivity and stability of the material. Our group is interested in the application of highly water stable MOFs[4] in MMMs systems to generate highly functional and efficient semi-permeable membranes to be utilized for osmotic power generation.

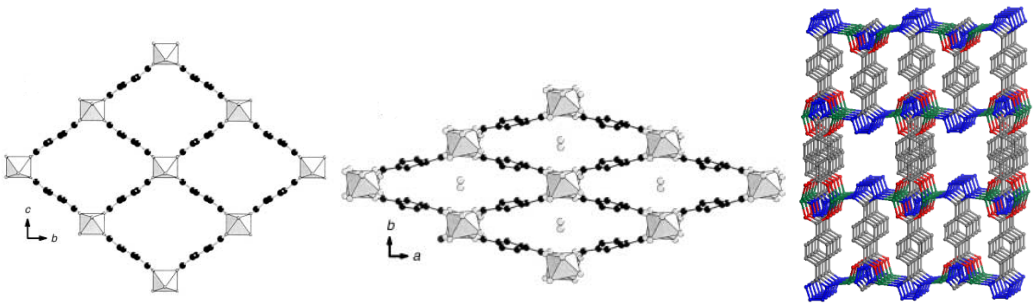

Figure 1. Water Stable MOFs that will be used in this study: (a) Empty, and flexible MIL-53(Al) MOF[4]. (b) Hydrated MIL-53(Al) MOF. (c) Highly porous {Zn-TBC}{MeOH} MOF.

Leaching evaluation of Uranium bearing waste rocks at the Ambrosia Lake Mining District, Mckinley County, New Mexico

A part of the EPSCoR Uranium Team Research Project

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The overall objective of this project is to predict leaching potential from uranium-bearing waste materials based on lithology, geochemistry and mineralogy in the Grants Mineral Belt. A part of the project stated in this proposal is a preliminary research focus on the Ambrosia Lake District for sample collection and subsequent laboratory analysis on mineralogy, geochemistry constituents and reactions to estimate leaching potential together with acid generation and neutralization potential.

Title of Poster: Extraction of lipids from Microalgae

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Abstract

As the demand for energy increases, the search for alternative sources of fuel becomes more apparent. Microalgae, a third generation biofuel, has the potential to meet the global demand for transport fuels. Microalgae has numerous advantages over first/second generation biofuels.

1. High growth rate, resulting in large oil yields.
2. Uses nearly one-third of the water than terrestrial crops
3. Reduction in CO_2 in the atmosphere

Microalgae currently produces as much oil as conventional biofuels. Consequently, it is important to effectively and efficiently extract lipids from microalgae.

The main purpose of this project is to extract fatty acids [FAs] from microalgae cultivated at Eastern New Mexico University algal site using different solvents in order to determine which provides the greatest yield.

Microalgae is harvested from the algal cultivation site at ENMU. It is repeatedly centrifuged to help separate micro-organisms and sediment from the desired biomass. The microalgae is spread onto plates and dried under vacuum to remove water. Dry biomass is grinded into a fine powder via pestle and mortar.

1.00 grams of microalgae were weighed and packed into a cellulose extraction thimble which in turn, was placed into a Sohxlet extraction apparatus. Sohxlet extraction utilizes varying solvents to disrupt the cell walls of microalgae and in turn, allowing for lipids to pass through the membrane and collect with the solvent. Chloroform, Ethanol, and Hexane were chosen to their variability in polarity.

200mL of solvent is placed into a 500mL round bottom flask and connected to the Sohxlet extractor. Each solvent is boiled via heating mantle. Extractions run for 3-6 hours.

Harvest	Amount of algae[g]	Solvent	Amount [mL]
8	1	Hexane	200.0
8	1	Hexane	200.0
8	1	Chloroform	200.0
8	1	Chloroform	200.0
8	1	Ethanol	200.0
8	1	Ethanol	200.0
8	1	1:1 Ethan/Chloro	200.0
8	1	1:3 Ethan/Hexa	200.0
8	1	1:2 Chloro/Hexa	200.0

ABSTRACT
Alexandra Minitrez, University of New Mexico

The overall objective of the NM EPSCoR geothermal component is to obtain a deeper understanding of geothermal systems in New Mexico. New Mexico has undeveloped and undiscovered potential that could expand geothermal production and offer sustainability. This purpose of this project is to compile existing geothermal water chemistry data from diverse sources and help incorporate data generated by the team into the data portal using methods shown in this presentation. The main purpose of this work is compiling existing geothermal data within New Mexico. Over the past several decades, there have been investigations of several areas, including the Jemez geothermal system in the north-central part of New Mexico, the Truth or Consequences area, south of Socorro, and the Gila Mountains in the southwestern part of the state. By incorporating the existing information about water chemistry, temperature and discharge into a database, we will make the task of comparing different systems and selecting sites for further study more manageable. Specifically our methods will be to combine various data sets using Excel, apply quality control measures to the data, and work with the cyber infrastructure team to develop metadata standards and upload information to the portal. The results to date include compiling data from several existing sources for New Mexico, making hundreds of geothermal water chemistries accessible through the EPSCoR data portal.

Spatial Wasting Effects in a Photo Bioreactor: A Selection Pressure based on Algal Physical Characteristics in a SBR

Derek J. Wichhart and Dr. Andrew Schuler

Abstract

Imposing selection pressures on mixed communities of bacteria is commonly done to improve performance of activated sludge systems for wastewater treatment. Much less research has been done on reactor design and operation to impose selection pressures in algal mixed cultures, in part because much biofuels research has focused on algal monocultures. It is hypothesized that imposing a selection for algae with good flotation characteristics will enrich for lipid storage, and lipids are often less dense than water, and/or that imposing a selection pressure for settling or floating algae will improve solids separation, which is a major challenge in algal cultivation and recovery.

The objective of this study is to determine if mixed cultures of algae can be enriched for useful functions, such as improved solids separation and/or lipid storage, by incorporating cyclic settling or floating phases to their operational cycle.

Three sequencing batch reactors with a defined media (Bold's Basal Medium) are being run in the UNM Environmental Engineering Laboratory run on a 4 day hydraulic residence time (HRT). The reactors are 10 cm in diameter and 30 cm high with a working volume of 2 liters and illuminated with 3500 K 90 degree LED lights. The 3 reactors are being run with 3 different cycles, with

(1) a reactor with continuous mixing at all times (control reactor)
(2) a reactor with wasting from the top after a no-mixing phase (settling-selector), and
(3) a reactor with wasting from the bottom after a no-mixing phase (floatation-selector).

The reactors were inoculated with BBM and operated as sequencing batch reactors on a 24 hour cycle. In this manner a selection pressure is introduced in favor of settling algae. The flotation-selector was operated identically, except the bottom 500 mL was wasted each cycle.

Parameters that are being monitored are biomass, total lipids, density with Percoll solutions, and pH. Lipids are being extracted using a solvent solution and are being analyzed by gas chromatography. Density is measured using Percoll gradients that are prepared with Percoll and mixed with varying amounts of sample to establish a fixed density, these samples are then centrifuged with the algae floating, sinking or establishing an equilibrium in the solution.

This study is ongoing and future work will include increasing the HRT from 4 days to 2 days, and inoculating with mixed cultures using pure strains or from natural sources. Preliminary results after 18 days of operation demonstrate approximately a 14 % lower biomass concentration in the effluent for the top wasting reactor and 17 % in the effluent for the bottom wasting reactor.

Exploring Soda Dam Travertine Mineralogy Through X-Ray Diffraction For A Better Insight Into Paleohydrology, Paleoclimatolgy And Geothermal History

THOMAS, G.K.1, CROSSEY, L.J.1, KARLSTROM, K.K1, PETERSON, E.1 and JEAN, A.2

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Travertine deposits from the Soda Dam springs in the Jemez Mountains, northern New Mexico, provide a record of the paleohydrology, paleoclimatology and geothermal history of the area. Travertine deposits occur along the Soda Dam fault just upstream of the village of Jemez Springs along the Jemez River. Travertine deposits here are predominately calcium carbonate precipitates from the Soda Dam hot springs and its precursors. Carbonates are a powerful tool because of the wide variety of information that can be received from slight changes its mineralogy and mineral chemistry. We employed X-ray diffraction to examine a suite of samples from the Soda Dam area. We used the Rietveld method to obtain calcite lattice parameters, magnesium occupancies, and to quantify concentrations of accessory minerals such as quartz, aragonite and dolomite. A goal is to test whether travertine age or stable isotope composition correlates with lattice parameters or mineralogy, and to evaluate whether perhaps temperature is recorded by mineralogic variation such as aragonite (hot) versus calcite (cooler). The calcite deposits also range from spars to micrites, suggesting possible differences in precipitation conditions. The samples analyzed ranged in age from modern deposits to deposits of > 500ka. Modern travertines were collected from deposits associated with waters that ranged from 20-40 C. We also examined laminated samples with alternating textures (e.g., spar and micrite). Preliminary analyses on the textural differences show encouraging results. All samples are composed of calicite. Using lattice parameters, we estimate magnesium content in the calcite ranging up to 5%. Site occupancy information shows a possibility of higher Mg contents. The micrites and spars of different ages also had measurable variations in magnesium content. These results are refined by a rietveld analysis, to take out the error involved with preferred orientation to make the results as accurate as possible. Additional analysis will determine determine if there is a correlation between trace element concentrations (Mn, Fe, Sr, Ba) and the magnesium content or lattice parameters. We anticipate that systematic examination of stable isotope composition and composition via xrd will allow greater understanding of the relative importance of factors such as fluid mixing and temperature variations in the travertine-depositing system.

TITLE:

Collection and Analysis of Dust and Soil Samples Adjacent to the Jackpile Mine, Laguna Pueblo, New Mexico

AUTHORS:

Susan F.B. Little (NMT), Daniel Cadol (NMT), Bonnie Frey (NMBG)

ABSTRACT:

Uranium mines and mills present a number of potential hazards to the local environment. Of particular relevance is the containment of contamination associated with these sites. If not properly maintained, tailings piles and ponds, and even the abandoned mines and mills themselves, may affect the surrounding communities and ecosystems.

This study aims to understand the migration of uranium from one such site, the Jackpile uranium mine and mill. By investigating the spatial, temporal, and chemical characteristics of this migration, and through the comparison of dust and soil samples, the proposed research will advance our understanding of risks related to legacy uranium mining and milling sites.

Fifteen Big Spring No. 8 (BSNE) stems (Custom Products and Consulting, Big Spring, TX) have been installed in the vicinity of the Jackpile uranium mine. Each stem has been outfitted with four BSNE sediment traps placed at heights of 0.25, 0.5, 1.0, and 1.5m. The locations of the sediment trap arrangements vary so as to address a number of issues related to vegetation density, topography, and distance from the mine.

Collected samples will be sieved into their respective size fractions. The size fractions will consist of 2mm to 0.18mm (10 to 80 mesh), 0.18mm to 0.09mm (80 to 170 mesh), 0.09mm to 0.02mm (170 to 635 mesh), and <0.02mm (-635 mesh). Once sieved, the samples will be split, and a fraction of the sample will be digested using a method involving the use of a hydrofluoric acid mixture and a hot block. Once total digestion has been achieved, each sample will then be processed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) to determine total uranium content.

Outlined here is the methodology and timeline for the remainder of this research, including the collection of dust samples and the analysis of both soil and dust samples. Also included is a discussion of previously used techniques as they apply to this study.

Triplet Formation Pathways in Poly (3-hexylthiophene) Nanofibers

Alan Thomas, University of New Mexico

Photoluminescence (PL) of single poly (3-hexylthiophene) (P3HT) J-aggregate nanofibers (NFs) exhibits strong quenching under intensity-modulated pulsed excitation. Initial PL intensities (I0) decay to steady-state levels (ISS) typically within ~1-10 μs, and large quenching depths (I0/ISS >2) are observed for~70% of these NFs. Similar studies of polymorphic, H-aggregate type P3HT NFs show much smaller PL quenching depths (I0/ISS =~1). P3HT chains in J-type NF π-stacks possess high intrachain order, which has been shown previously to promote the formation of long-lived, delocalized polarons. We propose that these species recombine nongeminately to triplets on time scales of >1 ns. The identity of triplets as the dominant PL quenchers was confirmed by subjecting NFs to oxygen, resulting in an instantaneous loss of triplet PL quenching (I0/ISS ~1). The lower intrachain order in H-type NFs, similar to P3HT thin-film aggregates, localizes excitons and polarons, leading to efficient geminate recombination that suppresses triplet formation at longer time scales. Our results demonstrate the promise of self-assembly strategies to control intrachain ordering within multichromophoric polymeric aggregate assemblies to tune exciton coupling and interconversion processes between different spin states.

Impacts of Conventional Uranium Mining on Groundwater in the San Juan Basin

Katie Zemlick and Bruce Thomson, University of New Mexico

With few exceptions, all conventional sources of electric power are associated with large volumes of water to produce the fuel and/or generate the electricity. Growing electric power demands thus result in increasing impacts on water resources, especially in the arid southwest. Electricity production from nuclear power provides 19% of total US energy demand, but more than 83% of the required uranium is currently imported. It is estimated that uranium reserves in the San Juan Basin in northwestern New Mexico contains nearly 600 million pounds of ore, primarily in the Morrison Formation, leading to renewed interest in uranium mining in the basin. However, most of these reserves are located in high quality and productive aquifers consequently future underground development would have large impacts on an already limited resource.

It is estimated that uranium reserves in the San Juan Basin in northwestern New Mexico contains nearly 600 million pounds of ore, primarily in the Morrison Formation, leading to renewed interest in uranium mining in the basin. This paper describes a spatial-compartmental (Roach and Tidwell, 2009) modeling study within a system dynamics framework that explores relationship between uranium development and water resources in the region. Results suggest that storage loss and cones of depression in the vicinity of potential mines are significant and vary largely as a function of sub-regional geology and groundwater hydrology.

The basin was divided into nearly 300 interconnected cells to account for geologic and hydrologic variability and a spatial-compartmental (Roach & Tidwell, 2009) or mixing cell approach within a system dynamics framework was applied to model groundwater flow and the impacts of uranium mining on groundwater resources in the Morrison Formation. Results from the model simulations show storage loss in cells in the vicinity of potential mines, very large cones of depression and extraction of large volumes of water associated with mining. The model suggests that the impacts of uranium mining on groundwater vary largely as a function of sub-regional geology and groundwater hydrology.

Keywords: uranium, water resources

NM EPSCoR Research Tools Webpage

Su Zhang, Anjanette Hawk, Isis Serna, and Karl Benedict

In an effort to help NM EPSCoR researchers achieve efficient data management, a webpage has been developed by the NM EPSCoR Cyberinfrastructure team and NM EPSCoR Website administrator. This webpage contains a vast of array of tools and technologies, including geographic information systems, database management, statistical analysis and visualization, and metadata. Each tool or technology provides a combination of description and review to help researchers select the most appropriate one. This webpage also has basic searching function, which enables researchers to search tools that meet their criteria. In addition, researchers can filter tools by license type or tool type.

ABSTRACT

Swagotom Sarker, New Mexico State University

The presence of toxic Cr^{6+} is one of reasons of severe water pollution. In contrast to Cr^{6+}, Cr^{3+} is not carcinogenic. We expect to show here how morphological differences in different molybdenum disulfide (MoS_2) nanostructures influence the conversion of Cr^{6+} to Cr^{3+} as well as its removal from water under a photocatalytic process.

Studying the surface expressions of potential geothermal systems in northern New Mexico

Marisa Repasch, Karl Karlstrom, Laura Crossey, and Valerie Blomgren
University of New Mexico

Fluvial systems are sensitive to active tectonic processes, and the northern Rio Grande provides an ideal location to evaluate neotectonic influences on river integration and incision. Mantle-surface interactions may be easily recognized through tomographic imaging of the upper mantle; mantle tomography images from the EarthScope Transportable Array and CREST show a 100-km-scale zone of low-velocity, potentially upwelling mantle beneath the Jemez volcanic lineament, which extends northeast through the southern Rockies and underlies the northern Rio Grande rift. The Rio Grande flows across the Jemez lineament and several fault systems appear to have driven differential rates of river incision. In addition to low-velocity mantle domains, modern tectonic signals within the Rocky Mountain-Rio Grande rift region include post-Miocene Quaternary faults, young volcanism along the Jemez lineament, springs rich in CO_2 and mantle helium (^3He) along fault zones, and travertine deposits that record significant CO_2 degassing. Based on these data, I hypothesize that neotectonic mechanisms, including regional mantle-driven uplift and faulting, related to the Jemez lineament, enhanced river incision in the northern Rio Grande rift, and led to the recent (post-5 Ma) evolution of the Rio Grande into a through-flowing river from the San Juan Mountains to the Gulf of Mexico.

I will test this hypothesis through provenance analysis of detrital sanidine and zircon grains in paleo Rio Grande sand deposits. Provenance will help us to understand how the river's headwaters have changed in response to broad-scale surface uplift. Additionally $^{40}Ar/^{39}Ar$ dating is underway on 2 to 5 Ma basalts that overlie tectonically offset river gravels. These ages will provide a datum for calculation of river incision rates over time and space. Using these data, I will be able to reconstruct paleoprofiles of the Rio Grande to test how faulting and post-5 Ma uplift have influenced its development. Results of this study will contribute to our understanding of the spatial and temporal scales of low-velocity mantle domains in the northern Rio Grande rift in the last 5 Ma, which has implications for the longevity of potential geothermal systems in New Mexico.

Solar driven conversion of CO2 to formate and methanol

Hanqing Pan, New Mexico Tech

Carbon dioxide (CO_2) is an abundant greenhouse gas that contributes to global warming, and anthropogenic CO_2 has steadily increased in concentration over the past fifty years. One way to reduce atmospheric CO_2 is through chemical carbon mitigation, an approach which traps atmospheric CO_2 and converts it to a useful product without the use of additional CO_2 generating power sources. This approach can lead to methanol as an end product, a potentially useful fuel. This idea of "methanol economy", pioneered by Chemistry Nobel laureate George Olah, has been highlighted as an alternative to using hydrogen as fuel because methanol is renewable and more readily transportable. The overall goal of this project is to catalytically convert CO_2 to formate ($CHOO^-$), and eventually to methanol (CH_3OH) using ambient solar energy.

This project is focused on evaluating different semiconducting materials as catalysts such as micron- and nano-sized zinc sulfide and copper (I) oxide. This oxide was selected based on its lower band gap relative to zinc sulfide. The catalysts were characterized by dynamic light scattering (DLS) and BET surface area measurements. Cyclic voltammetry was performed to estimate the bandgap energies of the catalysts. Photo-experiments were performed using a buffer system and along with the above mentioned catalysts. Ion chromatography was used to quantify formate concentration. Based on our results, we have demonstrated that nanoparticulate zinc sulfide is a more effective photocatalyst than micron size ZnS in the photoreduction of bicarbonate to formate.

The next step is choosing a suitable photosensitizer that is able to donate electrons to an acceptor when exposed to sunlight. Macrocyclic materials such as porphyrin and phthalocyanines have been evaluated as photosensitizers because they are stable and do not undergo photo-reduction. These systems are studied by cyclic voltammetry, UV-Vis and fluorescence spectroscopy. Our aims for this project include selecting both a semiconductor catalyst with valence band and conductor bands compatible with the HOMO and LUMO levels of macrocyclic photosensitizers in order to reduce carbon dioxide to formate (and eventually methanol) using ambient solar energy.

Uranium Mobility and Chemical Interactions along the Rio Paguate Adjacent to the Jackpile Mine, Laguna Reservation

Blake, J., DeVore, C., Avasarala, S., Ali, A.S., Roldan, C., Bowers, F., Artyushkova, K., Spilde, M., and Cerrato, J.M.

An investigation of the chemical interactions and mobility of uranium (U) and co-constituents near abandoned mine wastes was performed at a site located in Laguna Pueblo, New Mexico. The legacy of U mining activities in New Mexico has resulted in a number of abandoned mine sites that have not been adequately managed or remediated. Elevated U concentrations (ranging from 30 to 710 µg/L seasonally) in surface water below an abandoned uranium mine were detected using inductively coupled plasma mass spectrometry (ICP-MS); these U concentrations significantly decrease (5.77 to 10.0 µg/L) downstream at a reservoir five kilometers below the mine. Our water data suggest that U forms aqueous complexes with carbonate and calcium which could contribute to U mobility. Although U concentrations in stream water are high, acid digestions (performed using hydrochloric and nitric acid) reveal that there is limited U accumulation, with most sediment concentrations are near the 3 mg/kg crustal average, in co-located stream bed and bank sediments. However, U concentrations in sediments in a wetland approximately 4.5 Km downstream of the mine are 4 times the background concentrations in the area. Salt cedar roots from the sample site adjacent to the mine have U concentrations of 55 mg/kg and decrease to 15 mg/kg downstream of the mine. A grass root concentration in the wetland is 22 mg/kg. Discharge measurements from March 2015 reveal a 1.42% increase in discharge of the Rio Paguate downstream of the mine site, but an 11% decrease in discharge further downstream (and just above the wetland). Elemental flux calculations (Discharge * concentration) of U reveal an 800% increase of U flux from 100 m upstream of the mine to the sampling site adjacent to the mine, an 18% increase of U flux just downstream of the mine, followed by a 23% decrease in U flux just above the wetland. This study contributes to better understanding the fate and transport of metals in surface water and sediments close to the mine waste, which is essential to determine human health implications resulting from exposure to these metals in neighboring communities.

Elevated Concentrations of U and Co-occurring Metals within Abandoned Minewaste on a Native American Community

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The interfacial processes affecting the mobility of uranium (U) and other co-occurring metals (e.g. As, V, K, Fe,) from abandoned uranium mine wastes in Northeastern Arizona were assessed using spectroscopy, microscopy and aqueous chemistry techniques. The concentrations of U (67 – 170 µg/L) in surface water source samples (~pH ranges from 3.8 to 7.4) collected close to these abandoned mine wastes were higher than the EPA maximum contaminant limit of 30 µg/L. Elevated concentrations of U (6614 mg/kg), V (15814 mg/kg), and As (40 mg/kg) were detected in abandoned mine waste solid samples. X-ray photoelectron spectroscopy analyses detected U (VI), As (0, I, III and V) and Fe (II (73%), III (27%)). Electron microscopy (SEM and TEM/EDS) and X-ray absorption spectroscopy analyses identified a uranyl vanadate phases similar to carnotite [$K_2(UO_2)_2V_2O_8$]. The proportional release of U and V into solution was observed for batch experiments using 10 mM ascorbic acid (~pH 3.8) after 264 hours of reaction. A similar release was observed for As and Fe after 2 hours of reaction using the same experimental conditions mentioned previously. Lower concentrations of U, V, As, and Fe were detected in batch experiments using 10 mM bicarbonate (~pH 8.3). Our results suggest that adsorbed phases, and mineral phases such as carnotite and an As-Fe-bearing phase control the mobility of U and As in these abandoned mine wastes. This study contributes to better understand the factors that control the fate, mobility and transport of metal contaminants at abandoned mine waste sites.

Abstract

Olivia Chavez, New Mexico Tech

Microbiology of U-contaminated sites in New Mexico's Uranium Belt- a new NM EPSCoR project

The project spotlights the microorganisms in uranium-contaminated soil, specifically in the Jackpile Mine of Laguna Pueblo and the Section 12 mine at Ambrosia Lake. Previous studies have shown that some metal-reducing bacteria such as *Shewenella* and *Geobacter* are able to reduce U(VI) into the insoluble uranium oxide uraninite. The project is using small subunit rRNA gene-based clone libraries and high throughput metagenomics sequencing to identify the dominant members of the microbial communities along with their metabolic capabilities. Preliminary work shows the presence of bacteria from the *Planctomycetes* and *Acidobacteria* phyla in mine waste from the Section 12 mine. Metagenomic sequencing should reveal whether or not the genes encoding metal reduction are present in the Jackpile mine sites. If there are organisms in the soil that can reduce soluble U(VI) to uraninite, it will be indicative that there is potential to immobilize the uranium contamination .

Geochemistry of White Rock Canyon Springs, Northern New Mexico

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The Rio Grande runs through White Rock Canyon in North-Central New Mexico. White Rock Canyon is positioned on the East flank of the Jemez Mountains on the edge of Pajarito Plateau and exposes volcanic rocks related to both the Bandelier tuff eruptions and basalts of the Cerros del Rio volcanic field. Numerous springs emerge along the Rio Grande and along canyon tributaries. Previous workers examined spring water chemistry to inspect the possibility of environmental contamination from anthropogenic activities on the Pajarito Plateau. The purpose of this study was to resample springs and gases at selected sites to deduce likely groundwater flow paths based on geochemical parameters. This study is part of a regional examination of the extent of the Valles Caldera geothermal system and regional fault zones in influencing ground and surface water quality. We also compare results to previous studies. Samples were taken in March, 2015. The samples were analyzed for major ions, trace elements, and stable isotopes of water. In addition to the examination of this chemistry, gas chemistry will also be analyzed. Spring temperatures ranged from 11 to 20 degrees C. The pH ranged from 6.2 to 8.35 and total dissolved solids (TDS) are generally low (100-300 mg/L). Alkalinity ranges from a low of 80 ppm to a high of over 200 ppm as bicarbonate. The springs are uniformly higher in Br, F and silica concentration relative to the Rio Grande, although Li concentrations are similar. Sulfate concentrations are uniformly low in the spring waters relative to the Rio Grande. As gas and stable isotope data become available, multiple tracers can be applied to examine reasonable end-member mixing models to ascertain whether the waters mix with a geothermal component. Preliminary examination of major ion chemistry indicates that the waters are calcium-bicarbonate dominated and dominated by meteoric recharge.

Using Multiple Tracers to Evaluate Hydrothermal and Meteoric Water Mixing in North-Central New Mexico

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Mantle helium has been identified within surface and shallow groundwater in the Colorado Rockies, Jemez Mountains, and northern New Mexico in several previous studies. We examine a suite of springs in the southern San Luis basin and surrounding areas and categorize them based on geochemistry of both water and gas. Consideration of multiple chemical tracers (including gases) will help to better understand the nature of the regional geothermal systems. The springs and thermal wells of northern New Mexico have been grouped by geologic setting (major fault structures and hydrostratigraphic units) and we use multiple tracers to identify end member chemistry. Our methods include major ion chemistry, stable isotopes, gas abundance, and helium isotope analysis. Each tracer aids in understanding mixing between shallow and geothermal sources.

Our preliminary results show mixing trends using major ion compositions, non-reactive gas and helium isotope diagrams, with deeply-circulated fluid end members defined by Ojo Caliente and Ponce de Leon geothermal springs. The major ion compositions show two possible deep end members, Ojo Caliente, Na-HCO_3 waters, and Ponce de Leon, Na-SO_4 waters. Gas abundances, in particular the non-reactive gases Ar-N_2-He, compare dissolved gases in spring samples to air. Deeply derived end members typically have higher helium relative abundances. Our springs show water mixing ranging from deeply derived sources to air-like compositions, with Ponce de Leon along the mixing line. Helium isotope analysis reveals the presence of a mantle component. Several of our samples show 3-4% mantle derived helium assuming a MORB end member of 8 RA (where RA is the $^3He/^4He$ ratio of air). Our initial conclusions are that Ojo Caliente is a carbonic spring with mantle derived volatiles, and springs along the Embudo fault have similar R_c/R_a values as Ojo Caliente but are not carbonic suggesting different geothermal end members. The use of multiple tracers will allow us to make further conclusions concerning proportions of mixing, groundwater quality degradation, and to apply the gas compositional and isotopic results to better understand geothermal influences on surface systems of the southwestern US.

Lipid Extraction from Algal biomass cultivated on Dairy Wastewater for Biofuel Production

Tanaka Pfupajena, Eastern New Mexico University

As we know the fuel we use on a daily basis in our vehicles and other equipment, are nonrenewable, as a result, the world is running out of supplies of fuels. Many alternatives to using natural reservoirs as sources of fuel have been exploited and one of those that has been studied for a long time and people had once lost interest in but now it has gained popularity again as the problem gets worse is the use of algae as a source of biofuel. In this project we investigate the use of microalgae cultivated from dairy wastes to produce biofuels. Algae is also an inexhaustible source of energy, nutrients and raw material. This alternative will meet the transportation fuels requirements, and will be a good alternative to current fuels since microalgae consumes carbon dioxide in the atmosphere. When microalgae is grown and harvested, the biomass obtained contains lipids which are used to produce biofuels, these lipids are extracted in different ways, in this project we used Sohxlet extraction to extract the lipids and Gas Chromatography Mass Spectrometer to characterize the lipids, the extract from the biomass also contains the green pigment chlorophyll which needs to be separated from the lipids, for this process we use reverse Column chromatography to separate the different components. We found out that microalgae can be grown in the region of Eastern New Mexico and its biomass does contain lipids useful for the production of biofuels.