Feasibility of Using Computer-Assisted Software for Recognizing Individual Rio Grande Cooter (*Pseudemys gorzugi*)

Thanchira Suriyamongkol and Ivana Mali

Mark-recapture methods used in population demography studies involve marking of animals, such as tagging, notching, and tattooing. These techniques are invasive and potentially harmful to the animals. Photo-identification using natural animal markings is less invasive and has become more widely used for a range of taxa including invertebrates, fishes, reptiles, amphibians, and mammals. During 2016 and 2017, we studied the demographics of the Rio Grande cooter (*Pseudemys gorzugi*) using traditional mark-recapture techniques (i.e., shell notching and toe clipping). However, *P. gorzugi* displays plastral marks that could potentially be used for individual recognition. Because the photo-identification process 'by-eye' is time consuming, we tested the efficiency of three pieces of software: I^3S Pattern$^+$, Wild.ID, and APHIS, for individual identification of *P. gorzugi* using plastron pattern. Matching results of each program were generated into ranks with the 1st rank being the most likely match. Within the top 20 ranked images, Wild.ID yielded the highest number of correct matches (83.87%), followed by APHIS (ITM; 69.35%), APHIS (SPM; 67.74%), and I^3S Pattern$^+$ (61.29%). We found the quality of photos significantly contributed to the software effectiveness, however turtle age and plastron wear did not affect the accuracy of the photo-identification software. We concluded that Wild.ID can be used as a non-invasive photo-recognition technique for *P. gorzugi* in a short-term population study.

Keywords: photo-id, wildlife, turtle, conservation

Twenty Years Of Herping: Updated Visual Representation of Species Richness In New Mexico

Vinicius Ortega-Berno, William A. Parish, And Ivana Mali
Department of Biology, Eastern New Mexico University, Portales, NM 88130

Based on herpetofaunal records, New Mexico is one of the most diverse states in the American Southwest. We visually summarized reptile and amphibian diversity in New Mexico using occurrence data from the past 20 years. We also identified patterns of species richness by county and discuss survey bias as a factor. In general, northwestern counties had the lowest number of species while central and southwestern regions had the highest numbers of species. We also recognized species-rich counties with few to no new county records in the past 20 years as areas that potentially reached survey saturation.

Keywords: Herpetofauna, Richness, New Mexico.

Wastewater Remediation and Indoor Cultivation of Algae for Biodiesel Production

Jayamini Mudugamuwa Hewage, Eastern New Mexico University

Microalgae has been used in research for biodiesel production for many years. The reason for choosing microalgae rather than other lipid containing sources is because algae takes up carbon dioxide, a greenhouse gas and can be cultivated in any harsh condition. In addition to being used as a possible biofuel source, algae is also being used as a potential food source for humans and animals, a major ingredient in the cosmetic and pharmaceutical industries. Currently another issue that the world faces is disposing of dairy and agricultural wastewater. This research is based on cultivating algae in untreated dairy wastewater. This wastewater comes from a local Portales dairy near the university and it contains nutrients which facilitate the growth of algae. Using indoor cultivation in a photobioreactor, giving artificial light conditions, the growth of algae in wastewater is monitored to maximize biomass productivity. The growth rate and biomass concentration are obtained from UV-vis spectroscopy by determining the optical density values at a specific wavelength. The dairy wastewater is not directly applied for the growth, but standard medium is used to dilute it to a usable range. Procedures are followed to make the wastewater suitable for the cultivation of algae. The wastewater before and after cultivation is examined to obtain the nutrient uptake of algae for nitrogen and phosphorus. The lipid in dry algae is extracted using Soxhlet extraction. The percentage lipid content in indoor and outdoor cultivation is compared, also the different fatty acids found in both cultivations ae determined using GC-MS technique.

Key words- microalgae, biodiesel, GC-MS, indoor cultivation

Mineralogy Controlled Dissolution of Uranium from Airborne Dust in Simulated Lung Fluids (SLFs) and Possible Health Implications

Eshani Hettiarachchi[a], Shaylene Paul[b], Daniel Cadol[c], Bonnie Frey[d], Gayan Rubasinghege[a]*

a. Department of Chemistry, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801.
b. Navajo Technical University, Lowerpoint Road, Crownpoint, NM 87313.
c. Department of Earth and Environmental Science, New Mexico Tech, 801 LeRoy Pl, Socorro. NM 87801.
d. New Mexico Bureau of Geology, New Mexico Tech, 801 LeRoy Pl, Socorro. NM 87801.

The recent increase in cardiovascular and metabolic disease in the Navajo population residing close to the Grants Mining District (GMD) in New Mexico is suggested to be due to exposure to environmental contaminants, in particular uranium in respirable dusts (fine dust small enough to reach gas exchanging/ alveolar region of lungs). However, the chemistry of uranium-containing-dust dissolution in lung fluids and the role of mineralogy are poorly understood, as is their impact on toxic effects. The current study is focused on the dissolution of respirable-sized U-containing-dust, collected from several sites near Jackpile and St. Anthony mines in the GMD, in two simulated lung fluids (SLFs): Gambel's solution (GS) and Artificial Lysosomal Fluid (ALF). We observe that the respirable dust includes uranium minerals that yield the uranyl cation, UO_2^{2+}, as the primary dissolved species in these fluids. Dust rich with minerals uraninite and carnotite is more soluble in GS, which mimics interstitial conditions of the lungs. In contrast, dust with low uraninite and high kaolinite is more soluble in ALF, which simulates the alveolar macrophage environment during phagocytosis. Moreover, geochemical modeling, performed using PHREEQC, is in good agreement with our experimental results. Thus, the current study highlights the importance of site-specific toxicological assessments across mining districts with the focus on their mineralogical differences.

Keywords: uranium, lung fluids, heavy metal inhalation

Size Effect of Gold Nanoparticles on Graphene Quantum Dots' Fluorescence Intensity

Yuwei Zhang, Zack Schroer, Jiao Chen
Department of Chemistry, New Mexico Highlands University, Las Vegas, NM 87701

Graphene quantum dot (GQD) is a new type of nanomaterials, which has gained great attention in many application fields, such as biological, optoelectronic, and energy-related fields. They have some unique properties, such as strong and stable fluorescence emission, good chemical inertness, outstanding biocompatibility, low toxicity, and low-cost preparation; Therefore, they have been applied in various biosensors as "fluorophores" Gold nanoparticles (AuNPs) are good quenchers to many organic fluorophores as well as GQDs. However, very limited studies have been focused on the mechanism of the AuNPs quenching on GQDs. This study will broaden the application fields of GQDs, especially in bioanalytical field and biosensor design.

Identifying and Controlling the Impacts of Mining Activities on Groundwater Quality in the State of New Mexico

Stacy Kuykendall[1], Pedram Roghanchi[1]
[1] Department of Mineral Engineering, New Mexico Institute of Mining and Technology

Groundwater pollution poses a serious threat to both human health and to ecosystem stability. Sources of groundwater impacts from mining activities require identification to better develop solutions to protect. This research will identify solutions to this problem, while also raising awareness of the impact of abandoned mines on groundwater contamination. Abandoned mines in New Mexico are often unmonitored, and little data is available as to their effect on groundwater quality. Solutions to impacts that abandoned mines have on groundwater quality will be recommended by determining monitoring procedures and cost-effective cleanup plans based upon the level of groundwater contamination. Both the mining industry and regulatory agencies need to employ advanced treatment techniques to protect groundwater from the influence of closed and abandoned mines to minimize environmental impacts. This research will develop strategies to minimize that disturbance both to the groundwater and to the surrounding habitat. It is evident that continued environmental stewardship and a focus on future cleanup plans and ongoing mine site restoration should be a part of every mine's operating process.

KEYWORDS: Groundwater; mining activities; abandoned mines; treatment techniques; remediation.

The effect of transcranial direct current stimulation (tDCS) on audition

Audrey M. Morrow, Amie Amiotte, Michael C. Hout, Justin MacDonald
New Mexico State University

Individuals can experience hearing impairments from both structural and functional changes. Several auditory processing functions have shown to be enhanced with transcranial direct current stimulation (tDCS) in normal hearing individuals, such as improved syllable identification and language learning when applied to language areas. However, there is limited research aimed at using tDCS to improve individual hearing abilities in a way that could benefit those who experience hearing difficulties. This study used two experiments to identify whether there were changes in speech perception or tone detection in normal hearing individuals when anodal tDCS was applied to auditory areas of the brain. Experiment 1 bilaterally stimulated the primary auditory cortices (T3 and T4) for 10 minutes each, counterbalanced. These areas are contained in the superior temporal gyrus and mediate our ability to hear and process auditory input. Experiment 2 stimulated the left posterior superior temporal gyrus (halfway between T3 and T5) for 20 minutes, an area which contains Wernicke's and Broca's areas and is heavily involved in processing sounds. In both studies, we used a sham stimulation setting for the control group. There were no significant differences between stimulation and sham condition in either experiment for either task. These results suggest that this level of audition may be reliant upon structural components rather than functional or auditory processing changes.

Keywords*:* transcranial direct current stimulation (tDCS), audition, auditory cortex, superior temporal gyrus

Bluetooth Operation Verification Via Monitoring The Transmission Pattern Using Machine Learning

Abdelrahman Elkanishy, New Mexico State University

Bluetooth is a widely-used wireless communication protocol in small portable devices due to its low energy consumption and high transfer rates. Manufacturers normally buy their Bluetooth chips from third-party suppliers, which are then integrated into a complex hardware-software stack with a variety of potential vulnerabilities. Direct measurement of the output can help security functions prevent unauthorized data transmission. This work proposes a compact supervisory circuit to classify the operation of a Bluetooth chip at low frequencies by monitoring the radio frequency (RF) output of the Bluetooth chip through an envelope detector. The idea is that the envelope detector and classification algorithm can be inexpensively fabricated on a low-frequency integrated circuit in legacy technology and/or with minimal area. When the supervisory circuit detects abnormal behavior, it can be configured to shut down the Bluetooth chip. Using features extracted from the envelope of the RF output signal, we are able to train several machine learning (ML) algorithms to classify different Bluetooth operation modes and parameters such as operation profile, distance between the paired devices, and number of connected devices. In this work, we demonstrate ML models that can separate Bluetooth advertising and transmit/receive modes with ~ 100% accuracy and classify the operation profile of the Bluetooth chip with ~ 100% accuracy.

Heat Management in Underground Mines: Personal Risk Factors, Mitigation Practices, and Industry Actions

Elaheh Talebi[1], Pedram Roghanchi[1]
(1) Department of Mineral Engineering, New Mexico Institute of Mining and Technology (NMT)

There are many mining hazards that have long-term effects on the health, safety, and the life quality of mine workers. Some of these effects can be diagnosed immediately, others manifest after a period of time. Heat is a hazard that may be underestimated in many mining operations because people are unaware of its effects due to a lack of education in salient consequences of heat exposure. Hot and humid environments can negatively impact the health, performance, overall productivity, and the ability of the underground workforce to perform their job safely. The human body's reaction to excessive heat stress is different from person to person predominantly because the individual response to heat exposure is related to the each person's state of health and personal risk factors. Therefore, it is crucial to implement a heat management protocol to minimize the negative effects of heat exposure in underground mines. This project aims to promote heat management to control heat exposure and reduce heat-related incidents in the mining industry three levels; the individual level, corporate level, and industrial level. For each level, climatic heat stress risks, mitigation practices, and prevention methods are discussed. Furthermore, steps needed to implement the best heat exposure controlling techniques are addressed. We hope to find significant data that leads to policy recommendations to improve working conditions in underground mines.

KEYWORDS: Heat exposure; heat stress; heat-related incidents; mitigation practices

Attentional sensitivity and behavioral modeling of social grooming among immature East African chimpanzees (*Pan troglodytes schweinfurthii*) of the Kanyawara community at Kibale National Park

Kris Sabbi[1], Melissa Emery Thompson[1,2], Martin N. Muller[1,2], Zarin Machanda[2,3], Emily Otali[2] and Richard W. Wrangham[2,4]

[1]Anthropology, University of New Mexico, [2]Board of Directors, Kibale Chimpanzee Project, [3]Anthropology, Tufts, [4]Human Evolutionary Biology, Harvard

Recent developmental studies of wild chimpanzees (*Pan troglodytes schweinfurthii*) at Gombe argue that sex differences in adult sociality may be rooted in mothers adjusting their social strategies when they have sons versus daughters. Though early life social experience has important effects on social behavior later life, underlying sex differences in attention to and modeling of social interactions could exacerbate differential social exposure to encourage diverging social strategies during development. If so, adult social patterns should be reflected in immatures' attentional sensitivity to social interactions. Since adult male chimpanzees groom peers more often than females, young males should spend more time watching neighbors' grooming bouts and be more likely than females to begin grooming bouts immediately following exposure. To test this, we video-recorded chimpanzees under 10 y.o. at Kanyawara (n=24) in Kibale National Park, Uganda, for two minutes immediately following the start of grooming bouts between their nearest neighbors. We then scored the amount of time that immatures spent watching (TSW) grooming bouts and whether that immature groomed a partner after watching. TSW increased with age (GLMM, Int=23.61, β_{age}=1.998, p=0.01) but there was no sex difference in TSW (p=0.39). However, males were inherently more likely begin grooming a partner immediately following exposure (logistic regression, Int=-3.39, $p<0.01$; β_{sex}=4.09, p=0.03) and, further, males that watched longer were especially likely to begin grooming ($\beta_{sex*tsw}$=0.08, p=0.03). This supports the conclusion that underlying differences in attentional sensitivity may amplify the effects of differential exposure to shape the development of sex-typed social strategies in wild chimpanzees.

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Accurate Positioning of Quadrotor UAVs using a Wii Remote Camera and Signal Modulations for Outdoor Precision Landing

Brian Molley[1] and Kooktae Lee[1]
[1] Department of Mechanical Engineering, New Mexico Institute of Mining and Technology

Over a few decades, rapid advances in micro-controller and sensor technologies have brought proliferation of quadrotor Unmanned Aerial Vehicles (UAVs). This type of UAVs has been widely used in a variety of fields including monitoring and inspection, surveillance, search and rescue, military, and drone delivery. In these missions, an autonomous flight feature becomes increasing important and popular as it can provide autonomy of quadrotor UAVs during missions with more accuracy without human intervention. Unlike the autonomous flight stage, where the position is provided by GPS, the autonomous landing requires higher accuracy as collisions that may occur during the landing stage can cause severe damages. Although many research works have contributed to the development of precision landing, they either require expensive platforms or have been developed for indoor use. In this research, we develop a low-cost quadrotor platform for outdoor precision landing using Wii remote camera and Infra Red (IR) beacons. As this camera is sensitive to the sunlight that contains broad spectrums of IR light waves, the reflection of sunlight from environments may disturb the accurate positioning of a quadrotor. To circumvent this issue, we implement a signal modulation technique in which the IR beacons from the ground station transmit a modulated signal to the camera. If the camera receives this modulated signal with fixed pattern, the quadrotor recognizes this light source and hence, differentiate it from sunlight disturbances. This method will significantly contribute to the outdoor UAV precision landing in a cost-efficient manner.

Keywords: UAV, Precision Landing, Signal Modulation

Ray Matrices and SpMV Compression Methods

Ammar ELWazir, David Voelz, and Abdel-Hameed Badawy
Klipsch School of Electrical and Computer Engineering, New Mexico State University

Ray tracing is an efficient way to determine the performance of an optical system. For the ray transfer matrix approach, all interfaces and optical components, such as mirrors, lenses and distances, are define by a 2x2 matrix known as the ABCD matrix. The ABCD matrix transfers the input ray parameters (height and angle) to new output ray parameters and multiplying the component ABCD matrices gives the overall system matrix. However, complicated optical systems may have tens or hundreds of component matrices and hundreds of rays that need to be traced. Furthermore, the optimization of the system component parameters often takes many repetitions of the ray tracing process. Therefore, improving processing speed and reducing data storage is important. One solution is to use multiprocessor hardware, such as GPUs, to reduce the time for the matrix calculations but this solution can be expensive. In this work, we discuss an approach to improve the efficiency of the matrix multiplications. Most of the matrices for interfaces, mirrors, lenses or even distance contain zero values so we apply the coordinate format compression method to compress these matrices so zero values are excluded. The significant values are placed in a vector and their row and column indices are stored in two vectors. We split every row in the matrices to be multiplied in a single thread so it can work in parallel and the process time for all the multiplications is the just the time to multiply every row. In initial testing with systems involving several matrices and without the multithreading part, we found out that the process time is approximately 60% of the time required for conventional matrix multiplication. When multithreading is implemented, we are predicting the time to finish the multiplication will be equal to the time for the multiplication of only one row. For this work, we implemented a Graphical User Interface to test the compression approach and are currently considering how to combine the compression method with GPU systems.

I Can Fly if I Wanted To: Effectiveness of Tip Cross-Sectional Area versus Perimeter in Identifying Potential Lithic Armatures

Jackson Grady, University of New Mexico

Killing prey from a distance using complex projectile weapons is a behavior unique to *Homo sapiens*. The archeological remnants of these weapons are mostly limited to their lithic points, as their organic components have decomposed. In order to distinguish these points from stones fashioned for other purposes and more accurately determine the advent of this advanced technology, researchers have primarily utilized a measurement known as tip cross-sectional area (TCSA). This metric was thought to be the most ballistically significant one available for this purpose based on studies of high velocity projectiles. Sisk and Shea (2011) hypothesized that tip cross-sectional perimeter (TCSP) is a more useful ballistic measurement when identifying low velocity projectiles such as arrows and darts. To test this idea, we designed and printed six arrowheads divided into pairs with either the same TCSA but different TCSP, or the same TCSP but different TCSA. Our results support the Sisk and Shea hypothesis that TCSP is a better predictor of a point's penetration than TCSA. We also found that surface area, which is highly correlated to TCSP, may be the most useful ballistic measurement for low velocity projectiles. Utilizing TCSP and surface area, rather than TCSA, may allow archeologists and anthropologists to more accurately categorize points found in archeological sites prior to 40ka, a watershed moment in the development of modern human behaviors and population growth. If projectile weapons are identified prior to 40ka, their development may have served as a catalyst in the early cognitive evolution of man.

Changing the way water boils on surfaces

Lazar Cvijovic, New Mexico State University

Boiling of water to transfer heat has numerous applications, e.g., in power generation, water purification, and cooking. When water boils over a surface, substantial amounts of heat can be transferred from the surface to the water without causing a significant increase in the surface temperature; hence, boiling is also used in applications such as cooling of nuclear reactor rods and electronics where large temperature rises are prohibitive. However, when a large amount of heat must be removed from a small area through boiling, it encounters a crisis called the Critical Heat Flux (CHF) limit. At this limit, the rapidly generated vapor bubbles merge to form a vapor film on the hot surface which prevents liquid water to contact the surface. This project pursues a new type of surface, called the Binary Surface(s) (BiS), for extending the current CHF limits for the boiling of water.

A BiS is a highly wetting surface with many sub-surface micro-/nano-cavities, which are filled with a Non-Boiling Liquid (NBL) creating puddles around solid islands. The goal of this research project is to experimentally measure the CHF and the Heat Transfer Coefficient for the pool boiling of water on a copper-oil BiS (oil is the NBL) and compare them with those obtained on plain surfaces. Details of the BiS surface preparation and the boiling heat transfer experiments on these surfaces will be presented. This research helps to establish the feasibility of a new boiling enhancement mechanism that could have a significant impact in many critical fields.

Synthesis of Novel Ladder-Type Oligo p-Phenylenes for use in Organic Solar Cells

Vance Miller

The development of phenylene and fluorene based compounds has the potential to yield low-cost, readily available, semiconductor materials that can be used in a wide range of applications involving organic electronics. This study aims to synthesize specifically tuned nitrile-substituted ladder-type oligo-p-phenylenes to be later characterized and evaluated for applications in organic photovoltaics. These compounds have the potential to meet the charge carrier mobility, structural stability, affordability and ease of manufacture that is essential for large scale production components of the active layers in organic photovoltaics. The expected synthetic route for the target compounds follows a multi-step process involving multiple Suzuki cross-coupling, cyclization, alkylation, bromination, and lastly nitrile substitution reactions. Future instrumental assessments should reveal whether or not this material meets the criteria for use in the active layers of organic photovoltaics, specifically as an n-type semiconductor.

Bio-crude Oil Production From Organic Food Waste

Hengameh Bayat, Nicholas Soliz, Feng Cheng, Alan Moya, Jacob Usrey, Cesar Martinez Bejarano, Catherine E. Brewer, Umakanta Jena
Department of Chemical and Materials Engineering, New Mexico State University

In recent decades, food waste has been one of the most serious social, economic and environmental problems. In 2010, the U.S. discarded approximately 30.8 million tons of organic fraction food waste (OFFW), accounting for 14% of total generated municipal solid waste. OFFW is an inexpensive, energy-dense alternative to edible crops and has the potential to be converted into liquid transportation fuels. Most OFFW has high moisture content and is composed of carbohydrates, proteins, and lipids. Hydrothermal liquefaction (HTL) is a promising conversion methods for high-moisture content materials because HTL requires no initial drying, unlike the other thermochemical processes such as gasification and pyrolysis. HTL involves pressure-cooking of organic constituents in hot compressed water and produces an energy-dense liquid fuel, called bio-crude oil. This research targets the viability of HTL for OFFW and the effect of operating conditions on bio-crude oil yield and quality. OFFW was collected from lunch leftovers from Taos (cafeteria style) Restaurant at New Mexico State University, and characterized for physical and chemical properties. HTL of OFFW was performed using a 100 ml batch reactor at 240-295 °C, 15% OFFW solids loading, and 30 min. reaction time. Bio-crude oil yields ranged from 20-27% on a dry mass basis. HTL product characterization includes higher heating value, elemental composition, and chemical constituents. Preliminary findings suggest that HTL of OFFW can be effective for organic waste management and bioenergy production.

Keywords: Organic Food Waste; Hydrothermal Liquefaction; Bio-crude Oil

K-12 Education Component of Sustainable Bioeconomy for Arid Regions Project

Meshack Audu[1], Brian Treftz[1], Cathy Bradley[2], Tracie Mikesell[3], Umakanta Jena[1], Catherine E. Brewer[1]

[1]Department of Chemical & Materials Engineering, New Mexico State University
[2]Teacher, Lynn Middle School
[3]Teacher, Mesilla Valley Leadership Academy Middle School

Sustainable Bioeconomy for Arid Regions (SBAR) is a USDA-funded 5-year coordinated agricultural project (CAP) begun in September 2017 to develop guayule and guar bioeconomies for the desert Southwest region of the U.S. SBAR is led by the University of Arizona (UA) and includes New Mexico State University, Colorado State University, Colorado School of Mines, Bridgestone Americas, and USDA ARS. As one of nine regional CAPs, SBAR includes research, education, extension and outreach components. Research thrusts for the project include feedstock development and production (crop breeding, agronomy, irrigation engineering), post-harvest logistics and co-products (harvest and transportation optimization, value-added co-products, biomass conversion to biofuels), and sustainability modeling (techno-economic analysis, life cycle assessment). Extension and outreach efforts include grower workshops and demonstration plots, extension publications, and 4-H youth camps and programs.
With the development of hard rubber for tires, guar gum, animal feeds, chemicals, and biofuels from the two desert crops, there is a high potential for job creation. One goal of the SBAR education component is the development and implementation of STEM educational programs that will prepare the next generation of the labor force for those jobs. The SBAR Fellows program pairs graduate students doing research in SBAR-related fields with middle school science teachers to design and polish activities in formal classroom and informal settings. In summer 2018, six teacher-fellow pairs participated in a week-long 4-H biofuels camp hosted by UA, followed by a week of professional development to translate lessons learned in that camp for their classrooms in the 2018-2019 school year. The two New Mexico teacher-fellow pairs designed an afterschool STEM program called Guardians of the Biosphere to serve students at two middles schools in the Las Cruces Public Schools. Activities and demonstrations are built around the SBAR theme of guar and guayule for biofuels and bio-products, incorporating science, engineering and sustainability. Among the activities for the program are “dipping dots” liquid nitrogen ice cream, guar gum super-bubbles, conversion of vegetable oil into biodiesel, and creation of an aquaponics ecosystem for aquaculture and horticulture.

Keywords; Guar, guayule, sustainability, bio economy, professional development

Chemical Variations Among Particle Size Fractions: Examples from Uranium Deposits in New Mexico, USA

Marcus Silva, Virginia T. McLemore, John Asafo-Akowuah, Bonnie Frey, New Mexico Tech

Weathering of minerals involves surface reactions, and the rates of these reactions depend upon the available reactive surface area of the minerals. Mineral surface area is dependent on the mineralogy, chemistry, the extent to which the mineral is liberated from the rock matrix, particle size (especially mineral grain size), and the surface morphology (i.e., roughness of the mineral surface). Prior studies of metal deposits indicate that weathering is more pronounced in the fine-size fraction than in the coarse-size fraction, an observation consistent with the increase of surface area with decreasing particle size. Studies of chemical variations among particle size fractions can be used to 1) understand weathering of mine waste, 2) determine the best size fractions for prediction tests, such as humidity cell or other leach tests, 3) help plan and assess reclamation procedures, 4) understand the mobility of elements of concern, and 5) provide background data that can assist with the planning of future mining operations.

Four composite samples, sieved in the field to less than 12.5 mm, were collected from waste rock piles at two inactive uranium mines (Jeter and St. Anthony) in New Mexico and analyzed for major and trace elements. These samples were further sieved into six size fractions (12.5-4.76, 4.76-2, 2-0.5, 0.5-0.125, 0.125-0.001, <0.001 mm). The samples are heterogeneous and range in concentration from 24 to 11,050 ppm U. Chemical analyses indicate that U is correlated (R>0.6) with V, LOI, C, Zr, Y, Pb, As, Se, and heavy REE (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu). U, As, and C decreased in concentration with increase in particle size in the Jeter sample. However, U increased with increasing particle size or was concentrated in the middle sizes in the St. Anthony samples, whereas As and C had complex variations with change in grain size. These results suggest that weathering of certain U deposits may be more complex than previously thought and that this is largely tied to the organic material that hosts the uranium. However, more research is needed.

Joint Source-Channel Coding with Concatenated Spatially Coupled LDPC Codes

Ahmad Golmohammadi, New Mexico State University

Joint source-channel coding (JSCC) involves the use of a single coding scheme in order to encode data from a redundant information source (source coding/data compression) for reliable transmission over a noisy channel (channel coding/error correction). JSCC can be attractive in the non-asymptotic regime, where the residual redundancy of the source sequence can be used by the channel decoder to improve channel decoding. In this work, a method for JSCC based on concatenated spatially coupled low-density parity-check (SC-LDPC) codes is investigated. A construction consisting of two SC-LDPC codes is proposed: one for source coding and the other for channel coding, with a joint belief propagation-based iterative message passing decoder. Using a windowed version of the decoder, simulation results show a notable performance improvement compared to existing state-of-the-art JSCC schemes based on LDPC codes for approximately equal latency and complexity requirements.