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DUQUESNE UNIVERSITY

Duquesne University presentations at GSA Connects 2023

Sunday

Hall B, 8:00 am to 5:00 pm

Using Mixed Microbial Communities to Solubilize Critical Materials from Abandoned Mine Drainage Remediation Systems

Rowan Terra[1,2], Djuna Gulliver[2], and Nancy Trun[1]
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Abandoned coal mine drainage (AMD) can contain high levels of critical materials (CM), including rare earth elements. Several passive remediation systems for AMD in southwestern Pennsylvania precipitate CM in accessible locations. Microbial communities naturally occur within these systems and have the potential to resolubilize some elements relevant to industrial processes. We have characterized the CM levels in one of these systems using a variety of chemical analyses, including ICP-MS and ICP-OES. We have developed a lab-based system to evaluate re-solubilization of specific elements using either microbial communities, or isolated and characterized individual bacterial species. The mixed communities are being evaluated using bacterial 16S ribosomal gene analysis. Utilizing microbial communities to release industrially relevant elements can provide a valuable domestic supply for these critical materials, while using abandoned mine waste as a sustainable resource.

Hall B, 8:00 am to 5:00 pm

Characterization of Bacterial Manganese Reduction in Abandoned Coalmine Drainage that Contributes to the Re-mobilization of Pollutants

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In Pennsylvania, there are ~11,000 abandoned mines that pollute the environment. Passive remediation systems are constructed to treat abandoned mine drainage (AMD), designed to increase the pH and precipitate metals onsite. High levels of manganese (Mn) can cause staining, damage to water infrastructure, neurological deficits in children, and Parkinson-like symptoms. Passive systems are naturally colonized by microbes that can impact the remediation within these systems both positively and negatively. We have determined that in acidic AMD, manganese reduction is primarily geochemically based on pH. Whereas, in neutral AMD, manganese reduction can be microbially driven. However, the microbial mechanisms that contribute to this are poorly understood and characterized. Microbes that impact Mn reduction have been isolated using differential manganese reduction media as agar and broth. Despite manganese reduction in acidic systems being based on geochemistry, manganese reducers were detected in all ponds of the system. Manganese reducing isolates were identified via 16S sanger sequencing and whole genome sequencing. Within the neutral system of Wingfield Pines, the frequency of manganese reducers was determined using differential broth. Determining the microbial metabolism and genes involved in the resolubilization of manganese is of interest for biomonitoring system health, to determine what if any interventions can be done to slow or stop microbial driven manganese resolubilization, as well as future applications for biomining of AMD.

Tuesday

Hall B, 8:00 am to 5:00 pm

Comparison of Flood Extent Determination in the Limpopo River Basin, South Africa Using Elevation Data and Synthetic Aperture Radar

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The Limpopo River Basin (LRB) is a transboundary watershed that spans Botswana, Mozambique, South Africa, and Zimbabwe. It is home to over 18 million people, critical agricultural areas, and iconic conservation areas. The ecosystem services of the conservation areas are vital for downstream users. Variable precipitation across the LRB can cause flooding, which is difficult to predict or model. Flood extent data is limited to population centers or observation sites in conservation areas. To contrast methods of flood extent determination, we used two methods to examine a flood in Kruger National Park, South Africa, within the LRB. First, we used digital elevation model data from the Shuttle Radar Topography Mission to extrapolate water levels from known high-water data from observation points in the park. Second, we used synthetic aperture radar (SAR) data from Sentinel-1 to determine the flood extent. The primary advantage of SAR is that the radar signal can penetrate moderate cloud cover, which is not possible with optical remote sensing. The SAR-derived flood extent could be used to develop flood risk models based on river discharge statistics. This would have implications for flood extent risk, sediment transport, aquatic habitat remodeling, and water resources management.

Room 335, 10:40 to 10:55 am

Bacterial Nitrate Reduction Contributes to the Geochemical Oxidation of Iron and Subsequent Remediation of Acidic Abandoned Mine Drainage

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Abandoned mine drainage (AMD) in Pennsylvania pollutes 5,000 km of streams. Passive systems that remediate AMD can include settling ponds, vertical flow ponds, limestone beds, and wetlands that are designed to increase the pH and precipitate metals onsite, preventing metals from entering the watershed. High levels of iron (Fe) present in AMD cause staining, damage water infrastructure, can be toxic, is associated with an increased infection risk, and may lead to cancer. Passive remediation systems are naturally colonized by native microbes that can impact the remediation within these systems. In acidic AMD, iron oxidation from soluble Fe(II) to precipitated Fe(III) is mainly mediated by microbes. Within the acidic Boyce Park passive remediation system, we have isolated Paraburkholderia sp. AV18 that reduces nitrate to nitrite, followed by geochemical iron oxidation. Paraburkholderia sp. AV18 encodes periplasmic nitrate reductase, napA, in its genome that was used to develop novel primers to detect the expression of napA during nitrate reduction through reverse transcriptase PCR (RT-PCR). Understanding the microbial mechanism and genes involved in nitrate reduction coupled with indirect iron oxidation will allow us to determine the extent that nitrate reduction contributes to iron remediation by determining the abundance and expression of these microbes and their metabolic genes within the system.

Wednesday

Room 330, 8:05 to 8:20 am

Eastern Europe Holocaust Mapping Program: Recent Geoarchaeological Subsurface Investigations and Results from a High Impact Collaborative Undergraduate Research Program

Harry Jol[1], Philip Reeder[2], Sasha Kvasnik[1], Amik W. Redland[1], Joseph M. Reeder[2], Lauren Claas[1], Jake Cipar[3], Emma McConnell[2], Lydia G. Kruse[4], and Mikaela Martinez Dettinger[5]
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Many Holocaust geoarchaeological site investigations lack geospatial tools that will provide images of the subsurface in a non-invasive and non-destructive manner. In addition, our team focuses in educating undergraduate students on the use of geospatial tools. Due to this expertise, we have been invited to work with several Lithuanian and Latvian organizations to conduct collaborative original research at multiple locations, including killing sites located at Liepāja, Šķēde, Jungfernhof and Šeduva. Objectives for the project include providing a high impact academic experience for multiple students, including those from underrepresented populations, through a student-faculty collaborative international joint research project. The students acquire geospatial data (e.g., ground penetrating radar, unmanned aerial vehicles) at sensitive and significant Holocaust sites and disseminate results on ESRI StoryMaps while in the field. Upon return, the students will collate, process, plot, and analyze the collected geospatial datasets and work with collaborators and Holocaust survivors to interpret the data as well as publish results at professional conferences. Recent results will be presented that highlight the discovery and location of Holocaust mass burial pits and trenches. The experience provides a transformational international learning experience as well as providing cross-cultural and team-building skillsets. Results will be incorporated into lecture/lab components of classes that are being taught at our respective institutes, as well as presentations within our community, as well as incorporated into professional workshops/webinars. It is important that geosciences take an active role in helping identify hidden/forgotten sites of underrepresented populations.

Room 330, 8:20 to 8:35 am

A Subsurface Investigation with Ground Penetrating Radar in Šeduva, Lithuania: Do Holocaust Memorials Actually Mark the Location of Jewish Mass Graves?

Sasha Kvasnik[1], Jake Cipar[2], Lauren Claas[1], Lydia G. Kruse[3], Amik W. Redland[1], Joseph M. Reeder[4], Philip Reeder[4], Harry Jol[1], Mikaela Martinez Dettinger[5], and Emma McConnell[4]

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The genocide of WWII known as the Holocaust resulted in the death of 6 million Jewish people. The town of Šeduva in Lithuania had a growing Jewish population of 700 and in 1941, they were all executed. Over the past decade the town has placed multiple sculptures as memorials. A museum called “The Lost Shtetl” is presently being constructed to commemorate the memories of the Jewish people. The goal of the project is to answer the question about a memorial called “Adobe of the Star of Light” and whether it is located on the grave of the 27 Jewish victims murdered in the Liaudiškių Forest 10km southwest of Šeduva. Ground penetrating radar (GPR) provides information about graves in the subsurface non-invasively. GPR was the primary geophysics tool used to locate the buried deceased. The pulseEKKO Pro GPR with a 500MHz antennae frequency, 0.02m step size and line spacing of 0.25m was utilized. The EKKO_ProjectV5 GPR software allowed for the collation, processing, and interpretation of the 5mx30m grid containing 20 lines. The grid was on the west side of the memorial. Soil collected with a 6cm soil auger provide references for understanding the sediment layering in the GPR profile. The site was surrounded by a variety of deciduous and conifer trees with young oak and pine present closest to the target area. From the surface to a depth of 0.55m tree roots were seen throughout the grid. The location of the roots is characterized by hyperbolic reflections. An abnormal area in line 7 measuring 8m in length at a depth of 0.30m was sampled revealing tree roots and sandy soil with a Munsell hue of yellow-red (YR). Line 7 with a length of 14m at a depth of 2.3m-3.3m showed dipping reflections. The patterns seen on line 7 paired with grid depth slices raise the suspicion of human influences indicating that bodies may lie beneath the ground. A decomposed body that is 82 years old will be homogenous to the surrounding sediment samples in the site’s environment. Providing the community of Šeduva with the location of graves can give closure to people of Jewish descent by acknowledging an undocumented past. Knowing many of my ancestors were born and raised in the town of Šeduva elicits a unique connection fueled by local and international collaborators need for answers. GPR is a valued geoarchaeological tool that can identify features that illuminate the history below ground.

Room 330, 8:35 to 8:50 am

Changing Perspectives of the Holocaust Using Geophysics

Jake Cipar[1], Harry Jol[2], Philip Reeder[3], Lauren Claas[2], Lydia G. Kruse[2], Sasha Kvasnik[2], Mikaela Martinez Dettinger[4], Emma McConnell[3], Joseph M. Reeder[3], and Amik W. Redland[2]
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At least 300 Jewish people were executed by the Nazis and their Latvian collaborators near the lighthouse in the Liepāja Civil Harbor. Latvia and its Baltic counterparts, Lithuania and Estonia, are located on the Baltic coast and were all significantly impacted by the Holocaust. Testimony from a survivor of the Liepāja killings states the Jews were made to dig trenches, and upon being executed were buried in the trenches. The execution site is notable as the only one to have been filmed, done by a German man named Reinhard Wiener. Since 1944, when Luftwaffe aerial imagery of the area around the lighthouse was taken, the coastal dune region has become an industrial port complex, including new buildings. After WWII, in 1945, the State Extraordinary Commission of the USSR investigated the area, noting the existence of multiple execution sites. The primary goal of the research is to locate more execution trenches. A pulseEKKO SmartTow ground penetrating radar (GPR) system with 500 MHz antennae and a step size of 0.02m triggered by an odometer was used to image the subsurface. GPR emits electromagnetic signals into the subsurface, which are then reflected to the surface to the receiver antenna. Data were collected in a 7m x 20m grid [line separation 0.25m] located 25m NW of a WWI-era fortress. Topographical data of the grid were collected every 1m utilizing a survey rod and a Topcon RL-H4C laser leveler. The data were processed using EKKO_Project 5 software with the reflections being analyzed using radar stratigraphic principles. Review of the data shows a rectangular feature crossing the grid at (0,12) and (7,17) greater than 7m in length. The feature resides 0.8m below the surface and remains apparent for another 0.4m for a total thickness of 0.4m. A GPR line that transects our feature of interest shows a channel-like reflection pattern 3m wide and 0.4m thick. Based on our team's research, the rectangular reflection pattern is likely an execution trench. Similar reflection signatures have been identified by earlier research at the site. Based on the Wiener film, previously held perspectives of the lighthouse killings in Liepāja are that only one execution trench exists. However, based on our research in locating this interpreted execution trench, one can conclude more execution trenches exist in the coastal landscape by the lighthouse.

Room 330, 8:50 to 9:05 am

The Search for Holocaust-Era Mass Graves in Jewish Cemeteries in Latvia and Lithuania

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Research was completed at the Old Jewish Cemetery in Riga, Latvia, the Livas Jewish Cemetery in Liepaja, Latvia, and the Žaliakalnis Jewish Cemetery in Kaunas, Lithuania. A common practice used by the Nazis and collaborators in World War II, as part of the Holocaust, was to use existing Jewish cemeteries as places for mass burial. Each of the sites in this research have both shared and unique histories. Their shared history is that each was used for the burial of Jews for hundreds of years prior to World War II. The Old Jewish Cemetery in Riga was adjacent to the Riga Ghetto, and was used to bury individuals murdered in the ghetto. In Kaunas, an area of the cemetery is devoid of grave stones, and testimonies indicate that this area was used for the mass burial of Jews from the Kaunas Ghetto and other mass killings. In Liepaja, the history of Holocaust-related mass burials in the Livas Jewish Cemetery is unclear, but the local Jewish Heritage Foundation believes that there are mass graves within the cemetery. Methodologies for this research include the use of a pluseEkko Pro 500-megahertz ground penetrating radar (GPR) system. Electrical resistivity tomography (ERT) data was collected through a linear array of electrodes coupled to a direct current (DC) resistivity transmitter and receiver. Unmanned Aerial Vehicle (UAV) Photogrammetry and Multispectral Aerial Photography was also employed at each location. ERT and GPR data indicate three separate trench anomalies in the cleared quadrant of the Old Jewish Cemetery in Riga. The presence of these anomalies corroborates Holocaust survivor testimony that bodies were thrown over the cemetery wall and buried in that area. In the Žaliakalnis Jewish Cemetery in Kaunas, ERT and GPR data indicate an anomaly in the western part of the cemetery, and ERT data further indicates that other mass

graves may be present in other cleared sections. In Liepaja, preliminary GPR analysis indicates an anomaly in a cleared section of the cemetery. Based on these data, the ERT and GPR anomalies in all three cemeteries, correlated with Holocaust survivor testimony, have a high probability of indicating the location of mass graves. Future research directions include expanding the search areas in each cemetery, additional archival and testimony-based research, and the addition of other geophysical methodologies.

Room 330, 9:05 to 9:20 am

Uncovering the History of Jungfernhof Concentration Camp in Riga, Latvia

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Research was conducted in summer 2023 at the former site of the Jungfernhof Concentration Camp in Riga, Latvia. The main objectives of this research were to define the physical setting of the site, and to quantify land use history to determine the location of former camp buildings, and possible unmarked mass graves. Jungfernhof was created in December 1941 at site of the former Mazjumprava Manor Estate, on the Daugava River, to house nearly 4,000 prisoners in dilapidated barns and cattle sheds. During the harsh winter of 1941-1942, over 800 prisoners died from exposure and disease. In spring 1942 a mass grave was created within the camp, using dynamite to blast a hole in the still frozen ground, to hold their remains. Methodologies for this study included soil auguring, the use of a pulseEKKO Pro 500-megahertz ground penetrating radar (GPR) system, and comparative spatial analysis using overlays of a German military air photo from 1917, Google Earth satellite images, and maps from 1942 and 1947. The area's soil texture was mostly silt, with some sand, with a distinct clay layer one-meter below the surface. Soil parent material is derived from overbank deposits from the Daugava River. Soil structure type is predominately blocky, and structure grade is weak between zero and one meters, and the clay-rich soil has a strong, predominantly blocky to very blocky structure. Texture and structure type and grade are important because they effect the penetration of the GPR signal. GPR detected probable building foundations and a potential mass grave at depths between one and two meters. A circular anomaly was present in one of the GPR grids, which may be the mass grave. Using the air photo, map, and satellite image comparison, the location of two of the camps buildings were correlated with anomalies in the GPR data base. It was also determined that no buildings previously existed at the location of a circular GPR anomaly, thus adding further evidence to the assertation that the anomaly represents the possible location of the mass grave. Future research at Jungfernhof will include additional GPR analysis to locate other anomalies related to mass grave and building locations, and the addition of other geophysical techniques, like electrical resistivity tomography (ERT), to assist in better defining subsurface anthropogenic features.

Hall B, 8:00 am to 5:00 pm

Assessing Drivers of Salinization in the Lower Limpopo River, Mozambique

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Sea level rise and reduced river discharge are well-documented drivers of freshwater salinization in estuarine rivers. Few of these studies assess the relative contribution of both of these variables concurrently, and even fewer consider the impact of coastal land subsidence on local rates of sea level rise. In the lower Limpopo River basin (LLRB), located in southern Mozambique, stakeholders have reported increasing salinization of the lower Limpopo River. Upstream movement of the Limpopo River's saltwater-freshwater boundary poses a threat to the region's extensive agricultural schemes, which rely on the river for irrigation. In response to these stakeholder concerns, this study utilized remotely sensed and in-situ data to quantify trends in land deformation, sea level and river height to determine the relative contribution of these variables to river salinization. Land deformation was measured during the dry season (May to October) of 2017 to 2021 using ESA's Sentinel-1 interferometric synthetic aperture radar (InSAR) and extrapolated to mean annual rates. Mean annual eustatic sea level rise was calculated via daily tide gauge measurements collected at Durban, South Africa from 1971 to 2019. Mean annual height of the Limpopo River was calculated from a hydrometric gauge at Xai-Xai, Mozambique from 1996 to 2019. We found that land subsidence is occurring in the lower Limpopo River floodplain at an average rate of -2.98 cm/yr, based on the dry season acquisitions. River height decreased at a rate

of -1.93 cm/yr and eustatic sea level rose at a rate of 0.11 cm/yr. Our findings indicate that relative sea level rise rates are greater than eustatic sea level rates and, therefore, land subsidence is likely contributing to reported increases in river salinization, along with reductions in river height.