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THE LIFE OF A BEACH

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For the past twenty-two years I have been frequenting the small beach of Charlestown, Rhode Island. It was not until last year that I began to notice, the beach was shrinking. Erosion from devastating storms and the addition of dune weeds by those who habitat the beach community have attacked poor Charlestown beach from both sides. The following paper will address the affects of beach erosion and ways to reduce it. An understanding of the history behind the formation and life of Charlestown beach, including the affects of a major tidal storm that took 311 lives in 1938, and finally we will take a look at the possible future.

ROTATIONAL SLIDES IN SAPROLITIZED ALLUVIUM ON THE WESTERN FLANK OF THE BLUE RIDGE NEAR GROTTOES, VIRGINIA.

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Alluvial fans along the western flank of the Blue Ridge physiographic province near Grottoes, Virginia are primarily composed of highly saprolitized cobbles of the Antietam Quartzite that are suspended in a matrix of quartz sands and clay. Numerous floods have impacted these basins, most recently Hurricanes Camille (1969), Juan (1985), and Fran (1996). The flooding conditions associated with large storms alter the fluvial system, and initiate well-defined rotational slides. These slides originate from material comprising elevated alluvial fans that flank the inset modern stream system. Two linked rotational slides along the intermittent stream of Meadow Run were surveyed and analyzed to examine causes of failure, volume removal, denudation, and morphology. Tree ring data suggest that the cause of the most recent slope failure is attributed to a stream avulsion created during the Hurricane Fran flood of 1996. A logjam redirected stream flow towards the sidewall of the valley, causing rapid erosion and removal of the toe of the slope and, consequently, slope failure. Evidence suggests that this process has occurred at least one other time during the last century. Total sediment removed during the Hurricane Fran storm was 53, 000 ft^3, translating to 7.26 ft of denudation.

THE FUTURE OF GAS HYDRATES

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Limited natural gas reserves are leading to the investigation of alternative natural resources for the future; gas hydrates appear to be the source of fuel for the future. Increasing technology is making the extraction process cheaper, but right now commercial extraction remains a long-term proposition because the technology to tap the hydrates doesn’t exist yet. Experts predict it could take decades to develop the technology.

Methane hydrates are the most common and the most likely source of fuel in the future. Worldwide, there is approximately 400 million trillion cubic feet of natural gas potential produced from methane hydrates. Considering the 5,00 trillion cubic feet that currently make up the world’s known gas reserves, gas hydrates could potentially provide energy for hundreds maybe even thousands of years. The US alone has an estimated in-place gas resource locked in the hydrates of around 200,000 trillion cubic feet, dwarfing the 1,400 trillion cubic feet of conventional recovered gas resources and reserves.

GEOCHEMICAL SURVEY OF VALLEY SPRINGS WITH AN EMPHASIS ON IDENTIFYING REGULATORY REFERENCE SITES FOR IMPAIRED TROUT FARMS

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Although the karst terrain in the Shenandoah Valley hosts many springs that are used for a variety of purposes, little long term water quality monitoring of this important water resource has been done. In an ongoing effort to resolve this issue, we have collected geochemical data (such as pH, temperature, dissolved oxygen, and the concentrations of major dissolved ions) for a number of springs.

In addition to identifying geologic controls on the origin, flow, and chemical evolution of these springs, this project also assisted the Valley Regional Office of the Department of Environmental Quality (DEQ) as they try to identify potential controls on water quality for springs that are used by trout farms. To this end, a number of springs that are being used as a water supply for trout farms in the Valley that had been identified by the DEQ as impaired on the Year 2000 303(d) Impaired Water List were also sampled. Further, habitat data including spring flow type, substrate analysis, riparian cover, and watershed land use was collected to aid in the project.

It is anticipated that this work will help identify reference sites that can be used in a regulatory capacity to establish baseline conditions for what various trout-farm springs would have looked like, chemically and ecologically, prior to development. To date, our data has revealed that there exists at least two geochemically different types of springs that need to be considered when identifying reference sites for trout farms within the Shenandoah Valley.

COMPUTER MODELING OF CRYSTALLIZATION KINETICS: FORWARD AND INVERSE METHODS EMPLOYING CRYSTAL SHAPES OF 1:3:5

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A computer model was used to simulate crystallization of igneous rock with growing crystals maintaining shape ratios of 1:3:5 until grain-to-grain impingement effects alter crystal shapes and sizes. In our experiment we used a nucleation function that increased exponentially ($n = e^{a*t}$ where n is the number of new nuclei, a= 0.1 and t is the time step) and a constant linear crystal growth rate of 1.5 linear units /time step. The resulting CSD plot shows deflections from linearity due to the impingement effect. In the inversion process two-dimensional grain outlines were measured from three mutually perpendicular slices using SCION, and a 2-D CSD was obtained from these measurement. The 2-D CSD was then converted stereologically to an estimated 3-D CSD. Our results show that the estimated 3-D CSD has a slope that is in agreement with the known CSD verifying the inversion methods.

SHALLOW DEPTH, ELECTRICAL RESISTIVITY SURVEYS CONDUCTED IN THE KARST TERRAIN NEAR MT. SOLON, VIRGINIA

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Recent water chemistry and geomorphic investigations suggest that water is being lost from North River to Mossy Creek in a phenomenon known as stream piracy. In this case, the North River is losing volume to Mossy Creek near Mt. Solon, Virginia where fractured karst limestone dominates geologically.

This project uses geophysical techniques to gain an understanding of the nature of fractures and caverns that could serve as a route for the piracy. Specifically, the method utilized is known as the dipole-dipole resistivity survey. The premise for the project lies in the idea the water is being pirated via void space that is resistively different from the surrounding material.

Initially, measurements are taken at a control area between the two streams where groundwater is observed discharging into a spring. The measurements give an indication of both the resistivities of the bedrock, soil, and groundwater and how water filled void space appears using a dipole-dipole survey. These are used as a guide to model scenarios related to the nature of the water filled caverns and fractures using a computer program, IP2D. Variables tested in the modeling effort include shape, size, depth extent, and relative location. The models give an idea of what kinds of resistivity outputs can be expected from the field surveys.

Aerial photographs and topographic maps were observed in an effort to locate survey spots near fractures and sinkholes where the potential for the observation of void space is high.

Initial field measurements show that the resistivities of the soil, bedrock, and groundwater are 150-300, 1000+, and 50-70 ohm meters respectively. Further, the earth in this area appears to be homogeneous and layered. Unknown variables include the depth of void space within the ground and the saturation state of the openings.

Early indications suggest that there are several possible outcomes for the research which include:

1) underground void space is observable throughout the area
2) fractures and caverns are too small or too deep to observe using resistivity

3) a specific network of voids is responsible for the piracy and its location must be more apparent before resistivity can be used to detect it

Judging by the models and early resistivity observations, it is likely that the resistivity survey will be successful at detecting caverns.

In general, the goal of the project is to gain a more definitive understanding of how the karst terrain in the study area appears geophysically, thus providing more promising avenues of future research regarding the stream piracy in the area.

PREPARING THE JMU SOILS LAB TO PERFORM THE CALIFORNIA BEARING RATIO (CBR) TEST

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The California Bearing Ratio (CBR) test is routinely performed in most commercial and research soils engineering laboratories. The test measures the capacity of a soil to bear loads placed upon it. The test utilizes a piston to create the load, calibrated proving rings to measure the resistance, and a penetrometer to measure the penetration depth of the piston. Virtually all base materials placed under pavement wearing surfaces, such as highways or runways must undergo CBR testing. Of the four major soils tests that are standard in engineering soils laboratories; Proctor, Atterberg Limits, Gradation, and CBR, the JMU Soils Lab has been capable of performing three, the exception being the CBR. The purpose of this research was to obtain the necessary equipment and develop the procedures for performing CBR tests at JMU. This capability will be used in
student and faculty research and may be incorporated in the Engineering Geology course as a laboratory exercise. For this study, testing was done in the JMU Soils Laboratory, and in Staunton, VA at the Virginia Department of Transportation Soils and Aggregate Laboratory under the supervision of Robert Kester. All of the tests were run on the Millrock soil, collected in
Northern Augusta County, Virginia. The initial CBR values for the tests performed in Staunton and JMU were in good agreement being 15.5 and 14.5 respectively. Upon further testing of the same soil sample, a drop in CBR values was noted, the values dropped to 10, and then 8.8 and 8.2. Based on these results it is concluded that the JMU soils laboratory now has the capability to produce accurate results for the CBR test, these being verified by a professional laboratory. Interestingly, multiple tests run on the same sample of soil resulted in lowered CBR test results for the soil. The reason for the lower test values is unknown but may be due to a change in gradation to finer grain size coming as a result of repeated compactions with the drop hammer during compaction and pressures placed on the soil in excess of 300 psi during the test. It is recommended that future research be performed to determine the cause of the observed decreases in CBR values in soils undergoing multiple testing of the same soil sample.

AN INVESTIGATION INTO THE ROSGEN METHOD OF STREAM CLASSIFICATION AND RESTORATION

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The field of geomorphology has traditionally classified the channel patterns of streams as straight, meandering, or braided in their nature. Recently, workers have attempted to further refine this classification system for the purposes of stream channel design and restoration. In his 1994 Catena paper, David Rosgen developed a new classification for natural rivers that was based on further subdivisions of stream morphology, including the parameters of channel width, depth, slope, bedload material, meander amplitude and wavelength, pool and riffle spacing, and discharge. This method has not escaped criticism by the scientific community. Some researchers claim that the “Rosgen Classification Method” allows a “cook book” type of approach to categorizing streams, and may produce erroneous results by those not properly train in fluvial processes and stream restoration. Secondly, the method has been used in the past to predict how streams will respond and evolve from future events; this point has produced the most criticism by geomorphologists. This paper addresses these issues, as well as examines several stream restoration projects that have used the Rosgen Method.

UPPER PLIOCENE SEA SURFACE TEMPERATURES FROM ODP SITE 1012

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The 1.8 to 2.8 Ma interval covers a shift from an early period of global warmth to a cooler period of Northern hemisphere glaciation. Deep-sea sediment cores from Ocean Drilling Program site 1012, located in the East Cortes Basin approximately 100 km off the California coast, were analyzed for alkenones over the interval deposited 1.8 to 2.8 Ma. Alkenones are long chain ketones produced by the algae Emiliania huxleyi. The number of double bonds in these ketones varies according to the sea-surface temperature (SST) in which E. huxleyi growth occurs. Gas chromatography was used to determine bond ratios of alkenones in the sediment samples. Results from the chromatography were later converted to a SST record. Sampling of ODP site 1012 was sufficient to provide a SST record with a ~ 3 k.y. resolution. This resolution allows investigation into the presence of eccentricity, obliquity, and precession cycles of 100,000, 42,000, and 23,000 years in the SST record. Eccentricity, obliquity, and precession describe cyclic variations in the earth's orbit thought to influence global climate change. Examination of this interval is one of just a few attempts to find climate variation on an orbital scale prior to the Pleistocene.

EXPERIENCES OF A FIELD TECHNICIAN AT AN ENGINEERING CONSULTING COMPANY

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During my work last summer as a field technician at an engineering consulting company, I gained valuable experience in the field and laboratory, which may be of interest to other students. While in the soils lab and geotechnical division, where I spent about half of the summer, my background in geology helped me significantly in my work. In the soils lab, among other things, I performed Proctor Tests, classified soil according to the Unified system, prepared samples for Atterberg Limit tests, and performed grain size analyses. I was comfortable performing all of these tests since I had learned all of these skills in my engineering geology class at JMU. In the geotechnical division I worked closely with another field technician to do site research for the engineers and layout sites and mark boring locations in the field using GPS and aerial photography. All of this work related directly to the skills I had learned as a geology major and proved to be very rewarding.

The remainder of the summer was spent as a field inspector on construction sites. Here I sampled concrete and tested soil density using a nuclear gauge. I found the training I received, which consisted largely of the observation of other technicians in the field, did not adequately prepare me to be sent out to job sites on my own. My unfamiliarity with construction sites and the nuclear gauge made the job especially difficult. The work environment was highly stressful and it was essential to have confidence in the validity of the tests I was performing in order to be able to communicate effectively with the contractors and site foremen on a daily basis. For this part of the summer, more hands-on experience with direct supervision by a qualified trainer in the field would definitely have enhanced my knowledge of the procedures and protocols involved in on-site construction inspection.

DETERMINING PALEOSTRESSES FROM CALCITE DEFORMATION TWINS IN THE TRIPOLITZA LIMESTONE FROM EASTERN CRETE

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Limestone samples were collected from the Tripolitza unit in eastern Crete to determine their paleostress signature. Crete rests on the Hellenic Arc, the converging plate boundary between Africa and Europe. A major controversy in Cretan tectonics hinges on the nature of the fault contact between an upper nappe consisting of limestones of the Tripolitza unit (TU) and a lower nappe consisting of a Phyllite-Quartzite unit (PQU). Perhaps the dominant theory is that this contact is a detachment fault produced by crustal extension that placed the Tripolitza over the Phyllite-Quartzite. An alternative interpretation is that the contact is a thrust fault. This theory is supported by several pieces of data, including the large thicknesses of the TU and PQU, and also by microfabric strain studies and illite crystallinity data that shows higher grade metamorphic rocks on top of lower grade rocks. Our study of stress induced twinning in calcite supports the thrust interpretation of this contact. The Calcite twins in the Tripolitza limestone show N-S compressional stress fields, suggesting that the TU was thrust over the PQU in the N-S direction.

CONSTRUCTING A DIGITAL INTERFACE USING A LEHMAN SEISMOMETER

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In the seventies Jim Lehman, a JMU physics laboratory manager constructed what is known as the Lehman Seismometer, which is an inexpensive, but a practical way to detect seismic signals. It is a horizontal long period seismic sensor, which we placed in a N-S orientation on the floor in the basement of Miller Hall. This was to achieve a quiet environment with as few disturbances as possible. Originally the seismometer recorded directly to an analog strip-chart recorder. We have experimented with interfacing the seismometer to a digital recording system allowing it to acquire, analyze, and store the seismic waves being detected at the station. Interfacing the seismometer with a computer allows it to acquire, analyze, and store the seismic waves being detected at the station. A graphical programming language, LabView, is implemented as the controller, along with a DAQ PAD analog/digital converter. This allows a voltage coming from the seismometer to be converted into a digital signal that the computer plots continuously as a chart and stores on the hard drive. The collected information from the seismometer is stored in the computer and then used in the analysis of determining the degree of energy measured at our station compared to other stations that observed the earthquake. In conclusion constructing a digital interface with a Lehman seismometer gives a real-life look at accurately acquiring seismic waves, analyzing, and storing them.

THREE DIMENSIONAL GROUNDWATER FLOW MODEL OF THE THOMPSON EMBAYMENT, MICHIGAN

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Two theories have been proposed to explain a phenomenon in which upwelling groundwater has produced unusual pattern of plant diversity found in the Thompson embayment of the Upper Peninsula of Michigan. The first of the two proposed models attempts to explain the phenomena in terms of changing embayment shape and shoreline configuration through time as it fills in response to changes in lake level. Previous research using a two dimensional groundwater flow model showed that mechanism alone is insufficient to explain observed phenomena.

The second model, which is the focus of this research, proposes to explain the upwelling using a three-dimensional stratigraphic model that incorporates subsurface heterogeneities throughout the embayment. Ninety-five well logs from the area surrounding Indian Lake were acquired and synthesized into 15 representative strip logs. North/South and East/West fence diagrams were generated from this information and used to construct the three-dimensional subsurface stratigraphic model.

The stratigraphic model was then incorporated into a three-dimensional groundwater flow model. Boundary conditions for the flow model were assigned to represent the effects recharge, Lake Michigan water levels, the effect of an inland lake (Indian Lake), and from an underlying artesian aquifer. It is anticipated that the resulting groundwater flow model will be used by researchers in the area to determine how and when certain changes in plant diversity and type have occurred in response to changes in the groundwater flow system.

COMPUTER MODELING OF CRYSTALLIZATION KINETICS : FORWARD AND INVERSE METHODS EMPLOYING CRYSTAL SHAPES OF 1:5:5

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Geologists have long known that the textures of igneous rocks contain information on the kinetics of crystallization. Recent efforts in several laboratories have been directed toward trying to use inversion methods to extract the actual rates of crystal nucleation and growth and the crystallization time span from the crystal size distribution (CSD). However, rocks with known CSDs , crystal shapes, and kinetic histories are lacking in order to validate the inversion methods. To circumvent this we have built a computer model that simulates crystallization of a polycrystalline solid (the forward process) using an arbitrary exponentially increasing nucleation rate and an arbitrary constant crystal growth rate. In this experiment crystal shapes of 1:5:5 were maintained during growth until grain-to-grain impingement occurred after which grain shapes and sizes were altered by the impingement effect. In the inverse process we have taken slices resembling thin sections through the crystallization chamber, and made measurements of 2-D grain sizes using image analysis software, SCION. Stereological corrections were then applied to the measurements to obtain an estimate of the 3-D CSD. Although the CSD did not appear to be perfectly linear, it could be approximated by a linear function the slope of which was close to that of the known CSD. This suggests that the kinetic parameters can be extracted by the inversion methods provided crystallization was according to the rate functions described above.