

ELECTRICAL RESISTIVITY STUDY AT TIDE SPRING

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Ebb and flow springs have remained a mystery for observers worldwide for centuries. The spectacle of an oscillating flow pattern delights both the scientific community and the community at large, and has provided areas of debate in regards to the controlling mechanics behind these springs. Many geological procedures have been conducted in an attempt at better understanding ebb and flow springs.

This study is a quantitative electrical geophysical survey of Tide Spring, located on the Showalter farm in Broadway, Virginia. The basic principle behind this experiment is detection of electrical resistivity differences between the host Beekmantown limestone and the fluid conduits. Samples of spring water are measured as 14 ohm-meters. Early spot measurements put the host resistivity at about 250 ohm-meters. Subterranean voids would have very high resistivity. The experimental procedure was to inject a current into the mouth of the spring and measure its respective voltage at the surface. A pole-pole array of electrodes was used to survey a 2400m² area surrounding to mouth of the spring in hopes of locating its origin. Geometric corrections were applied to the measured voltage-to-current ratios, yielding apparent resistivity in ohm-meters.

The surface resistivity data reveal several features which correlate well with topographic expressions on the surface. The mouth of the spring is expressed as a distinct and localized low resistivity zone. The stream and a nearby hill are also apparent. This particular array is a relatively shallow sounding method and the spring's origin cannot be positively identified. A large region of low resistivity to the southeast of the spring's opening warrants further investigation as a possible reservoir zone.

DEVELOPING REGIONAL CURVES FOR STREAM HYDRAULIC GEOMETRY IN THE CENTRAL BLUE RIDGE, AND THEIR APPLICATION IN STREAM RESTORATION

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The 1995 Rapidan flood in western Madison County that initiated flooding and triggered over 1000 debris flow events caused great damage to an area of 130km², and claimed one life. The deluge destroyed buildings, roads and bridges, and impacted crops and livestock. The Rapidan River and, to a lesser extent, Robinson and Conway Rivers were severely modified and destabilized by the 1995 storm. Restoration of these streams using traditional methods soon followed the storm, only to be further damaged by the large, but lower magnitude Hurricane Fran storm in 1996. Since this time, a piecemeal approach has been used to restore these rivers, most of which have failed to remain stable. State funding from the Virginia Department of Transportation has provided the means to restore a 1500 ft. section of the Rapidan River using the Rosgen method of natural stream design. Unfortunately, the designers lack important data of proper dimensions of stream channel parameters (hydraulic geometry), including width, depth, slope, sinuosity, and pool and riffle spacing. Previous work has shown repeatedly that improper design dimensions of the channel likely initiates instability. This research begins to address these deficits in the data.

The research examined undisturbed stream reaches of basins proximal to the Rapidan River that contain similar geology and basin area. The Rosgen Stream Classification Method was used to identify and quantify each stream's morphological channel characteristics. Cross sectional models were developed and regional curves are currently being developed to define a stable morphological model for streams in the central Blue Ridge Mountain Province. Although this is a pilot study, this model can be extended and utilized in the restoration of other Blue Ridge streams under consideration for restoration by State and Federal Agencies.

SOURCE OF SULFUR IN THE HIGH SULFATE SPRINGS & WELLS IN THE SHENANDOAH VALLEY

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Previous work by a JMU geology student has established that some spring waters within the Shenandoah Valley have statistically elevated dissolved sulfate concentrations. Using stable isotopes of sulfur it has been determined that sulfate in these waters owe their origin to either the dissolution of pyrite and/or gypsum.

This study hopes to provide more detail to the previous work in the area by again using techniques of stable isotope analysis, water chemistry analysis, and adding EDAX analysis of rock from which these waters might originate. Seventeen rock samples were collected and analyzed using EDAX and eleven water samples were studied via chemistry analysis. Of these, five sulfate rich waters were chosen for isotope analysis. Using the aforementioned tests, we hope to make assessments of rock source and general chemical trend of the selected waters. It is anticipated that this research will show a correlation of sulfur content to the depositional environment these samples originate.

HYDROGEOLOGIC ASSESSMENT OF A KARST SYSTEM NEAR MAUZY, VA, AND IMPLICATIONS FOR LAND USE

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Karst terrains are rapidly receiving more interest in public issues due to potential implications of water quality and quantity in these areas. Development and land use in karstic terrains as well as rapid movement of surficial water into the subsurface is a major concern due to the unpredictable nature of water movement in these highly heterogeneous systems. We have conducted a karst/groundwater susceptibility study in a watershed of Smith Creek near Mauzy, VA. This area is a karst landscape underlain by predominantly Edinburg limestone, which is riddled with many conduits, caves, and fractures that lead directly to the groundwater system. A filling station/truck plaza covering five acres is proposed to be built in a headwater tributary of Smith Creek in this area.

In order to establish a background hydrogeologic assessment, we have collected water samples from residential wells, Smith Creek, and from a spring in order to establish a baseline condition of the groundwater system. Additionally, a dye trace has been performed during the fall of 2001 by the Virginia Department of Conservation & Recreation to establish potential flow

patterns and times of travel of the groundwater. We anticipate that the results of this study will help establish the current water status in Mauzy for comparison with future studies that will address any impact the filling station/truck plaza has on the karst system.

LAYERED ROCKS ON MARS

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The structure and origin of the surface of Mars has long been a topic of great debate and study. More than 100,000 images, from the Mars Orbiting Camera (MOC) reveal a surface of sharply contrasting geologic environments constantly being altered by high velocity winds and weathering. Recently, sharper higher resolution have offered a closer look into the general composition of some of the main features of Mars. One of the most important discoveries is that thick sequences of layered rocks occur over many different parts of the planet. My research attempts to summarize the more important environments where layered rocks occur. Many of these environments have sequences that closely resemble sedimentary sequences on Earth, although this has not been definitely established. Among the more important areas containing such sequences are the following: walls of impact craters, canyons or chasmas, dendritic channels, structural features such as grabens, and near the edges of the polar ice caps.

MOREFIELD MAGNETICS

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The Morefield Pegmatite in Amelia County, Virginia, is host to a wide variety of mineralogical specimens, including the distinctively blue amazonite, some of the largest phlogopite crystals ever discovered, and a wide variety of rare aluminofluorides. The known extent of the intrusive has been actively mined since discovery in 1929 by Silas Morefield, and until now, the only other evidence for possible extensions of the mine has been gained by a number of test pits and drillholes, emplaced and evaluated by the U.S. Bureau of Mines during World War II.

The idea of a magnetic survey of the Morefield pegmatite was proposed in the fall of 2000 when Dr. Will Frangos performed a test line across the trend of the intrusion to compare the gathered data with the theoretical results. The hypothesis was that the pegmatite had a low magnetic susceptibility in comparison with the host gneiss or chlorite schist. The extreme difference in relative susceptibility should stand out greatly in a field study, with the pegmatite giving a low reading, and the surrounding host rock giving a magnetic high.

In August of 2001, our research on the magnetics of the mine began. Our goals for this experiment were to map the attitude and extent of the main intrusive body, to look for any parallel intrusives, and to detect any concentrations of magnetite along the contact border of the pegmatite. Our method included measurements of the earth's magnetic field at systematically spaced points, analysis of the data with respect to relative magnetic susceptibility of the pegmatite and the surrounding host rock, and creation of a model in an attempt to gain a general understanding of what was underground. Drift corrections were made to account for the minute variations in the earth's magnetic field over time, but these corrections had a negligible effect on the final interpretation of the data.

The conclusions from this magnetic survey are based on manipulations of computer-generated models in regard to the collected data. Several figures with various magnetic susceptibilities were used in an attempt to match the magnetic field patterns generated from the observed data. These models took into consideration both the geology of the area surveyed, and the cultural interference from local structures (*e.g.*, buildings, train cars, machinery). It is important to note that the magnetic field in the proximity of these unnatural structures was greatly affected, and proved to be difficult to interpret. The present results from the area northeast of the main shaft were compared with research completed by Jason Carty in the fall of 2001 on the area southwest of the main shaft. From the data and interpretations, it does not seem that there is much support for significant pegmatite extension in the survey area northeast of the shaft along the presupposed trend, nor for nearby veins parallel to the known trend.

A LITERATURE REVIEW OF POSSIBLE LOESS DEPOSITS IN THE SOUTHEASTERN UNITED STATES

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This paper is an examination of available documents on the distribution of possible loess deposits in the Southeastern United States; most documentation involves Virginia, Maryland, Delaware and southeastern Pennsylvania. Also included is a segment of general information about loess, and recent studies on loess in other locations.

Loess is defined as silt size particles that have been transported by wind and deposited in blanket like deposits. Loess is often associated with glaciated areas, and areas proximal to glaciated areas due to silt sized particles found in glacial till. These particles are transported during the seasonal glacial thaw, and outwashed into stream systems. From stream systems the silt particles are then entrained by the wind and deposited.

It is apparent that areas of Virginia, Maryland and Delaware have suspiciously high silt contents in their soils. Areas of highest interest are located in the coastal plain and piedmont regions and areas with large rivers. These areas are consistent with loess deposition from glacial outwash during the Quaternary in other parts of the world.

It is generally accepted that loess occurs in southern Pennsylvania and New Jersey just south of the glacial front. However, identification of loess in Virginia and Maryland has been controversial since at least the late 1970's. Papers often exclude the possibility of loess in these soils, and few papers have addressed loess identification in these areas.

FIELD ANALYSIS OF SOILS AND BEDROCK IN THE WASHINGTON, D.C. AREA AND THEIR APPLICATIONS TO CONSTRUCTION AND LAND DEVELOPMENT

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Today, construction and land development constitute one of the biggest job markets for graduating geology students. In particular, the fields of civil engineering and engineering geology are growing rapidly, in part because of the demand for housing and infrastructure to support a growing population. While construction and land development involve numerous aspects of geology such as bedrock characteristics, soil properties, depth to bedrock, slope stability, and erosion, this job market has been tapped mostly by people with a background in civil engineering. However, many civil engineers possess only a rudimentary knowledge of

geology. To alleviate this condition, geologists are being hired in increasing numbers by the construction industry. This paper will summarize my experiences at Engineering Consulting Services, a civil engineering firm in Chantilly, Virginia, including collection of soil samples, field testing of soils for compressive strength through test pit excavation and caisson drilling, and classification of soils in both the field and the lab. It will explain how concepts of geology relate to civil engineering because they explain the natural materials and processes which form the conditions that civil engineers exploit in the design and construction of safe, sturdy structures.

GEOARCHAEOLOGIC/SOILS INVESTIGATIONS OF CONFEDERATE ARTILLERY POSITIONS, 1862 & 1863 BATTLES OF FREDERICKSBURG, VA

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Soils on the historic Willis Hill Civil War battle site in Fredericksburg, Virginia have been analyzed with data obtained from excavated trenches, test pits, and auger holes with the object of interpreting the complex history of land use and to locate the Confederate artillery positions, which played a critical role in the battle of Fredericksburg. Using field and lab data from undisturbed soil profiles the texture and color of each horizon has been compiled for reference. Following this phase, field data from disturbed sites are being used to construct profiles and fence diagrams portraying the types and the extent of disturbances on Willis Hill. Disturbances may be attributed to twentieth century use as a private school, over 200 years of agricultural activity, nineteenth century home and outbuilding construction, terracing of the slopes, trenches and lunettes constructed by Confederate soldiers, and/or exploding artillery shells fired by the Union during the 1862 and 1863 Battles of Fredericksburg. Research to date shows disturbed soils to be extensive with depths of disturbances exceeding 1.8 meters at several points. Interpreting the complex patterns exhibited by the disturbed soils is now underway. Preliminary results indicate at least one lunette and related trench work have been found.

ANALYSIS OF LONGITUDINAL VARIATIONS OF PARTICLE SIZE, SHAPE, AND ORIENTATION OF THE BLACKROCK BLOCK SLOPE, SHENANDOAH NATIONAL PARK, VIRGINIA

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Blackrock is a steep (20° - 30°) northwest-facing block slope covered predominantly with quartzite boulders (0.5 - 0.75 m^3) of the Harpers formation. The block slope originates directly below a tor exposed at the top of the ridge, and the field extends for approximately 0.5 km down slope, terminating at a gully formed by the juncture with another ridge. The block slope appears to terminate before the base of the opposite ridge. The material composing the block slope is probably not in place, but appears to originate from the tor feature. The lack of freshly-broken rock and tree scars suggests that current movement of the blocks are minimal. The forested areas that border the block slope are also mantled in quartzite rubble, but these areas have not been more than cursorily examined.

The profile of the block stream was surveyed at 10 m intervals, and at every 30 m the strike, dip, plunge, trend, and the three axes of the largest 50 rocks were recorded. The indices of sphericity, tabularity, and elongation were compared with volume, slope, and position. The data does not seem to show morphological similarity with other previously described

geomorphic features in the literature, such as fossil rock glaciers. Nor does there appear to be evidence for catastrophic collapse, rock fall sorting, or other features of talus cone development. Large-scale trends in sorting with respect to size and shape were not noted. However, smaller scale variations in topographic relief and size distribution were observed. The relationship between the step-like longitudinal profile, and the longitudinal fluctuation of size and shape indices is not yet clear. However, the periodic nature of the longitudinal change may be the result of some type of periglacial transport mechanism.

SURFACE WATER SULFATE DISTRIBUTION AND TRENDS IN THE RAPPAHANNOCK RIVER BASIN OF VIRGINIA. FROM THE HEADWATERS TO THE CITY OF FREDERICKSBURG

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Dissolved sulfate values in the Rappahannock River Basin covering over 50 years of record from 47 gaging stations were downloaded from the EPA and USGS websites for statistical analysis. Mean dissolved sulfate values for mountainous headwater streams were found to be uniformly low, closely resembling that of atmospheric deposition. Moving downstream into more densely populated areas, sulfate values exhibited significant increases. One remote headwater stream had an average mean dissolved sulfate value of 1.86 Mg/L while the furthest downstream station at Fredericksburg exhibited a mean of 6.83 Mg/L. Dissolved sulfate values for the Rappahannock River portion of the basin averaged 6.58 Mg/L compared to 5.43 Mg/L for the portion drained by the Rapidan River. Four gaging stations in the Rappahannock portion detected abnormally high mean dissolved sulfate values between 16.8 Mg/L and 41.4 Mg/L. Higher sulfate values in the Rappahannock sub-basin may be explained by higher population densities and increased anthropogenic activity. Temporal trends utilizing the Kendell Tau test revealed generally decreasing sulfate trends in the Rappahannock portion of the basin and increasing trends in the portion drained by the Rapidan River. A possible explanation for these trends may lie in the improvements made in wastewater treatment facilities from urbanizing areas emptying into the Rappahannock River. Since the portion of the basin drained by the Rapidan River is more rural and subject to less stringent permitting procedures, wastewater system upgrades may not be as aggressive, subsequently leading to gradually increasing sulfate trends.

SINKHOLE DETECTION WITH ELECTRICAL RESISTIVITY

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While drilling a well on his farm near Stuarts Draft, Virginia, Charles Barth had some unpleasant surprises. Sinkholes opened up on either side of the well shaft during drilling. These holes plunged ten meters into the ground, and the larger measures over 80 feet long and 25 feet wide. These sudden holes were a safety concern for the drillers and to the cattle in the field. Mr. Barth's primary concern was whether or not he would be able to provide water to the vineyard he plans.

Soil in this area changes from soft river sediment on the south side of the field to harder, rockier soil on the north. Visual inspection of the holes revealed a large cross section of soil on

top of sapprolite and rock. The two sinkholes lie directly along strike of the rocks and project directly toward the farmhouse to the west of the larger one. The rocks dip nearly vertically, and structurally it appears that the holes are connected.

Using resistivity measurements as a means of exploration, the area between and just outside the sinkholes was surveyed. Eight north-south trending dipole-dipole seven-spread arrays were set up with a ten-meter electrode spacing. This configuration was chosen because it provides both sounding and profiling information. Data were taken to the eighth separation, yielding detection of favorable targets to about twenty meters depth.

The data reflect the soil change as well as revealing low apparent resistivity readings at modest depth below surface between the holes. When surveying beyond the sinkholes these lows are absent. Low electrical resistivity is indicative of conductive material at depth, such as water in an underground cavity. The resistivity lows appear to connect the two gaping holes underground, and further drilling in this area could be quite dangerous. Though the area between the sinkholes could be cavernous, outside of the sinkholes to the east and west appears to be quite solid. The good news is that the farmhouse does not appear to be in immanent danger.

THE STUDY AND APPLICATION OF FRACTURE TRACE ANALYSIS IN THE HARRISONBURG QUADRANGLE

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Fracture Trace Analysis is an effective method for identifying and locating sites for high yielding water wells. Fracture traces are linear topographic features created from structural weaknesses in the rock. The fractures provide secondary porosity in an aquifer system, and can serve as collection zones for groundwater. The fractures are best found by examining aerial photographs through the process of stereoscopic imaging. On aerial photos, the fracture traces are highlighted by tonal variations in soils, alignment of vegetation patterns, straight stream segments in valleys, aligned surface depressions, gaps in ridges, or other features showing linear orientation. Water wells installed on a fracture or at an intersection of two or more fractures have the potential to yield water at significantly higher rates than wells installed in interfracture zones.

This research entails the application of fracture trace analysis of an area approximately 10 km², located 0.5 km northeast of Harrisonburg, VA near Melrose. This region has experienced accelerated development, and demands on groundwater resources have increased significantly. Phase 1 of the research entailed collecting water well data of yield, depth, and rock type for wells located in the study area. Phase 2 required the mapping of the fractures and location of current water wells on aerial photography. Preliminary analyses of the data suggest that water wells yields are greatest when located in topographic lows and in close proximity to fractures.

THE MINERALOGY OF THE BUCK HILL SYENITE INTRUSION AUGUSTA COUNTY, VIRGINIA

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Buck Hill is a small, elevated ridge located just east of the George Washington National Forest and slightly northeast of the old Stribling Springs resort located in the Stokesville Quadrangle,

Augusta County, Virginia. The surrounding country rock is composed of upper Ordovician, Silurian and lower Devonian carbonates and clastics, which are faulted by the Little North Mountain thrust.

On the northeastern flank of Buck Hill is an irregular shaped pluton of porphyritic, nepheline-natrolite syenite, mapped as approximately 0.3 by 0.1 kilometers in size. Its emplacement is related to the Jurassic - Cretaceous igneous activity noted in western Virginia and eastern West Virginia. Other (as many as 41) smaller, dike-like units of similar lithology are found near by, but the Buck Hill intrusion is the largest. In-place outcrops are scarce, but significant amounts of fresh material are present as surface float.

The alkaline intrusions contain well-formed micro-crystals in vesicles ranging from several millimeters to 3 centimeters in size with a variety of both common and rare minerals. Several different mineral species have been identified within the cavities using X-ray diffraction, scanning electron microscopy, and chemical EDS analysis. The host rock type and the presence of minerals such as catapleiite, a rare-earth carbonate (synchysite-(Ce), parisite-(Ce), or Röntgenite-(Ce) (new occurrences for the state of Virginia), and an unusual Zr-Ti-rich amphibole suggests an environment chemically similar to Mont Saint Hilaire, Quebec, although certainly not as mineralogically complex. Other mineral species such as rhodochrosite, natrolite, and analcime are common.

COMPUTER MODELING OF CRYSTAL SIZE DISTRIBUTION IN SYNTHETIC POLYCRYSTALLINE SOLIDS USING SIMULATED CRYSTALLIZATION KINETICS

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Modern crystal size distribution (CSD) theory was developed in chemical engineering because of the practical need to get kinetic information from the size distribution of crystals in a brine. Recently there have been efforts to apply CSD theory to polycrystalline solids to determine crystal nucleation and growth rates. However, concerns exist about the validity of the determined kinetic results because of differences between the (1) texture, (2) crystal shapes, and (3) growth characteristics of crystals in a polycrystalline solid versus those in a brine. Additional concerns deal with (4) the methods of estimating CSD's measured from two-dimensional slices that are then "corrected" stereologically. Our research addresses the concerns of (1), (2), and (3) above. We have implemented a computational and graphical model of the crystallization processes that result in a synthetic polycrystalline solid. In our model crystals grow "atomistically" according to certain nucleation and growth rates. The CSD in our synthetic polycrystalline solid plots as a straight line the slope of which is related to the product of the crystal growth rate and the crystallization time. These results indicate that CSD theory can be applied to determine the kinetics of crystallization of polycrystalline solids.

THE DETERMINATION OF POSSIBLE LOESS DEPOSITS IN THE STATE OF VIRGINIA, BY THE USE OF A HYDROMETER TEST

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This project has two purposes. The first is to prepare the JMU soils lab to perform hydrometer tests on soils. The hydrometer test uses specific gravity, hygroscopic moisture, and sieve analysis to determine the percentage of soil in suspension, and ultimately the diameter of the soil particles in suspension using Stoke's law. The second purpose is to use the hydrometer test to determine the grain size distribution in the silt fraction of selected Virginia soils. These data may be used to determine the existence of loess in Virginia. Loess is composed of silts with a particle diameter of 2 to 64 microns, which were laid down by aeolin activity during and after the last ice age. Loess deposits in the Midwest are tens of meters thick in many places. If loess exists in Virginia it would be in much smaller quantities due to the states distance from the nearest glaciers during the Pleistocene. The hydrometer is being used to analyze the grain size distribution, with attention focusing on the silt fraction in the A horizon. The diameter of the soil particles, and their distribution may provide the evidence needed to make this determination. Preliminary results are promising in that they point to high percentages of silt-sized particles in the soils under test. The next step will be the determination of the size fractions within the silt fractions.