

SGE Poster Session at the Annual Meeting of the Geological Society of America meeting in Philadelphia, PA, 24 October 2006



President Rick Ford congratulates Sean Porse and Joe Bell of the Eta Nu Chapter, James Madison University, on receiving the Austin A. Sartin Award for Best Poster.



President Rick Ford congratulates Lindy Straathof of the Epsilon Kappa Chapter, Central Michigan University, on receiving the National Council Award for Best Poster.

Several of the participants in the SGE Poster Session at the Annual Meeting of the Geological Society of America meeting in Philadelphia, PA, October 2006



U-TH-PB GEOCHRONOLOGY OF MONAZITE IN A QUARTZ-SILLIMANITE NODULAR LEUCOGRANITE FROM THE CARTHAGE-COLTON MYLONITE ZONE (CCMZ), NORTHWESTERN ADIRONDACK HIGHLANDS, NEW YORK

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The Carthage-Colton Mylonite Zone (CCMZ) is a prominent NE-trending and NW-dipping feature that represents the juxtaposition boundary between the Adirondack Lowlands and Highlands. U-Th-Pb dating of polygenetic monazite ($[\text{LREE}, \text{Th}]\text{PO}_4$) in a high-grade, quartz-sillimanite nodular, leucogranite from within the CCMZ has revealed Ottawan (~1055 Ma) and Rigolet (~994 Ma) orogenic signatures. The leucogranite has local mylonitic textures with a northwest dipping foliation. The quartz-sillimanite elongated segregations have been previously interpreted by McLelland et al. (2002) as magmatic-hydrothermal in origin with their formation taking place during syntectonic emplacement of the leucogranite. Electron microprobe analysis conducted on 155 spots in 3 monazite grains define apparent

age populations of 1055 ± 5 Ma and 994 ± 8 Ma (weighted means reported with 95% confidence). The older age population of ~ 1055 Ma is interpreted as growth during emplacement of the leucogranite and synchronous tectonism along the CCMZ during the Ottawa orogeny, as the supercontinent Rodinia was being assembled. Published work by Selleck et al. (2005) and McLelland et al. (2002) provide U-Pb ion microprobe (SHRIMP) results for nine spots obtained from well developed, oscillatory zoned zircon rims yield a weighted mean age of 1046 ± 7 Ma (2-sigma error) and U-Pb TIMS analysis for six zircons yield an upper intercept age of 1035 ± 3.8 Ma, respectively. These zircon ages, determined by two separate isotopic techniques, closely coincide with the older monazite age population obtained using chemical dating via electron microprobe analysis, further validating this dating technique. However, because monazite can crystallize/recrystallize over a wider range of metamorphic conditions, the younger age population documents an additional event, interpreted as occurring during the Rigolet orogeny at ~ 994 Ma (perhaps extensional normal faulting as proposed by others). Additionally, small clusters of younger age populations suggest that the CCMZ may have been subsequently reactivated; however, further monazite analysis is required to obtain a larger and more statistically sound dataset for populations < 994 Ma.



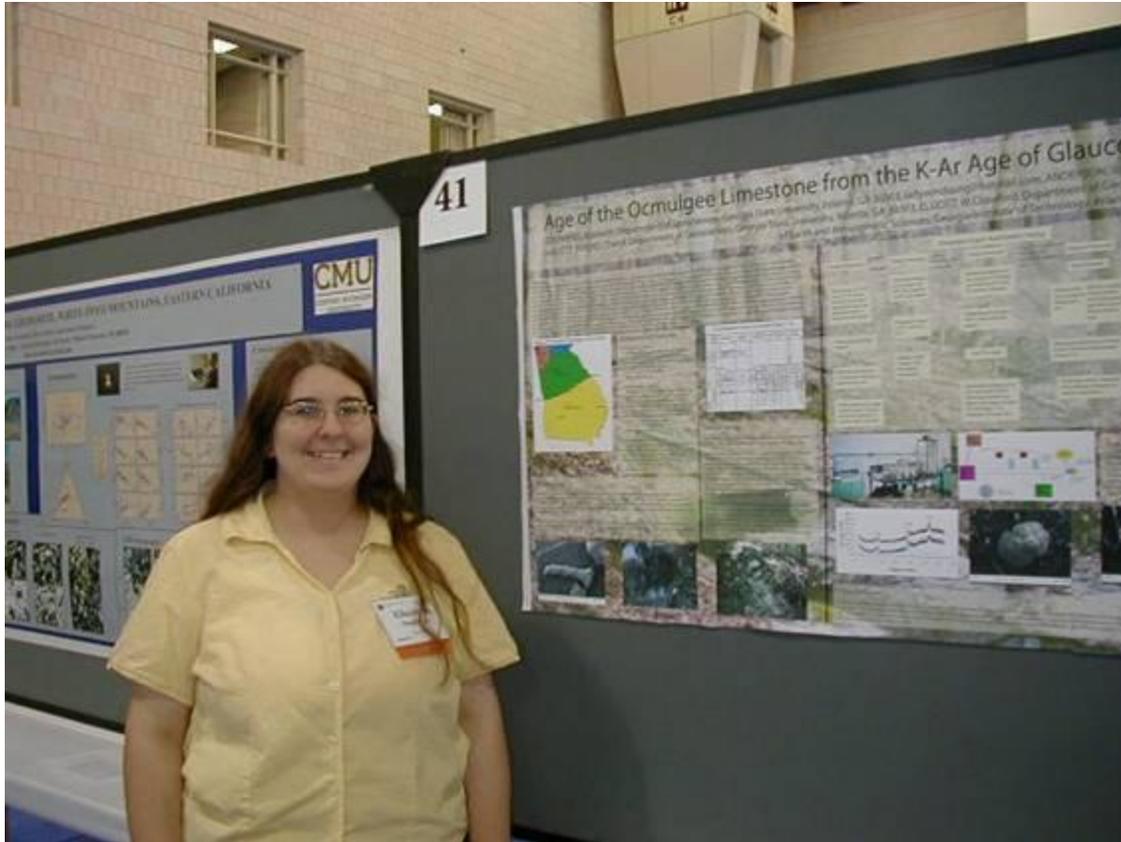
PETROLOGY AND GEOCHEMISTRY OF THE EJB DIORITE, WHITE- INYO MOUNTAINS, EASTERN CALIFORNIA

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The Jurassic EJB pluton crops out in the Deep Springs Valley/Eureka Valley region of the White-Inyo Mountains of eastern California. A composite pluton, the EJB comprises the Eureka Valley monzonite (EVM), the Joshua Flat quartz monzonite (JFQM), and the Beer Creek granite (BCG). South of the EJB, the JFQM forms a large portion of the Marble Canyon pluton, where it is extensively associated with the more mafic Marble Canyon Diorite (MCD). Diorite also crops out within the EJB pluton – most commonly along the southeastern margin of Deep Springs valley – where it is surrounded by rocks of the BCG. The diorite of the EJB is a dark rock composed of plagioclase feldspar, hornblende, biotite, quartz, K-spar, and sphene. Previous studies (Sylvester and others, GSA Bulletin, 1978; Miller, PhD Dissertation, 1977; Dietl, PhD Dissertation, 2000) have not fully addressed the significance of the diorite within the EJB system, nor of its relationship to other plutonic bodies in the area.

Observations of the contacts between the EJB diorite and the adjacent rocks reveal several different relationships. In at least one case, the contact relationships between the diorite and the surrounding BCG are characterized by apparent magma mingling. Elsewhere, contacts are characterized by elongated xenoliths of the diorite within the BCG suggesting intrusion into sheared ductile diorite. Finally, some contacts are characterized by angular, broken diorite xenoliths surrounded by BCG. Collectively, these observations suggest that the BCG may have intruded a cooling diorite mass of spatially variable rheology.

Preliminary XRF analyses of the EJB dioritic rocks shows them to be enriched in MgO and TiO₂, and depleted in Na₂O and K₂O, relative to other igneous rocks of the EJB. Trace element concentrations of the diorites include the following ranges: V, Cr: 100-300 ppm; Co: 8-50 ppm; Ni: 7-90 ppm; Cu: 25-100 ppm; Zn: 80-120 ppm; Rb: 30-80 ppm; Sr: 700-2000ppm; Zr: 130-400 ppm; and Ba: 800-1800 ppm. Preliminary assessment of these data suggests that the diorite may have either mixed with the BCG to form the JFQM or fractionated to form the JFQM and the BCG.

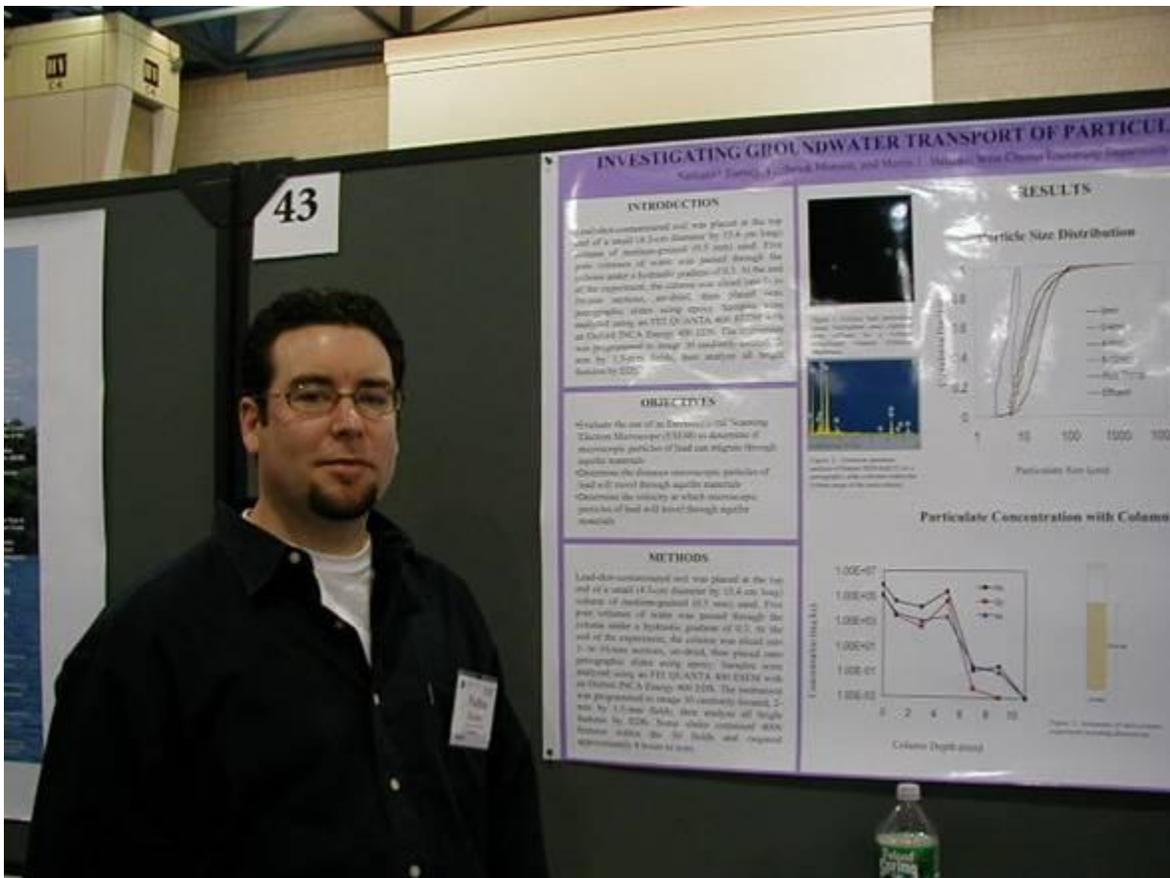


AGE OF THE OCMULGEE LIMESTONE FROM THE K-AR AGE OF GLAUCONY GRAINS, COASTAL PLAIN, GEORGIA

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The late Eocene Ocmulgee Limestone contains small amounts of dark grey-green to green-black botryoidal grains at 20-22 feet above the basal contact at its type locality at Taylor's Bluff (Pulaski County) Georgia. These grains contain glauconite and were separated for K-Ar study. A technique in which potassium is measured on the solid residue remaining after argon extraction was used to obtain the K-Ar age of a small amount (18 mg) of glaucony grains remaining after SEM and mineral study. Since only one sample, weighed into a copper-foil capsule, is used for both potassium and argon measurement in this technique, sample inhomogeneity does not contribute to error in the age value, nor does any error in weighing. Argon is extracted by heating the capsule and holding it between 1000°C and 1050°C for 10 minutes within a fused-quartz glass tube connected to the argon extraction

manifold. The argon is diluted with an Ar-38 spike of known amount and argon isotopic composition, cleaned by reaction of other gases with heated titanium, and isotopically analysed. The capsule and the residue remaining within it is then digested with a mixture of hydrofluoric, nitric, and perchloric acids. After evaporation of SiF₄ and excess acid, the remaining salts are dissolved in a Cs-bearing solution for potassium measurement by flame atomic absorption spectrophotometry. An age of 33.7 ± 1.0 Ma (5.58% K) from the 18-mg glaucony sample places this interval of the Ocmulgee Limestone in a numerical time range that is consistent with the late Eocene/early Oligocene biostratigraphic age for the Ocmulgee Limestone. Subsequent work with other glaucony samples, including the interlaboratory reference sample GL-O, has confirmed that essentially all of the argon is extracted from glaucony heated as described above and that all of the potassium remains within the copper-foil capsule. This verifies the technique described herein as an accurate way to determine K-Ar age values for small amounts of glaucony.



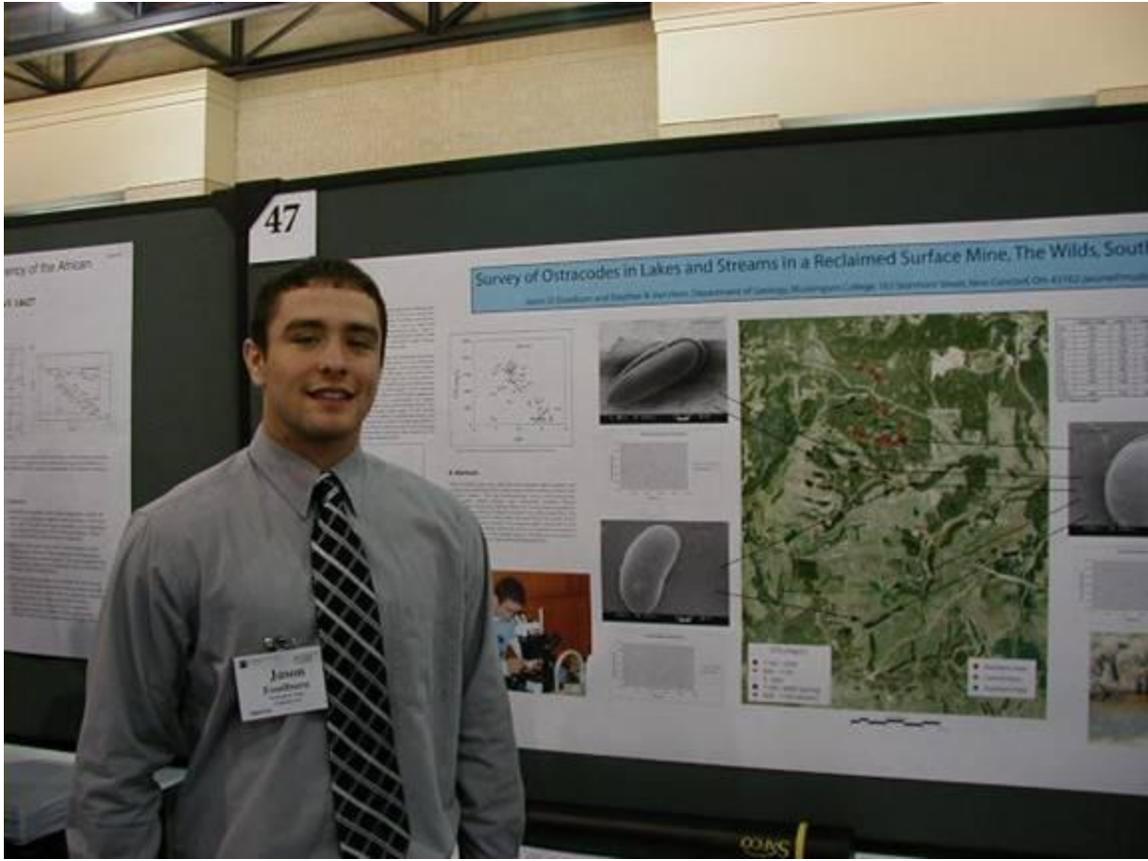
INVESTIGATING GROUNDWATER TRANSPORT OF PARTICULATE LEAD SHOT USING ESEM/EDS

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Lead contamination is an ever-present threat at shooting ranges, where lead concentrations commonly exceed 10 g/kg within the top 30 cm of soil. Lead projectiles typically form insoluble coatings of lead carbonates, oxides, or phosphates, and are assumed to remain stationary in the subsurface. Recent studies have shown, however, that projectile collisions can produce lead particles smaller than 5 microns in diameter, which might pass through aquifer pore throats and migrate with groundwater. The objective of this study is to evaluate the use of an Environmental Scanning Electron Microscope (ESEM) to determine if microscopic particles of lead can migrate through aquifer materials.

Lead-shot-contaminated soil was placed at the top end of a small (4.3-cm diameter by 15.4 cm long) column of medium-grained (0.5 mm) sand. Five pore volumes of water was passed through the column under a hydraulic gradient of 0.3. At the end of the experiment, the column was sliced into 1- to 10-mm sections, air-dried, then placed onto petrographic slides using epoxy. Samples were analyzed using an FEI QUANTA 400 ESEM with an Oxford INCA Energy 400 EDS. The instrument was programmed to image 30 randomly-located, 2-mm by 1.5-mm fields, then analyze all bright features by EDS. Some slides contained 4000 features within the 30 fields and required approximately 4 hours to scan.

After 5 PV, lead particles between 5 and 10 microns in diameter traveled a distance of 1.0 cm; equivalent to a velocity of approximately 3 m/day. Lead particles larger than 0.5 mm remained within the top 2 mm of the sand column, and lead particles 50-microns in diameter traveled 8 mm. Many lead particles included arsenic (14%) and antimony (35%), which are common toxic metals alloyed with lead shot. This study suggests that lead particulates have the potential to migrate through aquifer media, and ESEM serves as an effective method for evaluating the presence of particulate lead and other heavy metals in soil.



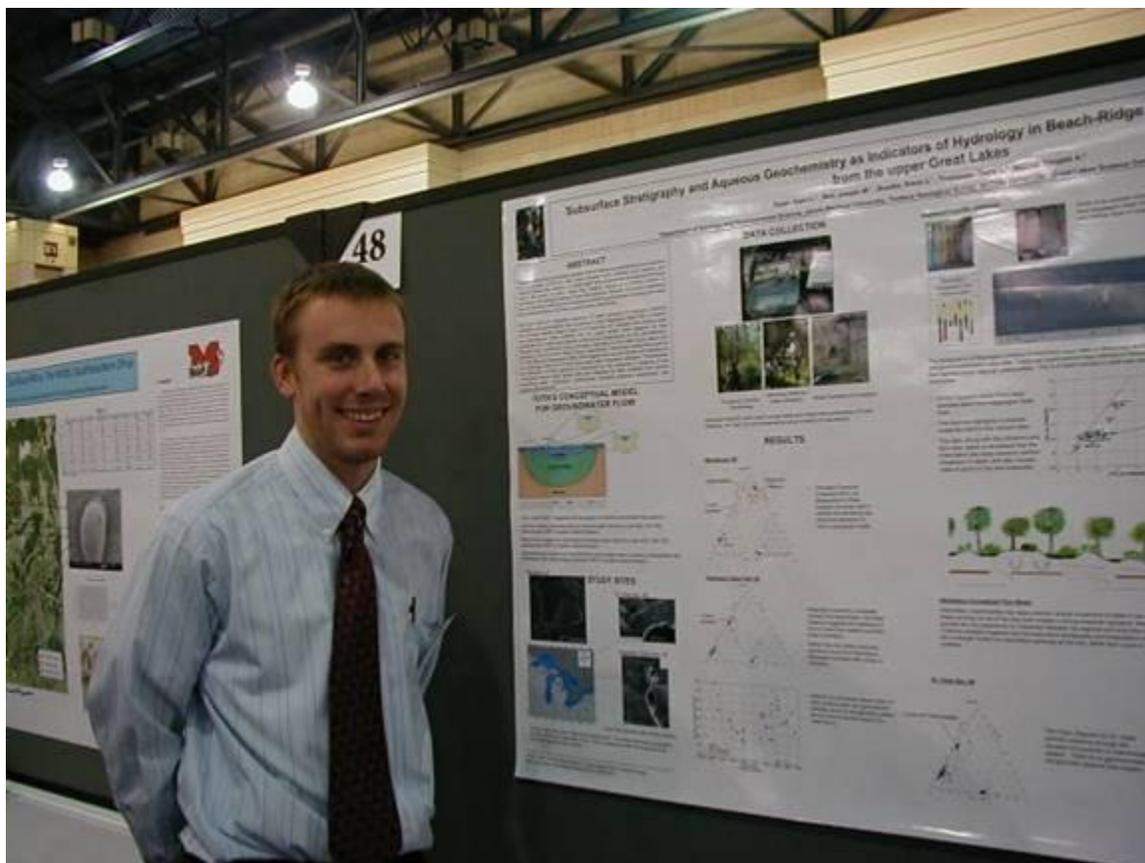
SURVEY OF OSTRACODES IN LAKES AND STREAMS IN A RECLAIMED SURFACE MINE, THE WILDS, SOUTHEASTERN OHIO

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Ostracodes are known to be good indicators of environmental conditions. Surface water chemistry at The Wilds varies from north to south and appears to be a reflection of the reclamation process. Reclamation of surface mining at The Wilds occurred from 1974 to 1984 and encompassed several changes in reclamation laws. During reclamation approximately 40 lakes were constructed. Today surface water, exclusive of springs, can be divided into three geographic regions based on characteristic levels of total dissolved solids (TDS). The northern region typically has TDS values between 1200 to 1400 mg/L. TDS values in the middle region range between 800 to 1100 mg/L and in the southern region range between 100 to 500 mg/L. The pH values of surface water at The Wilds vary between 6.5 and 9.0 and appear to be primarily controlled by the limestone-rich spoil. Northern region lakes are fed by surface runoff/groundwater or a combination of surface runoff/groundwater and springs, have very small drainage basins and are flow-through lakes. Lakes in the middle region are fed by a combination of surface runoff/groundwater and springs, have large drainage basins and are flow-through lakes. Most of the southern

region lakes are feed by surface runoff only, have small drainage basins and are not flow-through lakes. Southern region lakes based on TDS values appear to be above the groundwater table.

Ostracodes species were collected from sediment samples of several lakes from each of the above areas and from the three streams that drain the watershed. Spatial distribution of ostracode assemblages at The Wilds is demonstrative of the above trend in surface water chemistry. The identified assemblages *Physocypria globula*, *Darwinula stevensoni*, and *Candona elliptica* exhibit solute space preferences (measured by carbonate alkalinity/Ca ratio vs. TDS in ppm) as defined by NANODE. Carbonate alkalinity/Ca ratios vary from 0.83 to 4.77 due to the contrasting hydrochemistry across the sequentially reclaimed surface mine. From this data, the presence of *Darwinula stevensoni* appears to be an indicator of TDS values exceeding 1000 ppm characteristic of the central and northern subwatersheds.



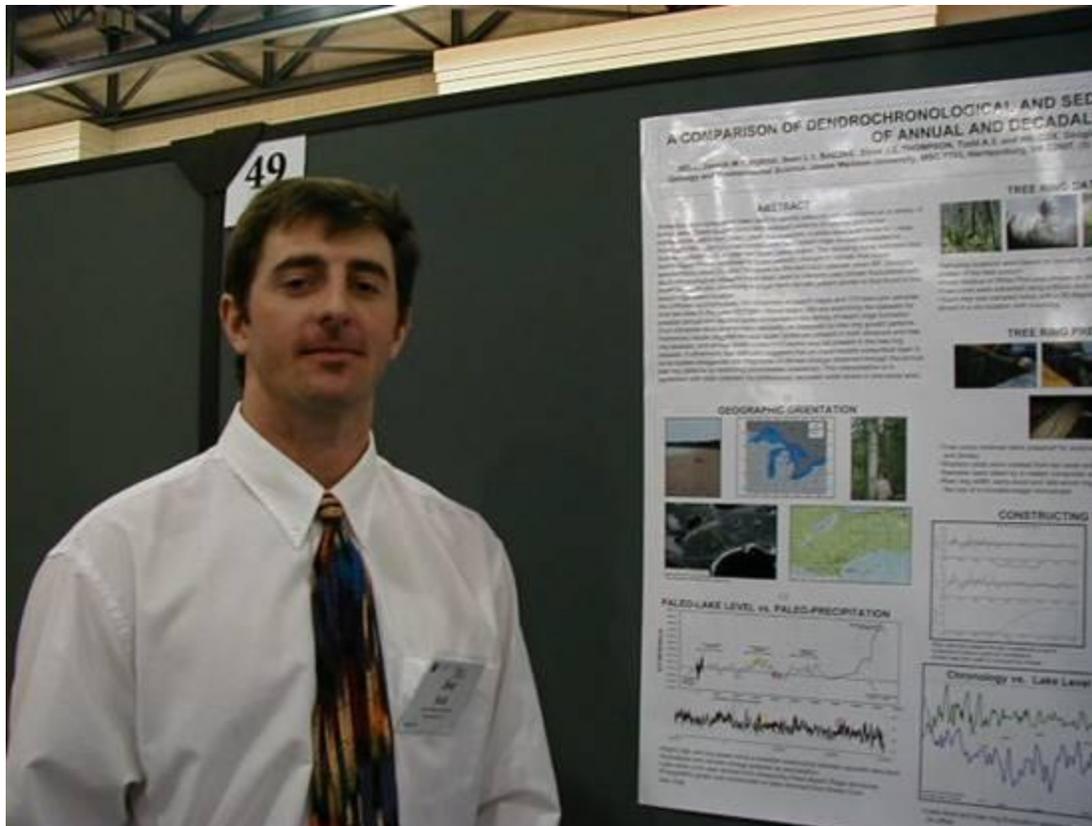
SUBSURFACE STRATIGRAPHY AND AQUEOUS GEOCHEMISTRY AS INDICATORS OF HYDROLOGY IN BEACH-RIDGE COMPLEXES: TWO CASE STUDIES FROM THE UPPER GREAT LAKES

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Surface-water and groundwater systems can be viewed as representing end members of a hydrologic continuum that exists between local (shallow) flow systems and regional (deep) flow systems. In beach-ridge filled embayments throughout the Great Lakes, the extent to which these flow systems interact is a primary control on hydrology. The linkages between these flow systems, however, are poorly understood and conventional methods of investigation (including groundwater modeling and water level measurements) may fail to quantify these interactions.

We have used an integrated approach of water sampling for aqueous chemical indicators and groundwater flow modeling to study Negwegon State Park in Alpena, MI and Lake Superior State Forest in St. Vitals Bay, MI. Samples from surface water and groundwater wells installed into the upper aquifer were analyzed for field parameters and major ions (specific conductance, temperature, pH, Eh, and alkalinity). Samples were distributed along transects originating at the Lake Huron beach and extending 1500 and 800 meters inland, respectively.

Preliminary results from work at St. Vitals Bay and Negwegon State Park suggest that we can identify end members of the hydrologic continuum at each site using water chemistry indicators. Furthermore, the distribution of flow systems is influenced by the presence or absence of low conductivity zones (clay layers) that are indicated by data collected from ground penetrating radar, vibracores, continuously recorded pressure transducers, and aqueous geochemistry.



A COMPARISON OF DENDROCHRONOLOGICAL AND SEDIMENTOLOGICAL DATASETS AND THEIR APPLICABILITY FOR THE INTERPRETATION OF ANNUAL AND DECADAL SCALE CLIMATE FLUCTUATIONS IN THE GREAT LAKES

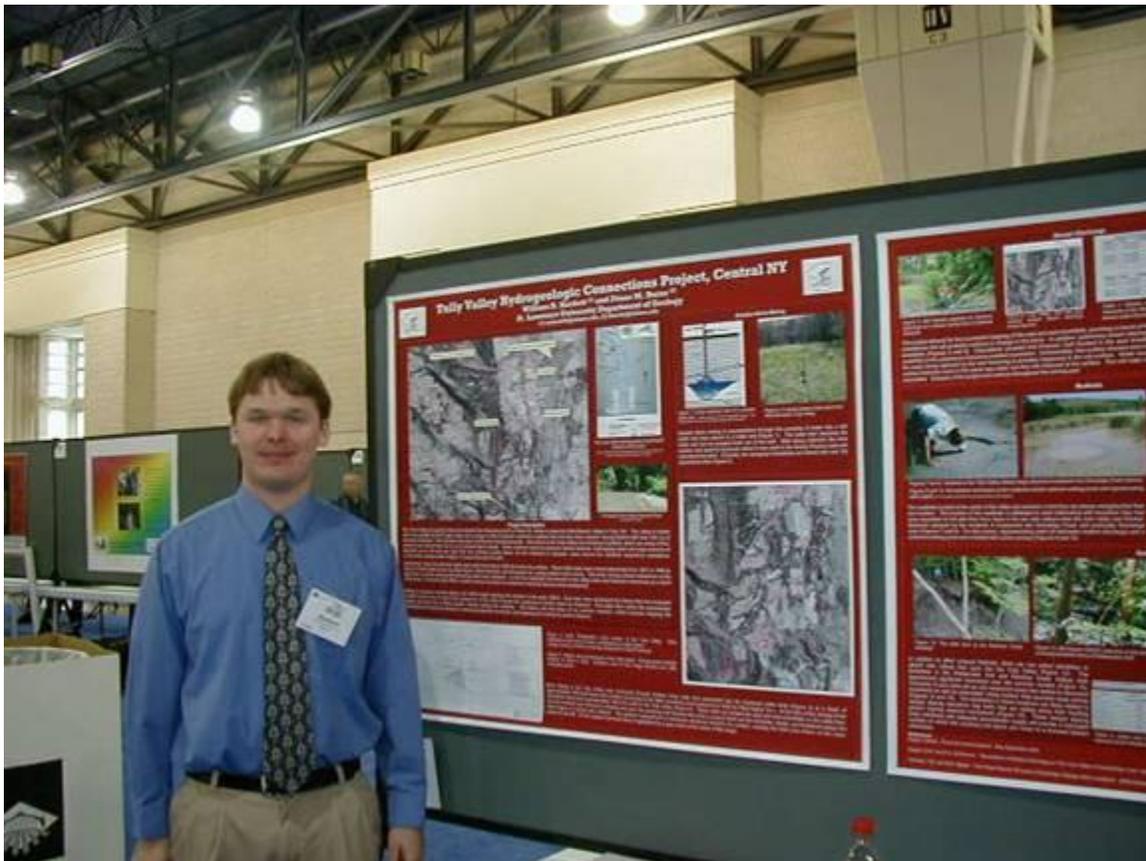
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Numerous techniques have been used to identify paleoclimatic conditions on a variety of time scales. These studies have also revealed patterns of warmer and cooler temperatures within the Great Lakes. For example, a paleo-lake level curve for Lakes Huron and Michigan has been constructed from beach ridge studies conducted in fourteen embayments around the Great Lakes region. The resulting curve indicates that beach ridges form in response to quasi-periodic changes in climate that occur approximately every 33- and 160-years for the last 4200 calendar years BP. Similarly, dendrochronological datasets have been used to interpret past climate fluctuations with recent research also

identifying a longer-term climate pattern similar to that found in the beach ridge based studies.

We collected approximately 160 vibracores of beach ridges and 110 tree-core samples from two sites in the Lake Michigan / Huron basin. We are examining the datasets for possible annual and decadal scale similarities in the timing of beach ridge formation (from vibracore data) and climatic variability as displayed by tree ring growth patterns.

Preliminary results suggest decadal scale cycles are present in both vibracore and tree ring datasets, and annual scale cycles (<10 years) may be present in the tree ring datasets. Furthermore, the data also suggests that an impermeable subsurface layer in some locales exaggerate the magnitude of climate change observed through the annual tree ring patterns by restricting groundwater availability. This interpretation is in agreement with data collected by continuously recorded water levels in one study area.

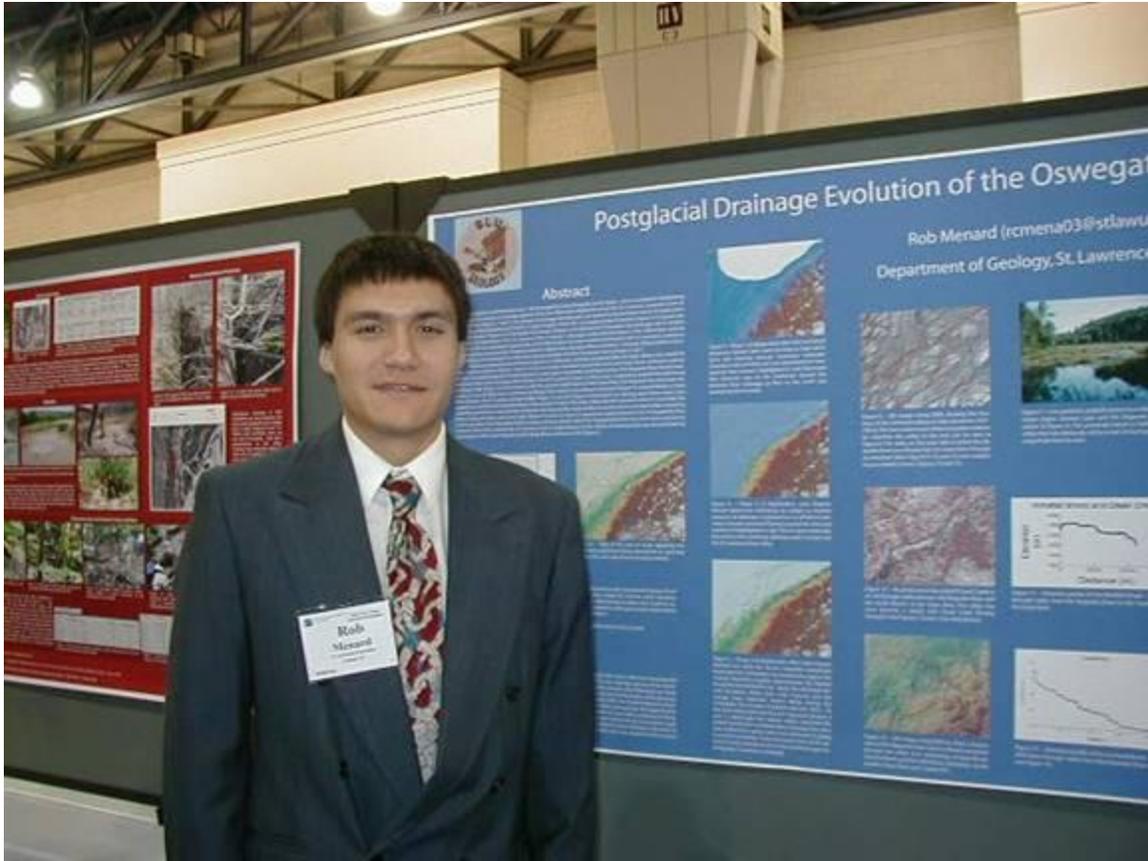


THE TULLY VALLEY BRINE FIELD/MUDBOIL HYDROGEOLOGIC CONNECTIONS PROJECT

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A mudboil is an artesian-pressured feature that discharges fine-grained sediment and water (fresh or brackish) to the land surface which, in time, can cause land-surface subsidence. The mudboils found in the Tully Valley of central New York, near Syracuse, have been a constant problem since the 1950's. In the southern part of this valley, solution brine mining of thick halite deposits (~150 feet or 45.7 meters thick) from the late 1800's through the 1980's caused land surface subsidence in the brine field area. This subsidence was caused by collapse in the brine-field cavities about 1,100 feet (335 meters) below land surface. This collapse in the bedrock eventually worked its way to the land surface along the valley walls. Fractures in the bedrock are currently capturing surface water streams and redirecting the water into a confined aquifer. The increased hydraulic head in the aquifer is believed to be a contributing factor to an increased level of mudboil activity.

Through the use of GPS, water monitors and on site measurements, evidence has been found for both a losing and a gaining stream, ongoing mudboil activity, as well as fairly active land movement. The presence of these features indicates the dynamic nature of the groundwater/surface water in the study area and its affect on the region in the immediate vicinity. This information is being analyzed to produce a remediation project to divert the surface water from the fractures which will hopefully slow the impact on the valley.



POSTGLACIAL DRAINAGE EVOLUTION OF THE ADIRONDACK NORTH-FLOWING TRIBUTARIES OF THE ST. LAWRENCE RIVER, NORTHERN NEW YORK

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Four adjacent, north-flowing rivers, Oswegatchie, Grass, Raquette, and St. Regis serve as models for deciphering the postglacial evolution of drainage patterns from the Adirondack Highlands across the St. Lawrence Lowlands to the St. Lawrence River. Five phases of drainage development are related to the primary events of deglaciation from the LGM including: 1) high (roughly 350 to 400+ m) proglacial lake formation; 2) Glacial Lake Iroquois formation; 3) Champlain Sea invasion; 4) rebound and Champlain Sea drainage; 5) modern, neotectonic adjustment of lower reaches tributary to the St. Lawrence River. In phase 1, drainage routes and elevations in the Adirondack uplands were to the SW and developed sequentially as the Wisconsinan ice mass wasted northward in the St. Lawrence Lowland as documented by several workers. Preglacial bedrock valleys most strongly influenced phase 1 drainage. Delta positions document initiation of northward flow into Lake Iroquois and later into the Champlain Sea in phases 2 and 3.

Numerous paleochannels drained stagnant ice meltwater and high proglacial lakes through valleys now over sized for their respective streams. Late in phase 1, the Raquette R. flowed westward near Sevey and cut a large valley that is now occupied by underfit Windfall Bk. and Dead Ck. and connected with the (present) South Branch of the Grass R. and then the Oswegatchie. The Raquette has since been pirated as it now abruptly turns northward at Moody Falls where it once flowed westward. Leonard Bk., a Grass R. tributary, lies in a vastly over sized valley that begins at a plunge pool where water once poured over a bedrock sill from the Raquette R. 2.4 km south of Colton. The large valley extends westward, where it now holds the underfit Grannis Bk. and Little R. Today the sill is dry, and the captured flow is northward. Rebound or neotectonism reversed the drainage direction during phase 4 or 5, causing flow to the NE. An over sized valley containing Indian Ck. and Upper and Lower Lakes represents a paleochannel of the Oswegatchie R. to the Grass R. from Rensselaer Falls to Canton active in phase 4. All flow has since been captured by the Oswegatchie as it drains to the north, meeting the St. Lawrence R. in Ogdensburg. Further effects of neotectonism are demonstrated by convergence of the Grass, Raquette, and St. Regis Rivers at Massena, NY.



TAPHONOMY AND PALEOENVIRONMENTAL ANALYSIS OF THE RED CANYON RANCH DINOSAUR SITE, UPPER JURASSIC MORRISON FORMATION, SHELL, WYOMING

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Continuing field studies are refining interpretations of the taphonomy and paleoenvironmental setting of a dinosaur site near Shell, Wyoming. The site has two bone-bearing levels preserved within high-sinuosity fluvial channel and associated overbank deposits. A detailed stratigraphic section and map of the lower of these levels shows the vertebrate and fossil plant taphocoenoses found in the various layers.

A basal unit composed of alternating fossil plant-rich and plant-poor lateral accretion surfaces incorporates scattered but fairly complete dinosaur bones, particularly caudal and dorsal sauropod vertebrae. This unit is overlain and truncated by a mud chip conglomerate that contains abundant, but fragmentary, bones and remains of coalified tree trunks and branches. The mud pebble conglomerate layer occasionally preserves dinosaur teeth, including at least one sauropod and two or more theropod taxa. Fossils recovered from the lower quarry are tentatively identified as *Camarasaurus*, *Diplodocus*, *Allosaurus*, and *Ceratosaurus*.

Quarrying progress was documented using digital photogrammetry to enable the construction of a 3-dimensional computer model, and locations of all fossils and relevant stratigraphic features were recorded using high-resolution real-time kinematic GPS.

Detailed sedimentary descriptions of the upper bone-bearing level record a succession of fining-upward beds composed of siltstones and sandstones. Vertebrate remains are located at the interface of a sandstone and underlying siltstone. The siltstone beds are structureless, but the sandstone beds preserve trough cross beds, ripple cross-lamination, and thin drapes of siltstone rip up clasts. Both the bone-bearing siltstones and rip-up clast conglomerate were screenwashed to assess the microvertebrate fossil record.

Additional studies place the dinosaur site into a broader context. Petrified wood from the Upper Morrison, Cloverly, and Sykes Mountain Formations was collected to assess the

plant taphonomy of the region during the Late Jurassic through Early Cretaceous, and the relative importance of sources of coarse clastic sediment in the hinterland was assessed by petrographic analysis of conglomerates and sandstones from the Morrison and Cloverly Formations in Wyoming and southern Montana.



RECONSTRUCTING THE LATE JURASSIC PALEOENVIRONMENT THROUGH CHRONOSTRATIGRAPHIC CORRELATION OF MORRISON FORMATION SUBSURFACE WELL LOGS, OUTCROPS, AND FOSSIL BEARING LAYERS IN THE EASTERN BIGHORN BASIN, WYOMING

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Sections of Morrison Formation outcrop were measured at Sheep Mountain, Red Gulch, Hyattville, Coyote Basin, and Red Canyon Ranch near Shell, Wyoming. Correlations of the sections with oil well log data of the eastern Bighorn Basin demonstrate a regional fluvial environment with local lacustrine systems characterized by cross-bedded sandstones, rip-up clasts and pockets of silty mudstone. The "Scorpion" sandstone at Red Canyon Ranch and similar fluvial sandstones across the study area are rich in both vertebrate and plant remains. In the upper Morrison, thick paleosols are locally well developed and indicate long periods of non-deposition. Large stacked channel sandstones of ancient river valleys occur where paleosols are thin or absent. An abundant record of dispersed cuticle is preserved in the highly sinuous, calcite cemented, fluvial deposits of mud and sand of the mid to upper Morrison Formation and occurs at the same horizon as dinosaur remains and in direct association with bone. Preliminary analysis of the cuticle flora indicates the presence of at least 5 species of gymnosperms, which are characterized by thick cuticles, sunken stomata with overarching papillae, and other features found today in evergreen, dry-adapted plants. Identified taxa include conifers belonging to the genus *Brachyphyllum*, the family Cheirolepidiaceae, and other taxa. The close relationship of vertebrate remains and abundant plant cuticle in the "Scorpion" sandstone and fluvial valleys of the Morrison Formation provide a rare opportunity to reconstruct the paleoenvironment of the eastern Bighorn Basin and to directly associate fossil vertebrates with the vegetation in which they lived.