

This talk summarizes insight gained by work mostly in Carter and Johnson Counties performed by this author and colleagues interested in groundwater in Tennessee. In these counties there are Rome Formation springs that have very low variability which serve as water supplies for thousands of customers. Ironically the Rome Formation is not typically recognized as a significant aquifer. This is due to errors derived from a lack of having a usable hydrogeologic framework to understand typical and non-typical aquifers specific to the karst in this region. Simple studies have shown it is possible to obtain an elementary framework to present hypotheses about the storage and flow in different lithologies and structural settings.

New efforts to instruct methods of karst investigations are coming to Tennessee. In particular the Rockhouse Cave karst field laboratory near East Tennessee State University will continue to grow, disseminate karst understanding, and evolve a usable framework that can be used on a regional scale. The answers to the most vexing karst problems will be started in Tennessee's groundwater setting and the best insight comes from ones still with so many unanswered questions.

**36-8 4:00 PM Kemmerly, Phillip R.**  
CHRONO-GEOMORPHIC MAPPING OF DOLINE FIELD EVOLUTION: POTENTIAL FOR DATING KARST TERRANES

KEMMERLY, Phillip R., Geosciences, Austin Peay State University, Clarksville, TN 37044, kemmerly@apsu.edu  
Recent work has shown that initiation and evolution of doline populations can be modeled with a family of functions known as logistic growth functions. As an outgrowth of this work, new insights provide an opportunity to map in chronological context the spatial evolution of a large doline population from the Western Highland Rim (TN) and contiguous Peninsular Georgia (GA). The initiation and evolution of a doline population begins with the development of sites of maximum systematic point-intersection loci. Parent doline initiation provides the geomorphic and hydrogeologic conditions conducive to initiation and development of one or more daughter dolines clustered around each parent doline within its respective karst-influence field. Daughter dolines develop within the initiation and enlargement are density dependent mechanisms and involve a negative feedback mechanism in which number and size of daughter dolines reflect this dependency. Parent doline initiation rates increased as the Cumberland River incised its valley and attendant ground-water hydraulic gradients increased with valley relief. Daughter doline initiation rates increased as the distance to the Cumberland River valley wall decreased, reflecting increased local hydraulic gradients. Both doline subpopulations (parent and daughter) reached steady-state conditions rates of valley incision decreased and fluvial steady-state equilibrium occurred. Limited radiometric dating and logistic growth analysis of parent and daughter doline subpopulations allow chronological mapping of karst terrane evolution using isochrons based on parent and daughter doline initiation rates and estimated times to reach steady-state conditions.

**36-9 4:20 PM Reid, Jeffrey**  
DIGITAL KARST LAYER AND COMPLICATION OF MAPPED KARST (SINKHOLE) FEATURES IN NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA - RELATIONSHIP TO CRITICAL FACILITIES

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Ground collapse and subsidence from limestone sinkholes is a geologic hazard in coastal areas (mainly Brunswick, New Hanover, Pender, Onslow, Jones, Lenoir and Beaufort counties, North Carolina). Karst (sinkhole) features are widespread and impact transportation corridors and development. Knowing the geology beneath the ground can assist in determining where sinkholes likely occur. Karst features were identified from color infrared aerial photographs, and supplemented with state government agency reports and field reconnaissance. Sinkholes in North Carolina come in many shapes and sizes. Many fill with water forming ponds or lakes, like around the town of Boiling Springs Lake and Sunny Point Military Ocean Terminal in Brunswick County, North Carolina. These features are distinct from the elliptical Carolina Bays which are much larger than sinkholes, and have an oval shape pointing in a northwest to southeast direction. Sinkholes may result in ground collapse and subsidence, and are a contributing factor in the rapid movement of contaminated groundwater. Sinkholes were responsible for the dewatering of Boiling Springs Lake, and for pavement subsidence such as along Interstate 44 near Wilmington. Sinkholes form naturally from limestone dissolution. Ground disturbing activity and changes in surface water and groundwater flow patterns can lead to the formation of new sinkholes. Notable sinkhole examples occur near Snow's Cut and Carolina Beach State Park (New Hanover County), Sunny Point Military Ocean Terminal and Boiling Springs (Brunswick County), and Catherine's Lunny area (Onslow County). Digital geographic information system (GIS) data are intersected with critical facilities layers from HAZUS to assist local and state emergency preparedness. Additional investigations are underway.

**36-10 4:40 PM Gao, Yongli**  
DEVELOPMENT OF A REGIONAL APPALACHIAN KARST FEATURE DATABASE

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Karst lands cover more than 40% of the contiguous United States east of Tulsa, Oklahoma. Many active karst areas exist in the southeastern U.S. This paper presents ongoing effort to develop a regional Appalachian Karst Feature Database (KFD) using Geographic Information System (GIS) and Database Management System (DBMS) technologies. A sub-regional KFD of the southern eastern part of Appalachian Karst is being assembled by merging available karst features and geological information in Tennessee, North Carolina, Virginia, and West Virginia. The ultimate goal of this research is to develop a complete regional Appalachian KFD. This KFD will provide data and tools for researchers and land-use planners to access karst hazards and to manage water resources of the Appalachian Karst.

**36-11 5:00 PM Weary, David J.**  
COMPLIATION OF NATIONAL SCALE KARST DATA BY THE U.S. GEOLOGICAL SURVEY WITH EMPHASIS ON THE SOUTHEASTERN UNITED STATES

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The U.S. Geological Survey KARST (Karst Applied Research Through geologic mapping) Project is producing a new national karst map of the United States in cooperation with the National Cave and Karst Research Institute (NCKRI) and the National Speleological Society (NS). This map will replace the national atlas karst map of Davies and others (1984). As a GIS-based map, improvements in precision and utility will be inherent to this product. In the eastern United States the extent of outcrop of soluble rocks provides a good first-approximation of the distribution of karst-prone areas. Our approach to producing a new karst map is to first compile a soluble rock map derived from various data sources, primarily state geologic maps. The potential karst areas

derived from this map are then subdivided based on regional styles of karstification inherent to these rocks. Criteria are being developed for further refinement of the map units including the distribution and density of cave, sinkhole, and other karst features. Issues complicating the compilation and classification process include: 1) unevenness in spatial precision and lithologic classification between the various geologic maps; 2) lack of easily obtainable statewide and region-wide karst data, especially cave locations; and, 3) recognition of key, non-lithologic factors affecting the development and distribution of karst features. Over the past four years, we have organized three regional workshops with various state geological surveys and other interested parties. The outcomes of these workshops include the establishment of personal contacts, offers of data support, suggestions for construction of the map, and regional perspectives on karst-related issues. One of our next goals is to find a way to bridge a current disconnect between portraying and serving national-scale data produced by the U.S. Geological Survey and data owned by other national, state, and local groups. A new karst digital data portal sponsored by NCKRI offers a potential framework for integration of data sets of all resolutions from national to local scales.

**SESSION NO. 37, 3:00 PM**

**Friday, 24 March 2006**

**T17. Paleontology, Paleoeology, and Paleoenvironments of the Gray Fossil Site, Gray, Tennessee (Paleontological Society)**

**Marriott Hotel, Alvin York**

**37-1 3:05 PM Bahn, Robert A.**  
OCCURRENCE OF THE GIANT ICE AGE BISON, BISON LATIFRONS, FROM LATE PLEISTOCENE COASTAL GEORGIA

BAHN, Robert A. and MEAD, Alfred J., Biological and Environmental Sciences, Georgia College and State Univ., Milledgeville, GA 31061, bobbahn1@hotmail.com  
When compared to neighboring states, Georgia's record of Pleistocene vertebrate fossil localities is rather depauperate. However, excavations at Clark Quarry near Brunswick, Georgia, have yielded abundant *in situ* Pleistocene-aged vertebrate fossils in recent years. The locality is dominated by macrofossils of the large Columbian Mammoth (*Mammuthus columbi*) and Bison. A recently recovered *Bison* skull with attached horn cores allows for its specific identification (late Pleistocene *Bison* species can only be distinguished based on horn core dimensions). In addition to the skull, numerous cervical, thoracic, lumbar, and caudal vertebrae, numerous ribs, three scapulae, six humeri, two radio-ulnae, one femur, one tibia, and numerous podials of the left hand were recovered. The skull exhibits a complete cranium, rostrum, a nearly complete left horn core and a partial right horn core. An estimate of the horn core spread (tip to tip) is 162 cm. The left horn core length on the upper curve (tip to burr) is approximately 77 cm. These measurements indicate that this species is the Giant Ice Age Bison (*Bison latifrons*, Radiocarbon (<sup>14</sup>C) dating with corrected Stable Isotope Ratio analysis on a partial radio-ulna of *B. latifrons* produced a date of 12,350 ± 70 YBP which raises interesting questions about the evolution and reduction of horn size in the Genus *Bison*. *Bison latifrons* had previously been thought to have been extinct since the late Wisconsinan, somewhere between 21,000 and 30,000 years ago. This date also raises interesting geologic questions. Previous geologic mapping in the area indicated that Clark Quarry lies within the Princess Anne Terrace of the Sallita Formation. However, the radiocarbon date suggests that the ages of the Princess Anne and Silver Bluff Terraces need to be reconsidered or that Clark Quarry sediments represent a more recent episode of fluvial cut and fill in these older sediments.

**37-2 3:25 PM Whitelaw, Michael J.**  
STRATIGRAPHY AND PALYNOLOGY OF THE MIO-PLIOCENE GRAY FOSSIL SITE, WASHINGTON COUNTY, EAST TENNESSEE

WHITELAW, Michael J., Physics, Astronomy and Geology, East Tennessee State University, Johnson City, TN 37614, whitelaw@etsu.edu  
The Gray Fossil Site (GFS) is a Mio-Pliocene locality in eastern Tennessee that has preserved a diverse suite of vertebrate, invertebrate and plant remains. The deposit occurs within carbonates of the Ordovician Knox Group, and is hypothesized to have originated as a paleo-sink hole. Sediment samples have been collected from approximately 12.0 m of exposed section within the feature and from a 37.0 cm core (GFS-1) drilled to basement. The sediments are generally dark and are dominated by cyclic couplets of organic rich clay and fine silt units, interpreted to have been deposited in a standing body of water. The fine sediments are occasionally interrupted by sands and/or gravel stringers, and boulders, some having diameters in excess of 3 m, which occur at various horizons across the site. The organic rich sediments, indicative of anoxic water conditions, may well be the reason for the large volume and remarkable preservation of the GFS biota. The vertebrate fauna is dominated by tapirs, but includes fish, frogs, alligators, turtles, snakes, lizards, rhinoceroses, camels, deer, a bear, a saber-tooth cat, a shrew, a gomphothere, a hyena, and a panda. The site is notable for the absence of horses. The presence of *Teleoceras* and *Ptilonotus* currently constrains the age of the site to 4.5-7.0 Ma. Recent paleomagnetic studies of GFS-1 indicate that most of the core is of reverse polarity. The combination of vertebrate fossil and paleomagnetic data constrain the duration of deposition to ~ 700 ka. Plant material has pollen. Identified plant macro fossils include pine, multiple species of oak, ash and hickory. A total of 36 samples were collected from GFS-1 for pollen analysis. The pollen population is dominated by *Pinus* (pine) and *Quercus* (oak) but includes a variety of other deciduous taxa, *Salix* (willow), *Cyperaceae* (sedges), and minor grasses. Both the pollen and the plant macro fossils indicate that the GFS sink hole was dominated by closed forest taxa and that grasses were a minor component. These findings support previous interpretations of the site, based on recovered vertebrate taxa and the notable absence of horses, as a closed forest environment and possibly a refugia.

**37-3 3:45 PM Sheets, Hope A.**

**A PALEOECOLOGY COMPARISON STUDY OF ANURANS FROM THE GRAY FOSSIL SITE, WASHINGTON COUNTY, TN, AND THE PIPE CREEK SINKHOLE, GRANT COUNTY, IN SHEETS, Hope A., Physics, Astronomy, and Geology, East Tennessee State University, Box 7063, Johnson City, TN 37614, zhas9@mail.etsu.edu, FARLOW, James O., Department of Geosciences, Indiana-Purdue Univ., Fort Wayne, IN 46805, SCHUBERT, Blaine W., Physics, Astronomy, and Geology, East Tennessee State University, Box 70636, Johnson City, TN 37614, and WALLACE, Steven C., Department of Physics, Astronomy, and Geology, East Tennessee State University, Johnson City, TN 37614-1709**

The Gray Fossil Site is postulated to be a late Miocene or early Pliocene (c. 4.5 - 7 million years BP) sinkhole deposit. As expected, such an assemblage of aquatic taxa, such as anurans are represented. Recent well-saving efforts are producing microfaunal remains but surprisingly, frogs appear to be underrepresented. In contrast, the Pipe Creek Sinkhole estimated to be early Pliocene (c. 5 million years BP) age, and often considered to be the "sister site" to Gray, has produced a multitude of anuran remains. Specific taxonomic differences noted thus far are that the anuran fauna from Pipe Creek is dominated by smaller aquatic species, identified as being in the *Rana pipiens* complex, whereas the fauna from Gray is primarily larger aquatic anurans similar in size and morphology to *Rana catesbeiana*. The Gray Fossil Site is in the early stages of excavation, and only time will tell whether or not these patterns represent true paleoecological differences.

**37-4 4:05 PM Schubert, Blaine W.**

**ON THE IDENTIFICATION OF FOSSIL SALAMANDERS AND SNAKES: A CASE STUDY FROM THE MIO-PLIOCENE GRAY FOSSIL SITE OF TENNESSEE**

SCHUBERT, Blaine W., Physics, Astronomy, and Geology, East Tennessee State University, Box 70636, Johnson City, TN 37614, schubert@etsu.edu  
The Mio-Pliocene Gray Fossil Site of northeastern Tennessee is primarily composed of laminated silty-clay sediments that indicate a ponded environment. The bulk of the reptiles and amphibians found up to this point (alligators, natricine snakes, aquatic testudines and anurans, and salamanders) reflect the ecological setting. Recent screenwashing efforts have produced an abundance of salamander and snake trunk vertebrae, the main elements used in the identification of fossils from these groups. Comparison with extant species revealed problems with the diagnosis of these taxa to lower levels of classification using currently published criteria. Similar troubles have recently been addressed with the identification of anurans, testudines, and small mammals. Examples of these problems in extant and fossil salamanders and snakes are discussed. The primary issues are: 1) ontogenetic, interspecific, intraspecific, and interclanular variation has not been accounted for, 2) discrete characters are not relied upon, and 3), too much reliance has been placed on modern biogeography.

**37-5 4:25 PM Hulbert, Richard C.**

**PHYLOGENETIC RELATIONSHIPS AND MORPHOLOGY OF TAPIRUS POKLSENSIS (OLSEN) FROM THE LATE NEOGENE OF THE SOUTHEASTERN UNITED STATES**

HULBERT, Richard C., Jr. Florida Museum of Natural History, University of Florida, Gainesville, FL 32611-7800, rhulbert@flmnh.ufl.edu and WALLACE, Steven C., Department of Physics, Astronomy, and Geology, East Tennessee State University, Johnson City, TN 37614-1709

The most abundant mammal at the Gray Fossil Site in eastern Tennessee is a small-sized species of *Tapirus*. Morphologic and statistical comparisons of the Gray tapir sample with specimens of *Tapirus poklensis* Olsen, 1960 from the late Miocene and early Pliocene (Hemphillian) of central Florida find no significant differences and the two are regarded as conspecific. These comparisons also indicate that the holotype of *T. poklensis*, an isolated upper premolar, is not a P4, as originally identified, but is instead a P3. Cladistic analysis of 10 extinct and 4 extant tapirids with 64 parsimony informative characters reveals strong support for a monophyletic *Tapirus* that includes *T. poklensis*, and that *T. poklensis* is a member of a clade that also includes *Tapirus bairdi*, *T. hayshi*, and *T. veroensis*.

**37-6 4:45 PM Wallace, Steven C.**

**A NEW POPULATION OF TELEOCERAS (MAMMALIA: RHINOCEROTIDAE) FROM THE SOUTHERN APPALACHIANS (GRAY, TENNESSEE)**

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Recent finds of the short-legged rhinoceros, *Teleoceras*, from the Gray Fossil Site (Late Miocene) of Washington County, TN, afford a closer look at this interesting animal. The Gray sample, which likely represents *T. hicksi*, includes at least three adults (including a complete skeleton) and one juvenile (likely fetal). Based on the small proportion of the site that has been worked, this sample will grow substantially.

Several interesting observations of the Gray sample can already be made: 1) although the nasals are very thick and fused, their smooth surface clearly demonstrates the lack of a terminal nasal horn. It seems more likely that the thickness of the nasals, and the complicated nature of the suture between them, acted in combination as a battering ram during male to male interactions; 2) of the two individuals preserving the manus, the MCV is present (as a small vestigial nubbin) in one, and completely lacking in the other. The presence of a mass of bone (in the specimen lacking) suggests that the MCV simply fused with the MCVI early in development. Reduction of the MCV is typical within many rhinoceroses, but the degree and frequency of the reduction within this population may prove significant; 3) there is a very small, vestigial p2 on the left side of the jaw of ETMNH-609 that is lacking on the right. The p2 is typically lost within this species, so the frequency of its presence could prove systematically significant; and lastly 4) limb elements from Gray (if indeed *T. hicksi*) are proportionally thinner, yet longer, than conspecific material from Florida. At present, these proportional differences do not warrant evaluation of the Gray population to specific status, however, additional material is needed.

**37-7 5:05 PM DeSantis, Larisa R. Grawe**

**EVIDENCE OF A FOREST REFUGIUM AT A NEOGENE FOSSIL SITE, GRAY, TN**

DESANTIS, Larisa R. Grawe, Department of Zoology, University of Florida/Florida Museum of Natural History, 223 Bartram Hall, P.O. Box 118525, Gainesville, FL 32611-8525, lgrawe@ufl.edu and WALLACE, Steven C., Department of Physics, Astronomy, and Geology, East Tennessee State University, Johnson City, TN 37614-1709

The Gray Fossil Site in eastern Tennessee, which is biostratigraphically dated between 4.5 and 7 Ma, can classify paleoecological dynamics during the Neogene. In particular, the potential of identifying a forest refugium will better our understanding of the environmental context of mammalian evolution during the late Cenozoic. Stable isotope analyses of bulk and serial samples of

fossil tooth enamel from all herbivorous mammals present at the Gray site elucidate paleoecological reconstructions. The herbivorous meio fauna include taxa of likely Euryasian ancestry including the tapir *Tapirus poklensis*, rhino *Teleoceras* cf. *T. hicksi*, camelid cf. *Megatylops* sp., peccary *Tayassuides*, and proboscidean Gomphotheriidae. The tapir, rhino, camel, and peccary all yield stable carbon isotope data with average values of -12.2‰, -13.2‰, -13.8‰, and -13.1‰, respectively, suggesting forest-dwelling browsers. This range of  $\delta^{13}C_{\text{org}}$  values indicates the presence of a  $C_3$  dominated forest environment. Because  $\delta^{13}C$  values decline with increasing canopy density, the ancient temperate forests from the Gray site were relatively dense. The lack of significant  $C_4$  forest consumption (i.e., tooth enamel  $\delta^{13}C$  values < -2‰) suggests the presence of forests large enough to independently support the continued browsing of sustainable populations of browsers from the Gray site. In contrast, bulk and serial  $\delta^{13}C$  values ranging from -0.7‰ to 0.3‰ from a gomphothere tusk support a diet consisting of dominant  $C_4$  flora. The analysis of trace elements and/or strontium and potassium from the gomphothere tusk, and if an alternative interpretation is responsible for the isotopic differences. Carbon and oxygen serial sample variation of the tapir, rhino, peccary, and proboscidean is less than 1.5‰, suggesting little difference in seasonal temperature and/or precipitation. These data support the presence of North American forest refugia in the southern Appalachians during the Neogene.

**SESSION NO. 38, 3:00 PM**

**Friday, 24 March 2006**

**T18. Hands-on Ichnology and the Union Chapel Track Site II (Paleontological Society, Eastern Section of the Society for Sedimentary Geology (SEPM))**

**Marriott Hotel, William Blount South**

**38-1 3:05 PM Buta, Ronald J.**  
DOCUMENTING THE STEVEN C. MINKIN PALEOZOIC FOOTPRINT SITE

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The Minkin Site at the Union Chapel Mine (UCM) near Jasper, Alabama, is recognized as one of the best and most prolific Carboniferous tracksites in the world. After the site was discovered in late 1999, more than a thousand slabs with trackways were salvaged during the first 18 months. The high recovery rate led to a major documentation program that continues to the present day. The documentation effort was initiated by the late Steven C. Minkin, who organized the first of several "Track Meets" at which collectors brought in specimens for photography and cataloging. This was the first time the collectors' group, today known as the Alabama Paleontological Society (APS), gathered for such a purpose, and was an effective way the large number of specimens could be handled without significant loss of scientific information. Almost every specimen found since 1999 has been given a UCM number, and all photographs have been made freely available to interested persons worldwide through an internet website, http://bama.ua.edu/~ruta/mograph/. The website currently includes nearly 3000 photographs of approximately 2000 specimens of trace fossils, of which about half are vertebrate trackways. The APS brought the specimens to the attention of scientists for identification and further study. The collaboration resulted in a meeting held at the University of Alabama in 2003 and a 400-page monograph, "Pennsylvanian Footprints in the Black Warrior Basin of Alabama," published by the Society in 2005. This monograph includes original research not only on the trace fossils found, but also on the rich paleoflora of the site. Many specimens have been donated to museums and a specimen location database has been prepared. The sustained effort by APS members is what made it possible for the Minkin Site to be rescued from reclamation and documented effectively.

**38-2 3:25 PM Atkinson, Prescott**

**SAVING THE UNION CHAPEL MINE: HOW A GROUP OF AMATEURS TEAMED UP WITH PROFESSIONALS TO SAVE A WORLD-CLASS CARBONIFEROUS TRACK SITE**

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In late 1999 a high school science teacher from Onotona, Alabama visited a surface coal mine in Walker County, Alabama and discovered that the spoil piles contained highly valuable vertebrate and invertebrate trackways and other trace fossils. This presentation will detail how he alerted an amateur group of fossil enthusiasts, which first salvaged specimens from the site and then began a campaign to save the site from federally mandated reclamation by engaging the assistance of professional geologists and paleontologists, the news media, and governmental officials. Preservation of this important site, dedicated in March 2005 as the Steven C. Minkin Paleozoic Footprint Site by the Alabama Department of Conservation and Natural Resources, is an exceptional example of the benefits of collaboration between amateurs and professionals and serves as a useful roadmap for future preservation efforts for other sites.

**38-3 3:45 PM Martino, Ronald L.**

**WALKING TRAILS OF THE GIANT TERRESTRIAL ARTHROPOD ARTHROPLEURA FROM THE UPPER CARBONIFEROUS OF KENTUCKY**

MARTINO, Ronald L., Marshall Univ., Huntington, WV 25755, martinor@marshall.edu and GREB, Stephen F., Kentucky Geological Survey, Univ. of Kentucky, 228 Mining and Mineral Resources Building, Lexington, KY 40506-0107  
Large arthropod trackways interpreted as trails of the giant terrestrial millipede *Arthropleura* have been found in strata of the Mid-Late Pennsylvanian Conemaugh Formation in eastern Kentucky. The trails represent the chironomid *Diplichnites* and are preserved as convex hyporelief on three slabs of fine to very fine, micaceous sandstone. The slabs are 4-14 cm thick and were derived from a 1.5 m thick, interbedded sandstone and shale facies of early Stephanian age. Associated features include parallel lamination, ripple cross-lamination, current ripple bedding, graded bedding, mudcracks, root traces, and rare leaves of *Cordaites* and amphibian footprint casts. The facies is interpreted to have been deposited during repeated river flooding which produced alternating crevasse splay sands and muds.