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Symposium 7

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AND THE 3RD

APPALACHIAN KARST SYMPOSIUM

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Images showing pre-construction setting and newly built Five-hundred-meter Aperture Spherical radio Telescope (FAST). This instrument, completed in 2016, is the world's largest filled-aperture radio telescope and was built within an extremely large karst depression, Dawodang, in Pingtang, Guizhou, China. Images courtesy Dr. Boqin Zhu, National Astronomical Observatories of China. See paper by Zhu et al., this volume.

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FOREWORD

Welcome to the Fifteenth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst and the Third Appalachian Karst Symposium. This year our meeting returns to the eastern United States, and to one of the cradles of karst studies from the prior century: the Appalachians of Virginia and West Virginia. Early cave exploration and science in this region occurred in tandem with groundbreaking European studies in speleology. In 1930 William Morris Davis published his comprehensive "Origin of Limestone Caverns," making use of sites in the Appalachians, as well as others. Important documentary compilations of Virginia caves by McGill (1933), Douglas (1964), and Holsinger (1975) appeared over the years, along with William Davies' "Caverns of West Virginia." In January of 1941, the National Speleological Society (NSS) was founded in nearby Washington, D.C. by cavers who were very active in the Appalachian karst regions. Through their publication of the "NSS Bulletin," later "The Journal of Cave & Karst Studies," a golden era of North American cave exploration and science was developed and documented. The work and discovery continue to this day, as both pure exploration and science move forward side-by-side.

The Sinkhole Conference, established in 1984 by Dr. Barry Beck, has a long history of bringing together scientists and engineers with interests in applied aspects of karst settings. The eastern U.S. with its population centers and dense infrastructure, is a critical locale with numerous examples of the challenges of co-existence with caves and sinkholes. This was one spur for the convening of the first Appalachian Karst Symposium (Kastning & Kastning, 1991). Twenty-seven years later we are happy to co-convene the 15th Sinkhole Conference with the 3rd Appalachian Karst Symposium, to bring together scientists, engineers, managers, and others, who share a stake in understanding karst systems.

Since 2011 The Sinkhole Conference has been sponsored by the National Cave and Karst Research Institute (NCKRI), a congressionally-created non-profit organization dedicated to pure and applied research on caves, karst phenomena, and karst hydrology. This year NCKRI joins with the Karst Waters Institute (KWI) as co-sponsors of the meeting. KWI, which is incorporated in West Virginia, has the mission to improve the fundamental understanding of karst water systems through sound scientific research and the education of professionals and the public. Both organizations, along with supporting groups indicated in these Proceedings, welcome you and hope you will have a great week at the National Conservation Training Center, Shepherdstown, West Virginia.

Ira D. Sasowsky, Proceedings Editor
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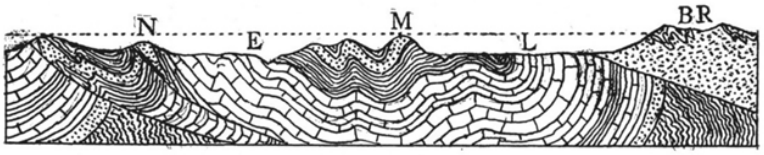

FIGURE 60.—*Cross-section of Shenandoah Valley, Virginia*
After Virginia Geological Survey.

Interpretation of the folded limestones of the Shenandoah Valley by Davis (1930)

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KEYNOTE SPEAKER

AN APPALACHIAN MYSTERY: THE HYDROGEOLOGY OF MOUNTAIN LAKE IN GILES COUNTY, VIRGINIA. LEAKY LANDSLIDE OR COVERED KARST?

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Abstract

Mountain Lake, in Giles County, Virginia was the principal filming location for the 1987 movie Dirty Dancing, at a time when the lake was full. Starting in about 2002, water levels decreased significantly during the fall months and recovered only partially during the summer months. In 2008, the lake went completely dry and then nearly so again in 2011. Mountain Lake is one of only two naturally formed lakes in Virginia. At an elevation of 3,875 feet above sea level, it is a truly unique feature in the Valley and Ridge Province within the unglaciated southern Appalachians. A karst collapse origin for the lake has often been suggested. Recent geophysical studies suggest that the lake owes its existence, at least in part, to colluvial damming of an ancient water gap in the breached limb of a dissected plunging anticline approximately 6,000 years ago.

Major conduits are believed to form periodically within the colluvial dam allowing water and lake sediment to pipe through the debris until such time as the conduits become sufficiently clogged to again hold back nearly 100 feet of water depth. The colluvial deposits are likely never completely free of leaks, however it does appear that leakage varied in severity somewhat over the thousands of years. In 2013, the owners undertook a massive earthmoving project intended to restore the lake by filling depressions at the base of the dam, caused by the piping of lake sediment, with naturally available materials from the site. The effort was successful and water levels rose rapidly until encountering additional side conduits at higher elevations that now appear to control lake levels.

Radford University researchers have utilized dye studies, electrical resistivity, seismic refraction, side scan sonar, SCUBA, submersible ROV, unmanned aerial systems, and more to investigate the lake. Observations indicate that the leaks overall are greatly reduced and that precipitation is nearly normal for this region, raising the question of whether changes within the watershed may also play a role by decreasing the inflow side of the water budget equation. In 2002, a part of the drainage basin was modified by the development of new cottages, parking lots, and storm water retention basins. Runoff modeling using the rational method reveals that annual surface flow to the lake has decreased from that area. Groundwater modeling reveals that infiltration beneath these stormwater retention basins lies outside of the groundwater divide for the system that provides base flow recharge to the lake, hence surface water captured by the retention basins appears permanently lost to the lake.

Biography

Dr. Skip Watts received his PhD from Purdue University in 1983. He teaches Geology Applied to Engineering and Hydrogeology at Radford University and Virginia Tech. Skip received several regional and national teaching awards, including the State Council for Higher Education's Outstanding Professor Award, Virginia's highest teaching honor, awarded by the Governor. He spent 18 months as a USGS Congressional Fellow serving Senator Joe Lieberman as a science adviser. He was named the 2003 Jahns Distinguished Lecturer speaking on the topics of Geology and Public Policy and Military Operations in Difficult Terrain. He appeared on The Weather Channel's documentary series Storm Stories in an episode entitled SLIDE! and as a guest on National Public Radio's Weekend Edition. Skip provides rock slope safety and stability consulting services for federal and state agencies as well as for private industry. He is presently serving as director of the Radford University GeoHazards Research Center, specializing in the use of unmanned aerial systems (UAS) for geologic mapping and investigating natural hazards of all types.

BANQUET SPEAKER

THE SCIENCE BENEATH THE OHIO STATE GEOTHERMAL FIELD FIASCO: A COOL STORY ABOUT A HOT TOPIC

E. Scott Bair
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Abstract
The geothermal wellfield at Ohio State University was designed to heat and cool five, 11-story dormitories. The estimated cost of the HVAC conversion project, including construction of 480 geothermal wells to a depth of 550 feet, was $4.5M. An east coast company received the drilling contract based on cost and use of multiple air-rotary drilling rigs to complete the wells with 100 feet of steel casing through 80-90 feet of unconsolidated glacial deposits, with the remaining depth completed as 'open hole' through limestones and dolostones. No problems occurred drilling the first well.

However, while drilling the second well at a depth of 280 feet, the first well, located 30 feet away, began spouting water 10-15 feet in the air. Work on the second well was halted as drilling began at a third well about 200 feet away. The first and second wells spouted water as the drilled depth in the third well hit 400 feet. As well construction continued, as many as seven wells often could be seen simultaneously spouting water. Commonly, previously drilled wells that had spouted water did not spout water as new wells were drilled in close proximity. The drillers, who normally worked in crystalline rocks, had not seen anything similar to the number, erratic pattern, and irregular participation of spouting wells. Engineers maintained that the air-rotary rigs pressurized an existing 'fracture zone' at a depth of 250 to 400 feet creating the 'geysers'. Three test wells spaced across the geothermal did not encounter the 'fracture zone,' nor did several of the geothermal wells. Drilling proceeded for several months despite the numerous spouting wells and associated runoff problems.

The state and city cited the university with daily fines for violating ordinances limiting drainage to a nearby river and sediment loads to sewers. Shortly thereafter, the driller was fired, lawsuits threatened, a new bid document released, and another company hired, one that proposed a different drilling method and a completion technique that would solve the problems caused by a well-known paleokarst zone. At least it was well known to local hydrogeologists and several faculties in the Earth Sciences Department. Ignorance delayed completion of the geothermal wells by a year and added $4M to the overall project cost.

Biography
E. Scott Bair took his B.A. in geology from the College of Wooster and his M.S. and Ph.D. from Penn State University. Following graduate school he worked six years at Stone & Webster Engineering Corporation. Tired of corporate politics and remembering academe to be devoid of it, Scott joined the faculty at Ohio State University in 1985. Over his career he taught courses in earth science, water resources, environmental geology, speleology, petroleum geology, hydrogeology, field methods in hydrogeology, and groundwater flow modeling. In 1991, he received the Ohio State award for teaching excellence; as penance he served six years as department chair. Scott advised 34 graduate students who worked on projects funded by Ohio DNR, Ohio EPA, NSF, USEPA, USDOE, USDA, USGS, and Ohio State.

Scott likes to talk. He's given seminars at more than 90 colleges and universities in the U.S., Canada, and Japan, at several federal and state agencies, the Ohio Bar Association, Harvard Law School, and the National Research Council. From 1987 to 2015 he co-taught short courses for the National Ground Water Association (NGWA) including Principles of Groundwater Flow, Transport and Remediation; Aquifer Test Design and Analysis; Groundwater Control and Construction Dewatering; Artificial Recharge and Induced Infiltration; and Delineating Capture Zones of Wells for Contaminant

Remediation and Wellhead Protection. He is co-author of the semi-successful textbook Applied Problems in Groundwater Hydrology.

He is a Fellow of the Geological Society of America (GSA), recipient of its Birdsall-Dreiss Distinguished Lectureship, and former chair of its Hydrogeology Division. Scott was an associate editor of the journal Ground Water for 11 years, a member of the Ohio Hazardous Waste Facilities Board for three governors, a technical reviewer for the Centers for Disease Control investigation of male breast cancers at U.S. Marine Corps Base Lejeune, and a member of the USEPA Science Advisory Board on Hydraulic Fracturing. He received the George B. Maxey Award from GSA and the Keith E. Anderson Award from NGWA for his service to those organizations and his contributions to the greater groundwater community. Scott and his wife recently retired to the Outer Banks of North Carolina where they plan to lollygag in the sun and surf until rising sea level carries them away.