

Cave and Karst Systems of the World

Max P. Cooper  
John E. Mylroie

# Glaciation and Speleogenesis

Interpretations from the Northeastern United States

 Springer

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# **Cave and Karst Systems of the World**

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Interpretations from the Northeastern  
United States

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## Foreword

John Mylroie's 1977 dissertation on caves and karst of the Helderberg Plateau in Schoharie County, New York has long been a bible for cave investigators in that area. Now, he and his student Max Cooper—who has investigated maze caves in the northeastern United States—have produced a book which incorporates the many findings from ensuing decades, and which emphasizes the profound effect of glaciation on cave and karst development. Not limited to Schoharie County, this book covers New York and New England—the entire Northeast.

Cave studies began in the Northeast in the 1950s, with systematic tabulation of cave and karst features, and initial mapping. This has continued to the present, as new caves are discovered and mapped. But in the 1960s, scientific studies of cave development (speleogenesis) began. Insights from this have resulted in the discovery of major caves like Barrack Zourie and Carthusian caves, Thunder Hole, and Vermonster. Informal digging groups have followed the water (and speleogenetic principles) to open many new caves.

To some geologists, glaciation is an annoyance, since it blankets large areas of bedrock and has eroded strata away. But to other geologists, glaciation is “the frosting on the cake” and a fascinating field of study. Cavers and speleologists might have similar feelings. Some shallow caves were destroyed by glaciers, and glacial sediment now blocks many cave passages. But glaciation also caused many new caves to form, and within preglacial caves it modified old passages and created new ones.

As just one example of glacial effects, consider drumlins—cigar-shaped hills composed of sediments of all sizes bulldozed under an advancing glacier and aligned with ice flow. A drumlin blocked the preglacial cave stream exit of Schoharie Caverns (Schoharie County, NY) and caused the stream to form a small tapoff exit passage and, during flood conditions, to force an exit up through the glacial till. Artificial excavation in 1958 resulted in the present spacious entrance, although slumping is starting to re-bury it. Multiple streams running off a drumlin east of Howes Cave, also in Schoharie County, have formed small pit caves in the underlying limestone. As the drumlin erodes back, the cave entrances have also migrated back following the edge of the drumlin. And finally, in eastern Schoharie County two adjacent drumlins have a narrow area of exposed limestone between them. New caves are forming along joints in this valley.

There are many other ways glaciation has had major effects on cave development, and *Glaciation and Speleogenesis: Interpretations from the Northeastern United States* discusses them in detail. The significant effects of glaciation on the development of non-solutional caves such as talus, fracture, and sea caves are covered as well. Each of the several karst regions of the Northeast is treated separately, with selected caves used as case studies.

*Glaciation and Speleogenesis: Interpretations from the Northeastern United States* also includes a geologic history of the Northeast, a summary of the cave-forming rock units in each region, and the prospects for learning paleoclimatic data from cave deposits.

*Glaciation and Speleogenesis: Interpretations from the Northeastern United States* is thorough, well-illustrated, and readable, and should be in the library of every serious northeastern caver as well as karst scientists worldwide who are interested in the effects of glaciation on cave development.

January 2015

Chuck Porter

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## Preface

Thoughts on the effects of glaciation and karst have evolved from the late 1960s to today. The effects of continental glaciation on karst have been primarily studied in Britain (e.g., Waltham 1974), Canada (e.g., Ford 1983, 1987), Norway (e.g., Lauritzen 1981), and the northeastern United States, particularly in the Helderberg Plateau of New York (e.g., Mylroie 1977). Alpine glaciation has additionally been studied for its effects on karst in the Alps, the Pyrenees, and the Canadian Rockies (Ford and Williams 2007). The studies on continental and alpine glaciation show varying effects between the two styles of glaciation, with alpine karst development having high hydraulic gradients and strong structural control that may be missing in lowland carbonate plateaus. Early thoughts on karst and glaciation were that glaciers removed the vast majority of pre-glacial caves and karst, and those larger cave systems, which could not be established in the time since deglaciation, were anomalous (e.g., Jennings 1971). In the early 1970s in Britain it was demonstrated that there are numerous cave systems that survived glaciation (Waltham 1974), albeit these caves are commonly filled with glacial sediments. Work in the Canadian Rockies also demonstrated the survival of pre-glacial cave systems in alpine glaciated settings (Ford 1983). The overall problem is best stated by Lauritzen and Skoglund (2013, p. 365): “Few landscapes reflect a single process; polygenetic development is the rule rather than the exception. In landscapes with a very strong glacial overprint, it is difficult to know by inspection whether karstification proceeded alongside glaciation, in intervals between glaciations, or in both situations.”

Following the work in Britain much research was done in the 1970s in Schoharie and Albany counties in New York State of the northeastern United States looking for, and studying large, pre-glacial cave systems (Baker 1973, 1976; Kastning 1975; Palmer 1976; Mylroie 1977, 1984). From these studies efforts shifted toward locating large, pre-glacial cave systems, with less attention paid to the small, presumed post-glacial caves. These efforts located several large, pre-glacial cave systems including those of scientific interest such as Barrack Zourie Cave (Dumont 1995).

Recent and current work in Norway (e.g., Faulkner 2008; Lauritzen and Skoglund 2013) has demonstrated that caves can form in the time since deglaciation, supporting the idea that caves can form to traversable size in 10,000 years (Palmer 1991), and that deglaciation may have stimulating effects on the formation of caves. Following this idea work continued in New York to demonstrate post-glacial origins for various caves (Cooper and Mylroie 2014). These studies have reintroduced the idea of post-glacial caves, and show that the current Holocene landscape of the northeastern United States includes a mixture of pre-glacial and post-glacial caves.

Several recent books have been published detailing karst regions that have undergone alpine glaciation (e.g., Wildberger and Preiswerk 1997) and continental glaciation (e.g., Waltham and Lowe 2013; Lauritzen 2010). The recent book *Caves and Karst of the Yorkshire Dales* (Waltham and Lowe 2013) details one of the world's classic glaciated karst regions, and includes a chapter on glaciation. For New York and New England, however, little has been done chronicling the impact this region has had on the evolving thoughts on glaciated karst. The two sources mentioning this region are a review paper by Mylroie and Mylroie (2004), and two chapters in *Caves and Karst of the USA* (Palmer and Palmer 2009) on New York (Engel 2009) and New England (Porter 2009). Other books on parts of the region, including *Vermont Caves: A geologic and historical guide* (Quick 2010), do not explicitly detail the studies that evolved thoughts on glaciated karst. The currently published works also do not include the recent studies that have taken place such as Faulkner (2009), Perzan et al. (2014), Weremeichik and Mylroie (2014), and Cooper and Mylroie (2014).

New York and New England therefore present an opportunity to discuss the caves of the region, as well as the evolving thoughts on continentally glaciated karst and how this region has influenced these thoughts. Within the boundaries of a 100 km-radius circle centered on Albany, New York, exist glaciated caves and karst formed in Precambrian marbles, Cambro-Ordovician marbles, flat-lying Cambrian through Devonian limestones, and Cambrian through Devonian limestones that are highly deformed. The karst exists from sea level through 1 km elevation, from areas once covered by traditional continental ice sheets in the Mohawk-Hudson lowlands to late-stage alpine glaciation in the Adirondack Mountains. No other place on earth displays the variety of carbonate rock types, tectonics, and glaciation as seen in the northeastern United States.

The Northeastern region offers chronicles of scientific works, as well as amateur works such as those published in the caving journal *The Northeastern Caver*. The region has a rich caving community that actively looks for new caves, and has recently discovered large systems such as Barrack Zourie and Thunder Hole in Schoharie County, New York.

This book will explore the scientific and amateur works on karst and caves in the northeastern United States, paying attention to the interaction of glaciation on the karst, the geologic controls on karst of the region, the human interaction with the caves by cavers and scientists, and the evolution of thought processes regarding glaciation and karst. For a detailed look at the physical and chemical processes in action during the glaciation of karst, the reader is referred to the exceptional treatise on the subject by Lauritzen and Skoglund (2013).

To explore these facets this book presents a brief review of the effects of continental and alpine glaciation including their effects on karst, the geology of the northeastern United States and its evolution through time, with details pertinent to karst landscape evolution, and a localized view of the northeastern US cave and karst studies comparing the karst regions of New York and New England to other worldwide examples such as Britain and Norway. Further, the book explores case studies of cave systems in the variety of settings within the region including karst developed in:



- (1) the Siluro-Devonian limestones of central New York including the gently tilted Helderberg Plateau and the deformed north-south band of Helderberg Group outcrops adjacent to the Hudson River,
- (2) the Cambro-Ordovician limestones of the northern New York and western Vermont lowlands,
- (3) the Precambrian, Cambrian, and Ordovician marbles of New England and eastern New York,
- (4) the Precambrian Grenville Marble of the Adirondacks.

Additionally, various non-dissolution caves are discussed in a chapter on pseudokarst, relating pseudokarst development to glaciation. These case studies each include various scientific and amateur studies performed in the region, and the human interactions with caves. Each case study also covers the landscape evolution of the settings from the pre-glacial caves to post-glacial.

Several conventions will be used in this book pertaining to terminology and the use of units. Units will be reported as given in their original database, with metric conversions following, if applicable. Karst terminology will on occasion reflect that commonly used in Britain, as many terms relating to glaciated karst originated there. An example of this includes “grike and glint” as opposed to “cutter and pinnacle” for dissolutionally opened joints and the residual blocks left between. Additional terminology preferences include the terms “dissolution cave” and “non-dissolution cave”, in place of “solution cave” and “non-solution cave”, and “pre-glacial” and “post-glacial” are meant as “pre-Wisconsinan” and “post-Wisconsinan”, unless otherwise specified precisely. The reader should be aware that the scientific publication of the National Speleological Society changed its name from *Bulletin of the National Speleological Society* to *Journal of Cave and Karst Studies* with the start of the 1996 publishing year.

The authors gratefully acknowledge the many people who have worked in this region on finding, exploring, and explaining the caves and karst. Chuck Porter, the editor of the *Northeastern Caver*, must be lauded for his long years of effort, gathering cave and karst information from the region, and publishing it in an effective, complete, and continuous manner. He was of great assistance to the authors in collecting facts, images, and maps; he has also been an active cave explorer in the region for more than half a century. Dr. Arthur Palmer, and his wife Margaret have been the leading scientific influence for cavers both young (Cooper) and old (Mylroie) since the 1960s; they also gave permission to use many of their maps and images. Their insights, advice, and support were invaluable. Michael Chu and John Dunham provided exceptional assistance, especially access to their excellent image libraries of northeastern caves; Eric Cooper, Tom Feeney, and Alex Bartholomew assisted with images, and Michael Nardacci provided important comments on draft chapters. The late Bob Carroll was a significant participant in northeastern caving, especially remote marble and pseudokarst areas of the Adirondacks and New England; his fieldwork, commonly done solo, greatly expanded our knowledge of karst and pseudokarst in the northeastern United States. The Northeastern Cave Conservancy has helped maintain cave conservation and cave access in the region for decades; Bob Addis, Emily Davis, and Thom Engel in particular have been helpful to the authors. Joan Saxon Mylroie has been a loyal and effective field companion for more than 47 years. The list of all who contributed over the years would be quite long. The principal players have been cited and appear in the bibliography and we apologize in advance for anyone we have missed.

The *Northeastern Caver* remains the best single source of information on caves in the northeastern United States (Higham 2013a); that publication is now going electronic, which will make its reach even wider and more useful. The long scope of history about caves and karst development in the glaciated northeast makes it likely that the authors have missed important places and events, omitted significant contributions by others, and perhaps misinterpreted both facts and opinions. The project was done under tight time constraints and the authors ask forgiveness in advance for all errors, for which we assume full responsibility. As noted in Mylroie and Mylroie (2004, p. 92) “Ernst Kastning once said ‘if all the caves in New York were laid end-to-end, they would be low, wet, muddy, and sparse in formations.’ We all went and worked there anyway.” And so we did.

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**Part I**

**Effects of Glaciation and Geology on Caves  
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