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Structural and lithologic control of karst features in northwestern New Jersey

By Donald H. Monteverde and Richard F. Dalton
New Jersey Geological Survey, PO Box 427, Trenton, NJ 08625

Abstract

Development is rapidly replacing farmland in western New Jersey with new housing tracts. Much of this new suburbia is underlain by carbonate bedrock so the understanding of karst formation and control is important in pre-development planning. We have initiated an ongoing study of karst, including sinkholes, caves and springs in an attempt to characterize the karst potential for these carbonate rocks.

Carbonate rocks crop out in the northwestern part of New Jersey along the regional, northeast-southwest Appalachian structural trend. The Wisconsinan Terminal Moraine bisects the outcrop belt into a northern glaciated sector and a southern unglaciated sector. The rocks range in age from Middle Proterozoic to middle Paleozoic. The varied structural and metamorphic histories influence their nature of karstification. The Franklin Marble and Wildcat Marble, here combined as Franklin Marble, are of Middle Proterozic age (Drake and others, 1991) and are at least 350 m thick locally (Drake and Volkert, 1993). They underwent amphibolite-grade metamorphism during the Grenville Orogeny that erased most evidence of original sedimentary features. Calcitic marble dominates the white, very coarse to coarse to locally fine grained Franklin; though dolomitic bands or zones have been identified (Haque and others, 1956). Foliation measurements parallel the transposed dolomitic bands (R Volkert, personal communication 2002). The Taconic and Alleghanian Orogenies also impacted the Franklin. Lower Paleozoic carbonate rocks include the Cambrian and lower Ordovician Kittatinny Supergroup and the unconformably overlying middle Ordovician Jacksonburg Limestone. The Kittatinny is as much as 1312 m thick while the Jacksonburg ranges between 41 and 244 m thick (Drake and others, 1996). The Kittatinny is fine- to medium-grained, thin- to medium-bedded dolomite. Limestone that escaped extensive dolomitization only occurs as isolated lenses. The Jacksonburg contains a lower crystalline limestone that grades upwards into an argillaceous limestone. These rocks experienced two strong deformation events in the Taconic and Alleghanian Orogenies and form a classic fold and thrust belt. Middle Paleozoic carbonates lie along the northwest boundary of New Jersey within parts of the Delaware River National Recreation Area. The carbonates are upper Silurian through lower Devonian in age and record several transgressive-regressive cycles. Limestone is the dominant lithology and the combined carbonate thickness is approximately 290 m (Epstein, 2001). A gentle northwest dipping monocline marks the main outcrop belt but dips steepen and overturn towards both the Pennsylvania and New York borders.

Our work compares cave densities and passage trends, measured from underground surveys (Dalton, 1976) with recorded structural information from recent 1:24,000 scale mapping. New Jersey caves are overall much smaller than Midwestern caves with shorter and narrower passageways. The Franklin Marble contains 22 caves, totaling 775 m of passage length (Dalton and Markewicz, 1972). It shows a strong agreement between foliation strike and passage direction suggesting lithology controls passage development in this unit. Some passageways follow contacts with small interior gneissic layers and further substantiate this trend. None of the known Franklin Marble caves occur at contacts with other Middle Proterozoic units, but form in more interior regions of this thick carbonate unit. Measured outcrop data on joints and fractures indicates that they appear to have little or no control on cavern development. Lower Paleozoic carbonates contain 83 caves with 2252 m of total passageways. The data on these caves show bedding, joints and fractures control. Surface water derived from non-carbonate watershed regions enhances carbonate solution features upon crossing into carbonate bedrock regions. Here, bedding

appears to play a more dominant role in cavern development. Cave passageways locally follow regional fracture trends within select lithologic horizons. Work has not yet reached middle Paleozoic units, which contain 6 caves encompassing 251 m of passageway (Dalton and Markewicz, 1972).

Only 11 of 142 known New Jersey caves are south of the glacial terminal moraine yet Dalton (1996) suggests increased sinkhole development in the south possibly due to a more mature weathering profile. Glacial deposits south of the Wisconsinan moraine has been correlated by Stanford and others (2001) to be Late Pliocene age which would yield over 2 Ma of weathering for these carbonates. Work continues to better characterize the karst formation in New Jersey.

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