Geologic Framework of Karst Features in Western Buffalo National River, Northern Arkansas

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Abstract

Caves, sinkholes, and springs are all common karst features developed in carbonate rocks in and adjacent to the western Buffalo River watershed in northern Arkansas. Recent geologic mapping at 1:24,000 scale, combined with data from cave and spring inventories and dye-tracer studies, provide insight into the geologic framework of the karst features and ground water pathways. These data provide a scientific basis for resource management at Buffalo National River (Mott and others, 1999), a 130-mile-long, river-corridor park established in 1972.

Physiographically, the western Buffalo River flows eastward near the junction of plateau surfaces of the Boston Mountains and Springfield Plateau, where it has eroded a valley network 130-400 m deep. Stratigraphically, the watershed for the western Buffalo River exposes an aggregate sequence of sedimentary rocks that is nearly 500 m thick. These rocks include alternating carbonate, sandstone, and shale formations of Pennsylvanian, Mississippian, and Ordovician age (Hudson, 1998). Limestone and dolomite, typical karst hosts, are important components of five of the eight major map formations exposed within the watershed and are most common in the lower half of the stratigraphic sequence. The most extensive carbonate unit is the Mississippian Boone Formation, a 120-m-thick cherty limestone. Chert content of the Boone Formation in the western Buffalo River watershed is variable but it is commonly less than the >50 percent chert that is typical elsewhere in northern Arkansas, enhancing continuity of karst features throughout the formation. Structurally, rocks the western Buffalo River region lie on the southern flank of the Ozark Dome. They are mostly gently dipping (<5°) but are broken by a series of faults and monoclinal folds that formed during late Paleozoic time (Hudson, 2000). In combination, these structures produce relief of as much as 300 m of a marker datum across the region. Faulting is complex and includes normal, strike-slip, and less common reverse structures. Maximum vertical offset across individual faults ranges from 30 to 120 m. Monoclinal folds that formed over buried faults typically have vertical relief of 20 to 40 m and contain strata that dip 10°-25°, and locally greater. Three main joint sets formed in the region with strike directions of N-S, NE-SW, and WNW-ESE, in order of decreasing frequency.

The stratigraphic distribution of karst can be inferred from an inventory of caves located within the boundaries of western Buffalo National River, although this inventory may exclude caves in upper formations that lie within the watershed but outside the park corridor. Of 96 inventoried caves, 78 percent are within limestone of the Boone Formation, 17 percent are in limestone or dolomite intervals within the Ordovician Everton Formation, and the remaining are in limestone of the lower part of the Pennsylvanian Bloyd Formation. Caves within Boone Formation are distributed throughout its thickness, but entrances are slightly more common within 12 m of either its upper or lower contact. The upper Boone contact is overlain by the 2- to 12-m-thick Batesville Sandstone that is commonly slumped into solution cavities within Boone limestone. These sinkholes serve to concentrate surface waters whose acidity is likely enhanced by oxidation of pyrite that is common within both the Batesville Sandstone and overlying Fayetteville Shale. The basal Boone limestone unconformably overlies sandstone of the Ordovician Everton Formation and hosts the greatest density of springs within the western Buffalo River watershed. This relation illustrates that the Boone Formation is the main karst aquifer for the region. Dye-tracer studies document that some large springs gather recharge from far beyond the watershed boundaries (Mott and others, 1999). Erosion of the Buffalo River valley has left most karst aquifers perched above the current river level and, consequently, their local base-level elevations are controlled by relief across structures. Down-dropped blocks of Boone Formation host both the largest springs and the most extensive cave systems known within this part of the watershed. Boone Formation within one graben lies below river level and here leakage into the Boone is sufficient to completely drain the river into the subsurface during low-flow periods. Increased fracturing associated with structures has probably further enhanced karst dissolution. As an example, several vertical shafts, including the deepest (48 m) shaft known in the park, developed within the fractured limb of one fault-cored fold.

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