# Karst Features and the Dissolution of Carbonate Rocks in Orange County

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Over a long period of time limestone, and to a lesser extent dolomite, will gradually dissolve in the presence of ground water that was derived from precipitation. Carbon dioxide from the atmosphere and from the soil is incorporated into the precipitation as it changes from atmospheric moisture to ground water. Ground water containing dissolved carbon dioxide forms a mild acid, which can slowly dissolve alkaline materials. The alkaline carbonate bedrock units are affected by this process when the slightly acidic ground water moves through the units and is neutralized by the carbonate. A portion of the carbonate unit is dissolved in this neutralization process thus increasing the size of the fracture in which the water is flowing. As this process continues through time larger openings, solution features, form in the rock allowing for increased ground-water flow.

Many types of solution features can result from this process, some subtle and others quite large. The most common features develop along preexisting fractures, joints, and bedding planes, which represent the initial flow path of the water through the rock. Over time, a variety of larger features can develop leading to cave systems with sinkholes and deep valleys as surface expressions.

The near-surface bedrock aquifers in the Mississippian carbonates contain a highly variable fracture pattern, which greatly affects ground-water flow through the bedrock. Fractured rock represents one of the most complex types of hydrogeologic systems known. While regional ground-water flow can be very predictable, local flow can be highly varied in terms of both quantity and direction. Consequently, determining the local direction of ground-water flow in fractured bedrock at the scale of a specific site may require elaborate instrumentation, monitoring, and dye tracing.

The dissolution of carbonate rocks results in karst topography and other karst features. These include closed depressions on the land surface (e.g., sinkholes and sinking streams), caves, and underground drainage channels or conduits, some of which are several feet in height and width. Karst areas are extremely vulnerable to contamination from point sources (e.g., spills, leaking underground storage tanks, and individual household septic systems) and broad area contamination (e.g., road salts, vehicle emissions, pesticides, and fertilizers). The karst features of subterranean conduits or streams are in many cases connected for great distances. These connected conduits create a potential for widespread contamination downstream of a contaminant source. In places the flow rates can be similar to surface streams, with some contaminants flowing through the system rapidly (especially after a rain or snow-melt event), while in other parts of the system contaminants may be trapped in pools, sediments, or minor fractures for much longer periods of time.

Some of the larger karst features (sinkholes and sinking streams) in Orange County are shown on the map. These features are based on digital coverages from the Indiana Geological Survey and the U. S. Geological Survey (hypsography, or land surface contours). The closed depressions, based upon hypsography coverage came from 1:24,000 scale topographic maps. The overwhelming majority of these depressions are associated with karst development. The map also shows locations of wells in which the drillers reported caves, crevices, or mud-filled cavities. In addition, the map

shows locations of wells with reported broken limestone and mud, a term that indicates extensive weathering or collapsed karst features.

The most extensive karst development in Orange County occurs in the outcrop area of the Blue River Group. This group consists primarily of carbonates and some evaporite deposits. The majority of the sinkholes or depressions occurs on the Mitchell Plateau physiographic section north and east of Paoli, and includes the towns of Orleans, Orangeville, Leipsic, and Millersburg. The Mitchell Plateau is underlain by Blue River Group carbonates. Typically, above the solid bedrock lies several feet of residual clay, which in many places is red in color (terra rosa). Below the typically 20 to 55 feet of clay and broken limestone, is solid bedrock. However, solid bedrock has been noted as deep as 95 feet below the surface. The areas of thickest clays tend to occur on the Mitchell Plateau. Other major areas of karst development occur in the valleys and lower slopes of the Lost River and its major tributaries. Additionally, water well records on file at the Division of Water indicate many caves or mud-filled cavities in this group. The height of the caves may be as much as 28 feet, but are typically 2 to 10 feet. Most of the water wells showing such cavities are also in the same general area as the surface karst features. However, a few are located in the upland areas and occur primarily in the Stephensport and West Baden Groups. The Lost River watershed is known for its karst features such as the Orangeville Rise and Wesley Chapel Gulf (Elrod Gulf). Both of these occur in the Blue River Group.

The West Baden Group, and to a lesser extent the Stephensport Group, shows some karst development in Orange County. These groups consist primarily of shale and sandstone, but have some limestone units. The Stephensport has a greater percentage of limestone than the West Baden. The karst features in the Stephensport and West Baden Groups are not as extensive or as connected as the features in the Blue River Group. The limestone formations are not as thick, and they are separated by shale or sandstones. Thus, fractures and joints are not as continuous. As in the Blue River Group outcrop area, several water well records show caves or mud-filled cavities in the subsurface. The caves and crevices are reported to be as much as 20 feet high, but are typically one to five feet high. Most such wells are located in a band trending from southeast to north-central Orange County on the western border of the Mitchell Plateau and on the small upland plains in the Lost River and Patoka River watersheds. The cavities generally occur between 20 and 125 feet below the land surface, but one was reported at 264 feet. Elevations of these cavities vary widely. This is expected because several different limestone formations are involved, they occur over a large area, they dip to the southwest at roughly 30 feet per mile, and the local relief on the land surface is up to 400 feet.

The Stephensport and West Baden Groups are not as vulnerable to widespread contamination as the Blue River Group. This is because the limestones units are relatively thin, they are separated by shale or sandstone, and the steep topography limits the size of areas contaminated.

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