

Hydrogeologic Characterization of a “Transitional” Karst Aquifer, South-Central Louisville, Kentucky

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Carbonate aquifers typically exhibit a continuum in ground-water flow that ranges between quick flow through solution conduits and solution-enlarged fractures and slow flow through fine fractures and intergranular pores. Hydraulic properties and water quality often change at different locations in carbonate aquifers depending on the degree of solutional (karst) modification—that is, the relative proportion between quick flow and slow flow. Either end member can present special difficulties to hydrogeologic and contaminant transport characterization. The transition between a quick-flow dominated karst aquifer and a slow-flow dominated fractured-carbonate aquifer is examined in this study.

The aquifer system is composed of westward-dipping Silurian-Devonian limestones and dolostones in Jefferson County, Kentucky. Moldic porosity due to calcite-to-dolomite mineral replacement has developed in parts of the aquifer system, but most ground-water flow is conducted through solutionally-enlarged, horizontal fractures. The quick-flow dominated part of the aquifer system occurs to the east, where the rocks crop out near the surface, are more weathered, and are recharged by infiltration and runoff into sinkholes. The slow-flow dominated part of the aquifer system is to the west, where the carbonates are overlain by Devonian-age carbonaceous shale. Solutional modification of the carbonates diminishes toward the west, as the thickness of the shale confining unit and distance from the recharge area increases. A transitional zone can be delineated in the aquifer system where the influence of quick-flow dominated karst decreases and the hydrogeologic characteristics of the aquifer system revert to that of a low-permeability, fractured limestone. This transitional zone is marked by a significant change in dominant water-quality type, from calcium-magnesium-bicarbonate water to sodium-chloride water, changes in the solubility indices of dissolved mineral species, and in tritium and stable isotope values.