area of the state has quality that can be minimally treated or mixed to achieve desirable taste and MCL standards. The western portion of the aquifer is the most mineralized, and therefore would need to undergo significant treatment before being used as a source of drinking water. The general water quality of the Cambrian-Ordovician tends to be most affected by the age and depth of the aquifer. Deeper areas with older water tend to have the highest concentrations of TDS and total radium. Geologic units above the aquifer also cause some difference in water quality especially in the northwestern part of the state.

Although vertical water quality in the Cambrian-Ordovician aquifer has not been extensively studied, there have been a handful of projects that have attempted to take samples at different depth intervals. The most extensive of these was a John Morrell Company well in Ottumwa, Iowa, sampled in increments of 50 feet with a bailer in 1943 (Figure 6) from depths of 1,335–2,600 feet. This and other data indicate that the dolomite and sandstone of the Prairie du Chien group (Shakopee and Oneota formations) typically have better water quality than the Jordan Sandstone. The St. Peter Sandstone is often cased off (as it was in this well) and therefore was not sampled during the project. Water quality quickly deteriorates below the Jordan Sandstone, where TDS concentrations can reach over 26,000 mg/L. Most of the increase in TDS is due to chloride concentrations, which can reach over 18,000 mg/L.

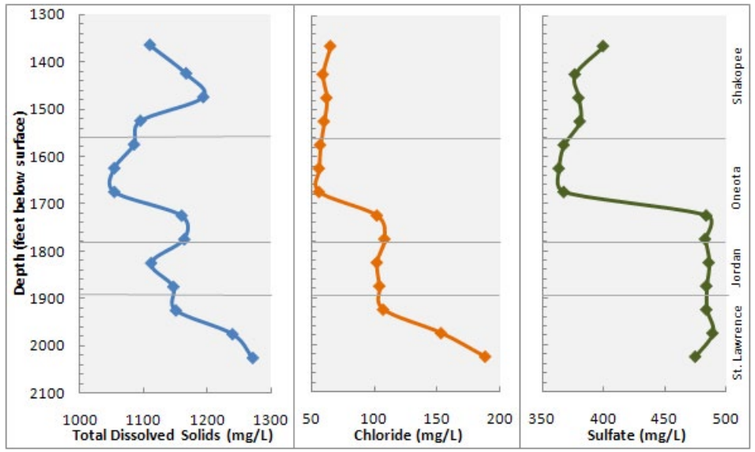

Figure 6. *Vertical water quality of the Cambrian-Ordovician aquifer (excluding the St. Peter Sandstone) from discreet vertical samples taken at the John Morrell Co. well in Ottumwa, Iowa.*

Conclusions

Water quality in the Cambrian-Ordovician aquifer is determined by age and depth, with the older, deeper formations in the southwest region of the state having higher radionucliides and dissolved constituents. The northeast portion of the state where the aquifer is shallower and younger has naturally potable water. Although the general water quality trends have not changed significantly since the initial 1978 study, certain constituents, such as total radium, have changed significantly, most notably in western areas of Iowa. These results are most likely due to increased information in specific regions rather than an actual change in water quality since 1978.

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Prior, J.C., Boekhoff, J.L., Howes, M.R., Libra, R.D., and VanDorpe, P.E., 2003, Iowa's Groundwater Basics: A geological guide to the occurrence, use, & vulnerability of Iowa's aquifers, Iowa Geological Survey Educational Series 6, 83 p.

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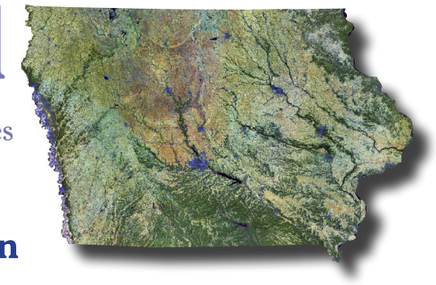
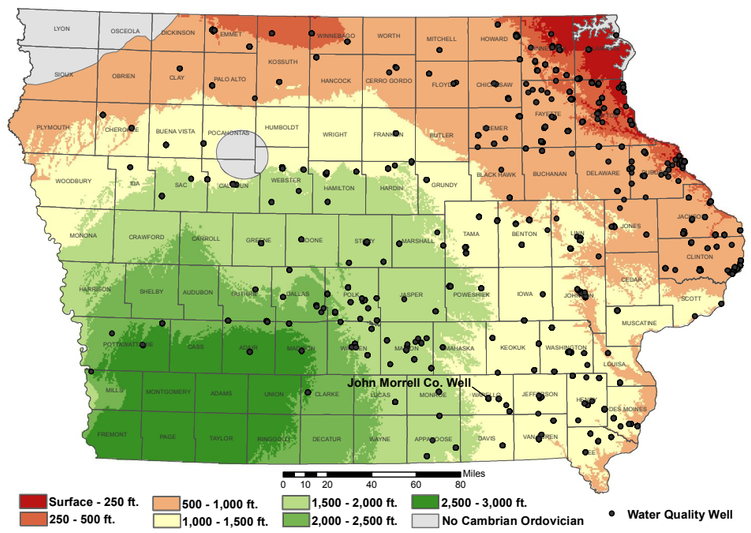


Water Quality of the Cambrian-Ordovician Aquifer in Iowa

Groundwater is an important resource for Iowa. Groundwater comprises 79% of our public drinking water systems and is an essential resource for many of Iowa's businesses, farms, and agricultural commodities (Prior et al., 2003). As stewards of this resource, all responsible agencies, as well as the public, must make every effort to preserve our groundwater quantity and quality for future generations.

Groundwater's suitability for drinking, irrigation, and industrial use is determined by its quality. The Environmental Protection Agency (EPA) regulates numerous dissolved constituents in drinking water to protect human health, and the food and beverage industry must also use clean water for their products. Water quality determines whether a company or system can use the natural water, or if the water will have to go through expensive treatment. This fact sheet covers naturally occurring

Figure 1. *Map of the areal extent, depth, and water quality sample locations of the Cambrian-Ordovician aquifer in Iowa. Highlighted is the John Morrell Co. well, which had water quality samples collected at different depths to evaluate vertical water quality variability.*



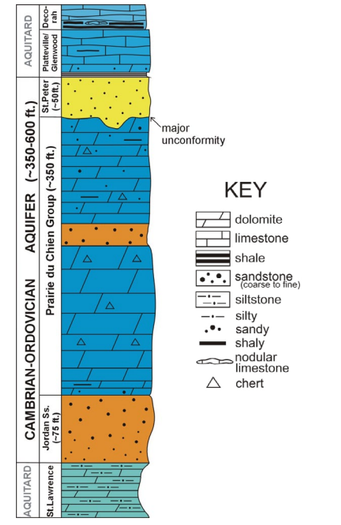


Figure 2. *Generalized stratigraphy and thickness of geologic formations that comprise the Cambrian-Ordovician aquifer. Included are the aquitards above and below the aquifer.*

contaminants of the Cambrian-Ordovician aquifer in Iowa, and is meant to be a resource to help estimate regional water quality.

Cambrian-Ordovician Aquifer Characteristics

The Cambrian-Ordovician aquifer, commonly called the "Jordan aquifer," is one of the most dependable and prevalent sources of groundwater in Iowa. Extending over 90% of the state, the Cambrian-Ordovician aquifer is absent only in the Manson Impact Structure in Pocahontas and Calhoun counties and in the extreme northeast and northwest areas of the state (Figure 1). Three separate water-bearing units comprise the aquifer; from top to bottom they are the St. Peter Sandstone, Prairie du Chien Group (including the Shakopee and Oneota formations), and the Jordan Sandstone. Over much of the state the Cambrian-Ordovician aquifer is sandwiched by the Platteville Formation above and the St. Lawrence Formation below (Figure 2). The depth of the aquifer varies greatly depending on the location within the state. The Cambrian-Ordovician aquifer is at or near the ground surface in northeast Iowa, and is over 3,000 feet below the ground surface in southwest Iowa (Figure 1). Thickness of the aquifer also varies throughout the state, with regions less than 150 feet thick in western Iowa, and areas of southeast Iowa reaching over 700 feet thick.

Water Quality Samples and Studies

A previous study of the Cambrian-Ordovician aquifer was completed in 1978 by the Iowa Geological Survey (Horick and Steinhilber, 1978). The study evaluated aquifer structure, use, and water quality. Water quality samples used to characterize the aquifer consisted of 250 samples from 185 wells across Iowa that tapped into the Cambrian-Ordovician aquifer. Sample dates were from 1910 to 1978.

The dataset used for this fact sheet has 2,374 samples from 463 wells in the Cambrian-Ordovician aquifer (Figure 1) and is derived from the Iowa Geological and Water Survey's Groundwater Quality Database (www.igsb.uiowa.edu/webapps/nrgislibx). The spatial database has over 19,000 samples, including over 300 analytes and 4,000 wells taken from multiple groundwater sources across Iowa.

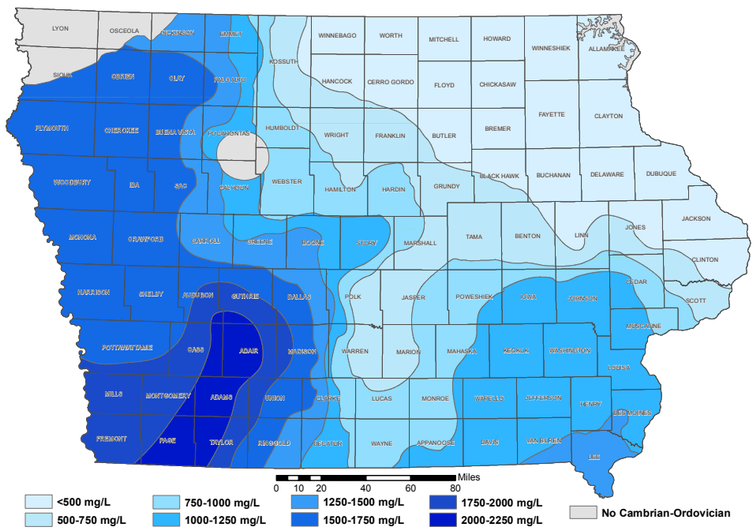


Figure 3. *Concentration of total dissolved solids in the Cambrian-Ordovician aquifer in Iowa, including where the SMCL drinking water standard of less than 500 mg/L is met.*

Spatial Trends

Total dissolved solids (TDS) is a measure of all organic and inorganic materials dissolved in water. High concentrations of TDS can lead to objectionable taste, problems with scaly buildup in pipes, and reduced efficiency in hot water heaters. Due to these and other problems associated with TDS, the EPA has set a secondary maximum contaminant level (SMCL) for TDS at 500 milligrams per liter (mg/L). SMCLs are suggested for either a cosmetic or aesthetic reason and are not directly attributable to public health concerns. Figure 3 shows contours of TDS concentrations from Cambrian-Ordovician wells in Iowa. In general, TDS levels are potable in northeast Iowa and get less palatable to the west/southwest. This trend matches the depth of the aquifer, with the exception of the better water quality portion noted at the south-central area of the state near the state capital of Des Moines.

Radium 226 and 228 are the two most common isotopes of radium found in the environment. Total radium is the sum of radium 226 and radium 228. As groundwater moves through the subsurface it slowly accumulates radioactivity from the small amounts of unstable radioactive elements found in the soil, glacial till, and bedrock. Radium in drinking water can cause certain types of bone and sinus cancers, and therefore has a maximum contaminant level (MCL) set at 5 picocuries per liter (pCi/L) for total radium. Total radium levels in the Cambrian-Ordovician indicate that north-northeast Iowa has naturally potable drinking water, with south-southwest Iowa having increasing radioactivity (Figure 4).

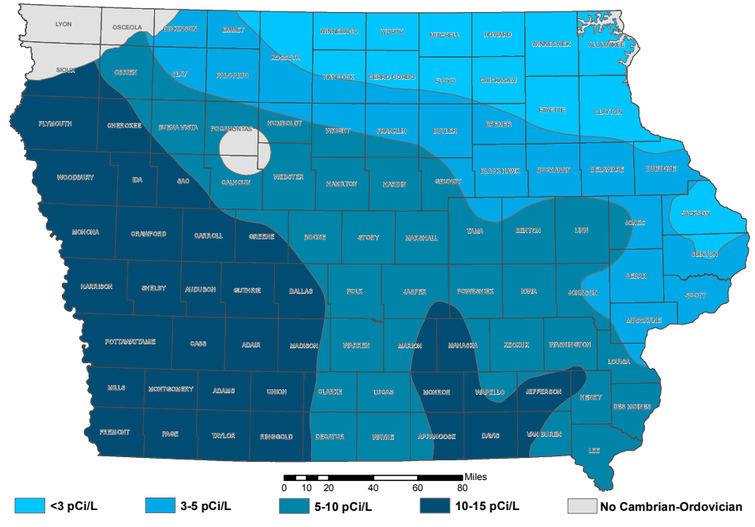


Figure 4. *Total radium (combined radium 226 and 228) in the Cambrian-Ordovician aquifer, including where the combined levels are below the MCL of 5 pCi/L.*

The general water quality map indicates naturally potable water in the Cambrian-Ordovician available in the north-northeast portion of the state, from Kossuth to Clinton counties (Figure 5). Total dissolved solids were the major constituent determining drinking water potability in the aquifer, except for an area in Linn County that was excluded due to excessive total radium concentrations. Cambrian-Ordovician water from this region is expected to be minimally mineralized and needs little to no treatment before being supplied to the public. The north-central to southeast

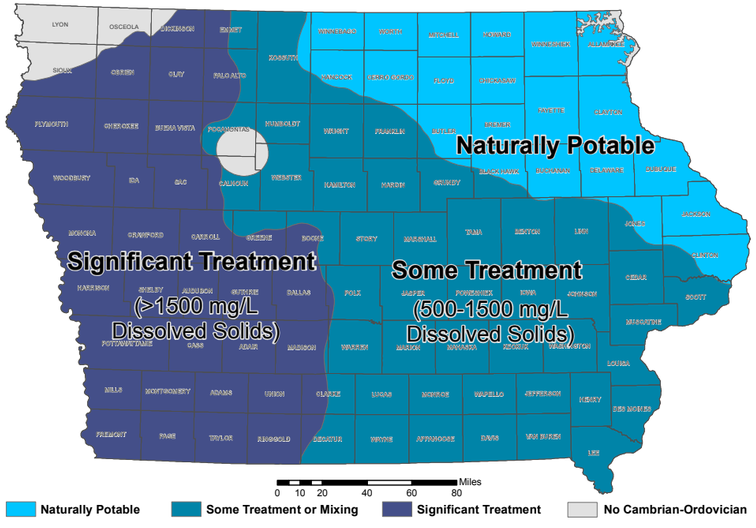


Figure 5. *General water quality map of the Cambrian-Ordovician aquifer, including where all dissolved constituents are projected to be below both secondary and primary MCLs.*