Monitoring the Recharge Edge of the Mt. Simon Aquifer

Jim Berg and Scott Pearson, Minnesota Department of Natural Resources, St. Paul, Minnesota

http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring_phase2.pdf jim.a.berg@state.mn.us 651-259-5680

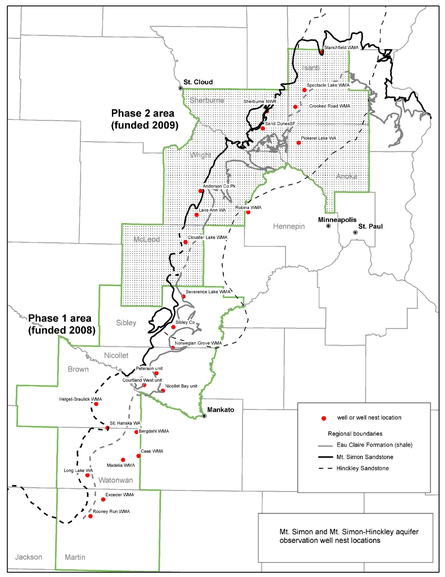
Abstract

This poster summarizes two reports covering groundwater investigations for the Mt Simon and Mt. Simon-Hinckley aquifers in southern and central Minnesota. The Phase 1 report published in June 2011 reported on work accomplished in Martin, Watonwan, Brown, Nicollet, and Sibley counties. Both investigation phases included observation well installations, water level monitoring, groundwater chemical analysis, and aquifer capacity testing to determine recharge pathways and sustainable limits for this aquifer. Most data collected for the Phase 2 study are derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties.

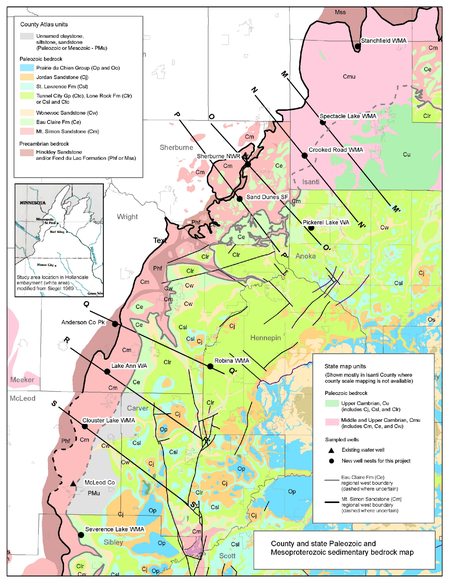
In the southern part of the study area (Phase 1 area) hydrograph and geochemical residence time data (14C and tritium) show relatively isolated conditions with groundwater ages ranging from 6,000 to 30,000 years for the Mt. Simon aquifer. In the northern portion of the study area (Phase 2 area) chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon-Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.

Investigation Area



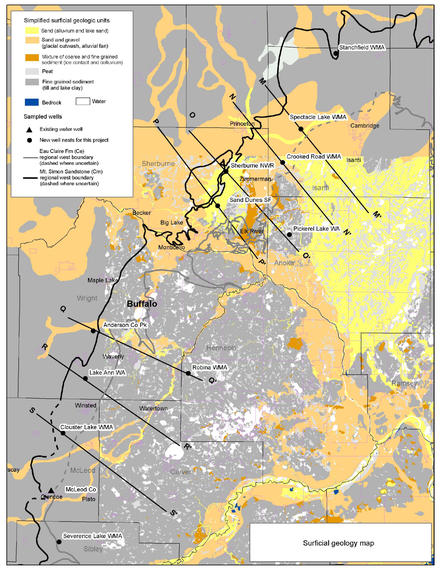
Bedrock Geology*



The focus of this investigation was the Cambrian Mt. Simon Sandstone. This formation was deposited at the base of a thick sequence of Paleozoic marine carbonate, shale, and sandstone formations that underlie central and southeastern Minnesota in a broad structural basin known as the Hollandale embayment. Few of the underlying rock formations, with the exception of the Hinckley Sandstone, have desirable aquifer properties for most purposes. Therefore, the Mt. Simon Sandstone and combined portions of the underlying Hinckley Sandstone, is the deepest bedrock aquifer in the region. The only aquifer available for large capacity (i.e., municipal and industrial) use along the western edge of the Hollandale embayment is the Mt. Simon aquifer in the Phase 1 area and the Mt. Simon-Hinckley aquifer in the Phase 2 area.

*Both geologic maps were modified from several Minnesota Geologic Survey sources

Surficial Geology*



Recharge of the Mt. Simon-Hinckley aquifer depends not only on the absence of overlying impermeablebedrock layers, but also on the existence of a downward gradient and interconnected surficial and buried sand layers that create pathways for focused recharge. The portion of the investigation area south of the City of Buffalo in Wright County is generally characterized by fine grained glacial sediments at the surface that inhibit rapid groundwater recharge. Northeast of the City of Buffalo, sand or sand and gravel at the surface is very common which creates the potential for focused recharge to the Mt. Simon aquifer.

Cited References

Alexander, S.C., and Alexander, E.C., Jr., 1989, Residence times of Minnesota groundwaters: Minnesota Academy of Sciences Journal, v. 55, no.1 p. 48-52.

Tipping, R.G., 2011, Distribution of vertical recharge to upper bedrock aquifers Twin Cities Metropolitan Area, Minnesota Geological Survey, Metropolitan Council Project Report (submitted), 74 p.

Groundwater Residence Time Indicators

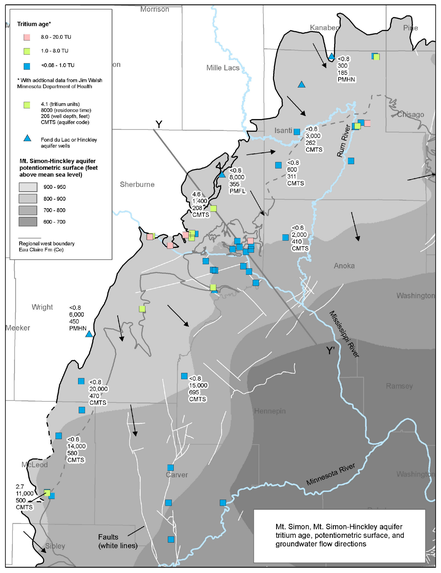
Residence time is the approximate time that has elapsed from when the water infiltrated the land surface to when it was pumped from the aquifer for this investigation. In general, short residence time suggests high recharge rates or short travel paths; whereas long residence time suggests low recharge rates or long travel paths.

Tritium (3H) is a naturally occurring isotope of hydrogen. Concentrations of this isotope in the atmosphere were greatly increased from 1953 through 1963 by above ground detonation of hydrogen bombs (Alexander and Alexander, 1989). This isotope decays at a known rate, with a half-life of 12.32 years.

Groundwater samples with concentrations of tritium equal to or greater than 8 tritium units (TU) are considered recent water (mostly recharged in the past 60 years). Concentrations equal to or less than 1 TU are considered vintage water (recharged prior to 1953). Concentrations between these two limits are considered a mixture of recent and vintage water and are referred to as mixed water.

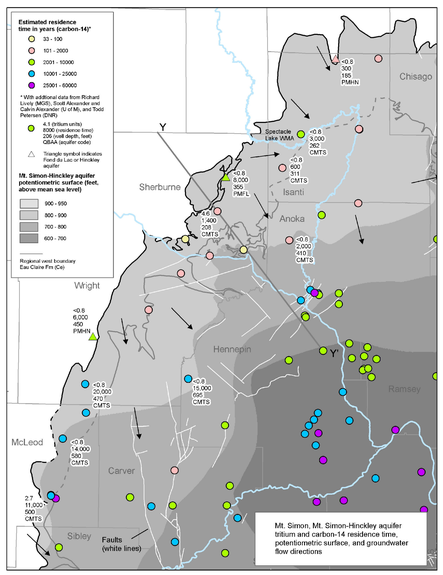
The carbon-14 (14C) isotope, which also occurs naturally, has a much longer half-life than tritium (5730 years). Carbon-14 is used to estimate groundwater residence in a time span from about 100 years to 40,000 years (Alexander and Alexander, 1989).

Tritium Data



Tritium data from the Mt. Simon-Hinckley aquifer are shown including data produced by this project (labeled symbols) and data acquired from the Minnesota Department of Health (James Walsh, unpublished data). Sixteen occurences of recent and mixed tritium have been found within or near the Mt. Simon Sandstone subcrop and within the area of laterally extensive surficial sand. These data represent an important starting point for beginning to understand the distribution of rapid recharge areas within Wright, Sherburne, and Isanti counties.

Carbon 14 Data



14C residence time values within or near the Mt. Simon Sandstone subcrop were generally young and ranged from recent to 2,000 years. A somewhat older 14C value of 3,000 years from the Mt. Simon aquifer well at Spectacle Lake WMA in western Isanti County seems anomalous and may be due to local isolated conditions or an upward gradient in the Rum River valley that may be bringing deeper and older water upward.

Other Investigation Topics

- Most δ18O values of groundwater samples from both project phases ranged from approximately δ -10‰ to δ -8‰ suggesting small variations of post-glacial climate and/or regional vegetation types.

- Hydrographs of Mt. Simon-Hinckley, Hinckley, and Fond du Lac aquifer wells in the northern portion of the Phase 2 area from early 2011 through the spring of 2012 correlate well with the precipitation pattern during that period. These data along with local stratigraphic information and residence time data indicate at least some direct hydraulic connection to the surface.

- As the wells were purged prior to sampling, the pumping rate and water level drawdown data showed specific capacities for the Mt. Simon wells ranged from approximately 1gpm/ft at Crooked Road WMA to 9 gpm/ft at Robina WMA.

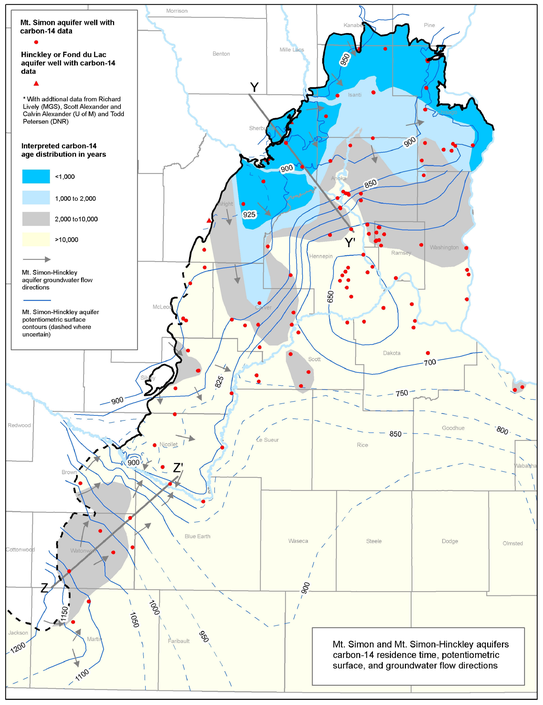
- Most Mt. Simon aquifer users in the northwestern metropolitan area are pumping water from the portion of the aquifer that ranges from 50 to 125 feet thick.

Conclusions, Recommendations

This project and Tipping (2011) have shown that the most critical recharge area for the Mt.Simon-Hinckley aquifer and Minneapolis -St. Paul metropolitan area water supply includes northeastern Wright County, eastern Sherburne County, and southern Isanti County. Protection of this region from water pollution should be a high priority for all levels of government. Additional data should be developed to determine unknown or poorly understood variables in a water budget equation for Mt. Simon-Hinckley aquifer recharge and discharge in the greater metropolitan area.

One of the primary purposes of the DNR and MGS County Geologic Atlas program is to create maps of pollution sensitivity for important aquifers. Atlases for Wright and Sherburne counties are currently in progress and will provide information for the next step in defining sensitive areas of the Mt.Simon-Hinckley aquifer. Unfortunately, there are no current plans for an Isanti County geologic atlas. This study has shown that protection of water resources in the Buffalo to Cambridge area has not only local implications but also is of significant importance for one of the major aquifers in the Minneapolis-St. Paul metropolitan area.

Interpreted Carbon-14 Age Distribution



Cross Section Recharge Interpretations