

Title: Stratigraphic controls on distribution of hydraulic conductivity in carbonate aquifers

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Investigators:

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Background/Need:

Carbonate aquifers form important regional sources of drinking water in eastern Wisconsin. This project addressed the problems of hydraulic conductivity distribution in shallow unconfined fractured-carbonate aquifers. These aquifers typically have a bimodal hydraulic conductivity distribution of both low-conductivity matrix blocks and high-conductivity fracture and dissolution zones that make these aquifers exceedingly susceptible to contamination, difficult to remediate, and challenging to model.

Objectives:

- 1) better understand the carbonate stratigraphy of both the Silurian and Sinnipee aquifers;
- 2) refine the regional stratigraphic framework via geophysical logging;
- 3) characterize the distribution of hydraulic conductivity;
- 4) correlate the stratigraphic data with the hydraulic conductivity distributions for both aquifers;
- 5) determine if sequence stratigraphy can provide a tool for predicting the distribution of high-permeability features in carbonate aquifers.

Methods:

- 1) detailed stratigraphic description and field-mapping of dolomite outcrops and cores to identify the position of zones prone to dissolution,
- 2) geophysical data (especially natural gamma) from wells and outcrop to correlate stratigraphy in three dimensions, and
- 3) detailed measurements of the distribution of hydraulic conductivity in boreholes. By combining these data we have been able to locate and describe high permeability features which occur at the same stratigraphic horizon across the region.

Results and Discussion:

The occurrence of fractured-controlled, flat-lying, high-permeability zones and the variation in matrix hydraulic conductivity are controlled by the stratigraphy; in specific by bedding planes where major contrasting lithologies are juxtaposed. From our results, it is compelling that lateral movement of groundwater in fractured carbonates is controlled by the lateral continuity of these regional bedding-plane fractures, and their distribution can be predicted using stratigraphic methods. Large-scale (>20 km) stratigraphic variations limit the extent of predictability and requires additional data collection.

Conclusions/Implications/Recommendations:

Knowledge of the distribution of lithologies and hydrostratigraphic units is essential for the design of monitoring systems, the investigation and remediation of existing contaminant sources, and the development of groundwater protection plans.

Related Publications:

Schreiber, M.E., Simo, J.A., and Freiberg, P.G., submitted, Stratigraphic and geochemical controls on the mobilization and transport of naturally occurring arsenic in groundwater: Hydrogeology Journal.

Muldoon, M., J.A. Simo, and K. Bradbury, submitted, Correlation of high-permeability zones with stratigraphy in a fractured-dolomite aquifer, Door County, Wisconsin: Hydrogeology Journal.
1999,

Choi, Y.S., J.A. Simo, B.Z. Saylor, Sedimentologic and sequence stratigraphic interpretation of a mixed carbonate-siliciclastic ramp, midcontinent epeiric sea, Late Ordovician Decorah and Galena Formations, Wisconsin: In Harris P.M., A. Saller and J.A. Simo, Eds, Advances in Carbonate Sequence Stratigraphy, SEPM Special Publication 62.
1998.

Choi, Y.S., and J.A. Simo, Facies and sequence stratigraphic models mixed carbonate-siliciclastic systems in an epeiric sea: Late Ordovician Glenwood and Platteville Formations, Wisconsin, USA: In Wright, V.P., and T.P. Burchette, Eds, Carbonate Ramp, Geological Society, London, Special Pub 149, p. 437-456.
1998.

Simo, J.A., M.T. Harris, and M.A. Muldoon, Stratigraphy and sedimentology of the Silurian dolostones, Door County, Wisconsin: SEPM Research Conference in Fluid Flow in Carbonates: Interdisciplinary Approaches, p. 3-15, 1998

Muldoon, M., J.A. Simo, K. Bradbury, and M.T. Harris, Field Trip Guidebook, Door County, Wisconsin: SEPM Research Conference in Fluid Flow in Carbonates: Interdisciplinary Approaches, p. 47-70.
1998

Muldoon, M., J.A. Simo, and K. Bradbury, Correlation of Hydraulic conductivity with stratigraphy in a fractured-dolomite aquifer, Door County, Wisconsin; SEPM Research Conference in Fluid Flow in Carbonates: Interdisciplinary Approaches, p 23-31.

Key Words: Stratigraphy, hydraulic conductivity, carbonates, Silurian dolomite, Ordovician Sinnipee, eastern Wisconsin, Door Co.

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Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.