

# MAPPING BEDROCK

## A New Tool to Identify Loss Potential in Vulnerable Landscapes

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There's a V-shaped swath of Wisconsin where carbonate bedrock (limestone or dolomite) is near the land surface (Figure 1). Due to fractures in the bedrock, the landscape is vulnerable to groundwater contamination and nutrient loss from farm fields. In these areas well contamination is common, resulting in costly well replacement.

The keys to minimizing contamination include identifying locations of shallow carbonate bedrock and applying nutrients at appropriate times and rates.

Discovery Farms is studying these landscapes to provide agricultural consultants, producers, educators and local officials with a better understanding of the land's geology so they can make informed decisions in nutrient management and land use policies.



Figure 2. Bedrock fracture traces in a field.



Figure 3. Bedrock at the surface.

### Vulnerable landscapes

The physical and chemical breakdown of limestone and dolomite results in a landscape characterized by sinkholes, caves and fractured bedrock (Figures 2 & 3). Applying municipal wastes and manure to land with these features runs the risk of contaminating drinking water.

Fractured bedrock presents a challenge to those managing agricultural lands because nutrients easily and rapidly move through these features, ending up in groundwater (Figure 4). The closer the carbonate bedrock is to the land surface, the higher the chance of losing nutrients. In addition, a large number of acres in agricultural production drain into closed depression areas with fractured bedrock, making it essential for critical site evaluation and sound nutrient management plans on a field-by-field scale.

Researchers at Discovery Farms recommend a program of identifying the thickness and distribution of soils and unlithified materials in these landscapes at a scale appropriate for agricultural producers to help develop sound nutrient management plans.

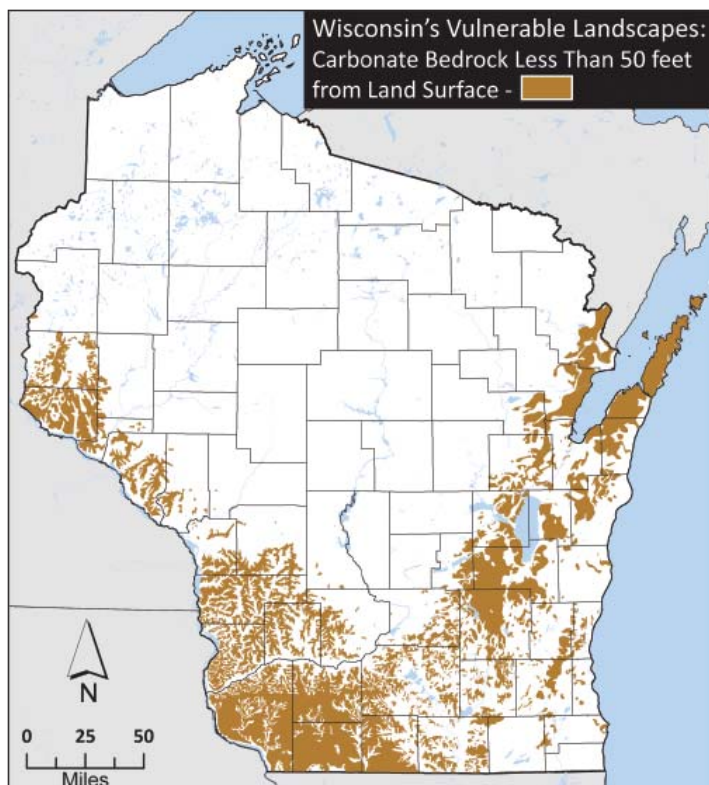


Figure 1. This map shows where thin, unconsolidated deposits overlie carbonate bedrock. These areas have a high potential for nutrient loss and groundwater contamination.

WGNHS



Figure 5. Discovery Farms used the Geoprobe to confirm accuracy of computer modeling.

### Mapping carbonate bedrock

In the summer of 2008, Discovery Farms partnered with the Wisconsin Geological and Natural History Survey (WGNHS) and the Calumet County Land and Water Conservation Department to study the thickness and texture of the materials between the bedrock and land surface.

The objective of the study was to map the depth-to-bedrock in Calumet County, an area that has long been grappling with groundwater quality issues. In landscapes such as those found in Calumet County, carbonate bedrock formations are extensively fractured. As a result, there is very little surface runoff in places where fractured bedrock is close to the land surface. Water quickly and easily infiltrates to the subsurface.

Researchers found that groundwater in Calumet County aquifers used for drinking-water supplies has a moderate to high risk of contamination. This susceptibility to contamination varies across the county and is largely dependent upon the thicknesses of the unlithified materials over the groundwater aquifers.<sup>1</sup>

Discovery Farms scientists hypothesized that knowing the depth-to-bedrock would give producers and local officials a tool to improve water quality and keep nutrients on fields, where they benefit crops. The project coordinators wanted to map the depth-to-bedrock on a scale that would allow farmers to make field-by-field decisions about nutrient application.

The key to producing depth-to-bedrock maps is using well construction reports (WCR) from the drilling of wells as surrogate geologic logs to identify individual layers of rock.

Discovery Farms conducted fieldwork in Calumet County to confirm the accuracy of the 3-D model through the use of an impact drill called a Geoprobe® (Figure 5) as well as seismic refraction – using an impact device or explosion to generate a wave that travels through the earth’s surface. By measuring the speed of the wave using sensors on the land surface, geologists are able to calculate depth-to-bedrock.

*High resolution depth-to-bedrock mapping in Calumet County revealed vulnerable landscapes susceptible to groundwater contamination and nutrient loss from farm fields.*

Combining rock layer data with well locations produced a high resolution depth-to-bedrock map. When the bedrock map was draped over aerial photographs, wet soils were observed in low-lying areas where bedrock holds water very near the land surface (Figures 6 & 7). Contaminated wells were common in these areas (Figure 8).

These vulnerable landscape features are not unique to Calumet County. Counties underlain by carbonate bedrock have similar features and accompanying risks to groundwater quality.

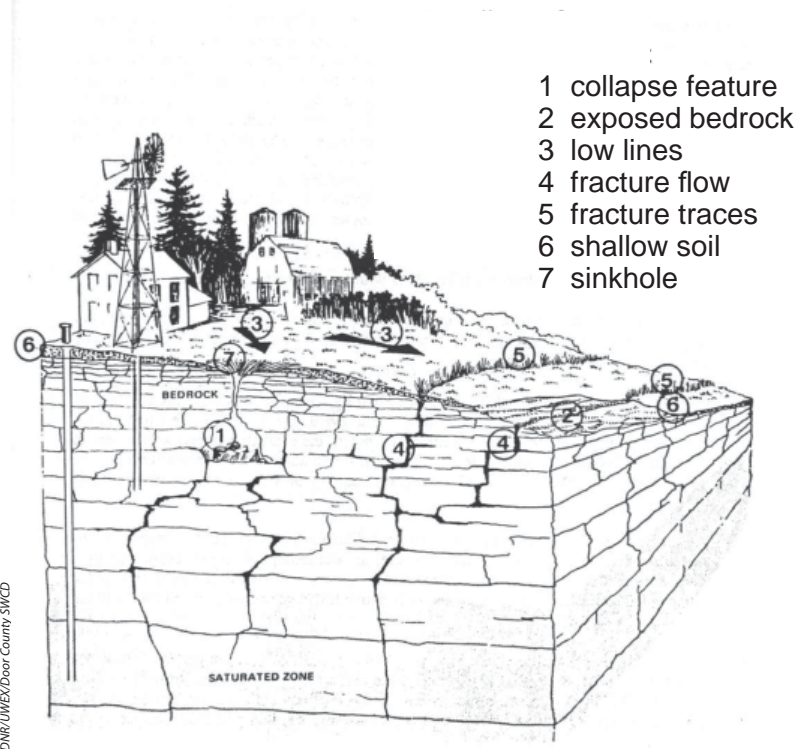


Figure 4. Features of a carbonate bedrock landscape.

**Conclusion**

High resolution depth-to-bedrock mapping in Calumet County revealed vulnerable landscapes susceptible to groundwater contamination and nutrient loss from farm fields.

In these areas, well contamination is common, resulting in costly well replacement.

Discovery Farms has developed a set of procedures to develop high resolution depth-to-bedrock maps. Developing these maps for other counties could equip decision makers involved in land application of nutrients.

Mapping carbonate bedrock features across the state in vulnerable landscapes could help counties prioritize areas for allocation of future resources and conservation measures.



Figure 6. Aerial photograph of wet soils observed in low-lying areas where bedrock is “holding” water near the surface. Figure 7 shows depth-to-bedrock in the same area.

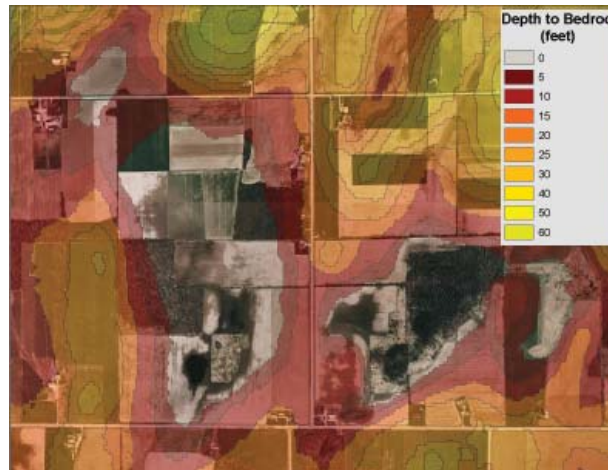


Figure 7. Depth-to-bedrock “draped” over aerial photograph seen in Figure 6. Each change in color represents a 5-foot interval in the depth-to-bedrock as indicated by the map legend.

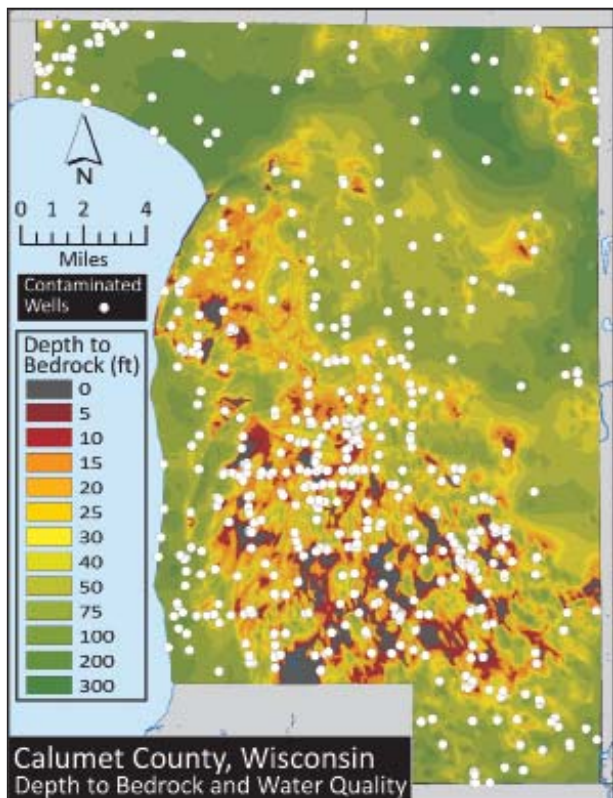


Figure 8. In Calumet County, wells contaminated with bacteria or nitrate were common in areas of shallow depth-to-bedrock.

1. Survey releases Calumet County groundwater study, <http://www.uwex.edu/wgnhs/calhydro.htm>



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