Geologic Mapping as a Basis for Sinkhole Susceptibility Prediction, Frederick Valley, Maryland

David K. Brezinski, James P. Reger, and Gerald R. Baum, Maryland Geological Survey

***Problem**:* The Frederick Valley in west-central Maryland (Fig. 1) has an abundance of active, cover-collapse sinkholes—a situation complicated by population growth and concomitant development pressures (Fig. 2). Altering surface drainage and lowering the ground-water table by quarry activities exacerbate the hazard. Detailed geologic mapping (Brezinski, in progress) provides a basis for assessing potential infrastructure damage and personal injury, because the distribution of cover-collapse sinkholes is controlled primarily by the underlying geology.

Geologic Map: The geologic map of the Frederick Valley shows the presence of two principal limestone formations, the Frederick and Grove (Fig. 3). At the formational level there is no discernable difference in sinkhole proclivity between the two units. When the two formations are subdivided into lithologically distinct members, the increased resolution allows the geologic map to be used as a predictive tool for potential sinkhole development.

Using the Geologic Map: The map of bedrock units and sinkholes demonstrates the correlation between sinkhole distribution and rock type. Table 1 illustrates that most sinkholes are present in the upper member of the Frederick. This contradicts the long-held axiom that the Grove Formation is the most susceptible unit in the Frederick Valley. While the Grove Formation clearly has a significant karst predisposition, a ranking of geologic units demonstrates that the upper member in the Frederick Formation is the most susceptible to sinkhole occurrence (Fig. 4). An increased level of detail in both the lithologic description and the mapping practices facilitates the evaluation of these geologic units' susceptibility to sinkhole formation. By subdividing and mapping units as precisely as possible, and accurately locating sinkholes with a global positioning system (GPS), the geologist is able to develop a semi-objective tool, the susceptibility index (SI), that portrays the relative sinkhole propensity for each unit (Brezinski and Reger, 2002) (Fig. 4). Planners and developers can use the SI as a comparative tool to evaluate the likelihood of sinkhole development.

Conclusion: Karst features represent one of the most widespread and often underevaluated geologic hazards in carbonate terranes. Geologic maps are the principal tools for displaying and conveying data important in understanding reasons for sinkhole distribution. Although hazards such as collapse sinkholes cannot be completely prevented, geologic maps that delineate karst features can be applied by policy makers and the public to develop strategies to minimize or avoid loss.

References

Brezinski, D.K., and Reger, J. P., 2002, Stratigraphy-karst relationships in the Frederick Valley of Maryland, *in* Kuniansky, E.L. (ed.), U.S. Geological Survey Karst Interest Group Proceedings, Shepherdstown, West Virginia, August 20-22, 2002: U.S. Geological Survey Water Resources Investigations Report 02-4174, p. 59-65.

Brezinski, D.K., in progress, Geologic map of the Frederick 7.5-minute quadrangle, Maryland: Maryland Geological Survey, scale 1:24,000 (digital).

Table 1. Number of sinkholes occurring in various stratigraphic units as revealed by recent mapping.

Stratigraphic Unit	Number of Sinkholes
Grove Formation middle member	3
Grove Formation lower member	12
Frederick Formation Lime Kiln Member	40
Frederick Formation Adamstown Member	3

Figure 1. Location map of the six 7.5-minute quadrangles mapped in the Frederick Valley. The Frederick 7.5-minute quadrangle is highlighted.

Figure 2. Sinkholes in collapsed parking area, Frederick, Maryland. Areas of depressed pavement marked by dashed line.

Figure 3. Geologic map with sinkhole locations (circles with hachures) for a part of the Frederick 7.5-minute quadrangle (Brezinski, in progress).

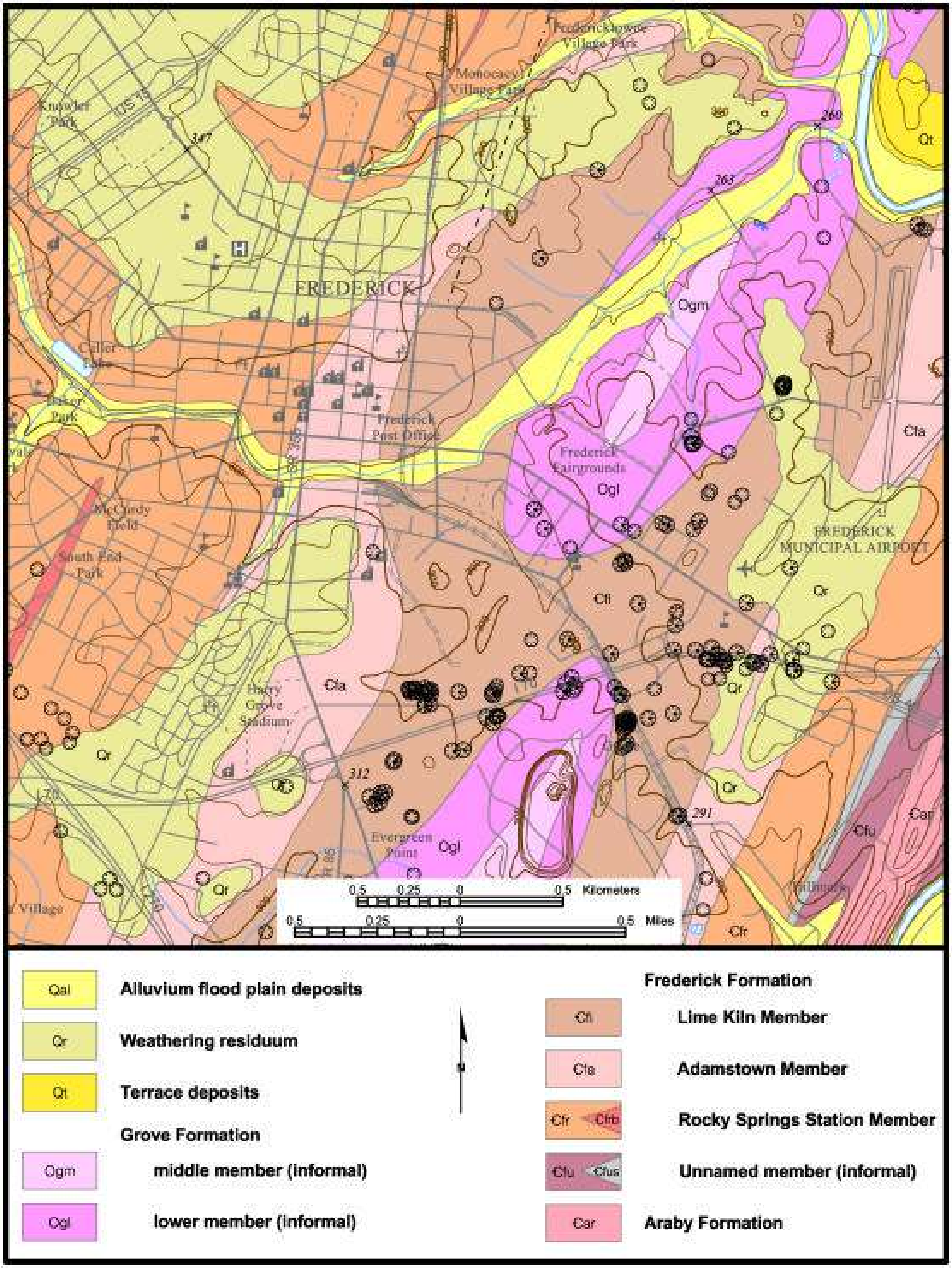

Figure 4. A conceptual depiction of relative susceptibilities to collapse sinkholes of the stratigraphic units in the Frederick Valley (modified from Brezinski and Reger, 2002).