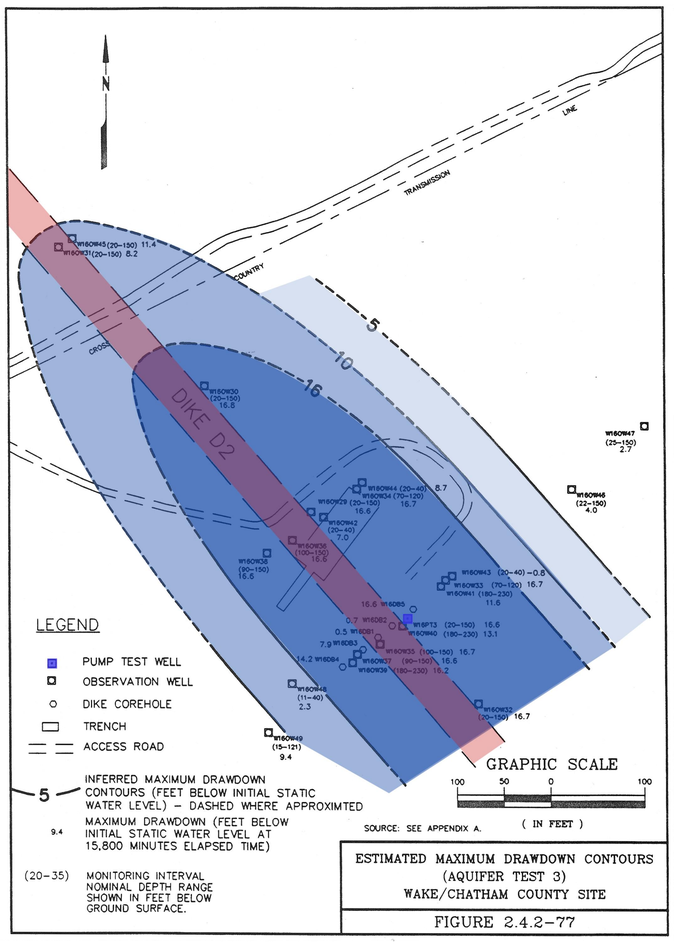
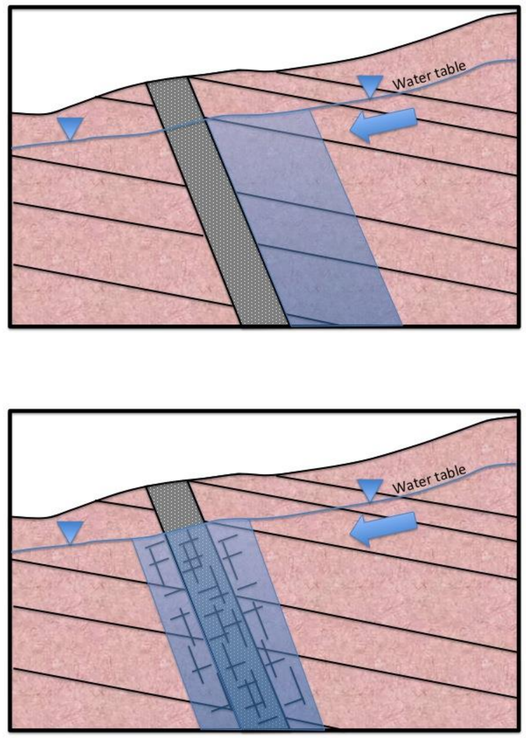
Hydrogeology of Diabase Dikes

For water wells in the Triassic basin, a preferred drilling target is a steeply dipping diabase dike. Yields of 10 to 20 gpm are common for wells in diabase, while wells in sedimentary rock seldom exceed 2 gpm, and many are dry holes. The mechanism by which groundwater utilizes the dikes is not well understood.



Aquifer test results for a large (approx. 50-foot wide) diabase. This test was conducted during the characterization phase of a proposed low-level radioactive waste storage facility in southwestern Wake County, NC in the early 1990s (never built). The pumping well was installed in the baked zone adjacent to the diabase dike. The results clearly show anisotropic hydraulic conductivity along the dike. Figure modified from Chem-Nuclear Systems (1993).



Cartoon cross-sections illustrating conceptual models for dike hydrology. Previous authors have noted the association of diabase dikes with groundwater, and have proposed conceptual models (*e.g.* Idris, 1980; Payne, 1984; Hicks and Tilford, 1985; Ponti, 1996; Wilson and others, 1997; CDM, 2003; Bolich and others, 2007), but no definitive study has yet been completed, to our knowledge.

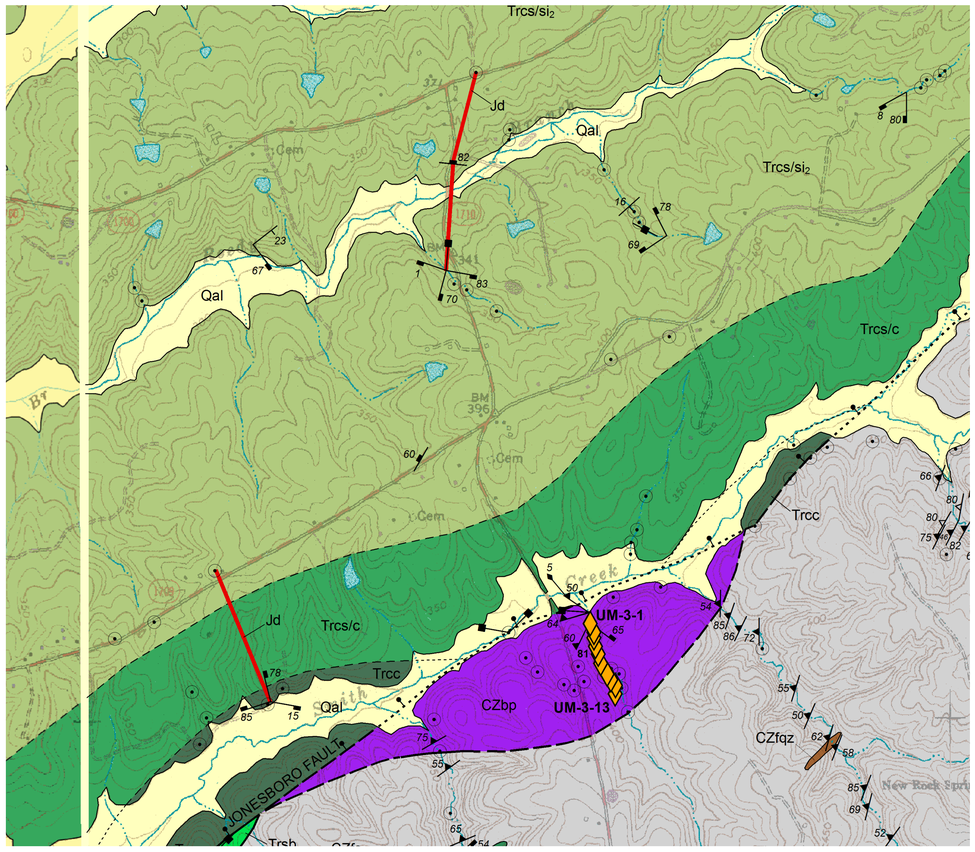
In the upper figure, the dike acts as a dam, and groundwater is ponded on its up-gradient side. In the lower figure, preferential groundwater flow occurs along sets of joints and fractures, either within the dike itself, and/or within the adjacent baked country rocks.

Variations on these simple models are equally plausible. For example, instead of actually ponding groundwater as implied in the upper figure, the dike may act as an impediment to the flow of groundwater to the other side; groundwater might still move freely along country rock fractures on the up-gradient side.

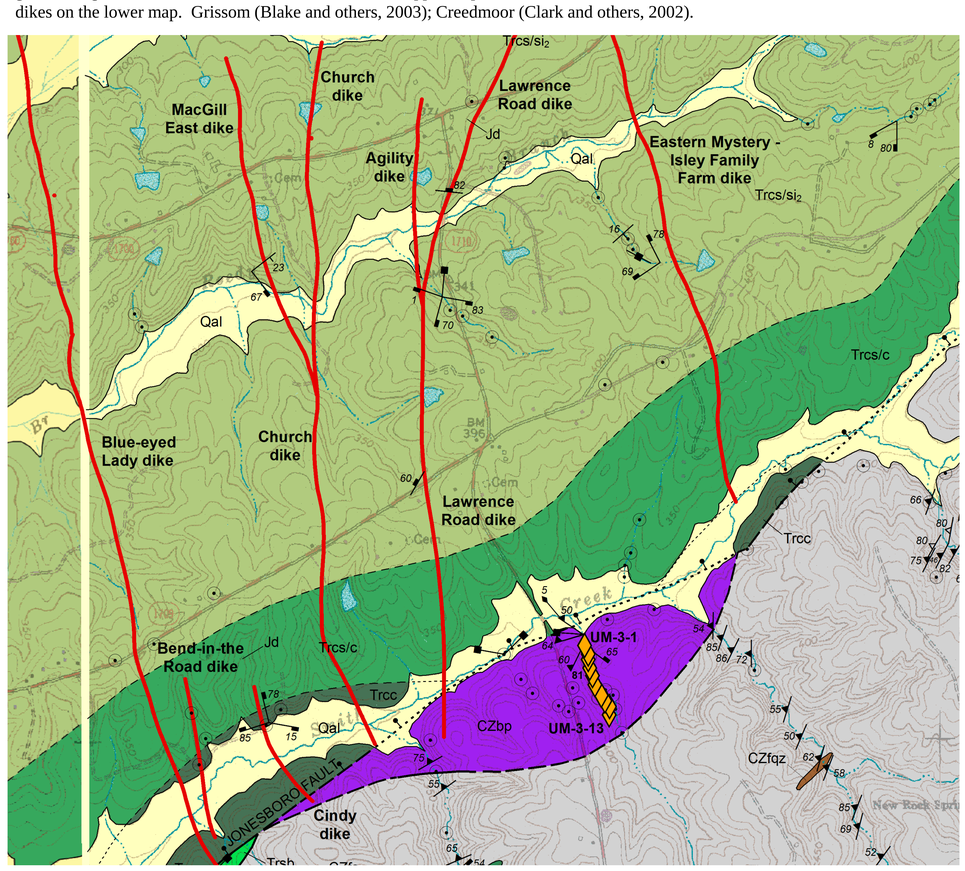
Note that a driller who knows a dike's dip will be more successful.

Abundance & Spacing of Diabase Dikes

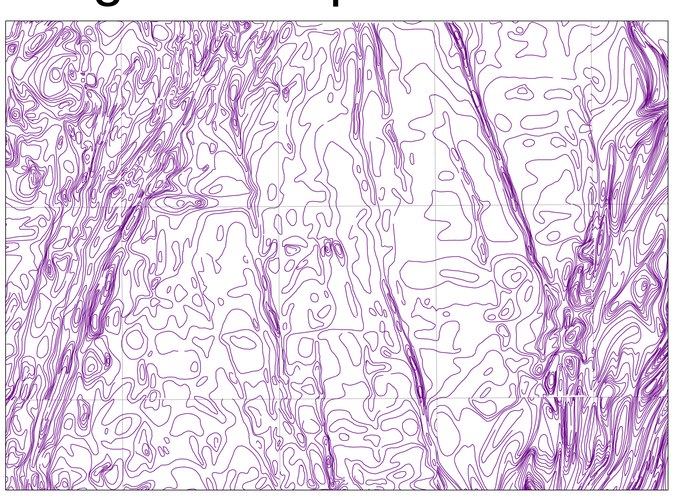
Geologic mapping at the 1:24,000 scale fails to reveal most diabase dikes. Only detailed mapping, aided by geophysical prospecting, gives a complete picture. Knowledge of the location of all dikes would be valuable to developers, drillers, government agencies, and environmental professionals.



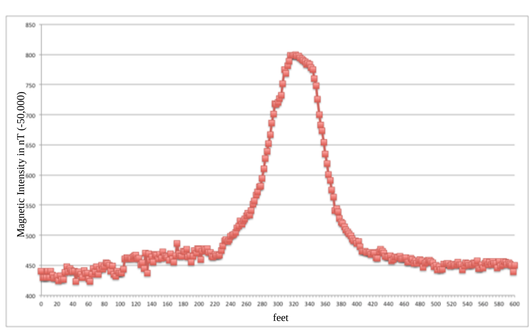
Excerpt from the Geologic Map of the Grissom and Creedmoor 7.5-minute quadrangles. On the upper map, the red lines labeled Jd are diabase dikes. The lower map shows the same area, but includes dikes traced in this study, using detailed field mapping and a ground magnetometer. The two dikes identified on the upper map are the same as the Lawrence Road dike and the Bend-in-the-Road dikes on the lower map. Grissom (Blake and others, 2003); Creedmoor (Clark and others, 2002).



Magnetic Expression of Diabase Dikes



Excerpt from aeromagnetic map of the Raleigh 1:100,000 scale sheet (Carpenter, 1996). Central portion is underlain by magnetically quiet granitoids of the Rolesville batholith. Large NNW-trending diabase dikes are obvious. Aeromagnetic maps are less useful for smaller dikes and in magnetically noisy country rock.



Cross-strike magnetic profile of a near-vertical diabase dike. This dike is the "Church dike" mapped in the figure to the right. In this profile, the maximum magnetic anomaly is around 350 nT. Dike anomalies in the area studied range from around 150 to 700 nT, using a Geometrics G-856 Proton Precession Magnetometer. The profile is 600 feet long, with intensity reading collected every two feet. Computer modelling (Won, 1981) suggests that the dike is about 20 feet wide and dips west at 85 degrees. A well drilled into this dike yielded 24 gpm.