

# Diabase Dikes, Fractures, and Faults

## Additional Threats to Triassic Basin Groundwater

September 6, 2013

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Existing and induced fractures in North Carolina's shallow shale are significant and cannot safely be ignored:

**"Fractures in rocks are recognized as the predominant pathways of resources and hazardous materials, such as groundwater, hydrocarbons, geothermal fluids, and the high-level nuclear wastes, because fractures usually have much greater permeability than the matrix permeability."**

Ishibashi, T., N. Et al. GeoFlow: A novel model simulator for prediction of the 3-D channeling flow in a rock fracture network, Water Resource. Res., 48, 2012.

**Not enough is known about the basics with Triassic Basin groundwater patterns:**

"No groundwater monitoring stations have been constructed in the Triassic Basins of North Carolina. Because of this, **our understanding of the hydrogeology of the Triassic Basins is limited** to information that can be recovered from water supply wells, which typically only extend a few hundred feet deep." p. 113

**There is insufficient information about the effects of the Triassic Basin faults on the flow of groundwater:**

".. the dominant fault orientations in the Triassic basins of North Carolina are northwest-southeast and, to a lesser extent, northeast-southwest. **The degree to which these faults may transmit water is not well understood and warrants additional investigation.**" p. 113

NC DENR and NC Dept. of Commerce. "North Carolina Oil and Gas Study under Session Law 2011-276" April, 2012.

**Diabase dikes are very common in Lee County and most of the Triassic Basin. Dense clusters of dikes like this are known as a "swarm of dikes".**



Sanford Sub-Basin. NC Geol. Survey –(2010)  
Reid, Taylor, Cumberbatch



Diabase Dikes of Eastern Piedmont of NC (1978)  
Burt, Carpenter, McDaniel, Wilson

Diabase dikes are probably far more common than is shown on the maps:

"Larry Daw, a Licensed Geologist in the State of North Carolina, carried out a lot of the geological field work during the Low Level Radioactive Waste Study. The site was in a very similar area in the Triassic Basin next to Sharron Harris. He found: **"The diabase dikes at that site were far more common than what was shown on the geological maps of the area"** - Personal communication, June 2013.

Dikes are known to serve as conduits for the flow of water:

**"While diabase intrusions are not particularly permeable features, contact metamorphism of the host rock could provide conduits for groundwater due to stress fractures and joints and high-temperature recrystallization of the rock matrix."**

**"Delineation of mafic intrusions near Bedford (Virginia, USA) using geological and geophysical methods"**  
Keane, James and Gilstrap, Tatiana. Environ Earth Science 66:1393–1402 (2012)

**"The intrusion of the diabase dikes and sills at temperatures of 1,200 degrees Fahrenheit baked the country rock, which significantly reduced the country rock's permeability. As the diabase cooled, cracks formed inside the dikes and sills, which provided avenues for water to further weather the diabase. This process provides the potential for a tabular body of groundwater to be held by the country rock like a cistern."** p. 25-26.

NC DENR Final North Carolina Oil and Gas Study. April, 2012.

**"The diabase dikes typically are well jointed, but are too thin to be considered a water-bearing unit. However, the presence of the dikes increases the probability for differential weathering, which could enhance ground- water movement along the contact of the dike with the adjacent country rock."**

Fracking's extreme high pressures will enhance migration of fracking fluids along fractures:

**"Once generated, natural gas and oil either remain within the source beds from which they were generated, or they migrate elsewhere in response to differential compaction and to temperature and pressure gradients within the Earth. Migration pathways are difficult to define, but apparently take place along relatively porous beds or fracture zones within the Earth. In general, migration is from areas of relatively high pressure to low pressure .."** p.2

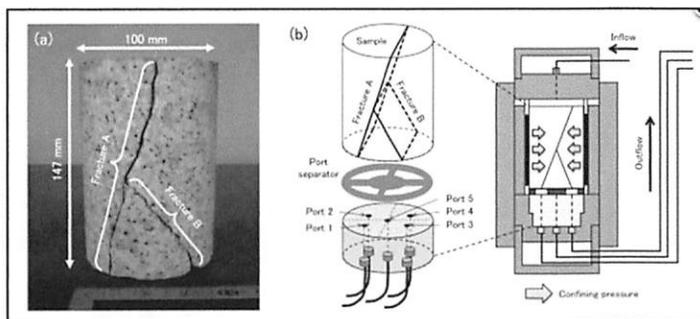
NC Geological Survey, Information Circular 36 "Natural Gas and Oil in North Carolina"  
Reid, Jeffrey. March, 2009

Models of fluid flows along fractures is still very simplistic, and cutting edge simulations and models are almost always limited to a few cracks, or to cracks that follow a grid –

like roads around a city block. Cracked rocks are very complex, and liquids flowing through cracks are less like traffic flows than a 3-dimensional swarm of angry killer bees. Cracks are unpredictable, and water will flow over, under, and through whatever obstacles or cracks are found.

Diabase dikes, especially thin ones, introduce the risk of providing a pathway for rogue fractures. The baked soil and rock on both sides of the dikes provide an unpredictable textured material that may also serve as a conduit for toxic hydrocarbons to reach groundwater. If the dikes can serve as a cistern, it should also be capable of serving as a pipeline to the surface.

**(Uses a granite cylinder with 2 intersecting fractures)**



“A novel model simulator for prediction of the 3-D channeling flow in a rock fracture network” *Water Resour. Res.*, 48, (2011).

In the MEC meeting on September 5<sup>th</sup>, Ken Taylor was asked about deep dikes as conduits. He said there is no data to show that the dikes do serve as conduits below 400 ft. **However, Dr. Taylor did not say that they cannot, just that there is no data.** There does not appear to be much that is known about hydrological flows around or along diabase dikes at these depths.

The dikes, faults, and fractures in the Triassic Basin, combined with the shallow shale deposits add complexity, unpredictability, and unacceptable risk to the approaching threats to our waters. When caustic liquids such as hydrofluoric acid, are combined with secret chemicals mixtures with unknown viscosity, solubility and density, the behavior of the slickwater injections into our complex geology and the presence of diabase dikes cannot be predicted. **Fracking simply introduces too many unacceptable long-term risks for a very short-term project.**