THE RELATIONSHIP BETWEEN GROUNDWATER AVAILABILITY AND DIABASE DIKES IN THE DEEP RIVER TRIASSIC BASIN, NORTH CAROLINA

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ABSTRACT

Among geologists, extension agents, and well drillers, the Deep River Triassic basin is well known for its low groundwater yields. Poor sorting and high clay content of the basin's sedimentary rocks limit infiltration and lead to low hydraulic conductivity; wells drilled in older crystalline rocks outside the basin are usually much more successful. Further, Triassic soils are poorly suited for septic systems. Unless there is access to a public water supply and sewage system, the geologic boundary of the Triassic basin poses an impediment to residential and commercial development, as can be seen today in many rural areas, including northernmost Wake and southern Granville Counties.

For water wells in the basin, a preferred drilling target is a steeply dipping diabase dike. Dikes vary greatly in thickness, but even thin dikes can be good targets. 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.

Dikes can commonly be traced on the surface on the basis of spheroidally weathered residual cobbles and boulders. Larger dikes can be located on aeromagnetic maps, and even small ones can be mapped easily and in detail using ground magnetic surveys. Diabase outcrops typically exhibit strongly developed orthogonal joint systems. The higher yield of wells in diabase dikes has been variously attributed to jointing within the dikes, damming of groundwater, or fractures in adjacent baked zones of country rock. Unlike dikes, sills do not seem to be associated with higher yields.

Most diabase dikes are unmapped, as only the most obvious are shown on existing geologic maps. In the parts of the basin we have surveyed, we encounter at least one dike per km on a typical east-west traverse. Geophysical methods could be employed to great advantage in order to produce high quality, detailed maps showing dikes in areas under consideration for development. Such maps would also be useful in addressing important environmental questions, including the prediction of groundwater behavior at sites of proposed hydraulic fracturing or wastewater injection or irrigation.

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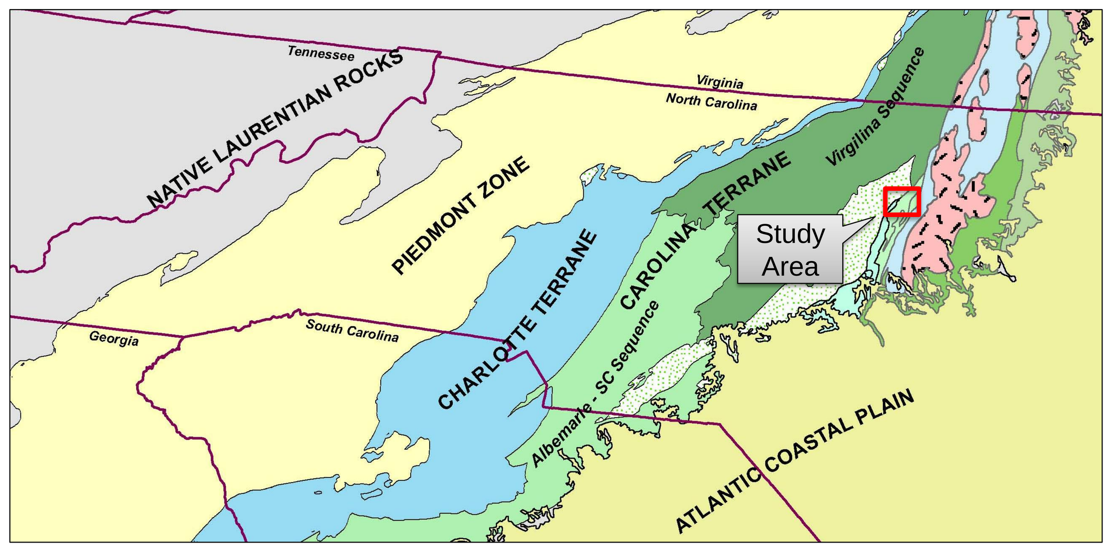
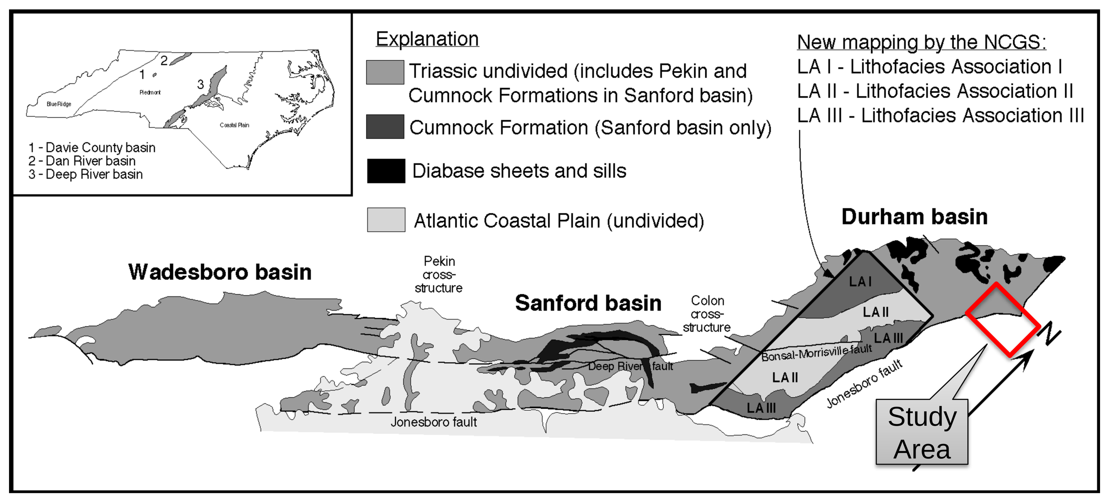
Geologic Setting



Terranes of portions of North Carolina, South Carolina, and Virginia. The Deep River Triassic rift basin is shown as the light-colored polygon with green dots. Map modified from Hibbard and others (2002, 2006). Approximate area of geologic maps shown to the extreme right is indicated by the red box.



Generalized geologic map of the Deep River basin, NC. General distribution of sedimentary rock types and of diabase sills is indicated. Dikes are not shown at this scale, and their true abundance is greater than what is shown on available 7.5-minute geological maps. Modified from Reinemund (1955), Bain and Harvey (1977), NCGS (1985), Olsen and others (1991), Hoffman and Gallagher (1989), Clark (1998), and Watson (1998).

Rock Types

Exposure of typical Triassic sedimentary rocks. The poorly sorted, clay-rich clastic strata of the Deep River basin impede downward percolation and movement of groundwater. Adequate-performing residential wells and septic systems are a challenge. Wave-cut outcrop at Bond Lake, Cary Quadrangle.

Jurassic diabase dike intruded into Paleozoic granitoid. Note orthogonal joint sets developed in the diabase due to contractional cooling and fracture zones along margins of dike in country rock. Crude columns form perpendicular to the cooling surface. Wake Stone quarry, Drake Quadrangle.

Field Expression of Diabase Dikes

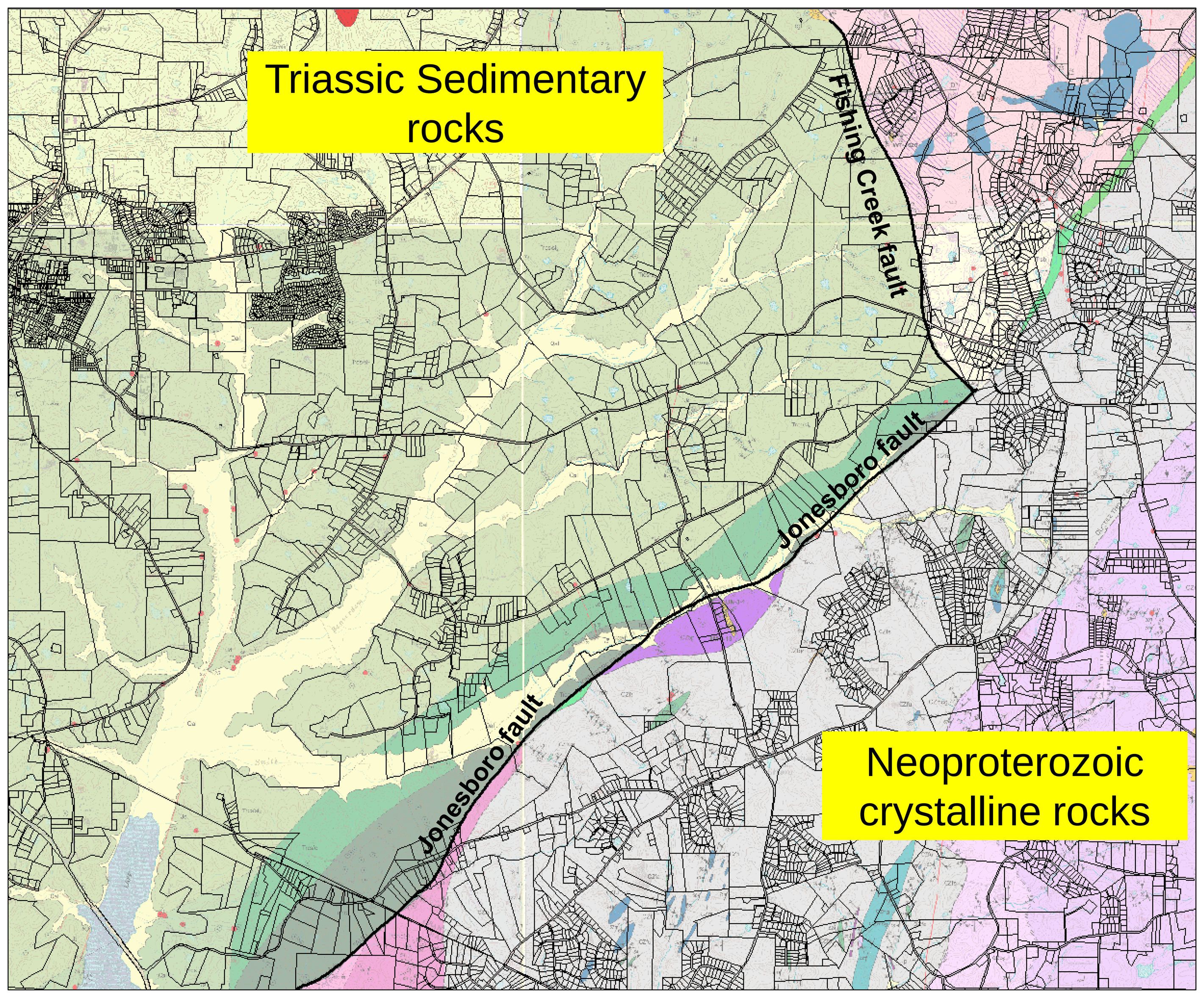
Natural creek outcrop of diabase dike. This dike displays both strike-parallel and strike-perpendicular joint sets typical of dikes in the region. Bayleaf Quadrangle.

Large block of excavated diabase. Note orthogonal joint sets intersecting at near 90-degree angles. Lawrence Road dike, Grissom Quadrangle (see dike map to the right).

Spheroidal weathering of diabase dike. In-situ chemical weathering of the jointed diabase results in the formation of concentric layers of highly decayed saprolite surrounding a competent and hard "core stone" of diabase. End result of this process is loose spheroidal cobbles and boulders. Shore of Falls Lake, Creedmoor Quadrangle.

Natural surface outcrop of diabase dike. This exposure shows in-situ blocks with rounded corners indicating incipient spheroidal weathering. Again, both strike-parallel and strike-perpendicular joints are evident. Site is along Falls Lake Trail, Northeast Durham Quad.

Geologic Control on Land Use & Development



Geologic map of portions of the Creedmoor, Grissom, Wilton and Stem 7.5-minute quadrangles. Geologic map is overlain by real estate parcel map. Triassic sedimentary units shown in green shades. Older metamorphic rocks of the Carolina, Falls Lake, and Crabtree terranes shown as pink, grey, and purple colors. The boundary between the Triassic and Neoproterozoic units is defined by the Jonesboro and the Fishing Creek faults, dip-slip normal faults related to the formation of the Deep River extension rift basin. The area of dense development in the northwest portion of the figure is part of the city of Creedmoor, served by public utilities.

High groundwater yield in the Neoproterozoic rocks (typically 6-30 gpm) allows for higher density subdivisions than are possible in the lower well yield areas of the Triassic sedimentary rocks (0-5 gpm). Furthermore, Triassic soils are poorly suited for septic systems. Unless there is access to a public water supply and sewage system, the geologic boundary of the Triassic basin poses an impediment to residential and commercial development. This pattern of development hindered the growth of Cary, NC, until a public water supply became available in the 1980s as a result of the creation of B. Everett Jordan Lake.

RESIDENTIAL SUBDIVISIONS WITHOUT ACCESS TO CITY UTILITIES
Southern Granville County

Located in older crystalline rocks east of Triassic rocks	Number of lots	Apprx. Avg. Lot Size (acres)
The Preserve at Smith Creek	194	1.2
Wilson Place	50	2.8
Marshall Landing	33	1.1
New Forest PH	66	1.2
Wayside Farm	56	1.3
Grissom Woods	27	1.5
Falls Meadow	42	1.1
Heritage Hall	33	2.5
Ironwood	105	1.0
Whitfield Chase	69	1.3
Mitchell Acres	79	1.4
Huntington Ridge	137	1.5
Brassfield Woods	65	1.1
Hawthorne	126	1.6
Copper Creek	52	1.4
Located in the Triassic rocks		
Beaver Creek	7	8.2
Brassfield Plantation	10	16.2

Partial list of the many newly developed residential subdivisions located east of the basin-bounding faults (shown on the map to the left) as compared with subdivisions located in the Triassic basin.

In this area, fractured crystalline rocks and associated regolith support rapid residential growth even in the absence of public utilities because water wells and septic systems perform acceptably. Subdivisions contain numerous relatively small lots, each with its own well and septic system. In contrast, subdivisions in the Triassic basin are practically nonexistent (or undeveloped), and have fewer and larger lots. This reflects the difficulty in finding an acceptable well and septic system on site.