Fault Zone Minerals of the Queens Water Tunnel, NYC
Orange County Mineral Society Lecture
Chester Senior Center
81 Laroe Road, Chester, NY 10918
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Between 1996 and 1999, a high-performance tunnel-boring machine (TBM) excavated a 23’ wide, 5-mile-long tunnel through metamorphic rocks of the Appalachian mountain chain in an area where no natural surface bedrock exposures exist in the subsurface of southwestern Queens (Figure 1). Varying in depth from 690’ to 760’ below the surface and extending in a curved path from Maspeth northeastward to Woodside thence westward to Long Island City, the tunnel has been excavated by a 300’ long tunnel boring machine or TBM (Figure 2). The new tunnel, lined with concrete beginning in 2000, has exposed a treasure trove of new information on the bedrock geology of New York City that we were fortunate enough to map in detail at a tight scale of 1” = 10’.

The geological staff at Duke Geological Laboratories were retained as geological consultants for the joint venture contractors (Grow-Perini-Skanska) during the construction of the Queens Tunnel between 1998 and 2001. During that interval, detailed geological mapping of the tunnel perimeter resulted in 250 maps of the tunnel and a number of technical publications. (See References.)

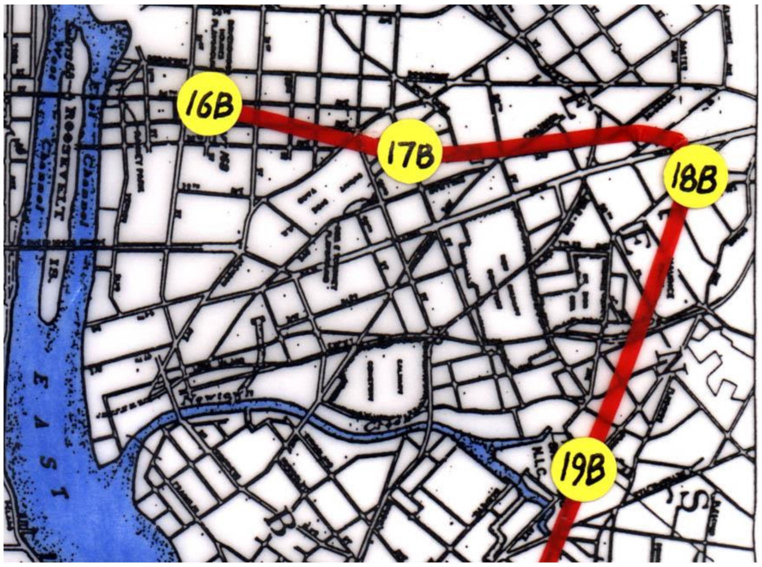

Figure 1 – Index map showing the trace of the 25,000’ long Queens Tunnel (red line) and the intervening shafts (16B, 17B, 18B, 19B). Tunnel stations begin at Station 0+00 at the main construction shaft (19B) and mark footages from Shaft 19B to 18B (~Station 100+00; 10,000’ away from 19B) where the tunnel curves from a NNE trend to a WNW trend. Note that Shaft 17B is at Station 171+00 and Shaft 16B is at Station 250+00.

Five generations of brittle faults are superimposed on polydeformed bedrock units of the Queens Tunnel often causing brittle reactivation of ductile faults and pre-existing brittle faults (Merguerian 2003). A hitherto unknown, steeply dipping, major NNE-trending fault set cuts the Queens Tunnel from beginning to end but most are strongly concentrated along the NW tunnel leg just beyond the major curve in the tunnel. In general, brittle faults are outlined by zones of fault breccia, clay-rich gouge, zeolite+calcite+pyrite mineralization, and quartz veins.

Figure 2 - The front cutterhead and thrust assembly (business-end = 84' length and 23' diameter) of the Tunnel Boring Machine that formerly operated beneath western Queens. With a total length of nearly 300', the complete machine excavates, processes, and removes the rock chipped by the cutters. The cutterhead rotates against the raw rock face with thrust applied hydraulically by mechanical contact from behind against the sides of the bored tunnel. The TBM holed-through beneath Long Island City in October 1999 after three years of nearly continuous subsurface mining.

The NNE-trending faults constitute a third (~100) of all mapped brittle faults in the tunnel. They form a system of geologically young dip-slip faults and related joints with an average N21°E trend and steep dips. The faults are characterized by thick clay, breccia, and clayey gouge that vary in thickness from 1 cm up to 5 m. Minerals found healing the NNE-trending faults show a clear paragenesis of apophyllite and/or heulandite followed by stilbite of two generations (yellow to orange followed by translucent stilbite). The stilbite is overgrown with spheres and interpenetrant cubes of pyrite, calcite, and clear crystals of chabazite.

Dr. Merguerian's PowerPoint lecture will include a discussion of the bedrock geology and brittle fault history of NYC based on his studies of the Queens Tunnel and his mapping elsewhere in NYC. The lecture will be highlighted with images of the fault zone minerals.

Reference List

Merguerian, Charles, 2005a, Geological controls on effective hard-rock TBM tunneling in crystalline terrains: *in* 84th Annual Meeting, 9-13 January 2005, Compendium of Papers CD-ROM, Transportation Research Board of the National Academies, 11 p.

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Merguerian, Charles; and Ozdemir, Levent, 2003, Rock mass properties and hard rock TBM penetration rate investigations, Queens Tunnel Complex, NYC Water Tunnel #3, Stage 2: p. 1019-1036 *in* Robinson, R.A. and Marquardt, J.M., *eds.*, Rapid Excavation and Tunneling Conference, 2003 Proceedings Society of Mining, Metallurgy, and Exploration, 1334 p.

Merguerian, Charles, 2002b, Brittle Faults of the Queens Tunnel Complex, NYC Water Tunnel #3: p. 63-73 *in* Hanson, G. N., *chm*., Ninth Annual Conference on Geology of Long Island and metropolitan New York, 20 April 2002, State University of New York at Stony Brook, NY, Long Island Geologists Program with Abstracts, 116 p.

Merguerian, Charles, 2001, Young rhyodacite dikes found in the Queens Tunnel, beneath Woodside, Queens: p. 9-19 *in* Hanson, G. N., *chm*., Eighth Annual Conference on Geology of Long Island and metropolitan New York, 21 April 2001, State University of New York at Stony Brook, NY, Long Island Geologists Program with Abstracts, 128 p.

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