

## **Brittle Fault Chronology of New York City (NYC)**

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Geologic mapping in the NYC Water Tunnel system has confirmed that five generations of brittle faults cut sheared granulite facies Proterozoic orthogneiss and imbricated Paleozoic bedrock units in NYC. From oldest to youngest, they include NW-trending gently SW-dipping normal- and reverse faults (**Group A**), ENE-trending faults with moderate to steep dips (**Group B**), lengthy subhorizontal faults and fractures (**Group C**), and steep dip-slip NNE-trending faults (**Group D**) with thick, clay- and zeolite-rich highly brecciated gouge zones. These are cut by NNW-trending strike-slip faults of the “Manhattanville” fault set (**Group E**), characterized by sharp, quartz-filled contacts. Reactivation and mineralization of older faults is quite common. The mineralization typically starts with stilbite +/- heulandite, followed by calcite and a spray of secondary zeolites (stilbite, apophylite, analcime, and chabazite), then by pyrite. The ages of older faults is difficult to ascertain but the faults of Groups D and E offset a swarm of late Paleozoic (295 Ma) glassy rhyodacite dikes in the Queens Tunnel. Field mapping throughout NYC area has shown that NW-trending faults (Group E) are the youngest structural geologic features found in the region.

In the Bronx, right-lateral offset of the Bronx River along the NW-trending Moshulu fault is post-glacial in age. The epicenter of a small earthquake (~2.4 Richter) localized in NYC on 17 January 2001 was along the trace of the right-lateral 125<sup>th</sup> Street (Manhattanville) fault near 102<sup>nd</sup> Street and Park Avenue. Later that year (27 October), another small earthquake (~2.6) struck NYC with an epicenter near 55<sup>th</sup> Street and Eighth Avenue. North of NYC, seismicity along the NW-trending Dobbs Ferry fault in late October 1985 included two small (~4.0) tremors and many aftershocks. More robust earthquakes in and around the vicinity of NYC were recorded in 1884 (~5.0-5.5), 1783 (~4.9), and 1737 (~5.2). Because slip along regional NW-trending faults has produced historic seismicity in the Manhattan Prong, the presence of NNW- and NW-trending faults of Group E portend seismic risk in the NYC area.

**To Cite This Abstract:** Merguerian, Charles, 2004a, Brittle fault chronology of New York City (NYC): Geological Society of America Abstracts with Programs, v. 36, no. 2, p. 73.