Great Falls Metagraywacke, and a bit more
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Over 400 million years ago (mya) the ancestral continent of North America and the remnants of an offshore volcanic island arc collided, evidence of plate tectonics at work. **Metagraywacke**, the dark bedrock of the Great Falls area, has its roots in that collision and in the earlier formation of a "dirty sandstone," **graywacke**, in the ancient Iapetus Ocean.

Over time, layers of sand and mud eroding from the island arc were deposited by underwater avalanches in the adjacent ocean trench, or subduction zone in geology-speak. With more and more layers put down, deeply buried layers were compressed and turned into **graywacke**, a sandstone with fewer grains of quartz and more of feldspar but also with a clay and silt content, making it "dirty."

When the island arc and the North American continent converged, 480-420 mya, the ocean **graywacke**, as well as everything else in between, was snowplowed onto North America's margin. This Taconic Orogeny (mountain-building event) included folding, faulting, metamorphism, volcanism and igneous intrusion. **Graywacke became metagraywacke; interbedded mudstones transformed into mica-rich schist.**

Metamorphism occurs when heat and pressure deep underground cause minerals to realign into more parallel orientations, called **foliation**. (*Foliation* in geology refers to repetitive layering in metamorphic rocks. Each layer may be as thin as a sheet of paper, or over a meter in thickness. The word comes from the Latin folium, meaning "leaf", and refers to the sheet-like planar structure.) Foliation is particularly evident in the **mica schist** at Great Falls, which owes its shiny and scaly appearance to its large mica crystals.

Metagraywacke is considered relatively lightly metamorphosed in that the general appearance of the original **graywacke** can still be seen. In particular, it is often possible to see the presence of distinct bands of larger and smaller grains, the result of the particle sorting that took place as the slurries of sand and mud slid down and settled into the ocean trench. Lightly metamorphosed it may be, but the high resistance of **metagraywacke** to erosion is key to the shaping of the falls and Mather Gorge.

Although our metagraywacke is attributed to the Taconic Orogeny, two additional mountain-building events occurred, the Acadian (410-360 mya) and, more importantly, the Alleghenian (320-250 mya), in which Africa collided with North America during the assemblage of the supercontinent, Pangea. The massive forces of this slow-motion impact raised mountains along our eastern seaboard, squeezed deeply buried layers of rock into tight folds and upthrust slabs, and shoved them many miles westward.

What we now see as a series of parallel ridges extending from Catoctin Mountain to the Allegheny Front (Dan's Mountain) west of Cumberland is evidence of that collision. This region (to geologists, the Blue Ridge and the Valley and Ridge Provinces) provided no easy route for the Canal builders other than the one cut by the Potomac. The ridges we see are the product not of tectonic uplift from the collision of plates but rather of an ongoing process of erosion of overlying material. The more resistant rocks, especially sandstones, were left as ridges while less resistant rocks, such as limestone and shale, weathered into valleys. **Quartzite**, sandstone metamorphosed during the Alleghenian Orogeny, is the rock now capping Catoctin and South Mountains in the Blue Ridge Province.

The thrust of the African Plate also caused a downward flexing that created a large basin and inland sea in what is now western Maryland and surrounding states. Then, 300 mya, vast masses of decaying organic material collecting in the bottom of tropical swamps were compressed into peat, buried deep under new layers of sand and mud, and eventually compacted by heat and pressure into **coal**, the savior and mainstay of the Canal.

Seneca Red Sandstone, yet another rock important to the Canal, was formed just west of Great Falls (mile 24) when streams carried sandy debris into a low-lying trough created by major faulting from the breakup (rifting) of Pangea (220-200 mya). Very distinct from **graywacke**, **Seneca sandstone's** rusty color is the result of being laid down, not in oxygen-poor ocean depths but rather in surface deposits where its iron content oxidized from exposure to the atmosphere. If you wish to be highfalutin, the formal name of this stone is **Upper Triassic Poolesville Member of Manassas Sandstone**.

Sources:

John Means, *Roadside Geology of Maryland, Delaware, and Washington D.C*. (2010)

USGS, *Geology of the Chesapeake and Ohio Canal National Historical Park and Potomac River Corridor, District of Columbia, Maryland, West Virginia, and Virginia* **(***2008)*
https:/pubs.usgs.gov/pp/1691/P1691.pdf

NPS, Graywacke Sandstone FAQ
https://www.nps.gov/goga/learn/education/graywacke-sandstone-faq.htm

USGS *The River and the Rocks, The Geologic Story of Great Falls and the Potomac River Gorge* (1970)
https://www.nps.gov/parkhistory/online_books/grfa/contents.htm

Callan Bentley (Professor of Geology, Northern Virginia Community College), "Billy Goat Trail pre-trip readings." Compiled as an aid for his students, this web page has many helpful pictures and a video:
http://www.nvcc.edu/home/cbentley/gol_135/billy_goat/readings.htm