Introduction to the Bedrock Geology of Newton

Editor's Note: This article is based on a field trip Newton Conservators' Vice President Chris Hepburn has led in the past around different sites in Newton. Chris is a geologist and retired professor of geology from Boston College specializing in igneous and metamorphic rocks, geochemistry, and plate tectonics applied to the formation of the Appalachians. The next field trip is scheduled for Saturday, October 27 at 9 am. See page 11 of this newsletter for more information.

"Yet a lump of puddingstone is a thing to look at, to think about, to study over, to dream upon, to go crazy with, to beat one's brains out against."

— *Oliver Wendell Holmes, The Professor at the Breakfast-table (after Rehmer and Roy, 1976)*

The rocks of the Boston area have been the subject of study and debate for almost as long as geology has been a science, starting in the early 1800s. It is fun to note the evolution of geological ideas as one reads the older literature and to observe the influence these rocks have had on it, given the famous early geologists who lived and worked in the Boston area. However, to adequately reference all the geological work upon which this field trip is based is clearly not possible here.

Newton is underlain by three geological formations with different rock types, the Roxbury Conglomerate, volcanic or intrusive rocks of the Brighton and Mattapan Volcanics, and the Cambridge Argillite or Slate. (In geological literature, rock formations are named for geographical "type" localities where they are first described or well exposed.) We will visit representatives of each of these rocks on our excursion with the goal of trying to assess the environment in which they were deposited.

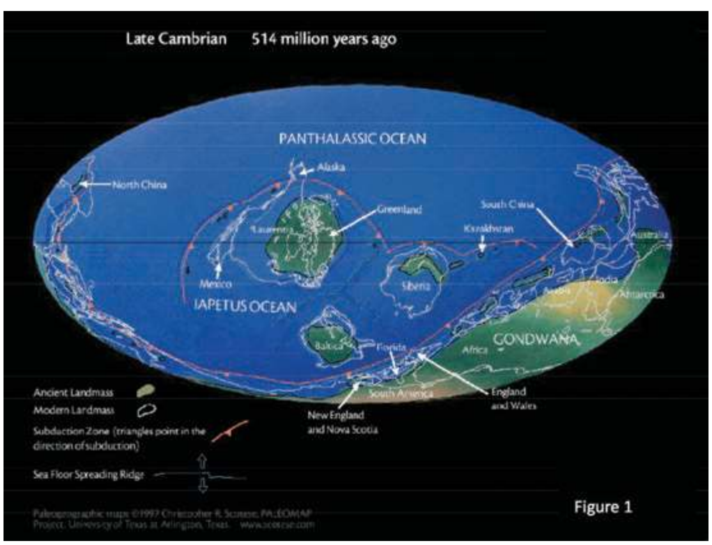

Figure 1. 514 million years ago. Paleogeographic Maps by C. R. Scotese Paleomap Project, Univ. of Texas, Arlington; www.scotese.com

Chris Hepburn previews a geology walk at Hammond Pond.

The rocks of Newton are part of the Boston basin, a fault bounded sedimentary basin that formed within an ancient volcanic arc in the latest Precambrian geological era, about 600-585 million years ago (Thompson, 2014). The basin formed between volcanic centers to the south, toward Westwood, and to the north in the Lynn area. Intra-arc basins are common in modern volcanic arcs like the Andes. The reason the Boston basin is a lowland, with higher terrain all around, is simply that the rocks within it are softer and were more easily eroded than the harder volcanic and granitic rocks that surround it. (Note, for instance, the view of downtown Boston as you descend the long hill travelling east on Rt. 2 in Belmont from the harder, less-eroded rocks on the west.)

Through paleomagnetic studies we now know that the rocks of Newton were formed as part of a large volcanic arc along the edge of the great southern continent of Gondwana, much like the modern Andes along the western coast of South America. Other fragments of this ancient arc are found today around the North Atlantic Ocean, from Atlantic Canada and Newfoundland to Wales and Morocco.

At the time this arc was active, it was not far from the South Pole, being at least 60 degrees south (Figure 1). Thus, our rocks have travelled a long way in the intervening years. However, within 50 million years after they were deposited, a ribbon continent broke away from Gondwana because of plate tectonic forces. It then moved out into the "paleo-Atlanitc" or Iapetus Ocean (named for the father of Atlantis in mythology) in much the same way that Japan has broken away from Asia in the more recent past.

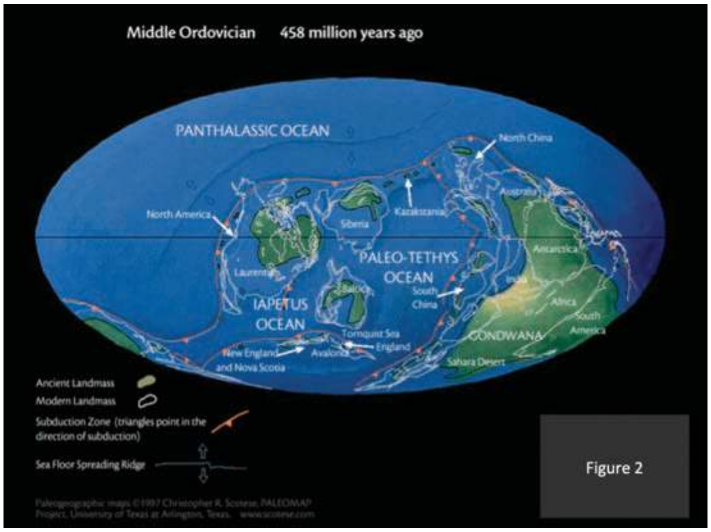

Figure 2. 458 million years ago. Paleogeographic Maps by C. R. Scotese Paleomap Project, Univ. of Texas, Arlington; www.scotese.com

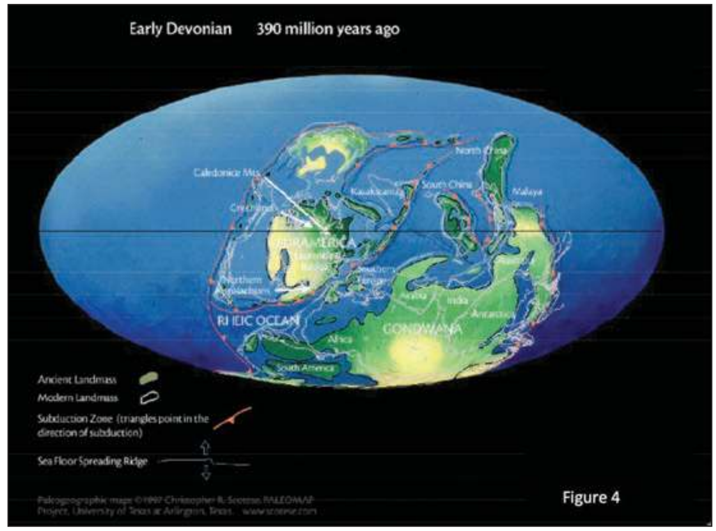

Figure 4. 390 million years ago.Paleogeographic Maps by C. R. Scotese Paleomap Project, Univ. of Texas, Arlington; www.scotese.com

The Iapetus Ocean separated Gondwana to the south from the ancient core of North America, called Laurentia, which was located more or less at the equator. The ribbon continent is named Avalonia for the type area on the Avalon Peninsula of eastern Newfoundland. In eastern Massachusetts, Avalonia extends only a short distance west of Rt. 128/I95, but it is more extensive offshore. Through time, Avalonia gradually crossed Iapetus until it collided with the edge of Laurentia beginning about 425 million years ago (Figures 2-4). This collision led to mountain building, folding and metamorphism that formed the northern

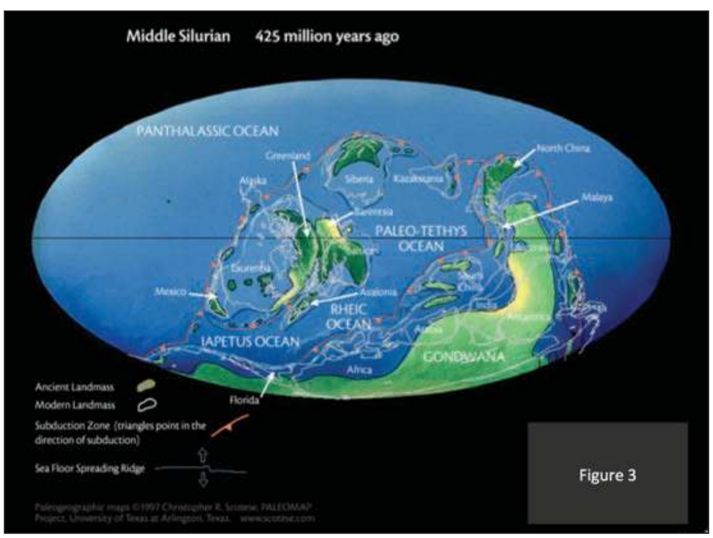

Figure 3. 425 million years ago. Paleogeographic Maps by C. R. Scotese Paleomap Project, Univ. of Texas, Arlington; www.scotese.com

Appalachians. Four hundred million years ago western Massachusetts, New Hampshire and Vermont would have resembled the Alps or Himalayas of today.

All the exposures we will visit on our tour were formed while Avalonia was still part of the Gondwanan continent in the high southern latitudes on the other side of the Iapetus Ocean. Note that the land was barren of plants and animals then and no life existed on the earth except primitive, non-shelled organisms in the oceans.

References cited:

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Thompson, Margaret D., 2014, "Conglomerate in and around the Boston Basin, Massachusetts: U-Pb geochronology, stratigraphy and Avalonian tectonic setting," *in* Thompson, M.D., *A Guidebook to Field Trips in Southeastern New England* (MA-NH-RI), New England Intercollegiate Geological Conference, 106th Ann. Mtg., Dept. of Geosciences, Wellesley College, Wellesley, MA, pp. B2-1 – B2-16. ◆

Chris Hepburn

Closeup of Roxbury Conglomerate