For additional information

Barber, M.B., 1996, Industry as rural landscape—The Fenwick iron mining complex, Craig County, Virginia: Unpublished report on file with the George Washington and Jefferson National Forests, Roanoke, Va., 20 p.

Collins, T.K., and others, 1997, Meeting human needs for food, water, minerals and other basic research—Maslow s hierarchy of human needs and its foundation: USDA Forest Service, General Technical Report SRS-17, p. 202-210.

Harder, E.C., 1909, The iron ores of the Appalachian region in Virginia: U.S. Geological Survey Bulletin 380-E, p. 215-254.

Holden, R.J., 1907, Iron, *in* Watson, T.L., Mineral resources of Virginia: Lynchburg, Va., The Virginia Jamestown Exposition Commission, p. 408.

Lesure, F.G., 1957, Geology of the Clifton Forge iron district, Virginia: Virginia Polytechnic Institute Bulletin 118, 130 p.

Woodward, H.P., 1932, Geology and mineral resources of the Roanoke area, Virginia: Virginia Geological Survey Bulletin 34, p. 103-116.

Wright, Wilna, and others, 1958, Iron and steel, *in* U.S. Geological Survey and U.S. Bureau of Mines, Mineral resources of the Appalachian region: U.S. Geological Survey Professional Paper 580, p. 396-416.

Cover: *Roaring Run iron furnace near Roanoke, Va.*

For more information

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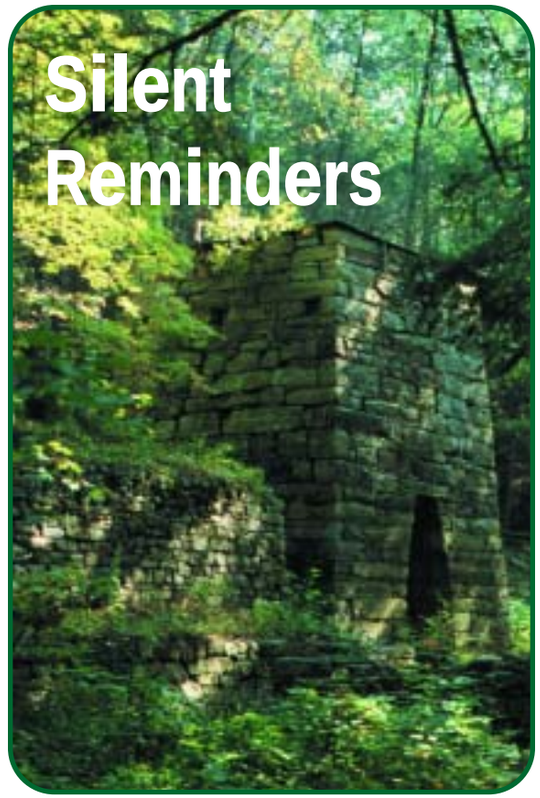

Silent Reminders

Geologic Wonders

of the George Washington and Jefferson National Forests

No. 3 in a Series

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The iron industry played a vital role in the industrialization of the United States and in the development of the U.S. economy and society. Much of the early history of the iron industry took place in Virginia. The remains of 11 iron furnaces and nearby mines in the George Washington and Jefferson National Forests in Virginia and West Virginia (fig. 1) are silent reminders of a time when iron mines and furnaces operated along a belt that extended through the Appalachian Mountains from New York State to Alabama.

Why was iron found and exploited along this belt?

Iron mines and furnaces were operated in the long, northeast-trending belt of the Appalachians because two key ingredients of the iron industry iron ore and limestone (to remove impurities and promote fusing of the metal) are found here. To understand how iron and limestone formed in this long belt, envision the landscape as it appeared between 200 million and 540 million years ago. During that time, much of what is now the United States was covered by a vast, shallow sea (fig. 2). Shells and hard parts of ancient marine animals and plants fell to the bottom of this sea and accumulated to form deposits that later became limestone (calcium carbonate).

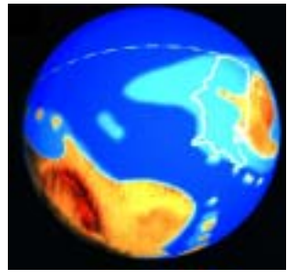

Figure 2. Paleomap showing ancient land masses and the extent of inland seas (light blue) about 480 million years ago. The present-day position of the United States is outlined in white. Based on http://www.scotese.com

Dates of furnace operation

Elizabeth 1836 -1889
Capon 1832 -1880
Van Buren 1837 -1850 s replaced in 1873 abandoned 1884
Catherine 1836 -1885
Mt. Torry 1804 -1892
Glenwood 1849 -1887
Australia 1854 -1863
Roaring Run 1832 -1864
Callie 1873/74 -1884
Raven Cliff 1810 -1883
Catawba 1830 -1865

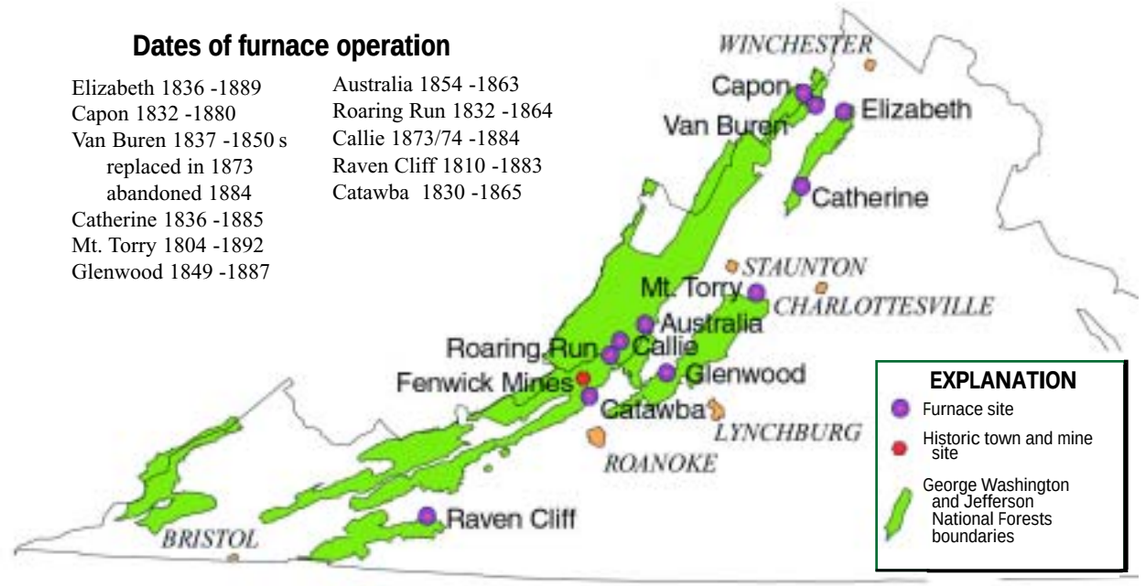

Figure 1. Map of Virginia showing the locations of iron furnaces and the Fenwick Mines company town and iron-mine site.

Iron, dissolved in water from the weathering of crystalline rocks, was carried down rivers to the sea. Most of the iron precipitated, or changed from a dissolved state back into a solid state, directly from seawater or replaced calcium carbonate in shells and grains on the sea floor. This iron was concentrated in elongate zones near and roughly parallel to the fluctuating position of the ancient northeast-trending shoreline. Some iron was deposited in limey oozes, and some in layers of sand or clay. Resulting deposits varied greatly in composition, shape, and size, depending on their original locations in the sea and their subsequent histories

What types of iron ore were found?

Brown ore. Among the first iron deposits to be exploited in the region were brown ores, hydrous iron oxides known as limonite. Brown ore forms when iron-bearing minerals, widespread in sedimentary rocks, slowly dissolve through weathering, and release iron. The iron travels in solution in ground water until it reaches a favorable site, where it is redeposited as a solid, creating concentrations of iron over time. Generally irregular and of small to moderate size, these deposits are numerous, found at shallow depths, and easily mined. Brown ores are minor ores of iron in the Nation but were by far the most important type of iron ore in Virginia. Brown ore was mined near the towns of Fenwick, Lignite, Oriskany, and numerous other sites in Virginia.

Red ore. Most iron deposits that form on the sea floor are dark red because this is the characteristic color of the main iron mineral, hematite (iron oxide). These deposits are generally in limestone or sandstone. Some of the largest iron deposits in the Appalachians consisted of red ore, although in Virginia, red ore was found only at Roaring Run and a few other locations.

Specular ore. Some iron deposits on the western flank of the Blue Ridge Mountains contained an unusual, dark-blue-green ore called specular ore because of its shiny, mirrorlike surfaces; the name is derived from speculum, the Latin word for mirror. The specular ore was in beds of varying thickness interlayered with sandstone and shale. These low-grade ores were mined along the Blue Ridge about 10 to 15 miles northeast of Roanoke.

Why were the iron furnaces abandoned?

During the early to mid-1800 s, most iron furnaces used nearby iron ores and charcoal made from the surrounding forests. Iron was used to make farm machinery, tools, and wagon wheels. During the Civil War, iron was produced to make Confederate cannons and other weapons, but the iron furnace industry declined after the war. Around 1870, coke made from coal began to replace charcoal as the major fuel for iron furnaces in Virginia. This change temporarily revived the industry, but most small furnaces were abandoned before the turn of the century as large, rich iron deposits in the Lake Superior region began production.

Although small iron furnaces eventually failed, large iron ore deposits were discovered in Virginia and mined from open pits and underground mines between 1890 and 1924 (fig. 3). The ore was taken by rail to furnaces at Clifton Forge and Shenandoah. Company towns, like Fenwick Mines (fig. 1), with a population of more than 300, and the nearby town of Lignite, sprang up around these mining operations. Later, when the mines closed, the town buildings were either sold and moved or torn down. Little surface evidence of the towns now remains, but they are important archeological sites in the George Washington and Jefferson National Forests. Former mining sites have been naturally reclaimed, and some form wetlands and ponds. An example can be seen from the Fenwick Ponds nature trail (fig. 4).

Figure 3. Iron mining near Lignite about 1910.

How did minerals save the forests?

From the mid-1800 s to 1910, the use of wood to meet the Nation s growing needs led to the deforestation of millions of acres. When charcoal furnaces were in full operation in the Appalachians, the scene was very different from today. Instead of wooded hillsides, the land was bare because of the enormous number of trees needed to make charcoal. Fuel for an average furnace deforested up to 300 acres annually.

Conservationists raised alarms about a looming wood famine and loss of vast forests. The transistion from wood fuels to mineral fuels (that is, from charcoal to coke) in the iron industry was part of a historic change. Americans switched from wood to minerals for many domestic and industrial needs. Coal replaced wood, not only in iron furnaces, but also as the major fuel for heating and cooking.

Steel and concrete made stronger, safer, and taller buildings, with more housing and office space on less land. This historic shift from the forests to the mines saved the forests.

Figure 4. Ponds and wetlands mark the sites of former open-pit mines at Fenwick Mines.